STUDIES CONVERGE ON BENEFITS OF A RAPID CLEAN ENERGY TRANSITION

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SUMMARY

This brief highlights key findings from a meta-analysis of eight studies released since 2020 and led by researchers at prominent universities, think tanks, nonprofits, and energy consultancies, all of which model clean energy policy packages and converge on the profound benefits and feasibility of achieving approximately 80 percent clean electricity by 2030 in the United States. These studies capture the latest renewable technology cost declines, which are largely responsible for models finding that such a goal is achievable at minimal cost—a conclusion not reached by older studies.

A review of these eight studies finds broad agreement on the widespread benefits of a rapid transition to clean electricity.

- **Affordability:** Three studies find wholesale electricity costs in 2030 in a high clean energy future would range from 4 percent lower to 3 percent higher relative to today's prices; other studies report different metrics (e.g., U.S. energy expenditures) but find similarly tight ranges from slight cost savings to modest increases.

[i] This study was updated on September 7, 2021, to include an analysis of 11 studies (i.e., 4 new studies in addition to the 7 in this report) and context on the Clean Electricity Payment Program. The updated report can be found here: energyinnovation.org/wp-content/uploads/2021/09/Studies-Agree-80-Percent-Clean-Electricity-Would-Save-Lives-and-Create-Jobs-at-Minimal-Cost.pdf.

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- **Jobs and investments:** Two studies find that strong clean energy policies would drive on the order of 500,000 to 1 million net new jobs; four studies find that such policies would spur on the order of hundreds of billions to trillions of dollars in new clean energy investment.
- **Climate:** All studies provide evidence that achieving approximately 80 percent clean electricity *and* ambitiously electrifying other sectors are required to achieve the Biden administration's greenhouse gas (GHG) emissions reduction target of 50-52 percent below 2005 levels by 2030—a level necessary to keep the U.S. on the path for a safe climate future.[1]
- **Public health:** Six studies find that strong federal clean electricity policy would avoid health and climate damages $100-250 billion through 2030-2035 and $1-3 trillion through 2050. It would also avoid 85,000 to 300,000 premature deaths through 2050. These benefits far outweigh any study's observed energy cost increases.
- **Feasibility:** All modeled technology-neutral policies are shown to drive deployments of almost exclusively wind, solar, and battery storage—rather than new nuclear, incremental hydropower, geothermal, biomass, carbon capture and storage (CCS), hydrogen, and even natural gas (where partial crediting is allowed). Specifically, the models show achieving approximately 80-90 percent clean electricity in the 2030-2035 timeline requires building on the order of 50-100 gigawatts (GW) per year of new wind and solar as well as 9-23 GW per year of new battery storage—a challenging but feasible pace of development.
- **Reliability:** All studies collectively suggest that a high clean electricity system would be dependable (e.g., able to match supply and demand), including three studies that provide more rigor by testing the grid in every hour of multiple weather-years and sample days.

Together, the studies infer that a strong national clean electricity standard is one of the best ways to achieve deep decarbonization of the power sector.

METHODOLGY

The meta-analysis reviewed five studies that model clean electricity standard (CES) designs ("Tier 1"), one study that models other power sector decarbonization policies ("Tier 2"), and two studies that model economy-wide decarbonization policy pathways ("Tier 3"). The studies vary widely in their source (e.g., universities, think tanks, nonprofits, energy consultancies), models and datasets employed, cases and sensitivities tested, and metrics reported, but they all demonstrate widespread benefits of ambitious federal clean energy policy. This brief summarizes the key findings, although much more detailed information by study is available in an accompanying public Google Sheet.2

The table below summarizes these eight studies. Where possible throughout this brief, we highlight assumptions and metrics for 2030, given the year's relevance to current federal policy discussions about an 80 percent by 2030 CES.

