Supplemental Information:

Effects of Renewable Energy Provisions of the Inflation Reduction Act on Technology Costs, Materials Demand, and Labor

Yohan Min[1], Maarten Brinkerink[1], Jesse Jenkins[2*], Erin Mayfield[1*]

1 Dartmouth College, Thayer School of Engineering, Sustainable Transitions Lab, Hanover, New Hampshire

2 Princeton University, Department Mechanical and Aerospace Engineering and Andlinger Center for Energy and the Environment, ZERO Lab, Princeton, New Jersey

*Corresponding authors contact information: mayfield@dartmouth.edu and jessejenkins@princeton.edu

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1 Supplemental methods

This section provides additional details regarding the methods, including a summary of policy provisions as well as tax credits and technology costs estimation approaches and underlying data.

1.1 Summary of policy provisions

Table S1 includes descriptions of the incentives for renewables (i.e., utility-scale solar, land-based wind, offshore fixed & floating wind) in the Inflation Reduction Act (IRA), in addition to the period over which each incentive is applicable and the eligibility of each technology. We consider the production tax credit (PTC) and investment tax credit (ITC) incentives (including sections 45, 45Y, 48, and 48E), in addition to the advanced manufacturing production credit (AMPC, section 45X). In this study, we do not account for all provisions within the IRA that can indirectly impact renewable costs (e.g., section 48C advanced energy project credit).

For the PTC and ITC, new and existing renewable energy can qualify for either a *base* rate, or a *bonus* rate that is equivalent to five times the base rate. For a project to qualify for the bonus rate, the following labor requirements must be met: 1) laborers and mechanics must be paid prevailing wage rates for construction, alteration, or repair work, and 2) a certain percentage of construction work must be performed by qualified apprentices[1,2]. Projects less than 1 megawatt (MW) in capacity are exempt from the labor requirements[2].

Table S1. Summary of IRA tax credits.

Provision	Description	Period	Technology Eligibility
Extension of Renewable Electricity Production Tax Credit (Section 45)	This provision extends the currently existing Production Tax Credit (PTC) for specific renewable technologies. Base rate 0.0055/kWh and bonus rate 0.0275/kWh in $2022.	2023-2024	All renewable technologies evaluated in study are eligible
New Clean Electricity Production Tax Credit (Section 45Y)	New Tech-Neutral PTC. Base rate 0.0055/kWh and bonus rate 0.0275/kWh in $2022.	2025-2032, phase-out period 2033-2035	All renewable technologies evaluated in study are eligible
Extension of Energy Investment Tax Credit (Section 48)	This provision extends the currently existing Investment Tax Credit (ITC) for specific renewable technologies. Base rate 6% and bonus rate 30%.	2023-2024	All renewable technologies evaluated in study are eligible except large onshore wind projects (>100 kW)
New Clean Electricity Investment Tax Credit (Section 48E)	New Tech-Neutral ITC. Base rate 6% and bonus rate 30%.	2025-2032, phase-out period 2033-2035	All renewable technologies evaluated in study are eligible

New Advanced Manufacturing Production Tax Credit (Section 45X)	New tax credit for the production and/or manufacturing of specific technology components.	2023-2029, phase-out period 2030-2032	Specific components used associated with all renewable technologies evaluated in study are eligible

In addition to the bonus and base rates for the PTC and ITC, a tax credit adder of 10% can be applied if renewable projects meet domestic content requirements or qualify as an *energy community*. To qualify for the domestic content adder, developers are required to utilize U.S. materials such as steel, iron, or manufactured products. To qualify for the energy community adder, a project must be located in an energy community which is defined as 1) a brownfield area where a coal-fired power plant closed since 2010, a brownfield area where a coal mine closed since 2000, or a metropolitan or non-metropolitan statistical area where a significant portion of employment or local tax revenues is linked to coal, oil, or natural gas activities, and 2) unemployment rates meet or exceed the national average in the preceding year[1,2]; **Figure S1** reflects energy communities as of 2023.

Under the ITC (section 48E), there are other tax credit adders for solar and wind projects with a maximum output of 5 MW. This includes an adder of 10% for projects that are located in a low-income community or on Indian land, or 20% for projects identified as a low-income residential building project or an economic benefit project.

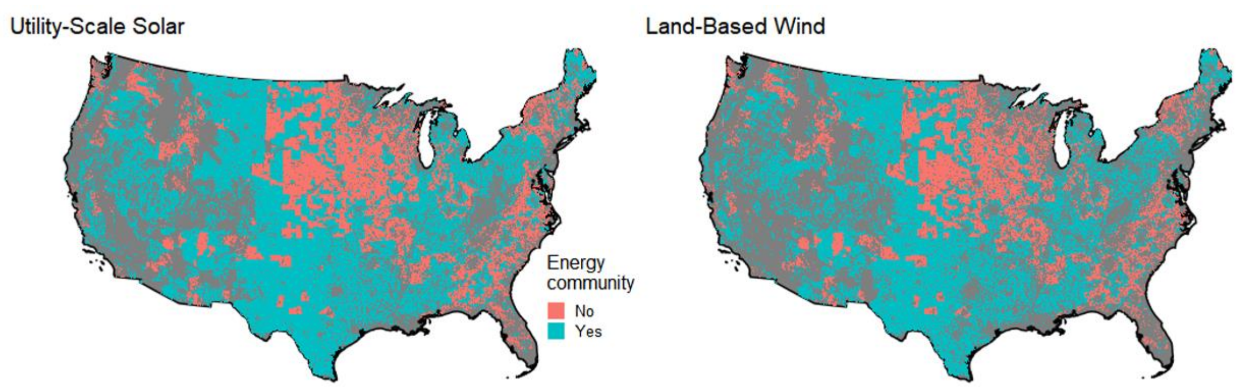

Figure S1. Candidate project areas (CPAs) where utility-scale solar (a) and land-based wind (b) can be sited. Turquoise and pink shading indicate whether or not CPAs qualify as an energy community, respectively. Gray shading indicates areas that are unsuitable for project development after undergoing a site suitability screening[3]. The utility-scale solar grid size is 4 by 4 km, while the land-based wind grid size is 8 by 8 km.

1.2 Tax credit estimation

This section details the parameterization, formulae, and sample calculations for each of the tax credits, including the PTC (sections 45 and 45Y), the ITC (sections 48 and 48E) and the AMPC (section 45X). We assume that the 45X tax credit is directly utilized to reduce solar and wind project costs. All monetary estimates are in units of 2022 real U.S. dollars (2022$), unless otherwise noted.

Table S2. Parameters, formulas, and sample calculation for PTC Section 45.

Parameter	Units	Values	Description
Rate	$/kWh	0.0055 (base) or 0.0275 (bonus)	Base rate is applied to any project. Bonus rate is applied if wage and apprenticeship requirements are met.
DC	%	0 or 10	If domestic content requirements are met, a 10% adder is applied.
EC	%	0 or 10	If a project meets the criteria for an "energy community", a 10% adder is applied.
LI	%	0, 10 or 20	If a project is <5 MW and qualifies as "Low Income Community or Tribal Land", a 10% adder is applied. If a project is <5 MW and meets the criteria for "Low Income Residential Building or Economic Benefit Project", a 20% adder is applied.
TR	%	21	Marginal tax rate.
TO	%	7.5	Credit transfer overhead.
Formula			**Description**
$PTC_t = \left(Rate * (100\% + DC + EC + LI) * \frac{100\% - TO}{100\% - TR}\right)$			Formula to estimate the PTC per kWh for a project that enters service in year *t*. PTC credits can be claimed for a 10-year period following the date the project entered service.
Sample Calculation			**Description**
$PTC_{2023} = 0.0055 * (100\% + 0\% + 0\% + 0\%) * \frac{100\% - 7.5\%}{100\% - 21\%} = \$0.0064/kWh$			Sample project that enters service in 2023, and does not meet apprenticeship and wage requirements nor the domestic content, energy community, and low income criteria.
$PTC_{2023} = 0.0275 * (100\% + 10\% + 10\% + 20\%) * \frac{100\% - 7.5\%}{100\% - 21\%} = \$0.0451/kWh$			Sample project that enters service in 2023, and meets apprenticeship and wage requirements and the domestic content, energy community, and low income criteria.

Table S3. Parameters, formulas, and sample calculations for PTC Section 45Y.

Parameter	Units	Values	Description
Rate	$/kWh	0.0055 (base) or 0.0275 (bonus)	Base rate is applied to any project. Bonus rate is applied if wage and apprenticeship requirements are met.
DC	%	0 or 10	If domestic content requirements are met, a 10% adder is applied.
EC	%	0 or 10	If a project meets the criteria for an "energy community", a 10% adder is applied.

