APPENDIX B

COST-BENEFIT STUDY

Los Angeles County Renewable Energy Ordinance (REO) Update Technical Study

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Prepared by:
Brian D. Healy
Stefan Unnasch

DISCLAIMER

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Life Cycle Associates, LLC performed this study under contract to Aspen Environmental Group. Negar Vahidi was the project manager.

Contact Information:

Stefan Unnasch
Life Cycle Associates, LLC
1.650.461.9048
unnasch@LifeCycleAssociates.com

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Terms and Abbreviations

ANL	Argonne National Laboratory
BESS	Battery Energy Storage System
BMS	Battery Management System
CARB	California Air Resources Board
CBA	Community Benefit Agreements
CEC	California Energy Commission
CHP	Combined Heat and Power
CI	Carbon Intensity
CSI	California Solar Initiative
DOE	U.S. Department of Energy
EIA	Energy Information Administration
EMS	Energy Management System
IRA	Inflation Reduction Act
ITC	Investment Tax Credit
LA	Los Angeles
LCFS	Low Carbon Fuel Standard
LCOE	Levelized Cost of Energy
MW	Megawatt
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
O&M	Operations and Maintenance
PCS	Power Conversion System
PPA	Power Purchase Agreement
PTC	Production Tax Credit
PV	Photovoltaic
REC	Renewable Energy Credit
RNG	Renewable Natural Gas
RPS	Renewables Portfolio Standard
SGIP	Self-Generation Incentive Program

1. Introduction

Renewable energy projects affect the local economy through the construction of the project, generation of energy, and ongoing maintenance and decommissioning activities. Economic impacts are associated with these activities as well as the displaced activity from conventional energy production and operation.

The economic impacts of renewable energy depend upon many factors including the technology, ownership entity type, scale, and other factors. To estimate these impacts, a Renewable Energy Database (RE Database) was developed to estimate the economic impacts to a range of renewable project types and ownership structures. The RE database calculates the following changes in economic activity associated with construction and operation within Los Angeles County (County):

- Economic output in the County
- Tax revenue to the County
- Employment in the County

Factors that affect the economic impacts from different renewable energy technologies include:

- Local or corporate ownership of project – affects use of funds from project revenues/energy savings
- Capital costs – affects construction spending and net revenue
- Energy/power output – affects net revenue
- Cost and source of displaced fossil energy – determines reductions in local spending
- Project-specific taxation rates and permitting fees – determines revenue to the County and affects net revenue to project developer

San Bernardino County Partnership for Renewable Energy & Conservation (SPARC Phase II) – REVEAL (Renewable Energy Value Evaluation and Augmentation Leadership) Initiative Report

In a prior San Bernardino County renewable energy cost-benefit study, the RE Database examined the economic costs and benefits of renewable energy projects and the impacts on San Bernardino County. Construction and operation costs as well as displaced fossil fuel generation savings combined with taxation rates and permitting requirement provide the basis for estimating local spending, changes in employment, as well as tax and permit fee revenue to San Bernardino County. The analysis was performed over a range of project power output capacities. The technologies examined include a range of photovoltaic, solar thermal, wind, and biomass projects. The costs and benefits to San Bernardino County were examined at four power generation capacities (less than 71 kW, 71 to 710 kW, 710 kW to 10 MW, and over 10 MW) with ownership structures that are consistent with scale.

The key observation from the RE Database for the REVEAL Initiative Report regarding economic activity, employment, and San Bernardino County revenue were the following:

- The local economic activity from renewable energy projects depends upon their life cycle cost and revenue generation or cost savings. Projects with local ownership generate the most local spending and jobs from operation because the funds are spent in the County. Large scale projects tend to create less local economic activity because the economies of scale reduce cost.

- Large-scale projects pay a much smaller share of permitting fees and sales tax per MW of power produced than smaller scale projects due to the structure of permit fees as well as economies of scale in power production. The County revenue from utility-scale projects on federal land can be as low as one-tenth of the revenue from a project on private land (i.e., county land).

- Policies that include an application fee and a public service fee for utility-scale projects would bring the taxes and fees per MW more in line with smaller scale projects. A policy to include a $/kW application fee for commercial and utility-scale projects as well as a 0.25% public service fee for greater than 10 MW projects would generate significant revenues for the County and the costs per MW would be comparable with those for smaller scale projects.

2. Renewable Energy Technology Market Analysis

Of the various renewable energy technologies, the following utility scale versions are examined in this study:

- Battery energy storage system (BESS)
- Photovoltaic (PV) Solar
- Utility Wind
- Green Hydrogen

The first three of these technologies are already in deployment throughout the State, and green hydrogen projects are in the planning and development stages within the State. In addition to these utility scale projects, smaller scale distributed generation is examined in this section.

2.1 Battery Energy Storage System (BESS)

Battery energy storage systems (BESS) are essential components for managing and storing electricity on a large scale. The systems provide grid stability and enable the integration of renewable energy sources at times that do not coincide with production. These systems are used to store electricity during times of low demand or when renewable energy production is high and then discharge it when demand is high or renewable generation decreases. Figure 1 shows a BESS facility co-located with a PV solar facility in San Bernardino County (Biss, 2024).

Figure 1. BESS Facility Co-Located with PV Solar Facility in California

To date, lithium-ion batteries have been the most commonly used technology in these systems due to their high energy density, efficiency, and lifespan. The core components of a commercial BESS include the battery cells, which store energy in chemical form, the Battery Management System (BMS), which ensures safe operation by monitoring the health and charge of the batteries, the Power Conversion System (PCS), which converts DC to AC electricity and vice versa, and the Energy Management System (EMS), which optimizes the system's operation to meet demand, price signals, and grid conditions. BESS facilities may be co-located with a renewable energy source such as solar or wind and include an interconnection component to access the grid.

Market Trends, Regulations, and Policies in California and the United States

California is the leader of battery energy storage deployment, driven by its renewable energy goals and commitment to reducing greenhouse gas emissions as shown in Figure 2 (EIA, 2024). Under SB 100, the state set a target to achieve 100% clean energy by 2045[1], making energy storage critical to its energy strategy. The State has established several mandates, such as the Energy Storage Mandate, which requires utilities to procure 1,325 MW of energy storage by 2020[2]. Programs like the Self-Generation Incentive Program (SGIP) offer financial incentives for businesses and residential customers to install energy storage systems[3].

[1] https://www.energy.ca.gov/sb100

[2] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/energy-storage

[3] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/self-generation-incentive-program

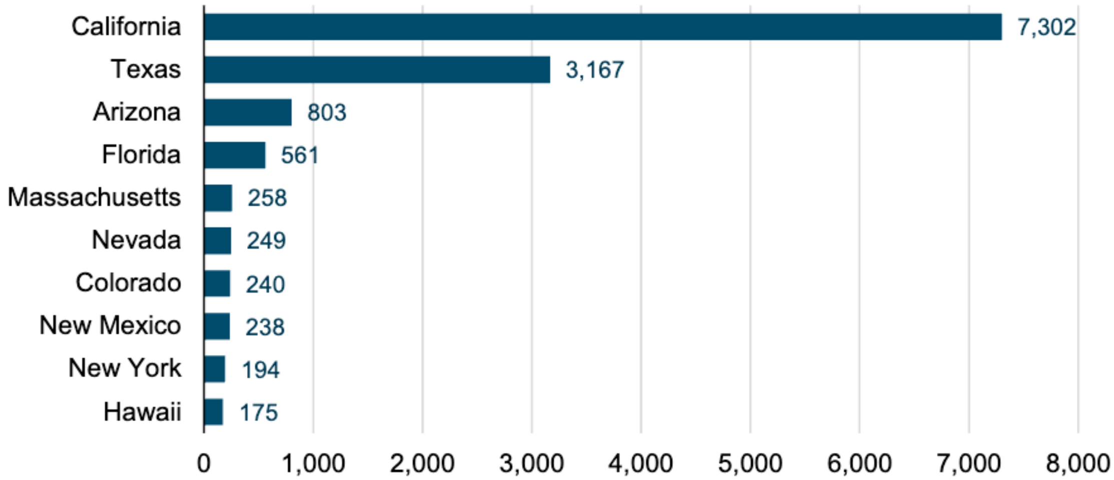

Figure 2. States Ranked by Installed Battery Capacity in Megawatts, November 2023

The adoption of BESS is expected to grow significantly in other states through 2050, as shown in Figure 3, supported by declining battery prices, grid modernization efforts, and increases in renewable energy projects (NREL, 2022). At the federal level, there has been a growing focus on energy storage as part of the broader push for renewable energy, with federal programs like the Investment Tax Credit (ITC) as a component of the Inflation Reduction Act (IRA), now the Clean Energy Investment Credit[4] for energy storage systems providing financial incentives. While adoption is strong in states like California, Texas, and Arizona, energy storage uptake in the broader United States is still expanding as new incentives and policies continue to emerge.

