A Plug Load View of Electrification




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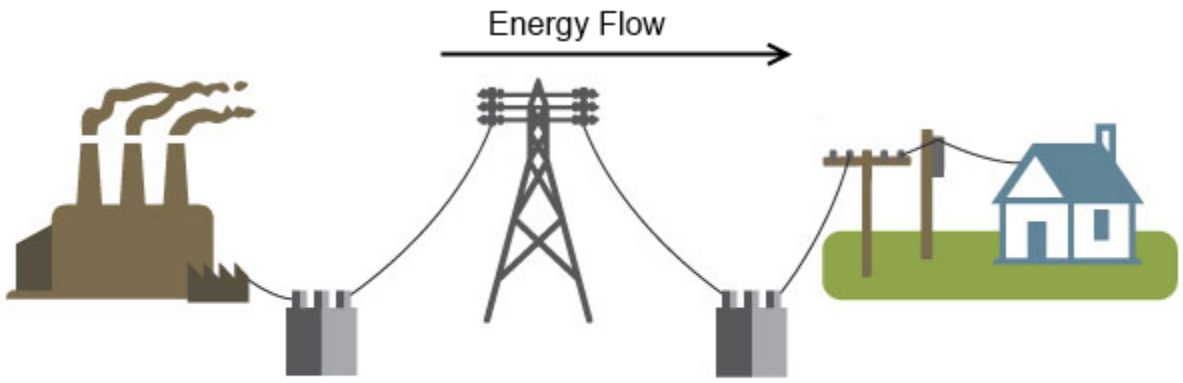
New Power Plays



Source: Adapted from National Energy Education Development Project (public domain)

Old Paradigm

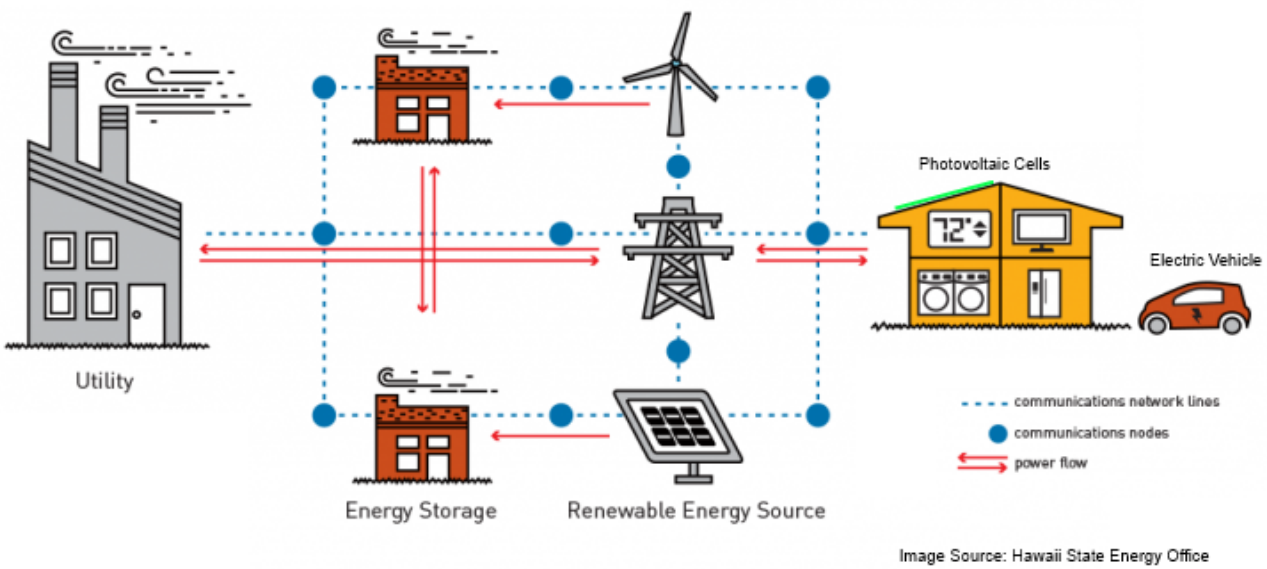
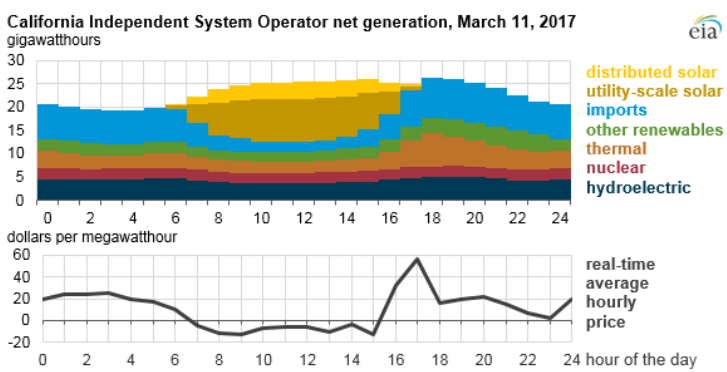


