MARSH & McLENNAN INSIGHTS

Risk in Focus

INFRASTRUCTURE **FAILURE AND SHORTFALL**

A guide for corporates to overcome Asia-Pacific's challenge

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INTRODUCTION

Aging and outdated infrastructure amplifies our exposure to major global risks such as natural catastrophe and cyberattacks. According to the results of this year's *Global Risks Perception Survey*, which underpins the *Global Risks Report 2019*, the failure of critical infrastructure and infrastructure investment feature prominently among longer-term concerns. Yet, level of investments often does not meet what is needed to have resilient critical infrastructure that will meet our current and future needs.

Given current investment trends, the *Global Infrastructure Outlook* estimates that there will be a shortfall of $18 trillion dollars in infrastructure investments by 2040.[1] Rising geopolitical and global economic uncertainties are also placing pressures on funding that are crucial for new infrastructure development.

The Asia-Pacific region dominates over half of the global infrastructure investment needs. The region has been developing incredibly fast economically, but the continuation of such growth will require matching developments in the region's infrastructure. However, underinvestment in critical infrastructure development in Asia-Pacific is a problem. Whilst some economies such as the Philippines and Indonesia are pushing ahead with massive infrastructure programs, many people in the region continue to suffer from the impacts of critical infrastructure failure and/or shortfall such as prolonged traffic congestions and power outages. Population growth, climate change and extreme weather events, and growing cyber dependency in the region will also exacerbate the shortage of resilient infrastructure while exposing the vulnerability of existing infrastructure.

This risk-in-focus report is thus dedicated to discussing the risks of critical infrastructure failure or shortfall in Asia-Pacific. This report is an extension of our 2018 edition of the *Evolving Risk Concerns in Asia-Pacific* publication which identifies critical infrastructure failure or shortfall as a significant long-term threat to doing business in the region.[2] This report begins with an overview of the critical infrastructure issues in the region and is followed by an analysis of the ongoing trends that will influence them, and how businesses can respond to these threats effectively. Through the report, we hope to provide vivid illustrations of how independent risks continue to be enveloped in mega trends that significantly impact how they will evolve. While the discussion is primarily from a business perspective, it also carries relevance to governments and policymakers.

CRITICAL INFRASTRUCTURE **FAILURE/SHORTFALL**

Infrastructure development in Asia-Pacific has historically faced a paucity of funds. There is a lack of private participation and governments finance more than 90 percent of infrastructure investment. However, most regional governments do not have the capacity and resources to meet their national infrastructure needs. The effects of this shortfall have been widely felt as large pockets of the region suffer from poor connectivity, prolonged traffic congestions, power outages or overload, and frequent breakdowns .

Table 1 shows various indicators for the state of transportation, energy and information and communication technology (ICT) infrastructure for selected countries in Asia-Pacific taken from the WEF's Global Competitiveness Index 2017–2018, the World Energy Council's (WEC) Energy Trilemma Index 2018, and World Development Indicators database.[3–5] Advanced economies in the region are included as benchmarks of infrastructure development.

An examination of these indicators suggests that the quality of infrastructure in transportation, energy and ICT in emerging markets in Asia-Pacific is at a relatively low level compared to their advanced counterparts in the region. Current development in infrastructure is already unable to keep up with rapid economic growth, a burgeoning population and rapid rates of urbanization.[6] However, as will be discussed below, this does not mean advanced economies do not have their share of problems.

TRANSPORTATION INFRASTRUCTURE

Business perception of the quality of transportation infrastructure in Asia-Pacific varies significantly across emerging markets and specific subsectors. While the quality of infrastructure in Malaysia is perceived to be nearly at par with that in developed markets, other countries such as Vietnam and the Philippines trail significantly behind. A recent report from the World Bank looked into data from the Asian Highway Network (AHN),[7] a regional system of priority highways that connects Asian countries with each other and with Europe, and found that a significant portion of the AHN in major emerging markets such as Indonesia and the Philippines needs restoration.

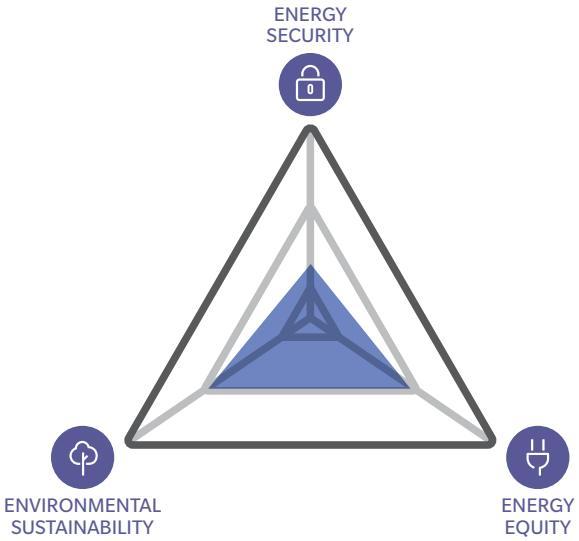
The poor quality of transportation infrastructure across the region has resulted in significant economic costs and continues to do so. The Asian Development Bank (ADB) estimates that lost time and increased transportation costs due to road congestion together cost Asian economies 2–5 percent of GDP every year.[8] In the Philippines, it is estimated that congestion will cost Metro Manila an astonishing $155 million a day by 2030.[9] Research has also pointed to the importance of transportation to trade flows and economic growth, suggesting that poor transportation infrastructure, particularly ports, can result in significant opportunity cost resulting from unrealized economic growth.[10] In fact, there are serious concerns over whether markets such as the Philippines and Vietnam can sustain their outstanding economic growth rates if weaknesses in transport infrastructure persist.

> Failure to adequately invest in, upgrade and/or secure infrastructure networks (for example, energy, transportation and communications), leading to pressure or a breakdown with system-wide implications
>
> **World Economic Forum's definition of "A failure/shortfall in critical infrastructure"**

ENERGY INFRASTRUCTURE

According to the Energy Trilemma Index, which tracks economies' performance across the parameters of energy security, energy equity and environmental sustainability,[11] Asia overall is underperforming across all three pillars (Exhibit 1). As with transportation infrastructure, the substantial increase in energy demand from economic growth will require substantial additional development and improvement to the region's energy infrastructure.

Exhibit 1: Asia's performance in the World Energy Trilemma 2018



The three pillars of the Energy Trilemma Index are defined as followed:

ENERGY SECURITY
Effective management of primary energy supply from domestic and external sources, reliability of energy infrastructure, and ability of energy providers to meet current and future demand.

ENERGY EQUITY
Accessibility and affordability of energy supply across the population.

