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Business Tax Credits for Wind and Solar Power

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At a Glance

The federal government provides tax credits for investments in energy sources that generate electricity without emitting carbon dioxide in the process. Two tax credits, the investment tax credit (ITC) and the production tax credit (PTC), directly support investment in wind and solar electric power. In the Congressional Budget Office's baseline projections, those tax credits reduce federal revenues and increase federal spending. In this report, CBO provides an overview of the tax credits and explains how the agency assesses their budgetary and economic effects.

- In CBO's January 2025 baseline projections, the ITC and PTC together increase projected deficits from 2026 to 2035 by about $300 billion. The cost of tax credits for investing in wind and solar electric power is uncertain because the underlying activity—the amount of investment itself—is uncertain.
- The ITC and PTC provide an incentive for private-sector investment. CBO estimates that without those tax credits, investment in wind and solar electric power from 2024 to 2026 would be about one-third less than is expected with the credits in place. But because investors' behavior is uncertain, including their response to changes in tax policy, the amount of investment attributable to the tax credits could be higher or lower than projected.
- The 2022 reconciliation act (Public Law 117-169) made the ITC and PTC more generous for investments in projects that pay prevailing wages and employ apprentices, are located in certain geographic areas, and use domestically sourced materials. Linking the tax credits to those other policy objectives can encourage investment in projects whose costs per unit of generating capacity are higher than they would otherwise be, thus involving a trade-off between supporting the objectives and stimulating investment in wind and solar power at the lowest possible cost.

Contents

Boxes

Notes About This Report

Numbers in the text, tables, and figures may not add up to totals because of rounding.

Unless this report indicates otherwise, all years referred to in describing budgetary effects or outcomes are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end. All other years are calendar years.

The Congressional Budget Office's baseline projections referred to in this report were published in January 2025 and include the effects of legislation enacted as of January 6, 2025. (The January 2025 baseline projections are discussed in *The Budget and Economic Outlook: 2025 to 2035*, available at www.cbo.gov/publication/60870.) Those projections are based on economic projections that were also published in January and that reflect laws, policies, and economic developments as of December 4, 2024.

Business Tax Credits for Wind and Solar Power

Summary

Investment in wind and solar power has contributed to reductions in emissions of carbon dioxide in the electric power sector.[1] In this report, the Congressional Budget Office provides an overview of two tax credits that support investment in wind and solar electric power and explains how the agency assesses their effects on such investment and the federal budget.

What Are the Business Tax Credits for Investing in Wind and Solar Electric Power?

Two tax credits, the investment tax credit (ITC) and the production tax credit (PTC), directly support investment in wind and solar electric power.[2] The ITC, added to the tax code in the late 1970s, is a onetime tax credit equal to a percentage of the amount invested. The PTC, added to the tax code in the early 1990s, is based on the amount of electricity produced and can be claimed during the first 10 years that a power-generating facility is in operation. Both tax credits were extended and substantively modified by the 2022 reconciliation act (Public Law 117-169).[3]

1. Congressional Budget Office, *Emissions of Carbon Dioxide in the Electric Power Sector* (December 2022), www.cbo.gov/publication/58419.

2. The ITC and PTC support a range of technologies for generating electricity with low or zero carbon emissions. This report focuses on wind and solar electric power because in the near and medium term, most investment in utility-scale zero-emissions generating capacity is expected to be made in those technologies.

3. In addition to expanding tax incentives for investment in wind and solar energy production, the 2022 reconciliation act expanded tax credits for carbon capture and sequestration, provided new tax credits for generating nuclear power, and (beginning in calendar year 2025) modified tax incentives related to the electric power sector to make credits available for investment in any zero-emissions electric power source. The legislation also included provisions that support investment in utility-scale batteries; batteries do not generate electricity but enhance the efficiency of intermittent generation technologies. The 2022 reconciliation act also extended and modified the tax credit supporting the installation of solar panels on residential buildings; that credit is outside the scope of this report.

What Are the Tax Credits' Budgetary Effects?

In CBO's January 2025 baseline budget projections, the ITC and PTC together increase projected deficits by $308 billion from 2026 to 2035. The actual budgetary and economic outcomes associated with the tax credits are uncertain and will not be known until after investments are made and the credits claimed; actual costs may be higher or lower than CBO projects. (When legislation modifies the Internal Revenue Code, the staff of the Joint Committee on Taxation, JCT, estimates how that change will affect revenues. For a description of how CBO's baseline projections incorporate such estimates, see Box 1.)

What Are the Tax Credits' Effects on Investment?

Tax credits have supported growth in the wind and solar power industries throughout the 2010s and into the 2020s. CBO projects that such growth will continue. The agency estimates that if tax credits for investing in wind and solar electric power were not available, investment in wind and solar facilities would be about two-thirds of the amount expected with the credits in place. Many factors other than tax policy affect investment in wind and solar electric power (and the cost of tax credits supporting that investment). For example, tariffs such as those first imposed on solar panels from China in 2012 discourage investment in solar power projects because they increase the projects' costs.

Because estimates of investment in wind and solar electric power are incorporated in CBO's projections of business fixed investment, factors that affect wind and solar investment can also affect the agency's macroeconomic projections. But investment in wind and solar power is small compared with economywide business investment, so even large changes in the former have limited macroeconomic effects.

What Other Policy Objectives Are Linked to the Tax Credits?

As modified by the 2022 reconciliation act, the ITC and PTC are more generous for investments in projects that pay workers prevailing wages and employ apprentices, are located in certain geographic areas, and use domestically sourced materials. (Prevailing wages are the average wages, including benefits, paid to workers in a similar occupation in the geographic area of employment. To meet the condition related to prevailing wages, workers must be paid at least that amount, either through wages or a combination of wages and benefits.) Because the tax credits are more generous when those conditions are met—they are five times larger if workers are paid prevailing wages and apprentices are employed, for example—the credits do not always stimulate investment in wind and solar power at the lowest possible cost. And when those conditions encourage investment in projects with a higher cost, tax credits that are based on the amount invested cost the government more.

Business Tax Credits for Investing in Wind and Solar Electric Power

Two tax credits directly support investment in wind and solar electric power. The ITC is a onetime tax credit equal to a percentage of the amount invested in a wind or solar project.[4] For a typical project, the rate (or amount) of the ITC is 30 percent, although that percentage can be more or less under certain circumstances (see Table 1). The PTC is based on the amount of electricity produced and can be claimed during the first 10 years that a power-generating facility is in operation.[5] The credit amount per kilowatt-hour is adjusted each year for inflation.

Businesses can claim either the ITC or PTC for a single project but not both. Investors are expected to choose the credit that provides a larger subsidy for a given project. They are more likely to choose the PTC for projects that are expected to produce more electricity for each dollar of investment.[6] However, the PTC comes with greater risk for the investor than the ITC does because the credit amount depends on the actual amount of electricity generated over a 10-year period, which is subject to uncertainties in operational, market, and weather conditions. Investors are more likely to choose the ITC, which provides an upfront tax benefit, for projects with higher capital costs or greater uncertainty about their potential to generate electricity—two characteristics that are often associated with emerging or less mature technologies.

The ITC and PTC can be used to offset a taxpayer's tax liability (the amount owed in taxes), can be transferred to another taxpayer, or received as a direct payment from the Treasury. Businesses can transfer (or sell, if transferred in exchange for cash) their tax credit, whereas tax-exempt and governmental entities can receive the credit as a direct payment from the Treasury. (Transferability and direct payment were options added to the credits under the 2022 reconciliation act.) Without transferability, taxpayers carry forward or carry back unused credits to offset their tax liability in a future or previous tax year. Without direct payments, tax-exempt entities cannot claim tax credits.

Provisions of the 2022 reconciliation act tied energy-related tax incentives to other policy objectives—specifically those related to labor and workforce standards, economic and community development, and domestic manufacturing.[7] The amount of the ITC or PTC is greater for projects that meet those other policy objectives.

- *Labor and Workforce Standards.* Adhering to certain labor standards results in tax credits that are five times the base credit amount (which, for the ITC, is 6 percent). The greater amount, or enhanced

4. The ITC has been extended and modified many times. For the legislative history of the ITC, see Molly F. Sherlock, *The Energy Credit or Energy Investment Tax Credit (ITC)*, Report IF10479 (Congressional Research Service, April 23, 2021), https://tinyurl.com/35zfkh7p.

5. The PTC has been extended and modified many times. For the legislative history of the PTC, see Senate Committee on the Budget, *Tax Expenditures: Compendium of Background Material on Individual Provisions* (prepared by the Congressional Research Service, December 2022), pp. 179–188, https://tinyurl.com/57aepw38.

6. That choice can have implications for the cost-effectiveness of the subsidy. See, for example, Joseph E. Aldy, Todd D. Gerarden, and Richard L. Sweeney, "Investment Versus Output Subsidies: Implications of Alternative Incentives for Wind Energy," *Journal of the Association of Environmental and Resource Economists*, vol. 10, no. 4 (July 2023), pp. 981–1018, https://tinyurl.com/yjmbbbje.

7. Before the ITC and PTC were extended and modified by the 2022 reconciliation act, the PTC was scheduled to expire for projects that began construction after 2022, and the ITC for renewable energy other than solar and geothermal was scheduled to expire in 2023. (There was a permanent 10 percent ITC for solar and geothermal; the ITC for offshore wind was set to expire in 2025.)

Box 1.

How CBO's Baseline Projections Reflect JCT's Revenue Estimates

The Congressional Budget Office's baseline projections reflect the budgetary effects of tax policy under the assumption that current laws governing taxes generally remain in place. By statute, the staff of the Joint Committee on Taxation (JCT) provides revenue estimates for legislation that would change the Internal Revenue Code.[1] When tax legislation becomes law, CBO incorporates into its baseline projections JCT's estimate of the budgetary effects of that legislation. With each new baseline, CBO includes updated projections of tax revenues and outlays to reflect newly available data, updated economic projections, new regulations or administrative actions, and any other relevant information that has become available since JCT initially estimated the effects of the legislation.

When the 2022 reconciliation act (Public Law 117-169) modified and extended the investment tax credit (ITC) and production tax credit (PTC), CBO incorporated JCT's estimate of the cost of those changes into its baseline projections. The cost of the modifications and extensions as estimated by JCT was added to amounts for those credits that were already reflected in CBO's projections.

In each subsequent update to its economic and budget projections, CBO has accounted for updated information on investment in wind and solar electric power. Thus, CBO's January 2025 baseline projections reflect the total cost of the ITC and PTC, including costs associated with tax credits that were available before the 2022 reconciliation act became law, estimates from JCT about the cost of changes to the ITC and PTC in the 2022 reconciliation act, and recent information about investment in wind and solar electric power.

JCT provides the official estimates of tax legislation considered by the Congress and would thus provide the cost estimate associated with any change to the ITC and PTC. If future legislation repealed a tax credit, JCT's cost estimate for that legislation would not necessarily be the same as the projection of the credit's cost in CBO's baseline (see Box 2).

1. For more information about how the work of CBO and JCT differs, see www.cbo.gov/faqs#jct.

credit, can be claimed if a project's workers are paid prevailing wages, as determined by the Department of Labor, and if apprentices perform a portion of work on a project (or a good-faith effort is made to hire apprentices).[8] In CBO's assessment, current and expected future conditions in the labor market indicate that most projects will meet the prevailing wage and apprenticeship requirements and that the larger credit amount associated with those requirements (30 percent in the case of the ITC) will be claimed.

- *Economic and Community Development.* A bonus credit is available for projects located in energy communities—areas where a coal mine or coal-fired power plant has closed (after 1999 and 2009, respectively) or areas with an average or above-average unemployment rate that have threshold amounts of economic activity related to coal, oil, or natural gas.[9] Properties known as brownfield sites, which contain (or potentially contain) a hazardous substance that complicates the expansion or redevelopment of the property, can also be designated as energy communities.
- *Domestic Manufacturing.* A bonus credit is available for projects that use domestically sourced materials. The bonus credit is awarded when the steel and iron used to build a new wind or solar facility meet Buy America domestic production requirements and when

8. Prevailing wage requirements are common features of construction projects that are supported or financed by the federal government, but those requirements were not associated with tax incentives before the 2022 reconciliation act became law. For more information, see Elizabeth Weber Handwerker and Jon O. Shimabukuro, *Federally Funded Construction and the Payment of Locally Prevailing Wages*, Report IF11927, version 3 (Congressional Research Service, November 13, 2023), https://tinyurl.com/24kpbpdc. Apprenticeship requirements are not usually a condition of federally financed or supported investments.

9. Roughly half of all U.S. land is designated as an energy community, and about one-fifth of the U.S. population lives in areas with that designation. Other tax incentives for investment have included place-based requirements. See, for example, Kevin Corinth and Naomi Feldman, "Are Opportunity Zones an Effective Place-Based Policy?" *Journal of Economic Perspectives,* vol. 38, no. 3 (Summer 2024), pp. 113–136, https://tinyurl.com/ya8phww9.

Table 1.

Overview of Tax Credits for Investing in Wind and Solar Electric Power

	Investment tax credit (ITC)	Production tax credit (PTC)
Summary	Tax credit for investment in specified energy property; after 2024, available for zero-emissions power and storage property.	Tax credit per kilowatt-hour of electricity produced at a new renewable generation facility; after 2024, available for zero-emissions electricity.
Amount[a]	30 percent[b]	$0.03 per kilowatt-hour in 2024; adjusted annually for inflation[c]
Duration	Onetime credit	10 years
Bonus credits	Located in an energy community: 10 percentage points Domestically sourced materials: 10 percentage points	Located in an energy community: 10 percent Domestically sourced materials: 10 percent
Direct payment / transferability	Direct payment for tax-exempt entities; otherwise transferable	Direct payment for tax-exempt entities; otherwise transferable
Phaseout/expiration	Emissions-reduction threshold phasedown, but not before 2032	Emissions-reduction threshold phasedown, but not before 2032

Data source: Congressional Budget Office.

For a single project, investors can claim the ITC or PTC but not both.

