Self-Generation Incentive Program

Framework for Assessing the Cost-Effectiveness of the Self-Generation Incentive Program

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Executive Summary

ES.1 Overview

This report presents the framework Itron, Inc. will utilize to assess the cost-effectiveness of the SGIP. The cost-effectiveness study, which we expect to complete by mid-2005, is the latest in a series of reports prepared by Itron as part of our SGIP evaluation effort.

The general cost-effectiveness framework identifies key benefits and costs associated with the SGIP, and proposes practical means by which the benefits and costs can be valued in dollar terms. Specific cost-effectiveness frameworks are developed for the different perspectives associated with the market: total resource costs, program participants, and nonparticipating electric and gas ratepayers.

This cost-effectiveness report incorporates material from two major sources. The first is the California Standard Practice Manual (SPM),[1] which outlines a variety of general cost-effectiveness tests to be used to assess ratepayer-funded demand side programs. The cost-effectiveness frameworks proposed in this report comply with the spirit of the SPM, although they are specified in more detail and tailored to the needs of evaluating distributed generation programs. We also rely on concepts presented in a recent report on avoided costs prepared by Energy and Environmental Economics, Inc. (E^3).[2] The E^3 material is used to support the discussion of various types of avoided costs and avoided cost "adders" designed to capture the resource benefits of energy market programs.

ES.2 Cost-Effectiveness Frameworks

On the basis of its review of potential cost-effectiveness frameworks, Itron proposes to employ three specific tests for the purposes of evaluating the SGIP:

- A Societal Test;
- A Participant Test; and
- A set of Nonparticipant, or Ratepayers, Tests.

[1] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects,* Governor's Office of Planning and Research, July 2002.

[2] Energy and Environmental Economics, Inc., Methodology and *Forecast of the Long Term Avoided Costs for the Evaluation of California Energy Efficiency Programs,* prepared for the California Public Utilities Commission, October 25, 2004.

The Societal Test can be considered a variant of the SPM's Total Resource Cost Test. This test includes a variety of benefits characterized as avoided costs or avoided cost adders, including avoided generation costs, avoided transmission and distribution (T&D) costs, line loss reductions, a reliability adder, an environmental adder, waste heat utilization benefits, and a price elasticity adder. We propose to use values of these benefits derived from a recent study conducted by E^3 for the Commission, with the exception of T&D benefits and the environmental adder. Since D.01-03-073 does not allow SGIP projects to enter into contracts for distribution services, the basic cost-effectiveness analysis will be conducted on the assumption that these benefits are zero for the SGIP. The environmental adder will be modified to reflect the relative emissions of the DG technology and the displaced conventional generation, as previously explained in Section 5.

Societal costs include four elements: gross installed equipment costs, operating and maintenance costs, including fuel costs where applicable, environmental costs (considered as part of other benefits and costs, as opposed to being a separate category of costs), and Program administration costs, including marketing, measurement and evaluation costs.

The Participant Test assesses the program from the perspective of its participants. Participant benefits include reductions in electricity bills, the value of displaced fuels previously used to create usable heat, where applicable, and incentives and tax credits. Participant costs include installed equipment costs, O&M Costs (including fuel costs), and participant environmental costs.

The Nonparticipant Test, or Ratepayers Test, is constructed from the perspective or nonparticipating customers, or ratepayers. *As prescribed in the SPM, the test is constructed separately for electricity and natural gas ratepayers.*

For electric ratepayers, benefits consist of avoided system electric costs, while costs include lost revenue from bill reductions, any uncovered interconnection costs, and all program costs paid for by electric ratepayers. From the perspective of electric nonparticipants, net benefits (costs) can be characterized as reductions (increases) in electric revenue requirements, which will lead to reductions (increases) in electric rates.

For gas ratepayers, benefits consist of avoided natural gas fuel costs associated with waste heat utilization and increased sales revenue from natural gas fuel used by participants, while costs consist of the loss of revenue from the displacement of conventional gas usage, as well as program costs paid for by natural gas ratepayers. From the perspective of natural gas nonparticipants, net benefits (costs) can be characterized as reductions (increases) in natural gas revenue requirements, which will lead to reductions (increases) in natural gas rates.

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Introduction

The California Self Generation Incentive Program (SGIP) is a statewide[3] program developed by the California Public Utilities Commission to provide incentives for the installation of certain renewable and clean distributed generation technologies serving all or a portion of a facility's electric needs.

This report presents the framework Itron, Inc. will utilize to assess the cost-effectiveness of the SGIP. The cost-effectiveness study, which we expect to complete by mid-2005, is the latest in a series of reports prepared by Itron as part of our SGIP evaluation effort.

The general cost-effectiveness framework identifies key benefits and costs associated with the SGIP, and proposes practical means by which the benefits and costs can be valued in dollar terms. As is traditional in the area of energy efficiency and demand control, specific cost-effectiveness frameworks are developed for the different perspectives associated with the market. Specifically, tests are developed from the perspectives of total resource costs, program participants, and nonparticipating electric and gas ratepayers.

This cost-effectiveness report incorporates material from two major sources. The first is the California Standard Practice Manual (SPM),[4] which outlines a variety of general cost-effectiveness tests to be used to assess ratepayer-funded demand side programs. The cost-effectiveness frameworks proposed in this report comply with the spirit of the SPM, although they are specified in more detail and tailored to the needs of evaluating distributed generation programs.

We also rely on concepts presented in a recent report on avoided costs prepared by Energy and Environmental Economics, Inc. (E^3).[5] The E^3 material is used to support the discussion

3 Available in the service territories of Pacific Gas & Electric, Southern California Edison, Southern California Gas Company, and San Diego Gas & Electric.

4 *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects,* Governor's Office of Planning and Research, July 2002.

5 Energy and Environmental Economics, Inc., Methodology and *Forecast of the Long Term Avoided Costs for the Evaluation of California Energy Efficiency Programs*, prepared for the California Public Utilities Commission, October 25, 2004.

of various types of avoided costs and avoided cost “adders” designed to capture the resource benefits of energy market programs. While the avoided cost report was intended primarily to develop avoided costs to be used in the assessment of energy efficiency programs, it deals with concepts that are also useful in the development of a cost-effectiveness framework for self-generation, and provides forecasts of these categories of avoided costs that could be used, with some modifications, in the implementation of the framework.

2

Background and Objectives

California is a national leader in the development of methods to assess the cost-effectiveness of spending public funds for energy efficiency programs since the early 1980s.[4] As a result of the state's energy crisis in 2001, California began the process of developing a standardized benefit-cost framework for evaluating other energy resource options like distributed generation (DG). These efforts have been facilitated by 1) legislative and regulatory directives to integrate DG into the state's distribution planning processes, 2) creation and extension of the state's multi-year, ratepayer-funded Self-Generation Incentive Program, and 3) legislative and regulatory directives to develop cost-benefit analysis frameworks for DG and net metering programs.

Recent efforts in California and elsewhere have focused on developing valuation methods for specific DG projects/systems to support the integration of cost-effective DG solutions in the state's electrical system. Rulemaking (R) 99-10-025 established policies and procedures by which DG could be integrated into utility planning and operation of the electric grid, and developed criteria to be employed by the utilities to compare DG alternatives to traditional system expansion.

The potential benefits of "wide-spread deployment" of DG that were identified in that proceeding included peak demand reduction, deferral of distribution system equipment investment and upgrades, increased life of distribution equipment, reduction of utility capital risk, power quality improvements, voltage support, line loss reductions, improvements in reliability, environmental benefits, customer satisfaction, and fuel diversity. However, no specific instructions were given with respect to the technical framework to assess cost-effectiveness or to the specific means by which specific benefits and costs should be valued.

Order Instituting Rulemaking R.04-03-017- *Regarding Policies, Procedures, and Incentives for Distributed Generation and Distributed Energy Resources* identified the development of a benefit-cost analysis methodology for distributed energy resources (DER) as a priority.

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4 The *Standard Practice Manual*, developed by the California Energy Commission and the California Public Utilities Commission, specifies several alternative tests for evaluating the cost-effectiveness of demand-side management programs. The first version of the Manual was published in 1983, and revised in 1987 and 2001.

2.1 Objectives

The objectives of the initial phase of this project are as follows:

- To consider the impacts of the SGIP on the various DG stakeholder groups
- To determine the perspectives from which these impacts should be considered in order to support policy decisions relating to the program and the broader DG market,
- To develop a formal framework for assessing the cost-effectiveness of the SGIP from these various perspectives
- To propose workable means of valuing benefits and costs for the purpose of implementing the framework.

2.2 Approach

Itron considered a broad range of sources in selecting a cost-effectiveness framework to evaluate the SGIP, including:

- Economic studies of distributed energy resources, with specific emphasis on the assessment of DG options, the SPM, and cost-benefit analysis.
- Public comments to the Commission and the California Energy Commission on the assessment of DG technologies and market development programs.
- The E^3 avoided cost study.

Specific references reviewed in the course of the study are listed in the *References* section at the end of this report.

3

Review of DG Cost-Benefit References

3.1 Introduction

The purpose of this section is to provide context for the discussion of specific framework issues in later sections. For the purposes of this discussion, we separate the literature into the following categories: 1) general cost-effectiveness frameworks; 2) technical literature on the assessment of distributed generation; 3) avoided cost literature; and 4) Commission decisions, comments and reply comments.

3.2 General Cost-Effectiveness Framework

The SPM was jointly developed by the California Energy Commission and the California Public Utilities Commission to guide the assessment of energy efficiency programs. The SPM identifies a series of cost-effectiveness tests, each from a somewhat different perspective: 1) a participant test, which evaluates benefits and costs from the perspective of program participants; 2) a ratepayer impact measure test, which assesses the benefits and costs accruing to nonparticipating ratepayers; 3) a total resource cost test, which addresses program benefits and costs from the perspective of all parties affected directly or indirectly by the program; and 4) a program administrator test, which focuses on benefits and costs to the administrator of the program. While the SPM tests have traditionally been used in the assessment of energy efficiency programs, the most recent version of the Manual indicates that the cost-effectiveness tests are meant to apply to a broader range of programs, including "conservation, load management, fuel substitution, load building and self-generation."[5]

In selecting an SGIP-specific framework, Itron started with the concepts in the SPM and tailored them for the specific purpose at hand. In general, this involved identifying the specific benefits and costs to be incorporated into each of the tests in order to apply them to self-generation.

