



The Economic and Fiscal Impact of Amazon's Demand for Carbon-Free Energy: Methodology Note





As part of The Climate Pledge, Amazon aims to reach net-zero emissions across its operations by 2040. Amazon is advancing its goal by scaling a diverse portfolio of carbon-free energy (CFE), including wind, solar, battery storage, and nuclear energy, to support its operations and bring new energy to the grids and communities where it operates. These projects support thousands of jobs and generate billions of dollars of investment, gross domestic product (GDP), and tax revenue in local communities.

Amazon partnered with economic advisory firm [Oxford Economics](#) to expand the industry-leading economic model it developed for a prior [renewable energy economic impact study](#). The updated study, developed using data and guidance from the U.S. Department of Energy's National Laboratory of the Rockies ([NLR](#), formerly the National Renewable Energy Laboratory), expands the scope to include solar + battery and nuclear projects; and reports impacts in terms of GDP, average annual jobs, and tax revenue supported at the U.S. national and state levels.



Approach

Amazon's methodology uses industry-leading sources from NLR to estimate the investment generated by the construction and operation of the utility-scale carbon-free energy projects to support its power purchasing agreements (PPAs). This investment by developers is enabled by Amazon's energy purchases through PPAs. The attribution of downstream investment to Amazon's PPA is consistent with the input-output methodology that Amazon uses to estimate the impact of its infrastructure investments. The investment in CFE projects attributable to Amazon's PPAs leads to direct effects (hiring and spending by energy developers) and supports ripple effects (hiring and spending by suppliers and workers) in the economy.

Modelling Inputs and Assumptions

For each project, the below inputs are used to estimate the investment supported by Amazon:

- Project location and energy technology, including solar, solar and battery storage, wind, and nuclear
- Operational start date (actual or expected) of the facility
- Megawatt (MW) capacity of the facility
- Annual megawatt-hour (MWh) of the facility
- Price per MWh of electricity output in the power purchase agreement (PPA), which drives the revenue the electricity generating facility will receive per unit of output

Typical cost assumptions for construction and operating costs by energy technology as well as the construction and expected operating life were sourced from the NLR. The following summarizes the assumptions used in the model:

Solar

Based on NLR data, we assume solar farms cost \$1,432 per kW to build and their construction takes one year. Once built they require \$20 per kW per year in operational expenses to run and maintain, which includes compensation of employees. Solar farms have an average useful lifespan of 30 years.

Solar and battery storage

Based on NLR data, we assume solar farms with battery storage capabilities cost \$2,191 per kW to build and their construction takes one year. Once built, they cost \$59 per kW per year in operational expenses to run and maintain, including compensation of employees. These facilities have an average useful lifespan of 30 years.

Wind

Based on NLR data, we assume wind energy facilities cost \$1,537 per kW to build, and their construction takes three years. Once they are running, they require \$31 per kW per year in operating expenses. They have an average useful lifespan of 25 years.

Nuclear

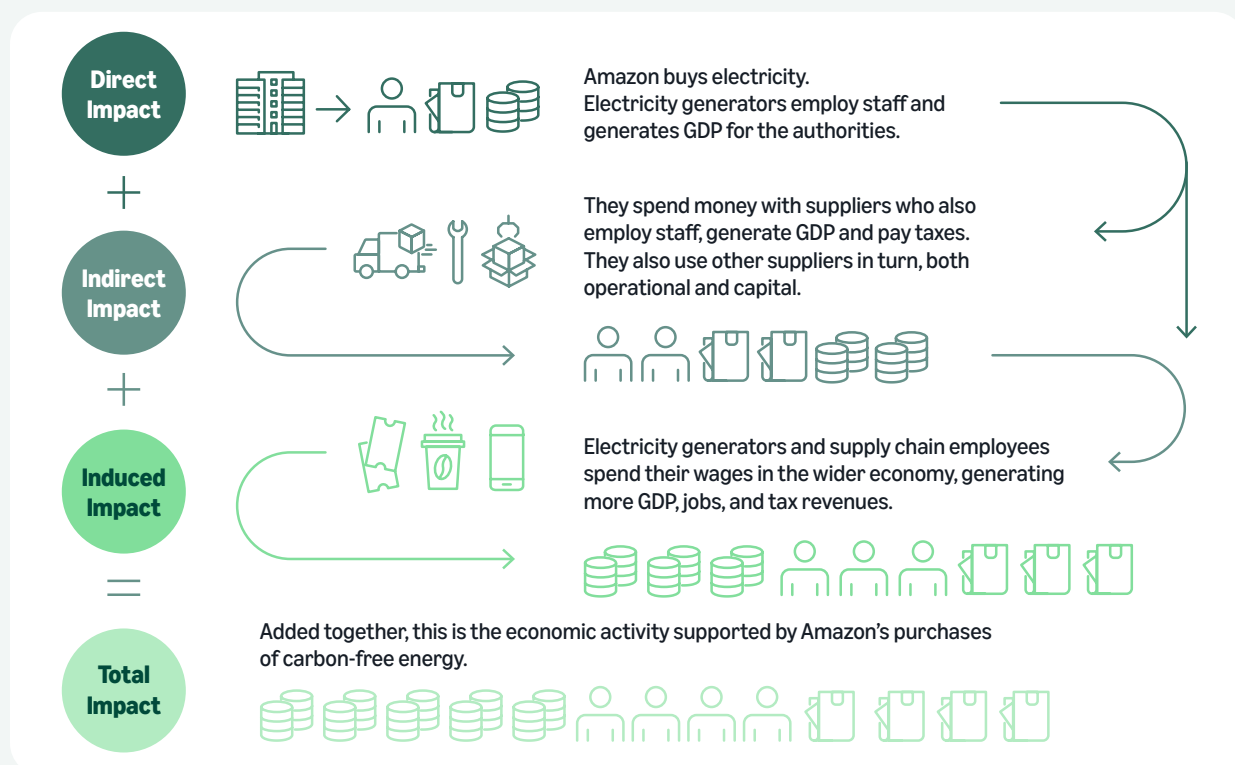
Based on NLR data, we assume nuclear facilities cost \$8,633 per kW to build, and their construction takes five years. When running, they require \$156 in fixed costs per kW per year to operate and maintain, \$2.70 in variable operation and maintenance costs per MWh, and \$10.60 per MWh for fuel costs. They have an average useful lifespan of 40 years.



