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Utility Scenario Planning:
"Always Acceptable" vs. the "Optimal" Solution

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About the Author

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Utility Scenario Planning:
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Regulators, utilities, forecasters, technologists, futurists, energy experts, consumers, and others should collaborate to develop scenarios that provide planning guidance and "always-acceptable" solutions.

> "Scenario thinking is both a process and a posture. It is the process through which scenarios are developed and then used to inform decision-making. . . . At its most powerful, scenarios help people and organizations find strength of purpose and strategic direction in the face of daunting, chaotic, and even frightening circumstances."[1]

No one knew what the future held 50 years ago, when America's electric utilities committed to build some of today's resources. Forecasters had no idea that the nation's electricity load growth, then a steady six percent or more, would dwindle to one percent. It would have been hard to foresee the prevalence of the internet, the economic surge in China and India, the omnipresence of powerful personal computers, 90-plus percent capacity factors at nuclear plants, or urgent concerns about climate change. None of these developments was foreseen or taken into account in forecasts of that era. No one used "scenario planning." How different might the decisions of the 1960s and '70s have been had utility scenario planning been applied? Would there have been the excess capacity struggles of the 1970s and '80s? Would transmission systems be more robust? Would we have moved to eliminate natural gas as a fuel for electric generation for a period, and then allowed it to become the fuel of choice for new generating stations for the past decade?

Scenario planning's purpose is to allow decisionmakers to assess potential strategies over widely—perhaps even wildly—different views of the future. Scenario planning for electricity—let's call it Utility Scenario Planning (USP)—differs from Integrated Resource Planning. IRP identifies a least-cost resource plan aimed at meeting future needs and, in some instances, is broadened to apply to a small band of projected trends—e.g., variations in future loads, fuel costs, resource construction, or purchased power costs.

Utility Scenario Planning, by contrast, first identifies sharply different views of a distant future—call them scenarios—and then seeks to define a resource strategy that is most successful[2] in addressing all of those potential futures. Utilities sometimes refer to their IRP processes as scenario planning. Although utilities and regulators engaged in resource planning must consider greater uncertainties than ever before, these uncertainties usually fall within a range bounded by high and low industry projections. Typical considerations include issues surrounding carbon

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[1] Heinrich Vogel, *Why Scenarios?*, Global Business Network, at http://www.gbn.com/about/scenario_planning.php.

[2] "Success" encompasses the sometimes-conflicting goals of providing adequate supplies of electricity, reliably, with minimal damage to the environment, and at a reasonable cost.

policy and the potential need to shut down a generation of coal plants; the potential for greater energy efficiency, demand response, and distributed generation; and the commercialization of new technologies under development. They are, for the most part, expected events that fall within a reasonable, though sometimes wide, range of values. Some IRP variations may assess which resource plan achieves a least-cost solution in the most cases and deem it to be scenario planning. In another paper,[3] I discuss how an expanded version of IRP can be performed using Uncertainty Distribution Analysis to consider the value of resources across the various cases within the trend. This is not the type of scenario planning suggested here.

Scenario planning, as contemplated in this paper, addresses circumstances that depart drastically from current trends. Some examples might be, for example: Internal instability in Mideast nations sharply curtails Mideast oil supplies, driving market prices to $300; or an unanticipated breakthrough in technology makes distributed generation more economic than new central station generation.

Scenario planning has at least a half-century of history, pioneered by planners for the U.S. military and then practiced with some success by companies such as Royal Dutch Shell (starting in the early 1970s), GE, and others.[4] Still others have used it for regional planning, land use planning,[5] or global planning initiatives.[6] It has not been in common use among this country's electric utilities or energy planners.

Utility Scenario Planning is appropriate where (1) the duration of commitments introduces profound uncertainty of a sort that falls outside the realm of even the outer boundaries of industry trends into a possible, but unpredictable, category of "what if"; and (2) there are multiple ways of meeting widely different futures that might occur. Given the time it takes to plan and build many components of electric utility infrastructure and the useful life of those assets, the planning horizon for electric utilities is very long—perhaps 50 years or more. We have seen many surprises over the past 50 years. What trend-defying futures might we face for the next 50 years? Will needle peaks[7] be a thing of the past? To what extent might electric vehicles supplant the internal combustion engine, and how rapidly might that market penetration

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[3] D. Boonin, *Reinventing the Crystal Ball: Assessing Uncertainty in Utility Resource Proposals*, http://electricitypolicy.com/index.php?option=com_content&view=article&id=2771:reinventing-the-crystal-ball-assessing-uncertainty-in-utility-resource-proposals&catid=99:article&Itemid=710.