Tier	Study	Authors	Date	Summary of Relevant Cases
1	2030 Report[i]	UC Berkeley, GridLab, Energy Innovation	Apr. 2021	**80 percent by 2030 CES** with high electrification of other sectors; no partial crediting for gas
1	Robust Decarbonization of the U.S. Power Sector: Policy Options[i]	Harvard University	Apr. 2021	Three 100 percent by 2035 CES policies **(with 80 percent by 2030 interim CES targets)** allowing partial crediting for gas; one 90 percent by 2035 CES policy **(with a 70 percent by 2030 interim CES target)** with no partial crediting for gas
1	Clean Energy Futures Project[i]	Syracuse University, Harvard University, Resources for the Future, Georgia Institute of Technology	Oct. 2020	Two 100 percent by 2040 CES policies **(with 72 percent by 2030 interim CES targets)** and two 100 percent by 2050 CES policies **(with 67 percent by 2030 interim CES targets)** that differ primarily on banking of credits and partial crediting for gas
1	2035 Report[i]	UC Berkeley, GridLab, PaulosAnalysis	Jun. 2020	90 percent by 2035 CES **(with a 70 percent by 2030 interim CES target);** no partial crediting for gas
1	Two Key Design Parameters in Clean Electricity Standards[i]	Resources for the Future	Mar. 2020	Four 100 percent by 2050 CES policies differing on partial crediting for gas and target escalation rates **(achieving 58-70 percent clean electricity by 2035)**[i]
2	Federal Clean Energy Tax Credits: A Vital Building Block for Advancing Clean Electricity[i]	Union of Concerned Scientists	Apr. 2021	Clean Energy for America Act (2019), which would extend technology-neutral tax credits at full value, phasing down in the mid-2030s **(achieving 62 percent clean electricity by 2035)**
3	Net-Zero America[i]	Princeton University	Dec. 2020	Five pathways to achieving net-zero economy-wide GHG emissions by 2050 **(achieving 70-85 percent clean electricity by 2030)**
3	The Biden Administration Must Swiftly Commit to Cutting Climate Pollution At Least 50 Percent by 2030[i]	Natural Resources Defense Council, Environmental Defense Fund, Evolved Energy Research	Mar. 2021	Suite of policies designed to achieve a 53 percent net reduction in economy-wide GHG emissions by 2030 relative to 2005 **(including an 80 percent by 2030 CES)**

FINDINGS

AFFORDABILITY

Rapid cost declines for wind, solar, and battery storage have enabled a transition to 80 percent to 100 percent clean electricity in the 2030-2035 timeline at a modest cost to electricity customers. The reviewed studies vary in the metrics used to assess affordability, making "apples-to-apples" comparisons challenging. Yet, as a group, the studies converge on the possibility of achieving rapid electricity sector decarbonization at relatively low incremental cost—generally ranging from bill savings to modest cost increases.

Notably, these cost projections do *not* factor in the avoided health and climate costs realized by a rapid transition from fossil to clean energy. Substantial reductions in harmful air pollution ultimately drive enormous benefits across all reviewed studies and make such a transition a "no regrets" approach to energy policy.

Three studies report affordability metrics in terms of wholesale electricity costs, which typically make up roughly 25 percent to 40 percent of customers' bills. The studies' reference scenarios[ii] suggest that **high penetration of clean electricity may result in 2030 wholesale electricity costs that are 4 percent lower to 3 percent higher than today's prices.**

- UC Berkeley's 2030 Report modeling an 80 percent by 2030 CES (with high electrification of other sectors) finds that wholesale electricity costs[iii] would be the same in 2030 as in 2020. Sensitivities[iv] ranged from costs being 8 percent lower to 4 percent higher in 2030 relative to 2020.
- UC Berkeley's 2035 Report modeling a 90 percent by 2035 CES finds that wholesale electricity costs would be 4 percent lower in 2030 relative to today. Sensitivities ranged from costs being 10 percent lower to 12 percent higher in 2030 relative to 2020.[v]

[ii] "Reference scenarios" are policy cases that use industry standard assumptions around electricity demand, fuel prices, financing costs, and renewable energy technology costs.

[iii] In the UC Berkeley studies, "wholesale electricity costs" include total capital and operational costs of power plants, plus incremental transmission costs (which the studies report as 5.1 cents per kilowatt-hour on average in the U.S. in 2020). They do not consider existing transmission or existing and new distribution system costs.

[iv] "Sensitivities" are policy cases tested against varying sets of assumptions, such as higher or lower electricity demand, fuel prices, financing costs, and/or renewable energy technology costs. The high end of sensitivities' cost outcomes is typically driven by assumptions of high demand, high fuel prices, high financing costs, and/or high renewable energy technology costs (and vice versa for the low end).

[v] Numbers estimated from The 2035 Report's accompanying Data Explorer.

- Harvard University's study modeling four 90 percent to 100 percent by 2035 CES policies finds that wholesale electricity costs[vi] would range from 3 percent lower to 3 percent higher in 2030 relative to today. Sensitivities ranged from costs being 19 percent lower to 17 percent higher than today's costs by 2030.[vii]

  Four other studies report useful affordability metrics that are each unique among these studies.

