BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of San Diego Gas & Electric Company (U902E) for Adoption of its Smart Grid Deployment Plan	Application 11-06-006 (Filed June 6, 2011)
And Related Matters.	Application 11-06-029 Application 11-07-001

RESPONSE OF ENVIRONMENTAL DEFENSE FUND REGARDING THE CONSOLIDATED APPLICATIONS OF SAN DIEGO GAS & ELECTRIC COMPANY, SOUTHERN CALIFORNIA EDISON, AND PACIFIC GAS AND ELECTRIC COMPANY, FOR ADOPTION OF SMART GRID DEPLOYMENT PLANS

LAUREN NAVARRO
Attorney
Environmental Defense Fund
1107 9th St., Suite 540
Sacramento, CA, 95814
lnavarro@edf.org

Dated: August 4, 2011

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of San Diego Gas & Electric Company (U902E) for Adoption of its Smart Grid Deployment Plan	Application 11-06-006 (Filed June 6, 2011)
And Related Matters.	Application 11-06-029 Application 11-07-001

RESPONSE OF ENVIRONMENTAL DEFENSE FUND REGARDING THE CONSOLIDATED APPLICATIONS OF SAN DIEGO GAS & ELECTRIC COMPANY, SOUTHERN CALIFORNIA EDISON, AND PACIFIC GAS AND ELECTRIC COMPANY, FOR ADOPTION OF SMART GRID DEPLOYMENT PLANS

I. INTRODUCTION

Environmental Defense Fund (EDF) is excited about the opportunity to comment on the IOU Smart Grid Deployment Plans. EDF has been actively participating in R.08-12-009[1] since February 2010, and provided much of the information that the Commission used to develop the environmental requirements in the Decision Adopting Requirements for Smart Grid Deployment Plans Pursuant to SB 17 (Padilla), Chapter 327, Statutes of 2009 (D.10-06-047). EDF is a leading national nonprofit environmental advocacy organization representing more than 700,000 members across the country, including more than 100,000 in California. These comments draw on the experience gained to date through our active participation in R.08-12-

[1] Order Instituting Rulemaking to Consider Smart Grid Technologies Pursuant to Federal Legislation and on the Commission's own Motion to Actively Guide Policy in California's, http://docs.cpuc.ca.gov/published/proceedings/R0812009.htm

009 and the Pecan Street Partnership ("PSP"),[2] and our involvement with the Citizen Utility Board (CUB) in Illinois.

Our deep involvement in these projects is motivated by the enormous opportunity that well-designed smart grids present for improving environmental conditions and empowering consumers in California and the United States. They can reduce our reliance on fossil fuels by optimizing grid efficiency, bringing clean power online, and even enabling the transformation of our transportation system, while priming the grid for dynamic pricing, innovation, energy storage and new energy services.[3] All of these abilities add up: leading analyses indicate that well-designed smart grids can reduce the emissions from the electric sector by 30% and the emissions from the transportation sector by 25% nationally by 2030.[4]

Since D.10-06-047 was issued in late June of 2010, EDF has been working on two "tracks" in preparation for our involvement in the consolidated application proceeding A.11-06-006. Since January 2011, EDF staff has 1) worked directly with SDG&E, and to lesser extent PG&E, to provide our opinions and insights to assist the development of their deployment plans and 2) created an Evaluation Framework For Smart Grid Deployment Plans ("Evaluation Framework") to evaluate the plans' ability to achieve the full range of environmental and consumer benefits possible through the smart grid. Our work with the utilities to develop environmental metrics informed these efforts. These two "tracks" are discussed in detail in the following sections, including our internal procedures to avoid biasing our evaluation of plans that we've helped to develop.

---

[2] PSP is a pilot for smart grid technology and related business models to enable the City of Austin to achieve aggressive renewable energy, energy efficiency, and other environmental goals. More information about the Pecan Street Project, a collaboration of EDF, Austin Energy, the Austin Chamber of Commerce, the University of Texas and the City of Austin can be found at PecanStreetProject.org. EDF's role in the project includes managing collaboration with leading technology companies including Cisco, Dell, Gridpoint, IBM, and Microsoft, and developing the environmental performance goals and metrics. On March 24th, 2010, the PSP participants released a report of recommendations for transforming electricity delivery into a customer-focused clean energy system.

[3] Electric Power Research Institute (EPRI), Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects, Jan. 2010, p. 1-1, *available at* http://my.epri.com/portal/server.pt?Abstract_id=000000000001020342

[4] Studies include: Silver Spring Networks, "Connecting Smart Grid and Climate Change," Michael Jung and Peter Yeung, Silver Spring Networks; PNNL: http://energyenvironment.pnl.gov/news/pdf/PNNL-19112_Revision_1_Final.pdf; Austin Energy 2010 Annual Report of System Information;US Energy Information Administration, Annual Energy Outlook, 2010; Khlaq Sidhu, Burghardt Tenderich: http://cet.berkeley.edu/dl/CET_Technical%20Brief_EconomicModel2030_f.pdf

II. TRACKS 1 AND 2: PROJECT DEVELOPMENT AND AVOIDING CONFLICTS OF INTEREST

Beginning in January of 2011, two EDF staffers worked closely with SD&GE on many aspects of its smart grid deployment plan, including its vision, strategy, baseline, roadmap, and cost-benefit analyses. James Fine, a Ph.D. economist who specializes in environmental and economic modeling, and Lauren Navarro, an attorney who heads EDF's smart grid regulatory work, met with SDG&E on numerous occasions and reviewed preliminary drafts of their plan. Our efforts with PG&E came later in PG&E's plan development process, and involved commenting on an initial, incomplete draft plan, and, subsequently, a draft of the plan's consumer engagement chapter.

Also in January 2011, Tim O'Connor, who heads EDF's AB 32 program in California and has special expertise in the area of industrial emissions and energy generation, began developing the Evaluation Framework (published in June 2011). For this project he recruited two expert consultants (please see Attachment A for resumés):

1. Karen Herter (Herter Energy Research Solutions, Inc.), who holds a Ph.D. in Energy and Resources and has designed smart grid and related projects for Lawrence Berkeley National Laboratory, and
2. Roger Duncan, former head of Austin Energy, the 9th largest utility in the U.S.

Throughout the period between January 2011 and August 2011, the two EDF teams followed strict protocol to ensure that the Evaluation Framework and related scoring were not biased by our work with SDG&E, with limited exceptions due to the small size of our smart grid staff. Tim O'Connor and Karen Herter were the responsible parties for developing the Evaluation Framework, and did not work with SDG&E or PG&E in the development of their plans, with limited exceptions related to high-level briefings by the two utilities. James Fine and Lauren Navarro, who worked directly with SDG&E and PG&E, were walled off from the Evaluation Framework scoring process. Collaboration between teams occurred only in the early development of the Evaluation Framework, when Lauren and James contributed their ideas.

Some overlap could not be avoided, due to the small size of EDF's California smart grid team and relatively small consultant budget. Both teams had to reach out to EDF smart grid staff across the country for additional expertise. For example, Miriam Horn, Director of EDF's Smart

Grid Initiative, helped to evaluate both drafts of the utility plans and the Evaluation Framework. She was not, however, involved in the scoring process. Roger Duncan, who has worked with our staff in Texas on the Pecan Street Project, helped to evaluate SDG&E's drafts, but did not attend meetings or speak directly with its staff. We are confident that these contributions strengthened our recommendations to the utilities and did not improperly influence the development of our Evaluation Framework or the subsequent scoring of the IOU's smart grid deployment plans.

III. EDF TRACK 1: Working with SDG&E and PG&E

Since January of 2010, James Fine and Lauren Navarro worked closely with SD&GE on many aspects of its smart grid deployment plan. In the months before we provided feedback on their drafts, for example, we helped SDG&E develop its cost-benefit analyses by reviewing the analytical construct it developed and identifying additional input assumptions and analytical procedures, notably to encourage robust treatment of uncertainties. Our efforts with PG&E came later in the process, resulting in two memos, commenting on the plan overall and on consumer engagement specifically.

This section begins with summaries of our work with the utilities linking smart grid investments to benefits and our other comments on their draft plans. We then introduce the next step to fully quantifying benefits from smart grid deployment - linking reduced air emissions to environmental outcomes (e.g. improved ambient air quality) and to health outcomes (e.g. reduced morbidity and mortality). This "integrated assessment modeling" can and ultimately should be used both for conducting cost-benefit analysis and for developing metrics.

a. Calculating Environmental Costs and Benefits with SDG&E

In advance of providing SDG&E and PG&E with feedback on their draft deployment plans, EDF worked closely with SDG&E to help calculate the environmental and economic benefits of proposed smart grid technologies. This analytical exercise involved several day-long meetings to agree on methods and exchange information, such as input data for calculations. The effort

was premised upon the mutual goal of accurately representing environmental benefits to be attained from smart grid deployment, while accounting for costs.

The benefits that we focused on were avoided emissions of greenhouse gases, nitrogen oxides, sulfur dioxide and particulate matter due to smart grid-enabled programs. Programs considered included peak load reduction and load shifting, integrating centralized and distributed renewable electricity generation, and integration of electric vehicles.

