The Innovation Hub

for Affordable Heating and Cooling

Final Sub-Project Knowledge Sharing report

IDS-11 WCC Ribbonwood Community Centre

Project IDS11

19 November 2021

The 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.

Final Sub-Project Knowledge Sharing Report

This report is produced at the completion of each IDS sub-project and captures the breadth of activities and information produced in the sub-project including studio logistics. It makes use of cross referencing the individual reports produced in each sub-project rather than repeating information wholesale.

\\Lead organisation	University of Wollongong		
Sub-Project number	IDS-11		
Sub-Project commencement date	8th March 2021	Completion date	19th November 2021
Report date	19 November 2021		
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Important Note: The Integrated Design Studios build upon the findings and lessons learned obtained from previous IDS's undertaken at University of Melbourne (UoM), on exploring the interactions between architectural and engineering students. Due to the cumulative nature of the research and lessons learned, there is a degree of repetition witnessed in the reports. To improve readability (for those reading multiple IDS reports) and information of a general nature and similar to knowledge shared in other IDS knowledge sharing reports will be highlighted in a greyed-out background.

Additionally, any cumulative research or learnings, or repeated outcomes associated with IDS10 (which ran in parallel to IDS11) will be highlighted in a blued-out background.

1. Sub-Project overview, objectives and importance to market/industry

The overall objective of the integrated design studio activity is to examine how integrated design occurs on case study projects with outcomes on two fronts:

Enabling of Integrated Design

Significant cultural barriers exist in the design of sustainable buildings in relation to achieving the high technical performance required in tandem with the architectural building amenity desired. The root cause of many of these barriers is the relationship of the engineering and architectural disciplines in the design environment. The integrated design studio programme has been designed to study how to best overcome these barriers.

Much has been written on how to achieve integrated design and yet its realisation in practice is often ad-hoc or poorly executed. The integrated design studio programme tests best practice integrated design methodologies in a working design environments. The methodologies trialled are refined through subsequent design studios.

The 'i-Hub IDS-KS Catalyst for Integrated Design' document provides the most up to date iteration of the integrated design methodology to be trialled in the IDSs (refer Section 4 for more detail).

The focus of the studios is on mobilising both engineering and architectural input into the conceptual ideation stages of project formation. Renewable energy and zero carbon are used as target outcomes. Concentrating on this key stage in the design of projects creates maximum downstream impact.

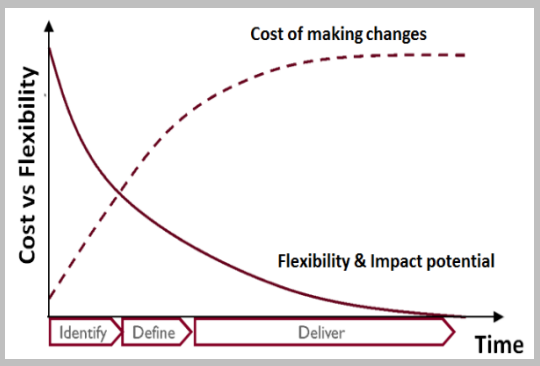

Figure 1 – Decision value: opportunity with time

Building Typology Research (Community Centre)

The IDS-11 Wollongong City Council Ribbonwood Community Centre Integrated Design Studio investigates design innovation to reduce net energy consumption of Wollongong City Council (WCC) soon to be renovated Ribbonwood Community Centre in Dapto. Over a 14-week period, a group of multidisciplinary students work collaboratively to respond to environmental challenges faced by WCC Ribbonwood Community Centre, with a particular focus on how WCC can achieve their organisational commitment of net zero emissions for its own operations by 2030.

Numerous councils and community centres alike are now making net zero emissions targets and are facing many challenges along this journey. Not least is the reliance on natural gas and the need for increased levels of thermal comfort whilst reducing energy consumption.

Based on WCC's commitment to move towards net zero emissions for its own operations by 2030 and a brief that was informed by representatives from WCC, students explore novel approaches to address Net Zero Carbon principles with a particular focus given to renewable energy technologies and strategies to improve the value of renewable energy.

Considerations are given to capital versus operation and life cycle costs and identifying opportunities for staging or future replacement/staging of technologies.

The key partner organisations involved in IDS-11 were:

Lendlease – Client representative.

ARUP – ESD consultant

Stantec – ESD consultant

MI Engineers – Structural engineering consultant

COX – Architectural consultant

The University of Wollongong – Academics from both the Sustainable Buildings Research Centre (SBRC), and the School of Civil, Mining, Environmental and Architecture Engineering. A diversity of students were involved including a mix of 3rd and 4th year Bachelor of Architectural Engineering, Civil Engineering, Environmental Engineering, and 3rd and 4th year Bachelor and Masters of Mechanical Engineering, and Mechatronic Engineering Students.

