Societal Implications of the Emerging Smart Grid

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What is the Smart Grid

"Think of the Smart Grid as the internet brought to our electric system." (U.S. Department of Energy 2008)

Origins of Term Smart Grid

As early as 1998 (Electric Power Research Institute work group discussions (EPRI)) then in Article "Toward A Smart Grid" by Amin and Wollenberg 2005

World Policies /Legislative Acts Related to Smart Grid Development

- U.S.- Energy Independence and Security Act (EISA) of 2007
- U.S.- American Recovery and Reinvestment Act (ARRA) of 2009
- U.S.- Energy and Water Development and Related Agencies Appropriations Act, 2010
- U.S.- FERC Smart Grid Policy [Docket No. PL09-4-000]
- EU-Second Strategic Energy Review - Securing our Energy Future
- China's Energy Conditions and Policies 2007
- India- Rajiv Gandhi Grameen Vidyutikaran Yojana – Scheme of Rural Electricity Infrastructure and Household Electrification 2005

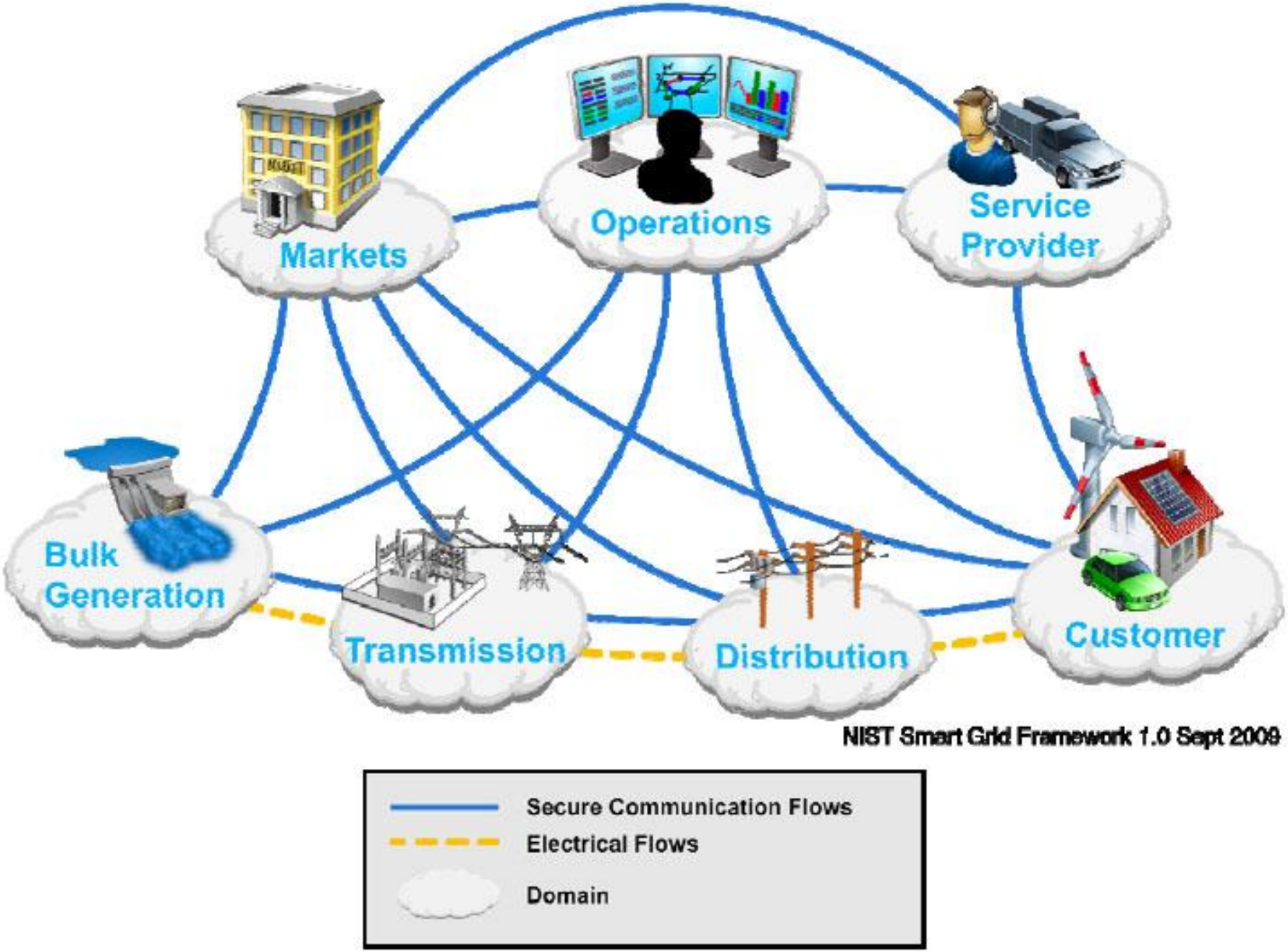


Figure 2. Smart Grid Domains

Goal:
Modernization & Optimization of the Aged & Dilapidated Electrical Grid

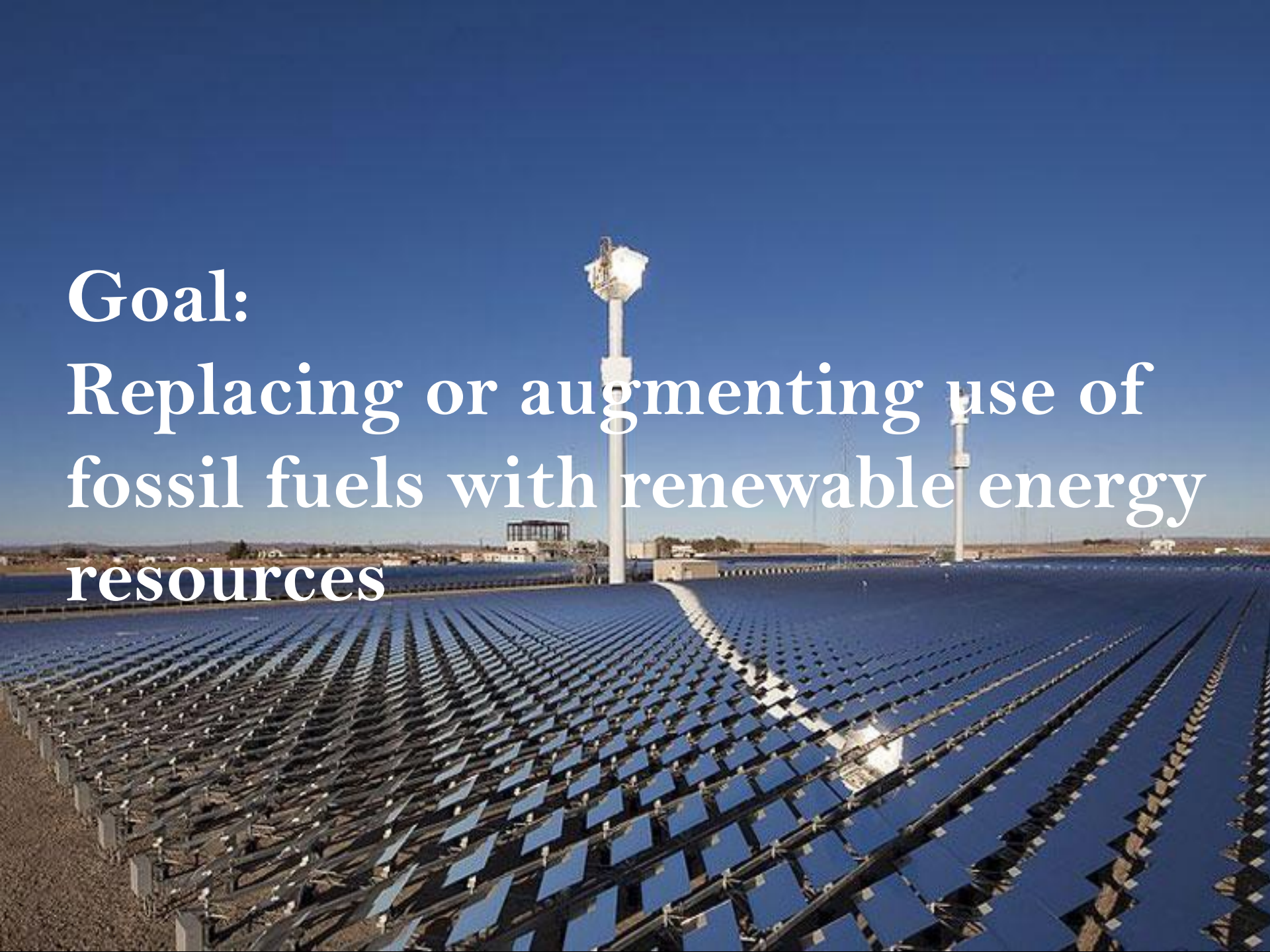
Optimizes asset utilization and operating efficiency