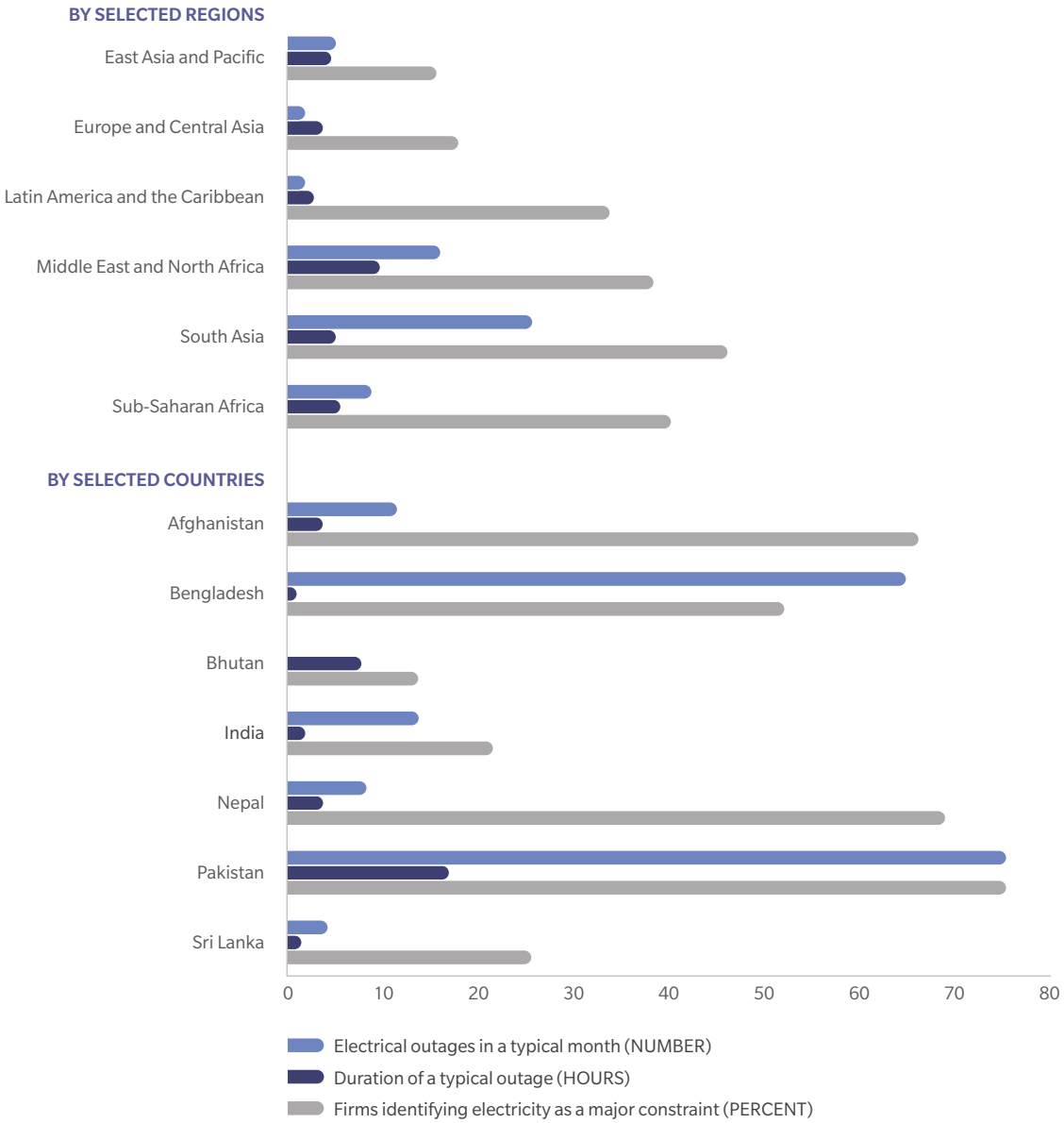
ENERGY SUSTAINABILITY
Encompasses achievement of supply- and demand-side energy efficiencies and development of energy supply from renewable and other low-carbon sources.

Source: Oliver Wyman and World Energy Council

While emerging markets in Asia-Pacific have come a long way in terms of energy equity, with access to electricity generally above 90 percent across much of Asia, an urban-rural access divide remains a significant challenge to universal electrification in several countries such as Cambodia and Laos.

In terms of energy security, a major ongoing challenge in the region is unreliable energy supply. A key contributing factor is the significant loss in transmission and distribution (T&D), which comprises both technical loss due to poor or inadequate infrastructure, and commercial loss from theft, non-metered consumption, or errors in estimations. Emerging markets in Asia-Pacific have trailed significantly behind advanced economies' standards for T&D loss. An extreme case is India, where loss from T&D is a staggering 20 percent of all electricity consumption. Poor quality and insufficient energy supply has led to frequent electric outages that affect companies' operations. In particular, uneven and unreliable access to electricity in South Asia means it suffers from power outages more frequently than any other world region (Exhibit 2).[11] While less severe in other growth markets such as Vietnam and Indonesia, electricity outage remains a major problem in these countries, where around 25 percent of companies reported experiencing outages in 2015.

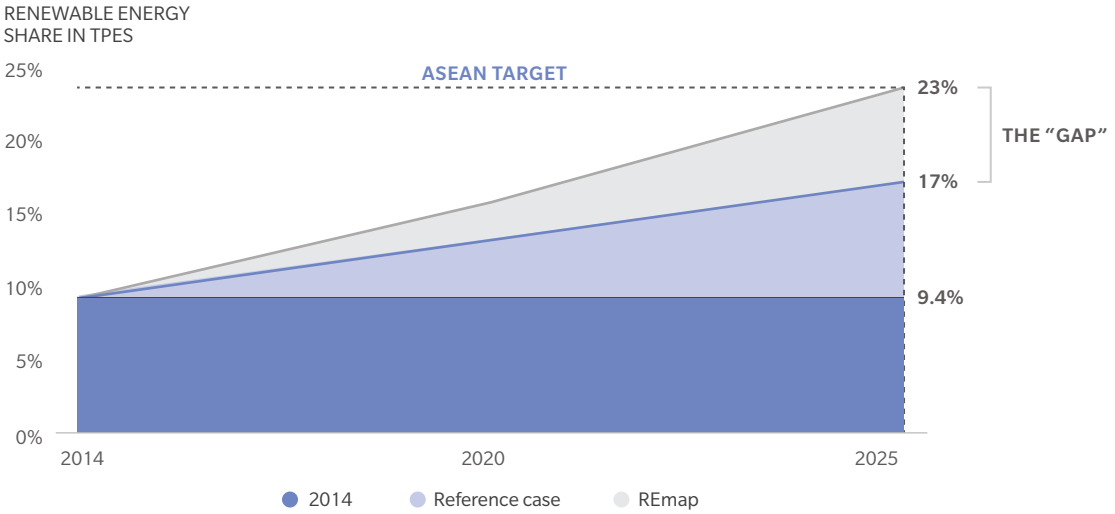
Exhibit 2: Reliability of power supply globally



Source: Zhang, *In the Dark: How Much do Power Sector Distortions Cost South Asia?* (2018) and *World Bank Enterprise Surveys* in Afghanistan (2014), Bangladesh (2013), Bhutan (2015), India (2014), Nepal (2013), Pakistan (2013) and Sri Lanka (2011).

