A Case Study to Automate Demand Response on a University Campus

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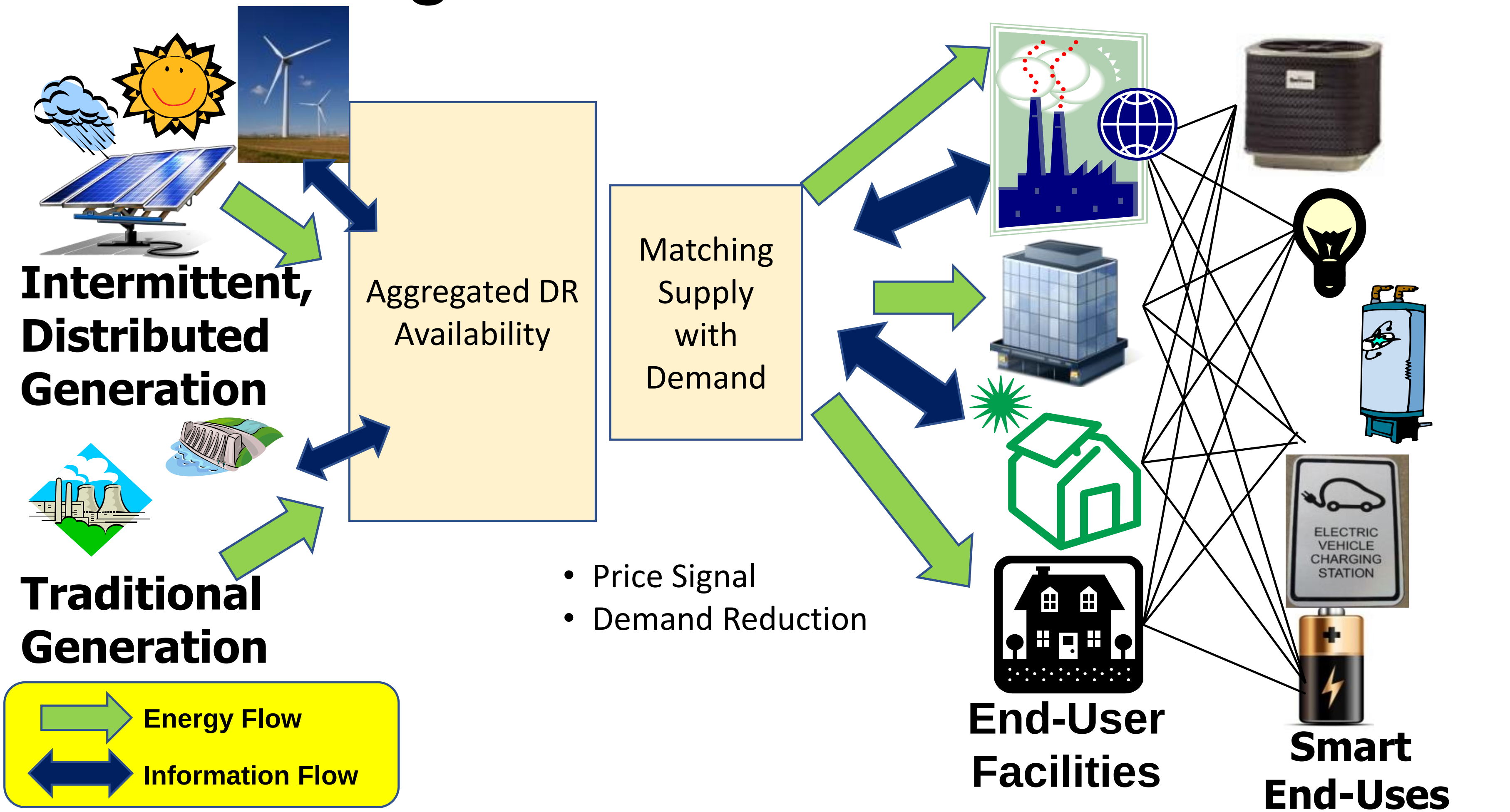
Outline

- Overview of smart grid, automated demand response (ADR)
- Challenges with ADR in existing buildings
- Methods to implement demand response
- Applications to a university campus

Grid Integration of the Future



Demand Response Scenarios

A. High Demand Relative to Supply:

- Reduce peak demand during high load conditions or grid "stress"
- Typically a summer cooling issue (occasionally in winter heating in some locations)

B. High or Variable Supply Relative to Demand:

- How to manage peak production from distributed generation systems (renewable, CHP)?
- Germany starting in 2013;
  Becoming more common in parts of U.S. (Texas wind; CA solar)

C. Managing for Low Carbon Energy Production:

- Management of demand to match type of supply available

Challenges with Existing Buildings on a Typical Campus

- ADR involves sophisticated communication and control capability
- Variability of building types, control systems
- Cost to upgrade legacy control systems
- Smart grid control features becoming available at the component or subsystem level

