



Shaping the Future of Energy

*Insights from
EPRI's Research*

Anda Ray
Senior Vice President
Energy, Environment and
External Relations -
Chief Sustainability Officer

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Electric Power Research Institute



Technology Innovation

Storage: Bulk to Micro



Cleaner Energy



Electrification



24x7 Quality & Capacity



Resiliency



24/7 Communications



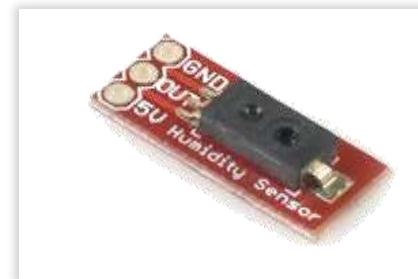
Energy Efficiency and Automation



Microgrids



Microsensors



Analytics

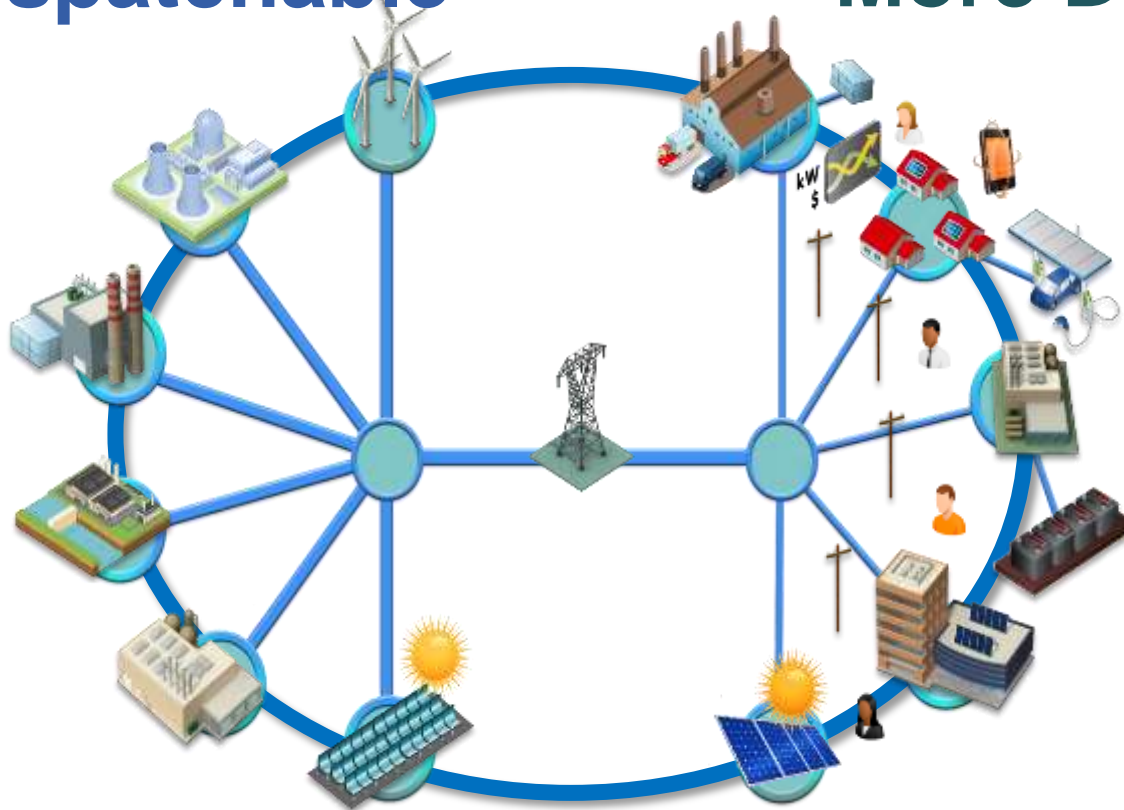


- Acceleration 25:8
- Breadth & Depth
- Integration

Electric System

Less Dispatchable

More Dynamic

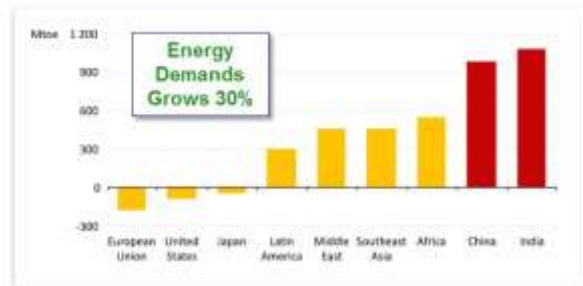


Less Forecastable

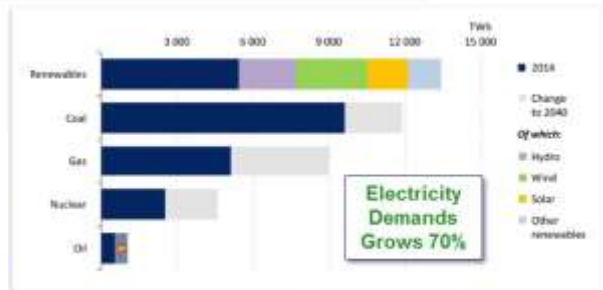
More Interactive

Energy and Emissions

ENERGY: Smarter Global Demand and Use of Energy



Increased Energy Demand, 2014-2040



Increased Electricity Demand, 2014-2040

EMISSIONS: Global Focus on Economy-wide Emission Reduction

Large Corporations Curbing Carbon Emissions



