21st Century
POWER
PARTNERSHIP
Accelerating the transformation of power systems

Next-Generation Performance-Based Regulation

VOLUME 2

Primer—Essential Elements of Design and Implementation

VOLUME I | VOLUME 2 | VOLUME 3

CLEAN ENERGY MINISTERIAL | RAP

Next-Generation Performance-Based Regulation

Volume 2: Primer—Essential Elements of Design and Implementation

David Littell, Camille Kadoch, Phil Baker, Ranjit Bharvirkar,
Max Dupuy, Brenda Hausauer, Carl Linvill,
Janine Migden-Ostrander, Jan Rosenow, and Wang Xuan
Regulatory Assistance Project

Owen Zinaman and Jeffrey Logan
National Renewable Energy Laboratory

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

Technical Report
NREL/TP-6A50-70822-2
April 2018

Contract No. DE Contract No. DE-AC36-08GO28308

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Available electronically at SciTech Connect http:/www.osti.gov/scitech

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
OSTI http://www.osti.gov
Phone: 865.576.8401
Fax: 865.576.5728
Email: reports@osti.gov

Available for sale to the public, in paper, from:
U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
NTIS http://www.ntis.gov
Phone: 800.553.6847 or 703.605.6000
Fax: 703.605.6900
Email: orders@ntis.gov

Front cover photo from iStock 183874153; back cover photo from iStock 000016542720

NREL prints on paper that contains recycled content.

The Next-Generation Performance-Based Regulation Report in Three Volumes

This three-volume report is based on the material found in *Next-Generation Performance-Based Regulation: Emphasizing Utility Performance to Unleash Power Sector Innovation*,[1] which, like this report, was created for the 21st Century Power Partnership (21CPP). Since 2012, the 21CPP—an initiative of the Clean Energy Ministerial—has been examining critical issues facing the power sector across the globe. Under the direction of the National Renewable Energy Laboratory (NREL), 21CPP provides thought leadership to identify the best ideas, models, and innovations for the modern power sector that can be implemented by utilities and governments around the world.

An earlier 21CPP report, *Power Systems of the Future*,[2] published in 2015, summarizes the key forces driving power sector transformation around the world and identifies the viable pathways that have emerged globally for power sector transformation, organized by starting point as illustrated in Figure P-1. In 2016, the 21CPP published an in-depth report describing the Clean Restructuring pathway originally elucidated in *Power Systems of the Future*. A related pathway identified in *Power Systems of the Future* was Next-Generation Performance-Based Regulation, and this report builds on that.

Figure P-1. Present status and adjacent pathways to power system transformation

Present Status	Adjacent Pathways
Vertical Integration • Little or no power market restructuring • Utility as single-buyer	Next Generation Performance-based Regulation Clean Restructuring
Restructured Market • Intermediate/high levels of power market restructuring • Independent system/market operator	Unleashing the DSO
Low Energy Access • Unreliable, limited, or no access to electricity • Can occur in restructured or vertically integrated market settings	Bottom-up Coordinated Grid Expansion Bundled Community Energy Planning

Source: Zinaman, O., Miller, M., Adil A., Arent, D., Cochran, J., Vora, R., Aggarwal, S. et al. 2015. *Power Systems of the Future: A 21st Century Power Partnership Thought Leadership Report*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-62611. http://www.nrel.gov/docs/fy15osti/62611.pdf.

[1] Littell, D., Kadoch, C., Baker, P., Bharvirkar, R., Dupuy, M., Hausauer, B., Linvill, C., et al. 2017. *Next-Generation Performance-Based Regulation: Emphasizing Utility Performance to Unleash Power Sector Innovation*. Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy17osti/68512.pdf.

[2] Zinaman, O., Miller, M., Adil A., Arent, D., Cochran, J., Vora, R., Aggarwal, S. et al. 2015. *Power Systems of the Future: A 21st Century Power Partnership Thought Leadership Report*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-62611. http://www.nrel.gov/docs/fy15osti/62611.pdf.

With this report, we have divided the full *Next-Generation Performance-Based Regulation* report into three volumes:

1. *Next-Generation Performance-Based Regulation*
   Volume 1: Introduction—Global Lessons for Success
2. *Next-Generation Performance-Based Regulation*
   Volume 2: Primer—Essential Elements of Design and Implementation
3. *Next-Generation Performance-Based Regulation*
   Volume 3: Innovative Examples from Around the World.

Acknowledgments

The authors would like to thank an advisory group for this report, who provided invaluable guidance and comments:

- Peter Fox-Penner, Boston University Institute for Sustainable Energy
- Marcelino Madrigal Martínez, Energy Regulatory Commission, Mexico
- Ann McCabe, Consultant
- Susan Tierney, Analysis Group
- Richard Sedano and Frederick Weston, The Regulatory Assistance Project.

We also acknowledge the comments and reviews by Douglas Arent of NREL and the 21st Century Power Partnership. The authors, however, are solely responsible for the accuracy and completeness of this study.

List of Acronyms

21CPP	Century Power Partnership
DEA	data envelopment analysis
DER	distributed energy resource
DISCOM	distribution company
DSM	demand-side management
EAM	earnings adjustment mechanism
FERC	Federal Energy Regulatory Commission
gridcos	grid companies
kWh	kilowatt-hour
MW	megawatt
NDRC	National Development and Reform Commission (China)
NREL	National Renewable Energy Laboratory
NY REV	New York's Reforming the Energy Vision
NY-PSC	New York Public Service Commission
PBR	performance-based regulation
PIM	performance incentive mechanism
ROE	return on equity
RIIO	Revenue=Incentives+Innovation+Outputs
T&D	transmission and distribution
UDAY	Ujwal DISCOM Assurance Yojana

Table of Contents

List of Figures

List of Text Boxes

1 Introduction

Volume 1 of this report, *Introduction—Global Lessons for Success*, defined performance-based regulations (PBRs) for the 21st century and provided examples of successful mechanisms from around the world. This volume, Volume 2, focuses on the importance of understanding institutional arrangements, the best practices for design, development, and implementation of PBR mechanisms. Section 2 discusses the importance of understanding the incentives inherent in institutional arrangements, especially utility composition and ownership structure. We start with this discussion because an understanding of the institutional arrangements and the corresponding incentives or disincentives that have evolved over time is critical to being able to successfully build a PBR that can influence institutional behavior to achieve different outcomes. One factor that is important in this analysis is determining the utility type, by which we mean whether the utility provides generation, transmission, and distribution services as well as natural gas and water service or any combination of these. This will affect how it responds to incentives. The ownership structure of the utility is also important because it determines the type of incentive structure that will have traction on the specific utility.

Once the institutional arrangements and inherent incentives are clearly understood, we can build on this understanding with some best practices for PBRs. Section 3 offers best practices for the development and design of successful PBR mechanisms. It focuses on the design process itself and principles for the approach of specific elements of the mechanism. This section is intended to provide guidance to decision makers as they craft PBR mechanisms for their jurisdictions. There is no "cookbook" to create a PBR mechanism because specific jurisdictional considerations require modification and thought. Section 3 details nine best practices that are important to successful PBR mechanisms.

Section 4 lists various PBR design elements that could be incorporated into specific jurisdictions. Not all these elements will be used in every mechanism, but some of the design elements will be useful for readers to consider during the design process.

2 Institutional Arrangements, Utility Composition, and Ownership Structure Matters

This section offers considerations for assessing existing system incentives and drivers, which are critical to understand before determining the appropriate PBR mechanism.

- **Key Point 1:** It is critical to understand the institutional arrangements within a jurisdiction, which have incentives inherent in the structure.
- **Key Point 2:** Consideration of the utility composition is critical to understand both the concerns the utility is facing with respect to technological change and how the utility will respond to incentives.
- **Key Point 3:** The ownership structure determines the types of incentives structure that will have traction on a specific utility.

Regulatory structures are embedded within the institutional arrangements that are unique to the history, context, and legal structures of each jurisdiction. It is important to examine these structures and evaluate the incentives that are inherent in it. An understanding of the institutional arrangements and the corresponding incentives or disincentives that have evolved over time is critical to successfully building a PBR that can influence institutional behavior to achieve different outcomes. Text Box 1 illustrates how transformative change in technologies tends to increase consumer control.

