DSM on A Smart Grid Platform

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Smart Grid Investments

- Substantial progress is being made on better defining smart grid investments and the road map for reaching the smart grid.
  - The Energy Independence and Security Act (EISA) of 2007 states that support for creation of a smart grid is the national policy.
  - It directed NIST (National Institute of Standards and Technology) to coordinate development a smart grid framework and roadmap.
  - The funding for smart grid investment through the American Recovery and Reinvestment Act (ARRA) has led to some detailed project specification.
- These efforts are beginning to focus the smart grid vision and define a path towards attaining that vision.
- Now, what is the role of DSM professionals – the hands on practitioners and planners that make EE and DR work?

DSM and the Smart Grid

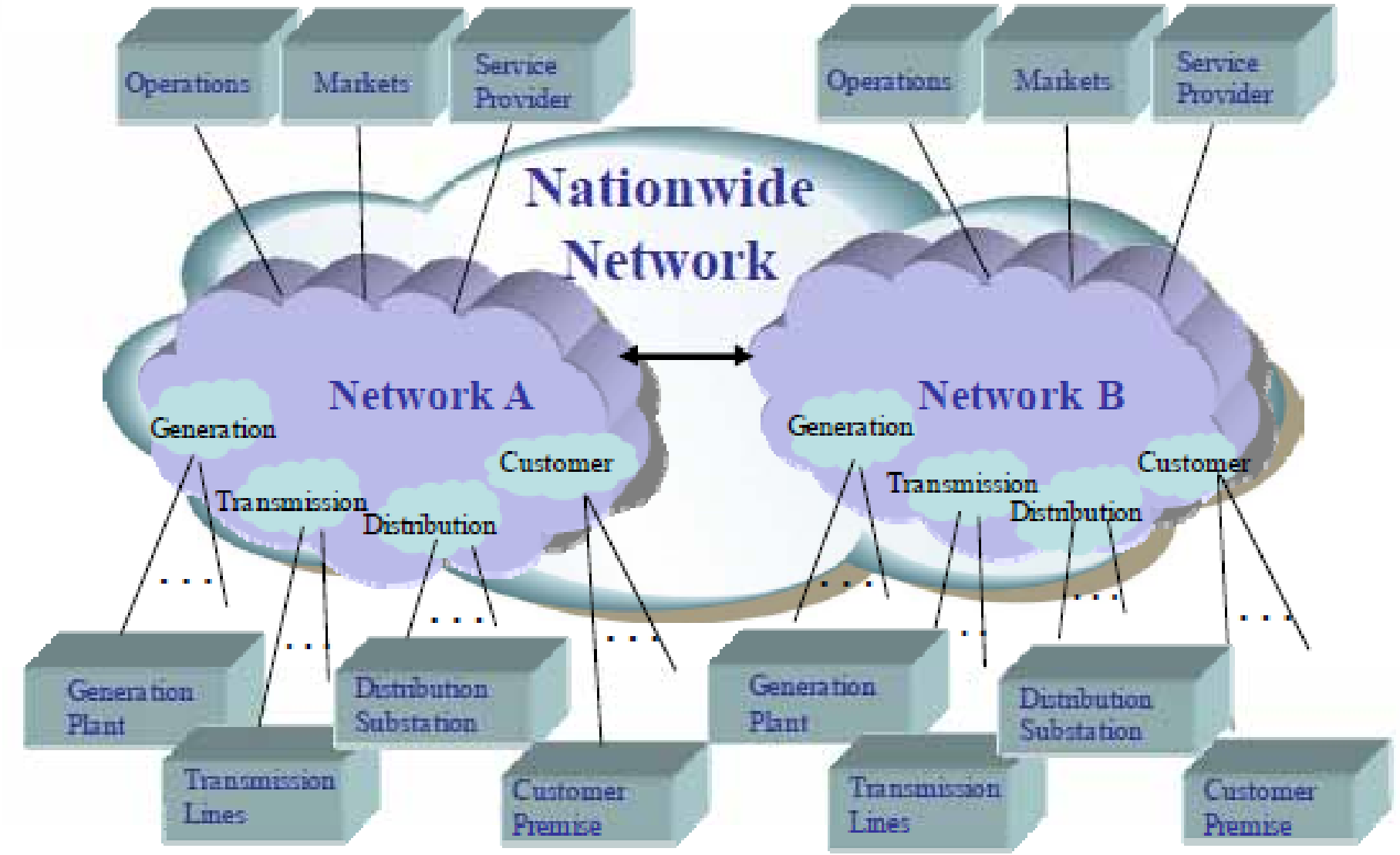
- Increased energy efficiency and demand response are claimed as being sizeable benefits from smart grid investments; but:
  1. What specific EE and DR investments are enabled by the smart grid?
  2. How does the existing EE and DR community work with the stream of investments that comprise the evolving smart grid?
  3. Are there changes needed to allow EE and DR to be advanced by the smart grid trend.
  4. Are traditional types of DSM programs -- R&D, EE/DR pilots, and market interventions still viable in a Smart Grid world?

