Cooling Energy Science and Technology Singapore (CoolestSG)

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Motivation: Meeting Challenges, Seeking Energy Efficient Solutions

1. Responding to increasing need to cool and the need to do it sustainably, mitigating the effects of rising urban temperature and global warming

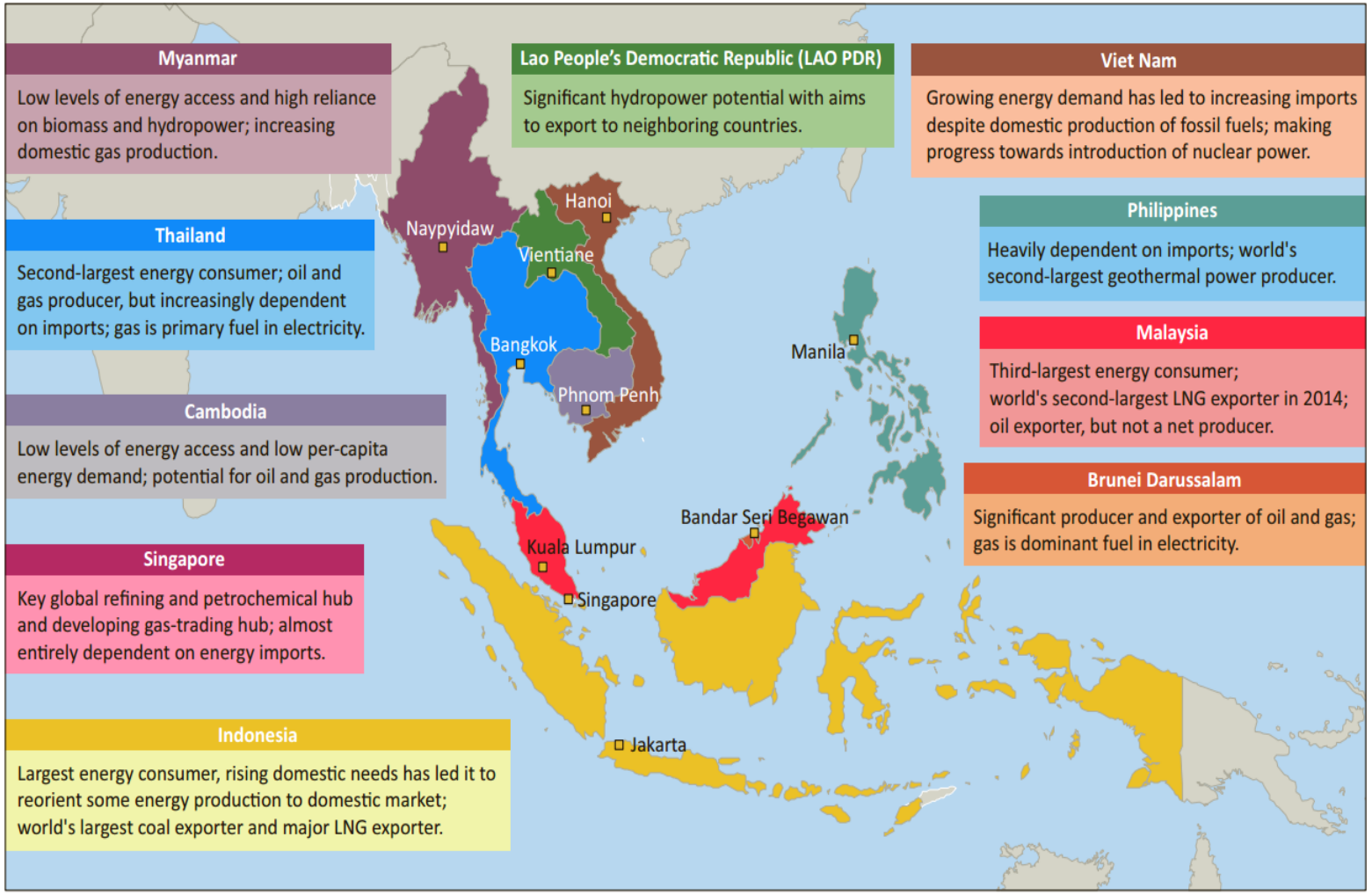
2. Closing the innovation gap through inter-disciplinary cross fertilization of ideas and expertise

