Challenges of the Global Energy Sector:

Impacts on Security, Transition and the Role of Renewable

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session

"Energy, Sustainability and Transport"

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Market Leaders and Scenarios for the 21st Century

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I

Setting the scene

current world energy situation:

Energy in Transition – the long term outlook

Global Energy Scene - Energy in Transition to NZE

- **COP26 confirmed strong commitment of governments, business and public to speed up the structural energy transition underway,**
- **Unlike the past shifts, the unfolding transition:**
  - is not taking place because of resource shortages, economic reasons, or technical imperatives;
  - Nor is it moving up towards higher energy and power densities;
  - rather, it is moving towards lower energy density (biomass vs. fossil fuels); lower power density, coupled with need for mass-scale distance transmission & stowage
- **However following Russian war in Ukraine war, energy security became another compelling driver**

- **ET is now characterised by heightened uncertainties, with increased volatility & likely disruptions , including uncertainties about:**
  - **Global economic growth**
  - **Availability of the huge investments required:**
  - **will investments in Res accelerate in Europe and elsewhere following COVID19 & war ?**
  - **will investments in Non-Re recover following Ukraine war?**
  - **Price of Supply (especially oil and gas), with increasing volatility as war rage in Ukraine and conflicts continue in producing regions & threat of economic and political instabilities rise**
- **Climate policies and move to accelerate energy independence may now be**

Long Term World Energy Outlook: Different Assumptions & approaches/targets of ET yield major differences in most aspects

- **Some, like IEA's NZE and IRENA's set the target and work backward to find out pathways , including policies, technology innovation and investments needed**

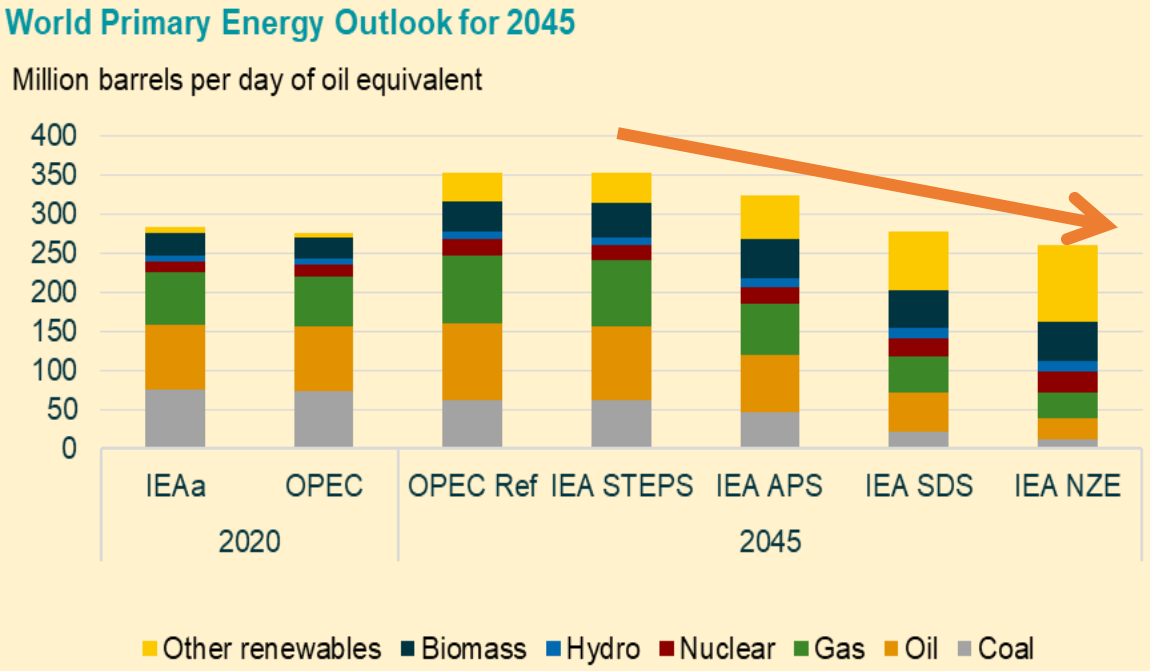
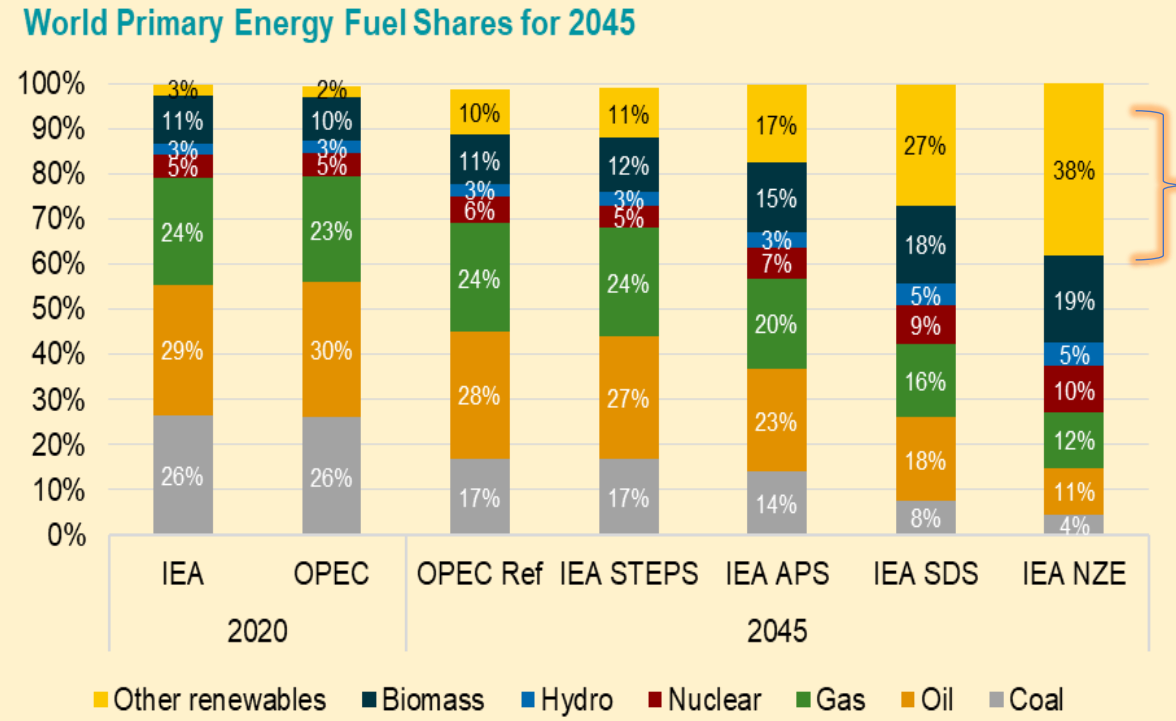


Figure 14 data sources: IEA WEO 2021, Annex Tables; OPEC WOO2021, Table 2.1 for Reference Case.
Figure 14 note: a IEA primary energy is converted from EJ per year to mboe/d by multiplying by 0.4825 mboed/EJ.
OPEC Sensitivity Scenarios do not provide fuel-specific data for non-fossil fuels.

Source: IEF- rff- comparison report 2022

- **Others, EIA, OPEC, etc.. continue to develop scenario with assumptions about GDP growth, prices and Climate POLICIES that lead to fast transitions without fixing the end post or choice of technology or primary sources**

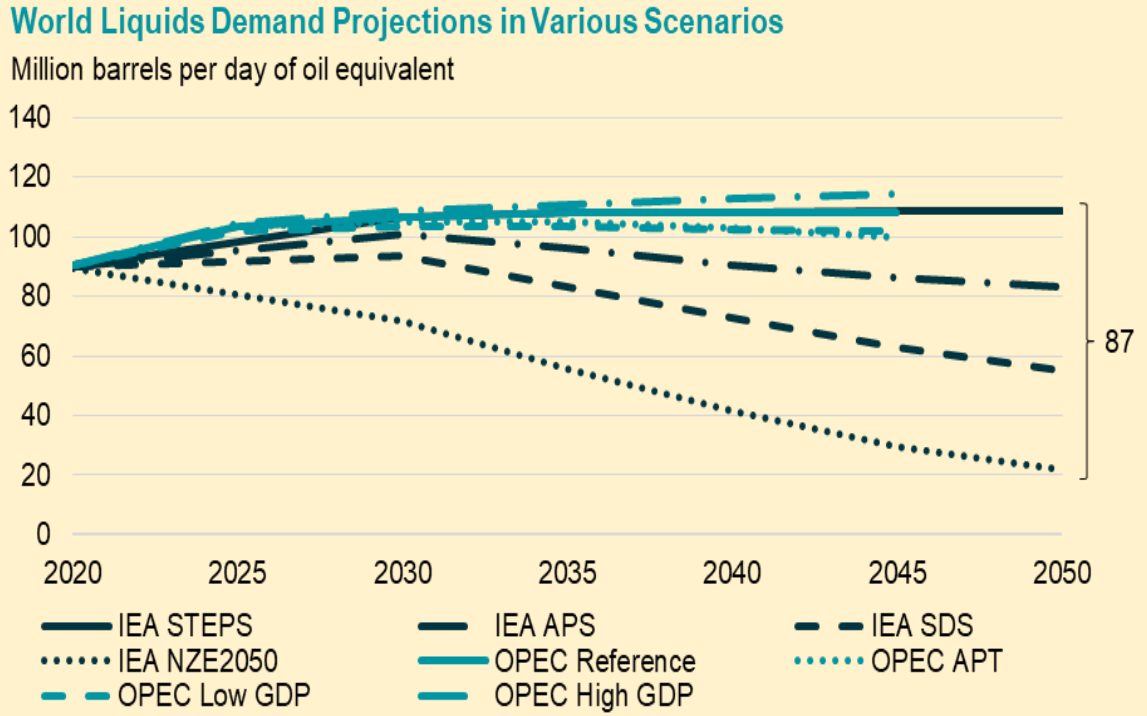


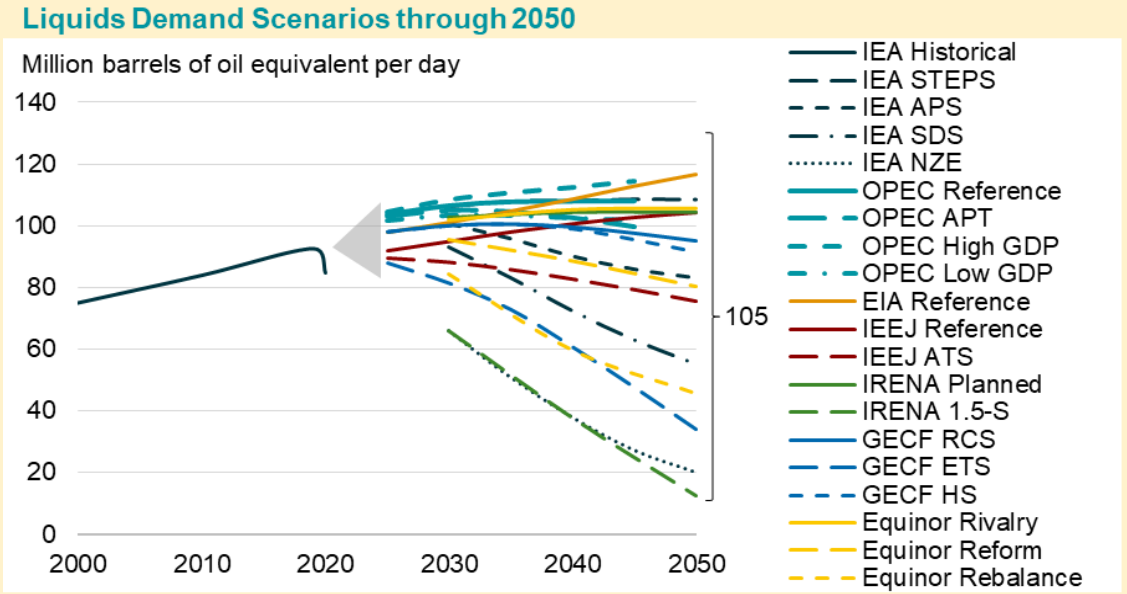
Source: See Figure 13. Sums in the data callouts may not total due to rounding.

