

Bridging the Gap Between Legacy Grid and Tomorrow's PV, Storage, and Microgrids: Feasibility and Design Considerations

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Advanced Energy Conference
March 27th 2018



How The Grid Will Evolve



Grid Defection
Loosely
connected
Islands of Self
Generation

**Distributed
Resource
Connected to
Grid but not
Integrated**

**Connection
Rules Require
DER to
Provide Grid
Voltage/VAR
and Fault
Ride-Through**

**Guided
Deployment of
DER
Integrated
with
Distribution
System
Operation**

**A Fully
Integrated
Grid with
Market/TSO/
DSO/DER
Coordinated
Planning &
Operation**

**Policy, Interoperability Standards, Market & Interconnection
Rules and Technology will Drive Transformation**

Power System Transformation



Generation Cycling and Flexibility



Grid Operations & Planning



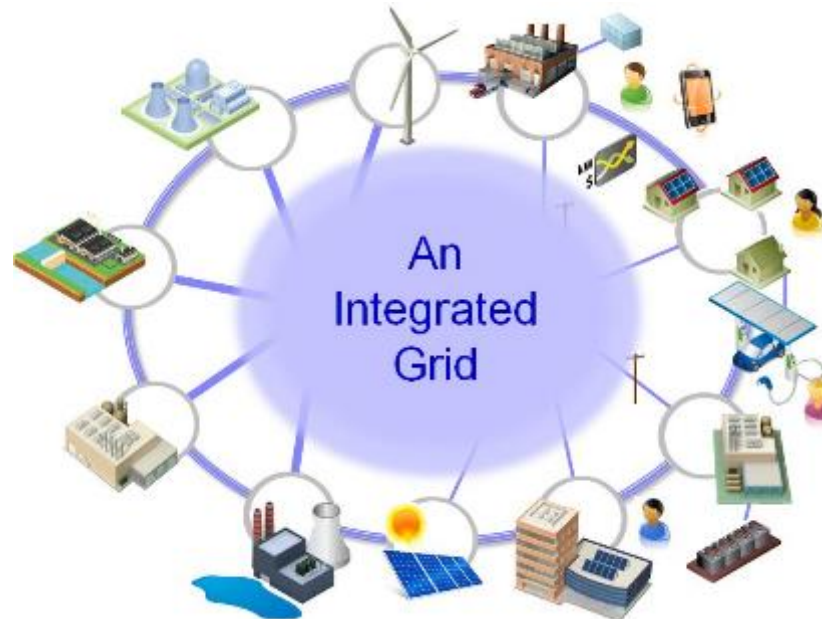
Renewable Integration and Energy Storage



