



University of
Zurich^{UZH}

chatSustainableEnergy

The Use of Generative AI for Informed Policy Making

Markus Leippold, September 2023

www.chatClimate.ai



Our mission is to
organize the *relevant*
information and make it
decision- accessible
and *useful.*



Generative AI's Impact on Productivity and the Global Economy

McKinsey White Paper, June 2023

© Key Points:

- Estimated Annual Impact: \$2.6T - \$4.4T
(Comparison to UK GDP: \$3.1T)
- Potential Increase in AI Impact: 15% - 40%

© Changing Nature of Work:

- Automation of 60-70% of Work Activities
- Accelerated Workforce Transformation
- Labor Productivity Growth: 0.1% - 0.6% Annually through 2040

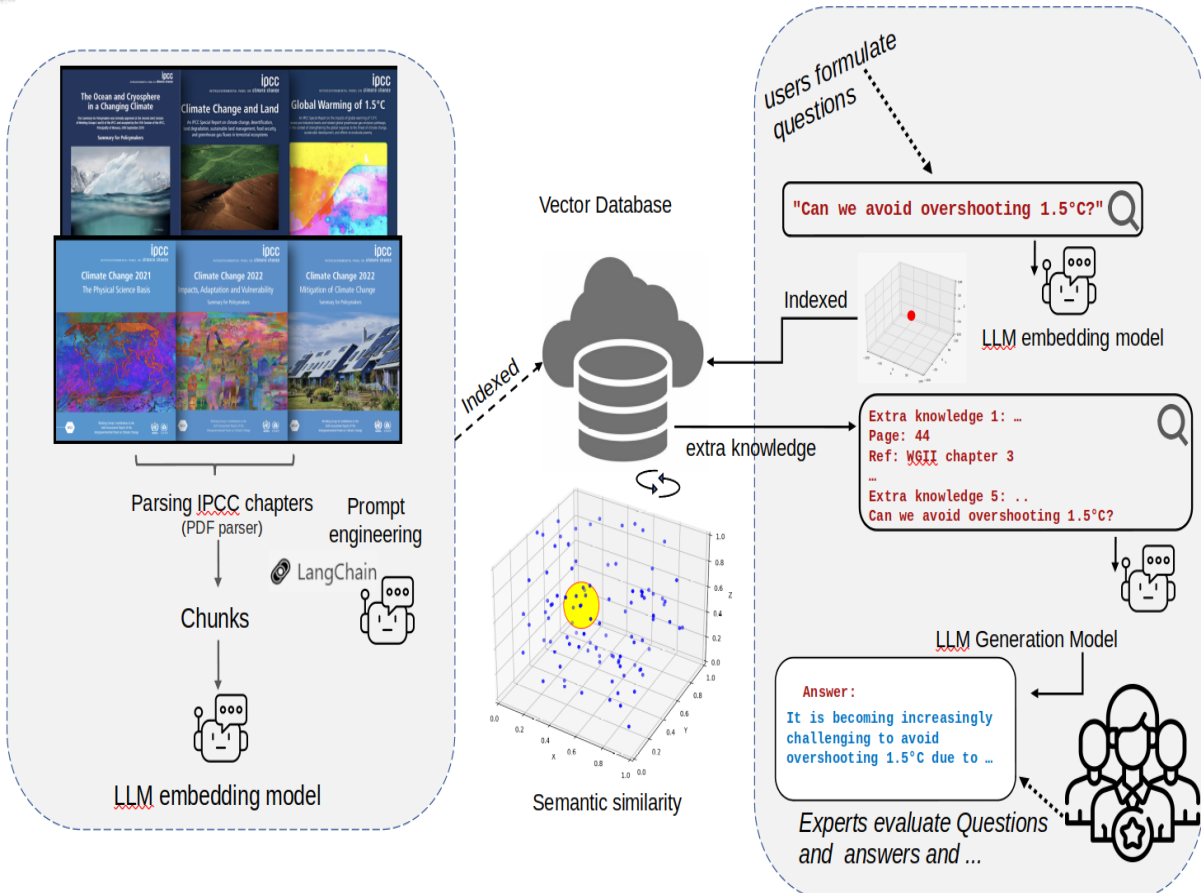
© Industries with Significant Impact:

- Banking: \$200B - \$340B
- Retail & Consumer Goods: \$400B - \$660B



www.ChatClimate.ai (f.k.a. ChatIPCC)

Can we avoid overshooting 1.5°C?