PBR design, as with all regulation, must be thought out in detail to ensure the explicit and implicit incentives are the desired ones. To do this, regulators must understand incentives at work in a particular context. Understanding the ownership of the regulated entity, the financial and management structure, and how it maximizes its revenue and profit, is critical. Transmission-only utilities will have different drivers than distribution-only utilities. State-owned entities will respond to different incentives than will investor-owned, vertically integrated utilities. That said, some utility elements are universal. Utility managers respond to institutional incentives and opportunities for recognition, advancement, and compensation in similar ways, regardless of the ownership structure. This section focuses on how regulators and stakeholders might most effectively set PBR for distinct utility forms, including regions with investor-owned utilities, government-owned utilities, and other contexts.

2.1 The Utility Type

The composition of the utility, by which we mean whether the utility provides generation, transmission, and distribution services as well as natural gas and even water service, or any combination of these, will affect how it responds to incentives. A brief explanation of utility constructs is warranted.

1. Vertically integrated utilities are responsible for generation, transmission, and distribution of power to retail customers. In many cases, they own all or some of the power generation plants and transmission lines, but they may also buy power through contracts from merchant generators.
2. Distribution-only utilities build, operate, and maintain the distribution wires connecting the transmission grid to the final customer. The "wires" and "customer service" functions provided by a distribution utility can be separated (but seldom are) so that two separate entities are used to supply these two types of distribution services.
3. Generation companies are regulated or non-regulated entities (depending on the utility industry structure) that operate and maintain existing generating plants. The generation company may own the generation plants or interact with the short-term power generation market on behalf of plant owners.

4. Transmission companies build, maintain, and either own or operate transmission lines.

Each utility type is also experiencing a wave of technological change and will have different concerns about these changes. Generation companies desire to have their generating plants called on by the system operators, and they do not want their plants to become stranded assets or seldom called on as less-expensive forms of generation (either utility owned or distributed) become available. Transmission companies want to ensure their existing wires are used in the most advantageous way, which may be problematic as many of the best renewable generation sites are not located along major transmission routes. Distribution companies want to sell power to customers, and they are concerned that increasing penetration of

Text Box 1. Transformative Technologies from the Past Increase Customer Control

Recent history is full of other transformative technology changes that were not foreseen by experts. These technologies often were initially opposed by the industry but ultimately led to altered business models and more consumer control and choice–a pattern that is unfolding similarly today in the power sector.

For example, as mass-market VCRs took off in the 1970s, they started to disrupt the television industry's business model. The TV industry initially did not see the potential in having TV content outside their network schedules and opposed the new technologies. Meanwhile, consumers viewed VCRs and VHS cassettes as the means to take control of their television and movie viewing through recording television programs for viewing at another time, and later through movie rentals. As VHS cassette use expanded and then gave way to DVDs in the late 1990s and 2000s, video rental stores prospered, and consumers bought new, lower-cost technologies that improved their home video experience. This increased their options and control of what to watch and when. More recently, those choices have expanded even more with video on demand (VOD) services, including pay-per-view video, video downloads, and streaming media. In early 2016, about half of Americans subscribed to VOD services like Netflix and Amazon Prime in their homes. Meanwhile, analysts say movie theater attendance and TV viewing are declining yearly, especially among younger consumers, whereas viewing media on tablets and smartphones is increasing. Today, customers enjoy a great availability of content across platforms, giving them significantly more power to control how, what, where, and when to view media. Business models of several industries have been born, died, or evolved to accommodate such changing technology and increasing consumer control.

A similar evolution resulted in the move from phone landlines to cell phones to smartphones. In 2007, more than three-quarters of U.S. households had a landline in their home, compared to an estimated 47% in the first half of 2016.[a] Meanwhile, households using only cell phones grew from less than 20% to an estimated 49% during the same period.[b] These changes have had wide-ranging and well-documented impacts on the telecommunications industry, which initially tried to fight the use of mobile phones, saying they were uneconomic and unreliable. As costs declined and reliability improved when the networks were built out, consumers trended away from relying on landlines, preferring the increased control of being able to make calls from almost anywhere. The emergence of smartphones opened up options, opportunities, and control for consumers, who now can make calls, text and email, maintain calendars, watch media, play video games, navigate by GPS, take photos and videos, access the internet, and run apps, all on a single pocket-sized device. The traditional landline utilities, particularly in rural areas, continue to lose ratepayers and revenue as costs increase and the number of ratepayers decreases. The power sector is amid a similar type of transformation.

[a] Pew Research Center. 2010. "Assessing the Cell Phone Challenge." http://www.pewresearch.org/2010/05/20/assessing-the-cell-phone-challenge/

[b] Pew Research Center. 2010. "Assessing the Cell Phone Challenge." http://www.pewresearch.org/2010/05/20/assessing-the-cell-phone-challenge/

distributed energy resources (DERs) and efficient uses of power are decreasing sales volume, and hence revenue. Vertically integrated utilities are facing all these concerns. Addressing these concerns and others is key to implementing an incentive structure that will be fruitful from a utility and power sector owner perspective.

2.2 Utility Ownership Structures

The ownership structure of the utility matters in the PBR context just as much as the utility composition. The ownership structure determines the types of incentives structure that will have traction on the specific utility. Investor-owned utilities (IOUs) are concerned with providing a high and stable rate of return for investors. Publicly owned utilities are more likely to have political or societal objectives, but they also often must pay borrowing costs in the form of bonds, so they may act like IOUs in some regards, because they need to ensure they can pay their bond holders. Ownership structure drivers, either investor- or publicly owned, will also vary depending on their location and on the needs of the particular jurisdiction.

2.2.1 Regions with Investor-Owned Utilities

A subtle evolution is already underway in jurisdictions with investor-owned utilities. This evolution is from a regulatory emphasis on rate-of-return structure to more of an emphasis on direct performance incentive structures. PBR frameworks can look as different and novel as the United Kingdom's Revenue=Incentives+Innovation+Outputs (RIIO) and New York's Reforming the Energy Vision (NY REV) from 20th century power sector regulation. Alternatively, PBR can look like a carefully designed performance incentive mechanism (PIM, or set of PIMs) layered onto a more traditional regulatory approach. Regardless of the exact structure, the pace of technological change is putting energy tools into customers' hands that will require utilities to change how they do business. For that transition to work most effectively for utilities, customers, and other stakeholders, regulators will be considering ways to change how they compensate utilities for doing business in ways they previously have not.

2.2.2 Regions with State, Provincial, or Other Governmental Ownership of Utilities

There are many different forms of governmental ownership and governance from state and provincial ownership governed by relevant agencies or ministries, to city- and municipally owned governed by local governments, boards, or commissioners, utility districts and cooperatives that are private non-profit entities governed by boards of utility customers, and other public and quasi-public entities. The institutional arrangements of these utilities will dictate how to consider appropriate PBRs discussed herein. An additional consideration for government-owned utilities is to assess whether PBR mechanisms will be enforced through internal incentives or through an independent government regulator. The effectiveness of compliance, reporting, transparency, and enforcement mechanisms would be part of that consideration.

2.2.3 Investor-Owned and State-Owned Utility Contexts

The nature of state-owned enterprises in China is quite different from the ownership structures of utilities in the United States and United Kingdom. Yet, the Chinese are adopting a system of revenue regulation transmission and distribution (T&D) reform that in principle parallels some Western regulatory systems. China has adopted an "allowed revenue" component of T&D price reform, and the central government has tasked certain provinces with developing outcome-specific PIMs for the grid companies. The PIMs will operate as overlays on the revenue regulation framework, targeting specific outcomes.[3] Yunnan and Western Inner Mongolia are the first provinces to try this framework. The policy documents in these two provinces explicitly mention demand-side management (DSM) program performance as one of the criteria. This new T&D price reform will coexist with an older method

[3] National Development and Reform Commission. 2016d. Notice on Issuing Provincial Grid T&D Pricing Rule (Trial). (NDRC Pricing Department No. 2711). http://www.ndrc.gov.cn/zcfb/zcfbtz/201701/t20170104_834311.html.

of regulating grid companies (gridcos), which is primarily a system of individual performance reviews for state-owned enterprise managers, based on specific target outcomes for the state-owned enterprise, including profitability and environmental performance.

PIMs appear to be part of the new T&D price reform in China, with some supplement to (or deduction from) revenues to be awarded (or subtracted) when a utility exceeds (or misses) a specific target for every item in the PIM, not only DSM.[4] Depending on local formulation details, the PIMs may differ across provinces. Specific PIMs under discussion focus on capital usage, reliability, service quality, DSM, or other criteria, such as "innovation."[5]

China's new revenue regulation also takes Western approaches to control cost and capital investment in three primary ways:

1. Operation and maintenance expenses are required to be benchmarked with the advanced standard costs and capped at a certain level.
2. Gridcos' capital investments are carefully examined to curb overinvestment, which does not serve load growth or reliability purposes.
3. Gridcos can share savings accrued with customers within the three-year regulatory period, if they operate more efficiently or reduce unnecessary capital investment.

