



World Economic Forum

In collaboration with Accenture

Shaping the Future of Energy & Materials
System Value Framework – US Market Analysis
October 2020

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System Value of the clean energy transition in the United States

The System Value framework more holistically evaluates economic, environmental, social and technical outcomes of potential energy solutions across markets. The framework aims to **shift political and commercial focus beyond cost to include value**.

Using the System Value framework, the World Economic Forum, supported by Accenture, conducted analysis across several geographies as part of market evaluations that examined recovery opportunities to accelerate economic growth and the clean energy transition.

Key system value dimensions for the US have been prioritized across the framework based on current market dynamics and its relative maturity of transition towards net-zero integrated energy system.

Economic, environmental, societal and energy value



Priority outcomes for US system

United States recovery solutions

Solutions to improve resiliency

Renewables Expansion

Proposed multi-year extensions of the investment tax credit (ITC) and production tax credit (PTC) could increase **solar** capacity by 25% (+33 GW) and **onshore wind** by 14% (+22 GW) over 2025 base case projections, with additional ITC, process and infrastructure support able to expand the nascent **offshore wind** industry (+11 GW).



Transmission Investment

Potential to increase renewable deployment, wind capacity by 11% (+18 GW) and solar by 2% (+3 GW) in 2025, through **transmission expansion, interconnection and reinforcement**.



Efficiency Investment

Replicating the investment level of the 2009 US Recovery Act, the US could achieve efficiency gains through implementing **smart buildings and energy infrastructure**, keeping energy costs low for consumers.



Electrification and Demand Optimization

Greater support for **battery storage systems, road transport electrification and electric heat pumps** can boost system flexibility and reliability while cutting emissions.



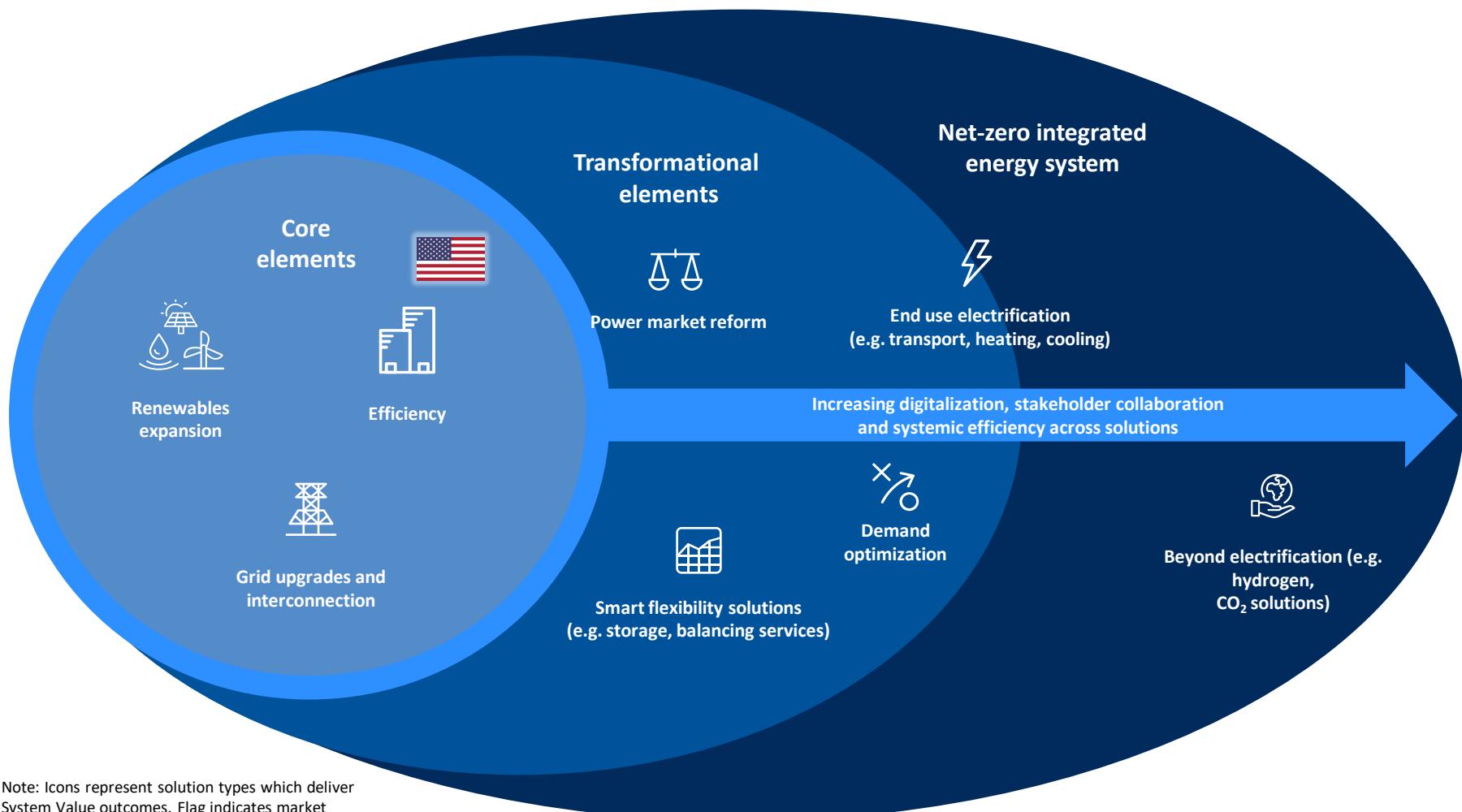
Note: Above CO₂ and human health benefit figures represent cumulative, incremental savings in addition to 2025 base case projections.

US path to maximize System Value

Markets are moving from addressing core elements of the electricity sector transition...

...through “pivot points” where generation mix hits 20%-30% annual variable renewables (>50% instantaneous) and transformational elements enable...

... acceleration to a net-zero integrated energy system with a strong focus on systemic efficiency



The US is at a pivot point in three large markets (CAISO, ERCOT, SPP), but **much of the US is in core transition**

Recovery solutions deliver against **core transition elements**, with some movement towards the pivot point

State net-zero goals are pushing the US towards a future integrated energy system



Analysis purpose and overview

The World Economic Forum, supported by Accenture, has developed the **System Value framework** to move beyond cost to a **more holistic evaluation** of energy sector opportunities **across economic, environmental, societal and energy system value dimensions**.

The US electricity market was one of several markets chosen to demonstrate how the System Value framework can be used to evaluate opportunities that **accelerate economic recovery and a clean energy transition**.

The following analysis of the US electricity market aims to answer several key questions for energy industry leaders and can be leveraged to consider opportunities to pursue and prepare for conversations with a range of stakeholders.

- What is the state of COVID-related stimulus and recovery activity at the US federal level?
- What short- to medium-term growth opportunities exist that can spur economic recovery and accelerate the clean energy transition?
- How can stakeholders move beyond a cost-centric dialogue to consider the value of outcomes to the economy, environment, society and energy system?



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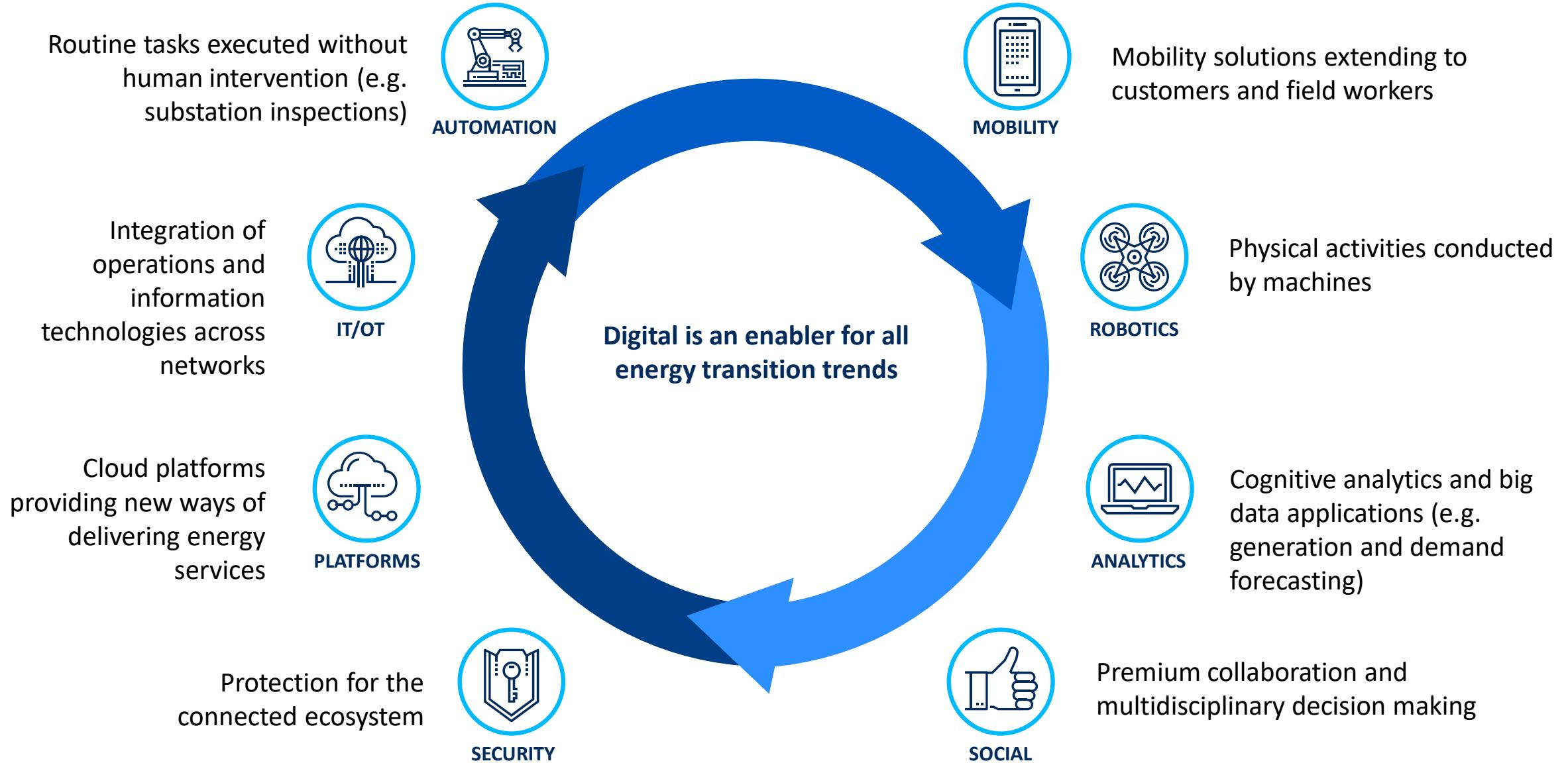


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Energy transition trends shaping the US electricity industry

Digitalization	<ul style="list-style-type: none">Increasing electrificationGrowth of green technologyNetwork of the futureEnterprise customer goalsConsumer activismInvestor activismCities in transitionInvestment in clean energy technology
	<ul style="list-style-type: none">Buildings: Smart, efficient electric appliances changing the load profile of buildings; heating/cooling also being electrified.Mobility: Electrification of passenger vehicles and fleets. Heavy duty transport exploring electrification and Power-to-X options.Industry: Electrification of light industrial applications and Power-to-X applications beginning to support new net-zero carbon goals of heavy industry and agriculture.Utility-scale renewable generation: New capacity is dominated by utility-scale renewables.Distributed energy generation: Decreasing costs driving increase in rooftop PV, batteries and microgrids.Energy efficiency technologies: Decreasing and controlling consumer demand, and therefore the need for new capacity.Resilient grid: Pressure to ensure power supply, withstand intense environmental events and cybersecurity threats.Flexibility: Need for greater flexibility through storage, matching forecasting to variable generation, increased interconnection and demand management.Development: Reinforcing or building out new grid capacity, often in face of customer NIMBY objections.Corporate sustainability goals: 200+ companies have made 100% renewable commitment as part of RE100 initiative.PPA growth: Increasing share of wind and solar development financed by industrial and commercial customer commitments.Energy management: Growing interest in site-level energy data and analysis to optimize energy usage, purchases and generation.Youth activism: Youth-led climate activist groups such as Sunrise Movement impact political conversation and proposals.New values beyond price: Additional considerations motivate consumers, from buying green electricity to efficiency.Digital expectation: Consumers, influenced by other industries and companies, expect seamless digital interactions.Greater choice: Consumers adopt a more active role, increasing self supply and optimizing consumption.Sustainable generation scrutiny: Activist investors target electric utilities to accelerate decarbonization efforts.Pressure on financiers: Activist investors put pressure on banks to limit or halt financing for carbon intensive projects.Investors going green: Large investors BlackRock and Vanguard pledge to include sustainability in investment criteria.Systemic efficiencies: Increased focus on building electrification, new green mobility and cross-sector efficiency optimization.Net-zero and air quality: From transit to buildings, cities move to net-zero and circular economy principles, improving air quality; more than 100 million people live in communities with a 100% renewable electricity target through efforts such as Sierra 100.Wired well-being: City digital solutions and public space design broaden utility infrastructure use, e.g. broadband, 5G.Driving down costs: Investments to drive down cost and scale technologies, e.g., hydrogen production, transport and use; 10 MW+ electrolyzers; lithium ion batteries; CCUS; floating offshore wind.R&D in new technologies: New clean energy technology, i.e. storage technologies beyond lithium-ion, new materials.

Digitalization underpins the energy transition



US COVID-19 impact on energy transition trends

Digitalization



Increasing electrification

- **Building gas ban momentum slows:** COVID-19 slows momentum of local government bans of natural gas in new building construction.



Growth of green technology

- **Distributed generation tumbles:** US distributed solar installations hit hard, with Q2 2020 residential installations down 23% compared to Q1 2020.
- **Energy efficiency pauses:** Non-essential utility work suspended, affecting energy efficiency efforts in the short term.



Network of the future

- **COVID-19 shifts load:** Load impacts differ by geography but often include later morning peaks.
- **Record share of renewables:** Share of renewables tops coal in US for a record 40 consecutive days.
- **Lower load impacts curtailment:** Renewables share rises due to lower demand, with CAISO reporting in March 2020 a 5%-8% drop in demand on weekdays and record levels of renewable curtailment on the system.



