Transmission upgrades and efficient energy demand management are essential for the clean energy transition

The United States requires a consistent supply of energy to both improve Americans' quality of life and grow the economy. Currently, the United States is shifting to clean electricity and moving away from fossil fuels to mitigate climate change and reduce the impacts of price volatility. To achieve these goals, the United States will have to create more electricity than it currently produces. Renewable energy generation is projected to increase from 21% of electricity generation in 2021 to 44% in 2050. This will help meet the demand for increased electricity, but more will need to be done. Other opportunities include expanding existing transmission abilities and streamlining the construction, deployment, and connection of new clean energy investments to the broader power grid.

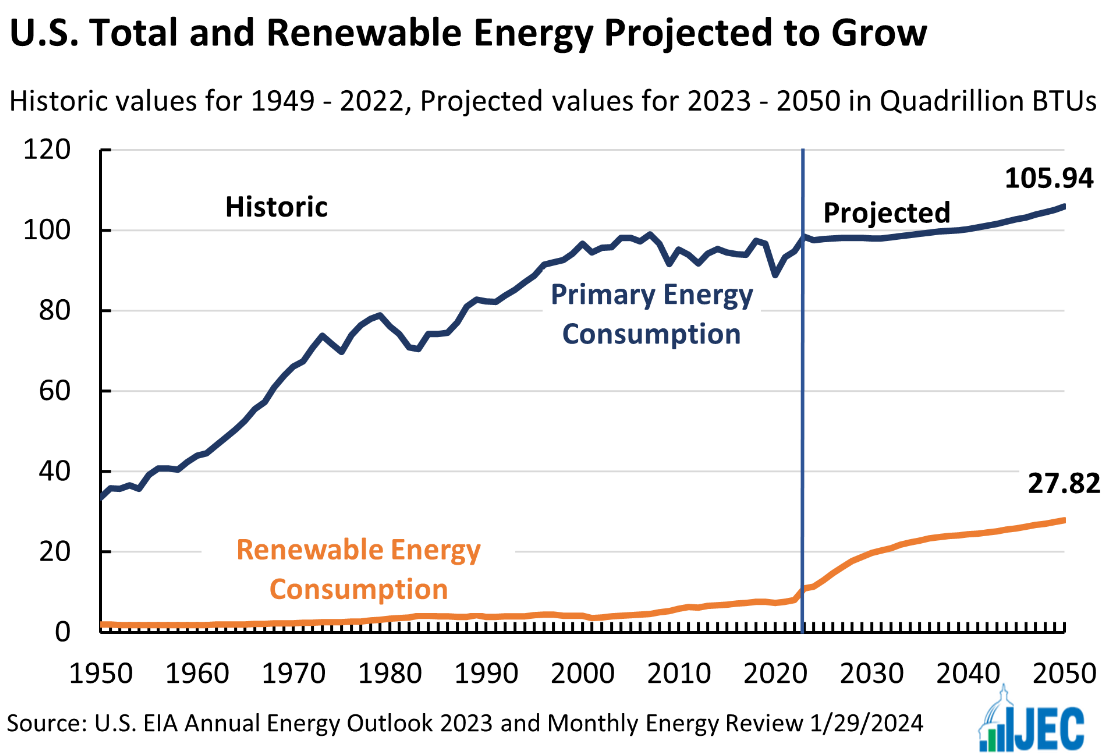
The United States can also explore ways to manage energy demand more efficiently, including using virtual power plants (VPPs) that can reduce the need for new energy supply or transmission by distributing where and when electricity is used. A VPP works by drawing on a network of energy resources like the solar panels on someone's house, WIFI-enabled heat pumps, or the battery of a plugged-in electric vehicle to meet peak demands for electricity and reduce the need to build more physical power plants. Via their smart technologies, VPPs can manage energy demand and reduce costs for consumers.

Policies like the Inflation Reduction Act (IRA) are already supporting this transition. Additional resources for long-distance, high-voltage transmission lines, increased interconnection, and grid-enhancing technologies are critical to further accelerating it.

Electricity demand is growing for the first time in a decade, with renewable sources poised to meet much of the new demand.

Estimates project that U.S. electricity consumption will grow roughly 1% per year and up to 15% over the next three decades. Electricity demand is expected to rise given the growth of industries with high electricity use—such as data centers (including for artificial intelligence), manufacturing, and chemical and hydrogen production—and because of the electrification of consumer electronic devices and home appliances.

Electric vehicle adoption could increase total U.S. electric demand by 38% by 2050, while their battery storage could also provide an immense benefit to the electric grid. The International Energy Agency recently projected that record clean energy growth from nuclear, wind, solar, and hydropower will offset this rising power demand. In the United States, projected increases in renewable energy consumption between now and 2050 should more than account for projected energy consumption increases, per EIA data shown below. Nuclear energy also provides essential baseload power—generation that can run around the clock—which is especially important when extreme weather events threaten the grid.



