Digital technologies and services affect the planet.

Every line of code, every photo uploaded to 'the cloud', and every smartphone, computer, or 'IoT' device, has an environmental footprint.

That footprint often takes the form of carbon dioxide emissions, ecosystem degradation, and resource depletion, which occur to varying degrees throughout the production, use, and end-of-life processing of our digital technologies.

I'm here to talk with you about those issues and how they intersect with public policy.

** In the next thirty minutes, I plan to answer these four questions for you:

1. ***Who am I?*** *(as in, why I am here to talk with you about these issues)*
2. ***What are the environmental effects of digital technologies?***
3. ***How have governments used public policy to address those effects?***
4. ***What more can be done?*** *(by us, the FWD50 attendees, and the Government of Canada, specifically)*

It's a lot to cover in a very short period of time. I could spend hours answering any single one of those questions, but. We have about thirty minutes together. So let's dive in.

** Let's start with: **who am I?** I am Dr. Vanessa Thomas.

I stand here, on unceded Algonquin territory, as a queer, settler Edmontonian who has a long history of involvement with social and environmental justice organisations. I've also worked as a computer scientist and creative technologist for much of the past fifteen years. And for a very long time, I kept my social and environmental justice activism separate from my technology-focused career.

But when I decided to return to academia five years ago, I started to suspect that this divide in my interests was no longer appropriate. My experiences working on ICT4D projects in Ecuador and Bolivia, as well as on digital projects for the Government of Alberta, had led me to believe that the pervasive reach of digital technologies was inseparable from their social and environmental effects. And I wasn't alone in thinking that.

I've been fortunate enough to spend most of the past four years and a half years studying these diverse effects, while working with a wide range of incredible people via the wonderful organisations listed in the top left.

What I'm about to present is… just a sliver of the research that my peers and I have conducted recently. If you'd like to know more about anything I mention, I'd be more than happy to provide you with a reading list or keep discussing this after the presentation. Tweet at me, grab me for a conversation, or come to the Q&A session later.

** But, let's dive into the second and most important question that I want to answer for you today: ***what are the environmental effects of digital technologies?***

Although I've listed three effects on this slide, there's actually no simple answer to my question. Like most important questions, the answer depends on… a lot of factors.

Making sense of those factors requires a bit more specificity about the term 'digital technologies', too.

By digital technologies I mean the obvious physical things—the hardware—that people can see and touch, like smartphones, computers, the deep-sea cables that allow the world wide web to function, and the sensors that help monitor our air quality.

I also mean the digital services or tools—the software—that have become so fundamental to many peoples' lives. Things like email services, online banking, social media services, Wikipedia, and personal or business productivity software (like Microsoft Office or Google Docs).

These two aspects of digital technologies—the physical devices and the digital services; the software and the hardware—both affect the environment because they are interconnected; they rely on each other.

The type of hardware in a device dictates the type of software that the device needs, and the type of software on a device influences how the hardware is used.

I mention this now, at the outset of my presentation, because hardware and software affect the environment in interconnected ways, during their production, use, and at the end of their lives, when they are being recycled or discarded.

I'm going to break those effects down by talking first about the production of digital technologies, then their use, then their end of life effects.

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Every digital device, every piece of hardware, is made up of a unique combination of natural resources, such as: gold, palladium, cobalt, petroleum, and lithium, among many other minerals, metals, and chemicals.

Extracting and producing those resources carries a variety of environmental costs, partly due to the diverse regulatory frameworks that influence mining and manufacturing around the world, but also due to the facilities, techniques, and types of labour used in mining processes.

In the case of digital technologies, several mines supplying hardware manufacturers have collapsed, had chemical spills, or been abandoned. These events have led to

water pollution, soil contamination, air quality degradation, and, in some cases, the serious harm of locals and workers.

The most notorious mines associated with the tech industry are probably the cobalt mines in the Democratic Republic of Congo. But many other mines exist in China, Bolivia, Brasil, Mozambique, South Africa, and even within Canada's own borders.

Once the minerals and metals are extracted and processed, then the hardware manufacturing begins. Some manufacturing facilities that supply tech companies use large amounts of freshwater to create their products, while others dump wastewater from the manufacturing process into rivers. This has been a serious issue in China, India and Japan specifically, where vast tracts of arable land are contaminated with heavy metals from electronics manufacturing plants.

