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NRF launches new Decarbonisation Programme to grow Singapore's capabilities in hydrogen utilisation, and non-fossil fuel-based pathways to produce sustainable aviation fuel and high-value chemicals

Permanent Secretary for National Research and Development, Professor Tan Chorh Chuan announced a new CREATE Thematic Programme in Decarbonisation at the CREATE Symposium today. The research projects will include leading investigators from NUS, NTU, CREATE partners¹, as well as top international experts from Max Planck Institute and Tohoku University. By tapping on innovative technologies in AI for materials discovery, autonomous laboratory, and novel flow chemistry setups, the programme will focus on carbon conversion and utilisation, using carbon dioxide and *non fossil fuel-based* feedstocks such as biomass to produce key commodity chemicals such as biofuels and specialty chemicals. The programme will also contribute towards building Singapore's capacity in hydrogen utilisation, developing new insights on the combustion behaviors of zero-carbon fuel blends, and building ammonia-ready fuel cells for power generation.

2 The CREATE Thematic Programme in Decarbonisation will be hosted by the National University of Singapore (NUS). NUS will work together with CREATE partners to implement the programme.

3 The National Research Foundation (NRF) will be investing SGD \$90 million on CREATE's Thematic Programme on Decarbonisation.

4 Table provides project and team details:

	Name of Project
1	AI Xploration of Catalysis on Inorganic Surfaces (UC Berkeley, NTU & A*STAR)
2	Sustainable Chemical Conversion of Biomass (Max Planck Institute, NTU & NUS)
3	Sustainable Manufacture of Molecules and Materials in Singapore (University of Cambridge, NTU & NUS)
4	Development of Advanced Catalysts for Electrochemical Carbon Abatement (NUS)

¹ University of Cambridge; CNRS: Centre Nationale de la Recherche Scientifique, Imperial College London, Shanghai Jiao Tong University, TUM: Technical University of Munich, and University of California, Berkeley

5	Carbon Negative Synthetic Biology for Biomaterial Production from CO2 (Shanghai Jiao Tong University & NUS)
6	Carbon Negative Production of Advanced Sustainable Aviation Fuel (SAF) Using Twin Synthetic Bacterial Consortia (Centre Nationale de la Recherche Scientifique & NUS)
7	Hydrogen Combustion in Singapore (University of Cambridge, NTU & NUS)
8	Decarbonization with Green Ammonia Using Solid Oxide Fuel Cell (SOFC) for Power Generation (Imperial College London & NTU)
9	Singapore's Pathway to Carbon Neutrality: Analysis of New Technologies (TUMCREATE & NTU)

Refer to Professor Tan Chorh Chuan's opening remarks in ANNEX A and details of demonstration booths set up by CREATE entities in ANNEX B

**SPEECH BY PROFESSOR TAN CHORH CHUAN
PERMANENT SECRETARY (NATIONAL RESEARCH DEVELOPMENT) AT
THE 2024 CREATE SYMPOSIUM 22 July 2024**

I thought I will start by just saying a few words about the CREATE programme itself, bearing in mind that many of you are very familiar with it. If we must find a very succinct way of characterising this programme, I think it will be this: it is an international collaboration, comprising top researchers from our international partners, who are themselves leading global universities and research institutions with researchers physically in Singapore, working alongside local researchers here at the CREATE Campus.

The CREATE programme is unique in several aspects and at this physical co-location, researchers working closely together on major research issues is a very important element. Right from the outset, the CREATE programme was focused on bringing together international experts to look at important scientific, social, and economic issues. We have had a strong focus on developing not just research, but innovation in terms of finding solutions and approaches to address important issues that we all collectively confront.

What's been exciting is that the current focus, with all the inputs from our governing council, international partners and with your support, is to embark on a new part of the programme portfolio, which is to work together on large scale, interdisciplinary programmes. We will do so in a synergistic way, making best use of the collective talents to advance knowledge, to achieve

impact, and to provide solutions for Singapore and the world. The culmination of the last two years with your support and help is the topic of today's symposium, which is the CREATE Thematic Programme in Decarbonisation.

All of us know that there is probably no single global issue which demands or warrants our collective action than global warming, and if you had come to Singapore in the last couple of days and thought it was hot, you are statistically correct. If you look at the chart, you will find that we will have many more days of higher average temperatures in the year. Climate change however is not just a matter of comfort, it is a global challenge of unprecedented impact. What is encouraging is that, around the world, more countries and companies are pledging to take actions to decarbonise economies.

Climate change is an existential threat for all of us, especially so for a small island state like Singapore. We are committed to taking decisive steps to achieve net zero emissions by 2050 and this will require us to address the major sources of emissions, namely from industry and power generation. In 2030, our nationally determined contribution target is to reduce emissions to around 60 metric tons of carbon dioxide equivalent, after peaking emissions earlier.

