CALFLEXHUB SYMPOSIUM

SEPTEMBER 24 | 8am-6pm PT

SARAH SMITH

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CALFLEXHUB RESEARCH SPOTLIGHTS

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2024

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STATE OF CALIFORNIA ENERGY COMMISSION

MOMENTUM

Technology Usability Assessments: Keeping Users in the Loop with "Invisible" Technologies

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CalFlexHub

UCDAVIS
Market Transformation
Research Program

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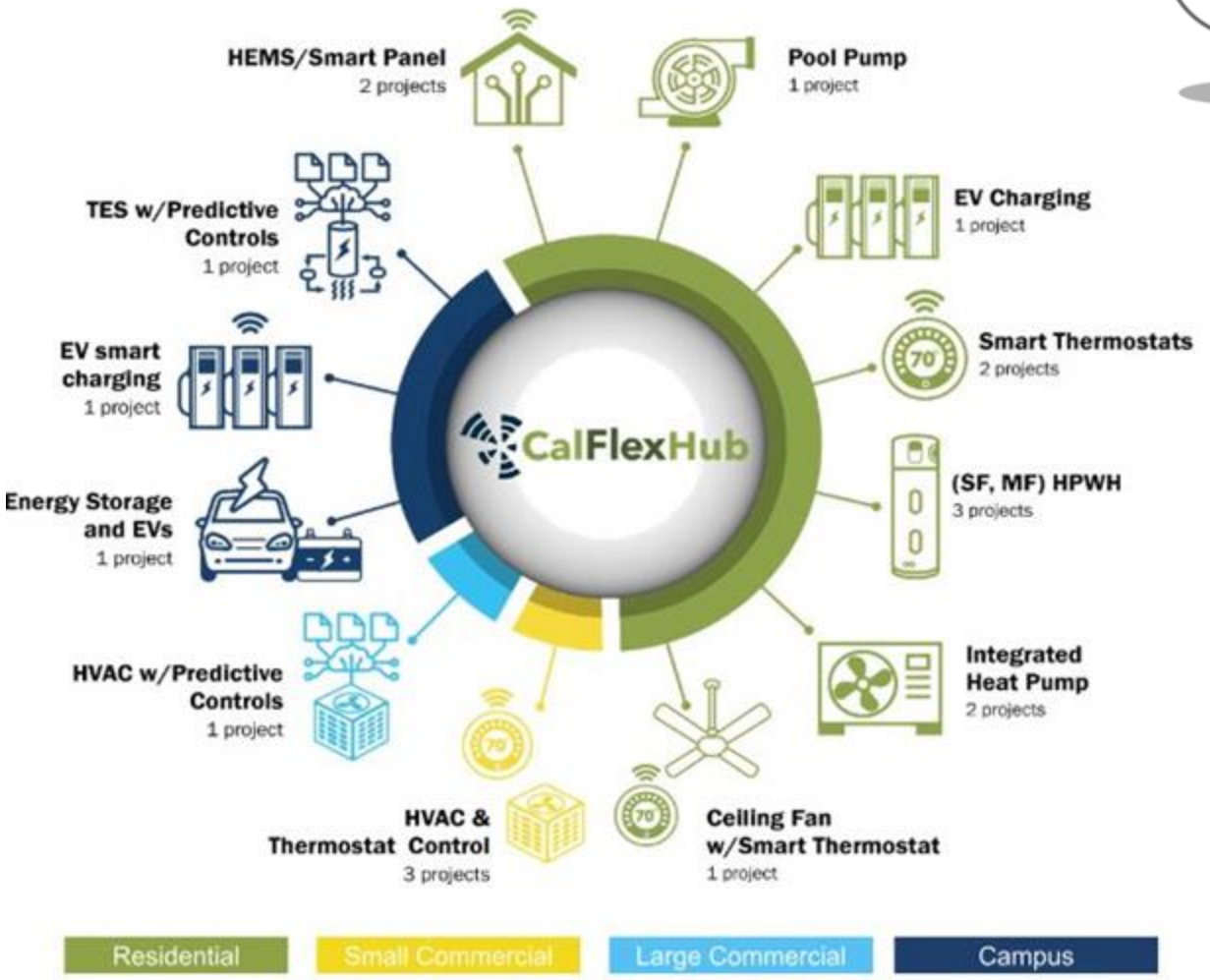
Background: CalFlexHub

- CA aiming for 3,000 MW of load flexibility from price response by 2030
- Hourly (or sub-hourly) electricity prices will be made available
- Automated load flexible devices



