

Presentation on Keppel's Sustainable Data Centre Solutions

CS-SGX ESG-Real Estate
Conference

04 May 2021

Keppel's Vision 2030

Transforming from a conglomerate of diverse parts into one integrated business providing solutions for sustainable urbanisation with an asset management arm to tap third party funds for growth and provide a platform for capital recycling.

Four segments, all part of a connected value chain, collaborating and harnessing synergies as *OneKeppel*

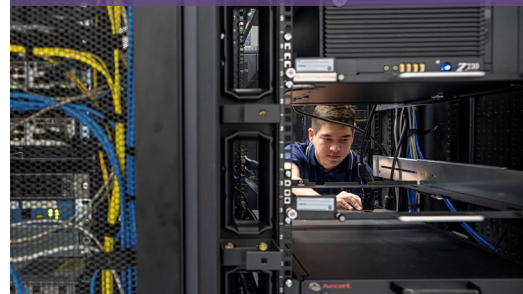
ENERGY & ENVIRONMENT



URBAN DEVELOPMENT



CONNECTIVITY



ASSET MANAGEMENT



Sustainability at the Core of Our Strategy

ENVIRONMENTAL SUSTAINABILITY

Running our business sustainably

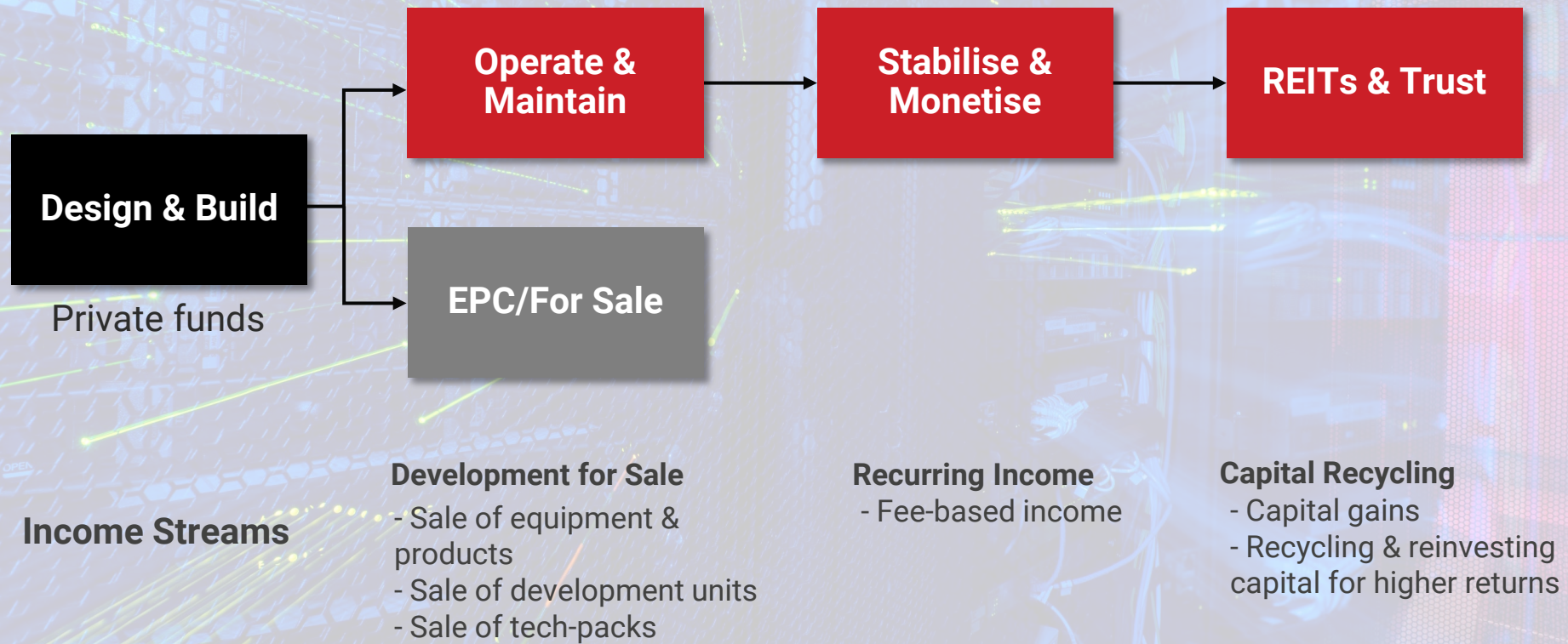
- Set measurable targets to reduce carbon emissions, water and waste intensity
- Include environmental sustainability in performance appraisal of senior management across the Group
- Apply shadow carbon pricing for major investment decisions

