Frontier International

Infrastructure – energy transition – part 2

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About us

Frontier has been at the forefront of institutional investment advice in Australia for over 25 years and provides advice on $600 billion of assets across the superannuation, charity, public sector, insurance and university sectors.

Frontier's purpose is to empower our clients to advance prosperity for their beneficiaries through knowledge sharing, customisation, technology solutions and an alignment and focus unconstrained by product or manager conflict.

Manish Rastogi

Head of Real Assets

Manish Rastogi is the Head of Real Assets with Frontier having joined the firm in 2017. He leads a dedicated team of real assets investment consultants that provides investment consulting, manager research and support on infrastructure, real estate and private equity to Frontier clients. Prior to joining Frontier, Manish worked at IFM Investors as Vice President in the infrastructure investment team, based in Melbourne, undertaking direct investments and asset management with a specialisation in airports and telecommunications. Prior to IFM, Manish worked in M&A advisory with O'Sullivan Partners (now Lazard) in Sydney and with Lehman Brothers in its Telecoms & Media M&A team in London. Manish holds an undergraduate degree in Engineering with a major in Computer Engineering (honours) from the University of Melbourne, and an MBA from the London Business School with a major in finance.

Martin Thompson

Senior Consultant

Martin is a Senior Consultant at Frontier, having joined the firm as an Associate in 2009. Martin provides consulting support to a number of clients and undertakes investment and manager research. Prior to joining Frontier, Martin worked at Starfish Ventures, an Australian venture capital fund manager focussed on high growth life sciences, information technology and clean technology companies. Prior to this Martin has worked in technology commercialisation at the University of Melbourne, virology research at Murdoch University and undertook a PhD in cancer research at the University of Western Australia. Martin has a Master of Applied Finance through Macquarie University, a PhD in Molecular Cell Biology and a Bachelor of Science with first class honours.

Ricci Steckoll

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Ricci joined Frontier as an Associate in 2020. He has responsibility for undertaking manager and investment research with a focus on property and infrastructure. Prior to joining Frontier, Ricci spent four years at Deloitte within the financial modelling team, with a predominant focus on transactions across a diverse range of sectors including, retail, property and technology. Ricci holds a Bachelors Degree of Engineering (Civil) with honours and Bachelor of Commerce (Finance) both from Monash University.

Chris Tran

Associate

Chris joined Frontier as an Associate in 2021. As part of the Real Assets Team, he has responsibility for undertaking manager and investment research with a focus on property, infrastructure, and private equity sectors. Prior to joining Frontier, Chris worked for over four and half years in corporate finance with Pitcher Partners and ASIC, consulting on M&A and valuation engagements for his clients and stakeholders. Chris holds a Bachelor of Commerce (Finance/ Accounting) from The University of Melbourne and is currently studying towards his CFA.

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Callum joined Frontier as an Associate in 2021. He has responsibility for undertaking manager and investment research with a focus on property, infrastructure, and private equity sectors. Prior to joining Frontier, Callum spent over three years at Lonsec where he conducted manager research across various asset classes, including property and infrastructure. He also spent three and a half years at the New Zealand Transport Agency, conducting due diligence on business cases for government infrastructure projects. Callum graduated from Massey University, in New Zealand, with a Bachelor of Applied Economics and is a CFA Charterholder.

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INTRODUCTION

Infrastructure – energy transition part 2

This paper is a continuation of the Frontier International [Infrastructure – energy transition – part 1] released by Frontier in December 2021.

While that paper provided a broad overview of the energy transition thematic and key areas of consideration for investors in the sector, this paper describes the sectors that may be impacted by the transition to a lower carbon economy, and sectors that may provide potential investment opportunities for investors. This is done by expanding on the four key energy transition investment thematics noted in the first paper:

- **decarbonisation of energy production**
- **decarbonisation of transportation**
- **decarbonisation of industrial processes and manufacturing**
- **energy efficiency.**