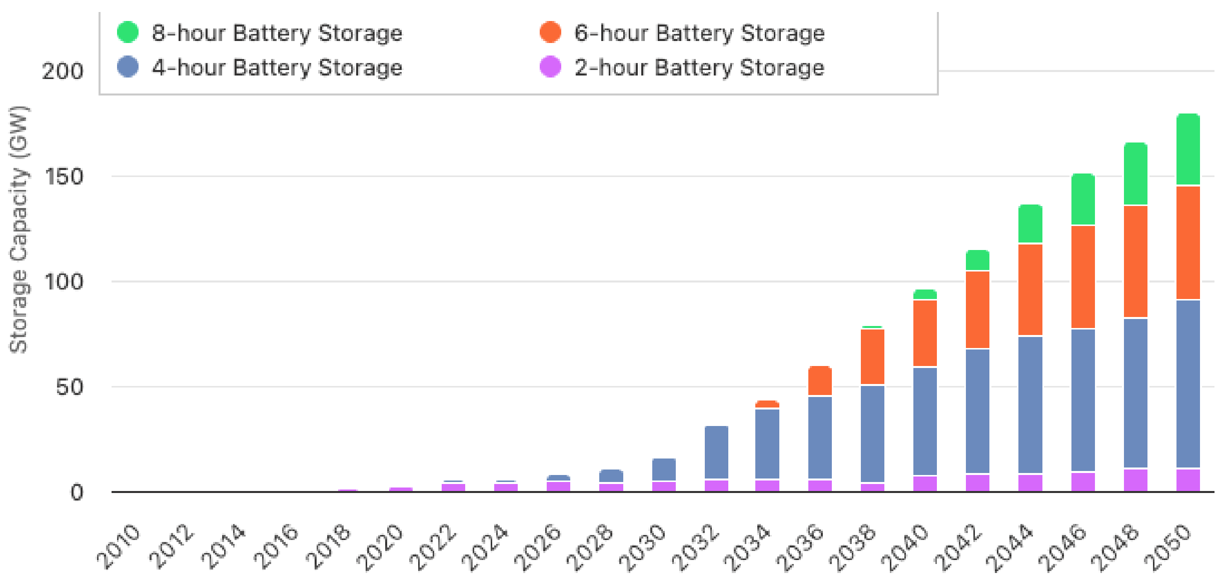

Figure 3. U.S. BESS Capacity Forecasted Growth Through 2050

[4] https://www.irs.gov/credits-deductions/clean-electricity-investment-credit

2.1 Utility Photovoltaic (PV) Solar

Utility-scale photovoltaic (PV) solar panel production facilities utilize photovoltaic technologies to convert sunlight directly into electricity, primarily using silicon-based solar cells[5]. The individual cells are assembled into solar panels, mounted on metal frames, and installed in large-scale solar power plants as shown in Figure 4 (Solar Power World, 2024).

Figure 4. Utility Scale PV Solar Project, Imperial County, California

The most common technologies used for manufacturing solar panels include crystalline silicon PV cells, which can be made as monocrystalline or polycrystalline types. Monocrystalline panels have higher efficiency but are more expensive when compared to polycrystalline panels[6]. Large-scale PV facilities require vast arrays of these panels, typically installed on fixed-tilt or tracking systems that follow the sun's path to maximize energy capture. Four to six acres are required for each MW of power produced from PV facilities[7].

[5] https://www.energy.gov/eere/solar/how-does-solar-work#pvbasics
[6] https://ases.org/monocrystalline-vs-polycrystalline-solar-panels/#:~:text=Compared%20to%20their%20efficiency%2C%20polycrystalline,resulting%20in%20less%20production%20costs.
[7] https://www.powertechenergy.com.au/a/how-much-land-do-i-need-to-build-a-5-mw-solar-farm

Market Trends for PV Solar in California and the United States

The market for utility-scale PV solar in California and the United States is experiencing rapid growth. California is a leader in solar energy adoption, owing to its ambitious clean energy goals and natural resource endowments that support the 100% clean energy goals by 2045. Across the United States, solar generation accounted for 3% of energy production in 2020 and is projected to account for 20% of electricity production by 2050 as shown in Figure 5 (EIA, 2021).

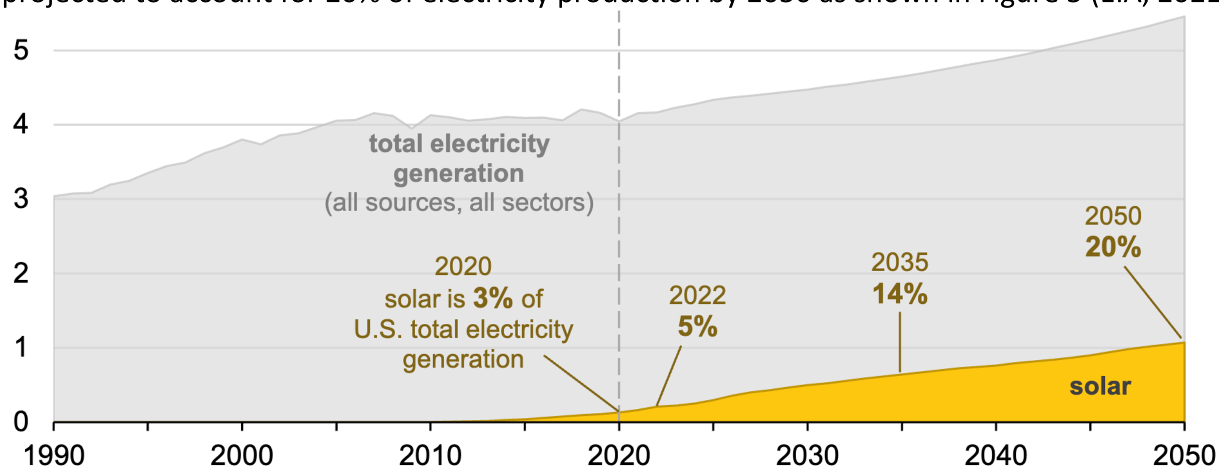

Figure 5. Annual U.S. Electricity Net Generation from All Sources, 1990-2050

Ongoing demand for utility-scale PV solar is driven by policies and the increasing cost competitiveness of solar, especially in declining costs of panels and advances in solar technology (EIA, 2022). The cost to install PV solar has dropped by nearly 40% over the last decade, as shown in Figure 6, making PV solar competitive with all other forms of generation (SEIA, 2024). The low cost of solar energy, driven by declining production costs and economies of scale, has made PV solar increasingly attractive for utilities. The trend is further supported by the increased usage of BESS systems, as discussed in the previous section, supporting the full capture of energy produced from PV systems.

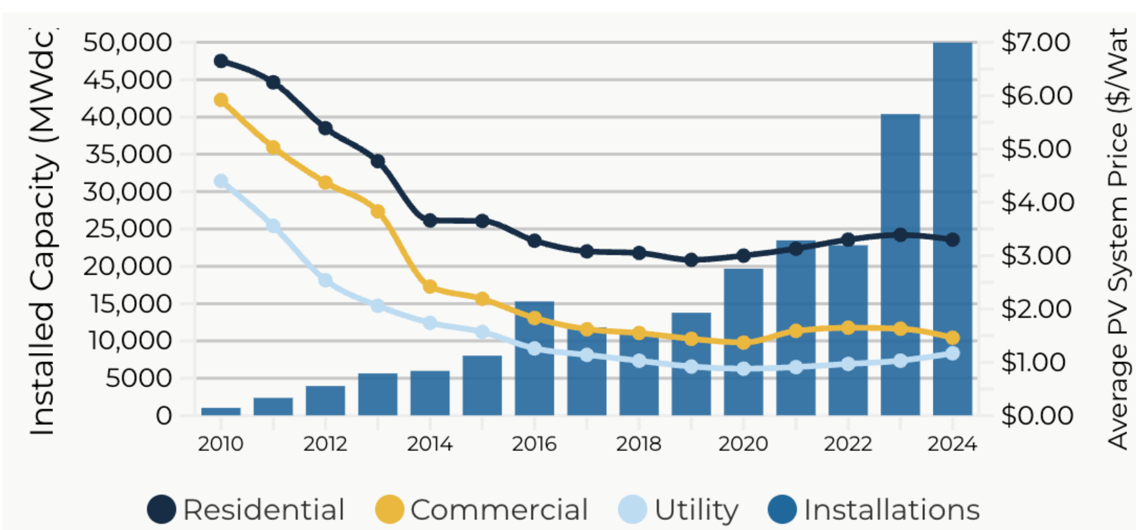

Figure 6. U.S. Solar PV Pricing Trends and Deployment Growth, 2010-2024

Regulations, Policies, and Funding Supporting the Uptake of PV Solar

A wide range of regulations and policies at both the state and federal levels have supported the growth of utility-scale PV solar projects. In California, the Renewables Portfolio Standard (RPS)[8] requires utilities to procure a growing percentage of their electricity from renewable sources, leading to 100% renewable procurement by 2045. Utilities can meet the requirements through their own production of renewable energy as well as through the purchase of Renewable Energy Credits (RECs) as the infrastructure is built out. Power purchase agreements (PPAs) are long term contracts that guarantee a fixed price for renewable power and include several projects in the County[9].

Federal incentives include the Investment Tax Credit (ITC), which reduces federal income tax liability for a percentage of installed cost, and the Production Tax Credit (PTC), which is a per kilowatt-hour tax credit for the first 10 years of a system's operation, as shown in Figure 7 (DOE, 2024). As of January 2025, program changes are ongoing for the IRA, which extended these two programs (EPA, 2025).

			Start of Construction						
			2006 to 2019	2020 to 2021	2022	2023 to 2033	The later of 2034 (or two years after applicable year[a])	The later of 2035 (or three years after applicable year[a])	The later of 2036 (or four years after applicable year[a])
ITC	Full rate (if project meets labor requirements[b])	Base Credit	30%	26%	30%	30%	22.5%	15%	0%
		Domestic Content Bonus				10%	7.5%	5%	0%
		Energy Community Bonus				10%	7.5%	5%	0%
	Base rate (if project does not meet labor requirements[b])	Base Credit	30%	26%	6%	6%	4.5%	3%	0%
		Domestic Content Bonus				2%	1.5%	1%	0%
		Energy Community Bonus				2%	1.5%	1%	0%
	Low-income bonus (1.8 GW/yr cap)	<5 MW projects in LMI communities or Indian land				10%	10%	10%	10%
		Qualified low-income residential building project/Qualified low-income economic benefit project				20%	20%	20%	20%
PTC for 10 years ($2022)	Full rate (if project meets labor requirements[b])	Base Credit			2.75 ¢	2.75 ¢	2.0 ¢	1.3 ¢	0.0 ¢
		Domestic Content Bonus				0.3 ¢	0.2 ¢	0.1 ¢	0.0 ¢
		Energy Community Bonus				0.3 ¢	0.2 ¢	0.1 ¢	0.0 ¢
	Base rate (if project does not meet labor requirements[b])	Base Credit			.55 ¢	0.55 ¢	0.4 ¢	0.3 ¢	0.0 ¢
		Domestic Content Bonus				0.1 ¢	0.0 ¢	0.0 ¢	0.0 ¢
		Energy Community Bonus				0.1 ¢	0.0 ¢	.01 ¢	0.0 ¢

Figure 7. Summary of Investment Tax Credit and Production Tax Credit Values Over Time

[8] https://www.energy.ca.gov/programs-and-topics/programs/renewables-portfolio-standard

[9] https://cal-cca.org/wp-content/uploads/2024/11/11.07.24-CCA-PPA-Spreadsheet.pdf

At the household level, the California Solar Initiative (CSI)[10], which has been succeeded by the Self-Generation Incentive Program (SGIP)[11], incentivizes the installation of solar systems through cash incentives and rebates, providing market signals to increase solar infrastructure investment. Other programs in California, like the Active Solar Energy System Exclusion, are in the form of exclusion of property value reassessment from new construction of solar and related component facilities[12]. The exclusion limits property tax increases from the installation of qualifying facilities.