Years are calendar years.

a. The amounts of the ITC and PTC shown here include the base amounts plus an enhanced credit for meeting requirements related to paying prevailing wages and hiring apprentices. CBO expects that most investors will claim the enhanced credit, which is five times the base amount that can be claimed for projects that do not meet those requirements. (Prevailing wages are the average wages, including benefits, paid to workers in a similar occupation in the geographic area of employment. To meet the requirement for prevailing wages, workers must be paid at least that amount, either through wages or a combination of wages and benefits.)

b. Small-scale wind and solar projects in low-income communities or on tribal lands can be eligible for a separate ITC bonus credit of 10 percentage points in addition to the base amount. Small-scale projects have a maximum net output of less than 5 megawatts. In addition, investors in small-scale wind and solar installations that are either part of a low-income housing project or that provide electricity to low-income households can apply to receive a 20 percent ITC bonus.

c. The rate available for newer projects, assuming that the prevailing wage and apprenticeship requirements are met.

a sufficient proportion of the total cost of the project's other manufactured components is attributable to domestic sources.[10]

The Tax Credits' Value to Investors and Cost to the Government

Because various features of the tax code interact, the amount claimed in tax credits and the value of those credits to the investor can differ, as can the credits' cost to the government. Interactions occur, for example, when a tax credit that offsets some of an investment's cost also reduces the amount of that cost that can be deducted over time, or depreciated. If, for example, a business invested $350 million in a 300-megawatt solar facility located in an energy community, the investment might accrue a $140 million investment tax credit (see Table 2). But that $140 million credit would not necessarily reduce the taxpayer's after-tax cost of making the investment by that amount, nor would it necessarily cost the government that amount.

In that example, the choice to locate the project in an energy community increases the cost to the government of supporting the project ($35 million of the $140 million credit is attributable to the energy community bonus). If the project would have been located in an energy community regardless of the availability of the bonus credit, then the bonus credit represents a windfall to the investor. Alternatively, the bonus credit might have

10. Federal financial support for infrastructure projects is often tied to Buy America requirements, but those requirements were not associated with tax incentives before the 2022 reconciliation act became law. The Buy America requirement for bonus tax credits stipulates that all iron and steel used in a project must be produced in the United States. Several federal statutes and regulations apply to Buy America requirements; the Buy America elements of the bonus tax credits are applied in a manner consistent with the Federal Transit Administration's Buy America regulations.

Table 2.

Illustrative Investment in a Utility-Scale Solar Facility in 2025

	Claiming the investment tax credit	Without claiming the investment tax credit
Investment amount	$350 million investment in a utility-scale solar faciility (300 megawatts of generating capacity) located in an energy community	
Tax credit amount	$140 million ($105 million for 30 percent credit, plus $35 million for being located in an energy community)	none
Depreciation deductions	$280 million	$350 million
Bonus depreciation (40 percent in 2025)	$112 million	$140 million
MACRS depreciation	$168 million, deducted over six years (investor's present value: $147 million)	$210 million, deducted over six years (investor's present value: $183 million)
After-tax cost of investment	$156 million: $350 million investment cost – $140 million in tax credits – $54 million (21 percent × investor's present value of depreciation deductions, including bonus depreciation and depreciation allowed in MACRS, or $259 million)	$282 million: $350 million investment cost – $68 million (21 percent × investor's present value of depreciation deductions, including bonus depreciation and depreciation allowed in MACRS, or $323 million)

Data source: Congressional Budget Office.

Values are rounded to millions and may not add up to totals because of that rounding.

In this example, a 21 percent corporate tax rate was used to determine the value of depreciation deductions. Depreciation deductions are reported in present value to illustrate the after-tax cost of investment in the current year. The total amount of depreciation claimed over a multiyear period would exceed the present value of depreciation deductions because of the time value of money. The present value of depreciation benefits for investors was calculated using the nominal rate of return for an equity-financed investment, which, in CBO's assessment, is 8.2 percent. (In this example, the investor is not a regulated utility; regulated utilities cannot claim bonus depreciation.)

MACRS = modified accelerated cost recovery system.

caused the investor to locate the project in an energy community instead of in another location at a lower cost. (Locating the project in an energy community might require more investment in transmission infrastructure, for example, but would still be economically viable if the amount of the bonus credit offset that additional cost.)

The Tax Credits' Value to Investors. Tax rules require taxpayers to capitalize and depreciate the cost of acquiring an asset (such as a power generating facility) that provides long-term benefits. When the ITC is claimed, the amount of the investment that can be deducted for depreciation is reduced by 50 percent of the amount of the tax credit. Thus, for a $350 million investment for which a $140 million tax credit is claimed, the taxpayer would be allowed $280 million in depreciation deductions over the depreciation period ($350 million minus 50 percent of the $140 million ITC). The depreciation period is generally specified by the tax code's modified accelerated cost recovery system (MACRS).

Bonus depreciation allows a fixed amount to be deducted in the calendar year of the investment. In 2025, the bonus depreciation amount is 40 percent (which equals $112 million in the example shown in Table 2). The remaining amount of allowed depreciation, $168 million in the example, would be deducted according to the MACRS depreciation schedule.[11] The present value of those depreciation deductions is $147 million; depreciation deductions allowed in future years are worth less than deductions allowed in the current year because of the time value of money. (The present value is a single number that expresses a flow of current and future income, or payments, in terms of an equivalent lump sum received or paid today.)

If the ITC was claimed, the after-tax cost of the $350 million investment would be $156 million. That is the $350 million investment cost minus the

11. Wind and solar power generators are classified as five-year properties under MACRS; depreciation deductions are claimed over six tax years under the assumption that the property becomes operational midyear.

$140 million ITC and the $54 million tax benefit associated with depreciation deductions. (The tax benefit from depreciation deductions amounts to 21 percent of $259 million, which is the sum of bonus depreciation and the present value of depreciation under MACRS.)

If that same $350 million investment was made without claiming the ITC, the full amount of the investment could be deducted for depreciation purposes. The bonus depreciation amount would be $140 million, and $210 million would be allowed in depreciation deductions under MACRS. (The present value of that $210 million would be $183 million.) Thus, the after-tax cost of the investment without the ITC would be $282 million (the $350 million investment cost minus 21 percent of the sum of bonus depreciation and the present value of MACRS depreciation).

The ITC and depreciation deductions reduce the after-tax cost of making an investment. In the example in Table 2, the $140 million ITC reduces the after-tax cost of investment by $126 million (the difference between the cost without the ITC and with it—$282 million and $156 million, respectively). The reduction in the after-tax cost of the investment is less than the amount of the tax credit because claiming the ITC reduces the value of depreciation deductions by $14 million. The net benefit of the $140 million tax credit is thus $126 million.

The Tax Credits' Cost to the Government. The amount the investor saves in taxes represents forgone revenue to the government. On a fair-value basis—in which the government discounts future depreciation deductions at the same rate as the investor—the cost to the government exactly equals the value to the investor. The cost to the government of the ITC plus depreciation is $194 million (the $140 million tax credit plus $54 million for depreciation). Without the ITC, depreciation deductions reduce federal revenues by $68 million. Claiming the ITC thus reduces the value of depreciation deductions by $14 million. The net cost to the government of the $140 million ITC is then $126 million.[12]

12. Discounting the government's future cash flows at a Treasury discount rate would result in a slightly lower cost, but one that still rounds to $126 billion. See Congressional Budget Office, *How CBO Uses Discount Rates to Estimate the Present Value of Future Costs or Savings* (October 2024), www.cbo.gov/publication/60284.

The Cost of Tax Credits When Policies Interact. When estimating the cost or change in revenues associated with a tax policy, the interactions between that policy and others can have important implications. If, for example, a policy proposal would repeal the ITC and simultaneously provide 100 percent bonus depreciation for all clean energy investments, the revenue estimate prepared by JCT would consider those changes as a single package. If the repeal of the ITC was estimated first (if it was "stacked first," in budgetary parlance), the cost of providing 100 percent bonus depreciation would be more than if that cost was estimated as a stand-alone proposal. That is because eliminating the ITC would increase the amount that can be claimed in depreciation deductions for an investment. Interactions between tax credits and other parts of the tax code can have implications for measuring the credits' cost (see Box 2).

Other changes to tax policy can affect the value of energy-related tax benefits. For example, higher tax rates would reduce the after-tax value of the ITC because depreciation deductions are worth more at higher tax rates. If higher tax rates were applied to the illustrative investment shown in Table 2, the $140 million tax credit would reduce the after-tax cost of the investment by less than $126 million because the resulting reduction in the amount that can be deducted for depreciation would be greater with a higher tax rate.

Other Beneficiaries of the Tax Credits

Not all of the government's cost for the ITC and PTC is received as a financial benefit by the investors or developers who claim those credits. Since the beginning of calendar year 2023, businesses investing in wind and solar projects have been able to transfer tax credits, most often selling them in exchange for cash. The ability to transfer tax credits can be valuable to investors whose tax liability is less than the amount of the credits. (Before transferability was allowed, tax credits that accrued in excess of taxes owed could be carried backward or forward and claimed against past or future tax liability.) Entities receiving (or buying) the transfers also benefit. Tax credits are sold for less than their face value, so buyers, which could be financial institutions or taxpayers in any industry, could, for example, pay $0.95 for a $1.00 reduction in tax liability.

Investors in wind and solar projects seeking to monetize the value of nontransferable tax benefits—tax credits and bonus depreciation—can do so by partnering with a tax

Box 2.

Measuring the Cost of Tax Credits to the Federal Government: Revenue Estimates and Tax Expenditures

The effects of tax credits on the federal budget can be measured in different ways. The staff of the Joint Committee on Taxation (JCT) provides the Congress with the official revenue estimates for tax legislation as well as estimates of tax expenditures.[1] Both types of estimates are developed using the Congressional Budget Office's projections of revenues as a baseline. Neither type of estimate accounts for the effects on the budget that would result from changes in the size of the economy or from the cost of servicing additional debt required to finance the credits.

- *Revenue estimates* measure changes in deficits that result from a specified policy change. The estimates reflect anticipated changes in taxpayers' behavior. If, for example, repealing the investment tax credit (ITC) meant that taxpayers were expected to invest in a plant powered by natural gas instead of one powered by solar energy, then repealing that tax credit would increase the government's revenues by eliminating ITC claims and would change the amount and timing of deductions for depreciation.[2]
- *Tax expenditures* are revenue losses attributable to special features of the federal income tax system, including tax credits, deductions, or provisions that change the timing of when tax payments are due.[3] Tax expenditures are calculated as the difference between taxes owed under the current tax system and taxes that would be owed if the special provision was not available. Estimates of tax expenditures do not reflect changes in taxpayers' behavior. For example, such estimates would not account for investors' responses if a tax credit supporting that investment was repealed. Thus, in Table 2 on page 5, the tax expenditure for the $140 million tax credit would be $126 million, reflecting the cost to the government of providing that credit.

An estimate of the budgetary effect of repealing a tax credit would probably differ from the estimate of the tax expenditure for that credit. That is because the revenue estimate that contributed to the budgetary effect would account for anticipated behavioral responses, whereas the estimate of the tax expenditure would not. For example, a repeal of energy-related tax credits scheduled for a future date could cause investors to increase investment before the credits expire. Revenue estimates also include effects of interactions between tax provisions, especially when changes to specific provisions are considered as part of a legislative package that modifies many tax provisions. Estimates of tax expenditures are prepared for provisions on a stand-alone basis and thus do not reflect that type of potential interaction.

In the case of the ITC and the production tax credit (PTC), tax expenditures and amounts reflected in CBO's budget projections are determined by both past investment and anticipated future investment. Because some of the budgetary effects stem from tax credits claimed for past investment, the amount of the deficit reduction that would result from repealing the credits would probably be less than the budgetary effects of the tax credit in CBO's baseline projections. Particularly in the case of the PTC, near-term tax expenditures depend on the amount of electricity generated by facilities already built. In the longer term, estimated tax expenditures depend more on anticipated future investment. A revenue estimate for a proposal to repeal the PTC (one that would eliminate availability of the credit for new investment) would be less than the estimate of the tax expenditure associated with the PTC and less than the amount reflected in CBO's baseline.

1. Legislation that changes the Internal Revenue Code can affect both revenues and outlays; tax expenditure estimates can also reflect effects on outlays.
2. In the illustrative investment shown in Table 2 on page 5, the investor is allowed $280 million in depreciation deductions when claiming the ITC. If $350 million was instead invested in a natural gas plant (and therefore without claiming the ITC), then $350 million in depreciation deductions would be allowed, but the pace of those deductions would be slower. The tax code treats solar facilities as 5-year properties, whereas natural gas electric power plants are treated as 20-year properties.
3. Congressional Budget Office, *How Specifications of the Reference Tax System Affect CBO's Estimates of Tax Expenditures* (December 2021), www.cbo.gov/publication/57543; and Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2024–2028*, JCX-48-24 (December 11, 2024), https://tinyurl.com/5mry925v.

equity investor, who funds projects in exchange for tax benefits. Before transferability was allowed, tax equity partnerships were the main way to monetize tax credits. Taxpayers may still use such partnerships to monetize tax credits and tax benefits stemming from depreciation. Tax equity financing structures are often complex, and that complexity prevents certain projects (smaller projects, for example) from accessing that source of financing. Tax equity investors, typically financial institutions, receive some of the value of the tax benefits, thereby reducing the amount of benefits that support investment in wind and solar power.

The Tax Credits' Budgetary Effects

In CBO's January 2025 baseline projections, the ITC and PTC together increase the estimated deficit for 2025 by $28 billion and projected deficits over the 2026–2035 period by $308 billion (see Table 3). Tax credits supporting investment in wind and solar electric power represent about one-third of the estimated total cost of federal energy-related tax expenditures in 2025. Total energy-related tax expenditures that year are expected to be $78 billion; $26 billion is for credits that support investment in wind and solar electric power.[13] (The $28 billion shown in Table 3 includes the ITC and PTC for all zero-emissions technologies, and not just wind and solar.)

Some of the cost of the ITC and PTC reflected in CBO's January 2025 baseline projections stems from tax credits tied to past investment. For example, that would be the case for a wind project that began producing electricity in 2016 and for which the PTC was claimed. Because the PTC is received during a facility's first 10 years in operation, such a project, which qualified for that credit under the tax rules in effect at that time, would still be claiming PTCs in 2025. And in that case, the budgetary effects would be reflected in CBO's 2025 baseline projections.

