GRID FLEXIBILITY

Grid flexibility is a key enabler in the transition to renewable energy. The current grid was built for centralized electricity production and is not well suited for a network of distributed and intermittent renewable energy sources. Redesigning the grid to include more energy storage and a diverse mix of renewable sources with different seasonal and diurnal production profiles will be a critical step to reducing reliance on fossil fuels.[1]

Demand-response tools can help match production and consumption of electricity, either by incentivizing the use of less energy when electricity is in high demand or reducing energy production when demand is low. These tools include time-variant electricity pricing, also called time-of-use pricing (which charges a higher price per kWh at times of peak demand), smart meters (which convey information about electricity usage to utilities in real time so that they can adapt production accordingly), smart thermostats (which turn the temperature down or up depending on occupancy and use patterns), and smart appliances (which allow the pre-scheduling of laundry, dishwasher, and electric vehicle charging cycles to synch with times when energy availability is high and prices are low). Penetration of electric vehicles into the automotive marketplace will assist grid flexibility because cars can charge at times of low demand and peak production, and once a car has reached the end of its lifespan, its battery can be repurposed for electricity storage.[2] The environmental externalities and fishery friendliness of lithium-ion batteries are discussed in "Distributed energy storage" and "Utility energy storage."

Investments in long-distance transmission can help connect the locations where energy is being produced to where it is being consumed at any given time. For example, there have been proposals to develop a North American "super grid" by linking regional transmission networks. This would enable the pooled transmission of wind energy on the Great Plains and in the Midwest, solar energy in the Southwest, geothermal energy in the Rocky Mountains and Great Basin, and hydropower in the Northwest and Southeast.[3] Such a project would involve significant upgrades and investments in new transmission lines, but many argue that such an upgrade is long overdue.

Like all land use, grid expansion can have varying degrees of fishery friendliness and environmental impact. Expansion of high-voltage transmission lines can impact fisheries habitat by fragmenting wetlands and forests and creating pathways for the spread of invasive species. Maintenance of transmission line rights-of-way often involves use of pesticides and herbicides,

[1] Project Drawdown: "Grid flexibility." https://drawdown.org/solutions/grid-flexibility
[2] Project Drawdown: "Grid flexibility." https://drawdown.org/solutions/grid-flexibility
[3] Climate Institute (2019). *North American Super Grid: Transforming Electricity Transmission.* http://climate.org/wp-content/uploads/2019/09/supergrid_9_2019.pdf

and can result in sedimentation of waterways.[4] Care should be taken to make grid maintenance and expansion as fishery friendly as possible.

Barriers to upgrades in grid flexibility include: public objection to new infrastructure such as transmission lines; reluctance on the part of regulated utilities to share data about system needs with unregulated competitors; privacy issues with regard to two-way communications between households and utilities; and the slow pace of changing regulations, as regulators face the challenge of encouraging innovation that benefits the system while protecting the interests of all rate payers.[5]

- Fishery friendliness: Grid flexibility is a diverse category of practices that boost grid efficiency and enable addition of renewable technologies into the grid. It may have indirect impacts to fisheries in instances where it facilitates greater adoption of energy generation systems that are harmful to fisheries, but conversely, it may be fishery friendly in cases where it facilitates adoption of energy generation systems that are fishery friendly. Expansion of high-voltage transmission lines can impact fisheries habitat by fragmenting wetlands, and maintenance of rights-of-way can lead to runoff of pesticides, herbicides, and sediments. Addition of energy storage to the grid in the form of lithium-ion batteries has the potential to impact fisheries through mining and disposal of mineral components. Efficiency measures like time-variant pricing and smart thermostats have the potential to improve the fishery friendliness of the overall energy portfolio by enabling reductions in total energy used.
- Co-benefits: Grid flexibility can improve energy resilience and save customers money.
- Environmental externalities: Grid flexibility is a diverse category of practices that boost grid efficiency and enable addition of renewable technologies into the grid, and its impacts to the environment will depend on the impacts of the energy systems that these practices facilitate. In addition, expansion and maintenance of high-voltage transmission lines can impact wildlife habitat by fragmenting wetlands and forests, creating pathways for the spread of invasive species, and inducing runoff of pesticides, herbicides, and sediments. Addition of energy storage to the grid in the form of lithium-ion batteries has the potential to impact the environment through mining and disposal of mineral components.
- Policy catalysts: Grid upgrades can be promoted through grants, planning, and permitting. Energy efficiency measures can be promoted through adoption of time-variant electricity pricing, combined with measures to help home and business owners adapt their energy use through smart thermostats and building automation, such as tax incentives, rebates, building codes, utility-based demand reduction programs, low-income energy efficiency programs, government procurement and lead-by-example policies, enabling of financing instruments (e.g., property assessed clean energy programs, energy savings performance contracting, green banks), certification

[4] USFWS. "Energy technologies and impacts: Electric transmission lines." https://www.fws.gov/ecological-services/energy-development/electric-transmission.html
[5] Project Drawdown. "Grid flexibility." https://drawdown.org/solutions/grid-flexibility

incentives (e.g., LEED, Energy Star), and carbon pricing. Storage (distributed and utility-scale) can be promoted through rebates, tax incentives, capacity payments, grants, peak reduction incentives, accelerated depreciation, demonstration-scale plants and storage standards.

- More information:
  - Drawdown: Grid flexibility
  - Department of Energy: Demand response
  - Environmental Defense Fund. *A primer on time-variant electricity pricing*.
  - Department of Energy. *How the smart grid promotes a greener future.*
  - Wikipedia: Smart meters
  - Climate Institute (2019). *North American super grid: Transforming electricity transmission.*
  - NCSL (September 22, 2021). *Modernizing the electric grid: State role and policy options.*
  - Brasington, Louis (April 14, 2020). "Smart grid flexibility markets: Entering an era of localization." *Cleantech Group.*
  - Aggarwall, Sonia & Orvis, Robbie (March 2016). *Grid flexibility: Methods for modernizing the power grid.* Energy Innovation.
  - Trabish, Herman K. (January 28, 2019). "An emerging push for time-of-use rates sparks new debates about customer and grid impacts."

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