Net zero: getting there with infrastructure

By Shane **HURST**

Infrastructure has a key role in the green transition, allowing investors to access this accelerating trend through high quality and geographically diverse liquid assets. We outline the state of play in four sectors: accelerating investments in electric utilities; and the shifting mentality in the rail sector; transitions in energy infrastructure; and the Scope 3 emissions challenge at airports.

As global policy provides support, social pressures grow and equipment costs fall, the trend towards net zero will accelerate.

While moving toward net zero is difficult, several pathways exist for infrastructure. Each will require substantial investment.

As global policy provides support, social pressures grow and equipment costs fall, this trend will speed up. But first it is worth looking at what is behind the drive to reducing carbon dioxide emissions.

Why is net zero important?

Net zero refers to the balance between the amount of greenhouse gas (GHG) produced and the amount removed from the atmosphere. Net zero is reached when the amount we add is no more than the amount taken away.

Under the Paris Climate Agreement, countries agreed to limit warming well below 2° Celsius, and ideally 1.5° Celsius. Climate impacts that are already unfolding around the world, even with only 1.1° Celsius of warming – from melting ice to devastating heat waves and more intense storms – show the urgency of minimizing temperature increases. The latest science suggests that to meet the Paris temperature goals, the world will need to reach net zero emissions according to different timelines for each degree scenario (Figure 1).

At the very least, major emitters (such as the USA, the EU and China) should reach net zero GHG emissions by 2050, and ideally much earlier, given the outsized role these economies play in determining the trajectory of global emissions.

The energy sector is responsible for around 80% of man-made CO2 emissions (according to the International Renewable Energy Agency, or IRENA) and has a central role in delivering the decarbonization required to reach net zero by 2050.

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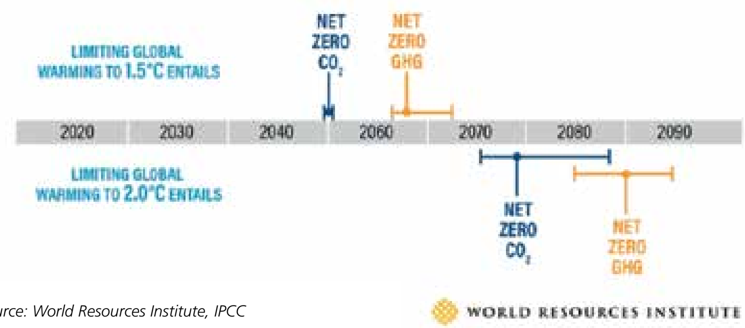
Figure 1: Global timelines to reach net zero emissions



Source: World Resources Institute, IPCC

Electrification allows for the use of carbon-free electricity in place of fossil fuels and significantly improves the overall efficiency of the energy service supply. Electric vehicles, for instance, are more efficient than those powered by internal combustion engines. Hydropower generation, as well, is more efficient than natural gas generation. This is important as reductions in energy intensity need to be accelerated.

Infrastructure has a key role in the move toward decarbonization and net zero. Here we examine how different infrastructure sectors have been moving toward a net zero target and what to expect next.

Case 1: Electric utilities

Electric utilities have broadly three subsectors: generation (gencos), transmission and distribution networks (T&D), and retail supply. Gencos and T&D are the most relevant in the net zero transition.

Over the past decade, power gencos' investments have increasingly skewed toward more renewables capacity, driven by conducive policies like tariff subsidies, tax credits and renewable portfolio standards.

Before 2010, global annual renewables capacity addition was below 100 GW per year. But the pace had doubled to almost 200 GW per year by 2019, led by utilities and energy companies. Meanwhile, utilities have been decommissioning thermal and nuclear plants.

The key to the global energy transition is the increasing use of low-cost renewable power technologies combined with wider adoption of electricity to power transport and heating.

The changing generation and capacity mix of these companies has been the pivotal force behind their GHG emission reductions.

Taking the biggest GHG emitter, China, as an example, major state-owned gencos have grown their wind and solar capacities at a much higher rate than coal-fired plants over the past decade, under the central government's strengthening directive to reduce reliance on coal and GHG emissions.