LI	%	0, 10 or 20	If a project is <5 MW and qualifies as "Low Income Community or Tribal Land", a 10% adder is applied. If a project is <5 MW and meets the criteria for "Low Income Residential Building or Economic Benefit Project", a 20% adder is applied.
TR	%	21	Marginal tax rate.
TO	%	7.5	Credit transfer overhead.
SF	%	0, 50, 75 or 100	The sunsetting factor reflects whether the full or adjusted credit amount can be claimed, which depends on the year that the project enters service. The final year of the provision is either 2032 or the year that sector-level emission targets are met (i.e., the electric power sector emits 75% less carbon than 2022 levels). The full credit amount (i.e., *SF* =100%) can be claimed for a project that enters service between 2025 and the final year of the provision. During the sunsetting period, sunsetting factor should be set to 100% for final year + 1, 75% for final year + 2, 50% for final year + 3, and 0% for final year + 4.
Formula			**Description**
$PTC_t = \left(Rate * (100\% + DC + EC + LI)\right) * SF * \frac{100\% - TO}{100\% - TR}$			Formula to estimate the PTC per kWh for a project that enters service in year *t*. PTC credits can be claimed for a 10-year period following the date the project entered service.
Sample Calculations			**Description**
$PTC_{2027} = \left(0.0055 * (100\% + 10\% + 0\% + 0\%)\right) * 100\% * \frac{100\% - 7.5\%}{100\% - 21\%} = \$0.0071/kWh$			Sample project that enters service in 2027, does meet domestic content requirements, and does not meet apprenticeship and wage requirements nor the energy community and low income criteria. Sector-level emission targets are also not met before 2033.
$PTC_{2035} = \left(0.0275 * (100\% + 10\% + 0\% + 0\%)\right) * 50\% * \frac{100\% - 7.5\%}{100\% - 21\%} = \$0.0178/kWh$			Sample project that enters service in 2035, does meet domestic content as well as apprenticeship and wage requirements, and does not meet the energy community and low income criteria. Sector-level emission targets are also not met before 2033.
$PTC_{2032} = \left(0.0275 * (100\% + 10\% + 10\% + 20\%)\right) * 75\% * \frac{100\% - 7.5\%}{100\% - 21\%} = \$0.0338/kWh$			Sample project that enters service in 2032, does meet domestic content as well as apprenticeship and wage requirements, and does not meet the energy community and low income criteria. Sector-level emission targets are also met before 2030.

Table S4. Parameters, formulas, and sample calculations for ITC Section 48.

Parameter	Units	Values	Description

Rate	%	6 (base) or 30 (bonus)	Base rate is applied to any project. Bonus rate is applied if wage and apprenticeship requirements are met.
DC	%	0, 2, or 10	If domestic content requirements are met, a 2% adder is applied for projects that receive base rate and a 10% adder is applied for projects that receive bonus rate.
EC	%	0, 2, or 10	If a project meets the criteria for an "energy community", a 2% adder is applied for projects that receive base rate and a 10% adder is applied for projects that receive bonus rate.
LI	%	0, 10 or 20	If a project is <5 MW and qualifies as "Low Income Community or Tribal Land", a 10% adder is applied. If a project is <5 MW and meets the criteria for "Low Income Residential Building or Economic Benefit Project", a 20% adder is applied.
TR	%	21	Marginal tax rate.
TO	%	7.5	Credit transfer overhead.
Formula			**Description**
$ITC_t = (Rate + DC + EC + LI) * \frac{100\% - TO}{100\% - TR}$			Formula to estimate the ITC for a project that enters service in year *t*.
Sample Calculations			**Description**
$ITC_{2023} = (6\% + 2\% + 0\% + 0\%) * \frac{100\% - 7.5\%}{100\% - 21\%} = 9.4\%$			Sample project that enters service in 2023, does meet domestic content requirements, and does not meet apprenticeship and wage requirements nor the energy community and low income criteria.
$ITC_{2023} = (30\% + 10\% + 10\% + 0\%) * \frac{100\% - 7.5\%}{100\% - 21\%} = 58.5\%$			Sample project that enters service in 2023, does meet domestic content requirement, apprenticeship and wage requirement, and energy community criteria, but does not meet the low income criteria.

Table S5. Parameters, formulas, and sample calculations for ITC Section 48E.

Parameter	Units	Values	Description
Rate	%	6 (base) or 30 (bonus)	Base rate is applied to any project. Bonus rate is applied if wage and apprenticeship requirements are met.
DC	%	0, 2, or 10	If domestic content requirements are met, a 2% adder is applied for projects that receive base rate and a 10% adder is applied for projects that receive bonus rate.
EC	%	0, 2, or 10	If a project meets the criteria for an "energy community", a 2% adder is applied for projects that receive base rate and a 10% adder is applied for projects that receive bonus rate.
LI	%	0, 10 or 20	If a project is <5 MW and qualifies as "Low Income Community or Tribal Land", a 10%

			adder is applied. If a project is <5 MW and meets the criteria for “Low Income Residential Building or Economic Benefit Project”, a 20% adder is applied.
TR	%	21	Marginal tax rate.
TO	%	7.5	Credit transfer overhead.
SF	%	0, 50, 75, or 100	The sunsetting factor reflects whether the full or adjusted credit amount can be claimed, which depends on the year that the project enters service. The final year of the provision is either 2032 or the year that sector-level emission targets are met (i.e., the electric power sector emits 75% less carbon than 2022 levels). The full credit amount (i.e., *SF* =100%) can be claimed for a project that enters service between 2025 and the final year of the provision. During the sunsetting period, sunsetting factor should be set to 100% for final year + 1, 75% for final year + 2, 50% for final year + 3, and 0% for final year + 4.
Formula			**Description**
$ITC_t = (Rate + DC + EC + LI) * SF * \frac{100\% - TO}{100\% - TR}$			Formula to estimate the ITC for a project that enters service in year *t*.
Sample Calculations			**Description**
$ITC_{2027} = (6\% + 2\% + 0\% + 0\%) * 100\% * \frac{100\% - 7.5\%}{100\% - 21\%} = 9.4\%$			Sample project that enters service in 2027, does meet domestic content requirements, and does not meet apprenticeship and wage requirements nor the energy community and low income criteria. Sector-level emission targets are also not met before 2033.
$ITC_{2035} = (30\% + 10\% + 0\% + 0\%) * 50\% * \frac{100\% - 7.5\%}{100\% - 21\%} = 23.4\%$			Sample project that enters service in 2035, does meet domestic content as well as apprenticeship and wage requirements, and does not meet the energy community and low income criteria. Sector-level emission targets are also not met before 2033.
$ITC_{2032} = (30\% + 10\% + 10\% + 20\%) * 75\% * \frac{100\% - 7.5\%}{100\% - 21\%} = 61.5\%$			Sample project that enters service in 2032, does meet domestic content requirement, apprenticeship and wage requirement, and the energy community and low income criteria. Sector-level emission targets are also met before 2030.

Table S6. Parameters, formulas, and sample calculations for AMPC Section 45X.

Component	PTC Units	PTC Values (for sales in 2023-2030	Domestic share (%) (as of 2021)
Thin-film PV cells	$/W-dc	0.04	0
Crystalline PV cells	$/W-dc	0.04	0
Solar PV wafers	$/m2	12[a]	0

	($/W-dc)	(0.0595)	
Solar grade polysilicon	$/kg ($/W-dc)	3[b] (0.009)	0
Polymeric back sheet	$/m2 ($/W-dc)	0.4[a] (0.002)	16
Solar modules	$/W-dc	0.07	16
Solar tracker - Torque tube	$/kg ($/W-dc)	0.87[c] (0.083)	100
Solar tracker - Longitudinal purlin	$/kg ($/W-dc)	0.87[c] (0.083)	100
Solar tracker - Structural fastener	$/kg ($/W-dc)	2.28[c] (0.217)	100
Wind energy - Blade	$/W	0.02	0 (offshore) 15-25 (onshore)
Wind energy - Nacelle	$/W	0.05	0 (offshore) 85-100 (onshore)
Wind energy - Tower	$/W	0.03	0 (offshore) 55-70 (onshore)
Offshore wind energy foundation - Fixed platform	$/W	0.02	100
Offshore wind energy foundation - Floating platform	$/W	0.04	100
Offshore wind vessel	% of sales price of vessel	10[d]	
Inverter - Utility	$/W-ac ($/W-dc)	0.015[e] (0.011)	0

Parameter	Units	Values	Description
Rate	$/W	Sum of applicable credits	AMPC tax rate in $/W.
SF	%	0, 25, 50, 75, or 100	The sunsetting factor reflects whether the full or adjusted credit amount can be claimed, which depends on the year that the component is sold. Value should be set to 100% for any component sold between 2023-2029, 75% in 2030, 50% in 2031, 25% in 2032, and 0% in 2033.
TR	%	21	Marginal tax rate.

Formula	Description
$AMPC_t = Rate * SF/(100\% - TR)$	Formula to estimate the AMPC that can be claimed for the manufacturing of components in a project that enters service in year *t*.

