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Report 3/2010

Extension of scope to the Australian SKA Pathfinder Telescope and the Pawsey High Performance Computing Centre for SKA Science

Parliamentary Standing Committee on Public Works

July 2010
Canberra

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Membership of the Committee

Chair	Senator the Hon Jan McLucas
Deputy Chair	Senator the Hon Judith Troeth
Members	Mr Nick Champion MP
	Mr John Forrest MP
	Senator Michael Forshaw
	Ms Jill Hall MP
	Hon Peter Lindsay MP
	Hon Roger Price MP
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Introduction

1.1 Under the *Public Works Committee Act 1969* (the Act), the Parliamentary Standing Committee on Public Works is required to enquire into and report on public works referred to it through either house of Parliament. Referrals are generally made by a delegate of the Minister for Finance.

1.2 All public works that have an estimated cost exceeding $15 million must be referred to the Committee and cannot be commenced until the Committee has made its report to Parliament and the House of Representatives receives that report and resolves that it is expedient to carry out the work.[1]

1.3 Under the Act, a public work is a work proposed to be undertaken by the Commonwealth, or on behalf of the Commonwealth concerning:

- the construction, alteration, repair, refurbishment or fitting-out of buildings and other structures;
- the installation, alteration or repair of plant and equipment designed to be used in, or in relation to, the provision of services for buildings and other structures;
- the undertaking, construction, alteration or repair of landscaping and earthworks (whether or not in relation to buildings and other structures);

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1 *Public Works Committee Act 1969* (the Act), Part III, Section 18(8). Exemptions from this requirement are provided for work of an urgent nature, defence work where is would be contrary to the public interest to conduct an open inquiry, repetitive work, and work undertaken by prescribed authorities listed in the regulations to the Act.

- the demolition, destruction, dismantling or removal of buildings, plant and equipment, earthworks, and other structures;
- the clearing of land and the development of land for use as urban land or otherwise; and
- any other matter declared by the regulations to be a work.[2]

1.4 The Act requires that the Committee consider and report on:

- the purpose of the work and its suitability for that purpose;
- the need for, or the advisability of, carrying out the work;
- whether the money to be expended on the work is being spent in the most cost effective manner;
- the amount of revenue the work will generate for the Commonwealth, if that is its purpose; and
- the present and prospective public value of the work.[3]

1.5 The Committee pays attention to these and any other relevant factors when considering the proposed work.

Matters addressed in this report

1.6 Agencies are required to seek the Committee's approval for any changes in scope or cost to approved projects. On occasion, significant changes in scope occur and the Committee will report on the matter in order to ensure that there is transparency in this process.

1.7 This report deals with a change in scope to the Murchison Regional Radio-astronomy Observatory (MRO) for the Australian SKA Pathfinder (ASKAP) project at Boolardy Station, WA and the Pawsey High Performance Computing Centre in Perth, WA.

1.8 The Committee received a written briefing outlining the proposed works on 23 June 2010 and conducted a public hearing with the CSIRO on 24 June 2010. The CSIRO subsequently provided a copy of advice received from the Australian Government Solicitor.

1.9 A lit of witnesses at the public hearing is listed at Appendix A, the written brief is at Appendix B and the Australian Government Solicitor's advice is at Appendix C.

2 The Act, Section 5.

3 The Act, Section 17.

2

Extension of scope

2.1 On 9 June 2010 the Government announced that the CSIRO[1] had been granted $47.3 million in funding through the Government's Education Investment Fund (EIF) for renewable energy solutions.[2] This money will be spent on infrastructure at the Murchison Regional Radio-astronomy Observatory (MRO) for the Australian SKA Pathfinder (ASKAP) project at Boolardy Station, WA and the Pawsey High Performance Computing Centre in Perth, WA.

2.2 On 21 June 2010 the CSIRO wrote to the Committee seeking approval to proceed with these infrastructure works as an 'extension of scope' to already approved projects rather than 'new works' and having to undertake a referral to the Committee pursuant to the *Public Works Committee Act 1969*.

2.3 The Committee has previously undertaken inquiries into the Pawsey High Performance Computing Centre (Pawsey Centre) and the Australian SKA Pathfinder (ASKAP) project. These proposed extended works were raised with the Committee during both of those inquiries.

2.4 In consideration of the request, the Committee received a written brief and held a public hearing with the CSIRO on 24 June 2010.[3] A list of witnesses appearing at the public hearing is at Appendix A and the brief outlining the scope of works is at Appendix B.

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1 The Commonwealth Scientific and Industrial Research Organisation is commonly referred to as the CSIRO.

2 Media Release, Senator the Hon Kim Carr, Minister for Innovation, Industry, Science and Research, Jointly with the Prime Minister and the Treasurer, *Sustainable Energy Boost for Super Telescope Bid*,9 June 2010.

3 The transcript is available on the Committee's website at <aph.gov.au/house/committee/pwc/briefingdocuments/index>.

2.5 The CSIRO also provided advice from the Australian Government Solicitor's office confirming that the works could be considered an extension of scope, rather than 'new works'. This advice is at Appendix C.

Works proposed for ASKAP

2.6 The Australian Square Kilometre Array Pathfinder Telescope (ASKAP) will provide a survey radio telescope intended for international research in cosmology, transient radio sources, pulsar astronomy and the structure and magnetic field of the galaxy at a cost of $111 million.[4]

2.7 The Committee considered the ASKAP project in hearings held on 1 October 2008 and tabled its report recommending the House of Representatives resolve that the works proceed on 1 December 2008.

2.8 Infrastructure to be delivered for the ASKAP project under this proposal, at a cost of $27 million, is:

> a high renewable penetration hybrid power generation system, and will enable an energy efficient MRO control building to be constructed, as well as sophisticated geoexchange cooling to be developed and deployed for cooling ASKAP antenna electronics and the data processing system in the MRO control building.[5]

2.9 In the original proposal presented to the Committee on the ASKAP project, the CSIRO noted that it was seeking more renewable energy solutions to reduce the cost and environmental impact of powering the ASKAP.[6] In discussions at the hearing held on 1 October 2008, the CSIRO stated:

> In the submission we have about 20 per cent as a solar photovoltaic power system, and we are investigating mechanisms to provide more of the power using other solar technologies. CSIRO is involved in energy technologies as well, and we are working with the Division of Energy Technology to further that.[7]

2.10 In its June 2010 written brief to the Committee the CSIRO states:

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4 For details see the Committee's Report 9/2008.

