Cover photo credit: Shutterstock.com.

DISCUSSION PAPER

Reinventing Fire in Southern California: Distributed Resources and the San Onofre Outage

Next Generation Electricity
AN RMI INITIATIVE

Rocky Mountain Institute®

Published September, 2012.
Authors: Mathias Bell and James Newcomb

Problems at San Onofre Nuclear Generating Station

The prolonged shut-down of the San Onofre Nuclear Generating Station in Southern California could mark an important turning point for the region's electricity system. Distributed and demand-side resources—including energy efficiency, demand response, and solar photovoltaics (PV)—offer a portfolio of solutions to help fill the near-term supply gap, while also advancing California's long-term goals of reducing greenhouse gas emissions and supporting local economic development and job creation.

The twin reactors at the San Onofre Nuclear Generation Station (SONGS) sit along the Southern California coast, wedged between Interstate 5 and the Pacific Ocean. For the past thirty years, the 2.2 gigawatt (GW) power plant has provided electricity to customers and helped maintain grid reliability in the region's densely populated metropolitan areas. In 2011, the plant generated 19% of the electricity in Southern California[1].

In January 2012, plant officials discovered that a small quantity of radioactive gas had leaked from one building. Since then, operators at SONGS, which is co-owned by three of the largest utilities in the region, have kept the plant shut down while seeking to identify the cause of the leak and determine the scope of the problem[2]. During the shutdown, inspectors discovered atypical wear in the steam tubes, which had undergone maintenance in 2010. Damage to some of these tubes is so severe that they must be plugged before the plant can restart[3], or perhaps the whole steam generator will have to be replaced[4].

Now, the future of SONGS is unclear. The Nuclear Regulatory Commission and plant operators continue to evaluate the power plant to understand why the damage occurred and what repairs will be necessary. Once it becomes clear how to address the issues in the plant, California regulators and policymakers will have to assess the costs and risks of conducting the repairs.

While SONGS has been offline, grid operators, including California ISO and the utilities, have continued to provide power reliably to residents and businesses in Southern California. Through September, meeting demand was not a problem. To make up for SONGS's lost capacity, grid operators and planners brought back online a decommissioned gas plant at Huntington Beach. The utilities also finished construction of the Sunrise

[1]So Cal Edison, *Power Content Label.*
[2]Lovett, "San Onofre Could Hint at a Non-Nuclear Future".
[3]United States Nuclear Regulatory Commission, "Special NRC Oversight at San Onofre Nuclear Generating Station".
[4]Fairewinds Energy Education. San Onofre's Steam Generators Significantly Worse than all others Nationwide. (http://fairewinds.org/content/san-onofre%E2%80%99s-steam-generators-significantly-worse-all-others-nationwide) July 22, 2012.

Powerlink, a long transmission line connecting the metropolitan areas with rich renewable resources in the eastern part of the state and enabling more power imports. Furthermore, generally temperate weather over the summer reduced overall demand. Even during high temperatures, Southern Californians reduced electricity demand by almost 5% in response to "Flex Alerts," helping to ensure that blackouts never occurred[5].

Some of the strategies that grid operators and planners relied on this summer may not, however, continue to be available. The Huntington Beach units that were brought out of retirement may not comply with clean air requirements in 2013. Summer temperatures next year could be much higher, increasing electricity demand and making blackouts more likely.

If SONGS remains out of service for another twelve to twenty-four months, or is permanently retired, Southern Californians will need to consider the tradeoffs among the strategies for making up the electricity shortfall. Though there are many options that rely on increased natural gas capacity and transmission investments, the goal of this paper is to highlight the role that distributed resources can play. These resources include efficiency, demand response, and solar PV. While distributed resources are promising for long-term energy planning, they can also help address the nearer-term shortfall in energy and capacity that Southern California faces. In this paper, we assess the role that could be played by:

- **BEHAVIOR CHANGE**
- **DEMAND RESPONSE**
- **ENERGY EFFICIENCY**
- **SOLAR PV**
- **COMBINED HEAT AND POWER (CHP) AND FUEL CELLS**
- **STORAGE**

Using distributed resources to replace a large, central power plant

When large, centralized plants go down for long periods, the conventional strategy is to cautiously proceed with a combination of behavioral measures and increased use of existing power plants, typically including older, less efficient units not normally used. A recent study by the International Energy Agency, *Saving Electricity in a Hurry* (2011) describes more than a dozen successful cases in which specific markets minimized the negative impacts of unanticipated electricity shortfalls by implementing emergency energy-saving programs[6]. These programs used tools such as rationing, price signals, technology replacement, and information campaigns to encourage energy savings. The tools stimulated and enabled consumers to quickly curb wasteful energy practices, delay certain activities to non-peak times, and replace old technologies with more energy-efficient ones. Countries achieved energy savings ranging up to 20% (Figure 1).