Enterprise customer goals

- **PPA market slowdown:** COVID-19 decreases PPA activity in short term, although new corporate sustainability pledges continue.
- **Cash-strapped companies:** Many segments – products, manufacturing, financials, transport, infrastructure – may not be in a solid financial situation to move forward with PPA deals.
- **Supply chain impacts:** Delays to equipment and labor put tax credits at risk.



Consumer activism

- **Remote workforce:** 30% of workers plan to increase the amount they work from home in the future. Half of those who had never worked from home before now plan to work from home more often in the future.
- **Digital adoption:** With COVID-19 accelerating customer digital adoption and a reliance on digital communications, companies will need to ensure positive customer experience across all customer groups, including elderly and income challenged.



Investor activism

- **Opening for activists:** The pandemic provides activists and shareholders a chance to make the case for changes to investment strategy around energy, with causal links between air pollution levels and COVID-19 fatality rates.



Cities in transition

- **Air pollution drops:** PM2.5 levels fall by 25% in New York City and 31% in Los Angeles in April due to less traffic and industry.
- **Budget shortfalls:** Nearly 90% of US city leaders anticipate budget shortfalls in 2020, affecting city services and staffing.
- **Population conditionality in stimulus:** Direct federal stimulus in March 2020 was limited to cities and counties with populations larger than 500,000, although some states funneled money to smaller municipalities.



Investment in Clean Energy Technology

- **Eyes on stimulus and infrastructure packages:** 2009 Recovery Act put forward billions of dollars in federal funding to support clean energy R&D and led to significant clean energy expansion in the following decade.

COVID-19 impact on US electricity market

As of September 2020, EIA projects year-over-year retail electricity sales for 2020 to fall 2.4%, primarily affecting coal generation and caused by lower demand from commercial and industrial (C&I) sectors.

Demand drops for C&I, rises for residential

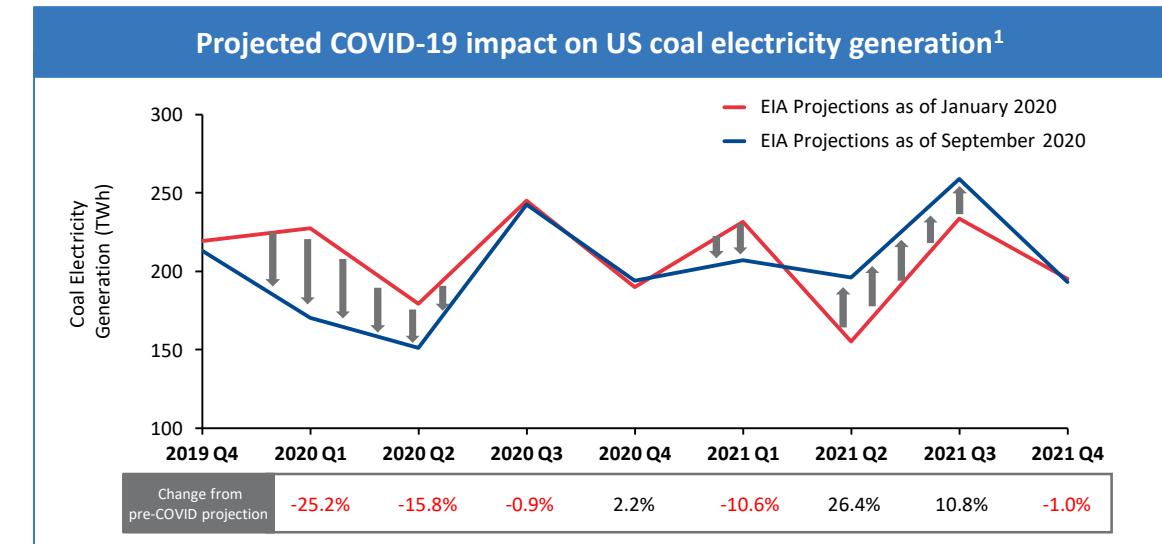
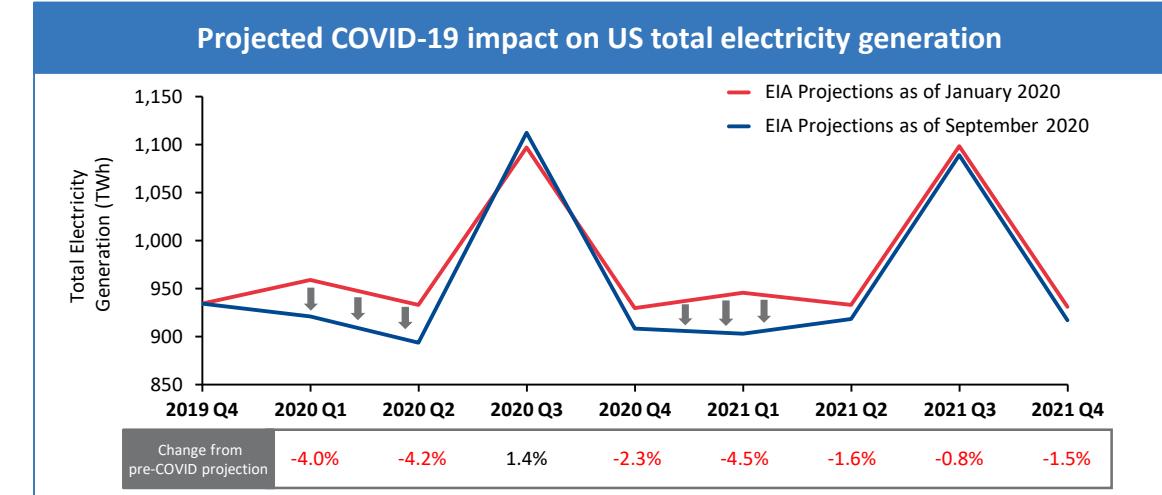
- Year-over-year electricity consumption changes
 - Residential to rise 3.5%
 - Commercial to drop 6.4%
 - Industrial to drop 6.0%
- Coal generation share expected to fall from 24% in 2019 to 20% in 2020 as cost-competitiveness lags
- Renewable generation share forecast to increase from 17% in 2019 to 20% in 2020, matching coal's share

Share of renewables in generation mix to match coal

- Renewable additions hurt in the short term by supply chain impacts, worker restrictions and tax equity market
- Distributed solar installations particularly affected, with Q2 2020 residential installations down 23% compared to Q1 2020
- When electricity demand from commercial and industrial segments will return close to pre-COVID-19 state is uncertain as COVID-19 impacts continue
- Questions surround economic viability of coal plants and if COVID-19 will accelerate closures

Wind and solar deployments slow

Recovery timing uncertain



Sources: EIA September 2020 Short-Term Energy Outlook; EIA January 2020 Short-Term Energy Outlook; Solar Energy Industries Association (SEIA); GreenTech Media

¹ September 2020 EIA Short-Term Energy Outlook, pg. 4: "EIA expects production to rise to 600 million short tons in 2021, up 89 million short tons (17%) from 2020. This forecast increase reflects rising demand for coal from US electricity generators because of higher natural gas prices compared with 2020."

COVID-19 impact on US clean energy jobs

Through July 2020, US clean energy jobs declined by 15% versus pre-COVID-19 employment levels, with jobs starting to return to both clean energy (10k+ increase) and the overall US economy (1.8m increase) in July.

Total clean energy job losses stood at more than 500,000 as of July 2020

- More than 500,000 US clean energy workers lost their jobs from March through July 2020
- June and July 2020 saw recovery with over 116,000 clean energy job additions
- Impacted workers are even higher than reported figures as furloughed and underemployed workers are excluded

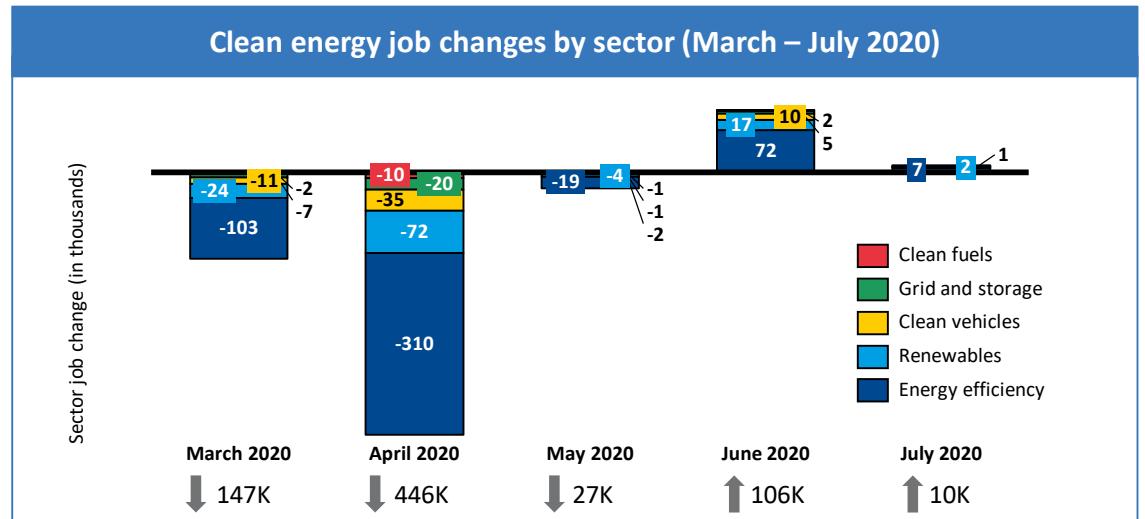
Energy efficiency and renewables jobs hit hard

- Energy efficiency represented 70% of clean energy job losses from March through June 2020, losing more than 350,000 jobs
- Job losses from the renewables sector amounted to 16% of total clean energy job losses from March through June 2020, losing more than 80,000 jobs

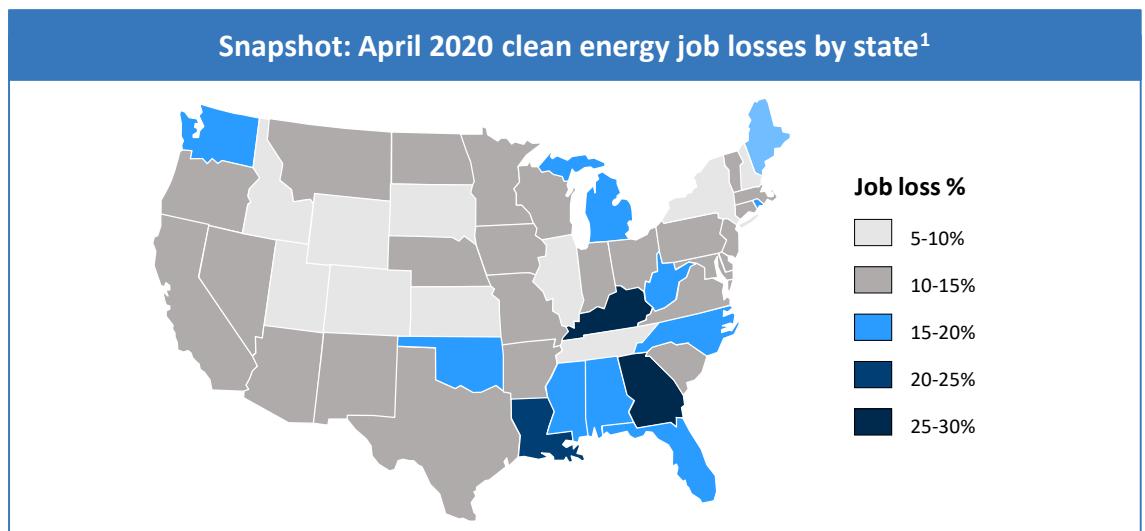
Hispanic/Latino clean energy workers most affected

- Hispanic and Latino clean energy workers are the hardest-hit demographic
- The US clean energy workforce is about 14% Hispanic/Latino, but an estimated 25% of the job losses in the clean energy industry through April were Hispanic/Latino workers

Clean energy job changes by sector (March – July 2020)

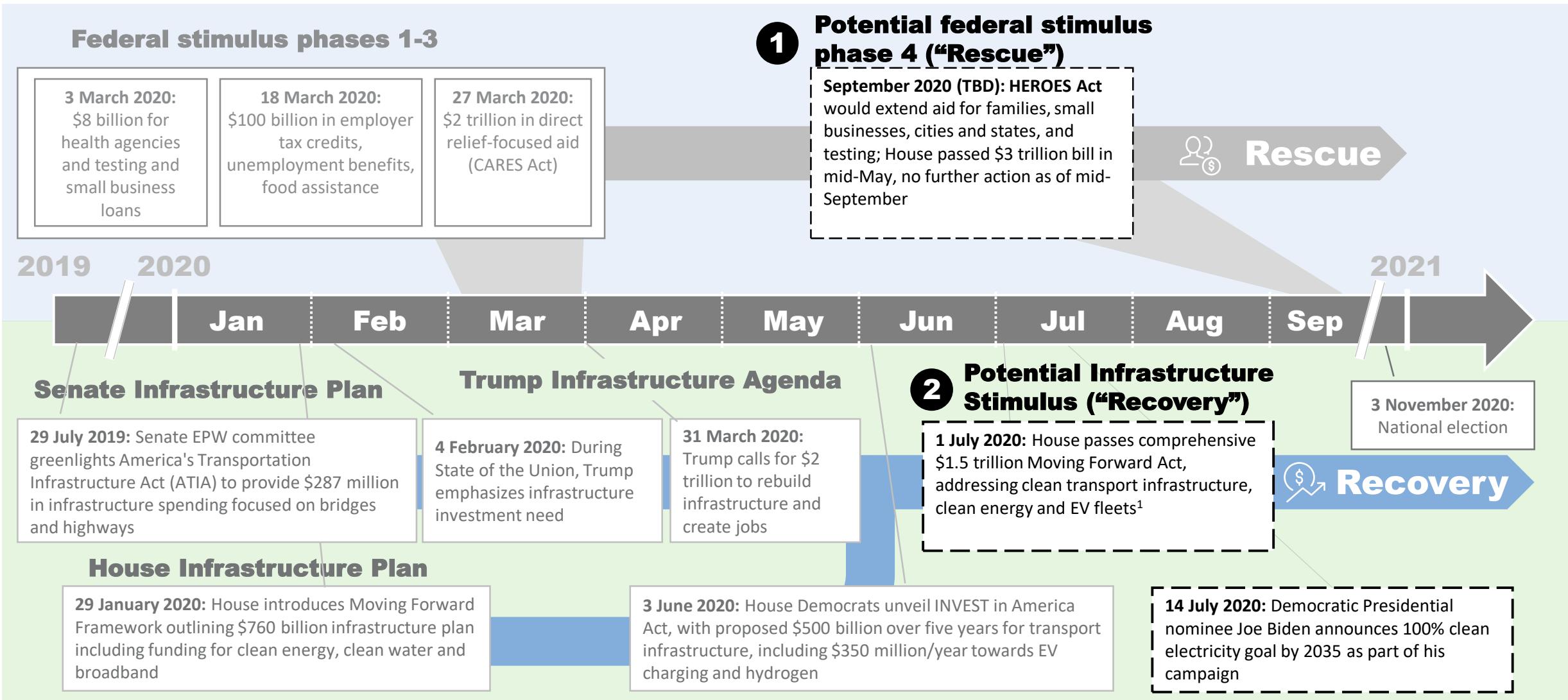


Snapshot: April 2020 clean energy job losses by state¹



US federal stimulus timeline

As of September 2020, recovery-targeted legislative proposals have been put forward through infrastructure bills, most notably the Moving Forward Act, which passed the House of Representatives in July 2020, although none have received votes in both chambers.