2.2 Utility Wind

Utility-scale wind production facilities harness the power of wind to generate electricity through the use of large wind turbines, like those shown in Figure 8 (2022). The turbines consist of three primary components: the blades, the nacelle (which houses the generator and gearbox), and the tower. The kinetic energy of the wind turns the blades which are connected to a drive shaft that turn an electric generator, which produces electricity that is then transmitted to the grid[13].

Figure 8. Utility Scale Wind Turbines in Coachella Valley, California

The turbines used in utility-scale onshore wind farms are placed in areas with strong, consistent winds and installed in arrays to maximize electricity production. Technological advancements in

[10] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative

[11] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/self-generation-incentive-program

[12] https://www.boe.ca.gov/proptaxes/active-solar-energy-system.htm

[13] https://www.eia.gov/energyexplained/wind/electricity-generation-from-wind.php

wind turbine design, such as longer blades and higher towers, have significantly improved efficiency by allowing turbines to capture more wind at higher altitudes. Onshore wind turbines have an average capacity of 2.75 MW per unit, and operations can consist of dozens to hundreds of turbines (USGS, 2022). Energy generated by these facilities is delivered to the grid through underground or overhead transmission lines. Wind energy is a variable source of power, so it is often paired with energy storage systems like BESS, or integrated into a smart grid to balance its intermittency.

Market Trends for Onshore Wind Energy in California and the United States

The market for onshore wind energy in both California and the United States has grown significantly in recent years, driven by technological advancements, lower costs[14], and increasing demand for clean energy driven by policy. Figure 9 demonstrates how wind energy production has increased since 1990, nearing 10% of total U.S. energy production in 2022 (EIA, 2023).

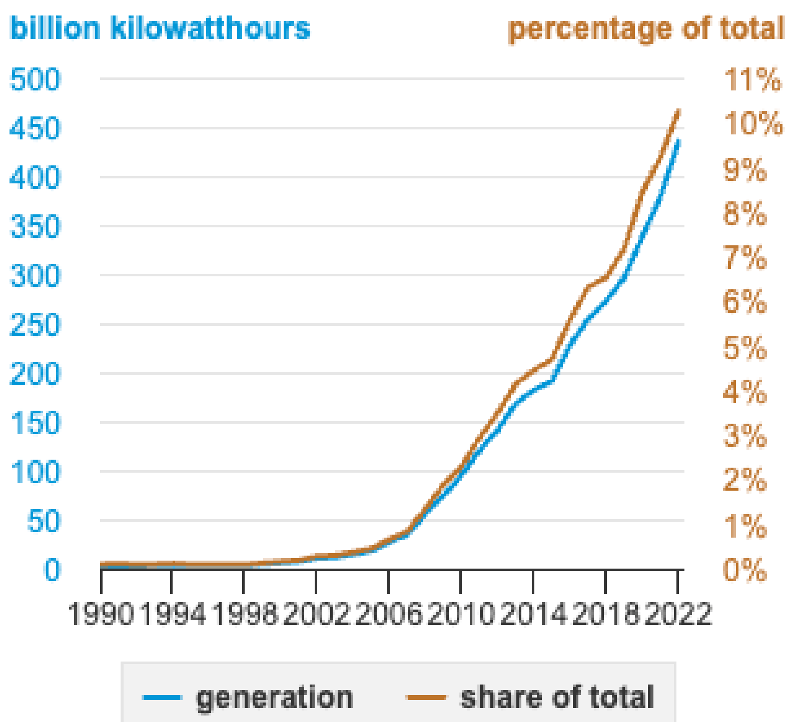

Figure 9. Wind Electricity Generation and Share of Total U.S. Electricity Generation, 1990-2022

Unlike PV solar, California is not the leader in utility scale wind energy production. Nationally, there has been growth in onshore wind capacity, especially in states like Texas, Iowa, Oklahoma, and Kansas, where wind resources are abundant, while California ranked eighth in national production (2024). The Levelized Cost of Energy (LCOE) for onshore wind has fallen

[14] https://www.eia.gov/energyexplained/renewable-sources/incentives.php

significantly since 2009 and is forecasted to continue falling through capital and operating expenses savings related to manufacturing and operational economies of scale (NREL, 2024).

Regulations, Policies, and Funding Supporting the Uptake of Onshore Wind Energy

Several regulations and policies at both the State and federal levels have played a pivotal role in supporting the uptake of onshore wind energy. In California, like with other renewable energy technologies, especially solar, the State's RPS mandates that utilities to procure a growing share of their energy from renewable sources, which has driven investments in onshore wind. The RECs produced by wind production in the state can be purchased by utilities to meet their obligations under the mandate.

At the federal level, the Production Tax Credit (PTC) is an incentive supporting the growth of onshore wind energy. The PTC provides a tax incentive for wind projects that start construction by a specific date, typically offering a significant per-kilowatt-hour tax credit for the electricity produced by wind turbines. The Investment Tax Credit (ITC) has also been applicable for certain wind projects (DOE, 2024). These are the same federal incentives supporting the solar industry.

2.3 Green Hydrogen

Green hydrogen is one of many variants of hydrogen production, as shown in Table 1, and is produced using renewable electricity sources such as solar, wind, or hydropower (IEA, 2019). The production process involves electrolysis, where electricity is used to split water (H_2O) into hydrogen (H_2) and oxygen (O_2)[15].

Table 1. Different Types of Hydrogen by Color Code

Color	Electricity Source	Process	Emissions	Cost per kg H_2
Green	Renewable electricity	Electrolysis	Potential for Zero GHG emissions	\$3 – \$7.5
Blue	Natural gas	Advanced gas reforming CCS	Low GHG emissions	\$1.5 – \$2.9
Grey	Natural gas	Steam methane reforming, no CCS	High GHG emissions	\$1 – \$2.1
Brown	Coal	Gasification, no CCS	Highest GHG emissions	\$1.2 – \$2.1

Given their power requirements, hydrogen production facilities may be co-located with a renewable energy resource such as PV solar or landfills that emit renewable natural gas (RNG), or the facility may be located away from the energy resource and the methane or electric power provided via the local utility. Therefore, hydrogen production facilities can deploy a variety of energy resources through contractual mechanisms. For example, a renewable

[15] https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis

hydrogen facility can operate on either solar wind or grid power, which the plant operator can modify to meet their operational requirements. The previous table highlights the various emissions from the different types of hydrogen production methods as well as cost per kilogram. Electrolysis from grid power has a particularly high carbon intensity, so it is unlikely that electrolysis systems would use any grid power, as this would have an adverse effect on California's Low Carbon Fuel Standard (LCFS) credit generation. However, natural gas-based steam reforming has a somewhat lower carbon intensity (CI) and, when coupled with the advantages of hydrogen fuel cells, this technology still results in reduced GHG emissions. When the feedstock is switched to biomethane, the carbon intensity drops significantly. Similarly, the carbon intensity for renewable hydrogen is zero which provides a favorable score under the LCFS.

Overview of Commercial-Scale Green Hydrogen Production Facilities and Technology

Commercial-scale green hydrogen production facilities produce hydrogen through electrolysis, using renewable electricity to split water into hydrogen and oxygen. Given these input requirements, green hydrogen production facilities require access to renewable energy, water, as well as storage and transportation infrastructure as shown in Figure 10 (S&P, 2021). Green hydrogen can be stored in gas or liquid form, and specialized pipelines, trucks, or ships are utilized to transport it to end users.

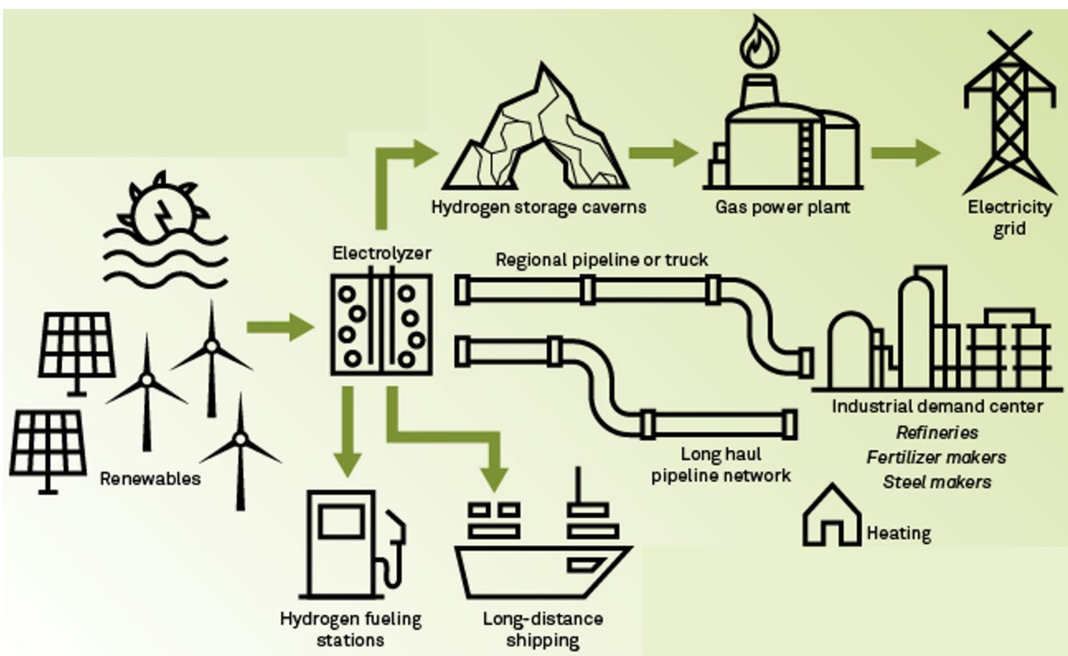

Figure 10. Green Hydrogen Production Process and Various End Uses

Market Trends for Green Hydrogen in California and the United States

California Senate Bill 1505 (SB 1505)[16], enacted in 2006, established regulations aimed at promoting the production and use of hydrogen fuel from renewable energy sources in the state. One of the key provisions of the bill is the requirement that hydrogen-powered vehicles fueled by hydrogen from state-funded fueling stations achieve well-to-wheel greenhouse gas emissions that are at least 30% lower than those of the average new gasoline vehicle in California. Additionally, SB 1505 mandates that at least 33.3% of hydrogen produced or dispensed by state-funded fueling stations must come from eligible renewable energy resources, as defined in the California Public Utilities Code, and shown outlined in green in Figure 11. Hydrogen fuel station operators have a further incentive to use 40% renewable feedstock to maximize their incentives under the California LCFS (CARB, 2023).