Once emissions benefits were calculated, the benefits were monetized using existing and forecasted emissions allowance prices. For NOx and SO_2, we used historic allowance prices in the RECLAIM program. Anticipated allowance prices in the AB32 greenhouse gas cap and trade program, instructed by economic and emissions forecasts, provided the basis for valuing avoided GHG emissions. We deem these input assumptions appropriate because they are indicative of what the utility would have to spend to either avoid emissions or to purchase emissions allowances in competitive, regulatory markets.

Together, EDF and SDG&E considered various methods for categorizing and treating uncertainties, ultimately choosing to represent uncertain values as ranges rather than as single data points. We also tackled analytical challenges that inherently require subjective judgments, such as the development of counterfactual future scenarios.

EDF supports the approach used by SDG&E to distinguish the unique benefits smart grid from other utility programs, such as meeting the renewable portfolio standard or energy efficiency programmatic goals. The approach draws from research that indicates what is made viable by smart grid. For example, the Cal-ISO estimated that 20% RPS is attainable without smart grid, but 33% RPS will require smart grid. With this objective assessment from Cal-ISO, SDG&E ascribed an RPS benefit to smart grid equal to the difference between the 20% and 33% RPS; that is, the benefit associated with smart grid is an additional 13% renewables.

In the case of electric vehicle integration, no attempt is made to estimate what would occur in the absence of smart grid deployment. Rather, the EV integration forecast already developed by SDG&E in the EV rulemaking is deemed as enabled by smart grid.

While it is not feasible to detail every step of each calculation in these opening comments, it is important to document essential assumptions. In addition to the approach for monetizing the value of avoided emissions, key representations included:

1. Where feasible, counterfactual scenarios were sought to identify the unique contributions of smart grid, as was the case with the RPS. Where counterfactual scenarios could not be developed in an analytically reliable manner, conservative estimates based on individual smart grid deployment programs were developed with the intent to avoid double attribution (i.e., ascribing benefits to smart grid that could be attributed to another utility program).
2. SDG&E developed estimates of the generation mix average and marginal emissions rates for GHG, NO_x, SO_2 and PM_{10} by seasonal hour, such as peak summertime afternoon, middle of the night, and typical (average) daytime. Where smart grid enabled programs, such as Auto-DR, can be pegged to changes in load at specific hours (i.e., summertime peak for DR), the marginal emissions rates for those hours were used. Where load changes could not be ascribed to specific hours, then the average emissions rates were used. Average and marginal emissions rates in the future were adjusted to reflect known energy contract expiration dates, as well as the decreasing emissions rates due to integration of non-emissions resources in support of the RPS.
3. SDG&E had already estimated EV integration as part of the EV rulemaking; emissions benefits from EV were calculated as the avoided gasoline fuel combustion associated with the conventional cars that the EVs displace. In so doing, fleet average fuel efficiency changes due to California-specific and federal (CAFÉ) standards were represented using estimates prepared by the California Air Resources Board. As well, the growth in utility grid-based emissions from the EV load was netted out of the benefit calculation.
4. Several important program benefits were not included where they would be clearly seen as double attribution because they have already been ascribed to monetary rewards in other proceedings.

The assumptions and methods used by SDG&E have yielded benefits estimates that should be considered conservative, based on the total value of the smart grid investment which includes both approved and incremental costs, and should be updated based on growing experience with smart grid technologies and programs. Furthermore, the bounded range provided in the SDG&E estimates should not be considered confidence intervals, but the potential range of value in the face of unavoidable uncertainty.

b. EDF Comments on Draft Plans Made Directly to Utilities

To organize our review, EDF started with the three core purposes of SG deployment plans identified by the PUC:

- provide evidence that the proposed Smart Grid investments are reasonable and consistent with the Commission's overall Smart Grid vision
- provide evidence that the proposed Smart Grid investments will promote the policy goals adopted by the Commission pursuant to SB 17 and the Energy Independence and Security Act
- develop a baseline against which to measure each utility's Smart Grid progress

EDF's comments to SDG&E focused on meeting the environmental requirements of D.10-06-047, particularly around the role of state policy in the Deployment Plan. We suggested direct discussion of the regulatory requirements that the utility industry must meet in the upcoming decades, linking challenges to potential smart grid solutions. To aid this analysis, we recommended foresight beyond year 2020, such as looking toward the state's 2050 greenhouse gas emissions limit set at 80 percent below 1990 emissions levels. We made specific recommendations for the smart consumer and smart market sections, including expanding the discussions about time differentiated rates for storage, electric vehicles and small distributed generation and about the sale of diverse distributed resources into the CAISO market. Finally, we asked that SDG&E identify comprehensive environmental metrics to be developed, and to identify needs for data gathering and analyses to be taken or planned for in the near term to report these metrics in plan updates.

EDF also provided feedback to PG&E on its draft Vision, Strategy, Roadmap, Baseline, Customer Programs, Benefits, and Consumer Engagement sections. Our comments included suggestions about the planning horizon, similar to those we made to SDG&E. We also suggested increased discussion of distributed generation, non-traditional consumer outreach, and addressing consumer concerns. For the baseline, we suggested more information with respect to an environmental baseline to help guide future deployments. Additionally, we gave detailed recommendations on PG&E's Roadmap, strategy, and benefits calculation.

Both SDG&E and PG&E were very open to and appreciative of our input. EDF did not have in-depth conversations with Southern California Edison during the development of their smart grid deployment plan.

c. The Next Step: Using Integrated Assessment Modeling to Link Health and Environmental Outcomes to Smart Grid Deployments

It is analytically feasible to link the benefits of smart grids, such as reduced air pollutant emissions, to improved ambient air quality and public health, including reduced morbidity and mortality. While this will involve an integrated assessment modeling exercise, these simulations are routinely undertaken by air management agencies as part of planning to attain ambient air quality standards.

A carefully planned and effectively deployed smart grid can reduce the environmental footprint of electricity generation, transmission, distribution systems, and even consumers. A smart grid will reduce total demand and also shift demand from peak to off-peak times. This will not only reduce emissions from electric generation but also shift the timing and location of those emissions, and therefore their impacts on public health.

Valuing the environmental impacts of emissions changes requires several computational steps:

- Linking electricity demand changes to power plant and motor vehicle emissions changes
- Representing emissions changes in air quality simulation and dispersion models to simulate downwind air quality outcomes
- Estimating health and ecological effects associated with air quality outcomes using dose-response models
- Monetizing health effects using econometric models

As we develop this methodology, we are focusing on two types of smart grid consequences: the reduced power plant emissions from changes in the magnitude and timing of electricity demand and the integration of electric vehicles. Smart grid-enabled changes in electricity demand can reduce the use of polluting generation resources. In addition, smart grid-enabled technologies and programs, such as time-of-use pricing, can shift the timing of electricity demand. Electric vehicle charging displaces vehicular emissions from internal combustion engines but potentially increases emissions from electricity generation.

The same methods can be applied to study a variety of smart grid-enabled measures and technologies, in isolation or aggregate. Multiple step modeling studies that link emissions to monetized outcomes are called Integrated Assessment Models. Going forward, EDF can provide considerable information on this methodology and is committed to working with IOUs and other stakeholders to develop integrated assessment methods for smart grid benefit analyses.

IV. EDF TRACK 2: EVALUATION FRAMEWORK

Early on, EDF saw the need to develop a mechanism to assist the thorough evaluation of IOU Smart Grid Deployment Plans to determine whether they are likely to lead to the full range of environmental and consumer benefits the smart grid can provide. In response, we worked with Karen Herter to develop a framework to evaluate the utilities compliance with the related requirements of D.10-06-047 without laying out a list of mandatory strategies or metrics or creating a rigid roadmap for uniform deployment. The Evaluation Framework (Attachment B and available online[5]) has been reviewed by individuals from Lawrence Berkeley National Lab, the Environmental Health Coalition, Galvin Electricity Initiative, the Brattle Group, two consumer advocacy organizations, the California Public Utilities Commission, the utilities, and other experts. These individuals provided feedback based on their personal knowledge of the smart grid and its attributes.

[5] Karen Herter and Environmental Defense Fund, Evaluative Framework for Smart Grid Deployment Plans, *available online at* http://www.edf.org/documents/11795_EDF_SG_Evaluation_Framework_June_2011.pdf

The express purpose of the Evaluation Framework is to thoroughly analyze the environmental and consumer requirements promulgated by the PUC and to compare the smart grid deployment plans to those requirements. It was developed around the core principles identified by D.10-06-047 as necessary to fuel a smart-grid enabled clean energy economy,[6] as well as the decision's other requirements. In the Framework, EDF focuses on four of these principles: delivering environmental and public health benefits; empowering customers to make choices about their energy use; creating a platform for a wide range of innovative energy technologies and management services; and enabling and supporting the sale of clean demand-side resources into wholesale energy markets. The remaining PUC principles are either included in one of these sections or are outside the scope of the framework, as indicated.

By comparing the framework to utility deployment plans, EDF can accurately analyze the comprehensiveness of each plan in pursuing the potential benefits to electric utility customers and reducing the environmental impact of the electric grid as a whole. We are scoring each utility for their plan's ability to meet the PUC's requirements, with emphasis on the utility's Vision, Strategy, Metrics, Baseline, and Roadmap for deployment the smart grid in its service territory. While this framework does not require that site-specific plans pursue every potential smart grid benefit it identifies, the scores will reflect the extent to which all relevant items have been sufficiently considered and addressed.

