Energy Storage for Social Equity

Microgrid and Energy Storage Applications
for Resilience and Energy Equity

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Bethel Tarekegne
Research Engineer
Pacific Northwest National Laboratory

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Agenda

- Context
- Energy Storage as an Equity Asset
- Energy Storage in Power Plant Decommissioning
- Energy Equity Metrics
- Energy Storage for Social Equity Initiative

Context

- There is already robust work around income, rates, and affordability – but the trends are going in the wrong direction.
- Not all customers have the same needs of the energy system. For example, elderly and disabled populations use energy in different ways and have different vulnerability profiles.
- Clear demand for explicit work and real stakeholder engagement.
- More analysis can be done around:
  - Differentiating needs & interactions by demographics (age, race, health, rural, deep poverty) and compound, cumulative effects
  - Understanding the relationships between policies and grid futures and people
  - Designing technologies to be safer and support well-being including life-cycle implications
  - Recognizing the procedural limitations of energy system decision-making

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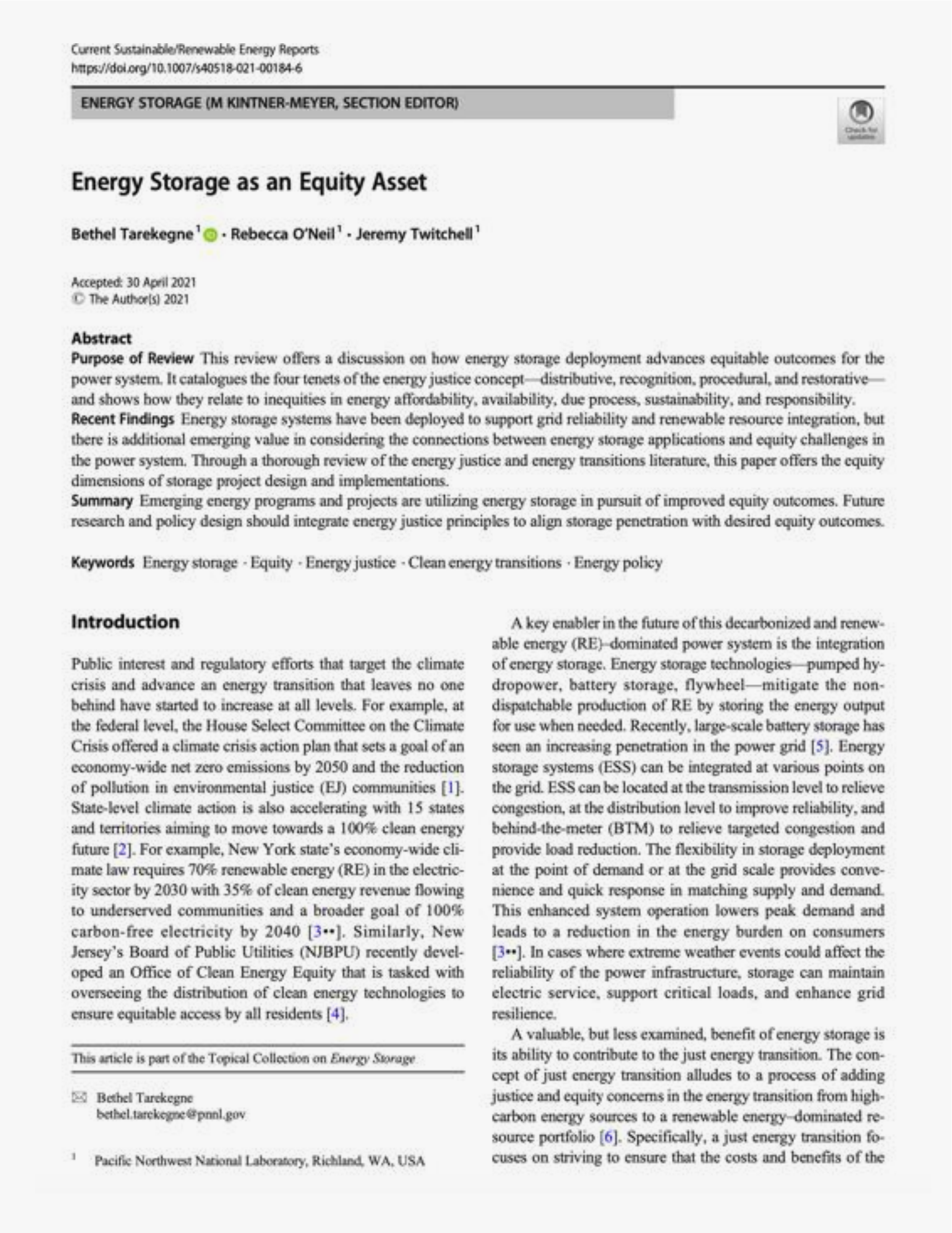
Energy Storage as an Equity Asset

- **Energy Justice:** The goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system, e.g., frontline communities.
- **Just Transition:** A transition away from the fossil fuel-based economy to one that provides dignified, productive, and ecologically sustainable livelihoods; democratic governance; and ecological resilience.



