Evaluation Framework for Smart Grid Deployment Plans

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

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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.

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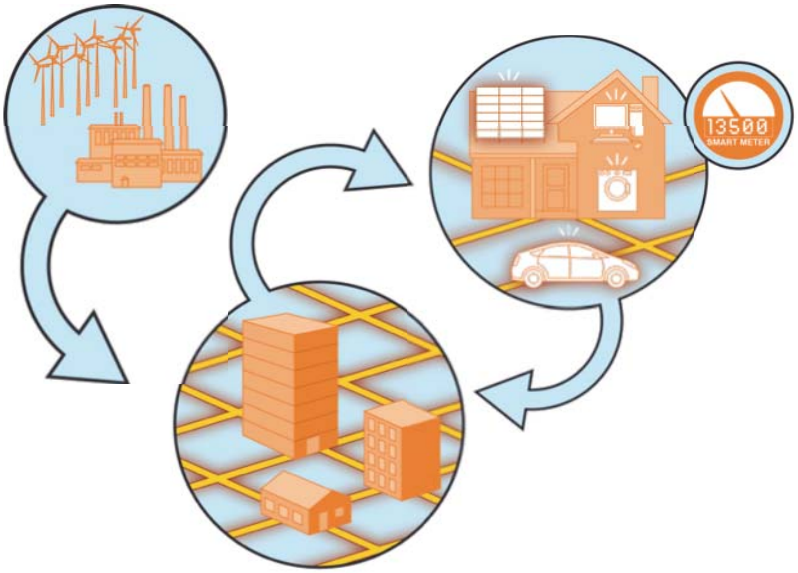
Background and Introduction

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)*