Finally, ambitious renewable energy development plans have been put forward across the region to improve environmental sustainability. The Association of Southeast Asian Nations (ASEAN), for example, has agreed to increase the renewable energy component of its primary energy supply from 10 percent in 2015 to 23 percent by 2025.[12] According to a report from the International Renewable Energy Agency, however, ASEAN is likely to fall short of its target by 6 percent unless regulators do more in terms of developing the renewable energy industry (Exhibit 3).[13] A key question, then, is how stakeholders can pursue environmental sustainability while ensuring the energy supply necessary for equitable access and economic development.

Exhibit 3: Renewable energy share in ASEAN total primary energy supply (TPES) in 2025 and 2030



Source: International Renewable Energy Agency (IRENA), *Renewable energy market analysis: Southeast Asia*, 2018.

ICT INFRASTRUCTURE

Asia-Pacific has been a major site for technological adoption, exemplified by the rapid penetration and proliferation of mobile internet devices. Mobile subscription rates in many countries in the region are at par, if not already greater than penetration rates in their more developed counterparts.

However, this has not been the case in other areas of ICT. Notably, the percentage of the population using Internet and fixed broadband subscriptions in emerging markets are both well below that in advanced economies. The indicators also reveal inadequacies in ICT security infrastructure and practices. Only a few companies in emerging markets conduct encrypted transactions over the Internet, as shown by the number of secured internet servers. The number is also markedly low for several advanced economies, notably South Korea and Japan.

Limited access to ICT suggests a dearth in infrastructure despite more investment being dedicated to the sector in Asia-Pacific. The demand for infrastructure in this space will undoubtedly increase substantially with the growth of online markets and services – and failure to meet this growing demand will significantly hamper growth in emerging countries, and contribute to a widening digital gap domestically and internationally.[14] At the same time, more and improved ICT infrastructure is also needed from a cybersecurity perspective. Despite the rise in cyber dependency and the growth in quantity and sophistication of cyberattacks in recent years, there is a basic lack of investment in appropriate cybersecurity measures, leaving many critical infrastructure exposed.[15] For example, Singapore topped the UN ranking on cybersecurity strategies, but has not been immune to cyber incidents – it was very recently the victim of a serious cyberattack on its healthcare institutions in which personal information of about 1.5 million patients, including the Prime Minister's, was stolen.[16]

Table 1: Selected indicators for the state of transportation, energy and ICT infrastructure across different economies in Asia-Pacific

SECTOR	QUALITY OF TRANSPORTATION				ENERGY			ICT			
	Road	Railroad	Port	Air transport	Quality of energy supply	Access to electricity	Loss from Transmission & Distribution	Mobile subscription	Individuals using the internet	Fixed broadband subscription	Secured internet servers
UNIT	1–7, best	1–7, best	1–7, best	1–7, best	1–7, best	% of population	% of electricity consumption	Per 100 people*1	% of population	Per 100 people	Per one million people
YEAR	2017	2017	2017	2017	2017	2016	2017	2016	2016*2	2017	2018
EMERGING ECONOMIES											
INDONESIA	4.1	4.2	4	4.8	4.4	97	9.8	148	25.3	2	1,284
MALAYSIA	5.3	5	5.4	5.7	5.9	100	6.1	141	78.8	8.7	4,837
PHILIPPINES	3.1	1.9	2.9	2.9	4.2	89	9.7	109	55.5	5.5	88
THAILAND	4.3	2.6	4.3	5.2	5.2	100	5.9	174	48	10.5	580
VIETNAM	3.4	3	3.7	3.8	4.3	99	9.2	128	47	9.6	1,335
CHINA	4.6	4.8	4.6	4.9	5	100	5.8	97	53.2	23	209
INDIA	4.3	4.4	4.6	4.6	4.7	79	19.9	85	29.5	1.4	123
ADVANCED ECONOMIES											
AUSTRALIA	4.8	4.1	4.9	5.2	5.7	100	5.1	110	88.2	30.6	21,547
NEW ZEALAND	4.7	3.5	5.5	5.6	6.5	100	6.6	124.4	88.5	32.8	14,980
KOREA	5.6	5.7	5.2	5.9	6.4	100	3.5	120.7	92.8	40.5	1,196
HONG KONG	6.2	6.3	6.5	6.6	6.8	100	9.4	240.8	87.5	36.0	10,484
JAPAN	6.1	6.6	5.3	5.6	6.7	100	4.6	131	93.1	31.2	5,980
SINGAPORE	6.3	5.9	6.7	6.9	6.9	100	1.7	150	81	26	58,690

***1** A Subscription rate of more than 100 subscriptions per 100 people implies that on average, every person has more than one subscription.

***2** Or latest available year.

Source: Global Competitiveness Index 2017–2018, *Energy Trilemma Index 2018*, and the World Bank's Development Indicators.

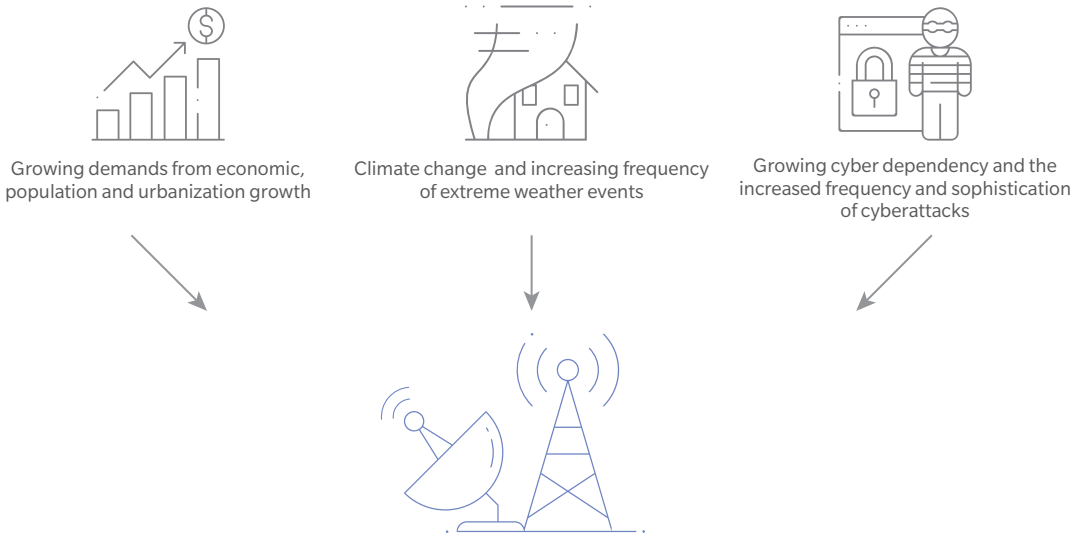
FUTURE COMPLICATIONS

HOW ONGOING TRENDS EXACERBATE INFRASTRUCTURE FAILURE/SHORTFALL

The existing infrastructure failure/shortfall in Asia-Pacific will be exacerbated by three ongoing trends in the region (Exhibit 4). These trends heighten the **shortage** of infrastructure, the **vulnerability** of existing infrastructure, and highlight the need to bolster critical infrastructure quantity and quality in the region.

