PROJECT:

GLOBAL ENERGY TRENDS COMPREHENSIVEANALYSIS OF KEY REGIONSS AND GENERATION MODES USING POWER BI

Abstract: -

This paper explores the technical and economic characteristics of an accelerated energy transition to 2050, using new datasets for renewable energy. The analysis indicates that energy efficiency and renewable energy technologies are the core elements of that transition, and their synergies are likewise important. Favourable economics, ubiquitous resources, scalable technology, and significant socio-economic benefits underpin such a transition. Renewable energy can supply two-thirds of the total global energy demand, and contribute to the bulk of the greenhouse gas emissions reduction that is needed between now and 2050 for limiting average global surface temperature increase below 2 °C. Enabling policy and regulatory frameworks will need to be adjusted to mobilise the six-fold acceleration of renewables growth that is needed, with the highest growth estimated for wind and solar PV technologies, complemented by a high level of energy efficiency. Still, to ensure the eventual elimination of carbon dioxide emissions will require new technology and innovation, notably for the transport and manufacturing sectors, which remain largely ignored in the international debate. More attention is needed for emerging infrastructure issues such as charging infrastructure and other sector coupling implications.

INTRODUCTION: -

Global energy trends are characterized by increasing demand, a shift towards renewable energy sources, and efforts to decarbonize the energy sector, with fossil fuels still dominating but facing increasing pressure from renewables like solar and wind. Record prices, fuel shortages, rising poverty, slowing economies: the first energy crisis that's truly global. Energy markets began to tighten in 2021 because of a variety of factors, including the extraordinarily rapid economic rebound following the pandemic.

Here's a more detailed overview:

1. **Rising Global Energy Demand:**

Global energy demand is steadily increasing, driven by population growth, rising living standards, and industrialization, particularly in emerging economies.

2. **Dominance of Fossil Fuels:**

Despite the growing trend towards renewables, fossil fuels (coal, oil, and natural gas) continue to be the primary source of global energy supply, accounting for over 80%.

3. **Shifting Energy Mix:**

There's a noticeable shift towards renewable energy sources, with solar and wind power becoming increasingly competitive and cost-effective.

4. **Renewable Energy Growth:**

Renewable energy sources like solar and wind are experiencing rapid growth, with solar PV and wind power generation expected to surpass hydropower and nuclear power by 2030.

5. **Decarbonisation Efforts:**

There's a growing global focus on decarbonizing the energy sector, with efforts to reduce carbon emissions from the energy supply and end-use sectors.

6. **Energy Efficiency:**

Improving energy efficiency is crucial for reducing energy consumption and emissions, with ongoing efforts to enhance energy efficiency in various sectors.

7. **Electricity Sector Transformation:**

The electricity sector is undergoing a transformation, with renewables playing an increasingly important role in meeting global electricity demand.

8. **Specific Trends: China's Energy Consumption:** China's energy consumption is growing rapidly, playing a significant role in global energy demand and consumption.
   BRICS Energy Consumption: The BRICS (Brazil, Russia, India, China, and South Africa) countries are experiencing significant energy consumption growth, accounting for a large share of global energy demand.

   OECD Energy Consumption: In contrast to the BRICS, energy consumption in the OECD (Organization for Economic Cooperation and Development) countries has declined in recent years due to factors like moderate economic growth and weak industrial activity.