Sample Calculations	Description
$AMPC_{2023} = (0.02 + 0.05 + 0.03) * 100\%/(100\% - 21\%)$ = \$0.1266/W	Sample domestic manufacturer in year 2023 that produces and supplies blades, nacelles, and towers.
$AMPC_{2030} = (0.02 + 0.05 + 0.03) * 75\%/(100\% - 21\%) = \$0.0949/W$	Sample domestic manufacturer in year 2030 that produces and supplies blades, nacelles, and towers.

a Assuming a 400W module with 2.0726m2 size (0.0052m2/W-dc for module, 0.0050m2/W-dc for wafer or cell, given 72 (12 x 6) units)[4].
b Assuming Polysilicon 0.003kg/W-dc (1.2kg needed for a 400W module)[5].
c Assuming 0.095kg/W for silicon module racking steel intensity[6].
d Not included in the analysis.

e Assuming dc to ac ratio of 1.34[7].

1.3 Technology cost estimation

1.3.1 Baseline technology costs

We estimate baseline capital costs and operations and maintenance (O&M) costs for utility-scale solar, land-based wind, and offshore wind projects in 2021. These estimates are based on the most recent publicly-available data. For utility-scale solar, the baseline costs are derived from estimates provided by the National Renewable Energy Laboratory (NREL)[7–9]. We updated these estimates to account for the current global and domestic prices of photovoltaic (PV) module components[10] and inverters[7,11,12]. The baseline costs for land-based wind projects are based on estimates developed by the U.S. Department of Energy (DOE) and NREL[13–15]. In **Table S7**, we present the capital costs associated with the production of domestically and internationally manufactured components. This includes the crystalline silicon photovoltaic module manufacturing supply chain, including as polysilicon, wafers, cells, and modules, as well as inverters. In addition, this includes the wind turbine supply chain, including blades, nacelles, and towers.

Table S8**, Table S9**, and **Table S10** provide a breakdown of the capital costs, incorporating all system and project development expenses incurred during installation[7–9,13–15]. Finally, **Table S11** displays the O&M costs associated with these projects[7,13].

Table S7. 2021 component costs for solar and wind technologies.

Component	Units	Costs	
		Domestic	Imported
Solar grade polysilicon	$/W-dc	0.050[a]	0.043[b*]
Solar PV wafers (excluding polysilicon)	$/W-dc	0.120 (0.070)[a]	0.088 (0.045)[b*]
Crystalline PV cells (excluding wafers)	$/W-dc	0.178 (0.058)[a]	0.143 (0.055)[b*]
Solar modules (excluding cells)	$/W-dc	0.383 (0.205)[a]	0.291 (0.148)[b*]
Inverter - Utility	$W-dc	0.040[c]	0.040[c]
Onshore Wind - Blade	$/W	0.281[d]	0.281[d]
Onshore Wind - Nacelle	$/W	0.458[d]	0.458[d]
Onshore Wind - Tower	$/W	0.183[d]	0.183[d]
Offshore - Rotor nacelle assembly	$/W	1.119[e]	1.119[e]
Offshore - Tower	$/W	0.182[e]	0.182[e]

a Values are based on the production costs for c-Si PV manufacturing in the United States from NREL[7–9].
b Values are derived from the production costs of c-Si PV manufacturing in China, as estimated by NREL, and are assumed to represent the global average[7–9].
c Inverter prices are based on MSP model from NREL[7,11,12].
d Values have been adjusted using the global average of $921 per kilowatt (kW), while taking into account the market share of leading wind turbine manufacturers such as GE Wind (47%), Vestas (26%), SGRE (13%), and Nordex (13%), as reported in the Land-Based Wind Market Report: 2022 Edition[14]. The ratio of components in wind turbine costs is from the 2021 Cost of Wind Energy Review by Wiser et al.[14] and Stehly and Duffy[15]. The values include delivery cost to the installation sites.
e Values are sourced from the Offshore Wind Market Report: 2022 Edition by Musial et al.[13] and are based on international costs as there is no available U.S. manufacturing data.
* Shipping cost of 10% included.

Table S8. Average 2021 capital costs for utility-scale solar in the U.S.

Parameter	Units	Value
Manufacturing		
Module price[a,b]	$/W-dc	0.31
Inverter price[a,b]	$/W-dc	0.04
Development / installation		
Structural Balance of System (BOS)	$/W-dc	0.12
Electrical BOS	$/W-dc	0.08
Install labor & equipment[c]	$/W-dc	0.11
EPC overhead	$/W-dc	0.06
Sales tax	$/W-dc	0.04
Permitting, interconnection, land, lease fee	$/W-dc	0.02
Transmission line	$/W-dc	0.01
Developer overhead	$/W-dc	0.02
Contingency	$/W-dc	0.02
Profit	$/W-dc	0.04
Labor costs (development / install only)	$/W-dc	0.11
Non-labor costs (development / install only)	$/W-dc	0.40
Total	$/W-dc	0.87
Total	$/W-ac	1.17

a Module and inverter prices are based on MSP model from NREL[11,12].
b Assume a wage rate of $27.7/hour, which is the 2021 average wage rate for the manufacturing sector reported by the U.S. Bureau of Labor Statistics[16].
c Assume a wage rate of $29.33/hour, which is the 2021 average wage rate for the construction sector reported by the U.S. Bureau of Labor Statistics[16].
d Assume an DC:AC inverter ratio of 1.34[17].

Table S9. Average 2021 capital costs for land-based wind in the U.S.

Parameter	Units	Value
Manufacturing		
Turbine price[a]	$/kW	921
Development / installation		
Development cost	$/kW	24
Engineering Management cost	$/kW	10
Foundation cost	$/kW	77
Site Access and Staging cost	$/kW	41
Assembly and Installation cost	$/kW	42
Electrical Infrastructure cost	$/kW	136
Construction Finance cost	$/kW	23
Contingency cost	$/kW	90
Labor costs (development / install only)[b]	$/kW	89
Non-labor costs (development / install only)	$/kW	354
Total	$/kW	1,364

a Assuming a wage rate of $27.7/hour, which is the 2021 average wage rate for the manufacturing sector reported by the U.S. Bureau of Labor Statistics[16].
b Assuming a wage rate of $29.33/hour, which is the 2021 average wage rate for the construction sector reported by the U.S. Bureau of Labor Statistics[16].

Table S10. Average 2021 capital costs for offshore wind in the U.S.

Parameter	Units	Fixed	Floating
Manufacturing			
Turbine price[a]	$/kW	1,301	1,301
Development / installation			
Development cost	$/kW	89	89
Foundation cost	$/kW	496	2089
Construction finance cost	$/kW	152	221
Assembly and Installation cost	$/kW	408	316
Electrical Infrastructure cost	$/kW	693	747
Lease price	$/kW	178	178
Engineering Management cost	$/kW	2	2
Insurance during construction	$/kW	34	52
Decommissioning bond	$/kW	117	101
Plant commissioning	$/kW	34	52
Contingency cost	$/kW	366	428
Labor costs (development / install only)[b]	$/kW	352	586
Non-labor costs (development / install only)	$/kW	2,217	3,689
Total	$/kW	3,870	5,576

a Assume a wage rate of $27.7/hour, which is the 2021 average wage rate for the manufacturing sector reported by the U.S. Bureau of Labor Statistics[16].
b Assume a wage rate of $29.3/hour, which is the 2021 average wage rate for the construction sector reported by the U.S. Bureau of Labor Statistics[16].

Table S11. Average 2021 operating and maintenance costs for each technology.

Technology	Operating & Maintenance Costs ($/kW/yr)		
	Labor	Non-Labor	Total
Utility-scale solar	6.97	15.03	22.00
Land-based wind	11.28	28.72	40.00
Fixed offshore wind	18.00	93.00	111.00
Floating offshore wind	19.00	99.00	118.00

We assume that capital and O&M costs will decline over time as a result of technology and cost efficiencies. As shown in **Figure S2**, we develop cost scaling factors to better represent costs for projects that enter service in future years. To derive scaling factors, we use the 2022 Annual Technology Baseline (ATB) from NREL[17], which includes cost projections out to 2050.

