# DISTRIBUTED GENERATION COSTS AND BENEFITS ISSUE PAPER


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**STAFF PAPER**


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# EXECUTIVE SUMMARY

The California Public Utilities Commission (CPUC) has identified the costs and benefits of distributed generation (DG) as a priority issue for their new rulemaking, R.04-03-017, for which the Energy Commission has opened a parallel proceeding, 04-DIST-GEN-1. The staff's of the commissions are working collaboratively in these two proceedings to more effectively coordinate their respective efforts related to DG. This issue involves a broad range of costs and benefits and is complicated by our limited ability to quantify these costs and benefits and to access publicly available data.

To understand the qualitative and quantitative nature of DG costs and benefits, the California Energy Commission (Energy Commission) has been conducting research to gain a better analytical understanding of how to calculate the costs and benefits of DG.

Based on the analysis presented in this white paper, collaborative staff concludes that the following benefits and costs be addressed in this proceeding:

| Benefits | Costs |
|---|---|
| Airborne or Outdoor Emissions | Utility Revenue Reduction |
| Reliability and Power Quality (Distribution System) | Standby Charges |
| Enhanced Electricity Price Elasticity | Incentives for Clean Technologies |
| Avoided T&D Capacity | Maintain System Reliability & Control DER |
| System Losses | Emissions Offsets |
| Ancillary Services | Airborne or Outdoor Emissions |
| | DER Fuel Delivery Challenges |

### Figure 1. DG Cost/Benefit Elements to Consider in R.04-03-017

In developing a methodology that can be used to quantify the benefits and costs listed in the figure, collaborative staff provides the following key observations:

- Traditional regulatory approaches such as incentive programs and customer class ratemaking will not adequately encourage priority DG benefits.
- Cost/benefit model(s) must be developed that is technically acceptable to stakeholders to be effective in a regulatory forum.
- A full evaluation of DG's deployment potential depends on better quantification methods and better access to data.

Based on these observations, collaborative staff has several near-term and long-term recommendations for the CPUC to consider in their DG proceeding.

First, the definition of DG should not be solely defined on the basis of size, technology, application, or ownership. DG uses many different technologies and can be applied in so many different ways, as mentioned above. The benefits that a particular DG project can provide are driven more by application than by technology type. To a large extent, the ownership of a particular DG device, whether by the utility, a third party or the end use customer, is unrelated to ability to capture DG benefits. For these reasons, the definition of DG needs to be as flexible as possible in order that its potential multiple benefits can be unlocked. Therefore, collaborative staff proposes the following definition:

> **Distributed generation is electricity production that is on-site or close to the load center and is interconnected to the utility distribution system.**

Second, the CPUC should consider these proposed process steps for addressing DG costs and benefits:

1. Identify costs and benefits
2. Develop method(s) to quantify costs and benefits
3. Quantify costs and benefits
4. Develop and implement market mechanisms to allocate costs and benefits.

In the near term, the CPUC should develop a common model(s) for utilities and other stakeholders to use for determining the identified high priority costs and benefits. This model(s) should be based upon project-specific oriented cost/benefit methodologies. A project-specific approach is less likely to show the interactions between multiple DG projects and their respective costs and benefits from the utility system perspective. However, this approach would reduce the complexity of developing and implementing a new model while getting costs and benefits of DG addressed in the marketplace.

The CPUC should require utilities to make publicly available their capital distribution investment plans, including the need for the proposed distribution expansion projects, costs of those projects, and their timing. Utilities should also be required to determine system losses and publicly identify where DG can be implemented to minimize these losses. The CPUC should then establish mechanism whereby utilities compensate DG customers who help reduce those losses.

In the longer-term, a system-wide approach for determining DG costs and benefits should be adopted. This should occur as better, more readily accepted methods, models, and data are developed that can more accurately determine the locational and time dependent benefits. The CPUC should require the utilities to implement a program that identifies from a system-level perspective where DG would be most cost effective to eliminate system losses, defer capital transmission and distribution projects, and reduce the need for ancillary services. The utility programs should also provide compensation to DG customers who are already providing these benefits to the utility system.

As an interim step to creating a system-wide approach, the CPUC should require the utilities to partner with the Energy Commission to validate a systems-level model and approach that optimizes the transmission and distribution system.  This model should then be vetted in a public workshop process.

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# INTRODUCTION

The California Public Utilities Commission (CPUC) has identified costs and benefits of distributed generation (DG) as a priority issue to be addressed in rulemaking R.04-03-017 opened March 16, 2004. The California Energy Commission (Energy Commission) will be assisting the CPUC in a collaborative capacity through the Energy Commission's own Order Instituting Investigation 04-DIST-GEN-1 which was opened on April 21, 2004. Cost and benefits of DG has been an area of great interest for some time to key stakeholders including DG equipment manufacturers, DG project developers, utilities, customers and government.

This white paper discusses issues Energy Commission and CPUC staff, henceforth referred to as collaborative staff, has uncovered regarding the costs and benefits of DG. These issues are presented to support the CPUC's scoping memo. It should be noted that collaborative staff is not recommending a specific methodology(s) or model(s) in this report.