The Smart Grid Vision

- Elements to this vision include:
  1. The Smart Grid will be characterized by a two-way flow of electricity and information to create an automated, widely distributed energy delivery network.
  2. The grid incorporates the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level.
  3. A common (and interoperable) pricing model is a key element of a smart grid. A pricing model/construct is needed for dynamic pricing in all its forms, demand-response systems, and trading.
  4. The Smart Grid is a network of networks cutting across control areas which emphasizes interoperability.
- This is an ambitious vision.

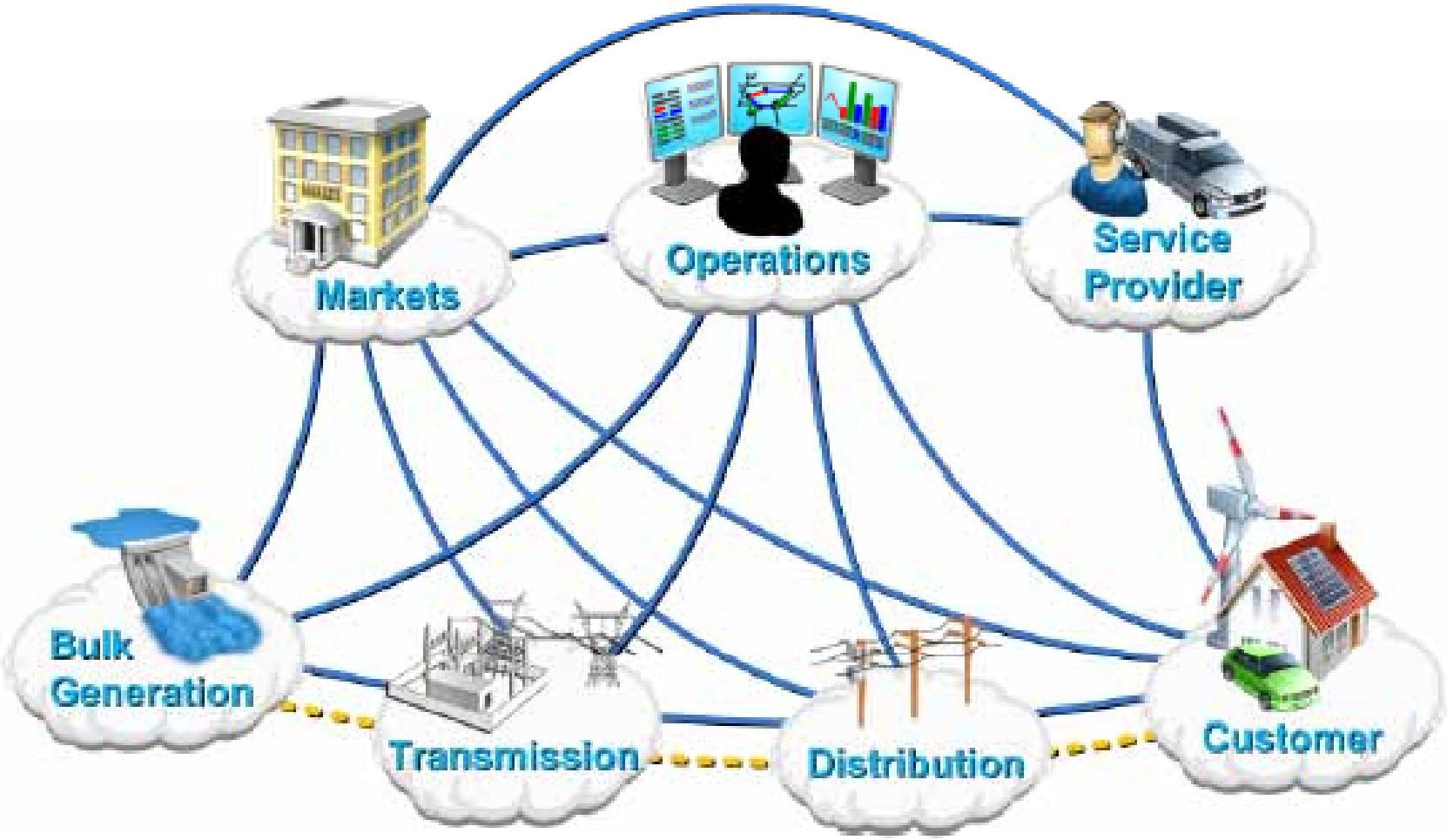
NIST Framework and Roadmap for Smart Grid Interoperability Standards; Release 1.0; September 2009.
http://www.nist.gov/public_affairs/releases/smartgrid_interoperability.pdf

