SOUTHERN CALIFORNIA EDISON
Energy for What's Ahead®

CATALINA ISLAND REPOWER OPTIONS

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Southern California Edison provides electric, water and gas service to Catalina Island and its 4,100 year-round residents, its commercial and industrial customers and its 1 million annual visitors. Powering the island, located 22 miles off the coast of Los Angeles, is a challenge that SCE has met since 1962.

The island's electricity is primarily generated by six diesel generators supplemented by propane-fueled microturbines. A pioneering battery energy storage system that has been in place since 2012 provides balance. All current island generation emanates from the 11.9-megawatt Pebbly Beach Generating Station, located one mile from the center of Catalina's primary population center, the city of Avalon.

Five of the current diesel generators do not meet South Coast Air Quality Management District (SCAQMD) 2018 emissions standards, which were implemented to improve air quality by reducing nitrogen oxide (NOx) emissions, and SCE has determined that refurbishment would not be feasible. Therefore, SCE will need to replace Catalina's current generation system within the next three to four years.

This has provided SCE with an opportunity to evaluate long-term strategies to improve air quality and increase the use of renewable energy, in keeping with the company's Pathway 2045 strategy. To provide a quantitative analysis of approaches to repower the island, SCE commissioned "Santa Catalina Island Repower Feasibility Study," a detailed technical and economic analysis, authored by consulting group NV5 in partnership with the National Renewable Energy Laboratory and U.S. Environmental Protection Agency. The analysis uses a techno-economic model to assess the leading repower options and provide actionable information, including cost, schedule and benefits and challenges of each option.

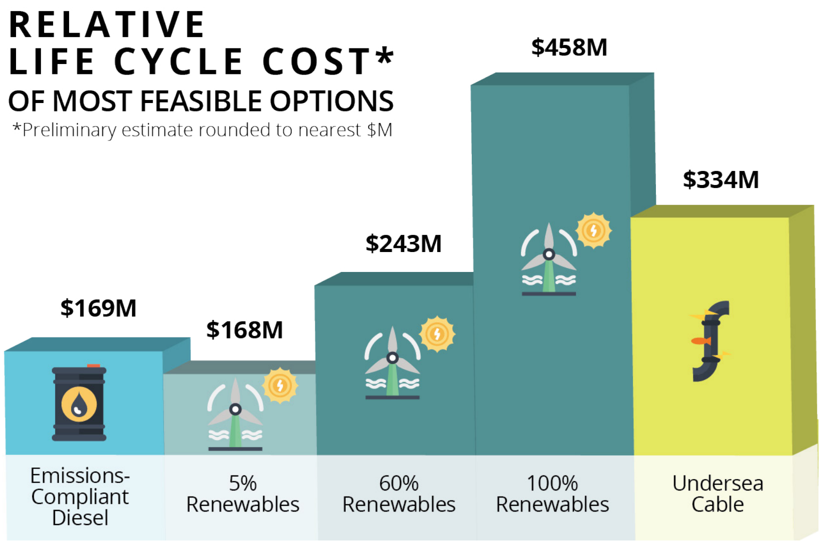
Looking at life cycle and capital costs, land availability, environmental sensitivities and other areas of risk, the analysis evaluates three general categories of emissions-compliant options:

- 100% emissions-compliant, fossil-fuel generation (diesel, propane and liquefied natural gas)
- Renewable energy and energy storage (at varying penetration levels)
- Undersea power cable to the mainland grid

For reliability purposes, every option includes at least some fossil generation, in some cases switching from prime to backup source over time.

The estimated life cycle costs for the projects range from approximately $168 million to $458 million. The life cycle cost includes estimates for initial capital costs and operations and maintenance costs, including fuel, over a 30-year period. Implementation times vary from two to eight years.

Separately, the analysis also examined the potential to reduce energy usage on the island using energy efficiency and demand response measures.



FOSSIL-FUEL GENERATION

Diesel generation: Since the 1920s, diesel generators have been the primary source of power on the island, using diesel fuel delivered by barge. The six current generators were put into service from the 1950s to the 1990s.