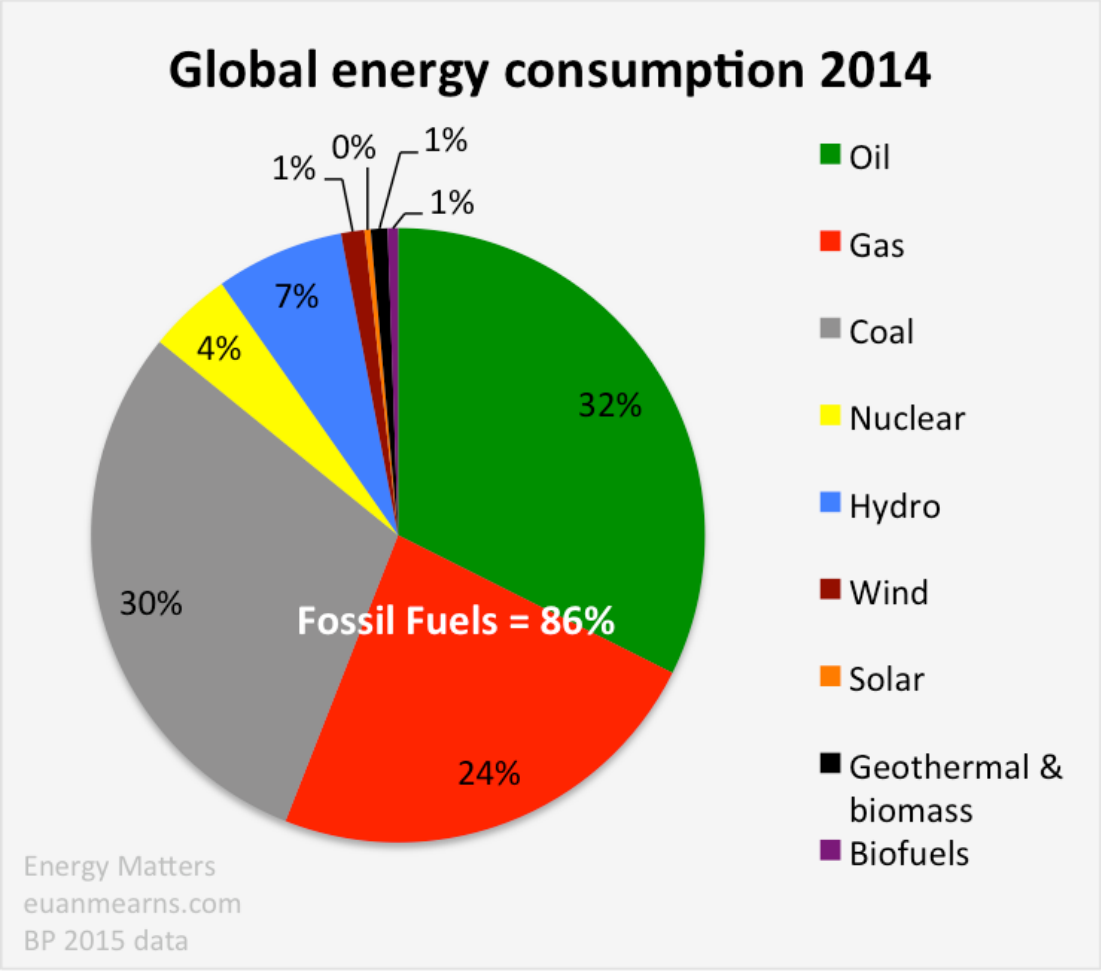


Fig. Global Energy Consumption 2014

Renewable Energy Growth:

- **Rapid Expansion:**

  Renewable energy sources like solar and wind are expected to grow at record rates, with global solar capacity projected to double by 2025.

- **Overtaking Coal:**

  Renewables-based electricity generation is projected to overtake coal-fired electricity generation by 2025.

- **Meeting Demand:**

  Clean electricity supply, including renewables and nuclear, is forecast to meet all of the world's demand growth through 2026.

- **Increased Capacity:**

  Global renewable power capacity additions need to reach an average of 1,066 GW per year from 2023 to 2050 under the 1.5°C scenario.

- **Electrification:**

  A high rate of electrification in sectors like transport and buildings will require a twelve-fold increase in renewable electricity capacity by 2050, compared to 2020 levels.

  Fossil Fuels Decline:

- **Coal Decline:**

  The combined share of coal, natural gas, and petroleum liquids is projected to decrease significantly by 2050.

