# Using the Cloud to Manage Energy-Related Services

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# Delivering Energy Services Through the Web: California's Experiences

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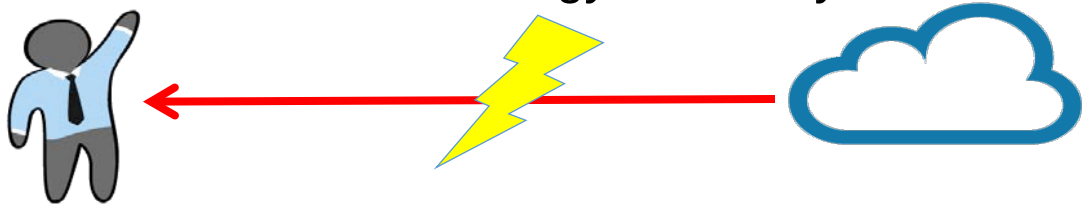
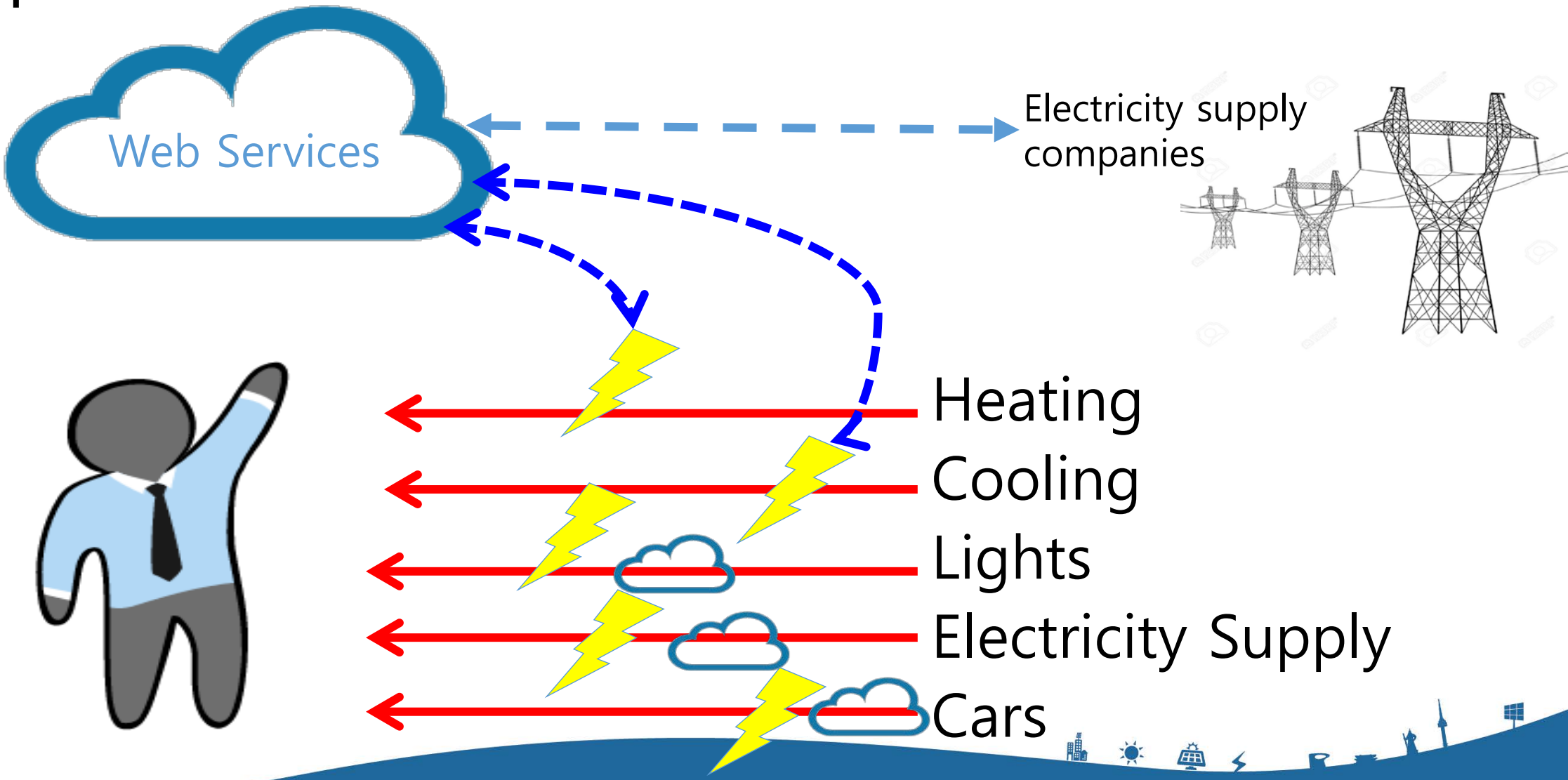
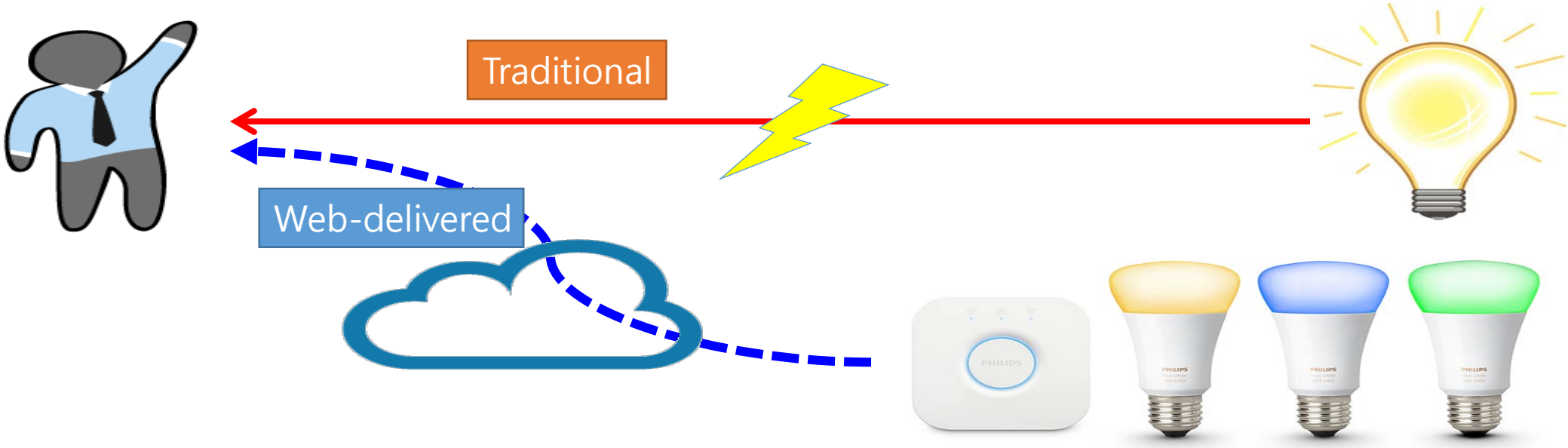