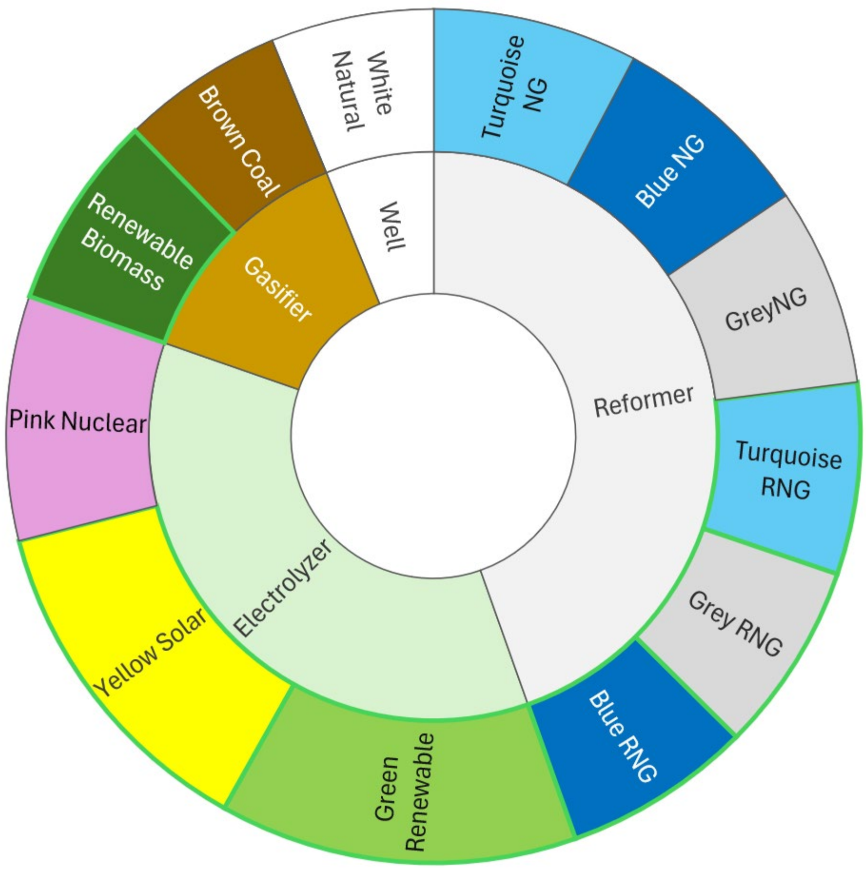

Figure 11. Hydrogen Types and Production Methods, Green Border Meets California SB 1505

Many types of hydrogen production methods could potentially be built in the Los Angeles area depending on methods of hydrogen production. Methods of hydrogen production are selected based on the cost of feedstock and production technology as well as incentives for low carbon

[16] http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_1501-1550/sb_1505_bill_20060930_chaptered.html#:~:text=The%20bill%20would%20require%20the,toxic%20air%20contaminant%20emissions%2C%20and

production. The previous figure highlights the primary production methods, which include water, electrolysis, reforming of methane or cracking of methane, or the gasification of solid materials (DOE, 2025). The feedstock determines whether the hydrogen qualifies as renewable in California, and the final determination for fueling projects is made by the California Air Resources Board (CARB) through the selection of a renewable fuel pathway code (CARB, 2020). CARB staff makes the determination whether the pathway is renewable based on the feedstock type and the requirements of SB1505.

Fuel cell vehicles are one of the end uses of hydrogen. Therefore, in order for uptake of the technology to be successful, fueling stations are required to deploy the hydrogen. Figure 12 shows the location of these stations throughout the state, with a heavy presence located in the County (CARB, 2025).

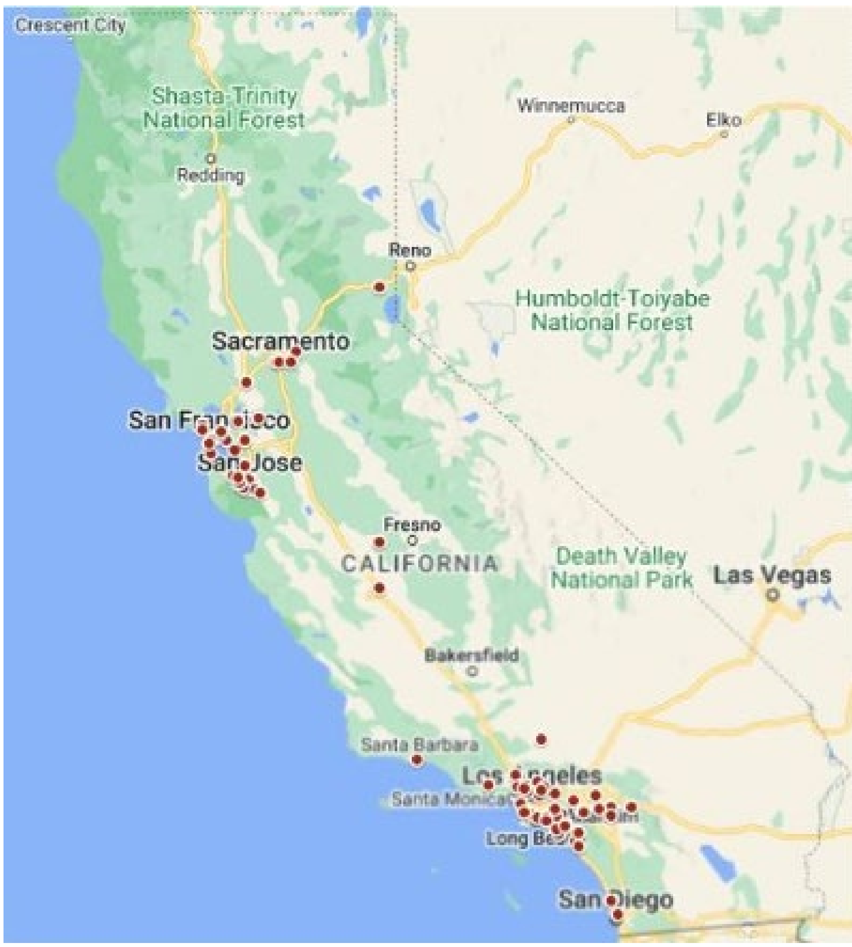

Figure 12. California Hydrogen Refueling Infrastructure Approved H_2 Refueling Stations

Regulations, Policies, and Funding Supporting Green Hydrogen Uptake

Several regulations and policies at both the State and federal levels support the uptake of green hydrogen. In California, CARB has set aggressive emission reduction targets supporting the uptake of low-carbon fuels under the LCFS[17]. The program provides financial incentives for the production of low-carbon hydrogen, including green hydrogen, by allowing producers to earn credits for reducing the carbon intensity of fuels. The California Hydrogen Action Plan[18] provides clear pathways for scaling hydrogen production and infrastructure, including incentives for green hydrogen production and the establishment of a hydrogen fueling network. At the federal level, The Clean Hydrogen Production Credit, established under the IRA of 2022, provides incentives to promote the production of clean hydrogen in the United States (IRS, 2025). It offers a tax credit for each kilogram of hydrogen produced, depending on its carbon intensity, with higher credits given to hydrogen with lower carbon emissions. The credit can range from $0.60 to $3.00 per kilogram, with the highest value awarded to hydrogen produced with near-zero emissions. The types of hydrogen that qualify for the credit are differentiated based on their carbon intensity, including green hydrogen, blue hydrogen, and turquoise hydrogen produced from methane pyrolysis. These categories of hydrogen are eligible for varying levels of the credit, with green hydrogen receiving the most favorable rate.

2.4 Distributed Generation

Distributed Generation refers to small-scale energy systems that generate electricity closer to where it is used, rather than large, centralized power plants (EPA, 2024). These systems are typically located on-site at homes, businesses, or industrial facilities, and include technologies such as solar panels, wind turbines, combined heat and power (CHP) systems, and fuel cells. In California and the United States, solar PV is the most common form of distributed generation, driven by cost reductions, small scale options, and supportive policies.

Distributed energy systems enable consumers to generate and store their own electricity, reducing their dependence on the grid. The national trend towards distributed generation is also growing in response to declining costs of renewable energy technology, including through homeowner incentives[19]. Distributed generation can be connected to the grid through various methods such as net metering, where excess electricity produced is fed back into the grid for credits, or through more advanced microgrid systems that operate independently from the main power grid in some cases.

