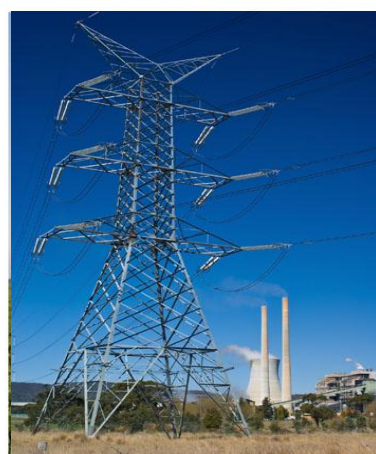


# SMART GRIDS & ENERGY MANAGEMENT



**Walter Schindler**  
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# Smart Grid and Energy Investment



- ***2010 was a record year for smart grid and related investment***
- ***A record \$23.9 billion was invested during 2010 in smart grid, energy management, power storage and electric vehicles***
- ***2010 investment was up 27% over 2009***

*Renewable energy will soon become the 2nd-largest source of electricity behind coal worldwide (international energy agency):*

- Geothermal power production is projected to grow 190% from 2008-2020
- Biomass generation will increase by more than 500% from 2007 to 2030
- 7000MW of Solar PV was installed in 2009
- Number of solar PV jobs is expected to grow 10X in the next 10 years
- Growth in renewable sources of energy is driving the worldwide demand for energy storage

# Government Investment



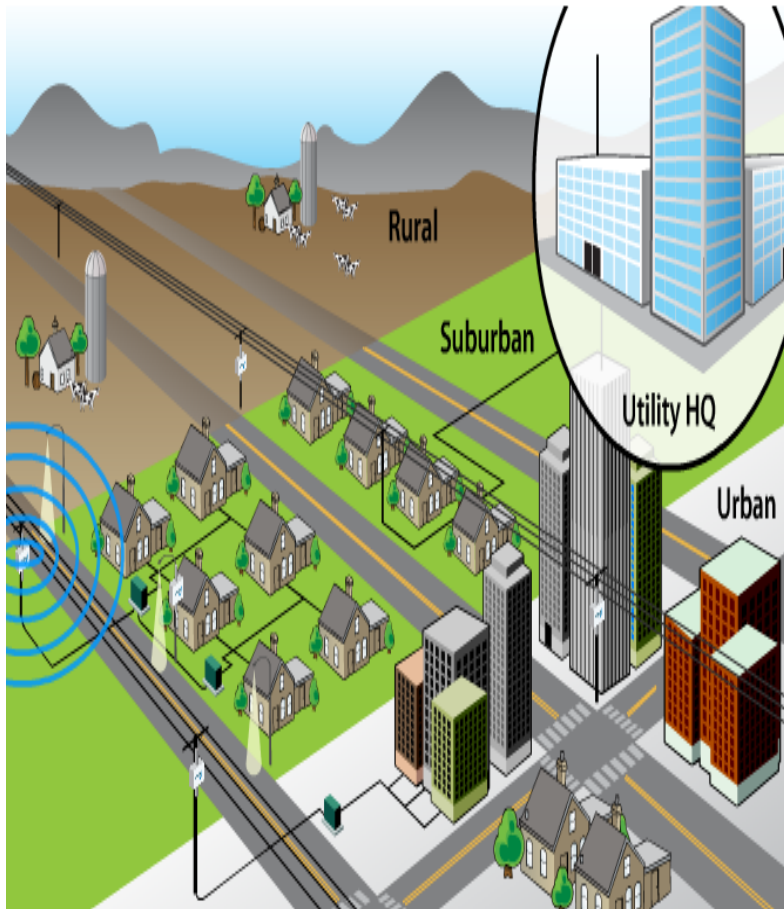
- Department of Energy will develop training programs for nearly 30,000 Americans, \$100 million to support 54 smart grid projects
- DOE states they will do more to support in the future:

1. Thermal Storage
2. Biofuels and biomass
3. Battery and storage
4. Clean coal and carbon capture



- The Obama economic recovery plan will invest in the modernization of our electricity infrastructure, in order to transform an often-overwhelmed patchwork of balkanized regional networks into a national “smart grid” based on Internet-like technology.

