EDISON ELECTRIC INSTITUTE

Summary of the June 2010 EEI Smart Grid Scenario Workshops

Prepared for EEI by Jesse Berst, Global Smart Energy

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Letter from Thomas R. Kuhn, President, Edison Electric Institute:

On behalf of the Edison Electric Institute (EEI), I would like to personally thank each of you who participated in these workshops. I would also like to thank the Electric Power Research Institute (EPRI) and IEEE for working with EEI to develop and conduct these workshops.

All of us are committed to the successful deployment of smart grid technology in the U.S. electricity industry; transformational technology that serves the interests of customers, businesses and U.S. competitiveness. For that to happen, we believe that all stakeholders must work together.

As a critical first step, we believed the timing was right to bring together our Nation's top smart grid thought leaders from across industry sectors to explore how the structure of the industry may evolve within the context of new and developing smart technology, emerging public policy goals and new customer/business relationships.

In two facilitated workshop sessions, over 50 of you engaged in vibrant, creative, rich thinking. Your collective knowledge resulted in thoughtful, informative insights that will provide important contributions to the emerging public policy dialogue and our common deployment goals.

Subsequent to the workshops, other stakeholders, including federal and state agencies, have expressed interest in the scenario futures approach. EEI is dedicated to continue bringing together industry sectors to collaborate on major policy and implementation areas of common interest. We will broaden our scope of participants, and I hope you will be a part of this process. I look forward to our continued work together to realize the goal of deploying a U.S smart grid.

Thomas R. Kuhn
President

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Published by:
Edison Electric Institute
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Phone: 202-508-5000
Web site: www.eei.org

October 2010

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Introduction

On June 24th in Washington, DC and on June 28th in Los Angeles, CA, the Edison Electric Institute (EEI), in collaboration with the Electric Power Research Institute (EPRI) and IEEE, held two smart grid scenario planning workshops. These facilitated workshops brought together more than 50 industry smart technology leaders (vendors, academics, regulators, consumer advocates, Wall Street analysts, private business and technology consultants and utility management) to consider:

- The impact that the deployment of smart technology might have on the industry
- Business opportunities that may arise
- Regulatory challenges that may emerge

This document contains a summary and synthesis of the major discussions and takeaways from those workshops. As such, it represents the consolidated opinions of the workshop participants and not necessarily the views of EEI, EPRI, IEEE or any of the individual participants or their companies. These workshops represent an initial step to bring together smart grid industry leaders in a collaborative setting to develop solutions to the issues that will emerge as smart technology is deployed.

EEI would like to extend its appreciation to both Glen Hiemstra of Futurist.com and Jesse Berst of Global Smart Energy for their invaluable assistance in making the workshops such a success. EEI would also like to thank our workshop hosts, Joseph M. Rigby, Chairman, President and CEO, Pepco Holdings, Inc. and Theodore F. Craver, Jr. Chairman, President and CEO, Edison International.

Executive Summary

Technology has transformed many of the world's largest and most important industries, including telecommunications, retailing, publishing, music and many others. Similarly, smart technology also has the potential to transform the electric industry -- its business models, its customer relationships and its regulatory framework.

To generate insights into the potential impact of smart technology on the future of the electric industry, EEI engaged Glen Hiemstra of Futurist.com to conduct two scenario-planning workshops. The approach used in those workshops does not attempt to forecast a single future. Rather, it suggests several likely scenarios (four in this case), so that executives can be prepared for a variety of outcomes. By monitoring key indicators, they can watch where the world is trending, and spot changes in time to take appropriate action.

To get the best possible input for this process, EEI invited over 50 senior business and thought leaders from all the major industry stakeholder groups (vendors, academics, regulators, consumer advocates, Wall Street analysts, private business and technology consultants and utility management) to participate in two separate all-day scenario planning sessions in late June 2010.

With the help of an EEI member-company Steering Committee, EEI crafted advance materials and an advance reading list (which are incorporated for your interest in the appendices). Participants were given four possible "starter" scenarios as the basis for their collaboration. During the session, they fleshed out the details of these four possible futures while suggesting the business implementation and policy issues that might result and when they might occur over a ten year period.

This document is both a *synthesis* and a *summary* of their work. It *synthesizes* the two separate workshops into a single document. And it *summarizes* the key themes of each scenario. As such, it consolidates the thinking of the leaders on the why, what and when of our likely future. We hope it will be of value as you plot the strategies for your individual organizations.

- For a quick overview of the four likely scenarios read the rest of this Executive Summary
- For deeper insight into the scenarios and their likely impacts turn to the individual descriptions that follow
- For "raw material" that may be useful to your in-house planning use the appendices at the end

With more than 50 of the country's top energy minds generating ideas for two full days, we could not hope to relay all of their individual insights. Although we could not pass along every detail, we feel confident that we have captured the key themes and important commonalities.

OVERVIEW OF THE WORKSHOP SCENARIO PLANNING PROCESS

Driving Forces Common to All Scenarios

For the purposes of our planning, we assumed that all four scenarios would take place in a high-tech, high-obligation, cost-constrained world.

High-Tech

- **An increasingly sophisticated population** expects choice, control and information delivered to them via multiple platforms (web, phone, television, etc.)
- **An increasingly diverse population** exhibiting geographic, gender, generational, income and aspirational differences, with each segment expecting to "have it my way"
- **An increasingly crowded market** with many new vendors entering the sector as they recognize the smart grid as the next high-tech frontier

High-Obligation

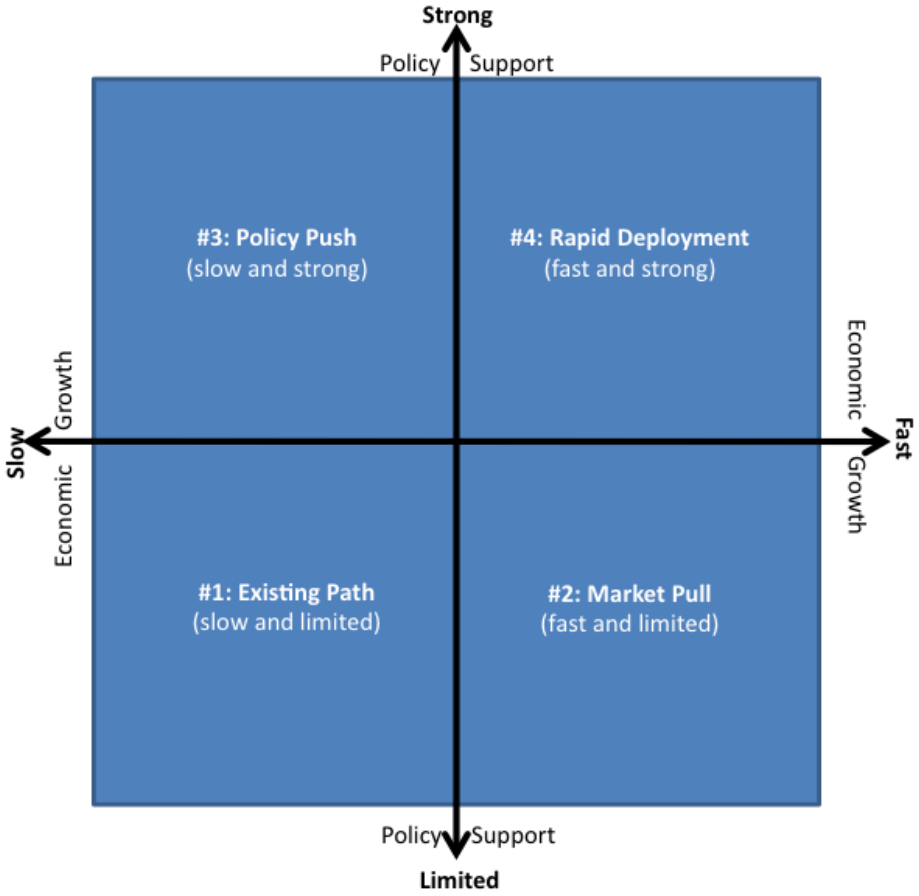
- **Continuing service obligations** imposed on utilities, including reliability, provider of last resort, backup and universal access
- **Federal and state jurisdictional tensions** increase, often "trapping" utilities between jurisdictional authorities and making regulatory issues more complex
- **Careful management of customer data and privacy** becomes an increasingly critical issue

Cost-Constrained

- **Customers expect technology** to add value at little or no extra cost
- **Regulators and utilities struggle** to cope with asset obsolescence, decoupling, dynamic pricing and other issues
- **Financial viability** of utilities is challenged
- **Aging workforce and skilled worker shortage** raises labor costs

A Quick Summary of the Four Scenarios

The initial scenarios were created by placing two critical factors—economic growth and policy support—along two axes, creating four quadrants and four scenarios, as shown in the following chart:



1. Existing Path (Slow economic growth / Limited policy support)

High unemployment and slow economic growth lower electric demand and reduce smart grid investments. Meanwhile, new federal legislation and programs supporting the smart grid are limited and state regulators are reluctant to approve smart grid investments. A significant transformation will still take place, but the pace is slower, given the lack of policy incentives and strong market demand.

2. Market Pull (Fast economic growth / Limited policy support)

A strong economy encourages new smart grid services and new market entrants. However, supporting federal legislation is minimal so progress is limited to areas the market can pull forward without incentives, mandates or subsidies. Policies, regulations and standards therefore vary widely by region.

3. Policy Push (Slow economic growth / Strong policy support)

Slow economic growth makes rate containment by state regulators the theme. This is counterbalanced by federal legislation on energy, renewables, climate, and infrastructure protection that creates powerful incentives and mandates for the smart grid. Utilities often find themselves pinched as policymakers push changes without providing the money to pay for them.

4. Rapid Development (Fast economic growth / Strong policy support)

This is the most disruptive and unpredictable scenario. A thriving economy combines with strong mandates and incentives to create a smart grid boom. The confusion of an Internet-style growth frenzy is counterbalanced somewhat by standards and guidelines from policymakers and regulators. Utilities have the most opportunities in this scenario… but also the most risk.

Outcomes Common to All Scenarios

Later in this document you will find descriptions of each scenario, with timelines and descriptions of their key themes. However, at least six outcomes were common to all four scenarios:

1. It's not whether… it's when

There was universal agreement the industry will be transformed top to bottom by smart technology. The scenarios differ mainly in how fast that change occurs.

2. Electric vehicles (EVs) and storage will be game-changers

Keeping with the "when-not-whether" idea, almost all participants expected electric vehicles to have an enormous impact, even though they differ on how fast that impact will occur. Likewise, most participants expected energy storage to become cost-competitive sometime in the next decade, and to shift the landscape dramatically when that happens.

3. Choice and diversity are key drivers

Every point along the value chain will have many options.

- ***Generation expansion will run the gamut*** from new centralized plants (including wind, solar thermal or even nuclear) to cogeneration, distributed generation and distributed renewables.
- ***End-use will be grid-connected and grid-involved.*** End-use will be increasingly connected to the smart grid, at the meter and behind the meter. All four scenarios foresee strong growth in demand response, energy efficiency, commercial and home energy management, grid-savvy appliances, electric vehicles and more.
- ***Transmission and distribution infrastructure will have to be transformed to accommodate this diversity.*** In particular, distribution must be upgraded to handle a world of variable energy renewables coupled with controllable demand and challenging uses such as server farms and electric vehicles.

4. Customers want more than electrons

The new energy consumers will want information about their energy use and options – the "iPhone" generation. They will want that information delivered to them anytime, anyplace, not just printed on a monthly bill. They will want more choice and control. And, long-term, they will want energy-related services. As corollaries:

- ***Competition for customers will be based on more than price.*** As has happened in so many other sectors such as telecommunications, we will see packages combining the commodity with value-added services.
- ***The industry will evolve from one-size-fits-all to a highly differentiated product marketplace.*** Companies will segment the market and offer combination services tailored to the special needs of each segment.
- ***Utilities may be disintermediated from their customers by new entrants.*** New market entrants will offer attractive energy packages that bypass and displace the utility. For instance, some of those packages may combine energy from distributed resources (localized and customer site specific) with energy management solutions.

5. New business models will emerge -- but no single model will dominate

A wide range of business model options for utilities will exist with varying probabilities of success.

- ***No single business model will dominate.*** Instead, there will be a continuum of choices from pure suppliers of "commodity electrons" to "behind-the-meter services" and many choices in between. Utilities must determine where they want to operate along that continuum.
- ***Regulators can't protect incumbents from change.*** They can make it easier or harder to make the transition, they can delay the inevitable, but they cannot stop the transformation any more than telecom regulators could stop that sector's makeover.

Leading Indicators Common to All Scenarios

How does a utility determine which scenario is coming to pass? Our participants suggested the following indicators should be monitored to determine which scenario is evolving.

Economic Growth Indicators

- Unemployment rate
- Gross Domestic Product (GDP) growth
- Load growth
- Cost of capital
- Venture capital investment in smart grid and other clean tech sectors
- Industry and government investment in smart grid and other clean tech sectors
- Oil and natural gas prices
- Adoption rates of EVs

Policy Support Indicators

- National climate legislation (with a price on carbon)
- Stringent Environmental Protection Agency (EPA) limits on carbon emissions from power plants
- National renewable portfolio standards (RPS)
- National broadband plan with mandates and funding
- National demand response (DR) plan with mandates and funding
- National smart grid policy and roadmap
- Additional stimulus funding for smart grid
- National mandates and funding for critical infrastructure security
- Incentives for EVs

#1 — The Existing Path Scenario

Slow economic growth and limited policy support make this the worst scenario for smart grid progress (but the best for those who prefer a slower pace of change). The economic side resembles a recession-that-won't-end. The policy side, however, is missing new energy and stimulus legislation that has been such an important driver since 2005. *Caution:* Although change happens more slowly in this scenario, it happens nonetheless. By the end of the decade in 2020, technology and business models both look very different from today.

Existing Path Economy: Stagflation until late in the decade

Early in the decade, tax cuts expire, high unemployment continues, and spending declines. Mid-decade is marked by "stagflation" (low GDP growth plus the return of inflation). Only in the final few years does the economy rebound.

- Electricity demand is flat for most of the decade, with load growth and utility sales increases of less than 1%
- Capital is hard to come by, whether for upgrades, assets, projects or startups
- Companies are slow to enter the industry
- When the recovery finally starts, reserve margins plunge to minimums due to deferred investments

Existing Path Policy: Federal policy stalls

New national energy and smart grid policies come to a halt. State regulators are hesitant to approve smart grid investments as customers shout for rate containment. The relatively slow pace of change causes many state regulators to fall back on "if it ain't broke…" and the U.S. continues to have a regulatory patchwork with regulatory overlap and conflicts:

- Carbon policy fails to pass
- The federal RPS never gets off the ground, (though existing state standards remain)
- Renewable and solar investment tax credits (ITCs) expire and are not renewed
- New regulatory paradigms don't emerge until the end of the decade

Existing Path Market: Backlash and consolidation

The decade starts with widespread consumer backlash and skepticism, which strengthens when early advanced metering infrastructure (AMI) installations fail to return all the benefits promised.

The lack of support from either policy or the economy creates a challenging climate for vendors that opens the door to low-cost technology from overseas.

- Smart meter deployments do not show the benefits promised
- Widespread consumer backlash followed by regulatory caution
- Companies are slow to enter the industry
- The market is not large enough to support the number of vendors; a shakeout occurs
- Only at the end of the decade do consumers become an engaged part of the electric power ecosystem

Existing Path Technology: Slowing deployments and innovation from overseas

As the decade progresses, deployments slow as the stimulus money is spent and there is nothing to replace it. The lack of a fast-growing market stunts U.S. companies and U.S. innovation, creating an opening for overseas solutions that stress lowest possible cost.

- Smart meter penetration starts the decade at 10% and ends at 25%
- Those utilities that did install smart meters and communications begin to layer on grid applications and distribution automation
- The U.S. fails to become a dominant supplier of smart grid products and services; low cost, overseas manufacturers will play an increasingly important role
- Home energy management matures in the second half of the decade
- EVs expand, but create problems because utilities have few resources to upgrade the transmission and distribution infrastructure

Existing Path Operations: Failed pilots and a shortage of resources

The pressure on the operations side is not as intense in this scenario, as opposed to others where policy or growth (or both) force rapid adaptation. Although pressures mount from renewables, DR, energy efficiency (EE) and EVs, they do not become intense until the final third of the decade.

- Stimulus projects fail to show real value; many pilots don't go to scale
- Utilities implement more sophisticated customer engagement in response to backlash
- Low-cost approaches such as DR and EE predominate
- Utilities with strong mandates (RPS, DR, EE, security) struggle to find the money to upgrade the grid to handle the resulting issues
- Smart grid develops as islands of innovation with limited interoperability (both technical and market)

Existing Path Business Models: Business-as-(almost)-usual until second half of decade

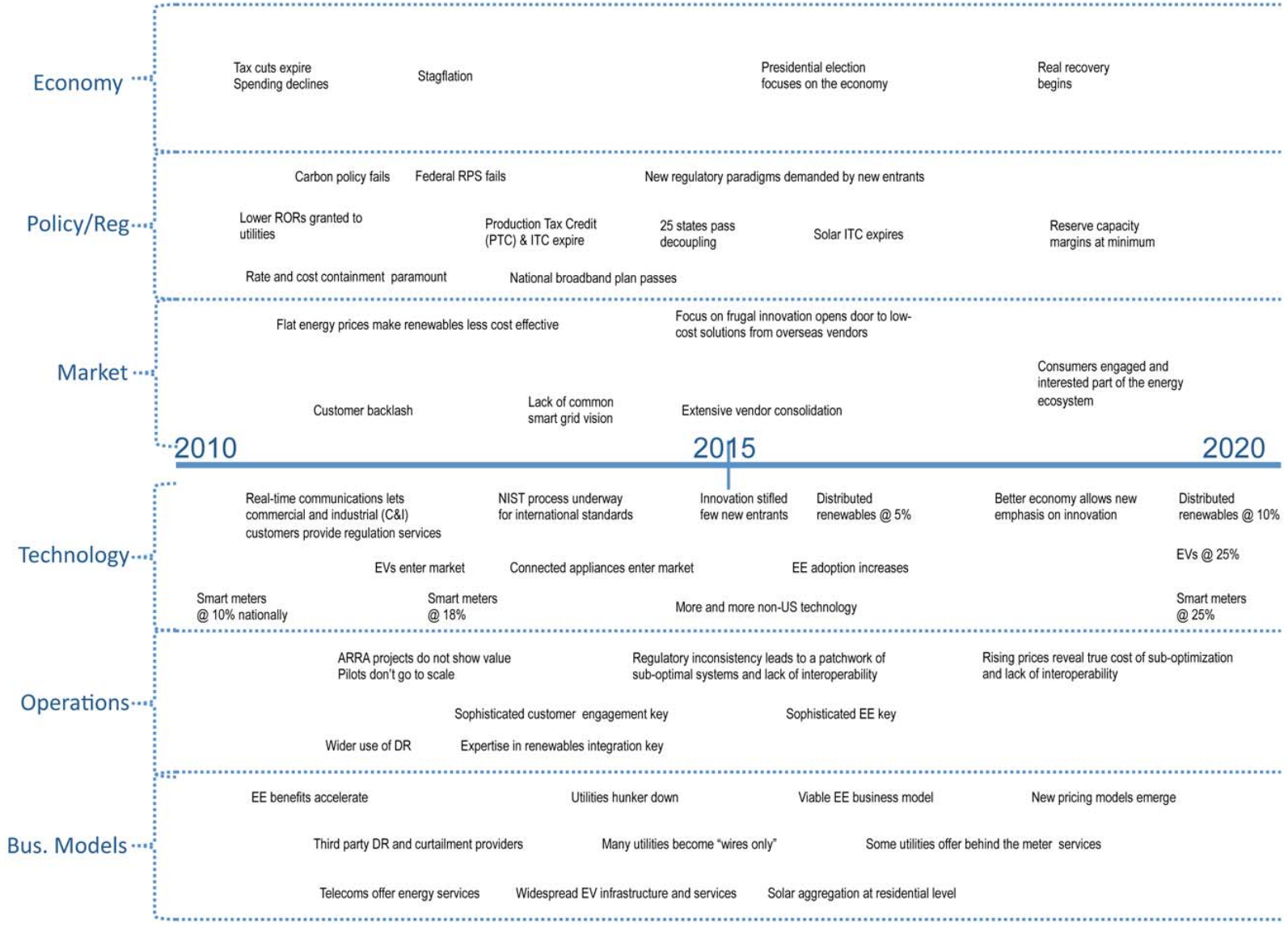
In the first part of the decade, consumers demand access to their energy data as a means to lower bills. Utilities hunker down, riding out declining sales and lower rates of return (RORs). Existing templates prevail until the end of the decade, when pressure finally mounts for new business models.