[4] Liam Fahey and Robert M. Randall, *Learning from the Future* (Wiley & Sons, 1998).

[5] Garry Peterson, et al, *Scenario Planning: a Tool for Conservation in an Uncertain World*, CONS. BIOL. (Vol. 17, No. 2, April 2003, at 358-66).

[6] The United Nations used scenario planning to help guide its Global Environmental Outlook 3 project. *See* http://www.unep.org/geo/geo3.asp.

[7] A needle peak is a utility's peak demand that lasts for just a few hours over a year but creates a large increase in demand compared to the rest of the year. When plotted on a load duration curve, it looks like a long, skinny wedge (a needle) at the left side and top of the curve.

occur? Will newcomers from other fields—innovators like Google and Oracle—bring their "disruptive" technology to the electric power field? Will distributed generation allow many customers to become independent of the grid? Will cost-effective storage become a transformative reality? These are just a few of the questions that USP requires we ask.

Asking provocative questions about uncertainties is the crux of USP. Although this paper offers a few ideas about these uncertainties, these ideas themselves are not scenarios. True scenario development demands thoughtful, internally consistent visions of the future—visions that can come about only through the participation of contributors from many disciplines, including many from outside the utility field. This paper calls upon regulators, utilities, and others to collaborate in regional and possibly even national efforts to develop such scenarios so that major resource decisions that must be made will meet our goals for success,[8] regardless of what future develops.

USP should apply to vertically-integrated utilities and utilities that have divested their generation. It applies as well to utilities serving within or outside of organized markets. USP might also apply to other utilities with long planning horizons such as gas and water utilities.

A Scenario Planning Example: Home Buying

Home buying is a useful way to distinguish scenario planning from resource planning. Consider a young couple planning to buy a house they hope to live in for the next 30 years. They might look at appreciation trends, maintenance costs, and demographic and economic trends in the neighborhood, then choose the most attractive, least-cost three-bedroom house based upon their then-view of the future. That effort resembles integrated resource planning: finding the least-cost solution for a defined need.

But what if the defined need is not so obvious? What if the couple adopted a different mindset and asked what house would work best under widely different views of the future? What if they were to have lots of children, or none? What if one spouse got a better job on the other side of town? What if one spouse became infirm and could not climb stairs? What if it became necessary to take in an elderly parent unexpectedly?

Under the single view of the future, the most economical solution ensures a good answer under that one scenario (e.g., an anticipated number of children, working in the same area, remaining healthy, etc.). That solution might become unacceptable, however, if the future were to turn out differently, and sooner than expected.

Now assume that the couple, before buying, expanded its decision process to consider the possibility of a different family size, employment, and health scenarios. They might then find that their best solution was a three-bedroom house with expansion possibilities, near multiple transportation modes, offering the ability to live on one level. Or perhaps uncertainty about the future would be so great that renting rather than buying produced the always-acceptable solution. The housing search and decision would be much different. The residence of choice might not be

[8] Note 3, *supra.*

the most desirable under any one of the plausible scenarios, but would be acceptable because it met the couple's needs regardless of which scenario became reality.

This simple example illustrates the distinction between Integrated Resource Planning and Utility Scenario Planning. Although IRP may incorporate assessment of different trends in fuel prices and load growth, it does not consider widely different future scenarios. Typically, it focuses on the probable rather than the plausible—that which falls outside the limits of the probable. By contrast, Utility Scenario Planning looks at uncertainties that are plausible but today would be considered improbable. These uncertainties drive widely different future scenarios. USP then seeks to develop a portfolio of resources that would work well under all those different scenarios, even if the portfolio may not be optimal for any one scenario.

The Purpose of Scenario Planning

Scenario planning is prompted by uncertainties typically associated with long-term commitments and multiple options. Scenario planning does not attempt to identify the most likely future. Its purpose instead is (a) to acknowledge that uncertainties can drive the future onto very different paths, and (b) to examine how particular solutions address or fail to address those different futures. Like war games for business or government decisions, scenario planning allows decisionmakers to examine several scenarios and strategies with the goal of accommodating multiple futures with one strategy—to take the first steps down a path that appears most robust, perhaps one that identifies new services and business opportunities as well as one that best avoids disastrous results. Scenario planning allows decisionmakers to rehearse the future and identify high-promise, low-risk responses. As a risk management tool, it helps identify consistently acceptable results under all scenarios.