[6] Decision Adopting Requirements for Smart Grid Deployment Plans, issued June 24, 2010, p. 30 to 34, http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/119902.htm

V. CONCLUSION

EDF is finalizing its Evaluation Framework scores and recommendations to be released in upcoming comments to the PUC and has already identified pathways for the utilities to deliver on the promise of the smart grid. EDF looks forward to working closely with the Commission and the utilities to ensure that smart grid deployments support California's continued leadership on clean energy.

Respectfully signed and submitted on August 4, 2011

ENVIRONMENTAL DEFENSE FUND

/s/ LAUREN NAVARRO

LAUREN NAVARRO
Attorney
Environmental Defense Fund
1107 9th St., Suite 540
Sacramento, CA, 95814
Tel: (916) 492 - 7074
lnavarro@edf.org

ATTACHMENT A:
RESUMES OF KAREN HERTER AND ROGER DUNCAN

SB_GT&S_0617504

****

***** *

****

****

**** * *******

****** **********

****

**** * ****

**** * ****

****

****

****

****

****

SB_GT&S_0617506

****

****	******** ********** * ********** * *********
****	********** **********
****	**********
****	**********

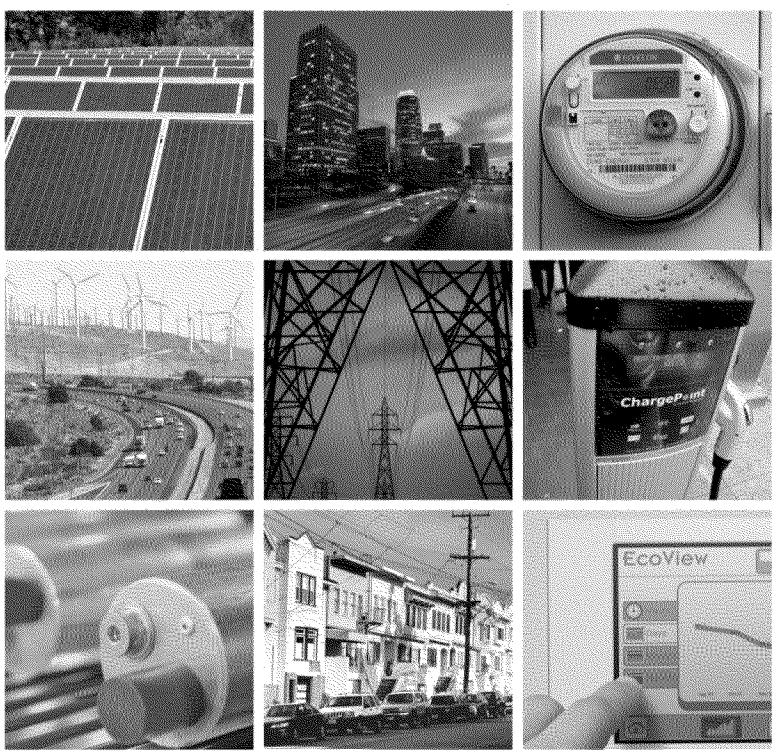
****

**** * *******	******* **********
**** * *******	******* * **********
**** * *******	**********
**** * *******	**********
**** * *******	**********
**** * *******	**********
**** * ****	**********
**** * ****	**********
**** * ****	**********
*********	**********
*********	******* **********
*********	**********
*********	**********

****

****

Evaluation Framework for Smart Grid Deployment Plans



A Systematic Approach for Assessing Plans to Benefit Customers and the Environment

June 2011

by
Karen Herter, Ph.D., Herter Energy Research Solutions, Inc.

In Collaboration with
Timothy O'Connor, Environmental Defense Fund
Lauren Navarro, Environmental Defense Fund

Herter Energy
RESEARCH SOLUTIONS

EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

Cover Page photo attributions

- Solar panels – Niels Sienaert (creative commons via Flicker)
- Wind farm – Kevin Dooley (creative commons via Flicker)
- Battery research – Courtesy Argonne National Laboratory (creative commons via Flicker)
- Los Angeles skyline – Hao K. Nguyen (creative commons via Flicker)
- High voltage power lines–Emmanual Huybrechts (creative commons via Flicker)
- Power lines into houses – Sharon Mollerus (creative commons via Flicker)
- Smart meter – Duke Energy (creative commons via Flicker)
- EV charging station – District Department of Transportation (cre ative commons via Flicker)
- EcoView thermostat – Advanced Telemetry (creative commons via Flicker)

Illustration on Page 1 reprinted with permission from Carol Zuber-Mallison

Foreword

In June of 2010, within Rulemaking 08-12-009 (R.08-12-009), the California Public Utilities Commission (CPUC) issued Decision 10-06-047 (D.10-06-047) outlining the requirements for California's investor-owned utilities' Smart Grid Deployment Plans, to be filed by July 1, 2011.[1] As described in the Decision, the purposes of the Smart Grid Deployment Plans (Plans) are to:

- provide evidence that the proposed Smart Grid investments are reasonable and consistent with the Commission's overall Smart Grid vision
- provide evidence that the proposed Smart Grid investments will promote the policy goals adopted by the Commission pursuant to California Senate Bill 17 (SB 17) and the U.S. Energy and Independence Security Act of 2007 (EISA)
- develop a baseline against which to measure each utility's smart grid progress

The purpose of this document is to provide a template by which the California Smart Grid Deployment Plans can be evaluated by external parties (e.g. the CPUC and the public). The focus of this evaluation is the comprehensiveness of each utility plan for pursuing the promised benefits to electric utility customers and reducing the environmental impact of the electric grid as a whole. Although this template was created to evaluate smart grid plans rather than actual deployments, it will be crucial to develop additional tools to assess those deployments and their progress toward meeting California's goals and regulatory mandates. Those future assessments could be designed around a similar framework.

As utilities develop plans to deploy the smart grid in their service territories, site-specific circumstances and considerations must be taken into account. Therefore, this evaluation framework does not require that every utility plan engage in every strategy listed herein, pursue every metric identified, or create an identical roadmap for uniform deployment. To a large extent, deployment strategies must flow from individualized smart grid visions that are calibrated to respond to both existing and future conditions. While this framework does not require that site-specific plans pursue every potential smart grid benefit identified in this document, scores will reflect the extent to which all relevant items have been sufficiently considered and addressed.

[1] R.08-12-009 stems from the requirements of California Senate Bill 17 (SB17)

Disclaimer

The information contained in this evaluation framework is expressly applicable to the smart grid deployment planning process currently occurring in California. When applying the information contained herein to smart grid deployment projects in other jurisdictions, strict attention to local rules and regulations is necessary to ensure compliance with applicable laws.

The information in this paper is derived from recent documents developed by state and federal government agencies, academic institutions, non-governmental not-for-profit organizations, and other institutions. Because smart grid technologies, strategies and policies are still in flux and evolving quickly, EDF makes no guarantees as to the accuracy or completeness of the information provided herein. This document may be revised in the future as new information becomes available.

Acknowledgments

The authors would like to thank the following for providing thoughtful comments during the development of this paper.

Shannon Baker-Branstetter, Consumers Union
Mark Brownstein, Environmental Defense Fund
Nicole Capretz, Green Energy/Green Jobs Campaign, Environmental Health Coalition
Roger Duncan, Former General Manager, Austin Energy
James Fine, Environmental Defense Fund
Marcel Hawiger, The Utility Reform Network
Ryan Hledik, The Brattle Group
Ron Hofmann, California Institute for Energy and the Environment
Miriam Horn, Environmental Defense Fund
John Kelly, Galvin Electricity Initiative
Roger Levy, Levy Associates
Charles McParland, Lawrence Berkeley National Laboratory

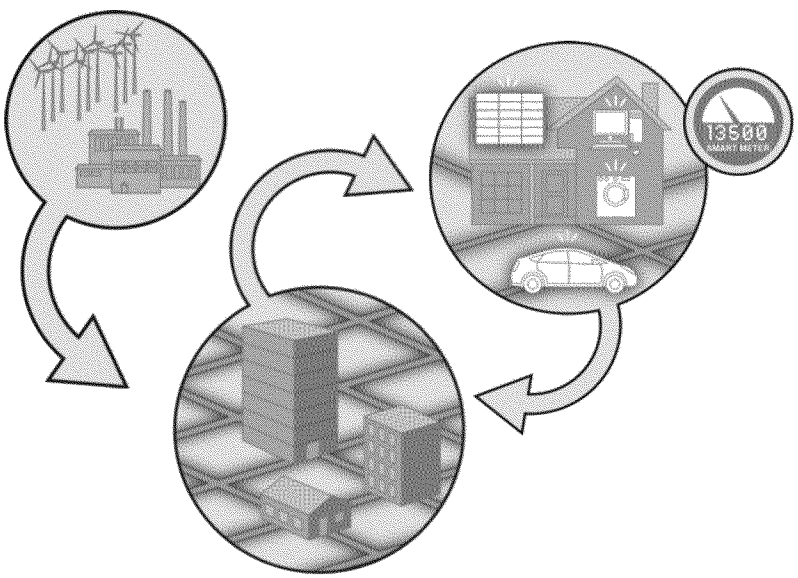
Table of Contents

Background and Introduction

In California, the need for more reliable grid operations became apparent in 2001 during the California electricity crisis. When overuse of demand resources caused participants to drop out of reliability programs en masse, utilities and regulators overhauled large-customer programs and began the business case for advanced metering infrastructure (AMI) or "smart meters," to enable new pricing structures and savings incentives for small customers (CPUC 2002).