13. That total is the sum of energy tax expenditures as reported in Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2024–2028*, JCX-48-24 (December 11, 2024), https://tinyurl.com/5mry925v. Before recent years, the total value of all energy-related tax expenditures did not exceed $30 billion per year. See Testimony of Terry Dinan, Senior Advisor, Congressional Budget Office, before the Subcommittee on Energy, Committee on Energy and Commerce, U.S. House of Representatives, *Federal Support for Developing, Producing, and Using Fuels and Energy Technologies* (March 29, 2017), www.cbo.gov/publication/52521.

Table 3.

Estimated Budgetary Effects of Tax Credits for Investing in Zero-Emissions Electric Power

Billions of dollars

	2025	2026–2035
Reduction in revenues	27	294
Outlays	1	14
Total	**28**	**308**

Data source: Congressional Budget Office. See www.cbo.gov/publication/61188#data.

Amounts include the revenue effects of tax credits that were available before the 2022 reconciliation act became law, as well as the modifications to tax credits and new provisions enacted as part of that law. Before the 2022 reconciliation act, the production tax credit was available for projects that began construction by the end of calendar year 2022 and applied to electricity produced during a facility's first 10 years in operation. A project that began construction in 2022 and started producing electricity in 2026 could claim tax credits through 2035. CBO expects that most of the tax credits claimed will be for wind and solar projects.

Years are fiscal years.

Tax credits can also be tied to past investment because a project's eligibility to claim the ITC or PTC is determined when construction on that project began, but the credit is not received until the facility is placed into service. So, for example, the investment associated with a project for which an ITC is claimed in 2025 might have occurred several years earlier.

In CBO's baseline projections, the ITC and PTC mostly reduce projected income tax receipts but also increase outlays. Tax-exempt and governmental entities (such as municipal utilities or public schools) can receive tax credits directly as payments from the Treasury. When credits are awarded as payments, they are recorded in the federal budget as outlays. Combined outlays for the ITC and PTC are estimated at $1 billion in 2025 and are projected to amount to $14 billion (or 5 percent of the total cost of $308 billion) over the 2026–2035 period.

The projected cost of the ITC and PTC is subject to uncertainty because of uncertainty about the underlying activity—investment in wind and solar power (and other eligible technologies). Information about taxpayers' past claims of the ITC and PTC can inform estimates of future claims, but such estimates ultimately depend

on the amount of investment.[14] If investment was less than anticipated—because of an unanticipated economic slowdown, for example—then the cost of the tax credits would be less than expected. If investment was greater than anticipated—because, for example, federal or state policies eased limits in transmission capacity, thus allowing utilities to bring more wind and solar power to the electric grid—then the cost of the tax credits would be more than expected. (For further discussion of that uncertainty and the models that CBO uses to evaluate other sources of uncertainty, see the section below titled "Modeling the Electric Power Sector Using CBO-ReEDS.")

The ITC and PTC are claimed for projects initiated in response to the available tax subsidy and for projects that would have been undertaken regardless of that subsidy. Uncertainty about investors' responsiveness to tax credits contributes to the uncertainty about the tax credits' budgetary effects. Tax credits that effectively stimulate new investment increase total costs but also drive greater investment, enhancing the effect on investment for each dollar of cost.

CBO will not know the actual budgetary effects of the ITC or PTC until the agency receives detailed tax data about claims. Those data usually become available about 18 months after the end of the calendar year for which tax returns are filed. Data on corporate claims of tax credits for calendar year 2023, for example, are expected to become available in late 2025. Data about outlays are available sooner; the Treasury provides information each month about outlays for energy-related tax credits in the prior month.

CBO routinely monitors investment in wind, solar, and other energy-related areas, along with market responses to tax credits supporting that investment. The agency regularly updates its estimates of tax credits in its baseline projections to reflect newly available information and data, as well as changes to regulations and federal policy.[15]

Two other energy-related tax credits support the domestic manufacture of clean energy equipment (wind, solar, and other equipment and durable goods; see Appendix A). Increasing the supply of domestically manufactured wind and solar equipment should, in isolation, reduce the cost of building new wind and solar infrastructure using domestically sourced materials. The ITC and PTC stimulate demand for wind and solar facilities, and that demand can be satisfied with either domestic or imported solar panels or wind turbines. As is the case with the ITC and PTC, the fiscal consequences of the manufacturing tax credits are decreased tax revenues and increased outlays.

The Tax Credits' Effects on Investment

The tax code has included tax credits for investing in wind and solar electric power since the late 1970s. The credits had little budgetary impact from their inception through the 2000s because investment in wind and solar power was limited. But throughout the 2010s and into the 2020s, the tax credits supported growth in investment in wind and solar power, and the cost of the credits increased.

Trends in Wind and Solar Investment

Investment in wind and solar power has trended upward since the early 2010s. Investment can be measured using various metrics. CBO's economic projections of investment are based on data from the Bureau of Economic Analysis (BEA). In the BEA's investment accounts, investment in electric power structures, which include power plants, transmission lines, and electric distribution systems, is a form of business fixed investment.[16] Investment in alternative electric power structures—mainly wind and solar structures but also dry-waste and geothermal structures—has increased since 2010 (the first year for which the data are available). From 2010 to 2024, nominal investment in alternative electric power structures grew at an average annual rate of nearly 10 percent, whereas investment in all other electric power structures, including transmission lines, grew at an average annual rate of almost 4 percent (see Figure 1). (Nominal investment is the amount of investment in current dollars, valued in the prices of the current year. Average annual growth rates are the compound annual growth rates over the specified period.)

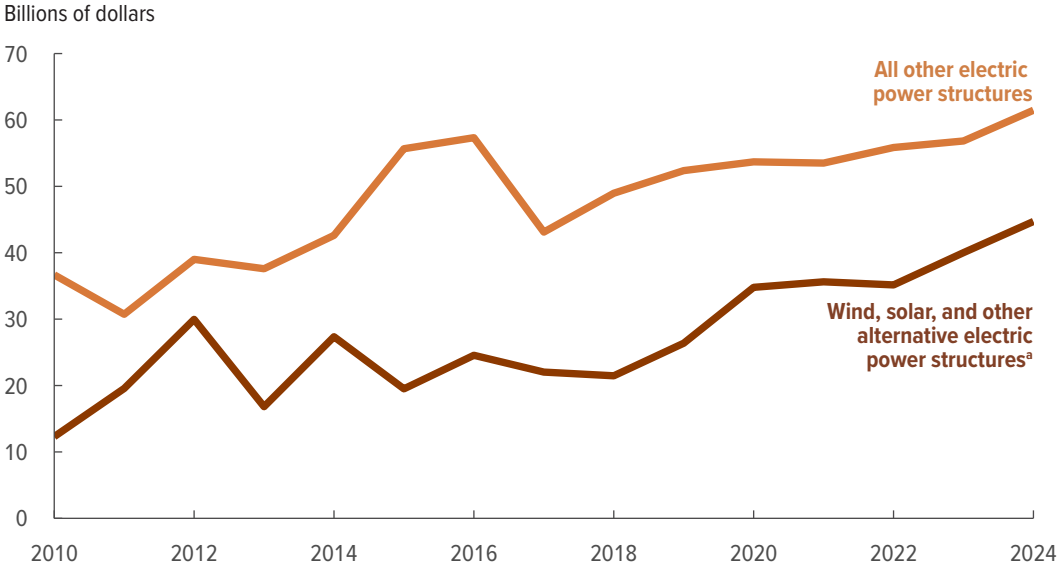
14. Joint Committee on Taxation, *Factors Considered When Estimating the Revenue Effects of the Energy Provisions of Public Law 117-169 and Subsequent Developments* (May 2023), https://tinyurl.com/3sparxn9.

15. For more information, see Congressional Budget Office, *CBO Explains How It Develops the Budget Baseline* (April 2023), www.cbo.gov/publication/58916, and *CBO Explains How It Incorporates Administrative and Judicial Actions When Updating Its Baseline Projections and Preparing Cost Estimates* (December 2024), www.cbo.gov/publication/60846.

16. Business fixed investment (also called nonresidential fixed investment) is a component of CBO's economic projections, which are available at www.cbo.gov/data/budget-economic-data#4. Investment in electric power structures includes two subcategories: alternative electric (consisting of wind, solar, dry-waste, and geothermal structures) and all other electric power structures.

Figure 1.

Investment in Electric Power Structures



From 2010 to 2024, nominal investment in alternative electric power structures—mainly wind and solar structures—grew at an average annual rate of nearly 10 percent; investment in all other electric power structures grew at an average annual rate of almost 4 percent.

Data source: Congressional Budget Office, using data from the Bureau of Economic Analysis. See www.cbo.gov/publication/61188#data.

Years are calendar years. Dollars are current-year dollars.

a. Other alternative electric power structures are dry-waste and geothermal structures.

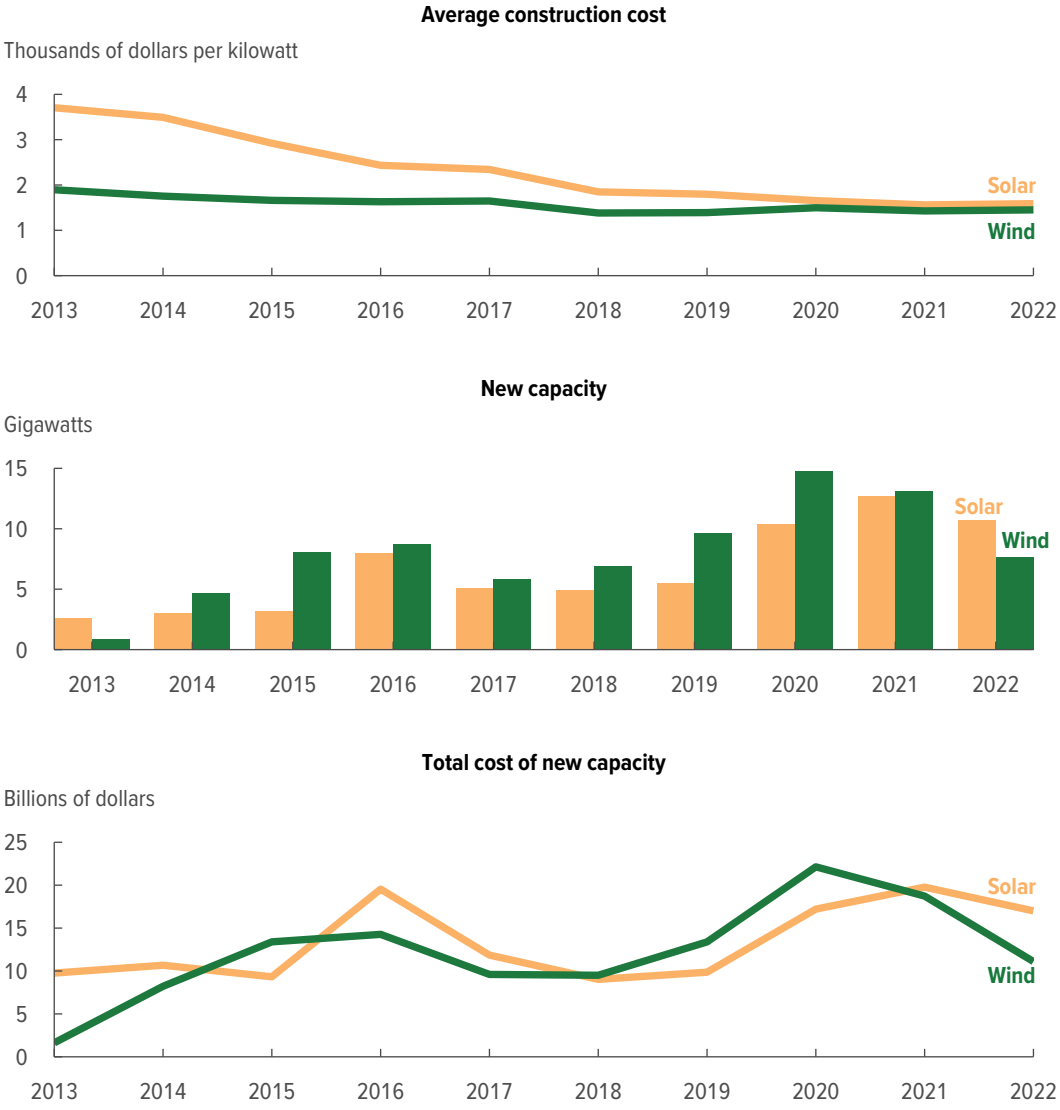
Investment can also be measured in terms of new generating capacity deployed. The Energy Information Administration collects data on new electric power generators and their costs. Wind and solar capacity has grown faster than nominal investment because prices for wind and solar technologies have decreased. Construction costs per unit of generating capacity for wind and solar facilities declined from 2013 to 2022, the period for which such data are available (see Figure 2). The decline in costs was greater for solar facilities. Investment measured in terms of new capacity for wind and solar power grew at an average annual rate of 20 percent. Because the cost of that capacity has fallen, investment grew at an average annual rate of 11 percent over the 2013–2022 period, when measured as the total cost of new wind and solar facilities.

Tax credits have historically supported increased investment in wind and solar power, and certain features of the credits (scheduled phaseouts or expirations) help explain deviations from longer-term growth trends. The ITC supporting investment in solar power was scheduled to expire at the end of 2016, following an eight-year extension enacted in 2008. The deadline was for when projects were "placed in service," so those completed after 2016 would not have been eligible for the ITC. That deadline prompted a push to install solar facilities in 2016, before the ITC was scheduled to expire, and it helps explain the spike in the total cost of new solar capacity in that year. (The ITC was subsequently extended—and the deadline was changed to apply to the start of construction—but investors may not have anticipated the extension.) Factors other than tax policy can contribute to volatility in investment trends. Disruptions to supply chains slowed utility-scale solar installations in 2022, for example.

The PTC, which historically supported investment in wind energy, expired several times before being retroactively extended. Lapses in the PTC's availability and frequent changes to tax credit rates for new investments contributed to uneven patterns of wind capacity deployment. The PTC lapsed during much of calendar years 2014 and 2015 before being retroactively reinstated. In 2015, the PTC was extended through 2019 but with the tax credit rate starting to phase down after 2016. After lapsing again for calendar year 2018 and much of calendar year 2019, the PTC was retroactively extended

Figure 2.

