

# **Sociotechnical Imaginary and Rationality: Political Factuality and Public Authority in Taiwanese Energy Politics**

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## Abstract

After the 2011 Fukushima nuclear disaster, an outcry erupted in Taiwanese society demanding a sustainable energy transition. However, the dominant sociotechnical imagination in postwar Taiwan – developmental high modernism – manifests itself in tacit answers to the questions of what a better society should be, how technical choices should be made to achieve that goal, and what the most pragmatic and viable approach is to make the particular dreamed-of future become reality. Using an approach informed by STS/SSK (sociology of scientific knowledge), this thesis explores the exclusion of alternative energy futures brought about by a high modernist imaginary and looks into its nationalist-high modernist rationality in the forms of shared story-lines, created factuality and routinised technical choices within governmental institutions. High modernism in East Asia is characterised by the authoritarian reflex of planning rationality, which gives paramount political weight to a collectivist and unitary idea of the public good which is crafted through performative technicality in constructing the impartiality and objectivity of public authority. I explore this rationality through two case studies: national planning around power shortage and reserve margins, and the setting of feed-in tariffs for renewable energy. By way of contrast, I then explore a third case study: the development of combined PV energy, agriculture and aquaculture initiatives in Linbian and Jiadong. I suggest that can this give us clues about an alternative, grassroots ‘indigenist-reformist rationality’ imaginary for Taiwan which reassembles and enacts an indigenous identity rooted in attachment to land and locality.

## 摘要

在 2011 年福島核災之後，臺灣社會中掀起了一股要求永續能源轉型的呼聲。然而，在戰後臺灣具有主導優勢地位的社會技術想像—發展型極度現代主義—它透過對「我們該追尋的更好社會為何？如何以技術選擇以達成該目標？而又有何最務實與可行的途徑來讓該夢想的明日世界成為現實？」等問題，提供默會不宣的答案來獲得彰顯。本論文由 STS/SSK (sociology of scientific knowledge) 研究取徑啟發，追問臺灣替代性的能源未來，怎麼在極度現代主義的想像下被排除，並考察那些在政府部門當中的共享故事主軸、創造出的實在與慣常例行化的技術選擇，即以此種種型態所展現的「國族—極度現代主義合理性」。極度現代主義於東亞展現出規劃合理性下映射出的威權特徵，也就是將無上的政治重要性加諸於具有集體主義與單元化色彩的公共利益概念上，它是經由構作公共權威的不偏不倚與客觀性過程中，在技術性問題的展演施為下巧妙出世。由下述兩案例的研究，我試圖探討此合理性：圍繞著缺電議題的國家規劃與備用/轉容量的討論、再生能源躉購費率的制訂過程。與之相較地，我隨後探討第三個案例：在林邊和佳冬地區的結合農業、養殖魚業與太陽光電倡議的發展。我認為此案例可以給予對臺灣來說，替代性、草根，亦即由組裝配與促動一個根源於鄉土與在地依戀的本土認同，為「本土—改良合理性」想像提供一些線索。

## **Declaration**

*I hereby declare that this thesis is my own work, and has not been submitted, either in the same or different form, to this or any other University for a degree.*

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*I sincerely hope this thesis contributes to the understanding of the political culture of democracy and demonstrates that seen reality is not destiny. I am indebted to my two supervisors, Prof Brian Wynne and Dr Bronislaw Szerszynski. Standing on their shoulders, I learned how to wear the lens of hermeneutics to explore the intricacy and richness in the mundane while keeping a heart of curiosity and flexibility. Special thanks go to the Viva Voce examiners, Dr Frauke Urban and Dr David Tyfield, for their constructive suggestions in response to the thesis. My sincerest gratitude goes to my wife Meiyin Lu and my parents, Chunming Yang and Yingsu Tsai. Without their substantial support, both financially and spiritually, the accomplishment of this PhD study would have been impossible. I want to express my appreciation to the friends in Lancaster who accompanied me through the lonely times of writing. Finally, I want to thank Taiwan, the land and the people, for being my guiding beacon in this emergent and contingent world.*

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# 1. Introduction

## Introduction

The Fukushima nuclear disaster caused by the earthquake in March 2011 triggered an outcry in Taiwan appealing for increasing the use of renewable energy in energy generation and the phasing-out of existing nuclear power plants. In response, the Nationalist (Kuomintang/KMT) government initiated the 'Millions Rooftop PVs' and 'Thousands On/Off Shore Wind Farms' programmes, both of which commenced in March 2012. However, four and half years later, when there was a change of government in May 2016, the accumulated installation of photovoltaics and wind power was merely 842MW and 647MW respectively, and renewable energy technologies in total still only accounted for 2.3% of electricity generation in Taiwan. This unsatisfactory state of affairs was the result of a long contention between nuclear power and renewable energy, in which nuclear power was imagined as cheap, reliable and safe while renewables were deemed technologically immature, expensive and not viable. At the same time, the idea of a perennial power shortage had the effect of instilling a deep fear in the public's mind about the overwhelming consequences that power shortage can bring to the nation as a whole.

My research problematics rise from the highly polarised contention over energy debates during the Nationalist administration from 2009 to 2015 when the governmental actors and energy policy community seemingly directed all their attention to ensuring the building and operation of Nuclear Power Plant 4 (NPP4). This implied an overwhelmingly supply-side approach, which came with the imaginary of nuclear energy being an unlimited and highly controllable energy source, and renewable energy as an 'immature' and 'unviable' technology. The key terms used in

this energy agenda and given paramount importance were ‘policy reasonableness’ and ‘technological viability’, both of which seriously constrained the space of debate as a whole to narrowly framed questions such as ‘how to foster an objective and reasonable policy over energy issues’, ‘how to maintain the trajectory of growth while deploying renewables in society’ and ‘how to find a practical and viable solution to avoid the imminent energy crisis’. While these policy agendas and terms are ostensibly reasonable and legitimate, the technopolitics that tacitly enacts meanings and exerts power through repetitive discourse, habituated expertise and institutional practice shows a tendency towards state-organised technocracy and an inclination to deprive Taiwanese civil society of the right to be free from domination and to exercise participation in energy policy. Therefore, my research starts with the probe: How did this particularly dreamed-of energy future become possible, and why has it been able to find an appreciative audience in Taiwanese society? I argue the answer lies in the Taiwan’s particular experience of modernisation and democratisation, which has involved tendencies towards autocracy and technocracy. In the hope of broadening the culture of democracy and deepening the understanding of political life in Taiwanese society, I propose the following three research questions:

- What does science and technology mean in our social and political life, especially in the public sphere, in respect to how public authority is constructed and policy reasoning is conducted? To what extent does the legacy of a state-organised technocracy originating from the postwar era have a prolonged impact on Taiwanese political culture?
- What does liberal-democracy mean in today’s politics, especially when it inevitably involves the issues of technoscientific development, such as the transition of energy system? How can the value of democracy make difference

in this highly complicated and professional process?

- If the impulse of expert politics is to close down the space of public participation rather than opening up new opportunities, then, as an STS researcher, how can I help to make Taiwanese society go further in democratisation?

I hope that through this thesis, which benefits from the concept of sociotechnical imaginary, an insightful new angle on world-making can be articulated – one that rejects linear, simple cause-and-effect relations and the overwhelmingly (human) actor-centred history while, at the same time, maintaining an empirical focus on where the reality-transforming ideas come from, how they acquire the mobilising momentum and how imagination, semiotics, materiality and social order, including the accepted modalities of public authority and their institutionalised regimes, become tightly coupled in practice.

### **The East Asian Developmental State: A Technoscientific Vision for Society**

In this thesis, it is argued that the contrasting images of nuclear power and renewable energy, which dominates the contemporary energy politics of Taiwan starting from the early 2000s, can only be understood through exploring the underlying sociotechnical imaginary of high-modernist developmentalism and its deep roots in the postwar and even pre-war periods. A 'sociotechnical imaginary' is the underlying vision shaping the framework of technoscientific policy and social order in a given society. The concept is used in order to capture a particular gestalt of 'less explicit, less issue-specific, less goal-directed, less politically accountable, and less instrumental' but 'pervasive meanings' around science and technology (Jasanoff and Kim 2009, 123). These

imaginaries are 'collectively held and performed visions of desirable futures (or of resistance against the undesirable) ... animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology'.

East Asian countries such as Taiwan, South Korea, and Japan are deemed to be successful models of postwar developmental states and share similar strategies of development. Industrialisation is the ultimate goal of state and the major approach to building a nationalistic economy; more importantly, in these countries this goal is pursued through the creation of a powerful and extensive bureaucracy and a centralised government (Cumings 1999). The clear aspiration to use science and technology to forge a new planned social order underlies the foundation of high modernism in many nation states during the 20<sup>th</sup> Century, as argued by James Scott (1998). High modernism is defined as 'a strong, one might even say muscle-bound, version of the self-confidence about scientific and technical progress, the expansion of production, the growing satisfaction of human needs, the mastery of nature (including human nature), and, above all, the rational design of social order commensurate with the scientific understanding of natural laws' (Scott 1998, 4). A nationalist form of high modernism is the dominant social and political imaginary in postwar East Asian countries, involving the belief that the modernisation of industry and the deployment of technoscience will ensure the expansion of the national economy and, therefore, the autonomy of the nation (Kim 2015). In the nationalist modernists' eyes, industrial, scientific, and technological developments would not only rebuild the nation's economy after the destruction brought by wars but also restore the nation's significance on the world stage (Chu 2011).

Although the aspiration to be a 'developmental Leviathan' is still clearly relevant among today's public debates, political rhetorics and more generally, the envisioned future of the national community, I do not claim that the sociotechnical imaginary in Taiwan is homogeneous or deny that high-modernist developmentalism is confronted by other challenging imaginaries; indeed, an alternative imaginary can definitely be observed. This modest imaginary can basically be conceptualised as a native, land-oriented modernism as well as a cultural and political reformism (Hsiau 2013), both of which can be traced back to civil movements in the Japanese colonial era. Additionally, with the ongoing tide of democratisation in Taiwan since the late 1980s, the face of high modernism changed; however, I believe that the dream of a developmental Leviathan, although scattered, remains pervasive as a latent and common cultural and political resource.

### **Structure of the Thesis**

In chapter 2, I start with the theoretical literature which informs my discussion of sociotechnical imaginaries and technopolitics in-the-making, and then, in chapter 3, I outline the methodological issues raised by studying the aspirational expressions, meanings and politics that are coproduced (Jasanoff 2004) in the development of technoscience, and how I dealt with them in this research. Science and technology, as the indispensable playground of modernity, are often seen as purely instrumental, objective and politically neutral. However, this way of thinking can be revealed as oversimplified, misleading and even teleological if we cast a critical eye on the diverging technological trajectories found around the world and the distinctive criteria of objectivity performed in one polity or another. Therefore, there is an urgent need to go beyond the surface of the strategy for science and technology policy deployed by actors, and ask how we can reveal the underlying visions of technoscience and social

order that shape the actors' very considerations, reasoning, and aspirations (Jasanoff and Kim 2009). It is such reasoning that lies behind my choice of an approach that focuses on *social meaning-making* rather than a more conventional *interests-based rationalist interpretation* of science and technology.

Chapter 3 covers the methodological framework. Table 1 provides a schematic view of the overall conceptual framework of the thesis, and the way my methodological choices relate to this.

<p>Overall theoretical framework</p>	<p><i>Sociotechnical imaginaries:</i> This concept is used to capture the 'less explicit, less issue-specific, less goal-directed, less politically accountable, and less instrumental' but 'pervasive meanings' involved in policy processes (Jasanoff and Kim 2009, 123). They are imbued with implicit meanings about what is sensible, what is relevant and what is desirable and good in the world. Such imaginaries 'encode not only visions of what is attainable through science and technology but also of how life ought, or ought not, to be lived; in this respect, they express a society's shared understandings of good and evil' (Jasanoff 2015, 4).</p>
<p>Methodological framework</p>	<p><i>Technopolitics in-the-making:</i> Sociotechnical imaginaries can be explicitly imagined as a 'desirable' future, and yet at the same time implicitly imposed in the making-and-doing of materiality or material semiotics. Technology is not, itself, technopolitics; rather, the practice of using technologies in political processes or toward public authority constitutes technopolitics. The phrase "in-the-making" is used to draw attention to how (and in what forms) a reality emerges and is considered as factual and legitimate —</p>

	<p>the making of normativity and rationality.</p> <p><i>Interpretive Analysis:</i></p> <p>Human beings are interpreting and meaning-making animals, and meanings are not static nor merely about facts. The action of practice is seen as a continuous struggle for meaning, blending imagination and materials into shape; therefore, framing the outlines of inception matters. In this sense, social processes are about the articulation of different collective public meanings. Studying the making of meaning includes attending closely to the practices actors do as they construct working accounts of problems. This is not to validate the authenticity of a claim or assume the consistency of social meaning. Two aspects should be highlighted: Linguistic components, and the effect of making difference and accumulation.</p>
	<p>The constitutive elements of <i>technopolitics</i> are a set of taken-for-granted habitual practices, identities, relationships, assumptions and beliefs — the less obvious, more subtle and routinized practices, presumptions and commitments.</p> <p><i>Archival research:</i></p> <p>Extensive documents are especially used to develop an analysis of the technical terms, frameworks, concepts, equations and concerns which are devised by engineers and experts, and used in public reasoning and governmental deliberation. An emphasis is put on the conventions and routines in their technical forms.</p> <p><i>Semi-structured interviews:</i></p> <p>Interviews are used as an effort to document ‘the process of generation of the assertions of interests and facts’ and to further thicken the analysis rather than simply as a way to validate and acquire verifiable information. The process of articulating interests and facts have their own performativity.</p>

	<p><i>Field observation:</i></p> <p>Field trips were made in order to provide observation of the installation sites and surrounding environment, to enhance the description on how a different sociotechnical imaginary, both in its cultural and material terms, is enacted.</p>
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Table 1 — a schematic view of the overall conceptual framework

In chapter 4, I explore the significant historical context of a particularly imagined modernity in postwar Taiwan: nationalist high modernism. High modernism is not only the means but also the end of a great social engineering, which summons support from a series of elites – bureaucratic intelligentsia, engineers, high-level administrators, and governmental planners – who all march under its banner. These expert bureaucrats are the **republican engineers** who share the belief in **pragmatism and pragmatic engineering**. For them, **depoliticised** economic construction and planning (經濟建設) is the only way to save the whole nation from upheaval and demise. This depoliticised economic planning is highly compatible with the inclination of an authoritarian government as well. The conciliation of authority and technicality is brought to reality through the hard work of these engineers. In the second half of the chapter, I turn to the nine-year long debate on the Renewable Energy Development Act (REDA), which exemplifies the complexity of energy politics and the contrasting images of different energy technologies as they have emerged in contemporary Taiwan. While nationalist high modernism can be seen as a manifest form of sociotechnical imaginary in the postwar era and its legacy is still evidently powerful in Taiwanese society, such imaginaries are neither static nor have a clear boundary. A schematic review of the literature on the three domains is presented – industrial policy; the professionalism of engineers groups; and forms of democratic movement – all of which provide aspects of the changing but enduring legacy of nationalist high-modernism.

Chapter 5 is the first empirical case of the thesis and focuses on how powering the nation with nuclear energy was presented in policy discourse as the only reasonable and viable answer to the national predicament through a particular framing of the idea of power shortage. The focus of democratic debates about energy politics moved from the open question of what a desirable common future might be to a particular narrow framing of the problem. A singular, overwhelmingly supply-side focused approach, largely based on the sociotechnical imaginary of an unlimited and highly controllable energy source — nuclear energy — was tacitly inserted into the policy agenda and regarded by the Nationalist government at the time as the only feasible way of solving what was seen as an imminent power shortage. This ‘difficult situation’ is in an extent settled down after a series of actions of the anti-nuclear movement and the following mothball of Nuclear Power Plant 4 in 2015. Although the Democratic Progressive Party (DPP) government which came in power in 2016 holds a quite different direction in the energy policy, **the technically formed agenda** of power shortage, the **demonstrated public authority via public witness** and the institutional puzzles that follow from this are still to be explained and largely have not changed: the tacitly attempted institutional knowledge–expertise in **electricity planning routines** still has its normative meaning and political strength.

In chapter 6, I start with a review of the embedded relation between the modern administrative state, representation in liberal-democratic politics, and expertise in order to explain why technoscientific knowledge and expertise is constitutive of modern democratic representative government. Scientific-legal rationality is **the statecraft of creating a ‘factual reality’** which in effect co-produces a combined technical and socio-political reality for people and institutions, and at the same time

expresses the need for representation in politics. Concentrating on the detailed arrangements of the Feed-in-Tariffs (FITs) committee in deciding on a 'reasonable tariff', I explore the way that **technoscientific knowledge-based technical deliberation**, with tacitly enacted roles and boundaries, seriously constrains the possible forms and meanings of renewable energy and the notions of public interests emerging from the process. The deliberation process reflects an incessant intention to purify the decision made by the committee and to eliminate the remaining discretion of the experts from wider visibility, which results in an overwhelming preference for **mathematical moderation** — the '**best interest**' is translated into the '**reasonableness**' of the FITs largely built on the choice of taking the average or median value of alternative FITs calculations.

Chapter 7 represents a turning point of the analysis whereby a brief conceptualisation of a 'native soil' and reform-oriented imaginary which derives from Taiwan's colonial past and resistance history is introduced as an alternative vision for the potentiality of technoscience in Taiwan, one in which the focus is **shifted from the controllability and predictability to the flexibility and responsiveness of a technology**. It can be understood as a continual trend of pursuing Taiwanisation (indigenisation) and the attachment to 'the native land'. The contemporary roots of this indigenised imaginary can be found in the calls for cultural and political reform pitched by young intellectuals in the 1970s. As an alternative to the 'great Chinese modernism', this imaginary pledges to go 'back-to-reality' and to forge a Taiwanese consciousness. Bearing **this crossover of locality and modernity** in mind, I explore the possibility of enacting an alternative sociotechnical imaginary which attributes technologies to **the values of resistance and resilience grounded in locality**. A local history of Linbian (林邊) and Jiadong (佳冬) is provided to situate the cases of the programme of CWGE (Cultivating

Water and Generating Electricity 養水種電), the floating PV system and the PV greenhouse, all of them documented in detail and used to exemplify that **the responsiveness of these ethno-epistemic assemblages** are best to be understood as endless actions and reactions among human actors, local materiality and the environment.

In chapter 8, I start by summarising the dominant story told in the previous chapters: the unceasing attempts in depoliticising the role of scientific knowledge in policy-making, presenting the public good as unitary and singular, and establishing public authority by excluding the articulation of different collective public meanings, all of which are observed in an otherwise ostensible liberal-democracy. I then suggest that, based on the cases studied, the way to facilitate the democratic role of technoscience in contemporary energy politics may be to take seriously the different ontologies and nonhuman actors observable in the public sphere — and that this is consistent with an imaginary that recognises the performative aspect of technoscience and the broader and legitimate concerns among the people. I hope along this imaginative way in understanding the fabrication of the world, we can start to understand ourselves as meaningful agents within an emergent world, and that transforming an authoritative-technoscientific regime into **an indigenous-responsive democracy** requires foregrounding non-human agency, interpreting multiple ontologies and opening the closed space of expertise politics.

*A developmental Leviathan*, as obscure as it may be, still hovers over the institutionalised conventions and habituated expertise of Taiwanese society. With the new wave of civil movements surging from the late 2000s, and the milestones of the 2014 Sunflower Movement, the NPP4 (Nuclear Power Plant 4) being mothballed in

2015, and the new initiatives supporting renewable energy usage and installation (Chiu 2014, Yang 2015), how can I, as an STS researcher, help Taiwanese society go further by scrutinising the admixture of the rationality of developmental planning, expertise and technopolitics?

## 2. 'Desired' Future — Imaginations, Technopolitics and Rationalities in the Pursuit of Modernity

### Introduction

When we review the literature on the science and technology policy and the postwar history of Taiwan, one clear common trope emerges— how can we catch up with Western countries? How can we develop further in economy, industry and society? The desire for development associated with a latecomer identity is the concept essentially constituting the underlying knowledge interests in Taiwanese academia across the humanities, social sciences and especially technology studies (Chen 2015). As elaborated further in chapter 4, 'the will to develop' can be said to summarise the predominant imaginary in the postwar period. Economic planning and development, and administrating national interest through pragmatic engineering are conceived as the cornerstone of nation building.

As suggested by Chu (2011), nationalist modernism's stress on 'general utility' and 'national strength' underlays this strong will to develop. It is mostly aroused by the feeling of threat from foreign forces and a perception of backwardness. This phenomenon is certainly not limited to Taiwan; for example, in postcolonial South Korea, science and technology are almost exclusively understood in terms of their role in rapid industrialisation and technological autonomy (Kim 2015). In this context, aspirational ideas such as 'being developmental', 'being progressive' and 'being better in the future' provide the common language among factions in the political universe and divergent social groups in society; such language provides the indispensable

premise for broad social negotiation and collective meaning-making in postwar Taiwan. For this reason, there is an urgent need to go beyond the surface of the strategy deployed by actors in technoscientific policies, and ask how we can reveal the underlying visions of technoscience and social order that shape the very considerations, reasoning, and actions of the actors involved.

In this chapter, I attend to the theoretical literature which informs my discussion on sociotechnical imaginaries and technopolitics in-the-making in the scene of searching for modernity, and outline the methodological issues raised by studying the aspirational expressions, meanings and politics coproduced in the development of science and technology. On the one hand, the conventional theory of modernisation attributes this great social transformation to the coming of rationality and technicality all around the globe, implying a linear and homogeneous development of society involving the massive institutionalisation of science and technology and rapid industrialisation (Smith 1983, Ichijo 2013, Scott 1998, Eisenstadt 2000b). Rationalisation and individualism are seen as the fundamental driving forces behind this global movement of conformity. On the other hand, the concept of imaginary is firmly established in interpretive social theory as a term referring to a set of common passions about what formations within a society can emerge and what is (or not) desirable. There is a gulf between these two strands of the conceptualisation of modernity — one is rational and technical, another is imaginative and even affective.

As I will show in the following sections, the rationalist approach is only maintained by a continuing denial of its emotional roots and by actively cultivating its lack of interests (Wynne 1982, 2010, Latour 1993). Science and technology, as the indispensable playground of modernity, in this regard, are seen as purely instrumental, objective and

politically neutral. However, this way of thinking is over-simplified, misleading and even teleological as we cast a critical eye on the diverging technological trajectories found around the world and the distinctive criteria of objectivity performed in one polity or another. In an alternative approach which is supported and backed up by a wide literature (Wynne 1996a, 1982, 2010, Wynne and Dressel 2001, Jasanoff 1996, 2004, 2005, 2015, Hecht 1998, Porter 1995, Winner 1980, Eisenstadt 2000b, Ichijo 2013, Scott 1998, Welsh and Wynne 2013) , the role that science and technology play in modernisation and politics is far from being depoliticised, disinterested, and purely objectified; on the contrary, science and technology are done both materially and culturally.

Science and technology constitute together a collective, aspirational and political project with hidden commitments, which shape the making of identities, institutions and discourses. The term 'sociotechnical imaginary' is employed here to describe the dreamscapes of modernity underlying different techno-national formations (Downey and Han 2014); such imaginaries 'encode not only visions of what is attainable through science and technology but also of how life ought, or ought not, to be lived; in this respect, they express a society's shared understandings of good and evil' (Jasanoff 2015, 4).

### **Sociotechnical System**

Reintroducing the often forgotten social complexity and richness to the accounts of the making of materials and the operation of technological systems has always been the pivotal aim of the field of Science and Technology Studies (STS). The complexity of a large technological system is captured in Thomas P. Hughes's inspirational analysis. Hughes' classic discussion about large technological systems indicates that

technological systems include messy, complex, problem-solving components. These components are not only physical artefacts like transformers, substations and power lines but also social organizations and arrangements such as banks, managers and development strategies, research programmes and national legislations (Hughes 1987, 1979, 1993). These components are constructed and adapted in order to function in systems; they will go through a process to force diversity and inconsistency towards unity, becoming interlinked with each other in whatever economic, political and technical, scientific ways and indissolubly to pursue the common system goal (Hughes 1987). The search for a common system goal should be regarded as 'problem-solving' (Hughes 1987). The problems here are those that 'stand in the way of the smooth working or extension of the system' (Law 1987, 112).

John Law argues that the 'goal' of a sociotechnical system mentioned above might be the extension and stability of a system, but it is also 'a purely contingent matter and can be determined only by empirical means' (Law 1987, 113). To be short, there is no single design of a system from the start; the image of the final system only becomes visible after it is all built. The system builders, when they act, never know what the final picture of the system being built will look like. Only after everything settles down can the trajectory be dug out and unpacked (Law 1987).

Socio-technological networks such as power systems are culturally constructed artefacts (Hughes 1987), assembled selectively from the material, physical, symbolic and intellectual resources of a society. They are made in different societies and contain some basic essentials such as technical and relational components, but the variations among them often show how political, economic and social arrangements vary from one society to another. In the example of the styles of power systems given by Hughes,

the layouts of power systems in the UK, the US and Germany reflect their own local characteristics respectively. In this sense, the variations of a technological system among different periods and spaces indicate the diverging social, political and economic practices at different times and places, and each of them constitutes 'a seamless web'.

### **Science and Technology in Multiple Modernities**

The idea of 'historical contingency' is the rationale often used to explain why there are clear distinctions among otherwise similar sociotechnical systems around the globe; however, as flexible as it is, the notion does not meet the explanatory need to elucidate the differences of reactions when national states respond to a 'globalised' technological catastrophe like Chernobyl and Fukushima, nor when a variety of formations of an emerging technology take shape in different regions, as is the case with the technology of genetic modification in East Asia, the US and Europe. Perhaps what the 'contingency' explanation lacks most is the ability to point out the projected and normative meanings smuggled within the name of scientific rationality in a modern political regime and the imaginative and aspirational elements enmeshed in technoscientific development projects conducted by national states when seeking a prosperous future.

That little has been done to analyse the link between the aspiration to modernity and the political and cultural enforcement of science and technology has been acknowledged by some literature (Feenberg 2010, Jasanoff 2015, Welsh and Wynne 2013). STS has focused its attention on the making and stabilization of collectives in materially interwoven practices, and has paid relatively less attention to the aspirational and normative dimensions of governmental-administrative governance

(Jasanoff 2015). This is especially true of the affective, hermeneutic, and collective aspects of the imaginaries in and of science and technology (Welsh and Wynne 2013).

Filling these gaps provides a chance to address some questions which are otherwise left unaddressed by the concept of contingency: why are technological trajectories split into different directions among different states, political regimes, and geographic regions; what makes some sociotechnical structures more durable than others and become established regimes; and what roles do science and technology play in forging the collective identities and sharing values in society?

Sociologists working on 'multiple modernities' have made a great effort to expand the definition of modernity; conventional modernity theory relies heavily on the notion of rationalisation to explain the distinctiveness of modern societies. Rationalisation refers to 'the generalisation of technical rationality as a cultural form' (Feenberg 2010, 129-130), which applies to a whole society. Registering calculation and certainty in daily life, modernity brings efficiency in its means – and sometimes makes it part of its ends. In contrast to traditional life, modern societies embrace technical manipulation and, therefore, reduce their normative and qualitative richness and diversity. Attempts have been made since the 19<sup>th</sup> Century to identify the single most important social change in the arrival of modern society. Drawing on the legacy of Enlightenment, conventional modernisation theorists all touch on similar arguments: social change is seen as invoked by human endeavours rather than divine forces. The affirmation of human agency is an undeniable feature of modernity and modernisation (Ichijo 2013).

However, the conventional view of modernity also entails an uncritical Eurocentric vision, if it is unconscious and implicit: all societies would naturally evolve from

primitive society, which is undifferentiated and homogeneous, to industrial and modern democratic society, which is symbolised by European societies, and this is driven by the linear and universal development of science and technology. As Shmuel Eisenstein put it, classical theorists of modernisation:

*all assumed, even if only implicitly, that the cultural program of modernity as it developed in modern Europe and the basic institutional constellations that emerged there would ultimately take over in all modernizing societies; with the expansion of modernity, they would prevail throughout the world (Eisenstadt 2000b, 1).*

It is fair to say that the theory of 'multiple modernities' is developed out of a deep sense of frustration that 'conventional theories of modernisation have failed to explain the diversity of modern societies found across the globe' (Ichijo 2013, 27-28). In contrast to the above, the theory of multiple modernities acknowledges human's agency but rebuts the idea that societies and their cultural-political institutions all over the world are bound to converge to the same model. As Eisenstadt argued, modernity should be understood as 'a story of continual constitution and reconstitution of a multiplicity of cultural programs' (Eisenstadt 2000b, 2). In short, the theory of multiple modernities considers modernisation as follows:

1. It involves struggles in every aspect of life, including not only technical and material issues but also normative consideration among various actors over the question of what a 'better' society should be. It is not a set of clearly demarcated development stages of a progressive-linear process;

2. It highlights human agency in interpreting as well as intervening in the surrounding environment rather than assuming a particular pattern of institutional development. It involves the capability of being imaginative and being able to have, if not necessarily develop proactively, the vision of a better world;
3. Modernity is seen as taking multiple and heterogeneous forms, which reflect the fact that human agency can draw from a variety of raw materials, including cultural, religious, and civilizational heritages, the availability of which is specific to the locality. Modernity can only appear in plural forms, never in the singular;
4. Multiplicity and heterogeneity of modernity are not confined to the inter-societal context. They can naturally also be observed within one societal setting; it is inevitable that there are conflictive, even, contradictory ideas (Ichijo 2013).

Modernity is a mindset but not a mindset in an individual. Since the essential feature of modernity is the ability to be imaginative and the ceaseless contestation over what a better society is, who we are as collectives, and what their prioritised actions are, modernisation is, first and foremost, a collective and political project. Because the meaning of being modern is subject to interpretation and re-interpretation, it is messy, potentially conflictive and fragile. However, despite this heterogeneity, how to modernise has still been seen by many as 'the' most salient problem to confront.

### **Science and Technology as a Playground of the Imaginations of Modernity**

That the two most salient forces of modernity are science and technology is seen as implying the institutional development of a similar pattern across societies; this

assumption is hardly scrutinized on most occasions. In its most conventional sense, this proposition means that science and technology play the role of the locomotive of industrialisation and the driving force of the statecraft of a modern economy. To see modernisation as a form of rationalisation is the dominant view from the 1950s to 1980s (Ichijo 2013, Scott 1998) and perhaps can be best exemplified by Anthony Smith's term 'scientific state'.

The scientific state is a state whose authority and legitimacy are dependent on its ability to harness science and technology for the good of the group of people identified as a nation. In addition, it is characterised by centralising and homogenising drives, focusing on efficiency and a marked interventionist tendency (Smith 1983). Whereas this over-simplified read of modernisation has been problematised by the theory of multiple modernities, it does show the aspiration to order the natural and social worlds with the power of science and technology. Furthermore, the strong faith in what science and technology can achieve in forging a new planned social order underlies the foundation of high modernism, as argued by James Scott (1998: 4), it is conceived as 'a strong, one might even say muscle-bound, version of the self-confidence about scientific and technical progress, the expansion of production, the growing satisfaction of human needs, the mastery of nature (including human nature), and, above all, the rational design of social order commensurate with the scientific understanding of natural laws'. This unspoken but salient commitment in the imagination to a close relationship among science, technology, and statecraft in modernisation<sup>1</sup> will be the

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<sup>1</sup> Science and technology is definitely not the only theme can be explored in modernisation, nor 'the' cause of modernisation. For example, in Liah Greenfeld's (1992) view, what led to the birth of nationalism, this particular style of thought, was the desire for dignity felt by the elite who found it difficult to achieve it in the old order. Nationalism— which allowed the new English aristocrats without genealogy to obtain what they craved: status, self-respect and pride— is now the factor to which modernisation is trying to respond.

main tune for this thesis.

So what is the imagination of modernity? Taylor (2004) explains in *Modern Social Imaginaries*: '[b]y social imaginary, I mean something much broader and deeper than the intellectual schemes that people may entertain when they think about reality in a disengaged mode. I am thinking, rather, of the ways people imagine their social existence, how they fit together with others, how things go on between them and their fellows, the expectations that are normally met, and the deeper normative notions and images that underlie these expectations' (Taylor 2004, 23). This negotiation between social members on what the things are 'ought to be' and how things 'fit together' resonates with the idea of *Imagined Communities* proposed by Benedict Anderson earlier. In his account, the rise of nationalism is the product of mutually imagined subjects. Several technological devices such as radio, railways and national newspapers, maps and censuses, made it possible for a large number of people to participate in the simultaneous act of imagining a nation, a community of fraternity, and being confident that everyone, including total strangers over a vast space, was involved in the same act (Anderson 1991). Obviously, the imagination of modernity does not purely build on the technical and rationalist consideration of efficiency or certainty; it includes a society's presumptions, values, and beliefs in practices which are constitutive of the very configuration of social order. It is about describing the facts but also the legitimate and normative ways of ordering lives into realities.

The insights provided by STS scholar Sheila Jasanoff can be used to support this proposition. The idiom of the 'co-production' of nature, science and society spells out this intricacy:

*Briefly stated, co- production is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it. Knowledge and its material embodiments are at once products of social work and constitutive of forms of social life; society cannot function without knowledge any more than knowledge can exist without appropriate social supports. Scientific knowledge, in particular, is not a transcendent mirror of reality. It both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments, and institutions— in short, in all the building blocks of what we term the social.*

*Science, in the co-productionist framework, is understood as neither a simple reflection of the truth about nature nor an epiphenomenon of social and political interests. Rather, co-production is symmetrical in that it calls attention to the social dimensions of cognitive commitments and understandings, while at the same time underscoring the epistemic and material correlates of social formations (Jasanoff 2004, 2-3).*

Science and technology, therefore, needs to be understood through both material and hermeneutic terms; to borrow Max Weber's seminal term, *Verstehen* — understanding how subjectively things fit together and what the 'elective affinity' between things is.

### **Scientific Knowledge in its Socio-political Ordering Formations**

This thesis embraces the historical indeterminacy of science and society and opposes the view of science and technology as the representation of technical rationality and merely a platform of rationalisation. To follow the imaginative resources interwoven

by social actors in the making of technoscientific artefacts and institutions, especially under the gaze of state and within governmental-administration projects, I choose the concept of 'sociotechnical' over 'technoscientific' to designate my elaboration of the generative proliferation of science-technology-society relations. For this purpose, the politics of science and technology needs to be highlighted.

Do artefacts have politics? Langdon Winner asked this question in his classic work exploring the political properties of technologies. He pointed out two ways that technologies can have politics. First, the material arrangement in a sociotechnical system can be designed in a way that produces a set of consequences where scientific knowledge, technological innovation, and corporate profit reinforce each other in deeply entrenched patterns. The design goes far beyond the decision of 'yes or no' — a series of choices on the specific features of the system need to be made throughout deployment. These technological details can have profound social and political implications. In this sense, technologies can be ways of building public order in our world, structuring different possibilities and constraints. In this respect, deliberately or inadvertently, technological features 'establish a framework for public order that will endure over many generations' (Winner 1980, 128).

Second, by contrast, a large modern socio-technological system is often said to 'require' or 'demand' some forms of human association. However, the key question here is 'what steps, if any, are practically necessary in the workings of particular kinds of technology and what, if any, such measures require of structures of human association' (Winner 1980, 132). The measures justified in the response to the 'practical necessities' required by the operation of the technological system are what we need especially to examine. The flexibility of choice is closed once the justification is successfully made;

those who cannot accept the hard requirements will be denounced as dreamers or fools (Winner 1980). The already-made technical decisions have their power of coercion.

STS historians have worked firmly to remind us that what appear to be matters-of-fact are in fact matters-of-social-concern and social order. Although Shapin and Schaffer (1985) did not use the term 'imagination' in their classic interpretation of the dispute between Robert Boyle and Thomas Hobbes in Restoration England, this is at its heart a story of competing, coproduced imaginations of natural and social orders. Boyle and Hobbes, Shapin and Schaffer argued, were fighting over a symmetrical problem: how to establish the truth and how to achieve authority in a time of immense epistemic as well as political crisis. Their study of the controversy suggests that what was at stake in that revolutionary period was not simply the legitimacy of the scientific experiment, although Boyle the scientist and Hobbes the political philosopher conflicted in their views of whether seeing an experiment could be a valid basis for believing its findings. In these two men's quarrels, we can say, was the emergence of a public sphere in which authority would depend on experimentally verifiable facts and truths, observable in principle by everyone, rather than on declarations from an inaccessible central authority such as the monarch (Shapin and Schaffer 1985, Jasanoff 2015).

The rise of experimental science — which practice depends on transparency, a common language for speaking about the matters of fact, and a public witness which does not necessarily happen in the room where the experiment is held— simultaneously laid an important foundation for the political movement toward modern democracy, the division of the public and private spheres, and the quest for scientific professionalism (Jasanoff 2015). Scientific experiments, in this sense, are

important performative occasions, requiring carefully orchestrated meetings of minds and eyes to build consensus around what was being shown and seen, and thus what is real.

This pioneering thought has been picked up and taken further by Yaron Ezrahi. In his *Descent of Icarus*, Ezrahi (1990) made a significant suggestion that the concepts brought by experimental science were eventually enrolled in the modern liberal-democratic polity. The instrumentalism and accountability of political action, as well as the discretion and autonomy of individuals, are at the central stage of this liberal-democratic theatre (Ezrahi 1990). Clearly influenced by the Enlightenment thinkers like Immanuel Kant and philosophers such as John Stuart Mill, Karl Popper and John Dewey, Ezrahi argues that 'the idea of objective public knowledge was a central element in this new modern model of a polity, the product of a new genre of the political imagination in which order rests on the capacity of discrete individuals to reach consensus or generate working majorities' (Ezrahi 2004, 264). Democratization entails in effect the conversion of the 'celebratory' eye of the passive subject into the 'attestive' gaze of the modern citizens who are able to question and evaluate the factual assertions of those in power (Ezrahi 1990).

Science and technology play an explicit role in the modern political project, which reconciles the internal tension between state coercion, political order and the freedom of individuals. Democratic individuals now work as active subjects, reviewing and casting their sceptical eye on the fact and information presented by the authority, rather than as passive objects consuming the state's display of authority (Ezrahi 2004). The democratic state requires continual work to prove itself to witnessing citizens. This ongoing demand for accountability and factuality can most easily be met through

public demonstrations of power and efficacy, leading to increasingly instrumental uses of technology. The Leviathan in a liberal democracy, according to Ezrahi, is objectified/depoliticised/observable scientific knowledge.

In his latest book *Imagined Democracies*, Ezrahi focuses more centrally on the feature of performativity, and the necessary dualism embedded in the imaginary framework of modern democracy. Again, legitimacy comes from individuals— ‘the presumed continual gaze of the public as the quasi-sovereign that unknowingly composes the very public reality...plays such a vast role as a resource of democratic politics’ (Ezrahi 2012, 105). However, in order for this to work, it requires ‘an imaginary of the world as a naturalized, universally accessible factual reality constituting a neutral referent for the various discourses on truth as well as non-arbitrary political action’ (Ezrahi 2012, 106). Science has obviously played a major role in the emergence and development of this modern common sense imaginary of reality as a resource of democratic political world making. Common-sense realism as a form of scientism, therefore, has come to rest on a form of epistemological literalism, a cluster of orientations and practices that relates to the world as a domain of plain public facts (Ezrahi 2012). The dualism of facts and fictions is an expedient strategy for a democratic polity to concretise and legitimise the particular imaginaries of political causality and agency when exerting power.

Certainly, this trend is also enhanced by the massive deployment of instrumental bureaucratic administration— ‘expert authorities could be widely deployed and justified in modern democracies because of the belief in the existence of an objective, universally accessible, public reality as a stable coordinator of the orientations and actions of a multitude of autonomous individual agents. Public acceptance of this view of reality appeared to make it a “solvent” that would render decisions in matters of

public affairs neutral, transparent, rational, impersonal and potentially consensual' (Ezrahi 2012, 133). However, his account of the inherent affinity among the rationalisation of politics, the moral consciousness of democracy, and science-backed public knowledge comes at the expense of singularity, and path dependency, which will be further explained in the following sections.

### **Virtue of Democracy? Rationality of Objectivity and Accountability**

The preference for objectivity in the public domain has wide support in a liberal-democratic polity. Government tends to distinguish between arbitrary and non-arbitrary forms of action, conceiving actions as observable social events and presenting political actions as public and impersonal rather than private and subjective (Ezrahi 1990). The use of experts and scientific knowledge has the intended outcome of depoliticizing political power and rationalizing governmental actions in meeting the concerns over accountability and legitimation. As Turner (2003b) suggests, the core role of experts in a democracy is to resolve the dispute over impartiality. Scientific knowledge grants experts the status of neutral authority and reaffirms this authority by establishing regulations on the findings of science or scientific consensus. Expertise is a 'fact surrogate', which is something taken as a fact for the purposes of political discussion. The idea is that political action should only deal with rational factors which can be represented by experts with reference to a partly knowable world of facts.

In this context, political instrumentalism implies that political actions are, first and foremost, *transparent and ingenuous rather than utilitarian*. Corresponding with objectivity in political representation, political instrumentalism suggests a commitment that public actions be deliberate, that their agents be free. This is the integral strategy to externalise and objectify political actions in the space of witness of

public facts. This also defines politics as a realm of plain observable facts which is accessible to all citizens as spectators (Ezrahi 1990). In short, scientific-legal rationality is the statecraft of creating a 'factual reality'.

Mechanical objectivity and quantitative expertise in the making of public decisions – that is, extracting knowledge by following strict rules – is a development well known to historians and social science scholars (Daston 1992, Bordo 1987). This point has been advanced further by Theodore Porter. In *Trust in Numbers* he explains that the pursuit of objectivity in the public sphere 'is not undermined by the democratic call for accountability, but defined by it' (Porter 1995, 90). Rigorous quantification is demanded in these contexts because subjective discretion has become suspect. Mechanical objectivity serves as an alternative to personal trust (Porter 1995). The preference for mechanical objectivity and its affinity to state administration can be well exemplified by the U.S. Army engineers and the prevalence of cost-benefit analysis in American technocracy. Making decisions by numbers is just a matter of engineers 'doing what comes naturally', the consequence of a marriage of technical knowledge and political power. Sometimes, the debate on impartiality in the name of public interest can reduce expert analysis to firm rules, but strictly following rules does not mean making a decision on a purely mechanical basis (Porter 1995). The tension between disciplinary objectivity (expert judgement) and absolute objectivity (mechanical objectivity) can at times be apparent, since mechanical objectivity can never be purely mechanical (Porter 1995).

Unlike the universal appropriation of objectification and impersonality of public affairs suggested by Ezrahi, Porter directs our attention to the relation between professions—academic scientists and social scientists—and bureaucratic officials. Their appreciation

for expertise and experts reflects their relationship to a wider social context. To understand the circumstances under which numerical objectivity and quantitative methods have come into demand, we need to look not only at the epistemological formation in experts but more importantly at the social basis of this particular form of authority. For Porter, the belief in objectivity associated with the rule of law in a political democracy is the *result* of a consistent distrust in bureaucracy and existed political structure especially when bureaucratic actors are highly vulnerable to outsiders, rather than the *cause* of it. The political culture of objectivity is more likely to arise at a time of turbulence and controversy, not a time of universal appeal for the rationalisation of political arrangement. In order to resist continuous temptation of teleology observed in the literature, this should be highlighted through the rest of this thesis.

According to Porter, trust in quantitative facts is, indeed, the result of a combination of social imaginary and political stratagem. First, quantification in economics and engineering did emerge in history with an aspirational imaginary and a practical reasoning, in that it was aimed at social reform, in order to improve the lives of workers— it was assumed that quantification could aid administration through the measurement of productivity of machines, animals, and men, could guide the improving activities of engineers and reformers. Efficiency could never be ignored in this regard (Porter 1995, 54-60).

Second, quantification is a political technology whose objectification emphasizes the neutrality of self-elimination, and transparency and disinterestedness marks the political manoeuvres necessary when actors are weak but have to appear to be strong. This is particularly true in 19<sup>th</sup> Century England and France, when a society of strangers

had come to the surface and the actors of no significant ascribed privilege fought for more freedom and less state intervention. For them, the knowledge of numerical facts was also a decidedly liberal science. Nonetheless, this comes at the expense of simplification and the loss of richness of an issue, but again, this superficiality is called, with some justification, openness, and it was designed to drive out corruption, prejudice, and the arbitrary power of elites (Porter 1995, 78-86).

Third, that three distinguishing modalities of the campaign of objectivity can be found respectively in Victorian Britain, Republican France, and the utilitarian 20<sup>th</sup> Century America shows the diverging pathways of making public knowledge and securing the basis of political authority.

In Britain, the fight for objectivity was caught up with the notion of social class, given that there is a high mutual trust in the British Oxbridge administrative elites and the government was sufficiently cohesive to rely more on people than on impersonal knowledge. It thus was able to depend only minimally on formal expertise. Here the trust in administrative elites could go further in the form that 'leaders already know what is best for society' – in other words, a paternalistic and even authoritarian relation between the elites and the masses. Likewise, actors wielding numbers, such as the British actuaries in the insurance industry, actually preferred gentlemanly professionalism over a rigid standardised protocol. Figures require professional consensus in order for them to work (Porter 1995, 89-113).

In France, the reliance on numbers could be found in an interaction between quantitative methods and administrative-bureaucratic routines. French state engineers — enjoying the privilege of exercising judgment over issues of public

importance and their relation with the national state — used a set of economic quantifications to justify the state's role in constructing roads, canals, and railways. Public utility or benefit — the utility for the whole nation — was a standard term in French political culture which surely was not confined to state engineers. Public or general interest cannot be compromised with mere financial success. More importantly, transforming the legal and moral term 'public utility' into a quantitative one might provide the state engineers some protection against the agonies of day-to-day politics. The French technocracy to which state engineers belong benefits from a unique social-political trust: it is a personal trust in action experience, but also an impersonal trust in official positions and bureaucrats' managerial skills (Porter 1995, 114-147).

If trust in the upper-class elite is the feature of British political culture, American political culture goes in quite the opposite way— impersonal objectivity is a distinctive feature of American science and American culture. It could be called 'institutionalised mistrust' as suggested by Brian Wynne, 'the adversary division of powers between legislature, administration, and judiciary system in the US Constitution'. The pursuit of a universal form of cost-benefit analysis in economic quantification grew up in the 20<sup>th</sup> Century America as an attempt to create a basis for mutual accommodation in a context of suspicion and disagreement. Cost-benefit methods were introduced to promote procedural regularity and to give public evidence of fairness in the selection of public projects when the U.S. Army engineers were challenged by such powerful interests as utility and railway companies. But even more importantly it is the intensive bureaucratic conflict between the U.S. Army Corps and other government agencies, especially the Department of Agriculture and the Bureau of Reclamation that contributed to the essential development of this quantitative rationality. More and

more intangible benefits were made tangible; the uniformity of cost-benefit methods was also gradually achieved in the context of departments' competition. In short, the transformation of cost-benefit analysis into a universal standard of rationality backed up by thousands of pages of rules cannot be attributed to the megalomania of experts, but rather to bureaucratic conflict in a context of overwhelming public distrust (Porter 1995, 148-189).

Diverting from the archetype of a rationalised democracy and the scientific-accountable structure for a modern liberal-democratic polity implied by Ezrahi, Porter pointed out that the key question for STS research should not be what 'the' rationality constructing the basis of the emergence of a democracy is, but instead 'in what way' scientific knowledge helps to build a valid and durable authority. This construction is done with largely implicit commitments and through the state performing objectivity, accountability, and transparency in front of the public. Positivist instrumental rationality is not the only entity that can be found in the politics of science. Scientific knowledge plays a complex role in modernisation, and therefore, the need to examine sociotechnical imaginaries and their enmeshed meanings is even more pressing.

### **Bring Back Social Imaginaries and the Meanings**

Technological artefact, scientific knowledge and technical objectivity are inherently political, we can argue. Nevertheless, this proposition does not address the big question: why, even in a time of globalisation, do different moralities and responses attach to new scientific ideas and technological inventions throughout the world, and why do differences persist in, what we might call, the innate characteristics of the political order of science and technology among national states and cultural circles all around the globe?

Given that divergent meanings and ontologies exist even in a 'modernised and globalised' world (Verran 2002) and have been rather downplayed in STS, and even anthropological work has tended to emphasise the epistemic dimensions of cultural difference relating to technoscientific initiatives (Overing 1990, Welsh and Wynne 2013) , social imaginaries and their enmeshed meanings, commitments and beliefs need to be put centre stage. As I argued above, they are about existing realities but also the legitimate, moral and normative ways of ordering lives into realities — they are symmetrical concerns which emerge from the continuous collective negotiation of shared meanings by people, the meanings of what the realities *now are* and how the realities *in the future ought to be*.

Scientific knowledge has its cultural/hermeneutic features in modern society, which seriously constrains the imagination of new forms of order and of how their social legitimation may be better founded (Wynne 1996a). This suggests an analytical approach focused on social meaning-making rather than the conventional interests-based rationalist interpretation of science involved social action (Flyvbjerg 2001). In focusing on the unspoken cultural dimension of science and technology in policy-making, the aim is therefore to reveal the less obvious, more subtle and routinized practices, presumptions and commitments embedded as constitutive components in institutions and local cultures — they are a set of taken-for-granted habitual practices, identities, relationships, assumptions and beliefs (Wynne and Dressel 2001). The investigation of the case of BSE and science-policy cultures in the European Union, Britain and Germany has indicated that the key differences can be found in the cultural framing of public policy in the form of what counts as 'actionable evidence'. Characteristic forms of public reasoning, epistemic commitment in academic and

intellectual circles, and habituated regulatory action could exist in different polities even when facing the pressure of homogenization brought by international trade (Wynne and Dressel 2001).

Hecht (1998) looks into the history of nuclear power development in postwar France and argues that the investigation on the people who designed, built, worked in and wrote about the technology is essential for understanding how specific technological choices, program development, and political involvement have been made. 'The artifacts elaborated...can be best understood as hybrids of technology and politics' (Hecht 1998, 5) and the people who engaged in it should be seen as active participants in the construction of a French technological identity. The imagined identities in play provide a site for actors to engage in how things should happen and also explains why things happened in that way.

For unpacking the interweaving correlation of technologies and political power, the tool of analysis applied here needs to be both material and cultural. 'Opening the black boxes of culture and technology simultaneously can give us insight into how technologies constitute a terrain for transforming, enacting, or protesting power relations within the social fabric...[which include] constitution, assertion, and exertion of power through material and discursive practices' (Hecht 1998, 10). What is the rationality that is being enacted in the choices being made in technological practices and artefacts? What are the material formations that they insist they are the only ones qualified to make? The relationship between technological choices and cultural preferences need to be problematised because the language of technical rationality and professionalism serves as a key tool for excluding alternative futures and can cover raw power.

The justification for the choices that engineers and planners relates to the concept of *technopolitics in-the-making*. Technopolitics must be understood as a struggle of defining who the actors in play are and how they believe the system should work, both in technical and social-cultural terms.

When discussing the divergence of technological national formations, the traits of cultural and epistemological characteristics need to be conceptualised; Jasanoff suggested the use of the term *civic epistemology*. Her study on biotechnology and its national trajectories and politics in the European Union, Britain, Germany and United States demonstrates that the patterns of interaction among life science, state power, and civil engagement follow distinctive paths. 'Science and technology continue to play diverse legitimating functions in the world's newer democracies, corresponding to differences in the nature and status of expertise and in cultural expectations about evidence and proof in the public sphere' (Jasanoff 2015, 13).

### **Unacknowledged Normative Commitment in Science Informed Policy-making**

The paramount characteristic of scientific knowledge in policy-making is its ostensible ability to establish facts and factual descriptions from the chaotic and ambiguous mundanity and its indispensable power of creating social-political order in an instrumental way. However this argument has been proven over-simplified and even naïve in the discussion above, not only because the criteria of factuality and the institutional culture that this impartialness builds upon differentiate from institution to institution, from polity to polity, but also because scientific knowledge in public reasoning does have its unspoken commitments and beliefs. These commitments and embedded meanings are practised in scientific-public reasoning tacitly without any

acknowledgement, although with large political implications.

The arguably dominant tradition in social science, rational individualism, assumes that people hold clear and stable social values and goals, and participate in politics in order to fulfil them. Political process is the ways in which priorities are reconciled or decided. From this perspective, as illustrated by Ezrahi, rational individualism is the fundamental element of modern democracy. The dichotomy of fact and fiction is the imagination *necessary even inevitable* for a democratic government. Science produces knowledge that informs public rational and voluntary choices. Nonetheless, this is the tradition I oppose.

In an alternative tradition, which I argue for in common with Wynne (Wynne 1982, 2010, 1996a, b, 2011) social actors' values and goals are held to be typically vague, ambiguous, conflicting, unstable and open to negotiation. Political performance and discourse, including technical assessment, bureaucratic planning, and scientific experiment report, can guide people tacitly in certain ways, influencing what is regarded as an accepted value, what is viable, indispensable and desirable, or at least tolerable. Scientific knowledge in this sense is not only politically instrumental — irrelevant to meaning-making and being impartial — but also generative in conveying normative meanings and creating moral judgements; it is a political practice that generates a particular form of understanding of effectiveness, objectivity, and trustworthiness.

Policy elites designate science as a crucial source of authority in ways which stretch out scientific and technical domains to include wider social and normative commitments. That science is commissioned as a source of public authority does generate

contestation and confusion in society as the normative commitments built into references to science are presented as if these involved no normative choices, only the findings and declaratory authority of science (Welsh and Wynne 2013). In short, culturally normative agendas are not just extraneous to science and its institutional practices but can also be constitutive of them. The following are the several methods in which science reaffirms its tacit commitment:

1. Scientific knowledge proceeds by exogenizing some significant uncertainties which thus become invisible to it; the built-in ignorance of science towards its own limiting commitments and assumptions is exacerbated when external commitments are built on it as if such intrinsic limitations did not exist. The conventional view is that scientific knowledge and methods enthusiastically embrace uncertainties and exhaustively pursue them, but this is seriously misleading (Wynne 1992b);
2. Scientific knowledge often imposes a prescribed social relationship between experts and lay people in the process of science-informed policy-making. What may have begun life as hypothetical assumptions about social worlds (for example, whether nuclear reactor maintenance and operating personnel will always follow the rules rigorously or not) become increasingly prescriptive 'demands' to be ordered into existence so as to confirm the expert analysis (Wynne 1996a);
3. In recent decades, science has been actively associated with the regime of the economics of technoscientific promise—the creation of a fiction in order to attract resources: financial, human, and political. According to these promises, emerging technologies (for example, biotechnology, and nanotechnology) 'will solve human problems' through a wide range of

applications. The credibility of this innovative conception of technoscience is linked to 'naturalisation' of technological advance, which is seen as almost a self-fulfilling prophecy (Felt and Wynne 2007);

4. Science does actively imagine publics. Recently, science has been increasingly seen as a pivotal platform for securing competitive commercial innovation and creating public authority. An increasingly aggressive state intervention, driven by the anxious pursuit of technoscientific-commercial competitiveness, has created a new modality of science-public relation. Three modalities can be identified in terms of the changing relations of science, commercial interests and state imposed technoscientific commitments in the U.K.: in the 50s to 80s the public was conceptualised as a passively compliant, awe-struck non-entity; in the 90s, the deficit model was firmly in place, which attributes public refusal of technological change to deep-rooted ignorance or misunderstanding of science and policy; in the 2000s and onwards, public obstruction of technoscience, identified as commercial innovation, is likely to be labelled as anti-science and as a state security threat. This creates the extension of surveillance-control over publics (Welsh and Wynne 2013, Wynne 2007, Welsh 2007).

