Chat Notes: C4ST Riding Rep/Riding Member Meeting Oct. 20, 2021
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Announcements:

This Wednesday Nov. 3, 7:30 pm EST, 4:30 PT
Guest Speaker: Kent Chamberlin
Emeritus, Electrical and Computer Engineering

https://ceps.unh.edu/person/kent-chamberlin

Chat notes from Oct 20 meeting

Dr. Schoechle's Presentation (see below and the attachments):
If you have any questions you would like sent to Timothy Schoechle, please send them to Shelley Wright shelleyw@c4st.org and cc. Marg Friesen marg.c4st@gmail.com

Call to Action

2. Please send us the names of candidates who did not sign up for CWC, but mentioned they would support implementing the HESA recommendations, following the election and let us know when you have set up a meeting with them. Shelley shelleyw@c4st.org and Marg marg.c4st@gmail.com

3. If your MP didn't sign up to our CWC, please send a follow up email/phone call to set up a meeting to discuss the Health and Safety of Canadians and the report from the Commons Committee on Health and let our leadership team know when the meeting time is.

Example email If your MP didn't sign up with CWC:
      1. My name is XXX. I live in your Riding at (address).

Canadians for Safe Technology (C4ST) had 110 candidates who signed up to support the Health and Safety Recommendations which were unanimously passed by the Conservative, Liberal and NDP Members of the Parliamentary Standing Committee on Health (HESA) to educate and protect Canadians from increasing exposure to wireless radiation.

I would like to meet with you to discuss these recommendations and why they are important to me and other constituents in our community.

Sincerely,

3. If your MP signed up with CWC:
Example of follow up email/phone call message to your MP:
Thank you (name of MP) for signing up to Canadian's For Technology Candidates Who Care about Canadian's Health. We had 110 candidates who signed up to support the House of Commons Health and Safety Recommendations.

I am thrilled that we have your support! I would like to set up a meeting with you to discuss these recommendations. I look forward to meeting with you.

Sincerely,

If the Assistant wants more information, you can share the website https://c4st.org/ and say: In June 2015 the Conservative, Liberal, and NDP Members of the Parliamentary Standing Committee on Health (HESA) unanimously passed to educate and protect Canadians from our increasing exposures to wireless radiation. These MPs supported the implementation of all the recommendations in the Committee's report, which is titled, "RADIOFREQUENCY ELECTROMAGNETIC RADIATION AND THE HEALTH OF CANADIANS". However, Health Canada and other parts of the government have not fully implemented those recommendations.

When you get an appointment or hear back from your MP, please let Shelley know shelleyw@c4st.org with a cc to Marg marg.c4st@gmail.com

Key Links
Documents provided by Dr. Timothy Schoechle are attached separately (see email).
His report: Re-inventing wires.
https://electromagnetichealth.org/wp-content/uploads/2018/02/ReInventing-Wires-1-25-18.pdf

- **5G and the Canadian Data Centre Rush, Joyce Nelson Oct. 5, 2021**
https://watershedsentinel.ca/articles/the-power-pull-of-5g/

- **Pure Fibre Bell**
https://www.bell.ca/Bell_Internet/Products/Fibre-to-the-home

- **Accelerating 5G In Canada: The Role of 5G in the Fight Against Climate Change**

https://www.cwta.ca/wp-content/uploads/2020/10/5G_Role_In_Fight_Against_Climate_Change.pdf

Suggested by Dr. Schoechle and is cited in the Suspend 5G Canada Appeal.
Book by Shoshana Zuboff on surveillance capitalism:

Zuboff, S. (2019). *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*. New York: Public Affairs. https://www.hbs.edu/faculty/Pages/item.aspx?num=56791

- Also attached is a summary that Marg compiled in 2019 on energy usage of Information of Communications Technologies (ICT).

