The Opportunity for Transaction Based Building Controls

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Office of Buildings Technology, EERE

DOE: EERE…

The Office of Energy Efficiency and Renewable Energy's mission is to:

- **Enhance energy efficiency** and productivity;
- **Bring clean, reliable and affordable energy technologies** to the marketplace; and
- **Make a difference in the everyday lives** of Americans by enhancing their energy choices and their quality of life.

EERE spent $16.8 billion in ARRA funds to stimulate jobs and help create a clean-energy economy in the US.

Office of Energy Efficiency and Renewable Energy

Program Priorities	
Biomass	Investing over $1.4 billion to achieve cost competitiveness and commercialization of cellulosic and other advanced biomass feedstocks and biofuels through applied research, next generation pilot scale development, commercial scale biorefinery demonstrations and targeted infrastructure activities.
Buildings	Implementing a systems approach in deploying technologies for "net-zero" energy buildings that produce as much energy as they consume. Builder's Challenge, the Commercial Buildings Initiative, and accelerated building codes and appliance standards implement this new approach.
FEMP	Doubled energy efficiency investment in Federal building through $1 billion of private-party performance contracting. New ESPC contracts will support up $80 billion in energy savings at federal facilities and increase individual contract ceilings to $5 billion over the life of the contract.
Geothermal	Program renaissance emerged on foundation of Enhanced Geothermal Systems (EGS) that allows geothermal energy to be harnessed nationwide providing up to 10% of our Nation's future electricity.
Fuel Cells	Added focus on near-term stationary and early market applications to create economies of scale, accelerate learning-by-doing, and reduce cost of technology for transportation market.
Industrial	Concentrating on the Save Energy Now program, which through energy assessments has resulted in savings of over $100 million and 75 trillion Btus of natural gas.
Solar	Achieve grid parity with PV and other solar technologies by 2015 through advanced R&D over the entire supply chain. Re-invigorate Concentrated Solar Power program through launch of energy storage research and demonstration.
Vehicles	Focusing on fuel flexible Plug-in Hybrid Electric Vehicles through greatly enhanced battery research activities and new utility partnerships.
Weatherization/SEP	Developed stronger ties with States and utilities by providing technical assistance and by developing "best practices" and model policies for faster and larger scale adoption of efficiency and renewable energy.
Wind & Water Power	Assessed feasibility for wind energy to provide 20% of our Nation's electricity which led to new industry vision. Launched new program in wave, tidal and current energy.

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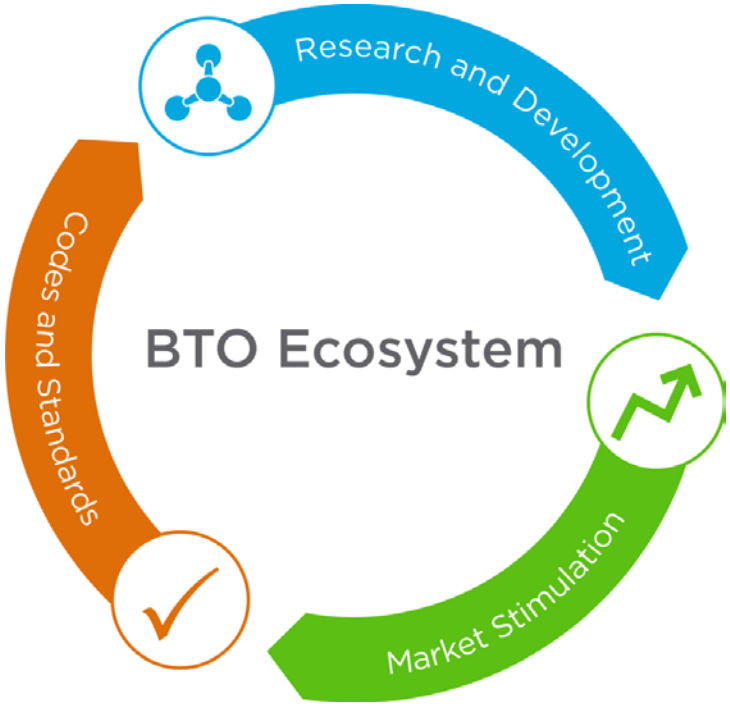
Building Technologies Office (BTO)
Delivering Energy-Efficient Solutions