AIRAH – The Australian Institute of Refrigeration, Air Conditioning and Heating.

IDS-11 was initiated in Semester 1 2021 (1st March) with semester work running for 13 weeks until the beginning of June 2021. Following the studio, the consultants completed a vetting process extracting the design ideas produced throughout the studio and examining for potential performance improvements. The conclusion of this analysis was output into a vetting report, contained within the final design studio outcomes report.

Figure 2: WCC Ribbonwood Community Center

2. Challenges experienced and how these were overcome

Some challenges were experienced in the setup and delivery of the studios. These challenges and the strategies implemented to overcome these are outlined below:

1) **Logistical issues for studio development.** Initial delays experienced at studio inception resulted in an extended period elapsing before agreements were executed with the sub-project partners. These same delays were experienced in receiving ethics approval. The final impact of these factors was felt to be minimal, though to mitigate any similar impacts in future projects, agreements and ethics should be sought at an early stage of studio development.

2) **Engagement of participants.** The advent of COVID-19 required instigation of remote delivery options for students, clients, consultants, and studio tutors. The dual-mode delivery for this studio allowed for students to participate face-to-face and online, though online participation did present limitations to the level of engagement. Alternate methods of communication were instituted, which improved the engagement of participants, and minimised the effects associated with remote learning. This was further explored in the studio report outlined in Section 4.

3) **Communication hesitancy limits outcome development**. Utilisation of the framework established through previous design studios was found to be very successful, allowing participants to progress their design in a logical manner which built upon the findings of the previous work. However, initial communication hesitancies slowed preliminary design development, which ultimately delayed and limited the final designs presented by participants. Some relaxation of submission times was afforded to participants, allowing for greater detail in submitted reports. Extended studio lengths may see further outcomes, however, the outcomes achieved were still considered to be a great success, with participants gaining greater insights into integrated design practices. These ideas were explored further in the studio report outlined in Section 4.

3. Summary of lessons learnt and Evaluation of the Sub-Project impact and technology

Technical and social learnings were attained through conducting the design studio, relating to both the integrated design process, and the building typology. These learnings are detailed further in the lessons learned report outlined in Section 4. A summary of these lessons learned is shown below:

Key Lessons Learned

Note: The lessons learned outlined below were attained through conducting IDS10 and IDS11 in parallel, so some lessons learned relate to both studios. Additional lessons relating to other IDS's can be found in their respective lessons learned reports.

- Existing structural form restricts integrated design opportunities (Building Typology)
- Importance of feedback mechanisms and student/consultant interactions (IDS Process)
- Evaluation matrices allow for simplified interdisciplinary design comparisons (IDS Process)
- Design frameworks provide beneficial milestones for project development (IDS Process)

This integrated design studio evaluated the Wollongong City Councils Ribbonwood Community Centre, an existing structure with retrofitted solutions being investigated. It was found that integrated design can successfully implemented for the associated building typology. The following summarises the implemented initiatives to achieve this successful design. Further details of this design can be found in the studio report outlined in Section 4.

WCC Ribbonwood Community Centre (Building Retrofit)

- Passive design measures
    - Improved glazing (e.g. double glazing) to reduce thermal gains
    - Window film to reduce solar gains
    - Additional window mesh to reduce solar gains
    - Additional insulative materials within the building envelope (e.g. walls, roofs, etc.)
    - Improved natural lighting
    - Passive shading (e.g. addition of louvers)
    - Green walls/Green façade
    - Improved airtightness to minimise air-changes
- Active design measures
    - Reduce lighting energy consumption (e.g. install LED's)
    - Increased size of active PV system
    - PDLC window film (activated via electric current)
    - Installation of a buffer tank to regulate internal comfort conditions
    - Phase Change Materials (i.e. thermal storage)
    - Solar Heating
    - PV windows (windows with embedded PV panels which permit light intrusion)
    - HVAC upgrades

Sub-Project Impact (linked to studio planned objectives)

Overcome discipline prioritisation and broader opportunities for the WCC Ribbonwood Community Centre: The close collaboration with Wollongong City Council was key in understanding the primary operational requirements and functionality associated with their community centre. Additionally, a site visit allowing students, consultants and subject tutors the opportunities to interact with the buildings staff gave additional insights into the functional requirements. The client brief primarily focused on the upgrades associated with the existing HVAC equipment (nearing its end-of-life), though student participants did consider additional active systems and potential passive systems to reduce the energy requirements this is in keeping with Wollongong City Councils net zero emissions by 2030 strategy

Opportunities for both passive and active measures to achieve a reduction in energy consumption: The examination of strategies undertaken throughout the design studio identified a number of both passive and active measures which may be implemented within the community centre to reduce energy consumption in keeping with the brief specified by the client.