Long-distance transmission and increased interconnection are needed to manage growth and connect more renewables to the grid.

As demand increases, increased energy supply, especially from renewables, will need to be added to the grid. The volume of projects that are waiting to be added to the grid (or interconnected) has overwhelmed the United States' old system used to connect new electricity sources to homes and businesses. Interconnection approvals for the nation's largest regional grid now take an average of four years. That is double the median wait time for projects built in 2000-2007. Research from Lawrence Berkeley National Laboratory has also shown that only 23% of proposals actually make it through the interconnection queue and that completion rates are even lower for solar and wind projects. The U.S. Energy Information Administration said Texas had to curtail 5 percent of its wind power and 9 percent of its solar power in 2022 because there was not enough transmission to take it to the urban load centers. Without any grid upgrades, those numbers could rise to 13 percent of wind and 19 percent of solar by 2035. The lack of transmission is the core problem driving these delays.

Building more long-distance transmission lines can help connect the energy generated to markets where it is in higher demand. The Department of Energy (DOE) recently released a

National Transmission Needs Study to inform where these transmission investments are most valuable. The Southline Project, for example, will move clean energy from wind in New Mexico to cities in Arizona, while other projects will support transmission in the Northeast and elsewhere in the Southwest. The SunZia project, which will move renewable energy from New Mexico to Arizona and California, recently broke ground. Once built, it will be the largest renewable energy project in the Western Hemisphere. Given that interregional transfer capacity needs to grow by 114% to meet future energy demands, with particularly high growth needs in the Southwest, these investments are important but insufficient alone.

Two tools that can help increase energy supply are community benefit agreements, which help smooth approval of new projects, and grid-enhancing technologies.

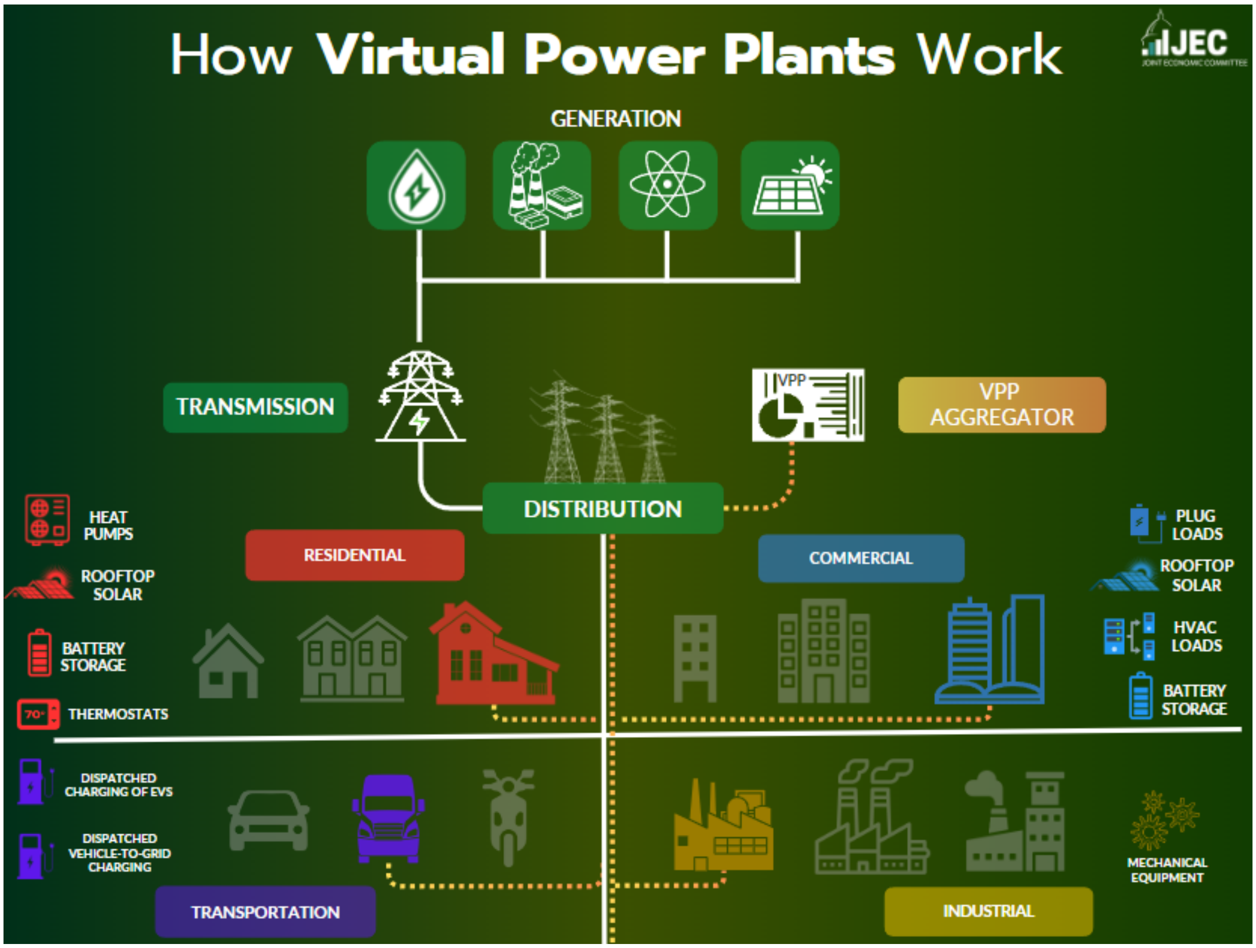
The United States could save more than $1 billion per year by deploying more transmission between the largest U.S. grid operators to allow more affordable energy to move across the country. Community benefit agreements (CBAs), legal agreements between community groups and developers that stipulate the benefits a developer agrees to fund or provide to a community, can help new projects get off the ground by garnering local buy-in and support. CBAs can guarantee local benefits, such as local job creation and training, economic trust funds, and revenue sharing or ownership configurations.

