CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

Energy Storage: The Next Major Job Creation Opportunity

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Executive Summary

The transition to a clean energy grid represents a massive job-creation opportunity for the United States. Given recent investments in a wide set of renewable generation assets, it is reasonable to expect that the procurement of storage technologies will grow in parallel, as these resource enable further renewable integration and increased reliability.

In this white paper, the California Energy Storage Alliance (CESA) analyzes energy storage employment and procurement data from California in order to approximate the number of jobs investment in this set of technologies has created. To do so, CESA relies on survey data collected from its member companies and a thorough compilation of storage procurement data derived from publicly-available documents. Using this data, CESA found the following:

- CESA estimates that recent and current energy storage project procurement, deployment, and operational activity has supported 20,510 jobs in California, of which:
    - CESA calculates that the energy storage industry in California has created or stimulated approximately 18,410 jobs associated with projects procured, in development, or operational over the last ten years.
    - CESA calculates that the SGIP program has supported an additional 2,100 jobs related to SGIP-incentivized energy storage projects from 2009-2020.
- New California energy storage investments and project development over the next ten years may support between 98,460 to 113,190 jobs.

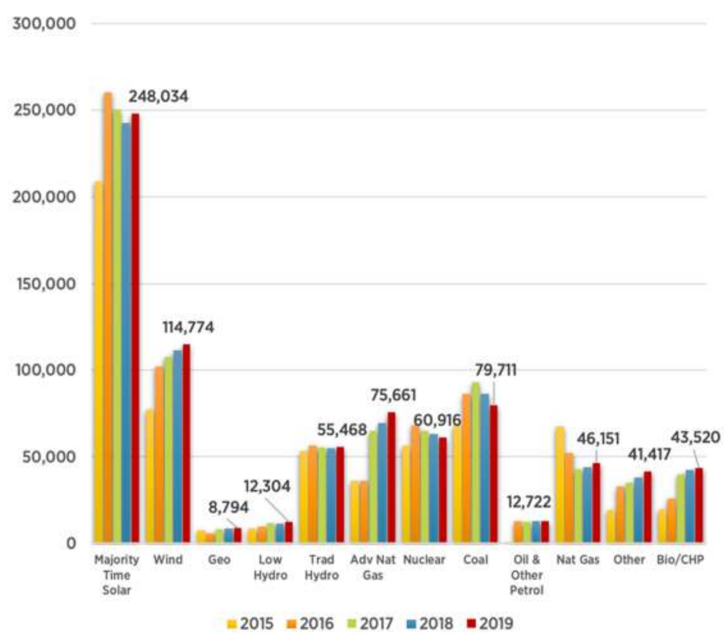
CESA's results are generally consistent with other benchmarked estimates and one that is bound to grow given the expected rise in energy storage procurement in light of the state's energy and environmental goals.

CESA considers that job creation related to the development of a cleaner electrical grid is an area of study that merits further detailed study. In this sense, CESA believes that these estimates could be significantly enhanced by better understanding the labor requirements associated with each step of the deployment process as well as the differences between the wide array of storage technologies being developed and deployed in the future.

Introduction

Clean energy jobs represent the next big job-creation opportunity in the United States. Multiple reports have shown that the clean energy economy has generated the highest growth rate in employment, and represents a sizable share of employment in the electricity sector. These trends are expected to continue as clean energy resources become a larger part of the electricity generation mix. As these clean generation resources grow, the need for energy storage resources logically also grows, creating another job creation opportunity for this asset class around its supply chain.