3. Unlocking pathways leveraging clean and renewable energy, AI and digitalization so as to seize opportunities beyond our borders

4. Strengthening human capital in cooling energy science and technology

Southeast Asia Energy Landscape

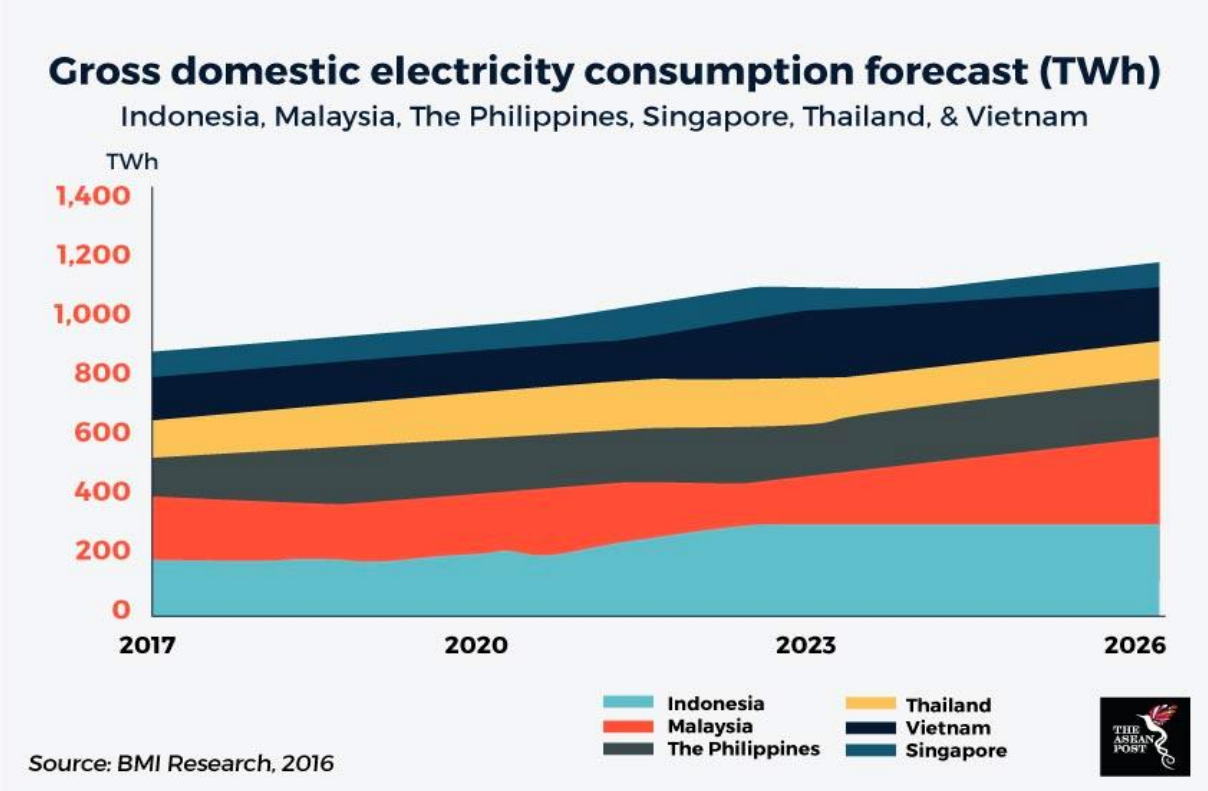
Southeast Asia Energy Landscape



Source: IEA

Cooling a major driver for electricity consumption

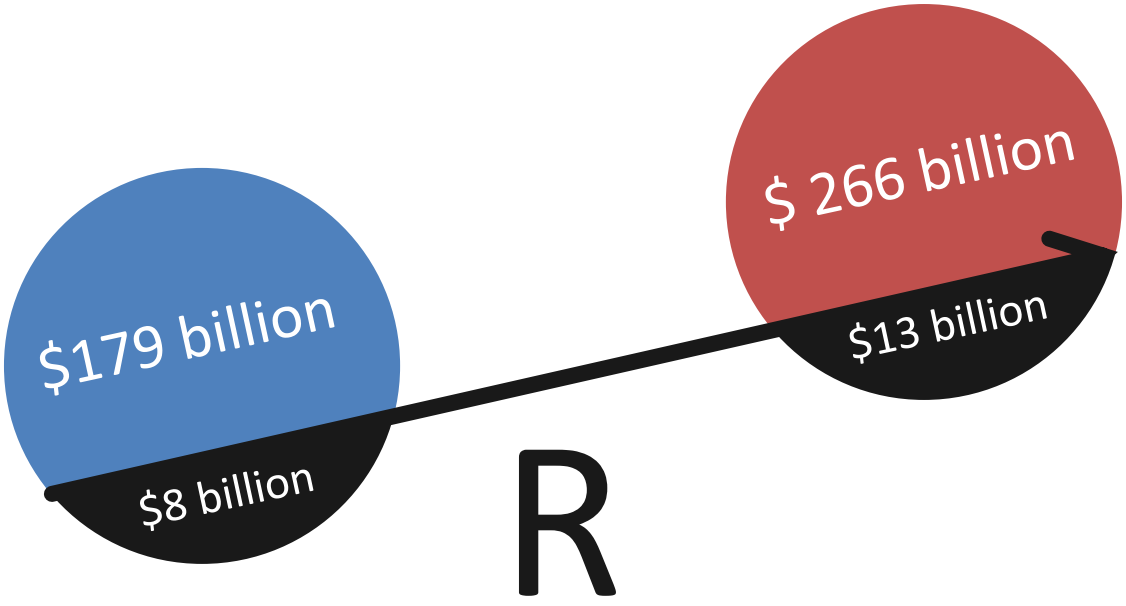
- 60% of electricity usage in Southeast Asian cities is attributable to use of air-conditioning.
- By 2040, air-conditioning could account for 40% of Southeast Asia's electricity consumption.



Source: ACE

HVACR Market up to 2023

2017
SEA occupied 4% global HVACR market share



2023