To get more out of existing transmission, grid-enhancing technologies (GETs) can enhance asset utilization, better manage congestion, and minimize curtailments of generation resources. Advanced conductor cables and dynamic line ratings are two examples of GETs that can accelerate the clean energy transition by getting more energy out of our existing grid. A recent study showed that GETs could help bring 6.6 GW of clean energy online in five states by 2027 while saving a little under $1 billion each year.

Managing peak electricity demand through VPPs can help reduce the need for new energy development and lower consumer costs.

Increased electrification will also increase peak demand —the maximum amount of electricity the power grid must provide at the time of day when demand is highest. Policymakers and electricity providers can design incentives to shift when this energy demand for things like EV-charging is at its peak. For example, electric vehicles that are charged at residences can be programmed to charge overnight when power demand is lower, which avoids straining the grid in the evenings when electricity demand is usually highest. This can be one part of a VPP. Policymakers could also improve daytime charging options to better align with solar generation for cars that are charging during the daytime.

VPPs offer another way to bolster the grid by aggregating the distributed energy of hundreds or thousands of homes and managing energy demand, such as through the timing of EV charging, while lowering consumer costs. VPPs are not virtual at all, but instead refer to this aggregation of distributed, grid-interactive electric devices, such as rooftop solar, batteries, EVs and their chargers, and smart devices such as water heaters and thermostats. VPPs enroll owners of these devices (including residential, commercial, and industrial consumers) into a range of reward models for their participation, including bill credits for energy sent back to the grid or for lowering demand during peak times. Some types of VPPs can also provide baseload power as well.



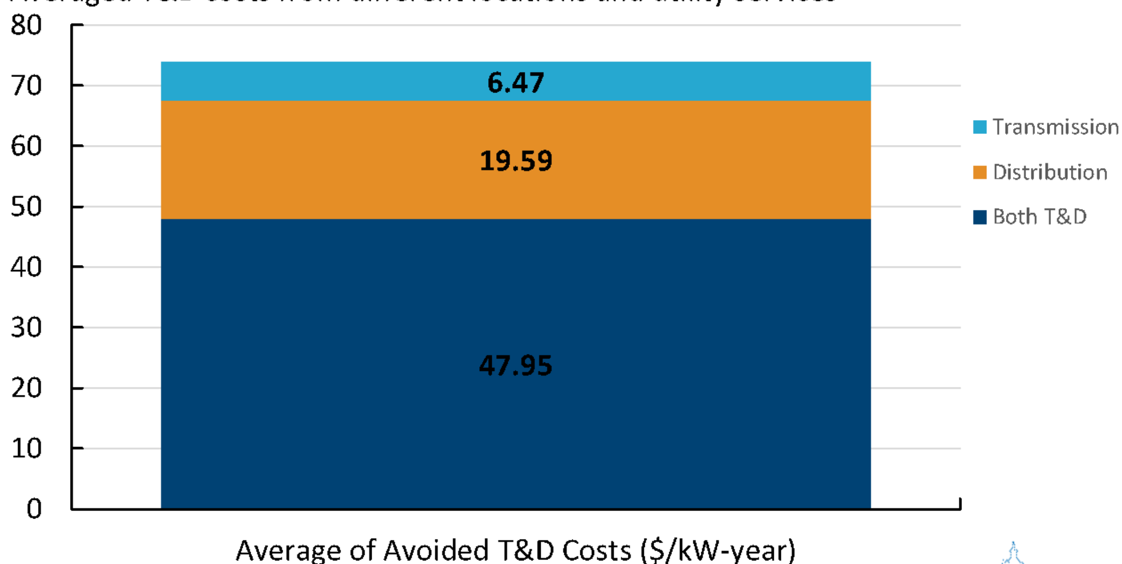
VPPs also improve grid reliability and resilience. VPPs that include battery storage allow electric utilities to wall off parts of the grid during emergencies. VPPs also allow for demand management during extreme events or heat, minimizing the need to build new peak energy generation. Decreasing power plant pollution, especially from natural gas-fired “peaker” power plants that come online when there is particularly high electricity demand, like on very hot days, is essential for minimizing negative health impacts. These health consequences disproportionately impact people of color and those with low incomes who often live in the vicinity of these plants.