World Liquids Demand Projections vary dramatically in Various Scenarios (*The Non-OECD region accounts for over 60 percent of liquids demand in all scenarios into 2045*)

the gap between IEA's NZE and that of OPEC's reference for liquid demand is huge @ 87 mbd

the gap between the highest scenario (EIA Reference) and lowest scenario (IRENA 1.5°C) is even larger, at 105 mb/

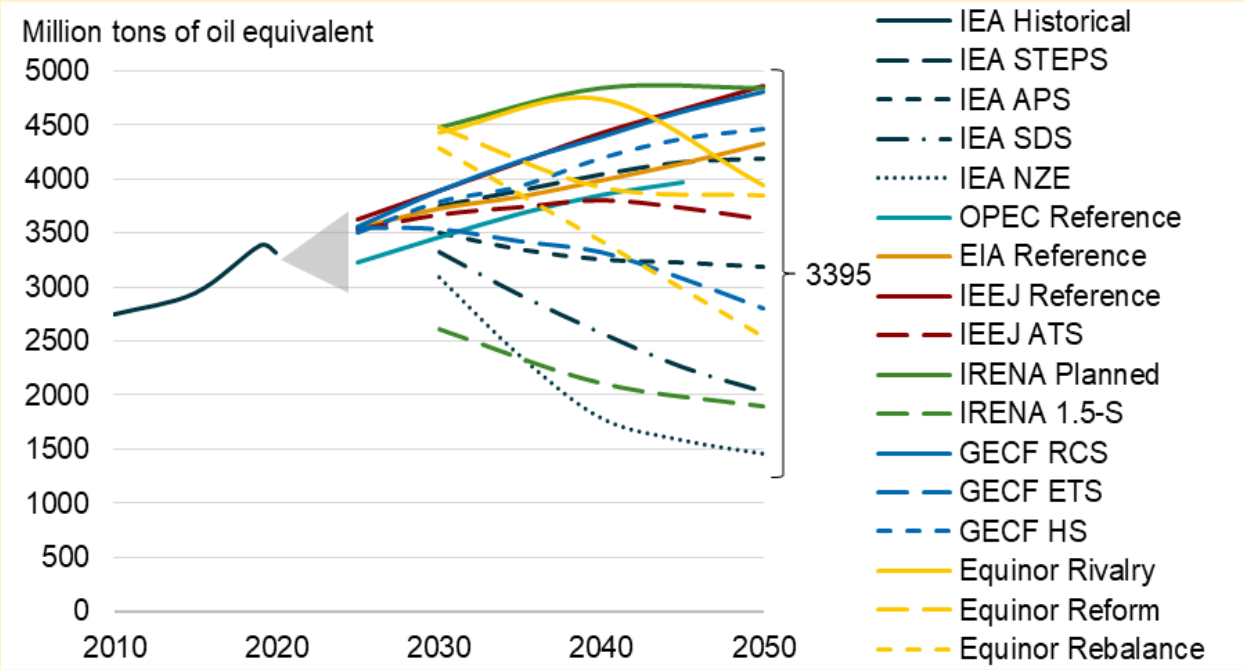




Source: IEF- rff- comparison report 2022

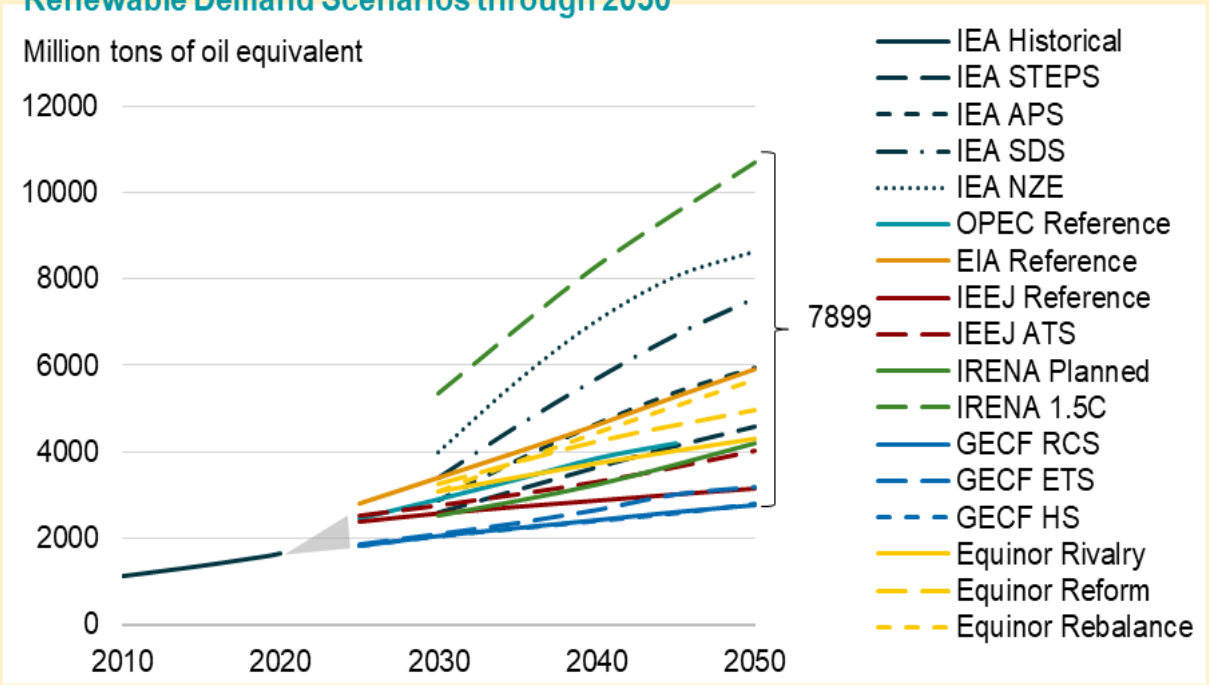
Huge differences between the projections for highest and lowest natural gas demand (3395 mtoe) in 2050, and even more huge for Renewable (7899 mtoe)

NG Demand Scenarios through 2050



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

Renewable Demand Scenarios through 2050



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

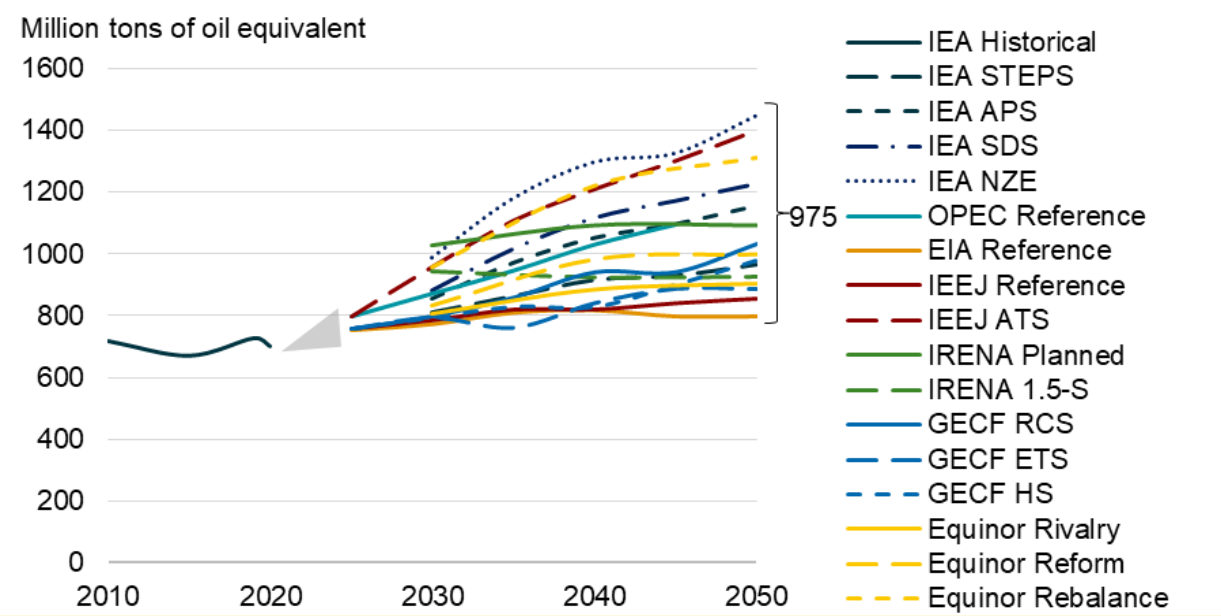
Source: IEF- rff- comparison report 2022

Large difference between the projections for highest & lowest Nuclear Demand (975 mtoe) in 2050, and even larger difference for needed deployment of CCUS (3213 m metric tons)

Nuclear demand grows much more rapidly under climate and technology scenarios

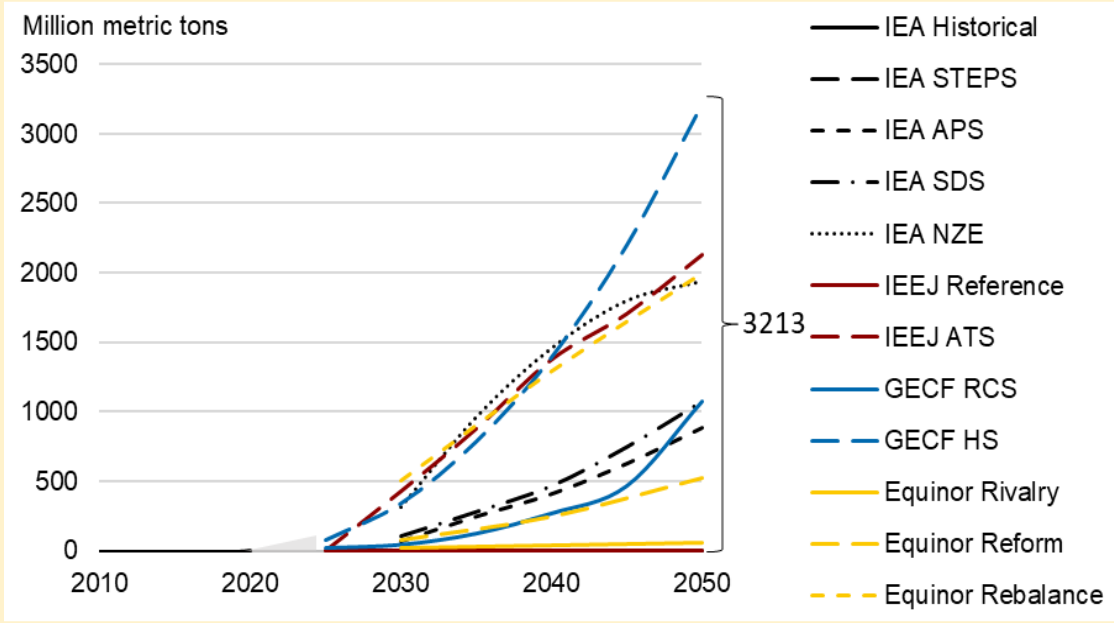
CCUS is prerequisite for large scale decarbonization of fossil fuels and DAC (Both critically needed as per most recent IPCC reports

Nuclear Demand Scenarios through 2050



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

CCUS Deployment Scenarios through 2050



Source: IEA WEO2021 Annex Tables, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

Source: IEF- rff- comparison report 2022

Key issues, and questions about fast pathways to NZE 2050

- Will total global energy use actually drop ~8% by 2050? with ~2 billion more people!
- Will ET proceed fast & just enough?
  - With Regional differences remaining large & ET not yet as high on the governments' nor people's Agenda in many parts of world
  - wouldn't China, India, SE Asia, etc.. need more time to NZE, & chose to use more nuclear, blue & green H & HC?
- How realistic the huge drop in fossil fuels use in IEA's NZE2050 to 25% of its present value?
- How realistic & What are implications of "no investment in new fossil fuel supply"? Tight markets, instability & volatility?

