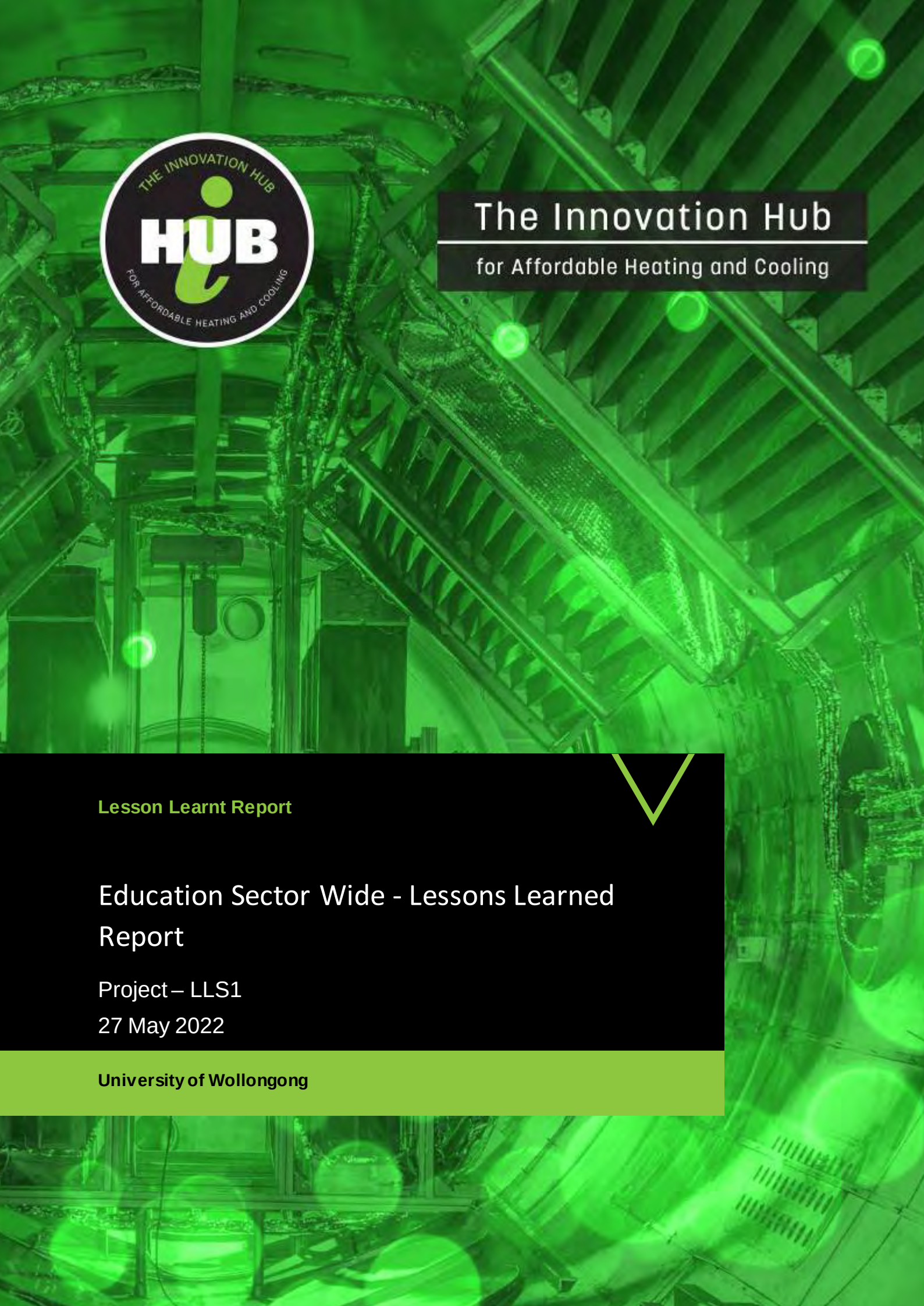


Lesson Learnt Report

Education Sector Wide - Lessons Learned Report

Project – LLS1

27 May 2022

University of Wollongong

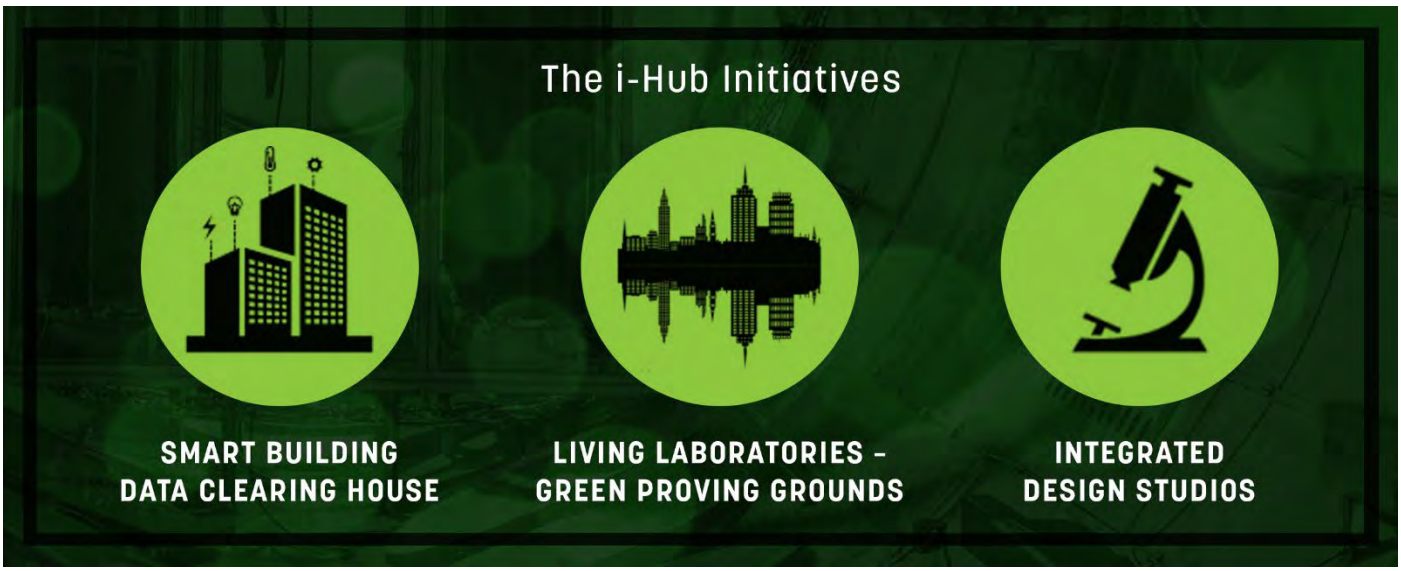
About i-Hub

The Innovation Hub for Affordable Heating and Cooling (i-Hub) is an initiative led by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) in conjunction with CSIRO, Queensland University of Technology (QUT), the University of Melbourne and the University of Wollongong and supported by Australian Renewable Energy Agency (ARENA) to facilitate the heating, ventilation, air conditioning and refrigeration (HVAC&R) industry's transition to a low emissions future, stimulate jobs growth, and showcase HVAC&R innovation in buildings.

The objective of i-Hub is to support the broader HVAC&R industry with knowledge dissemination, skills-development and capacity-building. By facilitating a collaborative approach to innovation, i-Hub brings together leading universities, researchers, consultants, building owners and equipment manufacturers to create a connected research and development community in Australia.

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program. The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

Primary Project Partner



i-Hub Design Studio Lessons Learned Report

The Education Sector Wide Living Laboratory (LLS1) assesses the existing historical data for a given sector, to evaluate how different technologies and energy sources impact the sector as a whole. Additionally, guidelines and frameworks are provided to assist education personnel in assessing existing assets and building stock, to upgrade and replace outdated and end-of-life technologies, in an attempt to decarbonise the schooling sector and achieve energy and emissions reduction targets set by relevant governing bodies.

This report explores the lessons that have been learned through establishing this living laboratory and through performing an education sector wide evaluation. The lessons learned were developed through evaluating the observations of the researchers and project team, and through interacting with the various stakeholders.

Lead organisation	University of Wollongong		
Sub-Project number	LLS1		
Sub-Project commencement date	01st July 2019	Completion date	27th May 2022
Report date	27th May 2022		
Contact name	Dr Georgios Kokogiannakis		
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Lessons learnt

Lesson learnt #1	Need for improved data collection and retention practices