Market and Economic Trends Relative to Distributed Generation

The market for distributed generation has been growing steadily in both California and the United States. The cost of renewable energy technologies, especially solar panels, has decreased dramatically over the past decade, making these systems more accessible to homeowners and businesses. In California, policies such as the California Solar Initiative (CSI) and the Self-Generation Incentive Program (SGIP) have driven the adoption of distributed generation, particularly solar energy. These initiatives offer financial incentives to residents and

[17] https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard
[18] https://www.energy.ca.gov/programs-and-topics/programs/clean-hydrogen-program#:~:text=The%20Clean%20Hydrogen%20Program%20is,environment%20%2D%20particularly%20in%20disadvantaged%20communities.
[19] https://www.irs.gov/credits-deductions/residential-clean-energy-credit

businesses to install solar systems. The introduction of Community Solar Programs and virtual net metering has expanded access to distributed generation to customers who may not have suitable rooftops or financial resources to install systems directly (CPUC, 2024). The trend is similar nationally, with distributed generation growth driven by various local incentives.

Economic & Labor Benefits to Local Communities

Distributed generation provides economic benefits to local communities through job creation and potential for long term energy cost savings at the household or business level. The installation, maintenance, and operation of renewable energy systems like home solar panels can create local jobs for periods that extend beyond the 12-18 months of a utility-scale build out. The growth of distributed generation in a local community can stimulate the local economy by creating demand for this skilled labor that may be less transient than workers for utility build out. This is in part due to installation within residential rather than rural, remote areas. Distributed generation enables residents and businesses to generate their own electricity, potentially reducing their energy bills over the long term. In California, homeowners with solar panels can take advantage of net metering, which allows them to earn credits for excess power fed back into the grid, helping to offset installation costs (CPUC, 2024). This reduction in energy costs can make a positive difference for households and increase disposable income in the community.

Various incentives, including the IRA, include provisions that require certain clean energy projects, such as those receiving tax credits, to pay prevailing wages and use apprenticeships, which are designed to benefit union labor (IBEW, 2024). These requirements ensure that workers on large-scale renewable energy projects are compensated fairly and that union jobs are prioritized. The act incentivizes projects to use union labor by offering higher tax credits for those built with a significant portion of unionized workers, promoting labor benefits in the renewable energy sector.

3. Opportunities and Challenges in LA County

There are many factors to consider for siting a renewable energy facility in the County given their unique hazard and safety concerns. Key factors include properly zoned land for the system and related electric infrastructure, proximity to renewable energy resources, population density, safety protocols, and environmental permitting requirements. Unincorporated Los Angeles County presents opportunities for the growth of various renewable energy production sources, in terms of available land area and need for energy resilience in rural areas. Utility-scale and distributed-generation systems could provide critical power to these areas, helping to stabilize the grid and improve energy reliability. As a part of California's overall push toward increasing use of renewable energy, large-scale storage systems are an integral part of capturing all renewable energy that is produced.

Unincorporated Los Angeles County holds growth potential for utility-scale PV solar energy, and the County as a whole already consumes a significant share of renewable energy[20]. The region benefits from its abundant sunshine, as shown in Figure 13, and proximity to existing energy infrastructure, making it an ideal location for solar projects (CEC, 2020).

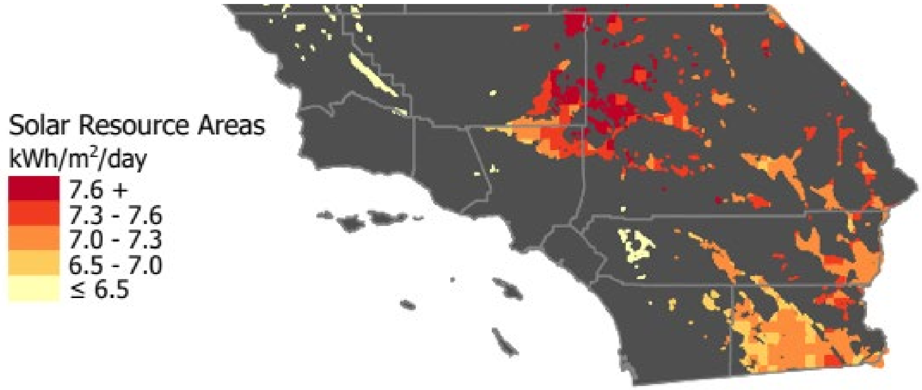

Figure 13. Southern California Solar Power Prospects

Zoning requirements and land use restrictions are potential challenges to realizing growth in BESS use in the County, as identified in the following sections. Projects within these unincorporated areas may require specific approvals for the installation of energy storage systems, particularly for projects that involve large battery arrays. Some remote areas may not be suitable for installing a BESS if there is no reasonable access to the existing grid infrastructure. Without reasonable access to grid infrastructure, increased project infrastructure and administration costs to meet regulatory and environmental compliance measures may become cost prohibitive. Additionally, the vast land requirements for PV solar and utility wind installations typically require contiguous tracts of land that may be cost prohibitive in certain parts of the County.

Other considerations for siting RE facilities include potential displacement of agricultural, residential, or other use development in portions of the County. For each new project permitted through the Opt-In program under AB 205, a developer is required to demonstrate that it provides net economic benefits[21] to the community. Fires at BESS facilities also require special attention, and California has had a number of public issues with BESS fires since 2022[22].

3.1 Project Siting Considerations

For each type of facility, production capacity has a significant impact on overall cost. Larger facilities may be able to offset higher costs related to land and infrastructure through efficiencies of scale. Facility size directly correlates with land area required to house the facility,

[20] https://www.ladwp.com/who-we-are/power-system/renewable-energy/renewable-energy-program?page=1
[21] https://www.energy.ca.gov/programs-and-topics/topics/power-plants/opt-certification-program
[22] https://www.orrick.com/en/Insights/2025/02/California-Battery-Fires-Mitigating-Commercial-Risks-in-BESS-Transactions#:~:text=The%20latest%20major%20fire%2C%20which,impact%20utility%2Dscale%20BESS%20development.

impacting location selection and price per acre of available land. In the case of both green hydrogen and BESS, both benefit in cost savings from proximity to existing pipeline or electric grid infrastructure. Proximity is a factor for both production inputs and for market offtake. Long distances from electric grid infrastructure can increase costs and raise the potential for new construction encountering ecologically sensitive regions.

Battery Energy Storage System (BESS)

Table 2 provides detailed descriptions of siting factors for BESS siting requirements, including inputs and considerations that are pros/cons for each siting requirement. The development of a BESS facility in Los Angeles County requires careful considerations that include securing adequate land for storage systems and infrastructure, proximity to renewable energy sources for charging, and access to the electric grid for discharging stored electricity. Additionally, safety protocols related to fire risks and environmental impacts must be addressed, particularly in relation to residential areas. The facility's location should also align with local zoning regulations and environmental assessments to streamline permitting and ensure long-term operability.

Table 2. Siting factors for a BESS facility

Siting Factors[a]	Description	Inputs	Considerations
Land Area	BESS, conversion units, auxiliary infrastructure	0.03-0.1 acres/MW[b]	Requires industrial zoning, urban zoning is costly
Renewable Electricity	Proximity or co-location with wind/solar power to charge system	Depends on facility capacity	Widely available, proximity impacts transmission line cost
Grid Connectivity[c]	Access to existing infrastructure for discharging electricity	Distance to substations, transmission lines, or integration	Connections and major infrastructure in place, potential grid congestion
Residential Proximity	Safety zone between facility and residential areas	Local code	Technical requirements, local community organizing
Permitting and Regulatory Compliance	Jurisdictional regulations for fire safety, electrical standards, environment, land use, emissions	Various agencies[d]	Regulatory frameworks in place, lengthy process
Environmental Impact	Ecosystem, air, water, wildlife impacts	Environmental impact assessment, risks	Established procedures, lengthy process

[a] https://www.energy.gov/femp/articles/lithium-ion-battery-storage-technical-specifications
[a] https://graham.umich.edu/media/files/BESS-guide.pdf
[c] https://www.nrel.gov/docs/fy19osti/74426.pdf
[d] https://www.energy.ca.gov/sites/default/files/2024-06/JA12_Qualification_Requirements_for_Battery_Storage_System_ada.pdf

Green Hydrogen Siting Requirements

Table 3 provides a detailed description of factors, inputs, and considerations that are pros/cons for green hydrogen siting requirements. Prioritizing locations with abundant renewable energy sources is essential for cost-effectiveness and maximizing tax credits under the IRA or LCFS.

Table 3. Siting factors for a green hydrogen production facility

Siting Factors	Description	Inputs	Considerations
Land Area	Process and ancillary, wastewater, utility access roads	5-7 acres/MW[a]	Requires contiguous industrial zoning, or zoning changes
Renewable Electricity	Wind/solar power for electrolyzers	45-55 kWh/kg H_2[b]	Widely available, proximity required to minimize loss
Water	Primary production input[c] and cooling	200L/h/MW, plus cooling[d]	High demand, cost structure dependent
Transport Infrastructure	Access to roads, ports and pipelines for distribution[e]	Onsite access and product distribution	Potential tie-in to new or existing pipelines
Residential Proximity	Safety zone between facility and residential areas	Local code	Highly flammable product, dense areas may not meet buffer requirements
Permitting and Regulatory Compliance	Jurisdictional regulations related to land use, emissions, safety	Various agencies	Regulatory frameworks in place, lengthy process
Environmental Impact	Ecosystem, air, water, wildlife impacts	Environmental impact assessment	Ecologically sensitive areas and local requirements lengthen siting

[a] https://www.nrel.gov/docs/fy23osti/83885.pdf
[b] https://www.iea.org/reports/the-future-of-hydrogen
[c] https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis
[d] https://www.eurowater.com/en/hydrogen-production#:~:text=FAQ%20%2D%20water%20treatment%20and%20hydrogen%20production&text=The%20amount%20varies%20depending%20on,not%20include%20water%20for%20cooling.&text=Water%20contains%20two%20atoms%20of%20hydrogen%20and%20one%20oxygen%20atom.
[e] https://www.energy.gov/eere/fuelcells/hydrogen-delivery

3.2 Impact on Local Labor in Los Angeles (LA) County

Across each utility-scale system, an economic impact is experienced over two unique periods: initial construction and ongoing operations and maintenance (O&M). Each of these project periods contributes direct, indirect, and induced benefits to the unincorporated portions of the

County. Further details about these specific contributions are found in Section 4. With further uptake of these systems, direct jobs in construction, installation, and O&M will grow, particularly as the State and federal governments expand renewable energy investment. For the local communities of the County, these new opportunities have the potential to reduce income inequality and stimulate local economic activity. Direct benefits at the local level may also be in the form of Community Benefit Agreements (CBAs). As part of a CBA, a project developer coordinates direct payments with local community organizations as a measure of additional, direct support to organizations, which may have benefits such as support of labor training to participate in future development projects (CEC, 2024).