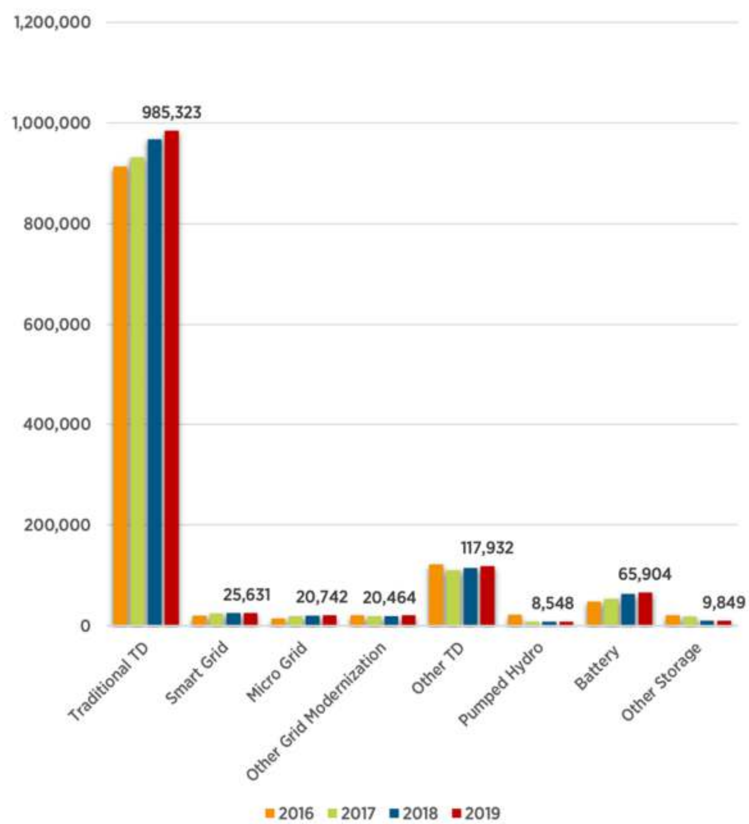
Figure 1: Electric Power Generation Employment by Technology, 2015-2019



Source: DOE Energy & Employment Report, January 2020.

The literature around clean and advanced energy jobs are growing as regular employment surveys are being conducted by AEE Institute, the U.S. Department of Energy (DOE), The Solar Foundation, and the B&W Research Partnership on behalf of public agencies. These sources are also increasingly reporting on the job figures of energy storage. In 2020, the DOE released the *2016-2020 Five-Year Trends Report*, a document that details the evolution of employment data over the aforementioned years. In this report, the DOE notes that employment growth in the Transmission, Distribution, and Storage (TDS) sector has grown significantly due to the deployment of new renewable resources, investment in grid modernization tools and infrastructure, the introduction of smart technologies, and a rising demand for energy storage.[1] This report highlights that TDS added the second-most jobs from 2015 to 2019, with more than 156,000 new jobs, or nearly 13% growth, such that 1.38 million Americans currently work in this sector.[2] Considering that most of these jobs relate to the expansion of the electrical grid, a majority of the new jobs created in TDS from 2016 to 2019, 74,200, were in construction.[3] It is worth noting that, within this sector, battery storage has experienced strong growth since 2016, adding 18,300 new jobs, or 38% growth, for a total of 65,900 workers in 2019.[4] These figure, added to the rest of storage technologies, signals that energy storage is linked with about 84,301 jobs.

Figure 2: Employment by Transmission, Distribution, and Storage Sub-Technologies, 2015-2019



Source: DOE Energy & Employment Report, January 2020.

[1] *U.S. Energy and Employment Report 2020: 2016-2020 Five-Year Trends*, Prepared by the National Association of State Energy Officials and BW Research for the Department of Energy, January 2020. https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5e780f28e8ff44374c2db945/1584926525529/USEER+2020+5year.pdf

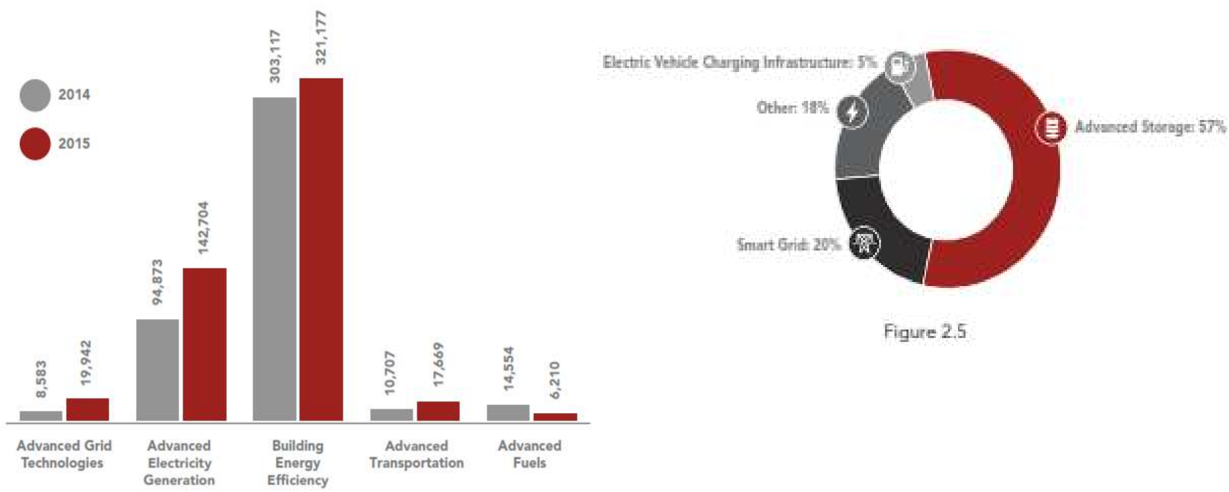
[2] *Ibid*.