Scenario planning is only as good as the scenarios created and used. Well-designed scenarios define plausible, internally consistent views of the future. As compared to IRP, USP's core questions are different, the planning process is different, and the decision metrics are different. Some may consider USP to be a variation of IRP, albeit one with a different focus and approach. They are indeed close relations, as both focus on planning, but there are fundamental differences between USP and IRP—even IRP that incorporates sensitivity and uncertainty analysis—in both their approach and process. The table on the next page summarizes key differences.

INTEGRATED RESOURCE PLANNING COMPARED TO UTILITY SCENARIO PLANNING		
	IRP	**USP**
What's the question?	What is the optimal mix of particular supply and demand resources to provide a least-cost set of resources to serve a particular future with relatively small differences? This is an optimization approach to resource planning.	What collection of resources allows the utility to meet acceptably a set of scenarios that define a broad set of plausible futures? This is a risk-management approach to resource planning, looking to serve multiple futures with a set of resources.
What's the view of the future?	The utility uses a limited set of forecasts to portray the future.	The plausible futures are diverse scenarios based upon key uncertainties. No single forecast drives the planning process.
What's the focus?	The focus is on the cost of different technologies and how the analysis changes over a set of probable assumptions (sensitivity analysis). The focus is, "What should I do, given a trend-driven view of the future?"	The focus is on identifying key uncertainties that define plausible scenarios. The focus is "What if?"
What's the preferred resource?	Preferred resources are the least-cost mix of resources to meet a particular view of the future, as tested under sensitivity analysis.	Preferred resources are a set of resources that provide an always-acceptable solution under widely different—but plausible—views of the future.

How Do Planners Develop Useful Scenarios?

Scenario planners emphasize uncertainties. This emphasis differs from forecasting an expected range of outcomes. The scenarios are plausible and provocative visions of how relevant external forces might interact. Scenarios provide decisionmakers with different visions of the future and, therefore, different challenges and opportunities.

Scenario planning starts by distinguishing uncertainties from trends and expected events. Trends, while uncertain in outcome, reflect known facts subject to gradual change (e.g., load growth, prices of fossil fuels, or business cycles). Expected events include technologies that remain in the testing stage but are likely to become commercial. Uncertainties, by contrast, depart from trends and expected events. Uncertainties are a dislocation rather than a minor tilt in a base forecast. Uncertainties take us to futures outside of traditional sensitivity analysis. They fall outside present knowledge and expectation. Developments such as unanticipated

technological breakthroughs and massive oil interruptions—such as would push electric vehicles and plug-in hybrids to the forefront much more rapidly than is now expected—are not unthinkable and indeed must be considered. But they are beyond the scope of IRP as commonly practiced.

The USP process focuses initially on obvious uncertainties, producing scenarios useful in gaining a general understanding of the situation. These "first-generation scenarios" do not help make resource decisions. It is not enough to identify resources that produce always-acceptable solutions under a case with $50/barrel oil and $300/barrel oil or with 1 million versus 20 million electric vehicles. Resource decisions are possible only after scenario participants, usually aided by an experienced facilitator, apply iterative refinements that produce scenarios—think of them as robust stories about the future that are useful for decisionmaking. The experience of long-time users of scenario planning indicates that it is almost impossible to jump directly to proper decision scenarios without defining an obvious scenario as a starting point.[9]

To develop scenarios that assist in decisionmaking, we need to identify the uncertainties that are driving forces—the true game-changers that make a difference to a scenario's story. The recurring question in the scenario development process is: Does this uncertainty create a new story or just a plot twist? Examples might include: demand for fossil fuel in China, India, and other developing countries increases annually by 20 percent; or, renewable energy is lower cost than non-renewable energy; or, energy efficiency reduces U.S. consumption of energy by 50 percent in 20 years; or, the U.S. has constrained access to foreign oil supplies for a protracted period. Scenario planning requires thinking about what is *plausible* rather than what is probable. The process focuses on what *might* happen, rather than on particular whys and hows.

The set of scenarios should define all plausible futures. Effective scenario planning focuses on a relatively small set of scenarios. Typically, scenarios define four quadrants of outcomes that create different futures that affect the decision at hand. Add another pair of uncertainties and that 2x2 matrix expands to a 2x2x2 cube of eight scenarios. According to existing research,[10] those three dimensions and eight scenarios are the practical outer limit for scenario planning that is efficient and transparent.