In the years after the crisis, dynamic pricing and load management technologies became a focus of utility research efforts (CPUC 2003). With early pilot projects showing promising results, the CPUC approved deployment of smart meters in all sectors (CPUC 2006-2008). Soon, smart meter efforts became intertwined with other utility efforts to expand intelligence throughout the generation, transmission and distribution levels, while at the same time, energy efficiency and consumer advocates lobbied for newly enabled applications on the customers' side of the meter.[2] Combined, the unified vision of these related efforts became known as the smart grid.

Figure 1. The Smart Grid: Generation, Consumption, Communications, and Information



"The smart grid is the electricity delivery system, from point of generation to point of consumption, integrated with communications and information technology for enhanced grid operations, customer services, and environmental benefits."

- U.S. Dept. of Energy

The Department of Energy's definition of the smart grid (Figure 1) describes not only what the smart grid *is* ("… the electricity system … integrated with communications and information technology …"), but also what it is *for* ("… enhanced grid operations, customer services, and environmental benefits.") It is the second part of this definition – the goals we ultimately hope to realize, rather than the equipment we hope to install – upon which this evaluation framework is built, in an effort to avoid endorsement of specific technologies or methods.[3]

[2] See, for example, the Division of Ratepayer Advocates position in Section 3.2 of CPUC D. 07-04-043 (CPUC 2007).
[3] Exceptions to this principle are evident wherever installation of components has been explicitly defined as a goal through state or federal laws.

EDF's Guiding Principles

The following principles informed the development of this evaluation framework.

- **Smart grid deployments should seek to share costs between utilities and consumers, and deliver benefits to consumers commensurate with investments.**[4] Smart grid deployment plans should share the investment and technology risk between utilities and their customers, while making sure customers get the full value from the investment, including reduced whole-system costs and improved reliability, environment quality and public health.

- **The smart grid should empower customers to make choices about their energy use, both to save money and to support clean energy.** In general, consumer empowerment is achieved through providing customers with the information, tools and incentives needed to effectively manage on-site energy production, storage and use. At the same time, consumer empowerment is also supported through maintaining or improving customer equity, protecting consumers from unnecessary financial risks and loss of electrical service, and protecting against loss of privacy.

- **The smart grid should create a platform[5] for a wide range of innovative energy technologies and management services.** This platform should enable new technologies and markets without compromising information security.

- **The smart grid should enable and support the sale of demand-side resources into wholesale energy markets, on equal footing with traditional generation resources**. Such demand-side resources should include energy efficiency, demand response, distributed generation, and storage.

- **The smart grid should deliver environmental and public health benefits.** Smart grid cost-benefit analyses should take into consideration the full range of benefits of deployment, including reduced use of high-polluting peak power plants and reduced air, water, land and wildlife impacts, for example by avoiding the construction of power plants and transmission lines.

[4] This framework focuses on benefits. The evaluation of costs, cost sharing, and cost effectiveness are within the purview of the CPUC and are not addressed here.

[5] The term "platform" used here refers to a flexible and modular framework of hardware, software and policies that enable other products. It is not used in the strict technological sense of a single software product on which all other products rely.

Alignment of this Framework with CPUC D.10-06-047

In D.10-06-047, the CPUC required that the utilities address eleven fundamental smart grid "Goals" and segment the smart grid deployment plans into eight chapters or "Sections." This evaluation framework is founded on these two structural elements as follows.

Goals

CPUC Goals. The CPUC provided a list of eleven Goals for the California smart grid, echoing those outlined in California SB 17 and elsewhere.[6]

a) Be self-healing and resilient;

b) Empower consumers to actively participate in the operations of the grid;

c) Resist attack;

d) Provide higher quality of power and avoid outages;

e) Accommodate all generation and energy storage options;

f) Enable electricity markets to flourish;

g) Run the grid more efficiently;

h) Enable penetration of intermittent power generation sources;

i) Create a platform for deployment of a wide range of energy technologies and management services;

j) Enable and support the sale of demand response, energy efficiency, distributed generation, and storage into wholesale energy markets as a resource, on equal footing with traditional generation resources; and

k) Significantly reduce the total environmental footprint of the current electric generation and delivery system in California.

EDF Goals. The evaluation framework presented here shortens the list of Goals to the four that, broadly defined, cover all of the CPUC goals from the perspective of consumers and the environment, and align well with EDF's guiding principles described in the previous chapter. The Goals defined for this framework are as follows.

(i) Empower Consumers (addressing CPUC goals a, b, c, d, e, and f)

(ii) Create a Platform for Technologies & Services (addressing CPUC goals e, f and i)

(iii) Enable Sales of Demand-side Resources in Wholesale Markets (addressing CPUC goals e, f and j)

(iv) Reduce the Environmental Footprint (addressing CPUC goals g, h, and k)

---

6 The first seven of these (a-g) can be found in the National Energy Technology Laboratory's "A Systems View of the Modern Grid" (2007), where they are referred to as "Principal Characteristics." The last three (i-k) were added by the CPUC in response to EDF testimony in R. 08- 12-009.

Sections

CPUC Sections. In D.10-06-047, the CPUC required that each utility Smart Grid Deployment Plan include the following eight Sections (emphasis added).

1. Smart Grid **Vision** Statement;
2. Deployment **Baseline**;
3. Smart Grid **Strategy**;
4. Grid Security and Cyber Security Strategy;
5. Smart Grid **Roadmap**;
6. Cost Estimates;
7. Benefits Estimates; and
8. **Metrics**.

EDF Sections. Of the eight Sections required by the CPUC, five were chosen to define the evaluation framework presented here.

1. ***Vision*** is the narrative defining the overall objectives and goals, and their alignment with policy and societal goals
2. ***Strategy*** is the detailed set of tactics to be employed in the pursuit of each goal
3. ***Metrics*** are the units by which progress toward each goal is measured
4. ***Baseline*** is a list of current (starting) values for each metric
5. ***Roadmap*** is the process and timeline for achieving target values for each metric

Evaluation Instructions

This section provides instructions for evaluators in using this framework for scoring utility Smart Grid Deployment Plans.

Plans are to be scored in two steps, with a maximum total score of 40 points, using a scorecard similar to the one provided in Figure 2. In Step 1, the four Goals are scored across all five Sections on a scale from 0.0 to 1.0, using a 4-by-5 matrix, for a total of 20 possible points. In Step 2, the overall clarity and coherence of each of the five Sections is scored on a scale from 0 to 4, again for a total of 20 possible points. Each Section score should also be coupled with a narrative that provides a critical review of the Section. Using this framework, utility plans can be easily compared and contrasted, allowing for identification and consideration of the best aspects of each plan.

Figure 2. Example of a Smart Grid Deployment Plan scorecard with the maximum possible score

		SECTIONS					
		(1)	(2)	(3)	(4)	(5)	
		Vision	Strategy	Metrics	Baseline	Roadmap	**Total**
GOALS	(i) Empower Consumers	1	1	1	1	1	
	(ii) Create a Platform for Technologies & Services	1	1	1	1	1	
	(iii) Enable Sales of Demand-side Resources in Wholesale Markets	1	1	1	1	1	
	(iv) Reduce the Environmental Footprint	1	1	1	1	1	
Step 1: GOAL Score *(sum of i-iv above)*		4	4	4	4	4	**20**
Step 2: SECTION Score		4	4	4	4	4	**20**
Final PLAN Score							**40**

While the CPUC provided a general structure for the Plans, as described previously, the specific structure of the evaluation framework described here will not match exactly the structure of utility Plans – which are likely to address requirements throughout the text, across chapters, and outside the boundaries of individual sections and goals as organized here. It follows then, that evaluators should assess the extent to which the Plan in its entirety meets the requirements defined here, without regard to placement in the Plan.

Step 1: Scoring of Goals

Of the two evaluation steps, Step 1, scoring of the Goals, is the more objective. Evaluators should use this Step to evaluate the comprehensiveness of the smart grid deployment plans without judging the expected effectiveness of the planned deployments. As such, Step 1 provides a framework for scoring the completeness of the plans in *addressing* the criteria outlined herein, not the likelihood of success in meeting them. (The latter evaluation process is covered in Step 2.)

For each of the Goals, I through IV, between 0.0 and 1.0 points will be allocated across each of the five Sections, thereby allowing a total maximum score of 5.0 points for each Goal, and a total of 20.0 points for all of Step 1 (see Figure 3). For each Goal, the Vision section is to be scored according to whether a vision is provided for each of the associated criteria.[7] Beyond the Vision section, the Strategy, Metrics, Baseline, and Roadmap sections are to be scored according to whether they address the criteria that the utility intends to pursue, as identified in the Vision.

Figure 3. Scoring of Goals

		SECTIONS					
		(1)	(2)	(3)	(4)	(5)	
		Vision	Strategy	Metrics	Baseline	Roadmap	**Total** *(sum 1-5)*
GOALS *(0.0 - 1.0 points each)*	(i) Empower Consumers	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*Max 5 points*
	(ii) Create a Platform for Technologies & Services	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 0.1 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*Max 5 points*
	(iii) Enable Sales of Demand-side Resources in Wholesale Markets	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*Max 5 points*
	(iv) Reduce the Environmental Footprint	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*0.0 - 1.0 points*	*Max 5 points*
Step 1: GOAL Score *(sum i-iv)*		*Max 4 points*	*Max 4 points*	*Max 4 points*	*Max 4 points*	*Max 4 points*	***Max 20 points***

[7] These criteria, listed in the following sections, have been cultivated from widely accepted literature on smart grids and the experience of the author and contributors.