Benchmark and test concepts developed against current industry standards identifying ideas worthy of further investigation and development: Student participants developed a business-as-usual benchmark to measure potential energy saving strategies, and approximate total energy savings resulting from their recommendations. This was aided by computer models used to simulate energy usage throughout the year. These simulations were able to assess the variety of active and passive solutions considered, which was able to provide reliable estimations for consideration by the client.

Contribute to the knowledge and development of the IDS process being developed and facilitated by i-Hub: The studio successfully examined retrofit solutions implementable within the Ribbonwood Community Centre, contributing valuable findings to the integrated design process. This is further elaborated on in the lessons learned report and studio report outlined in Section 4.

Maximise the local use of on-site renewable energy: Findings from this sub-project will progressively feed into the establishment of a 'Carbon Catalogue' where the IDS team will consolidate benchmarks related to different technologies in the context of a range of different project types. In return, this will inform the 'Knowledge Sharing' aspect of this initiative, as each sub-project will have an impact on the wider IDS program.

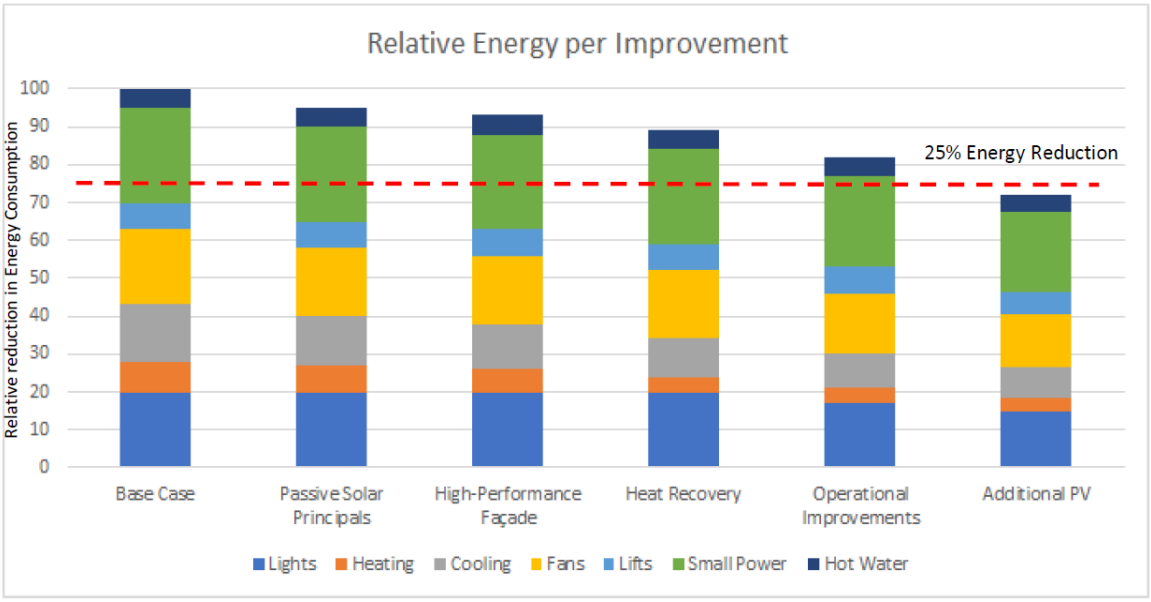

Figure 3: Relative energy improvement per strategy – Excerpt from vetting report

4. Links to reports

The following reports were developed for public sharing while undertaking IDS11, and relate primarily to lessons learned, project outcomes, and knowledge dissemination. All reports have been provided directly to i-Hub, with the with the titles being linked to the most up-to-date version of the associated report.

Note: Any supplementary report titles which are not linked were submitted to AIRAH alongside this knowledge sharing report and will be uploaded along with this report to the AIRAH website for public dissemination.

IDS-11 Supplementary Reports

- **i-Hub_IDS-11_Design_Studio_outcomes_report_100%_v2.0_Complete**: This report contains the primary lessons learned and outcomes of the WCC Ribbonwood Community Centre Integrated Design Studio. This report includes select examples of student work and the consultants vetting report. Additional feedback is also contained, with an assessment of this feedback and conclusions regarding studio outcomes.
- **i-Hub IDS-11 Lessons Learnt Report:** This report highlights the key lessons learned through conducting the design studios.