- The Resources for the Future study modeling four 100 percent by 2050 CES policies finds that retail electricity prices (i.e., customer bills) would be just 1 percent to 3 percent higher in 2035 relative to a business-as-usual case.[viii]
- The Union of Concerned Scientists' study modeling different federal tax credit policies finds that each would result in "slightly lower electricity bills for households and businesses" (all else equal), shifting any cost burden to taxpayers.
- The Natural Resources Defense Council's study modeling a 53 percent reduction in net economy-wide GHG emissions by 2030 (relative to 2005 levels) finds that such a policy package would require investments equivalent to a mere 0.4 percent of forecast U.S. GDP in 2030.
- Princeton University's study modeling five pathways that each achieve net-zero economy-wide GHG emissions by 2050 finds that the pathways would require total U.S. energy expenditures to increase by less than 3 percent through 2030.

JOBS AND INVESTMENTS

Four studies directly modeled and reported jobs impacts and/or clean energy investment, collectively finding that **ambitious clean energy policy would drive a net increase of 500,000 to 1 million jobs per year and hundreds of billions to trillions of dollars in clean energy investment.**

- UC Berkeley's 2035 Report shows that a 90 percent by 2035 CES would support a net increase of 530,000 jobs per year and support over $1.7 trillion in clean energy investments from 2020 to 2035.[ix]
- Princeton University's study finds that five policy pathways to net-zero economy-wide GHG emissions by 2050 would support a net increase of 500,000 to 1 million energy supply jobs per year through 2030; it also reveals that the pathways would deploy on the order of $1 trillion to

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[vi] In the Harvard University study, "wholesale electricity costs" are calculated as annualized capital costs plus annual fuel and operations and maintenance costs divided by annual load. The study reports such costs as approximately 3.6 cents per kilowatt-hour on average in the U.S. in 2020.
[vii] Numbers estimated from Figure 2 of the Harvard University study.
[viii] Numbers estimated from Figure 7 of the Resources for the Future study; 2030 data were not reported.
[ix] Jobs number calculated from the 2035 Report's accompanying Data Explorer tool.

10 trillion from 2020 to 2050 in energy supply-side capital (depending on the scenario, timeline, sectors considered, etc.).

- UC Berkeley's 2030 Report shows that an 80 percent by 2030 CES would drive $1.5 trillion in new clean energy capital and $100 billion in new transmission capital investments through 2030.
- The Union of Concerned Scientists' study modeling an expanded, full-value, long-term federal tax credit extension shows that this policy alone would drive $177 billion in wind and solar investments from 2020 to 2035, at a cost to the U.S. Treasury of only $63 billion (above those funds projected to be disbursed under existing federal tax credit policies).[x]

CLIMATE

The reviewed studies show that **reaching 80 percent clean electricity by 2030 puts the U.S. on track to meet President Joe Biden's goal of reducing economy-wide GHG emissions by 50 percent to 52 percent by 2030 (relative to 2005 levels).**[3]

- UC Berkeley's 2030 Report finds that an 80 percent by 2030 CES would cut power sector CO_2 emissions 84 percent by 2030 relative to 2005 levels. Paired with ambitious electrification policies in the transport, buildings, and industry sectors, the 2030 Report finds that this policy package would cut economy-wide GHG emissions 50 percent by 2030 relative to 2005 levels.
- The Natural Resources Defense Council's study modeled an 80 percent by 2030 CES as part of a broader set of economy-wide decarbonization policies (ultimately achieving 53 percent net GHG emissions reductions by 2030 relative to 2005 levels), finding it is a key component to meeting President Biden's target.

On the other hand, studies that model delayed targets or rely strictly on tax credit extensions appear to fall short of the deeper reductions necessary to safeguard the climate. Using Energy Innovation's Energy Policy Simulator as a proxy, power sector emissions reductions may need to fall approximately 84 percent by 2030 to achieve a 50 percent reduction in economy-wide GHG emissions by 2030 relative to 2005 levels.[xi,4]

- UC Berkeley's 2035 Report finds that a 90 percent by 2035 CES would achieve approximately 72 percent clean electricity by 2030 and cut power sector CO_2 emissions 71 percent by 2030 relative to 2005 levels.[xii]

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[x] The Union of Concerned Scientists study reports these investment and cost values in 2020 dollars, applying a 7 percent discount rate.

