Energy transition in Europe: Quo vadis?

In this paper we look at the factors that are influencing the energy transition, both at a macroeconomic and geopolitical level and how the transition is intertwined with the current energy crisis. We then analyse what green options are available today and the potential role they will play in the future. Finally, we highlight how the investment in renewable energy, the peculiar momentum we are witnessing and the collective action towards diversified renewable energy solutions are essential to create positive impact and succeed in our "Net Zero" goal.

While we were all aware that the race for energy transition was going to look more like a marathon than a sprint, few expected it could actually be more akin to a steeplechase. In 2022, we witnessed the rise of far more obstacles than we imagined, and the terrain on the horizon looks as bumpy as ever. Nonetheless, an increasing number of motivated and resilient competitors — aka stakeholders — are slowly but surely racing towards the finish line.

Will we all be winners or extinct losers?

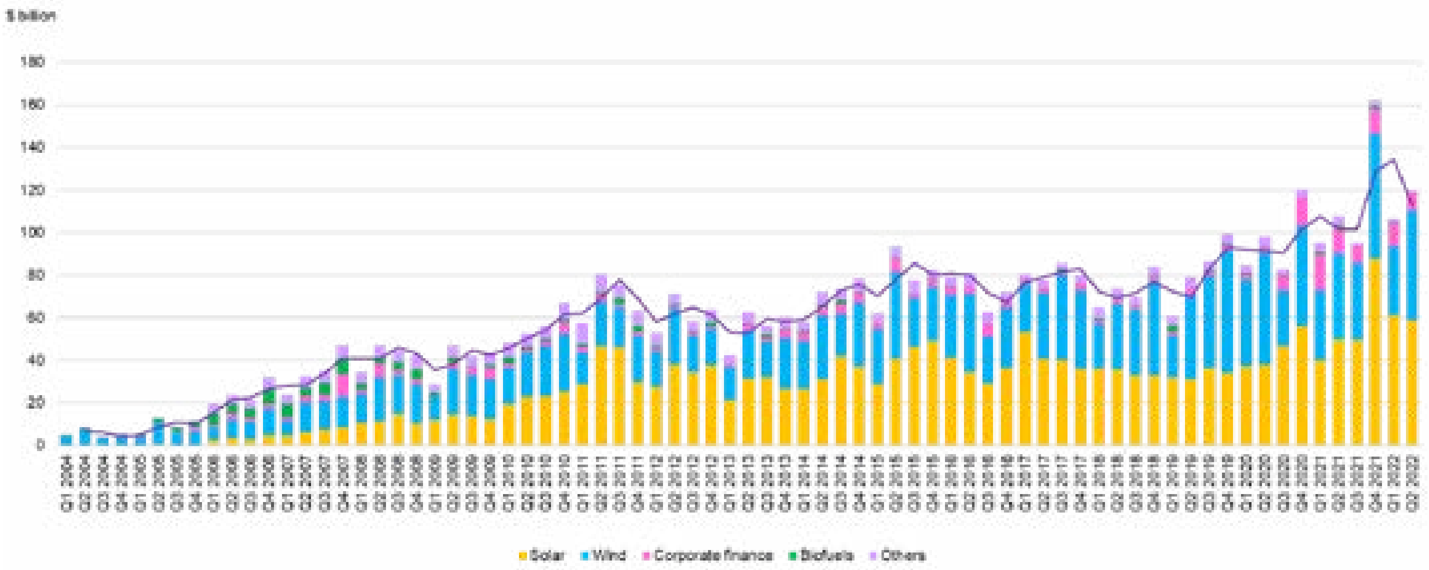
The race: What the energy transition looks like

It is widely acknowledged at this point that a shift from fossil-fuels to low-carbon energy is an essential contribution to our fight against climate change — with a goal of keeping an average temperature rise to well below 2°C to prevent the worst effects of global warming. The Paris Agreement calls for a goal of no more than 1.5°C above pre-industrial levels, which would require emissions be reduced by 45% by 2030 and reach "Net Zero" by 2050. To do so, governments, companies, investors and the broader civil society are committing to lower GHG emissions and to more sustainable activities.

Clean energy investment is central to the energy transition and to the final goal of Net Zero. As reported by the International Energy Agency ("IEA") in the World Energy Outlook 2022, achieving Net Zero emissions will require more than $4 trillion in annual spending by 2030, implying an approximate 23% increase in investment each year. However, the annual average growth rate in low-carbon energy investment in the five years after the Paris Agreement was signed in 2015 was just over 2%. Since 2020, despite the extraordinary disruption caused by the COVID pandemic, that has risen to 12%. This is still short of what is required to hit international climate goals, but nonetheless a clear sign of progress.