Distribution



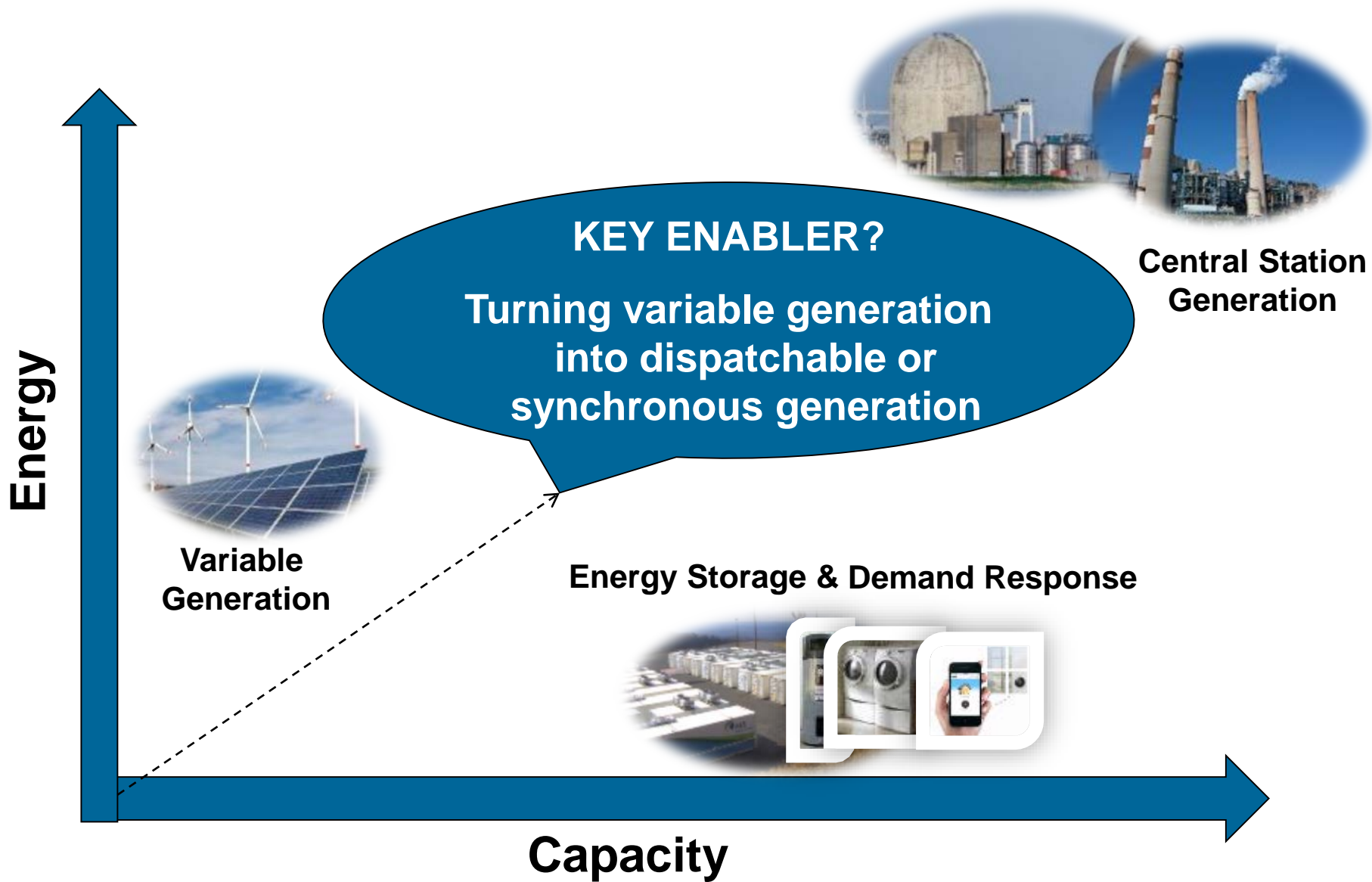
Information and Communication Infrastructure



Energy Utilization

Question is not “if” or “when” the change will come...but rather how fast

Technology Evolution and Impact on Capacity and Energy

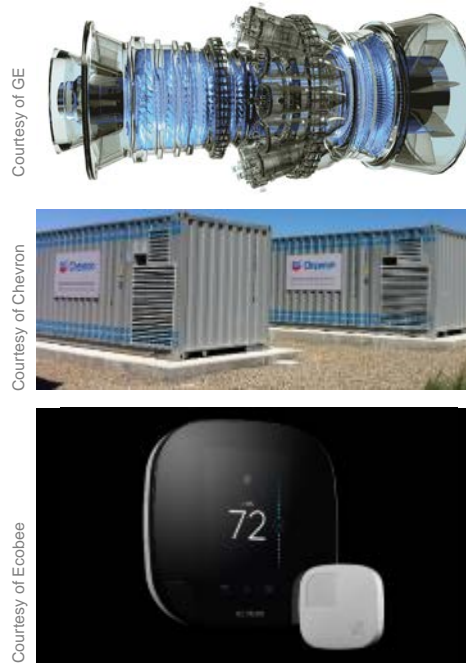


Integrated Grid Enables a Transition to Cleaner Electricity and Enables Integration of Energy

