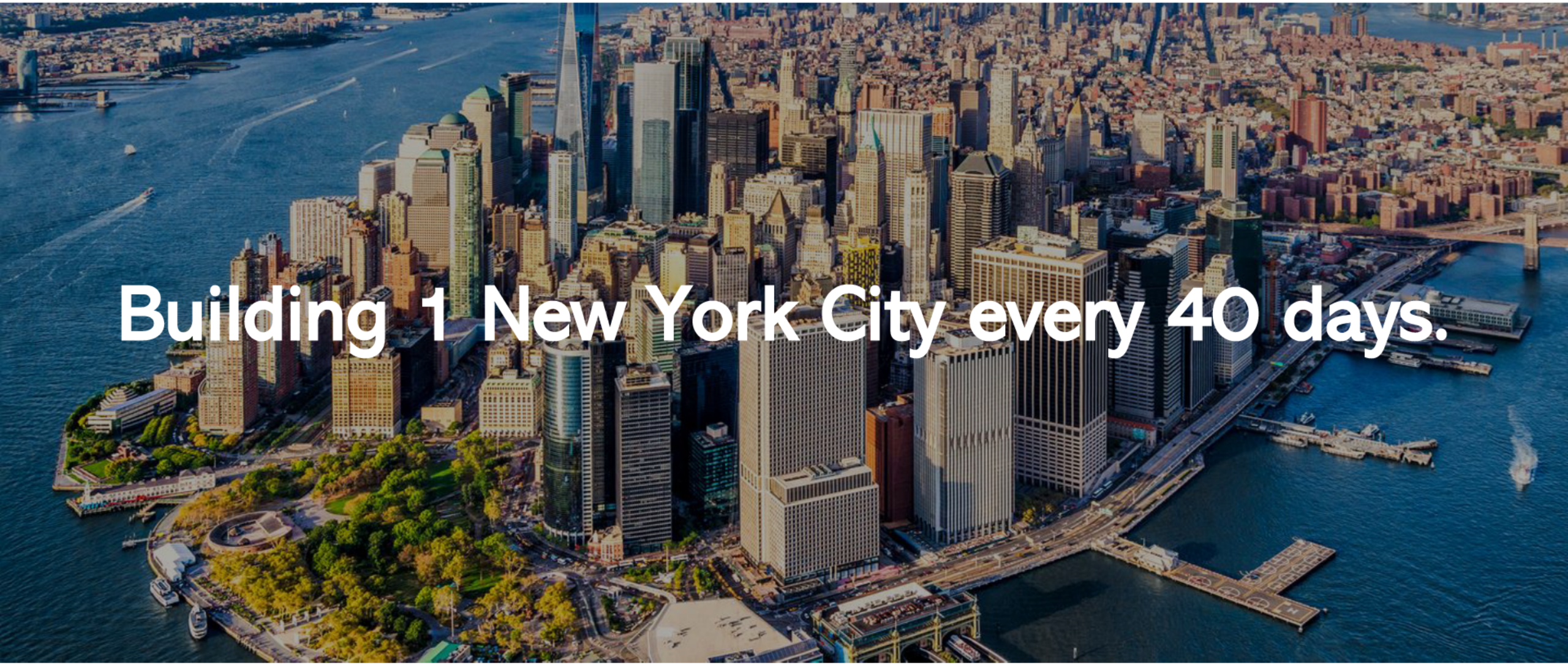
Delivering New Model of Sustainable Urban Development

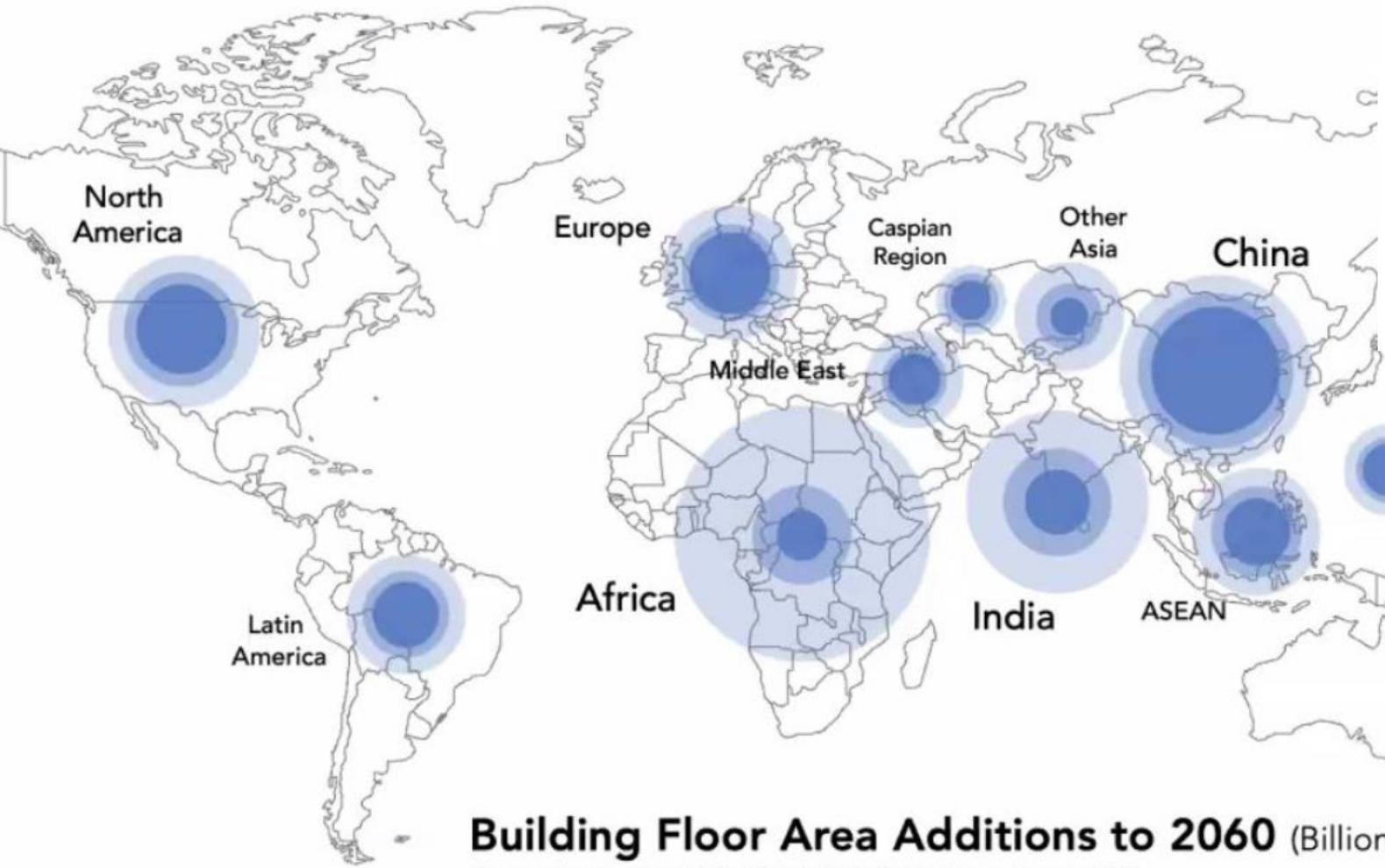
Keppel Corporation

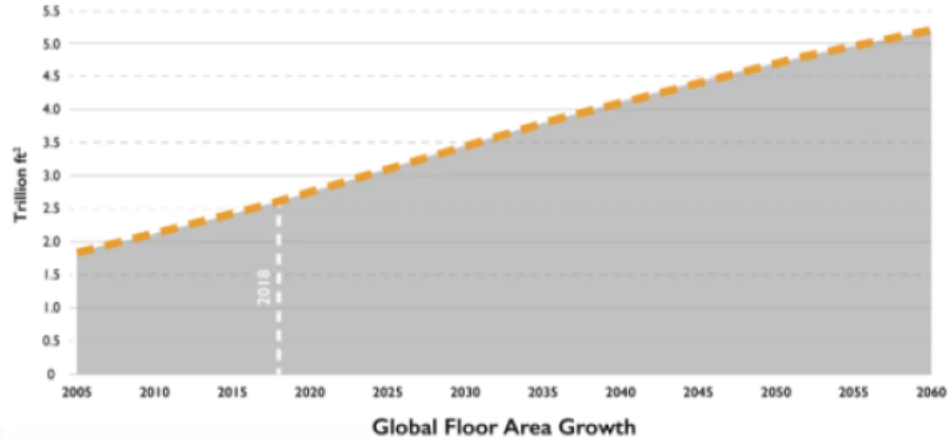
Unprecedented urbanisation



2.5 billion increase in urban population in next 30 years, 90% of increase in Asia and Africa. (Source: UN WUP 2018)