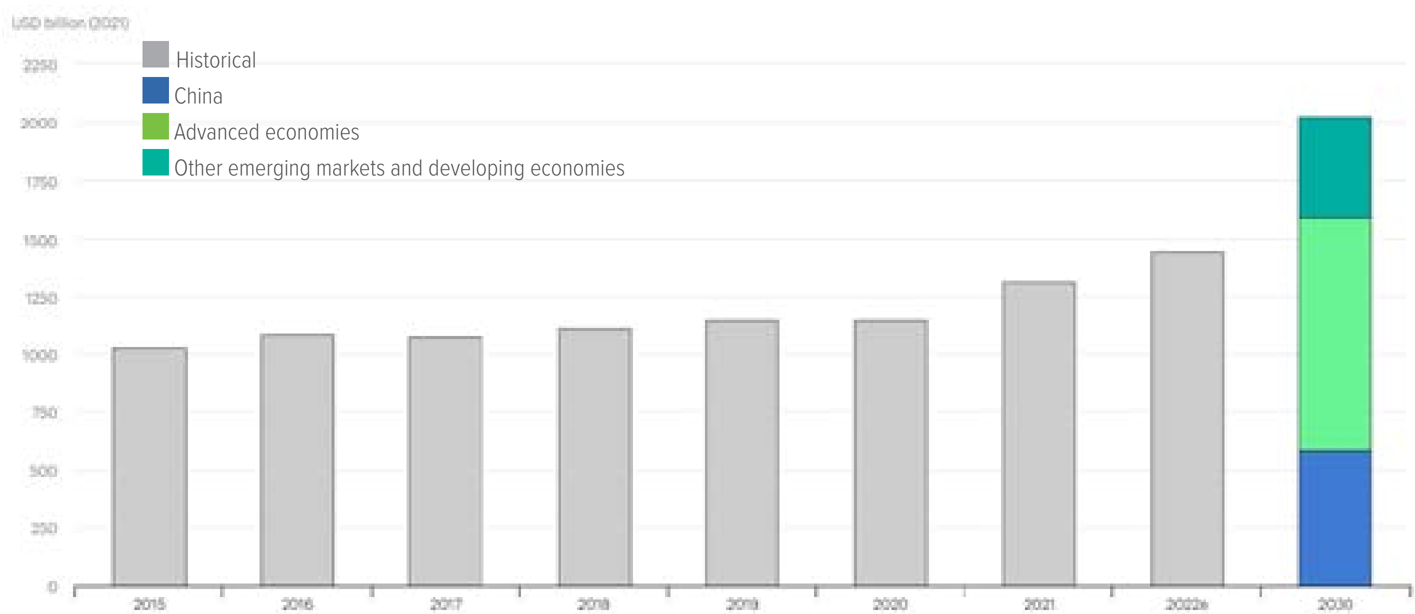
The highest levels of clean energy investment in 2021 were in China ($380 billion), followed by the European Union ($260 billion) and the United States ($215 billion). Finally, according to BloombergNEF, in 2022 a new all-time high for the first half of a year was recorded, with a total of $226 billion of new investments in renewable energy (+11% YoY). Again, China was the leader, investing $98 billion (+128% YoY), followed by the US with $12 billion and Japan with $5 billion (Figure 1).

FIGURE 1 – GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY



Source: BloombergNEF - Renewable Energy Investment Tracker 2H 2022. https://www.bnef.com/insights/29465

FIGURE 2 – TRAJECTORY OF CLEAN ENERGY INVESTMENTS WITH TODAY'S POLICY SETTINGS



Notes: The US Inflation Reduction Act, the EU's Fit for 55 package, Japan's GX, China's new clean energy targets and India's solar revolution propel clean energy investment to new highs, but $4 trillion is needed by 2030 to be on track for 1.5 °C.

Source: https://www.iea.org/reports/government-energy-spending-tracker-2/key-findings

The surge has been underpinned not only by increased investment in renewable energy projects, especially solar-related investments, venture capital and private equity funding (+63% YoY), but also by the increasing cost competitiveness of many clean energy technologies and by policy and fiscal measures enacted to support a sustainable energy transition. Such measures include the newly signed Inflation Reduction Act in the US, Fit for 55 and the REPowerEU plan in the EU, and Japan's Green Transformation (GX) programme. According to the IEA, policies in major energy markets around the globe will help spur annual clean energy investment to more than $2 trillion by 2030, following the trajectory of energy investments implied by the current policy regime (Figure 2). Yet there is still a long way to go, as the investment in clean energy needs to double by 2030 to avoid surpassing the 1.5°C threshold.

A bumpy track: The Russia-Ukraine conflict and the consequences of gas shortage

The already challenging environment of skyrocketing natural gas prices, supply chain bottlenecks and inflationary pressures has been furtherly exacerbated by the Russian invasion of Ukraine. The inhumane war in Ukraine led to a consensus among EU countries and other large economies to significantly reduce dependence on Russian energy, which was the largest single source of gas supply for Europe until the start of 2022 (Figure 3), and focus on Norwegian gas supply and liquefied natural gas (LNG) imports, predominantly from the US (Figure 4 & 5). It is worth mentioning that natural gas has been recently approved by the EU as a sustainable source of energy; while its combustion does emit greenhouse gases, it is less polluting than oil or coal and can thus be part of the energy transition, with some reservations. While it is true greater adoption of alternative renewable energy sources will reduce the need for natural gas in a Net Zero scenario, it will remain a critical source of power system flexibility in many markets, particularly to address seasonal scarcity needs.

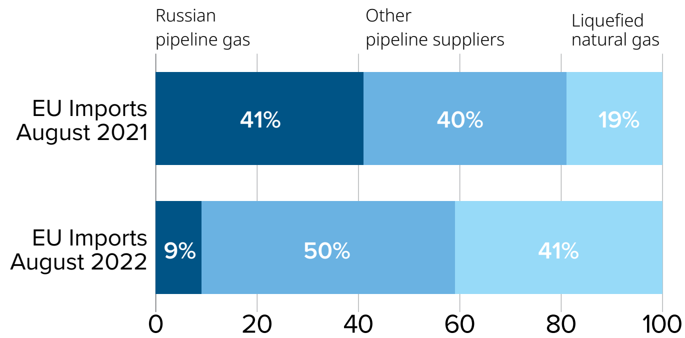
Indeed, this supply is currently mitigating the effects of the aforementioned challenges, preventing potential power blackouts in Europe, at least for this winter. However, the shift to new gas sources does not rule out the possibility of some energy rationing in the future. Other than the variable of milder or colder winters, several other factors will play a key role on whether energy shortages will take place or not in the upcoming winters.

