

NANYANG
TECHNOLOGICAL
UNIVERSITY

Role of Academia in Green & Smart Shipping and METB Initiative

presented by

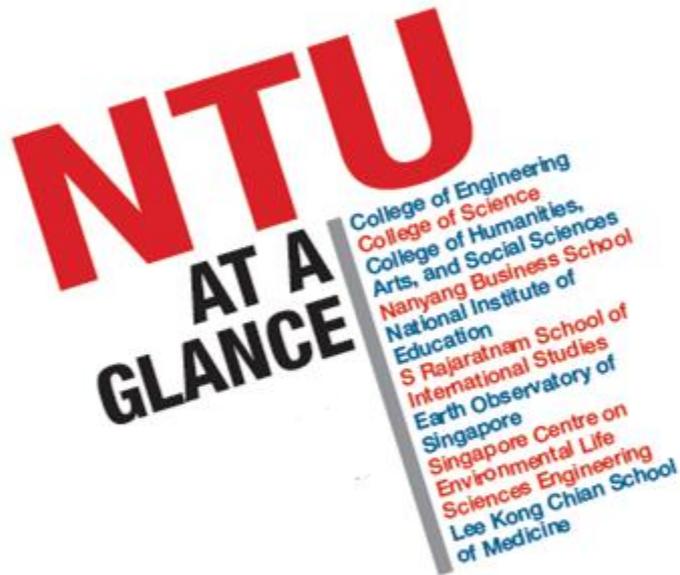
Prapisala Thepsithar

Senior Scientist

Energy Research Institute at NTU (ERI@N)

13 February 2015

OVERVIEW OF NANYANG TECHNOLOGICAL UNIVERSITY



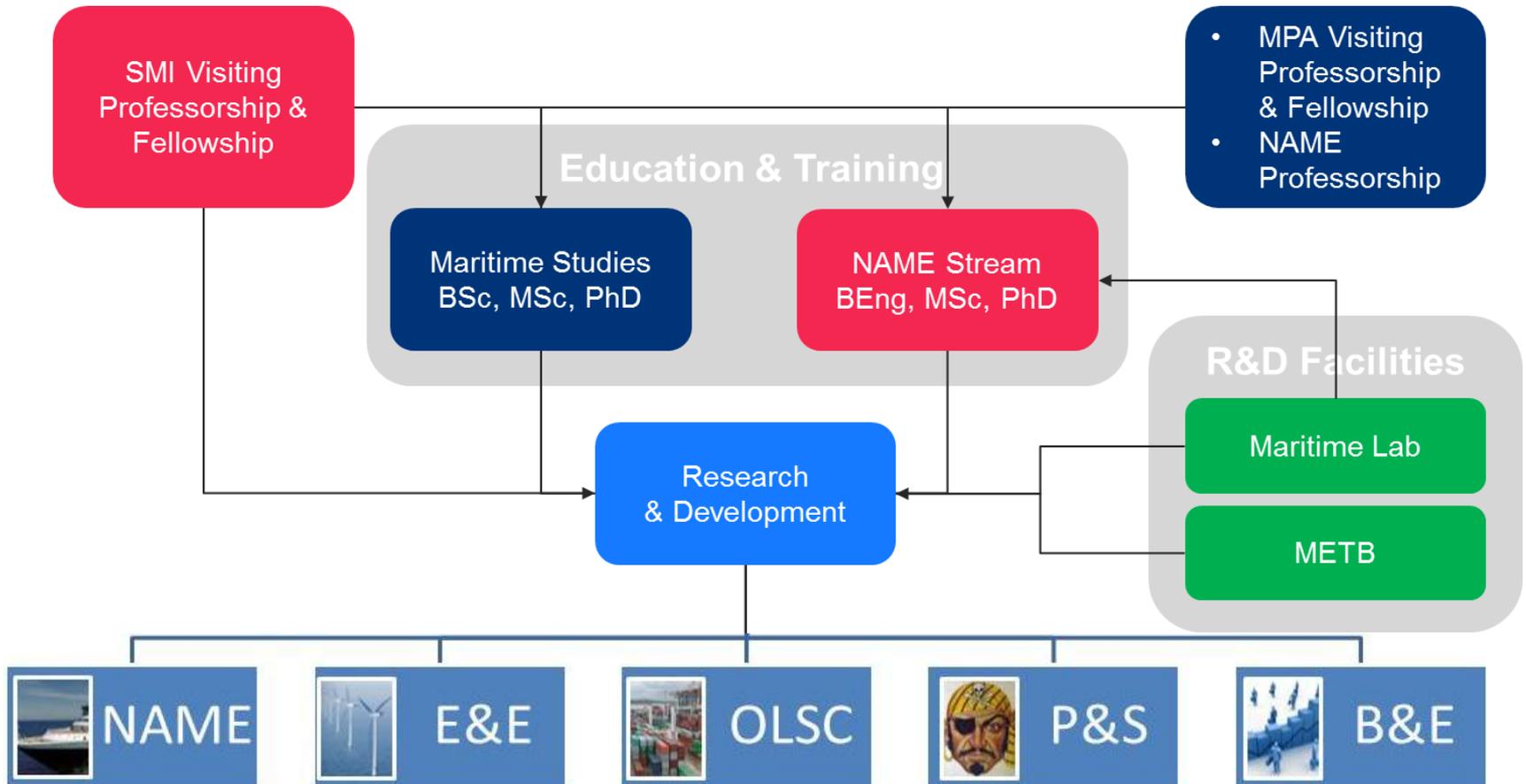
- Established in 1991
- Strengths in engineering, science, business, humanities, arts, social sciences, education, international studies and medicine
- Fastest-rising Asian university in the world's top 50;
ranked 41st in the world and 8th in Asia*
- Research-intensive
- Top 15 most beautiful university in the world, with 16 halls of residence for undergraduates and 5,000 new hostel places by 2015
- About 23,500 undergraduates and 9,500 graduate students from 83 countries
- More than 179,800 alumni in 127 countries