The study of the science-policy ramification has suggested that the normalisation of treating science as the instrument of discretion for public authorities and the ultimate source of legitimation has seriously narrowed *public meanings* to be equivalent to *scientific meaning*. The refusal of science to accommodate meanings and concerns other than those over which it feels it can exercise control demonstrates the deeply entrenched problem of an undemocratic and institutional tendency of state-organised

technocracy.<sup>2</sup> It allows technoscientific institutions to believe that they alone have authority, not just over correct public knowledge but, more importantly, that they are the adjudicators of correct and righteous public and policy meanings (Welsh and Wynne 2013).

Moreover, Wynne (2007) called our attention to the distinction between *invited* and *uninvited* public participation found in this tendency. The former constrains the agenda in the technical debates hosted by experts whereas the latter allows the agenda to be extended to challenging the normative social commitments projected and performed by science; more importantly, both of them contains an imagined role which public should play. To sum up, science imagines what the public should be and then acts accordingly. In this regard, examining what the imagined public is and how this public is enacted through the practices of science in state governance is an important objective of this thesis.

### **Sociotechnical Imaginaries and Technopolitics In-the-making**

As the above has shown, the notion of a monolithic modernisation driven by technoscientific rationality, the prototype of a liberal-democracy rigidly informed by scientific knowledge, and the notion that any variation in sociotechnical systems is purely a matter of contingency, all fail to capture the intricacy of the cultural-political dimension of science and the co-production of science and state governance. Moreover, these uncritical views ignore the embedded power and knowledge relation over which the dominant imaginary exerts its deterministic power, forging the limited

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<sup>2</sup> In the U.K. recently, public dissents from established scientific policy have increasingly been identified by authorities as continuous threats to security, in the global competitive struggle for the international economic market. Thus, publics are imagined as ignorantly vulnerable to media or to NGO exaggeration of risks, and consequently liable to obstruct the vital science-led innovation for economic survival (Welsh and Wynne 2013).

space of reasoning and seeing.

The state has much more resources than civil society to mount a massive representation in database, experiment reports, planning programmes, maps and statistics to create public facts, rendering civil society less able to put up any valid resistance. 'Other ways of seeing and reasoning — ways that would make injustice palpable — may not enter anyone's imagination, even in democratic societies, and hence, may never give rise to organized criticism or opposition, let alone to revolutions that could hold power accountable' (Jasanoff 2015, 14). Unlike the implied inevitability of transparency and democratic governance by Ezrahi, I argue, being observable and transparent alone does not guarantee democracy. Transparency, factuality and accountability may be necessary conditions for democracy, but are not by themselves sufficient conditions.

For this purpose, in this thesis I refuse to take on board the taken-for-granted which treats individualism, rationalism and the institutionalisation and legitimisation of science in society as if these were the only single reasonable way of explaining the technological trajectory and direction of society. Consequently, I decided to employ the notion of *sociotechnical imaginary* to help analyse the scientifically and culturally conditioned perceptions of reality and the mutual emergence of scientific-legal factuality and social order (Jasanoff 2004). Jasanoff and Sang-Hyun Kim use 'sociotechnical imaginaries' to capture these 'less explicit, less issue-specific, less goal-directed, less politically accountable, and less instrumental' but 'pervasive meanings' (Jasanoff and Kim 2009, 123). They are the imbued and implicit meanings about what is sensible, what is relevant and what is desirable and good in a social world.

In *Dreamscapes of Modernity: Sociotechnical imaginaries and the Fabrication of Power* Jasanoff and Kim extend this concept to accommodate a broader, diversified and materialised aspect of this collectively enacted vision. Sociotechnical imaginaries bring together the normativity of the imagination with materiality. They are:

*'Collectively held and performed visions of desirable futures (or of resistance against the undesirable) ... animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology. Unlike mere ideas and fashions, sociotechnical imaginaries are collective, durable, and capable of being performed; yet they are also temporally situated and culturally particular. Moreover, as captured by the adjective "sociotechnical", these imaginaries are at once products of and instruments of the coproduction of science, technology, and society in modernity'* (Jasanoff 2015, 19).

One aspect that is worth stressing is that this definition gives privilege to the concept of being 'desirable', because the efforts to build new sociotechnical futures are typically based on positive visions of social progress. Of course, this positive theme is always connecting to themes of fear, harm and failure, from which it cannot totally be separated. This point will be further elaborated in the chapter 4 when discussing high modernism.

These imaginaries are not limited to nation-states but can also be articulated and circulated by particular organized groups, such as corporations, social movements, and professional groups (Jasanoff 2015). This resonates with the idiom of multiple modernities as the aspiration of modernity by no means is a homogeneous inclination

within a society; it diverges even within a society. Though collectively held, sociotechnical imaginaries can originate in the visions of single individuals or small collectives, gaining momentum and approval through the overt exercises of power or actions of coalition building. Only when this pioneer's vision comes to be generally accepted by the members of society or a group, it rises to the status of an imaginary. It often falls to governmental policy, legislations, the media, or other institutions of power to lift some imagined futures above others, granting them a dominant position for policy purposes (Jasanoff 2015).

As mentioned before, the vital question for STS research may not be what the rationality working in the institutionalisation of science is but 'in what form' the implicit commitment and imaginary is embedded and enacted in state governance in the push for modernity. The approach of 'in-the-making' is highlighted in this thesis in response to this particular concern. The justification for the choices of technological necessity made by visionary actors does matter. This is what I call the concept of '*technopolitics in-the-making*' (Callon 1987).

Technopolitics must be understood as a continuous struggle to define who the actors in play are and how the system should work, both in technical and social-cultural terms. This can consist of the creation, assertion, and exertion of power through material and discursive practices. In the same way, sociotechnical imaginaries, as argued by Jasanoff and Kim, are 'associated with active exercises of state power, such as the selection of development priorities, the allocation of funds, the investment in material infrastructures, and the acceptance or suppression of political dissent' (Jasanoff and Kim 2009, 123). In other words, sociotechnical imaginaries can be collectively imagined as a 'desirable' future, and yet implicitly imposed in the making-and-doing of

technopolitics at the same time.

More clearly, I am interested in how visionary actors define their political niches in public reasoning, bureaucratic planning, and policy-making, and how they enact policy choices in technical practices and artifacts, how committee expert members establish their 'impartial' stand and assert agency in 'protecting and promoting' the public good, and how, if possible, local communities find an alternative vision invoked by grassroots concerns. In order to fully answer these questions, the further thoughts over methodological issues are provided in the next chapter.

# **3. Methodology — Technopolitics in-the-Making and Interpretative Analysis**

## **Introduction**

Sociotechnical imaginary certainly provided a powerful explanation for the direction of technological development and the design of the state-implemented scientific projects; however, it does not, by itself, constitute the means through which it shapes the decision made every day. In order to understand the mutually shaping relation between the sociotechnical imaginary and technoscientific making and doing, there is a need to conceptualise a set of methodological tools to operationalise the above-discussed theoretical framework. The analytical approach I am proposing needs to answer the following questions: How can we argue that the seeking of a ‘better’ modernity exists? How can we confidently identify a sociotechnical imaginary and argue that it is not mere political rhetorics, institutional ideology, or arbitrary policy preference? How can we be so sure that implicit values, commitments and technological materials and processes are mutually shaping each other at the same time? These questions will be justified and answered through the whole thesis but, here, some outline answers can be devised. In this chapter I address the practical questions arising from operationalising the concept of sociotechnical imaginary in the field: what methods and sources are most appropriate for identifying these formations and their constitutive elements?

## **Technopolitics In-the-Making**

As we are reminded by Wynne, the culturally situated, less obvious, more subtle and

routinized practices in institutions and the presumed values and commitments embroiled in public policy reasoning are, indeed, the indispensable vehicle for sustaining the particular relationships, identities and assumptions upon which a sociotechnical imaginary lives— an imaginary is neither abstract nor purely material.

As mentioned before, the vital question for STS research may not be what the rationality working in the institutionalisation of science is but ‘in what form’ the implicit commitment and imaginary is embedded and enacted. As I argued previously, technopolitics is politics not only by in the articulating and proposing of statements but in the making and doing of material artifacts. The process of enacting materiality-based performance grants the engineers an exceptional authority and influence which conventional politicians do not have. In short, only the notion of technopolitics in-the-making can help us to underpin this normative-cultural-material admixture of *politics and science*.

Similarly, technology is not, itself, technopolitics; rather, the practice of using technologies in political processes or toward public authority constitutes technopolitics. Technologies cannot be reduced to politics. For example, in deciding between the methods of calculating electricity margin, engineers are not open to unlimited options but only have a few. Therefore, the effectiveness (and constraints) of these technologies as objects designed to accomplish specific material purposes (for example, calculating the electricity margins of the grid and evaluating the possibility of power cuts) matters.

By focusing on dynamics and immobility in the process of making, the classical division of agency and structure is broken and mixed as I am treating ‘in-the-making’ as a

generative process. This has been termed 'emergence' as an ontological reality. Asking what is in-the-making, this thesis is curious about how a reality emerges and is considered as factual and legitimate — the making of normativity and rationality. The best method for researching this understanding of the emergent feature of reality is interpretive analysis.

### **Interpretive Analysis**

Human beings are interpreting and meaning-making animals, and meanings are not static nor merely about facts. Social institutions and governmental policy are expressive and instrumental at the same time. Institutional practices, here, should be considered not only as planned instruments to achieve a clearly articulated goal, but as emergent phenomena 'whose reproduction is incomplete, provisional, and unstable, and which co-evolve with a range of other complex emergent phenomena' (Jessop 2001, 1230). The action of practice is seen as a continuous struggle for meaning, blending imagination and materials into shape; therefore, framing the outlines of inception matters. To this end, the sociotechnical imaginary is thought to be best operationalised as a framework prescribing alternative futures, linking past and future times, and enabling or restricting actions in space — naturalising the ways of thinking about alternative futures (Jasanoff 2015).

Imaginations are, by their operational conditions, collective or group-held framings (Hecht 1998), not individual fantasy or inception. This point is also well illustrated by Welsh and Wynne, 'social movements work to identify new *collective stakes* [emphasis added by author] through iterative engagement with both their immediate object of concern and associated social, cultural and political actors. ... These social processes are thus about the articulation of different collective public meanings, which are

chronically in tension with singular collective reductions, such as invocations of the (singular) public interest' (Welsh and Wynne 2013, 559). Resources such as images, diagrams, text, memories, quantitative equations, technical rules, metaphors, repetition, discourses and other language elements are especially crucial in describing and tracing how an imaginary framework accumulates and comes into reality. In the next sections I will describe important forms of data this study often refers to.

### *Linguistic Components: Policy, Documents and Story-lines*

Language and linguistic components of public reasoning have their importance in this thesis. The language of the powerful, especially the languages of state, government, and the words in policy documents, are vital to the interpretative analysis; governmental discourses on public issues and agenda setting offer one commonly recognized starting point. Policy documents, in this regard, should be collected and extracted for the major role of framing the acceptable rationality and trustworthiness or exemplifying what a desirable future – and conversely an abhorred time – looks like. Also, policy language can be mined for specific verbal tropes and analogies that help identify the elements of the imaginary.

Sociotechnical imaginaries are not exclusively the property of state actors. National sociotechnical imaginaries may permeate into popular culture, finding expression in the mass media and in nonofficial genres such as advertising or the popular writings of prominent individuals; linguistic components should be held as context-situated practice, that is to say, language can only be understood in affiliation with other social practices. As Wittgenstein said, 'linguistic utterances cannot usefully be understood outside the practices in which they are uttered' (cited in Hajer (2006, 70).

Studying the making of policy language includes attending closely to the practices actors do as they construct working accounts of problems. This is not to validate the authenticity of a claim but to disclose the production process of partiality, 'the selective framing of the issues at hand, their elegance or crudeness of presentation, their political timeliness, their symbolic significance' (Fischer and Forester 1993, 2). Policy framing traditionally refers to the process through which people seek to reach conclusions through formal reasoning, but it definitely does not exclude more informal media such as advertisements, propaganda, readers' letters, blogging and even spoof images. It focuses on the ways that people — including opponents — reach and justify mutually acceptable decisions (Fischer and Gottweis 2012), though as, Wynne put it, it is often less acceptance than acquiescence, in that people simply think further resistance is futile.

Here, I am asking how visionary actors with authority shape the public imagination by telling crafted stories in their statements, and how they blend their expectations into science and technology programmes. The analysis of policy frameworks will lead us to reveal how policy language can be tuned for specific types of technopolitical order. I therefore employ the analytical method of identifying 'story-lines' to explore how an imaginary is orchestrated through hermeneutic relevance. According to Hajer, a story-line is 'a generative sort of narrative' used by actors to give meanings to material and social phenomena; people perceive 'facts' through stories. Story-lines 'suggest unity in the bewildering variety of separate discursive components of a problem' (Hajer 1995, 55) and are the condensed statements in which metaphors are deployed to summarise complex narratives. They are used by people as 'shorthand' in discussions. People do not merely refer to a problem with a fixed identity, but they are continually making the definition of the problem about which they are talking (Hajer 2006). Communication

is in fact based on interpretive annotation, not on comprehensive or coherent understanding, which is why the 'right-sounding' story-lines are so important in public reasoning.

### Making Difference and Accumulation

Let's ask again, how can we confidently identify a sociotechnical imaginary and argue that it is not mere political rhetorics, institutional ideology, or arbitrary policy preference? I think the answer to this question lies in *differences*. Welsh and Wynne (2013, 558) has argued, the *uninvited public existed* because 'different emergent imaginaries of society and different emergent imaginaries of science and reason are brought to life in the networked social movement'. Similarly, I argue, sociotechnical imaginaries *exist* because they can be imagined and enacted *differently* from the current dominant vision.

'Whatever resists trials is real' (Latour 1988). Resistance means making a difference. The imaginaries that do not make a difference do not matter or the fact no difference been made is the direct result of a dominant imaginary. A notable way of making a difference is by shape-shifting materially, but it is, at the same time, the way of making meaning implicitly. Shape-shifting takes place through practices, the practices that change patterns in materialization. The patterns in materialisation include routinised repetitive practices and established material arrangements; they are done and re-done culturally (Law 2008). For the third empirical case, an observation of an installation site is needed. The main purpose of this observation is to provide, as anthropologist Clifford Geertz put it, a 'thick description' of a *different sociotechnical imaginary*, both in its cultural and material terms. In other words, imaginaries accumulate, piece by piece, bit by bit, through the trivial arrangements in daily routines.

This is the essential way of giving these cumulative practices identifiable contours and of revealing the implicit meanings which attach to rituals and refrains (Singleton and Law 2013). Imaginaries are alive in ‘the minute by minute, day to day social life of individuals as they interact together, as they develop understandings and meanings, as they engage in joint action and respond to each other as they adapt to situations, and as they encounter and move to resolve problems that arise through their circumstances’ (Woods 1996, 37).

### **The Cases: Power Shortage, FITs Committee and Local Installations**

The three cases I choose to study present the three strands of the contemporary energy politics in Taiwan and they are interconnected in the sense that the dominant imaginary not only results in a clear preference for nuclear power in policy circles, but also relies on an implicit imaginary comparing nuclear power and its possible ‘replacement’: ‘immature’ and ‘unviable’ forms of renewable energy. After collecting the initial data mainly based on news reports, press releases and policy documents which were issued after the 2011 Fukushima nuclear disaster, I drew a conceptual map of the main forms of argumentation and knowledge mobilised in energy debates in the public sphere. From this emerged two groups of issues which repeatedly manifested in the data, each of which had respective episodes and agendas. However, due to the limited time and resources, I decided my focus should be especially put on exploring the relation among policy story-lines, institutionalised rationality and technical routines.

The first case —power shortage—is chosen because of the overriding agenda of the fear over power shortage observed in the initial data. The fear of an immediate power

shortage is the game-changing agenda, prohibiting further discussion and curbing the consideration of alternatives. In other words, 'power shortage' is the determinant argument which has the force to set an overriding agenda over other competing discourse. Power insufficiency, in this sense, is perceived to be the most exceptional nightmare of modern life and the primary formidable barrier to the development of industry and thus society. Electricity serves as the precondition for strong industrial productivity and collective prosperity. This case is used to explain how technoscientific knowledge constructs public authority, creates social order, and enacts sociotechnical imaginary tacitly; I focus not just on the rhetoric of policy makers but also the routinised practices that occur when engineers conduct developmental planning. It also shows that sociotechnical imaginary as a form of cultural asset does require a process of tacit accumulation: conventions and routines are often performed unconsciously or, at least, inadvertently.

The second case —the FITs committee—is selected to represent another obvious trope observed in energy debates at the time, illustrating the key patterns of legitimation and the key contents of presumption that were clearly noticeable in energy-related policy-making in Taiwan. Renewable energy was presented on the one hand as a technology that can generate social inequality and have a huge negative impact on people's livelihood, but on the other as a technology that can lead Taiwan to global market dominance and solve the problem of energy autonomy. The answer to this remarkable dilemma, however, is surprisingly simple — finding the 'reasonable' Feed-In Tariffs to tame this beast, the 'out-of-control' renewable energy installation, and devising an 'impartial' way to allocate this massive state subsidy. This technical deliberation of FITs done by the experts (meritocrats) and commissioned by the Ministry of Economic Affairs provides a great opportunity for analysing the relation

among the modern administrative state, representation in liberal-democratic politics, and expertise. This case also attempts to answer what the people look like when they are enlisted to authorising the state to safeguard and facilitate the public good.

The third case—local installations of renewables—is selected with the aim to provide a meaningful comparison to the previous two and based on the best available STS literature on local renewable energy installations in Taiwan at that time. If the problem of developmental technocracy lies in the often-presumed technical rationality which eradicates the multiplexity of social meaning(s) and concerns, I suggest that one important way to confront this monolithic and dominant sociotechnical imaginary is to revive those deleted meanings and ask how things could be done differently. Thus, this case is to show the public good is never singular and unitary; their multiple embodiments should be articulated in the democratic engagement of society. With the exploration of the customised installation designs in Linbian and Jiadong which response to articulated local concerns and needs, I hope to show that an imaginary which is based on a rich human-material-environment relationship and engaged in a broad civil participation is possible.

As I have argued in the previous chapter, scientific knowledge is a cultural and material enterprise which can seriously constrain the imagination of possible new forms of social order. In focusing on the unspoken cultural dimension of science and technology, the analytical aim here is therefore to reveal the less obvious, more subtle and routinized practices, presumptions and commitments embedded as constitutive components in institutions and local cultures — they are a set of taken-for-granted habitual practices, identities, relationships, assumptions and beliefs — the constitutive elements of *technopolitics*.

I rely on empirical materials derived from *archives* such as media reports, press releases, public disclosure information and policy communication documents. Extensive documents are especially used to develop an analysis of the technical terms, frameworks, concepts, equations and concerns which are devised by engineers and experts, and used in public reasoning and governmental deliberation. An emphasis is put on the conventions and routines in their technical forms. On the other hand, *semi-structured interviews* are used as an effort to document the process of generation of the assertions of interests and facts (Hajer 2006) and to further thicken the analysis rather than as a way to validate and acquire verifiable information. The assertions of interests and facts have their own performativity, even during a limited social interaction such as an interview. Trips were also made in order to provide *field observations* on the installation sites and the surrounding environments, to describe how a different sociotechnical imaginary, both in its cultural and material terms, is enacted.

The following Table 2 shows the details of interviews conducted by this study and Table 3 gives a quick view on the data used in each case.

1.	L1	Taipower worker	In a café	19/01/2016
2.	D2	Retired Taipower worker	Written interview	25/01/2016
3.	W8	Taipower worker	In a café	28/01/2016
4.	P1	Taipower Worker, Power development office	Written interview	28/01/2016
5.	L2	Committee expert member	In the interviewee's office	07/03/2016
6.	Q1	Committee expert member	In the interviewee's office	11/03/2016
7.	L3	NGO worker	In a café	11/03/2016
8.	Y1	ITRI staff	Exhibition site	14/10/2016
9.	L4	Commercial association worker	Exhibition site	14/10/2016
10.	K1	NGO worker	In the interviewee's office	20/10/2016
11.	C1	Energy social enterprise worker	In the interviewee's office	27/10/2016
12.	H1	Director of the promotion office of green energy (Shao-Kang Ho)	In the interviewee's office	07/04/2017
13.	C2	Director of SunnyRich company (Kuei-Kong Cheng)	On the two sites of PV greenhouses	05/12/2017

Table 2 — the interviews carried out for the research

Case	Interview	Main Sources
Power Shortage	L1, D2, W8, P1	<p>News: Liberty Times, Central News Agency, Apple Daily, PNN</p> <p>Taipower: <i>Sustainable Development Report</i>, <i>Taipower's Power Development Plan (10302)</i>, <i>TAIPOWER</i> magazine, <i>2015 Long-Term Power Development Plan</i>, <i>Industrial Sector Power Rationing and Planned Power Disconnection</i>, Public disclosure information section on the website, press releases.</p> <p>The MOEA: <i>Official Q&amp;A on Nuclear Issues</i>, <i>Electricity: Reliability and Stability</i>, <i>Measures to Power Rationing during the Power Shortage Period</i>, <i>New Energy Deal and Carbon Reduction Action Plan</i>, <i>National Long-Term Electricity Demand Forecast and Power Development Plan</i>, <i>The Assessment Report on the Possibility of Zero Electricity Demand Growth</i>, press releases.</p> <p>Legislative Yuan: <i>The Relevant Document of Legislative Motion (2010)</i>.</p> <p>Control Yuan: <i>The Report on the Controversy over Reserve Margin</i>.</p> <p>Other internet sources: Cool-Loud, E-Info, GCAA.</p>
FITs Committee	L2, Q1, L3, Y1, L4, K1, C1	<p>Legislative Yuan: <i>Renewable Energy Development Act</i>, <i>Legislative Issue Document N.887</i>.</p> <p>Council for Economic Planning and Development: <i>The Statement of CEPD in the fifth FITs Deliberation</i>.</p> <p>Control Yuan: <i>The Report on the Controversy over PVs Wholesale Prices and Management</i></p> <p>The Bureau of Energy: <i>Energy Monthly</i> magazine, <i>The Agenda Document of FITs Deliberation</i>, <i>the Archives of the Minutes of the Administrative Hearing from 2009 to 2014</i>, <i>the Archives of the Minutes of the Deliberation from 2009 to 2014</i>, press releases.</p>
Local Installations	H1, C2	<p>Morakot Post-disaster Reconstruction Council: <i>50 Days of Miracle</i>.</p> <p>National Archives Administration: <i>The Archives of Disasters - Typhoon Morakot</i>.</p> <p>Pingtung County Government: the policy documents of <i>Cultivating Water and Generating Electricity Reconstruction Plan</i>.</p> <p>Other resources: the Renewable Energy Policy Forum at the Legislative Yuan, documentary's interview transcripts, two field trips made on 31/03/2015 and 05/12/2017.</p>

Table 3—a summary of the data used in each case

### **Reflection on the Fieldwork**

When collecting the data, I did encounter some difficulties. The first difficulty was the complexity of the technical knowledge and definitions involved in the technical questions I aimed to analyse. While published definitions seem to present a plain and clear explanation of how terms are used, they do not give much explanation of why they came to be defined in that particular way. Before conducting my interviews I used extensive documents to equip me to the best of my ability with a common language which I could share and communicate with the interviewees, most of whom are experts of applied sciences such as engineering. However, the results from interviewing the engineers of Taipower were quite limited; replies to my questions were often little more than the reiteration of the published definitions. Therefore, I started to target retired members of staff as my candidate interviewees, and also to use personal contacts to find other potential interviewees in Taipower. Written interviews were conducted in some cases, at the interviewee's request. The results of interviews led me to revise my initial ideas about the Taipower Company: different departments do have different opinions about specific issues, although they also shared similar concerns, such as over anonymity and political sensitivity, since having an interview with an 'outsider' is seen as 'politically dangerous'.

Another difficulty came from interviewees' challenges to me. On one occasion, I was repeatedly asked the question, "what do *you* think?" I was probed by my interviewee repetitively, with the intention of finding out my own position regarding the issues discussed. After reflecting on this particular episode, I came to consider interviews as an effort to document 'the process of generation and stabilisation' of the 'assertions of interests and facts', an essential way of thickening the analysis, rather than as a way to acquire verifiable information. Certainly the assertions of interests and facts have

their own performativity, even during a limited social interaction such as an interview; furthermore, interviewees follow the imagined roles and identities that are being attributed to them by institutions and researchers. Furthermore, these roles and identities are not static; in this way, an interview is not designed to seek 'the answer to the researcher's question'; instead it is an occasion for both the interviewee and researcher to engage in 'Wittgensteinian play (Wittgenstein 1997)' and bring up whatever they deem relevant and significant in the session. Indeed, interviewees can sometimes take the opportunity of jumping out of the assigned official role and taking a totally different position when answering a question. In order to facilitate this dynamic, interviews should be semi-structured with minimum interference so as to preserve the flexibility of going beyond the defined agenda; however, from the researcher's point of view, the skills involved in time-control and the manoeuvring of communication can be demanding.

One person I talked to did not want to be recorded, or even be listed as having participated in the research officially, even after we had a dialogue for more than an hour. The reasons for rejection can be categorised as: 1. a presumed lack of expertise to speak on the topics discussed; and 2. a lack of representative authority. The claim of lacking expertise was surprising and problematic, since the person was an acting member of the FITs committee; however, they said that their expertise did not fit the topic of the interview. This shows that the perceived relevance of a particular kind of expertise to a topic is ambiguous and can be changed according to circumstances. The lack of representative authority usually is the other reason for rejection, even when interviewees are assured that their identity will not be revealed in any written document.



## 4. Developmental Leviathan — Nationalist High Modernism in Postwar Taiwan and Beyond

### Introduction

Inspired by the concept of sociotechnical imaginary (Jasanoff and Kim 2009, Jasanoff 2015) and multiple modernities (Ichijo 2013, Eisenstadt 2000a), in this chapter, I explore the significant sociotechnical context of a particularly imagined modernity in postwar Taiwan. *Nationalist high modernism* is the manifest social and political trend in postwar East Asia (Kim 2015), which embraces the belief that the modernisation of industry will ensure the expansion of the national economy and, therefore, the autonomy of a nation. Modernisation is not only the means but also the end of a great social engineering, which summons the support from a series of elites: bureaucratic intelligentsia, engineers, high-level administrators, and governmental planners all march under its banner. In the nationalist modernists' eyes, industrial, scientific, and technological development would not only rebuild the nation's economy after the destruction brought by wars but also restore the nation's place as a major player on the world stage.

The nationalist-pragmatist rationality gives an outline of what James Scott (1998) calls high modernism, underscoring the deterministic choice of state-directed industrialisation attempted by a group of bureaucratic elites in postwar Taiwan—a pragmatic transformation in the search for a great national future. Although national developmentalism and the call for general interest seem to be an ideology too hegemonic and powerful to mount any resistance to, the pledge to 'return-to-native-

soil' and 'back-to-reality' did constitute an alternative view on development and modernisation that can be found in Taiwanese society during the same period of time. These alternative *indigenist-reformist story-lines* stress re-discovering local concerns and conditions, and re-establishing contact with local society, in a cross-over of modernisation and locality. The celebration of being a nation was substituted with the overriding concerns over concrete local issues and life-experiences.

Finally, energy, as a technology of power and a pivotal technological field in national development, always receives tremendous attention from the national modernists' eyes. Three tropes found in the nine-year-long debate on the Renewable Energy Development Act (REDA) can exemplify the complexity of energy politics and the contrasting image of energy technologies emerged and perceived in contemporary Taiwan. While nationalist modernism can be seen as a manifest form of sociotechnical imaginary in the postwar era and its legacy is still evidently powerful in Taiwanese society, these imaginaries are neither static nor with a clear boundary. A schematic review of the literature on the three domains: industrial policy, the professionalism of engineers groups and forms of democratic movement, all of which give the contour of the legacy of nationalist high-modernism, follows. Nationalist high-modernism, and the story-lines which give it discursive strength in public debate and policy-making, all need to be re-examined in the undergoing transformation and struggles of energy politics in Taiwan.

### **Developmental State and the Bureaucratic Authoritarian Industrialising Regime**

Before I introduce my first empirical case of perennial power shortage in the next chapter, the relevant historical context needs to be described. To understand the nationalist-pragmatist story-lines and its full significance, we need to trace it back to

Taiwanese history in the postwar period and introduce the concepts of *developmental state* and *high modernism*. The island of Taiwan, or Formosa, was populated with indigenous people until the 17th Century, after which it saw centuries of immigration and colonisation, from the Dutch (1624–1662), the Spanish (1626–1642), the Cheng family (1662–1683), the Qing empire (1683–1895), the Japanese (1895–1945), and the authoritarian Nationalist regime (1945–1988) (Jacobs 2013, 2012).

The notion of a ‘developmental state’ started from the inspiring work of Chalmers Johnson (1982) on the comparison of the industrial policy of the Ministry of International Trade and Industry in Japan and its counterpart in the U.S.. Johnson came up with two conceptualised forms of state intervention in the capitalist market. For the U.S., the main role of a state is to keep overall market rules, including fair competition and legal order; in contrast, the Japanese government intervenes in the market to a much deeper extent, and industrial policy is designed to use rational plans to provide an overall target and coordination. The overall goal is to facilitate the utility of all sectors in economy and society (Johnson 1982). The former is conceptualised as a ‘regulatory state’ while the latter is named a ‘developmental state’.

Wan-Wen Chu (2011) approaches this topic from another angle, asking what the motivation and causes behind the reason-laden planned relation of economy and society in developmental states are. He concludes that there are three elements contributing to the rise of developmental state:

- A. Nationalist modernism, the strong ‘will to develop’. It is mostly aroused by the feeling of threat from foreign forces and the sentiment of backwardness.
- B. The creation of expert bureaucrats (scholar-officials) through establishing plan-

oriented institutions. These institutions have the ability to 'steer' the arrangements among social groups especially on the aspect of economy.

- C. The possibility to undertake development in a comparatively isolated environment without strong foreign intervention regardless of its direct political influence or the intercessions of outside capital (Chu 2011).

The strong presence of nationalist-pragmatist story-lines in energy politics is not a totally novel phenomenon and this rationality has long roots in postwar Taiwan. To understand the nationalist-pragmatist story-lines and their full significance, we need to trace them back to the Taiwanese history in the postwar period. The East Asian countries Taiwan, South Korea, and Japan are seen as successful models of a postwar developmental state. Regardless of distinctions between their relation with the U.S. and their positions in the Cold War, they all adopted bureaucratic authoritarian industrializing regime (BAIRs) as the means and ends of rapid modernisation. Elaborated by Bruce Cumings, a historian of modern Korea and U.S. international policy in East Asia, the BAIRs share a number of features of domestic governance:

1. They were all formed under the strong influence from the U.S. in the postwar period.
2. Their state was formed on the foundation of a powerful and extensive bureaucracy and centralised government.
3. They all imposed compulsory primary education and this means an ample and disciplined labour force. (Higher education was none of their concern.)
4. They all pursued the effective control of public opinion through all means;
5. They followed an ideology of nationalism and mercantilism. Industrialisation was the ultimate goal of this bureaucratic state and the major approach to

fulfil a nationalistic economy (Cumings 1999).

The fact that the Nationalist KMT government adopted BAIR as the main ruling approach in postwar Taiwan is a sequel to its wartime and even pre-war inclination rather than a whole new development. During the Second Sino-Japanese War, under a strong feeling of threat, a planned economy was unanimously taken as the most effective way to acquire rapid industrialisation. Industrialisation was deemed as a public asset (Chu 2007). The same approach can be both found in mainland China and Taiwan in the early 1950s; however, the Communist government did not allow the same extent of 'depoliticised' politics, therefore, some members of the elite engineers who chose to stay in mainland China did not have the same opportunity to act at the centre of state affairs as their counterparts did in Taiwan (Kirby 2000). The concept of BAIRs is echoed by Alice Amsden (2001). In her analysis, the late industrialisation state can be categorized into two distinct types: the integrationist and the independent. Latino countries belong to the former type, where the majority of industrialisation goes through the hand of international corporations and their co-existing ruling elites. East Asia countries count as the latter, where industrialisation is implemented by the domestic governmental forces and hence is comparatively independent of foreign intervention.

Why did the Nationalist government in Taiwan have a chance to accelerate industrialisation without foreign intervention? Chu (2007) points out the massive industrial estate left by the defeated Japanese colonial government, and the fact that these estates and factories were state-owned and operated by the centralised government created an easy-to-adopt premise for them and their retreating elite bureaucrats. Citing the earlier works by other Taiwanese scholars, he also argues that

this nationalist capitalism is, in fact, a combination of authoritarianism and paternalism. Domestic private capital and corporation grew under the paternalistic protection of a nationalist bureaucratic state. The private and the official were in a relationship of a special joint venture (Chu 2007).

### **Engineers as State Planners: The Republican Engineers in Taiwan**

As mentioned above, significant traits that BAIRs share are the emergence of nationalist bureaucrats and the strategy of mercantilism. Postwar Taiwan is no exception. The predominant phenomenon that emerged from the historical context of the postwar Nationalist government is the rise of expert bureaucrats (scholar-officials). They prefer to be called ‘technocrats’ but this doesn’t imply that ‘technician’ is their primary identity; nonetheless, most of them came from an applied science background and received some forms of education in the U.S. (Chang 2013b). After the Republic of China (ROC) was founded in 1911, the Nationalist regime undertook coordinated efforts at institutionalising technoscientific development in China, for example by sending young students abroad to study industrially relevant subjects 實學 such as science, engineering, medicine and agriculture (Chang 2013b) and establishing the National Economic Council 經濟委員會 (the predecessor of the MOEA), NEC, and the National Resources Commission 資源委員會, NRC (Greene 2008). Many returned students later became the elite bureaucrats (as scholar-officials) who led the high modernist statecraft of the industrialisation of China and Taiwan. Technoscience 科技, engineering 工程 and modernisation 現代化 were perceived not only as the means but also part of the ends of the historical mission of ‘nation-saving 救國’ (Chang 2013b).

The emergence of expert bureaucrats is a marriage of technical knowledge and political power, which cannot be reduced to either one. During the Second Sino-

Japanese War of 1937 to 1945, a pervasive sense of external threat led to a planned economy and a mighty state being seen as the most effective way to acquire rapid industrialisation and a strong nation. Industrialisation was deemed as a public asset (Chu 2007, Amsden 2001). In 1949, after being defeated in mainland China by the Chinese Communist Party (CCP) and fleeing to Taiwan, the Nationalist regime imposed martial law (until 1987) and adopted a bureaucratic authoritarian industrialising regime in Taiwan (Cumings 1999), through the 1950s to the late 80s, making this the main ruling approach in postwar Taiwan.

In 1950, the Korean War erupted. As part of the First Island Chain fighting against the expansion of the Communist party, the Taiwanese Nationalist government received huge US Aid. In the Korean War, Taiwan took the role of a logistical supply base; however, the Nationalist government, having retreated from mainland China in 1949, did not receive the full trust of the U.S. The operation of U.S. Aid was deliberately segregated from the other institutions of the Nationalist government and handed over to a group of Taiwanese engineers who had received training and education in the U.S. (Chang 2013b). Engineers became the surrogate of the authoritarian regime in Taiwan during this period of time (Kirby 1990, Chu 2007, Chang 2013b). From the Nationalist government's view, that engineers replace military generals as the direct channel to the U.S. government could also benefit the regime by diminishing the possibility of military mutiny (Chang 2013b). In this historic context, engineers gradually took the crucial but 'neutral' role in Taiwanese politics during that time.

The prevalence of nationalist mercantilism can be exemplified by the pursuit and study of 'national economy'. National economy is considered as a branch of applied science and often called '經建 (economic planning and development)'. Although expert

bureaucrats are not limited to the persons who have an applied science background, their common trait is the experience of undertaking economic policy-making. As pointed out by one of the most iconic figures, Kwoh-Ting Li (李國鼎): ‘people say that the industrial committee only has engineers and no economists, but this is totally wrong (Li quoted in (Chang 2013b). They are proud of their expertise in economic planning and development.

Here a planned national economy does not refer to macroeconomic policies such as monetary policy and financial market regulation but more ‘pragmatic’ topics such as the establishment of mining, refinery, steel, electricity, agriculture and military industries. For nationalist high modernists, these industries form the foundation of a national economy and national productivity. It is not insignificant that expert bureaucrats have worked as the Head of the Arsenal Department or as the Chief Engineer of Taipower before taking office in the Ministry of Economic Affairs (Chu 2011, Chang 2013b). These are not just technicians who work under political commands from the above; they are republican engineers who make a nation come into reality. Their identity was bound up with an ethic of national service rather than a desire for profit. These expert bureaucrats are republican engineers who share the belief in pragmatism and pragmatic engineering. For them, it is the only way to save the whole nation from upheaval and demise.

### **Depoliticised Industrialisation Project and Industrial Expansion**

Between the 1960s and the 1980s, the logics of pragmatism underlay the understanding of science. As articulated by the regime leader, Ching-Kuo Chiang (蔣經國), ‘the development of science should not only grow scientific roots in our nation but also bring science and national development together. This will enhance our national

strength' (Chiang quoted in (Chang 2013b). 'National autonomy' is the ultimate goal of this nationalist-modernist interpretation of science. Technology and science are regarded with pragmatic values due to the utilities which they can bring. 'National utility' and 'productivity' are standard terms in political discourse. Bearing the morality of nation-saviour, expert bureaucrats are also called 'Confucius bureaucrats' (Chang 2013b, Chu 2011).

However, this does not mean that the expert bureaucrats are merely the fig-leaf of an authoritarian regime. While the commands from high authority are definitely influential, the details in this nation-building blueprint are too trivial to be contemplated directly by the regime leader. Detailed technical strategies and plans about acquiring complicated technologies were left for the engineers to deal with (Tsai 2006). The integrated circuit development programme serves as a good example to illustrate this point. The integrated circuit was the strategic industry selected by these engineers to achieve national autonomy, despite disapproval from the scientists in the National Science Council (Tsai 2006). The members of this programme were said to 'bear the historic mission' to rapidly industrialise the land of Taiwan (Chang 2013b). The Industrial Technology Research Institute (ITRI), as the bastion of engineers, was established through a project proposed by the former Chief Engineer of Taipower, Yun-Suan Sun (孫運璿) (Chang 2013b). The technical rationality of state planning was used to depoliticise their tasks. This depoliticised economic planning is highly compatible with the inclination of an authoritarian government. The conciliation of authority and technicality is brought to reality through the work of engineers. It is not surprising that some of the engineers later became members of the KMT party's central commissioner (Chang 2013b).

The sense of the 'depoliticised' neutrality of industrialisation comes from its technicality and 'pragmatism'. On the one hand, transforming the moral term 'national strength' into a 'technical, pragmatic and doable' one provides these engineers some protection against the day-to-day court politics in the Nationalist government (Chang 2013b). For instance, Li argued that 'we are not economists but engineers in action', and that 'economists may hold different opinions on issues but we, engineers, only try to deal with the real challenges facing us and try to solve them in pragmatic ways' (Li, cited in (Chang 2013b). National economic growth is depicted as the emblem of a maximized general utility. National strength is translated as an overt goal, defined as national productivity and competitiveness among the international market. The affinity between national strength and a clear and neutral figure, GDP (gross domestic product), was constructed at the same time.

An aggregated national utility, with no need to be broken down to the individual level, is the prevalent legitimate reasoning in Taiwanese politic discourse. The highest goal of national utility is to determine the maximum economic growth for the nation through rapid industrialisation. It must not be compromised for mere financial success, since the goal is the general interest of the whole nation. Economic planning is to 'solve real problems effectively and efficiently' (Yi, quoted in (Chang 2013b) – in other words, to administrate national interest through pragmatic engineering. A highly modernised nation is not just imagined by these expert bureaucrats but also put into statecraft by them as a part of daily problem-solving.

Another obvious feature of the rise of expert bureaucrats is the lack of accountability to and engagement with the wider society. They are technical administrators who are only responsible to their direct superiors. In an authoritarian regime, they often have

a double identity, as both an official member of the Nationalist party and a civil servant. The policy-making process emphasises quantitative data, but also the 'personalised' experience and expertise acquired by expert bureaucrats in previous public projects. The extolled image of expert bureaucrats observed in the current mass media shows clearly that the imaginary of a collectivist developmental state is still alive and well.

### **The Will to Develop: But Which Version?**

As we have seen above, the notion of national development is the predominant tune in postwar Taiwan. However, giving 'development' and 'modernisation' precise definitions are nearly impossible; just like nationalism 'once created, they became modular, capable of being transplanted' and being 'merged with a correspondingly wide variety of political and ideological constellations' (Anderson 1991, 4); the meaning of modernisation and development is anchored deeply in historical context and divergent social imaginaries (Ichijo 2013). Chu (2011) argues in common with Dore (1990) that this 'will to develop and modernise' comes from the strong feeling of backwardness sensed by the ruling elites in terms of the international status. Dore (1990) further explains this by affiliating the sense of backwardness to a particular group of people, the ruling elites and intellectuals, designating this as their unique social experience rather than a more pervasive social consciousness. Backwardness may not express this emotion adequately; a sense of insult provides a sufficient description (Chu 2011). Not surprisingly, the grand story-lines are about 'how, starting in the mid-19th century, China had suffered from foreign bullying, resisting foreign powers, and committed to striving for independence, and prosperity'. The 'Century of National Humiliation 百年國恥' is not only a recurring theme in both the pre-1949 Republican writings (in China) and the post-1949 Nationalist discourse (in Taiwan) but also the official view of modern Chinese history in the People's Republic of China (PRC)

(Hsiao 2013)

Narrator/ protagonist	Chinese people, the Chinese nation
Time frame	The middle of the nineteenth century to the present
Central issues	Chinese nationalism: the Chinese nation's struggle for national sovereignty, independence and autonomy, involving resistance to political, economic and cultural invasion or aggression
Plot	Beginning: inveterately weak traditional China humiliated and bullied by foreign powers from the middle of the nineteenth century Middle: the Republican revolution, the strivings and setbacks involved in nation-building, foreign intimidation and invasion End: (see conclusion/resolution below)
Conclusion/resolution	Resistance to foreign oppression, the pursuit of Chinese political, economic, and cultural independence and autonomy in order to make China rich and powerful

Table 4 — the summary of the nationalist story-lines (Hsiao 2010b, 7)

Hsiao (2010b) argues that 'multiple ways of development' existed among the discourses in Taiwanese context, especially among the young intellectuals in the 1970s. Through discourse analysis, he tries to locate the changes of discursive identity in different generations. The discourses of identity ingrained by the KMT/Nationalist government can be summarised in table 4 above. While we can claim that the aspiration to be a developmental and modernised state permeated postwar Taiwan, it is necessary to stress that the meaning of development and modernisation can differentiate significantly over generations and segments of society. In fact, the KMT/Nationalist government's version encountered increasing challenges since the 1970s. It was not until the early 1970s when the major diplomatic setbacks caused the young intellectuals to mobilise around the demand for political reform and cultural innovation. They started to feel ashamed of being isolated from the land and especially the masses (Hsiao 2010b). 'For these young intellectuals, the lifeworld of workers, peasants, and other sections of the lower class rather than their own intellectual life constituted social reality. It needed to be understood in order to make social reforms'

(Hsiau 2010b, 19). A distinctive discourse can be found within this political-cultural reformism.

The nationalist expert bureaucrats became devoted to the building of an efficient and administrative state with depoliticised economic planning and pragmatic engineering; it was their vision to maximise 'general interest' in order to acquire the envied high national economic growth and productivity expansion. In contrast, in the indigenist-reformist story-lines, we shall find public issues and collective life-experiences in the centre of their argument. The desire to 'return-to-native-soil' and to get 'back-to-reality' in young intellectuals initiated many voluntary social service campaigns in universities; humanitarian concerns and the craving for participatory democracy are at the heart of this wave of Taiwanisation (本土化, indigenisation). This also led to the flourishing of realism in literature and cinema (Hsiau 2005, 2010b). This version of modernism distinguishes itself by calling for reform of the vested political scene and stressing the critique of everyday life; they were *awakening* (Hsiau 2010b), to put it concisely.

The proliferating social movements over environmental issues in the 1980s, such as polychlorinated biphenyls-polluted oil, cadmium rice, and green (copper-polluted) oysters, were marked by similar story-lines and the joining of action between intellectuals and local forces such as self-help associations (自救會) and hazard prevention alliances (公害防治聯盟). Intellectuals (mostly experts in social sciences and liberal arts) and self-organised citizen associations together raised the idea of environmental rights as a legitimate appeal against authoritarian power, and expressed shared concerns over the native land where future generations would live, despite the governmental scientific bodies having consolidated their own authority through

deploying scientific knowledge and statistics about toxic substances (Lii and Lin 2000).

The aspiration of reuniting land and people and the use of emotional appeals can be seen as the main background of the massive political change occurred at the end of that decade (the 1980s). Re-discovering local concerns and conditions, and re-establishing contact with local people, register the main tune of this hybrid of modernisation and locality. The celebration of being a nation was substituted with the overriding concerns over concrete local issues and experiences.

Borrowing the notion of sociotechnical imaginaries, this thesis argues that the above mentioned nationalist-pragmatist story-lines implies a particular interpretation of the relation among state, science and technology. That republican engineers consider nation-building as just a process of solving the problems lying ahead on the road of modernisation should be understood as a delicate technique combining politics and technicality. I argue that these expert bureaucrats have internalised the competence of turning politics into 'neutral' economic and engineering plans. The belief of 'depoliticised problem-solving' by engineers' eyes and hands has, through the ambitious plan of rapid industrialisation, overflowed to other domains such as agriculture, transportation, and education, even environment governance.

### **Developmental Leviathan: High-modernist Statecraft in Taiwan**

One of the prevailing features of the developmental state is that the expert bureaucrats who are responsible for planning policy share an overwhelming belief in achieving national strength via enormous state-sponsored projects. Building from scratch, in order to break from the humiliating history and reality, these bureaucratic

elites come to epitomise what Scott calls ‘high modernism’ (Scott 1998). As an imaginary preferred by a whole range of elites — engineers, bureaucrats, and high-level administrators, scientists and other professionals – the elements of high-modernist rationality can be summarised in the following three aspects.

The first is the aspiration to administrate nature and society through the statecraft of measuring, standardization, and aggregation, typification; in order for bureaucrats to comprehend the more than complicated realities, the complexity must be reduced to ‘schematic categories’. This is to say uniformity is highly preferred under statecraft. The invention of this statecraft and the deployment of abstraction illustrate an immense leap in state capability. Natural and social facts lose their local particularities under the aggregation done by officials. All of these made state intervention possible (Scott 1998). It is this process that enables elite bureaucrats to have immense discretionary power, given that they have the specialist knowledge and access to the newly-created state format.

As indicated above, the Nationalist government inherited the rich legacy left by the retreating colonial Japanese regime, not only including tangible assets like factories, mining sites, standardized plantations, irrigation systems, banks, railways and electricity generation and transmission systems but also intangible institutions such as the household registration system, land survey, population census, scientific documentation, and the sophisticated mapping of natural and social terrain. Through 50 years of governance under the colonial regime, the premise of high modernism had been well-established. This gave the expert bureaucrats of the Nationalist government an excellent opportunity of fulfilling their master plan of modernisation which had been interrupted in mainland China after 1949 (Chu 2007, 2011).

Second, massive state-enforced social engineering is often the work of progressive elites. The elites come to power as critics of existing reality and have a strong impetus to transform it. With the progressive claim comes a strong version of beliefs in linear technoscientific progress that is affiliated to industrialisation. As explained by Scott, high modernism is about belief in ‘continued linear progress, the development of scientific and technical knowledge, the expansion of production, the rational design of social order, the growing satisfaction of human needs’ (Scott 1998, 89-90). High modernism, in this sense, is the extensive prescription of a new society in the future which will be brought into being according to the intended blueprint. The dream of a utopia of egalitarianism and utilitarianism of high modernism can be perceived clearly; the idea lying in the centre of the highly modernised state is to improve ‘all the members of society, their health, skills and education, longevity, productivity, morals, and family life’ (Scott 1998, 91). The felicity of ‘a population’ comes under the gaze of state, not only as means but as the end of promised collective prosperity.

Reflecting the context of postwar Taiwan, the republic engineers embodied a similar utopianism to that of Confucianism, ‘大同 (the universal fraternity)’, and are often extolled for their role of paternalistic ‘Confucius bureaucrat’ (Chu 2007). For instance, comparing the case in South Korea with Taiwan, Chu argues that the Nationalist government achieved comparatively even wealth distribution by the principle of ‘雨露均霑’ (roughly translated as ‘spreading rainfall evenly’), enabling equal opportunity for state-owned large enterprises, private large enterprises and small and medium businesses – an approach, one can argue, consistent with Confucian egalitarianism and

utilitarianism.<sup>3</sup> In contrast, in South Korea the state-privileged Chaebol system dominated the postwar development of capitalism through the selective approach of incubating 'national champions' (Chu 2011, 256-257, Wang and Tsai 2009, Wang 2007). However, Confucianism should not be regarded as the primary cause of this historical phenomenon; instead, I argue it should be understood as a form of state-monopoly capitalism, one of the sub-projects of nationalist high modernism.

Finally, according to Scott, the troubling feature of high modernism is its affinity with autocracy which derives from its tendency towards disallowing other competing sources of legitimacy. High-modernist statecraft is argued for in the name of, and with the recognizable support from, citizens seeking protection and a better life. The assertion is that a radical break with existing reality and tradition is needed and traditions ought to be re-examined and re-designed to fit the order informed by scientific and technological knowledge; in the high-modernists' eyes, the past is an impediment and the present is a platform for launching plans for a better future (Scott 1998). Although it should be argued with caution, the people of Taiwan still benefit from the legacy of these enormous high-modernist projects, however, where it may go brutally wrong is when the society is subjected to unreasonable utopian experiments against which it lacks the capacity to mount a determined resistance.

Indeed, the claim that problems are being solved through the use of engineers' eyes and hands, rather than in ways that are shaped by invested political interests and social habits, does provide an excellent way to gain great public authority without much overt

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<sup>3</sup> An excellent example of this statist-economic egalitarianism and utilitarianism is the land reform policy called '37.5% Land Rent' where peasants only need to pay a rent with a maximum cap of 37.5% annual farm yield to landlords. Also see the policy of 'Creating Yeomen', through which 194823 new households of freeholding yeomen were established in 1953.

resistance. The emergence of nationalist elite bureaucrats is the key feature of high modernism in postwar Taiwan and it came with the tendency towards the devaluing and even banishing of political debate. De-politicisation provides a 'neutral, impartial and rationalised' position for calling for solidarity and 'the willingness to make sacrifice'. De-politicization and the call to make sacrifices for the public good constitute the very core element of nationalist-high-modernist story-lines, which keep coming back and exerting influence in contemporary Taiwanese energy politics.

### **Summary: Signifying the Unplanned, Uncertainties and Complexity**

The high-modernist faith in the possibility of long-term prosperity is used to justify the need for short-term sacrifice and the ingrained conviction of the importance of reducing complexity. Because the high-modernist state can only exert power on that which it understands, attempts are made to tame wild uncertainties through the steered development of knowledge and knowledge institutions. Risks – known probabilistic phenomena that threaten the planned enterprise – become part of the system, part of certainty, while uncertainties remains as *unknown* probabilistic elements which need to be quarantined. In high modernism, the inherent flexibility of technology and those aspects of knowledge tied to locality and experience are downplayed and ignored; these are the values and ontologies which cannot be quantified (Scott 1998).

Ulrich Beck approaches the topic of modernisation from another angle. In what he calls first modernity, society imbued with experts and expertise is rearranged to be in line with technocrats' categorized order of functionality. The modern state promises a long-standing and prosperous modern life which is divided into bureaus, institutional segments, and sub-systems, aiming to provide care from the cradle to the grave.

However, at the same time, life becomes fundamentally fragmented and endangered. Social life when attached too firmly to expert knowledge and judgment imposed by official institutions proves to be weak at generating significant meaning. Life in first modernity is uprooted from the social world. Beck points out the side effects of first modernity (which can be interpreted as a high-modernist state) is emerging in the collapse of postwar welfare state system, the approaching risks of technology, the consequence of environmental catastrophe, wars and hence a growing sense of collective insecurity. Structuralisation basing on individualism also results in a situation of insecurity. Beck argues that risks are, for this reason, the inherent consequence of first modernity (Beck 1999, 1992).

While this thesis argues in common with Beck that 'risk' is an endogenous problem of first modernity and therefore of high modernism, it stresses that the consequences of modernisation requires much more close examination and more analysis. One of Scott's insights about high modernism is, again, highly relevant to illuminating the multiplicity of modernity: that high-modernist schemes have never reached their self-claimed full control of the complicated lifeworld, or put it in other words, the total colonization of the lifeworld. He cites the example of the comparison of high-modernist planned model city of Brasilia and the real, existing Brasilia in order to show that the intended purely functionalist and stark spatially segregated city could never exist. 'The poor lived on the periphery and commuted long distances to the centre, where much of the elite lived and worked. Many of the rich also created their own settlements with individual houses and private clubs, thereby replicating the affluent lifestyles found elsewhere in Brazil' (Scott 1998, 130). The high-modernist Brasilia literally requires the unplanned Brasilia to make it able to operate.