Image Source: Hawaii State Energy Office

New Paradigm

(all new homes in 2020 must have solar in California)



A Dynamic Equilibrium

Operational Considerations:

- Supply/demand matching
- Spot price considerations
- Peak Demand /Capacity
- Phase balancing
- Dispatachability/Regularity
- Campus/Micro-grid Integ.
- Energy trading

How can connected coordination manage these factors?

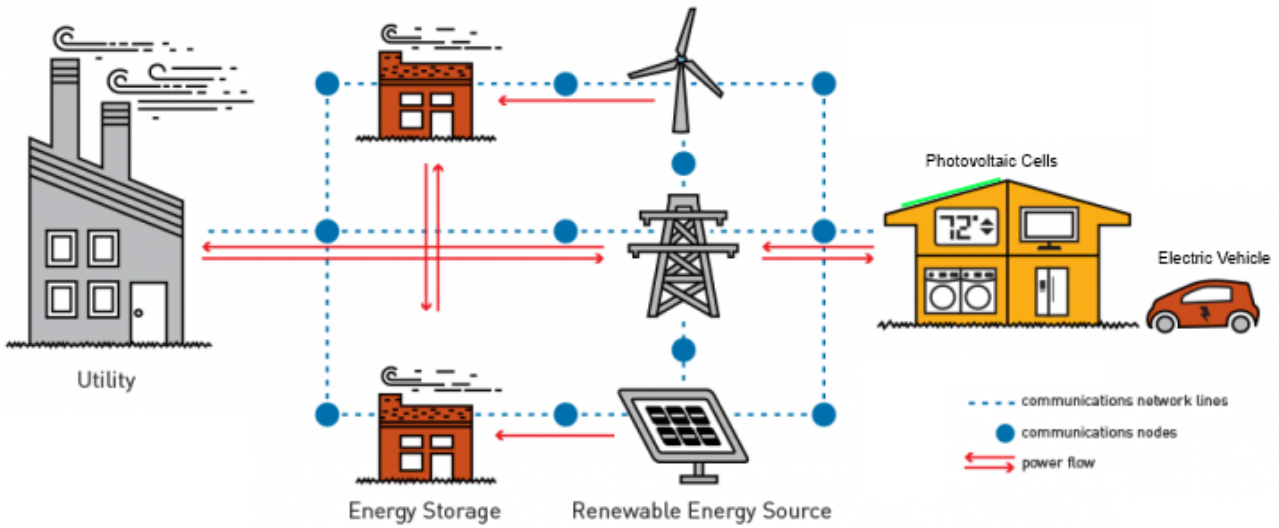
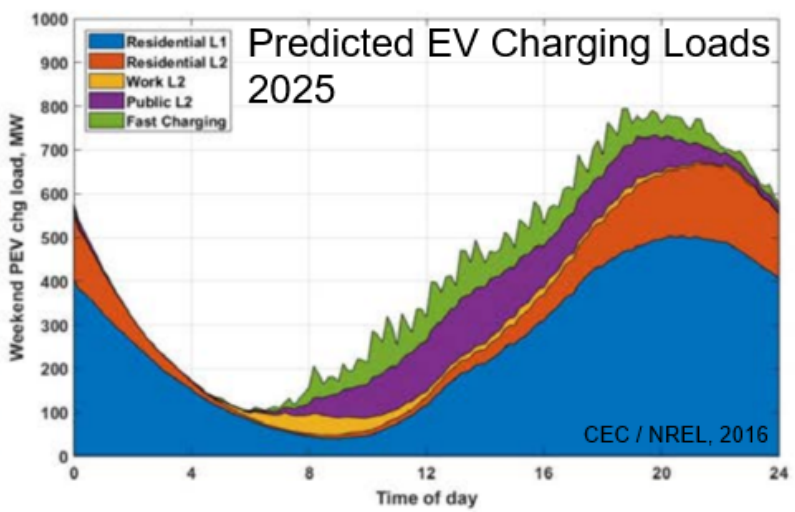
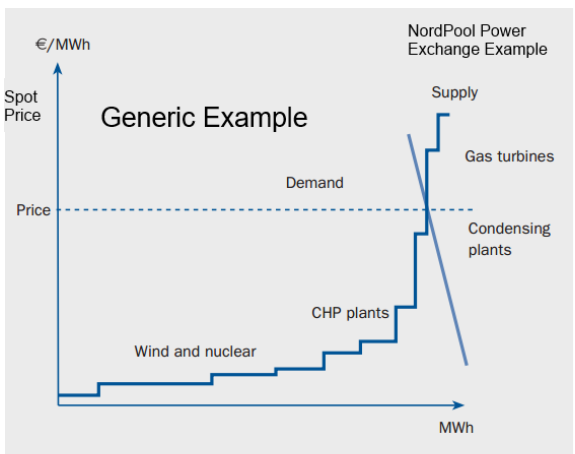
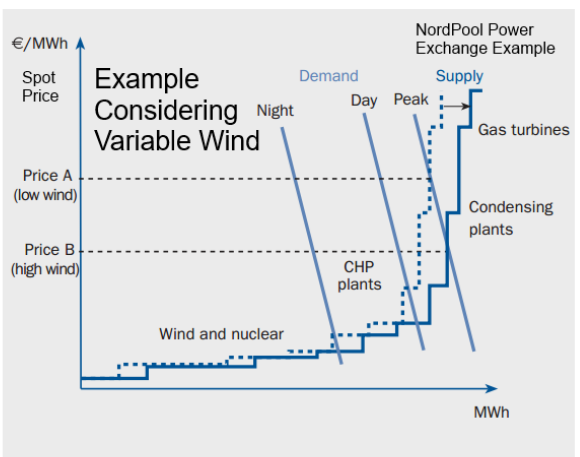


