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The role of fossil fuels in taxonomies: Canada case study

Whitepaper

Climate Bonds INITIATIVE

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Executive summary

It has been over a year since Climate Bonds Initiative (Climate Bonds), with funding from CSA Group, completed a landscape report and the Government of Canada's Sustainable Finance Action Council (SFAC) published its Taxonomy Roadmap Report: Mobilizing Finance for Sustainable Growth by Defining Green and Transition Investments. This paper is intended to inform the debate on the inclusion of fossil fuel-related activities in a future Canadian taxonomy, and whether they should be classified as green, transitional, or not permitted.

Purely green taxonomies, which constitute the majority globally, do not include activities related to extraction, utilization and transportation of fossil fuels. Mixed taxonomies that include both green and transitional components generally include fossil gas power generation, but with significant limits on both the level of emissions and the time when the activity is considered compatible with the taxonomy. Only one of the taxonomies, however, allows for new fossil gas-fired generation capacity beyond 2030–2035 (Thailand states 2040). Criteria and thresholds for such activities are expected to tighten as 2050 approaches.

Science-based transitional taxonomies (with a specific transition label for compliant activities) are still few: the first one was the Thailand Taxonomy, adopted in May 2023. The Singapore-Asia Taxonomy will share a similar format when adopted. Both of these taxonomies use a traffic light classification to differentiate an activity's contribution to transition: green, amber (transit) and red. Transitional activities, therefore, must follow a predetermined path leading to gradual improvement of their emissions profile in line with the Paris Agreement goals. Transitional taxonomies do not include activities related to new extraction or coal-based and oil-based generation. Although they do allow a more flexible approach when it comes to generation from fossil gas, this has very strict limitations and a clear gas phase-out date.

The inclusion of electricity generation from fossil gas in the EU Taxonomy was the result of lobbying, not scientific research. Nevertheless, the criteria for recognizing gas generation are currently so difficult to comply with that launching such a project, compatible with the provisions of the taxonomy, is meaningless from a technological and economic point of view. Existing alternatives in renewable energy are much cheaper and more efficient in almost all parts of the EU.

Canada's key trading partners, the United States (US), China and Germany, consider a dramatic reduction in hydrocarbon consumption either as one of the main direct goals of their policies, or as a natural result of achieving other goals (for example, decarbonization). Although none of the countries considers any hydrocarbons green, all three countries use fossil gas as a temporary support for the growing renewable energy industry and as a substitute for other, dirtier energy sources. However, adopted plans, programs and incentives are designed to lead to a decline in consumption of all major hydrocarbons in the medium term.

None of the three countries considers limiting climate change as the main imperative of their policy but instead, all three try to fulfill their commitments in the field of decarbonization. This is achieved through the creation of new opportunities and providing subsidies and financing incentive programs rather than through bans on the development of new hydrocarbon capacity. Even so, the European example of creating restrictive legislation (such as the emissions trading system and carbon border tax) will inevitably lead other countries to adopt similar measures and so transform the market. Comparable legislation adopted by the US as part of the Inflation Reduction Act (IRA) is aimed at curbing methane emissions, which could also prompt additional requirements from exporters to the US and level the playing field.

Recent scientific studies indicate significant fugitive emissions accompanying the extraction, transportation and use of fossil gas. Fugitive emissions of just 3% across the whole supply chain make fossil gas just as impactful on the climate as coal. Acknowledging this problem, the US and the EU are already implementing policies aimed at reducing fugitive leaks. Additionally, international taxonomies recognize the importance of this issue through the requirement to evaluate emissions from the use of fossil gas on a lifecycle basis rather than on a scopes 1 and 2 basis.

Introduction

It is no longer a question of whether countries need a strategy to decarbonize their economies, but how to do it faster, more efficiently and with the least damage to their economies. A taxonomy is a classification system that helps market participants distinguish projects that are aligned with the goal of achieving net zero by 2050 and allows governments to integrate ambitious climate policies into first-order public priorities. According to Climate Bonds, as of 2023, more than 40 countries and regions have a taxonomy or are in the process of developing one. The most recently published taxonomies for Thailand, Mexico and ASEAN demonstrate that there are different, but converging, pathways to this goal.

In May 2021, the Sustainable Finance Action Council (SFAC) was mandated to provide advice and recommendations to Canada's Deputy Prime Minister and Minister of Finance, and the Minister of Environment and Climate Change on developing a green and transition investment taxonomy. In September 2022, SFAC released the Taxonomy Roadmap Report: Mobilizing Finance for Sustainable Growth by Defining Green and Transition Investments.[1] The report provided a recommendation on whether a green and transition finance taxonomy would be an appropriate tool for the Canadian context. It also provided guidance on the optimal taxonomy design for Canada, including the key elements for success, the governance model, and the framework for the taxonomy.[2]

This document provides guidance on how to structure the future taxonomy to make it consistent with global best practices, and define its principles and objectives. The authors estimate that the country needs CAD115bn per year to implement the decarbonization policy, and a taxonomy is a proven means of attracting private capital to this task, including foreign direct investment. This also requires definitions in the future Canadian Taxonomy to be compatible with internationally recognized definitions and criteria for classifying various activities as green, transitional and sustainable.

While the debate over the future content of the Canadian Taxonomy continues in the press, the main stumbling block remains the inclusion of fossil fuels, particularly fossil gas where Canada is the world's fifth-largest producer. The controversy centers on whether fossil gas should contribute to a decarbonization pathway as an interim or a transitional fuel, or be phased out completely.

Canada's Taxonomy Roadmap Report suggested the creation of a green and transition taxonomy with two different labels for green and transition activities and financial instruments.[3] It would cover:

- Green activities. Projects expected to grow substantially during the transition include those with low- or zero-scope 1 and 2 emissions; low or zero downstream scope 3 emissions; and those that produce goods or services that are expected to see significant demand growth in the global low-carbon transition (green hydrogen production, zero-emissions vehicle manufacturing, electricity transmission infrastructure, etc.,).
- Transition activities include:
    - Activities that have high scope 1 and 2 emissions but low scope 3 emissions and have no technically viable net-zero alternative after 2050 (examples would be a steel production facility that installs an electric arc furnace or constructing a new blue hydrogen facility with a high emissions capture rate). These activities are expected to remain stable or grow in the transition.
    - Activities with high scope 3 downstream emissions that have viable alternatives after 2050, such as those associated with energy generation from oil and gas. Eligible activities in this category must have a well-defined lifespan that is approximately proportionate to the expected decline in global demand in representative 1.5 °C pathways. They must also lead to significant emissions reductions from existing assets, for example, installing world-leading methane capture on existing natural gas production (with a short to moderate lifespan); or installing carbon capture, utilization, and storage (CCUS) on an existing oil sands facility (with a short to moderate lifespan). These activities are expected to play a role but must be phased out completely and be replaced by green activities.
- Ineligible activities that:
    - are related to solid fossil fuels;

- create carbon lock-in and path dependency;
- are at a high risk of becoming stranded in net-zero pathways due to high scope 3 emissions and declining global demand;
- have scope 1 and emissions that are inconsistent with net-zero pathways;
- are unable to scale in transition.

The debate around transition proves the most complicated part of a future Canadian taxonomy, which needs to balance the presence of a vast oil and gas sector with the science-based and credible policies required to attract investors to finance the Canadian transition. This report informs the discussion from the perspective of Canada's three key economic partners, based on climate science, providing an overview of the status of fossil fuels in global taxonomies with an emphasis on the transition component of fossil gas.

Fossil fuels in world taxonomies

Taxonomies have gained the status of an effective tool for the implementation of government policy because they provide a system for classifying activities into different categories related to their place in the transition to net zero by 2050. For this reason, most of Canada's main trading partners (with the important exception of the US) have, to varying degrees, engaged in the development of one. Crucially, a taxonomy is simultaneously both rear- and forward-facing by indicating where new investments must be attracted to change existing sectors and activities, in accordance with climate objectives. Acting as an investment beacon, the taxonomy helps to avoid locking in outdated technologies that are incompatible with climate goals; especially important in the energy sector which is responsible for three-quarters of global greenhouse gas emissions.

The inclusion of fossil fuel activities in the taxonomy is controversial, given that fossil fuels still power about 80% of the world's energy requirements despite recent successes in the development of renewable energy sources. None of the taxonomies listed below allows the creation of new oil and coal generation capacities, but some do see fossil gas as a transitional fuel. This allows their use for a short period of time to support renewable energy sources and facilitate the transition away from coal and petroleum products. Nevertheless, in all cases, there is a time limit on the period for which fossil gas can be used, in line with the country's decarbonization pathway, after which its use is no longer compatible with climate policy.

A review of the taxonomies of 12 countries or trading blocs with different economic structures was conducted for the purpose of this research. China, the EU, Mexico, and South Korea are among the top ten Canadian trading partners.[4] Others such as Russia and Kazakhstan have a strong reliance on hydrocarbons. Table 1 below reviews three main sources of fossil energy (coal, oil and gas) and four categories of activities:

1. Extraction of fossil fuels.
2. Processing or transportation of fossil fuels, including construction of natural gas or oil pipelines.
3. Creation of new capacities involved in the generation of electricity, heating and cooling from fossil fuels.
4. Retrofitting of existing facilities, including fossil fuels infrastructure and power plants, to reduce emissions.

A glossary of taxonomy terms used in Table 1 is provided below.

Green taxonomy	A classification framework that focuses only on activities that are clearly compatible with the net-zero goal (e.g., solar power generation, use of electric vehicles). Usually, such taxonomies include only climate change mitigation and climate change adaptation activities. In Table 1, if the taxonomy lists other environmental objectives but includes only mitigation and adaptation activities, it is still considered green.
Sustainable taxonomy	A taxonomy that addresses a wider range of activities than green taxonomies. Typically, these are activities related to achieving sustainable development, environmental and social well-being goals.
Transitional activities	Activities for which there are no technological solutions for rapid decarbonization, but which can either be decarbonized gradually or are recognized as necessary for a certain limited period. It is important to note that activities in this category should have either a credible and science-based decarbonization pathway by 2050 or a clear timeframe after which they should be fully phased-out of the economy. For further explanation see the Climate Bonds white paper, Financing Credible Transitions.[5]
Transitional taxonomy	A taxonomy that clearly separates the category of transitional activities (e.g., through a traffic light system) from the category of green activities, which allows them to be given a separate label.