Moreover, they have been replacing small units (<300 MW) with larger and more efficient ones, promoting combined heat-power cogeneration (CHP) for thermal plants when possible, upgrading coal-fired units to decrease the unit coal consumption, and participating in the national research and trial of carbon capture, utilization and storage (CCUS) and carbon trading.

Consequently, coal-fired generation as a proportion of total capacity in China fell from 67% in 2010 to 49% in 2020. As of 2020, China already accounts for the largest amount of global wind and solar capacity in terms of annual addition and cumulative fleets.

T&D players globally have been investing more heavily in storage, digitalization, flexible demand management and rolling out smart meters to address the growing challenge of stability and flexibility amid increasing use of renewables.

These investments drive reductions in their indirect emissions, while direct (Scope 1) emission reduction is mainly achieved through lowering sulfur hexafluoride (SF_6) leaks. According to IRENA data, solar and wind energy as a variable renewable energy accounted for 10% of total global electricity generation in 2019, up from below 5% in 2015.

Taking China as an example again, power grids have invested heavily to improve reliability and reduce grid curtailment of wind and solar farms, that is, a deliberate reduction in output so as to balance the energy supply. They have also invested in ultra-high-voltage transmission lines to connect renewable-resource-rich western provinces to the high-power-demand eastern provinces. >

Utilities: Next steps

Electricity is set to account for most energy consumption by 2050, that is, roughly 51% of the total, up from 21% in 2018 and 30% expected in 2030, according to IRENA. Renewables, electrification and energy efficiency are the main pillars of this transition. By 2050, to achieve the 1.5° Celsius goal, renewables' share of electricity could become as high as 90% from 25% today.

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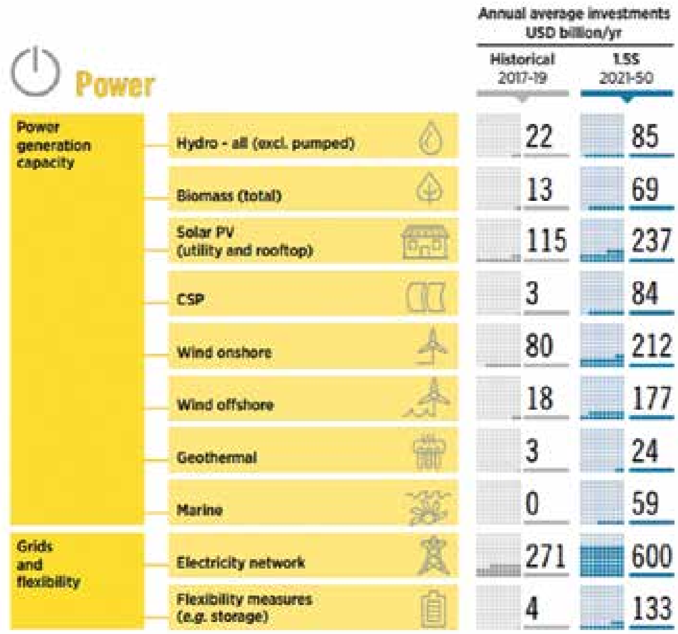
Transmission networks are evolving to be more flexible in coping with the increasing variable renewable energy share. Furthermore, increasing new demand sources, such as electric vehicle and heat-pump adoption means more investment in distribution networks and flexible measures, like storage.

For gencos and T&D companies to meet such electricity demand, IRENA forecasts $130tn of cumulative investment from 2021 to 2050, averaging $4.4tn per year, with 26% on renewables and 22% on electrification and infrastructure. This is a significant acceleration (Figure 2).

As the US power generation sector produces 31% of total US energy-related CO2 emissions, utilities remain topical in net zero conversations as the main operators of carbon-emitting power generation. However, since the Paris Agreement in 2015, environmental policy in the sector has developed quickly.

Most companies have emissions targets in their jurisdictions and have guided the market to a strategic pivot from fossil-fueled generation toward renewables. Consequently, renewables are expected to grow substantially at the expense of coal and gas-fired generation.