SEA is projected to occupy 5% global HVACR market share

Source: Various market research companies

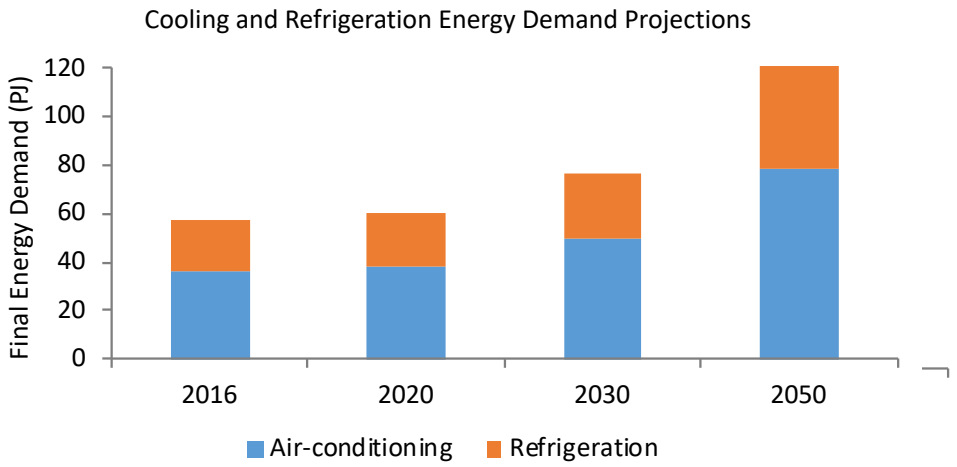
Global CAGR of 7%
SEA CAGR of 9.3%

Refrigeration and cooling energy demand projections

Industry: 5%

Building: 43%

Residential: 37%



Economy-wide Final energy consumption: 5%

Economy-wide electricity consumption: 35%

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Growing Trend for Cooling Demand

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1 **Increasing demand for cooling in Singapore:**

Cooling Energy consumption	385,000 TJ (2010)	73 % ↑	667,000 TJ (2030)

Singapore has the *highest per capita* installed rate of air-conditioning among ASEAN member states.

