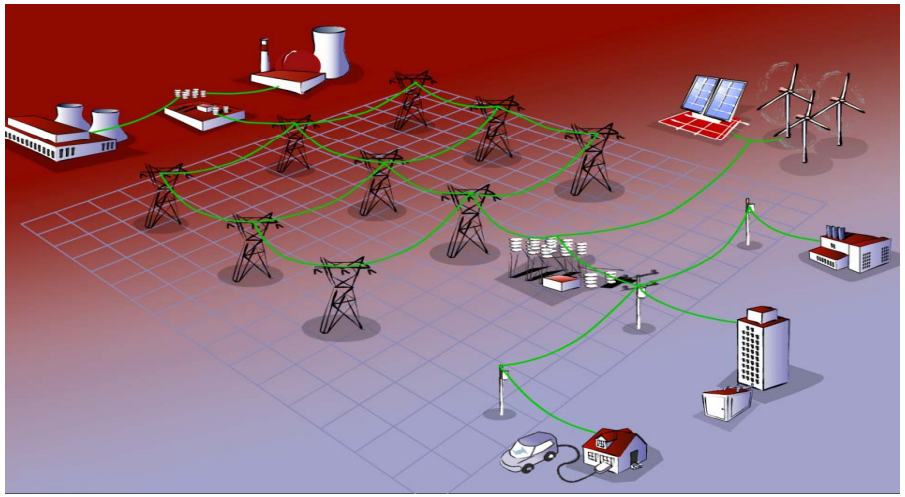
NATIONAL ENERGY TECHNOLOGY LABORATORY



Smart Grid School

MACRUC 15th Annual Education Conference

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June 28–29, 2010

This material is based upon work supported by the Department of Energy under Award Number DE-AC26-04NT41817

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Understanding the Smart Grid Value Proposition

Why invest in the Smart Grid?

- **Today's grid is aging and outmoded**
- **Unreliability is costing consumers billions of dollars**
- **Today's grid is vulnerable to attack and natural disaster**
- **An extended loss of today's grid could be catastrophic to our security, economy and quality of life**
- **Today's grid does not address the 21st century power supply challenges**
- **Missed opportunity to enjoy the benefits of a Smart Grid**

There is a "case for action"

Smart Grid Value Areas

- **Reliability —** *by reducing the cost of interruptions and power quality disturbances and reducing the probability and consequences of widespread blackouts.*
- **Economics —** *by keeping downward prices on electricity prices, reducing the amount paid by consumers as compared to the "business as usual" (BAU) grid, creating new jobs and stimulating the U.S. GDP.*
- **Efficiency —** *by reducing the cost to produce, deliver, and consume electricity.*
- **Environmental —** *by reducing emissions when compared to BAU by enabling a larger penetration of renewables and improving efficiency of generation, delivery, and consumption.*
- **Security —** *by reducing dependence on imported energy as well as the probability and consequences of manmade attacks and natural disasters.*
- **Safety —** *by reducing injuries and loss of life from grid related events.*