5 CSIRO, additional brief submitted 23 June 2010, p. 3 (See Appendix B).

6 Submission 1, Australian SKA Pathfinder Radio Telescope, p. 20-21

7 Dr D. De Boer, CSIRO, Transcript of Evidence, 1 October 2008, p. 4

> The funding provided by EIF enables the ASKAP project to realise its stated goals in three important areas…
>
> - The development of remote power generation infrastructure that utilises renewable technologies to reduce reliance on traditional energy sources by over 50%... together with an underground power distribution network to minimise radio-frequency interference to the sensitive ASKAP receiver systems …
> - The development and use of ground coupled cooling systems to cool the electronics in the ASKAP antennas and the data processing facility in the MRO control building. The EIF Sustainable Energy for SKA project provides funding for the project to deploy passive geoexchange cooling technology on the MRO…
> - The enhancement of the energy efficiency of the MRO control building though building techniques that reduce the power load whilst also preserving the radio-frequency interference integrity of the building.[8]

2.11 Australian Government Solicitor advice obtained by the CSIRO states:

> In our view, these activities can properly be regarded as part of the proposed work that was the subject of the motion agreed to [by the House of Representatives] on 3 December 2008. We say that, in particular, because it appears from the material that the funding will be used, in effect, to enhance or further develop aspects of the proposed work that was before the PWC, rather than to introduce new components into the proposed work.[9]

2.12 The Committee finds that the works proposed by the CSIRO for the ASKAP project as part of the EIF initiative to be an extension of scope to those works put to it in October 2008 and approved by the House in December 2008.

Works proposed for the Pawsey High Performance Computing Centre

2.13 The Pawsey High Performance Computing Centre for SKA Science will provide facilities for researchers in high-end computation and data-

8 CSIRO, additional brief submitted 23 June 2010, p. 8 (See Appendix B).

9 Australian Government Solicitor, advice obtained by CSIRO, p. 5 (See Appendix C).

intensive science to support the ASKAP project as well as other computing science at a cost of $66 million.[10]

2.14 The Committee considered the Pawsey Centre project in hearings held on 16 April 2010 and tabled its report on 21 June 2010 recommending the House of Representatives resolve that the works proceed. In its report, the Committee noted the possible use of geothermal technology in conjunction with this project.

2.15 Infrastructure to be delivered under this proposal, at a cost of $20 million, is:

> A drilling program to access the hot sedimentary aquifer under the Perth basin to power an absorption chiller to meet the significant cooling requirements of the Pawsey Centre super computer and the heating/cooling requirements of the adjacent Australian Resources Research Centre (ARRC). The infrastructure will establish the Pawsey Centre as Australia's largest direct-heat geothermal demonstration site.[11]

2.16 In its original submission to the Committee on the Pawsey Centre project, the CSIRO noted the cost of cooling the data centre and its desire to utilise geothermal technology. At the Committee's hearing on 16 April 2010 in Perth, the CSIRO told the Committee:

> **CHAIR**—I dare say you are going to use a lot of energy to keep those data centres cool.
>
> **Dr Zelinsky**—Just to add to that, we do have another application in with the EIF for a geothermal cooling application to actually reduce the energy footprint. We have a colleague here, Steve Harvey, who spoke to you this morning, and he is available to give a bit of background to that if the committee should require it.
>
> **CHAIR**—That would be useful.
>
> **Dr Harvey**—CSIRO has an active interest in geothermal energy research and development. We have recently established a centre here in Perth together with our colleagues at Curtin University and the University of Western Australia. The particular focus of that centre is looking at tapping into the hot sedimentary aquifers that in the Perth Basin and tapping into the heat that is associated with those aquifers. We have done quite a lot of work looking at the viability of using the hot water with off-the-shelf chiller

10 For details see the Committee's Report 2/2010.

11 CSIRO, additional brief submitted 23 June 2010, p. 3 (See Appendix B).

> technology to cool the data centre as part of this proposal. At the moment, as Dr Zelinsky said, we have got a proposal in for funding support and a very large part of that is drilling wells into the Perth Basin to access that hot water.
>
> **Dr Bryce**—About half the cost of running the facility after its commissioning is to cool the system—hence the real enthusiasm for finding a means of doing that that is much less expensive than using electricity from the grid.[12]

2.17 In its June 2010 written brief to the Committee, the CSIRO states the this project will 'access the heat resource within the hot sedimentary aquifers within the Perth Basin to run off-the-shelf absorption chillers' through a drilling program comprising:

> … three, 3km deep wells be drilled in the ARRC site:
>
> - an exploration well to provide critical data (water temperature, flow rates and water chemistry) to inform the engineering design specifications for the production system; and
> - a production "doublet" – geothermal extraction and re-injection wells.[13]

2.18 While this project is new technology and its success can only be determined once the exploration well is drilled, the CSIRO is confident on data currently available to it that it will be successful. Use of this technology rather than electricity off the grid is estimated to result in an annual saving in the order of $2 million.[14]

2.19 Australian Government Solicitor advice obtained by the CSIRO states:

> … it appears from the CSIRO's submission to the PWC … from evidence given to the PWC at its hearing on 16 April 2010 … and from the PWC's report itself … that the possible utilisation of geothermal energy for the purposes of the Pawsey Centre building was part of the proposed work.
>
> …
>
> In summary, it appears to us that the EIF funded works would increase the cost of the proposed work the subject of the motion of the House, but would not change it into a different work.[15]

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12 CSIRO, Transcript of Evidence, 16 April 2010, p. 11-12.