2 **Increasing demand for cooling in ASEAN:**

Air-conditioning electricity demand	25 % (current)	→	40 % (2040)

Meeting future cooling demand - Not "cool" without energy efficiency

Reference:

https://www.todayonline.com/commentary/high-time-singapore-does-something-about-its-inefficient-reliance-air-conditioning

https://www.imda.gov.sg/-/media/imda/files/about/media-releases/2017/annex-a---fact-sheet-for-high-rise-green-dc.pdf?la=en

Existing Overall National Targets

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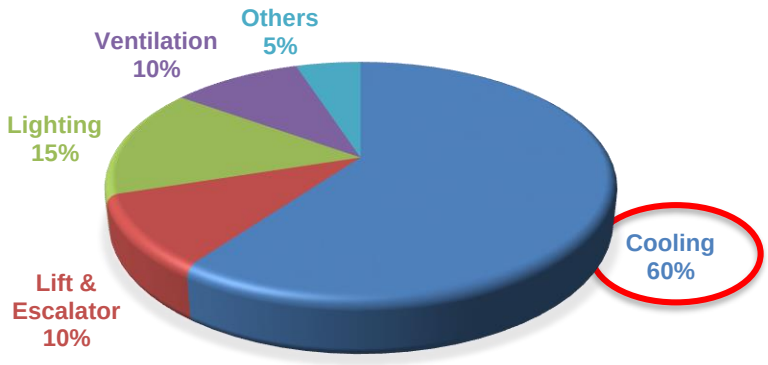
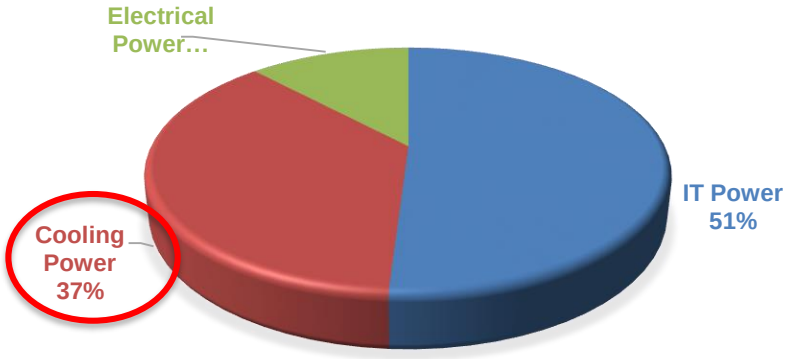
Buildings — BCA's targets

- 60%-80% more energy efficient over 2005 levels by 2030.
- Achieving super low energy
  (Positive Energy low rise, Zero-Energy mid rise, Super Low Energy high rise buildings)



Data Centres — IMDA's targets

- Achieving design Power Usage Effectiveness (PUE) of 1.2
- Reduction in overall energy consumption through Smart data center solutions
- Operate reliably and energy efficiently in a higher temperature environment



Significant Investments Made Towards Cooling R&D

Efforts on Addressing Energy Efficiency of Cooling can Help Achieve National Targets

Reference:
https://www.nccs.gov.sg/resources/technology-roadmaps

BCA Green Mark Scheme

Green Mark	Try Again	Certified	Gold	GoldPlus	Platinum
Score	0 – 49	50 – 74	75 – 84	85 – 89	90 – 100
Estimated Energy Savings		10% to 15%	15% to 25%	25% to 30%	> 30%

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Evolution of Green Mark Schemes

Ver. 1 (yr 2005)

- New Building Criteria
- Existing Building Criteria

Ver. 2 (yr 2007)

- New Building Criteria (v2)
  - Air-conditioned building
  - Residential building
- Existing Criteria (v1)

Prerequisite: For Gold^{plus} and Platinum Rating
1.Energy-modeling (For new buildings)
2.NEA's Energy Smart (For existing buildings)