# New Web Services Insert Themselves Between Traditional Appliances and Occupants



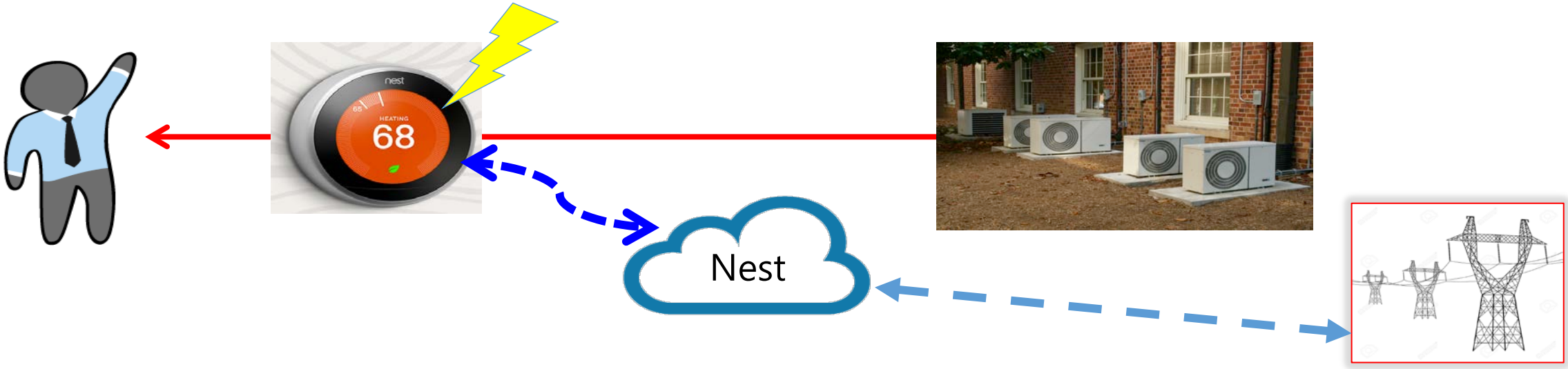
# Lighting Services



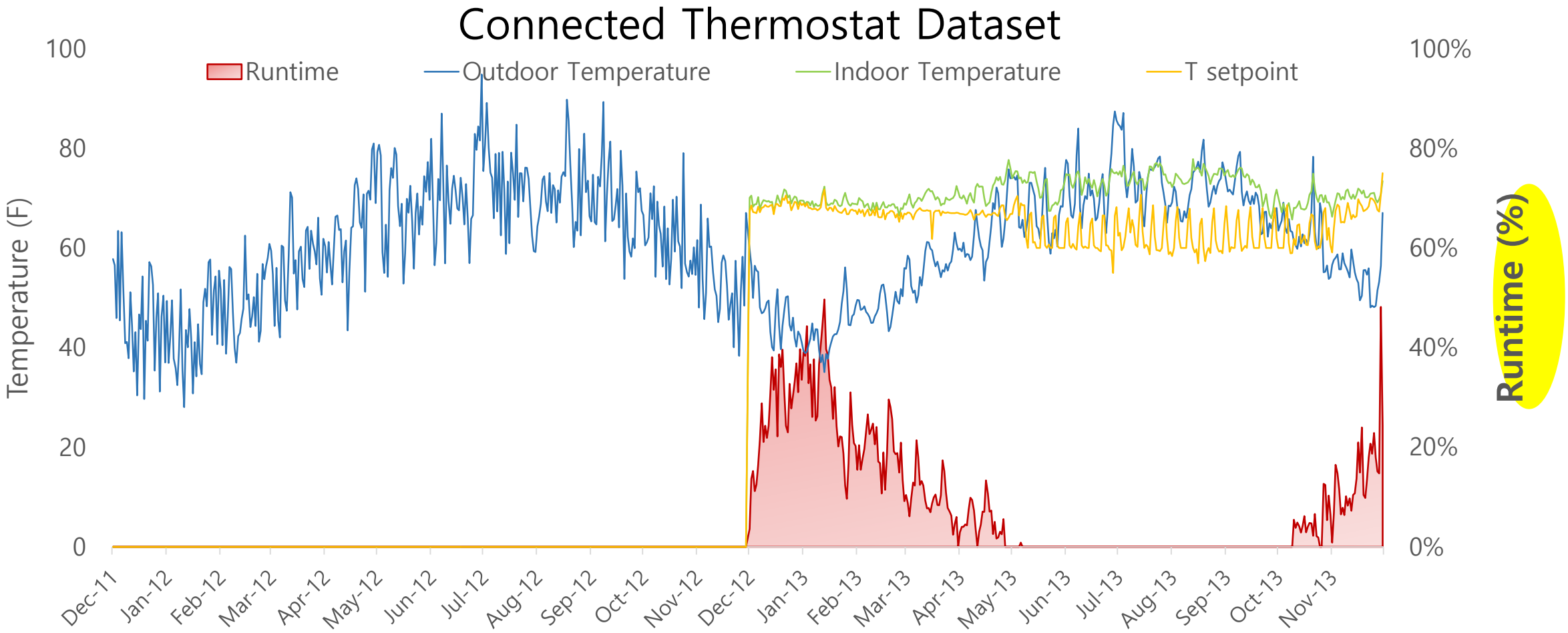

- Cloud-managed lighting usually saves electricity
- Cloud-managed lighting provide new services, such as “biologically-effective” lighting, which someti mes make people more productive or comfortable
- Newest lighting systems use Ethernet cables to exchange data and to supply power