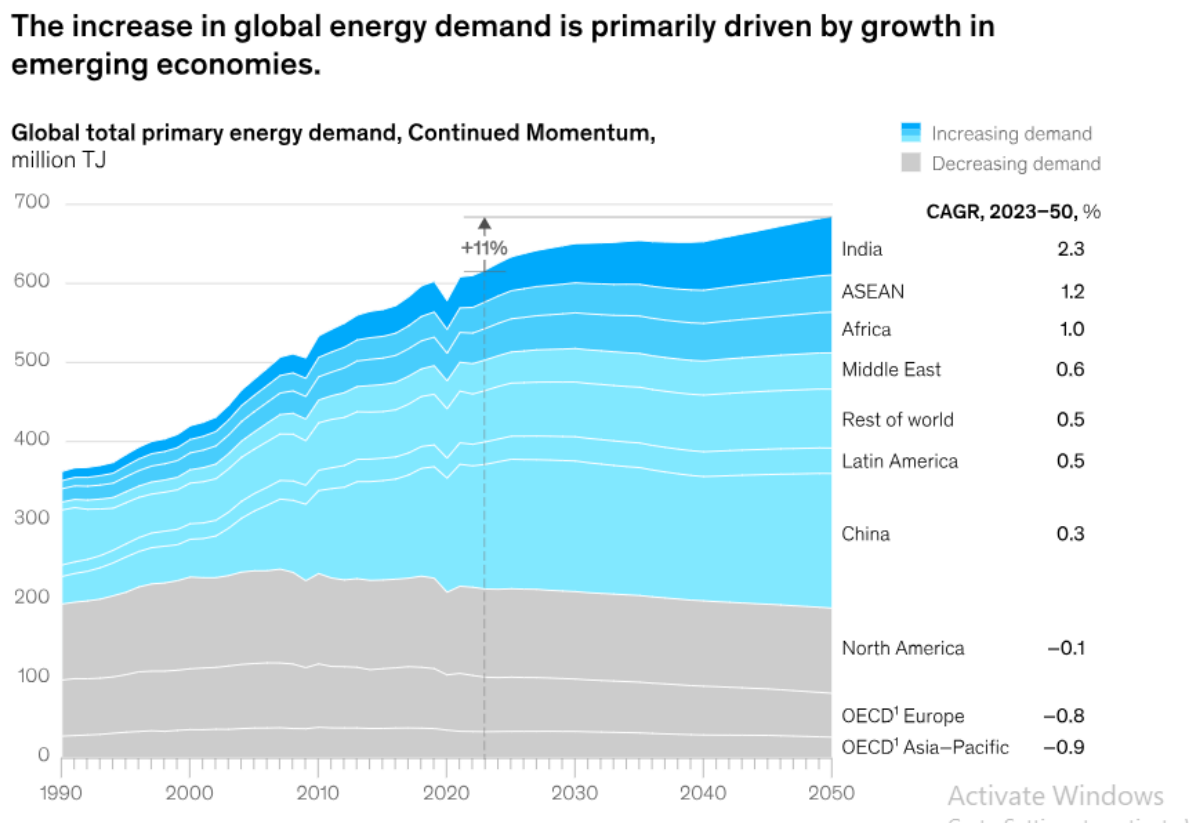


Fig. Global Energy Growth in countries

Global energy demand is projected to continue to increase to 2050: -

Global energy demand is growing faster than expected and a more challenging geopolitical landscape—combined with the emergence of new sources of demand and smaller-than-expected efficiency gains—means the evolution of demand growth could see rapid changes in unexpected directions.

Global energy demand is projected to grow between 11 percent (in the Continued Momentum scenario) and 18 percent (in the Slow Evolution scenario) by 2050. Most of this growth will come from emerging economies, where growing populations and a strengthening middle class will result in higher energy demand. The relocation of manufacturing industries from mature to emerging economies will further shift demand to these economies.

