PASSIVE COOLING INNOVATIONS

Canberra Deep Space Communications Complex (CDSCC), Tidbinbilla, ACT

Energy Case Study

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An innovative Heating, Ventilation & Air Conditioning (HVAC) and "night sky" transmitter cooling system for the new antenna at CSIRO's Tidbinbilla site is expected to achieve energy savings of up to 60,000kWh per year and reduce CO_2 emissions by 64 tonnes per year, based on computer modelling. The enhanced passive "night sky" cooling and other features will increase upfront costs by around $70,000, and provide a financial payback period estimated at less than 10 years.

Detailed technical research was carried out beforehand to reassure NASA and other key stakeholders that the design modifications would not adversely impact the antennae's core function. The "night sky" system will be tested and performance evaluated during the antenna commissioning phase in 2014 and beyond into service.

Background

Two new 34 m beam waveguide antennae are being constructed at the Canberra Deep Space Communications Complex (CDSCC) in the ACT as part of a major facility upgrade, with the first on line by 2014. The new dishes will be used to receive images and other data from spacecraft at Mars and throughout the solar system.

As the construction and operation of the additional antennae will have a significant impact on the site's electrical infrastructure and energy consumption, energy efficiency was a major focus in the design of the HVAC system.

Antennae already account for up to half of the total electricity consumption at the site and a recent energy audit estimated that around 30% of this consumption is associated with the dedicated HVAC systems that are used to reject the huge amount of heat generated by the transmitter system.

Innovative "night sky" cooling solution

To improve energy efficiency, the transmitter cooling system for the new antennae will use passive heat rejection via a 3,600m long closed loop pipe grid buried within the 1,100m2 external concrete slab that forms a road around the base of the pedestal. The design is based on under floor hydronic heating systems used in homes and takes advantage of Canberra's particular climate. The grid comprises sections of pipe each 73m long that are carefully laid to form a continuous loop that avoids any joints being located within the slab.

Backup cooling will eventually be provided by an evaporative (adiabatic) cooler supplied by a 60KL rainwater tank that collects off the concrete slab. A chilled water system will be used as a last resort in the event that neither the buried pipe loop nor the evaporative fluid cooler can meet the heat rejection demand.

'CSIRO initially asked us to investigate the potential for a conventional geothermal heat sink arrangement with pipes buried a few metres underground. This can work well for building air conditioning systems but we felt that the constant large heat loads from the antennae may increase the soil temperature and reduce the effectiveness of the system over time. This is why we proposed an alternative 'night sky' solution where shallow pipes could distribute heat throughout a concrete slab that would radiate heat to the atmosphere instead.

Using plastic pipes reduced the risk of corrosion and scale build up that are a problem in many other heat sink systems that use metal pipes. We also included a large number of meters and sensors so that the site can monitor the efficiency of the system and identify any leaks or other problems as early as possible'.