# Internet-Connected Thermostats Deliver Thermal Comfort

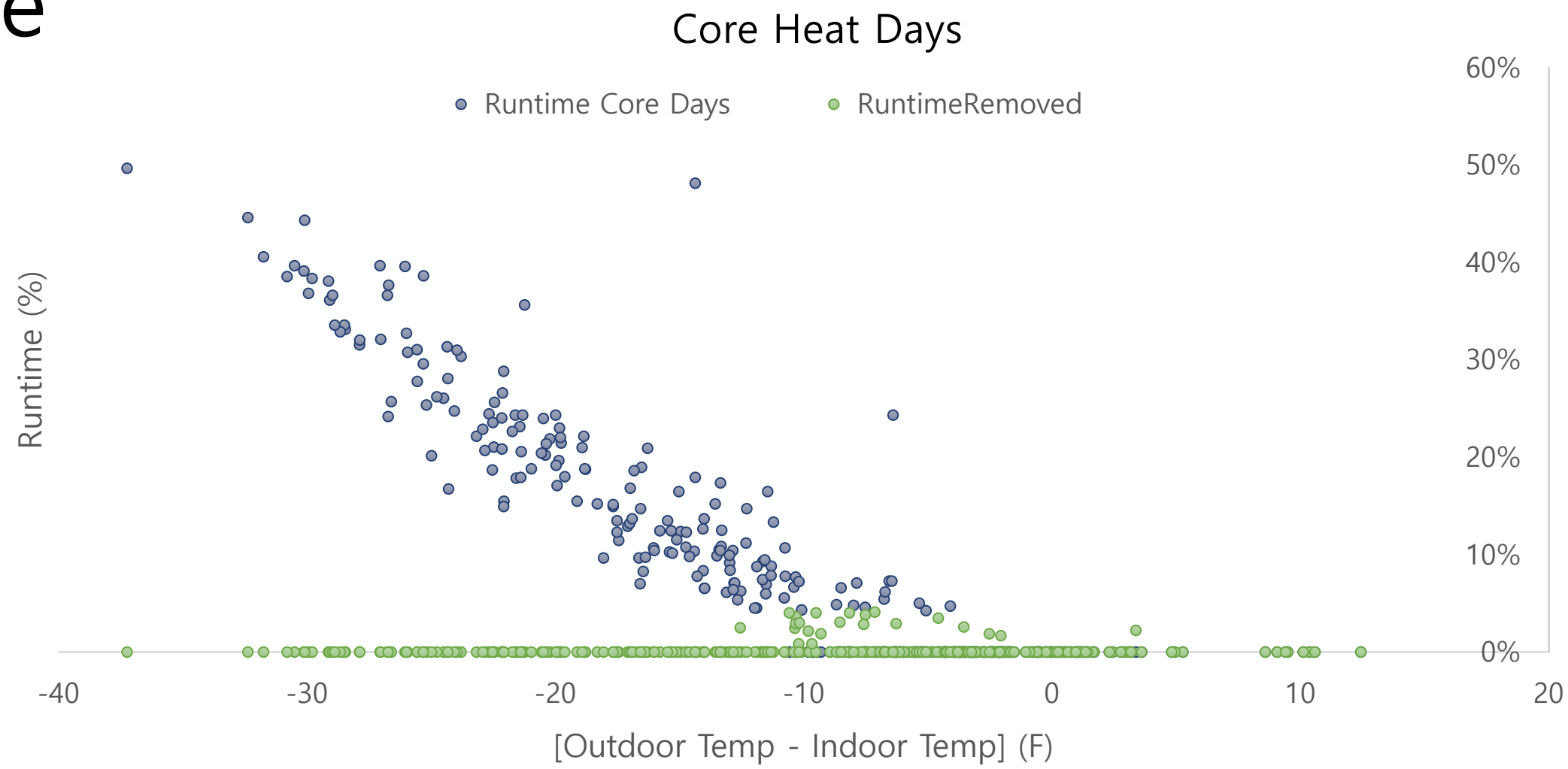
- The thermostats learn your schedule, notice if you are present, and use a cloud-based thermal model of your home to minimize heating and cooling energy.
- Heating and AC energy savings: 0 – 15%
- Already in 6 million homes and increasing 20% per year
- Millions of thermostats are linked to utilities to provide reductions in peak demand