[3] *Ibid*.

[4] *Ibid*.

For California, the latest publicly available report comes from AEE Institute, which reported 19,942 jobs in 2015 in advanced grid technologies, which includes energy storage, up from 8,583 jobs in 2014. Energy storage represents a significant share (57%) of the jobs reported in the "Advanced Grid" sector, which amounts to just over 11,000 jobs in 2015.[5]

Figure 3: Employment by Transmission, Distribution, and Storage Sub-Technologies, Q2 2015 to Q1 2016



Source: Advanced Energy Jobs in California, 2016.

Another, more recent, source on energy storage-related employment in California comes from the DOE's *2020 Energy and Employment Report*. In its California section, the DOE reports that by 2019, 18,571 people were employed by the energy storage sector.[6]

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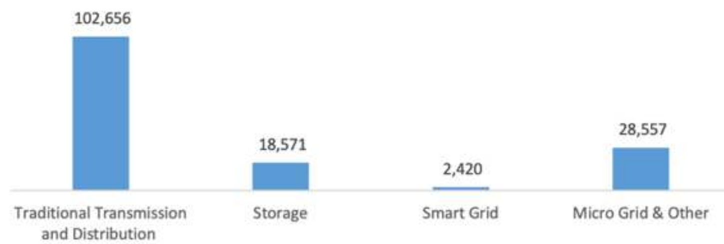
[5] *Advanced Energy Jobs in California: Results of the 2016 California Advanced Energy Employment Survey*, prepared by BW Research Partnership for AEE Institute. http://info.aee.net/hubfs/PDF/california-jobs-report-2016.pdf.

[6] *U.S. Energy and Employment Report 2020: California*, Prepared by the National Association of State Energy Officials and BW Research for the Department of Energy, January 2020.
https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5e78132228dc473dd321543a/1584927525795/California-2020.pdf

Figure 4: Employment by Transmission, Distribution, and Storage Sub-Technologies in California, 2019



Source: CA Report within the DOE Energy & Employment Report, January 2020.

Other work that has been done on measuring the level of employment from the energy storage sector includes state-specific studies and surveys conducted on behalf of Vermont, Rhode Island, and Massachusetts.[7]

Rather than just measuring the current level of energy storage related employment in a state, several organizations have used socioeconomic modeling to assess the impact of battery manufacturing cluster development in the state. The American Jobs Initiative predicted that up to 17,000 jobs in North Carolina could be supported annually through 2030 by building up the cluster around Alevo's manufacturing presence,[8] while Applied Economics estimated around 23,000 jobs created from the Tesla 'Gigafactory' in Nevada.[9] These types of studies are usually conducted on behalf of economic development agencies and support industry cluster development efforts, including justification for incentivizing specific companies to come to their state.

The Solar Foundation takes yet a different approach to measuring current and forecasting future employment for solar-plus-storage projects. Using a combination of its annual *National Solar Jobs Census* data and energy storage deployment data, The Solar Foundation projects 27,000 new solar-plus-storage jobs by 2021. These jobs include associated installation support jobs, but exclude related manufacturing, sales, and distribution jobs.