Estimated savings achieved through emergency energy saving programs

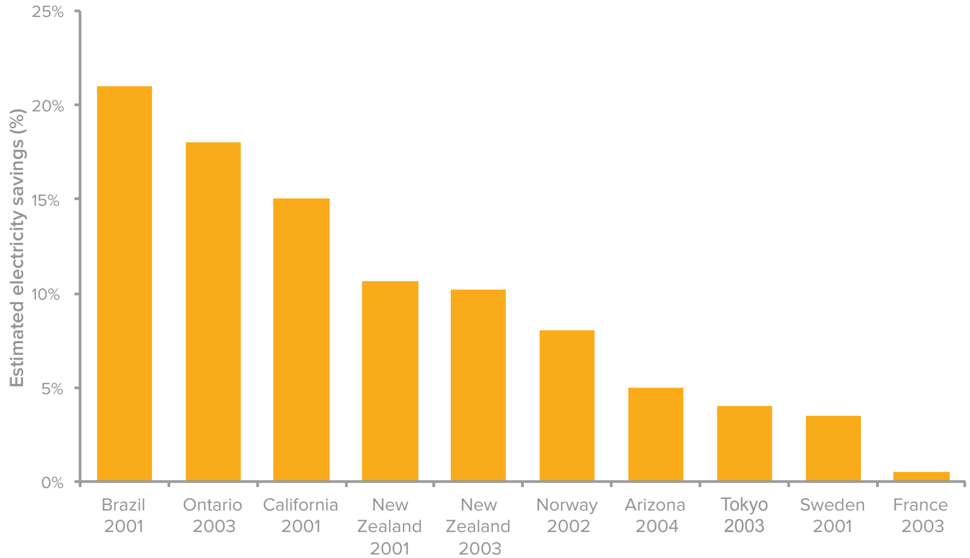

Figure 1: Estimated savings achieved through emergency energy savings programs.
Source: Pasquier, 2011

[5]Wolf, "ENERGY: Locals Respond to Energy Conservation Request, Slice Peak Load 1.4 Percent".
[6]Pasquier, Saving Electricity in a Hurry— Update 2011.

Daily electricity use in Juneau, 2007–2009

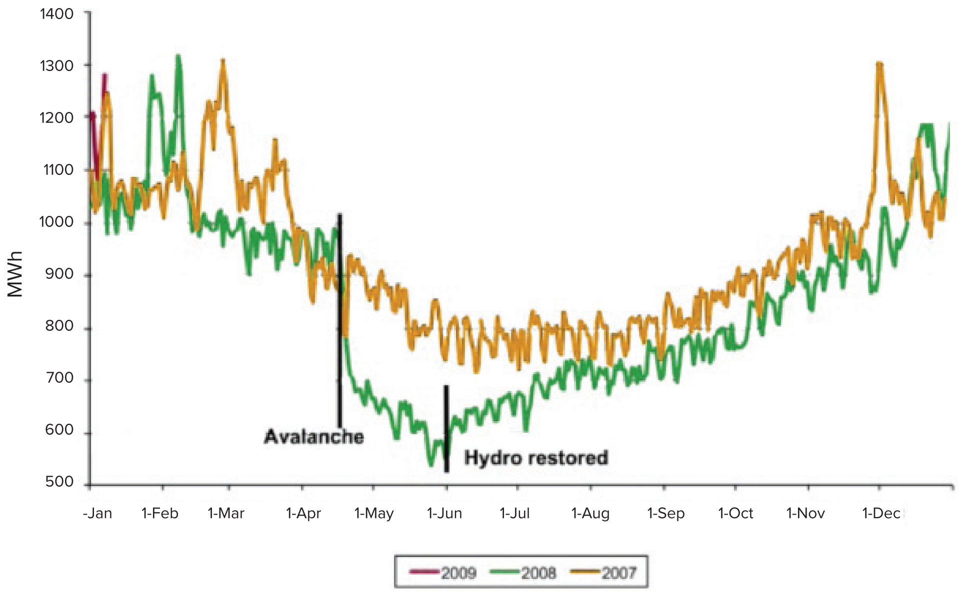

Figure 2: Daily electricity use in Juneau, Alaska before and after the April 2008 avalanche.
Source: Pasquier, 2011

In Juneau, Alaska, in 2008, an avalanche destroyed a section of the main transmission line to the city. Diesel backup generators temporarily replaced the lost power but at a cost several times higher than the city's normal supply. However, within two days of the event, the citizens of Juneau reduced their electricity consumption by 25% with a combination of behavior measures, such as turning off lights, and efficiency measures[7]. The transmission lines were eventually restored, and demand reduction efforts decreased (although some savings did persist)[8].