- Third-party companies offer energy management information and services
- EV infrastructure and services gradually come forward
- In a few locales, solar aggregation at the residential level creates new business opportunities
- Some utilities become "wires only"
- A few utilities partner to provide behind-the-meter products tied to "smart rates"

Existing Path Consensus Timeline

Displayed on the following page is the consensus Existing Path timeline that emerged from our two separate planning sessions. This timeline identifies the major events that the participants in the workshops believe could occur over a ten year horizon.

#1: Existing Path (slow growth, limited policy)



#2 — The Market Pull Scenario

Fast economic growth but limited policy support creates a chaotic situation in the Market Pull scenario. Customers (and the vendors who want to sell to them) drive developments in this scenario, which is probably the most challenging for the regulated business model. Utilities are pulled in two different directions, with customers saying "move forward" and regulators saying "stay where you are." Some utilities struggle financially until the end of decade finally brings viable business model options to utilities. At this point, some utilities are allotted a fair return to become the provider of last resort and to integrate and balance distributed resources scattered throughout the system.

Market Pull Economy: Growth creates vendor and customer demand

Economic growth accelerates through 2020, and unemployment drops to 4-5% by the end of the decade.

- Load grows, but not as fast as it would have without the system efficiencies created by smart technology
- Average electricity rates increase to more than 20 cents/kWh on average by 2018
- A rising economy means rising demand for oil, which hits $150/barrel, strengthening demand for EVs

Market Pull Policy: A Federal vacuum leaves utilities at risk

Few or no federal initiatives promote smart grid. There is increased conflict between federal and state policy makers. The lack of regulatory and policy support makes utilities more vulnerable to new market entrants, since they cannot adapt to the new conditions or respond rapidly to changing customer needs.

- Regulators approve only those smart grid projects with customer "pull" and clear payback
- Regulators resist new rate options for utilities
- Vendors lobby hard for the right to bypass utilities (for instance, to bundle energy services with products or to get direct access to customer data)

Market Pull Market: Wild west behind the meter

The customer is king in this scenario. In the first half of the decade, the customer side of the meter devolves into the Wild West, with vendors rushing in to stake claims with new energy devices and services. Midway through, growth is good but not great due to policy and regulatory obstacles. As the decade closes, mergers and partnerships accelerate, and a few of the vendors finally get to scale.

- Vendors large and small clamor to serve electric power customers, even if they have to go around the utilities to do so
- Growth happens first in a) markets where it is difficult to site new transmission or build new generation or b) restructured markets, where utilities can look for opportunities to be more market driven
- Customers turn to self-reliant solutions such as net zero homes; microgrids; DR; and bulk power purchases
- Some regions see significant utility bypass, with large customers participating directly in Regional Transmission Organizations (RTOs) by 2015
- EV adoption goes faster than anticipated — 1 million vehicles on the road by 2016 — and customers demand EV charging devices and services
- Partnering and competition between smart grid vendors accelerates as the decade progresses

Market Pull Technology: Enabling customers and energy storage

Technology development is focused on enabling customers and integrating distributed generation.

- The lack of a national vision creates a chaotic, fractured scene that hinders (but does not stop) growth while hampering interoperability
- Due to limited policy support, standards evolve slowly, and "Betamax vs. VHS" dilemmas arise
- Energy storage becomes a strong force, since it enables microgrids, EVs, and variable energy renewables
- Fuel cells and microturbines running low-cost shale gas make off-grid and microgrids viable, especially when buffered by energy storage
- As the decade closes, renewables reach economic viability

Market Pull Operations: Keeping things safe and integrating distributed generation and electric vehicles

Fast growth without strong policies means this scenario is likely to see more than one significant cyber event. Many nodes will be rapidly added to networks, but without the protection of centralized standards and enforcement.

- Operation and maintenance (O&M) costs will climb as individual utilities struggle to protect themselves
- Low unemployment combined with an aging utility workforce leads to a shortage of skilled workers
- Bulk renewables are constrained due to lack of policy support for transmission
- Distributed renewables grow as customers seek self-reliance because utilities are not keeping up

- The default supply model becomes natural gas plus wind
- As the decade progresses, utilities are forced to upgrade distribution to handle EVs and distributed generation (DG)

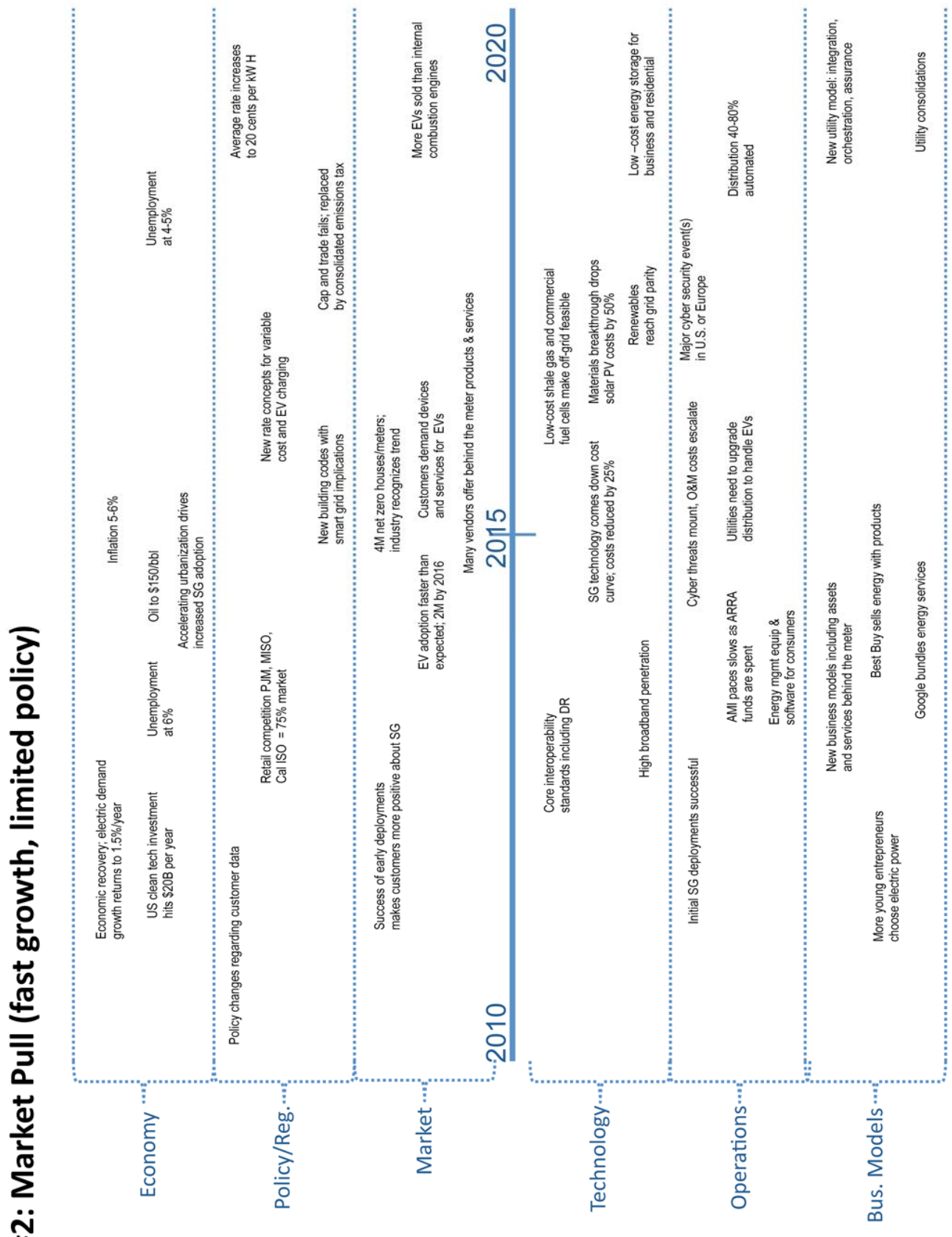
Market Pull Business Models: Utilities struggle to keep up

The Market Pull scenario may be the most challenging to regulated utilities, especially during the middle years of the decade. Customers demand new products and services, but regulators and policymakers won't make the changes that allow utilities to respond. As the decade winds down, some utilities find a viable model that makes them the foundation on which others build new services.

- Trapped between customers who say "yes!" and regulators who say "no!," many utilities struggle financially in the early and middle years
- Vendors offer behind-the-meter products/services, but many bypass utilities
- EV charging stations and services become a viable business
- Companies begin bundling electric power with devices and services. For instance, Google might bundle green energy with energy management; Home Depot might bundle programmable thermostats with electric power; telcos might bundle electric power with voice, video, data and home management
- On-site energy storage becomes a viable business as storage costs finally come down
- Eventually, some utilities become responsible for integrating, orchestrating and ensuring reliability among a wide variety of industry participants, and are allowed a fair return for this important contribution

Market Pull Consensus Timeline

Displayed on the following page is the consensus Market Pull timeline that emerged from our two separate planning sessions. This timeline identifies the major events that the participants in the workshops believe could occur over a ten year horizon.


#2: Market Pull (fast growth, limited policy)
Economy
Policy/Reg.
Market
Technology
Operations
Bus. Models
2010
2015
2020
Economic recovery; electric demand growth returns to 1.5%/year
US clean tech investment hits $20B per year
Unemployment at 6%
Inflation 5-6%
Oil to $150/bbl
Accelerating urbanization drives increased SG adoption
Unemployment at 4-5%
Policy changes regarding customer data
Retail competition PJM, MISO, Cal ISO = 75% market
New rate concepts for variable cost and EV charging
Cap and trade fails; replaced by consolidated emissions tax
Average rate increases to 20 cents per kW H
Success of early deployments makes customers more positive about SG
EV adoption faster than expected; 2M by 2016
4M net zero houses/meters; industry recognizes trend
Customers demand devices and services for EVs
New building codes with smart grid implications
More EVs sold than internal combustion engines
Many vendors offer behind the meter products & services
Core interoperability standards including DR
High broadband penetration
Low-cost shale gas and commercial fuel cells make off-grid feasible
SG technology comes down cost curve; costs reduced by 25%
Materials breakthrough drops solar PV costs by 50%
Renewables reach grid parity
Low –cost energy storage for business and residential
Initial SG deployments successful
AMI paces slows as ARRA funds are spent
Energy mgmt equip & software for consumers
Cyber threats mount, O&M costs escalate
Utilities need to upgrade distribution to handle EVs
Major cyber security event(s) in U.S. or Europe
Distribution 40-80% automated
More young entrepreneurs choose electric power
New business models including assets and services behind the meter
Best Buy sells energy with products
Google bundles energy services
New utility model: integration, orchestration, assurance
Utility consolidations

#3 — The Policy Push Scenario

Slow economic growth plus strong policy support creates an environment where utilities are pushed to move forward with the deployment of smart technology but don't have the money to comply. As mandates pile up, rates are forced up by the middle of the decade and continue to rise. Problems mount in the middle years as utilities are unable to keep up with the infrastructure demands. As a result, we see serious cyber incidents, neighborhood outages caused by overloaded circuits (from EV charging) and the financial failure of some utilities. Toward the end of the decade, utility consolidation occurs around a provider of last resort model.

Policy Push Economy: The triple dip recession

The double dip recession becomes a triple dip. Low economic growth is coupled with high unemployment. Then inflation rebounds, triggering another debt crisis, leading to more stimulus legislation, leading to more debt and the downward spiral continues.

- Electricity demand is flat for most of the decade, with load growth and utility sales increases of less than 1%
- Companies are slow to enter the industry
- China leads the way not just in economic growth, but in smart grid technology. As the decade progresses, their superior grid makes Chinese business more productive, further enhancing their global competitiveness and their lead.

Policy Push Policy: The Feds lead the way

In this scenario, smart grid technologies progress depends largely on aggressive federal policies. State regulators are generally favorable in theory. In practice, they are hesitant to approve cost recovery due to the sluggish economy.

- Within the first three years, Congress passes major legislation around climate, security and renewables
- Some legislation targets smart grid; other legislation targets other goals, but makes the smart grid more necessary (e.g. incentives for EVs, which require upgrades to distribution networks)
- The federal government funds numerous smart grid and critical infrastructure programs
- The Department of Defense (DOD) announces an aggressive program to make military bases independent of the electric grid
- Tension increases between the states and the federal government over who will control and who will pay

Policy Push Market: electric vehicles and the Department of Defense

Federal policies encourage smart grid expansion, but the faltering economy makes it hard to finance that growth. Startups and smaller companies from adjacent industries are cautious about entering the smart grid arena, due to low market demand. Larger companies may have the resources to take advantage of policy incentives while waiting for the economy to recover.

- Utilities partner with vendors to capitalize on federal and state funding for smart grid projects
- Drilling restrictions and other issues bring higher oil prices
- Higher oil prices plus environmentalism lead to incentives and higher demand for EVs
- The changeover to grid-independent military bases creates a large industry in and of itself
- Competitive decline of U.S.; Asia dominates tech/infrastructure development
- Grid bypass and grid divorce gradually accelerate, led by DG, local renewables, local energy storage, and microgrids.

Policy Push Technology: China leads, distributed generation and electric vehicles grow

Thanks to federal mandates and to the Department of Defense (DOD), standards are defined by 2014 and excuses are gone. The rules are clear, making interoperability and integration much easier. Even so, the lack of market pull reduces the number of startups and lessens innovation.

- China emerges as the smart grid technology leader
- DG and microgrids proliferate, thanks in part to government incentives and demand from military bases
- Incentives and policy help bring about energy storage breakthroughs, which further fuel the growth of microgrids, distributed renewables and EVs

Policy Push Operations: Smothered by mandates, overloaded by electric vehicles

Many utilities will be smothered by new mandates that require costly upgrades, while faced with flat or falling sales.

- As DR grows, electricity will not be priced by load shape. Load will be shaped by price.
- Climate legislation, the Clean Air Act, and coal ash and cooling tower (316b) regulations force retirement of 20% of the U.S. generation fleet
- Circuits overloaded by EVs cause neighborhood outages
- Some utilities outsource cybersecurity and information technology (IT)

Policy Push Business Models: Failures lead eventually to new models

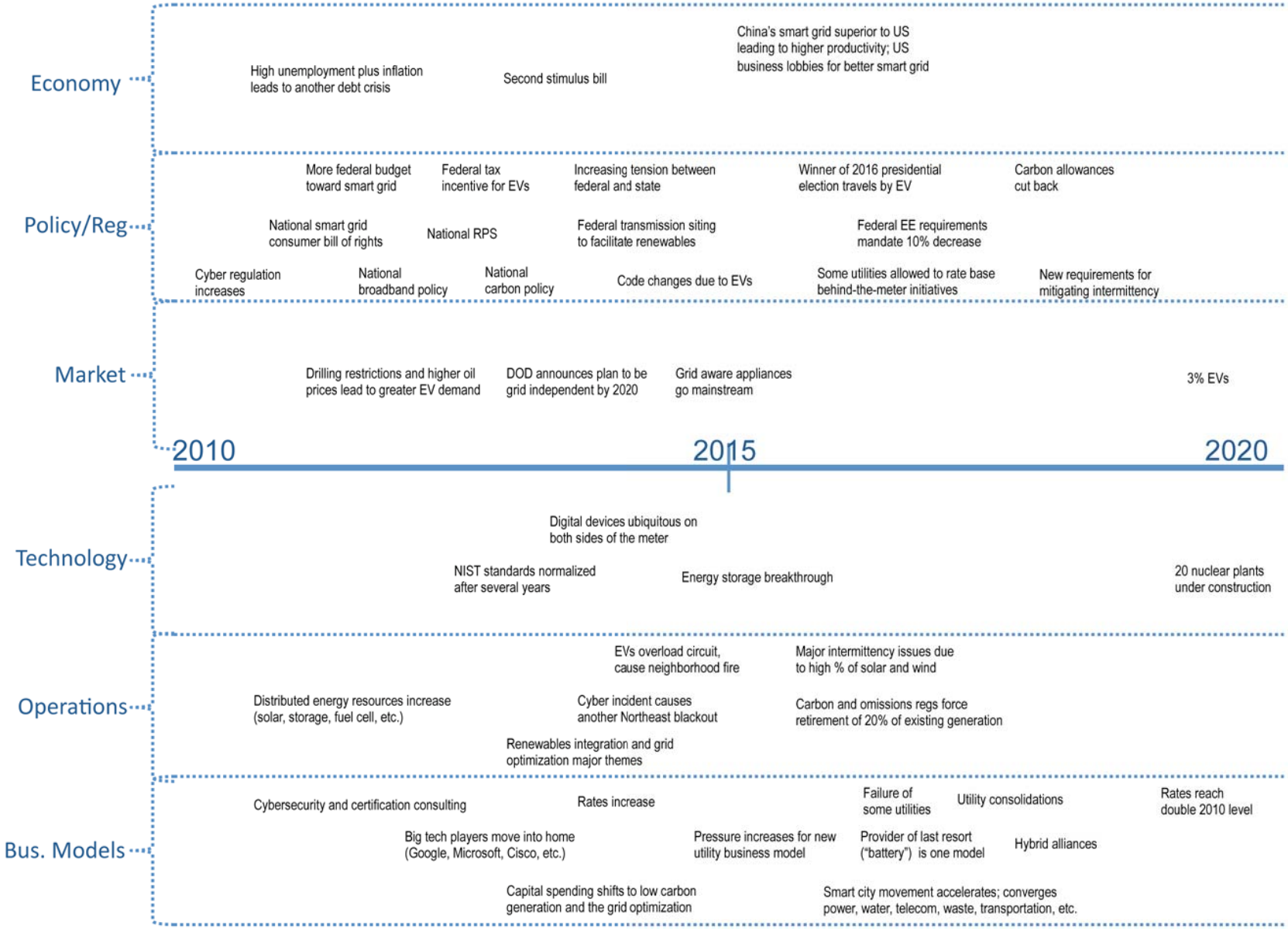
Trapped between mandates that raise costs and an economy that reduces revenues, some utilities fail. Fixed costs rise, but must be supported by a smaller base as some customers move to other companies (or become partially self-sufficient). Gradually, more sustainable business models emerge, including provider of last resort as well as hybrid forms.

