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Re-configuring energy systems and practices: Users' perceptions of engineering solutions to electricity consumption and overload

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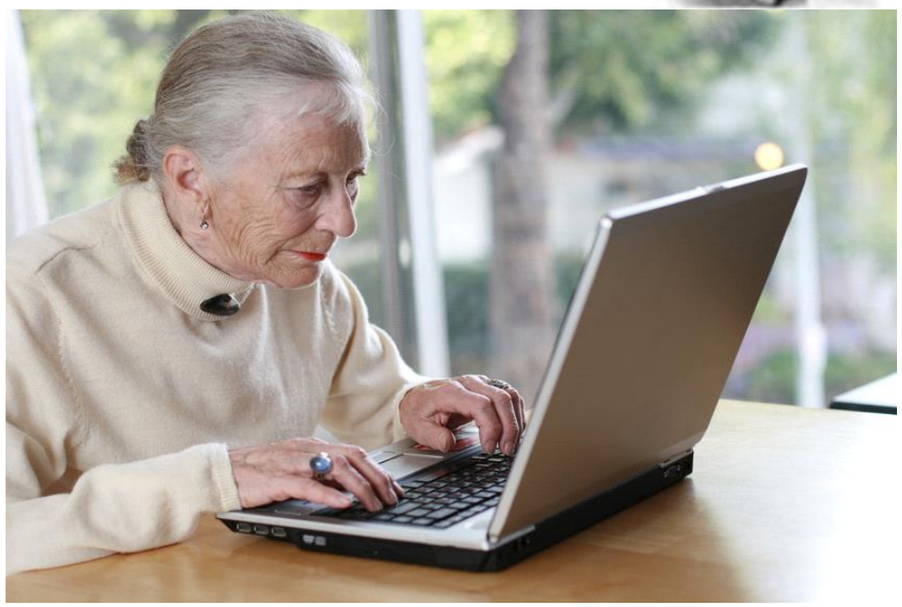
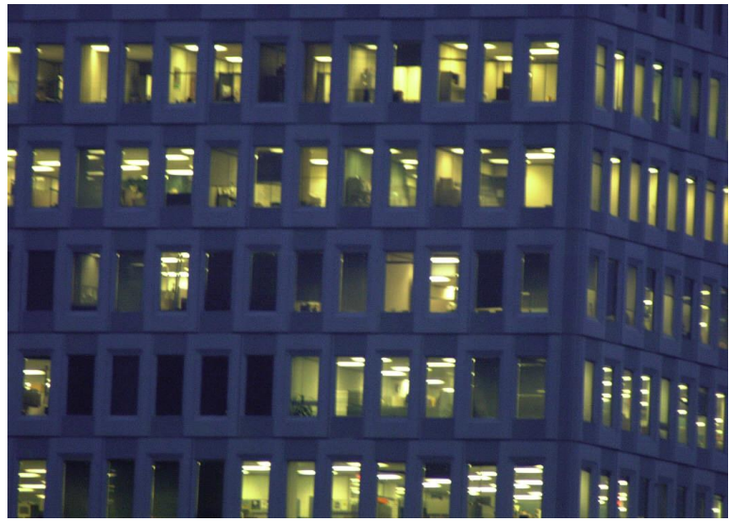
Imperial College London
ESA 2015, Prague,
25-28 August 2015

Introduction





230V +10% ~ -6%

- Cables in the ‘last-mile’ tend not to ‘overload’ thermally; rather, they ‘overload’ by voltage dropping outside the range
- A relaxation of the voltage quality definitions could avoid a large and disruption cable replacement programme.
  - e.g. A laptop can operate across 90V to 250V.


“Last-mile”

Question

- How do people see and feel about electricity overloads and *voltage relaxation*?

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  - How are engineers' conceptions of electricity overloads and how to achieve voltage relaxation perceived and understood by users?

Methodology

- Semi-structured interviews with:
  - 10 Project engineers
  - 10 Users = Housing professionals in housing development and regeneration programmes:
    - An architect, electrical and mechanical engineers, housing development managers, a construction manager, employer's contractors, a chartered building surveyor, and a private and social housing developer
    - *How do they see the engineering solution in relation to their practices of housing development?*
- Thematic analysis with open coding

Findings

Engineer Interviews:

- 4 themes raised by engineers as possible approaches to and issues surrounding voltage relaxation:

1) Use of Direct Current (DC) instead of Alternating Current (AC)
2) Existing infrastructure (e.g. cables)
3) Power quality
4) Future electricity demand

Housing Professional Interviews:

(1) Use of DC in place of AC – engineers are examining the efficiency of point of use voltage regulation by using of DC in the electrical connection into people's homes

- "In DC… you'd have to be 30 to 50 metres away from every transformer. So all of a sudden you need… 5 metre by 5 metre rooms everywhere to house additional DC transformers" (Electrical Engineer).
- "I'd say there are obvious dangers with the use of DC rather than AC current" (Mechanical Engineer).