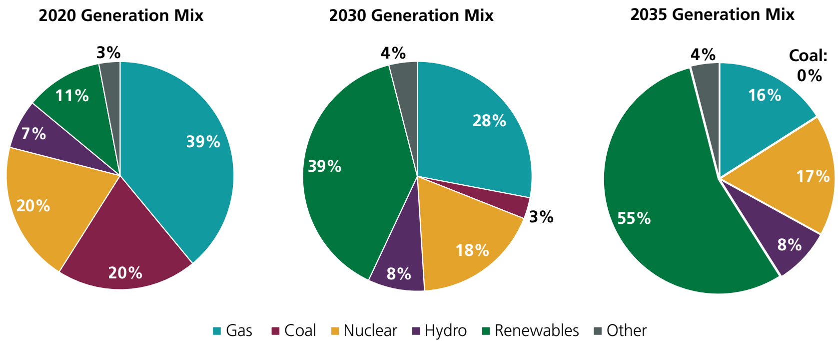
Figure 2: Energy transition requires significant investment



Power		Historical 2017-19 (Annual average investments USD billion/yr)	1.5S 2021-50 (Annual average investments USD billion/yr)
Power generation capacity	Hydro - all (excl. pumped)	22	85
	Biomass (total)	13	69
	Solar PV (utility and rooftop)	115	237
	CSP	3	84
	Wind onshore	80	212
	Wind offshore	18	177
	Geothermal	3	24
	Marine	0	59
Grids and flexibility	Electricity network	271	600
	Flexibility measures (e.g. storage)	4	133

Source: IRENA World Energy Transitions Outlook 2021

Figure 3: Expected changes in US power generation mix



Source: Morgan Stanley Research

Utilities: Challenges and risks

As technologies mature for onshore wind and solar, and entry barriers and upfront unit costs fall, many companies – including equipment manufacturers, oil majors, and financial institutions – are more actively competing with utilities.

Return spreads over the cost of capital may also become less lucrative than in

One caveat is customer affordability and the possibility that higher capex is reflected in the final bill; regulators need to balance social pressure and customers needs with allowing decent returns for operators.

reaching carbon neutrality by 2030, ahead of the EU's latest target of 2050.

Iberdrola has made commitments to a number of international organizations and business coalitions (e.g. the U.N. Global Compact, WBCSD, the Corporate Leaders Groups, the Race to Zero campaign and the Powering Past Coal Alliance) in order to combat climate change.

As of November 2020, it targets renewables capacity to grow from 35 GW in 2020 to 60 GW in 2025 and 95 GW in 2030, implying a 11% 10-year compound annual growth rate (CAGR).

It has launched initiatives to renew networks, improve key substations and infrastructure and adopt more digitalization programs. It expects the total regulated asset base (in the USA, Spain, the UK and Brazil) to grow from €31bn today to €47bn in 2025 and €60bn by 2030, implying a 7% 10-year CAGR.

previous years. Subsidy support may expire after the initial 10-15 years, leaving companies exposed to risks of merchant prices or lower returns.

However, the importance of subsidy support mechanisms may diminish thanks to a rapid fall in the levelized cost of energy. Utilities may still opt for contracting (e.g. through corporate power purchase agreements) to mitigate risks of power price volatility.

For new technologies like offshore wind, project preparation and construction take much longer, and may be more susceptible to construction and permitting delays. Given the long lead time, there may also be higher uncertainty around cost overrun and the ability to pass that on to customers.

On the other hand, network investments are typically built around multi-annual regulatory reviews or rate cases, so the achieved return and cash flow profile is relatively predictable.

One caveat is customer affordability, specifically if the increase in capex gets reflected in the final bill, as gas and electricity regulators (such as Ofgem in the UK) come to terms with the difficult task of balancing social pressure and customer needs against allowing decent returns for system operators. Nonetheless, the risks for T&D are generally small; for instance, transmission costs represent below 5% of end-user electricity bills in Italy.

In the USA, as we saw this winter in Texas, the key challenge for utilities amid a large buildout of renewables is maintaining a stable grid while baseload generation is replaced with intermittent resources.

Iberdrola: Combating climate change and growing the asset base

Iberdrola is a vertically integrated European utility with a global footprint of electricity supply, transmission and distribution networks, as well as generation assets, which has been increasing its focus on renewables in the last 20 years.