Certification Standards



International Agreements



Global Focus: Smarter Energy with *Significantly* Reduced Emissions

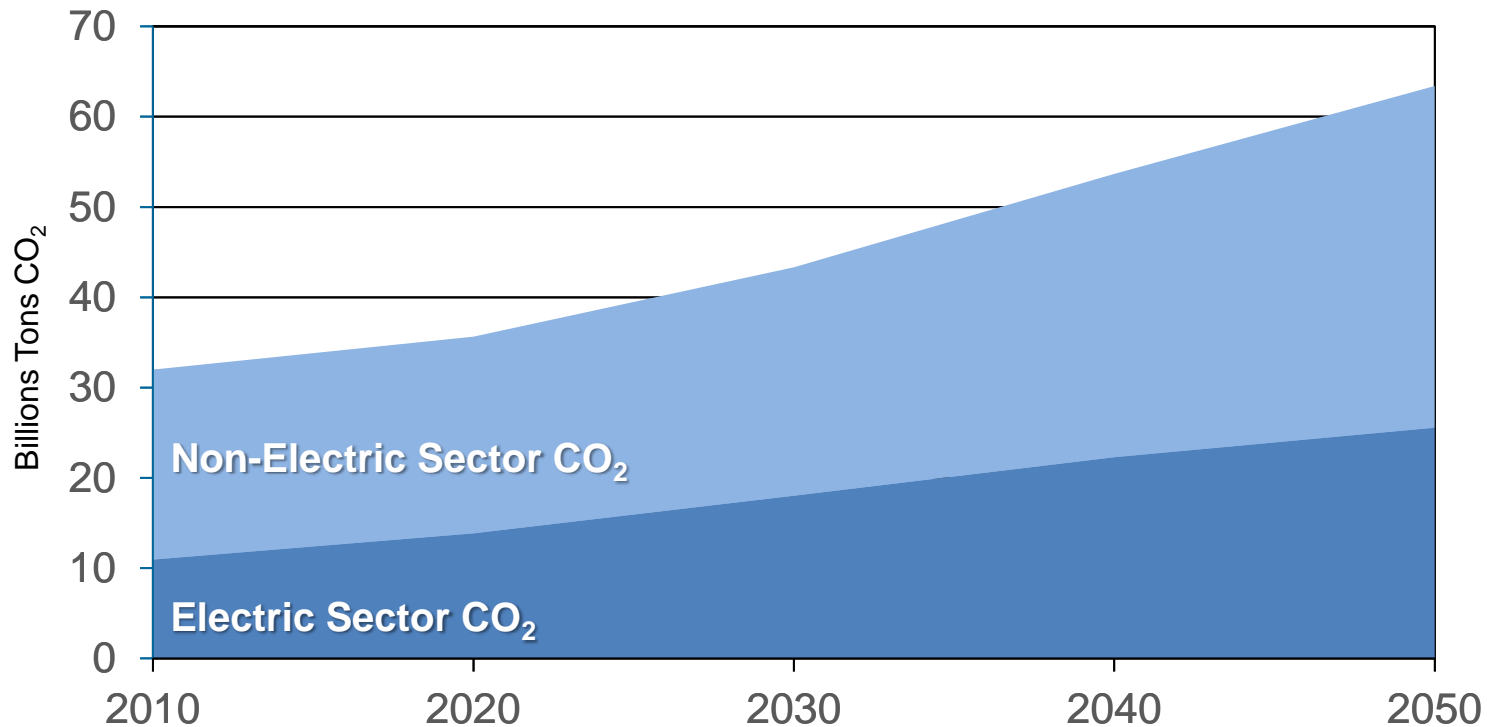
Integrated Energy Network™



***“Connecting customers
with reliable, safe,
affordable and cleaner
energy”***



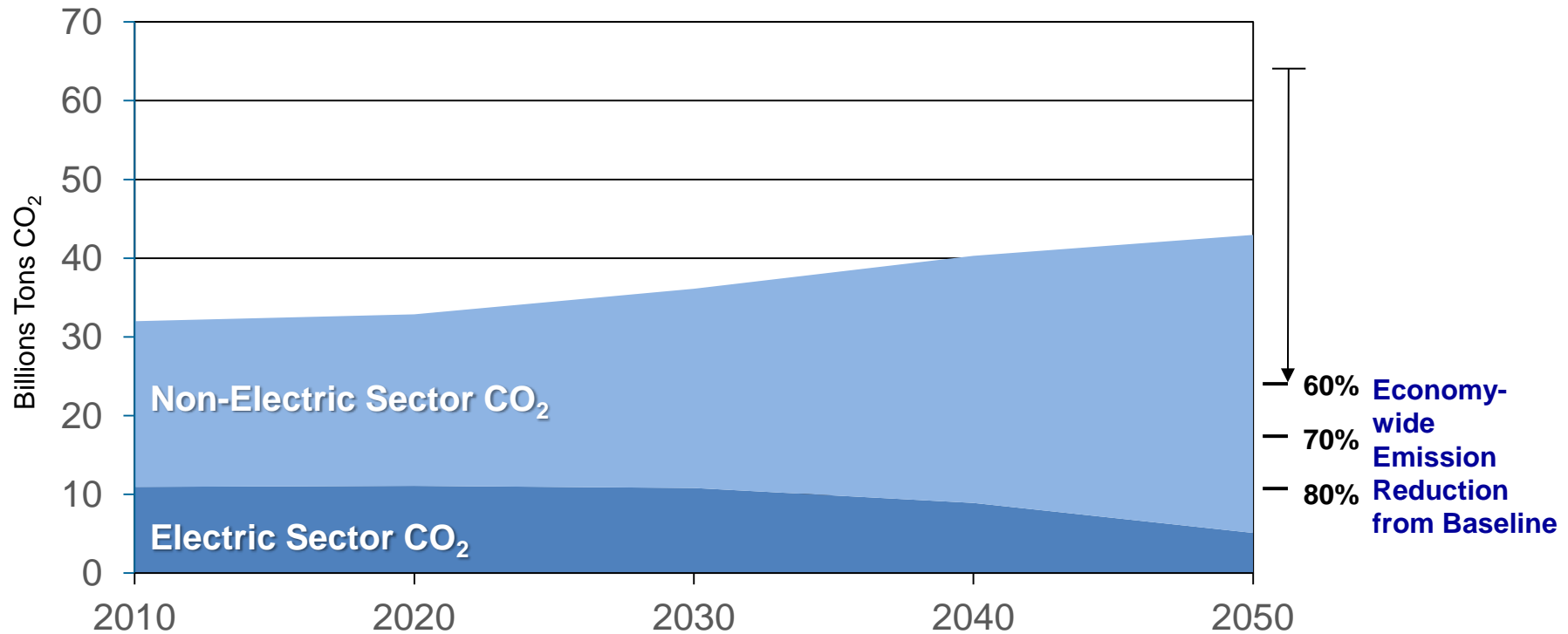
Projected Global CO₂ Emissions



Source: EPRI MERGE Baseline Projection for Global CO₂ Emissions with Electric Sector 80% Reduction

Efficiency and Electrification enable other sectors of the economy to decarbonize affordably