Though the situation in Southern California is not nearly as urgent as Juneau's was, there are some similarities. Unexpected events took a large fraction of generation capacity offline, and many individuals are motivated to act. Demand-side measures could play a similar role in Southern California, and some distributed renewable projects, rather than diesel, could make up for the shortfall in energy and capacity from the plant. In the mid- and long-term, Southern California could continue to use these resources as a foundation for building a more distributed, renewable-based electricity system. Figure 3 illustrates the range of demand-side policies used to cope with supply disruptions in five countries since 2007.

[7]Forgey, "Losing Power: Juneau's Utility Faces Consequences of Past Actions".
[8]Leighty, *Short-Term Electricity Conservation in Juneau, Alaska: A Study of Household Activities.*

Responses to Electricity Shortfalls

	JAPAN 2011	JUNEAU, AK 2008	NEW ZEALAND 2008	SOUTH AFRICA 2008/09	CHILE 2007/08
DECREASE IN ELECTRICITY CONSUMPTION (%)	15% for most sectors during summer peak period	25% to 40% across all sectors	3.6% to 6.7% in the residential sector	20%, primarily for industry	No electricity demand growth despite GDP growth
APPROXIMATE DURATION	Since March 2011	6 weeks	June–July 2008	January 2008–end 2009	Several months
INCREASE PRICES		x	x	x	x
REQUEST CHANGES IN BEHAVIOR	x	x	x	x	x
TECHNOLOGY REPLACEMENTS	x	x (CFLs only)	x	x	x
RATIONING	x	x		x	x
FUEL SWITCHING		x	x	x	
DAYLIGHT-SAVING TIME					x

Figure 3: Demand-side policies used to respond to electricity shortfalls.
Source: Pasquier, 2011

Distributed energy resources include a range of local supply- and demand-side measures, including efficiency and demand response, behavior changes, small-scale generation (e.g., solar PV and co-generation), energy storage, and grid-controllable electric vehicle charging. These resources provide many compelling benefits, including[9,10]:

ENERGY VALUE	These resources generate or reduce energy that can be directly supplied to the customer or interconnected and integrated into the grid.
GENERATION VALUE	These resources also reduce the amount of capacity needed for the system to operate during peak or other times of the day.
ENVIRONMENTAL VALUE	These resources reduce CO2 emissions as well as criteria pollutants that affect air quality.
TRANSMISSION AND DISTRIBUTION SYSTEM VALUE	Having these resources on the system reduces the need for transmission and distribution system investments.
RELIABILITY VALUE	Grid operators, in some cases, can call on these resources, during times of limited power, and they also supply ancillary services.
POWER QUALITY	These resources can improve power quality, preventing micro-second perturbations in the flow of electricity, which can damage equipment.
LAND-USE EFFECTS	Compared to centralized power plants and transmission and distribution equipment, distributed resources have a much smaller impact and have far fewer not-in-my-backyard (NIMBY) concerns.

California policymakers have introduced a variety of measures to encourage adoption of distributed energy resources. The state has committed to capturing all cost-effective energy efficiency and that 33% of electricity will be generated from renewable sources by 2020. California has been considering additional goals more recently, calling for 12,000 MW of localized renewables by 2020 and 1,000 MW of new storage.

Though the portfolio of distributed resources holds great promise, some resources are much better positioned to help address the immediate short-term concerns of generating enough power to maintain reliability. In this paper, we assess the size of the resource, its cost compared to building new natural gas capacity, the speed at which it can be deployed, and how long it will persist[11].

[9] U.S. Department of Energy. *The Potential Benefits of Distributed Generation and Rate-related Issues that May Impede Their Expansion.*
[10] For a more comprehensive list of benefits, see: Lovins, *Small is Profitable*.
[11] **Definitions**: Size of resource indicates how much energy each resource can provide relative to SONGS: “small” is less than 20% of SONGS’s capacity; “large” is greater than100%. *Cost* is relative to the levelized cost of energy of a new natural gas combined-cycle power plant (approximately $0.075/kWh): “low” is less than 50% of the cost, while “high” is greater than 100%. *Time to deploy* is relative to the time required to build a natural gas combined-cycle plant: “fast” is less than a year; “slow” is more than 3 years. *Persistence* indicates the continued existence of the resource: “low” means that the resource will quickly decline after its first year; “high” means it will continue to exist, with little operations and maintenance, for its lifetime.