Ver. 3 (yr 2008)

- New Building Criteria (v3)
  - Residential building
  - Non-residential building
- Existing Criteria (v2) (current version 2.1)

Prerequisite: For Gold^{plus} and Platinum Rating

1. **Energy-modeling (For non-residential air-con building)**
2. **Ventilation Simulation OR Wind Tunnel Testing**
3. **NEA's Energy Smart (For existing buildings)**

Ver.4 (Dec 2010)

- New Building Criteria (v4)
  - Residential building
  - Non-residential

1. **Advocate Passive Design**
   - **Natural Ventilation**
   - **Daylighting**
2. **Promote Sustainable Construction**
3. **Greater Emphasis on Greenery**
4. **Enhanced pre-requisites for higher GM ratings**

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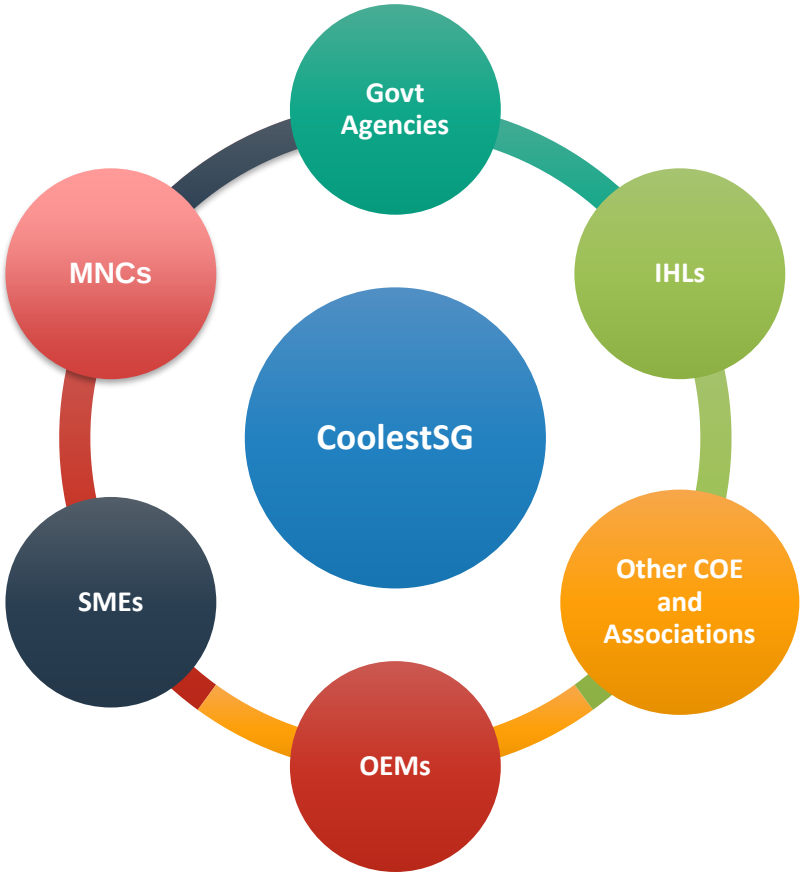
About CoolestSG



CoolestSG: "A synergistic platform to *accelerate* cooling integrated design and technology development, and promote technology transfer by *bridging the gap* to commercialisation."

CoolestSG Mission

Provide a Framework

for IHLs, agencies and Industry to collaborate on integrated design, technology development, transfer, and commercialization, and venture development