India has recognized the importance of accurately measuring progress on utility financial and energy efficiency with utility-, state-, and national-level measurement schemes. Ujwal DISCOM Assurance Yojana (UDAY) is a PIM that is designed to facilitate financial and operational improvements among Indian distribution companies (DISCOMs). Progress is measured on an individual level against specialized targets for each DISCOM and Indian state, and then at a national level to compare progress of all DISCOMs and states against each other. Initially UDAY states and DISCOMs are to be measured against their own metrics and targets, and progress is monitored on an "improvement barometer" that displays the post-UDAY cumulative progress (on an annual basis) made by the DISCOM on 14 selected parameters. For the first 12 parameters, the performance of the DISCOM is evaluated by comparing the achievement with respect to the targets submitted or memorandum of understanding projections. Calculations for assigning the marks against improvement are done quarterly and are based on data provided by the DISCOM. The quarterly rankings show how each DISCOM/state ranks against each other, thus providing a national dashboard and ranking of the comparative progress of each DISCOM.

Each one of the directional incentives mentioned previously for the UDAY initiative is to be measured accurately, that is, with smart metering to determine the benefits of system improvements such as upgraded transformers, energy efficiency (e.g., LED light bulbs sold and installed), reduced losses, and cost of power. For UDAY, it is also important to track incentives such as interest rates charged to state governments and financial measures, such as the gap between average cost of supply and average revenue recovered. The UDAY initiative has not reduced the incentives to formulas, but tracking of data will allow for evaluation of success of financial support in improvements in provincial utility operations, as well as refinement of the incentive structures, performance criteria, and metrics as UDAY and subsequent initiatives proceed.

Thus, in different contexts on different continents with different ownership structures, there are nonetheless efforts to use PBR mechanisms to pursue similar efficiency, renewable energy, and advanced technology goals.

[4] Ibid.

[5] Capital usage, reliability, and service quality are in the national guidance document. The other criteria, such as DSM and innovation, are adopted in local T&D pricing regulation.

2.3 Institutional Arrangements Allocate Costs and Risk

In most utility structures, revenue growth is a predominant goal. Multi-year rate plans may slow revenue growth compared to regular cost-of-service regulation. For this reason, utilities may oppose PBRs unless the regulation relieves the utility of costs or risks it otherwise would bear. Conversely, if the PBR produces faster-than-expected revenue growth, consumer advocates and groups may oppose it.[6] That tension may be productive if decisions on PBR are made transparently.

Any PBR scheme must account for factors that are significant in scale and beyond the utility's control that might affect metric achievement. For multi-year rate plans, an adjustment called a Z Factor is commonly used to identify factors outside the utilities' control. Advanced PBR target and metric setting can step beyond merely identifying risk within and outside the utility's control to consider who currently bears the risk of non-achievement, who pays for achieving or not achieving the goals, who can most efficiently address the risk (e.g., utility, consumers, or third parties), and how the risk will affect the utility's, customer's, and third parties' decisions.[7]

2.4 Examples of Underperforming Institutional Arrangements

There is evidence that the management of larger utilities receives higher compensation than their peers at smaller utilities.[8] This means that whether in the United States, Europe, China, or elsewhere, a utility executive may desire to both grow the size of their utility and to perform well in order to move to other larger utilities or enterprises rather than perform well for the sake of current customers. In an environment that focuses on revenues and company size, this will reinforce the incentive to invest in large infrastructure projects and to grow revenue, which may or may not provide the most cost-efficient system for producing and delivering electricity. Thus, these outputs are driven by a separate executive compensation institutional incentive. For instance, in China, utilities have a strong PBR inherent in their state-owned structure: performance evaluations for China's state-owned enterprise grid company managers.[9] The managers' performance evaluation focuses on economic criteria such as annual economic value added and net profit. Managers' income and promotion are directly linked to these evaluations, which has the potential to incentivize utility investment decisions that are not cost-optimal for the overall system.

---

[6] The Regulatory Assistance Project. 2000. *Performance-Based Regulation for Distribution Utilities*. Montpelier, VT: The Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-performancebasedregulationfordistributionutilities-2000-12.pdf, p. 36.

[7] The Regulatory Assistance Project. 2000. *Performance-Based Regulation for Distribution Utilities*. Montpelier, VT: The Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-performancebasedregulationfordistributionutilities-2000-12.pdf, p. 38.

[8] Lazar, J. 2011. *Beyond Decoupling, Creating an Effective Power Sector Framework for Clean Energy Objectives: Aligning Utility Business Models with Clean Energy Policies*. Unpublished manuscript. Montpelier, VT: The Regulatory Assistance Project.

[9] For example, see Xia, J. 2015. *Study of Evaluation Methods of SOEs Manager's Performance for Inhibiting Corruption*. http://file.scirp.org/pdf/ME_2015101614064199.pdf.

3 Best Practices for Successful PBR Mechanisms

This section offers best practices for developing and designing successful PBR mechanisms. It focuses on the design process itself and on principles for approaching specific elements of the mechanism. This section is intended to provide guidance to decision-makers as they craft PBR mechanisms for their respective jurisdictions.

- **Key Point 1:** Elements of a successful PBR mechanism set up incentives to take advantage of technological innovation opportunities and accommodate the highly dynamic technology environment of the 21st century.
- **Key Point 2:** The important first steps in creating a PBR mechanism are to identify, articulate, and prioritize goals, then to understand how well or poorly conventional regulation meets those goals in a business-as-usual scenario.

The examples in the previous section of PBR mechanisms that worked (or did not work) are informative of design practices that help ensure a given PBR mechanism is successful. Such design practices include the following, which are discussed in detail in this section:

1. **Set Clear Goals.** If the goal is not clearly set, the metrics, incentives, and outputs will likewise not be clear and could lead to an unsuccessful mechanism.
2. **Identify Clear and Measurable Metrics.** Metrics should be able to be clearly identified, with measurable data that provide objective information.
3. **Establish Transparency at Each Step**. Transparency at each step of the process, including the development of goals, metrics, and incentives, often improves the quality of the final goals.
4. **Make Clear the Value to the Public**. The public values understanding the utility services for which they are paying.
5. **Align Benefits and Rewards.** When rewards and penalties are applied closely in time with utility performance, the relationship of incentive to performance is easier to assess.
6. **Learn from Experience.** Modifying PBRs to address operational observations is a good management practice.
7. **Apply the "Compared to What" Test.** The simple question of "compared to what?" looks for improvement in regulatory mechanisms along a continuous improvement pathway.
8. **Use Simple Designs.** To minimize the risk of gaming, the best bulwark against manipulation is to design a clear and well-defined incentive and metric or metrics.
9. **Employ Evaluation and Verification.** Evaluation and verification of the outputs represent an essential element of a successful PBR program. For information about evaluation and verification design practices, see Section 4.1.2.

3.1 Set Clear Goals

The important first steps in creating a PBR mechanism are to identify, articulate, and prioritize goals, then to understand how well or poorly conventional regulation meets those goals in a business-as-usual scenario. An honest assessment is needed and is not trivial, because it is a self-assessment by the regulator of its process or an independent governmental or third-party review. If reallocation of risk is being considered (often as between ratepayers and utilities), the stakeholders must understand who bears the risk now, how a shift in risk would affect investment and operational decisions, reductions in net risk through providing more certainty, and whether there are cost-management implications to shifting risk.[10] The outcome of this

[10] The Regulatory Assistance Project. 2000. *Performance-Based Regulation for Distribution Utilities.* Montpelier, VT: The Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-performancebasedregulationfordistributionutilities-2000-12.pdf, p. 19.

Text Box 2. Key PBR Terminology

Guiding Goal (or Guiding Incentive)
A high-level PBR goal, referred to here as a guiding goal or guiding incentive, is informed by public policy priorities of the jurisdiction. An example could be a guiding goal to reduce ratepayer energy bills and utility rates through a strategy to limit the need to build a new or expanded transmission, distribution, and generation plant.