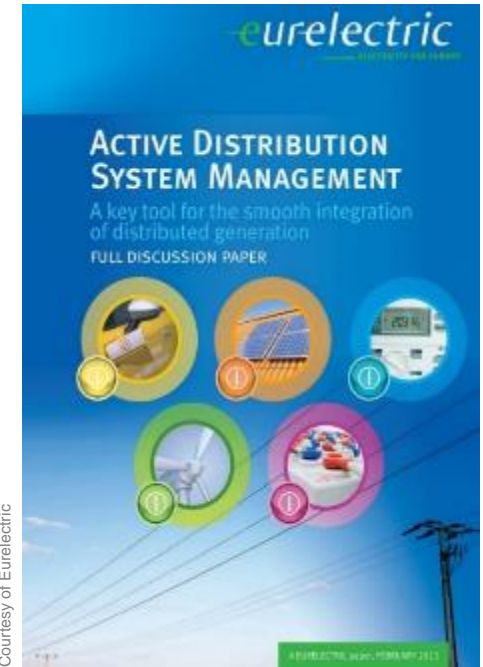
Transmission



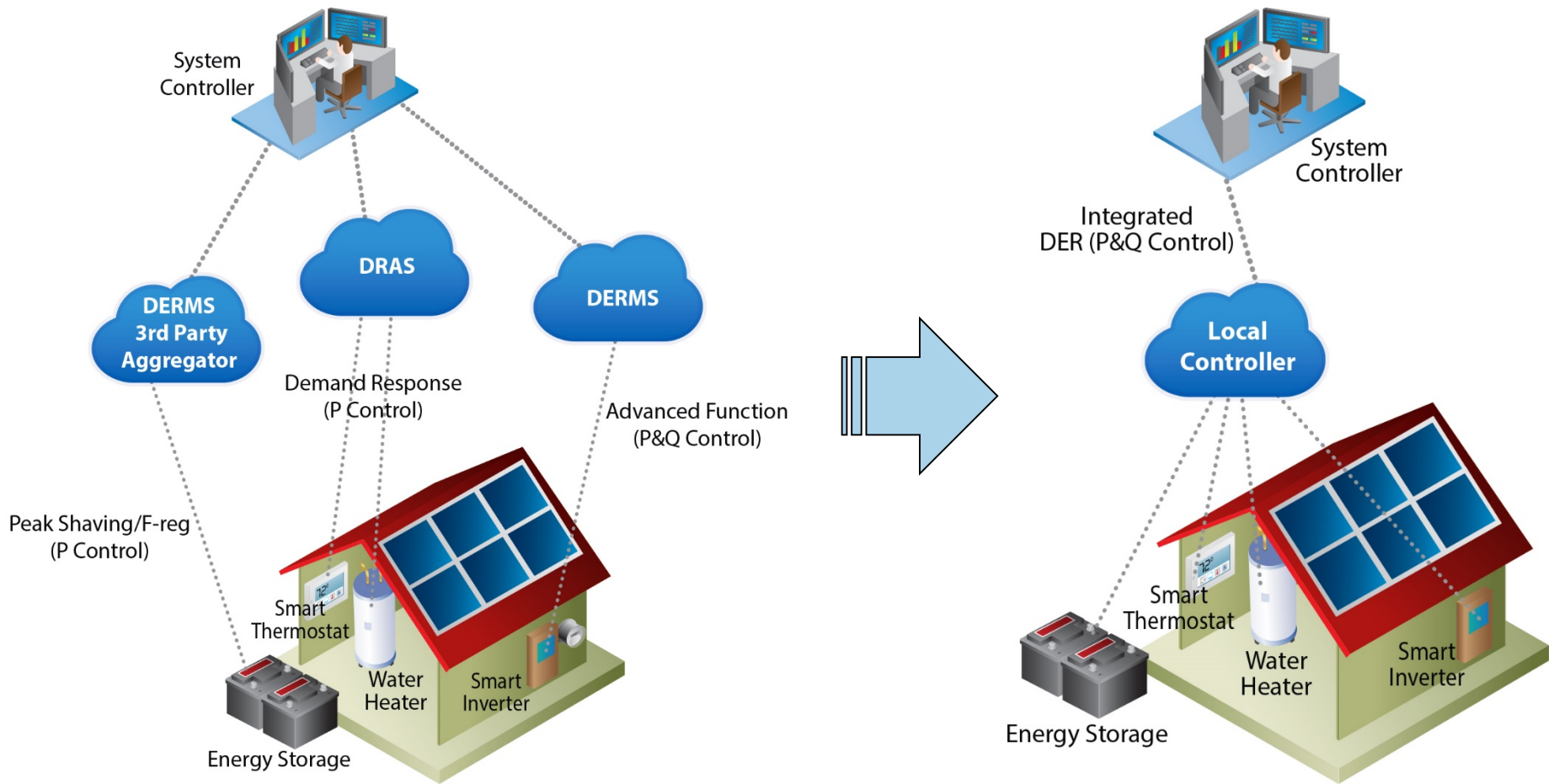
Flexible Resources



Smart Distribution



DER – Today vs Tomorrow



How The Grid Will Evolve: Possible Outcome
Interconnected -> Integrated

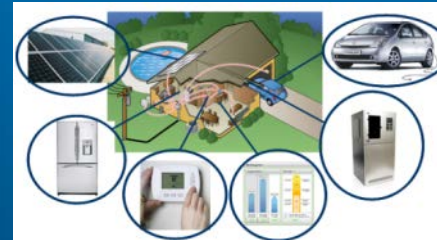
Key Elements within the Integrated Grid

Architecture for the Integrated Grid



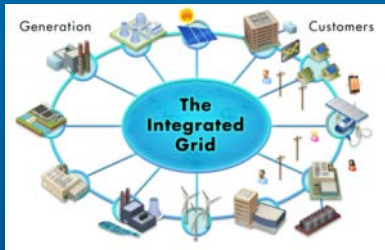
- Information and Communication Infrastructure
- Enterprise Interoperability
- Distributed Controls
- Open Application Platforms
- Cyber Security