# Energy Infrastructure



- **\$4.5 billion allocated for the smart grid in the American Recovery and Reinvestment Act will accelerate the rollout of a new, intelligent power system.**
- **Today, the North American electricity grid successfully delivers uninterrupted power—over 4 billion megawatt-hours of energy a day—to more than 100 million customers.**
- **According to the U.S. Department of Energy, the demand for U.S. electricity is expected to grow by more than 40 percent by the year 2030.**

# The Smart Grid Defined



***A “smart grid” combines and integrates all of the following with the vision of converging on system-wide digital power management:***

- ***Information and communication technologies that enhance active network monitoring, intelligence and automatic network management of key functions, such as voltage control***
- ***Increased and efficient usage of existing system assets***
- ***Multi-level information sharing among control systems, substations and deployed assets***
- ***Intelligent real-time power management and immediate responsiveness to demand***
- ***Utility-scale energy storage for renewable intermittent sources of power***
- ***Increased cyber security***

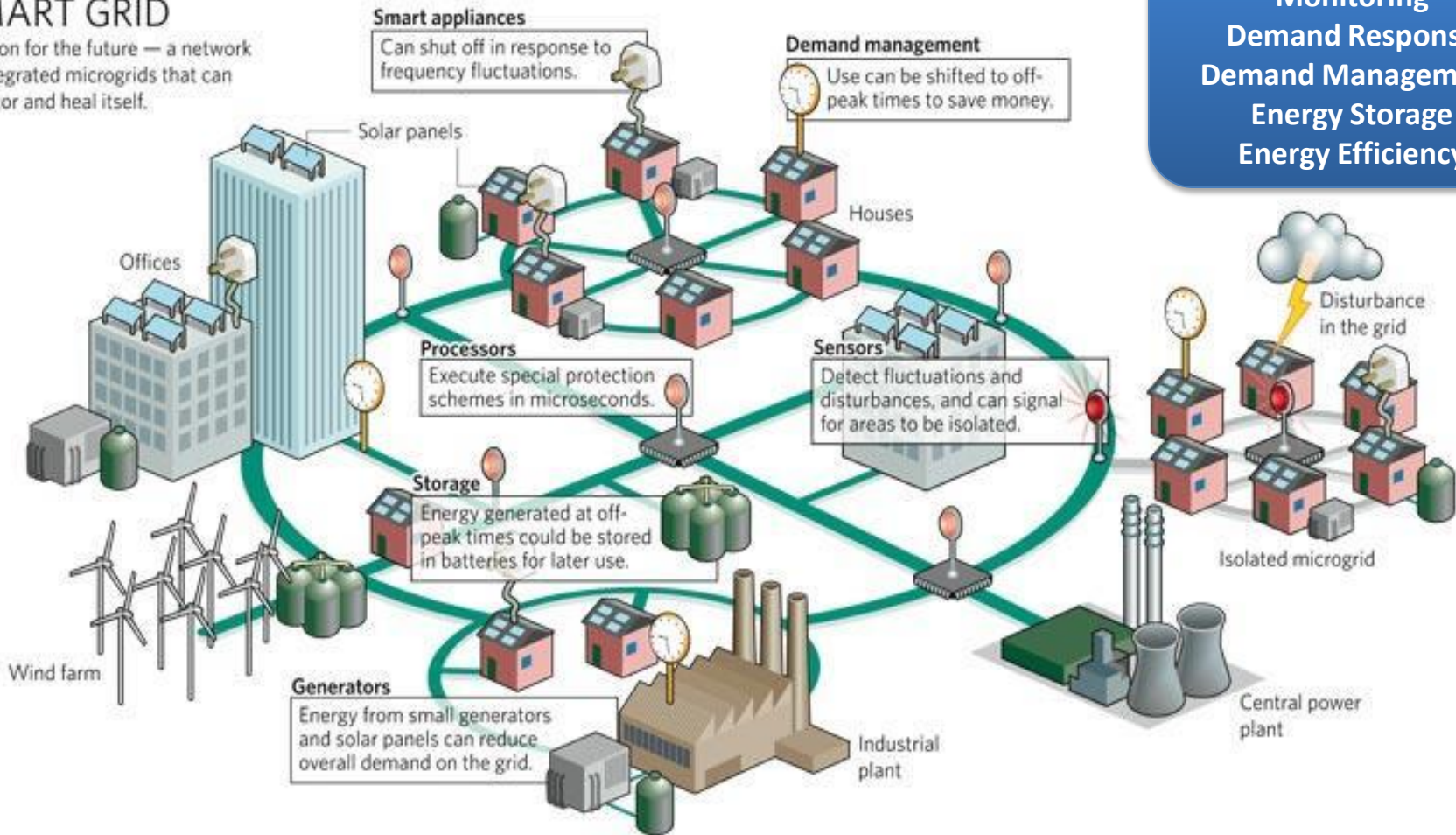
***The grid is stressed by multiple sources of both generation and also load. The grid is only “smart” if it can accommodate these without sacrificing reliability, cost, or quality.***