Firstly, while gas rationing risks have receded for this almost-over winter thanks to record LNG imports and high gas storage levels (reaching a high of 95.5% in mid-November 2023[1]), once a winter season starts, gas consumption ramps up and the reserves quickly decrease (EU gas storage capacity represents approximately only 26% of annual consumption).

Secondly, China's LNG import demand in 2022 has been affected by lower economic growth and lockdowns, which permitted the easing of market balances and the possibility for the EU to receive such a high quantity of LNG (+62% YoY). Therefore, uncertainty will rise when China's LNG demand starts to rise again this year, as expected.

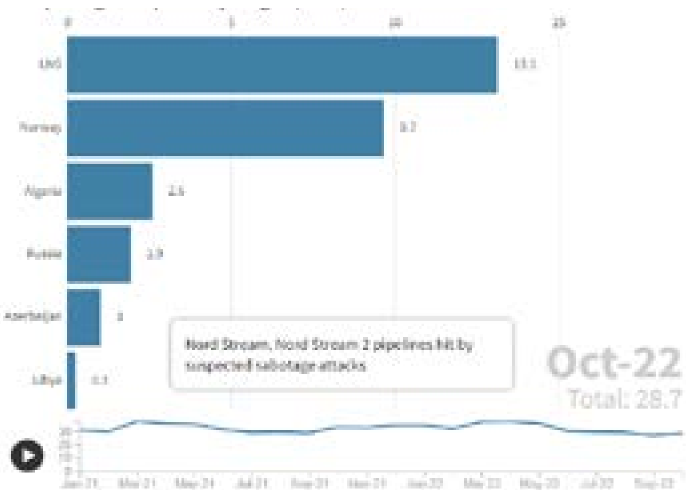
Finally, depending on which geo-political scenario will arise in the future, the EU will either continue to import a small percentage of Russian gas, or will cease completely.

FIGURE 3 – DIVERSIFICATION OF EU ENERGY SUPPLY



Source: Mackenzie Investments taken from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

FIGURE 4 – EUROPEAN GAS AND LNG IMPORTS BY ORIGIN – OCTOBER 2022

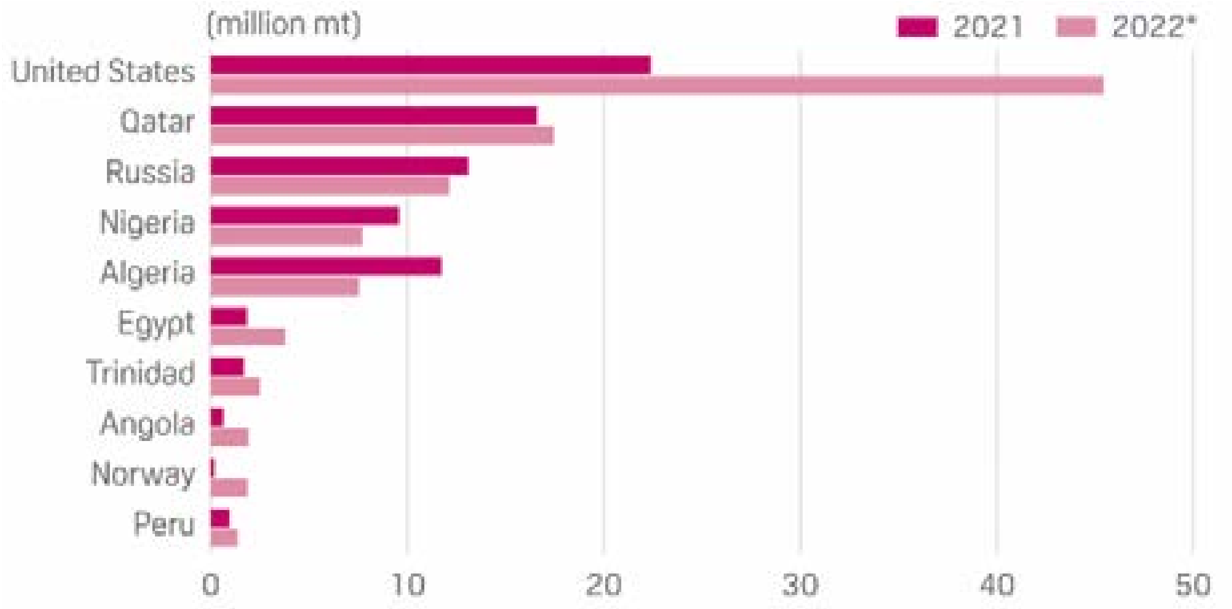


Notes: Country-specific sources are for pipeline gas. Shows gas imports into EU-27, UK and Balkans.

