The Twin Pillars of Sustainable Energy: Synergies between Energy Efficiency and Renewable Energy Technology and Policy

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EXECUTIVE SUMMARY

Energy efficiency (EE) and renewable energy (RE) are the "twin pillars" of sustainable energy policy. Both resources must be developed aggressively if we are to stabilize and reduce carbon dioxide emissions in our lifetimes. Efficiency is essential to slowing the energy demand growth so that rising clean energy supplies can make deep cuts in fossil fuel use. If energy use grows too fast, renewable energy development will chase a receding target. Likewise, unless clean energy supplies come online rapidly, slowing demand growth will only begin to reduce total emissions; reducing the carbon content of energy sources is also needed. Any serious vision of a sustainable energy economy thus requires major commitments to both efficiency and renewables.

Policies and programs for energy efficiency and renewable energy have generally been pursued on separate tracks. For example, different organizations take the lead on efficiency and renewable energy, and while there are statements of joint support and some coordination, it is could be more coordinated and strategically integrated. With the growth and increasing success of various clean energy industries, groups focused on these technologies have been addressing increasingly diverse agendas. This has created some divergences in policy priorities, such as the Renewable Portfolio Standards (RPS) and Production Tax Credits (PTC) for renewables vs. Energy Efficiency Resource Standards (EERS), Public Benefits Funds (PBFs), building energy codes, and appliance standards for efficiency. While these individual policies are each worthwhile, greater synergies between efficiency and renewable energy could be realized if the various clean energy communities combined their policy agendas more effectively.

This project, supported by the Rockefeller Brothers Fund, was commissioned to better define the most promising synergies between energy efficiency and renewable energy, from both a technical and a policy viewpoint, and to recommend some next steps toward a more coordinated set of policies and programs to increase the joint contributions of efficiency and renewables to a sustainable energy future.

Synergies between Energy Efficiency and Renewable Energy

Synergies between energy efficiency and renewable energy, in the broadest conceptual sense, include:

- ***Timing Synergies***. Energy efficiency can provide large savings in the short and medium terms, but if opportunities are aggressively pursued, in the long term remaining opportunities will likely be more limited. Renewable energy, on the other hand, can supply some energy in the short term, but its opportunities expand over time. For example, a recent ACEEE study on natural gas markets found that energy efficiency investments can lower natural gas prices by more than 20% over the next eight years, but beyond then substantial renewable energy production is needed to maintain significant price reductions. Likewise, the ACEEE/Union of Concerned Scientists' *Clean Energy Blueprint* study found that energy efficiency, renewables, and CHP could reduce U.S. electricity use in 2020 by about 2,900 billion kWh.

- ***Economic Synergies.*** Efficiency can be acquired relatively cheaply; the cost of saved energy in most efficiency studies is lower on a levelized basis than the cost of existing or new conventional power generation. Renewables are often more expensive per kWh than existing conventional utility power generation, but are increasingly cost competitive with new conventional utility power generation. Combining these two resource types can reduce overall electricity system costs compared to a renewables-only policy approach. Efficiency and renewables can also provide price stability benefits to power systems. Efficiency, by bringing down demand, can moderate wholesale price spikes, reduce average prices, and indirectly reduce the prices of affected generation fuels. In a complementary way, renewables, which are typically not subject to fossil fuel price volatility, provide their own hedge value. Thus energy prices in a region with aggressive commitments to both efficiency and renewables are likely to see less volatility and lower average power prices, since price spikes will be reduced.

  Efficiency and renewables also provide complementary economic development benefits by generating investment and employment in different sectors, which expands the total economic stimulus effect. The majority of utility expenditures in most states is exported to national and global energy companies, so efficiency and renewable investment is in fact the best way to generate new economic activity within a state's borders.

- ***Geographic Synergies.*** Efficiency and renewables complement each other in terms of regional resource availability. Some states and regions are richer in some renewable types than others. Efficiency, however, is consistently available across the country, so states with fewer renewables can exploit efficiency opportunities to compensate. This type of synergy helps build a broader political consensus around clean energy policy, because it tends to even out the regional differences among states and thus could make it easier to arrive at a national consensus.

- ***Power System Synergies.*** Efficiency and renewables, because they have different load shape impacts based on time of day and season, can improve overall system operations. On hot summer afternoons, efficiency can help bring down peak load, while solar and wind systems can operate at high output, reducing the use of high-cost, high-emission peaking generation. This brings down total electricity prices, acting as a diverse set of price hedges. It also improves system reliability by deploying a diverse set of efficiency and renewable technologies, especially in transmission-constrained "load pockets." Additionally, using EE and RE as distributed resources can reduce transmission and distribution line losses.

- ***Other Synergies.*** This report focuses primarily on the electricity sector. Looking beyond the scope of this report, there are additional synergies between efficiency and renewables in the motor fuels or heating fuels sectors. Also, there is potential in centralized versus distributed energy systems; clearly much of the potential for deploying efficient and renewable technologies lies in physical and regulatory changes that encourage smaller-scale technologies. There is tremendous opportunity in combined heat and power (CHP), involving the interactions between electric and thermal technologies in the power generation or buildings sectors. CHP is a central part of the energy efficiency and distributed energy challenge. These issues, while important, are beyond the scope of this project and should be addressed in subsequent work.

Combined Efficiency and Renewable Energy Resource Potential

The combined potential of energy efficiency and renewable energy to reshape America's energy future is substantial. The 2000 national laboratory study *Scenarios for a Clean Energy Future* showed that efficiency policies could reduce electricity usage by 24% compared to the reference forecast. This was corroborated by an ACEEE study, which in reviewing 11 efficiency potential studies found a median electricity savings potential of 24%.

The *Clean Energy Future* report projected that non-hydro renewables could double their energy production, from 2.3 Quads to 4.6 Quads, in 20 years. Combined with efficiency, these renewable energy technologies could reduce carbon emissions from power generation by 46%. State and regional studies tend to confirm these overall assessments. For example, the *Midwest Clean Energy Plan* identified a strategic clean energy development plan for the 10-state Midwest region that incorporates both energy efficiency and renewable energy resources. In that study, energy efficiency resources could reduce electricity use by 28% in 2020, and aggressive development of renewable energy technology, including wind power, biomass, and solar photovoltaics (PV), could provide 22% of the region's electricity generation by 2020. Combined, efficiency and renewables thus reduce conventional energy generation by 44% below a business-as-usual forecast. These studies are rather conservative in that they do not assume any penetration of emerging technologies.

These analyses illustrate the fact that through combined technology scenarios and policy commitments that embrace both efficiency and renewables, the U.S. can reduce its conventional electricity generation and carbon emissions by almost half in a 20-year timeframe.

Efficiency and Renewables Case Studies

To make this assessment more tangible and ground it more firmly in known technology and policy experience, we documented seven case studies where both renewable energy and energy efficiency are addressed in a policy or technology framework. These case studies are:

- ***Public Benefits Funds—***23 states operate efficiency or renewable energy Public Benefits Funds, in which a small public-goods or "system benefits" charge is assessed on utility bills, and the funds are used to support public education and incentive programs for these resources. Sixteen states operate both efficiency and renewables funds. Spending totals about $1.8 billion per year, with a trend towards increasing funding.
- ***Resource Standards—***Several states have instituted policies that set quantitative resource targets for renewables, efficiency, or both. Twenty-one states and the

District of Columbia have renewable portfolio standards, and eight states have efficiency resource targets (Washington recently passed legislation that will set efficiency targets, making nine when completed). Several states have closely coordinated efficiency and renewable resource targets—Hawaii, Nevada, Illinois, Pennsylvania, and Connecticut. Texas's efficiency and renewables targets, while not as closely linked, serve the same purpose; when Washington's efficiency targets are set, another state will be added to this list.

- ***Zero Energy Homes (ZEH)—***Through programs operated by the U.S. Department of Energy (DOE) and several states, a growing market is developing for homes that use aggressive efficiency and solar energy in combination to reduce electricity usage to very low levels. Early production models are showing combined reductions in electricity usage of more than 50%, and demonstration projects have shown combined savings as high as 93%. In addition, the solar PV systems on production homes have shown about a 2 kW reduction per home in utility peak demand, contributing to sharp reductions in the risk of blackouts.
- ***Corporate Efficiency and Green Power Commitments*****—**More and more major companies are making substantial commitments to both energy efficiency and renewable energy. Energy efficiency is typically their first step, because it is the most cost effective, and also enables renewable energy purchases to be acquired at lower total cost because they need only serve a reduced load. Staples' efforts are documented in this case study: the company reduced electricity use per square foot by 14% since 2001 and used these savings to purchase 10% of its electricity from solar and wind.
- ***Commercial Combined Efficiency and Renewables*****—**This case study documents The Moscone Center in San Francisco, renovated in 2003 with both high-efficiency energy systems and a major solar PV system on the roof. The project combined aggressive efficiency design, including advanced fenestration and lighting, with 675 kW of solar PV to produce energy savings of over 5 million kWh per year.
- ***Austin Energy*****—**This "green" Texas municipal utility has innovated energy efficiency and renewable energy programs since the 1970s. Austin Energy plans to meet 20% of its 2020 electricity needs from renewable energy and 15% from energy efficiency. This will be achieved through a range of efficiency and renewables programs and policies, including green power purchasing, advanced energy codes, zero energy homes, and other innovations.
- ***Landfill Gas and CHP*****—**The Innovative Energy Systems landfill gas co-generation project in Model City, New York illustrates how a landfill can reduce its greenhouse gas emissions while spurring development of a new hydroponic tomato farm through using waste methane from the landfill to power a CHP project. The project produces 5.6 MW of electricity and 31 million Btu/hour of heat, using the heat to run a ten-acre tomato-growing greenhouse.

Key Policy and Program Synergies

There are several areas in which coordinated policy and program approaches could create important synergies between efficiency and renewables. These include:

- ***Resource Standards—***Promulgating Renewable Portfolio Standards and energy Efficiency Resource Standards as a two-pronged clean energy policy. Several states, including Texas, Connecticut, Nevada, Hawaii, and California, have both RPS and efficiency resource targets, and Washington's new law will create such targets. Emerging policies in New Jersey and Illinois (and under consideration in Colorado and Oregon) show similar features.
    - Next steps:
        - A joint conference on clean energy resource standards. ACEEE currently holds the *Energy Efficiency as a Resource* conference every two years, and the American Council on Renewable Energy (ACORE) holds its annual renewable energy policy forum.
        - Developing model legislation on joint RPS–EERS policies. This could be discussed with various parties and legislative staff for possible inclusion in federal or state legislation.
        - A focused research, education, and advocacy effort in one or more states to advance expanded or better linked EE–RE resource standards. Candidates could include North Carolina (creating new policies), Pennsylvania (separate tier for EE), Illinois (bring draft plan to robust implementation), Texas (increase and possibly link targets), and Florida. Oregon and Colorado also bear consideration in this regard.

- ***Public Benefits Funds.*** Developing new, coordinated strategies for renewable and energy efficiency Public Benefits Funds, both to expand the total funding for both resource types and to achieve better synergies between EE and RE technologies and programs. Using RE and EE funds jointly for such purposes as zero energy buildings (ZEB), geographically targeted joint efforts to reduce transmission congestion, and other possibilities for making better and more coordinated use of existing funds. In addition, a federal Public Benefits Fund should be explored, which could support both efficiency and renewables.
    - Next steps:
        - A joint white paper with ACEEE, ACORE, the Clean Energy States Alliance, and other key parties that develops several options for advancing public benefits funding in ways that maximize EE–RE synergies. This would include both better coordination of state programs and new possibilities for a joint federal fund.
        - A workshop or conference that brings together key EE and RE organizations active in the public benefits arenas. The Clean Energy States Alliance (CESA) holds regular meetings and conference calls; leaders of the ACEEE Market Transformation Symposium and the Market Transformation Roundtable could also be considered for participation in such an event. In fact, some organizations already participate in more than one of these networks. This event could also be combined with a clean energy standards workshop.
        - A focused effort in one or more states to develop the more promising new public benefits funding ideas. Candidates could include North Carolina, Maryland, and Florida.

- ***Climate Policy.*** This area encompasses evaluating combined efficiency and renewables policy options in the framework of clean air or climate change policy initiatives. For example, the Regional Greenhouse Gas Initiative (RGGI) completed its model rule in 2006 (visit www.rggi.org), but its member states have broad discretion on how to achieve carbon emission reduction targets. This region could be ripe for detailed assessments of combined efficiency and renewables policies in support of RGGI's goals.
  - Next steps: The best candidates for these kinds of policies would be the RGGI states, including ME, NH, VT, CT, NY, NJ, DE, and MD. A focused project with targeted analysis and advocacy could leverage the RGGI program for substantial gains in coordinated EE and RE policies.

- ***Clean Energy Credits Markets.*** With the rapid growth of both voluntary green power and RPS-driven green tags markets, plus signs of emergence of a parallel White Tags market for energy efficiency credits, the possibilities for a large and liquid marketplace for clean energy credits are very encouraging. Technical issues (such as measurement and verification, or M&V) and market issues (such as aggregation) must be resolved, but a vibrant clean energy credits market could support many of the synergies described in this report.
  - Next steps:
    - A white paper among EE and RE experts on the technical, institutional, and market issues involved in developing effective, robust markets that would encompass efficiency and renewables.
    - A workshop involving EE M&V experts and green tags experts plus other stakeholders to discuss practical avenues for moving forward on making these markets more workable and expandable.
    - A focused pilot project to test one or more promising approaches in a leading market, with the goal of assessing the feasibility of near-term expansion of such clean energy credits.