Note: These meeting notes contain views expressed by various participants, and best-efforts interpretations and summaries by a volunteer note-taker. C4ST does not necessarily agree with all statements in these notes. These notes are marked "Draft" because they are not a transcript, are not meeting minutes, and are NOT FOR DISTRIBUTION.

Chat/Meeting Notes:

Guest speaker: Timothy Schoechle, Ph.D.
Some notes from his presentation.
Note: "fibre" is the Canadian spelling and "fiber" is the USA spelling. Dr. Schoechle (pronounced Scheckly) lives in Boulder, Colorado.

"Broadband" is a misnomer.
It originally referred to the width of the band for transmitting radio and television broadcasts. The wider the better.
Now all it means is fast. And it infers equivalence, which is incorrect.
Saying fibre broadband and wireless broadband would be correct, however, simply omit the word "broadband."

Fibre optic is unmatched in speed and performance, and no form of wireless can compare to it.
Cell sites require fibre connections anyway, and so adding wireless is another layer of complexity and another layer of commercial commitment of some kind.

Wireless is for things that move, not as a substitute for wired as wireless is inferior.

Symmetrical service means it is the same upload and download speed. Speed of 1 GB is what should be available to everybody, and that's generally the fibre that is being installed.

Fibre is very inexpensive to put in as a long term investment, and to put in more fibres is not a big-deal cost - the fibre is just glass and plastic

FTTP (Fibre To The Premises) is a public necessity, therefore it should be owned and managed by the community, not private corporations.

Rural electricity corporations, co-ops, and municipalities; the U.S. Treasury Dept. issued a memo that those should receive preference for the federal government funding (in U.S. Congress right now).

The story about Chattanooga, Tennessee is in *Re-inventing Wires*. Also see the report by Dr. Lobo (email Marg or Shelley for a copy).

The fibre network can be used for more than Internet, as side-benefits. Tim works on micro grids and their integration. Local solar gardens can be shared in neighbourhoods. And power that is stored can be moved to individual neighbourhoods. In an emergency such as flood or fire, if power is distributed around neighbourhoods, those neighbourhoods are somewhat self-sufficient even if the main grid is down - via micro grids.

A fascinating article in the latest issue of the IEEE *Spectrum* magazine. It's the professional society of electrical engineers all over the world. There was a diagram of a modern commercial aircraft. The article was about electromagnetic interference and managing all the electromagnetic interference with an aircraft's devices. Now our homes are generating a lot of electromagnetic interference. There are provisions in the Americans with Disabilities Act (ADA) to comply with federal guidelines regarding accommodation of persons with hhypersensitivity to **electromagnetic** radiation. This is becoming more and more recognized. Tim wrote a 20-page piece, during the past year, to the US Federal Communications Commission (FCC) about the state-of-the-art research and the limits. It has become an issue as to whether the FCC is the right agency to be setting limits for electromagnetic fields. There is some research going on at the University of Colorado regarding EMFs and cellular biology. Thermal effects are a superficial ways to look at it, because we've learned in labs that there are a lot of more subtle effects that are positive or negative biologically. Frank Barnes is doing the research.

Fibre is simpler. This is a big issue. All wireless, particularly 5G, is unbelievably complex to do. It's a miracle that they can make it work at all. Therefore it's very proprietary. When you have a fibre network you're connecting directly to the Internet, but when you connect via wireless that's another layer before you get to the Internet, so you have to go through other proprietary things such as advertising etc. Fibre is future-proofed, because it's just a wire. One way industry recovers the wireless investment is by making it obsolete often so you have to upgrade often; it's a massive waste of resources, in mining the minerals, and the toxic waste that is dumped into our environment.

The recent Senate hearings in Facebook include a serious issue: the toxic business model used by all the giant tech corporations in the way children and others absorb information and use it. It is out of control. This is another important reason to restrict it. It is particularly addictive and dangerous to children. An important book is about the business model of Google and Facebook and how they have changed the IT business from providing services to people to collecting data about people and monetizing it to drive a

massive advertising system that is really not helpful to our society: *Surveillance Capitalism*. This toxicity has implications in education and is a matter of real concern—that an education system becomes dependent on electronic devices.