Urban growth hotspots

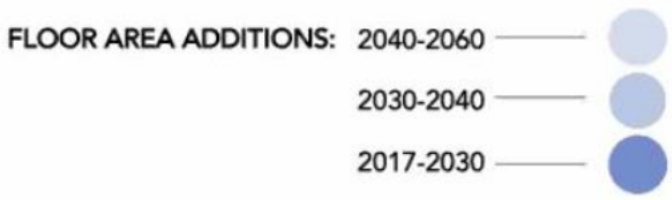


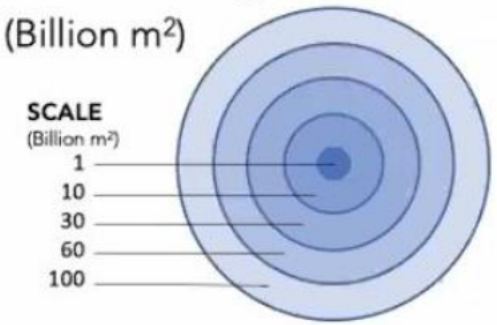


Global building stock will double in area by 2060, adding 2.5 trillion sq ft.

Building Floor Area Additions to 2060 (Billion m²)

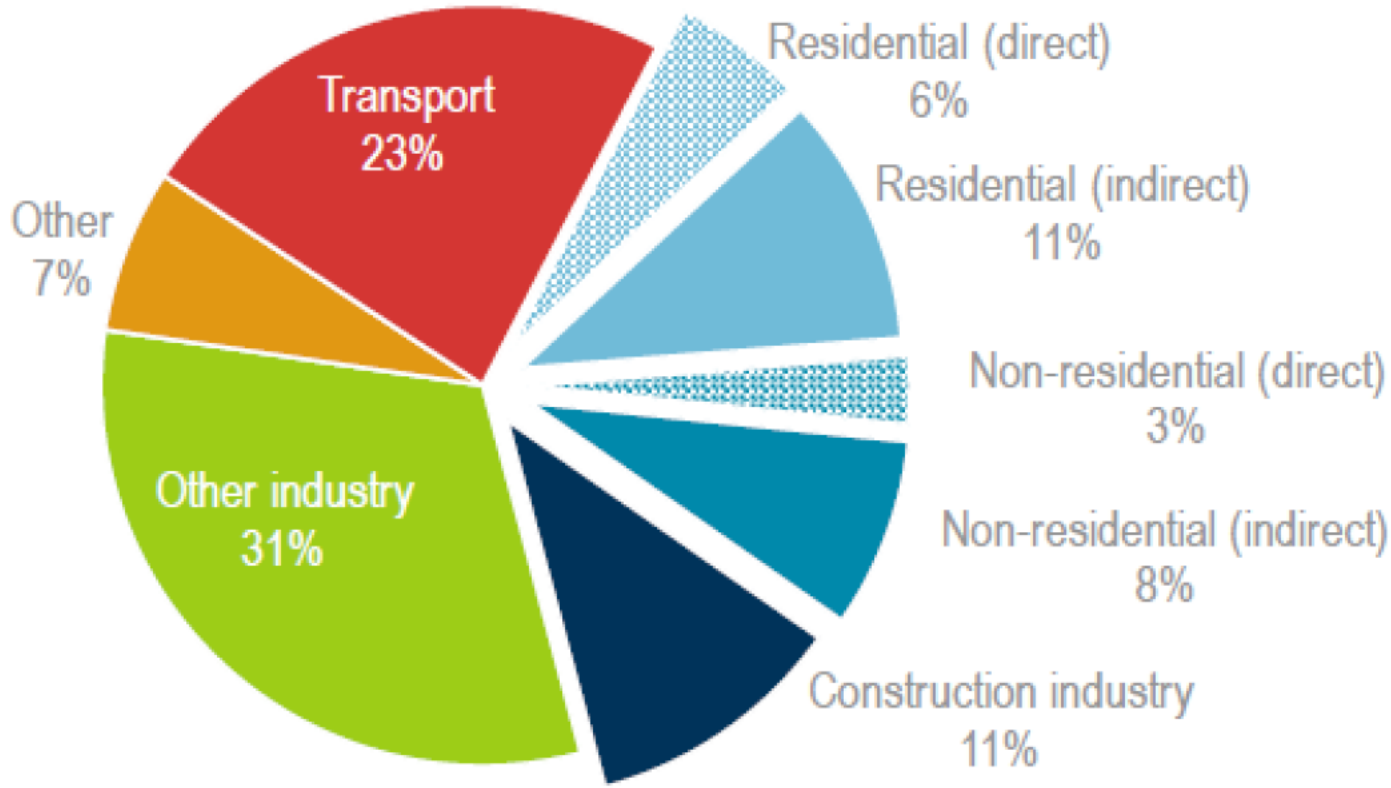
Source: Architecture 2030; Global ABC, Global Status Report 2017





Built environment emissions

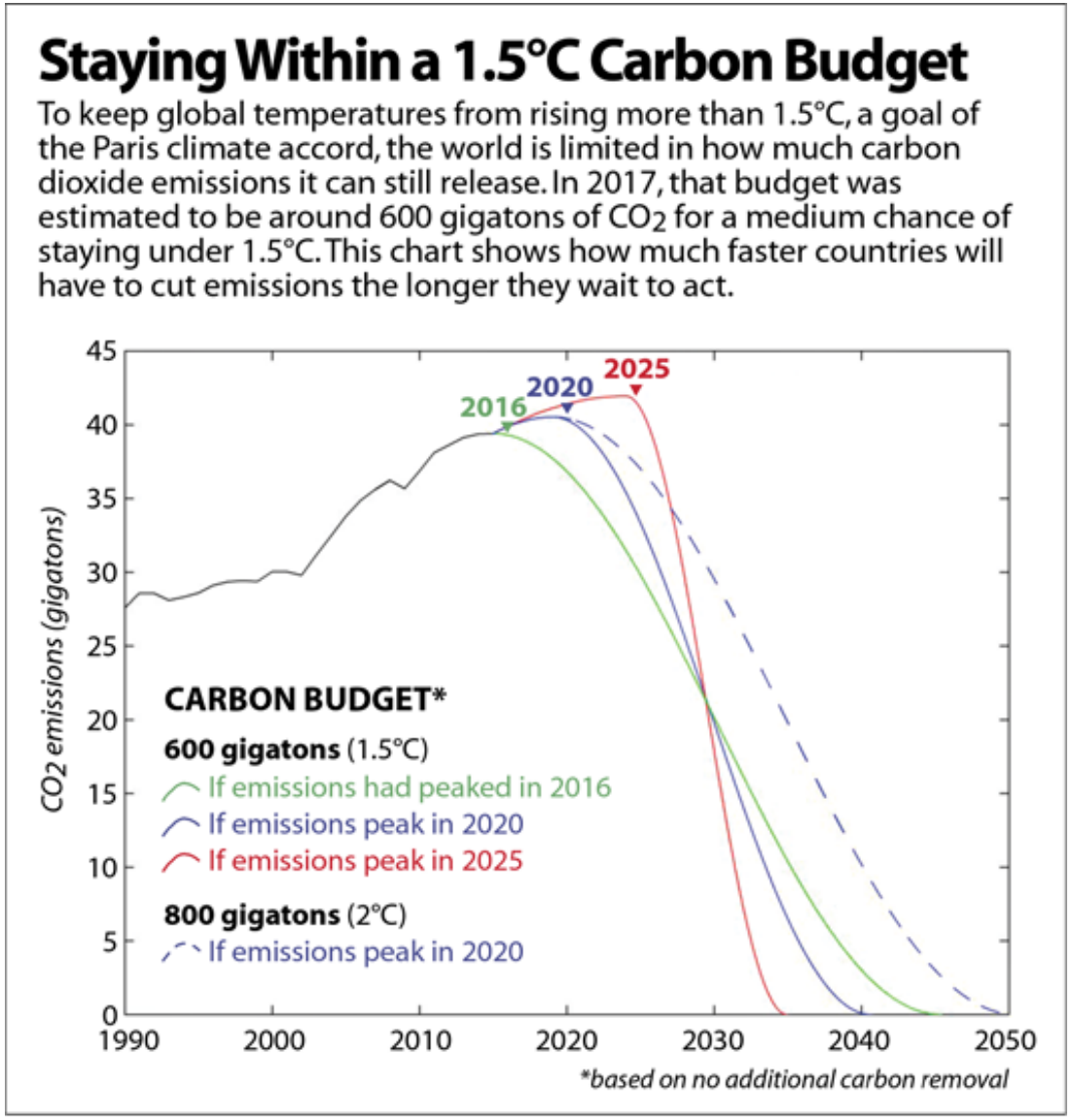
Buildings generate nearly 40% of annual global GHG emissions.
Direct and indirect emissions from electricity and commercial heat used in buildings rose to 10 GtCO2 in 2019, the highest level ever recorded.