Related material of interest produced in wider IDS activity

- **i-Hub IDS-KS Catalyst for Integrated Design :** Live integrated design methodology document (updated with learnings from each successive IDS).
- **IDS-KS JP01 – Creating integrated design in an academic environment: Process and a method**: Journal paper manuscript – note: not accessible publicly until published due to Journal IP restrictions. Link to be provided at that time.
- **IDS-KS JP02- IDS: An integrated design approach for architect/engineer education using Zero Carbon targets**: Journal paper manuscript – note: not accessible publicly until published due to Journal IP restrictions. Link to be provided at that time.
- **IDS-KS MA01 What are we doing about integrated** : PDF of published Ecolibrium August Issue.
- **IDS-KS MA02 Building Performance Attributes**: Article content (pending publishing).
- **IDS-KS i-hub summit I_IDSs**: YouTube recording of IDS June 2020 webinar series.
- **IDS-KS i-hub summit II_IDSs**: YouTube recording of IDS December 2020 webinar series.
- **IDS-KS i-hub summit III_IDSs**: YouTube recording of IDS June 2021 webinar series.
- **IDS-KS i-hub summit IV_IDSs**: YouTube recording of IDS November 2021 webinar series.
- **IDS-KS i-Hub Symposium IDS's**: YouTube recording of IDS November 2021 webinar.

5. Applicability beyond current contract.

The sub-project outcomes are envisaged to have the following applicability beyond the current contract:

- Catalyst for Integrated Design document: Envisaged this will be able to be used by industry in setting up integrated design environments. Note that the current version has already been requested by and provided to individuals in industry.
- Studio Outcomes Report: Is envisaged to be referred to by people in the data centres industry interested in building more sustainable data centres. Learnings from this report will also be incorporated into an IDS activity wide report planned to be produced as a compendium of integrated design findings across the various building typologies explored.
- Carbon Catalogue: Results from the project vetting will feed into a *Carbon Catalogue* per Building type that draws on the benchmarking undertaken by the IDS team.
- Integrated Design Studio Framework: The integrated design studios have been welcomed by clients and participating consultants and have been received positively by student participants. This framework can be implemented in future integrated design studios outside of the i-Hub Integrated design studio program, such as similar educational learning environments or industry technical workshops.
- Consultation with Industry: It is anticipated that relationships developed between the IDS research team and consultants will continue to be beneficial into the future and may develop into other educational or research endeavours.
- Further publications of the integrated design studios or integrated design process are anticipated to follow well into the future, utilising the findings of the various studios undertaken throughout the i-Hub IDS program.

6. CONCLUSIONS

Conclusions of the integrated design process

Progress of the studio was observed by the IDS research team over the course of the 13-week period, noting the development of the students and their respective designs. A well-defined framework of the integrated design process was found to be essential, guiding the student designers in advancing their respective designs. Additionally, feedback provided by clients, consultants and studio tutors was found to provide additional clarity and insight, allowing student participants to significantly improve their designs.

Through establishing evaluation matrices, engineers and architects were able to evaluate their designs side-by-side with quantifiable metrics, to communicate in a language both could understand, and determine which designs would be most beneficial and in keeping with the brief. These frameworks, when paired with experienced consultants and openminded clients result in collaborative integrated designs capable of meeting the requirements outlined in the brief, reducing the energy consumption of the investigated community centre.

Summary of building typology learnings

A reduction in energy consumption and emissions was found to be possible for the retrofitted design of the Ribbonwood Community Centre, which is in keeping with the desires of Wollongong City Council, to achieve net zero emissions by 2030. Solutions investigated by the students were shown to successfully reduce energy consumption, with the consultant vetting report confirming that a saving between 25-30% is possible. These reductions were primarily due to passive and active strategies, with some being due to energy offsets due to the addition of more PV systems. The following strategies were recommended by the consultants:

- Reduction in net energy consumption through improvements to building fabric
- Additional maintenance, cleaning and commissioning of existing HVAC to improve system efficiency
- Installation of ERV to reduce energy loss via ventilation
- Operational upgrades to reduce energy usage in unoccupied zones, or limiting energy expenditure to public areas
- Inclusion of additional PV systems to offset energy consumption

The 25-30% reductions in energy usage were determined through comparison to a baseline business-as-usual case, derived from existing statistics. The body of work undertaken by both students and consultants support that energy reductions in Community centers are possible.