Green/sustainable taxonomy with transitional activities	A taxonomy that includes transitional activities but does not separate them into a distinct category or give them a specific label.
Taxonomy eligibility	Whether the activity is present in a taxonomy at all.
Taxonomy compliance	Whether the activity complies with the principles and intentions of a taxonomy.

Table 1. Fossil fuels in world taxonomies

Table color coding			
Ineligible and non-compliant	Eligible with additional criteria (impossible or very hard to meet)	Eligible with additional criteria (easy to meet)	Eligible and compliant with minimal or no criteria

	Oil		**Gas**		**Coal**	
EU Taxonomy (a sustainable finance taxonomy with transition activities, but a single compliance label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
Climate Bonds Taxonomy (a green taxonomy with transition activities, but a single compliance label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✓
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
Chinese Green Bonds Project Catalogue 2021 (a white list of eligible activities and technologies with a single label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✓	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
Colombian Green Taxonomy	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗

(a green taxonomy with a single label)	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
Russian Taxonomy (a green taxonomy with a single label plus a catalogue of energy efficiency measures)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✓	Retrofitting	✗
ASEAN Taxonomy (a tick or cross applies to all three tiers); (three-tier green and transition taxonomy with a single label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✓ (Tier-2 Amber)
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
South African Taxonomy (a green taxonomy with transition activities and a single label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing	✗	Processing	✗	Processing	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
Kazakhstan Taxonomy (a sustainable taxonomy with energy efficiency activities and a single label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗
	Retrofitting	✓	Retrofitting	✓	Retrofitting	✓
Thailand Taxonomy (a green and transition taxonomy with two separate labels)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗

	Retrofitting	✗	Retrofitting	✓	Retrofitting	✗
Mexican Taxonomy (a green taxonomy with a single label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
South Korean Taxonomy (a sustainable finance taxonomy with transition activities but a single compliance label)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✗	Retrofitting	✗
Singapore-Asia Taxonomy (draft) (a green and transition taxonomy with two separate labels)	Extraction	✗	Extraction	✗	Extraction	✗
	Processing/ transportation	✗	Processing/ transportation	✗	Processing/ transportation	✗
	Electricity/heating/ cooling generation	✗	Electricity/heating/ cooling generation	✓	Electricity/heating/ cooling generation	✗
	Retrofitting	✗	Retrofitting	✓	Retrofitting	✗

EU Taxonomy

The EU taxonomy is officially labelled the sustainable finance taxonomy but despite its six environmental objectives, the focus is on climate change mitigation and adaptation. The taxonomy includes several activities labelled as transitional (e.g., aluminium, cement, and steel production with specific emissions limits per unit of production) but does not differentiate these activities in any way. They do not receive a separate label and are simply designated as compliant with the objectives of the document. Therefore, the expectation is that the per unit emission thresholds for such activities will be revised downwards as 2050 approaches.

Published in June 2020, the first version of the EU Taxonomy did not include fossil gas-related activities. However, a year after it entered into force, a Complementary Climate Delegated Act that included two fossil gas-related activities (4.29. Electricity generation from fossil gaseous fuels and 4.30. High-efficiency co-generation of heat/cool and power from fossil gaseous fuels) was adopted.[6] The activities were included under a transitional category of the Taxonomy Regulation to 'allow us to accelerate the shift from more polluting activities, such as coal generation, towards a climate-neutral future, mostly based on renewable energy sources.'[7]

The inclusion of fossil gas-related activities in the taxonomy was the result of an intense lobbying campaign by representatives of the oil and gas industry and was at odds with the scientific approach taken in the rest of the taxonomy .[8] A significant number of international investors opposed the move, emphasizing that the inclusion of gas would undermine the credibility of the taxonomy as well as the EU's own commitment to climate neutrality by 2050.[9]

However, the criteria for the two abovementioned activities are so specific and limiting in nature, that it is unlikely that any green financial products will align with the requirements.

EU new gas facilities criteria (electricity generation from fossil gaseous fuels)

1. To be aligned, construction or operation of gas-powered facilities must comply with the following criteria:

- EITHER the life cycle GHG emissions from the generation of electricity using fossil gaseous fuels are lower than 100 g CO_2e/kWh (carbon capture, utilization, and storage (CCUS) may apply)
- OR facilities for which the construction permit is granted by 31 December 2030 comply with **all of the following**:
    - direct GHG emissions of the activity are lower than 270g CO_2e/kWh of the output energy, OR annual direct GHG emissions of the activity do not exceed an average of 550gCO_2e/kWh of the facility's capacity over 20 years (CCUS may apply);
    - the power to be replaced cannot be generated from renewable energy sources, based on a comparative assessment with the most cost-effective and technically feasible renewable alternative for the same capacity identified, the result of which is published and is subject to a stakeholder consultation;
    - the activity replaces an existing high-emitting electricity generation activity that uses solid or liquid fossil fuels (oil or gas);
    - the newly installed production capacity does not exceed the capacity of the replaced facility by more than 15%;
    - the facility is designed and constructed to use renewable and/or low-carbon gaseous fuels and the switch to full use of renewable and/or low-carbon gaseous fuels takes place by 31 December 2035, with a commitment and verifiable plan approved by the management body of the undertaking;
    - the replacement leads to a reduction in emissions of at least 55% GHG over the lifetime of the newly installed production capacity;
    - where the activity takes place on the territory of a Member State in which coal is used for energy generation, that Member State has committed to phase-out the use of energy generation from coal and has reported this in its integrated national energy and climate plan.

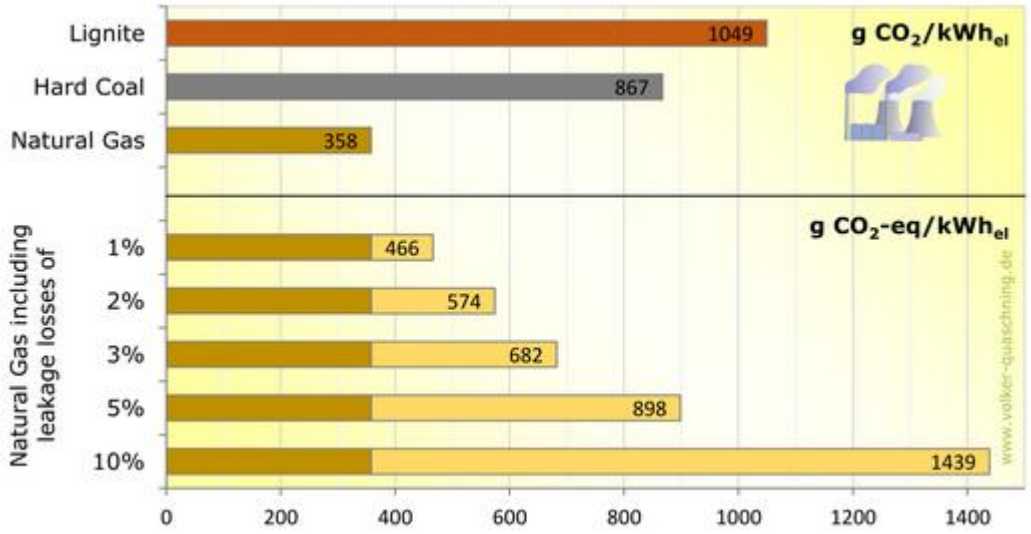
2. The activity meets either of the following criteria:

- At construction, measurement equipment for monitoring of physical emissions, such as those from methane leakage, is installed or a leak detection and repair programme is introduced;
- At operation, physical measurements of emissions are reported and leaks eliminated.

3. Where the activity blends fossil gaseous fuels with gaseous or liquid biofuels, the agricultural biomass used to produce the biofuels complies with the specific criteria from the EU Taxonomy.

The threshold of 100 gCO_2/kWh lifecycle emissions as well as the threshold of 270 gCO_2e/kWh of direct (scope 1) emissions are currently unachievable by gas-powered plants unless fitted with additional CCS/CCUS installations. Current best-in-class combined-cycle gas turbines (CCGT) have direct emissions of approximately 320-350g CO_2/KWh (see Figure 1 below), to achieve lower emissions than currently possible through further efficiency gains that could only be achieved though H_2 blending or with CCS. Real world emissions can be much higher.

Figure 1. Direct CO_2e emission of different types of fuel in relation to their primary energy content



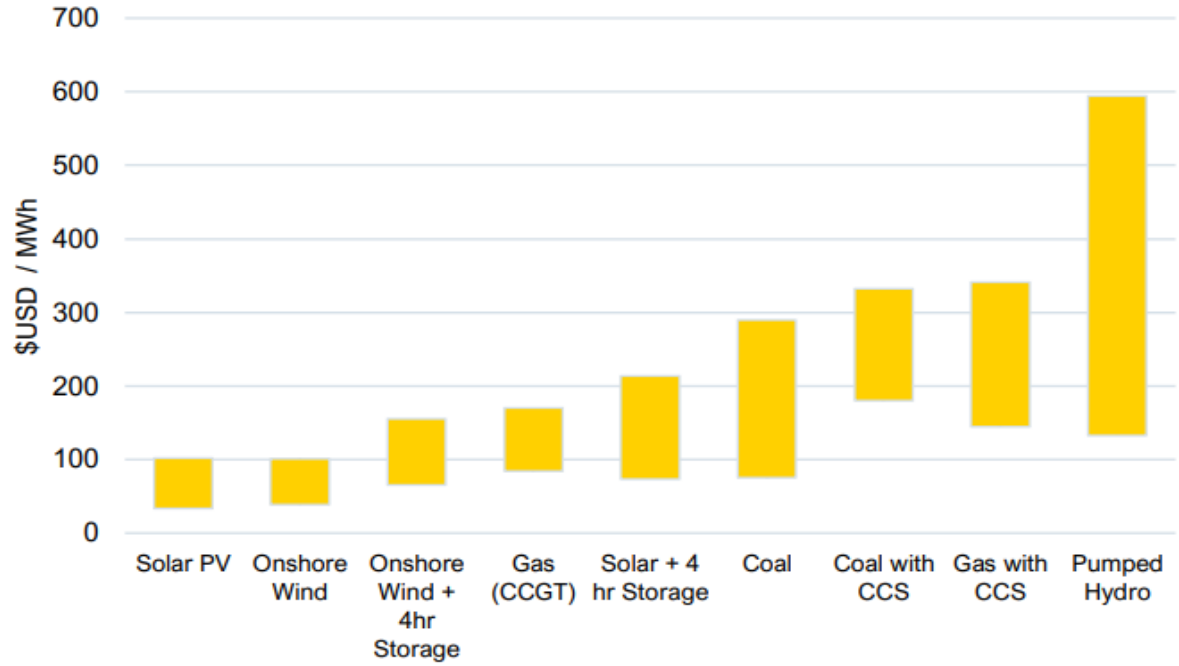
Source: Volker Quaschning

Detailed 2022 data on emissions intensity of different types of fossil fuels, calculated by the German Federal Agency for Environmental Protection, clearly shows that direct CO_2 emissions from natural gas in relation to the primary energy content of around 358g CO_2e/kWh.[10] Average efficiency of modern fossil gas power plants (based on German data) varies between 39% (turbine) and 59% (CCGT).[11] Consequently, real emissions intensity of these types of installations fluctuates between 512 and 340 gCO_2/kWh of direct emissions respectively.[12] The United Nations Economic Convention for Europe gives similar numbers: 434 gCO_2e/kWh on average of direct emissions for unabated gas power plants (CCGT) and 128 gCO_2e/kWh for natural gas plants (CCGT) with CCS. [13]

