ECE580

SIU CARBONDALE Southern Illinois University

SMART GRID

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THE OUTLINE

The scope of this presentation is about:

1) **Background:**
- The motivation of smart grid;
- The history of smart grid.

2) **The requirements and characteristics of smart grid.**

3) **The results of the Study Case project.**

4) **Some barriers of smart grid.**

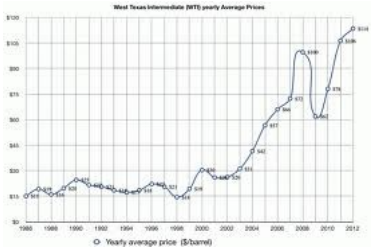
5) **Conclusion**

The Motivation of Smart Grid

Everything's gone SMART

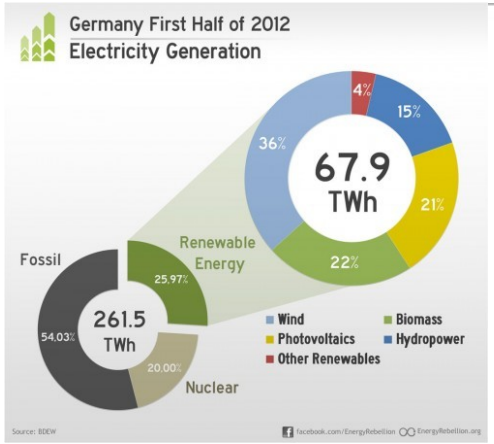
The Motivation of Smart Grid

Scarcity of fossil fuel & price fluctuation;



Concern on Environment;

Notable increase of using renewable resources.

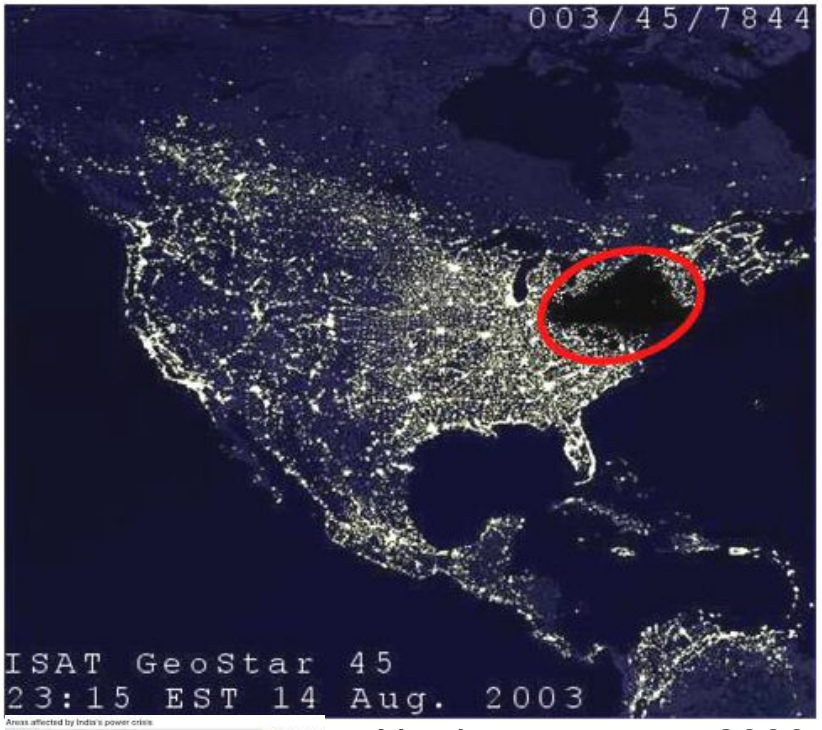


The Motivation of Smart Grid

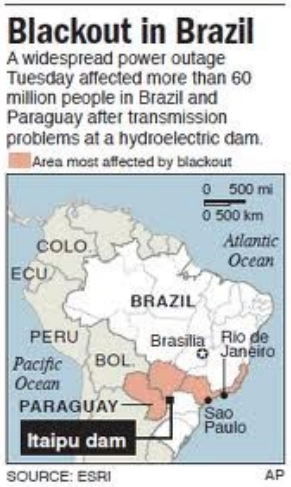
Today's grid Quality Reliability.

Is Electricity always there 24/7?

6 of 7 World's largest blackouts have happened since 1999



Northeast outage 2003



2009

Affected more than 600M

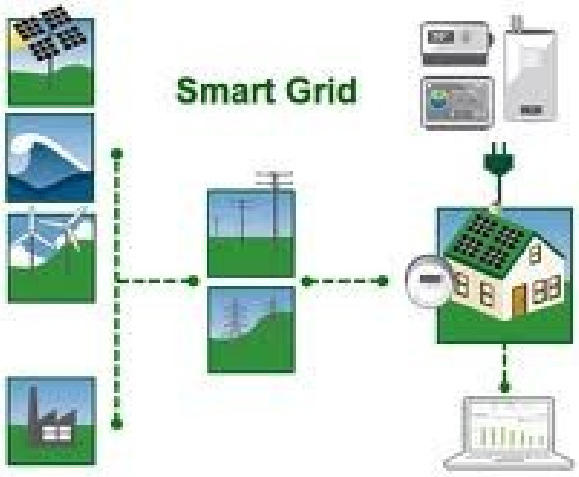
The Motivation of Smart Grid

Crucial reform to meet new market orientations.