Smart Grid Networks



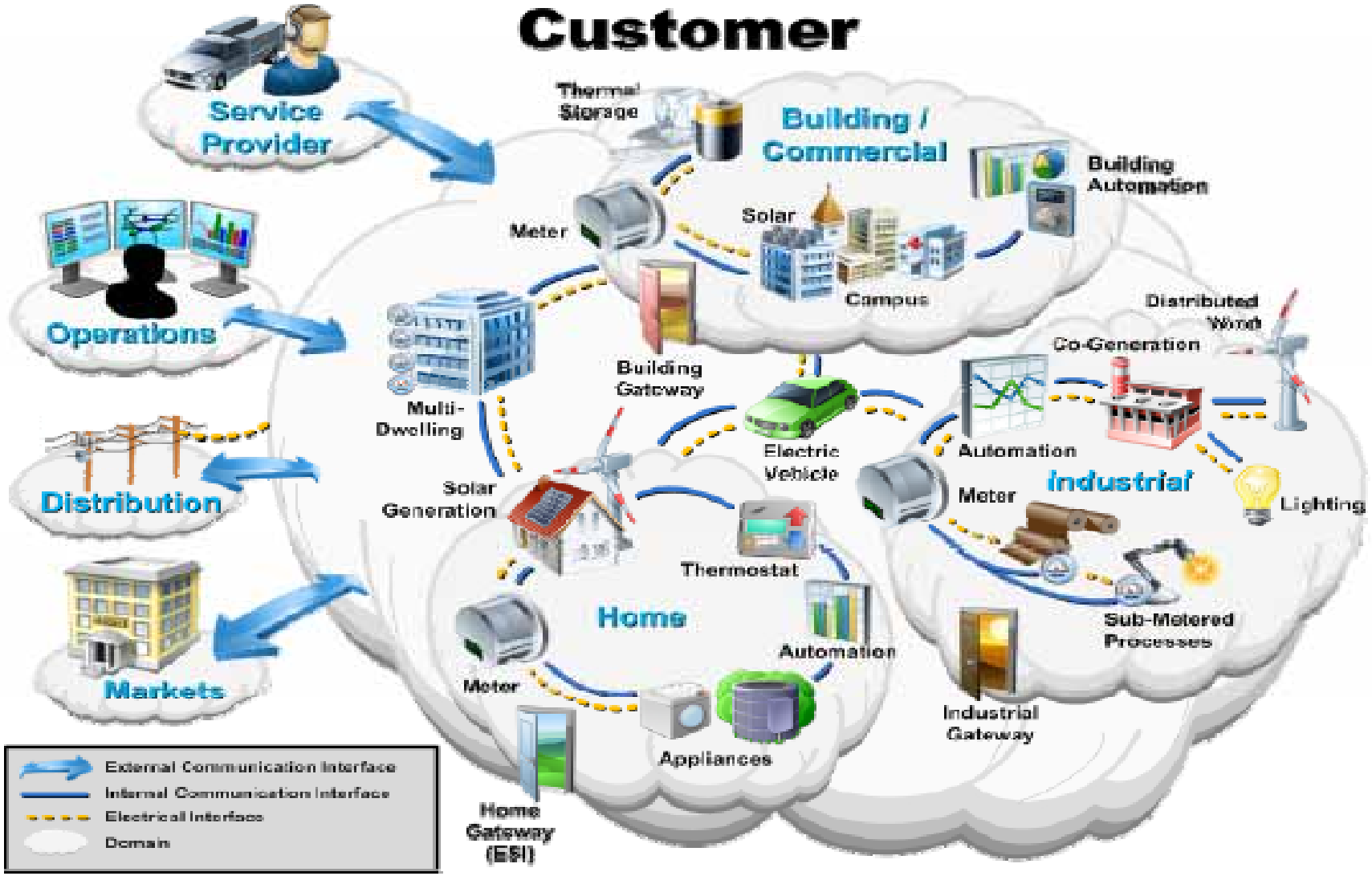
(From: NIST Framework and Roadmap for Smart Grid Interoperability Standards; Release 1.0; September 2009. http://www.nist.gov/public_affairs/releases/smartgrid_interoperability.pdf)