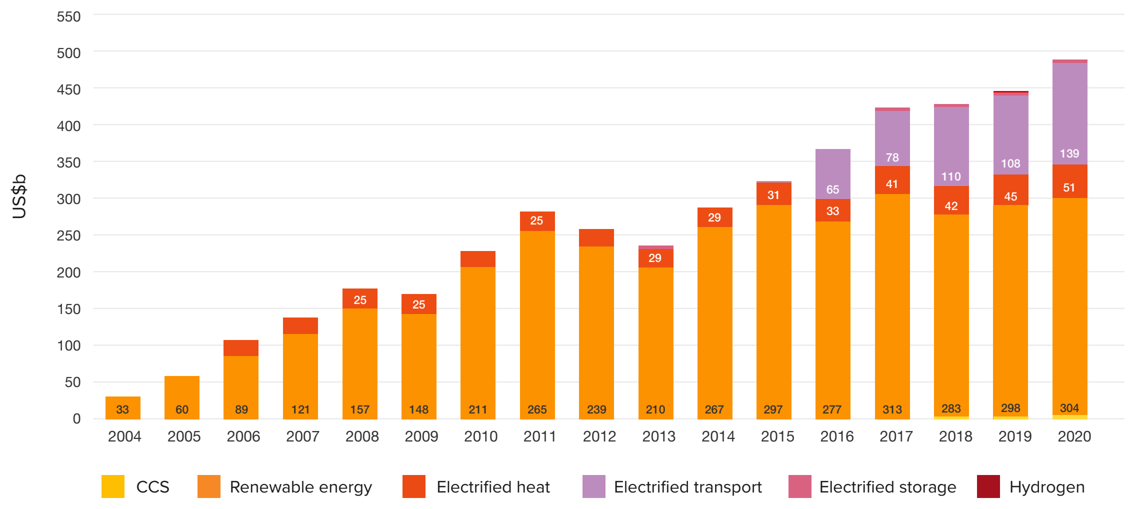
In the current climate, much of the energy transition focus is on the first theme (decarbonisation of energy production) as this underpins many of the potential investments in the other themes, and energy is also a well-developed and traditional infrastructure sector. However, this paper provides insights on each thematic.

Decarbonisation of energy production

In the calendar year 2020, US$501.3 billion was invested in low-carbon energy assets globally.

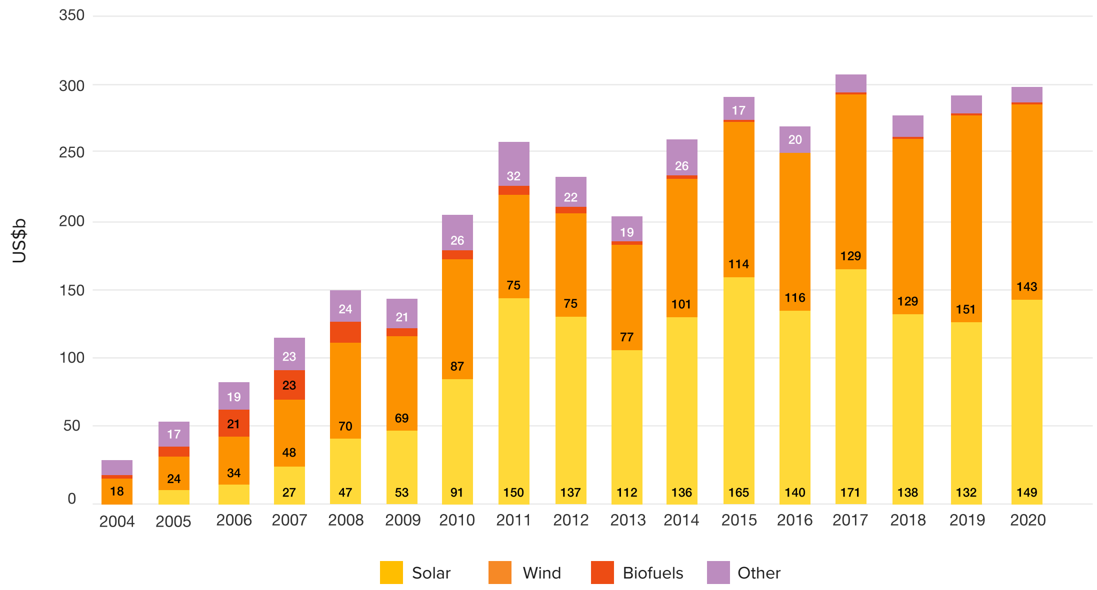
This includes renewable energy, energy storage, electric vehicle (EV) charging infrastructure, hydrogen production, and carbon capture and storage facilities. US$303.5 billion, or circa 60%, was invested in renewable energy technologies such as solar, wind and biofuels. This trend is likely to continue over time. This section outlines several sub-sectors and asset types that will be impacted by this trend.

Chart 1: Global investment in the energy transition by sector



Source: Bloomberg New Energy Finance.

Chart 2: Global investment in renewable energy technologies



Source: Bloomberg New Energy Finance.

