Energy Storage for Social Equity: Capturing Benefits from Power Plant Decommissioning

Introduction

Flexible and available at any scale, energy storage offers a useful framework and starting point in a larger conversation around energy equity.[1] Through the lens of energy storage deployment, stakeholders can imagine more broadly how improvements and investments in the grid can respond to social and health challenges and increase affordability, reliability, and community value leading to a more equitable, accessible, and sustainable energy future.

The following sections provide an overview of local energy effects and non-energy benefits of energy storage, with a focus on the role of energy storage in fossil fuel plant decommissioning and replacement strategies. The paper offers a brief summary of three case studies, Dynegy Oakland, Centralia, and Manatee power plants, where storage was integrated into plant decommissioning strategies to play the dual role of enabling the reduction of fossil sources from the grid while allowing increased integration of renewable sources into the electric grid. These case studies are intended to show the essential role of storage in accelerating deep decarbonization and the possibilities of enabling a just transition from fossil fuels.

Fossil-fuel power plants generate greenhouse gas emissions and health impacting criteria pollutants with plants often disproportionately located in disadvantaged communities.[2] This has resulted in an energy system with increased health and environmental burdens on vulnerable populations.[3] The strategic integration of energy storage in plant decommissioning plans can mitigate these negative impacts while providing energy system, environmental, and societal co-benefits including resiliency, reduced outages, decreased pollution, increased property values, lower compliance costs, lower utility bill, job creation, and reduced land use (Woods and Stanton 2019). This brief report uses the three case studies as a lens into the possibilities of storage in enabling the rapid decommissioning of fossil-fuel baseload and peaker power plants across the country.

[1] Equity, as defined in Executive Order No. 13985, "means the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality" (Executive Order No. 13985 2021).
[2] Disadvantaged communities are those who most suffer from economic, health, and environmental burdens.
[3] Vulnerable populations are those who are economically disadvantaged, racial and ethnic minorities, the elderly, rural residents, those with inadequate education, and those with other socio-economic challenges.

Benefits of Energy Storage

Integrating energy storage into fossil-fuel plant decommissioning strategies offers benefits for a wide range of stakeholders in the energy system (Saha 2019). For federal, state and local governments, replacing fossil fuel power plants with storage capacity could support their decarbonization and energy transition goals. For example, New York's Climate Act[4] sets a goal of achieving 100 percent zero-emission electricity by 2040 including a 3,000 MW energy storage target by 2030. The New York Power Authority (NYPA) also released its VISION2030 plan to an emissions-free electricity by 2035 including a commitment of 450 MW of energy storage deployment (Colthorpe 2021). For utilities, storage offers the operational flexibility to provide safe, clean, and reliable energy. In addition, for fenceline[5] and frontline[6] communities, switching to storage may offer benefits by minimizing air pollution, improving property value, attracting businesses, creating jobs and stimulating local economic activity.

Storage offers energy benefits at multiple points in the electric grid similar to baseload generation assets and peaker plants, including transmission, distribution, and cost (see Figure 1) (Rohit and Rangnekar 2017). Fossil fuel plants as a baseload generation asset guarantee supply reliability and wholesale market stability, while peaker plants support variable peaks in electricity demand. Energy storage can provide these attributes along with added non-energy benefits. The non-energy of storage are the values that energy storage participants – utility companies, individuals, communities, or society – receive in addition to the benefits to the energy system (Woods and Stanton 2019). Table 1 offers a brief overview and taxonomy of the plant-scale and community-scale non-energy benefits of storage that can be included in future valuation analysis and development. The energy benefits of storage are more well documented[7] and are included here in less detail. For additional information on the energy benefits of storage, see Balducci et al. (2018).