Overview of Distributed Energy Resources

	SIZE OF RESOURCE	COST	TIME TO DEPLOY	PERSISTENCE
BEHAVIORAL SAVINGS	Small	Low	Fast	Low
DEMAND RESPONSE	Medium	Low-Medium	Fast	Medium-High
ENERGY EFFICIENCY	Medium	Low-Medium	Fast	Medium-High
SOLAR PV	Large	High	Medium-Fast	High
CHP/FUEL CELLS	Medium	Medium	Medium	High
STORAGE	Large	Very High	Slow	High

Figure 4: Overview of distributed energy resource opportunities in Southern California.

BEHAVIORAL SAVINGS

SIZE OF RESOURCE: SMALL | COST: LOW| TIME TO DEPLOY: FAST |PERSISTENCE: LOW

Behavioral savings, which involve a focused effort to encourage customers to reduce energy demand through simple conservation actions, is the first of three types of demand-side management strategies to address the missing generation from SONGS. Behavioral savings programs have been common in the past, when shortfalls in generating capacity posed challenges. These events include Juneau (as mentioned before), during the California energy crisis, and even more recently, in the summer of 2012 when California issued "Flex Alerts" calling for curtailment.

The success of these programs depends on their ability to change customer decision-making. In the best cases, customer motivation is "triggered" when customers see their actions as a means to keep the lights on or decrease the cost to others. A robust behavioral savings program consists of targeting certain behaviors, determining where to intervene, choosing techniques for changing behavior, and evaluating the results[12].

For long-term planning, however, behavioral programs may not be sufficient. It is difficult to assess the persistence of the savings beyond 2 or 3 years, let alone along the timelines of power plants[13]. However, these measures can be effective in reducing energy demand over a finite period, especially if there are social motivations for doing so.

DEMAND RESPONSE

SIZE OF RESOURCE: MEDIUM | COST: LOW–MEDIUM | TIME TO DEPLOY: FAST | PERSISTENCE: MEDIUM–HIGH

Demand response encompasses a set of strategies that aim to reduce electricity demand at critical times using dispatchable control systems. Traditionally, grid planners have deployed demand response to reduce peak energy demand, or "peak shave." More recently, the Federal Energy Regulatory Commission (FERC) has emphasized that utilities should deploy demand response to meet a wider range of system needs[14], positioning it to serve as a tool for managing the variability of electricity supply and demand on the grid.

Though the California Public Utility Commission has prioritized the deployment of demand response, these measures have generally been underutilized. FERC has, for example, estimated that California's achievable demand-response potential to be 8,795 MW[15], nearly 13% of California's system peak; however, programs in 2010 captured only 2,400 MW, or about 5% of the system peak, according to the CPUC[16]. Demand-response programs that could be quickly expanded include those focused on commercial and industrial lighting, residential hot water heating, and air conditioning in all sectors.

Demand response can be considered a resource for both short- and long-term resource planning. Many regions outside California have begun to include demand response in capacity planning. At New England ISO and PJM, for example, project aggregators and program administrators now bid their demand-response services into these markets. Aggregators' bids into forward capacity markets have been quite low, coming significantly under the cost of combustion turbine natural gas plants[17].

For Southern California, demand response could serve as a key mechanism for addressing the capacity shortfall. Over the next two years, estimates show demand-response levels could be raised by as much as 1,100 MW statewide, an increase of more than 45%[18]. With proper controls and grid integration, demand response can also play a role in providing ancillary services, such as reactive power and voltage stabilization, all of which help prevent blackouts.

[12]Sullivan, *When "Not Losing" is Better Than "Winning".*
[13]Navigant Consulting, *Evaluation Report: OPower SMUD Pilot Year 2.*
[14]U.S. Department of Energy, *The Potential Benefits of Distributed Generation and Rate-Related Issues that May Impede Their Expansion.*
[15]Federal Energy Regulatory Commission, *A National Assessment of Demand Response Potential.*
[16]California Air Resources Board, *California's Clean Energy Future Progress Report.*
[17]New England Independent System Operator, *Forward Capacity Auction 5: Capacity Commitment Period 2014–2015.*
[18]California Energy Commission, *2009 Integrated Energy Policy Report.*

ENERGY EFFICIENCY

SIZE OF RESOURCE: MEDIUM | COST: LOW–MEDIUM | TIME TO DEPLOY: FAST PERSISTENCE: MEDIUM–HIGH

California has long been a leader on energy efficiency. Since 1978, with the creation of Title 24, the state's residents and businesses have saved energy, keeping per-capita energy usage virtually constant. By contrast, U.S. per-capita energy use has increased by 30% over the same period. From 2006 through 2010, efficiency savings achieved by California's investor-owned utilities (IOU) represent almost 8% of total demand.