Costs and Capacity of Wind and Solar Infrastructure



The average cost per unit of generating capacity to build wind and solar infrastructure declined from 2013 to 2022.

New generating capacity for wind and solar electric power grew at an average annual rate of 20 percent from 2013 to 2022.

Measured in terms of the total cost of new generating capacity, investment in wind and solar electric power grew at an average annual rate of 11 percent from 2013 to 2022.

Data source: Congressional Budget Office, using data from the Energy Information Administration. See www.cbo.gov/publication/61188#data.

In 2014, the Energy Information Administration began collecting data on construction spending for new electric power generators installed in 2013; data are released with a two-year lag. (Data on generators installed in 2022 became available in September 2024.) The total cost of new wind and solar capacity is the construction cost to completion (direct and indirect costs, including but not limited to feasibility studies and site preparation, equipment, labor, and interconnection) for facilities that began commercial operation in that year. Thus, those data do not necessarily represent investment taking place in a given year. (Solar capacity is reported as capacity of alternating current.)

Years are calendar years. Dollars are current-year dollars.

through 2020; projects that began construction in 2020 were allowed a higher tax credit rate than those that began in 2019 (the phasedown was partially reversed). In 2020, legislation extended the PTC through 2021 on terms similar to those available in 2020. The PTC lapsed again after 2021 but was retroactively reinstated for 2022 under the 2022 reconciliation act.

How CBO Models the Tax Credits' Effects on Investment

CBO uses two models to analyze the effects of energy-related tax credits on investment in the electric power sector and the federal budget:

- CBO's capital tax model, or CapTax, is designed to estimate the effects of federal taxes on capital investment incentives in the private sector.[17] CapTax can be used to evaluate the effects of tax credits on investment incentives for wind and solar facilities and how those effects are reflected in broader measures of economic investment.
- CBO-ReEDS is CBO's version of the Regional Energy Deployment System (ReEDS) model developed by the National Renewable Energy Laboratory. CBO-ReEDS is used to evaluate how policies affect the mix of energy sources in the electric power sector, as well as other factors and budgetary outcomes.[18] The model also provides information about the sensitivity of policy outcomes to various nonpolicy factors such as natural gas prices, for example.

CBO uses CapTax to estimate how the tax system affects the user cost of capital—the before-tax return on investment that provides the required return to investors after covering taxes and depreciation. That analytical framework is commonly used to evaluate the effects of taxes on investment.

Other economic and market conditions that are not accounted for in CapTax can affect investment in wind and solar electric power. CBO-ReEDS includes a detailed model of wind and solar generators and encompasses the entire electric power sector. CBO-ReEDS can thus be used to illustrate how changes in nonpolicy factors—natural gas prices, electricity demand, and technology costs—could affect wind and solar power and the effectiveness of tax credits for spurring investment.

Modeling Investment Incentives Using CapTax. Tax credits can encourage investment by reducing the user cost of capital. The user cost of capital for a specific investment depends on factors that can vary across industrial sectors and by asset type. The aggregated measure of the user cost of capital that CapTax provides is the relevant measure of economywide investment incentives.

Evaluating the Tax Credits' Effect on the User Cost of Capital. The user cost of capital depends on:

- *Tax parameters*, including tax rates, tax depreciation deductions, tax credits, and various other features of the tax code that can vary by industry and asset type;
- *Economic factors*, including rates of return on debt and equity, inflation, and economic depreciation rates; and
- *Financing and organizational structures*, including whether investments are financed with debt or equity and whether the business operates as a C corporation (whose profits are subject to the corporate tax) or as a pass-through entity (whose profits are taxed only under the individual income tax).

An illustrative scenario can demonstrate how the ITC and PTC affect the user cost of capital. In this scenario, a hypothetical investor structured as a C corporation evaluates a potential investment in a wind or solar electric power facility. If equity was used to finance the entire project but no tax credits were available, the investor's user cost of capital would be 9.2 percent (see Table 4). The project would thus need to yield a nominal return of 9.2 percent to compensate the investor, pay taxes, and cover economic depreciation.

That 9.2 percent user cost of capital is lower than it would have been without tax provisions providing favorable cost recovery allowances (bonus and accelerated depreciation). In 2025, bonus depreciation is 40 percent,

17. Paul Burnham and Dorian Carloni, *CBO's Model for Estimating the Effect That Federal Taxes Have on Capital Income From New Investment*, Working Paper 2022-01 (Congressional Budget Office, February 2022), www.cbo.gov/publication/57429; and Congressional Budget Office, "CBO's Model for Estimating the Effects on New Investment of Deductions to Recover the Cost of Capital" (December 2024), www.cbo.gov/publication/60985.

18. David Adler, *How CBO Uses the ReEDS Model to Analyze Policies in the Electric Power Sector*, Working Paper 2024-02 (Congressional Budget Office, May 2024), www.cbo.gov/publication/59880.

Table 4.

Illustrative Scenarios Showing Effects of Tax Credits on the User Cost of Capital in 2025

Percent

	UCC		Change in the UCC[a]	
	Investment that is 100% equity-financed	Investment that is 70% equity-financed and 30% debt-financed	Investment that is 100% equity-financed	Investment that is 70% equity-financed and 30% debt-financed
Without tax credits	9.2	8.1	n.a.	n.a.
With the investment tax credit (ITC)	6.1	5.4	-34	-34
ITC with energy community or domestic content bonus credit	5.0	4.5	-45	-45
ITC with energy community and domestic content bonus credits	3.5	3.1	-61	-61
With the production tax credit (PTC)	5.1	4.5	-45	-45
PTC with energy community or domestic content bonus credit	4.7	4.1	-49	-49
PTC with energy community and domestic content bonus credits	4.1	3.6	-56	-55

Data source: Congressional Budget Office. See www.cbo.gov/publication/61188#data.

The UCC is the before-tax return on investment that provides the required return to investors after covering taxes and depreciation.

To calculate the UCC, many parameter values must be identified. In 2025, bonus depreciation allows for expensing 40 percent of an investment. For both the ITC and PTC, the labor and workforce standards (prevailing wages and apprenticeships) are presumed to have been met. The ITC rate is thus 30 percent, and the investment credit equivalent rate for the PTC is 36 percent. Economic depreciation of wind and solar power structures is fixed at 3 percent. Expected inflation is 2.2 percent. Nominal returns on debt and equity are fixed at 6.2 percent and 8.2 percent, respectively. The share of interest that is deductible is 96.2 percent. Tax credit monetization costs are not considered. The investor is a C corporation.

UCC = user cost of capital; n.a. = not applicable.

a. The change in the UCC is the amount of change, expresseed as a percentage, from the scenario without tax credits.

but that amount will decline to 20 percent in 2026 and is scheduled to be zero in 2027. The more favorable the cost recovery allowances are in relation to economic depreciation, the lower the user cost of capital.[19]

If the ITC or PTC was claimed, the user cost of capital would be reduced by more than one-third. (In the framework of estimating the user cost of capital, the PTC is treated as a subsidy to investment.) Bonus tax credits earned for projects in energy communities or that use enough domestically sourced materials reduce the user cost of capital by even more. If both of those conditions were met, the ITC and PTC would each reduce the user cost of capital by more than one-half.

If 30 percent of the project was debt-financed (instead of being fully financed with equity), the user cost of capital would be lower because investors could deduct most of the interest payments associated with debt. In that case, the percentage change in the user cost of capital caused by removing the tax credits would be about the same as it was in the case in which the entire project was financed through equity.

Investors in wind and solar projects choose between the ITC and PTC, and that choice is affected by factors that are evident in the foregoing illustrative scenario. Without bonus credits stemming from a project's being located in an energy community or using domestically sourced materials, the PTC would reduce the user cost of capital by more than the ITC would. In the illustrative scenario, the investment subsidy equivalent of the PTC was determined by considering capital costs per kilowatt of generating capacity for a typical project and an expected capacity factor (that is, the amount of electricity that is expected to be generated over time, compared with the maximum possible output). If, however, a project's capital cost per kilowatt of generating capacity was higher than was assumed in that scenario, and if its capacity factor was lower than assumed, then the investment subsidy value of the PTC would be lower (leading to a higher user cost of capital). Those factors affect the choice between the ITC and PTC that investors make for each project.

19. Without bonus and accelerated depreciation, the user cost of capital for an equity-financed investment undertaken by a C corporation in an asset that generates wind or solar power would be 10.6 percent in 2025.

In the case of an investment in a project located in an energy community and for which domestically sourced materials were used, the ITC would reduce the user cost of capital by more than the PTC would: The increase in the ITC, by 20 percentage points, stemming from bonus credits would be more valuable than the 20 percent increase in the PTC.

Economic factors can also affect investment incentives. Changes in inflation, for example, affect the value of depreciation deductions and the nominal cost of financing investments, thus affecting the user cost of capital. Inflation that increases nominal interest rates and erodes the value of depreciation allowances increases the user cost of capital. Higher real interest rates increase the user cost of capital too, by increasing the cost of debt financing and reducing the value of depreciation deductions; lower real interest rates have the opposite effect.

How Energy-Related Tax Credits Affect the User Cost of Capital in CapTax. The ITC and PTC are part of current law and thus are reflected in CBO's projections of the user cost of capital. And in the agency's economic models, private investment responds to changes in the user cost of capital.[20] CBO uses the CapTax model to estimate those changes. (For information about other ways of measuring the effect of federal taxes on the incentives to invest, see Appendix B.) Without the ITC and PTC, the user cost of capital for investment in wind and solar electric power would increase substantially—which, in CBO's assessment, would reduce such investment.

The CapTax model estimates the user cost of capital (and changes to it) on the basis of various assets and industries, organizational structures (C corporations or pass-through businesses, for example), and sources of financing (debt or equity). Regulated and unregulated wind and solar power structures are 2 of the 85 types of assets classified in CapTax. Ownership of such assets is concentrated in the utilities industry, but the assets can also belong to owners in other industries (for example, pipeline transportation, farming, and broadcasting). CapTax allows the required rate of return, and thus the user cost of capital, to vary by industry, asset type, organizational structure, and source of financing. After the user cost of capital is calculated for specific industries and assets, the results are aggregated using weights that reflect the values of assets held by industry and asset type.

The CapTax model's estimates of the user cost of capital incorporate more information than is included in the illustrative scenario shown in Table 4. Specifically, the CapTax estimates reflect differences in the required before-tax rate of return across industries investing in wind and solar power and businesses' organizational structure and sources of financing. CapTax is unique in its level of detail; many models used to estimate the user cost of capital exclude the incentive effects of tax credits designed to encourage investment in specific assets or industries (such as the ITC, PTC, and energy-related manufacturing credits).[21]

The rates (or amounts) for the ITC and PTC used in CapTax reflect the share of investment that is expected to receive bonus credits associated with energy communities, the share that is expected to receive bonus credits for using domestically sourced materials, and costs associated with monetizing tax credits. (The cost of monetizing tax credits is the reduction in amounts received by investors when credits are transferred or claimed by tax equity partners.) After accounting for bonus credits, the ITC rate in CapTax for 2024 was 33.3 percent, and the rate of the PTC investment subsidy was 31.9 percent. In 2025, the ITC rate in CapTax is 34.4 percent, and the PTC rate is 35.1 percent.[22] In 2026, those rates are 34.5 percent and 37.2 percent, respectively. Those increases in rates result in a decline in the estimated user cost of capital for investment in wind and solar electric power over time (from 5.0 percent in 2024 to 4.7 percent in 2025 and 2026).

20. Other factors that can contribute to increased investment include incentives for some businesses to locate production in the United States and increases in economic activity. See Congressional Budget Office, *Key Methods That CBO Used to Estimate the Macroeconomic Effects of the 2017 Tax Act—Supplemental Material for The Budget and Economic Outlook: 2018 to 2028* (April 2018), https://tinyurl.com/bddykpvd; and Mark Lasky, *CBO's Model for Forecasting Business Investment*, Working Paper 2018-09 (Congressional Budget Office, December 2018), www.cbo.gov/publication/54871.

21. Tracy Foertsch, *U.S. Cost of Capital Model Methodology*, Technical Paper 10 (Department of the Treasury, Office of Tax Analysis, May 2022), https://home.treasury.gov/ota-technical-papers; and Jane G. Gravelle and Mark P. Keightley, *CRS Model Estimates of Marginal Effective Tax Rates on Investment Under Current Law*, Report R48277, version 3 (Congressional Research Service, March 3, 2025), https://tinyurl.com/3v3twv4m.

22. The parameter values for the ITC and PTC used in CBO's CapTax model, along with all code and parameters used in that model, are available at https://github.com/US-CBO/captax.

In CapTax, the ITC and PTC rates continue to increase over time because more projects are expected to qualify for bonus credits associated with the use of domestically sourced materials as more wind and solar components are manufactured domestically. The PTC investment subsidy is also expected to increase over time because the amount of the credit is adjusted for inflation, but the cost of installing new electricity-generating capacity is expected to decrease.

Using CapTax, CBO estimates that without the ITC or PTC, the user cost of capital for investments in wind and solar electric power would be 70 percent higher in 2025 (see Figure 3).[23] Removing the ITC and PTC in 2026 would lead to a similar increase in the user cost of capital.

The user cost of capital is higher for C corporations than for pass-through businesses, and it is higher for investment financed with equity than with debt; but the proportional increase in the user cost of capital from repealing the ITC or PTC would be similar for businesses with different organizational structures and sources of financing.

Changes in other factors could also affect the user cost of capital. Reductions in bonus depreciation, as well as higher tax rates on pass-through businesses, are scheduled for 2026. The effects of those changes on incentives for investing in wind and solar power would be small, however. Regulated utilities cannot claim bonus depreciation. Thus, changes in the tax code scheduled (under current law) for 2026 would have a limited effect on the user cost of capital for a regulated utility structured as a C corporation investing in wind and solar power. (CapTax distinguishes between regulated and unregulated utilities investing in wind and solar power structures.)