Dynamic Customer Engagement



- Energy Efficiency
- Voltage Response
- Demand Response
- Local Generation and Storage (EV)
- Resiliency
- Customer Services
- CIS

Integrated Planning and Operations



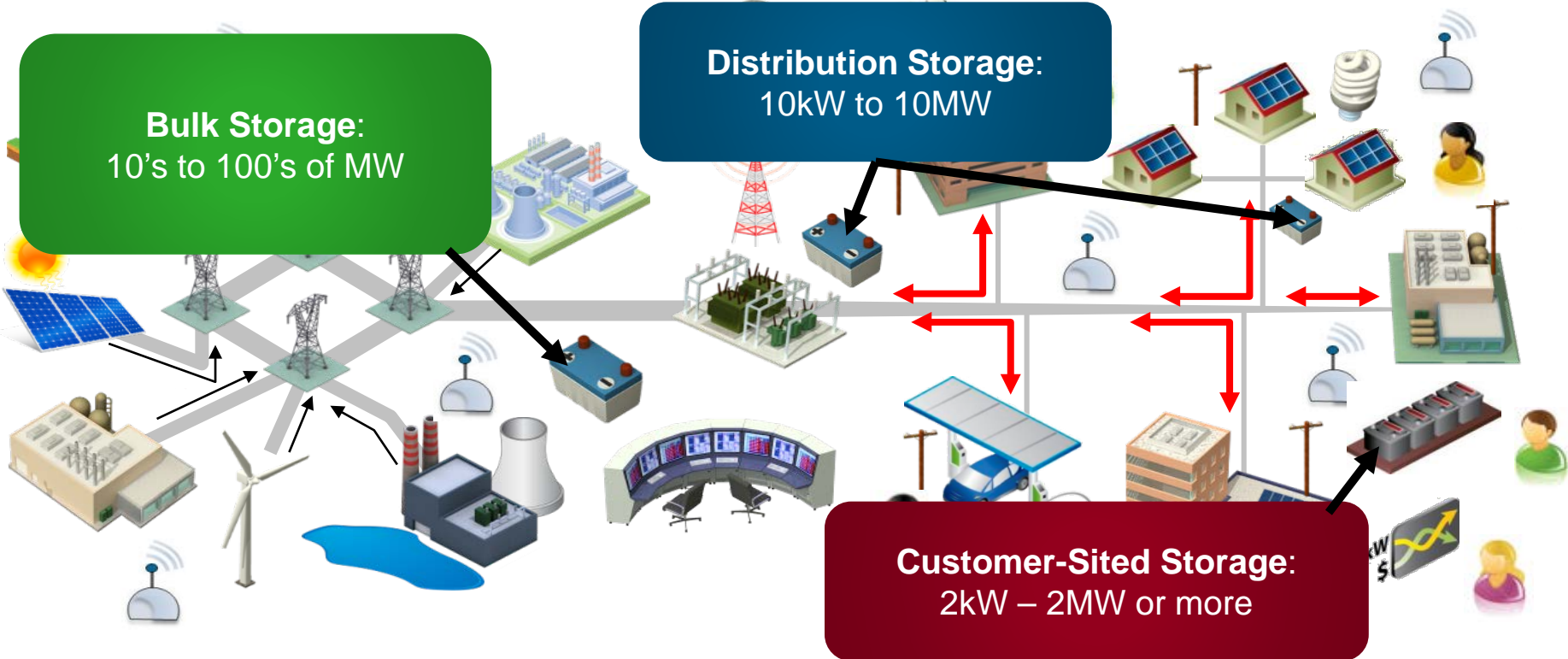
- Integrated Models
- Advanced Simulation
- Real Time Systems
- Distributed Controls and Demand Response
- Risk-Based
- Forecasting and Analytics
- Visualization

Advanced Asset Management



- Sensors and Communications
- Advanced Analytics
- Maintenance and Diagnostics
- Reliability and Resiliency
- Visualization and Decision Support