- ***Zero Energy Buildings.*** Pursuing zero energy buildings programs that combine aggressive efficiency with solar energy (solar electricity and solar heating) and other renewables to enable buildings to operate either grid-independent, or to allow new, "smart" power grids to use these distributed resources for wider benefit. California requires energy efficiency performance beyond minimum energy codes levels in order to qualify for the Governor's *Solar Roofs* campaign. Other possibilities for linking incentives and performance levels should be explored to encourage greater combined use of efficiency and onsite renewables at the building level.
  - Next steps:
    - A research and policy analysis project exploring the most promising approaches to expanding the market for zero energy buildings, including both market-based and regulatory approaches.
    - A workshop involving ZEB technical experts and other stakeholders, including builders, developers, and clean energy markets experts, to discuss and build consensus around the most actionable pathways toward rapid growth in ZEBs.

    - An advocacy project, focused on one state, region, or other marketplace, with the goal of testing the real-world viability of ZEB policies and programs.

- ***Utility Interconnection and Tariff Policies.*** Burdensome utility interconnection practices plus unreasonable standby and supplemental tariffs are used in many states to discourage both renewable and high-efficiency forms of distributed generation (e.g., CHP). Research has shown that while progress has been made in many states, in most areas these barriers are still significant. Sustained efforts are needed to remove these hurdles to clean energy market access.
    - Next steps: Advancing better policies in this category requires research, coalition-building, and sustained advocacy in individual states and regional power markets. National and regional workshops among experts, advocates, and other stakeholders could be helpful in developing coordinated strategies, followed by funded, focused advocacy efforts in the most promising areas.

By pursuing such strategies jointly in carefully selected regions, efficiency and renewable energy supporters should be able to achieve policy successes, resource impacts, and economic and environmental results in ways that neither community can do alone.

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INTRODUCTION

Energy efficiency and renewable energy are the two pillars of sustainable energy policy. Both resources must be developed aggressively if we are to stabilize and reduce carbon emissions in our lifetimes. Efficiency is essential to slowing the growth of energy demand to a low enough rate that clean energy supply growth can make deep cuts in fossil fuel use. If energy demand grows too fast, renewable energy development will chase a receding target. Likewise, unless clean energy supplies come online in large measures, slowing demand growth will not reduce total emissions to needed levels. Any thoughtful vision of a sustainable energy economy thus requires major commitments to both efficiency and renewables.

Energy efficiency can result in large and highly cost-effective energy savings and emissions reductions. However, energy efficiency often lacks the "sex appeal" that renewable energy enjoys among the general public and many policymakers. Renewable energy, on the other hand, often needs to address challenges regarding economics and near-term savings.

Policies and programs for energy efficiency and renewable energy have historically been pursued separately. For example, different organizations take the lead on efficiency and renewable energy, and while there are statements of joint support and some coordination, it could be more coordinated and more strategically integrated. With the growth and increasing success of various clean energy industries, groups focused on these technologies have been addressing increasingly diverse agendas. This has created some divergences in policy priorities, such as the Renewable Portfolio Standards and Production Tax Credits for renewables vs. Energy Efficiency Resource Standards, Public Benefits Funds, and appliance standards for efficiency. While these individual policies are each worthwhile, greater synergies between efficiency and renewable energy could be realized if the various clean energy communities combined their policy agendas more effectively.

The ACEEE-ACORE Project

ACEEE and ACORE developed a project designed to advance a dialog between the efficiency and renewables communities to take advantage of these synergies. The goal of the project is to identify and begin to pursue specific actions whereby working together, the efficiency and renewable energy communities should be able to better achieve mutual goals than by working separately. Principal components of the project are:

1. Reviewing studies on the interactions between efficiency and renewables, summarizing results in a format useful for policymakers, and identifying further specific analysis that would be helpful in better making the case on what efficiency and renewables can achieve together relative to long-term national, state, and regional energy and climate change goals.
2. Identifying recent examples of success in the U.S. and abroad where efficiency and renewables have been implemented together. Case studies include Public Benefits Funds, Energy Efficiency and Renewable Energy Resource Standards, zero energy homes, Staples' corporate efficiency and renewables efforts, The Moscone Center's

combined efficiency and renewable energy technologies, Austin Energy's use of the synergies between efficiency and renewables, and Innovate Energy Systems' landfill gas project.

3. Outline policy and program options where energy efficiency and renewables could be pursued jointly to better advance mutual goals. For each option, we describe what is needed, referring to the lessons from relevant past efforts, pros and cons, and possible impacts. Based on this review, we highlight the most promising of these opportunities where work together is likely to provide substantial additional value and recommend next steps. Options were developed through brainstorming and research at ACEEE and ACORE, and also through consultation with key efficiency and renewable energy organizations and experts.

Because of the limited scope of this project, this report focuses primarily on the electricity sector. It does not address the important synergies between efficiency and renewables in the motor fuels or heating fuels sectors. It also does not focus on the issues pertaining to centralized versus distributed energy systems. Nor does it take into account the interactions between electric and thermal technologies in the power generation or buildings sectors. These issues, while important, are beyond the limited scope of this project. A broader-scope assessment, building on this project, would be a valuable follow-on effort.

The findings of these tasks are summarized in this report. The next steps for putting this information into action will be to engage key members of the efficiency and renewable energy communities in discussions to review the report. We will also be seeking presentation opportunities, invited workshops, and individual discussions to pursue these discussions.

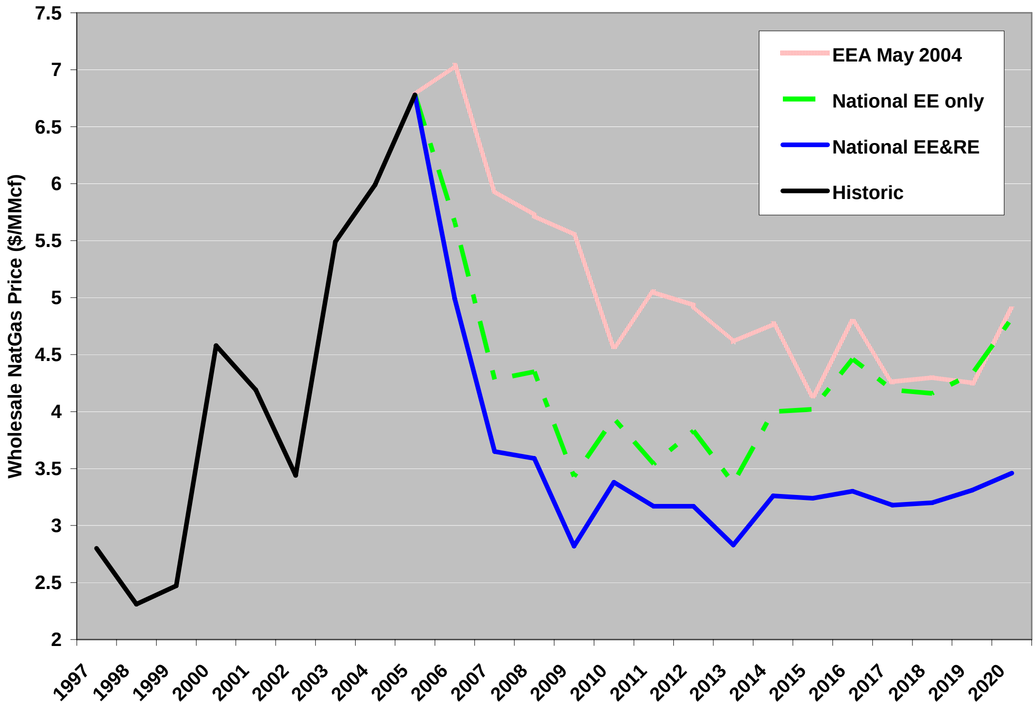
POTENTIAL SYNERGIES BETWEEN ENERGY EFFICIENCY AND RENEWABLES

Synergies between energy efficiency and renewable energy use the strengths of one to complement the weaknesses of the other, thereby advancing both. These synergies exist with regard to both broad goals and specific programs/policies.

Temporal Synergies

Energy efficiency can provide large savings in the short and medium terms, but if opportunities are aggressively pursued, in the long term remaining opportunities will likely be more limited. Renewable energy, on the other hand, can supply some energy in the short term, but its opportunities expand over time. For example, a recent ACEEE study on natural gas markets found that energy efficiency investments can lower natural gas prices by more than 20% over the next eight years, but beyond then substantial renewable energy production is needed to maintain significant price reductions (see Figure 1 below).

Figure 1. Effects of Energy Efficiency and Renewable Energy on the Henry Hub Wholesale Price of Natural Gas



Economic Synergies

Efficiency often bears a relatively low cost-profile when measured in terms of cost per saved kWh; the cost of saved energy in most efficiency studies revolves around 3 cents per kWh (Kushler, York, and Witte 2004). The levelized cost of conventional power generation typically runs 4 cents per kWh and higher (Specker 2006). New renewables have often been more expensive per kWh on a nominal basis than existing conventional utility power generation. However, conventional generation costs have risen sharply, making renewables more competitive in some markets. Moreover, renewables have been shown to offer significant price-hedge benefits in many power markets. Combining these two resource types can further reduce overall electricity system costs compared to a renewables-only policy approach.

Efficiency and renewables also provide price stability benefits to power systems. In unregulated power markets, fuel price spikes can drive market prices up substantially. Efficiency, by bringing down demand, can moderate such price spikes. In a complementary way, renewables, which are typically not subject to the same fuel price volatility, provide another kind of hedge value. Thus energy prices in a region with aggressive commitments to both efficiency and renewables are likely to see lower average power prices than would be the case without one or both of them.

Efficiency and renewables also offer complementary economic development benefits. Each generates investment and employment in different sectors, so pursuing both kinds of resources diversifies the economic opportunities created with a state or region. Since the majority of utility expenditures in most states are exported to outside fuel providers, efficiency and renewable investment can stimulate new economic activity with a state's borders. This has caused more and more governors and state legislatures to embrace efficiency and renewables as an economic development strategy.

Efficiency and renewables exhibit another type of synergy in their different patterns of resource availability. Some renewables can be somewhat site-specific, such as wind and geothermal, and some states and regions are richer in some resource types than others. Efficiency, however, is available relatively consistently in the building stock across the country. This means that states with fewer renewables to develop can exploit efficiency opportunities to complement these resources. This type of synergy can be important in building a political consensus around clean energy policy, because it tends to levelize the regional differences among states and thus could make it easier to arrive at a national consensus.

Power System Synergies

Efficiency and renewables bring complementary benefits to electricity systems. Because they exhibit different load shape impacts based on time of day and season, together they can improve overall system operations. On hot summer afternoons, efficiency can help bring down peak load, while solar and wind systems can operate at high output, reducing the use of high-cost, high-emission peaking generation. This brings down total electricity prices, acting as a diverse set of price hedges.

In terms of system reliability, deploying a diverse set of efficiency and renewable technologies can limit the risk of power outages, especially in transmission-constrained "load pockets." This also reduces line losses that can run as high as 30% in peak periods. In power markets based on locational pricing, this also serves to reduce electricity prices in affected regions.

Energy Efficiency and Renewable Energy Resource Potential

The combined potential of energy efficiency and renewable energy to reshape America's energy economy is very substantial. In 2000, national laboratories published *Scenarios for a Clean Energy Future* (Interlaboratory Working Group 2000), a comprehensive assessment of energy efficiency and renewable energy's contributions to the nation's energy economy over a 20-year timeframe. It showed that energy efficiency could reduce electricity use by 24% compared to the reference case. And by aggressively adding renewables to the power grid, carbon emissions from electric generation could be cut by a total of 46%.

Using more aggressive policy scenarios, the *Clean Energy Blueprint* study prepared by the Union of Concerned Scientists (UCS) with ACEEE assistance found that energy efficiency and CHP could reduce U.S. electricity use in 2020 by about 2,900 billion kWh. Growth in renewables would add more than 400 billion kWh in additional clean energy resources. Taken together, these efficiency and renewable energy investments would reduce U.S.

electricity generation from conventional sources by more than 60%. This would cut power plant carbon dioxide emissions by more than 400 metric tones, bringing power plant emissions to a level 47% below 1990 levels.

Most analyses of energy efficiency and renewable energy potential find that over a 5-year timeframe, energy efficiency forms the bulk of energy resource potential. In the longer term, 20 years or more, renewable energy contributes a more significant portion of clean energy resources (NYSERDA 2003). Because renewable energy technologies require longer lead times to develop and enter the market, energy efficiency measures provide near-term impact by reducing electricity sales and demand, and by reducing demand growth can increase the relative contribution of renewable technology to reducing the impact of conventional power generation. For example, if electricity demand grows by 1,368 billion kWh, 400 billion kWh of new renewable generation will offset only 29% of growth in conventional generation. But if electricity growth is cut two-thirds by efficiency investment, 400 billion kWh of renewables almost completely offsets growth in conventional power generation.