Using Changes in the User Cost of Capital to Estimate the Amount of Investment in Wind and Solar Electric Power Attributable to Tax Incentives. Reductions in the user cost of capital stimulate investment. CBO has estimated that a 1 percent decrease in the user cost of capital is associated with a 0.7 percent increase in investment, when the effects of taxation on investment are considered broadly.[24] In other words, the elasticity of investment with respect to the user cost of capital is –0.7. How responsive specific investments are to changes in the user cost of capital is uncertain and an empirical question. One study of the PTC's effects on investment estimated that the elasticity of investment with respect to the user cost of capital exceeded 1.0 (in absolute value).[25] Investment in certain assets could be more responsive to changes in the user cost of capital than investment overall; some additional investment in one type of asset within an industry could crowd out other investment. (Thus, an investment elasticity that is greater than 0.7, in absolute value, for one type of investment could be consistent with an overall elasticity of 0.7, if other types of investment were crowded out.)

Investment in wind and solar electric power structures has generally increased over time. CBO estimates that over the 2024–2026 period, such investment would amount to about $48 billion per year, on average, assuming that investment growth is consistent with historical trends (see Figure 4). Tax credits can be claimed for investment in wind and solar power structures whether that investment happened because of the tax credits or would have happened without them.

If the ITC and PTC were not available, investment in wind and solar power structures would have been expected to average about $33 billion per year from 2024 to 2026 (or two-thirds of what is currently expected), given a general investment elasticity of 0.7. If the investment elasticity was 1.2, thus reflecting greater responsiveness to tax incentives or changes in the user cost of capital, then investment over that period would be expected to average about $26 billion per year. Figure 4 shows the varying amount of expected investment in the absence of the ITC and PTC, given investment elasticities ranging from 0.5 to 1.2 (a plausible range based on existing research).

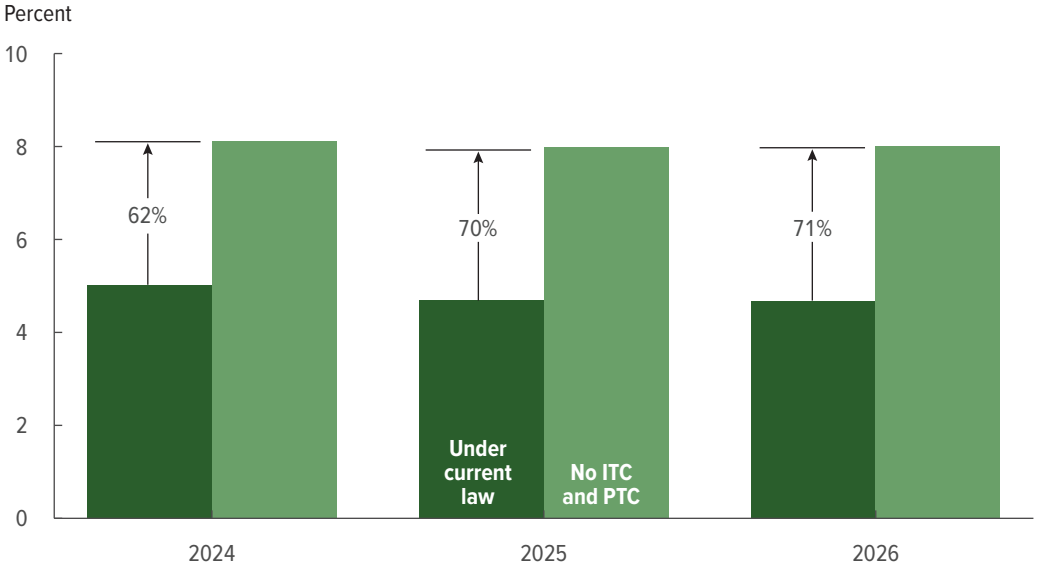
23. Because the ITC and PTC are part of current law, their values are included in CBO's baseline projections of the user cost of capital as estimated using CapTax. Thus, this discussion considers how the user cost of capital would increase if tax credits were no longer available. Table 4 provides scenarios that illustrate how tax credits affect the user cost of capital from an investor's perspective; in that table, the availability of tax credits decreases the user cost of capital.

24. Congressional Budget Office, *Key Methods That CBO Used to Estimate the Macroeconomic Effects of the 2017 Tax Act—Supplemental Material for The Budget and Economic Outlook: 2018 to 2028* (April 2018), p. 3, https://tinyurl.com/bddykpvd.

25. Gilbert E. Metcalf, "Investment in Energy Infrastructure and the Tax Code," *Tax Policy and the Economy*, vol. 24, no. 1 (2010), pp. 1–34, www.journals.uchicago.edu/doi/abs/10.1086/649826.

Figure 3.

User Cost of Capital for Investment in Wind and Solar Electric Power



CBO estimates that without the ITC and PTC, the user cost of capital for investments in wind and solar electric power would be 70 percent higher in 2025.

Data source: Congressional Budget Office. See www.cbo.gov/publication/61188#data.

The user cost of capital is the before-tax return on investment that provides the required return to investors after covering taxes and depreciation.

ITC = investment tax credit; PTC = production tax credit.

In CBO's economic models, the response of investment in structures to changes in the user cost of capital occurs gradually over several quarters to account for lags in the investing process. Thus, if tax credits were repealed, the investment response would not be expected to occur immediately. Changes to the ITC and PTC—or their repeal—could also affect the pattern of investment if investors accelerated or deferred investment in response to the changes.

Because the ITC and PTC increase the capital stock, the investment motivated by those tax credits contributes to additional economic activity and growth. (The capital stock is the total value of productive assets, such as power plants and related infrastructure, used to generate future output.) Investment in wind and solar power structures, however, is a small share of economywide business investment. In CBO's January 2025 baseline projections, business fixed investment averages about $4 trillion per year over the 2024–2026 period; projected investment in wind and solar power structures amounts to about 1 percent of that total.

CBO's estimate of the overall user cost of capital for business assets would be higher if the ITC and PTC were not available, but only by a small amount. In 2025, the overall user cost of capital is estimated to be 11.3 percent. Without the ITC and PTC, businesses' estimated user cost of capital is slightly higher, but that percentage is unchanged. Because investment in wind and solar power structures is a small share of total economywide investment, the tax credits have a small effect on CBO's estimates of the overall user cost of capital.

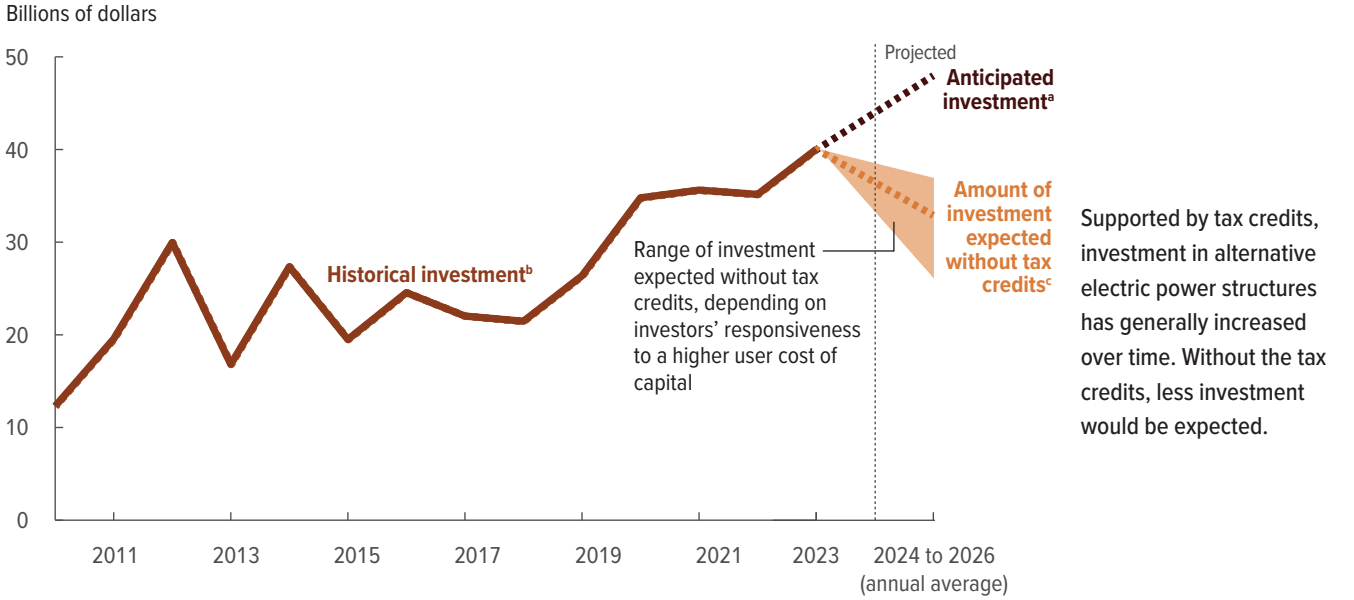
Modeling the Electric Power Sector Using CBO-ReEDS. Models of the electric power sector are designed to show how changes in technology, policy, or market conditions affect outcomes in that sector in relation to a fixed set of conditions, or base case. CBO uses such a model to assess the effects of federal policies on outcomes in the electric power sector and to explore the sensitivity of projected outcomes to uncertainties in the pace of technological developments and market conditions.

Using CBO-ReEDS to Assess Wind and Solar Capacity. The ReEDS model, developed by the National Renewable Energy Laboratory, is designed to analyze electricity generation over the long term, along with other outcomes in the electric power sector.[26] The model accounts for the

26. National Renewable Energy Laboratory, "Regional Energy Deployment System" (accessed February 2, 2025), www.nrel.gov/analysis/reeds.

Figure 4.

Investment in Wind, Solar, and Other Alternative Electric Power Structures



Data sources: Congressional Budget Office; Bureau of Economic Analysis. See www.cbo.gov/publication/61188#data.

a. CBO's assessment based on recent investment data and historical trends.

b. The amount of private fixed investment in alternative electric power structures according to the Bureau of Economic Analysis.

c. In CBO's economic models, the response of investment in electric power structures to changes in the user cost of capital occurs gradually over several quarters to account for lags in the investing process. (The user cost of capital is the before-tax return on investment that provides the required return to investors after covering taxes and depreciation.)

effects of many technical and geographic constraints—for example, differences in solar intensity and wind speed, land-use restrictions, and costs of connecting potential locations to the transmission network.

CBO-ReEDS incorporates CBO's assessments of electricity demand, fuel prices, and technology costs, as well as the agency's assessments of transmission capacity and siting access for new wind and solar projects.[27] Those assessments affect projected amounts of wind and solar capacity. When factors such as electricity demand, fuel prices, or technology costs differ from the base case, the result can be more or less projected capacity from wind and solar power sources.

In CBO-ReEDS, tax credits that support investment in wind and solar capacity reduce the cost of providing electricity using those sources. In turn, that reduced cost increases investment in wind and solar generating capacity, and more electricity is generated from those sources. CBO's baseline projections reflect the agency's estimates of the reduction in revenues and increase in outlays that are attributable to such tax credits. As the analysis below illustrates, the amount of tax credits claimed could differ from expected amounts as investors respond to varying market conditions.

Variation in Outcomes for Wind and Solar Capacity Under Different Market Conditions in CBO-ReEDS. At the end of 2023, total electric generating capacity from wind and solar sources in the United States was 237 gigawatts.[28]

27. Assumptions underlying the base case scenario (and the high/low natural gas prices, technology costs, and electricity demand scenarios) are described in David Adler, *How CBO Uses the ReEDS Model to Analyze Policies in the Electric Power Sector*, Working Paper 2024-02 (Congressional Budget Office, May 2024), www.cbo.gov/publication/59880.

28. That amount reflects the total generating capacity of utility-scale power plants (those whose total capacity is larger than 1 megawatt) in the electric power sector. See Energy Information Administration, "Short-Term Energy Outlook Data Browser" (accessed March 24, 2025), Table 7e, https://tinyurl.com/atapvt74.

In CBO's baseline projections, tax incentives support investment in additional wind and solar generating capacity through 2035, the final year of the projection period.

CBO-ReEDS allows CBO to evaluate how outcomes in the electric power sector might differ according to various scenarios. In the base-case scenario, wind and solar generating capacity at the end of 2035 is about 720 gigawatts (see Figure 5).[29] If, however, natural gas prices were higher than expected, markets would respond by adding more wind and solar generating capacity than in the base case, according to CBO-ReEDS. Similarly, technological advances that resulted in faster-than-anticipated declines in technology costs would lead to more wind and solar generating capacity by the end of 2035, as would growth in the demand for electricity that outpaced the growth expected in the base case. Conversely, lower-than-anticipated natural gas prices or electricity demand would lead to less wind and solar generating capacity by the end of 2035, as would technology costs that did not decline as much as expected in the base case.

In addition to increasing the *amount* of wind and solar energy capacity, higher natural gas prices and lower technology costs are expected to increase the *share* of electric power generated from wind and solar sources. But if the reason for greater-than-expected investment in wind and solar energy is a higher overall demand for electricity, then the share of electricity generated from wind and solar sources may not necessarily increase. Estimates of the amount of future generating capacity are particularly sensitive to assumptions about future technology costs. Factors that affect those costs, such as unanticipated constraints on supply chains or tariffs that make technologies more expensive than they otherwise would be, could affect deployment and capacity levels.

The cost to the government of the ITC and PTC depends on several factors, including the amount invested, the amount of installed power-generating capacity from wind and solar sources, and the proportion of projects eligible for bonus credits. If higher-than-expected natural gas prices led to more investment in wind and solar power, then the amount invested (in dollars) and the capacity installed would both increase, as would the cost of the tax credits. But capacity can decline without reducing the credits' cost. If wind and solar deployment slowed because technology costs were higher than anticipated, installed capacity could decline without a corresponding decrease in the cost of the ITC (since that cost depends on dollars invested rather than capacity deployed). But higher technology costs that led to less wind and solar deployment, and thus less installed capacity, would reduce the cost of the PTC because less electricity would be produced.

The Tax Credits' Various Policy Objectives

The 2022 reconciliation act tied energy-related tax credits to policy objectives in three other areas: labor and workforce standards, economic and community development, and domestic manufacturing. Because the amounts claimed in ITCs and PTCs partly depend on meeting conditions in those three areas, CBO does not expect the tax credits to stimulate investment in wind and solar electric power at the lowest possible cost. Structuring a project to meet those other policy objectives can increase a project's cost. Thus, tax credits that are based on the amount invested cost more.