Storage Anywhere



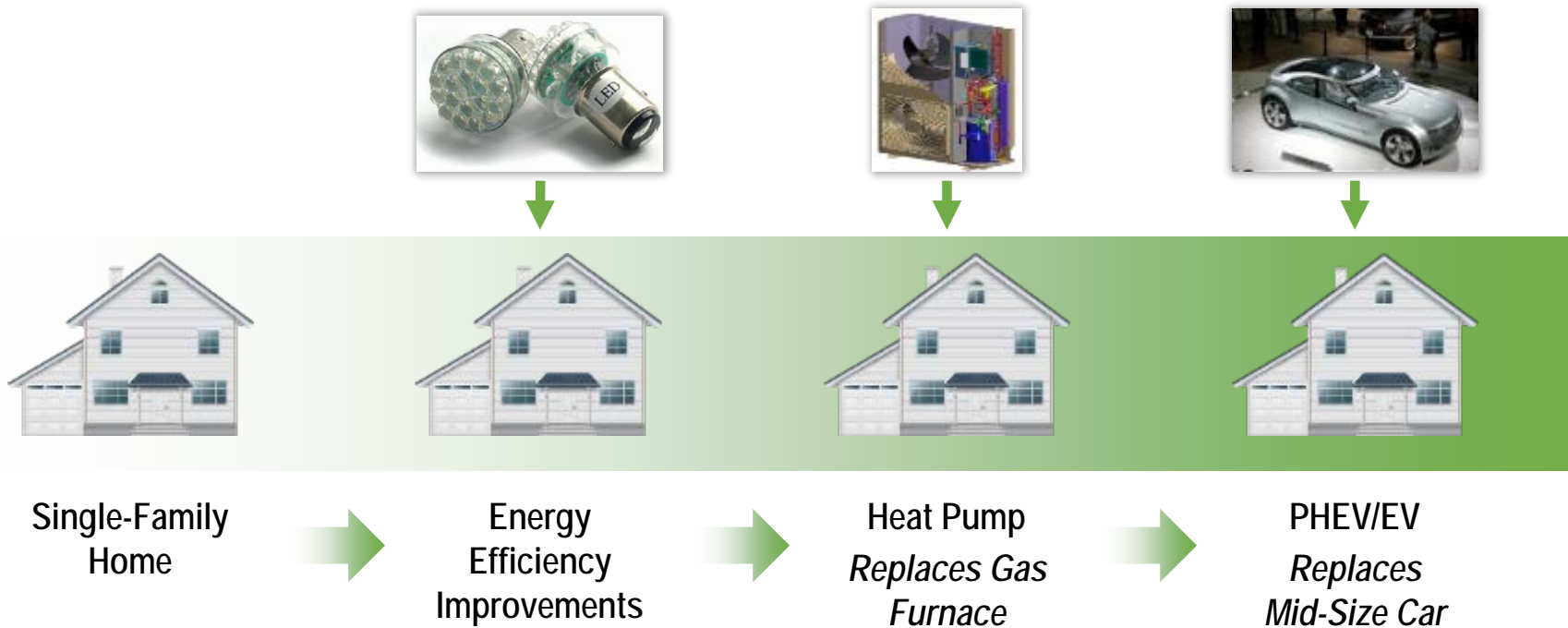
Almost limitless permutations of storage and other resources are possible

Energy Storage Can Serve Multiple Uses

- **Capacity Resource:** Peaker replacement or non-wires alternative
- **Flexibility Resource:** System ramping, renewable variability and uncertainty
- **Reliability / Resiliency Resource:** Electricity inventory for reserves
- **Voltage / Power Quality Resource:** Power conditioning system capabilities



