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American Council for an Energy-Efficient Economy

Intelligent Efficiency Conference

Track A: Integrating Distributed Resources

2A Unlocking Near-Term Load Potential with ICT

Teja Kuruganti, Oak Ridge National Laboratory

Decentralized Demand Management to Reduce Peak Demand and Integrate DERs

Opportunity to Control Building Loads

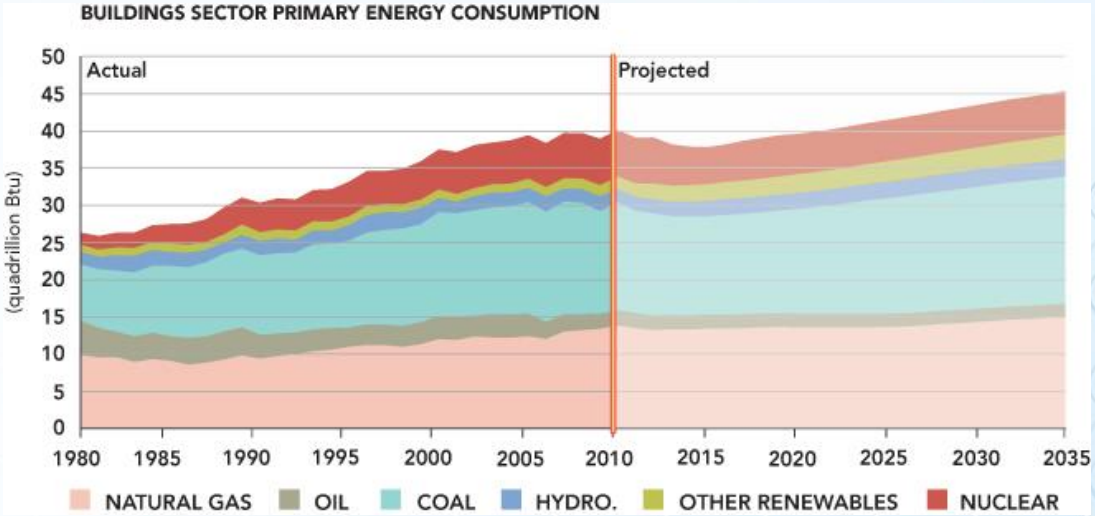
Buildings consume 74% electricity produced in the US (CBECS 2009)

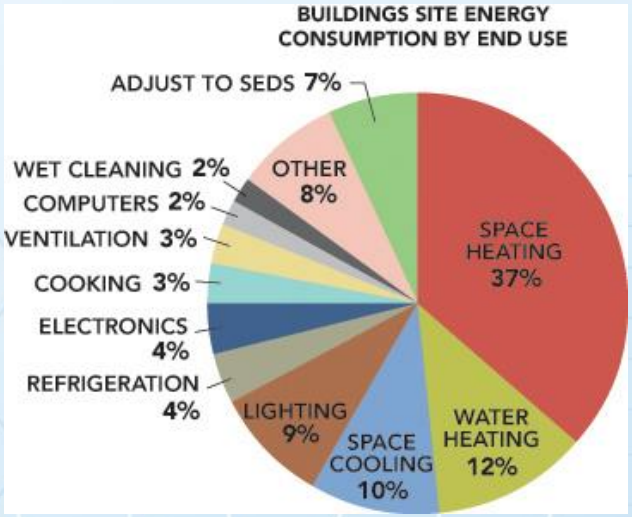
Buildings have the potential to reduce their consumption by 20%-30% (18 quads or 2,500 million tons of oil) through advanced sensors and controls

Potential nationwide value of demand dispatch could be several billion dollars yearly in reduced energy costs with 10% participation (NETL, Demand Dispatch – Intelligent Demand for a More Efficient Grid, August 2011)

One-fourth of the 713 GW of US electricity demand in 2010 could be dispatchable

90% of the commercial buildings are < 50,000 ft^2 and need aggregation





5.5 million commercial and 117 million residential, projected to be 80% of the load growth through 2040

