Sustainability and energy demand project topics HT 2022

Digital Ecologies Lab, Department of IT

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Visualising Solar Power

- **Supervisor:** Mike Hazas, Martin Stojanov, or another member of the “Solar Internet” project.
- **Background:** Solar power is a key renewable energy source for supporting environmental sustainability. This project will explore means to visualize solar power within the Swedish energy context – for instance, considering how much sunshine falls on each day, how much space is needed for solar cells, the cost in hours of sunshine of an activity like watching a TV show, and so on. For instance, the KiloWhat?? Website (http://kilowh.at/) demonstrate the equivalence of various energy practices and sources, where 1 square meter of solar paneling produces enough energy over a year to charge 26055 mobile phones.
- **Project/Task:** The project will involve the prototyping of visualisations for the web or other technologies (e.g. physical computing). The prototyping will require some preliminary research on solar energy production, visualization techniques and cognitive and information science, brainstorming design, use of either low- or high-fidelity prototyping tools, and final design of a visualization tool.
- **Method:** This would follow a standard design process, with critical reflection, and should include some user testing, as for example the following:
- Hedin, B., & Luis Zapico, J. (2018). What Can You Do with 100 kWh? A Longitudinal Study of Using an Interactive Energy Comparison Tool to Increase Energy Awareness. Sustainability, 10(7), 2269.

Designing Solar-powered Websites

- **Supervisor:** Mike Hazas, Martin Stojanov, or another member of the “Solar Internet” project.
- **Background:** The vast majority of websites and services are designed for always-on and high bandwidth connectivity. As a result, they use a lot of data, which in turn can use a lot of energy, which is in turn bad for the environment. At the same time high data demand can lead to bloated and slow user experiences. This project will build on examples of the solar internet, to prototype and test interaction techniques and design for the constraints of using solar-powered webservers, such as https://solar.lowtechmagazine.com/. The research will develop alongside the Solar Internet research project, funded by the Swedish Energy Agency to ask: How do we communicate the constraints of solar powered internet while maintaining or even extending the user experience?
- **Project/Task:** The project will involve the prototyping of interactions for websites and testing those with a small user group. The prototyping will require some preliminary research, brainstorming design, use of either low- or high fidelity prototyping tools, and design of user tests. User testing will be necessary to ensure successful design strategies are deployed.
- **Research Method:** The project will follow a research-through-design process, where the design of web interactions generates knowledge on constraints-based computing for sustainability. The method can follow standard design processes, likely with an emphasis on showcases multiple interactions, rather than one finished product. User testing should follow procedures for usability testing and could make use of the department’s usability lab.

Web design and electricity consumption

Electricity consumption from internet use is increasing. The digital infrastructure supporting cloud services induces environmental effects, . At the same time, web design can affect the energy consumption of surfing the web, there are efforts to redesign websites to be require less data to be transferred.

The purpose of this project is to add to existing research on how design practice affects the environmental impact of the internet. Because web design practice is likely affected by how web design is taught and the kinds of tools employed in the design practice, it is relevant to explore to what extent electricity use is considered in these domains. Hence, the purpose of this project is to explore:

- What is “good design” in the dominant discourse of web design practice?
- To what extent is electricity use considered in the design discourse?

This project is to employ qualitative methods to study how web design is being taught. The exact focus of the project can be adapted to the student’s interest but the focus should be on dominant discourse related to web design practice. Possible sources of material could be university educational material, interviews and/or observation teaching of web design. A focus on textual material could also be appropriate, such as textbooks or authoritative webbased resources on web design such as blogs. Another option could be to study software as a service for website building or other relevant the tools employed in web design. The analysis could be grounded in discourse analysis (or equivalent).

