WHITEHELM
CAPITAL

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THOUGHT LEADERSHIP:

INFRASTRUCTURE INVESTING IN A DISRUPTED WORLD

Part 1: INTRO, DIGITISATION & CLIMATE CHANGE

INFRASTRUCTURE INVESTING IN A DISRUPTED WORLD

TECHONOLOGY & DIGITISATION

Think of disruption and immediately products such as the iPhone, technology giants Google and Amazon, or firms such as Uber and Airbnb spring to mind. Each of these companies has completely changed their relevant markets or created entirely new markets that did not previously exist, within incredibly short periods of time. This level of disruption is not limited to technology but rather can be anything that potentially upsets the established order and challenges existing assumptions about the future, be that climate change, changing demographics, terrorism or the next financial crisis.

As long-term investments, infrastructure assets will naturally be affected by disruption over their lifetimes. The three most critical characteristics that underpin any infrastructure investment – the provision of an essential service to society, high barriers to entry and an asset-backed nature – could be transformed by technological progress and social, environmental and demographic changes, exposing investors to both risks and opportunities.

The evidence of such changes is already here: sharing-economy models and artificial intelligence have re-shaped the way people move around the urban environment, as well as the utilisation of existing assets.

On a less positive note, policy and market changes have shed billions of euros in capitalisation value in European utility companies alone. Not all of this is new, but the acceleration of innovation and the velocity of the resulting disruption has no historical precedent. While ten years ago many believed that driverless vehicles were nothing but a dream, today several automotive manufacturers are pushing to have fully automated vehicles launched within a few years.

Whitehelm aims to carefully identify and manage the risks and opportunities created by disruption, by putting in place mitigation measures at the asset level or by reducing exposure to assets at highest risk of disruption, while being at the leading edge of investing in true infrastructure assets that can benefit from disruption.

In this first of a series of articles, Whitehelm explores the key disruptive elements for infrastructure investors with a particular focus on technology, digitisation and climate change. The following articles will discuss three infrastructure sectors that are likely to be heavily impacted: power systems, transportation and telecommunication and broadcasting infrastructure

Technology and Digitisation

We are living in a world where technology is changing at faster speeds than ever before. Computer processing speeds are doubling every year and a half, resulting in technological change occurring at exponential rates. It is incredible how fast technologies have changed in the past 10 years, when wireless internet, smart phones, Facebook and Twitter were just being invented, yet these have become integral to many people's daily lives, disrupting many sectors, from paper maps to dial-up internet to phone directories.

While these examples may appear on the surface to have little impact on infrastructure investors, the consequences can be far broader reaching than initially assumed. For example, the invention and rapid uptake of the smart phone has been a leading factor in the growth of data generation and consumption, having an immediate impact on demand for telecommunications towers.

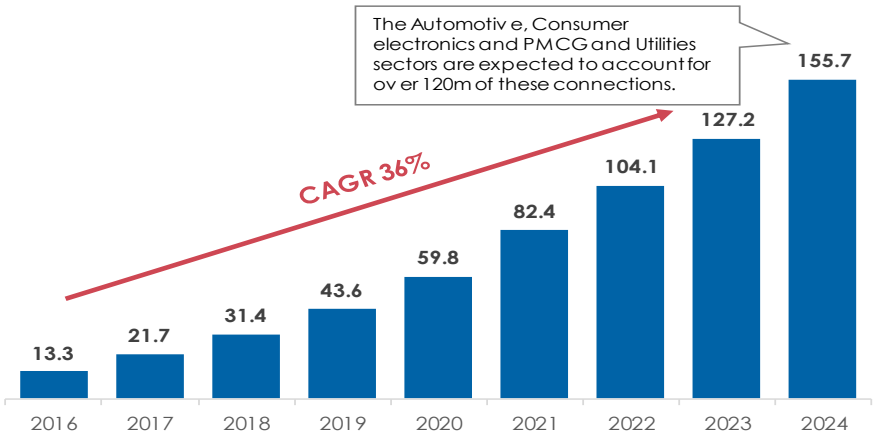
The following sections examine a number of technology trends that may impact the infrastructure sector in coming years and include a case study on investing in Smart Cities, which is made possible by technological advancements.