If it is true that high modernism never really achieves the annihilation of history, tradition, locality and informality, it should not be so surprising that an alternative imaginary, a indigenist-reformist modernism, seems to have been facilitated by the rise of the awakening young intellectuals in the 1970s, and the social alliance formed between university students, scholars and grassroots groups in the 1980s. The pivotal questions then become: How can we be sure that this resistance does exist? How can we trace this resistance against the monolithic high modernism? In what forms do the alternative imaginary takes shape? This thesis argues that high modernism as a human artefact is always flexible and negotiable in practice, as it is enacted and performed with materials, institutional culture and discursive practice. The legacy of the nationalist-high-modernist story-lines, as a particular version of the high-modernist imaginary of postwar Taiwan, is to be best understood through the considerations, reasoning, outlines of inception and practices in today's energy politics.

### **Energy and Technological Development under the Statist Gaze**

In postwar Taiwan, the Nationalist government imported nuclear technology as the solution to maintaining a stable domestic energy supply and the way to prolong a cooperative relationship with the US. The influence of the U.S. government on the postwar Nationalist government is paramount, and involved substantial resources support such as U.S. Aid and direct military protection. Between 1977 and 1984, three nuclear power plants with 6 nuclear generators had been built by American contractors. Nuclear power now constitutes 12.5% of total electricity generation capacity in Taiwan (Taipower 2014a).

When it comes to the energy sector of Taiwan, the Taiwan Power Company (台電, Taipower) is the dominant player. Based on the infrastructures built by the Japanese

colonial regime from 1895 to 1945, Taipower has been the most powerful actor in the electricity sector since its establishment in 1946. The prominent figure amongst technocrats in the electricity sector is Yun-Suan Sun (孫運璿). He is often hailed as the founding father both of Taipower and ITRI (see below). As a member of the NRC in the Nationalist regime, he like many other elite engineers was sent to the U.S. Tennessee Valley Authority in order to gain experience of managing the electricity grid and power stations; when he came back in 1945 after the surrender of Imperial Japan, he took the central role in the takeover of the key public infrastructures left by the Japanese colonial regime in Taiwan including the repair and further expansion of the Taiwanese electricity system. The repair of the transmission lines, hydropower dams and coal-fired stations were done not only by the group of mainlander elite engineers but also by engineers of Japanese, Taiwanese and other nationalities. However, Sun played the crucial role in guiding the transition of the original Japanese technical system to one with a strong American influence (Lin 2013).

He was promoted as the Chief Engineer of Taipower in 1950 and laid the foundation of power planning for the company. Being a key figure of the elite technocrats, he had an excellent chance of realising the high modernist dream of improving the nation through developmental planning and engineering that later he inaugurated as the Minister of the MOEA, the Energy Committee, the State-Owned Enterprise Commission and finally the Premier of Executive Yu in 1978. The way that the high modernist imaginary links national strength, productivity and the ethos of state engineers can be exemplified vividly using his own words:

*'The main purpose of accelerating economic modernisation is to strengthen the responding capacity of our economy, and another is to*

*strive for the competitiveness of our agriculture, industry and commerce sectors in the international market. The primary means to achieve these ends is to increase our overall productivity ... And the primary responsibility for increasing productivity should be borne by our engineers' (Sun quoted in Chang 2013).*

Taipower monopolises the business in the three key domains: generation, transmission and distribution. The present electricity regulatory framework— the Electricity Act — was legislated in 1947 and, regardless of consecutive moves to liberalise the Taiwanese electricity market since 1995, and partial deregulation in the generation domain, it is, by and large, unchanged.<sup>4</sup> The monopolistic influence of Taipower consists not only in physical infrastructures such as transmission lines and transformers but also in intangible knowledge such as electricity development methods and the experience of installing a distribution system in a particular area.

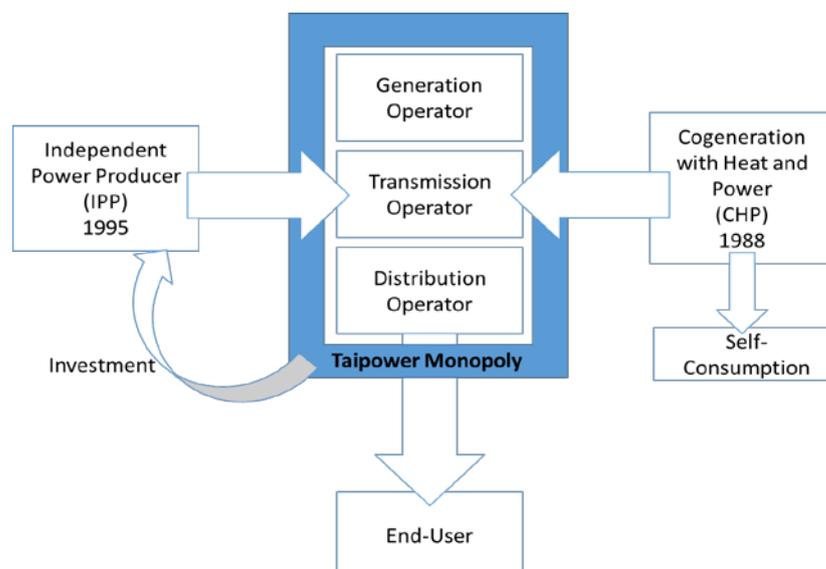


Figure 1 — the monopoly of Taipower.

<sup>4</sup> Major changes were made to the *Electricity Act* in 2016 under the newly elected DPP majority parliament.

Renewable energy, perceived as an alternative way of achieving energy autonomy by the Nationalist government, is always portrayed as a crucial technological fix to periodic energy outage and ensuing economic crisis. As a small but highly populated island, Taiwan cannot meet its domestic demand without importing energy from other countries. From 1988 to 2008, imported energy soared from 88.20% to 99.23% of total energy supply. The majority of the imported energy are raw materials such as coal, gas, and crude oil (Wu 2011). The stability and reliability of energy supply are always central topics in nationalist-high-modernist story-lines.

According to the theory of developmentalism, in contrast to the 'innovation' approach taken by developed countries, developmental states focus on the centrally coordinated and planned approach to technology development. The so-called approach of 'diffusion' draws upon establishing an official or quasi-official actor to facilitate the flows of information and finance inside the industry network and to overcome the barriers to the extension of network (Chen 2012). Hsinchu Science Park and Industrial Technology Research Institute are classical examples of this built-to-be-steered 'developmental network'.

The Industrial Technology Research Institute (ITRI) was born in 1973 due to the integrated circuit project devised by the former Chief Engineer of Taipower, Yunsuan Sun, one of the most iconic republican engineers. ITRI has played a vital role as the locomotive of technoscience development in Taiwan. Its statist-interventionist model of development in information technology has been regarded as a huge success. Called the 'ITRI mode', it involves encouraging technological learning through the centralised coordination of the network including intermediary research institutes and relevant

manufacturers.

The Nationalist government started to conduct some kind of research into photovoltaic technology from the 1970s. This was prompted by the world oil crisis at that time, although significant technological development did not happen until the 1980s. Given the 'huge success' of the ITRI mode in 1975, especially in the industry of semiconductor manufacture, a generic infrastructure of photovoltaics, the Nationalist government commissioned ITRI with the mission of developing photovoltaic technology in the late 1980s. However, from the 1980s to the end of 20<sup>th</sup> Century, the research was restricted to technological information exchange and technical communication with the group of countries leading in the technology (Chan 2012). The introduction of photovoltaics to society did not happen until the early 2000s. The stagnation between the 1970s and the late 1990s meant that most research activity stayed in the laboratory. Photovoltaic technology was not a technology taking root outside laboratories.

Although energy and relevant technologies are always at the centre of the high-modernist agenda, the actual process and outcome of the 'planned and coordinated developmental network' need more close examination in order to reveal the dynamics in a sociotechnical network and the important role played by the nationalist-high-modernist imaginary.

### **The Nine-year Long Debate on the Renewable Energy Development Act**

Although Taiwan plays no major role in international politics, the influence of global environmental agreements such as the Kyoto Protocol on Taiwanese society still cannot be ignored. The Kyoto Protocol was signed in December 1997 and is the key document that states the differentiated responsibilities of reducing greenhouse gas emission

among leading industrialised countries. Consistent with the feeling of 'keeping pace with the international society', the 1<sup>st</sup> Nationwide Energy Convention was held in 1998, giving a clear pledge on promoting 'energy saving and renewable and clean energy', which is considered as 'a policy of no regret'.

There are other two key strategic goals mentioned in the conclusion of this important nationwide convention. The first is to facilitate cooperation between industry and academy with the aim to 'accelerate new energy technology development and raise its application'. The second is to 'deploy energy policy instruments such as energy pricing and a carbon tax'. Renewable energy was considered to be the technological fix that can solve the problem of greenhouse gas and energy autonomy; however, the convention insisted, this solution needs to be implemented in 'a reasonable way'. The major goal of the policy is to achieve the 'rationalisation' of energy pricing (Bureau of Energy 2009b). Following the established approach of creating a planned and coordinated developmental network, 'statist facilitation' is deemed an indispensable policy instrument, putting subsidies at its centre.

In 2000, after the change of government, the DPP (Democratic Progressive Party) government stopped the on-going construction of Lungmen nuclear power plant (also known as nuclear power plant No.4, NPP4) which was initiated and partly built from the early 1980s. 'Nuclear abolition' had been a long-lasting political commitment of the DPP even before the lifting of martial law and its birth in 1987. NPP4 has always been one of the central topics of political struggle between the KMT and DPP. Through a short but fierce struggle which ended up with the resumption of the construction of NPP4, the DPP government decided to push for the installation of photovoltaics, a manifest way and a political expedient to distinguish itself from the KMT. The DPP

government initiated a series of demonstration installations. The goal was to keep the promise of creating a 'non-nuke homeland'. However, demonstration installations alone were not enough: the supportive legislation of the Renewable Energy Development Act (REDA) became the next main battlefield between the two parties in Parliament. Following the sociotechnical history of PV in Taiwan, three tropes can be found, which reflects the dynamic emergence of current high-modernist imaginary as the legacy of the postwar developmental state.

*Trope 1: Renewable Energy as an 'Opposite' and 'viable Technology'*

In 2000, after the change of government, the DPP Premier (head of the government) made a pledge to cease the construction of NPP4 for the following reasons:

1. There is no chance of power shortage, even without NPP4 being built;
2. In terms of stable power supply, an alternative proposal is totally possible;
3. Nuclear waste is a problem with no ultimate solution;
4. Taiwan is too small to endure the severe risks of nuclear disaster;
5. In order to avoid incoming contract penalties, we should stop now;
6. The pursuit of a 'non-nuke homeland' and a sustainable economy is our best vision for the next generations (Chang 2000).

Though this pledge was only maintained for about four months, the DPP government continued to propose policies such as the referendum over NPP4, the earlier decommissioning of existing nuclear power plants, the demonstration installation of renewable energy, and the legislation of the REDA, in order to differ itself from the KMT. After this event, the DPP government also concentrated on the news coverage of renewable energy; regardless of the scale of demonstration installation sites, they all

received highlighted news coverage (Guo 2002). For the KMT party, the REDA is seen as 'the anti-nuclear power act', which strengthened the opposition from the KMT legislators (Tsou 2011). The KMT as a major supporter of nuclear power insist that renewable energy is just too immature for immediate application. The feature of intermittent generation was said to directly threaten the stable provision of power, which is seen as the foundation of the IT and consumer electronics industries – the cornerstone of the national economy. Renewable energy's instability was said to incur highly frequent power outages, which could damage economic growth. In this context, the DPP's pledge on renewable energy was directly related to the NPP4 controversy and thus the KMT's nationalist-high-modernist discourse positioned renewable energy as the technology of 'opposition' and 'immaturity'.

### *Trope 2: Statist-interventionist Subsidy Based Industrial Policy*

Despite the insistence of the KMT party of the overwhelmingly negative impact of renewables on economic growth and the substantial financial burden brought by the early termination of NPP4, the statist-interventionist subsidy development policy was nevertheless approved by both the DPP and KMT parties. Renewable energy was perceived as indispensable to achieving energy autonomy and potential economic growth. The development of energy technology is almost reduced to the aspect of industrial development and a statist facilitation of technological progress. From the very beginning of the drafting of the REDA, renewable energy is continuously framed in terms of commercialization and technological competitiveness in the global market. The question of the legitimacy of such a policy therefore becomes one that involves justifying the statist 'investment' of a huge amount tax-payer's money to one particular industry. A certain answer came in the form of spillover benefits like job creation and economies of scale. The development of the renewable energy 'industry' is on the top

of the list of almost all political actors, placing stress on the creation of a friendly policy environment to accelerate the incubation of green technology industry.

It is clear that regardless of actors' positions on the political spectrum, a shared concern among policy makers, legislators, academics and business representatives was how to create more investment incentives and reduce risks for private actors, and how to privatise the electricity market to widen the space for recruiting more private contenders (Li 2012). While the validity of this massive subsidy is still under question, it may provide a partial explanation for a curious phenomenon in Taiwan. In 2011, according to the Photonics Industry & Technology Development Association<sup>5</sup>, Taiwan was a leading photovoltaic equipment manufacturer country with the second largest share (15%) of the global solar cells market, only second to China which was at 61%. However, when we turn to power generation, solar power accounted for merely 0.03%<sup>6</sup> of total installed capacity. The above mentioned 'planned economic welfare for everyone' rationale was reproduced in the state-led technoscientific project, 'the Rising Green Industry: LED and Photovoltaic Industry (綠色能源產業旭升方案：能源光電雙雄)' under the next Nationalist government (2009-2016).

For the DPP government (2000-2008), as a minority in the Parliament, the policy of massive subsidies was never put into question; however, when it comes to the details of how to allocate the subsidy, such as what the fixed FITs (feed-in-tariffs) should be for individual renewable technologies and which technology should in fact be counted as renewable energy and therefore able to receive subsidy, the details of how to

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<sup>5</sup> This report can be accessed through:

[http://www.pida.org.tw/report/html/member/2012/2012\\_pv\\_ch01.pdf](http://www.pida.org.tw/report/html/member/2012/2012_pv_ch01.pdf) (page.4)

<sup>6</sup> Calculated by this study on the data which is available from

[http://web3.moeaboe.gov.tw/ECW/populace/content/wHandMenuFile.ashx?menu\\_id=931](http://web3.moeaboe.gov.tw/ECW/populace/content/wHandMenuFile.ashx?menu_id=931)

implement the policy are not without internal disputes (Tsou 2011).

### *Trope 3: The Device of Controversy-settlement*

Since statist-interventionist subsidy is taken to be the best way of developing the renewable energy industry, the focal point shifted to a different question: to what extent can the FITs scheme be accepted by the general public as reasonable? In other words, through what mechanism can one legitimately determine 'a reasonable FIT'? Debates about reasonable price, and the legitimate mechanism for arriving at it, extended into a nine-year struggle between sectarian politics and interests groups (Tsou 2011), which ended up with the establishment of a FITs deliberation committee which is responsible for deciding the tariffs by an 'objective' formula. The first draft of the REDA included a fixed FITs scheme borrowed from the German Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG); however, when this fixed FITs scheme went to the Parliament, it set off an outcry over prices.

The rules concerning legislative procedures mean that the draft of any legislation which has not passed all legislative requirements at the end of every parliamentary session will not be carried over to the next session. The difficulty of reaching a final conclusion over what the FITs should be before the end of every parliamentary session resulted in the severe postponement of the REDA. In 2007, the amended fixed scheme was near the final stage of legislation, but it eventually failed due to a boycott staged by one of the KMT's legislators (Tsou 2011).

In 2008, after the second change of government, the newly elected KMT's President Ma, with a parliamentary election victory, made a pledge on energy saving and carbon emission reductions, mobilising the KMT's legislators. The latest draft of the REDA was

subjected to another significant amendment which involved replacing the fixed FITs scheme with an expert deliberation-based 'floating' FITs scheme. It came with the condition that the authority would hold administrative hearings when 'it is necessary' (Chou 2009). In April 2009, at the final stage, President Ma made a pledge to pass the REDA at the 3<sup>rd</sup> Nationwide Energy Convention. Just before that, a public intervention was made by Karl-Eugen Feifel, the chairman of German InfraVest Wind Power Group, who argued that the FIT for wind power was too low. In June 2009, the REDA finally passed all the necessary legislative procedures and became law.

The proposal to use expert deliberation-based technoscientific knowledge to solve a sociotechnical problem once and for all is yet fulfilled in our case. The 'objective' formula of FITs has been in dispute since the commencement of its operation. The main debate has been over issues such as how the public can participate in the deliberation and how to approach 'reasonable' FITs by calculating 'relevant' and 'objective' quantitative factors and values. This thesis argues that the expert committee which is backed up by technoscientific knowledge is best portrayed as a mechanism of controversy settlement.

### **Scattered High-modernist Dream: On the Bumpy Road to Democratisation**

While high modernism can be seen as an essential form of sociotechnical imaginary in postwar Taiwan, I believe that imaginaries are neither static nor in possession of a clear boundary. As argued by Hajer (2005), coherence should be never an assumption in policy analysis. The meaning of a policy is solely dependent on the institutional environment and the really existing situation of argumentation. 'What they said' does not always align with 'what they did'. Accordingly, the meaning of terms such as 'the public good', 'industrial strength', 'prosperity', 'objectivity' and 'justifiability cannot be

assumed, and the story-lines in the nationalist-high-modernist discourse should be re-evaluated at every point of their reproduction. Therefore, the enactment of the high-modernist sociotechnical imaginary needs to be evaluated in the following three fields which embody the scattered but still pervasive high-modernist dream in contemporary Taiwan: the dimensions of **industrial policy, engineer's identities and forms of democratic movement**.

First, **industrial policy** as the bastion of developmental state and, therefore, the manifest field of practice for high-modernists, industrial policy is subjected to the intensive gaze from the state. However, the idea of centralised planned coordination is hard to realise according to the recent research; instead, a network of collaboration, a local production network or local production community is now taking centre-stage. In this trend, the state may not play the traditional commanding role in engaging in technoscience development but it still has significance in building an interaction and innovation platform with other participants, in a state-led network (Wang 2007, Wang and Tsai 2009, Amsden and Chu 2003, Chen 2008).

The high-modernist view of research and technological development tends to assume a linear conceptualisation of the leap-frogging style of technological development with the aim of 'catching up' the leading country. Nevertheless, in the case of the precision machine tools industry, Chen (2012) finds that private company actors who are already established in the area often do not feel attracted by the incentives and research agenda proposed by the governmental research body (for example, ITRI). 'Advanced technology' is such an anchored image amongst the group of bureaucratic engineers. As a result, products emerging from industrial development projects often lack local market attractiveness. The 'promising and futuristic' technology or product targeted

by the industrial policy planning officials seldom finds a welcoming audience in private enterprise, reflecting a discrepancy between planning officials and industrial actors in the perception of market potentiality; the latter have true experience in local market engagement.

On the one hand, private companies are inclined to use research and development grants to conduct other improvements rather than the designated ones – for example, using a fund for researcher recruitment on the refurbishment of production-line facilities. On the other hand, the research agenda focus on ‘high-end technology’ and the turnover rate of research staff is quite high because the private sector provides better career perspectives. In this situation ITRI cannot but ask, quite often, their counterpart in the private sector for help, especially on practical technical solutions. Some even argue that ITRI is actually the biggest beneficiary of industrial development projects. This implies that bureaucratic engineers tend to engage in technological projects from which they can benefit (often demonstrated by the numbers of intellectual property), rather than those that respond to the real need of the private sector (Chen 2012).

The second dimension is about **engineers and their identities**, the pursuit of ‘independence’ and ‘agency’ in the post-autocracy era, and the reworking of the relationship between state and engineer. In the 1990s, two giant public construction projects were initiated; both of them had a long history of designing and planning stretching back to the authoritarian period: Taiwan High-Speed Rail and the Taipei Metro. Engineers, as a group of actors sharing the same expertise and the experience of conducting giant public construction projects under an authoritarian regime had the problem of how to transform their identity and argue for independence in the post-

autocracy era (Chang 2013a, 2011). Despite the fact that explicit calls for national strength and glory have gone, the contours of the developmental Leviathan are still recognisable. However, the dominant theme of national 'autonomy' is replaced by national 'agency'. Rather than simply resist foreign invasion, the 'nation as a community needs to pursue its agency through broad and enhanced cooperative relation with other countries' (President Lee, cited in (Chang 2011)).

For the engineers who were involved in the Taiwan High-Speed Rail (THSR) project, this was a good opportunity to claim their independence from political leaders through excellent engineering practice. It also involved the transformation of their identity — from followers in a newly industrialising country to proactive contributors in a leading industrialised country. This implicit identity change was reified by the design of the THSR project<sup>7</sup>; in the first place the project was outlined as setting up an 'open' platform to receive international competition for the best electrical and machinery system design, while the 'foundation' of civil engineering work was laid down by the Taiwanese engineers who had extensive local knowledge in local construction sites (Chang 2011).

In another case, the lingering concern in the engineers' mind is the 'advancement' of the VAL (light automated vehicle) system transplanted from France to Taiwan, which ended up as an open failure. The Taipei Metro system features almost all the characteristics of the high-modernist imaginary. It was designed to manifest the modernist qualities of punctuality, accuracy, and efficiency (high loading) of systematic operation; in short, the image of being orderly, tidy and clean. The transplantation was

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<sup>7</sup> The whole THSR project includes three major systems, the electrical, machinery and civil engineering systems (Chang 2011).

not going well in the end, but this predicament unexpectedly provided a chance for the rearrangement of the local sociotechnical system and the demonstration of showing their 'professional agency' by patching the potholes left by the French Company (Chang 2013a). Professionals and engineers as communities were starting to ask for their own agency, independency and social identity.

The final dimension is about political participation. Giving a detailed and comprehensive review of **the forms of democratic movement in Taiwan** is impossible; nevertheless, two aspects can give a clear overall impression: the dimensions of the professionalisation of grassroots environmental activism and the massive employment of expert advisory schemes. Institutionalised participation becomes the overriding characteristic of Taiwanese democracy at the end of the last century. Lii and Lin write on the change of grassroots environmental activism between the 1970s to the late 1990s, comparing the images of the activist's body observed throughout the campaigns. Four images of the activist's body can be found: during the 1970s, it was the image of a suffering body manifest. The activism stressed the expression of physical suffering directly resulting from local pollution. The state and its bureaucracy did not have an appropriate policy or legal scheme to accommodate this stark negative sensation. But in the late 1970s the state started to have corresponding institutions to accommodate this sensation; a legal framework was established and pollution was declared a 'public hazard (公害)', a direct threat to the general public. The activist's body was presented as a legitimate subject, although it was only validated through the governmental scientific organization.

In the 1980s, the image of a sacred body and a body of insurgency was formed through a series of social-environmental campaigns. The agency of the body trespassed onto

the legal landscape and the authority of scientific advice. The alliance of counter-experts and local forces was another feature of this time. Their body was forging in collectively attended social movements. In the late 1990s and afterward, the grassroots environmental activism was rapidly 'rationalised'. The number of people attending street protests shrank quickly; instead, announcements, press conferences, and expert interviews became the salient methods of expressing dissent. The professionalisation of environmental activism brought 'efficiency and rationalised order' to the way of engaging in societal debate; the technique of making expert discourse, citing numbers and law articles becomes the indispensable skill for campaign activists. Nevertheless, institutionalised participatory mechanisms such as administrative hearing, formal forums and workshops were mainly designed for enacting 'docile bodies' with relevant expertise (Lii and Lin 2000, 2003).<sup>8</sup> According to Lii and Lin, this is the domestication of grassroots forces.

As a response to the continual demand of democratisation, moving 'from government to governance' and 'from response to collaboration' are now the two key principles upon which policy-making is devised. The expert advocacy structure is thought be able to accommodate the well-organised and more diversified opinions from the whole society as long as an appropriate representativeness is achieved. Environmental Impact Assessment, EIA, is a good example to illustrate the expert-based governance mechanism. With this, stakeholders have the right to recommend selected experts to represent them in the committee.

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<sup>8</sup> Despite that, there was an incrementally significant wave of social movement since 2006 in contemporary Taiwan. While their predecessor focused on the more direct demand of the end of autocracy and the appeal of immediate, personal perception of local pollution, the new wave distinguishes themselves by massively mobilised internet social media campaigns and the redefined identity of indigenous Taiwanese society.

Tu (2012) focuses on this advisory EIA and examines its knowledge production, the roles of experts, and the underlying regulatory rationality. Her study reveals that the institutional design of the expert committee has failed to produce better scientific knowledge for environmental assessment. The ambiguity in its operational definition and accountability, such as the expert recommendation being treated as the final political decision, has proved contradictory to the aimed goal of open participation. Moreover, the information presented to the committee has been under major constraints due to the time and resources available; intentional delays caused by the faction receiving evaluation and the self-limiting mindset of some experts further erode the legitimacy of the EIA process.

### **Conclusion: Seeking the Collectively Imagined Future**

As was illustrated in the beginning of this chapter, the developmental Leviathan is a manifest form of high-modernist imaginary in postwar Taiwan, and more broadly speaking in postwar East Asia. It features a vision of collective economic prosperity in the future, and an over-simplified correlation among the statist interventionism, planning rationality and public good, all of which are tacitly enacted through the institutional arrangements and knowledge-making in policy-making. While its relevance is undeniable, high-modernist rationality and its twin, the nationalist-pragmatists story-line, both need to be re-examined in the context of the undergoing transformation and struggle of energy politics in Taiwan. They are tacitly acculturated in the arrangement of developmental priorities, the preferred method of capacity assessment, and the methodology of achieving 'reasonable' FITs. To be short, they are enacted through the making-and-doing of technopolitics.

In the myriad of modernity and democracy, the stark and monolithic calling for muscle-

bound national interest is no longer valid; nevertheless we still see numerous intuitional arrangements and policy discourses stressing the public good — the making of sensible argumentation in public debates, the recruitment of metaphors, the construction of impartialness, and an expert-based objectification mechanism.

Finally, if we can attribute the nationalist-high-modernist story-lines mainly to the aspiration to build a strong state standing proudly on the ‘world stage’, then for the indigenist-reformist imaginary the yearning utopia is to create a democratic modern state. For the proponents of the latter, democracy and locality are the double sides of the same coin (Lii 2009). The appeal to locality, practical concerns, indigenous experience and resistance, although to be reckoned a politically minor imaginary, is nevertheless not insignificant or without its own forms of rationality; it will be fully discussed in chapter 7. But in order to understand the commitments and assumptions that underlie the sociotechnical imaginary in energy politics under investigation — the authoritarian developmental planning rationality — the issue of power shortage which emerged from the aftermath of 2011 Fukushima nuclear disaster needs to be investigated. I will do this in the next chapter.



## 5. The Making of Power Shortage — Developmental Leviathan and its Authoritative Planning Rationality

*'Electricity is the cornerstone of modern life and the driving force behind the industrial development of both traditional industry and emerging high-tech industry. In the past sixty years, Taipower has provided sufficient electricity for the need of developing people's livelihood and economy. The transmission and distribution lines of Taipower have grown to every corner of Taiwan. Taipower lives with 23 million fellow citizens every day' (Taipower 2015c).*

*'The fact that 98% of our energy is imported and it is an isolated electricity system means that we cannot depend on interconnection to import electricity. Because of natural geographic characteristics, Taiwan has no advantage in using renewable energy; it poses a serious energy security challenge, the risk of power shortages, to us. The situation of Taiwan is much more serious than the other countries. Therefore the pursuit of a diversified energy portfolio and reducing energy dependence, and hence energy autonomy, constitutes the key foundation of safeguarding our energy security' (Ministry of Economic Affairs 2014c, I).*

*'When facing the predicament of power shortage, you would cry without tears [it will all end in tears]; I frankly think everyone [participating in the energy debate] should come up with figures to argue. How can you be so certain that there will be no power rationing?' Former President Ma, the Nationalist party quoted in (Xiao 2015).*

## **Introduction**

As discussed in the previous chapters, high modernism, as the dominant sociotechnical imaginary in postwar Taiwan, manifested itself on the topics of what a better society should be, how to make technical choices to achieve that and what the most viable plan is to make the particularly dreamed future come to reality. In this chapter, I explore the strings of the closure of alternative energy visions enacted by high-modernist rationality. I look into the features of this particularly imagined sociotechnical future in the nationalist-high-modernist story-lines shared by governmental actors and the orchestrated practices of emphasizing power shortage at present and economic prosperity in the future—if the current threat of power shortage is solved in a feasible way.

In the following sections, I will focus on the energy controversy which happened from 2011 to 2015. A summary of news reports followed by an analysis of discursive strategies exemplifies how power shortage is presented in the mass media and how the claimed crisis of power shortage jumped to the centre of public debate. The image of power shortage made through fear and discursive repetition builds itself on the ambiguous usage of terms such as ‘power shortage’, ‘power rationing’ and ‘power disconnection’ in the debate. With no intention of discriminating between the different meanings they bear or to clarify their ambiguity in public understanding, the high-modernists work on the boundary between mitigation measures and power rationing measures where the definition of power shortage resides. As a result, power shortage, as the predicament and nerve-racking situation for the nation, is declared through institutional practices of power rationing measures.

In the next sections, I show how the claim of power shortage is made not only through

ambiguity about power rationing, but also the calculation of reserve margin and the observation of operating reserve, both of which come with their assumption and political implication and, therefore, need to be explored carefully. Finally, I investigate the exclusion and inclusion of uncertainty through analysing the treatment of contingencies like maintenance, replacement, unplanned outage and high temperature when planning is made or dispatching is done. I conclude by stressing that we need to look how power planning is made and what the enacted rationality is. The rationality of authoritarian developmental planning observed here presents a salient rationale in bureaucratic planning tasks, consisting of a prescribed relationship between state and civil society and a deterministic view on what a better future and society should be; it prevents the coming forward of alternatives and a richer collective imagination of energy.

### **The High-modernist Hunger for Growth and Energy**

‘Economic prosperity’ sustained by industrial productivity expansion is a salient term in Taiwanese energy politics, which promises the coming of better collective livelihood and working conditions. Satisfying the power needs of industry is regarded as helping job creation, justifying the government’s fundamental responsibility to provide ‘sufficient’ power to industries. Energy is seen as ‘the main blood vessel of the economy’, since ‘a more developed country usually consumes more energy’ (Lin 2004). An ever-growing electricity demand is seen as the almost inevitable but desirable consequence of national development. In the nationalist high modernists’ eyes, a government’s responsibility is defined as bringing economic wellbeing to the ‘whole population’, and securing the path leading to ever higher growth.

### **Affluent Provision and Unlimited Growth**

An endless supply of energy, in this respect, is special to high-modernists because it is not only the means to the ever-growing economy but also symbolises the determination to achieve an ever-evolving society. The faith that it is humanity's destiny to tame nature to suit its interests and preserve its safety constitutes the keystone of high modernism (Scott 1998). For high modernists, energy is part of nature which can be modified and rendered in many material forms, permeating and growing to every corner of society. The idea that the Taiwanese electricity system 'lives with 23 million fellow citizens every day' reflects the intrinsic imagination in high modernism: that Society and Nature can be made legible and administrable by a self-confident, state-led engineering project (Scott 1998). Here the project is specifically about building a national electricity community, achieving the growing satisfaction of human needs and the expansion of productivity. This is undergirded by the strong belief in scientific progress and the mastery of natural laws. In order to understand fellow citizens' livelihoods better, high-modernists devise a legible but inevitably over-simplified power-consumption trend.

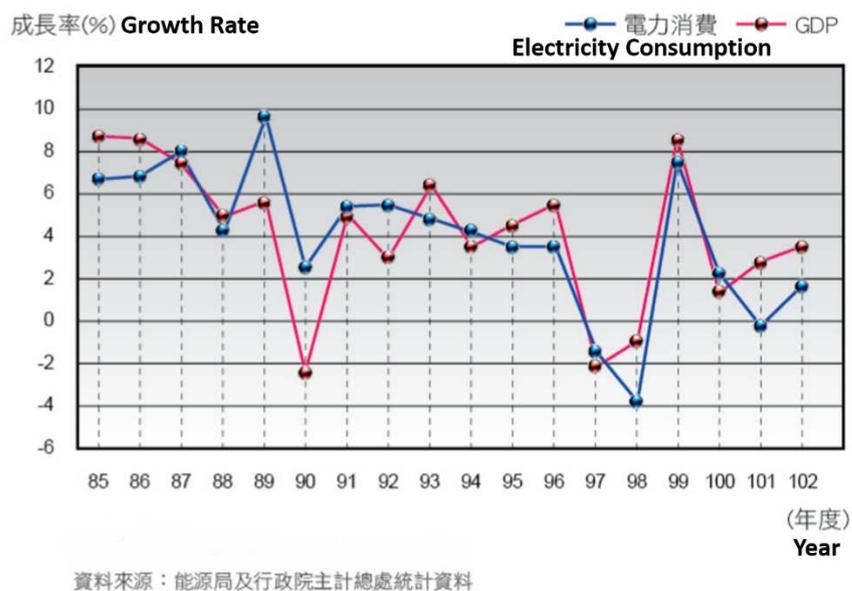


Figure 2 — the relation between energy consumption and growth (Ministry of

This attempt is informed by the application of another revolutionary political simplification of the modern era, the concept of unitary and homogeneous citizenship (Scott 1998). 'Every citizen's right of accessing electricity is the cornerstone of modern life' is an article of faith for Taipower. The promised state citizenship of electricity accessibility would create a new subjectivity: the electricity-craving citizen. In the high-modernist dream, the provision of electricity should exceed the natural or normal need and reach the extent of emancipatory affluence. Provision is *per se* desirable.

A similar metaphor was used in the Chairman's opening speech at the 70th Anniversary ceremony of Taipower: 'for 70 years ... the development of Taiwan's industry and economy has taken off, swiftly riding on the wings of electricity' (Taipower 2016, 22). The same trope can also be found in 1940s and 50s USA: as Leslie White argued, 'the degree of civilization of any epoch, people, or group of peoples, is measured by ability to utilize energy for human advancement or needs' (cited in (Nye 2010, 77). This view connotes a technological determinism, as if the 'development' of culture and society is correlated with economic growth and the consumption of energy. Additionally, in the Cold War era, a limitless supply generated by atomic power was also imagined in the U.S. and infinite energy abundance was presented as the 'natural' and 'developed' condition, in contrast to the 'undeveloped' and 'dark' parts of the world (Nye 2010).

The strong desire for growth does not only imagine an affluent society in the future; it also assumes current and forthcoming scarcity. Turning current scarcity into future

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<sup>9</sup> Years are shown in Republic of China Calendar here. To convert it to Anno Domini of Common Era, 1911 should be added.

affluence underlies the main tune of the nationalist-high-modernist story-lines. The manifestation of affluence in the future can only be secured by conquering the current imperfection of power shortage. The problem of power shortage constraining growth is identified as the key barrier to achieving collective wellbeing. The orchestrated choices of presenting a future of never-ending progress rely heavily on the visualizations showing an apparently inherent relation between ever-growing electricity consumption and the growth of national GDP (figures 1, 2, and 3). An underlying feature of a nationalist-high-modernist story-line is to strengthen its legitimacy by continuously referencing back to the ‘proud’ history. It is written by the proud record of statist achievement in attaining high GDP growth and its ability to satisfy the electricity demand of the growing industry hitherto. This implies continuing the same commitment of following the ‘proud history’ to march forward for further national glory.

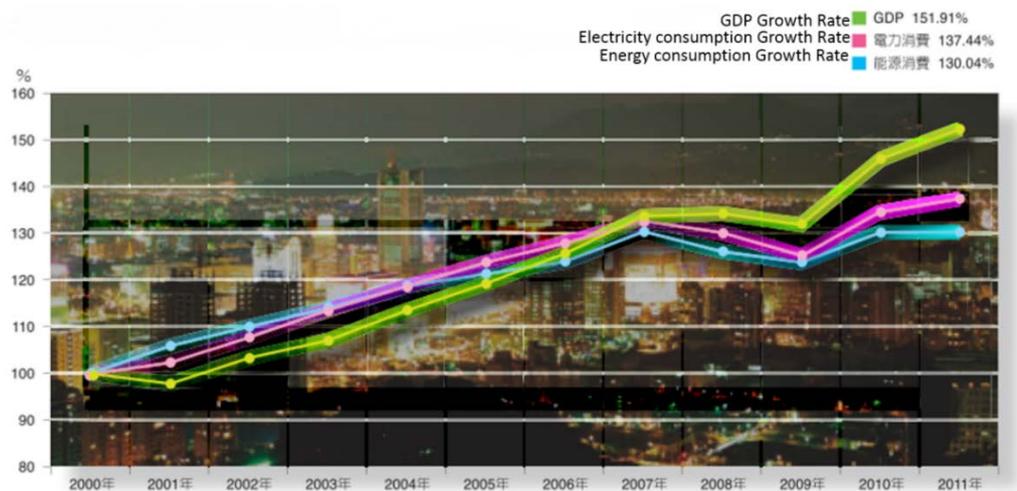


圖3 我國電力與整體能源消費占比  
資料來源：台灣電力公司、經濟部能源局。(資料日期：2012年12月)

Figure 3 — the relation among energy, electricity consumption and growth (Ministry of Economic Affairs 2014f, 6)

This selected representation of electricity and collective economic wellbeing is

expressed explicitly by Taipower: ‘electricity is the foundation of national economic development. Along with economic growth the demand for electricity is forecasted to increase between 2013 and 2023 at an annual rate of 2.1% ... the increase of provision ... should meet the demand of electricity of future economic development’ (Taipower 2015c).

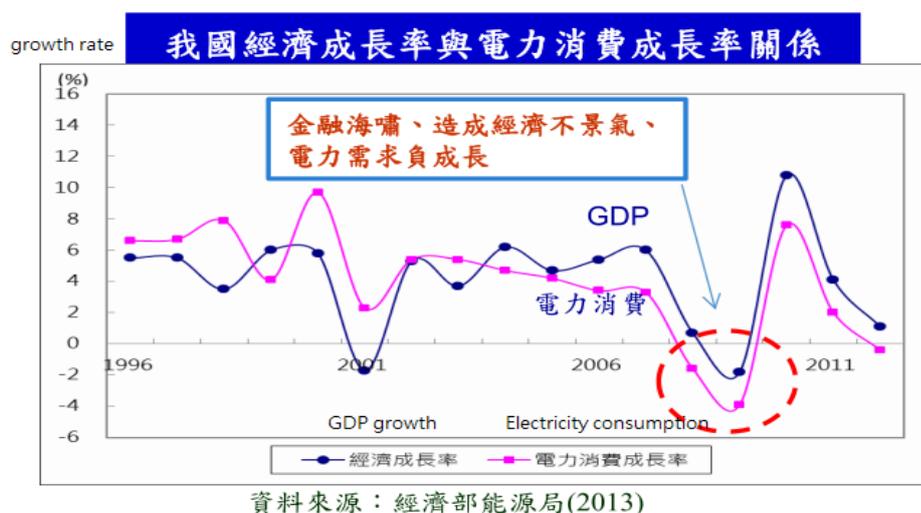


Figure 4 — the relation between electricity consumption and growth (Ministry of Economic Affairs 2014e, 6)

The statist gaze on the relation of electricity demand and GDP growth is not only underpinned by the over-simplified conceptualisation of its own past but also the schematic comparison with other countries. The period of negative growth of electricity demand in 2008 to 2010 (as shown in the figure 3) is regarded as the consequence of negative economic growth, which results from costly social unrest, financial crisis, the European debt crisis and the Jasmine Revolution. The U.K. and Denmark are outlined as examples of lower or negative electricity demand growth and conceived as out of the trajectory of economic growth in an official report written by

the Bureau of Energy, BOE.<sup>10</sup> It is argued that once the economy of these countries returns to the trajectory of growth, the demand will go up again (Ministry of Economic Affairs 2014e, 21, 24).

This story-lines combines an aspiration of nearly never-ending GDP growth and electricity demand growth with a faith in pragmatist planning for this certain future. It is continuously framed as a mission of pursuing collective happiness, a statist responsibility. It has to be established whether the state has the will and ability to provide population with a prosperous future. Like mentioned above, the story-lines also seek to establish the reality of imminent power shortage. Breaking away from the unbearable current situation is always the rationale for inviting sacrifice and great change. In order to do that, the message of an impending electricity scarcity needs to be convincingly demonstrated to the general public.

### *Efficiency, Stability, and Growth*

Attaining efficiency does not mean giving up the opportunity of growth; instead, in the governmental discourse, it indicates a better way of ensuring lasting growth. This was the point articulated particularly in the *Sustainable Energy Policy Framework* (永續能源政策綱領) issued by the Executive Yuan in 2009 when the Nationalist government was in power (2009-2016). Efficiency, cleanness, and stability were the three goals of this framework. A sustainable development of energy was said to recognize the natural limitation and fragility of the environment of Taiwan and, therefore, to advise an approach of increasing efficiency to make the best use of the limited natural resource. Efficiency should come along with the deployment of clean technology; nuclear power

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<sup>10</sup> The Bureau of Energy, BOE is an administrative body under the Ministry of Economic Affairs, MOEA. Both of them are under the command of the Executive Yuan.

was highlighted clearly as one of the carbon reduction options.

More importantly, the stability of energy provision was seen as the key to further development; a secure energy supply system should be measured by its ability to satisfy the expected growth of energy demand, achieving a continuous 6% GDP growth annually in the next four years and the goal of achieving US\$30000 GDP per capita (Ministry of Economic Affairs 2009c). The envisaged win-win relation amongst economic development, sustainable environment and stable energy provision was clearly depicted in this policy.

However, this complete harmony was not realised in the ensuing controversy. Following a number of controversial events concerning energy saving and energy efficiency, the meaning of energy saving was proved manoeuvrable and dependent on the argumentative situation. Aligning with the conclusion of the Nationwide Climate Change Convention in 2012, the Nationalist party president decided to initiate an official report on whether zero growth of electricity demand is possible. The assessment report of the BOE was an official response to the appeal for a more comprehensive national energy saving strategy made in the Convention. *The Assessment Report on the Possibility of Zero Electricity Demand Growth* (電力零成長評估報告) reveals that electricity demand growth can be curbed to 1.41% annual rate while sustaining an average GDP growth rate of 3.07% from 2013 to 2030 (Ministry of Economic Affairs 2014e), which was conceived by activists as an official endorsement of the possible scenario of termination of the nearly-finished NPP4 with no risk of power shortage.<sup>11</sup>

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<sup>11</sup> <http://www.gcaa.org.tw/post.php?aid=395>

In contrast to the view of high compatibility of energy efficiency and economic growth observed in the *Sustainable Energy Policy Framework* in 2009, this report focused on the extremism of the approach and the incompleteness of the current evaluation methodology, claiming that the impact caused by this 'extreme' approach will be costly if it were actually implemented. The BOE insisted on maintaining a 'pragmatic' approach to energy saving. They condemned the request made by the activists on implementing an 'extreme' approach, seeing this as an irrational, empty and irresponsible talk which would bring catastrophic consequences to civil livelihood and industry (Ministry of Economic Affairs 2014g). The underlying reasoning of the BOE was that the approach of energy saving should be economically positive and, at the same time cost-effective so that the action of adopting energy saving and efficiency will not diminish the possibility of future economic growth.

Energy saving and electricity demand are combined in moral terms as well. Since electricity 'is essential to the rise of living standards [and] all sectors of society will advance toward electrification, which inevitably causes an incremental increase in energy consumption', the extreme energy-saving approach 'requires high [installation and social] cost', and will have an unclear impact on the willingness of business investors (Ministry of Economic Affairs 2014e, 24). Energy saving should not be 'at the expense of economic development and the existing lifestyle ... [extreme energy saving can] lead to inflation, reduced income, reduced household consumption and, the loss of jobs' (Ministry of Economic Affairs 2014e, 24).

We have seen that the underlying rationale of the nationalist-high-modernist story-lines is the pragmatism and feasibility built on the ground of the past successful history

of bringing modernisation by providing 'sufficient' electricity to industry and the whole nation, and maintaining high GDP growth at the same time, especially when compared to other countries. It is defined as the only legitimate rationale in energy-related policy-making.

### **Presenting a Perennial Shortage**

Power shortage (缺電) is the perennial threat presented in the official discourse when it comes to the controversy over energy. In table 5 I present a summary of governmental discourse from 2011 to 2015 showing the recurrence of the unchanged narrative pattern over these 5 years over several different incidents and events. The deployment of the fearful story-lines of power outage can be exemplified by the following summary, in which I paraphrase government discourse upon particular events, assembled from a number of news sources.<sup>12</sup>

The earthquake-induced tsunami and the ensuing Fukushima nuclear disaster in 2011 triggered an outcry in Taiwan, with appeals to increase renewable energy capacity and to close down the existing nuclear power plants. In this context, power shortage is the game-changing strategy played out by the nationalist high modernists, prohibiting further discussion and curbing the consideration of alternatives. In other words, 'power shortage' is the determinant argument which has the force to set an overriding

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<sup>12</sup> The news summary is mainly made from the search result of three news sources. The first is Liberty Times which is broadly regarded as a voice of criticism to government. The second is Central News Agency which is a government affiliated and supported news agency. The third is Apple Daily, the biggest newspaper publisher in Taiwan, which can be seen as the most influential commercial media at national level. The search is made by entering keyword 'power shortage', 'nuclear power' and 'renewable energy' in respective news agency databases and refined by the condition of year 2011 to 2015. To document extra details of relevant episodes, this summary is also informed by the selective NGOs blogs such as Cool-loud, an activist blog in labour issues; PNN, a news magazine style blog maintained by Taiwan Public Television Service; E-Info, a NGO focusing on environmental issues; GCAA, the main voice of the campaign of NPP4 termination. The purpose of this summary, however, is not to comprehensively cover energy relevant debates happened in Taiwan, but to give readers a sense of the main patterns in governmental discourse.

agenda over other competing discourse. Power insufficiency, in this discourse, is assumed to be the most exceptional nightmare of modern life and the primary formidable barrier to the development of society, industry and therefore national strength. Electricity serves as the precondition for strong industrial productivity and collective prosperity.

However, there is a confusing situation in the much-covered 'power shortage problem'. The term power shortage (缺電) and power rationing (限電) are used indiscriminately in the mass media both by reporters and government officials. The concepts of operating margin and reserve margin are confusing as well when the percentage figures reported in the news sometimes refer to the former and sometimes to the latter. Both of them have different technical definitions, implications, and meanings. In general, the argument of power shortage can serve to curtail the debate by emphasising the high possibility of power disconnection which incurs deep fear. The competing discourse can come from broader considerations such as the demand for NPP4 termination, power saving, and the ban on using bituminous coal as a generation fuel or simply the request to review Taipower's business performance; nonetheless, the image and fear of power shortage can often deflate the agenda. In the following discussion, I aim to examine how power shortage jumped to the centre of Taiwanese energy debate and to explore its political implications.

Time	Background	Summary
2011	The immediate aftermath of Fukushima nuclear disaster.	If we shut three nuclear power plants down, the power shortage it causes will force 'one of third to a quarter of Taiwanese industry to close'. NPP4 (Nuclear Power Plant 4) termination would bring tremendous negative effect to national economy, as claimed in a parliamentary question session by an official of the State-Owned Enterprise Committee, MOEA (Ministry of Economic Affairs). The ' <i>New Energy Deal</i> ' announced by President Ma in November, pledging 'no power rationing'. <sup>13</sup>
2012	The 1st anniversary of Fukushima nuclear disaster. The alliance of NGOs was forming to appeal for the termination of nuclear power through staging a nationwide protest. The proposal of raising electricity and petroleum price resulted in the widespread	The immediate termination of nuclear power will cause immediate power shortage. In 2011, the actual reserve margin <sup>14</sup> (as contrasted to the statutory reserve margin 16%) is 20.6%. However, the shutdown of three nuclear power plants will result in the significant drop in reserve margin to 6%, which can only fulfil the basic need of system balancing but not cover planned maintenance and unexpected breakdown. This means a very high possibility of power rationing and even power shortage. Reserve margin has a different definition in different countries; generally speaking, larger systems need smaller reserve margin. Compared to other countries, the Taiwanese reserve margin is not too high. For an isolated system like Taiwan, 16% statutory reserve margin is not too high. Between 1991 and 1996, the average (actual) reserve margin was

<sup>13</sup> <http://www.cooloud.org.tw/node/58446>, <http://121.50.176.24/node/65666>, <http://121.50.176.24/node/64853>, <http://pnn.pts.org.tw/main/2011/04/15/>, <http://news.ltn.com.tw/news/politics/breakingnews/563177>, <http://e-info.org.tw/node/71380>

<sup>14</sup> The electricity planning terminology of reserve margin and operating reserve is explained in the following section.

	demand to review Taipower's business performance and operation model.	5.13% and there were 40 power rationing and shortage warnings. This indicates that lower reserve margins result in power shortages, as argued by the MOEA and Taipower. <sup>15</sup>
2013	The government decided to hold a referendum on the issue of the construction of NPP4. Moms Love Taiwan as a 'neutral' organization caring about 'our next generation's future' was formed. The Nationwide Nuclear Abolition Action Platform was formed to assemble the forces of citizen organization. Around 220,000 people attended the street	The MOEA Issued several policy explanatory documents: ' <i>Nuclear Safety and Nuclear-free Homeland</i> ', ' <i>Official Q&amp;A on Nuclear Issues</i> ' and ' <i>Ensuring Nuclear Safety and Keeping Steady Nuclear Reduction</i> '. A governmental explanatory website went online. The termination of NPP4 will cause high investment lost, higher electricity price, high possibility of power rationing and the sacrifice of further economic development and the possibility of achieving low carbon a homeland. The NPP4 termination and the scheduled retirement of existing nuclear power plants will reduce reserve margin to 10% in 2015 and 7.4% in 2018. When it is lower than 10%, there is a high risk of power rationing, and power shortage is inevitable. The potential impact on society, industry and economy is tremendous. The government should 'aim for energy security not only energy safety', according to President Ma in an interview. <sup>16</sup>
2013.08		'The termination of NPP4 will cause the reduction of economic growth by 0.52%, lose 19,464 jobs, increase the rise of electric price by 0.04 NTD per KWh in 2019' according to the official <i>Impact</i>

<sup>15</sup> <http://www.cna.com.tw/postwrite/Detail/100769.aspx#.VZQhFEYsBGA>, <http://430nonuke.blogspot.co.uk/p/qa.html>, <http://www.coolcloud.org.tw/node/66778>, <http://pnn.pts.org.tw/main/2012/03/13/>, <http://www.cna.com.tw/postwrite/Detail/101810.aspx#.VZUhhEYsBGB>, <http://news.ltn.com.tw/news/business/paper/578005>, <http://news.ltn.com.tw/news/business/paper/558685>

<sup>16</sup> <http://e-info.org.tw/node/84056>, <http://news.ltn.com.tw/news/focus/paper/657068>, <http://news.ltn.com.tw/news/focus/paper/674698>, <http://news.ltn.com.tw/news/life/paper/645048> <http://news.ltn.com.tw/news/focus/paper/673347>, <http://gcaa.org.tw/post.php?aid=39>, CAN news: 20130526CAP0201

	protest held on March 9 <sup>th</sup> , 2013.	<i>Report on the Termination of NPP4</i> prepared by Council for Economic Planning and Development in a parliamentary question session. <sup>17</sup>
2013.08		The highest demand is reached when the temperature soared to 37.4 °C. The reserve margin fell to 10.3%, 'the lowest point in nearly 10 years'. When it is lower than 10%, it will present a high risk of a power disconnection and rationing. If it is lower than 7.4%, power rationing is inevitable, argues Taipower. <sup>18</sup>
2014	April.27 after a fierce street protest/violence in the aftermath of another major social movement, NPP4 is decided to be mothballed and the 4 <sup>th</sup> Nationwide Energy Convention to be held in the beginning of 2015. NPP4 generator 1 is already near	The 'extreme energy saving' approach is hard to achieve. It does not take consideration of the possible resistance to the mandate of installing energy-saving production lines in the industry, the possible higher GDP growth in the future and the ever growing sudden peak demand. Power rationing is still highly possible. The termination of NPP4 and the scheduled retirement of existing nuclear power plants will cause power shortage, as reserve margin is expected to drop to 10.2% in 2016, with ensuing inevitable power rationing in 2021, argues the BOE. If power rationing is active, household power consumption will be the first area to be affected because the electronics manufacture factories need stable power to ensure normal operation in production lines, and power rationing would cause excessive impact on them, said the Minister of the MOEA. <sup>19</sup>

<sup>17</sup> [http://www.appledaily.com.tw/appledaily/article/finance/20130813/35216338/,2013-08-12/UDN News/A7](http://www.appledaily.com.tw/appledaily/article/finance/20130813/35216338/,2013-08-12/UDN%20News/A7)

<sup>18</sup> <http://news.ltn.com.tw/news/life/breakingnews/851382>

<sup>19</sup> <http://news.ltn.com.tw/news/focus/paper/759104>, <http://news.ltn.com.tw/news/focus/paper/759104>, <http://news.ltn.com.tw/news/life/breakingnews/983999>  
<http://news.ltn.com.tw/news/politics/breakingnews/1094217>  
<http://www.cna.com.tw/news/firstnews/201404280399-1.aspx>

2014.09	competition while generator 2 is still in construction.	Due to the extreme hot autumn as temperatures soared to 37.8 °C, the operating reserve fell to a mere 3.31% at the lowest point in nearly 15 years. When it falls under 6%, it means consumers should be prepared for power rationing, said Taipower in a press release. Taipower has begun the preparation for unexpected power rationing and later planned power rationing; however, the details of these will not be made public. <sup>20</sup>
2015	The 4 <sup>th</sup> Nationwide Energy Convention was held in January. NPP4 is mothballed in	The latest forecast indicates that reserve margin will be as low as 8.9% in 2016. When it falls lower than 10%, it means a high possibility of power rationing. If it is lower than 7.4%, then power rationing is inevitable, argued the BOE. <sup>21</sup>
2015.05	July 2015 for at least 3 years.	According to the latest forecast report, reserve margin will drop to lower than 10% in 2018, two years earlier than in the original prediction. It will be 4.8% in 2019, -1.6% in 2023 and -3% in 2024, report the BOE. Taipower said that this year the temperature in May is higher than expected. The maintenance generally is scheduled to be on off-peak time. Peak time is from June to September in Taiwan. Operating reserve was predicted to be as low as 3.3% in May (the actual lowest point was 3.38%). Taipower was accused by the activists of intentionally failing the generators during peak time, but this was strongly denied by Taipower. <sup>22</sup>

<sup>20</sup> <http://news.ltn.com.tw/news/life/breakingnews/1107728>, <http://news.ltn.com.tw/news/life/paper/813755>,  
<http://www.appledaily.com.tw/appledaily/article/headline/20140917/36089149/>, <http://www.appledaily.com.tw/realtimenews/article/new/20140916/470546/>,  
<http://www.cna.com.tw/news/firstnews/201409160166-1.aspx>

<sup>21</sup> <http://news.ltn.com.tw/news/politics/breakingnews/1217262>

<sup>22</sup> <http://news.ltn.com.tw/news/life/paper/872344> ,

2015.07		<p>This summer the lowest operating reserve is predicted to be merely 2%, so that power rationing is not only a warning but a real ‘normal’ situation now, Taipower warned. Taipower changed <i>the Precautionary Light Signal of Power Provision</i> scheme from three categories to five. Later, the unexpected outage of four coal-powered generators caused operating reserve to fall to 2.46%. High temperatures can reduce the generating capacity of power generators, Taipower later explained. If the maintenance is properly carried out there will be no power rationing, they admitted.<sup>23</sup></p>
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Table 5 — the summary of the official discourse of power shortage

<http://news.ltn.com.tw/news/business/breakingnews/1332434>,

<http://news.ltn.com.tw/news/life/breakingnews/1324311>, <http://news.ltn.com.tw/news/life/paper/880059>

<http://www.appledaily.com.tw/realtimenews/article/new/20150521/614208/>

<sup>23</sup> <http://news.ltn.com.tw/news/life/breakingnews/1365907>, <http://news.ltn.com.tw/news/life/breakingnews/1365885>,

<http://news.ltn.com.tw/news/life/breakingnews/1359814>

### **Making Shortage: The Image, Metaphor, and Boundary Object**

At the end of 2011, in the aftermath of the Fukushima nuclear disaster, the Nationalist government proposed a *'New Energy Deal'* in response to the mounting demand from civil society for energy-saving and the termination of nuclear power plants. Posited in the centre of this policy are three promises—no power rationing, a rationalised electricity price and the fulfilling of carbon reduction commitments (Ministry of Economic Affairs 2012a). The promise of 'no power rationing' is the precondition of all the other policy actions. This policy appeals to 'lower electricity demand growth rate through introducing new energy efficiency technology, curbing peak demand growth at the same time as raising production capability, using new energy technology to secure stable provision and energy autonomy, and reducing carbon emissions through new production and consumption schemes'. It is also argued that in order to avoid power rationing, nuclear power should be reserved as one of the possible options for the next generation.<sup>24</sup>

Nationalist-high-modernists have been trying to push forward their agenda by constructing the problem of current scarcity and a viable answer to it at the same time — making the right technical choice. In particular, the relevance of power shortage, the consequences and its meaning, needs to be expressed even more explicitly and strongly. Not surprisingly, the image of power shortage and indeed the image of suffering come to the foreground. The idea is that the impact on daily life and the condition of insufficiency of electricity should be directly observed and witnessed by the public. In order to understand the political meaning of power shortage, we need

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<sup>24</sup> NPP4 is mothballed in July 2015, however, it is still a crucial factor in the background shaping the debate of Taiwanese energy future especially when it comes to Taipower's discourse of securing sufficient future electricity provision.

to review the discursive practices as well as the institutional practices through which the national predicament of power shortage gets reified.