Emerging Technologies

High-impact building technologies

~Five years to market-ready

Residential Building Integration

Cost-effective technologies, tools, solutions

Peak energy performance in new & existing homes

Commercial Building Integration

Cost-effective technologies, tools, solutions

Peak energy performance in new & existing commercial buildings

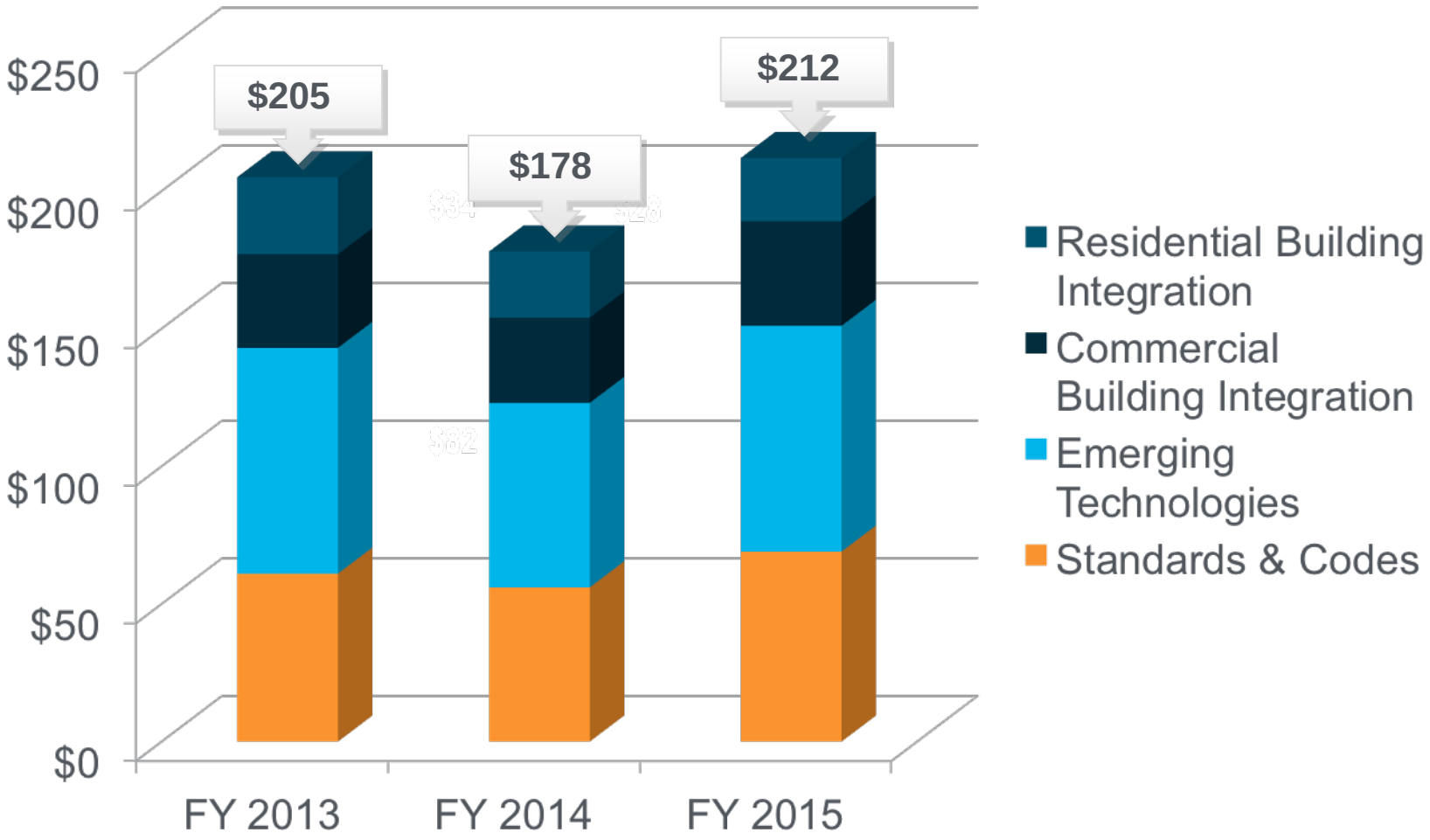
Codes & Standards

Building energy code language with adoption/compliance strategy

National appliance & equipment standards

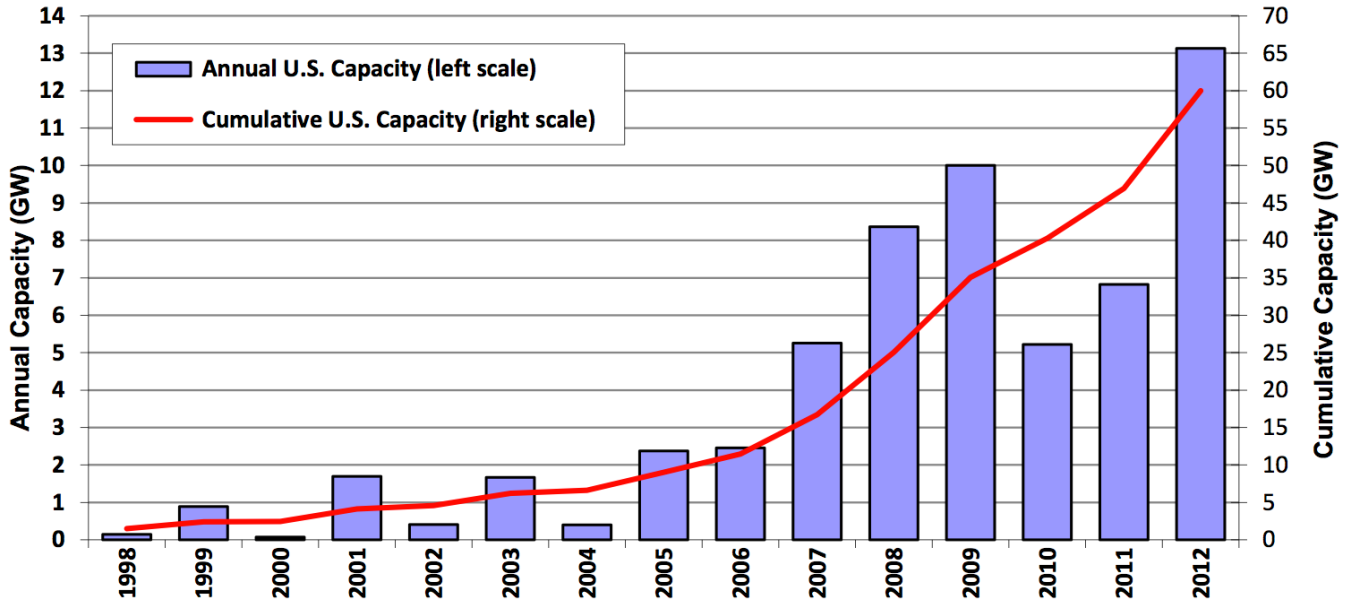
BTO Funding by Program

(in millions)



Grid Integration Initiative

- As EERE **drives down the cost** of emerging technologies, these technologies have started to proliferate into the energy system.
- The Grid Integration Initiative **addresses challenges** associated with the physical operation of the power system when these technologies are deployed at scale.



