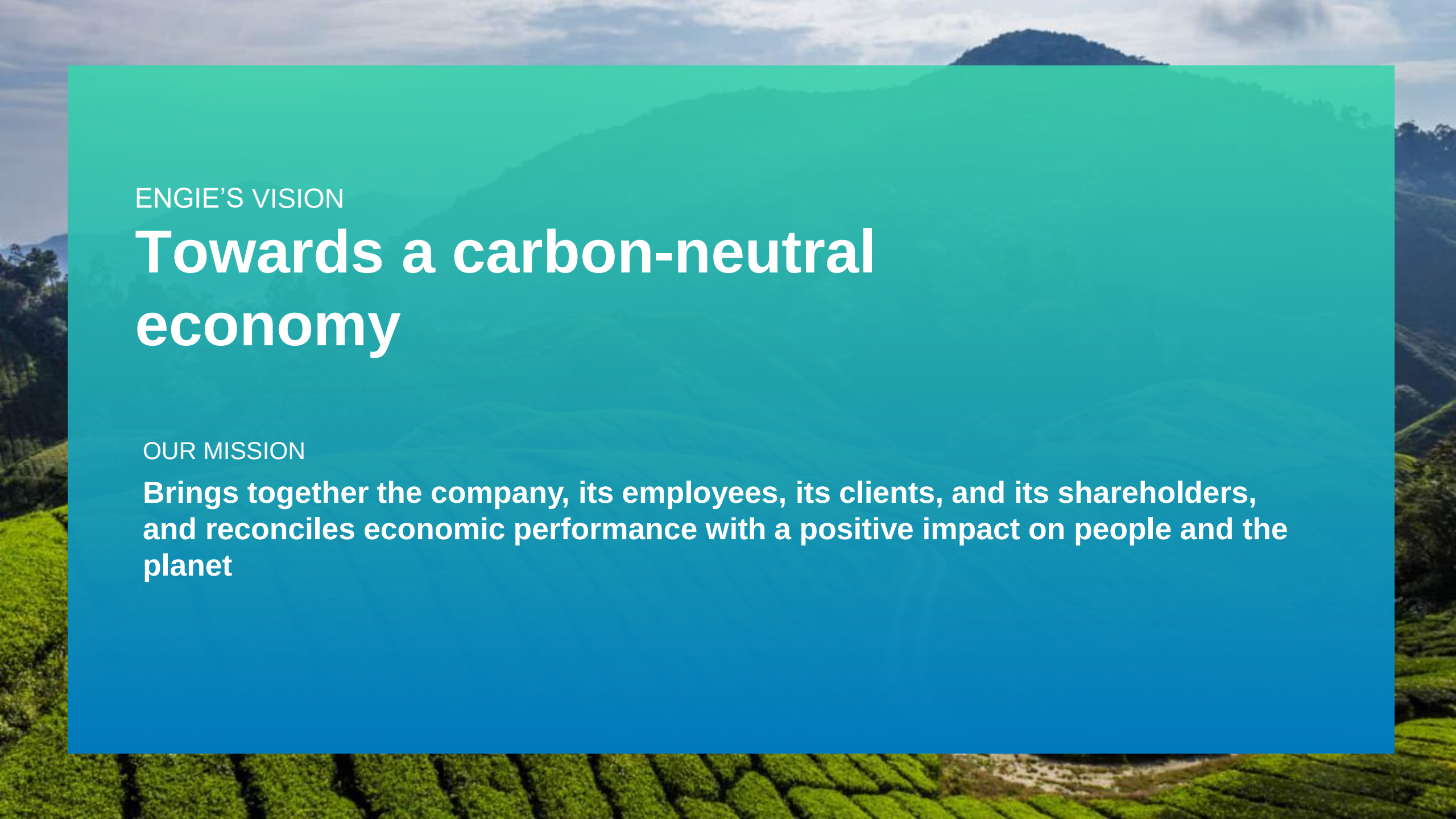
ENGIE Lab Singapore

The REIDS-SPORE Platform
One more step in ENGIE's R&D strategy in Asia-Pacific towards carbon neutrality