### *Fear and Repetition*

The explanation of the obsession with power shortage in nationalist-high-modernist story-lines cannot exclude the level of strategic discursive action. The image of power shortage has apparently become an ingrained political symbol due not least to the most basic rhetorical technique: repetition. It is through repetition that power shortage itself has effectively been mythicised. The effect of the reiteration of power shortage by the Nationalist government can be seen as a ritualisation of the problem, stabilising political conflicts and 'effectively suppress[ing]' (Hajer 1995, 130) competing discourses. This explains why the public as audience starts to turn a blind eye to what has actually happened and the exact meaning of that which has been argued. What power shortage actually means and how it is hinted at by power rationing measures are no longer consciously considered in the public sphere. Additionally, power shortage becomes a metaphor that can fuse with other parts of daily life experience, strengthening the sense of urgency. This move reinforces the attitude of indifference towards what exactly 'power shortage' means. This makes power shortage be perceived as an imminent problem from which everyone will suffer.

While the governmental line on power shortage maintains primarily on the collective level and abstract figures such as the falling of the stock market, reduced general living standards, the loss of industrial productivity, the loss of jobs and a curtailed GDP growth rate, it can be easily borrowed by affiliated actors to produce much more

concrete and graphic images which focus on the impact at daily level.<sup>25</sup> Examples used in news coverage include the blackout-caused failure of computers and air conditioning,<sup>26</sup> the elderly living in an unheated house<sup>27</sup> or suffering from heat exhaustion,<sup>28</sup> using candles at night, and cities being in darkness.<sup>29</sup> Electricity is conceived as an inalienable human right in this respect. Energy saving is also perceived as an issue of individual morality. It is argued precisely because of the inalienability of electricity, that unless you are prepared to give up the basic right to electricity then there is no moral footing for you to appeal for the termination of NPP4.

Moreover, the perennial warning (as observed in 2010, 2011, 2013, 2014, and 2015) of power shortage in late summer and early autumn, the traditional peak time in Taiwan, should be comprehended in this context as well. It is often assumed that high temperature and electricity demand has an inseparable relation, even when the exact relation between the two is never fully explained. When mentioning high temperature, it is assumed that the consequence must be higher demand and therefore an ensuing high probability of power shortage. This is a naturalistic construction of the problem because a higher temperature does not necessarily lead to power shortage and power disconnection thanks to the system-balancing measures that electricity operators can take.<sup>30</sup>

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<sup>25</sup> Nevertheless, 'the collective' can be selectively conceived as industrial sector. One minister argued that if power rationing needed to be imposed, civil power usage would be the first area to be affected. Civil society should sacrifice their temporary convenience and comfort to maintain the full potential of industrial productivity and economic development.

<http://www.cna.com.tw/news/firstnews/201404280399-1.aspx>

<sup>26</sup>2015-07-08/UDN news/A2

<sup>27</sup>2014-03-05/UDN news/A5

<sup>28</sup>2014-09-17/UDN news/A6

<sup>29</sup>2013-03-06/UDN news/A2

<sup>30</sup> The mitigation measures used by electricity operator will be explained in the next section.

### Argumentative Ambiguity

While the government discourse is mostly based on the institutional criteria for planned power rationing (限電), the term 'power shortage' (缺電), which implies power disconnection (停電), is a salient term in wider public discourse. However, in an electricity operator's view, there are multiple causes contributing to the situation or prevention of power shortage where provisions cannot fulfil demand. For example, the electricity operator has the ability to manoeuvre peak demand by implementing demand-side management measures. On the supply side, the generators can also be kept in operation during peak time by implementing a well-planned and well-performed overhaul work schedule. Certainly, 'power shortage' for electricity operators simply means a tightening buffer zone which can be used to undertake system balancing, but it does not necessarily mean that the ultimate measure of client disconnection must be done immediately so as to protect the system (OFGEM 2014).

As discussed above, power shortage means extra measures of system balancing are needed, one of which can be power rationing. But it clearly does not mean that power rationing will happen immediately, nor that disconnection is the only option available to electricity operators. However, this is a point never clarified by Taipower or the MOEA during this debate. Even worse, the ambiguity between power shortage, power rationing and immediate power disconnection is exacerbated by the indiscriminate use of the terms in mass media either by reporters or government officials. The different implications of the three terms do not get highlighted in governmental documents, meaning the questions such as for how long, how often and how likely that the public will be disconnected from the grid is hardly clarified; this leaves a vague but palpable fear of power disconnection pervasive in society.

### Declaration of Shortage: Power Rationing Measures

A number of practices around the concept of power rationing have contributed to the firmly established alarming image of power shortage. One of the important institutional practices in this respect is the Executive Order<sup>31</sup> 'Measures to Power Rationing during the Period of Power Shortage (電源不足時期限制用電辦法)'. Under this order, power shortage is categorized into four different levels of action reacting to different levels of power shortage (Ministry of Economic Affairs 2006, Taipower Hsinchu Office 2015).

Power shortage period	
Situations /Reaction levels	<b>Temporary demand reduction measure (臨時性減少用電措施):</b> The voluntary client-side temporary measures to reduce electricity demand. These measures are on the basis of voluntary participation. The concession tariff is provided as an incentive.
	<b>Other emergency reaction measures (其他緊急因應措施):</b> It includes emergency coal/gas generator maximum capacity operation, brownout (lower voltage), emergency procurement from private power plants and etc.
	<b>Industrial sector power rationing (限電):</b> Implemented in an incremental way. The reduction by 5% of the contracted capacity each time means that the industry client can only receive 95% of the electricity it requests. There are 5 incremental stages, divided into two categories: the category of contracted capacity between 1000KW to 5000KW, and 5000KW and above.
	<b>Planned power disconnection (停電):</b> After the reduced contract capacity cumulatively reaches 15% but a power shortage situation still exists, then a planned disconnection is imposed. Every time, clients in

<sup>31</sup> An executive order does not need to be approved by the parliament. It is issued directly by the responsible authority – in this case, the MOEA.

the specified region would go through 50 minutes of controlled disconnection.

Table 6 — the four levels of measures in *Measures to Power Rationing during the Period of Power Shortage*

「減少用電措施」之實施期間													
類別	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月	抑低用電期間
計劃性減少用電措施(一)				■	■	■	■	■	■	■	■	■	4~11月(5~12月電費月份),每週抑低1日星期一至星期五(離峰日除外),每日抑低7小時(10至17時),每月抑低4日
計劃性減少用電措施(二)					■	■	■	■	■	■			5月中旬~9月(6月中旬~10月電費月份),星期一至星期五(離峰日除外),每日抑低6小時(10至12時、13至17時)
計劃性減少用電措施(三)						■	■	■	■				6~9月(7~10月電費月份),每月抑低8日,每日抑低7小時(10至17時) 星期二至星期五(離峰日除外)
計劃性減少用電措施(四)							■	■					7~8月(8~9月電費月份),星期一至星期五(離峰日除外),每日抑低1或2小時(13:30至14:30或13至15時)
臨時性減少用電措施(一)	■	■	■	■	■	■	■	■	■	■	■	■	全年,限制用電前2小時通知用戶
臨時性減少用電措施(二)	■	■	■	■	■	■	■	■	■	■	■	■	全年,抑低用電前2小時、4小時或前一天下午4時前通知,每次抑低時間不低於4小時
臨時性減少用電措施(三)	■	■	■	■	■	■	■	■	■	■	■	■	全年,依二次變電所供電需要,於抑低用電前2小時通知用戶,每次抑低時間不低於4小時,屬區域性可停電力
臨時性減少用電措施(四)	■	■	■	■	■	■	■	■	■	■	■	■	全年,抑低用電前15分鐘、30分鐘或前1小時前通知,用戶得選擇每次執行抑低時間為2小時或4小時,以日為單位。

Figure 5 — the temporary demand reduction measures sorted by planned and contingent methods (Taipower 2015I).

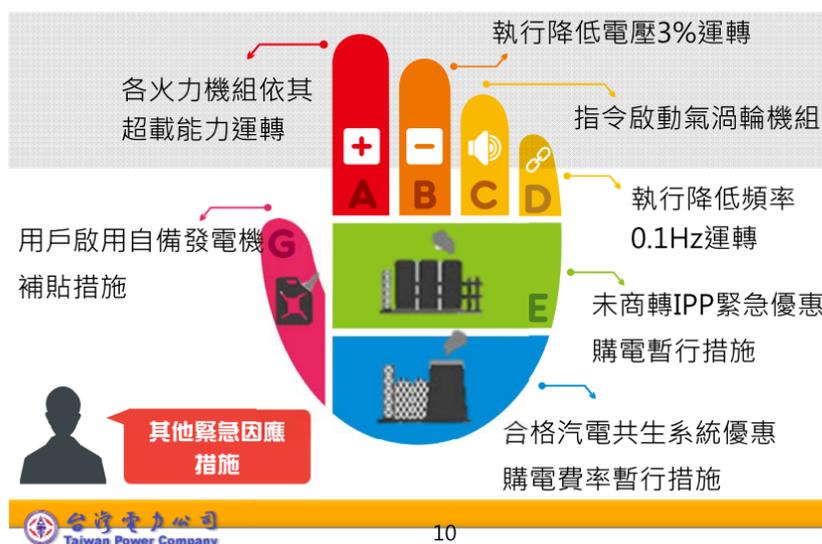


Figure 6 — other emergency reaction measures explained by Taipower (Taipower Hsinchu Office 2015)

In this Executive Order, the legal term 'power rationing' is used strictly to refer to the situation when all other possible mitigation measures including temporary demand reduction measure (also called as *demand side response*) and other emergency measures have been exhausted, and the industry clients start to receive capped power provision. However, Taipower has its own managerial conceptualisation of 'power rationing'. In its information disclosure webpage and publicly accessible documents, *emergency* power rationing refers to the totally unexpected and accidental loss of system balance where demand exceeds supply, for example, earthquake-incurred system damage. In this situation, the responsible division is the electricity dispatching unit. *Planned* power rationing refers to the situation when the measures are expected to be implemented the day after the decision is made by the operation unit (Taipower Hsinchu Office 2015, Taipower 2015k, d), and this would include all four levels of the action listed in the Executive Order.

Apparently the term 'power rationing' as defined in the executive order should be classified as *planned power rationing* in Taipower's managerial term. The key question here is whether voluntary measures of demand reduction and emergency reaction measures are regarded as part of system-balancing measures available to operators in order to *avoid* power rationing (as according to the Executive Order), or as *types* of power rationing as according to Taipower? This is the key point which creates ambiguity within the whole debate.

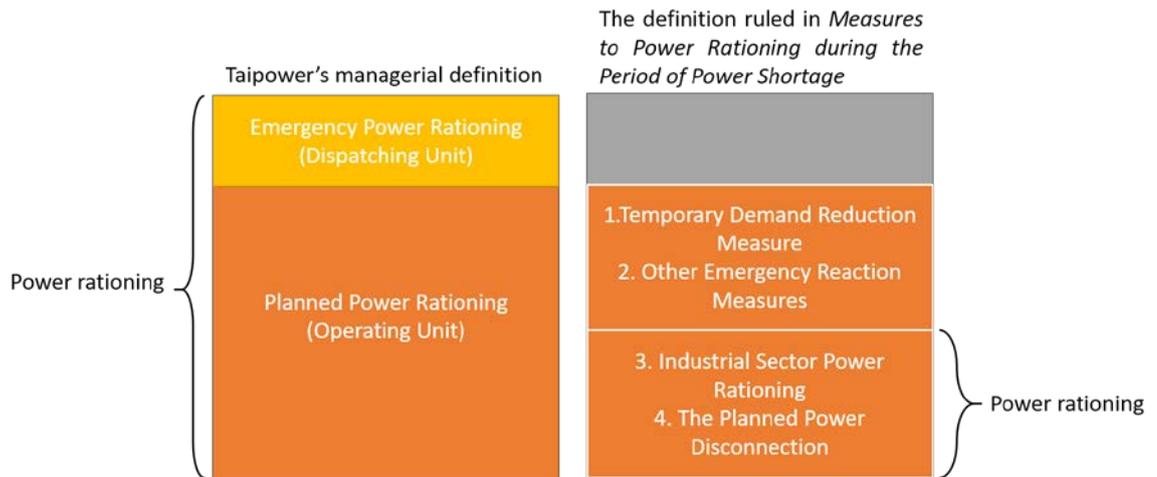


Figure 7 — the comparison of the definitions of the key concept of ‘power rationing’

This ambiguity is exacerbated by the title of this executive order. The title implies that if any measures mentioned in it has been implemented then the factuality of power shortage and power rationing is established, which means the nervous situation of the whole nation — the limited electricity consumption and the curbed productivity — comes to reality. The press released by the MOEA exemplifies this point well. Voluntary demand-reduction measures are described as one of the ‘power rationing’ measures in the MOEA’s press release (Ministry of Economic Affairs 2015b), which expands the definition of power rationing. However, the term ‘power rationing’ in the Executive Order is strictly defined to be only used in the situation when the provision to industry clients is capped.

The current usage of the term ‘power rationing’ can thus be problematised. **Industrial sector power rationing** and **planned power disconnection** means non-voluntary measures are imposed, while **temporary demand reduction measure** and **other emergency reaction measures** are part of options available to the operator to balance

the system.<sup>32</sup> The need of this clarification is due to the fact that the ‘system operator can use mitigation actions to manage supply shortfalls, with little or no impact on customers in most cases’ (OFGEM 2014, 23). More importantly, mitigation measures are invented and introduced on the basis of considering the operator’s resilience to manoeuvring peak demand. The electricity operator ‘can implement mitigation actions to solve capacity adequacy problems without disconnecting any customers’ (OFGEM 2014, 28). In other words, mitigation measures are all available means of balancing the grid which demonstrates the operator’s resilience. Although the press released by the MOEA stresses that some forms of demand-reduction and mitigation measures will be implemented first before adopting more serious action (Ministry of Economic Affairs 2015b),<sup>33</sup> these mitigation measures are still often referred as ‘power rationing’ measures. The ambiguity created here has political strength especially when it comes to the asserted commitment to ‘no power rationing’ as pledged in the *Sustainable Energy Policy Framework* in 2009 by the Nationalist government, and the MOEA’s clear preference to solving this predicament by adding more generation capacity, through the construction and operation of NPP4.

The factuality of power shortage is declared by the institutional practice around power rationing. The ambivalent usage of the key term ‘power rationing’ does not only effectively broaden the meaning of power shortage but also significantly diminishes

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<sup>32</sup> In the UK Ofgem report, LOLE (Loss of Load Expectation) describes the probability of demand exceeding supply from the view of electricity operator, measured in hours per year, and LOCD (Likelihood of Controlled Disconnections) is used as a measure of the probability that customers can experience a controlled disconnection when mitigation measures are exhausted, indicated in the form of 1 disconnection in N years. The difference between LOLE and LOCD is the reduced risk of power shortfall thanks to operator’s mitigation measures. To illustrate the potential impact on society and make it more understandable to the citizen, LOCD shows ‘the frequency of outages of a given severity when mitigation actions available to the System Operator have been exhausted’ (OFGEM 2014, 28).

<sup>33</sup> ‘After implementing power rationing measures, 1100MW peak demand can be curbed, this can add 3% more operating reserve to the system’ (Ministry of Economic Affairs 2015b).

the space of mitigation measures. The meaning of 'power shortage' is implicitly simplified as well as expanded at the point at which it comes out of the Taipower engineers' control room and the MOEA planners' office and arrives amongst the general public. The technical term 'power rationing'<sup>34</sup> has a strong political implication. **Now, any attempt to curb and manoeuvre power demand is established as the declaration of a power shortage, the most fearful and stressful situation in the national predicament.** The clearly established power shortage and its 'devastating consequence' are the best deterrent to any appeal for an alternative energy future.

Power rationing and power shortage are boundary objects, in that they 'are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites' (Star and Griesemer 1989a, 393). Power rationing and power shortage, among the whole controversy, play the important role of boundary objects among three groups of people who have quite different concerns, aims, and values. As described by the interviewee D2:

*Load restriction is the technical terminology of power rationing ... the outside word probably won't tell the difference between emergent load restriction and planned load restriction. For them, they are both called 'power rationing'. It is hard to ask the outsiders to share our perspectives, the perspectives of engineers. (Interviewee D2, 25/01/2016)*

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<sup>34</sup> 'Power rationing' this term is used in a rather inconsistent way in the documents of Taipower. While some attributes temporary demand reduction measure under the title of planned power rationing some does not. One document points out clearly that 'power rationing' is the term used broadly in press while 'load restriction (負載限制)' belongs to its strict technical usage.

Generalising is treated as a necessary process when a technical terminology comes from the engineers' control room to the planner's office, and finally to the sphere of general public. The concept of 'power rationing', as plastic and robust as it is, does a great job of communication among the three groups. However, this is done at the expense of simplification, and therefore carries great political implications. On the one hand, engineers, as the system operators, care about how to prevent the system from breaking down due to the unbalance caused by excessive demand. On the other hand, power disconnection is the situation that citizens most want to avoid. Consciously or unconsciously, actively or passively, the planners bridging the above two groups fail to highlight the different social concerns — the declaration of power shortage is made possible through the implementation of power rationing measures. **This is an implicit process of the attempted stabilisation of the definition of what is salient and priority for energy politics in Taiwan.**

The fundamental difference between the public, engineers and planners, in this case, is that the public is not really participating in the negotiation with engineers and planners. Surely, citizens do not want to encounter power shortage, but neither do they only find satisfaction in consuming electricity. Energy issues are not only about provision and consumption issues. The multiple implicit costs of electricity generation of different technologies, the safety of nuclear power, and the exploitation and degradation of the environment, and the industrial-economic development patterns implicitly built in the policy of demand satisfaction are all crucial concerns expressed in the recent massive street protests (GCAA 2013). In contrast, in the nationalist-high-modernist story-lines, engineers as planners are presumed to be uniquely placed to act on behalf of the public interest and the benefit of the whole nation. In the following sections, I will explore how this assumption is justified by the calculation of objective

reserve margin and operation reserve, the public witness of real-time operating reserve and the ‘technically necessary choices’ claimed by them in electricity planning tasks.



Figure 8 — the different concerns as represented by the key terms among different actors

### **Objective and Observable Figures: Reserve Margin and Operating Reserve**

The near-paranoid discourse about power shortage in the nationalist-high-modernist story-lines is also underlain by the creation of observable indicators and objective figures. If power shortage is substantiated by the institutional practice of power rationing then observable indicators and capacity figures give it objectification. There are two important concepts used by Taipower; the ‘proper understanding’ of these two concepts is considered by different actors as the crucial, if not the only, marker of eligibility for taking part in the relevant debate. To a large extent, it is seen as the only sensible way to discuss power shortage and the (in) sufficiency of electricity. They are powerful concepts that even competing discourses need to resort to: ‘reserve margin (備用容量)’ and ‘operating reserve (備轉容量)’. ‘Reserve margin’ is a concept mainly used for the long-term planning of system capacity, whereas ‘operating reserve’ is used for measuring system resilience during day-to-day operation. The definition of the two

concepts can be summarised as below (the equations for reserve margin and operating reserve are identical):

$$\text{total available capacity} - \text{peak demand (in MW)}$$

$$\frac{\text{total available capacity} - \text{peak demand}}{\text{peak demand}} \times 100 \text{ (in \%)}$$

The main difference between reserve margin and operating reserve can be summarised as follows (Taipower 2015f, i, Prada 1999):

Reserve margin	Operating reserve
The long-term ability of the system to meet the forecasted/expected demand	The short-term ability to meet a given load
In the long term, there is more uncertainty in planned construction of power plant and demand forecasts	In the short term, there is less uncertainty about load forecast and capacity
It is mainly used for <i>power development planning</i> purposes and is only released as one figure per year	It is mainly used for <i>daily dispatching operation</i> and released as one figure per day
The 'total available capacity' is referred as 'net peaking capacity <i>in planning</i> 系統規劃淨尖峰能力'. This is total available capacity which <i>does not</i> recognise the unavailability caused by annual repair 歲修, temporary repair 小修 and unplanned outage 故障機組.	The 'total available capacity' here is referred as 'net peaking capacity <i>in operation</i> 系統運轉淨尖峰能力'. It is a reduced figure which takes account of the unavailability caused by annual repair 歲修, temporary repair 小修, unplanned outage 故障機組 and other factors such as extreme high temperature 高溫, auxiliary equipment outage 輔機故障, environment protection policy driven restriction 環保法規限制.

Several points should be highlighted in terms of the definition of *reserve margin*.

- Reserve margin can also be called ‘capacity margin’ (OFGEM 2014). It is defined as ‘the excess of installed generation over demand’ (OFGEM 2014, 55) and ‘the level by which available electricity generation capacity exceeds the maximum expected level of demand’ (Royal Academy of Engineering 2013, 26).
- It is expressed either in MW of excess installed capacity or as a percentage excess over total demand.
- The ‘total available capacity’ is also referred to as ‘net peaking capacity for planning (系統規劃淨尖峰能力)’ by Taipower (Taipower 2015g, Cheng 2011). It is defined as follows:

For coal or gas plants:

*Installed nameplate capacity<sup>35</sup> – power station internal consumption*

For hydro plants:

*the maximum output by the water level in the dry season*

Therefore, the ‘total available capacity’ can be estimated as (Sun 2013, Taipower 2014b):

*The nameplate capacity × net peaking factor.<sup>36</sup>*

- Peak demand is defined as the highest average demand that can be expected within any 1 hour during the year.

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<sup>35</sup> Installed nameplate capacity can also be called ‘gross capacity’.

<sup>36</sup> Net peaking factor will be fully explored in the following section.

- The calculation of total available capacity does not take account of the unavailability caused by annual repair (歲修), temporary repair (小修) and the unplanned outage (故障機組).
- Reserve margin is mainly used for **power development planning purposes** and is only released as **1 figure per year** (Taipower 2015g, d, Cheng 2011);
- Capacity ‘must be planned and constructed in advance to provide for uncertainties<sup>37</sup> in the forecast of demand growth, overhauls of generating equipment and plant maintenance, and generation outages that are not planned or scheduled’ (Prada 1999, 19, Taipower 2015g).

With regard to the definition of operating reserve also, several points should be highlighted.

- Operating reserve ‘represents the capacity that must be available to replace the loss of generation due to forced outages’, ‘the allocation of operating reserves consists in the decision concerning the capacity and units to commit to replacing failed generating units’ (Prada 1999, 17-18).
- Peak demand is defined as the instantaneous highest demand in one day.
- The ‘total available capacity’ here is referred as ‘net peaking capacity in operation (系統運轉淨尖峰能力)’. It is a reduced figure which, unlike that used in the calculation of ‘reserve margin’, takes account of the unavailability caused by annual repair (歲修), temporary repair (小修), unplanned outage (故障機組) and other factors such as extreme high temperature, auxiliary equipment outage (輔機故障), environment protection policy driven restriction (環保法規限制).
- It is mainly used for **daily dispatching operations** and shown in **1 figure per day**

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<sup>37</sup> Reserve margin does include uncertainties, but the causes of uncertainties and its possible volume is not clearly recognised. They are left in ambiguity.

(Taipower 2015b, Cheng 2011).

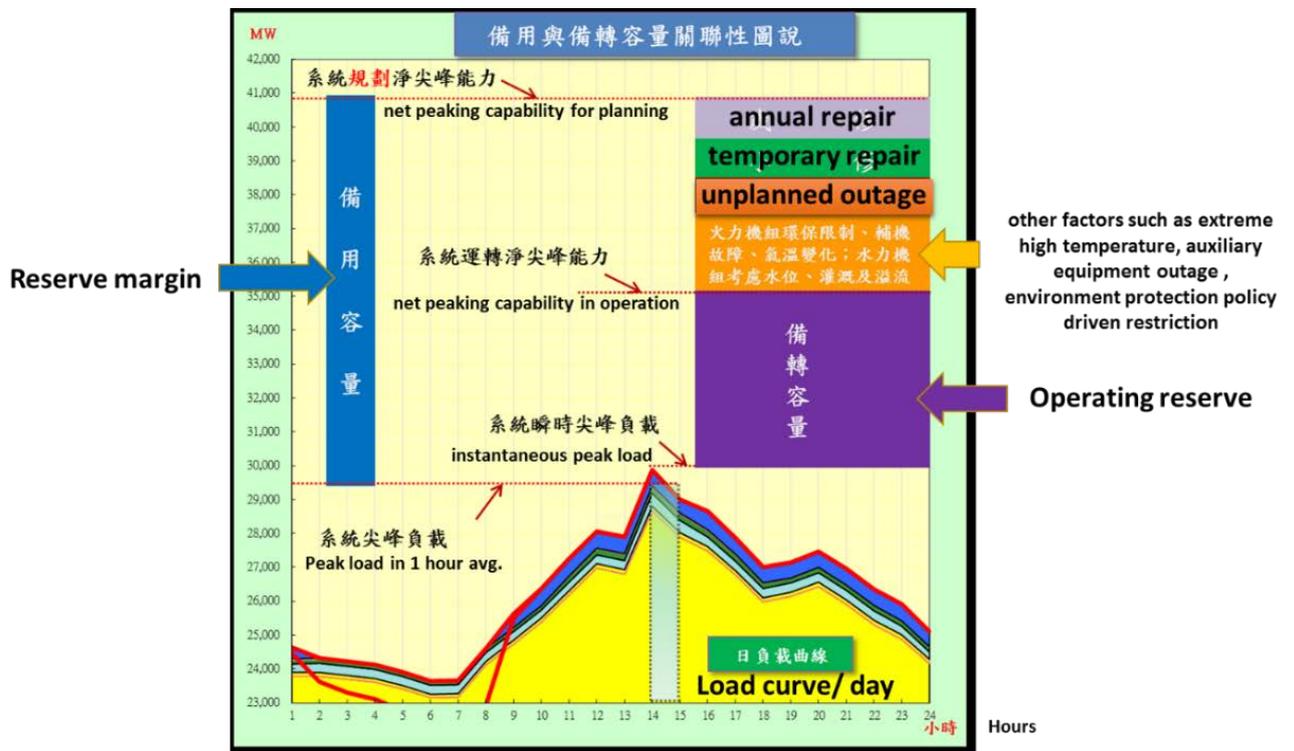


Figure 9 — the breakdown and comparison of reserve margin and operating reserve

(Taipower 2015g, b)

Both reserve margin and operating reserve are predicted figures; however, they are based on different time scales. The availability in reserve margin shows the estimated available capacity in 1 year; therefore, it is an estimated figure which ignores unavailability such as annual repair, temporary repair, unplanned outage and other factors which interfere with maximum power production from the total installed capacity. In contrast, the availability of operating reserve means the (also estimated) available capacity on a specific day, which takes account of the 'recognised factors' in that day (the estimation of operating reserve of a specific day is done normally only several days before) such as annual repair, temporary repair, unplanned outage and

other factors.

### *How Much Is Enough? Calculation of a 'Reasonable' Reserve Margin*

Over the period between 2011 and 2015, the calculation of reserve margin and operating reserve came to dominate the public debate over electricity. Taipower has always argued that *reserve margin* is the most important factor that can be used to evaluate the stability of electricity provision in power planning. Reserve margin can be seen as the built-in buffer zone in regard to uncertainty. A higher reserve margin means that more uncertainty can be allowed. Yet this buffer zone comes at the expense of a massive construction and maintenance cost. It is evaluated that an extra 1% reserve margin requires extra 10 billion NTD (206 million GBP) expenditure (Control Yuan 2012).

The volume of this capacity indicates the reliability of electricity provision; however, the 'excessive volume' also means the waste of budget on unnecessary construction and maintenance. In the nationalist-high-modernist rationality, the core question is how to attain a 'reasonable' reserve margin. Revealed in the report produced by the Control Yuan (the watchdog of government administration), the 'reasonable volume' which is defined as the 'statutory reserve margin' changed several times in the history with a general trend of decrease. The following table shows the statutory reserve margin and LOLE (Loss of Load Expectation):<sup>38</sup>

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<sup>38</sup> LOLE describes the probability of demand exceeding supply from the view of whole electricity system. The situation of smaller reserve margin and smaller LOLE reflects the improved expected reliability target of the electricity grid over the years, and reserve margin is not the only decisive factor in LOLE.

Year	1972	1977	1983	1985	1991	1993	1997	2005	2012
Statutory reserve margin (%)	-	-	25	25-20	20	20-15	20-15	16	15
Statutory LOLE Hours in 1 Year	72	72-24	-	24	24	24	12	8.76	8.76

Table 7 — the historical statutory reserve margin and LOLE as reliability target  
(Control Yuan 2012, 10, Taipower 2015g)

There is no official framework on how to set an ‘appropriate’ reserve margin. According to the Control Yuan report, there are several factors contributing to the setting of statutory reserve margin: the scale of power generation system (the numbers and total capacity of generators); the observed frequency of unplanned generator outage; the statutory LOLE; the ability to accurately forecast demand; the degree of confidence in the ability to repair breakdown; the ability to schedule repair; the percentage of renewable energy in generation capacity (since this is judged to be an unpredictable energy source); and the development of the economy and national income (GNP)<sup>39</sup> (Control Yuan 2012, 10). It is reiterated again in this report that the reserve margin is a precondition for a growing national economy and a symbol of the statist support to the aspiration of national prosperity.

While more reserve margin does bring higher system reliability, this surely does not

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<sup>39</sup> In governmental discourse, GNP is directed connected with the reliability of electricity provision. This is a main rationale used in the governmental discourse to argue higher electricity demand is the necessary and sufficient condition of a growing GNP.

means it is ‘the only way’ to ensure a sufficient supply. After all, the size of the reserve margin depends on multiple factors described above, especially when the official prediction of national economic growth historically tends to be optimistic (Legislative Yuan 2010). To predict lower or even negative economic growth seems to be hard for high-modernists to swallow. The consequence is that depending on predicted economic growth to plan the construction schedule of reserve margin brings huge waste.

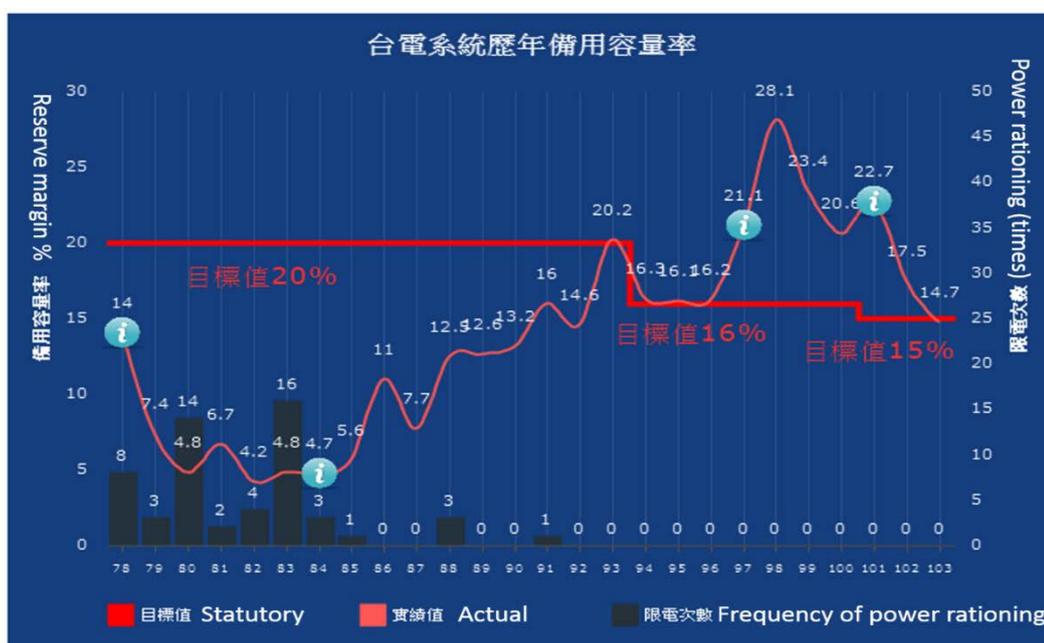


Figure 10 — the trend map of statutory targets, actual margins, and times of power rationing (Taipower 2015g)

The decision of setting statutory reserve margin depends, in the end, totally on the discretionary judgment of experts (Control Yuan 2012). Changing the statutory reserve margin is a process involving pressure from political actors and public opinion, rather than being a purely technological one. However, the ‘reasonable volume’, in the final stage, is always decided by officials and experts. Scientific advisory processes involve

presenting facts, evidence and observable indicators; but politics is subsequently responsible for making choices on the basis of those facts and rational factors. In this sense, the translation from technoscience expertise to policy-making ought to be quite unproblematic and straightforward (Jasanoff 2005, Ezrahi 1990). However, this view ignores the intrinsic political assumptions behind these expert judgements and the sensitivity of technical data, which is reflected in the extremely cautious attitudes displayed by my interviewees. Interviewee L1 for example talked about decisions concerning how to release technical data:

*The decision of how to and in what format we release technical data is made by my superior ... this is decided by my superior and other heads of departments ... permission must be granted firstly by the higher superior, then we can release it. This follows the [action] patterns of other civil servants, following [the rule of] hierarchical discretion. After all, this is important data. (Interviewee L1, 19/01/2016)*

My interviewee later admitted that there are no written rules about how to judge the political importance and sensitivity of data, and therefore the decision tends to be always referred to the higher authority. Technical data is far from merely the presenting of neutral facts and they are always understood as a matter of political sensitivity.

There have been improvements in the reliability of power supply system, as no power rationing has been recorded since 2003 (see figure 10). However, the discourse of reserve margin should be seen as a combination of the routinised form of historical comparison and an active downplaying of other factors rather than a proof of the required reserve margin. It is not only about the 'proud history' of Taiwanese

technoscience and the ability to keep a nationalistic promise but also involves **the construction of certainty and uncertainty**. The above trend graph of reserve margin and the frequency of power rationing in recent decades has a great political significance, hinting that an extra volume of reserve margin is needed in order to secure a promising future. However, the relation between these two factors needs much more examination.

The pragmatist value of objective figures deriving from Taipower engineers' experience and expertise is pivotal to high-modernist rationality. The main line of reserve margin discourse is that electricity supply should always invariably satisfy demand, which implies that 'sufficient extra capacity' should be built in order for the planned generation capacity to meet forecast demand. The MOEA and the BOE always claim that reserve margin should be maintained above 10% (and should preferably meet the statutory target of 15%). According to them, when it is lower than 10% power shortage and power rationing is highly possible; when it is lower than 7.4% then the shortage and ensuing power rationing is inevitable. The MOEA insists that power rationing would bring catastrophe to the nation and society (Ministry of Economic Affairs 2014c). This is the underlying rationale repeated again and again in the governmental discourse.

The discourse of reserve margin, especially the calculation of capacity volume, has effectively framed the whole debate in the way of mechanical objectivity by providing mathematical figures. The presentation of mechanical objectivity through the calculation of reserve margin has a powerful appeal to the wider public. Quantification is never merely a set of tools. Mechanical objectivity and quantitative expertise in the making of public decisions mean extracting knowledge by following strict rules (Porter 1995, Daston 1992). Instrumental quantification is demanded in these contexts

because subjective discretion has become suspicious (Porter 1995). Mechanical objectivity means fairness and impartiality, and therefore, the figures of reserve margin are seen as the impartial and only legitimate way to discuss electricity. This has become a taken-for-granted fact that is anchored deeply in institutionalised practice and is reproduced again and again through in all struggles with competing discourses.

Even so, the concept of reserve margin itself has many aspects which should be further examined. Since it is the capacity which ‘must be planned and constructed in advance to provide for uncertainties in the forecast of demand growth, overhaul of generating equipment and plant maintenance, and generation outages that are not planned or scheduled’ (Prada 1999, 19, Taipower 2015g), every single element mentioned above has significant influence over the availability of reserve margin.

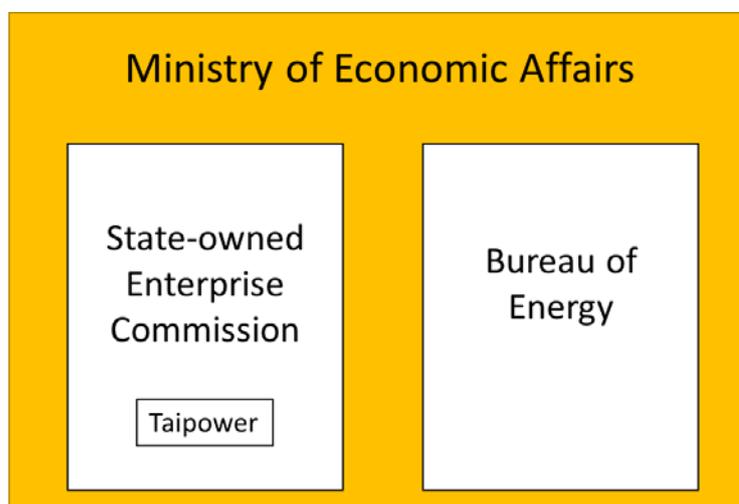


Figure 11 — institutional relation between the MOEA, BOE and Taipower

Reserve margin is calculated on the ground of multiple assumptions. In Taiwan, the survey of installed capacity and assessment of reserve margin is undertaken by the BOE and Taipower in a parallel way. Both institutions are under the supervision of the

MOEA. Their institutional relation can be illustrated by figure 11. The BOE is not the direct authority of Taipower, the electricity industry monopoly; Taipower is under the supervision of the State-Owned Enterprise Commission which is parallel to the BOE. The assessment of reserve margin is divided into two parts: the '*National Long-Term Electricity Demand Forecast (全國長期負載預測)*' and the '*Power Development Plan (電源開發規劃)*'. The logic behind these two documents is simple: to secure stable electricity supply, 'sufficient extra capacity' should be built so that it can meet the forecasted demand.

The specific method used to assess reserve margin has been explicitly criticised by the Control Yuan. Before revealed by the Control Yuan's report, despite the fact that the law requests the BOE to produce an assessment report by itself, the actual author of the assessment report is Taipower. Taipower has taken the leading role in demand forecast and electricity development planning since long before the establishment of the BOE in 2004. This is a routinised practice that is difficult to change. After the BOE's establishment, it outsourced the task to Taipower, which means Taipower is still both responsible for forecasting demand *and* planning the construction of capacity for meeting the demand forecasted. The role that Taipower plays in reserve margin assessment is highly ambiguous (Control Yuan 2012). Taipower is in effect the player and referee at the same time. After this problem was revealed by the Control Yuan in 2012, assessment reports of reserve margin have been done by the BOE and Taipower separately. The difference between the two reserve margin assessment reports can be shown in the diagram below.

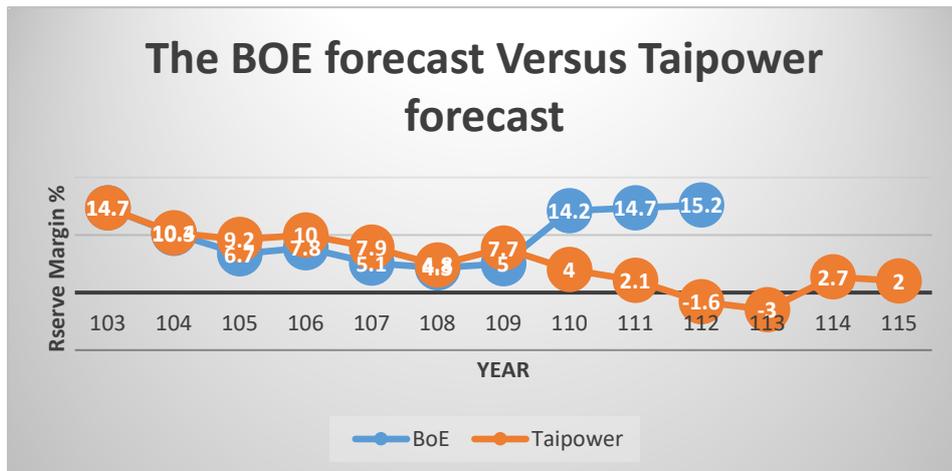


Figure 12 — the discrepancy between the forecasts made by Taipower and the BOE (Taipower 2015a, Ministry of Economic Affairs 2014d)

The crucial factors contributing to the significant difference between the two reserve margin forecasts in the year 110 (A.D. 2021) are the planned construction of new power plants on the supply side and the energy-saving effect on the demand side, both of which are included by the BOE but not by Taipower.<sup>40</sup> The scenarios used by the BOE and Taipower are both without NPP4 in operation, and with no extension of existing nuclear power plants. Looking into the details, the major difference shown after the year 2021 is created by the contrasting commitment the BOE made to build enough CCGTs (combined cycle gas turbines) to meet the forecasted demand (B. o. E. Ministry of Economic Affairs, 2014a, pp. 24-25),<sup>41</sup> while Taipower still tries to figure out the possibility of resuming NPP4, assuming that alternative options are all too late and all too uncertain to include in the prediction (Taipower 2015a, 2014b).

<sup>40</sup> Even inside Taipower, there are contrasted attitudes toward this ‘minus reserve margin’ forecasts. For the dispatching office, as implied by the interviewee D2, this is totally unacceptable and irresponsible. This is the power development plan which needs to be rebutted in the internal coordination meeting because it directly leads to the predicament of power rationing.

<sup>41</sup> This is also echoed by the technological features of CCGT. ‘CCGT plants are a lot quicker to build, the interviews providing the illustration of a CCGT plant taking around 3 years to construct, compared with 4.5–5 years for a coal fired plant’ (Branston 2002, 1316).

The discrepancy between different assessment reports can be very large. The report produced in 2014 by the BOE is the first time an official report outlined the contribution of energy saving to curbing demand growth. The discrepancy between different reserve-margin forecasts indicates the highly hypothetical nature of this kind of assessment, which means that untestable assumptions become key drivers. It is a demonstration of preferred energy futures of individual institutions, rather than a 'realistic future' to come and to plan for. The challenge the calculation of a 'reasonable' reserve margin brings is not the accuracy of prediction of energy sufficiency but **the premises and forms of rationality assumed in the way of making objectivity.**

*Making Observable Public Facts: The Light Signal of Operating Reserve*

Being able to be observed has been a crucial element of nationalist-high-modernist story-lines. When society is transformed from an autocratic regime to a liberal-democracy, the condition of the power supply should therefore be directly witnessed by the general public through empirical indicators. Citizens, after all, are the primary targets for whom the state enacts its scientific and technological demonstrations. As argued by Jasanoff, just 'as a play could not exist without spectators, so the grand narrative of progress through science and technology demands assenting publics to maintain its hold on the collective imagination' (Jasanoff 2005, 248).

The inherent rule laid down by the liberal-democratic polity is the possibility of knowing other people, and understanding and judging their actions. This is an important premise for the belief that true representation is achievable and that political agents can be held accountable to the public. 'This faith has been upheld in the liberal-democratic tradition by an optimistic political epistemology, according to

which politics consists of actions or events that are observable and reportable as public facts' (Ezrahi 1990, 67). Technical instrumental terms are constructed with the aim to externalise and objectify political actions in the visual space of publicly perceived facts (Ezrahi 1990). In contrasting to the alarming future depicted in the reserve margin discourse, the observable indicator of operating reserve presents **an observable, immediate, real-time indicator**. Operating reserve is the meter reading which can be obtained from the dispatcher's control panel. Compared to the probabilistic index such as LOLE (e.g. x hours in 1 year), it is more real and concrete for the dispatcher. It is a more empirically based indicator rather than a probabilistic indicator, in the dispatcher's opinion (Cheng 2011). Operating reserve shows in real time how much MW or capacity (%) can be used for balancing purposes.<sup>42</sup>



Figure 13 — the original 'Precautionary Light Signal of Power Provision'.

The idea is that the real situation of electricity provision should be opened to the general public. The figures showing how much operating reserve is available in real time were put online because of public pressure.<sup>43</sup> This is the information which until 2013 was regarded as internal data and not released to the public (Cheng 2011). One

<sup>42</sup> The availability used for operating reserve calculation is estimated on a daily basis.

<sup>43</sup> <http://203.69.66.120/news/view/2013-02-18/33726>

year after its release, the indicator scheme was online.<sup>44</sup> This is the indicator scheme called ‘the Precautionary Light Signal of Power Provision (電力供應預警燈號)’. It used three ‘light’ signals: green, yellow and red. In June 2015, after a series of declarations of power shortage, the classification was expanded to deliver more ‘clear information’.



Operating reserve level	$\geq 10\%$	10%~6%	$\leq 6\%$	Under 900,000 kW	Under 500,000 kW
Diagnosis and action	Ample	Tightening	More risk of power rationing	Power rationing alarm	Power rationing preparation

Figure 14 — the ‘Precautionary Light Signal of Power Provision’(Taipower 2015j)

It is stated clearly that when operating reserve is under 500,000kW, then the ‘Industrial sector power rationing’ stated in the executive order ‘Measures to Power Rationing during the Power Shortage Period’ will be initiated. It is said that the purpose of the re-design is to urge the public to ‘together sacrifices on the basis of understanding and appreciation (共體時艱)’ and support energy saving by action (not only by words) to

<sup>44</sup> <http://news.ltn.com.tw/news/business/breakingnews/1058513>

decrease the risk of power rationing(Ministry of Economic Affairs 2015b).<sup>45</sup>

Likewise, energy saving is defined in moral terms. The state has the responsibility to provide sufficient electricity to industry and society; however, this cannot be abused through the waste of energy, and ‘citizens’ have their own responsibility to do their bit to make sacrifices on the ground of understanding. I argue that an assumed paternalistic relation between state and society is at the core of this nationalist-high-modernist rationality, which implies that the state has done ‘all can be done’ in its pragmatic consideration, and the remaining responsibility should be taken up by citizens. This is a social convention which shows that the developmental Leviathan still lives on.

Although the indicator scheme of operating reserve represents ‘a matter of fact’ of how much capacity is left for dispatching, it fails to capture the complexity of the ‘matters of concern’ (Latour 2005a) embedding in the institutionalised practice of Taipower. The meaning and diagnosis of every signal are not as static and mechanically rigid as the indicator scheme intends to show. As suggested by interviewees W8 and D2:

*I guess [the handling of] operating reserve largely depends on dispatchers’ experience. So there isn’t a rigid quantitative mechanism behind the handing – it is decided by the conclusion of their internal meetings. Through the interaction with the dispatching office, I gradually realise that there are no fancy quantitative models like I assumed. Lots of things are based on their*

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<sup>45</sup> Here power rationing means any actions including mitigation measures.

*rule of thumb.* (Interviewee W8, 28/01/2016)

*Power rationing often results from the unplanned outage of high capacity generators ... this is why the dispatching unit needs to, in convention, prepare at least the equivalent operating capacity of the highest capacity generator [in the system] so it can react to an emergency situation. This can also be the half capacity of the highest capacity generator. The more operating reserve, the more provision stability, but it also means no economic efficiency ... in the isolated electricity grid like Taiwan, dispatchers [naturally] want more operating reserve ... I think this indicator scheme is invented on the basis of [the current dispatchers'] experience. In my opinion, it [the diagnosis of signals presented here] is slightly conservative.* (Interviewee D2, 25/01/2016)

The envisaging of the indicator scheme should be understood as an effort to make engineer's managerial figures into public facts for collective witness (Shapin and Schaffer 1985), while the black boxing of the internal convention and discussion is done at the same time. Through the collective witness of objective figures, the flexibility of the interpretation of operating reserve is diminished to the extent that relevant experience is deleted and replaced by static rules.

### **Examining the Technicality in Electricity Planning**

The institutionalised sociotechnical facts made through calculating reasonable reserve margin and the public witnessing of real-time operating reserve mean that the meter reading shown in the engineer's control room and forecast charts in the planners' office are given significant social meaning and turned into a convincing ground for the high-modernist vision. Engineers as planners make the decision not only

on the ‘facts’ available to them but also on the ingrained institutional culture and practice.

The 4<sup>th</sup> Nationwide Energy Convention held in January 2015 can be perceived as the Nationalist government’s attempt to resolve the controversy by making even more public facts. The international comparison has its significance in the nationalist-high-modernist story-lines; it is used to show the extent of Taiwan’s linearly-conceived technological progress in comparison with other leading industrialised countries. The nationalist-high-modernist position also registers itself in the belief in being able to keep pace with others in strictly technical terms. The comparison table was presented by Taipower in the Convention as an objective fact to start a rational discussion. This document later passed a publicly witnessed expert review panel and was perceived as an objective fact. Taipower has always argued that the ‘reasonable reserve margin’ in Taiwan should be in line with other industrialised countries, although it does recognize differences of context and definitions between them.

The British definition of reserve margin is considered as ‘similar’ to its Taiwanese counterpart (Taipower 2015g). The 20% ‘British reserve margin’ is said to be a good or even excellent practice which Taiwan should follow, reflecting how the ‘decent and reasonable’ Taiwanese statutory volume (15%) is. However, this is an argument which deserves much more scrutiny.<sup>46</sup> For example, according to the British government’s Electricity Market Reform Delivery Plan, the LOLE (Loss of Load Expectation) is set as 3 hours/year which is much more rigid than Taipower’s standards, 8.75 hours/year.

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<sup>46</sup> The 20% British reserve margin, after it is translated to Taipower’s reserve margin, can be much lower. The actual conversion is difficult to obtain because of the makeup of the renewables in two generation systems, but generally speaking the more proportion the renewables contributes, the larger the gap between the two. The figure of British LOLE provided by Taipower here is in different format and therefore can’t be used for comparison directly.

表 1 各國電業之供電可靠度標準與備用容量率水準

國家	我國	美國	英國	新加坡	韓國	日本	歐盟
供電可靠度 (缺電期望值)	0.365 天/年	1 天/10 年	9 冬天/100 年	3 天/年	0.3 天/年	0.3 天/尖峰月	1 天/10 年
備用容量率	15%	15%	20%	30%	22%	8-10%	20%-38%
備用容量率 制定考量原則	我國自 2012 年 9 月調降備用容量率為 15%，做為我國規劃長期電源開發方案之標準，用以因應未來機組大修、小修、故障、減載、機組老化、水力	北美電力可靠度公司(NERC)以供電可靠度 10 年缺電 1 天之標準，建議北美各區域電力的備用容量率標準參考值，其備用容量率計算主要考量各區域電	英國 2014 年夏季各週可用容量於正常情況下扣除負載用量，剩餘容量(remaining capacity)最高達 7.5 GW，可用於應付機組故障、非預期性尖峰負載激	2012 年新加坡最高供電能力約 7GW，在一級備用容量上約 0.4GW，在二級備用容量上約 0.5GW，在意外事故備用容量上最高約	韓國設定 2027 年備用容量率目標為 22%，其考量最低備用容量率 15% 加上電力需求不確定性 7%。前者是將發電機組故障、停止、維修、核電安全等政	日本長期電源開發規劃之備用容量率(即預備力)採 10% 以上，用以應付氣候異常高溫、景氣變動及機組故障等非預期性因素，惟其備用容量率計算業	歐洲輸電網操作機構(ENTSO-E)評估 2014 年夏季歐洲整體電力的備用容量率在考量 10 年 1 天缺電標準情形，於正常情況下，要有 155GW 即 38%
	變動、負載預測變動及工程計畫延宕等電力供需變化。	力容量資源、需求與電力交易情形。	增、及計畫之出口等。	1.1GW。全部備用容量率約 2GW/7GW=29%。	策納入考量，訂定備用容量率需要 15%；而電力需求不確定性則是以韓國第一至第四電力計畫(BPE)之平均年度目標需求誤差率為 7%。	已扣掉廠用電、機組定期檢修及枯水減載等不可用容量。	的備用容量。若遇超出正常用電需求的嚴峻情況，則至少要有 85GW 即 20% 的備用容量。

Country	Taiwan	U.S.	U.K.	Singapore	S. Korea	Japan	EU.
LOLE	0.365 day/year	1 day/10 years	9 winter days/100 years	3 day/year	0.3 day/year	0.3 Day/peak month	1 Day/10 years
Reserve margin	15%	15%	20%	30%	22%	8-10%	20-38%

Figure 15 — the comparison of LOLE and reserve margin (Taipower 2015g, e)

Working on Certainties: The Net Peaking Factor of Availability

While the concept of reserve margin is so established in the debate that it is treated as a common language crossing different competing discourses, the question ‘is it a reasonable and sufficient margin?’ produces no fertile outcome and fails to generate a reflexive understanding of its meaning. The major difference between the British definition and Taipower’s definition is the ways these two electricity industries

presenting the total availability when considering reserve margin.