Source: AWEA project database

Figure 1. Annual and Cumulative Growth in U.S. Wind Power Capacity

Seamlessly integrating these technologies into the grid in a safe, reliable, and cost-effective manner is critical to enable deployment at scale.

EERE Grid Integration Activities

- Successful large-scale deployment of EERE's portfolio of clean energy technologies will require the **development of new technologies and techniques to address grid integration barriers** and opportunities associated.

- EERE technologies and solutions includes **improved approaches to technologies and deployments of technologies**. Examples include…

  advanced power electronics (RD), "grid responsive" building technologies (INTEGRATION); vehicle-to-grid technologies (BOTH RD & INTEGRATION), etc…

- **Close engagement and collaboration** with and among industry and other stakeholders are needed to develop and deploy the necessary standardized communication and control protocols to enable these devices and techniques to successfully interface and interact to enable grid operations while maintaining or improving grid reliability.

How are we going to accomplish these goals…

- **Engage** with utilities, municipalities, and cooperatives for community scale solutions;
- **Develop** and advance common platforms, especially data formats and communication protocols, necessary for a modernized and more flexible distribution system; and
- **Leverage** substantial existing installations of photovoltaic systems, electric vehicles, building energy technologies, storage, and smart grid technologies.
- **Encourage** partnerships between industry, vendors, national laboratories, and other stakeholders;

What we believe in… the Opportunity for Buildings

- **Buildings have a large role** in helping to enhance grid reliability and enabling the rapid integration of Renewable Energy and Storage.

BUT

- **Buildings today are limited** by existing controls systems that can't easily transact at the speed or scale that is required by the grid
  - High cost to "get it right" with existing technology and economics
  - Currently only implemented in large buildings
  - Components are emerging with greater capabilities of control

- **Building solutions must "think across the meter"**
  - Energy Efficiency is at the core, but there are additional value streams to/from third party entrepreneurs
  - Better control of loads have other benefits

- Thinking Differently will unlock new value streams…

What would success look like in the building domain?

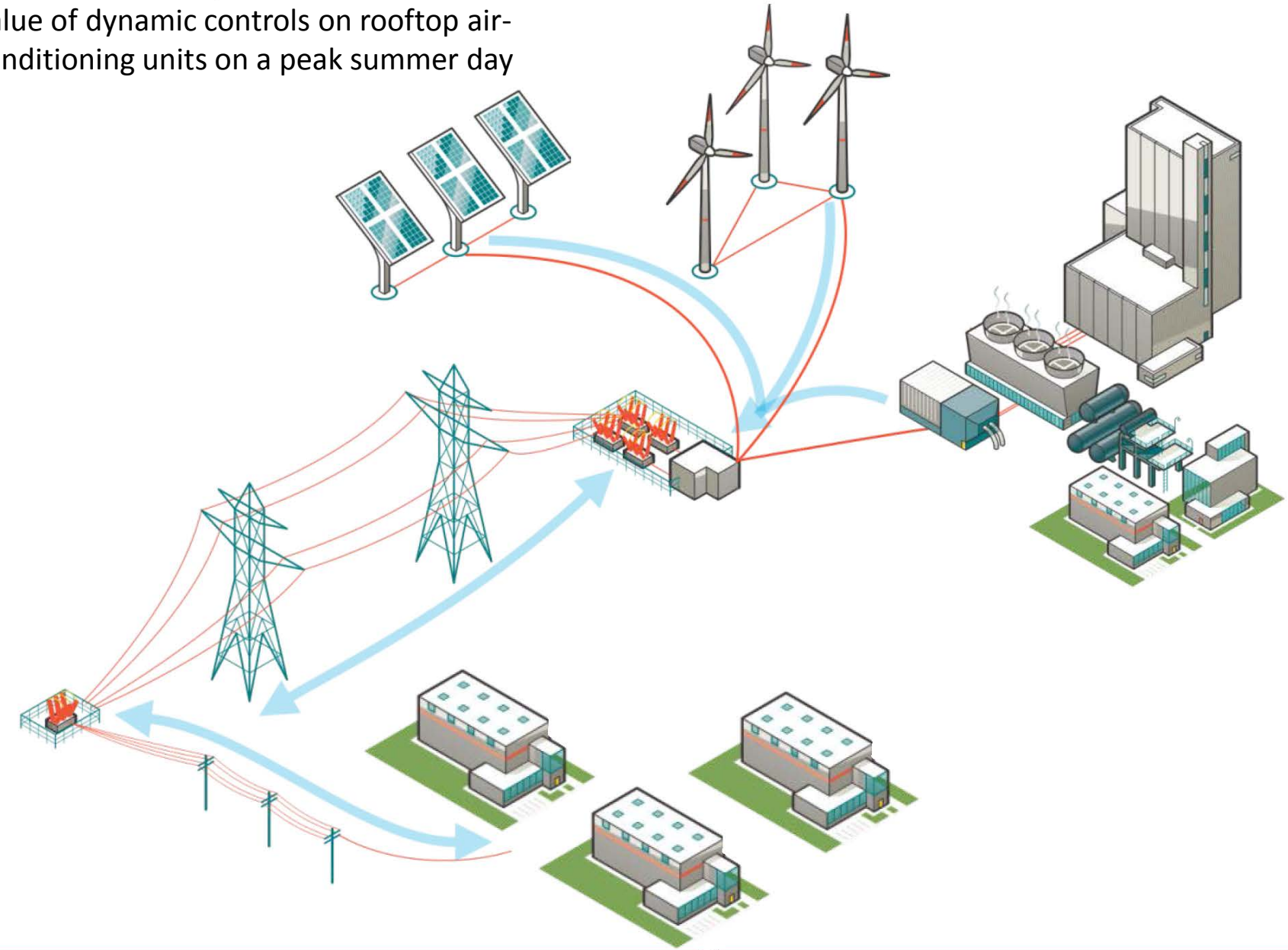
"Across the meter solution to enable transactions for commoditizing energy related services"