Background

Smart Grid is the grid that integrates advanced sensing technologies, control methods, and integrated communications into the current electricity grid.

Definition of Smart Grid
U.S. Department of Energy (DoE)



With much more information & control ➡ More precise system design & operation

Background

Historical Spots:

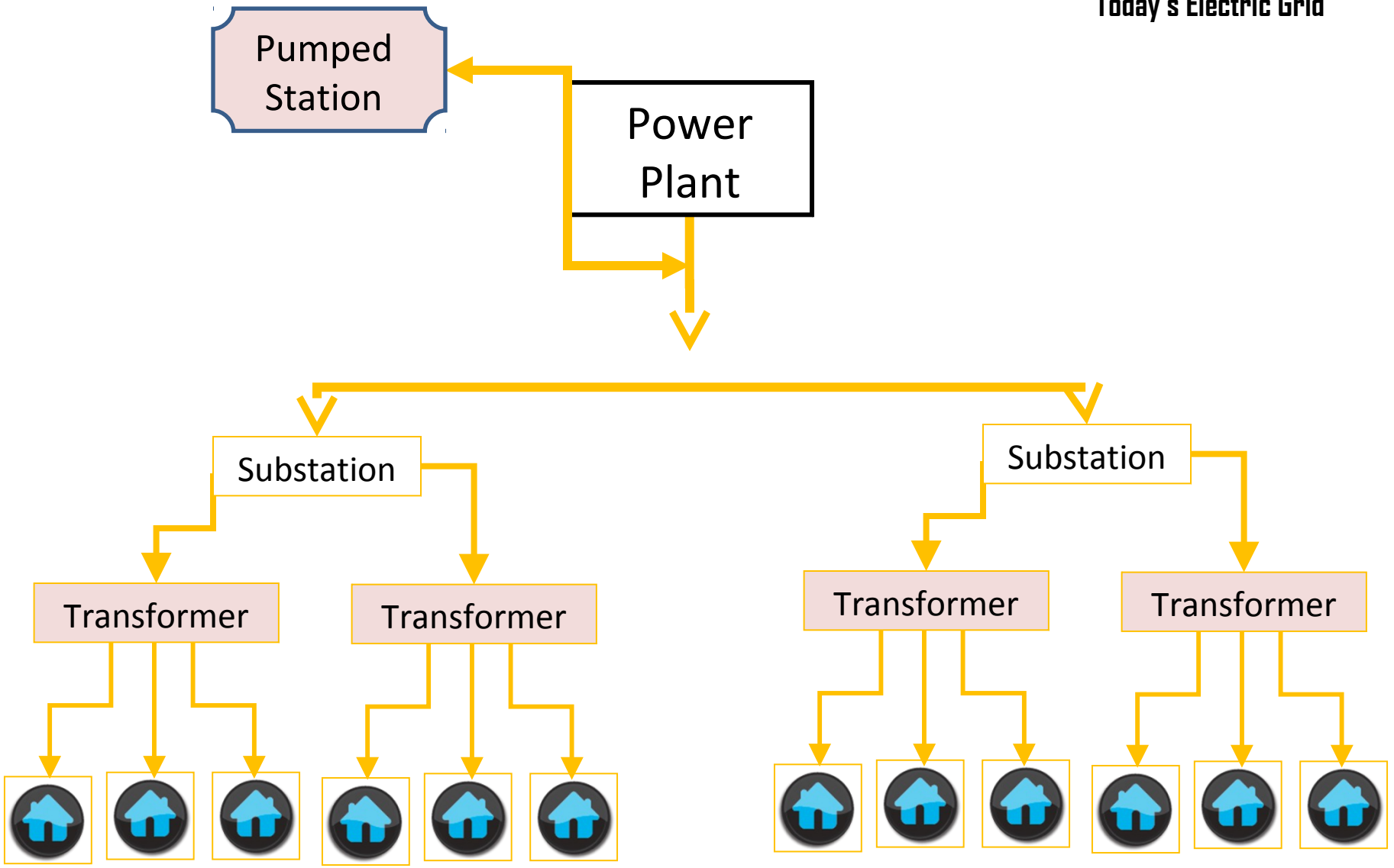
• EU: European Technology Platform Smart Grids in 2005;