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Recovery solution selection criteria

Selected recovery solutions are required to meet the following criteria:

- 1 Accelerates the energy transition

The solution moves the market closer to net-zero emissions



- 2 Stimulates economic recovery

Implementation of the solution should stimulate job creation by 2021+

- 3 Enables meaningful System Value assessment

It should be possible to model and assess the solution for meaningful results within a 2025 time horizon

Recovery solutions can support US post-COVID-19 economy and advance the clean energy transition

	Renewables Expansion	Transmission Investment	Efficiency Investment	Demand Optimization and Electrification
Solution overview	Multyear proposed extensions of ITC and PTC can increase solar capacity by 25% and onshore wind by 14% over 2025 base case projections, with additional process and infrastructure support to expand nascent offshore wind industry	Greater investment in transmission has the potential to increase wind capacity by 11%, stimulate job creation and create net benefits for consumers and the environment	Building on the 2009 US Recovery Act's success, tens of thousands of people can be put back to work quickly to achieve efficiency gains and keep energy costs low for consumers	With more renewables, the potential for clean electrification of buildings, mobility and industry grows. Greater emphasis must be placed on matching energy mix to load profiles through digitalization, demand optimization and storage
Capacity and generation impact	<ul style="list-style-type: none"> 66 GW incremental solar and wind capacity through 2025¹ Replaces 291 TWh of coal through 2025 (7% of 2021-2025 base case total) 	<ul style="list-style-type: none"> 21 GW incremental wind and solar capacity through 2025 Replaces 121 TWh of coal through 2025 (3% of 2021-2025 base case total) 	<ul style="list-style-type: none"> Duplicating \$20 billion energy efficiency investment from 2009 Recovery Act replaces 103 TWh of coal through 2025 (2.6% of 2021-2025 base case total) 	<ul style="list-style-type: none"> 300 MW of incremental annual storage from ITC 7-13 TWh of increased load by 2025 from heat pumps (0.7-1.4m), public EV fleets (100-200k), E-buses (10k)
CO ₂ emissions	 300 Mt Cumulative reduction in base case electricity emissions through 2025 ² , 152 Mt or 11.3% reduction in 2025	 121 Mt Cumulative reduction in base case electricity emissions through 2025, 66 Mt or 4.9% reduction in 2025	 103 Mt Cumulative reduction in base case electricity emissions through 2025, 26 Mt or 1.9% reduction in 2025	 5-9 Mt Reduction in CO ₂ emissions through 2025 across transportation, buildings and energy
Water footprint	 512bn liters Cumulative reduction in water footprint through 2025	 212bn liters Cumulative reduction in water footprint through 2025	 183bn liters Cumulative reduction in water footprint through 2025	<i>Not included in analysis</i>
Jobs impact	 >250k Economy-wide jobs in 2025	 60-110k Annual economy-wide jobs	 550k Total one-year jobs created through 2025	 22-25k Additional industry jobs through 2025
Human health	 \$34bn Human health benefits through 2025 from decreased air pollution ³	 \$14bn Human health benefits through 2025 from decreased air pollution	 \$12bn Human health benefits through 2025 from decreased air pollution	 \$2bn Human health benefits through 2025 from decreased air pollution
<p>While not included in above solutions, <i>hydrogen and carbon capture, utilization and storage (CCUS)</i> technologies hold significant promise as key components to achieve decarbonization across the energy, transportation, and industrial sectors in the coming years. The US Department of Energy budget for hydrogen and fuel cell technologies stood at over \$200 million in FY19, and the IEA⁴ notes that the US is home to 11 of 20 global CCUS facilities under development as of June 2020, spurred by new investment incentives to expand and enhance the 45Q tax credit.⁴</p>				

Note: Above recovery solutions assume each is enacted in isolation. Base case generation and capacity figures from BNEF. Figures are rounded, summed totals. For additional analysis detail, please see solution slides.

¹ 66 GW incremental capacity addition is comprised of the following additions: 33 GW solar from ITC extension, 22 GW onshore wind from PTC extension, 11 GW offshore wind from industry support and ITC.

² CO₂ emission changes are relative to combined total from coal and natural gas, with percentages reflecting drop in 2025 emissions compared to 2025 base case. Mt = million (metric) tonnes.

³ Estimated human health benefits from reduced NO_x, SO₂, PM2.5 levels from lower fossil fuel generation.

⁴ IEA, US Department of Energy

ITC Extension: Solar

Overview

A five-year extension of the US Investment Tax Credit (ITC) is being sought by renewable industry groups such the Solar Energy Industries Association (SEIA) and members of Congress through the Moving Forward Act to help stimulate the US economy and advance the clean energy transition.

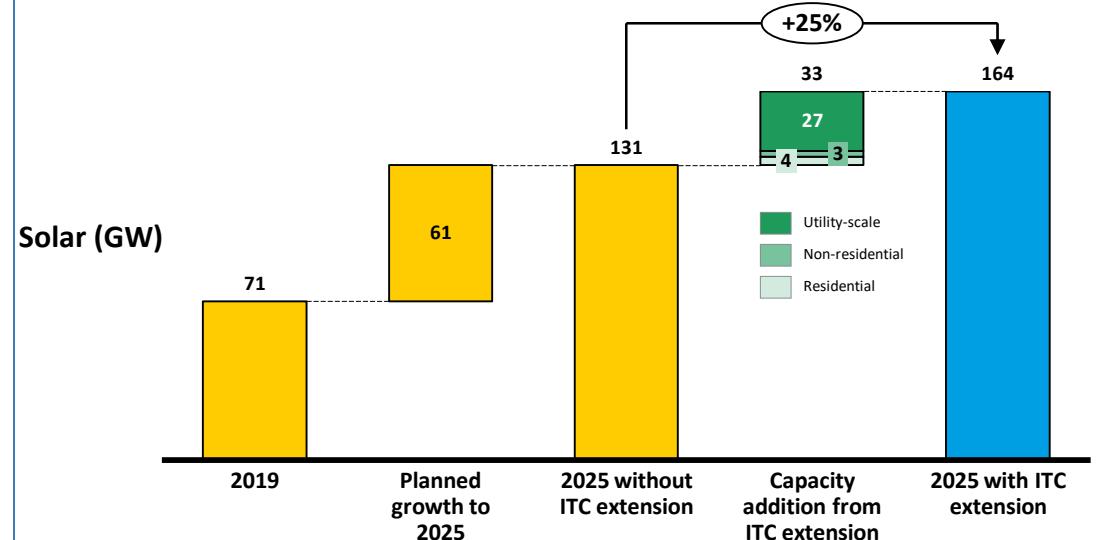
Benefits of solar ITC extension

If passed, a proposed five-year ITC extension would drive additional solar capacity beyond current projections across utility-scale, distributed non-residential and residential sectors. An estimated 33 GW of additional solar PV through 2025 could be added (26-27 GW utility-scale, 2-3 GW non-residential, 3-4 GW residential), a 25% increase over status quo projections.

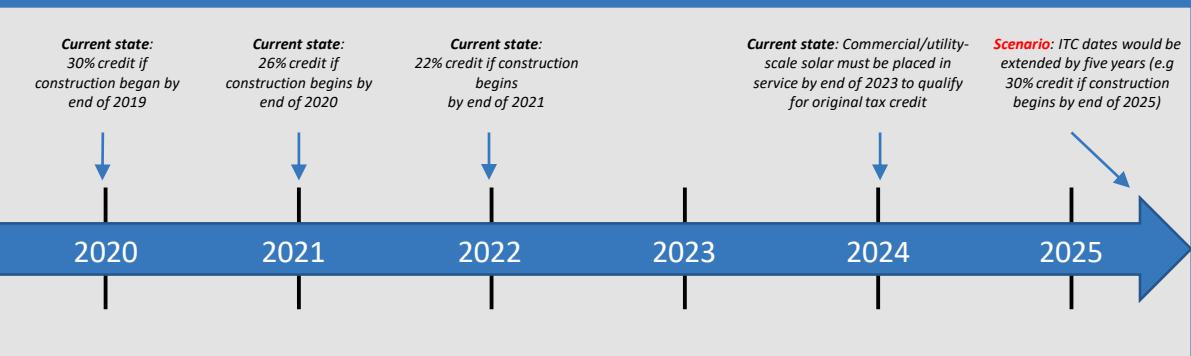
Increased solar capacity additions would decrease projected emissions and provide human health benefits from lower coal generation given the low marginal cost of solar. While the cost of the ITC to the federal government from incremental generation could exceed \$10 billion, estimated health benefits and job creation outweigh this cost.

Tens of thousands of solar-related jobs would be created as a result of the ITC extension, aiding the post-COVID-19 economic recovery.

Projected solar capacity additions from ITC extension



Current and proposed ITC timeline



System Value impacts of solar ITC extension compared to base case

Benefits	Costs
131 Mt	\$10-12bn
Cumulative reduction in base case electricity CO ₂ emissions through 2025	Present value cost to federal government of incremental solar ITC extension through 2025 ¹
209bn L	\$15bn
Cumulative reduction in base case water footprint through 2025 in liters	Human health benefits through 2025 from decreased air pollution
114k	\$114k
Economy-wide job impact in 2025	Human health benefits through 2025 from decreased air pollution

PTC Extension: Onshore Wind

Overview

In addition to the ITC, a five-year extension of the Production Tax Credit (PTC) is being sought to accelerate onshore wind development, with qualifying facilities able to claim the credit for the first 10 years of production. The current version of the PTC expires at the end of 2020, with two recent short-term extensions:

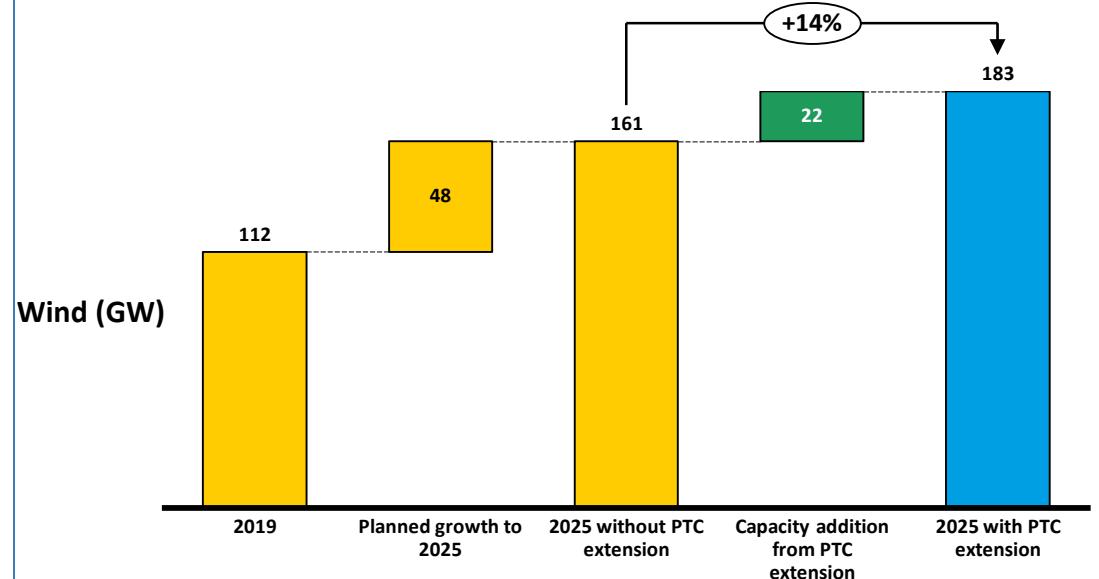
- At the end of 2019, the PTC was extended by one year to include onshore wind projects that begin construction by the end of 2020.
- In late May 2020, the US Internal Revenue Service (IRS) granted a one-year extension of safe harbor deadlines to help with COVID-related project delays.

Benefits of PTC extension

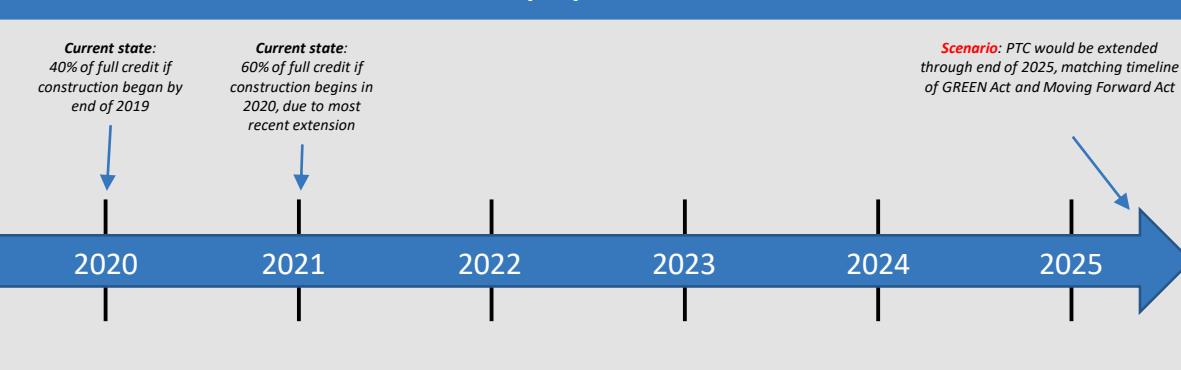
If passed, a proposed PTC extension could drive an estimated 22 GW of additional onshore wind capacity through 2025, a 14% increase over base case projections. While the cost of PTC to federal government from incremental generation is an estimated \$10 billion, health benefits and job creation are likely to outweigh this cost.