An important element of this evaluation framework is that each of the metrics provided are categorized as either (1) *Consensus*, (2) *CA-Exact*, or (3) *Suggested*. Under R.08-12-009, the California utilities have already agreed to report those listed as *Consensus* metrics (CPUC 2010), while *CA-Exact* metrics listed in this framework are necessary to track performance with the following California laws and goals:

- California Global Warming Solutions Act of 2006 (AB 32): reduce greenhouse gas emissions to 1990 levels by 2020, and to 80% below 1990 levels by 2050
- California Ambient Air Quality Standards for Particulate Matter (PM10 and PM2.5), Sulfur Dioxide (SO2), Ozone (O3), Visibility Reducing Particles, Nitrogen Dioxide (NO2), Lead, Sulfates, Hydrogen Sulfide (H2S), Carbon Monoxide (CO), and Vinyl Chloride
- The California Long Term Energy Efficiency Strategic Plan: zero net energy use for all new homes by 2020, and for all new commercial buildings by 2050
- Sections 454.5 and 454.55 of the California Public Utilities Code: utilities must meet resource needs first through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible, with specific targets to be determined jointly by the CPUC and CEC
- California Renewables Portfolio Standard: all retail sellers of electricity serve 33% of their load with renewable energy by 2020
- The California Solar Initiative: install 1,940 MW of new solar by 2017

Suggested metrics are presented as recommendations for tracking the performance of important smart grid goals as identified in D.10-06-047.

For a Goal to receive the maximum number of points:

1. Plans for pursuing criteria having one or more *Consensus* or *CA-Exact* metrics must be described in all five Sections: Vision, Strategy, Metrics, Baseline, and Roadmap.
2. The criteria having only *Suggested* metrics must be addressed in the Vision section in one of two ways: either how they will be pursued, or why they will not be pursued. The criteria chosen to be pursued must also be addressed in the remaining four Sections. The criteria that will not be pursued need not be addressed beyond the Vision section.

Goal I: EMPOWER CONSUMERS

The smart grid should empower consumers with better information and expanded choices in how they use, produce and store energy. Consumers should have the opportunity to respond to price signals and other economic incentives to decide if and when to purchase electricity and whether to produce or store it. Similarly, customers should be able to access technology that enables them to better control the magnitude and timing of their electricity use. Finally, consumers should be able to incorporate electric vehicles into homes, offices, parking garages, and other locations, with rates that reward them for charging off peak.[8]

With respect to consumer empowerment, D.10-06-047 states that a smart grid should enable consumers to change their behavior in response to dynamic prices. Further, California SB 17 encourages the incorporation of cost-effective smart technologies, including real time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices for metering, grid communications, and distribution automation. Plans should therefore address consumer empowerment in all five Plan Sections as follows.

1. The **Vision** section should provide a narrative of the how the Plan will empower consumers by addressing the criteria described below.

   A. ***Dynamic rate options:*** The smart grid is characterized by meters that collect hourly or sub-hourly energy use data, which can be leveraged to offer rates that vary hourly or sub-hourly. Dynamic rate options provide customers with the opportunity to reduce their bills and at the same time improve the efficiency of the grid. The effectiveness of dynamic pricing has been documented through recent pilots, which show that dynamic pricing saves consumers money and achieves high customer satisfaction. The Vision section should describe utility plans to offer dynamic rate options that encourage efficiency, load shifting, and/or critical peak reductions.

   B. ***Demand management***: The Vision section should describe utility plans to empower consumers to be more efficient and to manage their electric loads in real-time, thereby enhancing customer's ability to benefit from dynamic pricing and other demand management programs.

   C. ***Plug-and-play***: The Vision section should discuss utility plans for identifying and reducing barriers to the integration of customer-side devices that generate, store, or use electricity – furthering a vision in which the electric grid encourages third party participation, competition among evolving consumer products, and customer choice of innovative applications and products. *(Suggested)*

[8] National Energy Technology Laboratory. *Enables Active Participation by Consumers* , September 2009.

D. ***Generation choice***: The Vision section should describe utility plans to expand the ability for consumers to choose from a range of off-site generation options, in particular alternative and renewable energy supplies. *(Suggested)*

E. ***Consumer technologies***: New technologies can make it easier for consumers to reduce their energy usage, shift load to off peak times, and respond to demand curtailment signals. The Vision section should describe utility plans to expand the use of consumer technologies for these purposes.

F. ***Electric vehicles***: For the transportation and electric grid systems to benefit from electric vehicles, vehicles must have access to smart charging equipment that is able to respond to real-time grid conditions. The Vision section should discuss utility plans for identifying and reducing barriers to installation and use of smart charging equipment, both in public and private settings.

G. ***Information:*** An educated and informed customer base will facilitate the societal behavior changes needed to meet environmental goals. The Vision section should describe utility plans to provide customers with access to their own data, and improve customer understanding of electricity use, rates, bills, and where to turn for help. Methods for implementing these strategies might include expanding customer education efforts to provide more detailed energy use information and enhancing customer services.

H. ***Customer service:*** The smart grid opens up the potential for vastly improved customer service options and a more satisfied customer base. The Vision section should describe utility vision for expanding customer education and service options, enhancing relationships with customers, and improving customer satisfaction with the utility. The Vision should also address how the utility plans to maintain or improve current levels of consumer protections, especially relating to the implementation of remote disconnection, and traditional billing and dispute rights.

I. ***Customer bills:*** Electric grid costs are ultimately reflected in customer bills. While the smart grid is expected to improve grid efficiencies and lower energy costs, it is unclear how these benefits will compare to the costs of smart grid itself, the increasing costs of generation, and the increased electricity use of consumers, for example, through the adoption of electric vehicles. The Vision section should discuss how the smart grid will be leveraged to track and keep downward pressure on costs and customer bills. *(Suggested)*

J. ***Customer equity***: The smart grid is characterized by improved data systems, which can be leveraged to facilitate better analysis of customer equity issues. The Vision section should describe utility plans to monitor and address equity issues within and between customer classes. *(Suggested)*

K. ***Data access & privacy:*** The smart grid is characterized by increased flows of data, creating the potential for customer data to be appropriately accessed – and compromised. The Vision section should describe in general terms the utility's plans to provide customers access to their own data while protecting it from others, including but not limited to plans to comply with cyber-security standards and protocols (e.g. those developed by NIST). *(Suggested)*

L. ***Power quality***: The Vision section should discuss in general terms the utility's plans for developing and monitoring power quality indicators and for implementing automatic control operations that respond to fluctuations in power quality. *(Suggested)*

M. ***Power reliability***. The Vision section should discuss in general terms the utility's plans for leveraging smart grid functionality to maintain power reliability.

2. The **Strategy** should describe utility plans for pursuing each of the criteria identified in the Vision. Strategies for criteria that are not an accepted part of the Vision need not be provided.

3. The **Metrics** should be enumerated along with the required data and calculations that will be used to report progress towards the Vision. All metrics of criteria accepted in the Vision section should be addressed in one or more of the following ways: (a) the metric is listed in the Metrics section, (b) an explanation is provided for why the metric is not yet feasible, and a schedule for development is given in the Roadmap, or (c) a narrative rationale describes why the suggested metric is not appropriate (for suggested metrics only). Note that metrics for criteria that are not an accepted part of the Vision need not be addressed here.

Table 1. Metrics for Goal 1: Empower Consumers

Criterion	Metric	Description	Status
A	Dynamic rates	Number of customers that are on a time-variant or dynamic pricing tariff, by customer class, CARE, and climate zone	*Consensus*
B	Customer-controlled load	Number of customers, $/MW and MW with customer-controlled automation, by customer class	*Suggested*
B	Utility-controlled load	Number of customers, $/MW and MW for load-control programs, by customer class	*Suggested*
B	Residential efficiency	Average net energy use for new residential buildings, by year	*CA-Exact*
B	Commercial efficiency	Average net energy use for new commercial buildings, by year	*CA-Exact*

C	Ease of connection	Average time elapsed between customer action to initiate installation of a smart-grid connected device (of which the utility is aware) and the time it becomes operational, by technology type	*Suggested*
D	Generation choice	Number of utility-supplied generation options that can be purchased by customers	*Suggested*
E	Net metering	Number of customers with net metering	*Consensus*
E	Utility HAN	The number Home Area Network (HAN) or comparable consumer energy monitoring or measurement devices registered with the utility, by class, CARE, and climate zone	*Consensus*
F	EV tariffs	Number of customers enrolled in time-variant electric vehicles tariffs	*Consensus*
F	EV demand	MW of electric vehicle coincident demand	*Suggested*
G	Information portal	Number and % of customers with advanced meters using a utility-administered Internet portal to access energy information or to enroll in utility energy information programs	*Consensus*
H	Meter complaints	Number of escalated customer complaints related to (1) the accuracy, functioning, or installation of advanced meters, or (2) the functioning of a utility-administered HAN	*Consensus*
H	Bill or rate complaints	Number of escalated customer complaints related to the rate or bill, by tariff	*Suggested*
H	Disconnects	Number of customers disconnected as a result of billing issues	*Suggested*
H	Meter malfunction	Number of advanced meter malfunctions where customer electric service is disrupted	*Consensus*
H	Meter tests	Number of advanced meter field tests performed at the request of customers	*Consensus*
I	Average normalized electric bill	Average bill normalized for fuel costs and weather, by customer class	*Suggested*
J	Customer equity	Customer costs and benefits by customer class and demographics	*Suggested*

K	Data privacy	Documented cases of inappropriate disclosure and/or use of customer data	*Suggested*
L	Power quality	Description of high power quality options offered to customers, by sector	*Suggested*
M	SAIDI	The system-wide total number of minutes per year of sustained outage per customer served as reflected by the System Average Interruption Duration Index (SAIDI)	*Consensus*
M	SAIFI	How often the system-wide average customer was interrupted in the reporting year as reflected by the System Average Interruption Frequency Index (SAIFI)	*Consensus*
M	MAIFI	The number of momentary outages per customer system-wide per year as reflected by the Momentary Average Interruption Frequency Index (MAIFI)	*Consensus*
M	Customer outages	Number of customers and circuits per year experiencing greater than 12 sustained outages	*Consensus*

4. The **Baseline** section should provide current values for each reported metric. Scoring will take into account the extent to which baseline metric values are provided for all criteria pursued, as described in the Vision.