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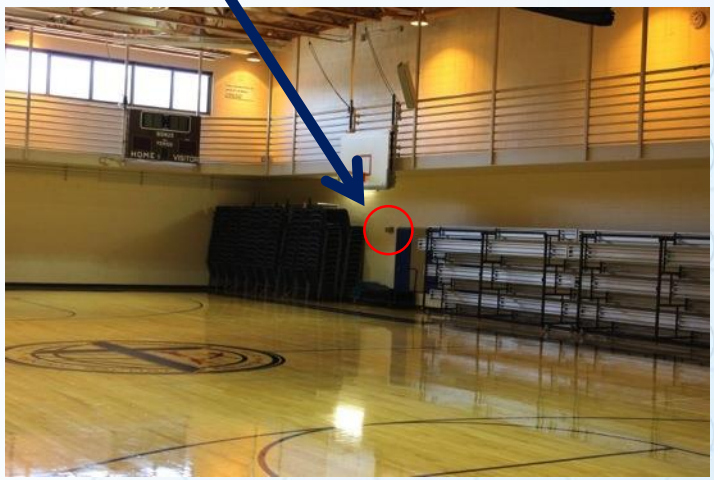
Load Flexibiity

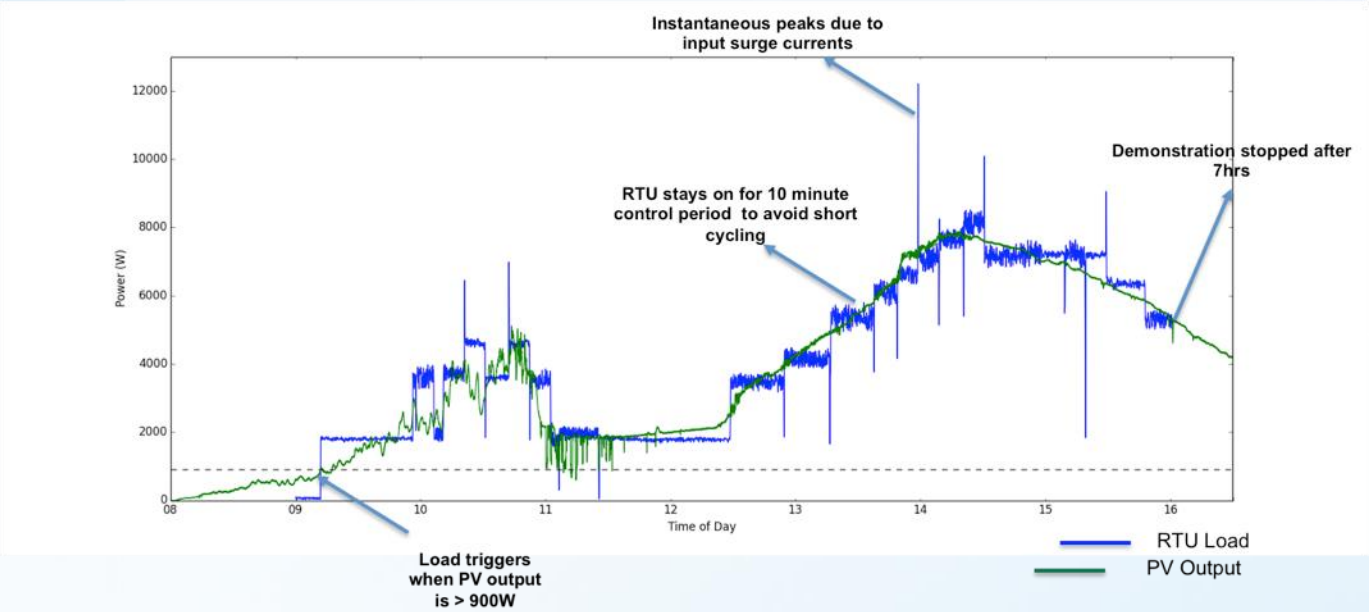
Four HVAC units removing heat at rates c_1, c_2, c_3, c_4 or adding heat at rates h_1, h_2, h_3, h_4

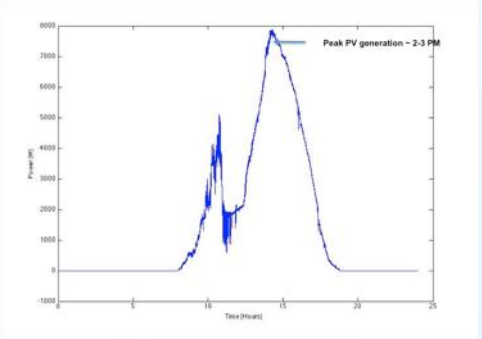
Four thermostats reading indoor air temperatures T_1, T_2, T_3, T_4



Outdoor air temperature T_{out}

Load Flexibility (cont'd)