Reducing demand growth by two-thirds has been shown to be achievable in several recent analyses. A meta-analysis of energy efficiency achievable potential studies found that energy efficiency measures can reduce electricity sales by about 1% each year over the next 20 years (Nadel et al. 2004). Realizing this potential would require a substantial and persistent policy commitment, but the leading states in energy efficiency investment are already documenting savings in the range of 1% of total electricity sales on an annual basis. Adding 400 billion kWh to the grid by 2020 is a modest goal; combined with EIA baseline forecasts, this would amount to 10% of total U.S. power generation. Leading states have already set 2020 RPS goals in the 20% range and above.

Regional and state analyses tend to support these overall national assessments. A report on efficiency and renewable energy potential in New York State found that aggressive energy efficiency and renewable policies and new technologies can lead to electricity savings of more than 27,000 GWh by 2022, or about 16% of the projected 2022 electricity load (NYSERDA 2003). Net economic benefits from pursuing a portfolio of efficiency and renewable resources are estimated at between $4.5 billion and $9.5 billion by 2012.

A Northeast regional analysis estimates that from 2000 to 2010 a combination of EE and RE policies may provide close to $6 billion in potential benefits to its economy, create thousands of new jobs, and reduce air pollutant emissions by millions of tons (RAP 2005). These savings would mostly result from EE measures, but also from investment in renewable generation to meet the RPS requirements of 1m000 MW of additional renewable energy by 2010. This would come from a mix of wind, landfill gas projects, biomass, and hydroelectric power. The study estimates that by 2010, the additional renewable energy will generate nearly 5,400 GWh of clean energy. Energy efficiency resources will contribute to 7,800 GWh energy savings by the same year.

The *Midwest Clean Energy Plan* identifies a strategic clean energy development plan for the 10-state Midwest region that incorporates both energy efficiency and renewable energy resources (ELPC 2001). Energy efficiency resources would save 17% of electricity use by

2010 and 28% by 2020. Aggressive development of renewable energy, including wind power, biomass, and solar photovoltaics, is predicted to account for 8% of the region's electricity generation by 2010 and 22% by 2020. Without the energy efficiency contribution, however, the percentage contribution from renewables would be smaller. The Union of Concerned Scientists recently issued a study of the Washington state clean energy ballot initiative (I-937). It sets a 15% RPS goal for 2020 and requires utilities to acquire all cost-effective efficiency resources. (See http://www.ucsusa.org/clean_energy/clean_energy_policies/washington-clean-energy-i-937.html for more information.)

These analyses, among others of their kind, have identified similar results for the potential savings from energy efficiency and renewable energy resources over the next 20 years. To capture these substantial potential energy savings, several policy measures, including those discussed above, will be important to state and regional strategic energy plans.

These analyses are typically based rather narrowly on known technologies and on policies constrained by politics, market forces, and other limited assumptions. Emerging analyses suggest that substantially larger efficiency and renewable resource contributions are possible. A review of U.S. energy demand forecasts from the 1970s shows that many reputable projections overestimated U.S. energy use by as much as two-thirds (Laitner 2003). This suggests that U.S. energy demand in 2030 could be substantially lower than EIA's *Annual Energy Outlook* forecasts. A recent draft analysis of U.S. renewable energy technical potential estimates that by 2020, renewable energy resources could contribute up to 64 quads of primary energy, over 50% of EIA's projected 2020 total primary energy consumption and over ten times that of the current 6 quads of primary energy per year that come from renewable energy resources (NREL 2006; EIA 2006). This analysis estimates that wind and biomass will make up the majority of renewable energy resources, contributing to about 41 quads per year of primary energy use or 64% of total renewable energy potential. These more aggressive assessments serve to show that the resource potential estimates for efficiency and renewables are relatively conservative.

CASE STUDIES

To bring the conceptual and aggregate concepts of the synergies between energy efficiency and renewables into more practical and quantifiable focus, we developed a series of case studies. These range from policy case studies affecting multiple states or national policy arenas, to individual projects and technology types. These case studies serve to demonstrate that the potential synergies outlined earlier are not theoretical, but rather than many of the important elements exist to bring these powerful synergies to fruition.

I. Public Benefits Funds

Summary

Public Benefits Funds, also known as Systems Benefits Charges (SBC), are set up at the state level to assure funding for clean energy and efficiency efforts. They are generated through a small charge on consumers' electric bills or through contributions from utilities. Roughly half of the states have been actively funding public benefit programs to advance energy efficiency and renewable energy technologies, encourage research and development, and invest in energy-efficient low-income housing development.

Key Synergies

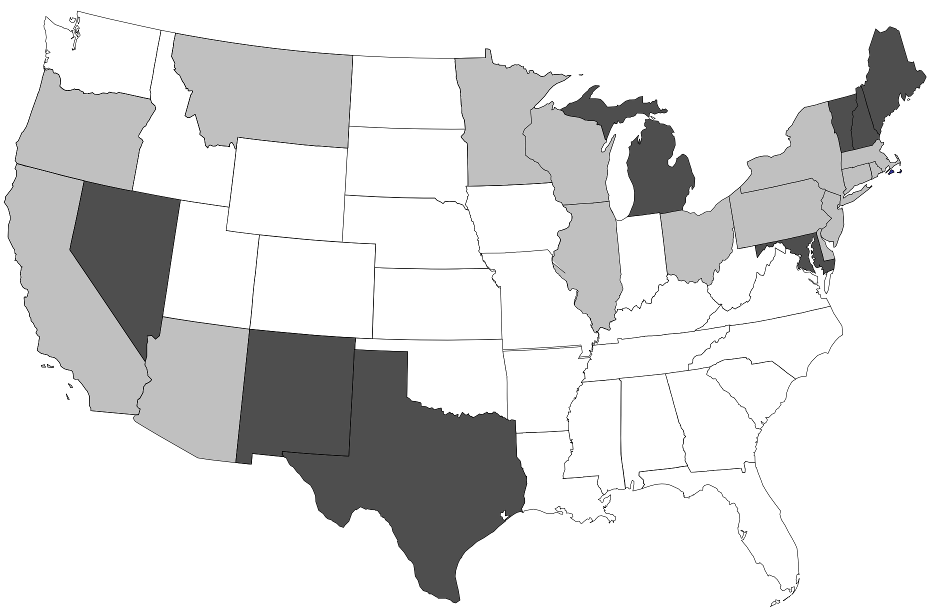
- **Consumer economic savings**: PBFs that integrate EE and RE can lower average cost for consumers on energy bills. Funding for EE and RE creates a more diverse energy portfolio, backing out electricity generated by coal and other conventional sources whose peak demand typically sets the price for all fuel sources. PBFs thus create price leverage over energy prices: while energy efficiency lowers demand from the grid, renewable energy creates a more diverse supply of energy, reducing peak price.
- **Improved reliability:** Allocating funds to renewable energy programs creates a more diverse generation portfolio, which limits the impact of outages from a single plant. Energy efficiency reduces load on the entire grid, enhancing energy reliability.
- **Economic stimulus:** PBFs invest in technologies that create more jobs per dollar invested than most conventional energy supply options. Energy efficiency provides economic benefits by increasing investment in energy-efficient products and services, creating jobs in the manufacturing, sale, and installation of these products. Renewable energy technologies stimulate economic benefits by encouraging investment in energy technologies within the state or region.
- **State resource balance**: Whereas energy efficiency measures are consistently accessible nationwide, renewable energy resources are more widely available in some states than others. This means that states can use energy efficiency measures to make up the balance where renewable resources are less available.
- **Reduced emissions:** A policy that both funds clean energy technologies and encourages more efficient consumer energy use can greatly reduce emissions at power plants by both reducing average emission rates and total power generation.

Introduction

The restructuring of the electric industry in the mid-1990s, an attempt to introduce competition into the market, resulted in a loss of incentive for distribution utilities in restructured states to invest in energy efficiency and renewable energy. To assure continued support for these vital energy initiatives, federal and state agencies, utilities, and local organizations began to implement a variety of financial incentives and regulations. Public Benefits Funds are one means to assure the continuation of such investments in the electricity sector. PBFs provide money in varying proportions for energy efficiency initiatives, renewable energy resources, research and development, and low-income housing energy assistance. PBFs have also been created in states that have not restructured their electricity markets, such as Wisconsin and Vermont.

Currently 23 states plus the District of Columbia have legislation or regulations that create PBFs (see Figure 2), most often through a mills/kWh surcharge on consumer electric bills. Of these states, seven fund only energy efficiency programs. The other 16 and the District of Columbia actively allocate funding to both energy efficiency and renewable energy initiatives. In most states, a portion of Public Benefits Funds also support low-income energy assistance. Not including low-income funding, states allocate about 70% of their PBFs for energy efficiency initiatives and 30% for renewable energy programs. On the renewable side, some 178 projects totaling 1,116 MW have been built and an additional 56 projects totaling 1,133 MW are in the development stages (Bolinger and Wiser 2006). There is a wide range of fund allocation among resources and program types, however, depending on the individual state's specific goals. PBFs for both EE and RE allow flexibility for each state to invest proportionally in technologies and programs that provide the best mix for its needs.

Figure 2. States with PBFs



Note: Light gray states have PBFs that support energy efficiency and renewable energy. Dark gray states have PBFs that support only energy efficiency (ACEEE 2004; UCS 2004).

Impacts

PBFs currently total about $1.8 billion among all states; of this total, about $1.3 billion is spent on efficiency and $500 million on renewables. These funds create significant economic benefits for individual consumers as well as local and state economies. PBFs serve consumers by allocating funds to a diverse package of energy sources including efficiency, wind, solar, hydroelectric, and biomass. A more diverse energy generation portfolio spreads energy production across more energy sources, thereby increasing flexibility on the electricity grid. Reduced demand on the grid lowers the overall electric price in competitive power markets. Reducing demand also improves reliability. California's emerging EE programs in 2001 reduced peak demand by 10%, helping to alleviate the blackouts that had threatened the state's economy.

As an economic stimulus, PBFs invest in programs that have the potential to create thousands of jobs. Each dollar invested in RE and EE creates more jobs in the labor-intensive light manufacturing, construction, retail, and services sectors than a dollar invested in capital-intensive fossil fuel technologies. EE and RE both create jobs at the local and national levels; however, each stimulates different sectors of the economy. Locally, energy efficiency programs increases the demand for more efficient appliances, building materials and systems, and other technologies. Local retailers, contractors, and design professionals profit from this increased demand. Funding for renewable energy programs stimulates other sectors of the economy at the state and regional levels, depending on the kinds of renewables that prevail in a given state.

The following states serve as models for PBFs that support EE and RE:

California: In 2000, California passed legislation extending public benefits funding through 2012. At $525 million/year, generated by levying an average 2.5 mills/kWh surcharge on consumers' electricity bills, California puts more toward PBFs than any other state. About 43% ($228 million) goes toward energy efficiency and 26% ($135 million) toward renewable energy initiatives. In September 2005, the California Public Utilities Commission authorized $2 billion in energy efficiency funding for 2006–2008 for the state's utilities. The size of the efficiency PBF will not change; the additional funds will come through electricity and gas rates.

Massachusetts: The Massachusetts' PBF was established in 1997 during restructuring and in 2002 funding was extended through 2007. The fund, called the Renewable Energy Trust Fund, authorized $500 million for 5 years. Each year $24 million, 17% of the total fund, supports renewable technologies including solar, wind, ocean, advanced biomass, fuel cells, and others. $117 million per year, 83% of total funding, supports energy efficiency.

New York: The New York State Public Service Commission voted in late 2005 to extend its Systems Benefit Charge through 2011 and to increase annual funding to $175 million per year. The fund, which was initiated in 1998, is generated from a small percentage of revenue from each of the state's six utilities. About 67% goes toward promoting energy efficiency, load management, and outreach and education, while 18% goes toward renewable energy initiatives (68% for wind and 32% for solar and biomass). The administrator of the PBF, the New York State Energy Research and Development Authority (NYSERDA), estimates that since the program's inception through 2005, annual electricity use had been reduced by 1,700 GWh and peak demand had been reduced by 1,000 MW. Consumers are estimated to have saved about $230 million annually on consumer bills and the program is expected to sustain an average 4,800 jobs annually.

While these PBFs are administered separately, and typically don't co-fund the same projects, they provide a number of synergies. The RE funds typically target technologies that are not yet cost-effective, whereas the EE funds typically aim to overcome market barriers to cost-effective efficiency measures. Pursuing these diverse resources simultaneously serves to balance both the supply and demand sides of electricity markets.

II. Energy Efficiency Resource Standards and Renewable Portfolio Standards

Summary

Energy Efficiency Resource Standards are quantitative targets for end-use energy savings, typically set for electric or gas utilities, or for other entities responsible for delivering energy efficiency programs. EERS typically contain multi-year targets and can be expressed in terms of energy units (such as kilowatt-hours of electricity or therms of natural gas), percentage of load growth forecast, or percentage of total energy sales. Renewable Portfolio Standards set targets for electric utilities' purchase of renewable power generation, typically as a percentage of total electricity sales.

EERS and RPS together can create the following synergies:

- **Reduced energy prices and bills.** EERS can reduce customer bills and wholesale energy prices, while RPS diversify fuel supplies and reduces emissions; while some renewables come at a price premium, they are increasingly competitive and also offer price-hedge benefits. Combined, efficiency and renewables provide customers lower electricity bills than RPS alone.
- **Greater emission reductions.** By reducing energy demand growth through EERS, and by reducing the fraction of power generated by polluting sources through RPS, a combined EERS–RPS policy can greatly increase total emission reductions.
- **Broader resource availability.** EERS can complement the resource mix provided by RPS. In some areas, the range of renewable resources is more limited than others, whereas efficiency is consistently available in all sectors and all regions of the U.S. This allows states to pursue combined EERS–RPS policies in all regions of the country.
- **Greater economic benefits.** EERS and RPS together provide greater economic benefits to the state economy. They each stimulate different economic sectors, and together provide a more diverse set of economic benefits as well as a greater total stimulus effect.