Lasath Lecamwasam, GHD consulting engineer

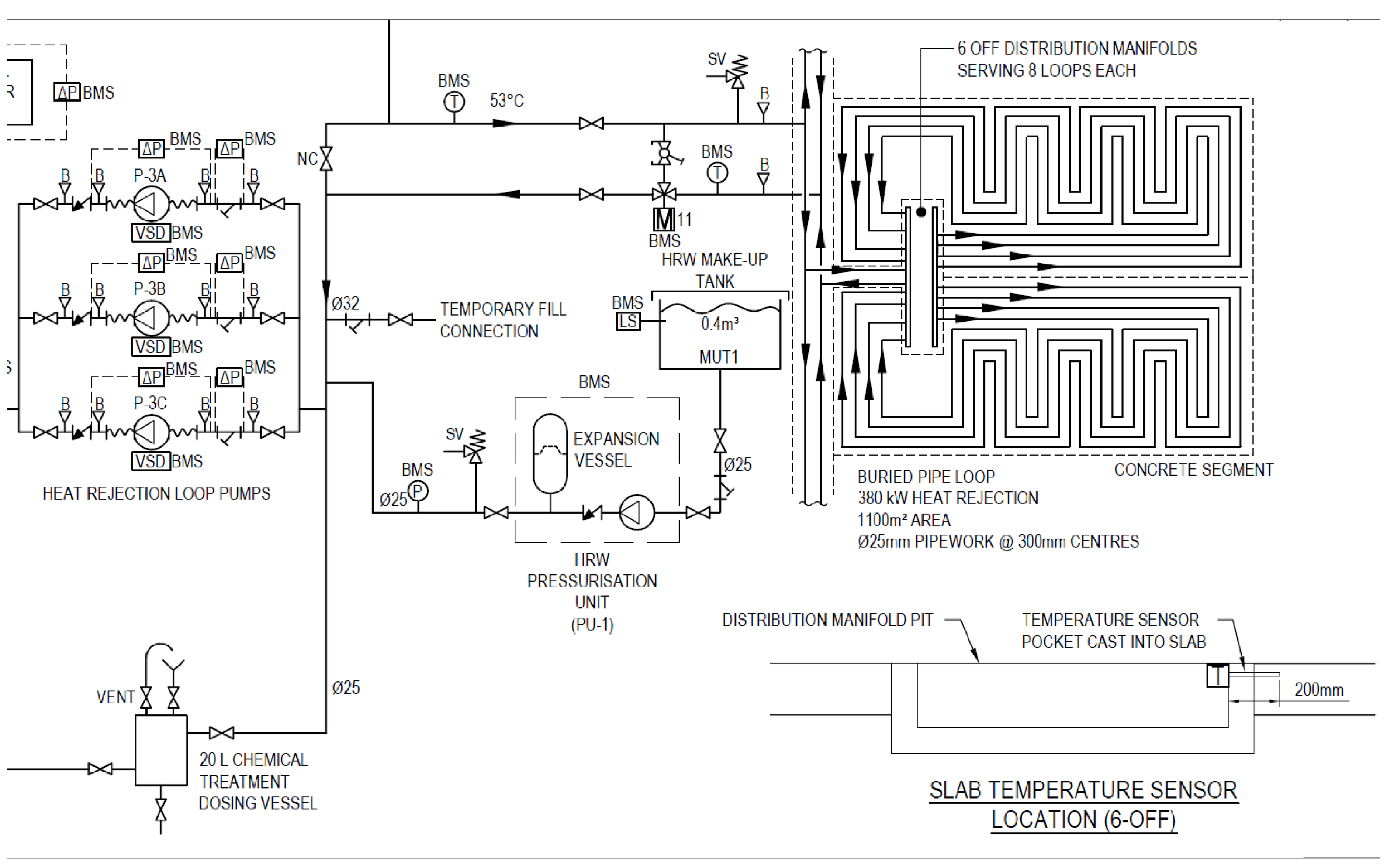


Figure 2: *An extensive network of 25mm diameter polyethylene cross linked (PEX) plastic water pipes will be incorporated into the concrete slab surrounding the base of the new antennae at CSIRO's site at Tidbinbilla. These pipes will reject heat generated by the transmitters to the slab that will in turn slowly release heat to the cold night sky.*

The buried pipe loop will be partially bypassed if the ground is too cold and fully bypassed if the ground is too hot – based on the average value of six ground slab temperature sensors.

Figure 1: *Installation of the night cooling system during construction of the antenna pedestal in November 2013. (Photo: Barry Davis)*