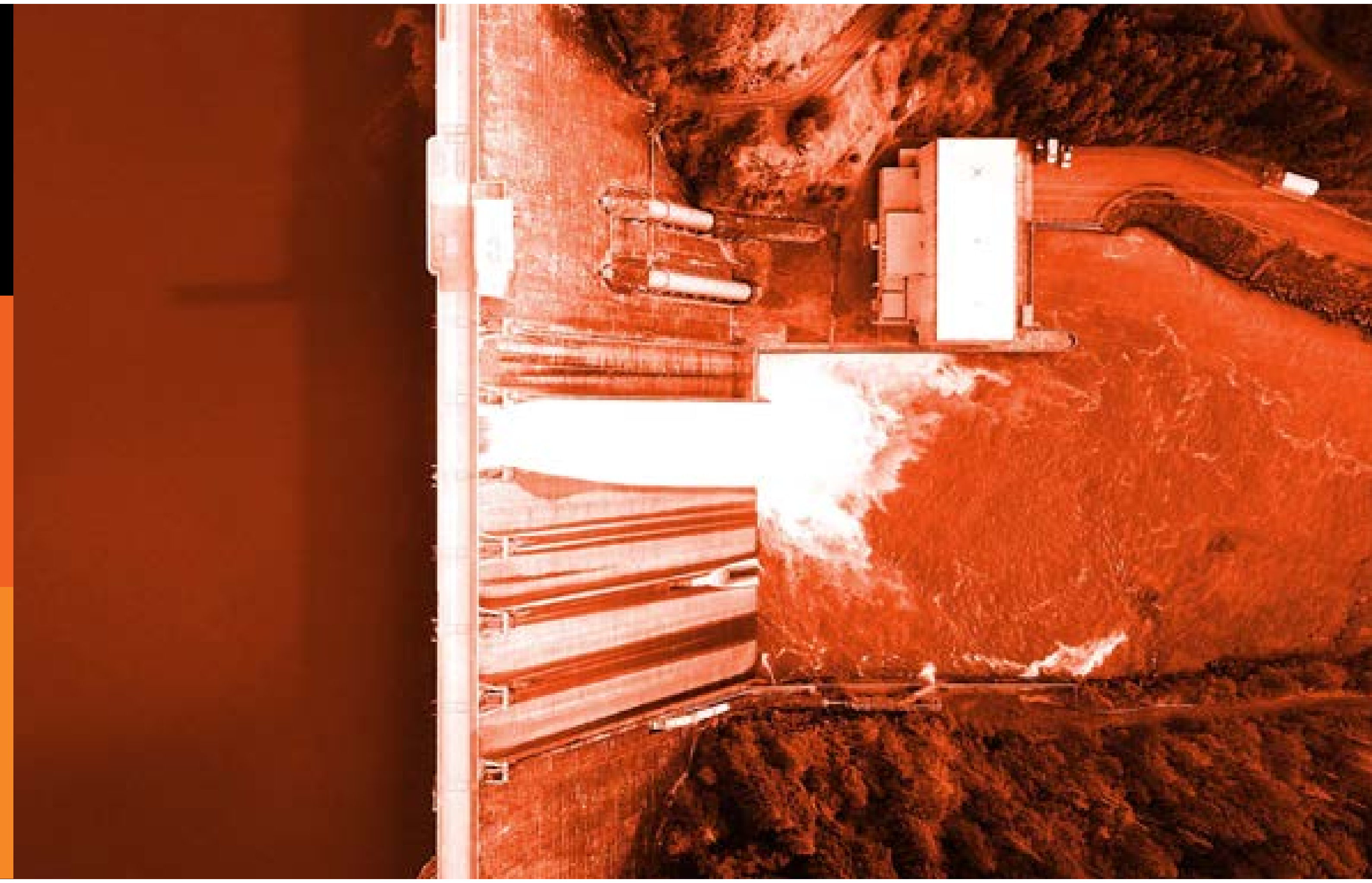
Renewable energy generation (solar, wind, hydro, geothermal)

Renewable energy may be considered the original energy transition sector in infrastructure. As the primary source of carbon neutral energy, it is a pivotal enabler of the transition to a decarbonised global economy. To date, the investment focus for renewable energy within the infrastructure asset class has been in well-established grid-scale assets, such as wind and solar generation. However, other assets, both established and experimental, fall under this category. This includes various forms of hydroelectric generation, thermal solar, geothermal generation and rooftop solar. Some of these other sectors are likely to generate investment opportunities over time, in addition to the well-established grid-scale renewables sector. As a whole, we believe renewable generation segment will benefit positively not only from an energy transition perspective but also from an economic development standpoint for nations/markets still developing their power generation sectors.