Every building device (whether generating or using electricity) should know **how it is performing, how it could perform, and be capable of communicating** that to the internal/external systems and the grid to unlock financial motivation for all participants.

- Add in technology with "smarts"/intelligence to protect owner/operator from negative consequences
- Must "know" actual and potential operational characteristics
- Must be able to match or settle transactions and "report back" to all parties

Example Opportunity:

- Value of dynamic controls on rooftop air-conditioning units on a peak summer day



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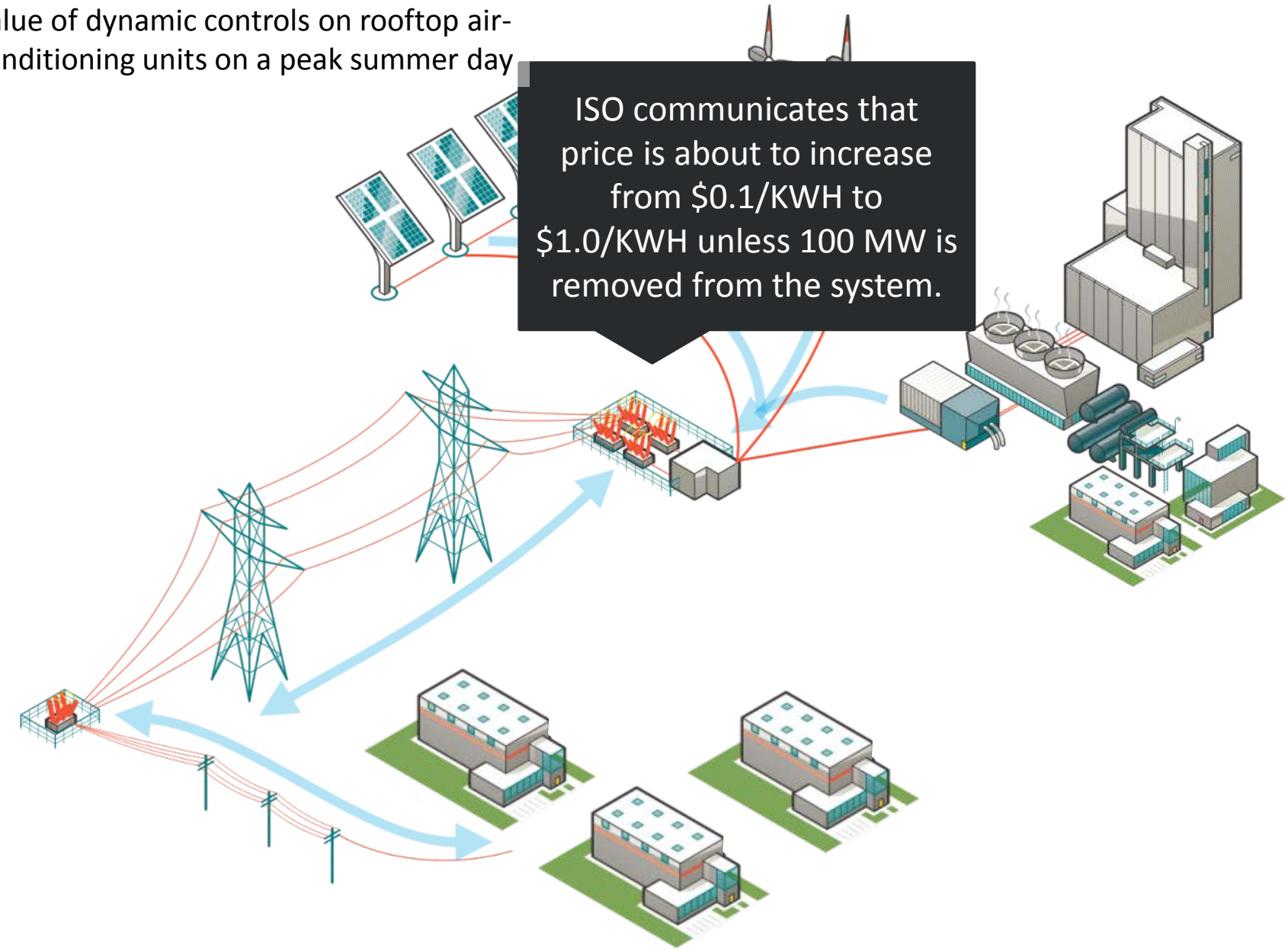