Source: S&P Global Commodity Insights. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/natural-gas/090622-interactive-europe-gas-imports-russia-market-share-lng-norway

[1] Data from the Aggregated Gas Storage Inventory. https://agsi.gie.eu/

FIGURE 5 – EUROPEAN LNG SUPPLY SOURCES



*2022 = Jan-Oct
Source: SEP Global Commodity Insights. https://www.spglobal.com/commodityinsights/en/market-insights/blogs/lng/102622-europe-lng-russian-gas-ukraine-war

This diversification of energy supply does not constitute an easy task for Europe, which is now facing a 'trilemma' among decarbonisation, supply and affordability. Indeed, the countries' short-term necessity of getting through the cold European winter does not go hand in hand with the long-term ambition of Net Zero that so many political and business players have committed to achieve.

Key questions remain. How can countries decarbonise the energy industry while guaranteeing security of supply and affordability? How can governments maintain the positive trend seen in the past years and support the acceleration of the energy transition through new legislation, while going back to using fossil fuel for electricity generation?

Not all evil comes to harm: A possible acceleration of energy transition through windfall gains?

There is no doubt that the shift from Russian energy to local fossil fuels and LNG could lead to higher-than-expected emissions for years to come as governments turn to more emissions-intensive sources as replacements — several European countries have already resurrected old coal plants amid the energy crisis. However, a possible acceleration of the transition into renewable energy should also not be excluded. Indeed, while it may appear absurd to associate the concept of "opportunity" to that of "scarcity" and "crisis", the current socio-political and economic conditions might be what we need to accelerate the energy transition.

According to Guido Giese, Global Head ESG and Climate Solutions Research at MSCI, the higher fossil fuel prices triggered by the crisis helped make alternative energy sources more cost-competitive, estimating that $200-300 billion in windfall profits in the energy sector could have a significant positive impact in accelerating energy transition. Governments have proposed windfall taxes, with the expectation that these would be invested in renewable energy. Alternatively, these windfall profits could be directly reinvested by companies into renewable energy products. This latter option of redeploying excess profits into new electricity generation assets would increase the investments in renewables up to 85% of the current amount, therefore making up for the higher emissions currently produced in the short-term. Moreover, the EU has rolled out the REPowerEU plan which aims to emancipate Europe from Russian fossil fuels well before 2030, accelerating the green transition while increasing the resilience of the EU-wide energy system. The plan is based on:

- The diversification of energy sources, with a short-term focus on LNG and hydrogen;
- The rapid roll out of solar and wind energy projects combined with renewable hydrogen deployment;
- An increase in biomethane production;
- EU-coordinated demand reduction plans in case of gas supply disruption.[1]

1 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure- and-sustainable-energy-europe_en

Do all roads lead to Rome? What green solutions are available

As described above, the pathways toward the energy transition are numerous. While most clean technologies are now cost-competitive with fossil fuel energy sources, there are some drawbacks for each. Indeed, the source of some clean energy technologies (e.g., wind or solar) makes their energy supply intermittent and not dispatchable, bringing the problem of storage capacity into the equation. Others, like nuclear, provide baseload power but face higher scrutiny and political debate since they are not widely recognised as renewable by society, leading to great reputational risks.

On top of the challenges caused by the nature of the clean energy, emphasis must be placed on the development of reinforced infrastructures, the increase of large-scale interconnections, and on loading pattern optimisation.

More energy and greater long-term energy storage will be needed to outweigh the advantages of high-emitter but easy-to-store fossil fuels. The current geopolitical situation reminds us of the importance of energy availability, and it is therefore important to analyse the advantages and disadvantages of each of the green energy solutions, focusing on which sector and for which purpose each is most suitable.

Solar PV

Solar is set to be the largest single source of electricity generation in a Net Zero scenario. Solar capacity has increased worldwide by almost 20 times over the past decade, with volume installed worldwide expected to exceed 250GW this year (up from 182GW in 2021) and to reach 16,000GW by 2050. Moreover, the cost of solar power has fallen significantly in recent years, from $0.38/kWh in 2010 to $0.06/kWh in 2020 with a strong policy push rising in key regions (e.g., REPowerEU and the US Inflation Reduction Act).

Solar also represents one of the top green energies on which oil and gas companies have currently been spending their capex and carrying out M&A activities to diversify their portfolios (Figure 6 & 7), with China being at the forefront in terms of share of solar capacity, accounting for 36% of the global capacity addition in 2021.