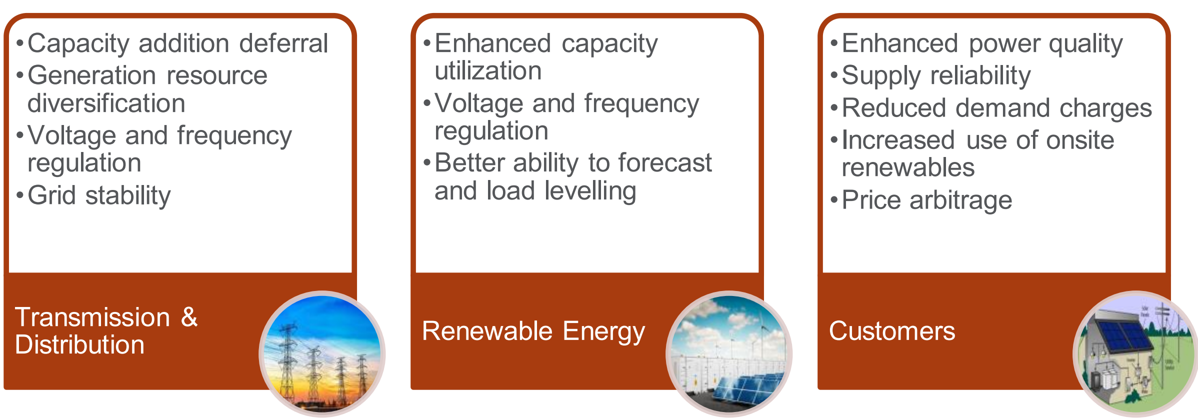

Figure 1 *Grid Benefits of Energy Storage*

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[4] In 2019, Governor Andrew Cuomo signed the Clean Leadership and Community Protection Act (Climate Act) into law. The law requires New York to reduce economy-wide greenhouse gas emissions 40 percent by 2030. https://climate.ny.gov/

[5] Fenceline communities are those living in closest proximity to dangerous facilities (within one-tenth of a facility's vulnerability zone).

[6] Frontline communities are those experiencing first and worst of air pollution resulting from energy systems.

[7] Despite the additional coverage of energy benefits, benefits at the transmission or distribution levels, and customer energy management of behind-the-meter (BTM) resources are only included in a few existing models (Balducci, et al. 2018).

Table 1 Local and systemic non-energy benefits provided by energy storage

Benefit Title	***Benefit category(ies)***	***Description***
Emissions reduction	*Environmental*	The emissions reduction impact of storage installations is dependent on how and when the storage system is charged and discharged. Storage facilitates the removal of fossil fuels from the grid through decommissioning strategies and renewable energy expansion, resulting in significant emissions reduction (Arabzadeh, et al. 2019).
Energy costs	*Economic, social*	For storage that is replacing fossil-fueled systems, utilities can minimize safety-related emergency calls and avoid fines related to environmental compliance. Peak demand currently results in demand charges and time-of-use (TOU) rates. Storage creates a resource to manage peak demand. Both instances reduce the cost to provide energy and the utility can pass on saved costs to ratepayers. As energy becomes more affordable to the ratepayer, the utility also saves costs by avoiding ratepayer collections and terminations (Woods and Stanton 2019).
Equity enhancement	*Social, economic*	Storage systems, if implemented with appropriate strategies, can provide targeted benefits to underserved communities including revenue generation and energy independence to improve energy affordability and reduce energy burden (Union of Concerned Scientists 2019, Tarekegne, O'Neil and Twitchell 2021).
Increased property value	*Economic*	For ratepayers with storage installed in buildings, storage provides the capability to keep heating and cooling systems reliably operational and may decrease energy costs leading to an increased property value. A study by the Appraisal Journal found that for every $1 decrease in the annual utility bill, property value increases by approximately $20 (NREL 2008). A meta-analysis study (Brinkley and Leach 2019) of energy infrastructure impact on housing value found a consistent positive property value impact for rooftop solar, a corollary to residential storage installations.
Job creation	*Economic, Social*	Storage creates job opportunities across the asset's lifecycle, including battery manufacturing, operation, maintenance, and management. The California Energy Storage Alliance (CESA) reported that energy storage projects in California have supported approximately 20,510 jobs and they project that number might increase up to 113,190 jobs in the next ten years (Noh 2020). Job creation benefits of energy storage could support communities in revitalizing their economies. This is especially critical for regions that will be negatively impacted by the energy transition. For example, in the Centralia case study, the decision to build storage capacity

		in the plant decommissioning strategy led to research and development efforts creating jobs and work opportunities in the storage supply chain (Centralia Coal Transition Grants 2021).
Less land use	*Environmental, social*	Utilizing energy storage to manage increasing power requirements (baseload and peak demand) decreases the need to build new or maintain existing power plants. Decreasing the land required for power plants allows communities to use the now available land for alternative public-serving uses including parks, conservations, commercial and residential facilities, health centers, schools, and recreation centers (Woods and Stanton 2019).
Resilience benefits	*Social, Economic*	The main resilience benefit is avoided energy outages and the resulting avoided disruption costs (financial and otherwise). For ratepayers, the avoided disruptions are in day-to-day life activities. However, there are currently limited metrics to assess the impacts despite their significance. For example, power outages can create life-threatening risks for vulnerable customers that rely on electronic devices, such as the elderly who require refrigerated medication. Currently, the "value of lost load" (VOLL) is used to estimate the avoided outage benefits to participants (Woods and Stanton 2019). Future valuation methods need to capture the avoided outage benefits of storage in critical and community-serving facilities such as hospitals, senior housing, community centers, schools, and emergency shelters (Rutgers 2019).