The way we will achieve this is outlined in the Singapore Green Plan, which has five main elements. The first is energy research, using clean energy and increasing our energy efficiency to move towards sustainable living, where the public, industry and institutions make reducing carbon emissions and saving resources and energy, an integral part of how they work and live. We also aspire to build a green economy, to seek green growth, create new jobs, transform industries, and harness sustainability as a competitive advantage. We want to show that while

doing all this is possible – to create a green and liveable city in nature – is not just pleasant to live in, but also sustainable. It is a place where we extend nature throughout our island. They increase overall liveability and provide very useful carbon dioxide sinks. Finally, we need to build-up Singapore's climate defences and resilience, including enhancing food security as part of our long-term effort to assure a resilient future for the nation.

We have many initiatives to support net zero goals and they can be clustered into supply side actions, actions on the grid, and demand side actions. Allow me to say a word about the supply side, which is the mainstay of a power generation that currently comes from natural gas. We will continue to diversify the sources of natural gas and improve efficiency of power generation. We have invested significantly in maximising solar deployment, and we have institutes in NUS, NTU and other institutions that are helping us to develop the R&D to achieve this.

On the diversification of our energy sources, we are also pursuing energy imports to access cleaner and cost-effective energy across our region through regional power grids. The final area that is very exciting for all of us today is to pre-position Singapore for new low carbon supply alternatives such as hydrogen, carbon capture, utilisation and storage, geothermal, and nuclear energy. I am particularly excited that the CREATE programme will be another prominent large-scale research effort that would help us to develop solutions that will be pertinent to this area.

Singapore and most of the world still relies on fossil fuels as the primary driver for our societies and economies. What we hope moving forward is to transition from fossil fuels to renewable sources and in Singapore, if you can optimise the use of hydrogen or hydrogen carriers, there is a potential to reduce our greenhouse gas emissions by up to 60%. Our aspiration going into

the future is to transit to fossil fuel-free, green sources of energy, which will then open many new opportunities for countries around the world, especially for energy disadvantaged countries like Singapore.

I find it incredible that we can have so many top research partners coming together and with your help, create what is a large-scale, but ambitious and synergistic programme that has four main domains of research. This includes hydrogen utilisation that tackles issues in hydrogen and combustion technologies, ammonia energy, hard fuel cells, green chemistry that focuses on the sustainable conversion of biomass to chemicals and biofuels, synthetic biology engineering microbes to convert carbon dioxide to chemicals and biofuels, and chemical translation, which develops net-zero pathways to produce health molecules for pharmaceutical applications.

In each of these areas, we have a number of local and international partners combining expertise and skills by working closely together. Beyond the collaborations that take place within each of these domains, there will be many opportunities for cross-learning between all these research workstreams, and I foresee more new opportunities to share knowledge and extended collaborations between the domains.

Finally, and very importantly, we will be able to leverage the tremendous AI and modelling capabilities and expertise in Berkeley and TUM that will not just enable research to proceed expeditiously and effectively, but also form yet another platform through which extended collaborations can occur. This is very exciting and ambitious, but a worthwhile and defining type of endeavour.

The CREATE Decarbonisation programme will leverage all our multi-lateral partnerships and the strong relationships that we have built over the years, to address foundational research challenges that will contribute to our quest for net zero emissions. This wide-ranging expertise would come together in a synergistic way on programmes or research that steers towards replacing fossil feedstocks, and it will create many solutions, including AI and automated labs, new research discoveries and processes, new catalysts and process discoveries, synthetic biology knowledge and approaches, and new insights into hydrogen utilisation.

The knowledge and novel solutions created by this programme will contribute towards sustainability and green growth not just in Singapore or in the homes of our global partners, but for the rest of the world. We are embarking on a very exciting new part of the CREATE's research portfolio.

I would like to thank all our partners and all our local and international research community for your strong support. I look forward to progressing this incredible and exciting programme and to the discoveries and innovations that will emerge. With that, I welcome everyone once again to the CREATE Symposium. Please do enjoy the company of our partners and researchers in the expanded CREATE ecosystem.

Thank you.

Demonstrations by CREATE entities at the CREATE Symposium 2024

Demos on Decarbonisation	
1	<p>CNSB-CREATE is a collaborative programme between Shanghai Jiao Tong University (SJTU) and National University of Singapore (NUS) under the Campus for Research Excellence and Technological Enterprise (CREATE) framework. The collaboration aims to build an efficient cell factory platform to produce high-value biofuels such as 1,4-butanediol (BDO), and iso- butanol, with the following three objectives:</p> <ol style="list-style-type: none"> 1) To produce bio-based biofuels using CO₂ as the sole starting substrate with synthetic biology. 2) To construct photosensitive materials-photosynthetic organism interfaces to augment photosynthetic efficiency with CO₂. 3) To innovate and create breakthrough with the usage of microbes such as cyanobacteria to efficiently utilize CO₂ and develop efficient microbial chassis to realise "light-driven cell factories" of green synthetic chemical production and simultaneously ease urgent environmental and energy pressures. <p>At CREATE Symposium 2024, the team will present polylactic acid material products produced from CO₂ and biomass. It is a marketable degradable plastic, capable of serving as a green alternative to traditional plastics and mitigate plastic pollution. The showcase will display products made from the biomaterial, such as children's tableware, tapes, cling film, and food containers.</p>

