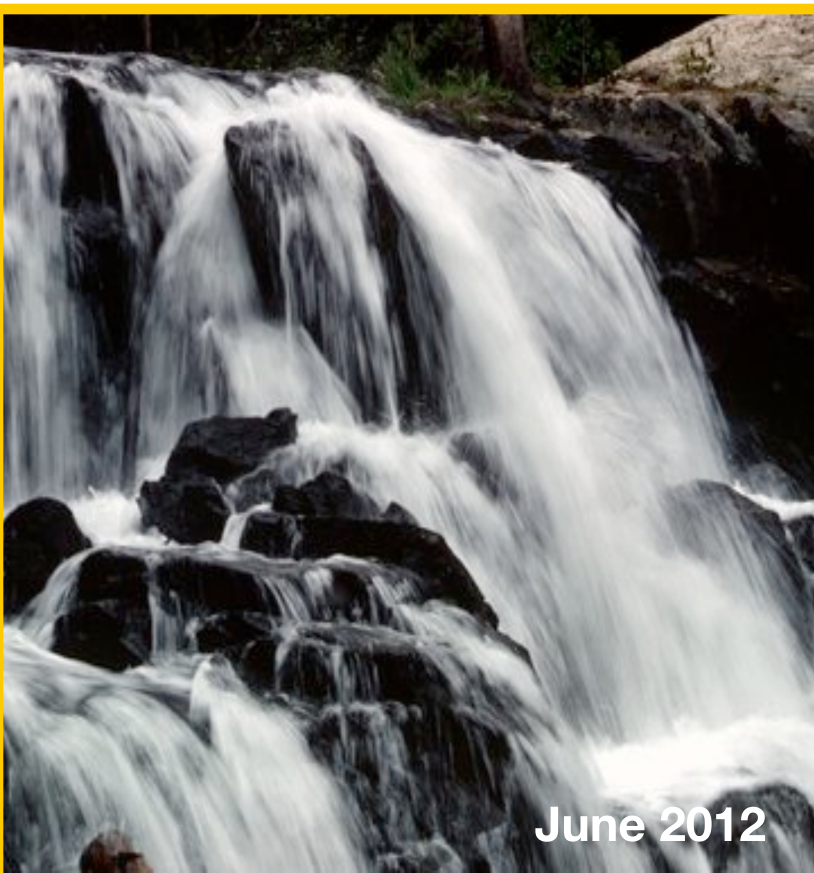
Module 3

CLEAN COALITION
Making Clean Local Energy Accessible Now

Local CLEAN Program Guide

Module 3: Evaluating Avoided Costs



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About the Clean Coalition

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to cost-effective clean energy across the United States. The Clean Coalition believes that the right policies will result in a timely transition to clean energy while yielding tremendous economic benefits.

Contact Us

If you have any questions about the Guide or if you are interested in becoming a local champion for a CLEAN Program in your community, please email LocalGuide@Clean-Coalition.org.

Clean Coalition
2 Palo Alto Square
3000 El Camino Real, Suite 500
Palo Alto, CA 94306
www.clean-coalition.org

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Table of Contents

Overview of the Guide

CLEAN Programs create local jobs and investment opportunities.

The Purpose of the Guide

This Local CLEAN Program Guide is designed to help communities and their local utilities evaluate, design, and enact **Clean Local Energy Accessible Now (CLEAN) Programs** based on global best practices and the expertise developed by the Clean Coalition through our work on designing and advocating for CLEAN Programs throughout the United States.

The Structure of the Guide

The Local CLEAN Program Guide is comprised of seven modules.

Module 1: Overview & Key Considerations provides an overview of CLEAN Programs and guides readers through the process of evaluating how a local CLEAN Program will match community goals, resources, and constraints.

Module 2: Establishing CLEAN Contracts Prices provides a roadmap for establishing optimal fixed prices for CLEAN Contracts.

Module 3: Evaluating Avoided Costs provides approaches for determining avoided costs to the utility and/or community.

Module 4: Determining Program Size & Cost Impact explains how to assess the amount of renewable electricity to purchase through a CLEAN Program and determine the associated cost impact, if any.

Module 5: Estimating CLEAN Economic Benefits provides approaches for estimating the local economic value of energy purchased through CLEAN Contracts.

Module 6: Designing CLEAN Policies & Procedures explains how to design streamlined program policies and procedures.

Module 7: Gaining Support for a CLEAN Program describes how to obtain community support and gain official approval for the program.

1) Overview of Avoided Costs Evaluation

This module of the Local CLEAN Program Guide provides approaches for evaluating the avoided costs of CLEAN energy. As described in Module 2, a community or its local utility can use an avoided costs assessment (i) to determine whether a cost-based CLEAN Program proposal is more or less expensive than current practices for purchasing energy, or (ii) to establish value-based CLEAN Program prices.

An avoided costs evaluation requires a comparison of (i) the full value to the utility of a certain amount of **replacement generation**, meaning the generation of electricity by a type of CLEAN project, and (ii) the full costs to the utility of **avoided generation**, meaning the generation of electricity that the utility would have otherwise procured by business-as-usual practices. This evaluation reveals that the "sticker price" expressed by power purchase agreements does not include the many hidden costs that the utility pays for avoided generation, such as transmission costs, or the hidden additional value of CLEAN replacement generation, such as the overlap between peak demand for energy and peak supply of solar energy. In addition, a community may decide to include in its avoided costs evaluation certain "external" costs of energy generation that have a substantial impact on the community, but incur no cost to the utility.

Table A: Steps for Evaluating Avoided Costs:

1) Select the type and capacity of replacement generation to evaluate
2) Identify the type and capacity of avoided generation
3) Identify costs and values of avoided generation and replacement generation
4) Compile costs and values data
5) Calculate the total costs of avoided generation and the total value of replacement generation
6) Check analysis for accuracy and scalability

The first step is to select eligible renewable energy technology types and aggregate generating capacity for analysis as replacement generation. The next step is to identify which types and capacities of existing generation will be avoided (see Section 2 below). Once the replacement generation and avoided generation have been defined, their respective costs and values can be identified, selected for analysis, and quantified in accordance with Section 3. Finally, Section 4 explains how to assess avoided costs and check the analysis for accuracy and scalability.

