
Problematizing the sustainability of 5G/6G networks and devising alternative ways forward

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5G/6G

Evolution of mobile networks

- 1G/2G/3G/4G/5G - - -> 6G?
- Increase in capacity and flexibility.
- New applications:
 - 5G: virtual reality, autonomous driving, games, tactile Internet, among others.
 - 6G: brain-machine interfaces, implants, augmented reality, digital twins.
- Implications of capacity and flexibility increase:
 - Massive MIMO, intelligent surfaces, higher frequencies, slicing, AI.
 - i.e., more antennas, base stations, processing power and equipment.



5G/6G sustainability is framed as a trade-off

“Positive” side: 5G/6G for Sustainability (Induced/indirect effects)

5G/6G for Sustainability

- Deals with induced effects of the services and applications 6G may enable.
- Due to the digitalization that they allow in different sectors:
 - Smart city, smart agriculture, smart factory, smart grid, etc.

6G flagship initiatives in Europe (Hexa-X), Finland (6G Flagship), China (IMT-2030 (6G) Promotion Group), North America (Next G Alliance 2022) all promote 6G as an enabler of the green transition.



5G/6G for Sustainability

- Problems:
 - Effects on the social metabolism are **hard to predict**.
 - *Rebound effects, new behaviours, etc.*
 - **Unclear** if mobile communications should account for all the benefit:¹
 - *Prone to double counting.*
 - *Building-block technologies should probably not account for any benefit.*
 - Difficult to consider the effects of other **(non)-technological contributions**.
 - *Ex. wired networks/thermal isolation.*³
 - Seen as the positive side of the trade-off, but may also be **negative!**
 - *Ex. increase in the extraction of oil offshore thanks to data analysis in real time.*³
- Already controversial for 5G networks wrt the GSMA report.^{2,3}

¹ Bergmark P, Coroamă VC, Höjer M, Donovan C (2020) A methodology for assessing the environmental effects induced by ICT services: Part II: Multiple services and companies. Proceedings of the 7th International Conference on ICT for Sustainability, June 2020, 46-55.

² GSMA. The Enablement Effect. The impact of mobile communications technologies on carbon emission reductions. Technical Report. (2019).

³ Roussilhe, G. Que peut le numérique pour la transition écologique? Available from:

<https://gauthierroussilhe.com/media/pages/ressources/que-peut-le-numerique-pour-la-transition-ecologique/739b60aef6-1659704444/NTE-Mars2021.pdf>

Negative side: Sustainable 5G/6G (direct effects)

Sustainable 6G

- Deals with direct effects (costs) of the technology itself.
- Focus on energy consumption of the network and per bit (efficiency).
- Ignores^{4,5}:
 - What matters is **global** energy consumption.
 - Energy consumption **may actually increase**.
 - Due to **induction** and **rebound** effects.
 - Higher demand implies higher need for **equipment**:
 - At the network, user and other infrastructures.
 - Impact on material extraction, production, transport and electronic waste.
 - Not all impact is amenable to **quantification and comparison!**

⁴ Williams L, Sovacool BK, Foxon, TJ (2022) The energy use implications of 5G: Reviewing whole network operational energy, embodied energy, and indirect effects. Renewable and Sustainable Energy Reviews 157:112033. DOI 10.1016/j.rser.2021.112033.

⁵ C. Cano, H. March. 5/6G: Networks of the future or defuturing networks. Available from <https://arxiv.org/abs/2207.02533>

Ways forward

Ways forward

- Understand that analyses are highly speculative, overly positive and that there is difficulty in quantifying impact.
- Rethink the services and the technologies:
 - What other imaginaries are we able to devise?
 - Concentrate on serving actual demand? Contain data growth? What do we do instead?
- Interdisciplinarity
 - Social and environmental impact, effects of technology, etc.

Final Remarks

Final remarks

- Current work on the impact of 5G/6G networks on sustainability is problematic for a number of reasons.
- Ways forward:
 - Caution!
 - To rethink future imaginaries.
 - Interdisciplinarity.

Discussion