28 October 2020



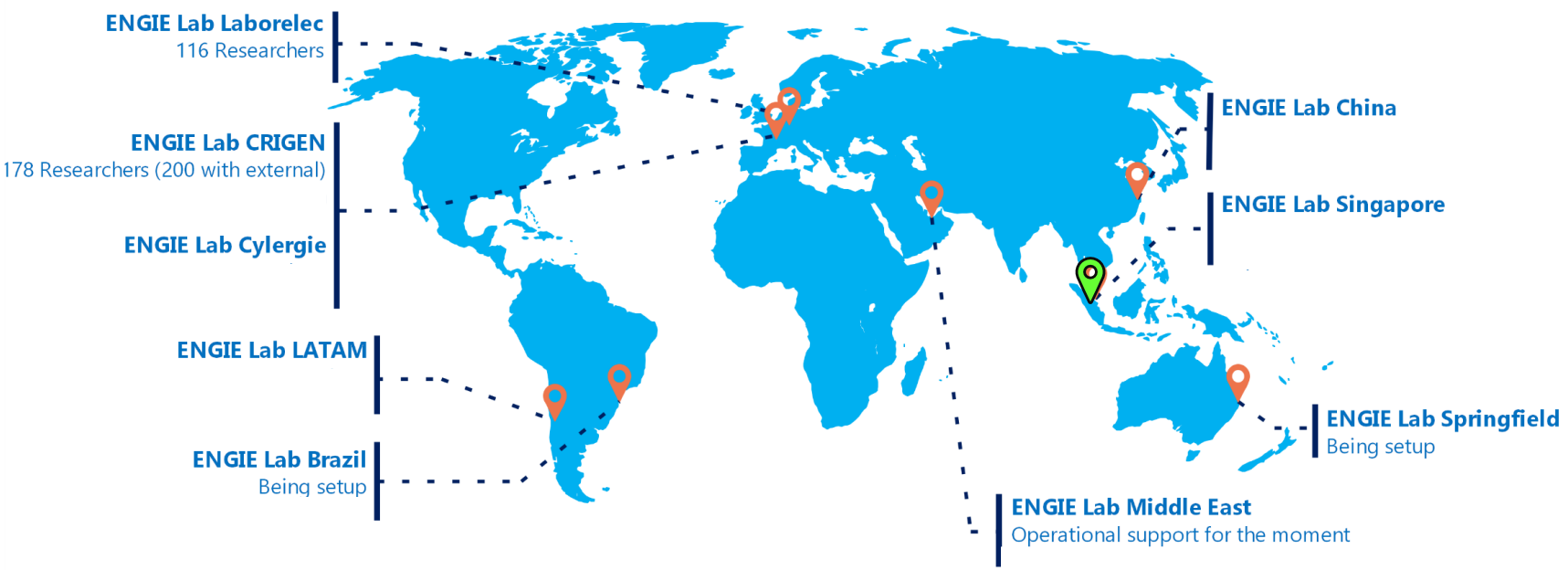
ENGIE’S VISION

Towards a carbon-neutral economy

OUR MISSION

Brings together the company, its employees, its clients, and its shareholders, and reconciles economic performance with a positive impact on people and the planet

ENGIE R&D NETWORK



190 million euros investment in research per year group-wide

8 research and development centres in **7 countries**

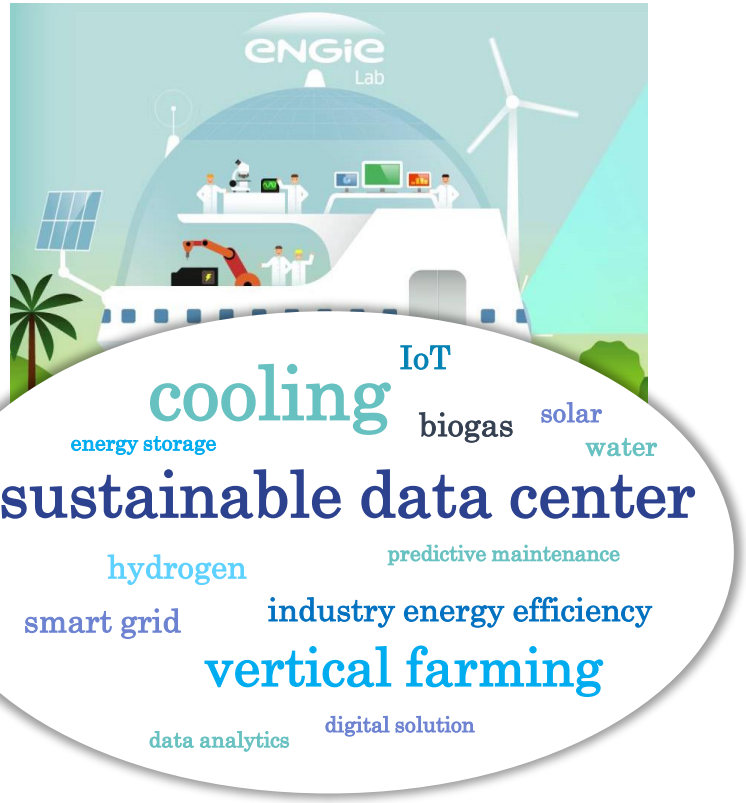
23 thematic research labs

900 researchers

10 patents filed in 2019

41 scientific articles published in 2019

ENGIE LAB'S MISSION



A Multi-thematic R&D Center

De-risk carbon neutral solutions and prepare the future

Improve connectivity with South East Asia research community

Contribute to develop local partnerships for ENGIE Research and ENGIE APAC

Pilot projects for tropical and urban environments

Improve business performance

SOME EXISTING R&D AND PILOTS

#Cooling

Name

Skycool

Type

Pilot

Partner

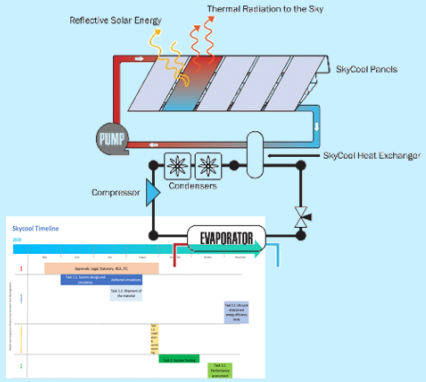
JTC
BCA (SG)

Duration

2019 – Now

Description

ENGIE Lab Singapore is leading a demonstration pilot in Singapore to validate its performances in the tropical environment for such passive cooling technologies.



#Cooling #GreenDataCenter

Name

Cryogenic Cogeneration

Type

R&D Lab Testing

Partner

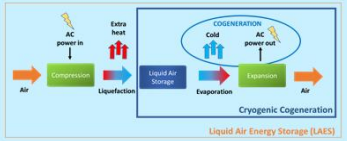
Nanyang Technological University

Duration

2018 – Now

Description

ENGIE Lab Singapore collaborated with NTU in developing the concept and prototypes of the technologies as well as conducting a techno-economic study for its market in green data center.