Case Studies

Case Study I: Dynegy Oakland Power Plant, California (1978 – 2022)

The Dynegy Oakland Petroleum Liquid Power Plant is a 223.5 MW capacity (County Office 2021) oil-fired energy generation facility owned and operated by Dynegy Oakland (Chhabra 2018). As a peaker plant, it provides up to 40 MW of support to the grid for 10 hours/day[8] (ENEFIRST 2020). The plant has been in operation since 1978 but is set to be retired in 2022 (Chhabra 2018).

The decommissioning of the Dynegy Oakland Petroleum Liquid Power Plant and the resulting loss of capacity was flagged as a potential local transmission reliability concern during the Independent System Operator (ISO) Transmission Plan planning process[9] (ENEFIRST 2020). In response, two replacement options were discussed. The first option was to repower the retiring plant with natural gas. However, according to the California EPA, the plant's fenceline communities were already exposed to extremely high levels of toxic particulates and air pollution (Chhabra 2018). Repurposing the plant with natural gas would only have extended pollution in the area and could have generated backlash from the local community. The second option was to build a high-power transmission line through Oakland, requiring expensive

[8] This requirement is to guarantee energy reliability under the California Independent Service Operator (CAISO) Reliability-Must-Run contract (ENEFIRST 2020).
[9] The process was led by California Independent Service Operator (CAISO).

transmission and distribution (T&D) investment and additional siting impacts to communities and local businesses in a heavily populated downtown area. Considering these constraints of environmental impact, economic and social disturbances, and significant economic investment needed, the planning process focused on local clean energy resources.

The local utility, Pacific Gas & Electric (PG&E), and the region's clean energy provider, East Bay Community Energy (EBCE), collaborated to create the Oakland Clean Energy Initiative (OCEI).[10] OCEI planned to replace the plant by expanding distributed resources including clean energy generation, energy system upgrades, and energy storage (EBCE 2020, PG&E 2019, CAISO 2020). OCEI resulted in a project portfolio mix of solar, energy storage, and demand response providing local environmental benefits and a cleaner electric portfolio with a 43 MW storage capacity.[11] The storage system will draw electricity from the grid when demand is low and supply power in times of increased demand, supporting the grid in meeting demand changes and securing reliability (ACORE 2020).

Utilizing storage in decommissioning the Dynegy Oakland Power Plant will reduce toxic emissions and may lead to improved indoor air quality, health outcomes, and comfort and quality of life for frontline communities (PSE Healthy Energy 2020). This in turn may improve property values, facilitate new business attractions, and create jobs in the community. The cost-savings from storage may be passed on to ratepayers to lower the energy burden on low-income customers while reducing their service disconnection risks.

Case Study II: Centralia Power Plant, Washington (1973 – 2025)

The Centralia Power Plant is a 1,459.8 MW capacity coal-fired energy generation facility owned and operated by TransAlta in Centralia, WA (Global Energy Monitor 2021). The Centralia Power Plant is composed of two coal-fired generating units, each with a 729.9 MW capacity (Global Energy Monitor 2021). While both units came online almost together, in 1972 and 1973, Unit 1 retired in December 2020 and Unit 2 is scheduled for early decommissioning in 2025.

The early decommissioning of the power plant was spurred both by local environmental stakeholders' environmental justice advocacy and Washington State's efforts in curbing greenhouse gas emissions.[12] In 2009, environmental stakeholders (for example, Earthjustice) appealed the renewal of Centralia's air pollution permit and led the effort to close the power plant (Earthjustice 2009). In 2010, the Washington legislature introduced a bill to revoke Centralia's tax exemption, which amounted to $4 million/year (Global Energy Monitor, 2021) because the plant was no longer using locally mined coal.[13] A year later in 2011, the state passed the TransAlta Energy Transition Bill which set in place an early decommissioning timeline due to the plant's negative impact on human and environmental health (Ecology, 2020).

The state worked with TransAlta to determine the 2020 and 2025 scheduled retirement dates. This met the state's goals of an early closure for the plant, being only five years later than the

[10] The Oakland Clean Energy Initiative (OCEI) was approved by CAISO during the 217-2018 transmission planning process. Under OCEI, PG&E focuses on utility-scale storage to meet Oakland's transmission reliability needs and EBCE focuses on local distributed energy resources.