References:

Abbing, R. R. (2021). ‘This is a solar-powered website, which means it sometimes goes offline’: A design inquiry into degrowth and ICT. LIMITS Workshop on Computing within Limits. https://doi.org/10.21428/bf6fb269.e78d19f6

Preist, C., Schien, D., & Blevis, E. (2016). Understanding and Mitigating the Effects of Device and Cloud Service Design Decisions on the Environmental Footprint of Digital Infrastructure. Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, 1324–1337. https://doi.org/10.1145/2858036.2858378

Stanfill, M. (2015). The interface as discourse: The production of norms through web design. New media & society, 17(7), 1059-1074.

Strengers, Y., Hazas, M., Nicholls, L., Kjeldskov, J., & Skov, M. B. (2020). Pursuing pleasance: Interrogating energy-intensive visions for the smart home. International Journal of Human-Computer Studies, 136, 102379. https://doi.org/10.1016/j.ijhcs.2019.102379

Widdicks, K., & Pargman, D. (2019). Breaking the Cornucopian Paradigm: Towards Moderate Internet Use in Everyday Life. Proceedings of the Fifth Workshop on Computing within Limits, 1–8. https://doi.org/10.1145/3338103.3338105

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Energy and environmental impact of games in Sweden

- **Supervisor:** Mike Hazas
- **Background:** In Sweden, gaming currently accounts for perhaps 0.3% of electricity demand; and a conservative estimate is that this will rise to about 1.2% by 2030. Or, 2.5% if 4K-capable cloud gaming services take off. As gaming continues to grow, we must shape this growth in sustainable ways.
- This is a broad and challenging topic, involving a variety of participants, stakeholders, and data. As such, a project could take any number of approaches, for example:
  - interviewing people that play games about what, when, and how they play;
  - talking to games companies and developers to understand how energy, resources and sustainability fit in (or not) to their system designs;
  - analysis of existing media or datasets to find out more about gaming's impacts (e.g. game-related content livestreamed or posted on YouTube and Twitch);
  - performing network and power measurements of games devices to better understand their potential impacts.
- There is a small amount of work on this topic, including one book recently published, and one UU master's project completed in summer 2022. So, any further work needs to be carefully scoped to have a non-overlapping contribution.
- **Diversity and inclusion:** Gaming has a broad following. And yet parts of the games industry, and online discourse about games, have gained a poor reputation for diversity and inclusion, particularly in their treatment of women and those identifying as LGBTQ. The master's thesis would need to specifically situate itself with respect to this problem, and if appropriate account for it through the empirical work (e.g. participants recruited, interview design, qualitative/quantitative analysis).
- **References:**
  Oliver Lönnqvist. Sustainable Game Development: Mapping the climate impact and the negative impact reduction actions in the Swedish gaming industry. UU master's thesis, STS programme. June 2022. http://uu.diva-portal.org/smash/record.jsf?pid=diva2%3A1691000

- Abraham, B. (2022). Digital Games After Climate Change. 1st ed. Palgrave Macmillan
- Matthew Marsden, Mike Hazas, and Matthew Broadbent. 2020. From One Edge to the Other: Exploring Gaming's Rising Presence on the Network. In Proceedings of the 7th International Conference on ICT for Sustainability (ICT4S2020). Association for Computing Machinery, New York, NY, USA, 247–254. https://doi-org.ezproxy.its.uu.se/10.1145/3401335.3401366

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Citizen science and heatwaves

Supervisor: Martin Stojanov

The rates and intensities of heatwaves are expected to increase with climate change. Heatwaves can have a negative impact on the health of vulnerable populations, which can be exacerbated by urban heat island effects. The availability of weather data affects the ability to mitigate negative health effects. Citizen science has been employed to provide data on the indoor heat stress to account for the micro-climate in urban areas and a way to supplement the weather data produced by weather stations located away from urban heat islands.

In the Nordic region, heatwaves are confined to a limited time period. Hence, infrastructure for citizen science based heatwave data could potentially be useful only for a few months.