- Smart grid applies the latest technologies to optimise the use of its assets
- Allow assets to be used at greater loads by continuously sensing and rating their capacities
- Provides the power quality for the range of needs


Goal:
To ensure energy reliability

Provides Resiliency due to disturbances, attacks and natural disasters

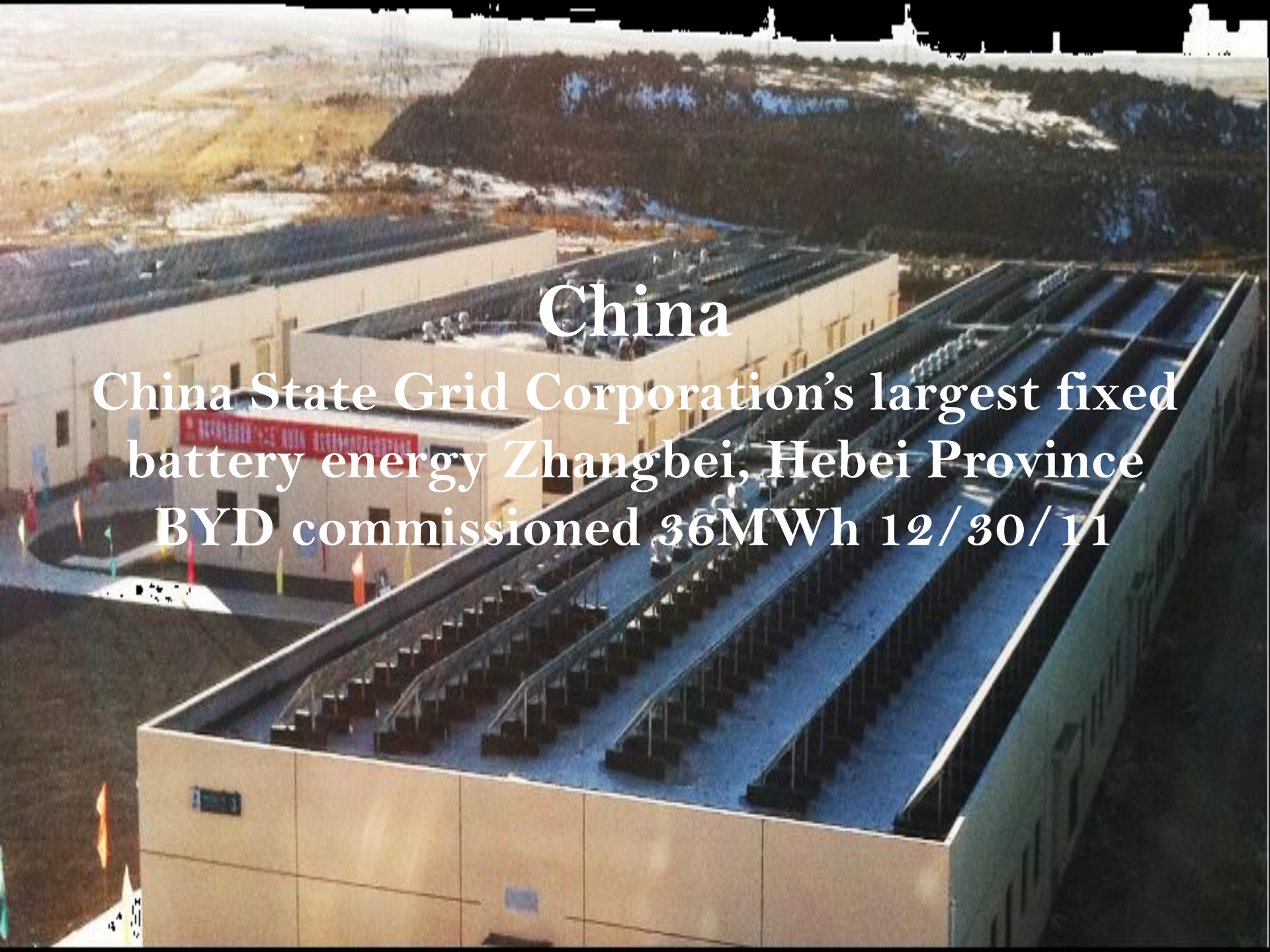
- Provides the automated ability to isolate problematic elements while the rest of the system is restored to normal operation. (Self Healing)
- Signals the need for equipment maintenance at precisely the right time.