Making sustainability our business

- Guide our portfolio towards sustainable urbanisation solutions
- Seize opportunities in renewables, green developments, new energy solutions, green data centres etc.
- Help communities and companies achieve sustainability goals with the solutions we provide
- Grow renewable energy portfolio to 7GW by 2030

The Keppel Difference

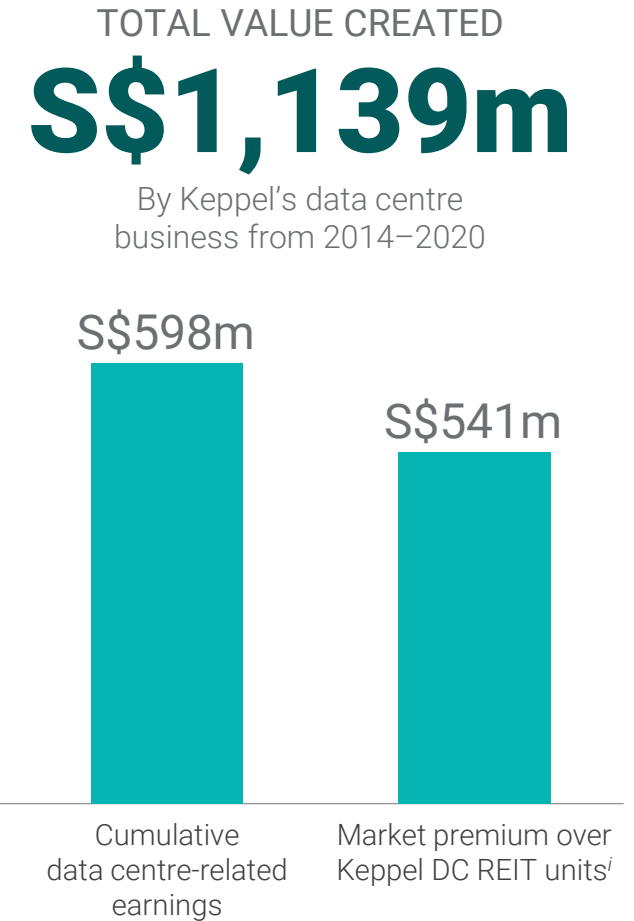
An integrated business providing end-to-end solutions for sustainable urbanisation with multiple income streams across the value chain



A Connected Value Chain



- 1 **Asset creation**
Project-based income
Recurring income
- 2 **Operation & maintenance**
Recurring income
- 3 **Asset monetisation**
Revaluation & divestment gains
- 4 **Asset management**
Operation & maintenance
Recurring income



ⁱ Market premium over Keppel's carrying value of KDCREIT units held as at 31 December 2020

About Keppel's Data Centre Business



Over 16 years of experience in data centre design, build, operation and maintenance



27 data centresⁱ globally with rapidly expanding footprint across Asia and Europe