The estimated efficiency resource still available in Southern California is large. In the IOU's service territories, despite billions of dollars spent and saved through efficiency programs, the remaining efficiency resource is about 20% of total energy demand. In some areas, the resource is relatively underexploited. At the Los Angeles Department of Water and Power (LADWP), the largest municipal utility in the country, program savings have been smaller than those achieved elsewhere in California. LADWP's energy efficiency budgets per customer have been $52, significantly lower than the $87 average at the IOUs.

In a promising change of events, this year LADWP committed $130 million to fund their efficiency program. This is good news for the region and will help further reduce demand.

If Southern Californians aggressively sell and adopt efficiency, it could be a resource that helps make up for much of the shortfall. If the utilities were able to double their savings this year and next, they would reduce energy consumption by approximately 4.5%[24]. These savings would amount to about 20% of San Onofre's output.

CHP/FUEL CELLS

SIZE OF RESOURCE: MEDIUM | COST: MEDIUM | TIME TO DEPLOY: MEDIUM | PERSISTENCE: HIGH

Combined Heat and Power (CHP) takes advantage of the combined efficiency of generating electricity in conjunction with providing heat for other purposes, ranging from water heating to industrial steam production. These sources of electricity are most common in industrial facilities, but are also found in some commercial facilities with excess heat, such as hospitals. California has aggressively pursued CHP, but abundant opportunities remain. In 2010, the governor set a goal to capture 6,100 MW statewide over the next 20 years, which is essentially all economic CHP, according to studies by the California Energy Commission[25].

CHP, however, cannot be installed as quickly as some of the resources described above. Though it could play an important role in California, it is doubtful that CHP capacity can grow significantly than the rates already projected for the next several years, given the relatively long lead times associated with capital planning and construction of CHP facilities.

Fuel cells, meanwhile, are promising, though still emerging. Encouraged by California's Self Generation Incentive Program, datacenter managers in particular have been installing fuel cells at their facilities[26]. Fuel cells are exciting because they provide uninterruptible power and can reduce emissions. Most applications use natural gas, but biofuels and hydrogen are promising options for the future.

[24]Calculation based on: Navigant Consulting. *Analysis to Update Energy Efficiency Potential, Goals, and Targets for 2013 and Beyond.*
[25]Darrow, *Combined Heat and Power: Policy Analysis and 2011-2030 Market Assessment.*
[26]New York Times. "A Maker of Fuel Cells Blooms in California".

SOLAR PV

SIZE OF RESOURCE: LARGE| COST: HIGH | TIME TO DEPLOY: MEDIUM–FAST | PERSISTENCE: HIGH

Solar is an abundant resource in the region. California's solar resource has more than 17 million GWh of technical potential[27], with many of the best sites located in Southern California. Furthermore, while the potential for utility-scale solar is large, California could theoretically power itself with just rooftop photovoltaics, which have a technical potential of 106,000 TWh[28].

Just as important, the costs for solar photovoltaics continue to decline rapidly. Though many observers perceive solar as expensive, costs have decreased by more than 60% since 2000. Today, solar PV costs roughly $3.50 per watt (Wdc), though costs in Germany are much lower, around $2.00/Wdc. In other words, there are plenty of opportunities to reduce costs further. Streamlining the permitting and interconnection processes represents a large cost-reduction opportunity.

California also has set big goals for solar. California's goal 12,000 MW of locally sourced renewables by 2020, which will largely be solar, will require an annual growth rate of 15%. California's installed capacity already dwarfs the rest of the country – almost 1,300 MW, which is higher than the installed capacity in all other states combined[29].

To overcome Southern California's shortfall in capacity, however, solar will have to deploy more quickly and in the areas most needed. To do that, challenges associated with permitting, interconnection, and incentives will have to be addressed.