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ENERGY STORAGE (M KINTNER-MEYER, SECTION EDITOR)

Energy Storage as an Equity Asset

Bethel Tarekegne[1] · Rebecca O'Neil[1] · Jeremy Twitchell[1]

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Abstract

Purpose of Review This review offers a discussion on how energy storage deployment advances equitable outcomes for the power system. It catalogues the four tenets of the energy justice concept—distributive, recognition, procedural, and restorative—and shows how they relate to inequities in energy affordability, availability, due process, sustainability, and responsibility.

Recent Findings Energy storage systems have been deployed to support grid reliability and renewable resource integration, but there is additional emerging value in considering the connections between energy storage applications and equity challenges in the power system. Through a thorough review of the energy justice and energy transitions literature, this paper offers the equity dimensions of storage project design and implementations.

Summary Emerging energy programs and projects are utilizing energy storage in pursuit of improved equity outcomes. Future research and policy design should integrate energy justice principles to align storage penetration with desired equity outcomes.

Keywords Energy storage · Equity · Energy justice · Clean energy transitions · Energy policy

Introduction

Public interest and regulatory efforts that target the climate crisis and advance an energy transition that leaves no one behind have started to increase at all levels. For example, at the federal level, the House Select Committee on the Climate Crisis offered a climate crisis action plan that sets a goal of an economy-wide net zero emissions by 2050 and the reduction of pollution in environmental justice (EJ) communities [1]. State-level climate action is also accelerating with 15 states and territories aiming to move towards a 100% clean energy future [2]. For example, New York state's economy-wide climate law requires 70% renewable energy (RE) in the electricity sector by 2030 with 35% of clean energy revenue flowing to underserved communities and a broader goal of 100% carbon-free electricity by 2040 [3••]. Similarly, New Jersey's Board of Public Utilities (NJBPU) recently developed an Office of Clean Energy Equity that is tasked with overseeing the distribution of clean energy technologies to ensure equitable access by all residents [4].

A key enabler in the future of this decarbonized and renewable energy (RE)–dominated power system is the integration of energy storage. Energy storage technologies—pumped hydropower, battery storage, flywheel—mitigate the non-dispatchable production of RE by storing the energy output for use when needed. Recently, large-scale battery storage has seen an increasing penetration in the power grid [5]. Energy storage systems (ESS) can be integrated at various points on the grid. ESS can be located at the transmission level to relieve congestion, at the distribution level to improve reliability, and behind-the-meter (BTM) to relieve targeted congestion and provide load reduction. The flexibility in storage deployment at the point of demand or at the grid scale provides convenience and quick response in matching supply and demand. This enhanced system operation lowers peak demand and leads to a reduction in the energy burden on consumers [3••]. In cases where extreme weather events could affect the reliability of the power infrastructure, storage can maintain electric service, support critical loads, and enhance grid resilience.

A valuable, but less examined, benefit of energy storage is its ability to contribute to the just energy transition. The concept of just energy transition alludes to a process of adding justice and equity concerns in the energy transition from high-carbon energy sources to a renewable energy–dominated resource portfolio [6]. Specifically, a just energy transition focuses on striving to ensure that the costs and benefits of the

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✉ Bethel Tarekegne
bethel.tarekegne@pnnl.gov

[1] Pacific Northwest National Laboratory, Richland, WA, USA

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Common Understanding of Energy Justice

- Distributive Justice (where?)
  - The unequal allocation of benefits and burdens and unequal distribution of the consequences
- Recognition Justice (who?)
  - The practice of cultural domination, disregard of people and their concerns, and misrecognition
- Procedural Justice (how?)
  - The fairness of the decision-making process
- Restorative Justice
  - The response to those impacted by the burdens of energy projects

Key Principles:

- Availability
- Transparency and accountability
- Due process
- Intergenerational equity
- Affordability
- Sustainability
- Intragenerational equity
- Responsibility

Key Terms	Definition
Energy Burden	Percent of household income spent to cover energy cost.
Energy Insecurity	The inability to meet basic household energy needs.
Energy Poverty	A lack of access to basic, life-sustaining energy.
Energy Vulnerability	The propensity of a household to suffer from a lack of adequate energy services in the home.