In 2006, eight states had EERS in place (Nadel 2006), with Washington's new Initiative 937 making ninth when implemented, and 21 states and the District of Columbia have RPS requirements (DSIRE 2006). Additional states, such as Illinois and Vermont, have established voluntary standards, and Minnesota has a non-mandated renewable energy objective. The states with the most closely coordinated EERS and RPS policies are Hawaii, Nevada, Pennsylvania, Connecticut, and Illinois.

Introduction

States have been developing clean energy resources in the form of energy efficiency and renewable energy for decades in order to diversify fuel sources, reduce environmental impacts of power generation, reduce customer bills, improve reliability, and stimulate the local economy. In the last 10 years, many states have built specific resource targets into their energy planning. Recognizing the significant and diverse benefits of efficiency and renewables, and also aware of the significant barriers they face, these states have realized that specific resource targets are needed to overcome these barriers and realize the benefits within a specific timeframe.

These clean energy resource targets typically take the form of Renewable Portfolio Standards and Energy Efficiency Resource Standards. RPS, which have been in place in several states for many years, set targets for electric utilities' purchase of renewable power generation, typically as a percentage of total electricity sales. EERS, following in the mold set by RPS in many cases, are quantitative targets for end-use energy savings, typically set for electric or gas utilities, or for other entities responsible for delivering energy efficiency programs. EERS typically contain multi-year targets and can be expressed in terms of energy units (such as kilowatt-hours of electricity or therms of natural gas), percentage of load growth forecast, or percentage of total energy sales.

EERS and RPS involve a wide range of technologies. Efficiency technologies exist for lighting, heating, cooling, water heating, motor drives, appliances, industrial processes, and other end-uses, plus combined heat and power systems that can be applied in large- and small-scale situations. RPS typically include wind, solar, geothermal, certain kinds of biomass, and some applications of hydroelectric power.

EERS and RPS policies require long-term commitments. These resources need to develop to certain scales to realize their full benefits. Five years is a minimum timeframe for such policies; most states set targets in timeframes of 10, 15, or even 20 years.

Combined EERS and RPS policies hold significant promise as cornerstones of a sustainable energy policy. EERS serves to keep electricity demand growth low enough that increased use of renewables through RPS can reduce total air pollution and greenhouse gas emissions. If energy demand grows too fast, renewable energy will not be able to keep up with demand growth. This form of synergy is especially important in meeting the climate change challenge. Since there are not yet practical and cost-effective "smokestack" technologies for controlling carbon emissions at the power plant level, combining efficiency and renewables in a common policy framework can produce a faster and more cost-effective carbon reduction scheme.

Combined RPS–EERS policies are rapidly proliferating. Just in the last few years, eight states have put EERS policies in place (Washington will soon become the ninth) and an additional three states are implementing or have non-mandated EERS requirements (Nadel 2006), and 21 states and the District of Columbia have mandated RPS requirements (DSIRE 2006). Six states have EERS and RPS policies that are especially well integrated:

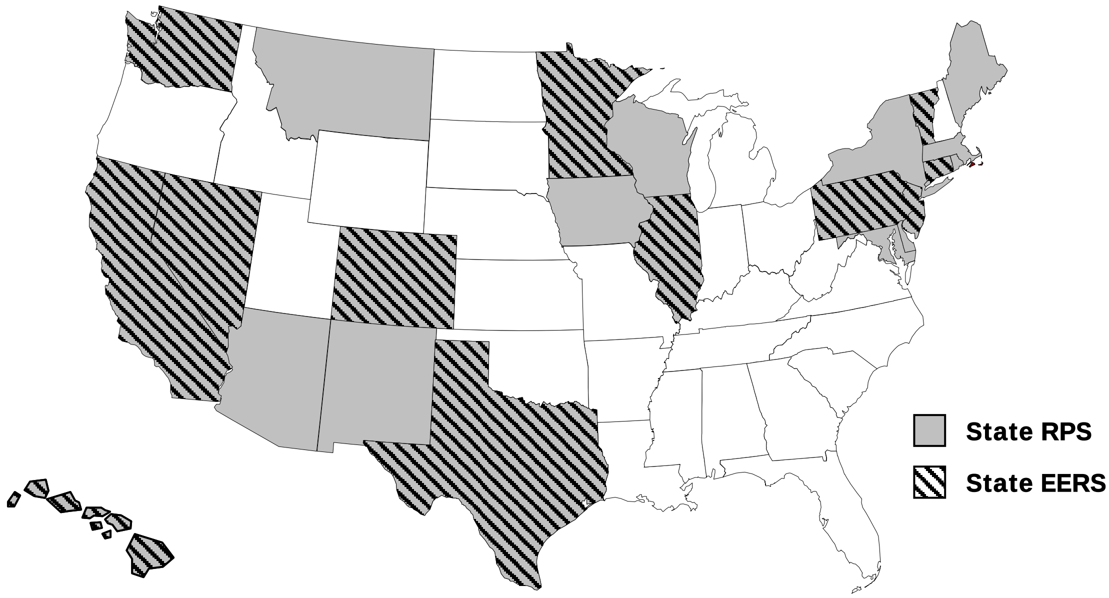
- **Nevada**: The legislature enacted RPS legislation in 2001. In 2005, this law was amended to increase the portfolio requirement, but also to allow utilities to use energy efficiency programs to help meet the requirements. Under the new law, renewable energy and energy efficiency must meet 20% of the state's electricity needs by 2015, of which amount up to 25% can be met with energy efficiency. Energy efficiency and renewable energy advocates jointly supported these provisions.

- **Connecticut** expanded its RPS in June 2005 when the legislature adopted legislation that complements the existing RPS by adding new "Class III" requirements covering energy efficiency and CHP. Under the new class III requirements, electricity suppliers must purchase 1% of supply from efficiency and CHP by 2007, and 4% by 2010. Efficiency and renewables thus have separate resource requirements within the same regulatory framework.
- **Pennsylvania**: The legislature adopted the Alternative Energy Portfolio Standards (AEPS) Act in late 2004. Under the law, renewable energy must account for 8% of the power sold in the state after 15 years of implementation. In addition, "Tier 2" "advanced energy resources" must account for an *additional* 10% of power sold in 15 years. "Tier 2" resources include energy efficiency, hydropower, and waste coal generation. The legislation also established interim requirements. Implementing regulations were developed in 2005; implementation began in 2006.
- **Hawaii**: Hawaii added efficiency as an eligible resource to its RPS via statute in 2004 (Act 95). The law set a renewable resource requirement of 8% of kWh sales in 2005, rising to 20% in 2020. Efficiency qualifies as a resource under these requirements with a cap of 50% of the annual requirements. In 2004, according to reports filed by Hawaii's utilities, renewable energy and energy efficiency resources accounted for about 11.2% of electricity sales, with renewables accounting for 68% of the total and efficiency 32%. [1]
- **Illinois**: The Governor's Sustainable Energy Plan asks the Commerce Commission to establish an energy efficiency portfolio standard that will meet 25% of projected load growth by 2017. A complementary provision would establish RPS requirements. The Commerce Commission is in the process of detailing and providing for implementation of the plan.
- **Washington**: In 2006, a ballot initiative called I-937 was approved by the state's voters. It set an RPS target of 15% by 2020 and also required utilities to obtain all cost-effective energy efficiency. Assuming that the implementation process produces specific and substantial efficiency targets over a comparable timeframe to the RPS calendar, I-937 will result in another coordinated RPS-EERS policy.

Some states are pursuing a different type of resource standard policy to acquire efficiency and renewables, using a "portfolio management" approach. Portfolio management typically means requiring distribution utilities to acquire resources such as efficiency and renewables in the same framework in which they acquire conventional power supplies. In many states with restructured electricity markets, utilities procure "default" or "standard-offer" electricity service (other terms also apply depending on the state) for the bulk of customers that do not or cannot choose unregulated suppliers. Some of these states are creating resource procurement policies such that when utilities go to the market to acquire default service, they are obliged to obtain efficiency and renewables, typically through a bidding or other type of procurement process. This report does not document case studies of this type, but they are worthy of future research.

[1] In June 2006, the Hawaii legislature made modifications to the RPS (Act 216), including capping EE at 50% of the annual requirements.

Figure 3. States with RPS and EERS Requirements



Note: Illinois, Minnesota, and New Jersey have pending EERS requirements.

Impacts

EERS and RPS can create significant resource impacts. EERS targets currently range from 10% of load growth to 1% of total sales; over 15 years, this can cut load growth substantially—even eliminate load growth completely, depending on the baseline forecast rate of load growth. RPS targets range from 1% to 24% of total electricity sales. Combined, EERS and RPS create larger impacts. For example, if an EERS reduces demand growth by 20% in 2020, and RPS targets are set at 20% of electricity sales in 2020, the two policies combined would reduce conventional energy generation by 36%. Carbon emissions would be reduced in like proportion, assuming no change in average emission rates from conventional generation.

The economics impacts of efficiency and renewable investments can be substantial. A UCS analysis showed that a 10% national RPS would save consumers $17.6 billion by 2020 (UCS 2003). A national EERS could reap net cumulative benefits of $64 billion by 2020 (Nadel 2006). ACEEE research shows that a combined EE/RE investment scenario could save over $100 billion in net benefits to U.S. energy users (Elliott and Shipley 2005).

Implications

EERS and RPS exhibit at least four major synergies:

- **Reduced energy bills.** EERS can reduce customer bills and wholesale energy prices, while RPS diversify fuel supplies and reduces emissions, usually at a price premium. Combined, they provide customers lower cost electricity than RPS alone.

- **Greater emission reductions.** By reducing energy demand growth through EERS, and by reducing the fraction of power generated by polluting sources through RPS, a combined EERS–RPS policy can greatly increase total emission reductions.
- **Broader resource availability.** EERS can complement the resource mix provided by RPS. In some areas, the range of renewable resources is more limited than others, whereas efficiency is consistently available in all sectors and all regions of the U.S. This allows states to pursue combined EERS–RPS policies in all regions of the country.
- **Greater economic benefits.** EERS and RPS together provide greater economic benefits to the state economy. They each stimulate different economic sectors, and together provide a more diverse set of economic benefits as well as a greater total stimulus effect.

III. Zero Energy Homes

Summary

ZEH represent the next generation of homes whose total energy needs can be generated on site. Energy efficiency and renewable energy technologies make this generation of homes possible, joining forces to minimize home energy requirements and provide direct energy production, with the ultimate goal of generating as much energy as is consumed. Today's zero energy homes utilize high-efficiency appliances, building materials and heating and cooling systems, as well as onsite energy production such as solar photovoltaic systems and solar thermal, to reduce energy consumption by 30–90% compared to standard homes.

Key Synergies

- **Reduced energy bills.** EE creates home energy savings through the use of more efficient resources. RE sources such as photovoltaics generate onsite power, lowering the need for electricity from the grid. Combined, these measures significantly cut energy costs.
- **Magnified resource impact.** Renewable energy resources, unlike energy efficiency measures, are some years away from being cost-effective in residential buildings on their own. By lowering a home's overall energy demand, efficiency creates leverage for the use of renewable energy production, thus magnifying its potential to serve a high proportion of energy demand.
- **Electric grid benefits.** EE and RE provide complementary benefits on electric utility load curves. While EE reduces demand across many hours of the day, solar generates energy during peak hours, providing maximum benefits to the electricity grid.
- **Capturing lost opportunities.** New homes are a key driver of growth in electric demand. ZEH can keep growth to a minimum. Designing ZEH with new homes provides maximum cost-effective and financial advantages.
- **Economic stimulus.** ZEH increase investment in energy efficiency and solar technology. These extra thousands of dollars per home stimulate sectors of the economy involved in the construction, sale, and installation of these technologies.

- **Reduced carbon emissions.** Energy savings from the use of more efficient appliances, lighting, and heating and cooling systems together with the generation of onsite power reduces electricity demand, decreasing carbon emissions at power plants.

Introduction

Zero energy homes couple maximum energy efficiency with renewable energy in a way that magnifies the effectiveness of both. Today's near-zero energy homes utilize a wide array of efficiency technologies: high-efficiency HVAC systems, insulated ceilings, sealed ducts, efficient water heaters, fluorescent lighting, and efficient appliances. Renewable energy technologies in single-family homes typically include photovoltaic solar electric and thermal systems.

The technologies required to build zero energy homes have been around for some years, but have not been integrated and refined as whole-house solutions. To address these problems, the U.S. Department of Energy formed the Building America Program, a private-public partnership to promote energy savings and facilitate change in the home building industry by helping builders perfect, build, and market resource-efficient homes. The ZEH program merged with Building America recently, having started its life in DOE's solar program. Achievements and current undertakings in the Building America program and others include:

- In 1998, ZEH helped construct two homes in adjacent lots in Lakeland, Florida, one ZEH and the other a standard home. This ZEH prototype had significantly lower energy bills and reduced peak demand from the grid.