Developments in emerging economies, particularly ASEAN countries, India, and the Middle East, are critical, given that these regions are projected to drive between 66 and 95 percent of energy demand growth to 2050, depending on the scenario. A substantial part of this growth is projected to come from ASEAN countries, cementing the region as a key energy demand centre—further reshaping global energy trade flows and increasing the region's geopolitical importance.

In mature economies, as well as in China, overall demand is projected to flatten in the short to medium term. However, there are several forces at work that could affect the demand trajectory in different regions. In the United States, industrial resurgence would drive demand growth through electrification, while in Europe, by contrast, continued deindustrialization would lead to declining demand in the region.

How the world will meet the projected increase in energy demand is one of the key questions of the energy transition. Both RES and new fossil fuels build-out will be required to ensure demand is met by supply, and nuclear power could play a bigger role in the years beyond 2050. However, for all these energy sources, lengthy project timelines and higher interest rates could add costs and put project execution at risk.

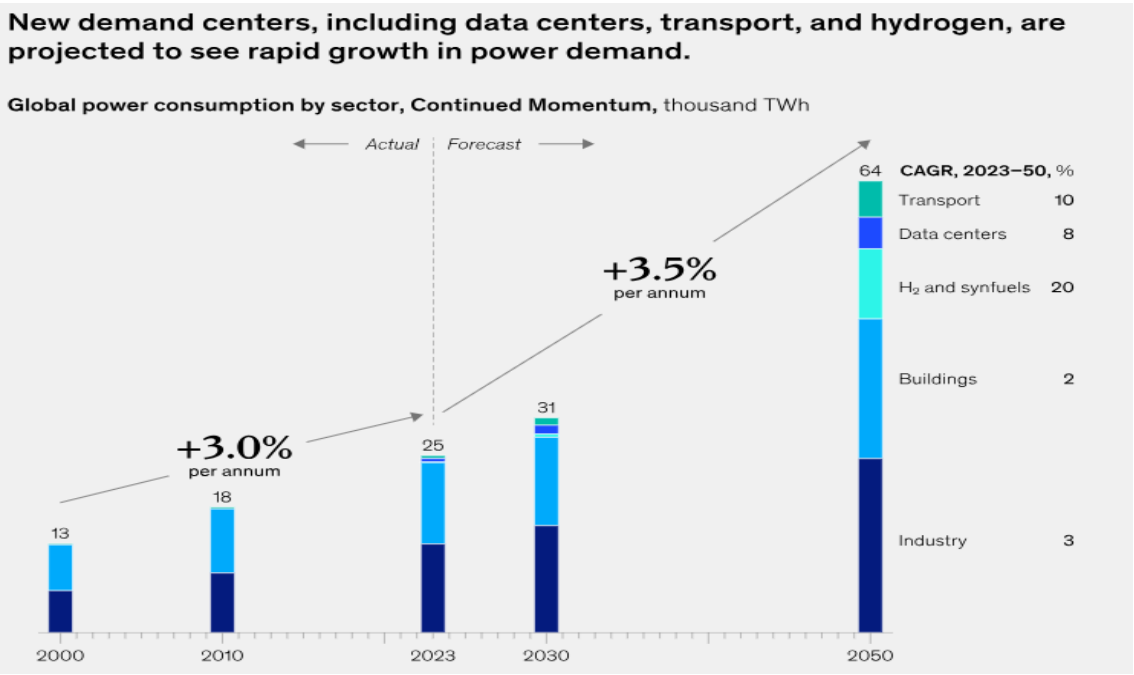


Fig. Global Power consumption by sector

Growth in electricity consumption is expected to accelerate as new demand centers emerge: -

Electrification is accelerating—our analysis suggests that, between 2023 and 2050, electricity consumption could more than double in slower energy transition scenarios, and nearly triple in faster scenarios. This is in comparison to total energy consumption growth of up to 21 percent over the same period. Electricity is projected to become the largest source of energy by 2050 across scenarios, with consumption coming from traditional sectors (for example, electrification of buildings) as well as newer sectors (such as data centers, EVs, and green hydrogen).