- Is it technically feasible that global electricity become all Re by 2040? What about the cost of storage & flexibility as its share increase > ~30%
- Who will pay the huge $3 Trillion/y investments by 2030? (tax payers in AEs? Who pays for the legacy CO2? [Indian view]
- International cooperation is critical - Will citizens in AEs vote for governments to spend huge amounts or vote them out? especially huge transfers needed by many EMDEs –w/o it their pathway to NZE not likely-
- Will required behavioral changes materialize soon enough? Case of COVID19
- What about developing geoengineering solutions, as insurance, ready to deploy if all fail? (e.g. need for DACs highlighted by IPCC)

II

***what** are the prospects for the price of oil and other commodities? **what** will be the probable impacts of the war in Ukraine?*

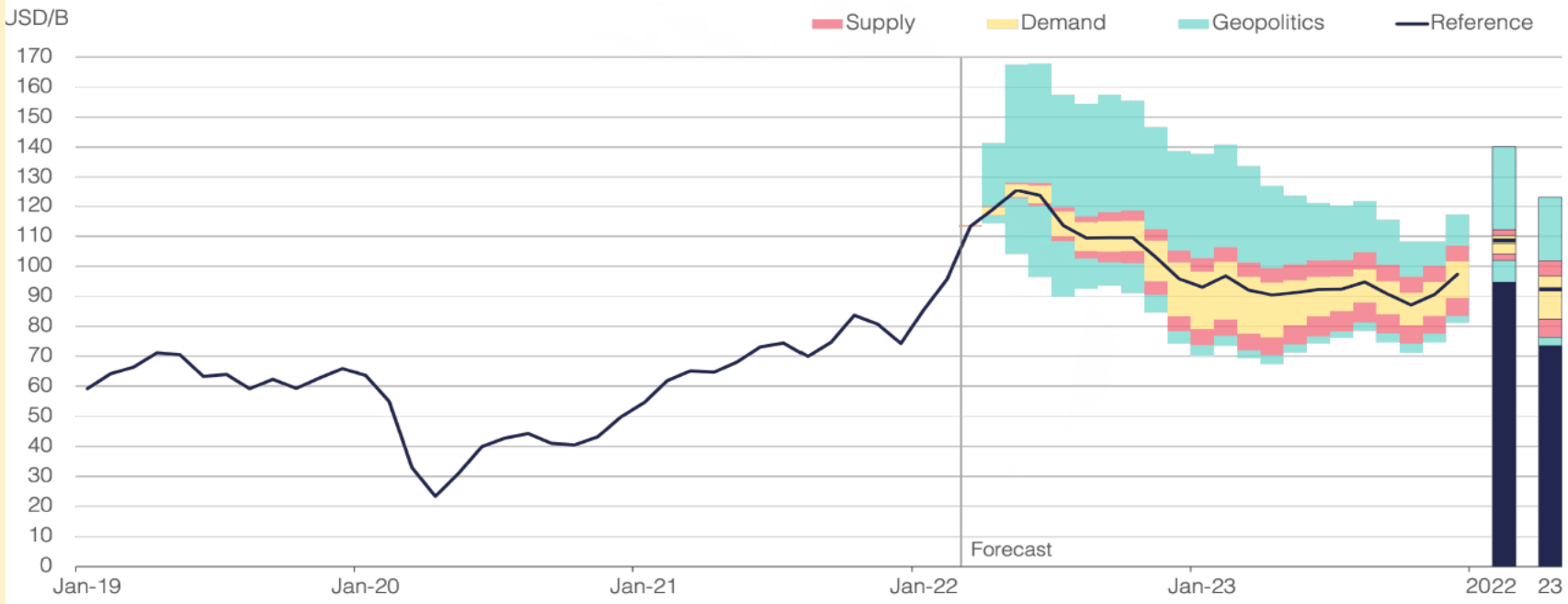
Oil Price Risks over the period 2022-2023

- **OIES Price Risk modelling**
- **Combining supply, demand and geopolitical risks**
- **Volatility high in both years, but eases towards H2 2023**
- {95-140} $/b in 2022
- {74-123} $/b in 2023

Oil price risks

Oil price volatility appears extremely high in both years but gradually eases towards H2 2023, with the annual Brent price bounds ranging between $95/b and $140/b in 2022 and $74/b and $123/b in 2023.

Balance of risks

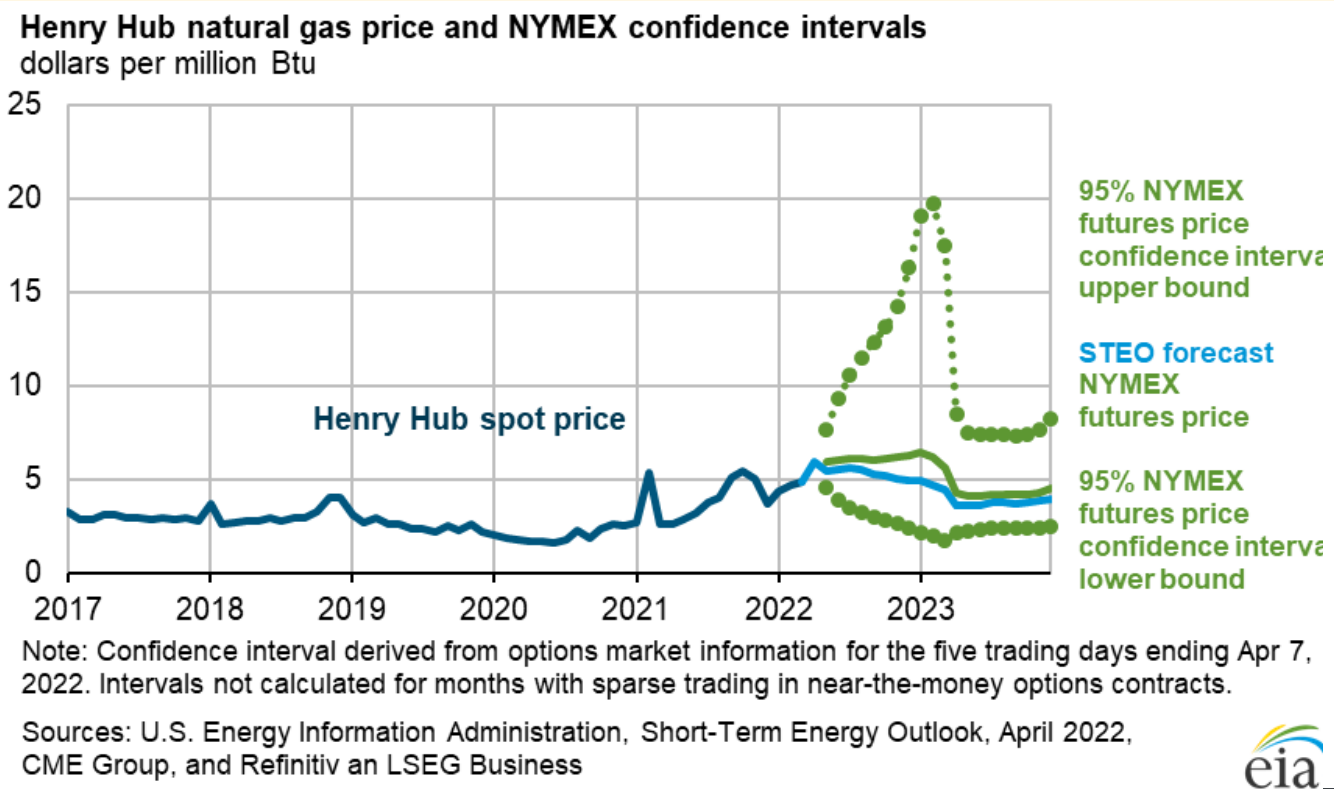


Notes: Brent price in *Reference case*.
Source: OIES

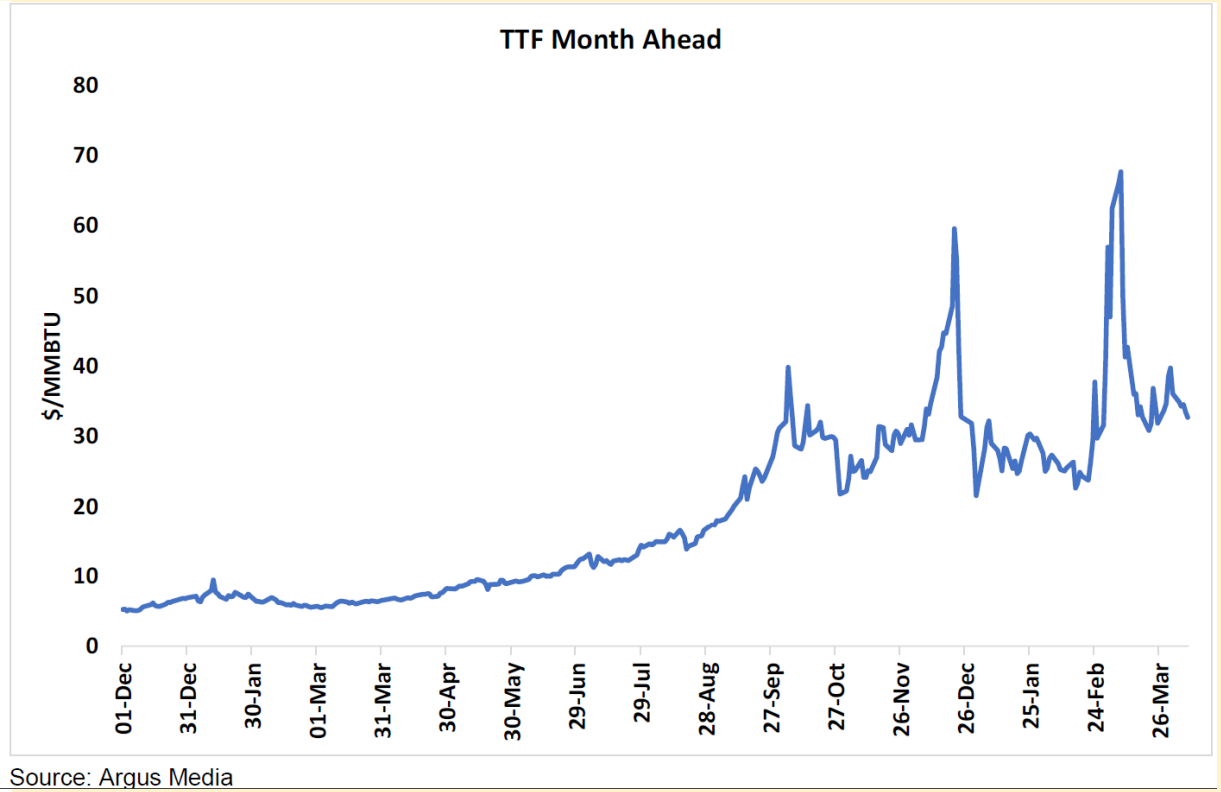
BALANCE OF RISKS

Natural gas price development in US and Europe exhibit current and expected continued volatility

HH spot price & NYMEX confidence intervals



TTF month ahead gas prices



Source: Argus Media

III

Challenges of the global energy sector in the current geopolitical scenario (following Russian war in Ukraine) and the role of renewable sources in overcoming them.