#MultifluidMulti-thematic

Name

REIDS-SPORE Platform

Type

Pilot

Partner

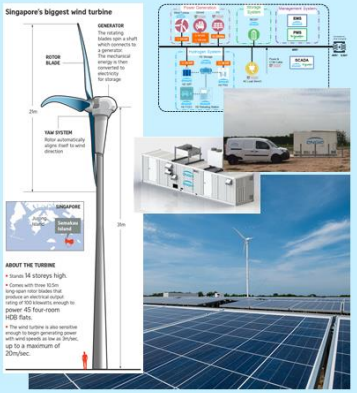
Nanyang Technological University

Duration

2016 – Now

Description

REIDS-SPORE is a multifluid (electricity, hydrogen) and multi-topic (electrical, hydrogen, water, wind, solar, cybersecurity, etc.) platform which is built on Pulau Semakau, Singapore.



REIDS-SPORE Project

ENGIE’s SPORE Microgrid under the “Renewable Energy Integration Demonstrator – Singapore” Initiative

HOW IT ALL STARTED

2016

Official launch of ENGIE Lab Singapore and SPORE

2017

Concluded procurement

Shipment of all assets to Pulau Semakau

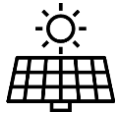
Installation of the biggest wind Turbine in Singapore

2018

SPORE partial commissioning

2019

New R&D pilot



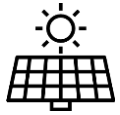
H2 full chain partial commissioning

General Smart grid R&D study

2020

SPORE partial commissioning

Launch of Lab services



Installation of H2P2P

Now

Official inauguration of REIDS-SPORE

WHAT MOTIVATED THE PROJECT?

- The expected increasing global electricity demand
- Challenges such as aging or missing networks
- The ambition for a carbon free future
- The growing number of users of the global electrical infrastructures
- The high cost of energy
- Energy digitalization for smarter control and optimization features

In a giant leap towards this goal:

EDB singapore

Economic
Development
Board
Of Singapore

Launched the **REIDS (Renewable Energy Integration Demonstration Singapore)** initiative. A program to set-up a **state-of-the-art multi-fluid microgrid solution**.