- The Building America program partnered with builders and suppliers to make substantial progress on 11 different ZEH projects in 2002–2003 and another 17 in 2004.

- In 2004, the Building Industry Research Alliance (BIRA), part of the Building America program, constructed side-by-side developments of two neighboring communities in Sacramento, California: Premier Gardens (94 zero energy homes) and Cresleigh Rosewood (efficient homes that save 30% on cooling). Annual electricity bills show a 59% average savings for Premier homes compared to Cresleigh homes.

- Through ZEH projects funded by BIRA, a total of 416 homes have been completed in California alone. Compared to standard homes, the zero energy homes saw on average 32% energy savings from energy efficiency and 19% savings from the PV system, an average total of 51% energy savings.

- In 2004, California legislation established the Zero Energy New Home Program, which pledges $10 million over 3 years to create at least 75 demonstration homes.

- State energy offices in New Jersey, Maryland, Illinois, Georgia, and Oregon funded ZEH programs in 2004.

While quantitative results vary, these projects are all showing the same results: substantially lower home electricity bills and significant peak demand savings. Both homeowners in these communities and the utilities benefit from these significant savings.

Impacts

The integration of energy efficiency and renewable energy resources in zero energy homes has the potential to significantly lower energy bills, reduce peak demand and operation costs for utilities, reduce carbon emissions, and stimulate the home-buying market and local economy.

A near-zero energy home built today cuts energy bills by at least 50%. Improved efficiency measures typically reduce energy costs by about 30–40% while solar energy (typically photovoltaic systems) cuts energy bills by 10–20%. Integrating energy efficiency into homes creates leverage for the use of renewable energy as a resource.

For example, energy consumption by the air conditioner (AC) in the ZEH prototype in Lakeland, Florida shows the potential synergistic effects of energy efficiency and renewable energy. In a typical Florida home, the AC accounts for about 35% of all electricity consumed. On the hottest day of the year, the standard home's AC consumed an average 2,980 watts. On the same day, the high-efficiency AC used in the ZEH consumed an average of only 833 watts, 72% less than the standard model. Even more impressive, when the power produced by the ZEH renewable solar system is factored in, the AC in the ZEH required only 199 watts, which represents a total electricity savings of 93%. Together, energy efficiency and renewable energy can create significant savings for homeowners.

Certain energy efficiency and renewable energy technology in ZEH creates complementary benefits on electric grid demand, reducing peak demand and creating significant electricity savings for ZEH owners. Energy-efficient appliances and HVAC systems reduce overall energy demand on the grid throughout the day. Photovoltaic systems generate power from sunlight during peak hours, typically from noon until 7 pm, and at times send energy back into the grid.

Electricity is most expensive for utilities to produce during peak hours, when ZEH enjoy the most significant demand savings. Results from a ZEH community in Sacramento show that PV systems are performing above predicted levels and reducing the municipality's summer peak load greater than expected. Power generated by PV systems, which typically peaks around 1 pm, combined with a lower net grid demand from energy efficiency measures, results in an average 1.82 kW of peak demand savings for near-ZEH homes from noon to 7 pm. At 5 pm, the time of peak demand on the grid, near-ZEH homes benefit from about 50% electricity demand savings. These savings benefit both home owners and the utilities, which profit from capacity, distribution, and transmission benefits.

ZEH can also stimulate the local economy by increasing demand for these homes, creating jobs in contracting, the manufacturing and sale of solar equipment, appliances, building materials, and HVAC systems. ZEH market research in California found that over two-thirds of survey respondents viewed a product that is both energy-efficient and "green" as more appealing than a product that has only one of these features (Pratsch 2005).

More efficient homes are also a key step toward reducing carbon emissions. The buildings sector makes up about 36% of U.S energy consumption and generates over 700 million metric tons of carbon. Integrating energy efficiency and renewable energy in ZEH can significantly reduce emissions at power plants.

Outlook

The Building America program aims to produce ZEH homes by 2020 that require zero net energy from utilities and pump electricity back into the grid during peak hours. These homes will cut energy bills by 50–70% from energy efficiency measures and an additional 30-50% from onsite renewable energy.

Although the technology is ready for market penetration of ZEH, research has shown that it is not currently economically attractive to construct ZEH without financial incentives (NREL 2006). In an effort to jump-start market penetration of photovoltaic systems, which are a key component of ZEH, the California Public Utilities Commission (PUC) adopted the California Solar Initiative early in 2006, a program that will provide $3 billion in incentives between 2007 and 2017 for customers installing photovoltaic systems. The program plans to encourage not only the installation of PV systems, but also the integration of energy efficiency and renewable energy by requiring homeowners to update their home's energy efficiency before installing a PV system. More efficient homes will benefit from reduced energy consumption, allowing PV systems to offset more of their energy needs. New residential buildings will also be targeted under the program, promoting near-zero homes through the use of both energy efficiency and renewable PV systems.

A study by the National Renewable Energy Laboratory on the potential impact of ZEH found that in addition to financial incentives, substantial research and development (R&D) is needed to reduce the cost of ZEH and to facilitate its market penetration in the new homes market (NREL 2006). Suggested efforts should include outreach to consumers, builders, real estate agents, appraisers, and utilities; technical training; policy development; and R&D on the integration of ZEH technologies in the new home building process.

IV. Corporate Purchases of Green Power and Efficiency

Summary

Staples, the largest office supply chain in the world, with 1,780 stores worldwide, 69,000 employees, and $16 billion in sales in 2005,[2] became an early leader of the pack of massive corporations to institute company-wide energy efficiency and renewable energy policies. By

[2] All facts and figures about Staples come from company-issued annual reports, unless otherwise noted. All recent annual reports can be found on the Web: http://investor.staples.com/phoenix.zhtml?c=96244&p=irol-reportsannual

developing synergistic energy efficiency and renewable energy projects, Staples was able to leverage money saved from energy efficiency measures to purchase 10% of its energy from renewable sources in 2004, leading the industry.

Key Synergies

- **Internal policy development:** Identifying synergies between energy efficiency and renewable energy corporate projects, including overall project costs and maintenance, can help companies smooth policy development for such projects and help justify initial capital investment.
- **Financial benefits:** Energy efficiency and renewable energy resources provide both short-term and long-term company financial savings. These include both direct energy savings through lower energy bills as well as long-term avoidance of rising and volatile fuel costs through continued energy efficiency measures and the purchase of renewable electricity at a fixed rate for a 10 + year term.
- **Magnified resource impact:** Money saved from investment in energy efficiency resources creates leverage to increase the amount of energy purchased from renewable resources.
- **Economic stimulus:** Corporate investment in energy efficiency and renewable energy resources, with the installation of advanced lighting and HVAC technologies and the purchase of Renewable Energy Credits (RECs), helps to stimulate the many sectors involved in these technologies and resources.

Introduction

Staples' development of synergistic energy efficiency and renewable energy projects allowed it to maintain its internal policies regulating return on all capital investments. Meanwhile it became the corporation with the largest percentage of its energy derived from green power (10%) in 2003. This successful synergy of company policies was recognized by the U.S. Environmental Protection Agency when it awarded Staples the Green Power Partner Award in 2004 for its "vision and creative approach." Since surpassed in volume and percentage of green power purchased by other corporations, most notably by the "green" grocer Whole Foods, Staples' early success in exploiting its landmark commitment to renewable energy deserves credit for spurring many other corporate giants to follow it into the renewable energy market. Simply the use of its early example by the World Resources Institute (a sustainability "think and do tank" that recruited Staples to join its purchasing block of large electricity users, the Green Power Market Development Group) can be credited with significant impact on other corporations.

Staples' energy efficiency and renewable energy program began in 2002, when the company established a central Office of Environmental Affairs. One of the biggest challenges this new department faced was justifying initial capital investment in projects that did not appear to deliver returns to meet the company's internal hurdle rate. To overcome this challenge, project champions developed a "whole-systems" planning approach to take into consideration the full range of project benefits. They looked at synergies among projects as well as overall project costs, including maintenance. They also weighed a project's long-term effect on reducing greenhouse gas emissions.

Using this approach, Staples was able to leverage the money saved from energy efficiency measures to increase the amount of energy it purchased from renewable sources from less than 2% in 2001 to 10% (leading the industry) in 2004. Through this longer-term, holistic strategy, Staples countered the traditional short-term budgeting mentality that evaluates energy efficiency and renewable energy as competing costs. A longer-term view also allowed Staples to take into consideration the most compelling financial benefits of both energy efficiency and renewable energy: the avoidance of rising fuel costs through perpetual savings with efficiency, and the ability to purchase renewable electricity at a fixed rate for a 10 + year term.

Technology

Armed with information about energy efficiency and load reduction gathered during the participation of California stores and warehouses in a load-reduction program during the 2001 statewide energy crisis, Staples began implementing best practices company-wide, and continues to use the standard prototypes from those practices to retrofit its stores. The company first harvested the low-hanging fruit of lighting retrofits and motion and sound-activated fluorescent lights at warehouses. Just changing standard lighting fixture specifications, at no cost, saved 2 watts for every lamp used. With the additional benefit of a 30% increased lifespan for each bulb in more than 1,500 locations, the savings added up. Staples calculated that it saved 46,000 MWh in the first year and 19,000 MWh in the second year from energy efficiency, equaling $4.5 million and $2.0 million respectively. Staples then used these savings to purchase over 46,000 MWh of green power each year, in 2004 leading the industry with 10% of power from renewables. To keep its percentage of power from renewables at 10%, in 2005 Staples purchased 53 million kWh of electricity in the form of renewable energy certificates from certified sources including wind, biomass, and landfill gas. In 2005, Staples also installed two 280 kW solar arrays on distribution centers in California (Rialto and Ontario) and one 120 kW system on the Staples Contract Home Office in Englewood, N.J. The three systems are estimated to provide the amount of electricity equivalent to that used by more than 90 average U.S. homes annually (Staples 2005).

These photovoltaic panels were not a large capital investment for Staples, in keeping with the company's need to meet its required near-term returns on investments. These solar arrays were designed, installed, financed and are currently still owned by a small firm called SunEdison, which has pioneered a unique model of solar electricity service for large-volume electricity users. SunEdison allows Staples to purchase its onsite solar electricity through a fixed-rate 10 year contract to buy the power at the 2005 cost of electricity in each location. SunEdison essentially acts like a small utility located on the roof—a utility with zero transmission costs. The mission-driven demand and no-net-cost strategy of Staples and other large corporations looking to ramp up their renewable energy use created the opportunity and impetus for SunEdison to begin this program. SunEdison uses access to favorable financing, federal and state subsidies, standardized modules, experienced installers, and economies of scale in purchasing to bring down its own costs. The service has only been offered to large corporate, municipal, and educational facilities.[3]

Impacts

From 2001 to 2005, Staples reported that it reduced its total energy consumption (including fuel used by its delivery fleet) per square foot of property by nearly 5%. It reduced its electricity consumption per square foot by 14% from 2001 to 2005. It topped its 2003 and 2004 purchases of renewable energy with a 53 million kWh total in 2005, bought in the form of renewable energy certificates. This is enough renewable electricity to power more than 4,800 homes in the U.S. for a year. These purchases still account for 10% of Staples' total U.S. electricity requirements.

Location

Staples' locations have influenced its renewable energy and energy efficiency policies in several ways. The nearly ubiquitous presence of Staples retail stores, warehouses, and office centers across the U.S. (a country where electricity markets are regulated at the state level and the cost of energy resources vary from region to region) has exposed the company to a wide range of electricity prices and market fluctuations. It has also forced the company to adhere to a complex matrix of laws and regulations that have created unique combinations of barriers to renewable energy and incentives for renewable energy and efficiency in different states. These include: a wide array of definitions of Renewable Energy Certificates; lack of electricity grid access; lack of net metering policies; scarcity of incentives for installing solar systems; and myriad other regulations that make each state's energy sustainability policy somewhat different.

These policy variations most strongly affect the renewable energy side of the equation. Staples cannot as easily implement standard, company-wide renewable energy procedures, as it can energy efficiency practices. As it currently buys the majority of its renewable energy in the form of RECs (the most efficient way to buy large quantities of renewable energy at the scale of Staples' purchases), policy changes are needed to reduce the transaction costs and improve liquidity in REC markets. These could include standardized definitions, information systems, and verification methods for RECs in power markets across the country. The emerging PJM market's Generation Attributes Tracking System (GATS) approach shows promise along these lines

In 2005, when Staples began to install photovoltaic solar panels on its buildings, numerous obscure regulatory hurdles to generating one's own distributed power came into focus for the company. California and New Jersey, where those installations are located, are the most solar-friendly states in the country. They both offer 50% or higher rebates for small solar systems and have favorable net-metering regulations. In these states, net metering (net metering regulations vary by state, utility, technology, and size of the facility) requires regulated load-serving electric utility companies to purchase power generated from small

[3] For more information, see http://www.sunedison.com/.

sources connected to the grid (i.e., solar panels on a building) for the same price that customer pays the utility for its grid-provided power. This allows the customer's electricity meter to roll backward when the customer is producing power for the grid. California and New Jersey have also eliminated the traditional interconnection fees that utilities leverage from any small generator who'd like to connect to the electric grid. These fees prohibit distributed generation in many places. Consistent state policies for net metering, interconnection, and related issues are important to the expansion of building-scale renewables such as Staples' solar investments.