Directional Incentives
Directional incentives specify measurable performance criteria. They use measurable goals and metrics. A directional incentive for the guiding goal could be to reduce the overall growth of transmission system peak to less than 0.5% annually. Alternatively, a guiding goal of reducing new or expanded plant would have a directional incentive that is focused on the distribution system to limit the growth of any distribution system circuit peaks to less than 2% annually on any one circuit, and to achieve zero growth overall by deploying energy efficiency, demand response, and distributed resources on a locally targeted basis.

Operational Incentives
Operational incentives relate to the guiding goals and often the directional goals. Operational incentives provide metrics to measure operational considerations when implementing guiding or directional goals. Operational incentives can be positive (e.g., to improve system reliability) or negative (e.g., to limit reductions in reliability). They are also an important check on how regulated entities achieve a specific guiding or directional goal. For example, a guiding goal that calls for reducing new transmission and distribution lines or new generation plant or a directional goal that calls for deployment of distributed resources could impact system reliability if certain operational factors are not monitored. These guiding or directional goals can be paired with a related operational incentive that would require a certain level of system reliability based on historical system reliability metrics.

Measurable Performance Criteria
Expressing incentives with measurable performance criteria is a best practice when feasible. Measurable performance criteria allow for straightforward assessment of whether guiding, directional, or operational incentives are achieved. The assessment of whether goals expressed as incentives are met is referred to variously as evaluation, verification, or compliance assessment—all these processes are meant to measure whether the intended outcome has been achieved and often whether a positive incentive is earned or a negative incentive is applied. Measurable performance criteria can be expressed in standard metrics when practical.

Metrics
A metric is a quantifiable measure of any incentive. A metric can be measured in standard power system measures or consumer impact measures. For example, reductions in system peak can be measured as a capacity reduction, such as megawatts, or as a percentage reduction from an already known prior peak, or as declining consumer energy bills. Metrics are often expressed in terms of energy capacity (megawatts) or energy generated or delivered (megawatt-hours or kilowatt-hours). A system reliability metric can be expressed as a measure of system interruption frequency or duration; a system average interruption frequency index and a system average interruption duration index are common reliability metrics.

Outputs and Outcomes
Outputs are specific results of utility actions, often measured as a measurable performance criteria or metric. Outcomes are how utility services affect ratepayers and society, and they are generally the desired results from a specific guiding goal, directional incentive, and/or operational incentive. The following examples illustrate these concepts:

- The output is a certain system average interruption frequency index result, and the outcome is reliable service.
- The output is x percent of calls to the call center answered in less than 20 seconds. The outcome is responsive customer service.
- The output is disconnections at less than x per month. The outcome is universal service.
- The output is interconnection of photovoltaic averaging x dollars in user costs accomplished on average in under y days. The outcome is motivating customer generation.

process could be that guiding principles support renewable development or could support DER adoption. The goals may also focus on cost-cutting or risk shifting.

One helpful way for considering PBR goals is as a set of guiding goals (or guiding incentives) informed by public policy priorities. These guiding goals are honed by more specific directional incentives that specify measurable performance criteria. The directional incentives are sometimes accompanied by a coordinated set of operational goals that also specify measurable performance criteria. Thus, goals can be guiding incentives with more targeted directional incentives using measurable goals/metrics, and/or operational incentives related to guiding goals. Although different jurisdictions use different terminology, we use consistent methodology, recognizing that in actual practice, variations on these terms will be encountered. Key PBR terminology we use in this report is listed in Text Box 2.

Guiding incentives set high-level goals that may or may not contain specific measurable performance criteria. A guiding incentive can also be a desired outcome, such as appropriately balancing benefits and costs, achieving least-cost service in the long run, realizing fairness, attaining equity, minimizing environmental impact, boosting energy independence, achieving economic development, or any combination of these. At the guiding incentive level, recognizing the importance of clear goal setting is critical.

Operational incentives to achieve operational goals can include reliability, customer service, and low-income customer protection. There is substantial experience implementing these traditional operational incentives to govern reliability and customer service. PBRs to encourage operational efficiency and low-income customer protection are both more innovative and more subject to trial and error. All PBRs should be designed with sufficient testing of baseline levels of performance and consideration of the costs and benefits of achieving desired outcomes. They should then be monitored during implementation with attention to whether the PBR is producing the intended results. For example, the NY REV process details each earnings adjustment mechanism (EAM) on a utility-specific basis, recognizing that the starting baseline, costs, and benefits of desired outcomes may vary across utility service territories and customer bases. And, for example, the low-income customer protections associated with NY REV are considered for each utility in light of that utility's prior low-income program success and failure, which vary from utility to utility.

It is also important to note that the PBR goals should be long-term. They should address what the regulator, utility, and stakeholders want the energy generation and delivery systems to provide to consumers in five, ten, and 20 years. Clear goals that are long-term in nature spanning a 15- to 20-year horizon or greater can provide the overarching guiding principles for a PBR framework. Text Box 3 describes the importance of long-term goals.

Text Box 3. Long-Term Goals and Costs are Important

The length of a goal is important, because the length of the term can affect how costs are evaluated. In the short run, many utility plant costs are fixed, but in the long run, almost all costs are variable. Looking out 15, 20, or more years, capital investments become variable costs and can be assessed as variable costs from a marginal cost perspective. This means that over the long run, capital investments increasingly become choices for system planners and regulators. The system may benefit from grid investments or may benefit more from other actions that may avoid capital, such as paying customers for distributed resources like energy efficiency, demand response, customer-sited generation, or storage instead of a new power line, or paying a cloud computing company for a subscription service instead of a utility-owned information technology system. This shows that in the long run, almost all costs, including capital costs are avoidable. The opportunities to use substitutes for capital are growing with technology and increasing ways to use customers as grid resources.

3.2 Identify Clear and Measurable Metrics

A metric is a quantitative measure that is useful in assessing utility progress toward a desired goal or target. A metric is best if it is objective and under the utility's control.[11] Whereas directional incentives provide measurable performance criteria to evaluate whether the guiding incentives are being met, metrics are the medium through which measurable performance criteria are applied. Utility performance metrics can be thought of as a set of specific quantifiable outputs of work that represent aspects of utility service that are critical to successful outcomes. Each metric should have a specific measurable performance criterion against which results can be measured. Individual accomplishments related to each metric are scored relative to a reward scale to determine an incentive level. Metrics can then be used individually or in combination to create a basis for an incentive reward.

Metrics work well if they can use a standard definition, or, lacking that, are precisely defined. Having relevant data to evaluate how close the utility is to achieving its goals is critical to determining the effectiveness of the directional or operational incentive. The availability of information applicable to the goals and metrics is necessary for awarding incentives or assessing penalties. Some basic considerations in setting metrics are:

1. Reliable data are a prerequisite to measuring utility performance. Data should be evident on their face and not subject to multiple interpretations. Ideally, data are available or can be made available so that results measured by metrics are more objective than subjective.

Public Metrics Only	• Metrics are publicized on a publicly available "dashboard" • *Examples:* HI Renewable Energy Performance Metrics, HI Solar DG distribution, Puerto Rico Customer Satisfaction, Illinois Response Times report metric
Public Metrics with Ranking	• Metrics are publicized and ranked • *Examples:* Denmark DSO efficiency ranking, RIIO
Public Metrics with Financial Incentives	• Metrics are publicly available and utilities receive financial awards or penalties depending on achievement of the metrics • *Examples:* NY REV

Figure 1. Metrics continuum

[11] Widespread use of performance systems in institutions and settings as disparate as employment and foreign aid programs shows that the entity subject to the performance evaluation should have control over the factors influencing their performance.

2. If data are unavailable, consider how and who will develop them and who will verify the data under the metrics adopted.
3. Avoid the need for precision where precision adds little value, particularly compared to the cost of obtaining such precision.

Reporting obligations for performance criteria and metrics themselves can be a weak form of PBR. Establishing a reporting obligation communicates the importance of those performance criteria and metrics. The requirement that utilities track, analyze, and report specific information can encourage different utility behavior, be precedent to establishing incentives, and provide transparency that may allow other stakeholders to address utility performance through various regulatory, public, or policy avenues. Figure 1 illustrates the continuum of metrics for PBR, ranging from reporting metrics that are publicly available to public reporting of metrics with financial awards or penalties based on performance.