13 CSIRO, additional brief submitted 23 June 2010, p. 3 (See Appendix B).

14 Dr S. Harvey, CSIRO, Transcript of Evidence, 24 June 2010, p. 4, 5.

15 Australian Government Solicitor, advice obtained by CSIRO, p. 5 (See Appendix C).

2.20 The Committee finds that the works proposed by the CSIRO for the Pawsey Centre as part of the EIF initiative to be an extension of scope to those works put to it in April 2010 and approved by the House in June 2010.

Committee findings

2.21 The Committee takes seriously its responsibility to ensure that all proposed infrastructure works put to it are necessary, with an appropriate scope and cost. This is a significant investment and it should not be undertaken without proper scrutiny.

2.22 However, in reviewing the evidence put to it in October 2008 and April 2010 as part of the Pawsey Centre and ASKAP project inquires alongside the proposal put to it in June 2010 by the CSIRO and advice from the Australian Government Solicitor's office, the Committee is satisfied that these works are an extension of scope, rather than 'new works'.

2.23 Therefore, the Committee finds that works should proceed without the need for a referral to it under the *Public Works Committee Act 1969*.

Senator the Hon Judith Troeth
Deputy Chair
12 July 2010

A

Appendix A – List of witnesses

Monday 24 June 2010 – Canberra

Public Hearing

Commonwealth Science and Industrial Research Organisation (CSIRO)

Dr David DeBoer, Research Scientist, Australia Telescope National Facility, Astronomy and Space Science

Dr Steve Harvey, Deputy Business Unit Leader, Earth Science and Resource Engineering

Mr Antony Mikulic, Manager, Capital Projects, Property Services

Dr Michelle Storey, Research Scientist, CSKA, Astronomy and Space Science

Dr Alex Zelinsky, Group Executive, Information Sciences

B

Appendix B – Scope of works

CSIRO

SUBMISSION TO
THE PARLIAMENTARY STANDING
COMMITTEE ON PUBLIC WORKS

Proposed Extension of Scope to the Pawsey High Performance Computing Centre and the Australian SKA Pathfinder (ASKAP) Radio Telescope Projects for the Provision of Sustainable Energy

June 2010

www.csiro.au

Proposed Extension of Scope to the Pawsey Centre and ASKAP Projects for the Provision of Sustainable Energy

1.0 Introduction

The Pawsey High Performance Computing Centre project was referred in March 2010 to the Parliamentary Standing Committee on Public Works (PWC) for examination. A public hearing was conducted by the Committee at Bentley, Western Australia on 16 April 2010, at which the possibility to provide cooling to the Pawsey Centre through geothermal power was raised with the Committee.

The CSIRO Australian SKA Pathfinder (ASKAP) radio telescope project was submitted to the PWC in June 2008 and a hearing was held in Geraldton in October 2008. The ASKAP project was approved by the PWC and the work was approved by Parliament in December 2008. The ASKAP proposal outlined that the power generation system for the Murchison Radio-astronomy Observatory (MRO) was being constructed to enable a higher penetration renewable energy solution to be deployed for ASKAP when it became feasible to do so. During the PWC hearing it was raised that the ASKAP team were exploring mechanisms to provide more of the MRO power using solar technologies.

On 9 June 2010 the Prime Minister announced funding of $47.3 million through the Commonwealth Government's Education Investment Fund (EIF) Sustainability Round for the *Sustainable Energy for SKA* project. The project will support the construction in Western Australia of renewable energy infrastructure for the Pawsey Centre and for ASKAP at the Murchison Radio-astronomy Observatory.

The Square Kilometre Array (SKA) is a major international project currently under development by scientists from 50 institutions across 19 countries, with a project construction budget in excess of Euro 2 billion. The project involves the development, construction and operation of the world's largest radio telescope. Provision of energy for the data intensive SKA operation is a major challenge for the international project. Effective demonstration of renewable energy solutions for the SKA pathfinder projects the Pawsey Centre and ASKAP will strengthen Australia and New Zealand's bid for hosting the SKA.

The EIF funding enables CSIRO to take up options for renewable technology deployments described and foreshadowed in the Pawsey Centre and ASKAP PWC

submissions. CSIRO is seeking the agreement of the Committee that the *Sustainable Energy for SKA* EIF-funded project be considered as an extension in the scope of the Pawsey Centre and ASKAP projects.

Approximately $20 million of the EIF grant awarded will be invested in a drilling program to access the hot sedimentary aquifer under the Perth basin to power an absorption chiller to meet the significant cooling requirements of the Pawsey Centre supercomputer and the heating/cooling requirements of the adjacent Australian Resources Research Centre (ARRC). The infrastructure will establish the Pawsey Centre as Australia's largest direct-heat geothermal demonstration site.

Approximately $27 million of EIF funding will be invested in infrastructure that will deliver a high renewable penetration hybrid power generation system, and will enable an energy efficient MRO control building to be constructed, as well as sophisticated geoexchange cooling to be developed and deployed for cooling ASKAP antenna electronics and the data processing system in the MRO control building.

2.0 Geothermal Infrastructure in Support of the Pawsey Centre

2.1 Background

The Pawsey Centre is a key part of the Federal Government's strategy to address the paucity of high ranked supercomputing systems in Australia. The supercomputer to be installed at Kensington will be at the forefront of facilities in Australia and will rank among the top twenty such facilities in the world at the time of its commissioning in 2013.

CSIRO will own and maintain the Pawsey Centre building. The supercomputer will be operated by iVEC, an unincorporated joint venture between CSIRO, Curtin University of Technology, Edith Cowan University, Murdoch University and the University of Western Australia.

The location of the proposed works is in Kensington, Perth on a CSIRO owned Greenfield site. It is situated adjacent to CSIRO's ARRC facility in Technology Park, Bentley approximately 6 km from the Perth CBD – see site map below.