It is important to note that the first entry within the EU Taxonomy fossil gas criteria limits emissions not only to 100g CO_2e/kWh but also on a lifecycle (LCA) basis, which requires taking account of the emissions during fossil gas extraction, transportation, storage, and utilization. The fugitive methane emissions that always accompany upstream and midstream gas operations (covered in detail under the US chapter) make it exceptionally difficult for any project to achieve this level. Figure 1 above demonstrates emissions with standard leakage factors applied.

This makes it challenging for any company to comply with the EU Taxonomy gas generation criteria without deploying the most up to date CCS installations. Although CCS and CCUS technologies can move emissions profiles of power plants closer to the targeted numbers, the price of electricity for consumers becomes economically questionable. Research conducted by the Institute for Energy Economics and Financial Analysis estimates the levelized cost of energy for gas with CCS power plants to be significantly higher than that of ordinary gas power plants and almost two times above current alternatives such as renewable energy plus storage.[14]

Figure 2. Levelized cost of energy per energy source



Source: Institute for Energy Economics and Financial Analysis

Finally, the alternative average annual direct emissions threshold of 550kg CO_2e/kW of capacity over 20 years initially appears feasible but it still creates investment risk. Compliance with the threshold requires a justified projection of future emissions that together add up to 550gCO_2e/kWh on average over the 20-year horizon, which may not be demonstrable. Even if it were (many financial professionals question its feasibility) the owner of the activity is also required to prove compliance with the eight other additional requirements.[15] As a consequence, these obligations make the project so expensive and cumbersome (no existing gas-powered plant meeting the requirements was identified at the time of writing) that the taxonomy can hardly be called gas friendly.

Climate Bonds Taxonomy

Since the Climate Bonds Initiative (Climate Bonds) published its first green taxonomy in 2013, it has become one of the most cited international taxonomies. Each set of criteria and thresholds is a product of a 15-stage process involving hundreds of technical experts from all over the world.[16]

The Climate Bonds Taxonomy is, in most circumstances, technologically agnostic, meaning that alignment of activities is subject to compliance with specific criteria and their related thresholds. While there are some exceptions, generally it does not label any technology directly as being harmful, but rather relies on limiting its application by designating specific science-based thresholds.

The Climate Bonds Taxonomy effectively excludes any use of fossil fuels. Coal and oil extraction are ineligible as activities, while generation using coal and oil power is eligible, but only with 100% of capture of emitted CO_2 with CCS. This rate is currently unachievable: existing CCS installations have an effective capture rate of 50-68%, with some installations achieving 90%, but never 100%.[17,18] Gas generation criteria have not been developed and included in the taxonomy yet, so at this point gas generation is ineligible.

China Green Bond Endorsed Project Catalogue

The China Green Bond Endorsed Project Catalogue (referred to as the China Taxonomy hereafter) differs from most existing taxonomies in that it is a list of aligned technologies rather than a list of eligible activities with criteria and thresholds.[19] It was developed with manufacturing rather than financial operations in mind and is used mostly by industrial companies. The taxonomy was first published in 2015 with major updates in 2021 which led to

tightening of the criteria for fossil fuels. Clean coal, and standalone liquefied and ordinary natural gas generation were completely excluded from eligible types of projects. Now, standalone generation of energy from any fossil fuels is completely excluded from the taxonomy. However, some fossil fuels-related articles remain, albeit minor in scope.

The taxonomy considers the following fossil fuels-related activities as eligible:

- Manufacturing of gas turbines (3.2.1.6),
- Use of hydrogen-natural gas mixture as fuel (3.2.2.8),
- Use of gas generation as part of multi-energy complementary projects (3.2.3.1 i.e., projects combining several sources of energy to achieve maximum efficiency and avoid waste,
- Construction and operation of natural gas transmission, storage, and peak load regulation facilities (3.2.3.3),
- Construction of gas-powered distributed energy resource installations (3.2.3.4, small-scale i.e., less than 10 MW- installations necessary in remote areas),
- Replacement of coal-powered municipal generation with gas-powered generation in urban centralized heating facilities (5.1.1.1).

In other words, the Chinese taxonomy permits the building of infrastructure that serves and supports fossil gas generation, building small gas generators in hard-to-reach areas, combining renewable energy sources with gas, and replacing coal generation with gas. This corresponds with China's general decarbonization policy, where gas is treated as a temporary replacement for oil and coal because it is considered a cleaner fuel. This is covered in more detail in the China chapter below.

ASEAN Taxonomy

The ASEAN Taxonomy is still in its development phase but the last update published at the beginning of March 2023 contained the first set of criteria and thresholds for compliance checks.[20] It is a complicated multi-layered document that defines three tiers of criteria with different stringency. Tier 1 is classified green and intended for use by the most developed countries. Therefore, it is generally compatible with other international taxonomies and climate science, stipulating 100 gCO_2/kWh as an internationally aligned threshold for energy generation.

Tiers 2 and 3 are classified as amber but have significantly weaker thresholds than tier 1 and are intended for use by less developed countries. This lack of rigour means they cannot align with 1.5^0C pathways and are directional in nature. The ASEAN Taxonomy has also been criticized for allowing electricity generation from fossil gas with an emissions threshold of up to 510 gCO_2/kWh (see Figure 3 below). However, the taxonomy does explicitly differentiate tier 1 from tiers 2 and 3, acknowledging that generation with emissions above the 100g gCO^2/kWh threshold is not compatible with the Paris Agreement. It also allows generation of electricity from hybrid fossil and renewable fuels as well as generation of heating and cooling with the same total threshold as would be achievable with electricity generation from fossil gas.

Although the ASEAN Taxonomy can be viewed as having an element of transition for all activities, it is not implemented in the same way as most other transitional taxonomies. Each ASEAN country chooses a baseline tier that corresponds to its level of economic and technological development. Although tiers 2 and 3 have significantly less stringent thresholds (i.e., up to 510 gCO_2e/kWh for electricity generation, which corresponds to the level of obsolete low-efficiency gas capacities), the expectation is that countries will migrate to higher tiers, as their economies develop, to be compatible with international standards.

This means that the taxonomy does not meet the strict criteria for transitional activities because it does not require a gradual movement towards decarbonization by a predefined date (Paris Agreement or NDC-based). Given that the choice of tier and ambition to transition are political decisions, the country may remain locked at a lower tier until 2050. Although paragraph 4.2.6 states that tiers 2 and 3 will discontinued in the future, it does not provide a timeframe or binding phase-out to align with the goals of the Paris Agreement.

Figure 3. ASEAN Taxonomy Energy Criteria abstract

3.1 351[011] Electricity Generation from fossil gas

- Includes:
  - Power generation as part of cogeneration
- Excludes:
  - Unabated power generation from coal or fuels derived from coal.
  - Co-firing of fossil fuels with fuels derived from renewable sources (refer to 351[012] and 351[014])

Tiers	EO1: Climate Change Mitigation TSC
Tier 1 (Green)	Lifecycle GHG emissions from the generation of electricity by the entire facility <100 gCO2e/kWh
Tier 2 (Amber T2)	Lifecycle GHG emissions from the generation of electricity by the entire facility: >100 and <425 gCO2e/kWh
Tier 3 (Amber T3)	Lifecycle GHG emissions from the generation of electricity by the entire facility: >425 and <510 gCO2e/kWh
TSC applicable to all Tiers	1. For facilities that are equipped with CCUS, CO2 from power generation that is captured for underground storage, must be transported and stored in accordance with the TSC for Activities 000[010] and 000[020]. 2. The Activity meets either of the following criteria: a. at construction, measurement equipment for monitoring of physical emissions, such as methane leakage is installed, or a leak detection and repair program is introduced; OR b. at operation, physical measurement of methane emissions is reported, and leak is eliminated.

Source: Asean.org

Russian Taxonomy

The Russian Green Taxonomy is generally compatible with scientific principles and follows the example of the EU in most of its thresholds .[22] However, in the case of gas generation, the activity must be compliant with the threshold of 100g CO_2e/kWH of direct (scope 1) rather than LCA (scopes 1, 2 and 3) emissions. Given the ubiquity of methane leakages in Russia, this caveat seriously undermines the profile of installations that can be certified as green.[23]

Russia has also developed a Transitional Taxonomy document, which consists mainly of energy efficiency measures rather than alignment with a 1.5^0C pathway. Therefore, it includes operations with all types of fossil fuel and generally requires a very modest improvement of installations for compliance. Analysis of this document is not included in the present paper because it does not qualify as a taxonomy, which aligns to net zero by 2050 or related time-bound goals).

Kazakhstan Taxonomy

No new energy generation from fossil fuels is eligible under the Kazakhstan Taxonomy. However, a loophole exists: articles 2.1.2., 2.1.3, and 2.1.4 allow introduction of energy efficiency measures on all existing power and heating plants with a threshold of 20% efficiency improvement required. The overwhelming majority of power and heat plants in the country are working on fossil fuels, and these articles allow the owners of the projects to align with the taxonomy by improving their efficiency.

Thailand Taxonomy

The Thailand Taxonomy was the first in the world where the principle of a science-based transition was fully applied.[24] The criteria in the taxonomy use the traffic light classification system: green indicates activities that are currently fully compatible with net zero by 2050; amber indicates transit activities that should either gradually

reach to net zero by 2050, or be phased out at some point in the future before 2050 (in the latter case, the emission intensity per unit of output should also be constantly reduced on the path to the phase-out date).