Even as Staples' ability to institutionalize some of its renewable energy purchasing practices company-wide is impeded by specific regulations in specific states and the general lack of standard policy across the board, several unique local experiences have done much to spur the company-wide renewable energy and energy efficiency synergies this report examines. For instance, Staples' significant presence in California during the energy crisis in 2001 allowed the company to begin thinking about energy efficiency and renewable energy in new terms. Suddenly energy efficiency and load reduction became a crucial cost-saving measure, and fixed-rate *relatively* low-cost renewable electricity became highly desirable in the face of unprecedented price volatility.

With successful renewable energy and energy efficiency plans in place, in May 2005 Staples officially announced a commitment to reduce greenhouse gas emissions in the U.S. by 7% by 2010 from a 2001 baseline. In the midst of a burgeoning market for large green power purchases by larger corporations, which Staples helped create, the company will need to continue to step up its goals to stay at the head of the pack.

V. Moscone Center—PV and Efficiency Technology

Summary

Energy-efficient, energy-generating buildings are the basic units of a sustainable infrastructure in which efficiency and renewables combine to provide most or all of the end-use energy services. This zero energy building concept could lead to a built environment that produces a very small energy and carbon footprint. With solar photovoltaic technology the potential exists for the skins of our buildings to generate electricity. If energy efficiency inside the building is maximized and photovoltaics generate power on the skin, it's possible to reach the net zero energy, zero emissions ideal. The newly renovated Moscone Center in San Francisco, a two million square foot expansion of the original building, finished in 2004 provides an example of well-planned integration of PV and efficiency. Aggressive efficiency measures and a variety of municipal, state, and national policy incentives and programs made possible the 675 kW PV installation on the roof of The Moscone Center completed in April 2004—the largest city-owned PV project in the U.S. at the time.

Key Synergies

- **Reduced energy bills.** High-efficiency building technologies and a renewable energy photovoltaic system lower electric demand from the utilities and reduce building energy bills.
- **Magnified resource potential.** Energy savings from the use of high efficiency building technologies provides leverage for the purchase and installation of renewable energy PV systems.
- **Reduced carbon emissions.** Lowered energy demand on utilities and increased use of energy from clean, renewable sources together greatly reduces carbon emissions.
- **Reduced electric grid congestion.** PV systems reduce a building's electric demand during peak daytime load hours, when electricity is most expensive. Demand on the electric grid and peak congestion is therefore lowered.
- **Economic stimulus.** Investment in energy efficiency and renewable energy technologies drives local economic development in the clean energy sector.

Context/Background

Spurred by rolling blackouts and soaring energy prices, in November 2001 a 73% majority[4] of San Francisco voters approved a $100 million bond initiative to fund solar generation, energy efficiency measures, and other renewable power sources for public buildings and community projects. The bond initiative, supported by a bipartisan coalition of organizations, won the largest majority of any energy initiative on the ballot in the city's history. Compelled to act by the energy crisis, in the midst of increasing attention to climate change and a plague of air pollution in densely populated areas, the state of California also sought solutions to a dysfunctional energy distribution system. Also in 2001, the California Public Utilities Commission approved a self-generation subsidy that pays for $1.00–4.00/W of the cost of the installed capacity of renewable energy technologies for residential and commercial projects under 1 MW. In this context, beginning in 2002 the city of San Francisco worked state-of-the-art energy efficiency upgrades and the largest municipal solar photovoltaic project in the country into its plan to revamp its premier conference venue, The Moscone Center.

Technology

The designers of the energy component of The Moscone Center's 2002–2003 renovation oriented their work around the concept of efficiency. Both the solar panels and the efficiency technologies are capital-intensive assets that produce continuous long-term savings in the amount of electricity to be bought from the grid. The 60,000 foot solar array on two rooftops, combined with the efficiency upgrades, was guaranteed to save 4,915,374 kWh/year, and have actually performed better.

The expansion of The Moscone Center, with the opening of Moscone West, included a thorough review of all opportunities to increase the building's energy efficiency. The project

[4] For more information, see Vote Solar Web site: http://www.votesolar.org/bonds.html.

consists of a 675 kW solar array on two rooftops, with a total of 5,400 solar panels, plus strategic efficiency built into the structure of the building and its electric appliances.

Efficiency

To maximize natural lighting and views of the city, the blueprint featured large expanses of glass. The new windows are all made of high-performance glazed glass with a thermal emissivity that exceeds the state's Title 24 building code requirements. Frit patterning at 30, 50, and 70% on the external side of the glass sheds extra light, further enhancing the performance of the glass as a heat-controlling device. Older, incandescent, T12 fluorescent and mercury vapor lighting fixtures were replaced with compact fluorescent lamps, T8 fluorescents, and metal halide fixtures. The newer, more efficient bulbs decrease maintenance costs with longer life spans—from an average of 15,000 hours before the renovation to 20,000 to 25,000 afterward. Lights were connected to daylight sensors to further reduce electricity waste. The watts of electricity used per fixture before the renovation were 570–2,525, and afterward, 234–1,274.[5] The water cooling and heating systems, air conditioning, and heating were all designed to exceed Title 24 energy efficiency standards as well.

Solar

Two types of photovoltaic panels were purchased – 207 kW of Shell Solar modules and 468 kW of Sanyo Corp's 15% efficient dual ply modules. PowerLight's PowerGuard® roofing tiles (lightweight and building-integrated tongue and groove structures) were used to install the panels over the existing roof membrane. PowerLight mounted the tiles on polystyrene insulation blocks to provide further installation, reducing the building's heating and cooling loads.

Location and Timing

Many factors worked together to create the impetus for the Moscone project. These included the chaotic state of the Californian electricity market during deregulation in 2001, new and longstanding renewable-energy-friendly policies, San Francisco's municipal commitment to climate change signed in 1998, the presence of a thriving local solar industry including the installer of the project (PowerLight), and a supportive public in San Francisco.

State and local policy incentives did much to help. The total cost of the project before factoring in those incentives was $8.1 million. This breaks down to a solar cost of $4.5 million and efficiency upgrades for $3.6 million. The PUC self-generation subsidy for the installed capacity of solar on both rooftops shaved off $2.3 million of that, and the Energy Commission Incentive for efficiency reduced it by another $186,000.

Despite San Francisco's notoriously cloudy weather, this system has been producing electricity at above the projected amount, with a combined total of PV and efficiency savings of 5,023,811 kWh/year. This translates into utility bill savings of $753,571/year, based on the

[5] See The Moscone Center case study at http://www.votesolar.org/tools_Moscone_Case_Study.pdf.

price of electricity The Moscone Center was paying when the project was completed in October 2004 ($.15/kWh) to the Hetch Hetchy Water District utility.

Significance and Impacts

This project represents the city of San Francisco's serious follow-through on a commitment it made to reduce greenhouse gas emissions, and its goals to reduce electric grid congestion and drive local economic development in the clean energy sector. In 2002, the city's Board of Supervisors acted on the mayor's 1998 signature of the Cities for Climate Protection Campaign and set a concrete target to reduce its greenhouse gas emissions by 20% below 1990 levels by 2012. Over the next 30 years, the solar-generated electricity and energy efficiency measures of The Moscone Center alone will reduce emissions of carbon dioxide by over 35,000 tons. These emissions reductions are equivalent to planting 330 acres of trees or not driving 88 million miles. The amount of electricity saved and generated by The Moscone Center is enough to power 8,500 homes.[6]

Implications

The dual engine of the California energy crisis and the increasing awareness of climate change drove San Francisco to seek to reduce both skyrocketing costs of electricity from the grid and greenhouse gas emissions through a holistic integration of efficiency and onsite renewable energy generation at The Moscone Center. Because of its large capital cost, solar photovoltaics are most cost-effective when combined with efficiency, which leverages the electricity savings over the life of the solar system (usually guaranteed for 30 years). Solar onsite essentially acts like efficiency, since it is a capital investment that produces continuous savings in electricity from the grid with zero fuel costs. An added benefit of solar in a congested grid is that it dramatically reduces the demand of the building during the day, at peak load time, when the electricity is most expensive.

Policies that would support more projects like The Moscone Center could include incentives funded through PBFs, combined EERS and RPS resource targets, and better interconnection and net metering policies.

VI. Austin Energy Municipal Utility

Summary

Austin Energy, a city-owned utility that provides electricity for the 692,000 people living in the capital of Texas, has for two decades been a leading utility pioneer of energy efficiency and renewable energy programs. Its strategic plan integrates energy efficiency and renewable energy policies, including demand-side management to improve customer energy efficiency, renewable energy rebates and investment opportunities for customers, green building training

[6] See PowerLight case studies: http://www.powerlight.com/case-studies/state/san_francisco.shtml

programs, and existing building energy audits. The utility's current goal is to obtain 20% of its energy supply from renewable sources by 2020.

Key Synergies

- **Financial savings.** Demand-side management programs targeting energy efficiency measures reduce energy use for customers as well as the utility's own facilities, leading to significant immediate savings on energy bills. The utility also offers customers the choice to invest in fixed cost renewable energy for up to 10 years, creating the opportunity to avoid volatile fuel prices and benefit from long-term financial savings.
- **Improved reliability:** Installing nameplate capacity in the form of renewable energy creates a more diverse generation portfolio, which limits the impact of outages from a single power plant. Energy efficiency reduces load on the entire grid, enhancing energy reliability.
- **Electric grid benefits.** Customer investment in energy efficiency and renewable energy measures provides complementary benefits on electric utility load curves. While EE reduces demand across many hours of the day, solar generates energy during peak hours, providing maximum benefits to the electricity grid.
- **Reduced carbon emissions.** Reduced customer energy demand due to energy efficiency efforts greatly reduces emissions at power plants. Interest in renewable energy, spurred by utility rebate initiatives and renewable energy investment options, further reduces emissions by increasing energy purchased from clean energy sources.
- **Strategic planning.** Utility strategic plans that integrate energy efficiency and renewable energy efforts gain more support and outreach than investment in one type of program or the other alone.
- **Magnified resource potential.** Energy savings from the use of high efficiency building technologies provides leverage for the purchase and installation of renewable energy PV systems.

Introduction

Austin Energy's early work on comprehensive sustainable building design, dating from the 1980s, has been widely credited with beginning the green building movement in the United States, and may have been the first initiative anywhere to formally analyze the synergistic impacts of efficiency and renewables. In 1992, Austin Energy was awarded the prestigious UN Environment Award at the Rio Earth Summit for its green building program. The same program later became the foundation of the U.S. Department of Energy's zero energy homes program.

According to an early leader of green initiatives at Austin Energy, Roger Duncan, the whole-systems approach of their green building initiative pushed its leaders to explore the synergies between energy efficiency and renewable energy technologies in a broader sense. The growing focus on combining the two for both maximum environmental and cost benefit soon began to influence Austin Energy's other programs.

Several decades later, the utility's visionary strategic plan, released in 2003 and driven by the utility's stated mission "to deliver clean, affordable, reliable energy and excellent customer service," serves as a prime example of thoughtful integration of renewable energy and energy efficiency policies on the municipal government level. The core goals of this plan include self-imposed renewable and efficiency portfolio standards, with commitments to obtain 20% of its energy from renewable sources and 15% from efficiency by 2020. These targets will be met through a diverse array of new and existing programs.

Context/Background

In 1979, Roger Duncan, an Austin City Council Member, ran a campaign to keep the city of Austin independent from the proposed South Texas Nuclear Project, which sought to raise money from municipalities to build a large-scale nuclear power plant. Though the nuclear plant was built, later on as city planning director and an executive at Austin Energy, Mr. Duncan worked to establish the energy conservation programs that would have been needed to balance this rejection of a major new power source for the city. By 1982 the efficiency programs were projected to reduce Austin's energy demand so dramatically that the city actually removed a coal-fired power plant from its long-term generation plan. Austin Energy began further reducing its fossil fuel use by ramping up renewable energy investments (primarily in wind technology), beginning in the 1990s. During international negotiations of the Kyoto protocol, Austin Energy made a formal commitment and mapped out a plan to reduce its carbon dioxide emissions through aggressive strategies to deliver both efficiency and renewable energy to its customers.

Tools

Austin Energy provides its municipality a comprehensive package of technologies, financing assistance, advice, and pricing schemes to institute and encourage energy efficiency and renewable energy use in Austin. Austin Energy also works very actively to extend its sphere of influence beyond its city's limits. The utility dedicates staff time to provide assistance to other municipalities seeking advice on implementing renewable energy and energy efficiency programs, through such programs as "Manage It Green," an internal consultancy recently hired by the California Public Utilities Commission to train local developers in green building practices.

Demand-Side Management

Beginning in 1982, Austin Energy pioneered a comprehensive demand-side management program to reduce electricity use in its own facilities and among its customers. These efforts to improve efficiency began with an analysis of the utility's own energy use for production, leading to the adoption of co-generation or "double-pass" generation technology in its own power production facilities. This technology reuses steam heated in the traditional generators to fuel other turbines. Austin Energy also emphasizes facilitating energy savings in the community through programs to provide the necessary technology, financing, and advice from energy experts to appeal to the varied needs of its residential and commercial customers.

Technology

In one scheme, the utility provides customers free radio-controlled Honeywell Superstat thermostats, which allow Austin Energy to turn off the customers' air conditioning remotely during times of peak electricity demand. This system allows the utility to reduce the demand for new "peaking" power plants. As of December 2005, 30,000 homes have voluntarily joined this program. Austin Energy has also replaced all traffic lights with Light Emitting Diodes (LED), which eliminate 90% of the energy used in traditional traffic lights.