Challenge: Economy-wide CO₂ Emission Reduction



Source: EPRI MERGE Baseline Projection for Global CO₂ Emissions with Electric Sector 80% Reduction

Electrification is Part of the Answer for Reducing Economy-wide Emissions

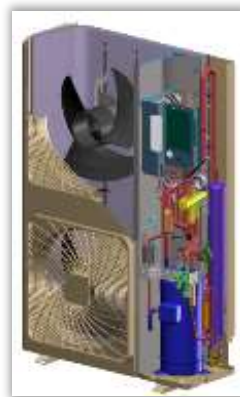
Pillar I - Using Cleaner Energy Through Efficiency and Electrification



“Efficiency and electrification enable other sectors of the economy to decarbonize affordably”



Using Cleaner Energy Through Efficiency and Electrification



Single-Family Home

Energy Efficiency Improvements

**Heat Pump
*Replaces Gas Furnace***

**PHEV/EV
*Replaces Mid-Size Car***

Pathway of Cleaner Energy Use ~2050



**Efficiency and
Electrification**

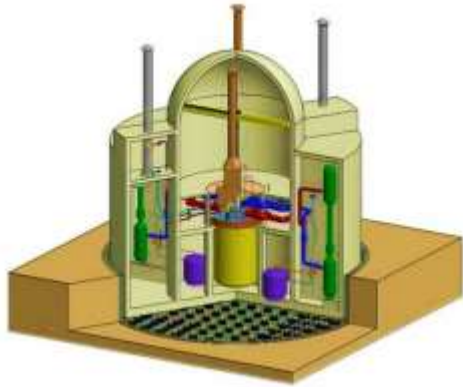
Pillar II – Producing Cleaner Energy



“Reducing emissions from the production of electricity and other forms of energy”



Producing Cleaner Energy



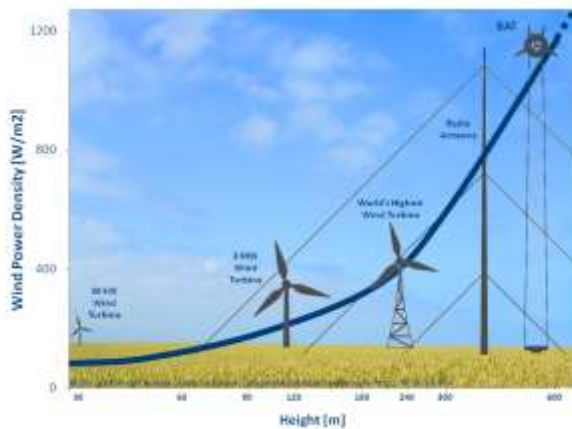
Generation IV Nuclear
(co-production – electricity,
hydrogen steam)



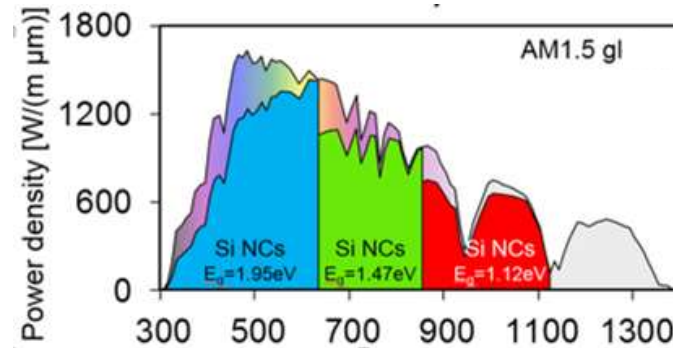
Large-Scale Storage



**Coal and Gas Carbon
Capture and Sequestration**



High-Altitude Wind



Gen III Photovoltaic (PV)
(e.g., High power density PV cells)