- First, as discussed in the previous section, the rapid economic growth in Asia-Pacific, which is accompanied with a rapid growth in population and urbanization, will create demand for new critical infrastructure in the transportation, energy and ICT sectors.
- Second, the increasing frequency and unpredictability of climate change events will inflict significant damage on critical infrastructure and heighten demand for the expansion and upgrade of old infrastructure. It will also result in the provision of new infrastructure that can contribute to climate change adaptation and mitigation.
- Finally, the rise in cyber dependency has made physical infrastructure significantly more connected and thus more vulnerable to cyber-attacks. The increased frequency and sophistication of these attacks in recent years have highlighted the need to protect critical infrastructure from a cybersecurity perspective.

Exhibit 4: Ongoing trends that will exacerbate infrastructure failure/shortfall

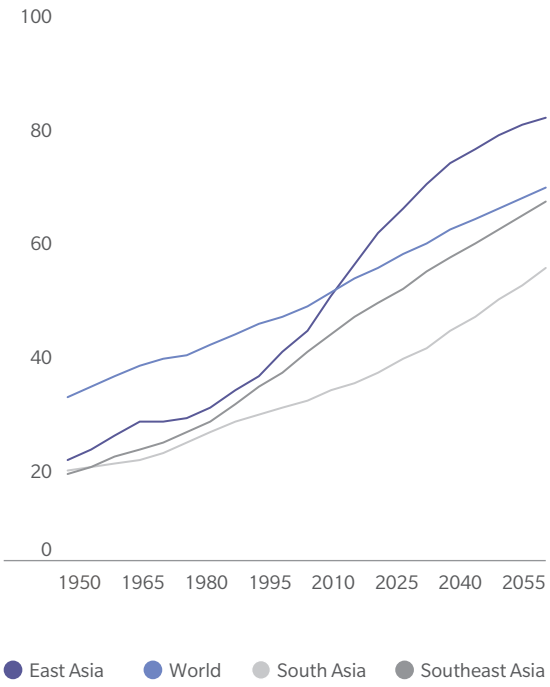


GROWING DEMAND FROM ECONOMIC, POPULATION AND URBANIZATION GROWTH

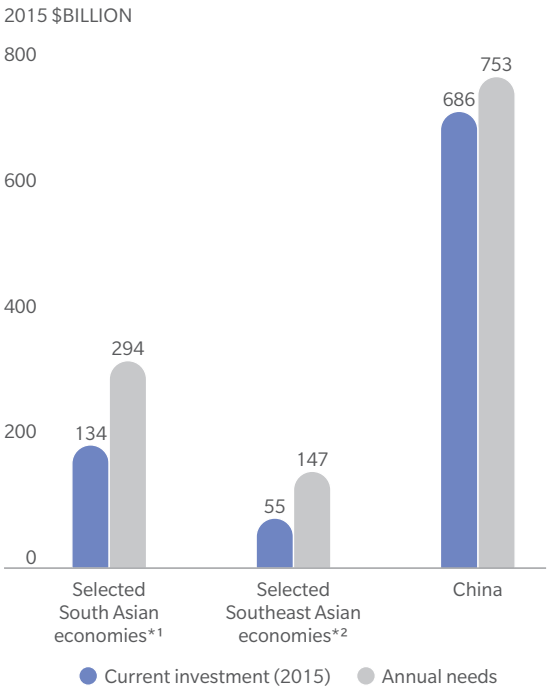
Strong economic growth in the past 10 years in Asia-Pacific has pushed up the demand for new infrastructure, particularly in the region's emerging markets. There is additional pressure in this regard from continued urbanization,[17] the rate of which in East Asian and Southeast Asian countries has exceeded the global rate of urbanization (Exhibit 5A). Demographic changes will also likely increase the demand for infrastructure, both in countries where the population is expected to continue growing like in India, or in aging societies where there is an increasing demand for infrastructure that can accommodate an older population.

Exhibit 5

5A PERCENTAGE OF URBAN POPULATION ACROSS REGIONS



5B INFRASTRUCTURE GAP IN ASIA (2016–2030)



*1 South Asian economies studied in the ADB report are Afghanistan, Bangladesh, Bhutan, India, Pakistan, Sri Lank, Maldives, Nepal

*2 Southeast Asian economies studied in the ADB report are Brunei, Indonesia, Cambodia, Laos, Myanmar, Malaysia, the Philippines, Singapore, Thailand, Vietnam

Source: UN World Urbanization Prospects, 2018; Asian Development Bank, 2015

According a recent report by the ADB, 45 developing countries in Asia (including Asia-Pacific and central Asia) will require an additional $22 trillion for infrastructure development to maintain economic growth and eradicate poverty between 2015 and 2030 (Exhibit 5B). As China has already been investing heavily in domestic infrastructure projects and the Belt and Road Initiative (BRI), the gap is presently a bigger concern in other countries in the region.[18]

In terms of sectors, investment needs are the highest in energy and transportation infrastructure. Together, the investment gap in these sectors constitutes more than 86 percent of the total infrastructure gap in Asia-Pacific. This is consistent with a previous ADB estimation,[19] according to which, the largest infrastructure gap is in the electricity sector at 3.17 percent of estimated regional GDP, followed by transportation (2.3 percent) and telecommunications (0.82 percent). It should be noted, however, that the composition of this gap varies widely across regions and countries. For example, the transportation infrastructure gap is significantly more acute in South Asia than in East and Southeast Asia, where investment needs are more concentrated in electricity infrastructure.

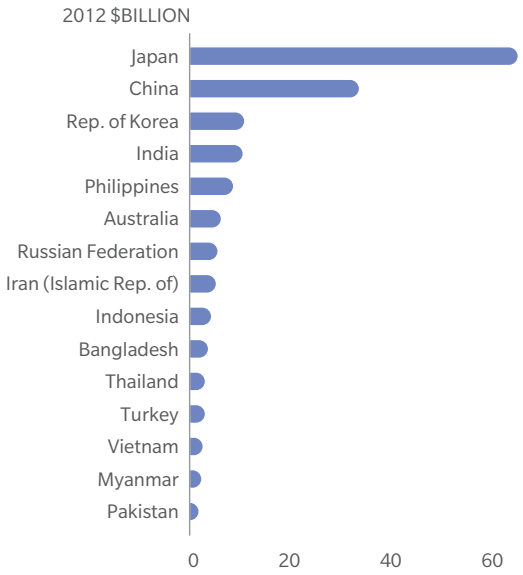
INCREASING FREQUENCY AND UNPREDICTABILITY OF CLIMATE CHANGE EVENTS

In the past few decades, we have witnessed a pronounced increase in the frequency of extreme weather events around the world. Economic losses from severe weather have been rising in tandem, and Asia-Pacific is perhaps most adversely affected – between 1997 and 2016, six of the 10 countries most affected by natural disasters were in the region.[20] From 2006–2015, economic