Financing

Austin Energy offers 5-year zero interest loans to residential customers who wish to replace their air conditioners with energy-efficient alternatives. For industrial customers, Austin Energy offers rebates for energy savings on a dollar per kW basis, up to $100,000. Beginning in 2003 Austin rolled out a landmark $4.00/Watt ($4.50 for nonprofit organizations) rebate for grid-tied solar photovoltaic systems, with different caps for businesses and individuals. The utility also included a net-billing option for owners of these solar modules, which compensates them for the electricity they feed into the grid.

The most widely publicized renewable energy initiative in Austin is its GreenChoice green power program, begun in 2001. GreenChoice allows customers to hedge against the volatile natural gas prices in Texas by investing in fixed cost renewable energy. It directly transfers the most financially attractive attribute of renewable energy—zero fuel cost, forever—into customers' pocketbooks by giving them the option of choosing to pay a GreenChoice charge that will remain fixed for 10 years, instead of a fuel surcharge that reflects the market price of fuel. This program is so popular that the utility has had difficulty meeting demand for renewable energy, even as it moves toward its target of generating 20% of its power from renewables in 2020. It currently has utility-scale renewable energy production facilities using windpower and landfill methane. Most of the utility's projected increase in renewable energy is from wind, with an expectation that solar will become increasingly cost-effective in the next ten years.

Technical Assistance and Regulatory Standards

Austin Energy has infused its municipality with a holistic outlook on energy savings and renewables. The utility currently runs a Green Building training program, which teaches builders and designers the principles of sustainable design. Roughly 25% of new homes in Austin go through this program, and all new buildings in the city are required by law to meet Leadership in Energy Efficient Design (LEED) standards. Austin Energy also offers owners of existing homes and businesses energy analyses that show customers where potential energy reductions could be made.

Impacts

Austin Energy's long-standing track record and new strategic plan to increase its power generation with a comprehensive mix of renewable energy and energy efficiency programs continues to contribute to the expansion and acceleration of the renewable energy and energy efficiency technology markets on a broad scale. It does this by purchasing large volumes of renewable electricity in its locality, serving as a well-publicized and lauded example on a much broader scale, sharing its substantive experience with newcomers, and maintaining its position on the cutting edge with bold goals and innovative implementation plans to meet those goals. In 2005, Austin Energy contracted and sold over 500 million kWh of electricity from renewable sources through its GreenChoice green power program. Over 200 MW of new installed capacity has been proposed for 2006 (DSIRE 2006).

Implications

As a municipal utility, Austin Energy is not required under the Texas Renewable Portfolio Standard (5,880 MW by 2015) (DSIRE 2006) to purchase a portion of its energy from renewable sources. The Austin City Council passed its own resolution that Austin Energy must obtain 5% of its energy from renewable sources by December 31, 2004, and 20% by 2020, which spurred Austin Energy's Strategic Plan. Municipal utilities, which together serve some 20% of U.S. electricity customers, are likewise being spurred to ramp up their renewable energy and energy efficiency programs. The U.S. Council of Mayors Climate Protection Agreement, spearheaded by Greg Nickels, Mayor of Seattle, has been signed by mayors representing 44 million Americans (Earth Policy Institute 2006). Senior leaders on these issues at Austin Energy have noted that to integrate renewable energy and energy efficiency for maximum environmental and cost benefits to the consumer, the focus must be on creating net zero energy buildings. On the other hand, for utilities to survive in a zero energy building marketplace (especially municipal utilities), a new model of utility business plans and structure of policy incentives needs to be created. To Austin Energy, always a pioneer, this represents the next great frontier.

VII. Landfill Gas (LFG), CHP, and Efficiency Project

Summary

The case of the Innovative Energy Systems landfill gas co-generation project in Model City, New York illustrates how one landfill reduced its greenhouse gas emissions and spurred the profitable development of an eco-efficient hydroponic tomato farm and power plant through combined heat and power technology, a healthy dose of business acumen, and a creative partnership. Landfill gas projects provide unique environmental and cost benefits because in many cases they actually capture greenhouse gas emissions and other potentially hazardous emissions—an environmental and potential cost liability for heavily regulated landfills. Landfill gas is also a broadly distributed resource across much of the United States, and the technology to convert it to electricity is widely commercial. The Model City Energy project illustrates a best practice case in this fast-growing area of non-traditional renewable energy, highlighting the potential value of a marriage of renewables with efficiency technology through co-generation of heat and power.

Key Synergies

- **Magnified resource potential.** The initial renewable energy resource of the landfill system, landfill gas, is first used to produce electricity, most of which is sold to the electric grid. Excess heat, the by-product of the cogeneration process, can be captured using efficient heat-recovery technologies to fuel other projects, magnifying the value of the initial energy resource.
- **Reduced greenhouse gas emissions.** The landfill system can both capture and burn greenhouse gases that currently escape from landfills into the atmosphere, as well as reduce demand for electricity that comes from carbon-emitting fossil fuels.
- **Financial benefits.** Heat recovered through the cogeneration process eliminates the need for the purchase of additional heat from fuel. With the recent volatility of natural gas prices, the fixed price of both the electricity and waste heat also provides short- and long-term hedges against financial risk.
- **Economic stimulus.** Investment in energy efficiency and renewable energy technologies such as cogeneration heat-recovery systems and LFG capture systems drives local economic development in the CHP and clean energy sector.

Introduction

The Innovative Energy Systems landfill now produces 5.6 MW of electricity, selling the great majority of this to the grid. The waste heat produced during electricity production—31,000,000 Btus/hour—is simultaneously recovered and used to heat a ten-acre tomato-growing greenhouse.[7] This eliminates the need for any additional heat even during the winter months. Two companies created the hydroponic tomato farm company, H2Gro, through a joint venture. Modern Landfill, Inc, owns and operates the New York State Department of Environmental Conservation (NYSDEC) Part 360 permitted non-hazardous waste solid waste landfill that produces the gas, and its partner, Innovative Energy Systems, Inc. (IES), brings expertise in the design, permitting, construction, and operation of landfill gas to energy (LFGTE) plants in New York State, as well as the installation of gas wells, collection systems, extraction blowers, and flare systems for all uses of landfill gas.

Modern Landfill has collected and burned the gas its property produces using an enclosed flare since 1991. The company explored options for landfill gas utilization in 2001 and decided on electricity production. Innovative Energy Systems won the contract to build and operate the facility, to be called Model City Energy, a 5.6 MW LFGTE plant located on land leased from Modern Landfill. When the project attracted inquiries about cheap electricity from local commercial enterprises on the grid, the principals of Modern and Innovative Energy began to explore creating an onsite enterprise of their own to take advantage of both the electricity and the waste heat produced there.

The next year, in 2002, Modern and IES founded H2Gro. On Modern Landfill's property, they built a half-acre pilot greenhouse. It was designed to use a portion of the waste heat generated by the LFGTE engines to grow tomatoes, a product in significant demand in the

[7] All information specific to the Model City Energy project and the H2Gro operation was culled from a report by Innovative Energy (2005).

area, especially during the New England winter. The small greenhouse was a success. The principals calculated that a full-scale hydroponic growing operation that recovered all of the waste heat available at the facility was the way to maximize financing benefits and ultimately profits, so they built another 7 acre greenhouse and a 28,000 square foot packhouse/office facility as well as a 6,000 square foot tank room, all on site. The entire facility was completed in November 2004. In total, the 10 acre hydroponic tomato-growing system produces 10,000 pounds of tomatoes each day, every day of the year. All of the facility's electricity and heat is produced onsite, and it uses a hydroponic irrigation system that supplements water piped in from the city with roof runoff, condensate collected in the greenhouse, and recycled water sterilized before reuse. No water from the hydroponic process is discharged.

Technology

Model City Energy draws gas from the landfill with positive displacement blowers, and then scrubs and filters it with seven Caterpillar G3516 engine-generator sets. The generators are reported to perform at an online efficiency of over 98%, well above the industry's average. Regulations require that the LFGTE facility send daily engine emission reports to the New York State Department of Environmental Conservation, as landfill gas can contain non-methane organic compounds such as benzene, toluene, chloroform, vinyl chloride, carbon tetrachloride, and trichloroethane. These contaminants typically account for less than 1% of the gas (EIA 1997; EPA 1991). Model City Energy has reported that it is performing at well below permissible emissions levels, with a zero emissions gas-scrubbing system designed to be entirely closed-loop. Any moisture collected in the knock-out tanks as the gas enters the power plant is sent back to the landfill's leachate collection system.

Numerous efficiency standards in the waste heat-capture process were considered. All engines at the power plant were converted from dry to wet exhaust manifolds to maximize heat recovery from each engine. A piping system with six inches of insulation is then used to transfer the heat (via water) to the greenhouse. Modern Landfill is a 117 acre operation with an annual permitted disposal rate of 815,000 tons. Roughly 7 million tons of biodegradable waste are estimated to be sitting in the landfill, generating landfill gas. The site currently holds the capacity to continue to receive waste at the same rate for more than 30 years.

Location

Landfill gas is a resource common to nearly all populated areas. An asset not often publicized on tourism brochures, it is especially concentrated in Pennsylvania, Virginia, and to a lesser extent New York State, created by the truckloads of solid waste hauled out of the population centers of the Northeast Corridor. Around 11,000 tons of solid waste leaves New York City alone every day. As of February 2006, there were 17 landfill gas recovery facilities in New York State. In 2004, these facilities produced approximately 240 million kWh of electricity. [8] Innovative Energy Systems' work to design, permit, and build two of these facilities before they built Model City Energy gave the company valuable insights for the project.

[8] See New York State Department of Environmental Conservation: http://www.dec.state.ny.us/website/dshm/sldwaste/gas.html

New York's code of renewable energy and distributed generation regulations only marginally factored into the construction of the Model City landfill project, but could spur more such development. Landfill gas is now included as a renewable resource under New York State's Renewable Portfolio Standard enacted in April 2005. The emerging mandatory compliance market that the RPS legislation creates has become an added incentive to exploit new landfill gas resources (DSIRE 2006). Existing projects built after January 1, 2003 are also eligible to play in the regulated market. Most of New York's other regulations to spur renewable energy use, such as net metering and interconnection standards for distributed generation, only apply to small residential installations of wind, solar, and biomass.

The Model City Energy project is unique in that it maximizes the recovery of a renewable resource through both electricity production and waste heat capture using super-efficient equipment, for use onsite.

Impacts

The project's electricity production capacity is 5.6 MW at 3 cents kW/h, and the heat captured through the cogeneration process amounts to 31,000,000 Btus/hour. H2Gro estimated in 2005 that this saved the company $800,000/year worth of fuel needed to heat a typical greenhouse of its size, a 38% cost savings on operations. With the recent volatility of natural gas prices, the fixed price of both the electricity and waste heat produced by Model Energy has also provided welcome short- and long-term hedges against risk.

Potential Impacts

Though burning landfill gas to make co-generated heat and power does emit some methane (a greenhouse gas), if widely replicated this type of project could reduce greenhouse gas emissions in the U.S. overall. The projects would do this by capturing and burning methane that currently escapes from landfills into the atmosphere, plus reducing demand for fossil fuels, which are greenhouse-gas-emissions-intensive to mine and transport over long distances. Municipal solid waste landfills are the largest source of human-related methane emissions in the United States, accounting for about 34% of these emissions.

LFGTE projects using co-generation can also contribute significant volumes of electricity to the grid, and heat to be used onsite—the most efficient place to use it, while spurring economic growth and producing jobs in blighted areas. In 2005, landfill gas energy projects in the U.S. provided over 9 billion kWh of electricity and 74 billion cubic feet of gas for corporate and government end-users—the equivalent of powering 725,000 homes with electricity and heating 1.2 million homes with natural gas. The emissions reductions gained from those projects are equal to removing 13 million cars from the road.

Landfill gas is one of the cheapest forms of renewable energy to produce. Contributing factors include the widely commercialized, cost-competitive technology used to collect and burn landfill gas and the relatively high concentrations of the fuel in spots (landfills) where it exists. Environmental regulations that force landfill operators to invest capital in gas-collection and capture technology also incentivize them to go to the next logical step and invest in a money-making LGFTE plant.

Implications

Policies that would spur more development of landfill gas co-generation plants include EERS and RPS resource standards, improved interconnection standards, and tax incentives for renewable energy development.

POLICY DISCUSSION

The literature and case studies in this report suggest several policy and program options as promising approaches to realize the economic and environmental synergies of energy efficiency and renewable energy. This section discusses leading candidate policies and outlines possible next steps to advance these ideas.

Resource Standards

Several states have establish quantitative resource standards in the electricity sector for both energy efficiency and renewable energy, including Texas, California, Nevada, Connecticut, Vermont, and Hawaii, and states like New Jersey and Illinois are developing such policies. While the specifics vary in terms of mechanism and enforceability, these policies share the approach of setting high-level, long-term targets for the power sector from the top down. This approach contrasts with many policy and program approaches, which operate on a short-term basis, from the "bottom up" in specific markets or technologies. While they can be worthwhile on an individual basis, these bottom-up initiatives may not result in the macro-level, aggregate resource impacts needed to realize the full economic and environmental potential of efficiency and renewables. Efficiency and renewable resource targets can be set to achieve goals based on economic criteria such as cost-effectiveness and job creation, and environmental criteria such as emission reduction. Setting such resource targets is an especially powerful policy approach because it enables policymakers to shape the long-term energy future with a high degree of certainty, while giving markets maximum flexibility.