- Standards bring clarity and make integration easier; but they also make it easier for third parties to displace utilities
- By the middle of the decade, some utilities can no longer finance new baseload
- Third parties offer DG and renewables; energy storage; EV charging; energy management and access to revenue from DR and ancillary services
- Microgrid developers emerge, integrating local generation and distribution and brokering a relationship with the local utility. Existing DOD contractors move into the utility space, providing systems integration and managing microgrids
- Utility failures force regulators to consider new models, including rate basing assets behind the meter
- Other utilities become the central organization that integrates, distributes, assures, and coordinates (similar to today's non-Independent System Operator (ISO) utilities with transmission).

Policy Push Consensus Timeline

Displayed on the following page is the consensus Policy Push timeline that emerged from our two separate planning sessions. This timeline identifies the major events that the participants in the workshops believe could occur over a ten year horizon.

#3: Policy Push (slow growth, strong policy)



#4 — The Rapid Deployment Scenario

Fasten your seatbelts as fast economic growth combines with strong policy support to create a frenzy of new ideas, companies, technologies and business models. In the early years, legislation strongly promotes smart grid. At the same time, a growing economy and the availability of capital encourages companies to jump into the sector. By the middle of the decade, Wal-Mart and Home Depot are selling smart energy devices, sometimes bundled with electric power. EVs grow rapidly, and so do the infrastructure upgrades and charging services to support them. By the end of the decade, the U.S. is a world leader in smart grid. Utilities have evolved several new business models while consolidating down through mergers and acquisitions significantly.

Rapid Deployment Economy: Boom times

The economy booms again and load grows (though not as fast as it would have before EE and DR became national themes).

- Unemployment falls and continues to drop to 4-5%
- There are several successful smart grid initial public offerings (IPOs) and a dramatic increase in venture capital funding for smart grid startups
- A variety of factors (economic growth, drilling restrictions, Oil Producing and Exporting Countries [OPEC] gaming) increases oil prices. Gasoline prices top $5/gallon in the U.S. (triggering stronger demand for EVs)

Rapid Deployment Policy: Early, aggressive mandates and incentives

Aggressive federal policies drive the development of smart technology. Congress passes major legislation around climate, security and renewables. The federal government funds numerous smart grid programs. State regulators fully support the smart grid deployment, providing full cost recovery and allowing dynamic pricing.

- The federal government passes legislation on climate (carbon), smart grid, EVs, RPS, cybersecurity and infrastructure protection, all of which promote smart grid expansion
- New pricing mechanisms emerge that deal with both fixed and variable costs and reflect the real cost of supply to the end consumer
- The passage of important federal legislation brings with it more regulatory consistency across the states in areas such as DR to ISO market; cybersecurity; and feed-in tariffs
- Although they resist at first, public utility commissions (PUCs) are forced to allow more mergers; the failure of some utilities will mandate that utilities combine to get economies of scale
- New building codes emphasize EE and grid connection

Rapid Deployment Market: A world of many flavors

In this scenario, customers are not merely engaged, they even revolt over lack of choice, demanding new energy options and services. The market becomes highly differentiated, with many different customer segments wanting many different flavors of energy services. Meanwhile, the number of vendors explodes, as many companies attempt to get in on the smart grid boom.

- Early in the decade, several smart grid companies have successful IPOs
- Competition between vendors is intense as everyone vies for a piece of the rapidly growing pie
- Retailers such as Home Depot, Best Buy and Wal-Mart jump in, offering not just smart devices, but bundles that include electric power and energy management services
- Developers begin to include energy in the properties they sell -- net zero subdivisions, premium power office parks, self-reliant microgrids, etc.
- Smart meters are ubiquitous by the end of the decade. Because the infrastructure is so prevalent, many companies compete to offer grid optimization and grid applications that ride on top
- The consumer side of the market comes to resemble the cell phone world, where customers can choose from a wide variety of options

Rapid Deployment Technology: Smart everything, everywhere

Standards are set early in the decade, unleashing a flood of standards-based products and services. By the end of the decade, the falling cost of energy storage combines with improvements in distributed renewables to make microgrids an increasingly common approach.

- Smart meters and thermostats proliferate
- Net metering and zero net energy sites grow rapidly
- EVs use surges, creating demand for EV charging while also pushing down the cost of batteries; demand grows for Level III fast charging
- DG (including distributed solar) becomes cost competitive
- By the end of the decade, renewables provide 25% of our energy

Rapid Deployment Operations: Keeping up is hard to do

Renewables, EVs and demand-side technologies take off like a rocket in this scenario, leaving utilities scrambling to upgrade their systems.

- The build out of high-voltage interstate transmission accelerates to accommodate renewables, which have been advantaged by federal legislation
- Rapid sales of EVs force upgrades to local distribution

- As the decade moves on, DG begins to become the standard to meet demand growth; large baseload plants are less common
- Climate legislation forces the retirement of some coal plants. To the extent DG cannot fill in the hole, replacement plants are natural gas
- Microgrids first take off in selected areas, such as hurricane alleys and military bases
- Later, DG and microgrids become a significant part of the electric power system in many areas

Rapid Deployment Business Models: A bifurcated world

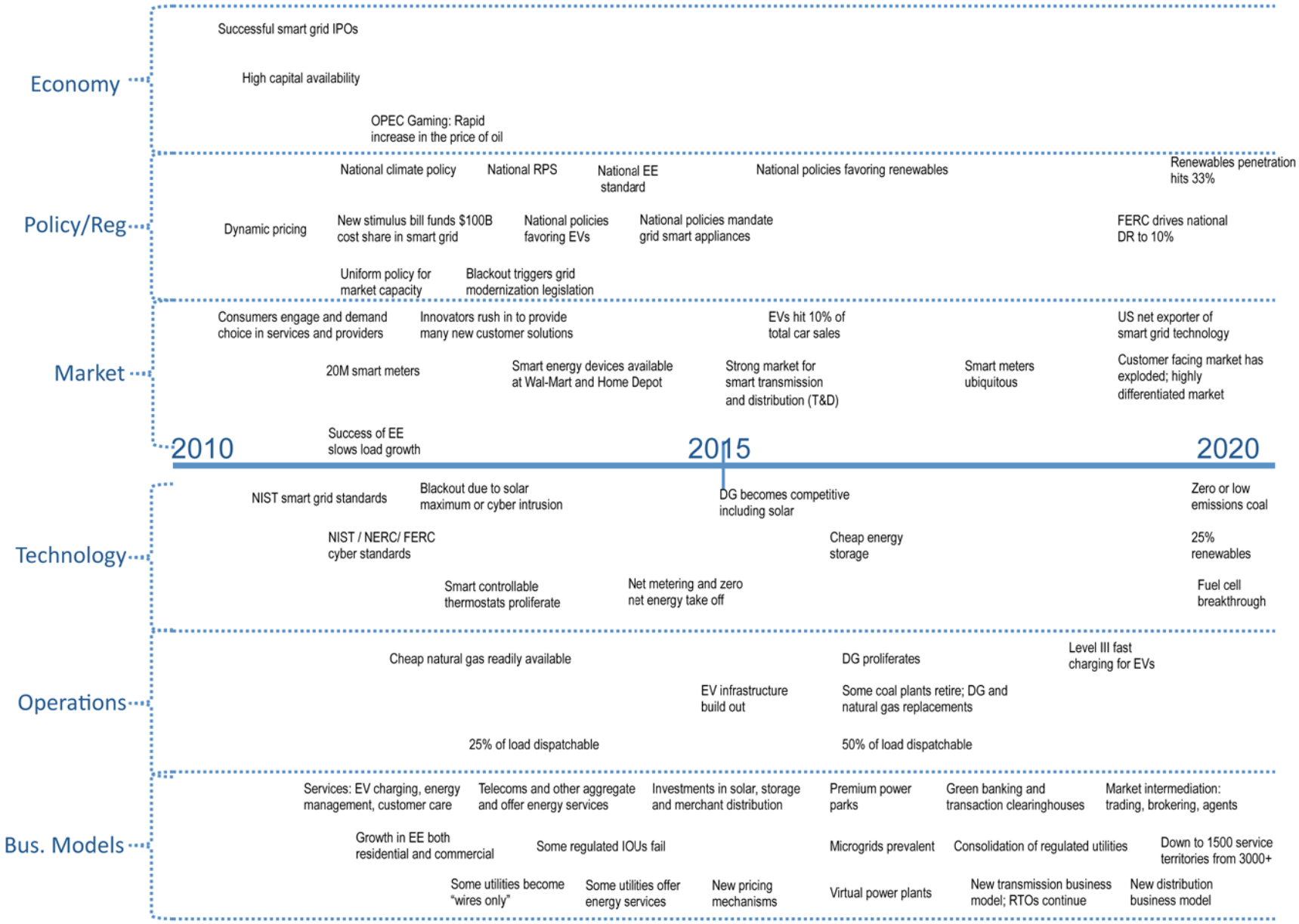
External events happen quickly, challenging regulators and utilities to keep up. Eventually, the industry bifurcates into a traditional centralized model versus a distributed model. New companies build highly differentiated customer services on top (the way telcos build differentiated services on top of fiber-optic lines).

- Differentiated customer offerings are provided by an array of new market entrants (Microsoft, Google, Wal-Mart, etc.)
- New services are custom tailored to the needs and preferences of each segment, including cost but also comfort, convenience, control, and altruism/sustainability. Possibilities include:
    - EV charging
    - Owning and managing assets
    - Customer care
    - Financial services (green banking, transactions/clearinghouses)
    - Wholesale market mediation (trading, brokering)
- Some regulated utilities move toward becoming the provider of last resort who assures the coordination and continuity of overall electricity service
- Other entities arise to focus on distributed electric power via microgrids and local power plants with local energy storage
- Municipals and cooperatives may lead the way to new distributed models, since they can move faster than investor-owned utilities (IOUs)
- The number of regulated entities is reduced via consolidation and failures. Consolidation happens in pockets in some states, though not across the board nationally

Rapid Deployment Consensus Timeline

Displayed on the following page is the consensus Rapid Deployment timeline that emerged from our two separate planning sessions. This timeline identifies the major events that the participants in the workshops believe could occur over a ten year horizon.

#4: Rapid Deployment (fast growth, strong policy)



Conclusion and Next Steps

These workshops provided a unique insight into potential smart grid futures. It was made possible because such a wide range of industry leaders across the electricity sector were willing to pool their knowledge in an exercise to create a common vision of deployment potentialities. The workshops were not intended to be an in-depth, commonly-held, final agreement of the future based on months of planning and analysis, but rather a starting point to look together at our common future and gain a deeper understanding of the issues that are likely to emerge and how they might impact our customers, businesses, and global competitiveness.

As such, these workshops should be viewed as an important initial step in establishing an inclusive industry stakeholder collaborative process designed to address the important public policy and implementation issues that will arise as smart technology is deployed.

Appendix A — Workshop Participants

Hosts

Edison International, Theodore F. Craver, Jr. Chairman, President and CEO
Pepco Holdings, Inc., Joseph M. Rigby, Chairman, President and CEO
Edison Electric Institute, Tom Kuhn, President

Participants

AEP, George Bjelovuk, Managing Director, Marketing, Research, & Program Development
Avista, Roger Woodworth, VP for Sustainable Energy Solutions
Balance Energy, Terry Mohn, Chief Innovation Officer
Brattle Group, Peter Fox-Penner, Principal and Chairman Emeritus
Cisco, Paul De Martini, VP & CTO
CMS Energy, Susan C. Swan, Vice President Smart Grid Development
CMS Energy, Wayne Longcore, Director of Enterprise Architecture & Standards & Chief Architect
ComEd, Val Jensen, VP Marketing & Environmental Programs
Current, Ray Gogel, President and COO
DC PSC, Betty Ann Kane, Chairman
DOE, Scott Harris, General Counsel
DTE, Lynne Ellyn, SVP & CIO
DUKE Energy, David W. Mohler, SVP & CTO
EEI, David K. Owens, Executive Vice President, Business Operations
EEI, Louis Jahn, Senior Director, Smart Grid Policy
Enernex, Erich Gunther, Chairman and CTO
EnerNOC, Inc., Tim Healy, Co-Founder, Chairman, & CEO
Environmental Defense Fund, Mark Brownstein, Deputy Director, Energy Program
EPRI, Arshad Mansoor, SVP R&D and Acting VP, Power Delivery and Utilization
Foundation Capital, Warren Weiss, General Partner
GE, John McDonald, Director, Technical Strategy & Policy Development GE Digital Energy
Gridpoint, Kenneth R. Floyd, Executive Vice President, Marketing and External Affairs
Grounded Power, Carl Gustin, Founder and President
Horizon Energy Group, Steven W. Pullins, President
IBM, Guido Bartels, General Manager, Global Energy & Utilities Industry
IEEE, Bob Grow, Chair IEEE-SA Standards Board
Illinois Citizens Utility Board, Chris Thomas, Policy Director
Innovari Energy, Chris Hickman, President
Integrys Energy Services, Mark Radtke, CEO
Itron, Philip Mezey, SVP and COO, North America
Macquarie, Andrew Weisel, U.S. Utilities and Smart Grid – Analyst
McKinsey & Company, Humayun Tai, Principal, Global Electric and Natural Gas Practice

Microsoft, Jon Arnold, Managing Director, Worldwide Power & Utilities
NASUCA, Mary Healey, President/Consumer Counsel for State of Connecticut
NEMA, Paul A. Molitor, Senior Industry Director, Smart Grid and Strategic Initiatives
NRDC, Ralph Cavanagh, Sr. Attorney, Co-Director NRDC Energy Program
NREL, Steve Hauser, Vice President, Grid Integration
NextEra Energy, Inc., Lakshman Charanjiva, VP & CIO
NextEra Energy, Inc., Phil Slack, Senior Manager, Enterprise Architecture
NorthWestern Energy, Robert C. Rowe, President and CEO
NorthWestern Energy, Patrick Corcoran, Vice President, Government & Regulatory Affairs
OGE Energy Corp., Craig Johnston, VP -Strategy & Marketing
OPower, Daniel Yates, Founder and CEO
Pepco Holdings, Inc., George W. Potts, VP Business Transformation
PG&E, Andrew Tang, Senior Director, Integrated Demand-side Management Products
PNNL, Mike Davis, Associate Laboratory Director, Energy and Environment Directorate
PUCO, Paul Centolella, Commissioner
SCE, Mahvash Yazdi, SVP Business Integration & CIO
SCE, Douglas Kim, Director, PEV Readiness Program
SCE, Mike Montoya, Director Grid Advancement, Advanced Technologies
Silver Spring Networks, Eric Dresselhuys, EVP and Chief Marketing Officer
Tendril, Ivo Steklac, EVP, Sales & Strategy
WPS, Barbara Nick, SVP, Energy Delivery & Customer Service and President, Upper Peninsula Power Company

Facilitator and Workshop Leaders

Futurist.com, Glen Hiemstra, Founder & Owner, Workshop and Facilitation Leader
CMS Energy, Wayne Longcore, Director of Enterprise Architecture & Standards & Chief Architect
IEEE, Larry Todd Wilson, IEEE Knowledge Transfer Advisor
EPRI, Barbara Tyran, Director, Washington Relations
GlobalSmartEnergy.com, Jesse Berst, Managing Director
SCE, Felix Oduyemi, Sr. Program Manager for Legislative and Regulatory Policy for Advanced Technology
WPS, Barbara Nick, SVP, Energy Delivery & Customer Service & President, Upper Peninsula Power Company

EEI Staff

Louis Jahn, Sr. Director, Smart Grid Policy
Alice Travis, Director, Project Consulting Group
Chris Eisenbrey, Director, Business Information
Joanne Hopkins, Sr. Analyst , Project Consulting Group
Mari Smallwood, Administrative Assistant & Meeting Coordinator

Appendix B — Workshop Advance Materials: Four Scenarios

EEI Smart Technology Workshop - Scenario #1 - "Existing Path"

In this scenario, the economic and government policy environment we are experiencing today more or less continues through 2020—characterized by low economic growth coupled with historically high unemployment.

Despite the $787 billion stimulus package passed by Congress and signed into law by President Obama in February 2009, the national economy is slow to recover from the current recession leading to an incrementally slow deployment of smart technology. Few business opportunities arise for smart technology investments and the influx of new capital into the industry by new market entrants is limited. Additional economic stimulus efforts over the 2010-2020 time period have a minimal positive impact on the economy. The public policy focus is on addressing unemployment and deficit reduction, with other government policy initiatives that would support the deployment of smart technology being limited. At the state level, regulators are cautious about approving any new smart technology programs that will pass costs on to customers given the fragile state of the economy. International financial and sovereign debt problems continue to exert a negative effect on domestic economic growth.

The bottom line is that neither the economics of the market or government policies are strongly driving the deployment of smart technology.

Scenario Driving Forces—Pre-Determined Elements Common To All Scenarios

- Technological Advancement Embedded In Culture
    - Advances in information technology are creating a culture where information covering a wide range of activities is expected to be easily available via multiple platforms and in real-time to the consumer.
    - The population is becoming increasingly technologically sophisticated through everyday use of computers, smart phones, cars w/bluetooth and GPS built in, etc.
    - As utilities transition towards the smart grid, there will be overlap - doing things in both new and old ways for a period of time.
- Customers Expect Smart Technology To Add Value
    - There will be a range of customer types, and each customer will have their own definition of value.
        - One type is the customer that no longer accepts what is handed down to them without question. They expect to be the determiner. They expect

control and choice. They are demanding, active, vocal and impatient. They expect sophisticated technology that will reduce their energy costs to be available to them in the smart technology world without regard to the industry and how it is structured.