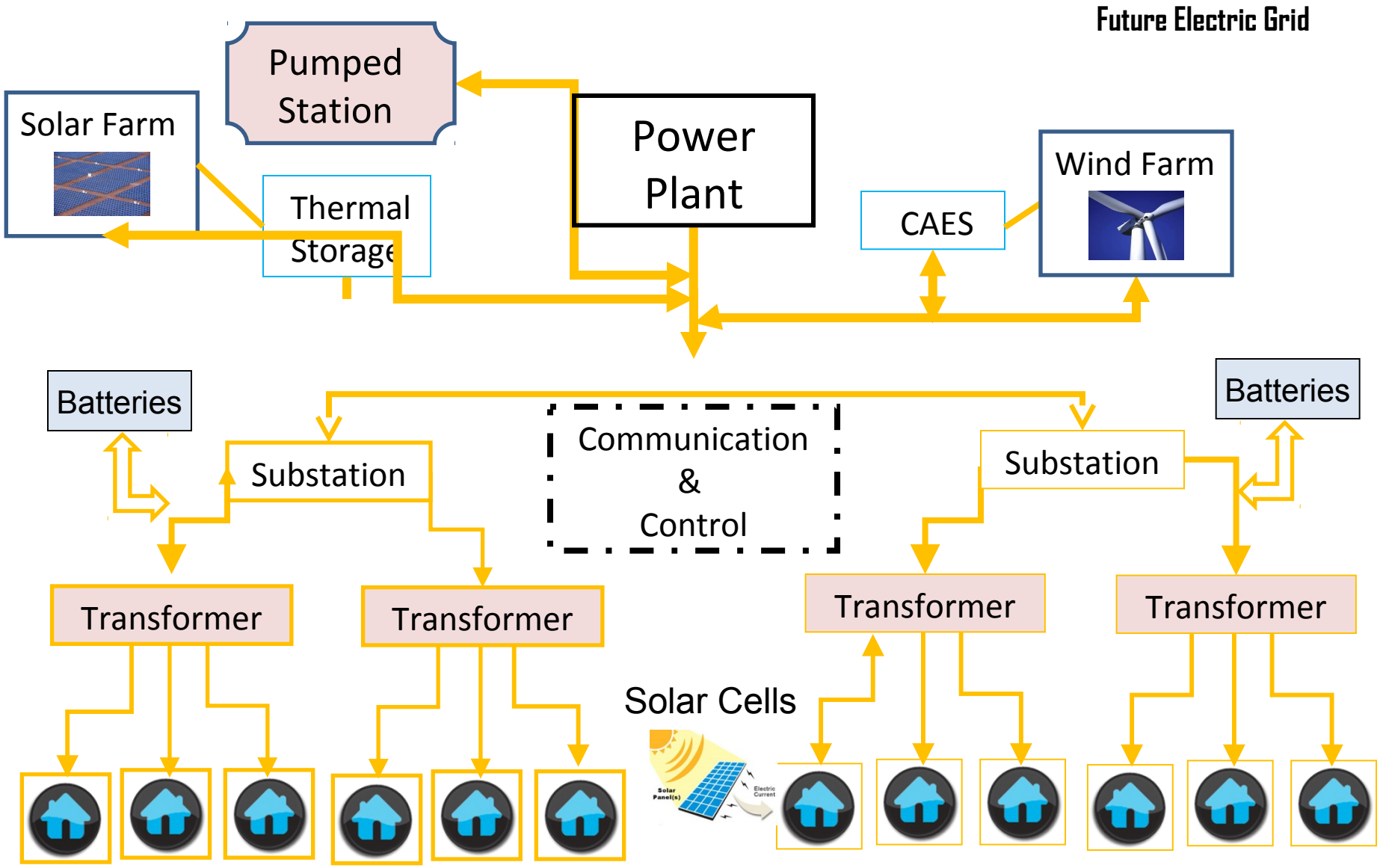
• USA: DoE dedicated to reform the current grid from 2002;

