Energy Transition: Implications for Infrastructure Investors

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Long-term Infrastructure Investors Association

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Foreword

In the face of cascading environmental, geopolitical and macroeconomic shocks, reshaping the world's energy landscape is no longer a mere policy option, but an urgent necessity.

The energy transition has come to the forefront of our collective consciousness in this pivotal moment, as it is one of the main means at our disposal to significantly bring down greenhouse gas emissions and reach net zero by 2050. The global energy transition is already underway, bolstered by ever-growing private investment flows.

Beyond climate change-related and ecological concerns, a new factor has come to the forefront in 2022, driving forward the energy transition: Geopolitics. The Russian invasion of Ukraine has only bolstered the resolve of policymakers across both sides of the Atlantic to achieve strategic sovereignty and security in energy production and provision. A year and a half since the war started, it would be no exaggeration to say that this driver has helped "turbocharge" the energy transition, particularly in Europe, and has shown that when the political will exists, policies can be rapidly implemented, and private actors can quickly align themselves.

Described as the "biggest global theme of our generation" at the Infrastructure Investor Network Global Summit earlier this year, investments in the global energy transition are already becoming a defining feature of the market. In 2022, such investments topped the USD 1tn mark, overtaking investments in fossil fuels for the first time[1]. However, there is no time to rest on our laurels, as average annual investments in the energy transition must grow three-fold by 2030 if we are to get on track for net zero. This is an enormous challenge, which investors in infrastructure must respond to by scaling up their act.

This report seeks to review and analyse these trends and their implications for Institutional Investors in Infrastructure, both sector-wise and in terms of business models and allocation strategies. The Long-term Infrastructure Investors Association (LTIIA) set up a working group specially to share feedback and experiences from January to June 2023, drawing as much as possible from concrete experiences and feedback from our investors (see our case studies) to identify takeaways, provide guidance, and, when appropriate, devise policy proposals and recommendations.

In the process we have elected to focus on certain sectors and leave aside others (such as nuclear) so as to make the most of the collective wealth of experience of the members who actively participated in the working group.

The energy transition, with its immense significance and far-reaching implications, stands as the linchpin in our collective efforts to combat climate change and forge a path towards a cleaner, greener, and more resilient world. Ultimately, we hope this report will help foster awareness of investors on their potential role and improve both public and private sector stakeholders' understanding of the issues, obstacles and opportunities to help catalyse and increase private investment in energy transition-related infrastructure.

Vincent Levita
Chair, LTIIA

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[1] Baker, D. (2023). '$1 Trillion Green Investment Matches Fossil Fuels for First Time', Bloomberg, January 26, 2023

Executive Summary

The devastating human and material impact of climate change continues to escalate with each passing day. The causes are well known, as is the solution: energy transition – which entails shifting from finite fossil fuels towards sustainable and renewable energy sources – is the potential key to mitigating and reversing the damage already done.

The energy transition is already in motion, fuelled by a wide array of factors. Global concerns over the climate crisis have spurred international and national decarbonisation agendas, while geopolitical crises, technological advancements and declining costs of renewables have further accelerated the process. Governmental and regulatory policies are also playing a significant role in driving the energy transition, along with the growing influence of the environmental, social and governance (ESG) paradigm on the global asset management industry.

It is important to note that the energy transition goes well beyond merely generating electricity from renewable sources. It encompasses a broad spectrum of technologies and measures, such as electric vehicles and their charging networks, batteries for electricity storage, grid adaptation and expansion, energy efficiency, and green hydrogen, among other vital components. And it's not just about sustainability: energy also has to be reliable and affordable. Infrastructure is on the front line, at all stages: energy production, distribution and consumption. To achieve the ambitious goal of decarbonising the entire economy and reaching global net-zero objectives, huge efforts are needed by all stakeholders – both public and private – across the entire Infrastructure asset class to drive forward the energy transition. The role of private investors – both institutional investors and specialised infrastructure funds – is critical to foster and finance innovative approaches and will lead to a reassessment of traditional business models and their risk-return profiles.

The energy transition investment gap

While global investments in the infrastructure underpinning the energy transition have been steadily increasing, global net-zero objectives remain elusive, and we are still far from the right trajectory to achieve them. Governments alone cannot finance the entire energy transition, making it imperative for the private sector to step in and fill in the gaps. Given the aforementioned ESG focus in the asset management industry, achieving this is becoming much more feasible, particularly through public-private initiatives.

Infrastructure investments have gained popularity with institutional investors due to their long-term horizon and stable, predictable returns, offering a refuge from macroeconomic volatilities. Recent years have witnessed a surge of investors seeking downside protection through Infrastructure funds, leading to an 18.5% increase in infrastructure assets under management (AuM) between 2019 and 2022. This growing interest in the infrastructure asset class presents a unique opportunity to channel investments towards sustainable and green projects that align with the energy transition.

The increasing investor appetite for renewable energy is evident in the fundraising for infrastructure projects. In 2019, Infrastructure funds focused on renewable energy raised more capital than those without such exposure, signalling a shift towards sustainable investments. This trend has continued in subsequent years, with funds dedicated to renewable energy attracting substantial capital and the interest of private investors. Infrastructure deals related to the energy transition have seen significant growth in recent years, with clean electricity projects – particularly solar energy – leading the way, while secondary market transactions have opened new avenues for private investors to rapidly expand their exposure to clean electricity assets.

A key aspect of renewable energy generation and storage is the availability of essential metals required for battery manufacturing. As the energy transition progresses, the global economy will gradually shift from a carbon-based model to one reliant on metals. Collaborative efforts between the public and private sectors can significantly contribute to achieving this shift, ensuring a sustainable supply chain for critical metals.

The need to modernise and expand grid infrastructure is attracting private investors for various reasons, including stable returns and diversification benefits. By collaborating with the private sector and benefiting from its expertise in project delivery, governments can accelerate the development of grid infrastructure, support the energy transition and create a more sustainable and resilient energy system for the future.

New business models

As the energy transition continues to gain momentum and renewable energy production keeps growing, both in MWh and as share of the total energy mix, new risks appear, linked to the difficulty to connect to the grid and to match at any time an intermittent production with consumption. These features lead to risks of curtailment or even negative prices on the market. The dynamics of Power Purchase Agreements (PPAs) are also shifting to align with the evolving needs and ambitions of both energy producers and consumers. These agreements between investors in Independent Power Plants (IPPs) and utilities traditionally spanned 15 years or more, but the trend has recently shifted towards corporate customers and shorter durations. This evolving landscape has even led some independent power producers to forgo PPAs altogether and take full market risk.

Renewable energy is taking on more risk than investors and lenders in infrastructure have historically assigned in terms of risk premium, but those emerging risks have yet to be reflected in the investors' return requirements and their business models. Investors and asset managers focused on the energy transition are recognising the need for a more direct and interactive relationship with corporate customers and, in due time, potentially interested household end-consumers. The focus is on ensuring that offtake agreements effectively translate into concrete commitments to exclusively utilise renewable energy, and that customers are not treated in a 'commoditised' manner. To facilitate this shift, digital technologies – particularly big data analytics – will be needed to create traceable relationships.

While newer and less mature renewable technologies, such as hydrogen, biofuels, and stand-alone storage, present uncharted risks that require careful consideration, 'plain vanilla' renewable energy projects – such as solar and wind – are not without their share of challenges, particularly in a context of high inflation and macroeconomic-related shocks. Although solar power boasts the lowest risk among available renewable technologies, it is not risk-proof as the intermittency of solar radiation poses a constant challenge, making the establishment of long-term offtake contracts complex. As for nuclear energy, even though it appears to be generating renewed interest across the board through smaller units that are easier to build and run ("Small modular reactors" – SMR) and will in any case be needed to balance and complement renewables by providing load and adaptable power capacity, it is still beyond the mandate of most private investors, and hasn't been retained in the report's scope.

Finally, a new and huge market is opening to investors with the need to upgrade and extend the transmission and distribution grids in order to adapt to the new energy mix. In the process, investors will be increasingly exposed to growth-impacted assets as opposed to the regulated utility risk prevalent so far.

As the energy landscape evolves, investors cannot restrict themselves to just financing renewable energy ventures: they should also contribute, whenever possible – particularly when participating in social infrastructure projects such as health or educational facilities – to educating end-users on responsible management of their energy consumption. This can also be achieved through demand aggregator tools, allowing optimisation and fine-tuning of energy use to generate savings and balance the grid. By promoting better and smarter energy use, investors stand to improve their reputational risk and social license to operate as well as achieve their financial objectives. Balancing objectives is essential, as sustainability and profitability are not mutually exclusive. Through a collaborative effort, investors can drive awareness and adoption of sustainable energy practices, creating a harmonious relationship between business goals and environmental stewardship.

Challenges

The energy transition is hindered by numerous structural constraints.

Given their long-term horizons, investments in renewable energy technology face the potential risk of policy shifts materialising prior to payout. This is in particular the case for tariff-setting policies – such as feed-in tariffs (FITs) and contracts for difference (CfDs[2]) – which have proved successful in incentivising renewable energy investments by guaranteeing an above-market price, but are periodically subject to revisions – sometimes with retroactive effect.

Other constraints include the high upfront costs, financing risks, high costs of capital and long lead times due to extended permitting processes: as in other sectors, inflation and rising interest rates are causing a shift towards more value-added strategies, as leveraging returns via low-interest credit is no longer an option.

Also at play are intermittency, price variability and the lack of flexibility, which make it less conducive to attracting debt financing and may favour those fund managers already specialised in energy transition-related assets.

[2] Contracts for Difference (CfD), pioneered in the UK, are a system of reverse auctions intended to give investors the confidence and certainty they need to invest in low carbon electricity generation. They work by fixing the prices received by low carbon generation, thus ensuring that eligible technology receives a price for generated power that supports investment.

Supply chain risks for hardware material and critical minerals alike, technological disruptions, difficulties in obtaining reliable and transparent data, political and regulatory barriers, infrastructure gaps – such as limitations in existing grid infrastructure and network integration limiting the integration of renewable energy – as well as possible ESG trade-offs constitute other challenges. Regarding the latter, certain clean energy solutions might have unintended adverse environmental and societal impacts as, for example, the energy transition is mineral-intensive and hence brings forth the risks of habitat loss and conflicts over natural resources supply.

Recommendations

For policymakers and governmental authorities

1. Public authorities should provide roadmaps: In the domains where they have direct authority – such as tariff-setting or deploying decarbonisation strategies – public authorities should provide clear, long-term roadmaps and commitments. They should also balance incentives through subsidies and tax credits with penalties such as restrictive regulations. Simplicity, clarity, and value for money should be prioritised.

2. Public financial support is still needed when technology or market risks are too high: Investors are looking for more incentives from public authorities to scale up investments in the energy transition. They expect public authorities, having set the roadmap, to assist in developing and deploying new technologies, such as charging stations for electric vehicles and green hydrogen facilities, with public-private partnerships being a tool of choice. In addition, public spending is needed to connect future renewables generation effectively, particularly when it comes to grid expansion and development.

Public CfDs with fixed prices through auctions offer stability, encouraging investments and benefiting consumers. The recent energy crisis underscores that deregulation does not always lead to lower prices, as the link between gas and power prices and market volatility can hurt consumers.

3. Stable policies are key: To maintain stability and investor interest, windfall taxes and price caps should be avoided where possible, as they may have long-term negative consequences. Emergency windfall tax measures may increase perceived political risk for investors, compounding the already rising market risks. Striking the right balance is crucial in supporting sustainable energy investments while fostering a stable and attractive investment climate.

For regulatory authorities

4. Adapted sectoral and financial/prudential regulations are needed: Regulations can and should support the energy transition and the decarbonisation of the economy alongside economic policy. Appropriate prudential regulations, such as capital charge ratios for banks or insurers, play a vital role in encouraging long-term investments in the energy transition.

To drive the additional investments needed, regulatory support and guarantees from public authorities or multilateral development banks are crucial. These measures provide reassurance to investors and help mitigate risks in renewable energy projects, especially in emerging markets.

For Investors (Asset Owners/LPs)

5. Investors should widen the scope of eligible assets: Stakeholders in the asset management industry should focus on investing in energy transition projects that go beyond core renewable energy generation and which incorporate transmission grids ("No transition without transmission") as well as digital and storage elements, and be conscious that this may mean accepting a higher risk-return profile.

6. A new, tailored approach to customers is needed: Relying solely on a subsidy-driven approach for building a strategy may be short-sighted. As renewable energy takes a larger share in the energy mix, with its inherent intermittency challenges, direct and interactive relationship with customers become essential. The 'commoditised' approach of old should be discarded.

For fund managers/GPs

7. In-depth technical and market expertise is key: Promoting energy transition-labelled new vehicles to attract increased fund-raising is only the start of a much deeper shift. As the market moves from traditional core-infrastructure models backed by long-term PPAs with public utilities and feed-in tariffs to a more merchant power market, investors must adapt their approach. Embracing a value-added strategy will be the key to capitalise on the growth opportunities in the infrastructure market. Ultimately, to contribute to the energy transition and the green transformation of the economy, flexibility is crucial, particularly in an era characterised by ever-rising geopolitical and macroeconomic uncertainties and disruptions.

Introduction: The Energy Transition, the Challenge of Our Time

The latest iteration of the United Nation's Intergovernmental Panel on Climate Change's Assessment Report, published in March 2023, has once again sounded the climate alarm, as humanity is fast approaching the tipping points which will lead to further destabilising shocks[3]. By now, this should come as no surprise, as the year 2022 saw a series of dramatic climate events hitting all four corners of the world. From floodings in Pakistan, deadly heatwaves across Asia and Europe, droughts and wildfires in Africa and the Americas, to melting glaciers – climate change is already upon us.

In addition to the death toll reaching the thousands and the millions displaced, these extreme events are causing untold infrastructural damage[4] at a time when a global debt crisis is brewing[5], severely hamstringing governments' ability to provide effective assistance to affected communities, let alone kickstart a green transition to mitigate, and hopefully reverse, the most severe consequences of climate change.

Since the mid-2010s, particularly following the adoption of the UN Sustainable Development Goals (SDGs) in 2015 and the landmark Paris Climate Agreement of the same year, stakeholders from the public and private sectors across the world have become cognisant of the need to adopt a multi-pronged strategy to adapt to, mitigate, and reverse climate change. However, analysis by Climate Action Tracker has revealed that the current policies implemented by governments continue to fall short of the objective to limit global warming to 1.5°C above pre-industrial levels, and that the world will experience significantly higher temperature increases should the status quo persist.[6]

Drastically transforming the global energy sector and reducing humanity's dependence on fossil fuels is arguably the key to solving climate change, with renewable energy at the front and centre of this energy transition (cf. Box 1).

The International Energy Agency (IEA) has been calling for more actions to accelerate the green transition in the energy sector, particularly given that energy-related CO_2 emissions reached a record high of 41.3 Gt CO_2-eq – with 89% of this CO_2 coming from energy combustion and industrial processes.[7] But to achieve this transition and reach net zero objectives by 2050 as prescribed by the Paris Agreement, huge investments are needed, both in terms of quantity and focus. According to recent estimates by the International Renewable Energy Agency (IRENA), a total of investment of USD 150tn is necessary to limit global warming to 1.5°C above pre-industrial levels. This would entail, among other things, redirecting the approximately USD 1tn annually allocated to fossil fuel-based technologies towards technologies and infrastructure of the energy transition.[8] Another recent report estimates that the energy transition will require roughly USD 275tn between 2021 and 2050 to reach net zero territory.[9]

With 149 countries, accounting for 89% of the world's population and responsible for 88% of global greenhouse gas (GHG) emissions, having already submitted net zero targets as of June 2023,[10] sustainability considerations have taken front and centre stage in the policy agendas of stakeholders in the public and private sectors alike.

Over the past three years, the energy transition has made notable advancements, largely attributed to a series of systemic

[3] IPCC. (2023). 'Synthesis Report of the Sixth Assessment Report,' March 20, 2023

[4] Rosane, O. (2023). '10 costliest climate disasters of 2022,' World Economic Forum, January 5, 2023. The article is based on Christian Aid. (2022), 'Counting The Cost 2022: A year of climate breakdown,' December 2022

[5] Grynspan, R. (2023). 'The world lacks an effective global system to deal with debt,' United Nations Conference on Trade and Development, February 2, 2023

[6] Data retrieved from Climate Action Tracker

[7] IEA (2023). 'CO2 Emissions in 2022,' March 2023

[8] IRENA (2023). 'World Energy Transitions Outlook 2023 – 1.5°C Pathway,' March 2023

[9] Krishnan, M. et. al. (2022). 'The net-zero transition: What it would cost, what it could bring,' McKinsey & Company, January 2022

[10] Data retrieved from Net Zero Tracker.

Box 1. The Energy Transition

- The energy transition refers to the energy sector's shift from finite fossil-based systems of energy production and consumption (i.e., oil, natural gas and coal) to renewable and sustainable energy sources such as wind and solar, as well as hydroelectric and biomass.

- Over the past few years, there has been a reassessment of the energy transition, leading to a widespread acknowledgment among all stakeholders that the mere replacement of carbon-intensive conventional energy production with renewables is insufficient. The energy transition now encompasses storage, transmission, energy efficiency, and security as integral components – all of which contribute to reducing the demand side through efficient energy solutions at the point of use. Its objective is to tackle the energy trilemma, which comprises the challenges of (1) ensuring affordability, (2) enhancing reliability, and (3) promoting sustainability.

- The global energy transition is underway, driven by global and national decarbonisation agendas, conducive regulatory developments, and technological progress (such as improvements in energy storage and digital applications to improve energy systems). Economic factors – such as the decreasing costs of renewable energy – and strategic security considerations are also key factors driving the transition. According to the IEA's 2022 annual report on renewable energy, global renewable energy capacity is expected to rise by 2,400GW between 2022 and 2027 – a figure almost 30% higher than what was forecast in the 2021 edition – while renewables are set to account for 90% of the expansion in global electricity capacity during this period.[11]

In recent years, the term 'energy transition' itself has gained much traction and has become something of a stand-in for 'clean energy' across many jurisdictions, particularly when used by policymakers. However, it is important to note that investible energy transition opportunities now go beyond traditional renewables and encompass:

- **Upstream:** Renewable capacity additions to generate the requisite power from low carbon/clean technologies.
- **Midstream:** Grid upgrades and initiatives to accommodate the rising share of variable renewable energy.
- **Downstream:** Delivery of cleaner and more reliable power solutions by generating energy at the point of use.

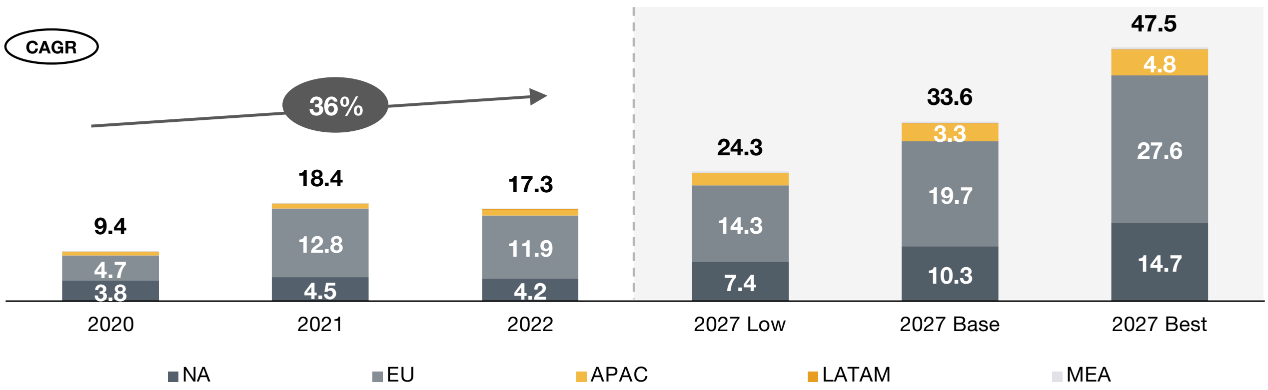
[11] IEA (2022). 'Renewables 2022: Analysis and forecast to 2027,' December 6, 2022

shocks that have spurred a renewed political determination to facilitate this transition. One particularly influential event was the Russian invasion of Ukraine, which heightened the awareness among policymakers in numerous developed nations about the importance of attaining energy sovereignty and independence through the adoption of clean energy sources. This event served as a catalyst, prompting a re-evaluation of energy strategies and emphasising the significance of transitioning towards sustainable alternatives. As a result, in 2022, the global economy is estimated to have become 2% less energy-intensive as governments, households and firms are estimated to have spent around USD 560bn on energy efficiency – with a large chunk of this amount going towards electric vehicles (EVs) and heat pumps.[12]

However, we are still far from being on the right trajectory. Huge amounts of investments from both the public and private sectors are required for the transition. Institutional investors and infrastructure funds have to play a key role in financing and fostering innovative approaches towards the transition, even if tensions between fiduciary duties and environmental, social and governance (ESG) commitments might arise.

In recent years, a paradigm shift has developed within the global Asset and Wealth Management (AWM) industry, whereby asset managers and investors – retail and institutional alike – have become heavily attuned to ESG principles. The latter increasingly want to see their investments directed towards businesses that actively implement ESG, while the former are busy devising financial products that cater to these demands. Regulatory authorities on the other hand, armed with relatively new and still-developing regulations, are increasingly keeping a watchful eye over the ESG credentials of asset managers' products to protect investors from any misleading ESG-related claims.