3.3 Establish Transparency at Each Step

Transparency can mean an open regulatory process or collaborative approaches among stakeholders, utilities, regulators, and other customers. For utilities, transparency has not always been understood as a regulatory necessity. On the other hand, stability at achieving traditional regulatory objectives is a critical utility business attribute. Most utilities are good at compliance with regulatory objectives and prefer to achieve compliance without much attention from the regulator. Compliance can be defined as performance that raises no issues when it is examined in a rate case or other commission investigation. Service meets expectations and cannot be characterized by regulators as either insufficient or more costly than necessary. Utility aversion to regulatory attention comes from a long history of utilities getting noticed when something undesirable occurs, such as an outage or major weather event. Adjusting to high transparency in operations and performance may require cultural adaptation at some utilities. In a related but different issue, utilities may resist publicly committing to a specific outcome. A utility may feel it can meet said outcome but be reluctant to commit to it for fear of perceived failure by regulators or even the public. That said, increased utility transparency and commitments to outcomes are both required by PBR and, more broadly speaking, expected as part of the 21st century utility environment, with more stakeholders involved in offering coordinated and/or competing products with consumers who are interested in good outcomes for themselves.

Transparency is essential at each step of the process of establishing a PBR, including the development of goals, metrics and incentives, and it often improves the quality of the final goals. Stakeholders, utilities, and the public may have more refined targets and experience than regulators. And transparency can lead to utility, stakeholder, customer, and public buy-in, enhancing the credibility of targets and reducing the risk for (oftentimes very public) disagreements when rewards or penalties are applied. Transparency is important in the following ways.

Broad stakeholder involvement is critical. Transparency is important for the stakeholder process (1) for ensuring broad stakeholder groups are involved and (2) because including broad viewpoints and incorporating them into the process makes consensus more likely. Regulators have process options for receiving stakeholder views and information—through informal workshops and technical conferences, regulatory dockets with comments, and/or adjudicative proceedings. Irrespective of the process chosen, stakeholder involvement in developing goals, incentives, and metrics is essential, especially because what is at stake is changing *how* regulation is accomplished. Transparency also may provide the benefit of attracting broad stakeholder involvement from companies, investors, and market participants, particularly when they can understand the value proposition. It can also assist with demonstrating to financiers and others how companies will create profits as market participants.

Stakeholder involvement can lead to consensus. Stakeholder involvement can be critical to achieving consensus. By having stakeholders work together to (1) develop a list of goals, incentives, performance measures, and metrics for utility performance improvement and (2)

Text Box 4. Transparency in the U.K.'s RIIO Framework

U.K. regulators saw value in engaging consumers more directly in the design of RIIO than they did in prior efforts,[a] as they concluded that getting a better understanding of consumers' perspectives was important to designing regulatory processes and policies that were aligned with consumers' preferences. The value of engaging consumers included improving the legitimacy of ratemaking and the performance evaluation processes:

- Ensuring the desired outcomes set forth by Ofgem were aligned with the needs of consumers.
- Assisting Ofgem with meeting emerging challenges in the power system, particularly around the transition to a sustainable energy system.

There are many ways that RIIO's PBR mechanisms encourage engagement with consumers and stakeholders.

For transmission:

- There is a stakeholder engagement incentive with a percentage of revenues available for companies based on how well they engage with their stakeholders.
- Metrics for assessing the credibility of the engagement include the:
  - Range of stakeholders whose views had been sought.
  - Information provided to stakeholders and the form the engagement took.
  - Impact of engagement (i.e., how network companies used the views expressed through engagement).

Each company receives a marking that can translate into an additional revenue allowance.

For distribution:

- Same stakeholder engagement scheme for transmission applies.
- Includes direct measurement of customer satisfaction for customers who have some direct dealing with the network company; this is judged through a survey in which Ofgem prescribes the methodology but which is conducted by the companies.

On reviewing this process in 2016, Ofgem found:

- Ranking has led companies to innovate and improve on how they engage beyond simply having a stakeholder panel.
- A broad focus on stakeholder engagement is needed rather than a narrow view of only consumer engagement, recognizing that this helps with considering a future consumer perspective in part through understanding future technology trends.
- The Consumer Challenge Group[b] should be maintained, but transparency regarding the selection of consumer experts needs to be increased.
- The Price Control Review Forum (in which wider stakeholders and the industry meet to debate key issues) should also continue, but with a clearer articulation of its role as engaging a wider group of stakeholders and hence with a focus on building mutual understanding across different groups and information sharing. The process was found to be useful, but the breadth of issues covered by the forum did not allow sufficiently detailed discussions, given the group met only five times.
- Information on RIIO was often not presented in an accessible way, preventing stakeholders and consumers from providing responses.

[a] Ofgem. 2010. *Regulating Energy Networks for the Future: RPI-X@20 Decision Document.* https://www.ofgem.gov.uk/publications-and-updates/regulating-energy-networks-future-rpi-x20-decision-document.

[b] Frerk, M. 2016. *Consumer Engagement in the RIIO Price Control Process: Review.* https://www.ofgem.gov.uk/system/files/docs/2017/01/consumer_engagement_in_the_riio_process_final_0.pdf.

consider how the utility will be rewarded and/or penalized as a result, the stakeholders may set the stage for more consensus building. Working together builds the relationship and opens dialogue among the parties, even when there are substantive disagreements. To the extent that consensus is reached, it reduces the risk for denial of requests for cost recovery. Utilities can have costs denied either in a request to increase rates or in finding that a particular cost or investment was imprudent. Energy efficiency collaboratives are an example of successful stakeholder engagements that many state utility commissions have used to resolve complex issues that emerge during a rate proceeding. Rather than debate the issues through the formality of a commission proceeding, disagreeing parties are sent to discuss issues in a less formal setting and bring back resolutions to the commission. Collaboratives for energy efficiency are being successfully used in more than half the states in the United States.[12]

It reveals the value of the PBR construct. A transparent process with broad participation provides a mechanism for regulators, stakeholders, and the utility to understand the value proposition offered by a PBR construct. For example, shared information and discussion can produce a comfort level regarding retail rate design and compensation levels. Consumers can participate in the development of metrics important to them. Utilities and investors may identify opportunities to increase earnings without shouldering the risks of traditional, large construction projects. Utility participation in stakeholder processes also affords utilities a sharper understanding of what is important to other stakeholders, and how achieving the goals of PBR constructs could improve their bottom line.

Text Box 4 illustrates the importance of transparency in the U.K.'s RIIO framework.

It is also important to note that transparency looks different in different contexts. The New York Clean Energy Advisory Council is developing the energy efficiency EAM in a collaborative stakeholder process on a utility-specific basis to allow participation by both utility-specific and broader public stakeholders. This is focused utility-specific transparency. Under China's new T&D pricing reform, the Chinese National Development and Reform Commission (NDRC) asked local governments to seek opinions from stakeholders, and it shares information with the central government and the public. This is seeking input from local officials in a context of perhaps less-direct customer engagement. Both forms of outreach can produce positive engagement with stakeholders and thus reflect the context of each jurisdiction. Consumer satisfaction can also be enhanced via measures intended to communicate directly with utility customers. Under RIIO, customer satisfaction has increased significantly, which seems to be a result of the published rankings as explored in Text Box 4.

3.4 Make Clear the Value to the Public

The public values understanding what utility services they are purchasing. A guiding goal with directional and operational incentives and performance criteria represents a transparent commitment from the utility to its customers and the public with an opportunity for reward. PBR can offer a clear "value for money" transaction to the utility, customers, and the public. Exceptional or beyond-compliance utility performance creates tangible value for specific customers or the public. A clear set of goals, performance criteria, and metrics that the public and stakeholders can understand is a benefit for them. And, they can be useful in a transition to a new regulatory model based on performance rather than rates.

It is also important that the value to the public be assessed appropriately to ensure clear value. Many regulators now design and implement more objective and verifiable customer satisfaction surveys. Regulators in

[12] Li, M., and Bryson, J. 2015. *Energy Efficiency Collaboratives.* State and Local Energy Efficiency Action Network. https://www4.eere.energy.gov/seeaction/system/files/documents/EECollaboratives-0925final.pdf.

Massachusetts, for example, found that surveys with very specific questions and yes-or-no answers allow for more objective measures of customer satisfaction. This is significant, because poor performance on customer satisfaction can lead to substantial penalties.[13]

3.5 Align Benefits and Rewards

Aligning customer receipt of benefits through timely payment of rewards and incentives (or imposition of penalties, if negative impacts occur) is advisable to the extent practicable and feasible. When rewards and penalties are applied closely in time with utility performance, the relationship of incentive to performance is easier to assess. A close linkage can reduce the probability that regulators over- or under-reward utilities for performance in the eyes of customers. For instance, if consumers have a season of poor service quality, reduced utility revenue or penalties is more easily understood and assessed by customers, the public, and the utility itself, if done close to that season and with direct reference to seasonal service quality.