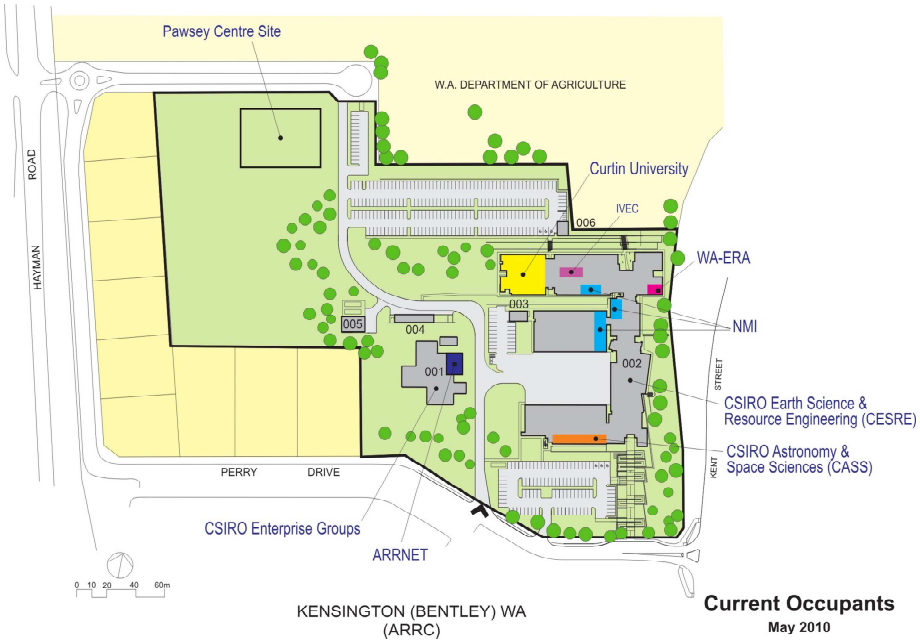

Figure 1. Site of the Pawsey Centre and ARRC facility

Recurrent operating costs associated with the Pawsey Centre will be significant, with electricity costs associated with running and cooling the supercomputer and associated infrastructure likely to exceed $5 million per annum. Of this total, up to 40% ($2 million pa) can be directly associated with the cost of cooling the Centre.

The geothermal component of this project aims to access the heat resource within the hot sedimentary aquifers within the Perth Basin to run off-the-shelf absorption chillers which will meet the cooling needs of the Pawsey Centre and the heating/cooling needs of the adjacent ARRC facility.

2.2 Objectives and Infrastructure Requirements

The objective of the geothermal component of the proposal is to establish the Pawsey Centre/ARRC as Australia's first large scale ($10MW_{th}$) direct heat geothermal demonstration site.

Other than CSIRO's cash contribution of $1.5 million for the acquisition of down-hole monitoring equipment for the exploration/research well, the proposed budget is directed exclusively towards the geothermal drilling program.

The drilling program proposes that three, 3km deep wells be drilled on the ARRC site:

- an exploration well to provide critical data (water temperature, flow rates and water chemistry) to inform the engineering design specifications for the production system; and
- a production “doublet” – geothermal extraction and re-injection wells.

The diagram below provides a generic schematic representation of a direct heat geothermal demonstrator, incorporating a slim-line exploration well, and extraction and reinjection production wells.

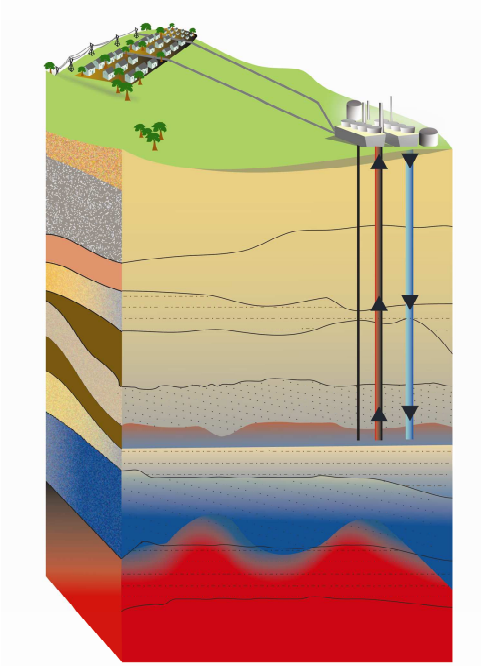

Figure 2. Schematic representation of a direct heat geothermal plant, incorporating a slim-line exploration well (black), and extraction (brown) and reinjection (blue) production wells.

The exploration well is critical as there are no hard data indicating water temperature (and chemistry) at depths of ~3 km in the Perth Basin – the proposed depth of the geothermal production wells.

This depth of drilling is based on data sourced from a ~800m Water Corporation bore adjacent to the ARRC site. Data recently acquired from re-logging this bore by the

WA Geothermal Centre of Excellence, suggest water temperatures of ~100^{O}C at a depth of 3km.

Current planning is based on a single deployment of a drill rig to minimise costs. In other words, all three wells will be drilled sequentially with minimal time delay between the exploration and production drilling programs – sufficient only to acquire the necessary engineering design specifications.

After acquiring the necessary design data from the exploration well, it is proposed that it be maintained at a depth of 1km as a research well to provide real time data on production well performance for R&D education & training purposes and as a test bed for down-hole monitoring equipment.

2.3 Budget

Infrastructure Item	**EIF Funding ($ million)**	**Other Funding ($ million)**
Exploration/Research Well	[redacted]	[redacted]
Production (extraction) Well	[redacted]	[redacted]
Production (re-injection) Well	[redacted]	[redacted]
Drilling Contingency	[redacted]	[redacted]
Down-hole Sensors	[redacted]	[redacted]
Project Management	[redacted]	[redacted]
Totals	**19.80**	[redacted]

3 Energy Management for the Murchison Radio-astronomy Observatory

3.1 Background

The Australian SKA Pathfinder (ASKAP) radio telescope will be an array of up to 36 parabolic dishes, each of 12 metres diameter. Phased array feed receivers at the focus of each dish will measure radio waves received from astronomical sources at frequencies between 800 MHz and 1700 MHz. The signals will be electronically

combined in a data processing facility at the MRO, and transmitted to a large supercomputer at the Pawsey Centre that will further process the information.