[xi] The "NDC Pathway" scenario allows users to explore policies and their impacts on meeting this GHG emissions reduction goal.

[xii] The 2035 Report does not analyze multi-sectoral electrification policies. Data were taken or estimated from the report's accompanying Data Explorer tool.

- Harvard University's study modeling four 90 percent to 100 percent by 2035 policies finds that they would cut power sector CO_2 emissions approximately 63 percent to 66 percent by 2030 relative to 2005 levels.[xiii]
- Syracuse University's study modeling four 100 percent by 2040-2050 CES policies finds that they would cut power sector CO_2 emissions approximately 57 percent to 75 percent by 2030 relative to 2005 levels.[xiv]
- The Resources for the Future study modeling four 100 percent by 2050 CES policies finds that they would cut power sector CO_2 emissions approximately 50 percent to 61 percent by 2035 relative to 2005 levels.[xv]
- The Union of Concerned Scientists' study modeling an expanded, full-value, long-term federal tax credit extension finds that the policy would cut power sector CO_2 emissions approximately 60 percent by 2030 relative to 2005 levels.

Princeton University's study models five pathways that each achieve net-zero economy-wide GHG emissions by 2050, with all pathways eliminating coal and achieving 70 percent to 85 percent clean electricity by 2030. The study's results imply that achieving lower clean energy shares by 2030 would require greater use of unproven geologic carbon sequestration technologies down the line. The sooner the U.S. enacts policies to achieve President Biden's 2030 GHG emissions reductions goal, the less we have to rely on more speculative and risky technologies to reach net-zero emissions by midcentury.

PUBLIC HEALTH

Public health benefits from deep power sector decarbonization are enormous and widely dispersed across the U.S. As coal- and natural gas-fired power plants operate less often and retire, particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x), and sulfur dioxide (SO_2) emissions fall accordingly, and the frequency with which people fall sick or die early from air pollution declines apace. These data are often reported in economic terms of avoided health damages, estimated by applying a value for a "statistical life." Studies sometimes also include avoided environmental or climate damages in their estimates, accounting for reduced CO_2 emissions by applying a social cost of carbon value.

[xiii] Numbers estimated from Figure 1 of the Harvard University study, referring only to the Reference Cases (approximating from the mid-point between low and high demand). Notably, looking to 2035, two of the four CES policy designs achieved power sector CO_2 emissions cuts of at least 80 percent relative to 2005 levels across all 10 tested scenarios (e.g., flexing fuel price and renewable energy technology cost trajectories), including reaching as high as a 95 percent reduction. One such policy modeled a 100 percent by 2035 CES with partial crediting for natural gas and a $40/ton penalty for undercompliance; the other modeled the same policy but included federal tax credit extensions.
[xiv] Numbers estimated from Figure 1 of the Syracuse University study.
[xv] Numbers estimated from Figure 6 of the Resources for the Future study; 2030 data were not reported.

The reviewed studies differ significantly in the ambition of policies studied, values used for statistical lives and social cost of carbon, financial assumptions (e.g., discount rates), and timelines considered. Viewed in the aggregate, the studies show **strong federal clean energy policy would avoid health and climate damages of $100 billion to $250 billion through 2030-2035 and $1 trillion to $3 trillion through 2050.** It would also **avoid 85,000 to 300,000 premature deaths through 2050.**

- The Resources for the Future study modeling four 100 percent by 2050 CES policies finds that they would avoid roughly $90 billion to $105 billion in health and climate damages by 2035 and that reductions in NO_x and SO_2 emissions would avoid 3,500 to 4,500 premature deaths per year by 2035.[xvi]
- The Union of Concerned Scientists' study modeling an expanded, full-value, long-term federal tax credit extension finds that the policy would avoid $255 billion in health and climate damages from 2020 to 2035 and that reductions in NO_x and SO_2 emissions would avoid 7,000 premature deaths over this period.
- UC Berkeley's studies modeling a 90 percent by 2035 CES and an 80 percent by 2030 CES find that, respectively, they would avoid $1.2 and $1.7 trillion in health and climate damages and 85,000 to 93,000 premature deaths from 2020 to 2050. Further, strong transportation electrification policies (as modeled in the 2030 Report) would avoid an additional $1.3 trillion in health and climate damages as well as avoid 150,000 additional premature deaths from 2020 to 2050.
- The Natural Resources Defense Council's study modeling a 53 percent reduction in net economy-wide GHG emissions by 2030 (relative to 2005 levels) finds that such a cross-sectoral policy package would avoid $150 billion in health and climate damages from the power sector alone through 2030.
- Princeton University's study modeling five pathways that each achieve net-zero economy-wide GHG emissions by 2050 finds that they would avoid $400 billion in health damages and avoid 40,000 premature deaths through 2030 across the power and transportation sectors alone. They would also avoid $2 trillion to $3 trillion in health damages and avoid 200,000 to 300,000 premature deaths through 2050.