We know this because the mining and manufacturing industries have faced scrutiny for decades. A less scrutinized industry is the software production industry.

By software production, I mean the planning and writing of computer code.

Software production tends to occur in homes, universities, and office places around the world. And the electricity, transportation, offices, and supplies used while producing software all influence the environmental footprint of our digital technologies. So, too, do the decisions that software developers can make about planned obsolescence–the notion that systems can intentionally become obsolete or stop working in a specific and artificially limited timeframe.

It's hard to get specific measurements on how those factors influence the environmental footprint of digital technologies because a lot of businesses and software developers don't track—or don't want to share—this sort of information.

Moreover, many of the large organisations who produce our software also support it while it's being used. Software support services sometimes take place in the same facilities as the software production process, making it difficult to track the specific footprint of either process.

** Of course, other difficult-to-track environmental effects also occur at other stages throughout the lifecycle of our electronics.

For example, when we use our digital technologies, we affect the environment in several ways. We change the shape and nature of physical spaces when we install devices and support infrastructure. These physical installations influence, and sometimes displace, local wildlife.

We also alter how, where, and when we engage with the environment every time we follow the 'most efficient' directions provided by mapping algorithms or when we replace our home furnishings so that our homes look more appealing to potential AirBnB guests.

I should clarify that these are not hypothetical or purely rhetorical scenarios. These are real issues unfolding faster than many academics can study them.

Sharks and squirrels have notoriously engaged with Internet infrastructures throughout the past two decades. Journalists have recently covered the AirBnB furnishings issue. And some of my former colleagues at Lancaster University are currently working on an air quality initiative with the City of London, where they're trying to reconfigure "last mile delivery" routing algorithms for delivery vans.

Beyond those examples, we're also creating a considerable amount of carbon dioxide (CO2) when we use our digital technologies. This mostly comes through an increased demand for electricity to power our at-home and workplace devices as well as our support infrastructure. Especially data centres.

Data centres are the backbone of the Internet; they are the physical places where we store much of our digital information and many of our digital services, like Netflix and Spotify. Data centres are almost always 'on', which means they require a lot of power, and generate a lot of heat.

To manage that heat, many data centres use an immense amount of water in their cooling systems. And by most estimates, overall globally, they have an annual carbon footprint that is equal to, if not greater than, that of the airline industry. It's an alarming statistic, which some engineers, academics, and government officials have argued we could address through greater energy efficiency.

But energy efficiency is only so effective. Even though our digital devices are more energy efficient now than they were a decade ago, countless studies have shown that our current devices and data centres have actually increased our overall energy use.

This aligns with something called Jevon's Paradox, which is a phrase used in environmental economics to describe the trend of higher efficiency tools and services promising to reduce the overall impact of those tools and services, but ultimately creating higher demand for the resources that fuel them.

In the case of digital technologies, this means higher demand for natural resources and electricity, despite the shrinking physical sizes and increasing energy efficiency of our devices. These higher demands are due to the growing number of data centres and higher overall number of devices charging in our homes and workplaces… trends which do not appear to be changing, especially with the ongoing emphasis on the "knowledge" and "gig" economies. And with the industry trend of designing 'planned obsolescence' into our devices. And with the consumer trend of replacing cell phones every two years.

** When we throw away or replace our digital technologies, they become electronics waste, or e-waste, and they continue to have a measurable effect on the environment. E-waste is—and has been for over a decade—the fastest growing waste stream globally.

This is, again, because we are buying more digital technologies now than ever, and the lifespans of those digital technologies are shrinking.

Moreover, many consumers do not know what to do with their old electronics when they buy new ones.

In some cases, people store their old devices in drawers or cupboards at home. In other cases, people recycle their old electronics at formal recycling facilities. But these electronics recycling facilities do not exist in all countries or regions, and some have prohibitive or deterring costs associated with their use.

Some people simply throw their old electronics in the trash, or donate them to organisations that ship them overseas.

Despite longstanding regulatory attempts to prevent this, many discarded and 'recycled' electronics from developed countries (including Canada, the United States of America, and members of the E.U.) have ended up in informal e-waste 'dumping grounds' around the world.

These dumping grounds–the largest of which have been located in India, China, Nigeria, and Ghana–are the sites of various socio-environmental issues. For example, the diverse processes used to dismantle electronics at these informal sites tend to be directly harmful for workers' health, as well as to the soil, air, and water quality in nearby communities.