Image Source: Hawaii State Energy Office

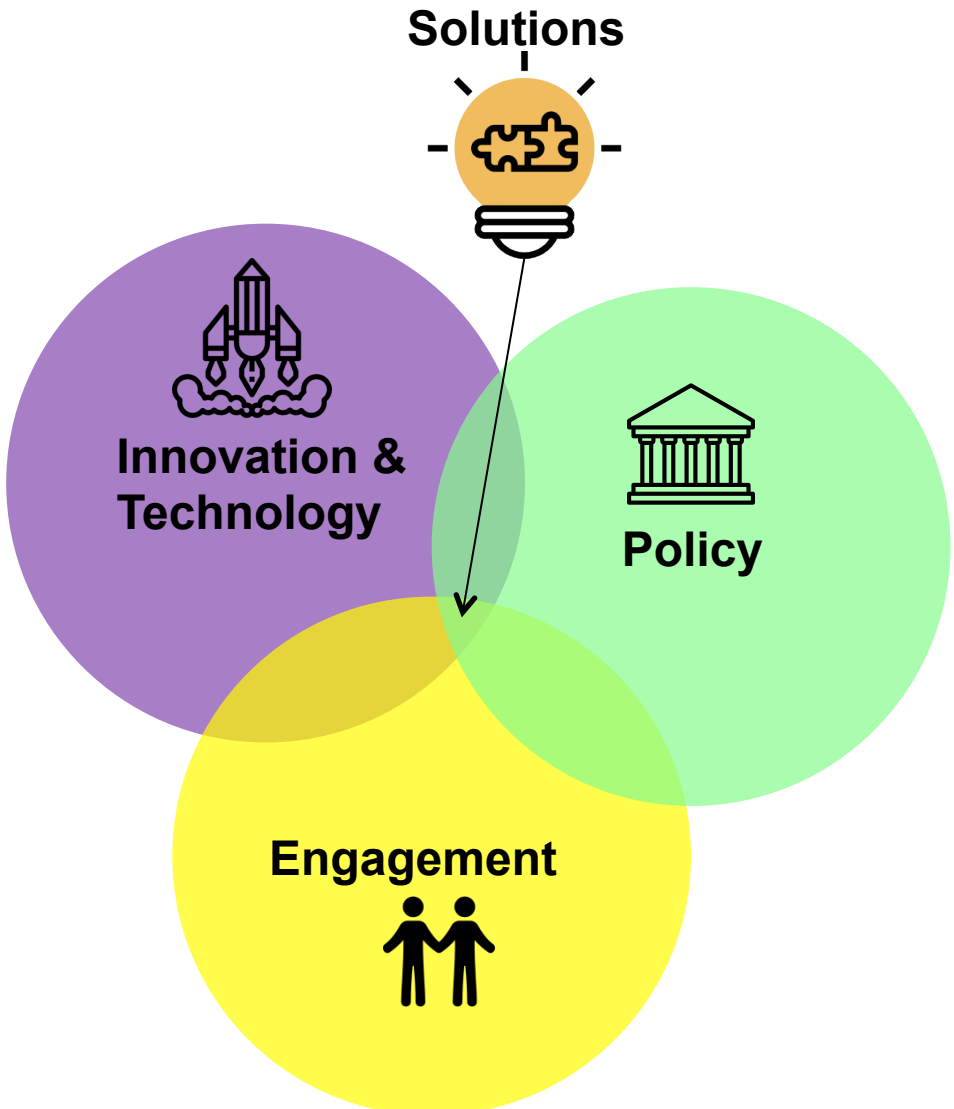




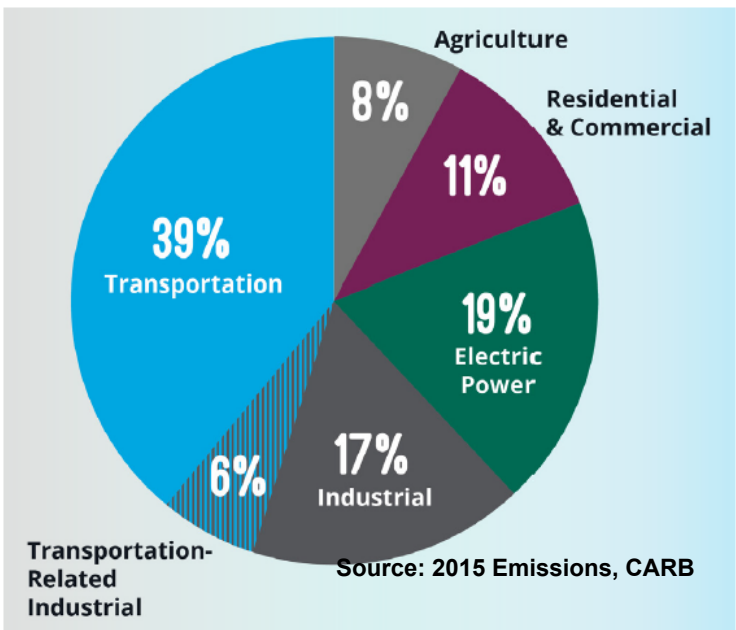


Source: Risø DTU

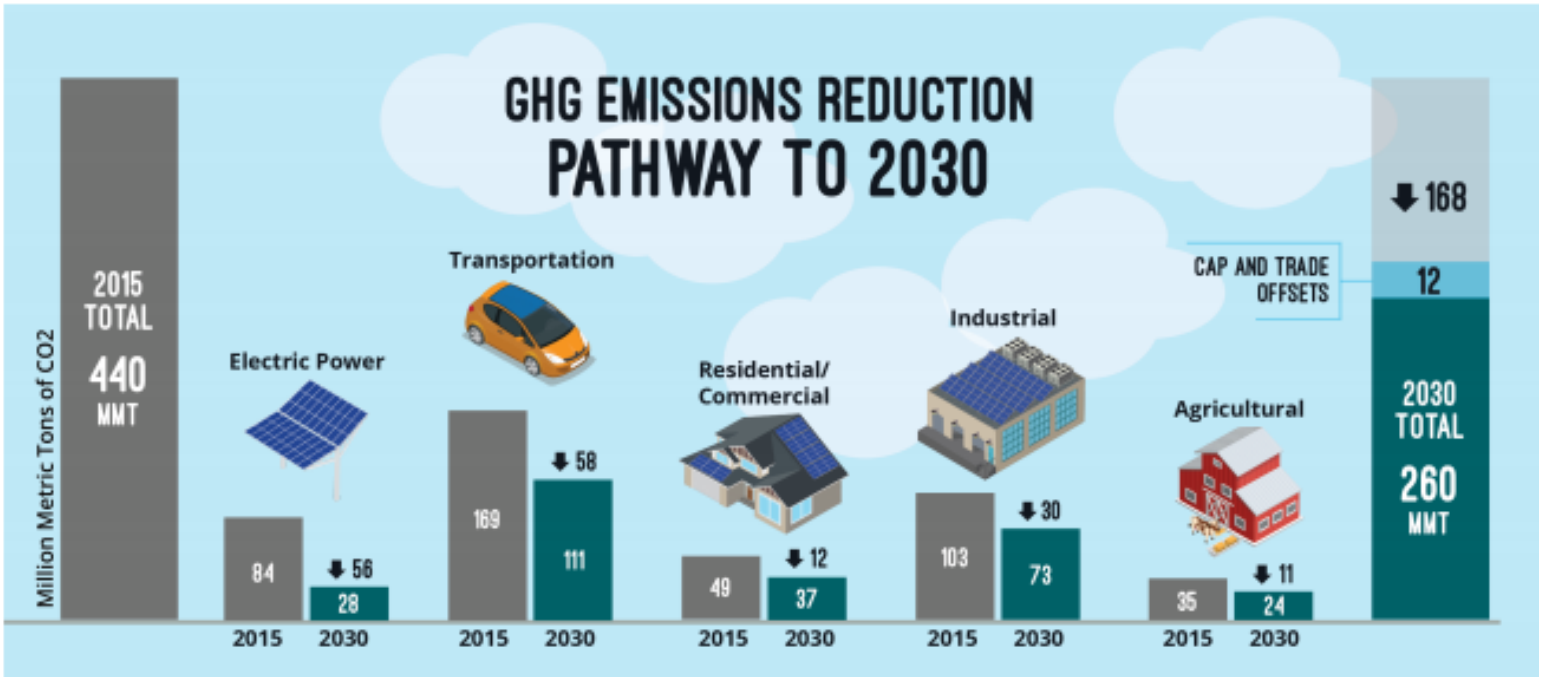
Tackling BIG Problems: Electrification



- Coupled goals, multiple pathways:
  - Reduce GHG emissions
  - Localized Pollution
  - Energy Sustainability
  - Energy Independence
- Effort across multiple industries
- Electricity as a flexible energy carrying medium