Source: IEA (2019)

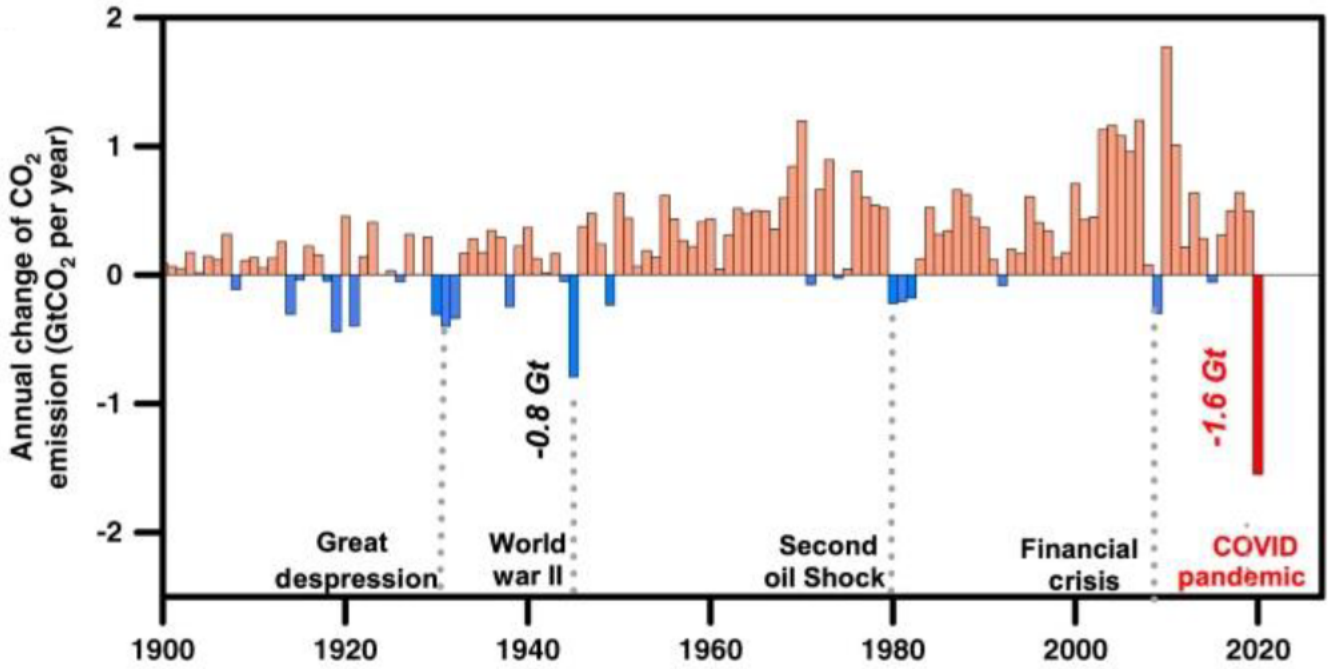
Carbon budget

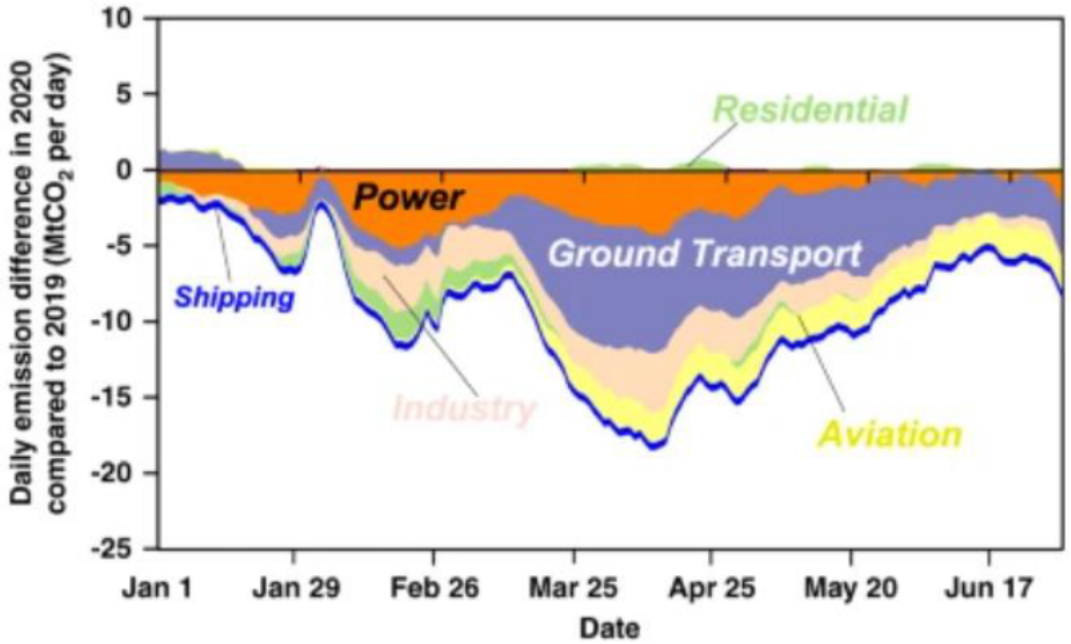
Carbon budget to be depleted in 15 years in Business-As-Usual scenario



Covid offering glimpse of the future?

The COVID-19 pandemic is impacting human activities, and in turn energy use and carbon dioxide (CO_2) emissions, resulting in an abrupt 8.8% decrease in global CO_2 emissions (−1551 Mt CO_2) in the first half of 2020 compared to the same period in 2019. The magnitude of this decrease is larger than during previous economic downturns or World War II.





Source: Liu, Z., Ciais, P., Deng, Z. *et al.* Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic. *Nat Commun* **11,** 5172 (2020).

Solutions for sustainable urbanisation

Energy

We support the safe and efficient harvesting of energy sources to power the world's needs.