<p>2 &3</p>	<p>The Cambridge Centre for Advanced Research and Education in Singapore (CARES) will be demonstrating a climate calculator that can support the sustainability of ships. EMICAST offers advanced visualisation of ship emissions through rigorous carbon accounting and forecasting techniques powered by machine learning algorithms. EMICAST aims to provide carbon accounting, reporting, and emissions forecasting to accurately quantify GHG intensities and their potential penalties. This follows the regulatory standards of CII and FuelEU Maritime.</p> <p>Timely low-carbon solutions can be tailored to individual ships, ensuring emissions compliance while safeguarding operators' profitability. At the CREATE symposium, guests will be able to use the standard version of this calculator at the booth and speak with the researchers behind the technology.</p> <p>There will be prepared examples of improved ship carbon emissions performance. Additionally, EMICAST will demonstrate a new application of their research work - the additional emissions caused by operational inefficiencies. The visuals will be captured on a monitor.</p> <p>The Cambridge Centre for Advanced Research and Education in Singapore (CARES) will also showcase a digital ecosystem The World Avatar that integrates knowledge graphs and semantic web technologies to create a comprehensive digital twin of the physical world. This project is designed to analyse vast amounts of data, provide insights and solutions for complex challenges in decarbonisation across multiple domains such as environmental monitoring, energy management, urban planning, human health, and infrastructure development.</p> <p>Guests can learn more about the current use cases being developed for lab management, city resilience from climate disasters, and energy distribution networks. They can interact with The World Avatar platform themselves by asking questions of possible real-world scenarios the team is developing for Singapore.</p>
<p>4</p>	<p>The French National Centre for Scientific Research (CNRS) at CREATE will be demonstrating its DesCartes Hybrid Digital Twins system which uses an interactive table specifically designed for decision-making, along with HoloLens headsets, for guests to interact with the digital twins of two districts: Marina Bay (Singapore) and La Défense (Paris). In real time, they can understand and visualise how different conditions (e.g., wind, temperature, pollution, no-fly zones) impact these neighbourhoods.</p> <p>The augmented reality platform offers an immersive solution, where information on a screen is enriched with a 3D model which can be manipulated in real time. Read also: https://descartes.cnrsatcreate.cnrs.fr/demos/</p>
	<p style="text-align: center;">Other demos</p>
<p>5, 6, & 7</p>	<p>The Singapore-ETH Centre will be showcasing an innovative optimisation algorithm designed to improve urban cooling systems. This algorithm minimises anthropogenic heat, costs, primary energy consumption, and greenhouse gas emissions by optimising both supply systems and thermal network connectivity. In the face of escalating urban heat stress due to climate change, this work aims to enhance city efficiency and sustainability. Urban planners and construction companies are the model's main target group. Given sufficient data about regional urban specificities this algorithm can be employed worldwide. It is open-source and has been shared with Singapore</p>

	<p>government agencies. By integrating this model into early urban planning, it can help identify the best thermal energy solutions, reducing heat stress, emissions, and energy costs. Website link</p> <p>The Singapore-ETH Centre will also showcase an innovative AI-powered chatbot that utilises advanced technology to provide reliable, evidence-based information on resilience studies. Leveraging research materials and published journals from the Future Resilient Systems (FRS) program, this chatbot aims to make complex academic insights accessible to the public. As the first AI chatbot service offering theme-based academic knowledge on resilience, FRS Bounceback seeks to connect individuals and organizations interested in enhancing their understanding of resilience. The significance of FRS Bounceback lies in its potential to democratize access to high-quality information, addressing the urgent need for robust and adaptable infrastructure systems in our interconnected world. By simplifying access to academic research, it empowers policymakers, urban planners, engineers, and the public to make informed decisions regarding resilience strategies.</p> <p>Currently in its testing phase, FRS Bounceback is set for wider implementation across various countries in the Asia Pacific region and beyond. Website link</p> <p>Additionally, as part of the '30-by-30' policy to meet 30% of Singapore's nutritional requirements through intensification of domestic food production by 2030, ETH Centre Singapore is developing a blueprint for an urban system to integrate food waste management and sustainable food production via black soldier fly (BSF) bioconversion. BSF can transform food waste into a sustainable high-protein feed ingredient for poultry and aquaculture diets. In addition, the mineral rich BSF frass (by-product of bioconversion) has the potential to supplement or even substitute commercial fertilizers in both soiled and soilless agriculture. (This showcase will be a poster session) Website link</p>
8	<p>TUM-CREATE is a multidisciplinary research platform between Technical University of Munich (TUM), public agencies, research institutes and universities. At the CREATE Symposium guests will be able to view TUM-CREATE's demo on Proteins4Singapore (P4SG) which aims to provide highly nutritive, savoury, and functional protein-based foods by designing and controlling cultivation of alternative protein sources, innovative extraction methods and novel reverse food engineering approaches. The P4SG demo will highlight snippets of TUM-CREATE's comprehensive approach spanning across raw material cultivation up to processing a product for consumption. There will be a 3D printer, CEA (Controlled-environment agriculture) demonstrator, microalgae cultivation, flavour tubes, and a gut microbiome model at the booth including a video showcasing TUM-CREATE lab capabilities.</p>

End of Media Release