Waste-to-energy (WtE)

WtE involves the re-direction of solid waste for the generation of heat and electricity. Frontier International 43 Waste-to-Energy Infrastructure looked at WtE in the US. Its net carbon emission impact depends on the type of input waste stream and the inclusion of offsets created from the avoidance of landfill methane emissions. The latter is a key factor in the emissions measurement scheme implemented. In some situations, WtE can be considered carbon negative. Unlike renewable energy, where the primary output is electricity, WtE is primarily about waste management, with electricity generation being a secondary consideration. Hence, the benefits and construction of WtE plants requires different considerations and economic drivers than those for renewable energy.

This is a sector numerous infrastructure managers have invested in over the years, primarily based on efficient waste management. However, historically, this sector has delivered mixed financial outcomes (i.e. in periods of recession, waste feed stock is constrained and revenue declines if not efficiently contracted). We believe WtE plants will continue to be implemented globally, but under much tighter contracting terms. They will also have to meet strict carbon emissions adherence targets.



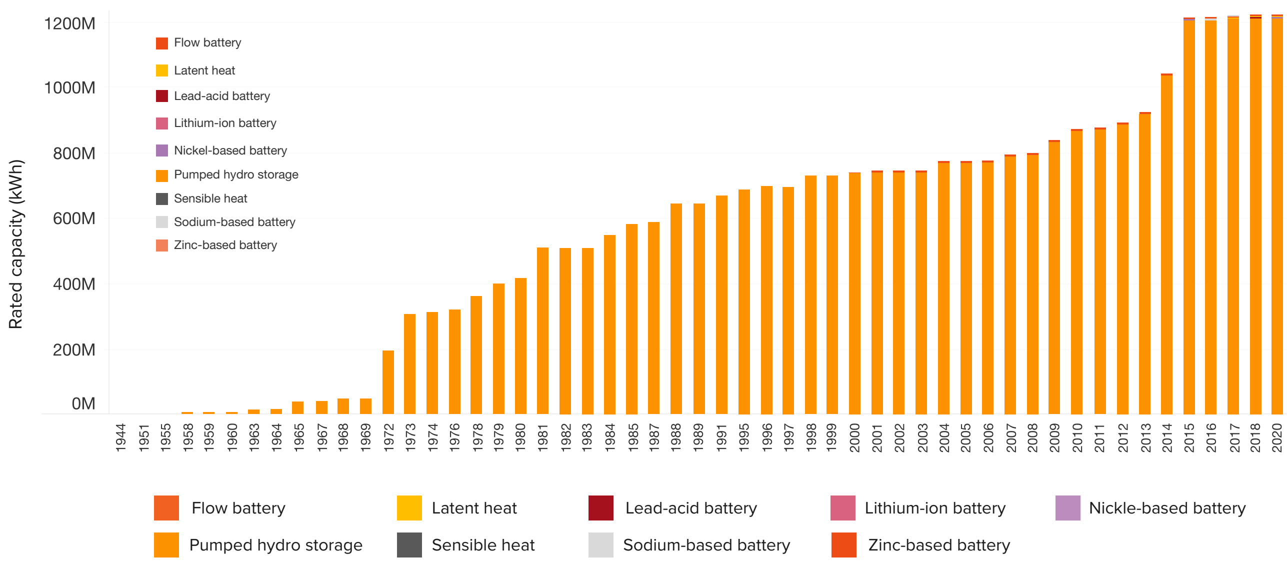
Energy storage

Energy storage covers a wide range of different technologies and was the topic of Frontier Line 131 [Grid Scale Energy Storage](). The dominant sub-sector, by stored energy, is pumped hydroelectric generation, as highlighted in chart 3. Each energy storage technology has its own set of advantages and considerations, and as forecast in the Grid Scale Energy Storage paper, non-hydro based energy storage has become an investible sector, though it is still relatively nascent.

Energy storage helps address one of the key disadvantages of wind and solar generation, which is its intermittency. Supply and demand for electricity needs to be carefully balanced in an electricity grid and the implementation of energy storage technologies can shift the supply of electricity to when it is needed. Solar generation has proven to be particularly problematic since peak generation typically occurs around midday, whereas peak demand occurs in the mornings and the early evenings. Energy storage can help address these grid imbalances (supply and demand mismatch) by storing surplus electricity for periods of high demand.

We are increasingly witnessing battery storage technologies being installed as part of broader renewable energy generation projects. We believe energy storage assets are primed to be a key beneficiary of the energy transition thematic given their importance in solving the 'intermittency' issue.