Most people working at these sites have little-to-no protective work gear; they openly burn plastics and electronic components, which leads to smoke inhalation as well as soil and water contamination. This contamination extends to regions nearby, creating serious global ecosystem insecurity.

Serious because recent estimates suggest only ~30% of global e-waste is processed in formal recycling facilities. The rest ends up in these informal dumping grounds, sitting in landfills, in peoples' drawers at home, or is illegally exported and unaccounted for.

** So, I've already mentioned a few legal, policy, and regulatory responses to these issues. Let's focus more directly on those responses and answer my third question: ***How have governments used public policy to address the issues that I've just described to you?***

As you noticed, the environmental effects of digital technologies are widespread and diverse. Unsurprisingly, the policy and regulatory responses have also been widespread and diverse.

For the rest of this presentation, I will focus on three groups of relevant policies: green public procurement, waste management, and clean energy policies. I've chosen these three because they relate to different stages in the lifecycle of a digital

technology. But these are not the only policies that matter. Climate change, resource management, taxation, education, and digital innovation policies are all relevant to this discussion, too.

I'm hoping that my examples inspire you to learn more about the diverse ways that policies and regulations influence this domain.

So let's start with green procurement policies.

** Governments have an immense amount of purchasing power, which they can use to influence the design, production, and consumption of products and services worldwide. They do this through their procurement policies, which guide them when they purchase goods, services, and other public works, such as support infrastructure.

In the case of digital technologies, procurement policies often work in tandem with "digital asset management" programs, which dictate how often digital technologies need to be replaced and what types of technologies should be purchased.

With digital technologies entering and reshaping the workplace in the past four decades, many levels of government have adopted sustainable or green procurement policies that attempt to integrate broader social and environmental concerns into the technology purchasing process. Green technology procurement policies have taken different forms around the world and involve the use of various governance tools.

For example, until quite recently in the United States, federal agencies were required to use the Electronic Product Environmental Assessment Tool, or EPEAT, when purchasing new digital technologies. EPEAT offers third-party assessments of electronic devices, and any "EPEAT registered products must meet specific environmental performance criteria related to: materials selection, product longevity, ease of reuse and recycling, energy conservation, and end-of-life management."

Dozens of governments apparently use EPEAT to meet their green tech procurement needs, including the Government of Canada, the Australian Government, the Government of the City and County of San Francisco, the Government of New Zealand, and Warwickshire County Council (in the UK).

Of course, EPEAT isn't the only mechanism that governments use to implement their green tech procurement practices. Some governments have their own unique rules, partnerships, and environmental assessment tools. For example, in Korea, the government has a long-established "Korea Eco-label" for many products, including tech products. They also have a 'Public Procurement Minimum Green Condition Product' program that went into effect to specifically encourage green technology development.

The Malaysian Government recently adopted a Green IT Guideline for public sector procurement that requires digital technologies to have “low energy consumption and minimal use of toxic material.

In the UK, the government has a “Greening Government: ICT Strategy” that addresses a wide variety of ICT issues, including the procurement, use, and disposal or decommissioning of computer applications, data centres, cloud computing services, end user devices and peripherals, as well as public service network infrastructures.

These are just a few examples of the types of green procurement policies and practices in place around the world. More exist.

However, there are places, including in Canada at the provincial and city scales, where no such policies or practices exist. Their presence or absence, and their implementation or lack of implementation, are always wrapped up in a variety of financial, legal, social, and institutional challenges. I’m not here to tell you which system is best, just that these systems exist and are influencing how systems are designed, which systems are being purchased by which governments, and, as a result, the environmental footprint of some of our digital technologies.

** Waste management policies also influence the environmental footprint of digital technologies because, as mentioned, electronics waste has been one of the fastest growing waste streams for well over a decade.

Policy leadership on this issue is generally thought to have started at the international, intergovernmental level. So in 2002, the UN formally recognised e-waste as a priority issue at the Conference of the Parties (COP). And four years later, the COP adopted the Nairobi Declaration, which “called for more structured and enhanced efforts towards achieving global solutions for management of e-waste problems”.

Alongside these developments, the European Union adopted a directive on waste electrical and electronic equipment (‘WEEE Directive’, Directive 2002/96/EC), as well as a directive restricting the use of certain hazardous substances in electrical and electronic equipment (‘RoHS Directive’, Directive 2002/95/EC).

The African Union created the Bamako Convention, which led many of its member countries to develop e-waste regulations, policies, and processing facilities.