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[7] *Vermont Clean Energy 2016 Industry Report*, prepared by BW Research Partnership for Vermont Clean Energy Development Fund, May 2016. http://www.revermont.org/wp-content/uploads/VCEIR-2016-Final.pdf
Rhode Island Clean Energy 2016 Industry Report, prepared by BW Research Partnership for Rhode Island Office of Energy Resources.
http://www.energy.ri.gov/documents/News/Rhode%20Island%20Industry%20Report%202016.pdf
2016 Massachusetts Clean Energy Industry Report, prepared by BW Research Partnership for Massachusetts Clean Energy Center.
http://files.masscec.com/2016%20MassCEC_IndustryReport_Full_Web.pdf
[8] *North Carolina 2016*, American Jobs Project, April 2016. http://americanjobsproject.us/wp-content/uploads/2016/04/NC-Full-report-update-4.13.pdf
[9] *Summary of Economic Impact Analysis and Impact Review*, prepared by Applied Economics for Nevada Governor's Office of Economic Development.
http://www.diversifynevada.com/documents/Full_Tesla_Summary_Report_Analysis_Letters.pdf

In conclusion, the current trends in energy storage job growth according to available data today are promising. Each year, the industry appears to be growing at a rapid pace in terms of megawatt deployments and associated job growth. However, despite the emerging data on energy storage related employment, there is still a dearth of energy storage specific jobs in general and literature on how energy storage projects can potentially drive further employment. Most energy storage and other clean energy job reports gauge the level of current employment using advanced surveys along with official labor statistics using the North American Industry Classification System (NAICS), while others take a narrower lens, such as by looking at solar-plus storage projects or assessing impacts of specific economic development strategies. It is not clear from the current literature how deployments of 'x' amount of megawatts of energy storage drive 'y' amount of employment – information that will be helpful for legislators and policymakers in shaping policy related to energy storage and clean energy.

In this paper, CESA therefore proposes to administer its own survey and cross-reference it with administrative data from the Self-Generation Incentive Program, publicly available procurement announcements and compliance reports compiled into CESA's own Energy Storage Procurement Tracker, and forecasts of planned and policy needs as identified in the California Public Utilities Commission (CPUC) Integrated Resource Planning (IRP) models through 2030 and 2045. The goal of this paper is to provide a preliminary assessment of the jobs supported by current and future energy storage projects, with a focus on California. Specifically, the goal will be to estimate how deployments of 'x' amount of megawatts of energy storage can drive 'y' amount of employment.

Methodology

As discussed, there has been a growing number of energy storage and clean energy jobs reports, which includes the U.S. Department of Energy's *2017 U.S. Energy and Employment Report (USEER)*, AEE Institute's *California Advanced Energy Employment Survey*, and The Solar Foundation's *National Solar Jobs Census 2016*. After reviewing these reports, CESA found several overarching methodological trends, which have informed the development of CESA's methodology in conducting its own survey and energy storage jobs impact analysis.

First, many of the state-level reports for California, Massachusetts, Vermont, and Rhode Island were completed using BW Research Partnership's *Energy Employment Index (EEI)* and the Bureau of Labor Statistics' *Quarterly Census of Employment and Wages (QCEW)*. BW Research Partnership administered an extensive survey through approximately 300,000 phone calls and 50,000 emails to participants throughout the U.S. about their involvement in the energy economy and their time dedicated to energy business. Their survey sample followed a stratified sampling plan representative of different NAICS codes, establishment size, and geography, and was then split into two categories – the 'known' and 'unknown' universes. The known universe includes establishments that have already been identified as energy-related; the unknown universe includes businesses in potentially energy-related NAICS codes. BW Research Partnership established their definition of "energy jobs" and explicitly mentioned what industries and job titles they were looking for and excluding (*e.g.*, survey excluded any employment in retail trade NAICS codes or a qualifying energy worker is an employee whose activities are less than 50% of their time). The survey results then extrapolated based on the QCEW dataset to arrive at its final employment figures.

Second, the AJI and Applied Economics take a socioeconomic modeling approach using tools such as Jobs and Economic Development Impact (JEDI) and Impacts for Planning (IMPLAN). These models incorporate input-output relationships to estimate the economic impact of 'a dollar invested' into a sector and the resulting multiplier effects across the economy to measure the direct, indirect, and induced jobs.