Increased onshore wind capacity would decrease projected emissions by lowering coal generation given low marginal costs. Additionally, tens of thousands of wind-related jobs would be created as a result of the PTC extension.

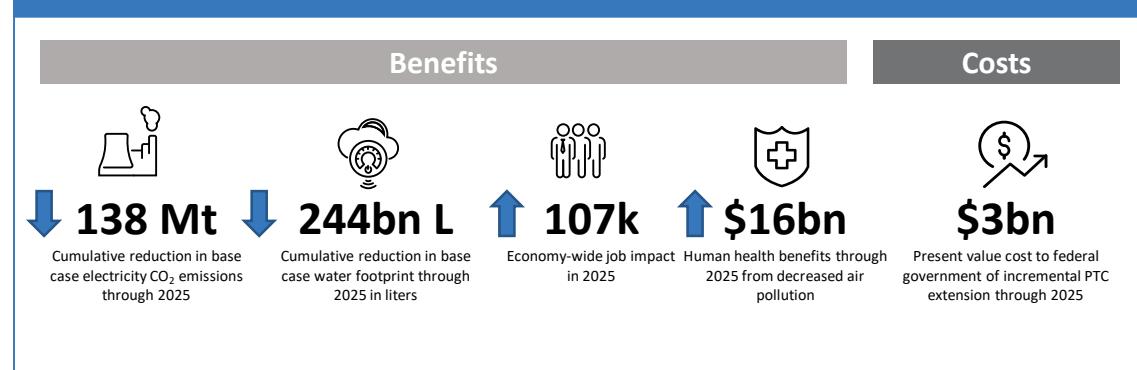
Projected capacity additions from PTC extension



Current and proposed PTC timeline



System Value impacts of PTC extension compared to base case



Offshore Wind (1 of 2): Industry Expansion

Overview

At the end of 2019, Bloomberg New Energy Finance projected nearly 3 GW of US offshore wind deployment by 2025. However, with only 30 MW of deployed capacity as of early 2020, the US lacks a significant domestic supply chain to support future growth.

With increasing state mandates, the US can improve processes and scale up the domestic supply chain, workforce and infrastructure to provide additional support to accelerate the industry and provide needed jobs. These actions can help realize AWEA's 9 GW base case projection for offshore wind capacity by 2025.

Opportunities to support the offshore wind industry

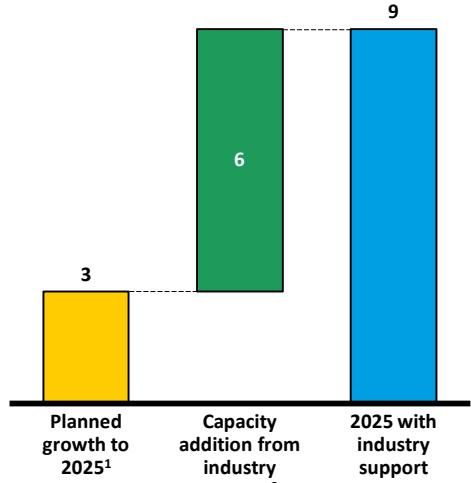
Several opportunities have been identified by AWEA, the Business Network for Offshore Wind, and UNLEASH to support US offshore wind in the near future:

- Add more regulatory review staff to the Bureau of Ocean Energy Management to reduce the backlog of offshore wind permitting documents currently pending review and accelerate project approvals
- Identify additional offshore wind lease areas and schedule adequate future offshore lease sales to reach established state goals
- Modernize shipyards to support construction and maintenance activities
- Have government agencies support talent development and training
- Subsidize capital investment in turbine component manufacturing facilities near East Coast ports that can construct larger turbines and towers

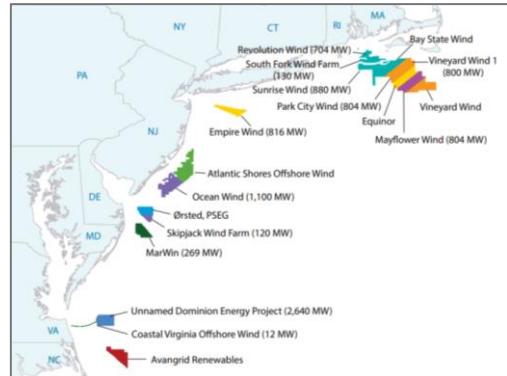
Local supply chain support

To date, local supply chain development has been an integral component of state energy policies to catalyze domestic offshore wind industry. States with active offshore wind procurement plans often explicitly treat the development of an in-state supply chain as one of the key non-price decision criteria. States can continue to support this development during COVID-19 recovery.

Projected capacity additions

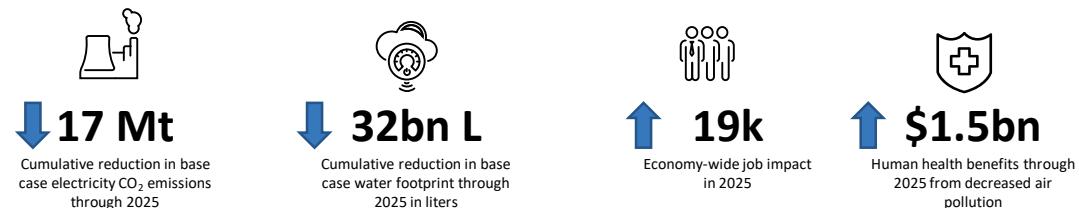


US East Coast offshore wind projects and lease areas



System Value impacts of offshore wind industry support compared to base case

Benefits



Offshore Wind (2 of 2): ITC Extension

Overview

In addition to supporting solar capacity expansion, the Moving Forward Act includes a five-year ITC extension to support offshore wind development. If passed, this extension could help drive additional offshore wind capacity to the higher range of current AWEA projections (14 GW by 2025).

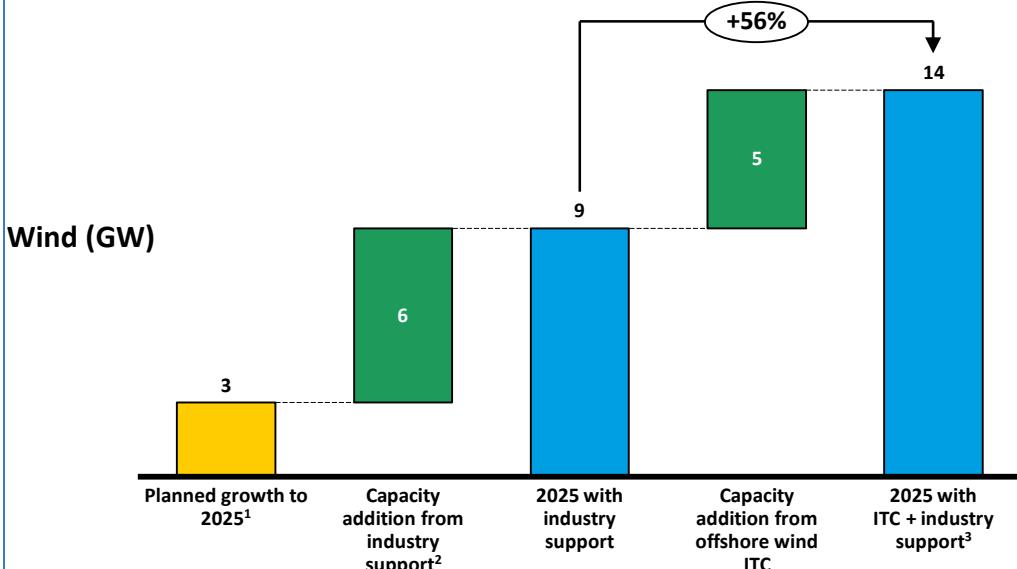
Benefits

The proposed five-year ITC extension could add an estimated 5 GW of additional offshore wind capacity through 2025. While cost of offshore wind ITC to federal government from incremental generation is an estimated \$13-15 billion, health benefits over the course of asset lifespan and job creation would likely outweigh this cost.

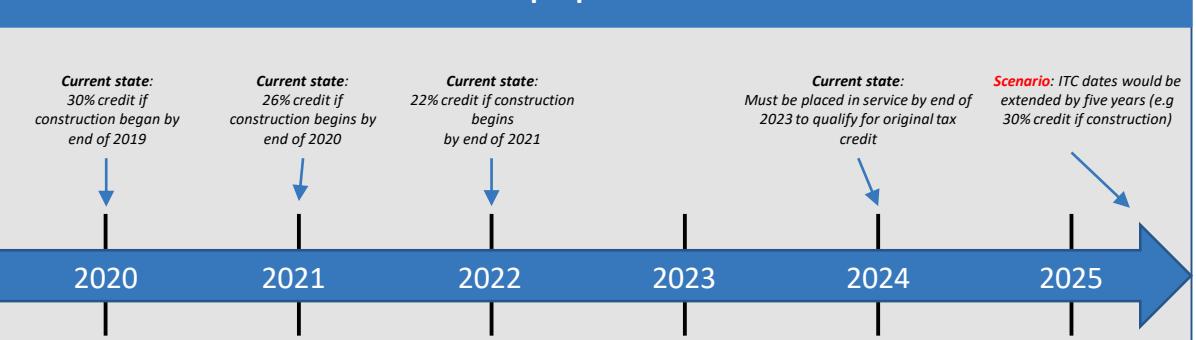
Increased capacity additions would accelerate the clean energy transition in the Northeast US and decrease projected emissions by lowering coal and natural gas generation given low marginal cost.

Although not included in this analysis, further reductions in natural gas and peaking plants are possible with two-way transmission of Canadian hydro and offshore wind in the Northeast US, with hydro serving as a balancing resource.

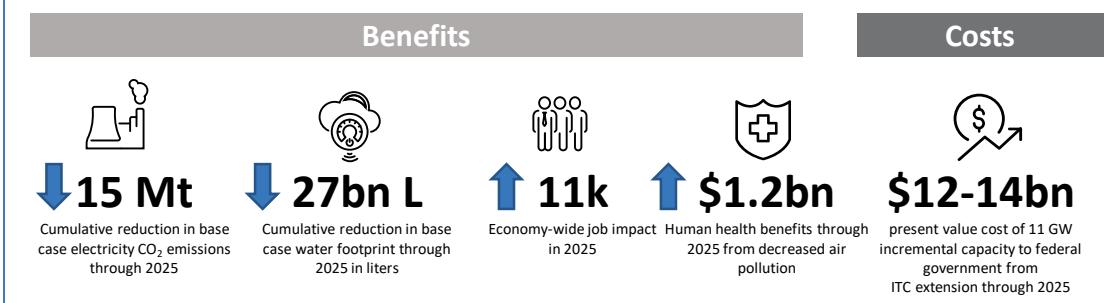
Projected offshore wind capacity additions from ITC extension



Current and proposed ITC timeline



System Value impacts of offshore wind ITC extension compared to base case



Sources: GreenTech Media (^{1, 2}); AWEA (^{1, 2}); Accenture analysis

¹ BNEF January 2020 figures, ² AWEA 2025 base case, ³ AWEA 2025 high scenario

Analysis and cost estimates assume transmission investment is part of the developer cost

Renewables Expansion

Transmission Investment

Efficiency Investment

Demand Optimization and Electrification

Transmission Investment

Overview

Greater transmission investment and process improvements being sought by industry groups such as AWEA have the potential to stimulate job creation, alleviate congestion and drive more renewable capacity, creating net benefits for consumers and the environment.

Benefits from transmission investment

- *Environmental benefit:* Greater interconnection lowers curtailment of renewable resources as high-potential resource areas often lie far from large population centers.
- *Economic benefit:* Transmission investment will add transmission and renewables jobs, enable greater system stability, and lower wholesale market prices.
- *Customer benefit:* MISO has calculated that new transmission benefits are 2.6-3.9 times their cost and provide \$13-50 billion in net benefits over the next 20 to 40 years.

Recommendations sought by industry groups to improve US transmission

- *Planning:* Require ISO planners to engage in forward-looking transmission planning, including integration of variable generation and storage that proactively includes public policy requirements established by state or federal laws or regulations, environmental regulations, market forces and new technologies.
- *Paying:* Transmission infrastructure can be furthered through broader cost allocation.
- *Permitting:* One of the main barriers is the difficult state siting process, which often requires multiple US states to approve lines. Establishing a workable US federal backstop siting authority for electric transmission lines could alleviate this roadblock.