[5] SPM, p. 2.

3.3 Technical Literature on Self-Generation Assessment

Itron reviewed recent literature on economic analysis of distributed generation (DG) systems and distributed energy resources (DER) in energy industry trade journals and studies conducted by national laboratories and research. To identify methodologies adopted in other states and regions, Itron interviewed individuals with NYSERDA, the Regulatory Assistance Project, and the Texas Public Utilities Commission. Finally, we reviewed deliberations and regulatory decisions under California's past and current distributed generation proceedings (R. 99-10-025 and R.04-3-017).

Itron found very few analyses regarding the cost-effectiveness of publicly funded renewable energy, DG, or combined heat and power (CHP) programs. This is primarily due to the fact that few states invest public funds in a structured DG program. There are, however, numerous studies that enumerate the benefits and costs of specific distributed generation systems. Many of these studies are engineering-based and provide analysis of individual projects as opposed to an economic analysis of an entire market-based program implemented within a particular geographic region. Some of these studies present estimated monetized values for specific projects [(Hoff, 2003), (Hoff, 1996)] while others provide a less technical, more qualitative presentation of the value of distributed generation compared to centralized generation, transmission and distribution systems [(CBO, 2003), (Cowart, 2001)].

Iannucci, et al. (2003) provides an analysis and categorization of thirty studies on DG benefits analysis. Among other things, all studies were systematically evaluated according to 1) the extent that benefits were quantitatively derived, 2) the accuracy and completeness of analysis, and 3) clarity of methodology. The study presents the broad range of impacts considered and the methodologies to evaluate DG. While most studies reviewed presented some level of quantification of DG benefits, no two studies used the same analytical model and no study attempted to quantify all of the identified benefits.

Perhaps the most relevant study is an economic analysis comparing DG to energy efficiency options prepared by the Office of Ratepayer Advocates (ORA).[6] Unlike other analyses and discussions Itron reviewed, this report provides a benefit-cost analysis of a *portfolio* of Self-Generation projects instead of a specific DG system or DER technology option. ORA did not develop a new benefit-cost methodology for this study. Rather, the study applied tests already approved to evaluate the cost effectiveness of energy efficiency programs, as presented in the *Standard Practice Manual*, including the Participant test, the Program Administrator Cost test, and the societal version of Total Resource Cost (TRC) test. ORA

[6] Office of Ratepayer Advocates, California Public Utilities Commission, *Public Financing for Self-Generation: Costs and Benefits of Onsite Photovoltaic, Fuel Cell, and Micro-Turbine Systems*, January, 2001.

found a self-generation program to be cost effective, with benefit-cost ratios equaling or exceeding 2.0 for all of the aforementioned tests.[7]

The fact that the ORA study employed existing benefit-cost methodologies to evaluate a DG program is not at all inconsistent with the current *Standard Practice Manual*. As noted above, the current manual does identify self-generation among the types of demand-side programs to be covered by the SPM. Moreover, the manual explains that "AB 970 amended the Public Utilities Code and provided the motivation to develop a cost-effectiveness method that can be used on a common basis to evaluate *all programs that will remove electric load from the centralized grid*, including energy efficiency, load control/demand-responsiveness programs and self-generation. Hence, self-generation was also added to the list of demand side management programs for cost effectiveness evaluation."[8]

3.4 Avoided Cost Literature

All of the sources reviewed in the technical literature on self-generation assessment recognized the central role of avoided costs from the perspective of the marketplace. Insofar as self-generation can displace conventional generation, transmission and distribution, its benefits are generally characterized in terms of the avoided costs of those displaced resources. Avoided costs are crucial for the application of total resource cost and ratepayer impact tests.

In recognition of the variation of hourly avoided costs in the partly deregulated marketplace, E3 developed avoided costs on an hourly basis, using a "time dependent valuation" methodology. Following specifications provided by the CPUC, E3 developed forecasts for the avoided costs of generation, transmission, and distribution, as well as "adders" designed to capture the effects of demand reductions on environmental quality, system reliability, and market price. Much of the discussion in Section 5 (Societal Test) of this report relates to the appropriateness of these types of avoided costs to the assessment of the SGIP.

3.5 Review of Commission Decisions, Comments and Reply Comments

Itron reviewed the comments, reply comments, and testimony regarding development of an overall DG cost-effectiveness methodology in R.04-03-017. Parties to the DG rulemaking have expressed divergent views on the characterization and valuation of benefits and costs,

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7 The ORA study was released before the state's current Self-Generation Incentive Program began in mid-2001.

8 SPM, p. 4, emphasis added.

especially from broad standpoints like those of society and ratepayers as a whole. To the extent possible, this report reflects full consideration of the parties' primary points relating to the inclusion of specific DG benefits and costs as well as the means of valuing these benefits and costs.

4

General Framework Issues

4.1 Introduction

This section considers some general issues that affect the development of cost-effectiveness frameworks for distributed generation. Section 4.2 discusses the need for a cost-effectiveness framework. Section 4.3 considers the context of this effort, most specifically its relationship to other proceedings currently under way at the Commission. Section 4.4 discusses the core tasks that need to be completed in order to develop a set of viable and operational cost-effectiveness frameworks.

4.2 Need for a Cost-Effectiveness Framework

Ratepayer funds have a variety of potential uses, and are allocated among competing applications in a way that minimizes the costs of serving the energy needs of the general population (or, equivalently, maximize the benefits from the use of these resources). A demand-side program is deemed cost-effective if it provides energy services at a lower cost than the use of the funds for investments in conventional generation, transmission, and distribution. The framework developed here for the SGIP, as well as the more general framework put forward in the SPM for a broader range of programs, essentially compare the use of ratepayer funds for a demand-side program as an alternative to using them for the construction of conventional supply-side resources.

4.3 Relationship to the Evaluation of Other Resource Options

In R.04-03-017, the Commission identified a number of tasks to be completed, including to "develop cost-benefit analysis methodologies for DER and for net metering as called for by the Legislature."[9] The Commission defined DER to include DG, energy efficiency, demand response, and electrical storage (p.4). In the OIR, the Commission expressed the desire to have a single framework that can be used to evaluate all DER options. This may be feasible in the most general sense, but it should be recognized that the types of benefits and costs, as

9 CPUC Order Instituting Rulemaking regarding Policies, Procedures and Incentives for Distributed Generation and Distributed Energy Resources, March 16, 2004, p. 2.

well as the valuations of these costs and benefits, may differ across the various resource options. Our focus here is on the evaluation of DG as used in the SGIP, and the specific elements of the benefit-cost framework we develop for this purpose may not apply equally well to other DER options.

The construction of a benefit-cost framework to assess resource options is intrinsically tied to the development of avoided costs estimates. The conceptualization and valuation of avoided costs is currently being discussed in various proceedings at the Commission. In order to maintain consistency across these proceedings, the Commission has expressed its intent to develop a "common methodology for assessing avoided costs across the full range of supply- and demand-side technologies…"[10] and has established a Rulemaking proceeding (R.04-04-025) for this purpose. Again, the specific avoided costs to be included in such a methodology, and/or the specific valuation of these costs, may differ across the four classes of DER options.

4.4 Core Tasks of Developing a Benefit-Cost Framework

In its Reply Comments on the DER OIR, Southern California Edison Company (SCE) noted that the design of a benefit-cost framework must address four key issues:

- The specific question or policy choice to be addressed by the analysis;
- The perspectives for these decisions and the associated benefit-cost analysis;
- The appropriate categories of benefits and costs to include; and
- The appropriate means of valuing the included benefits and costs.

This enumeration of the key benefit-cost issues is fairly traditional in the technical literature, and will be adopted throughout this report. A brief overview of these four issues is provided below.

4.4.1 The Policy Question

As noted above, our focus is on DG as an element of the SGIP, and on a framework to evaluate the SGIP as it is currently designed. We do not attempt to design the framework to be used to assess the cost-effectiveness of other program designs, although modifications to the framework for this purpose would be a reasonably straightforward process. Further, the framework is based upon the existing market structure in California, recognizing that costs and benefits could clearly be affected by some other market design.

[10] DG OIR, p. 5.

As a consequence of our sole focus on the SGIP, we also restrict our attention to the types of facilities that qualify for the program. While the models developed in this report may be more or less applicable to other DG applications, we have not tailored the application of these frameworks to applications other than those that characterize the current SGIP.

4.4.2 Perspectives of the Analysis

Our analysis framework is designed to support the evaluation of the cost-effectiveness of the Self-Generation Incentive Program. As noted by several parties to the DG proceeding, this type of analysis must take into account various perspectives, each with its own set of benefits and costs. This approach is fairly common in the assessment of publicly-funded programs. Many programs have a wide range of impacts, both favorable and unfavorable, on various affected parties. Because we care not only about total costs and benefits, but also the distribution of these costs and benefits among various affected parties, it is useful to take this multiple perspective approach. In keeping with the spirit of the SPM, we develop a separate framework for each of three perspectives:

- Society as a whole, as represented by a version of the Total Resource Cost Test,
- Ratepayers, and
- Participants.

The reason for adopting a Societal or Total Resource Cost perspective is that it is consistent with the Commission's desire to use this type of methodology to assess resource options, one of which (DG) is promoted through the SGIP. The rationale for developing a test from the ratepayer perspective is that the SGIP is funded through rates, so effects on ratepayers (rate impacts) are clearly relevant to policy decisions relating to the program. The purpose of developing a participant test is less straightforward, insofar as the participation decision is not the policy issue in question. (Participation is voluntary and is not contingent on cost-effectiveness.) However, the key elements of a participant test (utility bill impacts, equipment and project development costs, etc.) are needed for the development of other tests.