Finally, The Solar Foundation deduces its solar-plus-storage jobs number based on its jobs census data for the solar industry combined with energy storage megawatt deployments to date. While its solar jobs census uses both self-administered survey data as well as socioeconomic modeling, The Solar Foundation makes critical assumptions to convert its solar labor efficiency figure (measured in solar jobs per megawatt) to get an energy storage jobs number. Their methodology assumes energy storage deployments require 25% of the time that it takes to install solar given the same size work crew. With a converted energy storage jobs per megawatt figure for the utility-scale, non-residential, and residential sectors, The Solar Foundation then looks at current and future energy storage deployments measured in megawatts and using GTM Research's *U.S. Energy Storage Monitor* to estimate the 2015 and 2021 jobs for solar-plus-storage applications.

Upon review a wide range of reports and their methodologies, given the goals of this paper and the limited resources, CESA does not plan to take the extensive sampling and data-matching approach taken by BW Research Partnership. Meanwhile, socioeconomic modeling as done by AJI and Applied Economics are less applicable here due to the goals of this paper to measure demand-driven employment as induced by energy storage project deployment.

Instead, CESA takes a slightly different approach and adopts a modified version of the approach taken by The Solar Foundation. Rather than setting assumptions to convert solar labor efficiency with energy storage labor efficiency, CESA collects project-specific employment data directly from its members to estimate the number and types of jobs involved in developing, installing, and maintaining an energy storage project. CESA requested that member companies complete the survey more than one time to provide information for different types of projects in their portfolio. The type of information requested in the survey includes:

- Project name
- Survey respondent's role in the supply chain
- Point of interconnection (behind-the-meter, in-front-of-the-meter)
- Customer sector (residential, commercial, industrial, public)
- Location (address, city, state, zip code)
- Rated energy storage capacity and, if applicable, paired solar capacity (kW, kWh)
- Number of employees or contractors who worked or continue to work on the project
    - Manufacturing
    - Engineering and design
    - Finance, business, and other professional services

- Sales and marketing (customer acquisition)
- Installation
- Permitting, inspection, and interconnection
- Maintenance, operations, and repair
- Distribution, transport, and other logistics

CESA defines "jobs" in this survey to include employees or contractors who devote less than 50% of their time to the project. This definition assumes employees or contractors may work on multiple projects (not just one) and be employed to work on non-storage projects (*e.g.*, solar, wind, interconnection in general), does not differentiate between permanent versus temporary jobs, and does not capture all of the non-project-specific "indirect" job impacts. This approach and definition were intended for simplicity for member companies.

With the project capacity information and the number of employees or contractors who worked on a specific project, CESA will be able to directly obtain information on the number of energy storage jobs associated with a megawatt or kilowatt deployment of energy storage at different points around the meter and in different customer sectors. This labor efficiency number can then be used to extrapolate energy storage jobs associated with current and future projected energy storage deployments. This methodology expands upon the work done by The Solar Foundation by avoiding assumptions for the solar-to-storage labor efficiency conversion and broadens the energy storage jobs figures to all types of energy storage projects, not just solar-plus-storage applications.

There are many types of analyses that CESA can conduct using this primary dataset. In further reviewing the literature and publicly available data on labor and wages, CESA may also be able to disaggregate the data into permanent versus temporary jobs and ascertain the wage/economic impact associated with a given project. Furthermore, with location information, CESA will be able to attribute current and future energy storage project deployments to specific legislative districts and counties.

CESA understands that there are limitations to this methodology that requires further vetting and refinement to better reflect project-specific impacts, measure permanent versus temporary jobs, and identify the incremental jobs created by any given project. In future papers, CESA will work to address some of these limitations. A broader and more comprehensive survey effort will also be needed in the future to ensure a more robust survey population that better reflects the general energy storage industry while also capturing and identifying potential drivers of differences among energy storage technologies, project types, projects sizes, etc.

Results

CESA conducted a preliminary member survey and found that approximately 10 jobs are supported per megawatt of energy storage deployed (CESA 2017 Jobs Survey). Seventeen companies completed the survey.

The data from CESA's preliminary employment survey lends itself to be used in conjunction with CESA's *Energy Storage Procurement Tracker* in order to estimate the overall employment derived from recent energy storage procurement and deployments. This tracker presents procurement information that has been compiled from publicly available sources in order to estimate the current state of the energy storage market in California, focusing on storage assets that have been procured since 2010. Given its focus, CESA's procurement tracker omits certain storage assets in the state. For example, CESA is aware that pumped hydro storage plants such as Helms and Castaic are not captured in the tracker. This has been done in order to estimate recent incremental storage investments. The figures below summarize the current state of the storage market in California and represents the same data by technology.