- At the other end of the spectrum, is the customer that doesn't care to monitor or alter their energy usage and is not willing to pay for new services.

- There is customer confusion about what smart grid is and how they will benefit.
- Technology enablers, like social networking (e.g., Facebook, Twitter), allow customers to organize and communicate with an extremely wide network.

- Service Obligations Will Continue To Be Imposed On Utilities and New Service Obligations May Emerge
  - At both the federal and state level, utilities are obligated to maintain the reliability of the electric system—this will not change. The challenges and expectations to maintain reliability are likely to increase.
  - Utilities are and will continue to be obligated to be the provider of last resort for all customers.
  - Utilities will be held accountable for any cyber security issues arising from the deployment of smart technology.
- New Vendors Will Continue To Enter The Utility Space
  - New vendors are entering the utility space and are developing and offering the customer a wide range of smart technology tools that will enable customers to monitor and control their energy usage and costs.
  - New vendors will rarely enter as vertically integrated utilities. Instead, they will typically target one segment, focusing on high-margin customers to whom they can offer new and additional services. Current examples include commercial and industrial demand response; home energy management; distributed renewables; and microgrids.
  - Cyber security is a growing concern for government and utility executives as increasing numbers of smart devices are connected to the grid by new vendors, particularly at the distribution level.
- Federal Government Is Committed To Modernizing The Power Grid
  - Legislation including the Energy Independence and Security Act of 2007 (EISA) and the American Recovery and Reinvestment Act of 2009 (ARRA) have demonstrated the federal commitment to modernizing the electric grid through the deployment of smart grid technologies.
  - FERC is committed to increasing the level of energy efficiency, demand response, and renewable generation in the electricity markets.

- Federal and State Jurisdictional Tensions Are Increasing Where Agendas are Misaligned
    - Advanced smart technologies are blurring the jurisdictional boundaries between federal and state jurisdictional authority (for example —cyber security).
    - In some cases, federal policies and regulations are encouraging rapid smart grid implementation, while state policies and regulations are taking a more cautious approach.
- Utility Financial Regulatory Issues Are Increasing and Becoming More Complex
    - Cost recovery for smart technology investments issues have emerged, such as:
        - Rapid technological obsolescence is shortening the relevant lifespan of utility smart technology investments.
        - Traditional depreciation treatment is inadequate.
    - The financial viability of utilities will be challenged.
- Management of Customer Data and Access to that Data Will Become a Critical Issue
    - Increased amounts of data are going to increase concerns over customer privacy.
- The Aging Utility Workforce Will Make it Challenging to Find Skilled Workers
- The Smart Grid Will Create Alternative Energy Supply Options for Customers
    - Utilities and new competitors will offer a variety of services, including: energy efficiency, demand response, renewables, etc.

Scenario Critical Uncertainties—May Or May Not Happen, May Go One Direction Or Another

- The economy recovers slowly from the current recession and electricity demand is stagnant for the near term, slowly increasing over time. High unemployment becomes ingrained in the economy—6-8%.
- National energy policy initiatives are slow to develop. Minimal public policy activity in cyber security, reliability, interoperability, renewables and climate areas—legislation remains stalled in Congress and the National Broadband Plan recommendations are slow to be implemented.
- Due to the sluggish economy, state regulators are hesitant to approve cost recovery for major smart grid investments or institute dynamic rate programs and will fail to meet the financial obligations of utilities. State regulators are also very aggressive in challenging utility smart grid strategies.
- New market entrants are slow to enter the industry given the lack of economic incentives
- ARRA funding helped jumpstart a variety of pilot projects around the country, but the sluggish economy, regulatory challenges, and concern over costs and benefits hinder further expansion. Follow-on projects tend to be more cautious and incremental.
- Building high voltage, interstate transmission lines continues to be challenging in light of siting concerns with limited FERC backstop siting authority, financing difficulties as a result of the recent recession, and controversy over who pays and who benefits.

- Thirty states and the District of Columbia have adopted some sort of Renewable Portfolio Standard (RPS).

Discussion Questions For Scenario Team:

- Do you agree with the driving forces that form the basis for all 4 scenarios? Have we missed any?
- Have we captured the critical uncertainties for each scenario?
- If the features of this scenario more or less come to pass, how will smart technology be deployed?
- What technologies and services will provide the most value to customers under this scenario?
- Who will be the new market entrants under this scenario? What products will they offer?
- What smart technology public policy issues will arise under this scenario?
- Will the utility's relationship with its customers change under this scenario?
- What smart technology will the customer want under this scenario? Why?

EEI Smart Technology Workshop - Scenario # 2 - "Market Pull"

In this scenario, economic growth accelerates through 2020, leading to pre-recession unemployment levels early in the decade and by 2020, a shortage of skilled workers. Government policy initiatives that would accelerate the deployment of smart technology, however, remain limited.

The initial $787 billion stimulus package passed by Congress and signed into law by President Obama in February 2009, has a very positive impact on the rate of economic growth which continues to accelerate. Additional economic stimulus efforts over the 2010-2020 period continue to have a very positive impact on the economy. This creates an environment in which market opportunities drive the deployment of smart technology. New businesses see the opportunity to offer new smart technology products by partnering and competing with electric utilities—competition for the customer accelerates. However, other priorities still dominate the public policy agenda and little progress is made to implement national policies that would accelerate the deployment of smart technology. State regulators though, feeling more confident in the economy, support smart grid projects that demonstrate value to customers and more often than not, grant cost recovery for smart grid investments. International financial and sovereign debt problems are resolved and therein positively support the domestic economy.

The bottom line is that the economics of the market are driving smart technology deployment.

Scenario Driving Forces—Pre-Determined Elements Common To All Scenarios

- Technological Advancement Embedded In Culture

  - Advances in information technology are creating a culture where information covering a wide range of activities is expected to be easily available via multiple platforms and in real-time to the consumer.
  - The population is becoming increasingly technologically sophisticated through everyday use of computers, smart phones, cars w/bluetooth and GPS built in, etc.
  - As utilities transition towards the smart grid, there will be overlap - doing things in both new and old ways for a period of time.

- Customers Expect Smart Technology To Add Value
  - There will be a range of customer types, and each customer will have their own definition of value.
    - One type is the customer that no longer accepts what is handed down to them without question. They expect to be the determiner. They expect control and choice. They are demanding, active, vocal and impatient. They expect sophisticated technology that will reduce their energy costs to be available to them in the smart technology world without regard to the industry and how it is structured.
    - At the other end of the spectrum, is the customer that doesn't care to monitor or alter their energy usage and is not willing to pay for new services.
  - There is customer confusion about what smart grid is and how they will benefit.
  - Technology enablers, like social networking (e.g., Facebook, Twitter), allow customers to organize and communicate with an extremely wide network.
- Service Obligations Will Continue To Be Imposed On Utilities and New Service Obligations May Emerge
  - At both the federal and state level, utilities are obligated to maintain the reliability of the electric system—this will not change. The challenges and expectations to maintain reliability are likely to increase.
  - Utilities are and will continue to be obligated to be the provider of last resort for all customers.
  - Utilities will be held accountable for any cyber security issues arising from the deployment of smart technology.
- New Vendors Will Continue To Enter The Utility Space
  - New vendors are entering the utility space and are developing and offering the customer a wide range of smart technology tools that will enable customers to monitor and control their energy usage and costs.
  - New vendors will rarely enter as vertically integrated utilities. Instead, they will typically target one segment, focusing on high-margin customers to whom they can offer new and additional services. Current examples include commercial and industrial demand response; home energy management; distributed renewables; and microgrids.

  - Cyber security is a growing concern for government and utility executives as increasing numbers of smart devices are connected to the grid by new vendors, particularly at the distribution level.

- Federal Government Is Committed To Modernizing The Power Grid
  - Legislation including the Energy Independence and Security Act of 2007 (EISA) and the American Recovery and Reinvestment Act of 2009 (ARRA) have demonstrated the federal commitment to modernizing the electric grid through the deployment of smart grid technologies.
  - FERC is committed to increasing the level of energy efficiency, demand response, and renewable generation in the electricity markets.
- Federal and State Jurisdictional Tensions Are Increasing Where Agendas are Misaligned
  - Advanced smart technologies are blurring the jurisdictional boundaries between federal and state jurisdictional authority (for example —cyber security).
  - In some cases, federal policies and regulations are encouraging rapid smart grid implementation, while state policies and regulations are taking a more cautious approach.
- Utility Financial Regulatory Issues Are Increasing and Becoming More Complex
  - Cost recovery for smart technology investments issues have emerged, such as:
    - Rapid technological obsolescence is shortening the relevant lifespan of utility smart technology investments.
    - Traditional depreciation treatment is inadequate.
  - The financial viability of utilities will be challenged.
- Management of Customer Data and Access to that Data Will Become a Critical Issue
  - Increased amounts of data are going to increase concerns over customer privacy.
- The Aging Utility Workforce Will Make it Challenging to Find Skilled Workers
- The Smart Grid Will Create Alternative Energy Supply Options for Customers
  - Utilities and new competitors will offer a variety of services, including: energy efficiency, demand response, renewables, etc.

Scenario Critical Uncertainties—May Or May Not Happen, May Go One Direction Or Another

- The economy makes rapid economic gains over the next couple of years, rebounding more quickly toward the middle part of the decade, spurred in part by the development of green technologies. Demand for electricity increases in step with the recovery. Inflation starts to become an issue and unemployment drops to 4-5% level.
- With low unemployment and an aging skilled workforce, finding talent is increasingly difficult.
- National energy policy initiatives are slow to develop. Minimal public policy activity in cyber security, reliability, interoperability, renewables and climate areas—legislation

remains stalled in Congress and the National Broadband Plan recommendations are slow to be implemented.

- Given the strength in the economy, state regulators fully support deployment of smart grid technologies, and provide full cost recovery and move forward with dynamic rate programs.
- ARRA funded pilot projects expand beyond the pilot scale, implementing proven technologies throughout the grid.
- Building high voltage, interstate transmission lines continues to be challenging in light of siting concerns with limited FERC backstop siting authority, and controversy over who pays and who benefits.
- Thirty states and the District of Columbia have adopted some sort of Renewable Portfolio Standard (RPS).
- Partnering and competition between smart grid vendors exists to capitalize on business opportunities.

Discussion Questions For Scenario Team:

- Do you agree with the driving forces that form the basis for all 4 scenarios? Have we missed any?
- Have we captured the critical uncertainties for each scenario?
- If the features of this scenario more or less come to pass, how will smart technology be deployed?
- What technologies and services will provide the most value to customers under this scenario?
- Who will be the new market entrants under this scenario? What products will they offer?
- What smart technology public policy issues will arise under this scenario?
- Will the utility's relationship with its customers change under this scenario?
- What smart technology will the customer want under this scenario? Why?

EEI Smart Technology Workshop - Scenario #3 - "Policy Push"

In this scenario, the economic environment we are experiencing today more or less continues through 2020—characterized by low economic growth coupled with historically high unemployment. However, aggressive public policy initiatives drive the deployment of smart technology.

Despite the $787 billion stimulus package passed by Congress and signed into law by President Obama in February 2009, the national economy is slow to recover from the current recession leading to an incrementally slow deployment of smart technology. Additional economic stimulus efforts over the 2010-2020 time period have a minimal positive impact on the economy. Hence market forces are not driving the deployment of smart technology. However, the federal government, in

addition to passing initiatives attempting to reduce unemployment and the deficit, pass a wide range of laws that provide significant economic incentives for the deployment of smart technology. State regulators are still cautious about approving any new smart technology programs that will pass costs on to customers given the fragile state of the economy. International financial and sovereign debt problems continue to exert a negative effect on domestic economic growth.

The bottom line is that federal government programs are the primary driver for the deployment of smart technology.

Scenario Driving Forces—Pre-Determined Elements Common To All Scenarios

- Technological Advancement Embedded In Culture
    - Advances in information technology are creating a culture where information covering a wide range of activities is expected to be easily available via multiple platforms and in real-time to the consumer.
    - The population is becoming increasingly technologically sophisticated through everyday use of computers, smart phones, cars w/bluetooth and GPS built in, etc.
    - As utilities transition towards the smart grid, there will be overlap - doing things in both new and old ways for a period of time.
- Customers Expect Smart Technology To Add Value
    - There will be a range of customer types, and each customer will have their own definition of value.
        - One type is the customer that no longer accepts what is handed down to them without question. They expect to be the determiner. They expect control and choice. They are demanding, active, vocal and impatient. They expect sophisticated technology that will reduce their energy costs to be available to them in the smart technology world without regard to the industry and how it is structured.
        - At the other end of the spectrum, is the customer that doesn't care to monitor or alter their energy usage and is not willing to pay for new services.
    - There is customer confusion about what smart grid is and how they will benefit.
    - Technology enablers, like social networking (e.g., Facebook, Twitter), allow customers to organize and communicate with an extremely wide network.
- Service Obligations Will Continue To Be Imposed On Utilities and New Service Obligations May Emerge
    - At both the federal and state level, utilities are obligated to maintain the reliability of the electric system—this will not change. The challenges and expectations to maintain reliability are likely to increase.
    - Utilities are and will continue to be obligated to be the provider of last resort for all customers.

  - Utilities will be held accountable for any cyber security issues arising from the deployment of smart technology.

- New Vendors Will Continue To Enter The Utility Space
  - New vendors are entering the utility space and are developing and offering the customer a wide range of smart technology tools that will enable customers to monitor and control their energy usage and costs.
  - New vendors will rarely enter as vertically integrated utilities. Instead, they will typically target one segment, focusing on high-margin customers to whom they can offer new and additional services. Current examples include commercial and industrial demand response; home energy management; distributed renewables; and microgrids.
  - Cyber security is a growing concern for government and utility executives as increasing numbers of smart devices are connected to the grid by new vendors, particularly at the distribution level.
- Federal Government Is Committed To Modernizing The Power Grid
  - Legislation including the Energy Independence and Security Act of 2007 (EISA) and the American Recovery and Reinvestment Act of 2009 (ARRA) have demonstrated the federal commitment to modernizing the electric grid through the deployment of smart grid technologies.
  - FERC is committed to increasing the level of energy efficiency, demand response, and renewable generation in the electricity markets.
- Federal and State Jurisdictional Tensions Are Increasing Where Agendas are Misaligned
  - Advanced smart technologies are blurring the jurisdictional boundaries between federal and state jurisdictional authority (for example —cyber security).
  - In some cases, federal policies and regulations are encouraging rapid smart grid implementation, while state policies and regulations are taking a more cautious approach.
- Utility Financial Regulatory Issues Are Increasing and Becoming More Complex
  - Cost recovery for smart technology investments issues have emerged, such as:
    - Rapid technological obsolescence is shortening the relevant lifespan of utility smart technology investments.
    - Traditional depreciation treatment is inadequate.
  - The financial viability of utilities will be challenged.
- Management of Customer Data and Access to that Data Will Become a Critical Issue
  - Increased amounts of data are going to increase concerns over customer privacy.
- The Aging Utility Workforce Will Make it Challenging to Find Skilled Workers
- The Smart Grid Will Create Alternative Energy Supply Options for Customers

- Utilities and new competitors will offer a variety of services, including: energy efficiency, demand response, renewables, etc.

Scenario Critical Uncertainties—May Or May Not Happen, May Go One Direction Or Another

- The economy recovers slowly from the current recession and electricity demand is stagnant for the near term, slowly increasing over time. High unemployment becomes ingrained in the economy—6-8%, leading to a focus on jobs rather than the environment.
- Congress is very active in passing major legislation affecting public policies relating to cyber security, reliability, renewables and climate areas. Numerous well funded programs and incentives are established at both the federal and state level to support the deployment of smart technologies.
  - Congress passes climate legislation, implementing a national greenhouse gas cap and trade program and a national Renewable Portfolio Standard (RPS).
  - Congress grants FERC expanded backstop siting authority to facilitate the approval process for the construction of interstate transmission lines.
  - National Broadband Plan recommendations are implemented.
  - Interoperability standards are developed.
  - FERC implements wide reaching regulations to ensure the reliability and cyber security of the grid.
- Due to the sluggish economy, state regulators are hesitant to approve cost recovery for smart grid investments or institute dynamic rate programs.
- Partnering and competition between smart grid vendors exists to capitalize on federal and state funding for smart grid projects.
- The number of distributed generation and micro grid pilot projects grow, incentivized by government programs.

Discussion Questions For Scenario Team:

- Do you agree with the driving forces that form the basis for all 4 scenarios? Have we missed any?
- Have we captured the critical uncertainties for each scenario?
- If the features of this scenario more or less come to pass, how will smart technology be deployed?
- What technologies and services will provide the most value to customers under this scenario?
- Who will be the new market entrants under this scenario? What products will they offer?
- What smart technology public policy issues will arise under this scenario?
- Will the utility's relationship with its customers change under this scenario?
- What smart technology will the customer want under this scenario? Why?

EEI Smart Technology Workshop - Scenario # 4 - "Rapid Deployment"

In this scenario, the deployment of smart technology is driven by both healthy economy growth that creates economic market opportunities and supportive federal and state government programs.

The initial $787 billion stimulus package passed by Congress and signed into law by President Obama in February 2009, has a very positive impact on the rate of economic growth which continues to accelerate. Additional economic stimulus efforts over the 2010-2020 period continue to have a very positive impact on the economy. This creates an environment in which market opportunities are an important driver of the deployment of smart technology. New businesses see the opportunity to offer new smart technology products by partnering and competing with electric utilities—competition for the customer accelerates. In addition, progressive federal and state programs create an environment that also accelerates the deployment of smart technology. International financial and sovereign debt problems are resolved and therein positively support the domestic economy.

The bottom line is that a perfect environment for the deployment of smart technology is created—a booming economy supported by public policy initiatives that advance smart technology.

Scenario Driving Forces—Pre-Determined Elements Common To All Scenarios

- Technological Advancement Embedded In Culture
  - Advances in information technology are creating a culture where information covering a wide range of activities is expected to be easily available via multiple platforms and in real-time to the consumer.
  - The population is becoming increasingly technologically sophisticated through everyday use of computers, smart phones, cars w/bluetooth and GPS built in, etc.
  - As utilities transition towards the smart grid, there will be overlap - doing things in both new and old ways for a period of time.
- Customers Expect Smart Technology To Add Value
  - There will be a range of customer types, and each customer will have their own definition of value.
    - One type is the customer that no longer accepts what is handed down to them without question. They expect to be the determiner. They expect control and choice. They are demanding, active, vocal and impatient. They expect sophisticated technology that will reduce their energy costs to be available to them in the smart technology world without regard to the industry and how it is structured.
    - At the other end of the spectrum, is the customer that doesn't care to monitor or alter their energy usage and is not willing to pay for new services.
  - There is customer confusion about what smart grid is and how they will benefit.
  - Technology enablers, like social networking (e.g., Facebook, Twitter), allow customers to organize and communicate with an extremely wide network.