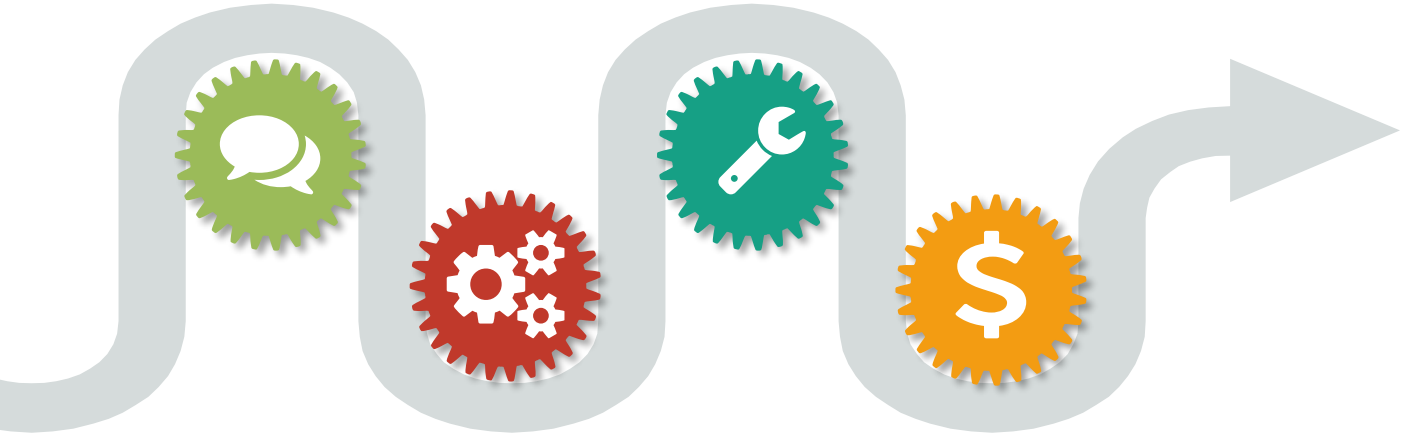
Develop Human Capital

to meet Singapore's future energy manpower needs

Research, Develop and Demonstrate

energy efficient cooling systems and technologies

CoolestSG Framework



Training of Manpower

Cooling Domains

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Commercial Buildings

Residential Buildings

Data Centres

Power Plants

Manufacturing Plants

Identified Topics from Industry Roundtables

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Cooling Solutions in Diverse Sectors*

Energy Efficient Cooling Systems*

- Fresh Air Treatment
- Thermal Energy Storage
- Data Centres Cooling
- Passive Displacement Ventilation
- Sustainable Facades
- Digitalisation and AI Enabling
- Measurement and Controls

Tropical Cooling Technologies*

- Indirect Evaporative Cooling
- Radiant Cooling
- Dehumidification (Membrane/Desiccant)
- Smart Thermostats
- Cool Paints and Solar Films

***Non – Exhaustive list**

Partners* Across the Value Chain

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Outreach

In collaboration with ASHRAE Singapore Chapter, BCA, IMDA

Domain Expertise

NUS, NTU, A STAR RIs, CREATE Centres, EWTCOI*

Enterprise

*Industry Translation Partnerships (*Start-ups, SMEs, MNCs)*

Agencies

NRF, BCA, EMA, ESG, etc.