Internet of Things and Big Data

The Internet of Things (IoT) is any system of interrelated computers, mechanical and digital devices (including sensors, probes and switches) which can transmit data over a network without requiring human intervention. Significant growth in the IoT is expected over the coming years, with 6-9 billion of IoT devices (excluding smartphones, tablets and computers) in use worldwide today and the latest forecasts for 2020 ranging from 21 billion (Gartner) to 31 billion (IHS Markit).

Similarly, IoT connections in the UK is expected to have a growth rate of 36% from 2016 to 2024, as illustrated below.

Chart 1: Forecast IOT Connections in the UK (millions)



Source: Cambridge Consultants

Currently most of the information collected by the IoT is not directly used or analysed. McKinsey claims that only 1% of data from an oil rig with 30,000 sensors is examined, and mostly for control and surveillance purposes. However, advances in technology will result in more analysis in the higher value-generating fields of optimisation and prediction.

This massive increase of connected devices and subsequently the data collected will not only impact major service providers such as fibre and telecom networks, but also redefine product offerings and branding strategies. In a recent study, McKinsey estimates that the IoT could generate up to US$11.1 trillion per year in economic value by 2025, with most of this created in areas such as factories and retail environments. Infrastructure-related areas such as cities (i.e. in the field of public health monitoring with air and water quality monitoring) or transportation (i.e. traffic-control systems, smart parking meters and autonomous vehicles) are also expected to benefit from these savings.

Smart meters are already being installed globally, enabling electricity, gas and water companies to analyse in real-time the usage by their customers but also to provide automatic billing and support for consumers in optimising their consumption.

Among Whitehelm's portfolio companies, Arqiva (a telecommunication tower business in the UK) is positioning itself to become the key connectivity infrastructure provider in the UK, covering the entire value chain from data gathering (through smart objects such as smart meters), to transmission of that data through Arqiva's networks, to IoT service platform providers. Arqiva has a 15-year exclusive program in the UK's Northern Region for the energy smart meter roll-out to more than 10 million households.

The strong growth in the IoT segment will also trigger significant investment into network backbones: as an example, the European Union forecasts more than $800 billion investment is required into digital infrastructure in Europe, simply to catch up with the United States and China.

Blockchain Technologies

Blockchain refers to a virtual, cryptographically secure chain of data blocks which store records of all transactions, so that a list of all user account balances can be generated. As this list is stored on many computers and can be accessed by all users, the system is considered very secure. Blockchain has enjoyed increasing popularity due to the rise of Bitcoin and other cryptocurrencies, which all rely on blockchain as their primary accounting methodology.

Blockchains are based on distributed ledger technology, which is somewhat like a decentralised database that is continuously being updated with a record of who owns what.

These technologies could have a particularly large impact on the way in which financial transactions for infrastructure assets occur, i.e., enabling the implementation of new energy (off-grid clusters) and transport (toll collection) business models.

Artificial Intelligence

Artificial Intelligence (AI) generally refers to the ability of machines to exhibit human-like intelligence, such as solving a problem without the use of hand-coded software containing detailed instructions and the ability to reason, discover meaning, generalise and learn from experience.

Most current applications of AI are classified as 'narrow' and relate to only a specific workstream or problem. These are only focused on a singular task without significant cognitive learning and comprise, for example, voice recognition (such as Apple's Siri or Amazon's Alexa) or internet bots (such as telephone bots providing customer service). There are however examples of more complex applications, including Google DeepMind's ability to learn and beat humans at an ancient and complex game of strategy and intuition, and the appointment of an AI algorithm to the board of directors of a Hong-Kong based venture capital firm, Deep Knowledge Ventures.

As discussed further below, AI is expected to be utilised in the infrastructure sector through applications such as the optimisation of electricity grid balancing. Over the longer term, AI is expected to create cost and efficiency savings in operations and maintenance across the sector.

Sharing Economy Models

The sharing economy is based on a business model where consumers engage in peer-to-peer exchange of products and services, without physical ownership. The most prominent disruptors include companies such as Airbnb, Uber, Netflix and Spotify, which all have dislocated their existing markets by offering platforms based on already available assets, data and information.