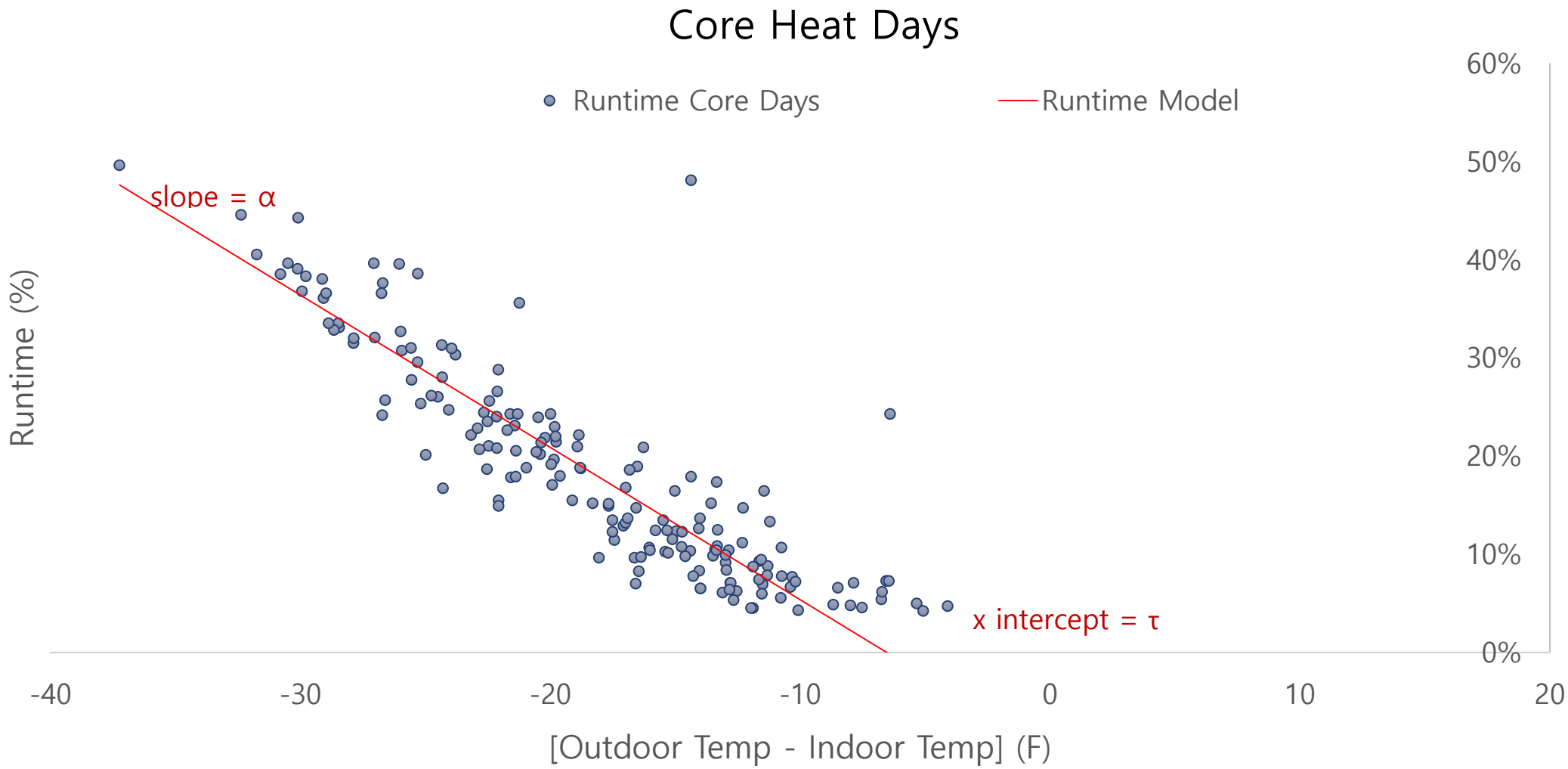


# Connected Thermostat data

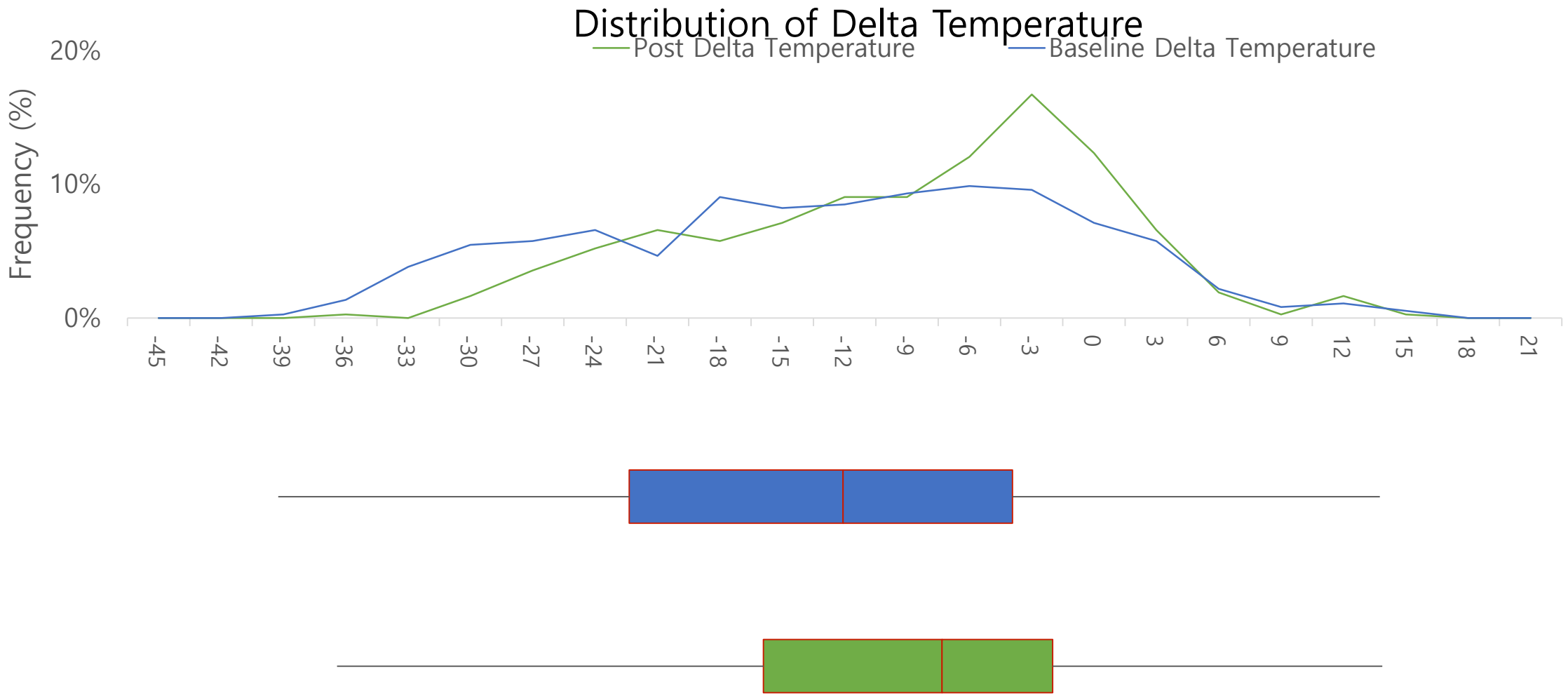


# Building a Thermal Model for Each Home




Core Heat Days
Runtime Core Days
Runtime Model
slope = α
x intercept = τ
Runtime (%)
60%
50%
40%
30%
20%
10%
0%
-40
-30
-20
-10
0
10
20
[Outdoor Temp - Indoor Temp] (F)

# Cloud Management Changed the Temperatures



PERSONALIZED CONTROL OF WORKPLACE COMFORT

Comfy