CalFlexHub User Assessments

Identify Users

- Residents
- Occupants
- Operators
- Installers
- Facility managers

Interview Users

- 45-60 min
- Incentivized (some)
- Zoom
- Recorded & transcribed

Assess

- Case by case
- Cross-cutting
- Thematic analysis

Interview Questions

- User experience
  - Onboarding/orientation to load flexibility (LF); equipment setup
  - Advance notifications of LF operations
  - LF operations
    - Perceived changes in operations/services
    - User interactions with interfaces/equipment
    - Energy and non-energy impacts
- Participation motivations and satisfaction with new equipment/operations

Assessments Conducted to Date

Technology	Sector: Field site	Technology readiness level	Interviews
Smart thermostats	Res: 50 CA homes	8	10
Integrated heat pump for water heating/space conditioning w/storage	Res: 1 home	5	2
Model Predictive Control (MPC) of chillers	Inst: CA university central plant	6	4
Home heating and hot water thermal battery system	Res: 2 homes	7	2
Model Predictive Control of rooftop HVAC	Inst: CA university campus building	(not given, low)	4
120 volt heat pump water heater	Res: 10 homes	(not given)	8

Limitations and Challenges

Goal: Study user experience with dynamic load flexibility given…

- Developing technologies
- Hypothetical price signals
- Convenience sampling
- Small sample sizes

Takeaways

Design interfaces to support key user interactions

Provide feedback to users about load flexibility impacts

Consider and track unintended consequences

User interfaces

Design interfaces to support key user interactions

Lessons from MPC of campus chillers

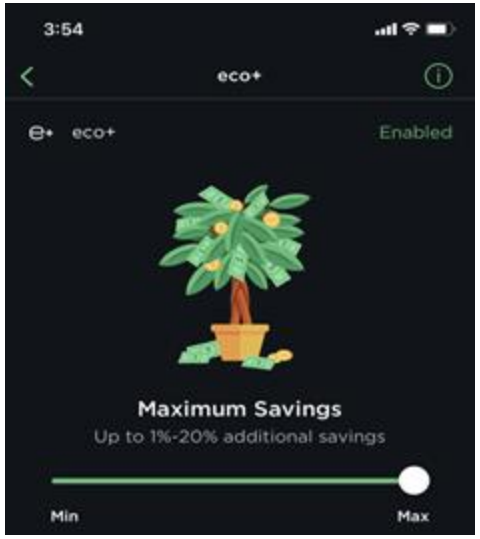
- Include a kill switch!
- Create predictability as needed

User interfaces

Design interfaces to support key user interactions

Lessons from smart thermostats

- Consider baseline control strategies
- Communicate control affordances

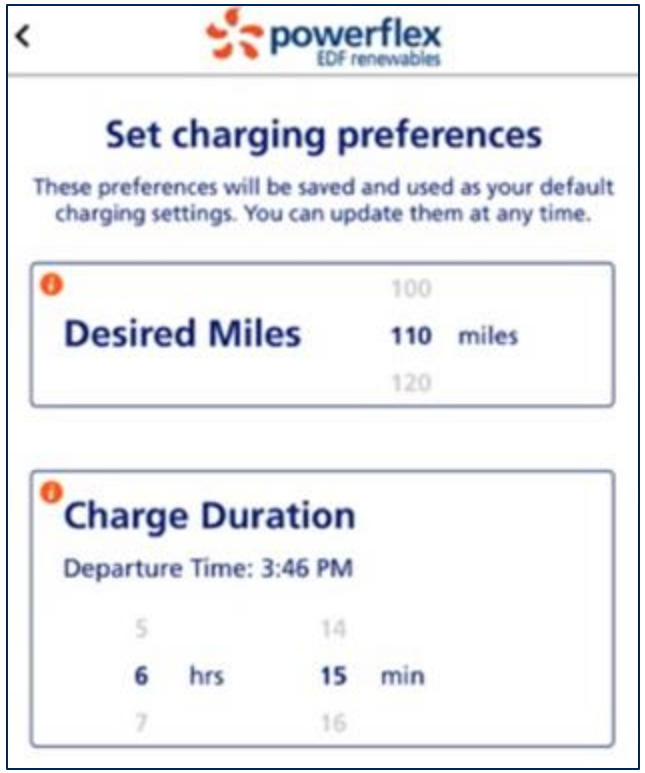


See: Stopps, H., & Touchie, M. F. (2021). Residential smart thermostat use: An exploration of thermostat programming, environmental attitudes, and the influence of smart controls on energy savings. *Energy and Buildings*

User interfaces

Design interfaces to support key user interactions

Lessons from EV charging



We confirm that there were no impacts on customer feedback and no complaints during the EV load flexibility tests at [the university]. **-Powerflex**