Exhibit 1: Total global ESG AuM by region (USD tn)



Note: Includes all asset classes across public markets, private markets and mandates

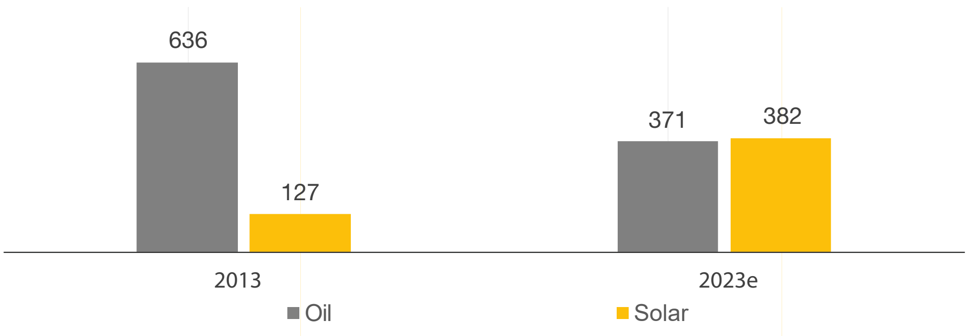
Source: *PwC Global AWM & ESG Market Research Centre*

[12] The Economist (2023). 'War and subsidies have turbocharged the green transition,' February 13, 2023

With ESG investing poised to become the dominant investment theme in the coming decades,[13] renewable energy now presents a massive investment opportunity. In 2023, as per a recent report by the IEA, investments in solar energy are expected to surpass investments in oil production for the first time (cf. Exhibit 2), and out of USD 2.8tn expected to be invested in the global energy sector in the year, over USD 1.7tn (close to 61%) will be directed towards renewable energy, nuclear power, EVs and improvements in energy efficiency.[14]

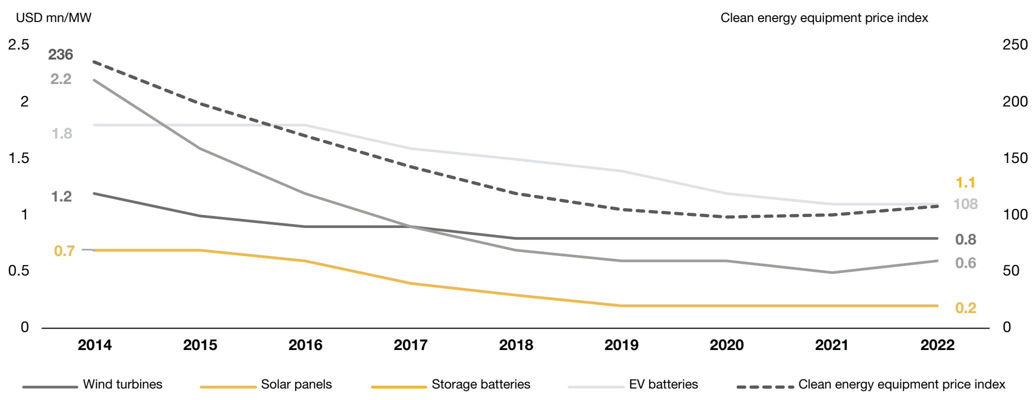
While the majority of clean energy spending is expected to flow from developed countries and China, further highlighting the disparities between countries when it comes to the energy transition, the IEA does indicate that investments in clean energy (particularly solar) are picking up steam in many emerging economies, most notably in India, Brazil, and the Arabian Peninsula.[15] This global uptick has been greatly sped along by the sharp decline in the average cost of solar and wind projects (driven by technological advancements, falling capital costs and increased competition), making such projects increasingly favoured over new fossil fuel projects across the world (cf. Exhibit 3).

Exhibit 2: Investments in oil production and solar energy, 2013 vs. 2023e (USD bn)



Source: *International Energy Agency*

Exhibit 3: Average prices for selected technologies, 2014-2022 (USD mn/MW)



Source: *International Energy Agency*

[13] For a recent overview of the ESG paradigm shift sweeping through the global AWM industry, see PwC (2022). '[Asset and wealth management revolution 2022: Exponential expectations for ESG,]' October 2022

[14] IEA (2023). '[World Energy Investment 2023,]' May 2023

[15] Ibid

Within the global AWM industry, many asset managers and institutional investors have made net zero pledges and established alliances and initiatives to reach these objectives and ensure that investment flows contribute to the Paris Agreement goals. However, the current climate pledges made following the 26th and 27th Conference of the Parties (COP) lack detail and support, while asset managers who made lofty net zero pledges have come under scrutiny by regulators, investors and the public alike.

Nonetheless, the energy transition is in rapid motion, driven by six major trends:

Climate Concerns

As the evidence of global warming becomes increasingly compelling, and as governments and the private sector find themselves footing an ever-growing climate-related bill, a paradigm shift in energy industry practices is taking place, with stakeholders' activism only adding to this trend.

ESG Focus

ESG considerations are becoming an important facet of companies' strategies across all sectors – including the energy sector. In order to meet their net-zero targets, many corporations will need to radically change the way they use energy, providing significant opportunities for private capital investment.

Energy Sovereignty and Security

Sovereignty and security-related considerations are urging a rethink in energy sourcing. Supply security is now a major concern both at country and corporate levels, accelerating the energy transition over the medium term.

Government Policies

Policymakers and regulators across the world are increasingly focusing on the long-term energy transition in order to achieve energy security and strategic autonomy.

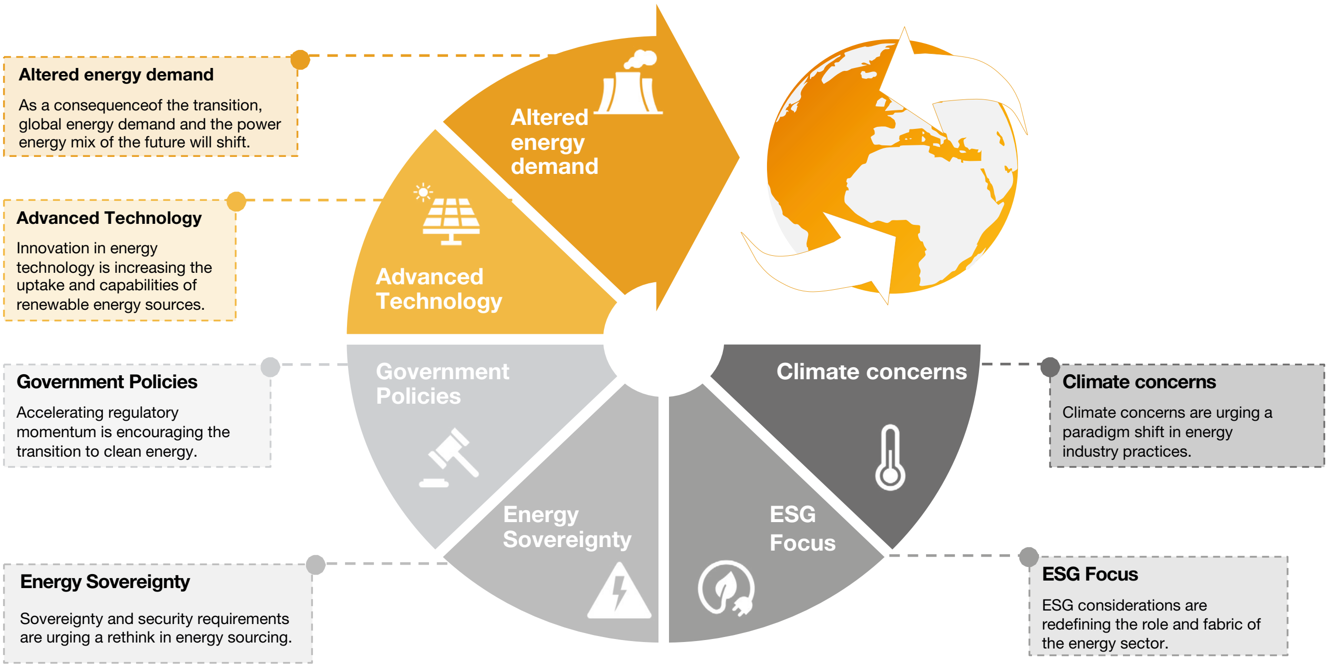
Advanced Technology

Technological developments and innovations driven by the public and private sectors are increasing the uptake and capabilities of renewable energy sources.

Altered energy demand

As the price of renewables declines, and as renewable energy projects gain in prominence and size, the global energy demand and the power energy mix of the future will shift to the detriment of fossil fuels. Beyond traditional renewable energy generation, Limited Partners (LPs) are now recognising the additional opportunities on offer across the supply chain – upstream, midstream and downstream. In this context, General Partners (GPs) are developing wider energy transition-focused products.

Major trends in the energy transition:



While fossil fuels accounted for 82% of primary energy use in 2021,[16] BP's Energy Outlook 2023[17] and IRENA's projections indicate that the global final energy demand will reach its pinnacle in all scenarios before levelling off, and that the final energy consumption could witness a remarkable decline of 15% between 2020 and 2050 – representing a clear and undeniable trajectory towards decarbonisation and sustainable energy solutions. A core part of this trajectory are the evolving consumer expectations and purchases, particularly when it comes to the purchase of EVs – in 2022, global spending on EV shot up to USD 425bn (a 50% increase relative to 2021), with the bulk of this spending coming from consumers directly.[18]

Although decarbonisation is impacting the whole Infrastructure asset class and investible energy transition opportunities span both the Infrastructure and Private Equity asset classes (and beyond), there is a case to be made according to Campbell-Lutyens[19] that the energy transition is gradually becoming an asset allocation in its own right.

Drawing upon numerous quantitative and qualitative data sources, as well as discussions with LTIIA members, this report aims to provide all stakeholders invested in the energy transition with a thorough overview of its financing landscape. Specifically tailored towards stakeholders in the AWM industry, the report delves deep into the intricate tapestry of challenges, barriers, and prospects inherent in the energy transition, particularly within the Infrastructure asset class.

[16] bp (2022). 'bp Statistical Review of World Energy – 71st edition,' June 2022

[17] bp (2023). 'bp Energy Outlook 2023 edition,' January 2023

[18] IEA (2023). 'Global EV Outlook 2023: Catching up with climate ambitions,' April 2023

[19] Campbell Lutyens (2023). 'Infrastructure Market Update,' January 9, 2023

Economic landscape

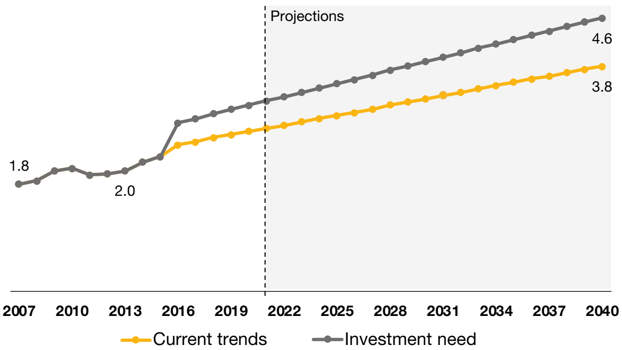
2.1 Infrastructure Investment Gaps

A robust energy infrastructure is a core part of modern economies, and plays a crucial role in bolstering prosperity, productivity, and well-being, and ultimately in achieving the UN SDGs. Yet, as of 2022, an estimated 775 million people did not have reliable and affordable access to electricity – a figure that has increased since 2021 due to the sharp uptick in fuel prices.[20]

Recent macroeconomic headwinds have widened the global infrastructure financing gap as governmental budgets have been severely squeezed, at a time when investing in clean energy and infrastructure resilience becomes evermore pressing due to climate change.

Projected to reach USD 15tn over 2016-2040, the global economic infrastructure financing gap will perpetuate a persistent deficit in infrastructure, impeding global economic growth and prosperity, as well as the ability to reach the targets set in the Paris Agreement (cf. Exhibit 4).

Exhibit 4: Global Estimated Economic Infrastructure* Gap (USD tn)

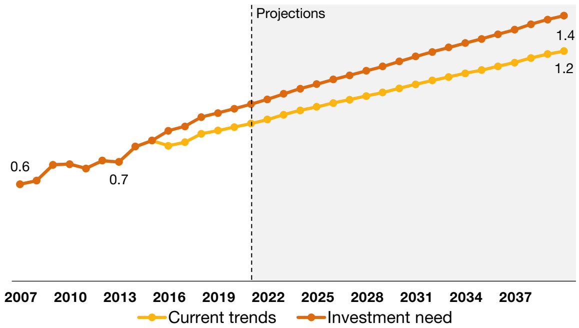


Note: Economic infrastructure includes energy, telecommunications, airports, ports, railways, roads, and water sectors. The USD 15tn financing gap represents the cumulative figure from 2016 to 2040.

Sources: *GIH, IRENA and IEA*

As for the global estimated energy infrastructure gap, it is projected to reach USD 2.9tn by 2040 – a figure that would rise to USD 5.6tn if the needs to achieve all the UN SDGs are added (cf. Exhibit 5).

Exhibit 5: Global Estimated Energy Infrastructure Gap (USD tn)

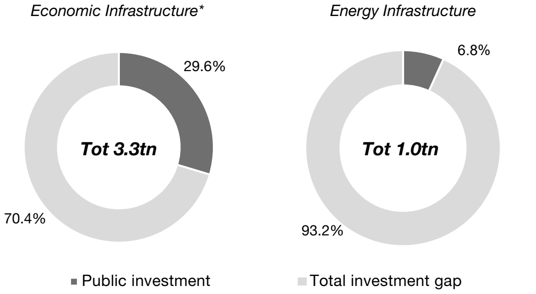


Note: The cumulative gap from 2016 to 2040 is USD 2.9tn for global energy infrastructure.

Sources: *GIH, IRENA and IEA*

While overall investment in energy infrastructure has been climbing steadily across the world, neither the pace nor the scale has matched the economic, environmental and social targets outlined in the UN SDGs and the Paris Agreement. Although public investments in energy transition infrastructure across developed economies received a substantial boost in recent years (cf. Boxes 2 and 3), the amounts invested fall far short of meeting the multiple challenges of the global energy system. Actual public investments currently represent 29.6% of total economic infrastructure investments needs but only 6.8% of current energy infrastructure investment needs, leaving a huge gap to be covered by the private sector in order to meet the projected economic and energy investments needs of the future (cf. Exhibit 6).

Exhibit 6: Total Economic Infrastructure* and Energy Infrastructure Investment Needs in 2022



Note: Economic infrastructure includes energy, telecommunications, airports, ports, railways, roads and water sectors.

Sources: *GIH, IRENA and IEA*

[20] Cozzi, L. et. al. (2022). '[For the first time in decades, the number of people without access to electricity is set to increase in 2022.](#)' International Energy Agency, November 3, 2022

2.2 Public policies in place

Robust public policies coupling incentives with clear strategic signals are thus needed to scale up and fasten the pace of the energy transition through mobilising both public and private actors.

Box 2. The United States' Inflation Reduction Act

Passed by the administration of President Joe Biden in August 2022, the Inflation Reduction Act (IRA) constitutes the single largest climate investment in the history of the United States, with USD 370bn earmarked for the coming decade.

The program seeks to decarbonise the US economy and strengthen the country's energy independence by investing massively in technologies that will reduce CO2 emissions and lower energy prices.

From EVs to hydrogen, solar energy, wind power, low-carbon energy-efficient buildings, climate-smart agriculture and carbon capture and storage solutions, the IRA is nothing short of a major overhaul of the American economy, with the public and private sectors driving its decarbonisation.[21]

Nonetheless, the law has also raised trepidations and concerns. For starters, some commentators are worried that the law and its quasi-protectionist measures – through domestic content requirements inducing home-market bias – risk alienating the United States' allies and provoking trade-related tensions, which would not only harm the country's geopolitical standing, but might also hamper the global energy transition,as countries could turn inward rather than adopt a cooperative approach anchored in collaboration and fair competition.[22]

Box 3. The European Union's 'REPowerEU-Plan' and the 'Green Deal Industrial Plan'

Launched in May 2022 by the European Commission in response to the Russian invasion of Ukraine and the EU's subsequent divestment of fossil energy from Russia, the REPowerEU Plan aims to help the EU diversify its energy supply, increase its renewable energy capacities, and save energy. The plan distinguishes between short-term measures (such as joint gas, LNG and hydrogen purchases by the EU Energy Platform for all EU Member States) and measures of a more medium- and long-term nature, such as deploying solar, wind and hydrogen energy projects in the coming years.[23]

The REPowerEU Plan was followed in February 2023 by the EU Green Deal Industrial Plan, which many observers view as the European Commission's response to the Biden Administration's IRA, albeit with significantly less funding allocation.

The Plan follows relevant recent efforts to change the industry, ultimately aiming to transform the European economy into a decarbonised and sustainable economy by 2050. This will be done via a wide array of measures – such as regulatory simplifications to boost competitivity and investments, and speeding up funding to access net-zero technologies. As part of the Plan, the European Commission proposed the Net Zero Industry Act in March 2023, which seeks to strengthen and scale up the continent's manufacturing capabilities of net-zero technologies, with the ultimate goal of contributing to the decarbonisation of the European economy and strengthening the EU's energy resilience.[24]

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[21] The White House (2023). 'Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action – Version 2,' January 2023

[22] Bordoff, J. (2022). 'America's Landmark Climate Law: The Inflation Reduction Act must spur virtuous competition, not vicious protectionism,' IMF Finance & Development, December 2022

[23] European Commission (2022). 'REPowerEU: Affordable, secure and sustainable energy for Europe'

[24] European Commission (2023). 'The Net-Zero Industry Act: Accelerating the transition to climate neutrality'

EU Green Deal Industrial Plan

The European Green Deal sets out the EU's strategy to achieve climate neutrality by 2050.

- ***EUR 250bn*** for green measures
- ***EUR 372bn*** from InvestEU
- ***EUR 40bn*** under the Innovation Fund

EU REPowerEU-Plan

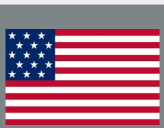
The REPowerEU Plan addresses Europe's dependence on Russian fossil fuels and the climate crisis by accelerating the clean energy transition.

- ***EUR 210bn*** by 2027
- ***EUR 113bn*** for renewables ***(EUR 86bn)*** and key hydrogen infrastructure ***(EUR 27bn)*** by 2030
- ***EUR 41bn*** for adapting industry to use less fossil fuels by 2030
- ***56bn*** for energy efficiency and heat pumps by 2030
- ***EUR 37bn*** to increase biomethane production by 2030
- ***EUR 29bn*** in the power grid by 2030 to enable greater electricity use
- ***EUR 10bn*** investments to import sufficient LNG and pipeline gas by 2030
- ***EUR 1.5-2bn*** for security of oil supply
- up to ***EUR 115bn*** from EIB by 2027 in investment for energy efficiency, renewables, grids, charging infrastructure, and storage

United States Inflation Reduction Act

The Inflation Reduction Act of 2022 is intended to fight inflation, lower deficits as well as energy and healthcare costs for American families, invest in domestic energy production and help achieve net-zero goals.

- ***USD 300bn*** in Deficit Reduction
- ***USD 369bn*** in Energy Security and Climate Change programs



United States Inflation Reduction Act

- The Inflation Reduction Act constitutes the single largest climate investment in US history. It includes i) supporting technologies that will lower emissions and energy prices; ii) strengthening energy security through measures to promote energy independence and cleaner production, along with investments in the domestic clean energy manufacturing industry; iii) decarbonizing the economy by providing targeted federal support for innovative climate solutions; iv) protecting vulnerable communities; and v) supporting rural communities through federal support for climate solutions.
- The bill also contains provisions to support R&D of clean energy technologies, expand the use of electric vehicles, promote energy efficient buildings and infrastructure, and reduce methane emissions from the oil and gas industry.

EU Green Deal Industrial Plan

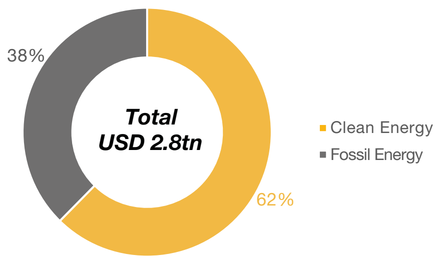
- Launched on Feb 1, 2023, the plan follows relevant recent efforts to transform industry, ultimately aiming to transform the EU economy into a sustainable and climate-neutral system by 2050.
- The plan aims to i) simplify regulations, boosting competitivity and encouraging investment; ii) speed up funding access for net-zero industry by ensuring a fair environment where public and private funds can be combined to finance the production of clean technologies in Europe; iii) improve workforce skills in green and digital technologies; vi) promote global cooperation and trade openness in the market of net-zero technologies.
- In March 2023, the EP and the Council made the provisional agreement to reinforce the EU Renewable Energy Directive, raising the EU's 2030 renewable target to a minimum of 42.5% and aims for 45% renewables by 2030.