Yes, it is still possible to limit global warming to 1.5°C, but it requires deep, rapid, and sustained reductions of greenhouse gases, including methane, alongside rapid reductions of CO2 emissions to net zero (Page: 31, Reference: IPCC_AR6_WGIII_Chapter03). This would limit the warming contributions from non-CO2 forcing agents as well as from CO2 emissions at low levels. However, the likelihood of limiting warming to 1.5°C with no or limited overshoot has dropped in AR6 compared to the Special Report on Global Warming of 1.5°C (SR1.5) because global GHG emissions have risen since the time SR1.5 was published, leading to higher near-term emissions (2030) and higher cumulative CO2 emissions until the time of net zero (Page: 4, Reference: IPCC_AR6_WGIII_Chapter03). In scenarios limiting warming to 1.5°C with no or limited overshoot, net energy system CO2 emissions fall by 87-97% in 2050 and net CO2 and GHG emissions fall by 35-51% and 38-52% respectively in 2030 (Page: 43, Reference: IPCC_AR6_WGIII_TechnicalSummary). Furthermore, net electricity sector CO2 emissions would need to reach zero globally between 2045 and 2055 (Page: 3, Reference: IPCC_AR6_WGIII_Chapter06). Therefore, while it is technically possible to limit warming to 1.5°C, it requires significant and immediate action to reduce greenhouse gas emissions. (In-house knowledge)

IPCC AR6, WGIII Chapter03, p31, Limiting warming to 1.5°C (>50%) or to 2°C (>67%) requires deep, rapid, and sustained reductions of other greenhouse gases including methane alongside rapid reductions of CO2 emissions to net zero. This ensures that the warming contributions from non-CO2 forcing agents as well as from CO2 emissions are both limited at low levels. The AR6 WGI estimated remaining carbon budgets until the time of reaching net zero CO2 emissions for a range of warming limits, taking into account historical CO2 emissions and projections of the warming from non-CO2 forcing agents (Box 3.4 in Section 3.3, AR6 WGI Section 5.5).

Executive Summary

Warming cannot be limited to well below 2°C without rapid and deep reductions in energy system carbon dioxide (CO2) and greenhouse gas (GHG) emissions. In scenarios limiting warming to 1.5°C (>50%) with no or limited overshoot (2°C (>67%) with action starting in 2020), net energy system CO2 emissions (interquartile range) fall by 87–97% (60–79%) in 2050. In 2030, in scenarios limiting warming to 1.5°C (>50%) with no or limited overshoot, net CO2 and GHG emissions fall by 35–51% and 38–52% respectively. In scenarios limiting warming to 1.5°C (>50%) with no or limited overshoot (2°C (>67%)), net electricity sector CO2 emissions reach zero globally between 2045 and 2055 (2050 and 2080). (high confidence) (6.7)

IPCC AR6, WGIII Chapter06, p3

Many pathways in the literature show how to limit global warming compared to pre-industrial times to 2°C (>67%) with no overshoot or to limit warming to 1.5°C (>50%) with no or limited overshoot. The likelihood of limiting warming to 1.5°C with no or limited overshoot has dropped in AR6 compared to the Special Report on Global Warming of 1.5°C (SR1.5) because global GHG emissions have risen since the time SR1.5 was published, leading to higher near-term emissions (2030) and higher cumulative CO2 emissions until the time of net zero (medium confidence). Only a small number of published pathways limit global warming to 1.5°C without overshoot over the course of the 21st century. (3.3, Annex III.II.3)