Meanwhile, here in Canada, the responsibilities for managing and processing e-waste have been split between provincial and municipal governments via extended producer responsibility (EPR) and product stewardship programs. These programs share WEEE costs and responsibilities between manufacturers and consumers, as well as public sector and private sector recycling facilities.

So, globally, there has been a lot of governmental and intergovernmental activity to try to manage and moderate e-waste flows. Public sector interventions that have

restricted hazardous substances in electronic equipment have been especially helpful at addressing the environmental and social issues related with e-waste.

But despite the widespread and heterogeneous public policy, regulatory, and infrastructural interventions, many of the social and environmental issues I noted previously about e-waste persist, and have persisted for over a decade.

According to most e-waste experts, this is in part because the policy, regulatory, and infrastructural systems that exist are not well-integrated and monitored, so it's easy to find loopholes to get your e-waste shipped illegally overseas. But e-waste flows also persist because of the globalised nature of the tech industry.

To share a personal story, my father worked as a network lab manager at the Edmonton office of a large tech company whose headquarters are in the US. And when that company decommissioned its Edmonton-based large-scale servers and small-scale personal devices, they insisted on shipping all of their decommissioned products back to the US headquarters for local e-waste processing. But why? Why increase the carbon footprint of already decommissioned technology? Especially when Edmonton has a world-class e-waste processing facility in its city limits!

Well, they insisted on shipping their machines back to the US because of local tax benefits that they could gain from donating the equipment to charities–charities which then might have shipped the products overseas, into our complex global electronics waste stream. Those polices were created in part to help the planet, but are instead hurting it by encouraging companies to ship their decommissioned devices back to the US.

Sometimes when policies succeed, they also fail. As policy makers in this complex space, we have to think like the people whose behaviour we are trying to change. We have to look for the loopholes in the changes we are trying to make.

What I'm trying to say is that there are no easy answer that comprehensively address the social and environmental effects of electronics waste. But there is space to try new solutions and refine existing approaches.

** The last policy domain I'll address, and I'll do so very briefly so that I can open this up to you for questions, is related to clean energy. It is, arguably, the least directly relevant policy domain I'll mention today. But it is also, arguably, the most important. Or at least it is while our growing reliance on data centres and our growing collections of personal devices continue to draw on our electrical grids.

According to several data centre experts in the UK, the amount of energy used by data centres is doubling every four years – despite the innovations in hardware that increase their data storage capacity. As a result of that doubling, data centres will consume about three times the amount of electricity in the next decade.

One way to curb their carbon footprint is to increase the amount of renewable energy we generate, which is part of why clean energy policies are so important. But we

need to work a lot harder and faster if we hope to offset the fast growth of internet traffic. A recent article in the Independent explained that “even if we shift to 100 per cent renewable electricity, the volume of energy that our data centres will need would put intolerable pressure on the world’s power systems.” Intolerable pressure.

This has led some people, including former colleagues of mine at Lancaster University, to raise questions about whether or not we need to more actively restrict growth in internet traffic so that our future electrical and ecological systems can cope. But it also raises questions about the scope, effectiveness, and urgency of clean energy policies, if they aren’t being developed in tandem with our digital strategies. How are we developing our energy systems in relation to our planned digital projects? Are we even making a connection between them?

I don’t have answers to those questions in Canada’s case. I’m hoping some of you might.

But what I do know is that, in all of the policy domains I’ve just mentioned, there remains considerable international debate about the effectiveness of the regulations, policies, and management systems.

But different levels of government are at least attempting to respond to these issues with regulatory, policy, and infrastructural initiatives.

And that, to me, is a positive sign.

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Another positive sign comes from the tech industry itself, if such a singular industry can be said to exist. The past decade has seen businesses like Apple, Dell, Google, and Fairphone embrace ‘green’ and ‘sustainable’ design practices. Fairphone is the first ethically produced mobile phone, and it offers an alternative vision of the supply chain for the mobile phone industry. Apple, Dell, and Google release regular reports on their environmental footprints, and are amongst the companies committed to carbon neutral operations. But I should note that they’re only committed to making their operations carbon neutral, and are not offsetting the increased energy demand caused by their products and services.

Other organisations, such as Greenpeace, Amnesty International, Friends of the Earth, and the United Nations University also often release reports tracking the environmental footprint and progress of technology companies.

