



*Independent Statistics & Analysis*  
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Administration

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# Climate Considerations in the International Energy Outlook 2021 (IEO2021)

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## Executive Summary

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In developing our *International Energy Outlook* (IEO) Reference case, EIA includes only existing climate law that can be reasonably quantified using our World Energy Projection System (WEPS) and assumes no changes in current law. Our Reference case can serve as a base to assess possible legislated energy sector policies as IEO side cases.

## Background

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EIA's *International Energy Outlook 2021* (IEO2021) presents our analysis of long-term world energy markets across various fuels, technologies, and end-use sectors through 2050. We develop the IEO using WEPS, an integrated economic model, which captures long-term relationships among energy supply, demand, and prices across regional markets. Inputs to WEPS include various assumptions addressing the future uncertainty of technological developments, demographic changes, economic trends, and resource availability, such as oil prices and rates of GDP growth.

Climate laws are an important economic consideration because they play an increasing role in shaping long-term energy consumption and production patterns. Multiple net-zero and fossil-fuel-reduction goals and policies have been announced since IEO2019, published September 24, 2019.<sup>1</sup> These goals and policies are especially prevalent in OECD countries and in the electricity and industrial sectors. These policies have multiple energy market impacts:

- Some laws directly limit fuel consumption or production. For example, a carbon emissions cap means that the total amount of fuel used in a market cannot exceed the amount of emissions produced by that fuel's end use. A vehicle tailpipe emission (fuel consumption) standard would similarly require fuel consumption limits.
- Some laws affect behavior, such as a price penalty (tax) for higher-carbon behaviors or an economic incentive for implementing lower-carbon technologies.

The IEO Reference case includes both policy types—policies that directly or indirectly target energy-related CO<sub>2</sub> emissions—as they relate to energy markets and where modeling allows. If established in law, the energy sector components of a country's Nationally Determined Contributions (NDCs) are included.

Although some policies increase or maintain the integrity of emissions sinks (for example, forestry), the Reference case does not include explicit representation of land use and emissions sinks, nor does it include other energy-related gases such as methane.

As countries enact these policies, our assumptions project an increased prevalence of higher efficiency technologies, decreasing the growth rate of overall energy consumption. In addition, it becomes more

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<sup>1</sup> <https://www.eia.gov/outlooks/archive/ieo19/>

economically favorable to use less carbon intensive sources of energy to meet demand. In summary, active climate policies are meaningful, relevant, and timely inputs to our IEO.

## What is the Reference Case?

The full IEO analysis includes assumptions across several cases: a Reference case and multiple side cases. The Reference case is a modeled projection under various assumptions. The Reference case in each edition of the IEO is not designed to be a prediction of what is most likely to happen. Instead, the Reference case reflects current trends and relationships among technology change, energy supply, demand, and prices projected forward over 30 years. We have summarized the kinds of change that are and are not accounted for in our IEO2021 Reference case in Table 1.

IEO side cases incorporate alternative assumptions about economic drivers, policy changes, or other factors relative to energy markets. The Reference case serves as a baseline (or control group, in scientific terms) that we establish to compare the side cases with to estimate the potential impact of the side cases' varying assumptions.

EIA includes existing climate law in our IEO Reference case. In some regions, the distinction between policy statements and law is not clear. In these cases, our analysts use their best judgement, based on their expertise in those areas. Analyst judgement may incorporate many considerations, including:

- A country's previous history in achieving policy statement requirements
- A country's financial ability to achieve policy statement requirements
- A country's economic incentives related to policy statement requirements
- Existing contracts (for example, liquefied natural gas )
- Regional trade flows

**Table 1. Future changes the IEO2021 Reference case does and does not account for**

Accounts for	Does not account for
Expected regional economic and demographic trends <sup>1</sup>	Possible changes to national boundaries and international agreements
Planned changes to infrastructure, such as new construction and announced retirements	Potential major disruptive geopolitical or economic events
Projected incremental cost and performance improvements in known technologies	Potential future technological breakthroughs
	Possible changes to laws and regulations

<sup>1</sup> Our regional macroeconomic trends use Oxford Economics.

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## How Does WEPS Model Climate Policy in IEO2021?

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WEPS is the series of macroeconomic, consumption, transformation (including electricity and district heat), supply, and emissions models we use to produce the IEO. The WEPS Greenhouse Gases Model calculates energy-related carbon dioxide emissions based on projected fuel combustion.

For IEO2021, WEPS divided the world into 16 regions<sup>2</sup> that were generally determined based on a country's economic size, OECD membership, proximity, and other factors. A region can contain one country or more countries.

Because individual countries set their respective climate policies, in the multi-country regions, the climate policies of individual countries are more challenging to represent. In these cases, the effects of one country's climate policies may be lessened or obscured by the energy consumption trends in other countries in the multi-country region.

The climate policies implemented in WEPS are specific to each module. A list of the modules and their respective treatment of climate-related policies is outlined below.

### Macroeconomic activity

- Economic growth in the IEO is based on Oxford Economics' market assessments, including its assessment of the impact of climate-related policies on macroeconomic trends.
- This module calculates fixed economic impacts to productivity per capita, based on temperature changes calculated from Oxford Economics' emission assumptions (factors developed externally to WEPS).

### Transportation

- Carbon tax policy is reflected in this module by fuel price.
- Other assumptions in this module include:
  - Light-duty electric vehicle sales targets
  - Fuel economy standards for light-duty vehicles
  - Efficiency standards for aircraft
  - Efficiency standards for maritime vessels
  - Efficiency standards for heavy trucks

### Industrial

- Carbon tax policies are represented by fuel price.
- Processes can switch fuels based on relative fuel prices (in other words, a carbon tax policy with carbon prices incorporated into fuel prices).

### Buildings (residential and commercial)

- Building and appliance efficiency standards are implicitly incorporated.
- Demand elasticities are included for each fuel.

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<sup>2</sup> [https://www.eia.gov/outlooks/ieo/pdf/IEO2021\\_ChartLibrary\\_References.pdf](https://www.eia.gov/outlooks/ieo/pdf/IEO2021_ChartLibrary_References.pdf)

- Carbon tax policies are reflected in these modules by fuel price.

## Electricity

- Input assumptions include:
  - A country's carbon taxes and carbon caps
  - A country's electricity sector targets (for example, capacity, generation, and consumption shares originating from renewable energy sources) that are enacted legislation

## District heat

- Carbon tax policies are reflected in this module by fuel price.
- Input assumptions include:
  - Heating fuel targets that are enacted legislation
  - Combined-heat-and-power targets

## Biofuels

- Biofuel estimates generally reflect a country's carbon-reduction policies.
- Biofuels include biomass-based diesel and ethanol.

## Coal

- This module's capabilities include:
  - Coal supply that is responsive to coal demand requirements, which reflect policies in the industrial, electricity, and buildings modules as appropriate
  - The adjusted cost of coal production based on new taxes or restrictions on coal mining output that might be imposed on a country or region

## What Uncertainties and Future Work Remain?

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We have several possible pathways for future development in subsequent *International Energy Outlooks*. We are currently monitoring and actively improving our understanding of:

- How to reconcile a country's policy goals with inconsistent past performance
- How to model and incorporate emerging technologies (for example, hydrogen)
- How to model new policies and new policy mechanisms that aren't easily incorporated in the WEPS framework

Future international energy developments are subject to significant uncertainties outside of the energy realm. Political developments (for example, elections and political initiatives) can significantly influence new policy mechanisms, and as a result, adopting or developing new technology. In addition, energy security and other noneconomic considerations can play significant roles in global energy projections.