The ASKAP telescope will deliver world-leading performance in a wide range of applications including cosmology, the study of transient radio sources, pulsar astronomy, and the study of the structure and magnetic field of our own galaxy.

ASKAP is being constructed in the Mid West of Western Australia at the Murchison Radio-astronomy Observatory (MRO). The MRO is approximately 315 km north east of Geraldton, on land within Boolardy Station pastoral lease (see Figure 3).

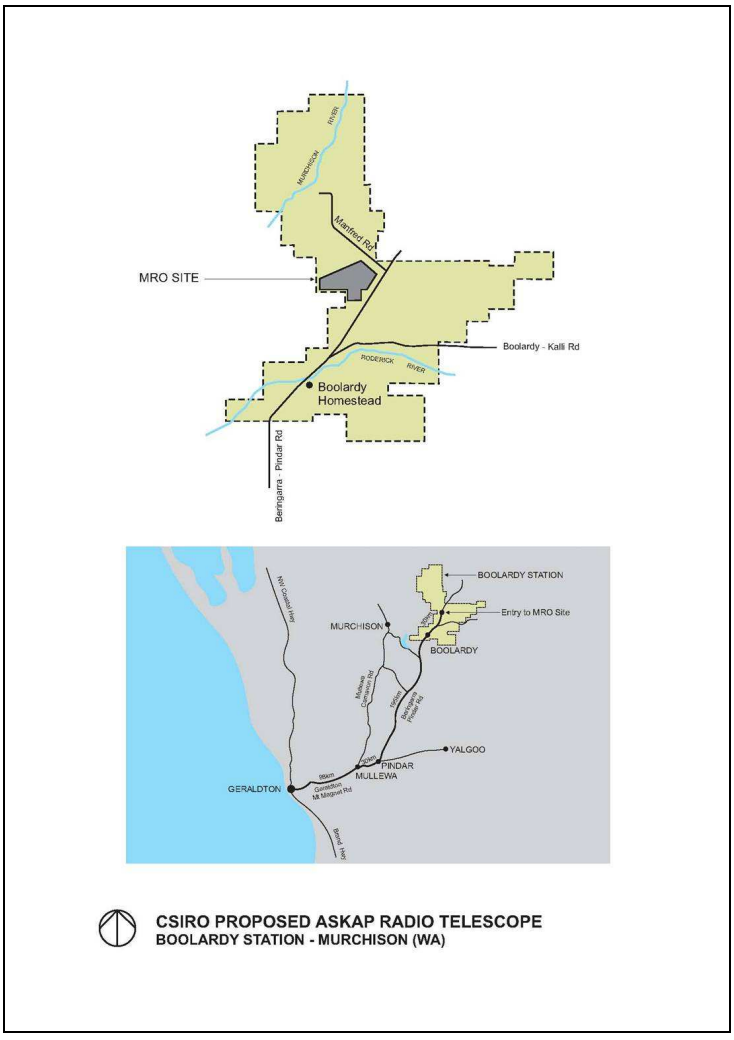

Figure 3. Site of the Murchison Radio-astronomy Observatory

The MRO is also Australia's candidate site for the international Square Kilometre Array radio telescope. Effective demonstration of renewable energy solutions at the MRO will strengthen Australia and New Zealand's bid for hosting the SKA.

3.2 Objectives and Infrastructure Requirements

The MRO is too remote for feasible provision of power through the grid. In order to minimise capital and operating expenses in power provision, there is a strong need for careful demand side management in the design of the telescope and support infrastructure. In addition, there is a need to provide as much power as possible through clean energy sources to minimise the carbon footprint of the operation.

The funding provided by EIF enables the ASKAP project to realise its stated goals in three important areas, which are outlined in more detail in the sections below:

- The development of remote power generation infrastructure that utilises renewable technologies to reduce reliance on traditional energy sources by over 50% (paragraphs 6, 160, 161 of 2008 PWC ASKAP submission), together with an underground power distribution network to minimise radio-frequency interference to the sensitive ASKAP receiver systems (paragraphs 162-165 of 2008 PWC ASKAP submission)
- The development and use of ground coupled cooling systems to cool the electronics in the ASKAP antennas and the data processing facility in the MRO control building. The EIF Sustainable Energy for SKA project provides funding for the project to deploy passive geoexchange cooling technology on the MRO (para 157 of 2008 PWC ASKAP submission
- The enhancement of the energy efficiency of the MRO control building through building techniques that reduce the power load whilst also preserving the radio-frequency interference integrity of the building (para 157 of ASKAP submission).

3.2.1 Power generation system

The peak power load of ASKAP and other facilities on the MRO is estimated to be of order 1 MW. CSIRO has been in negotiations with Horizon Power, a 100% WA Government owned company, regarding Horizon Power's provision of a solar/diesel hybrid power system to provide the energy requirements of the MRO. Horizon Power has proposed an initial investment by the company [redacted] in the initial power station infrastructure for ASKAP. The EIF funding provides $2.5 million to enhance the renewable component of the initial solar/diesel hybrid power station.

The proposed site for the power station is indicated in Figure 4. Clearing permits for the power station land have been obtained from WA Department of Environment and Conservation and, because the project goal has been to seek to enhance the renewable component, the clearing permit obtained includes sufficient land for the enhanced renewable deployment now possible with funding under EIF.

Figure 4. The MRO, showing the locations of the MRO control building and the proposed site for the power generation system

ASKAP, as a radio telescope that operates 24/7, has an unusually flat electrical load profile. This presents particular challenges for renewable solar energy provision, due to the expense of energy storage required to enable overnight operation. The EIF funding provides a further $11 million in 2013 for implementation of a next-generation energy system to enhance the renewable penetration of the power generation system. The goal is to reduce reliance on traditional energy sources by >50%. Various options will be investigated over the next two years to determine the most appropriate technology to achieve this goal. One option is further photovoltaic cells and battery storage, but it is possible that technologies currently under prototyping development, such as solar thermal plants, may be deployable on this timescale. We expect, at this stage, that the land already set aside on the MRO for the power station will be sufficient for this next-generation deployment.