**Digital power management with integrated storage and fast response is the backbone of this system.**

# The New Grid

## SMART GRID

A vision for the future — a network of integrated microgrids that can monitor and heal itself.



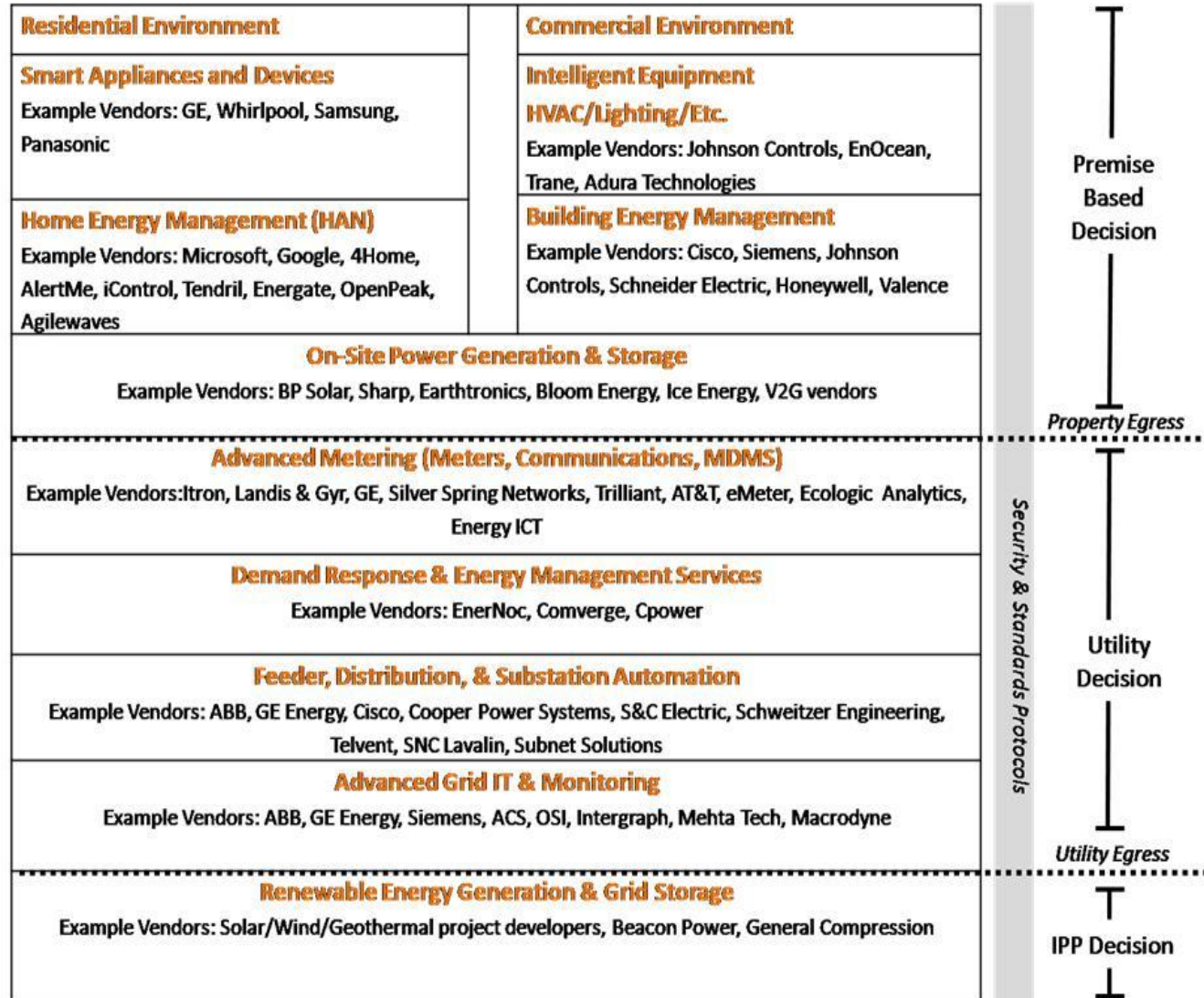
Generation  
Monitoring  
Demand Response  
Demand Management  
Energy Storage  
Energy Efficiency