SCHOOLS AND INSTITUTES

Maritime Institute at NTU
(MI@NTU)

College of Engineering	<p>MAE: Naval Arc & Marine Eng, Robotics & Control, Shipping operation & optimisation</p> <p>CEE: Maritime logistics/ Economics</p> <p>EEE: Electric power Eng</p> <p>MSE: Material technology</p> <p>SCE: Advanced information technology, Computational intelligence</p>
College of Business	<p>RSIS: Maritime security programme, International political economy</p>
College of Science	<p>Institute of Catastrophe Risk Management: Maritime insurance, insurance risk, Maritime port operation risk</p>
Energy Research Institute at NTU (ERI@N)	<p>Maritime Energy: Clean energy and emission</p> <p>E-mobility: Autonomous & electric vehicles</p> <p>Energy storage: VRB, Fuel cell</p> <p>Offshore Renewable: Wind turbine</p>
Nanyang Environment and Water Research Institute (NEWRI)	<p>SMTC, 3RC, AEBC: Ballast water, environmental engineering, oil recovery</p>
Fraunhofer IDM@NTU	<p>Visualisation, Maintenance support solution</p>

MI@NTU RESEARCH & EDUCATION



NAME: Naval Architecture and Marine Engineering

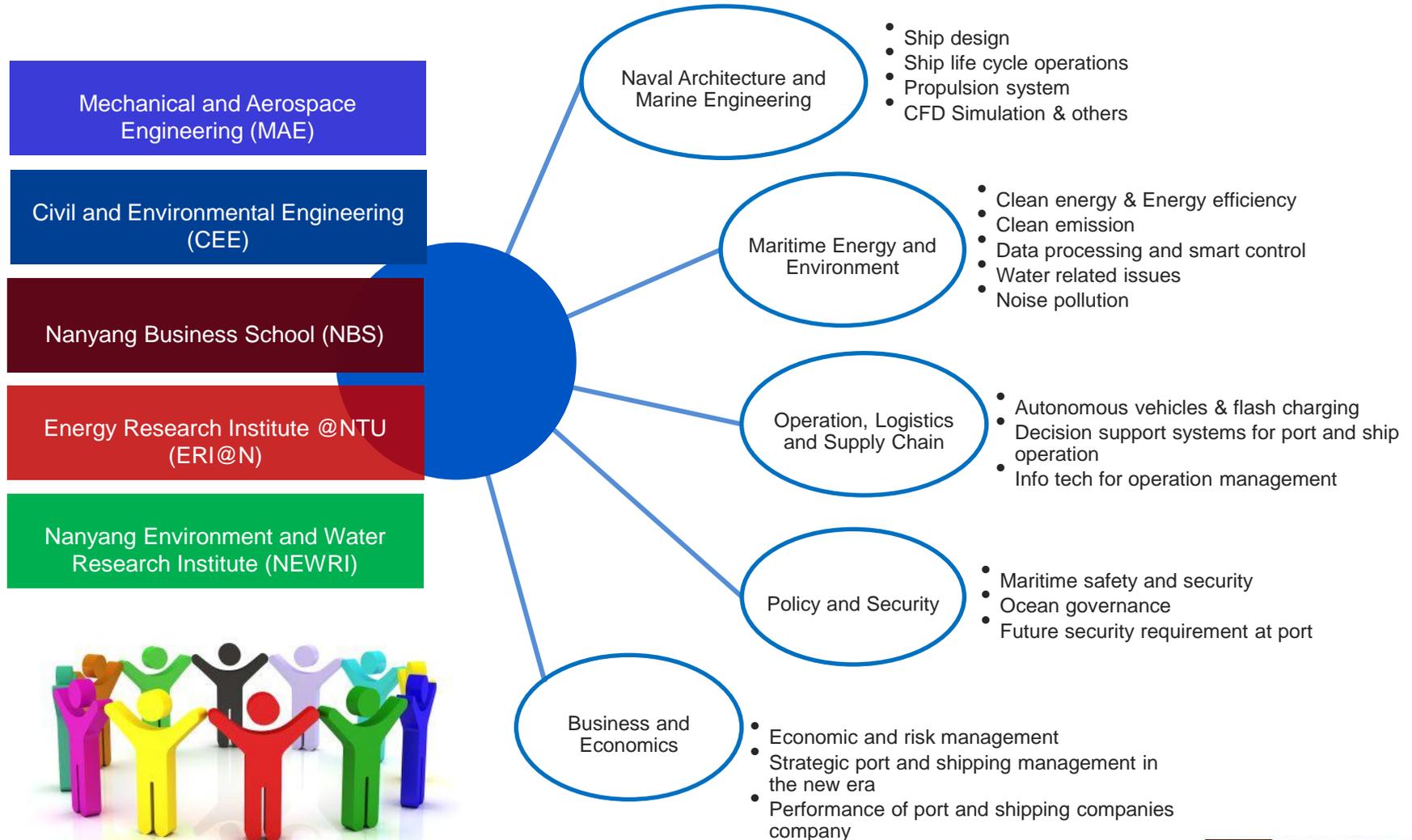
OLSC: Maritime Operations, Logistics and Supply Chain