FEASIBILITY

All reviewed studies' **clean energy policies are shown to drive deployments of almost exclusively wind, solar, and battery storage.** While these models are allowed to select other zero- or low-emissions technologies—such as nuclear, incremental hydropower, geothermal, biomass, carbon

[xvi] Numbers estimated from Figures 8 and 9 of the Resources for the Future study, applying a cumulative inflation rate of 11.10 percent from 2013 to 2020.

capture and sequestration (CCS), hydrogen, and even natural gas (where partial crediting is allowed)—they generally do not build any of these or deploy a marginal quantity through 2030.

Broadly, the models show **achieving approximately 80 percent to 90 percent clean electricity in the 2030-2035 timeline requires building on the order of 50 GW to 100 GW per year of new wind and solar as well as 9 GW to 23 GW per year of new battery storage.** The differences—detailed below—largely owe to the stringency of the targets as well as the level of electrification assumed for other sectors.[xvii,xviii]

- UC Berkeley's studies modeling a 90 percent by 2035 CES and an 80 percent by 2030 CES find that such targets would require 80 GW per year and 118 GW per year of new wind, solar, and battery storage from 2020 to 2035 and from 2021 to 2030, respectively (noting the latter target includes strong electrification measures). Neither study's model would build any other technology.
- Syracuse University's study modeling four 100 percent by 2040-2050 CES policies finds that three of the four policies would build exclusively wind, solar, and battery storage. One policy (100 percent by 2040 CES with partial crediting for gas and unlimited banking of clean energy credits through 2050) relies partly on CCS, though its use is limited to the post-2030 period.[xix]
- The Resources for the Future study modeling four 100 percent by 2050 CES policies finds that they would each build almost exclusively wind, solar, and battery storage through 2035, thereafter relying on a negligible amount of CCS.[xx]
- The Union of Concerned Scientists study modeling an expanded, full-value, long-term federal tax credit extension finds that the policy would build 191 GW of additional wind, solar, and battery storage through 2030 (and 274 GW through 2035) relative to business-as-usual conditions. The model does not build any other new zero- or low-emissions technologies despite them qualifying for tax credits.
- Princeton University's study modeling five pathways that each achieve net-zero economy-wide GHG emissions by 2050 finds that four of the five pathways would build only wind and solar from 2021 to 2030 (on the order of 300 GW of each technology). In the fifth pathway, wind and solar deployment rates are artificially capped at the maximum U.S. historical build rate—forcing significant geothermal and other zero- and low-emissions technologies to make up the

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[xvii] Notably, the models generally did not assume high levels of energy efficiency, greater reliance on demand response (including vehicle-to-grid integration), or the development of longer-duration energy storage—all of which would reduce the capacity buildout required in these transitions.

[xviii] Harvard University and the Natural Resources Defense Council studies did not report sufficiently granular data to merit mention in this list, though high-level takeaways appear consistent.

[xix] Numbers estimated from the figures in Appendix 3 of the Syracuse University study.

[xx] Numbers estimated from Figure 5 of the Resources for the Future study.

difference. However, wind and solar developers already exceeded these rates in 2020, and there is no evidence suggesting they cannot continue to do so.

These deployment rates will be challenging to meet. However, they rely on technologies that have robust supply chains and are commercially available today (rather than speculative technologies like CCS). U.S. developers have consistently broken domestic deployment records as technology costs have plummeted, and these rates are not unprecedented globally (for example, China added 120 GW of new wind and solar capacity in 2020). With the right supplemental policy support (such as federal action to address permitting and siting challenges, build new bulk transmission, and ease constraints in the interconnection process), developers could achieve these rates.

RELIABILITY

All reviewed studies demonstrated that **the U.S. power system would be dependable with high clean energy penetration** across a range of models (ReEDS, PLEXOS, RIO). While these modeling exercises vary in their fidelity, three test the grid in every hour of multiple weather-years (the two UC Berkeley studies) or multiple sample days (the Princeton University study), finding relatively low levels of renewable energy curtailment.[xxi] For example, UC Berkeley's 2030 Report finds that approximately 8 percent of renewable energy would be curtailed in 2030 in an 80 percent clean electricity system.