EU REPowerEU-Plan

- REPowerEU is the EU Commission's plan to end dependence on Russian fossil fuel imports, save energy, produce clean energy and diversify energy supplies.
- The plan consists of both short-term measures (e.g., joint gas, LNG and hydrogen purchases by the EU Energy Platform for all Member States) and medium- and long-term initiatives (e.g., deployment of solar, wind and hydrogen energy projects).
- These include accelerating industrial decarbonisation, faster approval of renewables, developing gas and electricity infrastructure networks, improving energy efficiency in the transport sector and a future orientated regulatory framework for hydrogen.

The large gap in public funding (see p.14) highlights a strong need for financing from the private sector, representing both a challenge and an immense opportunity for private investors to plug the gap. Much of these opportunities lie in the renewable energy category – in 2023, out of an estimated USD 2.8tn of investments in the energy sector, 62% is expected to flow towards clean energy (cf. Exhibit 7).

Exhibit 7: Estimated global energy investment in clean energy* and in fossil fuels in 2023 (USD tn)

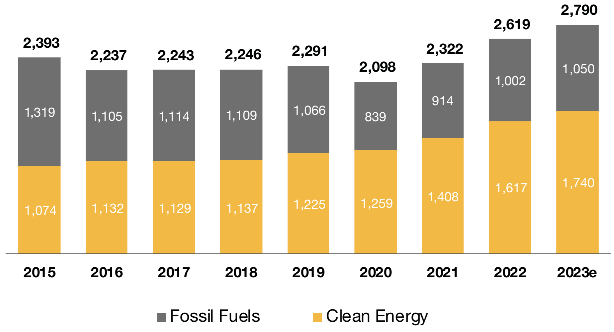


Note: Clean energy investments include renewable power, nuclear energy, grids, storage, low-emission fuels, efficiency improvements and end-use renewables and electrification.

Sources: *IEA and S&P Global*

This trend whereby clean energy takes up a larger share of investments than fossil fuels has been proceeding unabated since 2015, when investments in clean energy made up only 44.8% of global energy investments (cf. Exhibit 8).

Exhibit 8: Global energy investments in clean energy* and in fossil fuels 2015 – 2023e (USD bn)



Note: Clean energy investments include renewable power, nuclear energy, grids, storage, low-emission fuels, efficiency improvements and end-use renewables and electrification.

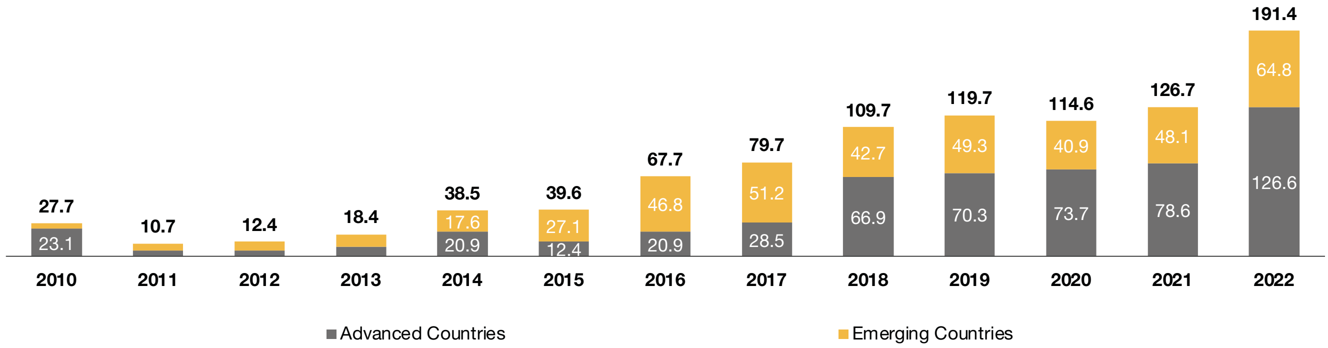
Sources: *IEA and S&P Global*

While public policies have undeniably contributed to the growth of clean energy investments, it is worth noting that these policies have been primarily focused on addressing short-term challenges associated with the COVID-19 pandemic and the energy crisis. In addition, while public investments in energy transition infrastructure have skyrocketed from USD 27.7bn in 2010 to USD 191.4bn in 2022 (with a significant leap of 61.1% from 2021 to 2022), these investment flows are increasingly concentrated in developed countries (cf. Exhibit 9).

A major challenge will thus be to narrow the gaps in clean energy investments between the developed and developing worlds. The latter currently relies heavily on public investments for the energy transition, with approximately half of energy investments in Asia and Africa being financed by state-owned enterprises. These investments are at risk of being significantly curtailed by a worsening global economic outlook, high capital costs, rising borrowing costs and mounting public debts. Global debt reached a new peak of USD 305tn in Q1 2023, with corporations from outside the financial sector and governments driving up much of the sharp uptick seen in recent times.[25]

In addition, while most people tend to think of the energy transition in terms of electricity generation, much work is required across the infrastructure spectrum if the whole economy is to be decarbonised and if global net zero goals are to be attained. A collateral dimension is that, as many European Limited Partners (LPs) are investing in carbon-free projects, this may often entail a narrow focusing on renewable energy generation, bringing about price bubbles – although the trend is less pronounced in the United States due to mixed approaches and political concerns among institutional investors.

Exhibit 9: Public Energy Transition Infrastructure Investment (USD bn)



Sources: *IJGlobal and IEA*

[25] Smith, E. (2023). 'Global debt nears record highs as rate hikes trigger 'crisis of adaptation,' top trade body says,' CNBC, May 18, 2023

Technologies at play

Lastly, one of the main features of the energy transition that has attracted investors of all stripes is the many technologies to choose from – from mainstream favourites such as wind and solar, to up-and-coming alternatives such as green hydrogen and biomass (cf. Table 1).

Table1: Technologies underpinning the energy transition

Technology	Description
Solar energy	Initially driven by governmental subsidies and regulatory frameworks built around bilaterally negotiated contracts or Power Purchase Agreements (PPAs), with mandated utilities and corporates seeking to support their own ESG objectives, solar energy has become a fixture of the energy mix across the world. While some traditional power networks may still push back against access for customers producing their own energy and wanting to sell on their surplus to the grid, a new business model is now taking root, where commercial and retail customers are directly accessing solar power generation through the distribution network. Investments in solar projects have been rising significantly – according to Bloomberg NEF, USD 308bn flowed towards solar projects in 2022, a 36% year-on-year increase[26] – while the cost of photovoltaic (PV)-generated electricity has come down and is now broadly in line with the cost of fossil fuels. Many corporations have been embarking on solar projects to reduce their carbon emissions, reduce energy-related costs, and drive forward their ESG strategies. However, obtaining a permit to design and build large solar farms can still be an onerous and time-consuming process in many cases ***(see Case Study 'Powerflex').***
Wind power	Since the world's first wind farm was installed in 1980, wind power has gradually become a key component of the global energy mix, particularly once offshore wind farms began to be installed. In 2022, investments in wind power stood at roughly USD 175bn, in line with the previous year. Slow administrative procedures to obtain permits to build onshore wind farms and connect them to the grid have hampered growth in this technology.[27] Often, it can take more time to obtain a permit than to build the wind farm itself. In addition, recent disruptions in global value chains, combined with inflationary pressures, have raised the cost of installing wind turbines, resulting in an inversion of the cost curve for wind power. Nonetheless, there is considerable scope for growth, particularly when it comes to offshore wind farms (including floating wind turbines) and energy islands in the North Sea ***(see Case Study 'Service Operations Vessels for Dogger Bank wind farms')***.

[26] BloombergNEF (2023). 'A Record $495 Billion Invested in Renewable Energy in 2022,' February 2, 2023

[27] Ibid.

Technology	Description
Electricity storage, batteries and EV charging networks	Investors are increasingly focusing on solutions such as battery storage to meet global climate and sustainability targets, and in 2022, corporate funding for energy storage companies grew by 55% to reach a record USD 26.4bn globally. That year, a record 28 acquisitions were completed (up from 20 in 2021), while six storage electricity companies went public (up from four in 2021).[28] Batteries are increasingly seen as the leading energy storage option – be it for integrating renewable energy into the electricity grid or for scaling the usage of EVs. According to a report by the IEA, grid-scale battery storage capacity should expand 44-fold between 2021 and 2030 in order to stay on track for the net zero objectives.[29] The sooner locally-produced renewable power can be stored in significant volumes, the more countries will be able to rely on it for clean electricity generation. Electric Vehicles (EVs) – a core part of global decarbonisation efforts – are already becoming widespread across the world, particularly in jurisdictions where policies and regulations have been enacted to discourage the usage of traditional internal combustion engine vehicles. However, battery production for EVs will need to increase significantly from 160GWh in 2021 to 6,600GWh by 2030.[30] While battery storage is currently considered to be the best solution to deal with the short-term volatility of increasing intermittent solar and wind energy in the system, it may prove to be a volatile business, as it relies increasingly on a merchant (rather than a fixed price) business model, and the economics will have to improve as battery capacity revenue currently does not often even pay for the land and space occupied. Finally, huge investments combined with strong policy support will be required to ensure that the supply of several key minerals grows fast enough. While there is no geological resources shortage of any of the raw materials needed to support the transition to a net-zero economy – whether in batteries, transmission cables, solar panels or wind turbines – scaling supply rapidly enough to meet demand growth between now and 2030 will be challenging for some key energy transition materials: lithium, nickel, graphite, cobalt, neodymium and copper. Mining and refining/processing capacity, as well as strong action to improve materials efficiency, increase recycling and optimise inventory management will be needed.[31] A coordinated public-private policy will have to be implemented to secure the strategic supply of critical minerals over the long term. The French government's strategy is one prominent example in this vein[32] ***(see Case Studies 'Vattenfall and Sakndia's Battery Parks,' 'Allego EV Charging Stations,' and 'InfraVia – Critical Metals Fund').***
Grid adaptation	"No transition without transmission." The best locations for renewable energy generation are often found in sites far from the power grid: desert territory, rural areas, and offshore maritime territory. As legacy grid infrastructure was not built with the energy transition in mind, a fundamental shift is required to ensure that grid connectivity is up to the standards required for the transition, and that surplus renewable energy generated can be distributed in a reliable, fast and secure way. Digitally-enhanced smart grids connected to national grids are also needed to optimise the use of renewable power, as they will be key to managing load balancing and demand spikes. In the US, the average grid connection takes 3 years to be completed, and the lag is getting longer.[33] The country will need to expand its electricity transmission systems by 60 percent by 2030,[34] and may need to triple it by 2050 if it is to keep pace with various net-zero carbon goals. In 2021, annual investments in electricity grids stood at a little over USD 300bn – a figure that should double by 2030 in order to reach net zero objectives.[35] Such figures should, in theory, provide huge opportunities for infrastructure investors. However, private participation has been throttled by complex and time-consuming permitting processes and outdated cost-allocation practices. In Europe, private investors have started funding interconnector projects, as the best places to generate wind and solar energy are found in remote areas (e.g., Nordic countries, the North Sea, the Mediterranean). Major investments in new transmission lines and interconnectors are needed to deliver power to the more densely populated areas. Infrastructure funds have started to focus on the transmission challenge, and a number of privately-financed interconnector projects are now under construction ***(see Case Study 'NeuConnect Interconnector').***

[28] Mercom Capital Group (2023). 'Energy Storage Firms Tap $26.4 Billion in Corporate Fundings in 2022, up 55% YoY,' January 20, 2023

[29] IEA (2022). 'Grid-Scale Storage: Infrastructure deep dive,' September 2022

[30] Waine, C. (2023). 'Batteries lead the charge,' Infrastructure Investor, May 9, 2023

[31] Energy Transitions Commissions (July 2023). 'Material and Resource Requirements for the Energy Transition,' July 2023

[32] Ministère de l'économie, des finances, et de la souveraineté industrielle et numérique (2022). 'Le Gouvernement dévoile sa stratégie pour sécuriser l'approvisionnement en métaux critiques,' January 11, 2022

[33] The Economist (2023). 'Electric grids: The ultimate supply chains,' Technology Quarterly, April 8, 2023

[34] Princeton University (2021). 'Net-Zero America,' October 2021

[35] IEA (2022). 'Smart Grids: Infrastructure deep dive,' September 2022

Technology	Description
Green Hydrogen	Large parts of the economy cannot be easily decarbonised with electricity. These are the 'hard-to-abate' sectors, such as steel, cement, and aviation, to name a few. This is where alternative green fuels come into play. Hydrogen produced from renewable energy by means of electrolysis can be used as a fuel in all major CO2-emitting sectors where direct electrification is not possible. Green hydrogen is produced by splitting water using only renewable electricity, and therefore produces no GHG emissions. Increasing interest from the private sector and growing policy support – such as the European Commission's proposed hydrogen bank[36] or the Biden Administration's National Clean Hydrogen Strategy[37] – have made green hydrogen appear as a very promising technology for decarbonisation ***(see Case Studies 'Green Hydrogen in Utah' and 'Power Plant in French Guiana')***. However, cost is still a major concern, and there is a need for a regulatory framework, support schemes and technological advances to scale up faster production of electrolysis-based green hydrogen. In 2022, global investments in clean hydrogen stood at USD 1.1bn – up from just USD 0.3bn in the preceding year.[38] But expanding hydrogen production is only the first half of the equation. Distribution makes up the second one. According to the European Hydrogen Backbone – an industry body composed of over 30 energy infrastructure companies – Europe could come close to 28,000 km of hydrogen pipelines across 21 countries by 2030, with around 60% consisting of repurposed existing pipelines and the rest being new ones.[39]
Biomass	Biomass energy is a non-renewable type of energy which consists of using living organisms – such as municipal solid waste, grass, wood etc. – to generate energy through several processes, most notably combustion. While biomass energy does encapsulate many advantages in terms of carbon capture and emissions, scaling up biomass energy inevitably entails numerous resource- and collection-related issues, as well as trade-offs against agricultural, food or "rewilding" concerns. In addition, the significant decline in the cost of solar and wind has made it harder for biomass-related projects to catch up, as investments flowed to the former. Nonetheless, a new generation of projects is now being rolled out around biogas and biomethane, whereby biomethane produced from households and similar waste is injected directly into gas distribution networks as a substitute for fossil natural gas ***(see Case Study 'Biogas Waste Recovery Projects in France').***
Energy efficiency	Beyond production and distribution of renewable energy, a case can be made that private investors can help improve efficiency by investing in measurement, control and optimisation systems (e.g., smart meters) as well as educate end-users on the ways, means and benefits of reducing their energy consumption without affecting the quality of services. While this may seem counter-intuitive for players used to maximising their sales, a new culture is emerging which sees utilities or asset managers effectively valorising "negawatts" and encouraging their users to consume energy more appropriately. According to the European Investment Bank, 53% of EU firms invested in climate action in 2022 and about 40% of them – and over 50% of large firms – invested in energy efficiency in 2022. On average, firms in the EU devote 10% of their investments to energy efficiency (compared to 6% in the United States[40]). Nurseries, schools and universities that are built and run in a sustainable manner can play a significant role in the decarbonisation of the economy and the ecological transition by resorting to both material and immaterial investments. Education or social infrastructure facilities that are designed, built and financed at the cutting edge of sustainability via public-private partnerships (PPPs) can go hand-in-hand with programmes to help colleges and universities reduce their dependence on fossil fuels and thus minimise their carbon footprints, while freeing their investment for core educational programmes. Energy efficiency goes beyond the technical approach to appliances and buildings, with initiatives that engage with users on sustainability and aim to involve both students, teachers and other administrators in consuming less and better, incorporating energy efficiency in the curriculum by building on real-time data and performance from the system ***(see Case Studies 'Meridiam's Schools and Day Care Centres in Espoo' and 'Voltalis power-use Optimisation Model').***

[36] European Commission (2023). 'Commission outlines European Hydrogen Bank to boost renewable hydrogen,' March 16, 2023

[37] Department of Energy (2023). 'Biden-Harris Administration Releases First-Ever National Clean Hydrogen Strategy and Roadmap to Build a Clean Energy Future, Accelerate American Manufacturing Boom,' June 5, 2023

[38] BloombergNEF (2023). 'Global Low-Carbon Energy Technology Investment Surges Past $1 Trillion for the First Time,' January 26, 2023

[39] European Hydrogen Backbone (2022). 'A European Hydrogen Infrastructure Vision Covering 28 Countries,' April 2022

[40] European Investment Bank (2023). 'EIB Climate Investment Report 2022-2023: European companies are stepping up their investment in climate action,' April 13, 2023

LTIIA members' case studies: Filling the Gap through Private Investments

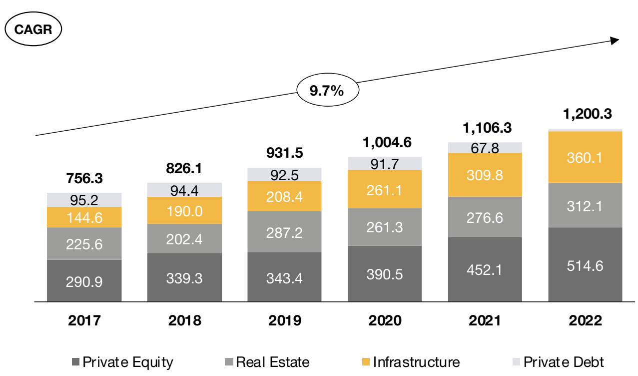
4.1. The ESG driver...

Propelled by increased regulatory momentum, societal focus and increased acknowledgement that investing sustainably does not hamper performance, investors are increasingly adopting ESG-oriented investment philosophies. While the 'ESG shift' is largely discussed within the context of public markets, ESG investing today also represents an increasingly focal point in the Private Funds landscape, with assets under management (AuM) growing at a 9.7% CAGR since 2017 to reach USD 1.2tn as of end-2022.

ESG investing holds great untapped potential, as ESG assets only account for 9.1% of total global Private Market (PM) Funds AuM of 13.2tn as of end-2022. Infrastructure represents the fastest-growing asset class for ESG, climbing at a CAGR of 20% between 2017 and 2022, and ranking second behind Private Equity in 2022 (cf. Exhibit 10).

This opportunity is particularly compelling within energy transition infrastructure, where ESG considerations are paramount and present an opportunity for ESG-oriented investors and asset managers to enhance the sustainable impact of their portfolios. Indeed, as per a recent survey by Investments and Pensions Europe, 96 of the largest 100 Infrastructure investors follow a dedicated ESG strategy in their portfolio.[41]

Exhibit 10: ESG Private Market Funds AuM split by Asset Class (USD bn)



Sources: *PwC Global AWM & ESG Market Research Centre, Preqin*

While a positive causation between ESG and higher returns is yet to be established, a recent report by PwC highlighted that "nine in ten asset managers are convinced that integrating ESG into their investment strategy will improve overall returns in the long term."[42] The positive performance impacts are likely to be particularly pronounced in investments on infrastructure tied to the energy transition, as these investments represent long-term fixed assets with secure, predictable and inflation-linked returns. Thus, alongside such returns, investors focused on energy transition infrastructure would make a difference by supporting the transition to a low-carbon and sustainable future, and hence aligning their financial goals with environmental and social objectives.

Electricity storage, batteries and EV charging networks are among the most recent trends, rapidly developing from niche to growth markets:

[41] Lowe, R. (2022). 'Top 100 Infrastructure Investors 2022: Survey,' September/October 2022

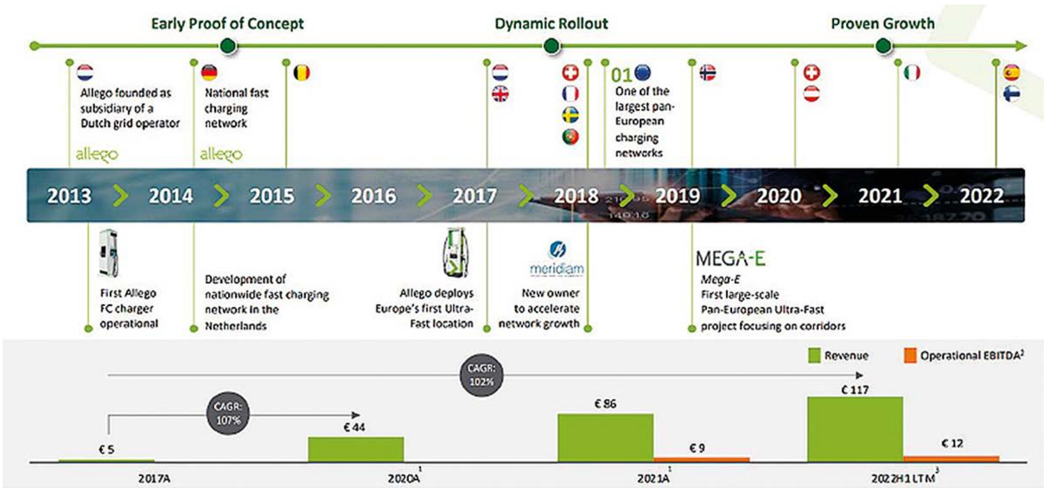
[42] PwC (2022). 'Asset and wealth management revolution 2022: Exponential expectations for ESG,' October 2022

Case Study: Allego EV Charging Stations – Meridiam

Founded in the Netherlands in 2013 as part of grid operator Alliander, Allego is one of the European market leaders in EV charging solutions. In 2018, it was acquired by Meridiam, and on March 17, 2022, it went public on the New York Stock Exchange.