There are 13 reasons that fibre should be preferred, rather than 4G/5G cellular wireless.

NISLAP's next study will be a paper on Sustainability In Telecommunications. It will be a 15-page briefing paper, and then another larger paper more than 100 pages.

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Q&A

Participant:
How have schools boards, government, and IEEE responded to your message? Are they listening at all when you present this information?

Tim:
It's hard to know what the long-term effects are.
We published in 2018, which was a different world, and I found that a lot of things we predicted in *Re-inventing Wires* started to happen, such as the massive interest in fibre. Technology has changed education, the way we work, and everybody's life, and made telecommunications ever more important in continuing to move forward. Schools realize the need for it. However, we're over-relying on computers in the classrooms right now, and people seem to be reconsidering that. Wiring a classroom requires you to be a little more deliberate about using it. Elementary school students are constantly distracted by it, so if they have to plug it in it will be more deliberate and the teacher will have more control over how it is used. It should be for homework not during lecturing.

Participant:
Center For Humane Technology, founded by tech people, such as Tristan Harris, the young people in those online meetings who realize the overuse problem and it seems like they don't know how to stop.

Tim:
Wireless systems aren't designed to the standards of resilience that the copper landline system was.
In classrooms, I would say check your cellphone at the door and get it when you leave. Copper has also advanced, in new forms. One simple twisted pair, even smaller than a lamp cord, that will carry 10 GB Ethernet and power/charge a device with the same wire. That would be one cheap way to do it in classrooms. It isn't Cat5 cable. It's just cheap wire.

Shelley:
School boards are concerned about energy cost-saving. How can I prove, suggest, or recommend to school boards that wired connections are energy-efficient, reduce the carbon footprint, and reduce their cost?

Tim:

Chapter 6 in *Re-inventing Wires* is about energy-efficiency. The differential is basically that wireline is 10 times more efficient than wireless. I can share with you studies that have been done that show that. Wireless is radiating in all directions to get to a person who might want to use it. But wireline has the energy focused inside the cable or wire, so more energy-efficient. The Fiber Broadband Association and Rural Electric Associations showed that fixed wireless broadband service may seem cheaper at the outset but it is not because of ongoing extra energy consumption and maintenance; refer to report "Vantage Point Study." For example the long-haul can extend 50 to 60 miles. The money should be available to run fibre everywhere; there's no place it can't go. Anywhere we can run electricity, we can run fibre. Maybe it's harder in northern Canada or Alaska, but there are other ways to approach it.

Tim:
Here on screen is another paper about energy-efficiency (see attachment, White Paper Page 4). This chart shows the relationship of power consumption between 1/2/3G and then 4G and then 5G. You can see that it's substantially more. The more they go into millimeter-wave frequencies, such as 30 or 60 GHz, but that is a huge cost because it uses more energy to do it and the nature of modulating all the high frequencies and beamforming has a cost to it too. And then the more you create the dependency on it, the more things people find to do with it. As with the Jevon's Paradox, by making something more appealing, your net is an increase in energy.

Participant:
Canadian government said the towers we will use for 5G will be put into "sleep mode" when no one is using them?

Tim:
Sleep mode has been around for a long time.
IEEE made a recent presentation. "5G AND BEYOND: A ROADMAP APPROACH." Anyone can get these slides, it isn't secret. These are the challenges as they see them (see screen shot below): they're problems because all of these take energy. And if they have to send out all the frequencies, the cell site will get hot.