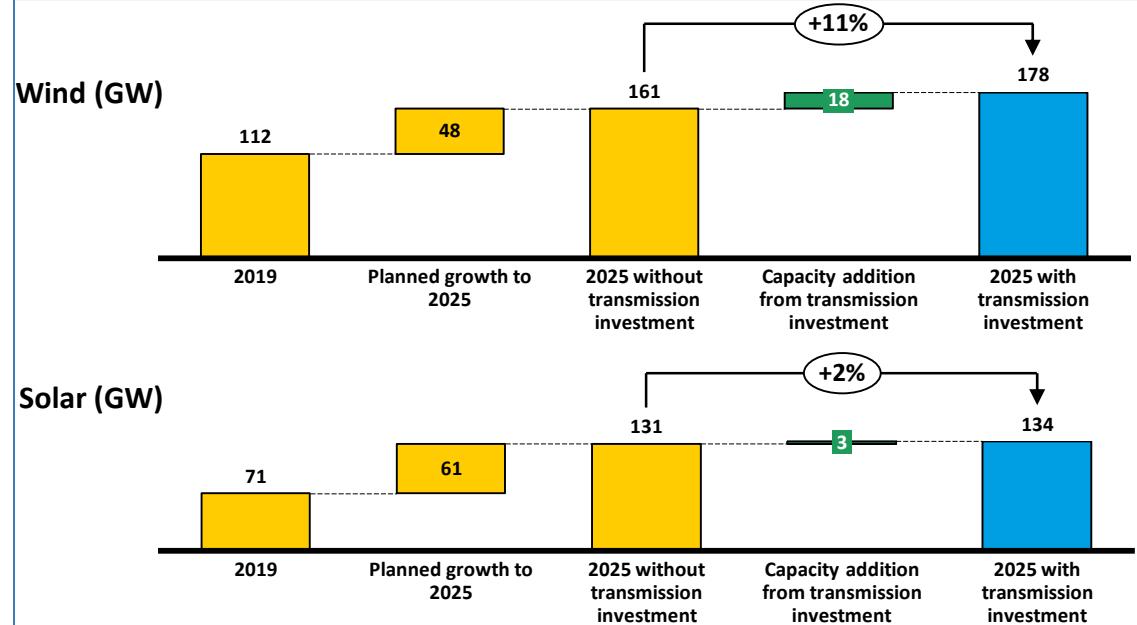
TSO-DSO collaboration

Greater TSO-DSO collaboration, increased investments in digitalization areas such as digital controls, and a shift to time-of-use (ToU) pricing can complement transmission and renewable investments for further system improvement.

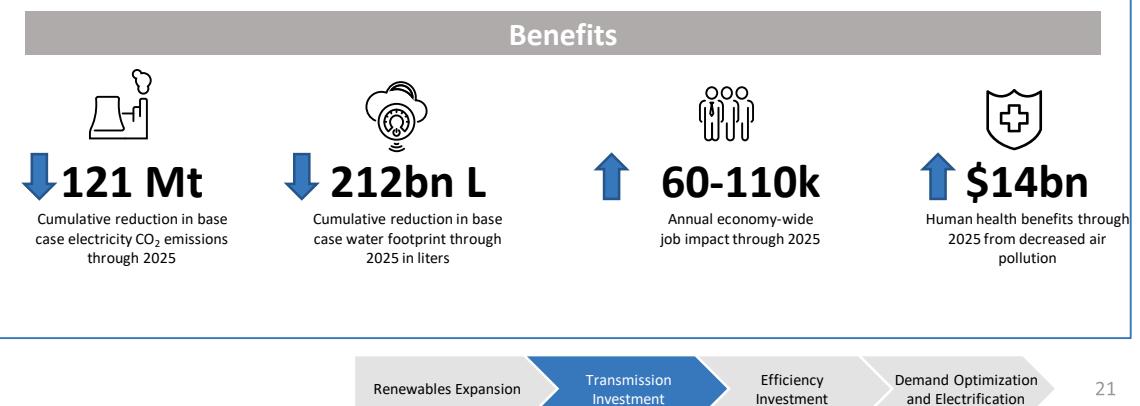
Cross-border projects between Canada and the Northeast US

Greater cross-border interconnection can provide load balancing, cost savings and carbon benefits at a regional level by linking hydro in Quebec with US offshore wind. Demonstrating value to residents in areas hosting transmission lines is a key factor.

Projected capacity additions from transmission investment



System Value impacts of transmission investment compared to base case



Efficiency Investment

Overview and definition

Energy efficiency employs more workers than any other clean energy field, nearly 2.4 million US workers pre-COVID-19. While social distancing guidelines must be top of mind, improving efficiency is a major prospect for recovery packages. For purposes of this evaluation, “efficiency” is defined as initiatives and actions that decrease energy usage, including energy conservation.

Assuming a \$20 billion investment towards energy efficiency similar to the American Recovery and Reinvestment Act of 2009 (ARRA or 2009 Recovery Act), the US could achieve a reduction of 103 TWh in generation in 2025, accelerating the reduction in coal generation.

2009 Recovery Act (ARRA) benefits

- Investment:** Nearly \$20 billion (22%) of ARRA’s \$90 billion in clean energy appropriations went towards energy efficiency to support jobs and clean energy transition.
- Job creation:** DOE study showed economy-wide gain of 62,000 jobs from \$2.28 billion of energy efficiency funding allocated through the Energy Efficiency and Conservation Block Grant Program (27 jobs per \$1 million invested).
- Energy savings:** ARRA support helped weatherize more than 1 million homes between 2009 and 2012.

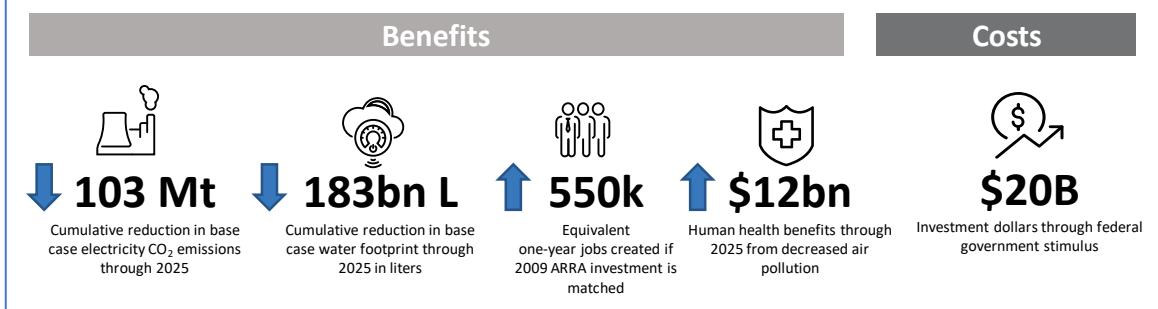
Efficiency opportunities for COVID-19 recovery

- School and university smart efficiency retrofits:** Smart building retrofit opportunity for schools and universities, with funding distributed to states and local jurisdictions through Block Grant Program (\$1 billion allocated to retrofits through Block Grant Program in 2009 ARRA)
- Weatherization Assistance Program:** Increased funding to help those hurt most by pandemic’s economic consequences (\$5 billion allocated in 2009 ARRA)
- Financial incentives:** Rebates, financing, and loan activities provide 2x energy savings over retrofits per dollar spent (\$480 million allocated to financial incentives through Block Grant Program in 2009 ARRA)
- Federal, state and municipal facilities:** Energy savings from smart technology and efficiency upgrades to government facilities will benefit US taxpayers (\$8.8 billion allocated in 2009 ARRA)

2009 Recovery Act clean energy allocations

Category	Initial allocation (\$B)
Renewable generation	\$26.6
Energy efficiency	\$19.9
Transit	\$18.1
Grid modernization	\$10.5
Advanced vehicles	\$6.1
Green innovation and job training	\$3.5
CCUS	\$3.4
Clean energy equipment manufacturing	\$1.6
Other	\$0.4

System Value impacts of efficiency investment



Demand Optimization and Electrification

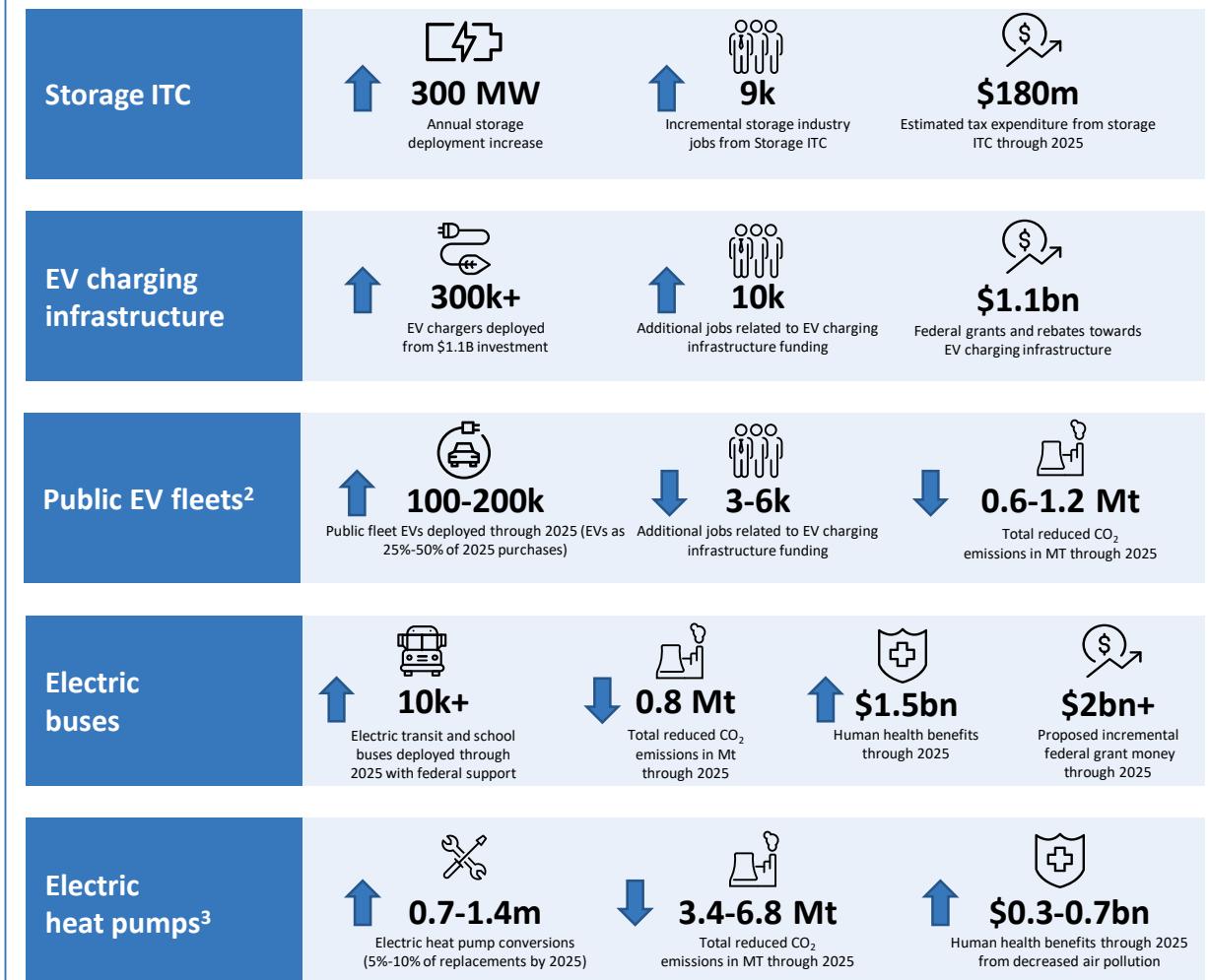
Overview

As more renewables are deployed, the clean electrification potential for buildings, mobility and industry grows. Greater emphasis on grid flexibility, achieved through increased digitalization, smart technology, demand optimization and storage, is needed. Additionally, physical and digital distribution system upgrades are necessary to deliver more variable generation, with 70% of US transformers more than 25 years old.

Demand optimization and electrification opportunities for COVID recovery

- Expand storage ITC:* US Storage ITC phases out in 2020; extending and expanding the storage ITC as proposed by the Energy Storage Association to include multiple stand-alone technologies has potential to increase annual deployments by 300 MW, according to Wood Mackenzie.
- Invest in EV charging infrastructure:* Proposed \$1.1 billion in federal grants and rebates could generate 10,000 jobs and deploy hundreds of thousands of chargers nationwide, with focus on designated EV corridors.
- Advance public EV fleets:* With over 1.3 million automobiles owned by US state, county and municipal entities, there is great potential for government entities to convert their passenger fleets to EVs, with California setting a 50% purchase goal by 2025.
- Increase funding of electric buses:* Building on state-allocated VW settlement funds, the US federal government can increase funding for electric bus deployment for public transit and schools, with \$520 million annual incremental funding towards electric transit buses and \$50 million towards electric school buses per year put forward in recent congressional bills.¹
- Deploy efficient electric heat pumps:* Shifting some of the 70 million consumers who have oil, propane or natural gas HVAC systems to efficient electric heat pumps can decrease emissions and allow demand to shift energy usage to times with higher renewable output or lower cost. Policy-makers can integrate heat pumps into portfolio standards and introduce all-electric new construction requirements, with Maine instituting a target and rebate program to install 100,000 heat pumps by 2025.
- Incorporate time of use (ToU) pricing and demand response:* To increase grid flexibility and achieve benefits from greater share variable renewables, electrification and storage, rate structures can be shifted to ToU rates and utilities increase utilization of demand response as a tool to match supply.