The Case of Europe

Europe leadership in Energy Transition: Setting progressively more Ambitious climate/green energy targets, especially since 2015

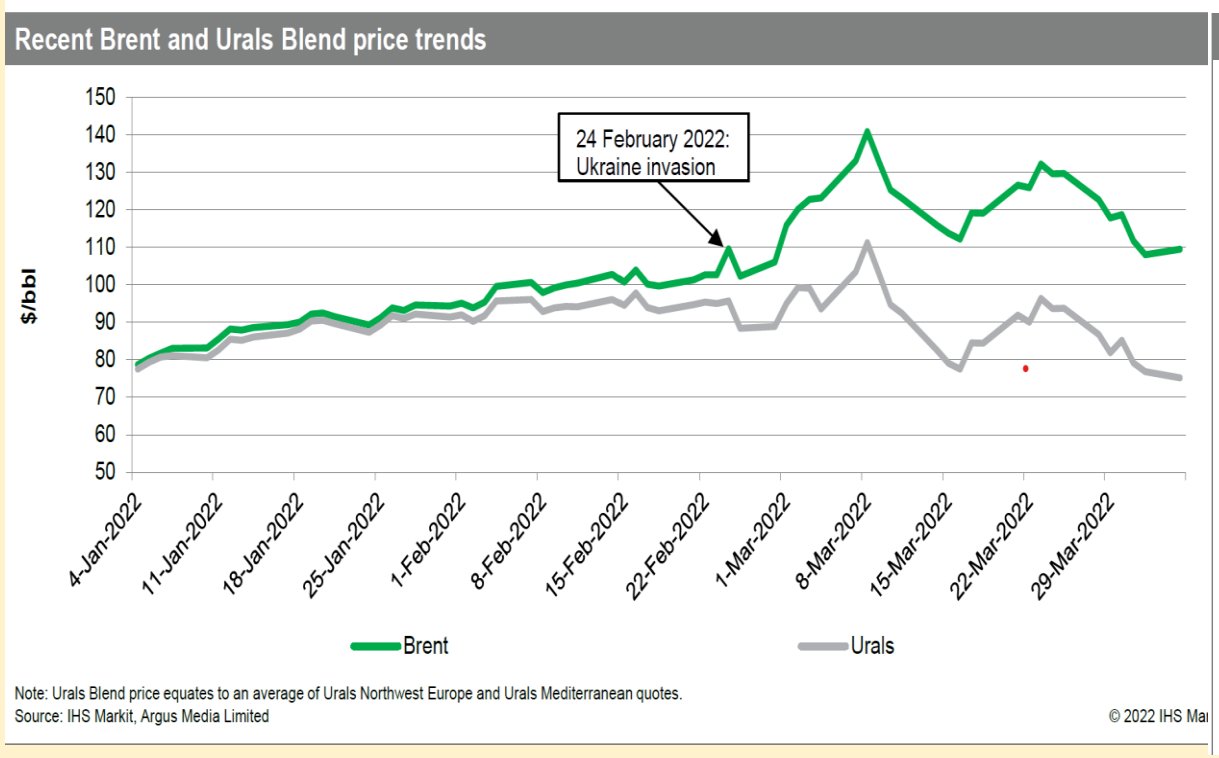
- **EU has been leader in adopting national & EU wide plans, policies & programs in response to Climate change**
- **Relying almost exclusively on Renewable for new power capacity in GER resulted in progressively higher costs as share approach 30-40%**
- **EU Climate score card since Paris Agreement indicate good progress, though many challenges threaten ability of reducing emissions by 50% by 2030. More is needed!**
- **The latest is the Green Deal announced 2019: with series of policies, programs, investments:**
  - **To transform EU to modern, resource efficient & competitive decoupled economy growth, NZE by 2050; & no person or place behind**
- **The War in Ukraine created more urgency to accelerate the rolling out of the plan, updating targets and advancing timelines, (e.g. Fit for 55: cut by 55% by 2030)**
- **With prospect of expanding sanctions against Russia, plans are in place to move away of all Russian energy imports, including proposed:**
  - **RePowerEU, aiming to terminate dangerous overdependence on fossil fuels from Russia before 2030:**
- **Coal imports from Russia is easiest to cut; followed by Oil. Gas hardest if not impossible w/o severe hardship**
- **IEA, others, have recommended similar plans. All involve accelerated Renewable, but over the short term other measures are more impactful**

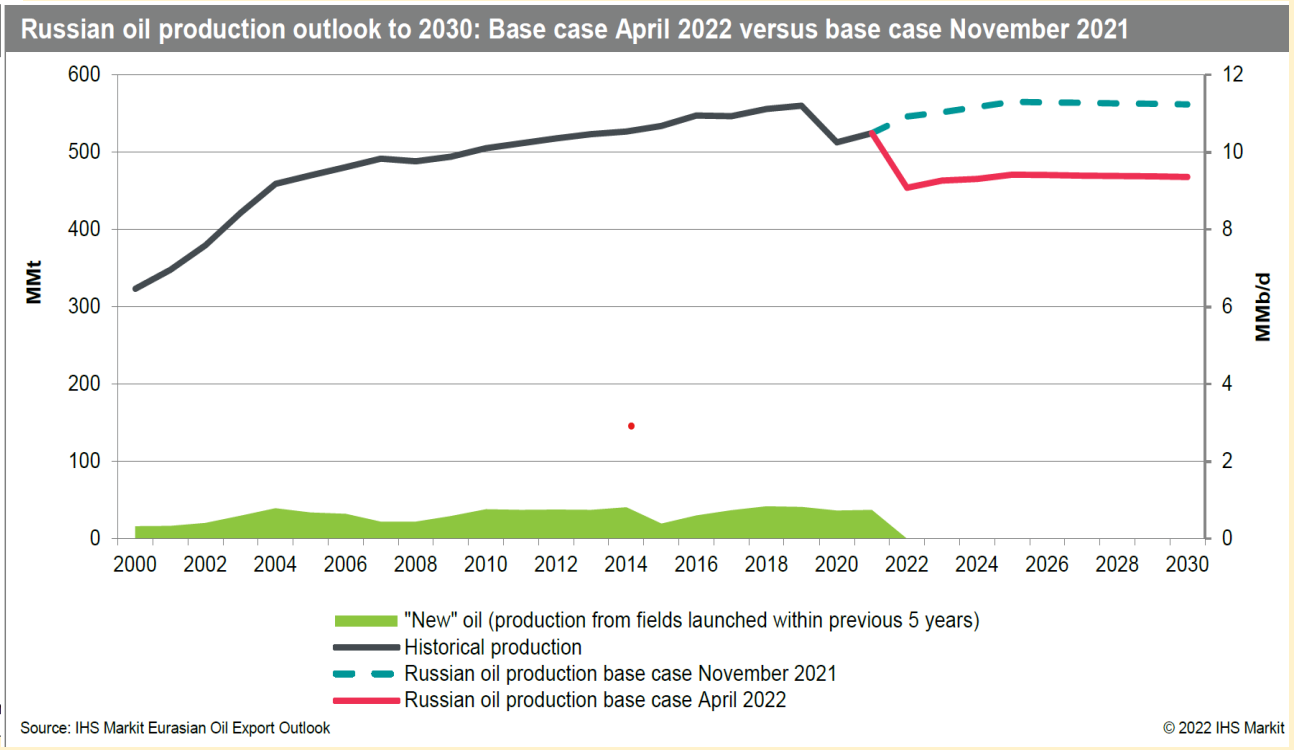
Relative weight of EU/Russia oil trade is not symmetrical

- EU imported~ 27% of its oil from Russia – relatively easier to replace over short term
- Russia export ½ of its crude to EU – It can find other markets, but must offer heavy discount initially and need years to recover exports fully

~ Half of Russia's oil crude exports (2.2/4.7 mbd) goes to EU, with ~ 1.2 mbd of products (NL, GER, POL largest

Dependence on Russian imports vary between 80% (e.g. Finland) to less than 5% (e.g. Austria); Germany ~ 30%