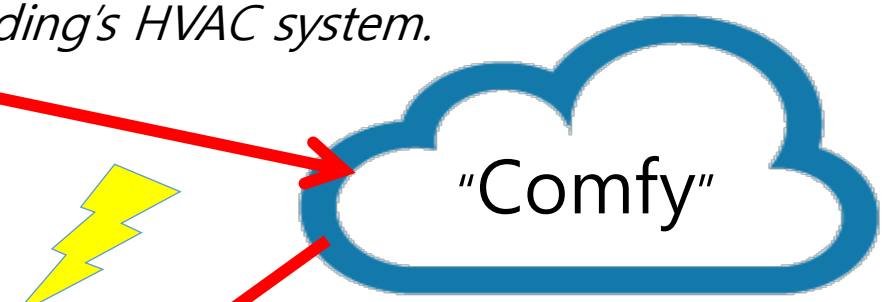
# Office Thermal Comfort & Productivity

*Comfy works between the occupants and the building's HVAC system.*


Comfy is a web and mobile app that allows you and your colleagues to request warm or cool air anywhere in the office!

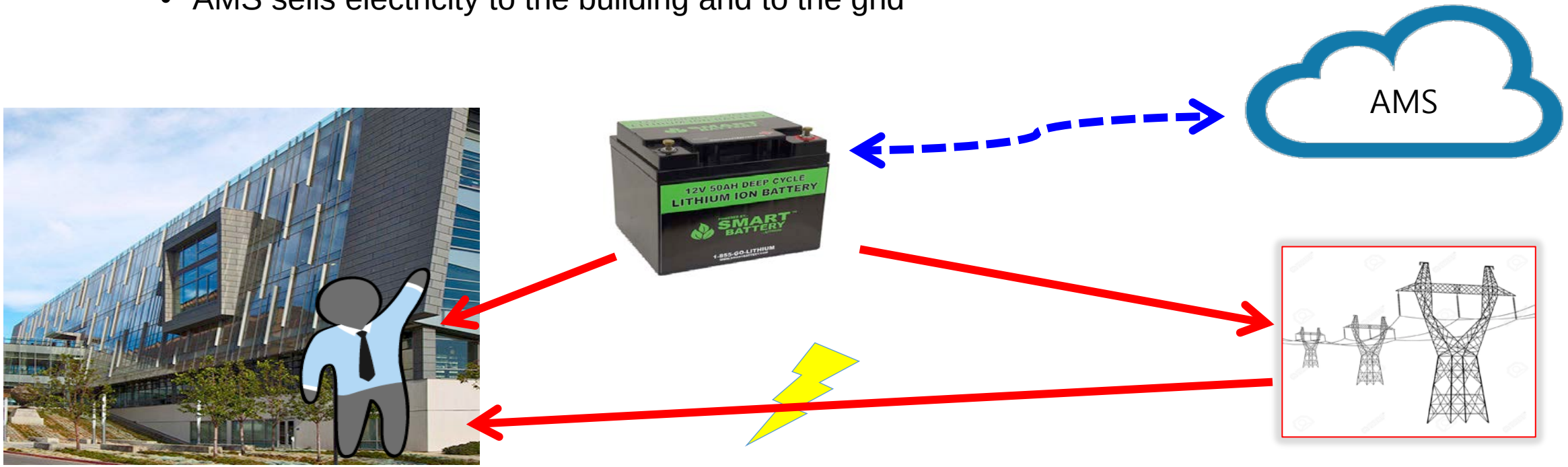
Comfy delivers immediate relief to your workplace or conference room and over time it learns from your requests to make you more comfortable.