System Value impacts of Demand Optimization and Electrification investments



Sources: Energy Storage Association (1, 2, 3); PV Tech; NREL; INVEST in America Act; CLEAN Future Act; Transportation Infrastructure Act; US DOE; ACEEE; US PIRG;

Thomas Built Buses; Mass. Dept. of Energy Resources; US DOT; Transit Chicago; RMI; Maine.gov; Accenture analysis

¹ Bus analysis examined proposed funding in INVEST in America Act and CLEAN Future Act

² Range reflects base case (25% EV public fleet passenger vehicle sales by 2025) and accelerated scenarios (50% of 2025 sales)

³ Range reflects base case (5% replacements by 2025) and accelerated scenarios (10%), analysis based on figures from RMI 2018 Study

Renewables Expansion

Transmission Investment

Efficiency Investment

Demand Optimization and Electrification

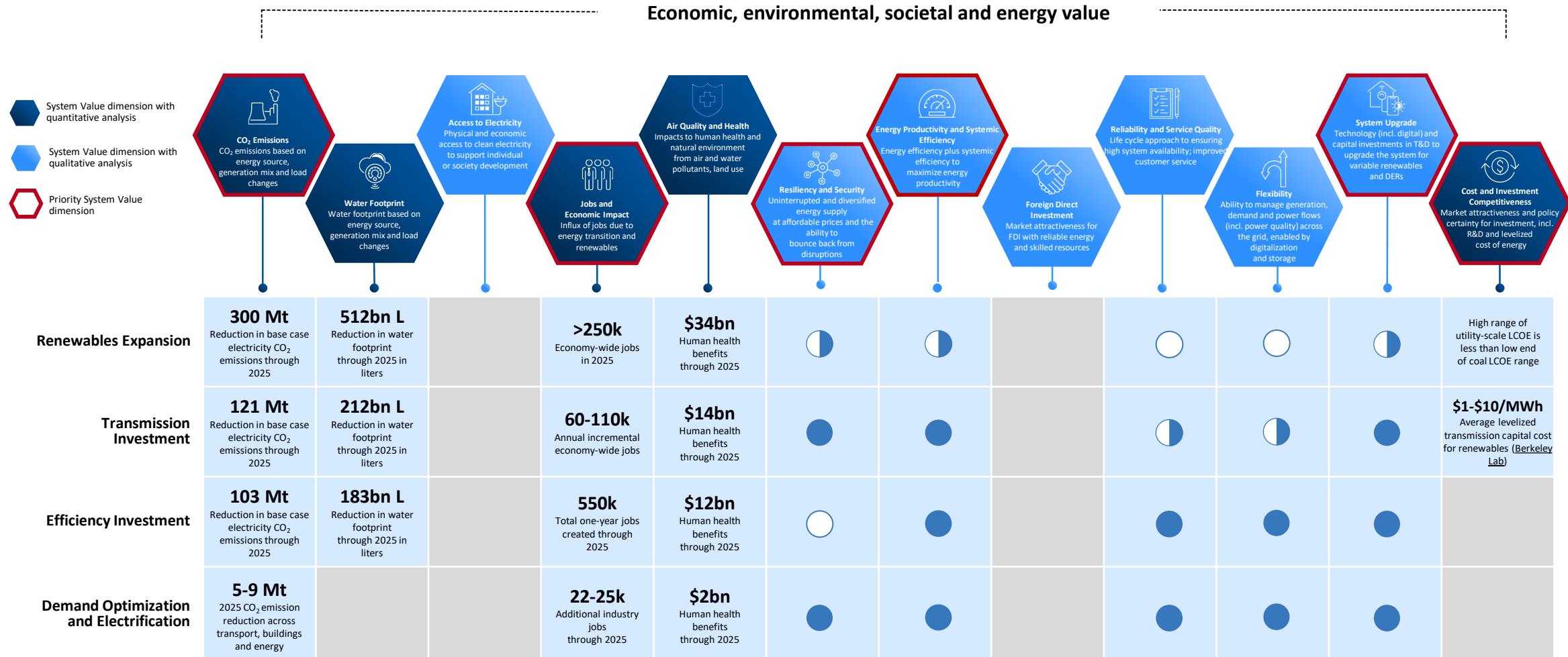
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System Value of clean energy transition

System Value benefits are seen across all US solutions.



Analysis performed for given System Value dimension and recovery solution. For more detail, please see specific solution and/or relevant System Value dimension slide(s).

System Value dimension not as relevant to geographic market or not considered with given recovery solution.

Relative System Value dimension benefit for given solution within market

High benefit

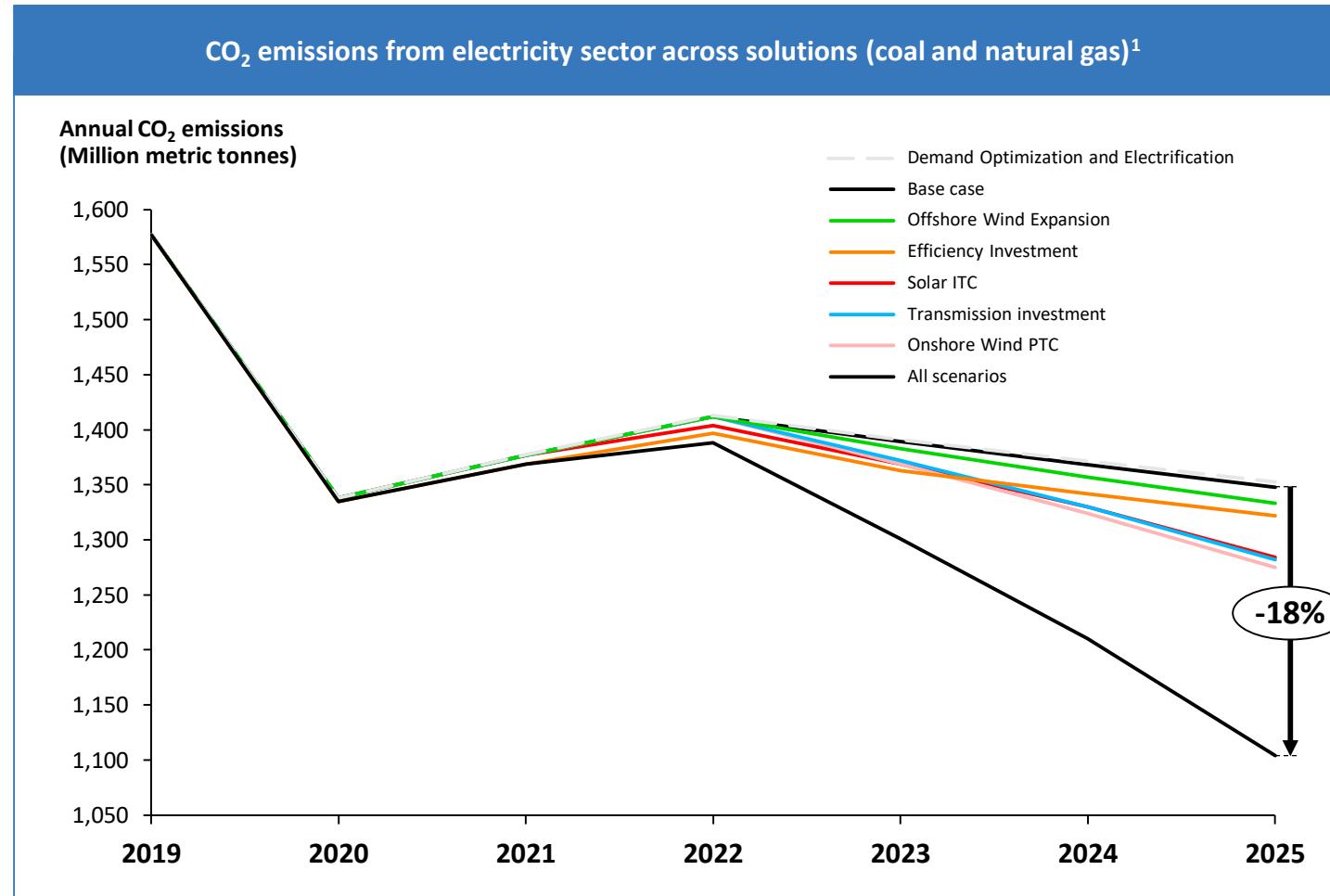
Medium benefit

Minimal-to-no benefit

System Value dimension: CO₂ emissions

The differential in electricity generation from coal and natural gas was examined to calculate CO₂ emissions benefits across US recovery solutions, with a combined effect of lowering electricity sector CO₂ emissions by 18% over base case in 2025.

Cumulative electricity sector CO ₂ emission impact by solution through 2025		
Renewables Expansion	Solar ITC	131 Mt 1.9% of projected 2021-2025 base case footprint
	Onshore Wind PTC	138 Mt 2.0% of projected 2021-2025 base case footprint
	Offshore Wind	32 Mt 0.5% of projected 2021-2025 base case footprint
Transmission Investment		121 Mt 1.7% of projected 2021-2025 base case footprint
Efficiency Investment		103 Mt 1.5% of projected 2021-2025 base case footprint
Demand Optimization and Electrification ²		11 Mt 0.2% of projected 2021-2025 base case footprint
All solutions		513 Mt 7.4% of projected 2021-2025 base case footprint



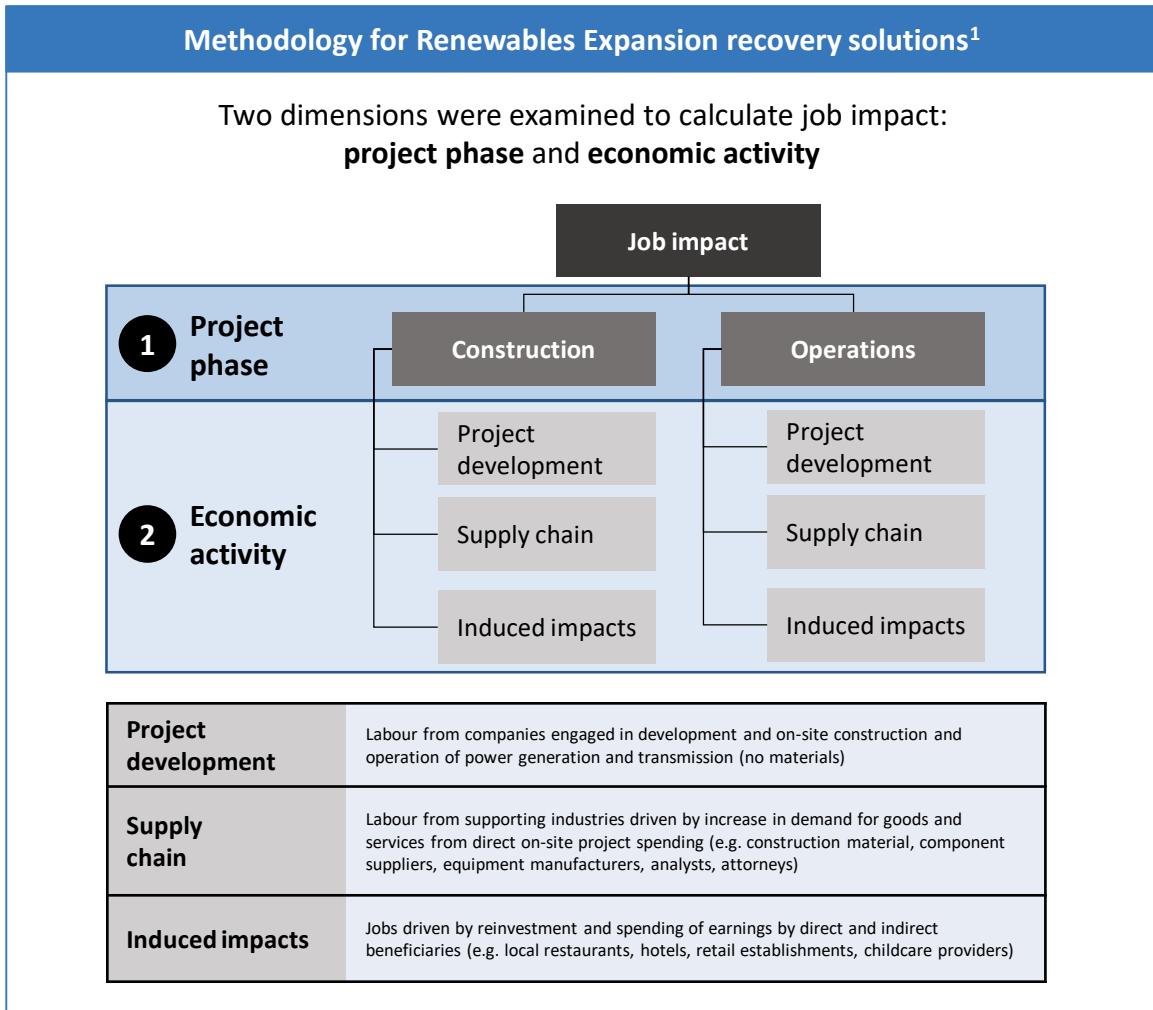
Sources: 2018 US EIA statistics, published February 2020; Accenture analysis

¹ Emissions from electricity generation sources outside coal and natural gas were not evaluated

² Demand Optimization and Electrification solution shifts emissions from transportation and buildings sectors to electricity, leading to an increase in electricity emissions but an overall decrease of economy-wide CO₂ emissions by 7 Mt on average in scenarios. 11 Mt is average increase in electricity sector emissions through 2025 in scenario.

System Value dimension: Jobs impact

Implementing solutions can create hundreds of thousands of jobs through 2025.



Job impact across solutions	
Renewables Expansion¹	114k Economy-wide job impact in 2025
Solar ITC	107k Economy-wide job impact in 2025
Onshore Wind PTC	30k Economy-wide job impact in 2025
Offshore Wind	60-110k Annual incremental economy-wide jobs
Transmission Investment¹	550k Total one-year jobs created through 2025
Efficiency Investment²	22-25k Additional industry jobs through 2025
Demand Optimization and Electrification³	

Sources: NREL JEDI model; DOE; Obama White House Archives; Accenture analysis. Note: analysis does not take into account any potential job impacts from lower fossil fuel generation.

¹ Solar, onshore wind, offshore wind, transmission job impacts based on NREL's JEDI model (300 MW wind farm, 50 MW solar farm, 345kV 250-mile transmission line).

² Energy efficiency figures based on 2009 Recovery Act job impact figures (\$20 billion investment).

³ Job figures from Demand Optimization and Electrification reflect different methodology and are specific to energy technology and utilities, not economy-wide job impact.

System Value dimension: Energy productivity and systemic efficiency

US energy productivity will increase by improved matching and optimization of supply and demand through the identified solutions.

Energy productivity and systemic efficiency benefits by solution		
Renewables Investment		<ul style="list-style-type: none">Renewables deployment can be prioritized towards high availability geographies that maximize capacity factors, getting more for less.Increased distributed solar, benefitting from ITC extension, has potential to lower T&D losses due to more local generation.
Transmission Investment		<ul style="list-style-type: none">Transmission line build-out can improve systemic efficiency by reducing congestion and curtailment.Greater interconnection and transmission planning at a regional level improves balancing of resource variability (reducing wasted) and improving cost effectiveness of achieving a zero-carbon future, such as onshore wind in the interior to high demand areas and offshore wind and hydropower in the Northeast US and Canada.
Efficiency Investment		<ul style="list-style-type: none">End consumer efficiency improvements can be achieved across sectors through smart appliances, greater building efficiency and energy conservation, achieving the same work or economic output for less electricity.
Demand Optimization and Electrification		<ul style="list-style-type: none">Demand optimization can improve systemic efficiency by increasing energy productivity, better aligning supply and demand to ensure cost-effective generation and minimized curtailment.Electric vehicles and heat pumps are more energy efficient than their fossil fuel counterparts. According to the US Department of Energy, EVs convert over 77% of the electrical energy to power at the wheels, whereas gasoline vehicles only convert 12%-30% of the energy stored in gasoline.