- **Gas and Electricity Retail**
- 1 Smart rigs
- 2 Offshore wind farm solutions
- 3 Floating production systems
- 4 FLNG vessels and LNG carriers
- 5 Floating power plants and FSRUs
- 6 LNG bunkering
- 7 Power plants
- 8 District cooling and heating plants

Connectivity

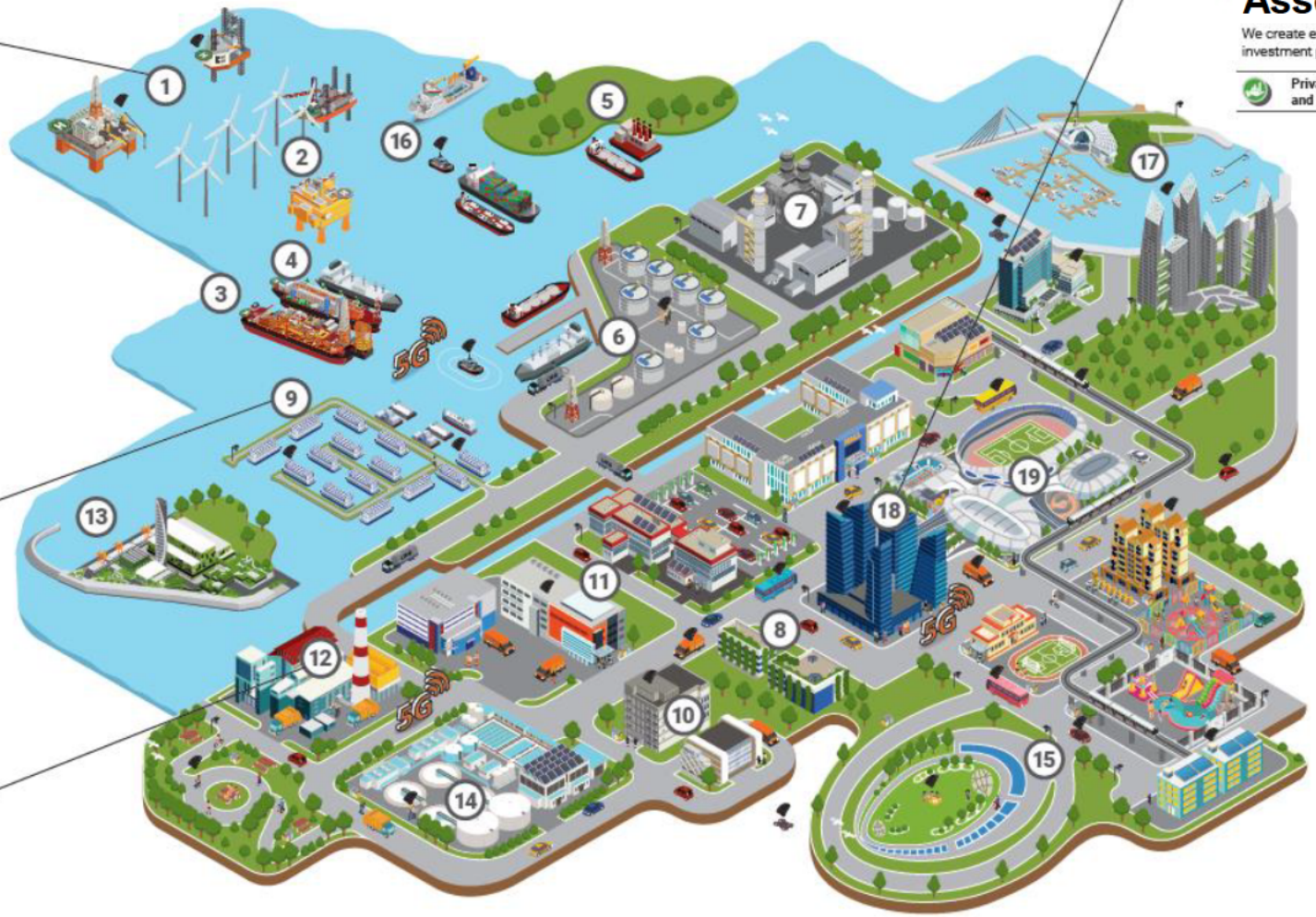
We connect people and businesses with information, goods and services in an increasingly digital economy.

- **Communications Solutions**
- 9 Floating data centre parks
- 10 Data centres
- 11 Urban logistics

Environment

We green cities with solutions for waste and water & wastewater treatment.

- 12 Waste-to-energy plants
- 13 Integrated waste management plants
- 14 Wastewater treatment plants
- 15 Desalination plants



Urban Development

We shape skylines and lives through vibrant urban developments and smart cities.

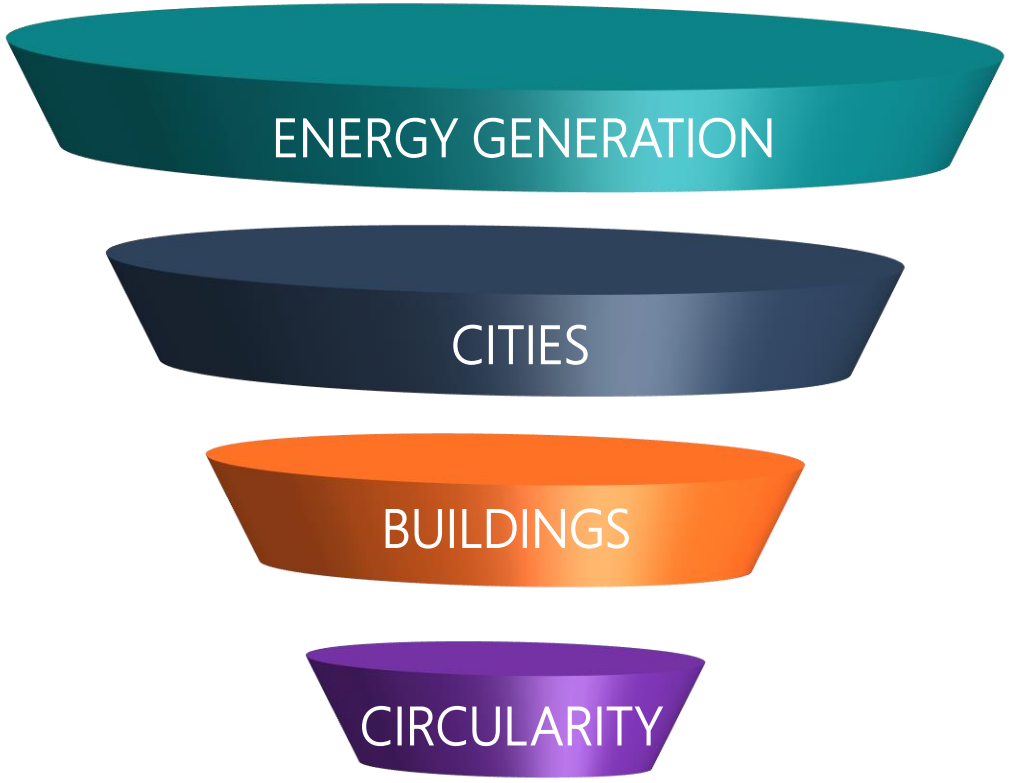
- 17 Quality homes
- 18 Green office buildings
- 19 Smart townships

Asset Management

We create enduring value with quality investment products and platforms.