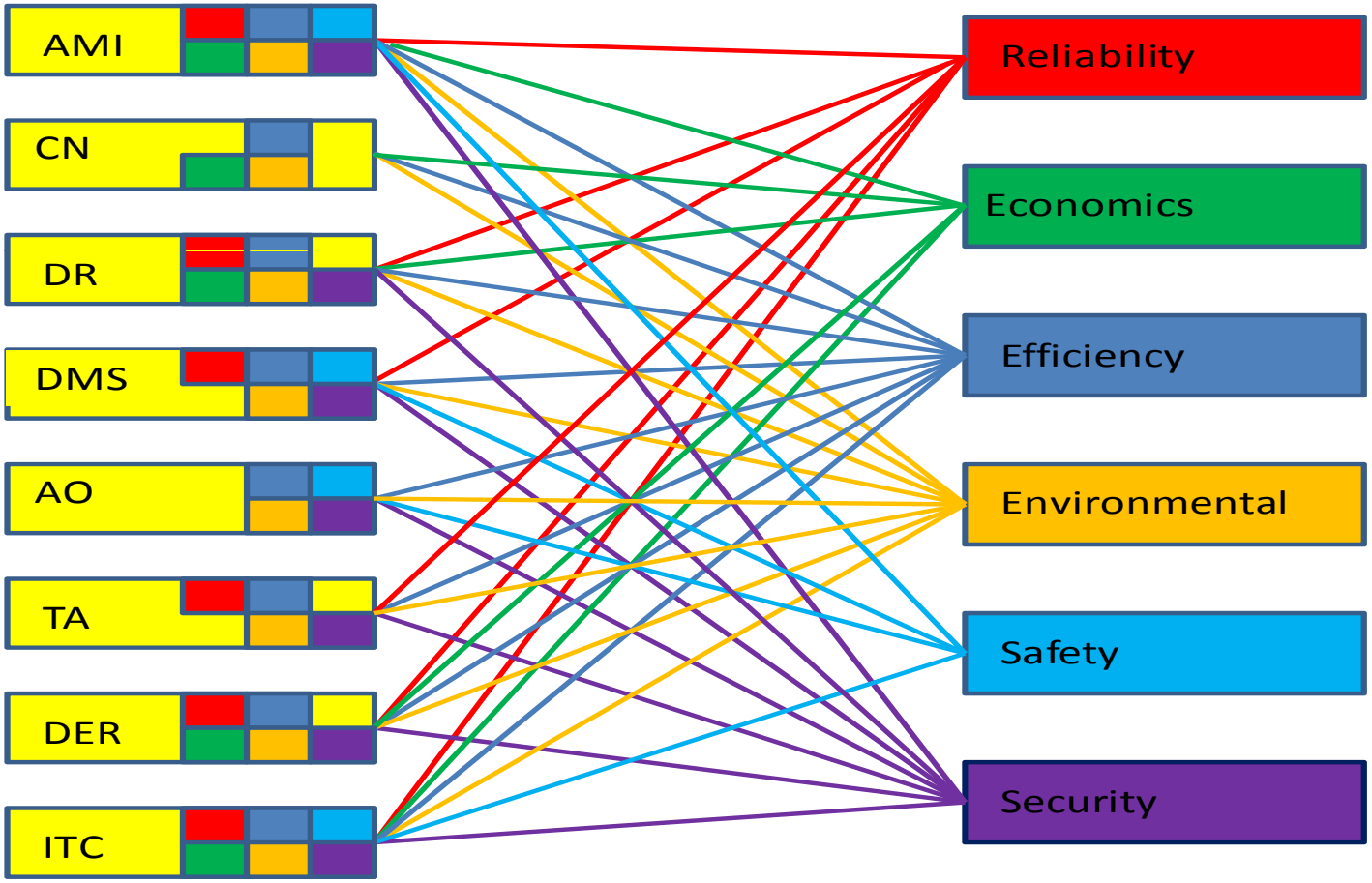
How does the Smart Grid Generate Benefits?

Technology Solutions

- Advanced Metering Infrastructure (AMI)
- Customer Side Systems (CS)
- Demand Response (DR)
- Distribution Management System/Distribution Automation (DMS/DA)
- Transmission Enhancement Applications (TA)
- Asset / System Optimization (AO)
- Distributed Energy Resources (DER)
- Information and Communications Integration (ICT)

It gets complicated—fast

Technology Solution vs. Value Area



Do benefits have “dimensions”?

Direct Benefits

- “Feels good” now without additional effort
- “Get what you pay for”
- Example—a good deal on purchase of land

Optional Benefits

- Must do something to enjoy the benefit
- “On my nickel”
- Example—build a pole barn for antique car collection

Conditional Benefits

- “Build it and they will come”
- Example—area prospers and property values rise

Are these dimensions valued differently?

Who are the Smart Grid Beneficiaries?

- **Delivery Companies**
- **Generators**
- **Consumers (R, C, I)**
- **Society**

The value of Smart Grid depends on who you ask!

What's in it for the Delivery Company?

+ **Happier customers (in theory)**
+ **Return "of and on" investment (regulated)**
+ **O&M Savings**
  - o *Process improvement (metering, billing, work force, OM)*
  - o *Reduced losses (energy)*
  - o *Asset utilization and maintenance program*
+ **Capital Expense Savings**
  - o *System planning (deferral of capital projects)*
  - o *Asset management (e.g., life extension)*
- **Risk of cost recovery (regulated)**

Is this compelling…many are moving forward?

What's in it for the Generators?

+ **Return "of and on" investment (regulated)**
+ **More reliable product delivery**
+ **New market opportunities**
  - o *Renewables*
  - o *Storage*
  - o *Ancillary services*
+ **Increased value of baseload generation?**
- **Operational risk**
  - o *Market uncertainty*
  - o *Some peakers stranded as peak is reduced*

Growth of renewables is occurring and will be enabled by SG

What's in it for the Residential Consumers?

+ **More reliable service**
+ **Potential bill savings**
+ **Transportation cost savings (PHEVs vs. conventional vehicles)**
+ **Information, control, and options for managing electricity**
+ **Option to sell consumer-owned generation and storage resources into the market**

- **Costs passed on to the consumer**

Answers "What's in it for my family and me?"