Of these new demand centers, the most striking is the rise of artificial intelligence (AI) and the associated boom in data centers. The effect that AI could have on future energy demand could vary substantially depending on the growth trajectories of its many applications, as well as those of other technologies. Our research estimates that the rise of cloud solutions, cryptocurrency, and AI could see data centers accounting for 2,500 to 4,500 terawatt hours (TWh) of global electricity demand by 2050 (5 to 9 percent of total electricity demand). Data centers are mostly powered by electricity (with backup generators) and have constant demand, creating greater need for gas or other firming sources of energy to balance out the intermittency of renewable energy sources (RES). Electricity consumption in transport could grow by around 10 percent annually in the Continued Momentum scenario, driven by increased penetration of EVs. Battery electric vehicles (BEVs) are projected to account for most global passenger car sales by 2050, up from 13 percent today.

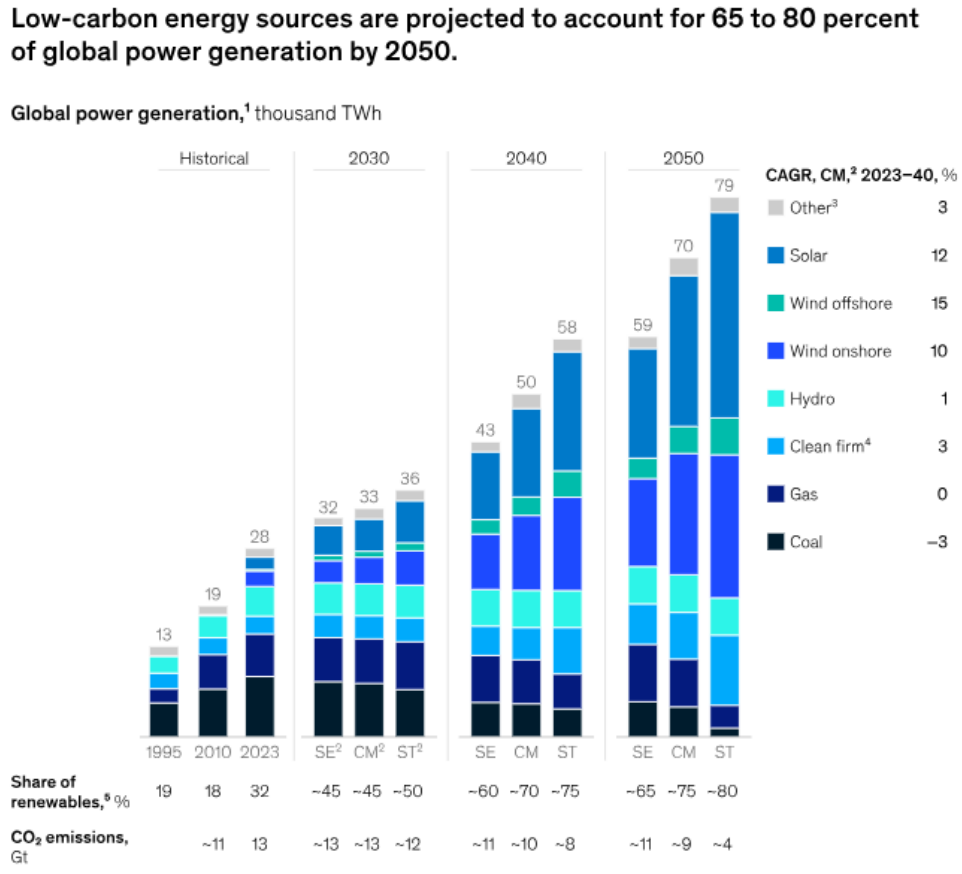


Fig. Global Power Generation by 2050

Low-carbon energy sources are projected to grow, accounting for 65 to 80 percent of global power generation by 2050, depending on the scenario, up from 32 percent today. This growth is primarily driven by the lower cost of RES, though policy and incentives also play a role.

