



BETTER TOGETHER: BUSINESS, GOVERNMENT, SOCIETY AND OUR SUSTAINABLE FUTURE

Ecosperity Conversations 2018



FOREWORD

The United Nations Sustainable Development Goals (SDGs) have built momentum towards a more resilient and inclusive world. The 17 SDGs cover a wide-ranging set of ambitions for 2030 that resonates with Temasek's commitment to sustainability and good governance. In Temasek, we have organised the 17 SDGs into three pillars: **A-B-C for Active Economy, Beautiful Society, and Clean Earth**, translating these SDGs into reality.



ACTIVE
ECONOMY

An active, robust economy delivers good jobs and creates opportunities.



BEAUTIFUL
SOCIETY

A sustainable and beautiful society fosters resilient individuals, cohesive families and inclusive communities.



CLEAN
EARTH

A clean, cool Earth is our home and common inheritance.

The name “Ecosperity” twins ecology with prosperity as we believe that sustainable development goes hand in hand with economic growth. The private sector has an important role to play to make Sustainability *sustainable*. By applying the innovation, drive, and capital of the private sector, we can begin to have long-term solutions that are economically viable to solve our sustainability challenges.

We launched the Business and Sustainable Development Commission's (BSDC) Asia report, titled “Better Business, Better World” at Ecosperity 2017. It was a call to action for policy-makers, businesses, and civil society to work together to build an **ABC World**. The report outlined up to US\$12 trillion of global business opportunities, with US\$5 trillion coming from Asia, in areas such as food and agriculture, health and well-being, and energy and materials.¹

Over the past 12 months, Temasek worked with a number of knowledge partners, including AlphaBeta, A.T. Kearney, and Ernst & Young, to explore the business case for sustainable development further. We organised a series of closed-door discussions involving participants ranging from business leaders to stakeholders from the Singapore government and civil society. The *Ecosperity Conversations 2018* report provides a synthesis of the main takeaways from these discussions.

A number of cross-cutting insights emerged:

- **“Business-as-usual” approaches that ignore sustainability concerns will no longer be feasible going forward.** It is becoming clear that if businesses do not dramatically shift their focus on sustainability, they face risks to their reputation and business operations from climate change impact and additional regulations from the government. In the food and agriculture discussion, for example, a report from McKinsey indicated that the costs of soft commodities could increase between 50 to 450 percent with the implementation of carbon taxes and the reduction of water subsidies. On the

1. BSDC and Temasek (2017), *Better Business Better World Asia*. Available at: <http://businesscommission.org/news/sustainable-businesses-can-unlock-us-5-trillion-in-new-market-value-in-asia-by-2030>



other hand, businesses would benefit from solving these climate change challenges and anticipating regulatory reforms. The agricultural company, Olam, has established the Olam Farmer Information System (OFIS), a smartphone app which can generate personalised recommendations for smallholder farmers such as how to improve their agricultural practices, boost sustainability, save costs and increase yields.²

- **New business models and approaches help to capture emerging business opportunities.** Technology advancements have enabled the rise of different business models and approaches. For example, the rapid adoption of mobile phones in emerging markets has enabled healthcare access to remote areas through telehealth applications. Likewise, in agriculture, mobile-phone enabled access to information and application of precision agriculture technologies have helped to significantly improve production yields. Businesses have started to leverage human behavioural insights to unlock opportunities and manage costs. For example, power companies provide their customers with benchmarking against their neighbours to encourage more efficient energy usage. Insurance companies incentivise their customers through lower premiums to adopt healthier lifestyles and to manage the rise of non-communicable diseases.

- **Systems approach to sustainability challenges will require breaking out of usual silos.** Addressing many of the sustainability challenges will require businesses, governments, and civil society to think differently about collaboration models. In particular, there is likely to be an increasing need to work with players outside their own sector silos. For example, there will be a crucial need to shift the focus in healthcare from treatment to prevention in order to deal with escalating demand and costs. Effective prevention programmes will require engagement with a broad set of stakeholders, including activity service providers (such as gyms and bike sharing firms), food companies (around product reformulation to reduce fat, sugar, and salt content of food), and technology companies (that can support development of devices for early detection of medical concerns).

Efforts for sustainability have begun but more can be done. The theme for United Nations World Environment Day 2018 is “Beat Plastic Pollution” where the world will come together to combat single-use plastic pollution. Similarly, Singapore has declared 2018 to be the Year of Climate Action, reaffirming our commitment to the Paris climate agreement. As the stewards for our next generations, the time is ripe to translate our collective actions into tangible outcomes, turning **Ideas to Impact**. I look forward to continuing the discussion with all of you at Ecosperity 2018.

A handwritten signature in black ink, appearing to read 'Robin Hu', written in a cursive style.

- ROBIN HU
Head, Sustainability & Stewardship Group
Temasek International

2. Olam (2018), Olam Farmer Information System (OFIS). Available at: <http://olamgroup.com/sustainability/ofis/>



ABBREVIATIONS

ABBREVIATIONS DEFINITION

AI	Artificial Intelligence	MGI	McKinsey Global Institute
ASEAN	Association of Southeast Asian Nations	NCD	Noncommunicable Disease
AMR	Antimicrobial Resistance	R&D	Research and Development
APAC	Asia-Pacific	SDG	Sustainable Development Goal
BSDC	Business & Sustainable Development Commission	SME	Small and Medium-sized Enterprise
EAP	East Asia & Pacific	UN	United Nations
EV	Electric Vehicle	UNICEF	United Nations Children's Fund
FAO	Food and Agriculture Organisation	WHO	World Health Organisation
GDP	Gross Domestic Product	WRI	World Resources Institute
GHG	Greenhouse Gas	WWF	World Wildlife Fund
IoT	Internet of Things	4IR	Fourth Industrial Revolution

CONTENTS

ii	Foreword
iv	Abbreviations
6	<i>Chapter 1: Healthcare</i>
18	<i>Chapter 2: Food and agriculture</i>
30	<i>Chapter 3: Energy & Materials</i>
42	<i>Chapter 4: Cities</i>
54	<i>Chapter 5: Textiles</i>
66	<i>Chapter 6: Industry 4.0</i>
78	<i>Chapter 7: Resource recovery</i>





“

The largest business opportunities in the health and well-being system could have a commercial value of US\$1.8 trillion in 2030 (US\$670 billion of those opportunities are in Asia).

”



Chapter 1: **HEALTHCARE**

This chapter explores the sustainability challenges and opportunities related to healthcare, as discussed in the breakfast event, entitled “The Ecosperity Series - Thriving in a Sustainable Economy: Health and Well-being”. The event was held on 5th October 2017 and included a range of stakeholders from the healthcare industry, government, investors, and academics.

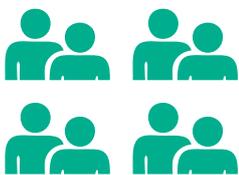
Led by Dr. Fraser Thompson, Director of AlphaBeta, the session participants discussed how global healthcare systems face a series of challenges driven by a combination of ageing populations, pressures on public finances, the rise of non-communicable diseases, and drug-resistant disease strains. A new sustainable approach could transform healthcare and create significant business opportunities. The largest business opportunities in the health and well-being system could have a commercial value of US\$1.8 trillion in 2030 (US\$670 billion of those opportunities are in Asia).³ Unlocking these opportunities will require a shift in business models, including adopting “lean” models to healthcare delivery, developing partnerships with adjacent industries and other organisations to spur scale benefits and innovation, and creating new incentive models to change consumer behaviour. The session participants discussed the practical barriers which can impede some of these models, and ideas for how they could be tackled.

3. AlphaBeta and the Business & Sustainable Development Commission (2017), *Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth*. Available at: <http://businesscommission.org/our-work/valuing-the-sdg-prize-unlocking-business-opportunities-to-accelerate-sustainable-and-inclusive-growth> and BSDC, Temasek, and AlphaBeta (2017), *Better Business, Better World Asia*. Available at: <http://businesscommission.org/news/sustainable-businesses-can-unlock-us-5-trillion-in-new-market-value-in-asia-by-2030>

SUSTAINABILITY CHALLENGES IN HEALTHCARE...

Global healthcare systems face a series of challenges driven by a combination of ageing populations, pressures on public finances, the rise of non-communicable diseases, and drug-resistant disease strains.

EXAMPLES OF CHALLENGES



400 MILLION
people worldwide do not have access to essential health services

There are only **2 DOCTORS PER 10,000 PEOPLE** in Indonesia, well below WHO's recommendations



HEALTHCARE ACCESS



100 MILLION
redundant tests are ordered every year in India



Prevalence of obesity has doubled since 1980, costing over **US\$2 TRILLION ANNUALLY**

COST OF CARE



ONE MILLION
people die annually from counterfeit drugs

3 OUT OF 4
people over 50 do not do regular colorectal cancer screenings in Singapore



QUALITY OF CARE



Antimicrobial resistance of key disease strains could cost up to **US\$2 TRILLION** annually by 2030



Bringing a new drug to the market takes up to **12 YEARS AND COSTS US\$1.9 BILLION**

AFFORDABLE & TIMELY INNOVATION



...AND OPPORTUNITIES

THE BUSINESS OPPORTUNITIES LINKED TO SUSTAINABLE APPROACHES

The largest business opportunities in the health and well-being system could have value of **US\$1.8 TRILLION** in 2030



ALMOST 40% of these business opportunities are in Asia (representing US\$670 billion of opportunities in 2030)

3



Largest opportunities (in terms of 2030 revenue size) are **RISK POOLING, REMOTE PATIENT MONITORING, AND TELEHEALTH**

EXAMPLES OF EMERGING NEW BUSINESS MODELS

SERVING THE BOTTOM OF THE PYRAMID

NARAYANA HEALTH is able to perform surgeries at 75% lower cost with same health outcomes through bulk procurement and standardisation



EMBRACING NEW FORMS OF COLLABORATION

By partnering with governments, industry, and civil society, **GLOBAL ALLIANCE ON VACCINES AND IMMUNIZATION (GAVI)** has vaccinated half a billion children, saved 7 million lives and achieved US\$80 billion to US\$100 billion in economic benefits



LEVERAGING INNOVATIONS IN OTHER SECTORS

ZIPLINE uses drone technology in the delivery of blood and medicine



COMBINING BEHAVIOURAL INSIGHTS WITH TECHNOLOGY

Models that focus on the behavioural change needed to support unlocking opportunities. For example, **AIA** offers monetary incentives for consumers to stay healthy via its Vitality app



A “BUSINESS AS USUAL” APPROACH TO HEALTHCARE GOING FORWARD IS NOT FEASIBLE AND A FUNDAMENTAL SHIFT IN FOUR AREAS IS CRUCIAL

A fundamental shift in four key areas is needed to create a sustainable healthcare system (Exhibit 1):

- Healthcare access.** There will be rapid growth in demand for healthcare in Asia over the next 15 years due to a combination of ageing, a rising consuming class, and also increases in chronic diseases, such as cancer and diabetes. However, there are significant gaps in supply and a lack of healthcare coverage in terms of both insurance and geographical reach of healthcare facilities. 400 million people currently do not have access to essential health services and 100 million people fall below the poverty line each year due to health expenditures in developing countries.⁴ A lack of health insurance coverage and gaps in skilled workers are key underlying drivers of this. For instance, in Indonesia, there are only 2 doctors per 10,000 people, well below the WHO’s recommendations.⁵

100 MILLION PEOPLE FALL BELOW THE POVERTY LINE EACH YEAR DUE TO HEALTH EXPENDITURES IN DEVELOPING COUNTRIES

World Bank research has shown that the “out-of-pocket” share of total health expenditure in East Asia and Pacific reached over 25 percent in 2014 and was as high as 62 percent in South Asia in the same year.⁶ The WHO estimates that 18 million additional medical professionals will be required by 2030 worldwide, however, based on current trajectories there is likely to be a significant shortfall.⁷ Increasing the penetration of private, public-private and community insurance schemes is an essential step towards making healthcare affordable and

achieving universal healthcare coverage in line with the Global Goals. In addition, modern technology in medicine has the disruptive potential to increase the geographical reach of quality treatment, diagnosis, and communication between medical service departments and locations. Mobile adoption has surged globally, and particularly in developing countries. The deployment of 5G mobile technology will also reduce latency allowing webcam and audio technology to not only be used for physicians giving advice remotely but also potentially doing surgery remotely as well (through the use of robotics).

- Cost of care.** Increasing costs are testing the sustainability of healthcare systems. Global spending on health is forecasted to increase from below US\$8 trillion in 2013 to close to US\$20 trillion in 2040.⁸ In-hospital treatment is often particularly expensive. In countries without proper electronic medical records, doctors might prescribe more procedures than required. McKinsey Global Institute (MGI) estimates that in India, more than 100 million redundant tests are ordered every year.⁹ Furthermore, a significant share of healthcare costs can be attributed to administrative and bureaucracy. In the United States, about 30 percent of medical bills are used for administrative costs such as processing bills.¹⁰

GLOBAL SPENDING ON HEALTH IS FORECASTED TO INCREASE FROM BELOW US\$8 TRILLION IN 2013 TO CLOSE TO US\$20 TRILLION IN 2040

Cost of care could be rapidly reduced through a combination of remote patient monitoring, lean

4. World Health Organisation and World Bank (2015), *Tracking universal health coverage: First global monitoring report*.

Available at: http://apps.who.int/iris/bitstream/10665/174536/1/9789241564977_eng.pdf and World Health Organisation (2015), *Health in 2015 from MDGs to SDGs*. Available at: <http://www.who.int/gho/publications/mdgs-sdgs/en/>

5. World Health Organisation (2018), “Density per 1000 Data by country”. Available at: <http://apps.who.int/gho/data/node.main.A1444>

6. BSDC, Temasek, and AlphaBeta (2017), *Better Business, Better World Asia*.

Available at: <http://businesscommission.org/news/sustainable-businesses-can-unlock-us-5-trillion-in-new-market-value-in-asia-by-2030>

7. WHO (2016), *Health workforce needs, demand and shortages to 2030: an overview of forecasted trends in the global health labour market*.

Available at: http://www.who.int/hrh/com-heeg/Needs_demands_shortages.pdf and UN (2017), “Goal 3: Ensure healthy lives and promote well-being for all at all ages”. Available at: <https://unstats.un.org/sdgs/report/2017/goal-03/>

8. Joseph L Dieleman et al (2016), “National spending on health by source for 184 countries between 2013 and 2040”. *The Lancet*.

Available at: [http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(16\)30167-2/abstract](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)30167-2/abstract)

9. McKinsey Global Institute (2014), *India’s tech opportunity: Transforming work, empowering people*.

Available at: https://www.mckinsey.com/~/media/mckinsey/industries/high%20tech/our%20insights/indias%20tech%20opportunity%20transforming%20work%20empowering%20people/mgi%20india%20tech_full%20report_december%202014.ashx

10. Singlecare (2016), “30% of Medical Bills Go To Administrative Costs”.

Available at: <https://www.singlecare.com/blog/30-medical-bills-go-administrative-costs/>

surgery interventions, and lifestyle management. Remote patient monitoring can reduce the cost of chronic disease treatment by 10 to 20 percent through reducing emergency room visits as well as unnecessary routine monitoring in the hospital for those whose conditions could be remotely monitored on a regular basis, making preventative care the standard.¹¹ Using 'lean' surgical interventions could give many more low-income consumers access to secondary healthcare. Hospitals practising these high-volume, low-cost approaches tend to be in high density areas and target low-income groups requiring basic medical care. Since the services available are limited, patient throughput is extremely high (up to 100 patients per day per doctor). Examples include R-Jolad Hospital in Nigeria, Selien Hospital in Tanzania, and the Nsambya Hospital in Uganda.¹² Despite the low cost, quality is high, with complication rates comparable to procedures in developed countries.¹³

As a side effect of Asia's increased affluence, inactive lifestyles are becoming more prevalent leading to chronic non-communicable diseases, with over 190 million people now diagnosed with Diabetes type 2.¹⁴ Studies have also estimated that obesity has a global social cost of US\$2 trillion per year.¹⁵ With increased emphasis on preventative care, the lifestyle sector will continue to grow, including activity services such as gym, as well as healthier foods. Food product reformulation alongside other levers has the potential to lower obesity levels in 2030 from a projected 41 percent of the global population to around 5 percent.¹⁶

- **Quality of care.** Quality of care has multiple aspects, covering everything from the skills of the

medical professionals to the state of healthcare infrastructure. Three areas that are often overlooked, but important for the quality of care, are the lack of usage of screening to diagnose ailments early and take corrective action; the continued use of cumbersome, paper records; and the high rates of drug counterfeiting. There is a lack of screening and follow-up in many countries, even developed ones. In Singapore, 75 percent of people over 50 do not undergo regular colorectal cancer screenings and only 25 percent continue with the follow-up after the screenings.¹⁷ Less than 30 percent of adults in Hong Kong had a medical check in 2016.¹⁸ Implementing cloud-based systems to store easily



LESS THAN 30 PERCENT OF ADULTS IN HONG KONG HAD A MEDICAL CHECK IN 2016

accessible and consistent records can provide large potential benefits in treatment. When combined with big data techniques to merge with medical evidence reports and clinical trials, this can be used to compare each patient's individual symptoms, vital signs, family history and medications to diagnose and recommend a treatment plan with the highest probability of success, and to avoid misdiagnoses.¹⁹ It can also save time for doctors and nurses and reduce costs by avoiding unnecessary or duplicative tests and procedures. Counterfeit drugs deprive the

ONE MILLION PEOPLE DIE ANNUALLY FROM COUNTERFEIT DRUGS

11. McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy*. Available at: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx

12. International Finance Corporation (2008), *The Business of Health in Africa: Partnering with the Private Sector to Improve People's Lives*. Available at: <http://healthmarketinnovations.org/sites/default/files/The%20Business%20of%20Health%20in%20Africa.pdf>

13. Private Sector Innovation Programme for Health (2014), *Understanding the India Low Cost Model of Healthcare Delivery: A Review of the Literature*. Available at: <http://www.psp4h.com/wp-content/uploads/2014/05/Understanding-the-India-Low-Cost-Model-of-Healthcare-Delivery-3.pdf>

14. Deloitte (2015), *A perspective of future healthcare landscape in ASEAN and Singapore*.

Available at: <https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/risk/sea-risk-future-healthcare-thought-leadership-noexp.pdf>

15. AlphaBeta and the Business & Sustainable Development Commission (2017), *Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth*. Available at: <http://businesscommission.org/our-work/valuing-the-sdg-prize-unlocking-business-opportunities-to-accelerate-sustainable-and-inclusive-growth>

16. McKinsey Global Institute (2014), *How the world could better fight obesity*.

Available at: <https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/how-the-world-could-better-fight-obesity>

17. The Straits Times (2013), "Survey: Too few go for regular colorectal cancer screening". Available at: <http://www.straitstimes.com/singapore/survey-too-few-go-for-regular-colorectal-cancer-screening> and The New Paper (2017), "1 in 4 don't go for follow-up after health screening".

Available at: <http://www.tnp.sg/news/singapore/1-4-dont-go-follow-after-health-screening>

18. AIA (2016), "2016 Healthy Living Index – Key Regional Findings".

Available at: <https://www.aia.com/content/dam/group/en/docs/healthy-living-pdf/aia-healthy-living-index-infographic-regional-2016.pdf>

19. McKinsey Global Institute (2014), *India's tech opportunity: Transforming work, empowering people*.

Available at: https://www.mckinsey.com/~/media/mckinsey/industries/high%20tech/our%20insights/indias%20tech%20opportunity%20transforming%20work%20empowering%20people/mgi%20india%20tech_full%20report_december%202014.ashx



private sector of revenue and pose a health risk to patients. In 2013, Interpol estimated that one million people die annually from counterfeit drugs and that up to 30 percent of drugs sold in many parts of the world are counterfeit.²⁰ The use of electronic tagging and tracking technologies in supply chains can improve traceability and reduce counterfeiting.

- Affordable and timely innovation.** Pathogens have rapidly evolved to resist antibiotics' ability to treat communicable diseases. It has been estimated that antimicrobial resistance (AMR) could cost the global economy up to US\$2 trillion yearly by 2030.²¹ It is only in recent years that AMR has become a global health problem as research and development in antibiotics have declined. Around 700,000 people die each year from infection by drug-resistant pathogens and parasites.²² Without action, the global number dying from AMR could rise to 10 million by 2050.

BRINGING A NEW DRUG TO THE MARKET TAKES UP TO 12 YEARS AND COSTS US\$1.9 BILLION

By then, the economic cost would be enormous, potentially reducing global GDP by 2 to 3.5 percent.²³ Although the need for novel antibiotics is urgent, the Association of the British Pharmaceutical Industry estimates that bringing a new drug to the market takes up to 12 years and costs US\$1.9 billion.²⁴ Businesses can save time, effort and money spent on cleaning and analysing data by using more modern digital tools to collect it. Tools like digital sensors for improved data collection can partly automate the work of tracking what every patient is doing, reducing the number of patients' clinic visits during the R&D period.²⁵

20. Insight Crime (2013), "Counterfeit Drugs Kill 1 Mn People Annually: Interpol" Available at: <https://www.insightcrime.org/news/brief/counterfeit-drugs-kill-1-million-annually-interpol/>

21. BSDC, Temasek, and AlphaBeta (2017), Better Business, Better World Asia.

Available at: <http://businesscommission.org/news/sustainable-businesses-can-unlock-us-5-trillion-in-new-market-value-in-asia-by-2030>

22. The Huffington Post (2014), "Drug-Resistant Infections Could Kill 10 Million A Year By 2050".

Available at: https://www.huffingtonpost.com/2014/12/11/drug-resistant-infections_n_6311720.html

23. AlphaBeta analysis.

24. ABPI (2016), Delivering value to the UK. Available at: https://www.abpi.org.uk/media/1673/delivering_values_dec2014.pdf

25. The Guardian (2016), "The price of health: the cost of developing new medicines".

Available at: <https://www.theguardian.com/healthcare-network/2016/mar/30/new-drugs-development-costs-pharma>

EXHIBIT 1:

A SUSTAINABLE HEALTHCARE SYSTEM WILL REQUIRE FUNDAMENTAL SHIFTS ACROSS FOUR ISSUES

ISSUE	FROM...	TO...
Limited Healthcare Access	Low levels of access outside developed world	Innovative risk pooling, including microinsurance
	Lack of healthcare coverage	Telehealth
High Cost of Care	Products designed for developed-country consumers	Low-cost products, e.g. accessible sanitary and contraceptive products
	High-cost surgical interventions	Lean surgical interventions
	Regular in-person check-ups	Remote monitoring of patients
	Doctor-centred health systems	Task-shifting to other healthcare workers
	Lack of focus on prevention, with rising cost of NCDs	More holistic focus on prevention, including focus on food and physical activities
Varying Quality of Care	Cumbersome, paper records	Digital, cloud-based records
	High rates of drug counterfeiting	Track-and-trace systems in supply chains
Barriers to Innovation	High-cost innovation	<ul style="list-style-type: none"> • Frugal innovation models and PPPs • New commitment to antibacterial R&D and vaccine development

A NEW SUSTAINABLE APPROACH COULD TRANSFORM HEALTHCARE AND CREATE SIGNIFICANT BUSINESS OPPORTUNITIES

These system-wide changes along the health and well-being value chain will lead to the emergence of a number of disruptive business opportunities (Exhibit 2). The largest business opportunities in the health and well-being system could have a value of US\$1.8 trillion in 2030 (US\$670 billion of those opportunities are in Asia). The biggest opportunities in Asia include risk pooling (US\$240 billion), remote patient management (US\$115 billion), and telehealth (US\$85 billion). Even low-cost surgery, ranking outside the top 10 largest business opportunities, is worth US\$15 billion.

Several opportunities with particular relevance in Asia were discussed in further detail during the session:

- **Risk pooling (US\$240 billion in Asia).** Risk pooling in healthcare insurance considers the potential medical costs of a group of individuals to determine their premiums. This way, the lower medical costs of healthier individuals can offset the higher medical costs of less healthy ones.²⁶ In addition to distributing health risks better across communities, risk pooling arrangements often include organised contracting functions that purchase healthcare on behalf of the individuals covered, which in turn encourages higher-quality private sector providers to develop.²⁷ Despite these benefits, health insurance coverage remains very low in many parts of Asia because of the lack of both consumer knowledge and suitable products. The expansion of risk pooling arrangements will require educating consumers to invest in their future health needs and building the analytical talent to operate risk-pooling arrangements. This is a particular challenge given the lack of good-quality health statistics in many parts of developing Asia. There are three major business opportunities associated with risk pooling:
 1. **Micro-insurance:** Micro-insurance for the low-income sector with flexible pay-as-you-go

options and designed to ensure affordability. Swiss Re estimates the market for “commercially viable microinsurance products” to be 2.6 billion people and US\$40 billion in direct written premiums, and Lloyd’s estimates a market of 1.5 to 3 billion policies at an annual growth rate of 10 percent.²⁸ Supported by micro-insurance, Philippines’ healthcare coverage rose from 20 percent in 2012 to almost 30 percent in 2014.²⁹

2. **Exploiting big data:** Artificial Intelligence (AI) and machine learning can be used for optimal risk pricing, underwriting, and loss control. For example, South African health insurer Discovery runs Vitality, a wellness programme, and uses big data analytics to build insights and compute individual risk.
 3. **P2P or social insurance:** It is broadly defined as a risk sharing network where a group of like-minded people or friends pool premiums to insure against a similar risk. For example, Friendsurance developed the first peer-to-peer insurance model worldwide. It rewards customers with a claims-free bonus if there are no insurance claims.
- **Remote patient monitoring (US\$115 billion):** Remote monitoring systems, which can reduce unnecessary hospitalisation and make preventative care more effective, involves using sensors that read the vital signs of patients at home so that nurses and doctors can be alerted to problems before they worsen. There are three main business opportunities associated with remote patient monitoring:
 1. **Hardware:** Emerging technologies include wearable patches that can diagnose heart conditions, sensors that monitor asthma medication intake and detect poor air quality,

26. American Academy of Actuaries (2018), “Risk Pooling: How Health Insurance In The Individual Market Works”.

Available at: <https://www.actuary.org/content/risk-pooling-how-health-insurance-individual-market-works-0>

27. AlphaBeta and the Business & Sustainable Development Commission (2017), *Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth*. Available at: <http://businesscommission.org/our-work/valuing-the-sdg-prize-unlocking-business-opportunities-to-accelerate-sustainable-and-inclusive-growth>

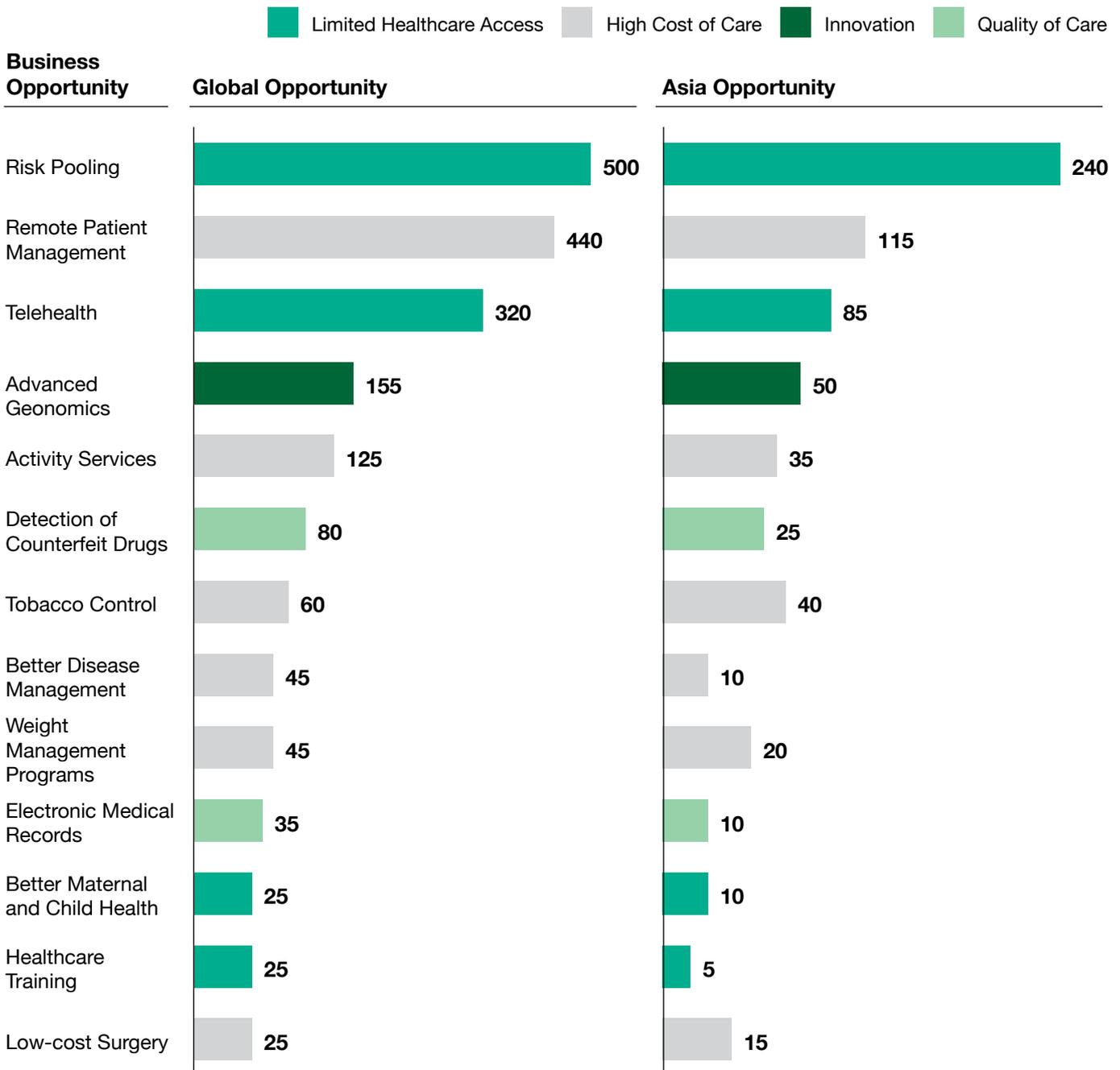
28. The International Association for the Study of Insurance Economics (2013), *Shin Research Excellence Awards: A partnership of The Geneva Association/International Insurance Society*. Available at: <https://link.springer.com/content/pdf/10.1057/gpp.2013.36.pdf> and Lloyd’s 360

Risk Insight and the MicroInsurance Centre (2009). *Insurance in developing countries*. Available at: <https://www.insurancejournal.com/news/international/2009/11/20/105464.htm>

29. GIZ and Insurance Commission Philippines (2016), *The Philippine Approach to Inclusive Insurance Market Development*.