3.6 Learn from Experience

Learning from experience and modifying PBRs to address operational observations is a good management practice. The New York Public Service Commission (NY-PSC) observed in eliminating the penalty provisions of its energy efficiency incentives that the penalties resulted in an increased utility aversion to risk and created an adversarial dynamic between the NY-PSC and the utility. The NY-PSC also observed a drain on staff and utility resources to address these issues that would have been better spent administering the efficiency program.[14]

Because some outcomes are driven by influences partially outside utility control, utilities may be reluctant to accept a pure outcome target or metric. One method to address this is to consider a rolling multi-year average rather than a pure annual target or annual metric. Over time, the range of utility performance becomes evident as do trends in a rolling average. As an example, the U.K. regulator Ofgem, under the RIIO framework, implemented a rolling average target for reliability purposes. Specifically, an unplanned outage target is set based on either the minimum of a utility's 2014-2015 outage target or the utility's own four-year moving average.[15] This is an example of an approach that regulators might use to implement targets or metrics in which utility performance may be subject to appreciable uncertainty.

3.7 Apply the "Compared to What" Test

It is also helpful in setting PBRs to apply the "compared to what?" test. PBR discussions can get mired in efforts to reach the perfect set of incentives (in a very imperfect world). It is easy to focus on areas that are not especially important and to lose recognition of how a proposal compares to the existing utility system.[16] This question is helpful in designing programs and examining program improvements. It is a simple question that looks for improvement in regulatory mechanisms along a continuous improvement pathway.

[13] Lowry, M., Woolf, T., and Schwartz, L. 2016. *Performance-Based Regulation in a High Distributed Energy Resources Future*. Lawrence Berkeley National Laboratory, Rep. No. 3. https://emp.lbl.gov/publications/performance-based-regulation-high, p. 30.

[14] Whited, M., Woolf, T., and Napoleon, A. 2015. *Utility Performance Mechanisms: A Handbook for Regulators*. Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, p. 55.

[15] Ofgem. 2012. *Reliability and Safety Working Group: Quality of Service*. https://www.ofgem.gov.uk/sites/default/files/docs/2012/07/rswg_17_may_slides_qos_0.pdf.

[16] The Regulatory Assistance Project. 2000. *Performance-Based Regulation for Distribution Utilities*. Montpelier, VT: The Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-performancebasedregulationfordistributionutilities-2000-12.pdf, p. 4.

3.8 Use Simple Designs

The best bulwark against risk for gaming is to design a clear and well-defined metric. If the metric, as well as the corresponding data required to evaluate it, are difficult to measure, manipulation can be more difficult to detect. This is especially the case if data are collected and analyzed by the utility, because conducting regulatory or third-party verification of the data accuracy and analysis is potentially expensive and difficult. Data collection and analysis that is difficult to audit or review should be avoided. Furthermore, third-party experts can be used to collect, analyze, and verify data when practical.

Although simple incentive designs are good and clarity for the public is important, designing proper goals, incentives, performance criteria, and metrics is not necessarily simple. Indeed, having smart and well-financed regulatory staff is critical for sophisticated PBR design and implementation. The best PBR designs are simple and clear but require substantial expertise, effort, and regulatory competence to achieve and implement successfully.

4 Design Elements and Options for Establishing and Implementing Successful PBRs

This section provides design options for establishing and implementing successful PBRs. It is intended to provide decision-makers with specific design elements within the PBR mechanism.

- **Key Point 1:** There is no "cookbook" for PBR approaches that can be taken off a shelf and implemented.
- **Key Point 2:** Although numerous successful PBRs exist to learn from, PBR approaches are continually evolving, and adapting a portfolio of PBRs (and PIMs) is necessarily specific to the context and goals in the jurisdiction.

4.1 Design Elements

Each PBR construct will be unique, as it should be crafted to reflect the specific policy goals of the jurisdiction in which it is implemented. For this reason, there is no "generic" PBR construct that can be implemented from a "cookbook" of successful PBR programs. However, there are some general design considerations for specific PBR elements *if* the element is necessary in a specific PBR. To reiterate, not all the following elements will be in each PBR construct, but if they are considered, consider the following.

4.1.1 How Performance Levels Are Set

The methods for determining and evaluating reasonable expected utility performance levels vary on a scale that one might call the "public's ability to understand what they are paying for." Value should be demonstrable to the public. The public aspect of ensuring ratepayers and stakeholders understand the value of utility performance to the goals set is critical.

From the regulator's point of view, getting the foundation of PBR set properly is critical. PBR schemes do not start from scratch—they are tied to a foundation. Incentives and penalties are set on top of a baseline. To get the baseline level right, regulators may need to model out and set prices for utilities functioning properly under a cost-of-service rate structure. PBR does not avoid the need to properly set base rates, and it can add to the regulatory burden. Regulators must first create a baseline, which may be cost-of-service regulation, and then design the incentives around the baseline.

A utility's performance baseline can be determined from historical data if data were and are collected and maintained. A second method is to use peer utility performance data to determine either a baseline or a performance target. To identify a relevant group of peer utilities, a process known in the regulatory world as "indexing," statistical and econometric methods are often used. Both methods rely on objective data sets (where available) and methods that are easy for the public to grasp.[17]

Some methods to establish performance baselines and targets are less easy to grasp in both concept and application, because they rely on statistical and engineering methods.[18] A third method is a form of data envelopment analysis (DEA) called frontier analysis. Frontier analysis measures the efficiency of a sample of utilities, in terms of their inputs and outputs, to identify the most efficient utility operations. There is substantial complexity in the

[17] Whited, M., Woolf, T., and Napoleon, A. 2015. *Utility Performance Mechanisms: A Handbook for Regulators.* Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, pp. 36-37.

[18] Statistical methods commonly are used for cost benchmarking for unit costs or productivity indexes and for econometric methods in rate designs. They are less commonly used to derive performance targets beyond traditional industry performance benchmarking. These two methods are state-of-the-art methods for PBR target setting.

statistical methods to exclude factors outside the utilities' control, as well as lack of internal validation, misspecification, and statistical "goodness of fit," all of which contribute to making this method more difficult for the average customer and even sophisticated customers to follow. The difficulty presented by methods like DEA and other complex models is that discussion over the model inputs, method, computations, and model results can distract regulators, stakeholders, and the utility from a focus on achieving utility outputs and outcomes desired by ratepayers and stakeholders. Nonetheless, despite these concerns, DEA analysis has been used in Austria, Australia, Germany, the Netherlands, and Norway to benchmark and determine retail tariff levels and utility revenue requirements.[19]

A fourth method is to use utility-specific studies that rely on economic and engineering methods to set baselines or targets. Production cost simulations can model efficient power system dispatch. These models can be used to derive benchmarks for utility performance. California did just this to set generation dispatch performance incentives in the 1990s.[20] These latter two methods (DEA and production cost simulation) suffer from a lack of understandability for all but the most sophisticated utility and statistical experts. Moreover, the last two methods, DEA analysis and utility-specific studies, require detailed and sophisticated analysis that can lead to manipulation of a model or analysis to achieve tilted results, with little means available to compare those results unless historical data or peer benchmarking is used as well.

4.1.2 Evaluation, Measurement, and Verification

Evaluation and verification of the outputs achieved are essential to ensure ratepayers and the public receive the value anticipated in a PBR reward scheme. That said, evaluation of compliance and verification of benefits is a topic unto itself, and it is outside the scope of this report. It is easier when metrics are clear and data are available and independently verifiable.

Beyond these general considerations such as establishing a proper baseline and having an evaluation, measurement, and verification plan, there are specific PBR design considerations, which are explored below.

4.2 Design Options

Depending on the objective and needs of each jurisdiction, there are a variety of PBR and PIM design options. This section focuses on PBR mechanisms with a proven record.

4.2.1 No Explicit Incentive

"No explicit incentive" represents a default scenario. However, it does not mean the system in place does not incentivize specific utility behavior. As mentioned earlier, all regulation is incentive regulation, and regulated entities will respond to the inherent incentives that are built into traditional regulation. A desire for no incentives is a position often held by consumer advocates and industrial groups that want the absolute minimal rates, desire minimal ratepayer risk, and believe it is the utility's obligation to operate its business as efficiently as possible without any additional remunerations from ratepayers.