Using Cleaner Energy – A Customer’s Perspective



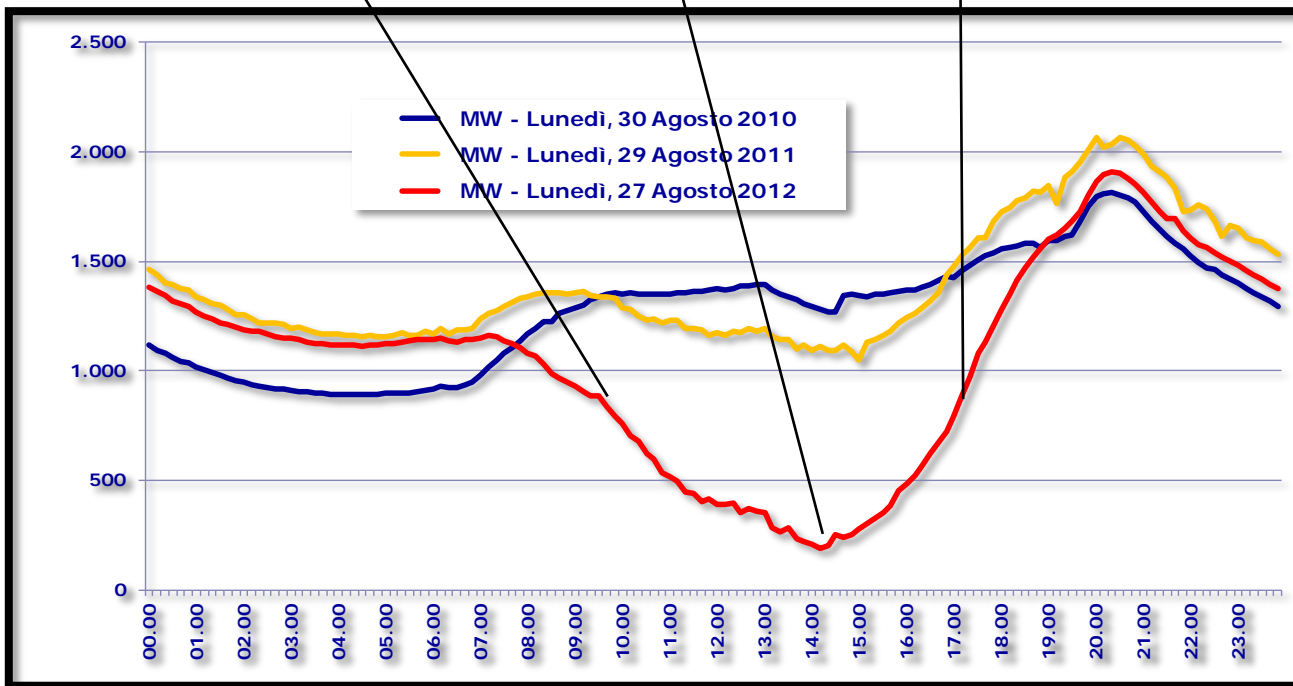
Electrification and efficiency are steps to reduced emissions you can take today

Example of Technology Demonstration

DER as a Load Shaping Tool



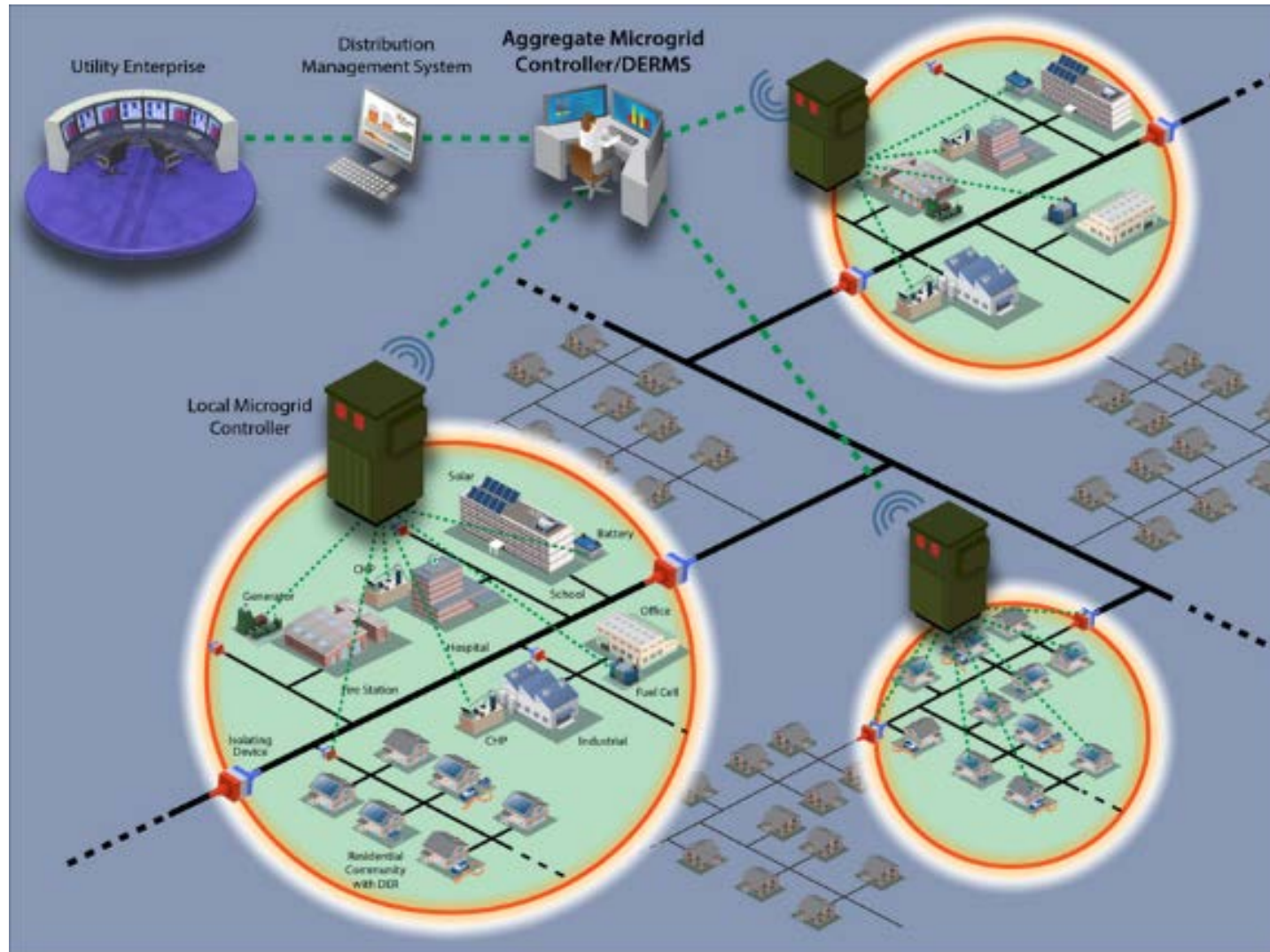
What can impact of DER be on the overall load shape?



