ENERGY-EFFICIENT COOLING FOR THERMAL COMFORT

CONTEXT

Energy efficiency in the manufacturing industry has become a significant area of focus in recent years, primarily driven by increasing concerns about climate change and the escalating costs of energy. However, many manufacturing companies are housed in old plants with existing Air Conditioning and Mechanical Ventilation (ACMV) systems which are not as energy-efficient and pose challenges in introducing energy efficiency intelligence in existing building management systems (BMS).

The challenge owner is a global manufacturer of flavours, fragrances and cosmetic ingredients with a heritage of over 250 years. In Singapore, their customers are mainly in the food industry, spanning across key segments including beverages, sweet goods, savoury goods, snacks, and dairy. Besides innovation in their core businesses of scents and tastes, the challenge owner is also committed to innovating sustainable solutions for long-term growth.

The challenge owner's plant in Singapore is more than 30 years old and is using an old centralised ACMV system. Comprising of three blocks for administrative offices, production and labs, each block of the plant is served by individual Air Handling Units (AHUs) that are controlled manually. Only the chiller has recently been replaced with a newer system and is able to collect data on the cooling load and energy consumed for tracking purposes, while the other parts of the ACMV are not energy-efficient (e.g. belt-driven ventilation fans), resulting in high energy costs.

To reduce their operational costs and carbon footprint, the challenge owner has made efforts to increase energy savings, including setting the air-conditioning to a thermal comfort temperature of 23 degrees Celsius across all blocks and areas, running the air-conditioning for 12 hours a day instead of round the clock, and training staff to be aware on energy savings. They are also looking into replacing their belt-driven fans with direct current fans that have higher energy efficiency. However, these efforts have not been able to sufficiently reduce energy consumption to meet their sustainability targets.

Hence, the challenge owner is looking for an Energy and Climate Management System (ECMaS) that can optimise ACMV control settings dynamically based on the thermal loading[1] in the building. This will result in maximising energy savings while still delivering human thermal comfort in accordance to (ASHRAE-55 / ISO 7730 standards), with the overall aim to reduce operational costs and contribute towards a more sustainable future. The data collected by the solution on thermal loading and energy usage can also be used to identify trends and help to inform long-term planning of energy management strategies and potential process improvements to improve sustainability in the manufacturing sector as a whole.

This sector-wide challenge is supported by the Advanced Remanufacturing and Technology Centre (ARTC), as part of the A*STAR Advanced Manufacturing Startup Challenge 2023, focused on the theme of "Sustainability". ARTC is led by the Agency for Science, Technology and Research (A*STAR), in partnership with Nanyang Technological University Singapore. ARTC's expertise in advanced manufacturing and remanufacturing accelerates the transfer of innovation from applied research to industrial applications and solutions, building capabilities through collaboration with their industry members. A*STAR aims to catalyse startup challenge winners to co-innovate and co-deploy advanced manufacturing solutions through ARTC's consortium.

[1] Thermal loading is the amount of heat energy generated within the system boundary from sources such as humans, lighting, machines, electronics etc.

PROBLEM STATEMENT

How might we optimise energy efficiency in air-conditioning for thermal loading, while still delivering thermal comfort?

WHAT ARE WE LOOKING FOR?

The challenge owner is looking for a startup to work with A*STAR to develop a smart solution that can detect and determine thermal loading within the plant and use recommended control settings to optimise energy usage while prioritising occupant well-being. As far as possible, the solution should work with the existing ACMV system and AHUs to maximise energy efficiency, without a need to replace/redesign the entire system.

The solution should meet the following criteria:

- <u>Sensor implementation and database consolidation</u>
  - Thermal loading identification through human detection and temperature sensors.
  - Data capture of humidity, temperature and air speed/flow rate of indoor ACMV through sensors.
  - Data capture of outdoor climate parameters (temperature, humidity).
  - Consolidate and upload all synchronized time series sensor data to ARTC ECMaS module to run backend analytics thru MQTT or web API.
  - The data should be able to be stored in large volume and be able to provide historical data for sustainability reporting.

- <u>Control system integration</u>
  - Able to seamlessly integrate with and access the control logic of existing building management systems (BMS) to enhance functionality and data-driven decision-making, including the building management system, ACMV, lighting systems, and building automation systems (e.g. sensors, controllers, communication networks).
  - Able to receive output from ARTC ECMaS module on control action recommendations for users and to provide automated notifications and alerts if there are any irregularities in the system
  - (Optional) Able to have closed loop feedback to enable automated dynamic adjustment of ACMV controls based on data driven recommendations. This will enable fully automated regulation of thermal comfort at different areas without the need for human intervention. (High risk and requires long validation period)

- <u>Data Visualisation (Dashboard)</u>
  - Live temperature mapping visualisation of temperature and thermal loading of different zones within building based on data captured and surrogate models developed by ECMaS modules.
  - Provide visualisations of energy consumption data (including backend data like algorithms, sustainability metrics calculations) that effectively communicates and simplifies energy usage, trends, and performance metrics into digestible insights through a dashboard.