Genomic Medicine

Genomic medicine is an emerging medical discipline that involves using genomic information about an individual as part of their clinical care (i.e. for diagnostic or therapeutic decision-making) and the health outcomes and policy implications of that clinical use. The significant breakthroughs in the areas of genomic medicine and health care have reduced the costs and speed of genomic testing, allowing patients to be treated earlier and through more targeted therapies.

Further breakthroughs in this field are likely to contribute to extending life expectancy, thus further increasing the world's population and changing the infrastructure requirements (amongst other things) for an ageing society, with enhanced capabilities for diagnosis and treatment of long-term conditions. Additionally, hospitals may begin to see a different operating profile, with more planned and preventative medicine or surgery, and fewer emergency cases, which could influence the type and location of hospitals required.

Smart Cities Case Study

Smart Cities utilise city-wide applications of smart or connected solutions to the benefit of the city and its residents and visitors, benefitting from technological advancements. For example, Smart Cities may include a city-wide Wi-Fi network that can be utilised both for smart applications on the city's infrastructure, but also by residents when out and about. Infrastructure applications may include smart parking (sensors guide you to a free parking space, and also process a charge as you park there), smart garbage collection (sensors detect when garbage needs collecting), smart traffic management (emergency vehicles approaching can turn traffic lights red to allow safe, quick passage, or traffic build up automatically redirects traffic flow) and so on.

Whitehelm has identified Smart Cities as a key new infrastructure sub-sector and, in particular, is focused on financing investments that create immediate economic value, such as smart street lighting. The energy savings incurred in the switch to LED street lighting are reinvested in the roll out of a Wi-Fi network that is the key infrastructure backbone of a smart city, under a long-term concession model. Whitehelm's financing solution provides local governments with the upfront capital to carry out such projects and investors with a long-term annuity stream. Whitehelm is one of the founding partners of the City Infrastructure Financing Acceleration Program promoted by the global technology giant Cisco.

INFRASTRUCTURE INVESTING IN A DISRUPTED WORLD

CLIMATE CHANGE

Climate Change

Climate change is a global challenge, the likes of which the modern world has not previously faced, causing both increased average temperatures and more extreme weather events, which will directly impact the entire global population. Most infrastructure sectors are naturally going to be affected by climate change, whether by efforts to reduce carbon emissions and thus the extent of climate change, or by climatic events themselves, such as rising sea levels or extreme weather events.

Significant risks may be found in assets exposed to weather-related disruption, such as ports or tank storage and container terminals exposed to rising sea levels, and increased high wind events, or water distribution assets that are more likely to face water shortages or salt water contamination.

Infrastructure owners regularly ensure that new investments take these long-term trends into account and that portfolio companies seek to mitigate the impact of such events well in advance, particularly where new capex is being incurred.

It is important to note that there are also opportunities for infrastructure investors, particularly in the renewable energy and energy efficiency sectors, driven by government targets to reduce global carbon emissions.

Rising Sea Levels

One of the major consequences of global warming is rising sea levels, with recent projections ranging between 0.5 and 2 meters by 2100. Once sea levels have increased due to melting polar ice, the phenomenon is irreversible even if global warming eventually slows down.

If no mitigation plans are implemented, a number of regions will suffer from the destruction of critical infrastructure, disruption of economic activities and salt water contamination of the water supply. Some coastal areas or islands may even completely disappear.

In the infrastructure sector, the risks associated with rising sea levels are material. For instance, rising sea levels may drastically reduce the lifetime of an asset and/or increase maintenance costs over the long-term. The investment case for an acquisition or an expansion/upgrade of an existing asset today needs to include an assessment of those risks and carefully budgeted mitigation plans to ensure that the target useful life can be met.

As an investor in Deepwater Container Terminal Gdańsk, Poland, which was commissioned in 2007 and opened a second terminal at the end of 2016, Whitehelm has been assessing the impact of rising sea levels rigorously. The terminal's quays have been laid three meters above sea level, which provides a sufficient buffer against anticipated rising sea levels.

Many countries are working on adapting their infrastructure to make it resilient to rising sea levels, by elevating assets, upgrading sewage systems to increase drainage capacity, and building more and bigger seawalls and breakwaters.

Some cities have already started implementing mitigation plans. For example, Miami Beach which experiences periodic flooding during high tides has embarked on a US$100 million anti-flooding project to raise roads by 75 centimetres, install stormwater pumps and upgrade sewer connections over two years.