Chart 3: Global culmulative energy storage installations



Source: DOE Global Energy Storage Database.

Grid support and enhancement

In addition to balancing supply and demand, electricity networks need to balance several other characteristics and be able to transmit electricity from generators to consumers. Changing the nature of electricity generation requires the traditional grid to be reconfigured to account for more geographically dispersed electricity production, greater intermittency, and the loss of grid stability that is currently provided by traditional generation.

To address these challenges, several types of assets will be in greater demand, including transmission lines, synchronous condensers (example below) and battery storage.

Each of these asset types can play multiple roles in strengthening an electricity network. This topic and others have previously been covered in Frontier Line 161 Network level challenges facing Australian renewables.

The investment opportunities that occur in this space are often captured by the incumbent providers of the regulated transmission and distribution (T&D) infrastructure (i.e. T&D utilities), however, in some jurisdictions, these may be made available as stand-alone investments (e.g. through market or competitive tenders).

A synchronous condenser

Source: ABB Australia.

Natural gas

Natural gas can serve several roles in supporting an electricity network that is transitioning to more intermittent generation such as renewable energy. A key benefit is in providing electricity supply over very short to medium time-scales such as minutes to hours, as gas-fired power plants have the capability to dispatch electricity quickly. Gas-fired power plants are ideally placed to address the grid balancing challenge intermittent green generation exacerbates.

Another role is balancing the grid over seasonal timescales, though this is a more traditional role. Electricity demand typically exhibits seasonal cycles (peaking in summer in hot climates or winter in cold climates). Gas storage for gas-fired power plants can be refilled in low demand periods ready to be utilised in high demand periods when other generation sources may not be sufficient.

Furthermore, gas generation offers lower overall carbon intensity relative to other fossil fuels. However, it is not carbon neutral, and fugitive emissions and gas leaks can still cause significant environmental damage. Hence, gas generation is widely accepted as an interim pathway to a net-zero emissions world. Potential options to transition gas-fired generation to carbon neutrality include carbon capture and storage. Another option is conversion to green or blue hydrogen use which is discussed later in this paper.

Nuclear

Nuclear power generation is a form of carbon-neutral generation that can operate at very large scale. Unlike renewable energy generation from solar and wind, it is also a reliable source of baseload power. However, developing nuclear energy plants in the current economic climate is an extremely expensive form of electricity generation (considerably more expensive than wind or solar technologies). There are also other concerns including nuclear waste handling and storage, security, and societal acceptance. Following the Fukushima disaster in Japan in 2011, nuclear energy generation is generally shunned by the investment community, including investment managers, several of whom Frontier has spoken to. Several nations such as Japan, Germany and the US are currently phasing out their nuclear power generation plants. This makes nuclear generation economically and politically unfeasible, and if there is a turn-around in attitudes towards nuclear power generation, it is likely to be initiated by national governments and not the investment community.

Carbon capture and storage

Carbon capture and storage (CC&S) involves collecting carbon dioxide generated in industrial and/or power generation processes and storing it underground, to avoid carbon emissions into the atmosphere. CC&S can form an integral element of electricity generation but also of other processes (discussed later but including hydrogen production and other industrial processes).

There is also the possibility of direct air capture, where carbon dioxide is taken from the atmosphere and stored (potentially as an offset from other carbon polluting activities), but this has not yet been developed at any substantial scale.

To date, most CC&S projects have had limited success, though several infrastructure managers have indicated they have assessed potential projects. Where CC&S projects have been successfully implemented, the stored carbon dioxide is often used to enhance oil recovery, which leads to increased carbon pollution. We believe CC&S is likely to be a beneficiary from energy transition, however, the timing and wide-scale commercial adoption of this technology remains distant.

Hydrogen

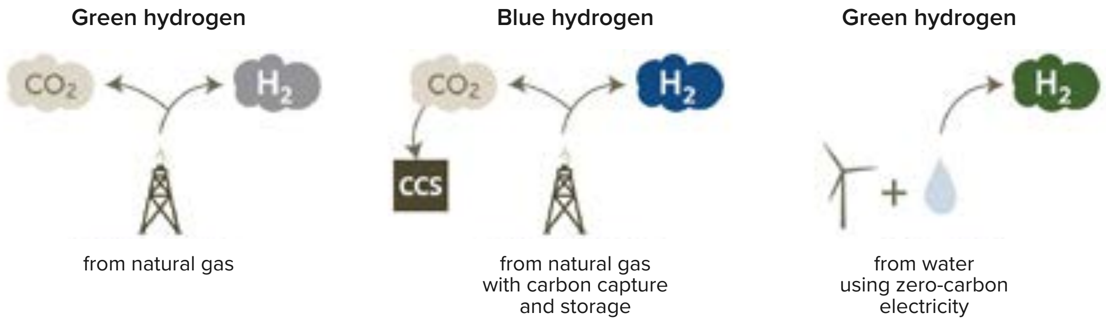
Hydrogen has a range of uses, including as a fuel in gas generation, heating, and transportation. It is used in industrial processes and can be converted into other products. For example, hydrogen can be converted into methanol or ammonia for use as a fuel or for fertiliser production.