B&E: Maritime Business and Economics

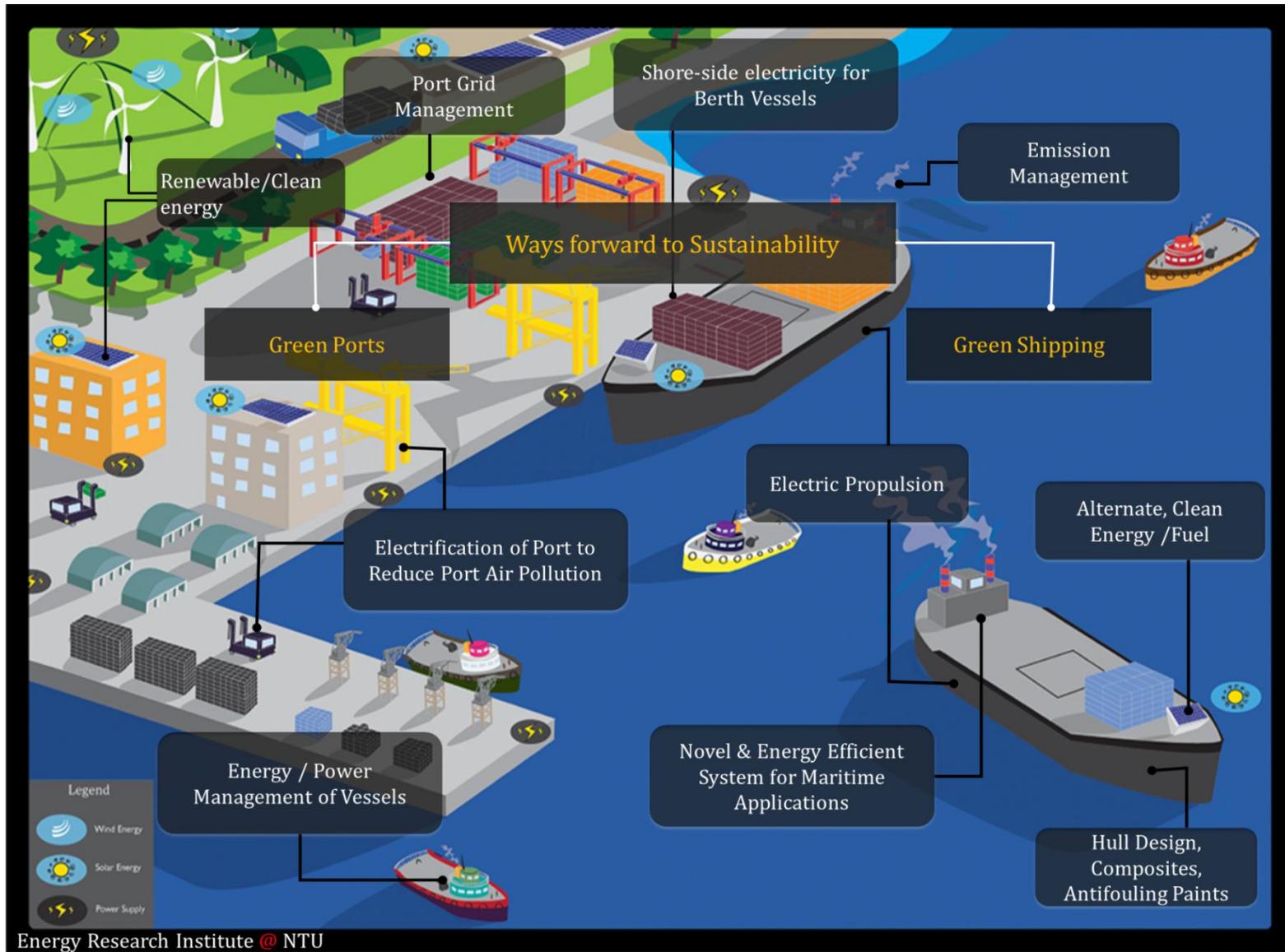
E&E: Maritime Energy and Environment

P&S: Maritime Policy and Security

MARITIME RELATED EXPERTISE

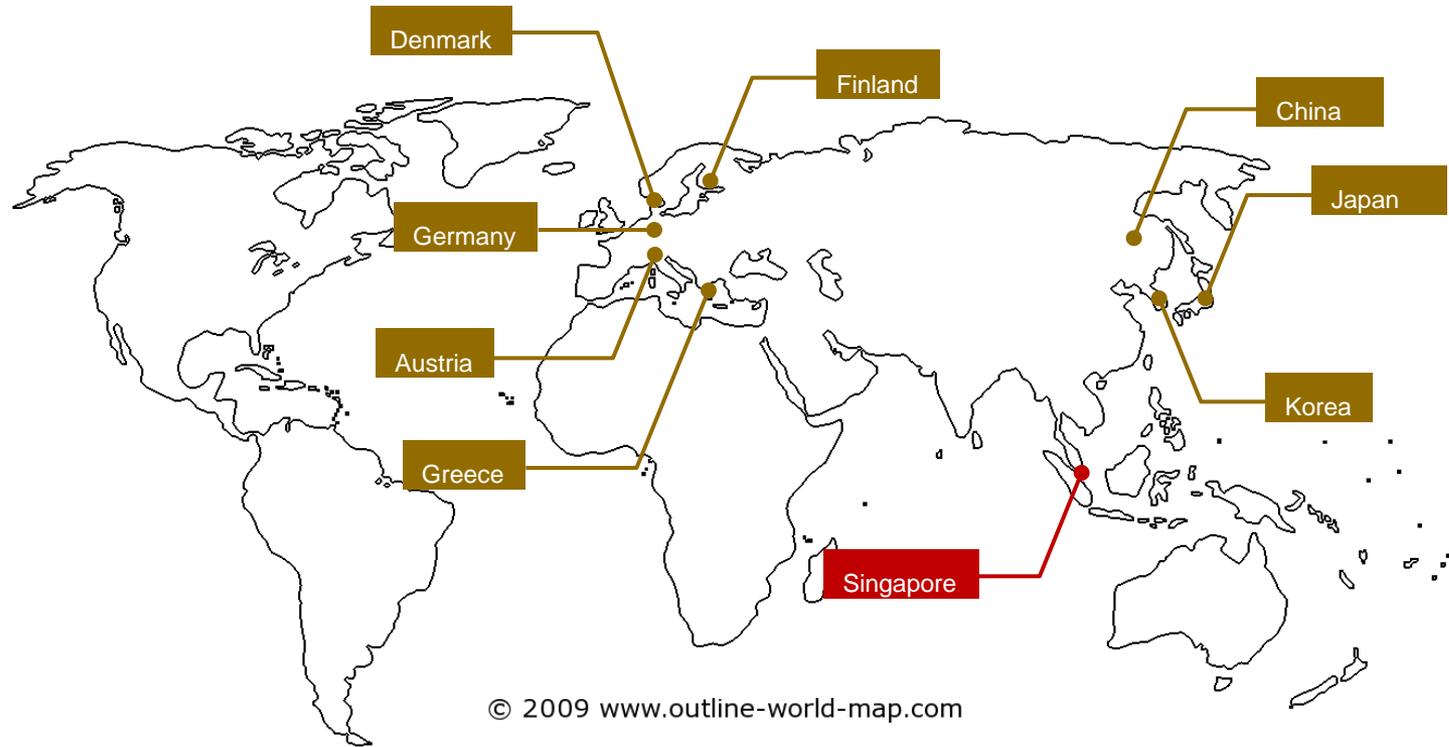


Maritime Energy: Focus Areas



METB INITIATIVE - TESTING FACILITY

Maritime **E**nergy **T**est **B**ed: *The first well-engineered marine energy test bed in the region* mainly to support R&D activities in maritime industry in next ten years.



WHY METB?

Maritime **E**nergy **T**est **B**ed: provides a platform for research institutes and companies to test various green technologies that promote innovation solutions for maritime industry with translation from lab-scale to real-application scale.

Engine Specification

1.5 MW Daihatsu Engine - 4 Stroke, Tier 1, 6 cylinders , 720rpm

Fuel – HFO & Diesel

Alternator – AC 450V, 3-phase, 60Hz

Exhaust Gas – 10,300Nm³/hr

Time and Cost for Equipment Installation

Loading/ unloading & Installation/ removal of Equipment with Cost Involved

Interruption to Ship Operation

Due to unforeseen problems when testing under real conditions

Availability of Instrumentation for Measurement and Control

Flow meter (mass and volumetric), Gas analyses, etc.

Accuracy & Precision of Testing and Obtained Results

Due to uncertainty from external factors such as weather, loads, etc. for each tests and from tests to tests