Conceptual Model



From: NIST Framework and Roadmap; September 2009.)

Customer Interfaces



(From: NIST Framework and Roadmap; September 2009.)

What makes the Grid "Smart"

- To assess progress of deployments, DOE is tracking activities by six chief characteristics of the envisioned Smart Grid:
  1. Enables informed participation by customers;
  2. Accommodates all generation and storage options;
  3. Enables new products, services, and markets;
  4. Provides the power quality for the range of needs;
  5. Optimizes asset utilization and operating efficiently; and
  6. Operates resiliently to disturbances, attacks, and natural disasters.

  Note: The Modern Grid Initiative adds a 7th Smart Grid characteristic:

  7. Anticipate and Respond to System Disturbances (Self-heal).

  [These seven characteristics represent a consensus regarding what capabilities a smart grid should have -- reached among Modern Grid Strategy, GridWise Alliance, Galvin Initiative, and EPRI IntelliGrid]

Implications of this Vision

- The Smart Grid will affect every person and every business in the United States – there is a need to understand and address the requirements of all these stakeholders (NIST).
  - Key research is needed. DSM professionals have experience working with customers.
  - Regulatory models that allow for value propositions under dynamic pricing will be needed – history has shown this poses many challenges.
  - Assessing the behavioral issues will be a key component: How will customers interact with the grid? What enablers are needed? How to make it simple enough?
- The smart grid is an evolving goal. All that the Smart Grid is, or can be, is not known at this time (NIST).
- The smart grid will demand continuing R&D to assess the evolving benefits and costs, and to anticipate the evolving requirements.
  - Pilots and testing will be needed – pricing and DSM pilot experience will help in design.

Pricing in the Smart Grid Vision

- A common specification approach for determining prices is critical for the Smart Grid:
  - Actions in the NIST Framework and Roadmap are designed to produce a common dynamic specification for prices.
  - Businesses, homes, electric vehicles, and the power grid will benefit from automated and timely communication of energy prices, characteristics, quantities, and related information.
  - Price also is used to assess abundance, scarcity, and other market conditions.
  - A common price model will define how to exchange data on energy characteristics, availability, and schedules to support efficient communication of information in any market
- ACTION: Develop the common pricing approach/model with NIST working with other relevant Standards Organizations that traverses the entire value chain.

Smart Grid Pricing Model

Questions regarding a common price specification process:

- Likelihood of state regulator and other stakeholder acceptance.
- Response of different customer groups to dynamic prices from this model, i.e.., what are the behavioral issues that need study?
- Development of enabling equipment and creating an easy, hands-off response capability for customers – Innovation is needed here.
  - Simple approaches may be needed, e.g., set networked equipment to allow for the selection of one option from 5 settings representing different levels of comfort.
  - Setup of equipment will reflect user preferences
  - The use of navigation equipment in cars is now common and viewed as a benefit, but it was viewed as complicated at first.
- What level of geographic disaggregation in pricing is appropriate?
- How accurate is accurate enough in pricing?

5 Categories of Smart Grid Benefits

1. Power reliability and power quality.
   - The Smart Grid provides a reliable power supply with fewer and briefer outages, “cleaner” power, and self-healing power systems.
2. Energy efficiency benefits.
   - The Smart Grid is more efficient, reducing total energy use with the ability to induce end-user use reduction instead of new generation.
3. Environmental and conservation benefits.
   - The Smart Grid is “green”. It helps reduce greenhouse gases (GHG) and other pollutants.
4. Direct financial/economic benefits.
   - Operations costs are reduced or avoided. Customers have consumption, cost and pricing choices based on access to energy information. Entrepreneurs can accelerate technology introduction to create new markets and products for grid and consumer use.
5. Safety and cyber security benefits.
   - The Smart Grid continuously monitors itself to detect unsafe or insecure situations that could detract from its high reliability and safe operation.