On the one hand, the literature would benefit from more robust analyses to further demonstrate the reliability of a grid supplied predominantly by renewable energy, particularly on the urgent timelines required by the climate imperative. Recent research from the National Renewable Energy Laboratory shows with higher fidelity the reliability of the electricity system with approximately 60 percent wind and solar energy, or roughly what is required to reach 80 percent clean electricity if existing nuclear and hydro generation is held constant.[5] The Biden administration should prioritize federal funding to enhance scientific understanding of reliable grid operations with high renewable energy penetration.

On the other hand, these studies do not account for measures like demand response, emerging technologies (e.g., long-duration energy storage), and cross-sectoral uses for otherwise-curtailed renewable energy (e.g., generating green hydrogen for use in industrial applications). Researchers and practitioners should continue to study reliability, and policymakers should allocate funding for research and development in this space, but this meta-analysis did not reveal any challenges that should prevent immediate action on rapidly deploying clean energy.

[xxi] Sometimes wind and solar resources are positioned to generate more electricity than is needed; in these instances, operators may reduce their output to maintain the balance of supply and demand – a process called "curtailment." Changing when energy is needed (e.g., through smart charging or use of appliances), building longer-duration energy storage, and building more bulk transmission can all help reduce this waste.

POLICY RECOMMENDATIONS

This meta-analysis reveals a few important considerations for designing U.S. energy policy.

THE IMPORTANCE OF CLEAN ENERGY STANDARDS

All studies show that a strong CES is one of the best ways to achieve deep decarbonization of the power sector. **Passing a CES of 80 percent clean electricity by 2030 can put the U.S. on a path to meeting its GHG emissions reduction goals,** while tax credit extensions alone—though helpful—would fall short.

Relatedly, models show that allowing natural gas to qualify for partial credit under a CES would translate to more GHG emissions for a given target, all else equal. While they also show it could achieve such targets at lower cost, real-world dynamics are more complicated—partial crediting could drive more investment in gas infrastructure that is quickly stranded, ultimately raising costs that must be recouped by captive customers.

COMPLEMENTARY POLICIES

A strong CES will require the rapid construction of new wind, solar, and battery storage systems. Achieving this deployment rate—and capturing the immense net benefits—may depend on a few important complementary policies, some of which exist in President Biden's American Jobs Plan:[6]

- Congress should establish and fund a Grid Deployment Authority at the Department of Energy to support the building of new bulk transmission that can reduce congestion and allow more generators to be deployed where wind and solar resources are of highest quality.
- Congress should reaffirm the Federal Energy Regulatory Commission's authority to reform grid operators' interconnection processes, developing means to allocate the costs of new transmission among all beneficiaries (rather than forcing one project to build infrastructure from which a subsequent set of projects would freely benefit) and requiring a quicker timeline for interconnection studies (to prevent years of project delays).
- Congress should extend the federal clean energy tax credits at their full values through at least 2030, convert them to "direct pay" mechanisms (i.e., grants) to reduce soft costs associated with securing tax equity financing, and allow all clean energy technologies to qualify. Doing so would provide greater business certainty, shift the cost burden of the clean energy transition from ratepayers to taxpayers, and unlock additional emissions reduction potential.

See Rewiring the U.S. for Economic Recovery by Energy Innovation for other policy design considerations related to the clean energy transition.[7]

NOTES

[1] The White House, "Fact Sheet: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies," April 22, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/
[2] Dan Esposito, "CES Study Comparison Matrix," Energy Innovation, June 2021, https://docs.google.com/spreadsheets/d/1PsNgqIVNUnd9e99POU0PQ-bjfEgFeO_tCB3z0UOey8g/edit#gid=1016272207
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[4] Energy Innovation, "Energy Policy Solutions," https://us.energypolicy.solutions/scenarios/home
[5] Gregory Brinkman, Dominique Bain, Grant Buster, Caroline Braxl, Paritosh Das, Jonathan Ho, Eduardo Ibanez, Ryan Jones, Sam Koebrich, Sinnot Murphy, et al., "The North American Renewable Integration Study: A U.S. Perspective," National Renewable Energy Laboratory; GE Energy; Evolved Energy Research; June 2021, https://www.nrel.gov/docs/fy21osti/79224.pdf
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