Note that this module does not address federal or state guidelines for determining avoided costs since programs created by municipal and cooperative utilities generally are not subject to such guidelines.

2) Identifying Avoided Generation

An avoided costs evaluation should not be based on an assumption that the utility would avoid the average costs of generating energy through business-as-usual practices. Instead, the evaluation should be based on the *specific* energy generation that would be avoided by CLEAN energy generation. The utility should aim to avoid the most expensive planned investments and expenditures, such as new peaking power facilities, upgrades to existing plants, replacement of facilities scheduled for retirement, spot market energy purchases, and distribution infrastructure upgrades or expansions.

Avoided generation can be evaluated in terms of these factors:

- Aggregate capacity of the replacement generation
- Time-of-delivery (TOD) profile of the replacement generation
- Status of compliance with renewable energy and other sustainability requirements

Aggregate Capacity

Depending on planned investments and the scale of CLEAN procurement, CLEAN energy generation may replace all or a portion of one or more existing or planned sources of electricity. For example, replacement generation may displace construction of a new fossil fuel facility for peak generation. Alternatively, CLEAN procurement may simply replace spot market energy purchases.

Time-of-Delivery Profile

Some types of renewable energy have generation profiles that vary with time-of-delivery (TOD) profiles, meaning that the quantity of electricity they produce varies with the time-of-day and/or the season. This is the case for renewable technologies that require sun or wind, which have naturally varying intensities. Other renewable technologies, such as geothermal and biopower, have naturally consistent generation profiles. Water-based renewable technologies may have seasonal variations.

The average generation profile of an intermittent generator can be modeled fairly accurately with a variety of available modeling tools.[i] Final conclusions must at least consider seasonal variations and the aggregate variability of all replacement generation systems. However, a generic time-of-day profile for each technology is sufficient for initial estimates.

The geographic diversity achieved through local renewable energy generation can significantly offset challenges associated with intermittency of a single renewable energy project. For example, Lawrence Berkeley National Laboratory researchers found that the aggregated variability of many distributed solar photovoltaic (PV) facilities is far less than the variability of an individual solar PV facility.[ii] Therefore, from an avoided costs perspective, only the aggregated input into the system should be evaluated.

Once local renewable energy supplies account for roughly 20% of total energy consumption within a distribution substation, back-up generation capacity required for intermittent generation should be assessed based on aggregated variability of each type of replacement generation.[iii] At lower penetration levels, the variability of renewable generation sources has a negligible impact on procurement and reserve requirements.

Renewable Energy Compliance

If the replacement generation would fulfill state or local renewable energy requirements, then the avoided generation may include a type of renewable generation that also fulfills such requirements. For example, if the local utility has not fulfilled an existing mandate to purchase a certain amount of solar power and the CLEAN generation is anticipated to consist of solar facilities, then the avoided costs assessment should show the cost of fulfilling the existing solar mandate with business-as-usual practices.

The avoided costs evaluation should be based on the specific energy generation that would be avoided by CLEAN energy generation.

3) Identifying Avoided Costs and Values

Before analyzing the avoided costs of proposed generation, a utility must determine which costs and values of avoided generation and replacement generation should be considered. This decision will depend on data availability, significance, and measurability.

Table B: Key Costs and Values:

- Procurement cost
- Price certainty value
- Peak demand value
- Transmission cost
- Distribution cost
- Energy losses and congestion costs
- Renewable Energy Credit (REC) value
- Environmental compliance costs
- Grid reliability value

To the extent that such factors are relevant to a specific utility, the key costs and values listed in Table B should be included in an avoided costs analysis. Other potential factors have not been included in this list because their impact on the utility is indirect, negligible, or impractical to determine. A community may decide, on a case-by-case basis, to include one or more of the "external" costs and values described at the end of this section.

The process of pricing CLEAN Contracts, described in Module 2, involves making initial rough assessments, gathering additional data, revisiting goals, making refined assessments, and then repeating the process. For the initial avoided costs assessment, factors that appear to have a low impact can be roughly estimated and aggregated, and may even be excluded from the calculation if the aggregated impact is not significant. This will simplify the process of selecting the eligible renewable technologies for the proposed CLEAN Program. In contrast, a final determination of avoided costs should be based on more refined data and analysis.

Procurement Cost

An avoided costs analysis will include the procurement cost for energy produced by an avoided generation facility. For energy purchased from a third party facility owner or from the spot market, the relevant procurement cost is the contract price of each kilowatt hour (kWh) of electricity; this price often fails to include transmission-related costs, which are generally significant.

The procurement cost of a new utility-owned generating facility is the levelized cost of the facility, meaning the present value of the total cost of building and operating the new facility over an assumed financial life and utilization rate, converted to cost per kWh. The levelized cost reflects capital costs, fuel costs, operating and maintenance costs, financing costs, and an assumed utilization rate, often referred to as the capacity factor. The levelized cost should be expressed as the cost per kWh that must be charged over time to pay the total cost of the new facility.[iv]

Avoided procurement cost data may be found in recent request for offer bids, open market data, or marginal cost estimates for new utility-owned generation.

Price Certainty Value

A CLEAN Contract guarantees a fixed price over an extended period, typically 20 years, providing valuable cost certainty. If the avoided generation procurement price does not include this cost certainty, then the value of avoiding projected cost increases must be considered. Between 2001 and 2011, the average cost of electricity for U.S. consumers increased by 38%.[v] In many locations, electricity costs had increased more dramatically. Throughout the nation, there is a substantial risk that electricity costs will increase more quickly in the future, partly due to anticipated transmission investments that can be avoided by adopting CLEAN Programs.

A fixed price contract must also be compared with a variable price contract on a levelized basis that takes into account future price increases throughout the life of the variable price contract. This levelized cost is expressed in current year value for direct comparison.