Channels of Economic Impact

To assess the impact that Amazon supports through its purchases of carbon-free energy we consider expenditure in both the construction and operational phases of the energy facilities and examine the multiplier effects using an input-output framework. Amazon's contribution is estimated across three impact channels – direct, indirect, and induced (see Figure 1).

Figure 1: Economic impact channels of Amazon's demand for carbon-free energy



Source: Oxford Economics

- **Direct impact:** Amazon's PPAs create revenue at developers that generate direct effects on the economy and support employment. To meet Amazon's CFE demand, energy developers hire workers and provide compensation to managers, technical experts, and maintenance staff responsible for operating the projects. The revenue created at firms and compensation provided to these workers directly contribute to the value add in the local economy where the project occurs.
- **Indirect impact:** Developer purchases made to support CFE projects create revenue and support jobs at their direct suppliers and at businesses in the downstream supply chain. During the construction phase of a project, developers purchase construction labor and materials from contractors. These purchases create upstream business-to-business transactions, where the contractor purchases inputs from their own suppliers. These might include engineering services or raw materials required for them to support construction. Similarly, developers make purchases to support the operation of a CFE project, such as spare parts, technical expertise, and professional services, such as accounting and financial services.
- **Induced impact:** Developers, their suppliers, and the other businesses across the CFE supply chain pay compensation to workers. The workers then spend their earnings on consumer goods and services, such as housing, restaurants, entertainment, healthcare, and education. These purchases have a multiplier effect in the local consumer goods supply chain, stimulating further GDP, jobs, and tax contributions.

Estimating the Total Economic Impact of Carbon-Free Energy Projects

The direct, indirect, and induced effects are created by the revenue earned by developers from Amazon's PPAs, and the purchases and compensation paid to support this economic activity. To quantify this impact, the following variables are estimated:

- **Revenue** is calculated as the annual MWh output of a solar, solar and battery, wind, or nuclear plant multiplied by the price per MWh from Amazon's PPAs.
- **Capital expenditure (Capex)** is calculated as NLR's estimate of construction cost per KW multiplied by KW of capacity of the solar, solar and battery, wind, or nuclear facility that was or will be constructed to meet a PPA with Amazon.
- **Operational expenditure (Opex)** is equal to NLR's estimates of fixed Opex per KW multiplied by the KW of capacity of the electricity generating facility plus NLR's estimate of variable Opex per KWh multiplied by KWh of output of the electricity generating facility.
- **Compensation of employees (COE)** is calculated as a share of OPEX inclusive of compensation of employees.

Once total CAPEX and OPEX are determined, total spend vectors are created to split expenditure by sector and by location—within the subject state, in other states, and in 185 other countries and regions. These vectors are then applied to the input-output model.

The impact channels are quantified using the following metrics:

- **Contribution to GDP:** For a business, GDP is the sum of compensation of employees and earnings before interest, taxes, depreciation, and amortization (EBITDA) or alternatively revenue minus the cost of bought-in goods and services used to produce that revenue. For the direct channel this is calculated as revenue minus OPEX exclusive of compensation of employees (COE).
- **Employment:** The number of jobs is measured in headcount terms for comparability with national statistics. For the direct channel this is calculated as total COE divided by average COE per worker for the relevant sector.
- **Tax:** The contribution to government revenue supported by the projects, including corporate tax, taxes on production, taxes on products, taxes on labor, and sales taxes.

For fiscal impact, the ratios used to estimate direct taxes are based on the "Electricity power generation sector", which contains all energy types. Wind and solar plants often get favourable tax treatment, which may not apply to other types of projects (i.e. fossil fuel power station). The model is unable to account for this differential tax treatments in the absence of project-level information about project specific taxes, exemptions, and subsidies. Therefore, we provide a conservative estimate of the fiscal contribution based only on tax revenue supported through supplier activity and household spending while excluding taxes paid directly by CFE developers.



amazon

The Amazon logo, featuring the word "amazon" in a bold, lowercase, sans-serif font. A curved arrow is positioned below the text, starting under the letter 'a' and ending under the letter 'n', pointing to the right.