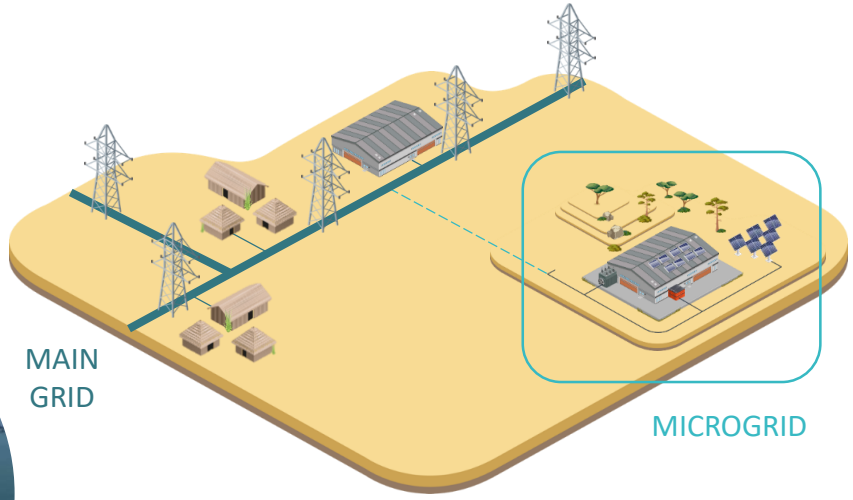
In collaboration with

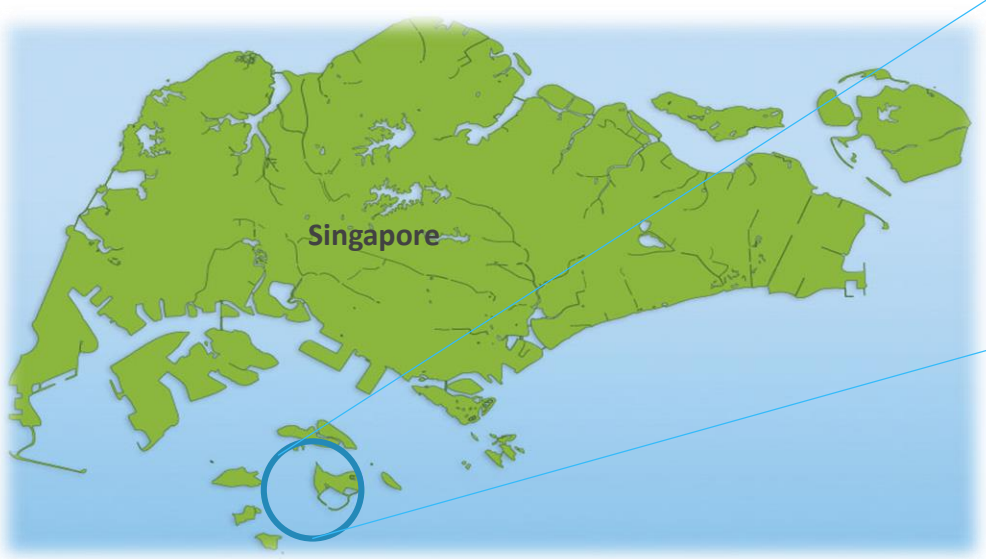
ENGIE

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

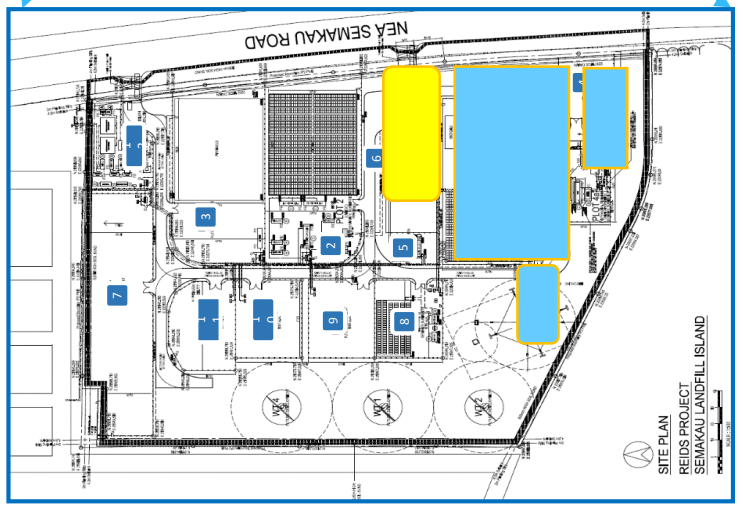
Schneider Electric

WHERE IS THE PROGRAM INSTALLED?





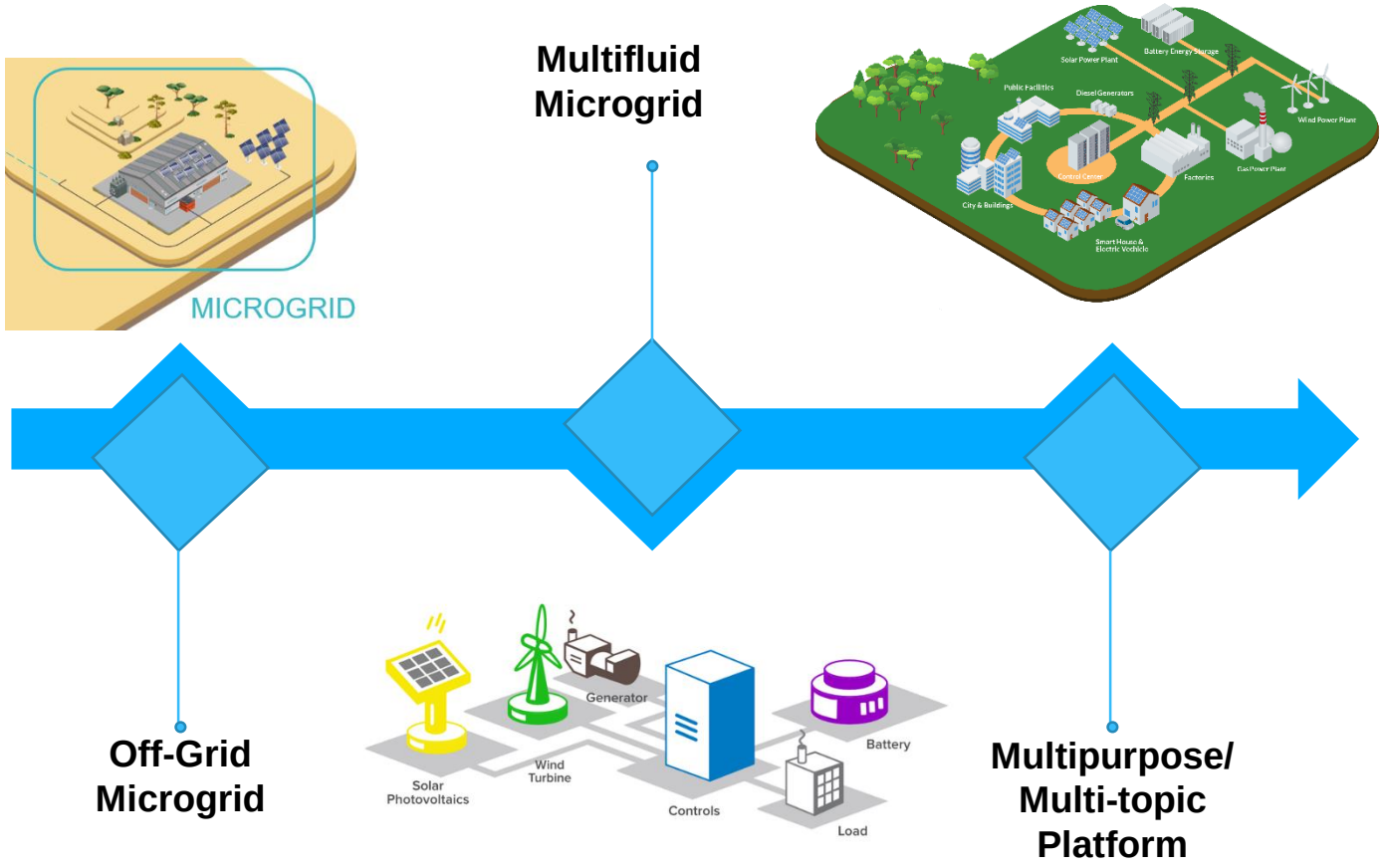
ENGIE's SPORE microgrid is the biggest of the potential 8 microgrids (3 others already existing) in REIDS. And the global objective of the REIDS platform will be to interconnect all the microgrids to emulate future distributed energy scenario.