Business model: Allego illustrates the technology risks and time lag involved in bringing an innovation to scale. After identifying fast EV charging as a priority segment of its strategy, and one that, once installed, features high-barriers to entry and quasi-monopoly features, Allego's anchor infrastructure investor, Meridiam, began looking towards developing a pan-European ultrafast EV network. In the absence of guarantees or revenue-backing from automobile manufacturers, the only solution in view of the technological and market risks was to finance the rolling out of the network on a full equity basis.

Allego closed the first EV charging transaction to raise capital on a project finance basis, to equip a network of parking lots in commercial malls with EV charging stations. The advanced technology used enables sophisticated energy demand forecasts, which facilitates optimised operations, maintenance and billing, so as to minimise costly presence on the ground. The European Investment Bank's initial participation (at EUR 40mn) in the innovative financing in 2018 would no longer be needed today as that business segment is now financeable on purely commercial terms. Nonetheless, some public funding in the system is still useful to decrease the cost of electrical supply, particularly in low density and rural areas, as this would help financially balance the concession model. As for the supply of power to the charging stations, it is entirely green (with 200 MWH consumed in 2022). Allego concluded a PPA to buy power directly from an independent renewable power producer at a fixed price so as not to depend on retailers and utilities.



An attractive feature of Allego's business model is that it allows for modular growth through the gradual densification of EV charging stations linked to increasing EV usage, although some costs are of a fixed nature. In 2022, price elasticity to power prices was low, giving an element of comfort to potential lenders.

Case Study: Vattenfall and Skandia's Battery Parks

In December 2014, Vattenfall, Sweden's state-owned energy company, and Skandia, a Swedish financial institution, announced a plan to invest in four wind farms across the country, to be managed by a jointly-owned company.

Several years later, the two partners announced the construction of two battery storage systems to be connected with two of these 100 MWe wind farms located in southern Sweden (Höge väg and Hjuleberg). The batteries will be housed in a total of 102 battery modules with energy storage capacities of 29 MWh for Höge väg and 35 MWh for Hjuleberg and will help stabilise the grid.

Business model: The battery park offers grid support and other ancillary services to the transmission system operator, bringing additional operational and financial flexibility to the project. This was made possible over a short time period thanks to the pre-existing grid connection, which allowed an otherwise long and protracted authorisation process of 5 to 10 years to be avoided.

Remuneration comes through the ancillary services rather than by being linked to the capacity. Skandia, as the primary investor, is taking some risk here – but this is justified by the general interest and the high visibility of such schemes. Grid instability is already preventing some new renewables capacity to be added, hence the need for such innovative solutions to foster continuous development of renewable energy projects.

Although the high-grade batteries had to be sourced from minerals – rather than from recycled sources – new types of more environmentally-friendly and recyclable batteries are being developed.

As previously mentioned, a key dimension of sustainability for the renewable energy generation and storage is the availability of critical metals necessary for the manufacturing of batteries. As the energy transition proceeds, the global economy will gradually transition from a carbon-based model to a metal-based one. Public-private initiatives can contribute to achieve this goal.

Case Study: InfraVia Critical Metals Fund

In May 2023, InfraVia Capital Partners, a French fund investing in Infrastructure and Technology, launched a dedicated Critical Metals Fund whose purpose is to invest in critical metals that buttress the energy transition and secure supply chains for French and other European industries.[43] Securing these metals represents not only a major sovereignty challenge but also an exceptional investment opportunity, similar to the ones experienced in Infrastructure and Technology in recent decades.

The fund will concentrate on investments within and outside of France which meet the demands of the energy transition while reinforcing French and European sovereignty. It will also allocate investments targeting the supply chains of critical metals such as lithium, nickel, and cobalt, as well as the entire value chain (extraction, processing and recycling).

The fund's initial closing is anticipated at EUR 1bn by the end of 2023, with a target size of EUR 2bn, allowing investments to be made on an industrial scale. With an initial term of 25 years, the fund is also geared towards long-term "industrial time" objectives. The French government has already committed to supporting the fund through the allocation of EUR 500mn as part of the 'France 2030' investment plan. In addition, the fund's investors will include industry stakeholders who are most directly concerned, as well as numerous institutional investors eager to contribute to the energy transition.

[43] InfraVia Capital Partners (2023). 'InfraVia launches a Critical Metals Fund with the backing of the State,' May 11, 2023

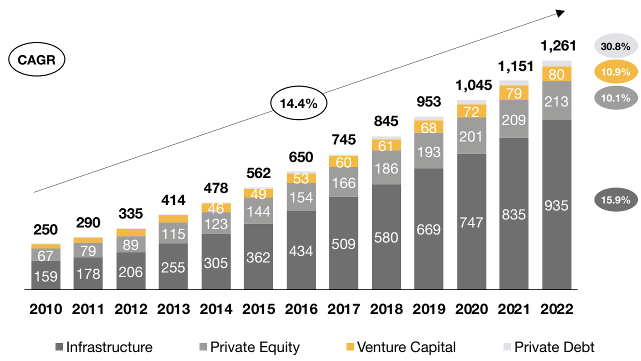
4.2. ... for private investments

Between 2010 and 2022, the AuM of renewable energy funds skyrocketed from USD 250bn to USD 1,261bn, representing a CAGR of 14.4%. Infrastructure funds currently account for the lion's share of such funds, with just under three-quarters of their total AuM in 2022 (cf. Exhibit 11a). Much of the AuM remains concentrated in North America and Europe – with the former being home to 53.6% and the latter 33.4%. (cf. Exhibit 11b).

LPs can choose to access the energy transition either via diversified funds (or cross-sector decarbonisation) or through specialist funds. In both cases, there is significant risk reduction and potential to enhance returns in decarbonising non-power-related assets (e.g., transportation, social infrastructure, digital technologies etc.).

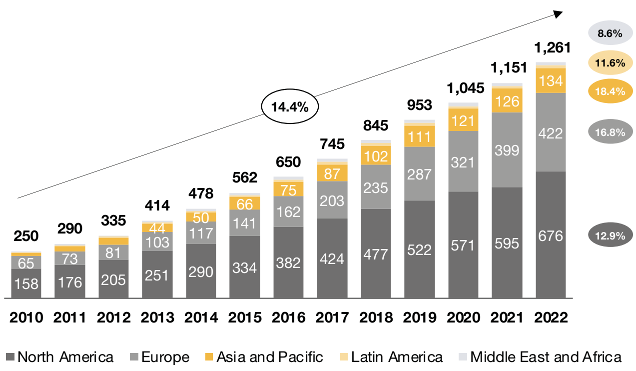
The last years have seen a notable surge in the number of Infrastructure funds exposed to Renewable Energy-related (RNE) projects, with assets held in funds focused on or exposed to RNE projects surging at a respective CAGR of 18.0% and 15.4% since 2010. In 2022, assets held in funds focused on RNE reached a record USD 216bn. These funds posted the strongest growth during our period of analysis, reflecting the strong surge in investor interest and uptake (cf. Exhibit 12).

Exhibit 11a: Renewable Energy Funds AuM by Asset Class (USD bn) growth rates



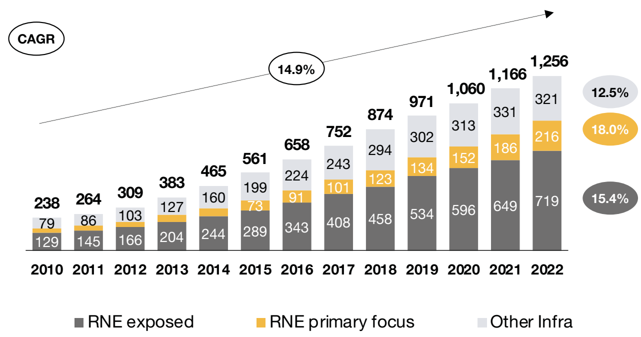
Sources: *PwC Global AWM & ESG Market Research Centre, Preqin and IJInvestor*

Exhibit 11b: Renewable Energy Funds AuM by Region (USD bn)



Sources: *PwC Global AWM & ESG Market Research Centre, Preqin and IJInvestor*

Exhibit 12: Infrastructure Funds AuM (USD bn)



Sources: *PwC Global AWM & ESG Market Research Centre and IJInvestor*

Case Study: Green Hydrogen in Utah – Manulife

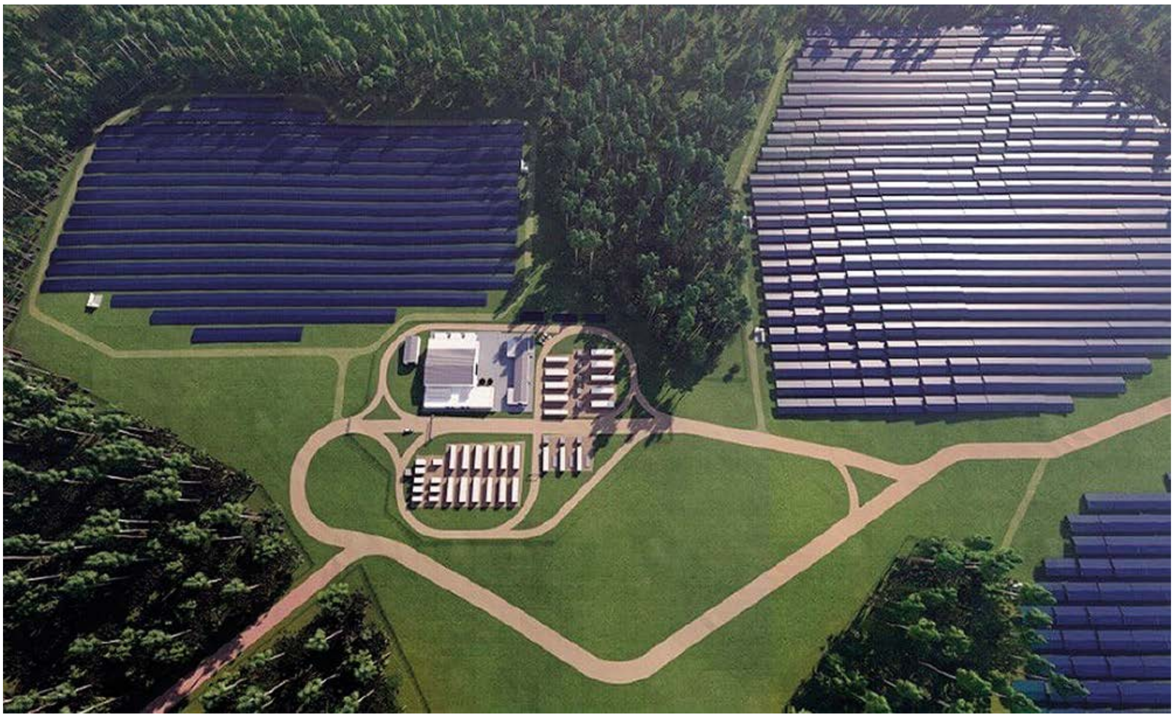
Given that hydrogen pipeline networks do not currently exist, hydrogen transportation and storage costs are an issue currently hampering the development of green hydrogen. ACES Delta, a US-based joint-venture between Mitsubishi Power Americas and Magnum Development – a portfolio company of funds managed by Haddington Ventures, through which Manulife is an investor – that develops large scale energy transition projects, has been developing a hydrogen hub in the state of Utah. This hub, once completed, will be the largest green hydrogen platform in the world, and will contribute to reducing current fossil fuel demand in the United States. The 10,000-acre site sits directly above a vast underground salt formation which is ideally suited for the storage of natural gas, hydrogen, compressed air, and liquid energy products. In addition, the site is strategically located in close proximity to existing and developing energy infrastructure.

Business model: Funded with initial equity investor commitments of USD 650mn with rights to increase to USD 1.5bn for future projects, and supported by a USD 504.4mn loan guarantee issued by the US Department of Energy, the initial project will supply green hydrogen under a long-term contract with the Intermountain Power Agency, which supplies power to its member municipalities, electric co-ops and municipal utilities in Southern California. Intermountain Power Agency will use the green hydrogen to run a new power plant. The project includes electrolysers to split water into hydrogen and oxygen through renewable energy supplied by the Intermountain Power Agency, and two underground salt-dome caverns to store the green hydrogen.

The project is commercially viable by itself, but the Inflation Reduction Act – adopted after investment decision was taken – opened the way for tax credits and facilitated commercial agreements, improving its competitiveness against other forms of power generation and battery storage. As for the market price risk, it is mostly borne by the project customers thanks to pass-through provisions.

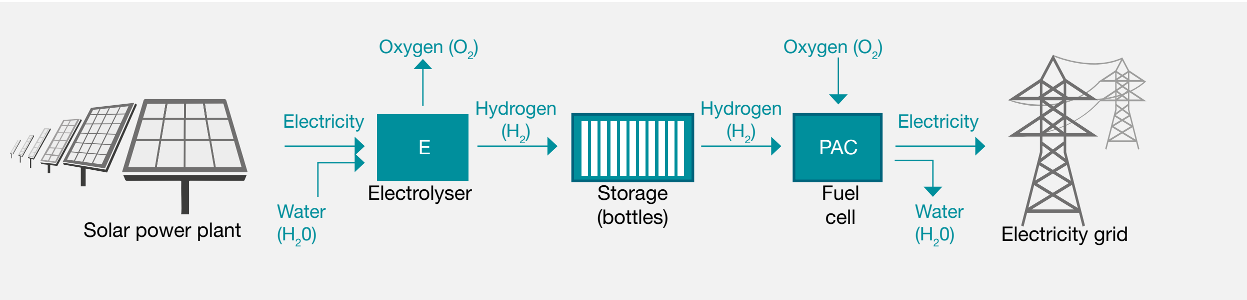
Case study: Multi-megawatt Power Plant in French Guiana - Meridiam

In 2021, Meridiam partnered with Hydrogene de France (HDF), a French company specialised in developing hydrogen storage solutions, and Société Raffinerie des Antilles, Groupe Rubis (SARA), a French company specialised in the distribution of petroleum in French Guiana and the French Caribbean, to develop the Central Electrique de l'Ouest Guyanais (CEOG), an innovative and flagship hydrogen-based project under development in French Guiana.



At 10 MW capacity, CEOG is considered the greatest project worldwide of a power plant that can also store intermittent renewable energy using hydrogen. It consists in the development, construction, financing, operation and maintenance of a power plant that combines a photovoltaic (PV) plant with battery and hydrogen storage.

Whereas batteries provide good services for short-term energy storage, they are not suitable for long-term energy storage (i.e., for more than 5 hours). In addition, batteries usually induce a significant environmental impact. This is where green hydrogen, produced through PV-powered electrolysis, comes in, allowing for an estimated 39,000t CO2 to be avoided per annum.



Business model: The power plant will deliver a firm capacity of 10 MW (3 MW during the night). It will thus generate non-intermittent renewable electricity for 10,000 homes in French Guiana which is facing an important increase in electricity demand. Power will be delivered to the electricity grid through Electricité de France's substation in Saint-Laurent-du-Maroni, at a price set by PPA for 25 years.[44]

[44] NS Energy (n.d.). '[Central Electrique de l'Ouest Guyanais (CEOG) Hydrogen Power Project](#)'

Given this growth in Infrastructure Funds AuM, it is unsurprising to note that the total value of energy transition-related Infrastructure deals has grown consistently since 2010, experiencing a more than tenfold increase from approximately USD 100mn to around USD 1.2bn per year.

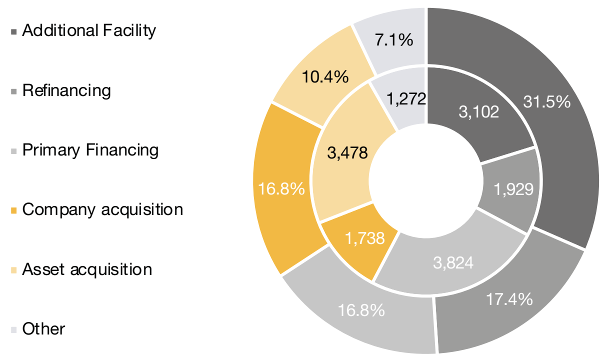
4.3. Still more brown than greenfield...

Since 2010, infrastructure deals related to the energy transition have mostly involved Primary Financing, closely followed by Asset Acquisitions. However, Additional Facility transactions have been the most significant, comprising 31.5% of the total infrastructure deal value associated with the energy transition. Refinancing follows at 17.4%, and Primary Financing accounts for 16.8% of total deal value (cf. Exhibit 13).

Table 2: Global Energy Transition Infrastructure Transaction value since 2000

Region	Number of Deals	Value of Deals (USD, bn)
North America	4,733	1,806.7
Europe	7,166	2,032.8
Latin America	1,726	389.1
Middle East and Africa	684	241.5
Asia-Pacific	2,785	934.8
Global Market	**17,094**	**5,405.0**

Exhibit 13: Number of Energy Transition Infrastructure deals (inner circle) and Share of Total Deal Value (outer circle) since 2010, by transaction type



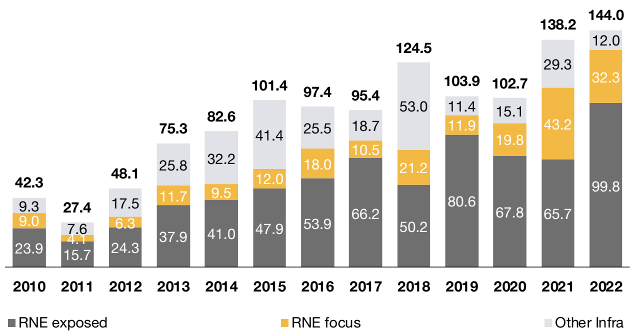
Source: *IJGlobal*

The ever-growing investor appetite for renewable energy is underlined by fundraising for Infrastructure. Indeed, in 2019, Infrastructure funds primarily dedicated to RNE projects raised more capital than funds without any exposure to RNE for the first time. This trend has continued unabated, as in subsequent years, funds without RNE exposure raised USD 12bn while funds with an RNE focus managed to raise a substantial USD 32.3bn. Overall, fundraising linked totally or partially to RNE has grown from 77 to 92% over the period (cf. Exhibit 14a).

Among all regions, Europe boasts the largest proportion of RNE-exposed Infrastructure AuM, as only 17.1% of the AuM of European Infrastructure funds is not dedicated to renewables in 2022, compared to the global average of 25.6%. Additionally, Europe leads in terms of the share of AuM with a primary focus on renewables, accounting for 30.6% (in contrast to the global figure of 17.2%) (cf. Exhibit 14b).

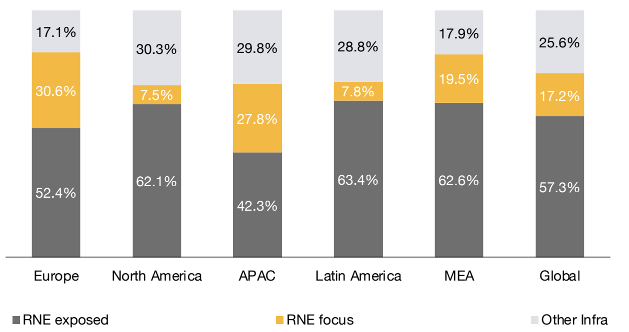
North America ranks last on both counts, with only 7.5% of Infrastructure funds AuM being focused on RNE, and 30.3% having no exposure to RNE projects. This may be a consequence of the higher degree of political infighting and apprehension with regards to ESG investments in the United States.

Exhibit 14a: Global Historical Fundraising of Infrastructure Funds by RNE Exposure (USD bn)



Source: *IJInvestor*

Exhibit 14b: Regional Infrastructure Funds AuM split by RNE Exposure in 2022



Source: *IJInvestor*

The number of Infrastructure funds focused on the energy transition has also been growing. Out of 25 unlisted funds with the words "energy transition" in their name as of end-2022, 11 were either launched or closed that year, and they were seeking or had already committed USD 16bn to be invested in a wide array of Infrastructure projects (from "plain vanilla roof-top solar", to "offshore wind enterprises" and "hydrogen […] green and otherwise").[45]

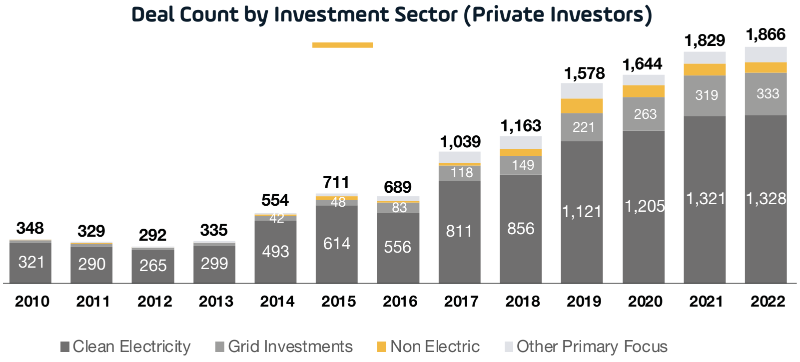
The first energy transition mega fund was also launched in 2022 – Brookfield Asset Management's USD 15bn Global Transition Fund[46] – while BlackRock began establishing a "perpetual strategy to help drive the global energy transition" which would "invest in integrated businesses, such as utilities and end-to-end renewable energy infrastructure players, and assets, like data centres, grid digitisation technologies, battery storage systems, and natural gas storage and transport facilities that can be adapted for hydrogen."[47] The world's first pure-play clean hydrogen fund was also launched by French asset manager Hy24, closing in at EUR 2bn (after an initial target of EUR 1.5bn).[48]

With this growing number of energy transition-related funds, private investors' have shown an affinity towards Clean Electricity and Grid Infrastructure investments, which together account for 77% of total Global Energy Infrastructure Deal Value as of end-2022. This is unsurprising, given the importance of Clean Electricity in decarbonising the energy mix and propelling the energy transition forward, as well as the subsequent expected increased reliance on electricity as more carbon-intensive energy sources are phased out. Similarly, Grid Infrastructure will also need to be upgraded to adapt to and accommodate the increased Clean Electricity production capacity.