OVERALL PERFORMANCE REQUIREMENTS

- <u>Easy to use</u>. Intuitive and user-friendly dashboard interface.
- <u>Robust and reliable sensor network</u>. Minimal sensor/server/database downtime.
- <u>Scalability</u>. The solution should be scalable and can be also implemented in other future facilities.

There are no restrictions on the geographical location of the problem solvers who may choose to apply to this challenge. However, the prototype must be demonstrated in Singapore.

POSSIBLE USE CASES

1. Optimised energy-efficient cooling for dynamic thermal loading. Vijay is from the operations team at the plant, which manages the ACMV system and other building systems. Due to hybrid working arrangements, he is aware that there are significantly fewer staff in the buildings on certain days when more people are working from home. However, due to the centralised aircon system, the level of cooling remains the same throughout all blocks and areas, regardless of the number of people present. With the new solution, Vijay is able to see the thermal loading of each zone, which the solution determines based on the actual number of people present. After determining the thermal loading, the solution generates recommendations for the most energy-efficient temperature settings, catered for each zone. Vijay is able to make the necessary adjustments to regulate the temperature controls, thereby reducing energy consumption and costs, and contributing towards the company becoming more sustainable.

2. Thermal comfort for occupant satisfaction. Due to the old centralised aircon system with the same level of cooling throughout all buildings, the staff at the production block experience a lower level of thermal comfort compared to the other blocks, as they are required to wear personal protective equipment for their work. The new solution allows Vijay to use different parameters of thermal comfort for each zone based on their unique needs. For the production block, Vijay uses a lower temperature parameter for thermal comfort, which can be further adjusted, based on the staff's feedback of their actual comfort level on the ground. With a level of thermal comfort customised to their needs, the staff at the production block are happy with the comfortable working environment, which contributes to their overall satisfaction and productivity.

WHAT'S IN IT FOR YOU

- SGD50,000 of prize money for each winner of this challenge (see Award Model)
- Access to IMDA's innovation consultancies (e.g. Design Thinking, Digital Storytelling, UI/UX) and PIXEL corporate innovation hub (e.g. hot-desking, project studios, ARVR, usability, 5G test labs) for prototyping and commercialisation
- SGD150,000 A*STAR Innovation Voucher and 2-year ARTC Membership
- Shortlisted 3 Grand Winners of the Startup Challenge 2023 to be fast tracked to ESG's SLINGSHOT Top 50 and can look forward to SGD30,000 Startup SG grant
- Opportunity to commercialise solution for deployment and adoption by ARTC members

EVALUATION CRITERIA

The evaluation process shall take place over two stages. Proposals shall be evaluated based on the evaluation criteria set out for the first stage. Thereafter, shortlisted proposals shall be subjected to a second stage evaluation in the form of an interview / pitch, and the scoring shall be based on a re-defined assessment criteria for the selection of the challenge finalist(s).

Solution Fit (20%)	Relevance: To what extent does the proposed solution address the problem statement effectively?
Solution Readiness (40%)	Maturity: How ready is the proposed solution to go to the market? Scalability: Is there any evidence to suggest capacity to scale?
Solution Advantage (20%)	Quality of Innovation: Is the solution cost effective and truly innovative? Does it make use of new technologies in the market, and can it potentially generate new IP?

Company Profile (20%)	Business Traction/Model: Does the product have user and revenue traction? Is the company able to demonstrate financial capabilities and resources to complete the prototype? Team Experience: Do the team members possess strong scientific/technical background?

AWARD MODEL

30% of the prize money will be awarded to each selected finalist at the start of the POC/prototype development process. The remaining 70% will be awarded after completion of the POC/prototype solution, based on milestones agreed between Problem Owner(s) and the solver. Prize money will be inclusive of any applicable taxes and duties that any of the parties may incur.

Note that a finalist who is selected to undertake the prototype development process will be required to:

- Enter into an agreement with Problem Owner(s) that will include more detailed conditions pertaining to the prototype development;
- Complete an application form with IMDA that will require more financial and other related documents for potential co-funding support.

Teams with public research performers are required to seek an endorsement from their respective Innovation and Enterprise Office (IEO) and submit the IEO form together with the proposal.

DEADLINE

All submissions must be made by **11 August 2023, 1600 hours (SGT/GMT +8)**. Problem Owner(s) and IMDA may extend the deadline of the submission at their discretion. Late submissions on the OIP, or submissions via GeBIZ, will not be considered.