REIDS Hub

MG1 – ENGIE SPORE

STAGES OF THE REIDS-SPORE PLATFORM



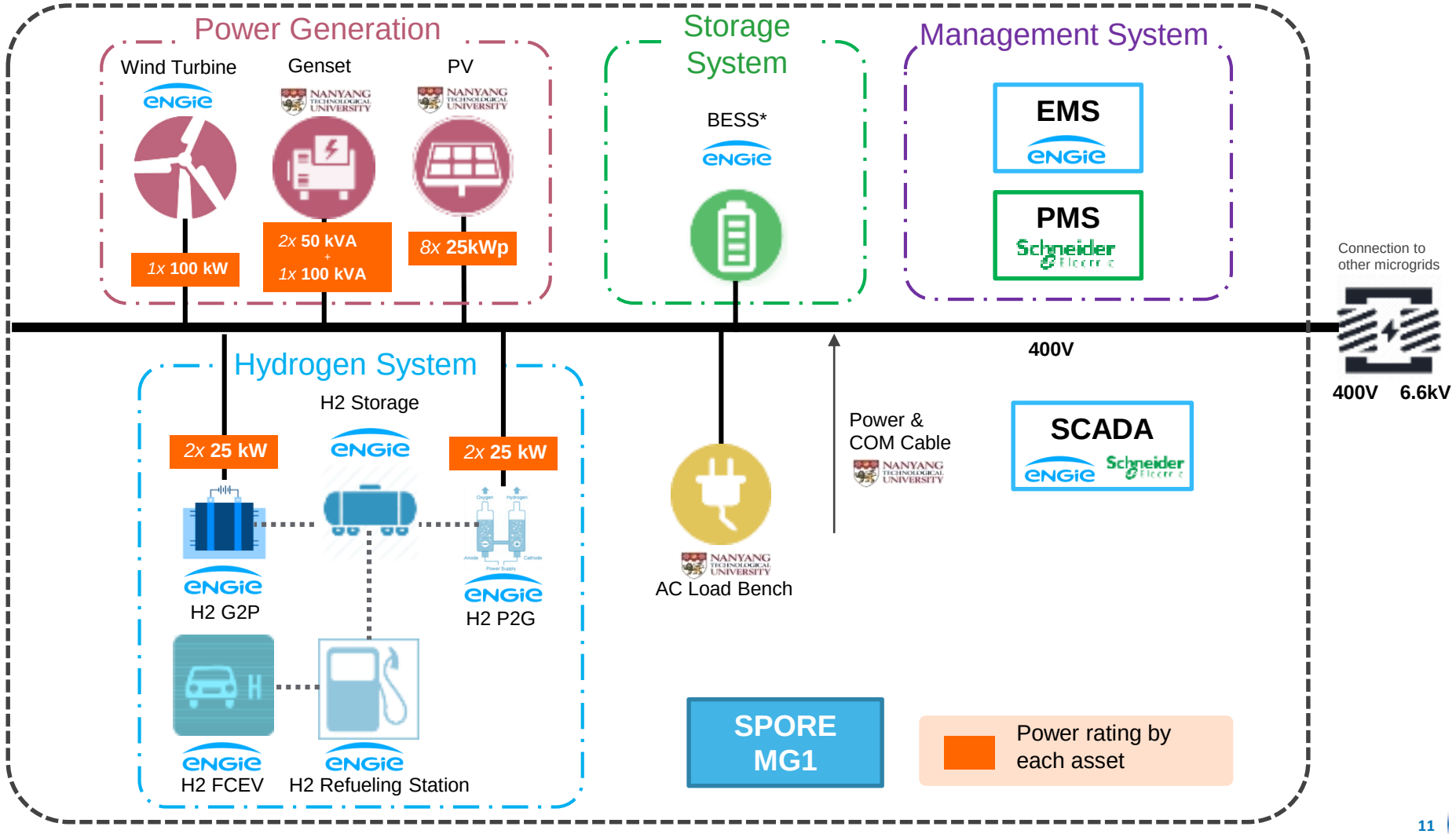
GLOBAL VIEW OF THE ASSETS – THE SPORE MICROGRID SLD

Peak power production on the site

around
550 kW

* BESS is still under further study as safety vs. site condition on Semakau requires additional effort to ensure group HSE policy.

** Logos beside the assets represent asset ownership only. The whole grid O&M is managed entirely by ENGIE.



POWER GENERATION : WIND TURBINE

The technology:

- An **M-21** wind turbine of **100 kW**, producing between **250 and 450 MWh/year** and provided by ENGIE.
- **Innovative winch design** to lower the wing turbine and **downstream blades**

The benefits:

- Reliability: designed to reduce the risk of failures especially in the tropical conditions since it can withstand CAT4 and CAT5 hurricanes
- Easy transport: fits in one 40 feet container
- Easy maintenance: can be erected with a lift-up system
- High yield: One of the highest Annual Energy Yield in the market

- **ENGIE Services** was the main contractor for the WT Erection.

BACK UP GENSETS

- 2 gensets of **50 kVA** and **1 of 100 kVA** provided by **NTU**.
- The ultimate goal of SPORE is to demonstrate that **100% renewable microgrid is possible**. But gensets were set up in order to demonstrate the **scalability** of the solution for brown field situations.
- Part of the used cases consist to switch from pure genset (which is the most common way of producing electricity today in South East Asia and Pacific islands) to progressively 100% of renewable energy.

IMPLEMENTATION: PV PANELS

- **The technology:**

- Model: Rec Peak Energy Series panels. REC combines leading standards of design and manufacturing to produce high performance solar panels with uncompromising quality.

- Grid-tie PV string inverters, built and provided by Schneider Electric, were designed for tropical humidity and heat conditions. These inverters are not able to act as voltage sources i.e. grid-forming DER for the grid. However, combined with the PMS algorithms and other grid-forming entities, they are able to maximize PV penetration within the microgrid up to 100%.