IPCC AR6 WGIII Technical Summary, p43

IPCC AR6, WGIII Chapter03, p4

TS.5.1 Energy

A broad-based approach to deploying energy-sector mitigation options can reduce emissions over the next ten years and set the stage for still deeper reductions beyond 2030 (high confidence). There are substantial, cost-effective opportunities to reduce emissions rapidly, including in electricity generation, but near-term reductions will not be sufficient to limit warming to 2°C (>67%) or limit warming to 1.5°C (>50%) with no or limited overshoot. (6.4, 6.6, 6.7)

Warming cannot be limited to 2°C or 1.5°C without rapid and deep reductions in energy system CO2 and GHG emissions (high confidence). In scenarios limiting warming to 1.5°C (>50%) with no or limited overshoot (likely below 2°C), net energy system CO2 emissions fall by 87–97% (interquartile range 60–79%) in 2050. In 2030, in scenarios limiting warming to 1.5°C with no or limited overshoot, net CO2 and GHG emissions fall by 35–51% and 38–52% respectively. In scenarios limiting warming to 1.5°C with no or limited overshoot (likely below 2°C), net electricity sector CO2 emissions reach zero globally between 2045 and 2055 (2050 and 2080) (high confidence). (6.7)



JAKE-CLARK.TUMBLR

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Could we reach net zero targets without nuclear energy?



gpt-3.5-turbo gpt-4

Responses:

▾ WMO

▾ IPCC

▾ UNECE

▾ OSCE

▾ IEA

▾ IAEA

▾ Summary

Demo

Activities Firefox Web Browser Sep 12 05:24

chatclimate.ai x +

https://www.chatenergy.app

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Ask your question...

gpt-3.5-turbo gpt-4

Try asking

What is the resilient energy system? What are the main pillars of resilient energy systems? Could we reach net zero targets without nuclear energy?

SSD

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Could we reach net zero targets without nuclear energy? Explain it to a school kid.



gpt-3.5-turbo gpt-4

^ Summary

Reaching net zero targets means that we need to stop adding more greenhouse gases to the atmosphere than we are able to remove. This is like a balance scale, where we need to make sure that the amount of gases we put into the air is equal to the amount we can take out.

Right now, a lot of our energy comes from things like coal, oil, and gas. When we use these for energy, they release greenhouse gases into the air. To reach net zero, we need to switch to energy sources that don't release these gases. This is where renewable energy like solar, wind, and hydropower come in. They can generate electricity without adding greenhouse gases to the atmosphere.

Nuclear energy is another way to generate electricity without releasing greenhouse gases. It's like a powerful battery that can provide a lot of energy. Some countries use it a lot, while others don't because they have concerns about safety and waste.

So, could we reach net zero without nuclear energy? It's possible, but it would be a big challenge. We would need to use a lot more renewable energy, and we would also need to get much better at saving energy and using it more efficiently. We would also need to develop new technologies to store energy and to capture and store the greenhouse gases that we can't avoid releasing.

In other words, it's like trying to fill a big bucket with a small cup. You can do it, but it would be much easier if you also had a big jug (nuclear energy) to help fill the bucket. But remember, even if we use the big jug, we still need to be careful not to spill any water (which is like making sure nuclear energy is safe and doesn't create other problems).

Next Steps

- ⦿ Implement a debating system
- ⦿ Include multi-modality
- ⦿ Work on local LLMs
- ⦿ Differentiating the tool for different users (politicians, educators, experts)
- ⦿ Collecting feedback from users