Category	Technical

Describe what you learnt about this aspect of the Project.

In order to reduce the energy demand and decarbonise the existing schooling stock, it is important to first establish baseline metrics from which improvements can be measured, to quantify any improvements which have been implemented, or to identify any assets in need of replacement. To achieve this, data is required to measure or predict the energy demand across different days, months or seasons, as practices change in relation to internal and external comfort conditions. However, while data collection is important, it is the storage and collation of this data which is of greater importance.

Data collection and storage is a simple task, however without adequate collation practices, data becomes confusing and overwhelming, becoming difficult to interpret and utilise. Adequate policies and practices are required, to better summarise (and potentially visualise) collected data so that it may be further assessed to better ascertain the relevance to operational practices within the school (or across the sector), or to better identify and replace/upgrade any assets contributing to higher emissions or energy consumption.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

Data retention and collation policies need to be established, as a means to set a standard practice for the collection of data at either a school or state level. A standardized format will allow for better interpretation of school or statewide data, allowing for continual assessment of energy baseline on an ongoing basis to assist in the evaluation of strategies or technologies being installed within schools.

A standardized format will also allow for the simplified sharing and interoperability of data between education directorates or third-party users. Ideally, a standardized format would be utilized by all directorates, though this would require substantial communication and cooperation to achieve.

Additionally, it is important to define the types of data that are included within this format. For example, aggregation of data has been identified as being of highest importance, so the inclusion of both GFA and enrollment data is critical. Establishing the type of data included within the database formatting will allow for greater future comparisons, while also identifying any additional monitoring equipment required to record this data (e.g. smart meters for more granularity in energy monitoring).