Going through the archives of these reports suggests that some tech companies have become increasingly aware of and responsive to the footprint of their work, but many companies—like Amazon, EMC, and Samsung—continue to ignore these issues. And many individuals, as well as organisations, remain unaware of the existing, growing, and overall footprint of digital technologies.

** As this quote, from a recent Greenpeace report suggests, there are many lingering challenges to address with regards to the complex issues I've just outlined. Raising awareness about the seriousness of these issues is merely one of those challenges.

Once people and organisations are aware of the environmental footprint of digital technologies, they then face a process of learning about how their actions and policies influence that footprint. This should be followed by some difficult decisions about what to do and how to change. And that's not easy.

We need to balance the very real and exciting promises of digital technologies with their very real and considerable environmental costs. Moreover, we need to make our decisions based on incomplete information. Because researchers often struggle to keep up with the quickly changing pace of the tech industry, as well as the ever-shifting infrastructures, policies and regulatory frameworks that influence our digital technologies.

But with every new device, with every new big data project that is approved, the environmental footprint of digital technologies silently grows. And for many of us studying this field, watching global climate change issues unfold alongside the growth of the tech industry, we worry that leaving things as they are will have serious long-term consequences for all future generations.

I mean, I've personally interviewed very bright people who, thanks to the marketing materials from tech companies, think that the cloud is an actual cloud that has no environmental footprint. Which is demonstrably not true.

** So, of course, this leads me to my final question: **what more can we do?**

And I've come up with some potential answers to that question, not because I think they are the only answers or the best answers, even. But just to start a dialogue with you, my fellow FWD50 attendees.

At an individual level, I think we could all commit to deepening our knowledge of the issues I've just discussed. In this presentation, I've needed to reduce the complexity of a lot of diverse research. Almost every section of this presentation drew on a distinct research domain. And some of the research underpinning my presentation changes regularly. So there is always space for us to learn more.

Alternatively, we could examine how our organisations manage their electronics procurement and waste, and push for changes there. In those cases, we might want to establish partnerships with researchers and non-state actors who are experts in these issues, working in domains like 'green computing', 'information and communication technologies for sustainability' (ICT4S), and human geography.

At the national level, for any federal employees in the audience, I think the Canadian federal government could consider expanding and extending its 'Policy on Green Procurement' to digital services. If they extend their policy to digital services, it would

be an internationally ground-breaking decision, and could ensure the government and its ministries were procuring and maintaining green software.

The Government of Canada could also adopt a mechanism for assessing how new digital projects and service increase the long-term demand for energy, data and additional digital devices, then fund sufficient clean energy projects to offset that increased demand. I suspect any of these ideas will involve asking federal departments and agencies (e.g. Canadian Environmental Assessment Agency) to develop relevant evaluation and assessment tools, which are still sorely lacking.

Beyond the ideas listed here, yesterday's workshops at FWD50 also inspired me to think about another set of important actions. Pia mentioned that digitising 18th, 19th, and 20th century ideas isn't innovative and just gives us faster versions of those outdated ideas. That applies to the environmental footprint of digital technologies, too. Going paperless doesn't mean you're saving the environment, it means you're shifting how and where you're affecting the environment.

Moreover, user-centred design and human-centred design are amazing methods, that I have used in my own projects, but they are amongst the 20th century ideas that are bringing us faster environmental degradation. Because, as methods, they allow us to stop thinking about anything beyond human needs and requirements. They do not ask us to think about the needs and requirements of the animals or ecosystems that our projects also affect. And given that here, in Canada, all of our projects should now start from a point of reconciliation, from a point of acknowledging that our technology design and deployment projects are being developed on stolen land, I feel that one of our challenges, together, is to come up with a more suitable and comprehensive design method than what user- or human-centred design offer.

** Of course, what we actually do is up to us. Given the incredible and diverse people at FWD50, I think this community *does* have an opportunity to make a difference in this domain. So, in the spirit of this talk's theme of "50 days", I thought this call to action might be helpful: in next 50 days, we have a unique and exciting opportunity to drastically rethink the links between our environmental, digital, and policy agendas. I've suggested a few opportunities that we could pursue on individual levels, as well as a few options for Canada at the federal level.

I'd love to see us to seize those opportunities.

** That it's from me. I'll turn this over to you and do my best to address any questions you might have.

Thank you for listening. Thank you for your time. Thank you to the organisers and the AV team for their work!