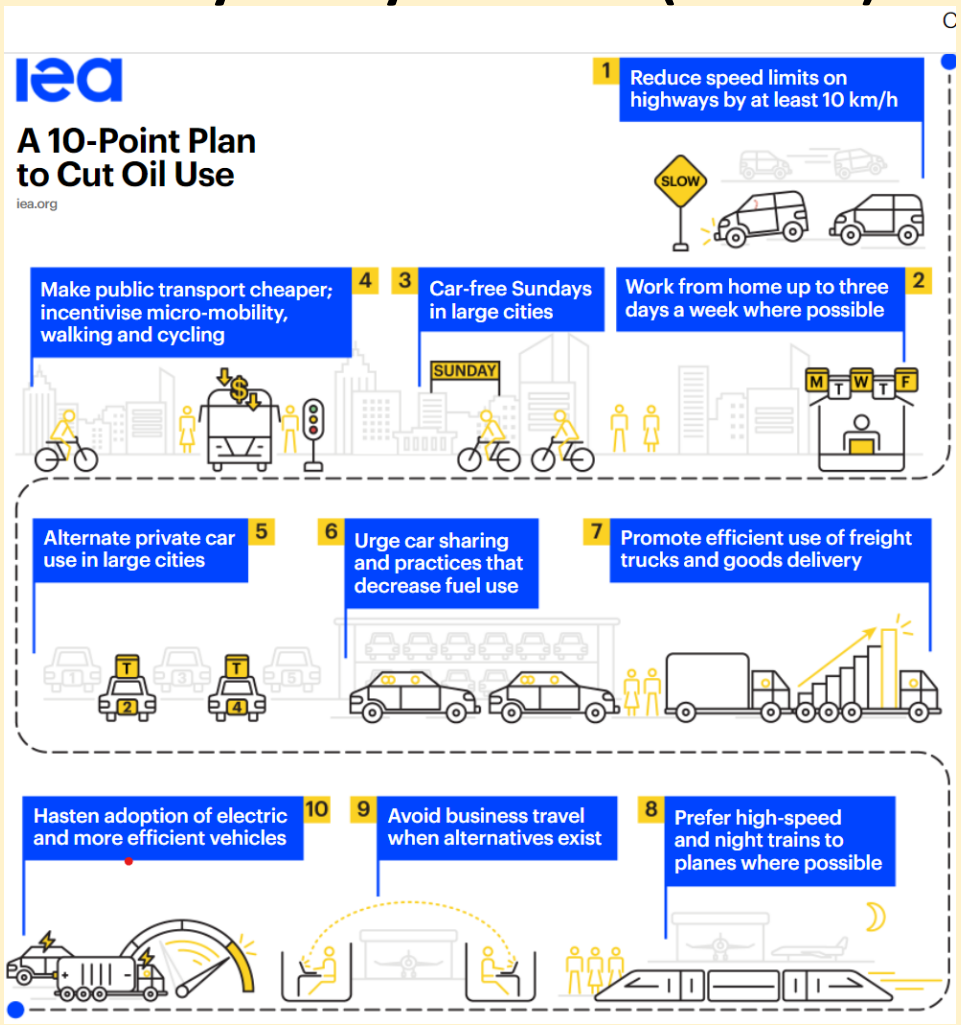




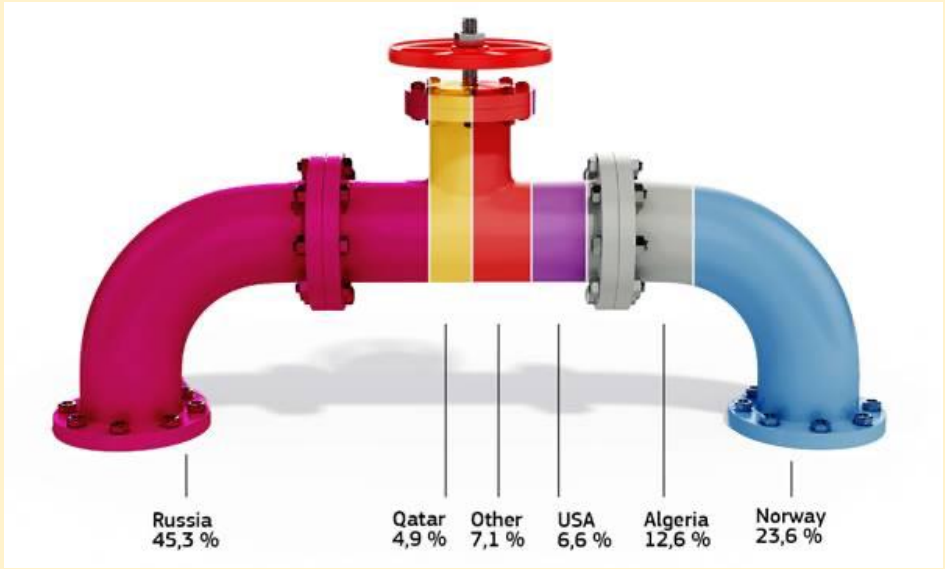
IEA issued a) 10 point plan to Cut Oil Use for transport in OECD & b) Guide on how individuals can help to reduce reliance on Russian energy

How individuals can save money, reduce reliance on Russian energy

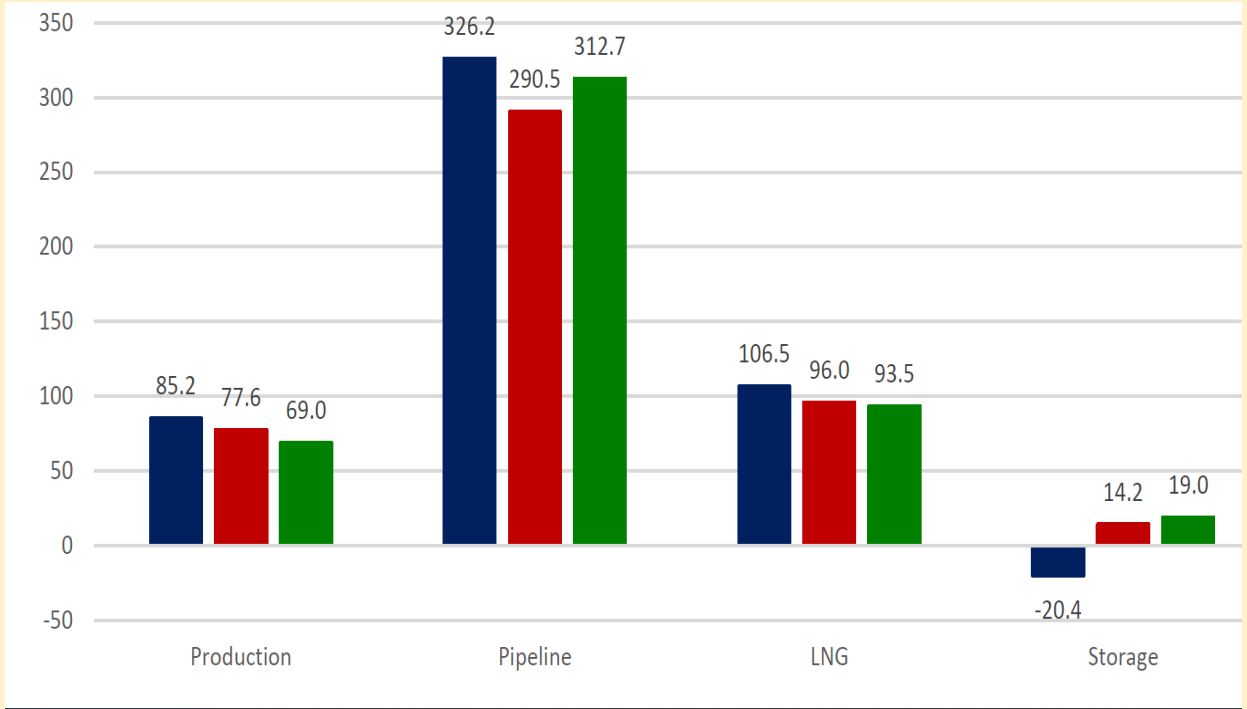
10 point plan to cut transport fuel in OECD by 9% by summer (3mbd?)



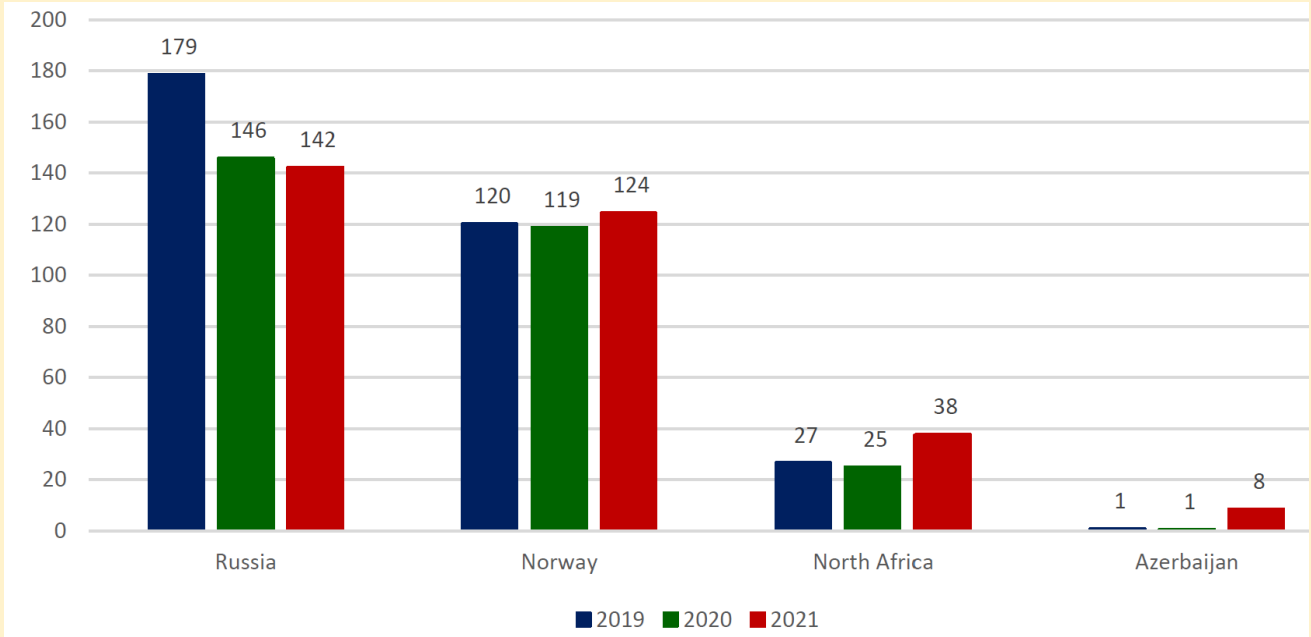
Current Major suppliers of NG to Europe (2021)



Gas supply to Europe by source



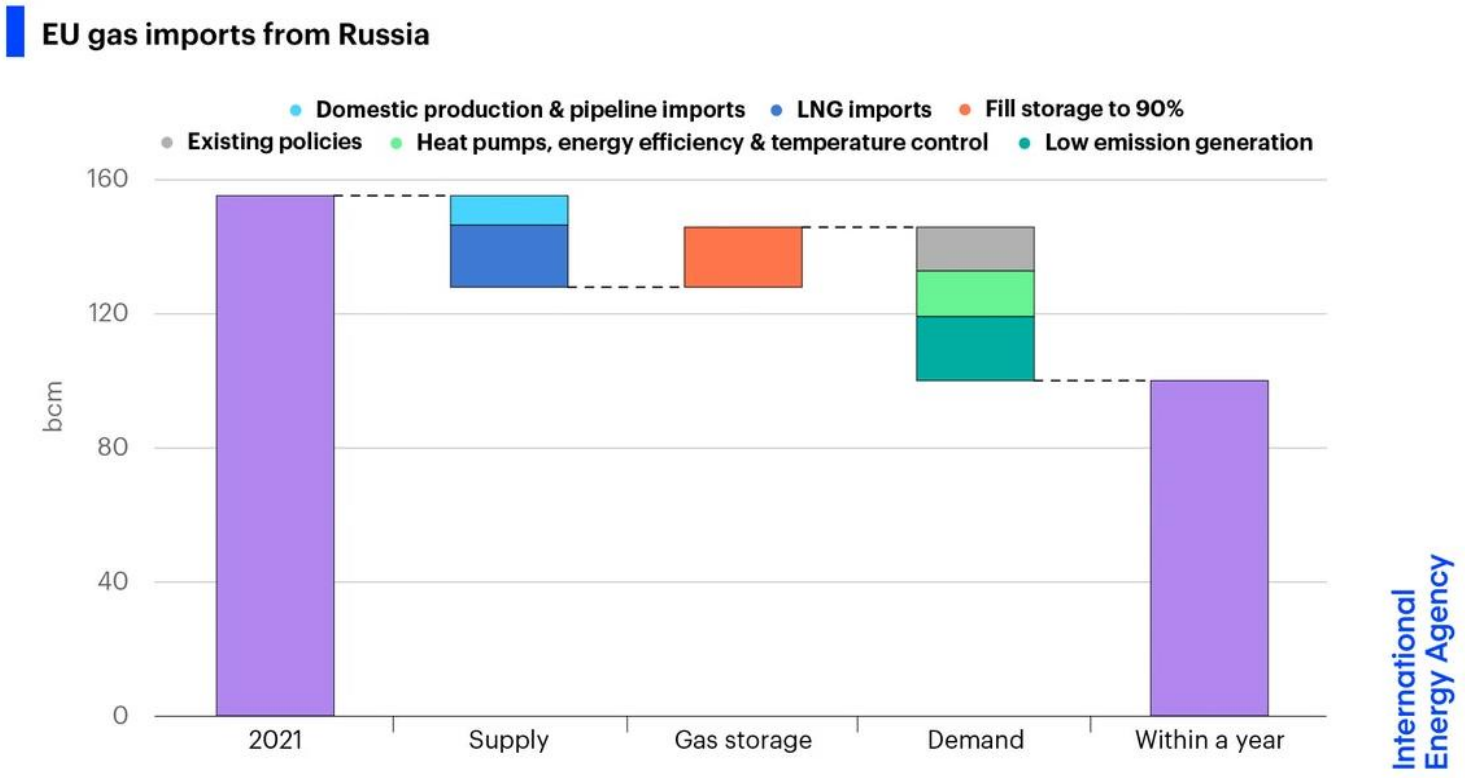
European pipeline gas imports by source



Source: Data from the ENTSOG Transparency Platform. Graph by the authors

IEA's 10 point plan to Reduce EU dependence on Russian Gas by 1/3 within a year – Accelerated Renewable impact small