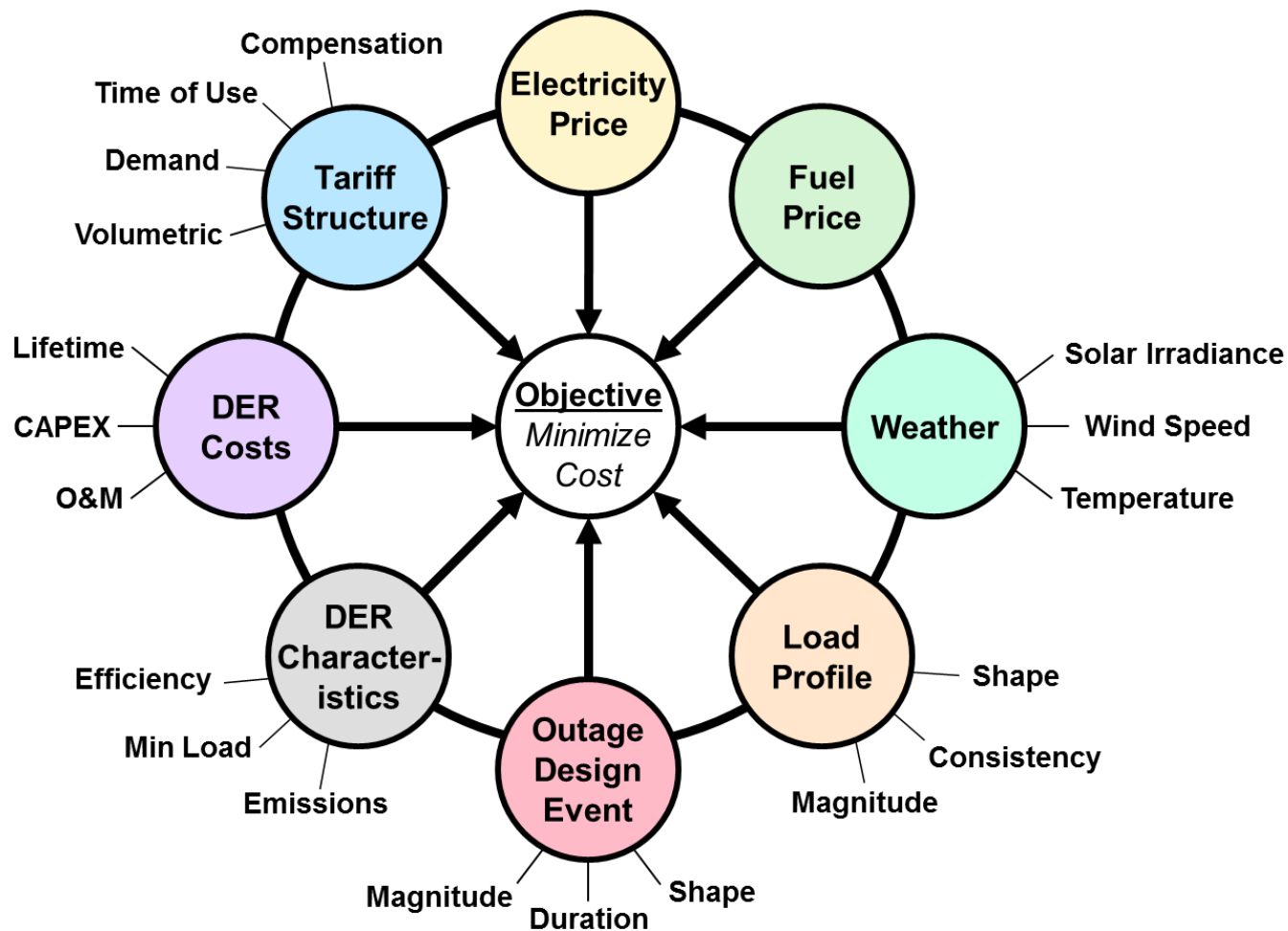
Source;
ENEL –
Measured
Data from
Southern
Italy