[11] Vistra Energy and esVolta/Tierra Robles Energy Storage, LLC were chosen to develop utility battery storage systems to partially replace the capacity of the retiring plant. The facilities will have a 36.25 MW and 7 MW capacity respectively (Dohrety 2020)

[12] In 2006, the power plant emissions per MWH were approximately: CO2 7,974,564 tons, SO2 1668 tons, NOx 9699 tons, and Mercury 315 lb (Global Energy Monitor, 2021; Vartan, 2018)

[13] The Centralia coal mine was closed in 2006 and The Centralia Power Plant then began sourcing coal from Rawhide Mine in Peabody and Spring Creek Mine in Navajo (Global Energy Monitor 2021)

state's original 2015 retirement proposal, while achieving significant benefits for the local community. TransAlta was also able to recoup its investment while planning to finance a $55 million Coal Transition Fund used to assist workers and communities impacted by the plant closure (TransAlta USA 2020). The Coal Transition Fund will pay $25 million for clean energy projects, $10 million in grants for energy efficiency and weatherization projects (with specific carve-out for low-to-moderate-income households), and $20 million for economic and community development. The community development payment includes an $8 million fund for payout for displaced workers and an additional $1 million for education and retraining. Displaced workers will get a lump sum payment of $44,000 and they can apply for education grants up to $15,000 (McIntosh 2020). Environmental and labor groups played a significant role in the development of the Coal Transition Fund, particularly in negotiating benefits for older workers to retain benefits. The extended plant decommissioning timeline allowed 40 percent of workers to reach retirement age before the plant closure. It also added 8 years for non-retirees in their current jobs (Centralia Coal Transition Grants 2021).

To replace the retiring plant, TransAlta is supporting a feasibility study for long-duration battery storage technology (Centralia Coal Transition Grants 2021). A grant in the amount of $350,000 has been approved from the $25 million clean energy transition fund. This work will assess the role of storage in delivering reliable renewable power while providing benefits to the community. Decommissioning fossil fuel plants requires planning that considers diverse stakeholders, particularly community members. The Centralia case also illustrates how a community-centered model for the decommissioning process can actively engage local environmental and labor groups, local policy makers, and the plant owners in planning a decommissioning and replacement strategy that results in tangible economic benefits to workers and the local community.

Case Study III: Manatee Power Plant, Florida (1970s – 2021)

The Manatee Power Plant is a 1,638 MW capacity natural gas peaker power plant owned and operated by the Florida Power & Light Company (FPL) in Parrish, FL (Proctor 2019). The plant came online in the mid-1970s and is scheduled for retirement in 2021.

FPL decided to replace Manatee's gas-fired generation with battery storage at least partly due to the utility's plan to eliminate over one million tons of carbon dioxide emissions from its portfolio and generate $100 million in savings for ratepayers (FPL 2019). This plan includes installing 30 million solar panels by 2030. Through several smaller battery installations across the state, FPL has demonstrated the cost-effectiveness of battery technology. The Manatee replacement project includes a solar plus storage plant including a 409 MW capacity energy storage facility (Manatee Energy Storage Center). The storage system will cover a 40-acre parcel of land and will be distributing 900 MWh of electricity. According to FPL, this will be the world's largest energy storage system (FPL 2019).

The storage technology will help Florida realize the full benefits of its abundant solar power and other clean energy resources. The solar plus storage integration offers a compounded benefit in saving customers money (approximately $100 million savings to ratepayers), reduced emissions (1 million tons of CO_2), improved service reliability, increased clean energy penetration, and new job creation (approximately 70 new jobs during construction) (FPL 2019).

Considerations for future research

All three case studies identified storage as the technology of choice to support the energy transition from fossil fuel plants. These case studies also highlighted the current stages of storage project development, from the initial feasibility study (Centralia) to implementing 43 MW (Dynegy Oakland) to 409 MW (Manatee) of storage. In the next decade, many fossil fuel power plants will be reaching the end of their working life, while clean energy mandates and tax incentives are increasing (Pontecorvo 2020, Balducci, et al. 2018). Storage can provide the critical services that were traditionally offered by fossil fuels in the energy system, filling a critical capacity gap, while supporting federal, state, and local decarbonization goals and community needs (Table 2 Summary of energy storage benefits in power plant decommissioningTable 2) (Deloitte 2015, Balducci, et al. 2018).

Table 2 Summary of energy storage benefits in power plant decommissioning

Benefit	***Description***
Reliable and affordable energy supply	• Accommodates variable renewable energy and expanded electrification advancements • Energy security during physical and cyber-security threats
Clean environment	• Increased and effective renewable energy integration • Decreases need for new baseload/ peaker power plant construction
Strong energy infrastructure	• Enhances grid flexibility • Supports efficient power plant operation, transmission, and distribution

Capturing the full capabilities and benefits of energy storage is crucial to accurately assess the value of storage systems. Without, assessments will significantly undervalue energy storage systems and investment will be stalled with repercussions on ratepayers, communities, and the energy transition. As future work continues to assess the non-energy benefits, researchers, utilities, and policymakers need to work with communities to understand past decisions and inform future decision-making tools that account for environmental, economic, and social impacts, particularly on disadvantaged and fenceline communities.

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