Enabling 5G and Beyond | FutureNetworks.ieee.org

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Small Cell Migration: Challenges

- Spectral efficiency Vs. energy consumption
- Interference
- Complicated control plane
- Coverage in mmWave bands
- Improved coverage depending on traffic variations
- Improved signal rank and coverage for specific users

MIMO is for beamforming, which is an electronic technique, which they can only do with the higher frequencies of millimeter waves (not the lower mish-mash of frequencies). These are the solutions they propose:

Enabling 5G and Beyond | FutureNetworks.ieee.org

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Base Station Power: Challenges & Solutions

	Challenges	Solutions
Near Term	Distortion (out of band noise)	mMIMO radios with many low-gain antennas
Near Term	Macro and small cells	Management of Power states and Power-down
Near Term	Support for Many RF Bands	Support for Dynamic Spectrum Access
Near Term	Heatsink/Package Size	Highly integrated solutions and hybrid integration
Med. Term	Power/Energy Telemetry: Data Acquisition and Analytics	Real time measurement of energy utilization and analytics to enable Energy control loops
Long Term	Energy-optimal Control Feedback Loops	Optimization of Real-time Cell Energy Consumption, based on predictive models and coordination of system-level resources

Participant:
What does the beam look like if you could see it?

Tim:
Like a flashlight or spotlight. It doesn't go far and won't go through leaves or rain or walls.

Participant:
If my neighbour was using the beam, would it be wide enough to impact the houses around the house?

Tim:
It is a very narrow beam so that they reduce energy use. It takes expensive equipment that they can't install everywhere, so you can't rely on that.

Participant:
The lower 5G frequencies, are they MIMO and beamforming?

Tim:
No, they don't work well for that.

Marg:
Please comment on satellites: quality of internet, base stations required, etc.? Such as Starlink.

Tim:
A study shows the long-term future of that is not very good in terms of being able to supply broadband. It's going to be slower. Maybe it's better than you get today from geostationary Internet satellite services. It is going to cost a lot of money and if a lot of people are using it, it will degrade very quickly. The Fibre Broadband Association study goes into detail about why. Tim doesn't see any economic model that works there. And it can't compete with fibre, except in very remote areas. It will not serve an urban area, for instance.

Marg:
Converter boxes. The fibre optic backbone connects to the tail. Dirty electricity may be produced.

Tim:
It's a case by case situation. The problem is there's no radiation from the fibre itself but the converter boxes needs a power supply. The manufacturers make them so cheap by removing the components that would filter the harmonic emissions (i.e., dirty electricity) that are extraneous, a.k.a. electromagnetic interference. The cheap wall-plug power supply for my Apple computer blocks out an FM radio station that I want to listen to. Junk power supplies are the problem. You can look at the specifications if they bother to publish them. The only test is to have your own receiver box and find a power supply that doesn't make a lot of "noise." Tune an old AM portable radio away from a station, and use that as a detector.
If we have batteries and inverters in our houses, they may create harmonic emissions. May need a filter for the dirty electricity and to get rid of it.
You have to measure it - that's the only way to know which device is good or bad.

It's possible to make a decent power supply, it might cost more.

Marg:
We need to find them, be educated about them, and then promote them. Dollars talk, vote with our dollars.

Tim:
They don't care about interfering with people, they care about interfering with other products.
Wireless shouldn't be used just because it's there; only where it's necessary.

Participant:
I'm an airline pilot. I'm aware of two big problems with wireless systems interference on the aircraft. Display units, and radar altimeters. I would love to be introduced to anyone you're working with.

Tim:
The latest issue of IEEE Spectrum has that good article. I think it mentions who is working on it and what they're trying to do about it. The problem in your house is the same as the problem on aircraft, and it's getting worse.

Participant:
We measured with just one phone on, and it was a massive amount of radiation inside the fuselage.

Participant:
In 45 minutes, we will be presenting to a school board about a proposed 5G cell tower. We were asked by PAC—the parents are so concerned about covid—the Chair said if we can communicate on a level that parents understand about the symptoms and some things they can do. Do you have ideas?

Tim:
What has 5G got to do with the school?

Participant:
The tower would be within about one km of the school of 300 students. It is a 5G cell tower. It doesn't necessarily mean the millimeter waves but of course all of it is concerning for health.