Without question, addressing the complexities of the DG cost/benefit issues in a regulatory forum is challenging. Some of the complexity has to do with the broad range of costs and benefits that have been identified. Another complexity is the knowledge base needed to quantify costs and benefits in an acceptable and equitable manner. Limited publicly available data needed for calculating costs and benefits has also confounded the discussion. Past regulatory proceedings where costs and benefits have been raised as an issue for DG have been ineffective at resolving the issues or furthering our understanding of the true costs and benefits of DG. This is primarily due to the absence of data and accepted methods for calculating costs and benefits, which has tended to relegate the discussion to one of qualitative nature versus quantitative.

Understanding this challenge, the Public Interest Energy Research (PIER) Program at the Energy Commission has been conducting research over the past several years that has sought to understand the qualitative and quantitative nature of DG costs and benefits. The PIER program has focused its efforts more recently to gain a better analytical understanding of how to calculate the costs and benefits of DG. This is no easy endeavor, but insights have been gained.

In anticipation of dealing with the costs and benefits of DG in R.04-03-017, collaborative staff conducted a public workshop on May 5, 2004 to focus on identifying costs and benefits and methodologies for quantifying them. The workshop looked at several past analyses that have been attempting to quantify or understand costs and benefits of DG from multiple stakeholders' perspectives. The workshop also highlighted several promising research projects currently underway that are developing more applicable ways to understand some of the utility system benefits that DG can provide. Section 2 of this paper proposes steps that the CPUC should follow to identify, quantify, and implement market mechanisms for unlocking untapped costs and benefits of DG. This paper also discusses a proposed definition for DG (Section 3) that is consistent wit the approach we are proposing for quantifying DG costs and benefits. Section 4 identifies what costs and benefits should be addressed in the CPUC rulemaking. Section 5 discusses availability of data, methods and models needed to calculate DG costs and benefits. Conclusions and recommendations are made in Section 6. Finally, all of the documents that were inventoried in this analysis are listed in the Appendix.

# PROCESS FOR UNLOCKING DG COSTS AND BENEFITS

The CPUC Order Instituting Rulemaking (OIR) identified a host of issues related to the costs and benefits of DG that touched upon several topics areas including assignment of risk, avoided costs, market structures, monetization of costs and benefits, standby charges, emissions and so forth. Collaborative staff recommends a systematic approach composed of discreet process steps be followed. These steps are shown in Figure 1.

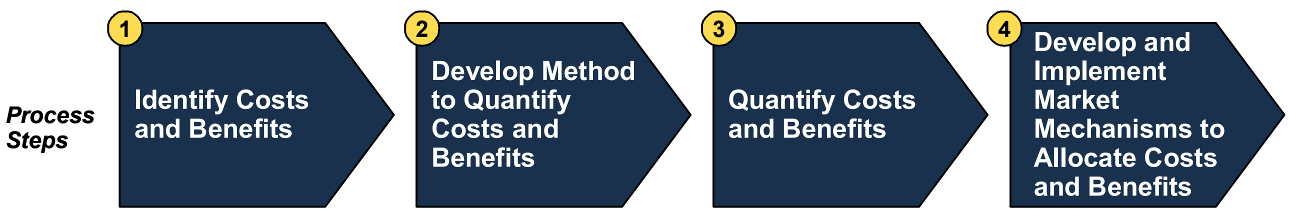


**Figure 1. Cost and Benefit Identification, Quantification and Monetization Steps**

Looking at the issues laid out in the CPUC DG OIR within this process framework will help to organize and prioritize stakeholder thinking around this broad subject area. Additionally, it provides a structured and logical flow to address the issues as the CPUC moves forward in this proceeding. The issues surrounding costs and benefits can then be described as follows:

## Cost and Benefits Identification Issues

- What are the costs and benefits of DG and under what circumstances will they be realized?

## Costs and Benefits Quantification Issues

- What is the value of the benefits?
- What are the costs to achieve these benefits?

- Do costs and benefits vary by DG technology, and if so, how is that accounted for?
- When and where are these costs and benefits realized?
- What is the methodology to measure the costs and benefits?
- What is the magnitude of the costs and benefits?
- What is the amount of the costs and benefits?
- To whom are the costs and benefits appropriated – DG customer, DG owner, utility, ratepayer, taxpayer, society?
- What is the quality of available models to assess DG value and cost?
- What is the availability of data to assess DG costs and benefits?
- How accurate can we calculate these costs and benefits?

## Market Mechanisms Issues

- What is the preferred mechanism to capture the value of DG benefits?
- Should there be different mechanisms to capture different values?
- What is the efficacy of these mechanisms to capture the value?
- Are these potential mechanisms a complete listing?
    - Rate and tariff structures
    - Wholesale and retail markets
    - Utility contracts
    - Utility planning (e.g., RPS procurement, distribution deferral, etc.)
    - Financial incentives (e.g., incentives, subsidies, etc.)
- Do these mechanisms allow for consideration of standby charges, need for separate DG customer classes, assignment of risk, etc.?
- How and when will the DG market evolve and how would the preferred market mechanisms change as the market evolves?
- Should the CPUC consider reforms to the net metering program, such as development of wholesale transaction tariffs to allow actual sales from the DG owner to the utility?