Red corresponds to activities that are under no circumstances compatible with the goals of the taxonomy: new and existing generation from oil and coal with any level of emissions, and new gas generation. Within the green category, conversion of gas capacities to hydrogen is permissible, and within the amber category, conversion of gas plants to reduce their emissions is in accordance with a pre-calculated trajectory leading to 0gCO_2e/kWh by 2050 (see Figure 4 below). The construction of gas distribution infrastructure is also prohibited but within the framework of the green category, its conversion into infrastructure for the transportation of hydrogen is allowed. The taxonomy establishes a deadline of 2040 as the cut-off for any gas generation activity to be eligible.

Figure 4. Thailand Taxonomy energy sector thresholds, gCO2e/kWh

	2022-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050
Green Activities	100	100	100	100	50	
Amber Activities	381	225	191	148	N\A	N\A
Red Activities	>381g	>225g	>191g	>148g	>50g	>50g

Source: Thailand Taxonomy Board

South Korean Taxonomy

Energy production based on liquefied natural gas and mixed gas (i.e., the gas that is a mixture of two or more gas types including hydrogen, ammonia, and by-products of gas and liquefied natural gas) as well as liquefied natural gas-based hydrogen (blue hydrogen) production are eligible in the South Korean Taxonomy under the transition sector.[25] The sunset date, after which fossil gas generation can no longer be considered eligible, is currently defined as 2030. However, as in the EU Taxonomy, no separate label is provided for the transitional activity.

Singapore-Asia Taxonomy

As of August 2023, the Singapore-Asia Taxonomy is still in draft form but as it is almost complete, the criteria for power generation are unlikely to change. Like the Thailand Taxonomy, the Singaporean one is built upon a traffic light system with green, amber, and red activities. It does not allow for the construction of new purely fossil gas-powered generation facilities but provides a wide range of amber options for retrofitting of existing facilities:

- Retrofit of existing power plants to allow ≥50vol% hydrogen or its derivatives,
- Retrofit of existing plants with CCS that is designed at the outset to allow the facility to meet the green criteria by 2035 at the latest,
- Retrofit of existing transmission and distribution networks that allow ≥50vol% low-carbon gases,
- Retrofit of existing storage systems that allow ≥50vol% low-carbon gases,
- Other investments directly supporting or facilitating H_2 uptake in the plant are eligible if the measures result in ≥50vol% hydrogen or its derivatives (e.g. purchase, operation, and maintenance measures).

In addition, the taxonomy permits the construction of new fossil gas power plants with the following limitations:

- New power plants (e.g. CCGTs or fuel cells) that can allow ≥50vol% hydrogen or its derivatives (e.g. ammonia), or,

- New power plants that capture at least 50% of emissions and are designed to meet green criteria by 2035 at the latest, or,
- New transmission and distribution networks that allow ≥50vol% low carbon gases, or,
- New storage systems that allow ≥50vol% low carbon gases.

Additionally, both retrofitting and construction of new power plants must meet the following criteria:

- The power cannot be generated from renewable energy sources, based on a comparative assessment with the most cost-effective and technically feasible renewable alternative for the same capacity identified; the result of which is published and subject to a stakeholder consultation.

Summary

The main global taxonomies are unambiguous about the incompatibility of meeting the goals of the Paris Agreement with the development and use of hydrocarbons, especially the construction of new fossil fuel plants. The only issue on which there is disagreement is the use of fossil gas, which in some cases is seen as an intermediate/transitional fuel that can be used to replace other fuels with worse emissions characteristics.

Purely green taxonomies, which constitute the majority globally, generally do not include hydrocarbon-related activities. Mixed taxonomies that include both green and transitional components generally include fossil gas power generation, but with significant limits on the level of emissions and a cut-off date for when the activity is no longer considered compatible with the taxonomy. All of the taxonomies, however, ban new fossil gas-fired generation capacity beyond 2030-2035 (2040 for Thailand). None of the science-based taxonomies, whether green or transitional, include new fossil fuels exploration projects.

Fossil fuels in national policies

Even though national and international taxonomies are generally built on scientific principles and correspond to the goals of the Paris Agreement, they are only one component of a national decarbonization policy. These policies consider not only international treaties, but also domestic politics and economics, the views of various interest groups, and issues of energy security and social stability. This accounts for why none of the taxonomies described in the previous chapter have abandoned the use of hydrocarbons, including the construction of new power-generation capacity.

To date, Canada's largest trading partners, the US, EU, and China, have not banned the construction of new fossil fuel facilities directly, but opted to stimulate the development of new technologies and replacement of outdated technologies with green ones. Nevertheless, all three regions have different grounds for selecting their decarbonization policies. EU countries prioritize reducing emissions and meeting climate commitments while the US is upgrading its infrastructure as a new driver for economic growth. China is prioritizing its own energy security and taking the lead in new market niches. Even so, hydrocarbons will play a diminished role in the future economy of all three regions.

United States

The US is Canada's main trading partner (77% of trade) with hydrocarbons and their derivatives as Canada's major export class (35.6% in 2022).[26,27] Therefore, US long-term carbon and climate change policies are of key importance to Canada's economy. Although Washington does not have a plan to introduce carbon tax mechanisms comparable to those in the EU, the Biden administration has dramatically stepped-up climate policy and also adopted several ambitious goals that will inevitably affect the country's trade.

Does the US consider fossil fuels as green or sustainable?

The **US Environmental Protection Agency** clearly states that 'green power is defined as electricity produced from solar, wind, geothermal, biogas, eligible biomass, and low-impact small hydroelectric sources.'[28] All three fossil fuels (oil, gas, and coal) are defined as 'conventional power' and are clearly excluded from both the list of green and the list of renewable sources of energy.

The Ministry of Energy recognizes natural gas as 'relatively clean burning fossil fuel' but at the same time, clearly excludes it from the list of climate-friendly fuels underlining two facts:

- Natural gas is mainly methane—a strong greenhouse gas,
- Natural gas exploration, drilling, and production affects the environment.[29]

However, this view is not universally held among US politicians and officials, although the attempts to recognize fossil fuels as green are rarely met with support. At the beginning of 2023, Ohio legislators adopted a bill with a last-minute addition, labelling natural gas a green energy.[30] The fact that Governor Mike DeWine signed the bill into law despite its dubious nature and the circumstances of its creation (the fossil gas provision was added into a bill originally focused on poultry sales, late at night on the second-to-last lawmaking day of the year) led to public outrage and several lawsuits .[31,32] According to the local media, the law was financed by a gas industry-sponsored non-profit and was not based on any scientific analysis.[33] To date, no other state has decided to follow in the steps of Ohio

Some of the administration's first actions after taking office in January 2021 were to bring the country back into the Paris Agreement and establish a Climate Task Force of 25 ministerial-level members, which was tasked with the following objectives:

- Reducing US greenhouse gas emissions 50-52% below 2005 levels in 2030,
- Reaching 100% carbon pollution-free electricity by 2035,
- Achieving a net-zero emissions economy by 2050,
- Delivering 40% of the benefits from federal investments in climate and clean energy to disadvantaged communities.[34]

In September 2021, the US joined the Global Methane Pledge and adopted the US Methane Emissions Reduction Action Plan that outlines the measures necessary to achieve a 30% reduction in 2020 overall methane emissions levels by 2030.[35] These measures do not limit the production and use of hydrocarbons but rather, include a list of measures to reduce fugitive emissions and increase efficiency of operations (such as reducing wasteful venting and flaring of gas during drilling operations, elimination of leaks or ruptures of oil and gas pipelines, and plugging abandoned oil and gas wells).

The most significant climate-related policy of the current administration has been the adoption of the Inflation Reduction Act (IRA) in August 2022.[36] Despite the omission of the reference to climate, the act contains the largest climate-related economic stimulus package in American history with more than USD500bn to be spent on energy and climate-change related projects.[37] The act involves a multitude of incentives to drastically transform the energy profile of the US economy by 2030, including:

- USD250bn to upgrade, repurpose, or replace energy infrastructure;
- USD216bn worth of tax credits to catalyze private investment in clean energy, transport, and manufacturing;
- USD43bn in tax credits to lower emissions by making electric vehicles, energy-efficient appliances, rooftop solar panels, geothermal heating, and home batteries more affordable;
- The creation of the National Green Bank that will work as a development body and will partner with the private sector to help secure funding for green projects.

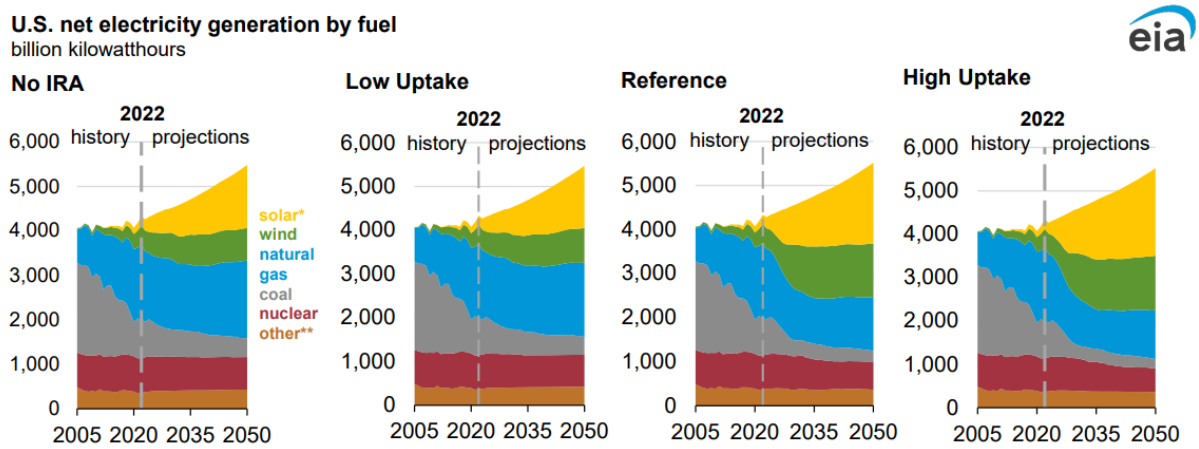
The IRA included a complex set of measures related to the control of methane (the main component of fossil gas) emission, including:

- More than USD1bn to provide financial and technical assistance for preparing and submitting reports on greenhouse gases, monitor methane emissions, reduce methane and other greenhouse gas emissions from oil and gas systems, improve and deploy emissions reduction equipment, support innovation, permanently close and plug wells, and mitigate health impacts in low-income areas;
- USD350m in formula grant funding for eligible states to help oil and gas well-owners (as well as operators of applicable facilities), and voluntarily and permanently reduce methane emissions from low-producing conventional wells on non-federal land.[38]

The IRA establishes a waste emissions charge for methane from applicable facilities that report more than 25,000 metric tons of CO_2 equivalent per year to the Greenhouse Gas Reporting Program (GHGRP) petroleum and natural gas systems source category, and that exceed statutorily specified waste emissions thresholds (see the last chapter for further details). Analysis from Bloomberg NEF indicates the implementation of climate targets will eventually require the US to apply CCUS to all its gas generation.[39] However, this type of generation will only be economically sustainable if the government continues to subsidize CCUS technology, making it artificially cheaper than renewables. Currently, the IRA plans CCUS tax credits to be phased out by 2028, without which the new gas plants paired with CCUS will have questionable profitability.