In addition, a CLEAN Contract has "hedge" value for protection against the risk that the actual escalation rate of the market price of energy will exceed the projected escalation rate. A study commissioned by Austin Energy quantified the value of solar photovoltaic (PV) generation as a hedge against fluctuating natural gas prices. The study showed that this hedge value can be assessed from two key inputs: (i) the price of the avoided conventional energy over the life of the solar PV system as reflected by futures contracts, and (ii) a "risk-free discount rate" for each year of system operation. Focusing on the short-term gas futures market applicable to Austin Energy, and assuming that the trajectory of gas prices would remain steady, they quantified this hedge value of solar PV at roughly 50% of the actual anticipated gas costs.[vi] In other words, the utility's true cost of natural gas is far higher than the basic procurement cost of natural gas alone.

Peak Demand Value

The value of energy is greater during periods of high demand and low supply. Accordingly, the market price of electricity is higher during times of the day and times of the year when customers have greater demand for electricity. As noted above, many types of renewable electricity generation have varying generation profiles. When assessing the value of replacement generation, it is important to account for how generation profiles align with demand for electricity.

Utilities generally must pay extra for electricity during peak demand periods in accordance with time-of-delivery (TOD) price schedules. In addition to or as an alternative to these TOD schedules, suppliers may impose "demand charges" to offset their cost of maintaining sufficient generating and delivery capacity to meet peak demand. These charges are often substantial and are sometimes even higher than the procurement cost of the energy itself.

It is possible that values for avoided TOD adders and demand charges have already been calculated for local demand response or other programs. Hence, current data is often readily available in published rate tables through the utility, the transmission operator, and/or the energy supplier. Consideration should be given to price trends and future cost recovery related to anticipated investment to maintain or increase capacity; a well-designed CLEAN Program could allow a utility to avoid many of these anticipated investments.

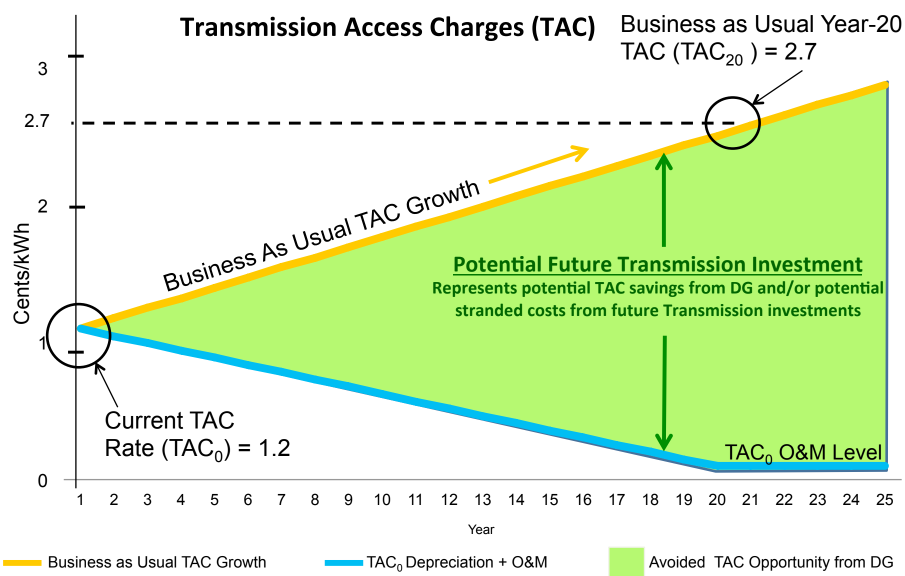
Transmission Cost

When evaluating avoided costs, it is imperative to consider the point-of-delivery. Power purchase agreements are often priced at the point of interconnection, and therefore do not include the hidden transmission costs that the utility pays for central station energy.

A CLEAN Program avoids the costs of delivering electricity through the transmission system. Transmission costs are often substantial; transmission and congestion-related costs exceed 4¢ per kWh for New York City.[vii] The charges for using the transmission system are known as transmission access charges (TACs) in most areas. Utilities are commonly charged a flat rate per unit of energy delivered via the transmission grid; however, some areas have TACs that reflect voltage level, distance, time-of-delivery, peak and/or standby capacity charges. For example, the current average flat rate TAC value in California is about 1¢/kWh, and the 20-year levelized value is about 1.5¢/kWh.[viii]

Since transmission costs are expected to escalate over time, the levelized value of avoided future costs over the term of a CLEAN Contract should be included. Consideration should be given to price trends and future cost recovery related to anticipated investment to maintain or increase transmission capacity. Current data should be readily available from published rate tables through the transmission system operator or supplier.

Figure 1: Potential Transmission Access Charge Savings from Distributed Generation



Source: The Clean Coalition

Distribution Cost

The cost of operating, maintaining, and upgrading the electricity distribution system is a major component of the cost of delivered energy. Distribution systems are designed with sufficient capacity to deliver peak power loads from remote large-scale generators to every corner of a utility's territory. When replacement generation is sited closer to consumption, which is often referred to as load, less distribution capacity is required to transport electricity from remote generators. As a result, CLEAN energy generation often reduces system wear and allows utilities to defer or reduce the scope of capital investment in distribution capacity upgrades.

The avoided distribution costs of replacement generation depend on the specific siting of replacement projects and the generation profile of these projects. These factors will determine whether CLEAN generation will reduce the costs of maintaining the existing distribution grid or displace planned investment in distribution grid upgrades or expansions. Consultation with system planners and engineers is useful for determining these generally significant financial considerations. Excellent research reports are freely available for some locations, such as a September 2011 report commissioned by the California Public Utilities Commission (CPUC) that shows the locational benefits value of clean local energy to easily be greater than 5 cents per kWh from avoided distribution investments alone.[ix]

Energy Losses and Congestion Cost

Energy is lost throughout the system in relation to the distance, voltage, and carrying capacity of the lines involved in transmission and distribution. According to the U.S. Energy Information Administration, national transmission and distribution energy losses average 7% of all transmitted energy each year.[x] Most of these losses occur in the transmission system. For example, energy losses in the California transmission system alone range from 7.5% (average load) to 14% (peak load).[xi] Energy losses range well above average during peak load periods, when congestion and heat effects are highest;[xii] this is another reason why the time-of-delivery profile of the proposed replacement generation is a major consideration in the avoided costs valuation.