# DEFINITION OF DG

In order to get at the issues of costs and benefits of DG however, the definition of DG must be dealt with. How DG is defined will have an impact on cost and benefit identification, quantification and market implementation. It will also have implications for other parts of the CPUC DG OIR. The CPUC DG OIR lays out the questions of how is DG defined, including megawatt (MW) size ranges. Collaborative staff believes the question of DG definition needs to be unpacked to a greater degree because there are aspects of DG that help to define it. The question of definition should be recast as follows:

- What locations on the grid constitute DG connections?
- What is the MW size range of DG?
- What technologies are considered to be DG technologies?
- How does application affect the definition of DG?
- Are there other issues that must be considered in the definition of DG?

After careful consideration and discussion around these questions and evaluation of numerous research projects, collaborative staff has concluded that size is indirectly defined by looking at whether DG is interconnected at transmission or distribution system voltages. Collaborative staff believes that since DG is typically sized to match local load which varies greatly depending on customer need, limiting the definition of DG to a particular MW size is unwarranted. A more useful characteristic is to define it as interconnected to the utility distribution system.

With respect to technology type, many technology types are available in the marketplace today. These vary from photovoltaic systems to fuel cells, microturbines, combustion turbines, wind turbines, and reciprocating engines, the latter being the dominate technology today. Furthermore, storage technologies such as flywheels, batteries and ultra capacitors are beginning to make their way into the marketplace and present new opportunities to meet end-use customer and utility needs. Each of these technologies has its own unique characteristic, cost-performance attribute and competitive position, which will change over time as DG technologies mature. As long as these DG and storage technologies can interconnect to the distribution system in compliance with adopted interconnection requirements, we believe technology type should not be viewed as a criterion for defining DG.

How DG is applied to meet customer or utility needs can vary greatly. Applications include co-generation, standby or back-up power, premium power, peak shaving, utility system support and others. Applications vary by technology type and customer group and this is expected to continue to evolve over time as DG markets mature. Consequently, collaborative staff believes that how DG is applied has no bearing on how DG is defined.

Finally, in consideration of other issues that could affect the definition of DG, collaborative staff looked at Energy Commission policy documents and research projects. Some thought has been given to the issue of whether DG provides customers choice for securing their electricity supply. We are presently performing research which looks at the locational value of DG. Consideration of these issues leads collaborative staff to conclude that installations of DG systems alone do not enhance security of electricity supply outright. Other factors such as fuel supply, DG performance, operation and maintenance contribute toward ensuring energy security. Customer choice is one of the benefits of DG, but not necessarily something to consider for defining DG.

In light of these various considerations, collaborative staff believes the definition of DG should not be dependent on size, technology, application or other issues. Because DG can be applied is so many different ways or applications, how it is defined needs to be as flexible as possible in order that its multiple benefits can be tapped. Collaborative staff proposes that DG be defined as shown in Figure 2.

**Distributed Generation is electricity production that is on-site or close to the load center and is interconnected to the distribution system.**

**Figure 2. DG Definition**

# COST AND BENEFIT WORK THAT SHOULD BE ADDRESSED IN R.04-03-017

As mentioned previously, collaborative staff assessed past analyses, research, existing policies and other information sources (see Appendix for list of documents), including the May 5th DG cost and benefit workshop. These various pieces of information have considered a broad number and types of costs and benefits associated with DG. This section discusses the range of costs and benefits identified, how to prioritize them in terms of what should be addressed in the CPUC DG OIR, different stakeholder perspectives to consider, and the temporal and spatial nature of these costs and benefits.

## Identified DG Costs and Benefits

Collaborative staff concludes that a realistic characterization of typical costs and benefits can be captured by looking at 17 distinct benefits and 15 costs. Tables 1 and 2 list these benefits and costs and provide definitions for each.

| What are the Benefits? | | |
|---|---|---|
| 1 | Support of RPS Goals | The value of allowing a utility to meet renewable portfolio standards by having renewable DG |

| What are the Benefits? | | |
|---|---|---|
| 2 | Mitigation of Market Power | The value to the system from reducing output from high marginal production cost plants, mitigating capacity shortages and countering the seller's market power |
| 3 | Airborne or Outdoor Emissions | The economic incentives to owners of clean DG technologies and the reduced health risks to society. The pattern of emissions from outdoor or airborne pollutants such as NOx, $SO_2$, and others from clean DG units that are less hazardous than emissions of the conventional plants that DG replaces. |
| 4 | Reduced Security Risk to Grid | The value of reducing the reliance on the central grid, making the grid a less appealing terrorist target and reducing the impact of other grid disruptions |
| 5 | Reliability and Power Quality (Distribution System) | The value to the utility of avoiding outage costs and improving the quality of the power at or near customer sites |
| 6 | Voltage Support to Electric Grid | The value to the utility of providing voltage/VAR control. Small-scale generation in the distribution system can support voltage by injecting reactive power thereby improving power quality and lowering losses. |
| 7 | Enhanced Electricity Price Elasticity | The value of increasing the elasticity of electric demand, which will tend to lower prices to the benefit of all consumers. |
| 8 | NIMBY Opposition to Central Power Plants and Transmission Lines | The value of reducing the "Not in my back yard" sentiment towards the siting of new power plants. Opposition to small scale on site facilities is likely to be less of an impediment to development of DG than of central stations. |
| 9 | Land Use Effects | The value of reducing "foot-print" or space needed by generation, transmission and distribution infrastructure |
| 10 | Avoided T&D Capacity | The financial value of avoiding or deferring a capital investment in transmission and distribution system capacity |
| 11 | System Losses | The value of the energy saved through reduced resistive system losses. Energy is lost when it is transmitted through wires. The larger the distance, the more the losses are. Siting small-scale generation close to load lowers losses |
| 12 | Combined Heat and Power/ Efficiency Improvement | The monetary savings from utilizing waste heat from the DG in customer applications to meet heating or cooling needs, increasing overall efficiency of energy use |