Figure 5: Energy Storage Procured in California by Status, 2010-2020

Energy storage procurement by status (MW)	
Status	**Contract MW**
Online	287.45
In development	1553.54

Source: CESA Energy Storage Procurement Tracker, April 2020.

Figure 6: Energy Storage Procured in California by Technology, 2010-2020

Energy storage capacity procurement by technology type (MW)	
Technology	**Contract MW**
Li-ion battery	1717.51
Pumped hydro storage	40.00
Zn-air battery	10.00
NaS battery	7.00
LiFePO4 battery	2.00
VRF flow battery	2.00
Flow battery	0.50
Flywheel	0.01
Metal halide battery	0.00

Source: CESA Energy Storage Procurement Tracker, April 2020.

CESA has gathered these data by meticulously reviewing documents issued by the California Public Utilities Commission (CPUC), energy storage developers, and buyers of equipment such as the investor owned utilities (IOUs) and other load serving entities (LSEs). It is worth noting that due to the disaggregated nature of procurement reporting in the State, this data set is limited by the availability of complete information.

Using the employment estimation derived from the CESA 2017 Jobs Survey and the procurement data from CESA's *Energy Storage Procurement Tracker*, ***CESA calculates that the energy storage industry in California has created or stimulated approximately 18,410 jobs associated with projects procured, in development, or operational over the last ten years***. It is worth noting that these figures are consistent with the data reported by California for the DOE's

2020 Energy and Employment Report, which estimates 18,571 people are employed in the energy storage sub-sector within California, as shown in Figure 4 above.

CESA's *Energy Storage Procurement Tracker* is not inclusive of behind-the-meter (BTM), customer-sited energy storage projects installed and deployed using SGIP incentive funds.[10] Based on SGIP data of around 210 MW of BTM energy storage projects that are installed and operational as of April 2020, ***CESA calculates that the SGIP program has supported an additional 2,100 jobs related to SGIP-incentivized energy storage projects***.

In sum, ***CESA estimates that recent and current energy storage project procurement, deployment, and operational activity has supported 20,510 jobs in California***.

Figure 7: SGIP Energy Storage Installed in California, 2009-2020

SGIP energy storage procurement by PA (MW)	
PA	**Installed MW**
Center for Sustainable Energy	37.10
Pacific Gas and Electric	62.20
SoCalGas	11.86
Southern California Edison	98.90

Source: SGIP Weekly Statewide Report, April 2020.

If the relationship between jobs created and MW of energy storage procured and deployed is accurate, the California energy storage sector may see significant growth through 2030. In an integrated system modeling and resource planning process at the CPUC, state regulators identified 8,873 MW in battery storage and 973 MW in long-duration storage to meet "base-case" policy- and reliability-driven new resource needs through 2030. Altogether, California needs 9,846 MW of new and incremental storage buildout. In a more aggressive scenario, the IRP process identified the need for 9,714 MW of battery storage and 1,605 MW of long-duration storage, totaling 11,319 MW of new and incremental storage needed through 2030.[11]

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[10] Projects claiming SGIP incentive funds are typically not considered "incremental" and thus are not eligible for supply-side solicitations from California's load-serving entities. As a result, this is separately tracked from CESA's Energy Storage Procurement Tracker using weekly reports available at selfgenca.com.

[11] *2019-2020 Electric Resource Portfolios to Inform Integrated Resource Plans and Transmission Planning* (D.20-03-028) issued on April 6, 2020.
http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772681.PDF

Figure 8: New Resource Buildout of CPUC 2019-2020 Reference System Portfolio

Resource Type	2020	2021	2022	2023	2024	2026	2030
Wind	-	34	1,950	1,950	2,737	2,737	2,837
Wind on New Out-of-State Transmission	-	-	-	-	-	-	606
Utility-Scale Solar	2,000	4,000	6,000	8,000	8,000	8,000	11,017
Battery Storage	152	2,453	2,453	2,453	3,299	6,127	8,873
Pumped (long-duration) Storage	-	-	-	-	-	973	973
Shed Demand Response	-	222	222	222	222	222	222
Natural Gas Capacity Not Retained	-	-	-	-	-	-	(30)

Source: Table 5 of CPUC Decision 20-03-028..