Tim:
I question the basic assumption that you need the latest technology from a toxic industry. I would start out by pointing out the Senate hearings, the whole issue of surveillance and the suicide rate of young girls from exposure to that medium. It's legitimate to raise the issue: "Why do we need this? If you need Internet access in the school, put in fibre optic and Ethernet access. And people shouldn't be using cellphones in the schools at all."

Participant:

We're a little town, many seniors, already have some towers, and a particular voting block of people are concerned about making emergency calls because there are dead zones.

Tim:
Why don't they have (landline) phone service at home? TELUS puts in fibre, so why can't they put in fibre? They want to sell you wireless that costs you more money for the phone etc.; it's a bait-and-switch. They shouldn't even consider wireless service until after they have fibre service to the house.

Participant:
Fibre optic cables are already installed along the street.

Tim:
It's like putting in water. Don't they have sewer service? Unlike that, the problem is that telecommunications is a private service.

April:
Can they call satellite emissions "5G"? It wouldn't travel far.

Tim:
There is only a 5-10 minute window of that satellite being over your head. It sends to a receiver device cell site (for you or a bunch of houses). 17,000 mph. It hands off to the next, next, next, etc. satellite. It's very susceptible to anything. If the Chinese decide to shoot it down, it's destroyed in an instant. It isn't reliable. The 5G part is totally separate from the satellite itself; it would be local on-the-ground, just like always. The satellites are only backhaul either direct to your computer or a local network.

Shelley:
Those base stations on the Earth will have more energy?

Tim:
Yes

April:
Interfering with weather forecasting?

Tim:
Specific bands have been allocated for 5G in 50-60 GHz, which interfere with longstanding data collection networks, particularly for humidity measurements they need to keep that frequency clear.
5G from the ground is interfering with the weather forecasting.

Barb:
About metal core in types of fibre optic cable that aren't called "Pure"? (Barry answered.)

Participant:
(Sentinel article, 8-15% energy used)

Tim:
I dispute that.

Participant:
Who is listening to the need to clamp down?

Tim:
Presently the U.S. Senate regarding especially Facebook. There needs to be break-up of these huge corporations. The issue of privacy is just really out of control and it's time to change the way the large corporations are governed because right now they are ungovernable and they have no incentive to serve the public commons.

Participant:
COP26 soon.

Tim:
The closest I can come is the upcoming Sustainability paper. My aspect is solar and battery storage and distribution. I think the only answer is to reconfigure the entire power system worldwide.

Participant:
Micro grids and smaller electrical utility companies working together. In my area they are rolling out high-speed 5G, or whatever they call it, in our rural areas. My municipal Councillor offers to talk to Bell about it, but the Councillor doesn't get it. How do we steer a rollout that is already underway? The municipal role, and they claim to not have jurisdiction.

Tim:
Localization of both electricity and telecommunications should be a public priority and a public policy issue. Federal government should take a more localized view of empowering communities to do these things, and fund that.

Participant:
I used to work with Huawei, Alcatel, etc. Usually I hear them say "ease of installation" of wireless devices, convenience, cost of wireless installation being less because they don't mention the greater cost of operation and maintenance. Chances are there will be wired systems and wireless systems, so would a hybrid healthier wireless system be recommended for confined areas? By hybrid, I mean fibre from sites to home and then in-home you have a wireless router and other devices.

Tim:
The cost of maintaining a fibre system is always going to be lower than a wireless system that always breaks and requires so many things. Fibre is future-proof; the wire sitting there for a long, long time, not requiring maintenance. So their argument is disingenuous.

I think wireless should be optional; if everyone has a wired system, we wouldn't need much wireless. We don't need 5G for anything.

New versions of ethernet are extremely cheap—even cheaper than Cat-whatever—single pair wire. And it can carry electricity also.