GHG Reduction Electrification Pathway



A GHG reduction plan using electrification for 2030:

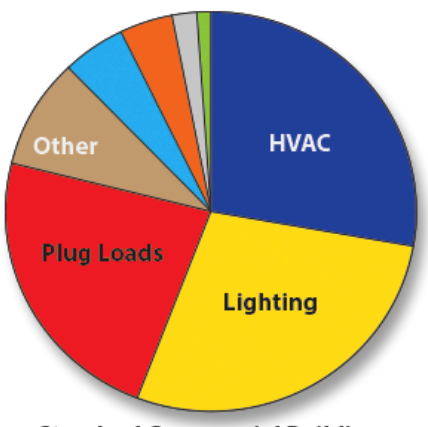
- **Decarbonize the electricity sector (80% carbon free)**
- **Electrify the transportation sector (24% light-duty vehicles electric)**
- **Electrify Buildings (30% efficient electrification in space/water heating)**
- **Continued energy efficiency targets**

Data/Image Source: SCE Clean Power And Electrification Pathway, 2017

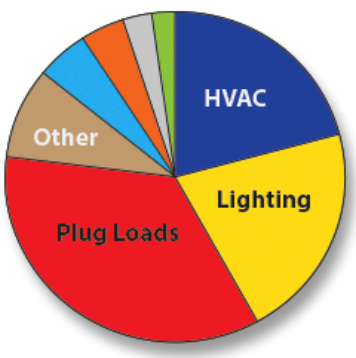
A Plug Load Duality in Electrification

1) Addressing total savings (and time of savings!) in devices, consumer electronics, and plug loads

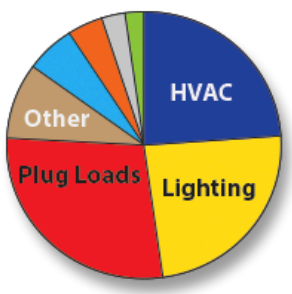
2) Use study of plug loads/consumer electronics as a paradigm for advanced grid management - Users very sensitive to how they live, work, and play.