Labor and Workforce Standards

ITC and PTC amounts are increased by a factor of five for projects that pay prevailing wages and employ apprentices (or make a good-faith effort to hire them). CBO expects that most projects will meet those conditions and thus be eligible for the enhanced credit. Investors would be willing to incur higher costs associated with paying prevailing wages and hiring apprentices if the enhanced credit was large enough to offset those costs.

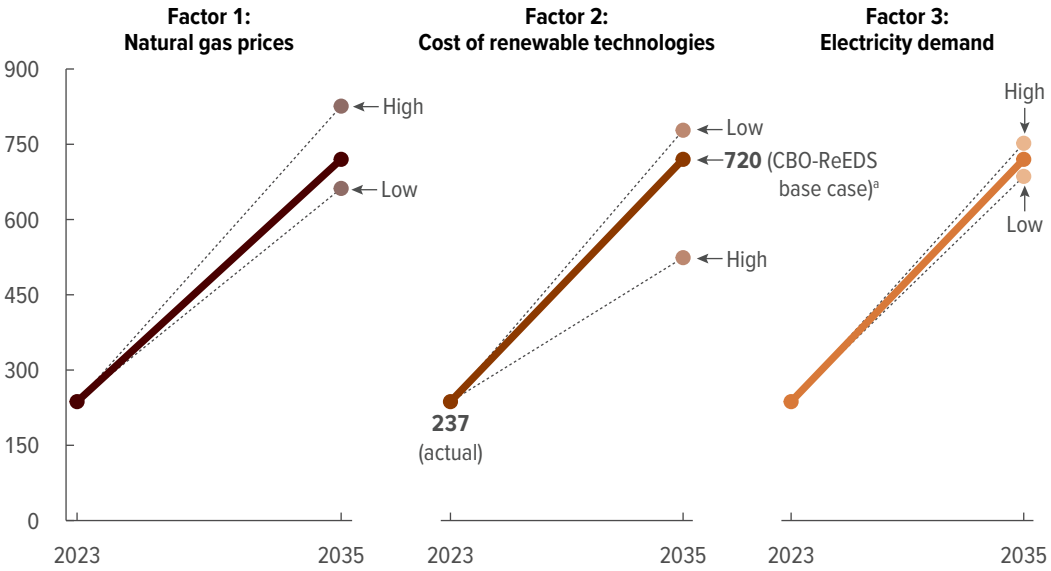
Strong demand for labor in the electric power and energy manufacturing sectors has put upward pressure on wages in those sectors, independent of prevailing wage standards. If labor markets softened, it could be more costly for projects to meet requirements for prevailing wages and apprenticeships. If labor costs were higher because of those requirements, then some of the cost associated with the tax credits would support labor policies instead of maximizing investment in wind and solar power.

29. Wind and solar capacity projected by CBO-ReEDS is within the range of findings from a broad class of energy-sector models. See John Bistline and others, "Emissions and Energy Impacts of the Inflation Reduction Act," *Science*, vol. 380, no. 6652 (June 2023), pp. 1324–1327, www.science.org/doi/10.1126/science.adg3781; detailed information is available in the supplemental tables. Also see John E. T. Bistline and others, "Power Sector Impacts of the Inflation Reduction Act of 2022," *Environmental Research Letters*, vol. 19, no. 1 (November 2023), https://tinyurl.com/26uadbn9. The comparisons among models provide information for the years 2025, 2030, and 2035. This report focuses on the year 2035 to coincide with the end of CBO's current budget projection period.

Figure 5.

Effects of Selected Factors on Wind and Solar Generating Capacity

Gigawatts



CBO's baseline projections are subject to uncertainty because investment in wind and solar generating capacity is uncertain. If natural gas prices were higher, or the cost of wind and solar technologies was lower, or if demand for electricity was greater than anticipated, the result would be more new wind and solar generating capacity than is currently projected.

Data sources: Congressional Budget Office; Energy Information Administration. See www.cbo.gov/publication/61188#data.

Solar generating capacity includes solar photovoltaic generation, which includes distributed utility-scale solar (but not solar thermal). Wind generating capacity includes onshore and offshore wind infrastructure.

Scenarios illustrating the effects of natural gas prices, costs of renewable technologies, and electricity demand are described in David Adler, *How CBO Uses the ReEDS Model to Analyze Policies in the Electric Power Sector*, Working Paper 2024-02 (Congressional Budget Office, May 2024), www.cbo.gov/publication/59880.

Years are calendar years.

a. CBO-ReEDS is CBO's version of the Regional Energy Deployment System (ReEDS) model developed by the National Renewable Energy Laboratory. CBO-ReEDS is used to evaluate how policies affect the mix of energy sources in the electric power sector, as well as other factors and budgetary outcomes. The base case is the estimated amount of wind and solar generating capacity expected on the basis of a fixed set of conditions in the economy and energy markets.

Economic and Community Development

The bonus tax credit for projects located in energy communities encourages investment in geographic areas that historically were economically reliant on the fossil fuel industry. The energy community designation, however, may not target the communities most in need of support.[30] The designation is broad and covers about half of all U.S. land area and one-fifth of the U.S. population.[31]

Renewable energy projects tend to be located where resources (sun or wind) are abundant and where infrastructure and workforce needs are met. If some energy communities already have those desirable attributes, then the bonus credit may not have been necessary to incentivize investment.

Moreover, shifting investment to targeted communities probably comes at a cost. The incremental incentive provided by the place-based bonus credit could encourage investors to build projects in less optimal (less sunny or windy, for example) locations. Shifting more investment to energy communities could thus result in less renewable energy generated from that investment.

Domestic Manufacturing

The 2022 reconciliation act included new subsidies for domestic energy-related manufacturing and added bonus credits to the ITC and PTC for projects that use domestically sourced materials. Those incentives, combined with

30. Kailin Graham and Christopher R. Knittel, "Assessing the Distribution of Employment Vulnerability to the Energy Transition Using Employment Carbon Footprints," *Proceedings of the National Academy of Sciences,* vol. 121, no. 7 (February 2024), https://tinyurl.com/3fxahe95.

31. For more details, see Daniel Raimi and Sophie Pesek, "What Is an 'Energy Community'?" *Resources* (blog entry, September 7, 2022), https://tinyurl.com/ymkfrpyt; and Rajat Shrestha, Sujata Rajpurohit, and Devashree Saha, "Redefining America's 'Energy Communities' Can Boost Clean Energy Investment Where It's Needed Most," *World Resources Institute* (July 2023), https://tinyurl.com/5673z978.

tax credits for semiconductor manufacturing, supported a recent surge in investment in buildings and facilities used for manufacturing activities, including the manufacture of wind and solar components, as well as semiconductors. (For a discussion of the energy-related manufacturing credits, see Appendix A; for a discussion of investment in manufacturing structures, see Appendix B.)

Because global markets tend to supply wind, solar, and other energy-related technologies at a lower cost than domestic markets do, there is a trade-off between developing domestic industries to supply those technologies and maximizing the deployment of wind and solar electric power capacity. Policies that require the use of domestically sourced materials slow the deployment of assets that generate wind and solar power in the United States. When tax credits offset the higher cost of projects that use domestically sourced materials, the credits encourage the use of such materials but do not stimulate investment in wind and solar power at the lowest possible cost. Policies that promote the use of domestically sourced materials have led to concerns about trade relations with allied trading partners. Tariffs have also been used to encourage the use of domestically sourced materials in wind and solar power projects. (For more about tariffs, see the section below titled "Interactions With Other Government Policies.")

The Tax Credits' Administrative Costs and Fiscal Interactions

Using tax credits to support investment in wind and solar power results in administrative costs, which are reflected as spending in the federal budget. Tax credits also interact with other tax and nontax policies, and those interactions can affect the projected cost of the tax credits supporting wind and solar power.

Implementation and Operational Costs

New and expanded energy-related tax provisions effectively assign new responsibilities to the Internal Revenue Service (IRS). Administering energy-related tax provisions has required the IRS to acquire additional technical expertise. The 2022 reconciliation act appropriated $500 million to the IRS, available for 10 years as supplemental funding to implement energy-related tax credits. The IRS anticipated spending $180 million in both 2024 and 2025 to administer the credits; the remaining $140 million (of the initial $500 million appropriation) would be spent in 2026.[32] At the end of February 2025, the IRS's energy security account (which holds the $500 million in supplemental funding for energy-related provisions) had an unobligated balance of $436 million.[33]

In 2023, the IRS anticipated devoting a total of about $4 billion in appropriated funds to implement the 2022 reconciliation act's energy-related tax provisions through 2031.[34] That total includes amounts in taxpayer services, enforcement, and operations support accounts (not just the energy security account). Rescissions of IRS funding would probably result in fewer available resources for implementing, administering, and auditing the energy-related tax provisions. (Rescissions are provisions of law that cancel budget authority previously provided before it is scheduled to expire.) Rescissions of IRS funding, such as those provided in the Further Consolidated Appropriations Act, 2024, can reduce revenues (and thus increase deficits) by decreasing the resources available for enforcement activities.[35]

Verifying eligibility for energy-related tax credits can be challenging for the IRS. For credits with a direct payment option, including the ITC, PTC, and manufacturing-related energy credits, there is a risk of payments being made when they should not have been or in the wrong amounts. The IRS is taking steps to reduce the risk of improper payments (or payments made in error) for energy-related tax credits. Specifically, entities that elect to receive energy- or manufacturing-related credits as payments are required to register with the IRS before filing a tax return. The IRS will then assign eligible projects registration numbers, which are submitted on tax returns when credits are claimed. That multistep process for receiving tax credits as payments places a higher administrative burden on taxpayers and the IRS than is typical of other tax credits.

Federal agencies other than the IRS incur costs associated with administering energy-related tax policy. For example, within the Department of Energy, the Office

32. Internal Revenue Service, *IRA Strategic Operating Plan: Annual Update Supplement* (2024), p. 31, https://tinyurl.com/5n6mmw59.

33. Office of Management and Budget, "MAX Information and Reports (Executive, Legislative, and Judicial Users): FY 2025-SF 133 Reports on Budget Execution and Budgetary Resources" (accessed March 25, 2025), https://tinyurl.com/4pfbuvbk.

34. Internal Revenue Service, *Internal Revenue Service Inflation Reduction Act Strategic Operating Plan, FY2023–2031* (April 2023), p. 129, www.irs.gov/pub/irs-pdf/p3744.pdf.

35. Congressional Budget Office, *How Changes in Funding for the IRS Affect Revenues* (February 2024), www.cbo.gov/publication/59972.

of Manufacturing and Energy Supply Chains evaluates applications for the advanced energy project credit. (For more information about that tax credit, see Appendix A.) The Department of Labor's Wage and Hour Division assists taxpayers who seek help in complying with prevailing wage requirements for certain tax credits.

Tax credits supporting investment in wind and solar electric power are complex, and claiming those credits can involve parties beyond the investor and the federal government. In the case of transferred tax credits, the business that buys the tax credit may also be involved. Additionally, buyers may purchase a tax insurance policy to address the risk that the amount of the tax credit may be less than anticipated, perhaps because of unforeseen circumstances that prevent an investor from using domestically sourced materials (and thereby qualifying for the associated bonus credit) as expected. Markets have responded to the complexity of the tax credits with innovative insurance policies and consulting arrangements. Those developments and the financial intermediaries that support them divert funds away from directly investing in wind and solar electric power.

Interactions With Minimum Tax Policies

When U.S. or international tax policy includes a minimum tax, there is a trade-off between providing tax credits and achieving the objectives of the minimum tax policy. A minimum tax is designed to ensure that the amount of tax paid is above a specified fixed portion of income. When taxpayers who are subject to a minimum tax also qualify for tax credits (such as the ITC or PTC), there is a policy choice: The credits could be reduced to ensure that the threshold amount of income is paid in taxes, which would weaken the credits' incentive effect.[36] Alternatively, the credits could be allowed to reduce taxes below the minimum tax threshold, which would undermine the objective of the minimum tax.

Corporate Alternative Minimum Tax. Certain large corporations are subject to the corporate alternative minimum tax (CAMT), calculated as 15 percent of financial statement income, adjusted for items such as tax depreciation, net operating losses, and certain tax credits. Corporations subject to the CAMT pay the larger of taxes owed under the regular corporate tax or under the CAMT. Domestic tax credits, including the ITC and PTC, can offset up to 75 percent of the combined amount owed in regular corporate tax and CAMT.[37] Energy-related tax credits can result in corporations subject to the CAMT paying less than 15 percent of their income as tax.

Businesses may also purchase transferable energy-related tax credits, including the ITC, PTC, and credits for energy-related manufacturing, and use those credits to reduce their CAMT by up to 75 percent of the limit. Because transferable energy-related tax credits are typically sold at a discount, purchasing them is a way to reduce the cost that a corporation incurs to cover its CAMT liability.

Base Erosion and Anti-Abuse Tax. The base erosion and anti-abuse tax (BEAT) is a minimum tax intended to discourage profit shifting (that is, moving reported profits that would be taxed in the United States to lower-tax jurisdictions). Certain large multinational firms making substantial base erosion payments (such as royalties, interest, and service payments to related entities abroad) may be subject to that add-on tax. The amount of the BEAT is determined using a lower alternative tax rate (which is currently 10 percent and is scheduled to increase to 12.5 percent after 2025) on a base amount that adds certain payments made to related foreign corporations to the regular corporate income tax base. Foreign tax credits cannot be claimed against the BEAT. Through 2025, 80 percent of the amount claimed for the ITC or PTC is disregarded when considering regular tax liability.[38] Because the BEAT is an add-on tax, disregarding a portion of energy-related credits reduces BEAT liability (by increasing the amount of regular tax liability that is subtracted from the BEAT amount).

Energy-related tax credits other than the ITC and PTC are included when determining the amount of regular corporate income tax paid. (After 2025, all tax credits would be included in that determination.) Including the full value of energy-related tax credits reduces regular tax liability and increases the add-on amount

36. In this case, credits could be allowed to offset regular tax liability in a future year.

37. Tax credits that cannot be claimed in the current tax year can be carried forward to offset future tax liability. Taxes owed because of the CAMT result in a credit that can be claimed against future regular corporate tax liability.