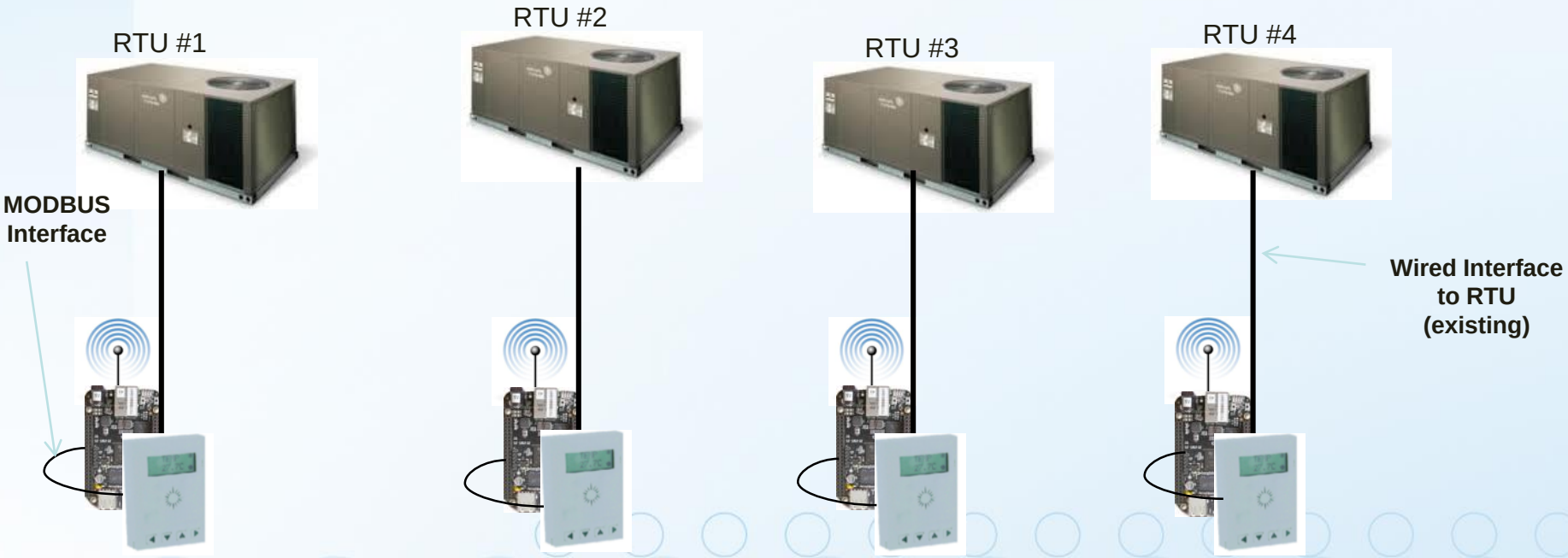




Data for 13.5KW PV array with two SMA Sunnyboy inverters SB7000-12 and 24 Hanwha HSL 72 PPA

- Load tracks PV with in safety constraints while reducing number of cycles
- Load is ~3X the maximum capacity of the PV generation capacity
- Resolution of load controllability is carefully chosen
- 4 Packaged RTUs controlled to provide renewable support

Possible Today



- Perform peak reduction by peer-to-peer communication to share state of each RTU and estimation of future states
- Small form factor and plug compatible with Thermostat interface but provide “app loading” functionality

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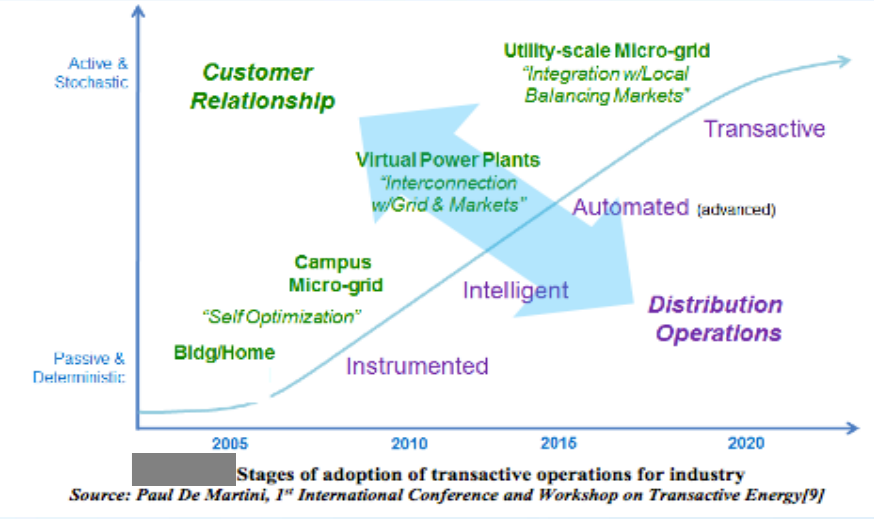
Building-to-Grid Vision