- **Private funds, REITs and Business Trust**

Work to be done across all urban scales



FUEL SOURCE, STORAGE, DISTRIBUTION

SELF-SUFFICIENT, TRANSIT-ORIENTED, ADAPTABLE

LOAD REDUCTION, EFFICIENCY IMPROVEMENT, RENEWABLES, GREEN MATERIALS

WASTE AS RESOURCE, CARBON SEQUESTRATION, GREEN CITIZENRY, GREEN FINANCING

Energy Generation – Wind, LNG, Hydrogen

Offshore Wind Farms

Wind farm installation vessel

- Can carry up to twelve 3.6MW turbines, six 6MW turbines

Wind farm substations

- Provide grid connection for offshore wind farm
- Orsted Greater Changhua – 2.4GW 2.8mil households
- Dolwin 5 – 900MW 1 mil households

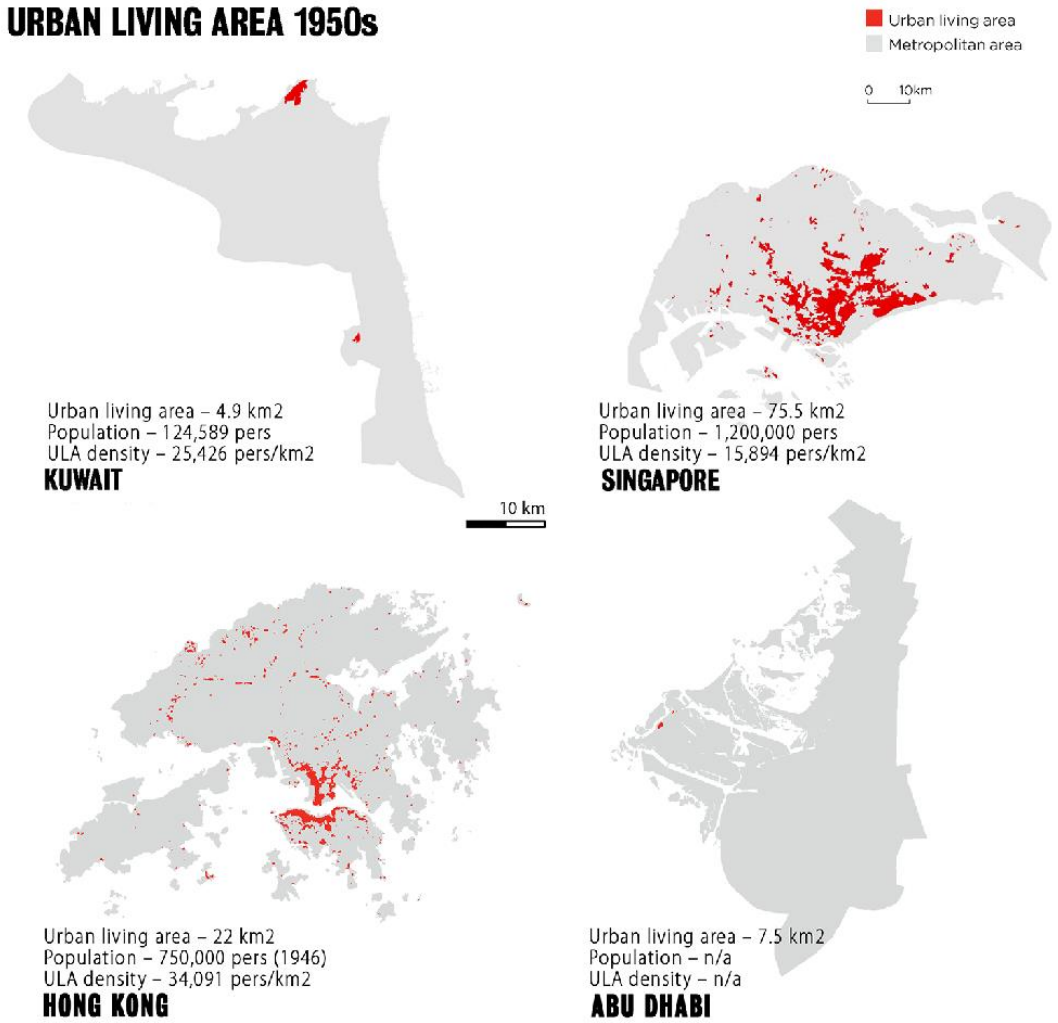
LNG Bunkering

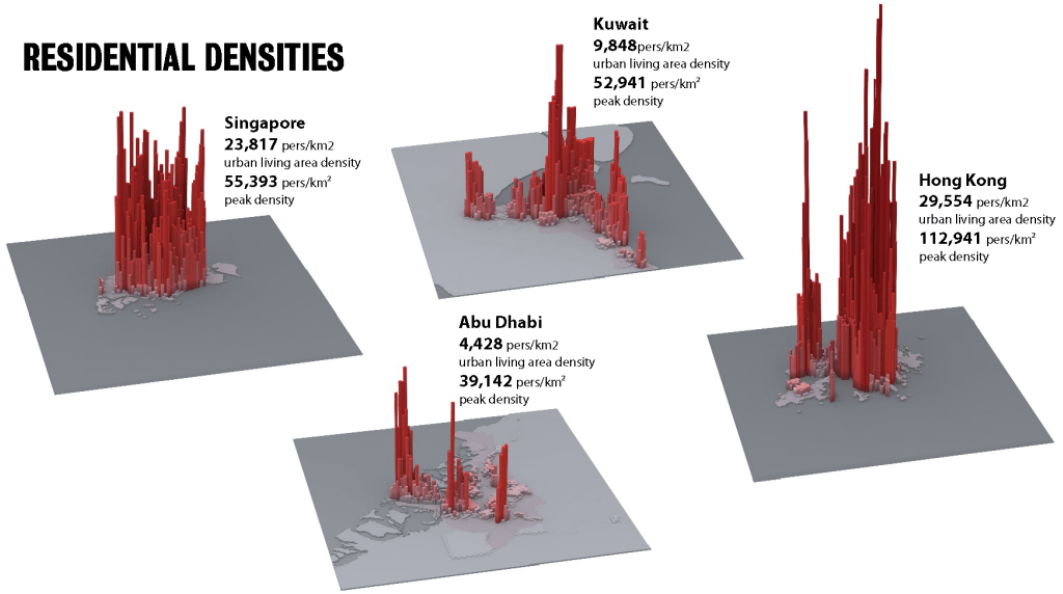
- First LNG bunkering vessel in Singapore
- Increase adoption of LNG as marine fuel
- Complete removal of SOX and particle PM emissions
- Reduction of NOX emission of up to 90% by using LNG
- Reduction of CO2 emissions by at least 20%

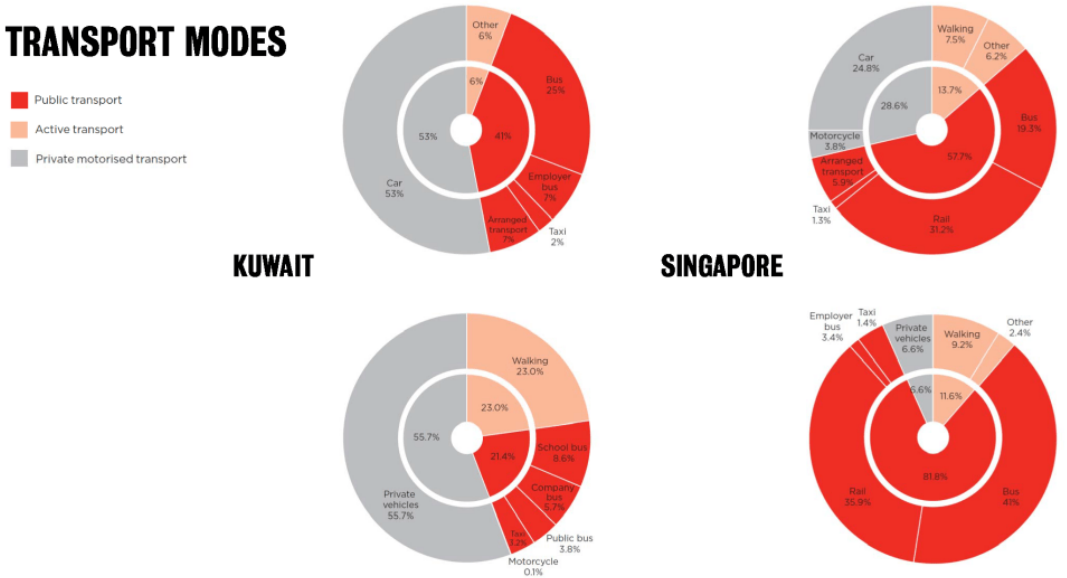
Floating data-centre park

- Explore hydrogen tri-gen plant
- Use of liquefied natural gas (LNG)
- Harnessing cold energy for LNG regassification
- Harnessing seawater for cooling