Issues – Smart Grid Investment

- The smart grid vision sometimes seems to refer to “perfect” customers -- homes and businesses with networks that automatically and appropriately adjust energy use based on a price or value signal.
  - But, how many of these highly responsive customers are needed?
  - Eventually, will costs and prices be set such that all customers will automatically have the appropriate level of DR and EE technology?
  - Until then, how much EE and DR should be enabled -- where and when?
- What are the pros and cons of different smart grid investments --building out DR and EE now versus other T&D grid investments?
- Pacing deployment provides a trade-off between spreading out upfront investment costs and the overall payback period.
- Targeting deployment in areas where there are opportunities for greater benefits can improve the economics of a rollout.
- How to go about assessing alternative paths comprised of a series of many decisions by different entities in a region over a period of years.

Assessing Near-Term Investments

- Targeting investment:
  - Residential customer applications seem to have drawn the most attention in terms of home area networks and DR.
  - However, the commercial sector can provide significant EE and DR from a smaller number of customers; and:
    - They are often located in T&D congested areas – urban areas.
    - And, in areas in which it is expensive to expand T&D.
- Utilities are quite diverse with respect to current legacy systems and investments, geography, and customers.
- These factors can result in the economics of different technology roll-outs and smart grid investments being different across utilities.
- Some utilities may be a bit parochial about capital investments and want to see near term operational savings before investing.

Challenges in Investment

- Legacy investments that may not be full depreciated.
- Concerns over technology obsolescence in making decisions.
- Cautious skepticism regarding whether the expected benefits will, in fact, be forthcoming.
- Regulatory uncertainty – but risks may cut both ways in this environment.
- Concern over un-intended consequences regarding investments that may affect multiple systems across a utility.
  - Results in pilots and testing rather than investments at scale.
  - Makes utilities conservative with respect to cross-cutting investments.
  - Example: Certain utilities may not want to upgrade their CIS/Billing Systems to handle the data produced by smart grid and pricing. A recent CIS upgrade might have posed a number of operational and budget challenges.

Lessons and Questions?

- Does the 80/20 rule apply to near-term smart grid investments?
- Where are benefits concentrated given that the smart grid is likely to develop in phases?
- How are investment priorities set for distribution companies, RTOs, and generation companies that each have different circumstances?
- Possible Priorities:
  - Developing a retail “price” to incent loads to become responsive and giving private industry incentives to develop enabling technologies.
  - Address clear operational and reliability issues with T&D investments.
  - Create a value signal that applies to distribution system investment.

Two Tracks for Investment?