Since 2010, the total number of Infrastructure deals related to the Energy Transition has grown significantly, rising from 348 to 1,866 in 2022. Among these deals, Clean Electricity takes the lead, with 1,328 (or 71%) of the 1,866 deals made in 2022 (cf. Exhibit 15a).

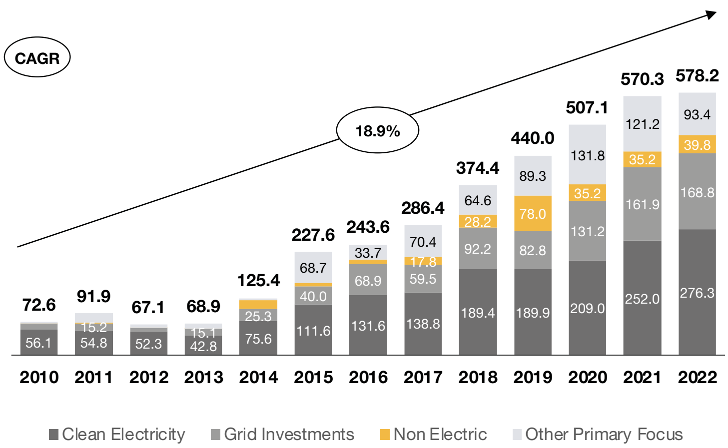
However, the Clean Energy deals make up only 47.7% of the value of private energy transition deals that year (cf. Exhibit 15b), indicating that the average deal size in this sub-sector is relatively smaller compared to others.

Exhibit 15a: Annual Energy Transition Infrastructure Deal Count by Investment Sector (Private Investors)



Source: *IJGlobal*

Exhibit 15b: Annual Energy Transition Infrastructure Deal Value by Investment Sector (Private Investors)



Source: *IJGlobal*

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[45] Petersen, A. (2022). 'Themes of the Year: The rise and rise of energy transition funds,' Infrastructure Investor, December 27, 2022

[46] Brookfield Corporation (2022). 'Brookfield Raises Record $15 Billion For Inaugural Global Transition Fund,' Press Release, June 22, 2022

[47] EnergyTech (2022). 'BlackRock investing big in perpetual Energy Transition project building,' June 20, 2022

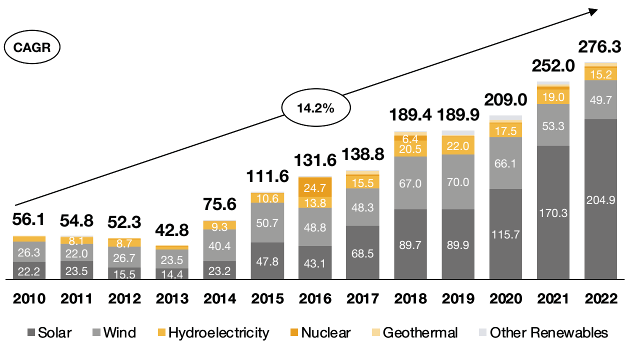
[48] Petersen, A. (2022). 'Hy24 closes world's first pure-play clean hydrogen fund on €2bn,' Infrastructure Investor, October 22, 2022

4.4. Clean electricity and beyond

The value of private investments in Clean Electricity on an annual basis has expanded since 2010, with renewables – particularly solar energy – driving this growth. Accounting for more than USD 204bn of annual private investments in 2022, close to three-quarters of private investments in Clean Energy have been directed towards solar energy. Wind energy, on the other hand, stood at a distant second with USD 49.7bn – or 17.9% of total private investments (cf. Exhibit 16). Other renewables, such as biogas or biofuels, are also distant.

The significant total annual Clean Electricity deal value for investment in both solar and wind sub-sectors, in contrast to their relatively small average deal size, implies the presence of numerous deals with comparatively lower values.

Exhibit 16: Clean Electricity Annual Deal Value (USD bn) by Investment sub-sector – Private Only



Source: *IJGlobal*

Case Study: Biogas Waste Recovery Projects in France - Meridiam

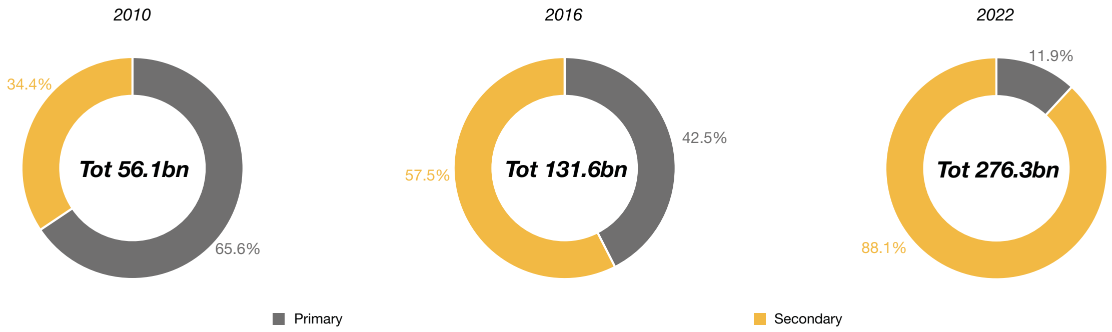
Meridiam, together with Evergaz, a French firm specialised in biogas, has implemented 15 biogas waste recovery projects in France, whereby biomethane produced from household and similar waste is injected directly into gas distribution networks as a substitute for fossil natural gas.

The latest project covers the needs of roughly 3,000 households in the Greater Perigueux in southwestern France – be it through heating, cooking, domestic hot water, and even fuel supplied to vehicles. By replacing fossil natural gas, the project contributes to the energy transition by avoiding the emission of 3,300 tCO2e per year.

With private investments in clean energy having grown approximately five-fold since 2010 to reach USD 276.3bn as of end-2022, secondary market transactions have opened new avenues of rapid expansions for private investors seeking exposure to clean electricity infrastructure.

Amidst volatile market disruptions, portfolio managers choose infrastructure allocations to increase exposure to investment themes such as the energy transition. Since Infrastructure projects often span years to deliver desired returns, the secondary market presents a compelling opportunity to invest in already mature projects that generate solid, recurring yields from the very beginning. Infrastructure secondaries also offer a strategy for accessing hard-to-reach opportunities, allowing investors to reallocate from volatile public markets to more stable asset classes. Other factors that have driven investors to the secondary market include reduced blind pool risk, discounted acquisitions and diversification.

Exhibit 17: Clean Electricity Private Investments Evolution – Primary vs. Secondary Market Split (USD bn)

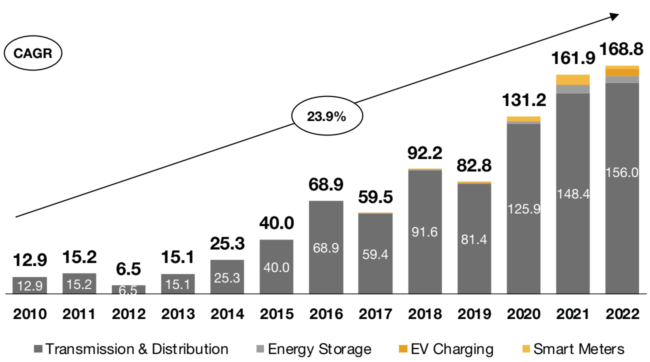


Sources: *IJGlobal and Infrastructure Investor*

4.5. Investing in the power grid

The focus of grid investment in public markets is shifting, as private sector participation is gaining momentum, driven by increasing demand for grid modernisation and expansion. Over the past twelve years, annual grid investment deals have demonstrated a growth rate that surpasses that of clean energy. With a CAGR of 24%, the growth has been driven primarily by transmission and distribution – which alone accounts for 92.4% of deal value in the sub-sector as of end-2022. This sub-sector serves as a notable example of the growing role of the private sector in an area that has historically relied heavily on public investment (cf. Exhibit 18).

Exhibit 18: Grid Investment Growth rate & Annual Deal Value (USD bn) by investment sub-sector – Private Only



Sources: *IJGlobal and IEA*

Case Study: NeuConnect Interconnector – Allianz Capital Partners & Meridiam

Developed by an international consortium that includes Meridiam, Allianz Capital Partners (on behalf of Allianz Group), Kansai Electric Power and TEPCO, the NeuConnect Interconnector project is the first electricity transmission interconnector that will link the United Kingdom with Germany through the North Sea, at the cost of EUR 2.8bn. The project is one of the first transmission projects to be undertaken and financed entirely by the private sector, with no government grants or subsidies.

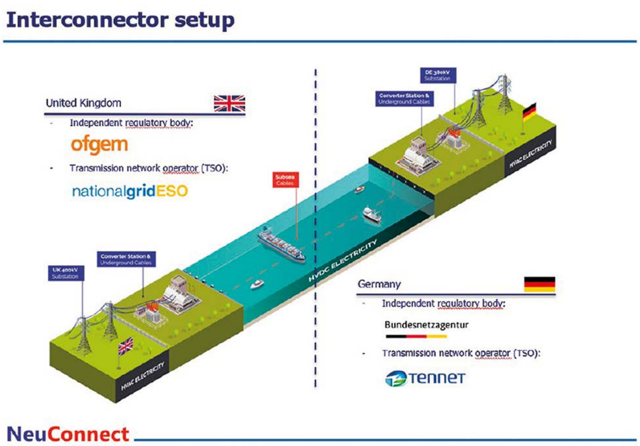
NeuConnect reached financial close in July 2022, with more than 20 banks and financial institutions contributing debt financing. It will be operational by 2028 and will help deliver greater energy resilience, security of supply and consumer benefits (up to 1.4GW of electricity can flow in either direction, which is enough to power up to 1.5 million homes). The project will also lead to an estimated net reduction of over 13 $MtCO_2$ over 25 years as it integrates renewable energy sources in both the United Kingdom and Germany.

The project ultimately got off the ground thanks to the legal and regulatory changes that took place (particularly in Germany), as well as the alignment of UK and German regulatory bodies. In addition, the strong and credible sponsors – such as Meridiam and Allianz on the equity side – alongside appropriate risk allocation played a key role in driving the project's implementation.

Business model: The project has a strong commercial rationale beyond the ESG dimension: the EUR 2.8bn financing (via Equity and Debt) is fully privately financed, with no need for governmental grants or subsidies. The project works on a combination of Regulatory Asset Base regime (Germany) and Cap & Floor regime with upside potential (UK) and a technical asset life significantly longer than the duration of the regulatory regimes (25 years).

NeuConnect is also a pioneer as it is one of the first of such projects to be entirely rolled out by the private sector, and it could pave the way for other similar projects, particularly when it comes to scalability and replicability. A number of similar projects are currently being prepared – such as Greenlink, a privately-owned underwater interconnector cable linking the electricity grids of Ireland and the United Kingdom expected to be operational by the end of 2024.[49] The North Sea is a competitive landscape for this type of Infrastructure assets.

While such projects may experience delays due to administrative and technical reasons (such as issues with manufacturing and the provision of cables), they would benefit from the groundwork that NeuConnect has established.



[49] Greenlink Interconnector (2022). 'Greenlink Interconnector reaches financial close,' March 21, 2022

Although marginal in terms of deal value, there has been a noticeable uptick in the prominence of energy storage, EV charging, and smart meters, despite their comparatively smaller deal values. This growth can be attributed to a combination of factors, including the increasing consumer demand for EVs, supportive regulatory measures (such as the EU's landmark ban on the sale of new fossil fuel cars by 2035), advancements in technology, the expanding share of renewable energy sources, and the growing market demand for these solutions.

In terms of average deal size, secondary financing deals in the energy transition infrastructure sector tend to be larger in value than their primary financing counterparts, indicating a higher share of large-scale deals in the secondary market (cf. Table 3).

Table 3: Average Grid Investment Deal Value 2010-2022 (USD mn) – Private Only

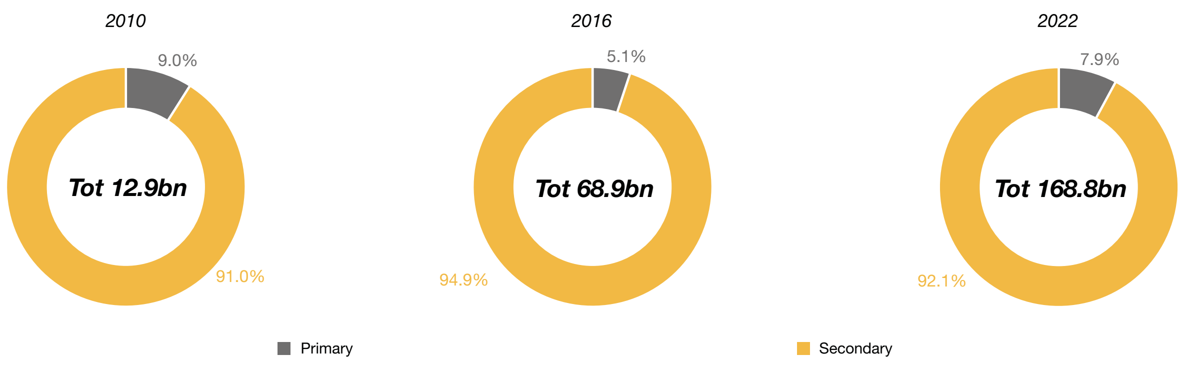
		North America	Europe	Asia-Pacific	Latin America	Middle East and Africa	Global
Primary	Transmission & Distribution	893.1	501.2	418.0	164.0	180.4	409.2
	Energy Storage	198.4	29.7	91.8	20.0	15.5	83.8
	EV Charging	N/A	61.2	4.3	N/A	N/A	46.9
	Smart Meters	N/A	374.1	N/A	N/A	N/A	374.1
Secondary	Transmission & Distribution	620.3	785.8	710.3	214.2	351.1	623.6
	Energy Storage	113.2	50.7	148.2	16.0	150.0	81.8
	EV Charging	232.4	99.3	200.0	N/A	N/A	129.6
	Smart Meters	308.9	481.9	423.8	N/A	N/A	457.1

Sources: *IJGlobal and IEA*

The increasing demand to modernise and expand grid infrastructure has attracted private investors to this sector who are motivated by various factors – such as the potential for stable returns, the diversification benefits, the opportunity for earlier returns, and the ability to leverage the private sector's expertise in project delivery. As opposed to public investments, private investors seek their exposure in the secondary market rather than in greenfield projects, as investing in later stage assets offers greater visibility, lower risks and a shorter time horizon to liquidation than the primary market.

Unlike investments in clean electricity, private investments in the electricity grid already tend to be overweighted in the secondary market. Total private grid spending skyrocketed approximately 12-fold from a total of USD 12.9 bn in 2010 to USD 168.6bn in 2022, with most investments taking place in the secondary market. As a result, the share of private investment in grid investments has remained relatively stable, with the secondary market accounting for 91.0% of private investment in 2010, compared to 92.1% as of end-2022 (cf. Exhibit 19). The total amount has significantly increased since 2010, thus demonstrating the huge momentum and opportunities for private investment in the years to come.

Exhibit 19: Private Grid Investment Evolution – Primary vs. Secondary Market Split (USD bn)



Sources: *IJGlobal and Infrastructure Investor*

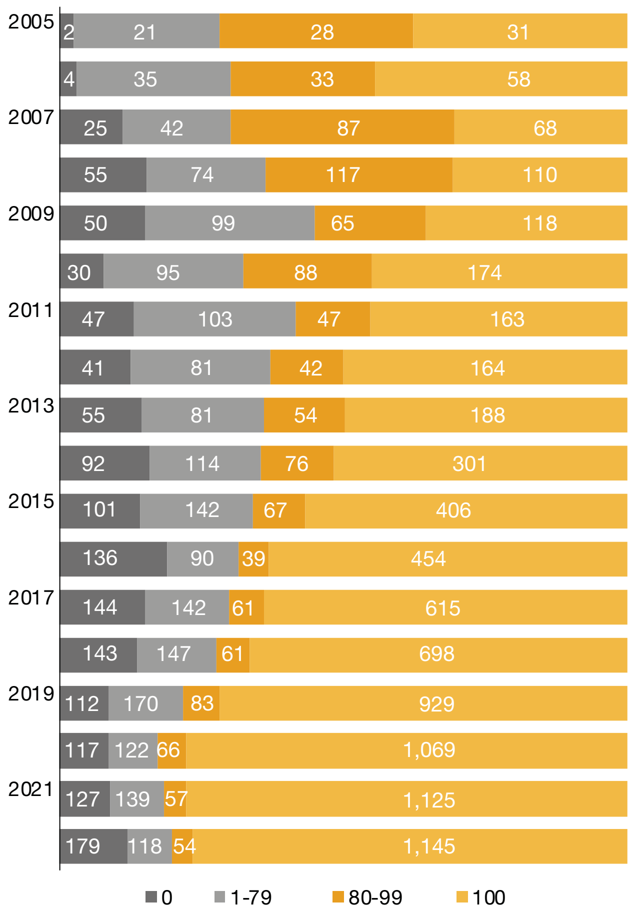
4.6. Debt vs equity

In the period following the global financial crisis, investors' strategies were profoundly altered due to the persistently low interest rates, particularly in the realm of Infrastructure investing. The favourable low-rate environment facilitated the adoption of "core" and "super-core" strategies, characterised by low risk, while still generating satisfactory returns through liquidity inflows. This trend allowed investors to balance the pursuit of stable returns with the benefits of ample liquidity.

Traditionally, infrastructure deals followed an 80:20 debt-to-equity ratio. From 2005 until the early 2010s, the average proportion of debt in these deals generally stayed around this level, reaching its highest point of 85.4% in 2011. However, since then, a noticeable shift away from this customary split has been observed, with most deals now being fully financed through debt. In contrast, the proportion of all-equity deals has remained relatively stable, indicating a decline in the share of deals that combine both debt and equity components over time (cf. Exhibit 20).

As the long period of low interest rates has ended, investors' strategies may need to be adjusted in order to uphold returns. Adopting a "value-added" approach could become more appealing, and investors may need to be more discerning when selecting which projects to finance, focusing on opportunities where they can add value and maximise returns. Additionally, the increased uncertainty surrounding the renewable energy independent power producer (RNE IPP) business model, driven by factors such as intermittency, price variability, and corporate PPAs makes it less conducive to attracting debt financing.

Exhibit 20: Share of Energy Transition Infrastructure Deals by Debt Ratio per Year



Source: *IJGlobal*

Box 4. Green Bonds attracting ever more inflows

Designed to finance environmentally beneficial projects and provide investors with an opportunity to contribute to the energy transition while reducing the carbon footprint of their fixed-income portfolios, green bonds have experienced a significant increase in issuance in recent years. However, in 2022, market volatility and rising interest rates led to the first annual decline of 13.3% in green bond issuance. Nevertheless, the outlook for green bond issuance appears positive in 2023. SEB Group predicts a rebound in the sustainable debt market, with a projected 20% year-on-year growth compared to 2022 and a 5% growth relative to 2021, provided that financial markets stabilise.[50]

The growing size of the green bond market reflects the active engagement of bond issuers, including energy companies, and the commitment of governments to finance the necessary infrastructure for the energy transition and address pressing environmental concerns. For investors, green bonds provide a powerful funding tool to support energy transition infrastructure projects while delivering tangible environmental advantages. Moreover, with the increasing availability of mutual funds offering exposure to green bonds, investors have the option to allocate a portion of their traditional bond investments towards these products, thus aligning their investment portfolios with sustainability goals.

A substantial majority of the capital raised through green bonds are now allocated to, or have the flexibility to be utilised for, energy-related initiatives – from projects in the clean and sustainable transportation sector, to projects in energy efficiency, green construction, climate change adaptation, and clean energy production. This wide range of applications highlights the suitability of green bonds as a financing mechanism for energy transition infrastructure projects and their versatility in supporting various aspects of sustainable development.

[50] SEB (2023). 'The Green Bond: Your insight into sustainable finance,' February 2, 2023

New Business Models for Infrastructure Investors

5.1 Evolution of risk-return profile for investors

The business models for investors are changing as the share of renewables in the global energy mix increases. As declining costs of RNE projects have allowed power generation to be directly accessible to commercial and retail customers through the distribution network, we are observing a shift from user to customer. One can already imagine a world whereby "buildings will increasingly become small power plants [and] generate the energy they consume themselves and can also feed energy into the grid."[51] With the energy transition currently underway, such a vision might not appear too far-fetched in the very near future.

But the only way to scale is through attracting and retaining such customers effectively, which necessitates acquiring the skill sets for customer acquisition and management, which will be key differentiators for success. Investors in the energy transition space will need to recognise this paradigm shift and no longer operate on the premise that the government or the local utility will continue to be the primary counterparty. Not only are such RNE assets poised to experience strong growth, they also form a key dimension of the energy transition. At the same time, inflation and rising interest rates are causing a shift towards more value-added strategies, as leveraging returns via low-interest credit is no longer an option.