Goal:
Replacing or augmenting use of fossil fuels with renewable energy resources

Accommodates all generation and storage options

A smart grid accommodates not only large, centralized power plants, but also the growing array of customer-sited distributed energy resources. Integration of these resources – including renewables, small-scale combined heat and power, and energy storage – will increase rapidly all along the value chain, from suppliers to marketers to customers.


China
China State Grid Corporation's largest fixed battery energy Zhangbei, Hebei Province BYD commissioned 36MWh 12/30/11


China
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2.83 GW Golden Sun Program goals

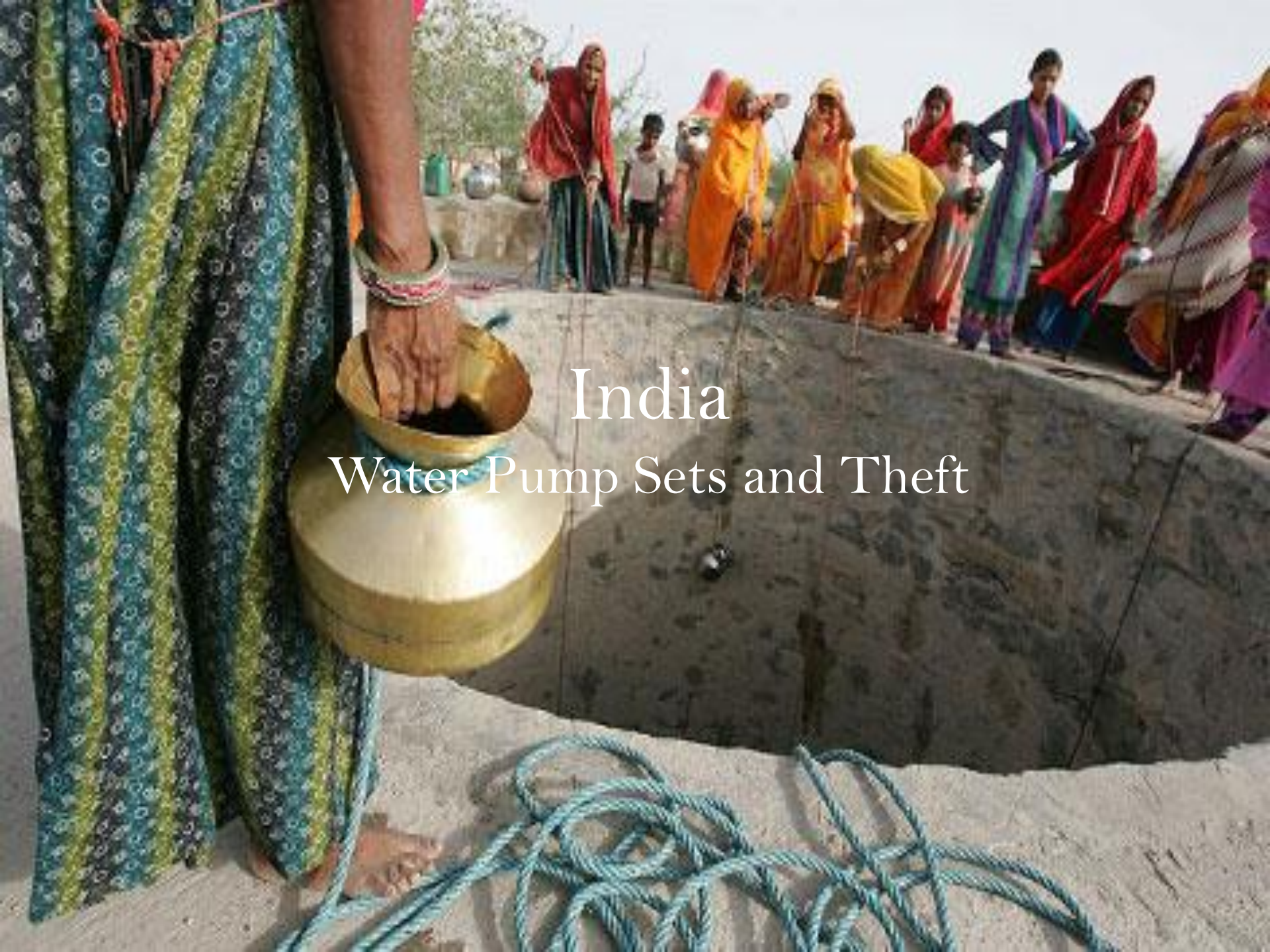

Goal:
A means to control Green House Gas emissions into the atmosphere

EU Climate and Energy Package 2009

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

Goal:
A means to reduce dependency on oil from volatile nation states

Goal:
Control the costs of energy (electrical & transportation)



India

Water Pump Sets and Theft

Stakeholders (DOE 2010)

Societal Implications

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Privacy (Consumer Usage)

Security (Individual and National)

Pricing & Equity (Electric Rates)

Privacy

- Infrastructure components and Consumer devices will become Data acquiring Network devices
- Monitoring and Management of Electric Power systems requires constant and detailed data
- Information Communications Technology (ICT) infrastructures are typically subsidized by selling data (use vs. misuse ?)

Potential Privacy Consequences of the Smart Grid (EPIC, n.d.)

1. **Identity Theft**
2. **Determine Personal Behavior Patterns**
3. **Determine Specific Appliances Used**
4. **Perform Real-Time Surveillance**
5. **Reveal Activities Through Residual Data**
6. **Targeted Home Invasions (latch key children, elderly, etc.)**
7. **Provide Accidental Invasions**
8. **Activity Censorship**