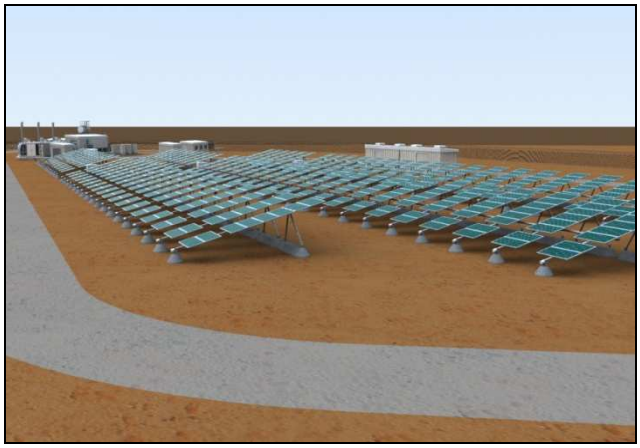

Figure 5. An artist's impression of a hybrid diesel/solar PV power station similar to the proposed initial power station for the MRO.

3.2.2 Demand-side management

Ground-coupled cooling system

CSIRO has been exploring with Direct Energy, an Australian start-up company, the potential for use of geoexchange direct heat pump cooling system for the ASKAP antenna electronics and the cooling requirements of the MRO control building. This technology has the potential to significantly reduce the power demand of the ASKAP system. Direct Energy is a co-investment partner in the *Sustainable Energy for SKA* project, and EIF funding of $3 million has been provided to fund the installation of geoexchange direct heat pump cooling at the MRO.

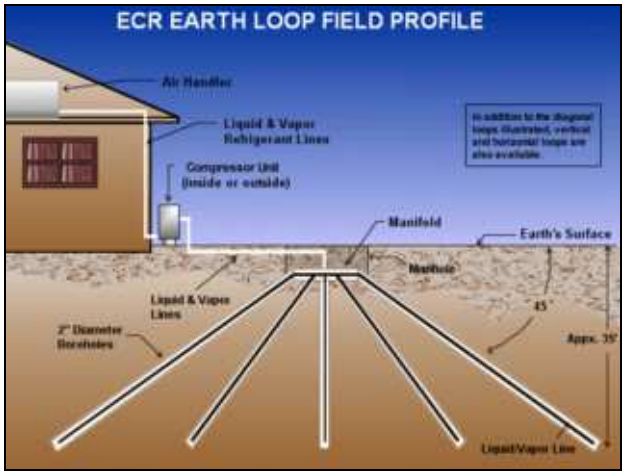

Figure 6. A schematic illustrating a direct heat pump geoexchange cooling system.

MRO control building

The MRO control building presents an unusual challenge. The intensive processing of raw ASKAP data required in the building is energy intensive and generates significant heat. On the other hand, the stringent radio-frequency screening requirements of the building, necessary to preserve the pristine radio-quiet environment of the MRO, limits traditional techniques of passive cooling such as enhanced free air flow. A design study has optimised the energy efficiency solutions for the MRO control building and EIF funding of $4.5 million has been provided to enable a building to be constructed that is sensitive to energy efficiency and yet meets the stringent radio-quietness constraints.

3.3 Budget

The Table below indicates a budget breakdown of the MRO component of the *Sustainable Energy for SKA* project. EIF funding, and other funding are indicated.

Infrastructure Item	**EIF funding ($million)**	**Other Funding ($million)**
MRO Control building	[redacted]	[redacted]
Geoexchange cooling at MRO	[redacted]	[redacted]
Power distribution network	[redacted]	[redacted]
1st stage power generation system	[redacted]	[redacted]
2nd stage renewable power generation system	[redacted]	[redacted]
Project management	[redacted]	
Performance monitoring/education	[redacted]	[redacted]
Total	**27.5**	[redacted]

4.0 Environmental Impact

Establishing the Pawsey Centre/ARRC as a geothermal demonstration site will confirm the long-held potential of the Perth Basin as a significant direct heat renewable energy source. If successful, the Pawsey Centre/ARRC deployment will provide proof-of-concept for much larger-scale exploitation of the Perth Basin hot, sedimentary aquifers and thus has the potential to significantly reduce the carbon footprint of the Perth metropolitan area. Specifically, the geothermal demonstrator will reduce energy consumption at the Pawsey Centre by up to 40%. Our plan includes provision for full environmental approvals to ensure that developments at the Pawsey Centre/ARRC showcase best-practice sustainable management of the aquifer resource within the Perth basin.

The energy management systems proposed for the MRO will reduce the carbon footprint of the radio astronomy operations at the MRO by over 50%, and thus will assist CSIRO to reach its goal of carbon neutrality. The development of sustainable energy solutions for the SKA pathfinders will also assist the international SKA program to develop energy efficient solutions for SKA deployment.

CSIRO has already obtained environmental approvals and clearing permits for the MRO land proposed for the power generation system, and is committed to follow a detailed Environmental Management Plan for the site.

This investment has the potential to cut energy costs by $5 million per year, and reduce Australia's carbon emissions by 12,000 tonnes per year - the equivalent of taking 6,000 cars off the road.

5.0 Community Impact

Performance monitoring data from the energy infrastructure is to be made available via a web-accessible interface to enable learning institutions to utilise the data in teaching and learning programs. The EIF funded infrastructure will thus have broad impact in the development of renewable energy technologies in Australia and overseas. It is estimated that the data generated will support more than 20 existing research groups in Australia, and has the potential to create more than 15 new research collaborations. In addition, construction of the infrastructure is expected to generate over 80 jobs for the duration of construction, including many in regional areas.

The EIF-funded renewable energy technologies proposed for the Pawsey Centre and ASKAP were described and flagged as options being pursued in the previous submissions on these projects to the PWC. The community have been consulted about the projects and submissions by members of the public on the projects were reviewed by the PWC.

6.0 Timing

The Table below indicates the key development milestones for the project.