Available at: <http://www.mefin.org/files/reports/CaseStudy-Philippine-approach-to-developing-inclusive-insurance-market.pdf>

EXHIBIT 2:

THE LARGEST BUSINESS OPPORTUNITIES IN HEALTH COULD HAVE VALUE OF US\$1.8 TRILLION IN 2030 (WITH US\$0.7 TRILLION IN ASIA)
**SIZE OF INCREMENTAL OPPORTUNITY IN HEALTHCARE IN 2030¹
(US\$ BILLIONS; 2015 VALUES)**


1. Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest US\$5 billion.

Source: Literature search; AlphaBeta analysis

and glucose monitors that send diabetics' data straight to their smartphones. For example, Royal Philips has launched the Philips Asia-Pacific (APAC) Centre in Singapore, which will create customised solutions and serve as a gateway to patients in the Association of Southeast Asian Nations (ASEAN) and the Pacific region.

2. **Software and platform delivery:** General purpose platforms like Vivify Health and Exco InTouch can be customised to provide the adequate level of patient engagement based on medical history.
 3. **Service providers:** Service providers include specialists in advanced data analytics and human resources. For example, Sentrian uses clinician-directed machine learning and disease deterioration models to remotely detect personalised health patterns. In terms of human resources, there is now an emerging group of firms that recruit and train nurses in functions linked to remote patient monitoring such as telephone triage, reviewing medical records, and case management. One example is Portea Medical, a Bangalore-based homecare provider with a 24-city network in India and which is rapidly expanding into Malaysia.
- **Telehealth (US\$85 billion):** Telehealth facilitates greater access to healthcare through the expansion of remote consultation and diagnosis of patients. Using basic mobile internet technologies, such as video conferencing, doctors, and patients – or doctors and local health workers – can discuss symptoms and determine treatment without having to travel or queue for services. There are three main business opportunities associated with remote patient monitoring:
 1. **Upskilling workers:** This involves using technology to upgrade the skills of lower-trained workers to conduct the activities of higher-skilled workers. For example, handheld ultrasound scanners are used by trained midwives to monitor foetus health in remote rural villages, greatly improving the care afforded to high-risk patients and decisions about when patients should be referred to hospital.³⁰
 2. **E-doctor services:** Greater access to health care can be facilitated through expansion of remote consultation and diagnosis of patients using basic mobile and internet technologies. For example, TeleDoctor in Pakistan provides qualified doctors at affordable prices (charged on a per minute basis) through Telenor's mobile service provider which covers 95 percent of Pakistan's rural underserved population.³¹ Another example is Zipline, which aims to use drones to deploy healthcare (e.g., blood, vaccines) in less than 15 minutes around Rwanda, overcoming poor transport infrastructure.³²
 3. **Consumer power:** Consumer-focused applications (apps) enable storage and sharing of medical records, and links to doctors and pharmacists (e.g., MyDoc, Ping An Good Doctor). Revenue streams include commission on consultations, subscription fees for providers and fees per employee of a corporation signed onto the platform. One example of this model is Ping An Good Doctor, valued at around US\$3 billion and backed by insurance giant Ping An. The company is reported to have 77 million registered app users and 50,000 doctors on its medical service platform.³³ The app provides a full suite of services including free diagnostics, internet consultation, an appointment booking service and an online pharmacist and health store.³⁴ By consolidating healthcare providers onto a common platform, Ping An Good Doctor encourages price competition as well as collaboration among healthcare providers.

30. GE Healthcare (2013), *Indonesian Maternal Healthcare to Benefit from GE Pocket-sized Ultrasound*.

Available at: <http://newsroom.gehealthcare.com/page/17/?s=GE+ultrasound&submit=search>

31. Centre for Health Market Innovations (2018), "TeleDoctor". Available at: <https://healthmarketinnovations.org/program/teledoctor>

32. Wired (2017), "Blood-Carrying, Life-Saving Drones Take Off for Tanzania". Available at: <https://www.wired.com/story/zipline-drone-delivery-tanzania/>

33. South China Morning Post (2016), "Medical services app Ping An Good Doctor raises US\$500m".

Available at: <http://www.scmp.com/business/article/1948859/medical-services-app-ping-good-doctor-raises-us500m>

34. South China Morning Post (2016), "Medical services app Ping An Good Doctor raises US\$500m".

Available at: <http://www.scmp.com/business/article/1948859/medical-services-app-ping-good-doctor-raises-us500m>

THERE ARE A NUMBER OF INNOVATIVE BUSINESS MODELS THAT CAN SUPPORT THE CAPTURE OF THESE OPPORTUNITIES

The session participants discussed how making this happen will require a new approach from businesses and the development of new business models. Four business models will be useful to consider for businesses trying to capture the opportunities identified earlier:

- Serving the bottom of the pyramid:** These are models that look to create “stripped down” models to profitably serve low-income segments. For example, Narayana Health’s use of “assembly line” lean surgical operations, bulk procurement of medical supplies, and highly standardised processes and protocols, has enabled them to perform surgeries at a quarter of the cost of other hospitals in India, and with mortality rates comparable to high-income countries. Another example is the use of medicine vending machines, in India, which reduces operating costs as well as increases accuracy and productivity.³⁵
 - Embracing new forms of collaboration:** These are models involving partnerships with other industry participants (often outside the sector) to capture value. For example, the Global Alliance on Vaccines and Immunization (GAVI) involves a collaboration of developing countries and donor governments, the World Health Organisation, UNICEF, the World Bank, the vaccine industry, research and technical agencies, civil society, and the Bill & Melinda Gates Foundation. GAVI has vaccinated half a billion children, saved 7 million lives, and achieved US\$80 billion to US\$100 billion in economic benefits.
 - Leveraging innovations in other sectors:** These are business models that seek to draw on disruptions in other sectors and apply them in healthcare. For example, a company, Zipline, is using drone technology in the delivery of blood and medicine in Africa.³⁶ Singapore start-up Yonah, comprised
- of National University of Singapore alumni and students, is building a cargo drone delivery system to provide measles vaccines to remote villages in Papua New Guinea.³⁷ Session participants discussed the challenges of replicating this model to other countries. For example, in the Philippines, there have been concerns about the possibility of the system being abused by terrorists, which has limited its use in transporting medical supplies. Another example mentioned by the session participants is how the National University Health System in Singapore has developed a way to draw blood samples from subjects without the latter having to make a trip to the hospital or clinic. A membrane is posted to the subject and securely seals the blood sample. This can then be securely delivered back to the lab via post.
- Combining behavioural insights with technology:** These are models that focus on the behavioural change needed to unlock opportunities. For example, there is a need to focus on consumer acceptance in scaling up product reformulation to reduce sugar, salt, and fat content of food. Another example is how new insurance models are incentivising prevention of non-communicable diseases. The AIA Vitality Programme enables subscribers to receive 15 percent discounts on their premiums when they adopt healthier lifestyle approaches.³⁸ Session participants discussed how preventive measures are important in prolonging and improving the quality of life but often not being actively pursued. For example, one senior executive of a local hospital observed that health screenings and checks are not widely conducted in Singapore, despite being low-cost and even free for senior citizens. This indicates the need to look at other levers, potentially including financial incentives, to make it more attractive for people to go for health screenings.

35. U.S. Mission India (2016), “First-of-its-kind Medicine Vending Machine Inaugurated at Aam Aadmi Mohalla Clinic”.

Available at: <https://in.usembassy.gov/first-kind-medicine-vending-machine-inaug-aam-aadmi-mohalla-clinic-jt-initiative-delhi-govt-usaid-wish-q/>

36. Quartz (2017), “We haven’t considered the true cost of drone delivery medical services in Africa”.

Available at: <https://qz.com/1090693/zipline-drones-in-africa-like-rwanda-and-tanzania-have-an-opportunity-cost/>

37. Channel news Asia (2018), “Singapore start-up aims to bring healthcare to Papua New Guinea’s needy, one drone at a time”.

Available at: <https://www.channelnewsasia.com/news/technology/singapore-start-up-aims-to-bring-healthcare-to-papua-new-guinea-9956414>

38. The Straits Times (2017), “Staying healthy can be a rewarding exercise”.

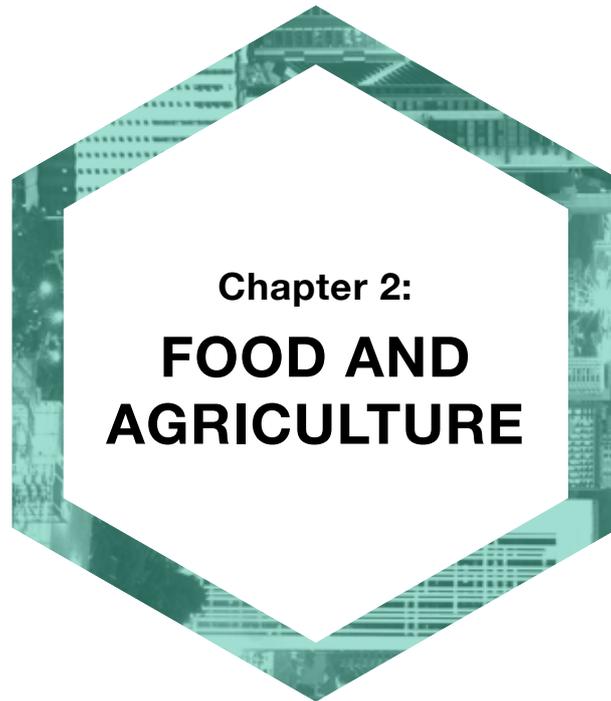
Available at: <http://www.straitstimes.com/singapore/health/every-step-counts-for-vitality-members>

A black and white photograph of a woman in traditional attire carrying a large woven basket on her back, walking through a field of tall rice plants. In the background, there are terraced rice paddies on a hillside under a bright sky.

“

The largest business opportunities in the food and agriculture system could have a commercial value of US\$2.3 trillion in 2030 (US\$1 trillion of those opportunities are in Asia).

”



Chapter 2:
**FOOD AND
AGRICULTURE**

This chapter explores the sustainability challenges and opportunities related to food and agriculture, as discussed in the breakfast event, entitled “The Ecosperity Series - Thriving in a Sustainable Economy: Food and agribusiness”. The event was held on Wednesday, 20th June 2017, and included a range of stakeholders from the food industry, government, investors, and academics.

Led by Dr. Fraser Thompson, Director of AlphaBeta, the session participants discussed how the food system in 2030 is faced with a number of challenges related to innovation, demand, supply, and regulation. A new sustainable approach could transform the food and agricultural sector and create significant business opportunities. The largest business opportunities in the food and agriculture system could have a commercial value of US\$2.3 trillion in 2030 (US\$1 trillion of those opportunities are in Asia). Unlocking these opportunities will require a shift in business models, including adopting “lean” models to serve low-income consumers, developing partnerships with adjacent industries and other organisations to share resources, creating closed-loop systems to minimise waste, developing new incentive models to change behaviour, and resetting the competitive playing field by getting ahead of looming regulatory action.

SUSTAINABILITY CHALLENGES IN FOOD...

The food system to 2030 is faced with a number of challenges related to innovation, demand, supply and regulation.

EXAMPLES OF CHALLENGES

Costs of soft commodities could increase by **BY 50% TO 450%** with GHG pricing and water subsidy reform



51% OF REMAINING ARABLE LAND

are subjected to both infrastructure and political risks



Growth rates in agricultural yields are currently

BELOW POPULATION GROWTH



INPUTS & PRODUCTION



US\$1 TRILLION

of food wasted throughout the value chain – a large share in food processing in developed countries

Cost of food fraud estimated at up to **US\$40 BILLION PER YEAR**



FOOD PROCESSING & LOGISTICS

Soda sales

DECREASED, ON AVERAGE, 8%

in Mexico over 2 years after the introduction of 10% sugar tax



ABOUT 10%

of produced plastics is lost to the ocean



RETAIL & DISPOSAL



...AND OPPORTUNITIES

THE BUSINESS OPPORTUNITIES LINKED TO SUSTAINABLE APPROACHES



The largest business opportunities in the food and agricultural system could have value of **US\$2.3 TRILLION** in 2030



OVER 40% of these business opportunities are in Asia (representing US\$1 trillion of opportunities in 2030)



3 largest opportunities (in terms of 2030 revenue size) are

REDUCING FOOD WASTE IN VALUE CHAIN; FOREST ECOSYSTEM SERVICES; AND LOW-INCOME FOOD MARKETS

EXAMPLES OF EMERGING NEW BUSINESS MODELS

SERVING THE BOTTOM OF THE PYRAMID

In the Philippines, small portion sized products (“tingi-tingi”) are particularly popular due to the low disposable incomes



EMBRACING NEW FORMS OF COLLABORATION

SABMILLER (a global brewer), works alongside local communities to protect watersheds they share



CLOSING THE LOOP

UNILEVER has pledged to ensure 100% of its plastic packaging is fully reusable, recyclable, or compostable by 2025



COMBINING BEHAVIOURAL INSIGHTS WITH TECHNOLOGY

Extension services in Thailand delivered through the mobile phone include automatic reminders on crop planting time



INTERNALISING THE SOCIAL COSTS

OLAM is developing digital solutions to quantify water footprint of products, and to identify actions to reduce



A “BUSINESS AS USUAL” APPROACH TO FOOD AND AGRICULTURE GOING FORWARD IS NOT FEASIBLE AND A FUNDAMENTAL SHIFT IN SEVERAL AREAS IS CRUCIAL

The food and agriculture system, both globally and in Asia, faces significant challenges across the full chain of activities over the next 15 years. A fundamental shift in several areas is needed to create a sustainable system (Exhibit 3):

- **Inputs.** Yield growth has steadily fallen due to a combination of land degradation, yield growth approaching current agro-ecological potential in many countries, and a lack of investment in innovation. Whilst traditional fertilisers may face constraints to volume growth, there could be a shift in value towards microbial fertilisers. New breeding techniques will be needed to develop crops appropriate to changing environmental conditions. Aquaculture disease control and feedstock innovation could transform the inputs to protein production.
- **Production.** The supply challenge to meet future food demand will be equally significant. By 2030, roughly 175 to 220 million hectares of additional cropland will be needed to meet projected food, feed, and fuel demand (even with continued 1 percent improvement in annual yield growth).³⁹ Whilst there is sufficient arable land available to meet this need, over half of this land (51 percent) is in places which have limited infrastructure and/or high political risk, and there are also rising environmental constraints. 33 percent of soils are moderately to highly degraded due to erosion, nutrient depletion, acidification, salinisation, compaction and chemical pollution; and at least 20 percent of the world’s aquifers are overexploited, including in important production areas such as the Upper Ganges (India) and California (United States of America).⁴⁰ As a result, water, energy and land-intensive products (e.g., beef) will face constrained growth from rising costs caused by reductions in resource subsidies

BY 2030, ROUGHLY 175 TO 220 MILLION HECTARES OF ADDITIONAL CROPLAND WILL BE NEEDED TO MEET PROJECTED FOOD, FEED, AND FUEL DEMAND

and the pricing of environmental externalities. It is estimated that prices of soft commodities could rise by between 50 to 450 percent if there are carbon pricing and water subsidy reform.⁴¹ In their place, less resource-intensive food groups, such as cereals, fish, and poultry, will experience faster growth.

Forest degradation through unsustainable farming practices will be replaced by more sustainable forest management practices, such as reduced impact logging and agroforestry approaches. There will be shifts towards sustainable agriculture approaches including holistic farming, no-till agriculture, and micro-irrigation, as well as increased focus on animal health and welfare. Contract farming and new partnership models with smallholder farmers will become increasingly prevalent and there will be a step change in the application of technology to farming, with increasing utilisation of big data to enable precision farming.

- **Food processing.** Between 20 and 30 percent of food is wasted somewhere along the value chain, even before allowing for food waste at the point of consumption.⁴² There will be a shift of value

BETWEEN 20 AND 30 PERCENT OF FOOD IS WASTED SOMEWHERE ALONG THE VALUE CHAIN, EVEN BEFORE ALLOWING FOR FOOD WASTE AT THE POINT OF CONSUMPTION

39. McKinsey Global Institute (2011), *Resource revolution: Meeting the world’s energy, materials, food, and water needs*. Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/resource-revolution>

40. International Resources Panel (2016), *Food systems and natural resources*. Available at: <http://www.resourcepanel.org/reports/food-systems-and-natural-resources>

41. McKinsey Global Institute (2011), *Resource revolution: Meeting the world’s energy, materials, food, and water needs*.

Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/resource-revolution>

42. FAO (2011), *Global food losses and food waste*. Available at: <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf>

towards low-waste producers given a combination of cost concerns and consumer focus, supported by increasing sustainability reporting requirements for food retailers. Concerted efforts to reduce the impact of non-communicable diseases, including obesity, are an important element of the SDGs and a growing concern for governments and consumers. In response, producers will need to focus on product reformulation to reduce fat and sugar and improve the nutritional content of processed food.

THE CURRENT COST OF FOOD SAFETY IN LOST PRODUCTIVITY, MEDICAL CLAIMS AND BILLS IS ESTIMATED AT BETWEEN US\$8 BILLION TO US\$23 BILLION ANNUALLY

- Logistics.** Logistics will need to change to address food safety and sustainability concerns of consumers. The current cost of food safety in lost productivity, medical claims and bills is estimated at between US\$8 billion to US\$23 billion annually.⁴³ Food fraud is a related additional concern. Food fraud is defined as the “deliberate and intentional substitution, addition, tampering, or misrepresentation of food, food ingredients, or food packaging; or false or misleading statements made about a product, for economic gain.” and is economically motivated.⁴⁴ The Food Fraud Initiative at Michigan State University has reported that the global cost of food fraud was between US\$30 billion to US\$40 billion in 2014, after accounting for a wide range of negative situations caused by food fraud (e.g. lost sales, bankruptcies, and health consequences).⁴⁵ This presents a significant

opportunity for food security and food safety diagnostic companies to provide solutions to tackle these issues. This will also fuel the rapid growth of cold storage systems and full traceability of products.

- Retail & disposal.** The retail sector will be one of the most transformed areas of the value chain, with opportunities for new markets serving low-income consumers, and sustainably sourced products emerging from a niche category to the industry standard. Among consumers under age 20 in the United States of America, 41 percent said they would willingly pay a premium for sustainable products.⁴⁶ In Mexico, soda sales decreased by 6 percent and 10 percent in the first and second year respectively (averaging 8 percent over 2 years) after the introduction of a 10 percent sugar tax.⁴⁷ Consumers are also increasingly concerned with animal treatment, animal-welfare standards, and overall farming conditions. At the end of the value chain, traditional waste management will be replaced with the establishment of closed loops systems and energy capture processes (e.g., biogas production). With about 10 percent of produced plastic lost to pollution in ocean ecosystems, and just under half placed in landfills, there are ample opportunities to increase the amount of material that is recycled.⁴⁸



AMONG CONSUMERS UNDER AGE 20 IN THE US, 41 PERCENT SAID THEY WOULD WILLINGLY PAY A PREMIUM FOR SUSTAINABLE PRODUCTS

43. The University of Rhode Island (2017), “Current Food Safety Issues”. Available at: <http://web.uri.edu/foodsafety/current-food-safety-issues/>

44. Michigan State University (2011), “Backgrounder: Defining the Public Health threat of Food Fraud”.

Available at: <http://foodfraud.msu.edu/wp-content/uploads/2014/07/food-fraud-ffg-backgrounder-v11-Final.pdf>

45. Food Industry Asia (2016), “Fighting US\$40 Billion Food Fraud to Protect Food Supply Systems”.

Available at: <https://foodindustry.asia/fighting-us40billion-food-fraud-to-protect-food-supply-systems>

46. USA Today (2015), “Younger folks want healthier food - and will pay for it”.

Available at: <https://www.usatoday.com/story/money/2015/01/19/healthy-food-nielsen-global-health--wellness-study/22000167/>

47. The Guardian (2015), “Mexican soda tax cuts sales of sugary soft drinks by 6% in first year”. Available at: <https://www.theguardian.com/world/2015/jun/18/mexican-soda-tax-cuts-sales-first-year> and The Guardian (2017), “Mexico’s sugar tax leads to fall in consumption for second year running”.

Available at: <https://www.theguardian.com/society/2017/feb/22/mexico-sugar-tax-lower-consumption-second-year-running>

48. Seabin (2018), “Seabin Project’s “Whole Solution” Proposal for Ocean Conservation And Sustainability”. Available at: <http://seabinproject.com/seabin-projects-whole-solution-proposal-for-ocean-conservation-and-sustainability/> and Time (2015), “Here’s How Much Plastic Ends Up In the World’s Oceans”. Available at: <http://time.com/3707112/plastic-in-the-ocean/>

EXHIBIT 3:

A SUSTAINABLE FOOD SYSTEM WILL REQUIRE FUNDAMENTAL SHIFTS ACROSS THE VALUE CHAIN

VALUE CHAIN	ISSUE	FROM...	TO...
Inputs	Falling Yield Growth	Basic cross-breeding	Precision phenotyping and Bioinformatics
Production	Inadequate Arable Land	Securing land with high infrastructure / political risk	<ul style="list-style-type: none"> • Urban agriculture (vertical farming) • Shift to aquaculture
		Unsustainable farming	Holistic grazing; low till/no till agriculture
	Lack of Sustainable Farming	Low water efficiency	Micro-irrigation
		Low data, traditional farming	Precision agriculture
	Cost of Government Subsidies	Subsidies to energy, water, and fishing	<ul style="list-style-type: none"> • “Energy-smart” agriculture • Dietary shift to less resource intensive food
Food Processing	Consumer Pressure on Food Waste	Lack of storage facilities	Modern, cold storage systems
		Restaurant Waste	Internet of Things (IoT) in the kitchen
		Limited Waste Capture	Composting and energy capture
Logistics	Food Safety	Limited traceability	IoT and fully traceable supply chains
		Limited monitoring of animal welfare	Animal health monitoring & diagnostics
Retail & Disposal	Food Poverty	Unfortified food	Food fortification
		High cost distribution	“Lean” distribution and micro-products
	Obesity	High sugar/fat products	<ul style="list-style-type: none"> • Product reformulation; low fat/sugar products • Activity services; weight management programs
	Packaging Waste	1/3 of produced plastic lost to pollution in ocean and land	Increased recycling and waste-2-energy

A NEW SUSTAINABLE APPROACH COULD TRANSFORM FOOD AND AGRICULTURE AND CREATE SIGNIFICANT BUSINESS OPPORTUNITIES

These system-wide changes along the food and agriculture value chain will lead to the emergence of a number of disruptive business opportunities (Exhibit 4). The largest business opportunities in the food and agriculture system could have a value of US\$2.3 trillion in 2030 (US\$1 trillion of those opportunities are in Asia). The biggest opportunities include reducing food waste in the value chain (US\$405 billion), forest ecosystem services (US\$365 billion), and low-income food markets (US\$265 billion). In Asia, reducing consumer food waste and sustainable aquaculture also represent sizable business opportunities.

Below are further details on some of the largest opportunities:

- Food waste (US\$260 billion in the value chain in Asia).** According to the FAO, total food waste is worth about US\$1 trillion today.⁴⁹ WRI estimates that roughly 35 percent of food is wasted at the consumption level, with the remainder lost during production and in the value chain.⁵⁰ The majority of losses in the value chain occur in developing countries, where poor storage facilities and inadequate transport infrastructure mean that a significant share of food is wasted after harvest. There is a range of investment opportunities, ranging from data systems to better manage production processes, through to investment in cold storage facilities. The Japan Weather Association has collaborated with food producers such as Mizkan Holdings and Sagamiya Foods to develop a novel artificial intelligence system to predict food demand based on weather information and sales data.⁵¹ This system aims to help companies scale back redundant production and cut food inventory losses. Solar E. Technology, which has offices in Australia and Bangladesh, and Bangladesh Clean Technology Company Ltd are introducing affordable solar-based micro cold storages to farmers in Bangladesh to replace traditional ammonia-based cold stores.⁵² In countries like China and Malaysia, more companies

are building automated freezer storage that use robots to stack and retrieve food products efficiently, reducing food wasted through human error or delays. A key challenge to scaling this opportunity is the high capital outlay required for cold chain systems, although partnerships between firms can make financing viable.

- Technology in farming production (US\$50 billion in large-scale farms and US\$55 billion in small-scale farms).** Yield growth has steadily fallen due to a combination of land degradation, yield growth approaching current agro-ecological potential in many countries, and a lack of investment in innovation. This underinvestment in innovation in agriculture is sizeable – for example, agriculture represents 10 percent of global GDP, but AgTech accounts for only 3.5 percent of global venture capital funds.⁵³ However, a range of new technologies could help transform productivity in large-scale and small-scale farms.

Opportunities include:

- Enhanced extension services to smallholder farmers.** Technology can play a particularly important role in overcoming information gaps and supporting cost-effective business models serving smallholder farms. For example, almost 200,000 farmers use the *1677 Farmer Information Superhighway in Thailand. This began as an SMS-service and has evolved into MMS, videos over 3G, mobile phone apps and a mobile marketplace for helping farmers improve productivity.

