

**MEDIA RELEASE**

## **INDUSTRY LEADERS COLLABORATE TO DEVELOP SINGAPORE'S FIRST END-TO-END DECARBONISATION PROCESS TO MITIGATE CLIMATE CHANGE**

**Singapore, 2 July 2020** – Industry leaders, Keppel Data Centres, Chevron, Pan-United and Surbana Jurong, with the support of the National Research Foundation, signed a Memorandum of Understanding (MOU) today, committing to harness their combined resources and jointly develop the first end-to-end decarbonisation process in Singapore. This collaboration is aimed at accelerating the development of a highly integrated clean and energy efficient Carbon Capture, Utilisation & Sequestration (CCUS) system that can lead to a low-carbon economy and potential commercial developments for Singapore.

Carbon emissions make up 97% of Singapore's total greenhouse gas emissions. Under the Paris Agreement, Singapore has pledged to, by 2030, reduce its emissions intensity by 36% from 2005 levels, and to stabilise its emissions and peak around 2030. The Singapore Government has announced its long-term strategy to halve emissions from its 2030 peak and achieve net-zero emissions as soon as viable. To this end, the partnership will develop CCUS technologies that are readily applicable, with high technical readiness and cost efficiency to implement in Singapore's key industries such as energy, chemicals and construction.

Under the MOU, Keppel Data Centres, Chevron, Pan-United and Surbana Jurong will jointly explore, identify and develop mature carbon capture technologies, coupled with novel technologies that utilise cryogenics, membranes and hydrogen. The four companies will also leverage the combined resources, knowledge and capabilities with other research partners, Institutes of Higher Learning and international partners to advance the development of the CCUS technologies.

When commercially viable, the CCUS technologies are expected to help reduce carbon intensity across the industry sectors and help Singapore halve emissions from its peak to 33MtCO<sub>2</sub>e by 2050, with a view to achieving net zero emissions as soon as viable in the second half of the century.

Mr Thomas Pang, CEO of Keppel Telecommunications & Transportation, the parent company of Keppel Data Centres, said, "Keppel is committed to sustainable development and combatting climate change. This MOU augments the different efforts that the Group has

taken to reduce the carbon footprint of data centre operations, including exploring floating data centres as well as LNG and hydrogen infrastructure for power generation. The CCUS technologies are scalable and can potentially be implemented in Keppel Data Centre's local and overseas operations, as well as other parts of the Keppel Group, thus contributing to the circular economy and advancing climate action."

"Chevron shares the society's concerns about climate change. We are committed to advancing technologies and forming strategic partnerships in our efforts to deliver reliable, and ever cleaner energy. I am excited that Chevron will be working with like-minded partners in Singapore to progress polymeric membrane research for carbon capture solutions across various applications and industries. These efforts take us a step further along in Singapore's and the energy industry's long-term, low-emissions development strategy." said Mr Law Tat Win, Chevron Singapore Country Chairman.

Ms May Ng, Chief Executive Officer of Pan-United Corporation Ltd, said, "Multi-industry collaboration is a key strategy to innovate commercially viable clean technologies that can decarbonise the built environment. I am confident that Pan-United's industry-leading research and development of specialised ready-mix concrete technologies can contribute to this landmark collaboration to combat the adverse effects of climate change. Pan-United is fully focussed on creating concrete solutions in embodied carbon reduction technologies to advance Singapore's sustainability ambitions."

Mr Wong Heang Fine, Group Chief Executive Officer of Surbana Jurong said, "As a multidisciplinary urban and infrastructure design consultancy, Surbana Jurong is providing step change solutions for sustainability across the project lifecycle. We are actively engaged in R&D to facilitate decarbonisation, focusing on delivering technologies that reduce and eliminate emissions as well as solutions that remove and sequester carbon from the atmosphere. Together with our partners, we are excited about exploring new solutions in carbon capture, use and storage that can scale and be commercially deployed to help us get to a net-zero future."

Professor Low Teck Seng, Chief Executive Officer of the National Research Foundation (NRF), said, "Investing in low-carbon R&D to drive cost-effective solutions is crucial for Singapore in our journey towards a low-emission economy. While Singapore, like the world, is still dependent on fossil fuels for our energy needs, technologies that enable efficient CCUS would help mitigate our emissions greatly. CCUS also presents opportunities for converting carbon dioxide into novel chemicals, materials and fuels, offering potential in growing new industries. This MOU demonstrates commitment from both industry and researchers to co-develop innovative solutions to achieve Singapore's long-term carbon goals of net-zero emissions."