Issues to consider in pursuing this approach include:

- Whether to establish national standards. RPS legislation has passed in the Senate but not the full Congress. Efficiency resource standards legislation has been introduced in Congress. The arguments against a national RPS revolve around the notion that states' renewable potential varies too greatly to set a national standard. However, efficiency potential is relatively constant across state and regional boundaries. Combined, an efficiency/renewables resource standard might be more viable in addressing the resource availability issue. Also, a national standard would tend to create a larger and more liquid market in clean energy credits, such that utilities could more easily and economically meet their resource requirements.
- Whether to institute joint or separate efficiency and renewable resource standards. In Texas, the requirements are separate, covered by different legislative provisions. In

Connecticut, the RPS law was amended to create a specific class of efficiency resources, beyond current renewables requirements. In Nevada, the RPS target was expanded from 15% to 20%, with efficiency authorized to meet up to 5% (one-quarter of the total requirement).

- How to link the resource standards concept to utility procurement. The portfolio management approach, under development in several states, puts requirements on distribution utilities to procure efficiency and renewables in the same framework in which they acquire electricity service for customers that do not have electricity service from unregulated suppliers.
- Whether to include temporal sequencing. In California, the utility commission established a "loading order" for resource acquisition, so that efficiency must be pursued first, followed by renewables for new generation needs, with conventional generation to be acquired as a third option.
- How to pay for resource acquisition. Some states simply allow utilities to pass through resource costs in rates. Others use Public Benefits Funds and other forms of subsidy to fund resource acquisition costs. Other states have created cost recovery and incentive mechanisms for energy efficiency program costs.
- Decoupling utility revenues from energy sales. Because efficiency resource standards will reduce growth in utility sales, some states have modified ratemaking policies to separate revenues from energy sales, typically through annual rate adjustment mechanisms that "true up" variations in energy sales from forecast levels. This approach gives the utility an assured revenue amount, while removing the disincentive to reduce growth in energy sales that is endemic to traditional volumetric ratemaking.

Next Steps. To move forward on this issue, possibilities include:

- A white paper describing current state and federal efforts on RPS and EERS. This could expand on a recent ACEEE report on EERS.
- A joint conference on clean energy resource standards. ACEEE currently holds the Energy Efficiency as a Resource conference every two years, and ACORE holds its annual renewable energy policy forum.
- Developing model legislation on joint RPS-EERS policies. This could be discussed with various parties and legislative staff, for possible inclusion in federal or state legislation.
- A focused research, education, and advocacy effort in one or more states to advance the idea of effective joint EE–RE resource standards. Candidates could include Pennsylvania, Illinois, Texas, and Florida.

Public Benefits Funds

Seventeen states have both energy efficiency and renewable energy Public Benefits Funds, supported by small public benefits charges on each unit of utility energy sales. These funds provide a stable and in some cases substantial source of market incentives for these clean energy resources. Currently spending about $1.8 billion altogether, such funds could be substantially expanded. Every mill (1/10 of one cent) per kWh levied in a public benefits fund would raise over $3 billion annually on a national basis. Levying three mills per kWh on a national basis, which several states currently charge, would create over $9 billion for efficiency and renewables nationwide. This would more than quadruple current spending levels, and would thus create a substantial economic stimulus for clean energy markets.

Efforts to date to create a national public benefits fund have not succeeded. In 2001, the Congressional Budget Office ruled that a Public Benefits Fund levied on whole electricity sales is a tax, which severely dimmed its political future. However, other options could be considered as potential sources for clean energy funds, including:

- Federal royalties from fossil fuel extraction;
- Increases in energy taxes such as the gasoline tax;
- Proceeds from carbon taxes; and
- Proceeds from auctions of carbon emission allowances.

In addition, Public Benefits Funds could achieve better synergies, in both technical and programmatic terms, if they were better coordinated. For example, zero energy building projects could draw funds from both EE and RE funds, enhancing the economics and the total impact of such initiatives. Targeting EE and RE projects in geographic areas where transmission constraints or other issues enhance their joint value could create additional synergies. In addition, coordinated administration of funds could reduce overhead costs.

Next Steps. To further the public benefits funding issue, possibilities include:

- A joint white paper with ACEEE, ACORE, the Clean Energy States Alliance, and other key parties, developing several options for advancing public benefits funding in ways that maximize EE–RE synergies. This would include both better coordination of state programs and new possibilities for a joint federal fund.
- A workshop or conference that brings together key EE and RE organizations active in the public benefits arenas. The Clean Energy States Alliance (CESA) holds regular meetings and conference calls; leaders of the ACEEE Market Transformation Symposium and the Market Transformation Roundtable could also be considered for participation in such an event.
- A focused effort in one or more states to develop the more promising new public benefits funding ideas. Candidates could include North Carolina, Illinois, Maryland, and Florida.

Climate Policy

The common assumption today is that any national policy for reducing greenhouse gas emissions will focus on a cap-and-trade approach, modeled somewhat on Clean Air Act programs like the sulphur dioxide cap-and-trade system. However, this assumption overlooks the fact that in the electricity sector, energy efficiency cannot be directly credited with emission reductions, despite its well-documented benefits (Prindle 2004). This is because end-use efficiency is an indirect, “downstream” measure, while the emissions cap is placed directly at the power plant or “upstream” level.

Some policymakers are considering complementary or "hybrid" policies, centering on cap-and-trade mechanisms but also including parallel policies outside the cap mechanism. In the northeastern-state Regional Greenhouse Gas Initiative (RGGI), for example, states are considering increasing their efficiency funding and setting efficiency resource standards. Their motivation is to more fully tap efficiency as a low cost emission reduction strategy. Establishing or increasing renewable portfolio standards and other policies to stimulate renewable energy development are also under consideration.

Robust complementary policies that actively encourage efficiency and renewable investment can thus lead to a least-cost climate policy. While a cap-and-trade framework has the advantage of being flexible and market-based, it does not address the barriers to efficiency and renewables that would keep them from fully participating in a cap-and-trade system. For these reasons, policymakers designing climate protection strategies should consider complementary policies that directly engage efficiency and renewable resources.

Next Steps. The best candidates for these kinds of policies would be the RGGI states, including ME, NH, VT, CT, NY, NJ, DE, and MD. A focused project with targeted analysis and advocacy could leverage the RGGI program for substantial gains in coordinated EE and RE policies.

Robust Markets for Tradable Efficiency and Renewable Energy Credits

The green power market that is expanding rapidly with residential, business, and government utility customers depends largely on the "green tags" mechanism to create a liquid market for clean energy. There is discussion about the emergence of a "white tags" market for energy efficiency; in some states, efficiency projects have qualified for emission allowances under set-aside programs, using established measurement and verification protocols such as the International Program Measurement and Verification Protocol (IPMVP).

If robust national markets for green tags and white tags could be developed, based on rigorous criteria for additionality, technical accuracy, and temporal persistence, this would enable clean power markets to grow even more rapidly. These mechanisms would also be essential enablers for state and national resource policies such as EERS and RPS. Also, if national, state, or regional carbon cap-and-trade policies were to be enacted, these market mechanisms would ensure liquid and efficient markets for clean energy resources.

Next Steps. To build the basis for such markets, possible next steps include:

- A white paper among EE and RE experts on the technical, institutional, and market issues involved in developing effective, robust markets that would encompass efficiency and renewables;
- A workshop involving EE M&V experts and green tags experts plus other stakeholders, to discuss practical avenues for moving forward on making these markets more workable and expandable; and

- A focused pilot project to test one or more promising approaches in a leading market, with the goal of assessing the feasibility of near-term expansion of such clean-energy credits.

Zero Energy Buildings

A critical issue in clean energy policy is minimizing the energy and environmental impacts from new building construction, because new buildings constitute the majority of growth in energy demand in a typical utility system. The zero energy building concept, integrating aggressive efficiency designs with onsite renewable energy such as solar, holds the greatest promise for realizing this goal. However, the high cost of solar capacity remains a limiting factor, making it difficult to create a robust private market for such buildings. Policy action is clearly needed to make this happen.

Policy options for zero energy buildings include:

- Building codes—Code policies could include creating incentives in code compliance software and other materials that favor renewables, such as linking energy usage calculations to a time-dependent valuation approach, as California has done, or granting renewables added energy value in compliance calculations.
- Connection fees—Levying utility connection fees that are scaled to the total connected energy demand of the building; charging $1,000 or more per connected kW would create an incentive for builders to minimize demand through efficiency and renewables
- Net metering—While many states have net metering policies that support building-scale solar, this should be made a consistent policy nationwide. Careful attention should be paid to the details of net metering policies, to ensure not only consistency but also that such policies are technically sound and appropriately encourage distributed energy systems in a fair and reasonable fashion.
- Ratemaking policies—Some states offer favorable buyback rates for building solar installations; this practice should be expanded, in combination with net metering policies. In regions with functioning wholesale power markets, buildings with solar installations should be able to participate in hourly price markets; this would typically yield the highest value for solar generation.
- Financing policies—The nation's mortgage lending institutions have experimented with Energy Efficient Mortgages, which factor the value of energy savings into mortgage qualification procedures. However, these programs have not been widely used. Other approaches should be explored, including creating federal guarantees or other forms of credit enhancement to lenders, so that mortgages on homes meeting zero energy criteria could qualify for substantially lower interest rates.
- Links to clean energy credits—Since achieving literal, onsite zero energy performance is technically challenging and may not be economically justified in the near term, one way to achieve zero energy/zero emissions impact is to establish policies in which new buildings either would have to achieve zero energy performance at the building site, or would have to purchase credits sufficient to offset

their energy/emissions impacts. This approach would need to be linked to robust clean energy credit markets as discussed above.

Next Steps. Possible new initiatives could include:

- A research and policy analysis project exploring the most promising approaches to expanding the market for zero energy buildings, including both market-based and regulatory approaches;
- A workshop involving ZEB technical experts and other stakeholders, including builders, developers, and clean energy markets experts, to discuss and build consensus around the most actionable pathways toward rapid growth in ZEBs.
- An advocacy project, focused on one state, region, or other marketplace, whose goal would be to test the real-world viability of ZEB policies and programs.

Utility Interconnection and Tariff Policies

Distributed generation technologies, or projects that tend to be smaller than traditional utility central-station power plants, have faced widespread obstacles in both wholesale and retail interconnection policies and accompanying rate tariffs. Interconnection studies that take inordinate amounts of time and money, queuing policies that put independent projects behind utility-owned projects, and high tariffs for standby and supplemental power supply are common examples of the barriers that have halted many promising projects.

Distributed generation can include both high-efficiency and renewable energy technologies. In this sense, improving policies in this area would create synergies by bringing both kinds of resources more fully onto the electricity grid. Because of the different grid-impact characteristics of these technologies, encouraging all types creates synergies for the entire power system. For example, the availability profiles of efficiency technologies like combined heat and power can complement the more intermittent profiles associated with solar and wind resources. By increasing diversity in distributed resources, efficiency and renewables can reduce and stabilize wholesale power prices, while enhancing reliability and reducing transmission losses in “load pocket” areas.

The *Energy Policy Act of 2005* requires states to consider improved interconnection policies, although it does not impose mandatory requirements or recommend specific and detailed policies. This means that the energy efficiency and renewable energy communities must, for the present at least, promote consistent interconnection and tariff policies on state and regional levels. Initiatives such as the Northeast and Mid-Atlantic Demand Response Initiatives have generated progress in this area; more work is needed in other parts of the country.

Next Steps. This is a relatively well-known and focused policy topic. Advancing better policies in this category requires research, coalition-building, and sustained advocacy in individual states and regional power markets. National and regional workshops among experts, advocates, and other stakeholders could be helpful in developing coordinated strategies, followed by funded, focused advocacy efforts in the most promising areas.

CONCLUSIONS

Energy efficiency and renewable energy are the cornerstones of sustainable energy policy. Demand growth for energy must be brought into a sustainable range, so that clean renewable energy technologies can begin to "catch up" with energy demand. If energy demand grows too fast, no supply technology, no matter how clean, will be able to substantially reduce fossil fuel consumption.

Energy efficiency and renewables thus must go hand in hand in any clean energy future. Fortunately, pursuing them jointly offers several important synergies over pursuing one to the exclusion of the other, such as:

- Lower total energy cost—A combined efficiency/renewables resource portfolio is typically less expensive than a renewables-only portfolio, and also generates greater total resource impacts;
- Better timing—Efficiency can typically be deployed quickly, achieving important impacts in the near and mid terms; renewables can take longer to deploy, but may ultimately deliver larger resource impacts;
- Electricity price stability—Efficiency and renewables provide complementary price hedges in power markets, by both moderating demand and diversifying fuel sources;
- Electric system reliability—Energy efficiency can reduce peak demand, reducing the risk of blackouts, while renewables diversify generation sources, and both efficiency and renewables can provide locational benefits in the form of distributed generation; and
- Regional resource balance—While renewables' availability varies from region to region, energy efficiency is consistently available in end-use sectors across the country. Pursuing both efficiency and renewable resources in tandem thus makes it easier to attain national energy resource targets in any given state.

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