**AGRICULTURE REPRESENTS
10 PERCENT OF GLOBAL GDP, BUT AGTECH
ACCOUNTS FOR ONLY 3.5 PERCENT OF
GLOBAL VENTURE CAPITAL FUNDS**

49. FAO (2018), "Seeking end to loss and waste of food along production chain".

Available at: <http://www.fao.org/in-action/seeking-end-to-loss-and-waste-of-food-along-production-chain/en/>

50. World Resources Institute and UNEP (2013), "Reducing food loss and waste".

Available at: <http://www.wri.org/events/2013/06/unep-wri-press-conference-reducing-food-loss-and-waste>

51. Nikkei Asian Review (2016), "AI could solve Japan's food waste problem".

Available at: <https://asia.nikkei.com/Tech-Science/Tech/AI-could-solve-Japan-s-food-waste-problem>

52. Solar E. Technology Bangladesh (2017), "Solar Energy for Cold Stores". Available at: <http://www.solar-e-technology-bd.com/solar-energy-cold-storage>

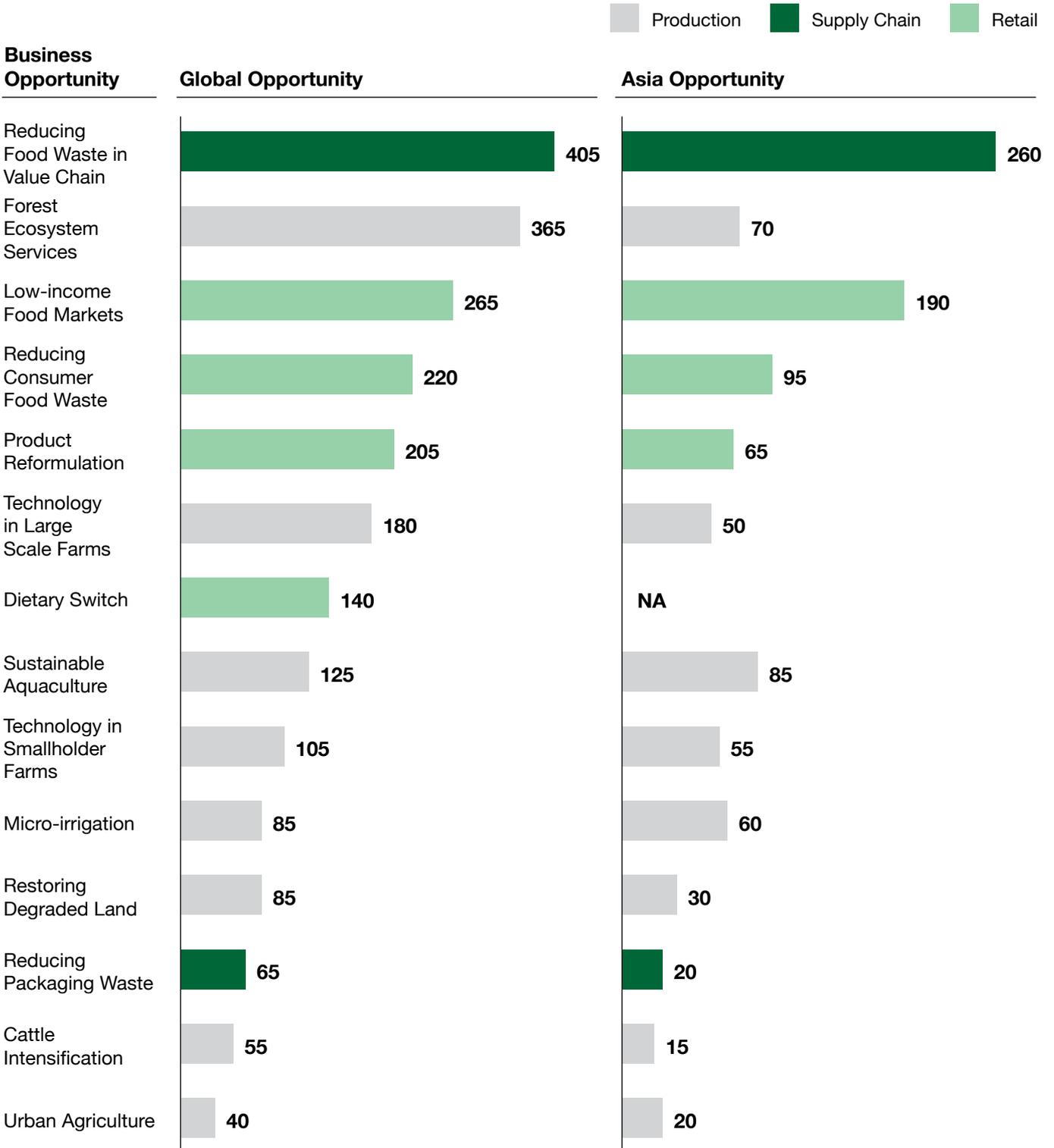
53. Anterra Capital (2017), *Transforming the way we produce, move, and consume food*.

Available at: <https://nrclive.nl/wp-content/uploads/2017/06/Adam-Anders.pdf>

EXHIBIT 4:

THE LARGEST BUSINESS OPPORTUNITIES IN THE FOOD SYSTEM COULD HAVE VALUE OF US\$2.3 TRILLION IN 2020 (WITH US\$1.0 TRILLION IN ASIA)

**SIZE OF INCREMENTAL OPPORTUNITY IN 2030¹
(US\$ BILLIONS; 2015 VALUES)**



1. Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest US\$5 billion.
Source: Literature search; AlphaBeta analysis

2. **New financing models.** Financing is a particular challenge for smallholders and here a range of new models are also being developed. Financial institutions such as Root Capital, MicroVest, and Alterfin, Grassroots Capital Management and Saroni are exploring financing models which lower transaction costs by using mechanisms such as certification programmes to create investible pipelines, as well as lowering distribution costs through mobile transfers, and using crop and weather insurance products to reduce default risk. In addition, if agriculture yields become more consistent (and higher) through the application of these technologies, there could also be a significant financing benefit – contracts could be restructured with risk premiums reduced and longer-term commitments, resulting in higher volumes of finance being available at lower interest rates.
 3. **Big data and IoT solutions.** A range of solutions can help improve yields on large-scale farms, including using big data techniques to optimise crop yield, fitting tractors with global-positioning-systems (GPS) and multispectral sensors (to allow precise application of nitrogen), farm-management software, drone technology, and advanced robotics.⁵⁴ The critical barriers relate to capital requirements (and gaps in local financial systems) to support investment in precision farming; lack of basic infrastructure connecting farms to markets; and the need to manage potential negative impacts on the environment through the appropriate use of fertilisers and soil management.
- **Dietary switch.**⁵⁵ Growing concern with the environmental footprint of food production and health-related issues are leading to shifts in diets. For example, the environmental footprint of vegetarian diets is substantially lower than diets based on animal consumption – less land, water and fertiliser are required. Similarly, the resource intensity of producing beef is estimated to be 10 times larger than a calorie-equivalent amount of poultry and pork: up to 26 times more land, 10 times more water and five times the GHG and nitrogen emissions.⁵⁶ Consumer preferences are already starting to change in some developed countries, and may be further pushed by price signals as resource subsidies are removed. Better education of consumers will also be important – there is an information failure related to the benefits of different diets, including the ability of plant-based diets to provide the required amount of nutrients and protein.⁵⁷ The Chinese government, for example, has recently issued new dietary guidelines and begun a public education campaign aimed at reducing meat consumption by up to 50 percent.⁵⁸

A range of new forms of food is also emerging with the aim of providing sufficient nutrients and calories, while preserving the environment. For example, companies like Beyond Meat and Impossible Foods in the United States have developed plant-based burgers that look and taste more like meat. Other emerging food innovations include insects such as crickets, which are consumed in powdered-form and contain more protein and micronutrients per pound than beef. A further example is Kernza, a perennial plant that produces grain for five years (as opposed to wheat's single year of production) which can be used in baking and beer production. It has numerous ecological benefits, due to its deep roots providing drought resilience, as well as depositing carbon into the soil, and boosting overall soil health.⁵⁹ Even algae is being used to produce a new form of oil which could potentially substitute for palm oil.

54. *The Economist* (2016), "The future of agriculture". Available at: <https://www.economist.com/technology-quarterly/2016-06-09/factory-fresh>

55. Given the nascent stage of many of these food innovations, the overall market potential in Asia is currently difficult to size.

56. G. Eshel, A. Shepon, T. Makov & R. Milo (June 2014), *Land, irrigation, water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States*, *Proceedings of the National Academy of Sciences*, Vol. 111, No. 33.

57. *World Resources Institute* (2016), *Shifting Diets for a Sustainable Future*.

58. *The Guardian* (2016), "China's plan to cut meat consumption by 50% cheered by climate campaigners".

59. *National Geographic* (2018), "Menu of the Future: Insects, Weeds, and Bleeding Veggie Burgers."

Available at: <https://news.nationalgeographic.com/future-of-food/future-of-food-agriculture-ecology/>



THERE ARE A NUMBER OF INNOVATIVE BUSINESS MODELS THAT CAN SUPPORT THE CAPTURE OF THESE OPPORTUNITIES

The session participants discussed how making this happen will require a new approach from businesses and the development of new business models. Five business models will be useful to consider for businesses trying to capture the opportunities identified earlier:

- **Serving the bottom of the pyramid:** These are models that look to create “stripped down” models to profitably serve low-income segments. For example, in the Philippines, small portion sized products (“tingi-tingi”) are particularly popular due to the low disposable incomes.
- **Embracing new forms of collaboration:** These are models involving working on partnerships with other industry participants (often outside the sector)

to capture value. For example, SABMiller plc (a global brewer now owned by Anheuser-Busch InBev), works alongside local communities to protect the watersheds they share and on which they each depend.⁶⁰

- **Closing the loop:** Given the increasing consumer and regulatory concern with food and packaging waste, a range of new business models are seeking

**UNILEVER HAS PLEDGED TO ENSURE
100 PERCENT OF ITS PLASTIC PACKAGING
IS FULLY REUSABLE, RECYCLABLE, OR
COMPOSTABLE BY 2025**

60. *The Guardian* (2012), “SABMiller: more beer from less water”. Available at: <https://www.theguardian.com/sustainable-business/best-practice-exchange/sabmiller-more-beer-less-water>



to create so-called “closed loop” systems which aim to reduce, reuse, and recycle key inputs in order to eliminate waste. For example, Unilever has pledged to ensure 100 percent of its plastic packaging is fully reusable, recyclable, or compostable by 2025. To support this, it has launched a pilot plant in East Java, Indonesia, which aims to validate the commercial viability of technology for recycling waste sachets.⁶¹

- **Combining behavioural insights with technology:** These are models that focus on the behavioural change needed to support unlocking opportunities. For example, extension services for smallholder

farmers in Thailand delivered through the mobile phone include automatic reminders on crop planting time.

- **Internalising the social costs:** These are models that anticipate regulatory action to address social costs and are designed to “get out in front” of this. For example, Olam is getting ahead of potential regulatory concerns on the environmental footprint of agricultural production by developing digital solutions to quantify the water and environment footprint of products and to identify potential opportunities to reduce this footprint.

61. Unilever (2013), “Tackling sachet waste”.

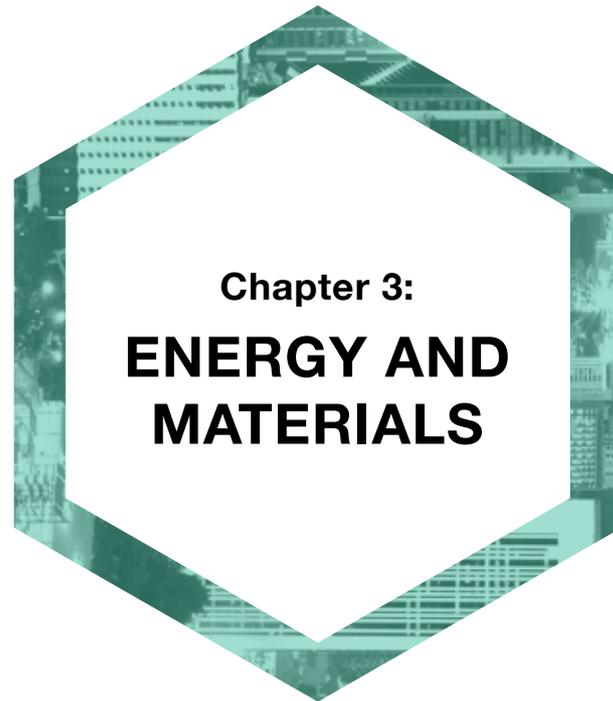
Available at: <https://www.unilever.com/sustainable-living/sustainable-living-news/news/Tackling-sachet-waste.html>



“

The largest business opportunities in the energy and materials system could have a commercial value of US\$4.4 trillion in 2030 (US\$1.9 trillion of those opportunities are in Asia).

”



Chapter 3:
**ENERGY AND
MATERIALS**

This chapter explores the sustainability challenges and opportunities related to energy and materials, as discussed in the breakfast event, entitled “The Ecosperity Series - Thriving in a Sustainable Economy: Energy and Materials”. The event was held on Monday, 27th November 2017, and included a range of stakeholders from industry, government, investors, and academics.

Led by Dr. Fraser Thompson, Director of AlphaBeta, the session participants discussed how slower demand growth for energy and materials alongside more diverse and flexible supply offer new challenges and opportunities in this area, including new forms of partnership between extractive companies and resource-rich countries. A new sustainable approach could transform the energy and materials system and create significant business opportunities. The largest business opportunities in the energy and materials system could have a commercial value of US\$4.4 trillion in 2030 (US\$1.9 trillion of those opportunities are in Asia). Unlocking these opportunities will require a shift in business models, including adopting “stripped down” models to profitably serve low-income segments (e.g., Kenya’s “pay-as-you-go” access to lighting); developing new forms of partnership (particularly in infrastructure sharing with other operators and community groups); transforming goods into services (with closed loop models such as Michelin selling truck miles rather than tyres); and getting ahead of regulatory action by adopting resource-efficient models in areas such as carbon and water.

SUSTAINABILITY CHALLENGES IN ENERGY AND MATERIALS...

The shift of production to more geographically complex and politically risky locations, combined with increasing concerns about access to basic resources and the environmental footprint of energy & materials creates a series of challenges for this sector.

EXAMPLES OF CHALLENGES



ALMOST HALF of new copper projects are in countries with high levels of political risk



Since 1995, **MORE THAN 50%** of resource-driven countries have failed to match the average growth rate of all countries

LICENSE TO OPERATE



32% OF COPPER MINES AND 39% OF IRON ORE MINES

mines are in areas of moderate to high water scarcity

Climate regulation could create **US\$300 BILLION** of potentially 'stranded' assets worldwide by 2035



SUSTAINABLE PRODUCTION

By 2025, the world's cities could generate

2.2 BILLION TONNES OF WASTE



In less than 10 years, there could be

250 MILLION TONNES OF PLASTIC IN THE OCEANS



SUSTAINABLE CONSUMPTION

1.2 BILLION PEOPLE GLOBALLY

still lack access to electricity, and

512 MILLION

of those are in Asia



ACCESS



...AND OPPORTUNITIES

THE BUSINESS OPPORTUNITIES LINKED TO SUSTAINABLE APPROACHES



The largest business opportunities in the energy and materials system could have value of

US\$4.4 TRILLION
in 2030



MORE THAN 40%
of these business opportunities are in Asia (representing US\$1.9 trillion of opportunities in 2030)



3 largest opportunities (in terms of 2030 revenue size) are

THE EXPANSION OF RENEWABLES, CIRCULAR MODELS IN BOTH AUTOMOTIVE AND APPLIANCES

EXAMPLES OF EMERGING NEW BUSINESS MODELS

SERVING THE BOTTOM OF THE PYRAMID

Mobile “pay-as-you-go” access to lighting in Kenya



EMBRACING NEW FORMS OF COLLABORATION

Sharing infrastructure (such as roads, energy plants, and railways) between extractive companies and local communities



TRANSFORMING GOODS INTO SERVICES

MICHELIN selling truck miles and not tyres



COMBINING BEHAVIOURAL INSIGHTS WITH TECHNOLOGY

UNILEVER incentivises recycling efforts through monetary incentives in Morocco and Indonesia



INTERNALISING THE SOCIAL COSTS

Pricing of water in mining operations



A “BUSINESS AS USUAL” APPROACH TO ENERGY & MATERIALS GOING FORWARD IS NOT FEASIBLE AND A FUNDAMENTAL SHIFT IN FOUR AREAS IS CRUCIAL

Asia is not only home to much of the world’s energy and mineral resources, it is also pivotal for future demand. For example, Asia is expected to account for 88 percent of the expected global growth in demand for oil from just below 90 million barrels a day in 2013 to around 109 million barrels a day by 2035.⁶² Perhaps surprisingly, not all this demand growth is coming from China and India: ASEAN (which includes Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam) forecasts an increase in members’ energy demand through to 2035 of 80 percent, a growth rate faster than China’s and an absolute increase equivalent to Japan’s current total energy demand.⁶³ The energy and materials system is currently being impacted by a range of demand, technological, and regulatory shocks, and a sustainable energy & materials system will require a fundamental shift in four key areas (Exhibit 5):

- License to operate.** Historically, almost 90 percent of that investment has been in high-income and upper-middle-income countries. But in the future, the share of resource investment outside these two groups – to low-income and lower-middle-income countries – could almost double.⁶⁴ These changes will mean that extractive companies will not only have to increasingly focus on improving cost efficiency (which is already starting to happen given the current state of the commodity cycle) but also form stronger partnerships with developing countries that can address the political risks and other concerns that have plagued previous relationships. As a result, extractive industries will need to evolve their business models to ensure they maintain their ‘licence to operate’. Almost half of new copper projects are in countries with high levels of political risks.⁶⁵ Hence, closer engagement with local communities through increasing the local content in their supply chains and partnering to develop
- Lack of sustainable production.** Production is shifting to more complex supply sources, including tar sands and deep-water oil in the case of energy; and to more remote locations with weak infrastructure. Water access could also significantly constrain output given that 32 percent of copper mines and 39 percent of iron ore mines are in areas of moderate to high water scarcity. This not only increases the risk of disruptions to supply but also makes supply even more inelastic. In addition, climate regulation could put returns on capital invested in energy at risk, affecting US\$300 billion of potentially ‘stranded’ assets worldwide by 2035.⁶⁷ Pricing of carbon and water would significantly alter cost curves for major resources and fuels. For example, pricing water to reflect its ‘shadow cost’ – the economic value of the water if put to its best alternative use – could increase iron ore costs by 3.3 percent across the industry.⁶⁸

ASIA IS EXPECTED TO ACCOUNT FOR 88 PERCENT OF THE EXPECTED GLOBAL GROWTH IN DEMAND FOR OIL FROM JUST BELOW 90 MILLION BARRELS A DAY IN 2013 TO AROUND 109 MILLION BARRELS A DAY BY 2035

shared infrastructure will be critical. This is also important as resource-driven countries have tended to underperform those without significant resources: since 1995, more than half of these countries have failed to match the average growth rate of all countries. Only one-third have maintained growth beyond the resource boom.⁶⁶

62. Organisation of the Petroleum Exporting Countries (2013), “Economic Growth and Energy Demand Outlooks in Asia”. Available at: http://www.opec.org/opec_web/en/2611.htm

63. International Energy Agency and ERIA (2013), *World energy outlook special report: Southeast Asia energy outlook*. Available at: https://www.iea.org/publications/freepublications/publication/WEO2015_SouthEastAsia.pdf

64. McKinsey Global Institute (2013), *Reverse the curse: Maximizing the potential of resource-driven economies*. Available at: <https://www.mckinsey.com/industries/metals-and-mining/our-insights/reverse-the-curse-maximizing-the-potential-of-resource-driven-economies>

65. McKinsey Global Institute (2015), *No Ordinary Disruption: The Four Global Forces Breaking All the Trends*.

Available at: <https://www.mckinsey.com/mgi/no-ordinary-disruption>

66. McKinsey Global Institute (2013), *Reverse the curse: Maximizing the potential of resource-driven economies*. Available at: <https://www.mckinsey.com/industries/metals-and-mining/our-insights/reverse-the-curse-maximizing-the-potential-of-resource-driven-economies>

67. International Energy Agency (2014), *World Energy Investment Outlook*.

Available at: <https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf>

68. McKinsey Global Institute (2011), *Resource Revolution: Meeting the world’s energy, materials, food, and water needs*.

Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/resource-revolution>

Dealing with these trends will require a transformation in production approaches. Extraction processes will focus on minimising the environmental footprint of activities through using technologies to improve recovery rates, reduce energy and water consumption, and enhance the rehabilitation of post-extractives sites and communities. Generation infrastructure will be radically reshaped, spurring demand for smarter grids with increased storage capacity and more interconnection to manage the variable output of most renewable energy sources. At the same time, the efficiency of fossil fuel generation will increase as coal plants move to supercritical technology, and combined cycle gas turbines become the norm. Remaining coal generation will make increased use of carbon capture and storage to reduce emissions.

- Lack of sustainable consumption.** The retail and consumer market will change considerably by 2030. While overall demand may face some headwinds, APAC's consuming class is expected to more than double by 2030, from the current 552 million households to roughly 1.2 billion households, stimulating future demand.⁶⁹ This growth in demand will place further emphasis on the environmental footprint of this consumption, and companies will also need to find new ways to secure access to key material inputs. The importance of disposal and recovery processes in the value chain will grow significantly. In 2012, the World Bank estimated that the world's cities generated 1.3 billion tonnes of solid waste, around double the amount from ten years earlier; by 2025, this is expected to reach 2.2 billion tonnes.⁷⁰

This rapid increase is challenging the ability of local and national governments to manage waste effectively. Most of this growth is taking place in developing countries – over 90 percent of the municipal solid waste volume increase to 2025 will occur in low- and middle-income countries.⁷¹ Plastic

APAC'S CONSUMING CLASS IS EXPECTED TO MORE THAN DOUBLE BY 2030, FROM THE CURRENT 552 MILLION HOUSEHOLDS TO ROUGHLY 1.2 BILLION HOUSEHOLDS, STIMULATING FUTURE DEMAND

waste is particularly challenging. The development of plastics over the last eighty years has led to a revolution in packaging and consumer goods and enhanced convenience for billions of people. Yet a massive amount of plastic has leaked into our environment. An estimated 8 to 14 million metric tonnes of plastics enter the oceans of the world annually.⁷² With the rapid expansion in the size of the consumer class, the quantity of plastic marine debris could accelerate quickly. In less than 10 years, there could be 250 million tonnes of plastic in the oceans.⁷³

As a result of these trends, there could be a transformation in production and consumption models. Consumers will no longer be end-points but important links in a circular chain. Consumer durables will be leased out or sold back to manufacturers and recyclers at end-of-life. The growth of distributed renewable energy devices (e.g., rooftop solar photovoltaic (PV) cells) will allow consumers to sell energy back into the grid. Consumers' awareness and concern about the sustainability of the supply chains for the products they consume will also increase.

AN ESTIMATED 8 TO 14 MILLION METRIC TONNES OF PLASTICS ENTER THE OCEANS OF THE WORLD ANNUALLY

- Enhancing access.** Despite the increasing affluence of many consumers, 1.2 billion people globally still lack access to electricity, and 512 million of those

69. McKinsey & Company (2015), *No ordinary disruption: The forces reshaping Asia*.

Available at: <https://www.mckinsey.com/global-themes/asia-pacific/no-ordinary-disruption-the-forces-reshaping-asia>

70. World Bank (2012), "What a Waste: A Global Review of Solid Waste Management". *Urban Development Series Knowledge Papers No. 15*.

Available at: <https://openknowledge.worldbank.org/handle/10986/17388>

71. McKinsey & Company and the Ocean Conservancy (2015), *Stemming the tide: Land-based strategies for a plastic-free ocean*.

Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/stemming-the-tide-land-based-strategies-for-a-plastic-free-ocean>

72. J. R. Jambeck et al (2015), "Plastic waste inputs from land into the ocean," *Science*, vol. 347, no. 6223, pp. 768–771. Available at: https://www.iswa.org/fileadmin/user_upload/Calendar_2011_03_AMERICANA/Science-2015-Jambeck-768-71_2_.pdf; NRDC (2015), "The Blue (Plastic) Planet". Available at: <https://www.nrdc.org/onearth/blue-plastic-planet>, and Mashable Asia (2015), "We dump about 19 billion pounds of plastic into the ocean every year".

Available at: <https://mashable.com/2015/02/19/plastic-oceans-19-billion-pounds/#OIOT43YOMaG>

73. McKinsey & Company and the Ocean Conservancy (2015), *Stemming the tide: Land-based strategies for a plastic-free ocean*.

Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/stemming-the-tide-land-based-strategies-for-a-plastic-free-ocean>



are in Asia.⁷⁴ Providing universal access to modern energy by 2030 may require annual investments of over US\$40 billion.⁷⁵ However, the poor already spend up to 10 percent of their monthly household income on inefficient traditional fuels, such as kerosene, wood, and charcoal.⁷⁶ The International Finance Corporation estimates that even without major investments in grid infrastructure, energy access could be significantly improved through low-cost household products, such as solar lanterns and improved cookstoves, and community-level mini-utilities. These products need to be sold

**PROVIDING UNIVERSAL ACCESS TO
MODERN ENERGY BY 2030 MAY REQUIRE
ANNUAL INVESTMENTS OF OVER
US\$40 BILLION**

through financing arrangements that recognise the circumstances of the poor. In Bangladesh, for example, Grameen Shakti provides large-scale home solar installations for a small upfront cost, then monthly payments over three years.

74. World Energy Outlook (2016), "Electricity access database". Available at: <https://www.iea.org/energyaccess/database/>

75. IIASA, UNIDO & GEF (2012), Access to modern energy: Assessment and Outlook for Developing and Emerging Regions.

Available at: http://www.iiasa.ac.at/web/home/research/researchPrograms/Energy/IIASA-GEF-UNIDO_Access-to-Modern-Energy_2013-05-27.pdf

76. International Finance Corporation (2012), From Gap to Opportunity: Business Models for Scaling Up Energy Access. Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_report_gap-opportunity

EXHIBIT 5:

A SUSTAINABLE ENERGY AND MATERIALS SYSTEM WILL REQUIRE FUNDAMENTAL SHIFTS ACROSS FOUR ISSUES

ISSUE	FROM...	TO...
License to Operate in Resource-rich Countries	Low levels of local content	Higher local content in the supply chain
	Weak infrastructure in many resource-driven countries	Development of shared infrastructure with local communities
Sustainable Production	Low recovery rates	Higher recovery rates based on improved mechanisation
	Wasteful industrial use of water	Focus on water efficiency and water partnerships
	Traditional grids with limited storage capacity from pumped hydro	Automated smart-grids with higher storage capacity from batteries
	CO ₂ intensive energy	Distributed, interconnected grids
	Inadequate remediation of mine and well sites	Rehabilitation of post-extractives sites and communities
Sustainable Consumption	Buying goods	Buying services
	Landfill disposal	Disassembly for remanufacturing
	Low energy efficiency	Energy use as core efficiency opportunity
Consumer Access	“One size fits all” pricing	Low cost energy access models

A NEW SUSTAINABLE APPROACH COULD TRANSFORM ENERGY AND MATERIALS AND CREATE SIGNIFICANT BUSINESS OPPORTUNITIES

These system-wide changes along the energy and materials value chain will lead to the emergence of a number of disruptive business opportunities (Exhibit 6). The largest business opportunities in the energy and materials system could have a value of US\$4.4 trillion in 2030 (US\$1.9 trillion of those opportunities are in Asia). The biggest opportunities include circular models in automotive (US\$810 billion), renewable energy expansion (US\$605 billion), and circular models in appliances (US\$525 billion).

The session participants discussed several business opportunities in further detail:

- Circular economy (US\$255 billion in automotive; US\$165 billion in appliances; and US\$115 billion in electronics in Asia).** The session participants discussed how circular business models based on recycling and remanufacturing may displace linear models in durable goods and automotive, driving changes in product design and value chains. The automotive sector will be particularly affected. There are almost 2 billion registered vehicles globally, and a third of these are found in China, India, Indonesia, and Japan.⁷⁷ Already in 2008, approximately 2 million vehicles were disposed in China every year: at historical growth rates, over 20 million vehicles a year will be disposed in China by 2020.⁷⁸ Some of these end-of-life vehicles (ELVs) will be exported as second-hand and the rest sent from automobile retailers to auto dismantlers and scrap metal companies to be processed for reusing and recycling. Collection rates for ELVs are generally very high in countries that have a legislative ELV system that sets the target recovery rate at around 95 percent. China, Japan, and South Korea all have legislative ELV recycling systems in place and India and Vietnam are preparing to.⁷⁹ Recycling ELVs into base materials is energy intensive and results in loss of value. Given that the failure of only a small number of 'weakest-link' components is typically responsible for the end of a vehicle's life, it is possible to extend vehicle life significantly by

APPROXIMATELY 2 MILLION VEHICLES ARE DISPOSED OF IN CHINA EVERY YEAR; THIS COULD GROW TO OVER 20 MILLION VEHICLES A YEAR BY 2020

increasing rates of refurbishment and remanufacture of these components. This increases the efficiency of material and energy use and raises the residual value of the vehicles. Michelin's scheme for billing tyres provides an example of 'weakest link' management. Trucking companies and airlines can choose to be billed based on the number of kilometres travelled, the number of tonnes transported, or the number of landings carried out using tyres supplied and maintained by Michelin.

However, shifting to a circular model is challenging. Vehicle designs will need to anticipate disassembly, and capital will be required to build centralised refurbishment plants. Consumers may also resist buying refurbished vehicles, though warranties should partly assuage their concerns. For opportunities in e-waste, one of the participants opined that the best place to start gold extraction is from mobile phones. The challenge is that current handset designs do not make it easy for metals extraction, although this is starting to change.