Some Key Figures
16.1% Efficiency
260 Wp Nominal power – PMPP

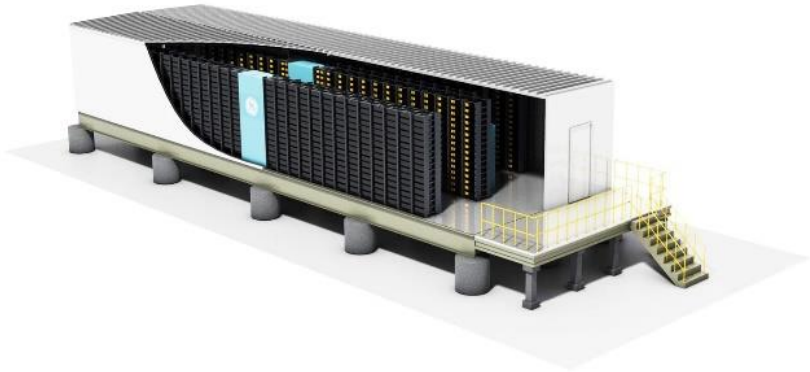
60 multi crystalline cells with bypass diodes between the strings

IMPLEMENTATION: BATTERY ENERGY STORAGE SYSTEM

The Battery Energy Storage System: A technology to be developed to test the storage of electricity by using specially developed batteries. Such stored energy can be utilized at a later time.

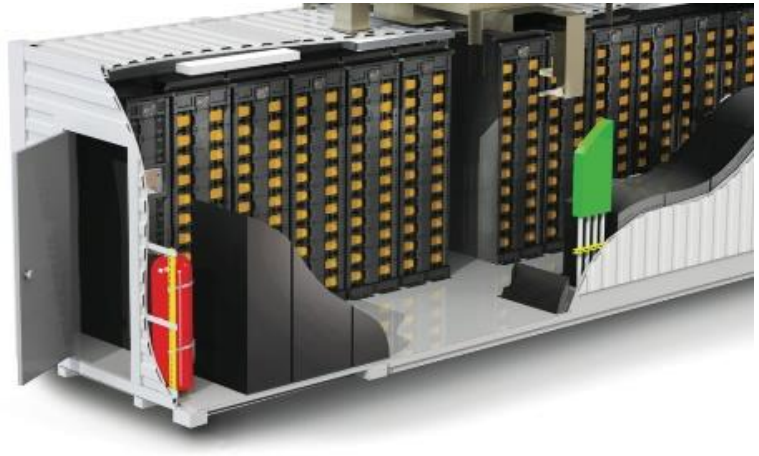
Benefits:

✓Small footprint
✓No restrictions on geographical locations that it could be located in
✓Can offer high energy and high power densities suitable for utilizing at distribution transformer level



Some characteristics:

Frequency regulation: Charges and discharges in response to fast increases or decreases in load to maintain balance between supply and demand
Energy density: The amount of energy that can be stored for a given amount of area, volume, or mass
Power density for the delivered power

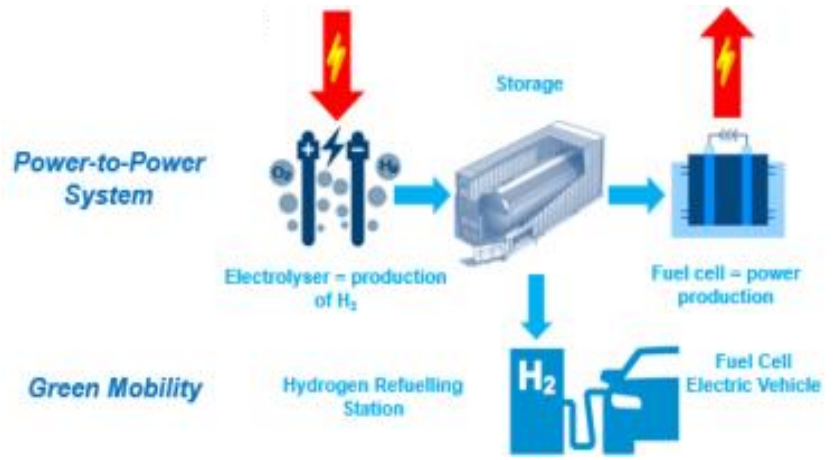


IMPLEMENTATION: H2 CHAIN

The H2 Chain Consists of:

- **An H2 power-to-power (P2P) system,** serving as an energy storage system (ESS) similar to a traditional battery ESS
- **An H2 refueling station (HRS)**
- **And a fuel cell electric vehicle (FCEV)**

The H2 Chain of the SPORE microgrid aims to demonstrate the use of H2 in a distributed manner offering various additional services rather than energy storage only.



IMPLEMENTATION: H2 CHAIN

1) H2 P2P

Hydrogen is the most abundant element in the universe. Naturally present in atmosphere, it can also be easily produced from water through electrolysis.

The containerized P2P solution consists of the following components aside from the H2 and O2 container-size tanks:

- **2x 25kW P2P Modules:** Vertical integration of three modules; the Power-to-Gas, the Gas-to-Power and the DC/DC converter modules
- **The QAux:** a cabinet that provides power supply and the management of the modules and the auxiliary systems of the container like lighting or thermal management

- **The Purification systems:** a 12 Nm3/h Hydrogen purification system with 3 main functions (purification, deoxying, drying)
- **The PCS (Power Conversion System):** A 70kVA C-BESS70 supplied by Electro Power Systems
- **The demi plant:** to demineralize water system.