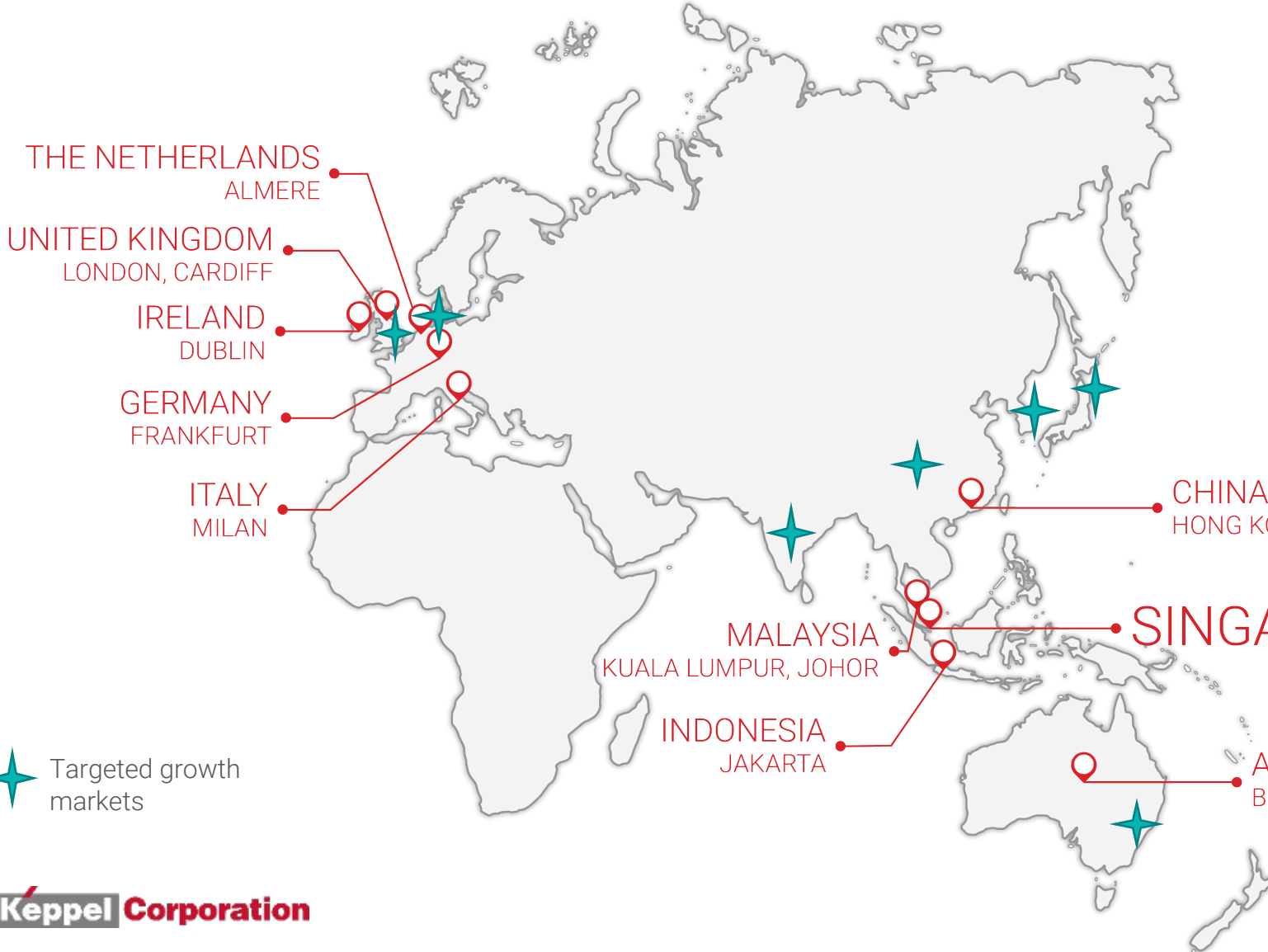
Leverage expertise of the Group to deliver solutions for sustainable urbanisation



Industry leader in innovation to drive decarbonisation and the proposed floating data centre park