IEO offices

*NUS ILO, NTUitive, A*STAR ETPL*

***Non – Exhaustive list**

Consortium Members* Across the Value Chain

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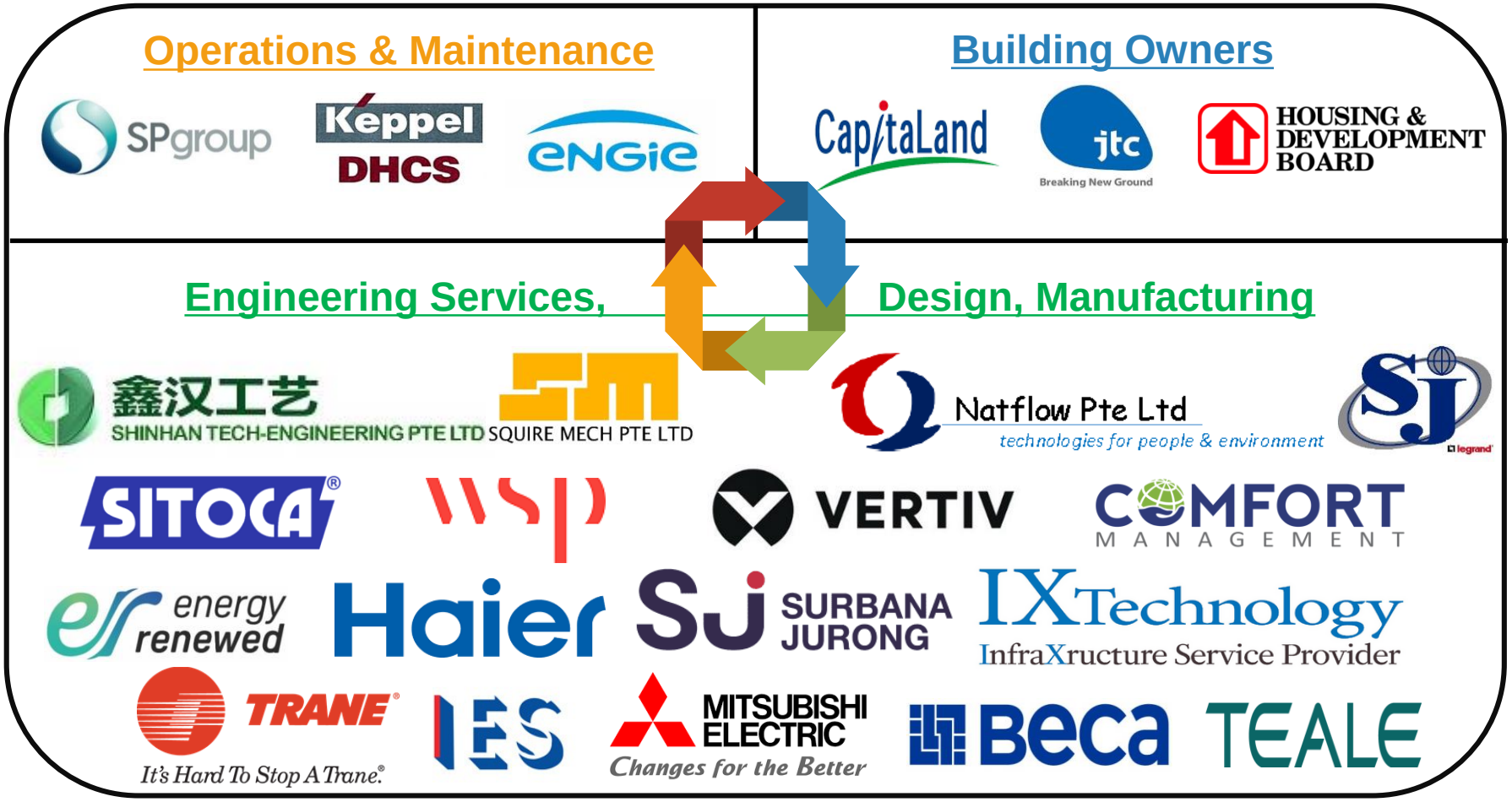

Focusing on the entire value chain to translate and accelerate technologies to market.