Other changes to standard antenna design

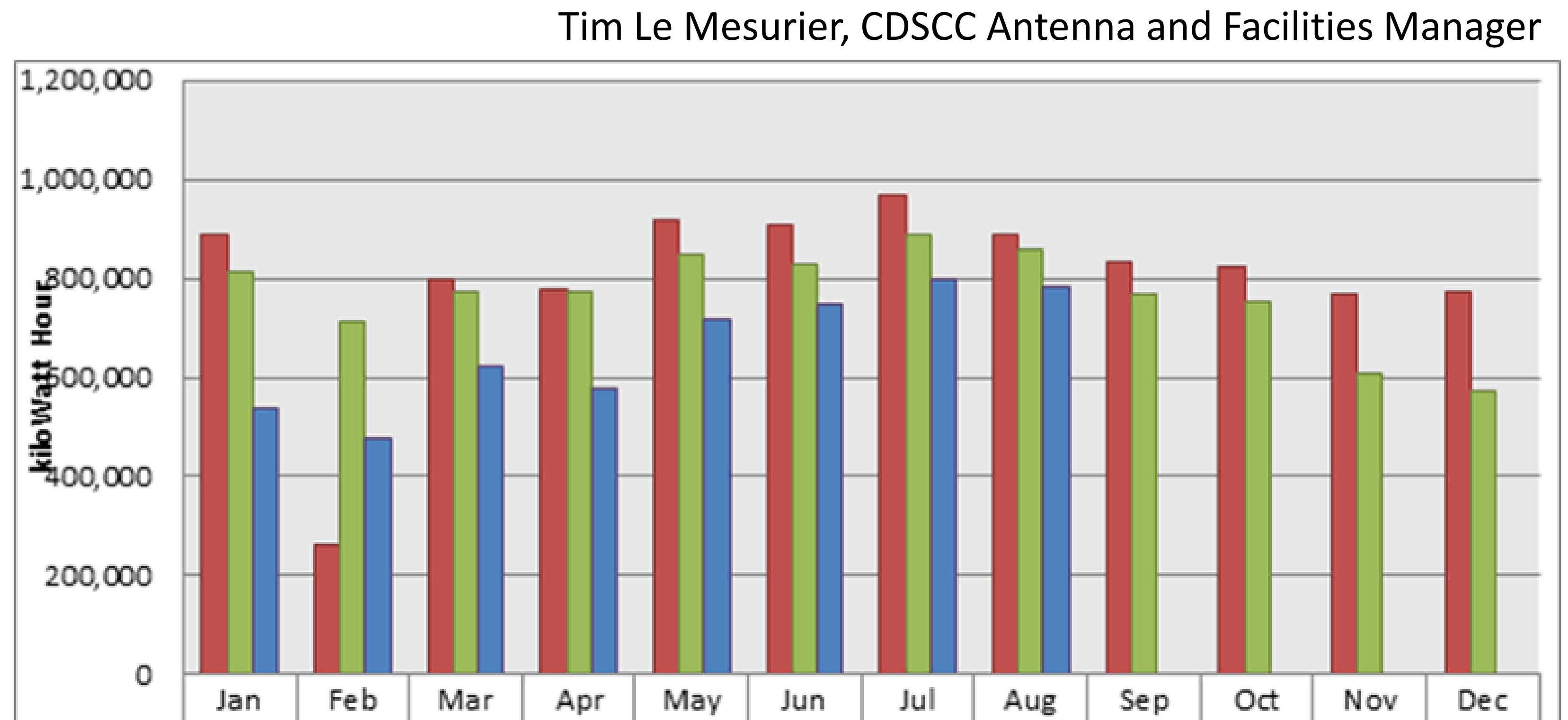
In a departure from conventional ventilation system design used in previous transmitters, the air handling systems will use an 'economy cycle' for free cooling whenever outside conditions are suitable and will not 'bleed' conditioned air through the transmitter hoods to the outside.

Additional energy management measures being included are variable speed drives (VSD) in the air handling units and a thermal storage vessel that can be used to reduce peak loads and allow chillers to run at night when energy costs are cheaper.

The new mechanical systems will be connected to and monitored by the existing site wide Building Management System (BMS), with energy consumption being a key performance indicator.

'Canberra's cold nights are ideal for this type of set up but we believe a similar system may be suitable for our sister sites in the Deep Space Network at Madrid and California. The design is also very water efficient as it is based on closed loop systems and rain and stormwater harvesting. This helps to reduce our water consumption, especially as we do not have a mains water connection at this site.'

Tim Le Mesurier, CDSCC Antenna and Facilities Manager



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	888,30	264,57	798,14	778,62	915,89	906,26	966,11	888,83	830,74	823,34	769,78	773,41
2012	810,35	713,60	772,80	772,63	846,65	827,65	886,76	858,58	767,27	751,77	605,65	574,73
2013	536,39	478,88	620,32	579,94	718,53	746,98	796,89	785,16				

Energy audit

GHD undertook a comprehensive energy audit of Tidbinbilla's operational support facilities in 2011-12 with funding from CSIRO's Environmental Sustainability Strategy. The report identified over 30 key recommendations to improve energy management, including some that achieved immediate savings with little or no upfront cost.

By August 2013, energy savings of around 15% had been achieved with a payback of around 1.5 years (including the cost of the audit and implementation costs).

FOR FURTHER INFORMATION
Contact: CSIRO's Environmental Sustainability Team
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