Tripling the current scale of VPPs to 80 – 160 GW by 2030 could support accelerated electrification while redirecting grid spending from peaker power plants to participating consumers and decreasing grid costs by approximately $10 – 17 billion per year. Deploying VPPs at this scale would account for 10-20% of peak demand; though, coverage would be higher in some places than others. VPPs are already experiencing large growth, and more is expected by 2030. For example, Green Mountain Power, Vermont's largest utility, expanded its subsidized home battery program or VPP last year, which can also provide emergency power during outages. Three utilities in Massachusetts have implemented VPP programs that pay customers in exchange for utility control of their home batteries, and efforts in Colorado are close to launching their first VPP program. A startup installer and financier of distributed energy storage recently acquired a regional installer in the Carolinas and Georgia to move into new markets.

These increases in VPP uptake are particularly important because VPPs can provide the same resource adequacy as gas and batteries at a significant cost discount. After accounting for the avoided emissions, increased grid resilience, and fewer infrastructure needs, it would cost only $2 million to produce 400 MW of electricity using a VPP, compared to $43 million using natural gas and $29 million using expanded batteries.

Avoided Transmission and Distribution Costs With Increased Virtual Power Plant Uptake

Averaged T&D costs from different locations and utility services



Source: Brattle, Real Reliability: The Value of Virtual Power, May 2023

JEC

Policies and investments are already supporting the energy transition, and many current policy proposals would support a more efficient and flexible grid.

Many policies, including the IRA, are already directing substantial resources to support clean energy supply and demand needs. The IRA's Residential Clean Energy Credit provides a tax credit for local solar, wind, geothermal, and battery storage that in many cases can become part of flexible energy demand management. The IRA also allocates $362 million in funding for smart buildings through commercial energy efficiency tax deductions. Investments are flowing from DOE's Energy Grid Resilience and Innovation Partnerships for batteries and microgrids.

More policies to increase transmission and support grid-enhancing technologies and household-level renewable energy and electrification could accelerate transmission, bolster the grid, and lower costs. Seven proposed bills in the 118th Congress address this need. These include Chairman Heinrich's Grid Resiliency Tax Credit Act to provide tax credits for large scale transmission projects and grid-enhancing technologies, the BIG WIRES Act to mandate minimum interregional transmission transfer capacity, and the Promoting Efficient and Engaged Reviews Act of 2023 (PEER Act) to establish cost-allocation and transmission planning processes that include grid-enhancing technologies. Chairman Heinrich's Streamlining Homeowner Installation of New Energies (SHINE) Act would accelerate the process for residents to set up home energy systems, like solar. Additionally, Chairman Heinrich's FASTER ACT aligns government, developer, and community incentives to improve and accelerate the siting, planning, and permitting process for interregional transmission.

As renewable energy capacity and transmission increases, there is also an opportunity to provide energy access and the related economic benefits to people and places with little or no electricity. This is especially problematic in rural areas, as well as for Tribal communities where 54,200 American Indian and Alaska Natives live without electricity. Low-income households have also been slower to adopt clean energy technologies because they may have difficulty financing projects due to insufficient savings or low credit scores. Home electrification rebates funded through the IRA can support the expansion of clean energy and VPPs, and the Biden administration has focused on an equitable roll-out.

The Biden administration is offering bonus tax credits for clean energy investments in low-income or tribal areas and providing billions to increase access to residential solar. A grid with many distributed resources, like VPPs, is also predicted to support many more jobs than a utility-only one. More skilled trades workforce development, such as through pre-apprenticeship and worker-serving community-based organizations, would support this expansion.

While electricity demand is growing for the first time in decades, renewable energy is poised to meet much of that demand. To enable increased electricity on the grid, community benefit agreements would smooth new energy development, and GETs would allow the United States to get more energy out of existing infrastructure. Virtual power plants can also be scaled up to help manage increasing peak energy demand, make the grid more resilient to extreme events, and save consumers money.