'Green hydrogen' is produced by utilising electricity generated from renewable sources to operate large-scale electrolysers to split water (H2O) into separate hydrogen and oxygen gas molecules. The electrolysis process allows for the storage of hydrogen (in the form of methanol or ammonia) as a clean fuel source. However, most hydrogen currently in use, is generated from natural gas via a well-established process called 'steam reforming', which has high carbon dioxide emissions. The hydrogen produced is referred to as 'grey hydrogen' since it is not carbon emissions free. Where CC&S is applied to the generation of grey hydrogen, the resultant product is referred to as 'blue hydrogen'. While less carbon polluting than grey hydrogen, blue hydrogen still has some residual emissions.

At present, green hydrogen requires at least 40% subsidies to reach price parity with grey hydrogen. To move green hydrogen towards price parity with grey hydrogen, both electricity input costs and the costs to construct the required facilities (electrolysers and ancillary infrastructure) need to fall substantially. Constructing generation facilities in locations with the best solar irradiance and wind resources will help with the former while scale in manufacturing facilities will help with the latter. However, green hydrogen requires subsidies or substantial demand for non-polluting hydrogen to make it viable. It also requires large amounts of fresh water (nine litres for every kilogram of hydrogen) which is a significant challenge for some areas.

In Frontier's recent meetings with investment managers, hydrogen received a disproportionately large amount of interest as a potential investment segment, including hydrogen-only infrastructure fund strategies. A number of high-quality investment opportunities also appear to be located in Australia given the abundance of remote locations along Australia's coastlines with very high renewable energy and water resources. While these are interesting, hydrogen remains a nascent segment with several risks. However, the hydrogen segment (particularly 'blue' and 'green' hydrogen) is slated to benefit from the energy transition thematic as the cost of production reduces over time.

Chart 4: Types of hydrogen by source



Source: Manager research.

Decarbonisation of transportation

It is important the transportation sector is decarbonised since it is a significant contributor to global carbon emissions. Several approaches have been taken to address this.

Electrification of transport

While electric vehicles (EVs) have garnered disproportionate attention when considering the decarbonisation of transportation, it goes without saying that the utilised electricity needs to have been generated from a carbon neutral source (i.e. renewable energy) in order for electrification of transport to be justified as contributing to the energy transition. Infrastructure managers have been particularly focussed on investing in EV charging station infrastructure in recent years, but more recently we are also witnessing greater interest in the provision of EV fleets, particularly heavy vehicles such as electric buses and electric trucks. We expect this opportunity set to gain further traction as managers explore different methods by which they can gain exposure to this thematic.

Carbon neutral fuels

Changing to carbon neutral fuel sources such as biofuels or hydrogen related products is yet another way to decarbonise transportation.

Biofuels are created from biological feedstocks (e.g. food crops, wood, agricultural waste, or by algae). Biofuels have a range of forms including, methane ('biogas'), ethanol, biodiesel, syngas, methanol, hydrogen and butane. These fuels emit carbon dioxide when burned. However, the original organic matter absorbs carbon dioxide from the atmosphere when it is produced, hence the overall process is carbon neutral. Landfill methane capture (biogas), biodiesel and ethanol production are well established. However, algal fuels and aviation biofuel technology remain in the early stages of development.

Several fuel types can be generated from hydrogen, including ammonia, methanol and synthetic fuels, plus hydrogen can be used as a fuel in its own right. These may be certified carbon neutral if the hydrogen input is carbon neutral.