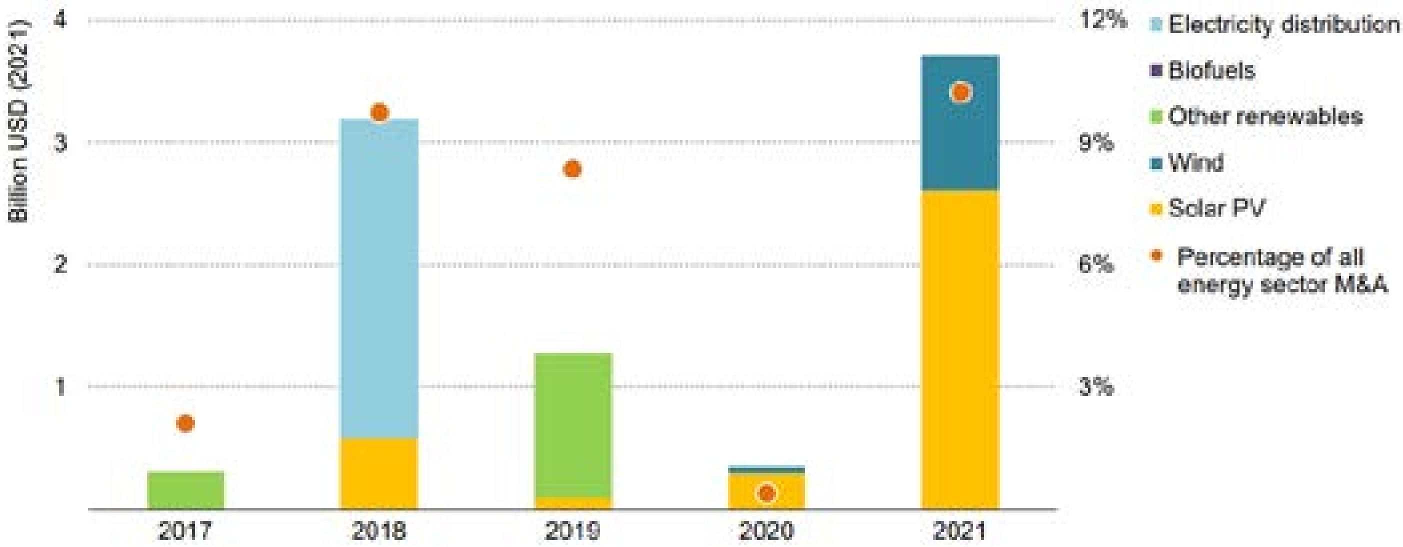
While it is not as reliant on minerals as other clean energy sources, the IEA's Sustainable Development Scenario (SDS) foresees capacity additions in 2040 to be triple those of 2020, resulting in a near tripling of copper demand from solar PV. However, potential material intensity reductions could significantly dampen demand growth for both silver and silicon, with 2040 levels only 18% and 45% higher than in 2020, respectively. Moreover, given the low energy generation due to its intermittency of production, commercial solar applications remain limited to grid and off-grid power, with only a limited potential usage in the transportation sector in the future.

Wind

Wind is also a relatively mature renewable technology, expected to contribute around one-third of clean electricity supply by 2050. Around 80% of current capacity comes from onshore wind. However, investments in offshore wind are rising and seen as a complement to onshore wind over the coming decades, despite the higher investment needs required for the connection of offshore wind farms. On the price side, the cost of wind could drop around 54% over the next decade in a Net Zero scenario, according to IEA.

Like solar, Chinese policy has been highly supportive of wind. In 2021, China remained the main driver also of wind capacity growth, accounting for about 40% of the global capacity addition. The US Inflation Reduction Act recently extended a tax credit for wind that was due to be phased out. In addition to intermittent energy supply and having its application limited to the grid, wind power requires several metals and minerals that can potentially expose it to shortage risks and increase in supply prices other than geopolitical and reputational risks linked to the management of the supply chain (Figure 8 & 9).

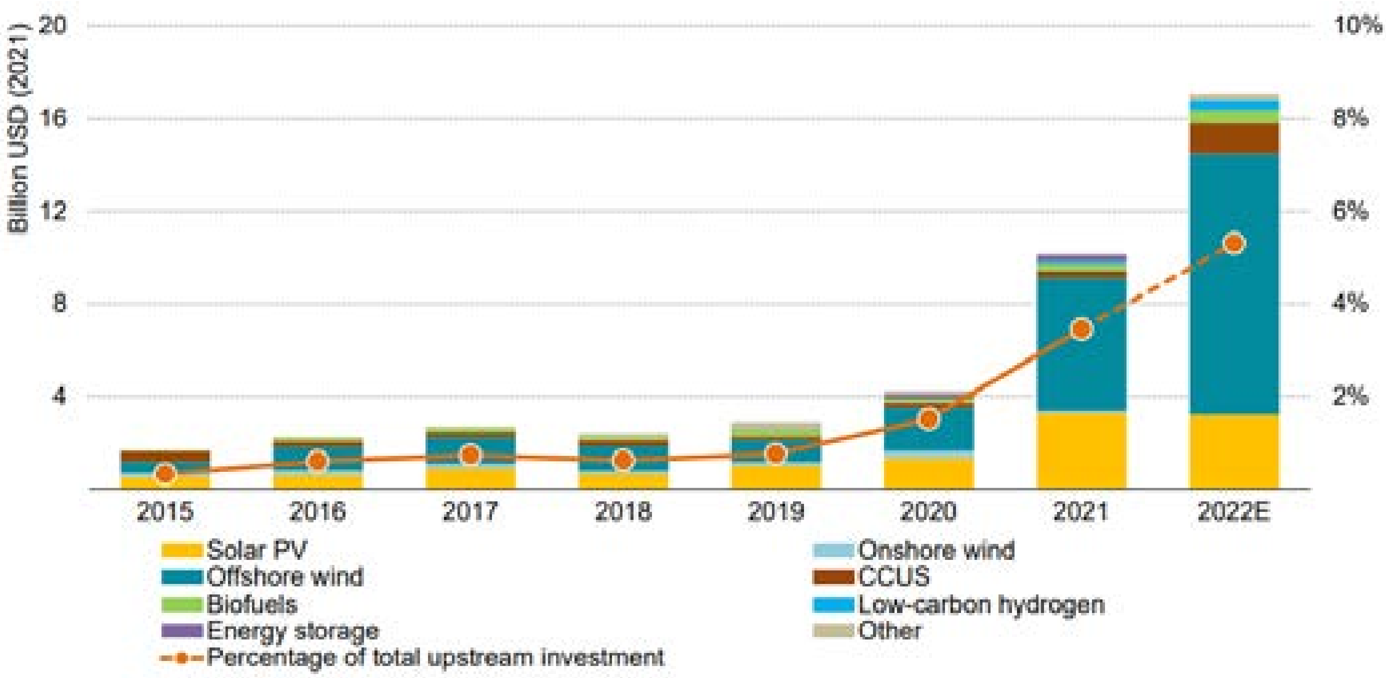
FIGURE 6 – M&A SPENDING BY OIL AND GAS COMPANIES ON CLEAN ENERGY TECHNOLOGIES



Notes: Includes the majors, ADNOC, CNPC, CNOOC, Equinor, Gazprom, Kuwait Petroleum Corporation, Lukoil, Petrobras, Repsol, Rosneft, Saudi Aramco, Sinopec and Sonatrach. "Other renewables" comprises combined deals for solar, wind and hydro.

