

1 Summary

Chasing Carbon (2021, IEEE HPCA): In this paper, the authors highlight the trend that carbon emissions from computing (both from data centers and consumer devices) has shifted from hardware use and operational energy consumption (opex) to hardware manufacturing and facility infrastructure (capex). They characterize and quantify the overall environmental impact of opex and capex related activities, showing the capex activities dominate carbon output, and is likely to remain dominating it even if those kinds of emissions are reduced. Their findings demonstrate the need for redesigning systems to be both more efficient and environmentally sustainable; as computing needs are only likely to increase in the future, we need more novel approaches in order to reduce technology's overall carbon footprint.

2 Strengths

- The Greenhouse Gas (GHG) Protocol in the context of data centers, mobile devices, and how it applies to hardware manufacturing industry was well described and included plenty of clear examples of which scopes different parts of a hardware's life-cycle fit.
- Visualization of the breakdown of each kind of hardware life-cycle carbon emission were simple and relevant, and helped clarified their discussions on variation in carbon footprints of different platforms and scales.

3 Weaknesses

- There could have been more explanations on how carbon footprinting is addressed across computing stacks touched on in Section VI; this section was brief, broadly touching on areas that their research could help support drive more sustainable work, and did not cite as many sources or data in a way they had done in Section II - V (although it could be that there was a lack of sources to cite for these discussions).

4 Rating: 4

5 Comments

With the growing active push for a greener world, across all domains, it makes sense to generate more interest in more sustainable hardware manufacturing and manufacturing practices, which starts with a more sustainability-conscious approach to systems and hardware design. The authors here take a data-driven approach to paint a detailed picture of the current state of the environmental impact of the tech industry. Amongst their findings, they showed that, even though switching to renewable energy and decades of focus on energy efficiency generally

decreased the operational carbon output, a rising percentage of the hardware life-cycle carbon emissions still comes from manufacturing. It is jarring seeing the breakdown of different companies' emissions across many familiar products and in their warehouses; for example, battery-powered devices, against other sources of their emissions, manufacturing accounted for almost 75% of their carbon emissions, and manufacturing stills account for a substantial 40% of emissions of for always connected devices. This demonstrates an opprtune route to address environemntal impacts in tech is to target the emissions seen from infastructure and manufacturing, even if it seems they will always remain the majority holder of overall carbon emissions in hardware life-cycle. I believe the authors' quantititative approach is a good way to not only motivate innovation with reducing carbon footprint in mind, but estabish a base to support even environment related industry protocol and legislation, because historically, if a sustainable approach was not seen as profitable to a corporation, it is not pursued. I think this paper will inspire more interest in system designs with reduced carbon footprint, if not change the way how poeple teach it in engineering classes and practice it in industry; without making sacrifices to the demand for increased performance, the future of the field may see a more balanced approach between energy efficiency, performance, and environemntal impact.