- Option A: The purpose of this study is to explore to what extent citizen science infrastructure for heatwave sensing fulfils needs in households in the remainder of the year.
- Option B: The purpose of this study is to explore to what extent existing weather data sensors in households could be incorporated into citizen science infrastructure for heatwave sensing.

The project will follow a research-through-design process to generate knowledge on constraints-based computing for climate change adaptation.

Reference:

Rajagopalan, P., Andamon, M. M., & Paolini, R. (2020). Investigating thermal comfort and energy impact through microclimate monitoring- a citizen science approach. Energy and Buildings, 229, 110526. https://doi.org/10.1016/j.enbuild.2020.110526

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Building the Internet Microscope

- **Supervisor:** Mike Hazas or Martin Stojanov or Christian Rohner
- **Background:** How can we better investigate home Internet service demand, and how that ties with everyday practices? One way is to look at what Internet services are being relied upon in the home, and how inhabitants report spending their time. This would require a network monitoring device installed in the home, and something like a time-use diary.
- **Project:** Design, evaluate with participants in homes, and redesign a time-use diary app that could be deployed at scale (thousands of homes). There are established methods for studies of time-use, and a recent study of domestic electricity in the UK (link below) may provide a starting point for your app.
- **References:**
  The METER Study (University of Oxford). https://www.energy-use.org/data/
  Kelly Widdicks, Mike Hazas, Oliver Bates, and Adrian Friday. 2019. Streaming, Multi-Screens and YouTube: The New (Unsustainable) Ways of Watching in the Home. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). https://doi.org/10.1145/3290605.3300696

Sustainable Smart Home Technologies

Supervisor: Miriam Börjesson Rivera

Background: Smart home technologies are often perceived as facilitating sustainable energy usage through optimizing and energy efficiency measures. In reality these promising features are often offset by other qualities such as pleasance and comfort that drive energy consumption, thus causing rebound effects. At the same time, recent developments have proven that energy is becoming a precious commodity that needs to be managed frugally.

Task: In this thesis proposal we want you to build a smart home technology proof of concept based on the principles of digital sufficiency as well as energy resilience. It could for example be a redesign of an existing system such as Philips Hue or Google Nest.

References:

Hasselqvist, H., Renström, S., Strömberg, H., & Håkansson, M. (2022). Household energy resilience: Shifting perspectives to reveal opportunities for renewable energy futures in affluent contexts. *Energy Research & Social Science*, *88*, 102498.

Hasselqvist, H., Renström, S., Håkansson, M., & Strömberg, H. (2022, April). Exploring Renewable Energy Futures through Household Energy Resilience. In *CHI Conference on Human Factors in Computing Systems* (pp. 1-18).

Pohl, J., Frick, V., Hoefner, A., Santarius, T., & Finkbeiner, M. (2021). Environmental saving potentials of a smart home system from a life cycle perspective: How green is the smart home?. *Journal of Cleaner Production*, *312*, 127845.

Santarius, T., Bieser, J. C., Frick, V., Höjer, M., Gossen, M., Hilty, L. M., ... & Lange, S. (2022). Digital sufficiency: conceptual considerations for ICTs on a finite planet. *Annals of Telecommunications*, 1-19.

Strengers, Y., Hazas, M., Nicholls, L., Kjeldskov, J., & Skov, M. B. (2020). Pursuing pleasance: Interrogating energy-intensive visions for the smart home. *International Journal of Human-Computer Studies*, *136*, 102379.

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Rural broadband in Sweden

- Supervisor: Mike Hazas or Miriam Börjesson Rivera

70 % of Swedish households have fibre to the premises (gigabit capable). But there is still a fairly large amount of households that still has no possibility to have broadband in their homes. This project would look into this topic and focus specifically on the possible implications for sustainability and social justice.

This project could either have a desk-based research approach, looking into the government vision and analysing the the policies. It could also have a more ‘empirical’ approach including interviewing and (qual or quant) observation in rural households that have no access to broadband in their homes.