There is a variant of no explicit incentives: jurisdictions that rely only on penalty authority. This might extend to regulators who believe that any desired utility output or behavior can be ordered by the regulatory authority. The implicit incentive in a "penalty-only" jurisdiction is to avoid actions that would run afoul of the regulator's view of utility behaviors, outputs, or outcomes worthy of a penalty, which include experiencing a serious reliability failure or simply not following regulator orders. Assessing what incentives exist, even in jurisdictions with no explicit incentive structure, is important.

[19] Whited, M., Woolf, T., and Napoleon, *A. Utility Performance Mechanisms: A Handbook for Regulators.* Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, p. 37.

[20] Whited, M., Woolf, T., and Napoleon, A. 2015. *Utility Performance Mechanisms: A Handbook for Regulators.* Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, p. 37 and Footnote 17.

4.2.2 Shared Net Benefits

Under shared net benefit incentives, the utility would share along with ratepayers in the benefits associated with, and identified from, the metric achieved. This can mean sharing in financial benefits between the utility and ratepayers. In the context of energy efficiency programs, a "shared savings" approach is often used in the United States to recognize and share the energy efficiency savings between ratepayers and the utility.

A shared net benefits approach needs to be carefully thought out and implemented to clearly identify the shared benefits, ensure the utility appropriately controls costs, and ensure the mechanism cannot be gamed. Implementation of shared savings schemes can be difficult because the focus on evaluation, measurement, and verification, which is the concept of shared net benefit's inherent imprecision, and translation to dollars can negatively impact a utility–regulatory relationship. This approach relies on accurate benefit calculations through evaluation and measurement, and a clear evaluation, measurement, and verification plan based on objective metrics is the best remedy for this issue.

Shared net benefit mechanisms can blunt the incentive for utilities to control costs, which is otherwise a prime motivation for implementing PBR constructs. To ensure cost control incentives are maintained in a PBR scheme with a shared net benefit construct, the mechanism can be designed to apply only to benefits outside a band where earnings are not affected. A "deadband" approach adopts a range around a performance level that results in no modification or incentive until the range is exceeded.[21]

Shared net benefit regimes also need to be carefully designed to avoid the possibility of gaming. For example, in the context of a shared savings mechanism for cost of natural gas, a large U.S. utility was ordered to refund $72 million to ratepayers when it manipulated its gas storage to release gas it had purchased previously at a lower cost. In this case, the gas in storage had a year-vintage, so the utility chose to release gas from a very low-price year to artificially produce a "cost savings" under a shared savings PBR.[22] And, in this case, the ability of the utility to control purchase and sale times with no relevant performance guideline left the system open to manipulation.

4.2.3 Program Cost Adders and Target Bonuses

Program cost adders provide a payment to the utility for costs of a particular program. Target bonuses provide a payment for hitting a specified performance metric. Program cost adders and target bonuses can be used when a program has a direct utility cost. The program cost adder can be a simple percentage paid to the utility based on program cost. This type of program cost bonus is often a share of a specific program, and administrative costs are tied to achieving a target or goal. Of significance, it is tied to expenditures and not savings. For this reason, there may not be disincentive for the utility to control program costs.

Target bonuses are, simply put, a one-time financial incentive for achieving a specific performance criteria or metric. This approach has been criticized for being discontinuous (i.e., minus one unit of performance gets nothing, the next unit hits the bonus jackpot). When regulators want to drive a quantum leap in performance, and when more than that specific amount is not useful, this bonus approach is simple and works.

[21] For example, no sharing of savings from energy efficiency may be appropriate within a band of energy efficiency savings of 0.00 to 0.02% of sales, which are expected to be produced through market forces, such as enhanced appliance efficiency standards. So, as designed, a sharing mechanism with a "deadband" operates as a reward for only exemplary performance for marked increases (or decreases) in performance. For more information on shared net benefit mechanisms and deadbands, see The Regulatory Assistance Project. 2000. *Performance-Based Regulation for Distribution Utilities*. Montpelier, VT: The Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-performancebasedregulationfordistributionutilities-2000-12.pdf, p. 4.

[22] Whited, M., Woolf, T., and Napoleon, A. 2015. *Utility Performance Mechanisms: A Handbook for Regulators*. Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, p. 94.

4.2.4 Base Return on Equity + Performance Incentive Payments to Reach Maximum ROE Cap

Under a base ROE PBR, the utility earns a base ROE, and that return then increases (or goes down) based on a performance incentive structure that rewards (or penalizes) performance with modifications to the ROE. The utility can increase its ROE through performance incentive adders up to a maximum PBR payment or set of payments. And poor performance can potentially decrease the ROE as well. The regulator assigns a value range for a series of metrics, for which the utility would receive a return if it satisfies the metrics assigned. The incentives can also scale higher or lower if certain values are achieved with the specified range. The adder value may vary from metric to metric based on the value assigned by the regulator. A more complex option is to provide a range that provides a level of incentives for satisfying the target and a higher incentive for exceeding it. In establishing this type of PBR mechanism, a regulator may ask the following:

- At what level should the base ROE be set in the event the utility does not meet any of the targets? Should this amount be its approved ROE from its last rate case or some amount lower or higher?
- What level of maximum allowable ROE incentivizes good behavior without causing the utility to over-earn at the expense of ratepayers?
- What metrics should be subject to an incentive adder?
- For the metrics chosen, what value range should be assigned to each?
- How much reward should be given for each metric so that the sum-total of all the metrics equals the maximum cap with the base ROE?

For example, the NY-PSC in the REV process has allocated 100 basis points of return broadly across all EAMs. Each utility then has EAMs set in the context of a rate case in which those points will be allocated among those mechanisms.

Text Box 5 illustrates the importance of properly designing bonus ROE programs.

4.2.5 Bonus ROE for Capital for Projects or Programs

A bonus ROE for capital invested in a project or program provides additional ROE for capital rather than program costs. This is more consistent with traditional rate base

Text Box 5. Poorly Designed Bonus ROE Example

An example of a poorly designed bonus ROE plan is the U.S. Federal Energy Regulatory Commission's (FERC's) incentive-based rate treatment of transmission investments. To broadly improve transmission reliability and reduce congestion, FERC's Order No. 679 awards the transmission utility a higher rate of ROE for new transmission investment. There is no requirement to quantify the benefits of a given investment in relationship to overall costs, and by applying the ROE adder to the project's actual (not budgeted) costs, utilities and transmission developers have a perverse incentive to increase project costs. This incentive is estimated to have cost ratepayers in the six New England states alone hundreds of millions of dollars in added charges, which increased the costs of delivered energy. Much if not all of those transmission projects would likely have gone forward without any incentive scheme, so the incentive merely increased costs to ratepayers.

Whited, M., Woolf, T., and Napoleon, A. 2015. Utility Performance Mechanisms: A Handbook for Regulators. Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, p. 94.

principles of allowed ROE only for capital investments in utility plant but tends to favor heavy capital investments. This approach has been used for energy efficiency, and it could certainly be used for other types of projects. When used, it tends to encourage capital-intensive efficiency investments, and it has been disfavored for that reason. An additional downside is this mechanism rewards capital spending (an input) rather than outcomes. To avoid a pure spending/input flaw, a bonus ROE for capital could be awarded only if triggered by exceptional output performance.

4.2.6 Base Incentives on kWh Reduction Targets

A base incentive for meeting kWh reduction targets would enhance ROE for meeting reduced load target metrics. A reduced load in absolute terms or a reduced load growth could be a PBR directional incentive. Reduced load can occur through deployment of varied distributed resources, including efficiency and distributed generation. If properly designed, this form of PBR could recognize and reward utilities for investments and system modifications that reward efficiency and distributed resources. If improperly designed, it could provide a payment for reductions that new technologies and consumer investments will produce anyway. Furthermore, this directional incentive alone may still also allow over-investment in utility plants if not joined with other PBR mechanisms to address the Averch-Johnson effect.[23] For example, even if load growth is reduced to zero, utilities still may pursue reliability-oriented projects to continue to invest in rate base.

4.2.7 Peak Reduction Targets

On a system in which growth in peak demand is driving generation, transmission, or distribution investments, system-wide savings are potentially available from efforts to reduce system peaks. This can be true on a system-wide basis and may be true for individual grid zones or even distribution circuits. Where investments that reduce peak demand can defer or avoid altogether the need for new and more expensive investments, overall system costs can be reduced. PBR mechanisms can be designed to incentivize utilities to pursue these types of cost-saving investments.