The expansion of BESS in the region may encourage further investment in renewable energy technologies, fostering a positive feedback loop of local job creation in areas like solar and wind power. Each facility requires onsite O&M support to maintain peak operating capacity. As the technology advances, more skilled labor will be required, which could lead to an increase in training programs and certification opportunities in energy storage systems that support ongoing county initiatives (LACCSO). Training programs may be supported by CBAs, as well as vocational education. The installation of new utility-scale systems in the County is likely to generate growth of additional economic benefits in the form of revenue from tax incentives, property taxes, and further infrastructure development associated with the installation of these systems.

Potential negative economic externalities associated with the rapid deployment of these systems include the significant land requirements, potentially displacing agricultural use or affecting the aesthetic value of certain areas, which could lead to local opposition or land use conflicts. Bird strikes do occur at wind farms[23] at varying rates; therefore, those impacts must be factored into the broader environmental impact assessment of the project. Other externalities to consider that are not local to the facility are the extraction methods for the source materials[24] and local manufacturing processes and labor standards within the supply chain because many of the renewable technology systems components are not produced domestically (DOE, 2022).

Renewable Energy Production and Carbon Neutrality

Carbon neutrality refers to the state in which the net carbon emissions released into the atmosphere are reduced to zero, typically through a combination of reducing carbon emissions and offsetting any remaining emissions by activities like carbon capture or purchasing carbon credits. California's commitment to an equitable and just carbon neutrality transition is documented in 2018's Executive Order B-55-18[25]. The goal is to transition away from fossil fuels and towards renewable energy sources such as wind, solar, and systems that support their uptake, while ensuring that any remaining emissions are effectively managed or neutralized.

[23] https://www1.eere.energy.gov/wind/pdfs/birds_and_bats_fact_sheet.pdf
[24] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions
[25] https://archive.gov.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf

BESS and other renewable energy systems play an integral role in facilitating California's 2045 carbon neutral transition. The systems generate and store excess energy generated during periods of high renewable output and discharge it when renewable generation is low or when grid demand peaks, smoothing the variability of renewable generation. BESS also reduces the reliance on fossil fuels for backup power, which in turn lowers greenhouse gas emissions. Forecasted cost reductions in BESS system components will support uptake in the future, ensuring access to an equitable and just transition of the technology. Figure 14 projects the cost reductions for the battery components of various sized systems through 2050, demonstrating the steep curve of price reductions realized in the last decade (NREL, 2022).

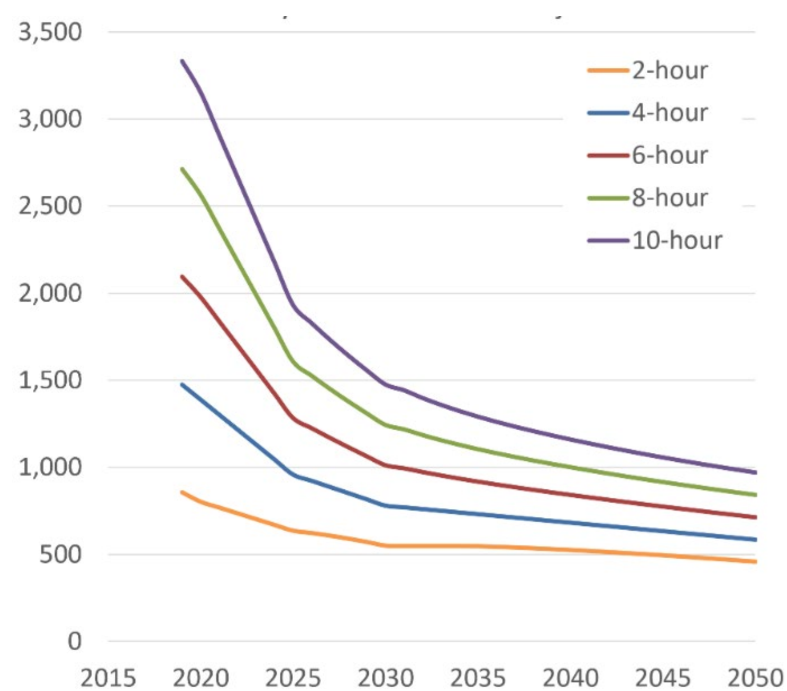

Figure 14. Utility-scale BESS Installed Capital Cost Projections on a 2018 $/kW basis, 2015-2050

Green hydrogen also supports achieving carbon neutrality goals, while relying on renewable energy for production. The benefits accrue in sectors where direct electrification is not feasible or cost-effective such as steel production, fertilizer production, as well as long-haul transportation, aviation, and maritime shipping. Green hydrogen can be used as a fuel or feedstock in these sectors, offering a zero-emission alternative to fossil fuels, which are otherwise difficult to decarbonize. Green hydrogen can serve as an energy storage solution[26], storing excess renewable energy generated during periods of low demand or high production and releasing it during peak demand periods. This ability to act as a form of long-term storage could increase grid reliability and help manage intermittency of renewable energy sources .

[26] https://www.energy.gov/eere/fuelcells/hydrogen-storage#:~:text=Hydrogen%20can%20be%20stored%20physically,pressure%20is%20%E2%88%92252.8%C2%B0C.

Green hydrogen could also be blended into existing natural gas infrastructure, allowing for the decarbonization of heating and electricity in various sectors.

3.3 Federal Trade and Energy Policy Impacts

Many components of renewable energy systems are imported into the U.S. and therefore subject to U.S. trade policy, including tariffs (IEA, 2023). Depending on the energy system, these components may be parts that are then manufactured into a finished product in the U.S. or are finished system components, ready to be installed upon arrival. Each component is subject to a tariff based on what it is and its country of origin. Recently, the Trump Administration announced a series of tariff rate increases (The White House, 2025). These increased tariff rates will have a direct impact on costs of the required components to build renewable energy facilities. While the values of the tariffs are not finalized, the following section describes how renewable energy systems are exposed to changes in tariffs.

Utility-scale BESS, is heavily reliant on imports where up to 90% of system components are sourced from abroad, primarily from China (Energy Storage News, 2025). These include lithium-ion battery cells, inverters, and advanced control systems. Similar to BESS, the PV solar industry also relies heavily on imported products including solar panels, assemble modules, and raw materials. In addition to the blanket tariffs announced on April 2nd, major solar exporting countries are now subject to even higher tariffs, specific to solar components, citing injury to U.S. domestic producers (PV Magazine, 2025). Onshore wind energy, also faces the threat of tariff rate increases for key components (DOE, 2022). Figure 15 showcases the import value and country of origin for various onshore wind facility components (NREL, 2023).

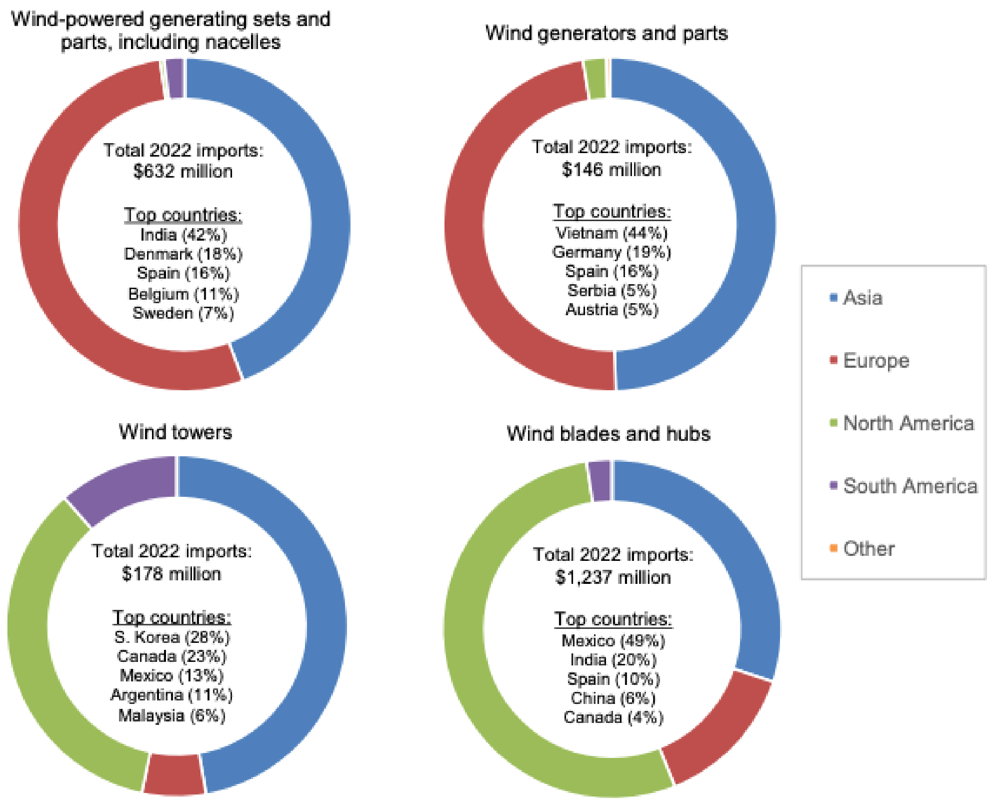

Figure 15. Origins of U.S. Imports of Selected Wind Turbine Equipment, 2022

Changes to federal policies will impact the incentive stack that project developers may use to offset increases to tariffs or to be viable in the market more generally. Changes in federal policies such as the Investment Tax Credit (ITC), Production Tax Credit (PTC), and the Inflation Reduction Act (IRA) would impact the viability of BESS, PV solar, and utility-scale wind in California by impacting project economics, investor confidence, and supply chain development. A reduction or rollback of the ITC or PTC would increase capital costs and slow deployment, particularly for solar and wind projects, while weakening the IRA's clean energy incentives could reduce domestic manufacturing momentum and stall grid-scale battery adoption. The outcome of these changes ranges from short term, higher costs, to long term manufacturing onshoring, or policy reversal under a different Administration where tariff rates are dropped.