4.4.3 Categories of Benefits and Costs to be Included

One of the first steps in the assessment of any publicly funded program is to identify the types of impacts, or costs and benefits, associated with the program. In the course of this exercise, it is important to consider the appropriateness of each benefit or cost, and to avoid the omission of important impacts as well as the double-counting of benefits and costs. Various studies have enumerated extensive lists of benefits and costs to be included in the analysis of the cost-effectiveness of DG. However, there is no consensus on the appropriateness of some of these benefits and costs. This lack of consensus is at least partly attributable to the following factors:

- Perspectives of the cost-effectiveness analysis differ, with most analyses focusing on participant benefits and costs, and relatively few on the broader program or societal perspectives,
- Some benefits (costs) overlap with each other,
- Terminology differs across parties, leading to different classification schemes,
- Views on the institutional/market setting differ,
- Perceptions of the feasibility of quantifying certain benefits and costs vary, and
- Policy positions with respect to the efficacy of DG vary.

In Sections 5 through 7, we examine a comprehensive list of benefits and costs and then attempt to make judgments about the appropriateness of these impacts for the specific SGIP cost-effectiveness test in question.

4.4.4 Valuation of Benefits and Costs

Once program impacts (benefits and costs) are identified, the application of cost-effectiveness analysis requires that *at least* the most important types of benefits and costs be valued in dollar terms. This “monetization” or “valuation” of benefits and costs is necessary in order to facilitate the comparison of these benefits and costs and to allow the determination of whether or not benefits outweigh costs. Of course, not all program impacts may be susceptible to valuation; nonetheless decisions are greatly facilitated to the extent that such valuation can be accomplished.

Even for benefits and costs that are considered appropriate for certain tests by many experts, and for which dollar valuation is possible, there are sometimes marked differences in specific approaches to valuing these effects. As will be pointed out in Sections 5 through 7, these differences are often attributable to the perspectives of the parties, the assumptions they are prone to make, and their views of the marketplace. Sections 5 through 7 provide recommendations regarding the valuation of the benefits and costs. It is important note that it is often necessary to adopt available valuations, even when they are less than ideal, in order to develop the best *operational and feasible* cost-effectiveness analysis. This is a particularly important factor in the context of this report, insofar as the framework developed here is meant to be implemented in the near term to conduct an initial assessment of the cost-effectiveness of the SGIP. This timetable does not permit the opportunity to await the outcome of the contentious issues surrounding valuation pending before the Commission.

5

Societal Test

5.1 Introduction

This section focuses on the development of a Societal Test to be used in the evaluation of the SGIP. The perspective of the Societal Test is comprehensive, in the sense that it covers all affected parties. The societal test is a variant of the CPUC's Total Resource Cost (TRC) Test. The TRC "…represents the combination of the effects of a program on both the customers participating and those not participating in a program."[11] The perspective of the Societal Test differs from that of the standard TRC in three ways:

- The Societal Test ignores tax credits, which are benefits to participants but costs to other taxpayers,
- The Societal Test considers a series of "externalities," which affect society as a whole, and
- The Societal Test makes use of a societal discount rate, which is generally lower than the private discount rate employed in the TRC test.

Section 5.2 considers the benefits included in the Societal Test. Section 5.3 considers the associated costs. Finally, Section 5.4 discusses figures of merit used to summarize the results of the Societal Test.

5.2 SGIP Societal Benefits

5.2.1 Potential Societal Benefits

The following potential societal benefits have been cited either in the literature or in the comments and reply comment associated with the Commission's DG OIR.

- Avoided Generation Costs
- Avoided Transmission and Distribution Capital Costs
- Reliability Net Benefits
- Reduced Line Losses

[11] *SPM*, p. 18.

- Voltage Support and Power Quality Benefits
- Environmental Net Benefits
- Price Effects
- Economic Impacts
- National Security Impacts
- Waste Heat Use Benefits of Combined Heat and Power Applications

In what follows, we discuss the appropriateness of these potential benefits for inclusion in a Societal Test. For those benefits that are conceptually valid for this framework, we also consider the proper means of valuing them.

5.2.2 Avoided Generation Costs

Virtually all researchers and commenting parties agree that distributed generation facilities installed under the SGIP displace conventional generation, and thus provide benefits of avoided conventional generation costs. It is also generally agreed that these avoided costs should take into account the actual operating pattern of DG facilities, and that these patterns may differ appreciably across specific technologies. Considering this temporal variation requires forecasts of hourly (time-dependent) avoided costs.

As noted earlier in this report, the most recent source of forecasts of avoided generation costs is a study conducted by E^3,[12] currently under consideration in the Commission's Avoided Cost rulemaking proceeding (R.04-04-025). Given that the previously approved forecasts of avoided costs are fairly old, it seems reasonable to consider the E^3 forecasts for use in the evaluation of the SGIP. The E^3 study provides hourly values for the full forecast period, and is thus well-suited in this respect for the analysis of the cost-effectiveness of DG. Itron intends to develop hourly generation profiles for each technology. To the extent possible, data will also be developed by location. These profiles will be used, along with hourly avoided costs, to estimate total avoided cost benefits.

It is important to note that the avoided generation forecasts provided by E^3 were developed using a somewhat different approach than has been used historically in California. For electric avoided costs, for instance, the methodology entailed the chaining together of three distinct approaches over the forecast period:

- In the first period (2004-2007), forward prices were used to develop forecasts of hourly values of generation avoided costs. These costs reflect generation marginal costs, inclusive of environmental control costs actually paid by generators.

12 Op. cit.

- In the second period, avoided costs are derived through the linear interpolation between the last year of period 1 and the first year of period 3. In the base forecast provided by E^3, however, no such transition period was necessary.
- The third period of the forecast horizon (2008 through 2023 in the base forecast), is assumed to be one of "resource balance," in which system supply matches system demand. Because of the assumed ease of entry and exit and the existence of workable competition, the supply curve is assumed to be flat.[13] During this period, the trajectory of avoided costs depends upon natural gas prices, using an assumption that the marginal unit is a combined cycle gas plant.[14]

In a traditional approach, separate energy and capacity costs were customarily developed, and the combustion turbine was typically used to develop capacity costs. E^3 contends that a separate capacity value is not needed as long as cost-effectiveness analyses are conducted at the hourly level. E^3 points out that it used the combined cycle gas turbine only to forecast the average annual market price, and that an hourly market price shape is applied to this average price to obtain hourly price forecasts. The variations in hourly prices capture the fact that different units are used at the margin during different hours of the year.[15]

The E^3 methodology is meant to be reflective of a market-based approach, and this perspective does not require the inference of a separate capacity cost. It seems reasonable to base long-term average annual market price forecasts on the cost of generation with the dominant form of incremental plant, and this tends to be the combined cycle unit. For purposes of the SGIP evaluation, we propose to use the E^3 avoided generation cost forecasts to value the societal energy benefits of SGIP, and more specifically, to use an hourly analysis based on estimated hourly generation profiles and hourly avoided costs. If those forecasts are modified in the avoided cost proceeding, such refinements can be incorporated into subsequent evaluations of the cost-effectiveness of the SGIP.

5.2.3 Avoided Transmission and Distribution Costs

Studies suggest the consideration of the transmission and distribution (T&D) benefits of DG. To the extent that DG reduces customer demand on the grid, T&D benefits may occur. From a conceptual standpoint, it seems to be widely recognized that if such benefits occur, they should be considered in the evaluation of DG programs. The value of deferring or avoiding capital investments in transmission and distribution capacity were identified as the strongest drivers for DG and the most often valued DG benefits found in the studies reviewed by Iannucci (2003). Depending on the time, location, and installation of DG (and "physical

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[13] Note that this implication of a flat supply curve also presumes that the market is a constant cost industry—i.e., that factor prices are invariant to the level of production.

[14] See pp. 59-69.

[15] See E^3, pp. 260-1.

assurance"), DG can be considered an economical solution to defer high-cost, long-term centralized distribution system upgrade projects.[16] Indeed, much of the rationale for self generation to date is based on such benefits.

E^3 provides forecasts of avoided T&D costs by utility, climate zone, division, voltage level, hour, and forecast year. These costs are meant to be discounted savings from deferrals of T&D investments. Electric T&D avoided costs are estimated on an annual basis through the use of two central pieces of information derived from utility resource plans: a) projected load change in each area, and b) anticipated T&D investments in those areas by year. For each year, the deferral (in years) in investment associated with a load change is determined, then converted to an annual value with an annualization factor. The annual values are distributed to hours of the year using the results of research conducted for the CEC's Title 24 Time-Dependent Valuation (TDV) project.[17] These hourly allocations are based on typical meteorological year (TMY) weather conditions.

The E^3 avoided cost forecasts were developed most specifically for the evaluation of energy efficiency and demand-side management programs. As a result, their applicability to the evaluation of SGIP needs to be considered carefully. Energy efficiency options tend to be widespread and relatively uniformly distributed. Unlike energy efficiency, the evaluation of DG options requires very location-specific information on T&D avoided costs, and must be evaluated using distribution system conditions in the specific area(s) in question.

In D.03-02-068, the Commission adopts four conditions under which DG may provide distribution benefits:

- The DG resource is in an area in which distribution investment needs have been identified,
- The DG is operational in time to allow a deferral of distribution investments,
- The amount of DG is appropriate to the area's needs, and
- The DG is accompanied by contractual physical assurances.

The consideration of the four conditions would appear to warrant the exclusion of T&D benefits from the current analysis of the SGIP. It would be impossible within the constraints of the evaluation to make judgments on the first three requirements. E^3's avoided T&D costs do take into account to some extent the general state of the distribution system by planning

[16] "Physical assurance" is the requirement that the installed DG system will provide a real load reduction on the facility where expansion is deferred.