See: Will, C., & Schuller, A. (2016). Understanding user acceptance factors of electric vehicle smart charging. Transportation Research Part C

Feedback

Provide feedback to users about LF impacts

I'm curious how much it would actually impact our total grid demand. **-Central plant operator**

Content

- Substantiate the value proposition
- Energy bill savings
- GHG emissions averted
- Collective impact on local community

Channel

- OEMs through user interfaces
- Program providers through communications

If there was an obvious thing in the phone or the the wall screen that said, 'You have saved this much by being in this program'... that'd be interesting." **-Smart Thermostat User**

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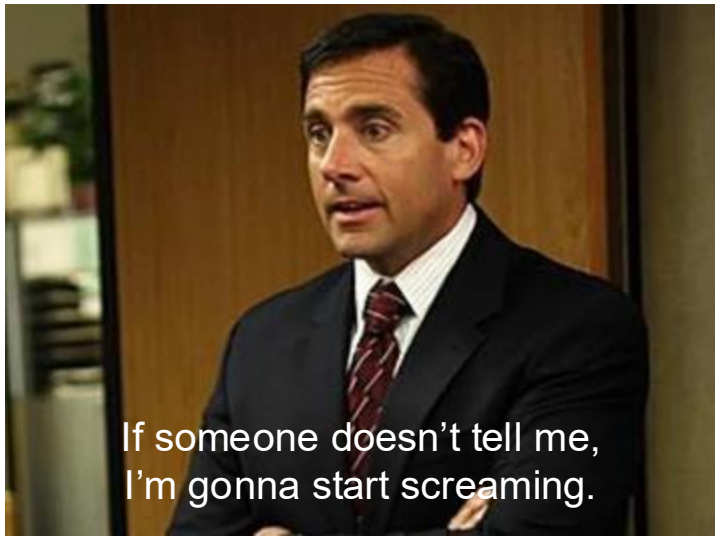
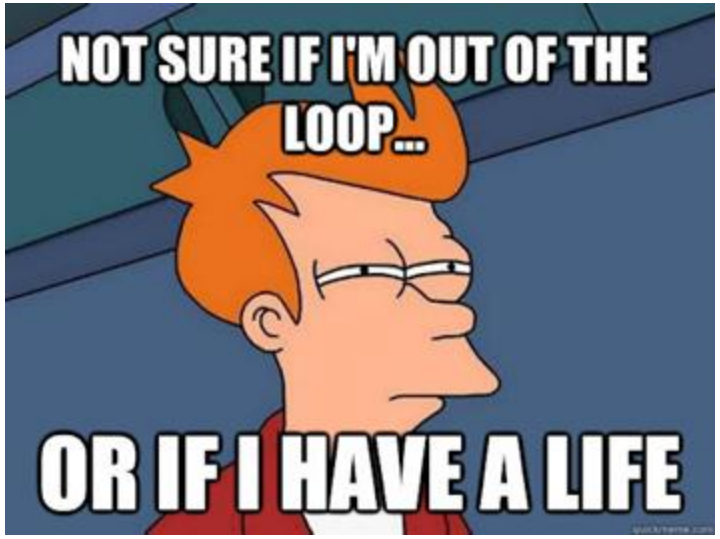
A note on user preferences and engagement

- They vary widely and can be contradictory



"I would like to see my usage when the system goes on and goes off, how much energy is being used… adjust the water temperature, obviously, or maybe even override my thermostat temperature remotely if necessary."

"I just have other things that concern me more than technological details, I guess is what I would say."

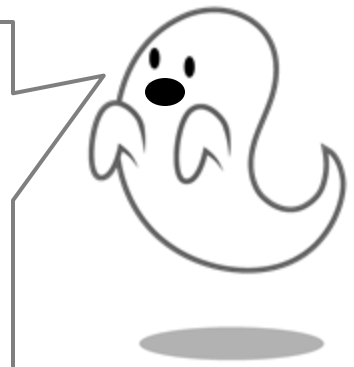


Unintended consequences

Consider and track unintended consequences

- **Behavioral adaptations**
- **Thermal comfort impacts of wider temperature ranges**
- **Noise**
- **Perceived control**

It was a lot more stressful than my normal day-to-day… It's stressful when someone else is running your equipment from somewhere else. If it all breaks down, are we just going to tell everyone it was an algorithm's fault?" **-Plant Operator**



What's next?

- More user assessments
- Integrate findings with wider literature on user experiences with demand response

Thank you, and thanks to coauthors:

Eli Alston-Stepnitz, Sarah Outcault, Margaret Taylor

Questions?

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