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Ecolibrium

Cape crusader

A coastal project aims to be a change agent.





Flower power

A team of students from the University of Wollongong showed the value of preparation, teamwork and belief when they took their Desert Rose House to the 2018 Solar Decathlon Middle East, writes **Mark Vender**.

It was the last day of the 2018 Solar Decathlon Middle East, and either because of Dubai's harsh desert climate or the competition, Project Manager Clayton McDowell, Stud.AIRAH, was feeling the heat. After years of painstaking design work, trial runs and late nights, the team from the University of Wollongong (UOW) was staring at the possibility of returning home without a medal.

The Solar Decathlon is an international competition with the backing of the US Department of Energy.

It challenges collegiate teams to design, construct and operate solar-powered houses that are sustainable, stylish and cost-effective. Last year the event was held in the United Arab Emirates and attracted 15 team entries, comprising 600 students from 28 universities around the world – including UOW.

A month earlier Team UOW had arrived in Dubai with all the materials for their Desert Rose House packed into eight shipping containers. Competitors had just two weeks to construct their houses, then another 10 days to show them

“With Desert Rose, Team UOW wasn't just trying to win a competition; they were endeavouring to change the way the world views sustainable housing

off to the public and the judges and convince them that their solar-powered home was the most sustainable, stylish and cost-effective.



Comfort results from good design and control of the HVAC system.

With Desert Rose, Team UOW wasn't just trying to win a competition; they were endeavouring to change the way the world views sustainable housing. The idea was to build a home that was architecturally inspiring, affordable and adaptive to someone's needs as they continue to age – a house for life.

Unfortunately, initial problems left Team Desert Rose low on the leader board, and their morale took a battering. But with better performances they scored trophies in some of the judging categories and clawed their way back into contention.

Before the last challenge – the prestigious Innovation category – the team sat in third by just 0.15 of a point, with three other teams breathing down their necks.

COOL COMFORTS

The scoring system for the Solar Decathlon is – as the name suggests – divided into 10 categories. It was in the Comfort Conditions contest that Team UOW regained some ground by winning gold. Teams had to meet extremely strict internal conditions, including maintaining the internal temperature of the house between 23°C and 25°C, and relative humidity between 35 and 60 per cent.

Wenye Lin was Team UOW's HVAC coordinator. He says the excellent performance in the Comfort Conditions competition was a result of good design and control of the HVAC system, as well as the passive design of the house.

"We designed a comprehensive HVAC system by considering the extreme

weather conditions in Dubai, the demand of humidity and temperature control, load shifting, the fast cooling of the house after tourists visited, uniform indoor air distribution, and the necessity of noise control," says Lin. "These aspects were simulated or tested beforehand to enhance our confidence."

In terms of HVAC, Desert Rose uses an enthalpy recovery ventilator (ERV) to treat hot humid fresh air before it enters.

The benefit of the ERV is that it can recover both sensible and latent heat from the exhaust air. It employs a thin film element to exchange the temperature and humidity – the thin film used decreases the moisture exchange resistance, while releasing more space for extra film layers in the element.

The hot water tank, air-to-water heat pump, and phase-change tanks onsite.



Desert Rose uses an enthalpy recovery ventilator (ERV) to treat hot humid fresh air

The exhaust air then passes through a desiccant humidity control system that employs a heat pump to remove moisture from the air. Its key feature is two desiccant-coated heat exchangers (DCHEs), which serve respectively as the condenser and evaporator.

Because moisture can be more effectively trapped on desiccant material at a lower temperature, the DCHE enables the removal of the adsorption heat during the air dehumidification process when it serves as an evaporator, which significantly improves the dehumidification performance.

The desiccant can then be switched and regenerated by using the released heat when the DCHE is served as a condenser, which provides a reliable and energy-saving approach for regeneration. The coefficient of performance of the heat pump can be over 5.

The phase-change material up close.





SCORING POINTS WITH PASSIVE

Glasswool insulation was used in the cavities and extruded polystyrene (XPS) applied externally to Desert Rose's steel frames to increase the R value and reduce thermal bridging. A ventilated cavity was designed between the external façade and the XPS layer; this is open at the base and top of the walls allowing built up hot air to escape.

Recycled hardwood timber frames and triple-glazed argon-filled low-E coated windows and doors were employed to reduce heat gains throughout the day and heat loss on cooler nights.

For windows affected by direct sunlight, Viridian's Microshade mesh was installed on the internal surface of the external layer of glass. This consists of microscopic lamellas that shade the direct sun progressively. It has the equivalent effectiveness of exterior shades but maintains natural lighting.

In summer, when the sun is high in the sky, the energy from sunlight can be reduced by up to 90 per cent.