[17] Energy and Environmental Economics, Inc. and Heschong-Mahone Group. *Time Dependent Valuation of Energy for Developing Building Energy Efficiency Standards: Time Dependent Valuation "Cookbook*," Submitted to Pacific Gas & Electric, April 12, 2002.

area, and the first requirement of capacity need is reflected at least generically in the T&D avoided cost forecasts. However, the second requirement of timely availability and the third condition of appropriateness of DG capacity cannot be assessed without more detailed information on the distribution system. This information is not currently available at a detailed distribution system service level.

It should be noted that none of the SGIP projects provide, or are required to provide, physical assurance. Decision 01-03-073 states that DG projects with contracts to provide distribution support are ineligible to receive SGIP incentives.

It seems most appropriate under the circumstances to recognize that T&D benefits should be included in a general cost-effectiveness framework designed for the assessment of DG, but to set these benefits equal to zero for the upcoming analysis of the SGIP. However, in order to provide potentially useful information for the regulatory process we propose to test the sensitivity of the results to this assumption by conducting a variation of the basic analysis that includes the E^3 T&D avoided costs in the estimation of T&D benefits.

5.2.4 Reliability Net Benefits

Its potentially favorable impact on system reliability is cited as a benefit of DG in most of the studies reviewed by Iannucci, et al (2003). While these studies recognize the need to monetize this benefit, they have different specific interpretations of these reliability impacts. We can generally characterize them as reductions in outage costs or reductions in the system capital and operating costs necessary to maintain a given level of reliability.

Using the latter characterization, E^3 values reliability benefits as induced reductions in purchases of ancillary services by the California Independent System Operator (CA ISO). E^3 points out that some ancillary services are more or less proportional to system loads, including operating reserves, regulation and replacement reserves.[18] E^3 suggests that since the need for these services is roughly proportional to system loads, anything that reduces system loads conveys the benefit of reduced expenditures on these services. E^3 develops a reliability adder to value this benefit.[19]

The reliability adder reflects the assumption that load reductions result in a proportional reduction in ancillary services procured in the CA ISO's day-ahead and hour-ahead

18 E^3, op. cit., 144-5.

19 E^3 also identifies ancillary services that are purchased on a long-term basis: voltage support and black start capability. However, E^3 notes that these services are not particularly sensitive to loads, and thus does not consider these services in the development of the reliability adder. See E3, op. cit., pp 144-5.

markets.[20] Historically, the ratio of ancillary services capacity to total load has varied between 8% and 18%. Hence, the adder for reduced ancillary services per kWh of reduced load is based on only *that fraction* of the cost of a kW of ancillary capacity. It should be understood that this treatment, if applied to DG, does not assume that DG actually provides ancillary services,[21] only that the load reductions associated with DG induce a proportional reduction in required ancillary services.

On the other hand, while the presence of DG (like energy efficiency) may reduce the amount of ancillary services required to mitigate a blackout, the impact may not be as favorable as for load reductions stemming from energy efficiency. Some DG operations (those without black start capability) will shut down in the event of an outage. This does not mean that they have no reliability benefit, since E^3 is not claiming that they are equivalent to ancillary capacity, just that they reduce the amount of such capacity needed.

There is some disagreement over the extent to which the reliability adders developed by E^3 are fully appropriate to the assessment of DG resources. The appropriateness of such adders depends upon the actual impact of DG-related demand reductions on the need to procure auxiliary services. Applying the E^3 avoided cost value for reliability essentially assumes that reductions in demand caused by DG have at least roughly the same impacts as changes caused by energy efficiency or any other source of fluctuation. To the extent that the CA ISO uses historical demand patterns to assess the need for ancillary services, and to the extent that actual hourly reductions in demand are used to assess reliability impacts of DG, this assumption should be met. Some modifications could be made to the energy reductions applied to the reliability adder; however, according to our calculations, the reliability adders amount to only between 1% and 5% of total energy costs, so this would have relatively little impact on any societal test like the one recommended here. Therefore, we propose to use the E^3 reliability adders, without adjustment, in the Societal Test.

5.2.5 Reduced Line Losses

There are two ways in which DG could affect line losses.

- First, because of the location of DG at the customer's site, line losses are obviously lower for locally consumed on-site generation than for consumption satisfied through central station generation.

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20 E^3's explanation of this adder is confusing. On p. 144, E^3 indicates that load reductions lead to a "one-to-one" reduction in the three covered ancillary service requirements. However, we have verified with E^3 that the actual calculation of the reliability adder is based on the assumption that load reductions have an equal *proportional* impact on auxiliary service requirements.

21 In order for DG to actually supply ancillary services, it would have to meet the CA ISO's requirements for procurement of such services.

- Second, it could be argued that the presence of DG (by reducing line loading) reduces line losses for all energy transmitted through the grid.

The first phenomenon will be captured indirectly in the Societal Test by the use of E^3 generation avoided costs that encompass line losses (and the recognition that there are no line losses with on-site generation). However, the second potential impact on line losses will not be factored into the Societal Test, as we are unaware of any studies that would support generalizations with respect to such effects of DG on line losses. In the remainder of this framework report we will not list reduced line losses as a separate program benefit, but will account for the applicable portion of it as part of generation avoided costs.

5.2.6 Voltage Support/Power Quality Benefits

Studies indicate that DG provides voltage support/power quality benefits for both participants and for the system as a whole. For instance, Gumerman, et al (2003) points out that DG "could raise voltages to customers nearby, thereby improving the quality of their service and reducing distribution system losses."[22] However, these impacts are very localized, and difficult to quantify from the perspective of a broad-based program like the SGIP.[23] As a consequence, we will not attempt to incorporate them into the SGIP cost-effectiveness framework.

5.2.7 Environmental Net Benefits

Displacement of conventional central station generation with self-generation may have environmental impacts. To the extent that these are not internalized by the marketplace, these impacts should be valued and included in a societal test. This has been a fairly standard practice in California for the assessment of energy efficiency options. However, several parties object to the consideration of these environmental values in the assessment of distributed generation. These arguments are considered below.

Some parties have pointed out that some types of self-generation covered by the SGIP also yield emissions of certain pollutants. In this respect, the environmental avoided costs that might be relevant for the assessment of energy efficiency options (which do not typically yield emissions) may not be appropriate for the assessment of the SGIP. As a result, any cost-effectiveness framework should either value the net change in emissions as benefits, or include self-generation system emissions as costs.

Some parties also argue that the costs of emission controls are already included in generation avoided costs, so no environmental adders are necessary. While this is true, there are still residual emissions that cause economic costs. So this argument, in itself, does not eliminate

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[22] Gumerman, et al (2003, p. 23), p. 23.
[23] Ibid.

the need to consider the societal value of reducing residual emissions. However, conventional generators are required to provide emission offsets for residual emissions of some pollutants. To the extent that this is true and the costs of generation reflect the costs of these offsets, these costs are internalized by the market and need not be considered separately as an additional benefit. Such offsets are currently required for NOx, and PM-10, but not for CO_2.

In recognition of the requirement for NOx, and PM-10 offsets, E^3 did not specify such costs as externality costs over the period of time for which forward prices (which should reflect such costs) were used as indicators of avoided generation costs. In the second portion of the forecast period, over which the cost of a combined cycle plant was used to reflect avoided costs, however, the forecasted costs of NOx and PM-10 offsets were incorporated directly into the generation costs of this reference unit. This approach appears to avoid the issue of double-counting raised by SCE in its DG OIR comments.

The costs of CO_2, for which offsets are not required, were included in avoided costs over the full forecast period. As pointed out by E^3, the CPUC has already ruled in R.01-10-024 that this issue of CO_2 should be considered in the rulemaking dealing with avoided costs (R.01-08-028).[24]

The approach used by E^3 seems to be a theoretically appropriate means of incorporating environmental costs into the avoided costs used to assess energy efficiency measures and programs. These avoided costs would also appear to be appropriate for evaluating the benefits of distributed generation resources that do not yield these emissions. However, it is important to be consistent in the treatment of environmental costs associated with conventional and distributed generation.

We propose the following approach to evaluate the environmental benefits of the SGIP:

- First, in order to maintain comparability with the calculation of avoided generation costs, the costs of control equipment and emission offsets will be included in the cost of DG.[25]
- Second, the E^3 environmental adder, which pertains only to CO_2 emissions, will be modified for individual technologies. For SGIP DG energy coming from solar, and wind technologies, which do not yield CO_2, the full adder will be used. For other technologies, the adder will be modified to reflect the net CO_2 impacts of the

[24] Op. cit., p. 276.

[25] Technically, this treatment assumes that the NO_X and PM-10 offsets required for non-renewable DG facilities are the same as for conventional generation. While this is not the case, we use this as a simplifying assumption. The simplification is necessitated by the lack of an alternative approach for valuing emissions for which offsets are not required.

DG as compared to the DG technology in question. Net CO_2 emissions will be estimated based on DG heat rates (as compared to heat rates for conventional generation) as well as the displacement of natural gas combustion at the end use through the recovery of useful waste heat from cogeneration systems.[26]

5.2.8 Price Effects

Several sources have proposed that electricity price effects of distributed generation be included as benefits in a cost-effectiveness assessment. The rationale is as follows. Distributed generation reduces the demand for electricity purchased in spot markets, thereby leading to reductions in prices. Because the electricity supply schedule is relatively inelastic at high volumes, these price effects will be particularly significant for peak periods. These induced reductions in price, which apply to all units of energy purchased in the spot market for the periods in question, constitute benefits to ratepayers in the form of reductions in energy expenditures. The appropriateness of incorporating this price effect as a benefit depends upon two main factors:

- First, it depends upon the perspective of the cost-effectiveness test. While it is true that the induced reductions in market prices benefit consumers, they are basically transfers from producers to consumers. If a cost-effectiveness test is designed from the perspective of consumers, these benefits should be included. However, if the test is designed from the perspective of society (a group to which producers presumably belong), then the transfer from one group to another does not constitute a net societal benefit.
- Second, the characterization of the consumer benefit depends upon the period in question. While it is true that the price reduction conveys a benefit to consumers in the short run (given generating capacity), the long run effect will be diminished by the tendency for lower prices to result in less construction of new generation. That is, the short run supply schedule will shift to the left (over the long run in relative terms) with the program-induced reduction in short-term prices, thereby causing prices to rise. E^3 recognizes this phenomenon indirectly by assuming that the market price will be determined by the cost of a reference generating unit in the long run with ease of entry and exit. That is, the price elasticity adder is assumed to be zero in the latter part of the forecast period after resource balance is achieved.[27]

The choice of including or excluding price elasticity effects in the societal TRC is a difficult one. It hinges essentially on the first issue cited above: Are non-DG power producer benefits and costs to be included in the societal test, or should society be more narrowly

[26] The use of recovered heat will be determined through ongoing Incentive Level 2 and Level 3-N measurement and evaluation activities.