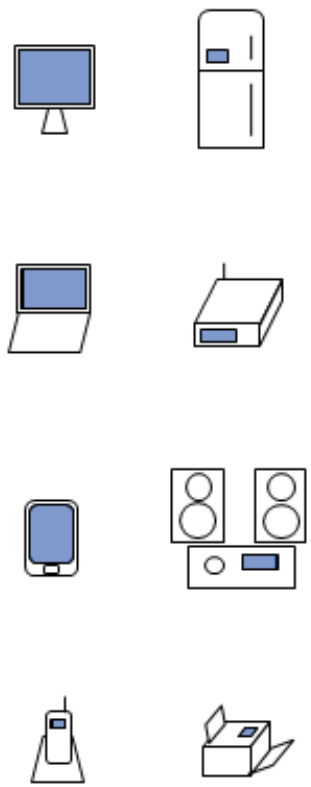
Standard Commercial Building



Standard Commercial Building
High Efficiency Design
~50% Below Standard



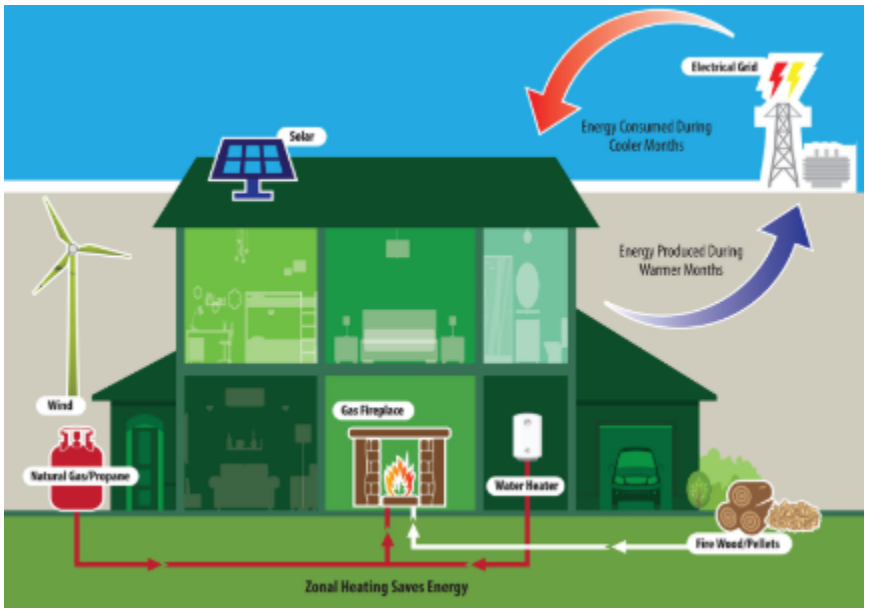
Standard Commercial Building
High Efficiency Design
+
Optimized Plug Loads
~60% Below Standard



Building Based Efforts

The 5 R's of Economical Zero Net Energy (ZNE)

1. **Reduce** - ***Reduce structure on-peak demands followed by total demand***
2. **Replace**- ***Generate energy to offset building use, fuel switching***
3. **Relocate** - ***Generation in a community can be shifted between bldgs.***
4. **Retain** - ***Energy storage***
5. **Reevaluate** – **Verify the balance and stability of a dynamic equilibrium**



Electric Vehicle

Heat Pump W/H

Ductless Heat Pump

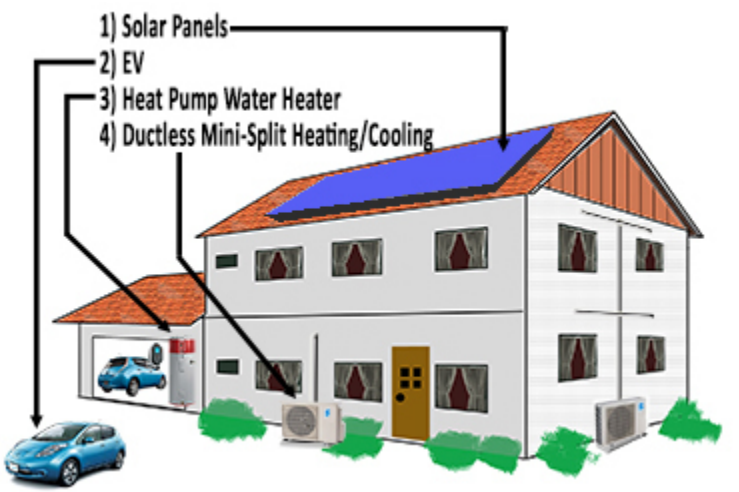


Figure Source: HPBA, netzeromadesimple.com

Device savings strategies with controllability

More Interactivity/Safety





- The classics: HVAC, Water Heating
- The strugglers: Major appliances, lighting
- The newcomers: Electric Vehicles, personal device charging
- The "be carefuls": STBs, Security, Refrigeration, in use AV equipment/game consoles, in use computers and computer accessories


Consider both "Heavy Touch" and "Light Touch" approaches


Key solution adoption factors:

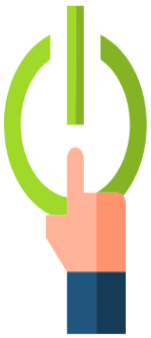
- Provide accessible and easy to use integrated solutions (shared operation)
- Do not reduce utility, reduce wasteful operation

Image Sources: flaticon.com

Improving Engagement of Managed Devices

Interacting with users to control demand:

- **Light Touch - (Passive Targeting): Notification, behavior encouragement, EE measures focused on peak load reduction via cost motivation mechanism (assuming TOU rates).**
- **Heavy Touch - (Active Targeting): Notification, external direct control, local managed control with reporting or locally managed control with triggering, use curtailment.**



Specific device usability considerations

1. Prevent disruption or degradation of user experience, especially with no warning or opt-out control.
2. Prevent complication of user's normal routine without substantial, clear value added while not compromising the inherent image of reliability and quality.
3. Prevent user confusion by expected and clear operation with intuitive operation and small operation learning curve.
4. EASY TO USE Require little to no maintenance for continued use, resilient in operation.
5. Respect users' privacy, wishes / intentions, and data security.
6. With external controls: Target devices with multiple operational states with periods of waste to target: either via cutout, state shifting, or throttling with high load reduction potential to offset cost of controllability.
7. Avoid frustrating, confusing or unintentionally mis-training users of typical/logical device operation.