- Expansion of renewables (US\$300 billion):** Renewable energy – including solar power, hydroelectric power, wind, and geothermal energy – can potentially increase energy generation and reduce local pollution while also mitigating global climate change. Renewable energy capacity has surged over the past decade. Between 2006 and 2010, capacity in China, Europe, and the Americas jumped 23 percent a year, while the five years between 2010 and 2015 saw a capacity rise by another 20 percent a year.⁸⁰ Renewables are also capturing a larger share of new energy investment. In 2015, global investment in renewables amounted

77. WHO (2015), "Global Health Observatory data repository, Registered vehicles, Data by country".

Available at: http://www.who.int/gho/road_safety/registered_vehicles/number/en/

78. Peter Dauvergne (2008), *The Shadows of Consumption: Consequences for the Global Environment*.

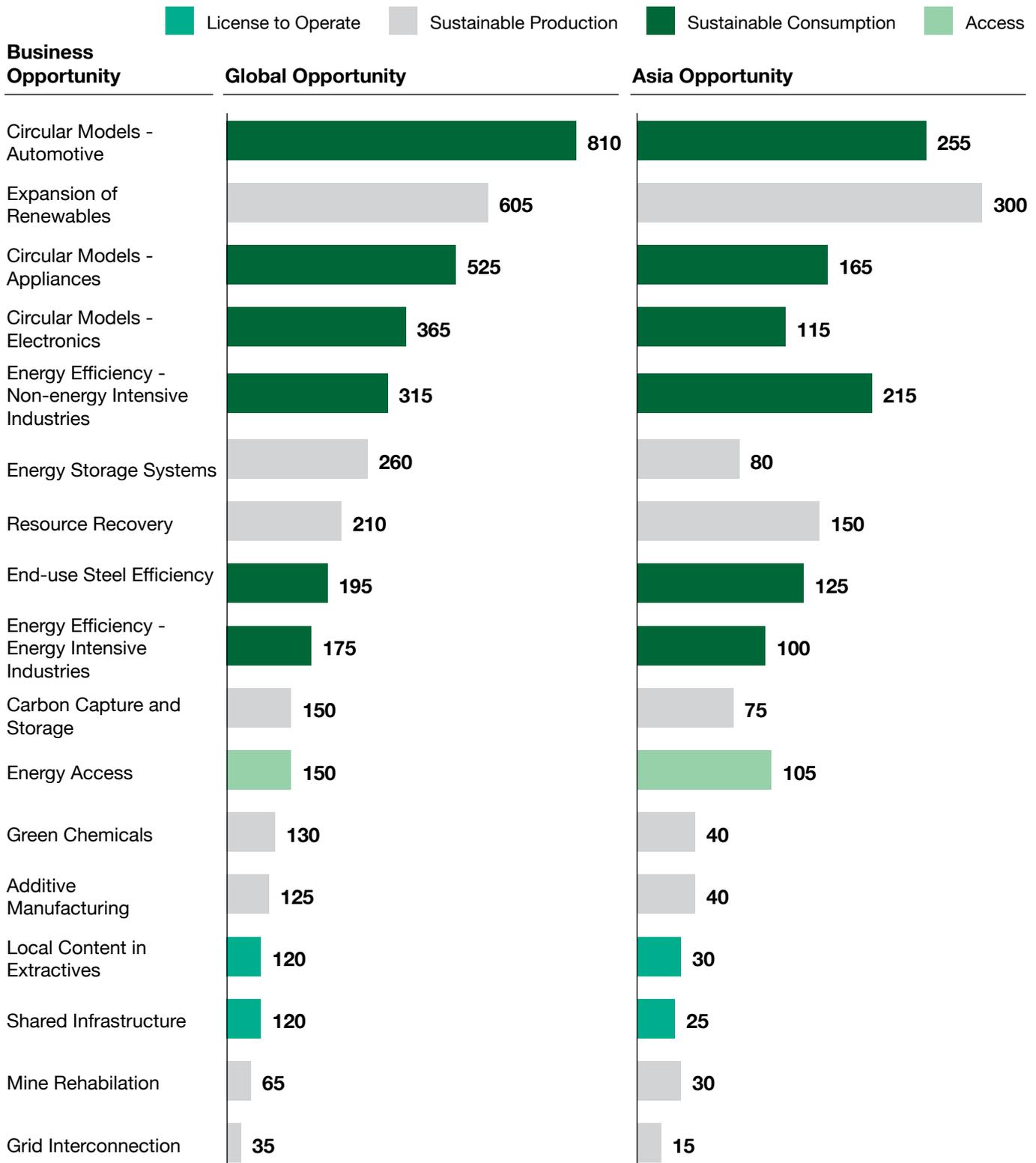
Available at: <https://mitpress.mit.edu/books/shadows-consumption>

79. Sakai, S. I et al (2014), "An international comparative study of end-of-life vehicle (ELV) recycling systems", *Journal of Material Cycles and Waste Management*, 16(1), 1-20. Available at: <https://link.springer.com/article/10.1007/s10163-013-0173-2>

80. Switch Asia (2016), *Advancing the circular economy in Asia*.

Available at: <http://www.switch-asia.eu/publications/advancing-the-circular-economy-in-asia/>

EXHIBIT 6:

THE LARGEST BUSINESS OPPORTUNITIES IN THE ENERGY AND MATERIALS SYSTEM COULD BE WORTH US\$4.4 TRILLION IN 2030 (US\$1.9 TRILLION IN ASIA)
**SIZE OF INCREMENTAL OPPORTUNITY IN 2030¹
(US\$ BILLIONS; 2015 VALUES)**


1. Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest US\$5 billion.

Source: Literature search; AlphaBeta analysis

IN 2015, GLOBAL INVESTMENT IN RENEWABLES AMOUNTED TO US\$286 BILLION, MORE THAN DOUBLE THE US\$130 BILLION COMMITTED TO NEW COAL AND GAS GENERATION

to US\$286 billion, more than double the US\$130 billion committed to new coal and gas generation.⁸¹ Three broad areas of opportunities are particularly interesting in renewables:

1. **Low cost deployment models.** New business models are being developed that can significantly lower the cost in the residential and commercial segments. In the residential segment, successful operators in rooftop solar have been able to minimise customer-acquisition and installation costs by using a combination of digital channels to pre-screen and market to customers; and by forming partnerships with adjacent sectors (such as broadband providers and security companies). In the commercial segment, deployment costs have been lowered by using 'lean' techniques such as prefabricated components, automation, and aerial site assessments to speed up design prototyping, and collaborating with engineering, procurement, and construction companies to share cost-saving ideas
2. **New financing approaches.** Although falling technology costs have lowered the capital needed to invest in new systems, financing such projects is still difficult in the many parts of Asia where financial markets remain underdeveloped. Policymakers and bankers in the region often have limited experience of assessing

the feasibility and risks of renewable energy investments. As a result, such investments might not be made even when they would be economically or commercially efficient. This lack of experience can make it difficult or impossible to obtain the types of financing required at reasonable costs. Investors perceive projects as high-risk, which raises the risk premium and adds to the cost of funding. New investment vehicles are emerging to address this, including asset-backed securities where contracted revenues from renewable projects are bundled and sold to institutional investors.

3. **Next generation technologies.** The challenge for scaling renewable energy is not purely an economic one. Certain countries are constrained by geography (e.g., lack of available land space) or climate (e.g., cloud cover). A range of new technologies is opening up exciting opportunities, particularly in solar, with the potential to address some of these challenges. This includes solar panel positioning robots, photovoltaic transparent glass, solar fuel, space-based solar power, and 2nd and 3rd generation biofuels. Even while some of these technologies may be technically feasible in the near future, the commercial feasibility still remains uncertain.

The session participants also discussed opportunities related to energy storage and energy access. In energy storage, a range of new software solutions is enabling businesses and consumers to identify peak demand and capture cost-saving opportunities. In energy access, improved biomass stoves, solar lanterns, and the development of mini-grids were highlighted as interesting emerging opportunities.

81. Bloomberg New Energy Finance (2016), *Global Trends in Renewable Energy Investment 2016*. Available at: http://fs-uneep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf

THERE ARE A NUMBER OF INNOVATIVE BUSINESS MODELS THAT CAN SUPPORT THE CAPTURE OF THESE OPPORTUNITIES

The session participants discussed how making this happen will require a new approach from businesses and the development of new business models. Five business models will be useful to consider for businesses trying to capture the opportunities identified earlier:

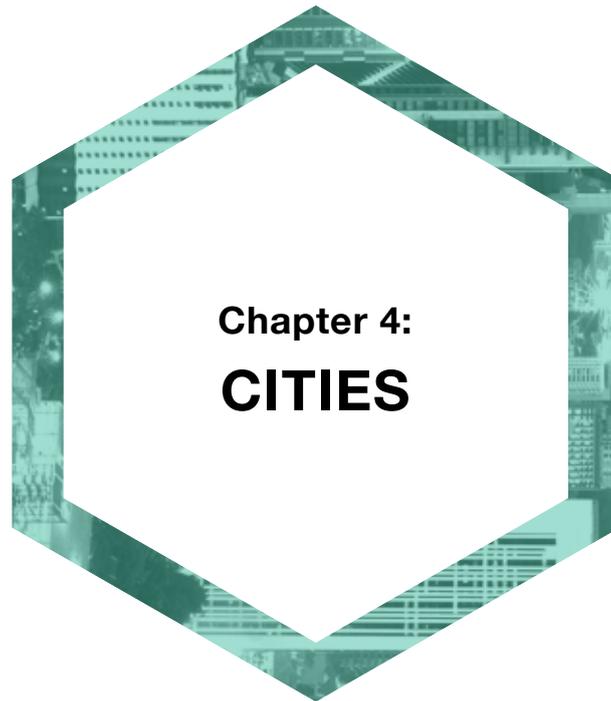
- Serving the bottom of the pyramid:** These are models that look to create “stripped down” models to profitably serve low-income segments or radically reduce costs. For example, in Kenya, there are mobile “pay-as-you-go” services to access electricity, which are popular with low-income groups. The session participants also discussed how 3D printing had the potential to significantly reduce costs. It is estimated that 20 percent of spare parts used in oil & gas could be potentially produced using 3D printing.
- Embracing new forms of collaboration:** These are models involving working on partnerships with other industry participants (often outside the sector) to capture value. For example, Dell, the multinational computer technology company, established an unlikely partnership with actor and entrepreneur Nikki Reed to create a closed loop system. Together, they have launched the “Circular Collection by BaYou with Love and Dell”, a jewellery collection made with gold recovered from Dell’s recycling programmes.⁸²
- Transforming goods into services:** These are models that look to retain ownership of the final good to reduce waste and keep valuable inputs in the value chain. An example highlighted earlier with Michelin selling truck miles, rather than tyres. Session participants also discussed how Singaporean companies like Sembcorp and Keppel are also evolving into one-stop service providers (including electricity provision, logistics, and wastewater processing), rather than just selling resources.
- Combining behavioural insights with technology:** These are models that focus on the behavioural change needed to support unlocking opportunities. For example, in the circular economy, it is critical to explain the importance of this to consumers. Unilever has developed programmes in Morocco and Indonesia to educate consumers on the importance of the circular economy and to incentivise them to recycle plastics.⁸³ For instance, in Morocco, consumers can exchange 12 used sachets for a traditional Moroccan teacup.
- Internalising the social costs:** These are models that anticipate regulatory action to address social costs and are designed to “get out in front” of this. Session participants discussed how several mining and oil & gas companies are now internally pricing CO₂e and water into their decision-making processes.

82. Sustainable Brands (2018), “Trending: New Cross-Industry Partnerships Give Circular Design a Major Push”. Available at: http://www.sustainablebrands.com/news_and_views/collaboration/sustainable_brands/trending_new_cross-industry_partnerships_give_circul

83. Unilever (2018), “Rethinking waste - towards a circular economy”. Available at: <https://www.unilever.com/sustainable-living/reducing-environmental-impact/waste-and-packaging/rethinking-waste-towards-a-circular-economy/> and Unilever (2017), “Towards a new plastics economy”. Available at: <https://www.unilever.com/news/news-and-features/Feature-article/2017/towards-a-new-plastic-economy.html>

An aerial night view of a futuristic city, likely Singapore, featuring illuminated buildings, greenery, and a waterfront. The image is in grayscale with a light overlay. The text is centered and reads:

“ The largest business opportunities in cities could have commercial value of US\$3.7 trillion in 2030 (US\$1.5 trillion of those opportunities are in Asia). ”



Chapter 4: **CITIES**

This chapter explores the sustainability challenges and opportunities related to cities, as discussed in the breakfast event, entitled “The Ecosperity Series - Thriving in a Sustainable Economy: Cities”. The event was held on Friday, 7th July 2017, and included a range of stakeholders from industry, government, investors, and academics.

Led by Dr. Fraser Thompson, Director of AlphaBeta, the session participants discussed how urbanisation is a crucial driver of economic growth but also poses a series of challenges including transport congestion, lack of affordable housing, environmental impacts, and the need to financing new infrastructure development. A new sustainable approach could transform cities and create significant business opportunities. The largest business opportunities in cities could have commercial value of US\$3.7 trillion in 2030 (US\$1.5 trillion of those opportunities are in Asia). Unlocking these opportunities will require a shift in business models, including adopting “lean” models to construction, developing new partnerships (particularly in transport), transforming goods into services (such as with high fixed cost items like office buildings), creating new incentive models to change consumer behaviour, and anticipating regulatory action to unearth new business ideas.

SUSTAINABILITY CHALLENGES IN CITIES...

Urbanisation is a crucial driver of economic growth. However, this urbanisation also poses a series of challenges including transport congestion, lack of affordable housing, environmental impacts, and the need to financing new infrastructure development.

EXAMPLES OF CHALLENGES



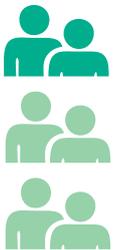
Congestion can cost as much as
2% TO 5% OF NATIONAL GDP



ALMOST 25,000 HECTARES

of space in Bangkok is dedicated to parking (equivalent to over 15% of the city's land area)

CONGESTION



By 2025,
ONE-THIRD OF URBAN POPULATION
could lack access to affordable housing

In APAC, the gap between income available for housing and the annualised market price of a standard unit is

US\$295 BILLION



AFFORDABLE HOUSING

Cities are responsible for
AROUND 70% OF GLOBAL
energy use and energy-related GHG emissions



70% OF THE WORLD'S MAJOR CITIES

are already highly vulnerable to flood-related mortality and economic losses



ENVIRONMENTAL FOOTPRINT



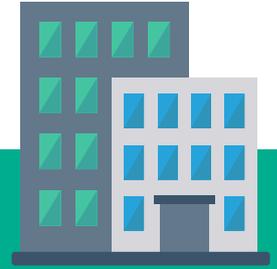
US\$90 TRILLION
infrastructure investment over the next 15 years is needed to support growth

Based on current trajectories, there will be a
GAP OF US\$350 BILLION
annually between infrastructure needs and spend



INFRASTRUCTURE BUILDING

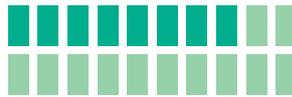
...AND OPPORTUNITIES



THE BUSINESS OPPORTUNITIES LINKED TO SUSTAINABLE APPROACHES



The largest business opportunities in cities system could have value of **US\$3.7 TRILLION** in 2030



OVER 40% of these business opportunities are in Asia (representing US\$1.5 trillion of opportunities in 2030)



3 largest opportunities (in terms of 2030 revenue size) are

**AFFORDABLE HOUSING;
ENERGY EFFICIENCY IN
BUILDINGS; AND ELECTRIC
& HYBRID VEHICLES**

EXAMPLES OF EMERGING NEW BUSINESS MODELS

SERVING THE BOTTOM OF THE PYRAMID

The use of lean construction management to support affordable housing



EMBRACING NEW FORMS OF COLLABORATION

UBER and the **PINELLAS SUNCOAST TRANSIT AUTHORITY (PSTA)** in Florida announced a “first mile, last mile” partnership to support public transport



TRANSFORMING GOODS INTO SERVICES

New shared office and co-working models optimise building utilisation



COMBINING BEHAVIOURAL INSIGHTS WITH TECHNOLOGY

Energy efficiency company **OPOWER** benchmarks household energy usage against client’s neighbours to motivate change



GETTING AHEAD OF REGULATION

Efforts to curb traffic congestion could significantly reduce demand for car parking, and open up this space for alternative uses



A “BUSINESS AS USUAL” APPROACH TO CITIES GOING FORWARD IS NOT FEASIBLE AND A FUNDAMENTAL SHIFT IN FOUR AREAS IS CRUCIAL

ASIA IS AT THE HEART OF THIS URBANISATION WAVE, WITH MORE THAN 550 MILLION PEOPLE EXPECTED TO MOVE TO CITIES IN APAC BY 2030

By 2030, 60 percent of the world’s population will live in cities, up from about 54 percent today – adding over 1 billion people to cities over the next 15 years.⁸⁴ Asia is at the heart of this urbanisation wave, with more than 550 million people expected to move to cities in APAC by 2030, where they will create more than 85 percent of GDP and bring the urban share of the population to roughly 44 percent.⁸⁵ While this urbanisation will be a crucial driver of growth, it also poses a series of challenges related to inclusiveness, economic efficiency, and the environment. A fundamental shift in four key areas is needed to create a sustainable model of urbanisation (Exhibit 7):

- **Dealing with congestion.** A large share of urban growth around the world involves unplanned, unstructured urban expansion, with low densities and high rates of car use. This not only increases the land requirements of cities but also adds to congestion. The number of cars could almost double, from 1.2 billion today to 2 billion by 2035.⁸⁶ Congestion is already close to unbearable in many cities and can cost as much as 5 percent of national GDP, by measures such as lost time, wasted fuel and the increased cost of doing business.⁸⁷ Almost 25,000 hectares of land in Bangkok is estimated to be dedicated to parking – equivalent to over 15 percent of the city’s land area.⁸⁸ In the transition required to meet these challenges, private vehicle ownership could experience a slow decline in favour of public transport, cycling, walking, and ridesharing.

One of the biggest winners will be software companies. Consumers can already use apps on their electronic devices to find out about real-time traffic conditions and reroute journeys away from heavy traffic; access car sharing, e-hailing, and on-demand private shuttles; find appropriate routes for cycling and walking, and enable public transit agencies to analyse and improve network performance.⁸⁹ Transport systems will increasingly become more multimodal, on-demand and shared, increasing consumer choice and convenience. Smart pricing for the use of road infrastructure is also likely to become more widespread to manage congestion and vehicle traffic in cities.

THE NUMBER OF CARS COULD ALMOST DOUBLE, FROM 1.2 BILLION TODAY TO 2 BILLION BY 2035

- **Providing affordable housing.** The growth of cities can lead to inclusiveness challenges, particularly as housing becomes increasingly expensive. By 2025, one-third of the urban population (or 440 million urban households) could lack access to affordable housing.⁹⁰ In APAC, it has been estimated that the gap between income available for housing and the annualised market price of a standard unit is US\$295 billion.⁹¹ Various aspects of residential buildings

BY 2025, ONE-THIRD OF THE URBAN POPULATION (OR 440 MILLION URBAN HOUSEHOLDS) COULD LACK ACCESS TO AFFORDABLE HOUSING

84. United Nations (2015), “UN projects world population to reach 8.5 billion by 2030, driven by growth in developing countries”. Available at: <http://www.un.org/sustainabledevelopment/blog/2015/07/un-projects-world-population-to-reach-8-5-billion-by-2030-driven-by-growth-in-developing-countries/>

85. McKinsey & Company (2015), *No Ordinary Disruption: The forces reshaping Asia*.

Available at: <https://www.mckinsey.com/global-themes/asia-pacific/no-ordinary-disruption-the-forces-reshaping-asia>

86. Navigant Research (2014), *Transportation Forecast: Light Duty Vehicles 2015-2035*.

Available at: <https://www.navigantresearch.com/research/transportation-forecast-light-duty-vehicles>

87. Asian Development Bank (2012), “Transport in Asia and the Pacific: 12 Things to Know”.

Available at: <https://www.adb.org/features/12-things-know-2012-transport>

88. Boston Consulting Group (2017), *Unlocking Cities: The impact of ridesharing in Southeast Asia and beyond*.

Available at: <https://www.unlockingcities.com/content/documents/unlocking-cities-report-bcg-uber.pdf>

89. McKinsey & Company (2015), *Urban mobility at a tipping point*. Available at: <http://transact.org/mckinsey-report-urban-mobility-tipping-point/>

90. McKinsey Global Institute (2014), *Tackling the world’s affordable housing challenge*.

Available at: <https://www.mckinsey.com/global-themes/urbanization/tackling-the-worlds-affordable-housing-challenge>

91. BSDC, Temasek, and AlphaBeta (2017), *Better Business, Better World Asia*.

Available at: <http://businesscommission.org/news/sustainable-businesses-can-unlock-us-5-trillion-in-new-market-value-in-asia-by-2030>

will be transformed in the implementation of the SDGs, with a focus on increasing the supply of affordable housing, less wasteful construction and design techniques, and more efficient energy use. Construction will shift towards more modular and durable designs and materials.

- Reducing the environmental footprint of cities.** Urbanisation could consume an estimated two million hectares of land per year, with about three-quarters of that being agricultural land.⁹² In addition, cities are responsible for around 70 percent of global energy use and energy-related greenhouse gas (GHG) emissions.⁹³ Many cities are also highly exposed to natural disasters and environmental concerns, particularly rising sea levels. A UN assessment found that more than 70 percent of the world's major cities are already highly vulnerable to flood-related mortality and economic losses.⁹⁴ Meeting this challenge will require a set of fundamental shifts in energy, water, and transport. In non-residential buildings, energy efficiency

CITIES ARE RESPONSIBLE FOR AROUND 70 PERCENT OF GLOBAL ENERGY USE AND ENERGY-RELATED GHG EMISSIONS

interventions will become mainstream, including more energy efficient heating and cooling systems, and better lighting technology, and will be incorporated into building design processes. New approaches will develop to improve the utilisation of existing office and non-residential buildings, including office sharing and telecommuting. In residential buildings, energy savings will be achieved by using more energy efficient cooking,

cooling, heating, and lighting appliances. Increasing penetration of smart meters will also help consumers manage their energy use. Utilities will focus on actively monitoring and addressing water leakage to improve efficiency and using technology to better match wastewater generators with potential users. In transport, there will be a shift for traditional, low-efficiency vehicles with internal combustion engines to electric and hybrid vehicles.

US\$90 TRILLION INFRASTRUCTURE INVESTMENT OVER THE NEXT 15 YEARS IS NEEDED TO SUPPORT GROWTH

- Financing infrastructure building.** MGI estimates that the world needs to invest an average of US\$3.3 trillion annually just to support currently expected rates of growth, but that based on current trajectories there will be a gap of US\$350 billion annually, and this could be three times larger if the additional investment required to meet the SDGs is included.⁹⁵ Other studies have projected that US\$90 trillion infrastructure investment over the next 15 years is needed to support growth.⁹⁶ A range of shifts are required to meet this challenge, including strengthening the balance sheets of the growing “middleweight” cities which currently have limited access to finance; creating new funding models such as user charges, capturing property value, or selling existing assets and recycling the proceeds for new infrastructure; and improving infrastructure productivity. Construction productivity has flatlined for the last two decades, but improving project selection, delivery, and management of existing assets could reduce the cost of infrastructure development by around 40 percent.⁹⁷

92. World Bank (2015), *The dynamics of global urban expansion*.

Available at: http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/dynamics_urban_expansion.pdf

93. New Climate Economy (2014), *Better Growth Better Climate: Synthesis report*.

Available at: http://static.newclimateeconomy.report/wp-content/uploads/2014/08/NCE_SynthesisReport.pdf

94. UN Population Division (2015), *Risk of Exposure and Vulnerability to Natural Disasters at the City Level: A Global Overview*.

Available at: <https://esa.un.org/unpd/wup/publications/Files/WUP2014-TechnicalPaper-NaturalDisaster.pdf>

95. McKinsey Global Institute (2016), *Bridging global infrastructure gaps*.

Available at: <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/bridging-global-infrastructure-gaps>

96. The New Climate Economy (2015), “Ensuring new infrastructure is climate-smart”.

Available at: <http://newclimateeconomy.report/2015/wp-content/uploads/sites/3/2015/10/Ensuring-infrastructure-is-climate-smart.pdf>

97. McKinsey Global Institute (2013), *Infrastructure productivity: How to save \$1 trillion a year*.

Available at: <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/infrastructure-productivity>

EXHIBIT 7:

A SUSTAINABLE MODEL OF URBANISATION WILL REQUIRE FUNDAMENTAL SHIFTS ACROSS FOUR ISSUES

ISSUE	FROM...	TO...
Dealing with Congestion	Individual car ownership	Shared mobility and autonomous vehicles
	Low cost parking / road usage	Smart pricing for usage of road and parking infrastructure
	Time inefficient construction	Durable and modular design in buildings
Providing Affordable Housing	Lack of low cost housing	<ul style="list-style-type: none"> • Lean build and maintenance models • Inclusionary housing development models
Reducing the Environmental Footprint	Traditional ICE vehicles	EVs and hybrids
	Using halogen and inefficient lighting solutions	Energy efficient lighting solutions in building
	Fuel intensive methods for water and space heating	Using electricity/renewables for space and water heating
	Vacant office space	Office sharing
	Low resilience to climate-related weather events	Climate resilient buildings
	Building-level heating and cooling systems	District heating and cooling systems
Financing Infrastructure Build	Weak balance sheets of Tier 2 cities	New financing models for Tier 2 cities, including user charges
	Low focus on infrastructure productivity	High focus on infrastructure productivity (e.g., municipal water leakage)

A NEW SUSTAINABLE APPROACH COULD TRANSFORM CITIES AND CREATE SIGNIFICANT BUSINESS OPPORTUNITIES

These system-wide changes in cities could lead to the emergence of a number of disruptive business opportunities (Exhibit 8). The largest business opportunities in cities could have a value of US\$3.7 trillion in 2030 (US\$1.5 trillion of those opportunities are in Asia). The biggest opportunities in Asia include affordable housing (US\$505 billion), energy efficiency in buildings (US\$245 billion), and electric and hybrid vehicles (US\$145 billion).

Below are further details on some of the largest opportunities in Asia:

- **Affordable housing (US\$505 billion in Asia).** In the APAC region, the gap between income available for housing and the annualised market price of a standard unit is currently US\$295 billion.⁹⁸ This affordability gap is set to grow as the number of households needing affordable, adequate housing increases. Turning this gap into an opportunity will depend on three broad initiatives:
 1. **Inclusionary housing development.** This gives developers planning concessions in return for providing affordable housing units. For example, in return for a density bonus from the government, which allows the developer to increase the floor space on a plot of land and therefore its potential revenue, the developer sets aside a certain portion of each project for affordable units to be sold or rented to lower-income residents. Several Asian cities (including Mumbai and Chengdu) have granted commercial development rights on plots to private sector partners in return for them building affordable housing on a specified percentage of the total land under development.⁹⁹
 2. **Lean approaches to construction.** This includes adopting industrial techniques such as prefabricating components off-site and assembling them onsite, and standardising major operations like the structural design and finishing elements. In India, private players, such

as Xrbia, use on-site manufacturing techniques and prefabricated components to shorten construction times and costs.

3. **Low cost property management.** Techniques include retrofitting units with more energy efficient appliances and integrating repair and maintenance services to provide a 'one-stop shop'.

- **Electric and hybrid vehicles (US\$145 billion):** According to Navigant Research, global electric vehicle (EV) sales will grow at a rate of 10 percent a year from 2019 to reach more US\$318 billion by 2030. In Asia, sales of EV are projected to reach US\$144 billion by 2030.¹⁰⁰ The environmental impact of EVs depends crucially on the broader energy system – if fossil fuel energy sources such as coal (rather than renewables) are being used to generate electricity, then the CO₂e benefits of EVs become limited. Other than obvious opportunities in EV manufacturing (e.g. Tesla), there are other major opportunities in the supply chain, including:

IN ASIA, SALES OF EV ARE PROJECTED TO REACH US\$144 BILLION BY 2030

1. **Micro-hybrids:** Adding a small degree of electrification to existing internal-combustion-engine powertrains enables engines to be downsized and the fuel efficiency to be increased by 15 percent to 20 percent. This market is growing 29 percent annually.¹⁰¹
2. **Cathodes:** The cathode component is a significant component of EV batteries and a rapidly growing market. However, there are a number of competing models, each with different product attributes in terms of power, lifespan, cost, and safety. There is still uncertainty about which technology will eventually prevail.