Global Portfolio – Asia Pacific & Europe




27 Data centres

10 Countries

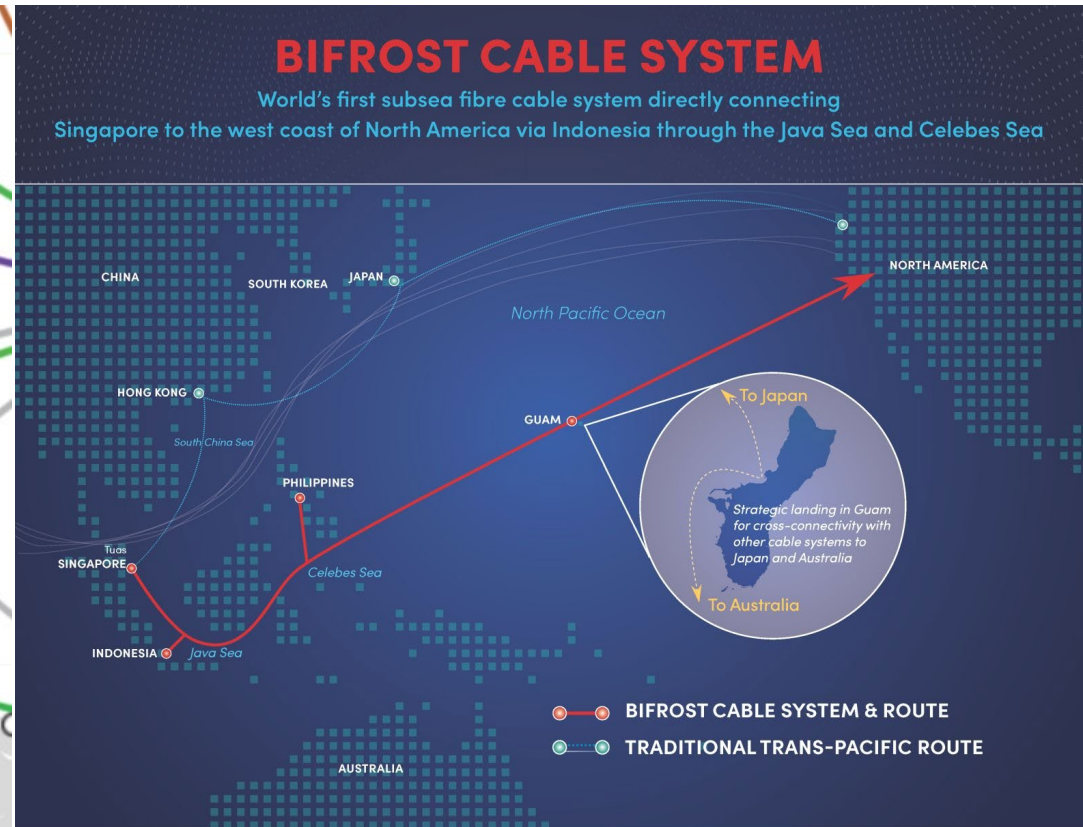
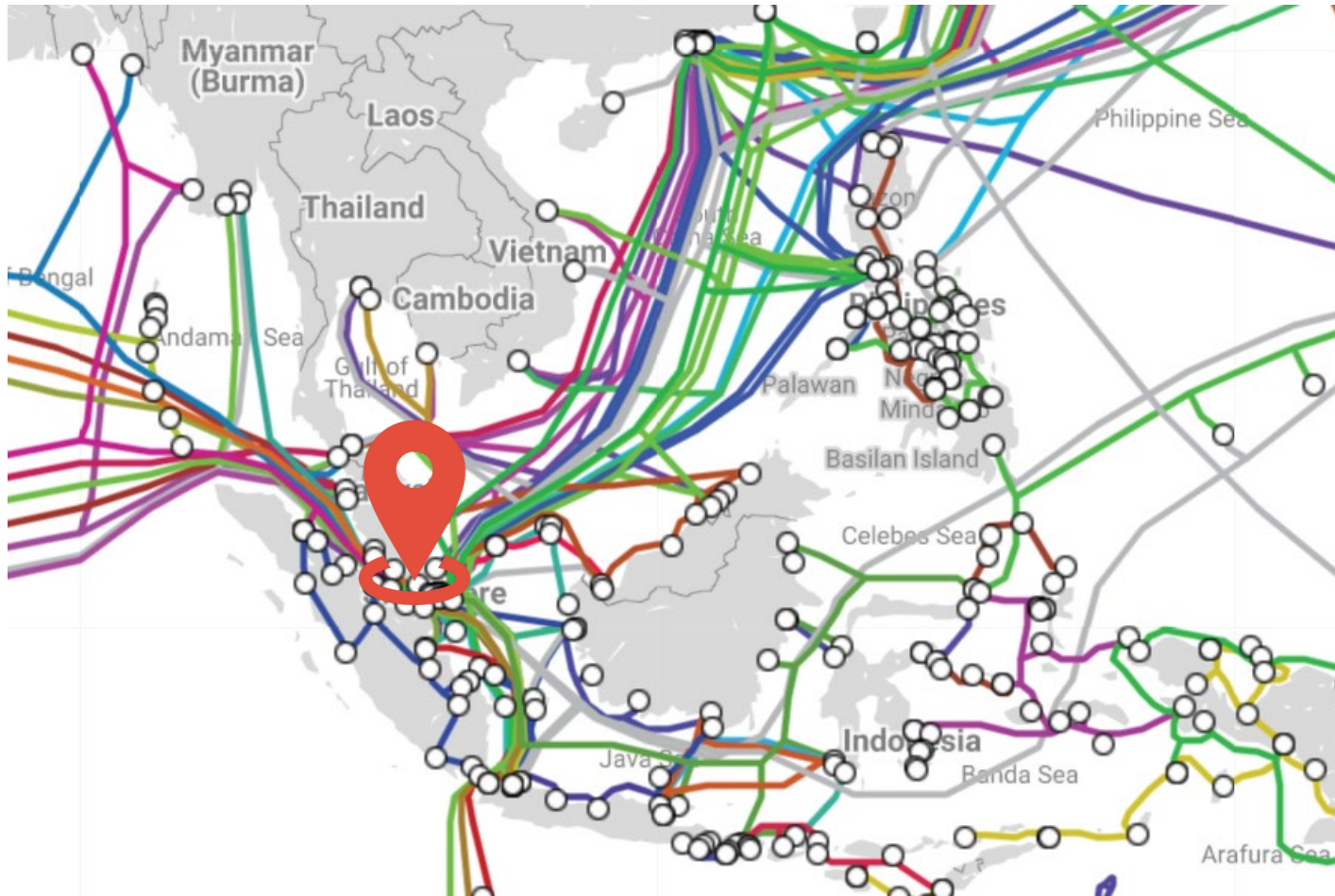
~S\$4b Combined portfolio value