Congestion refers to the existence of limitations on the system's ability to transmit power, which results in a higher cost of electricity transmission or distribution. Congestion costs and congestion relief values can be attributed directly to the node causing or relieving the congestion. Ideally, a generator that relieves congestion should be paid a premium that reflects the locational benefits provided, and a generator that causes congestion should receive a lower price for the energy it produces. However, it is often more practical to develop a general proxy to reflect locational benefits value. For example, any generation that is interconnected to the distribution grid for local use should receive a defined locational benefits adder for avoiding the significant costs associated with transmission and for potentially offsetting distribution-related costs as well.

Congestion is typically associated with lack of transmission or distribution capacity, but it is often a reflection of locational imbalance between generation, load, and transmission resources. For example, generation or load pockets may exist which stress the transmission or distribution system due to limited capacity at the location of the load or generation source. The flow of power, the loading and temperature of lines, and the voltages of the system all affect system congestion.

While all distributed generation will avoid transmission-related energy losses, distribution losses of replacement generation are relative to the facility's proximity to load and congestion. Accordingly, system planners should assess potential avoided energy losses based on siting in relation to load and congestion.

Data on total existing distribution system losses is often available in published reports contrasting generated or contracted energy entering the system against metered delivery and sales. If data on energy losses due to congestion during peak demand is not available, it can be estimated based on data from studies of comparable localities. Marginal losses data, which reflects incremental energy losses due to congestion and distance of transmission, may also be available.

Renewable Energy Certificate (REC) Value

Renewable energy has additional value beyond the simple energy value due to state and local goals and mandates, such as Renewable Portfolio Standards (RPS), which are also known as Renewable Energy Standards (RES). For certain RPS programs, the renewable energy requirement may be met with the purchase of Renewable Energy Certificates (RECs), which represent the environmental attributes of renewable energy and which are sometimes sold separately from generated renewable electricity. When the RECs are sold separately, the value of the renewable energy is reduced to the value of the conventional energy.[xiii] Separately traded RECs are priced on the open market, which directly establishes their value. The U.S. Department of Energy's Green Power Network provides resources for determining REC prices.[xiv]

Although many jurisdictions are opposed to buying tradeable RECs, sometimes utilities will purchase RECs to meet state and local renewable energy goals. If a utility would otherwise purchase RECs, then the projected price of a REC can be used to determine the avoided costs of a REC. Likewise, if RECs would be produced with CLEAN generation in excess of requirements, the RECs could be sold to provide income that would increase the value of the CLEAN generation. The key is to count the REC value of renewable generation only once.[xv]

On the other hand, if the avoided generation, possibly from a remote renewable energy power plant, would have also counted towards renewable energy targets, the assessment should separate the bundled REC value of the avoided generation from its energy value. The energy value of the avoided generation is equal to the cost of conventional energy that matches its generation profile, and the balance of the avoided generation price is the bundled REC value.

The REC value of renewable electricity may depend on the source of generation. Renewable energy requirements can differentiate between types of renewable sources, resulting in different values for RECs from different types of generation. This is common for solar RECs, where the market value may be multiple times the value of RECs from other sources due to highly valuable attributes of solar and/or limited supplies of solar RECs. Likewise, when REC requirements limit eligible resources to generators located within the state or a group of cooperating states, valuation must be based on prices from eligible location-specific markets. Similarly, several states give greater credit towards meeting renewable energy requirements based on factors such as the date delivery begins, the type of production, the location of production, generation directly connected to the distribution grid, and/or to the nature or size of the utility.

It is important to note that REC market prices may fluctuate dramatically, and this price risk should be accounted for in the avoided costs assessment. Further, it is important to read the fine print requirements of REC bonuses and multiplier credits. For example, REC bonuses may only apply to projects completed by a certain date or energy generated before a certain date. The State of Colorado provides an excellent example of how RECs can carry additional attributes that substantially increase their value for purposes of meeting state RES requirements. Colorado has established the following multipliers for clean local energy:

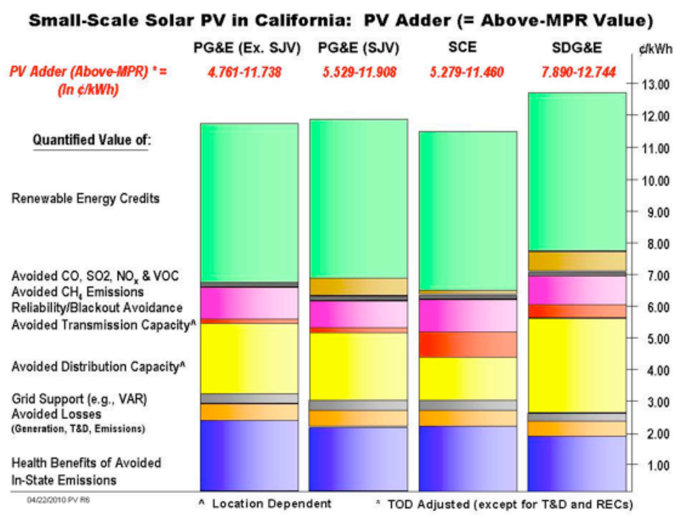
- RECs generated within the State of Colorado are worth 25% more than RECs generated outside of the state.[xvi]
- In-state projects owned by local residents, local governments, cooperatives, or tribal councils generate RECs that are worth 50% more than out-of-state RECs.[xvii]
- The first 100 MW of projects installed in-state before the end of 2014 and connected within a municipal or cooperative utility service territory generates RECs that are worth twice (200%) the value of out-of-state RECs.[xviii]
- Solar projects located within the territory of a Colorado cooperative or municipal utility that commence operation before July 1, 2015 generate RECs that are worth three times (300%) the value of out-of-state RECs.[xix]