To keep the number of scenarios small but the scope broad, it might become necessary to define a driver broadly. Typically, one of the scenarios might default to a surprise-free scenario (i.e., a scenario that would be implicit to an IRP process), providing decisionmakers with an IRP-like vision of the future.

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[9] *See* P. Wack, *Uncharted Waters Ahead,* HARV. BUS. REV., Sept.-Oct. 1985; and "Scenario Planning" at www.NetMBA.com

[10] *Ibid.*

What Is the USP Process?

> "Scenario thinking is both a process and a posture. It is the process through which scenarios are developed and then used to inform decisionmaking. After that process itself is internalized, scenario thinking becomes, for many, a posture towards the world—a way of thinking about and managing change, a way of exploring the future so that they might meet it better prepared. At its most basic, scenarios help people and organizations order and frame their thinking about the long-term while providing them with the tools and confidence to take action soon. At its most powerful, scenarios help people and organizations find strength of purpose and strategic direction in the face of daunting, chaotic, and even frightening circumstances."[11]

Scenario planning is a process. Outlined below is a six-step scenario-planning process with an electric utility focus.

Step 1 — Gather a team: An organization's process in developing scenarios requires both internal and external human resources and ideas. Utilities and regulators need to include people other than their core planning groups, as this is not a forecasting exercising as much as a "what if" project. Whether initiated by the utility or the regulator, more than the typical stakeholders need to be included in a scenario-planning team—e.g., business and governmental leaders, technologists, academics, researchers, and others. The planner should identify and involve all those whose responsibilities require them to imagine outcomes and whose responsibilities may affect those outcomes. What happens at one electric utility might affect the long-term plans of others. This interdependency could require consideration of all of a region's electric utilities, similar to the way electric utilities cooperate within regional transmission and reliability organizations and other regional efforts.[12] With such a diversity of participants, it is desirable, if not absolutely necessary, to provide a neutral facilitator to lead the process.

Given the broad and complex nature of the uncertainties and drivers, I suggest establishing a national or at least regional teams, rather than looking to each utility to try to define scenarios. Issues such as national environmental and energy policies, unrest in the Middle East, rising international energy demand and competition for scarce materials and skilled labor, and new technologies affect all utilities; they all need to be considered in views of the future, no matter if scenarios are developed nationally or regionally. Utilities and regulators can then adjust these scenarios to reflect individual utility or regional differences.

Step 2 — Define a starting point: Scenario development is much harder if a starting point, based on present circumstances—such as projected loads, the cost of alternative resources,

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[11] Vogel, *supra* note 2.

[12] Gas-electric interaction might require the involvement of regional gas utilities and their customers and suppliers in the scenario-building stage. Competitive considerations would, however, preclude gas and electric utilities from jointly participating in their respective processes of designing resource plans to address the scenarios.

and fuel costs—is not defined. Scenarios about the unexpected require that we first define the expected. What are the existing trends regarding technology, environmental policies, load forecasts, and fuel prices? What is the expected business cycle? What costs and performance do we expect for various resources? This step is similar to the trend projections that planners develop for IRP.

Step 3 — Define the question facing the decisionmakers: The USP asks questions broad enough to avoid focusing on a single outcome but focused enough to empower decisionmakers to solve the problems they face. For example, "What actions must the utility take to be prepared, under a variety of potential futures, to supply energy needs cleanly, reliably, and at reasonable cost?" This might not be the only or best question; that would be an issue to be determined through the USP process.

Step 4 — Explore the unexpected, identify key drivers, and develop scenarios: Scenario planning requires more than keeping current on events likely to affect utilities, such as expected changes in technology or legislation. Planners must make assumptions about the unexpected. They must ask: Where *might* we be? What is plausible? Exploring the unexpected is what identifies the key drivers. At the crux of meaningful scenarios are key drivers discovered through exploration and research. Drivers are unknowns that define each scenario. They lead decisionmakers to find a single set of policies and resources that lead to an acceptable strategy to meet the requirements of each scenario. An "acceptable" result is one that satisfies the initial question. The challenge is to conceive of a small set of scenarios that define futures that are internally consistent, yet without redundancy.

Step 5 — Assess potential strategies: Scenario planning is not an academic exercise. It aims for a single strategy that works across the range of scenarios, even if the strategy is not the "least-cost" solution in any one scenario. To meet the needs of scenarios, one must consider all options. Issues such as build vs. buy, term of commitment, transmission vs. generation, supply vs. demand resources, and commit now or defer—all should be considered in fashioning an acceptable strategy.