System Value dimension: Resiliency and security

With the US electrical grid facing resiliency challenges from COVID-19, increasingly severe natural disasters and cyberattacks, the clean energy transition can help benefit grid resiliency through more distributed, digital and secure operations.

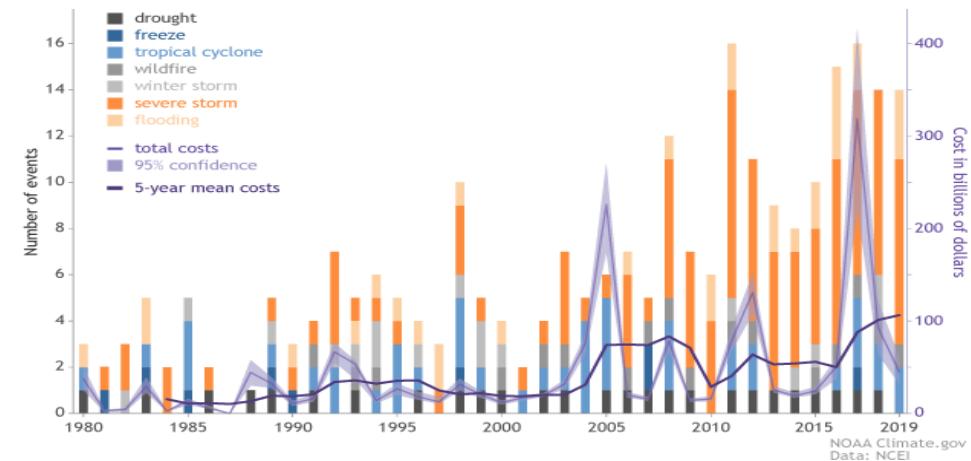
Threats to US electrical system resiliency

- The **COVID-19 pandemic** has tested US grid resiliency as in-person operations of centralized generation and grid assets have been challenged by worker illness and ability to socially distance.
- From wildfires and hurricanes to severe storms and winter events, utilities face increased pressure as the **severity of natural disasters** grows with climate change. Puerto Rico's grid was severely affected by Hurricane Maria in 2017 with billions in damages.
- Cybersecurity threats** are of great concern for US grid operators as digital applications increase. Traditionally, managing major outage risks meant dealing with issues such as component failure or inclement weather via robust mitigation and recovery plans. Today, however, resilience plans for governments and energy ecosystem stakeholders must integrate a carefully designed cyber resilience strategy.

How the clean energy transition can bolster system resiliency

- Transition lowers fuel import reliance and insulates from price volatility
- Renewable energy is significantly less reliant on on-site workers to operate, facing fewer challenges in a pandemic
- Greater transmission investment would increase resiliency as more power is made available from other regions
- A more distributed, digital system can be sectionalized
- DERs, such as EVs and storage, can form the basis for solutions to support local resiliency where the network itself has failed
- Increased storage and microgrids can protect critical facilities
- Demand optimization schemes can automatically switch off load

The number and cost of billion-dollar US disasters is rising



Recovery solution impact on System Value dimension

Renewables Expansion



Domestic energy source with operations allowing for social distancing

Transmission Investment



Greater interconnection to diversify electricity sources from affected areas

Efficiency Investment



No material benefit

Demand Optimization and Electrification



Storage aids during disasters and longer-term interruptions

System Value dimension: System upgrade

Investments in grid infrastructure and digital solutions across transmission and distribution will be needed for the US to achieve a greater variable renewable system.

Overview

- One of the most significant challenges to achieving a clean energy transition will be modernizing US grid infrastructure to enable a system able to transact much more variable, decentralized and disaggregated power.
- The physical and digital infrastructure needed to support variable renewables and DERs spans transmission and distribution, as wind and solar can be connected to both.

Network upgrades across the value chain

- Renewable generation can be paired with storage and digital platforms to increase dispatchability and control over the production profile, run assets in portfolios and enable predictive maintenance.
- An expansion of the transmission and distribution network and connectivity across the US market will shift the grid from a one-way, baseload network with centralized production to two-way, variable sources of energy from utility-scale renewables and DERs.
- At the end-consumer and retail level, installing smart, efficient technology and devices such as smart meters, smart thermostats, smart EV chargers, smart heat pumps and residential and commercial energy management systems will allow improved system balancing and better management of grid congestion and constraints.
- Across the value chain, improving digital capabilities using sensors, data, analytics, AI, machine learning and automation will support the clean energy transition and shift to a more variable, decentralized and disaggregated system.

Recovery solution impact on System Value dimension

Renewables Expansion



Minimal standalone benefit to network upgrades, rather the impetus for upgrades

Transmission Investment



Transmission investment is an essential network upgrade to spur utility-scale renewables, opening up possibility for greater interconnection and balancing across states and regions

Efficiency Investment



Smart technology and digitalization of buildings and appliances enables two-way communication, unlocking load shifting capabilities

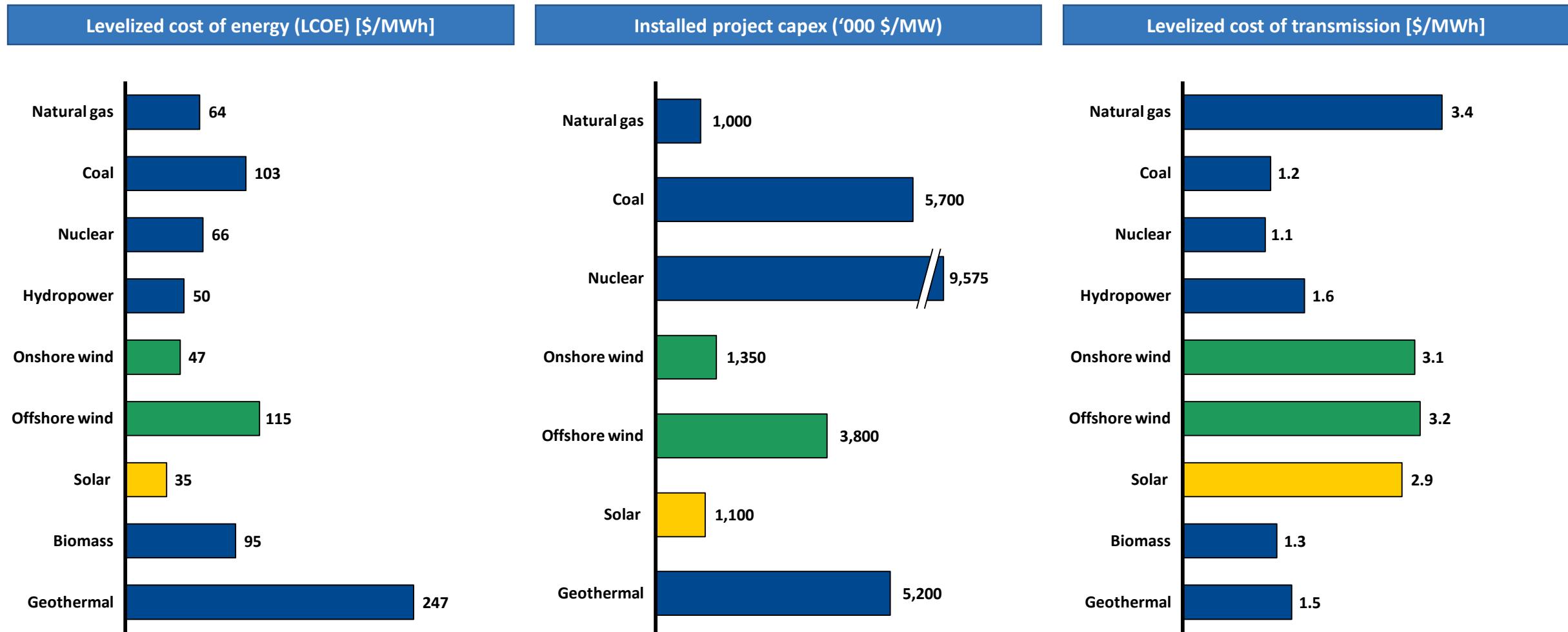
Demand Optimization and Electrification



Adding storage and digitalization allows more dispatchable renewable energy, while electrification of vehicles and HVAC systems can play a key role with demand optimization

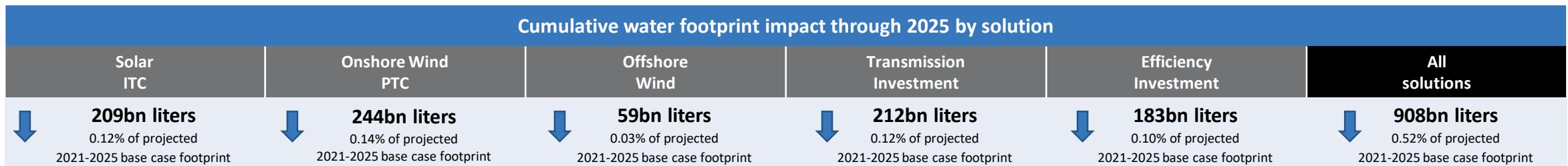
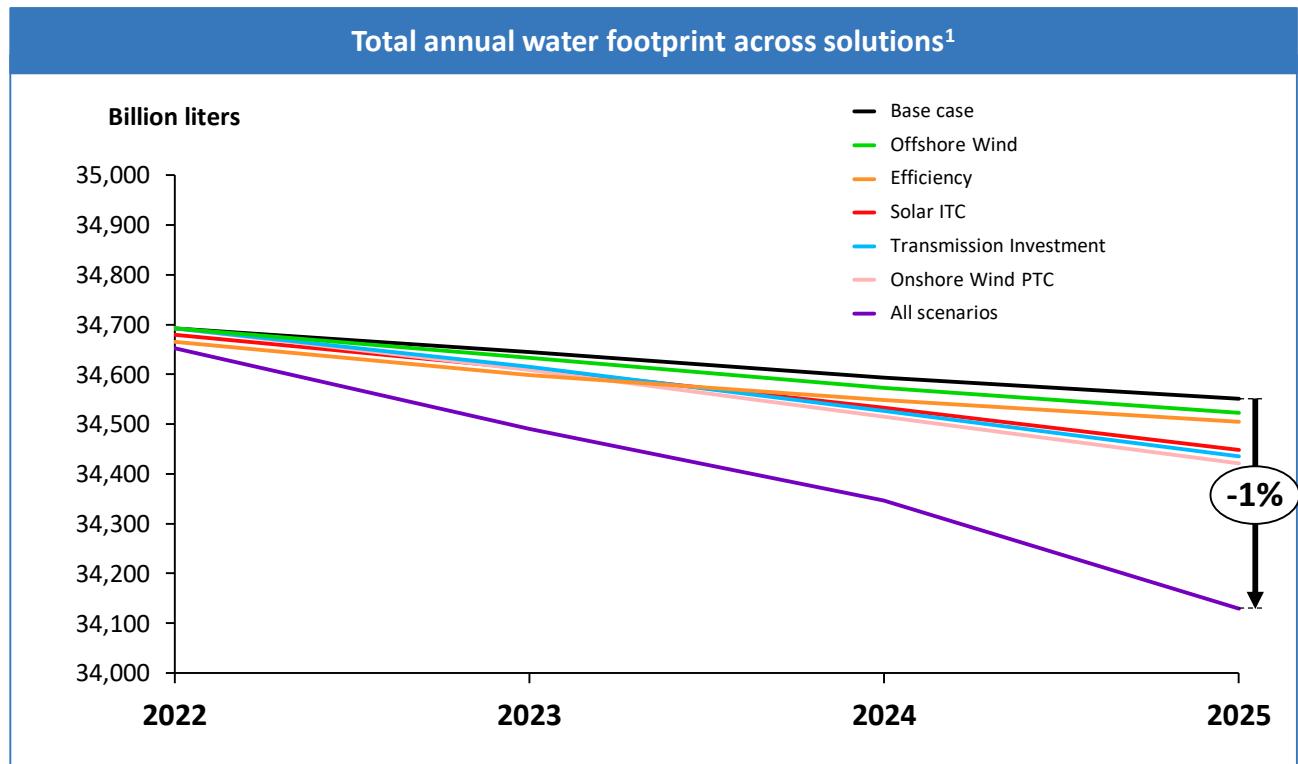
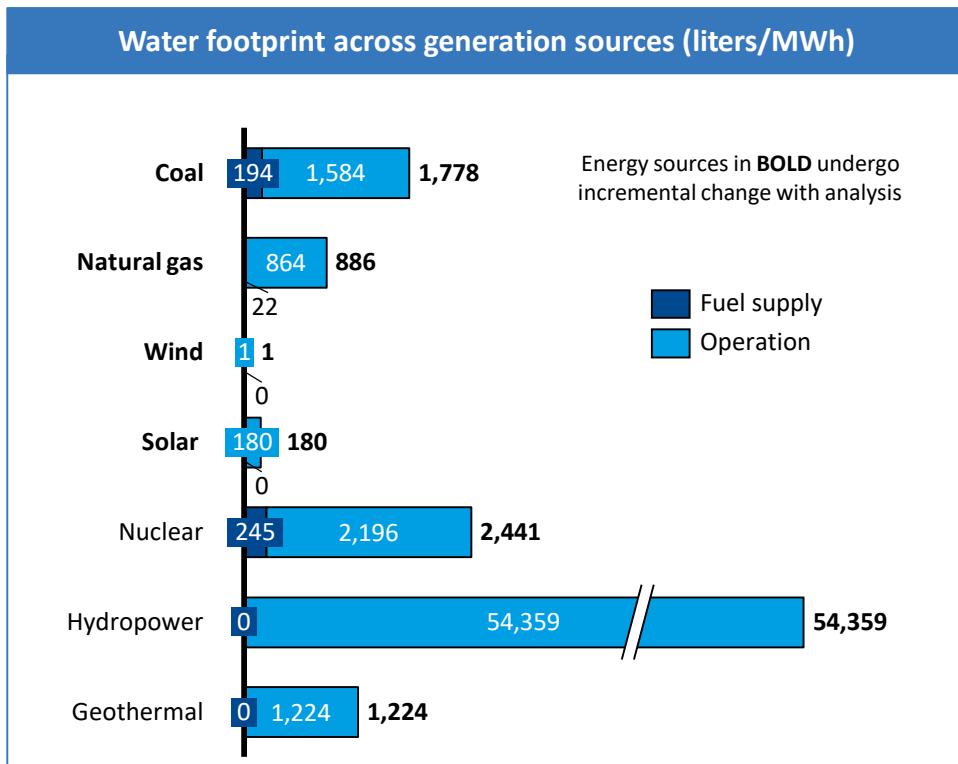
System Value dimension: Cost and investment competitiveness

When considering new capacity addition options such as wind and solar, leveled cost of energy (LCOE), project capital expenditures and leveled cost of transmission remain important considerations for project developers, investors and regulators.