The British electricity industry presents the total availability; it is the theoretical and nameplate capacity of generators installed. As explained by the Royal Academy of Engineering 'traditionally, total available capacity was taken as **the sum of full theoretical or nameplate capacities** of all plant on the system' (Royal Academy of Engineering 2013, 9). However, this theoretical and nameplate capacity is only useful for electricity developmental planning purposes. The definition stresses its 'gross' attribution of listed capacity, therefore, it can also be called as '**gross capacity**' (Royal Academy of Engineering 2013). However, this concept is gradually losing its preference due to 'the increasing contribution of variable renewable resources, whose average output is considerably lower than their full rated nameplate capacity'. An increasingly preferred capacity margin measure is the 'de-rated capacity margin' (Royal Academy of Engineering 2013, 9).<sup>47</sup> However, Taipower's definition of the total availability is regarded as 'net peaking capacity for planning' which is defined as:

*the nameplate capacity × net peaking factor*

**Net Peaking Factors (NPFs)** is the factor decided by the Taipower's internal convention which is established in the assumed condition. For gas or coal plants it is (Taipower 2015d):

$$\frac{\text{installed nameplate capacity} - \text{power station internal consumption}}{\text{nameplate capacity}}$$

For hydro plants it is:

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<sup>47</sup> The definition of de-rated capacity will be explained in the following paragraphs.

(the maximum output with the water level in the dry season)  
nameplate capacity

For renewables such as solar, wind and biomass which are technologies comparatively new to Taipower's generation system, the peaking factors are simply 'set' as assumed figures. NPFs<sup>48</sup> are summarised as below (Sun 2013):

Net peaking factor <sup>49</sup>	
Nuclear	94%
Coal	94%
Gas	97.8%
Biomass	50%
Hydro	85.78%-40.15%
Solar	20%
Wind	6%

Table 8 — the values of NPFs

Net peaking factors are calculated not on the current output, but simply by assuming the 'right figures' — figures which are habituated in Taipower's institutional practice, and do not receive regular and appropriate review and check.<sup>50</sup> Interviewee D2 recognises the inadequacy of the operating experience of renewables in Taipower,

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<sup>48</sup> This is defined as the average of 85% available output in a year. Some argues this should be set as 50% when it comes to the renewables due to their intermittent generation, otherwise the availability of the renewables can be underestimated.

<sup>49</sup> According to American National Renewable Energy Laboratory, this capacity value for PV is in the range of 50%-80%. For wind power, it is 25%, says Pacific Northwest National Laboratory, which is similar to the figure shown by Royal Engineering Academy—17%-24%.

<sup>50</sup> This is the point that invoked criticism when NGOs demanded these factors to be examined and reviewed in the 4<sup>th</sup> (2015) Nationwide Energy Convention. The conclusion is that these factors need to be reviewed and checked. The conference record can be accessed at:

[http://2014energy.tw/image/download/plenary/ConferenceRecord\\_02.pdf](http://2014energy.tw/image/download/plenary/ConferenceRecord_02.pdf),  
[http://2014energy.tw/image/download/plenary/Wrap-up\\_session\\_02.pdf](http://2014energy.tw/image/download/plenary/Wrap-up_session_02.pdf)

which contributes to the lack of checking and correcting the NPFs of renewable energy:

*Taipower currently has inadequate actual records of renewable energy generation. The accumulation of data is not adequate and neither is the coverage of data. They [The net peaking factors of renewables] should be revised accordingly in the future. As for the operating reserve forecasted by the dispatching unit ... it can always be forecasted on the basis of recent actual generation results and the last year results. It [the forecast] should not be as conservative as it is in the power development unit. (Interviewee D2, 25/01/2016)*

The NPFs are habituated in the electricity planning circle and treated as ‘figures of consensus’ instead of as figures that reflect the latest actual results of the newly constructed renewable installations. They are used as facts in internal discussion:

*These figures are used to discuss the impact that the installation of renewables would bring to the national grid during an internal conference. The dispatcher referred to these figures to explain the possible instability renewables can bring when they are connected to the grid — can they support the huge demand in Taiwan? ... These figures are the consensus in the group of people who engage in energy development. I visited the Institute of Nuclear Power Research — they also use these figures. (Interviewee W8, 28/01/2016)*

Interviewee W8 later told me that these NPFs are understood as ‘the average performance benchmark of a particular technology’ (Interviewee W8, 28/01/2016).

They would not be challenged until a ‘new technology’ or a ‘new generation’ of the technology in question was invented. This implies that these figures do not need to be checked and reviewed against the latest actual generation results. This argument is echoed by the written reply I received from the Power Development Office of Taipower:

*It [net peaking capacity] is used for the purpose of calculating reserve margin and future power development ... the particular output of a renewable installation (solar or the wind) is influenced by the local weather conditions on that day, and therefore, the actual output/nameplate capacity ratio of the same type of renewable energy installations [in different places] on the same day would not be identical. The net peaking capacities of the solar and the wind power are calculated on the basis of the national average of output, not on the particular installation. (Interviewee P1, 28/01/2016)*

While the use of a national average is understandable, the reported observed output/nameplate capacity ratios (the net peaking factors) of different photovoltaic installations around Taiwan are potentially problematic. According to Taipower’s 2015 Long-Term Power Development Plan (p.2-7), the claimed observed NPFs of these installations, regardless their geographic positions, are all about 0.2 – that is, 20% in northern Taiwan, 19% in the central Taiwan, 20% in southern Taiwan and 19% in outside islands. Due to the huge difference of latitudes and solar irradiance distribution, this correlation is problematic and deserves further investigation. The **NPFs have their politics and are the concentrated form of making social meaning implicitly — correct knowledge makes normative meaning**. Working as facts of consensus and objectivity, they are enacted as **the inherent technical capacity of generation technologies, a part of habituated technical expertise, and the legal qualification for engaging in**

**electricity planning debates.**

		The nameplate capacity	The observed net peaking capacity	Ratio
	太陽光電	42.20	8.44	
Northern Taiwan	北部	0.95	0.19	20%
Central Taiwan	中部	8.21	1.64	19%
Southern Taiwan	南部	32.83	6.57	20%
Outside islands	離島	0.21	0.04	19%

Figure 16 — the reported observed (actual) output/nameplate capacity ratios of photovoltaic installations around Taiwan (Taipower 2015m)

In fact, Taipower does have a definition on how to define a net peaking factor of a renewable energy calculated on the basis of actual generation results. According to the definition, for solar power, it is as follows (Taipower 2015m, 2-4):

*Base on the output recorded from 10 hours to 17 hours every day in a year, the maximum power a generator can supply during this specific period for at least 85% of the time is defined as its net peaking capacity, that is, about 20% of the nameplate capacity*

For wind power, it is:

*Base on the output recorded every day in a year, the maximum power a generator can supply during this specific period for at least 85% of the time is defined as its net peaking capacity, that is, about 6%*

*of the nameplate capacity*

Two key implications need to be highlighted in terms of the technical choice made by Taipower here: the first, the standard of ‘the capacity available in the 85% of the time’ can be considered as strict especially for the intermittent generation technologies like the renewable. According to a report commissioned by Taipower in 1996, this is a standard originally designed for coal-fired technology because it can generally produce stable output at all times of the year. Under this standard, the contribution of renewables to the total net peaking capacity (the total availability in reserve margin calculation) is significantly underestimated, and therefore, I would argue that the standard should be set as the capacity available for 50% of the time, instead of 85% of the time, in order to avoid the ‘zero contribution’ scenario of solar power (Wang 1996). Taipower has since made a revision to the definition; however, the 85% standard originating from the incumbent coal-fired generation is proving a convention too firmly rooting in institutional practice to be easily changed.

The second, most important reason to calculate ‘net peaking capacity for planning (the total availability/supply)’ is to examine whether supply can meet the demand during peak time. While taking account of the output records for a whole year is quite sensible for the incumbent generation technologies like nuclear, coal-fired, and gas-fired power because they can in principle always produce stable output, this rule becomes problematic for renewables — indeed it may be seen as discrimination against renewable energy.<sup>51</sup> The output of renewables can fluctuate quite markedly depending on weather conditions, meaning the weather patterns in different seasons a crucial

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<sup>51</sup> According to the British government’s Electricity Market Reform Delivery Plan, in the calculation of de-rated margin, it only takes account of the output records of the peak season, that is, the winter season in the U.K.

factor that cannot be neglected. In Taiwan, summer and early autumn are the traditional peak time of power consumption, due to the widespread use of air-conditioning – and photovoltaics, fortunately, can produce much higher output than it is in winter.<sup>52</sup> Thus it might be more reasonable to argue that renewables are not meant to replace ‘base load’ generation, but to help meet the peak demand in a year.

Two distinctions should be noted in the comparison of the two approaches used by British electricity industry and Taipower. The first is, in British electricity industry, reserve capacity is clearly treated as a rough, imprecise and hypothetical figure, as it only shows the designed capacity in an ideal environment such as a laboratory. This total availability registers an ideal situation which indicates the desirable future towards which the electricity development planners are aiming. It is an approximate capacity and indicatively aimed for institutional assurance.<sup>53</sup> For Taipower, by contrast, reserve margin is, without a doubt, more than a purely hypothetical and indicative figure. It is a figure used in the planning for the nation’s future and adjusted according to assumed net peaking factors – these figures are hard to check and review for third parties, given that Taipower is the only body possessing the records of and expertise in running a large scale electricity generation system in Taiwan.

### **Ordering the Future: The Creation of Factual Certainty**

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<sup>52</sup> There is an unsolved problem that the calculation of reserve margin (%) only takes account of the average demand of the peak hour in the whole year, but, for the renewables in the supply side, why does it take account of the output records of the whole year?

<sup>53</sup> ‘In the past, the CEGB would typically have planned the system on the basis of maintaining a 20% gross capacity margin’ (Royal Academy of Engineering 2013, 9). Although reserve margin now is rarely used in British electricity planning, the result of a more complicated assessment today is treated with caution as well. The possible energy futures as highly constructed and complicated as they are in the Ofgem report, however, the intention of this report remains an indicative and suggesting position rather than prescribing and ordering the reality. This is a point clearly declared in the report, saying scenarios and sensitivity analysis used in the report are not meant to ‘predict the future’ (OFGEM 2014, 30).

High-modernist rationality has a crucial role to play in the ordering of the future, since the concern of Taipower’s electricity developmental planning is to ensure a potent national economy in the decades to come. It is not hard to comprehend why Taipower’s conceptualisation of reserve margin relies heavily on making factuality. The total availability (and, therefore, reserve margin in Taipower’s definition) is treated as a factual certainty by Taipower and used in public persuasion, which thus requires authoritative commitment and coercive power in order to build the future of the whole nation. Uncertainty has to be ruled out, and hypothesis needs to be transformed into established factuality. The rationality of developmental planning which underlies nationalist-high-modernist story-lines involves an obsession with creating certainty – creating certainty for planning the future nation!

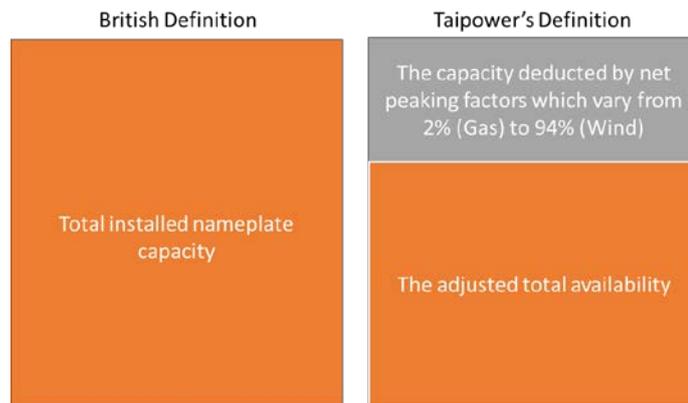


Figure 17 — the comparison of British and Taipower’s definitions of ‘reserve margin’

Total availability (Reserve margin)	British definition	Taipower’s definition
The implication	A hypothetical, rough and indicative capacity. A nameplate capacity	A capacity of factual certainty adjusted by net peaking factors

Table 9 — the comparison between British and Taipower’s definitions of ‘reserve margin’

While in the British electricity industry the obsolescence of the concept of reserve margin is gradually recognised due to the rising contribution of renewables to the generation system, Taipower has no intention of following suit. For them, the incumbent generation technologies such as nuclear, coal and gas can provide highly controllable availability for planning tasks, while renewables give no clear guarantee on how much capacity can be assumed as available. The characteristics of intermittent generation possessed by renewable technology bring a huge challenge to the institutionalised convention, and therefore pose an unpleasant trouble to Taipower's planners. The 'immaturity', and indeed the 'incompatibility' of renewables to the incumbent planning conventions, should be explained as incompatibility with the preferred controllability. Judged by the standards of controllable availability and stability, renewables are seen as truly 'immature', as they can merely provide as low as 6% availability (wind power) when traditional generation technology can provide as high as 97.8%-94%. The entrenched methodology originating from the incumbent generation technology keeps enacting renewable energy as an 'immature' technology.

#### *Working on Uncertainties: Unavailability*

In the British electricity industry, *de-rated capacity or margin* is a concept enjoying increasing preference and replacing reserve margin as the main concept used in electricity planning. The preference for de-rated margin comes from the higher and higher contribution made by renewables in the generation system, which makes the concept of reserve margin obsolescent.<sup>54</sup> Under this concept, the nameplate capacity

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<sup>54</sup> The Ofgem assessment report also uses the concept of Equivalent Firm Capacity to accommodate the contribution made by wind power. This is 'the quantity of firm capacity (i.e. always available) that can be replaced by a certain volume of wind generation to give the same level of security of supply'<sup>54</sup> (OFGEM 2014, 57).

is de-rated by ‘a factor which reflects the statistically expected level of reliable availability from that plant type during a given season’ (Royal Academy of Engineering 2013, 9).<sup>55</sup> How this ‘historically statistical factor by specific technology’ is aggregated and produced is another question which cannot be explored here.<sup>56</sup> The key point is that the ‘historical level of availability of each technology’ is considered as a ‘known factor’ which is explained in that **‘the historic level of availability can account for unavailability caused by unplanned outages, planned maintenance as well as commercially driven unavailability’** (Royal Academy of Engineering 2013, 26). The invention of de-rated margin gives renewables and traditional generation technologies equal footing in the planning task, as the available capacity of both technologies are now equally evaluated through appropriate historical records of availability.<sup>57</sup>

Institutionalised rationality is reflected in the process of making and choosing technical concepts. The design of concepts is far beyond a decision of ‘yes or no’. A series of choices on the specific features of the system needs to be made. These technological choices have profound social and political implications (Winner 1980). In this respect,

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<sup>55</sup> ‘A given season’ here should mean the peak season. In Taiwan, it is late-summer to autumn. In the U.K., it is winter.

<sup>56</sup> De-rated margin comes with a scheme of highly regulated uncertainty. It represents an extended promise of the reliability of generation system. ‘We de-rate the installed capacity of generators, as generators are not available at all times, for example because of planned and unplanned outages. These are derived from analysis of the historical availability performance of the different generating technologies’ (OFGEM 2014, 13). The certainty that de-rated margin provides is guaranteed by strict historical statistical data. The data is treated as an entity detached from the particular utility company and operator, and only reflects the attribution of individual generation technologies rather the performance of utility operators. The extended confidence shown in the measurement of de-rated margin means not only that planned outages and maintenance are expected to be scheduled and finished on time (and during off-peak and low seasons) but also that unplanned outages can be conceptualized into patterns through the analysis of statistical data. De-rated margin implies an improved confidence in the institutional commitment to ensure that planned maintenance finishes on time and reducing the frequency of unplanned outages.

<sup>57</sup> The Ofgem report relies heavily on probabilistic models and aggregated historical data to construct possible futures. The claimed ‘immaturity of the renewables’ which constitutes the essential reason for rejecting renewables in Taiwanese nationalist-pragmatist story-lines is replaced by historical patterns of generation and the adoption of concepts of de-rated margin and equivalent firm capacity.

deliberately or inadvertently, technological features 'establish a framework for public order that will endure over many generations' (Winner 1980, 128). In ways that echo Winner's analysis, I argue that the formulation of reserve margin and operating reserve in Taipower's electricity planning brings about a specific treatment of uncertainties, of the recognised and not recognised.

As we saw above, NPFs do not receive regular and appropriate review and adjustment. The factors used for de-rated capacity can only be acquired through the records of the existing generation system – this means that renewable technologies would need to be installed within the generation system before enough data could be acquired to precisely determine the factors of the de-rated capacity of renewables. This should be a gradual change. The use of de-rated margins and the use of renewable energy in generation system mutually enhance one another.

In contrast to de-rated margin, Taipower's reserve margin and operating reserve leaves an ambivalent space for the privileged operator. The gap between reserve margin and operating reserve can be conceived as an ambivalent gap between certainty and uncertainty. As stated in the definition, reserve margin is designed for a planning task in advance; therefore the unavailability caused by annual repair, temporary repair and the unplanned outage is clearly 'unknown'. Operating margin, on the other hand, is the reality which includes the in-the-moment and thus 'known' unavailability caused by annual repair, temporary repair and unplanned outage. The two concepts are shaped by Taipower's managerial practice, reflecting the difference between uncertainty when planning is carried out and the understanding of certainty when dispatching is performed.

Taipower's definition	Reserve margin	Operating reserve
The purpose	For electricity planning	For electricity dispatching
The implication	A capacity of made factuality needs to be achieved by authoritative commitment to the better future	The reality of dispatchable capacity as represented by the meter-reading in the control room
The recognised	Assumed net peaking factors for each types of technology, which are based on the 'right' figures and consensus among planners	Observed unavailability caused by annual repair, temporary repair and the unplanned outage and other factors such as extreme high temperature, auxiliary equipment outage, environmental policy driven restriction
The unrecognised	Unavailability caused by annual repair, temporary repair and the unplanned outage	x

Table 10 — the gap of uncertainty between reserve margin and operating reserve

In the Taipower scheme, the unavailability caused by delayed annual repair and temporary repair, the improperly scheduled retirement of generators, and the unplanned outage are all left in ambiguity. Several sources have pointed out that delayed maintenance work and unplanned outages can be one of the primary causes of a sudden drop in operating reserve (Control Yuan 2012, Cheng 2014, Taipower 2015h, Ministry of Economic Affairs 2015c, Wang 2015); however, the nationalist-high-modernist story-lines treat all of them as 'unexpected situations' (Ministry of Economic Affairs 2015c).

The ambiguity is brought about by the routinised division of reserve margin and operating reserve as two unrelated facts. The concern over the exact causes of unavailability is continuously excluded from the manifest discourse on how low the current margin is, how real the situation of power shortage is,<sup>58</sup> and thereafter how to add more generation capacity in the future, which implies that the only feasible way to keep lights on is to add extra generation capacity, rather than to manage the system better (see figure 9 above for an illustration).

Risk	When the system behaviour is basically well known, and chances of different outcomes can be defined and quantified by structured analysis of mechanisms and probabilities.
Uncertainty	When we know the important system parameters but not the probability distributions.
Indeterminacy /ambiguity	When there is an open-ended question of whether knowledge is adapted to fit the realities of application situations, or whether those (technical and social) situations are being illicitly reshaped to 'validate' the knowledge. It can be kept hidden by the interlocking social commitments and conventions which constitute scientific paradigms or technological systems.
Ignorance	Where there are factors which escape recognition entirely.

Table 11 – categories of uncertainty (Wynne 1992b).

<sup>58</sup> The actual de-rated margin should be similar to operating reserve according to their definition. While Taipower always claims if operating reserve is lower than 6% then power rationing (and power shortage) is inevitable, Royal Academy of Engineering expresses other opinion, 'some of our interviewees noted that in the period of 2003–05 the system was operating on de-rated margins of around 2%. Although there were no major supply disruptions, the tightness of the system was evidenced by the fact that the system operator National Grid issued several Notices of Inadequate System Margin (NISMs) during this period...Interviewees suggested that a de-rated margin of 4% would be an appropriate level to aim for' (Royal Academy of Engineering 2013, 10).

The causes of unavailability are routinely ignored and excluded from the planner's gaze. Attention is not given to the investigation of what cause unavailability at peak time. Unavailability is left in ambiguity in the Taipower's institutional practices. The stark gap between the recognised and the un-recognised deriving from the engineer's planning and managerial concern brings a simplified and impoverished energy imaginary in society, thereby resulting in broader indeterminacy<sup>59</sup> and social resistance. The 'will to develop' is performed at the expense of neglecting the present and inflaming distrust.

### **Conclusion: The Particular Rationality of Authoritarian Developmental Planning**

The high-modernist commitment to a better future for the whole nation and society constitutes the backbone of nationalist-high-modernist story-lines in Taiwanese energy politics, which is substantiated by the particular ambiguous discourse, the routinised practices in calculating margins, and the exclusion of renewables from the composition of generation systems. I would argue that in Taipower's discourse, the engineer, as a pragmatic practitioner and a foresighted planner, is expected to orchestrate both materials and social order to acquire legitimacy. A specific energy future is prescribed by Taipower's engineers, and society is ordered to follow it, according to the underlying logics of developmental planning. These logics are underscored by an authoritative state-civil society relationship which emerges from an impoverished sociotechnical imaginary in the postwar period. The closure of alternative energy futures is constructed through technical choices and rhetorical techniques in the making and witnessing of power shortage. The range of possible future trajectories is narrowed onto that single future in which NPP4 takes centrality in providing more generation

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<sup>59</sup> Brian Wynne has classified different kinds of uncertainties into four categories – see table 11 (Wynne 1992).

capacity. This is achieved by a social amplification effect taking place in the engineer’s control room. Suddenly, the meter reading of operating reserve situated on the energy dispatcher’s panel becomes the most nerve-racking fact for the whole nation. The meaning of power shortage is effectively and efficiently simplified. However, none of these is helpful to the public understanding of Taiwan’s energy future. The essential element of the developmental planning rationality is the tendency to replace broader and richer values and concerns with a simplified managerial one, underlying the unstated authoritative commitment to the suppression of alternatives.

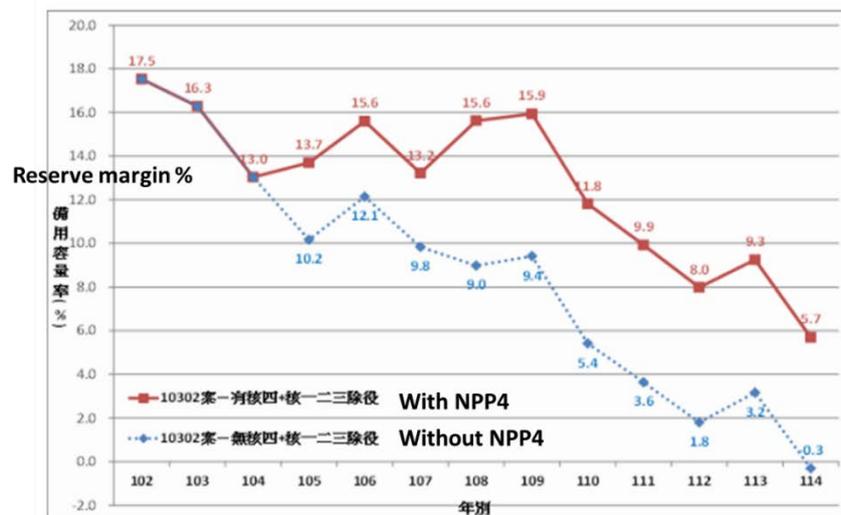


Figure 18 — reserve margin forecasted by Taipower: the termination of NPP4 will result in a ‘bleak future’ (Taipower 2014b)

The spectre of a developmental Leviathan still hovers over Taiwanese energy politics. ‘Power shortage’ and a ‘reasonable electricity price’ are the two top agendas in the energy politics in Taiwan. Together, they set an overriding framework for what a better society and energy future is conceived to be. The perceived power shortage and its ‘devastating consequence’ are the best deterrent to the appeal for an alternative

energy future. Renewable energy is always blamed for its expensive costs and conceived as unviable without considerable government subsidy. Therefore, for high-modernists, the predominant premise for using renewable energy in electricity generation is an 'objective and reasonable' feed-in-tariff (FIT). In the next chapter, I will explore how reasonable electricity tariffs, that is, 'impartial and objective' FITs for renewables, are achieved through the mobilisation of mechanical formula and technoscientific expertise.



## 6. 'People' in the FITs Deliberation — Assumed Unitary Public Good and its Stabilisation Process

### Introduction

As we have seen in the previous chapter, one of the most influential elements in contemporary energy politics in Taiwan is the sociotechnical imaginary of an ever growing and modernising national state, being underpinned by the continuous quest for an abundant, stable and cheap energy source. With this in mind, nuclear power is depicted as the energy source of predictability, low cost and technological maturity, thus reliability. By contrast, in the institutionalised practice of Taipower renewable energy is depicted as a technology of immaturity (Cf. Chapter 5) and described in policy discourse as a 'precarious' technology . It is described as 'if, without careful management, it could bring a huge negative impact on people's livelihood'.

In this chapter, I will further explore the sociotechnical imaginary of a high-modernist developmental state in Taiwan while shifting my focus to another side of the imaginary — the idea of one united people and their general public good. Where the previous chapter focused on the sociotechnical problem of power shortage and the way it is embedded in policy discourses, story-lines, visualizations and the routinised practices of electricity planning in Taipower, in this chapter I will focus on how the high-modernist-rationalist imaginary of the 'unitary public good' discerned by meritocrats has an effect on the way that governance is done in a liberal democracy.

Starting with a review of the embedded relation amongst the modern administrative state, representation in liberal-democratic politics and expertise, I will explain why

technoscientific knowledge and expertise is constitutive of modern democratic representative government. Scientific-legal rationality is the statecraft of creating a 'factual reality' which in effect co-produces a combined technical and socio-political reality for people and institutions, and at the same time expresses the need for representation in politics. Whereas, at a theoretical level, ruling with a factual, impartial and transparent contract is the generic order of a liberal democracy (Ezrahi 2004, Brown 2009), expert, or more precisely, meritocratic representation plays an important role in making this 'social contract' work in practice through articulating people's best interest. In some rationalist-liberal theories of democracy, a division of labour between meritocrats and citizens is, therefore, established: citizens choose the ends of politics and meritocrats (experts) determine the means. However, this is a view that I will show is problematic.

In the next sections, I will briefly review the ambivalent role of renewable energy within the long social debate over the REDA (the 2009 Renewable Energy Development Act) — in which it is seen as a 'precarious' technology that requires careful management — and then move to a short exploration of the historical decision to make an expert committee central to the policy-making process against the background of democratisation which includes the depoliticisation of policy-making and the inclination to solve expertise problems by bringing in even more expertise. I will also emphasise the way that this creates a clear demarcation between the expert insider and the lay public outsider.

Following this brief contextualisation of the background, the chapter will concentrate on the detailed arrangements of the Feed-in-Tariffs (FITs) committee in deciding on a 'reasonable tariff'. I will explore the way that **technoscientific knowledge-based**

**technical deliberation, with tacitly enacted roles and boundaries, seriously constrains the forms and meanings of renewable energy and the face of public interests emerging from the process.**

We will see that the prevailing process of a limited deliberation relies on a crucial sociotechnical imaginary — the existence of a generalisable public welfare which is discernible to and thus able implicitly to be represented by the internal experts involved. As demonstrated later in this chapter, the deliberation process reflects an incessant intention to purify the decision made by the committee and eliminate the remaining discretion of the experts from wider visibility, which results in an overwhelming preference for **mathematical moderation** — the ‘**best interest**’ is translated into the ‘**reasonableness**’ of the FITs largely built on the choice of taking the average or median value of alternative FIT calculations.

In the conclusion, a short review will be given by asking what has been forgotten or simply effaced in this process of normative stabilisation, especially when it comes to the materialisation of renewable energy in installations on the ground. I will be asking, how, if possible, installation might be **done differently** – an issue to be taken up in the next chapter.

### **Professional Expertise, Representation and the Public Good**

Science and technology, as explained in my discussion on the work of Ezrahi in chapter 2, have a major role in forming the underlying imaginary in a modern liberal-democratic polity. By transforming citizens’ passive ‘celebratory’ eyes into proactive ‘attestive’ eyes, the world is imagined as a neutral and universally accessible reality. Political actions are conceived as grounded in observable and comprehensible social

facts and are thereby distinguished from arbitrary actions. The expedient political dualism of fact and fiction has immense power in creating a new social order within which professionals and experts take the central position of depoliticising political power and rationalising government actions in order to meet potential concerns over accountability and legitimation (Ezrahi 1990, 2004, 2012). Experts are ‘fact surrogates’, which implies that real facts can only deal with rational factors and, at best, only be revealed by following strict rules in extracting plain truths from Nature (Porter 1995, Daston 1992, Turner 2003a). In short, scientific-legal rationality is the statecraft of creating a ‘factual reality’ and, at the same time, expresses the need for representation in politics.

As discussed in previous chapters, transparency, factuality and accountability may be a necessary condition for democracy, but they are not a sufficient condition. The problem lies in the co-produced nature of factuality. Surely, when 17<sup>th</sup> Century experiment scientists demonstrated their cautiously arranged performance of materials — the settings of the air pump — the audience that was borne in their mind were a group of gentlemen. The rest of society can and should only witness the same truthful event via literary and social technologies — the technologies of describing and conveying the truth from members to outsiders (Shapin and Schaffer 1985). In this sense, the science that eventually backed up democratic representative government incorporated two potentially contradictory elements at the same time — egalitarianism and elitism; it constitutes the egalitarian norms of ingenuousness and transparency on one hand, and merit-based restrictions on membership on the other (Brown 2009).

To explore the intricate relation between representation and science, a brief diversion

reviewing the notions of consent, social contract and public good is needed. Liberal-democratic theories have argued that representative government is legitimately established only because of the social contract granted via citizen's consent. However, the argument can easily shift to the idea that since a government is established in the first place, it proves that the citizens have 'tacitly' consented to the original social contract. From this perspective, the legitimacy of representative government rests not on a multilevel and continuous participatory consent but on the terms of conditions which have been written in the 'original social contract.' In this respect, it is not the *de facto* consent which creates the condition of being legitimately ruled, but rather the presumption of the existence of an original contract (Brown 2009). This echoes the above mentioned necessary imaginary which connects liberal democracy with science: a factual, impartial and transparent contract signed by the freely consenting public. The source of elite authority is simply shifted from divine right and traditional privilege to the presumptive expert affirmation of this 'original social contract'.

The prototype of representation can be traced back to the idea of 'virtual representation' in the 18<sup>th</sup> Century, where representatives who share the interests and sentiments of their constituents are seen as able to speak for them without any specific or overt expression of consent given by their constituents (Brown 2009). Edmund Burke, the British Parliament member and Irish political philosopher, 'sees interest very much as we today see scientific fact: it is completely independent of wishes or opinion, of whether we like it or not; it just is so' (Pitkin 1967, 180). For Burke, 'the point behind representing all the various interests of the nation was not to allow them to balance each other out. It was to bring to light all the evidence required for determining the national interest' quoted in (Brown 2009, 70).

That expert representatives can discover the objective public interest among *de facto* disordered and competing social interests resonates with what the French state engineers have attempted to do in order to secure the planned railway routes in the debates among local forces — deploying mathematical equations to assert a particular view of public interest (Porter 1995). This sociotechnical imaginary is enacted through the imaginary of a general public good as well as prescribing technoscientific methods to articulate it, a key element to which I will regularly return later in this chapter.

### **Egalitarianism and Meritocracy in the Modern Administrative State**

Perhaps it is not so surprising that the boundary between authoritarian high modernism and elite–expert representative liberalism is not always clear. The appeal to the general public interest in the political arena, as murky and ambiguous as it is, continuously shapes the landscape of modern democratic politics. In the utopia of planned socialism where Vladimir Lenin calls for ‘the unity of will’ for enormous industrial economic growth and everyone’s equal position in state administration, the division of labour between expert representatives and lay constituents and between professionals and professionals established an institutional order of scientific technicality in which politics and quarrels were beside the point (Scott 1998). Yet this monolithic imagination of ‘public good’, as exemplified by the singular, objectively correct, efficient design of production and state planning in Lenin’s vision is simply an extreme manifestation of the same high modernism that can also be found in many modern representative democracies.

The institutionalisation of science, expertise and professionals in modern liberal-democracies reflects a long line of development, moving from the Enlightenment in Europe and then the Progressive Era in the United States, finally to the modern

administrative states of both Europe and the US. Experts and professionals are granted legitimate status by the modern administrative states through a process of licensing designed to ensure both their competence and commitment to acting responsibly in the interest of those served. In this respect, the civil service in Germany, France, or Britain is widely considered a prestigious occupation (Fischer 2009). The key point here is to highlight the implicit relationship between expert competence and popular consent in calling for citizens' equal rights of being served and governing in the general interest in modern states.

According to Mark Brown (2009), the major principle of democratic representation envisaged in the period of the American revolution and the popularisation of people's sovereignty is the idea of competence. Competence shown by elected representatives is thought to be the best way of promoting the public good and establishing confidence in the government. It was regularly said that those who governed should have greater talent, knowledge, and wisdom, virtue than those who elected them. Under this conceptualisation, the core question of liberal representation turns on how to design institutions to ensure that a government operates according to the citizens' best interest — the proposed answer is meritocracy.<sup>60</sup>

The political morality of equality, the instrumentalism (ingenuousness) of meritocracy and the dichotomy of facts and fiction are the three principles underlying this interpretation of liberal democracy (Ezrahi 2012, Brown 2009). In the prevailing justificatory theory of liberal democracy, the division of labour between lay citizens

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<sup>60</sup> The concept of meritocrats in East Asia may be quite different from the one in English-speaking world. They are historically the class of 仕大夫. In ancient China, they are often the intellectuals who passed the literary exam and got admission to the national Confucian academy, and also finally passed the higher civil service exam. This will gain them the aristocratic status as a 'scholar-official' (Downey and Han 2014) who works in the royal councils or offices.

and expert representatives is necessary and even desirable: citizens choose the ends of politics and experts determine the means. 'A division of labour grants representative governments the latitude they need to find the best means for promoting citizens' interests, while citizens remain the final judges of whether the government has in fact fulfilled their interests (Brown 2009, 86).<sup>61</sup> Nonetheless, I argue that this demarcation drawn by some rationalist-liberal theories of democracy, one which echoes the appeal of the depoliticisation of technical knowledge made by republican engineers discussed in chapter 4, is problematic due to artifacts' politics (Winner 1980). Technical artifacts are constitutive of human-political relations and discretionary power (see chapter 2 for details). More importantly, experts and lay citizens do have different ontologies, that is to say, **hermeneutical differences of meanings and concerns**, and thus different framings of issues. The Institutions backed up by scientific-legal rationality often dictate what 'the' public and technical issues at stake are and therefore, what should be discussed, what is deemed relevant, and what is to be ignored (Wynne 2008, 2014).

In short, in this version of representative democracy, the issue of legitimacy in the process of communication and meaning-making involved in creating an accepted collective and shared future is simplified to the action of electing talented meritocrats who can discern the public interest through rational deliberation. The expert committee as a scientific knowledge-based representative assembly is implicitly put together in ways that imitate an idealised scientific community engaging in rational deliberation for the public interest, while citizens play the role of lay witnesses to the display of expert competence (Brown 2009). In the following sections, I will briefly review the ambivalent character of renewable energy in the nine-year-long social

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<sup>61</sup> It also can be described like 'as long as the means and strategies are separable from the aims' (Brown 2009, 86), as if means and ends, methods and aims can be totally separated.

debate over the REDA (the 2009 Renewable Energy Development Act), as both a 'precarious' and 'prominent' technology that requires careful management.

### **The Ambivalent Character of Renewable Energy Technology**

As elucidated in chapter 4, the legacy of developmental rationality is still clearly traceable in the contemporary energy politics of Taiwan. When we review the debate on the REDA, three entrenched tropes can be found in this episode of the struggle over energy politics (see also chapter 4):

- Renewable energy is perceived as an 'opposite' and 'immature' technology;
- Renewable energy is a statist-interventionist, subsidy-based industrial policy;
- A FITs committee is established as a device of controversy-settlement.

Amongst them, there are two characters that should be highlighted— 'technologically immature' and 'financially nonviable' — these are often referred to as the rationales why the widespread installation and application of renewable energy in generation portfolio is just not feasible. Firstly, the inconsistency of the generation of wind and solar power is often referred to as 'the' technical limit which prohibits a greater installation in the generation system because of the risk that this would bring to the whole system. However, given the fact that renewable energy only accounts for 4.5% (excludes hydropower) of the total installed capacity (2.3% of the generation capacity) in Taiwan in 2016, and that the contribution it can make to reserve margin is routinely underestimated by Taipower's internal practices (Cf. chapter 5), the ostensible technical incompetency of renewables is far from a self-evident cause for excluding them from playing a much larger role in an energy future. Secondly, in the same way, in Taipower's discourse, renewable energy is continuously presented as much more

expensive than nuclear power. In an astonishing cost comparison given by Taipower, the average cost of nuclear power is given as 1.04 NTD/kWh, while solar power is 9.44 NTD/kWh and wind power is 2.50 NTD/kWh; <sup>62</sup> given such figures, nuclear power seems to be a more reasonable and economic choice in terms of the national finance and 'public interest'.

Nevertheless, renewable energy is also seen as a futuristic technology potentially achieving the goal of energy autonomy — the premise of an autonomous and potent state economy — it is an ingrained imaginary since the inception of renewable energy in the 1970s (Cf. chapter 4). Renewable energy technology is also pitched as an invincible economic force in a globalised economy and as having the potentiality to lead a new wave of industrialisation. In the state-organised project 'the Rising Green Industry: LED and Photovoltaics Industry (綠色能源產業旭升方案/綠色能源產業躍升計畫：能源光電雙雄)', it is argued that:

*'[the National industrial policy is to] ... pick up the target industry [the photovoltaics manufacturer industry] and facilitate its development on the basis of its technical potentiality and features ... converge forces from domestic industries to form the environment [industry chain] for the rise of the great power of Taiwanese export and energy technology'* (Board of Science and Technology 2009).

*'[Photovoltaics] is the strategic technology helping us to secure the pivotal position in the world market and international division, and to attain an*

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<sup>62</sup> [http://www.taipower.com.tw/content/new\\_info/new\\_info-a02.aspx](http://www.taipower.com.tw/content/new_info/new_info-a02.aspx)

*exponential growth in exporting package plants'* (Ministry of Economic Affairs 2012b).

It is fair to say that the ambivalent character of renewable energy observed here can be attributed to its contradictory position — it is excluded from the current energy portfolio but at the same time included in the aspiration of technoscientific-economic promise as it is believed to be able to lead the Taiwanese industry to global market dominance.

In the nationalist-high-modernist story-lines, renewable energy is treated as a technology requiring careful management, as if it will easily cause immediate power shortage, crash state finances, and increase electricity price significantly, bring huge negative impact on the outlook for the national economy, and lower the quality of life, in contrast to the 'controllable' nuclear technology. In short, it is perceived as a 'precarious' technology which can create disasters if it is not kept under watchful eyes. The policy principle of 'initially slow and subsequently speedy' (先緩後快) (Bureau of Energy 2011a) suggests that it should be explored in a cautious, trial-and-error manner. In the following sections, a short exploration of the historical development of the expert committee in policy-making against the background of democratisation is carried out, as later we will discuss how expertise gradually become an indispensable force in dictating how the FITs should be achieved.

### **Institutionalisation of Expertise and Democratisation in Taiwan**

In a similar manner to what happened in the 'Progressive Era' in the U.S. between the 1860s and the 1910s (Fischer 2009), a technical expertise-based administrative structure was institutionalised by the Nationalist government in postwar Taiwan as a

significant part of the 'modern package' aiming for rapid industrialisation and catching up with developed countries. By linking technical expertise to the impressive technoscientific-industrial achievements of the time — from the construction of nuclear power plants and steel-making factories to the eradication of pandemic disease and the soaring output of farmlands by utilising chemical fertilisers — experts were imagined as the agents of the emerging modern industrial society, a desired national development. As suggested by Scott (1998), this high-modernist imaginary of technoscience came in the name of people and with the recognisable support from citizens seeking protection and a better life. Taiwan is no exception. Nonetheless, this description overlooks the fact that the presumptive idea of the expert's public responsibility relies on the paternalistic relationship between state and society where the general public is imagined by experts and its kind (and also by a range of institutions) as a murky, interest-seeking but voiceless entity. We can call this **'the first wave of expertise institutionalisation (1950s-1980s)'**.

As discussed in chapter 4, apart from the sociotechnical imaginary of the high-modernist developmental state, there is an alternative imagination of modernity: the indigenist-reformist rationality deriving from the crossover of modernity and locality. This imaginary comes from a series of social-environmental movements focusing on local issues, native land-attached memory and directly voiced concerns (Lii and Lin 2000, 2003, Hsiao 2005, 2010b, Wu and Lii 2005, Ho and Lin 2011). In this participation-oriented dream of modernity, the people represented in politics are imbued with memories, emotions and local experiences. For them, participatory democracy and the modern state are two sides of the same coin (Lii 2009). This imaginary can be traced back to the early 1970s, but it was the 1980s — when martial law was lifted, the political system was liberalised and the speaking of concerns directly to power was legitimised,

the 'golden decade of social movements' (Hsiao 1989) – that saw the climax of this force of grassroots democratisation. We can call this '**the first wave of democratisation (1970s-1980s)**' (Hsiao 2011).<sup>63</sup>

Notwithstanding, since the beginning of the 1990s, this social force was, bit by bit, domesticated and co-opted by the expansion of the expertise-based representative advisory (Lii and Lin 2003, Ho 2003). We can call this '**the second wave of expertise institutionalisation (1990s-)**'. The most broadly documented case is the scheme of Environmental Impact Assessment, EIA. EIA was introduced in Taiwan in 1994 and designed to imitate the Federal Government Advisory Committee Act (FACA) and the National Environmental Policy Act (NEPA) in the U.S., and the Act of Environmental Impact Assessment (環境影響評價法) in Japan (Tang and Chiu 2010). However, significant modifications can be observed in its two decades of practice, which means that its current operational logic diverges from the original design. These distinctive modifications can be summarised as follows (Tang and Chiu 2010).

- The policy-maker was replaced by the expert in decision-making. In the original design, professional judgement and technical knowledge provided by experts are fed to policy-makers, aiming for the latter to have informed decisions. The role of expertise is explanatory and advisory, not decisive. By contrast, the practice of EIA in Taiwan gives the expert committee the decisive right of veto, which transfers the right of decision from politicians to expert members and transforms the right of decision to the right of veto. This can result from the intention to quickly settle down widespread controversies over construction

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<sup>63</sup> Expertise institutionalisation and democratisation are the two parallel forces, meaning although expertise institutionalisation started in the 1950s before the wave of democratisation, it was still an ongoing force when the wave of democratisation initiated in the 1970s-1980s.

projects.

- The independence of the committee became the source of legitimacy. The establishment of the Environmental Protection Administration in 1987 can be considered as a political manoeuvre in an attempted de-escalation of the ever-growing conflicts and distrust between the government and society against the background of the rise of environmental movements since the 1980s. 'Independent experts' constitute at least two thirds of the membership of the expert committee and are considered the 'prudent consciousness of society' (社會的良心). It was designed to shelter the government from the tremendous political pressure coming from society,
- A two-phase design ensured the exclusion of the 'outside political forces'. The expert committee is used as an 'objective arbitrator' who can determine the way to enact impartial interest distribution and rebuild public trust toward the government. Phase one focuses on expert deliberation, which stresses the 'facts' provided by case applicants; although this process can be audited by citizens, the decision is intended to be made without outside political interference. Phase two includes more participatory mechanisms such as public hearings and field interview; however, only 9.5% of the cases proceed to this phase and even then the decision was still firmly in experts' hands.

It is clear that although the second wave of institutionalisation of expertise may restrain the rigidly closed and innately autocratic characteristics of the first wave, the practice is still overwhelmingly oriented to the quick closure of controversies and to the rebuilding of trust via the introduction of experts as impartial arbitrators. A 'virtual commission' granted to the experts from the public is undoubtedly lying at the centre of this 'advisory scheme'. The expert committee is positioned as an idealised scientific

community deliberating the public interest with integrity and objectivity, while citizens are assumed to be passive, ignorant, driven by self-interest or simply too irrational to comprehend the whole picture and weigh factors fairly. Some commentators say that this is a more democratic form of governance than before (Tsai and Lee 2015), but I argue there are still huge questions to answer. This includes the undemocratic features of the EIA procedure, the discrimination against local knowledge found in the assessment practice (Tu and Shih 2014), and even the presumed legitimacy of the ‘virtual commission’ in the first place. Generally speaking, the EIA demonstrates the tendency of ‘solving expertise problems by bring in even more expertise’ (Tang and Chiu 2010).

Back to my study of the FITs committee, much resemblance between the Taiwanese EIA and FITs committees can be found. In order to get this imagined quasi-scientific community to work, in the case of the FITs committee, attention has to be paid to: 1. the firm segregation between meritocrat insiders and citizen outsiders; 2. the staged ‘people’ and their unitary public good; and 3. the public authority and objectivity demonstrated by the rigid technicality of mathematical formula when tariffs are calculated. More importantly, I will explore one unstated sociotechnical imaginary — the existence of a generalisable public good discerned by meritocrats (experts) — and how this is invoked and re-performed throughout the deliberation of the FITs committee.

### **Institutionalised Segregation between Insiders and Outsiders**

Like the EIA committee, the FITs committee was established within a highly polarised atmosphere of confrontation — the nine-year-long parliamentary debate and social controversy over the Renewable Energy Development Act (Cf. chapter 4). From the

beginning, the FITs committee has been perceived as a mechanism of controversy-settlement. In short, an independent committee was set up to deliberate the FITs every year because of the failure to strike a deal on tariffs and to reach a consensus in Parliament over which technology should be adopted.

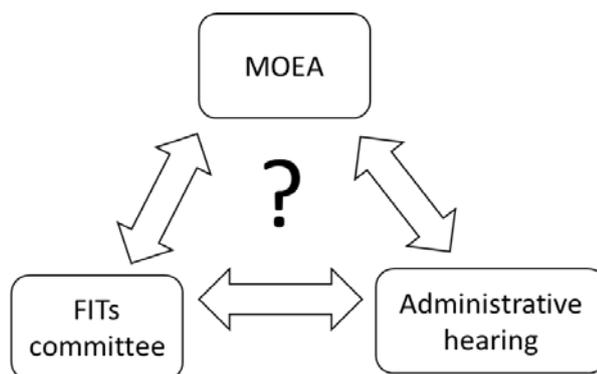


Figure 19 — the REDA does not stipulate the statutory relations amongst the three bodies

Although it is stated clearly in the REDA that before the final decision is made the authority (the MOEA) may hold the administrative hearing when 'it is necessary' (Legislative Yuan 2009), the act does not stipulate clearly the exact relations amongst the deliberation of the FITs committee, the recommendation gathered in the hearing, and the role of the MOEA in making the final decision. This under-regulated territory leaves much space for the government to manoeuvre and these relations are eventually arranged through unspoken institutional routines rather than written rules. The committee acting as an impartial arbitrator is tacitly enacted through the whole deliberation. In an ideal situation where the citizen's concern and expert's judgement were given equal standing, the MOEA would weigh up the different arguments, concerns and rationales between the experts of the FITs committee and the citizens of the administrative hearing before making the final decision by itself, and then take full

political responsibility. However, this never happens.