98. McKinsey Global Institute (2014), *Tackling the world's affordable housing challenge*.

Available at: <https://www.mckinsey.com/global-themes/urbanization/tackling-the-worlds-affordable-housing-challenge>

99. Navigator (2017), "5 institutional models for successful housing options in Asia". Available at: <https://www.navigatorconnect.com/hello-world/>

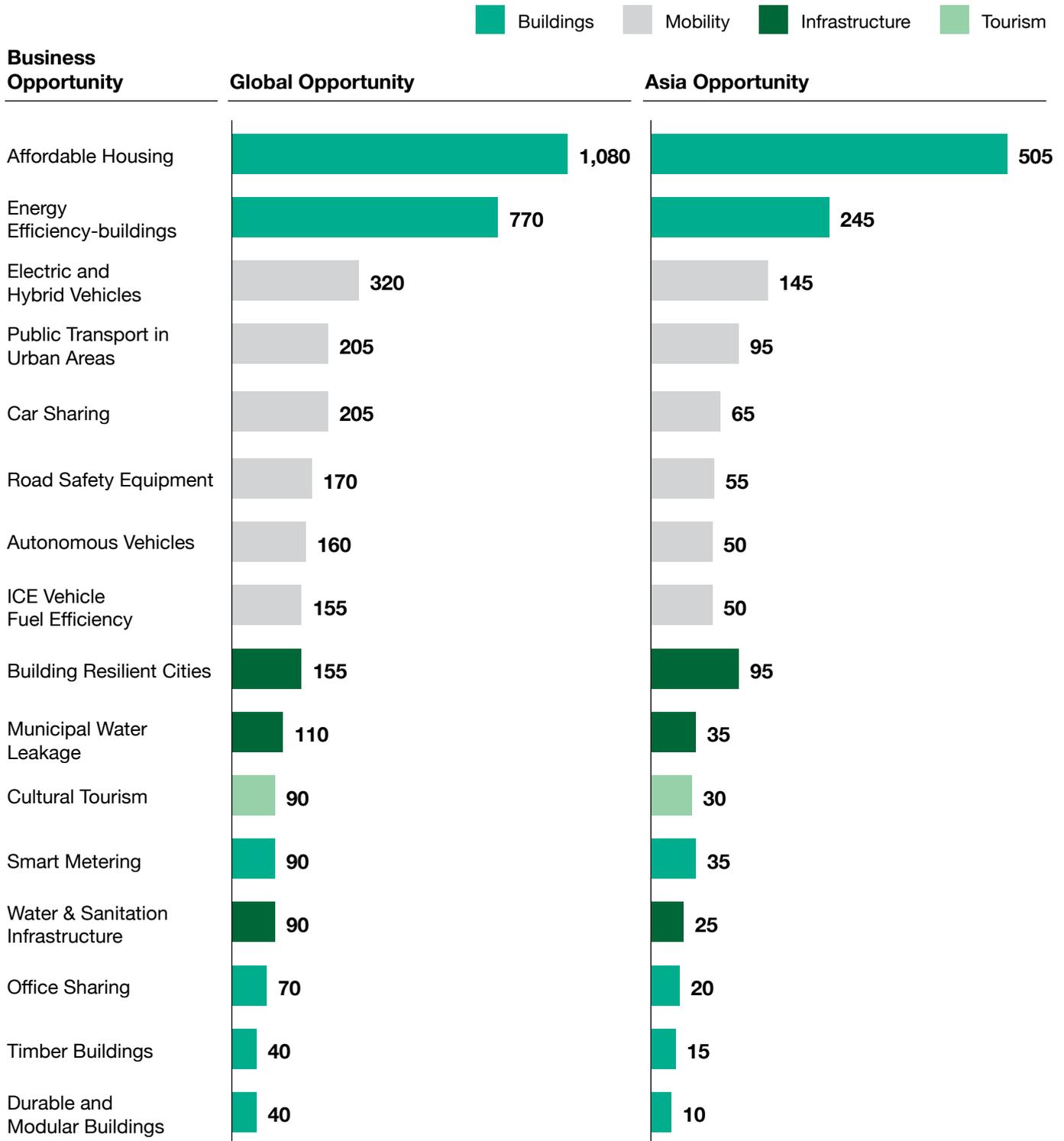
100. Navigant Research (2016), *Market data for electric vehicles*.

Available at: <https://www.navigantresearch.com/research/market-data-ev-market-forecasts>

101. Fidelity (2014), *Investing in the car of the future – a battery power perspective*.

Available at: <https://www.readkong.com/page/investing-in-the-car-of-the-future-8261598>

EXHIBIT 8:

THE LARGEST BUSINESS OPPORTUNITIES IN THE CITIES SYSTEM COULD BE WORTH US\$3.7 TRILLION IN 2030 (WITH US\$1.5 TRILLION IN ASIA)
**SIZE OF INCREMENTAL OPPORTUNITY IN 2030¹
(US\$ BILLIONS; 2015 VALUES)**


1. Based on estimated savings or projected market sizings in each area. Only the high case opportunity is shown here. Rounded to nearest US\$5 billion.

Source: Literature search; AlphaBeta analysis



3. **Charging infrastructure:** The global EV Charger (EVC) market is forecasted to grow from more than 1 million units in 2014 to more than 12 million units in 2020.¹⁰² Retailers, shopping centres, hotels, fast food outlets, car parking providers and all kinds of businesses with off street parking could offer charging services. There are two main types of plug-in EV charging stations – AC or DC. AC charging stations are the dominant type of plug-in vehicle charging type and given its advantages in terms of cost and the requirements for smaller upgrades of the electricity grid, it is well-placed to grow in urban areas. Japan is a key growth region for the EV charging stations and recently passed a key milestone by having more EV charging stations than petrol stations.
4. **E-Bikes.** An electric bicycle, also known as an e-bike or booster bike, is a bicycle with an electric motor that riders can use to boost their pedal power. While EVs may receive more media attention, e-bikes dwarf them in current scale of demand: about 700,000 electric cars were

ABOUT 700,000 ELECTRIC CARS WERE SOLD WORLDWIDE IN 2016 COMPARED TO ROUGHLY 35 MILLION E-BIKES

sold worldwide in 2016 compared to roughly 35 million e-bikes.¹⁰³ China is the world's largest market for e-bikes, accounting for approximately 85 percent of global demand, while the APAC region as a whole accounts for approximately 95 percent of global demand.¹⁰⁴ The competitive landscape is also likely to change significantly, particularly in China, given the current industry fragmentation and the entry of new players. At the same time, major motorcycle manufacturers (such as Zonshen and Dayun) are also entering the e-bike industry as demand from the motorcycle market shrinks. Going forward, new models targeting specific customer segments are likely to appear, such as off-road e-bikes, as well as businesses providing supporting infrastructure. From a regulatory standpoint, countries differ in their approach to licensing

102. IHS (2015), *EV Charging Infrastructure report*.

Available at: <http://news.ihsmarket.com/press-release/automotive/global-ev-charging-stations-skyrocket-2020-ihs-report-says>

103. Navigant research (2016), "Electric bicycles". Available at: <https://www.navigantresearch.com/research/electric-bicycles>

104. INSG Insight (2014), *The global e-bike market*. Available at: http://www.insg.org/docs/INSG_Insight_23_Global_Ebike_Market.pdf and Statista (2016), "Worldwide sales of electric bicycles in 2016, by region (in million units)". Available at: <https://www.statista.com/statistics/255658/worldwide-sales-of-electric-bicycles-by-region/>

these bikes. In the US, there are conflicting regulations at the federal, state, and local levels. In some countries, including China, cities place limits on the operation of e-bikes depending on their power rating.

- **Carsharing (US\$65 billion):** Evolving mobility options are set to change the automotive industry and private-vehicle ownership patterns significantly. According to a study by McKinsey, most cars sit idle 90 percent of the time or more.¹⁰⁵ More car sharing could substantially improve vehicle usage and reduce the number of cars on the roads. Widespread car sharing would also mean more intensive use of each vehicle. While the rise of ridesharing firms like Uber and Grab are well-known, this trend is also giving rise to other less-obvious opportunities:

MOST CARS SIT IDLE 90 PERCENT OF THE TIME OR MORE

1. **Financial services.** Ride-hailing apps Grab and Go-Jek have developed digital payment apps that also provide a place to store cash for everyday payments. Research in Indonesia has shown the potential to also transform digital financial inclusion for drivers, and not just customers.¹⁰⁶ Online ridesharing services could promote financial inclusion by providing a means for drivers to establish bank accounts and become accustomed to performing transactions online: 39 percent of Uber driver-partners in Indonesia agreed or strongly agreed that they are more financially active since joining Uber. This could have significant income benefits for these



OVER 400,000 INDONESIANS COULD BE BROUGHT INTO THE FINANCIAL SYSTEM THROUGH ONLINE RIDESHARING SERVICES

Indonesians. International evidence suggests a potential boost to incomes of anywhere from 5 percent to 30 percent from increased financial inclusion. The results of the 2020 scenario analysis provide even more support, with over 400,000 Indonesians brought into the financial system through online ridesharing services

2. **Shared trucking:** Use of smartphone apps can bring shippers, carriers, and buyers together with real-time information on prices, load details, and delivery routes to increase capacity. For example, Coyote is a Chicago-based freight broker and logistics services provider that matches client shipments demands with available supply by utilising carriers' return trips when they are often travelling empty.
3. **Parking transformation:** There is a potential to reduce parking requirements by up to 95 percent through encouraging shared mobility, and rethinking policies related to parking (e.g., minimum parking requirements, price controls on parking, and urban planning processes). This prime urban space could then create a range of new business opportunities. For example, in the United States, BrightFarms builds and manages hydroponic greenhouses on store rooftops, parking garages, and empty lots to create fresh produce that is convenient for consumers.

105. McKinsey & Company (2015), *Urban mobility at a tipping point*. Available at: <http://transact.org/mckinsey-report-urban-mobility-tipping-point/>

106. AlphaBeta (2017), *Rethinking urban mobility in Indonesia: The role of shared mobility services*. Available at: <http://www.alphabeta.com/rethinking-urban-mobility-indonesia-role-shared-mobility-services/>

THERE ARE A NUMBER OF INNOVATIVE BUSINESS MODELS THAT CAN SUPPORT THE CAPTURE OF THESE OPPORTUNITIES

The session participants discussed how making this happen will require a new approach from businesses and the development of new business models. Five business models will be useful to consider for businesses trying to capture the opportunities identified earlier:

- **Serving the bottom of the pyramid:** These are models that look to create “stripped down” models to profitably serve low-income segments. For example, this includes the use of lean construction management to support affordable housing.
- **Embracing new forms of collaboration:** These are models involving working on partnerships with other industry participants (often outside the sector) to capture value and save costs. For example, in the Philippines, Grab, the ridesharing firm, worked with the World Bank to develop a pilot open-source platform to understand and manage traffic better. The anonymised GPS data generated by more than 500,000 Grab drivers in the country, allowed the World Bank and the Philippines government officials to analyse traffic congestion patterns and travel times, providing them with the ability to pinpoint the incidence and location of congestion chokepoints in cities. Furthermore, three mobility companies (Grab, Easy Taxi, and Le Taxi) are working with the World Bank and its partners to make traffic data derived from their drivers’ GPS streams available to the public through an open data licence for over 30 countries globally.¹⁰⁷
- **Transforming goods into services:** This involves aiming to maximise the usage of large fixed investments by encouraging sharing between different users – in other words, transforming goods into services. Beyond car sharing, another major opportunity in cities is office sharing. It is estimated that approximately 40 billion square metres of floor space globally remains under-utilised during office

ABOUT 700,000 ELECTRIC CARS WERE SOLD WORLDWIDE IN 2016 COMPARED TO ROUGHLY 35 MILLION E-BIKES

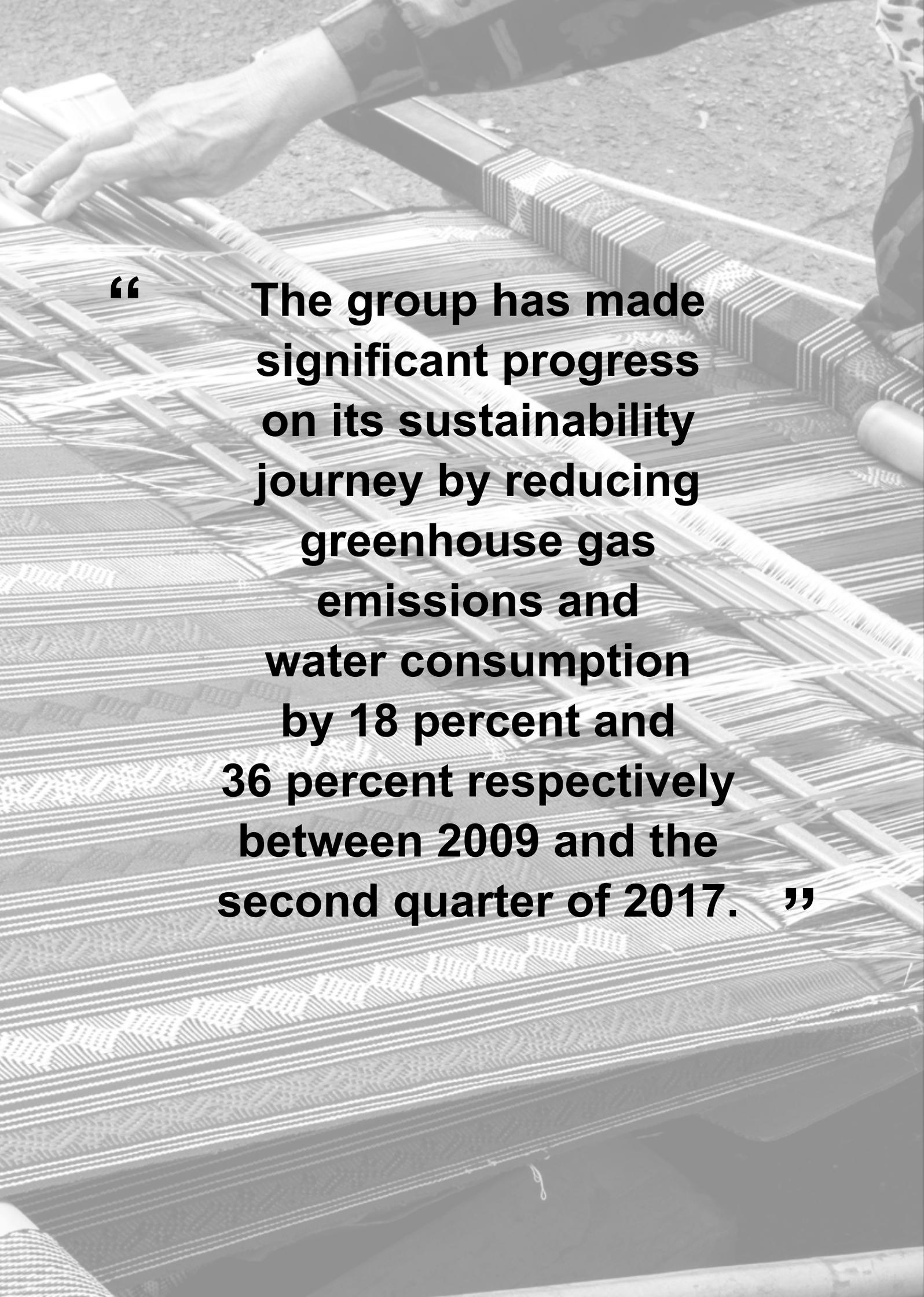
hours.¹⁰⁸ This points to a significant opportunity to better utilise the existing office and commercial space in cities to meet emerging demand. This will reduce the need for new office space to be constructed and improve the productivity of precious urban land. New shared office and co-working models provide tenants with greater flexibility, reduce upfront costs, and foster new forms of collaboration. Further development of technology platforms (e.g., apps and websites) will be necessary to make office sharing easily accessible to customers, and tenants may need to be educated to accept a different style of office environment with reduced privacy and less customised facilities.

- **Combining behavioural insights with technology:** These are models that focus on the behavioural change needed to support unlocking opportunities. For example, the energy efficiency company OPower has found that benchmarking household energy usage against their neighbours is a much more effective mechanism for encouraging energy efficiency than simply highlighting the potential savings.
- **Getting ahead of regulation:** These are models that anticipate regulatory action to address social costs and are designed to “get out in front” of this. For example, efforts to curb traffic congestion through mechanisms such as dynamic road pricing and encouraging carpooling, could potentially significantly reduce demand for car parking, and open up this space for alternative business uses.

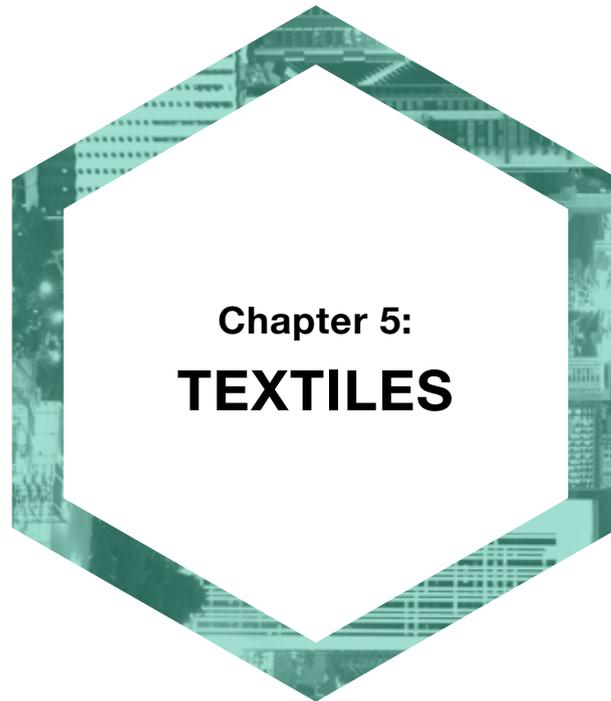
107. World Bank (2016), *Open Traffic Data to Revolutionise Transport*.

Available at: <http://www.worldbank.org/en/news/feature/2016/12/19/open-traffic-data-to-revolutionize-transport>

108. Estimated based on European floor space numbers and vacancy assumptions, which have been scaled globally based on GDP. Ellen MacArthur Foundation (2015), *Growth within: A circular economy vision for competitive Europe*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf



“ The group has made significant progress on its sustainability journey by reducing greenhouse gas emissions and water consumption by 18 percent and 36 percent respectively between 2009 and the second quarter of 2017. ”



Chapter 5: **TEXTILES**

This chapter explores the sustainability challenges and opportunities related to the textiles sector, as discussed in the breakfast event, entitled “The Ecosperity Series - Thriving in a Sustainable Economy: TAL’s Sustainability Journey”. The event was held on 15th September 2017 and included a range of stakeholders from the manufacturing industry including government, investors, and academics. Additional material has been gathered to supplement the insights from the session.

Despite being the world’s oldest branch of consumer good manufacturing, the textile industry remains one of the most economically important industries today, accounting for more than half of the total manufacturing exports in Cambodia, Bangladesh, Pakistan, and Sri Lanka.¹⁰⁹ However, the sector faces a range of challenges, from labour rights to environmental concerns. TAL, a major textile and apparel manufacturer with 11 facilities in Asia, shared its sustainability experience and the lessons learned. The group has made significant progress on its sustainability journey by reducing greenhouse gas emissions and water consumption by 18 percent and 36 percent respectively between 2009 and the second quarter of 2017.

109. Overseas Development Institute (2008), *The role of textile and clothing industries in growth and development strategies*. Available at: <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/3361.pdf>

SUSTAINABILITY CHALLENGES IN TEXTILES...

The global textiles industry currently faces concerns linked to its environmental footprint and working conditions, which will require a shift in approach.

EXAMPLES OF CHALLENGES



500 GALLONS OF WATER

to produce one pair of jeans in India



Cotton growing accounts for **3% OF GLOBAL WATER USE**

WATER USE

Dyeing contributes

20% OF INDUSTRIAL WATER POLLUTION GLOBALLY



Textiles account for

35% OF TOTAL MICROPLASTICS DISCHARGE INTO OCEANS



POLLUTION



The textile industry produces **10% OF GLOBAL CARBON EMISSIONS**

Textile waste occupies

5% OF GLOBAL LANDFILL SPACE



GLOBAL WARMING

80% OF TEXTILE JOBS WORLDWIDE

at risk of being displaced by automation



HALF A MILLION

Indian children work in cotton fields



LABOUR CONDITIONS



LESS THAN 20%

of factories in Bangladesh fulfil safety compliance standards

In Jaipur,

MORE THAN 10% DIFFERENCE

in prevalence of respiratory disease in child textile worker vs. peers in other industries



SAFETY & HEALTH



...AND OPPORTUNITIES

FOUR CHANNELS TO BENEFIT FROM MORE SUSTAINABLE PRACTICES

EFFICIENCIES IN EXISTING PROCESS

- Efficiencies by making simple changes to existing production processes
- **SMART MYANMAR** helped local factories reduce fabric wastage by 18%, energy consumption by 20%, water consumption by 16%. Safety precautions and trainings reduced monthly labour fluctuation rate by 20%



PROCESS INNOVATION

- Efficiencies by structurally modifying supply chain processes
- **We aRe SpinDye** has technology to introduce colour to fibres during the spinning process, thus eliminating the need to dye fabrics and yarns



PRODUCT INNOVATION

- Actions that improve the sustainability of raw materials used in production
- **MODERN MEADOWS** manufactures biofabricated leather by growing collagen from DNA sequencing



NEW BUSINESS MODELS

- New business models include a radical rethink of the consumer value proposition
- **FILIPPA K** runs a profitable collection service and resale store where consumers return used clothing in return for a 15% discount on their next purchase



FOUR LESSONS TO CAPTURE OPPORTUNITIES

1.
MAKE
SUSTAINABILITY A
STRATEGIC CHOICE



2.
AGREE ON
WHERE TO
FOCUS



3.
CONCRETE
TARGETS AND
ACCOUNTABILITY



4.
COLLABORATION
WITH INDUSTRY
PLAYERS



A “BUSINESS AS USUAL” APPROACH IN TEXTILES IS NOT FEASIBLE GOING FORWARD

The textiles industry currently faces concerns linked to its environmental footprint and working conditions, which will require a shift in approach:

- Environmental footprint.** Currently, four of the nine planetary boundaries, including climate change, have already been breached due to human activity.¹¹⁰ Textile production is one of the most polluting industries in the world and activities across its production chain have contributed considerably to global environmental problems.¹¹¹ For example, the unsustainable use of water and resulting pollution is a key concern for the industry. It is estimated that cotton alone (in terms of production and processing) is responsible for almost 3 percent of global water use, while textile dyeing contributes up to 20 percent of industrial water pollution globally.¹¹² For instance, it requires 500 gallons of water to produce one pair of jeans in India.¹¹³
- Working conditions.** Several high-profile incidents in recent years have put the spotlight on the negative social aspects of the industry. They include the Rana Plaza collapse which killed more than 1,100 people and revealed the poor working conditions of garment factory workers in Bangladesh, underlined by long working hours in overheated facilities without proper fire exits.¹¹⁷ Progress on reforms, such as the Accord on Fire and Building Safety, has been slow, with less than 20 percent of factories in Bangladesh having completed at least 90 percent of the compliance standards, leaving the majority lagging behind schedule in corrective action plans.¹¹⁸ In India, about 500,000 children work in the cotton fields.¹¹⁹ Studies have shown that child textile workers in Jaipur are at a higher risk (more than 10 percent) of developing respiratory diseases compared to their peers.¹²⁰ There are also concerns that textile workers in developing countries have not

COTTON ALONE IS RESPONSIBLE FOR ALMOST 3 PERCENT OF GLOBAL WATER USE

Furthermore, the discharge of chemicals and microplastics found in fertilisers used to grow cotton, and dyes for colouring textiles, have significant impacts on the sustainability of rivers and oceans. A recent study by the International Union for Conservation of Nature (IUCN) also finds that textiles account for 35 percent of total microplastics discharged into oceans.¹¹⁴ The amount of waste generated by the industry is another key area of concern, with the US Environmental Protection



LESS THAN 20 PERCENT OF FACTORIES IN BANGLADESH HAVE COMPLETED AT LEAST 90 PERCENT OF THE COMPLIANCE STANDARDS

110. Scripps Institution of Oceanography (2015), “Earth Has Crossed Several ‘Planetary Boundaries,’ Thresholds of Human-Induced Environmental Changes”. Available at: <https://scripps.ucsd.edu/news/earth-has-crossed-several-planetary-boundaries-thresholds-human-induced-environmental-changes>

111. Boström M and Micheletti M (2016), “Introducing the Sustainability Challenge of Textiles and Clothing”. *Journal of Consumer Policy*. Volume 39, Issue 4, pp 367–375. Available at: <https://link.springer.com/content/pdf/10.1007%2Fs10603-016-9336-6.pdf>

112. *Environmental Leader* (2014), “Assessing the environmental impact of the fashion world.”

Available at: <https://www.environmentalleader.com/2014/10/assessing-the-environmental-impact-of-the-fashion-world/>

113. *The Wall Street Journal* (2009), “Yet Another ‘Footprint’ to Worry About: Water”. Available at: <https://www.wsj.com/articles/SB123483638138996305>

114. IUCN (2017), *Primary Microplastics in the Oceans: a global evaluation of sources*.

Available at: <https://portals.iucn.org/library/sites/library/files/documents/2017-002.pdf>

115. *Global Fashion Agenda & The Boston Consulting Group* (2017), *Pulse of the Fashion Industry*.

Available at: http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_Executive-summary.pdf

116. *Forbes* (2015), “Making Climate Change Fashionable – The Garment Industry Takes on Global Warming.” Available at: <https://www.forbes.com/sites/jamesconca/2015/12/03/making-climate-change-fashionable-the-garment-industry-takes-on-global-warming/#27ed416179e4>

117. *The Guardian* (2016), “Rana Plaza collapse: workplace dangers persist three years later, reports find”.

Available at: <https://www.theguardian.com/business/2016/may/31/rana-plaza-bangladesh-collapse-fashion-working-conditions>

118. *Conscious* (2017), “The 4 areas of progress 4 years after the Rana Plaza Factory collapse”.

Available at: <http://consciousmagazine.co/the-4-areas-of-progress-4-years-after-the-rana-plaza-factory-collapse/>

119. *BBC* (2012), “India’s exploited child cotton workers”. Available at: <http://www.bbc.com/news/world-asia-16639391>

120. *Fibre2fashion* (2017), “Safety and health issues in the textile industry”.

Available at: <http://www.fibre2fashion.com/industry-article/2554/safety-and-health-issues-in-the-textile-industry?page=1>



been fairly compensated for their labour, with wages growing at a considerably slower rate than industry profits.¹²¹ This has continued to put a toll on living standards, compounded by the lack of access to employment benefits including medical insurance and paid leave.¹²² Globally, much work remains to be done on creating robust enforcement of health and safety standards in the textile industry, dealing with various issues such as chemical exposure from the processing and dyeing of materials, exposure to cotton and other organic dusts, musculoskeletal stresses, and noise exposure.

Industry trends imply that the situation will deteriorate rapidly if no remedial action is taken. Population growth and rising incomes will drive demand for textile and apparel products in many developing countries. “Fast fashion”, a term used to describe the focus on speed and low pricing to deliver frequent new collections, has promoted a culture of waste. For example, the average



6,000 KG OF CLOTHING IS DUMPED IN LANDFILL EVERY 10 MINUTES IN AUSTRALIA

American disposes around 70 pounds of clothing annually¹²³, while 6,000 kilogrammes of clothing are dumped in landfill every 10 minutes in Australia. Despite multiple warnings from environmental and sustainability experts, “fast fashion” remains popular and is taking hold amongst the emerging middle class in many developing countries. Consequently, the Boston Consulting Group (BCG) estimates that overall apparel consumption will rise by more than 60 percent between 2015 and 2030 - equivalent to a 50 percent increase in water consumption, 60 percent rise in energy emissions and waste creation, and an almost 10 percent increase in number of workplace injuries over the same period.¹²⁵ If the industry continues on its current path, by 2050, it could use almost 30

121. A.T. Kearney (2017), “Social innovation offers five golden opportunities to the apparel industry.” Available at: <https://www.atkearney.com/documents/20152/895701/Social+Innovation+Opportunities+in+the+Global+Apparel+Industry.pdf/07f98a85-2691-9188-479b-d389306ca395>

122. A.T. Kearney (2017), “Social innovation offers five golden opportunities to the apparel industry.” Available at: <https://www.atkearney.com/documents/20152/895701/Social+Innovation+Opportunities+in+the+Global+Apparel+Industry.pdf/07f98a85-2691-9188-479b-d389306ca395>

123. World Economic Forum (2015), “5 things you probably didn’t know about the fashion industry”. Available at: <https://www.weforum.org/agenda/2015/07/5-things-you-probably-didnt-know-about-the-fashion-industry/>

124. The Conversation (2017), “For a true war on waste, the fashion industry must spend more on research”.

Available at: <https://theconversation.com/for-a-true-war-on-waste-the-fashion-industry-must-spend-more-on-research-78673>

125. Global Fashion Agenda & The Boston Consulting Group (2017), Pulse of the Fashion Industry.

Available at: http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_Executive-summary.pdf

percent of the carbon budget associated with a 2°C pathway.¹²⁶ Moving away from the current linear and wasteful textiles system is therefore crucial to keeping within reach the 2°C average global warming limit.¹²⁷

On the social side, automation could significantly disrupt the textile industry by displacing low-skilled, manual workers. The International Labour Organisation estimates the textile, clothing and footwear sector is most vulnerable to automation compared to other manufacturing sectors, with almost 80 percent of jobs (on average) potentially displaced by robotics and 3D printing.¹²⁸ Without a sustainable strategy to upskill workers, the social impact of high unemployment, and the spillover effects into the real economy could be devastating for many developing countries.

Environmental and social impacts are increasingly costly to textile companies. Business-as-usual is unfeasible because management and investors are starting to realise the toll that environment impacts could have on profits, and hence the need to take a more strategic approach to hedging risks associated with natural capital dependencies. For example, China's drought in 2010 led to price increases of cotton of around 150 percent, resulting in hefty hits to the bottom lines of apparel companies including H&M, which announced a 30



CHINA'S DROUGHT IN 2010 LED TO PRICE INCREASES OF COTTON OF AROUND 150 PERCENT, RESULTING IN HEFTY HITS TO THE BOTTOM LINES OF APPAREL COMPANIES

percent decline in profits.¹²⁹ A recent BCG report reveals that rising energy, labour, and material costs will cause global clothing companies' profit margins to fall around 3 percent by 2030 if the business-as-usual scenario persists.¹³⁰ Another study by the Danish Ministry of Environment estimates that the cost to the country's textile sector for internalising the natural capital costs of indirect land use change, water consumption, air, and water pollution and GHG emissions is about 12 percent of total revenues. Given the average profit margin of 6 percent, this implies that the sector will be operating at a net loss if it was to integrate the environmental costs.¹³¹

Furthermore, there are increasing reputational costs associated with the business-as-usual path. Increased awareness of end customers, in part driven by increased digitisation, is also forcing manufacturers to adopt more sustainable practices and buyers to source more sustainably.