Cost trajectories for Solar PV

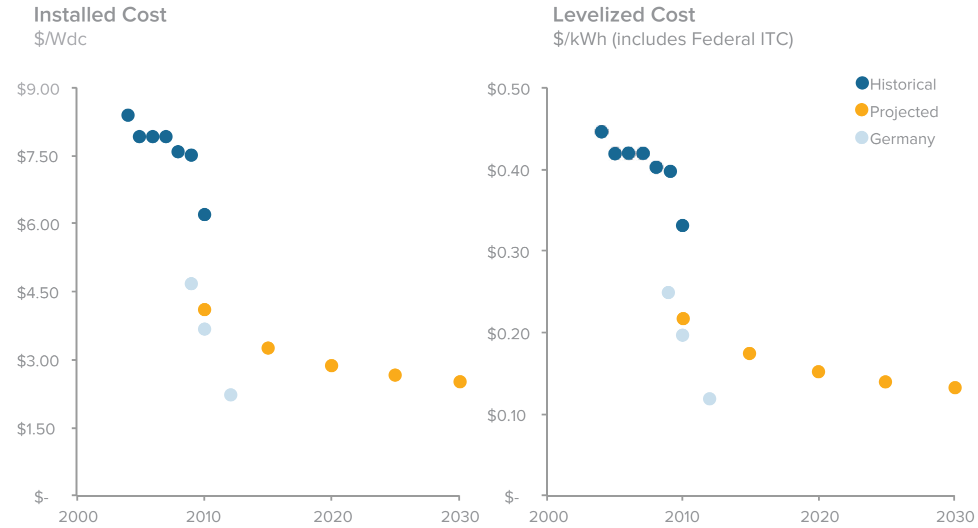

Figure 5. Costs projections for solar.
Source: Barbose, 2011; Black and Veatch, 2011.

[27]Lopez, U.S. Renewable Energy Technical Potentials.
[28]Lopez, U.S. Renewable Energy Technical Potentials.
[29]NREL, *Open PV Project.*

STORAGE

SIZE OF RESOURCE: HIGH | COST: VERY HIGH | TIME TO DEPLOY: SLOW | PERSISTENCE: HIGH

The governor has established a goal of 1,000 MW of new energy storage by 2020[30]. While many promising storage technologies are in development, few are available to make a sizeable contribution to Southern California's peak supply needs today. In the long term, electric vehicles could play an important role in enabling more renewables on the grid and help balance the evolving portfolio of electricity supply. Compressed-air energy storage and flywheels could provide a similar benefit.

Storage options already on the California system are sizeable, including pumped hydro. California currently has more than 2,500 MW of capacity[31]. California could build more pumped hydro, which would have many benefits. However, these facilities have a long lead time and could not address in a significant way the short-term problem of replacing the capacity and energy from San Onofre.

[30]California Air Resources Board, *California's Clean Energy Future Progress Report*.
[31]Darrow, *Combined Heat and Power Market Assessment*.

Opportunities to Accelerate Adoption

These distributed energy resources could replace a significant portion of the capacity, energy, and ancillary services that SONGS has provided to Southern California. However, policymakers and grid planners hesitate to rely on these resources as a substitute, because their historical levels of adoption fall far short of what is needed to replace a power plant as large as SONGS. There are many opportunities, however, to accelerate the adoption of these resources (Figure 5). In the section that follows, we distill this list of opportunities to the options with the most potential to enable Southern California to mitigate the outage at SONGS and encourage the highest level of adoption for distributed energy resources now and in the long term.

BEHAVIORAL SAVINGS	Improve information sharing Leverage customer feedback Influence customers through social media
DEMAND RESPONSE	Improve integration between customer, utility, and CAISO Make measurement and verification more robust Introduce capacity market
ENERGY EFFICIENCY	Enhance program budgets Allow more flexibility in program design Provide financing (On bill financing, Commercial PACE) Provide targeted incentives
SOLAR PV	Standardize permitting Streamline interconnection Provide financinf (i.e. Commercial PACE) Provide targeted incentives
CHP/FUEL CELLS	Provide targeted incentives Streamline interconnection
STORAGE	Provide targeted incentives

Figure 5: Menu of opportunities to accelerate adoption of distributed resources in Southern California

Recommendations

In this section, we present our recommendations for encouraging higher levels of distributed energy resources for Southern California:

1. Create a level-playing field

Despite many policies intended to advance renewables, California continues to display a bias toward developing large-scale, centralized resources over distributed ones. When San Onofre was temporarily shut down, planners and the utilities looked first to assess what other power plants could be utilized to make up for SONGS lost capacity for the summer.

If many of these distributed energy resources are cost effective, then California should pursue policies that fairly account for the benefits of these resources and encourages them to scale up quickly.

California can follow the lead of other regions, like PJM and New England ISO, and create capacity markets that would allow these resources to compete fairly with supply-side power plants.

2. Investigate targeted incentives

In a situation like the one Southern California faces, the location of the resource matters. Today, California's incentives are the same for all customers, even though the benefits derived from distributed resources varies.

To encourage deployment of distributed energy resources in areas where energy is most needed, California could explore the possibility of developing differentiated incentives based on the value provided to the grid by these resources. If there were a ”bonus“ for developing resources in certain areas or providing supply at certain times of the day, planners could direct the development of distributed resources to create greater value for the system as a whole.