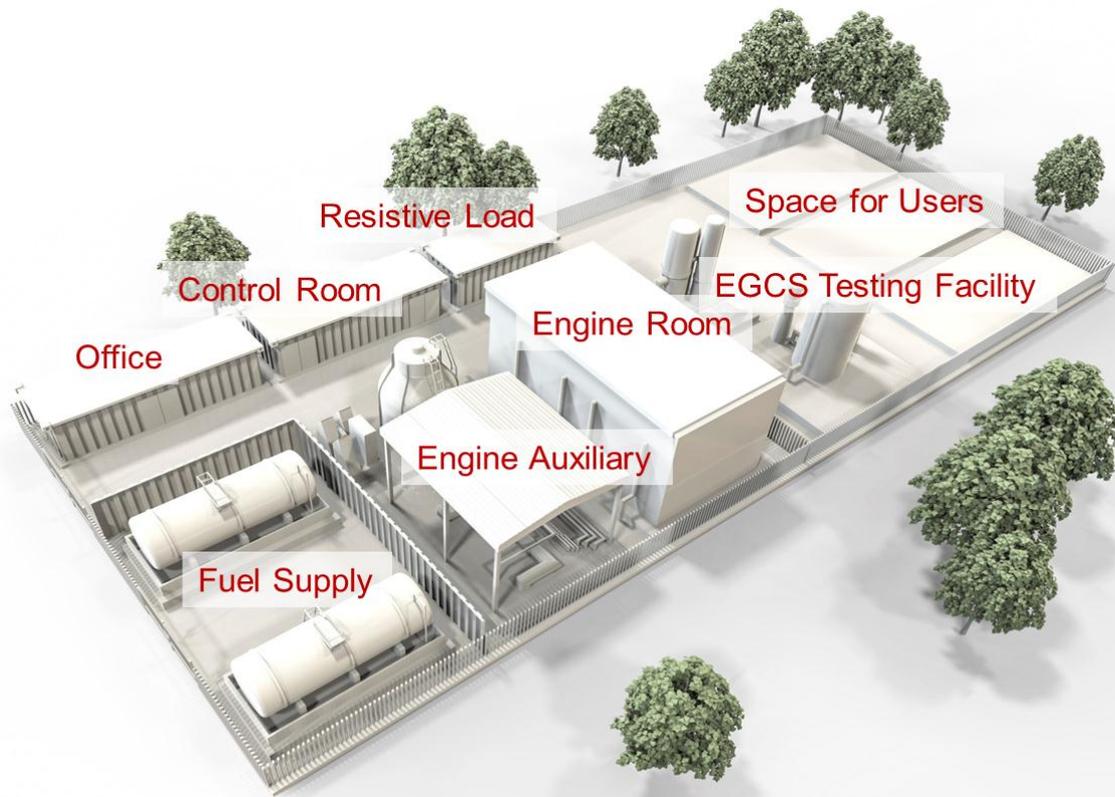
METB INITIATIVE - ESTABLISHMENT

Supported by Singapore Maritime Institute (SMI), METB is jointly initiated by the Maritime Institute at NTU (MI@NTU) and Energy Research Institute at NTU (ERI@N)

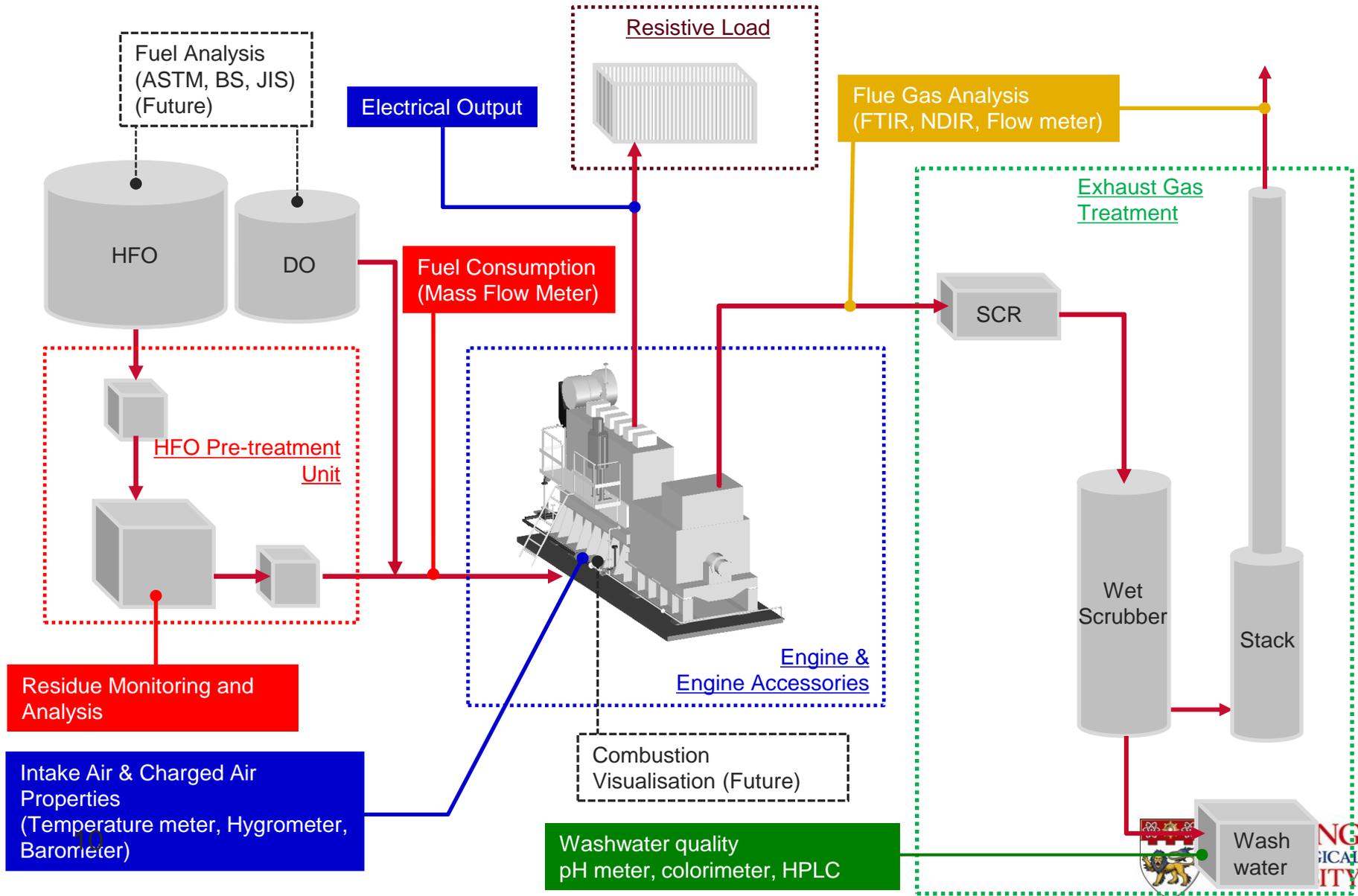
ClassNK
R & D PROJECT

A key supporter and user of METB.