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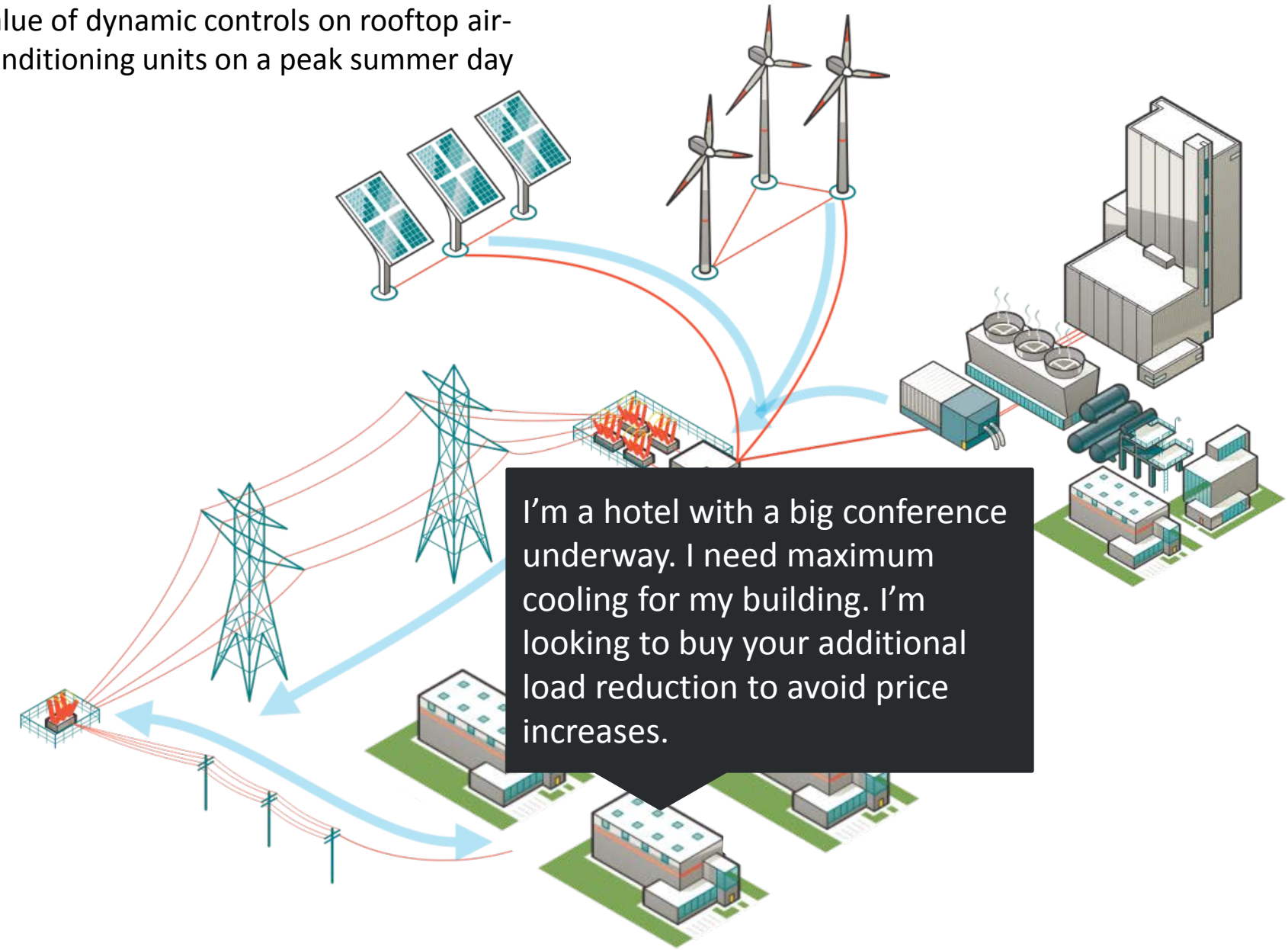

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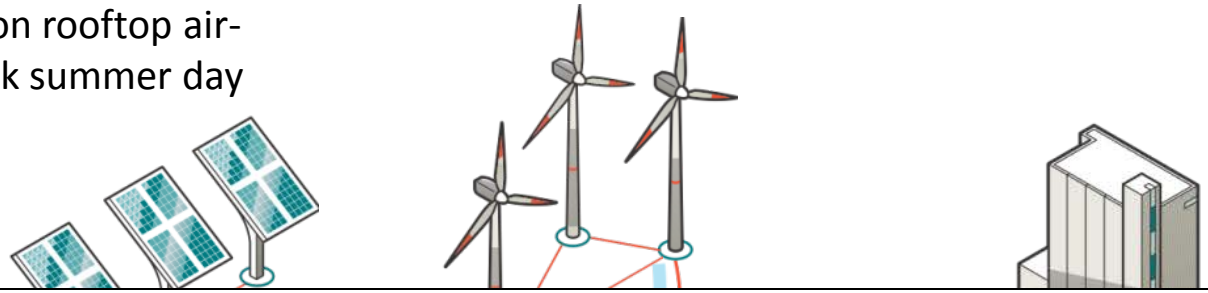
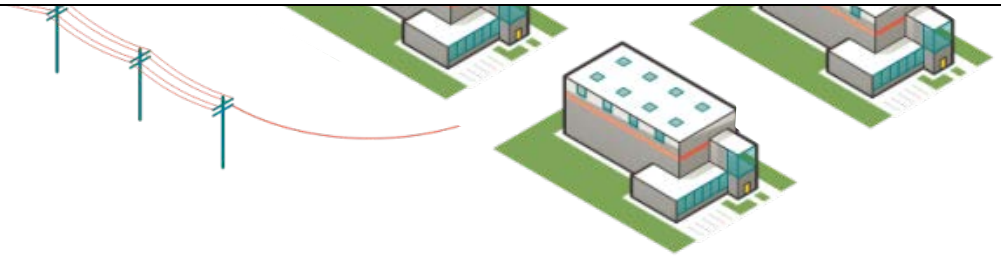


But to reach 100MW, negotiating and controlling across a few RTUs in a few buildings won't realize an impact.