>3m Square feet of net leasable area

**Updated as of Feb 2021*

 Targeted growth markets

Connectivity Infrastructure



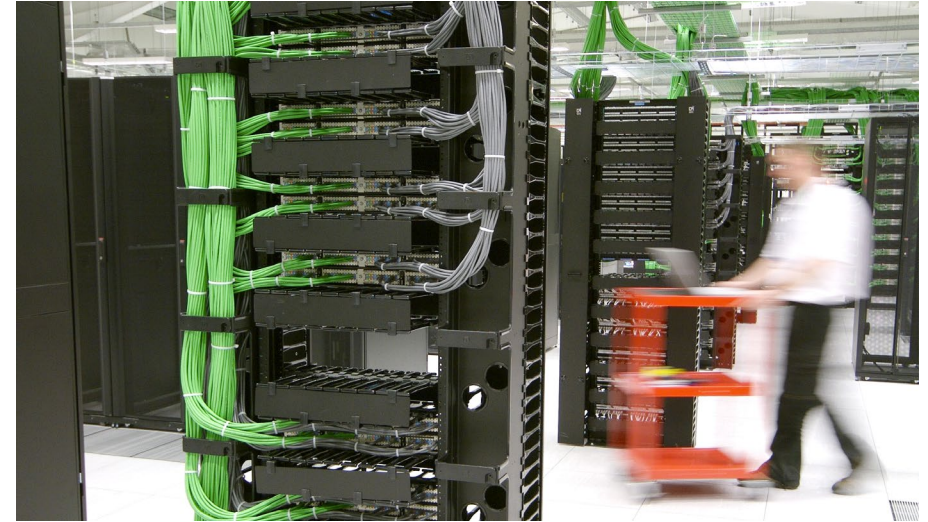
The Interconnected World Today



Exponential Growth in Data Creation

Strong and resilient data centre demand

- Global colocation market grew by 15% in 2020 amid the pandemic, as data centres continued to be seen as critical infrastructure¹
- Expected to record a further 14% yoy growth in 2021 as businesses continue to remain reliant on the cloud for remote collaboration and operations²
- End-user spending on global data centre infrastructure is forecasted to grow 6% yoy in 2021 and through 2024³



APAC data centre spending to surpass US\$35b by 2024 to account for >35% of global market¹



>70% of all hyperscale data centres are located in facilities that are leased or owned by partners⁴



Smartphone subscription estimated at 6.1b as at end-2020 and forecasted to reach 7.5b in 2026⁵



European data centre market to grow by >40% to over US\$25b by 2024, despite limited new supply¹



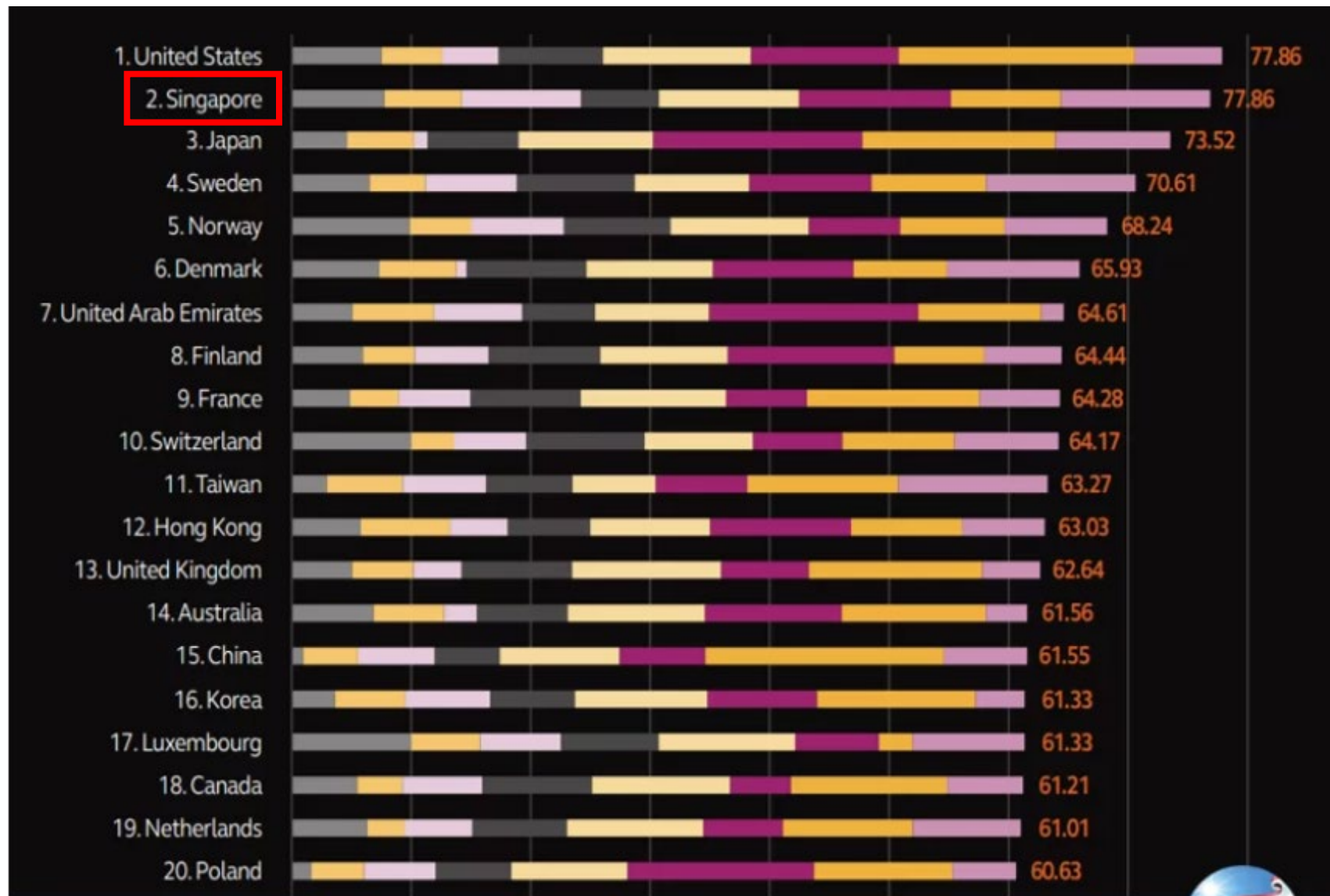
Enterprise spending on cloud infrastructure expected to grow by 22%² CAGR over next 5 years