Pillar III – Integrated Energy Resources

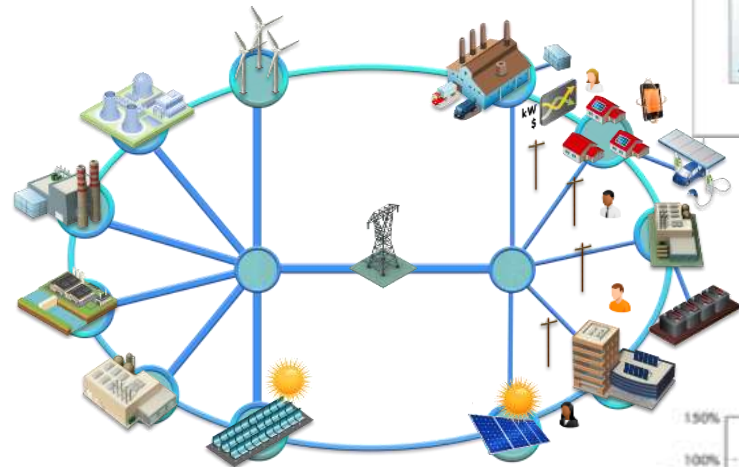


***“The Integration of Electrons,
Molecules and Bytes”***

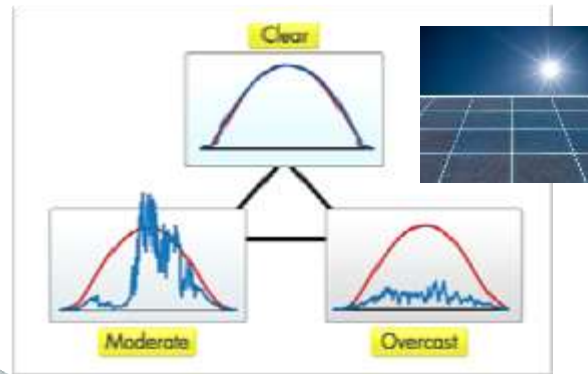


Integrating Energy Resources

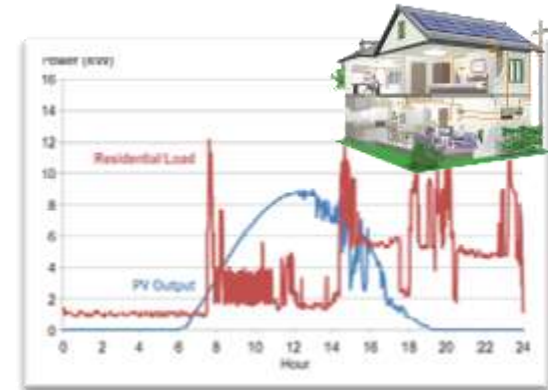
The Value of the Grid



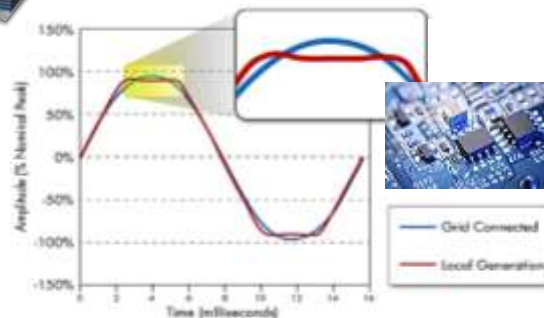
24 by 7 Electricity



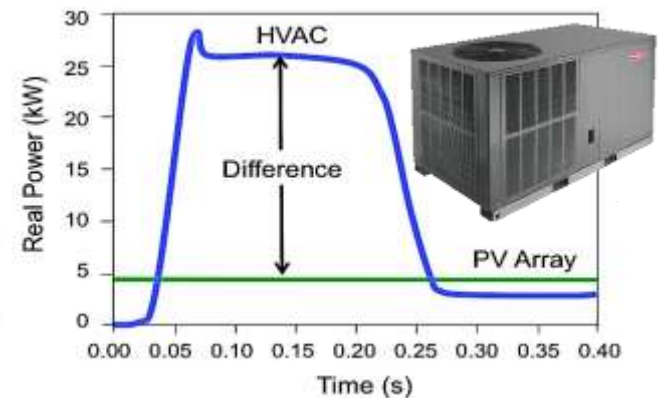
Supply and Demand



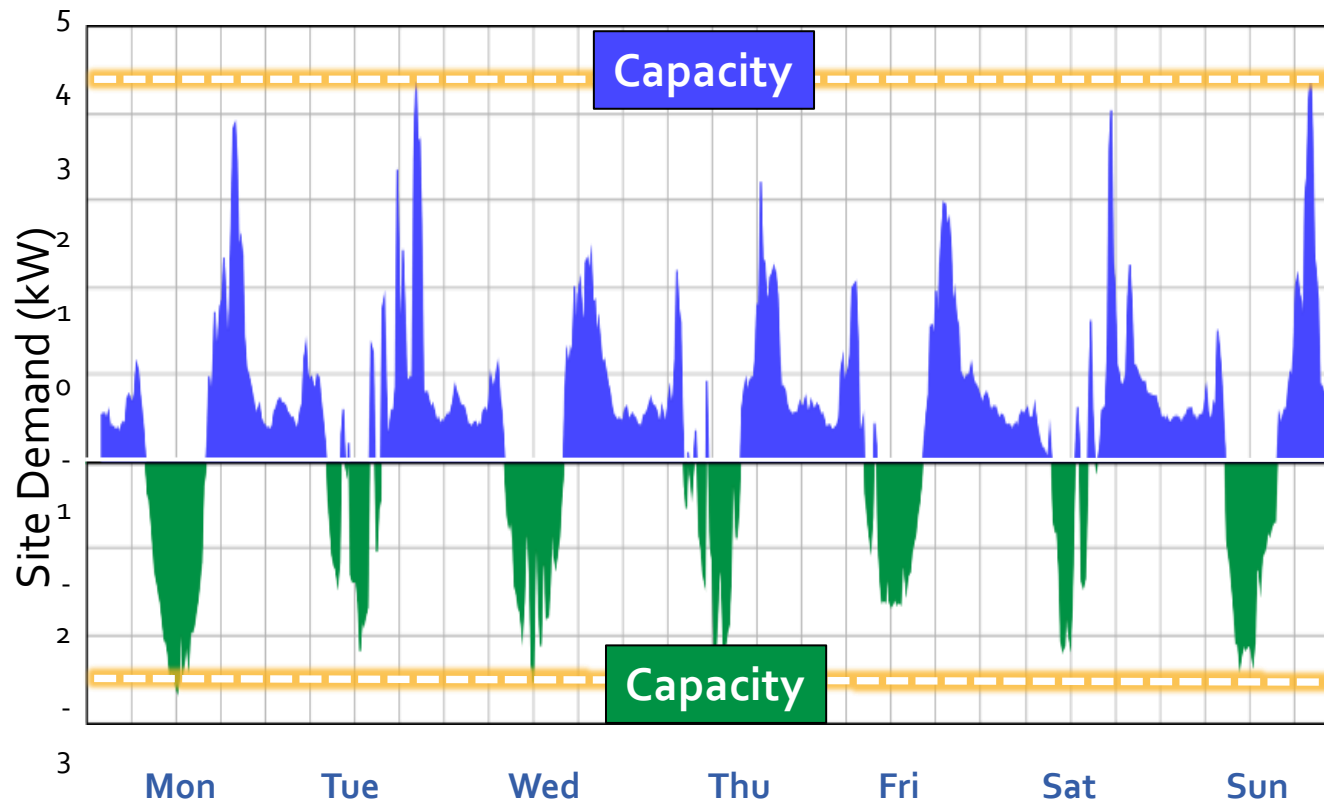
Voltage Quality



Startup Power



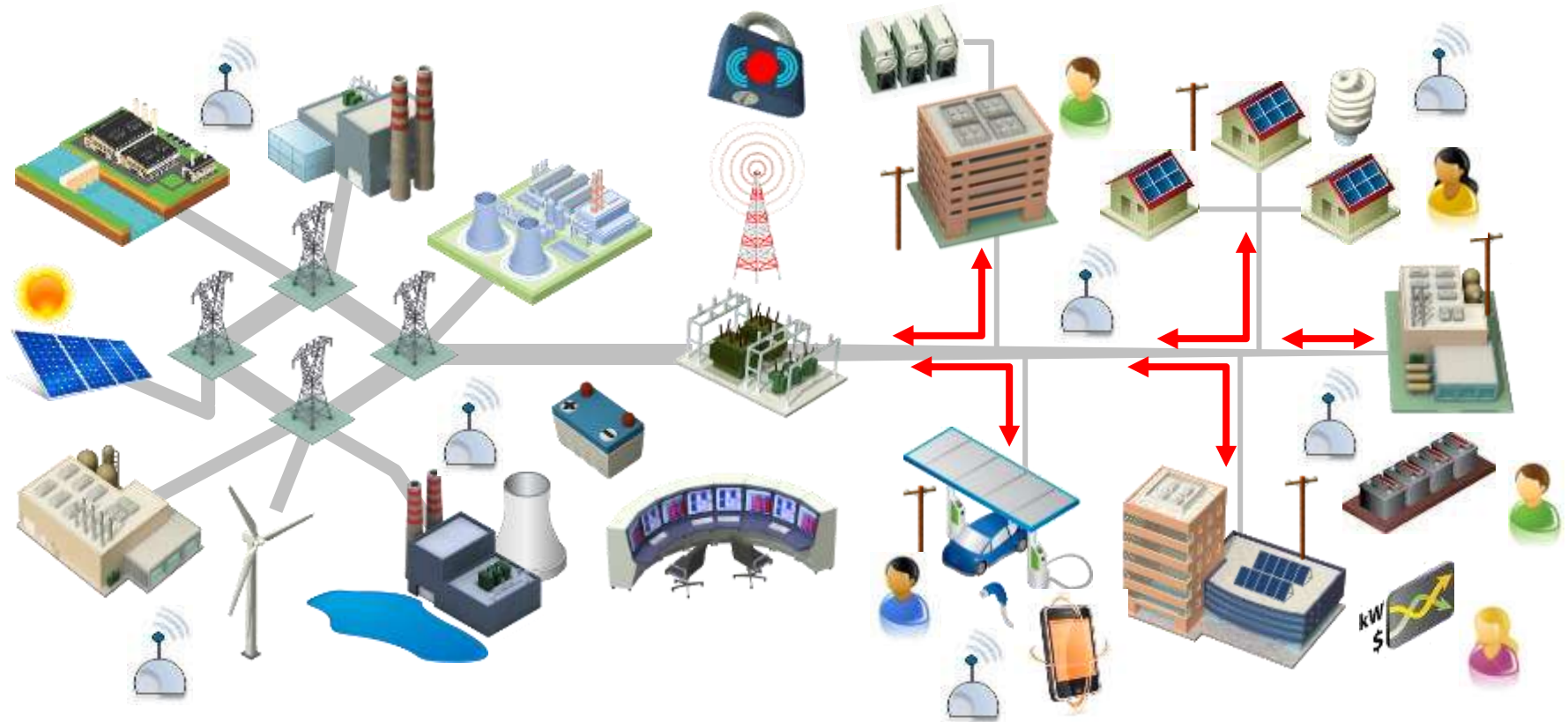
Integrating Energy Resources



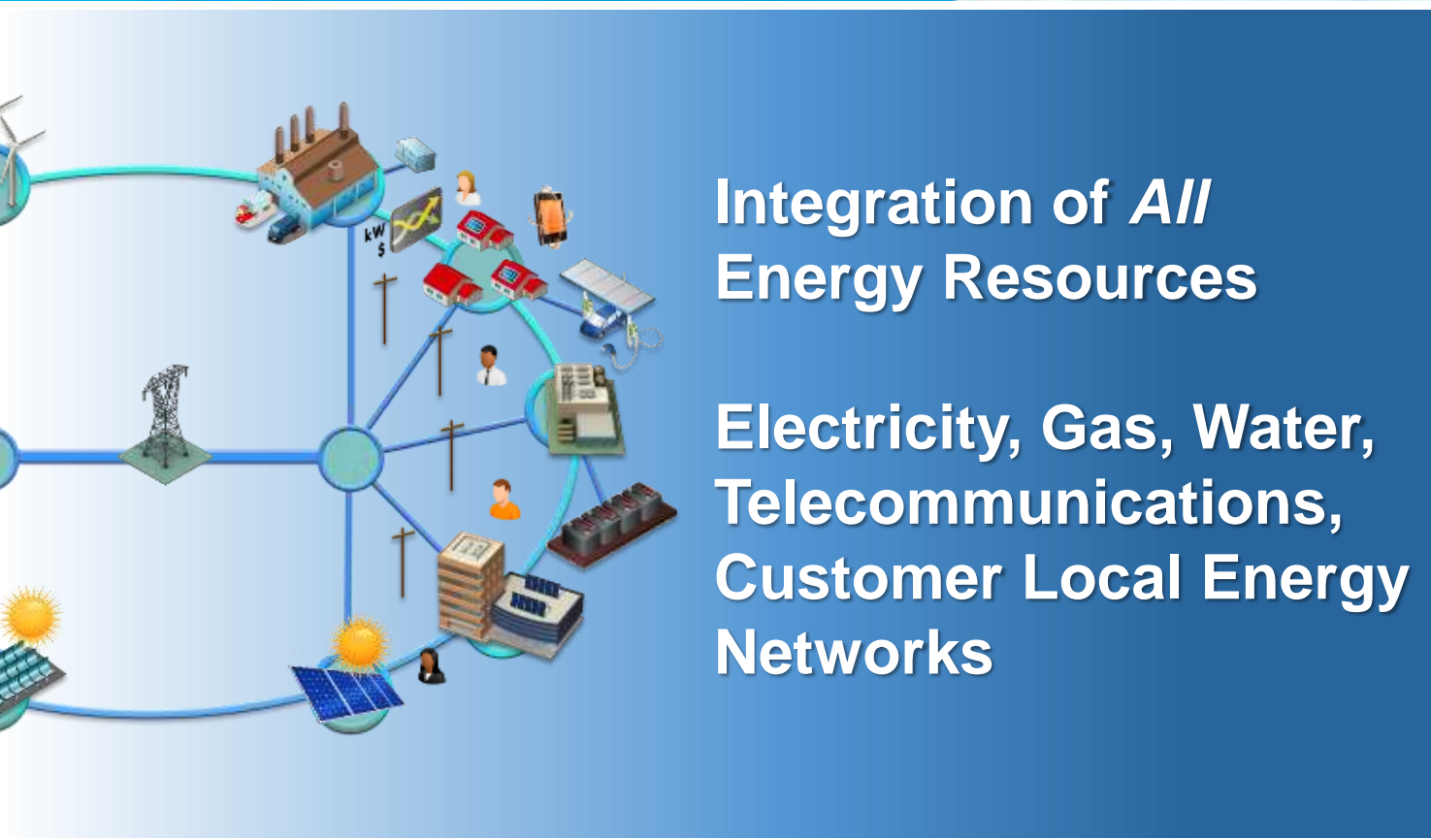
**Capacity... Reliably Deliver Energy Every Second,
Every Place**