### An Insulated Deliberation Space

As stated by the MOEA in 2010, the legitimacy of the FITs committee derives from its disinterestedness, impartiality and transparency:

*[The committee] ... constitutes 21 expert members who come from several areas of expertise. All of them have signed the terms of avoiding conflicts of interests so as to ensure that the deliberation of the FITs is undertaken out of expertise, impartiality, and justice, objectivity ... the MOEA stresses that the process of the deliberation is open to and communicated with the general public with integrity ... the documents of the sessions this year and onwards will be uploaded to the Internet for public access ... (Ministry of Economic Affairs 2010e)*

As we can see from the illustrative diagrams below, the design of the proceedings is not for broadening public participation; in contrast, the design intends to give committee members a sheltered space within which they can deliberate 'independently'. This can be well exemplified by the one-way arrangement of the communication between the committee members and broader participants. Only three occasions provide the opportunity for outside opinions to be heard and there is no statutory obligation for the committee members to respond to or take account of the opinions they are presented with. The following diagrams summarises the change of the proceedings between 2009 and 2015's deliberations:

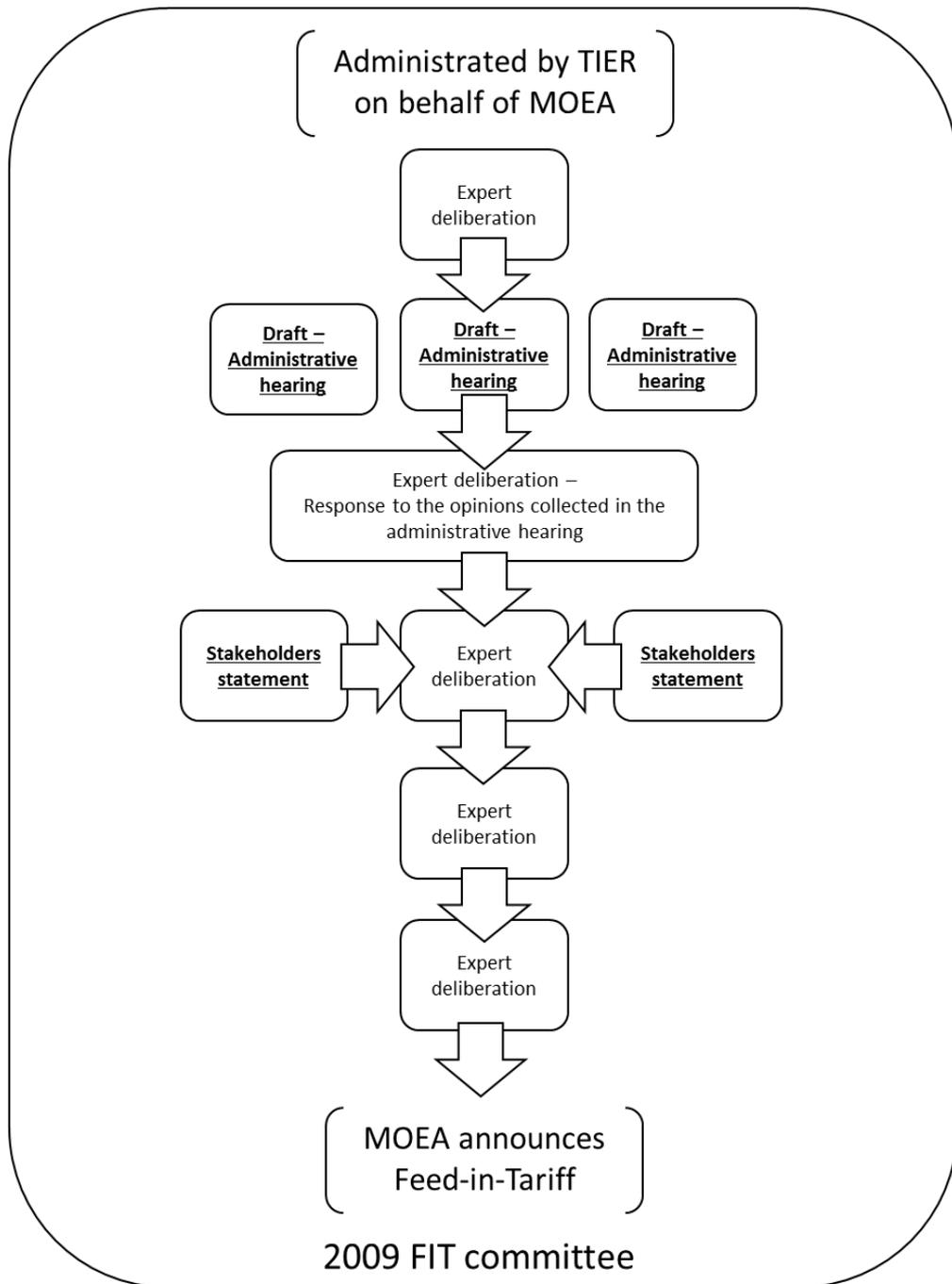


Figure 20 — the proceedings of the FITs 2009 deliberation

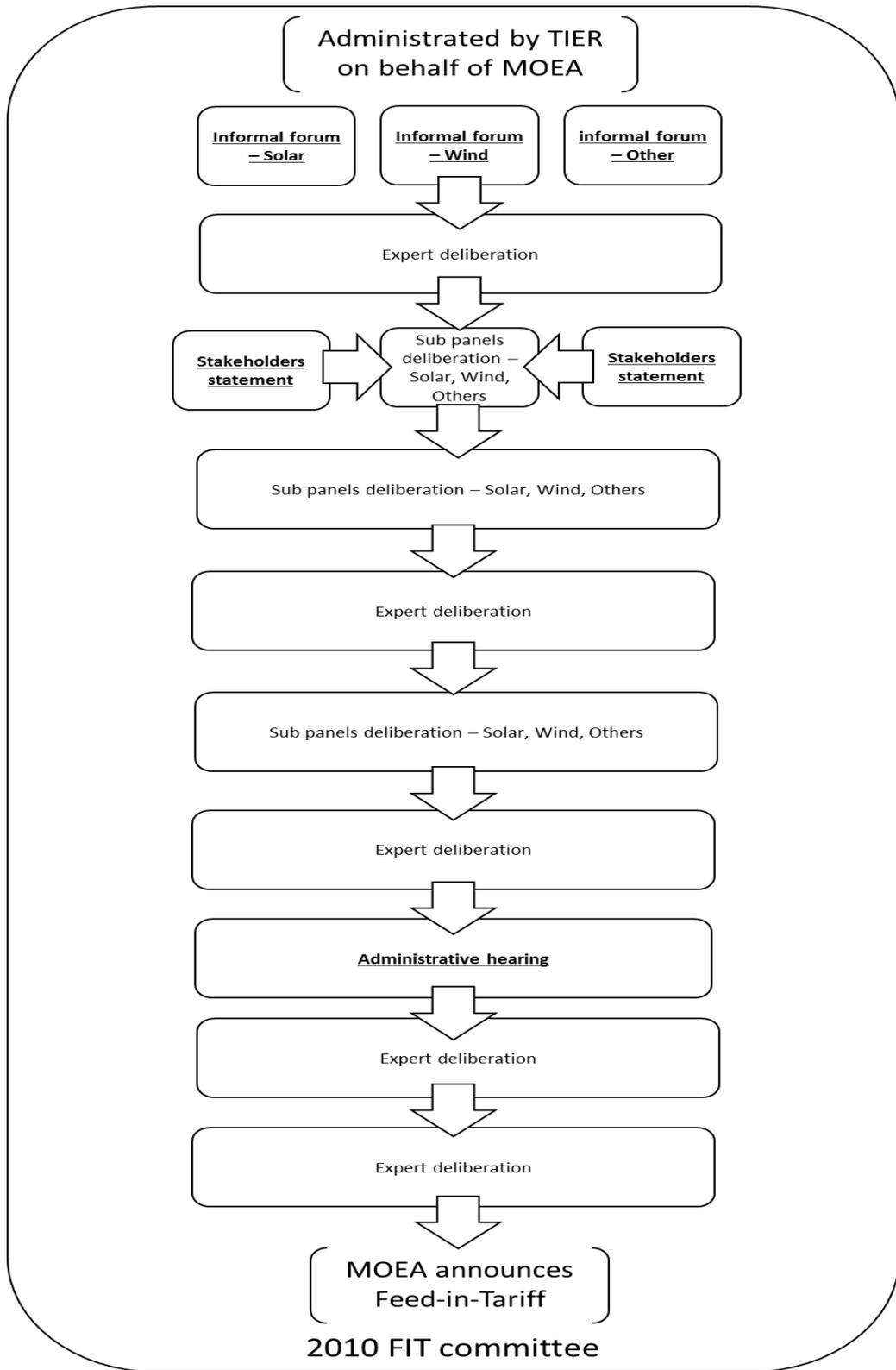


Figure 21 — the proceedings of the FITs 2010 deliberation

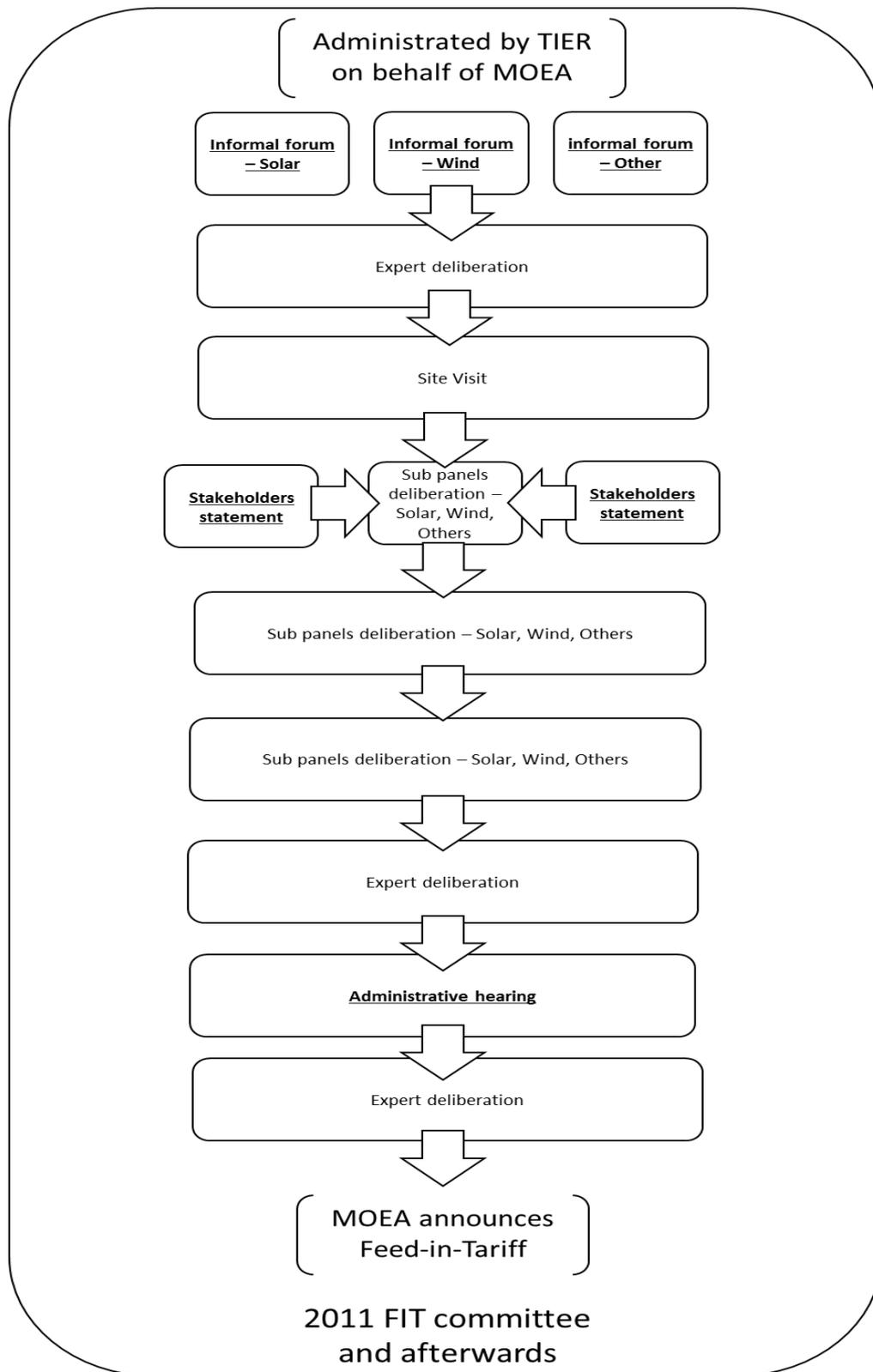


Figure 22 – the proceedings of the FITs 2011 and afterwards deliberation

In the initial stage, there are informal forums in which opinions are collected from industry unions, associations and industry representatives. These opinions are taken and digested by the non-governmental body, the Taiwan Institute of Economic Research, TIER. This is a private think-tank, founded in 1976, with which the MOEA tasks the mission of being the general secretariat of the FITs deliberation. The opinions collected by the TIER from the informal forums and later, presented to the committee are strictly ‘tariff-relevant’. Furthermore, in the sub-panels, the committee is divided into three bodies which are responsible for the tariffs for solar power, wind power and other sources (micro hydro, geothermal, and biomass, biodegradable waste) respectively. In this phase, stakeholders’ opinions are treated as testimonies which are to be put to the tribunal and await being sanctioned by the **arbitrator** — the **committee expert members**. The demarcation between outsiders and insiders is carefully managed. The representatives of NGOs or industry associations are only allowed to present their views to the committee members in a specified session, and once finished, they will be asked to leave. Other experts are also consulted for their extended expertise yet this has to be done in the another closed session (Ministry of Economic Affairs 2010a, 38).<sup>64</sup>

The administrative hearing before the committee makes its final recommendation is the only occasion on which the broad public<sup>65</sup> have the statutory right to talk directly to the authority and request direct feedbacks. However, according to the minutes of

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<sup>64</sup> Since 2014, the MOEA does not prescribe a rigid one-way communication in the sub-panel deliberation as before; it simply says ‘invite industry representatives for discussion’. However, at the same time, one expert member claims that ‘the session should not be open for industry representatives to attend, in order to maintain just discretion’ (2014.08.18.1400). There is no evidence that the proceedings were changed to allow more dialogue-style, two-way communication.

<sup>65</sup> The stakeholders in sub-panels are the ‘representatives of industry’ while the participants in administrative hearings include the broader citizen participants, e.g. university students, NGO workers, and the staff of private research institutes and MP’s offices.

the administrative hearing, the following issues severely hamper its legitimacy:

- Participants are not informed in a timely manner when administrative hearings are to be held, which leads to a small attendance (Bureau of Energy 2010, 3-4).
- Participants are not provided with a written agenda, documents or data before the meeting, which gives no time for the citizen participants to understand the data and make informed contributions (Bureau of Energy 2011b, 2).
- The one-off session is not enough to clarify what the pivotal factors relating to the FITs-decision are. One participant argues that there should be a second hearing session for discussing and answering the questions raised in the first session (Bureau of Energy 2009a, 2,5).
- This is the only statutory chance for citizen participants to hear direct answers from the authority. However, the responsible authority here is the MOEA and committee members are not required to attend the hearing. That is to say, the chance of committee members meeting with citizen participants face to face and having a direct dialog is quite low (Bureau of Energy 2012, 2).

The proceedings of the whole deliberation are implicitly enacted to separate meritocrats (experts) insiders from citizen outsiders, and technical issues from other issues. For the MOEA, discerning the FITs is both a political issue and a technical one, nonetheless, it can only be 'discerned' by detaching technical bits from political parts. However, this orchestrated demarcation creates further problems. The legitimacy of the administrative hearing and the model of one-way communication were raised as

problematic by citizen participants in the very first place, but were continuously ignored until in 2014 when the leader of a photovoltaics manufacturer association threatened to sue the MOEA unless the promised second administrative hearing was held. The reply from the MOEA was decisive and coercive this time and can be summarised as follows:

- The decision that the prior notification is made seven days before an administrative hearing is held is under the discretionary privilege of the MOEA. The decision meets the legal requirement stated in the law (Ministry of Economic Affairs 2014b, 8).
- The REDA and its practice guidelines do not require any FITs committee members to attend the administrative hearing. The attendance of committee members is irrelevant to the legitimacy of the hearing (Ministry of Economic Affairs 2014b, 8).
- The chairman of the administrative hearing who is the minister of a responsible authority, according to the Administrative Procedure Act, has the power to terminate a hearing session early (Ministry of Economic Affairs 2014b, 8).
- The legal purpose of the administrative hearing is to let all participants express opinions freely. Besides that, all of the opinions voiced in the hearing are recorded integrally by the MOEA and then, sent to the FITs committee members 'for consideration'. (Ministry of Economic Affairs 2014b, 9, Bureau of Energy 2014, 10)

### *Technical Issues and Something Else*

Although a few committee members have attended the hearing voluntarily since 2012,

in the MOEA's view they are not there to engage with citizen participants. The same issue was raised in 2015 and dismissed again — 'the points of disagreement in the hearing are clear' claimed the MOEA, and 'there is no need to hold a pre-hearing session or a second hearing session' (Ministry of Economic Affairs 2015a, 9). It is clear that the only issue allowed to be discussed in the hearing is the one about formulas, and the values used in the formulas. Other issues are either effaced or ignored under the discretionary flexibility of the MOEA. The committee members' working space is firmly segregated from citizens' presence; the FITs committee is confined to dealing with 'core' technical issues such as what the reasonable values to be chosen and used in the calculation are, and what the objective methods of collecting data are; other issues, such as the legitimacy of the administrative hearing, and the broad impact that renewable energy can bring to society, are seen as irrelevant to the agenda.

According to Wynne, 'what is "technical knowledge" precisely here is open-ended, and ambiguous; the precise definition and the boundary with "non-technical knowledge" is woven up with history, and cultural practices' (Wynne 2013, 3). The effort of distinguishing **the 'core technical issues'** from **'the others'** documented here is thus intrinsically political and should be conceived as the underlying layout of the whole deliberation practice — **that technical issues can be properly solved through experts' competency and discretion while other issues are irrelevant and ought to be left behind.** The Idea that there is a clear and final categorical distinction between the territory of technical expertise and the territory of politics comes with **a deep presumptive judgement** that **technical issues and choices should not be mixed with political and social concerns while priority is set implicitly at the same time** (Wynne 2008). Nonetheless, as I have argued above, the decision over the FITs should not be considered as 'apolitical'. Certainly, the ambiguity over what is technical and what is

not, and what is relevant and what is irrelevant, is gradually pinned down via the administrative discretion over legal provisions and the deliberation proceedings, but this does not mean that the committee and the MOEA consider their involvement as apolitical or, more precisely, interest-free.

Quite the contrary: the involvement of the committee and the bureaucrats in the process of deliberation relies on a crucial imaginary — the existence of a generalisable and discernible public good. The subsequent question becomes ‘how to discern it legitimately’. The answer given by them lies in **the disinterestedness, impartiality and transparency of the way that this general public good is discerned and demonstrated** — the righteous and fair way of distribution, insofar as the process remains free of interference. Thus the distance between the arbitrator and the others must be maintained mindfully as the experts are conceived as the discerners and guardians of a general public good, and other participants are treated as self-interest seekers.

Like the laboratory experiments conducted in the 17<sup>th</sup> Century Royal Society, the practice of the FITs committee is at once uniquely public and reserved for professional elites. It is public, impartial, and supremely open to criticism — and private, exclusive, and immune to objections from outsiders at the same time. This is a concept to which I will constantly return in the rest of the chapter.

### **Staging State, People and the Collective Good**

If the first promise of developmental state is an ever-expanding public good then the second promise is the fair determination and allocation of this general good. Impartiality serves as an elemental factor constituting the basis of a generalisable public good. The reason why it can be perceived as ‘apolitical’ or ‘depoliticised’ is the

tacitly presumed fair allocation of the public good. The stress on the general public good and its fair allocation should be seen as the legacy of the promise of a planned economic prosperity for everyone in the postwar era (Cf. chapter 4). The strictly planned high-modernist statecraft of economic and social engineering may have faded away, but its legacy, as the constitutive element of a sociotechnical imaginary still shapes today's energy politics.<sup>66</sup>

As discussed above, from this rationalist-liberal view, the accomplishment of the general public good can only be demonstrated by disentangling it from any particular interest holder and hand it over to impartial representatives (Brown 2009, Pitkin 1967). That is to say, politics is seen as, above all, the struggle of competing interests or the dispensation of the public interest among social groups, a conceptualisation totally omitting the dimension of meaning-negotiation in political life. What is the public good that the committee claims to protect, and who are the 'invited' public (Wynne 2007) attending the deliberation? Probing these two questions can help us understand the fundamental elements of a generalisable public good.

#### *State, a Unitary People and the Arbitration Tribunal*

How does the representation of 'the people' work? The representational scheme of the committee is rather obscure. According to the REDA Article 9:

*The central competent authority shall invite the relevant government agencies, scholars and experts, organisations to form a committee to*

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<sup>66</sup> As stated clearly in the Constitution of the Republic of China (Taiwan), the state is authorised to deprive the right and freedom of the people under four circumstances: 'to prevent infringement upon the freedoms of other persons, to avert an imminent crisis, to maintain social order or *to advance public welfare*' (Article 23).

*validate the wholesale purchase rate and the calculation formula for the FITs of renewable energy facilities. When it is necessary, hearing sessions may be held... (Renewable Energy Development Act, 2009.07.08)*

The majority of the committee members are officials (5/21), and social and natural science experts (13/21). The only exception is a few representatives of social groups (3/21). For example, in 2014, these were representative of the Chinese National Federation of Industries, the Consumer’s Foundation and the Formosa Association of Resource Recycling. The Chinese National Federation of Industries is famous for their long-standing pro-nuclear power position, and supports the extension of the current nuclear power plants and the operation of NPP4. The renewable energy industry sector is expressly not included. The decision is made by voting, which means the decision requires to be approved by more than half of ‘the attending members’.<sup>67</sup>

	類別	姓名	單位	職稱	
<b>Officials</b>	部會代表	召集人兼委員	沈榮津	經濟部	次長
		委員	王運銘	經濟部能源局	局長
		委員	汪宗煌	國家發展委員會	簡任技正
		委員	沈維正	經濟部工業局	組長
		委員	柯美琴	行政院消費者保護處	簡任消保官
<b>Scholars-Economics</b>	能源經濟	委員	洪德生	財團法人台灣經濟研究院	院長
		委員	張四立	台北大學自然資源與環境管理研究所	教授
<b>Accounting Law</b>	財務會計	委員	林良楓	政治大學會計系	副教授
	法律行政	委員	林誠二	東吳大學法學院暨法律學系	教授

<sup>67</sup> The meeting needs to be attended by more than the half of all members to be valid. The attendance is another tricky part, the governmental agency representatives can use surrogates to attend the meeting but the individual expert members can't. The interviewee L2 told me the selection of the date of the meeting is tricky, too. It can be used as an inadvertent method to deny an expert member's participation.

	類別	姓名	單位	職稱	
Scholars- Natural science and electronic engineering	理工 科學	委員	陳斌魁	大同大學電機工程學系	教授
		委員	林大惠	成功大學機械工程學系	特聘教授
		委員	錢建嵩	中原大學化學工程學系	教授
		委員	江青瓚	健行科技大學電機工程系	副教授
		委員	宋聖榮	台灣大學地質科學系暨研究所	教授
		委員	蔡政翰	台灣海洋大學海洋環境資訊系	教授
		委員	胡耀祖	工業技術研究院綠能與環境研究所	代所長
Environmental engineering	資源 環境	委員	張添晉	台北科技大學環境工程與管理研究所	教授
		委員	顧洋	台灣科技大學化學工程系	教授
Social group representatives	團體 代表	委員	蔡宏明	中華民國全國工業總會	副秘書長
		委員	雷立芬	中華民國消費者文教基金會	秘書長
		委員	陳偉聖	台灣資源再生協會	秘書長

Figure 23 — the composition of the 2014 FITs committee (Ministry of Economic Affairs 2014a, 6-7)



#### 一、整體訂定原則

1. 優於「再生能源發展條例」立法前之水準。
2. 再生能源業者應有正當經營之合理利潤。
3. 顧及社會公平性，以避免衍生相關電費上漲等民生問題。
4. 各類再生能源躉購費率考量
  - (1) 發展量對我國環境之影響在社會可接受範圍。
  - (2) 設置再生能源同時，可帶動我國本土產業發展。
  - (3) 有利具前瞻性本土再生能源資源之利用。

Figure 24 — the four postulates of the FITs deliberation announced by the MOEA (Ministry of Economic Affairs 2009a, 4)

While bearing a resemblance with a scientific community, the FITs committee does not only acquire its legitimacy from the scientific knowledge, nor does it represent ‘Nature’. Rather, it obtains legitimacy from a sociotechnical imaginary — the general public good of affordable electricity. This can be observed in ‘the four postulates’ of the FITs committee. According to the guidelines, the overall principles of deliberating the FITs are prescribed as the following (figure 25):

1. *The subsidy level should be better than the one before the legislation of the REDA.*
2. *The renewable energy industry should receive a reasonable profit, provided that their business models are legitimate.*
3. *Considering social equality, the subsidy should not result in any problem affecting people's livelihood, such as the raising of electricity prices.*
4. *The other factors relating to the FITs*
  - a. *The impact on the environment of the renewable energy installation should be within the range which is acceptable to society.*
  - b. *The installation of renewable energy should contribute to the development and autonomy of the domestic energy industry.*
  - c. *It should deliver a prospective facilitation of domestic renewable energy resources.*

Generally speaking, the four postulates of the FITs deliberation resonate with another image of renewable energy portrayed in the Nationalist government's energy policy: it is a 'precarious' technology which needs careful management. Renewable energy is presented as a technology that can lead Taiwan to global market dominance and solve the problem of energy autonomy (cf. the discussion on *Sustainable Energy Policy Framework* in chapter 5) – but also as a technology that can generate social inequality and have a huge negative impact on people's livelihood. The answer to this remarkable dilemma, however, is surprisingly simple — **finding the 'reasonable' FITs to tame this beast, the out-of-control renewable energy installation (and avoid a crisis in national budget and retail electricity prices)<sup>68</sup> and an 'impartial' way to allocate this massive**

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<sup>68</sup> See the following section 'When Experts Disagree' for details. Also from 2009 to 2012, the reports of 'the assessment on the impact of the FITs brought to retail electricity prices' is presented in the deliberation process.

**state subsidy (and avoid a crisis of further social disturbance).**<sup>69</sup> Facing these tough challenges, the state is summoned by the people to protect the general public good by balancing between private interests.

According to Thomas Hobbes's political theory, a sovereign, a commonwealth or a Leviathan is formed only with the people's authorisation, as an 'actor' that acts in their name. Nonetheless, 'prior to the formation of a commonwealth a People does not exist, since it was not then a person but a crowd of individual persons' (Brown 2009, 120). **Indeed, 'the people' here need to be murky and vague. The people acting in the authorising state to safeguard and facilitate the public good are essentially faceless and unitary.** Substantial individual citizens, social organisations and groups in this sense are seen as a threat, rather than the source of legitimacy for the general public good. This is the **implicitly imagined relationship between the people and the state,** promoting and protecting the people's interest against private rent-seeking. It is crucial to understand that in this collectivist imagination of a modern state the citizens' political participation only exists up until the moment when they authorise the sovereign representatives. The denial of the two democratic rights of the citizen — freedom from domination and participation in self-government — makes this representation deeply autocratic.

Drawing on the analysis above, I argue, in the case of the FITs committee where the state summons a group of meritocrats to make arbitration on the public good, the people's interest is exclusively represented by state agencies. In terms of expert members, they not only play the role of an impartial arbitrator but also of knowing the

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<sup>69</sup> The political claim of ensuring the FITs do not turn to someone's special advantage at the expense of the general public good, especially in maintaining an affordable electricity price, is the central rationale of all the deliberation principles. It stays unchanged since 2009.

‘rule of the public good’ best (i.e. the role of referee); the three social group representatives can be seen as taking the role of a passive audience who represents the passive ‘disembodied’ and ‘distanced’ people and witnesses first-hand the creation and performance of the general public good. The renewable energy industry and pro-renewable energy groups are conceived as self-interested stakeholders. In contrast, the role of the three ‘social’ representatives is essentially ambiguous. They are passive witnesses, and the representatives of a silent majority. They are distinguished from the interested, or the ‘rent-seeking’ participants — the renewable energy industry and NGOs — by their disinterestedness and generality. These assumed roles are implicitly attributed to the participants involved in the FITs deliberation.

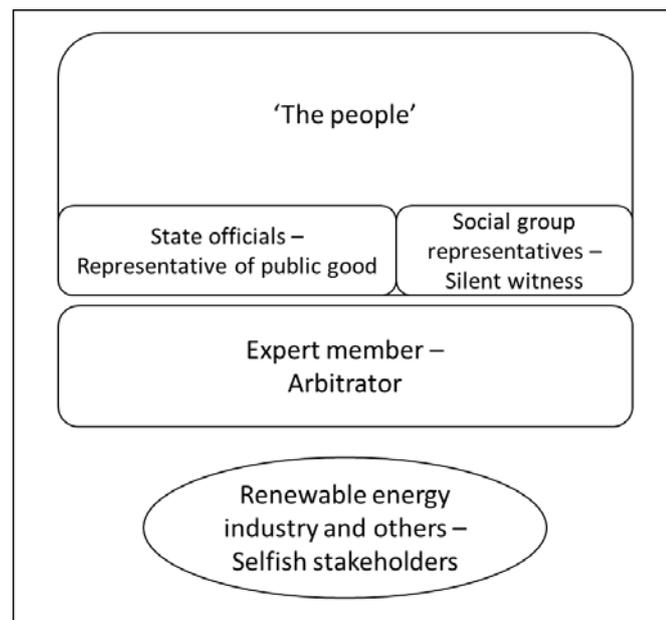


Figure 25 — the assumed roles in the FITs deliberation

My interviewee Q1 told me that the expert members should act as the referee of the public good in the sense of maintaining a ‘fair negotiation’ between the state and industry:

*That's precisely because it is the negotiation between the state and industry, so we need to maintain the reasonableness of negotiation. For the civil society [i.e. industry representatives], they will always think why I can earn more but I don't. For the government, they think why I can save more but I can't? From a fair point of view, I can say, this is a negotiation process, there is no absolute fairness ... between the government and industry, we, the committee members, are in the middle position (Interviewee Q1, 11/03/2016).*

While the operation of advisory committees can fall in line with a clear demarcation between 'Nature' and 'Society' as in the case of the UK GM controversy (Reynolds and Szerszynski 2006, Reynolds 2013), in the Taiwanese FITs committee, it does not work in that way. The experts of technoscientific knowledge are joined by officials, social scientists and social group representatives; together, they find out the basic rule of the general public good. It is believed that with the help of the scientific facts and technical-industrial experience provided by scientists and engineers, and the technical-social knowledge offered by the social scientists, the basic rule of the general public good, proposed by the government's bureaucrats (the four postulates and the FITs formula), can be discerned and endorsed. In the nationalist-high-modernist imaginary, the general public good is inherently a 'hybrid' in the sense that the technical and social elements are invited to be mixed up. How should one interweave science and society into a technoscientific utopia? How can one devise a general public good materially and epistemologically? In this conceptualisation of a collectivist identity in a hybrid, the public good is always 'thick with things' (Latour 2005b, 12) – although this does not mean it is done without purification and selective representation.

#### Assigned Roles and Acquiescence

Certainly, the contour of the public good is not clear before the practice and performance which have been done by committee members in the deliberation process; nonetheless, when it comes to the key question – has the deliberation been done without any interference of interest? – The answer is not always straightforward, even for the committee member themselves. My interviewee L2 told me:

*After the meeting, one industry person approached me and ... [made an allegation of conflicts of interest] ... I was trying to tell them [the MOEA] that one industry person made such allegation: should you behave yourself [rigidly follow the principle of avoiding conflicts of interest] ... the principles of the public good and conflicts of interest, have you really acted upon it? Including the Bureau of Energy ... (Interviewee L2, 07/03/2016)*

In the day-to-day work, the segregation between industry and committee members, therefore, the insulation between arbitrators and stakeholders is not as rigid as the MOEA wants to suggest. More importantly, the informal exchange between officials and industry, and the committee members and industry, can take place without formal recognition (as claimed by my interviewee L2: *'they [the committee members and industry] always have contact with each other'* and interviewee C1 *'they [the authority and industry] all know each other'*).

The question here is not about whether the segregation is fake or compromised, but it is about how the deliberation is performed **as if** made in an insulated laboratory and purely on the basic rule of the general public good. I argue that this kind of informal exchange behind the scene actually helps to form the basis for making a decision by consensus, or more precisely by addressing participants' concerns. This informal

exchange is indeed happening and has become routinised since the late 2015 when a three-party bimonthly meeting (involving Taipower, industry and the MOEA) was scheduled regularly according to my informant L4. Furthermore, this demarcation between experts and social representatives based on the assigned roles has a deeper consequence and creates dilemmas: who am I actually representing? What are the people's public good?

*Because I am the representative of [a social group], from my [assigned] point of view, of course, I want it [the tariff] to be low, not to let the industry have speculative interests. However, from my point of view as a scholar, I want to question the data [and its collecting methods] and the feedback coming from the industry, to see if this feedback is addressed properly. My position is in a dilemma [because] if I ask these questions then what is the position I am taking? ... The scholars in the committee didn't really speak out on these issues.*

*Interviewer: would you think the persons who attend the meeting as scholars are more likely to be the expert of nature and engineering science?*

*Yes, definitely right. (Interviewee L2, 07/03/2016)*

A structure of interest rivalry is assumed here — particular interests against the universal interest; it portrays particular interests as mere private rent-seeking on the one hand, and impoverishes the collectively made public meaning of renewable energy by diminishing this meaning to the indulgence of low electricity prices on the other. Based on the interviews above, it is fair to say the imposed demarcation does not only exist between committee members and the lay public — it also exists in the form of the

discrimination of expertise *within the committee*. Even though my interviewee has a strong competence and expertise (as a university professor), because she was invited to the committee as a social group representative, her expertise is considered as irrelevant and therefore cannot (and should not) be brought up in the meeting. In this rationalist view of representation, 'experts do not have interests, and representatives do not have expertise' (Brown 2009, 103). The Nationalist government intends to show that the deliberation is purely done through expertise and objective arbitration. However, social imaginary, expertise and social order are indeed co-produced at the same time, as my interviewee L2, a professor, is assigned as a social group representative and thus is not expected to voice outside from the position assigned.

Consensus and acceptance in the committee are too often based on the **acquiescence** among the committee members, given the minimal amount of time and resources allowed for them to arrive at understanding and conduct examination on the data presented (Interviewee L2, 07/03/2016). Additionally, even the committee members themselves can feel trapped by the established routines:

*Every year I look at the data [presented by the TIER and MOEA] and know how the data are still coming from the same institution and collected by the same methods [even though the data and methods have been challenged fiercely by the industry almost on an annual basis] ... when you attend the meeting two or three times knowing its routines, you start to feel there is nothing more to say ... I can hardly challenge anything ... (Interviewee L2, 07/03/2016)*

Under the implicitly imposed assumption of the public good and the assigned roles of committee members, even committee members can feel powerless. When facing

these routinised arrangement, they can feel that nothing more can be done to confront the overwhelmingly presumed social order. This is the consensus of acquiescence, a point which will be further discussed in the following sections.

### **The FITs Formula: How to Achieve the ‘Optimal’ Public Good**

By transforming a controversial issue into the technicality of picking up the reasonable values used in the calculation, the FITs formula, as a socio-technicalisation technique providing a much needed shield for the policy-makers to avoid proliferating criticism, acts as an essential instrument for reducing social-political concerns and meanings; the deployment of the FITs formula proves politically expedient for the Nationalist government to bypass further broad democratic discussion. Regarding disagreement within the committee, as we will see, it is comparatively easy to be managed because the ‘consensus among experts’ has been always assumed in the nationalist-pragmatist rationality.

The decision about the introduction of a tendering scheme on PV tariffs in 2010 marked a dramatic disagreement within the committee.<sup>70</sup> The idea was initially proposed in 2009 by the Council for the Economic Planning and Development (CEPD). The rationale for introducing a tendering scheme was to achieve the most efficient (building the largest capacity with the least money) and the most objective (achieving a fair subsidy distribution) way of installation.<sup>71</sup> For the CEPD, the question of which value is chosen and used in the calculation is always subjective and can invoke disputes unless the final tariffs are decided by a ‘freely participated’ tendering scheme (Council

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<sup>70</sup> The decision made in 2010 is to be implemented in 2011.

<sup>71</sup> How the tendering scheme works in the FITs deliberation will be explained in detail later in this chapter.

for Economic Planning and Development 2009). ‘Public welfare, equality and efficiency’ are reiterated again and again in their statement.

In the beginning, this was a proposal rejected by the 2009 committee because it was conceived as not compliant with the legislative motif of the REDA, which is to promote the installation of renewable energy with a fixed tariff (Ministry of Economic Affairs 2009b, 5). Proposals for an annual quota on the subsidised installation capacity and a tendering scheme were both rejected because the committee thought it was not authorised by the law to make this specific discretion (Ministry of Economic Affairs 2009b, 7). However, in 2010, the issue of an annual quota was settled by another expert committee with an even greater discretion power: the New Energy Development and Promotion Committee (NEDPC) of the Executive Yuan, a cross-ministerial committee. It is clear that the CEPD is a firm supporter of the idea of imposing an annual quota on the subsidised installation capacity and adjusting the FITs according to the results of the last year’s installation — whether it was above, equal or under the target.

#### *When Experts Disagree: The Out-of-control Installation?*

As discussed above, the imagination of renewable energy as a ‘precarious’ and ‘immature’ technology was deeply anchored in the policy-making circle at that time. It is a ‘precarious technology’ because it can cause financial and economic disaster to the nation if it is left without watchful control. The inherent ‘immaturity’ of renewable energy technologies is often referred as the reason why a broad installation and the use of renewables in the generation portfolio are considered just not feasible by the Nationalist government. Resonating with the story-lines around a ‘precarious’ technology, the results of the installation of photovoltaics in 2010 seems to provide a

convincing evidence for calling for a tighten control and watchful eyes on the FITs of PV. According to the installation target set by the NEDPC, 64MW of photovoltaics capacity was to be installed in 2010, 70MW in 2011, 75MW in 2012, and 80MW in 2013.<sup>72</sup> Just before the opening of the 2010 FITs committee, the chairman of the NEDPC, addressing the topic '*the Flaw in the Current Development of Solar Power and its Possible Reaction Plan*' in a meeting in the Executive Yuan and the Premier, then immediately gave the instruction to review the relevant policies to **avoid the installation of PV running out of control** (Control Yuan 2011, 2-3).

In the first FITs 2010 committee meeting (2010.09.24), the CEPD argued strongly that in order to avoid the **over-installation of PV**, a quota should be imposed. This time, the MOEA also argued that, since the amount of installation capacity already in the application process<sup>73</sup> is 105MW, there **should be incrementally reduced FITs for PV to slow down the flow of applications**. In the 2010 committee, this sparked debates on what the government's role is in the installation of PV. The reasons put forward by some committee members against the incrementally reduced PV tariff can be summarised as the following (according to the minutes of the FITs committee):

- *The first year results of application and installation are not reliable for predicting the future application situation. It is not an adequate*

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<sup>72</sup> <http://energymonthly.tier.org.tw/outdatecontent.asp?ReportIssue=201012&Page=14>. The targets for 2010 and 2011 were announced in 2010.08.16 when 2012 and 2013 targets were announced in 2011.09.21.

<sup>73</sup> The installed capacity 'in application' is not equal to the 'approved' capacity (Application–Approved–Contracted–Constructed). In the MOEA's press release, it attributed the policy installation target as 'contracted capacity'. According to the figure released in 2013, the actual contracted capacity in 2010 is merely 13MW, but this may be caused by the delayed process. In 2011, it is 96MW. Comparing the accumulated contracted installation in these two years with the policy target, the former is still lower than the latter (13+96MW:109<64+70MW:134). The constructed capacity is only, for example, in 2015, 57% of the approved capacity. Being approved does not necessarily mean being contracted and built.

*reason for imposing the reduced tariff now.*

- *The renewable energy installed capacity only accounts for 0.78% (wind), 0.02% (solar) of total installed generation capacity. The electricity generated by wind only accounts for 0.16% of the total generation. These figures are near 0, there is no need for putting a limit on installation and tariff now. A limit should be imposed only after renewable energy has accounted for a certain percentage of electricity generation portfolio.*
- *The government should not use the relation between the results of installation and the policy target to set the tariff. The policy target should not become a rooftop cap.*
- *The factors considered in setting the policy target are not clear, nor have the committee members been informed about the reasoning behind how the targets are set.*
- *The REDA is only passed for two years, and the FITs are only in effect for one year. It is too soon to decrease the tariffs; we should wait until two to three years later.*
- *The tendering scheme does not meet the spirit of the REDA and could produce a deteriorated quality of installation.*

(Ministry of Economic Affairs 2010b, d, c)

As observed above, the proposal to introduce a tendering scheme and reduce the PV FITs in just the second year of the implementation was far from being a consensus decision in the committee. The Nationalist government's resolution on renewable energy was also debatable, as pointed out by the Parliament document:

*'If [the pace of installation] follows the current planned pace of installation, achieving the targeted 2000MW installation will need 30 years ... if it follows the actual pace of installation and generation observed in 2010 ... it will need 869.57 years'* (Legislative Yuan 2011).

The disagreement over the introduction of a tendering scheme on the PV FITs is obvious. A committee member argued that the consensus on introducing a tendering scheme is just the consensus **'reached by a section of the committee members'** (Ministry of Economic Affairs 2010d, 1). However, due to the assumed 'consensus of experts'<sup>74</sup> over a particular decision, dissent was managed and controlled. The decision was then recorded as **'approved by the members of the PV sub-panel in principle'**<sup>75</sup> (Ministry of Economic Affairs 2010d, 1). Although the worry that the scheme will slow down the pace of photovoltaics installation significantly was still voiced in the 2010 committee's final (5<sup>th</sup>) session (Ministry of Economic Affairs 2011a), this 'consensus' has proved unstoppable.

The above analysis shows that if the government insists on a particular policy direction, it is nearly impossible to oppose it in this 'independent' committee, especially when the statutory chairman of the meeting is the chief of the competent authority. While the intention and policy direction of the government may vary and change, the imagination that the state safeguards the public good with suitable means is proved fundamentally compelling, and along with the administrative technique of denying public participation it has become even more powerful.

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<sup>74</sup> Indeed, the interviewee Q1 told me 'the most thing we are afraid of is that the committee members cannot produce consensus' (Interviewee Q1, 11/03/2016).

<sup>75</sup> It does not need to be approved by the whole committee; instead, it only needs to be agreed by half of the members of the solar power sub-panel.

Although all the committee members may identify themselves as meritocrats whose public responsibility is to safeguard the public good out of their competencies and good will, the disagreement observed above shows they may hold different ideas about what renewables (especially photovoltaics) can bring to society. The disagreement documented above should be perceived as involving different ‘matters of concern’ (Latour 2005a) in the committee; however, the arrangement of the deliberation process serves not to debate them further but to canalise social value differences into technical or even mathematical choices. The governmental discretionary power has expanded extraordinarily behind the disguise of ‘pure’ technical and administrative issues. Furthermore, in this case, precisely because the overall targets of renewable energy installation are not set by the FITs committee, it renders the committee a purely instrumental body in deciding a technical method of achieving the set targets. This is a carefully orchestrated division of labour: the cross-ministerial committee, the NEDPC, takes the political bit and the FITs committee takes the technical part.<sup>76</sup> The technical deliberation is staged to demonstrate the rationality of impersonality and fairness.

### *The Formula: Steering Tariffs in a Sea of Uncertainties*

**The choice to deliberate the FITs on the basis of a calculative formula is fundamental to the conceived form of the ‘public good’; it effectively fences the meanings and forms of the public good that are allowed to emerge from the deliberation process.<sup>77</sup>**

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<sup>76</sup> The NEDPC was, for some reason, dismissed in 2014. In 2015, the MOEA takes the role of setting an overall installation target. In 2016, a new office the ‘Energy and Decarbonisation Office’ was formed under the DPP government. The new target for PV installation is 1.44GW in 2 years. In 2015, the total accumulated (2009-2015) installation of PVs is merely 842MW.

<sup>77</sup> Certainly, using formulae to decided tariffs is not unique in Taiwan; other energy retail prices such as

Generally speaking, by deploying formulas the Nationalist government is able to avoid an often polarised debate over tariffs by using the formula as a device of controversy-settlement. In short, the FITs should be conceived as a delicately crafted sociotechnical artefact which can never be merely extracted from facts nor replaced by policy preference. It is, indeed, a process of technopolitics in-the-making and the creation of an artefact that is both social and technoscientific. Therefore, it would be naïve to argue that the decision over the FITs only follows the rigid technical data and requires no human discretion. As I have argued above, the deliberation process itself actively involves continuous boundary work — distinguishing technical issues from something else, which reflects an incessant intention to purify the decision made by the committee and eliminate the remaining human discretion from wider visibility.

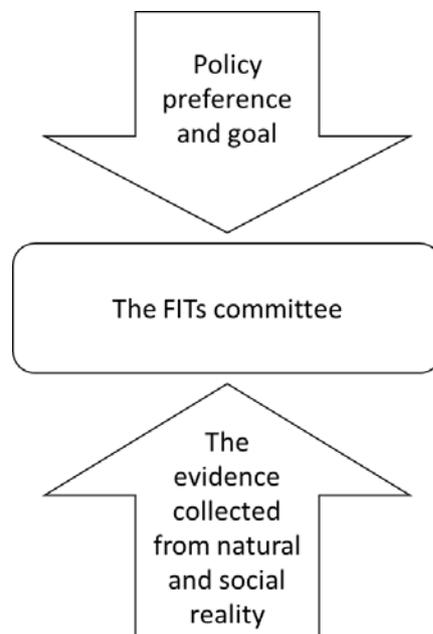


Figure 26 — the FITs committee as a hybrid space combining the technical and non-technical

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petroleum prices and electricity prices are also decided by 'floating price formulas'.

In order to understand how this stabilisation is done, the following paragraphs will firstly explain what the formula is, and secondly, how the numerous fine-tunings are done to seal up the gap left between the technical and non-technical. It is clear that from the very beginning the formula is designed to 'steer' the FITs through the sea of 'uncertainties' (Wen 2009, 9). According to the designer Dr. Lih-Chyi Wen (PhD in Economics), the formula is designed with the following concerns in mind:

- To steer the FITs through uncertainties: the simplified formula should reflect the real costs of installation, maintenance, risks and other factors while giving the industry a 'reasonable profit'. The 'reasonable profit' can motivate the industry to develop the high (cost-performance ratio) efficiency renewable energy technologies and also save the nation a huge fortune. Forms of low-efficiency renewable energy technology will be phased out of the market naturally.<sup>78</sup> This means that the formula cannot be too complex and needs to deal with uncertainties. In short, it needs the characteristic of controllability.
  
- To focus on the (annual) value of 'present time': referring to the 'time value' concept of instalments in the Engineering Economics, the formula is designed to make the annual income of one installation site equal to its annual assets depreciation plus its annual maintenance cost and a 'reasonable profit'. The capital recovery factor is created for this purpose.
  
- To focus on the 'discount rate' (later, the Weighted Average Cost of Capital,

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<sup>78</sup> It acts as a standard of cost-performance rate, the industry at least need to meet this minimum cost-performance rate to make profit.

WACC) as the most important policy instrument in the formula: this is seen as the ‘rudder’ of the FITs. The discount rate is acknowledged by the designer as the only ‘subjectivity-focusing’ and ‘policy-preferring’ factor in the formula, representing a comprehensive consideration of factors such as the national financial situation, the features of policy-planning, policy preferences and the total investment pledged by the government. It is said that when two countries have ‘similar economic conditions’, they should share ‘a similar capital recovery factor’ (Wen 2009).

$$Tariffs^{79} = \frac{\text{initial installation cost} \times \text{capital recovery factor} + \text{annual maintenance cost}}{\text{the annually accumulated output in kWh}}$$

$$\text{Annual maintenance cost} = \text{initial installation cost} \times \frac{\text{annual maintenance cost}}{\text{initial installation cost}} (\%)$$

$$\text{Capital recovery factor} = \frac{\text{discount rate} \times (1 + \text{discount rate})^{20}}{(1 + \text{discount rate})^{20} - 1}$$

In 2009, this formula faced a major challenge from the industry focusing on the value of discount rate. This value has a huge influence on the final tariffs. At that time, the

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<sup>79</sup> The unit used here is KWp/per year. For photovoltaics, KWp is the power output achieved by a solar module under the Standard Test Conditions. 25°C, air mass 1.5 and irradiance 1000W/m<sup>2</sup> is used to define as the standard conditions. In the following sections, I am focusing on photovoltaics only due to the length constraint of the thesis. Different technologies have different tariffs.

discount rate was a given value which is proposed by MOEA/TIER to the committee and then approved by the latter. The deliberation process did not provide much explanation about this key value that decides what a ‘reasonable profit’ is, except to say that this rate should be higher than the rate of the 20-year government bonds and to involve a surplus to cover the risks involved in the investment. As argued by its designer at the very beginning, this discount rate is the rudder of the whole formula and reflects policy preferences and a comprehensive political consideration. However, in the 2009 administrative hearing it was perceived as a ‘black box’ by some participants and received much criticism.

In 2010, this discount rate was further explained as the Weighted Average Cost of Capital rate, WACC:

$$\begin{aligned}
 \text{WACC} &= R_o \times W_o + R_l \times W_l \\
 &= R_o \times W_o + (R_o + \beta) \times W_l \\
 &= (R_f + \alpha) \times W_o + (R_f + \alpha + \beta) \times W_l
 \end{aligned}$$

R <sub>o</sub>	Loan interest rate
W <sub>o</sub>	Ratio of loaned capital
R <sub>l</sub>	Private remuneration rate
W <sub>l</sub>	Ratio of private capital
R <sub>f</sub>	Risk free interest rate
A	Credit spread
B	Risk premium

$$R_o \text{ (Loan interests rate)} = R_f \text{ (Risk free interest rate)} + \alpha \text{ (Credit spread)}$$

$$R_l \text{ (Private remuneration rate)} = R_o \text{ (Loan interests rate)} + \beta \text{ (Risk premium)}$$

Figure 27 — the parameters used in the FITs formula

This 'objectivity turn' should be seen as a strong effort to objectify and naturalise the last bit of subjectivity left (i.e. 'reasonable' profit) in the FITs formula through deploying more even equations. The shaking up of the FITs now means that committee members merely determine reasonable values to be used in the formula. Objectivity and impartialness is said to derive from two aspects of the process: 'the reflection of true costs' and 'a reasonable profit rate'. The initial installation cost, the annual maintenance cost and the annually accumulated output are attributed to the part of the natural evidence, and the 'reasonable profit rate' which resides in WACC is counted as the part of the social evidence. **'Correspondence'** to the evidence about 'true costs' and 'reasonable profit rates' found in the world is one of the most overriding doctrines in the deliberation process. A FIT produced by the formula seems to follow perfectly impersonal rules and, therefore, should generate no more controversies. However, as argued by Porter (1995), objectivity never only comes from the collected facts; objectivity always requires human discretion. As I am going to show below, in the FITs deliberation the boundary between the technical and the non-technical, and between objectivity and subjectivity is highly relative, and often manoeuvred from time to time.

The evidence <sup>80 81</sup>	
Initial installation cost NTDs/kWp	Risk free interest rate %
Annual maintenance cost %	( $\alpha$ ) Credit spread %
Annually accumulated output kWh	( $\beta$ ) Risk premium %

<sup>80</sup> The natural evidence is collected by the TIRE from the records of the implemented public construction projects, the ITRI conducted research projects, demonstration site surveys, Taipower operation records, the third-part data base such as Solarbuzz, IMS research, the Word Bank, Bloomberg, DECC (UK), EIA (US), Electric Power Research Institute and etc.

<sup>81</sup> The social evidence is collected by the TIRE from the reports from the public and private banks, Taiwan central bank, Taipei Exchange, private securities companies, the records of the implemented public construction projects, and the other projects and companies invested by the government.

Risk free interest rate = 10-year government bonds yield to maturity rate  
Credit spread = bank's overweight for the extra risks on the basis of credit rating  
Risk premium = the rate for the investor to accept compensation for the risk

Figure 28 — the 'factual elements' used in the FITs formula

On the macro level, deciding the FITs through a mathematical formula is technical and objective compared to the politically negotiated tariffs in the Parliament; the introduction of a 'freely participated' tendering scheme is also considered as objective and without private-interest interference compared to the tariffs decided directly by a committee . On the meso level, the natural evidence (initial installation costs, annual maintenance costs and annually accumulated output) is objective compared to the policy instrumental rudder 'discount rate'. Nonetheless, even this 'subjective' policy rudder can be further dismantled into the social evidence (risk free interest rates, credit spread and risk premium) found in the social reality, and thus objectified. In the next section, I will show, on the micro level, how it is nearly impossible to find an element that is without expert discretion and interpretation.

#### *Eliminating Discretion by Narrowing Down the Gap between Numbers*

Although the boundary between objectivity and subjectivity is always in tension and not static (Levidow and Carr 2007) especially on the micro level, the determination to distinguish them from each other is continuously observed in the committee:

*The target for installed renewable energy capacity is a policy goal and the calculation of the FITs is objective. Both of them can be independently decided and*

*therefore we should discuss them separately* (Ministry of Economic Affairs 2013, 2).

The CEPD (and, after 2010, also the MOEA) suggested implementing an overall ‘planned and coordinated approach’, a tendering scheme, on installing renewable energy (according to the annual quota of subsidised installed capacity), reflecting the familiar technoscientific policy trajectory of the ITRI discussed in chapter 4; the tendering scheme can also be considered as a mechanism for demonstrating objectivity on the micro level. The tendering process is organised in two terms, the first half of the year and the second half of the year, each with their respective ‘maximum tariffs’ which are approved by the committee. The participating companies propose discount rates (%) in order to bid for the quota of subsidised installed capacity; for example, in the band of ‘over 30kW and under 100kW’ installations, one company offered a discount rate of 7.68%<sup>82</sup> on the announced maximum tariff of 9.4645 NTD/kWh; thus the final tariff for that particular company would be  $9.4645 \times (1 - 0.0768) = 8.73762$  NTD/kWh.

This scheme only operates on the PV FITs and was implemented in 2011. After being approved by the 2010 committee in response to the perceived ‘out of control’ photovoltaics installation; for the MOEA, this scheme is ‘impartial, reasonable and effective’ (Ministry of Economic Affairs 2011b, 17). The interviewee Y1 said:

*You don't need a PhD in Economics to help set the tariffs. They only know theory.*

*We, the ITRI, have regular exchanges and contacts with the industry ... the FITs are*

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<sup>82</sup> The minimum reduced rate for this term is the average of the reduced rates proposed in the last term.

*full of policy preferences and decided on the basis of policy goals ... when you [get to] know the way they decide the tariffs once or twice, you just won't believe it anymore...they finally use the tendering scheme to adjust their results [of the FITs deliberation] (Interviewee Y1, 14/10/2016).*

This claim points out that the tendering scheme has the ability to transfer policy preferences into the objectified artifact through the **'consent'** of the **participating companies** — by participating in the tendering scheme, renewable energy companies **agree with** the announced tariffs and the regulated quota of a subsidised installed capacity. This **'tacit consent'** and the **'objectified artifact'** build simultaneously on the action of participating in the tendering scheme.

The below table summarises the fine-tuning(s) that have been done in order to narrow the gap between the values 'collected from evidence' and 'submitted by the industry', and the reasons given by the committee through the period from 2009 to 2015. It shows the foundation of the FITs objectivity is floating and never really attached to a static rule; however, the enactment of the formula as an 'obligatory passage point' (Callon 1986) does create an invincible political constraint for the discussion — **negotiation should be done by numbers and only in numbers.**

	2009	2010	2011
Initial installation	Industry: 220k MOEA: 185k Committee: 197k	Industry: 154k MOEA: 145k Committee: 145k	Industry: none MOEA: 130k <sup>85</sup> Committee: 130k

<sup>85</sup> From 2011, this represents the predicted cost of the second half year, as the predicted cost in first half year only accounts the half of the 'international prices trend'.

costs NTD/kWp <sup>83</sup>	<i>Takes no consideration on the international prices trend</i>	<i>Takes consideration on the international prices trend<sup>84</sup></i>	<i>Takes consideration both on the international prices trend and the latest results of the tendering scheme<sup>86</sup></i>
Annual maintenance costs %	Industry: 3% MOEA: 0.5% Committee: 0.7% <i>Uses the value (0.7%~1.5%) recorded at the demonstration sites of the ITRI</i>	Industry: 3% MOEA: 0.5% Committee: 0.7% <i>Uses the value (0.7%~1.5%) recorded at the demonstration sites of the ITRI</i>	Industry: none MOEA: 0.7% Committee: 0.7% <i>The average value of the collected data is 0.6%. After applying the annual rate of inflation, it is 0.7%</i>
Annually accumulated output kWh	Industry: 1200 is too high MOEA: 1200 Committee: 1200 <i>Uses the value (1260) recorded at the demonstration sites of the ITRI</i>	Industry: 1200 is too high MOEA: 1300 Committee: 1250 <i>Prioritises the installation for the optimal location (southern Taiwan)</i>	Industry: should consider the attenuation of output MOEA: 1250 Committee: 1250 <i>Prioritises the installation for the optimal location (southern Taiwan). The decision of reducing 1300 to 1250 has taken attenuation into account</i>

<sup>83</sup> This represents the costs of the installation in the band of from 1kW to 10kW. This cost is always a predicted cost because the decision is made one year before the tariff is to take effect. The 'international prices trend' is especially mentioned by the MOEA which is presented as the average rate of falling prices observed in the international market.

<sup>84</sup> Some members did not agree on taking this factor into account.

<sup>86</sup> The average reduced rate from the latest results of the tendering scheme is 6.5% and therefore, the 'retrospectively estimated' installation cost is 136,000 NTDs/kWp. The international prices trend is - 4.54%, and thus, it is estimated as 136,000 x (1-4.54%) = 130,000 NTD.

Discount rate % /WACC	Industry: 6%~8% MOEA: 3% Committee: 5.25% <i>Uses a unitary rate for all kinds of renewable energy installations</i>	Industry: 6%~8% MOEA: 5.15% Committee: 5.25% <i>Uses a unitary rate for all kinds of renewable energy installations<sup>87</sup></i>	Industry: none MOEA: 5.25% Committee: 5.25% <i>Uses a unitary rate for all kinds of renewable energy installations<sup>88</sup></i>
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	2012	2013	2014
Initial installation costs NTD/kWp	Industry: none MOEA: 115 Committee: 115 <sup>89</sup> <i>Takes consideration both on the international prices trend and the latest results of the tendering scheme</i>	Industry: none MOEA: 99.5 Committee: 99.5 <i>Takes the latest results of the tendering scheme and a 'half' of the international prices trend. No installation cost falling for the second half year</i>	Industry: 104 MOEA: 90.7 <sup>90</sup> Committee: 90.7 <i>Takes a 'half' of the latest results of the tendering scheme and a 'half' of the international prices trend.</i>
Annual maintenance costs %	Industry: none MOEA: 0.7% Committee: 0.7% <i>The values collected are 0.4%~1.2%. 0.7% is in the middle of the range</i>	Industry: none MOEA: 0.8% Committee: 0.8% <i>The drop in installation costs is huge so the annual maintenance</i>	Industry: 2.5% MOEA: 1% Committee: 1% <i>The values collected are 0.4%~2.09% and 0.62%~1.04%. 1% is in the middle of the range</i>

<sup>87</sup> The Risk premiums ( $\beta$ ) of public construction projects presented in the meeting range from 1.412 to 10.723.

<sup>88</sup> The Risk premiums ( $\beta$ ) of renewable energy installations should be slightly lower than the Risk premiums of the public construction project of a city-wide sewer system (30-50 years lifespan) and therefore, should be 6.177%.

<sup>89</sup> 130,000 NTD (the cost in the second half of the last the year) x (1-7.68%) (The average reduced rate from the latest results of the tendering scheme) x (1-3.95%) (the full international prices trend) = 115275 (the predicted cost in this second half of this year)

<sup>90</sup> From 2014, this represents the cost of the installation in the band of from 1kW to 20kW.