Environmental Compliance Cost

Many states have air and water quality statutes and regulations that require mitigation measures for fossil fuel generation. In the future, many states will also require compliance with greenhouse gas emissions regulations. Compliance with environmental statutes and regulations may require substantial capital investments for mitigation, purchase of tradable emissions credits, conversion to cleaner fuels, or the retirement of non-compliant facilities. For example, as the result of a settlement with the U.S. Environmental Protection Agency, the Northern Indiana Public Service Corporation (NIPSCO) announced in 2011 that it will invest $600,000,000 in pollution control technology to protect public health.[xx] For NIPSCO's 457,000 electric customers, this will cost more than $1,000 per customer.[xxi]

While current compliance costs may be reflected in the basic energy procurement costs described above, such costs do not typically incorporate compliance with future requirements, whether planned or unplanned. Accordingly, compliance with future requirements and the avoided risk of noncompliance with future requirements should be evaluated separately from current compliance costs. Although these costs are challenging to determine with accuracy, they are likely to be significant, and should therefore be considered.

Figure 2: Value of Solar PV in California (¢/kWh)



Source: The California Solar Energy Industries Association (CalSEIA)[xxii]

The California Public Utilities Commission established a baseline Market Price Referent (MPR) value of electricity based on generation from a new 500 MW combined cycle natural gas facility. The MPR value captured the cost of production up to the point of connection to the transmission system. The above graphic reflects the findings by CalSEIA of the additional value of distributed generation from small-scale PV, excluding transmission access charges, for each of the major investor owned utilities in the state, expressed as a value range.

Grid Reliability Value

Large central station grids are vulnerable to a wide range of threats, including thunderstorms, natural disasters, terrorist attacks, and human error. In September 2011, nearly six million people in southern California, western Arizona, and northern Mexico lost power when an electric transmission line failed in Arizona.[xxiii] The addition of CLEAN generation can prevent the overloading of various grid components[xxiv] and thereby lower the utility's statistical outage rate, often known as the "Loss of Load Probability". If the CLEAN Program will lower the utility's Loss of Load Probability, then this value should be included in the avoided cost analysis.

External Costs and Values

Some costs and values of energy generation do not directly affect utilities, ratepayers, or energy producers. However, these "external" costs and values have a great impact on communities. Since external costs and values do not affect utility bills and are often difficult to quantify, they are rarely included in avoided costs evaluations. Regardless, it is important to understand these factors because they often motivate communities and their leaders to support CLEAN Programs. For example, the economic benefits of CLEAN Programs (described in Module 5) and the environmental benefits of CLEAN Programs (described in Modules 1 and 7) are two especially compelling external values.

Environmental

As discussed above, avoided costs evaluations include the utility's cost of compliance with existing environmental regulations for air and water pollution. However, the environmental costs to the community of permitted emissions of pollutants and greenhouse gases are borne by the community, rather than the utility, and therefore represent unaccounted for external costs.

There are two main approaches to estimate the external costs of emissions: by estimating direct damages, or by estimating the cost of abatement.[xxv] The direct damages method involves calculating the damages that can be definitively linked to emissions of a particular pollutant. The cost of abatement approach typically uses the cost of pollution controls imposed by regulatory decisions as a proxy for the true externality costs imposed by a pollutant.[xxvi] Once the total external costs have been determined, the results of either approach can be expressed in a per kWh basis with relative ease.

Health

In addition to the environmental costs, conventional energy has significant external costs to human health. Some of the human health risks include a reduction in life expectancy due to both short- and long-term exposure to pollutants, and increased respiratory illnesses, such as chronic bronchitis and asthma, among others. Health-related costs include increased medical costs, decreased productivity, and decreased life expectancy. Air pollutants from fossil fuel power plants can be carried hundreds, or even thousands of miles from their source.[xxvii] Researchers have found that the toxic emissions from coal-fired power plants can cause asthma, obstructive pulmonary disease, lung cancer, heart attacks, and birth defects.[xxviii] Studies have also begun to emerge detailing the health impacts of natural gas. Drilling natural gas wells generates emissions and millions of gallons of hazardous waste that are dumped into open-air pits, which have been found to leak into groundwater and create toxic emissions as fluids evaporate. Residents living near natural gas fields have reported respiratory infections, headaches, nausea, skin rashes, and neurological impairments.[xxix]

Grid Security

The utility's cost of power outages represents only a small portion of the total costs of these disruptions. Blackouts and brownouts cost Americans an estimated $150 billion per year.[xxx] CLEAN generation can increase local grid security and facilitate microgrids that can provide essential services even during long-term emergencies.[xxxi] The societal value of enhanced grid security can be estimated based on the relationship between electricity consumption and economic productivity.[xxxii] The amount of electricity that is available after a power outage can proportionally alleviate both economic productivity losses and asset losses due to power outages.[xxxiii]

4) Assessing Avoided Costs

An avoided costs evaluation shows the total value of avoided generation and often reveals that CLEAN energy has substantially greater value than conventional energy generation. When conducting this evaluation, special attention must be paid to accuracy, scalability, and communication.

Accuracy

Since an avoided costs evaluation may impact the program size and/or the pricing for a CLEAN Program, it is important to evaluate the accuracy of each cost and value component included in the final avoided costs calculations. When applying the value-based pricing method, a variation of a few percentage points can dramatically affect the anticipated rate of return for CLEAN projects. When the program goals include a cost impact limit, the accuracy of an avoided costs valuation can have a major impact on the calculated premium for CLEAN energy, which will affect the program size. If the total value of the replacement generation is later found to be much higher than calculated, then the program size was set substantially smaller than it should have been for the cost impact limit.

The final avoided costs assessment should include the margin of error and certainty interval, taking into consideration the inherent uncertainty of many of the costs and values described above, relative to the scale of their contribution to the avoided costs total. For example, the final figure could be 15.5¢/kWh, +/- 1¢, with a 90% certainty.