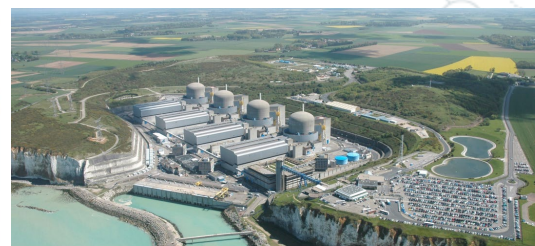
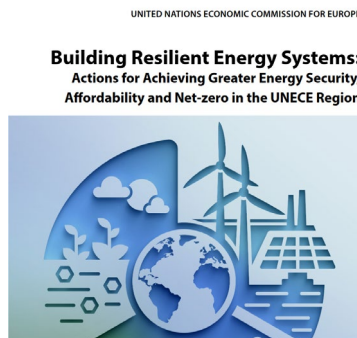
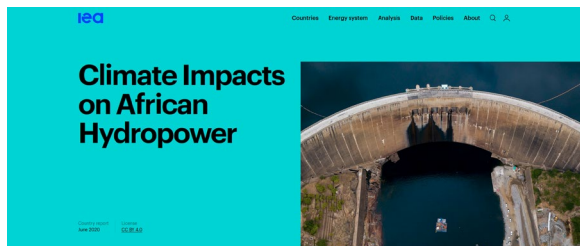


<https://www.chatEnergy.app/>

Appendix



Database



A	B	C	D	E	F
id	Title	Date	Author	Urls	Org
1	Energy Exemplar to the User Interface Platform of the Global Framework for Climate Services	2017	WMO, GFCS	https://gfcs.wmo.int/sites/default/files/Priority-Areas/Energy/GFCS_En	WMO
2	2022 State of Climate Services: Energy (WMO-No. 130)	2022	WMO, GFCS	https://library.wmo.int/index.php?lvl=notice_display&id=22136#_Y3N3K	WMO
3	Integrated Weather and Climate Services in Support of Net Zero Energy Transition (WMO-No. 1312)	2023	WMO	https://library.wmo.int/index.php?lvl=notice_display&id=22249	WMO
4	State of the Global Climate 2022 (WMO-No. 1316)	2023	WMO	https://library.wmo.int/doc_num.php?explnum_id=11593	WMO
5	State of the Climate in Europe 2022 (WMO-No. 1320)	2023	WMO	https://library.wmo.int/index.php?lvl=notice_display&id=22285	WMO
6	Advancing Energy Security in Central Asia	2022	OSCE	https://www.osce.org/oceea/513787	OSCE
7	Protecting Electricity Networks from Natural Hazards	2016	OSCE	https://www.osce.org/secretariat/242651	OSCE
8	Office of the Co-ordinator of OSCE Economic and Environmental Activities Energy Security	2017	OSCE	https://www.osce.org/resources/factsheets/energy-security	OSCE
9	OSCE Economic and Environmental Dimension COMMITMENTS Reference Manual 2020	2021	OSCE	https://www.osce.org/secretariat/481270	OSCE
10	Climate Resilience for Energy Security	2022	IEA	https://www.iea.org/reports/climate-resilience-for-energy-security	IEA
11	Carbon Neutrality in the UNECE Region Technology Interplay under the Carbon Neutrality Concept	2022	UNECE	https://unece.org/sites/default/files/2022-09/Technology%20Interplay_	UNECE
12	Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources	2021	UNECE	https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March9	UNECE
13	Climate Impacts on Latin American Hydropower	2021	IEA	https://www.iea.org/reports/climate-impacts-on-latin-american-hydropo	IEA
14	Climate Impacts on African Hydropower	2020	IEA	https://www.iea.org/reports/climate-impacts-on-african-hydropower	IEA
15	Climate Impacts on South and Southeast Asian Hydropower	2021	IEA	https://www.iea.org/reports/climate-impacts-on-south-and-southeast-a	IEA
16	Building Resilient Energy Systems: Technical Considerations and Actions for Achieving Greater Energy Security, Affordat	2022	UNECE	https://unece.org/sites/default/files/2023-04/Building%20Resilient%20	UNECE
17	Building Resilient Energy Systems: Actions for Achieving Greater Energy Security, Affordability and Net-zero in the UNEC	2022	UNECE	https://unece.org/info/Sustainable-Energy/pub/374820	UNECE
18	Carbon Neutrality in the UNECE Region Technology Interplay under the Carbon Neutrality Concept	2022	UNECE	https://unece.org/sites/default/files/2022-09/Technology%20Interplay_	UNECE
19	WMO_Global_Annual_to_Decadal_Climate_Update_2023-2027	2023	WMO	https://reliefweb.int/report/world/wmo-global-annual-decadal-climate-u	WMO
20	State of the Climate in Asia 2022 (WMO-NO 1321)	2023	WMO	https://library.wmo.int/doc_num.php?explnum_id=11734	WMO
21	State of the Climate in South-West Pacific 2021 (WMO-NO. 1302)	2022	WMO	https://library.wmo.int/index.php?lvl=notice_display&id=22309	WMO
22	State of the Climate in Africa 2021 (WMO-No. 1300)	2022	WMO	https://library.wmo.int/doc_num.php?explnum_id=11512	WMO
23	TECHNOLOGY BRIEF CARBON CAPTURE, USE AND STORAGE (CCUS)	2021	UNECE	https://unece.org/sites/default/files/2021-03/CCUS%20brochure_EN_f	UNECE
24	TECHNOLOGY BRIEF HYDROGEN	2021	UNECE	https://unece.org/sites/default/files/2021-10/Hydrogen%20brief_EN_fir	UNECE
25	TECHNOLOGY BRIEF NUCLEAR POWER	2021	UNECE	https://unece.org/sites/default/files/2021-08/Nuclear%20brief_EN.pdf	UNECE
26	TECHNOLOGY BRIEF CARBON NEUTRAL ENERGY INTENSIVE INDUSTRIES	2021	UNECE	https://unece.org/sites/default/files/2022-11/Industry%20brief_EN_2.p	UNECE
27	Climate Change and Nuclear Power 2022	2022	IAEA	https://www.iaea.org/sites/default/files/iaea-cnnp2022-body-web.pdf	IAEA
28	CLIMATE CHANGE AND NUCLEAR POWER 2020	2020	IAEA	https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1911_web.pdf	IAEA
29	Nuclear Energy for a Net Zero World	2021	IAEA	https://www.iaea.org/sites/default/files/21/10/nuclear-energy-for-a-net-	IAEA
30	Transitions to low carbon electricity systems: Key economic and investments trends	2021	IAEA	https://www.iaea.org/sites/default/files/21/06/transitions-to-low-carbon-	IAEA
31	Nuclear Science and Technology For Climate Change Mitigation , Adaptation a n d Monitoring	2022	IAEA	https://www.iaea.org/sites/default/files/22/10/nuclear-science-and-tech	IAEA