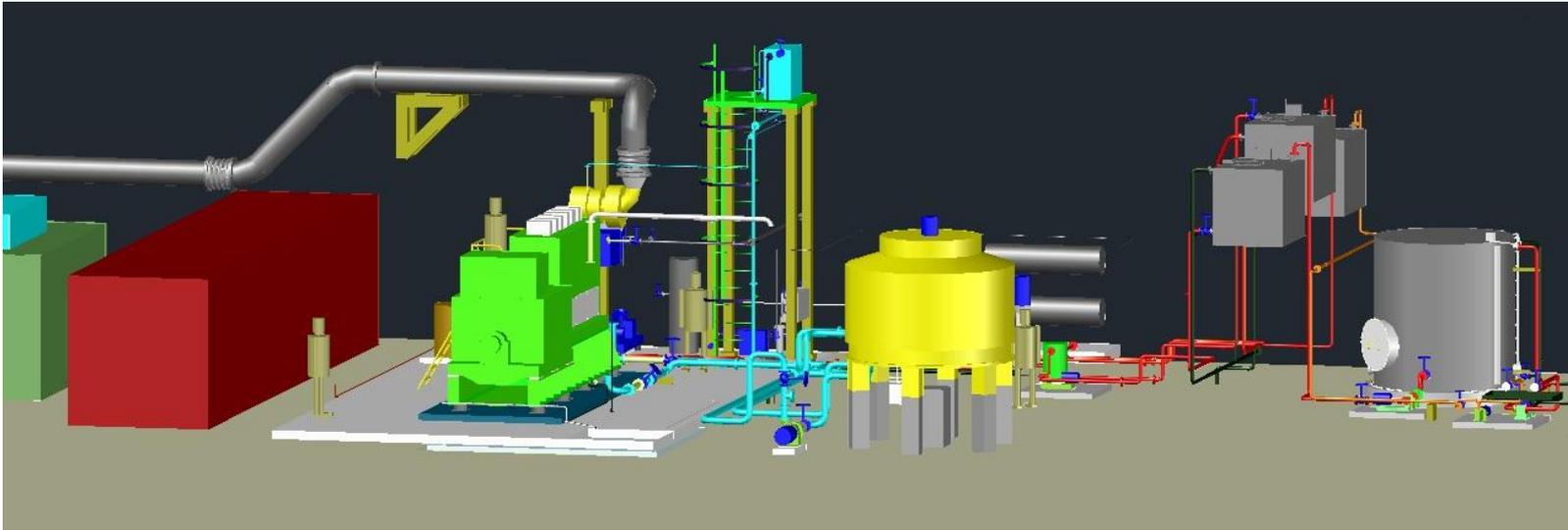
Through ClassNK Joint R&D for Industry Program, ClassNK has supported 7 current and pending projects jointly with NTU and other major maritime stakeholders.



METB - COMPONENTS



DATA TO BE OBTAINED REAL-TIME FROM METB



Fuel and Lubricating Oil

- Fuel oil consumption (mass & volumetric)
- Fuel oil @ engine inlet (temperature & pressure)
- LO @ engine inlet (temperature & pressure)
- LO @ cooler unit inlet (temperature)

Cooling Water

- HTCW @ engine inlet & outlet (temperature & pressure)
- LTCW @ air cooler unit inlet (temperature & pressure)

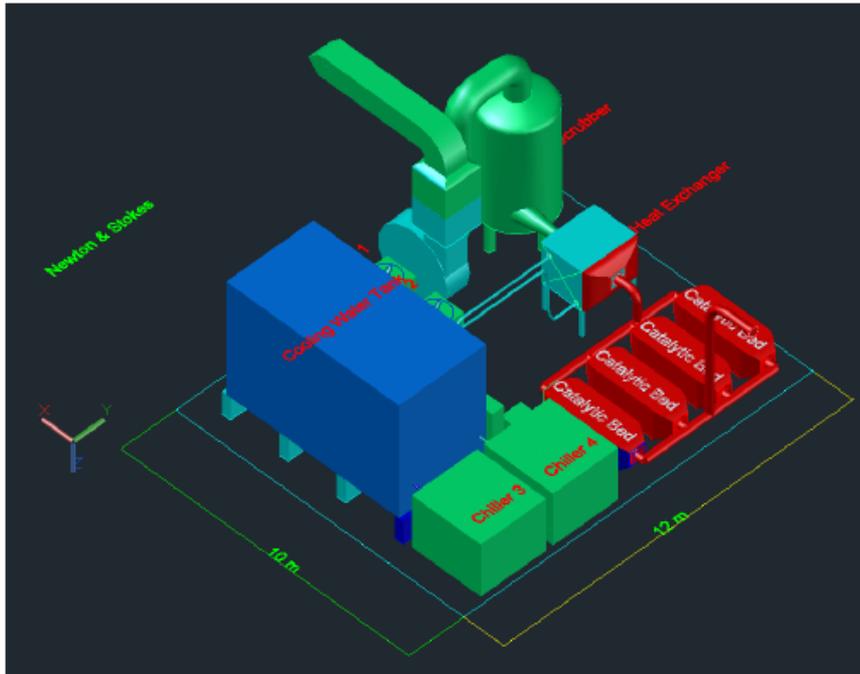
Intake and Charged Air

- Intake air (temperature, pressure & humidity)
- Charged air (temperature)
- Exhaust gas T/C inlet & outlet (temperature)