| What are the Benefits? | | |
|---|---|---|
| 13 | Consumer Control | The value of allowing customers to control their energy source and avoid dependence on a large centrally controlled system |
| 14 | Lower Cost of Electricity | The difference for a customer between the cost of purchasing electricity and the cost of generating electricity onsite |
| 15 | Consumer Electricity Price Protection | The value for customer of having the ability to lock-in prices for their energy requirements for the long term |
| 16 | Reliability and Power Quality (DG Owner) | The value to the customers with sensitive loads of avoiding outages and improving the quality of their power |
| 17 | Ancillary Services | The value of providing spinning reserve, regulation, or other ancillary services |

**Table 1. DG Benefits Definitions**

| What are the Costs? | | |
|---|---|---|
| 1 | Utility Revenue Reduction | The reduced revenues that a utility will receive from a customer that is self generating electricity |
| 2 | Standby Charges | The charges a self generating consumer will pay the utility for the right to maintain a grid interconnection |
| 3 | Incentives for Clean Technologies | The cost to ratepayers and society of government incentives to promote the use of clean (e.g., low pollutant emissions) energy generation technologies |
| 4 | Noise Disturbance | The cost to people of having a noisy DG unit close by |
| 5 | Indoor Emissions | The health risks caused to people from indoor emissions of DG units |
| 6 | Maintain System Reliability and Control Distributed Resources | The system cost of maintaining grid reliability while allowing a significant (up to 20%) penetration of interconnected DG units |
| 7 | Emissions Offsets | Environmental permitting fees paid by the owner of a non-clean DG unit |
| 8 | Airborne or Outdoor Emissions | The cost to society of having increased health risks. The pattern of emissions from outdoor or airborne pollutants such as NOx, $SO_2$, and others from non-clean DG units that are more hazardous than emissions of the conventional plants that DG replaces |

| What are the Costs? | | |
|---|---|---|
| 9 | DER Fuel Delivery Challenges | The number of typical DER units that might substitute for one conventional central power plant would be large. Hence, fuel delivery systems must be extended to bring fuel to the DER unit and this will cost ratepayers |
| 10 | Equipment | The cost of all the equipment needed to generate on-site (e.g., fuel cells, microturbines, IC engines, inverters, communications and controls, switchgear) |
| 11 | Interconnection (system studies and upgrades) | The cost to study the interconnection feasibility as well as the cost of upgrading the distribution system to allow for the interconnection |
| 12 | Fuel | The costs (fuel, delivery, storage) associated with fueling the on-site generator |
| 13 | Maintenance | The fixed and non-fuel variable costs to operate and maintain the DG system |
| 14 | Insurance | The premiums paid to insure DG systems, as well as the increases in other insurance premiums resulting from running an onsite generation system |
| 15 | Exemptions from Cost Responsibility Surcharges | The cost to ratepayers resulting from distributing the energy surcharges (e.g., DWR bond service) among a reduced base of utility served KWh |

**Table 2. DG Costs Definitions**

## Prioritization Criteria

Due to the broad subject area of DG costs and benefits and the range of uncertainty associated with some of them, collaborative staff recommends the proceeding should produce a prioritized list of costs and benefits, focusing on the highest priority ones.

Collaborative staff evaluated three principal characteristics for each cost and benefit:

1. Whether policy intervention is required to unlock or tap a cost or benefit
2. The relative economic magnitude of each
3. Its analytic tractability

In this context, need for *Policy Intervention Requirement* is defined as whether or not policy changes are required to unlock the cost or benefit based on the possibility of markets developing that internalize costs and benefits without policy intervention. *Economic Magnitude* is defined as a relative measure of the cost or benefit to other costs or benefits. This could be in terms of either MW or $, but for the purposes of this assessment, collaborative staff determined the relative, unit less size was sufficient for prioritizing costs and benefits. Finally, *Analytic Tractability* is defined as the possibility and ease of quantifying a cost or benefit. This includes such factors as availability of data, methods and models for quantification of costs or benefits.

Next, collaborative staff prioritized which costs and benefits should be addressed in the CPUC's DG proceeding. This was accomplished by screening each characteristic described above for each cost and benefit. Priority was first given to those costs or benefits where policy intervention was likely needed or unclear in order to unlock the particular cost or benefit. Secondly, priority was then given to this subset of costs and benefits where the relative economic magnitude was rated at least medium.