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Could we reach net zero targets without nuclear energy?



gpt-3.5-turbo gpt-4

Responses:

▾ WMO

Reaching net zero targets without nuclear energy is theoretically possible, but it would require a significant increase in the use of renewable energy sources and improvements in energy efficiency. The energy sector contributes around three quarters of global greenhouse gas emissions, so transitioning to clean energy sources such as solar, wind, and hydropower is crucial. According to the World Meteorological Organization (WMO), we need to double the supply of low-emissions electricity within the next eight years to reach net zero targets (2022 State of Climate Services: Energy, Page:4, WMO, URL: [\[ref\]](#)).

The International Energy Agency (IEA) also suggests that to reach net zero energy emissions by 2050, net zero electricity emissions will be required (Integrated Weather and Climate Services in Support of Net Zero Energy Transition, Page:19, WMO, URL: [\[ref\]](#)). However, only 56% of Nationally Determined Contributions (NDCs) include quantified targets for renewable power, which would need to reach 7.1 TW of clean energy by 2030 to meet the Paris Agreement goal (2022 State of Climate Services: Energy, Page:30, WMO, URL: [\[ref\]](#)).

While nuclear energy can contribute to the reduction of greenhouse gas emissions, it is not the only solution. Other strategies, such as the development of green hydrogen and the revitalization of the renewable energy sector, can also play a significant role in achieving carbon neutrality (2022 State of Climate Services: Energy, Page:39, WMO, URL: [\[ref\]](#)).