### **About Keppel Data Centres**

Keppel Data Centres Holding (Keppel Data Centres) is a 70-30 joint venture between Keppel Telecommunications & Transportation (Keppel T&T) and Keppel Land, both subsidiaries of Keppel Corporation, one of Singapore's flagship multinational companies with a global footprint in more than 20 countries. Keppel provides solutions for sustainable urbanisation, focusing on four key areas comprising Energy & Environment, Urban Development, Connectivity and Asset Management.

Keppel Data Centres has a track record of more than a decade in owning, developing and managing high-quality carrier-neutral data centre facilities that support mission-critical computer systems. Strongly committed to environmentally sustainable business practices, Keppel Data Centres offers a comprehensive range of wholesale, build-to-suit and colocation solutions built to the highest industry standards.

Keppel T&T is also the sponsor of Keppel DC REIT, the first data centre Real Estate Investment Trust (REIT) listed in Asia and on the SGX-ST. Keppel Data Centres, together with other members of Keppel Group, owns and operates a global portfolio of more than 20 data centres located in key data centre hubs across Asia Pacific and Europe. For more information, please visit [www.keppeldatacentres.com](http://www.keppeldatacentres.com)

### **About Chevron Corporation**

Chevron Corporation is one of the world's leading integrated energy companies. Through its subsidiaries that conduct business worldwide, the company is involved in virtually every facet of the energy industry. Chevron explores for, produces and transports crude oil and natural gas; refines, markets and distributes transportation fuels and lubricants; manufactures and sells petrochemicals and additives; generates power; and develops and deploys technologies that enhance business value in every aspect of the company's operations. Chevron is based in San Ramon, Calif. More information about Chevron is available at [www.chevron.com](http://www.chevron.com).

### **About Pan-United Corporation**

Pan-United Corporation Ltd is a listed Asian technology company focused on concrete innovation and a global leader in concrete technologies. Its wholly-owned subsidiary, Pan-United Concrete Pte Ltd, is Singapore's largest concrete and cement company. Pan-United Corporation also operates in Malaysia, Indonesia and Vietnam, where it became the top brand in Ho Chi Minh City within six years.

Pan-United has extensive in-house R&D capabilities which create high-performance, sustainable ready-mix concrete products and specialised solutions for their customers. Using the latest digital tools, they have developed deep industry-leading logistics capabilities to deliver large-scale volumes of concrete on time, and of consistent quality. For more

information, please visit: [www.panunited.com.sg](http://www.panunited.com.sg)

### **About Surbana Jurong**

Surbana Jurong Group is a global urban, infrastructure and managed services consulting firm, with over 70 years of track record in successful project delivery. Headquartered in Singapore, the group has a global talent pool of 16,500 across Surbana Jurong and our member companies AETOS, B+H, KTP, Prostruct, RBG, SAA, Sino-Sun and SMEC, based in more than 120 offices in over 40 countries. They include architects, designers, planners, engineers and other specialists driven by progressive thinking and creative ideas to help shape a better future.

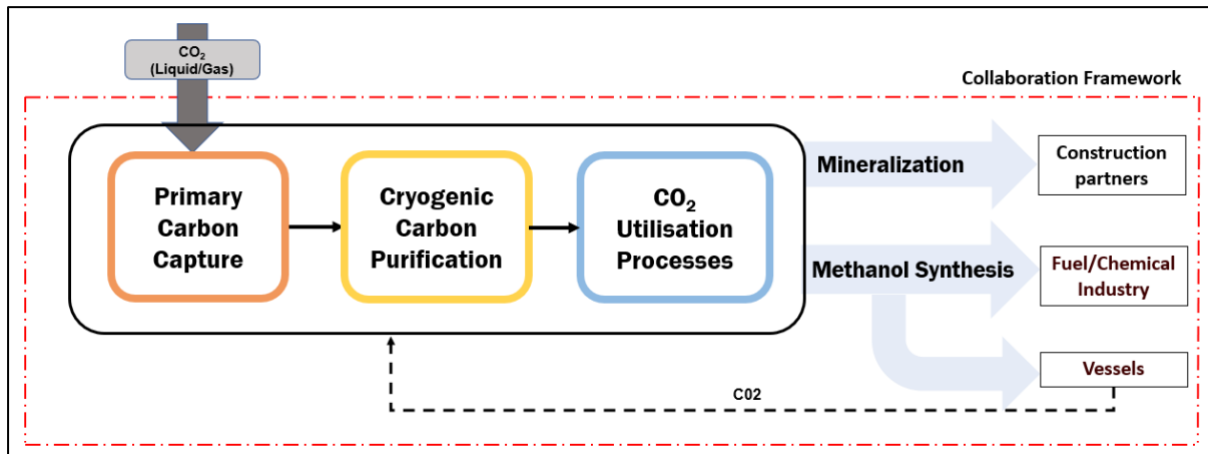
Our technical experts deliver sustainable solutions that cover the entire project life cycle from planning and design, through to delivery and management, as well as decommissioning and closure. We provide a full suite of multidisciplinary consultancy services across a diverse range of sectors that includes aviation, healthcare, hospitality, transport, water and environment as well as energy and resources.