Engine and Alternator

- Engine load
- Engine speed
- Electrical power output

DATA TO BE OBTAINED REAL-TIME FROM METB



Exhaust Gas

- Exhaust gas @ cylinder outlet (temperature)
- Exhaust gas from engine (flow rate & temperature)
- Composition of exhaust gas (19 pollutants, including SO_x , NO, NO_2 , CO, CO_2 , HCs, H_2O)

Water

- Ions, e.g. SO_4^{2-} , NO_3^-
- PAH
- Temperature
- pH

Data Processing

- To demonstrate the level of NO_x emission in g/kWh



R&D FOCUS AREAS

Fuels

- Alternative and/or clean fuels (e.g. biofuel, emulsified fuel and synthetic diesel from biomass)



Marine Engine

- In-cylinder combustion analysis (heat release, injection delay, ignition delay, combustion duration and their relationship with specific fuel consumption and engine failure)*
- Establishment of new methodology for time resolved fuel consumption measurement based on emission data
- Exhaust gas recirculation, humidified air, etc.

Exhaust Gas

- Emission control technologies (Wet processes and catalyst)
- Real-time monitoring
- Process modelling

Electricity*

- Grid scale redox flow batteries
- Fuel cells

Fuel Additives

- Fuel additives for improved combustion efficiency and cleanliness on engine parts

Heat

- Waste heat recovery, waste heat utilisation and energy conservation (e.g. heat to cooling, heat to electricity)

*Future development

METB CAPABILITIES

Maritime **E**nergy **T**est **B**ed: Providing appropriate testing conditions to overcome issues prior to onboard ship trial.

System Performance & Reliability Verification

- Complex matrix of pollutants
- Actual quantity & quality of waste heat
- Large amount of electricity available
- Measurable performance & reliability with minimum uncontrollable parameters
- Motion sensitivity

Safety Related Issues and Solutions

- Chemical handling, bunkering & storage
- Sludge handling
- Gases evolution

Assessment of Compliance

- Rules and regulatory compliance
- Overall environmental impact of the developed technologies

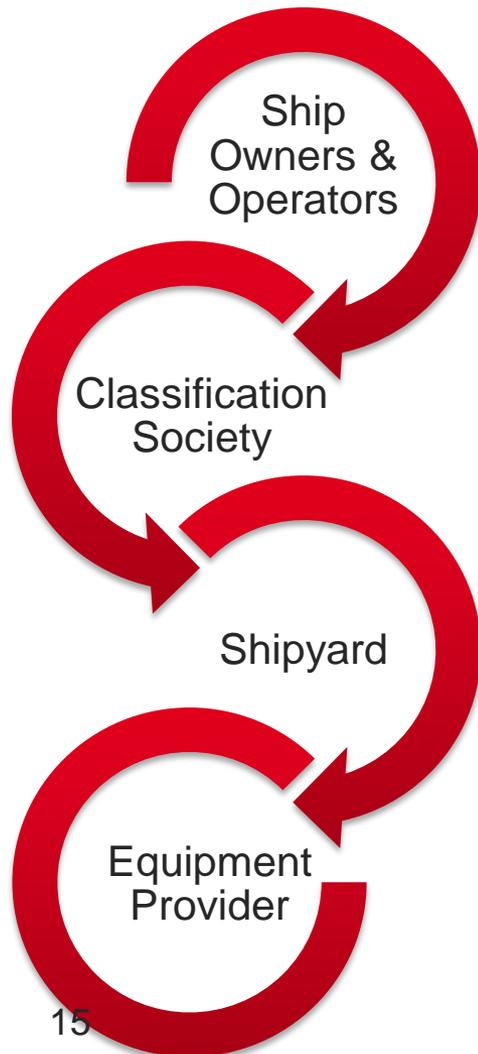
Engineering Related Issues and Solutions

- Scaling, corrosion, and biofilm
- Back pressure or other detrimental effects on engines
- Space and power requirement
- Installation
- Operating and maintenance

Economic Evaluation

- Overall CAPEX, OPEX and payback period

BENEFITS TO VALUE CHAIN



- *Potential end-users of green & smart technologies/ products* to be developed and/or tested (emission, heat recovery and alternative fuel) and/or potential users of the test bed
- *Keeping abreast in green & smart technologies* and help technology developers to overcome foreseen issues in terms of regulations, safety and environmental protection.
- Besides being a global leader in rigs and ships retrofitting, *shipyard will be able to expand its capabilities and services to be more competitive* in attracting customers to retrofit and install systems developed, consequently benefiting our *local suppliers* of shipyards.
- *Potential parties for technology Commercialisation*