Execution of Demand Response

- Buildings typically contain both deferrable and non-deferrable electric loads for the same end-users.
- Key questions to answer:
  - What to curtail?
  - How long?
  - How to verify (and who does the verifying)?
  - Comfort considerations
  - Safety, security concerns
  - Control and monitoring
- Externally generated versus internally created events:
  - External by utility or outside agent
  - Internal at owner's discretion (demand limiting or peak shaving) - May be more effective

Davis, P. "Smart Grid and Building Operations," ASHRAE Journal 55(11):B23-B25, November 2013

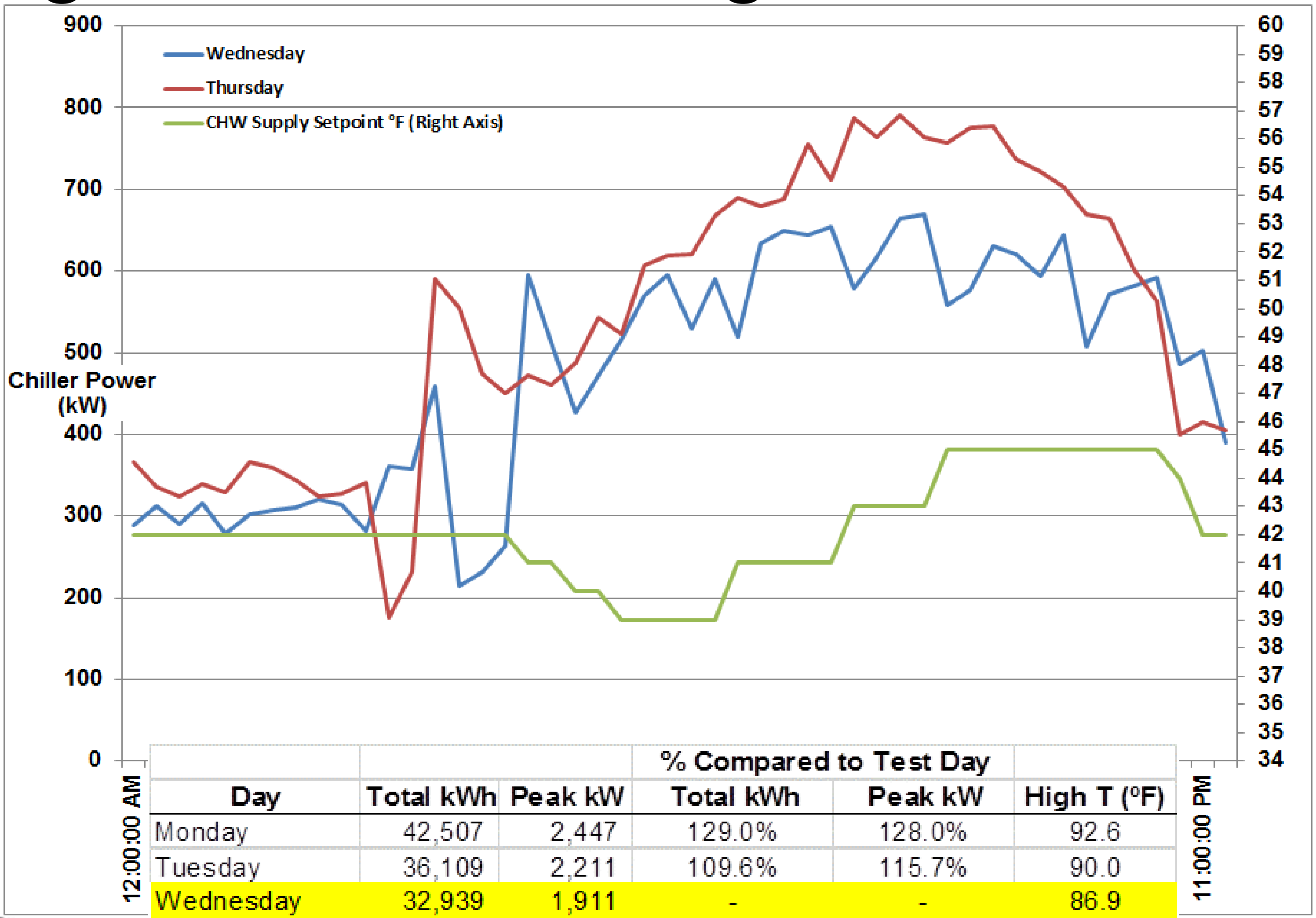
What “Tools” Are Available for DR?