4. Cost-Benefit Model For Los Angeles (LA) County

Renewable energy projects consist of many different technologies, four of which are examined in this study as shown in Table 4. The capacity for each technology corresponds to utility-scale projects.

Table 4. Renewable Technologies and Capacities Examined in LA County REO Study

Renewable Technology	Capacity
BESS Utility Scale Solar PV Utility Scale Wind Green Hydrogen	100 MW

Each renewable energy project has unique economic impacts within the County over the lifetime of the project. These impacts are accumulated during the permitting and construction phase of the project, as well as the ongoing operations and maintenance required to maintain peak facility operation. The direct impacts module captures these impacts, and economic multipliers are used to estimate the direct impacts of the corresponding renewable energy project in the County. The direct impacts module considers the number of projects, cost of inputs, and the net present value of the projects.

The RE Database combines direct impacts with indirect and induced economic multipliers and an estimate of the share of economic activity in the County. The location of economic activity is categorized in order to determine regional economic output and tax revenues. These impacts are reported on an aggregate basis with economic activity broken out by sector within the County. The results of the RE Model are not specific to the unincorporated portions of the County as they are highly disparate and some contain significant portions of Federally owned land, which impact the level of benefits accrued to a local community, such as property taxes. Results can be refined to more specific regions based on local population, portion of federal land, local municipality rates, or other factors, however, that granularity is beyond the scope of this analysis.

The direct impacts module is combined with macroeconomic multipliers from Input/Output models including JEDI[27] and IMPLAN[28] to determine the indirect and induced impacts. Direct impacts are the economic activities occurring at the renewable energy project or displaced fossil energy production. Examples of direct impacts include purchase of capital equipment and maintenance. Indirect impacts occur in other sectors of the economy that experience changes in output as a result of renewable energy production. Induced impacts occur as the direct and

[27] JEDI (Jobs and Economic Development Impact) models estimate the economic impacts of constructing and operating power generation at the local and state levels. Based on project-specific or default inputs (derived from industry norms), JEDI estimates the number of jobs and economic impacts to a local area that could reasonably be supported by a power generation project.

[28] IMPLAN is commonly used in the industry to perform basic input/output economic modeling, and can provide geographic specificity at the county, regional, state, and national levels.

indirect expenditures trigger a chain reaction of spending through the economy. Any of these impacts may occur within or outside of the County.

With the total economic output, the RE Database identifies key economic indicators including local tax revenue, consumer savings, LA County sales tax and permitting fees, and employment. These metrics are compared with a base case to assess the fiscal and economic impacts of renewable energy projects.

Analysis Scope

The costs and benefits of renewable energy projects were evaluated for the technology and capacity options shown in Table 4. For each configuration, the RE Database calculates:

- Capital costs
- Tax credits
- Operating costs
- LA County tax income and permitting fees

Approach

Costs, cost savings, and revenues are calculated over the life of a project. The RE Database provides the basis to evaluate the economic costs and benefits of renewable energy projects in the County. The goal of the RE Database is to examine the following:

- The costs and benefits of existing and future renewable energy development to the County government with potential policy initiatives;
- Comparisons of the net lifetime costs and benefits utility-scale renewable energy; and
- Evaluation of economic metrics including local expenditures, employment, and revenue to the County.

The costs for each renewable energy technology, which are presented in 2024 Dollars ($2024), are examined on a life cycle basis as shown in Table 5. These costs are then grouped according to economic sectors where the in-County economic activity as well as indirect and induced effects are calculated.

Table 5. Cost factors for renewable energy (BESS example)

Cost Factor	Year 1
Capital Cost ($2024)	
Modules	$74,504,597
Other Hardware	$17,476,387
Total Installed	$91,980,984
Federal Tax Credit	$27,594,295
Net Cap Cost	$64,386,689
Operating Cost	$1,197,585
Operating Cost Net Present Value (NPV)	$28,658,150
Generation, MWh	794,094
Power Purchase Agreement (PPA) Payments	$23,822,820
NPV PPA Payments	$352,707,659
Net Costs	$41,761,453
Cumulative Net Costs	$41,761,453
NPV of Investment	$230,280,499
Revenue to County (permit fees)	$294,300
Revenue to County (sales tax)	$4,207,700
Operating Revenue to County	$24,880,321

Table 6 details the various economic sector categories for the cost factors associated with renewable power at net present value (NPV). The economic value is localized to the County through percentage estimates of local share of each sector to derive the County-level economic benefit.

Table 6. Economic sectors for cost factors associated with renewable energy

Economic Sector	Activity NPV	Activity in LA County %	Activity in LA County $
Plant Investment Hardware	$100,770,610	50%	$50,385,305
Plant Installation	$10,966,592	100%	$10,966,592
Fleet Investment	$0	0%	$0
Processing Materials	$0	0%	$0
Maintenance	$102,898,828	100%	$102,898,828
Feedstock Collection	$0	0%	$0
Feedstock Transport	$0	0%	$0
Plant Earnings	$441,096,625	30%	$132,328,987
Household Savings	$0	100%	$0
Government Revenue	$2,371,576	100%	$2,371,576
Utility Generation	-$406,867,262	47.8%	-$194,482,551
Total			**$104,468,737**

These localized results are combined with economic multipliers and in-County activity factors as illustrated in Table 7. Economic multipliers[29] are used to estimate the impact of a change in economic activity, such as the installation of a renewable energy facility, on the overall economy. The multipliers quantify the impacts of spending in one sector across other impacted sectors of the local economy, through multipliers of stimulated demand. Each unique multiplier is applied to the activity sector to estimate the direct, indirect, and induced impacts of the new renewable energy project for the local community.

These multipliers are based on previous California Energy Commission (CEC) renewable energy databases and derived from the IMPLAN model. The economic multipliers generate the total output, employment, personal income, and value added from a new project.

[29] https://support.implan.com/hc/en-us/articles/18944332362523-Economic-Effects-Multipliers

Table 7. Macroeconomic multipliers for direct, indirect, and induced impacts

Economic Activity	Macroeconomic Multipliers		
	Direct	Indirect	Induced
Plant Hardware less taxes	1.00	0.35	0.38
Plant Installation	1.00	0.35	0.38
Fleet Investment	1.00	0.35	0.38
Processing Materials	1.00	0.35	0.38
Maintenance	1.00	0.35	0.38
Feedstock Collection	1.00	0.35	0.38
Feedstock Transport	1.00	0.35	0.38
Plant Earnings	1.00	0.35	0.38
Community Expenditure	1.00	0.35	0.38
Government Revenue	1.00	0.35	0.38
Sales tax on non-Construction	1.00	1.00	1.00
Utility Generation	1.00	0.35	0.38

4.1 Quantification of Direct Costs

The following section examines the methodology for quantification of direct costs for BESS, utility-scale PV solar, utility scale wind, and green hydrogen.

General Methodology

The general methodology to quantify economic impacts relies on inputs of installed cost, incentives, operating costs, and revenue streams from avoided power purchases or power sales. These values are calculated on a $/MW basis so that facilities of various sizes can be estimated. While there are improvements of cost efficiency that are realized at scale, these estimates are meant to encompass the utility market. The NPV of the projects are estimated over a 35-year lifetime as applied to all costs and revenues using a discount rate of five percent. Once categorized within the respective economic sector, these values are localized to the County, and the economic benefits are derived through the multipliers.

Battery Energy Storage System (BESS)

For economic benefit analysis for BESS projects, publicly available data from ongoing CEC projects are used to create an industry average. Table 8 includes the various categories for capacity, system efficiency, and $/MW of various system components and operations. The projects highlighted in Table 8 include Compass Energy Storage Project, Corby Battery Energy Storage System Project, and Darden Clean Energy Project.

Table 8. Summary of utility-scale BESS projects and average inputs in $2024

Category	Compass[a]	Corby[b]	Darden[c]	Average
Capacity(MW)	400	300	1,150	-
Efficiency	87.30%	-	94.00%	90.65%
Degradation	1.27%	-	-	1.27%
System Total ($/MW)	$750,000	$1,283,333	$726,096	$919,810
Hardware ($/MW)	$607,500	$1,039,500	$588,138	$745,046
Installation ($/MW)	$142,500	$243,833	$137,958	$174,764
Operation & Maintenance (O&M)	$5,000	$29,667	$1,261	$11,976

[a] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=24-OPT-02; Data Request Response 4_Attachment 1_Economics Technical Memorandum
[b] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=24-OPT-05; Corby BESS Opt-in Application Volume 1 Part 3
[c] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=23-OPT-02; Darden Clean Energy

For the RE Model, the costs and other input values were averaged across the three projects as an average as shown in Table 9. The federal tax credit is 30% and assumes each project meets the prevailing wage and labor requirements of the regulation. NPV operating costs are subject to a 2.5% escalation factor over the 35-year lifetime of each project. Depending on the operator of the facility, more comprehensive maintenance at ten-year increments may occur to switch out battery units to maintain a certain facility capacity factor. These incremental upgrades increase O&M costs, which raises NPV of operating costs, and are required to generate system profits. BESS systems typically store energy at peak production, coinciding with the lowest energy prices, $50/MWh, and can sell back to the grid at peak demand at $110/MWh. The NPV of the power purchase agreement is the difference between those values (i.e., $60/MWh). For a 100MW facility, the NPV is $4.4 million.