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

It is difficult to obtain energy use data for schools from some states/territories due to limitations on collection methodologies and energy billing responsibilities. A more uniform approach and collaborations across states/territories would be of great benefit to identify best practices and develop effective net zero energy policies.

Please include any other information you feel is relevant or helpful in sharing the knowledge you learnt through this stage of the Project. This may be qualitative or quantitative and may include a graph, chart, infographic or table as appropriate.

Refer to Baseline Report (LLS1 Technical Report: Living Labs Educational Sector Energy Baseline and Key Performance Indicators) for greater insights into how differing datasets impact quality of overall assessment.

Lesson learnt #2	Determining appropriate metrics for benchmarking energy use in schools
Category	Technical

Describe what you learnt about this aspect of the Project.

The baseline assessment for the education sector analysed 3,701 primary schools, with school enrollments ranging from 2 to 1852 students, and sizes varying from 220m^2 up to 18,720m^2. These schools (especially the extremities) are directly incomparable to one another, given the vast size differences and corresponding energy demands. Aggregation of these schools is a necessity to better assess their energy requirements on a per student or per m^2 basis, providing a means of improved comparability. However, while aggregation provides a means of better comparing the energy demands of schools, it does not always allow for a direct comparison.

LLS1 offers an assessment of a significant portion of the Australian schooling stock, providing an overview of the energy demands of primary schools across eastern Australia. However, more detailed data is required to determine the efficiency of classrooms. For example, smaller schools may underutilise classroom spaces (e.g. 1 student per 200m^2) whereas larger schools better utilise available GFA (e.g. 1 student per 6m^2). This is likely a result of densification in cities compared to rurality of some schools. While aggregation provides a means to better assist in school comparability, it does not always allow for a direct comparison.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

Both GFA and enrolments are found to have a regression value of (approximately) 0.6, indicating their similar correlation to energy consumption. However, there may be a combination of these factors (or other factors entirely) which may yield a greater correlation which would account for additional discrepancies.

Additionally, the collection and incorporation of complementary data would yield further insights into the schooling sector, with more conclusions being able to be drawn. While the existing sector wide dataset is considered to be accurate with relevant conclusions being obtained, further insights may yet be concluded from the incorporation of additional data.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

N/A

Please include any other information you feel is relevant or helpful in sharing the knowledge you learnt through this stage of the Project. This may be qualitative or quantitative and may include a graph, chart, infographic or table as appropriate.

Refer to Baseline Report (LLS1 Technical Report: Living Labs Educational Sector Energy Baseline and Key Performance Indicators) and Journal Manuscript (*Energy consumption in Australian primary schools: influences and metrics*) for further insights.

Lesson learnt #3	Limitations to low-hanging fruit solutions
Category	Technical

Describe what you learnt about this aspect of the Project.

While low-hanging fruit solutions (e.g. installation of solar PV, electrification of HVAC, installation of battery storage, etc.) can offer fast solutions to reduce energy demand and improved thermal comfort conditions, these solutions alone may not have the necessary requirements to completely decarbonise schooling stock, nor make them independent of the electricity grid. Sector wide analysis indicate that the currently available installation of PV on average reduces energy demand on average by 16%, indicating that additional, more holistic retrofits or larger installations of PV systems are necessary to ensure significant long-lasting reductions to both energy demand and carbon emissions.

Bundling retrofits within a single upgrade, or procedural conditional upgrades may be more affordable and efficient, with smaller consistent improvements being more substantial over time when compared against solutions which offer quick but immediate improvements (i.e. low-hanging fruit solutions). Additionally, low-hanging fruit solutions may overlook underlying issues within the building envelope which may offer a greater return-on-investment. To maximise the potential decarbonisation of schools, a more holistic assessment of assets within the schooling stock is required.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

The sector wide analysis identifies the impact of discrete technology-centric approaches within the schooling stock (i.e. soalr PV, limited AC installations), largely due to the limited data availability. To better highlight the differences between these low-hanging fruit solutions and more comprehensive upgrades or retrofits, it may be necessary to complete a comparison of specific buildings employing procedural upgrades compared against “low-hanging fruit” classrooms.

Additionally, the *proposed hybrid pathway for schools energy transformation* (within the enabling technologies Roadmap that was produced in this project) highlights a proposal for schools to undertake this assessment themselves, using pilot sites to evaluate the impact, before rolling out across the sector.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

Further research may be required into the potential (or limitations) of low-hanging fruit solutions, especially in comparison to more comprehensive retrofits or upgrades.

Please include any other information you feel is relevant or helpful in sharing the knowledge you learnt through this stage of the Project. This may be qualitative or quantitative and may include a graph, chart, infographic or table as appropriate.

Refer to Enabling Technologies Roadmap (Renewable Energy and Enabling Technologies and Services Roadmap for Schools) for greater insights into low-hanging fruit solutions and hybrid pathways