[27] It should be noted here that if resource balance is achieved prior to 2008, the price elasticity adder would be even smaller.

defined to exclude this group in the context of this test? This is a value judgment, and we will leave this decision to decision-makers. For the purposes of the evaluation of SGIP, we will leave the price elasticity adder in the cost-effectiveness model. However, it should be noted here that the adder is extremely small, amounting to less than 0.3% of total avoided costs over the forecast period.

5.2.9 Economic Impacts

Several participants in the OIR process propose that economic effects of DG should be considered as benefits.[28] While it is true that spending on the construction and operation of DG facilities has positive direct impacts on employment, income, and tax revenues, these effects are only one dimension of a broader range of effects. From a societal (or overall resource) standpoint, it has to be kept in mind that higher expenditures on DG are matched by lower expenditures elsewhere in the economy. This point can be made by looking at the alternatives to DG.

First, since DG presumably replaces conventional generation, increases in DG spending lead to at least partly offsetting reductions in expenditures on conventional generation. There is no reason to believe that the economic impacts of DG expenditures are higher than those of the displaced investment in conventional generation.

Second, another way to look at this issue is to consider the SGIP's contribution to the development of DG projects, or the subsidy provided by the program. While it is clearly true that this subsidy promotes favorable economic effects, it is subsidized through a charge to ratepayers. The charge leaves ratepayers with less disposable income, and this causes them to reduce expenditures on other goods and services. This in itself causes adverse economic impacts, and, again, these offset at least part of the favorable economic impacts of the subsidy.[29]

In order to assess the net economic impacts of the SGIP, a detailed economic impact analysis would have to be conducted to compare favorable and unfavorable impacts. In the absence of a credible study of this sort, we will leave this potential benefit out of the model and assume zero net economic impacts in our analysis of the cost-effectiveness of the SGIP.

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[28] See, for example, *Opening Comments of the Office of Ratepayer Advocates*, May 17, p. 5, and Opening *Comments of the Center for Energy Efficiency and Renewable Technologies and the Natural Resources Defense Council in R.04-03-017*, p. 4.

[29] The relative impact of the rate-financed subsidy depends upon the state of the economy to some extent. If unemployment is high, the net effect may be positive, for much the same reason that the net effect of an increase in tax-financed government expenditures is positive under such circumstances. If unemployment is low, the net effect is likely to be very low.

5.2.10 National Security Impacts

The impacts of DG on national security were cited in comments by a number of parties, including City and County of San Francisco,[30] ORA,[31] Distributed Energy Strategies, et al.,[32] and CalSEIA.[33] Two themes run through the literature on this point. Some authors indicate that DG—especially renewables-based DG—reduces reliance on imported oil, and thus conveys benefits to society in the form of reduced expenditures on protecting foreign oil supplies. Others (e.g., Gumerman[34]) suggest that, by dispersing generation facilities, DG can reduce the susceptibility of the grid to terrorist activities. While we do not dispute the potential for such benefits, we have no way of valuing them for the purposes of the evaluation of the SGIP. As a result, they will not be included in the quantitative cost-effectiveness framework.

5.2.11 Waste Heat Use Benefits

DG operating in a combined heat and power (CHP) mode provides a source of heat (steam, hot water, or direct heating) to be used in various processes. From the perspective of the societal test, this benefit can be captured by the avoided cost of fuels that would otherwise be used to serve these heat requirements. For the purposes of this analysis, we assume that natural gas would be the displaced fuel. Hence, the benefit of using waste heat will be characterized as the reduction in gas usage, valued at the avoided cost of natural gas. Note that in keeping with the treatment of environmental costs associated with generation, E^3's avoided costs, which include an environmental component, will be used for valuing reductions in gas usage.

5.2.12 Summary of Societal Benefits

In summary, we propose to include the following benefits in the SGIP societal test:

- Avoided generation costs, as valued by the E^3 forecast,
- Avoided transmission and distribution costs, *valued alternatively at a zero value and using hourly energy impacts valued by the E^3 T&D avoided cost forecast*,

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30 *Opening Comments of the City and Count of San Francisco on the Scope and Schedule for the Order Instituting Rulemaking Regarding Policies, Procedures and Incentives for Distributed Generation and Distributed Energy Resources*, May 17, 2004, p. 5.

31 Op. cit., p. 5.

32 *Opening Comments of Distributed Energy Strategies, Encorp, Equity Office Properties, Northern Power Systems, RealEnergy, Sonnenblick Del Rio, TRC Solutions and the United States Combined Heat and Power Association (USCHPA) on the Scope of the Order Instituting Rulemaking Regarding Policies, Procedures and Incentives for Distributed Generation and Distributed Energy Resources*, May 17, 2004, p. 8.

33 *Opening Comments of the California Solar Energy Industries Association in R.04-03-017*, May 17, 2004, p. 13.

34 Op. cit.

- Reliability net benefits, as valued by the E^3 forecast,
- Reduced line losses associated directly with reductions in power purchases by DG participants, but not losses induced by overall reductions in system demand,
- Environmental net benefits, as valued by the E^3 forecast but modified to recognize emissions from DG facilities,
- Price effects, and
- Waste heat benefits of combined heat and power applications.

Formally, the societal benefits of the program (*SocietalBenefits*) will be specified as the sum of societal benefits associated with individual technologies ($SocietalBenefits_i$):

$$(1)\quad SocietalBenefits = \sum_{i=1}^{N} NTG_i(AvoidedElectricCosts_i + WasteHeatBenefits_i)$$

where $AvoidedElectricCosts_i$ represents avoided electric costs associated with technology i, $WasteHeatBenefits_i$ reflects total waste heat benefits associated with technology i, and *NTG is a net-to-gross ratio for the technology in question.* This net-to-gross ratio reflects the fraction of benefits that are actually attributable to the program, and is defined as the percentage of distributed generation of the technology in question that would have been installed in the absence of the SGIP. Net-to-gross ratios will be estimated based on surveys that have been conducted by Itron as part of the impact and process assessments of the program.

Equation (1) emphasizes the need to recognize differences in societal benefits across technologies. As pointed out by a number of parties in the DG proceedings, a variety of specific benefits (and costs) vary across technologies. The analysis will be done at the technology level, then aggregated to the program level.[35]

Avoided electric costs for each technology will be developed on an annual basis for the assumed lifetime of the technology, then discounted back to present value. That is:

$$(2)\quad AvoidedElectricCosts_i = \sum_{t=0}^{T} \frac{AvoidedElectricCosts_{it}}{(1+d)^t}$$

Where t denotes the year in question, T is the lifetime of the technology, and d is a societal discount rate. For each technology, annual avoided electric costs will initially be developed

[35] It may also be prudent to disaggregate the analysis by voltage level. This issue will be considered by Itron in the course of implementing the framework.

at the hourly and regional level, then summed over regions and hours to create annual values for the technology in question:

$$(3) \quad AvoidedElectricCosts_{it} = \sum_{r=1}^{R} \sum_{h=1}^{8760} \Delta kWh_{irh} \, AvCost_{irht}$$

where ΔkWh_{irh} is the hourly electricity output of technology *i* in region *r*, and $AvCost_{irht}$ is the avoided electric cost per kWh in hour *h* in year *t* in region r for technology *i*. The regions will be defined based on the planning areas used in the E^3 study. This specification requires that hourly energy impacts be derived separately by technology and planning area and applied to the relevant hourly profile of avoided generation costs. The hourly analysis will be supported by the use of hourly generation load profiles being developed by Itron under contract to the SGIP Working Group. As discussed earlier, the hourly avoided cost rates include avoided costs of generation ($AvGCost_{hrt}$), avoided cost of transmission and distribution ($AvTDCost_{hrt}$), an environmental adder that varies across technology ($EnvAdd_{ihrt}$), a reliability adder ($ReAdd_{hrt}$), and a price elasticity adder ($PEAdd_{hrt}$). Avoided generation costs take into account line losses on displaced purchases. It should be noted again that T&D benefits will be assumed to be equal to zero in one set of analyses and equal to hourly generation times the E^3 forecast of avoided T&D costs in a sensitivity analysis. This term is left in the model in anticipation that issues surrounding the proper treatment of T&D benefits will ultimately be resolved, perhaps by some means of derating the hourly energy output used in this calculation.

The equation for avoided costs can be written as:

$$(4) \quad \begin{aligned} AvCost_{ihrt} &= AvGCost_{hrt} + AvTDCost_{hrt} + ReAdd_{hrt} \\ &+ M_i EnvAdd_{ihrt} + PEAdd_{ihrt} \end{aligned}$$

As discussed above, the modifier on the environmental adder will take into account the net differential in CO2 emissions between the specific DG technology and conventional generation. For solar and wind applications, the modifier will be equal to 1. For technologies that emit more CO_2 than conventional generation (e.g., non-CHP applications of fossil fuels), the modifier will be negative, thus recognizing the net environmental cost. For biogas systems, the multiplier would depend partly on the use of supplemental natural gas.[36] For CHP applications, the size of the multiplier will depend on relative heat rates and waste heat utilization.

[36] Note that we are ignoring the differences in CO_2 additions v. reductions in CH_4 emissions (or their flared equivalents).