1. Do not sign any new gas supply contracts with Russia. [**Impact**: Enables greater diversification of supply this year and beyond]
2. Replace Russian supplies with gas from alternative sources [**Impact**: Increases non-Russian gas supply by around 30 bcm within a year]
3. Introduce minimum gas storage obligations [**Impact**: Enhances resilience of the gas system by next winter]
4. Accelerate the deployment of new wind and solar projects [**Impact**: Reduces gas use by 6 bcm within a year]
5. Maximise power generation from bioenergy and nuclear [**Impact**: Reduces gas use by 13 bcm within a year]
6. Enact short-term tax measures on windfall profits to shelter vulnerable electricity consumers from high prices [**Impact**: Cuts energy bills even when gas prices remain high]
7. Speed up the replacement of gas boilers with heat pumps [**Impact**: Reduces gas use by an additional 2 b bcm within a year]
8. Accelerate energy efficiency improvements in buildings and industry [**Impact**: Reduces gas use by close to 2 bcms within a year]



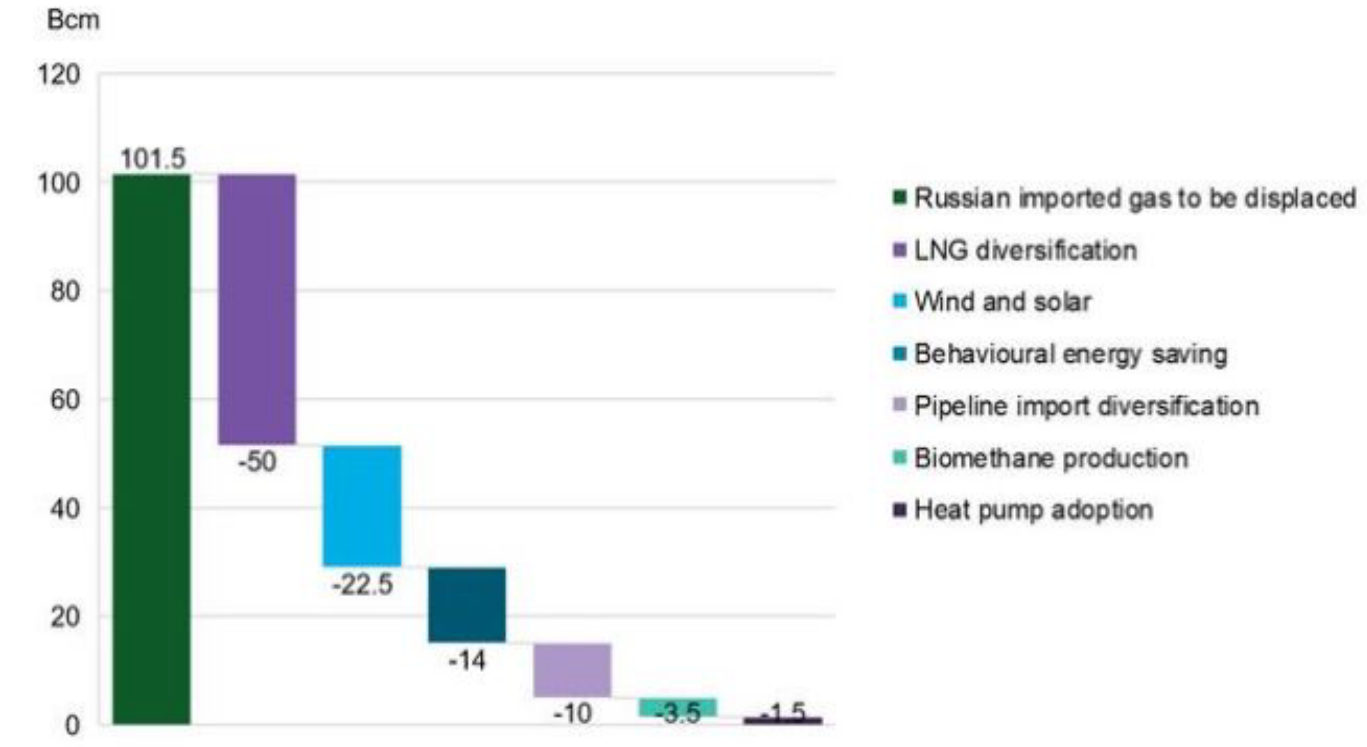
9. Encourage a temporary thermostat reduction of 1 °C by consumers [**Impact**: Reduces gas use by some 10 billion cubic metres within a year]

10. Step up efforts to diversify and decarbonise sources of power system flexibility [**Impact**: Loosens the strong links between gas supply and Europe's electricity security]

EU short & medium term plans for cutting Russian gas imports are ambitious

- They are doable but need more time, and Risk of locking in LNG and delay achieving NZE by 2050

Targets of EU plan to reduce Russian imports by 2/3 by Sectors 2/3 by next winter



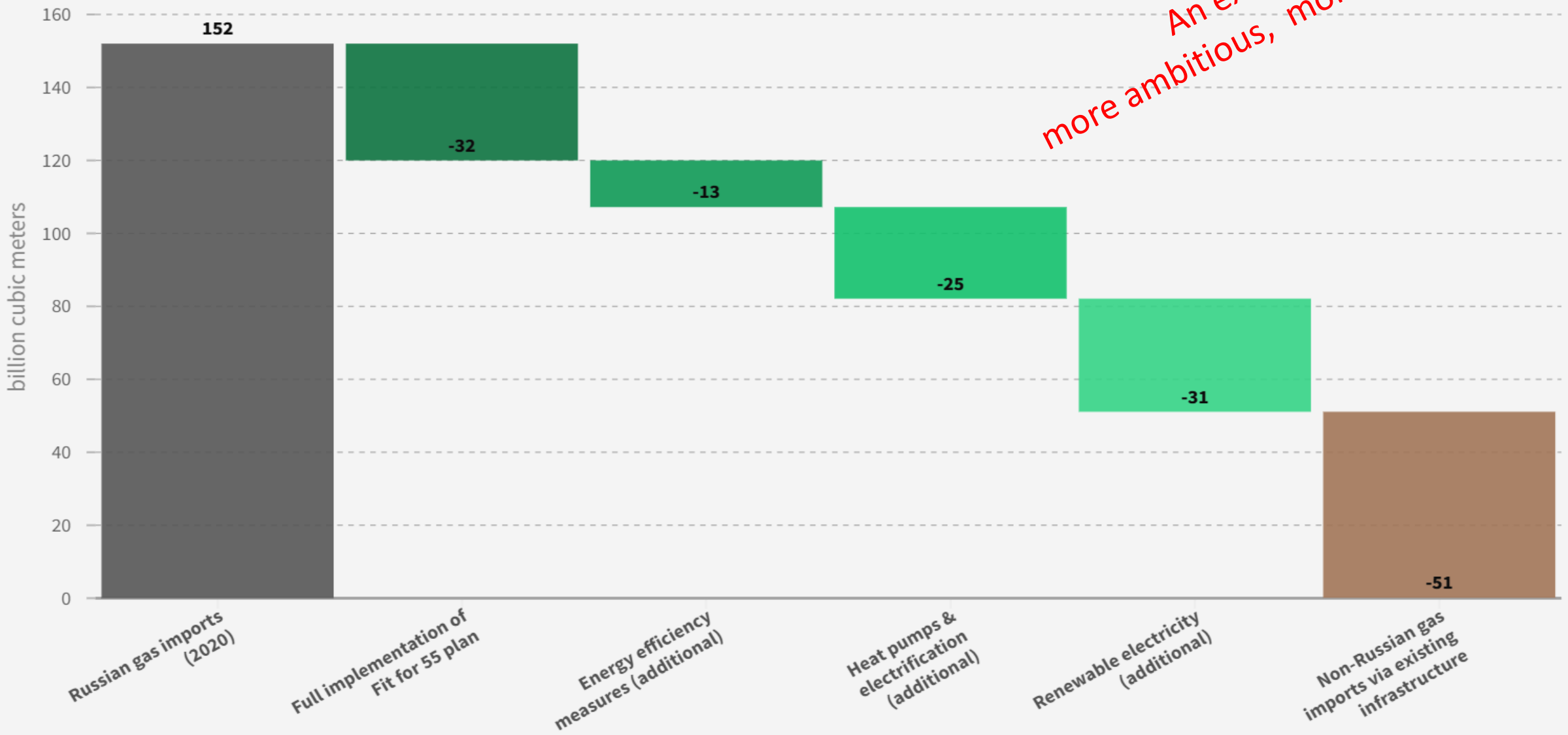
Source: European Commission

REPowerEU aims to replace all 155 bcm/a of Russian gas (2021), through

- Urgent action on prices to protect consumers
- Refilling gas storage for next winter (90%)
- Cut dependence on Russian gas through:
  - more RTPV, HPs and energy saving;
  - decarbonizing industry,
  - speeding up renewable to minimize time to roll out projects,
  - diversifying gas supplies ;
  - doubling EU ambition for biomethane, and
  - Hydrogen accelerator

EU can stop Russian gas imports by 2025

Russian gas imports cut by 2025 through the implementation of Fit for 55 plus additional clean energy solutions

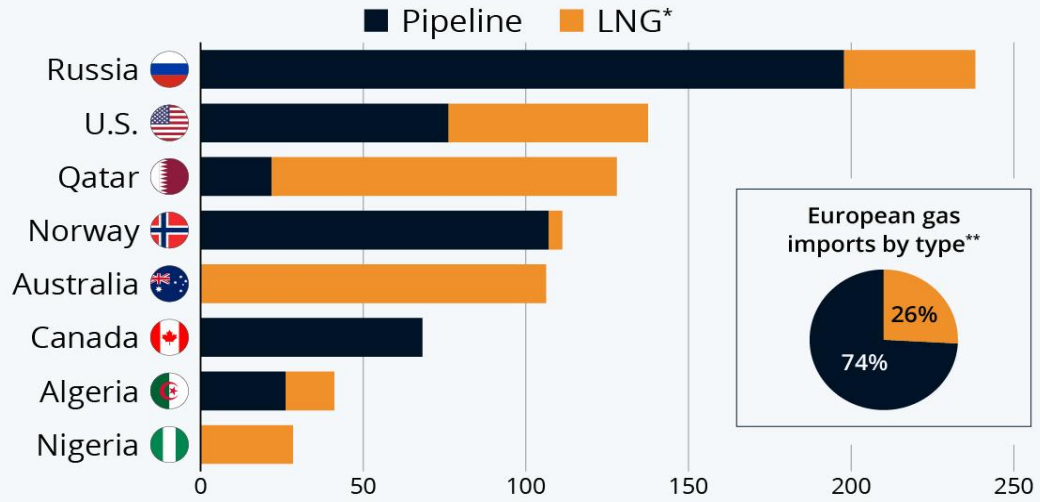


Who is vulnerable & What Alternatives Does Europe Have to Russian Gas?