Planned Project Milestone	**Expected Completion Date of Project Milestone**
Commissioning of MRO control building completed.	May 2011
Commencement of geothermal drilling program – exploration/research well, followed by production wells.	August 2011
Completion of geothermal drilling program and equipment installation down- hole.	November 2011
MRO power station and distribution network construction and commissioning completed.	December 2011
Commissioning of geoexchange cooling: antennae & central site completed.	March 2012
Installation commencement for next-generation renewable penetration technology at MRO.	March 2013
Installation of next-generation renewable penetration technology at MRO completed.	August 2013
Project completion.	December 2013

7.0 Conclusion

CSIRO has presented an outline of the infrastructure to be constructed under the *Sustainable Energy for SKA* EIF project. The EIF funding enables CSIRO to take up

options for renewable technology deployments described and foreshadowed in the Pawsey Centre and ASKAP PWC submissions. The EIF funded infrastructure will have broad impact in the development of renewable energy technologies in Australia and overseas.

CSIRO is seeking the agreement of the Committee that the *Sustainable Energy for SKA* EIF-funded project be considered as an extension in the scope of the Pawsey Centre and ASKAP projects.

C

Appendix C – Australian Government Solicitor Advice

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Your ref. CLIO200800035
Our ref. 10040569

2 July 2010

Mr Mark Baker
Senior Legal Counsel
Commonwealth Scientific and Industrial
Research Organisation
GPO Box 1483
CANBERRA ACT 2601

Dear Mr Baker

Public Works Commitee Act 1969

1. Thank you for your request for urgent advice dated 30 June 2010 concerning the application of the *Public Works Committee Act 1969* (PWC Act) in relation to the Pawsey High Performance Computing Centre (the Pawsey Project) and the Australian SKA Pathfinder (ASKAP) Radio Telescope (ASKAP Project).

SUMMARY OF ADVICE

2. In our view, the works proposed to be funded under the *Sustainable Energy for SKA* project would not give rise to the need for a new approval process to be undertaken with the Parliamentary Standing Committee on Public Works (PWC) in respect of the Pawsey Project or the ASKAP Project. In this context, in our view, carrying out the works would not have the effect that there is a new or different work to the proposed work that has been the subject of an expediency resolution in the House of Representatives in respect of each of the Pawsey Project and the ASKAP Project.

THE PAWSEY PROJECT

3. On 18 March 2010 the House of Representatives agreed to the following motion:

> That, in accordance with the provisions of the *Public Works Committee Act 1969*, the following proposed work be referred to the Parliamentary Standing Committee on Public Works for consideration and report: Pawsey High Performance Computing Centre for SKA Science at Kensington, Western Australia.

4. In short form the proposed scope of the works for the Project was described in Report 2/2010 of the PWC as follows (at p 33):

- Pawsey Centre building to house the high performance computing facility including:
  - Single story building with 4,000 square metres gross floor area providing working accommodation for administrative and ancillary support, computer hall and plant rooms;

- Mechanical services;
- Electrical services;
- Hydraulic services; and
- Landscaping.

— High performance computing (HPC) facility will comprise:

- High performance computing subsystem;
- Disk storage subsystem; and
- Tape storage subsystem[1]

5. The total estimated out-turn cost for the Project is stated in the Report to be $66 million comprising $26 million in building works and $40 million for the HPC system (see p 33 of the Report).

6. On 24 June 2010 the House of Representatives resolved that it was expedient to carry out the proposed work.

7. It appears from a further submission that has been made by the CSIRO to the PWC in respect of the Pawsey Project - Proposed Extension of Scope to the Pawsey High Performance Computing Centre and the Australian SKA Pathfinder (ASKAP) Projects for the Provision of Sustainable Energy (the further submission) - that certain Commonwealth funding (EIF grant) has become available that would 'support the construction in Western Australia of renewable energy infrastructure for the Pawsey Centre...' (see p 2 of the further submission). The proposed use of this funding has been described in the further submission as follows (at p 3):

> Approximately $20 million of the EIF grant awarded will be invested in a drilling program to access the hot sedimentary aquifer under the Perth basin to power an absorption chillier to meet the significant cooling requirements of the Pawsey Centre supercomputer and the heating/cooling requirements of the adjacent Australian Resources Research Centre (ARRC). The infrastructure will establish the Pawsey Centre as Australia's largest direct-heat geothermal demonstration site.

8. We understand that an issue has arisen whether the activities contemplated by the EIF grant, described in some detail in the further submission, need to be treated as a separate new work for the purposes of the PWC Act rather than as a part of the proposed work that was the subject of the motion agreed to by the House on 24 June 2010.

9. In our view, those activities can properly be regarded as part of the proposed work that was the subject of the motion agreed to on 24 June 2010.

10. In particular, it appears from material in the CSIRO's submission to the PWC (see p 16), from evidence given to the PWC at its hearing on 16 April 2010 (see the

[1] Submission 1, CSIRO, p.10 -11, Report 2/2010

evidence of Dr Harvey at PW 11) and from the PWC's report itself (see paras 6.21-6.23), that the possible utilisation of geothermal energy for the purposes of the Pawsey Centre building was part of the proposed work. For example, at para 6.21 of the PWC's report, after referring to the fact that 'the CSIRO has told the (PWC) that it is looking at utilising the geothermal energy of the Perth basin to reduce the impact of cooling in the building' the report states that 'subsequently, the Government has announced funding for the construction of geothermal and solar power generation and distribution infrastructure...and the Pawsey High Performance Computing Centre'.

11. We note that the further submission also refers to the geothermal component also meeting the heating/cooling needs of the adjacent Australian Resources Research Centre (ARRC) facility. We do not think this feature of the geothermal component means that the work is not the same proposed work that was the subject of the motion agreed to by the House on 24 June 2010. That is to say, we do not think that the fact that the ARRC facility would also be intended to benefit from the geothermal energy has the effect that the work cannot be seen, in substance, as a work concerned with the Pawsey Centre. As we understand the matter, the geothermal component would not take place but for the Pawsey Centre. As between the Centre and the ARRC facility it will be the Centre that will, overwhelmingly, have access to any benefit to be derived from the utilisation of the geothermal energy. In these circumstances, in relation to any possible application of the PWC Act, any access that the ARRC facility will have to the geothermal energy could be seen as merely incidental to the access intended to be enjoyed by the Pawsey Centre.