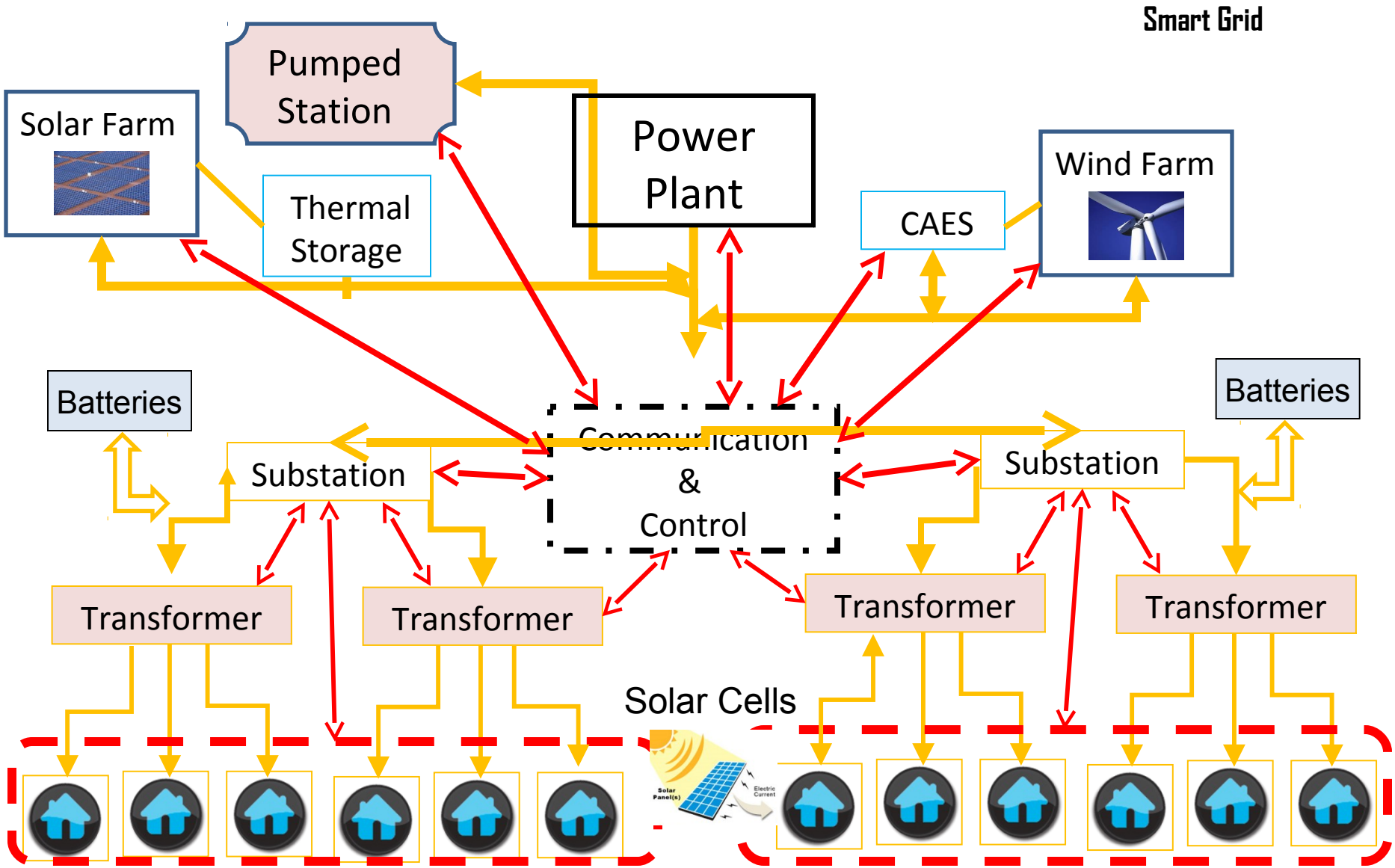
• China: Starts a grid comprehensive development in 2009.

*The target time to complete (**2030**)*

Today's Electric Grid




Future Electric Grid
Pumped Station
Solar Farm
Power Plant
Thermal Storage
CAES
Wind Farm
Batteries
Substation
Communication & Control
Substation
Batteries
Transformer
Transformer
Transformer
Transformer
Solar Cells
Solar Panel(s)
Electric Current


Smart Grid
Pumped Station
Solar Farm
Power Plant
Thermal Storage
CAES
Wind Farm
Batteries
Batteries
Communication & Control
Substation
Substation
Transformer
Transformer
Transformer
Transformer
Solar Cells

The requirements and characteristics of Smart Grid

Seven principal Characteristics:

1.Enables active consumer participation;

2.Accommodates all generation and storage options;

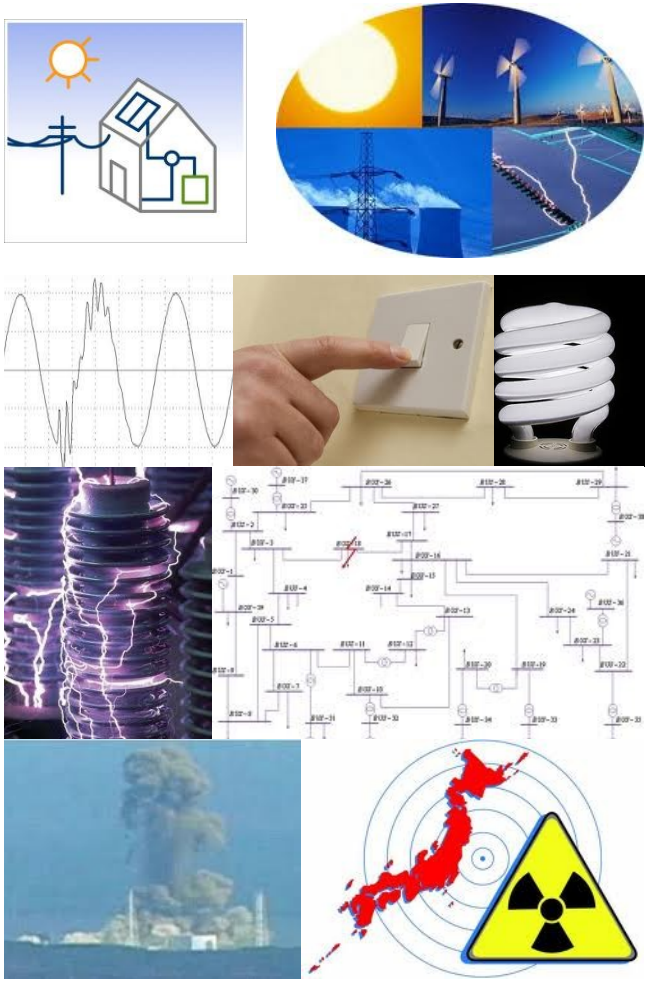
3.Enables new products, services, and markets;