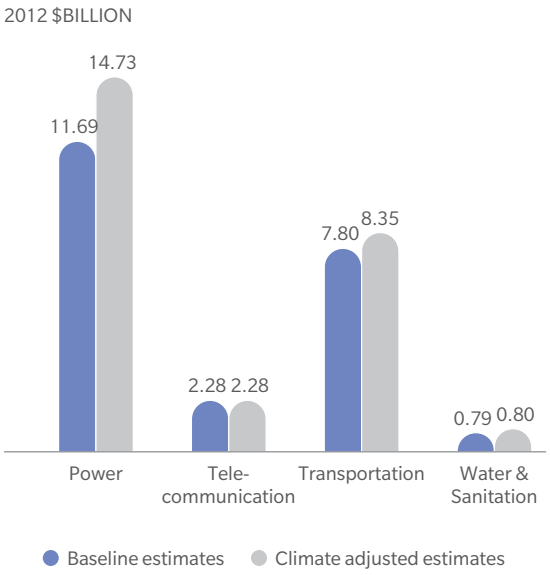
losses from natural disasters in Asia amounted to $126 million a day,[21] and this figure is projected to increase (Exhibit 6A).[22] Climate change is expected to severely impact all types of infrastructure and threatens the reliability and efficiency of energy, transport and water networks.[23] In July 2018, for instance, Typhoon Maria caused over 55,000 households in Taipei to be left without power for hours. In addition to direct losses, natural disasters also often delay repair and maintenance operations, hindering the emergency response needed for a prompt recovery. The in-focus section lays out four key climate risks and their effects on infrastructure.

Exhibit 6

6A ESTIMATED ANNUAL AVERAGE FUTURE LOSS*1



6B INFRASTRUCTURE GAP IN ASIA (2016–2030)



*1 Average annual loss (AAL) refers to the estimated average loss annualized over a long time period considering the full range of loss scenarios relating to different return periods

Source: UNESCAP, 2017; Asian Development Bank, 2015

Climate change events will likely exacerbate the shortfall of critical infrastructure. The already substantial infrastructure gap increases significantly when taking into account the investment needed to prepare new and existing infrastructure against the effects of climate change. Above the estimated baseline $22 trillion addition investment needed, countries in Asia-Pacific will require an extra $4 trillion over the next 15 years for this endeavor, mostly concentrated in the power sector, according to the ADB (Exhibit 6B). As indicated by the United Nations Development Programme, the development of climate-resilient infrastructure requires the deployment of both structural and non-structural risk mitigation strategies.[24] The former involves any physical intervention on infrastructure aiming at reducing or avoiding the impact of catastrophic events. A new class of "sustainable infrastructure" (SI), which entails the building of sustainable, low-carbon and climate resilient infrastructure, has recently received more attention, and efforts are underway to promote and support SI investment opportunities.[25] However, there are significant barriers to this endeavor, including a lack of formal frameworks, investor conviction and effective initiatives that investors can be on board with.[26] This is where non-structural measures, which encompass the adoption of policies and laws such as building codes and land use planning, and also training, education and public communication initiatives, are required.

CLIMATE RISKS AND THEIR EFFECTS ON INFRASTRUCTURE

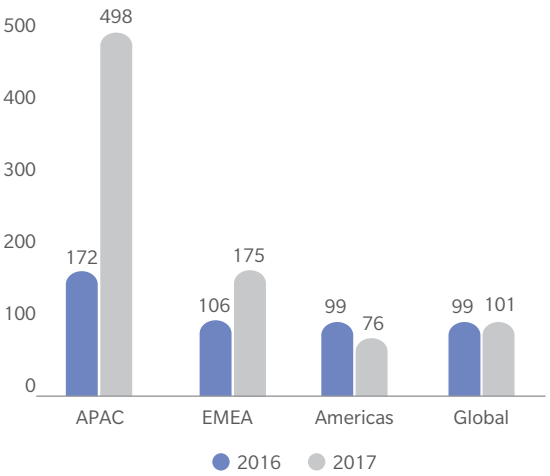
		HOW IT AFFECTS INFRASTRUCTURE	EXAMPLES
FLOODS	 Floods are projected to increase globally under climate change.[27]	Infrastructure in coastal areas will become prone to more frequent flooding and storm surges due to sea level rise, and many low-lying areas will require barriers to be protected from water. Flooding also increases the probability of landslides and mudslides, affecting transportation infrastructure and power lines.	Roads, bridges, railways and airport across India, Bangladesh and Nepal have been damaged by severe floods in 2017, isolating many areas across the region.[28] In Japan, which is considered a leader in earthquake planning, heavy rainfalls in July 2018 exposed how it had overlooked the importance of making key infrastructure flood-resilient.[29] Torrential rain has destroyed roads, derailed trains and disrupted many businesses and supply chains.[30]
TROPICAL CYCLONES	 Among the costliest types of natural disaster, with climate model projections pointing at a future increase in extreme rainfall and winds associated to these events in East, Southeast and South Asia.[31]	Tropical cyclones cause disruption to transportation, energy, and telecommunication infrastructure. In addition, tropical cyclones are responsible for coastal erosion, increasing the risk of assets along coastlines. Tropical cyclone losses have been increasing in the last decades. This is linked to population growth, especially in densely populated areas of high hazard, and to macroeconomic trends, with a pronounced increase in exposure value.	In August 2017, typhoon Hato struck South China with wind gusts reaching 240 km/h, producing along its path losses amounting to $6.82 billion. Insured losses in Hong Kong, Macau, China and Vietnam amounted to over US$1.1 billion, making Hato score among the top 20 most expensive events for the insurance sector in 2017.[32] In September 2018, Japan's Kansai International Airport was completely shut down after high storm tides caused by Typhoon Jebi flooded the airport. Thousands were also left stranded because the only bridge linking the airport to the mainland via road and rail was severely damaged. [33]
GLOBAL WARMING AND HEAT WAVES	 Average temperatures around the world have been increasing but at an uneven pace. In South Asia, average annual temperatures in some areas, such as South-eastern India and western Sri Lanka have increased by 1 to 1.5 degree Celsius between 1950 to 2010. In other areas, such as south-western Pakistan, average temperatures have increased by 1 to 3 degrees Celsius over the same period.[34] Climate change has contributed to the observed global trends in the increasing intensity, frequency, and duration of heatwaves, and such changes are expected to persist in the future.[35]	A warmer climate will reduce the efficiency of energy infrastructure, as higher temperatures increase electric power losses in transmission and distribution network and reduce the efficiency the cooling systems employed in energy production plants. On the demand side, heatwaves are and increasingly will be responsible for steep surges in the energy demand of electricity used for cooling.[36] Heatwaves will increasingly cause thermal stress and buckling in steel infrastructure not designed to withstand prolonged period of high temperatures.[37] Additionally, heatwaves can cause asphalt to soften and expand, damaging roadways, and affect all types of infrastructure projects, as extreme temperatures limit construction labor productivity, especially in conditions of high humidity.[38] A warmer climate will also increase the risk of droughts, with the consequent reduction in the amount of water available for hydropower production.[39]	Railway failures caused by extreme temperatures have been one of the major causes of train service disruption in Australia.[40] During the heatwave which affected Australia in early 2018, more than 50,000 households in Sydney did not have access to electricity because the surge in consumption caused distribution networks to overload and fail.[41]

CYBER DEPENDENCY AND THE INCREASED FREQUENCY AND SOPHISTICATION OF CYBER-ATTACKS

Cities and businesses in Asia-Pacific are increasingly dependent on technology for their everyday operations (Exhibit 7B). This growing cyber dependency has two major implications for infrastructure development. On the one hand, it will lead to a growing demand for ICT infrastructure that is currently already not being met. On the other, it also means that cities and businesses in the region are progressively under the threat of a systemic breakdown from a cyber-attack.

