Reducing plug-load electricity footprint of residential buildings through low cost, non-intrusive sub-metering and personalized feedback technology

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Columbia University (in collaboration with Lucid©)
Prof. P. Culligan, Civil Eng. & Co-Director Data Science Institute

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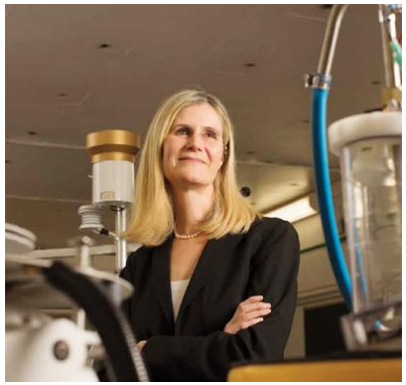

- **Prof. Patricia Culligan (PI)**
  Distributed solutions for sustainable cities
  Focus in this project: Metering & social science aspects of feedback
- **Prof. Kathleen McKeown (co-PI)**
  Natural Language processing
  Focus in this project: Automatically generated personalized feedback with visuals and text
- **Dr. Christoph Meinrenken (co-PI)**
  Low carbon energy systems
  Focus in this project: Load-disaggregation scheme and load optimization vis-à-vis NYCity tariffs
- **Dr. Ali Mehmani (co-PI)**
  Controls and optimization
  Focus in this project: Algorithms for load disaggregation and design of publicly available database
- **Lucid (corporate partner)**
  "BuildingOS" and tenant engagement
  Focus in this project: Online tenant feedback platform; market insights

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Feedback on residential consumption has been shown effective in modifying consumption behavior …
… but jury is till out on what type of feedback works best on what demographic

… so what if:

- Feedback could be **personalized** to improve effectiveness (above and beyond the current ~30% benchmark)
- Feedback could include **appliance level info** (stove, WindowAC, etc.) to squeeze out additional effectiveness reported in previous pilot studies
- The overall system could be **low-cost, non-intrusive**, and designed for maximum customer engagement
- The feedback would encourage not only overall **reduction** in electricity consumption but also **load-shifting** to consider regional grid constraints, e.g. in order to facilitate more renewables
- Financial and environmental **benefits could be quantified** for each tenant
- … as well as aggregated for **building operators** or local municipalities to show overall value (net of equipment cost) and payback times
- **A public database** was available of hundreds of electricity consumption patterns in multi-family housing, covering multiple years, and including appliance level information

→ **Overarching idea: Bringing CPS-type smart building and grid resilience capabilities to the residential sector**

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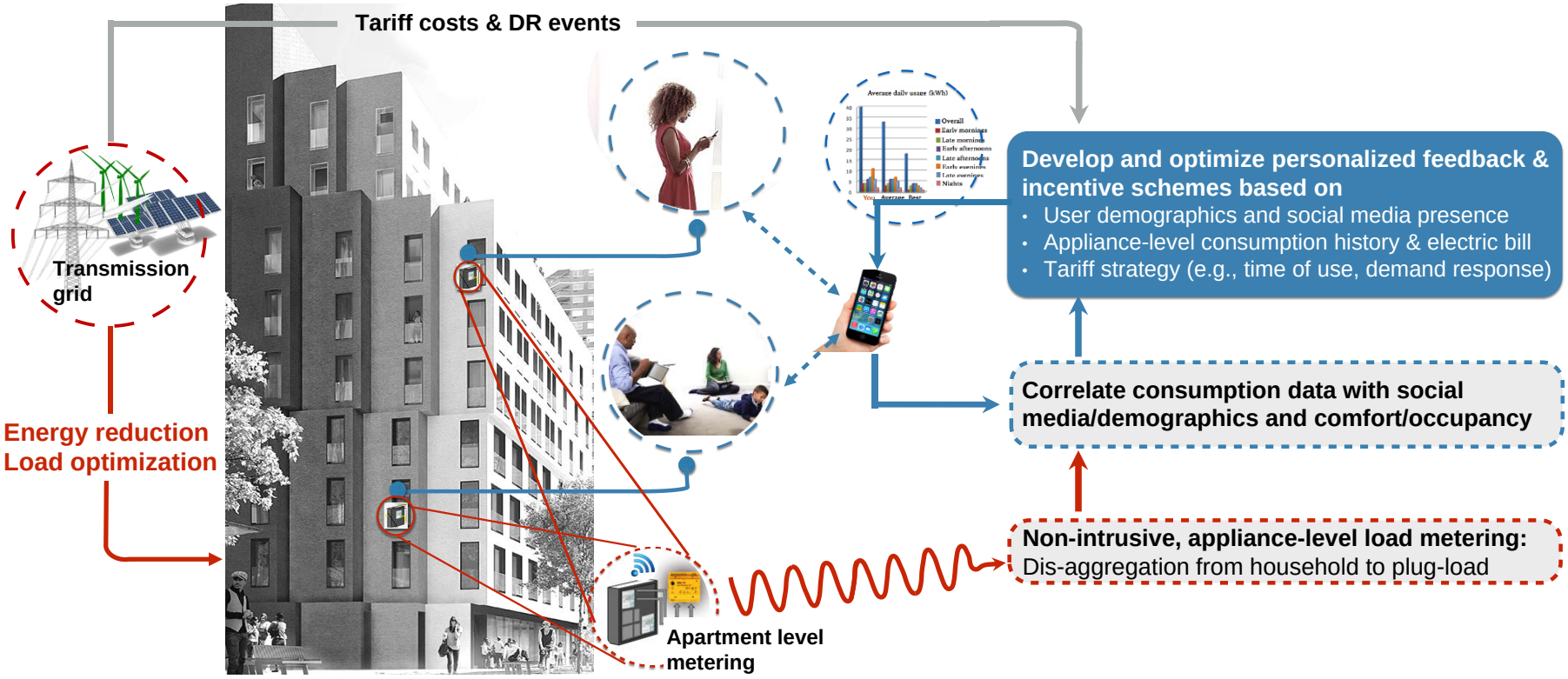
Schematic of Technology Solution



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Advantages, Differentiation, and Impact:

- **First of its kind size and type of study**: ~300 apartments in multi-family housing
- Non-intrusive load metering (**NILM**): Disaggregation to appliance level unlocks additional effectiveness with minimal cost to consumer or nuisance in installation
- **Personalized, targeted feedback**: We will test a variety of feedback types against multiple socio-demographic markers → rich dataset
- **Reduction and load-shifting** of consumption can be directly quantified in $ terms for consumers and grid stability benefits
- Beyond our own analysis of the data, the project will make the **unique dataset** available to the general public (24/7 consumption profiles incl. demographic and feedback tags)
- Corporate partner **Lucid** will inject market knowhow and accelerate **path to commercialization**

→ **Open up multi-family residential sector to contribute to wider smart grid initiatives**

Thank You

Columbia University & Lucid

PI Patricia Culligan