Sources: Bloomberg (2022); BNEF (2022). https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf

FIGURE 7 – CAPEX BY SELECTED OIL AND GAS COMPANIES ON CLEAN ENERGY TECHNIQUES



Notes: Includes the majors, ADNOC, CNPC, CNOOC, Equinor, Gazprom, Kuwait Petroleum Corporation, Lukoil, Petrobras, Repsol, Rosneft, Saudi Aramco, Sinopec and Sonatrach. The estimated clean capex in 2022 is based on investment spending announced to 31 March 2022 and assumes that this pace of investment is maintained throughout the year.

Sources: IEA calculations based on BNEF (2022); Clean Energy Pipeline (2022); company reports and websites. https://iea.blob.core.windows.net/assets/b0beda65-8a1d-46ae-87a2-f95947ec2714/WorldEnergyInvestment2022.pdf

Nuclear

The new EU taxonomy that labels both natural gas-fired power plants and nuclear as environmentally sustainable transitional energy sources was highly debated and criticized. But the decision sounded a reassuring note in the uncertainty of the energy crisis, where the power system needs to be highly reliable. Past political decisions in Europe to drift away from nuclear resulted in a decrease of 25.2% between 2006 and 2020,[2] but the Ukraine conflict appears to have given nuclear power a boost.

Nuclear is certainly the most mature technology and among the cleanest in terms of zero-carbon emissions. Nuclear applications include the grid and district heating. While its initial costs remain high and have not fallen meaningfully in the recent years, there is growing interest in the potential of new technologies, namely small modular reactors (SMRs), that could lead to more affordable versions of nuclear energy production. Moreover, post-construction operating costs remain relatively low and nuclear power does not experience the same price volatility of traditional energy sources like coal and natural gas. In the past nuclear plants were highly rejected by society due to the risk of catastrophic accidents, but it seems that policies have shifted towards more acceptance (e.g., the Japanese government is actively considering building more capacity, a decade after the Fukushima disaster).

In 2020, nuclear plants generated around 24.6% of the total electricity produced in the EU, with France producing more than half of that. Worldwide, nuclear is not expected to play a major role in the energy generation mix, remaining at around 10% of the total amount.

It is worth highlighting that while nuclear power plants do not emit greenhouse gases, they still have a substantial impact on the environment by being water intensive and producing extremely toxic, radioactive waste, which poses a threat to agricultural land, freshwater sources and wildlife. Moreover, nuclear power stations are metals intensive. This not only poses potential risks to input costs — the price of uranium has risen sharply in the last 18 months — but also reputational risks in terms of respect of human rights during the mining and extraction phase.

Bioenergy and biofuels

Bioenergy is energy produced through biomass, defined as plant- and animal-based materials taken from renewable sources. The current market environment has exacerbated the conditions for production of bioenergy. Indeed, the disruption of food supply chains and high fertiliser prices have caused the liquid biofuel costs to rise sharply. To avoid such conflicts of food production and affordability, several companies are moving away from conventional bioenergy sources by developing several advanced second-generation biofuels made from non-food feedstocks, such as sustainable waste streams, algae, perennial grasses and forestry residues that do not require dedicated land use. According to the World Energy Outlook 2022 released by the IEA, modern bioenergy will increase from around 41 exajoules (EJ) today to more than 75 EJ by 2030 and will play a key role in meeting Net Zero emissions pledges.

Biofuels such as biogas and biomass are utilised with a view to decarbonizing transport. Gas or liquid fuels are very versatile and applicable as low-carbon solutions for existing technologies (e.g., light-duty vehicles and heavy-duty trucks, ships and aircraft). Ethanol from corn and sugarcane, and biodiesel from soy, rapeseed and oil palm dominate the current market for biofuels.

Biomethane is the most common biofuel utilised as a low-carbon, direct replacement for natural gas. In March 2022, the European Commission announced the willingness to increase biomethane production to reach 35 billion cubic meters by 2030 as part of its REPowerEU plan. In doing so, biomethane will replace approximately 20% of the total natural gas imports from Russia and will help the decarbonisation of the European gas consumption.