5G subscriptions are expected to reach 3.5b in 2026, and account for an estimated 54% of total mobile data⁵

Sources: 1. Danseb Consulting (formerly Broadgroup Consulting) Dec 2020; 2. CBRE Nov 2020; 3. Gartner Oct 2020; 4. Synergy Research Dec 2020; 5. Ericsson Nov 2020
Compiled by Keppel DC REIT CITIC CLSA ASEAN Access Month: Digitising ASEAN Mar 2021

Singapore is well placed for data centre growth



Singapore is the second most attractive city to build data centres, out of a total of 50 cities.



Singapore is well placed for data centre growth

2021 data centre – global market comparison
Singapore takes 5th place



Climate Awareness

Growth in local data centres

2015: 240MW (est)



2020: 500MW (est)

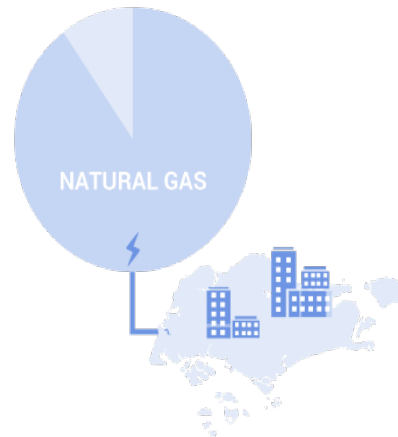


2022: 700MW (est)



2030: 1200MW ?

Carbon constraints & limited renewables

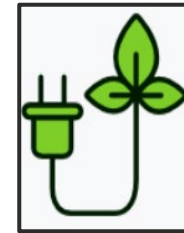


95% of fuel-mix from NG
110,000 tonnes CO₂/yr
for each 30MW data centre

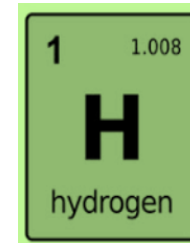
Global tech's green ambitions



Exploring green energy options



Renewable energy



Clean H₂ power

Keppel Data Centre's Sustainability Thrust

Constantly innovate and challenge the thinking

Maximise land use

Explore high rise data centres

Explore underground data centres

Explore floating data centres

Optimise for better performance

Explore tropical data centres

Explore using cold energy from LNG

Explore seawater cooling

Access green power

Explore renewable energy

Explore hydrogen power

Where are We Now?

History of continual innovation for efficient data centres

ENERGY EFFICIENCY: Lower PUE

High rise green data centres

IMDA enlists support to explore green data centre



BY TAN WEIZHEN
weizhen@mediacorp.com.sg
PUBLISHED: 4:00 AM, JULY 20, 2017

SINGAPORE— The Info-communications Media Development Authority (IMDA) is looking into the possibility of developing a high-rise green data centre here, which would seek to address the island's land constraints and humid climate.