		<i>costs are slightly increased to 0.8%</i>	
Annually accumulated output kWh	Industry: 462 MOEA: 1250 Committee: 1250 <i>The values collected are 1158~1398. 1250 is in the middle of the range</i>	Industry: none MOEA: 1250 Committee: 1250 <i>The values collected are 1243~1286. 1250 is in the middle of the range</i>	Industry: 1192 MOEA: 1250 Committee: 1250 <i>The values collected are 1237~1277. 1250 is in the middle of the range</i>
Discount rate % /WACC	Industry: none MOEA: 5.25% Committee: 5.25% <i>Uses a unitary rate for all kinds of renewable energy installations</i>	Industry: none MOEA: 5.25% Committee: 5.25% <i>Uses a unitary rate for all kinds of renewable energy installations</i>	Industry: 7.24% MOEA: 5.25% Committee: 5.25% <i>Allows off-shore wind to use a slightly higher <math>\beta</math> %; however, after deducing its received 'demonstration awards', the tariffs still use a unitary rate for all kinds of renewable energy installations</i>

	2015
Initial installation costs NTD/kWp	Industry: none MOEA: 74.6 Committee: 79.7 <i>Takes consideration on the latest results of the tendering scheme and the 'real prices' in the market</i>
Annual maintenance costs %	Industry: 1%~3% MOEA: 2.08% Committee: 1.97%

	<i>In 20 years, averagely 2 new inverters will be required for replacement. This cost is moved out from the initial installation costs and rearranged to the annual maintenance costs</i>
Annually accumulated output kWh	Industry: 1200~1225 MOEA: 1250 Committee: 1250 <i>The values collected are 1236~1348. 1250 is in the middle of the range</i>
Discount rate % /WACC	Industry: none MOEA: 5.17% Committee: 5.25% <i>To maintain the stability of the investment environment, the rate is kept unchanged</i>
Final adjustment	Due to the disappointing results (the accumulated output kWh) in the northern Taiwan, the tariff for this area is + 12.5%

Table 11 – the socio-technicalisation by assigning values to the FITs calculation

Three pivotal patterns of socio-technicalisation can be observed in the FITs deliberation from 2009 to 2015, and they can be summarised as the following:

The first, picking up a 'reasonable' value among numbers: the main deliberation space is constrained to these six factors and their values, making the whole deliberation rather technical and merely about cost-performance consideration. The discretion space of the committee shrinks to the extent that it only allows committee members to make choices between the different values presented by the MOEA/TIER or submitted by the industry; in some cases, only between the values collected by the TIER from different public construction projects and data resources. More importantly, when it comes to which value exactly to settle on, the answer is beyond the surface of

numbers. For example, when talking about how to choose the slightly different numbers to be used in the calculation, interviewee Q1 said:

*For all these years, the framework of the formula has been agreed by the committee and all the discussion has gone in the same direction ... the differences between expert members are left [minimalised to] small things; for example, 'I think this should be 1800 kWh, you think this should be 1900 kWh'<sup>91</sup> ... there is no absolutely right or wrong about this matter, maybe the majority of the committee think it is more reasonable, then okay, that's it ... In the committee, all the members are professors, 'you honour my expertise, I honour your expertise' ... 'this time I follow your recommendation, next time you follow my suggestion' (Interviewee Q1, 11/03/2016).*

**The second, reinventing the purpose of the factors:** the initial installation costs and annual maintenance costs, being 'ostensibly objective' factors which should only reflect the 'true' costs, in fact comprise a range of costs, such as the rent for the installation site, the insurance fees, the administration fees paid to Taipower for connecting to the grid, the regular administrative costs of the company, the site construction costs, the license fees, the repair costs, the regular maintenance costs and so on. What costs are included (or not included) in what categories is a point of continuous dispute and still not clear.<sup>92</sup> For example, in 2015, the annual maintenance costs were raised sharply from 1% to 1.97% because the cost of the two inverters was 'moved out from the initial installation costs to the annual maintenance costs'. Similarly,

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<sup>91</sup> However, he also told me that the industry always has the intention to argue the value to the 4<sup>th</sup> decimal point, which is 'so important' to the final tariff. The importance of the slight differences between values seems not to be based on the values themselves but on who argues for them.

<sup>92</sup> Interviewee Q1: 'there is no absolutely right or wrong here, they all just need to follow the general operation rules in this sector [finance and economic expertise]'.

after 2010, the latest results of the tendering scheme were taken into account, along with the existing international prices trend (the retail prices trend of solar modules in the global market), as the two major variables influencing the costs of the initial installation. As noted above, the committee uses these two variables as the key tool to exert its discretionary power — *they can choose to adopt either one of them or both of them, and the full value or the half of them*. Often, this is based on the outcome of the installation last year.<sup>93</sup> Since 2015, the initial installation costs are essentially detached from the international prices trend and now take the ‘real prices presented by invoices’ (another variable) into account.

The third, taking the median or the average value: the *legitimacy* and *reasonableness* of expert discretion seem to build largely on a key concept — mathematical moderation, which means that the value they choose to use is always a number ‘somewhere in the middle’. Expert discretion is not only made on the basis of picking a number but often a number of the average or median value. This preference to mathematical moderation is explicitly expressed by my Interviewee Q1:

*I think this formula is very reasonable; it considers the key factors such as the initial installation costs, the annual maintenance rates [and etc.] ... if you say in the beginning there are no records [of the renewable energy installations in Taiwan] then should we just do nothing? ... We collect the data from many cases in the other countries ... the only problem is we cannot decide what the renewable energy development [in Taiwan] will look like in the future, like the U.K. or Germany or Japan? Then we take the median ... this is the safest way. Of course,*

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<sup>93</sup> The decision is relevant to the the outcome of the installation last year (compared to the policy target) as my interviewee Q1 told me, the adjustment of the value is out of the ‘reasonableness’ or policy target.

some will take a little advantage, some will suffer a little disadvantage by this move, but for the position of impartialness, this is the best way. (Interviewee Q1, 11/03/2016)

For example, for the annually accumulated output, 1250 kWh is ‘reasonable’ because it is in the middle of the observed range, 1237 kWh ~1277 kWh (2014) or 1236 kWh and 1348 kWh (2015). For the risk premium ( $\beta$ ), it is also argued that the values on the two ends of the range (1.59% and 10.69%) should be excluded because they are extreme, therefore, the risk premium ( $\beta$ ) of renewable energy installations should be between 4.56% (the public construction of a university dormitory) and 6.60% (the public construction of a city-wide sewer system). Further, because the lifespan of a typical renewable energy installation is 20 years whereas that of a sewer system is 30 years to 50 years (a higher risk), therefore, the risk premium ( $\beta$ ) of renewable energy installations should be slightly lower than the risk premium of a sewer system; it is thus reasonable to set it to 6.177%.

	Natural gas development	University dormitory	Wind farm in China – the minimal	Wind farm in China – the median	Photovoltaics development in Germany – WACC 6.5%	Value used by 2010 committee	City-wide sewer system	Photovoltaics development in Germany – WACC 8%
標竿	瓦斯公司	工程建設BOT案例	中國風力下限	中國風力中間值	德國(以WACC為6.5%估算)	100年審定會	汙水下水道BOT案及中國風力上限	德國(以WACC為8%估算)
自有資金報酬率(%)	4.99	7.96	8.00	9.00	9.09	9.537	10.00	14.09
WACC (%)	3.877	4.768	4.780	5.080	5.108	5.250*	5.380	6.608
$\beta$ 風險	1.590	4.560	4.600	5.600	5.690	6.177	6.600	10.690

Figure 29 — the range of risk premiums ( $\beta$ ) presented by the MOEA/TIER (Ministry of Economic Affairs 2011c)

It is hard to see what commonalities are shared by public construction cases as diverse as a university dormitory, a city-wide sewer system and an installation of renewable energy except that all of them provide that abstract utility, the general public good. While **picking up a value of the average or the median is perfectly reasonable in technical terms**, especially when absolute accuracy is not possible, it ignores the issue of the quality of the data and crucially, the social meaning that the data can embody and deliver — **any social-political concerns are simply replaced by the discretion made by the committee experts out of technicality.**

To sum up, the socio-technicalisation of the FITs deliberation has been built on the following three premises: the **assumed consensus** in the committee, the **presumptive and static boundary** between the technical and political, and between objectivity and subjectivity and finally the general public good which can be somehow discerned by **mobilising technoscientific reasonableness**. In the conclusion, I will give a short review of what has been forgotten or simply effaced in this process of socio-technicalisation.

### **Conclusion: Effaced Manifold Meanings**

What does energy mean for our society? I suggest the answer depends on **the kinds of rationality, normative values and political commitments that we perform in the utilisation of energy for our collective matters**. Renewable energy, in the case documented above, is simplified and purified simultaneously as a universal and quantitative utility which contributes to the general public good of the murky faceless people. The sociotechnical imaginary of the existence of a generalisable public good is tacitly enacted as the underlying framework in the FITs deliberation, dictating the meaning of renewable energy — as an abstract utility to be *quantified* and *engineered*

by the *state*, rather than as a *tangible material* to be made and done by *different groups of people with different concerns and ontologies*.

The imaginary of the unitary public good discerned by meritocrats and its socio-technicalisation process provide a perfectly satisfactory answer to some citizens' aspiration to an ever growing and modernising national state. Notwithstanding, it is lamentably unsatisfactory to the dream of a participatory democracy which haunts other citizens; it presents a powerful control over democracy where experts dictate the face of the public good and eradicate public meaning(s) through a participatory scheme designed to have no participation. Ironically, this state of technocracy fulfills the principles of a liberal democracy: transparency, objectivity, accountability, representation and participation. As I have argued again and again, these principles may be the necessary conditions for democracies, but are not sufficient conditions. The problem lies in the often-presumed technical rationality which *eradicates the multiplexity of meaning(s) and different sets of priority concerns* (Wynne 2008). I suggest that one important way to confront this monolithic and dominant sociotechnical imaginary is to revive those deleted meanings and ask how things could be done differently. The interviewee K1 told me:

*[When] we talk about tariffs, the multiplicity [of tariffs] should be taken into account ... for instance, for the ground photovoltaics installation, it should be considered in a meticulous way. In areas of subsidence like Pingtung, the land is troubled by the problem of soil salinisation. The steel used for the elevated piles of the installation there should be different. Additionally, if the site is on farmland and you want to build a PV greenhouse, a PV farm, then the costs should be different. If you really want to let the crops grow under the [PV] greenhouse and*

*the [structure of] installation survive typhoons...*

*The point is not only about the costs and prices, it is more about the quality of installation [the ways the installation are done]. The FITs should consider this multiplicity; the tariffs should consider both what a good installation is in the respects of local environmental features and the efficiency ... the tariffs should allow for the diversified installation configurations according to the local conditions (因地制宜) and should not convey the image of snatching farmlands from agriculture (Interviewee K1, 20/10/2016).*

In her opinion, the tariffs should be able to accommodate different configurations of installation and follow the principle of tailored settings responding to local needs.

*It [the installation of renewable energy] should provide solutions to local problems [instead of creating new problems to the locality]. For example, the tariffs could be categorised into three bands. For the first band, the installation is done on heavily polluted land with no possibility of revitalisation. The installed piles [in this case] can be low to make it easy to be maintained. It can also take account into the [costs of] prevention of metal corrosion... For the second band, the land is polluted but still has the possibility to be revitalised, then a [uniquely modified] installation design should be in place to allow the particular [non-agricultural] plants to grow under it, to make it [the phytoremediation processes] happen ... the third band is PV greenhouse which allows you to grow multiple forms of agricultural crops under it...this can also bring agricultural tourism. This is a high additional value ... (Interviewee K1, 20/10/2016)*

As described above, one key feature of renewable energy is that its forms of installation can be done differently to reflect the divergent local needs and local characteristics. This relies on how to shake up and create human-material relationships and depends on how the multiplicity of meanings is included and allowed to emerge from the discussion over the FITs:

*If we say that green energy has a social value and makes a contribution to the [sustainable] environment, then this value should be added to the tariff; however, this is not done. The tariffs are created as purely out of economic rationality ... [it is only about] spend[ing] the least money to do the greatest thing [buy the most volume of electricity] ... The so-called social equality highlighted in the deliberation principle is not fulfilled, either... [Currently,] if a household wants to install solar PV on the rooftop, they need to be higher than middle class to afford it ... the tendering scheme has not driven the whole market to small and decentralised installation, either. The market [under the current regulatory framework] still develops toward massive installation and is dominated by big corporations... the people are more open than they [the policy makers] thought; prices is not the only concern existing in the people's mind (Interviewee C1, 27/10/2016).*

For my interviewee C1, the most significant value of renewable energy is its potential for open access. Renewable energy should be accessed by everyone and should not be limited to a few privileged players. It is not just an abstract policy but a technology with the potential to step into daily life and be embedded with daily experience. For her, profit generated by installed systems should be shared among the participants, and the operation of the system should create tangible links between the investors and the

installation sites. In practice, her company offers two innovative programmes for citizen's solar power plants: one focuses on minimising the threshold of participating in solar PV by dividing the installed capacity into tiny units which can be bought by ordinary citizens. Another one focuses on providing the vulnerable in society a continuous and stable income through crowd-funded solar power systems.<sup>94</sup>

Renewable energy could mean customised installation designs which response to articulated local concerns and needs on the one hand; it can also establish a human-material-environment relationship through broad civil participation and sharing on the other hand. Multiple tariffs could be applied to multiple configurations and operation modes of installation. After all, the public good is never singular and unitary; their multiple embodiments should be articulated, included and negotiated through the democratic engagement of society instead of through a technocratic developmental planning and deliberation dictated by experts and meritocrats. Following this argument and the quest for an alternative sociotechnical imaginary, in the next chapter I will explore how different materialisations of installation are possible, and what divergent assemblages of human-material hybrids they may bring.

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<sup>94</sup> The details of the programmes can be found at <http://www.sunnyfounder.com/>



## **7. Reassembling Solar Power — Crossover of Locality, Materiality and an Alternative Imagination**

### **Introduction**

The high-modernist developmental state's legacy has occupied an essential position in the Taiwanese energy politics as illustrated in the previous chapters. However, by naming nationalist high modernism the dominant sociotechnical imaginary in postwar Taiwan, I do not claim that the imaginary in Taiwan is homogeneous or deny that it has been confronted by other challenging imaginaries. Although it is crucial to point out the dominant version of a sociotechnical imaginary can establish the perimeter of acceptable legitimacy, given the latent and alternative imaginary that can be traced back to the civic movements in the 1920s and 30s under the Japanese colonial rule is equally important for us to understand that a high-modernist-authoritative regime, as powerful as it is, can never really efface the different ontologies in society and destroy all resistance.

Following this line of thought, I make a short review of the constrained public meanings in the bureaucratic—scientific policy circle where policy-making is done with exclusive reliance on references to technoscientific rationales, and claimed commercial-economic and societal benefits. The public do have the capacity to position themselves in relation to sociotechnical development in both epistemic and hermeneutic terms. However, a continual denial of the public's ability to engage in meaning-making and knowledge-making in the state administration circle can be clearly observed. This rationalist and universalist view on meaning-making, knowledges and ontologies

invokes the urgent need to go further and explore ethno-epistemic technoscientific assemblages. Inspired by Alan Irwin and Mike Michael's work, I am going to explore the situatedness, stickiness and locality of renewable energy installations in southern Taiwan.

In the next section, a brief conceptualisation of a 'native soil' and reform oriented imaginary which derives from Taiwan's colonial past and resistance history is presented. It can be understood as a continual trend of pursuing Taiwanisation (indigenisation) and greater attachment to 'the native land'. The contemporary roots of this indigenised imaginary can be found in the calls for cultural and political reform aired by young intellectuals in the 1970s. As an alternative to the 'great Chinese modernism', this imaginary pledges a going 'back-to-reality' and the forging of a Taiwanese consciousness. Bearing this crossover of locality and modernity in mind, I am going to explore the possibility of enacting an alternative sociotechnical imaginary which attributes technologies with values of resistance and resilience grounded in locality.

In the following sections, a local history of *Linbian* (林邊) and *Jiadong* (佳冬) is provided to situate the cases of the programme of CWGE (Cultivating Water and Generating Electricity 養水種電), the floating PV system and the PV greenhouse which will be documented in this chapter. The assemblages of the grouper fish and the wax apple were the backbones of the local economy until they were challenged by Typhoon Morakot in 2009, and since then the local community has been anxious about the future of local life, as existing industries were being destroyed and residents were leaving the area. The CWGE programme was initiated by the local government both as a land rehabilitation and reconstruction plan, and PV technology was pulled in to form a new assemblage to be juxtaposed with the other existing ones. This assembling of a

sociotechnical system should be seen as involving endless actions and reactions among human actors, local materiality and the environment. The empirical data used in this chapter includes policy documents issued by Pingtung County government and the Post-disaster Reconstruction Council; one pilot study field trip and one field trip to the SunnyRich's two installation sites; two interviews conducted with the directors of the Promotion Office of Green Energy of the County government and SunnyRich company; and interview transcripts that appear in the appendix of Fu-Tsung Cheng's (鄭富璫) Master's degree thesis published by the Graduate Institute of Studies in Documentary & Film Archiving, Tainan National University of the Arts.

To sum up this chapter in advance, I suggest that, based on the cases studies so far, the way to facilitate the democratic role of technoscience in contemporary energy politics is to take seriously different ontologies in the public sphere and everything else, including nonhuman actors — in an imaginary that recognises the performative aspect of technoscience and the broader and legitimate concerns among the people — a topic which will be further explored in the final chapter of this thesis.

### **Revisiting the Public(s): Silent, Ignorant – or Meaningful Differences?**

As I mentioned in chapter 2 and numerous other places, science in the perspectives of conventional modernisation and political theories tend to be seen as an instrument that establishes factuality in the ambiguous mundane, distinguishes facts from fictions, and generates objective knowledge in the public sphere. Objective knowledge is used in order to create public authority through the simplification of public meaning. The messiness of knowledge-making and sense-making is cleaned and guided by scientific knowing and its corresponding governing structures. The use of science in various contexts such as the routinised practices of electricity planning and the mobilisation of

formulas, factors and values in the calculation of FITs, with the effect of rendering the discussion of public interest and a common energy vision as transparent, ingenuous and depoliticised while hiding the presumptions and commitments imbued in technical choices and institutional arrangements. In the same sense, science also has converted the 'celebratory' eyes of the passive subject into the 'attestive' gaze of the modern citizen; 'the people' are able to question and evaluate the factual assertions made by those who are in power (Ezrahi 1990), testing the claims of authority and confronting many obstacles, diversions, and mystifications. Scientific literacy is equated with the capacity to act as a citizen in a liberal democracy (Irwin and Michael 2003).

The public(s) are 'required' to have scientific literacy and to be intellectually better equipped to contribute to the processes of a liberal democracy. But, at the same time, scientists are not required to understand the political, cultural influences in scientific knowledge. In this respect, common sense realism and its legitimate scientific methods of knowing the world (Ezrahi 2012) are now the standards in social and political engagement, despite assuming a taken-for-granted unstated power distribution between the public(s) and experts whereby the views of the public, which are not considered as parts of scientific literacy, are either simply dismissed as irrelevant or presented as an irrational challenge to scientific and political authority (Irwin and Michael 2003, Wynne 1992a, Irwin 2006). Furthermore, scientific knowledge in this sense is not innocent or only politically instrumental — irrelevant to meaning-making and impartial; on the contrary it is generative in conveying normative meaning and creating moral judgements; it is a political practice that generates a particular form of understanding of effectiveness, objectivity, and trustworthiness (Wynne 1996a).

Wynne described this scientists and policy-makers' continuous denial of the publics' different abilities of meaning-making as the 'deficit mode' (Wynne 1991), whereby authority mistakenly deems public dissidence as the consequence of people 'falling short of some level of scientific understanding' (Wynne 1991, 112), which itself makes the background assumption that all issues are scientific issues as if no other, perhaps different and conflicting, meanings exist. The denial of experience-based public knowledge by scientific and policy-making authorities is the direct result of the institutionalised inability to recognise the publics' different values and ontological choices extending beyond the epistemic culture dominated by experts and their kind.

In the previous chapter, I have demonstrated the high-modernist developmental state's monolithic insistence on the technicality of mathematical calculation as the ultimate arbitrator in finding the optimised and unitary public good among competing interest groups. The public imagined by the experts and bureaucrats in a high-modernist state, in this sense, is inherently silent and murky. It is imagined as an aggregated faceless people with the same interest in consuming endless electricity, craving collective economic growth and seeking out only cheaper electricity prices. The charge that non-expert publics lack scientific knowledge here has important implications—the public are assumed to be incapable of understanding the complexity of operating large technological systems and achieving independence in allocating public interest. Experts and scientific professionals are thus called to serve the public need, not only because of their competency in possessing relevant knowledge in operating large technological systems and predicting the possible future, but also because of their capability of administrating the public good in the most impartial and optimal way (Cf. chapter 5 and 6).

As I articulated and documented previously, science and technology are far from being depoliticised, disinterested, and purely instrumental, as assumed; on the contrary, they are done materially, politically and culturally, and done differently in different societies, cultures and polities. Nonetheless, this point is endlessly denied by the elite bureaucratic-scientific policy circle, and due to this ontological and epistemic denial, the views within this circle fail to recognise different meanings, complexity and indeterminacy that are constitutive of sociotechnical development. Acknowledging the legitimacy of the public concerns and meanings that are different from the more narrowly conceptualised one, the unitary public good and its static attribution, would locate political meaning and legitimacy outside of the scientific–technical realm. Such a change in perspective would undermine the exclusive reliance on references to technoscientific rationales and the claimed commercial-economic and societal benefits. Instead, ‘it would involve recognising wider, legitimately-held public concerns, priorities, values and meanings, and thus a broader remit for acknowledged politics, instead of performing politics obliquely, and in undemocratic, declarative, scientific modes’ (Welsh and Wynne 2013, 546).

Uncovering the situated ontological differences proposed above is meant to open a wider arena for debate and negotiation (Woolgar and Lezaun 2013) about the initial framings of technoscientific issues, imbued with historical indeterminacy, cultural performativity and public hermeneutic differences. Here the emphasis is put on meaning-making (imaginary-making) and cultural stakes (Welsh and Wynne 2013). The public have their capacity to situate themselves in relation to the complex and perplexing sociotechnical development in both epistemic and hermeneutic terms (Wynne 2008). First, the public have their hermeneutic capacity in formulating their concerns; that is, to articulate different collective public meanings through public

engagement including civil movement and continuous practices-based negotiation on issues-framing, relationship-making and forms of life-choosing (Wynne 2008, Welsh and Wynne 2013). This social and cultural process is often, though not necessarily, in tension with the singular collectivist reductions, such as the summoning of a singular and unitary public interest performed by imposing a scientific-legal or commercial-economic rationality. Second, the public do have so-called 'lay expertise' or as Harry Collins and Robert Evans called it, 'contributory expertise'. This means that the public, on some occasions, have 'enough expertise to contribute to the science of the field being analysed' (Collins and Evans 2002, 254). For example, in Wynne's famous study, 'the non-scientifically expert hill-sheep farmers in the Lake District did hold technically salient specialist knowledge which the scientific experts did not know' (Wynne 2013). However, the key issue here should not be about the technical expertise that lay people have can contribute to or facilitate scientists' working, but about the public's capability to consider what the salient concerns, questions, and thus knowledges are and 'what imagined social purposes and priorities [are] thus help define the going criteria for valid knowledge' (Wynne 2008). To put it simply, the public are able to judge the relevance and validity of factors, knowledges and experiences according to their own ontologies. They have the ability to play their democratic role along with other salient scientific knowledge and policy-practitioners in establishing the criteria for 'what questions knowledge should be addressing ... what (the combinations of) knowledge should be in play' (Wynne 2008, 24).

In the next section, I am going to introduce the concept of 'ethno-epistemic assemblage' proposed by Irwin and Michael as an extra analytical tool to help explain why science and technology should be treated as the locally understood, culturally and materially performed enterprise.

### **Relating Ethno-epistemic Assemblages**

The sociotechnical development of the installation of photovoltaics in the area named above is embedded in a distinctive cultural and historical context, involving an admixture of local politics, imaginaries and heterogeneous actors. The interpretative analytical concept of ethno-epistemic assemblages here is meant to highlight the interrelations between, and the blurrings and mixings of, sociotechnical imaginaries and materiality in the process of sense-making at the local level. According to Irwin and Michael, 'epistemic' here means that the emergence of assemblages is fundamentally oriented to the generation and distribution of the claims of what is real (Irwin and Michael 2003). Those claims can be derived from different forms of technoscientific knowledge but also, as I have stressed above, the knowledges about politics, the process of liberal-democracy, cultural values, moral responsibilities and identities as well as economic-commercial implications. It is about factuality-creation, whether it is rigid and even authoritative as technoscientific conventions, like the 'reserve margins' in Taipower's electricity planning, or in more flexible forms like the discussions about local PV installation I am going to describe. In this sense, it is about factuality but also about the legitimate and normative ways of ordering lives into realities. As argued by Jasanoff (2015), it contributes to what the (meanings of) realities *now are* and how the realities *in the future ought to be*.

Furthermore, 'ethno' part of the nomenclature signifies the idea of *locality* in the sense that the classifications and categories of materials and human actors are often locally made and therefore, however much the realities (both knowledges and meanings) might be ostensibly 'mobile', they are always generated and taken up in the context of local cultural conditions (Irwin and Michael 2003). In other words, they can only be

understood and interpreted as *situated knowledges* (Haraway 1988) in relation to the location and time at which they occur. In stressing this emerging process, another key point needs to be put forward. In contrast to the above mentioned conventional and universalist knowledge, these local, situated and ‘non-universalist’ forms of knowledge recognise their ‘ethno’ characters, and thus are also modest in relation to other different forms of knowledge. In this sense, the meanings of all these knowledges are always contestable and ambiguous (Irwin and Michael 2003, Welsh and Wynne 2013). Meanings are always invoked and reproduced within the dynamics of context.

Moreover, boundary objects (or artifacts) clearly play an important role in forming an assemblage. Drawing on Actor-Network-Theory (ANT) as an important inspiration, my focus here is on the process of assembling. Assembling is regarded as a process of explaining, sense-making and connecting entities with other entities (whether human or nonhuman) – that is, ‘a very practical world-building enterprise’ (Latour 2005a, 103). Boundary objects are seen as mediators and intermediaries in the assembling process which are *common enough* that their formations can be recognised by different groups of actors and *plastic enough* to allow different ontologies to be enacted through and invoked with them (Star and Griesemer 1989b); however, they can be interpreted and performed in so disparate ways that they never generate permanently stable, universal coherence. According to this view, the stable shape of an assemblage is an effect rather than a cause (Law 2009) of mediation and translation. As I have discussed previously, for example, story-lines can be one type of boundary object when they are used as shorthand in social engagement (Hajer 2006). Story-lines work in both ways: they *reduce complexity* as well as *increasing flexibility*; they can work as a focal point in sense-making (and thus performative), but never produce exactly the same meaning for disparate actors in the process of assembling.

Last but not least, in this regard photovoltaics, the main actor I am going to explore in this chapter, is a key boundary object and fluid technology (Law 2009). It will show a totally different character from that which has been performed in the nationalist-high-modernist rationality which I have centred on in previous chapters – namely the ‘universalist’ claim that they are technologically immature and financially unviable. Situated in the aftermath of a disaster, this chapter is going to show how a fluid technology like photovoltaics can be reconfigured differently when local ontological and epistemological issues are in play in the process of (re)assembling.

### **Taiwanisation 本土化: Return-to-Native-Soil as an Alternative Imaginary**

Before turning to the case in southern Taiwan, a short detour is needed to the imaginary emerging from the young intellectuals in the 1970s — a call for the culture of ‘native soil’ and ‘return-to-reality’ (Hsiao 2013). In postwar Taiwan, the KMT/Nationalist government led by Kai-Shek Chiang (蔣介石) claimed that Taiwan was the ‘only legitimate representative of all China’; the KMT government repeated its determination to retake mainland China and to continue the unfinished project of building a powerful and ‘modernised China’<sup>95</sup> which had been disrupted after they lost the Chinese Civil War in 1949. Against this background, a nostalgic cultural politics of the exiles was pervasive in Taiwanese society. The collective memory, cultural values, symbols, and art, music, and theatre, handicrafts, and the like which were defined as belonging to ‘orthodox’ Chinese tradition, were officially promoted at the expense of their local counterparts (Hsiao 2013).

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<sup>95</sup> The background of this grand narrative is about ‘how, starting in the mid-nineteenth century, China had suffered from foreign bullying, resisting foreign powers, and striving for independence, and prosperity. The “Century of National Humiliation” is not only a recurring theme in both pre-1949 Republican writings and post-1949 Taiwanese discourse as well but is also the official view of modern Chinese history in the PRC’ (Hsiao 2013, 181).

However, it was during the turmoil of the early 1970s that an increasing number of young intellectuals who, shocked by a series of diplomatic failures, began to emerge as a new social force that challenged the existing political order and cultural traditions. Most of them were strongly influenced by the idea of 'modernisation' prevailing at the time and hoped that the country could become a rich and powerful nation through political, social, and cultural modernisation. As a result of this awakening, the young intellectuals reflected on and denounced the 'exile mentality' that had imbued postwar Taiwanese society, realising the importance of a deeper understanding of Taiwanese society and of the ties between themselves and the larger external reality; they were eager to call for social reform, political democratisation and a return to the culture of 'the native land (鄉土)' (Hsiau 2010a, 2013).

Their socio-political reformism and the return-to-reality idea were closely related to each other. Certainly, this is not the first time a crossover of modernisation and political-cultural reform emerged from Taiwanese society. A number of episodes of activism calling for autonomy, equality and same rights for Taiwanese people had also occurred during the 1920s and 30s when Taiwan had been a Japanese colony (Ho 2003, Hsiau 2013).

Pursuing a closer connection with the land (土地) and the people (人民) through the act of rediscovering Taiwan's particular past (especially the resistance and activism of the people in the 1920s and 30s), the young activists showed their discontent with the exile mentality encouraged by the KMT government and cast a critical eye on the implicit nostalgia for the Chinese mainland cultivated by the political propaganda and school education. Their attention gradually turned to present mundane realities: 'for

these young intellectuals, the lifeworld of workers, peasants, and other sections of the lower class rather than their own intellectual life constituted social reality. It needed to be understood in order to make social reforms' (Hsiau 2010a, 19). This is a distinctive discourse combining modernisation and political-cultural reformism; for these cultural activists, the masses' life experience, feelings, and destiny, whether local Taiwanese or mainland origins, constituted those of the 'people'. The folk way of life, folk way of thinking, and what ordinary people want in this life constituted the most sensible reality for them (Hsiau 2013, 2005).

They became increasingly concerned with the past, present, and future of 'the native land of Taiwan' (鄉土臺灣). Their efforts to 'de-exile' Taiwanese culture not only deeply affected Taiwan's cultural and political changes in the 1970s, but also laid a basis for the historical narrative and cultural development of Taiwanese nationalism from the 1980s onwards. Taiwan is perceived as a state, a society and a land of immigrants. Despite having different origins and ethnicities, whoever identifies with Taiwanese values and life experiences can be regarded as 'citizens of the community of common destiny' (命運共同體), in a civic nationalism. In the 1980s, the proliferating social movements over environmental issues such as polychlorinated biphenyls-polluted oil, cadmium rice, and green (copper-polluted) oysters, were marked by similar story-lines, due to them joining forces with the intellectuals and local forces. Intellectuals (mostly experts in social sciences and liberal arts) and self-organised citizen associations joined forces in using the idea of environmental rights as a legitimate appeal against authoritarian power, and expressed shared concerns over the homeland where the next generations have to live – despite the effort made by the official bodies in consolidating authority via scientific observations and the statistics of toxic substances (Lii and Lin 2000).

Taiwanisation (or indigenisation 本土化) emphasises identification with Taiwan, and the consciousness of Taiwan (Jacobs 2013). In this formation of a general sense of identification with the local — land, people and home — it has developed into a ‘Taiwanese consciousness’ (臺灣意識) and even a ‘Taiwanese nationalism’ (臺灣國族主義) (Hsiao 2013, Jacobs 2013). Taiwan had been colonised since the establishment of the Dutch colony in 1624, and until the death of Ching-Kuo Chiang in 1988, Taiwan was ruled by six colonial regimes (Jacobs 2013). Under the last two regimes, as was articulated in chapter 4 and 5, the main tune of colonisation always revolved with the aim of modernisation. Whether in the Japanese ‘model-colony’ (Hsu 2006) or the Nationalist’s ‘modernised China’, the prowess of technoscience and the authority over technological development constituted the key legitimacy of ruling regimes. Under each of the regimes, Taiwanese could not push their Taiwan identity without incurring the rage of the ruling regime; Taiwanisation was extremely limited both in its political power and forms of realisation.

In contrast to this clear trajectory of the high-modernist and statist modernisation in the colonial past, Taiwanisation, in this respect, has the potential to provide a distinctive sociotechnical imaginary which reassembles and enacts an indigenous identity rooted in attachment to the native land and locality, rather than the faraway mainland China or inland Japan. This can take many forms. One of them is through the making of knowledge and the (re)arrangement of technological artifacts. For example, in the scientific project ‘Taiwan Biobank’ initiated in the early 2000s, the main narratives are ‘Taiwan must have its own laboratory’ and ‘Taiwan’s unique genetic composition is characterised by its multiple ethnic origins’ (Tsai and Lee 2016).

So what is Taiwanisation, both as a form of political-cultural reformism and a form of modernisation? The answer lies in the possibility of enacting an alternative sociotechnical imaginary which attributes technoscience to *the values of resistance and resilience grounded in locality*. The above-noted history of cultural-political reformism and modernisation is a significant context of the case that is going to be discussed and sheds a light on possible alternatives to the almighty nationalist-high-modernist rationality. By the help of this meaningful index — the indigenous-reformist story-lines rooting in the history of cultural resistance and political activism — we can realise that even when a particular imagination manifests itself through the regime of an authoritative government, reality is not destiny (Law 2009). However, this claim poses a crucial question for the study — if this alternative legacy was to persist and develop, then what form could it take? In the following sections, I am going to explore the particular formations of photovoltaic installation emerging from the area in southern Taiwan that suffered greatly in 2009's Typhoon Morakot, and how the sociotechnical imaginary mentioned above and in chapter 4, with its indigenous-reformist story-lines, can help us explain and understand this sociotechnical development.

### **Assembling and Sense-Making in the Aftermath of a Disaster**

Typhoon Morakot battered Taiwan from the 6<sup>th</sup> to 10<sup>th</sup> August 2009 and brought strong winds and heavy rainfall, with the worst impact in the south and east of the country. The excessive precipitation was concentrated in the mountain area of the region: record-breaking rainfall was observed at Alishan observation station with 1623.5mm rainfall recorded in a 24-hour period (and 2361mm within 48 hours).<sup>96</sup> The cumulative

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<sup>96</sup> The most excessive rainfall recorded in recent years is 341.4mm of a 24-hour period brought by storm Desmond in December 2015, which also made a new UK record.

rainfall brought by Morakot exceeded the 'critical rainfall threshold', causing landslides and mudflows, and resulted in barrier lakes, a massive amount of driftwood and severe flooding.

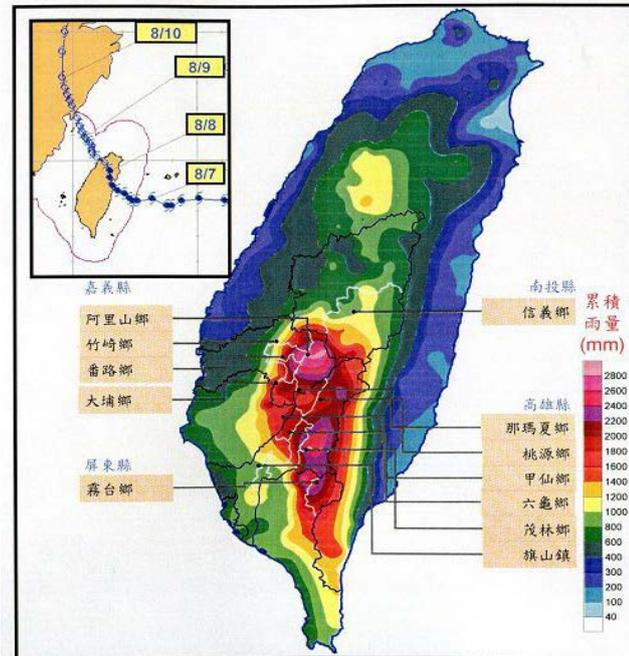


Figure 30 — the cumulative rainfall during typhoon Morakot (National Archives Administration 2016)





Figure 31 — townships were flooded when river Linbian bursted its bank (Morakot Post-disaster Reconstruction Council 2014)

*Linbian* (林邊) and *Jiadong* (佳冬) are low-lying townships located in the coastal area of Pingtung County and are just beside the estuary of the river Linbian. In addition to the excessive rainfall, which far exceeded the capacity which the drainage system can deal with, floods also occurred with tonnes of driftwood, and at the unfortunate time of a high tide, resulting in the river bursting its banks at an unprecedented scale. The consequence was catastrophic: 602 hectares of farm lands were damaged; the total financial loss to agriculture and aquaculture was approximate 2.3 billion NTDs (60 million British pounds), and casualties totalled 11 dead, 6 missing and 17 in hospital.

#### *Linbian and Jiadong: Changing Local Economic Practices*

Linbian and Jiadong areas are especially liable to flooding due to land subsidence, which is partly contributed to by local economic activities such as fish farming and fruit planting. In 2005, the areas were both classified by the Water Resources Agency as areas of 'severe land subsidence'. Compared to the widespread industrialisation in the 1960s onward in Taiwan, Pingtung, at the very southern end of the island, is mostly

untouched by this frantic development. For coastal and rural towns like Linbian and Jiadong, life has always been connected to agriculture and aquaculture, but this does not mean the local economic patterns have not changed since the first settlers came in the middle 18<sup>th</sup> Century. Local economic activity went through a huge change in the 1960s, seeing the traditional and small scale agriculture turn into a specialised and sophisticated business. Transforming from rice paddy cultivation and banana plantations to eel and grass shrimp fishery, and later to the farming of groupers (a kind of fish), and wax apple planting, the dynamics shown in the local economy illustrate that local farmers do not just repeat routines but also reassemble and renew (if not reinvent) farming techniques and the materials at hand.

The best example to depict this local dynamic is the case of wax apple planting. Starting from the 1970s, local farmers found that wax apples were juicier, sweeter and more smooth-textured if the orchard is planted near a coast or in an area of land subsidence. This unexpected result had been found in experiments and reproduced by local farmers, and they gave it a descriptive name: the wax apple of salty water. Later, it was given the more business-wise name of the 'black pearl' (Yang 2002). The wax apple was thus reassembled on the basis of land subsidence, renewed farming techniques, a marketing sensibility and a mind-set of adaptation (Yang 2002). However, this ostensibly contingent product certainly has its own history. While pumping underground water for agricultural usage has been a common practice for a long time, the widespread aquaculture fisheries are considered as the most important cause of land subsidence in the area. For decades, a large quantity of underground water has been pumped out at a pace that is too quick and at amounts too considerable for underground water to be replenished by rainfall (Yang 2015). The situation even gets worse in winter, when the total quantity of groundwater and underground water

declines rapidly because of lower levels of rainfall. Coincidentally, this is also the cold season when fisheries need an enormous volume of underground water (which is warmer than ground water) in order to create a good environment for rearing groupers (Yang 2015).

This local practice of pumping underground water is seen as one of the main causes of the continuous land subsidence observed over a number of years; as a consequence, salinity coming from seawater has permeated coastlines, resulting in soil-salinisation. Fortunately or unfortunately, salty wind blowing from the sea and land subsidence caused by the common practice of pumping underground water have both contributed to the fact that the soil in the area contains more and more salinity, a condition which is adverse to cultivating rice and banana but favourable to planting wax apple orchards and to the subtropical fruit reaching its best quality (Yang 2015). The farmers of wax apples and groupers both have a prosperous business in this contingent assemblage.

*Anxiety and Resilience: The Assemblage of Grouper Fish*



Figure 32 — catching a grouper in a fishery

Although clearing the streets of the silt and sludge brought by the flood, and restoring

the damaged and blocked drainage system, only took around fifty days (Morakot Post-disaster Reconstruction Council 2014), a pressing issue nevertheless emerged from the post-disaster reconstruction work. A majority of orchards and fisheries were destroyed in the flood, as they had been covered by a thick layer of sludge and infected by bacteria in the floodwater. Aquaculture and agriculture in the area are both investment- and technique-intensive businesses; for example, selective breeding in grouper farming consumes both time and money; it can take years to cultivate a successful breed. It was estimated that restoring the fisheries and plantations back to their pre-disaster condition and productivity could take at least three years (the disaster happened in autumn, and fish stocking and sprout planting are only viable in spring) and millions of dollars (Cheng 2016). The restoration of the local selective breeding industry could take even longer. During all this time, farmers would not have any income – and wider factors made it even more complex. Although the government provided a low-interest loan and relief fund for farmers affected by flooding, because the percentage of registered aquaculture licenses among local fish farmers is quite low, approximately 30%, the result is that the majority of them could not receive a full payment from the fund (Cheng 2016).

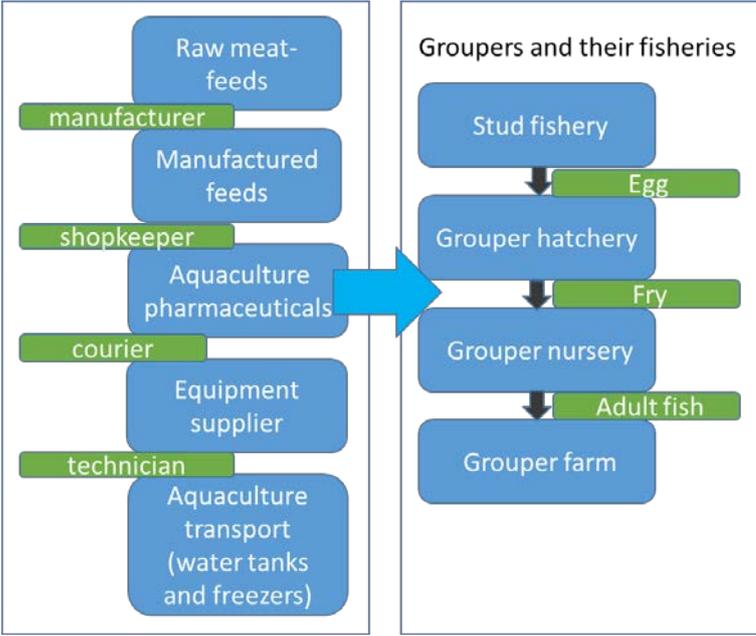


Figure 33 — the actors in the grouper-assemblage



Figure 34 — water wheels pumping oxygen into fisheries

And yet, however difficult the recovery is, the assemblage of the grouper is messy and resilient, and is not inclined to fall apart at once. Figure 33 depicts the relevant industries and actors revolving around the assemblage. From raw meat, feeds, drugs to water wheels, electronic panels and pipelines, the entities in the assemblage are well inter-connected and depend on each other to clarify their meanings and roles. Groupers in their different forms — egg, fry and adult fish — are the boundary objects which glue together all these so disparate local actors, constituting a sophisticated picture of local life. One aspect needs to be mentioned is that, while the equipment used around fisheries is not necessarily made locally, it has to be maintained by local technicians. Grouper fishery relies heavily on a system of water circulation which includes components such as generators, water pumps, water wheels and heating devices. Technicians servicing these components form another layer of the assemblage which is equally crucial to the persistence and working of the assemblage. As we shall see, they will play an important role in the initial stage of the installation of PV documented in the coming sections.

Furthermore, the local experience of rearing groupers also constitutes a key part of the assemblage. When talking about how typhoons and the ensuing flooding can affect the daily practices of rearing grouper, the head of the local aquaculture association mentioned two key aspects. Firstly, the fine particles of the silt left by floodwater can block the gills of the groupers and cause hypoxia and inflammation. Therefore, procedures to remove the silt are absolutely important. Secondly, the *'cultivation of water (養水)* is pivotal to the whole practice of rearing groupers.

*'This sort of water to us, the colour of the water (水色) containing*

*[considered as] turbid...if we take a walk downwind, we can smell an odour. This odour is generated by germs at the bottom of the fishery....'*

*'During the period of typhoons, raining and cloudy days can be 7, 8 days or even 10 days long. After raining, the ecological environment in a fishery can change. When the sun reveals itself (開日), land is heated and bacteria grows...if you let the germs grow and the groupers are healthy, and they (groupers) feel hungry and start to eat, it is all finished (完了). It is the time they need oxygen but there is no oxygen...there is not enough oxygen for them to digest...they die from gastroenteritis. Documentary's interview transcripts 10/29/2009 (Cheng 2016, 181-182)*

Aquaculture farmers can notice the subtle changes in the water of a fishery, including colour, odour and temperature, and perform preventive measures to avoid the loss of groupers. Apart from this experience-based knowledge, there is also a sense of real attachment to the local fisheries. Local fisheries have their long history, and may have even been built by the current farmers' grandfathers (Cheng 2016, 115). Turning a piece of farmland into a fishery can be an action both of adaptation and of response to economic incentive. According to the documentary's interview transcripts (Cheng 2016, 105, 115, 139, 140, 145) I refer to, initially farmlands (the ones near the coastline) were turned into fisheries after they were salinised; however, the more fisheries there were in operation, the quicker salinisation spread. There is also a pride in the ever-changing nature of local economic activities. From rice paddies and banana plantations to eel and grass-shrimp fisheries, and later to grouper farming and wax apple planting, the dynamics shown in the local economy indicate that local farmers do not just repeat daily routines but intend to seize the opportunities which fit the ever-changing

situation. They are proud of the *resilience* and *vitality* embodied in the transitions observed in local life. But at the same time, they feel attached to the native land — they can only be sustained by the water and soil of the homeland. As argued by the head of a local culture and history association:

*'...[again] we continue to 拚/pīn/ (in Taiwanese it means to struggle and to strive) another enterprise. What I am always saying, what we Taiwanese always feel proud of ourselves is that Taiwan (the land and people) has an enduring and uplifting vitality. Documentary's interview transcripts 10/29/2009 (Cheng 2016, 174)*

Perhaps knowing the resilience of the grouper assemblage, Pingtung County government proposed to build a Seawater Pumping Plant at the very beginning of the post-reconstruction period. With the construction of the plant with the capacity to supply seawater to up to 700 hectares of fisheries (including the current 240 hectares), the local government also came up with a programme advising and tutoring practical skills to local aquaculture farmers, aiming to transform the original freshwater or semi-seawater based aquaculture to seawater grouper farming. The plant has been built and in operation since July 2014.

The assemblage certainly is resilient, not least because the post-construction planning, compared to the high-modernist economic construction planning discussed before, is rather responsive to local needs rather than simply imposing a designed future on the local public. While the construction itself is a grand engineering project, the whole post-reconstruction policy is nevertheless introduced in a way that transforms some key factors in the local ethno-epistemic assemblage (e.g. by enrolling a species of

seawater grouper and a technology of digitalised pumping plant), instead of simply ordering the current assemblage to dissolve and to build a new one. The ethno-epistemic assemblage of grouper in Linbian and Jiadong has been transformed but still thrives.

### *Cultivating Water and Generating Electricity 養水種電*

A sociotechnical imaginary is not singular and by no means a homogeneous inclination within a society; it can diverge even at the local level. After typhoon Morakot, a thick layer of sludge covered orchards and contained very fine particles of silt, rendering it unbreathable. The soil was damaged and also infested by bacteria and fungi brought by floodwater. Three years were estimated to be needed to restore the orchards. Additional to the extra time and resources needed in order to restore plantations and fisheries to pre-disaster conditions, the farmers still had to face the uncertainty of possible extreme weather in the future. At that time, no one knew if the same extreme precipitation could happen again the next year, given that on average three to four typhoons make landfall on Taiwan every year. There was a heightened anxiety over the future of local life. It was against this background that the land rehabilitation and post-disaster reconstruction programme 'Cultivating Water and Generating Electricity (CWGE)' was initiated by the county government. The programme was composed of three elements: first, an emergency livelihood support mechanism; second, a land rehabilitation programme; and third, a limited experiment involving the flexibility of PV assemblage.

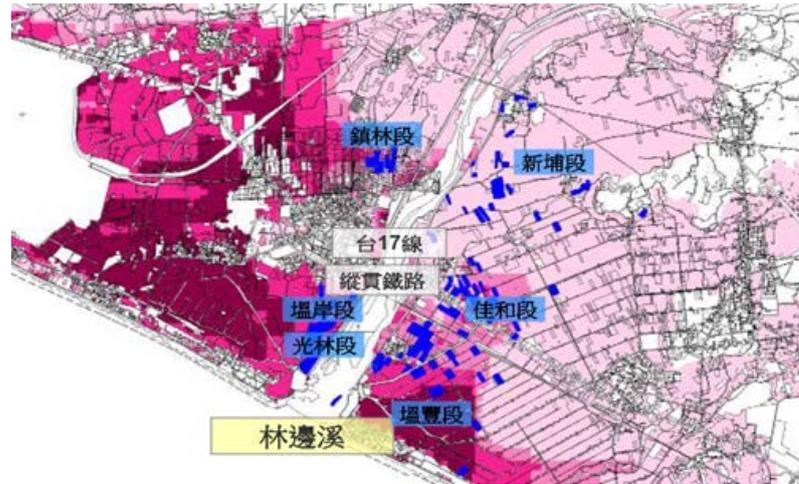


Figure 35 — the area of land subsidence (marked in red) and the locations of PV installations (marked in blue). Source: Pingtung County government

**The first, an emergency livelihood support mechanism**

The typhoon made landfall on Taiwan in August 2009, which was just two months after the REDA was finally passed by the Parliament after a nine-year long debate (Cf. chapter 4). Learning about the excellent amount of solar irradiance in Pingtung, some PV system companies had contacted the county government to see if there was any opportunity to install solar panels on the damaged lands. This was the same time that the FITs had just become the main mechanism of promoting green energy. The programme was proposed jointly by the county government and the PV system companies, and a cooperative mode was also introduced: the county government would give administrative support and political assurance, the PV companies money and technological resources, and the farmers the right to land-usage and equipment maintenance (Lee 2012).

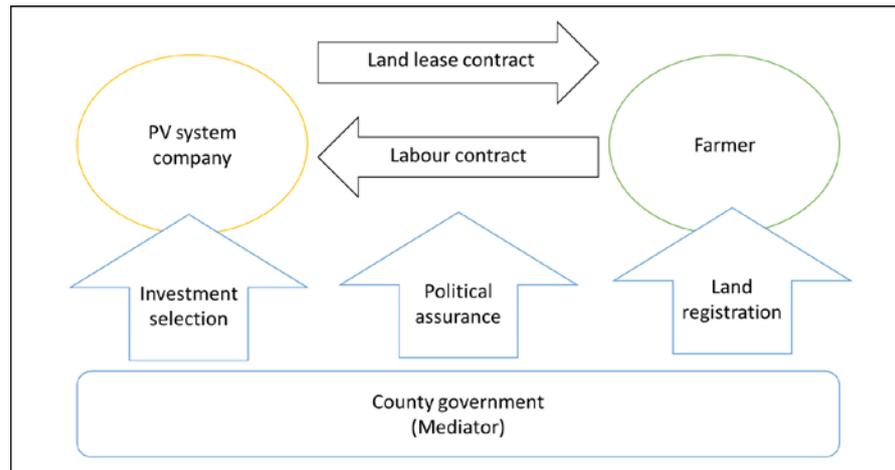


Figure 36 — the cooperative mode among the three

*The Pingtung County government plays the important role of a platform. We don't let it become a private economy, a private contract between companies and farmers, private competition and mediation. Through the platform of mediation, it is like the landlords entrust their lands to the [county] government to lease... and treat them as the county government's lands to call for investment...it is an open process of selection. We hire experts and people with practical experience to do this selection...we worry about the farmers, their incomes received from aquaculture has now dropped to land rent only...the PV installations need operation and maintenance, we ask this work to be attributed to the locals in the written contract. Ho, 07/04/2017*

Starting in April 2010, the proposal was negotiated among the county government, the Council for Economic Planning and Development, the Council of Agriculture and Taipower. The programme was implemented in August 2010 with the aim to reach the operation stage in 2011.

### **The second, a land rehabilitation programme**

According to the County Mayor Chi-Hung Tsao (曹啟鴻):

*'since land subsidence is a fact, then we should not rear fish anymore. We should cultivate water....we should keep rainfall in the ponds. They are retention basins. The land which is already salinised, we let it gradually be desalinised. The land with chemical fertiliser, we let it rest....cultivating water is for disaster mitigation and avoidance. If we cannot plant rice, then we plant electricity' (Tsao 2015).*

Before taking the seat of County Mayor, Mr. Tsao was a long-serving member in the Legislative Yuan (Parliament) and has a deep connection with his constituency, the Linbian area. As a leader of the local government, Mayor Tsao had his own vision of the sustainable future to be accomplished. After becoming the head of the county government in 2005, he immediately began work on the thorny problem of severe land subsidence in his previous constituency. Faced with the high possibility of flooding caused by typhoons and focused precipitation every year, Mr Tsao was determined to sort out the problem that repeatedly devastating the lands and lives of local residents (Yang 2015).

*A homeland rehabilitation programme is definitely not a short-term programme ... homeland needs rehabilitation, (then) this means it was injured. It needs rest... a single aquaculture fishery does not pump excessive amount of water, but the fisheries, in total, pump an excessive amount of underground water and ... accelerate the speed of land subsidence ... The FITs last for twenty years, it is able to let the land rest, and for the farmers, it*

*also provides them a stable income. Ho, 07/04/2017*

Due to the reasons above, the CWGE programme was designed to offer an alternative to the incumbent local economic practices, which could provide ‘*better*’ sustainability. It means a low intensity of land usage. In a context of the interruption of local practices, it was meant to provide a *relatively stable* income against the uncertainty of extreme weather and to lower the local consumption of electricity and water. Taking the advantage of a massive amount of sedimentary soil in the basin of river Linbian brought by floodwater, after the surface of silt was removed, it was used to refill and level the sites of the damaged orchards and fisheries, making a good foundation for the installation of PV and much-needed soil improvement for the land. The PV installation is comparatively easy to remove and the land is said to be capable of returning to its original shape after the end of the 20-year FITs contract. The programme was not designed to replace the grouper assemblage discussed previously, but to assemble an alternative coexisting network and diversify the forms of land-usage.

### **The third, a limited experiment and the flexibility of PV assemblage**

The CWGE programme is an experimental project which in many ways explores the possibilities of customising PV installations to fit local needs and conditions. Their installation sites are on flooded fisheries or farms, so due to the high moisture content in the soil and muddy silts left by floodwater the installers did not have absolute confidence in being able to successfully carry out their work. *They were not sure which engineering approaches (工法) should be taken in order to finish the job ... how to do piling in a land subsidence area?* (Ho, 07/04/2017). Besides this engineering problem, the county government faced another huge challenge: the capacity of the feeder lines (饋線, the lines running between installation sites and substations). The original plan

was to build solar panels on all the flooded areas (486 hectares), providing 300MW capacity, and to divide the implementation into four phases. However, because of the 'extremely high cost' of building new feeder lines and renewing the transmission system that was flagged up by Taipower (billions of NTDs), the county government made a compromise and decided, instead, to install PV panels along the existing feeder lines (Lee 2012). The result was that, in the first phase, which was the only phase actually put into action, 25MW of PV were installed on almost 50 hectares of flooded lands along the existing feeder lines.