- Service Obligations Will Continue To Be Imposed On Utilities and New Service Obligations May Emerge
    - At both the federal and state level, utilities are obligated to maintain the reliability of the electric system—this will not change. The challenges and expectations to maintain reliability are likely to increase.
    - Utilities are and will continue to be obligated to be the provider of last resort for all customers.
    - Utilities will be held accountable for any cyber security issues arising from the deployment of smart technology.
- New Vendors Will Continue To Enter The Utility Space
    - New vendors are entering the utility space and are developing and offering the customer a wide range of smart technology tools that will enable customers to monitor and control their energy usage and costs.
    - New vendors will rarely enter as vertically integrated utilities. Instead, they will typically target one segment, focusing on high-margin customers to whom they can offer new and additional services. Current examples include commercial and industrial demand response; home energy management; distributed renewables; and microgrids.
    - Cyber security is a growing concern for government and utility executives as increasing numbers of smart devices are connected to the grid by new vendors, particularly at the distribution level.
- Federal Government Is Committed To Modernizing The Power Grid
    - Legislation including the Energy Independence and Security Act of 2007 (EISA) and the American Recovery and Reinvestment Act of 2009 (ARRA) have demonstrated the federal commitment to modernizing the electric grid through the deployment of smart grid technologies.
    - FERC is committed to increasing the level of energy efficiency, demand response, and renewable generation in the electricity markets.
- Federal and State Jurisdictional Tensions Are Increasing Where Agendas are Misaligned
    - Advanced smart technologies are blurring the jurisdictional boundaries between federal and state jurisdictional authority (for example —cyber security).
    - In some cases, federal policies and regulations are encouraging rapid smart grid implementation, while state policies and regulations are taking a more cautious approach.
- Utility Financial Regulatory Issues Are Increasing and Becoming More Complex
    - Cost recovery for smart technology investments issues have emerged, such as:
        - Rapid technological obsolescence is shortening the relevant lifespan of utility smart technology investments.
        - Traditional depreciation treatment is inadequate.

  - The financial viability of utilities will be challenged.
- Management of Customer Data and Access to that Data Will Become a Critical Issue
  - Increased amounts of data are going to increase concerns over customer privacy.
- The Aging Utility Workforce Will Make it Challenging to Find Skilled Workers
- The Smart Grid Will Create Alternative Energy Supply Options for Customers
  - Utilities and new competitors will offer a variety of services, including: energy efficiency, demand response, renewables, etc.

Scenario Critical Uncertainties—May Or May Not Happen, May Go One Direction Or Another

- The economy makes rapid economic gains over the next couple of years, rebounding more quickly toward the middle part of the decade, spurred in part by the development of green technologies. Demand for electricity increases in step with the recovery. Inflation starts to become an issue and unemployment drops to 4-5% level.
- Congress is very active in passing major legislation affecting public policies relating to cyber security, reliability, renewables and climate areas. Numerous well funded programs and incentives are established at both the federal and state level to support the deployment of smart technologies.
  - Congress passes climate legislation, implementing a national greenhouse gas cap and trade program and a national Renewable Portfolio Standard (RPS).
  - Congress grants FERC expanded backstop siting authority to facilitate the approval process for the construction of interstate transmission lines.
  - National Broadband Plan recommendations are implemented.
  - Interoperability standards are developed.
  - FERC implements wide reaching regulations to ensure the reliability and cyber security of the grid.
- State regulators fully support deployment of smart grid technologies, provide full cost recovery and move forward with dynamic rate programs.
- Competition between smart grid vendors is intense, as everyone vies for a piece of the smart grid.
- Distributed generation and micro grids are a significant part of the electric power system.

Discussion Questions For Scenario Team:

- Do you agree with the driving forces that form the basis for all 4 scenarios? Have we missed any?
- Have we captured the critical uncertainties for each scenario?
- If the features of this scenario more or less come to pass, how will smart technology be deployed?

- What technologies and services will provide the most value to customers under this scenario?
- Who will be the new market entrants under this scenario? What products will they offer?
- What smart technology public policy issues will arise under this scenario?
- Will the utility's relationship with its customers change under this scenario?
- What smart technology will the customer want under this scenario? Why?

Appendix C — Workshop Advance Reading Recommendations

The catalog below was provided to workshop participants as suggested reading assignments. It may also be useful advance reading for EEI members who undertake their own planning sessions.

EEI SCENARIO PLANNING PROJECT

SECONDARY RESEARCH CATALOG

CONTENTS

Introduction

In June 2010, EEI will host two scenario planning workshops. These meetings will solicit views on possible futures for the electricity industry that may emerge from the interaction of transformative technologies and public policy initiatives. This catalog presents several dozen reports and articles that may prove valuable to participants. It is divided into three sections:

- **Highly recommended.** Broad, foundational documents that should be read by all who have the time.
- **Also of interest -- electricity futures.** More specialized documents that concern themselves with one aspect or another of the electric power industry.
- **Also of interest -- parallel industries.** Documents that discuss lessons to be learned from other industries that have previously undergone transformations.

Documents are listed in alphabetical order within each section. Regardless of the section in which it appears, every listing includes:

- A capsule summary
- Notes to suggest who might find it of interest and why
- Representative quotes that give a flavor of the style and substance
- A clickable link to the document (where available)

We believe the documents in this catalog will be valuable to the workshop process, and for the planning and report writing that will follow. Even so, the process of conducting this secondary research underlined the value of EEI's current scenario project, since we were unable to find any documents that spoke directly to the intersection of technology, policy, and business models. Most of reports that treat electric power focus on the supply side. Of those that deal with the grid, most focus on policy as the major driver of change. Only a few discuss the impacts of technology as well. Very few consider how new technology can allow new business models -- and how those new models can transform entire industries.

Highly Recommended

The five documents in this section are highly recommended as useful background for all participants.

Scenario-Based Technology R&D Strategy for the Electric Power Industry: Volume 1 - Executive Summary

http://wpweb2.tepper.cmu.edu/ceic/SeminarPDFs/EPRI_Office_of_Innovation_Strategic_Planning_Report_by_Schainker%20_Number_01014385_Vol_1.pdf

- By: C. Gellings, R. Schainker, and S. Hoffman
- Electric Power Research Institute (EPRI), 2006

Overview:

This is the executive summary and is a companion to a second paper which presents background and details.

The report itself notes that scenarios "have a shelf life of about 2 to 3 years." By that metric, these scenarios are past their prime. Even so, they remain worthwhile reading. The four scenarios in this report attempt to answer the question: "How will demand for U.S. energy services and the potential externalities that may result shape electricity technologies over the next 20 years?" The authors stress that uncertainties are part of scenario development, citing changes in primary fuels and changes in the value society places on externalities such as carbon dioxide. The report concludes with 10 technology recommendations, several of which apply directly to the grid. As the title implies, this report focuses on technology and does not spend much time on business models, or on policy recommendations.

Of Note for:

- An excellent example of scenario planning and narratives.
- An industry insider point of view with a deep understanding of the electric power sector's special needs and concerns.

Representative Quotes:

- In the last several years, EPRI has led a broad-based industry endeavor to develop and publish the *Electricity Technology Roadmap*, a high-level document that provides guidance on strategic technology planning over the next 40-50 years for the electricity industry. However, critical uncertainties over this timeframe – such as fuel prices, the economy, the environment, technology advances, and regulatory policies – complicate effective identification and development of R&D priorities.
- The scenarios that were defined are not global societal scenarios that address all global issues and all business sectors, but instead focus on the use of key drivers relevant to the electricity sector in the western world. EPRI elected to develop its own scenarios, rather than use scenarios of others, to provide a unique perspective on how technology advances can challenge the conventional wisdom of the energy future.
- Individual companies and organizations that support the electric utility industry have concerns that mirror those of the industry, as well as concerns that are more specific to their company or organization. Also, there are micro-level or utility specific concerns that address

issues such as competitiveness, optimal use of limited investment capital, human resource and management development, and merger and acquisition opportunities.

- The world of Digging in our Heels is characterized by the continuation of current trends related to high fuel prices and manageable costs to meet environmental requirements in the energy sector. The focus is on short-term operations issues—fixing problems—rather than creation of fundamentally new technologies. Executives and managers recognize that strategic issues will have to be addressed, but they postpone the needed work. Instead, they are forced to spend time on urgent crises that divert their attention from longer-term issues. Nevertheless, progress is evident in some areas.

Scenario-Based Technology R&D Strategy for the Electric Power Industry: Volume 2 - Background Information and Details

http://wpweb2.tepper.cmu.edu/ceic/SeminarPDFs/EPRI_Office_of_Innovation_Strategic_Planning_Report_by_Schainker_Number_01014385_Vol_2.pdf

- By: C. Gellings, R. Schainker, and S. Hoffman
- Electric Power Research Institute (EPRI), 2006

Overview:

This is the companion to a first paper which presents the executive summary. This document includes significant background material and more detail on the 20 R&D needs identified in the companion document. It also includes relevant mapping of each R&D need to one or more of the four scenarios provided in the Executive Summary, Volume 1.

Of Note for:

- A deeper dive into the technology issues.

Representative Quotes:

- The purpose of the present report is to describe the critical technology R&D needs of the electric power industry and map them to the four scenarios defined in the December 2005 EPRI work. This report is not intended to include an exhaustive list of technology R&D priorities; instead, it covers R&D needs perceived to be particularly important. The report also presents preliminary technology R&D timelines that address the most critical R&D needs.
- The time horizon of the *Roadmap* extended to 2050. A fundamental premise of this work is the feasibility of painting a vivid picture of the desired electrified world in 2050, and the ability to reach this end state through a combination of decades-long technology development efforts. During the development of the *Roadmap*, it was understood that quantitative assessments and functional specifications for such a distant future are problematic. Uncertainties in driving factors – such as fuel prices, the economy, the environment, technology advances, and regulatory policies – are large on the time scale of

the *Roadmap* and do not provide sufficient granularity for R&D actions to be implemented in the next 10-20 years.

- This report addresses institutional, political, regulatory, and financial factors to the extent that they are relevant to the defined scenarios. While this report focuses on the R&D technology needs in each of the scenarios, institutional and other factors are often inextricably linked with technology advances. Hence, institutional and other factors are also discussed in this report, but to a limited extent.

Shell Energy Scenarios to 2050

http://www-static.shell.com/static/public/downloads/brochures/corporate_pkg/scenarios/shell_energy_scenarios_2050.pdf

- Authored and published by Shell Energy, 2008

Overview:

This accessible, easy-to-read, 52-page report studies two vastly different scenarios for the industry's future challenges of providing adequate and secure energy supplies while dealing with pollution and climate change. In one scenario, entitled Scramble, policy makers do very little regarding energy efficiency until supplies are scarce — and fail to address greenhouse gas emissions until the climate is severely affected. In the second scenario, Blueprints, a shift toward dealing with challenges such as economic development, energy security and pollution begins at the local level and progresses to become a global mission incorporating all stakeholders. Although it says little about the grid itself, it is highly instructive about broad global challenges and about presenting scenarios.

Of Note for:

- Getting a look at the way Shell -- which originated scenario planning -- formats and presents scenarios to bring them to life.
- Considering how climate change and energy security policies could impact electric power sector.

Representative Quotes:

- The global energy system sits at the nexus of some of the deepest dilemmas of our times: the development dilemma – prosperity versus poverty; the trust dilemma – globalization versus security; and the industrialization dilemma – growth versus the environment. There have always been tensions in the global energy system, but it is evident today that the strains are becoming more acute.
- There is a great deal of inertia in the modern energy system, given its vast complexity and scale. The often lengthy timescales required for planning and constructing new energy infrastructure mean that strains within the system cannot be resolved easily or quickly, if at all. It will be several years before major changes become apparent. But below the surface, the pieces are already shifting. The question is how to recognize and grapple with these changes.

- Although change must and does occur, the turnaround takes a decade because large-scale transformations of the energy system are required. High domestic prices and exceptionally demanding standards imposed by governments provoke significant advances in energy efficiency. Eventually, locally developed alternative supplies -- biofuels, wind, and thermal solar -- also contribute on a much greater scale than before. By 2030, healthy economic growth is restored, with particular vibrancy in the new energy sector that has received a massive stimulus to innovation through this difficult period.

Southern California Edison Smart Grid Strategy & Roadmap

- By Southern California Edison, 2010

Overview:

This 56-page illustrated document can be thought of as one utility's viewpoint on the smart grid's most likely future for its service territory, presented in a format designed to be accessible to regulators and ratepayers. It defines the smart grid; explains Southern California Edison's development methods and principles; explains SCE's smart grid architecture; and lays out a likely roadmap through 2030.

Of Note for:

- A view of the smart grid's likely future from the perspective of one of the country's most progressive and proactive utilities.
- A clear description of the many mandates and policy initiatives (renewable portfolio standards, energy efficiency, etc.) that are pushing utilities towards a smart grid.
- A view of the four likely stages of smart grid evolution: 1. Foundation (1995-2008); 2. Inform and Automate (2009-2012); 3. Interactive (2013-2019); 4. Intuitive and Transactive Grid (2020-2030).

Representative Quotes:

- Several aspects of SCE's smart grid vision must be developed by 2020 in order to comply with ambitious state and federal policy goals related to climate change, clean energy and infrastructure security. However, it is impractical to think that all aspects of this Vision can be developed and implemented within 10 years given the nascent stage of many technologies and the ratepayer costs. As such, deployment of a smarter grid is a journey that will extend well beyond 2020.
- Five key smart grid strategic themes… serve as the basis for SCE's smart grid vision:
    1. Empower Customers…
    2. Improve Workforce Safety…
    3. Integrate Renewable and Distributed Energy Resources…
    4. Improve Grid Efficiency & Resiliency…

5. Provide Information and Connectivity…

- Over the past year, SCE's scenario planning efforts have resulted in the development of four potential pathways for the pace of technology development and adoption for the smart grid. A key objective of this analysis is to ensure that the SCE's smart grid strategy provides a viable adoption roadmap in any of the four potential pathways.

Switching Perspectives: creating new business models for a changing world of energy

http://www-935.ibm.com/services/us/gbs/bus/pdf/gbe03289usen.pdf

- By Michael Valocchi, John Juliano and Allan Schurr
- IBM Institute for Business Value, 2010

Overview:

This 18-page white paper is one of the few documents that tackles utility business models head on. It states that "long-standing electric utility business models are rapidly becoming outdated." It signals three major drivers: new technologies, new policies, and more demanding consumers. It suggests three main strategies for innovating business models, but spends most of its time focusing on the first strategy, which it has named "industry model innovation" -- innovating by moving into new industries or redefining existing ones. It also includes an explanation of "platforms" and how they will affect the industry. A sidebar covers the rise and fall of the traditional grow-and-build business model.

Of Note for:

- An explanation of the industry's new value model, wherein customers no longer play a passive role. Instead, they pass value back in the form of demand response, distributed generation or distributed storage.
- A clear sense of the danger facing utilities that fail to rethink their business models -- and that the opportunities for those that do.

Representative Quotes:

- Today, customers are demanding more from their providers than merely reliable power at reasonable rates. Our global utility consumer surveys show consumers want more control over their expenditures and environmental impact and more information about their energy usage.
- Distributed resources will play an increasingly vital role in both operations and value creation and, in the longer term, may ultimately be positioned to radically disrupt the portion of the value chain comprised of the traditional generation-transmission--distribution-retail electricity pathway.

- Because of their enormous investments in smart grid and other improvements, today's electric companies will… be responsible for putting in place of most of the infrastructure required for new industry participants to emerge. At the same time, it is likely that new electricity related business models... will be launched by entities that did not make direct investments in it. Incumbent electricity companies must be aware of this likelihood.

Also of Interest -- Electricity Futures

The documents in this section will have value to those who wish to drill down on a particular aspect of the electric power industry transformation, whether technology, policy, or business models.

2020 Global Energy Scenarios

http://www.millennium-project.org/millennium/scenarios/energy-scenarios.html

- By: Jerome C. Glenn, Theodore J. Gordon, and Elizabeth Florescu
- The Millennium Project: Independent non-profit global participatory futures research think tank, 2008

Overview:

This online document contains four exhaustive scenarios depicting alternative global energy conditions into 2020. The scenarios were built around four axes that included 1) rate of technological breakthroughs, 2) strength of environmental movements, 3) economic growth and 4) geopolitical conditions, including war, peace and terrorism. Specifically, the scenario alternatives are:

- Business as usual
- Environmental backlash
- High tech economy (in which technological innovation outstrips expectations)
- Political turmoil

Spends most of its time talking about total energy use, oil supplies, and geopolitical issues.

Of Note for:

- How to create a narrative around scenarios.

Representative Quotes:

Please note: Quotes taken directly from the narratives of the scenarios.

- So, yes, it's easy to be a skeptic. We've heard it all before. What people miss most about the old days is vacations in distant places, freedom to drive what they wanted and where they wanted, having a government they could believe in, that tells the truth—if indeed anyone knows what truth is any more—and stability. Today there is too much pessimistic thinking about energy. Reserves have grown in the past when depletion was forecast, and now many

people in the industry say it will happen again. As for developing new energy systems, with effort and fortitude the world powers can solve the problem; they can do anything they want to do. But the World Soccer Games are on TV now, so let's worry about all this tomorrow.

- The promise of the hydrogen economy is still just a promise—but an attractive future possibility. There are many alternative production methods and applications for hydrogen, and more than 7% of all new cars are powered by hydrogen today; nevertheless, it has not become the dominant fuel yet. Many would not buy hydrogen cars before sufficient numbers of local gas stations carried hydrogen, and few hydrogen producers and car manufacturers would take the risk of investing in distribution systems and new car designs that might not sell.
- Now the world is a decade into the New Fire program, and the countries that could have developed alternatives to oil have not. There have been only "Band-Aid" quick fixes and timid projects that pander to special interests, not the unified and massive programs that could have been justified. The technological development programs have been largely left to the free markets, and the marketplace believed that instability in energy prices should limit the levels of "prudent" investments. When people today wonder how the world has developed as it has, most often they point to many culprits: corruption, greed, irresponsible environmental extremism, short-term profit-taking and policymaking, the oil companies, life-style excesses, failure of imagination, and a lack of understanding that resources are, after all, finite.