However, if all the RTUs in a service territory -- across the national accounts AND the independents -- could autonomously and automatically aggregate to deliver a solution for the utility, the system would be optimized and building owners/operators would realize energy savings.

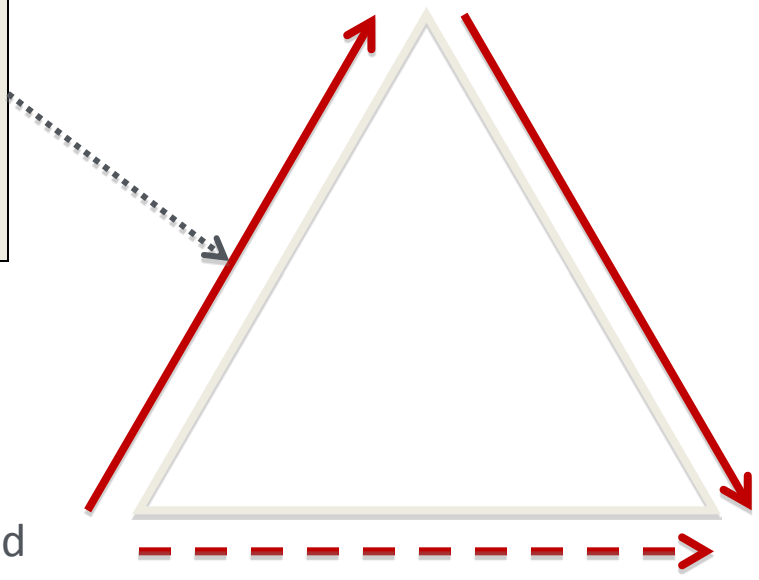
If only the controllers could systematically communicate, transact, and settle amongst themselves. These solutions are beyond simple Demand Response because they inherently understand, value, and can act for the owner's operational needs while simultaneously optimizing to help the grid.



Today's Energy Eco-system

There is a grid-metric mismatch: the grid generates in MW; the customers use kW & W, but they only understand in $.

Energy
Physical energy absent information and value; Value is assigned based on the amount and time used, "post fact"



Distribution Management Systems (DMS) [MW]

Distributed Energy Resources (DER – PV, Wind, CHP, FC, etc) [kW, MW]

The Loads (Buildings, EV, appliance, equipment, etc) [kW, W]

What is the future? A Transaction Based Energy Eco-system*

* There are many forms of "transaction based energy systems" that go by other names: Transactive Energy, Prosumers, etc. Transactive Energy was chosen for the FY15 budget because it is a proven open source solution, originally funded by DOE (OE), and already in use by the utilities.

- Transactive Energy = Physical energy is commingled with information and assigned value.
  - That "value" is allocated and can be based on a non-energycriteria expressed as price (i.e. "green-ness" of the power, asset valuation, comfort, etc).
  - Transactive Energy is inherently..
    - Physical (Transactive Energy is Energy + Information + Value (price))
    - Logical (Transactive Controls are control systems that act on information)
    - Financial (Transactive Settlements use price to determine value to users)

- Transactive Energy Eco-system …
  - allows for these three components of energy to be managed separately, but settled such that the system is always whole.
  - can use the existing energy infrastructure by augmenting the physical energy with data to create new opportunities and value streams in energy usage.
    - These "new opportunities" are services – Energy Services, Grid Services, Building Services.

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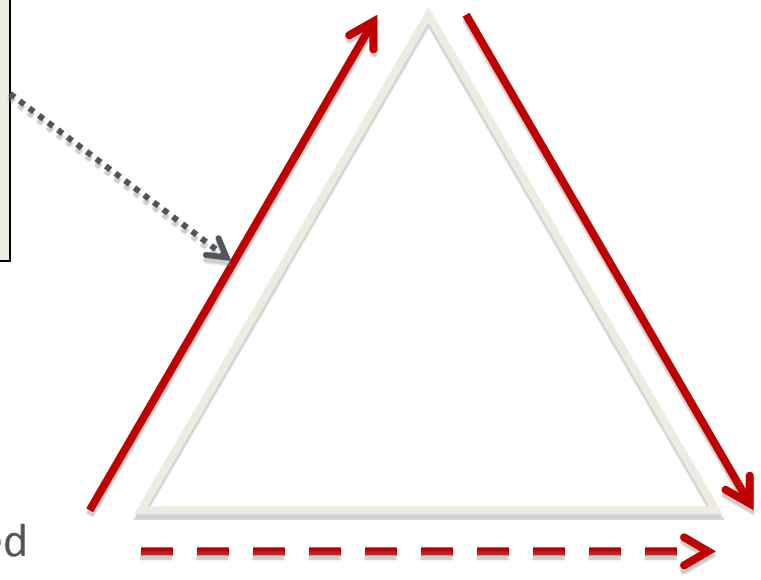

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Transactive Energy Eco-system