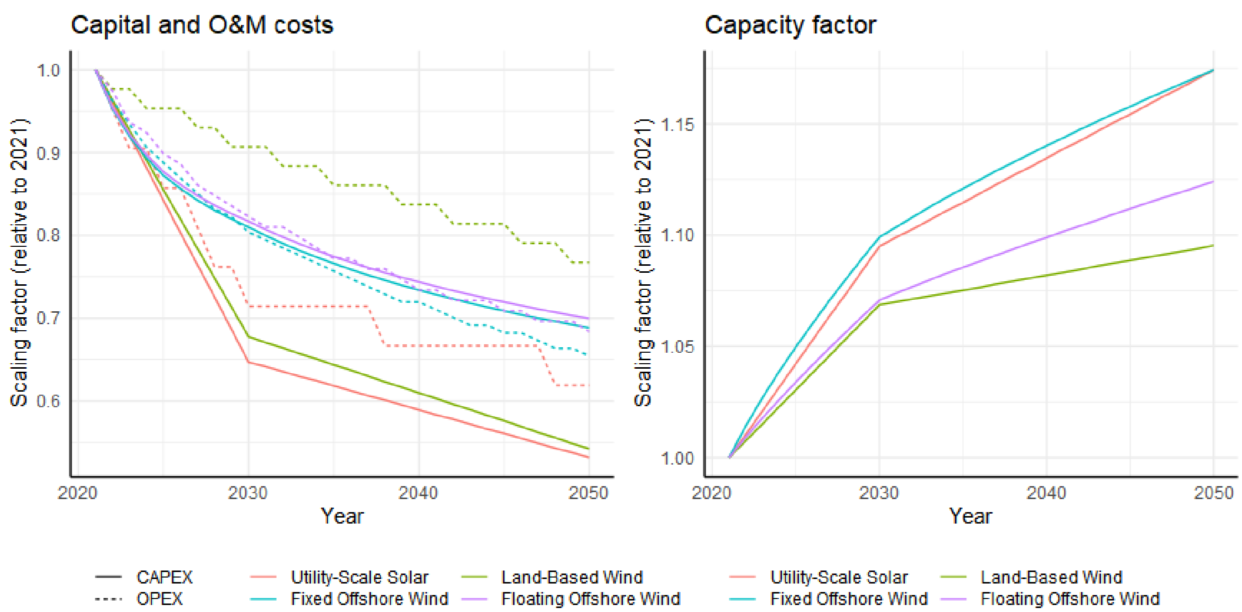

Figure S2. Scaling factor (relative to 2021) of the capital costs, O&M costs, and capacity factors for each technology.

1.3.2 Capacity factors

Table S12 includes the U.S. average capacity factors for each technologies in 2021, which are based on the 2022 NREL ATB[17]. To reflect geographic differences in renewable potential, we further use spatially-explicit capacity factors for utility-scale solar and land-based wind developed by Leslie et al. (2021)[3]. Specifically, following the site suitability screening conducted by Leslie et al. (2021)[3], unsuitable areas are excluded, and we identify Candidate Project Areas (CPAs) using a grid of 4km x 4km for utility-scale solar and 8km x 8km for land-based wind. We also account for changes in U.S. average and spatially-explicit capacity factors over time based on NREL ATB projects, as shown in **Figure S2**. **Figure S3** and **Figure S4** depict spatially-explicit capacity factors in 2021 for utility-scale solar and land-based wind, respectively.

Table S12. U.S. average capacity factors for each technology for 2021.

Technology	Capacity Factor
Utility-scale solar	0.244
Land-based wind	0.431
Fixed offshore wind	0.490
Floating offshore wind	0.381

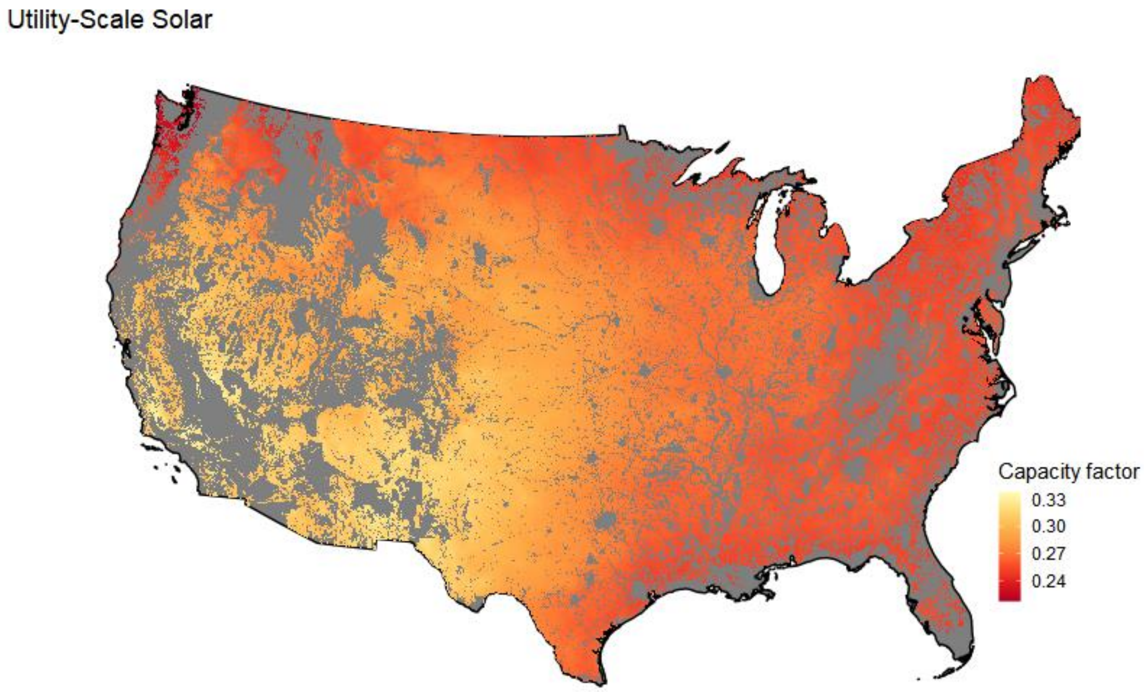

Figure S3. Utility-scale solar capacity factors in 2021 for each candidate project area. Gray shaded regions indicate exclusion areas. The grid size is 4 by 4 km.

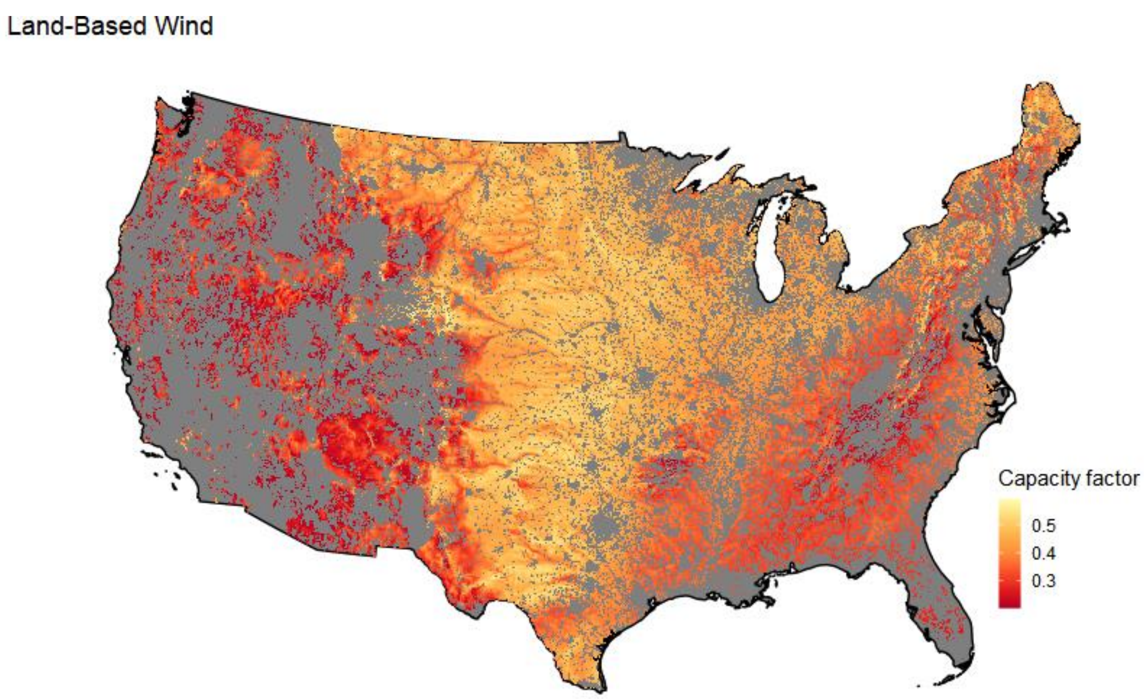

Figure S4. Estimated land-based wind capacity factors in 2021 for each candidate project area. Gray shaded regions indicate exclusion areas. The grid size is 8 by 8 km.

1.3.3 Interconnection cost estimation

In determining interconnection costs, we follow the methodology outlined by Patankar et al.[18] This involved considering several factors, such as the proximity of the wind or solar project to the nearest substation, the capacity and voltage level of the transmission line, and the construction expenses associated with the line. **Figure S5** provides an illustration of the estimated interconnection costs for each CPA for utility-scale solar and land-based wind.