- Centralised Power Plant
- Centralised Cooling Plant
- Land Demand Alleviation



RENEWABLE ENERGY
PV Installation on Roof
Vertical Axis Wind Turbine on Roof
Low Wind Speed - Vertical Axis Wind Turbine on High Floor Facade
PV Panel-shading Space on Facade

Keppel Infrastructure
Keppel Technology & Innovation

NATIONAL RESEARCH FOUNDATION
PUBLIC RESEARCH CENTRES
SINGAPORE

INFOCOMM MEDIA DEVELOPMENT AUTHORITY

HOME > NEWS > SUSTAINABILITY

Singapore to trial first Tropical Data Center in Q3 2016


State-sponsored project aims to develop new approaches to infrastructure in hot, humid countries

June 20, 2016 By: Paul Mah

Singapore plans to conduct trials of what it calls the world's first data center designed specifically for tropical climates, as part of a bid to drive innovation and explore new green technologies.

Initiated by the Infocomm Development Authority of Singapore (IDA), the Tropical Data Center (TDC) project will be set up in partnership with hardware makers and industry experts. Partners will provide either hardware, software or expertise, and the trial will be conducted in a test environment at a Keppel Data Centre facility.

NUS, Keppel, SLNG in tie-up to develop better cooling technology for data centres



Cooling and running the equipment in data centres requires plenty of energy, but three Singapore entities have joined forces to develop novel cooling technology that is more efficient and can save costs.

The new cooling technology - called Semiclathrate Thermal Energy Carrier System - may boost the power usage effectiveness of data centres by 20 per cent.

It should also save space and construction costs through reducing the footprint of the cooling infrastructure, said the National University of Singapore's (NUS) Faculty of Engineering, Keppel Data Centres Holdings and Singapore LNG (SLNG), which teamed up to develop the technology.

This innovation could pave the way for more sustainable and compact data centres, the partners added in a statement yesterday.

The research project is supported by the Singapore Government's National Research Foundation, under its Green Data Centres Research Programme. It comes amid a rapid expansion for cloud-based services, which has in turn pushed up the demand for data centres.

Due to the high internal load and the need for consistent cooling and operations, data centres are among the major power consumers in the building sector.

Last year, data centres accounted for 7 per cent of total annual electricity consumption in Singapore.

A team from NUS Engineering, Keppel Data Centres and SLNG will be working on a prototype of a new cooling medium that can efficiently store and carry cold energy from the Singapore LNG Terminal to the data centres. This will then be circulated within the cooling loop in each data centre to perform effective cooling. The prototype will be designed, built and operated for demonstration by 2020 at NUS.

In addition, Keppel Data Centres and SLNG are exploring ways to harness and use the cold energy from the Singapore LNG Terminal to offset the energy demands at data centres. SLNG chief executive Tan Soo Koon said that SLNG is exploring other ways to harness the LNG cold energy from its terminal and be part of the circular economy on Jurong Island.

Associate Professor Praveen Linga of NUS said: "NUS Engineering researchers will leverage our expertise in hydrate technologies and process engineering to identify a suitable semiclathrate promoter as well as develop a reactor and process design for this novel cooling technology." Prof Linga is from NUS' Department of Chemical and Biomolecular Engineering and leader of the project team.

Keppel Data Centres chief executive Wong Wai Meng said: "We are pleased to collaborate with NUS and SLNG on (making) cooling - which is a key aspect of data centre operations - more efficient, and thus contribute to a more sustainable future."

Keppel Data Centres is a 70-30 joint venture between Keppel Corp subsidiaries Keppel Telecommunications & Transportation and Keppel Land.