According to scenario analysis conducted by the US Energy Information Administration in March 2023, even partial realization of the IRA (full data is yet to be incorporated) will lead to a drastic reduction in the share of hydrocarbons in the electricity generation sources mix by 2030 (in two of the three scenarios including the reference one).[40]

Figure 5. US net electricity generation by fuel



Source: Annual Energy Outlook 2023

While the IRA is mainly concerned with decarbonization of the energy generation sector, the largest share of US emissions (28%) comes from the transportation sector.[41] In January 2023, the US administration published the US National Blueprint for Transportation Decarbonization. The document was jointly developed by the departments of energy, transportation, housing and urban development, and the Environmental Protection Agency as a guide for future policymaking and research, development, demonstration, and deployment in the public and private sectors. The document clearly stipulates that to achieve the goal of net zero by 2050 the country must 'transition to clean options by deploying zero-emission vehicles and fuels for cars, commercial trucks, transit, boats, airplanes, and more'.[42]

Blueprint developers emphasize that most new vehicle sales will need to be zero-emissions by the mid-2030s, and the legacy stock of fossil-based vehicles must be simultaneously transitioned to electric vehicles to achieve 2050 goals. The document mentions the Executive Order on Catalysing Clean Energy Industries and Jobs Through Federal Sustainability which directs the federal government to 'use its scale and procurement power to achieve ambitious goals, including 100% zero-emission vehicle acquisitions by 2035 and 100% zero-emission light-duty vehicle acquisitions by 2027'.[43] Overall, current policies aimed at decarbonizing the most climate-material parts of the transportation sector are as follows:

Table 2. Key US decarbonization policies related to transportation sector

Transportation mode	Share of current emissions within transportation sector	GHG Emissions Reduction Goals
Light-duty vehicles	49%	• Achieve 50% of new vehicle sales being zero-emission by 2030 supporting a pathway for full adoption, and ensure that new internal combustion engine vehicles are as efficient as possible.[44] • Deploy 500,000 EV chargers by 2030.[45] • Ensure 100% federal fleet procurement be zero-emission by 2027.[46]
Medium and heavy-duty trucks and buses	21%	• Aim to have 30% of new vehicle sales be zero-emission by 2030 and 100% by 2040.[47] • Ensure 100% federal fleet procurement is zero-emission by 2035.[48]
Maritime	3%	• Continue to support the Zero-Emission Shipping Mission (ZESM) goals to ensure that 5% of the global deep-sea fleet are capable of using zero-emission fuels by 2030, at least 200 of these ships primarily use these fuels across the main deep sea shipping route, and 10 large trade ports covering at

		least three continents can supply zero-emission fuels by 2030.[49] • Support the US domestic maritime sector by performing more RD&D into sustainable fuels and technologies and incentivize US commercial vessel operators to move towards lower GHG emissions. • Work with countries in the International Maritime Organization to adopt a goal of achieving zero emissions from international shipping by 2050.[50]
Aviation	11%	• Reduce aviation emissions by 20% by 2030 when compared to a business-as-usual scenario. • Achieve net-zero GHG emissions from the US aviation sector by 2050. • Catalyze the production of at least three billion gallons of SAF per year by 2030 and ~35 billion gallons by 2050, to supply the entire sector.[51]

Source: The US National Blueprint for Transportation Decarbonization

Although the full effect of these policies on the consumption of hydrocarbons by the US has not yet been calculated, it will be significant. Rhodium Group analysts estimate that the IRA will lead to a substantial reduction in US domestic production imports of hydrocarbons by 2030: domestic fossil gas production will decrease by 1-5%, net imports of crude oil will decrease by 1-6%, and net pipeline imports of natural gas will decrease by 9-11%.[52]

After 2030, the decline in consumption of hydrocarbons should accelerate due to the introduction of new energy sources, the falling cost per kilowatt hour due to economies of scale, and the replacement of a significant proportion of cars with electric vehicles. The speed of this change will be subject to the political situation in the US, but the trajectory of current trends is clear as is the amount of money budgeted to underpin them.[53]

China

China's hydrocarbon policy remains largely dependent on the economic, rather than environmental, plans of its government. Nevertheless, China remains the world's undisputed leader in the production of technologies that lead to a shift away from coal, oil and gas. The country not only actively exports these products around the world, but also introduces them on its territory.

Does China recognize any of the fossil fuels as green?

China does not currently recognize coal and oil and their derivatives as clean fuels. Clean coal was a part of the Chinese Taxonomy until 2021, but was removed in the update, marking a major change in the role of fossil fuels in the energy transition.

The situation is more complicated with respect to fossil gas. On the one hand, direct electricity generation using natural gas is not eligible in the Chinese Taxonomy, and the government's low-carbon transformation and decarbonization plans (see Figure 5. below) clearly state a commitment to reducing consumption of all hydrocarbons, including fossil gas.

However, fossil gas is often mentioned as a clean or low-carbon fuel when it comes to the implementation of these plans. For example, in March 2023, the National Development and Reform Commission listed fossil gas on a list of clean fuels on par with hydro, nuclear, wind, and solar.[54]

The white paper on China's green and low-carbon transformation, published by the State Council of the People's Republic of China in January 2023, identifies one of the government's tasks as 'promoting cleaner end-use energy; encouraging the substitution of coal with natural gas, electricity, and renewable energy; and actively promoting cleaner heating during the winter in northern regions.'[55]

In most cases, natural gas is mentioned as a clean fuel where it substitutes dirtier fossil fuels like coal or oil, but no official document recognizes it as being green per se.

The XIV Five Year Plan, adopted in March 2021, includes very concrete targets for reducing energy intensity and carbon intensity.[56] It also includes the following energy targets for the share of non-fossil fuels in the power and electricity sectors:

- By 2025, China will establish the initial foundation for a green, low-carbon and circular economy and significantly improve the energy efficiency of key industries. Energy consumption per unit of GDP will decrease by 13.5% from the 2020 level; carbon dioxide (CO_2) emissions per unit of GDP will decrease by 18% from the 2020 level; and the proportion of non-fossil energy consumption will reach 20%.
- By 2030, China will make significant progress in economic and social development through comprehensive green transformation, and energy efficiency in major energy-consuming industries will reach international advanced levels. Energy consumption per unit of GDP will decrease significantly; CO_2 emissions per unit of GDP will be reduced by more than 65% from 2005 levels; the proportion of non-fossil energy consumption will reach about 25%; and the total installed capacity of wind power and solar power will reach more than 1,200 gigawatts.
- By 2060, China will have fully established a green, low-carbon and circular economy and a clean, low-carbon, safe and efficient energy system. Energy efficiency will be at an internationally advanced level, and the proportion of non-fossil energy consumption will be more than 80%.

In November 2021, following the plan's release, China's national climate goals were updated.[57] They were submitted to the UNFCCC secretariat in June 2022, and state the following objectives:

- To have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060.
- To lower CO_2 emissions per unit of GDP by over 65% from the 2005 level.
- To increase the share of non-fossil fuels in primary energy consumption to around 25%.
- To increase the forest stock volume by 6 billion cubic meters from the 2005 level.
- To bring the total installed capacity of wind and solar power to over 1.2 billion kilowatts by 2030.

To achieve these goals, China plans to implement more than 50 different policies contained within multiple plans and strategies but two documents are particularly relevant:

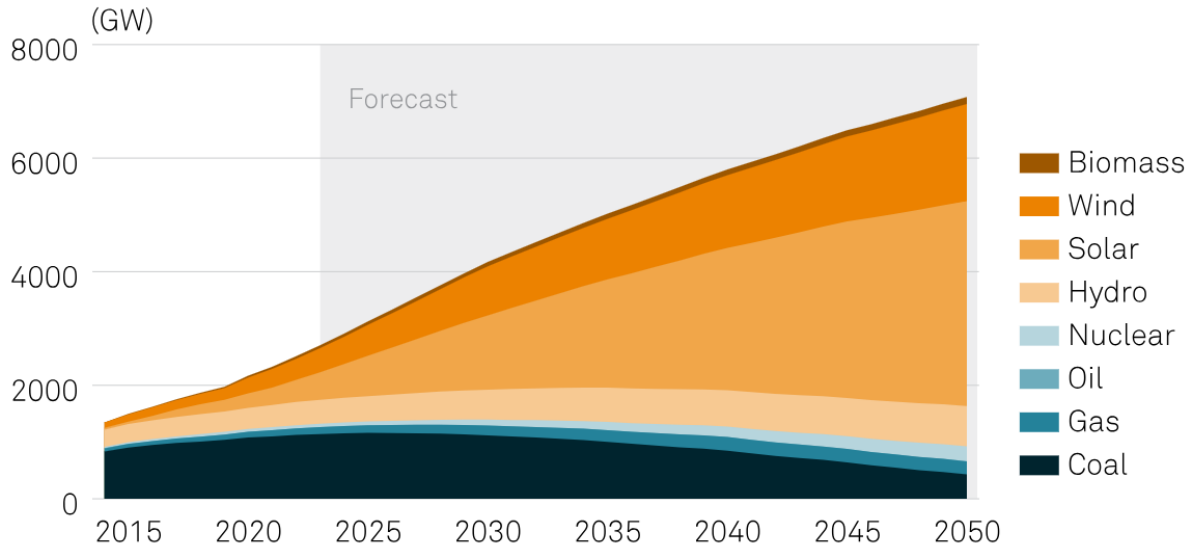
- Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy,[58]
- Action Plan for Carbon Dioxide Peaking Before 2030.[59]