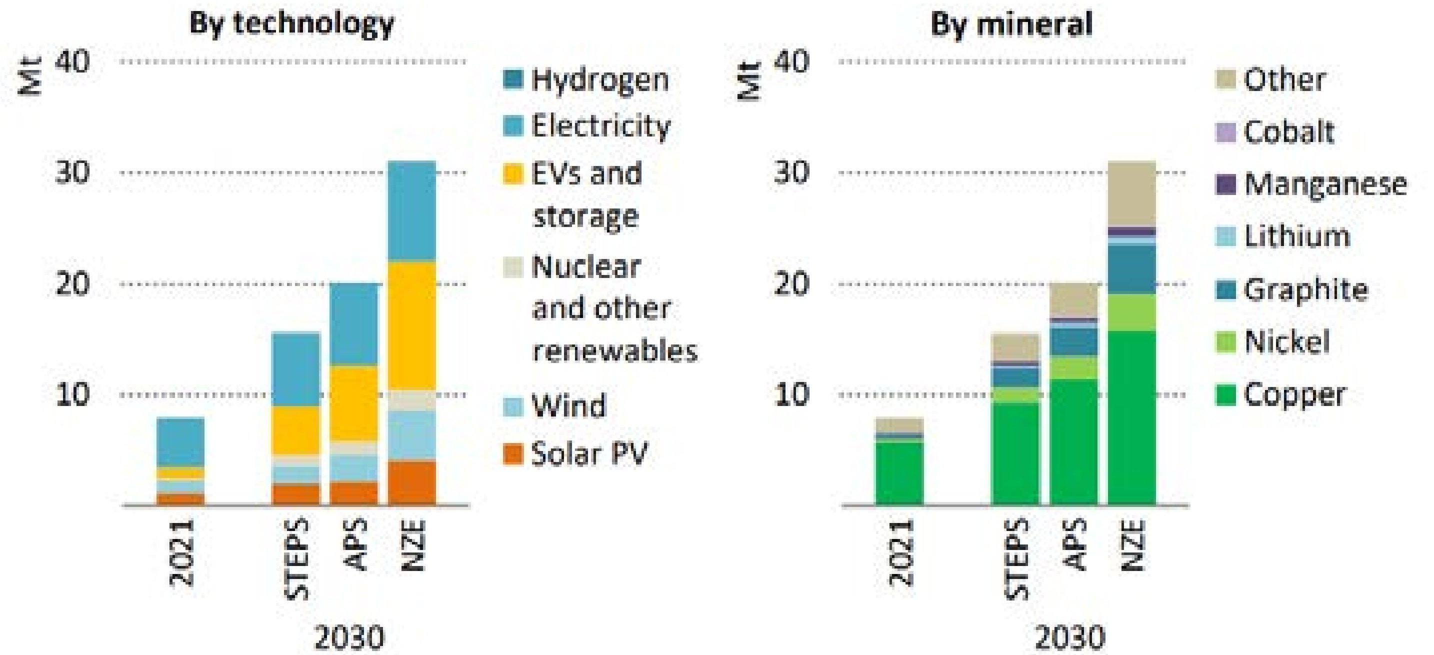
Battery storage

Energy storage provides the key to electrification and a solution to intermittent renewable energy supply, being applicable to both grid and transportation. Investments into electric vehicles (EVs) have also driven innovation in the battery storage sector. Together with technology and policy spillovers from the EV industry, both investment and capacity are foreseen to increase sharply in the coming decade. The IEA estimates that in a Net Zero scenario, global battery capacity will reach 780 GW by 2030, with storage expanding thirtyfold from 2021 to 2030, and will account for about 15% of all dispatchable power capacity. By 2035, lithium-ion battery capacity will surpass natural gas-fired capacity as the principal source of energy flexibility in many markets.

However, battery storage requires metals and minerals that have seen a sustained upward price rise since the start of 2021. According to the IEA, demand for such minerals for clean energy technologies will rise two to fourfold by 2030. A substantial increase in lithium, nickel, cobalt, graphite, manganese and other minerals will be required to meet demand. Another factor to consider in an overall sustainable and just transition is the high concentration of critical minerals' extraction and processing in localised geographical areas. The lack of diversity in supply chains together with the increased use and importance of these materials could become a risk for clean energy deployment and an overall geo-political and economic risk (Figure 10).

2 https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Nuclear_energy_statistics#Nuclear_heat_and_gross_electricity_production

FIGURE 8 – MINERAL REQUIREMENTS FOR CLEAN ENERGY TECHNOLOGIES BY IEA SCENARIOS



Notes: Mineral requirements for clean energy technologies quadruple to 2030 in the NE Scenario, with particularly high growth for materials for electric vehicles Notes: Mt = million tonnes: EVs = electric vehicles. Includes most of the minerals used in various clean enerev technologies, but does not include steel and aluminium. See IEA (2021b) for a full list of minerals assessed. The Stated Policies Scenario (STEPS) shows the trajectory implied by today's policy settings. The Announced Pledges Scenario (APS) assumes that all aspirational targets announced by governments are met on time and in full, including their long-term net zero and energy access goals. The Net Zero Emissions by 2050 (NZE) Scenario maps out a way to achieve a 1.5 °C stabilisation in the rise in global average temperatures, alongside universal access to modern energy by 2030.

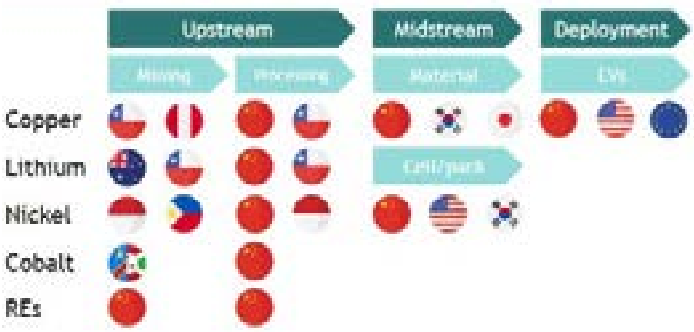
Source: https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf

FIGURE 9 – PRICE INCREASE FOR SELECTED ENERGY TRANSITION MINERALS AND METALS

Notes: IEA, Scale of price increase for selected energy transition minerals and metals, IEA, Paris.