THERE ARE ECONOMIC UPSIDES LINKED TO MORE SUSTAINABLE PRACTICES IN THE INDUSTRY

A common misconception is that more sustainable practices must come at the expense of lower profitability. However, as demonstrated by BCG and Global Fashion Agenda's (GFA) recent study, it is possible to generate up to US\$197 billion of value each year if the textile and apparel industry grows at the current projected rate while maintaining its environmental and social footprint.¹³² For example, US\$39 billion can be generated annually if the industry is able to adopt innovative practices that enable water consumption to be kept constant.

US\$39 BILLION CAN BE GENERATED ANNUALLY IF THE INDUSTRY IS ABLE TO ADOPT INNOVATIVE PRACTICES THAT ENABLE WATER CONSUMPTION TO BE KEPT CONSTANT

126. Ellen MacArthur Foundation (2017), *A New Textile Economy: Redesigning Fashion's Future*.

Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf

127. Ellen MacArthur Foundation (2017), *A New Textile Economy: Redesigning Fashion's Future*.

Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf

128. HR in Asia (2016), "86% Textile, Clothing and Footwear Workers in Vietnam are at Risk to Automation".

Available at: <http://www.hrinasia.com/hr-tech/86-textile-clothing-and-footwear-workers-in-vietnam-are-at-risk-to-automation/> and ILO (2016), *ASEAN in transformation*. Available at: http://www.ilo.org/asia/events/WCMS_495244/lang--en/index.htm

129. Trucost (2014), "The Colour this Season is Green". Available at: <https://www.trucost.com/trucost-blog/colour-season-green/>

130. Global Fashion Agenda & The Boston Consulting Group (2017), *Pulse of the Fashion Industry*.

Available at: http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_2017.pdf

131. Danish Ministry of Environment (2014), *Danish apparel sector natural account*.

Available at: <https://www2.mst.dk/Udgiv/publications/2015/01/978-87-93283-07-7.pdf>

132. Global Fashion Agenda & The Boston Consulting Group (2017), *Pulse of the Fashion Industry*.

Available at: http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_Executive-summary.pdf

THERE ARE FOUR WAYS THAT INDUSTRY PLAYERS CAN REAP THE UPSIDE POTENTIAL

The most straightforward channel to exploit is to tackle inefficiencies within existing processes. Beyond that, new business models and innovation in both products and processes are required to achieve longer-term, transformative impact on the industry. The following section provides some examples of existing practices.

- **Improve efficiencies of existing processes.**

“Low-hanging fruit” for the textile industry that does not require much capital expenditure is to improve efficiencies in the existing manufacturing process.¹³³ By implementing simple changes such as controlling steam pipe temperatures, regulating the air-fuel ratio in boilers, and setting up heat exchangers using warm wastewater, it is possible for the textile industry to save up to 15 percent in energy costs.¹³⁴ For example, a leading garment manufacturer in Asia was able to derive savings and meet its sustainability targets by optimising chillers performance which reduced the costs of air conditioning. A critical step to improve efficiencies is for facilities to simply start tracking their energy, water, and emissions usage beyond compliance requirements, which will allow them to pinpoint the processes that use excessive resources or generate unnecessary waste.¹³⁵

Another example of improving existing efficiencies is the SMART Myanmar project organised by the EU-funded SWITCH-Asia, where a team of local and international textile experts advised local factories on resource efficiencies, leading to reductions in fabric wastage of around 18 percent, energy consumption reduction of almost 20 percent, and water consumption reduction of 16 percent.¹³⁶ Moreover, steps to improve workers safety (e.g. fire prevention training, new emergency exits, and access to basic healthcare) helped to reduce monthly labour fluctuation rate by 20 percent, contributing

to the overall enhanced productivity of the industry in Myanmar.¹³⁷

- **Process innovation.** This aims to alter the supply chain processes to achieve more sustainable outcomes. For example, clothing retail company H&M has announced ambitions to establish a climate-positive value chain by 2040 by exploring natural carbon sinks and initiating programmes to protect natural biomass and promote sustainable agriculture, as well as investment in technological innovations to absorb greenhouse gases.¹³⁸ A specific process with many exciting and commercially viable innovations is in dyeing, where there are efforts to shift away from traditional practices that are not economical and environmentally unsustainable. Some companies have developed or acquired technologies in this area, including Nike’s ColorDry technology which replaces water with recyclable CO₂ in the dyeing process.¹³⁹ Likewise, We aRe SpinDye works with textile companies to introduce colour to fibres during the spinning process, thus eliminating the need to dye fabrics and yarns.¹⁴⁰

Another process innovation that is gaining ground in the garment production phase is customisation and automation using 3D body scans and 3D printing. Major benefits include more accurate measurements and higher quality products which reduce the potential for waste on the demand side. From the supply perspective, the ability to manufacture “on-demand” reduces production risks which can lead to inventory stockpiles. An example is Body Labs, a company that sells software that captures the body’s shape and motion in 3D and was recently purchased by Amazon. An emerging innovation is coded yarns for improved traceability. Researchers at the University of Borås in Sweden have developed a technology where intelligent yarns are fully integrated into textiles during the manufacturing

133. American Association of Textile Chemists and Colorists (2011), *Staying Alive: Making Textiles Sustainable*.

Available at: <https://www.aatcc.org/wp-content/uploads/2015/03/Sustain1111.pdf>

134. Fibre2Fashion.com, “A Facelift to Textile Machinery with Renewable Energy”.

Available at: <http://www.fibre2fashion.com/industry-article/7069/a-facelift-to-textile-machinery-with-renewable-energy>

135. American Association of Textile Chemists and Colorists (2011), *Staying Alive: Making Textiles Sustainable*.

Available at: <https://www.aatcc.org/wp-content/uploads/2015/03/Sustain1111.pdf>

136. Switch-Asia (2015), “Sustainable development of Asia’s textile and garment industry”.

Available at: <http://www.switch-asia.eu/publications/sustainable-development-of-asias-textile-and-garment-industry/>

137. Switch-Asia (2015), “Sustainable development of Asia’s textile and garment industry”.

Available at: <http://www.switch-asia.eu/publications/sustainable-development-of-asias-textile-and-garment-industry/>

138. For more information, see: <https://about.hm.com/en/sustainability/sustainable-fashion/climate-emissions.html>

139. Nike (2013), “Nike Inc. unveils ColorDry technology and high-tech facility to eliminate water and chemicals in dyeing”.

Available at: <https://news.nike.com/news/nike-colordry>

140. ISPO (2017), “Sustainability in the textile industry: “Stay on the ball, or you’ll be left behind”.

Available at: https://www.ispo.com/en/products/id_79702904/more-sustainability-textile-industry-has-to-reinvent-itself.html

stage to produce traceability tags that have similar functions as barcodes but is more secure as the coded yarn cannot be removed, and also facilitates textile recycling since the yarns do not alter the feel of textiles unlike barcodes and radio-frequency identifications (RFIDs).¹⁴¹

- **Product innovation.** This includes actions that improve the sustainability of raw materials used in the manufacturing process. For example, Dutch Awareness is a leader in developing eco-effective textile innovations and managing circular textile supply chains. The company creates clothes using 100 percent recyclable polyester that does not compromise on quality and uses 95 percent less water, 64 percent less energy and produces 73 percent fewer carbon emissions compared to standard cotton.¹⁴²

Similarly, Levi's has collaborated with EVRNU to manufacture jeans made entirely from regenerated post-consumer cotton waste.¹⁴³ Some companies have pushed the boundaries of material innovation even further. For instance, Modern Meadows manufactures biofabricated leather by growing collagen from DNA sequencing and has mastered the process such that the desired structural and aesthetic properties can be achieved.¹⁴⁴

Textile firms and industry groups are also collaborating to enhance the sourcing of sustainable raw materials. For example, the Organic Cotton Accelerator is a multi-stakeholder initiative that aims to build a fair and robust organic cotton market with appropriate integrity at every relevant level, whilst growing both supply and demand through raising awareness.

- **New sustainable business models.** These new business models aim to radically rethink the consumer value proposition to lower the environmental footprint of products. Many textile and clothing companies are already experimenting with innovative models aimed at reducing, recycling, repairing, and reusing, but much more can be done to scale up these models relative to the size of the industry. One increasingly popular area is the increased "servitisation" by retail brands, where the customer experience (more than just the product itself) becomes a fundamental value proposition, allowing for the disconnection of profit and production volume.¹⁴⁵ "Servitisation" models include promoting product repairs and warranties or encouraging renting and leasing of products.

For example, Patagonia employs full-time technicians to repair apparel sent in by customers, with the price of repair determined on a case-by-case basis.¹⁴⁶ To encourage resale and reusing of products, Yerdle Recommerce provides logistic and technical support to brands such as Levi's and Eileen Fisher to buy back and resell their products.¹⁴⁷ Filippa K runs a profitable collection service and resale store where consumers return used clothing in return for a 15 percent discount on their next purchase.¹⁴⁸ The owner of the used clothing also enjoys a commission if his or her item is successfully resold, while the programme has led to marketing exposure and stronger customer loyalty for Filippa K.

Start-ups are also providing the digital and physical platforms to facilitate the sharing, leasing, or sale of pre-used clothes. One example is Singapore-based Refash, which is looking to capitalise on the commercial opportunity of reducing waste, and recently closed a seed round of US\$303,000.¹⁴⁹

141. Sustainable Brands (2017), "Coded yarns poised to weave transparency, traceability into textile supply chain." Available at: http://www.sustainablebrands.com/news_and_views/product_service_design_innovation/sustainable_brands/coded_yarns_poised_weave_transpa

142. Environmental Leader (2014), "Assessing the environmental impact of the fashion world."

Available at: <https://www.environmentalleader.com/2014/10/assessing-the-environmental-impact-of-the-fashion-world/>

143. Business Beyond Borders (2017), "Top 5 latest innovations in textiles and fashion".

Available at: <http://www.businessbeyondborders.info/top-5-latest-innovations-in-textiles-and-fashion/>

144. For more information, see: <http://www.modernmeadow.com/our-technology/>

145. Circular Economy for Sitra (2015), *Service-based business models and circular strategies for textiles*. Available at: <https://s3-eu-west-1.amazonaws.com/stjm/20160330092502/Service-based-business-models-and-circular-strategies-for-textiles-2015-SITRA-STJM.pdf>

146. Circular Economy for Sitra (2015), *Service-based business models and circular strategies for textiles*. Available at: <https://s3-eu-west-1.amazonaws.com/stjm/20160330092502/Service-based-business-models-and-circular-strategies-for-textiles-2015-SITRA-STJM.pdf>

147. World Wildlife Fund (2017), *Changing Fashion: The clothing and textile industry at the brink of a radical transformation. Environmental rating and innovation report 2017*. Available at: https://assets.wwf.ch/downloads/changing_fashion_2017.pdf

148. Circular Economy for Sitra (2015), *Service-based business models and circular strategies for textiles*. Available at: <https://s3-eu-west-1.amazonaws.com/stjm/20160330092502/Service-based-business-models-and-circular-strategies-for-textiles-2015-SITRA-STJM.pdf>

149. DealStreetAsia (2016), "VC Roundup: Latize raises \$1.5m growth round, Refash closes \$294k seed".

Available at: <https://www.dealstreetasia.com/stories/54151-54151/>

KEY LESSONS ON HOW TO CAPTURE THE SUSTAINABILITY OPPORTUNITIES IN TEXTILES

The discussion above shows that there are many areas of sustainability where the textile industry can focus on. However, various surveys show that there is much scope for industry players to do more. For instance, the World Wildlife Fund (WWF)'s assessment of 12 major clothing brands shows that none of them are considered "visionary" regarding environmental issues, and more than half the companies have not taken any steps at all to counter climate change.¹⁵⁰ "Rank a Brand's" assessment of 37 cotton-intensive companies finds that almost 80 percent of them "appear to do virtually nothing on cotton sustainability."¹⁵¹

To better understand how industry players can embark on their own sustainable journeys, TAL provided some lessons from their own experience. Some of the key takeaways include:

- **Make sustainability a strategic choice.** To generate real impetus and impact, sustainability initiatives should not be treated as another corporate social responsibility programme. Instead, management should view sustainable initiatives as a strategic choice, and embed its principles into the actual business and operating models. For TAL, sustainability is one of seven value drivers that guide the firm's strategy (Exhibit 9). For example, manufacturing cost-cutting efforts were selected based on specific sustainability targets to be met.

To ensure that the socially and environmentally responsible mindset flows through the organisation, TAL simplified its sustainability practices as much as possible, as well as dedicated resources to educate its workers, so that practices are operationalisable at the factory level.

- **Agree on where to focus.** The textile supply chain consists of many stages and processes, ranging from production to design to distribution and retail. This implies that there are many areas where firms can

make a difference in terms of being more sustainable. That said, the lack of focus and prioritisation have hampered efforts and led to less-than-satisfactory results in many firms (including those outside the textile industry), where initiative outcomes become fragmented, decentralised, and misaligned across business units.¹⁵²

TAL managed this by having a clear criterion for selecting sustainability projects, with the requirement that projects could pay for themselves within 10 years. Projects that do not meet the requirement will not be implemented.

- **Importance of concrete targets to create accountability.** Without concrete targets that are measurable, it is impossible to achieve accountability of sustainable initiatives. Examples of systemic target setting at TAL include reducing water use and GHG emission per garment piece by 13 percent and 12 percent respectively. TAL also created 3-year sustainability plans to track progress at each of their factories.

SYSTEMIC TARGET SETTING AT TAL INCLUDE REDUCING WATER USE AND GHG EMISSION PER GARMENT PIECE BY 13 PERCENT AND 12 PERCENT RESPECTIVELY

The company created a management system called the "Plan-Do-Check-Act" approach to track different aspects of their operations, where sustainability targets were set and measured against the actual outcomes (e.g. water and energy audit footprint reduction or percentage of recycled water etc). Beyond targets, it may also be necessary to create accountability by aligning incentives such as executive remuneration with sustainability performance.¹⁵³

150. World Wildlife Fund (2017), *Changing Fashion: The clothing and textile industry at the brink of a radical transformation. Environmental rating and innovation report 2017*. Available at: https://assets.wwf.ch/downloads/changing_fashion_2017.pdf

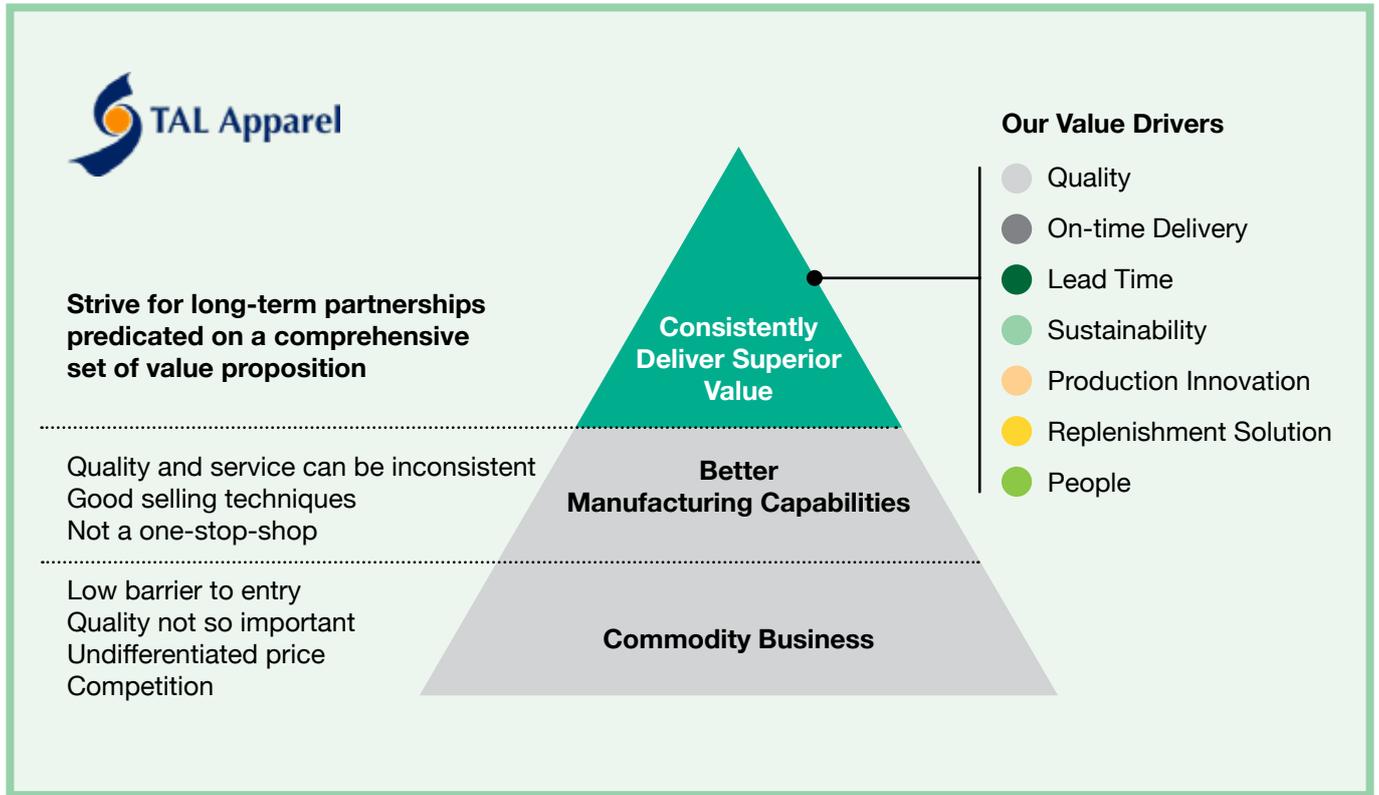
151. Sustainable Brands (2016), "Of Top Cotton Users, Over 75% 'Appear to Do Virtually Nothing' on Cotton Sustainability". Available at: http://www.sustainablebrands.com/news_and_views/supply_chain/hannah_furlong/top_cotton_users_over_75_appear_do_virtually_nothing_sustainability

152. McKinsey & Company (2014), "Bringing discipline to your sustainability initiatives". Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/bringing-discipline-to-your-sustainability-initiatives>

153. McKinsey & Company (2014), "Bringing discipline to your sustainability initiatives". Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/bringing-discipline-to-your-sustainability-initiatives>

EXHIBIT 9:

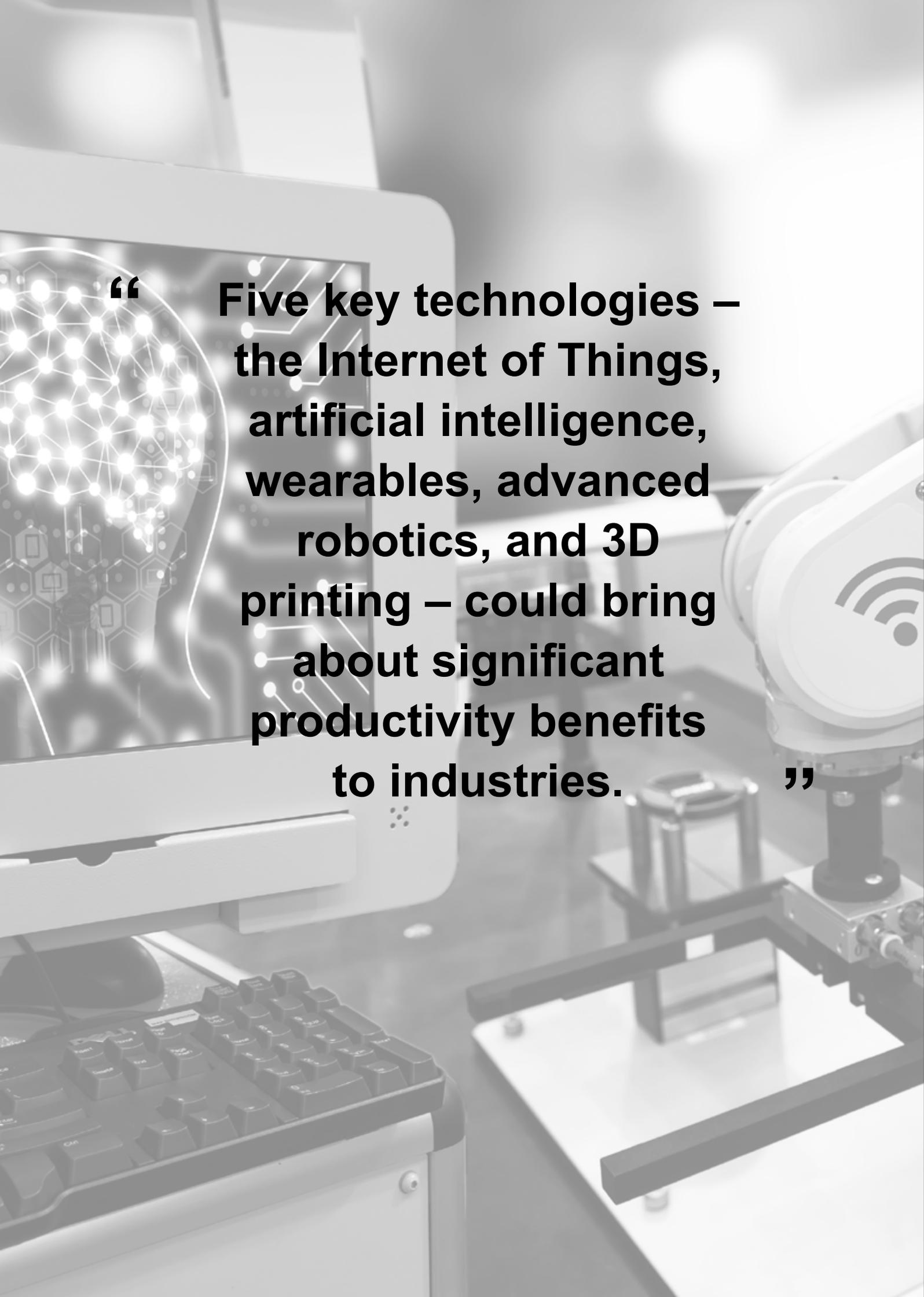
TAL: OUR VALUE DRIVERS



Source: TAL website



- **Collaboration with industry players.** The textile industry involves a wide range of players, from manufacturers to brands and retailers. A collaborative approach across the different stakeholders could be the catalyst to achieve sustained breakthrough impact. This is particularly so for some process and product innovation processes which may require a certain level of scale economies to make financial sense. For example, TAL revealed that it cost an estimated 10 cents per shirt to recycle and treat water discharge. This puts considerable pressure on their already thin margins unless brands are willing to share the cost burden, or consumer awareness is developed enough such that end customers are willing to accept higher prices for more sustainably made products.
- Industry bodies such as the Sustainable Apparel Coalition (SAC) brings together the private, public, non-government organisations and academia to share best practices and commit to transparency. For example, SAC members, including TAL, have contributed to the development of The Higg Index which enables brands, retailers, and facilities to measure their sustainability performance using a standard methodology.



“ Five key technologies – the Internet of Things, artificial intelligence, wearables, advanced robotics, and 3D printing – could bring about significant productivity benefits to industries. ”



Chapter 6:
INDUSTRY
4.0

This chapter explores the societal and business opportunities from leveraging digital technologies in production processes, as discussed in the breakfast event, entitled “The Ecosperity Series - Industry 4.0: Applications and Lessons Learned”. The session was led by Mr. Johan Aurik, Managing Partner and Chairman of the Board, of A.T. Kearney on Wednesday 25th October 2017, and included a range of stakeholders from the technology sector including industry, government, investors, and academics. Additional material has been gathered to supplement the insights from the session.

Five key technologies – the Internet of Things, artificial intelligence, wearables, advanced robotics, and 3D printing – could bring about significant productivity benefits to industries. However, they also raise genuine concerns such as sustainability, cybersecurity, and inequality risks. The session participants discussed how this upside potential could be captured and how these concerns could be mitigated.

5 KEY TECHNOLOGIES ARE SHAPING THE FUTURE OF PRODUCTION

Five technologies are identified as the main drivers of change to the future of production - transforming what, where, and how goods are produced.

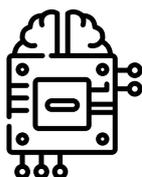
SOME FACTS ON THE FIVE TECHNOLOGIES



Investments in industrial IoT - the use of connected systems in production is expected to

DOUBLE TO US\$70 BILLION BY 2020

INTERNET OF THINGS



70% OF CAPTURED PRODUCTION DATA

are still unutilised, implying that the use of artificial intelligence could further optimise current production chains in a material way

ARTIFICIAL INTELLIGENCE

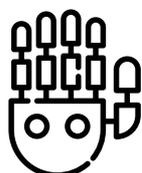


This nascent market is expected to

GROW BY 7X TO US\$5 BILLION

by 2020 with pilots being implemented across industries

WEARABLES



It is projected that the use of advanced robotics in production will

INCREASE BY UP TO 45%

by 2030. SATS invested in new production line to automate

OVER 50% OF KITCHEN TASKS

ADVANCED ROBOTICS



3D printing units are mainly found in North America and

INSTALLED IN THESE INDUSTRIES WHERE CUSTOMISATION IS KEY:

aerospace, automotive, electronics, and healthcare

3D PRINTING

UNDERSTANDING THE COSTS AND BENEFITS, AND AREAS OF ACTION FOR TECH ADOPTION

THE TECHNOLOGIES INTRODUCE BOTH BENEFITS AND COSTS

BENEFITS

- Increased productivity and efficiency
- Safer working environment
- Greater innovation
- Lower production waste



COSTS

- Rise in e-waste
- Uneven adoption rates
- Automation of jobs
- Rethinking learning approaches
- Increased cybersecurity risks



KEY SUCCESS FACTORS IN RESOURCE RECOVERY

FOCUS ON RESEARCH AND INNOVATION

- To spur innovation, detect loopholes or bugs, and improve the technological readiness of the production industry
- **SOUTH KOREA** has directly invested US\$460 million to ramp up automation



DEMOCRATISE PRODUCTION KNOWLEDGE

- Reduce information asymmetries for SMEs and small entrepreneurs
- **SINGAPORE** launched the Tech Access initiative to provide tech training to SMEs



CREATE NEW PATHWAYS

- Overhaul formal education and promote continuous learning
- **DENMARK** has a comprehensive training programme for unemployed workers



PRIORITISE PUBLIC-PRIVATE PARTNERSHIPS

- Effective solutions require collaboration between governments and private sector
- **US** government strengthened cybersecurity laws to encourage tech adoption in industries



FIVE KEY TECHNOLOGICAL DISRUPTIONS WILL SHAPE THE FUTURE OF PRODUCTION

Production activities cover more than just the manufacturing of goods, they comprise the entire value chain ranging from product design and material sourcing to reuse or disposal. Technological advances have historically been disrupting production and, in most instances, beneficial for the global economy. For instance, the Second Industrial Revolution at the beginning of the 20th century introduced the concepts of assembly lines and mass production, resulting in more affordable goods for the masses.¹⁵⁴

Currently, the world is in its Fourth Industrial Revolution (4IR) as over 60 technologies advance the ubiquitous connectivity of people, machines, and real-time data, resulting in a new phase of production activities across the value chain with the restructuring of factories and redefinition of job scopes.¹⁵⁵ For instance, product designs experience fewer constraints as new technologies such as 3D printing are enabling engineers to manufacture

comprehensive impact of the 4IR is still unclear and more studies need to be conducted, the future of production is likely to impact more industries and businesses in the short term.