An Example

Potential Bill Savings

Estimated residential bill/year	$1,200
Expected reduction from EE/DR	10% – 15%
Potential savings/year	$120 –$180
Assumed bill increase to pay for smart grid/year	$60 – $120
Net consumer value/year	$0 –$120

Positive value but not very compelling!

Another Example

Potential Transportation Cost Savings

Assumed miles driven/year	10,000
Fuel cost (gas)/mile	$0.10 – 0.15
Fuel cost (PHEV)/mile	$0.03 – 0.05
Annual fuel cost (gas)	$1,000 – $1,500
Annual fuel cost (PHEV)	$300 – $500
Potential fuel cost savings/year	$500 – $1,200
Premium to purchase PHEV over gas	$4,000 – $10,000

More compelling but is it enough?

What's in it for C & I Customers?

+ **Opportunity to reduce energy and demand charges on bills**
+ **More reliable service resulting in a reduction in the costs of lost production and lost productivity**
+ **Option to sell consumer-owned generation and storage resources into the market**
+ **Information, control, and options for managing electricity**

- **Costs passed on to the consumer**
- **Many already have interval metering and energy management systems**

Answers "What's in it for my business?"

What's in it for the U.S. and us?

Societal Benefits

- ***Reduced losses from outages and PQ***
- ***Downward pressure on electricity prices***
- ***Improved national security***
- ***Improved environmental conditions***
- ***Economic growth and opportunity***

Hard to quantify but potentially a tipping point?

Societal Benefits

Reduced losses from power outages and power quality issues

- Reducing the probability of regional blackouts can prevent significant losses to society. The societal cost of the August 2003 blackout was $8.6 billion.
- Reducing by even 20% the cost of outages and power quality issues, which are estimated to be at least $100 billion annually, would save $20 billion per year.

Societal Benefits

Downward pressure on electricity prices

- Eliminating or deferring large capital investments in generating plants, substations, and transmission and distribution lines, could reduce overall costs $46–$117 billion dollars over a 20-year period according to a 2003 PNNL report.
- Reducing O&M spending by 10% as a result of Smart Grid operational savings would save up to $4 billion annually.
- Reducing T&D Losses, estimated at over $25 billion per year, by even 10% would save $2.5 billion/year.
- Reducing transmission congestion costs, which range from $4.8 billion to as much as $50 billion annually, by 10%, could save up to $2 billion/year.

Societal Benefits

Improved National Security

- Reducing the U.S. dependence on foreign oil through the use of PHEVs could be up to 52% based on a recent PNNL report. This is an equivalent of reducing U.S. oil consumption by 6.5 million barrels per day. According to ORNL, the value of reducing this dependence is $13.58 (2004 dollars) for every barrel of oil import reduced, creating a potential societal benefit of over $30 billion/year.
- Reducing the probability (and consequences) of widespread and long-term outages due to terrorist activity could prevent significant societal costs that are immeasurable.

Societal Benefits

Improved Environmental Conditions

- Reduction in total emissions — Through conservation, demand response, and reduced T&D losses, the total U.S. electricity consumption could be reduced by 56 to 203 billion KWh's by 2030 (1.2–4.3%).
- Per PNNL, Smart Grid could reduce carbon emissions by 12% by 2030 (442 million metric tons).
- Deep penetration of electric vehicles – Smart Grid enabled – could reduce CO_2 emissions by 60 to 211 million metric tons by 2030.
- Improved public health — The impact of vehicle particulate emissions in urban areas can be reduced as the number of miles driven by CVs is offset by miles driven by electric vehicles.

Societal Benefits

Economic Growth and Opportunity

- Creation of new jobs — up to 280,000 to create a Smart Grid alone.
- Demand for new products and services created by Smart Grid related opportunities.
- Creation of new electricity markets enabling society to offer its electricity resources to the market (DR, DG, storage).
- Improved conditions for economic development — economic development depends on a reliable source of electric power.
- Reduced wholesale electricity prices compared with BAU – This reduction will be achieved through a reduction in peak loads and energy conservation.

Societal Benefits come with little incremental cost

What are some of the challenges?

Regulatory Policy

- ***Consumer education and alignment***
- ***Time based rates –*** incentives for consumers to become actively involved
- ***Policy changes that provide incentives and remove disincentives to utilities –*** investment in a Smart Grid should make business sense
- ***Clear cost recovery policies –*** uncertain cost recovery increases investment risk
- ***Barriers to community microgrids***
- ***Societal benefits –*** quantified and included in business cases
- **Different regulatory models** (51 PUC's and FERC)

How do we engage the consumers?