IMPLEMENTATION: H2 CHAIN

2) HRS

An HRS serves the purpose of compressing and dispensing the large storage of hydrogen to other usages such as fuelling a hydrogen powered vehicle.

The technology:

- ✓ Model: McPhy McFilling 20-350;
- ✓ Hydrogen compression, storage an distribution to vehicles up to 350barg.

Some key figures:

- ✓ High Pressure Buffer: 11.2 kg
- ✓ Flow rate: 24Nm2/h
- ✓ Nominal pressure: 420 bar

The benefits:

- ✓ Enables power to mobility;
- ✓ Up to 20 vehicles refilled per day (refills each car by only 5 minutes);
- ✓ Corner stone of the multi-fluid aspect of the microgrid.

IMPLEMENTATION: H2 CHAIN

3) Fuel Cell Electric Vehicle

The FCEV is an EV with a hydrogen extender. It's a light good vehicle, and is meant to demonstrate the multi-application from a multifluid microgrid.

The technology:

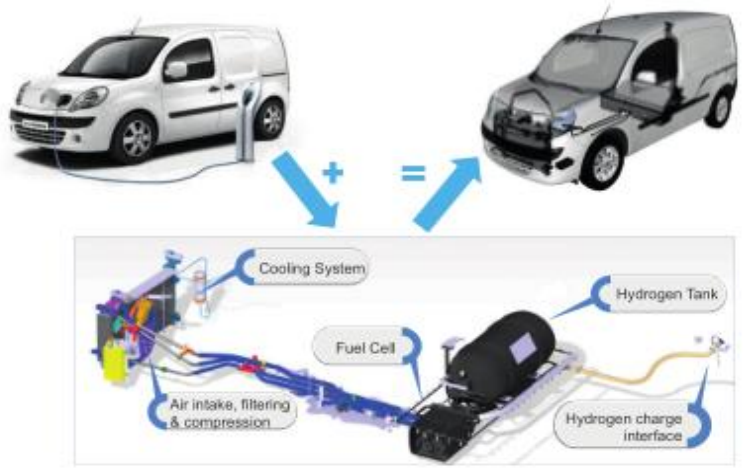
- ✓ Renault Kangoo Z.E = Electric Vehicle
- ✓ Modified by Symbio Fcell to add a Fuel Cell = battery extended with Hydrogen

Some key figures:

- ✓ Power: 44kW/70HP
- ✓ Tank size: 74L
- ✓ Working pressure: 350barg

The benefits:

- ✓ Enhanced cars range: battery recharged by the Fuel Cell, refilled in less than 5 minutes for 200km autonomy
- ✓ Green mobility: reduce the CO2 footprint



MANAGEMENT SYSTEM

EMS Energy Management System

- **Optimizes** the usage of different assets in the microgrid with the goal to provide **affordable, reliable energy** with a **low environmental impact**
  - A mid-term layer: aims to maximize the lifetime of the assets too and reduce the equipment/maintenance cost
  - A short-term layer: focuses on intraday optimization and deals with real time fluctuations to maintain the magnitude and the frequency.

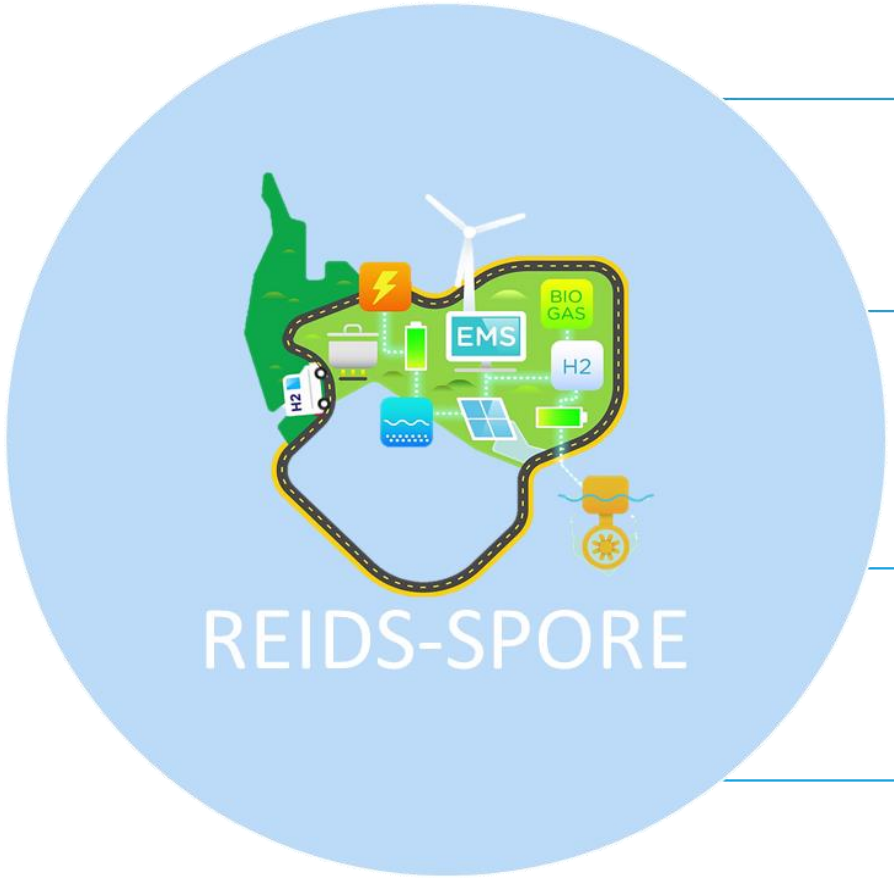
PMS Power Management System

- Real-time power control module in the solution enables to orchestrate the decentralized energy resources in order to :
  - Ensure the **stability** of the microgrid through a balance of active powers for the frequency stabilization and reactive powers for the voltage
  - **Accommodate** optimization set-points from the EMS module to respect operational constraints around each DER.