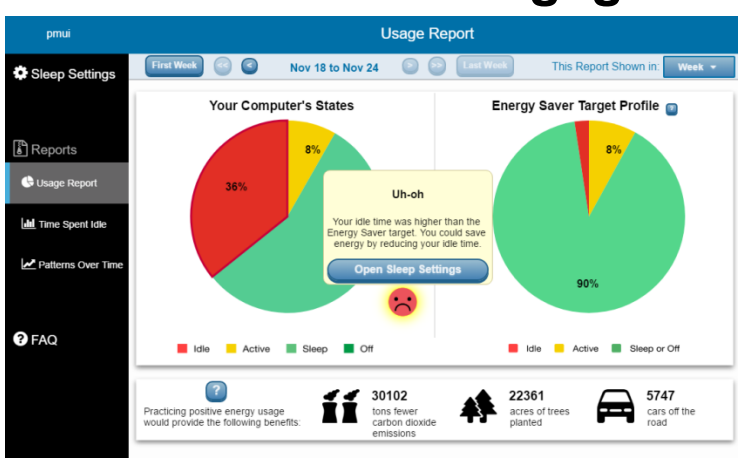
Clear Actionability of information provided

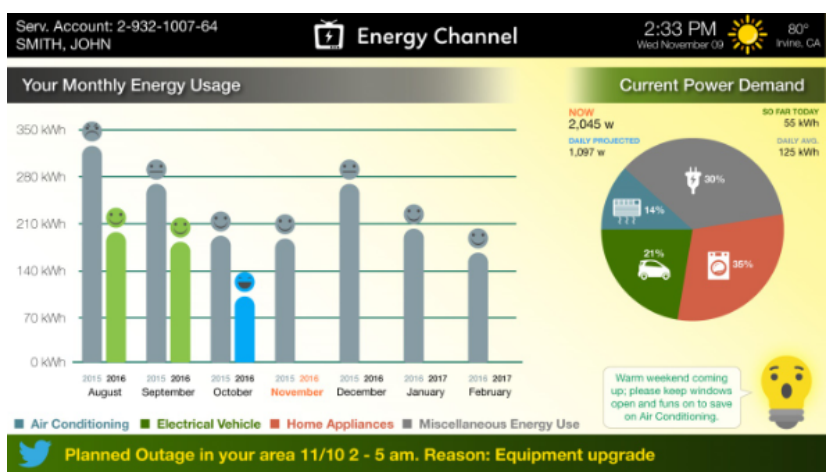
1. *Clear notification of the user of information and direction toward corrective steps to be taken. Gamification strategies can also be used.*

2. *For automated events, ability to opt out on an event basis to avoid interruption – consideration for multiple users.*

3. **Provide external information to empower decisions proactively or prime for reactive efforts.**

4. **Interaction with the local utility – source for rebates and information, and a means to reengage a relationship.**





Final Thoughts

- **Electrification solutions are integrated and multidisciplinary – stakeholder engagement is key.**
- **Consumer electronics (plug loads) can serve as a model of consumer engagement and solution design for acceptance.**
- **User acceptance and the impact on how they live, work, and play must be considered for long-term wide-scale solution adoption.**
- **Connectivity and improved analysis with AI can allow deeper savings in integrated energy controls. Automation also has an impact. Solutions still being explored. Data collection and analysis powers the solutions of today and tomorrow.**

Thank You!