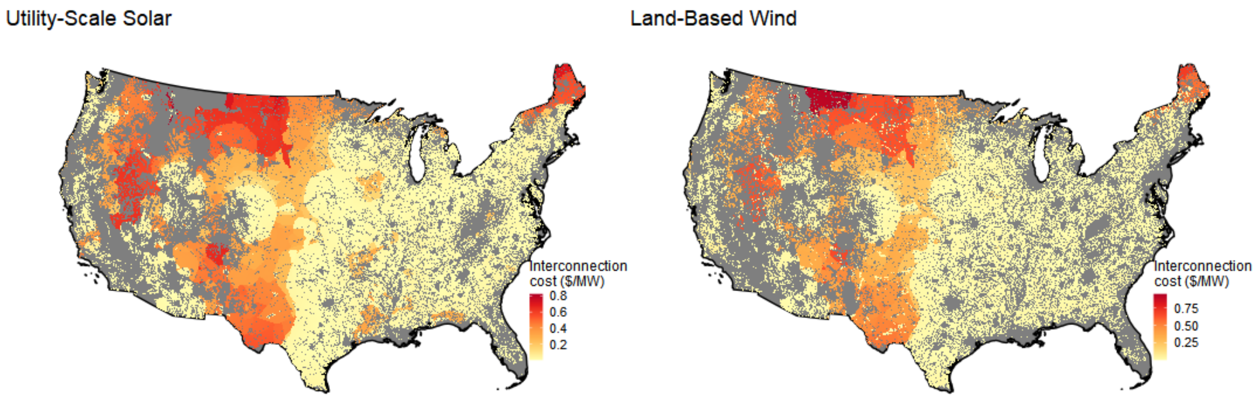

Figure S5. Estimated interconnection costs for each CPA. Gray shaded regions indicate exclusion areas. The utility-scale solar grid size is 4 by 4 km, while the land-based wind grid size is 8 by 8 km.

1.3.4 Levelized cost of electricity estimation

The following details the parameterization, formulation, and sample calculations of the levelized cost of electricity (LCOE) with the application of the tax credits. For the LCOE estimation, we use the formula following methodology described in NREL (2021)[15]. This LCOE estimation (Table S16) takes into account the capital costs (**Table S13**) and O&M costs (Table S14), both scaled to reflect changing costs over time and adjusted to reflect the potential cost savings due to the eligible PTC credits. Future costs for the PTC are adjusted to reflect the net present value as summarized in Table S15.

Table S13. Parameters, formulas, and sample calculations of capital costs for LCOE estimation.

Parameter	Units	Values	Description
CC_d	\$/kW	See **Table S7**.	2021 capital costs for domestically-produced technology component *d*.
CC_i	\$/kW	See **Table S7**.	2021 capital costs for imported technology component *i*.
DMS_t	%	0-100%	The domestic content share for each component and year that the project enters service *t*.
CCR_t	%	See **Figure S2**	Factor representing decline in capital costs (relative to 2021) for the year a project enters service *t*.
$AMPC_t$	\$/W	Project specific	The relevant AMPC value for a project that enters service in year *t*.

ITC_t	%	See Section 1.2.	The relevant ITC value for a project that enters service in year *t*.
Formula			**Description**
Formula to estimate the O&M costs for a project that enters service in year *t*.			Formula to estimate the capital costs for a project that enters service in year *t*.
Sample Calculations			**Description**
$CC_{2025} = \left(\left(\left(383 * 16\% + 291 * (100\% - 16\%)\right) * 85.5\%\right) - (16\% * 0.07 * 1000)\right) * (100\% - 35.13\%) = \$162/kW$			Sample utility-scale solar project that enters service in 2025, with a CC_d of \$383/kW and CC_i of \$291/kW for solar modules, DMS_t for 2021 of 16%, CCR_t in 2025 of 85.5%, $AMPC_t$ of \$0.07/W for solar modules, and an ITC_t of 35.13%.

Table S14. Parameters, formulas, and sample calculations of operating and maintenance costs for LCOE estimation.

Parameter	Units	Values	Description
OC	\$/kW/yr	See **Table S11**.	Annual O&M costs for 2021.
OCR_t	%	See **Figure S2**.	Factor representing decline in O&M costs (relative to 2021) for the year a project enters service *t*.
Formula			**Description**
$OC_t = OC * OCR_t$			Formula to estimate the O&M costs for a project that enters service in year *t*.
Sample Calculations			**Description**
$OC_{2025} = (40 * 95\%) = \$38/kW/yr$			Sample onshore wind project which enters service in 2025.

Table S15. Parameters, formulas, and sample calculations of the net present value of the PTC for LCOE estimation.

Parameter	Units	Values	Description
WACC	%	2.70 (utility-scale solar), 2.72 (offshore wind), or 2.80 (onshore wind)	Technology specific weight-average cost of capital. Based on data from Stehly and Duffy[15].
T_n	year	1-10	The nth year of operation for a project. The PTC credit is applicable for a maximum of 10 years.
PTC_t	\$/kWh	See Section 1.2.	The relevant PTC value for a project that enters service in year *t*.
TL	years	25 (wind) or 30 (utility-scale solar)	Assumed technical life of project. Based on a data from[15,17].
Formulas			**Description**
$PTC_{NPV_{10}} = \sum_{T_n=0}^{10} \frac{PTC_t}{(1+WACC)^{T_n}}$			Formula used to calculate the 10-year net present value of the PTC credit for a project that enters service in year *t*.

$PTC_{NPV_{TL}} = GoalSeek(TL, PTC_{NPV_{10}})$	To estimate the LCOE, a single average PTC credit value is required for the full technical life of a project. Thus, we apply a goal seek function to find the equivalent *PTC* if it would be received on an annual basis over its full *TL* with the same *NPV* as for the actual 10-year credit period of the *PTC*.
Sample Calculations	**Description**
$PTC_{NPV_{10}} = \sum_{T_n=0}^{10} \frac{0.0322}{(1+2.8\%)^{T_n}} = \$0.2775/kWh$ $PTC_{NPV_{TL}} = GoalSeek(25, 0.2775) = \$0.01558/\text{kWh}$	Sample onshore wind project which enters service in 2025 with a PTC_t equal to \$0.0322/kWh.

Table S16. Parameters, formulas, and sample calculations for LCOE estimation.

Parameter	Units	Values	Description
CC_t	\$/kW	See **Table** S8**, Table S9, Table S10,** and **Table S11.**	Capital costs for a project that enters service in year *t*.
$Int_{t,i}$	\$/kW	See **Figure S5**.	Interconnection costs for a project that enters service in year *t* (CCR_t weighted depending on *t*) at geographic location, CPA *i*.
OC_t	\$/kW/yr	See **Table S11**.	O&M costs for a project that enters service in year *t*.
FCR	%	4.40% (utility-scale solar), 5.82% (offshore wind), or 5.88% (land-based wind)	A fixed charge rate reflecting the cost of capital needed to finance projects. Based on a data from[15,17].
CF_i	%	See **Table S12**, and **Figure S4**.	Technology-specific capacity factor for 2021 at geographic location, CPA *i*.
CFR_t	%	See **Figure S2**.	Factor representing change in capacity factor (relative to 2021) for the year a project enters service *t*.
Formula			**Description**
$LCOE_t = \frac{\left((CC_t + Int_{t,i}) * FCR\right) + OC_t}{CF_i * CFR_t * 8760} - PTC_{NPV_{TL}}$			Formula used to calculate the levelized cost of electricity in \$/kWh for the year a project enters service *t*.
Sample Calculations			**Description**
$LCOE_{2025} = \frac{(751.95 * 5.88\%) + 38}{43.09\% * 103\% * 8760} - 0 = \$0.0212/kWh$			Sample onshore wind project which enters service in 2025 with a an ITC_t adjusted total CC_{2025} of \$751.95/kW, VC_{2025} of \$38/kW/yr, baseline *CF* of 43.09%, and a CFR_{2025} of 103%.

$LCOE_{2025} = \frac{(1159.17 * 5.88\%) + 38}{43.09\% * 103\% * 8760} - 0.01558 = \$0.0117/kWh$	Sample onshore wind project which enters service in 2025 with a CC_{2025} of \$1159.17/kW, $PTC_{NPV_{TL}}$ of \$0.01558/kWh, baseline *CF* of 43.09%, and a CFR_{2025} of 103%.

2 Supplemental results

2.1 Technology costs

We provide several visual representations of our findings related to the impact of AMPC on the cost of domestically produced and imported wind and solar components in **Table S17**. Additionally, we present LCOEs for different policy scenarios in 2030 in **Figure S6**. To further analyze the data, we illustrate the temporal LCOEs for each policy scenario from 2023 to 2050 in **Figure S7**. Moreover, **Figure S8** displays spatially explicit LCOEs for alternative policy scenarios in 2030, excluding the interconnection costs associated with the construction of new transmission lines. Lastly, we examine the differences in LCOEs for policy scenarios relative to the baseline for utility-scale solar and land-based wind in 2030 in **Figure S9**. These figures provide valuable insights into the cost implications and variations across different scenarios and timeframes.