- “They [developers] are completely carbon focused. They don’t consider the difference between AC and DC… There is new research into delivering direct current … I think traditionally it couldn’t be delivered well over long distances… and now they’ve come up with a new technology that can deliver DC over long distances… But clients [developers] wouldn’t look at that and consider that… they don’t think about the advantages of that… There has been a big change to reduce electrical loads, so we have been using a lot of LEDs in communal areas in flats… so they are thinking about reducing the use of electricity” (Chartered Building Surveyor).

- The interviewees' perceptions about the use of DC in the residential sector are rather negative, as it would require additional work and costs for them. They also have a concern over safety in using DC. Developers want to focus on and deal with reducing carbon emissions and electrical demand, rather than provide for an increase in electrical loads.

(2) Existing infrastructures – engineers are exploring the capacity of cables to handle different voltages (e.g. stress tolerance)

- "They (the cables) have a certain capacity that's already in the ground… you know that the level of capacity required in that neighbourhood is going to be much higher. And it is largely controlled through the local substation and delivery to the substation… And if that supply to the substation is inadequate and they need to upgrade it, it comes at a hell of a cost… So you know, it's just a simple financial evaluation, really" (Head of Construction, Social Housing Association).

- Although this theme is about exploring the potential of cables to handle different voltages, the interviewees interpret the improvement of existing infrastructures as a concern with ‘how much it might cost’.

(3) Power quality – engineers are examining power quality in the distribution system before it gets to the 'end user', as relaxing voltage can affect power quality

- Most interviewees *did not understan*d what the term 'power quality' referred to, as it was seen as *irrelevant* to their normal working practices of housing development and design.
- "We haven't really ever experienced quality issues. In a domestic setting a lot of our equipment we use is quite robust, so it doesn't need fine, good quality power" (electrical engineer).
- "I would hope that we are moving towards a scenario that's decreasing [electrical loads] with Building Regulations changing all the time. So I don't anticipate that [power quality issues] being an issue (Electrical Engineer).

- Power quality is an unfamiliar topic for the interviewees, except for the electrical engineer, and they found it difficult to respond to and comment on our questions. They work to comply with building regulations. For most, this is where their thinking about electrical provision and demand ends, as they have had limited experience of bad power supply issues in developing residential housing.

(4) Future electrical loads – engineers create an 'electrical demand profile' by examining future electrical demand to understand how a voltage network may operate in future

- "In Ealing we allowed for a number of electric car charging points… we didn't know what the demand would be… I think it's really hard with a project of this scale… it will be 15 years of construction before the first spade goes in the ground, before the final bits are finished. How do you kind of 'future proof' something and allow for all of these changing and emerging technologies to be incorporated?" (Architect).

- “Our general policy would be to build to building regulation standards… We wouldn’t bother with that [future electrical loads] really” (Head of Construction, Social Housing Association).
- “We would go along with the building regulations… largely though thermal insulation standards… One would start with the ‘fabric first’ approach, so using the fabric of the building… to provide the easiest route to meeting those standards” (Head of Construction, Social Housing Association).

- For the housing professionals, understanding and calculating future electrical loads into housing design is not part of their work. They think that future loads are unpredictable because of rapidly developing new technologies; they are more concerned about complying with current building regulations.

Conclusions

- Construction methods that aid insulation and air tightness are more popular than complex approaches such as AC-DC conversion and voltage relaxation.
- Power quality, and future electrical loads, are not really considered, as improvements are seen in a reduction in electrical loads with the requirement for LED lighting in new builds.
- Interviewees do not consider future electrical demand and loads, as their focus is on a present concern of developing for the minimum cost.

- Only a select few of the interviewed housing professionals felt confident to comment on the issues/approaches identified by project engineers.
  - Predominantly, these were professional actors who had a background in either mechanical or electrical engineering.
  - Presenting the issues/approaches identified by engineers thus demanded of the interviewees a similar expertise to be able to respond

Implications

1. Engineers in the last-mile power delivery need to engage with potential users and communicate the needs and advantages of the solutions they are offering.
    - Public seminars, consultations and articles in trade magazines could provide users with familiarity and awareness
2. Policy makers could incorporate the element regarding future electrical loads into building regulations.
    - Users are anxious to comply with building regulations/ requirements of local planning agencies.
    - Government/local authorities need to create a strong message to make users aware of issues of future electrical loads and convince them that energy efficiency measures alone might not be enough.

3. Engineers who wish to transform current electricity systems

need to consider potential users' practices and contexts in order to better understand how issues concerning electrical provision and demand are approached by those users.

- This way engineering solutions to highly technical issues, or the 'last-mile' innovations, could incorporate a good understanding of varied knowledge and working practices of potential users.

Thank you!

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