20% Wind Energy by 2030

http://www.20percentwind.org/20percent_wind_energy_report_revOct08.pdf

- By: U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Office of Electricity Delivery and Energy Reliability (OE), and Power Marketing Administrations (PMAs), National Renewable Energy Laboratory (NREL, Lawrence Berkeley National Laboratory (Berkeley Lab), Sandia National Laboratories (SNL), Black & Veatch, American Wind Energy Association (AWEA)
- Department of Energy, 2008

Overview:

This 248-page report describes the costs, challenges and impacts of generating 20% of U.S. electricity from wind energy in 2030. It examines requirements and results in technology, manufacturing, transmission and integration, markets, environment and siting. The modeling estimates that wind farms with 300 GW or more would be required to produce the 20% wind scenario. Major assumptions are highlighted in the report and summarized in the appendices.

Of Note for:

- In-depth analysis of the possible impact on the grid of one technology with game changing potential.
- Accessible paper suitable both to industry professionals and the general public.

Representative Quotes:

- Current turbine technology has enabled wind energy to become a viable power source in today's energy market. Even so, wind energy provides approximately 1% of total U.S. electricity generation. Advancements in turbine technology that have the potential to increase wind energy's presence are currently being explored.
- Measuring potential wind energy generation at a 100-m elevation (the projected operating hub height of the next generation of modern turbines) greatly increases the U.S. land area that could be used for wind deployment, as shown in Figure 2-2 for the state of Indiana. Taking these measurements into account, current U.S. land-based and offshore wind resources are estimated to be sufficient to supply the electrical energy needs of the entire country several times over.
- The amount of energy in the wind available for extraction by the turbine increases with the cube (the third power) of wind speed; thus, a 10% increase in wind speed creates a 33% increase in available energy.

Are Sustainable Futures Possible?

http://www.undp.org/energy/activities/wea/drafts-frame.html

- By: Nebojsa Nakicenovic, Tom Kram, Alexi Makarov, Bent Sorensen, Kelichi Yokobori, Zhou Fengqi, Yasumasa Fujii, Jeffrey Stewart, John Weyant
- World Energy Assessment: Energy and the Challenge of Sustainability, 2001

Overview:

This 35-page chapter of a larger report identifies three alternative global development scenarios for economic growth, population trends and energy consumption. Each scenario offers potential outcomes for affordable, reliable, flexible and convenient energy services, but with vastly different degrees of sustainability. Although the assertions are not groundbreaking to anyone involved in energy, the report does underscore the need for technological advances and significant policy and behavioral changes. Despite being almost 10 years old, this report remains an alarmingly relevant cautionary tale: The longer we wait to make choices, the fewer choices we will have.

Of Note for:

- Understanding how economic and population trends could impact scenarios.

Representative Quotes:

- Because they affect affordability and economic competitiveness, energy prices need to be taken into account when analyzing options for sustainable energy development. Moreover, energy supplies should be secure and reliable. For that reason, attention should be given to:

- The dependence on energy supplies from politically unstable regions or unevenly distributed locations.
- The possible disruption of energy supplies due to severe accidents.
- The sociocultural environment in which energy systems operate.
- The eventual exhaustion of finite energy resources such as coal, crude oil, natural gas, and uranium, for which alternative options must be developed.
- Finally, the development and introduction of sustainable energy technology must occur in a socially acceptable manner, with a broad range of citizens participating in decision-making.

Deciding the Future: Energy Policy Scenarios to 2050

http://www.worldenergy.org/documents/scenarios_study_online.pdf

- Authored and published by World Energy Council, 2007

Overview:

This 100-page report uses scenarios along with analytics and energy metrics to establish a view of the physical energy landscape well into the future. The report notes that energy needs will climb dramatically as the 21st century progresses, populations grow and emerging nations demand greater and greater shares of available energy — and that substantial policies need to be developed to meet the challenges the future presents. While framing possible energy futures, the report asks deceptively simple questions that do not yield simple answers: "Where will this energy come from? How will it be used? What will it cost? What are the ancillary impacts?"

Of Note for:

- Considering electric power scenarios in developing nations.
- Understanding how resource competition could affect electric power globally.

Representative Quotes:

- A nation poor in natural and financial resources has little to offer and is unlikely to attract support from the rich. The private sector will not invest there because it cannot earn returns commensurate with the risks, and the country is too poor to pay appropriate returns to attract investors. There is no transfer of know-how and technology and no development of human capacity. A poverty spiral often results unless there is some form of goodwill (e.g., Development Agencies) that bridges the gap and supports cooperation.
- The heart of this study is a qualitative assessment of how policies and measures can meet emerging challenges and achieve outcomes closer to the 3 A's (Accessibility, Availability, Acceptability) than would otherwise be the case.

Distribution Utility Technology Roadmap 2025: Meeting the changing needs of customers in the 21st century

http://capgemini.emailreaction.net/go.asp?/.newsletter.france.fuelext.2007q4.industry/bCGE001/uI5I95/xCF5J7#article1http://www.worldenergy.org/documents/scenarios_study_online.pdf

- Authored by Capgemini
- Centre for Energy Advancement through Technological Innovation (CEATI), 2007

Overview:

A comprehensive overview of technology trends for distribution utilities, with an emphasis on the communications infrastructure. The report predicts a major shift in the entire electric distribution business, resulting in a dramatic increase in data being generated, moved, received, and analyzed. It also examines various smart metering installations and discusses their operational benefits.

Of Note for:

- Thorough discussion of technology options for distribution utilities.

Representative Quotes:

- The common infrastructure's primary goal is to share the cost of communications amongst a large population of devices using many technologies and provide a unified way for data to return to a central location. This is by far the greatest challenge facing a Smart Grid implementation and the next generation distribution utility.
- Operational Smart Metering means smart meters will clearly play a key role in providing intelligence and switching on the grid. For other utilities, meters may be in the minority as sensors on the grid. This difference will have a major impact on communications. The wrong commercial contract could conceivably stop any use of Smart Metering for operational purposes. This is just one example of the decisions that will have to be taken as the implementation of new technology unfolds.
- The fundamental driver in our industry may shift completely from being a "load following system" to being "supply following" in the next 10 to 30 years. There are only a few utilities with an abundance of Hydro or other green power that exceeds the projected needs in 2025 and beyond. As an industry we will have to make a decision on whether we want to proactively drive the future changes or give up our position of leadership.

Electricity Network Scenarios for Great Britain in 2050

http://www.eprg.group.cam.ac.uk/wp-content/uploads/2008/11/eprg0513.pdf

- By: I. Elders, G. Ault, S. Galloway, J. McDonald, J. Köhler, M. Leach, E. Lampaditou
- EPRG Group, 2006

Overview:

This 48-page paper provides six future electricity industry scenarios for Great Britain concentrating on the year 2050. It discusses major technologies to explore possible effects on the electric power system in 40 years. The authors note that technological development will cause changes in both the structure and operation of power networks. The paper is a chapter in a book titled *Future Electricity Technologies and Systems.*

Of Note for:

- Focusing on the infrastructure rather than on the supply side.
- Useful for understanding the process of developing scenarios.
- Prepared as part of the Supergen Future Network Technologies research effort - useful to analysts, regulators and policy makers

Representative Quotes:

- In this paper, the process by which the six scenarios were developed is described, and the key characteristics which are used to delineate possible "future worlds" are tabulated. The set of six "highlevel" scenarios, focusing on the year 2050, are possible future circumstances in which electricity networks will be required to operate.
- Force has presented scenarios graphically as quadrants within a "scenario space." While early iterations of the scenarios described in this paper made use of such a representation, further reflection and wider discussion with members of the Supergen research consortium suggested that in this case the approach tended to encourage the consideration of technically uninteresting and mutually similar scenarios, while failing to adequately represent the diversity of issues of interest.
- In this scenario, strong economic growth leads to a corresponding increase in the demand for energy services as people become more affluent and able to afford new and improved energy consuming devices which are developed. Equipment such as air conditioning becomes more popular and railway electrification is extended.

Electricity Technology Roadmap: 2003 Summary and Synthesis — Power Delivery and Markets

http://www.iea.org/work/2004/distribution/presentations/Gellings_bkgd_%20paper.pdf

- Authors not identified
- Electric Power Research Institute (EPRI), 2003

Overview:

This report offers a vision for the future of the electricity delivery system and electricity markets. It enumerates challenges that must be met and technologies that must be developed for that vision to occur. The report also notes that "gold plating" the existing system by throwing money at it will be inadequate. Innovative technologies, automation, communication architecture, distributed energy sources, integrated storage and other elements will be the keys to a successful energy future.

Of Note for:

- Although dated now, still useful for the comprehensive overview of the many aspects of electric power technology transformation.

Representative Quotes:

- In taking the lead in this Roadmap endeavor EPRI is acting as the catalyst of an ongoing process of engagement, consensus building, and collaboration among the diverse stakeholders inside and outside the electricity enterprise.
- Today, the use of electricity is indispensable to modern life. Yet at the same time, it has become so pervasive that it is "transparent" to most users, at least until there is an outage. Were it possible to "unplug" the whole of U.S. society, for example, from its electricity supply for a few hours, and assess the impact, the full measure of electricity's role in the U.S. economy would become evident.
- The North American power delivery system is vulnerable to increasing stresses from a variety of sources. One such stress is caused by an imbalance between growth in the demand for electric power and enhancement of the power delivery system to support this growth.

Energy Scenarios and Visions for the Future

http://www.tse.fi/FI/yksikot/erillislaitokset/tutu/Documents/publications/eBook_2009-10.pdf

- By: Jyrki Luukkanen, Jarmo Vehmas, Suvisanna Mustonen, Francesca Allievi, Anne Karjalainen, Mikko Vartto, & Maria Ahoniemi
- Authors and Finland Futures Research Centre, Turku School of Economics, 2009

Overview:

This 175-page report was prepared for participants in the Finnish Energy Industries futures process, which is developing energy scenarios to 2050. Content is heavily slanted toward the supply side, though it does conclude with a brief discussion of T&D issues. Most notable for an overview international energy scenarios prepared by others. The well-documented and referenced report also provides overviews of development in other major world economies and a discussion of international climate change negotiations.

Of Note for:

- An overview of eight other energy scenarios prepared by organizations such as the World Energy Council and the United Nations.
- Use of a "reference" scenario as a baseline.

Representative Quotes:

- According to WEC's Energy Policy Scenarios to 2050 energy supplies must double by 2050 to meet the energy demand of all households worldwide. The main driver to address this challenge is higher energy prices. Higher prices will also propel the developed world toward greater energy efficiency and attract much higher levels of public and private capital investment in infrastructure, research, development and deployment of clean and more efficient technologies. Different levels of government engagement in these and other areas can have different outcomes in the future.
- In a Reference Scenario, which provides a baseline vision of how energy markets are likely to evolve without new government measures to alter underlying energy trends, global primary energy demand increases by 53 % between now and 2030. Over 70% of this increase comes from developing countries, led by China and India. Oil remains its position as a number one primary energy source as the World's oil demand reaches 116 million b/d in 2030 (84 million b/d in 2005). Consequently global carbon dioxide (CO2) emissions reach 40 Gt in 2030, a 55% increase over today's level and China overtakes the United States as the world's biggest emitter of CO2. These trends would amplify the magnitude of global climate change.
- Energy storages have been internationally seen as a key component for the further implementation of distributed energy. Most of the problems in power quality, distribution reliability and peak power management can be solved with energy storages. Energy storage gives new possibilities for demand-side management and for customer level energy cost control. Cost effective, smart energy storages give new potential for building energy management especially when they are used in combined heat and power (CHP) production systems such as fuel cells and microturbines.

Energy system analysis of 100% renewable energy systems - The case of Denmark in years 2030 and 2050

http://www.sif.it/SIF/resources/public/files/Lindgard.pdf

- By: H. Lund & B.V. Mathiesen
- Energy, May 2009

Overview:

This paper analyzes a Danish power supply system fed exclusively by renewable energy. Input for the scenarios came from a long-term project conducted by the Danish Association of Engineers. The paper presents the analysis methodology, which includes hour-by-hour computer simulations for flexible systems capable of balancing power supply and demand. It concludes that achieving 100% renewable energy by 2050 is possible with biomass and combinations of wind, wave and solar power. While the conclusions may seem fanciful, the science appears solid.

Of Note for:

- Discussion of the impacts of integrating renewables into the grid, especially at very high percentages.

Representative Quotes:

- From a methodology point of view, the conclusion is that the design of future 100 per cent renewable energy systems is a very complex process. On the one hand, a broad variety of measures has to be combined in order to reach the target, and on the other hand, each individual measure has to be evaluated and coordinated with the new overall system. If the 100 per cent renewable energy system proposed for year 2050 is implemented, the primary energy supply will fall to approximately 400 PJ and the CO2 emission will, in principle, be equal to zero. However, it should be mentioned that Denmark will still contribute to greenhouse gas emissions from other gasses than CO2. In total, the Danish greenhouse gas emissions will decrease by approximately 80 per cent.
- The export potentials have been estimated on the basis of the Danish development of wind turbine manufacturing and are to be considered a very rough estimate. However, the estimate provides valuable information on both the different relevant technologies and the magnitude of the total potential.

Energy Use in China: Sectoral Trends and Future Outlook

http://www.escholarship.org/uc/item/7qk5k371

- By: Zhou, Nan; McNeil, Michael A.; Fridley, David; Lin, Jiang; Price, Lynnde la Rue du Can, Stephane et al.
- Lawrence Berkeley National Laboratory, 2008

Overview:

This 98-page paper notes that there have been numerous scenarios describing long-term patterns of greenhouse gas emissions, but most models do not offer descriptions of sectoral variables. The intent of this project was to build a "new generation" global energy and CO_2 emissions model based on the level of diffusion of end use technologies.

Of Note for:

- Prepared primarily for policy analysts.
- Those interested in better ways to model greenhouse gas emissions.
- Those interested in a deeper look into China's current and future emissions profile.

Representative Quotes:

- China's rapid economic expansion has propelled it into becoming one of the largest energy consuming nations in the world, with demand growth continuing at a high pace commensurate with its economic expansion. As the second-largest energy consumer, China's energy consumption has a growing impact on world energy markets, affecting the availability of energy resources and global market prices. Foreign governments as well as global oil, gas, coal, and power industry participants are increasingly concerned with understanding and responding to China's emergence as a new and increasingly decisive player in energy markets.
- China contributed 31% of the world's energy consumption increase from 2003 to 2004. The growth of the Chinese energy demand was 16% between 2003 and 2004. Around 37% of the world's electricity consumption increase in 2004 is due to China (IEA, 2005.2006. NBS, 2005). China has been the main driver of world energy demand growth, and the phenomenon is accelerating.
- In the transportation sector, China should further tighten fuel economy standards beyond 2008 to offset escalating vehicles sales. Standard enforcement is also critical to ensure the new vehicle to meet the minimum level of the fuel efficiency.

Future Scenarios: Mapping the cultural implications of peak oil and climate change

http://www.futurescenarios.org/content/view/12/26/

- By David Holmgren
- Future Scenarios.org, 2008

Overview:

In this paper, futurist and author Holmgren provides his scenario-building approach to generate an understanding of the possible interactions between climate change and peak oil. The paper also

introduces his "permaculture" concept, a design system intended to foster sustainability and a response to futures of progressively fewer energy resources.

Of Note for:

- Those involved in environmental/climate change/energy resources issues, but also may interest a general audience.
- A description of one scenario building methodology.

Representative Quotes:

- Global oil peak has the potential to shake if not destroy the foundations of global industrial economy and culture. Climate change has the potential to rearrange the biosphere more radically than the last ice age. Each limits the effective options for responses to the other.
- Most of the comparative discussion about energy resources has focused on "Proven, Probable and Possible Reserves". These are economic concepts about what can be profitably extracted using current technology and prices. Banks lend massive amounts of money to develop energy projects over long periods with risks of price collapses that can reduce or eliminate profits.
- In classic corporate scenario planning the two variables might be the growth rate in the wider economy and the regulatory framework that constrains or encourages business. Climate Change and Oil Production Decline are the variables I use as the primary drivers in creating the four energy descent scenarios because I believe these are the strongest forces shaping human destiny over the 21st century and beyond.

Great Transformation: What Will the Customer Want?

http://www.utilipoint.com/issuealert/article.asp?ID=3252

- By Mark Burlingame
- Utilipoint IssueAlert, 3/26/2010

Overview:

This brief online article discusses the coming smart grid transformation with emphasis on the gap between traditional utility views and changing customer expectations.

Of Note for:

- An excellent example of scenario planning and narratives.
- An illustration summarizing the gaps between the electric power industry and its customers. For instance , the industry talks about such things as smart meters, distribution automation and dynamic pricing. Customers think in terms of affordability, reliability and control.

Representative Quotes:

- … managing customer expectations in a capital-constrained business environment is essential for a positive return on investments that will also provide ways for a customer to save on energy costs. Closely related to that question is the belief by many… that utilities and retailers must "re-learn" who the customer really is.
- David Dollihite, Vice President, Direct Energy… stressed that West Coast electronics companies are investing $6 billion with the aim of bringing in disruptive technologies. These companies have done "… a huge amount of consumer research."

Limiting the Financial Risks of Electricity Generation Capital Investments under Carbon Constraints: Applications and Opportunities for Public Policies and Private Investments

http://wpweb2.tepper.cmu.edu/ceic/theses/Adam_Newcomer_PhD_Thesis_2008.pdf

- By Adam Newcomer
- Carnegie Mellon University, 2008

Overview:

This 162-page thesis observes that growing demand for electricity coupled with aging generating facilities are the primary drivers of near-term capital investment in the U.S. electric power infrastructure. The paper offers two scenarios. In one, coal continues to have major role in power generation. In the other, the use of coal is limited or non-existent. It is intended to offer guidance for both companies and policy makers, as well as for private investment with limited risk under carbon constraints.

Of Note for:

- Understanding alternative supply side scenarios involving coal.
- Prepared for policy makers and industry as a doctoral thesis requirement.

Representative Quotes:

- The US electricity sector is facing an operating environment with an unprecedented number of opportunities and challenges. Increasing demand for electricity, an aging fleet of generators and stricter multi-pollutant emission regulations, principally, are driving a need for large capital investments in the US electric power sector in the near term. The decisions (or lack thereof) by firms, regulators and policy makers in response to this challenge have long lasting consequences, incur large economic and environmental risks, and must be made despite large uncertainties about the future operating and business environment.
- Capital investment concerning coal generation is particularly uncertain. Producing electricity from coal is advantageous because it is an abundant, inexpensive domestic energy source, making it generally free of supply and geopolitical concerns. The current process of

generating electricity from coal combustion, however, produces criteria pollutants such as sulfur dioxide (SO2), nitrogen oxides (NOx), as well as mercury and a large amount of carbon dioxide (CO2). Stricter multi-pollutant regulations such as the Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR), as well as increasing policy signals that carbon dioxide emissions may soon incur a cost have made the current coal combustion process less favorable.