Unlike IRP, USP involves no sensitivity analysis. Each scenario contains its own set of internally consistent assumptions about loads, resources, and exogenous events. The analysis examines the underlying question and sees whether the strategy provides sufficient resources, consistent with environmental standards, and provides electricity service at an acceptable price. If the answer is "no" under any of the defined scenarios, the strategy is rejected and others are considered. When a strategy produces acceptable results across all the scenarios, the job is not done. The planner must ask: Are there other strategies that might perform even better? Is there an always-acceptable solution that is superior? As with war games, many strategies are tried until the process ceases to produce superior solutions.

Some utility resource commitments have time horizons of 50 years (e.g., a nuclear plant) while others' are shorter (e.g., purchased power or demand response). Planners need to account for these different time horizons and the potential to modify a strategy as more information becomes known. As USP is about managing future uncertainties (risk management vs. cost optimization), smaller, shorter planning-horizon strategies might bring risk management benefits that a large and lengthy-horizon project might not. It is easier to develop ten-year scenarios than

50-year ones. But if a longer-term project produces superior results across all scenarios as compared with short-term solutions, decisionmakers should not fear the long-term commitment.

Step 6 — Monitor conditions: Uncertainties change over time. New technologies that were not part of plausible scenarios initially can become commercial. Environmental and tax rules change. Political and economic sea changes occur. Old uncertainties become defined paths. These changes require that scenarios be periodically revisited and changed. Scenario planning requires ongoing monitoring and reassessment of scenarios and planned actions. Changing plans may take courage, but if an updated USP indicates that abandoning a strategy is superior to continuing it, a course adjustment should be made.

Moving Forward

Scenario planning not only affects an organization's planning process but dramatically changes how an organization operates.

> "Experience has taught us that the scenario technique is much more conducive to forcing people to think about the future than the forecasting techniques we formerly used."
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> "A willingness to face uncertainty and understand the forces driving it requires an almost revolutionary transformation in a large organization. This transformation is as important as the development of scenarios themselves."[13]

Scenario planning changes everything—from the core questions asked, to the planning process, to the people involved in it, to the resource decision process, to the nature of interactions with customers, regulators, and the general public. USP demands a sea change in how utilities and regulators assess the future. Given the marked difference in approach from IRP, it seems appropriate that utility regulators should determine whether, given the many uncertainties the industry now faces, electric utilities within a state or a region, in conjunction with regulators within that state or region, should undertake a Utility Scenario Planning exercise.

IRP was a major breakthrough, integrating demand-side and supply-side resources into a single planning process. There are ways to deal with uncertainty under traditional IRP without moving to USP.[14] But IRP provides a least-cost plan over only a small range of expected outcomes and ignores the unexpected.

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[13] These comments come from former executives of Shell Oil Company. See P. Wack, *Uncharted Waters Ahead*, HARV. BUS. REV., Sept.-Oct. 1985. Scenario planning was adapted as a business-planning tool in the 1970s by Shell Oil. According to one Shell executive, scenario planning helped turn Shell from a second-tier player in the oil industry to an industry leader, because its planning allowed it to respond differently from other oil companies during the oil crises of the 1970s and early 1980s.

[14] *See* Boonin, note 3, *supra.*

USP is a relatively new planning tool—one that could point to new opportunities as well as disasters to be avoided. It requires building and relying upon scenarios, glimpses of plausible futures. It's a process that may take time to evolve. The very nature of uncertainty planning, more art than science, may seem overwhelming and imprecise to utility planners and regulators. But it is the profound effect of uncertainties—those stunning developments that we did not anticipate 40 or 50 years ago—that makes USP such a potentially useful tool. Can anyone seriously argue that the rate of change today and the uncertainty of its direction present a challenge less urgent than before?

To initiate this effort, key players—regulators, utilities, technology experts, consumers, and others—should collaborate on building scenarios for USP, with a regional and possibly even a national focus. Collaboration by these organizations should produce a process that makes America's most vitally important industry stronger and more resilient in decades to come. It is time to go beyond analysis that relies largely on extrapolation from current information and trends. It's often said, "Nothing runs without electricity." It's time, in this far-reaching, most central industry, to construct a more robust basis for the essential service the industry provides.

The futurist Louis Mumford said, "Trend is not destiny." Utility Scenario Planning embraces that maxim. USP acknowledges the many uncertainties and seeks to navigate them safely and beneficially for the public good. It's time regulators and utilities started using this tool.