Absolute volumes and share, %, matter in understanding the ease or difficulty of reducing or cutting Russian Gas imports - Case of Germany

What Alternatives Does Europe Have to Russian Gas?

Main gas exporting countries in 2020,
by type of export (in billion cubic meters)



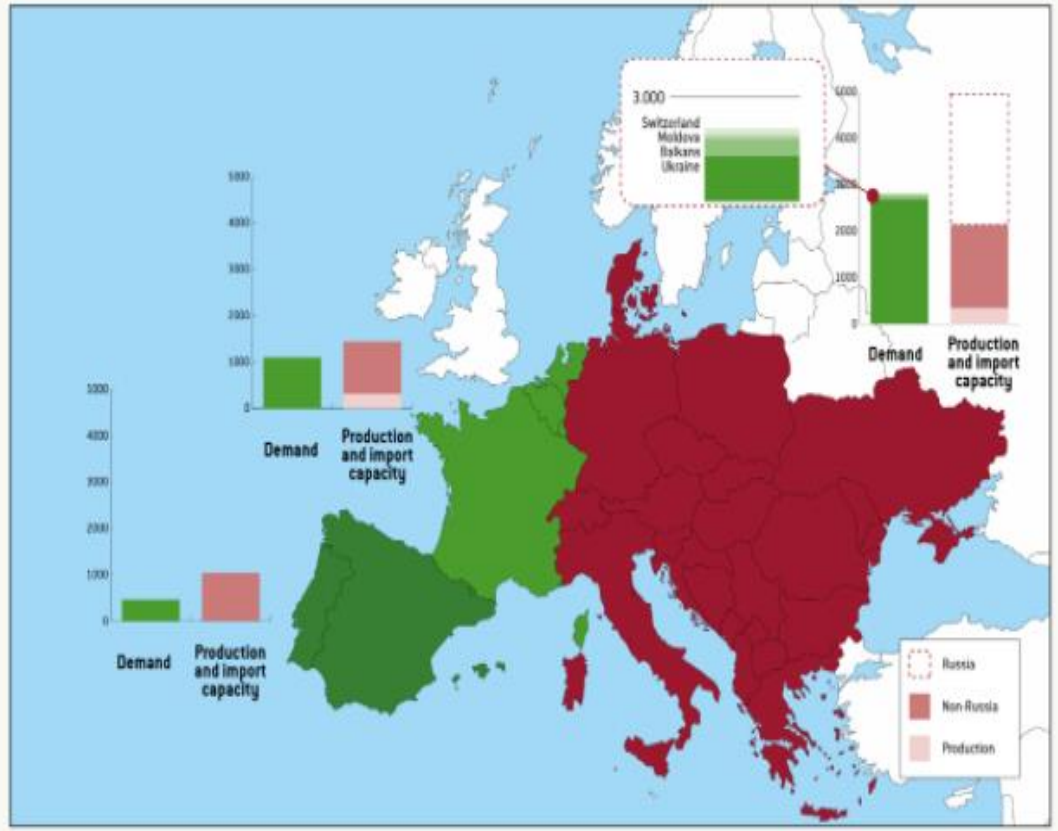
* typically exported by ship
** EU-27 + UK (2020)

Sources: BP - Statistical Review of World Energy 2021,
U.S. Energy Information Administration

statista

Figure 2: Direct exposure to a gas disruption from Russia differs across Europe

bruegel



Sources: Bruegel based on Eurostat (nrg_cb_gasm), ENTSOG, GIE, GIIGNL, GIE, NPD.

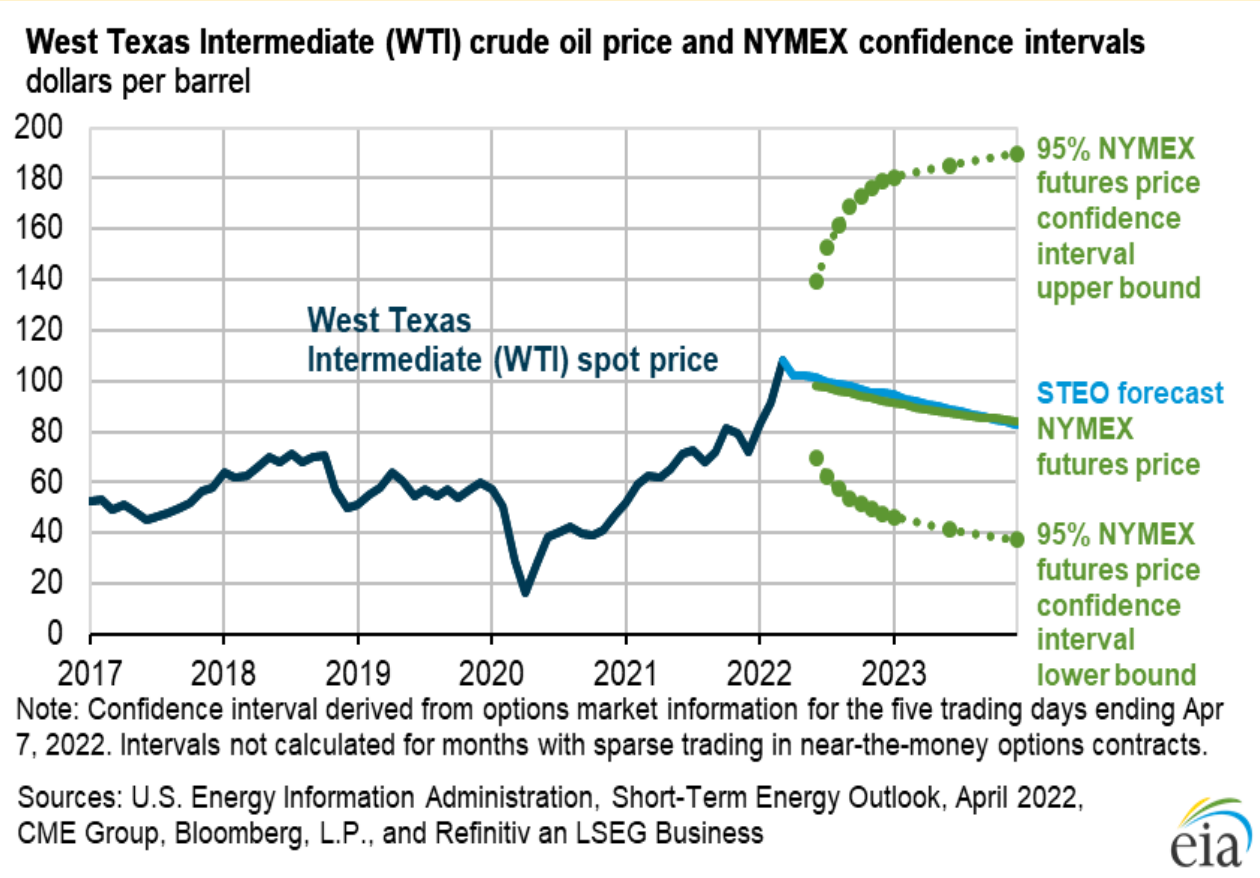
Closing Remarks

- Energy transition is likely a **very uneven journey;**
  - **Europe is moving fast** towards clean energy economy
  - **Asia and Africa will** continue to rely heavily on fossil fuels for the foreseeable future
  - **Fossil exporters racing** to secure markets for clean decarbonized HC fuels (e.g.blue hydrogen)
- The transition needs **new** governance structures, **driven by strong government policy and proactive support to technology innovation and financing**
- **ET will proceed fastest and least costly if all low carbon technologies that could contribute competitively, on LC cost, net emissions and Health Risk, are pursued equally (as in CCE)**
- **Pace of energy transition highly uncertain, and fraught with black swans, like COVID19 & War in Ukraine – each offer opportunities and risks**
- Expectations and perceptions are changing faster than potential changes in energy mix
- **Technology mastering and dominance battles of ET will produce winners and losers** and alter the existing geopolitical relationships
  - How to identify winners and losers?
  - What are the implications of winning/losing?
    - **Winners: China and the EU**
    - **Losers: Russia?**
    - **What about the US? its foreign policy?**
    - **What about MENA and other major O&G exporters?**
- **Old geopolitics revolved around access to resources and trade flows, but transition is about electrons, assumed to offer more security/self sufficiency - not self evident!**
- **Security & NZE feasible via diversifications of sources, resources and technologies**