Similarly, with only 50% of its land exceeding one meter above sea level, the Netherlands is heavily exposed to rising sea levels, but has been managing water levels using dikes and sea barriers for many years. Nevertheless, the Dutch government has started to look at ways to live with water rather than withhold it.

The construction of Ijburg, a partially floating and reclaimed neighbourhood in Amsterdam, started in 1997 and the first residents moved in in 2002. In 2010, a floating conference centre surrounded by floating trees was built in Rotterdam. In 2016, the Westermeerwind 144MW offshore wind farm, which unlike typical offshore projects in that it is situated in a lake rather than in the open ocean, became operational.

Wastewater facilities in coastal areas are particularly exposed as they are typically constructed in low-lying areas to utilise gravity rather than having to pump the effluent into the receiving facility. In Boston, the Deer Island water treatment facility was elevated about 60 centimetres as part of an upgrade that was completed in 1998 to accommodate potential sea level changes over the planned life of the facility to 2050, highlighting the long-term nature of such capex decisions.

Additionally, subsurface structures, such as water and sewer pipes, are expected to corrode at faster rates due to the intrusion of seawater, which will increase maintenance requirements or require a material investment to upgrade to more resistant materials.

Should saltwater intrusion into groundwater aquifers occur, investment in new or expanded desalination plants may be required. Pumping fresh purified water into aquifers may help in overcoming sea water pressure while also controlling land subsidence (land sinking due to depleting aquifers), however this would add further pressure on fresh water availability.

Sea level changes are also expected to alter tides across the world. A recent study conducted by the National Oceanography Centre, the University of Southampton and Deltare indicates that, depending on the characteristics of the bay in question, the tide may increase or decrease. These tidal changes will have implications for existing and future tidal renewable energy sites. For instance, the proposed Swansea Bay tidal lagoon in Wales may generate less energy than forecast if sea levels rise by two metres. Construction is due to start in 2018 for this innovative project of 'U' shaped breakwater with a bank of hydro turbines.

Seaports, tank storage and container terminals located in ports are also at risk, given basic port infrastructure usually lasts for half a century or longer. As such, infrastructure built today needs to address the rapidly changing environmental conditions to ensure that the useful lifetime is not reduced.

Extreme Climatic Events

In addition to rising sea levels, global warming is expected to result in more frequent and more extreme weather events, such as storms, hurricanes, flooding and drought. Infrastructure assets need to be resilient to such events, both structurally resistant to damage, but also able to mitigate or insure the operating risks during those extreme weather events. These capabilities need to be regularly assessed and infrastructure upgraded whenever necessary, as well as ensuring that appropriate insurance is in place to cover both physical damage and business interruption caused by such events.

Whitehelm has a deep track record in managing critical infrastructure that is exposed to climatic events. One such example in the mid-stream energy sector is portfolio company LBC Tank Terminals, which operates a one million cubic metre terminal in Houston. The company has a well-developed 'Hurricane Plan' in place. Thanks to this plan, in 2017, the terminal only suffered minor damage from Hurricane Harvey. Employees assigned to manage the storm water successfully kept the terminal free from serious flooding within the dike walls and operating areas. Several portable pumps and electric pumps were utilised. No loss or degradation of product, and no environmental spills, were reported, reflecting the importance of well understood and practised disaster plans.

Water Scarcity

Increasing water consumption, driven by needs of the agriculture and industrial sectors and a growing global population, is putting pressure on groundwater aquifers, from which many cities draw their water supply. They are being depleted faster than they are being replenished through the water cycle. As global warming adds more frequent and extended events of drought, a number of countries face scarcity of water whether now or in the longer term.

In the UK for example, scarcity of water is expected within the next 20 years and the water sector has started to prepare for this challenge. Ofwat, the UK Water regulator, has decided to include water resources in a separate price review from 2020 onwards, ensuring the setting of better targeted regulatory incentives.

Water resources are an ongoing focus for Whitehelm's portfolio company Southern Water. The company is working on medium and long-term plans to ensure security of water supply for its customers into the future. The economic viability of conventional desalination technologies is unclear at this stage. New technologies that are currently in development, such as graphene filtration, could provide additional tools in the long term. In the medium term, the company is focusing on developing water recycling, particularly in agriculture, which is the biggest water consumer and currently uses (but does not require) potable water.