Waste heat benefits will cover combined heat and power applications, and will be computed as the present value of annual values:

$$(5)\quad WasteHeatBenefits_i = \sum_{t=1}^{T} \frac{WasteHeatBenefits_{it}}{(1+d)^t}$$

The annual values of waste heat benefits will be given by:

$$(6)\quad WasteHeatBenefits_{it} = \sum_{m=1}^{12} DisTherms_{im} AvGasCost_{mt}$$

where $DisTherms_{im}$ is the gas consumption displaced by technology i in month m and $AvGasCost_{mt}$ is the avoided cost of gas in month m and year t.

5.3 SGIP Societal Costs

5.3.1 Potential Societal Costs

The following potential societal costs have been cited either in the literature or in the comments and reply comments associated with these costs:

- Gross Installed Equipment Costs,
- Operating and Maintenance Costs,
- Environmental Costs, and
- Program Administrative Costs.

These costs are reviewed briefly below.

5.3.2 Gross Installed Equipment Costs

One of the central costs to be included in the Societal Test will be the installed cost of DG equipment, both eligible and ineligible.[37] This cost will include all design, equipment, and installation costs associated with the DG facilities installed under the program. They will also include any one-time payment for required emissions offsets. Equipment costs should also include the costs of any instrumentation provided by participants, whether installation is voluntary or required by the program. Finally, installed costs should include electric and/or gas interconnection costs, which are paid by participants.

From the perspective of the societal test, these costs will be gross of any incentives paid by the SGIP. These incentives are transfer payments from ratepayers to participants. While they reduce participants' costs, they do not reduce the societal costs of equipment.

[37] This would include, for instance, the cost of heat recovery equipment that may not be eligible for the purposes of determining Program incentives.

5.3.3 Operating and Maintenance Costs

All annual operating and maintenance costs will be included in the cost-effectiveness framework. These costs will be defined to include fuel, annual purchases of emissions offsets, if any, as well as other system O&M costs. If the DG application is a CHP technology, the costs of fuel usage will be partly offset by the displacement of fuel that would have been used in the absence of the DG facility to serve heat requirements (as reflected by the waste heat benefits identified above). In the event that the fuel used for the CHP application is natural gas, the E^3 avoided cost of natural gas (including the environmental adder) will be used to value fuel usage.

5.3.4 Environmental Costs

Environmental costs will not be included as a free-standing component of costs, but will be included in the analysis implicitly and explicitly. Emissions control equipment costs and any one-time purchases of offsets will be included in installed equipment costs (see above). The annual costs of NO_X and PM-10 offsets required for DG facilities will be included under O&M Costs (see above) explicitly. Environmental costs associated with CO_2 will be reflected indirectly by netting out these costs in the calculation of the modified CO_2 adder used to value reductions in purchases from the grid for all technologies. (See the discussion of environmental benefits).

It should be noted that several parties have suggested that DG applications may cause indoor air quality impacts associated with the proximity of the generation facilities. While this cost may be very real for some technologies, we have no reasonable means of valuing it. As a consequence, we will exclude this potential costs from the cost-effectiveness framework.

5.3.5 Program Administrative Costs

Program administrative costs must be included in any societal test, insofar as they reflect true resource costs. These costs would exclude project incentive costs (as explained above), but would include marketing, administration, and program evaluation costs.

5.3.6 Summary of Societal Costs

In summary, societal costs will include gross installed equipment costs (*InstCost*), operating costs (*O&MCost*), and program administrative costs (*AdminCost*). The present value of societal costs will be given by:

$$(7) \quad SocietalCosts = \sum_{i=1}^{N} NTG_i (InstCost_i + O\&MCost_i) + AdminCost$$

Note that costs associated with participant activity are multiplied by the net-to-gross ratio to reflect the fact that some of these costs would have been incurred in the absence of the program. Program administrative costs, of course are all attributable to the program and are thus not multiplied by *NTG*.

Both installation costs and program administration costs are assumed to be incurred in the year of the program; O&M costs and environmental costs occur over the lifetime of the DG, and are discounted back to present value by using the societal discount rate:

$$(8) \quad O\&MCost_i = \sum_{t=1}^{T} \frac{O\&MCost_{it}}{(1+d)^t}$$

Note that, for gas-fired DG applications, the fuel cost component of O&M costs will be given by:

$$(9) \quad FuelCost_{it} = \sum_{m=1}^{M} ThermsUse_{imt} AvCostGas_{imt}$$

where $ThermsUse_{imt}$ is the monthly usage of natural gas for the DG application and $AvCostGas_{mt}$ is the monthly avoided cost of gas, including any environmental adders.

5.4 Societal Test Figures of Merit

Several indicators can be used to represent the results of a societal test. We propose to use two indicators for the assessment of the SGIP: Net Societal Benefits and a Societal Benefit-Cost Ratio. The Societal Net Benefits of the SGIP will be characterized as the difference between gross Societal Benefits and Societal Costs:

$$(10) \quad Net\ Societal\ Benefits = Societal\ Benefits - Societal\ Costs$$

The Societal Benefit-Cost Ratio is given by:

$$(11) \quad Societal\ Benefit\text{-}Cost\ Ratio = \frac{SocietalBenefits}{SocietalCosts}$$

6

Participant Test

6.1 Introduction

This section describes a Participant Test relating to DG applications. The purpose of developing this test is not to replace any assessment conducted by prospective participants prior to entering the program. That is, we do not suggest that this test should be used to screen participants, insofar as the program is voluntary, and participants may have many reasons other than strict cost-effectiveness for installing DG. Moreover, we do not suggest a Participant Test be used directly to determine whether or not the program should be offered. Instead, the value of a Participant Test in this context is twofold. First, it provides some of the ingredients needed to construct a Nonparticipant Test, which may have relevance for public decision making with the program; and second, the framework can be used to assess the likely effects on participants of changes in program designs.

Section 6.2 considers participant benefits. Section 6.3 enumerates participant costs. Finally, Section 6.4 presents two alternative Participant Test figures of merit that can be used to depict cost-effectiveness from this perspective.

6.2 Participant Benefits

Several participant benefits are discussed in available research. Gumerman (2003), for instance, enumerates the following benefits:

- Lower cost of electricity,
- Electricity price protection,
- Reliability and power quality,
- Combined heat and power, and
- Consumer control.

These potential benefits are considered below in the context of the development of a workable Participant Test for SGIP.

6.2.1 Lower Cost of Electricity

The generation of electricity with DG systems lowers the customer's need for purchased electricity and thus lowers the customer's electricity bill. The reduction in the bill is dependent upon the energy used on site and the rate structure under which the customer receives power. Moreover, some customers with capacity beyond what is need for on-site use may sell energy back to the grid. Depending upon the applicability of net metering, this power may be sold at avoided costs or at retail rates. PUC Section 2827 provides for net metering for customer generators with solar, wind, solar/wind hybrid, biogas digester and fuel cell systems less than 1 MW.

Reductions in electricity bills will be computed as the sum of two elements:

- Hourly reductions in purchases of electricity, valued at the appropriate retail rates on the energy component, and
- Reductions in billing demand, valued at the appropriate demand charge component.

These calculations will be made by rate schedule and technology to capture temporal variability of tariffs and power output of SGIP technologies.

It should be noted here that bill reductions are dependent on the applicability of net metering provisions. Customers under net metering agreements receive and bank credits against future usage of utility power in return for deliveries to the grid in periods where generation is in excess of the site usage. These credits expire if not used within 12 months.

For customers installing photovoltaic or wind systems under 1 MW, credits for power delivered to the grid are based on retail rate components. Specific provisions of these net metering tariffs depend on system size and/or technology type. For participants installing digester biogas-fueled generators or eligible fuel cell generators, credits are given at the value of generation-related components only. Customers with DG facilities not falling into any of these classes do not receive credit for net production, although power purchase arrangements could be established for such sales. In conducting the cost-effectiveness analysis for the 2004 SGIP, current net metering provisions will be considered in estimating bill savings.

6.2.2 Combined Heat and Power

The value of the usable heat produced by participants with CHP systems is included as a specific benefit of the program. From the Participant perspective, this benefit can be captured by the retail cost of fuels that would otherwise be used to directly serve these heat requirements. For the purposes of this analysis, we assume that natural gas is the displaced fuel. Hence, the participant benefit of using waste heat will be characterized as the implied reduction in gas usage, valued at the expected future price of natural gas.

6.2.3 Electricity Price Protection

Gumerman argues that DG owners may have a stronger ability "to lock in prices for their energy requirements for the long term than customers directly exposed to volatile electricity prices." (p. 13) In the case of solar and wind technologies, DG provides a considerable degree of insulation from price movements; in the case of DG applications using fossil fuels, however, fuel price risk is still present. Although reductions in price risk have economic value to SGIP participants, we do not have estimates of such benefits to use for the evaluation of the 2004 SGIP. As a consequence, we do not propose to quantify this value for the purposes of the Participant Test. It should be kept in mind, then, that participant benefits will be understated to this effect.

6.2.4 Reliability and Power Quality

From the perspective of participants, DG can provide enhanced reliability and power quality. This may be particularly important in cases where customers have end-use equipment with special reliability and/or power quality needs. The site-specific nature of this benefit makes it difficult to value in a broad-based cost effectiveness analysis like the one planned for the SGIP in 2005. Moreover, extracting the benefits of increased power quality may require the purchase of specialized equipment (switchgear, upgraded circuits, etc.), and it is unclear that data on such costs will be available for the analysis of the 2004 SGIP. As a result, we are forced to exclude this benefit from the quantitative cost-effectiveness framework. Again, however, it should be remembered that this benefit, while considered only qualitatively, could be important in many individual SGIP projects. If and when estimates of such reliability values become available, the framework could be expanded to include this benefit.

6.2.5 Consumer Control

Gumerman[38] suggests that "the 'control' that [DG] offers therefore can be appealing and will benefit many with an individualistic outlook." This sense of customer control, or independence, may indeed be an important motivator for installation of DG, but it will not be addressed in the quantitative cost-effectiveness model as a consequence of its subjective nature.

6.2.6 Incentives and Tax Credits

From the perspective of program participants, incentives and tax credits can be considered benefits. These incentives would include both those offered under SGIP as well as any

[38] Op. cit., p. 18.

others offered by other entities. Tax credits would include those offered by all levels of government.