4.Provides power quality for the digital economy;

5.Optimizes asset utilization and operates efficiently;

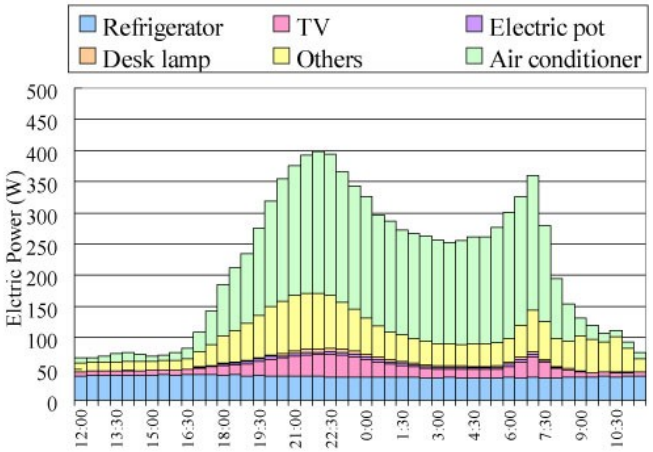
6. Anticipates and responds to system disturbances;

7.Operates robustly against attack and natural disaster.



Requirements of Smart Grid

- Advanced measurement Infrastructure (AMI):
  - Interface between the utility/customer
  - Real-time electricity pricing.
  - Multi-choices and Demand Response (DR)

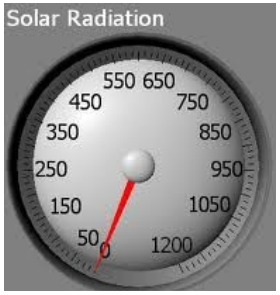


Requirements of Smart Grid

- Advance Sensing systems:

  - Check health of equipment;
  - Detecting faults early.

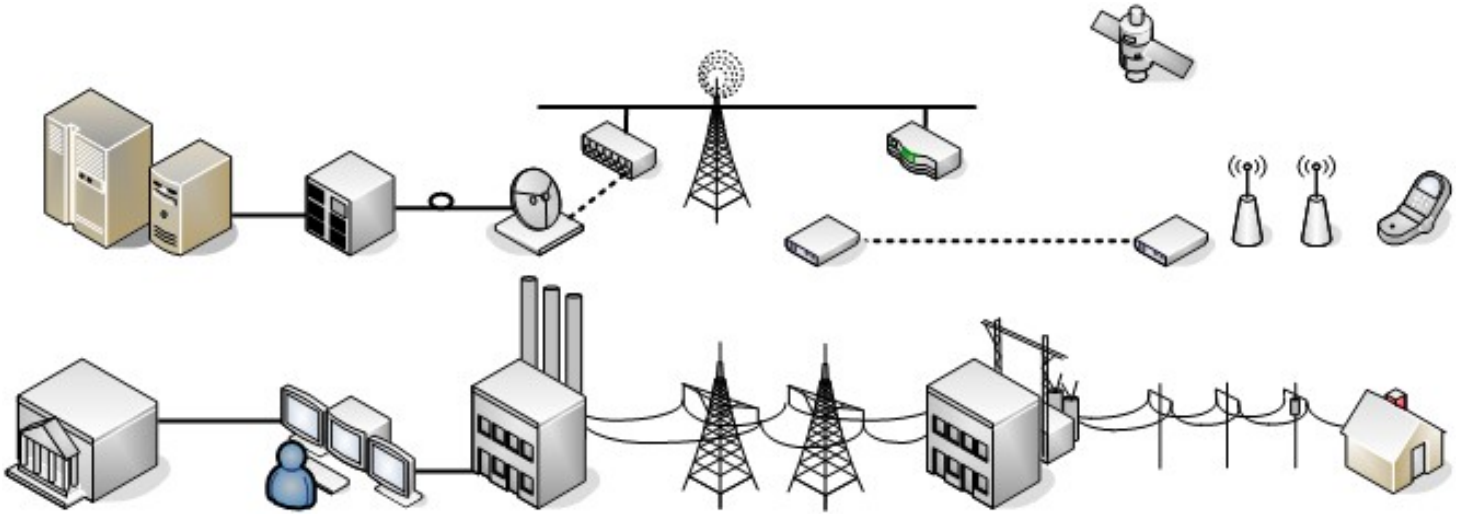
- **Distributed weather sensing:**
  - Improve the predictability of renewable energy;
  - Adjust controls to ensure the power supply continuity.