Now that the prolonged era of low interest rates has ended, investors' strategies may need to be adjusted to uphold returns. In this context, adopting a "value-added" approach could become more appealing, and investors may need to be more discerning in their selection of projects to finance, focusing on opportunities where they can add value and maximise returns in a potentially less favourable interest rate environment. As already mentioned, uncertainty surrounding the RNE IPP business model makes it attractive to debt financing. Ultimately, this new environment may generate a comparative advantage for fund managers who are already specialised in energy transition-related assets.

Most energy transition investments have so far been directed at renewable and intermittent technologies such as wind and solar, with electricity storage and network adaptation lagging behind. The growing share of intermittent renewable energy in the power system brings new risks for investors. These include volume and price volatility (which could extend to negative prices in certain instance[52]), as well as the risk of curtailment due to market imbalance and grid congestion. As mature renewable technologies become more cost competitive, the regulatory landscape is evolving while incentives are being removed, which brings forth both potential risks and new opportunities, such as the ability to earn revenues on the balancing market by reducing production.

The emerging risks have yet to be reflected in returns requirements. Investors have historically benefitted from yield compression while their appetite for investments that bring both financial and environmental returns has kept the risk premium in check. This makes it all the more important to manage risks effectively. To do this, investors can hedge revenues, buy self-insurance (e.g., through energy storage) or build diversified portfolios. Diversifying investments by country and technology reduces portfolio risk significantly. Accessing different power markets and jurisdictions also translates into financial diversification benefits.[53]

5.2. Convergence between the Digital Revolution and Energy Transition

Investors and asset managers in the energy transition will need a more direct and interactive relationship with their corporate customers to ensure that the Power Purchase Agreements (PPA) signed will be delivered exclusively with renewable energy. Customers can no longer be treated in a 'commoditised' manner, as they may have different levels of expectations when it come to the energy they are purchasing.

[51] PwC and the Urban Land Institute (2022). 'Emerging Trends in Real Estate – Europe 2023: In the Eye of the Storm,' November 2022 (p.32)

[52] As in Finland in spring 2023 due to abundant rains generating excess hydroelectricity, or in Belgium on March 24, 2023, where prices reached negative territory (-12€/MWh) due to strong winds. In Europe, the peak of photovoltaic production is between 1 p.m. and 4 p.m. and corresponds exactly to the trough of consumption, which is why negative prices often occur in the middle of the afternoon.

[53] Monnier, L. et. al. (2022). 'Does the rise of renewable energy create new risks for investors? Insights from 20 years of energy transition in the UK,' EDHEC, October 2022

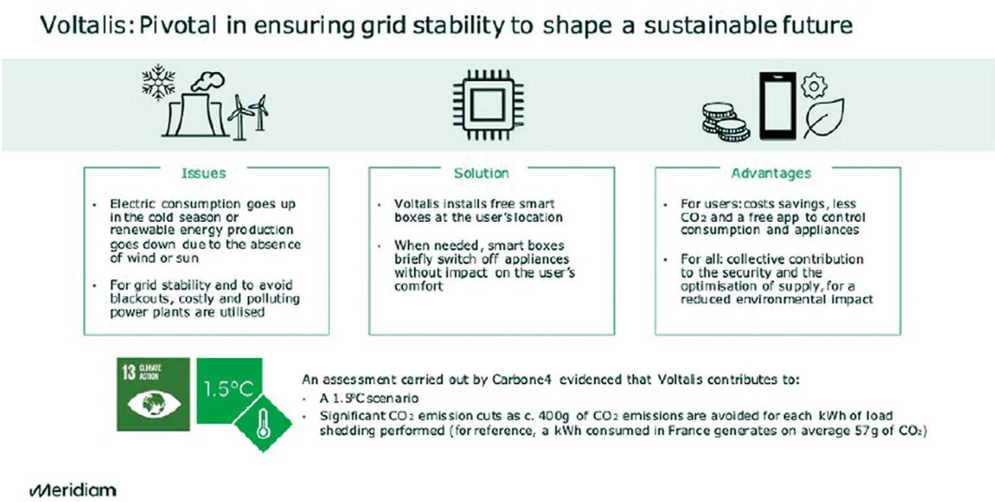
This is where advances in digital technologies – particularly in the field of big data analytics – come in, making traceable relationships possible. However, this could potentially lead to overlapping between Infrastructure and Private Equity strategies on energy transition, and hence push the former up the risk curve and closer to the risks associated with the latter, as the following case study illustrates:

Case Study: Voltalis and Its Innovative Business Model - Meridiam

Established in 2006 and acquired by Meridiam in 2020, Voltalis is a pan-European system in demand-side management in power consumption for commercial and residential buildings.

Business model: Voltalis embodies a new, innovative business model, straddling Infrastructure and Private Equity, akin to selling "negawatts" by utilities. It seeks to optimise actual individual power consumption and demand through an aggregator, to generate savings, and better balance the grid. In essence, Voltalis provides smart boxes (or 'smart thermostats') to end-users in their homes – at no cost to them – which, thanks to an elaborate software, can then cut the home power consumption at peak power demand for short periods of time without significantly impacting the comfort or level of service. On average, thanks to the smart boxes, end-users manage to achieve around 15% in monetary savings. By aggregating the individual boxes effect, Voltalis can substitute or play the role of a big quasi-battery of 500MW.

Voltalis implements a hybrid revenue model partly based on the revenue paid by the transmission system operator on the basis of its installed capacity. The power saved is then 'sold' on the spot market. Early investors are now considering the deployment of the system to better manage their own tertiary or social infrastructure assets portfolio, which illustrates the replicability and scalability of the system. Voltalis relies on a virtuous infrastructure business model: i) Asset companies finance the roll-out of the fleet of 'smart boxes' and ii) Voltalis acts as an operations and maintenance (O&M) operator responsible for the deployment, replacement and maintenance of the fleet.



Innovative features: Potential conflicts of interest with providers of energy-saving devices for home appliances and buildings are mitigated by the fact that those providers lack the aggregator platform developed by Voltalis. As for risks, assets are financed through a separate special purpose vehicle, allowing senior funding by lenders who are not expected to shoulder the business risk, while installation is subcontracted. Regarding the resale of excess power freed up by the demand cut, a peak PPA may be envisioned as a hedge at some stage in the future to complement the spot market, particularly given that the EU is pushing for such types of contractual arrangements.

Case Study: Aurora Infrastructure – InfraVia

Launched in 2013 by Infrastructure & Private Equity firm InfraVia, Aurora Infrastructure is a Finnish power distributor that manages to reach 99.9% availability without battery storage. Instead, this level of performance is achieved through redundancy in capacity, data intelligence analysis, and corresponding internal software enabling predictive maintenance and ambitious efficiency targets, alongside three connecting lines to the national grid.

Aurora Infrastructure thus contributes to increased energy efficiency and decreasing carbon footprint at its clients' industrial sites, with plans to reach net zero emissions by 2035. It does not shoulder any tariff risk, as it is essentially a pass-through for the national grid tariff policy. Its approach is also replicable for energy producers such as wind farms and clients such as data centres.

5.3. Opportunities on the risk-reward spectrum

In the recent past, utilities PPAs tended to be cut-and-dry. But this has significantly changed recently: whereas 20-year agreements used to be the standard, the number of years has fallen recently to 10, seven or even five. In addition, the length and flexibility of PPAs is now different, as large corporations strive to source clean energy for all their operations on a 24-hour basis, leading some independent power producers (IPPs) to forgo PPAs altogether.

In addition, a degree of merchant risk is embedded in renewables. The long-term merchant model for renewables is not yet clear, and while it is acknowledged that batteries-related developments will positively impact conventional renewables, they may also have unforeseen negative impacts on the pricing of renewables. In other words, renewable energy is taking on more risk than investors and lenders have historically assigned in terms of risk premium. With more aggressive structures, merchant power-type risks are now seen as creeping back, and the global renewables industry may be witnessing the beginnings of a bubble, with debt taking equity-type risks.

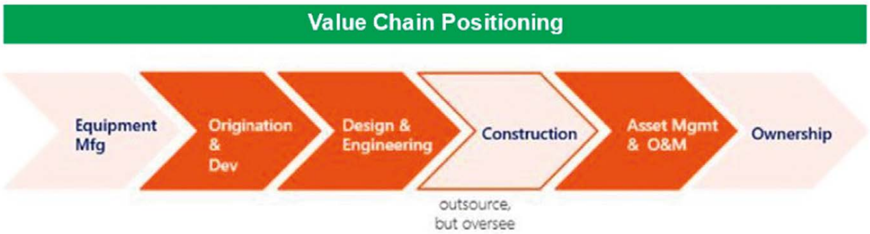
Case study: PowerFlex – Manulife

PowerFlex is a US-based energy company providing decarbonisation solutions to commercial and industrial customers. PowerFlex develops on-site solar energy storage and EV charging solutions, an in-house combination of hard and software technical offer, and energy management capabilities. PowerFlex enables clean and affordable onsite energy for its customers, providing real-time insights and intelligent control over project performance, energy consumption, and greenhouse gas emissions reductions. Patented and proprietary offerings, including Adaptive Load Management enabling power consumption optimisation across a large EV charging network without costly electrical system upgrades, further support customer energy and sustainability objectives. Also available on a standalone basis, multiple PowerFlex technologies may be integrated to maximise customer value.

An affiliate of EDF Renewables North America, PowerFlex recently received a USD 100mn investment from Manulife Investment Management, which joined the board of directors.[54]

PowerFlex's on-site solutions provide meaningful economic and environmental benefits to customers:

- **Reduces energy bills:** Market data suggests that average commercial property owners in the United States can slash their overall energy costs by 75% through installation of onsite solar. Onsite Solar, in addition to energy storage systems, reduces exposure to volatile energy and demand charges from utilities, and replaces them with controllable and predictable costs.
- **Boosts resilience:** Onsite energy at point of use reduces reliance on utilities and vulnerability to extreme weather events, accidents and other threats.
- **Supports sustainability:** PowerFlex's clean energy solutions support decarbonisation efforts. The company's 'PowerFlex X' proprietary software and hardware provides the ability to track GHG emissions reductions, and on-site systems provide visible reminders of environmental commitments.



Business model: PowerFlex provides its solutions largely through design-build agreements with commercial and industrial customers, typically also serving as the long-term asset manager and O&M provider. Upfront, PowerFlex focuses on high-value development and engineering activities, outsourcing manufacturing and core construction works. In select cases, customers elect to not own the systems, instead entering into long-term PPA-style contracts.

[54] Manulife Investment Management (2022). 'PowerFlex Receives a $100M Investment from Manulife Investment Management,' December 13, 2022

Such merchant power-type industry-level risks are amplified as inflation has crept back across the global economy in the last two years. Inflation risks impacting energy transition-related infrastructure, as cost overruns and supply chain issues – particularly when it comes to materials such as steel, nickel, copper or silicon – have already hit solar energy, and particularly offshore wind, since early 2022.

While the newer and less mature technologies, such as hydrogen, biofuels and stand-alone storage, have many risks which have not yet been fully identified, 'plain vanilla' RNE projects – such as wind and solar – also have their fair share of risks that go beyond inflation and other macroeconomic-related shocks. Solar power currently has the lowest risk of all renewable technologies available, as it relies on a set of electronic connection points – as opposed to engines or moving parts requiring frequent maintenance or replacement – which means that it has lower maintenance costs and lower risks of asset breakdown. Solar projects thus translate into high EBITDA margins that can reach the 70% range, while annual irradiation – which drives asset performance in solar – is relatively constant and predictable on a yearly average compared to other renewable energy technologies.

However, solar is not risk-proof. Given that solar radiation can be volatile on an hourly or daily basis, intermittency is a constant issue within solar projects, and it has made it challenging to establish long-term offtake contracts. This issue also affects wind energy projects, as wind power relies on the number of wind hours in a day. When not accompanied by a commensurate rise in energy storage, intermittency can bring pressure on the electricity grid as it constantly and instantly must establish a balance between supply and demand. It also increases the volatility of the volume and price of power to the point where volumes can get to zero and prices enter negative territory. Without such an appropriate rise in energy storage, investments in renewable energy become inherently riskier for institutional investors. The shift to merchant power model enables IPP operators to take advantage of lower production costs and higher energy market prices. Some operators may thus choose to run their assets at higher power levels, trading off shorter asset lives against reaping higher revenues as prices peak.

Nonetheless, a growing desire for energy price certainty may eventually lead to a trend reversal toward spot prices, with buyers now valuing the security that comes with long-term purchase agreements, even if they come at higher prices. Many corporates are now seeking to sign PPAs with renewable IPPs to mitigate volatility in energy prices. While this would mean less upside gains potential for developers and investors, this would be offset by greater possible debt leverage, hence boosting the internal rate of return (IRR).

5.4. Beyond Hardware: educating end-users

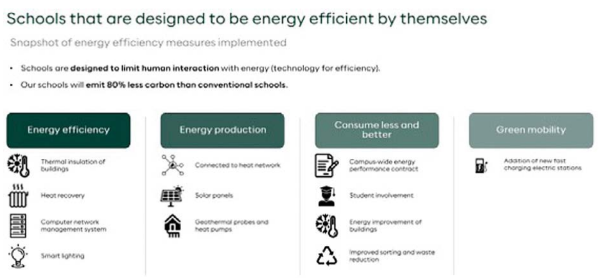
Finally, as previously mentioned, investors are expected to do their part when it comes to educating end-users in consuming energy better and smarter. Beyond improving their reputational risk and social license to operate, such measures should align with financial targets, as both objectives can be reconciled:

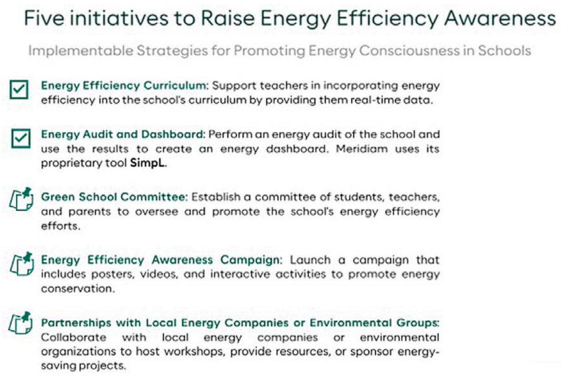
Exhibit 21: Investors' options to manage their risks

Diversification	Hedging	(Self) Insurance
Location and Country	Contract for Difference	Battery Storage
Technology	PPAs	Power-to-X technologies
Co-Location	Market	

Case Study: Meridiam's Schools and Day Care Centres in Espoo, Finland

In October 2019, a consortium composed of YIT Corporation and Meridiam Investments submitted a successful bid to the City of Espoo in Finland to design, build, finance and maintain five schools and three day care centres. The project is considered to be Finland's first PPP involving social infrastructure, and is structured as a 22-year availability payment contract. In addition, the project is part of the City of Espoo's active efforts in achieving the UN SDGs, as the schools and day care centres will be very energy efficient.





Such actions can have a strong leverage effect over time and fit well within educational environments, as students simultaneously learn about energy conservation matters, as well as environmental and financial responsibility, and hence become better prepared to serve as role models for their communities in service of a more sustainable future.

Business model: apart from the technical approach to minimise human interactions (with the combined costs of all energy optimising features being in the 15-20% range of the total project cost), it includes a strong drive to involve students, teachers, and other relevant stakeholders in consuming less and better, and to incorporate energy efficiency in the curriculum by building on real-time data and performance from the system.

This approach does not contribute to a higher financial return or a longer contract duration, as financial gains for Meridiam are contractually limited: savings made above a benchmark level are shared on a 50/50 basis – with penalties imposed if the benchmarks are not reached. Availability payments represented 98 to 99% of total expected revenue, as the energy efficiency bonus is capped. The main benefits for the investor lies on the extra-financial side, with student support and buy-in – Meridiam can offer internships to students to work on their facilities – contributing to a more fruitful and proactive partnership in the long term.

Such a scheme has already been replicated in other educational or social infrastructure assets. For example, ENGIE and Meridiam were awarded a 50-year concession in 2019 to address the University of Iowa's energy, water and sustainability goals.[55] The next year, Meridiam successfully won a contract from the Welsh government to "develop, build, operate and maintain new schools […] with "stringent environmental and social standards," such as reduced energy consumption and carbon emissions.[56] In the near future, such PPPs could potentially be used in other infrastructure assets, such as airports.

Overall, this approach of leveraging investment in material assets and systems to shape end-user behaviours is a way to reinforce the investors' social license to operate collective assets, particularly in social infrastructure, a sector where private investment remains sensitive to public opinion concerns.

[55] ENGIE (2019). 'ENGIE and Meridiam awarded 50-year Utility Management Concession with the University of Iowa toward a zero-carbon transition,' December 10, 2019

[56] Meridiam (2020). 'Meridiam selected as preferred bidder for a major education contract to deliver new schools across Wales,' September 7, 2020

Challenges and Recommendations

6.1 Structural Constraints Hindering Private Investments

Driven by both public and private investments, as well as increasing demands by consumers and businesses alike, the energy transition presents a wide array of opportunities for investors and asset managers alike. A report by PwC from late 2020 even labelled ESG – of which the energy transition makes up a core part – as the global asset management industry's "growth opportunity of the century,"[57] and subsequent reports show that ESG investments across both public and private markets have only expanded throughout the world.[58]

However, as with any transformative changes, the energy transition is paved with many obstacles and roadblocks.

1. High Upfront Costs

The cost of renewable energy has fallen drastically since 2010, while the infrastructure buttressing has become much more resilient and durable. Nonetheless, the primary obstacle for investors lies in the substantial upfront expenses associated with the initial implementation and establishment of clean energy technologies, particularly in the case of renewable energy generation and large-scale energy efficiency projects. These considerable upfront costs present a significant challenge as returns on investments may not materialise for several years.

Over the last two years, cost increases have represented a particular hindrance to power generation investment. This upward trend is attributed to higher expenses associated with critical minerals, semiconductors, and other materials such as steel and cement. In early 2022, photovoltaic modules experienced a significant increase in year-on-year cost, reaching close to 20%, although this gradually subsided. The cost of wind turbines, on the other hand, remained high all the way through 2023, with an increase of roughly 35% compared to 2020.[59]

Leading turbine makers are now going through financial difficulties, impacting their capacity to deliver on time and on budget for project sponsors. In such a context of increasing prices of renewable energy, investors are finding it more challenging to access capital and acquire land for energy transition projects, in both developed and developing economies.

As equity risk premiums rise, highly leveraged companies, particularly those in the power utilities sector, may encounter challenges – namely the escalation of debt levels that could impact credit ratings, jeopardising investors' financing structures.

2. Financing Risk and High Cost of Capital

Given the high level of initial investment required, financing represents a key challenge for energy transition investments – with increased project expenses resulting in a higher levelised cost of electricity (LCOE) for various technologies. Capital structures vary across energy sectors, with power investments in renewables and grids traditionally relying heavily on debt due to fixed cost and revenue structures. Smaller transactions and higher-risk technologies rely more on equity financing, while debt is more accessible in advanced economies. Overall, funding is largely reliant on the availability of low-cost credit on a large scale.

Rising global interest rates therefore reduce the relative attractiveness of renewable energy, especially in developing countries. Low- and middle-income countries are home to about 89% of the coal-fired power generation that the World Bank estimates is at risk of being stranded.[60] Simulations indicate that doubling discount rates would have minimal impact on the LCOE for gas-fired power plants, while the LCOE for offshore wind plants could rise by around 45%.[61] For instance, the IEA estimates that while energy efficiency and end-use investments experienced a boost in 2022 due to new policies in Europe and North America, coupled with unusually high energy prices, the outlook for 2023

[57] PwC (2020). 'The growth opportunity of the century: Are you ready for the ESG change?'

[58] For instance, see PwC (2023). 'GPs' Global ESG Strategies: Disclosure Standards, Data Requirements and Strategic Options,' the latest report in the Sustainable Finance Series

[59] IEA (2023). 'World Energy Investment 2023,' May 2023

[60] World Bank (2023). 'Scaling Up to Phase Down: Financing Energy Transition in Developing Countries,' April 20, 2023

[61] IEA (2020). 'Projected Costs of Generating Electricity 2020'

suggests a flattening of spending in this sector, due to the impact of higher borrowing costs, strains on household budgets, and a slowdown in construction activity.[62]

Despite the availability of currency hedging, exchange rate risk poses a further serious challenge to attracting foreign capital for clean energy projects, according to Columbia University's Center on Global Energy Policy, raising the cost of capital while discouraging investment in emerging and developing markets.[63]

3. Long Lead Times and Lack of Flexibility

Energy transition projects often suffer from long lead times, primarily due to extended permitting processes often characterised by manual procedures, insufficient resources, fragmented decision-making, limited digital support, and delicate public consultations. These factors tend to exacerbate the complexity, uncertainty, and delay in project implementation, creating challenges for investors and potentially undermining the financing of energy transition infrastructure. As a result, renewable energy projects can take over a decade to mature, with transmission and grid projects lasting even longer. For instance, there are currently four times more wind capacity projects in Europe stuck in permitting delays than there are currently under construction. Northern European governments have taken action to address this, adopting a 'one-stop-shop' system for wind energy development, consolidating the permitting process within a specialised agency to minimise risk and uncertainty and maintain investor demand.[64]

While regulatory efforts worldwide have been successful in stimulating investments in renewable energy projects, public resistance continues to represent a significant challenge. Despite the expedited approval of renewable energy projects through emergency permissions and the development of long-term permission frameworks (such as Europe's Renewable Energy Directive, which was revised in 2018 to speed up the EU's uptake in clean energy[65]), phenomena like NIMBY ("Not In My Backyard") and BANANA ("Build Absolutely Nothing Anywhere Near Anything") persist as obstacles for energy transition infrastructure. These phenomena reflect local opposition to projects being built near residential areas for various reasons, ranging from concerns about potential impacts on property values to aesthetic considerations. Addressing public resistance and finding ways to mitigate these concerns is crucial for a successful energy transition. Public engagement, community consultations, and effective communication strategies can help bridge the gap between citizen expectations and the need for sustainable infrastructure development.