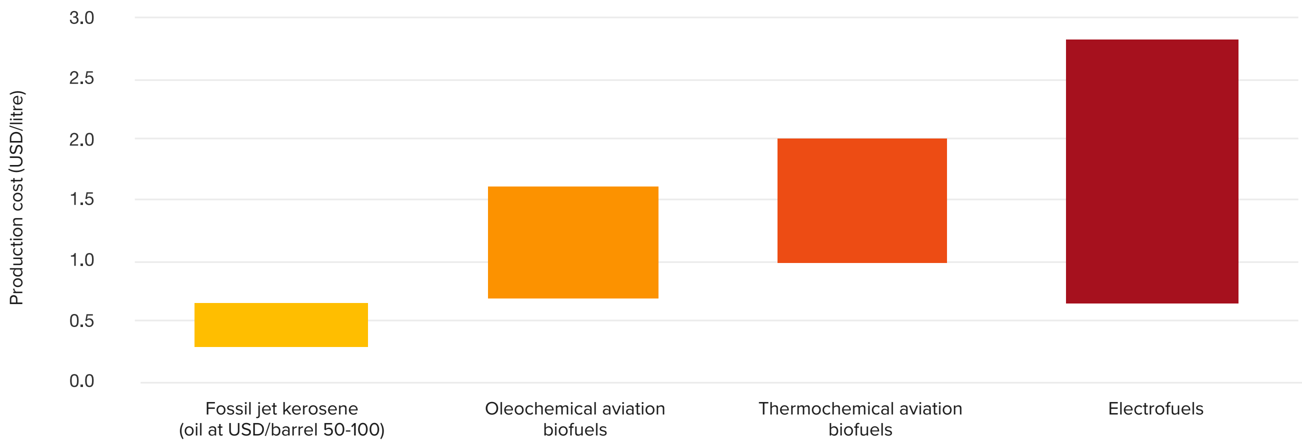
In some cases, existing transportation fleets may be re-purposed to utilise these new fuels. Though, it is more likely that new vehicles capable of operating on new fuel types will be required. For example, Maersk has ordered, and will integrate into its fleet, container ships that can operate on green methanol to provide a decarbonised shipping option to its customers.

Currently, the obvious opportunity for infrastructure investors appears to be in the generation of renewable energy andconversion of this into suitable fuels. However, investors will need to ensure there is sufficient demand for its product. As the carbon-neutral or renewable fuels segment draws further interest and demand, we expect new investment opportunities will arise.

Air transport

Decarbonisation of air transport is a more challenging proposition. Aircraft fleet replacement timeframes are prolonged and many of the technologies required to reduce carbon emissions within the sector are in their infancy. The main pathways for the industry are improving fuel efficiency, changing propulsion types (such as hybrid-electric, electric or hydrogen powered) and shifting to lower carbon fuels, such as biofuels and synthetic fuels (also called 'sustainable aviation fuels'). As with shipping, the role of the infrastructure investor may be in the production of clean electricity and conversion into suitable fuels (renewable fuels).

Chart 5: Production cost ranges for fossil jet fuel and aviation biofuels



Source: ITF (2021), "Decarbonising Air Transport: Acting Now for the Future", International Transport Forum Policy Papers, No. 94, OECD Publishing, Paris.

Decarbonisation of industrial processes and manufacturing

There are a range of traditional industrial processes that generate large quantities of carbon emissions, either directly or indirectly. The ease with which these processes can be decarbonised depends on how the carbon emissions are generated.

Decarbonisation of energy usage

Where carbon emissions are primarily due to energy usage, substitution of energy inputs with carbon neutral energy sources is the obvious route. This could involve a shift to carbon neutral electricity or source of heating (e.g. green hydrogen or biofuels). The role of the infrastructure investor is most likely in the provision of these alternative energy sources, though potentially capital expenditure will also be needed to shift to an alternative heat source.

Decarbonisation of industrial processes

Many industrial processes can produce carbon dioxide as part of the process itself, rather than indirectly via energy inputs. The largest direct industrial source of carbon pollution is cement production which is estimated to generate around 8% of global carbon dioxide emissions, of which around 50% is due to the chemical process. Another key example of industrial carbon pollution is the production of steel, which requires the use of carbon (typically in the form of 'coke'), which results in carbon dioxide emissions. While these emissions are separate to energy consumption (hence arguably separate to the energy transition), they are still important to address under the broader drive towards decarbonisation.

How to decarbonise an industrial process is very much linked to the specific process itself. For example, in steel production, coke developed from metallurgical coal may be substituted with a renewable carbon source such as biochar. In cement production alternative chemistries or carbon capture and storage technologies may be utilised.

The viability of decarbonising different industrial processes is an important factor since it is reliant on the feasibilities of technological and economic solutions currently available, as well as the willingness of the market to bear what is likely to be a more expensive 'green' product.

The role for infrastructure investors in this sub-sector is reliant on the technology and commercial implementation, as well as the structure of the investment. For example, we would expect an infrastructure investor to structure an investment in this sub-sector as an availability-based or a fully contracted transaction, that passes-through all operational and demand risks to a third-party technology/service provider and off-taker, respectively.