Finally, the smaller subset of costs and benefits where screened for where the analytic tractability was easy or medium. In this fashion, collaborative staff prioritized which costs and benefits to address where there is a need for policy guidance, the economic magnitude warrants addressing it, and it is tractable to quantify it. Figures 3 and 4 show the results of the characterization and prioritization process for each cost and benefit. The costs or benefits highlighted in yellow are the recommended highest priority costs and benefits that should be addressed in the CPUC DG proceeding.

| | What are the Benefits? | Policy Intervention Requirement[1] | Economic Magnitude[2] | Analytic Tractability[3] |
|---|---|---|---|---|
| 1 | Support of RPS Goals | Likely | Medium | Difficult |
| 2 | Mitigation of Market Power | Unlikely | Medium - Low | Medium |
| 3 | Airborne or Outdoor Emissions | Likely | Medium | Medium |
| 4 | Reduced Security Risk to Grid | Likely | High - Low | Difficult |
| 5 | Reliability and Power Quality (Distribution System) | Likely | Medium -Low | Medium |
| 6 | Voltage Support to Electric Grid | Unclear | Low | Medium |
| 7 | Enhanced Electricity Price Elasticity | Unclear | Medium -Low | Medium |
| 8 | NIMBY Opposition to Central Power Plants and Transmission Lines | Likely | Low | Difficult |
| 9 | Land Use Effects | Likely | Low | Difficult |
| 10 | Avoided T&D Capacity | Likely | High- Medium | Medium |
| 11 | System Losses | Likely | Medium-Low | Medium |
| 12 | Combined Heat and Power/ Efficiency Improvement | Unlikely | High | Easy |
| 13 | Consumer Control | Unlikely | Low | Difficult |
| 14 | Lower Cost of Electricity | Unlikely | High- Medium | Easy |
| 15 | Consumer Electricity Price Protection | Unlikely | Medium -Low | Medium |
| 16 | Reliability and Power Quality (DG Owner) | Unlikely | Medium | Easy |
| 17 | Ancillary Services | Likely | High-Medium | Medium |

Priority Benefits for R.04-03-017

1 Requirement for policy intervention based on the possibility of markets developing by that internalize the benefit without policy intervention
2 Relative size of the benefit
3 The possibility and ease of quantifying the benefit (method, model and data availability)

## Figure 3. Characterization and Prioritization of DG Benefits

| | What are the Costs? | Policy Intervention Requirement[1] | Economic Magnitude[2] | Analytic Tractability[3] |
|---|---|---|---|---|
| 1 | Utility Revenue Reduction | Likely | High | Medium |
| 2 | Standby Charges | Likely | Medium | Medium |
| 3 | Incentives for Clean Technologies | Likely | Medium | Easy |
| 4 | Noise Disturbance | Likely | Low | Difficult |
| 5 | Indoor Emissions | Likely | Low | Difficult |
| 6 | Maintain System Reliability and Control Distributed Resources | Likely | High-Low | Difficult |
| 7 | Emissions Offsets | Unclear | Medium | Easy |
| 8 | Airborne or Outdoor Emissions | Unclear | Medium | Medium |
| 9 | DER Fuel Delivery Challenges | Unclear | Medium-Low | Easy |
| 10 | Equipment | Unlikely | High | Easy |
| 11 | Interconnection (system studies and upgrades) | Unlikely | High-Low | Easy |
| 12 | Fuel | Unlikely | High | Easy |
| 13 | Maintenance | Unlikely | High | Easy |
| 14 | Insurance | Unlikely | Low | Easy |
| 15 | Exemptions from Cost Responsibility Surcharges | Regulation in place | High | Easy |

Priority Benefits for R.04-03-017

1 The possibility of markets developing that internalize the cost without policy intervention
2 Relative size of the cost
3 The possibility and ease of quantifying the cost (method, model and data availability)

**Figure 4. Characterization and Prioritization of DG Costs**

## Stakeholder Perspectives

When considering the costs and benefits of DG, it is critical all costs and benefits first be considered together in their entirety. This is necessary in order to understand the tradeoffs among the costs and benefits and which stakeholder is most affected. In this analysis, collaborative staff looked at the costs and benefits from four perspectives: DG owner, utility, ratepayers and society. In most instances, costs and benefits impacting the utilities flow down to ratepayers. Examples include benefits such as Reliability and Power Quality of the Distribution System, or costs such as Utility Revenue Reduction. However, some costs and benefits more directly affect the utility and less so the ratepayers. Examples include utility benefits such as Avoided T&D Capacity. Some costs and benefits more directly affect the ratepayer. Examples of ratepayer benefits include Enhanced Electricity Price Elasticity or Ancillary Services. Examples of ratepayer costs include Incentives for Clean Technologies. For the purposes of this analysis however, collaborative staff did not attempt to understand the magnitude or efficacy of how costs and benefits flow from utilities to ratepayers, other than to recognize it.

For the priority benefits identified the following stakeholders are the principle beneficiaries:

- Airborne or Outdoor Emissions – Society
- Reliability and Power Quality of Distribution System – Utilities and Ratepayers
- Enhanced Electricity Price Elasticity – Ratepayers
- Avoided T&D Capacity – Utilities
- System Losses – Utilities
- Ancillary Services – Ratepayers

For priority costs, stakeholders who principally pay the costs are:

- Utility Revenue Reduction – Utility and Ratepayers
- Standby Charges – DG Owner
- Incentives for Clean Technologies – Ratepayers and Society
- Maintain System Reliability and Control Distributed Resources – Utility and Ratepayers
- Emissions Offsets – DG Owner
- Airborne or Outdoor Emissions – Society
- DER Fuel Delivery Challenges – DG Owner and Society

## Spatial and Temporal Nature of DG Costs and Benefits

In the course of conducting this assessment, it became evident that DG costs and benefits cannot be treated in an equal manner since they are so different in nature. This is because of the unique attributes that DG has relative to the traditional way electricity is generated and delivered to customers. Because these costs and benefits are different and because different market mechanisms are necessary to unlock them, it is possible different methods to quantify DG costs and benefits will be needed. For example, environmental costs and benefits may need to be quantified differently than utility system costs and benefits.