4. Reliable Data and Transparency

Emissions reporting and net-zero strategies are of the utmost importance to financial institutions. However, inadequate frameworks, the lack of binding standards to-date, and ambiguous net-zero targets raise concerns surrounding greenwashing practices and hinder the ability to make meaningful comparisons.

Open access to data plays a crucial role in facilitating research, tool development, and informed decision-making. In the context of the energy transition, the availability of accessible, accurate and standardised data is of paramount importance. Insufficient access to accurate and comprehensive information poses a significant risk for investors in the energy transition, as it hampers the ability of policymakers, investors, and stakeholders to make well-informed decisions, monitor progress, and evaluate the effectiveness of renewable energy projects and policies.

Insufficient transparency hinders public access to information regarding the environmental impacts, costs and benefits of different energy sources. For instance, the energy sector across more than twenty Asian economies suffers from significant data deficiencies. The problems go beyond transparency, as the data must be not only comprehensive but also comprehensible. However, India's progress in establishing a unified and open-access data portal is seen as a positive example.[66] As sustainable finance regulations expand across the world – from taxonomies and ESG-related disclosures, to climate risk management, product standards, stewardship practices, and green bond frameworks[67] – we can expect the data challenges to be progressively overcome.

[62] IEA (2023). 'World Energy Investment 2023,' May 2023

[63] Center on Global Energy Policy (2022). 'Policy Note: Scaling Clean Energy through Climate Finance Innovation,' October 6, 2022

[64] Dosanjh, M. et. al. (2023). 'Speeding up renewable energy – bottlenecks and how you resolve them,' World Economic Forum, January 5, 2023

[65] European Commission (n.d.). 'Renewable energy directive'

[66] Lee, U. & White, J. (2023). 'Asia Data Transparency Report 2023: Understanding the state of data transparency for power sector decarbonisation in Asia,' Ember and Subak, May 4, 2023

[67] Sandner, L. & Cherki, N. (2022). 'The Depth & Breadth of Sustainable Finance Initiatives: Global Developments in 2022,' Institutional Shareholder Services, October 3, 2022

5. Political and Regulatory Barriers

While several regions are in the process of developing regulatory frameworks for clean energy solutions, numerous shortcomings remain.

The current lack of inter-regional standardisation is causing uncertainty regarding cross-border investments, while inadequate domestic regulatory frameworks and policies, coupled with complex permission and licensing procedures, are restraining investors and delaying projects. Moreover, given their long-term horizons, investments in renewable energy technology face the potential risk of policy shifts materialising prior to payout. For instance, while solar deployments are growing steadily, project pipelines for other technologies are fluctuating, with investments in wind power strongly reacting to policy changes in major markets.

While tariff-setting policies – such as feed-in tariffs (FITs) and contracts for difference (CfDs) – have been successful in incentivising renewable and nuclear energy investments by guaranteeing an above-market price, these policies have raised some concerns. The primary issues related to dampened electricity, price fluctuations, distorted intraday and balancing markets, and failure to reduce volume risks. In recent years, an increasing number of countries have moved from FITs to competitive auctions, which are a more market-driven mechanism. However, while competitive auctions have gained prominence, regulatory support and guarantees from governments or multilateral development banks continue to play a crucial role in the success of energy transition solutions. These measures provide reassurance to investors and mitigate risks associated with renewable energy projects, provided they are implemented in a consistent and predictable way – which hasn't always been the case.[68]

6. Infrastructure Gaps

Limitations in the existing grid infrastructure and network integration also hinder the sustainable infrastructure transition, hampering the integration of renewable energy sources and the efficient distribution of electricity, and impeding the progress of energy transition infrastructure projects. In some instances, renewable capacity construction efforts are even brought to a standstill.

The investment in upgrading and expanding the electricity grid is being delayed in many countries, creating a widening disparity as the proportion of solar and wind power in the energy mix continues to rise.

In light of this, ensuring adequate financial resources for technologies that enhance energy system flexibility is crucial. This includes investing in digitally-enhanced smart grids, advanced monitoring and control systems, and energy storage technologies to balance supply and demand. It also involves developing grid infrastructure designed to support bi-directional power flows, which enables the seamless integration of distributed energy resources such as rooftop solar panels and EVs.

In addition, the increased sophistication and digitalisation of the energy sector increasingly requires a highly skilled workforce. Countries' and companies' ability to recruit and retain skilled workers around the world will define the quality of tomorrow's energy infrastructure network and the overall progress of the energy transition.

Lastly, pressure on port infrastructure across the world is expected to grow significantly in the coming years, as the offshore floating wind industry takes off.

Many quaysides are currently unable to accommodate wind turbines brought onshore for repairs – a situation which will need to change rapidly if net zero goals are to be achieved and wind power's share of the global energy mix is to grow. Beyond port infrastructures, the bottlenecks also concern specialised ships needed to service offshore wind platforms. While some oil-rig service ships can be retrofitted for the needs of windfarms, many more will have to be built and operated as a key component of the growing wind energy sector, opening a new niche for infrastructure investors:

[68] As in Spain and France, more recently, for photovoltaic tariffs.

Case Study: Service Operation Vessels for Dogger Bank wind farms - Allianz GI

In 2021, Allianz Global Investors (AllianzGI) provided GBP 127mn of long-term senior secured financing to North Star Renewables to support the construction of four hybrid Service Operation Vessels (SOVs) to service the maintenance of Dogger Bank offshore wind farms which will start generating electricity to the grid in Summer 2023 and will become fully operational in 2026.

North Star's state-of-the-art SOVs are used to accommodate offshore wind farm technicians operating in the field as well as provide a logistics hub. These high-performance ships are powered by hybrid technology (electricity and fuel) to deliver safe, efficient, and sustainable access to the wind turbines.

Located 130 kilometres off the North-East coast of England, the Dogger Bank offshore wind farms will be the world's largest offshore wind farms once fully operational. With a total installed capacity of 3.6GW, they will deliver 5% of the UK electricity demand, powering up to 6 million homes annually. The four SOVs will take around 3 years to be completed – and the first one has already been delivered on time in early 2023.

Business model: The project's economics are supported by the long-term availability-based charter contracts with Dogger Bank offshore wind farms. SOVs have prevailed as the optimal and most cost-efficient O&M solution for offshore wind farms, due to their ability to provide the fastest response time to ensure the highest uptime of the wind farms.

O&M costs can account for 30% of the overall lifetime cost of a wind farm. In the UK alone, the market for O&M could reach GBP 2.6bn p.a. by 2050 if the country achieves its goal of 50GW offshore wind capacity.[69] This represents both a major financial challenge for investors in wind farms, and a big opportunity to invest in infrastructure to service wind farm O&M.

[69] Vivid Economics (2019). 'Energy Innovation Needs Assessment – Sub-theme report: Offshore Wind,' Department for Business, Energy and Industrial Strategy, October 2019

7. Supply Chain Risks

A robust and diversified supply chain of clean energy technology is fundamental to the energy transition. Investments in EV sales and battery storage are flourishing, and the number of lithium-ion battery manufacturing projects globally is on the rise. The IEA estimates that demand for lithium will increase by almost 90% over the next two decades given its role in EVs.[70] As a result, the availability of essential materials such as copper, lithium, cobalt and nickel is shifting the energy security playing field.

Extracting and processing such essential minerals is highly concentrated geographically, with around 75% of the existing battery manufacturing capacity being concentrated in China which emerges as the dominant supplier for refining rare earth elements.[71] As for lithium mining, Australia and Chile lead the way.[72]

Ensuring a stable supply of critical minerals is a key concern for battery manufacturers as demand grows. Robust EV sales, significant battery storage investment – expected to double to almost USD 40bn in 2023[73] – and government efforts to expand domestic supply chains have stimulated the emergence of numerous lithium-ion battery manufacturing projects worldwide.

However, the transition from exploration to production could take over 10 years, raising concerns surrounding the hindering impact of limited investment in critical minerals on clean technology manufacturing. Innovation in critical minerals and batteries remains crucial, but venture capital funding for clean energy faces challenges in the current macroeconomic environment.

Recent geopolitical disruptions have significantly impacted global supply chains essential for the energy transition. While the rising prices of fossil fuels enhance the competitiveness of renewables, supply chains are facing challenges due to inflation and material scarcity – leading to increased vulnerability to supply shortages, quality issues, geographic dependency, price volatility, and longer lead times.

8. ESG Trade-off

Encouraging and propagating the shift towards clean energy solutions is often thought of as the prerequisite of meeting environmental goals. However, this transition does not come without its own unintended adverse environmental impacts. These impacts vary depending on the energy source, with the installation, maintenance and dismantling of power plants producing GHG emissions and pollution, while hydroelectric power plants contribute to changes in temperature and precipitation through such emissions.

Similarly, solar energy technologies also emit GHGs and contribute to the depletion of the ozone layer. In fact, with the sole exception of biomass, all renewable energy sources directly impact aquatic environments, with hydropower causing eutrophication, suspended sediments, and disruptions to ecosystems and water-related activities. Other risks associated with the energy transition could arise from habitat loss, conflicts over water resources, the use and transport of materials such as rare earth metals, as well as impacts on fauna, flora, or human populations. Given that the energy transition is mineral-intensive – a sector prone to many environmental and social risks – mining companies will need to have very strong ESG policies.

Nonetheless, the environmental risks associated with the energy transition are far less significant compared to the risks stemming from continued reliance on fossil fuels. Steps must be taken to thoroughly assess and minimise the potential environmental impacts of new renewable energy projects.

Research by the Business & Human Rights Resource Centre has uncovered several claims of environmental and human rights abuses in renewable energy and mineral projects in certain regions.[74] These allegations have the potential to cause project setbacks and hinder the progress of the energy transition.

[70] IEA (2022). 'The Role of Critical Minerals in Clean Energy Transitions,' March 2022

[71] BloombergNEF (2022). 'The battle to break China's battery-making supremacy, in five charts,' December 1, 2023

[72] Brigham, K. (2023). 'How Chile is shaping the global market for lithium, a vital component of EV batteries,' CNBC, May 8, 2023

[73] IEA (2023). 'World Energy Investment 2023,' May 2023

[74] Business & Human Rights Resource Centre (2023). 'Transition Minerals Tracker: 2022 Analysis,' June 2023

6.2. Recommendations

For the energy transition to succeed and bring about a sustainable future, public authorities are required to make it investable, while keeping it affordable. Although governments across the world have encouraged and adopted measures to speed up the energy transition in recent years, the policies in place are not yet sufficient to drive the massive transition needed to achieve net-zero targets.

The recommendations highlighted below therefore first revolve mostly around governments' and regulatory authorities' role in facilitating the energy transition, before reviewing what mostly depends on the investors.

- **For policymakers and governmental authorities**

Our survey (cf. Appendix 1) clearly established the prevailing perception by investors that public authorities in their jurisdictions are not doing enough to incentivise private investments in the energy transition, which generates uncertainty and dilutes incentives to invest.

For the areas under their direct control (e.g., tariff-setting, decarbonisation strategies and trajectories, technical and regulatory developments etc.), public authorities should strive to offer a clear, long-term path in terms of expectations and requirements, and stick to the path as much as possible. They should seek the right mix between incentivisation – through subsidies and tax credits (the Inflation Reduction Act in the United States being a case in point) – and penalisation – through restrictive regulations and taxation, as is the case in some EU programs. This should be done while prioritising clarity, simplicity of implementation and value for (public) money.

Price support, through feed-in tariffs, may no longer be needed as it was a few years ago, but regulations offering the option to fix the price of electricity – through contracts for difference (CfDs), for example – remain critical to support investments in greenfield projects. Negative auctions can also be a way of combining subsidies with competition. The private market for corporate power purchase agreements is growing rapidly but remains insufficient to support the vast volumes of investments needed. Public CfDs, where the price is fixed through auctions, offer price stabilisation which not only encourages investment but also benefits consumers. The current energy crisis has highlighted that deregulation is no guarantee for low prices – with the link between gas and power price and the rising market volatility hurting consumers.

Regulatory reforms offering price stabilisation options can ensure that investors continue to direct the vast capital flows needed at competitive cost to the renewable energy sector, while ensuring that customers can also share the benefits of low-cost renewable energy generation.

The right balance may vary from one jurisdiction to the other, based on national fiscal constraints and considering the state of opinion on ESG matters. The path to decarbonisation should be specified with appropriate mid-term intermediate milestones and not just focused on a long-term goal beyond most investment decision-makers' radar-screens, which would deprive them of real enforcing power. A case in point is the Japanese government auction system for power supply capacity, designed to reconcile addressing short-term capacity constraints with long term decarbonisation targets (cf. Appendix 3).

Wherever grids are to remain the exclusive remit of public investment, a significant budgetary effort needs to be made to enable future renewables generation to be connected. Investors increasingly expect public authorities to support the development and deployment of new technologies (e.g., EV charging stations; facilities for green hydrogen production, transportation, and usage etc.) via PPPs for instance.

An important dimension – and a relatively low-hanging fruit inasmuch as it need not entail additional public spending – is the streamlining of administrative processes and acceleration of delays in land acquisition, permitting and licensing of new energy transition facilities, whether in generation or transmission. Exceptional steps have recently been taken in several jurisdictions in that direction, in view of the current energy crisis, and these steps should now be made permanent as much as possible.

Addressing supply-chain issues such as the availability of critical metals is also a key responsibility of public authorities.

Lastly, stability is of the essence, and last-minute windfall taxes and price caps should be avoided as much as possible, as they may have long-term negative consequences on investors' appetite. Emergency windfall tax measures put in place to protect consumers will only raise investors' perceptions of political risk, at a time when the market risk is also set to rise.

- **For regulatory authorities**

By driving structural changes and influencing the way the financial sector thinks about sustainable investments, financial regulations can complement economic policy when it comes to driving the energy transition and decarbonising the economy.

In particular, prudential regulations such as capital charges ratios, whether applying to banks (via the Basel III framework) or insurers (in the EU, via the European Insurance and Occupational Pensions Authority and the Solvency II Directive) have a key role to play in encouraging – or at least not deterring – the additional long-term investments needed for the energy transition.

Regulatory support and guarantees from public authorities or multilateral development banks are needed now more than ever to provide reassurance to investors and mitigate risks associated with renewable energy projects, particularly in, but not limited to, emerging markets.

- **For Investors (Asset Owners/LPs)**

Until end-2022, investors have benefitted from a long streak of favourable fund-raising environments for energy transition projects as well as from a low-interest rate environment. Standing at USD 27.5bn, renewables-focused fund-raising in 2022 exceeded the total for 2019 and 2020 combined, and already represented one-sixth of all funds raised in infrastructure.

The focus should now be on investing those amounts, and the amounts raised by more generalist funds, in energy transition projects that go beyond the core renewable energy generation sector, and add value through innovation, combining and incorporating digital and storage dimensions as needed and accepting whenever possible a higher risk-return profile.

Stakeholders in the asset management industry should focus on investing in energy transition projects that go beyond traditional renewable energy generation and which incorporate transmission grids ("No transition without transmission") as well as digital and storage elements, and be conscious that this may mean accepting a higher risk-return profile.

Building a strategy mostly in a subsidy-driven approach may be short-sighted. Moving towards an environment where renewable energy takes up an ever-growing share of the energy mix, with the corresponding intermittency issues, will require more direct, interactive relationships with end-customers and abandoning the 'commoditised' approach. If investors are to deliver the substantial transformation needed, flexibility will be needed more than ever in this uncertain environment marked by technology disruptions; it may also entail moving from a culture focused on core-infrastructure, backstopped by long term PPAs with public utilities and FITs, to a more merchant power market. The price to pay to benefit from this energy transition market growth will be to move towards a more value-added approach.

- **For fund managers/GPs**

Promoting energy transition-labelled new vehicles to attract increased fundraising is only the start of a much deeper shift. As the market moves from traditional core-infrastructure models backed by long-term PPAs with public utilities and feed-in tariffs to a more merchant power market, infrastructure fund managers must adapt their approach.

Embracing a value-add strategy will require acquiring and assembling the appropriate technical and market skillset, eventually providing the key to capitalise on the growth opportunities in the energy transition market. Ultimately, to contribute to the energy transition and the green transformation of the economy, flexibility is crucial, particularly in an era characterised by ever-rising geopolitical and macroeconomic uncertainties and disruptions. Capitalising on the energy transition will be anything but a boring, business as usual shift for fund managers.

7

Conclusion

The energy transition is a crucial and urgent endeavour to mitigate the impacts of climate change and bring forth a sustainable future. Shifting from finite fossil fuels to sustainable and renewable energy sources holds the potential to mitigate and reverse the damage already done. The energy transition is already underway, and taking up speed recently, driven by global concerns, technological advancements, and regulatory policies, as well as investors and asset managers' growing appetite for ESG-related products and services.

However, we are still far from the required level and pace of investment: significant challenges remain, and they are not going to dissipate from the horizon anytime soon. The "wall of investment" required for the energy transition and for a net-zero future is gargantuan, and current levels of financing fall well short of what is needed. Significant obstacles remain, from the high upfront costs and the financing risks, to the political-regulatory barriers and the grid infrastructure gap. Collaborative efforts from both public and private sectors are needed to address these obstacles effectively and plug the financing gap. Policymakers and regulators should provide clear long-term expectations and incentives, alongside regulatory support and guarantees, to encourage private investments in the energy transition and help them mitigate risks.

Stakeholders in the asset management industry should also look beyond traditional renewable energy generation and embrace innovative and intersectional projects that incorporate transmission grids and digital tools alongside energy efficiency and storage elements. A strategy reliant on governmental subsidies may not suffice, and a direct and interactive relationship with end-customers is crucial. As the market evolves towards a more merchant power focus, strategies based on the value added alongside financial returns will enable investors to capitalise on what constitutes the largest growth opportunity in the infrastructure market. That may require accepting and managing a higher risk-return balance for many investors.

In this uncertain landscape, characterised by geopolitical tensions, macroeconomic instability, and an ever-growing number of climate change-induced shocks, flexibility and innovation alongside a commitment to ESG principles are paramount to support the energy transition and contribute to the green transformation of the economy.

Nothing less than the future of our planet depends on it.

LTI/A

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Glossary

AuM	Assets under Management
AWM	Asset and Wealth Management
CAGR	Compound annual growth rate
CCUS	Carbon Capture, Usage and Storage
CfD	Contract for Difference
DSO	Distribution System Operator
ESG	Environmental, Social and Governance
EV	Electric Vehicle
FiT	Feed-in Tariff
GHG	Greenhouse gas
GP	General Partners (in charge of managing funds)
GW	Gigawatt
IEA	International Energy Agency
IPP	Independent Power Producer/Independent Power Plant
IRENA	International Renewable Energy Agency
LP	Limited Partner/Limited Partnership
O&M	Operations and maintenance
PM	Private Market
PPA	Power purchase agreement
PV	Photovoltaic
RAB	Regulated asset base regime
RNE	Renewable Energy
SDGs	Sustainable Development Goals
SOV	Service Operation Vessel
TSO	Transmission System Operators

Appendix 1

In addition to the qualitative and quantitative research that forms the bulk of this report, two surveys were conducted with members of the LTIIA working group, encompassing asset owners, and asset managers and/or service providers. Given that the sample is too small, we caution against making any generalisable claims. Nonetheless, the results provide interesting qualitative trends and insights that helped inform this report.

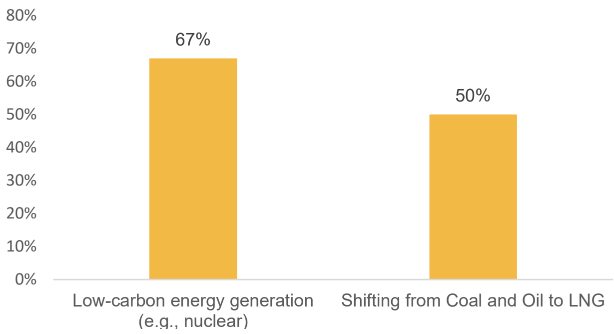
Below are the key takeaways from both surveys:

- **Converging definitions of scope**

There is a consensus among the survey respondents that renewable energy generation, transmission and storage, alongside energy efficiency, clean tech solutions and carbon capture, usage and storage should be considered as the defining features of the energy transition.