Distributed Effects

Availability	Access to energy technologies across the socio-economic spectrum
Energy storage for equity	Targeted incentives for households that cannot access energy technologies
Affordability	Low-income households spend a high percentage of their income on energy cost (three times higher). This is exacerbated by systemic inequities across demographic indicators: race, gender, ability status, age, health status, geography, income, education
Energy storage for equity	Helps reduce energy burden ▪ Curbing demand charges ▪ Community-serving facility support ▪ Affordable housing energy cost Helps decrease household energy insecurity ▪ Supports grid reliability and resilience through backup power

Energy Storage in Power Plant Decommissioning

Dynegy Oakland Power Plant, California (1978–2022)

- Replacement — 43 MW battery storage facility (reduces toxic emissions, improves air quality, health outcomes, and quality of life for frontline communities)

Centralia Power Plant, Washington (1973–2025)

- Replacement — long-duration battery storage (currently at the feasibility study stage—$350,000 grant out of a $25 million clean energy transition fund)

Manatee Power Plant, Florida (1970 –2021)

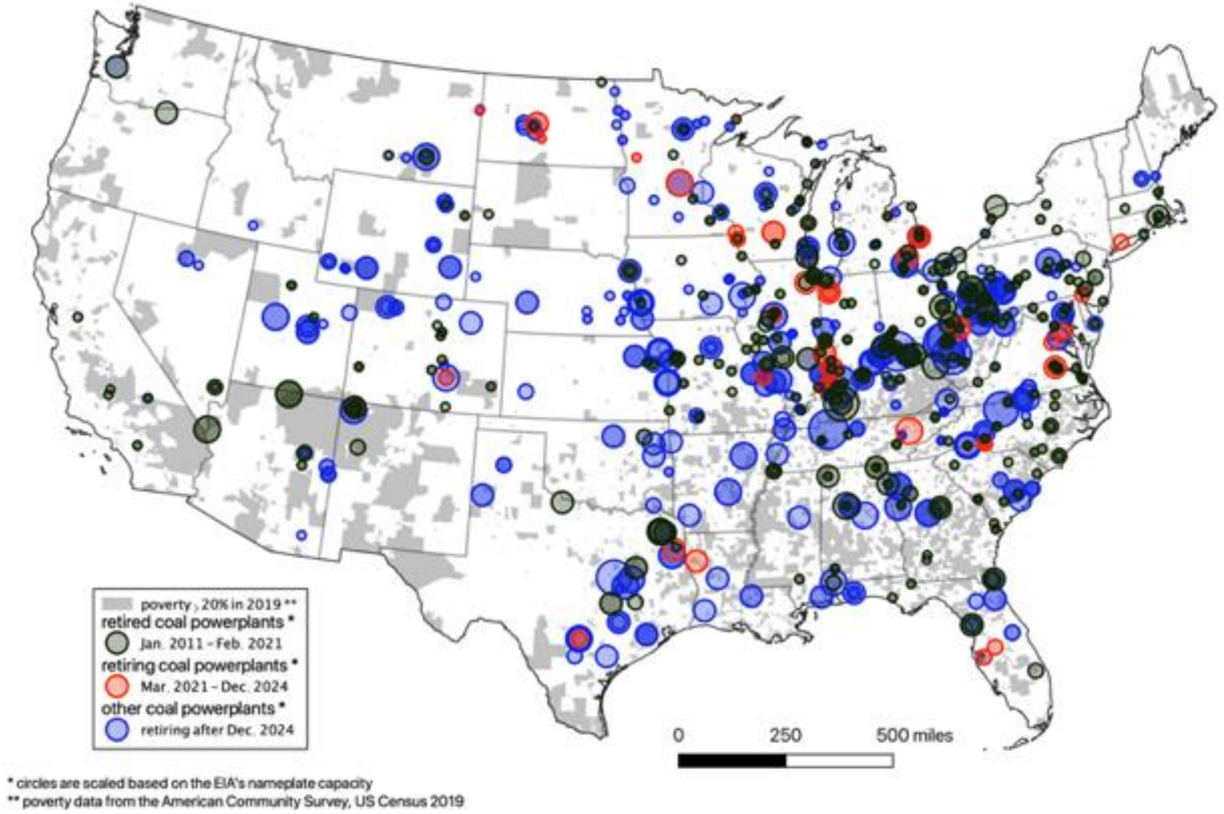
- Replacement — Manatee Energy Storage Center, 409 MW/900 MWh battery storage facility (~ $100 million savings to ratepayers, 1 million tons of CO_2 emissions reduction, improved service reliability, increased clean energy integration, and ~70 new jobs created during construction)