Five key technologies have been identified as the main drivers of change to the future of production, transforming what, where, and how goods are produced.¹⁵⁷ The Internet of Things, artificial intelligence, wearables, advanced robotics, and 3D printing are in various stages of maturity; for instance, enterprise wearables (including virtual and augmented reality devices) are still in the nascent stage of development while 3D printing is considered mainstream and used widely in certain industries.¹⁵⁸ Furthermore, most of these technologies are adopted in North America, Europe, and developed parts of APAC (China, Japan, and South Korea). Excluding Internet of Things (which might overlap with the other technologies in terms of application), the total market size of the other key technologies was close to US\$50 billion in 2015 (see Exhibit 10).¹⁵⁹

US\$50 BILLION ANNUAL MARKET OPPORTUNITY ASSOCIATED WITH KEY TECHNOLOGIES RELATED TO PRODUCTION

with greater details using voxel level controls.¹⁵⁶ Another technological impact is the reduction in production costs and space requirements due to advanced robotics and wearables, enabling companies in capital-intensive markets to re-optimize their supply chains abroad and reshore their factories nearer to the consumers. Leveraging these innovations, certain industries which value customisation and quick turnaround times (such as aerospace, electronics, and automotive) are already embracing the future of production. While the

The five key technologies are as follows:

- Internet of Things (IoT).** IoT refers to the network of physical devices with embedded sensors and software to enable the communication and exchange of data. The underlying technologies have been around for over 15 years but IoT has grown rapidly recently mainly due to reduced sensor costs, enhanced computing power, and improved cloud solutions. Adoption of industrial IoT (IIoT), referring to the use of connected systems in production to streamline operations, is currently concentrated in the manufacturing industry, but quickly spreading to other sectors. IIoT investments are projected to

154. Richmond Vale Academy (2016), "Second Industrial Revolution: The Technological Revolution". Available at: <http://richmondvale.org/second-industrial-revolution/> and World History (2015), "Industrial Revolution and Assembly Line Work". Available at: <http://www.worldhistory.biz/sundries/29022-industrial-revolution-and-assembly-line-work.html>

155. The 60 technologies range from emerging technologies such as quantum computing and 4D printing to mainstream ones like digital twins and cloud computing. World Economic Forum (2017), *Technology and Innovation for the Future of Production: Accelerating Value Creation*. Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

156. Business Wire (2017), "Stratasys Sets New Standard in Voxel-Controlled 3D Printing with New GrabCAD Voxel Print – Forging a Breakthrough Approach to Research and Discovery". Available at: <https://www.businesswire.com/news/home/20171114006047/en/Stratasys-Sets-New-Standard-Voxel-Controlled-3D-Printing>

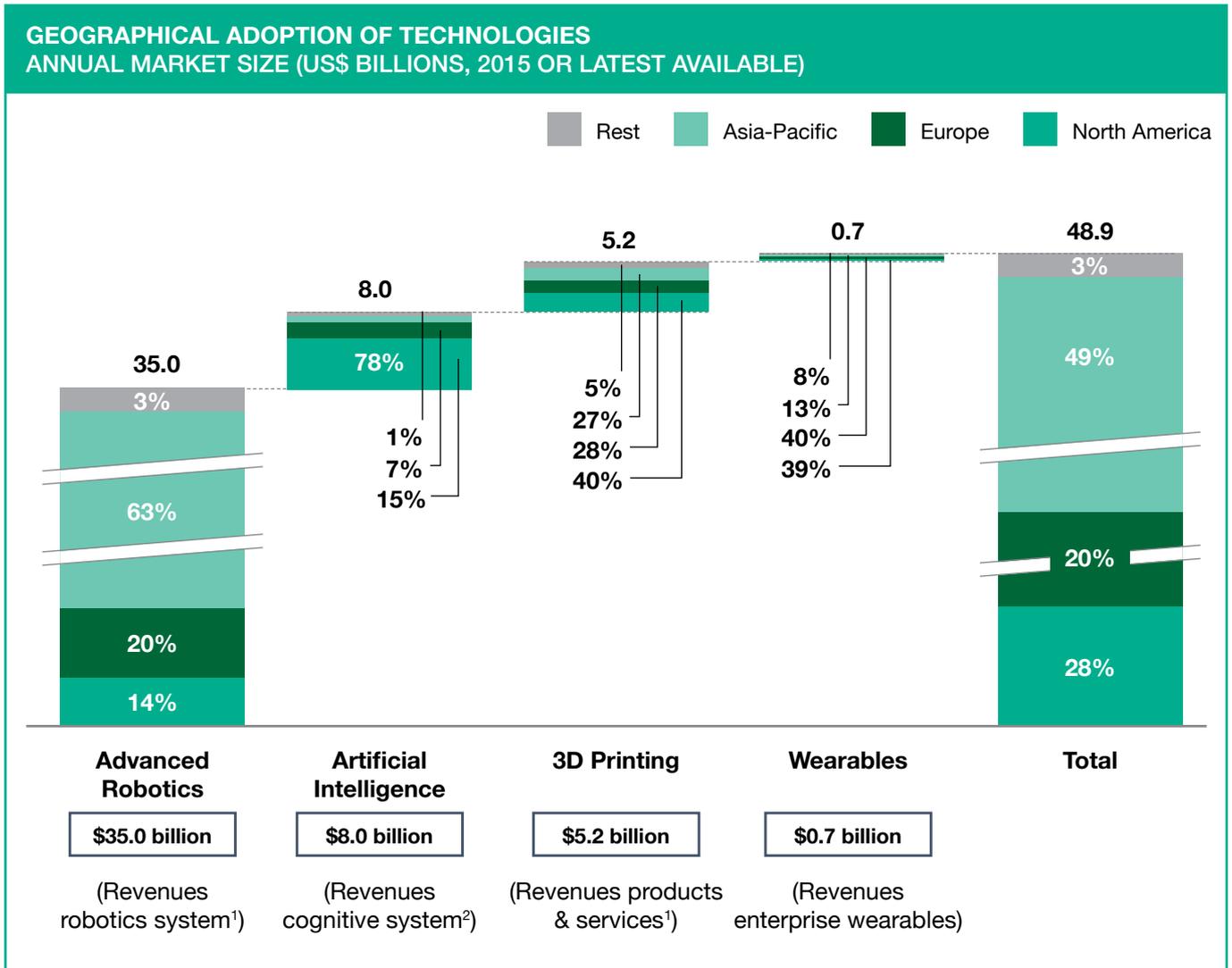
157. Based on interviews and discussions, The World Economic Forum and A.T. Kearney have shortlisted 5 key technologies out of the list of over 60. These technologies "transform what, where, and how products are designed, manufactured, assembled, distributed, consumed, serviced after purchase, discarded, and even reused." World Economic Forum (2017), *Technology and Innovation for the Future of Production: Accelerating Value Creation*. Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

158. Straits Times (2016), "Engineers on 3D printing and how data analytics boosts manufacturing". Available at: <http://www.straitstimes.com/opinion/now-printing-a-revolution-in-how-things-are-made>

159. To remain conservative and accurate, the enterprise models for these five key technologies, such as enterprise wearables, are considered. Public estimates for the industrial Internet of Things (IIoT) vary widely and could overlap the other technologies in terms of application such as wearables and advanced robotics. Hence, market size for IIoT was not reported in Exhibit 1.

EXHIBIT 10:

ADOPTION OF THE KEY TECHNOLOGIES, RELATED TO PRODUCTION, IS CONCENTRATED IN SOME PARTS OF ASIA WITH A TOTAL MARKET SIZE OF ALMOST US\$50 BILLION



1. Distribution based on units sold in 2015.

2. Estimates for Asia-Pacific and Rest based on International Data Corporation (IDC) data.

Source: A.T. Kearney; World Economic Forum; IDC; and expert interviews

increase from US\$35 billion to over US\$70 billion by 2020.¹⁶⁰ There is significant growth potential for the spread of IIoT: 85 percent of current production assets are not connected yet.¹⁶¹

- **Artificial Intelligence (AI).** AI refers to the simulation of human intelligence by software applications. Given the appropriate data training and interactions, these solutions can learn and evolve over time. 70 percent of captured production data are unutilised today, implying that the use of AI could further optimise current production chains.¹⁶² Currently, AI has been deployed in a range of operations such as adaptive manufacturing and predictive maintenance.¹⁶³ For example, Sembcorp has developed a “Virtual Brain” system with AI to optimise water treatment operations and facilitate predictive maintenance.¹⁶⁴
- **Wearables.** Referring to electronics that are worn on the body during production and operations (e.g., conducting repairs), enterprise wearables are still largely in the development stage. For instance, SATS has been equipping its staff with smart watches and augmented reality smart glasses to enable them to operate faster and better.¹⁶⁵ This nascent market is expected to grow rapidly to US\$5 billion by 2020 with pilots being implemented across industries to improve productivity, safety, and training concerns.¹⁶⁶
- **Advanced Robotics.** For a long time, programmable robots have been handling the dangerous and mundane tasks of production alone such as welding metals. Recently, technology advancement

has enabled robots (referred to as “cobots”) to work continuously for hours, alongside humans, to increase outputs and ensure consistency. For example, SATS has invested in a new production line to automate up to 50 percent of certain kitchen tasks.¹⁶⁷ Industrial robots are found mainly in the automotive and electronics industries. From a geographical perspective, in 2016, it is estimated that China accounts for about 30 percent of robots used in production; while Japan is responsible for over 35 percent of robot production.¹⁶⁸ It is projected that the use of advanced robotics in production will increase by up to 45 percent by 2030.¹⁶⁹

- **3D Printing.** 3D printing, sometimes known as additive manufacturing, is the process of producing three dimensional solid objects by creating successive layers of materials using digital software. 3D printing units are mainly found today in industries where customisation is key, such as aerospace, automotive, electronics, and healthcare. 3D printing creates benefits in terms of customisation, reduction in waste (e.g., better inventory management), longer lifecycles of products, “just in time” logistics, and rapid innovation and prototyping.¹⁷⁰

While effective when used in isolation, these technologies hold most promise when used collectively in production activities. For instance, adopting advanced robotics and AI could boost productivity across industries by 30 percent while lowering labour costs by up to 33 percent.¹⁷¹ This is estimated to create economic benefits of over US\$600 billion by 2025.

160. World Economic Forum (2017), *Technology and Innovation for the Future of Production: Accelerating Value Creation*.

Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

161. eGov Innovation (2017), “The future of production: IIoT, AI, robotics, wearables and 3D printing”.

Available at: <https://www.enterpriseinnovation.net/article/future-production-iiot-ai-robotics-wearables-and-3d-printing-51643031>

162. Gartner (2015), *Predicts 2016: Opportunities Abound for the Factory of the Future to Reach Its Potential*.

Available at: <https://www.gartner.com/doc/3172033/predicts--opportunities-abound-factory>

163. Forbes (2017), “Factories Of The Future Need AI To Survive And Compete”.

Available at: <https://www.forbes.com/sites/mariyayao/2017/08/08/industrial-ai-factories-of-future/#67344be9128e>

164. Sembcorp (2015), *Sembcorp Industries Annual Report 2014*.

Available at: <http://infopub.sgx.com/FileOpen/Sembcorp%20Industries%20Annual%20Report%202014.ashx?App=Prospectus&FileID=25428>

165. The Straits Times (2016), “Smart watches for Sats ground handling workers at Changi Airport”. Available at: <http://www.straitstimes.com/singapore/transport/smart-watches-for-sats-ground-handling-workers-at-changi-airport> and The Straits Times (2017), “Sats to boost operations with smart glasses”. Available at: <http://www.straitstimes.com/business/sats-to-boost-operations-with-smart-glasses>

166. World Economic Forum (2017), *Technology and Innovation for the Future of Production: Accelerating Value Creation*.

Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

167. SATS (2016), “SATS Invests \$18 Million in New Production Line, Expands Kitchen”. Available at: [https://www.sats.com.sg/Media/NewsContent/SATS%20invests%20\\$18%20million%20in%20new%20production%20line,%20expands%20kitchen.pdf](https://www.sats.com.sg/Media/NewsContent/SATS%20invests%20$18%20million%20in%20new%20production%20line,%20expands%20kitchen.pdf)

168. IFR (2017), *Executive Summary World Robotics 2017 Industrial Robots*. Available at: https://ifr.org/downloads/press/Executive_Summary_WR_2017_Industrial_Robots.pdf and World’s Top Exporters (2017), “Top Industrial Robots Exporters”. Available at: <http://www.worldstopexports.com/top-industrial-robots-exporters/>

169. World Economic Forum (2017), *Technology and Innovation for the Future of Production: Accelerating Value Creation*.

Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

170. PwC (2017), “Five ways 3-D printing is changing manufacturing”. Available at: <http://usblogs.pwc.com/emerging-technology/5-ways-3d-printing-revolutionizes-manufacturing/>, The Economist (2013), “3D printing scales up”. Available at: <https://www.economist.com/news/technology-quarterly/21584447-digital-manufacturing-there-lot-hype-around-3d-printing-it-fast> and Forbes (2017), “The State Of 3D Printing, 2017”.

Available at: <https://www.forbes.com/sites/louiscolombus/2017/05/23/the-state-of-3d-printing-2017/#3418e7d857eb>

171. World Economic Forum (2017), *Technology and Innovation for the Future of Production: Accelerating Value Creation*.

Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

THESE DISRUPTIVE TECHNOLOGIES COULD PROVIDE SIGNIFICANT BENEFITS, BUT ALSO RAISE GENUINE CONCERNS

The five key technologies are expected to deliver significant benefits to production ranging from increased productivities to safer jobs. However, these same enablers for greater economic growth also introduce concerns which need to be addressed (see Exhibit 11). If not, widespread adoption of technologies might be hindered, or the benefit and costs may be inequitably distributed (e.g., blue-collared workers impacted by job losses). Hence, understanding the impact of IoT, AI, wearables, advanced robotics, and 3D printing on inequality, innovation, education, employment, and the environment is critical for stakeholders to make informed decisions (e.g., whether governments should promote them).¹⁷²

Potential benefits:

- **Increased productivity and efficiency.** Technologies can help streamline operations and ensure better allocation of resources. For example, major shipping firm DHL has managed to reduce its training period for its staff by 50 percent using enterprise wearables in its pilots.¹⁷³ 3D printing also enables designers to use 30 percent less inputs. The time savings could be channelled to other productive activities such as business development and research.
- **Safer working environment.** As disruptive technologies reduce the routine, tedious, and dangerous manual tasks, there could be lower health risk for employees in the production industries. For instance, it is estimated that workplace injuries will fall by 11 percent as dangerous manual tasks are automated in Australia.¹⁷⁴

WORKPLACE INJURIES COULD FALL BY 11 PERCENT AS DANGEROUS MANUAL TASKS ARE AUTOMATED

- **Greater innovation.** Technologies change how people consume and give rise to new business

models, products, and services. For instance, AI-as-a-service platforms and hyperpersonalised products (due to the convergence of AI and 3D printing) are gaining popularity.

- **Lower production waste.** Technologies such as IoT support the circular economy and help to streamline the production supply chains by identifying leakage gaps, allowing faster intervention and hence, less waste. For instance, sensors in storage facilities help ensure the shelf lives of perishables. It is estimated that by matching supply and demand more efficiently in global manufacturing supply chains, technologies could eliminate US\$1 trillion of waste.¹⁷⁵

Potential concerns:

- **Rise in e-waste.** Technological advancements could lead to more electronic waste (e-waste). Growing mountains of discarded screens and equipment are a threat to human health and the environment. Discarded e-waste is forecasted to rise from 40 million tonnes in 2014 to 52 million tonnes in 2021.¹⁷⁶ Furthermore, with the rise of machines and cloud-based solutions, the increasing energy consumption by industries and data centres will lead to more pollution.
- **Uneven adoption rates.** Technological advances might increase the gap between large-scale producers and smaller players due to uneven adoption rates by firms. While technology advancements can help firms overcome many scale-related barriers, such as the cost of IT systems (lowered by cloud computing in particular) and the ability to export (by using Internet-based research



LESS THAN 20 PERCENT OF SMES HAD HEARD OF DIGITAL 4.0 IN GERMANY

172. Furthermore, some of these benefits and concerns are linked to the Sustainable Development Goals. For instance, these are important areas to consider for Goal 4 (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all) and Goal 8 (Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all). World Health Organisation (2015), "UN Sustainable Development Summit 2015". Available at: <http://www.who.int/mediacentre/events/meetings/2015/un-sustainable-development-summit/en/>

173. Benzinga (2017), "Vuzix Smart Glasses Used in DHL's Successful Trials, DHL Making Smart Glasses New Standard in its Supply Chain Logistics". Available at: <https://www.benzinga.com/pressreleases/17/08/n9864797/vuzix-smart-glasses-used-in-dhls-successful-trials-dhl-making-smart-gla>

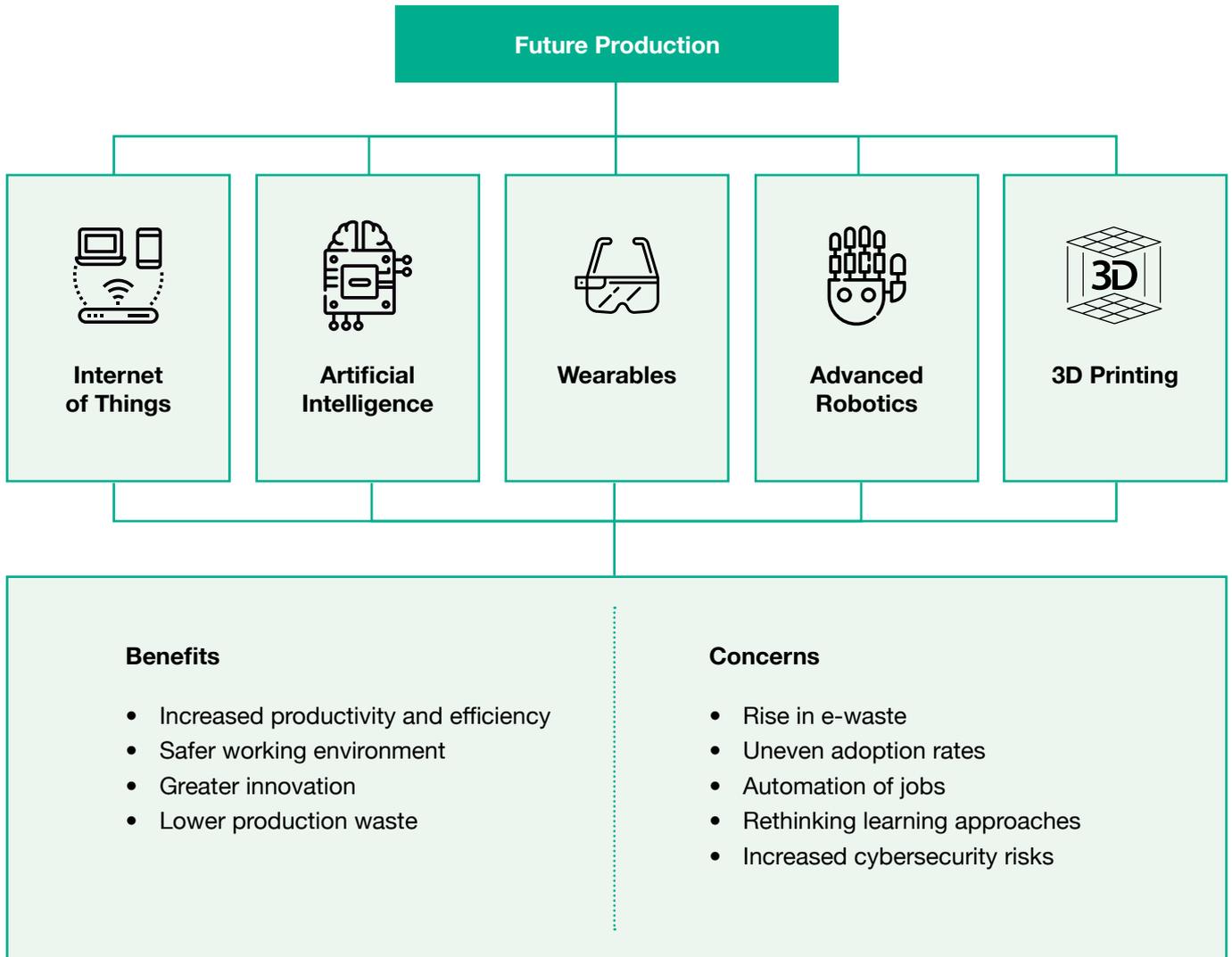
174. AlphaBeta (2017), The Automation Advantage. Available at: <http://www.alphabeta.com/wp-content/uploads/2017/08/The-Automation-Advantage.pdf>

175. IDC (2018), "IDC Manufacturing Insights". Available at: <https://www.idc.com/prodserv/insights/#manufacturing>

176. United Nations University (2017), The Global E-Waste Monitor 2017. Available at: https://collections.unu.edu/eserv/UNU:6341/Global-E-waste_Monitor_2017__electronic_single_pages_.pdf

EXHIBIT 11:

THE 5 KEY TECHNOLOGIES SHAPING THE FUTURE OF PRODUCTION COULD INTRODUCE BOTH BENEFITS AND CONCERNS WHICH NEED TO BE ADDRESSED



Source: Literature search; A.T. Kearney; AlphaBeta analysis

and marketing tools), adoption rates vary significantly by firm size. Some might not even know about these technological opportunities. For instance, in Germany, less than 20 percent of 4,500 small and medium-sized enterprises (SMEs) had heard of Digital 4.0.¹⁷⁷ Therefore, SMEs might lose out on the potential benefits and be less competitive compared to more established brands.

- **Automation of jobs.** There have been fears that greater technology adoption will lead to the massive displacement of jobs. For instance, advanced robotics might remove the blue-collared workers in assembly lines and fabrication sub-contractors might face retrenchment as companies handle the tasks themselves via 3D printers. Most of the media commentaries on automation focus on the impact at the jobs level—on jobs destroyed or created. However, most of the change from technology won't come from changing the jobs we do, but rather changing the way we do our jobs. Research by AlphaBeta has shown that over 70 percent of the total expected reduction in work time in countries like Australia will come from people doing the same job but completing fewer manual and routine tasks on the job.¹⁷⁸ Only 29 percent of the automation driven workplace change will involve workers changing jobs. Whilst these workers are at risk of unemployment, it is important to understand that this does not imply all workers at risk will lose their jobs. The impact of automation will vary significantly however across economies based on their different industry mixes and their level of development. In general, economies with more routine, manual-based jobs (such as factory line workers) will be

THE MAJORITY OF THE IMPACT OF AUTOMATION WILL NOT BE ON REPLACING JOBS, BUT WILL RATHER BE ON CHANGING THE WAY WE DO OUR JOBS

most exposed to automation-led job displacement. Countries will need to put in place strong retraining and social protection mechanisms to help workers deal with this disruption. Automation is also likely to create new jobs for displaced workers. For example, hundreds of thousands of new jobs have been created in shared mobility, Internet content development, and data analytics.

- **Rethinking learning approaches.** Technological advances such as automation and AI will require a radical shift in education systems. For instance, it has been projected that over 50 percent of students are being trained in jobs that will be radically changed by automation.¹⁷⁹ New, lifelong learning approaches will be needed that enable individuals to keep pace with the changing skill demands of the labour force.
- **Increased cybersecurity risks.** Cybersecurity risks are rising due to more unmanaged devices, greater connectivity amongst devices via IIoT, lack of security training, failure to adhere to security patches and best practices, and the emergence of more hackers.¹⁸⁰ Cybersecurity breaches cost businesses US\$4 billion in 2016 and the number of breaches is expected to rise by 36 percent in the following years.¹⁸¹

177. ITIF (2016), *A Policymaker's Guide to Smart Manufacturing*. Available at: <http://www2.itif.org/2016-policymakers-guide-smart-manufacturing.pdf>

178. AlphaBeta (2017), *The Automation Advantage*. Available at: <http://www.alphabeta.com/wp-content/uploads/2017/08/The-Automation-Advantage.pdf>

179. AlphaBeta (2015), *The New Work Order*. Available at: <http://www.fya.org.au/wp-content/uploads/2015/08/The-New-Work-Order-FINAL-low-res-2.pdf>

180. The number of registered global computer software security vulnerabilities has increased from 4,930 in 2010 to 11,170 in 2017. Statista (2018), "Software Security Risks at All Time High". Available at: <https://www.statista.com/chart/12805/software-security-risks-at-all-time-high/>

181. HBR (2017), "The Internet of Things Is Going to Change Everything About Cybersecurity". Available at: <https://hbr.org/2017/12/the-internet-of-things-is-going-to-change-everything-about-cybersecurity>, *Manufacturing Business Technology* (2017), "Understanding The Cybersecurity Risks Of IIoT Machines". Available at: <https://www.mbtmag.com/blog/2017/09/understanding-cybersecurity-risks-iiot-machines>, and *Manufacturing Business Technology* (2017), "IIoT And The CyberThreat: A Perfect Storm Of Risk". Available at: <https://www.mbtmag.com/article/2017/06/iiot-and-cyberthreat-perfect-storm-risk>



THERE ARE FOUR AREAS OF ACTIONS THAT STAKEHOLDERS, SUCH AS GOVERNMENTS AND BUSINESSES, CAN IMPLEMENT TO MAXIMISE THE BENEFITS AND MITIGATE THE CONCERNS

The session participants discussed how to fully leverage the potential benefits of the 4IR and mitigate the potential downside. Four areas of action were identified and discussed:

- Focus on research and innovation.** As many of these technologies have not reached mainstream adoption yet, there must be a greater focus on research activities to spur innovation, detect loopholes or bugs, and improve the technological readiness of the production industry. For instance, South Korea has directly invested US\$460 million to ramp up automation and the Swiss postal service has conducted successful delivery trials using robots.¹⁸² Furthermore, more research efforts could be channelled to tackle the rapidly increasing environmental impact of new technologies (e.g., waste companies finding ways to optimise e-waste recycling and collection) and beef up cybersecurity defense software.¹⁸³
- Democratise production knowledge.** There are significant information asymmetries in the production industry as, most of the time, only large companies have access to the latest production principles, technologies, and tools. As such, SMEs or entrepreneurs only have a limited grasp of the technical knowledge. Stakeholders such as governments could help to consolidate the information and make it easier for all to access. For instance, the Singapore Economic Development Board, together with leading academics and industry experts, recently developed the Singapore Smart Industry Readiness Index, which serves as a diagnostic tool that companies across all industries and sizes can use to better understand Industry 4.0 concepts, evaluate the state of their facilities, and develop a plan to support greater adoption of Industry 4.0 concepts in their businesses.¹⁸⁴

182. Business Korea (2016), "South Korean Government to Invest 500 Billion Won in Robotics Industry".

Available at: <http://www.businesskorea.co.kr/english/news/industry/16173-investment-robotics-south-korean-government-invest-500-billion-won-robotics> and Swiss Post (2017), "Swiss Post delivery robots in use by Jelmolli". Available at: <https://www.post.ch/en/about-us/company/media/press-releases/2017/swiss-post-delivery-robots-in-use-by-jelmoli>

183. Elsevier (2015), "Is there a future for e-waste recycling? Yes, and it's worth billions".

Available at: <https://www.elsevier.com/atlas/story/planet/is-there-a-future-for-e-waste-recycling-yes,-and-its-worth-billions>

184. Singapore Economic Development Board (2017), "The Singapore Smart Industry Readiness Index".

Available at: <https://www.edb.gov.sg/en/news-and-resources/news/advanced-manufacturing-release.html>



- Create new pathways.** As traditional job scopes get disrupted by technologies and skills learned in the current school systems become increasingly less relevant, there is a need to overhaul formal education and promote continuous learning. Possible ways include emphasising the importance of hands-on training through internships, evaluating the skills taught in schools (e.g., teaching enterprise skills such as problem-solving), and establishing reskilling and upskilling programmes for the workforce.¹⁸⁵ Denmark has a comprehensive training programme for unemployed workers while Estonia introduces computer programming education in its primary schools.¹⁸⁶
- Prioritise public-private partnerships.** Effective solutions often require collaborative efforts from governments and the private sector. Governments could support via capital funding and regulatory

policies while companies could develop niche expertise in these disruptive technologies and aid commercialisation activities. For instance, the US government has moved to strengthen cybersecurity laws over the past years, encouraging industries to adopt more technologies in their operations.¹⁸⁷ These innovative partnerships could make technological adoption more affordable and facilitate increased business formation, innovation, and growth.