# Smart Grid is a Multi-Layer Solution



*Relationships among technology, regulation, and consumers will change.*

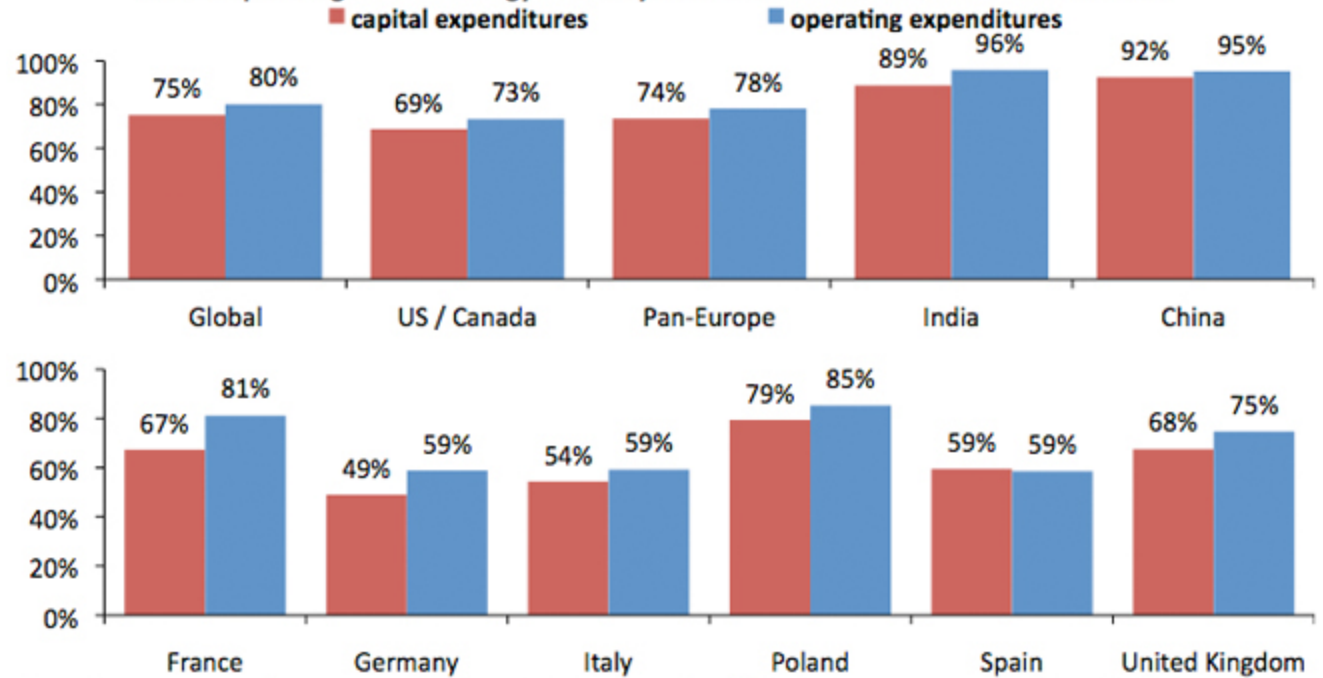
*Some technologies, like energy storage, will overlap several layers and have markets in commercial, residential, and utility applications.*