Decarbonisation of industrial processes, while at a nascent juncture today, is expected to be a beneficiary from the broader decarbonisation thematic over the long-term given the vast scope to reduce greenhouse gas emissions.

Recycling

Recycling is a broad and a diverse sector with an ability to make an impact, of varying magnitude, on the energy transition thematic. The recycling of metals is one area of relevance to industrial processes as the production of metals, such as aluminium and steel, generates significant carbon emissions. Recycled metal, on the other hand, has a considerably smaller carbon footprint than newly smelted metal. Hence recycling of metals is positive from an overall carbon footprint perspective. We have observed interest in this segment from some infrastructure managers.

Energy efficiency

The potential for investment in energy efficiency is expected to be much larger than renewable energy, with the segment estimated to have an addressable market size of US$10-30 trillion in Europe alone, compared to renewable energy at US$5-9 trillion. However, the market is also considerably less developed, with only US$4 billion raised to date, compared to US$55 billion for renewable generation. The market appears to be under-served and may provide advantages for early movers.

Clearly defined and investable sub-sectors of any scale are relatively few at present, which highlights the fragmented nature of the segment and challenge in consolidating small assets. For example, opportunities may lie in the replacement of heating, ventilation, and air-conditioning units (HVAC) and lighting with more energy efficient systems. However, such investment is more likely to be within the domain of real estate investors, at least where this relates to individual commercial properties. In saying this, we have observed infrastructure investors aiming to develop portfolios of building services and street lighting opportunities, which have an energy-efficiency angle. District heating and cooling is another sub-sector that provides an energy-efficiency opportunity and in which infrastructure investors have a history of participation.

District heating and cooling

District heating and cooling assets are localised energy networks which provide heating and cooling to buildings in a specific locality or municipality. These assets typically source heating and cooling from high carbon emitting fossil-fuel sources and, therefore, require considerable investment and operational effort to transition to low carbon sources. This latter need fits rather neatly with the 'decarbonisation of energy production' thematic. Though, a key aspect to district heating and cooling is the efficient manner in which heating and cooling is provided, relative to decentralised approaches. It can also allow access to sources of heating and cooling that require scale, such as waste heat from power generation or deep lake water cooling.

The district heating and cooling sub-sector is already familiar to numerous infrastructure investors, there is a track record of investment and operational performance, and we expect the sub-sector to align very well with plain vanilla or focussed energy transition strategies.

The final word

There exists a broad range of sub-sectors that will be impacted by the energy transition thematic, many positively due to the sheer scale of climate and socio-political benefits they represent. However, there are some sub-sectors that have inherent risks that may not be overcome.

While infrastructure investors are keenly drawing up the investment landscape, much of their investment focus is centred on, or predicated on, renewable energy. This is both understandable and legitimate given the importance of renewable energy generation to the broader energy transition, its well-established business models, its well-established industrial ecosystem, as well as investor familiarity and knowledge.

Over the long-term, Frontier expects investment attention to shift toward energy transition investments not directly related to investing in renewable energy. Several factors will drive this shift, including advances in technological solutions, familiarity with these other energy-transition sub-sectors, acceptance of business models suitable for infrastructure investors, and development of supporting services and manufacturing. However, the key driver is likely to be the hunt for better risk adjusted returns.

In the foreseeable future, Frontier expects investor focus to remain on the familiar sectors, such as renewable energy, which will continue their slow decline in yields. Investors that can tap into the less-established energy-transition sub-sectors of the future have the potential to achieve superior risk adjusted returns while still investing in the energy transition thematic. While this entails additional risk, investors can defray that risk to a degree by choosing to invest alongside an experienced investment manager. Frontier's recent virtual research trip identified a few such capable managers, with the potential to subject their energy transition strategies to detailed due diligence and a ratings assessment.

We believe the opportunity set in energy transition is large, with a wide range of potential investments. The sector is likely to develop quite dramatically as consensus on the need to transition the global economy to energy efficient and low carbon-emissions infrastructure grows louder. Infrastructure investors will be required to play a pivotal role in this development. This 'part 2' paper, in conjunction with Infrastructure - energy transition - part 1, provides a sound investment rationale and pinpoints the sub-sectors for this exciting and rapidly developing investment thematic.

Want to learn more?

Frontier has undertaken extensive research on energy transition and is well placed to advise investors on this theme. We encourage investors to reach out to Frontier's Real Assets Team for a discussion on how we may be able to help.

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