3. Facilitate solar resources coming online faster.

Every resource discussed in this paper faces some impediment to quick deployment, but solar is most affected by regulatory, or ”white tape,” delays. Solar projects can take up to a year to be approved for installation[32], even though the actual installation on a residential site takes no more than a day. These lags hinder adoption by customers and can increase installed costs by 15% or more[33].

Permitting and interconnection procedures could be significantly streamlined, resulting in lower costs and faster adoption of distributed resources. First, standardized and expedited permitting by local authorities would reduce costs for customers and developers. Second, interconnection requirements govern whether and how solar panels or other distributed resources can be connected to the grid while still ensuring the safe and reliable operation of the electricity grid. Allowing for higher penetrations of renewables before requiring an interconnection study would allow more projects to come online faster. Promising solutions to hasten permitting include developing a single queue for all projects and creating better online and software tools to facilitate the interconnection process.

[32]SunRun, *The Impact of Local Permitting on the Cost of Solar Power*
[33]Russel, *California's Transition to Local Renewable Energy: 12,000 Megawatts by 2020.*

In Conclusion

In this report, we have analyzed possible demand-side and distributed supply-side options for replacing the lost generation capacity of the San Onofre Nuclear Generating Station. Together, the resources identified here provide a sizeable and diverse portfolio of measures to help mitigate the capacity shortfall.

California utilities, planners, regulators, and policymakers will have to act boldly and quickly, however. Replacing the lost capacity from San Onofre is an immediate need, not a scenario that lends itself to years of workshops, feasibility studies, and hearings. Stakeholders will need to move rapidly to put policies into place. While these changes will benefit the short-term situation in Southern California, they will also enable the state to move more certainly and swiftly toward renewable energy generation levels well beyond the current 33% goal and thereby meet California's long-term greenhouse gas emissions targets.

The unexpected loss of electricity supply from the San Onofre plant presents a formidable short-term challenge for utilities, system planners, and grid operators. But stakeholders can turn the current challenge of providing electricity reliably in Southern California into a new opportunity with distributed energy resources.

Acknowledgements

This report was made possible through the generous support of our donors. We thank them for their partnership in our work.

We have greatly benefitted from interviews and review from many experts in the field, including Kevin Barker, Kristin Eberhard, Jamie Fine, Neil Millar, David Miller, Michael Picker, Snuller Price, Heather Sanders, Nick Schlag, and Carl Zichella. We'd also like to thank Thom Shaw and the RMI Communications Team for their support.

RMI is solely responsible for the contents of this report.

ABOUT ROCKY MOUNTAIN INSTITUTE

Rocky Mountain Institute (RMI) is an independent, entrepreneurial, nonprofit think-and-do tank. RMI emphasizes integrative design, advanced technologies, and mindful markets in fulfilling its mission to drive the efficient and restorative use of resources. RMI's strategic focus is to map and drive the U.S. transition from fossil fuels to efficiency and renewables by 2050.

If you are interested in contacting the authors, or engaging with Rocky Mountain Institute, communications can be sent to mbell@rmi.org.

References

2010. "A Maker of Fuel Cells Blooms in California." *The New York Times*, February 24.

Barbose, Galen, Ryan Wiser, and Naim Darghouth. 2011. *Tracking the Sun IV An Historical Summary of the Installed Cost of Photovoltaics in the United States.* LBNL.

Black and Veatch. 2011. *Cost and Performance Data for Power Generation Technologies. National Renewable Energy Laboratory.* http://bv.com/docs/reports-studies/nrel-cost-report.pdf.

California Air Resources Board, California Energy Commission, California Public Utilities Commission, California Environmental Protection Agency, and California Independent System Operator. 2010. *California's Clean Energy Future Progress Report: Meeting California's Energy and Environmental Goals in the Electric Power Sector in 2020 and Beyond.*

California Energy Commission. 2009. *2009 Integrated Energy Policy Report, Final*

Commission Report. http://www.energy.ca.gov/2009_energypolicy/.

———. 2011. *Staff Draft Report on Renewable Power In California: Status and Issues.*

California Public Utilities Commission. 2010. *2006-2008 Energy Efficiency Evaluation Report.*

California Public Utilities Commission. 2010. http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/2006-2008+Energy+Efficiency+Evaluation+Report.htm.

———. 2011. *Energy Efficiency Evaluation Report for the 2009 Bridge Funding Period.* http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/2009_Energy_Efficiency_Evaluation_Report.htm.

———. 2012. *2010–2011 Energy Efficiency Annual Progress Evaluation Report.*

Cooney, Kevin. 2011. *Evaluation Report: OPOWER SMUD Pilot Year2.* Navigant Consulting.