System Value dimension: Net water footprint

While the US does not experience significant water scarcity at present, fuel supply and electricity production should be evaluated in terms of risk of water shortage, particularly on a regional basis.



Sources: Royal Society of Chemistry; Accenture analysis

Biomass, not included in above graph, assumes same water footprint as firewood in analysis (563k liters per MWh)

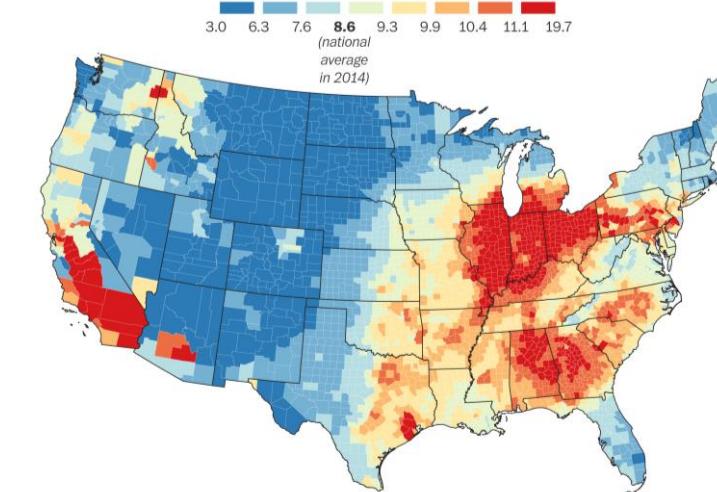
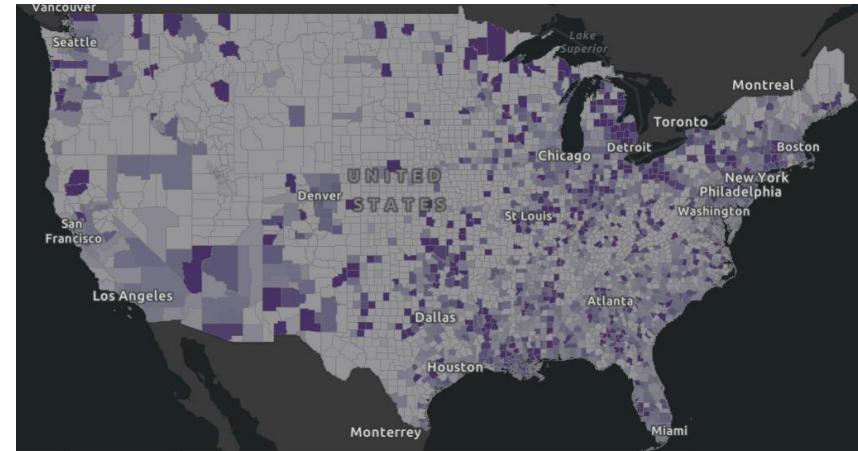
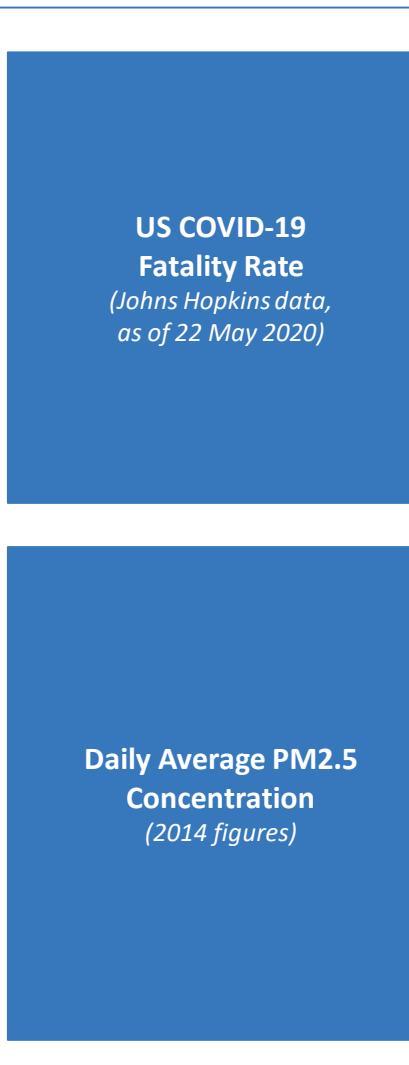
¹ Analysis excludes Demand Optimization and Electrification solution

System Value dimension: Air quality and health (1 of 2)

An April 2020 study from Harvard has linked higher COVID-19 death rate to areas in the US with high PM2.5 emissions.

Harvard study findings

- In April 2020, Harvard's School for Public Health released the first US nationwide study to show a **statistical link between COVID-19 deaths and other diseases associated with long-term exposure to PM2.5**.
- The study concluded that a **small increase in long-term exposure to PM2.5 leads to a large increase in the COVID-19 death rate**.
- An increase of only 1 $\mu\text{g}/\text{m}^3$ in PM2.5 was associated with a 15% increase in the COVID-19 death rate.
- Findings such as these can bolster the rationale for accelerating the clean energy transition.



Source: Robert Wood Johnson Foundation County Health Rankings THE WASHINGTON POST

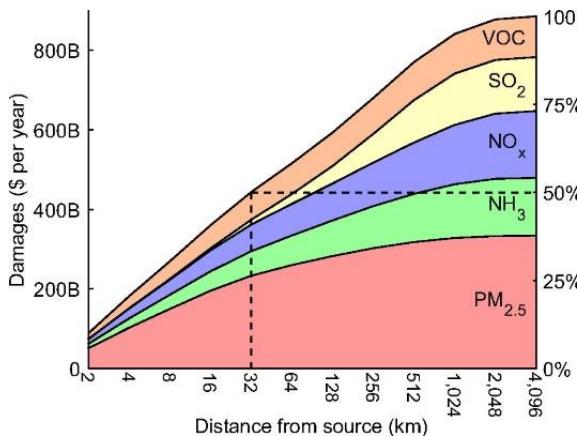
System Value dimension: Air quality and health (2 of 2)

Lower air pollutants across solutions to have an estimated \$62 billion in cumulative human health benefits through 2025.

US overview

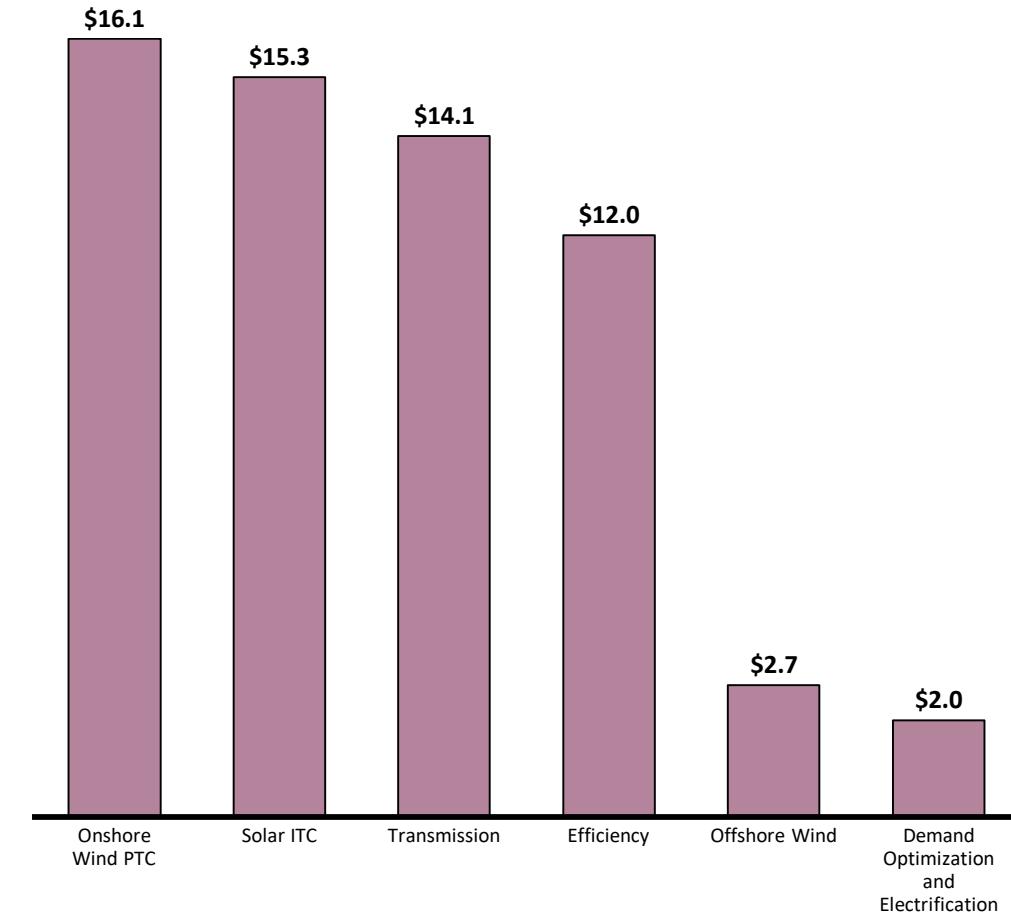
- Studies have linked air pollution to **more than 100,000 annual premature deaths** in the US from heart attacks, strokes and other illnesses, at a **cost to society of \$886 billion**
- Air pollutants are estimated to be responsible for **5%-10% of the total US annual premature mortality**
- While air pollution impacts are often tied to proximity to pollution sources, studies have found that **half of air quality-related premature mortality results from emissions from outside that state**
- Emissions from electric power generation have the greatest cross-state impact** as a fraction of their total impact

Cumulative damages by pollutant and distance



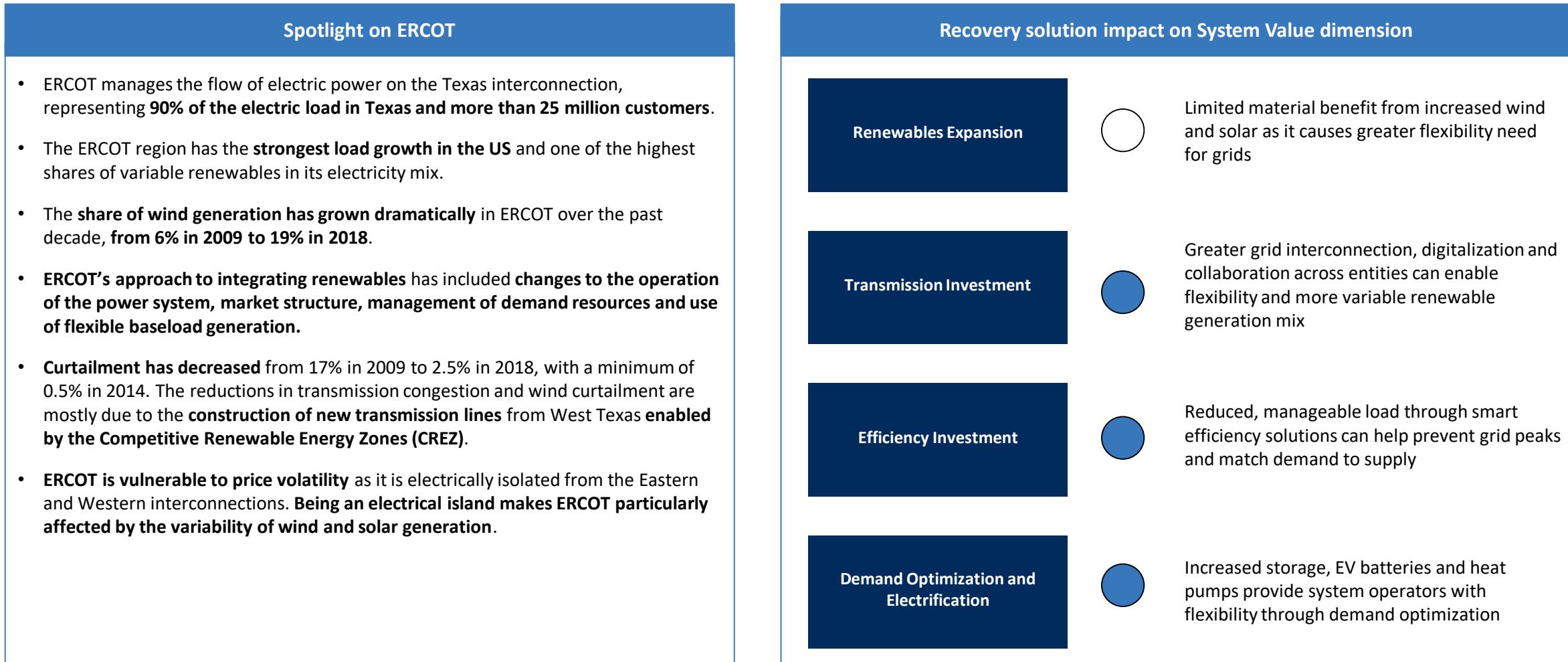
- Dotted line shows that 50% of pollutant damages occur within 32km of source
- Most PM_{2.5} damage is close to source compared to other pollutants, such as SO₂

Cumulative human health benefits by solution through 2025 (\$B)¹



System Value dimension: Flexibility

The need to manage generation, demand and power flows across the grid will grow as the US sees an increasing share of variable generation, with transmission, smart efficiency, demand optimization and electrification investments poised to improve flexibility.



System Value dimension: Reliability and service quality

The US electrical grid has a high degree of reliability with few interruptions outside major events, such as severe weather, with increase in renewables in the short term unlikely to cause any impacts.