- The obvious first choices:
  - HVAC systems
    - Setpoints
    - Thermal energy storage
  - Lighting
- Perhaps you have considered:
  - Plug load management
  - General overall energy conservation effects
- Other more unique considerations
  - Non-traditional thermal energy storage (pre-cooling chilled water supply for example)

August 2016 Testing Example

- Changed zone setpoints by +1.7°C (3°F)
- Changed supply air setpoint also + 1.7°C
- Changed upper limit for AHU fan speed from 100% to 90% of maximum (when possible)
- Step schedule change in network chilled water supply temperature, pre-cooling first before ADR to 3.9°C, then letting temperature rise to 7.2°C during ADR
- Energy consumption monitoring and thermal comfort surveys: Test date compared to baseline date (day before)

August 2016 Testing Results



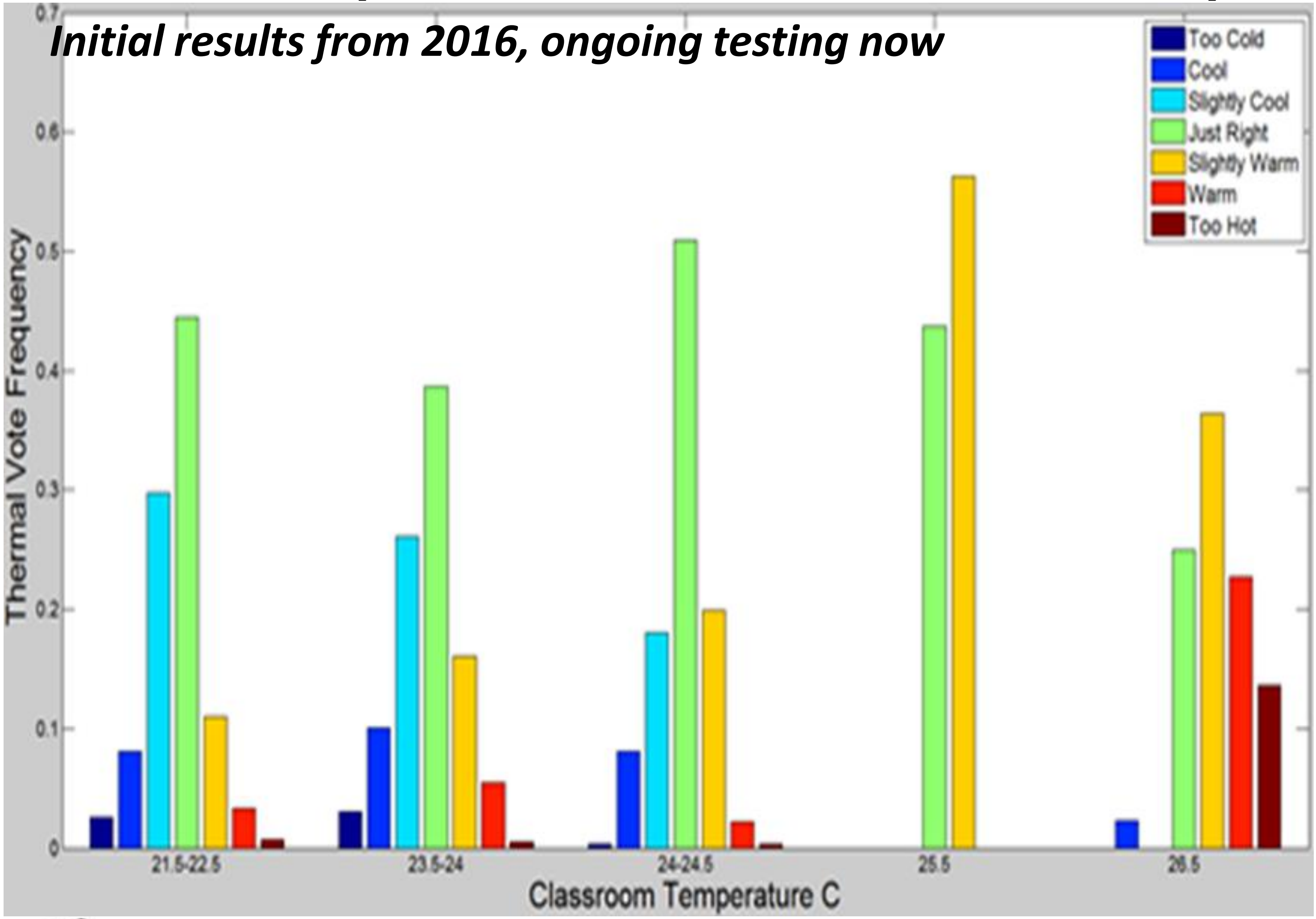
			% Compared to Test Day		
Day	Total kWh	Peak kW	Total kWh	Peak kW	High T (°F)
Monday	42,507	2,447	129.0%	128.0%	92.6
Tuesday	36,109	2,211	109.6%	115.7%	90.0
Wednesday	32,939	1,911	-	-	86.9
Thursday	36,584	2,132	111.1%	111.5%	87.0

Lessons Learned from this Testing

- Could temperature setpoints overall could be altered, or at least during higher cost time periods?
- Timing and scheduling
  - What are the optimal setpoint changes?
  - What times to start and stop?
  - How to avoid the rebound effect (‘soft-start’)?
- Most difficult… Need to be adaptable to the technologies in place
  - How to implement with automation and controls not designed for ‘automated’ demand response

Next Steps: Thermal Comfort Testing in Real World (How Far Can We Go?)

Initial results from 2016, ongoing testing now



Thank you

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