A sensitivity analysis should be performed on each of the cost and value components with modeling software, such as the National Renewable Energy Laboratory's System Advisor Model (SAM).[xxxiv] The purpose of the sensitivity analysis is to identify components where uncertainty may have a substantial effect on the overall avoided costs valuation, and then determine how this sensitivity may be addressed.

A sensitivity analysis is critical for certain factors, such as the rate of inflation or the choice of discount rate applied when calculating the net present value of future costs or savings. The use of a higher discount rate will lower the net present value of future costs. In effect, this "short-term thinking" approach minimizes the costs incurred by future ratepayers. For example, a $10 million investment today may save ratepayers $50 million thirty years from now. If future savings are discounted at a rate of 3%, it will have a net present value is $20 million and will be deemed to be a good investment; if, however, the future savings were discounted at 7%, it would have a net present value of only $6.5 million and would be deemed a poor investment.

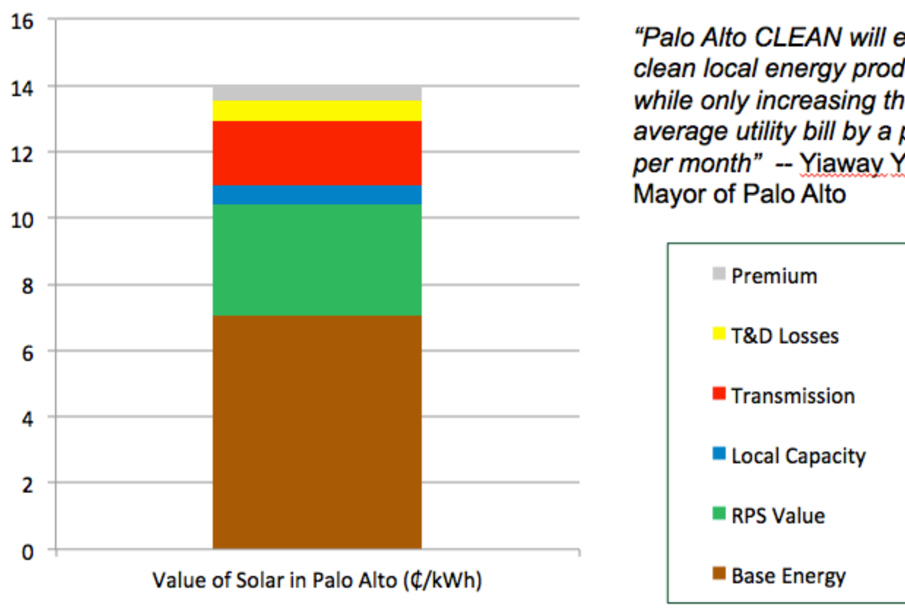
Scalability

An avoided costs evaluation requires analysis of the *specific* energy generation that would be avoided by replacement generation. As a result, the avoided costs of the first 10 MW of renewable energy may be different than the avoided costs for the next 10 MW of renewable energy. For example, new generation that meets peak demand may avoid the cost of building a small peaking power plant and keeping it in reserve, or purchasing peak power on the spot market. However, generating additional power in excess of the amount necessary to meet peak demand could not be used to avoid these same costs.

Communication

Once an avoided costs evaluation has been completed, policymakers will use this information to determine program goals and design guidelines. A visual representation of the avoided costs values and components included in this assessment will help policymakers make these decisions. Figure 3 below demonstrates how to express this information in a manner that highlights the superior value of CLEAN energy.

Figure 3: Value of Rooftop Solar PV in Palo Alto, CA



"Palo Alto CLEAN will expand clean local energy production while only increasing the average utility bill by a penny per month" -- Yiaway Yeh, Mayor of Palo Alto

Source: City of Palo Alto Utilities and the Clean Coalition[xxxv]

A 2012 assessment of the full value of CLEAN energy generation by the City of Palo Alto Utilities shows its substantial additional value over conventional generation, which is referred to as "Base Energy" in the chart.

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References for Module 3

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Appendix A – Avoided Costs of Fort Collins' Proposed CLEAN Program

In 2010, Fort Collins Utilities began to evaluate the potential of a CLEAN Program (locally known as the Fort Collins Solar Program) to achieve a variety of community goals, including compliance with the renewable energy requirements of the State of Colorado.[i] All analyses reflected in this Appendix were performed by RightCycle, a consulting firm founded and managed by Craig Lewis, Executive Director of the Clean Coalition.

I. **Rates, Ranges, and Trends**
   A. Avoided Costs of Energy
   B. Avoided Demand Charge
   C. Avoided Renewable Energy Certificate (REC) Costs
      i) Wind Power REC Value
      ii) Fort Collins Solar REC Value
II. **Potential Avoided Costs Factors Not Included**
III. **Secondary Effect on Utility Costs**
IV. **External Costs Not Included**

I. Rates, Ranges, and Trends:

The primary components of these avoided costs are:

- Fort Collins rates for energy purchases from the Platte River Power Authority (PRPA), which include energy and peak demand charges
- The costs of compliance with Colorado's Renewable Energy Standard (RES)
- Local policy preferences regarding how that RES is met

Table A: 2010 Avoided Costs Values for Fort Collins' CLEAN Program

Qualifying Renewable Energy Source	REC Value ¢/kWh	Energy Value ¢/kWh	Demand Charge Value ¢/kWh	Total Avoided Costs Value ¢/kWh
Wind Power	4.08	2.02	0.24	6.34
Local PV with State REC Value	12.24	2.02	0.24	14.50

The avoided costs values listed above are based on 2010 energy rates, current supplier quotes, market rates reported by the U.S. Department of Energy[ii] and recent renewable energy contracts held by the City. Discussion of pricing trends, value ranges, and recommended values are detailed below. Future rates and contract costs will vary based on the cost of energy and demand for renewable energy and the Renewable Energy Credits (RECs) that are required for fulfilling RES requirements.