New York's Brooklyn-Queens Demand Management program is an example of a PBR arrangement that reduces system peak. This program was implemented by Consolidated Edison (Con Edison) with encouragement and ultimately approval of the NY-PSC to avoid the need for an expensive new substation and other load-related items totaling over $1 billion, for a less expensive set of DER solutions and a smaller set of traditional grid upgrades. Con Edison was allowed a regulated rate of return on its DER investments and an additional 100 basis points if specific objectives were met. The guiding goals were to achieve "DER animation" and "lower costs to customers" with the 100-basis-point incentive tied to specific metrics: 45 basis points for achieving 41 megawatts (MW) or more of alternative measures, 25 basis points for increasing diversity of DERs in the market place (more contracts with a greater number of small DER providers), and 30 basis points for assembling a portfolio of solutions that achieves a lower $/MW value than the traditional investment solution. For this last metric, such $/MW value was based on the present value of the lifecycle benefits and costs of the portfolio and the traditional investment. For example, if the portfolio includes measures that result in reduced energy usage or increased renewable energy generation, those benefits can be included in the lifecycle analysis, thereby reducing the resulting $/MW metric.[24] In this way, the NY-PSC and Con Edison used a complex PBR construction using both ROE on DER investments and additional basis points to achieve 41 MW or more of peak load reduction to avoid a more expensive set of traditional grid investments.

[23] The Averch-Johnson effect is identified by economists as the tendency of regulated companies to engage in excess capital investments to increase their profits.

[24] NY-PSC. 2014 (December 12). Order Establishing Brooklyn-Queens Demand Management program. Case 14-E-0302, pp. 21-22.

Arizona and California[25] are considering a different version of a peak reduction strategy to encourage development of clean resources through a "clean peak demand standard" implemented through a renewable portfolio standard.[26] This proposal would both increase the renewable energy (renewable portfolio) requirement *and* add a requirement that new resources be available to meet the net system peak. The net system peak is the time when electricity demand, less wind and solar generation, is highest, and it is increasingly moving later in the day when the sun sets, owing to increased solar generation on the system.[27]

4.2.8 Every Employee with a PBR Goal, Target, and Metric?

Historically, PBR mechanisms have acted on the utility and not on individuals at a utility. However, PBR can be applied to individuals as well, as examples from China illustrate. The concept is that every utility employee has at least one metric in the PBR system that applies to their work and that can be used to evaluate eligibility for performance-based compensation. Achievement of goals and metrics can raise the visibility of program managers and units within a utility. Enhanced visibility of relevant business units for each goal within the utility can create positive incentives with respect to performance in accordance with the goals and targets. This suggestion is in some regards unsurprising, as many utilities use incentive bonuses for managers and sometimes for employees too, including stock options and stock price options. If utility performance influences the stock price, executives or employees benefit and often help meet those performance goals.

For state-owned utilities, these enterprise-wide incentives are typically in the form of employee reviews and promotion opportunities, including opportunities at other state-owned enterprises. Applying PBR on the individual level is being pursued in China. The Chinese grid company evaluation criteria were modified in 2016 when the State-Owned Assets Supervision and Administration Commission of the State Council decided to include "social benefit" criteria in the evaluations of state-owned entity grid companies. These will reflect activities that "serve social objectives" or are "essential to national security and economic operation." Although details have yet to be decided, these criteria may include outcomes such as improvements to reliability in underserved and rural areas, "green technology development," and support for philanthropic efforts. How this change will affect grid company behavior is yet to be fully evaluated. China's grid utility revenues were traditionally derived from the difference between administratively set—and rarely revised—retail and wholesale prices. Transmission and distribution reform is currently evaluating Chinese grid company revenue.[28] Therefore, it is reasonable to say that the overall set of incentives faced by grid company executives is undergoing a significant shift.

[25] California Assembly. Bill 1405. 2017–2018 Regular Session. An Act to Amend Sections 454.52 and 9621 of the Public Utilities Code, Relating to Electricity. http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1405; and California Senate. Bill 388. 2017–2018 Regular Session. An Act to Amend Sections 454.52 and 9621 of the Public Utilities Code, Relating to Electricity. http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB338.

[26] Trabish, H. 2016 (December 9). "Arizona Proposal Seeks to Mandate Renewable Generation During Peak Demand Hours." *Utility Dive*. http://www.utilitydive.com/news/updated-arizona-proposal-seeks-to-mandate-renewable-generation-during-peak/432031/.

[27] Huber, L. 2016 (December 1). *Evolving the RPS: A Clean Peak Standard for a Smarter Renewable Future*. Berkeley, CA: Strategen Consulting. https://static1.squarespace.com/static/571a88e12fe1312111f1f6e6/t/58405ac4d2b85768c5e47686/1480612551649/Evolving+the+RPS+Whitepaper.pdf.

[28] China's power sector reform effort, launched in March 2015 with the issuance of "Document #9," includes a new approach to gridco regulation called "transmission and distribution (T&D) pricing reform" that, in principle, is similar to revenue regulation. Under the new approach, grid company revenue will be subject to revenue regulation, based on the basic concept that allowed revenue equals "approved costs" plus reasonable return on asset base. The revenue of the grid companies will be approved for three-year periods. All three state-owned enterprise grid companies in China (State Grid, Southern Grid, and Inner Mongolia Power Company) are to be covered. Chinese officials framed this approach to gridco regulation to shift away from the status quo with limited regulatory access to gridco financial information and a lack of transparent cost review and price setting. And, Chinese authorities are publicly discussing increased transparency, improved government oversight, and reduced costs.

That said, unintended consequences can result from a PBR system on individuals and can create perverse incentives. For example, when the California Public Utilities Commission required reporting of employee injury data for rewarding workplace safety, it found that supervisors encouraged non-reporting, self-treatment, or treatment by personal physicians and other measures to avoid internal reporting of injuries. Furthermore, the reporting of injury data by group and incentives provided on a group basis within the utility led to employee desires to see their group or unit safety rankings maintained, and thus created a disincentive to report injuries.[29] The lesson from this experience is that careful consideration of internal data management and reporting within the utility may be necessary, particularly when there is a reward-and-penalty aspect of an incentive that affects individual and group employee compensation.[30]

[29] Whited, M., Woolf, T., and Napoleon, A. 2015. *Utility Performance Mechanisms: A Handbook for Regulators*. Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/Utility%20Performance%20Incentive%20Mechanisms%2014-098_0.pdf, pp. 31, 63-69.

[30] Another booby trap is that a focus on a specific metric may take employee attention away from tasks that do not have a reward or any reported metric and instead focus their time on tasks that do influence achievement of performance targets, such as the customer experience or societal benefit. Regulators can address this with a broader array of metrics that are reported without reward (a scorecard) such that all utility performance is subject to public disclosure and a likely future correction.

5 Conclusion

PBR mechanisms vary widely by jurisdiction, as they should. Following a design process that considers the institutional arrangements and then sets clear goals, an articulated design process will help jurisdictions implement successful PBR mechanisms.

The first step in the process is to understand the institutional arrangements within a jurisdiction, which have incentives inherent in the structure. Consideration of the utility composition is critical to understanding both the concerns the utility is facing with respect to technological change and how the utility will respond to incentives. The ownership structure determines the types of incentives structure that will have traction on a specific utility.

Elements of a successful PBR mechanism set up incentives to take advantage of technological innovation opportunities and accommodate the highly dynamic technology environment of the 21st century. As a result, the process should focus on clearly articulating goals—not methods or technology. The important first steps in creating a PBR mechanism are to identify, articulate, and prioritize goals, and then to understand how well or poorly conventional regulation meets those goals in a business-as-usual scenario. There is no "cookbook" for PBR approaches that can be taken off a shelf and implemented. But, past PBR successes and failures are a source of guidance. Opportunities to learn by comparison continue, because while numerous successful PBRs exist, PBR approaches are continually evolving.

21st Century
POWER
PARTNERSHIP
Accelerating the transformation of power systems

www.21stCenturyPower.org

The 21st Century Power Partnership is a multilateral effort of the Clean Energy Ministerial and serves as a platform for public-private collaboration to advance integrated policy, regulatory, financial, and technical solutions for the largescale deployment of renewable energy in combination with deep energy efficiency and smart grid solutions.

CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

RAP®

NREL/TP-6A50-70822-2 | April 2018 | NREL prints on paper that contains recycled content.