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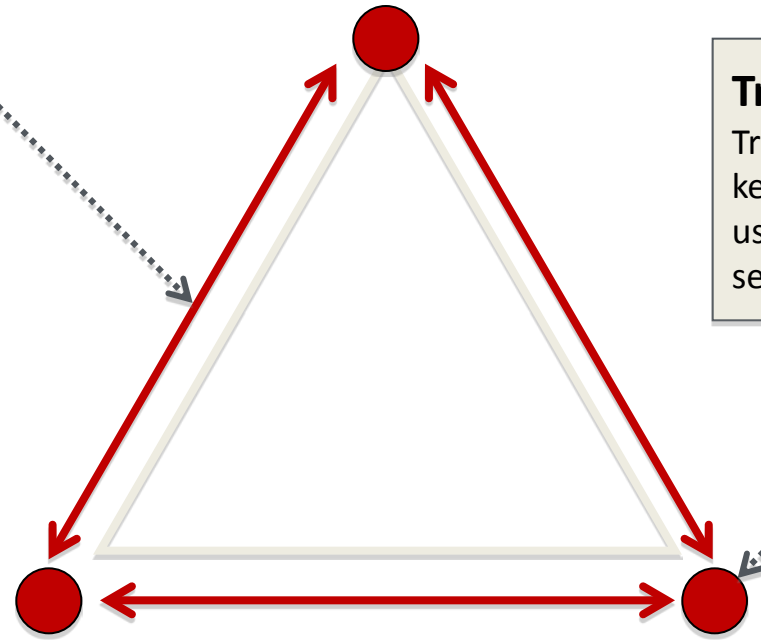

Transactive Based Control
Transaction based controls are a key enabler – control the physical, use the logical, and contribute to settling the financial.

Why is a Transactive Energy Eco-system important?

- Adds very cost effective benefits to the existing energy system…
  - Improved resiliency (Bill Parks - OE)
  - Improved reliability (Bill Parks – OE /Roland Risser - BTO)
  - Empowers EE (Roland Risser - BTO)
- Solves growing problems…
  - Inherently de-centralized (Chris Irwin - OE)
  - Addresses two-way power flows to help balance variable, DER (Rob Pratt - PNNL)
- Creates new opportunities…
  - New entry point for new market players (George Hernandez - BTO)
  - New entry point for new owners of the energy system (Chris Irwin - OE)
  - Supports introduction of cleaner energy systems (Chris Irwin - OE)

"Viable market based solution for utilities as they struggle with the retirement of old, coal power plants." (Kathleen Hogan - EERE)

How do we enable Transactive Energy?

- Seek agreement for integrated interoperability of equipment
  - We need larger agreement from all involved parties that there is more to gain by things integrating properly than forcing a standard

- Enhance three key areas…
  - Enhanced Distribution Management Systems 2.0 (DMS 2.0) >>> DMS 2.0 must manage two way power flows as demonstrated in the Pacific NW.
  - Integrated Distributed Energy Resources (iDER – PV, Wind, CHP, FC, etc) >>> DER is integrated by augmenting physical energy to share data and states.
  - The Loads (buildings, EV, appliance, equipment, etc) >>> Loads aggregate at the various scales and coordinate through transaction based controls.

- Develop foundational reference documents that explain how these pieces fit together and can scale.

Transactive Energy Eco-system

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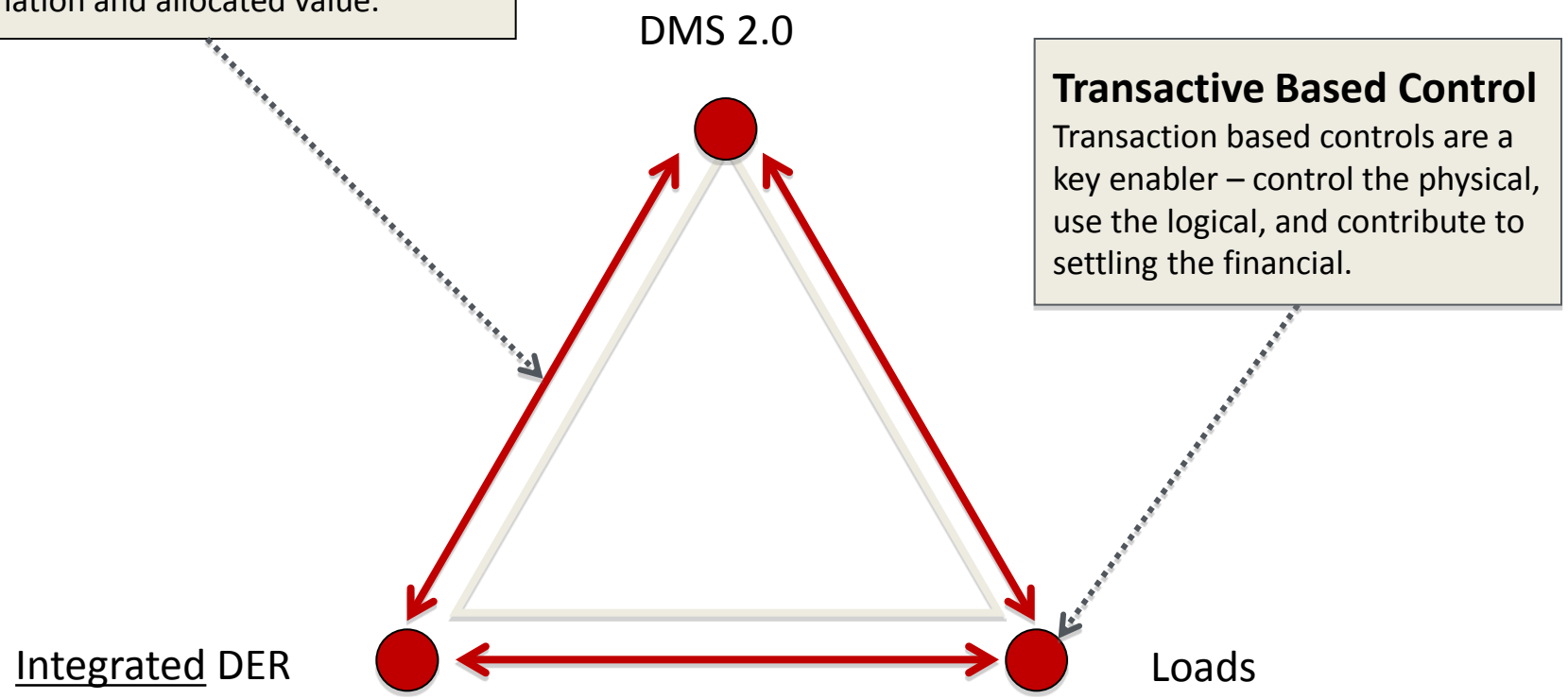

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BTO's Grid-Integration Opportunity is "no regrets" for our core program.