While many climate activists believe these targets are not ambitious enough, for the most populous and the most polluting country in the world, these targets represent an enormous challenge. However, the Oxford Institute for Energy Studies concluded two years after the majority of these plans were adopted that they are being thoroughly implemented and all targets remain within reach.[60]

Coal dominates China's fossil fuels mix, with fossil gas and oil combined comprising less than half of all hydrocarbons used in the country. China currently consumes 54% of the coal produced globally, which comprised 56% of its energy mix in 2022, and is the biggest single contributor to its emissions.[61,62] The country's new coal capacity creation had been in decline for the most of the 2010s, but Covid (and the associated closure of cities and interruption of supply chains), the effects of climate change (heatwaves, which simultaneously led to excessive use of air conditioning and interruptions to hydropower facilities) and Russia's invasion of Ukraine forced China to ramp up construction of coal-fired capacity for the first time in a decade, citing the importance of energy security.[63]

However, China is generally considered an outlier in this respect and the majority of research puts peak Chinese coal consumption at 2026 or 2027.[64,65] Its Five-Year Plan for Energy (2021-2025) stipulates that between 2026 and 2030, coal consumption will begin to decline and it will gradually be phased out as the country's main source of energy, moving to a supporting role for other sources.[66] A solid basis is being created for the fulfilment of these plans: on June 12 2023, China reported for the first time in its history that the installed capacity (by size) of renewables overtook the capacity of fossil fuels (50.9% vs 49.1%).[67] This trend is expected to continue in the future, given that in February 2022, China's National Energy Administration issued a decree instructing local provincial governments not to build any further coal-fired capacity if the goal was solely to generate electricity. New capacity can only be built to support grid stability or the integration of renewable energy.[68]

Figure 6. China projected cumulative installed energy capacity development



***Source**: S&P Global Commodity Insights*

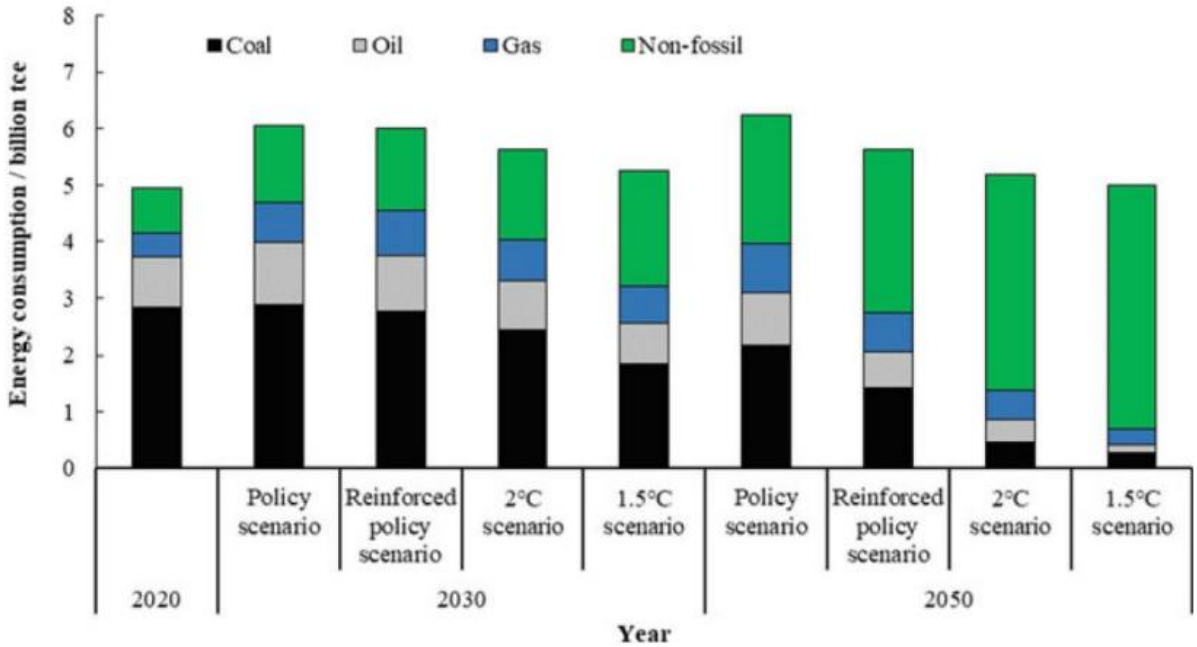
Oil came a distant second in 2022, with 18% of the country's energy mix, mostly consumed by the transportation sector (energy only accounts for 1%). Although the oil sector does not receive as much attention as coal in Chinese policy documents, it is heavily impacted by the booming development of the Chinese electric vehicles market. The International Energy Agency (IEA) and consultancy Rystad Energy have brought forward forecasts of China's peak gasoline demand by about a year to 2024, while Chinese state companies PetroChina and Sinopec forecast 2025.[69] In the first half of 2023, 28% of all cars sold in China were electric compared to just 9% in the first half of 2021.[70] By 2035, China intends that half of all cars sold will be fuelled by electricity, hydrogen or a mix of electricity and fuel.[71]

Fossil gas currently occupies 9% of the country's energy mix with 46% used in industrial processes while energy generation consumes only 16%.[72] Natural gas is seen as a bridging fuel and a much cleaner source of energy than the more commonplace coal. In 2017, China launched a program to convert its existing coal capacities to gas which led to significant improvements in air quality.[73] However, despite the fact that China is the world's fourth largest gas producer, its gas imports already account for half of consumption and continue to grow. The economic consequences of this were felt when China had to purchase gas on the spot market last year following a sharp jump in gas prices, caused principally by the war in Ukraine. The impact on China's energy supply led to several dormant coal-fired facilities being brought back to life.[74] This may make provoke a review of existing renewable energy capacity, including facilities supported by coal.

However, in all energy mix scenarios conducted by the Tsinghua University's Institute of Climate Change and Sustainable Development, the share of fossil-based generation goes down by 2030 within the next two decades, while the share of renewables goes up in all scenarios (see Figure 7 below).

China's hydrocarbon policy combines three intentions: to strengthen energy independence, to maintain economic growth, and to meet decarbonization targets. Although hydrocarbon divestment in general is not the main goal of the country's climate policy, the combination of actual policies inevitably leads to this outcome. As renewable energy technologies improve and the adoption of electric vehicles increases, hydrocarbon use will fall. This process will be driven by the volatility of fossil energy prices, which are subject to geopolitical risks.

Figure 7. Forecasts of China's energy mix



Source: Tsinghua University cited by Oxford Institute for Energy Studies

Germany

Germany is Canada's largest trading partner among the EU countries, which although subject to EU policies, has also adopted its own ambitious programs aimed at reducing emissions, including from hydrocarbon use.

Does Germany recognize fossil fuels as green?

According to all policy documents, Germany does not consider hydrocarbons, including oil, coal and fossil gas, to be green, clean and environmentally friendly. The country has adopted clear guidelines for decarbonization and intends to phase out fossil fuels by 2045. Nevertheless, natural gas is seen as a necessary interim fuel in a period of transition away from oil, nuclear power, and coal towards renewable sources.

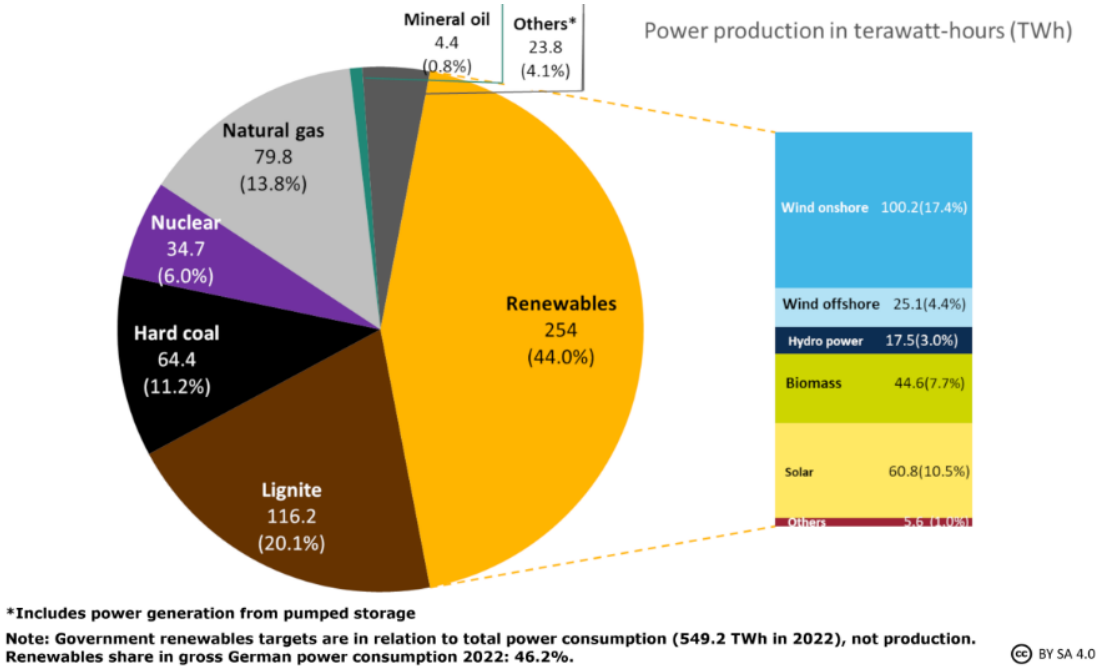
Commenting on the inclusion of some gas generation options in the EU taxonomy at the beginning of 2022, a government spokesperson stated 'for the German Government, natural gas is an important bridging technology on the way to greenhouse gas neutrality against the background of the phase-out of nuclear energy and coal-fired power generation.'[75] As Europe's largest industrial powerhouse, Germany has always had to take the opinion of industrial associations into account. In February 2020, the country's largest energy-related companies issued a joint statement titled Protecting the climate and securing competitiveness together, which called on the Federal Government to protect the fossil gas industry and infrastructure. It states 'The energy mix of the future consists of renewable electricity and gas, which will become increasingly green over time.'[76]

In November 2022, the German Ministry of Economic Affairs and Climate Action published a paper called Climate Action in Figures, which recognizes natural gas as a greenhouse gas with a negative effect on the world's climate.[77] However, it reiterates that **natural gas still currently serves as a bridge technology** for transitioning the energy system to renewable energy sources. Fossil gas, according to the paper, is far more flexible in operation and, therefore, well suited as a transitional technology to compensate for the natural fluctuations when generating power from renewable energy sources. However, it is emphasized that this gas must be phased out and is not a part of zero-carbon future.