Darrow, Ken, Bruce Hedman, Eric Wong, and Anne Hampson. 2012. Combined Heat and Power Market Assessment. California Energy Commission, PIER Program. http://www.energy.ca.gov/2012publications/CEC-200-2012-002/CEC-200-2012-002.pdf.

Fairewinds Associates. 2012. "San Onofre's Steam Generators: Significantly Worse Than All Others Nationwide." http://fairewinds.org/content/san-onofre%E2%80%99s-steam-generators-significantly-worse-all-others-nationwide.

Federal Energy Regulatory Commission. 2007. *The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion: A Study Pursuant to Section 1817 of the Energy Policy Act.* Washington, DC. http://www.ferc.gov/legal/fed-sta/exp-study.pdf.

Forgey, Pat. 2008. "Losing Power: Juneau's Utility Faces Consequences of Past Actions." Juneau Empire, March 18. http://juneauempire.com/stories/051808/loc_280270110.shtml.

Itron Inc., and Kema Inc. 2008. *California Energy Efficiency Potential Study.* Pacific Gas & Electric Company.

Leighty, W., and A. Meier. 2010. "Short-term Electricity Conservation in Juneau, Alaska: A Study of Household Activities." The Proceedings of the 2010 Summer Study on Energy Efficiency in Buildings. Washington, DC: ACEEE.

Lopez, A., B. Roberts, D. Heimiller, N. Blair, and G. Porro. 2012. *US Renewable Energy Technical Potentials: A GIS-Based Analysis.* http://www.nrel.gov/docs/fy12osti/51946.pdf.

Los Angeles Department of Water and Power. 2012. "LADWP Announces New Energy Efficiency Director." http://www.ladwpnews.com/go/doc/1475/1465359/LADWP-Announces-New-Energy-Efficiency-Director.

Lovett, Ian. 2012. "San Onofre Could Hint at a Non-nuclear Future." *New York Times,* July 5.

Lovins, Amory B. 2002. *Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size*. Rocky Mountain Institute.

National Renewable Energy Laboratory. 2012. "The Open PV Project." https://openpv.nrel.gov/.

Navigant Consulting, Inc. 2012. *Analysis to Update Energy Efficiency Potential, Goals, and Targets for 2013 and Beyond.* California Public Utilities Commission. http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Energy+Efficiency+Goals+and+Potential+Studies.htm.

New England Independent System Operator. 2011. *Forward Capacity Auction 5: Capacity Commitment Period 2014–2015.* http://www.iso-ne.com/markets/othrmkts_data/fcm/cal_results/ccp15/fca15/index.html.

Pasquier, S. 2011. *Saving Electricity in a Hurry — Update 2011.* International Energy Agency. https://www.iea.org/publications/freepublications/publication/name,3996,en.html.

Russell, J., and Weisman, S. 2012. *Local Renewable Energy Project Report: The Governor's Conference on Local Renewable Energy Resources.* Center for Law, Energy, and the Environment. http://www.law.berkeley.edu/files/ccelp/CA_Transition_to_Local_Renewable_Energy.pdf.

Southern California Edison. 2011. "Power Content Label." http://asset.sce.com/Documents/About%20SCE/2010_SCE_PowerContentLabel.pdf.

Sullivan, D., C. Armel, and A. Todd. 2012. *When "Not Losing" Is Better Than "Winning:" Using Behavioral Science to Drive Customer Investment in Energy Efficiency.* 2012 Summer Study on Energy Efficiency in Buildings. Washington, DC: American Council for an Energy-Efficient Economy.

Sunrun. 2011. *The Impact of Local Permitting on the Cost of Solar Power.* http://www.sunrunhome.com/solar-lease/cost-of-solar/local-permitting/.

The Brattle Group, Freeman, Sullivan & Co., and Global Energy Partners, LLC. 2009. *A National Assessment of Demand Response Potential.* Federal Energy Regulatory Commission.

U.S. Energy Information Administration. 2011a. F*orm EIA-861 Annual Electric Power Industry Report.* DOE. http://www.eia.doe.gov/cneaf/electricity/page/eia861.html.

———. 2011b. State Energy Data System. http://www.eia.gov/state/seds/.

United States Nuclear Regulatory Commission. 2012. "Special NRC Oversight at San Onofre Nuclear Generating Station: Steam Generator Tube Degradation." http://www.nrc.gov/info-finder/reactor/songs/tube-degradation.html.

Wolff, Eric. 2012. "ENERGY: Locals Respond to Energy Conservation Request, Slice Peak Load 1.4 Percent." *North County Times,* August 19. http://www.nctimes.com/business/energy-locals-respond%20to-energy-conservation-request-slice-peak-load/article_29b445d3-2de4-5b82-917c-e23dfdac6fe5.html.