Three Step Process

- ***Create Understanding*** of Smart Grid concepts and issues through effective communication, education, and debate
- ***Create Alignment*** using a collaborative approach and by allowing consumers to impact the direction of the Smart Grid transition in their respective areas or regions
- ***Motivate*** :
  - *Value in moving forward*
  - *Cost/penalties of doing nothing*
  - *Address their questions and concerns*

Commissioner, "Where is my Smart Grid?"

Answering Consumers' Questions

- Why do we need to pursue the consumer side (smart meters) before smart grid upgrades are made to the delivery system?
- Why can't many of the benefits that Smart Grid provides be done with existing technologies, e.g., existing demand response technologies?
- All consumers will pay for Smart Grid investments, but only some will (can) take the initiative to achieve the benefits. Is that fair?
- Will consumers have to purchase additional devices to participate with the Smart Grid and enjoy its benefits, e.g., home area networks, in-home displays?
- Will Smart Grid technologies increase the risk of cyber security events resulting in a less secure grid?

So is the Smart Grid worth it?

My Score Card

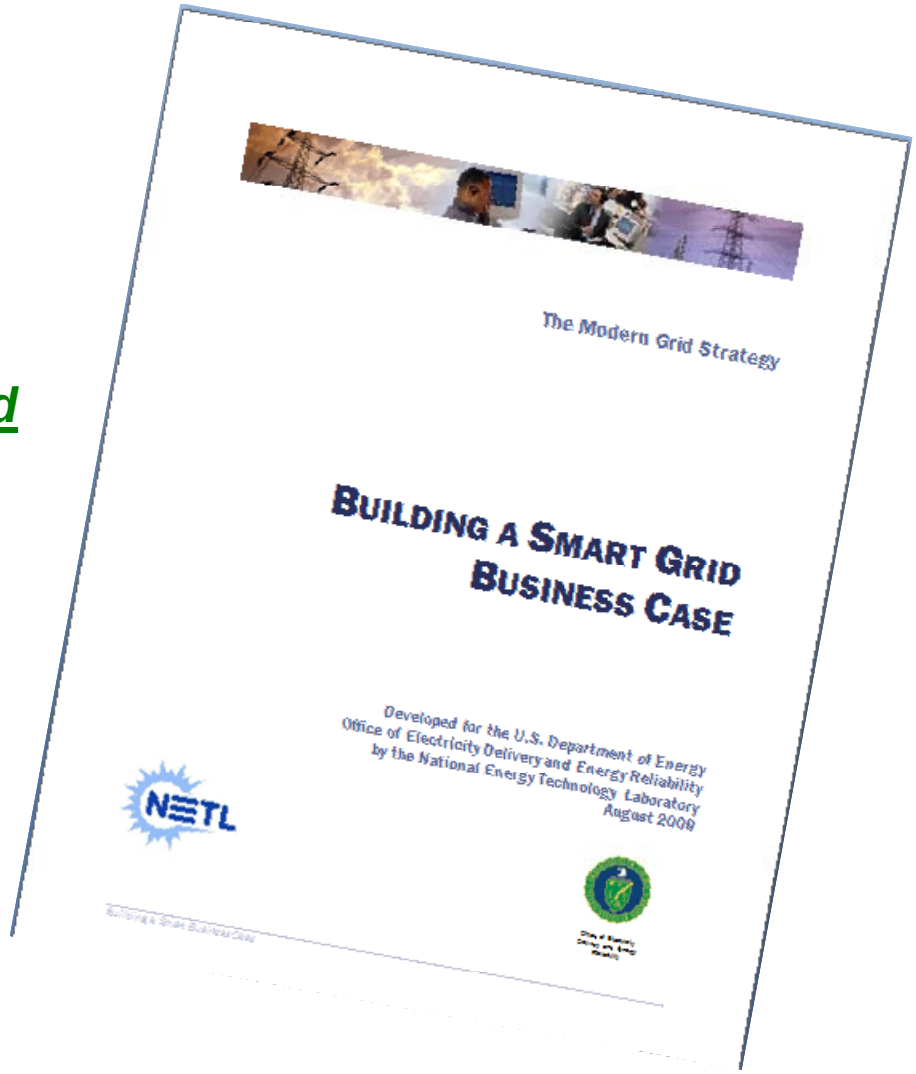
+ Delivery companies (but cost recovery a concern)
? Generators (new risks but new opportunities)
? Residential consumers (risk/reward and other concerns)
± C&I consumers (some yes, some no)
✓ Society (hard to quantify, will they happen?)

What's yours?

For More Information

For additional Information:

http://www.netl.doe.gov/smartgrid



Questions?