In conclusion, while nuclear energy can be part of the solution, it is not strictly necessary to reach net zero targets. However, without it, the challenge of transitioning to a low-carbon energy system would be significantly greater. (In-house knowledge)

▾ IPCC

▾ UNECE

▾ OSCE

▾ IEA

▾ IAEA

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Could we reach net zero targets without nuclear energy?



gpt-3.5-turbo gpt-4

Responses:

▾ WMO

▴ IPCC

Yes, it is possible to reach net zero targets without nuclear energy, but it would require a combination of other strategies. Some analyses find deep mitigation pathways, including net zero GHG emissions and 80-90% reduction from 2013 levels, feasible without additional nuclear power in EU-28 and Japan respectively. These pathways assume a combination of bio- and novel fuels and carbon capture and storage (CCS) or land-use based carbon sinks (IPCC_AR6_WGIII_Chapter04, Page:31, URL: [\[ref\]](#)).

Achieving net zero emissions from the industrial sector is also possible, requiring the provision of electricity free from greenhouse gas (GHG) emissions, increased electrification, low-carbon feedstocks, and a combination of energy efficiency, reduced demand for materials, a more circular economy, electrification and carbon capture, use and storage (CCUS) (IPCC_AR6_WGIII_Chapter17, Page:28, URL: [\[ref\]](#)).

However, it's important to note that while 100% renewable electricity generation by 2050 is found to be feasible, it is not without issues. Challenges exist with speed of expansion, ensuring sufficient supply at all times or higher costs compared to other alternatives (IPCC_AR6_WGIII_Chapter04, Page:28, URL: [\[ref\]](#)).

In modelled pathways that limit warming to 1.5°C, the share of fossil fuels in energy supply has to decrease significantly. This implies a rapid scaling down of new fossil fuel-related investments, combined with a scaling up of financing to allow energy and infrastructure systems to transition (IPCC_AR6_WGIII_Chapter15, Page:20, URL: [\[ref\]](#)).

▾ UNECE

▾ OSCE

▾ IEA

▾ IAEA

Summary

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Could we reach net zero targets without nuclear energy?



gpt-3.5-turbo gpt-4

Responses:

▾ WMO

▾ IPCC

▸ UNECE

Reaching net-zero targets without nuclear energy would be challenging, but not impossible. The transition from fossil fuels to low-and zero-carbon technologies is crucial for achieving net-zero emissions. Technologies such as solar and wind, hydrogen, and Carbon Capture, Utilization, and Storage (CCUS) are expected to progress and decrease traditional fossil fuel use. However, the practical delivery of any rapid pathway to carbon neutrality will be subject to infrastructure capacity and access to natural resources (Carbon Neutrality in the UNECE Region Technology Interplay under the Carbon Neutrality Concept, Page:31, UNECE, URL: [\[ref\]](#)).

Nuclear power has the potential to play a significant role in achieving net-zero emission targets. Some countries may choose to pursue nuclear power as a viable decarbonization option, while others may not due to concerns relating to safety, waste, or their endowment of natural resources. The push for decarbonization, increased energy prices, and improved safety measures are changing attitudes towards nuclear power, creating new markets for large-scale reactors and advanced nuclear power technologies (Carbon Neutrality in the UNECE Region Technology Interplay under the Carbon Neutrality Concept, Page:40, UNECE, URL: [\[ref\]](#)).

To achieve carbon neutrality by 2050, the supply of renewable energy will need to grow fastest, followed by nuclear power. Policies promoting renewable energy, alternative energy vehicles, CCUS, small nuclear power modular reactors, and new energy storage systems will be crucial (Carbon Neutrality in the UNECE Region Technology Interplay under the Carbon Neutrality Concept, Page:37, UNECE, URL: [\[ref\]](#)).