Traditionally, the German energy mix has been dominated by fossil fuels, but over the past decade, the country has made substantial progress to change under the policy commonly known as Energiewende.[78] As a result, by

2022, renewables occupied roughly the same share of the country's energy sector as fossil fuels (44% against 46%) growing exponentially every year since 2002 when they were non-existent.

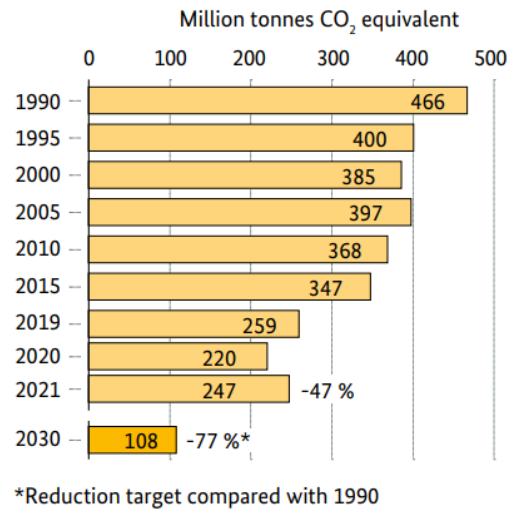
Figure 8. German energy generation sources mix, 2022



Source: Clean Energy Wire

At the heart of Germany's climate policy lies the 2019 Climate Change Act, under which the country has pledged to reach climate neutrality by 2045.[79] As part of its adopted Nationally Determined Contribution (NDC), the country has also committed to a 65% reduction in emissions below 1990 levels by 2030. The Climate Change Act details how much emission reduction must occur in each sector by 2030. In November 2022, Germany updated its Long-Term Strategy for Climate Action and submitted it to the UNFCCC. Reduction in the use of hydrocarbons is defined as one of the primary methods of achieving this goal.[80]

Figure 9. German emission reduction plans 1990-2030



Source: Climate Action in Figures

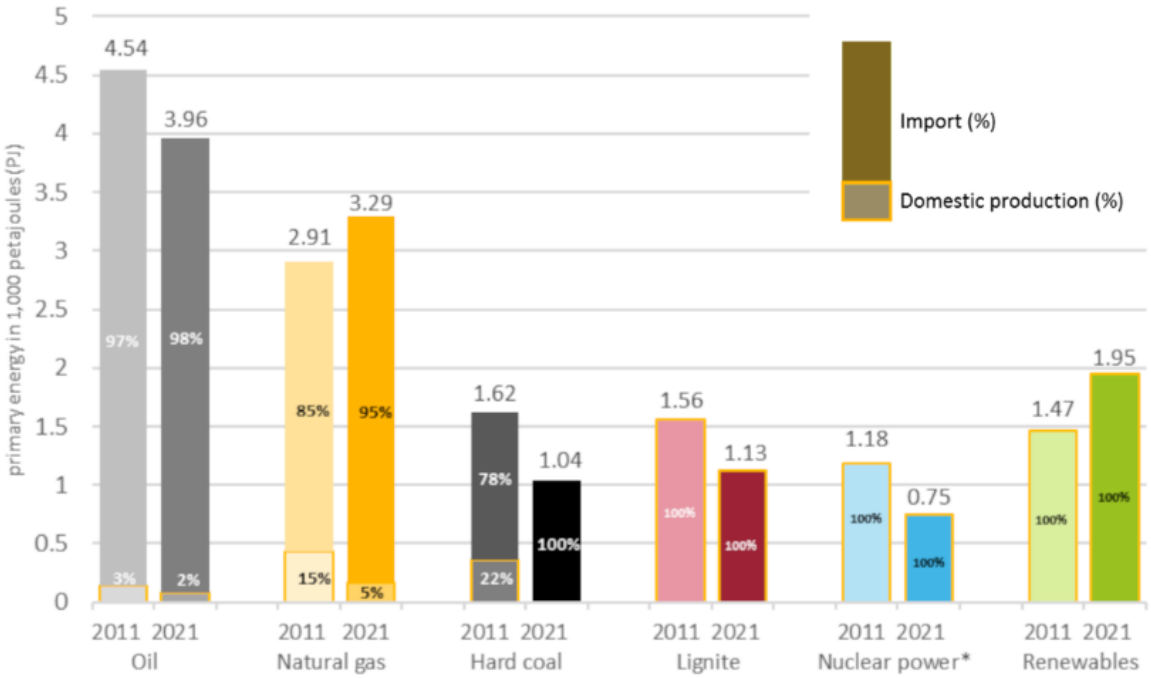
The strategy sets a deadline of 2030 by which at least 80% of Germany's gross electricity consumption will be generated by renewable sources, and coal-fired power generation phased out. Once the phase-out of coal-fired power is complete, Germany will aim for a power supply that is greenhouse gas neutral. Here, **the use of fossil gas to generate power will be gradually cut back and partly replaced by green hydrogen**. Similar policies were

adopted for the transportation sector. Germany is actively promoting construction of electric charging stations through the Charging Infrastructure Master Plan and incentivizes state and private bodies to procure electric cars through Electric Mobility Funding Guidelines.[81,82]

Fossil fuels are not only a climate problem, but also a political one, given that Russia was the largest supplier of hydrocarbons to Germany before 2022. Climate Action in Figures stipulates that 'the shift away from fossil energy sources and increases in energy efficiency should be implemented and accelerated in all sectors – from industrial production to mobility and agriculture'.[83] As a result of cutting supplies from Russia, Germany had to increase the import of liquefied natural gas (LNG) and expand LNG infrastructure. However, in July 2023, the Federal Government updated an act to accelerate the use of LNG, which required all new LNG terminals to be green-ready, meaning that the terminals must be easily convertible from LNG to hydrogen.[84]

As Germany has very few reserves of fossil fuels of its own, the switch to renewables is as much about decreasing costs and providing energy security as climate. Over the last decade, Germany has reduced coal and oil imports substantially, in favour more renewable energy.

Figure 10. Import dependency by primary energy source in Germany, 2011-2021

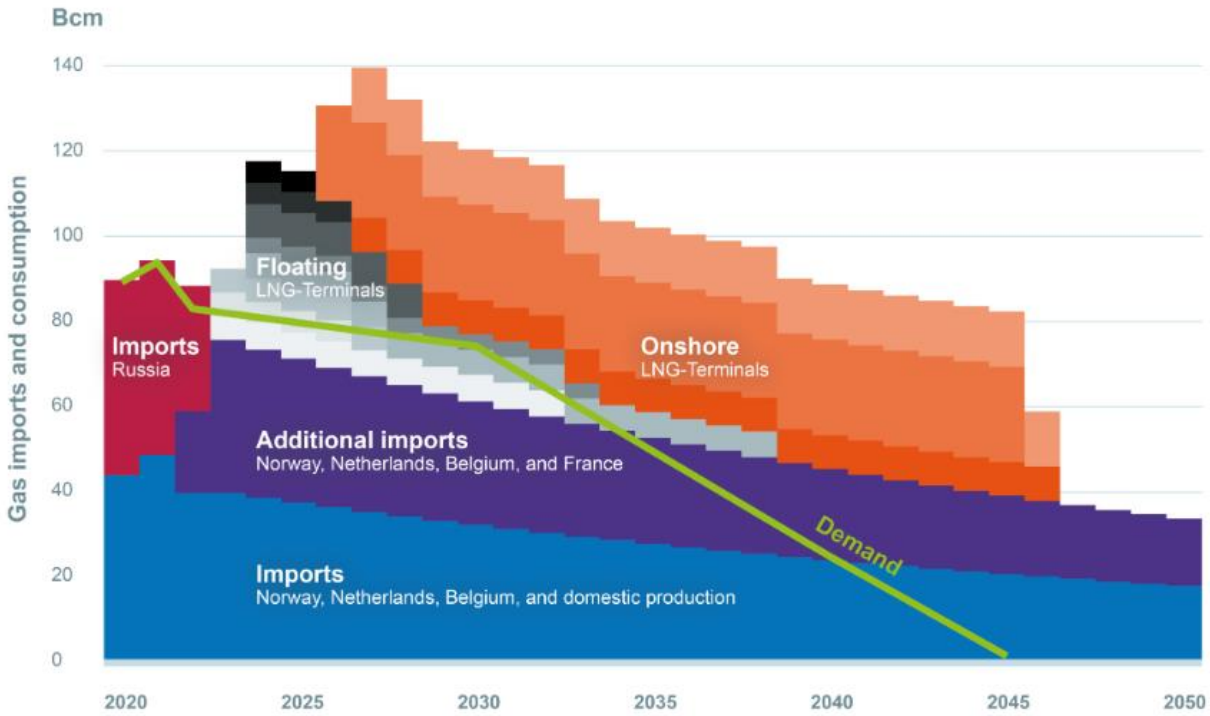


Source: Clean Energy Wire

As the result of all these policies, Germany is expected to completely phase out coal by 2030. Gas will remain until 2045, but new gas power plants will have to be convertible to hydrogen.[85] New wind and solar capacities will be introduced every year and hydrogen production will also increase, displacing gas to a certain extent. Despite the significant generation and receptive capacity, demand must go down to zero by 2045.

The German hydrocarbon strategy implies an accelerated phase-out of hydrocarbon imports and use over the horizon of the next 20-25 years. Fossil gas will still be used as a transition fuel, but all new capacity will be adapted for switching to hydrogen. As the cost of renewable energy falls and transportation technologies improve, this process will accelerate, although imported LNG capacity will continue to grow for some time.

Figure 11. Germany's capacity and demand for fossil gas, 2020-2050



Source: New Climate Institute

Summary

All three countries have adopted ambitious goals and policies to move away from fossil fuels and towards clean energy sources. As the industrial giants of their respective regions, the US, China, and Germany are not able to phase out hydrocarbons overnight, but all three countries have made great efforts to create incentives to reduce hydrocarbon consumption and eventually replace them with renewables. Among the elements of this system are economic incentives for clean technology development, government programs to support infrastructure upgrades, loans and subsidies for businesses, and government regulations and standards that close the door to outdated and dirty technologies.