- Only compressed gas storage options are considered since it is the most relevant large-scale stationary storage method for syngas production facilities and is less expensive than alternatives such as liquefaction. Compressed gas storage is the simplest storage solution, as the only required equipment is a compressor and a pressure vessel [26].

Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation

http://www.libertyparkusafd.org/lp/BuildingGreenUSA/Hybrid%20Vehicles/Potential%20Impacts%20of%20Plug-In%20Hybrid%20Electric%20Vehicles%20on%20Regional%20Power%20Generation%20-%202008.pdf

- By: Stanton W. Hadley, Alexandra Tsvetkova
- Oak Ridge National Laboratory, 2008

Overview:

This 93-page paper analyzes potential PHEV impact on electricity demand, supply, generation, pricing, and emissions levels in 2020 and 2030. It considers 13 regions specified by the North American Electric Reliability Corporation (NERC), and the Department of Energy's (DOE) Energy Information Administration. Seven scenarios were provided for each region. Electricity requirement projections for PHEVs are based on analysis from the Electric Power Research Institute (EPRI) with an optimistic expectation of 25% market penetration by 2020. Calculations were provided by the Oak Ridge Competitive Electricity Dispatch model, which was developed over the past 12 years to assess various significant electricity sector issues.

Of Note for:

- In-depth analysis of the possible impact on the grid of one technology with game changing potential.
- Appropriate for utility personnel involved in asset and load management and demand response, policy makers and regulators

Representative Quotes:

- Plug-in hybrid electric vehicles (PHEVs) are being developed around the world, with much work aiming to optimize engine and battery for efficient operation, both during discharge and when grid electricity is available for recharging. However, the general expectation has been that the grid will not be greatly affected by the use of PHEVs because the recharging will occur during off-peak hours, or the number of vehicles will grow slowly enough so that capacity planning will respond adequately.

- This analysis identifies some of the complexities in analyzing an integrated system of PHEVs and the grid. Depending on the power level, timing, and duration of the PHEV connection to the grid, there could be a variety of impacts on grid constraints, capacity needs, emissions generated, and cost to the customer, utility, and society as a whole.
- Plug-in vehicle technology can help to address the "underutilization" of generation and transmission capacity in the country. Peculiarities of electricity generation and distribution technology, combined with an extremely volatile demand that must be satisfied at every location and every moment, require that the capacity and infrastructure is available for unexpected or expected surges in demand.

Predicting the Impact of Climate Change on U.S. Power Grids and Its Wider Implications on National Security

https://www.aaai.org/Papers/Symposia/Spring/2009/SS-09-09/SS09-09-027.pdf

- By: Pak Chung Wong, L. Ruby Leung, Ning Lu, Mia Paget, James Correia Jr., Wei Jiang, Patrick Mackey, Z. Todd Taylor, YuLong Xie, Jianhua Xu, Steve Unwin, Antonio Sanfilippo
- Pacific Northwest National Laboratories, Spring 2009

Overview:

This 6-page article details cutting edge modeling theories to predict and assess the impact of climate change on U.S. electric grids and the resulting implications for national security. The model incorporates theories from climate, energy, social sciences and national security coupled with an interactive visual interface for technosocial analysis. The goal is to create practical future scenarios that address technical and social factors in the model domains. The paper includes an executive summary of the preliminary work of the past year and a brief overview of anticipated work in the second year of a multi-year project.

Of Note for:

- Understanding how advanced computer modeling could be used to deepen scenario planning.
- Learning how computer modeling can incorporate social as well as technical aspects.

Representative Quotes:

- The interdisciplinary R&D effort extends the latest modeling theories and practices derived from atmospheric physics, electrical engineering, building engineering, social sciences, economics, and public policy to form a tightly coupled technosocial predictive analytics system.
- On the social study front, we have focused our investigation on the impacts of demographic and technological changes to our study. A preliminary visual analytics system prototype has been developed to guide analysis.

- The social analytics study will continue to insert new social factors into our predictive model. Major topics to consider include lifestyle changes, economic sectors, market behaviors, and policy changes. The results will be redispatched by the model to study their impacts on the power grids.

Scenarios for a Clean Energy Future

http://stephenschneider.stanford.edu/Publications/PDF_Papers/BrownCEF.pdf

- By: Marilyn A. Brown, Mark D. Levine, Walter Short, & Jonathon G. Koomey
- Energy Policy, 2001

Overview:

Examines the energy, environmental and economic impacts of varied public policies and programs through 2020. Hundreds of technologies and about 50 policies are included in the analysis that led to the development of three scenarios: Business as Usual, Moderate and Advanced. The study's conclusion was that existing policies can substantially reduce oil dependence, air pollution, carbon emissions and energy production and end use inefficiencies — at no net cost to the U.S. economy. While the study was published in 2001, its real value today is that it underscores the unpredictability of the future and that scenarios are simply well-reasoned (hopefully) extrapolations of contemporary data, and not predictions.

Of Note for:

- An in-depth look at the effect of policy on electric power sector.

Representative Quotes:

- The CEF study develops three primary scenarios: a business-as-usual (BAU) forecast and two alternative policy cases called the Moderate and Advanced scenarios. The BAU scenario assumes a continuation of current energy policies and a steady, but modest pace of technological progress. In contrast, the Moderate and Advanced scenarios are defined by policies that are consistent with increasing levels of public commitment and political resolve to solve the nation's energy-related challenges. Some of the public policies and programs that define the scenarios are cross-cutting; others are designed individually for each sector (buildings, industry, transportation, and electric generation). All of the scenarios are assessed for impacts through the year 2020.
- The largest energy and carbon savings in residential buildings are due to improvements in ''miscellaneous'' electric uses including cooking, clothes dryers, clothes washers, dishwashers, color TVs, and personal computers. A large fraction of these savings comes from movement toward a ''1-W'' standby loss goal by 2010, based on the switch-mode power supplies that are now widely used in the best new equipment.
- Restructuring also plays a significant role. By removing incentives for regulated utilities to retain capital investments that are no longer cost-effective, deregulation encourages the retirement of inefficient plants when new plants represent a more cost-effective option. A somewhat contrary impact is that restructuring promotes real-time pricing and customer shifts in peak load requirements.

Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities

www.smartpowerbook.com

- By: Dr. Peter Fox-Penner, Principal & Chairman Emeritus of the Brattle Group, 2010

Overview:

This newly-released book examines strategies for the development of an energy efficient business model for the utility industry. It reviews the current prospects for long-term power generation alternatives, from solar panels attached to our homes and offices, to new coal-burning plants that will allow for the capture and sequestration of carbon emissions. It explains how and why the utility industry must adapt to the climate imperative by examining the industry's technology, cost characteristics, and ability to function as a sustainable business, as well as the practical and political dimensions of making these dramatic changes.

Of Note for:

- Considering policy changes and business model changes along with technology changes.

Representative Quotes:

- The new electric power industry will have to be designed with three objectives in mind – creating a decentralized control paradigm, retooling the system for low-carbon supplies, and finding a business model that promotes much more efficiency. A system and a business model that each took more than a century to evolve must be extensively retooled in the span of a few decades. Many of the technologies and institutions needed for the job are still being designed or tested. It is like rebuilding our entire airplane fleet, along with our runways and air traffic control system, while the planes are all up in the air filled with passengers.
- The shift in the industry's operations enabled by the so-called Smart Grid could revolutionize the industry. These new grid technologies will transform electric pricing and create enormous regulatory challenges, all with little or no growth in overall power sales.
- How utilities can structure themselves to respond to all of these challenges and remain viable investor-owned firms is an especially difficult challenge, as the industry must finance hundreds of billions of dollars of investment and retool its operating paradigm without much of an increase in power sales for many years to come.
- The industry's current business model and regulatory structure both must undergo a radical redesign to pursue a new economic mission: to sell least-cost energy services, not larger amounts of kilowatt-hours.
- The lessons for this industry from the global financial sector that collapsed in mid-2008 with astonishing speed and momentous repercussions are chilling. Even within the power industry, A much smaller set of challenges ignited the California electricity crisis of 2000, bringing on rolling blackouts, bankruptcies, and billions of dollars in increased electricity costs. Getting it as right as we can is important – for our climate, our economy, and our safety and national security.

Transforming America's Power Industry: The Investment Challenge 2010-2030

http://wpweb2.tepper.cmu.edu/ceic/theses/Joule_Bergerson_PhD_Thesis_2005.pdf

- By Joule Andrea Bergerson
- Carnegie Mellon University, 2005

Overview:

This 149-page doctoral thesis notes that the electric power industry is confronted with massive change in relation to many issues, such as security, reliability, growing demand, aging infrastructure, competition and environmental impacts. It offers scenarios in three time horizons: near-, mid- and long-term. The basis for the scenarios and their analyses is a hybrid life cycle analysis that incorporates a variety of models and frameworks, including process and input-output life cycle analysis, an integrated environmental control model, social costing, forecasting and future energy scenario analysis.

Of Note for:

- A look at sophisticated modeling as applied to scenario planning.
- Addressing policy issues that will make it useful to analysts, policy makers and utility professionals responsible for planning.

Representative Quotes:

- This thesis addresses several key policy questions facing the electricity industry today. The framework proposed in this thesis focuses on three time horizons (near-term is less than 10 years, mid-term is 10 to 25 years, and long-term is 25 to 50 years).
- The only hydrocarbon fuel in which the U.S. has hundreds of years of reserves at current prices is coal. Currently, more than 50% of electricity is generated from coal. While many future energy scenarios are possible, coal is likely to play a large role for at least the next half-century, barring significant technological changes and large hydrocarbon discoveries.
- A hybrid life cycle comparative analysis (LCA) framework is an appropriate tool to assess the economic and environmental impacts associated with every stage of the production of electricity. This method combines the benefits of the EIOLCA (Economic Input-Output Life Cycle Analysis) (Hendrickson, et al., 1998) method with those of the traditional Society of Environmental Toxicology and Chemistry (SETAC)/ U.S. Environmental Protection Agency (EPA) approach (SETAC, 2004).

Technology R&D Strategy for the Electric Power Industry: "Wild Cards"

To download, use this link and choose the title shown above from the menu on the left side:
http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=CommunityPage&parentid=6&in_hi_userid=210&control=SetCommunity&CommunityID=237&PageID=325

- Electric Power Research Institute (EPRI), 2008
- Cost for non-members (of EPRI): $500

Overview:

This report is related to the EPRI reports profiled in our "Highly Recommended" section. EPRI has for several years led a broad-based industry effort to create the Electricity Technology Roadmap, essentially a guidebook for technology planning in the next 40-50 years. But some project participants found that the long time frame made it difficult to identify and develop industry R&D priorities. Their response was to create a shorter horizon of 20 years that includes four scenarios to outline the evolving technology needs of the electricity industry.

Of Note for:

- Those creating technology roadmaps.

Representative Quotes:

- Not available.

Also of Interest -- Parallel Industries

The documents in this section will have value to those who wish to learn more about other industries that have faced similar transformations.

Climate Risks: Lessons from the Financial Crisis

http://www.countercurrents.org/hahnel150409.htm

- By Robin Hahnel
- CounterCurrents.org, April 15, 2009

Overview:

This web commentary examines the parallels of the impact of an unforeseen "black-swan" event on the financial industry during the first decade of the 21st century, and the plausibility of a similar "black-swan" climate change event for the energy industry.

Of Note for:

- Considering the likely impacts if climate change becomes a major policy driver.
- Considering whether and how to include highly unlikely "black swan" events in scenario planning.

Representative Quotes:

- At the same time that the financial industry was building its risk management models, economists were constructing their own, ever more complicated models to assess the risks of climate change. Despite the emerging consensus from scientists that climate change posed significant and potentially catastrophic risks, these economic models purportedly demonstrated that the costs of emissions reduction in the present could not be justified by the future benefits of avoided damages from climate change. One reason these models reached conclusions so at odds with climate science was because they failed to recognize the implications of climatic black swans.
- But what if the consequences of a highly improbable event are exceedingly large - bordering on the incalculable? Combine "incalculable" with "highly improbable" and you have two good reasons for analysts to avoid what is now popularly referred to as a black swan - an event that is highly improbable but whose consequences dwarf the consequences of more probable outcomes.
- The danger of black swans is becoming increasingly well recognized. Nassim Taleb popularized the notion of "black-swans" in his best-selling book of the same name. The book criticizes the Black-Sholes and Capital Assets models that revolutionized Wall Street for ignoring these types of risks.

Cross-Industry Project Management Lessons Learned

http://www.powergenworldwide.com/index/display/articledisplay/371575/articles/nuclear-power-international/volume-2/issue-4/nucleus/cross-industry-project-management-lessons-learned.html

- By Stephen Cabano
- POWER-GEN Worldwide, February, 2010

Overview:

This report focuses on the nuclear power sector of the industry as it prepares for the forecasted surge in work. "Lessons learned" from other industry sectors can be used to develop a strategy around the value-added lessons in planning, resourcing, implementation and execution of future power/energy sector capital projects.

Of Note for:

- Looking to other industries for ideas on what to do next (rather than for lessons on what went wrong).

Representative Quotes:

- Industry project management best practices have been established that cross all industry sectors, but in the heat of an active project environment we often circumvent these best practices due to time constraints, resource limitations or a lack of respect for the benefits of the practice.
- All projects, no matter how small or large, need to be evaluated using a consistent project approach with clearly defined phase deliverables and decision gates. This will assure that management has the opportunity to challenge the scope, quality, cost and schedule for any given project opportunity and evaluate the project against the defined business case or industry opportunity.
- To assure that we do not encounter some of the "train wrecks" of past nuclear projects, we must learn from those mishaps and also take some lessons from the last round of major projects in other industry sectors. One aspect always seems to rise above all others: if we implement the proven project management tools and techniques and communicate effectively to all team members (management as well as contractors), the odds of completing a project within acceptable expectations are increased dramatically.

Disruptive Civil Technologies: Six Technologies with Potential Impacts on US Interests out to 2025

http://www.dni.gov/nic/confreports_disruptive_tech.html

- National Intelligence Council, November 2008

Overview

This online report from an April 2008 workshop posits that six technologies could enhance or degrade U.S. power and influence over the next fifteen years: biogerontechnology (life extension), energy storage technology, biofuels and bio-based chemical technology, clean coal technology, service robotic technology, and information technology devoted to increased connectivity of people and things.

Of Note for:

- A discussion of the geo-political effects of disruptive technologies, which can amplify their impact on nations and economies.
- Appendix B- Background: Energy Storage Materials, which includes a technology roadmap for nine important energy storage materials (use link below to jump directly to this appendix).
  http://www.dni.gov/nic/PDF_GIF_confreports/dzisruptivetech/appendix_B.pdf

Representative Quotes:

- The biggest level of disruption that could occur, both in economic terms and in terms of global socio-economic structure, would be the potential for one of these technologies (or a combination) to lead to a paradigm shift away from fossil fuels.
- Why are energy storage materials potentially disruptive? Four distinct scenarios seem plausible, including one that is dark and negative ("Running on Empty"), one that is conservative, having small technology breakthroughs ("Competitive Conservatism"), and two that have different types of huge technology breakthroughs ("Super Clean" and "Hydrogen Economy")."
- By 2025 Internet nodes may reside in everyday things -- food packages, furniture, paper documents, and more. Today's developments point to future opportunities and risks that will arise when people can remotely control, locate, and monitor even the most mundane devices and articles. Popular demand combined with technology advances could drive widespread diffusion of an Internet of Things (IoT) that could, like the present Internet, contribute invaluably to economic development and military capability.

Disruptive Technology: How Kodak Missed the Digital Photography Revolution

http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VG3-4VPCVFM-2-C&_cdi=6027&_user=10&_pii=S0963868709000043&_orig=browse&_coverDate=03%2F31%2F2009&_sk=999819998&view=c&wchp=dGLzVzz-zSkWz&md5=63197040b7ebccbe999c43cf207f1f03&ie=/sdarticle.pdf

- By: Henry C. Lucas Jr. and Jie Mein Goh
- The Journal of Strategic Management Systems, 2009

Overview:

In this nine-page, scholarly article, the authors employ an extended version of Christensen's theory of disruptive technologies to explore how a company responds to challenge from a transformational technology that threatens its long-standing business model. The Kodak story may seem an unlikely place to look for lessons for electric utilities, but the authors discuss relevant issues such as organizational change, organization culture. Even though Kodak's inability to embrace digital technology led to widespread misery for the company, that scenario need not be played out again for the country's electric utilities.

Of Note for:

- Utility executives interested in understanding more about change management.

Representative Quotes:

- When a firm is confronted with a discontinuous, highly disruptive technology, senior management has to bring about significant changes in the organization at all levels. Our first extension to Christensen is to emphasize the change process required to adopt a disruptive technology. Senior management has to convince others of the need to move in a new

direction. Specifically we are interested in how middle managers change themselves and also bring about change in the organization (see Rouleau, 2005; Balogun, 2006).

- In confronting a technological disruption, a firm faces a struggle between employees who seek to use dynamic capabilities to bring about change, and employees for whom core capabilities have become core rigidities. Management propensities for change drive the process (see Fig. 1). We describe this ongoing struggle using concepts from dynamic capabilities, core rigidities and management propensities.
- Leonard-Barton suggests that core capabilities that are appropriate in one situation may turn out to be inappropriate in another, for example, the challenges for an incumbent firm from a new entrant. These core capabilities, rather than being dynamic and helpful in coping with change, become core rigidities that inhibit a response. There are a number of paths to rigidity. Because corporate resources are limited, firms often emphasize one discipline, which makes the company less attractive to people from non-dominant disciplines.

Global Trends 2025: A Transformed World

http://www.dni.gov/nic/PDF_2025/2025_Global_Trends_Final_Report.pdf

- National Intelligence Council, November 2008

Overview:

Identifies key trends for society as a whole, including globalization, demography, the rise of new powers, the decay of international institutions, climate change, and the geopolitics of energy. Discusses the factors driving these trends and where they might take us. It uses scenarios to illustrate ways in which those drivers might interact and redo it for what it is you as a written air act to generate challenges and opportunities for future decisionmakers.
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Of Note for:

- A discussion of the dawning of a post-petroleum age.
- A discussion of the geopolitics of energy.
- Four global scenarios with emphasis on geopolitical and demographic changes that could strongly impact electric power in unexpected ways.
- Write-ups that use pretend news articles and maps to make scenarios come alive.

Representative Quotes:

- By 2025 the world will be in the midst of a fundamental energy transition—in terms of both fuel types and sources.
- Timing Is Everything: All current technologies are inadequate for replacing traditional energy architectures on the scale needed, and new energy technologies probably will not be commercially viable and widespread by 2025... Despite what are seen as long odds now, we cannot rule out the possibility of a transition by 2025 that would avoid the costs of an

infrastructure overhaul. The greatest possibility for a relatively quick and inexpensive transition during that period comes from better renewable generation sources (photovoltaic and wind) and improvements in battery technology.