NUS Department of Chemical and Biomolecular Engineering and

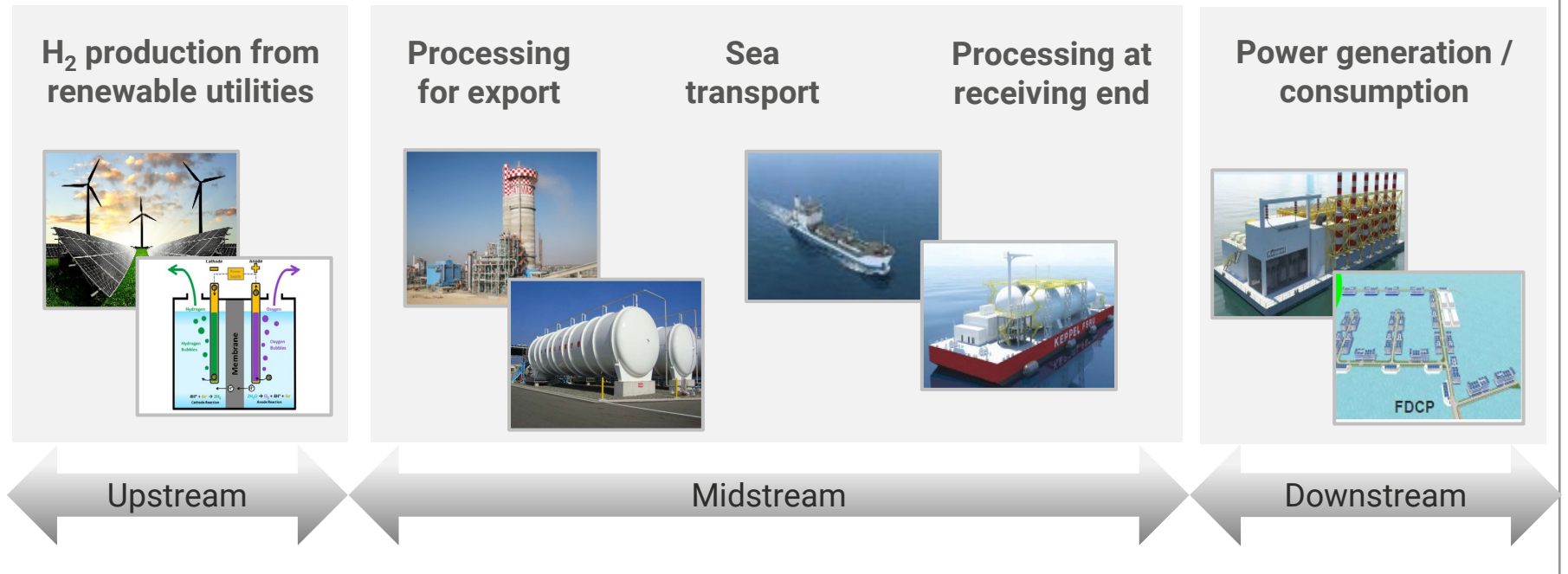
Green Energy Sources

Explore importation of hydrogen, renewable energy, and pioneer decarbonisation technologies

Short term:
Green energy import



Long term: Establishing a hydrogen supply chain in Singapore

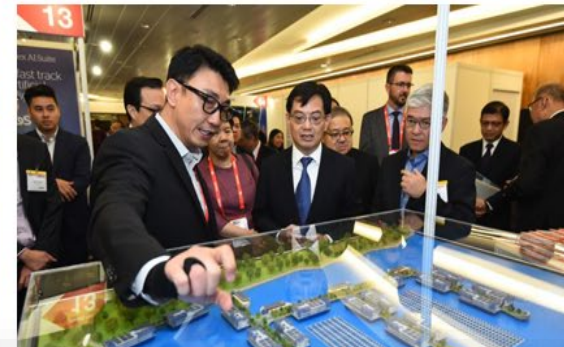


Floating Data Centre

Creating new spaces, breaking new frontiers



- Centralised Power Plant
- Centralised Cooling Plant
- Land Demand Alleviation
- Modular Design/Construction
- Reduce time to market
- Reduced Carbon Footprint
- Recyclable



Floating data centre being developed to overcome land, energy constraints | Video

31 Aug 2019 10:59PM
(Updated: 31 Aug 2019 11:02PM)

Floating data centres at sea may be the way forward to overcome the land, water and energy constraints of such facilities. Keppel Data Centres said it has a concept which it is ready to deploy.

26 Oct 2020

Keppel Data Centres, City Gas, City-OG Gas Energy Services Sign MOU To Explore Use Of LNG And Hydrogen To Power Floating Data Centre Park

Keppel Data Centres Holding Pte Ltd (Keppel DC), City Gas and City-OG Gas Energy Services (City-OG) today signed a Memorandum of Understanding (MOU) to explore using Liquefied Natural Gas (LNG) and hydrogen to power Keppel DC's Floating Data Centre Park (FDCP) in Singapore, which is currently in its exploration phase.^{[i] [ii]}

Under the MOU, the three parties will jointly explore and evaluate LNG procurement strategies and the energy transition to hydrogen in the longer-term. The parties will also deliberate on cold energy harnessing for the FDCP and share expertise on steam methane reforming. In line with Keppel's Vision 2030, which places sustainability at the heart of its strategy, this collaboration is part of a Groupwide effort to study ways to create more energy efficient and greener data centres solutions so that the burgeoning needs of the digital economy can be met in a safe, reliable and environmentally friendly manner.

Green Data Centre Park

Putting Future Oriented Ideas into Reality



A future-oriented data centre cluster

Consisting landed and floating data centres



Powered by green energy, zero-carbon

Innovated for efficiency and sustainability



Economies-of-scale shared facilities

For machines and people

Questions & Answers

This presentation may contain forward-looking statements which are subject to risks and uncertainties that could cause actual results to differ materially from such statements. Such risks and uncertainties include those arising from COVID-19, industry and economic conditions, competition, and legal, governmental and regulatory changes. The forward-looking statements reflect the current views of Management on future trends and developments.