Exhibit 7

7A MEDIAN DWELL TIME*[1] (DAYS), BY REGION



7B GROWTH IN GLOBAL DIGITAL TRANSFORMATION BY THE YEAR 2020 WILL BE LED BY APAC, LEADING TO HIGHER THREAT POTENTIALS

35 EB/month*[2]

Mobile network traffic, from 7EB/mth in 2016

4.7 billion

Connections among 4G devices, from 1 billion in 2015

4.2 billion

Internet users, from 3.7 billion in 2016

***1** Dwell time is the time between an attacker compromising a secured network and the breach being detected

***2** Exabyte (EB) is equal to 10^{12} megabytes

Source: 2018 M-Trends, FireEye

Countries across Asia-Pacific have similarly experienced cyber-attacks on what they considered critical infrastructure. For example, last year, reports in Australia showed a rise in cyber-attacks on the health, finance and transport sectors.[42] The government has responded by updating the sabotage law to include major critical infrastructure such as utilities, key transport facilities and healthcare facilities, among others.[43] The government has also passed the Critical Infrastructure Bill to establish guidelines to better monitor critical infrastructure.[44] Similarly, Singapore also passed a Cybersecurity Act in early 2018, with the strengthening of critical infrastructure as one of its key priorities.[45]

This dual effect of cyber dependency means that the shortfall in ICT infrastructure in the region should be considered not only in terms of infrastructure quantity but also in terms of security and resilience. There is already a serious dearth in investment in the security aspect of ICT infrastructure in Asia-Pacific, as exemplified by the lack of secured Internet servers in the region. FireEye's annual M-Trends reports have consistently found that dwell times are higher in Asia-Pacific than in any other region globally, suggesting that the cyber security architecture in the region is significantly slower to pick up breaches (Exhibit 7A).[15,46] The increased frequency and sophistication of cyber-attacks in Asia-Pacific will only worsen the current shortfall, and it highlights the need for governments and businesses alike to make new and existing infrastructure resilient against potential cyber threats.

BUSINESS IMPLICATIONS

Critical infrastructure failure/shortfall can have adverse effects that directly impact businesses' operations. Companies may see their operations disrupted due to sudden power outages, while in the long run, they may face a significant decrease in productivity and increase in costs. These effects are delved into in more detail in the following discussion.

While the studies cited below mostly reference the manufacturing sector, it is important to stress that the impact of critical infrastructure failure/shortfall extends to various areas. Healthcare delivery, for example, can be severely hampered by a lack of basic transportation infrastructure, notwithstanding additional shortage of social infrastructure such as hospitals. The efficiency of service delivery can also be impacted by a lack of energy infrastructure. For instance, the WHO has cited poor infrastructure as one of the key factors contributing to the spread of Ebola in several African countries in 2014.[47]

DAMAGES TO COMPANIES' OPERATIONS: CONGESTIONS, OUTAGES AND PRICE SHOCKS

A sizable proportion of companies in the Asia-Pacific region cite transportation and electricity as major operational constraints, but these problems are significantly more severe in South Asia and dominate business leaders' concern there (Table 2).[48]

Table 2: Damage to companies from critical infrastructure failure/shortfall

	EAST ASIA AND THE PACIFIC	SOUTH ASIA
Percent of companies identifying transportation as a major constraint	14.8	21.1
Percent of companies identifying electricity as a major constraint	15.5	46.1
Average losses due to electrical outages when outages occur (% of annual sales)	3.2	10.9

Source: World Bank Enterprise Surveys

POTENTIAL BUSINESS DISRUPTION DUE TO CRITICAL INFRASTRUCTURE BREAKDOWN

Electricity outage is a major source of disruption for companies, particularly in South Asia where the average company experiences nearly one outage per day, with each lasting on average 5.3 hours. In India, despite the recent projected surplus, several cities, as well as an estimated 45 million rural households, are still under the threat of regular blackouts. Similarly, neighboring Pakistan is also facing gaping electricity shortages, contributed by an upstream gas shortfall and a dearth in renewable energy infrastructure despite the country's substantial hydro, wind and solar potential.[49]

For businesses in these countries – particularly in the manufacturing sector – the unreliable electricity supply results in loss in output when unanticipated outages happen, and results in them being forced to move away from investing in energy-intensive capital.[50] Across South Asia, for example, average loss in annual revenue due to power outages is estimated at an astonishing 10.9 percent of annual sales, the highest globally .[51]

In Pakistan, which suffers the largest average losses due to electrical outages globally, a 10 percent increase in outage durations is expected to cause a 0.14 to 0.28 percent decrease in total revenue and a 0.36 percent decrease in value added at the company level.[50]

Blackouts and associated costs to businesses, however, are not exclusive to emerging markets or South Asia. For instance, in August 2017, a power outage in Taiwan resulted in a $3 million loss for 151 affected companies.[52] Blackouts have also occurred in other advanced economies such as Australia in 2016 due to high demand and the inability of renewable sources to fill the gap.[53]

Separately, poor transportation and ICT infrastructure quality make these infrastructures more vulnerable to external disruption such as extreme weather events, cyber incidents, or terrorist attacks. This will, in turn, have significant impacts on companies. In a recent report on the cost of cyberattacks to the healthcare industry, Marsh & McLennan Insights found that the potential loss from cyberattacks for infrastructure-

related sectors such as manufacturing, transportation and rail, and energy are among the highest across different industries.[54]

For example, a cyberattack on several ports run by Maersk, in India in 2017, left the complex global supply chain heavily disrupted, especially as ports these days are increasingly reliant on communication systems for normal operations.[55] A recent report also documented the substantial costs of Internet shutdown in India, which amounts to approximately $3 billion from 2012 to 2017.[56] While these shutdowns had originated from government censorship, the report provides a glimpse into the potential size of damage companies may face.