Tim:

I will provide Shelley with my *Solar Today* article that can be distributed.
I can be part of a meeting with your parliament representatives.
The Sustainability upcoming report will be out soon.

Marg:

Any Canadian experts (other than Dr. Magda Havas) to help us prepare something for our Members of Parliament? A group at McMaster University.

Tim:

(didn't know the McMaster group, and Marg will send him that; Tim doesn't know any Canadian experts)
[Added by Marg: Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. *Journal of Cleaner Production*, 177, 448.463. https://doi.org/10.1016/j.jclepro.2017.12.239
Also see the attached summary.

April:

Would you be interested in later exploring and writing on the Canadian situation?

Tim:

Of course. I have personal friends in Canada, especially in British Columbia.

Participant:

2G network coverage was at lower power overnight. Regarding newer networks: Can one antenna incorporate multiple frequencies?

Tim:

Yes, within certain limits they can. For the millimeter frequencies the requirements are significantly different.
Turning them off, they could've done that before they just didn't bother.
MIMO and beamforming doesn't work well with the lower frequencies.

Participant:

Exponent, the product defence firm in the U.S., their William Bailey is defending the indefensible in Canada. They claim human beings radiate more than Wi-Fi does.

Tim:

I don't know that company. I'll look it up.

C4ST Leaders thanked Dr. Schoechle for his presentation and the extra time he took to answer questions from our Riding Representatives and Riding Members.

This concludes Dr. Schoechle's presentation and Q & A.

Informal Discussion With Riding Representatives and Riding Members:

Participant - What are copper lines used for to the home? If we are able to get fibre to the premises, should we consider keeping the copper wires for any reason?

Participant - Copper and fibre are the same but fiber is high speed hence it is recommended over copper. It is important to mentioned that they are both broad bands… fibre has more reach, speed, durability and reliability.

Participant – Dr. Schoechle has touched on a whole lot, however I would like to hear his views on an hybrid deployment of wireless (mobility) and wired telco systems.

Marg – I think Dr. Schoechle's position is that only use wireless if you can't use wired connections.

Thank you for attending this meeting! These meeting notes contain views expressed by various participants, and best-efforts interpretations and summaries by a volunteer note-taker. C4ST does not necessarily agree with all statements in these notes. These notes are marked "Draft" because they are not a transcript, are not meeting minutes, and are NOT FOR DISTRIBUTION.

Report by Marg Friesen, 15 Dec.2019: Energy Consumption by Wireless Technology Relating to Climate Change

4 main ways energy is consumed for Information Communications Technology (ICT) e.g. Internet of Things (IoT):

1) Data Centers 2) Machine-to-machine Communications 3) Embodied Energy 4) Obsolescence of Digital Technologies e.g. E-waste.

Quotes: "We have found that, if unchecked, ICT GHGE [Global Green House Gas Emissions] relative contribution could grow from roughly 1–1.6% in 2007 to exceed 14% of the 2016-level worldwide GHGE by 2040, accounting for more than half of the current

relative contribution of the whole transportation sector." (Belkhir & Elmeligi (2018) – McMaster University, Canada)

"The communications industry could use 20% of all the world's electricity by 2025, hampering attempts to meet climate change targets and straining grids as demand by power-hungry server farms storing digital data from billions of smartphones, tablets and internet-connected devices grows exponentially. The industry has long argued that it can considerably reduce carbon emissions by increasing efficiency and reducing waste, but academics are challenging industry assumptions. A new paper, due to be published by US researchers later this month, will forecast that information and communications technology could create up to 3.5% of global emissions by 2020 – surpassing aviation and shipping – and up to 14% 2040, around the same proportion as the US today. (Climate Home News/ The Guardian, 2017)

LIST OF SOME PUBLICATIONS ON ENERGY CONSUMPTION

 RELATED TO INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) E.G. INTERNET