- The BTO prioritization tool indicates that various building controls measures have the potential to offer significant cost effective energy savings (> ~500 TBTUs in 2030). These savings are derived from…
  - Commercial building automation, particularly in small and medium buildings
  - Advanced controllers in new refrigeration systems
  - Demand control ventilation in commercial buildings
  - Predictive thermostats in homes and commercial buildings
  - Residential building automation (a sector of high market activity)

- ***Development and deployment of various cost effective transaction based control measures can contribute to 30% energy savings by 2030.***

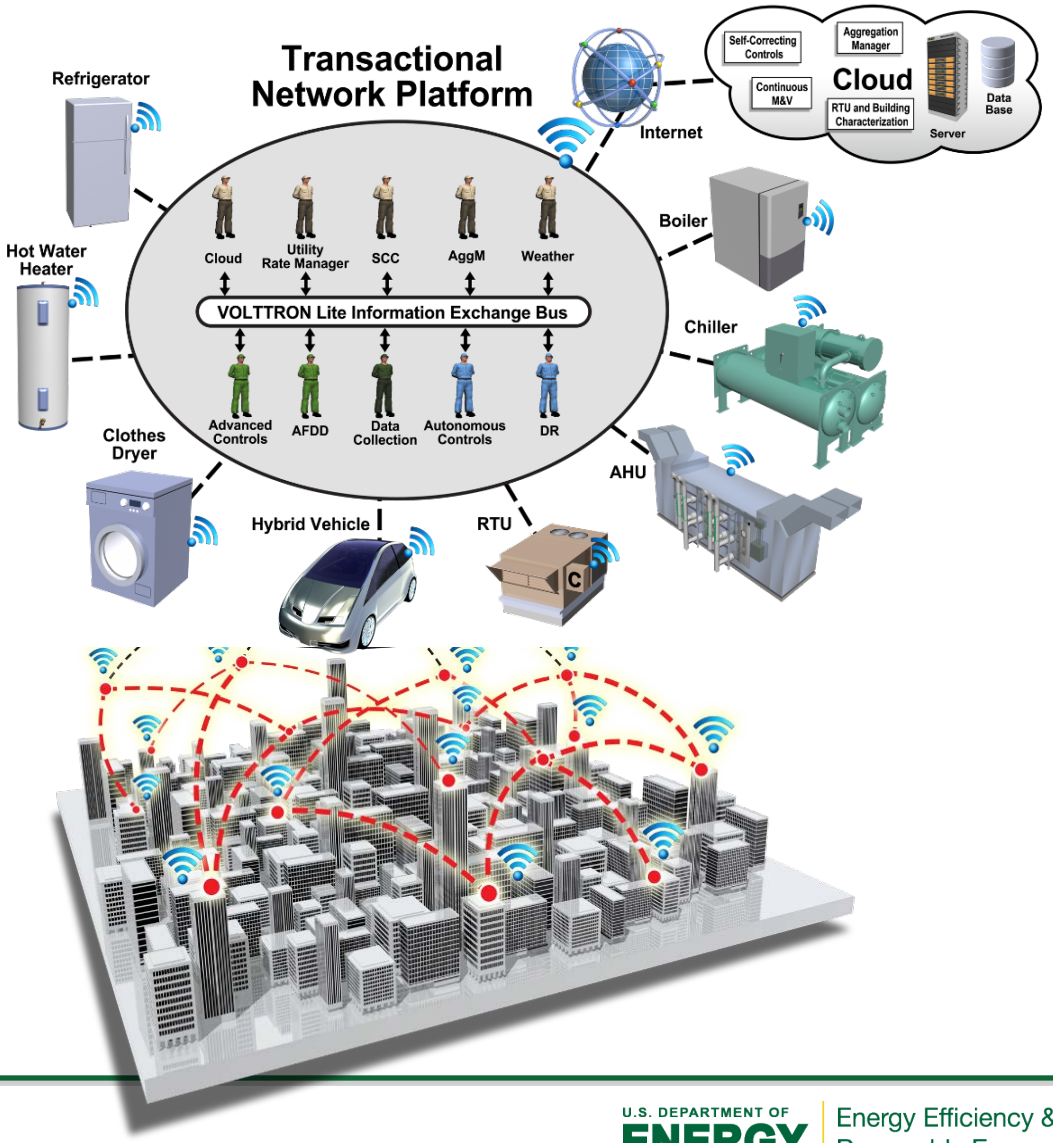
"As we think across the meter, our work should be 'no regrets' for our primary mission – EE." (Roland Risser)

The Future: Transactional Network Controls

- Buildings need to be smarter to participate in transactions within the building, with other buildings, and with grid entities.
- Sensors and controls are fundamental to optimize DER and the grid.
- **An open source transactional network enables scalable energy saving retrofit solutions**

  AND

  The networked systems to transact with all grid connected devices (e.g. EV, storage) and with the grid to help mitigate DER related disturbances.



EERE BTO's BTG Website

EERE >>> Building Technologies Program >>> Emerging Technologies

http://www1.eere.energy.gov/buildings/technologies/buildings_grid_integration.html