RISING OPERATIONAL COSTS

Poor transportation infrastructure results in a substantial increase in companies' operational costs. The cost of moving goods in Indonesia, for example, was estimated at around a whopping 26 percent of GDP in 2016. [57] This is significantly higher than the 13 percent in Malaysia and 8 percent in Singapore, where the quality of transportation infrastructure is markedly better. Increased costs of moving are primarily a result of delays in shipments due to severe congestion. In some instances, however, such delays can also impact operating costs through wider market distortions. For example, severe congestions at key ports in China and Indonesia from late 2017 to early 2018 have caused a short term coal price spike and increased costs for related companies.[58]

Inadequate energy infrastructure can also have a longer-term cost impact, as a shortage in energy supply may push energy prices up significantly. In Australia, businesses experienced a near doubling of their electricity bills in 2017,[59] directly impacting their bottom line and prompting companies to consider layoffs or reconsider their business viability.[60] The surge in price was mainly due to a supply and demand mismatch, in which an unclear strategy on the renewable energy transition at the national level led to an uncoordinated close-down of coal-fired plants even though renewable energy sources were not able to match adequate capacity, and exacerbated by high network costs – it is estimated that 41 percent of the increase in electricity price over the last decade in Australia can be attributed to transmission and distribution costs.[61]

LONG-TERM DECREASE IN PRODUCTIVITY

Research has pointed to the role played by transportation infrastructure in fostering market access and contributing to companies' productivity and production. A recent paper shows that for the Chinese manufacturing sector, the expansion of highway networks played a significant role in increasing companies' productivity and output.[62] Elsewhere, in Australia, congestion has been estimated to cost Australian companies in the country's major cities around $2.6 billion every year in lost working hours.[63]

Inadequate transportation has also impacted productivity in less direct ways. One example is pollution, a side effect of congestion. Recent research focused on China has shown that daily air pollution levels have a negative impact on workers' health and productivity.[64] These findings suggest that workers' getting stuck in congestion will not only cost companies lost working time, but prolonged exposure to pollution in traffic will also likely have a longer-term impact on employees' health and subsequently their productivity levels.

Separately, ICT infrastructure is also playing an increasingly critical role in company productivity and in facilitating trade. The dramatic growth of ICT in India, for instance, has significantly contributed to increase in total factor productivity in the manufacturing sector.[65] Conversely, the lack of ICT infrastructure can be a major barrier to productivity – slow Internet speed and the lack of affordable high-speed options have been quoted as among the key issues for businesses in Asia-Pacific, forcing them to develop separate offline/online options to get around the problem where telecom infrastructure is poor.[66]

ADDRESSING CRITICAL INFRASTRUCTURE FAILURE/ SHORTFALL: OPERATIONAL AND STRATEGIC RESPONSES

Given the far-reaching impact of critical infrastructure failure/shortfall, how can companies realistically respond to this threat, particularly because infrastructure development traditionally falls outside the purview of the private sector in Asia-Pacific?

A longer-term, strategic approach is important. Here, the focus is on critical strategic decisions, such as where to locate a company's manufacturing center, or whether a company should take an active part in the development of infrastructure in the region to help close the infrastructure gap. Simultaneously, businesses will also have to consider the impact of critical infrastructure failure/shortfall at an operational level. This entails employing risk mitigation strategies such as risk transference through insurance, employing business continuity management solutions, and wider restructuring of their operations to bolster resilience.

FACTORING IN INFRASTRUCTURE FAILURE/SHORTFALL IN STRATEGIC CONSIDERATIONS

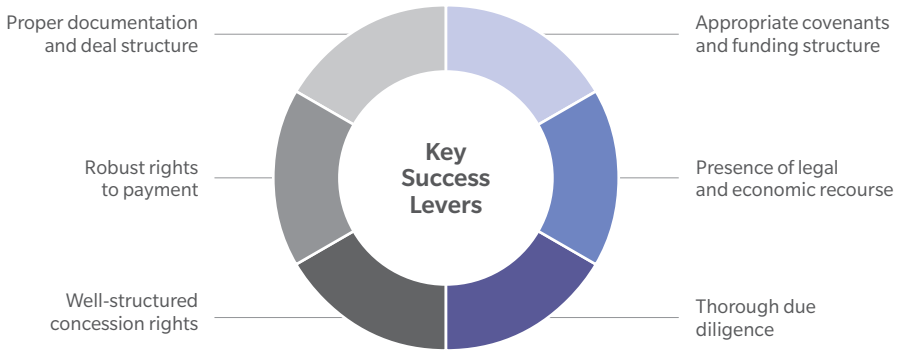
Infrastructure is a major factor contributing to a country's competitiveness and constitutes the second pillar in the World Economic Forum's annual Global Competitiveness Index. Correspondingly, for companies and particularly international businesses, the state of critical infrastructure in the country of operation features prominently in their strategic considerations. International businesses looking to set up operations in countries with less developed infrastructure must weigh between the potential trade-off from accessing these markets and the risks of disruption due to infrastructure failure/shortfall. Domestic companies in these countries too will have to factor inadequate infrastructure in their business development and risk management plans.

That said, governments in the region are investing heavily in infrastructure development, with some (such as China, India and Vietnam) spending a significant portion of their national budgets on this. In the long run, this will lessen the risks associated with inadequate infrastructure for companies in the region.

In the short- to medium-term, the current infrastructure investment wave led by Asia-Pacific governments also presents ample opportunities for businesses and other stakeholders to take an active part in infrastructure development. Apart from public-private partnership (PPP) ventures, governments in the region are also implementing other programs to attract private capital into infrastructure, such as asset recycling, notably in the case of Australia.[67] Public assets are privatized (sold or leased out long-term), with the proceeds reinvested in new infrastructure. Programs like this provide private businesses with the chance to take up and operate relatively low-risk brownfield assets, as opposed to taking on more risk when participating in a greenfield type deal.

In general, one of the key criteria for consideration from a private business and investor perspective when entering this space is whether projects are bankable. Marsh & McLennan Insights' recent report on closing the financing gap for infrastructure projects in Asia-Pacific identified six levers for project bankability (Exhibit 8).[68]

Exhibit 8: Levers of infrastructure project bankability



Source: "Closing the financing gap: Infrastructure project bankability in Asia", Marsh & McLennan Insights, 2017

Efforts to institutionalize these levers in Asia-Pacific are still relatively nascent. For example, findings from the World Bank's PPP Benchmark report showed that while South Asian countries are at par with the global average, countries in East Asia and the Pacific have largely fallen short in PPP preparation and procurement processes.[69] Despite the fact that risks are inevitable, businesses looking to enter this space will be supported by governments' continued efforts to improve institutional frameworks as well as incentives provided for PPP projects. These opportunities are also extended to other industries that are not directly tied to infrastructure development. For example, investment in infrastructure can be a stable source of cash yield for financial institutions such as commercial banks, insurance companies and investment funds.