Source: https://www.iea.org/data-and-statistics/charts/scale-of-price-increase-for-selected-energy-transition-minerals-and-metals, IEA.

FIGURE 10 – BATTERY MATERIALS SUPPLY CHAIN



Sources: https://iea.blob.core.windows.net/assets/4eb8c252-76b1-4710-8f5e-867e751c8dda/GlobalSupplyChainsofEVBatteries.pdf

Carbon capture, utilisation and storage (CCUS)

Carbon capture, utilisation and storage (CCUS) is not strictly a clean energy source per se, but rather a technology used to remove carbon emissions either at the point of combustion or directly from the atmosphere. Given its unique potential applications for those sectors that are currently difficult to decarbonise and that must rely on carbon offsetting mechanisms, great investments in the upcoming years are projected, especially regarding carbon capture attached to a bioenergy or natural gas plant. Moreover, CCUS technologies require less input than other technologies described above.

While CCUS is not yet price competitive, the significant potential that CCUS technologies have is reflected in the rise of governments' policies and investments (e.g., the US Inflation Reduction Act includes subsidies for carbon capture). Nevertheless, greater action will be required globally to effectively reduce costs and bring them in line with clean energy sources.

The "energy gel" we may need: Is hydrogen a utopic vision or a pragmatic project?

Hydrogen is receiving unprecedent attention by investors and governments that is accelerating a cost reduction in its production, transmission, distribution, retail and end-use applications. This momentum has been further boosted by the Russian invasion of Ukraine and the EU reaction that followed.

At a global level, we are witnessing the rise of hydrogen projects — with two of the world's largest electrolysers coming online in 2022 —and of partnerships among corporations to explore business opportunities in the renewable hydrogen production. Large industrial-scale hydrogen projects are also rising in Europe and combine the expertise and specificities of companies from different sectors (e.g., GET H2 Nukleus, MadoquaPower2X, HyGreen Teesside). Capital spending on hydrogen electrolyser projects starting operation or under construction was around $1.5 billion in 2021, more than three times that of 2020.

Hydrogen appears to avoid all the problems of the previously mentioned sources, yet there are several limits on how much more capacity can be built (e.g., geographic, infrastructural, large-scale consumption, efficiency). Moreover, it is important to specify that only renewable hydrogen (often referred as green hydrogen and blue hydrogen) align with the EU taxonomy on sustainability.

Worldwide, hydrogen strategies have intensified, with the EU making clean hydrogen a pillar of both its Net Zero strategy and its near-term efforts to get off Russian gas. The US Inflation Reduction Act offers a 10-year production tax credit for "clean hydrogen" production facilities. In total, 35 countries have set out hydrogen strategies, with another 17 preparing one and six have started an initial discussion.[3]

Nevertheless, the biggest constraint to green hydrogen adoption remains its expensive technology and inefficiency. As a gas or liquid, it doesn't have the same input risks as the other technologies, but it requires a great deal of renewable electricity. According to the World Economic Forum, about 30%-35% of the energy used to produce green hydrogen is lost during the process of electrolysis. Hydrogen also needs to be stored and transported, therefore there is the necessity of building a hydrogen transport infrastructure or of integrating hydrogen network planning into the established gas network planning. Furthermore, when hydrogen is stored as a gas, it needs to be highly compressed. If stored as a liquid, it requires cryogenic temperatures of about −252.8°C to prevent evaporation. It is reported that about 10% of the energy is lost in this phase. When fuel cells convert hydrogen to electricity, up to 50% of energy is lost.

Although studies have shown differences in the data on the percentage decrease of energy in each phase of manufacturing, all of them agree that hydrogen is far from being efficient. It is estimated that the round-trip efficiency, the percentage of electricity put into storage that is later retrieved, is only about 30%. In comparison, lithium-ion batteries have a round-trip efficiency of up to 95%.

3 Source: BloombergNEF, as of October 2022 https://www.bloomberg.com/news/articles/2022-10-18/engie-sees-green-hydrogen-competing-with-lng-within-a-decade

Final remarks

The world has never gone through an energy transformation of this scale before and renewable energy has never been more competitive. The increase in fossil fuel prices and the decreasing cost of renewables, together with the potential channelling of the current windfall profits of the energy sector into renewable energy investments might be the perfect recipe to turn the current geo-political planetary constraints into possibilities of further development.

Investment will be central to tackle the multi-layered energy crisis in the short-term and the different challenges posed by the energy transition in the long run. On the one hand, investment is needed to relieve pressure on consumers, not to get the world derailed from the net zero pathway, to spur economic recovery and — for Europe in particular — to reduce its reliance on Russian natural resources.

On the other hand, the new round of innovation that could be generated from the peculiar moment we are living in is exactly what is needed to push runners towards the finish line of clean energy adoption, carbon neutrality and ultimately of Net Zero.

Investments will aim at making renewables more economical, efficient and available, accelerating also the modernisation, digitalisation and electrification of the industries and infrastructures surrounding the components of the energy distribution and transmission system operators.

It is in the interests of governments, shareholders, companies and — most of all — the planet, to promote green equity to scale deployment of competitive clean technologies. Collective action is essential to tackle the current and future energy crisis and win the long, bumpy race of energy transition.

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