In spite of the significantly reduced installation scale, the five companies participating in the first phase came up with remarkably different styles of PV installation design. For example (see the figures below for illustration), PV can be installed on elevated piles and the ponds below can be used as retention basins and ecological fisheries (e.g. for oysters); they can also be installed on greenhouses built with steel frames, and the land inside can still be used as farmland; they can be installed on elevated piles and the land below can be used as the shelters for animal husbandry; they can be built on floating boards covering the surface of water and blocking out the sunlight, therefore preventing the eutrophication of a water body; they can be built with an experimental sun-tracking mechanism working as a trial for later similar installations; and so on. Although not all the companies designed their installations with a clear concern for sustainability, and indeed some of them focused on profitability, PV technology and the CWGE programme acted as a prospective opportunity and flexible technological platform for the different companies to realise their disparate sociotechnical imaginaries. Finally, these installations relied on local technicians for bringing blueprints into materiality and after being built they are maintained by local farmers (often the landowners) as one of the key features of the contract facilitated by the

county government.



Figure 37 — elevated piles with retention basins and ecological fisheries below



Figure 38 — steel-framed PV greenhouses



Figure 39 — elevated piles and shelters for animal husbandry



Figure 40 — floating PV panels



Figure 41 — PV panels with sun-tracking mechanism

*Assembled locally: Situated identities, feelings and materiality*

The success of the programme should largely be attributed to its local connections. As mentioned above, County Mayor Tsao was a former teacher at the local high school and a Member of Parliament representing Linbian constituency. Some of the landowners or their families or friends are his former students; this personal connection builds a foundation of trust for the programme. Knowing that Nuclear Power Plant 3 (at the very south end of the county) is a potential threat to the whole nation if there is a nuclear accident, he showed determination over local environmental issues and concerns over nuclear risks pretty early in his career (Lee 2012). He stressed the importance of renewable energy as a technology that generates electricity locally to be consumed locally. He represents the programme as building 'people's power plants', that can solve the challenge of energy autonomy of Taiwan (Tsao 2015).

At the beginning of the programme, the farmers felt very suspicious about the programme, especially when it required landowners to sign a 20-year contract with private companies. He and his dedicated team in the county government held several public meetings to explain their plan and to ensure that concerns were heard. They also visited local farmers' and fishermen's associations in order to gain support and mutual understanding for the programme. His team constituted of several task forces from different divisions of the county government. The team was responsible for relevant administrative support and dealing with numerous legal barriers. The programme was initially formed by the county government in the beginning of 2010; at the end of the year, PV installers had started to build systems.

Three out of the five pioneer companies have local affiliations. Some of company directors have blood relations in the local area, or already have a significant investment around the place. One of them is Apollo New Energy Corporation (阿波羅新能源股份有限公司), which has actively designed, modified, and experimented with the first version of a floating PV system, incorporating the local knowledge about water, soil, wind and sunlight of the area that they have obtained from several aquaculture farmers. The company hired a team of local technicians and workers to do the initial installation work. They are not necessarily trained as professional electricians or have a specialised expertise in PV system, but all of them came from the local area and had relevant experience and expertise. Three kinds of expertise were regarded as relevant here: those of ironworkers, plumbers and plate-mould (cement) workers. The team was assembled through a local 'black hand (黑手)' who worked on the pumps used in fisheries; he is also a voluntary worker in the local culture and community association. He has worked as an important 'boundary actor' to bridge the local materials, the people and the company:

*The company is an outsider and I am an insider (local person). You even can call me a local master of 'black hand' ... I know a lot of local people and business. After all, I have had a business here for 40 years. Regardless [of the company] asking for hardware appliances or other things, I can give them an overt guidance to find them quickly.*

*They [local installers] have integrated with the native land and weather so deeply. They were born in Pingtung, they are the people of Pingtung. Of course, they have an advantage compared to the northern people...We are sun people. We are the people under a huge sun [used*

*to working in a high solar radiance environment such as Pingtung]. Now what we are installing is the power of the sun – here is the best place for [this kind] electricity generation. This is the area of tanned people, the people of affection [hot weather, local solidarity and the attachment to the homeland].* Documentary's interview transcripts 05/26/2010 (Cheng 2016, 187-188)

Through the help of the 'black hand', the company could start the installation swiftly. Here, in the process of a locally assembled PV system, a specific kind of expertise can be observed. Compared to the 'contributory expertise' (the ability to contribute to an agenda which has been written by scientists or engineers) (Collins and Evans 2002), this kind of expertise involves translating an engineering problem (possibly defined by engineers) into a local project by finding relevant materials, expertise and persons. 'Black hand' is a commonly used term in Taiwan, meaning a general technician, typically someone who has served an apprenticeship and is now a self-employed tinker. A 'black hand' is a master of relating local materiality and people, rather than commanding them. Being a 'black hand' means he (or she) has the clear acknowledgement of a broad local-social-material history. This is a form of expertise which allows the flow of existing experiences, social-material relations and morality into the newly introduced PV technology. This is evidently reflected in the attempts to devise a system that meets local requirements: there were at least four generations of floating PV system trialled locally, each of them learning from the previous one. From the outset, local conditions were taken into consideration when the systems were devised. Due to the regular occurrence of typhoons, the structures were built to resist gales and dramatic changes of water level in the local area. The salty water and salty wind (from the sea and nearby water bodies) were other problems to be tackled when

building PV on fisheries, retention basins and reservoirs. Several materials were tried in building up the frames of a floating system: steels, white cast iron, and PE, PVC plastics. This was a process of trial and error, always bearing the durability question in mind. Cheng said:

*...as long as it is built bearing durability in mind; in terms of water, we use Typhoon Morakot as the benchmark for the flooding scenario. In terms of [gusty] winds, then is Typhoon Thelma. We use the cases we suffered locally as the design baseline for durability. They are made to have the strength to endure forty to fifty years [battering]...we assemble one after one, we fail and we progress. We break one bottleneck after another. I feel pretty happy.* Documentary's interview transcripts 09/09/2010 (Cheng 2016, 203)

The installation of PV technology was also embedded in a deep feeling of local attachment. Outward migration of population is a common problem in the rural areas of Taiwan, and Pingtung County is considered one of the most deprived regions. After the disaster, there was a deep anxiety over the future of local life in the county. The existing industries of grouper and wax-apple farming had suffered seriously from the flood, and people were leaving the area. People lost hope as he (the black-hand) argued:

*Why do people lose hope? ... I think that's because of work and incomes. If the situation of losing income continues, in less than three years people will be leaving. There is no life here.*

*[We are] hiring the local young people because we want them to come back to their hometown. This community now has only elderly people – we want them to come back ... But, if there are no good job opportunities, why would they want to come back? They are also taking a lot of stress when working in outlands. They have their ancestor's property in hometown. This is the most intimate place to them, the place of their birth. The vitality of a community and an area comes from industry, culture and young people. The [local] population is ageing and the local area is declining ... after typhoon Morakot ... the flood not only washed away our industry but also our culture and [local social] solidarity. The rehabilitation programme now is about bringing a new industry – but can it bring back our self-confidence and our people?*

Documentary's interview transcripts 05/26/2010 (Cheng 2016, 189)

The aspiration for PV technology here is nothing like that of their counterparts, the state engineers of the ITRI. It is not enacted as a technology of advancement and the national future, of energy autonomy and national budget's efficiency, but as a technology which should be built with the appropriateness to local conditions, bringing resistance to the floods and gales brought by typhoons, and bringing back *resilience* and *vitality* to the homeland. As I explained above, the ethno-epistemic assemblage of PV, like its brother, the assemblage of grouper fish, is pretty *messy*. Both *emerge* from local contexts. There is no centrally guiding mind or master plan that stipulates in every phase who should act and what should be done. Rather, they assemble amongst the dynamics of locality and the situated identities, feelings and materiality. They should be seen as *endless* actions and *reactions among human actors, local materiality and*

*the environment*. This sociotechnical imaginary involves a deeply rooted meaning-making progress in relating to local history, attachment and materiality through framing what is the common question they face, one that is not purely technological but intertwined with local culture, economy and environment.

In the next section, I turn to the case of a more recent development of PV greenhouse. Instigated during the early stage of reconstruction period in 2010, a company called SunnyRich (向陽優能) is leading the innovation of PV technology with a combination of PV generation and agricultural production, through an innovative composition of greenhouse and a new model of agricultural activity. As I will show, this innovative ethno-epistemic assemblage constitutes the mobilisation of different experiences and expertise(s), including the local, institutionalised and interdisciplinary ones.

### **PV Greenhouse: Local Attachments, Concerns and the Hybrid**

SunnyRich is one of the pioneer companies participating in the CWGE programme and the chairman of the company, Mr Kuei-Kong Cheng (陳貴光), has a strong local affiliation; he was born in *Zhutian* (竹田), a neighbouring village of Linbian. Mr Cheng was the child of a local farmer and started working on his father's farmland when he was just 11.

*'When I was in the fifth grade, I started working on the farmland regardless whether it was sunny or raining, on work days or weekends. Every day I needed to go to the farmland, helping my parents with farm works. I know the fate of farmers — living at the mercy of '天' [Nature, heaven, weather]. Because of this, I particularly understand the farmers' feeling and really sympathised with them (感同身受) when they were*

*facing the destruction brought by typhoon Morakot to the farms and lands ... I still remember once a typhoon swiped southern Taiwan. It was three or four o'clock in the morning and my father had already come to the farmland to check [the crops]. It was still all dark. Seeing that the farm was destroyed by the torrential rain, he stood on a farm ridge, saying nothing ... Cheng quoted in (Yen 2013, 79)*

*The harvest of crops solely depends on the mercy of '天'. There are many typhoons making landfall on Taiwan every year. When the time of harvest is coming, suddenly, everything is gone. Harvest is coming – suddenly, everything is gone. This can be a problem of survival ... this experience is an important source for me to [devise] what I should do now. Another serious problem the farmer facing is lightning ... additionally, intensive precipitation is also horrible for farming... in the past, it seems that you cannot grow crops without using heavy pesticide, but it is totally [environmentally] unfriendly. Cheng, 05/12/2017.*

Due to this local connection and experience, when his team were faced by the suddenly reduced FITs at the end of 2010 (Cf. chapter 6), they were determined, no matter how low the tariff will be, to still participate in the programme (Lee 2012). A mentality of *thanksgiving and making a contribution to hometown* (回饋家鄉) underlies their continuous commitment to devising a technology of PV greenhouse locally. Echoing the deep anxiety over the future of local life and the high possibility of people leaving the area mentioned in the last section, Cheng stresses that the building of PV greenhouses should come with a newly developed model of refined agriculture. One of the main concerns of this model is to bring the younger generation back to their

hometown by creating local jobs. Cheng explains:

*After a long time, he [my father] suddenly turned back and told me 'you should catch any opportunity going to Taipei, and do not come back. Being a farmer is no future and the most unrecognised job!' Cheng quoted in (Yen 2013, 79)*

*The rice paddy and banana farm are destroyed. He stands there for such a long time, I was concerning something bad may happen [to him]. Although he was still in his 40s, I can feel this sense of helpless, sadness and pain. Feeling the pain, but there is no right for you to cry out ... he told me 'you cannot ever become a farmer in the future'. This is the situation of traditional agriculture ... this is why I aim for new agriculture, the combination of PV generation and agricultural production. Cheng, 05/12/2017.*

His personal experience is not unique and reflects a continuous trend of outward migration of population from Pingtung County since the late 1960s. As I mentioned above, compared to the widely spread industrialisation from the 1960s onward, Pingtung is at the very southern end of Taiwan and mostly kept untouched by this state-guided development. The long-lasting problem of the urban-rural gap is still relevant in Pingtung even today. After finishing study in a local vocational school, Cheng left for Taipei to seek out better opportunities. He worked in finance, construction and the optoelectronics industries and opened his own businesses later in his career. After typhoon Morakot, he decided to come back to Pingtung to participate in the CWGE programme and start a new business — a combination of PV generation and a refined

organic farming model.

### Resilient Technology with Local Considerations

*'Farmland for agricultural purpose (農地農用)'* is the motto he adheres to. Food sufficiency is still an issue debated in the public sphere; in Taiwan farmlands are often used to build private villas and cottages or even occupied by small to medium-sized factories. Putting a PV installation on a farmland can easily be considered as yet another way of taking land away from agriculture and therefore, can face fierce local criticism. Knowing this, from the very beginning he insists that electricity generation is not enough. The local installation of PV technology must provide more than the solely economic incentive of electricity generation; it needs also to accommodate the original usage of the land it built on: agricultural production.



Figure 42 — the terrain of Pingtung

*'Farmland for agricultural purpose' means land for agricultural*

*production. Lands in Taiwan have been affected by pollution or lie fallow for a long time. Food production is the root of a nation, we cannot discard this root. Manufacturing electronics can bring economic prosperity as it is, but it cannot replace the vital place of agriculture. Another reason is the freshness of vegetables and fruits; imported food cannot meet this requirement. The third is the issue of sustainable farming, especially the one without a huge subsidy of the government ... This also means that land can have combined usage. For the lands which have been polluted and considered as 'not fit for farming purpose', we can still use them to do elevated cultivation. The thing is, PV generation does not need to hamper the original usage of the land. Cheng, 05/12/2017.*

Taking the combination of PV technology and agriculture seriously quickly brings challenges. Pingtung County is a north-south strip of land, including a narrow peninsula. In the middle is the southern end of the Central Mountain Range, the home to more than one hundred and eighty one 3000-meter peaks. Due to this spectacular terrain, hot and humid air is quickly lifted and produces rain easily. Apart from excessive rainfall brought directly by typhoons every summer, torrential rain is also brought by their peripheral circulation, which can mean extended precipitation even after a typhoon has moved away. Flooding is certainly a continuous problem. Rainfall intensity is another challenge: rainstorms are not rare and afternoon thunderstorms are quite common, too. While the weather conditions are not friendly to the local farmers, the crops grown here are also not particularly resistant to strong and intensive precipitation. A high percentage of the crops grown are leafy vegetables, flowers with short growth-cycles and fruit. Plants are routinely damaged by the gusty wind of

typhoons or intense rain.

The high solar irradiance is another key feature of the local environment. The large amount of sunshine, rich precipitation and warm temperature result in an all-year growing season and multiple harvests in one year. However, excessive sunshine and high temperature can also hinder the growth of plants. Heat can cause leaves to wither from the tip, reducing the price for which it can sell on the market. Working under direct sunshine for a long time can be life-threatening due to heat exhaustion. Lightning is another potential threat to them. Pingtung ranks the third highest lightning-struck county in Taiwan. Although cold is not a usual condition in this part of Taiwan, the sub-tropical crops are definitely not cold-resistant. It drops to 12 to 14 degrees Celsius occasionally in winter. Pests and diseases are another problem. Given the conditions above, the structure of a PV greenhouse, as a site of both generation and farming, should foremost be weather-resilient. As Cheng says:

*Taiwan is a beautiful island and our home. We should treasure every inch of our land, so when we are doing this [installing PV greenhouses], we consider every land individually, what to grow and how to drain. We think about the composite usage of land, making it more valuable ... there were three typhoons making landfall on Taiwan last year and climate change is an ongoing trend ... we entered this industry when typhoon Morakot happened. We went to the location [Linbian] and saw all of the lands were destroyed. We think how many times can Taiwan endure this kind of destruction? ... Generation is necessary but agriculture should be protected ... if you are asking for 80% or 70% of the original agricultural production [in a PV greenhouse], that's okay ...*

*we can even grow bananas in the greenhouse now. Speech at the Renewable energy policy forum at the Legislative Yuan (Cheng 2017)*

If being weather-resilient is one of the pillars of this initiative, then another pillar is bringing back the young generation to the homeland. To him, technology innovation should be positioned among other locally derived concerns:

*We need to have innovative thoughts. This includes the aspect of farming labour. One of my friends, in this case, finds four farmers [to do the farming work]. They [the sum of their age] are over 300 years. How many more years can they work? The average age of the farmers is 75. In the future, there will be fewer agricultural workers ... can we bring in technology, even the mechanisation of farming? ... Now we have the reimbursement from PV generation. Can we combine PV with agriculture, better still fish farming? ... PV technology has multiple flexibilities. I think our young people, if you don't have innovated job opportunities, they won't come [to agriculture]. [In terms of] ordinary agricultural work, some farmers suffer from heat exhaustion, some are struck by lightning. The vegetables that are about to be harvested may, in the end, be harvested [destroyed] by typhoons. Rainstorm is another problem. If we have a good environment, then we can create an environment to which the young people are willing to come back. This is where we are putting our continuous efforts to. Speech at the Renewable energy policy forum at the Legislative Yuan (Cheng 2017)*

It is clear that in this alternative sociotechnical imaginary, his team devises a hybrid ethno-epistemic assemblage of PV greenhouse to which young people are conjured along with solar panels, soils, and vegetables, steel frames, rainfall and gusty winds. The 'environment' talked about here is not only a social environment such as the local community or a working space for the young people but also a crafted natural environment for organic farming involving plants such as pakchoi, peppers, and bananas, courgette and papaya; but the most important boundary actor here is the PV technology which makes this hybrid assemblage possible through the extra funding of FITs. As I wrote in my field notes after interviewing Mr Cheng:

*They assemble available modest technologies together so that a solution can be found to meet a particular target. For example, if today the plant grown in a PV greenhouse is strawberry then ventilation, humidity and temperature control become vital. In this circumstance, the arrangements of water wall, PE foil wall and a set of automatic ventilation/diversion fans are placed. A PV greenhouse is an open and flexible platform, it is like an open workshop or guesthouse (for both human and non-human actors). Inside, space can be used for crops farming, animal husbandry or as a plant nursery. Mr Cheng mentioned many times, they keep trying the new usage of the greenhouse. Field note S-2-1 05/12/2017.*

Certainly, coupling different actors together is not easy, and requires incessant effort and an interdisciplinary approach to keep them stick together. In the following, I will focus on five dimensions of the emergence of this locally framed hybrid assemblage.



Figure 43 — SunnyRich's PV greenhouse

Growing crops under solar panels is not always approved of by agriculture experts, as argued by one of the experts in the Council of Agriculture: *'light and plant growth are closely related. The question whether plants can grow healthily depends on photosynthesis and the elements of light: light quality (the composition of light wavelength), light intensity (light exposure) and photophase (number of hours per day)'* cited in (Wang and Lin 2015). This expert does not think growing plants in a PV greenhouse is possible, even when light exposure and photophase is adequate (Wang and Lin 2015). Facing this barrier, Mr Cheng asked a retired agriculture expert, Shan-Ney Huang from the Tainan District Agricultural Research and Extension Station, to help.

*We have three kinds of expertise in our team, the expertise of agriculture, construction and PV generation. The work is done through the internal meeting among the three groups. I personally worked as the chairman of a PVs company and also as a field engineer on telecommunication towers, so I have basic knowledge of building steel frameworks and how PVs system work ... We started the trial with basic leafy vegetables then moved to fruits and herbal plants.*

Cheng, 05/12/2017.

*We are helping farmers to do this new kind agriculture. We are training farmers to learn the new techniques. Some of them are old farmers and some are young. Sometimes the habituated practices are hard to change, so we need to teach them again and again. Now the [young] farmers also value breaks and rest, so we need a comfortable and new environment. We have in-house agriculture experts to teach them how to do it. This includes establishing the traceability of agricultural product.*

*The young farmers are responsible for this and leading the way. However, sometimes young farmers cannot manage old farmers. Cheng, 05/12/2017.*

Growing crops and installing PV system involve very different forms of expertise. Although Mr Cheng has experience working on open farmland, planting crops in a greenhouse is very different. Another challenge is that the CWGE programme required participants to install solar panels on farm lands or fisheries that have been destroyed by flooding. As mentioned above, a thick layer of sludge brought by floodwater inherently changed the quality and permeability of the soil, therefore a certain soil improvement is needed. Dr Huang and the sedimentary soil in the basin of the river Linbian played important roles in converting the destroyed fisheries to planting-conducive farmland, as the sedimentary soil was used for soil improvement purposes. Inviting plants to live in a greenhouse is not effortless and requires a series of interdisciplinary negotiations. More than twenty kinds of vegetables and fruits are experimentally selected and planted (according to the season) in the greenhouse and the elements of the indoor environment are also carefully designed, tested and controlled, involving the deployment of many modest technologies and a process of tuning. For the maximum generation efficiency, apparently the roof should be fully covered with solar panels; however, this would make plant growth impossible. For weather-resilience, the greenhouse needs to be built with quality steel, adding extra costs. Economically, this initiative is a project with high risk. Working together, Mr Cheng and Dr Huang need to strike a balance between PV generation efficiency and the conduciveness of farming. This is a continual experiment, and involves large investment as the costs of building the greenhouses of this kind are four times higher than the average.

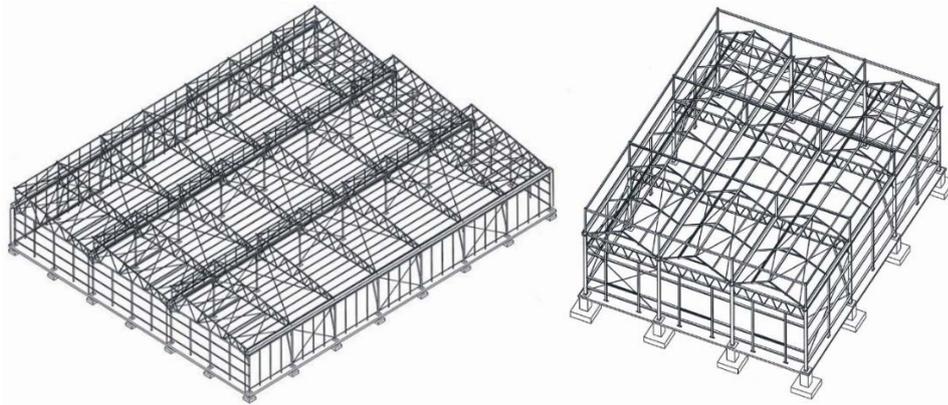


Figure 44 — the structures of greenhouse designed for gusty wind-resilience

*The project of PV greenhouse is an ongoing experiment, they have built four generations of PV greenhouses and the fifth generation will be built in early 2018. Each of them is improved a little bit to reflect the experience learned in the previous generation. For example, the latter generation is equipped with Monocrystalline Silicon panels so that it does not need to mount a sun-tracking mechanism to achieve the same generation efficiency. This also reduces the load of the steel framework of a greenhouse so that the house now can be built with cheaper square-shape steels (instead of the H-shape steels) and provides the same typhoon endurance. The different generations of PV greenhouses with divergent designs are also built for plants with different needs. They also build PV greenhouses with different light transmittance for comparison (65% vs. 55%). The next big step for them is to use sensors to capture the data of the environment: to accumulate experience and create knowledge. Field note S-1-1 05/12/2017.*

### Sunlight

In order to increase light transmittance, solar panels are carefully arranged, making a pattern with intervals. The gap between two installed solar panels is made equal to the width of a panel. To make up the lost generation opportunity, the panels are fitted with a sun-tracking mechanism, so that the panel is always positioned at a 90-degree angle toward the incoming sunlight, insuring that they can reach the maximum potential generation efficiency. On the rooftop, lightning rods are also installed. Besides that, the framework of the greenhouse is built with premiere steel and its structural stability is validated by architectural technicians. The height of its rooftop ranges from 4.5 meters (the lower eave) to 6 to 7 meters (the rooftop), making sure that enough and sufficiently distributed sunlight lands on the farmland through direct light and light scattering. Thanks to this design, even full-sun plants like banana trees can grow indoors. Building this kind of agriculture-conducive and weather-resilient PV greenhouse is not cheap; however, with the help of the joint income from agricultural production and the Feed-In Tariff, this is possible.



Figure 45 — banana trees in the PV greenhouse

## Water

Farmland in this area commonly uses water brought from nearby wells along irrigation ditches. Knowing the relation between pumping underground water and land subsidence, the PV greenhouse is equipped with spray irrigation and drip irrigation technologies using tap water as the source. Irrigation scheduling can be precisely controlled and the water consumption of irrigating in the greenhouse is only 1% to 10% of the usage of traditional farming methods.



Figure 46 — the drip irrigation 'Israeli' system

### Soil

In addition to 'farmland for agricultural purpose, 'land spirit (土地精神)' is another motto they adhere to. This means growing plants in soil instead of using hydroponics. To them, soil and the land are the root of life; as Dr. Huang argued, '*we need to engage our lands sustainably; through our management, soil can be made better and better. This is what we can leave for our next generations and our generations can leave for their next. Soils can be engaged by our descendants, this is our fundamental goal*' (National Geographic 2014). Salinisation is reduced and the drainage, permeability and aggregate stability of soils are continuously improved. The farmers use organic liquid fertiliser to change the quality of soil and do not use chemical fertiliser and insecticide. Benefiting from the indoor environment, pests and diseases are largely excluded. They have also acquired the full certificate of organic agriculture.

### Warmth

As mentioned above, excessive sunshine and high temperature can hinder the growth of plants, so farmers sometimes put up a black insulation net above plants to protect them from direct sunlight exposure during the peak of summer. However, in a PV greenhouse, because the roof is covered partially by solar panels this is not a problem. The greenhouse is also designed to benefit from natural ventilation, as some parts of the walls are made of maneuverable PE foils, facilitating extra ventilation if required, and also uses fans to increase air circulation if necessary. The temperature inside is maintained around 24 degrees Celsius, making it a mild space for both farmers and plants. In the uncommon situation of cold spells, the greenhouse can be sealed in order to keep in the warmth.

**Conclusion: Local installation as a Modest and Responsive Technoscience**

Is the PV greenhouse a 'successful' project? There is no clear answer to this question as yet. This is an ongoing project that builds on the legacy of the CWGE programme. While only the first phase of the county government's programme was in the end implemented, SunnyRich has gone on to build three PV greenhouses in the area since 2010. Despite this being a big investment – as one greenhouse costs around 20 million NTDs (a half million British pounds), and relying on the income from FITs alone it would take sixteen to seventeen years to reimburse the initial installation costs – they are still enrolling more different kinds of crops and more young people to work around the greenhouses as of December 2017. The PV greenhouse project has successfully brought back a certain vitality to the local community and provided a prosperous alternative to the existing grouper-fish and wax-apple industries. In this sense, I argue that it should be understood as an ongoing experiment of an alternative sociotechnical imaginary that assembles local materiality, the aspiration for local resilience and the attachment to the homeland.

The local installations of renewable energy I documented have demonstrated an inherently distinctive feature, a technoscience of conditionality and flexibility. These installations do not seek a universalist solution, nor do they intend to replace the existing ethno-epistemic assemblages; rather, as a response to mundane local concerns and the myriad of local materiality, they are composed, bit by bit and piece by piece. Through continuous try and error, and incessant tuning, they engage in a limited but flexible problem-solving process with the specificities of the local community, environment and materiality. The installation of renewable energy here, as a limited and situated technoscience, recognises its 'ethno' elements, and thus is also modest in contrast to other different forms of assemblages and knowledges. Compared to the nationalist-high-modernist rationality, this native-soil and reform-

oriented sociotechnical imaginary is truly messy (Law 2004). It emerges from local contexts, as there is no blueprint devised in the very beginning and no preoccupation with the creation of a universal factuality, characteristics of the technoscientific imaginary explored in the previous chapters. It rather depends on continual interactions and responses among the actors within the ethno-epistemic assemblages: seawater, grouper fish, wax apples, water pumps, feeder lines, steel, white cast iron, gusty wind, rainstorm, banana tree, pakchoi, sunlight, soil and the local attachment, identities, and aspiration of local resilience and vitality. It requires taking the different ontologies (Law and Lien 2013) and everything else seriously — it is an imaginary that recognises the performative aspects of technoscience, and the broader and legitimate concerns among people, in the sense that we are constitutively engaged with our material world, we exert impacts on it, and it does the same back to us, on and on forever; the identities (or interests) of actors in this continuous flow and interaction are truly dynamic and always relational. This is a sociotechnical imaginary that always leaves some blank space to be filled (留白), a space preserved for other imaginaries and ontologies, and is open to negotiation.

In the next and final chapter of the thesis, I will draw an indicative comparison between the nationalist-high-modernist imaginary and its alternative — the native-land and reform focused imaginary – drawing on the three cases studied above. I will also seek to answer the question articulated briefly in chapter 6: how can we disagree with the salient call for the public good found in the statist technoscientific programmes and authoritative past in Taiwan, when we still agree that the ‘public good’ as the underlying generic imaginary in democratic society is still very relevant for guiding the ways whereby technologies are imagined and materially enacted?



## 8. Conclusion

### **Summarising and Comparing the Three Cases**

In the concluding part of this thesis, a summary of what has been documented, investigated and explored so far is first needed. For this purpose, in the following a schematic framework will be used to summarise the overall story-lines, forms of rationality and styles of public authority which constitute the corresponding imaginaries in the three empirical chapters above. This will also help to facilitate an indicative comparison between the nationalist-high-modernist and indigenous-reformist sociotechnical imaginaries later in the chapter.

Imaginary	High-modernist Developmental State		Indigenous-responsive Democratic Society
Chapters/ cases	The Making of Power Shortage — Developmental Leviathan and its Authoritative Planning Rationality	People in the FITs Deliberation — Assumed Unitary Public Good and its Stabilisation Process	Reassembling Solar Power — Crossover of Locality, Materiality and an Alternative Imagination
Overall Story-lines	Technoscience and industrialisation are the only way to guarantee a nation's autonomy. Electricity provision is the cornerstone of modernisation and technoscientific development, the best way to bring prosperity to the national economy, industry and people's livelihood. A growing demand for electricity marks the development and advancement of a society. The government's responsibility is to harness this technological power and meet the nation's electricity demand. In this sense, a perennial power shortage is the greatest threat to the whole nation and its people, symbolising backwardness among the international markets and in competition with other nations. Renewable energy sources are immature and unreliable.	The understanding of scientific knowledge can help to establish a liberal democracy whereby a factual, impartial and transparent social contract is implicitly signed by the freely participating public. Expert representatives with their 'virtual commission' can discover the objective public good among de facto disordered and competing social interests, and therefore the purpose of political institutions is to establish a government that operates on the basis of the citizens' general and best interest — meritocracy— the citizens' equal rights of being served and the idea of governing according to the basic rule of the general interest discerned by competent, accredited experts. In this sense, the contentious FITs should be decided by an expert committee.	Refocusing on Taiwan means shifting attention from mainland China to the immediate and mundane: the masses' life experience, feelings, and folk ways of thinking, ordinary people. Technoscience is ascribed with values of resistance and resilience grounded in locality and local history rather than the aspiration of rebuilding national glory. The ability to be flexible in and adaptive to a continuously changing environment with emergent challenges is pivotal. Sociotechnical projects are initiated with locally framed concerns and lived experiences, recognising their 'ethno' elements and being modest towards other, different forms of assemblages and knowledges.

<p>Grounding Practices</p>	<p>Differences between three key terms – load restriction, power rationing and power disconnection – consciously or inadvertently, are not clarified by the governmental actors and at the same time, demand-side mitigation measures are considered as ‘power rationing’ measures. Adding more capacity to the generation system (especially through nuclear power) and maintaining a 20% reserve margin are treated as the most viable ways of tackling the situation of power shortage.</p> <p>Taipower invents the ‘Precautionary Light Signal of Power Provision’ scheme and the MOEA urges the public ‘together we make sacrifices on the basis of understanding and appreciation’.</p> <p>Taipower engineers treat ‘Net Peaking Factors’ as a routinised convention and do not review them regularly. Renewable energy is considered by them as ‘technologically immature’, and not suitable for grid stability and satisfying growing demand.</p> <p>The gap between reserve margins and operating reserves, such as the unplanned outages and delayed overhauls, are not itemised separately.</p>	<p>A technical expertise-based administrative structure was established and continuously maintained by the Nationalist government since the 1950s.</p> <p>Environmental Impact Assessment (EIA) was introduced when the government faced growing environmental movements in the event of democratisation in the 1990s. The FITs committee of the MOEA was established after a 9-year long debate over Renewable Energy Development Act. Much resemblance between the EIA and FITs committees can be found.</p> <p>Clear demarcation between outsiders and insiders. The proceedings of the FITs deliberation have resulted in the separation between meritocratic (expert) insiders from citizen outsiders, and technical issues from other issues.</p> <p>The FITs formula with its perplexing equations rendered the decision as only following rigid technical data, requiring no human discretion. Its objectivity and impartialness are said to come from two sources: ‘the reflection of true costs’ and ‘a reasonable profit rate’. Committee members’ responsibility is only to decide which reasonable values are to be used.</p>	<p>Local farmers are trying to devise new techniques from local experiences when facing the challenges of land subsidence and salinisation, turning challenges into advantages. Ever-changing local economic activity, from rice paddies and banana plantations, to eel and grass shrimp fishery, and later to the farming of groupers and wax apple planting.</p> <p>Facing the long-term uncertainty of changing weather and the risks of natural disasters, the programme of CWGE is initiated as an emergency livelihood support mechanism, a land rehabilitation programme and a limited experiment with the flexibility of PV assemblage.</p> <p>A PV floating system that satisfies local weather and hydrological conditions is assembled locally with the help of local expertise. A PV greenhouse assemblage is initiated locally: the building structure is resistant to extreme weather, and the young generation comes back to the hometown due to the new local jobs.</p> <p>The local ethno-epistemic assemblage involves the bringing together of different forms of expertise, modest technologies, soil, sunlight, water and plants.</p>
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The Roles of the State and the Public	The government is imagined not merely as a referee who administrates the laws and rules but a proactive (developmental) player in generating public good. However, when it faces challenges from other players, it often turns to extending its high modernity by employing even more formulas, equations and classifications for establishing a ‘reasonable-rationalised’ and objective ground for further regulations. The voice of the people is vague, murky and (most of the time) kept in silence because of the assumed ‘virtual commission’ of experts.	The government is treated as a platform for incubating new ideas proposed by divergent publics and acts like a gatekeeper rather than a player. Regulating standards now reflect the multiple rationalities within the society rather than the ‘impartial and rationalised’ policy ground. The people are no longer a passive audience of statecraft but an engaged player in public affairs.
Forms of Factuality (reality)	Factuality is established through the repetition of technical routines, an intensified public witness, mechanical forms of objectivity and forms of participation confined to the invited – and usually to the human (Wynne 2007) in a deliberation process dominated by expert discretion. Factuality is determined and bedrock-like (a grounding order) (Law and Lien 2013).	Factuality is established through the ‘uninvited participation’ of both human and non-human actors (Wynne 2007, Law and Lien 2013) in practices of trial and error and incessant tuning. Factuality is undetermined and stratum-like (Law and Lien 2013).
Forms of Public Authority	Although formally satisfies the requirement of a liberal democracy, public authority in a high-modernist developmental state focuses on transparency, objectivity, accountability, representation and participation, and thus performs a closed rationality of technicality, treating technical conventions, developmental planning routines and scientific-legal facts discerned by experts as the only single reasonable way of conducting politics, as if no other, perhaps conflicting, meanings ever exist.	The public authority in an indigenous-responsive democratic society adopts an open rationality of multiplicity (Law and Lien 2013), giving multiple actors the space to act experimentally and recognising local, situated forms of knowledge, their ‘ethno’ characters and agencies, and is modest in relation to other different forms of meaning-making.

Table 12 — the summary of main story-lines and key practices of the two sociotechnical imaginaries documented in the three cases

### **Sociotechnical Imaginaries in Comparison: State, Technoscience and Society**

On the basis of this summary of the cases studied previously, it is now possible to provide an indicative comparison between the nationalist-high-modernist and indigenous-reformist sociotechnical imaginaries. However, it is important to point out that the conceptualisation below should be seen as an interpretative, analytical tool, contrasting *Weberian ideal types*, rather than be regarded as *describing 'objective' facts*, especially given that ongoing democratisation, the distinctive contexts and cultural resources derived from historical indeterminacy, and the changing nature of the locally framed and hybrid assemblages are all highly relevant to those characteristics suggested below. Sociotechnical imaginaries are always in an incessant process of mutual shaping in a situation of indeterminacy. I will start with the developmental Leviathan which I focused on in chapters 5 and 6.

#### *The High-modernist Developmental State*

In a high-modernist developmental state, the state is in the dominant position of governing knowledge, and scientific knowledge is seen as an integral part of a modern state: that is to say, scientific knowledge and technological prowess are used by the state as its underlying source of public authority. Not only that, technoscience is further seen as an essential public good, and a necessary public service which can be planned and developed accordingly. Therefore, the state is deemed to have a proactive role in generating scientifically grounded knowledge through its departments of education and research, and the centralised coordination of private sector research. In this circumstance, the rationality of politics behind this proactive state is the legitimacy of strong interference in deciding which technoscientific trajectory should be followed and the necessity of creating a 'reasonable-rationalised' ground for policy-making, like that which I have documented in the case of the statist development of renewable energy technology and its FITs (chapters 4 and 6). In this respect, the statist and coordinated development of technoscience shows the tendency of both of utopianism and a broadly authoritarian technocracy.

Regarding forms of politics, experts of various kinds take the central role in identifying the general public good and its egalitarian distribution. Meritocracy is the salient term used in this expert- and expertise-dominated form of public authority. Qualified experts are called on to frame and decide what the public issues are that the nation is facing, and in which forms the public good should be pursued — usually by resorting to established academic disciplines, practicality, and legal-commercial rationales. The public good is imagined by experts as unitary and singular, as I have documented in chapter 6. The face of the public is inherently vague and murky. Experts' practice in deciding what is relevant and what is not — telling facts from fictions— is to arrange things according to their own conventions, commitments and culture like the mighty Taipower as documented in chapter 5. This often involves the exclusion of other public meanings and cultures, and sometimes results in protests and even uprisings; however, mechanical forms of objectivity, as an essential way of forming and shaping public reasoning, can be further utilised to dissolve and release this pressure.

Through the accumulation of disagreement, the relation between state and civil society can become confrontational and distrusting. However, this growing pressure does not necessarily lead to unveiling the assumptions in the existing techno-political agendas and may further create a pervasive feeling of apathy in the public. This unstable situation can, to an extent, be contained through further state-enforced security measures such as extended surveillance, limiting freedom of speech and filing criminal prosecutions. This disturbance does not only exist between government and society; it also generates grievance and conflict among different sections within society. The key to significant change relies on a widespread resistance to the current situation that makes proposed alternatives believable and appealing, even if it would involve immense struggle and sacrifice. However, the alternatives still need to be rooted in local culture and history. There is no definite future that can be predicted for a high-modernist developmental state, as even if apathy is growing in the public sphere it might be the case that no effective resistance can be formed; as long as the economic promise made by the commercial-technoscientific developmental regime is

more or less kept, and the technique for controlling the masses is continuously refined, then fundamental change is not inevitable.

### *An Indigenous-responsive Democratic Society*<sup>97</sup>

In an indigenous-responsive democratic society, the (national or local) state acts as a platform to provide assistance in assembling whatever relation between technoscience and society emerges from democratic participation, as illustrated by the case of Pingtung County (chapter 7). *The state is a catalyst and incubator in the domain of knowledge-making, which operates in a process of **open problem-solving**.* This is a bottom-up process attended by potentially every self-invited citizen in which bearers of scientific knowledge are treated as *key informants* but *not decision-makers*. This means that many assumptions and implicit meanings embedded in technoscientific routines and choices, such as those concerning the ‘immaturity’ of renewable energy or experts as the arbitrators of a unitary public good, which I have documented and illustrated in chapter 5 and 6, are revealed and brought into open debate. Due to the tendency for scientific knowledge to be engaged with and practiced within a small group of professionals, elites or experts, the responsibility of ***the government is to ensure that, in the very beginning, the rationales of why a particular research topic is conducted are fully discussed in the society*** and, at the end, ***that the impacts which the research brings are thoroughly assessed, reflected and learned from***. In this respect, the development of technoscience is a process in which different sociotechnical imaginaries are struggling and unfolding. Things can be otherwise!

The rationality of politics in this responsive and democratic society is that sociotechnical projects are framed locally, at least in the beginning stage. The cases of the development of a localised PV floating system and a PV greenhouse assemblage

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<sup>97</sup> The conceptualisation of an IRDS, which is a policy recommendation derived from my three empirical cases about what kind of role the state should play in technoscientific knowledge-making, bears a similarity to what some call ‘responsible innovation’ (RI) (Stilgoe, Owen, and Macnaghten 2013).

can be used to exemplify this well (chapter 7). The concept of the public good is still relevant; however in this case it is entangled with the messy forms that emerge from mundane complexity (Law 2004). *Public good(s) are not universally valid but spatially and materially situated*, and only to be found temporarily on the flowing consensus achieved by continuous negotiation. The local framing process is not always initiated solely by governmental actors; instead, *it can have a humble beginning, as an innovative experiment aimed at meeting local needs and finding a 'better' solution for the local future* carried out by a few local members of the public as was the case in the humble beginnings of the CWGE programme and the SunnyRich company. Locality takes a crucial position here, not only because situated concerns, problems and history are fundamental to the understanding of the challenges that local society is facing but also because local knowledges, actors and materiality (environmental conditions) are the indispensable participants in the forming of an ethno-epistemic assemblage. There is no need to assume in this dynamic process that a clear boundary between the national and the local can be maintained. A local assemblage, following its initial vision, cultural attributions and flexibility, can sprawl across geographic boundaries and scale. It can create policy mechanisms, story-lines and regulatory schemes.<sup>98</sup> *Through the reinvention of what citizens' rights mean in regard to locally emerging issues, social movements can play an important role, exploring the wild potentiality of different ways to discover and build a desirable future.* The case of PV greenhouse discussed above is a good example of this wild potentiality.

As I argued in greater detail above, the sociotechnical projects taken in this approach do not need to be modest and humble (or even primitive) in scale, complexity or ambition. They can be as great as the seawater pumping plant documented in chapter 7, since the essential features of the *appropriate technology* I am talking about are not physical size and complexity, but responsiveness and flexibility. That is to say, it should

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<sup>98</sup> There is always a possibility that a grassroots imaginary would shift and take the high modernist forms of order to express itself, especially when it reaches a national policy level, which exclusively elevates the importance of technicality, experts' discretionary power and the orchestrated public good. The imaginaries of a high modernist-developmental state and an indigenous-responsive society when they are enacted in practices are not necessarily mutually exclusive.

not seek to replace or exclude fully existing ethno-epistemic assemblages; *it can, rather, provide a juxtaposing alternative and a transitional middle ground, a platform for further shifts to happen. In other words, appropriate technology flows into existing conditions and adapts to current arrangements.* It is about Latourian ‘translation’ (Latour 2005a). As stated clearly in the beginning of the thesis, I treat science as a hermeneutic and cultural enterprise, and a sociotechnical imaginary as something that is done culturally and materially. Therefore in the next section, I will explain why the advent of an indigenous-responsive democracy would require a cultural transition, or, an ontological turn, since it requires taking different ontologies and everything else, including nonhuman actors, seriously (Law and Lien 2013) .

Drawing on the analysis in previous chapters and two ideal types proposed above, it is now possible to give concise answers to the three research questions posted in the very beginning of this study:

- What does science and technology mean in our social and political life, especially in the public sphere, in respect to how public authority is constructed and policy reasoning is conducted? To what extent does the legacy of a state-organised technocracy originating from the postwar era have a prolonged impact on Taiwanese political culture?

As already reiterated frequently in the thesis, it is crucial to point out that science and technology is far from apolitical, instrumental, disinterested, and purely objective; on the contrary, science and technology are done materially, politically, and culturally and are done differently in different societies, cultures, and polities. I have documented that in the postwar Taiwan, a clear aspiration to use science and technology to forge a new planned social order emerged from the historical and cultural context — the rise of Republican engineers (scholar-officials) — engineers who, through economic planning and development, work as ‘neutral’ state planners to make the rationally designed blueprint come to reality. Although this deeply technocratic and patriarchal imagination of the relation between society and state is, to an extent, becoming scattered and fragmented after democratisation, nevertheless the imagined nation-

savour and ever-growing production remain pervasive as a latent and common cultural and political resource in today's politics. Furthermore, I have also documented that, through the reiteration and practice of habituated electricity planning routines, reserve margin and operating reserve, this incumbent electricity planning scheme continuously enacts nuclear power as a 'reliable and predictable' energy source and renewable energy in contrast as an 'immature' technology. I argue that institutionalised expertise and habituated technical choices are innately normative and have great political strength, indicating they are the crucial way of implicitly constructing public authority.

- What does liberal-democracy mean in today's politics, especially when it inevitably involves the issues of technoscientific development such as the transition of energy system? How can the value of democracy make a difference in this highly complicated and professional process?

The answer to these questions is more indirect, and involves going beyond the formality of democracy and exploring the cultural practice and understanding of liberal-democracy. Like science and technology, liberal-democracy is also a cultural enterprise and a historical product which assumes no universal expression. Clearly, there are principles that we all can follow: transparency, accountability, objectivity and factuality. However, these are necessary conditions for liberal-democracy, but are not by themselves sufficient conditions. Attention should be paid to the institutional practices and arrangements that perform and constitute the democratic values mentioned above. I have illustrated in chapter 5 that the inherent affinity among the rationalisation (合理, reasonableness) of politics, the moral consciousness of democracy, and technoscience-backed public knowledge comes at the expense of eradicating the multiplicity of meanings and concerns in the public and replacing it with technical rationality. By articulating and documenting how (e.g. in what forms) a singular and unitary public good emerges from the technical deliberation of FITs, this thesis wants to signal an urgent warning: the boundary between high-modernist technocracy and elite–expert representative liberalism is not always that clear, even in a developed democratic polity.

- If the impulse of expert politics is to close down the space of public participation rather than opening up new opportunities, then, as an STS researcher, how can I help to make Taiwanese society go further in democratisation?

I suggest that the answer to this question depends on how can we bring back the eradicated, ignored but divergent concerns, priorities, meanings and ontologies of the public and how we can show that reality is not destiny. One of the possible approaches to this is to take the perspective of an ethno-epistemic assemblage while recognising the complexity in the simultaneous process of knowledge-making and sense-making. In order to re-energise imaginaries that are often ignored and excluded by nationalist-high-modernist developmentalism and to re-discover alternative visions, we not only need to study the interpretation of scientific knowledge and materiality, and understand the social fabrics of power and meaning, as I demonstrated in the first two case studies, but also to take an ontological turn — the turn towards recognising the open-ended dance of agency (Pickering 1995). This turn can include not only mobilising a new set of analytical language and tools but also adopting a new identity in the emergent world, both of which is elaborated further in the last section of this chapter.

### **Transforming the Future: An Indigenous-responsive Democracy**

In this thesis, I have explored and explained the interweaving relations among modernity, sociotechnical imaginaries, and science and technology by treating the dream of modernity as a platform of sociotechnical imaginary that brings technoscience, with its particular forms and rationalities, into messy reality. I have shown how the concept of the sociotechnical imaginary and its culturally conditioned resources deriving from local and historical contingencies can be used to explain why societies follow the paths they do and why some formations endure while others weaken and disperse. I have also documented the two leading imaginaries in Taiwanese energy politics — the high-modernist-developmental state and the indigenous-responsive democratic society; in these two different paths of meaning-

making, the technology of renewable energy is enacted in different material formations and enmeshed with different characteristics. They are different projects of world-making and the latter can be seen as the resistant imaginary to the former.

This analysis raises the important implication that in the dreamscape of energy futures there can be coexisting and multiple ontologies within a given technoscientific assemblage. Taking different ontologies and everything else (regardless whether they are human or nonhuman actors) seriously is arguably the most distinctive difference between the two imaginaries and explains why and how, for an ingenious and democratic society, technoscience should be responsive to local needs and issues. The dance of agency in a post-humanist ontology requires us to consider the world in terms of performance or practices (Pickering 2017). This is to say, we should treat everything equally as in principle performative agents and we are not different in kind; as Andrew Pickering puts it, 'we do things in the world – but so do rocks and stones, cats and TV sets, stars and machine tools' (Pickering 2013, 26). Through performance or practices (doings), we are continually enmeshing ourselves into the world and becoming parts of it rather than splitting off from it. Echoing the Taoist ontology of ancient China (Law and Lien 2013), this vision seeing 'humanity as just a part of a larger world' is 'a necessary condition for finding questions of materiality and space, the concrete substrate of our being, interesting' (Pickering 2013, 26).

While I do recognise that specific kinds of agency such as *imaginative agency* and *hermeneutical agency* may well be human-exclusively-owned capabilities as argued by Jasanoff (2015), more attention needs to be paid to the other kinds of agency that nonhuman actors can have. This is necessary if we are to understand the distinctive features of local ethno-epistemic assemblages. In the local assemblages documented in the previous chapter, the assembling process should be seen as involving endless actions and reactions among human actors, local materiality and the environment.

A further point needs to be made in regard of the characteristics of the ontology of modern technoscience: scientific knowledge and engineering always seek to organise the dance of agency in a peculiar and distinctive way. Whether or not the attempts may fail or the objects may escape from the roles assigned, science does, often through the creation of a machine, establish ‘islands of stability in the flux of becoming — configurations, socio-material set-ups— where some sort of reliable regularity in our relations with nature is to be found’ (Pickering 2017, 140). Perhaps we can call these islands of *institutionalised (or extended) stability* in the sense that they are devised and created arrangements, in order to show the once-and-for-all achievements of scientific knowledge and in governmental institutions. Habituated routine and expertise are key parts of such an island of stability. The use of the NPFs and FITs formula can be seen as the entrenchment of a previously created stable relation. One of the key traits of high-modernist statecraft is to deny or conceal the instability and uncertainty it dances upon; this requires the continuous reiteration and re-confirmation of the predicted and prescribed human-material relations through performances such as the regular (repetitive) meetings between Taipower and the Atomic Energy Council.

On the other hand, an indigenous-responsive democracy involves a deeply rooted meaning-making progress, relating to local history, attachment and materiality that is oriented to framing the common questions we are facing, questions which are not purely technological but intertwined with local culture, economy and environment. From rice paddies and banana trees to eel and grass shrimp fisheries, and later to the farming of grouper fish and wax apples, the endless trimming and adaptation emerging between environmental conditions and human actors are best understood as an implicit orientation attributing a similar, if not the same, agency to nonhuman actors, compared to their human counterparts. Taoism provides us with an alternative ontology of the non-human-centric understanding of the world as endless decentred flows, transformations and becomings. In the *Dao De Jing* (道德經), Laozi (老子) said

that everything in the world is mutually coupling and reciprocally shaping (萬物相生相形)<sup>99</sup>.

However, it is not just about materiality; it is also about understanding that human agency too can be otherwise: humans are ‘not ... carriers of fixed properties (interests, values, symbol systems, expertise or whatever) but ... malleable, mangle-able, always liable to become something new in interaction with each other as well as with things’ (Pickering 2013, 37). The human condition is just a part of and a temporary outcome of this messy and rich assembling. Perhaps it is not so surprising that in the fieldwork (chapter 7) I often find that nonhuman entities are referred to by my interviewees in an anthropomorphic way and they generally feel an inner connection to the local environment.

Borrowing from Pickering, I argue that the hallmark of high modernism is its distinctive obsession with finding islands of stability and zones of human mastery where the world performs as a predictable machine (Pickering 2017). High-modernists are engrossed in creating factual certainty and stability. In contrast, an indigenous-responsive democracy is best described as an emergently transforming, mutating and evolutionary becoming of entanglements of humans and nonhumans in an openly participated process of culture-accumulating, knowledge-making, public authority-forming and rationality-institutionalising — allowing human and nonhuman to both be unpredictably and emergently transformed. However, this is not to say the relations between humans and materials are totally unstable and unpredictable. Indeed, we can more or less rely on causes and effects, and one key aspect of culture is that, with repetition and accumulation, the interaction and relations among entities can become meaningfully predictable. But forms and degrees of meaningful stability can vary to a great extent. In an indigenous-responsive democracy, stability does not

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<sup>99</sup> Further explanation of the ontology of Taoism can be accessed at: [http://club.ntu.edu.tw/~davidhsu/New-Lao-Chuang-Lecture/LAO/lao\\_10.htm](http://club.ntu.edu.tw/~davidhsu/New-Lao-Chuang-Lecture/LAO/lao_10.htm) Confucianism and Taoism are not mutually exclusive, in practice, ‘得意的時候是儒家，失意的時候成道家’.

squeeze all the other agencies, meanings and ontologies out of the world (or even just insist that they should be backgrounded and ignored). The case of the local ethnopedemic assemblages has shown us that the finding of islands of stability can, in fact, include lively and even disastrous non-human environmental elements that can evoke fear and reverence (Graeber 2015) as well as human traits of local attachment, collective memories and aspirations concerning the question of who we are and what we desire.

What I have elaborated is that the shift to the performative and practice-centred angle offers us some analytical tools and imaginative insights for grasping and taking seriously the possibility of multiple ontologies and imaginaries, not only within the high-modernist developmental state but also in the better society founded on technoscientific flexibility and responsiveness. I hope through the discussion above we have started to understand ourselves as meaningful agents within an emergent world, and that transforming an authoritative-technoscientific regime into an indigenous-responsive democracy requires foregrounding non-human agencies, interpreting ontologies and opening the closed space of expertise-based politics. This is as far as I can go with this line of thought. If an indigenous-responsive democracy is characterised by Wiebe Bijker's 'different set of criteria for democracy': community, justice, precaution, solidarity, plurality, variability, and creativity (Bijker 2017) – then I hope that this thesis on sociotechnical imaginaries and rationality can become a form of political discourse and action which provides substantial examples explaining how they can emerge and reminds readers that existing reality is not destiny.



## Postscript

*Karl Marx once said: '[I] confine myself to the mere critical analysis of actual facts, instead of writing recipes for the cook-shops in the future' (Marx 2011, 21). John Law also argued that '[the system goal is] a purely contingent matter and can be determined only by empirical means' (Law 1987, 113). Borrowing their wisdom, I plead that prescribing a concrete policy recommendation is out of the scope of this study. However, a little suggestion over the direction of further exploration is possible. I have argued in the conclusion that an analytical shift to the performative and practice-centred angle and an identity change to the meaningful agents within an emergent world are both necessary for making a better society founded on technoscientific flexibility and responsiveness come to reality. STS researchers in a democratic polity can play the pivotal role of an infrastructure builder, gauging terrains, installing generic components and signifying the weakened and damaged structure. This paves the foundation for the work of other architects – especially ones with policy planning and public administration interests. Together we can be mediators between civil society and state, and between experts and the public, empowering the suppressed through foregrounding their ignored concerns and experiences. We can also become a modest eyewitness to the emerging social order, documenting, piece by piece and bit by bit, how power, in its technoscientific forms, rises and is exerted tacitly – and, if needed, act as a cultural-epistemic assassin to the hegemony.<sup>100</sup>*

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<sup>100</sup> The nationalistic high-modernist developmentalism is an analytic trope that should not be ignored in the study of China either. In addition to giving accounts on how a sociotechnical imaginary rises to its dominant status, it should also keep a critical eye on the orchestration of harmony and the treatment of dissidents.

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