MANPOWER DEVELOPMENT

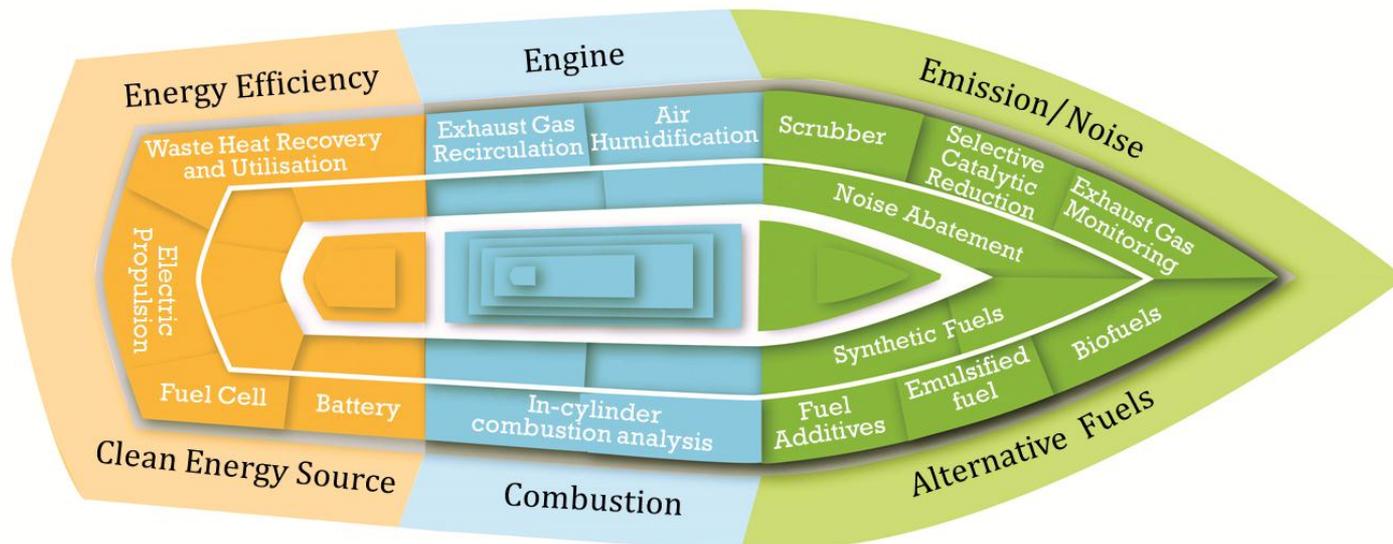
Maritime **E**nergy **T**est **B**ed: Manpower training with world-class R&D facility and projects

Manpower training and development in the following aspects:

- Testing and handling of green technology developed, including emission control system and equipment energy efficiency technology
- Understanding of concept, Ability to design & retrofit the technology developed onboard ships.

Knowledge and technology transfer:

- SMI Fellowship
- Collaborative projects (Industry and Institutes of Higher Learning)



LOCATION



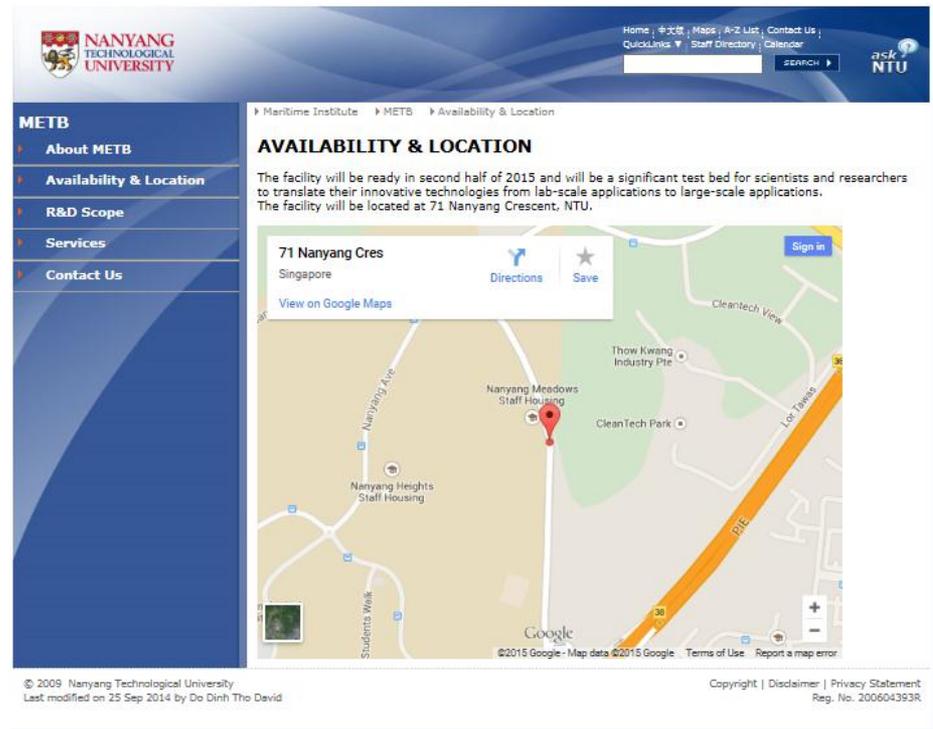
AVAILABILITY AND CONTACT DETAIL

To be ready by 2nd Q 2015

Open to all scientists and engineers from academia and industry for R&D in green & smart shipping technologies.

Website: <http://mi.ntu.edu.sg>

Email: metb@ntu.edu.sg



The screenshot displays the website for the Maritime Institute of Technology, Business (METB) at Nanyang Technological University. The page is titled "AVAILABILITY & LOCATION" and provides the following information:

- Availability:** The facility will be ready in the second half of 2015 and will serve as a significant test bed for scientists and researchers to translate their innovative technologies from lab-scale applications to large-scale applications.
- Location:** The facility will be located at 71 Nanyang Crescent, NTU.

The page features a Google Maps integration showing the location of 71 Nanyang Cres in Singapore. The map includes labels for "Nanyang Meadows Staff Housing", "Nanyang Heights Staff Housing", "CleanTech Park", "Thow Kwang Industry Pte", and "CleanTech View". The map also shows "Nanyang Ave" and "Lot 10000". The page footer contains the following text:

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THANK YOU