In conclusion, while it may be possible to reach net-zero targets without nuclear energy, it would require significant advancements and investments in other low-and zero-carbon technologies, as well as robust policy support.

▾ OSCE

▾ IEA

▾ IAEA

Ask from trusted resources

(UNECE, WMO, IPCC, IEA, IAEA, OSCE)

Could we reach net zero targets without nuclear energy?



gpt-3.5-turbo gpt-4

Responses:

▾ WMO

▾ IPCC

▾ UNECE

▾ OSCE

Reaching net zero targets without nuclear energy is theoretically possible, but it would require significant changes in energy infrastructure, policy, and technology. The transition would need to rely heavily on renewable energy sources such as wind, solar, and hydroelectric power. However, these sources face challenges such as intermittency, the need for significant grid infrastructure upgrades, and financial obstacles (Advancing Energy Security in Central Asia, Page:32, OSCE, URL: [\[ref\]](#) Protecting Electricity Networks from Natural Hazards, Page:61, OSCE, URL:<https://www.osce.org/secretariat/242651>).

Decentralized energy solutions, such as autonomous renewable energy facilities, could also play a role, particularly in remote or difficult-to-reach areas that currently rely on coal (Advancing Energy Security in Central Asia, Page:33, OSCE, URL:<https://www.osce.org/oceea/513787>).

The European Union's roadmap for reducing greenhouse gas emissions by at least 80% by 2050 primarily through renewable energy generation demonstrates that ambitious renewable energy targets can be set and pursued. However, achieving these targets will require substantial changes to the grid infrastructure and an increase in the share of renewable energy (Protecting Electricity Networks from Natural Hazards, Page:61, OSCE, URL:<https://www.osce.org/secretariat/242651>).

Financing the transition to clean energy is a significant challenge, and governments will need to provide new targets and strategies for financing the transition (Advancing Energy Security in Central Asia, Page:25, OSCE, URL:<https://www.osce.org/oceea/513787>).

In conclusion, while it is theoretically possible to reach net zero targets without nuclear energy, it would require overcoming significant challenges and making substantial changes to our current energy systems (In-house knowledge).

▾ IEA

Could we reach net zero targets without nuclear energy?



gpt-3.5-turbo gpt-4

Responses:

▾ WMO

▾ IPCC

▾ UNECE

▾ OSCE

▾ IEA

▾ IAEA

▾ Summary

Reaching net zero targets without nuclear energy is theoretically possible, but it would present significant challenges. Nuclear power currently provides a substantial portion of low-carbon electricity, and it is projected to grow in the future to meet net zero targets. For instance, in 2021, nuclear power was the second-largest source of low-carbon electricity, providing 10% of electricity generation globally. To achieve net zero emissions by 2050, nuclear capacity needs to grow towards 871GW, which requires annual capacity additions to be nearly four times their recent historical average (Reference: Climate Resilience for Energy Security, Page:75, ORG:IEA, URL: [\[ref\]](#)).

However, some studies have found deep mitigation pathways, including net zero GHG emissions and 80-90% reduction from 2013 levels, feasible without additional nuclear power in EU-28 and Japan respectively, but assuming a combination of bio-and novel fuels and CCS or land-use based carbon sinks (Reference: IPCC_AR6_WGIII_Chapter04, Page:31, ORG:IPCC, URL: [\[ref\]](#)).

Moreover, 100% renewable electricity generation by 2050 is found to be feasible, but it is not without issues. Challenges exist with speed of expansion, ensuring sufficient supply at all times or higher costs compared to other alternatives (Reference: IPCC_AR6_WGIII_Chapter04, Page:28, ORG:IPCC, URL: [\[ref\]](#)).

In conclusion, while it is theoretically possible to reach net zero targets without nuclear energy, it would require significant advancements in renewable energy technologies, energy efficiency, and carbon capture and storage, as well as changes in energy consumption behaviors. It's also important to note that the feasibility of a non-nuclear pathway may vary by country, depending on factors such as natural resource endowments, infrastructure capacity, and policy support.