Table S17. Impact of the 45X AMPC on cost of domestically produced and imported wind and solar components.

Component	Units	Costs		
		Domestic pre-45X	Domestic post-45X	International
Solar grade polysilicon	$/W-dc	0.050	0.041	0.043
Solar PV wafers (excluding polysilicon)	$/W-dc	0.120 (0.070)	0.051 (0.010)	0.088 (0.045)
Crystalline PV cells (excluding wafers)	$/W-dc	0.178 (0.058)	0.069 (0.018)	0.143 (0.055)
Solar modules (excluding cells)	$/W-dc	0.383 (0.205)	0.202 (0.133)	0.291 (0.148)
Inverter - Utility	$W-dc	0.040	0.029	0.040
Onshore Wind - Blade	$/W	0.281	0.261	0.281
Onshore Wind - Nacelle	$/W	0.458	0.408	0.458
Onshore Wind - Tower	$/W	0.183	0.153	0.183
Offshore - Rotor nacelle assembly	$/W	1.119	1.049	1.119
Offshore - Tower	$/W	0.182	0.152	0.182

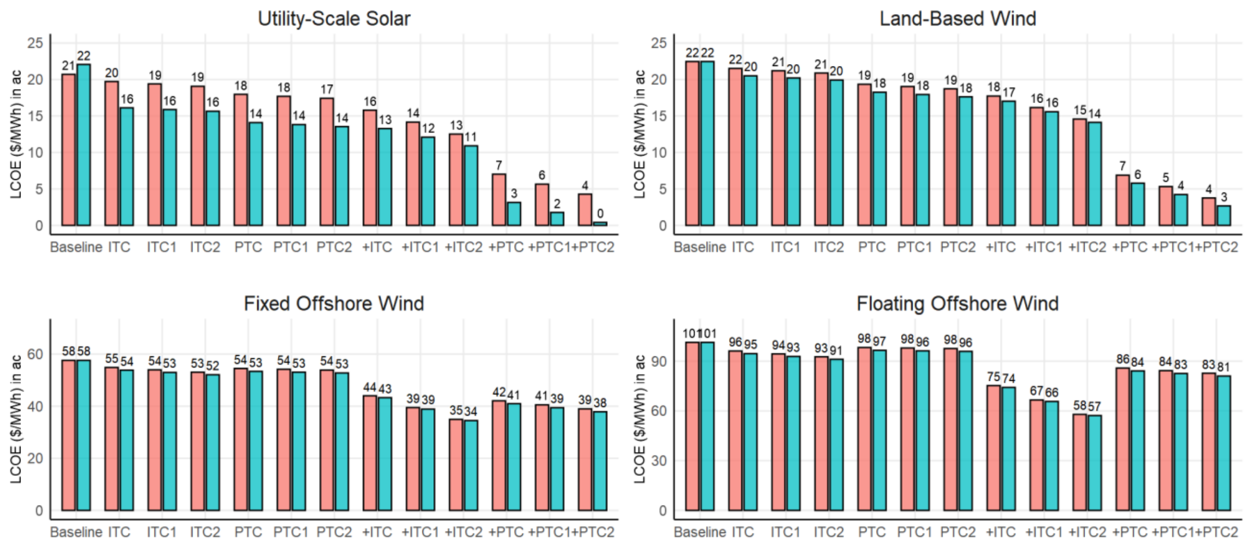

Figure S6. LCOE in 2030 for each policy scenario. The policy scenarios are indicated as follows: base or bonus rates (+), ITC or PTC incentives, and whether the requirements of domestic content (1), energy community (1), or both (2) are satisfied. Pink bars indicate 2021 domestic content shares and turquoise bars indicate 100% domestic content shares across renewable products. Costs for U.S. manufactured content account for the 45X AMPC. LCOE values include a standardized interconnection costs.

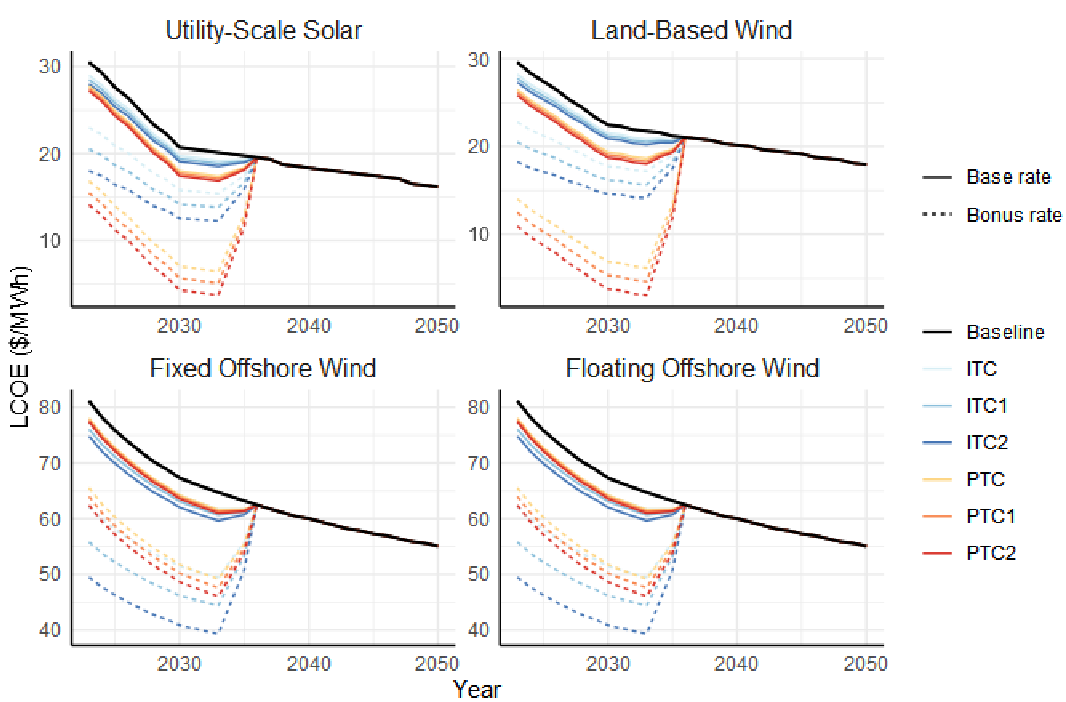

Figure S7. LCOE for policy scenarios from 2023 to 2050. The policy scenarios are indicated as follows: base or bonus rates (+), ITC or PTC incentives, and whether the requirements of domestic

content (1), energy community (1), or both (2) are satisfied. Current (as of 2021) domestic content shares are assumed.