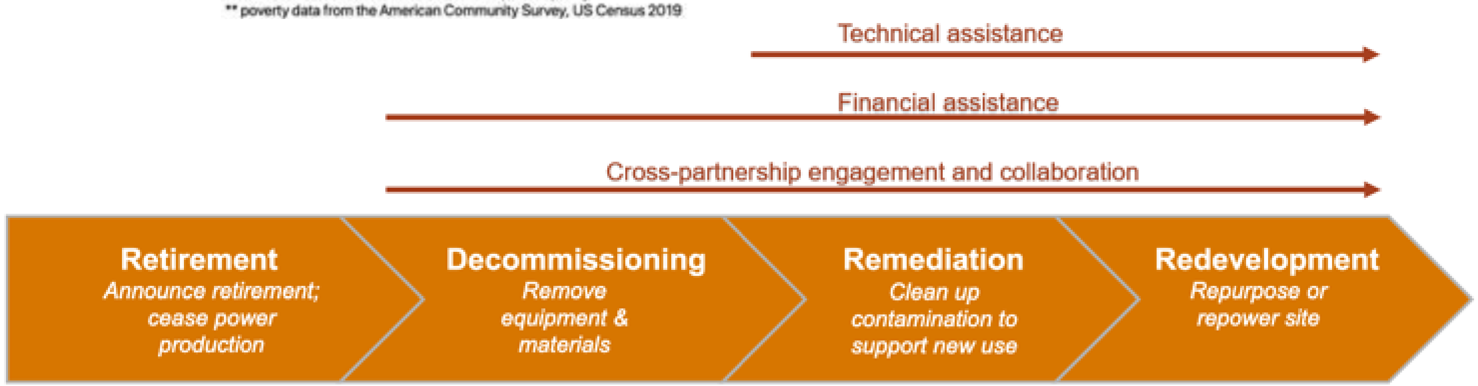
See *Capturing Benefits from Power Plant Decommissioning*
https://www.pnnl.gov/sites/default/files/media/file/Energy%20Storage%20for%20Social%20Equity%20Case%20Study.pdf

Equitable Power Plant Decommissioning

Best practices for equitable transition include:

- Early and continued engagement throughout the transition process
- Early planning of post-decommissioning projects to replace lost jobs, revenue, and economic activity
- Recognition (and mitigation, if possible) of social impacts on the community
- Identifying funding sources, technical experts, and/or strategic partnerships to support decommissioning and the affected communities up-front
- Acknowledging communities as stakeholders who have a role in the conversation and right to determine their futures.





See *Coal-dependent Communities in Transition: Identifying Best Practices to Ensure Equitable Outcomes*
https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-31909.pdf

Distributed Effects – Non-Energy Local Effects

Benefit Title	Benefit categories	Description
Emissions reduction	Environmental	Storage facilitates the removal of fossil fuels from the grid through decommissioning strategies and renewable energy expansion.
Energy costs	Economic, Social	Storage creates a resource to manage peak demand and reduce cost.
Equity enhancement	Social, Economic	Storage systems can provide targeted benefits to underserved communities including revenue generation and energy independence.
Increased property value	Economic	Storage provides the capability to keep heating and cooling systems reliably operational and may decrease energy costs leading to an increased property value.
Job creation	Economic, Social	Storage creates job opportunities across the asset's lifecycle, including battery manufacturing, operation, maintenance, and management.
Less land use	Environmental, Social	Storage decreases the need to build new or maintain existing power plants.
Resilience benefits	Social, Economic	Storage mitigates energy outages and disruption costs (financial and otherwise).

See *Capturing Benefits from Power Plant Decommissioning*
https://www.pnnl.gov/sites/default/files/media/file/Energy%20Storage%20for%20Social%20Equity%20Case%20Study.pdf

Measuring Equity — Metrics

Metric—quantitative measurement for a qualitative phenomenon that can help measure a specific equity outcome.

Indicator—representation of a relevant equity outcome that can be used to establish the state of equity at a given point in time and is useful in collecting baseline equity measurements.

Indices—multiple indicators that are aggregated into a single measure.