From the Grid Perspective

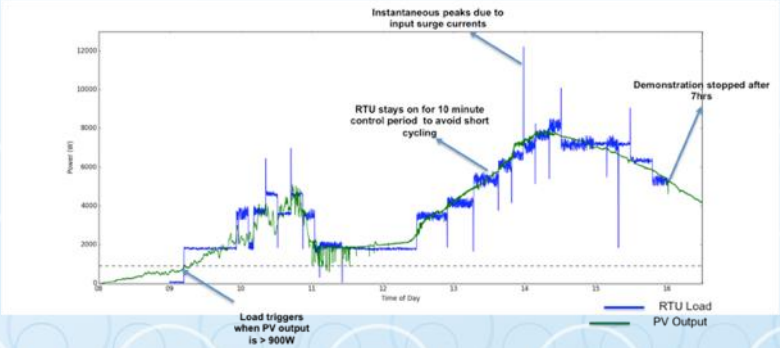
- Increase and enhance the hosting capacity of EE and RE technologies scale - *"thinking beyond DR"*
  - (Fast) Demand Response
  - Ancillary Services
  - Load Shifting



Stages of adoption of transactive operations for industry
Source: Paul De Martini, 1st International Conference and Workshop on Transactive Energy[9]

From the Building Perspective

- encourage transactive markets, both regulated and non-regulated, behind the meter to **drive EE** deeper or through new means - *"thinking beyond EE"*
  - Fully automated, self learning, dynamic and responsive
  - **Create a market for EE solutions to DRIVE**
  - Seamless deployment



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Transactive Energy – Energy Efficiency & Grid-responsive

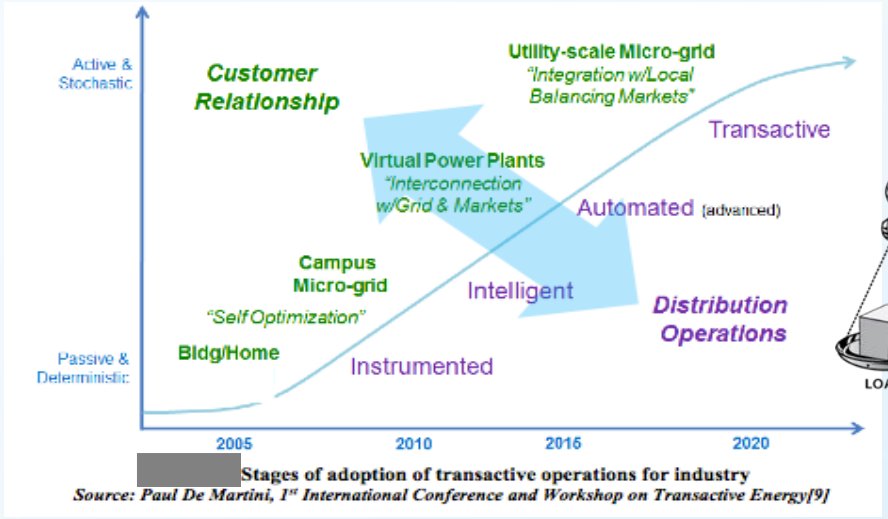
High-speed wide area control of loosely coupled loads

Control response

- Centralized or distributed
- Utility level information
- Building-level loads

VOLTTRON Platform

- Unlocking Load Potential



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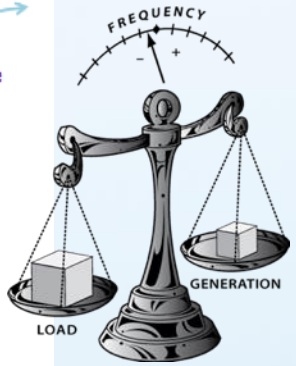