It has set a goal of reaching global carbon neutrality by 2050 and reducing emission intensity by 86% to 50g CO_2/kWh globally by 2030 (versus 2000). In Europe – where it already generates 100% of energy with zero-emissions in the UK, Germany and Portugal – Iberdrola targets

Rail is reaping the benefits of service improvements that are enabling a gradual modal conversion from trucks.

Case 2: Rail

The North American rail industry plays an essential role in servicing the freight industry. For long-distance freight, rail represents the cheapest and most fuel-efficient form of transportation and is an important business partner of the industrial sector. Key goods shipped via rail include agriculture and forestry products, construction materials, automotive parts, coal and chemicals.

Railroads are one of the ultimate ESG winners in the transportation industry due to their unique ability to reduce transport-related GHG emissions. Rail is on average 4x more >

fuel efficient than trucks, producing up to 75% less GHG emissions. The sector is viewed favorably from a regulatory standpoint due to these environmental benefits, and clients are becoming more willing to make the shift from trucks to rail in order to reduce their carbon footprint.

Until recently, railroads set conservative improvement benchmarks, with the average rail committing to reducing GHG emissions by 5-8% over time. These targets were easily achieved, and today rail is laser-focused on improving the reliability of service and becoming a viable alternative to trucks for shorter lengths of haul (Figure 4).

Rail is reaping the benefits of service improvements that are enabling a gradual modal conversion of trucks to rail (Figure 5).

Rail: Next steps
Reflecting a strong shift in mentality across the sector, over the last two years railroads have begun committing to the CDP Science-Based Targets (SBT) initiative, which independently assesses corporate emissions reduction targets in line with what climate scientists say is needed to meet the goals of the Paris Agreement. Rail companies that have published targets are aiming for 30% less GHG emissions, on average, by 2030.

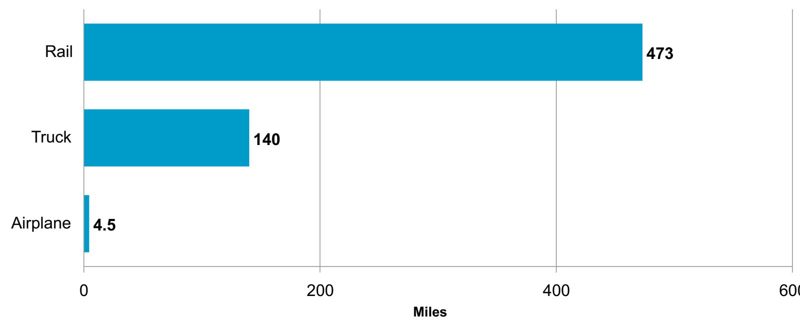
While the sector is ultimately required to burn diesel to fuel locomotives, there has been a dramatic improvement in efficiency.[1] Due to the industry-wide adoption of Precision Scheduled Railroading (PSR), rail is now burning less fuel per ton mile than ever before and has significantly cut GHG emissions. This is not only better for the environment; it also helps the bottom line.

Rail: Challenges and risks
The main challenge to rail achieving ESG targets is likely the regulator, Surface Transportation Board (STB), which has fielded complaints by shippers that PSR causes unwanted disruption even while it boosts fuel efficiency. The STB appears increasingly to be supportive of PSR, however.

Further improvement is also predicated on rail companies continuing to improve their technology in the form of trip optimizers and natural-gas-operated locomotives (versus diesel). Improvements in technology are assumed to occur over time, thus GHG reduction targets will be at risk if rails cannot continue to efficiently develop and deploy these technologies.