# Energy Efficiency

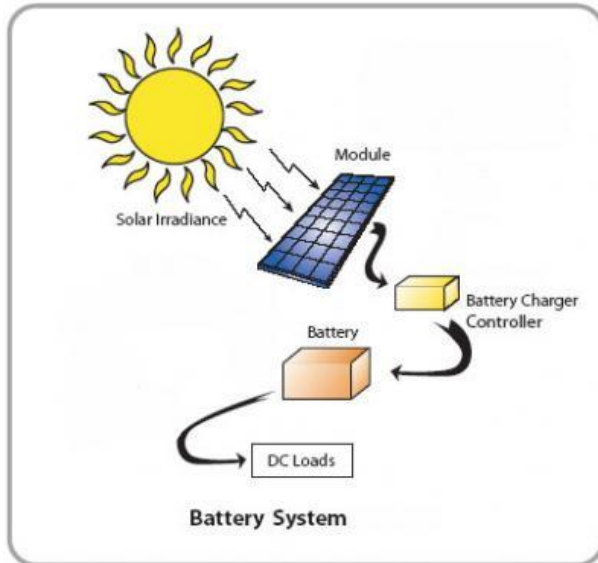


Figure 6. Planned energy efficiency investment, by region (of those responsible for > 100,000 sq. feet)  
**Fraction planning to make energy efficiency investments over the next 12 months with...**



Note: Among respondents responsible for 100,000 square feet / 10,000 sq meter or more (N = 1571)

# Energy Storage



Storage Technologies	Advantages (relative)	Disadvantages (relative)
Pumped storage	High capacity, low cost	Special site requirement
CAES	High capacity, low cost	Special site requirement, need gas fuel
Flow batteries: PSB VRB ZnBr	High capacity, Independent power and energy ratings	Low energy density
Metal-Air	Very high energy density	Electronic charging is difficult
NaS	High power and energy densities, high efficiency	Production cost, safety concerns (addressed in design)
Li-ion	High power and energy densities, high efficiency	High production cost, requires special charging circuit
Ni-Cd	High power and energy densities, efficiency	
Other advanced batteries	High power and energy densities, efficiency	High production cost
Lead-Acid	Low capital cost	Limited cycle life when deeply discharged
Flywheels	High power	Low energy density
SMES, DSMES	High power	Low energy density, high production cost
E.C. capacitors	Long cycle life, high efficiency	Low energy density
Dry cell, E.C. capacitors	Long cycle life, high power and energy densities, efficiency, high capacity	

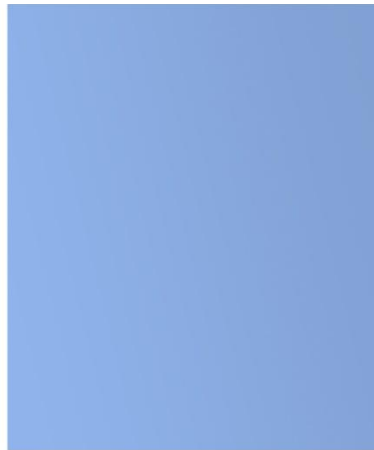
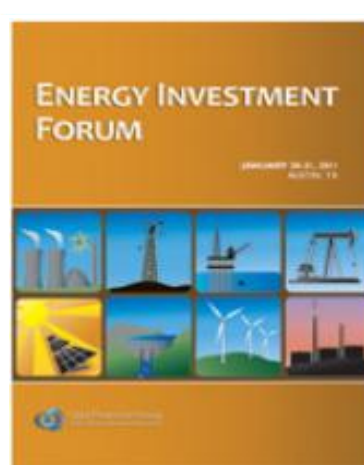
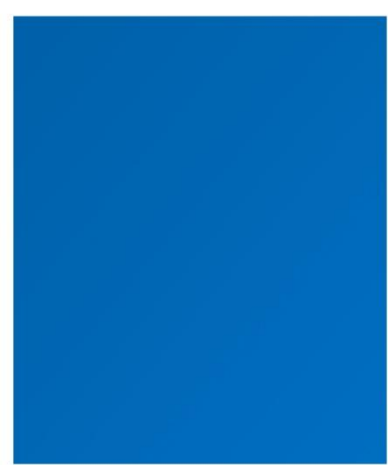
Source: Electricity Storage Association

# SAIL's Investment Strategy



- *Pursue the largest global markets*
- *Co-invest with corporate partners*
- *Diversify within subsectors of large markets*
- *Evaluate technology and markets on a global basis*
- *Exploit global inefficiencies in pricing IP assets*
- *Invest growth capital in customer-driven companies with rising revenues*
- *Back strong management teams and boards of directors*





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