38. This treatment only applies to the regular ITC and PTC that are scheduled to expire for projects that begin construction after 2024—not the zero-emissions ITC and PTC that supersede those tax credits starting in 2025. The full value of the research tax credit is also disregarded through 2025.

for corporations with a BEAT liability. Thus, more corporations are subject to the BEAT. The treatment of energy-related tax credits under the BEAT, particularly after 2025 (when changes are set to take effect), weakens the incentive effects of credits for certain multinational corporations because the BEAT effectively recaptures a portion of the tax credit.[39]

Global Minimum Tax. Currently, some countries (but not the United States) are working to implement a 15 percent global minimum tax on large multinational corporations through the global anti-base erosion rules (GLoBE). If other countries adopt GLoBE but the United States does not, then U.S.-based multinational corporations could owe additional taxes to other countries. Under those circumstances, reduced effective tax rates that result from tax credits, including energy-related credits, could trigger an additional tax that offsets the incentive effects of the credits. Under current guidelines, transferable tax credits, and thus the ITC and PTC, would not trigger a "top-up" tax under the GLoBE framework—at least through 2025.[40] Longer-term uncertainty remains about the treatment of U.S. energy-related tax credits under such a framework.

Interactions With Other Government Policies

A range of policies at the federal, state, and local level will influence future outcomes in the electric power sector and thus the cost of tax credits for investing in wind and solar power. In particular, regulations and tariffs may have significant effects on investments in that sector. Changes to other federal tax policies could also affect the cost of the tax credits, as could changes in state policies (affecting renewable portfolio standards, for example) and local policies (affecting land use restrictions, for example). Those potential changes are sources of uncertainty, as are numerous other potential policies and actions.

Regulations. Outcomes in the electric power sector could be affected by many federal regulatory policies. Oftentimes, policymakers can choose between using regulations or incentives to achieve desired policy objectives; when both are used simultaneously to support investment in wind and solar power, the tax incentives provided by the government reduce the cost to the private sector of complying with the government's regulations. Regulations that reduce investment in wind and solar power reduce the cost of tax credits supporting that investment.

In April 2024, the Environmental Protection Agency finalized a rule that tightens emissions requirements on new natural gas plants and existing coal-fired power plants, particularly those expected to remain in operation after 2032.[41] Tax credits supporting investment in wind and solar power (as well as those supporting carbon capture and sequestration) reduce the cost of building zero-emissions power plants and other generators that comply with that rule.[42] And to the extent that investment in wind and solar power increases because of the rule, the cost of tax credits for wind and solar power increases.

Other regulations or executive orders, such as those that restrict wind and solar leases on federal lands or limit federal authorization of wind and solar projects, could reduce investment in wind and solar power. In that case, the cost of tax credits supporting such investment would be lower.

The effects of regulatory policies on the cost of tax credits are difficult to quantify. Moreover, such effects are usually felt in the medium or long term—a time frame in which the projected costs of tax credits for wind and solar energy are particularly uncertain.

39. The illustrative investment described in Table 2 on page 5 can demonstrate that effect: If an investor claiming the $140 million tax credit began construction on a project in 2024 and was subject to the BEAT, then claiming the credit in 2025 would reduce their adjusted regular tax liability by 20 percent of the credit amount (or $28 million). That $28 million would be taxed at the 10 percent BEAT rate, so $2.8 million in additional BEAT would be owed as the result of claiming the credit. For a similar investment made in 2026, when the new BEAT rules take effect, the adjusted regular tax liability would be reduced by the full credit amount of $140 million. That $140 million would be taxed at the 12.5 percent BEAT rate; the investor would thus owe $17.5 million in additional BEAT as the result of claiming the credit.

40. Organisation for Economic Co-operation and Development, *Tax Challenges Arising From the Digitalisation of the Economy—Administrative Guidance on the Global AntiBase Erosion Model Rules (Pillar Two)* (July 2023), https://tinyurl.com/2nmjscre.

41. New Source Performance Standards for Greenhouse Gas Emissions From New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units; Emission Guidelines for Greenhouse Gas Emissions From Existing Fossil Fuel-Fired Electric Generating Units; and Repeal of the Affordable Clean Energy Rule, *89 Fed. Reg. 39798* (May 9, 2024).

42. Joseph E. Aldy, "How Big Is the "Biggest Climate Spending Bill Ever?" Key Factors Influencing the Inflation Reduction Act's Clean Energy Impacts," *National Tax Journal*, vol. 78, no. 1 (March 2025), pp. 201–221, https://tinyurl.com/2u4xxfj8.

Tariffs. For more than a decade, the United States has imposed additional duties—amounts above standard tariff rates—on solar panels imported from China. Duties on goods sold below their normal value (known as antidumping duties) and on goods that have been subsidized by a foreign government (known as countervailing duties) were imposed on Chinese solar panels in 2012. Those duties have been in place continuously since then, though the details and scope have evolved over time. In June 2024, for example, a two-year suspension of antidumping and countervailing duties on solar products with Chinese components imported from Cambodia, Malaysia, Thailand, or Vietnam expired.

Administrative actions have imposed other tariffs on solar cells and modules. In 2018, tariffs were imposed on imported solar panels regardless of the country of origin.[43] Those tariffs remain in place, but their rates have declined over time. More recent administrative actions have focused on solar panels imported from China. On September 27, 2024, the Administration increased the duty rate on Chinese solar cells from 25 percent to 50 percent. In February and March 2025, the Administration imposed an additional 10 percent tariff on goods shipped from China; those actions increased tariffs on solar products imported from China to over 70 percent in March 2025.

Tariffs on solar products and other imported goods interact with tax policies in many ways. The increased tariff rates on imports from China are meant to protect U.S. solar manufacturers from low-cost Chinese imports and to address concerns about Chinese control of and influence on supply chains for solar components. Strengthening solar and other import tariffs would be expected to increase domestic manufacturers' claims of tax credits for wind, solar, and battery manufacturing (see Appendix A).

Import tariffs make capital goods more expensive and thus increase the cost of deploying solar and other energy technologies that use inputs (such as aluminum and steel, for example) subject to the tariffs. If costs increased, even if businesses chose to maintain a fixed level of investment, the amount of renewable energy capacity deployed would be reduced. For investment credits, tariffs that lead to higher costs mean higher tax credits per unit of electricity generating capacity deployed. In addition to making capital goods more expensive, tariffs can prompt retaliatory trade policies and have generally been found to reduce U.S. output.[44]

Other Energy-Related Tax Credits. Tax credits that support technologies such as electric vehicles, heat pumps, and clean hydrogen can lead to an increase in the adoption of those technologies and can thus increase the demand for electricity. Changes in such demand can affect the amount of investment in generating capacity from sources such as wind and solar and can thus affect the cost of tax credits supporting that investment.

43. For information about how administrative changes in tariffs are reflected in CBO's baseline budget projections, see Congressional Budget Office, "How CBO Projects Tariff Revenue" (October 2024), www.cbo.gov/publication/60692.

44. Congressional Budget Office, "The Effects of Tariffs and Trade Barriers in CBO's Projections," *CBO Blog* (August 22, 2019), www.cbo.gov/publication/55576.

Appendix A: Tax Credits for Manufacturing Clean Energy Equipment

Two tax credits subsidize the domestic manufacture of what is sometimes called clean energy equipment. The advanced manufacturing production credit (known as the 45X credit) can be claimed for producing solar, wind, and battery components as well as critical minerals, such as lithium, used in clean energy equipment.[1] The advanced energy project credit (known as the 48C credit) is an allocated tax credit that supports investment in projects that reequip, expand, or establish certain energy manufacturing facilities. The Congressional Budget Office's baseline projections reflect the budgetary effects of the two tax credits; several factors make those projections uncertain. (For more details about the credits, see Table A-1.)[2]

Budgetary Effects

Established under the 2022 reconciliation act (Public Law 117-169), the 45X credit became available to taxpayers in calendar year 2023. The staff of the Joint Committee on Taxation estimates that in 2025, the 45X credit, which represents most of the cost of the two clean energy manufacturing tax credits, will be the fourth-largest corporate tax expenditure, at a cost of $18 billion.

The cost of the 48C credit is limited by the amount that the Congress authorizes for credit allocations. The 2022 reconciliation act provided $10 billion for new allocations that were made in March 2024 and January 2025.

CBO projects that under current law, the 45X and 48C credits will increase the deficit in 2025 by $20 billion and deficits over the 2026–2035 period by $105 billion (see Table A-2). Along with tax-exempt and government entities, businesses that pay taxes also can elect to receive the 45X credit as a payment rather than a reduction in the amount of taxes owed. As a result, CBO expects that about 60 percent of the cost of the manufacturing credits will be recorded as outlays.

Uncertainty About Costs

Initial claims for the 45X credit are expected on 2023 tax returns, which were first filed in calendar year 2024. Thus, there are currently no data from past claims to inform projections of the credit's cost. As a result, and because of uncertainty about future battery, solar, and wind manufacturing capacity, the actual budgetary cost of the 45X credit could be substantially higher or lower than projected.

There is also uncertainty about who will claim the credit and the proportion of claims that will increase outlays instead of reducing revenues. The 45X credit could be claimed by businesses against their own tax liability, received as a direct payment. It could also be transferred and thus claimed by the recipient of the transfer. Credits received as direct payments are recorded in the budget as outlays instead of reductions in revenues. If more businesses than anticipated chose to transfer the credit rather than receive it as a direct payment, then outlays would be less than projected, with an offsetting reduction in revenues.

The $10 billion limit on allocations for the 48C credit is the maximum amount that can be claimed for that credit and thus serves to limit its cost. The budgetary effects of the credit and their timing are nonetheless uncertain. Not all entities that are allocated credits will ultimately claim them: The credits might be forfeited because some projects may not be completed or may fail to meet certain criteria. The credits will be claimed on tax returns filed after investments are made, and those investments are expected to occur over several years.

1. 45X refers to the section of the Internal Revenue Code that allows the credit.

2. In addition to the 45X and 48C tax credits, a 25 percent tax credit—the advanced manufacturing investment credit (sometimes called the 48D credit)—is available through calendar year 2026 for investments in facilities that manufacture semiconductors or equipment used to make them. Semiconductors are an important component of many renewable energy sources.

Table A-1.

Overview of Tax Credits for Clean Energy Components and Facilities

	Advanced manufacturing production credit (45X)	Advanced energy project credit (48C)
Summary	A fixed amount can be claimed for the domestic production and sale of wind, solar, and battery components. A 10 percent credit can be claimed for producing critical minerals.	$10 billion in allocations for investments in projects that reequip, expand, or establish certain energy manufacturing facilities. Taxpayers receiving allocations are selected. At least $4 billion is to be allocated to energy communities.[a]
Amount	Varies by component; can be a fixed value (for example, an amount per kilogram or square meter), an amount per unit of capacity (for example, cents per watt), or a percentage of production cost or sales price.	30 percent[b]
Duration	Available in any period in which qualifying components are produced and sold	Onetime credit
Direct payment/transferability	Direct payment for tax-exempt entities and for first five years for other taxpayers; also transferable	Direct payment for tax-exempt entities; otherwise transferable
Phaseout/expiration	December 31, 2032[c]	Fixed amount competitively awarded to applicant taxpayers

Data source: Congressional Budget Office.

Taxpayers cannot claim both the 45X and 48C credits for the same facility.

a. Energy communities are areas where a coal mine or coal-fired power plant has closed (after 1999 and 2009, respectively) or areas with an average or above-average unemployment rate that have threshold amounts of economic activity related to coal, oil, or natural gas. Properties known as brownfield sites, which contain (or potentially contain) a hazardous substance that complicates the expansion or redevelopment of the property, can also be designated as energy communities.

b. The amount includes the base amount plus an enhanced credit for meeting requirements related to paying prevailing wages and hiring apprentices. CBO expects that most projects will be eligible to claim that enhanced credit. (Prevailing wages are the average wages, including benefits, paid to workers in a similar occupation in the geographic area of employment. To meet the requirement for prevailing wages, workers must be paid at least that amount, either through wages or a combination of wages and benefits.)

c. The 45X credit for critical minerals does not expire. The credit begins to phase down in calendar year 2030, with 75 percent of the full credit value available in that year. In calendar year 2031, the credit is reduced to 50 percent of the full credit value; it is further reduced to 25 percent of the full credit value in calendar year 2032.

Table A-2.

Estimated Budgetary Effects of Tax Credits for Clean Energy Components and Facilities

Billions of dollars

	2025	2026–2035
Reduction in revenues	7	40
Outlays	13	66
Total	**20**	**105**

Data source: Congressional Budget Office. See www.cbo.gov/publication/61188#data.

Tax credits for clean energy components and facilities include credits for wind and solar components, batteries, and other machinery or systems that support the reduction of carbon dioxide emissions.

Not included in the above totals are the effects of the advanced manufacturing investment credit (sometimes called the section 48D, or "CHIPS," credit), which supports investment in facilities that manufacture semiconductors or equipment used to make them. The staff of the Joint Committee on Taxation estimates the cost of that credit to be $8 billion in 2025; CBO expects that less than $1 billion of that total will be recorded in the federal budget as outlays.

Years are fiscal years.

Appendix B: Alternative Measures of the Tax Burden on New Investment

The Congressional Budget Office uses its capital tax model, called CapTax, to estimate the effect of federal taxes on the incentives to invest in capital. That effect is otherwise known as the tax burden on investment. One of several measures that accounts for the tax burden is the user cost of capital—the before-tax return on investment that provides the required return to investors after covering taxes and depreciation.

If, for example, an investor required a 7 percent after-tax rate of return on an asset that depreciates at a rate of 5 percent per year, then a 12 percent rate of return would be required to pay the investor the required return and to cover depreciation. If returns were subject to a 21 percent corporate income tax, the before-tax rate of return required for the investor to break even would be 15.2 percent—which is the user cost of capital. In CBO's economic projections, changes in the user cost of capital are one way that changes in the tax system affect private investment.