1. Amazon Employees for Climate Justice. (2019, September 20). Amazon employees are joining the Global Climate Walkout, 9/20. Medium. Retrieved from https://medium.com/ @amazonemployeesclimatejustice/amazon-employees-are-joining-the-global-climate-walkout-9-20-9bfa4cbb1ce3

2. Andrae, A. S. G., & Edler, T. (2015). On Global Electricity Usage of Communication Technology: Trends to 2030. Challenges, 6(1), 117–157. https://doi.org/10.3390/ challe6010117

3. Anonymous, K. (2019, December 2). Why aren't more climate change activists fighting 5G? Stop Smart Meters Australia. Retrieved from https://stopsmartmeters.com.au/ 2019/12/02/why-arent-more-climate-change-activists-fighting-5g/

4. Barger, S. (2019, November 8). The gathering storm: Computing's climate change problem. TechTalks. Retrieved from https://bdtechtalks.com/2019/11/08/global-warming-shared-computing/

5. Belkhir, L. (2018, March 25). How smartphones are heating up the planet. The Conversation. Retrieved from http://theconversation.com/how-smartphones-are-heating-up-the-planet-92793

6. Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. Journal of Cleaner Production, 177, 448–463. https://doi.org/ 10.1016/j.jclepro.2017.12.239

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9. Climate Home News. (2017, December 11). 'Tsunami of data' could consume one fifth of global electricity by 2025 | Environment | The Guardian. The Guardian. Retrieved from https://www.theguardian.com/environment/2017/dec/11/tsunami-of-data-could-consume-fifth-global-electricity-by-2025

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11. Cook, G. (2017). Clicking Clean: who is winning the race to build a green Internet? Greenpeace Report. 2017 (p. 102). Greenpeace. Retrieved from https://www.ong2zero.org/blog/clicking-clean-who-is-winning-the-race-to-build-a-green-internet-greenpeace-report/

12. Darby, S. J. (2018). Smart technology in the home: time for more clarity. Building Research & Information, 46(1), 140–147. https://doi.org/10.1080/09613218.2017.1301707

13. De Decker, K. (n.d.). The monster footprint of digital technology. LOW-TECH MAGAZINE. Retrieved from https://www.lowtechmagazine.com/2009/06/embodied-energy-of-digital-technology.html

14. Elegant, Naomi Xu. (2019). The Internet Cloud's Dirty Secret: It Consumes Tons of Energy, Has Large Carbon Footprint. Fortune. Retrieved from https://fortune.com/2019/09/18/internet-cloud-server-data-center-energy-consumption-renewable-coal/

15. Elliot, John, & et al. (2017). Energy consumption in smartphones: an investigation of battery and energy consumption of media related applications on android smartphones. Retrieved from http://eprints.leedsbeckett.ac.uk/4703/1/SEEDS%20FINAL%20Paper%202017%20150%20Fehmi.pdf

16. Hussain, S.M. Suhail, Nadeem, Furquan, Aftab, Mohd Asim, Ali, Ikbal, & Ustun, Taha Selim. (2019). The Emerging Energy Internet: Architecture, Benefits, Challenges, and Future Prospects. Electronics, 8, 1037. https://doi.org/10.3390/electronics8091037

17. International Environmental Technology. (2019, April 29). How Does Smart Home Automation Affect the Environment? Envirotech Online. Retrieved from https://www.envirotech-online.com/news/environmental-laboratory/7/breaking-news/how-does-smart-home-automation-affect-the-environment/45838

18. Kommenda, N. (2019, July 19). How your flight emits as much CO2 as many people do in a year. The Guardian. Retrieved from http://www.theguardian.com/environment/ng-interactive/2019/jul/19/carbon-calculator-how-taking-one-flight-emits-as-much-as-many-people-do-in-a-year

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21. Loken, Andrea. (2019, October 17). From climate to health, spread of 5G networks poses multiple risks. Rabble.Ca. Retrieved from https://rabble.ca/blogs/bloggers/views-expressed/2019/10/climate-health-spread-5g-networks-poses-multiple-risks

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