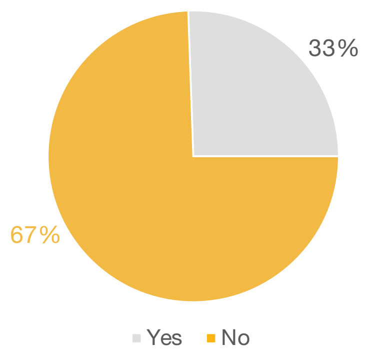
On the other hand, not all respondents considered low-carbon energy generation (e.g., nuclear energy) and activities pertaining to the early retirement of coal plants and the shift from coal and oil to LNG, as part of the energy transition (cf. Exhibit 22).

Exhibit 22: What should be included in the energy transition?



Source: *LTIIA*

Exhibit 23: In view of the recent geopolitical crises affecting energy supply, have you undertaken or are you planning on undertaking steps in terms of energy security beyond efficiency?



Source: *LTIIA*

Lasty, none of the respondents considered strategic autonomy and energy sovereignty – such as, for instance, investing in floating LNG terminals – as a driver of the energy transition, at least for private investment purposes.

Nonetheless, 33% of our respondents have undertaken or plan to take energy security-related steps that go beyond energy efficiency due to the recent geopolitical crises that have affected energy supply (cf. Exhibit 23).

- **A positive attitude**

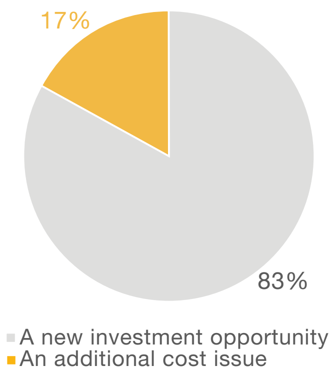
The vast majority of respondents (83%) consider the energy transition mostly as a new investment opportunity (with the rest seeing it as an additional cost issue), with large capital needs required to shift existing energy systems. The same proportion considers it to be part of their fiduciary duties, but only half have set up a specific instrument or fund targeting investments in the energy transition.

- **Tools and Key Performance Indicators**

Two-thirds of our respondents have developed or are planning on developing specific metrics to measure the impact of their investments on the energy transition (e.g., monitoring the GHG emissions of financed assets…). The rest are still either at an early or immature stage.

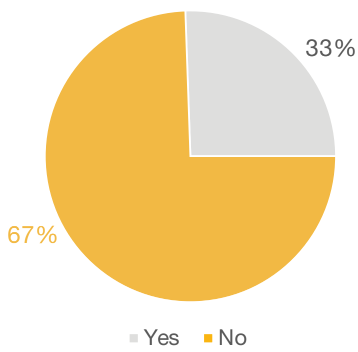
Appendix 1

Exhibit 24: You consider the energy transition to be mostly...



Source: *LTIIA*

Exhibit 25: Would you be comfortable with shifting away from the long-term contracting model to a more merchant power or hybrid approach for future investments in renewable power?



Source: *LTIIA*

- **How to finance the energy transition?**

Survey respondents were generally in agreement that, given the existing substantial funding gaps, all players are needed to finance the energy transition – from dedicated funds ('pure players'), to existing infrastructure funds, and even major players in the oil and gas industry.

Three-quarters of respondents also believe that financing the adaptations and repurposing of existing fossil fuel assets (e.g., gas pipelines and stations) to make them compatible with renewable biogas, biofuels and green hydrogen is Infrastructure investors' responsibility. However, none of our respondents consider it the responsibility of Infrastructure investors to finance investments in mining the minerals and rare earths needed to power the energy transition.

'Pure player' energy transition funds, with their higher risk-return profile, were unanimously viewed as an attractive investment theme for fundraising.

- **Implementing an energy transition-focused approach to the portfolio**

Half of our respondents applied an energy transition-focused approach to their Social Infrastructure or Transportation assets, with fewer instances in waste, water and digital assets. While formal approaches at the portfolio level are still being defined, respondents unanimously consider it their responsibility to sensitise and educate the users of their assets on the energy transition and on how they can better support it.

Regarding their investment plans in the near future, all our respondents are planning on investing in battery storage, while 83% have their eyes on green and blue hydrogen as well as biogas and biofuels. In addition, two-third are considering investing in geothermal or ammonia assets.

- **Business contracting model**

Two-thirds of our respondents are not comfortable with moving from long-term contracting to a more merchant power purchasing model.

Accordingly, all our respondents would be willing to sign a PPA with corporate offtakers to secure better visibility for their investments in renewable IPPs.

- **Risk-return profile**

When asked whether they have observed or expect a change towards higher risk-return profiles as a result of the increasing share of renewables in the energy supply market, all respondents gave a resounding 'yes.'

Appendix 1

- **Expected full decarbonisation of Infrastructure portfolio**

When asked when they expect to reach the full decarbonisation of their portfolio of investments in Infrastructure, three-quarters of our respondents stated that they would reach this objective by 2040.

Decarbonisation is not *"fully feasible [...] for all sectors. But reduction at core focus."*

- **Role of public authorities**

All of our respondents believe that public authorities in their jurisdictions are not doing enough to incentivise private investments in the energy transition.

Public authorities *"should support new technologies e.g., EV charging, hydrogen production, transportation, usage – for instance, via PPPs."* They should also provide *"more support to buildings' energy efficiency."*

Public authorities should *"limit permitting requirements to the really essential parts [as] environmental permitting is very extensive."* They should also focus on the *"insourcing of crucial supply chains"* and develop *"attractive regulation around grid investment to strengthen capacities to accommodate more renewable power".*

Public authorities should *"regulate on a long-term visibility basis."*

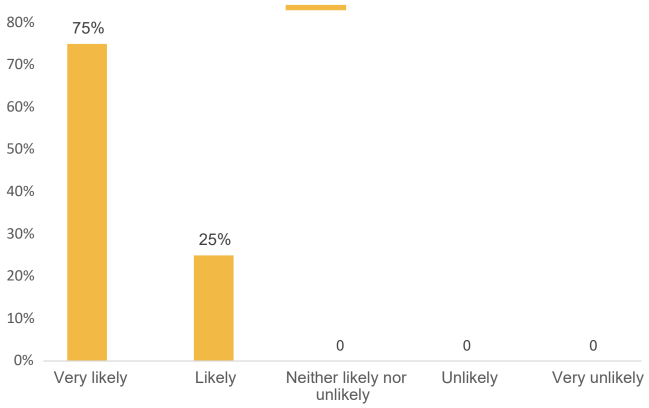
- **Investing in interconnector and grid extension/adaption**

Investing in interconnectors and grid extension and adaptation is a popular option with all of our respondents (cf. Exhibit 26).

- **The energy transition as a new standalone asset allocation in its own right?**

None of our respondents believe the energy transition should already be viewed as a new standalone asset allocation, and they all still consider it as part of the wider Infrastructure asset allocation.

Exhibit 26: How likely are you to consider investing in interconnectors and grid extension/adaptation to inject renewable energy into the network?



Source: *LTIIA*

"In terms of fundraising/capital mobilisation, it may make sense to have specialised energy transition strategies/platforms alongside generic infrastructure strategies, even if infrastructure strategies do contribute to the energy transition."

The energy transition is *"gradually becoming an investment strategy in its own right, like Solar PV or Wind. We see migration from both ends, general Infrastructure managers and sector/asset specialists."*

The energy transition is *"expected to figure in many different asset classes, from listed Infrastructure to Private Equity."*

Appendix 2

- **Top 20 renewables-focused funds closed between 2018 and 2022[75]**

Fund Name	Asset Manager	Amount Raised (USD bn)	Year	Region focus
Brookfield Global Transition Fund	Brookfield Asset Management	15.0	2022	Multi-regional
Copenhagen Infrastructure Partners IV	Copenhagen Infrastructure Partners	8.28	2021	Multi-regional
Global Renewable Power Fund III	BlackRock	4.80	2021	Multi-regional
Copenhagen Infrastructure Partners III	Copenhagen Infrastructure Partners	4.13	2018	Multi-regional
Stonepeak Global Renewables Fund I	Stonepeak	2.75	2021	Multi-regional
Clean H2 Infra Fund	Hy24	2.10	2022	Multi-regional
Macquarie GIG Renewable Energy Fund 2	Macquarie Asset Management	1.89	2021	Europe
GS Renewable Power	Goldman Sachs Asset Management	1.88	2018	North America
Mirova Energy Transition 5 Fund	Mirova	1.68	2022	Multi-regional
Quinbrook Low Carbon power Fund	Quinbrook Infrastructure Partners Ltd.	1.60	2019	Multi-regional
FLAVEO III Green Energy (Luxcara Fund IV)	Luxcara	1.42	2018	Europe
Greencoat Renewable Income	Schroders Greencoat	1.35	2021	Europe
Q-Energy IV	Q-Energy	1.30	2021	Europe
Sustainable Asset Fund III	Vision Ridge Partners	1.25	2021	Multi-regional
Foresight Energy Infrastructure Partners & Co-Investments	Foresight Group	1.21	2021	Europe
Capital Dynamics Clean Energy and Infrastructure VII	Capital Dynamics	1.20	2018	North America
Capital Dynamics Clean Energy and Infrastructure V	Capital Dynamics	1.20	2018	North America
LCIV Renewable Infrastructure Fund	London Collective Investment Vehicle	1.17	2021	Europe
ECP TerraGen Growth Fund, LP	ECP	1.17	2021	North America
Generate Capital Fund I	Generate Capital	1.00	2020	North America

[75] Data retrieved from Infrastructure Investor

Appendix 2

Top 10 Energy Transition Investors: Global – Infrastructure Developers[76]

Infrastructure Developer	Total Transaction Value (USD bn)	Debt (%)	Equity (%)	Percentage of investment with the energy transition as primary focus
General Electric	132.5	57.4%	42.6%	2.2%
Enel	129.2	97.4%	2.5%	68.1%
Engie	115.7	96.3%	3.7%	89.6%
EDF	111.2	95.5%	4.5%	93.8%
NextEra Energy	91.5	95.3%	4.6%	95.8%
Iberdrola Group	69.7	78.1%	21.8%	99.8%
Duke Energy	58.2	97.6%	2.4%	26.5%
RWE	52.6	60.4%	39.6%	99.0%
AES Corporation	47.4	87.6%	12.4%	87.3%
KEPCO	41.7	86.6%	13.4%	97.8%

Top 10 Energy Transition Investors: Global – Non-Bank Institutional Investors[77]

Non-Bank Institutional Investor	Total Transaction Value (USD bn)	Debt (%)	Equity (%)	Investor type
Canada Pension Plan Investment Board	32.6	44.9%	55.1%	Pension Fund (Public)
AustralianSuper	26.8	59.2%	40.8%	Pension Fund (Public)
Caisse de dépôt et placement du Quebec	22.3	62.2%	37.8%	Pension Fund (Public)
Ontario Municipal Employees Retirement System (OMERS)	21.6	69.9%	30.1%	Pension Fund (Public)
Public Investment Fund	21.0	100.0%	0.0%	Sovereign Wealth Fund
Ontario Teachers' Pension Plan	16.4	53.3%	46.7%	Pension Fund (Public)
Castleton Commodities International	16.3	100.0%	0.0%	Non-Infrastructure Corporate
Reliance Industries	16.1	100.0%	0.0%	Non-Infrastructure Corporate
Abu Dhabi Investment Authority	15.3	54.8%	45.2%	Sovereign Wealth Fund
Siemens	15.3	69.2%	30.8%	Other Institutional Investor

[76] Data retrieved from IJGlobal

[77] Ibid.

Appendix 2

Top 10 Energy Transition Investors: Global – Asset Managers[78]

Asset Manager	Total Transaction Value (USD bn)	Debt (%)	Equity (%)	Percentage of investment with the energy transition as primary focus
Brookfield Asset Management	108.7	72.1%	27.9%	84.8%
Macquarie	68.7	63.1%	36.9%	94.2%
KKR	50.0	54.0%	46.0%	70.3%
JP Morgan Asset Management	39.3	78.4%	21.6%	66.7%
Global Infrastructure Partners	22.3	71.7%	28.3%	81.5%
Berkshire Hathaway Energy	21.4	92.9%	7.1%	44.1%
Blackstone	14.9	27.0%	73.0%	68.3%
State Development & Investment Corporation (SDIC)	14.7	78.9%	21.1%	100.0%
DE Shaw	13.0	92.4%	7.6%	100.0%
Cubico Sustainable Investments	12.5	84.6%	15.4%	100.0%

Top 10 Energy Transition Investors: Global – Banks[79]

Bank	Total Transaction Value (USD bn)	Debt (%)	Equity (%)	Percentage of investment with the energy transition as primary focus
Mitsubishi UFJ Financial Group	17.7	0.5%	99.5%	4.4%
BNP Paribas	11.8	80.4%	19.6%	100.0%
ING Group	6.1	100.0%	0.0%	100.0%
AMP	6.1	80.8%	19.2%	100.0%
BBVA	4.8	100.0%	0.0%	0.0%
Allied Irish Bank	4.7	100.0%	0.0%	100.0%
Citigroup	4.6	100.0%	0.0%	100.0%
Hua Xia Bank	4.2	100.0%	0.0%	0.0%
FMO	4.1	100.0%	0.0%	100.0%
Goldman Sachs	4.1	58.3%	41.7%	63.1%

[78] Ibid.

[79] Ibid.

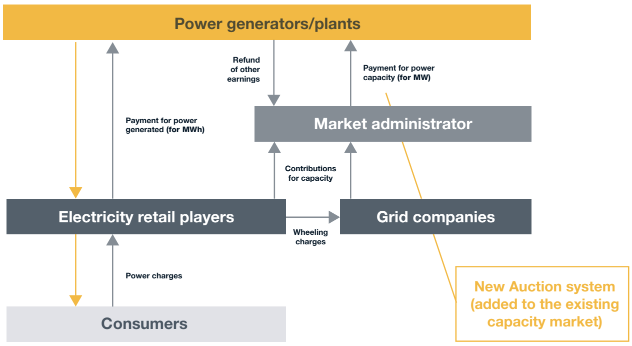
Appendix 3

One of the challenges surrounding the energy transition is investing in assets which may be needed in the short term, but not considered necessary in the long term from a decarbonisation perspective.

An obvious example is a thermal power plant. Such a plant may need new capacity to ensure there is sufficient short term power supply to respond to an energy supply crisis or to increasing demand. It will also be needed to stabilise the electricity system and balance the new inputs of renewable energy that are expected to be intermittent.

However, decision makers may find it difficult to commit huge capital spending to thermal power plants, since they have rather long payback periods and could, in a worst-case scenario, become stranded assets.

The Japanese government has thus decided to introduce a new auction system for long-term power supply capacity:[80]



Thermal power plants are eligible for long-term fixed revenue under the auction as long as they are equipped with certain features such as co-firing with hydrogen/ammonia to reduce the CO2 emission. The idea is to provide certainty and cash flow visibility to decision makers and investors while simultaneously making sure that the target power assets in question will be well aligned with long-term carbon neutrality goals.

Government support	Auction system for long-term power supply capacity
Purpose	Pursue carbon neutrality while procuring sustainable electricity supply: • Secure a long-term revenue stream for newly built power plants which are required for energy security during the energy transition period. • Incentivise power suppliers to build new power plants which are necessary for a sustainable electricity supply while contributing to carbon neutrality targets.
Description	Auction of 20-year tenor fixed price (multi price auction). The fixed price is supposed to cover the fixed costs of newly built power plants (CAPEX related costs, finance costs etc.).
Types of power plants eligible for the auction	4GW from the following (for FY2023 auction) • Over 100MW new build/replacement : Renewables (solar PV, onshore and offshore wind, geothermal, hydro, biomass), nuclear, Gas co-firing of hydrogen (over 10%) • Over 10MW new build/replacement : Battery storage, pumped hydro • Refurbishment of existing thermal power plants : Co-firing of ammonia (over 20%, over 50MW), Co-firing of hydrogen (over 10%, over 50MW), Biomass (100%, over 100MW) * Other than the abovementioned power plants, new built/replacement power plants listed below in urgent need of reliable electricity supply will also be secured under the auction: • LNG fired power plants on the condition that they will become "carbon free" by 2050 • Tentatively introduced during FY2023-2025, 6GW for the three-year period
Revenue/Refund payment	The market administrator makes payments based on the fixed price to the generators for secured capacity (for MW). The generators make refund payments to the administrator in case the generators make earnings from other electricity transactions/markets.

[80] Development Bank of Japan Inc., based on public information disclosed by the Organization for Cross-regional Coordination of Transmission Operators, Japan.

Definitions of Terms

Deal value: measures the total transaction value recorded on a specific year. Transactions may include acquisitions, primary financing, additional facility, refinancing etc. Data gathered from IJ Global.

Energy Transition (ET): describes the comprehensive shift from conventional, carbon-intensive energy sources to sustainable and renewable alternatives, driven by the need to mitigate climate change, reduce greenhouse gas emissions, and ensure long-term energy security.

Energy Transition Infrastructure: refers to the network of physical systems and facilities, including renewable energy generation, storage, and distribution technologies, that are essential for transitioning from fossil fuel-based energy sources to cleaner and more sustainable alternatives. In this report, Energy Transition Infrastructure is divided into Clean Electricity (Solar, Wind, Hydroelectricity, Nuclear, Geothermal and Other Renewables), Grid Investments (Transmission & Distribution, Energy Storage, EV Charging and Smart Meters), Non-Electric (includes Biofuels, Biomass, Carbon Capture & Storage and Hydrogen) and Other Primary Focus.

Fossil fuels: include raw materials derived from organic matter, such as coal, oil, and natural gas, which are burned to produce energy but also contribute to greenhouse gas emissions and environmental damage.

Greenhouse gases (GHG): describes gases that trap heat in the atmosphere; carbon dioxide (CO2) is the primary contributor to GHG emissions; carbon dioxide equivalent (CO2eq) is a metric used to compare the warming potential of different greenhouse gases relative to carbon dioxide, providing a standardised measure for assessing their overall impact on climate change.

Infrastructure funds AuM: refers to all assets managed by Infrastructure funds. Data gathered from IJ Investor.

Nationally Determined Contributions (NDCs): are climate action plans submitted by each country under the Paris Agreement that outline their unique targets, policies, and measures aimed at reducing greenhouse gas emissions and addressing the effects of climate change.

Net-zero/ Net-zero carbon emissions (NZE): refers to achieving a balance between the amount of greenhouse gases emitted into the atmosphere and the amount removed or offset, resulting in no net increase in greenhouse gas concentrations and effectively mitigating climate change.

Power Purchase Agreement (PPA): stands for an agreement between a power producer and a buyer, usually a utility or a corporate entity, that sets out the terms and conditions for the buying and selling of electricity generated from a specific renewable energy project for a defined duration.

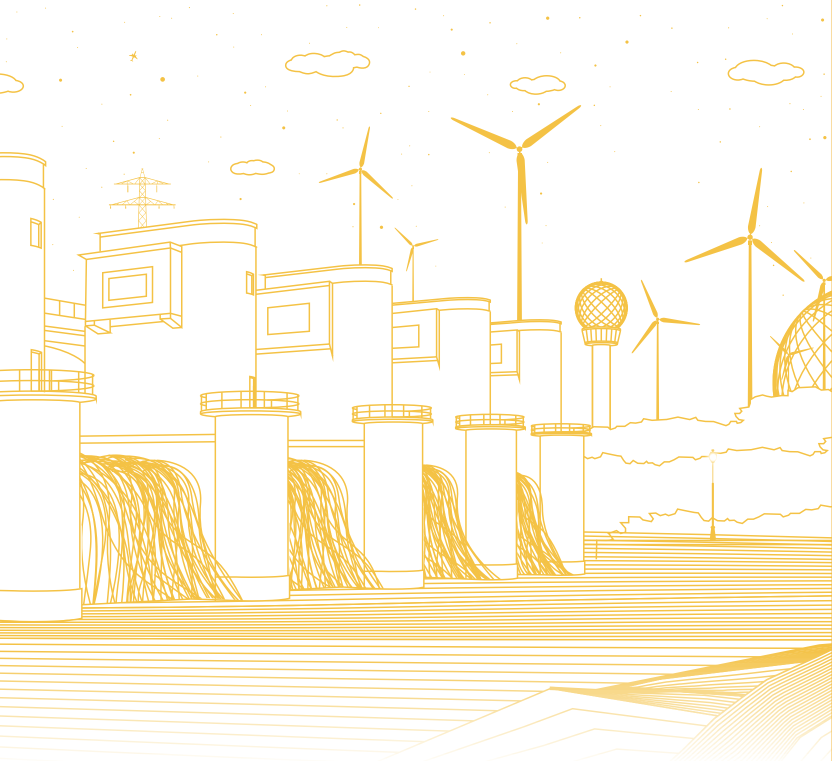
Public Private Partnership (PPP): describes contractual LT arrangements with a public procuring authority where the private party bears significant risks, having an overall responsibility to deliver performance over time, and provides part or all of the upfront financing.

Renewable Energy (RNE): energy from renewable resources that are naturally replenished on a human timescale, including sunlight, wind, the movement of water, and geothermal heat.

Renewable Energy Focused Funds (RNE Focused): defined as funds whose primary sector target is Renewable Energy.

Renewable Energy Exposed Funds (RNE Exposed): funds exposed to Renewable Energy while having another primary sector target.

Notes



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