CBO uses two other measures of the tax burden in its analyses: the tax wedge and the effective marginal tax rate (EMTR). Unlike the user cost of capital, tax wedges and EMTRs account for individual income taxes (such as taxes on interest, dividends, and capital gains) that savers are expected to pay on marginal savings; those measures thus account for how the tax system affects incentives to save as well as invest. The agency has used the tax wedge and EMTR to examine how tax law might create inefficiencies in the economy by taxing various activities differently.[1] CBO publishes supplemental tables that list the tax wedges and EMTRs for different types of investment alongside most of its *Budget and Economic Outlook* reports.[2]

The Tax Wedge and the Effective Marginal Tax Rate

The *tax wedge* is the difference between the real (adjusted for inflation) before-tax rate of return required by investors undertaking an investment and the real after-tax rate of return required by savers providing the funds for that investment. The real before-tax rate of return required by investors equals the user cost of capital net of economic depreciation. A higher tax wedge indicates that a marginal investment (one that would not be made if it earned any less) must have a higher before-tax rate of return for the investor to break even.

Returning to the earlier example, if the user cost of capital was 15.2 percent and the savers providing the funds required a 7 percent return on their investment, the tax wedge would be 3.2 percentage points—15.2 percent minus the 7 percent return and 5 percent for depreciation. (In this example, only taxes on business investment are accounted for; thus, any taxes on individual savings are excluded.) If there was no tax on the income from the investment's return, the user cost of capital would be 12 percent. The required before-tax rate of return would be the same as the return required by the savers providing the funds—7 percent (which is the user cost of capital minus economic depreciation)—and the tax wedge would be zero. Thus, with higher taxes, higher returns are required for investors to break even.

Tax credits that subsidize certain types of investments can result in a negative tax wedge. The tax wedge can be used as a measure of how much taxes affect decisions about whether to make a particular investment. The larger the tax wedge, the greater the influence the tax system has on those decisions.

1. Congressional Budget Office, *How Taxes Affect the Incentive to Invest in New Intangible Assets* (November 2018), www.cbo.gov/publication/54648; and Paul Burnham and Dorian Carloni, *CBO's Model for Estimating the Effect That Federal Taxes Have on Capital Income From New Investment*, Working Paper 2022-01 (Congressional Budget Office, February 2022), www.cbo.gov/publication/57429.

2. See, for example, Congressional Budget Office, "Tax Parameters and Effective Marginal Tax Rates" (budget data posted with *The Budget and Economic Outlook: 2025 to 2035*, January 2025), www.cbo.gov/publication/60870.

Table B-1.

Effect of Tax Credits on the User Cost of Capital, Tax Wedge, and Effective Marginal Tax Rate

Percent

	Without tax credits		With the investment tax credit (ITC)[a]		With the production tax credit (PTC)[b]	
	Cost recovery under current law[c]	Economic depreciation	Cost recovery under current law[c]	Economic depreciation	Cost recovery under current law[c]	Economic depreciation
C corporation; investment that is 100% equity-financed						
User cost of capital[d]	9.2	10.6	6.1	7.3	5.1	6.5
Tax wedge (percentage points)[e]	0.2	1.6	-2.9	-1.7	-3.9	-2.5
Effective marginal tax rate[f]	3	21	-94	-40	-189	-72
C corporation; investment that is 70% equity-financed						
User cost of capital[d]	8.1	9.3	5.4	6.4	4.5	5.7
Tax wedge (percentage points)[e]	-0.2	1.0	-3.0	-2.0	-3.9	-2.7
Effective marginal tax rate[f]	-5	15	-124	-58	-258	-100

Data source: Congressional Budget Office. See www.cbo.gov/publication/61188#data.

a. The ITC rate is 30 percent, reflecting a project that meets the requirements for prevailing wages and apprenticeships but that does not qualify for bonus credits associated with an energy community or domestically sourced materials. (Prevailing wages are the average wages, including benefits, paid to workers in a similar occupation in the geographic area of employment. To meet the requirement for prevailing wages, workers must be paid at least that amount, either through wages or a combination of wages and benefits.)

b. The PTC investment subsidy equivalent rate is 36 percent, reflecting a project that meets the requirements for prevailing wages and apprenticeships but that does not qualify for bonus credits associated with an energy community or domestically sourced materials.

c. Under current law, depreciation for 2025 includes 5-year cost recovery under the modified accelerated cost recovery system and 40 percent bonus depreciation.

d. The before-tax return on investment that provides the required return to investors after covering taxes and depreciation.

e. The difference between the real (adjusted for inflation) before-tax rate of return required by investors undertaking an investment and the real after-tax rate of return required by savers providing the funds for that investment.

f. The user cost of capital minus economic depreciation and a saver's required after-tax return, divided by the user cost of capital minus economic depreciation.

The *effective marginal tax rate* is equal to the tax wedge divided by the real before-tax rate of return required by investors. It is the rate that would offer the same investment incentives implied by various features of the tax code, if that rate were applied directly to economic income generated in every year of the investment's life. The EMTR is the fraction of the capital costs (excluding economic depreciation) needed to pay taxes over the lifetime of a marginal investment. The higher the EMTR, the less incentive there is to make the investment. In many cases, the EMTR can be interpreted as a statutory tax rate that varies on the basis of the type of investment. However, the EMTR can take on large negative values when the required before-tax rate of return is close to zero, which can happen when tax credits subsidize certain investments. In those cases, the EMTR is no longer analogous to a statutory tax rate.

The Tax Burden on Hypothetical Investments in Wind and Solar Electric Power

The analysis used in Table 4 on page 13on page 13 to illustrate the effects of the investment tax credit (ITC) and production tax credit (PTC) on the user cost of capital can be extended to illustrate effects on the tax wedge and EMTR (see Table B-1, which includes additional information about the effects of accelerated cost recovery by including an economic depreciation scenario).

For an investment financed entirely with equity and for which tax depreciation equals economic depreciation, the EMTR without the ITC or PTC is 21 percent (which is equal to the statutory corporate tax rate). In that scenario, the user cost of capital is 10.6 percent, and the tax wedge equals 1.6 percentage points (the

difference between the 7.6 percent required before-tax rate of return and the 6.0 percent required after-tax rate of return).

The user cost of capital, tax wedge, and EMTR are lower with current-law bonus and accelerated depreciation in place: The user cost of capital is 9.2 percent, the tax wedge equals 0.2 percentage points, and the EMTR is 3 percent.[3] The user cost of capital and EMTR are lower for investments that involve debt financing because of the favorable tax treatment of interest paid on debt.

The user cost of capital is lower for investments that qualify for the ITC or PTC. Those tax credits are associated with tax wedges and EMTRs that are negative. With tax credits and accelerated cost recovery, EMTRs are negative and large in magnitude because the required after-tax rate of return is substantially less than the required before-tax rate of return. And because the nominal return on debt is lower than the nominal return on equity, the absolute value (that is, the value without regard to its sign) of the tax wedge is larger for certain debt-financed investments when tax credits are available.

Tax wedges and EMTRs that are larger in absolute value indicate that taxes have a greater influence on the incentive to invest. In the case of an equity-financed investment without the ITC and PTC, the tax system has little influence on the incentive to invest. (The tax wedge is small—0.2 percentage points—with current-law cost recovery rules in place.) The availability of tax credits increases investment incentives: Claiming the ITC reduces the tax wedge to –2.9 percentage points; the PTC reduces the tax wedge to –3.9 percentage points. (With those negative tax wedges and small required before-tax rates of return, the EMTRs associated with these hypothetical investments are –94 percent and –189 percent, respectively.) Those values indicate a strong incentive for investment. An EMTR of –100 percent indicates that the tax system makes a project viable that has a before-tax rate of return that is about half of what a potential investor would otherwise require. EMTRs that are large in absolute value can be difficult to interpret. When the required before-tax rate of return (the denominator in the EMTR formula) becomes small in relation to the tax wedge, such rates are not analogous to statutory tax rates.

3. Bonus and accelerated depreciation reduce the required before-tax rate of return to 6.2 percent. (The required after-tax rate of return is unchanged.) Thus, the tax wedge is 0.2 percentage points.

Table B-2.

Tax Credits and Effective Marginal Tax Rates on Business Investment

Percent

	2024	2025	2026
EMTR under current law	18.1	18.5	21.3
EMTR without tax credits for investing in wind and solar electric power			
Without the ITC and PTC	18.6	19.0	21.7
EMTR without tax credits for manufacturing			
Without the 45X	18.7	19.0	21.7
Without the 45X and 48D	18.9	19.2	21.9
EMTR without tax credits for wind and solar investment and for manufacturing			
Without the ITC, PTC, 45X, and 48D	19.3	19.4	22.1

Data source: Congressional Budget Office. See www.cbo.gov/publication/61188#data.

Years are calendar years.

45X = advanced manufacturing production credit; 48D = advanced manufacturing investment credit; EMTR = effective marginal tax rate; ITC = investment tax credit; PTC = production tax credit.

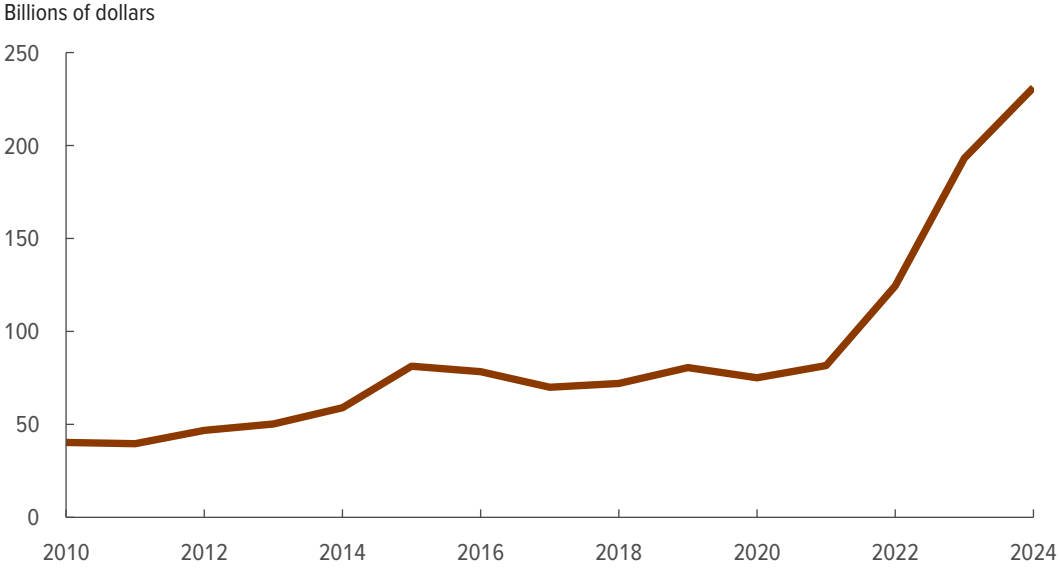
Energy-Related Tax Credits and Effective Marginal Tax Rates in CBO's CapTax Model

CBO's CapTax model provides estimates of the user cost of capital and EMTRs that inform the agency's assessments of how changes in tax policy would affect investment, saving, and economic output. For example, CBO uses the change in the economywide EMTR to assess how a change in tax law would affect saving. Higher EMTRs tend to discourage personal saving, thereby reducing the amount of savings available for investment.

CBO estimates that in 2025, the EMTR for a typical business's investment in wind and solar power structures is about –170 percent. An EMTR of –170 percent suggests that if savers required an after-tax return of 7 percent, the before-tax return on the investment would be about 2.6 percent. (That EMTR reflects all industries investing in those structures because estimates of the EMTR in CapTax incorporate industry-level differences in the required before-tax rate of return.) As Table B-1 shows, the EMTR may have an even greater negative value when investors claim the PTC or when the source of financing is debt instead of equity.

Figure B-1.

Investment in Manufacturing Facilities



The recent surge in facilities construction was supported, in part, by tax credits for wind, solar, battery, and semiconductor manufacturing. Such investment is a component of CBO's business investment projections.

Data source: Congressional Budget Office, using data from the Bureau of Economic Analysis. See www.cbo.gov/publication/61188#data.

Years are calendar years.

Tax credits supporting wind and solar electric power reduce the overall EMTR on business capital investment. Under current law, that rate is estimated to be 18.5 percent in 2025 and increases to 21.3 percent in 2026, reflecting the increase in EMTRs that result from changes in tax parameters scheduled to take effect (see Table B-2 on page 31). Without the ITC and PTC, the EMTR on business assets would be higher: 19 percent in 2025 and 21.7 percent in 2026.

CBO's CapTax model includes the subsidies to investment provided by the advanced manufacturing production credit (sometimes called the 45X credit), which supports investment in wind, solar, and battery components, and the advanced manufacturing investment credit (sometimes called the 48D credit), which supports investment in facilities that manufacture semiconductors or equipment used to make them. Repealing those tax credits, or repealing them along with eliminating the ITC and PTC, would result in higher EMTRs than if just the ITC and PTC were repealed.

The 45X and 48D credits supported a recent surge in investment in manufacturing structures (that is, buildings and facilities used for manufacturing activities, including the manufacture of wind and solar components, as well as semiconductors; see Figure B-1). That investment contributed to strong business investment in recent years. Like investment in wind and solar power structures, investment in manufacturing structures is modest in relation to economywide business investment, so even large changes in that sector are associated with modest macroeconomic effects.

List of Tables and Figures

Tables

Figures

About This Document

This report was prepared to enhance the transparency of the Congressional Budget Office's work by describing how business tax credits that support investment in wind and solar electric power affect the agency's baseline projections. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Molly Sherlock wrote the report with guidance from John McClelland, Joseph Rosenberg (formerly of CBO), Molly Saunders-Scott, and Joshua Shakin and with contributions from David Adler and Dorian Carloni. David Austin, Sheila Campbell, Nicholas Chase, Michael Falkenheim, Michael Fialkowski, Ann E. Futrell, Joseph Kile, Aaron Krupkin, Mark Lasky, Donald Marron (a consultant to CBO), Noah Meyerson, Sarah Sajewski, Chad Shirley, and Emma Uebelhor offered comments. Daniel Page fact-checked the report.

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Jeffrey Kling reviewed the report, and Scott Craver edited it. R. L. Rebach created the graphics, illustrated the cover, and, with assistance from Jorge Salazar, prepared the text for publication. The report is available at www.cbo.gov/publication/61188.

CBO continually seeks feedback to make its work as useful as possible. Please send any comments to communications@cbo.gov.

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Director
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