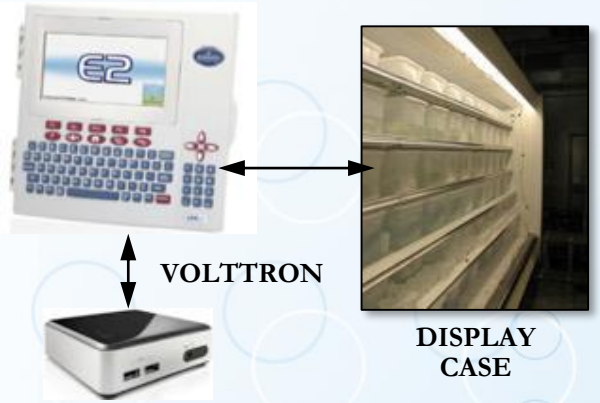

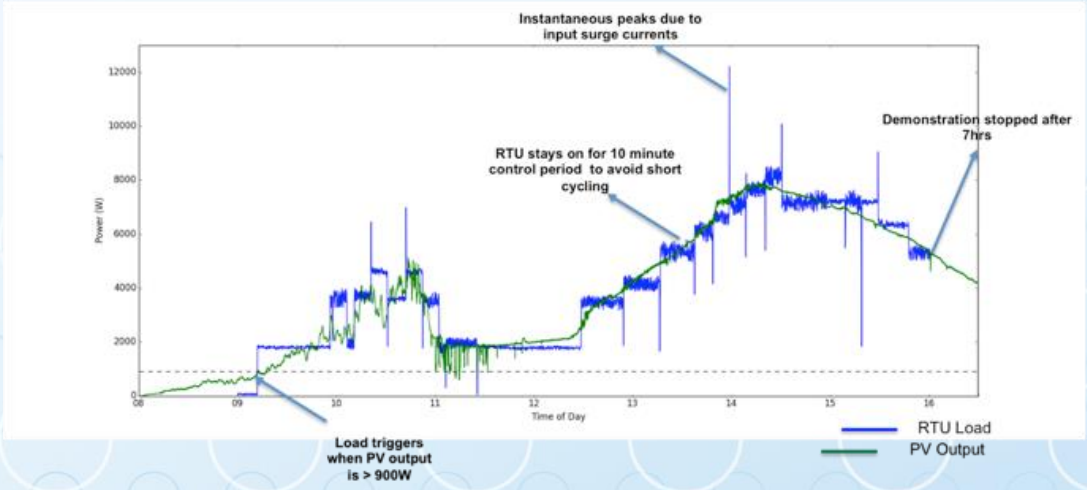

EMERSON Climate Technologies

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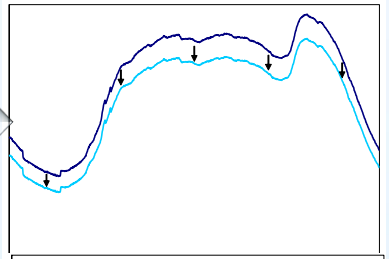
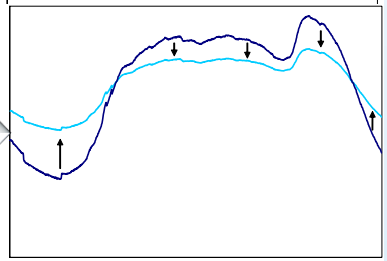
What types of responsive loads are needed

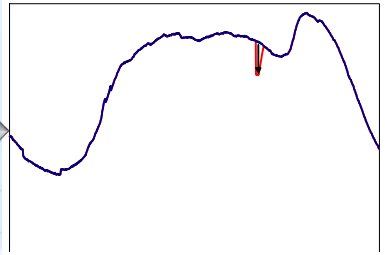
Energy efficiency: Reduce electricity consumption and usually reduce peak demand.



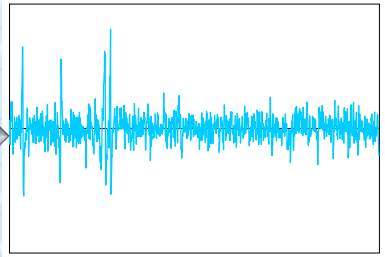
Peak shaving: Move consumption from day to night.(Price Response, Direct Load Control)



Reliability response (contingency response): Requires the fastest, shortest duration (required during power system "events") **– new and slowly developing**



Regulation response: Continuously follows the power system's minute-to-minute commands to balance the aggregate system **– very new and could dramatically change electricity costs**



To arrive at such responsive loads, integrated end-use control is needed

Addressing Barriers

Thermostat

- No longer “stick-on-wall” – Sensors, Cloud etc.
- Assumes HEMS role
- Enable a platform solutions for implementing “Apps”

Advanced Applications.. OR… features

- Retrofit peak demand limiting control app
- Capable of peer-to-peer with other Tstats
- Interoperability considerations – CEA2045, OpenADR etc
- Fault detection and diagnosis