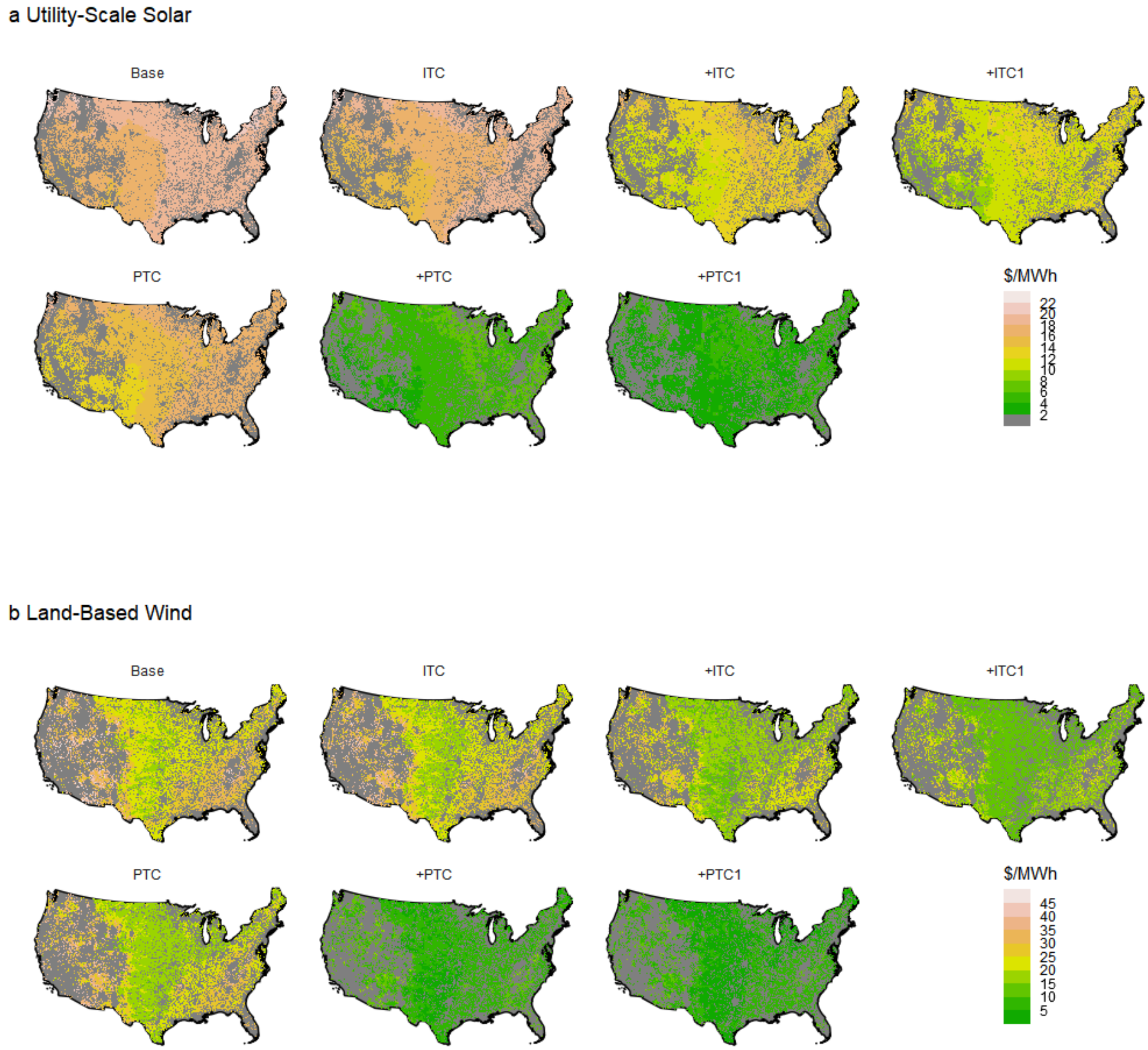

Figure S8. Spatially-explicit LCOE for alternative policy scenarios for 2030 (excluding interconnection costs associated with construction of new transmission lines). The policy scenarios are indicated as follows: base or bonus rates (+), ITC or PTC incentives, domestic content share requirement met (1), and with the energy community credit (for relevant regions). Gray shaded regions indicate areas that are unsuitable for project development. In the case of utility-scale solar projects, unsuitable areas were eliminated after undergoing site suitability screening[3]. For land-based wind projects, in addition to the screening process, areas with a capacity factor under 0.2 were also considered unsuitable.

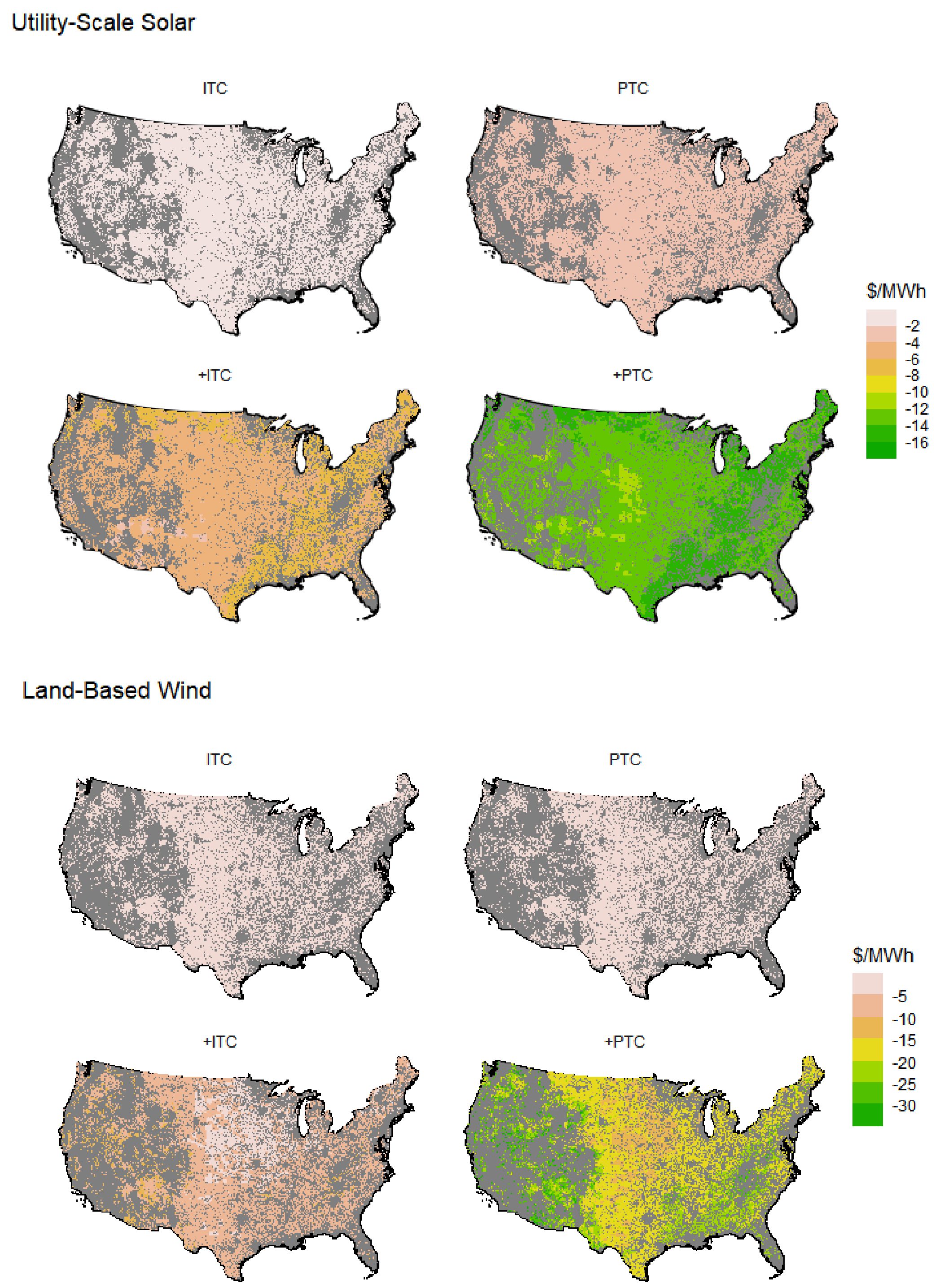

Figure S9. Differences in LCOE for policy scenarios relative to the baseline for utility-scale solar and land-based wind in 2030, taking into account each scenario's incentives (either ITC or PTC) and rate types (base or bonus rates denoted by "+"). Gray indicates regions that are unsuitable for project development. In the case of utility-scale solar projects, these areas were eliminated after undergoing site suitability screening[3]. For land-based wind projects, in addition to the screening process, areas with a capacity factor under 0.2 were also removed.

2.2 Materials demand

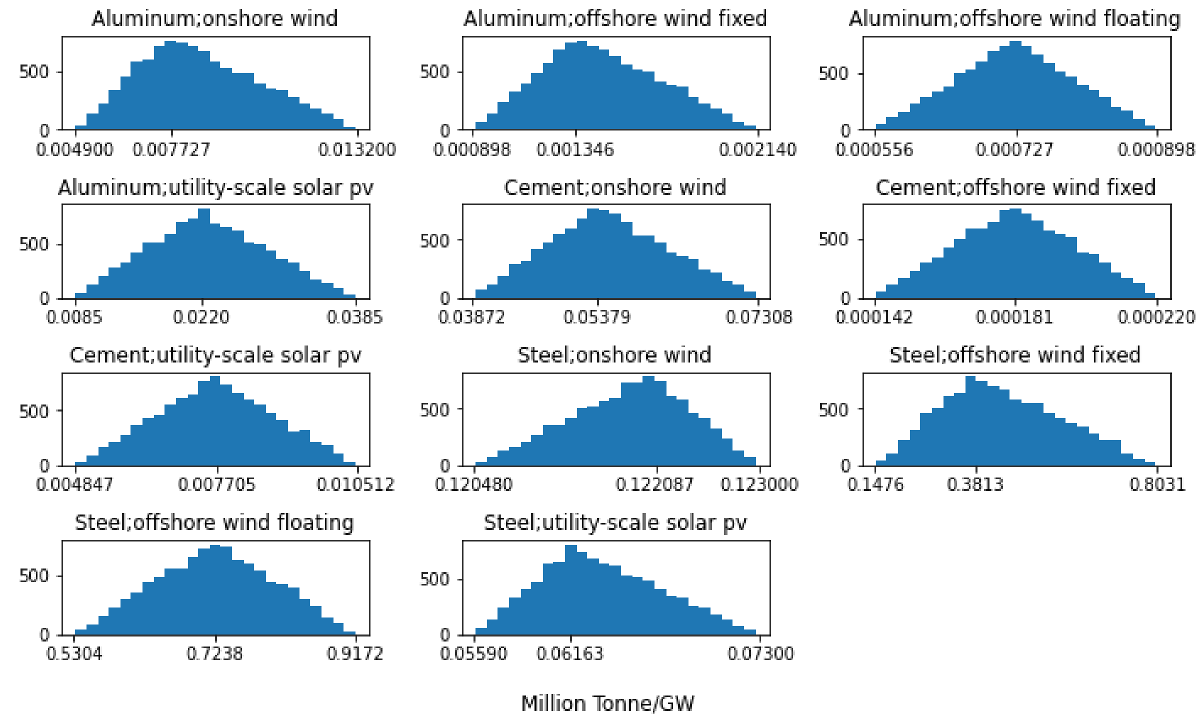

Figure 10. Monte Carlo simulation outputs for material intensity values based on a triangular distribution. N = 10,000. Values on the x-axis represent the min, mean and max values. The mean is chosen as middle value over the median or mode because of the relatively low number of available material intensity values.