12. In summary, it appears to us that the EIF funded works would increase the cost of the proposed work the subject of the motion in the House, but would not change it into a different work.

THE ASKAP PROJECT

13. On 18 March 2008 the House of Representatives agreed to the following motion:

> That, in accordance with the provisions of the *Public Works Committee Act 1969*, the following proposed work be referred to the Parliamentary Standing Committee on Public Works for consideration and report: Proposed Australian SKA Pathfinder radio telescope in Geraldton-Greenough and in Murchison Shire, WA.

14. In short form the proposed scope of the works for the Project was described in Report 9/2008 of the PWC as follows (at p 8):

> **Scope of works**
>
> The proposed scope of works is detailed in Submission 1: CSIR0. The project will provide the infrastructure necessary for the operation of the ASKAP. In short, the project proposes the following works:
>
> - the antenna array, consisting of up to 36 parabolic antennas, mounted on concrete footings, and distributed over the Murchison Radio-astronomy Observatory (MRO) site. Each antenna has a 12 metre diameter reflector. Each antenna site will be provided with lightning protection in the form of

an earth mat and will be provided with in ground power and data connection. The antennas will be equipped with sophisticated phased array feed receivers at the focus of the dish reflector, and beamformer and other electronics in the antenna pedestal;

- a central compound, located within the MRO site, containing a control building, site services and areas for storage;
- a remote power generation facility, adjacent to the central compound;
- renovated facilities within the Boolardy Station homestead precinct to provide accommodation, working, and recreational facilities for additional staff and visitors to the MRO. The facilities will provide for after-hours remote monitoring of the equipment at the MRO;
- an MRO Support Facility (MSF) located at the Geraldton Universities Centre in Geraldton-Greenough, WA. This facility will contain a telescope control room, computer room, monitoring and processing equipment, electrical and mechanical workshops, office and meeting space and amenities. The building will also include an education/ outreach centre;
- access and services infrastructure, including access corridors at the MRO, fencing, power reticulation, data and communications cabling, water and waste water management;
- high bandwidth optic-fibre cabling connecting the MRO to the MSF to provide essential data connectivity; and
- radio telescope infrastructure in NSW to connect to ASKAP in Western Australia to achieve high resolution pictures of the sky and to demonstrate cross-continent connectivity at astronomically useful data rates.[2]

15. The total out-turn cost for the Project is scheduled to be $111 million (excluding GST) (see p 9 of the Report).

16. On 3 December 2008 the House of Representatives resolved that it was expedient to carry out the proposed work.

17. It appears that 'ASKAP is being constructed in the Mid West of Western Australia at the Murchison Radio-astronomy Observatory (MRO)' (see p 7 of the further submission).

18. It appears from the further submission that certain Commonwealth funding (EIF grant) has become available that would 'support the construction in Western Australia of renewable energy infrastructure for the...ASKAP at the Murchison Radio-astronomy Observatory' (see p 2 of the further submission). The proposed use of this funding has been described in the further submission as follows (at p 3):

[2] Submission 1, CSIRO, p.12, Report 2/2010.

> Approximately $27 million of EIF funding will be invested in infrastructure that will deliver a high renewable penetration hybrid power generation system, and will enable an energy efficient MRO control building to be constructed as well as sophisticated geoexchange cooling to be developed and deployed for cooling ASKAP antenna electronics and the data processing system in the MRO control building.

19. We understand that an issue has arisen whether the activities contemplated by the EIF grant, described in some detail in the further submission, need to be treated as a separate new work or works for the purposes of the PWC Act rather than as a part of the proposed work that was the subject of the motion agreed to by the House on 3 December 2008.

20. From the available material (see p 8 of the further submission) it appears that these activities fall into the following areas;

- the development of remote power generation infrastructure (together with an underground power distribution network to minimise radio-frequency interference to the ASKAP receiver systems)
- the development and use of ground coupled cooling systems and
- the enhancement of the energy efficiency of the MRO control building.

21. In our view, these activities can properly be regarded as part of the proposed work that was the subject of the motion agreed to on 3 December 2008. We say that, in particular, because it appears from the material that the funding will be used, in effect, to enhance or further develop aspects of the proposed work that was before the PWC rather than to introduce new components into the proposed work.

22. For example, an important element of the proposed work is 'a remote power generation facility, adjacent to the central compound' (see para 2.13 of the Report).It appears to have been contemplated that there would be a 'mix' of traditional and renewable components in the power generation system (see para 160 of the CSIRO's submission). However, the EIF funding will enable a greater use of renewable technologies over reliance on traditional energy sources for that facility than had previously been contemplated. A possible change to the mix had been 'flagged' with the PWC (see para 199 of the CSIRO's submission to the PWC and the evidence given to the PWC by Dr DeBoer on 1 October 2008 at PW4).

23. Another important element of the proposed work is 'a central compound, located within the MRO site, containing a control building, site services and areas for storage' (see para 2.13 of the Report). The CSIRO's submission underscores the need for buildings and other structures to have appropriate features given the climate and the operations of those structures (see, for example, paras 157 and 201 of the CSIRO's submission). It is intended to use the EIF funding for the purpose of enhancing the control building's energy efficiency without compromising the integrity of the radio frequency.

24. Also, the intended use of funding on development of an underground power distribution network and the development and use of ground coupled cooling

systems relate to aspects of the proposed work dealt with in the CSIRO's submission (see paras 157 and 162-165). In relation to the latter aspect the submission states that 'passive solar design and ground coupled cooling systems will significantly reduce the base load and peak power requirements. Technologies and providers of such systems have been identified'.

25. In summary, it appears to us that the EIF funded works would increase the cost of the proposed work the subject of the motion in the House, but would not change it into a different work.

26. If you have any queries in relation to this matter, please don't hesitate to contact me.

Yours sincerely

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