Given the uncertainties of the impact of disruptive technologies, how the future of production evolves over the next decade will depend on the current collaborative efforts of businesses and governments as well as the progress of key enabling conditions (such as policies to equip workers, dedicated institutions to ensure cybersecurity frameworks, and sufficient investment in network infrastructure).¹⁸⁸

185. AlphaBeta (2016), *The New Basics: Big Data reveals the skills young people need for the New Work Order*. Available at: http://www.fya.org.au/wp-content/uploads/2016/04/The-New-Basics_Web_Final.pdf and AlphaBeta (2017), *The New Work Smarts: Thriving in the New Work Order*. Available at: http://www.fya.org.au/wp-content/uploads/2017/07/FYA_TheNewWorkSmarts_July2017.pdf

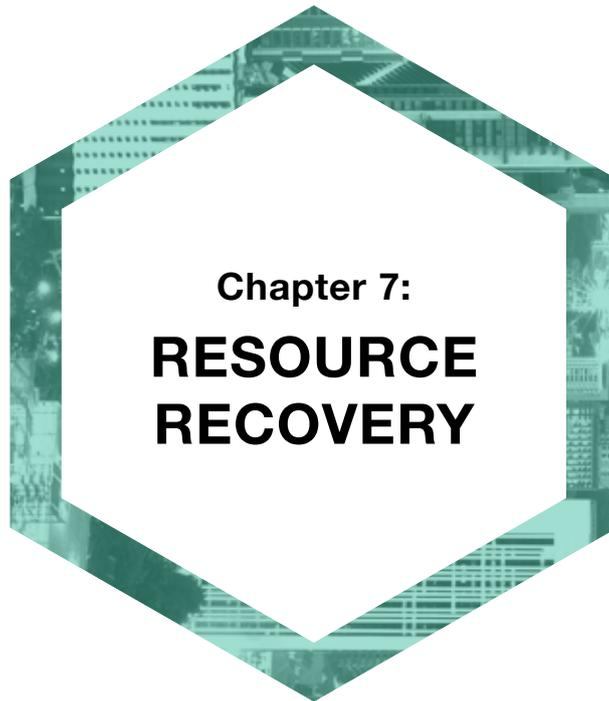
186. Future of Work (2018), "Education and Training - Lessons from Denmark". Available at: http://www.futureofwork.nz/education_and_training_lessons_from_denmark and BBC (2014), "Computer coding taught in Estonian primary schools". Available at: <http://www.bbc.com/news/av/education-25648769/computer-coding-taught-in-estonian-primary-schools>

187. BBC (2015), "Obama makes push for stronger cyber security laws". Available at: <http://www.bbc.com/news/world-us-canada-30807463>

188. World Economic Forum (2017), *Shaping the Future of Production: Four Contrasting Perspectives in 2030*. Available at: http://www3.weforum.org/docs/WEF_White_Paper_Shaping_Future_Production_.pdf



“ Waste management is currently a US\$1.4 trillion market globally, but this could grow to as much as US\$2.1 trillion in 2021 due to the rising demand for waste management services and the innovative new business models being developed. ”



Chapter 7:
**RESOURCE
RECOVERY**

This chapter explores the societal challenges and business opportunities associated with resource recovery, as discussed in the breakfast event, entitled “The Ecosperity Series – Waste Management”. The session was led by Mr. Sriram Changali, Partner (Rapid Transformation and Turnaround), of Ernst & Young on Thursday 1st March 2018, and included a range of stakeholders from the waste management sector including industry, government, investors, and academics. Additional material has been gathered to supplement the insights from the session.

Waste management is currently a US\$1.4 trillion market globally but this could grow to as much as US\$2.1 trillion in 2021 due to the rising demand for waste management services and the innovative new business models being developed. There are also significant opportunities in ASEAN, where the market for waste management is currently between US\$5 billion to US\$6 billion for the ASEAN-6 countries, with Indonesia and Thailand comprising over 50 percent of that total. Participants discussed three main success factors in resource recovery: (1) Robust enforcement and compliance standards on waste at the country-level; (2) Strong local presence and connections; and (3) Integration across the value chain (from collection to treatment).

SUSTAINABILITY CHALLENGES IN RESOURCE RECOVERY...

The global growth in sold waste is a serious side effect of the twin forces of urbanisation and economic development, and improperly disposed waste can create issues for the environment, health, and the economy.

EXAMPLES OF CHALLENGES

More than
8 MILLION METRIC TONNES
of plastic enter the oceans of
the world annually



Burning of trash could represent
AS MUCH AS 5%
of current carbon emissions globally, and
could increase significantly in the future



ENVIRONMENT



MORE THAN 40%
of the total waste is disposed of
through unregulated burning every year,
contributing to deaths caused by air
pollution in Asia



Issues from contamination of fish from
plastic consumption,
WITH AROUND 25%
of fish containing plastic particles

HEALTH



US\$1.3 BILLION
impact to fishing, tourism, and
transportation industries from marine debris
in 21 APEC countries

ECONOMY



...AND OPPORTUNITIES

THE BUSINESS OPPORTUNITIES LINKED TO RESOURCE RECOVERY



Waste management is a **US\$1.4 TRILLION** market in 2016. By 2021, it is expected to grow at a CAGR of between 5% to 9%, to a range of **US\$1.8 TRILLION TO US\$2.1 TRILLION**



70% OF COMPANIES in waste management are achieving returns above their Weighted Average Cost of Capital (WACC), with highest returns generally among local players



Total market value of **BETWEEN US\$5 BILLION TO US\$6 BILLION** in ASEAN-6 countries, with Indonesia and Thailand comprising **OVER 50%**

KEY SUCCESS FACTORS IN RESOURCE RECOVERY

1

ROBUST ENFORCEMENT AND COMPLIANCE STANDARDS ON WASTE AT THE COUNTRY-LEVEL



2

STRONG LOCAL PRESENCE AND CONNECTIONS



3

INTEGRATION ACROSS THE VALUE CHAIN (FROM COLLECTION TO TREATMENT)



WASTE MANAGEMENT REPRESENTS A MAJOR AND GROWING SOCIETAL CHALLENGE, PARTICULARLY IN ASIA

The global growth in solid waste is a serious side effect of the twin forces of urbanisation and economic development. Currently, there are over 3.5 million tonnes of waste per day generated in urban areas, and this could rise by 72 percent by 2025 (Exhibit 12). Some of the fastest growth is expected to occur in Asia – the East Asia & the Pacific (EAP) region plus South Asia combined are forecasted to account for almost 60 percent of the increase in urban waste generation to 2025. Per capita waste generation in EAP is expected to increase by roughly 58 percent in urban areas due to increasing affluence and industrialisation.¹⁸⁹

Globally, solid waste is classified into 4 major categories:

- **Municipal solid waste (MSW).** Solid waste from residential areas, commercial buildings, streets, and public places. It includes food waste, green waste, paper, plastics, metals, glass, and various other items.
- **Industrial waste.** Waste material from manufacturing processes in various industries, such as construction, mining, oil & gas, and agriculture. It includes hazardous (e.g., chemicals, heavy metals) and non-hazardous (e.g., wood chips, scrap metal) waste.
- **Medical waste.** Waste generated within healthcare facilities, including hospitals, medical research centres, and laboratories. It includes hazardous (e.g., syringes, laboratory waste) and non-hazardous (e.g., recyclable materials) waste.
- **E-waste.** Electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of reuse. It includes household appliances, consumer electronics, and IT & telecommunications equipment.

Only just over 70 percent of waste in EAP is collected.¹⁹⁰ Improperly disposed waste ends up at least in three ways, creating high environmental, health, and economic impacts:

- **Ocean debris.** A large amount of waste, including plastics, has leaked into the environment. More than 8 million metric tonnes of plastic enter the oceans of the world annually.¹⁹¹ With the rapid expansion in the size of the consumer class, the quantity of plastic marine debris could accelerate quickly. In less than 10 years, there could be 250 million tonnes of plastic in the oceans.¹⁹² Once in the marine environment, plastics harm marine animals; ingestion has been shown to inhibit growth, make them more prone to tumour development, less successful in reproduction, and less able to detect and evade predators. Asia is at the heart of the challenge due to its fast pace of development, its lack of collection systems, and the large number of archipelagos (enabling waste to escape more easily into the ocean). More than half of the plastic leakage into the ocean occurs in Asia.¹⁹³ In 2008, marine debris was estimated to have directly cost the 21 Asia-Pacific Economic Cooperation (APEC) member economies approximately US\$1.265 billion in terms of impact to the fishing, tourism, and transportation industries.¹⁹⁴ More recent data has suggested that plastic waste debris in the ocean has an annual economic cost of at least US\$13 billion, including impacts on human health, tourism, greenhouse gases, and wildlife.¹⁹⁵

PLASTIC WASTE IN THE OCEAN IS ESTIMATED TO HAVE AN ANNUAL ECONOMIC COST OF AT LEAST US\$13 BILLION

189. World Bank (2012), *What a waste: A global review of solid waste management*. Available at: <https://openknowledge.worldbank.org/handle/10986/17388>

190. World Bank (2012), *What a waste: A global review of solid waste management*. Available at: <https://openknowledge.worldbank.org/handle/10986/17388>

191. Jenna R. Jambeck et al (2015), "Plastic waste inputs from land into the ocean," *Science*, vol. 347, no. 6223, pp. 768–771.

Available at: https://www.iswa.org/fileadmin/user_upload/Calendar_2011_03_AMERICANA/Science-2015-Jambeck-768-71__2_.pdf

192. McKinsey Centre for Business and Environment and Ocean Conservancy (2015), *Stemming the Tide: Land-based strategies for a plastic-free ocean*. Available at: <https://oceanconservancy.org/wp-content/uploads/2017/04/full-report-stemming-the.pdf>

193. Jenna R. Jambeck et al (2015), "Plastic waste inputs from land into the ocean," *Science*, vol. 347, no. 6223, pp. 768–771.

Available at: https://www.iswa.org/fileadmin/user_upload/Calendar_2011_03_AMERICANA/Science-2015-Jambeck-768-71__2_.pdf

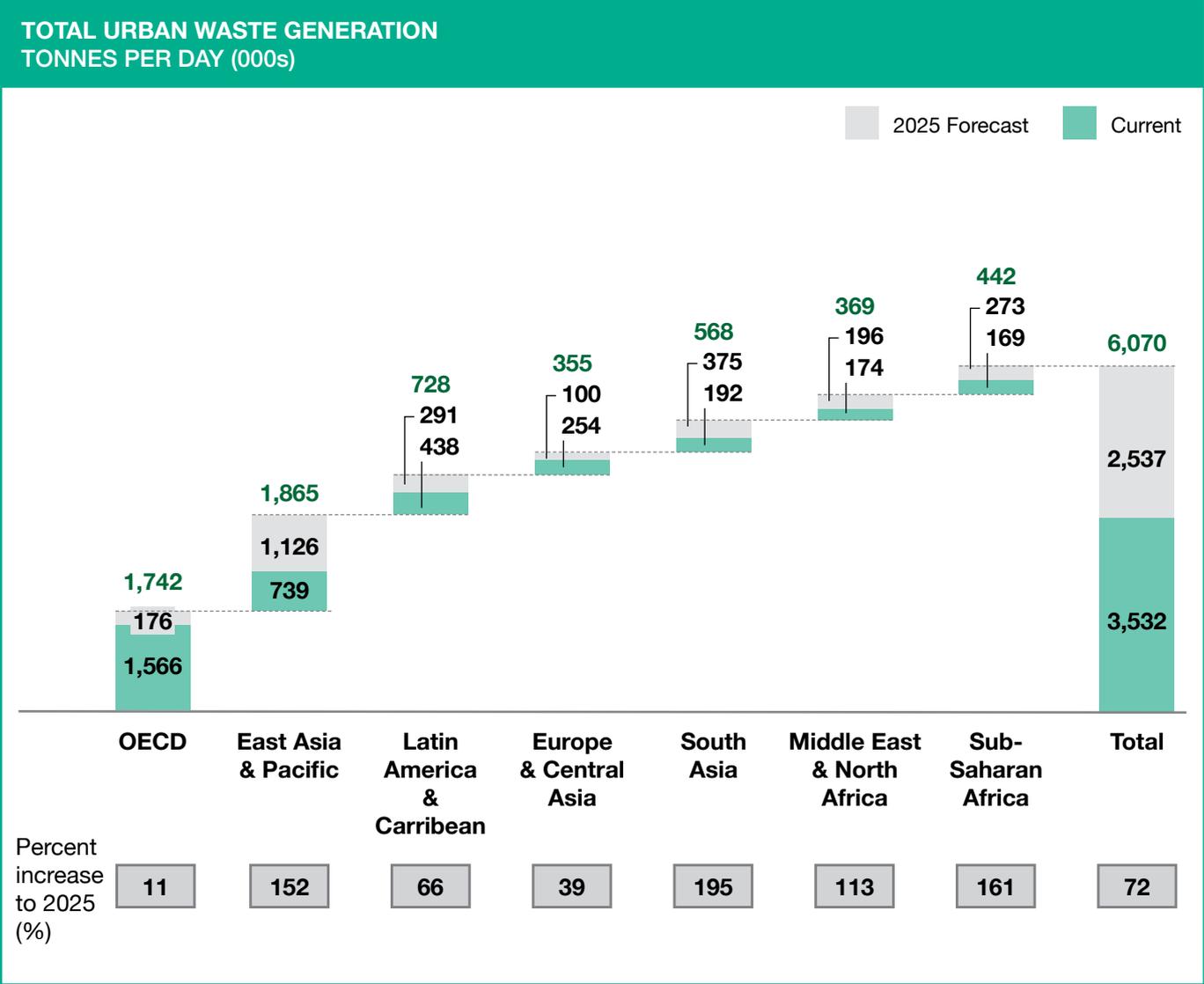
194. McIlgorm, A., Campbell H. F. and Rule M. J. (2008), *Understanding the economic benefits and costs of controlling marine debris in the APEC region. A report to the Asia-Pacific Economic Cooperation Marine Resource Conservation Working Group by the National Marine Science Centre*. Available at: <http://www.nowpap.org/data/ML%20ref/APEC%27ML-control...Cost-vs-Benefit.pdf>

195. TakePart (2014), "Ocean Plastic Pollution Costs \$13 Billion a Year".

Available at: <http://www.takepart.com/article/2014/06/30/ocean-plastic-pollution-costs-13-billion-year-and-your-face-scrub-part-problem>

EXHIBIT 12:

CURRENTLY THERE ARE OVER 3.5 MILLION TONNES OF WASTE PER DAY GENERATED IN URBAN AREAS AND THIS COULD RISE BY 72% BY 2025



Source: World Bank; AlphaBeta analysis

- **Open dumpsites.** Open dumpsites can create a range of environmental and health issues, linked to contamination of surface water, groundwater, and soil from potentially toxic elements; and underground fires fuelled by landfill gas and gas leakage. Research has shown that these issues can create health issues for surrounding populations, such as allergies, asthma, skin irritations and other gastro intestinal diseases.¹⁹⁶
- **Open burning.** More than 40 percent of the total waste generated is disposed of through unregulated burning every year.¹⁹⁷ This can create significant environmental impacts (through the carbon emissions released during burning – representing as much as 5 percent of current CO₂ emissions),¹⁹⁸ as well as public health impacts through the

particulates released into the atmosphere. The WHO calls air pollution the greatest environmental risk to human health. About 90 percent of related deaths take place in low- and middle-income countries, most of them in Southeast Asia and the Pacific.¹⁹⁹ Waste burning, along with other factors such as car emissions and land clearing, are major drivers of this air pollution.

Despite the scale of these challenges, the session participants noted that the negative impact from improper waste management has to be widely seen and felt before it translates into sufficient political will to drive policies, regulations and enforcement. Historically, examples have been seen in London where the Great Smog of 1952 led to the 1956 Clean Air Act; and more recently in China's attempts to deal with growing air pollution.

THE GLOBAL WASTE MANAGEMENT INDUSTRY COULD BE WORTH UP TO US\$2.1 TRILLION IN 2021

The typical waste management value chain consists of 5 segments, namely (1) waste source (e.g., manufacturing, pharmaceuticals, agriculture, household, etc); (2) on-site services (e.g., one-site treatment, recycling, and disposal); (3) collection and transport (e.g., collection and grouping platform, and transportation to waste treatment site); (4) treatment (e.g., chemical, physical, incineration and biological, depending on waste type); and (5) recycling and disposal (e.g., recycling of heavy metals, landfill, and deep burial in some cases). Globally, the waste management market was worth US\$1.4 trillion in 2016 and could grow at 5 to 9 percent per annum to 2021 due to rising waste demand and increasing attention of governments on the negative impacts of improper waste treatment (Exhibit 13).

The waste management market in ASEAN is also set to grow strongly. Ernst & Young estimates that 6 ASEAN countries (Indonesia, Thailand, Vietnam, Philippines, Malaysia, and Singapore) generated a total of 243 million tonnes of waste in 2016. At present, Ernst & Young estimates that 53 percent of the waste generated in ASEAN is uncollected (largely driven by the Philippines and Indonesia). Of the waste that is collected, under

THE ASEAN-6 COLLECTIVELY GENERATED 243 MILLION TONNES OF WASTE IN 2016, BUT ONLY 11 PERCENT IS CURRENTLY RECYCLED

a quarter is currently recycled. The remainder is either illegally dumped after collection (around 34 percent of collected waste) or treated and disposed (around 43 percent of collected waste). Today, Ernst & Young estimates the waste management market in these countries is worth between US\$5 billion to US\$6 billion, with Thailand comprising over half of this value (Exhibit 14). The long-term potential is considered to be highest in Indonesia and Thailand however due to the substantial room for improvement in proper waste treatment rates. However, government inertia in tightening regulation and enforcement could hamper the growth of the market in these countries. In Vietnam, the heavy involvement from local municipalities across the MSW value chain translates to relatively lower illegal dumping post-collection, increasing the size of the potential market. In Malaysia, the imposition of high fines and strong regulation related

196. Shaoli De and Biswajit Debnath (2016), "Prevalence of Health Hazards Associated with Solid Waste Disposal- A Case Study of Kolkata, India". *Journal of Procedia Environmental Sciences*, Vol. 35. Available at: <https://www.sciencedirect.com/science/article/pii/S1878029616301700>

197. National Centre for Atmospheric Research (2014), *Global Emissions of Trace Gases, Particulate Matter, and Hazardous Air Pollutants from Open Burning of Domestic Waste*. Available at: <https://pubs.acs.org/doi/abs/10.1021/es502250z>

198. National Centre for Atmospheric Research (2014), *Global Emissions of Trace Gases, Particulate Matter, and Hazardous Air Pollutants from Open Burning of Domestic Waste*. Available at: <https://pubs.acs.org/doi/abs/10.1021/es502250z>

199. Reuters (2018), "Asia a key battleground in fight against killer air pollution: U.N."

Available at: <https://www.reuters.com/article/us-asia-air-pollution/asia-a-key-battleground-in-fight-against-killer-air-pollution-u-n-idUSKBN1GX0S7>

to medical and industrial hazardous waste has helped to reduce illegal dumping. Considering the nature of the waste markets and expectations on future regulatory

settings, Ernst & Young forecasts that the market growth is likely to be highest in Malaysia, Philippines, and Vietnam.

THREE MAIN FACTORS DRIVE SUCCESS FOR WASTE MANAGEMENT AND RESOURCE RECOVERY COMPANIES

There are three key success factors in the waste management industry:

1. **Robust enforcement and compliance.** Countries with high enforcement rates on waste collection and management tend to have the largest markets and players. Most of these are currently in developed markets, such as the United States (with local players such as WM and Republic Services); France (with local players such as Suez and Veolia environmental services); and Australia (with local players such as Cleanaway).
2. **Strong local presence and connections.** Based on an analysis of larger companies in the waste management market, Ernst & Young found that companies with local scale tend to have earnings before interest, taxes, depreciation, and amortisation (“EBITDA”), with EBITDA margins of between 24 to 28 percent; compared to regional and global players which have lower EBITDA margins of 12 to 22 percent.
3. **Integration across the value chain.** Companies that are integrated across the entire end-to-end waste value chain (from collection through to treatment) tend to have stronger financial performance than companies only focused on 1 to 2 activities (e.g., collection, recycling). On average, the EBITDA margins are anywhere from 4 to 7 percentage points higher for these integrated players compared to niche players. Companies that handle multiple (e.g. 3 to 4) waste streams also tend to have stronger financial performance than companies which are more focused on single waste streams (e.g., medical, e-waste).

Disruptions in the waste management industry can occur within and outside the industry. An example of a disruption from within the industry can be found from waste management start-ups. Rubicon Global, known informally as the “Uber of trash”, connects haulers to customers, streamlines billing, and verifies waste reporting. There

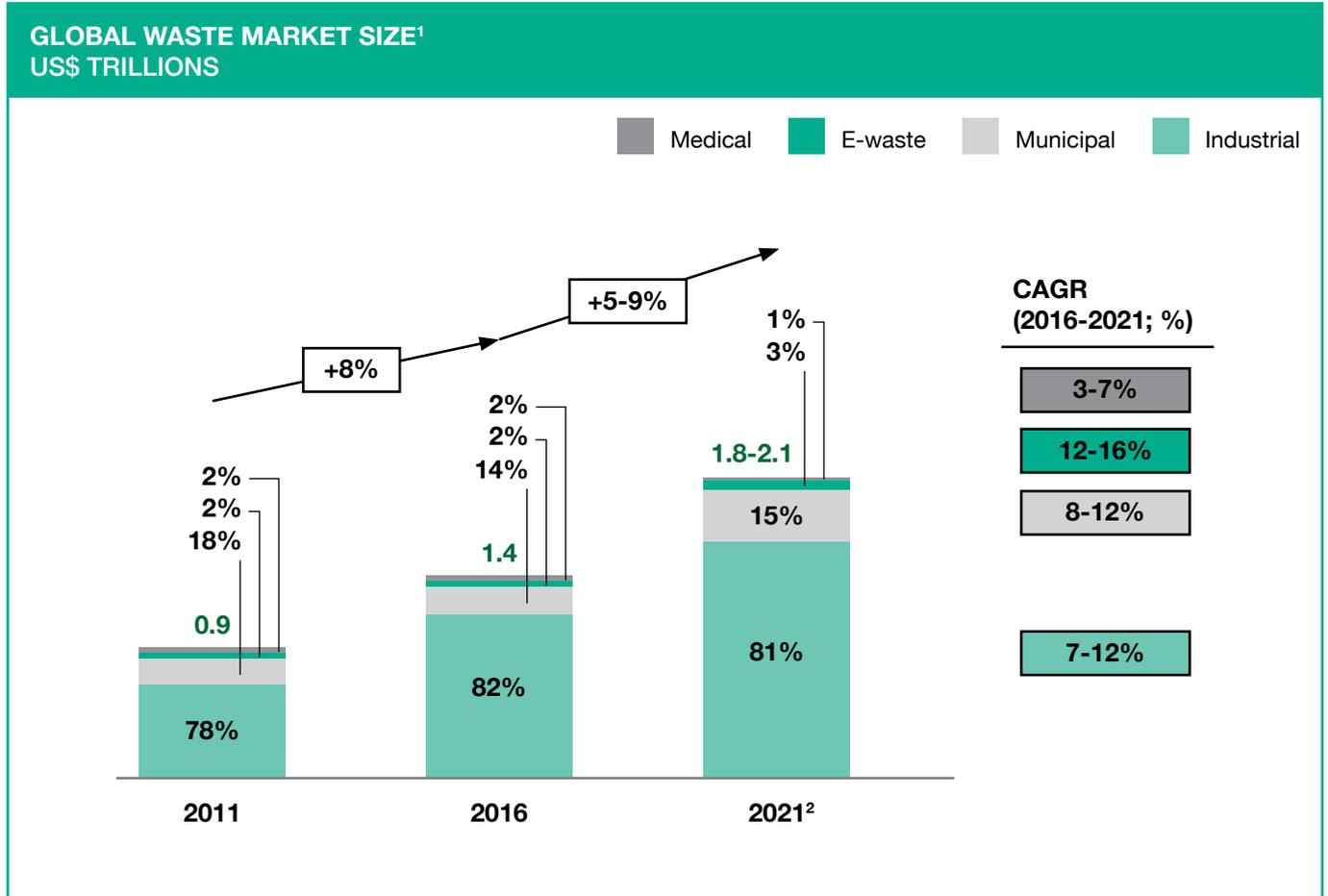
COMPANIES THAT ARE INTEGRATED ACROSS THE ENTIRE END-TO-END WASTE VALUE CHAIN HAVE HIGHER EBITDA MARGINS OF 4 TO 7 PERCENTAGE POINTS ON AVERAGE (COMPARED TO NICHE PLAYERS)

are also similar technologies that can perform sorting of waste using optical technologies (e.g. plastics/metal identification and extraction in e-waste). However, the error rates are currently high and hence manual processes are far more common. Other disruptions within the industry could come from new policies and regulations that could drive changes in behaviours. On the other hand, disruptions from outside the industry could come from pre-consumption such as the better design of smartphones for easy resource recovery or a reduction of packaging size for selected merchandise. However, the session participants noted that regulation and enforcement will be critical to unleashing these innovations – technology alone is not enough.

A combination of strong regulatory settings with investment in innovative business models could transform the waste management system. There will no longer be a positive correlation between affluence and waste generation if substitution effects could come in the form of digital services and consumption (with the exception of e-waste); there will be less need for waste collection if the treatment and disposal process can be decentralised, (e.g. micro-incineration where the entire circularity loop is managed on-site). Hawker centres in Singapore provide an interesting example of the potential for this disruption - 70 to 80 percent of the food waste weight is comprised of water, and if treated on-site, the collection business will be disrupted. Just like in the energy sector, the trend is moving towards decentralisation. The ultimate vision of an efficient waste management system will be to create a fully closed system as part of a circular economy, where the full value of waste is extracted in terms of reduction of waste volumes, reuse, and recycling.

EXHIBIT 13:

THE GLOBAL WASTE MANAGEMENT MARKET WAS WORTH US\$1.4 TRILLION IN 2016 AND COULD GROW AT BETWEEN 5 TO 9% PER ANNUM TO 2021



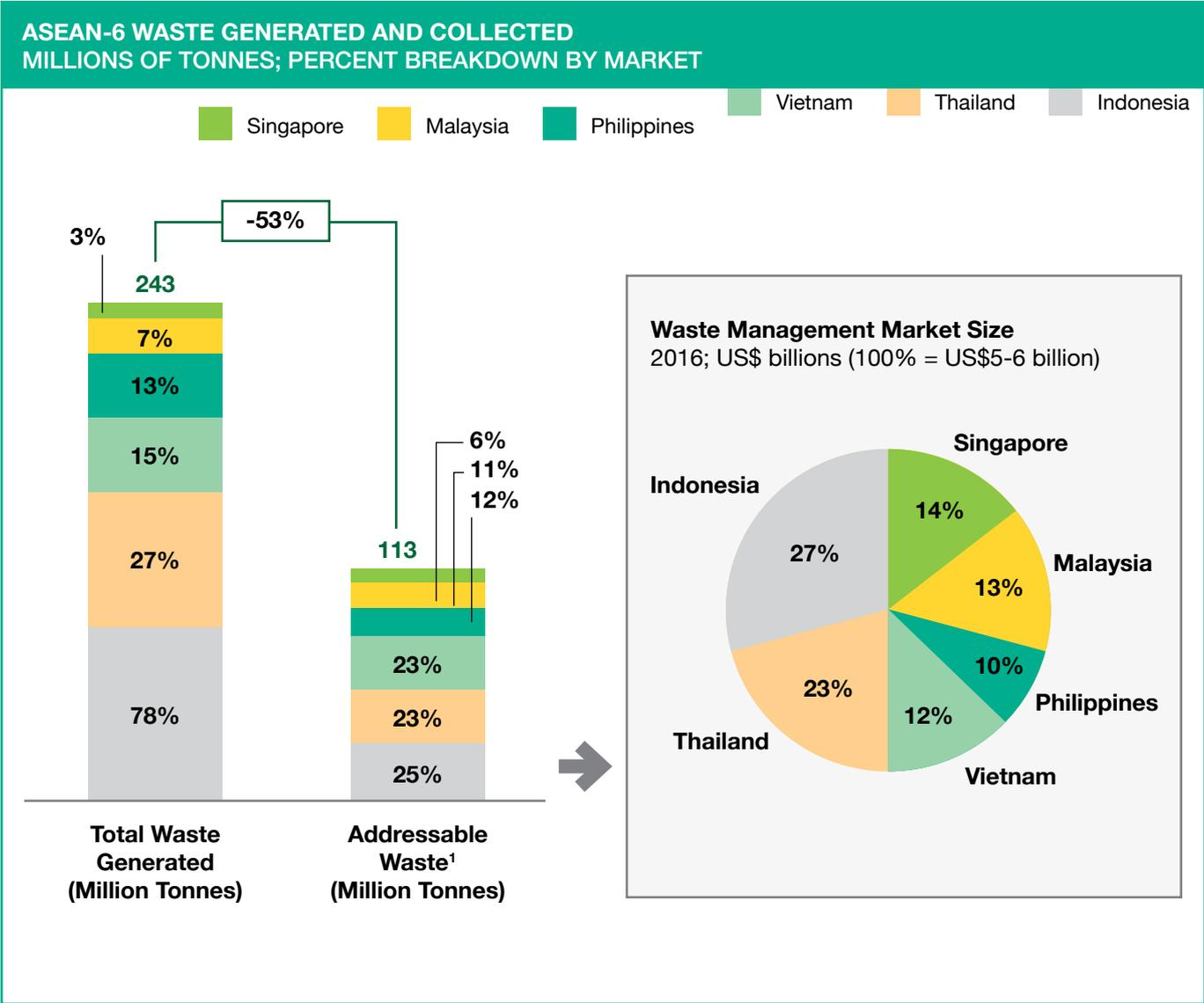
1. Includes both addressable and non-addressable waste.

2. Forecast based on expert interviews.

Source: EY analysis; Technavio report; Marketsandmarkets reports; World Bank; OECD; Expert interviews

EXHIBIT 14:

FOR 6 COUNTRIES IN ASEAN, THE TOTAL MARKET VALUE OF WASTE MANAGEMENT IS ESTIMATED AT BETWEEN US\$5 BILLION TO US\$6 BILLION, DOMINATED BY INDONESIA AND THAILAND AND THAILAND



1. Refers to total volume of waste collected.

Source: EY analysis; Country data

αlphaβeta
strategy x economics

ecosperity
2018 SINGAPORE