Fort Collins purchases its electricity from the cooperatively owned Platte River Power Authority,[iii] and currently purchases wind power under PRPA contracts to meet renewable energy acquisition goals;[iv] these comprise the City's current costs and the basis for determining avoided costs values for the CLEAN Program. PRPA charges both an Energy Charge for the total quantity of energy used each month and a Demand Charge for the maximum rate of use in any one-hour period during a month.

A. Avoided Costs of Energy: 2.02¢/kWh
(value range 2.02 – 3.8¢/kWh)

The price for energy use is defined in the rate schedule, and was set at 2.02¢/kWh for 2010. This is a flat rate and does not vary by time-of-delivery (TOD); however PRPA is considering changes to its rate schedule. Energy charges have maintained an upward trend that has increased in recent years;[v] this upward trend is expected to continue with a proposed rate of 2.31¢/kWh for 2011.

Any change in the allocation of generation cost recovery between the energy rate and the demand charge or adoption of TOD rates will impact the avoided costs value of alternate sources of electricity. A TOD proposal currently before the PRPA Board would result in a 1.8¢/kWh increase in avoided costs value for energy from solar generation, but this is not included in present calculations.

B. Avoided Demand Charge: 0.24¢/kWh
(value range 0.12 – 0.48¢/kWh)

Under current PRPA contract rate schedules, Fort Collins pays a Coincident Peak Demand Charge based on the City's energy use during the single hour of each month in which there is the highest total aggregate demand among the four municipal utilities served by PRPA. This charge varies, but is generally greater than the total Energy Charge that is billed each month, averaging 2.4¢/kWh when averaged across total energy usage. However, according to PRPA, power generated at times other than the coincident peaks does not reduce peak loads, and therefore does not reduce the Demand Charges.

While solar power generation largely overlaps with the energy demand profile on summer days,[vi] at actual peak demand in Fort Collins, fixed position photovoltaic (PV) panels typically produce only 30% of full rated capacity during Demand Charge hours in the summer months, and do not produce at all during the Demand Charge hours in the winter months, which occur after dark. Rooftop solar PV's annual weighted average energy production during the Demand Charge hours is only 10% of the PV's full capacity. Therefore, the impact of solar energy on peak Demand Charge reduction is 10% of the average apportioned value of 2.4¢/kWh, resulting in an avoided Demand Charge of 0.24¢/kWh. The use of single-axis tracking solar generating systems, typical in ground-based installations, would improve the Demand Charge reduction by an additional weighted average of 10%, increasing the avoided Demand Charge to 0.48¢/kWh; however, wide use of tracking systems is not anticipated in the initial version of the Fort Collins CLEAN Program, which is anticipated to be limited to rooftop solar projects.

Wind power, currently the City's primary source of renewable energy, has a markedly different generation profile than solar; wind facilities often operate at low capacity during hot summer days and produce mostly at night. Nonetheless, when evaluated over an annual period, the weighted average effect of wind power on the Demand Charge is comparable to solar generation, avoiding about 10% of the annualized Demand Charge.

C. Avoided Renewable Energy Certificate (REC) Costs
Wind (recent contracts): 4.08¢/kWh (value range 3.08 to 6.98¢/kWh)
Solar located in Fort Collins: 12.24¢/kWh (value range 9.24 to 20.94¢/kWh)

Beyond the avoided costs value of energy purchases, the source of generation establishes additional value either through the sale of RECs or the use of RECs to meet state or local renewable energy goals. A utility that does not meet state RES requirements must purchase RECs on the open market, either as stand-alone RECs or bundled with the electricity associated with them.

REC values in Colorado are dependent on the type of renewable energy they represent and the location of their production, such that the values of RECs are not all equal. In addition, the Fort Collins City Council has expressed a preference to acquire RECs through the direct purchase of renewable energy ("bundled RECs") rather than purchasing stand-alone credits ("unbundled RECs"). The City utility is accordingly pursuing a policy goal of eventually replacing all of its purchased stand-alone RECs with bundled RECs, meaning RECs that are associated with the purchase of electricity from renewable sources. The City of Fort Collins and the State of Colorado have also expressed a preference for local generation, with the State awarding enhanced compliance value for RECs derived from local renewable energy generation.[vii]

i) Wind Power REC Value

a) Bundled Wind Value: Energy + REC

The economic value of energy is the current cost of purchasing additional energy of the same type. The price of renewable energy bids and contracts has risen over time and is subject to market fluctuation.

- After remaining level in the first half of this decade, prices for wind energy have increased steadily since 2005 to an average of 5.1¢/kWh in 2008 and 6.1¢/kWh in 2009 (weighted national average).[viii]
- This closely matches the costs of Fort Collins' existing contracts, and is consistent with the trend in wind power project costs, which have also risen steadily over the past six years.
- Recent bids and offers through PRPA were close to 7¢/kWh in 2009 and 9¢/kWh in 2010, consistent with these data trends; however, these bids did not result in contracts and are not included in Fort Collins' current renewable energy portfolio.
- Current quotes from wind energy wholesaler Green Mountain Energy are approximately 6¢/kWh (12/8/2010); however, they are unable to supply to Colorado.

Based on the above most recent contracts and price reports, a price for wind of 6.1¢/kWh was used as the midrange avoided costs value for bundled REC wind energy for Fort Collins.

b) REC value of wind (recent contracts)

In order to determine the portion of the price paid for bundled energy that should be attributed to its REC value, the value of base energy, as previously determined, must be subtracted from the bundled value of wind energy:

(bundled wind energy value) – (base energy value) = REC value
6.1¢/kWh – 2.02¢/kWh = REC value of 4.08¢/kWh

Hence, a market-based avoided costs value of RECs was calculated to be 4.08¢/kWh. Note that due to the 20-year contract terms of the proposed Fort Collins CLEAN Program, the use of shorterterm wind contracts for REC value determination may substantially undervalue the actual avoided costs value of RECs over the 20-year period.

ii) Fort Collins Solar REC Value

RECs can carry additional attributes that substantially increase their value. For purposes of meeting state RES requirements:

- RECs generated within the State of Colorado are worth 25% more than RECs generated outside of the state.[ix]
- In-state projects owned by local residents, local governments, cooperatives, or tribal councils generate RECs that are worth 50% more than out-of-state RECs.[x]
- The first 100 MW of projects installed in-state before the end of 2014 and connected within a municipal or cooperative utility service territory generates RECs that are worth twice (200%) the value of out-of-state RECs.[xi]
- Solar projects located within the territory of a Colorado cooperative or municipal utility that commence operation before July 1, 2015 generate RECs that are worth three times (300%) the value of out-of-state RECs.[xii]

Fort Collins' proposed solar program meets the highest generation quality criteria and would qualify for any of the above State valuation multipliers, including the 300% credit described in category (d) above. The CLEAN Program would avoid the significant costs of purchasing additional RECs to meet State requirements.