Cities – Comprehensive long-term planning



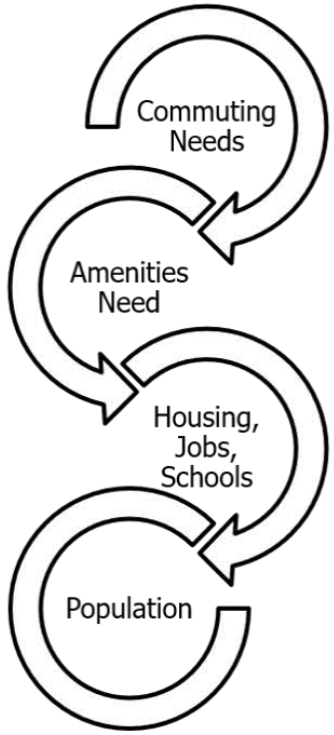


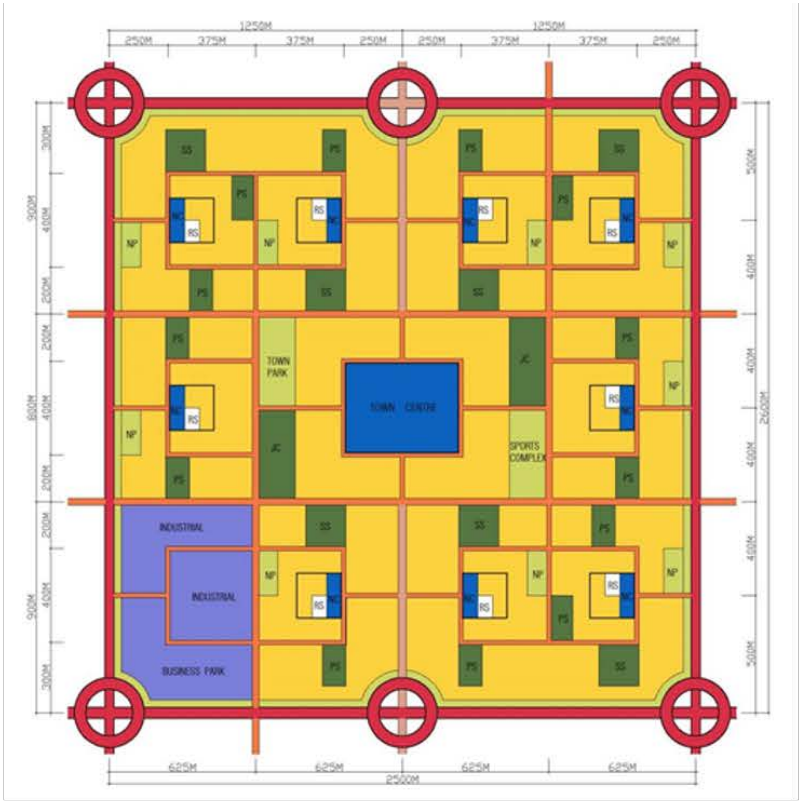


Source: LSECities

Cities – 15-minute urban cells

Intrinsic sustainable values of our towns since 1960s.





Source: HDB

15-minute Towns

Transit Oriented Development (TOD)

Walkable & Accessible

5-minute Neighbourhoods

Self-sufficient

Work-live-play-learn

Compact Cities

Inclusive Shared Spaces

High-density

Community Building

Cities - Unifying IoT platform for city intelligence

Efficient troubleshooting, intelligent optimisation, smooth operation, fast informed decision-making

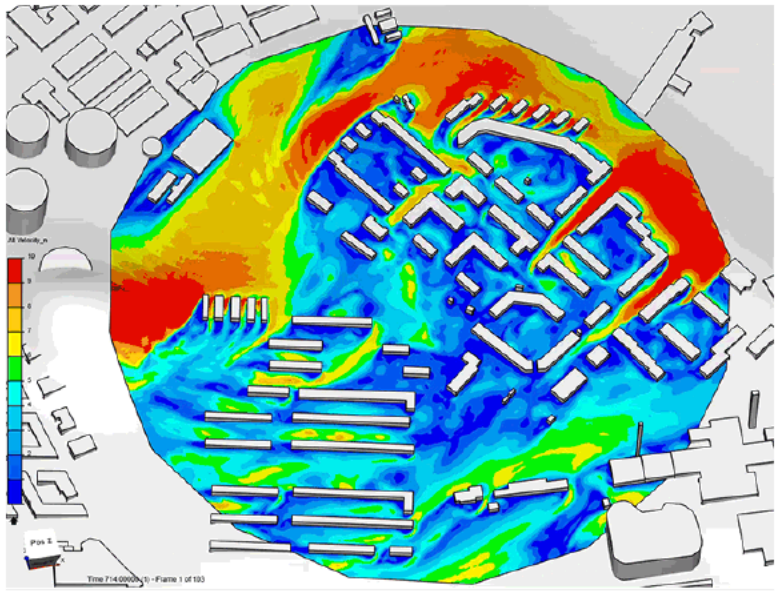
Power of Aggregation

Energy	Security	M&E Functions	Environmental Services
		Workflow Automation System	
 EPC Remote Monitor BCA Portal	 Video Monitoring with Incident Detection	 Lift Monitoring	 Toilet Sensors, Compactor
 Connected Services for Chiller Optimization	 Security Kiosk and Occupants Engagement	 Failure Prediction	 Usage and Feedback data to optimize cleaning
	Connected Lighting Systems, with temperature/RH and occupancy sensor		 Rodent Surveillance