*Non – Exhaustive listing

Global Network of Domain Expertise

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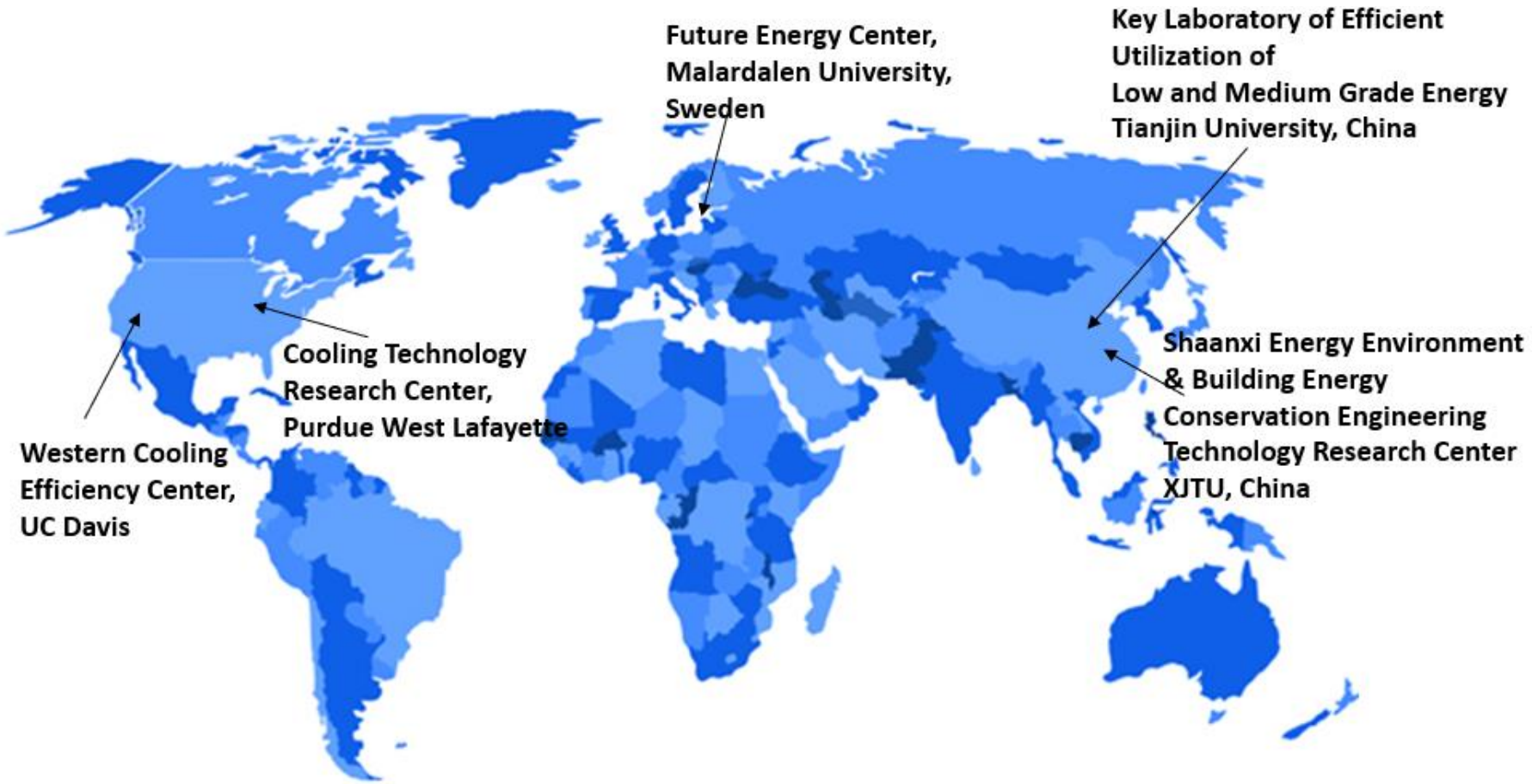

Access to Cutting Edge Cooling Technology Globally

Commercialization

- Accelerate translation of R&D outcomes to I&E value creation
- Licensing, Startups, etc.
- Technology – Offers

In Partnership with IPI

Member Directed Projects

- One-to-one project
- Leverage on existing funding programmes

Seed Projects

- Pre-competitive work
- Shared risks & results
- Co-funded from membership fees

Membership Fees

Potential Projects

- Fresh air treatment
- Passive displacement ventilation
- Data centre cooling with load matching and variable capacity
- Thermal energy storage and PCMs
- Low grade heat recovery for cooling and power
- Cooling and heating with natural refrigerants
- Sustainable facades
- Smart thermostats for energy efficiency improvement
- Metering, interconnection and smart control systems
- I-O-T enabled energy saving cooling

Access to Funding

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Catalysing **Public-Private Partnership,**
Leveraging **on existing funding programme**

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- **NRF – Central Gap Funds**
- **A*STAR – Industry Alignment Fund (IAF)**
  Industry Collaboration Projects (ICP)
- **BCA – Green Building Innovation Cluster (GBIC)**
- **MND – Cities of Tomorrow (CoT)**
- **IMDA - Green Data Centre Innovation Programme**

***Non – Exhaustive list**

Upcoming Events

1. Focus group discussions on seed projects, collaboration and manpower development

2. Workshop on measurement and verification

3. Seminar on the use of natural refrigerants

4. Seminar on data centre cooling and standards

For more info, please contact
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