Surbana Jurong has built more than a million homes in Singapore, created master plans for more than 30 countries and developed over 100 industrial parks globally. Our tag line “Building Cities, Shaping Lives” expresses how every project or undertaking is, for the Group, an opportunity to fulfil aspirations and enrich lives. By designing and delivering quality housing, work spaces, roads, rail, hydropower, dams, underground and coastal protections and other critical infrastructure needed by our clients, we are redefining cities and transforming them into sustainable and liveable spaces where communities and businesses, present and future, can thrive. For more information, please visit: [www.surbanajurong.com](http://www.surbanajurong.com).

### **National Research Foundation**

The National Research Foundation is a department within the Prime Minister's Office. NRF sets the national direction for research and development (R&D) by developing policies, plans and strategies for research, innovation and enterprise. It also funds strategic initiatives and builds up R&D capabilities by nurturing research talent. The NRF aims to transform Singapore into a vibrant R&D hub that contributes towards a knowledge-intensive, innovative and entrepreneurial economy; and make Singapore a magnet for excellence in science and innovation.

## Annex A: Carbon Capture Utilisation and Sequestration (CCUS) system and value chain



In the first stage of the CCUS system – Primary Carbon Capture. Membrane separation technology is currently limited by the selectivity of currently available membrane materials as well as the high cost of materials. One of the most promising gas separation method is using polymeric membrane that acts as the filter for the separation CO<sub>2</sub>/N<sub>2</sub> mixtures and generates a specific gas rich permeate.

In the second stage of the CCUS system – Cryogenic Carbon Purification. Cryogenic Carbon Capture is a post-combustion technology method that that cools CO<sub>2</sub>-laden flue gas to desublimation temperatures (-100 to -135 °C), separates solid CO<sub>2</sub> that forms from the flue gas from the light gases, uses the cold products to cool incoming gases in a recuperative heat exchanger, compresses the solid/liquid CO<sub>2</sub> to final pressures (100-200 atm), and delivers a compressed CO<sub>2</sub> stream separated from an atmospheric pressure light-gas stream. Overall resulting in significantly reduced fixed capital and operational capital, especially with the availability of waste cold from LNG regasification.

In the third stage of the CCUS system - CO<sub>2</sub> Sequestration Processes. Sequestration projects today are limited at oil/gas fields for subsequent EOR utilisation. The cost for storage, transport and sequestration of CO<sub>2</sub>, particularly in land scarce Singapore is expected to be high. However, aggregation of the captured CO<sub>2</sub> and storing in liquid phase in pipelines networks (used as cold energy transfer medium etc.) or in solid phase in unused storage tanks or caverns could potentially provide alternative commercially viable options.

In the last stage of the CCUS system, Carbon utilisation. There are 3 tracks that will be explored:

- Low-Carbon Concrete: This concrete with a much-reduced carbon footprint is achieved by maximising the use of ground granulated blast furnace slag or GGBFS (a cementitious by-product of steel production) to replace ordinary Portland cement, which has high carbon emissions. In addition, natural aggregates are replaced by recycled concrete aggregates and washed copper slag. Carbon dioxide is injected into the concrete mix, converting the carbon

dioxide into a mineral that increases the concrete strength, enabling less cement to be used. The final product is a very low carbon concrete that has a carbon footprint approximately 46% lower than normal concrete.

- Mineralisation: Carbon sequestration in construction materials (cement, sand, aggregates etc.) can be achieved through the introduction of carbonates. One of the primary objectives of concrete sustainability innovation is to increase the carbon dioxide (CO<sub>2</sub>) sequestration in such materials and consequently enable it to still meet construction industry standards.

- Methanol: Green methanol production, i.e. methanol synthesised via direct CO<sub>2</sub> hydrogenation or via syngas hydrogenation after the reverse water-gas-shift reaction, rather than from methane reforming, can be a highly attractive CCU pathway for a future low-carbon economy