Hard and Soft Ways to Create Value from Information Flows: Lessons from the Canadian Financial Services Industry

http://findarticles.com/p/articles/mi_qa3981/is_200303/ai_n9178087/?tag=content;col1

- By: Albert Lejeune, Tom Roehl
- Canadian Journal of Administrative Sciences, 2003

Overview:

This 20-page report relies on interviews with top bank management and secondary information to explain how Canadian banks moved to capture the technological potential for developing and exchanging information. The report notes that the technology alone was not enough to ensure sustainable competitive advantages; organizational change was also required to enhance the value of the information.

Of Note for:

- A reminder that organizational and business process change is often the most difficult part of an industry transformation.

Representative Quotes:

- In the mid- 1990s, Canadian banks found themselves with an organization that did not have good flows of information with its most important clients. They needed to find ways to take advantage of the new information technologies in their organizations. The bank-soon transformed into a "one-stop" financial services group--becomes available where customer business is. As the number of branches has steadily diminished, the level of integration between traditional and automated branches has become more sophisticated.
- Designed to meet our customers' individual needs--on their own terms and on their own turf-mbanx represents the true democratization of banking products and services available to millions of customers ... That is why mbanx is a true breakthrough: it reinvents client relationships by offering unprecedented levels of access and service. (Bank of Montreal, 1996 Annual Report, p. 6)
- In other words, the e-bank concept was once thought to deliver a better mix of hard high tech and soft high touch: the best digital access coupled with the best customer relationship management.

Impact of Skype on Telecom Service Providers

http://www.commnow.com/reports/EVS-Impact_of_Skype_on_Tele_Opr-January10.pdf

- By Evalueserve
- Evalueserve Report, 2005

Overview:

This 17-page report examines the impact of Skype and VoIP as a whole on profitability on the more traditional elements of the telecom industry. At the time this report was written, Skype was making waves with its high level of quality and cutting its cost for Skype-to-Skype calls to zero. The report establishes a scenario for Skype's continued success and what it means for the industry. Since the report is now dated, it is best read for general concepts rather than specific recommendations.

Of Note for:

- Finding parallels between what telecommunications has experienced and what may happen in the electric power sector.

Representative Quotes:

- By 2008, incumbent telecom operators offering fixed and mobile services are likely to face a significant risk of permanent reduction in overall profitability and revenues of at least 22-26 percent and 5 percent respectively over and above previously communicated expectations. Another additional reduction of profitability will come from an erosion of long-distance revenues in the business customer segment, once Skype and other VoIP providers offer viable solutions in this segment.
- However, Skype's performance and its ability to compete in the business segment will be seen, only after it introduces its business solutions in the market. The value proposition of Skype and its revenue model will improve further, once it starts offering and pricing value-added services in the business and retail customer segments.
- The profit margins of telecom service providers are expected to decline considerably due to a reduction in revenue. Since telecom operators have a high fixed cost base, a decline in the top line will have a direct impact on the bottom line. The sections below outline the various factors that will have an effect on the profitability of telecom operators.

Lessons for Utilities from the Google Attack

http://www.americainfra.com/article/Lessons-for-Utilities-from-the-Google-Attack/

- By Andy Bochman
- U.S. Infrastructure, 2010

Overview:

The author uses the recent attack on on Google's servers to highlight potential risks in electric power. He contends that the biggest difference between our current electric grid and the Smart Grid boils down to software. It is what makes the difference between modern business and their pre-IT ancestors. And while software offers a faster, smarter, more efficient and flexible way of conducting business, it also creates a new vulnerabilities— and not just to hacker attacks. In addition, there is a large degree of uncertainty in the consistent operation of a most critical corporate component.

Of Note for:

- Those seeking to understand the new risks and vulnerabilities brought about by the smart grid.

Representative Quotes:

- Most large organizations don't know where their software came from, at least not in a comprehensive manner. Software provenance is often quite opaque to users. Even when you buy software from Vendor X, there's no guarantee that all the code was developed by Vendor X coders.
- One feeds the other. Zero-day vulnerabilities are very hard to find. Most popular software packages have been around for a while, and have been well wrung-out in the market. Finding something new and vulnerable in them is neither common nor simple. With the source code, however, it becomes much more straightforward. Looking from the inside out, it is like having a map to the functionality, and weaknesses are revealed that would be very hard to find just searching from the surface.
- Despite repeated warnings from experts and the press since the Google breach headlines appeared, progress on disclosure from other affected organizations, forensics on the actual mechanisms, and informed recommendations have been slow, and that must change. Utilities and their software/service providers should be pressing for information and for assistance. Nothing could more fundamentally weaken our nation and our competitiveness than an organized and successful attack on our power infrastructure, and these incidents present an uncommon opportunity to learn.

Lessons from Change: Transforming the Power & Utilities Industry

http://www.ey.com/Publication/vwLUAssets/LFC-power_and_utilities/$FILE/LFC_power_and_utility.pdf

- By Ernst & Young
- Ernst & Young, 2005

Overview:

Ernst & Young based the recommendations in this 36 page report on over 1,500 meetings with utility management and with professionals in 13 other industry sectors. Although most of the recommendations are generic -- "remain alert and adaptive" -- they nonetheless provide a useful overview of the characteristics utilities will need to embrace during the coming transformation.

Of Note for:

- A sense of the attitudes of utility executives about change.
- A reminder of the attitudes utilities must adopt going forward

Representative Quotes:

- Executives interviewed in our study indicated that power and utilities companies have held up well in the global recession compared to other industries, but the hard times have taken their toll. An overall drop in industrial demand has struck a serious blow to revenues.
- Most critically, any analysis must consider how the company is positioning itself for the future, recognizing that what once worked may no longer be the optimal approach. For example, Terasen Gas, a Canadian gas utility, recently approached the British Columbia Utilities Commission with a proposal to replace its seven-year-old outsourced customer care model with an in-house customer care organization beginning in 2012.
- In the US, when the commercial paper market dried up, some power and utilities found it very difficult to maintain liquidity and needed to find alternative sources of cash quickly. Some utilities went as far as cutting their dividend payments by 50% and drawing down credit lines.
- Power and utilities has traditionally been a risk-averse sector, where long-term decisions are made on the basis of an exhaustive deliberation and justification. To accelerate corporate decision-making, some utilities are beginning to hire outside the sector to leverage the talent and skills from more entrepreneurial fields, such as the clean tech sector, to help lead the cultural change.

Lessons From Past, Other Industries Provide Impetus for Transformation

http://findarticles.com/p/articles/mi_qa3636/is_200003/ai_n8899799/?tag=content;col1

- By James P. McNutt
- Pulp & Paper, 2000

Overview:

This report is ostensibly about the woes and shortcomings of the forest products industry. However, it is most notable for a review of historical industry transformations. The author uses the U.S. steel and textile industries as examples. He maintains that they are decline came because they failed to pay attention to the advances of adjacent industries.

Of Note for:

- A reminder of the many previous industry transformations and what they have taught us.

Representative Quotes:

- Potentially the problem ties in our lack of being able to grasp the full realization of the role that real change can play for our industry, what happens without it, and how to communicate to and motivate our respective organizations to truly strive to achieve it. To this end, if we take a look backward in time and towards other industry sectors and a history of successes and failures there, we may be able to better crystallize the true power of change and the true ultimate agony of failure to change.
- Scientific Management: Also around the turn of the century, Frederick Winslow Taylor (1836-1915) began advancing his evolutionary theories on scientific management at the Mayo Clinic and the US Army's Watertown Arsenal. Winslow's approach to running a business focused on activities-based efficiencies of management, wherein the (dominant) owners and their (lowly) helpers, without organizational structure, introduced with great positive effect the first wave of what we now call optimization improvement work processes.
- The message here is that in spite of a vast array of critical structural issues and a lack of effective focus on reaching our industry's true potential, our opportunities to do so are real and achievable. Other managers in other times and other industries have faced more seemingly insurmountable challenges and triumphed. Our industry has the means and the opportunity to transform itself. The problem is that there are no magical solutions. But there are solutions-solutions for reshaping our industry and for generating a true pulp and paper industry evolution.

Managing in an Age of Change: Lessons from Previous Industrial Transformations

- By Jesse Berst
- Prepared in behalf of EEI, January 2010

Overview:

Utility executives can gain important insights from previous industrial transformations as they consider how to respond to the threats and opportunities of the smart grid. This 12-page white paper highlights lessons from transportation, retailing and telecommunications. It suggests that strategic adjustments typically require the "Three Rs" -- recognizing, rethinking, and repositioning. It counsels watchful waiting for utility executives, while preparing for quick action when trigger events occur. It presents several examples of winners and losers from previous industry transformations, with special attention to the challenge of "disintermediation" and how it may occur in the electric power industry.

Of Note for:

- Documenting the threat of disintermediation.
- Suggesting specific questions utilities can ask themselves to recognize, rethink and reposition for the coming changes.

Representative Quotes:

- In both transportation and retailing, it was new transformative technologies that allowed enterprises to be disintermediated from their core customers
- As MIT lecturer Jonathan Byrnes has pointed out, the winners recognized the scope of the change and rethought the strategic paradigm. More specifically, they segmented the customer base and then went all-out to secure the high-growth, high-profit segments. When industries transform, says Byrnes, companies can "have any part of the market they choose, but not everything. If they fail to choose, and try to hold on to it all, they will lose the best parts."
- A quick study of Google Voice (a voice portal) and Google Android (an operating system for cell phones) gives every indication that Google intends to disintermediate the mobile phone operators. In December 2009, the Wall Street Journal reported that Google plans to sell its own brand of smart phone in 2010, without partnering with a wireless provider, escalating "the Internet giant's assault on the traditional business model of the wireless industry."
- As we consider the many competitors and new entrants attacking the telecom sector, let's remind ourselves that there is at least as much money in electric power -- the nation's annual electric bill is as large or larger than the nation's phone bill according to most estimates. As the Googles of the world come to realize how much money is at stake and come to believe there is a way they can tap into that revenue stream, the electric power industry will come under assault as well.

Restructuring Energy Industries: Lessons from Natural Gas

http://tonto.eia.doe.gov/FTPROOT/features/jess.pdf

- By Margaret Jess
- Energy Information Administration / Natural Gas Monthly, May 1997

Overview:

This 15-page article provides an overview of the similarities and differences between electric power and the natural gas industry. Despite the title, which promises lessons learned, this scholarly piece is most useful as a reminder of the differences between the two industries. It also does a good job of laying out transitional challenges such as stranded costs and the creation of new institutions. Because the author assumes deregulation as the driving force, the article does not deal with the issues that occur when an industry comes under attack by innovative newcomers who seek to disintermediate the incumbents and siphon away high-margin customers.

Of Note for:

- A recap of the challenges faced when a regulated industry transforms.

Representative Quotes:

- Perhaps the greatest parallel between the two industries is in the area of regulation. The regulatory histories of the two industries are closely intertwined... both industries usually are regulated by the same board or commission; hence, there is a tendency for regulatory bodies to apply the same approaches to both industries.
- Industry restructurings usually are grounded in inefficient practices that resist change and innovation. An initiating event sometimes appears to be a change in the regulatory framework, but the underlying cause is usually the result of major economic stress in the industry.
- There is no reason to believe that firms in transition from sanctioned, regulated monopolies to competitive markets will bypass opportunities to seek market power. In fact, one could argue that seeking market power is, in some sense, a competitive firm's obligation.

Restructuring Industries: The Carrot and the Stick

http://www.bepress.com/cgi/viewcontent.cgi?article=1035&context=rne

- By Roger Sherman
- Review of Network Economics, Vol.2, Issue 4, Dec., 2003

Overview:

This 27-page paper examines how market regulation has been transformed in the last quarter century from sprawling territorial monopolies to deregulated and restructured industries. Old

monopolies were vertically integrated across local and long-distance telephone services or across generation and transmission of electricity. Restructuring has separated those functions and opened some of them to competition, aiming to harness market incentives to achieve efficiency in a partly regulated environment.

Of Note for:

- A thoughtful analysis of how regulation may soon change -- not as a total overhaul, but as a series of smaller changes that, taken together, to have a large impact.
- Insightful comparisons between telecommunications and electric power.

Representative Quotes:

- Deregulation will not be treated here. Attention goes instead to the still more ambitious step of restructuring regulated industries, retaining regulation in some parts but trying to apply the healthy carrot or the brutal stick to other parts. Specifically, our topic is the restructuring of the telephone and electricity industries.
- A rate-of-return regulated monopoly faced only a slice of the carrot, for instance, because profit controls pared its profit incentive. It faced a twig rather than a stick in the weak form of unsystematic invidious comparisons to others' costs. Its prices were based primarily on its own costs, which virtually eliminated the stick. When costs are high, prices are high, and the inefficient firm goes unpunished. To recover the stick, competitors have been granted access to once-monopolized essential facilities as part of the restructuring of formerly regulated network industries. Tracks of one railroad have been made available to other railroads for many years. Pipelines for natural gas can be an essential facility for the gas distributor who needs access to pipelines for transportation of natural gas. When long-distance telephone service providers were granted access to local monopoly exchange networks in 1984 they were forced to compete. Access to transmission wires enables an independent generator to participate in a wholesale market for electricity.
- The pace of innovation in the telephone industry is remarkable today, and would probably not have been matched by the old regulated-monopoly regime. Electricity markets require new thinking about market power, plus a wide variety of new arrangements to provide efficiency incentives, not the least of which would allow consumers to respond to the changing price of electricity. In both industries, ultimate benefits in production and allocative efficiency appear to be worth the costs of change.

Skype's Disruptive Potential in the Telecom Market: A Systematic Comparison of Business Models

http://www.hec.unil.ch/yp/Pub/05-skype.pdf

- By: Alexander Osterwalder, Jan Ondrus, Yves Pigneur
- University of Lausanne, 2005

Overview:

This 18-page report weighs the disruptive potential of VoIP runaway Skype. At the time the report was written, Skype was considered an Internet start-up and many were predicting solid growth for the company. They were right. This report, in addition to other analyses and observations, identifies which elements of Skype's business model would likely lead to continued success. Although not written for an electric utility audience, it offers lessons learned that can be applied to how utilities face future challenges and how they might evaluate different business models.

Of Note for:

- Understanding how to conceptualize and compare new business models.

Representative Quotes:

- A disruptive innovation is a technology, product or process that creeps up from below an existing business and threatens to replace it. In this paper we aim at analysing whether Skype, an Internet Start-up Company founded in 2003, has the potential to play such a role in the global telecom market. Few authors have systematically and analytically investigated the question.
- As outlined above, our first goal is to identify Skype's disruptive potential. An innovation, product or process is considered disruptive when its utilization allows the design of new products, services, and processes at lower prices (Christensen 1997). It brings a very different value proposition to the market than had been available previously.
- In this paper we apply two of the conceptual approaches to business models, in the form of business ontologies, in order to describe and compare two different business models in the same industry, which in this case is telecommunication.

Telecom Industry Lessons for Electric Utilities

http://www.smartgridlibrary.com/2010/01/18/telecom-industry-lessons-for-electric-utilities/

- By Christine Herzog
- Smart Grid Library: Blog site, 2010

Overview:

The writer, a telecom veteran, notes in this short blog that there are striking similarities between telecomm 25 years ago and electric utilities. And where there are similarities, there are lessons to take home. The services provided by both are essential, so much so that few people think about their power supply until an outage takes it away temporarily. Monopoly and regulation issues also are similar, although it should take utilities less time to adapt to a changing business environment if telecom's lessons are learned.

Of Note for:

- A thought-provoking opinion piece that will interest electric utility professionals and decision makers.

Representative Quotes:

- I sometimes see and hear bewilderment, frustration, and defensiveness in utility resources when talking about the traditional grid and the changes the Smart Grid will bring. Lesson #1 – Change is not a criticism of past performance. Be excited that electricity is something that will no longer be taken for granted.
- In 1980 you had no choice for local phone service except Ma Bell. Phone company practices, policies, and processes were heavily influenced by state Public Utility Commissions and the Federal Communications Commission (FCC). The price of monopoly is regulation, and utilities are very good at interacting with regulators. Another price of monopoly is the lack of utility skills in working in any other type of market.
- It will be a painful climb for some utilities, but it can be accomplished faster and at less cost to ratepayers by learning from telecom industry experiences. Lesson #2 – Hire outside talent to build corporate readiness for a transitioning marketplace. Develop and deploy corporate-wide change management plans that address concerns of existing employees.

The Comparative Success of Disruptive Innovations in the Fiberoptic Industry

http://www.allbusiness.com/public-administration/national-security-international/425439-1.html

- By Mahmud Awan
- American International College Journal of Business, 2002

Overview:

Disruptive technologies and innovations have or can affect almost every industry segment. Here, the author explores the experience of the fiberoptic industry, a segment where disruptions are quite common. As a general rule, the industry rode high in the 1990s but lost its luster to become plagued by excess capacity and a worldwide glut. The experiences of transnational corporations such as Corning and Lucent and small-scale players are shared, which can be easily translated as lessons for utilities.

Of Note for:

- A detailed and academic look at the impact of a disruptive technology on the telecommunications sector.

Representative Quotes:

- With the onset of a key disruptive innovation of this period, fiber amplifiers, the long distance communications, whether underwater or on-land, were about to change forever. These were first thought out again at American Optical by Dr. Eli Snitzer when he had actually moved away from optical fiber research to concentrate on lasers. Erbium-doped fibers turned out to be perfect amplifiers, and submarine cables just like the above ground cables started using these amplifiers instead of repeaters for global communications.
- There have been significant discontinuities within the U.S. local telecoms markets over the last twenty years. Many companies have lost business and market shares in this market in a pattern different from the European and other global markets. They assumed that entry would be relatively cheap, that the market would be capable of sustaining multiple local access networks immediately, that existing companies would not seek to deter entry of new companies in hopes of entering long-distance business agreements, and that regulators would reduce (not raise) entry costs to new firms.
- Following years of double-digit growth, the market for optical networking equipment retrenched in 2001 and has continued to erode during 2002 and 2003. However, new DWDM producers such as Atoga, Altamar, Movaz, PacketLight, PhotonEx, Lumentis, Seneca, Innovance, All Optical Networks, Ceyba, Xtera, Zaffire, Astral Point, ONI, and Sycamore, are showing resilience in the market.

Notes

- Alternative generation
- Traditional vertical integration
- Wires only
- Wires plus platform
- Wires plus platform plus energy services
- Microgrid

The choices run along a continuum from a) commodity provider to b) wires only to c) wires plus provider of last resort to d) POLR plus platform for energy services to e) platform plus partnerships to provide some of the energy services to f) spinout of non-regulated energy services companies.

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