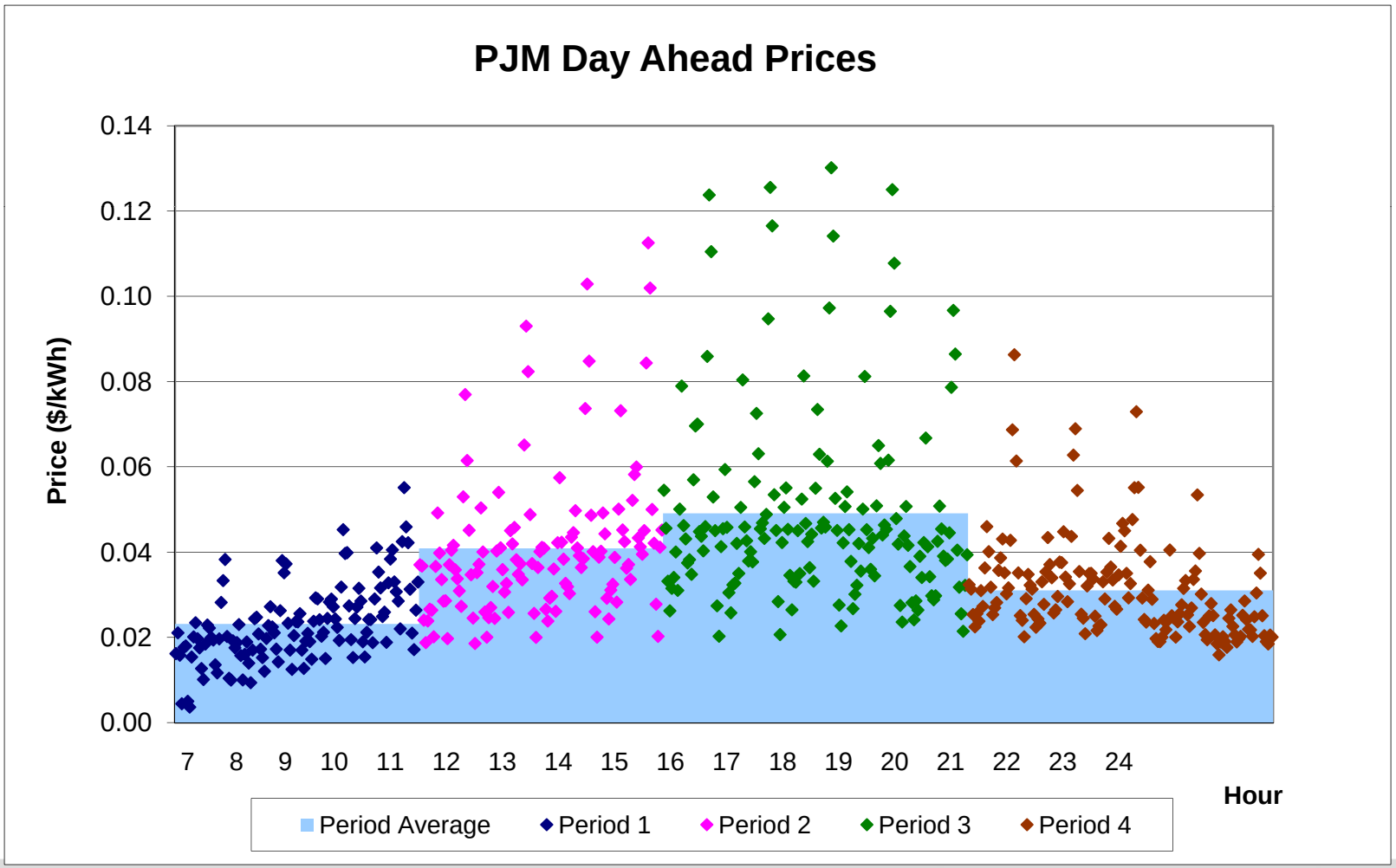
1) investment for longer-term benefits, i.e.., the interoperability platform; and,
2) Investments for near-term operational benefits.

Issues in Dynamic Pricing for EE

- Arguments are made that true dynamic pricing may not be acceptable to customers and/or regulators:
  - Too complex, i.e.., customers won't take the time to understand and respond to hourly pricing.
    - But, through innovation, they can respond through packages that are set up for customers with enabling technology?
    - Equity – Even if customers don't change their energy use, is it more equitable for those customers that use the most electricity during periods of high prices to pay more?
  - A concern that some customers might see large increases in bills.
    - But, simulations based on load shape data for different types of customers has shown that the annual expenditure on electricity will not vary much for most (90% plus) of the customers.
    - If some customers do experience large changes in bills (e.g., 5% or more), these customers can have the billed phased in over 2 years.
  - How accurate is accurate enough – TOU, TOU/CPP or PTR, or RTP?

Comparing of TOU Prices with RTP

- Four TOU daytime periods are compared to RTP. TOU leaves quite a bit of potential price response unaccounted for, and CPP or PTR may not make this up.



Conclusions -- EE and DR w/ Smart Grid

- Dynamic prices are a core smart grid concept and EE and DR will need to account for this:
  - EE programs/offers that have a profile where more savings occur during high priced hours (not necessarily the peak hour) will be more economic.
  - Utility and service company efforts will need to incorporate pricing into their offer design – and, innovate and simplify customer responses to changing prices.
  - Results of benefit costs tests will change – the TRC test should improve (more avoided costs); but the RIM test will tend to get worse (more revenues lost with "conservation pricing" and higher prices avoided on bills).
    - However, as EE and DR are viewed as long-term resources, are B/C tests like the TRC and RIM still appropriate ;
    - Or should resource planning approaches be used?
    - Total costs of meeting electricity and gas requirements will decline.

Conclusions -- EE and DR w/ Smart Grid

- With appropriate price signals, are EE and DR programs still needed or will the market result in appropriate levels of investment?
  - Programs are still needed as there will be a constant evolution of DSM technologies and market barriers will still exist as technology evolves
  - Reaching market-potential EE and DR numbers will still need programmatic approaches.
  - Achieve least-cost resource levels – but, these efforts may be more focused on using the price and usage information provided.