Table 9. Summary of utility-scale BESS costs and project NPV for 100 MW facility

Category	BESS Average
Capital Cost	
Hardware	$74,504,597
Installation Costs	$17,476,387
Total Installed Cost	$91,980,984
Federal Tax Credit	$27,594,295
NPV of Operating Costs	$32,027,592
NPV of PPA	$130,158,757
Project NPV	$4,362,155

Utility-Scale PV Solar

Table 10 shows the average costs in 2024 Dollars ($2024) associated with fixed and single tracking PV solar facilities at utility scale. The values are derived from Solar Reviews[30], Coldwell Solar[31], and National Renewable Energy Laboratory (NREL)[32] and are based on a 100 MW facility. The table compares fixed panels with single axis tracking panels that can adjust to optimize electricity production. Tracking panels are slightly more expensive on the front end as well as in maintenance cost but offset by greater production capacity.

Table 10. Summary of utility-scale fixed and single tracking PV solar costs in $2024

Category	Fixed	Single Tracking
Capital Cost ($/MW)	$921,238	$1,070,803
Modules ($/MW)	$239,541	$343,100
Other Hardware ($/MW)	$295,402	$327,420
Soft costs[33] ($/MW)	$386,295	$400,283
O&M ($/MW-yr)	$23,000	$29,900
O&M Escalation	2.50%	2.50%
Capacity Factor	22%	31%
Degradation (%/yr)	0.4%	0.4%
PPA, $/MWh	$50	$50
Annual Discount Rate	5%	5%

Table 11 summarizes the direct project economics for a 100 MW utility-scale PV solar facility with a 30% tax credit. Capital and operating costs are higher for the tracking system but yield a 3.8x increase in NPV of investment.

Table 11. Summary of utility-scale fixed and single tracking PV solar costs in $2024

Category	Fixed	Single Tracking
Capital Cost ($2024)		
Modules	$23,954,081	$34,309,953
Other Hardware	$29,540,210	$32,742,025
Soft costs	$38,629,506	$40,028,278
Total Installed	$92,123,797	$107,080,255
Federal Tax Credit	$27,637,139	$32,124,077
Net Cap Cost	$64,486,658	$74,956,179
Operating Cost NPV	$55,038,908	$71,550,581

[30] https://www.solarreviews.com/blog/how-does-utility-scale-solar-work#:~:text=the%20electricity%20generated-,The%20cost%20of%20building%20a%20utility%2Dscale%20solar%20system,of%20solar%20projects%20by%2030%25.
[31] https://coldwellsolar.com/commercial-solar-blog/how-much-investment-do-you-need-for-a-solar-farm/#:~:text=How%20Much%20Does%20it%20Cost,electricity%20derived%20from%20fossil%20fuels.
[32] https://www.nrel.gov/docs/fy23osti/87303.pdf
[33] Soft costs for utility-scale PV solar refer to non-hardware expenses that include costs associated with permitting, financing, installation labor, interconnection, legal fees, project management, and overhead.

NPV PPA Payments	$131,537,339	$185,348,069
NPV of Investment	$9,417,044	$35,827,112

Utility-Scale Wind

There are several recent cost estimates for utility-scale wind generation from the Energy Information Administration (EIA)[34] and NREL[35]. Table 12 summarizes the costs, O&M, and other inputs for a utility-scale wind facility of 1-100 MW in $2024. The PPA price for wind is typically between the BESS and solar rates. This is based on the variability of production of wind throughout the day relative to more peak, midday timing of solar energy production. With BESS, energy is already stored so facilities are designed to optimize sales around peak market demand, which coincides with peak prices[36]. Based on these production factors, the wind PPA is set at 65 $/MWh.

Table 12. Summary of utility-scale wind costs and project NPV for 1-100 MW facilities

Category	Utility Wind
Capital Cost ($/MW)	$1,140,979
Hardware ($/MW)	$1,031,313
Soft costs ($/MW)	$109,666
O&M ($/MW-yr)	$43,000
O&M Escalation	2.50%
Capacity Factor	46.8%
Degradation (%/yr)	1.0%
PPA, $/MWh	$65.0
Annual Discount Rate	5%

Table 13 summarizes the direct project economics for a 100 MW utility-scale wind facility with a 30% tax credit. The degradation factor impacts energy output; however, it is not modeled with 10-year upgrades like the BESS scenario.

Table 13. Summary of utility-scale wind costs and project NPV for 100 MW facility

Category	Utility Wind
Capital Cost ($2024)	
Hard Costs	$103,131,283
Soft costs	$10,966,592
Total Installed	$114,097,875
Federal Tax Credit	$34,229,363
Net Cap Cost	$79,868,513

[34]https://www.eia.gov/todayinenergy/detail.php?id=63485#:~:text=The%20cost%20for%20wind%20farms,in%202022%2C%20up%201.4%25.
[35] https://www.nrel.gov/docs/fy25osti/91775.pdf
[36] https://www.utilitydive.com/news/ppa-power-purchase-prices-wind-solar-levelten-ascend-analytics/730245/#:~:text=Renewable%20PPA%20prices%20continue%20to%20rise%20%E2%80%94,so%20through%202030%2C%20say%20LevelTen%2C%20Ascend%20analysts.&text=North%20America%20hasn't%20seen%20those%20kinds%20of,as%20of%20the%20third%20quarter%20of%202024.

Operating Cost NPV	$102,898,828
NPV PPA Payments	$406,867,262
NPV of Investment	$224,059,702

Green Hydrogen

Building a green hydrogen plant includes several key cost components as shown in Table 14. The primary hardware cost is for the electrolyzer used to split water into hydrogen and oxygen. As with other renewable energy projects, there are also ongoing operational and maintenance costs for the hydrogen production facility. Grid connection and energy storage solutions may also incur costs, particularly if the plant operates in areas with intermittent energy supply. Regulatory compliance and project development expenses contribute to the total cost of building and running of the facility.

Table 14. Cost summary of 100 MW green hydrogen facility[37]

Category	Green H_2
Capital Cost ($/MW)	$2,000,000
Hardware ($/MW)	$1,600,000
Soft costs ($/MW)	$400,000
O&M ($/MW-yr)	$40,000
O&M Escalation	2.50%
Capacity Factor	51.0%
Degradation (%/yr)	1.5%
Power Purchase Agreement (PPA), $/MT	$6,000
Annual Discount Rate	5%

Table 15 summarizes the direct project economics for a 100 MW utility-scale green hydrogen facility with a 30% tax credit. The capacity factor includes 100% renewable energy from co-located wind and solar as well as on-site BESS. No overhaul is assumed over the lifetime of the facility.

Table 15. Summary of utility-scale green hydrogen and project NPV for 100 MW facility

Category	Green H_2
Capital Cost ($2024)	
Hard Costs	$160,000,000
Soft costs	$40,000,000
Total Installed	$200,000,000
Federal Tax Credit	$60,000,000
Net Cap Cost	$140,000,000
Operating Cost NPV	$95,719,840

[37] https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/24005-clean-hydrogen-production-cost-pem-electrolyzer.pdf

NPV PPA Payments	$773,520,189
NPV of Investment	$537,760,129

4.2 Economic Results

From these various outputs, the RE Model applies economic multipliers to generate County level results for each of the various renewable technologies. These benefits are demonstrated through new jobs and County revenues through permitting and taxation. Overall economic benefits accrue to the County as well through indirect and induced benefits. Each facility type has a direct cost of nearly $1 million per megawatt in direct construction costs, which contribute to permitting and sales and use tax revenues. Ongoing operations and maintenance costs incur $11,000-$34,000 per megawatt each year.

Table 16. Local economic impact on LA County of utility-scale renewable energy projects

Economic Intensity (per MW)	BESS	Utility PV Solar, Fixed	Utility PV Solar, Single Tracking	Utility Wind	Green Hydrogen
Construction					
Total Employment	32.8	44.2	56.3	86.6	119.2
Indirect and Induced Employment	1.0	4.1	4.5	5.3	10.2
Total Local Spending	$86,701	$351,101	$378,830	$447,869	$862,713
County Revenue (Benefits)					
Taxes to County	$42,077	$2,303	$2,677	$23,205	$36,000
Fees	$2,943	$2,807	$3,263	$402	$402
City Sales Tax	$0	$20,728	$24,093	$23,205	$36,000
Total County Revenue	$45,020	$25,838	$30,033	$46,811	$72,402
Operation					
Total Employment	24.3	29.6	39.1	64.1	87.0
Indirect and Induced Employment	6.6	6.8	8.8	12.6	13.1
Total Local Spending	$1,533,275	$1,431,487	$1,773,649	$1,924,736	$710,820
County Revenue (Benefits)					
Taxes	$27,735	$4,683	$5,500	$40,791	$62,799
Fees	$0	$0	$0	$0	$0
Other	$0	$0	$0	$0	$0
Total County Revenue	$27,735	$4,683	$5,500	$40,791	$62,799
Total County Revenue (Benefits)/MW	**$72,755**	**$9,793**	**$11,440**	**$64,398**	**$99,201**
Direct Costs					
Construction Cost ($/MW)	$919,810	$921,238	$1,070,803	$1,140,979	$921,238
Operation Cost ($/MW/y)	$10,530	$18,095	$23,523	$33,830	$31,469.5

5. CONCLUSION

The evaluation of a range of utility-scale renewable energy projects demonstrates positive economic benefits to the County. Large-scale utility projects result in economic activity from construction and ongoing maintenance of the facilities. While equipment such as PV panels, inverters, electrolyzers, and other specialty items may be manufactured outside of the County, it is possible for the County to capture some of the benefits through sales taxation if purchases are made using a local address. This purchasing structure can support the project developer in making a case that the facility contributes to a net positive economic impact for the local community as required by Assembly Bill 205[38] for projects that go through the Opt-In application process with the CEC.

Additionally, other components of construction such as structures, concrete work, and other components of the capital investment can originate in the County, furthering local economic benefits. During the construction phase, additional labor is also required, creating additional direct, indirect, and induced benefits to the County. Further direct County benefits include permit fee generation and sales tax revenues that vary depending on the location of the project.

[38] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB205

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