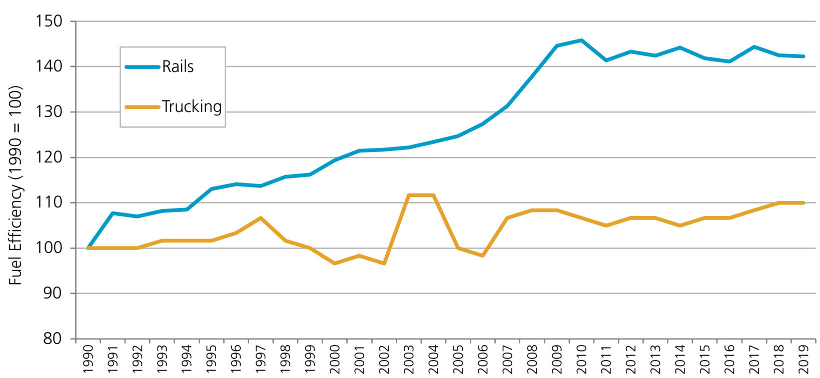
CSX was the first US railroad to adopt PSR, and consequently it has become the first US Class 1 railroad to operate at a fuel efficiency rate of less than one gallon of fuel per thousand gross ton miles.

Figure 4: Rail covers more distance per unit of fuel



Source: Wolfe Research

Figure 5: Fuel efficiency – rail vs. truck



Source: Association of American Railroads, US Energy Information Administration.

CSX commits to Science-Based Targets, saves on fuel and lowers emissions
In 2019, CSX was the first US railroad to commit to the SBT initiative, formally setting a goal of reducing GHG emissions intensity by 37.3% by 2030 (from 2014 levels).

CSX was also the first US railroad to adopt PSR, and consequently it has become the first US Class 1 railroad to operate at a fuel efficiency rate of less than one gallon of fuel per thousand gross ton miles. In the three years following CSX's implementation of PSR, it has recognized 7.1% better fuel efficiency and 6.5% fewer GHG emissions.

1. *Electrification of the freight rail network is a long-term possibility that would yield significant fuel efficiency savings. At this point, there is no desire from either the rail sector or regulator to pursue this option, given the unrealistic costs associated with electrifying their network and locomotives. However, as technology evolves, electrification could become a possibility.*

Figure 6: Sources of emissions at airports

Source: Airport Carbon Accreditation

Gas, which had been a solution in cutting GHG emissions in the past, has now itself become a target for reduction.

Case 3: Energy infrastructure

Energy infrastructure consists primarily of large oil and gas pipelines that transport the commodities through oil and gas fields to various demand markets. Gas utilities are also part of the value chain that ultimately takes the gas from the large pipelines through its networks to the end customer.

The gas pipeline sector has been a large contributor to the reduction of GHG emissions in the electricity sector, largely because gas contributes approximately half the CO2 emissions of coal, and has been replacing it as a fuel to generate electricity.

This trend has slowed considerably recently, with renewable energy approaching price parity with fossil fuels, helped by increasing commitments and subsidies from governments moving toward cleaner energy. This means gas has become a target to reduce GHG emissions in recent years, rather than a solution in prior decades. In addition to this, the evolution of electrifying transport through electric vehicles now threatens the future of oil and the existence of oil pipelines.

Energy infrastructure: Challenges and risks

Amid growing net zero commitments, the oil and gas sectors face greater challenges than other infrastructure sectors as their primary business lines are part of the value chain of GHG emitters. Yet pipeline companies are still attempting to contribute to the transition to net zero, and many are embracing this as a growth opportunity.

The main challenges for energy infrastructure companies are balancing the disruption to the traditional oil and gas businesses and the new technologies and investments in clean energy.

With most cash flows sourced from traditional means over the next decade, the execution risk will be their inability to commercialize new businesses or fail to compete effectively with new players. While we are optimistic about achieving net zero, we remain skeptical that all pipeline companies will benefit from the transition, outside of retro-fitting the pipeline network to handle renewable natural gas and hydrogen.

North American pipelines: Seizing green opportunities

Many North American pipeline companies are embracing the clean energy opportunity:

- **Cheniere,** the largest exporter of US liquid natural gas to emerging markets, is meeting energy demand while supporting the transition from coal to gas. This underpins the goal of lowering GHG emissions, as many emerging countries are not yet able to transition fully to green energy.
- **Enbridge,** a North American pipeline owner, is building an offshore wind capability to transition the business away from oil and gas infrastructure into renewable energy.
- **Sempra Energy,** a California-based utility and energy infrastructure company, is piloting hydrogen projects through its gas utility to align with the state's goals of decarbonizing.
- **Williams Companies,** an owner of primarily gas pipelines, has laid out plans to reach net zero by leveraging its existing networks, including hydrogen-blending and renewable gas interconnections.