BOLSTERING OPERATIONAL RESILIENCE

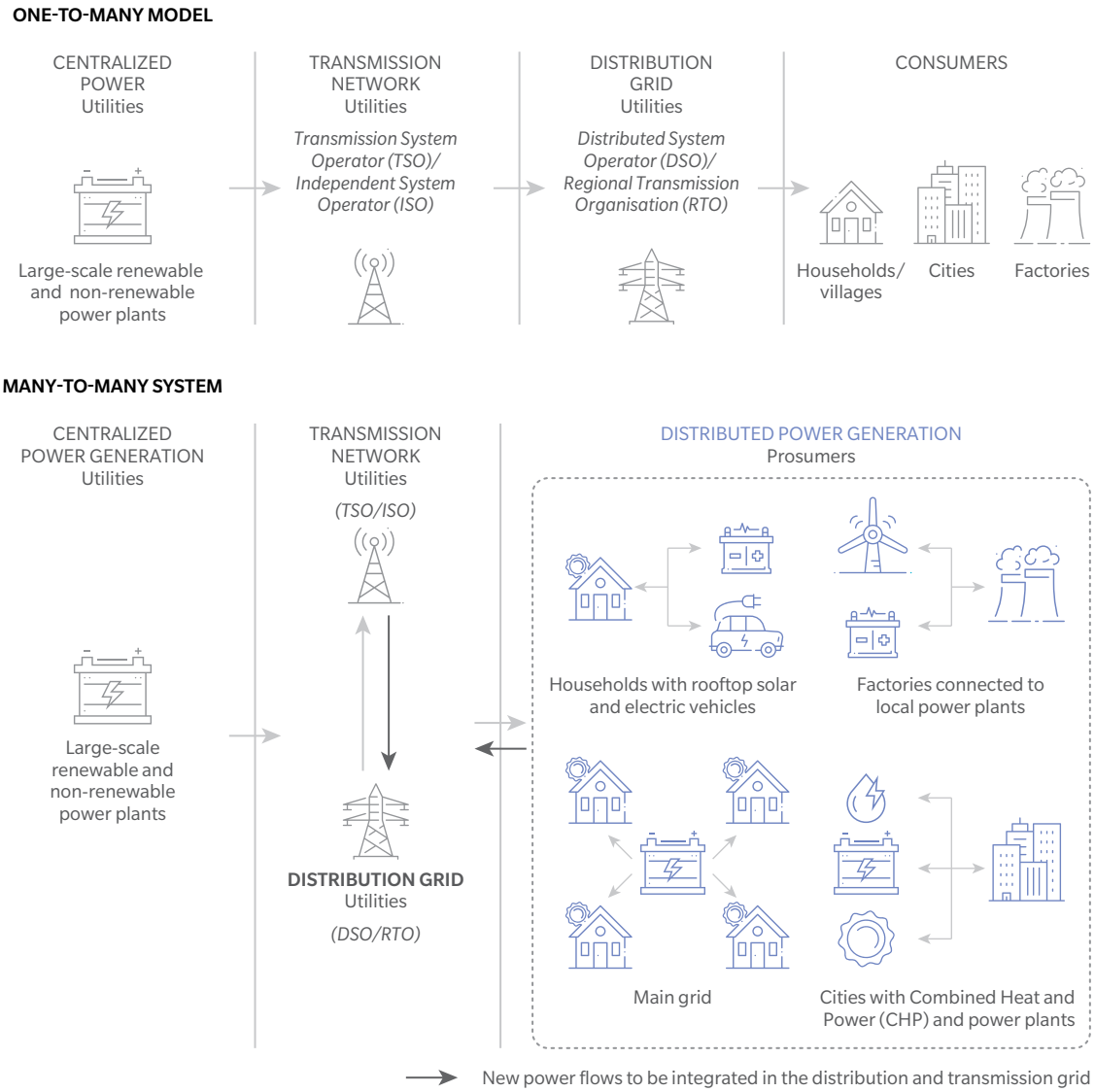
It is important that companies evaluate the role of critical infrastructure failure/shortfall in relation to climate change events as well as cyber-attacks. These events not only directly impact company facilities and operations which the company has control over, they can also lead to the breakdown of critical infrastructure such as outages and damaged bridges that are not under the companies' purview, but nevertheless have an impact on its operations.

For example, even when a company's production lines are not affected by a climate event (such as a flood), the supply chain may still be disrupted from transport infrastructure being damaged or rendered unusable.

Where critical infrastructure is not built to be resilient against such threats, damages to businesses can be greatly exacerbated. For instance, the lack of investment and planning in urban infrastructure has greatly amplified the risk and damage of floods in cities in India.[70] In this case, companies located in urban areas with poor drainage and sanitation may suffer the same substantial damages as those with operations located on low-lying flood plains.[71] Solely focusing on the direct damage to companies' properties from weather events and cyber incidents can lead to second order damage due to infrastructure failure being overlooked and total damage being underestimated.

Addressing the problem of critical infrastructure failure/shortfall with a mind for climate change and cyber-attacks may require companies to rethink the organization as a whole. Possible solutions such as operational reengineering, or the establishment of spare capacity/backup production capabilities can also be considered as longer-term strategic responses.

Exhibit 9: From the One-to-Many model to Many-to-Many model



Source: Oliver Wyman and World Energy Council, 2017. Adapted from World Energy Trilemma 2017: Changing Dynamics – Using Distributed Energy Resources to Meet the Trilemma Challenge

An example of this latter approach is the shift from "consumers" to "prosumers" of energy. In this arrangement, organizations take an active part in the production, consumption, and management of energy (Exhibit 9). Prosumer-driven organizations also go beyond ensuring redundancy and resilience and aim to harness new technology and analytics to more efficiently use energy, saving substantial operational costs in the process.[72]

In practice, some companies have been investing in off-grid distributed energy systems,[73] using renewable energy to bolster operational resilience in the face of frequent outages. Major airports have been among the leaders in implementing this solution in India. For instance, in 2016, Delhi International Airport announced a plan to expand its solar power capacity from 7.8 MW to 20MW by 2020 to reduce the electricity it draws from the

grid.[74] Elsewhere, Cochin International Airport has already achieved self-sufficiency on solar power since 2015. These successful cases provide a viable model for businesses in India and across the region.

Finally, an important consideration for companies is to insure against loss associated with critical infrastructure failure/shortfall. For example, disruptions can be considered as Business Interruption (BI) incidents, and can thus be covered by traditional BI risk transfer approaches. However, it is important to note that traditional transactional insurance is not always enough to maintain shareholder value, prevent loss of market share, or protect against other adverse risks in the case of BIs. There are a variety of additional solutions that companies can employ in this regard, including:[75]

- Business recovery planning
- Introduction of backup single suppliers
- Outsourcing of critical functions to spread the risk
- Adjustment of inventory control strategies

Ultimately, companies will need to employ a combination of strategies to adequately bolster resilience against the risk of critical infrastructure failure/shortfall.

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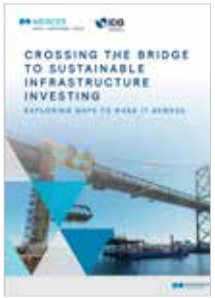

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