5. The **Roadmap** should identify anticipated cumulative values for all metrics annually through 2020, with targets at ten-year intervals through 2050. With the exception of targets predetermined by California statute, scoring will take into account only the completeness of the list of metrics provided. Scoring will not take into account a judgment of the appropriateness of the values provided, except where a target for the metric has been previously set by state law. Where reporting of a metric is not yet feasible, it should be explained in the Metrics section and a development schedule should be provided here.

Goal II: CREATE A PLATFORM FOR TECHNOLOGIES & SERVICES

Effective deployment of the smart grid should readily allow for integration of new market participants (third-parties), technologies and energy management services, both on the distribution system and behind the meter, for both demand and supply side applications. This market for competition and participation can create a platform to reward innovation, promoting business agreements and technologies that engender new opportunities for improvements in the energy system.

With respect to a platform for technologies and services, D.10-06-047 states that smart grid plans should enable maximum access to the grid by third parties, creating a

welcoming platform for deployment of a wide range of energy technologies and management services. Plans should therefore discuss the creation of a platform for consumer technologies and services in all five Plan Sections as follows.

1. The **Vision** section should provide a narrative of the how the Plan will lead to the creation of a platform for technologies and services by addressing the criteria described below.

   A. ***Interoperability***: The Vision section should discuss how the smart grid will support open architecture that allows for incorporation of evolving technologies on both the supply side and demand side.

   B. ***Standard protocols***: The Vision section should discuss how standard data protocols (e.g. NIST) will be used for customer and data communications systems to provide a platform for innovative technology and services markets.

   C. ***Upgradable software***: The Vision section should discuss how the system will avoid stranding investments on both sides of the customer meter by allowing for frequent software upgrades as systems evolve. *(Suggested)*

2. The **Strategy** section should describe utility plans for pursuing each of the criteria identified in the Vision. Strategies for criteria that are not an accepted part of the Vision need not be provided.

3. The **Metrics** should be enumerated along with the required data and calculations that will be used to report progress towards the Vision. All metrics of criteria accepted in the Vision section should be addressed in one or more of the following ways: (a) the metric is listed in the Metrics section, (b) an explanation is provided for why the metric is not yet feasible, and a schedule for development is given in the Roadmap, or (c) a narrative rationale describes why the suggested metric is not appropriate (for suggested metrics only). Note that metrics for criteria that are not an accepted part of the Vision need not be addressed here.

Table 2. Metrics for Goal 2: Create a Platform for Technologies and Services

Criterion	Metric	Description	Status
A	DG capacity	Number of and total nameplate capacity of customer-owned or operated, grid-connected distributed generation facilities	*Consensus*
A	DG energy	Total annual electricity deliveries from customer-owned or operated, grid-connected distributed generation facilities	*Consensus*
A	Storage	MW and MWh of grid connected energy storage interconnected at the transmission or distribution system level	*Consensus*

B	Platforms	List and description of technology platforms utilized within the smart grid deployment area for energy management services	*Suggested*
B	AutoDR	Percentage of demand response enabled by AutoDR (Automated Demand Response) by DR program	*Consensus*
C	Upgradeable software	List and description of technologies utilized within the smart grid deployment area for energy management services, including a description of their ability to allow software upgrades	*Suggested*

4. The **Baseline** section should provide current values for each reported metric. Scoring will take into account the extent to which baseline metric values are provided for all criteria pursued, as described in the Vision.

5. The **Roadmap** should identify anticipated cumulative values for all metrics annually through 2020, with targets at ten-year intervals through 2050. With the exception of targets predetermined by California statute, scoring will take into account only the completeness of the list of metrics provided. Scoring will not take into account a judgment of the appropriateness of the values provided, except where a target for the metric has been previously set by state law. Where reporting of a metric is not yet feasible, it should be explained in the Metrics section and a development schedule should be provided here.

Goal III: ENABLE SALES OF DEMAND-SIDE RESOURCES IN WHOLESALE MARKETS

Smart grid technologies can enable the participation of demand-side resources (i.e. demand response, energy efficiency, distributed generation, and energy storage) based on the ability to facilitate changes in energy use. Traditionally these resources have been unable to fully participate in wholesale energy because of data communication requirements with the independent system operator (ISO). Advancements in data management and communication associated with the smart grid change this and create new opportunities to facilitate energy use reductions and use shifting.

The smart grid should enable brokers, integrators, aggregators and individual consumers to interact in real-time with the electricity market, new commercial goods and services. Interaction that leads to healthy competition for energy goods and services will engender new markets and cause restructuring of existing ones. In addition, creating real-time interaction with energy markets will provide for consistent market operation across the various regions.[9]

[9] National Energy Technology Laboratory, *Enables New Products, Services, and Markets* , February 2010.

With respect to participation of demand-side resources in energy markets, D.10-06-047 states that utility smart grid deployments should have the infrastructure and policies necessary to enable and support the sale of demand response, energy efficiency, distributed generation, and storage into wholesale energy markets as a resource, on equal footing with traditional generation resources. California SB 17 requires the deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air-conditioning. Plans should therefore discuss sales of demand-side resources in wholesale energy markets in all five Plan Sections as follows.

1. The **Vision** section should provide a narrative of the how the Plan will lead to demand-side resource participation by addressing the criteria described below.

    A. ***Data access:*** To allow for third party providers to offer the maximum range of demand side services, access to energy usage, demand, voltage, current, kVar, power factor, frequency and other information is required. The Vision section should discuss the utility plans for allowing access to this data, subject to customer consent and appropriate privacy and security protection. *(Suggested)*

    B. ***Data transmission***: Maximizing the ability of demand side programs to impact energy system generation requires transmittal of near real-time operations data to the California Independent System Operator. Utility smart grid plans should discuss utility plans for removing the barriers for third party providers to communicate with grid operators. *(Suggested)*

    C. ***Real-time Market Integration:*** Improved communications and data systems throughout the smart grid have the potential to create beneficial interaction between electricity buyers and sellers at both the regional level and the consumer end-use level. The Vision section should describe utility plans to enable and encourage real-time market integration.

    D. ***New Commercial Markets***: Improved communications and data systems throughout the smart grid also have the potential to facilitate the incorporation of new commercial goods and services within existing markets. The Vision section should describe utility plans to allow these new energy management services to get in front of customers and integrate into the grid to enable and encourage new commercial markets. Additionally, the Vision should describe utility plans to allow for the growth in energy markets for aggregated small-scale generation resources. *(Suggested)*

2. The **Strategy** section should describe utility plans for pursuing each of the criteria identified in the Vision. Strategies for criteria that are not an accepted part of the Vision need not be provided.

3. The **Metrics** should be enumerated along with the required data and calculations that will be used to report progress towards the Vision. All metrics of criteria accepted in the Vision section should be addressed in one or more of the following

ways: (a) the metric is listed in the Metrics section, (b) an explanation is provided for why the metric is not yet feasible, and a schedule for development is given in the Roadmap, or (c) a narrative rationale describes why the suggested metric is not appropriate (for suggested metrics only). Note that metrics for criteria that are not an accepted part of the Vision need not be addressed here.

Table 3. Metrics for Goal 3: Enable Sales of Demand-side Resources in Wholesale Markets

Criterion	Metric	Description	Status
A	Data access	Description of data available, with and without customer consent, to third party providers of demand-side energy services, by sector	*Suggested*
B	System operator communications	Options for third party communications with the ISO	*Suggested*
C	Distributed generation in power markets	Total annual electricity deliveries from customer-owned or operated, grid-connected distributed generation facilities	*Consensus*
C	Demand response in power markets	Total MW of demand resources bought and sold in wholesale markets, by sector	*Suggested*
C	Energy efficiency in power markets	Total MWh of demand resources bought/sold in wholesale markets, by sector	*Suggested*
D	New commercial markets	Commercial sales of new smart grid related goods and services, in dollars	*Suggested*

4. The **Baseline** section should provide current values for each reported metric. Scoring will take into account the extent to which baseline metric values are provided for all criteria pursued, as described in the Vision.