Despite the significant differences in the political structure of the three countries, there are some common features that make the phase-out of hydrocarbons a difficult but unavoidable measure, not only for climatic, but also for economic and social reasons.

- Dependence on hydrocarbons is a direct socio-political risk, as China and EU countries experienced in Q1 2022, when gas prices surged as a result of the invasion of Ukraine. This contrasts with renewable energy sources, which are not tied to supply and are able to exist autonomously, providing for the communities in which they are located.
- Decarbonized technologies (including sustainable energy, industry, agriculture, and transport) promise economic leadership for those who establish themselves as leaders in their technological development. The IRA has already generated conflict between the EU and US, fuelled by the EU's concerns over a drain of skilled labour and technology overseas.[86] However, China provides a striking example of how a country, which had no chance of gaining a foothold in the highly competitive market for traditional cars, has become the undisputed world leader in sales of electric vehicles.[87]
- The imminent introduction of the EU carbon border tax leaves countries that want to trade with the bloc (and remain competitive) no choice but to reduce the consumption of hydrocarbons in their industrial and energy systems.[88] In doing so, these countries will move closer to implementing similar systems to protect their own domestic market and prevent local companies from moving to other jurisdictions with reduced environmental legislation.

The future of fossil gas

The harmful effects on climate of oil and coal extraction and utilization are well known, yet there is no concrete discussion on their future phase out, while fossil gas is perceived as a safer and cleaner fuel. However, in recent years, the expansion of its production has been increasingly associated with growing atmospheric concentrations of methane, which is emitted in huge quantities during the extraction and utilization of fossil fuels. On a 20-year horizon, methane has 80 times the greenhouse effect of CO_2 and is now responsible for nearly a quarter of all global warming.[89] Two thirds of methane comes from human activity, mostly from fossil fuel industries.

Research led by Stanford University scientists in 2020 clearly demonstrated that there has been an unprecedented rise in global levels of methane emission over the past decade.[90] It described the growth in methane concentrations as 'dangerously fast'.[91] One of the causes identified was the increased extraction, transportation, and utilization of fossil gas, perceived as a transitional and less dirty fuel compared to other hydrocarbons. However, natural gas-related operations often result in massive leakages of methane (fugitive emissions) with the average US leakage rate between 1.4% and 3.7%.[92] A recent report found that average Canadian fugitive emissions stand close to 2.7%, which is twice as much as was previously thought.[93]

As a result of the fugitive emissions recently detected by satellites, the majority of green taxonomies require emissions from energy to be assessed on a lifecycle basis, which is a material change from just scope 1 or scope 2 assessments.[94] While a modern CCGT gas power plant has an average emissions intensity of 360-380 gCO_2e/kWh, just adding an additional 3% of fugitive emissions makes fossil gas generation almost comparable in its greenhouse potential to coal.[95] Research conducted by a consortium of US scientists found that on a 100-year timeframe, the effects of life-cycle GHGs from fossil gas with about a 5% leakage rate are on a par with low-methane content coal mines, and 7.6% leakage is on a par with average coal mine methane leakage.[96] The report also found that considering the maximum life-cycle emissions from gas from all studies surveyed, gas with a 0.2% leakage rate is on par with coal at all analyzed levels of coal mine methane leakage.

Table 3. Leakage factor importance in calculating fossil gas generation LCA emissions

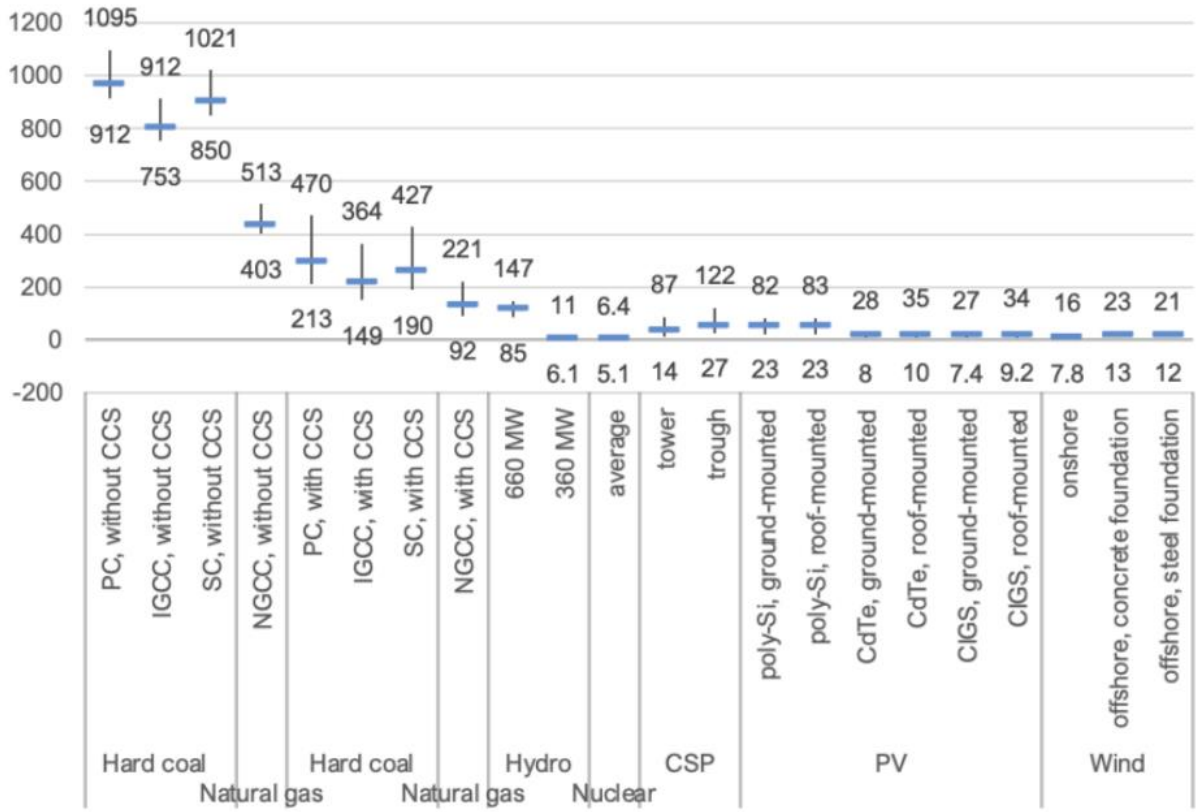
Leakage losses	Diffuse emissions[1)]	Diffuse and direct emissions[2)]
	g CO_2-eq/kWh_{el}	g CO_2-eq/kWh_{el}
0%	0	358
1%	108	466
2%	216	574
3%	324	682
5%	540	898
10%	1081	1439

1) At an efficiency of 56.1 %, about 129 grams of methane are needed to generate one kilowatt-hour of electricity. Each gram of methane has a climate impact (GWP20) of 84 grams of CO_2. If only 1 % of the methane escapes additionally, the total emission increases by $0.01*129*84=108.4$ g CO_2-eq. The upstream emissions have been disregarded here because they already include assumptions about leakage losses. In total, they are reported as 65.8 g CO_2-eq/kWh_{el}.

2) To each of the fugitive emissions are added the 358 grams of CO_2 produced by burning 129 grams of methane.

Source: Volker Quaschning website

Figure 12. Average lifecycle CO_2 equivalent emissions by energy type, gCO_2/kWh



Source: UNECE

**Vertical black lines indicate ranges of emission intensity. Blue horizontal lines indicate the average for each emission type. NGCC: same as CCGT.*

The consequences of fugitive methane emissions may potentially erase years of energetic and ambitious climate policy. In 2020, a study conducted by the Environmental Defense Fund found that 3.7% of natural gas produced in the US Permian Basin leaked into the atmosphere, which alone was enough to erase the greenhouse gas benefits of the coal-to-gas switching program that on paper allowed the US to substantially cut its emissions.[97]

Flaring, or burning of fossil gas emitted by oil and gas wells has long been thought of as a powerful tool to combat emissions of leaking oil and gas wells. Combustion of methane has previously been thought to destroy up to 98% of this gas (producing CO_2 instead) and reduce the potential harm from uncontrolled methane emissions. In September 2022, a group of US and European scientists published a study demonstrating that these beliefs are not compatible with reality.[98] Airborne sampling around three US basins responsible for more than 80% of flaring found that flares effectively destroyed only 91.1% of methane. This represented a fivefold increase in methane emissions above previous assumptions and could constitute between four and 10% of total US oil and gas methane emissions.

Awareness of the methane problem in general, and its relationship to the oil and gas industry in particular, was reflected in the 2021 UNEP Global Methane Assessment.[99] In November 2021, at COP26 in Glasgow more than 100 countries (including Canada) signed a Methane Pledge, promising to cut methane emission by 30% by 2030 compared to 2020 levels.[100,101] Since then, many countries have adopted policies to cut the emission of methane or make it more expensive for the oil and gas industry to produce it.

As a part of the IRA adopted in 2022 and discussed in the previous chapter, the US will charge from USD900 (in 2024) to USD1500 (after 2026) per tonne of methane emitted, which equates to USD36 and USD60 per metric ton of carbon dioxide equivalent, respectively.[102] Simultaneously, IRA includes a disbursement of USD850mn through the Environment Protection Agency to fund improving and deploying industrial equipment and

processes that reduce methane emission. An additional USD700mn is destined for the upgrade of the emissions profile of marginal conventional wells.

In May 2023, the EU parliament voted to reduce methane emissions through enhanced leak detection and repair requirements.[103] Now, companies will have to conduct regular equipment checks every two months, and from 2026 this requirement will be extended to all exporters to the EU. This measure is designed to improve the methane situation beyond the bloc's borders. In practice, the mechanism will serve as a methane addition to the carbon border adjustment mechanism (CBAM) which will also come into effect in 2026.[104]

Summary

As taxonomies are based on international climate science, the recent studies in the sphere of hydrocarbons cannot be ignored. The alarming growth of excess methane emissions is starting to be addressed by the policies of Canada's trading partners. To date, the measures taken have been relatively modest, but as 2030 approaches, countries will have to become increasingly strict, on both domestic producers and importers, to ensure emissions reduction targets are met. Most existing taxonomies already require fugitive methane emissions to be taken into account by assessing the lifecycle emissions of fossil fuel utilization instead of limiting it to scope 1 and scope 2, which is expected to become standard.

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