Case 4: Airports

Air travel has grown strongly since the 1960s as real ticket prices have fallen and wealth has increased. Consequently, traffic at airports has grown strongly during this period. Today air travel accounts for approximately 2.5% of global CO2 emissions and 12% of transport emissions, with emissions per kilometer traveled relatively high, resulting in trends such as "flight shaming".

Typically, emissions from airports are low relative to travel-related emissions from airplanes and ground transport to and from the airport (Figure 6). The main source of airports' direct GHG emissions is electricity consumption. Historically, efforts to reduce airport GHG emission have focused on energy efficiency, for example installing LED lighting and improving the efficiency of heating, ventilation, and air conditioning (HVAC) systems as well as building thermal/lighting characteristics.

Airports have also sought better real-time information sharing between parties such as air traffic control, airlines, airport operations and ground-handling to reduce indirect, or Scope 3, emissions >

Sydney Airport issued the first-ever sustainability-linked bond in the US private placement market in 2020.

through more efficient flight and ground transport operations.

Airports: Next steps

To lower direct emissions, airports are seeking to:

- Procure renewable energy, either through purchase agreements or through installing solar on the airport site. Electricity consumption can often represent 70% of direct airport emissions.
- Decarbonize ground fleets with electric or hydrogen vehicles.
- Improve the efficiency of building design and HVAC systems. Heating and cooling can be a substantial source of energy use in warmer and colder climates.

Indirect emissions, such as airline take-off (within one kilometer of the airport), landing and ground transport, can be around 10x an airport's direct emissions. To cut emissions airports are seeking to:

- Adopt and improve Airport Collaborative Decision Making (A-CDM). For example, by sharing real-time updates on operations, airports can reduce unnecessary airline engine operation.
- Install ground-based electricity and cooling to limit airline engine operation.
- Support decarbonization of ground-handling fleets.
- Support the availability of biofuels for use by airlines.

Airports: Challenges and risks

Airports are expected to achieve their Scope 1 and 2 emissions targets, as sources of emissions are relatively well understood. Given airports typically have significant surface area, they may either purchase or invest in renewable energy. Scope 3 reductions are significantly more challenging given this requires aircraft technology development to achieve lower emissions.

Airports also have a significant role in reducing emissions with ground transport associated with air travel. In many cases this will be dictated by the decarbonization of road transport, however in many cases airports can influence and encourage the shift toward lower emission ground transport within their precincts.

Sydney Airport: Reducing Scope 1 and 2 emissions

Sydney Airport has a highly integrated approach to sustainability. It issued the first-ever sustainability-linked bond into the US private placement market in 2020.

Airports have a complex array of stakeholders; in Sydney Airport's case, the federal government (lease, operating license, biosecurity, border control), state government (ground transport, emergency services), local government (local community and business, waste management, noise, roads), and airlines (key customers), to name a few.

Sydney Airport's key targets for direct emissions include carbon neutrality by 2025 and reducing carbon emissions per passenger by 50% by 2025 (versus a 2010 baseline). In order to achieve this, it is seeking, among other things, to procure renewable energy, electrify its landside bus fleet and achieve a minimum 4-star Green Star Design and As-Built rating for new developments.

The airport is also supporting its stakeholders in emission reductions by:

- Improving airspace and airfield efficiency through A-CDM and the installation of ground power and pre-conditioned air at aircraft parking bays to reduce aircraft engine operation.
- Facilitating the increase of airside vehicle usage to 50% electric.
- Improving landside efficiency and emissions.
- Acquiring fuel infrastructure to enable improved direct fueling connections and biofuel supply.
- Exploring further efficiency improvements through initiatives such as co-location of certain domestic and international activities and runway re-balancing.

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Hurst joined RARE Infrastructure, a predecessor organization of ClearBridge Investments in 2010. Prior, he worked at Hastings Funds Management, Tribeca Investment Partners and AMP Capital.