Given these results, ***the next ten years of California energy storage investments and project development may support between 98,460 to 113,190 jobs***.

Conclusion

In this white paper, CESA sought to show the massive job-creation opportunity energy storage investments represent for the US. By collecting empirical data on employment and procurement, CESA estimated a roughly linear relationship between procurement (in MW) and employment within the energy storage sector. Survey data compiled by CESA shows that a 10x multiplier per MW is an adequate methodological bypass (at this time) to calculate energy storage-related employment for California as it yields comparable results to those reported by the DOE. Such methodology results in approximately 20,510 jobs related to recent and current energy storage projects in California, which is roughly in line with benchmarked results reported in the DOE's *2020 Energy and Employment Report*.

Given this consistency and based on the information available to date, CESA believes it is adequate to use a 10x approximation to forecast job growth for future storage deployments. To this end, given the results of the CPUC's forecasted need for energy storage through 2030, California may see between 98,460 to 113,190 jobs created or supported that are tied to California's future energy storage investments and project development.

CESA is aware that jobs estimation for the energy storage industry merits further research. Particularly, CESA considers that the study of employment trends within the energy storage sector could benefit from better understanding of the labor requirements associated with each step of storage's deployment process. As previously mentioned, a majority of the jobs linked to energy storage deployment are related to construction; thus, understanding the pace of development would further our comprehension of the fluidity of employment in this sector.

Furthermore, increased clarity on the labor differences between the wide array of storage technologies being developed would enable more precise approximations for the future. Currently, the vast majority of energy storage in terms of installed capacity comes from pumped hydro plants while most recent procurements have been focused on lithium-ion battery technologies. As the investment in battery technologies rises, better estimations related to their relative labor intensities will enable more precise employment forecasts. Lastly, it is important to consider the differences related to the procurement of energy storage in-front-of-the-meter (IFOM) and BTM systems. Since several energy storage technologies can be deployed at different points of the electrical system, the labor required for their deployment may vary significantly. A clearer picture on the differences between these processes would shed light on the proper assessment of future employment.

About CESA

Founded in 2009, CESA is a non-profit membership-based advocacy group committed to advancing the role of energy storage in the electric power sector through policy, education, outreach, and research. CESA's mission is to make energy storage a mainstream energy resource which accelerates the adoption of renewable energy and promotes a more efficient, reliable, affordable, and secure electric power system. As a technology-neutral group that supports all business models for deployment of energy storage resources, CESA membership includes technology manufacturers, project developers, systems integrators, consulting firms, and other clean-tech industry leaders.

CESA's membership consists of: 174 Power Global, 8minutenergy Renewables, Able Grid Energy Solutions, Aggreko, Amber Kinetics, Ameresco, Aparrent, Arevon Energy Management by Capital Dynamics, Avangrid Renewables, B2U Storage Solutions, Better Energies, Boston Energy Trading & Marketing, Bright Energy Storage Technologies, Buchalter, Carrier, Clean Energy Associates, ConEd Battery Development, Connect California, Customized Energy Solutions, Dimension Renewable Energy, Doosan GridTech, Eagle Crest Energy, East Penn Manufacturing, EDF Renewable Energy, Emera, Enel X, Energport Inc., Energy Storage Response Group, Energy Vault, Engie, ESS Inc., esVolta, Fluence, Form Energy, General Electric, Gridwiz, Hecate Energy, Highview Power, Honda, Hydrostor, Jensen Hughes, Lendlease Energy Development, LG Chem Power, Li-Ion Tamer, Lockheed Martin AES, LS Power Development, Malta, NantEnergy, NEC Energy Solutions, Inc., NextEra Energy Resources, NEXTracker, NGK Insulators, Nostromo, NRStor, Nuvve, Ormat/Viridity, Plus Power, PolyJoule, PXiSE, Quidnet Energy, Range Energy Storage, RAW Energy, Recurrent Energy, Reimagine Power, RWE, Southwest Generation Company, Stem, Stoel Rives, Elsys, Sumitomo Electric, Sunrun, Swell Energy, Tenaska, Trane, UL, VRB Energy, Wartsila, WattTime, Wellhead Electric and Zitara Technolgies.