5. The **Roadmap** should identify anticipated cumulative values for all metrics annually through 2020, with targets at ten-year intervals through 2050. With the exception of targets predetermined by California statute, scoring will take into account only the completeness of the list of metrics provided. Scoring will not take into account a judgment of the appropriateness of the values provided, except where a target for the metric has been previously set by state law. Where reporting of a metric is not yet feasible, it should be explained in the Metrics section and a development schedule should be provided here.

Goal IV: REDUCE THE ENVIRONMENTAL FOOTPRINT

The smart grid can facilitate the integration of low carbon, low emitting energy generation resources, while also reducing demand for new energy at peak times, thereby reducing the need for investments in new fossil fired generation equipment. Smart grid functions can also make the overall grid more efficient: improving load factors, lowering system losses, and reducing unnecessary consumption by providing optimal power for machine and engine performance. These improvements can lead to reductions in air and water pollution, water use, land use and biological impacts. Importantly, reductions in environmental impacts are directly correlated to improvements in human health and welfare.

With respect to environmental goals, D.10-06-047 states that the smart grid should significantly reduce the total environmental footprint of the current electric generation and delivery system in California. Similarly, SB 17 directs the CPUC to evaluate the impact of the smart grid on achievement of state goals for reducing emissions of greenhouse gases as set forth in the California Global Warming Solutions Act of 2006 and other state directives. Plans should therefore discuss the environmental footprint of the grid in all five sections as follows.

1. The **Vision** section should provide a narrative of the how the Plan will lead to a long-term reduction in the overall environmental footprint of the grid by addressing the criteria described below.

    A. ***Asset utilization:*** The Vision section should describe utility plans to leverage smart grid capabilities to improve the utilization of supply and demand side assets, leading to system wide efficiency improvements.

    B. ***System losses***: The Vision section should describe how improved data and communication systems can facilitate reductions in system power losses throughout the transmission and distribution infrastructure. Reduced system losses can be directly translated into reduced need to generate base load power from non-renewable resources. *(Suggested)*

    C. ***Criteria air pollutants***: The Vision section should describe utility plans to use smart grid resources to facilitate reduced criteria air pollutant emissions across the utility service territory as a whole and at relevant power generation units. The Plan should discuss plans for incorporating the value of avoided criteria pollutant emissions into smart grid resource procurement cost test calculations.[10]

[10] Although not scored within this framework, utility plans would also benefit from coordinating and communicating smart grid enabled criteria pollutant emissions reductions with the local and statewide agencies responsible for overseeing compliance with ambient air quality standards.

D. ***Greenhouse gas emissions:*** The Vision section should describe utility plans to use smart grid resources to facilitate reduced greenhouse gas emissions across the utility service territory as a whole and at relevant power generation units. The plan should also discuss the utility plans for incorporating emissions reductions metrics into smart grid resource procurement cost test calculations.

E. ***Renewables***: The Vision section should describe utility plans to use the smart grid to allow for increases in the generation of renewables to meet the RPS goal of 33% renewables by 2020. The Vision should also describe plans to utilize smart grid mechanisms to remove barriers to renewables development that are associated with its intermittency.

F. ***Water use***: The Vision section should describe utility plans to use smart grid resources to reduce wastewater discharge volume, water contaminant concentrations, and water use across the utility service territory as a whole and at relevant power generation units. *(Suggested)*

G. ***Land use***: The Vision section should describe utility plans to use smart grid resources to reduce land use and habitat impacts associated with energy system infrastructure. *(Suggested)*

H. ***Solid waste***: The Vision section should describe the potential for smart grid to affect the solid waste stream related to the electric power system, for example, through meter replacement.

2. The **Strategy** section should describe utility plans for pursuing each of the criteria identified in the Vision. Strategies for criteria that are not an accepted part of the Vision need not be provided.

3. The **Metrics** should be enumerated along with the required data and calculations that will be used to report progress towards the Vision. All metrics of criteria accepted in the Vision section should be addressed in one or more of the following ways: (a) the metric is listed in the Metrics section, (b) an explanation is provided for why the metric is not yet feasible, and a schedule for development is given in the Roadmap, or (c) a narrative rationale describes why the suggested metric is not appropriate (for suggested metrics only). Note that metrics for criteria that are not an accepted part of the Vision need not be addressed here.

Table 4. Metrics for Goal 4: Reduce the Environmental Footprint

Criteria	Metric	Description	Status
A	Load factor	System load factor and load factor by customer class	*Consensus*
A	Capacity factor	Average capacity factor for generation units, by fuel type	*Suggested*

A	Renewables utilization	Number of renewable energy generation curtailment situations due to over-generation conditions	*Suggested*
A	Avoided capacity	MW deferred or avoided capacity as a result of improved system utilization	*Suggested*
A	Line capacity	Average capacity margin of power lines by type (distribution vs. transmission)	*Suggested*
A	Efficiency	% energy met by efficiency resources	*CA-Exact*
A	Demand response	% peak capacity met by demand response resources	*CA-Exact*
A	Demand response impacts	Load impact from smart grid-enabled, utility administered DR programs, in total and by customer class	*Consensus*
B	System losses	% system losses	*Suggested*
C	Nitrogen oxide	Total emissions of NOx in lbs per MWh of power delivered to customers	*CA-Exact*
C	Sulfur oxide	Total emissions of SOx in lbs per MWh of power delivered to customers	*CA-Exact*
C	Carbon monoxide	CO emissions in lbs per MWh delivered	*CA-Exact*
D	Greenhouse gases	CO_2 and CO_2 equivalent emissions, reductions from baseline and 1990 levels, total (net) and % change	*CA-Exact*
E	Renewables	% of delivered electricity generated by renewable resources	*CA-Exact*
F	Water use	Gallons of water used per MWh delivered	*Suggested*
G	Land use	System map and total land area, with a description of effects on sensitive areas	*Suggested*
H	Smart meter waste	Number of utility-owned advanced meters replaced annually before the end of their expected useful life	*Consensus*
H	Hazardous waste	Tons of hazardous waste disposed of annually by the utility	*Suggested*
H	Other utility waste	Tons of other waste disposed of annually by the utility	*Suggested*

4. The **Baseline** section should provide current values for each reported metric. Scoring will take into account the extent to which baseline metric values are provided for all criteria pursued, as described in the Vision.

5. The **Roadmap** should identify anticipated cumulative values for all metrics annually through 2020, with targets at ten-year intervals through 2050. With the exception of targets predetermined by California statute, scoring will take into account only the completeness of the metrics and timelines provided. Scoring will not take into account a judgment of the appropriateness of the values provided, except where a target for the metric has been previously set by state law. Where reporting of a metric is not yet feasible, it should be explained in the Metrics section and a development schedule should be provided here.

Step 2: Scoring of Sections

Of the two evaluation steps, Step 2, scoring of the Sections, requires a more in-depth assessment of the plan in its entirety. Sections should be scored according to their overall clarity and cohesiveness, and the extent to which the story of the smart grid plan is both compelling and plausible.

Evaluators should score the five Sections on a scale from 0 to 4 as follows:

0: The section addresses **none** of the issues described in the requirements
1: The section addresses **very few** of the issues described in the requirements
2: The section addresses **some** of the issues described in the requirements
3: The section addresses **most** of the issues described in the requirements
4: The section addresses **all** of the issues described in the requirements

For each Section, the score should be coupled with a qualitative critique in narrative form. The structure of the Section scoring is shown in Figure 4.

Figure 4. Section Scoring

	SECTIONS					
	(1)	(2)	(3)	(4)	(5)	
	Vision	Strategy	Metrics	Baseline	Roadmap	**Total** *(sum 1 -5)*
	Narrative Critique	*Narrative Critique*	*Narrative Critique*	*Narrative Critique*	*Narrative Critique*	
Step 2: SECTION Score	*0 -4 points*	*0 -4 points*	*0 -4 points*	*0 -4 points*	*0 -4 points*	***Max 20 points***

Section 1: VISION

Vision is the narrative defining the overall objectives and goals, and their alignment with policy and societal goals.

Each plan must have a Vision statement that argues in concrete terms for the envisioned smart grid deployment goals, strategies, and targets. The Vision should enumerate and discuss the smart grid criteria to be pursued, provide justification for not pursuing those that are not pursued, and provide a narrative of how the portfolio of chosen strategies will work together to achieve the smart grid goals pursuant to D.10-06-047.

The Vision resides at the core of this evaluation framework, so it must be a thorough and strategic description of the deployment Plan. The entirety of the smart grid deployment will ultimately flow from the Vision, so this section must be more than a cursory overview, outlining a real, substantial, and documented effort that is directed at deploying infrastructure to support the service territory. This section should also document which line of the utility business is responsible for overseeing the implementation of the Vision, as well as the extent to which the Vision is subscribed to by senior utility staff and management.