9. **Decisions and Actions Based Upon Inaccurate Data**
10. **Profiling**
11. **Unwanted Publicity and Embarrassment**
12. **Tracking Behavior Of Renters/Leasers**
13. **Behavior Tracking (possible combination with Personal Behavior Patterns)**
14. **Public Aggregated Searches Revealing Individual Behavior**

Security

- Convergence of ICT and Power Networks introduces the security issues of the internet
- Power Disruption can cause loss of Infrastructure, endanger Public Safety and jeopardize National Security
- Personal security as an issue

Potential Security Vulnerabilities

- Physical security of power
- ICT networks and equipment
- Security of huge databases and computers that analyze the data
- Interdependencies of systems (Tightly Coupled?)
- Encroachment of surveillance technologies
- Cyber-attacks both crime based and state sponsored

Pricing & Equity

- Equitable Pricing and Subsidies to Poor?
- Control of energy devices by Utilities (Smart Devices)
- Energy Management burden on uninformed consumer
- Managing Consumer behavior

Potential Pricing and Equity Consequences of Smart Grid

- Utility controlled variable pricing (limited consumer autonomy)
- Consumer control variable pricing (energy management burden on those with lower educational levels, limited Internet access and computer skills medical or cognitive impairments, or those who simply lack time, resources)

Conclusions

- Sociotechnical systems especially those that are infrastructure pose complex ethical considerations in design
- As Sociotechnical systems merge to form technical clusters the ethical issues of the new clusters are not merely the sum of the previous technologies
- Social implications are often overlooked or ignored as functional and non-functional requirements of technology design
- The emergence of Smart Infrastructures will become the catalyst behind policy and governance issues concerning privacy, security and equity in smart grid and other "smart" sociotechnical systems