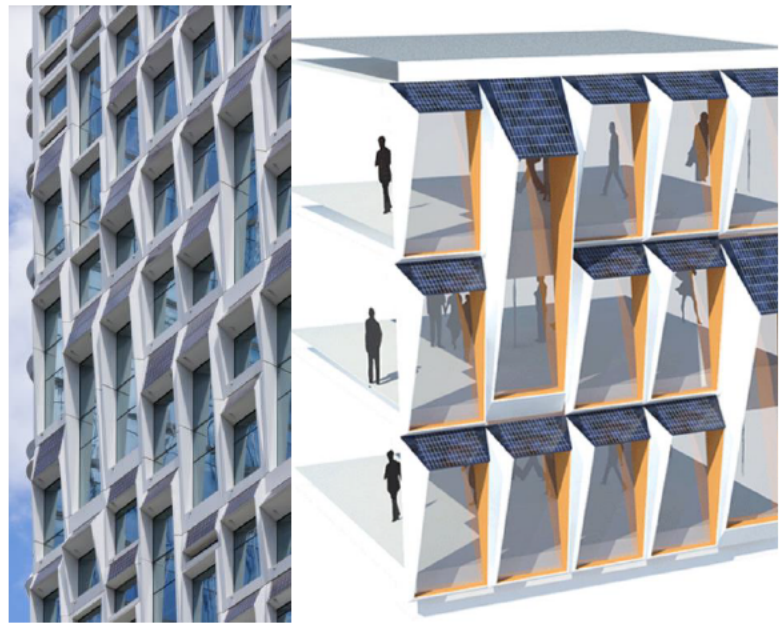
Conventional Silo BMS/ FM systems

All-in-one City Platform & Dashboard

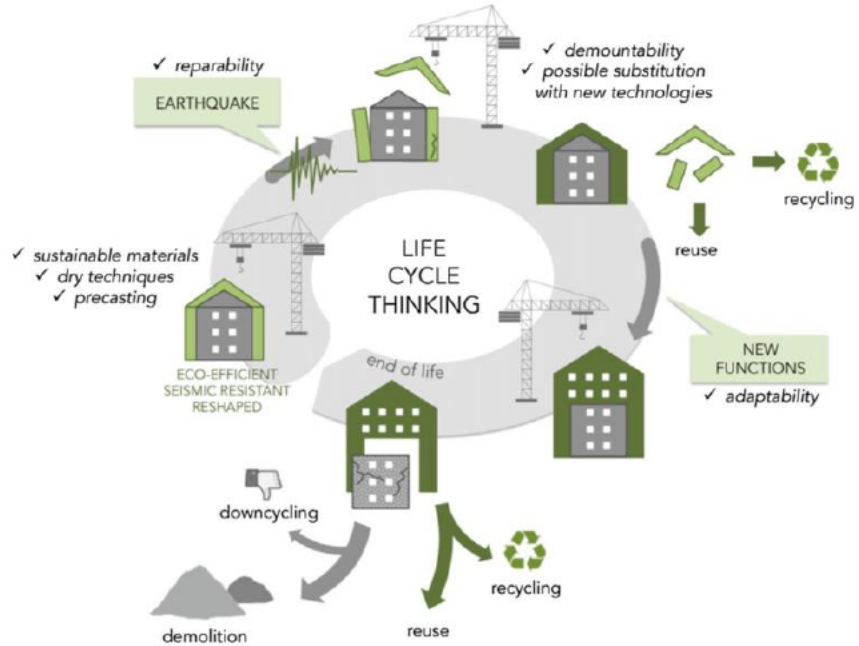
Buildings – Bioclimatic passive design



Micro-climate modelling



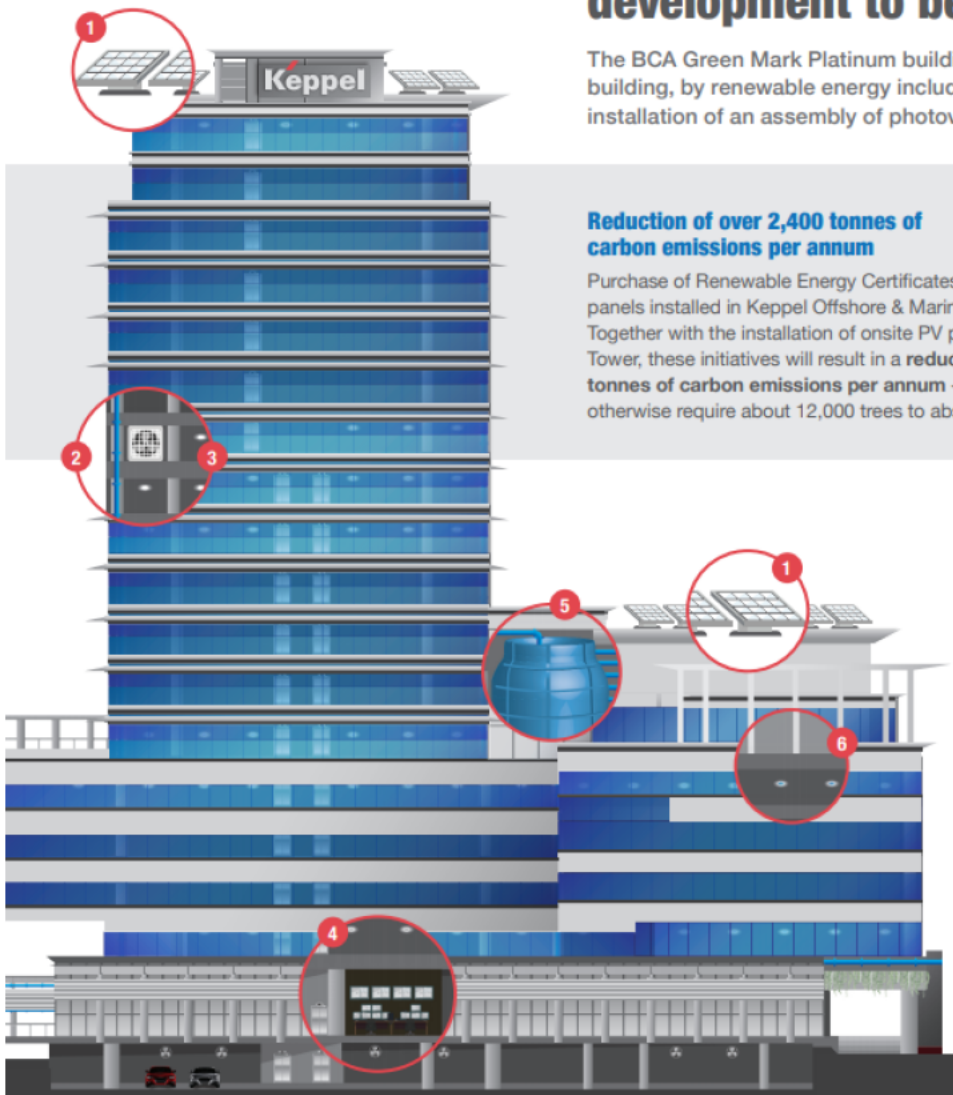
Computational design



Material & durability

Buildings – High-performance active design

Net-zero buildings



Keppel Bay Tower – Singapore's first commercial development to be fully powered by renewable energy

The BCA Green Mark Platinum building will power its operations fully, as well as the offices of tenants in the building, by renewable energy including through the purchase of Renewable Energy Certificates as well as the installation of an assembly of photovoltaic (PV) panels onsite

Reduction of over 2,400 tonnes of carbon emissions per annum

Purchase of Renewable Energy Certificates generated from PV panels installed in Keppel Offshore & Marine's yards in Singapore. Together with the installation of onsite PV panels at Keppel Bay Tower, these initiatives will result in a **reduction of over 2,400 tonnes of carbon emissions per annum** – an amount which would otherwise require about 12,000 trees to absorb over about 50 years

Overall energy savings of 20% or 1.5 million kWh/year

which is equivalent to the amount of energy required to power more than 300 five-room HDB flats for a year

Energy Efficiency Index (EEI) of 115 kWh/m² per year

An average Green Mark Platinum building has an EEI of 145 kWh/m² per year

Smart, eco-features of Keppel Bay Tower

1
PV Panel System allows the harvesting of about 100,000 kWh per annum

2
Energy Efficient Air Distribution System features an air handling unit fan which is about 25% more energy efficient than other best-in-class technologies

3
Demand Control Fresh Air Intake System utilises integrated sensors to regulate fresh air intake according to indoor activities, optimising energy usage for better thermal comfort and indoor environmental quality

4
Intelligent Building Control System employs a high precision physics-based simulation engine to improve data analytics and control

5
Cooling Tower Water Management System utilises a patented solution that reduces cooling tower water usage and eliminates the need for chemical water treatment

6
Smart Lighting System utilises occupancy sensors which allow seamless transition in lighting levels according to building occupancy

Buildings – Cooling as a Service

Demand for cooling is expected to grow quickly as the world gets hotter, using up **25%** of today's global energy consumption by 2050, and contribute to more than **50%** of peak energy demand.

Benefits of District Cooling System (DCS)

- ✓ 30 - 40% energy savings
- ✓ Reduce refrigerant use
- ✓ Reduce noise and waste heat from compressors/ chillers
- ✓ Improved control and management
- ✓ Free up roof space and preserve architectural heritage