A main theme about how costs and benefits vary is most easily characterized by how we view them – for example, some costs and benefits are best viewed on a central power system basis while others are best viewed on a distributed basis. Another variance is that some costs and benefits are very time dependent. Traditional ratemaking philosophies that are customer class specific and averaged, or are fixed in time may not be feasible for costs and benefits that are distributed in nature. This spatial and temporal nature of the costs and benefits of DG will have to be taken into account throughout the CPUC's proceeding as methods and models to quantify costs and benefits are developed. It will also have a bearing on what data is needed in order to calculate these costs and benefits. For example in the case of utility system oriented costs and benefits which are distributed in nature, it will be necessary to have much more detailed, granular, time and location specific information about the utilities distribution systems. The spatial nature of the priority benefits is:

- Airborne or Outdoor Emissions – Central and Distributed
- Reliability and Power Quality of Distribution System – Distributed
- Enhanced Electricity Price Elasticity – Central
- Avoided T&D Capacity – Distributed
- System Losses – Central
- Ancillary Services – Central and Distributed

The spatial nature of the priority costs is:

- Utility Revenue Reduction – Central
- Standby Charges – Distributed
- Incentives for Clean Technologies – Central
- Maintain System Reliability and Control Distributed Resources – Central
- Emissions Offsets – Central
- Airborne or Outdoor Emissions – Central and Distributed
- DER Fuel Delivery Challenges – Central

# AVAILABILITY AND ACCEPTANCE OF DATA AND METHODS

Finally in this assessment, collaborative staff evaluated the status of our collective understanding of available data, methods and models necessary in order to calculate the different DG costs and benefits. In this part of the assessment, collaborative staff did a relative evaluation of whether or not data needed for calculations is accepted, publicly available or unavailable. Likewise, collaborative staff considered whether or not methods or models for calculating costs and benefits are accepted, publicly available or unavailable.

What became evident from this analysis is that reaching agreement and acceptance on methods and the data required for these methods will be a challenge for the high priority benefits. In contrast to benefit quantification, cost related data, methods and models appear to have better acceptance. Additionally, because costs and benefits vary by stakeholder perspective, distributed versus central nature, or how they are implemented, the CPUC may need to group common benefits and costs together (e.g., system or environmental). This may also require more than one method or model; for example, system costs and benefits may be calculated all together while environmental costs and benefits are calculated with a separate method and model.

Figures 5 and 6 illustrate the status of data, method and model availability and acceptance.

| | Benefits | DG Owner | Utility | Ratepayers | Society | Central vs Distributed |
|---|---|---|---|---|---|---|
| 1 | Support of RPS Goals | | | | | Central |
| 2 | Mitigation of Market Power | | | | | Central |
| 3 | Airborne or Outdoor Emissions | | | | | Central/Distributed |
| 4 | Reduced Security Risk to Grid | | | | | Central |
| 5 | Reliability and Power Quality (Distribution System) | | | | | Distributed |
| 6 | Voltage Support to Electric Grid | | | | | Distributed |
| 7 | Enhanced Electricity Price Elasticity | | | | | Central |
| 8 | NIMBY Opposition to Central Power Plants and Transmission Lines | | | | | Distributed |
| 9 | Land Use Effects | | | | | Distributed |
| 10 | Avoided T&D Capacity | | | | | Distributed |
| 11 | System Losses | | | | | Central |
| 12 | Combined Heat and Power/ Efficiency Improvement | | | | | Distributed |
| 13 | Consumer Control | | | | | Distributed |
| 14 | Lower Cost of Electricity | | | | | Distributed |
| 15 | Consumer Electricity Price Protection | | | | | Distributed |
| 16 | Reliability and Power Quality (DG Owner) | | | | | Distributed |
| 17 | Ancillary Services | | | | | Central/Distributed |

Priority Benefits for R.04-03-017 — Data: *Accepted* *Publicly Available* *Unavailable*

Not impacted — Methods/Models: *Accepted* *Publicly Available* *Unavailable*

## Figure 5. Acceptance and Availability of DG Benefit Data and Methods/Models

| | Costs | DG Owner | Utility | Ratepayers | Society | Central vs Distributed |
|---|---|---|---|---|---|---|
| 1 | Utility Revenue Reduction | | | | | Central |
| 2 | Standby Charges | | | | | Distributed |
| 3 | Incentives for Clean Technologies | | | | | Central |
| 4 | Noise Disturbance | | | | | Distributed |
| 5 | Indoor Emissions | | | | | Distributed |
| 6 | Maintain System Reliability and Control Distributed Resources | | | | | Central |
| 7 | Emissions Offsets | | | | | Central |
| 8 | Airborne or Outdoor Emissions | | | | | Central/ Distributed |
| 9 | DER Fuel Delivery Challenges | | | | | Central |
| 10 | Equipment | | | | | Distributed |
| 11 | Interconnection (system studies and upgrades) | | | | | Distributed |
| 12 | Fuel | | | | | Distributed |
| 13 | Maintenance | | | | | Distributed |
| 14 | Insurance | | | | | Distributed |
| 15 | Exemptions from Cost Responsibility Surcharges | | | | | Central |