Requirements of Smart Grid

- Advanced communication systems:

- Fully integrated, two-way communication technologies for real-time Data;
- Store information about the user and grid conditions;
- Cyber Security.

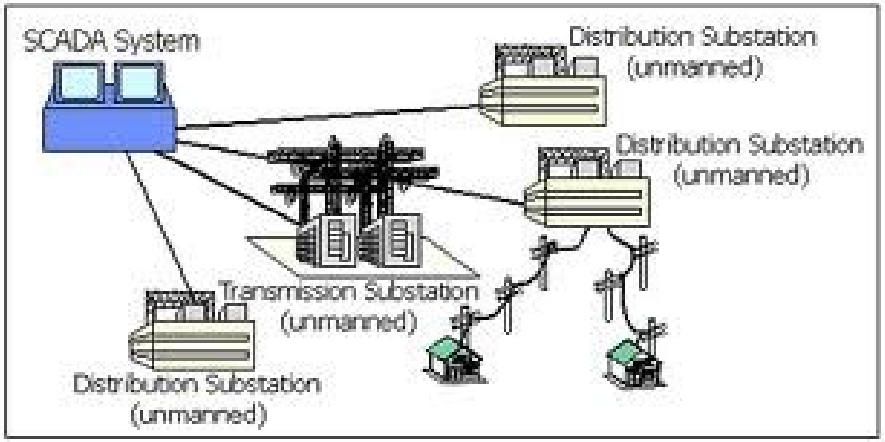


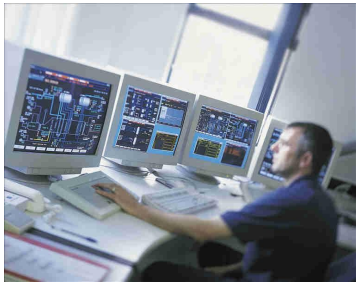
Requirements of Smart Grid

- Automation of power stations:

SCADA (Supervisory Control and Data Acquisition), On substations.

Automation (control & monitoring) within the substations.



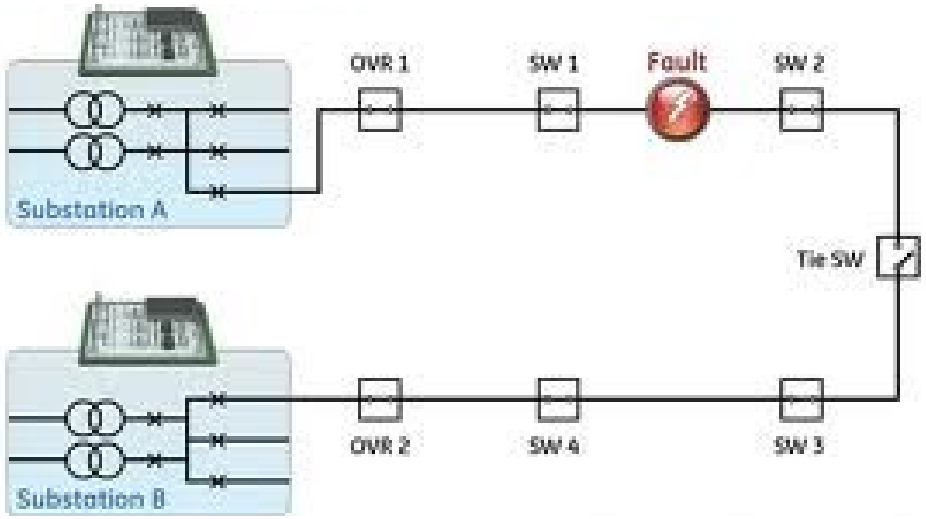


Requirements of Smart Grid

- Automation of distribution areas:

Located on distribution feeders.

- Restore the gird in failures;
- Reconfigurations during failures;
- Improve the voltage.