The analysis evaluated two diesel replacement options, both of which would replace the five noncompliant generators with diesel engines that meet the new emissions standards:

- Option 1: replace five diesel generators before a regulatory deadline of Jan. 1, 2024.
- Option 2: replace two of the existing generators by Jan. 1, 2023, and replace the three remaining noncompliant generators by Jan. 1, 2027. Replacing just two generators now could enable greater flexibility to add more renewable energy and energy storage in the future.

Because fossil-fuel generation is required as backup for all other options, these emissions-compliant diesel generators could function as part of the long-term energy mix, even as that energy mix might become more renewable over time.

Propane: SCE currently uses propane for microturbines and delivers propane to Avalon residents for heating and cooking via an on-island distribution system (the propane is barged to the island from the mainland). However, quickly replacing all diesel generators with propane generators would be challenging and costly because of site limitations, the need for new off-site fuel storage capacity and fire protection requirements. Future or phased conversion of some diesel generators to propane may be a feasible option to further reduce NOx emissions.

FOSSIL-FUEL GENERATION

	Emissions-compliant diesel generators 2 units now 3 later	Emissions-compliant diesel engines 5 units now
Advantages	• Technology familiar to plant operators • Reuse of existing infrastructure • Moderate schedule for installation of 2 engines and deadline extension for remaining engines	• Technology familiar to plant operators • Reuse of existing infrastructure
Disadvantages	• Uncertainty that engines conforming to new emissions standards are commercially available • Requires multiple phases of generator installation	• Uncertainty that engines conforming to new emissions standards are commercially available • Aggressive schedule for installation by regulatory service date
Timing	Less than 2 years (for first phase)	Less than 2 years
Cost*	**$169M**	**$169M**

*Preliminary estimate rounded to nearest $M

Liquefied natural gas (LNG): LNG infrastructure would be more costly in comparison to diesel or propane because there is no LNG infrastructure on the island. Moreover, facilities could not likely be permitted and built in time to meet the first NOx reduction target deadline.

RENEWABLE ENERGY

Solar power paired with battery energy storage: Solar and energy storage at some penetration levels could offer a practical cost-effective option. Renewable energy and energy storage technologies are becoming more technologically advanced and economical over time and additional renewable and energy storage projects could be phased in as obstacles such as cost and footprint are reduced.

One challenge to high-penetration solar on Catalina is that some of the larger plots of land that are suitable for solar/ energy storage development are not near Avalon. While some amount of solar plus storage might be installed without significant distribution upgrades, high levels of solar could significantly increase distribution upgrade costs. (Upgrade costs were figured into this analysis.) Fully 88% of the land on the island is set aside for preservation and recreational opportunities, potentially limiting availability for solar development.

For all solar scenarios, power flow control, environmental permitting and further interconnection analysis would be required.

RENEWABLE ENERGY

	High-penetration renewables	
5% renewable hybrid: solar, energy storage, emissions-compliant diesel generators	**60% renewable hybrid:** solar, energy storage, emissions-compliant diesel generators	**100% renewables:** solar, energy storage, emissions-compliant diesel generators
Advantages		
• Reduced annual NOx emissions • No infrastructure upgrades • Familiar technology • Least-cost option • Steppingstone to potential wider deployment of renewable energy	• Reduced annual NOx emissions • Grid benefits from potential non-SCE solar projects in Two Harbors	• No annual NOx emissions • Grid benefits from potential non-SCE solar projects in Two Harbors
Disadvantages		
• Uncertainty around land availability • Requires compliant fossil-fuel generation to meet SCAQMD deadline	• Uncertainty around land availability • Environmental permitting depends on locations chosen • Site selection will affect results and costs of distribution line upgrades	• Uncertainty around land availability • Environmental permitting depends on locations chosen • Site selection will affect results and costs of distribution line upgrades
Timing		
~3 years	~8 years	~TBD
Cost*		
$168M	$243M	$458M

Solar panels at the USC Wrigley Institute for Environmental Studies, near Two Harbors. Credit: Karl Huggins/USC Dornsife

Solar/energy storage was further modeled at various penetration levels, including:

- **100% Solar/Energy Storage:** Going all-renewable today would require approximately 280 acres of land. Given the complexity of this land use, there is no timing estimate associated with this option. This option would also require a very large energy storage system and, like the other options, would require backup fossil-fuel generation equal to 100% of the load to meet SCE redundancy requirements. The fossil-fuel generation system could be permitted and built first, in order to meet SCAQMD deadlines.
- **60% Solar/Energy Storage:** With similar constraints as the 100% renewable option, 60% solar/energy storage is also an expensive option. And, as with other options, the fossil-fuel generation system could be permitted and built first, in order to meet SCAQMD deadlines.
- **5% Solar/Energy Storage:** This scenario was identified by the model used in the analysis as the least-cost option for generation on Catalina. It also has the advantage of being a steppingstone to potential wider deployment of renewable energy on the island. This option could potentially be permitted and built in under three years, could supplement the diesel generator strategy and could be extended out in future years to include an increased percentage of renewables — either the example 60% modeled in this analysis or a different threshold depending on actual costs.

Other renewable generation options: Additional renewables evaluated include wind turbines, wave power and other emerging technologies. Wind power was not found to be cost-effective on Catalina due to low wind speeds and high capital costs. Costs would have to be reduced by 75% to make this a viable option. Wave power is in earlier stages of technology readiness and does not currently appear cost-effective as a solar/energy storage alternative. It could be considered for a small-scale pilot project or future reevaluation as the technology develops and costs reduce.

UNDERSEA CABLE

Connecting Catalina Island's power supply with the mainland via an undersea cable was studied in 2004-2005. The current analysis is based on these previous studies that used a 35.5-mile route originating in Huntington Beach. The undersea cable would enable Catalina Island to be connected to the increasingly clean generation mix on the mainland. However, the cost of this project makes it one of the most expensive options.

UNDERSEA CABLE

35.5-mile undersea cable
clean-burning diesel backup

Advantages

- Could transport renewable energy from the mainland

Disadvantages

- Extensive environmental permitting
- Does not include redundant cabling
- Requires upgrades to the existing mainland/island substations and routing infrastructure
- Susceptible to extreme mechanical and environmental exposure or damage
- Repairs may be very costly or unavailable

Timing

~5 years

Cost*

$334M

*Preliminary estimate rounded to nearest $M

The undersea cable would require extensive permitting from 11 federal, state and local agencies, looking at the extent of environmental risks to underwater terrain, species and other resources, some of which might require mitigation measures. Permitting complexity is one of the factors leading to a project execution period of almost five years.

The cost includes the need for a backup emission-compliant, fossil-fuel generation system on Catalina to ensure power if the cable were to be damaged in an earthquake, accident or other failure. The backup system would have to be permitted and built in parallel, in order to meet SCAQMD deadlines. An alternate approach would be to build two undersea cables, but this would add to costs and would not meet SCAQMD deadlines.

ENERGY EFFICIENCY AND DEMAND RESPONSE

"Santa Catalina Island Repower Feasibility Study" also includes a preliminary analysis of opportunities to reduce the overall electric load on the island through energy efficiency and demand-response programs. (This part of the analysis was hampered by the global pandemic starting in March 2020.)

Early estimates suggest total electricity consumption could be reduced by approximately 21% via cost-effective investments in energy-efficiency improvements. However, this does not include many factors including inflation, revenue from customers and the value of peak load reduction.

While energy efficiency can reduce current electricity consumption, new development or other new electricity uses such as building, transportation or cruise ship electrification would increase total electric load over time.

SUMMARY

There are challenges to implementing any source of electricity generation on Catalina, given its remoteness from mainland infrastructure, environmental sensitivities, land ownership structure and higher cost factors for completing projects on the island. However, there is no "do-nothing" option available, as the current diesel generators meet neither SCAQMD nor SCE's clean air goals.

Among the options available are near-term solutions that will provide safe and reliable electricity while reducing overall emissions and allowing for future clean energy planning. As SCE moves to meet its Pathway 2045 vision, these options will allow flexibility to integrate more renewable sources of energy in the medium and long term.

For more information and to read "Santa Catalina Island Repower Feasibility Study," visit sce.com/catalinarepower

For more information on SCE's clean energy vision, visit edison.com/pathway2045

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