Growth rates are projected to differ by technology. Those technologies for which the level zed cost of energy (LCOE) is already low at the point of production, such as solar, wind, and energy storage systems, are projected to continue to grow, while those with higher costs—including hydrogen and other sustainable fuels, and carbon capture, utilization, and storage (CCUS)—lack sufficient demand and policy support for strong growth. Solar stands out with particularly strong growth projections, while hydrogen growth to 2050 has been revised downward by 10 to 25 percent compared to previous estimates due to higher cost projections.

To supply projected energy demand and increase the viability of RES-based power systems, stakeholders now need to consider how to build a fully running and reliable energy system based on renewables. Here, emerging economies have an opportunity to build a renewables-based system from the ground up to meet their burgeoning energy needs, potentially leapfrogging some of the constraints imposed by adapting a preexisting energy system to run on renewables. Doing so would require conscious planning; purposeful, pragmatic action; and a supportive policy environment to ensure that a renewables-based energy system could meet rapidly growing demand.

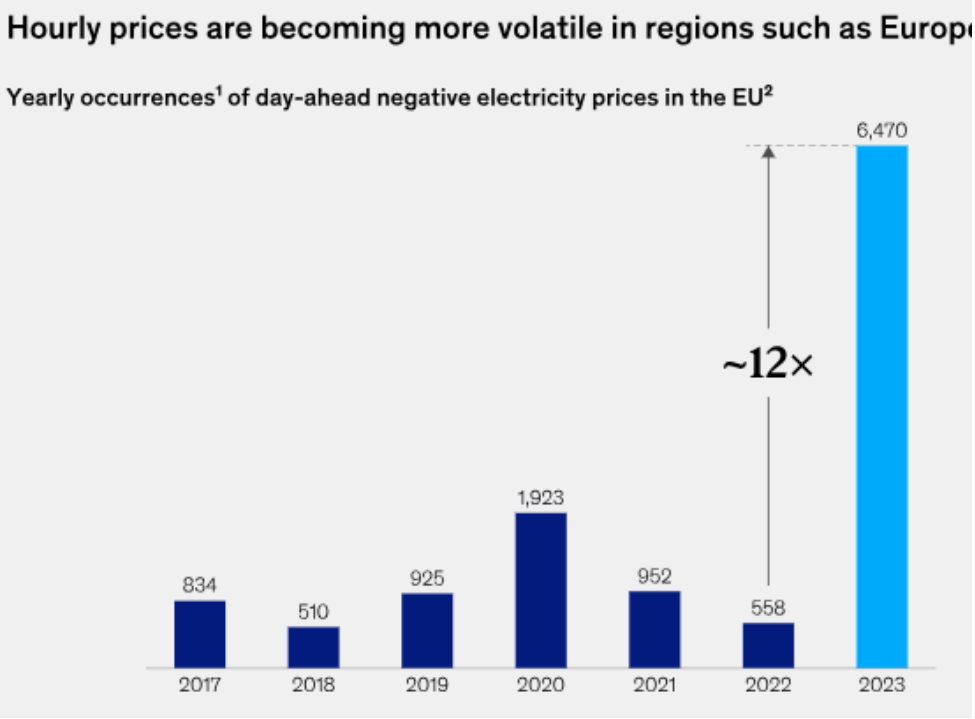
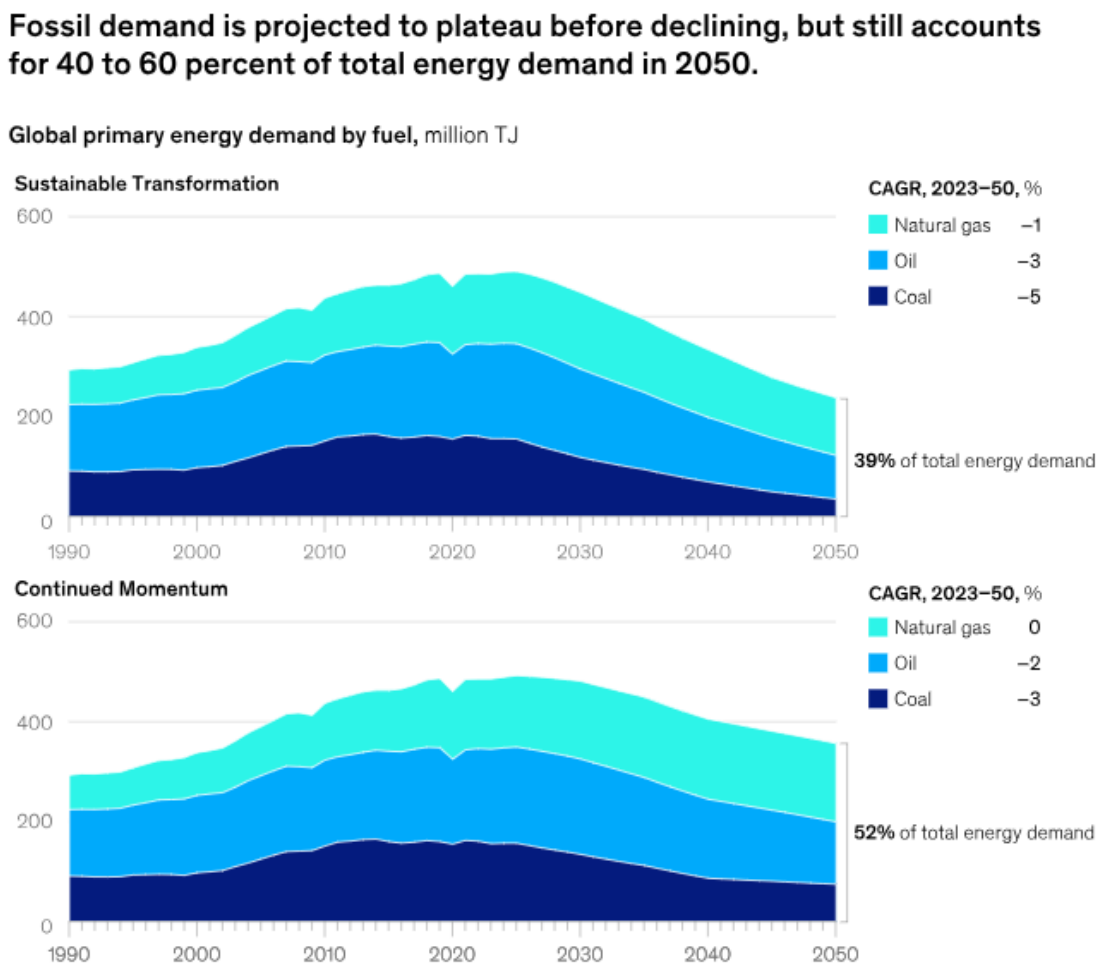


Fig. Prices in Europe



<u>Fossil demand is set to decrease, but fossil fuels are expected to continue to help meet growing energy demand across all scenarios: -</u>

Despite progress in RES build-out, the energy transition has been slower than expected in certain areas, and key transition levers are not yet mature, scalable, or cost-effective. This, combined with the constraints facing renewables build-out and growing energy demand, means renewables alone are not currently projected to be sufficient to meet the world's future energy needs in all our bottom-up scenarios.