6.2.7 Summary of Participant Benefits

In summary, the recommended Participant Test will be designed to focus on three quantitative benefits:

- Reductions in electricity bills (*RedElecBills*);
- The value of displaced fuels previously used to create usable heat, where applicable (*ValDispFuels*); and
- Incentives and tax credits.

In order to recognize variations in participant benefits across technologies, the analysis will be conducted at the technology level, and then aggregated to the program level. That is, we can express program-level participant benefits (*ParticcpantBenefits*) as:[39]

$$(1)\quad ParticipantBenefits = \sum_{i=1}^{N} RedElecBills_i + ValDispFuels_i + Inc_i + IncO_i + TC_i$$

where Inc_i represents SGIP incentives, $IncO_i$ reflects other incentives, and TC_i indicates tax credits and any other tax benefits. Reductions in electric bills will be computed as the sum of reductions in energy charges ($RedEnChg_i$) and reductions in demand charges ($RedDemChg_i$). These reductions will take into account the specific treatments of net metering under the SGIP, which differ across DG technologies. Note that these reductions are net of any charges associated with the use of DG, like standby charges and departing load charges, if any.

$$(2)\quad RedElecBills_i = RedEnChg_i + RedDemChg_i$$

Each of these elements of bill impacts will be computed as a present value of the associated streams of bill effects:[40]

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39 Note here that the Participant Test is based on gross, rather than net, benefits and costs. This is consistent with the SPM, which indicates that "Load impacts from Participants should be based on gross, whereas for all other tests the use of net is appropriate." (p. 27)

40 It is unclear what discount rate should be used here. One could argue that participants tend to have a high time value of money, and that a relatively high discount rate should be used to bring participant benefits and costs back to present value. The SPM is silent on this issue for all of the cost-effectiveness tests, except that it suggests that a societal test, unlike other tests, should use a societal discount rate. (see p. 19) The societal test is typically lower than a market rate to reflect risk pooling and spreading associated with public programs.

(3) $$Re\,dEnChg_i = \sum_{t=1}^{T} \frac{Re\,dEnChg_{it}}{(1+d)^{t-1}}$$

(4) $$Re\,dDemChg_i = \sum_{t=1}^{T} \frac{Re\,dDemChg_{it}}{(1+d)^{t-1}}$$

Annual reductions in energy and demand charges will be computed as:

(5) $$Re\,dEnChg_{it} = \sum_{i=1}^{N} \sum_{p=1}^{P} \sum_{h=1}^{8760} \Delta kWhOnSite_{ipht}(EnergyRate_{pht} - DLChg_{pht})$$

and

(6) $$Re\,dDemChg_{it} = \sum_{i=1}^{N} \sum_{p=1}^{P} \Delta kWOnSite_{ipt}\, DemChg_{pt}$$

where $\Delta kWhOnSite_{ipht}$ and $\Delta kWOnSite_{ipt}$ indicate reductions in on-site energy use and billing demand, respectively, $EnergyRate_{pht}$ and $DemChg_{pt}$ reflect the prevailing energy and demand charges for customers on rate *p*, and $DLChg_{pht}$ and $SBChg_{pt}$ reflect departing load and standby charge rates, respectively.

Note that reductions in energy use reflect the provisions of net metering, if applicable, in the sense that they include any net metering credits that were ultimately used by the facility.

The value of displaced fuels for combined heat and power applications will be determined as the present value of the stream of future cash flows:

(7) $$ValDispFuels_i = \sum_{t=1}^{T} \frac{ValDispFuels_{it}}{(1+d)^{t-1}}$$

And the annual value of displaced fuels will be computed as:

(8) $$ValDispFuels_{it} = \sum_{i=1}^{N} \sum_{m=1}^{12} DisTherms_{imt}\, PGas_{mt}$$

where $PGas_{mt}$ is the price of natural gas in month m and year *t*.

6.3 Participant Costs

Participant Costs will include the following elements for the DG system:

- Gross Equipment Costs,
- O&M Costs including Fuel Costs, and
- Participant Environmental Costs.

6.3.1 Gross Equipment Costs

One of the central costs to be included in the Participant Test is the net installed cost of the DG-related equipment. As in the Societal Test, equipment costs include all planning, design, development, equipment and installation costs associated with the DG facilities installed under the program. Installed costs include any up-front environmental costs, including both controls and offsets. Equipment costs also include the costs of any instrumentation installed by participants, whether installation is voluntary or required by the program. They include electric and natural gas interconnection costs, which are currently paid by participants. As is customary in the SPM approach to cost-effectiveness, these costs will be *gross* of tax credits and the incentives paid by the SGIP and any other agency like the CEC, LADWP, or the Department of Defense.[41] These credits and incentives are included directly as benefits (see above).

6.3.2 Operating and Maintenance (O&M) Costs

All annual O&M costs are included in the Participant Test. These costs are defined to include fuel costs where applicable. Note that since the usage of waste heat is treated explicitly as a participant benefit, the fuel cost included here is the gross cost of fuel used for the DG system. In the event that the fuel is natural gas, the associated fuel usage is valued using the forecasted price of natural gas. In the event that biogas is used, the relevant fuel cost is the cost to condition the biogas on a per-them basis. O&M costs also include any offsets paid on an annual basis.

6.3.3 Participant Environmental Costs

As noted above, environmental costs actually paid by participants will be included as costs in the Participant Test. That is, emission control costs will be included in equipment costs, and the costs of NO_X and PM-10 offsets required for DG facilities will be included explicitly as either up-front costs or O&M costs. Environmental costs associated with CO_2 will *not* be included, insofar as they are not incurred by participants. The potential costs of any indoor air quality impacts associated with DG will also be excluded from the Participant Test as a consequence of our inability to provide a means of valuing them.

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[41] That is, these costs will be calculated before the application of these credits and incentives.

6.3.4 Summary of Participant Costs

Participant costs can be expressed as:

$$(9)\quad ParticipantCosts = \sum_{i=1}^{N} (InstCost_i + O\&MCosts_i)$$

where $InstCost_i$ is the gross installed cost of equipment and offsets and $O\&MCosts_i$ reflects O&M costs. Installed costs are assumed to be incurred in the first period, and incentives are assumed to be paid in that period as well. O&M costs are recognized to occur over time, and their present values are defined as:

$$(10)\; O\&MCost = \sum_{t=1}^{T} \frac{O\&MCost_t}{(1+d)^{t-1}}$$

The fuel cost component of participant O&M costs will be given by:

$$(11)\; FuelCost = \sum_{t=1}^{T} \frac{FuelCost_t}{(1+d)^{t}}$$

where annual fuel costs will be computed as:

$$(12)\; FuelCost_t = \sum_{m=1}^{M} ThermsUse_{mt}\; PriceGas_{mt}$$

where $ThermsUse_{mt}$ is the monthly usage of natural gas for the DG application and $PriceGas_{mt}$ is the monthly retail price of gas (or, in the case of biogas, the operating cost to condition the biogas on a per-therm basis).

6.4 Participant Test Figures of Merit

Two indicators of the Participant Test are defined the SGIP cost-effectiveness framework: Participant Net Benefits and a Participant Benefit-Cost Ratio. Participant Net Benefits will be characterized as the difference between gross Participant Benefits and Costs:

(13) *Net Participant Benefits = Participant Benefits – Participant Costs*

The Participant Benefit-Cost Ratio is given by:

$$(14)\; Participant\ Benefit\text{-}Cost\ Ratio = \frac{ParticipantBenefits}{ParticipantCosts}$$

7

Nonparticipant Test

7.1 Introduction

This section considers the cost-effectiveness of SGIP from the perspective of nonparticipants (ratepayers). This test is sometimes called the Ratepayer Impact Measure (RIM) test. Following the provisions of the California Standard Practice Manual, the benefits of DG to nonparticipants can be characterized in terms of the avoidance of system costs that would otherwise have to be covered by rates, plus any revenue increases associated with the program. Costs can be conceptualized as reductions in electricity revenues from participants, which would ultimately shift the burden for rate recovery to nonparticipants, plus program costs that would have to be covered through rates. These benefits and costs are considered below.

It should be noted that unlike the other tests discussed above in Sections 5 and 6, the Nonparticipant Tests will be conducted first separately for gas and electricity, then on an overall gas and electric ratepayer basis. This practice is consistent with the policy specified in the SPM.[42]

7.2 Electric Customer Nonparticipant Test

7.2.1 Electric Customer Benefits

The overall benefits accruing to electric ratepayers include the reductions in system costs associated with the replacement of conventional generation with DG. As with the other tests discussed above, electric ratepayer benefits will be derived at the technology level, and then aggregated to the program level. That is, we can write:

$$(1) \quad ElecRatePBen = \sum_{i=1}^{N} NTG_i AvNPEleCosts_i$$

[42] See SPM, p. 5.

where NTG_i is the net-to- gross ratio associated with technology i and $AvNPEleCosts_i$ is gross avoided costs from the electric ratepayer perspective. Note that the net-to-gross ratio is required by the SPM for use in ratepayer tests.

The discounted value of avoided electricity costs can be computed as:[43]

$$(2)\quad AvNPEleCosts_i = \sum_{t=0}^{T} \frac{AvNPElecCosts_{it}}{(1+d)^t}$$

where represents annual avoided electric costs from the nonparticipant's view. These annual costs can be computed as:

$$(3)\quad AvNPElecCosts_{it} = \sum_{i=1}^{N} \sum_{h=1}^{8760} \Delta kWh_{irh} NPAvCost_{hrt}$$

where ΔkWh_{irh} is the hourly electricity output of technology i in region r during hour h, and $NPAvCost_{hrt}$ is the avoided electric cost per kWh in hour h in year t in region r, specified from the perspective of nonparticipants (see below).

The question here is whether all of the elements of avoided electric costs used in the development of the Societal Test should be used in the RIM, or Nonparticipant Test. As defined before, these elements are the avoided costs of generation ($AvGCost_{hrt}$), avoided cost of transmission and distribution ($AvTDCost_{hrt}$), an environmental adder ($EnvAdd_{hrt}$), a reliability adder ($ReAdd_{hrt}$), and a price elasticity adder ($PEAdd_{hrt}$).