For this valuation, the base bundled REC value is 4.08¢/kWh, and since the REC value of each kWh generated by the Fort Collins Solar Program is worth three base bundled RECs, the avoided costs value of the Fort Collins Solar Program RECs is 12.24¢/kWh.

II. **Potential Avoided Costs Factors Not Included:**
(value range 0.1-2.1¢/kWh)

The following factors reflect avoided costs values attributable to renewable energy, however, they have not been included in the Fort Collins avoided costs analysis because they either a) represent uncertain future policy and pricing, b) represent cost avoidance realized by PRPA and not directly by Fort Collins Utilities, or c) are minor values.

- Time-of-delivery adjusted energy rates proposed by PRPA, combined with a 50% reduced Demand Charge rate, would result in a net increase in the blended average wholesale energy avoided costs for a typical solar project in the Fort Collins Solar Program. This increase could be worth up to 2¢/kWh.
- Line losses within Fort Collins distribution system have averaged 2.3% over the past five years, representing 0.1¢/kWh cost.
- Reduced use of conventional generation at high heat/lower efficiency periods saves 0.1¢/kWh.
- Reduced transmission loss at high heat/lower efficiency periods costs 0.1¢/kWh.
- Reliability/avoided system stress costs 0.1¢/kWh.

- Avoided air pollution control costs 0.1¢/kWh.
- Avoided water use – steam generation and cooling costs 0.1¢/kWh.

III. Secondary Effect on Utility Costs:

Since renewable electricity is purchased before other sources, the size of the remaining demand to be purchased on the spot market is reduced. Under cost-based merit ordering, the lowest cost energy sources are used first to meet demand, with more costly plants or spot market supplies being brought on line later if needed (imported energy purchases account for 4% of PRPA total). The most expensive conventional power supplies are therefore no longer needed to meet demand, offsetting the cost of renewable energy by the marginal value of the last increment of supply rather than the average energy price. This "merit order effect" is realized directly by PRPA and is ultimately reflected in energy rates charged by PRPA.

IV. External Costs Not Included:

Community goals and social values, including direct economic investment and job growth, are highly significant factors to the Fort Collins community; however, no value is currently reflected for these factors in the price of power in Fort Collins. The additional value categories listed below will result in benefits realized by the community as a whole, and therefore the City may choose to consider them when investing in renewable procurement practices:

- Direct employment
- Energy price stability
- Green business leadership and development
- City reputation, state and national Profile
- Fort Collins' Energy Plan
- Fort Collins' sustainability goals – 20% greenhouse gas (GHG) reduction by 2020 (vs. 2005 base year)
- Fort Collins' preference to phase out use of unbundled RECs in favor of actual renewable generation for meeting RPS standards
- Colorado Climate Action Plan
- National or State GHG emission avoidance value (if not included in current REC value)
- Healthcare cost reductions attributable to avoided emissions
- Criteria air pollutant compliance and control value: particulate matter 2.5 and 10 ($PM_{2.5}$ & PM_{10}), volatile organic compounds (VOCs), nitrogen oxide (NO_x), sulfur dioxide (SO_2)
- Reliability and self-sufficiency enhancements from diversifying energy supply with distributed generation

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Appendix B – Avoided Costs of Sacramento's CLEAN Program

Sacramento Municipal Utility District (SMUD), the municipal utility of Sacramento, California, is the sixth largest publicly owned utility in United States.[i] In January 2010, SMUD enacted a robust CLEAN Program (locally known as a "feed-in tariff"), which includes several renewable energy technologies and has a total program size cap of 100 megawatts.[ii] For context, it is worth nothing that the proportional expansion of SMUD's 100 megawatt program across the State of California would result in 2,500 megawatts of clean local energy.

SMUD used the value-based pricing method for its CLEAN Program.[iii] The following factors were used to calculate the avoided costs:[iv]

- Market energy price
- Ancillary services
- Generation capacity
- Transmission
- Sub transmission capacity
- Avoided greenhouse gas (GHG) mitigation
- Risk avoidance from future natural gas price increases

Avoided costs were based on several key assumptions, including the following:[v]

- Energy costs based on market simulation model and 2010 gas price forecast
- Ancillary services based on historical California Independent Systems Operator (CAISO) cost
- Generation capacity cost based on the California Energy Commission's installed cost for the advanced simple cycle merchant plant (from August 2009); annual costs are based on the Market Price Referent (MPR) cash flow model
- Net capacity value based on CAISO NET CT Net Revenue Methodology
- GHG adder
- Gas adder based on gas price risk
- Avoided costs were levelized using SMUD's nominal discount rate

Table A: Cost Components of SMUD's Base CLEAN Contracts Rates[vi]

Cost Component	2-Year Levelized Cost 2010 Start Year ($/kWh)	% of Total
Energy	$0.0678	61%
Capacity	$0.0202	18%
GHG Adder	$0.0101	9%
Gas Adder	$0.0126	11%
Total	$0.1107	100%

SMUD's base CLEAN Contracts rates are adjusted by time-of-delivery (TOD) and season, so the applicable average rate for any project will depend on the project's start year and generation profile, with the highest rates given to projects with a 2012 start date that deliver electricity during "Summer Super Peak" hours. As an example, a solar photovoltaic (PV) project under a 20-year contract with a 2012 start date will receive a levelized rate of 14.8 cents per kWh.[vii]

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