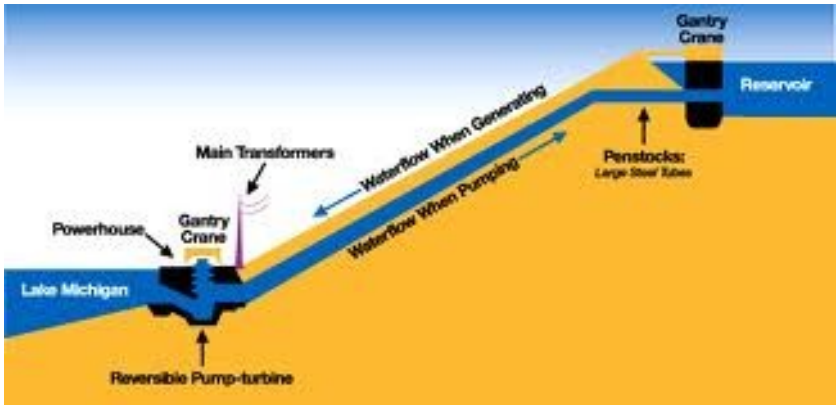


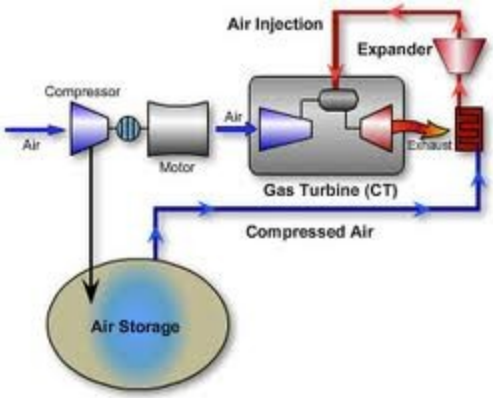
Requirements of Smart Grid

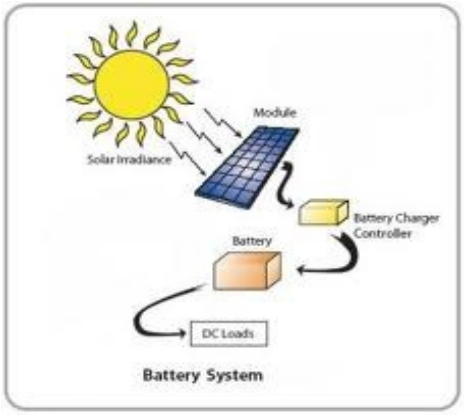
- Energy storage:

- Energy Storage Systems needed with renewable energy sources.

Energy storage and Distributed generations should be integrated in grid physically and financially (bills).



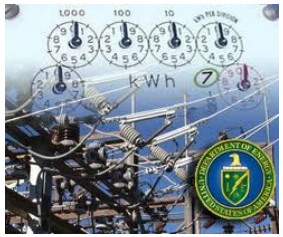


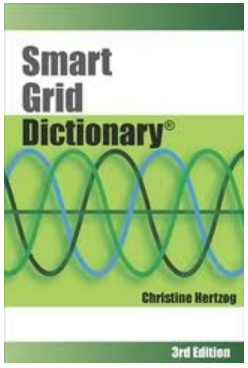


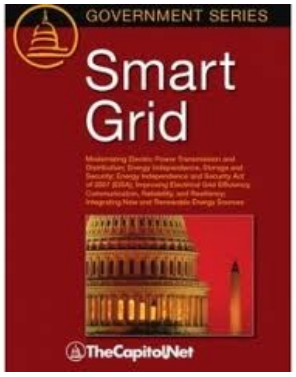
Requirements of Smart Grid

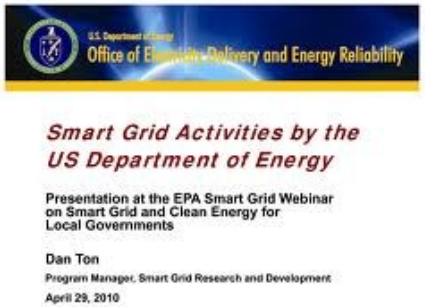
- Regulations and standards:

Standard practices and protocols for smart grid are necessary.