SCADA by

- To **visualise**, **interact** and **monitor** the good performance of the microgrid.

FUTURE PLANS



Site visit and Showcase

Solution Site Test Bedding

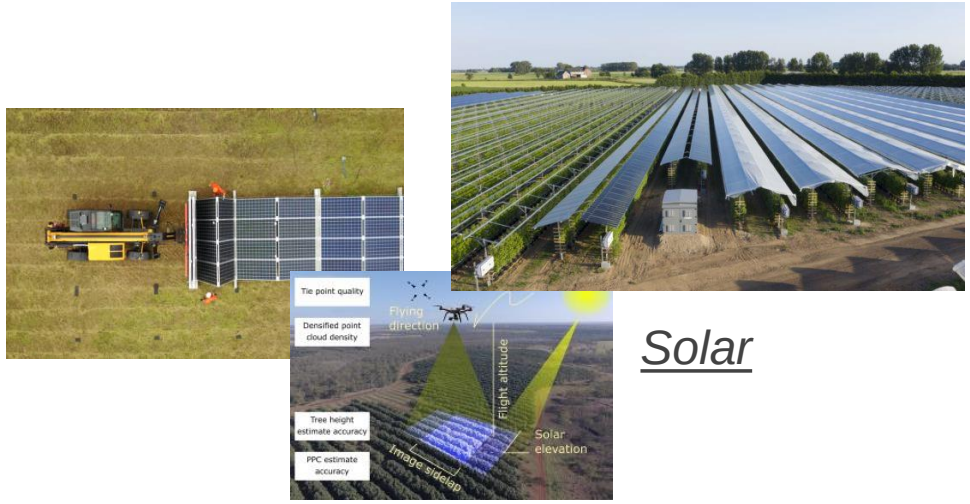
Offsite and Onsite Training

Data

FUTURE PLANS – TEST BEDDING

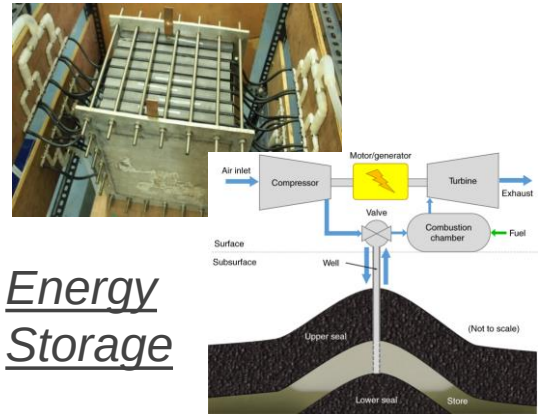
The platform is a living lab to:

- Demonstrate and showcase different technologies
- Test different technologies in tropical conditions
- Validate different technologies utilizing existing assets
- Benchmark digital solutions for energy systems

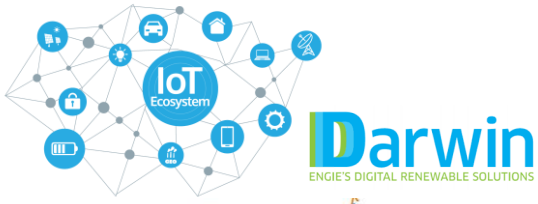


Solar

Other Utilities



Energy Storage



Digital

Others

FUTURE PLANS – TRAINING

ENGIE LAB SINGAPORE
5- YEAR ROADMAP

NEW R&D FOCUS AREAS FOR ENGIE LAB SINGAPORE

Thematics 2016-2020

Smart Grids

Future Cities

Future Industry

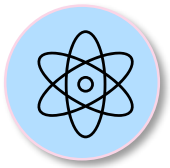
New R&D focuses 2021-2025

Sustainable Data Center

Cooling

Technical Consultancy

Industry Energy Efficiency



Other Energy Related Topic

SUSTAINABLE DATA CENTERS

01

Design and Operational Excellence

- Alternative cooling technologies
- Waste Heat Recovery from Data Centres
- Cybersecurity of OT Systems

02

High Availability Green Energy Supply

- 24/7 green energy supply
- DC or AC/DC hybrid data centre
- Green backup solutions
- Liquid Air Energy Storage

Market Study | Techno-watch/ Benchmarking | Technical/ Case Studies | Tool Development | POC | Showcase

COOLING

Production	1	Low carbon cooling systems for energy efficiency and indoor thermal comfort	Enabling CAPEX and OPEX reductions for low carbon cooling technologies and mastering hybrid technologies to offer comfort contracts
Storage	2	Thermal Energy Storage technologies to optimize cooling systems capacity	Developing / improving cooling storage and recovery technologies with better cost efficiency for ENGIE to integrate in its C&I offer
Distribution	3	Technologies and materials to reduce thermal losses of cooling installations	Understanding the economic impact of distribution losses and mastering technologies to reduce these thermal losses
Optimization	4	Digital and IoT solutions for connected and smarter cooling installations	Enabling better maintenance, monitoring of cold production assets as well as cold exchanges by bringing digital and IoT solutions to maturity
Urban planning and design	5	Technologies and methodologies to reduce cooling needs and urban heat islands	Mastering methodologies, tools and technologies to understand and mitigate Urban Heat Islands and improve outdoor thermal comfort.

#ActWithENGIE

Let’s work together towards a Carbon-neutral Economy