The Changing Consumer

Distributed Energy and “The Internet of Things”



Technology, Policy and Customer Preferences are Changing the Electricity Business: *Integrated Grid*



Electricity, Gas, Water, Telecommunications, Customer Local Energy Networks

Enables Optimization of Local and Central Energy Resources

Integrated Electric Grid: Enables Electricity and Transportation Interface



- **National Charging Infrastructure Deployment**
 - >\$1B US of utility-owned/operated infrastructure
 - Utility web portal data access and analytics, billing interface



- **Electricity Grid-to-Vehicle Interface**
 - Time-of-Use rates and Demand Response signals
 - EV batteries: grid optimization



- **High Power Fast Charging Infrastructure**
 - 150 kW / 350 kW leads to ~1.5 MW / 3.5 MW per “gas station”

Value of the Grid: Electricity to Cleaner Transportation

Increasing Interface: Electricity, Gas and Water Infrastructure



- **Natural Gas and Electricity**

- Pipeline and gas compression/electric generation station
- Electric/gas markets
- Power to gas (H_2) and gas to power (fuel cell)

- **Water and Electricity and Energy**

- Water for electricity and electricity for water transportation
- Electricity for water treatment, e.g., desalination
- Electrotechnology for reducing water use, e.g., microwave drying

Value of the Grid: Electricity to Cleaner Gas and Integrated Water Infrastructure

Shaping the Future of Energy

More Reliable, Affordable Energy

**Cleaner, More Diverse
Energy Portfolio**

**Expanded Customer
Choice, Dynamic and
Individualized
Engagement**

**Highly Connected
Customer Energy
Information**

Innovative, Collaborative Thinking

**Reduced Environmental
Footprint**

**Increased Efficient
Energy Production and
Customer End-Use**

**Growing Energy-
Water Interface**

**Increased Cyber and
Physical Security**



Integrated Energy Network™: A Pathway to the Future



Together...Shaping the Future of Electricity