Given the potential scale of the lack of water in London, Thames Water is even considering water recycling for potable uses. Instead of discharging treated wastewater, the treated water would be discharged upstream in the Thames, where it would mix with river water and go into drinking-water treatment works.

Investors in the water industry are expected to work to reduce leakage, water consumption through education and smart meter installation, and invest in mitigating the decline in water resources, through building reservoirs, wastewater recycling, desalination or new technologies. The provision of this essential service and hence long-term investor returns depend on that.

Ofwat has also asked UK water companies to stretch their performance targets on leakage, given that an astonishing circa 20% of water is currently lost to leakage. The 2020-2025 business plans of UK water companies will be required to target at least a 15% reduction in leakage during the five-year regulatory period. Ofwat wants to encourage innovation in the sector and technology is seen as key. Implementing smart solutions with sophisticated location tools, for example through acoustic or vibration detection sensors, will make it easier and faster to identify leaks and undertake repairs.

Wind Resources

The development of renewable energy will certainly have a key role in climate change mitigation, however global warming could also have an impact on renewable resources themselves. For example, changes in weather patterns are expected to have a reshuffling impact on wind resources. Some experts have highlighted that global warming will in general terms weaken wind power in the northern mid-latitude regions and increase it in certain southern coastal regions. In the northern mid-latitudes, wind primarily results from the temperature difference between the Arctic and the tropics. As the Arctic warms, the temperature difference reduces and weakens the wind.

Japan, where the development of wind power has recently accelerated following the Fukushima nuclear disaster in 2011, is expected to suffer one of the biggest falls in wind energy. A study by Karnauskas et al published in Nature Geoscience predicts that wind energy in Japan will fall by 58kW, or about 10%, by 2100, as shown in the chart below.

This finding might not change the government's plans to have over 35GW wind power capacity by 2030, more than tenfold the 2016 level, but it may change the longer-term roadmap which forecasts more than 70GW capacity by 2050. The central US is the second region that is expected to be most affected, with a 49kW drop (17%) forecast. In the UK, wind energy is forecast to fall by 36kW, or 5%.

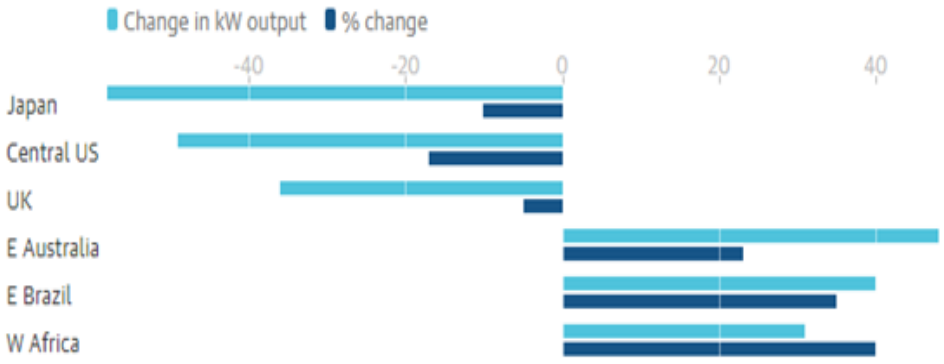
On the other hand, certain coastal areas of the southern hemisphere will have stronger wind levels as the world's land is warming faster than the ocean and that difference is expected to increase the energy source in that region. For example, wind power in eastern Australia is expected to rise by 48kW, or 23%, by 2100.

The study forecasts long-term changes and therefore may not have a significant impact on wind resources for existing wind farms, which typically have a lifetime of about 25-30 years.

However, these longer-term forecasts may impact the choice of geographical location of future wind farms, and may result in slowing down the development of wind energy in the northern hemisphere in favour of alternative renewable technologies.

Wind farm infrastructure will also need to be more resilient to extremely strong winds associated with extreme weather events, i.e. not only not break in such conditions, but be able to continue to operate at higher wind levels. Most wind turbines currently shut down when the wind level reaches 25 metres per second. As the upscaling trend (increased blade size and taller turbines) is expected to go on, the increasing load may put more pressure on the cut-out wind speed.