Current equity indicators to collect baseline measurements			
Income	Energy access	Access to renewables	Program eligibility
Age	Energy use intensity	Energy assistance	Education programs
Race, ethnicity, language	Energy burden	Access to public services	Community engagement
Geographical location	Energy efficiency	Incentive accessibility	Grid resilience
Urban/rural	Energy affordability	Heat island mitigation	Internet, communication
Building type, ownership	Customer cost savings	Disaster frequency, cost	Transportation

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Measuring Equity

Target Population Identification

- Program equity index
- Program accessibility
- Energy cost index
- Energy burden index
- Late payment index
- Appliance performance
- Household-human development index

Investment Decision Making

- Community acceptance rating
- Program funding impact
- Energy use impacts
- Energy quality
- Workforce impact

Program Impact Assessment

- Profits
- Program acceptance rate
- Energy savings (MWh)
- Energy cost savings ($)
- Energy burden change
- Change in household-human development index

See *Metrics for an Equitable and Just Energy System*
https://www.pnnl.gov/sites/default/files/media/file/Metrics%20for%20Energy%20Equity_0.pdf

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Immediate Opportunities and Recommendations

Enhance capabilities to map and track inequities

- Identify target populations (i.e., where are the disadvantaged communities?)
- Quantify and compare inequities across population
    - Modify measurement and visualization tools such as EJScreen, LEAD, PNNL Electricity Affordability Metrics

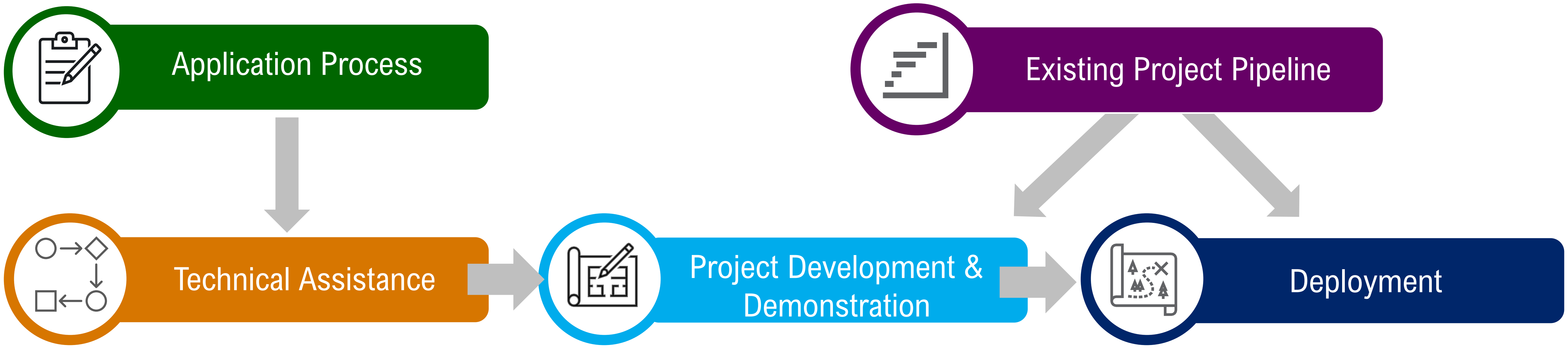
Assign appropriate scales for equity measurement

- Measuring dimensions of time – different time scales of benefits/burdens
- Measurement levels – at what level to assess equity effects (i.e., societal, community or neighborhood, household, or individual)
    - Enhance data granularity based on desired measurement level (run community surveys to build new datasets)

Environmental Justice Screening and Mapping Tool (EJScreen) https://ejscreen.epa.gov/mapper/
Low-income Energy Affordability Data Tool (LEAD) https://www.energy.gov/eere/slsc/maps/lead-tool

Energy Storage for Social Equity (ES4SE) Initiative

Goal: *support disadvantaged communities affected by unreliable and expensive energy systems. Through this program, eligible communities have access to direct, non-financial technical assistance and potential support for new energy storage project development and deployment.*



OUTCOMES

Connect disadvantaged communities with energy solutions that support equitable outcomes	**Demonstrate** the role of energy storage in energy equity	**Develop** methods and metrics to analyze impact of investment on equity	**Report** on lessons learned and best practices to support future work across DOE	**Grow** and strengthen DOE project pipeline

Acknowledgment and Resources

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Energy Equity at PNNL
https://www.pnnl.gov/projects/energy-equity

Energy Storage for Social Equity Initiative (ES4SE)
https://www.pnnl.gov/projects/energy-storage-social-equity-initiative

Communities in Energy Transition
https://www.pnnl.gov/projects/energy-equity/communities-energy-transition

Contact
Bethel Tarekegne
bethel.tarekegne@pnnl.gov

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Thank you