Fossil fuels, including oil, natural gas, and coal, are therefore projected to continue to play a role, albeit a moderating one, in the global energy system to 2050, meeting between 40 and 60 percent of global energy demand in 2050, depending on the scenario, down from 78 percent in 2023. Analysis of the data shows that investment and capital flow into fossil fuels are projected to continue for at least the next ten years to ensure the global energy system can keep up with demand.

Highlights

- Energy-related CO_2 emissions increase 6% from 33 Gt in 2015 to 35 Gt in 2050 under current and planned policies.
- Emissions need to fall to 9.7 Gt in 2050 for an emissions pathway compatible with the 2 °C target of the Paris Agreement.
- Renewable energy and energy efficiency, combined with electrification of end-uses, make up 94% of the emission reductions.
- The share of renewable energy in total primary energy supply would rise from 14% in 2015 to 63% in 2050.
- To achieve this share an average annual growth rate of 1.4ppt/yr is need - a six-fold increase from recent years rate.
- The share of renewable energy in the power sector would increase from 25% in 2015 to 85% in 2050.
- To 2050, USD 120 trillion would need to be invested in the energy-system in the REmap energy transition case.
- This represents an increase of USD 27 trillion compared to the Reference Case.
- The energy transition case results in strong overall economic growth and employment.
- Cumulative gain through increased GDP between 2015 and 2050 amounts to USD 52 trillion.
- Additional 11.6 million direct and indirect jobs in the energy sector would also result.

Cost and benefits of energy transition:-

- Investment Requirements:

  Achieving a net-zero emissions economy by 2050 would require substantial global investments, estimated at $9.2 trillion annually in physical assets, a $3.5 trillion increase compared to current spending.

- Front-Loaded Spending:

  The initial years of the transition will likely see the highest spending, with the next decade being crucial.

- Uneven Impacts:

  The transition's effects will vary significantly across countries and sectors, requiring tailored policies and strategies.

- Risks:

  The transition is not without risks, including energy supply volatility and the potential for job displacement in fossil fuel industries.

Benefits of the Energy Transition:

- Reduced Carbon Emissions:

  Transitioning to renewable energy sources and improving energy efficiency is crucial to mitigating climate change and avoiding its worst impacts.

- Improved Air Quality:

  Shifting away from fossil fuels leads to cleaner air, benefiting public health, particularly in urban areas.

- New Economic Opportunities:

  The energy transition creates new industries and jobs in renewable energy technologies, energy efficiency, and related sectors.

- Reduced Energy Dependency:

  Diversifying energy sources and promoting energy independence can enhance a country's economic resilience.

- Health Benefits:

  Cleaner air and water resulting from reduced pollution from fossil fuels can improve health outcomes, especially for vulnerable populations.

- Improved Energy Efficiency:

  Focusing on energy efficiency can reduce energy consumption and costs, benefiting consumers and businesses.

- Global GDP:

  McKinsey estimates that the global GDP will double every 25 years post-1970, which suggests that the costs of the energy transition are manageable.

Conclusion: -

In conclusion, global energy trends point towards a significant shift towards renewable energy sources and a growing demand for energy efficiency, driven by climate change concerns and economic factors, with emerging economies playing a key role in this transformation. An increasing number of indicators point to an accelerating energy transition that can have profound implications for energy supply and demand in the coming decades.

As the analysis shows, rapid innovation is taking place that facilitates the ongoing transition through falling costs of renewable technologies and also enabling technologies such as batteries. Along with the new policy imperatives, innovation

strengthens the momentum of energy transition. As technology improvements are permanent, they reduce the risk of policy volatility. The progress for solar and wind technology is a prime example that the future can be steered in a certain direction through technology policy.

The share of renewable energy can grow from 15% in 2015 to 63% of total primary energy supply in 2050 as this paper shows. Such renewables growth in combination with higher energy efficiency can provide 94% of the emissions reduction that is needed to stay within the limits of the Paris Climate Agreement. While absolute numbers vary there is consensus across recent scenario studies that renewable energy and energy efficiency is the most feasible direction to meet climate objectives.