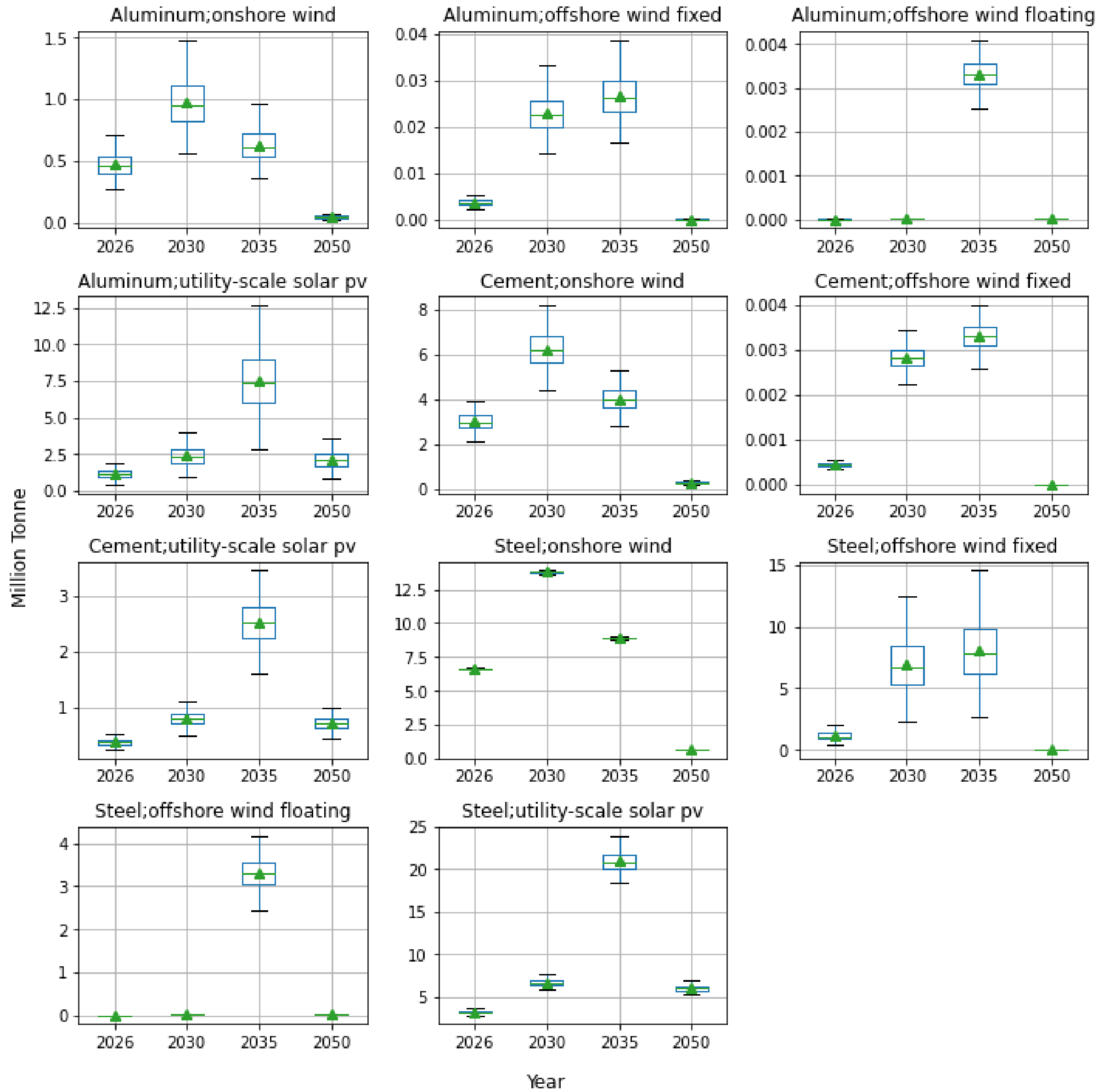

Figure 11. Range of projected material demand values per technology and material for the ira_mid scenario based on the Monte Carlo simulation outputs for aluminum, cement and steel material intensity. The mean values (green markers) are the assumed material intensity values as utilized in the main part of this paper.

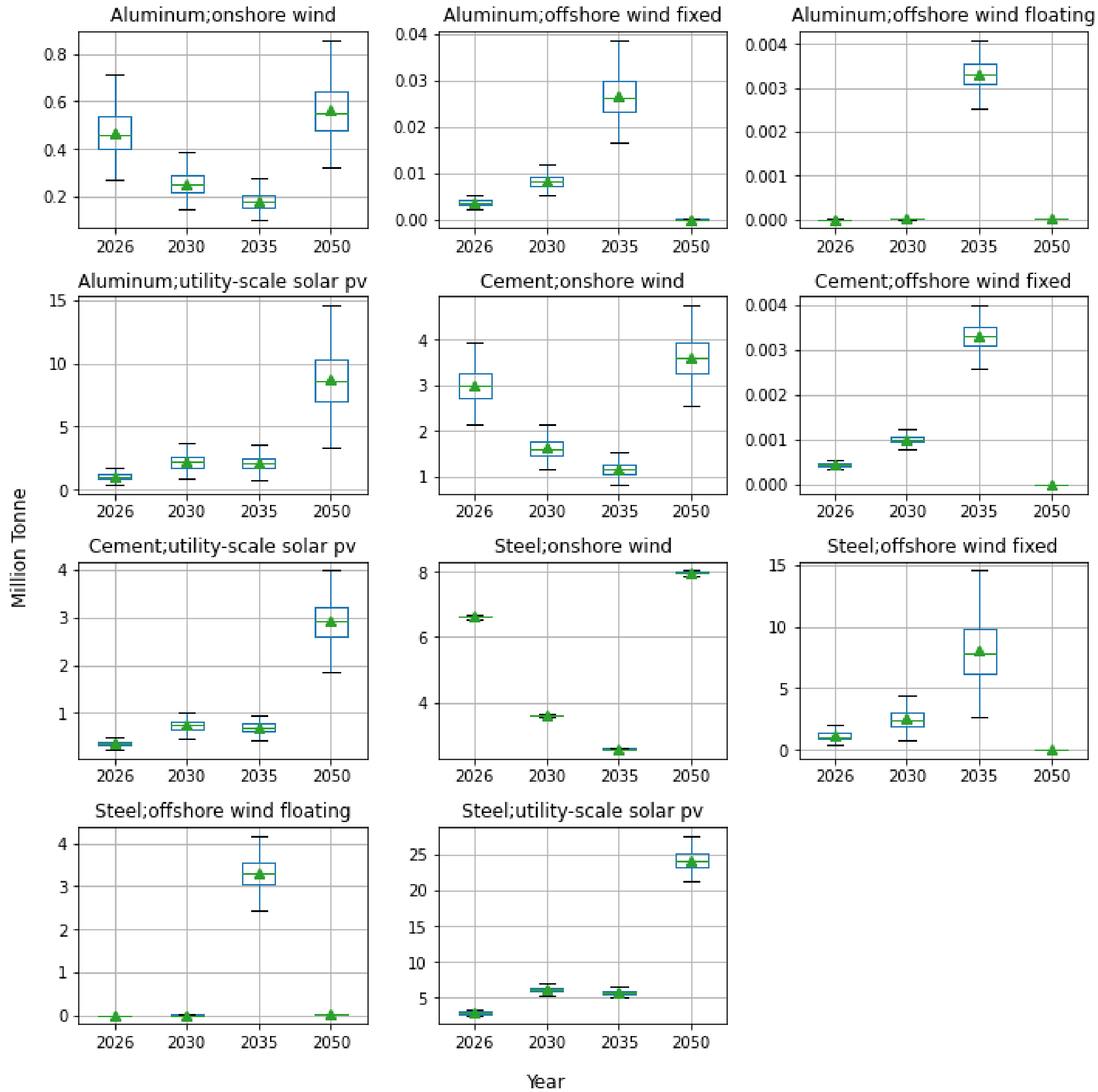

Figure 12. Range of projected material demand values per technology and material for the baseline scenario based on the Monte Carlo simulation outputs for aluminum, cement and steel material intensity. The mean values (green markers) are the assumed material intensity values as utilized in the main part of this paper.

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