Chart 2: Projected Change in Wind Power by 2100



Source: The Guardian, Karnauskas et al., Nature Geoscience

Climate Change Case Study – Deepwater Container Terminal Gdańsk

As an infrastructure investor, Whitehelm recognises both risks and opportunities related to Environmental, Social and Governance (ESG) issues.

One of such items is climate change, where Whitehelm addresses both the asset's contribution (or reduction) to emissions, as well as the impact that climate change has on the performance of its assets. The case study below highlights this approach for the portfolio company Deepwater Container Terminal Gdańsk, Poland, and how it actively focuses on assessing and mitigating climate change risks.

Risk Area	Assessment	Performance and Mitigation
Vulnerability to Climate Change	› Degree of vulnerability to climate change? › What mitigation strategies are/should be in place? › Are there opportunities to be considered?	› Limited vulnerability to rising sea levels, quays 3m above current sea level and low tidal range › New equipment designed to operate at higher windspeeds (80-90 km/h vs 72 km/h industry standard)
Contribution to Climate Change	› Does the company generate hazardous/toxic emissions? › Does the company generate CO_2 emissions? How are they measured? › Are measures taken to reduce or offset greenhouse emissions?	› Does not generate hazardous/toxic emissions › Emits CO_2, measured quarterly › Many measures implemented to reduce energy consumption (ISO 50001) and reduce emissions
Corporate Governance	› Is there a risk management system including ESG issues? › If yes, who is in charge of it? › How are the risks identified and benchmarked against industry standards?	› A comprehensive risk management system includes ESG issues › A HSE and Sustainable Development Manager appointed › Room to improve by further benchmarking against industry standards
Risk Management	› What procedures are in place to assess climate change risks? › What systems are in place to ensure assessed risk measures are enforced and measured? › How often are climate change risk systems and reports reviewed?	› Risks are actively assessed against the ISO 14001 standard › An Environmental Management System (EMS) is in place › EMS standards are reviewed annually. Compliance with EMS is audited annually

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OTHER EXTERNAL RISKS

There are many other external threats that could impact infrastructure assets, from the physical in the form of natural disasters, to terrorist attacks.

Whitehelm recently expanded its footprint in the energy mid-stream sector with the acquisition of Vopak Terminal Eemshaven B.V. (VTEH), a strategic storage asset in the Northern part of the Netherlands. Due diligence discovered that the local area has become susceptible to earth tremors, caused by the extraction of gas from local gas fields.

Whitehelm spent significant time understanding the risks, the underlying causes of the earth tremors and the possible impact on VTEH and the terminal infrastructure. Ultimately, this process allowed us to gain comfort in the robustness of the terminal design and its ability to withstand significant tremors.

Cyber security is a growing issue given the ever-increasing level of connectedness. Companies are likely to be connected to the internet, often remotely accessible and even remotely operated. For example, many renewable generation assets such as wind farms or solar parks are connected to a remote operations centre to allow for economies of scale in operations and management of these dispersed assets.

Management of cyber-risk is increasingly important, as cyber-attacks are a serious threat to critical infrastructure. As such, infrastructure businesses must be as alert to digital threats as they are to physical ones, with a particular focus on how quickly these digital threats can be adapted and therefore how regularly cyber security needs to be updated. Just as with physical security, the importance of business continuity planning cannot be overstated.

There are of course other external events that could have a large impact on infrastructure assets, one example being another global financial crisis. Many financial observers believe that the risk of another such crisis is currently elevated, and that governments lack the tools with which to tackle such an event, given most countries already have interest rates close to zero and have carried out extensive quantitative easing.

Should another financial crisis occur, infrastructure assets would face similar problems to those that they faced in the previous crisis. Those with significant exposure to GDP would likely suffer the greatest impact to revenues, and those with high fixed costs will find that difficult to sustain. Similarly, those who are over-geared will suffer, as revenues drop, or debt becomes more difficult to obtain and more expensive, thus making refinancing difficult.

These lessons from the previous crisis remain highly relevant today. Recent market transactions, particularly for large assets, have seen very high levels of competition, resulting in some all-time high valuations being paid. Should another crisis hit, those investors may face some unwelcome write-downs in their valuations, highlighting the importance of ensuring investment discipline across market cycles.

Value investing in infrastructure remains as important today as it ever has.