Example of Technology Demonstration

Grid Interactive Microgrids



Key Parameters Impacting Microgrid Cost



A variety of factors, many interconnected, impact the overall design and cost of a microgrid. Certain factors are considered fixed inputs (i.e. assumptions) while other factors are varied to in order to evaluate the sensitivity of their impact on overall cost.

The Integrated Energy Network and Efficient Electrification Enables:”



“Advanced Energy Cities”

And

“Smart Cities”

DOE SHINES Project: Beneficial Integration of Solar, Storage, and Load Management



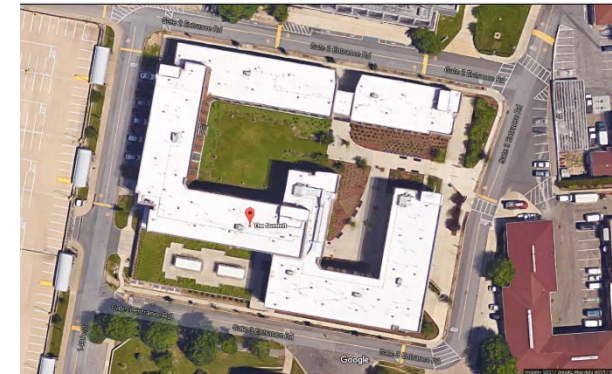
Case Western Reserve University (CWRU) Cleveland, OH

PV-50kW, ES-50kW/200kWh



Residential Demo Site, Pensacola, FL

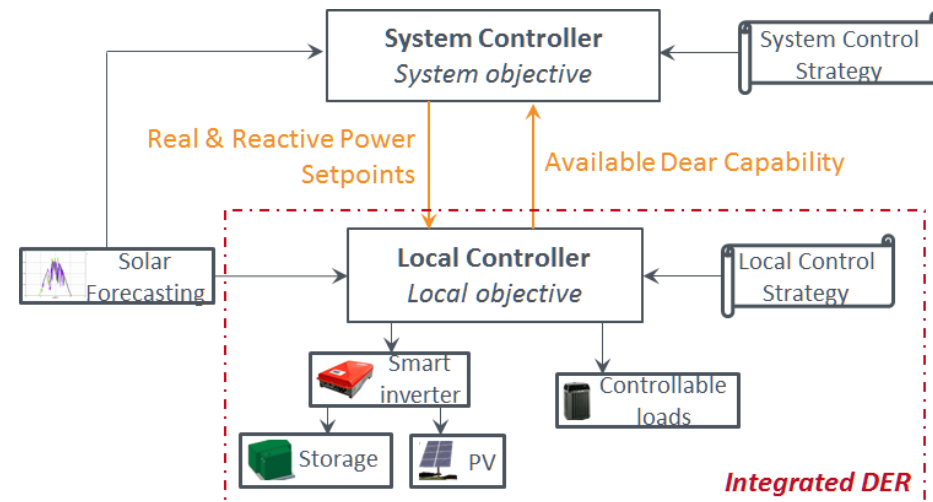
PV-10kW, ES-14kW/40kWh



CUNY, Queens Flushing, NY

PV-50kW, ES-100kW/200kWh

- **Making the grid ready for seamless integration of solar plus storage to support customer choice**
 - *while optimizing the electric system: technically and economically*
- **Making solar plus storage more operationally integrated**
 - *in a cost competitive manner*
- **Improving the value proposition of solar plus storage and other distributed energy resources**
 - *extending benefits beyond customer premises*





Together...Shaping the Future of Energy