Priority Benefits for R.04-03-017 — Data: *Accepted* *Publicly Available* *Unavailable*

Not impacted — Methods/Models: *Accepted* *Publicly Available* *Unavailable*

## Figure 6. Acceptance and Availability of DG Cost Data and Methods/Models

# CONCLUSIONS AND RECOMMENDATIONS

## Key Observations

Based on this issues assessment, collaborative staff provides the following key observations:

1. Traditional regulatory approaches such as incentive programs and customer class ratemaking will not adequately encourage priority DG benefits.
2. Cost/benefit model(s) must be developed that is technically acceptable to stakeholders to be effective in a regulatory forum.
3. A full evaluation of DG's deployment potential depends on better quantification methods and better access to data.

Traditional regulatory approaches that are average based, such as incentive programs and customer class ratemaking, are not sufficient to encourage benefits. This is because some benefits and costs are distributed in nature and are location and time dependent. For example, a locational benefit that affects a distribution feeder would be benefiting multiple customer classes on that feeder. Additionally, benefits are mostly technology neutral and driven more by the type of DG application. Examples of technologies include engines, fuel cells, wind turbines and others, where as applications include peak shaving, cogeneration, backup and others.

A second major observation, through its rulemaking, the CPUC needs to develop models that will have credibility with all stakeholders. Currently, models are available to analyze the high priority benefits of DG; however, not all stakeholders accept these models. The lack of publicly available data is another problem that will need to be resolved if California is to reap the benefits of DG.

Third, more efficient deployment of cost effective DG will require an evolution of market mechanisms over time. Market mechanisms are the means by which DG costs and benefits are put into play in the marketplace. Market mechanisms include such things as incentives, tax subsidies, rates and tariffs, utility contracts, wholesale and retail markets, utility procurement and planning processes and others. The evolution of market mechanisms over time will be driven by development of better quantification methods and more publicly available data. Presently there are many costs and benefits to consider and the ability to analyze them varies widely. Simple approaches such as project-specific methods could be implemented first. More sophisticated methods, based on a system-wide approach, are under development and could be implemented when they become available. In order to get started on unlocking DG costs and benefits, regulatory activity should be prioritized based on the most important benefits and costs.

## Recommendations

Based upon these observations, collaborative staff has several near-term and long-term recommendations for the CPUC to consider in their DG proceeding regarding:

1. Definition of DG
2. Proposed process steps for identifying, quantifying and unlocking costs and benefits
3. Model development and data needs
4. Implementation strategies for the near-term and long-term

First, the definition of DG should not be solely defined on the basis of size, technology, application, or ownership. DG can be applied in so many different ways or applications as was mentioned above. The benefits it can provide are driven more by application than by technology type. Whether the utility, a third party or the end use customer owns the DG devices is also irrelevant to whether the DG benefits can be tapped. For these reasons, how DG is defined needs to be as flexible as possible in order that its potential multiple benefits can be unlocked. Therefore, collaborative staff proposes it be defined as: distributed generation is electricity production that is on-site or close to the load center and is interconnected to the utility distribution system.

Second, the CPUC should consider these proposed process steps for addressing DG costs and benefits

- Identify costs and benefits
- Develop method(s) to quantify costs and benefits
- Quantify costs and benefits
- Develop and implement market mechanisms to allocate costs and benefits.

In the near term, the CPUC should develop a common model(s) for utilities and other stakeholders to use for determining the identified high priority costs and benefits. This model(s) should be based upon project-specific oriented cost/benefit methodologies. A project-specific approach is less likely to show the interactions between multiple DG projects and their respective costs and benefits from the utility system perspective. However, this approach would reduce the complexity of developing and implementing a new model while getting costs and benefits of DG addressed in the marketplace.

The CPUC should require utilities to make publicly available their capital distribution investment plans, including the need for the proposed distribution expansion projects, costs of those projects, and their timing. Utilities should also be required to determine system losses and publicly identify where DG can be implemented to minimize these losses. The CPUC should then establish mechanism whereby utilities compensate DG customers who help reduce those losses.

In the longer-term, a system-wide approach for determining DG costs and benefits should be adopted. This should occur as better, more readily accepted methods, models, and data are developed that can more accurately determine the locational and time dependent benefits. The CPUC should require the utilities to implement a program that identifies from a system-level perspective where DG would be most cost effective to eliminate system losses, defer capital transmission and distribution projects, and reduce the need for ancillary services. The utility programs should also provide compensation to DG customers who are already providing these benefits to the utility system.

As an interim step to creating a system-wide approach, the CPUC should require the utilities to partner with the Energy Commission to validate a systems-level model and approach that optimizes the transmission and distribution system. This model should then be vetted in a public workshop process.

# APPENDIX

The following is a list of all the policy, research and decision documents that were evaluated in the process of inventorying our present position or state of knowledge relative to the issues of DG definition, and DG costs and benefits. The inventory includes CPUC and Energy Commission policy documents, PIER research project documents, and other research or analysis documents.