The Vision must be aligned with defined policy objectives and societal goals, providing sufficient detail concerning the benefits and opportunities for consumers and the environment. Pursuant to D.10-06-047, the Vision should explicitly express plans for meeting the goals addressed by the following:

- California Global Warming Solutions Act of 2006 (AB 32): reduce greenhouse gas emissions to 1990 levels by 2020, and to 80% below 1990 levels by 2050
- California Ambient Air Quality Standards for Particulate Matter (PM10 and PM2.5), Sulfur Dioxide (SO2), Ozone (O3), Visibility Reducing Particles, Nitrogen Dioxide (NO2), Lead, Sulfates, Hydrogen Sulfide (H2S), Carbon Monoxide (CO), and Vinyl Chloride
- The California Long Term Energy Efficiency Strategic Plan: zero net energy use for all new homes by 2020, and for all new commercial buildings by 2050
- Sections 454.5 and 454.55 of the California Public Utilities Code: utilities must meet resource needs first through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible, with specific targets to be determined jointly by the CPUC and CEC
- California Renewables Portfolio Standard: all retail sellers of electricity serve 33% of their load with renewable energy by 2020
- The California Solar Initiative: install 1,940 MW of new solar by 2017

The score for the Vision section should reflect the reasonableness and consistency of the overall vision for the proposed approach on a case-by-case basis. All else being equal, Vision sections that address each of the criteria included herein – how each will be pursued or why any will not be pursued – will be considered more complete and receive higher scores than those missing one or more of the criteria identified. Where Plans use alternative strategies to achieve the same goals, evaluators must use discretion in equating expected benefits and assigning points.

Section 2: STRATEGY

Strategy is the detailed set of tactics to be employed in the pursuit of each goal.

The Strategy section should describe in detail the approach for pursuing the criteria enumerated in the Vision section of the Plan. The Strategy Section will be scored on whether it delineates a clearly defined and plausible path between the approach and the

desired end result, including the decision-making framework for smart grid implementation, the technology evaluation process, and prioritization of deployment efforts. Criteria that are not part of the Vision need not be discussed in the Strategy section.

Section 3: METRICS

Metrics are the units by which progress toward each Goal is measured.

One of the main promises of the smart grid is that it will enable the collection of data that can inform optimization in nearly every area of utility operations. The Metrics section should describe the measures that can be reported to assess future progress, along with a general description of the plans for collecting pertinent data and methods of calculation.

The Metrics section should be scored on whether it provides reasonable methods for the measurement and reporting of metrics related to the criteria to be pursued, as defined in the Vision, and whether the planned metrics are sufficient to enable stakeholders to evaluate the future effectiveness of the smart grid deployment at reasonable intervals. Where a utility does not currently possess the capability to measure and report performance of a particular criterion – whether it is a Consensus, CA-Exact, or Suggested metric – the Plan should explain the circumstances and describe the plan for resolving the issue. Alternatively, a narrative rationale describing why a Suggested metric is not appropriate or feasible may also be acceptable. Consensus and CA-Exact metrics must be included. Metrics for criteria that are not an accepted part of the Vision need not be addressed in the Metrics section.

Section 4: BASELINE

The Baseline is a list of current (starting) values for each metric

The evaluation of smart grid progress requires a documented baseline of values for each metric, to which future values can be compared. In this framework, the baseline is defined as the status of the electricity supply system at the time the Plan is submitted, with the intention that future progress of the grid as a whole will be monitored – without regard to attribution to the smart grid effort versus some other parallel effort. The smart grid is, in essence, the connective tissue that integrates a whole host of beneficial utility applications, some of which can exist – although perhaps to a lesser extent – in the absence of the smart grid. Because the comparison of future realized metrics with an estimated business-as-usual baseline would require significant effort with unverifiable results, this evaluation framework does not require the calculation of hypothetical future baseline scenarios. Rather, this framework defines the baseline as the conditions existing at some reasonably current point in time for which metrics can be attained.

Baseline sections should be scored for providing accurate current values for all metrics related to the criteria to be pursued, as defined in the Vision. Baseline metrics required by consensus or statute must be included. Baseline metrics for criteria that are not part of the Vision need not be provided.

Section 5: ROADMAP

Roadmap is the process and timeline for achieving target values for each metric.

Smart Grid Deployment Plans should provide a clearly defined Roadmap that lays out a detailed timeline of milestones or targets for each metric – annually through 2020, and then every 10 years through 2050. This timeline should be coupled with a brief narrative that parallels the more detailed process description provided in the Strategy section, including the adaptive management process by which target values are attained. Target values for criteria metrics that are not part of the smart grid deployment plan need not be provided.

The Roadmap will be scored for its likelihood to achieve targets specified by the utility, including CA-Exact goals. The value of specific future targets for metrics that are not required by statute will not be judged or scored; however, pursuant to D.10-06-047, the roadmap should align with the targets addressed by each of the following statutes:

- California Global Warming Solutions Act of 2006 (AB 32): reduce greenhouse gas emissions to 1990 levels by 2020, and to 80% below 1990 levels by 2050
- California Ambient Air Quality Standards for Particulate Matter (PM10 and PM2.5), Sulfur Dioxide (SO2), Ozone (O3), Visibility Reducing Particles, Nitrogen Dioxide (NO2), Lead, Sulfates, Hydrogen Sulfide (H2S), Carbon Monoxide (CO), and Vinyl Chloride
- The California Long Term Energy Efficiency Strategic Plan: zero net energy use for all new homes by 2020, and for all new commercial buildings by 2050
- Sections 454.5 and 454.55 of the California Public Utilities Code: utilities must meet resource needs first through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible, with specific targets to be determined jointly by the CPUC and CEC
- California Renewables Portfolio Standard: all retail sellers of electricity serve 33% of their load with renewable energy by 2020
- The California Solar Initiative: install 1,940 MW of new solar by 2017

Finally, in the spirit of linking these Plans with eventual actions, the Roadmap should describe the adaptive management strategies that will be used to ensure that deployments follow the Plan and/or any future modifications to the Plan approved by the CPUC, and respond nimbly to unexpected conditions that arise during the smart grid deployment process.

Scorecard

Figure 5 is a blank scorecard to be used in the evaluation of Smart Grid Deployment Plans. For each Section evaluated in Step 2, the score should be coupled with a qualitative critique in narrative form.

Figure 5. Blank EDF Scorecard

		SECTIONS					
		(1)	(2)	(3)	(4)	(5)	
		Vision	Strategy	Metrics	Baseline	Roadmap	**Total**
GOALS	(i) Empower Consumers						
	(ii) Create a Platform for Technologies & Services						
	(iii) Enable Sales of Demand-side Resources in Wholesale Markets						
	(iv) Reduce the Environmental Footprint						
Step 1: GOAL Score							
Step 2: SECTION Score							
PLAN Score							

References

— . *California Global Warming Solutions Act of 2006. An act to add Division 25.5 (commencing with Section 38500) to the Health and Safety Code, relating to air pollution* . September 27, 2006.

— . *California Senate Bill 17: An act to add Chapter 4 (commencing with Section 8360) to Division 4.1 of the Public Utilities Code, relating to electricity* . October 11, 2009.

— . *United States Energy Independence and Security Act of 2007: Title XIII Smart Grid* . 2007.

California Public Utilities Commission. *R.02-06-001: Order Instituting Rulemaking on policies and practices for advanced metering, demand response, and dynamic pricing* . June 10, 2002.

California Public Utilities Commission . *D.03-03-036: Interim opinion in phase 1 adopting pilot program for residential and small commercial customers* . March 13, 2003.

California Public Utilities Commission . *D.06-07-027: Final Opinion Authorizing Pacific Gas And Electric Company To Deploy Advanced Metering Infrastructure* . July 20, 2006.

California Public Utilities Commission . *D.07-04-043: Opinion Approving Settlement On San Diego Gas & Electric Company's Advanced Metering Infrastructure Project.* April 12, 2007.

California Public Utilities Commission. *Energy Action Plan: 2008 Update* . February 2008.

California Public Utilities Commission . *D.08-09-039: Decision Approving Settlement On Southern California Edison Company Advanced Metering Infrastructure Deployment.* September 18, 2008.

California Public Utilities Commission. *R.08-12-009: Order Instituting Rulemaking to Consider Smart Grid Technologies Pursuant to Federal Legislation and on the Commission's own Motion to Actively Guide Policy in California's Development of a Smart Grid System* . December 18, 2008.

California Public Utilities Commission. *D.10-06-047: Decision Adopting Requirements For Smart Grid Deployment Plans Pursuant To Senate Bill 17 (Padilla), Chapter 327, Statutes of 2009.* June 28, 2010.

California Public Utilities Commission . *Administrative Law Judge's Ruling Seeking Comments on Proposed Interim Metrics To Measure Progress by Pacific Gas And Electric Company, Southern California Edison Company and San Diego Gas & Electric Company in Implementing a Smart Grid* . R.08-12-009. December 29, 2010.

Electric Power Research Institute. *Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects* . Report 1020342. January 2010.

Federal Energy Regulatory Commission. *Smart Grid Policy: Proposed Policy Statement and Action Plan.* Docket No. PL09-4-000. March 19, 2009.

Federal Energy Regulatory Commission. *National Action Plan on Demand Response* . Docket No. AD09-10. June 17, 2010.

Galvin Electricity Initiative. *Perfect Power Seal of Approval* . www.galvinpower.org . May 2011.

National Energy Technology Laboratory. *A Systems View of the Modern Grid* . January 2007.

North American Electric Reliability Corporation. *Special Report: Accommodating High Levels of Variable Generation* . April 2009.

Pacific Northwest National Laboratory. *The Smart Grid: an Estimation of the Energy and CO_2 Benefits*. January 2010.

United States Department of Energy Office of Electricity Delivery and Energy Reliability. *American Recovery and Reinvestment Act of 2009: Funding for Smart Grid Activities.* 2009.