Comfy is a simple software application that connects to your building's existing system to make it more intelligent.



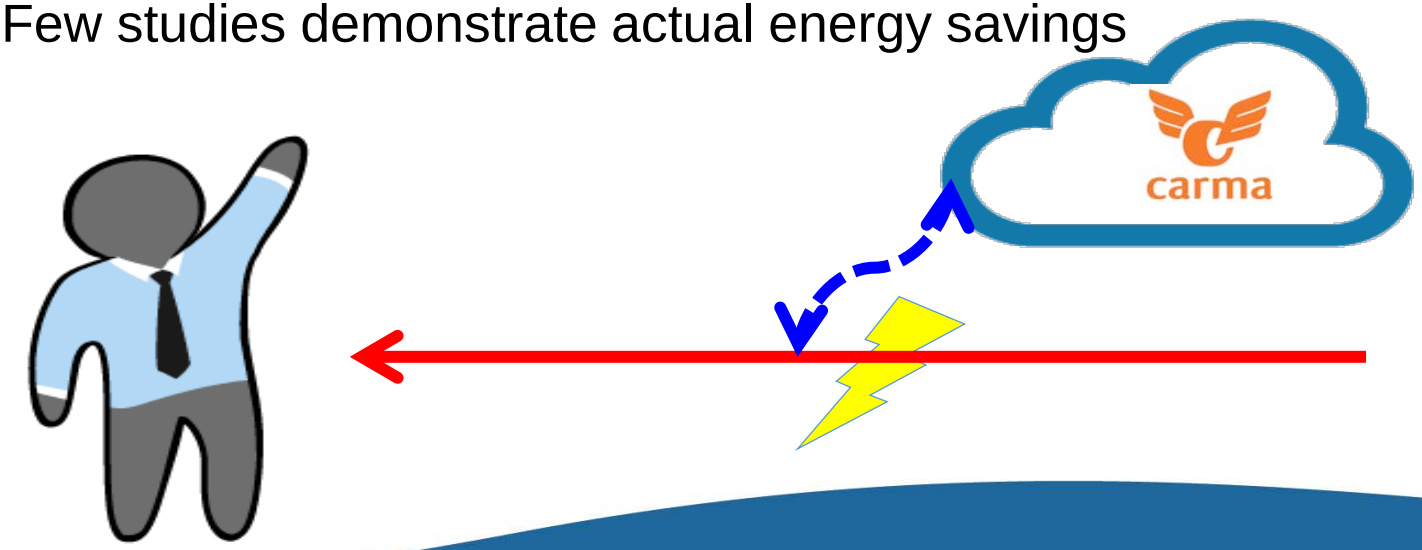

# Energy Storage Services

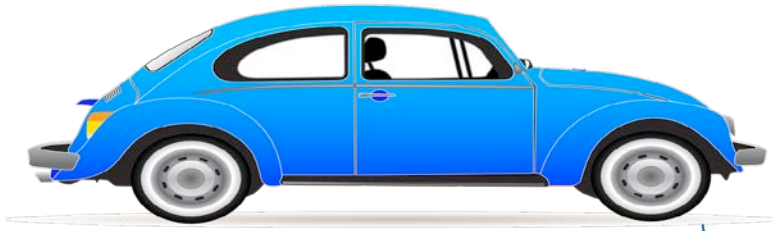
- New California regulations encourage energy storage services (usually batteries) to support intermittent, renewable energy sources
- Advanced Microgrid Solutions (AMS) manages batteries in buildings
  - AMS sells electricity to the building and to the grid



# Carpooling Apps To Use In San Francisco That Are Not Uber

- San Francisco is an incubation lab for web-based travel
- Many different business models are being created to share vehicles & rides, to transport kids, and provide other services
- Sharing vehicles & sharing trips will save energy, money, resources, and time
  - US cars are idle 95% of time
  - More people share capital and operating costs
  - Fewer vehicles and parking requirements, less traffic
- Few studies demonstrate actual energy savings