ANSI
American National Standards Institute

NIST
National Institute of Standards and Technology

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Study Case

Smart Grid City: Project Status

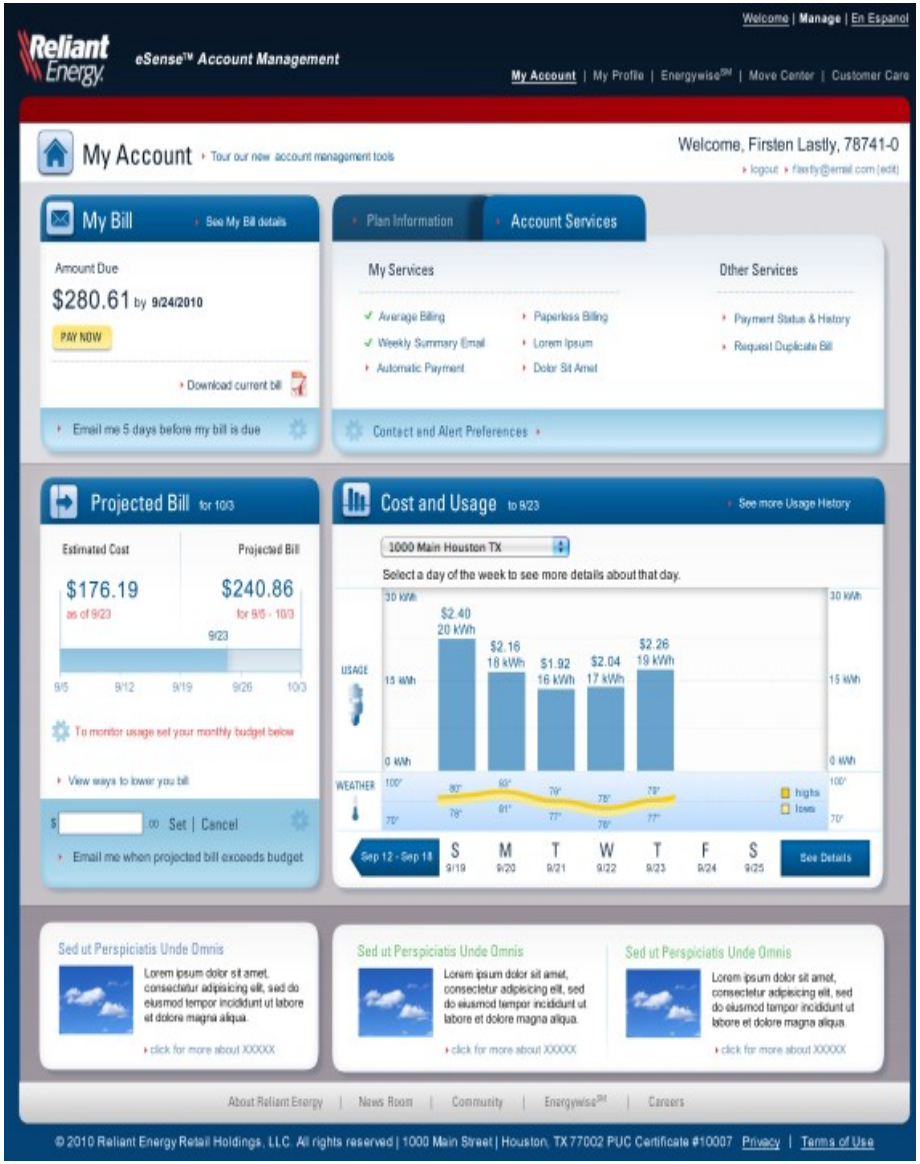
- **Scope: City of Boulder, CO. - 45,000 accounts;**
- **Starts in April 2008;**
- **More than 100 miles of fiber installed for Communication;**
- **About 25,000 two-way smart meters installed;**
- **Monitoring 3,200 transformers and 5,200 network elements;**
- **Web portal and in-home devices offered to customers 2009;**
- **New pricing tariffs, offered in 2010.**

The World's first smart grid city 2009

Study Case

Smart Grid Web portal:

- Monitor and manage energy use;
- More options, choice and personal control.



Study Case

In-Home Energy Management Devices

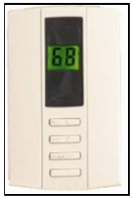
Homebase Gateway

Light switch Controller

AC Meter

GridPoint Connect C36
(Embedded Energy Manager)

GridPoint Thermostats



Programmable Thermostat

GridPoint Load Manager

High Voltage Controller

Outlet Controller

Residential Load Panel

Secure Load Panel

Protected Loads:
- Home Office
- Security System
- Refrigerator
- Microwave
- Well Pump
- Sump Pump
- Select Lighting

Plug In Hybrid Vehicles

Solar PV Integration

Air Conditioner

Air Conditioner

Water Heater

Pool Pump

Study Case

Home Energy Monitor & Programmable Thermostat

- Real Time Usage & Cost Information;
- Communicates with Smart Meter.

Study Case

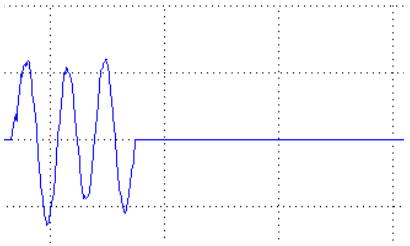
Results of the Smart Grid Demonstration:

- Provide real world experience;
- Characterize the economics of wide deployment;
- Identify the requirements (especially the standards);
- Identify work force requirements (manpower, skills, training);
- Provide the overall cost and benefits.

Smart Grids Constraints

- Uncertainty of costs and Benefits

- Existing Grid is hard enough;
  Will the computerized grid be more efficient?



- The education and welfare of users.
- Grid stability,
  Especially with intermittent energy sources.

- Security and Privacy.

Conclusion

The transformation from the antiquated electric infrastructure to the modernized smart grid could be the best option to solve many problems in the current electric grid.

References

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Thanks for listening

Any questions?

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