Avoided costs of generation should be included in this test, as should the reliability adder. These reduce revenue requirements. The avoided cost of T&D should conceptually be included in the test on the grounds that DG can lead to benefits under appropriate conditions; however, as was the case for the Societal Test, we will assume a zero value for these benefits in the assessment of the 2004 SGIP. The price elasticity adder should be included, insofar as the price effects accrue to nonparticipants. In fact, the case for including this term in the Nonparticipant Test is stronger than for the Societal Test, because these benefits clearly accrue to ratepayers. The costs of environmental controls and offsets for conventional (central station) generation should be included indirectly. The environmental adder probably should not be included in the calculation of nonparticipant benefits, insofar as the benefits of reduced global warming (the only impact covered by the E^3 adder) accrue more broadly to

43 Again, it is unclear which discount rate should be used for nonparticipant tests. The SPM is silent on this issue.

society at large. Thus, we omit this term, and write nonparticipant avoided electricity costs as:

$$(4) \quad NPAvCost_{hrt} = AvGCost_{hrt} + AvTDCost_{hrt} + Re\,Add_{hrt} + PEAdd_{hrt}$$

7.2.2 Electric Ratepayer Costs

Electric ratepayer costs (*ElecRatePCosts*) would include foregone revenues from sales of electricity ($RedElecBills_i$),[44] any interconnection costs not covered by participant payments, plus electric program incentive and administration costs paid by electric customers. Electric ratepayer costs can be expressed as:

$$(5) \quad ElecRatePCosts = \sum (NTG_i RedElecBills_i + IntCosts_i + IncCostE_i) + AdminCostE$$

where $IncCostE_i$ indicates electric incentives provided to technology I, *AdminCostE* depicts admin costs funded by electric ratepayers, and $IntCosts_i$ includes any utility interconnection costs not paid for by participants. The calculation of electric bill reductions ($RedElecBills_i$) was discussed in Section 5.

7.2.3 Electric Customer Figures of Merit

Two indicators of the Electric Customer Nonparticipant Test are defined the SGIP cost-effectiveness framework: Electric Customer Nonparticipant Net Benefits and an Electric Customer Nonparticipant Benefit-Cost Ratio. Electric Nonparticipant Net Benefits will be characterized as the difference between net Electric Customer Nonparticipant Benefits and Costs:

$$(6) \quad Electric\ Nonparticipant\ Net\ Benefits = ElecRatePBen - ElecRatePCosts$$

The Electric Customer Nonparticipant Benefit-Cost Ratio is given by:

$$(7) \quad Electric\ Nonparticipant\ Benefit\text{-}Cost\ Ratio = \frac{ElecRatePBen}{ElecRatePCosts}$$

[44] These estimated bill reductions will take into account the specific treatment of net metering for qualifying technologies.

7.3 Gas Customer Nonparticipant Test

7.3.1 Gas Ratepayer Benefits

From the perspective of gas customers, benefits (call these *GasNPBenefits*) consist of avoided fuel costs associated with the use of waste heat by CHP projects (*WasteHeatBenefits*), plus increased revenues from the sale of natural gas for gas-fired DG (*IncrGasRev*). These benefits are computed at the technology level and then summed to the program level, as given by:

$$(8) \quad GasNPBenefits = \sum_{i=1}^{N} NTG_i (WasteHeatBenefits_i + IncrGasRev_i)$$

Note that the use of the Net-to-Gross Ratio limits benefits to those that are attributable to the program.

Waste heat benefits for each technology will be estimated for the lifetime of the technology and discounted back the present period as:

$$(9) \quad WasteHeatBenefits_i = \sum_{t=1}^{T} \frac{WasteHeatBenefits_{it}}{(1+d)^t}$$

The annual values of waste heat benefits will be given by:

$$(10) \quad WasteHeatBenefits_t = \sum_{i=1}^{N} \sum_{m=1}^{12} DisTherms_i AvGasCost_{mt}$$

where $DisTherms_{im}$ is the gas consumption displaced by technology i in month m and $AvGasCost_{mt}$ is the avoided cost of gas in month m and year t.

Revenues from the sale of natural gas as a fuel for CHP applications can be written as

$$(11) \quad IncrGasRev_i = \sum_{t=1}^{T} \frac{IncrGasRev_{it}}{(1+d)^t}$$

$$(12) \quad IncrGasRev_{it} = \sum_{m=1}^{12} CHPTherms_{im} CHPGasPrice_{mt}$$

where $CHPTherms_{im}$ is the monthly use of natural gas for CHP applications using technology i and is $CHPGasPrice_{mt}$ the price of natural gas to be used in CHP applications.

7.3.2 Gas Ratepayer Costs

Gas ratepayer costs include foregone revenues from sales of gas for conventional applications displaced by CHP applications, as well as gas program costs.

$$(13)\ GasRatePCosts = \sum_{i=1}^{N} (NTG_i ValDispFuels_i + IncCostG_i) + AdminCostG$$

where $IncCostG_i$ and $AdminCostG$ are the costs of SGIP incentives and program costs funded by gas ratepayers. The calculation of the value of displaced gas ($ValDispFuels_i$) was discussed in Section 5. It will not be possible to disaggregate program administrative costs across technologies.

7.4 Overall Nonparticipant Test

The Nonparticipant Test will also be conducted for all ratepayers taken together. Overall nonparticipant benefits (both electric and gas ratepayers) will be expressed as:

$$(14)\ NonparticipantBenefits = GasRatePBenefits + ElecRatePBenefits$$

Overall Nonparticipant Costs will be derived as:

$$(15)\ NonparticipantCosts = GasRatePCosts + ElecRatePCosts$$

Two indicators of the Nonparticipant Test will be defined: Nonparticipant Net Benefits and a Nonparticipant Benefit-Cost Ratio. Nonparticipant Net Benefits will be characterized as the difference between gross Nonparticipant Benefits and Costs:

$$(16)\ Nonparticipant\ Net\ Benefits = NonparticipantBenefits - NonparticipantCosts$$

The Nonparticipant Benefit-Cost Ratio is given by:

$$(17)\ Nonparticipant\ Benefit\text{-}Cost\ Ratio = \frac{NonparticipantBenefits}{NonparticipantCosts}$$

8

Summary and Conclusions

In this report we developed a cost-effectiveness framework for the SGIP that includes three separate tests, each representing a different perspective. These tests include the Societal, Participant, and Ratepayer perspectives, which are summarized briefly below.

8.1 The Societal Test

The Societal Test can be considered a variant of the SPM's Total Resource Cost Test. This test includes a variety of benefits characterized as avoided costs or avoided cost adders.

- Avoided generation costs,
- Avoided transmission and distribution (T&D) costs,
- Line loss reductions,
- A reliability adder,
- An environmental adder,
- Waste heat utilization benefits, and
- A price elasticity adder.

We propose to use values of these benefits derived from a recent study conducted by E^3 for the Commission, with the exception of T&D benefits and the environmental adder. Since D.01-03-073 does not allow SGIP projects to enter into contracts for distribution services, the basic cost-effectiveness analysis will be conducted on the assumption that these benefits are zero for the SGIP. The environmental adder will be modified to reflect the relative emissions of the DG technology and the displaced conventional generation, as previously explained in Section 5.

Societal Test costs include four elements:

- Gross installed equipment costs
- Operating and maintenance costs, including fuel costs where applicable
- Environmental costs (considered as part of other benefits and costs, as opposed to being a separate category of costs)

- Program administration costs, including marketing, measurement and evaluation costs.

Two "figures of merit" are proposed for the Societal Test: a net societal benefits test, and a societal benefit-cost ratio.

8.2 The Participant Test

The Participant Test assesses the program from the perspective of its participants. Participant benefits include the following:

- Reductions in electricity bills
- The value of displaced fuels previously used to create usable heat, where applicable
- Incentives and tax credits

Participant costs include:

- Installed equipment costs
- O&M Costs (including applicable fuel costs)
- Participant environmental costs

Again, two indicators of cost-effectiveness are proposed for this test: participant net benefits and a participant benefit-cost ratio.

8.3 The Nonparticipant (Ratepayers) Test

The Nonparticipant Test, or Ratepayers Test, is constructed from the perspective or nonparticipating customers, or ratepayers. *As prescribed in the SPM, the test is constructed separately for electricity and natural gas ratepayers.*

- For electric ratepayers, benefits consist of avoided system electric costs, while costs include lost revenue from bill reductions, any uncovered interconnection costs, and all program costs paid for by electric ratepayers. From the perspective of electric nonparticipants, net benefits (costs) can be characterized as reductions (increases) in electric revenue requirements, which will lead to reductions (increases) in electric rates.
- For gas ratepayers, benefits consist of avoided natural gas fuel costs associated with waste heat utilization and increased sales revenue from natural gas fuel used by participants, while costs consist of the loss of revenue from the displacement of conventional gas usage, as well as program costs paid for by natural gas ratepayers. From the perspective of natural gas nonparticipants, net benefits

(costs) can be characterized as reductions (increases) in natural gas revenue requirements, which will lead to reductions (increases) in natural gas rates.

As with the other tests, two indicators are proposed: nonparticipant net benefits (net rate impacts) and a nonparticipant benefit-cost ratio. These performance indicators are first constructed separately for gas and electricity ratepayers, and then aggregated to provide an overall ratepayer perspective.

8.4 Conclusions

Itron is utilizing the framework presented here for the *interim* SGIP cost-effectiveness evaluation as described in D.04-12-045. We have not attempted to resolve issues that will ultimately be addressed by the Commission.

In developing the proposed Cost-Effectiveness Framework, we have been guided by a statement included in reply comments filed by SDG&E on June 7, 2004: "Striving for the *perfect* approach [to analyzing cost-effectiveness] should not interfere with the implementation of a *good* approach."[45]

[45] P. 8.

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