Building integrated photovoltaic thermal (BIPV-T) tiles were fitted to the south-facing roof (sunny side in the northern hemisphere) to provide a five-in-one combination of roof, insulation, electricity, solar PV cooling and hot water, and are engineered to withstand extreme weather conditions. The north-facing roof was sheeted in steel*, which has a high reflective coating that achieves a Nominal Solar reflectance of 1 = 0.77 and a solar reflectance index of 1 = 0.95, thus reducing solar heat gains. A ventilated cavity was constructed beneath the BIPV-T tiles and steel sheets to prevent pockets of hot air building up.

The Desert Rose's south, east and western facades are wrapped in a lightweight second-skin concrete wall that was designed and built by Team UOW students. This acts as a shading element, reducing heat gains. The second skin has a series of holes and is open at the top and bottom to allow air to freely move around it, cooling the concrete at night.

*Colorbond's Coolmax steel



The team works on the second skin.



Part of the comprehensive HVAC system.

To generate the chilled water, Team UOW employed an air-to-water heat pump, which can be run as required. However, to shift thermal loads it constructed two chilled water tanks containing tubes of a phase-change material (PCM).

The PCM is a type of salt hydrate which is non-flammable, non-toxic and can easily be obtained.

In total there are 338 tubes, each with a storage capacity of 0.102kWh, equating to almost 35kWh of thermal storage capacity.

These tanks allowed the heat pump to run at night – when the ambient temperature is lower and energy is cheaper – to charge the chilled water tanks.

“During the day when we require cooling, we pump the water from the fan coils through the tank and back up to the coils, thus reducing the need for us to run the heat pump and improving the overall efficiency of the system,” says McDowell.

“Our system also has two chilled radiant panels, primarily as a demonstration, showing that we can provide comfortable living environments without the need to cool the entire room to a specific temperature.”

AND THE WINNER IS . . .

Finally, it was time for the closing ceremony, where the winner of the Innovation competition and the overall placings would be announced. The entire Solar Decathlon competition hinged on the result with six teams within reach of the top three places.

McDowell had spent the previous few days mentally preparing the team, in case they didn't finish in the top three. He had shared the wise words of one of the Dutch team: “I do not learn any more from coming first”.

He reminded them that they did not need a trophy, that the only trophy they needed was the one they had built and poured their hearts and lives into: the Desert Rose.

But the reality was that three years of hard work had boiled down to that moment.

Third place for Innovation was announced, and it went to BaityKool – a collaboration between Amity University, An-Najah National University and the University of Bordeaux.

WINNER'S WORDS

Eco: How did it feel to win second at the Solar Decathlon?

YB: I am so proud of this result. After receiving first place in Innovation, we found out we had won second place (overall). The duration between these two announcements was only couple of minutes and for me this period was like a dream – a slow flashback of all our team efforts over the past two years.

As a woman who is an engineer, by having this result, I felt more confidence and power in myself. Of course, being involved in an amazing, knowledgeable team is a great opportunity that provided me with the strength that I'm talking about.

This silver is proof of our success in building a smart, sustainable and solar-powered building that celebrates life by targeting the wellbeing sector.

Eco: What lifted you above the competition in the innovation competition?

YB: By integrating dementia-friendly design and Middle-Eastern cultural values in a sustainable, solar-powered residential house, I can say Desert Rose house is an innovation in itself. It also contains so many innovative features that are futuristic but tangible.

The result secured them a well-deserved silver or bronze in the overall competition.

Second place went to FutureHaus, the entry from Virginia Tech. It was another great result for the clear leaders of the competition.

They had won the gold overall and were already celebrating. But McDowell's heart sank.

Team Desert Rose were set for fourth place overall – still an amazing result but with so much effort poured in they had always hoped for more.

There was a buzz of anticipation in the room to see who would get first place in Innovation. If not FutureHaus, who could it be? Probably the Romanian team.



Yeganeh Baghi

And these creative solutions have been developed, implemented or improved by students.

Some of the outstanding innovations are the HVAC system, the second-skin wall, the predictive control within our BMS system, and the digital taps from Enware.

We were also the first team in the history of the Solar Decathlon that developed an innovation framework.

Eco: If you had your time again, is there anything you would do differently?

YB: I do not believe in going back and doing things differently because I do the best I can based on the situation that I am in at the time. But of course I learnt a lot of lessons from this experience, which I will apply in the future.

The Middle East Solar Decathlon is finished, but I do believe the best is yet to come by planting Desert Roses all over the world.

The presenter started to announce the first place for Innovation, in Arabic first. But at the end came the Australian word “Wollongong”.

The team surged to their feet with a cheer. McDowell looked around but was stuck in his seat, hands and legs trembling. His head collapsed into his hands and tears ran down his face. Team UOW had come from almost last position to snag overall second place at the last minute.

As the team was called up to the stage, the other teams stood as well and applauded.

“Coming second was a great honour,” says McDowell, “but to come second and receive a standing ovation from the very teams that we were competing against after earning their respect and friendship is even greater.” ■