Conclusions -- EE and DR w/ Smart Grid

- Load response (energy and demand) can take advantage of a wide range of information produced by the grid and smart appliances or control systems.
  - Information on equipment that may not be operating appropriately.
  - Real time feedback to customers on savings potential for an end-use.
  - More options to use information in marketing, or in conjunction with specific EE and DR actions or enabling technology.
- M&V protocols will evolve as the smart grid provides information.
- Past smart grid benefit analyses show that a majority of the benefits come from DR, EE and reliability improvements.
- With ARRA funding and the priorities of the current administration on smart grid design, now is the time for DSM practitioners to get involved.

[See References in "Sixth Northwest Electric Power and Conservation Plan;" Northwest Power and Conservation Council; Sep 2009 | document 2009-12; http://www.nwcouncil.org/energy/powerplan/6/default.htm -- Large scale smart grid deployment benefit studies include: www.rand.org/pubs/technical_reports/2005/RAND_TR160.pdf and www.pnl.gov/main/publications/external/technical_reports/PNNL-14396.pdf. More work is underway, but these are the general citations today for comprehensive efforts.}

Conclusions

- NIST (2009, p. 83) states that "The vision of the Smart Grid includes dramatic increases in energy efficiency and cost savings to both utilities and consumers …"
- To date, the Smart Grid vision has been focused on the capabilities of the technology required to realize that vision.
- This is a critical juncture for the DSM profession – there is a need to:
  - Work with the smart grid process to ensure that the promise of EE and DR is achieved.
  - Understand the needs of the customer as the Smart Grid will affect every home and business and important research needed.
  - Assess behavioral issues -- Key questions include:
    - How will customers interact with the grid?
    - What enabling information and technologies are needed to allow customers to appropriately respond to price or value signals?
    - Examine customer response to value signals sent through the grid and determine what types of signals are most effective.

B/C of Smart Grid Investments

- DSM professionals are likely to be more involved in smart grid B/C studies. Analyses should be ongoing even though there may be gaps:
  - Cost data are uncertain given that many smart grid technologies have not seen wide-scale deployment.
  - Data management may pose cost issues as the information flow from a smart grid project produces a lot of data.
  - Defining the end state may for a diverse smart grid study (see next slide on "market maturity model" – seek level 4 as an end point?).
  - Benefits due to smart grid investments are uncertain as the alternative to a smart grid, i.e., the baseline, is uncertain.
  - What upgrades to the T&D system would have occurred under some sort of Business-As-Usual (BAU) case which may be used as a baseline?
  - EE and DR are being delivered today, so how much would have been implemented under a BAU baseline?
  - Is there really a baseline for a "smart grid" or are many of the smart grid technologies simply the natural progression of advances in technology?

How Smart is Smart – Biz Case Assumption?

Level	Level Descriptor	**Strategy, Management, and Regulatory:** *Vision, planning, decision making, strategy execution, discipline, regulatory, and investment*
5	**Innovations: the Next Wave**	– Overall strategy expanded due to SG capabilities – Optimized rate design and regulatory policy (most beneficial regulatory treatment for investments made) – New business model opportunities present themselves and are implemented
4	**Optimizing Enterprise Wide**	– Smart grid is a core competency that drives strategy and influences corporate direction – External stakeholders share in strategy – Willing to invest and divest, or engage in JV and IP sharing to execute strategy – Now enabled for enhanced market-driven or innovative regulatory funding schemes
3	**Integrating Cross Functional**	– Completed smart grid strategy and business case incorporated into corporate strategy – Smart grid governance model deployed – Smart grid leader(s) (with authority) ensure cross-LOB application – Mandate/consensus with regulators to make and fund smart grid investments – Corporate strategy expanded to leverage new smart grid enabled services or offerings
2	**Functional Investing**	– Integrated vision and acknowledgement – Initial strategy and business plan approved – Initial alignment of investments to vision – Distinct smart grid funding and budget created in collaboration with regulators and stakeholders – Commitment to proof of concepts – Identify initial smart grid leader
1	**Exploring & Initiating**	– Developing first smart grid vision – Support for experimentation and informal discussion with regulators – Funding likely out of existing budget

Source: Market Maturity Model (www.sei.cmu.edu/smartgrid/)