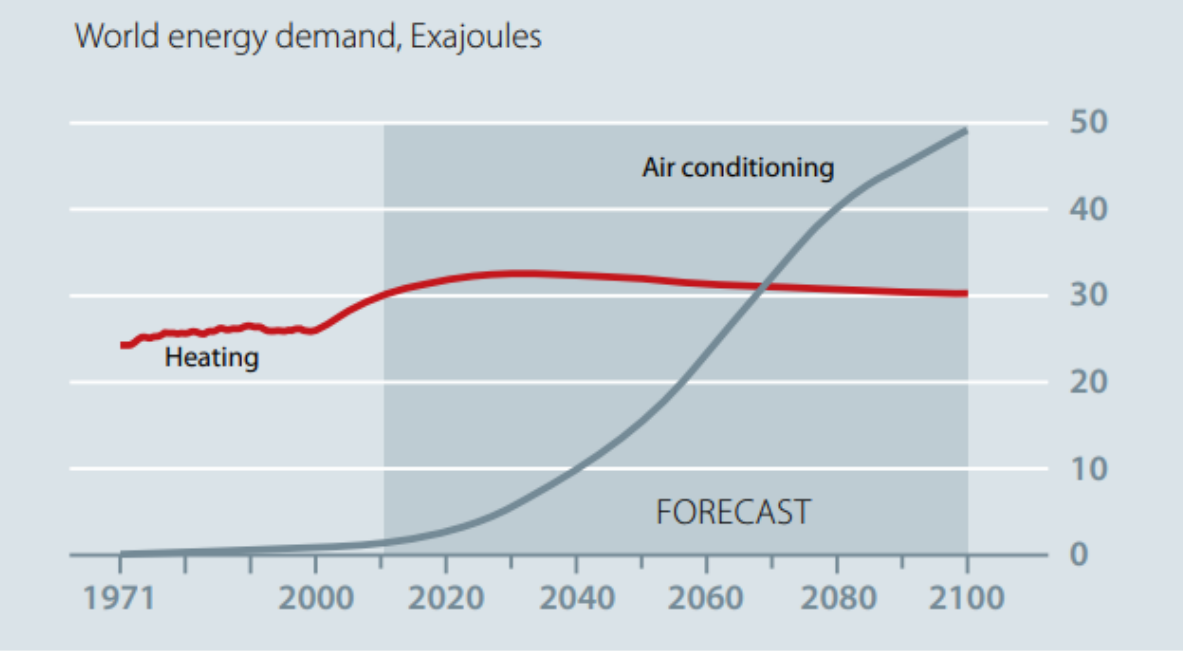
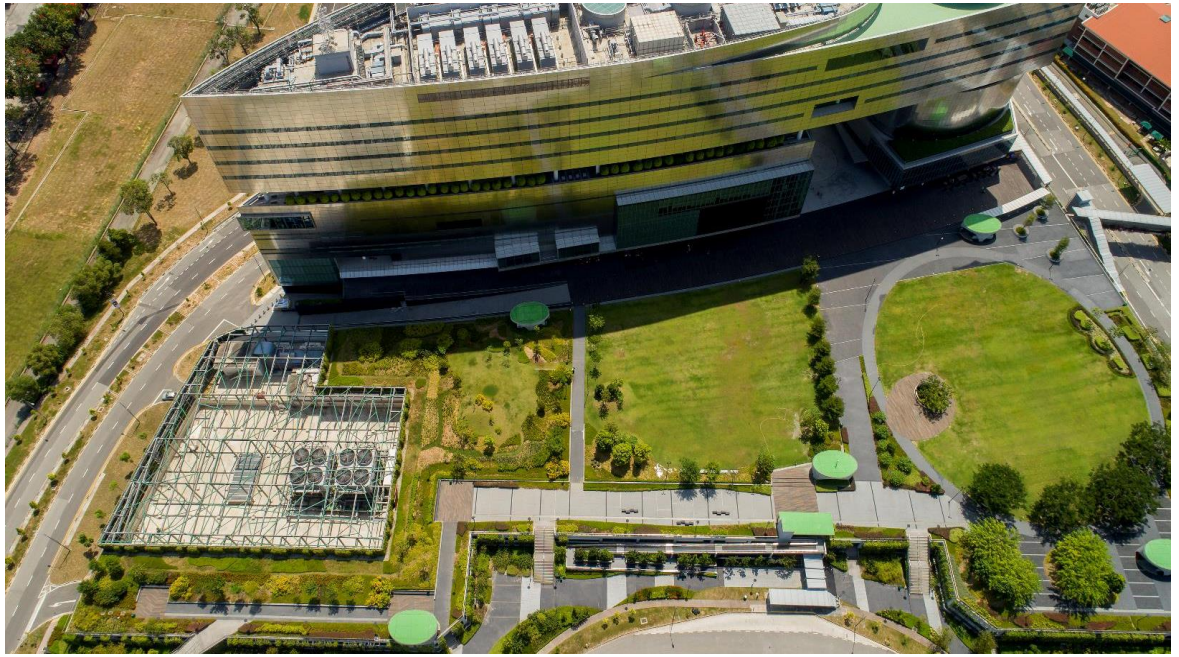


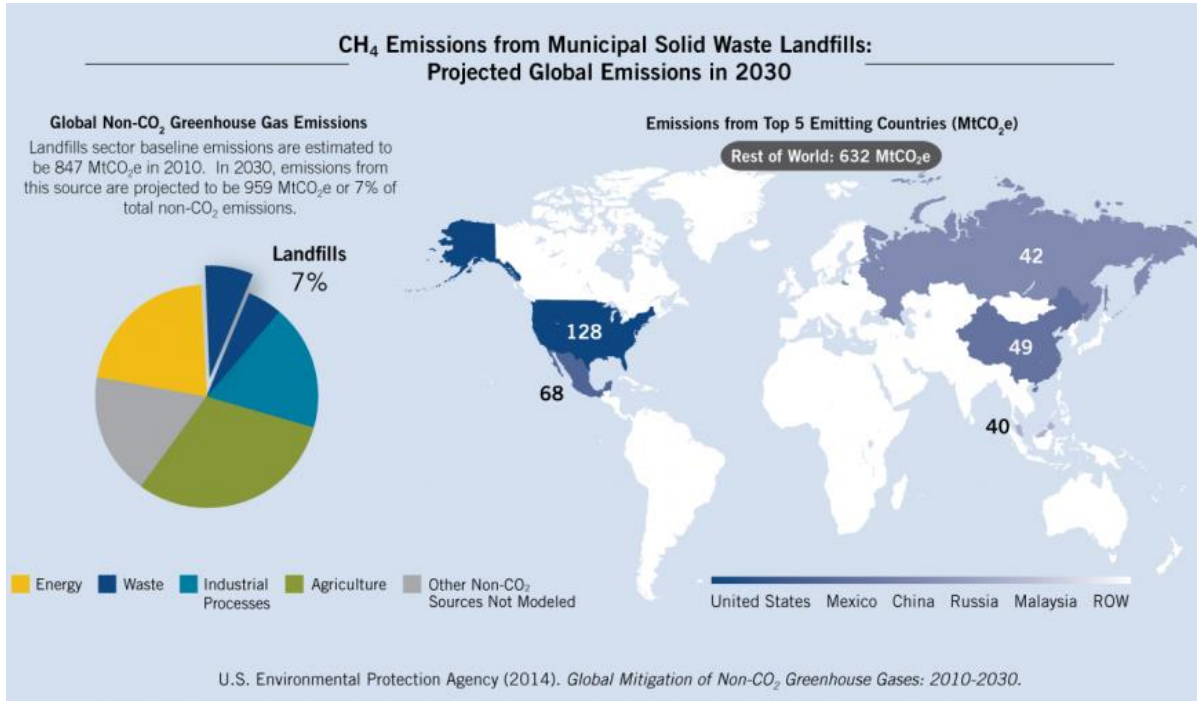
Figure 1:
Projected development in global demand for heating and cooling until 2100.
Source: PBL Netherlands Environmental Assessment Agency



Mediapolis Keppel DCS (28,000 RT)

Circularity – Waste as resource

As the world's population grows, local WTE infrastructure will be increasingly needed in cities, to **divert waste from landfills**. As densities increase and consumption patterns change, WTE will continue to emerge as an acceptable and affordable source of renewable energy alongside a portfolio of other sources, such as solar, wind, and biomass.



Tuas Integrated Waste Management Facility

- Singapore's first integrated waste management facility
- Designed and built by a Keppel-led consortium comprising Keppel Seghers, China Harbour and ST Engineering Marine
- Capacity to treat 2,900tpd of MSW
- Includes a 240tpd Material Recovery Facility
- Targeted to be completed in 2024

Key Takeaways

- Critical window of opportunity in the built environment sector
- Systems thinking approach from power generation to city planning
- Work on both new and existing buildings
- Multi-pronged approach:
  - ❑ Avoidance of emission
  - ❑ Reduction of demand
  - ❑ Adaptation for climate response
  - ❑ Sequestration to reverse emission
- Multi-party effort:
  - ❑ Policy + Investments + Technology + Participation
  - ❑ Public-Private-People Partnership

Building a Sustainable Future