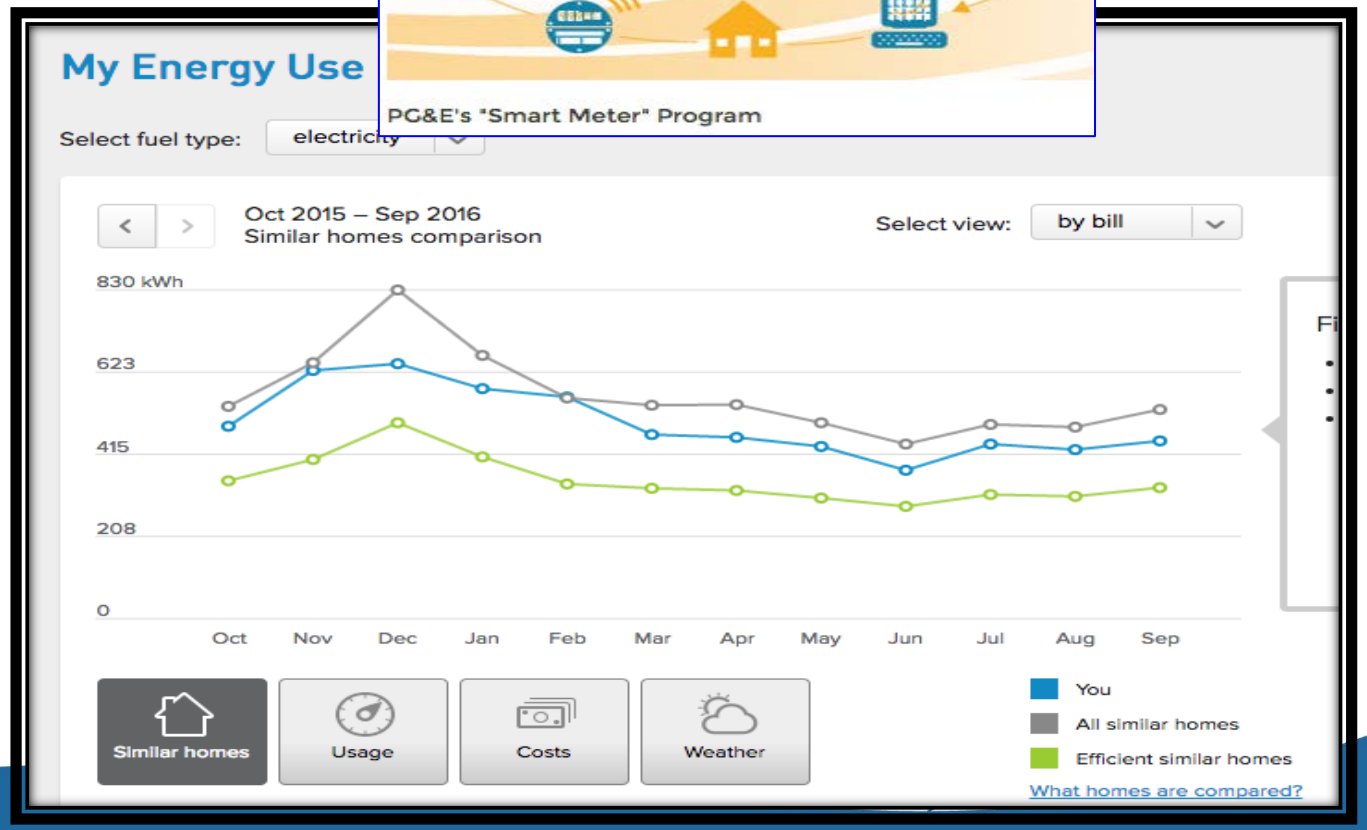


# Curiously, Few Web Services Use Smart Meters

- Why?
  - The electric utility company wants the data
  - Privacy protection
  - Obsolete technology
  - Poor security
- Meter-based solutions can't "scale up" to other regions
- **Smart meters are still needed for time-of-use pricing**





# Technical Challenge:  How to Evaluate the Quality of Algorithms?

- Why are evaluations needed?
  - Energy Star ratings
  - Appliance standards
  - **Consumers!**
  - Manufacturers
- What forms of evaluation are possible?
  - Simulations
  - Before/After
  - Departure from a standard value/condition

# Conclusions

- Web-delivered services in California are growing rapidly and some are already commonplace
- Web-delivered services “disrupt” traditional relationship between user and energy-intensive appliances
- Anecdotal data show energy savings from web services
- But it’s too early to observe economy-wide energy savings