This issue paper summarizes issues discussed in greater detail in the CEC DG Working Group: DG Definition and Cost-Benefit Analysis – Policy Inventory, July 9, 2004, publication number 500-04-049 which is available at www.energy.ca.gov.

## California Energy Commission

CEC-1 Distributed Generation Strategic Plan - June 2002
CEC-2 Electricity and Natural Gas Assessment Report - December 2003
CEC-3 Energy Action Plan - May 2003
CEC-4 Integrated Energy Policy Report - December 2003
CEC-5 Integrated Energy Policy Report Subsidiary Volume: Electricity and Natural Gas Assessment Report - December 2003
CEC-6 Integrated Energy Policy Report Subsidiary Volume: Public Interest Energy Strategies Report - December 2003
CEC-7 DG Working Group: DG Definition and Cost-Benefit Analysis – Policy Inventory, July 9, 2004, publication number 500-04-049

## California Public Utilities Commission

CPUC-1 Energy Action Plan - May 2003
CPUC-2 Decision Adopting Interconnection Standards, December 2000 (D.00-12-037)
CPUC-3 Interim Opinion: Implementation of Public Utilities Code Section 399.15(b), Paragraphs 4-7; Load Control and Distributed Generation Initiatives, March 2001 (D.01-03-073)
CPUC-4 Interim Opinion: OIR to Establish Policies and Cost Recovery Mechanisms for Generation Procurement and Renewable Resource Development, October 2002 (D.02-10-062)
CPUC-5 Interim Opinion: OIR to Establish Policies and Cost Recovery Mechanisms for Generation Procurement and Renewable Resource Development, January 2004 (D.04-01-050)
CPUC-6 Opinion Approving the 2003 Servicing Order Concerning Southern California Edison Company and the California Department of Water Resources, December 2002 (D.02-12-071)

CPUC-7 Opinion: OIR into Distributed Generation, March 2003 (D.03-02-068)
CPUC-8 Final Opinion: OIR into Distributed Generation, April 2003 (D.03-04-060)
CPUC-9 Opinion on Cost Responsibility Surcharge Mechanisms for Customer Generation Departing Load, April 2003 (D.03-04-030)

## Public Interest Energy Research

R&D -1 SOW: Energy and Environmental Economics Inc, Electrotek Concepts Inc, San Francisco Co-op DER
R&D -2 SOW: New Power Technologies
R&D -3 Installation, Operation and Maintenance Costs for DG; EPRI, February 2003
R&D -4 Innovative Ratemaking Treatment for DG – Statement of Work (Synapse Energy Economics), March 2004
R&D -5 SOW: Commonwealth Program under PIER Renewables
R&D -6 San Francisco as a Distributed Energy Resource 'Test Bed' Site, M-Cubed, Electrotek Concepts, Energy & Env. Economics, PowerPoint Presentation.
R&D -7 Final DG Scenario Development Report for Air Quality Impacts of DG, by University of California, Irvine; September 24, 2003.
R&D -8 Distributed Utility Integration Test, PIER, 2 page note
R&D -9 'Advanced Control Systems for the Grid' and DER, CADER International Symposium, January 2004.
R&D -10 A framework for developing collaborative DER Programs: Working Tools for Stakeholders; Draft Report, E21 DER Partnership, December 2003.
R&D -11 Air Pollution Emissions Impact Associated with Economic Market Potential of DG in California, DUA, June 2000
R&D -12 Commonwealth Energy Biogas/PV Mini-Grid Renewable Resource Program, Project Prioritization, CH2M Hill and Itron, August 2003.
R&D -13 Commonwealth Energy Biogas/PV Minigrid Renewables Resources Program, by Itron Inc., July 2003.
R&D -14 Commonwealth Energy Biogas/PV Mini-Grid Renewables Resources Program, by Itron, Draft Report, August 2003
R&D -15 DER Research Assessment Report, Addendum: 2003 Update, Navigant Consulting Inc., January 2004, publication number 500-04-059AD
R&D -16 Distributed Energy Resources with Combined Heat and Power Applications, LBNL, June 2003
R&D -17 Distributed Power Integration Needs Assessment and Testing, DUIT White Paper, April 2001, Distributed Utility Associates
R&D -18 Optimal Portfolio Methodology for Assessing DER Benefits for the Energynet, CADER International Symposium, January 2004.
R&D -19 Pre-demonstration Summary Report, task 3.2.5: Micro Scale Technology Demonstration- Project Development and Engineering, Nov 7, 2003
R&D -20 San Francisco PUC/Hetch Hetchy Baseline Data Report for DG Assessment Project, Draft Document, August 2003.
R&D -21 SOW: Distributed Utility Integration Testing

R&D -22 SOW: San Francisco PUC/ Hetch Hetchy, April 5, 2004
R&D -23 Relative Merits of Distributed vs. Central PV Generation, Navigant Consulting and Kema-Xenergy, March 2004

## Other Documents

O-1 A forecast of Cost Effectiveness - Avoided Costs and Externality Adders - CPUC - Jan 2004
O-2 DER Benefits Analysis Studies: Final Report - NREL - September 2003
O-3 Evaluation Framework and Tools for DER - LBNL - February 2003