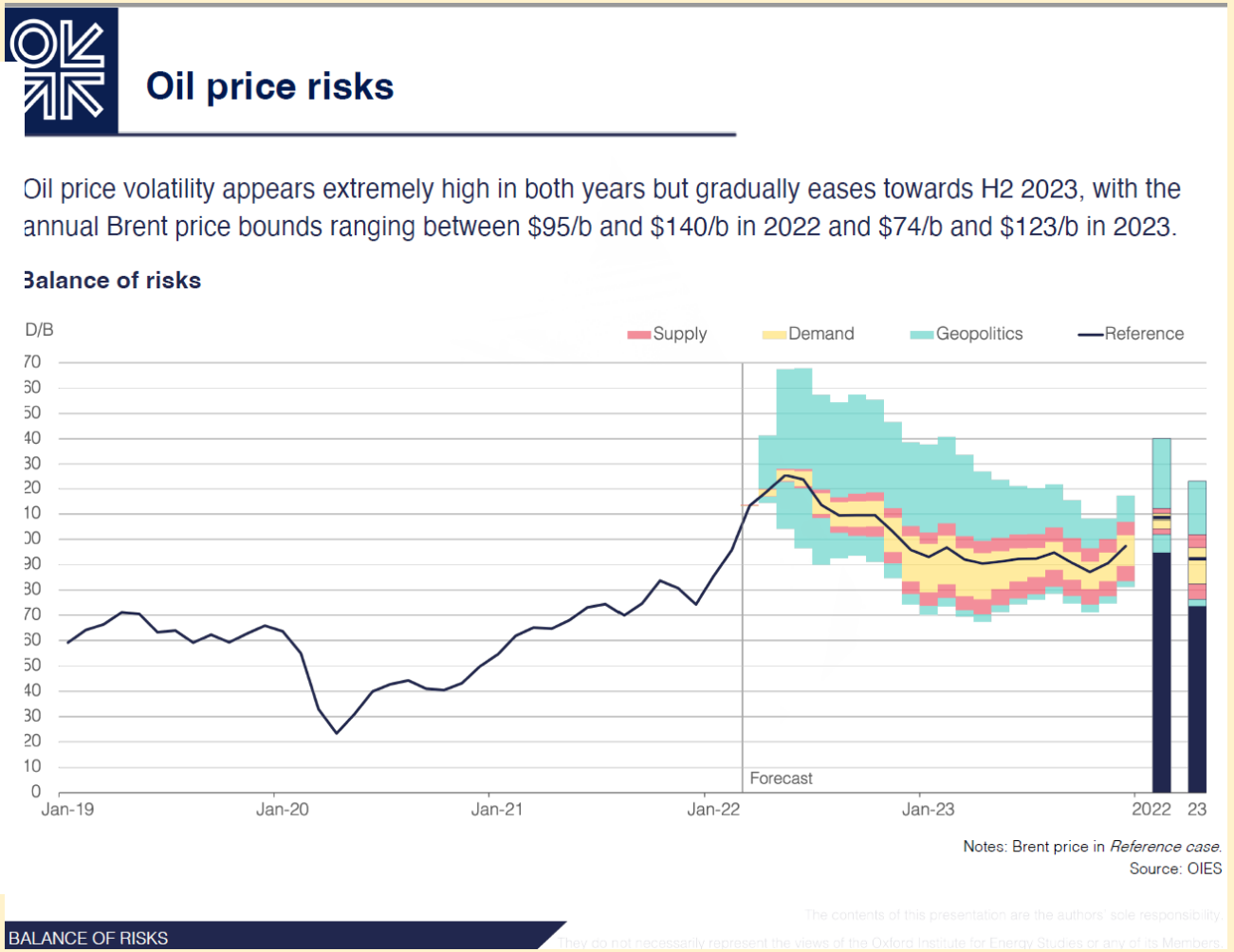
Thank you

Oil Price Risks over the 2022-2023

EIA price outlook with futures price confidence interval



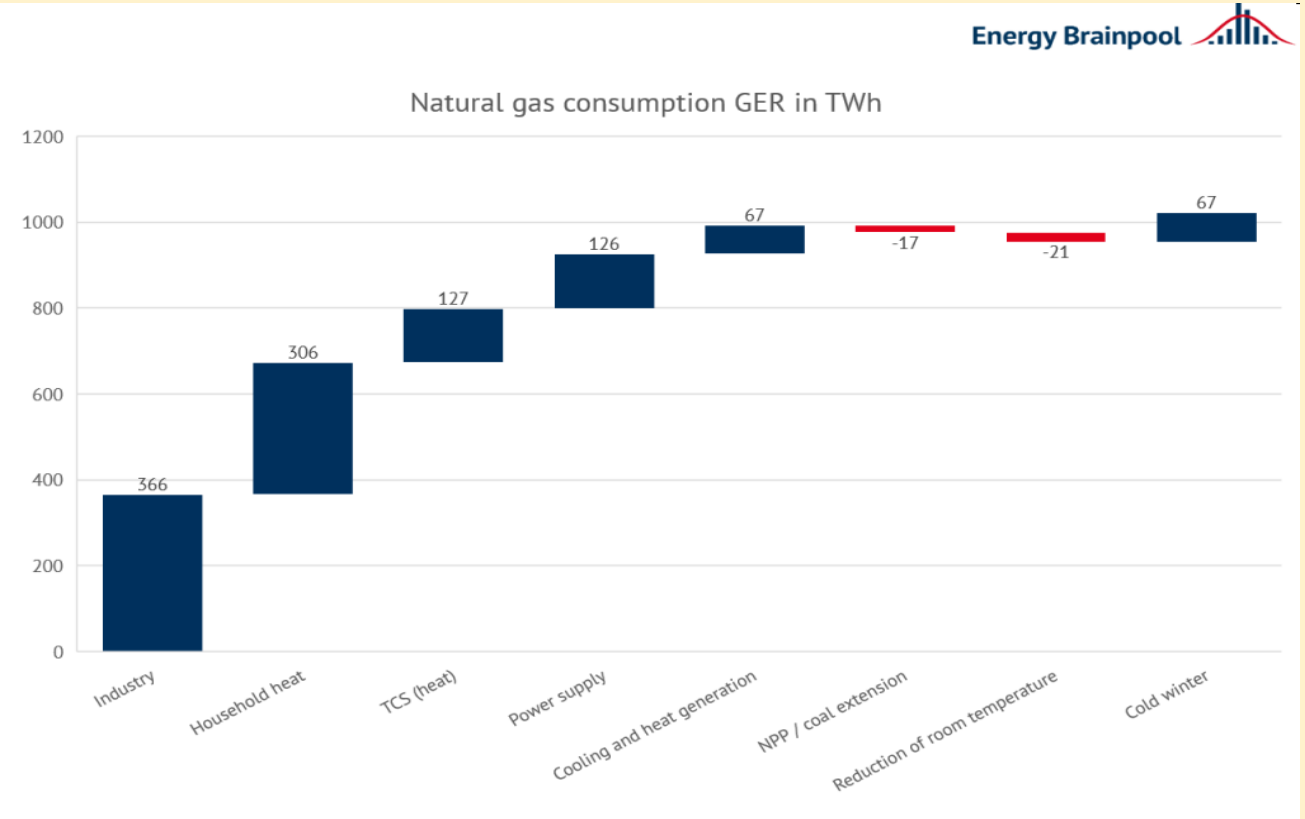
OIES price Risk combining supply, demand and geopolitical risks



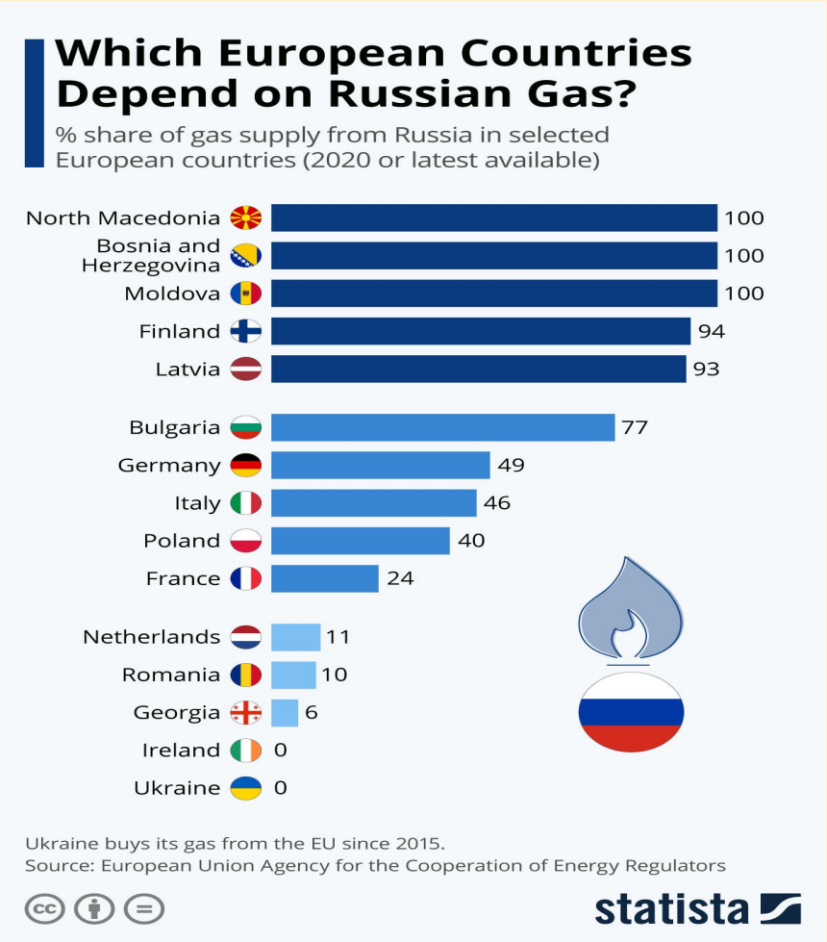
Absolute volumes and share, %, matter in understanding the ease or difficulty of reducing or cutting Russian Gas imports

Case of Germany

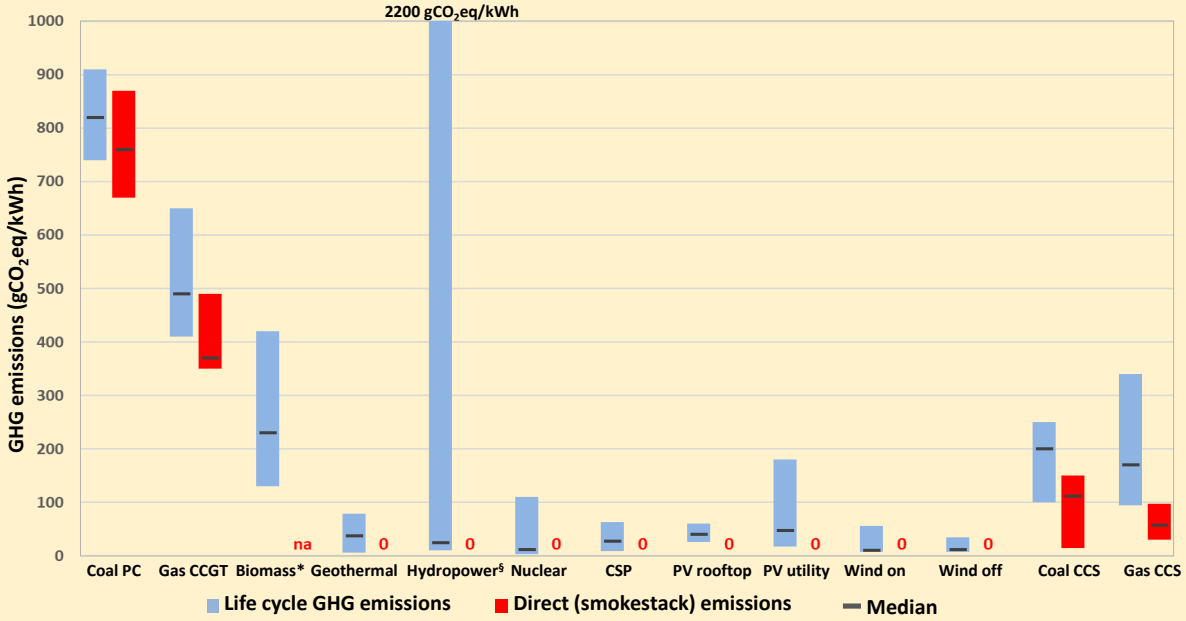
Natural gas consumption in Germany, by Sector,



Dependence of European Countries on Russian Gas



All low carbon technologies that could contribute competitively, on LC cost, net emission and Health Risk, should be pursued to speed up reaching NZE targets and energy security (as described for by the CCE framework endorsed by G20 in, 2020)



*Biomass CO_2 emissions from combustion are assumed to be absorbed again when it regrows again.
§The global median GHG of hydropower is 24 gCO_2-eq/kWh. Hydro reservoirs can release up to 2,200 gCO_2-eq/kWh due to decomposition of flooded organic material.