



SEDO GRANTS PROGRAM

Research and Development Project Application Form

The Sustainable Energy Development Office (SEDO) Grants Program provides grants for community-based sustainable energy initiatives and sustainable energy research and development projects. This application form is for Research and Development projects.

Applications for grants can be made through competitive funding rounds. The eligibility requirements for research and development projects and the process for making an application are set out in the *Research and Development Project Guidelines*.

The guidelines, details of the next funding round, information about research and development projects and further information about the SEDO Grants Program are available by contacting SEDO on 9420 5685 or sgc@energy.wa.gov.au. Further information is also available online at www.sedo.energy.wa.gov.au. All applications should be sent to sgc@energy.wa.gov.au.

1. APPLICATION SUMMARY

The Applicant must be the organisation that will be responsible for implementing the project.

Project title	A general purpose data logging system for weather, environmental noise, energy use and production monitoring stations for schools.	
Applicant name	University of Western Australia	
Applicant ABN	37 882 817 280	
Applicant type	<input checked="" type="checkbox"/> University <input type="checkbox"/> Registered business with an ABN <input type="checkbox"/> Government organisation <input type="checkbox"/> Incorporated, not-for-profit organisation	
Grant amount applied for (\$)	20,000	

2. APPLICANT CONTACT PERSON

Name	Jonathon Thwaites	Prof Jie Pan
Position	Convenor ATA WA	Director of Centre for Acoustics, Dynamics and Vibration School of Mechanical Engineering, UWA
Phone	0419 924 355	6488 3600
Email	jthwaites@admin.uwa.edu.au	pan@mech.uwa.edu.au
Postal address	Safety and Health M350, University of Western Australia	
Suburb / town	Crawley WA	Postcode 6011

3. PROJECT INFORMATION

The project must primarily relate to stationary, sustainable energy.

Project type

Select the box most relevant to the proposed project.

- Research and development of a particular new and innovative sustainable energy product, service or discrete sustainable energy installation.
- Research that assists the development of the wider WA sustainable energy industry.
- Research that assists groups of WA energy consumers or energy suppliers to increase their use of renewable energy or adoption of energy efficiency.

3.1 Briefly summarise the purpose of the project *(maximum 50 words)*

The project is to develop an integrated weather station, noise and simple data logging system to allow students in schools, technical colleges and other educational institutions to use the data collected to run education programs using real data for their own circumstances and location. The system would include web hardware and software to allow the data collected to be available in real time on the web.

It is envisioned that data from a network of logging systems in more than 100 schools, many of who will be participating in the Solar Schools project, will be available through a central server either at the University of Western Australia or within the Education Department of Western Australia.

Data logging of power usage for various appliances, water heaters, air conditioners, lighting, etc and temperature and noise levels and ambient climate conditions outside and inside buildings will be implemented.

All of the source code and technical notes will be made available and shared between schools on the central server site. Educational packages, web training, project suggestions and new developments will be maintained on the web for school usage and sharing.

3.2 Briefly summarise the activities that will be undertaken as part of the project *(maximum 50 words)*

- Review equipment available on the market for general data and weather station logging.
- Develop software and electronic hardware for logging.
- Develop interactive web and site and software for storing and accessing data on line.
- Establish a centralised server at UWA for the web sites.
- Coordinate the role out of the logging systems.
- Develop course materials and experimental procedures for schools.

3.3 Briefly summarise the expected outcomes of the project (i.e. the project deliverables)

(maximum 50 words - note that a more detailed description of project outcomes is required under Section 4)

The benefits to arise from this project are to provide a significant input into the promotion and general awareness for young people of renewable energy and sustainable technology in Western Australia. In particular it will graphically demonstrate the links between climate, energy usage and habits, total energy used and the capacity to generate useful energy in the form of electricity.

It is envisioned the network of weather stations and data logging will eventually become Australia wide, although at this stage Western Australia is our target. On the central web site there will be a map of WA with a dot indicating active and/or live data logging sites. Clicking on any dot will bring onto the users screen detailed data from that site, current activities and information. There will be predesigned experimental and study projects, quizzes and worksheets for students and to assist teachers.

3.4 Additional information

Please include further information on any other activities that will be undertaken as part of the project and/or any background information on the project where necessary.

At this time the Solar Schools project needs to include the full picture in relation to energy use and production to provide a comprehensive learning tool. Knowing how much energy is produced by a PV system has very limited educational value. To be able to link energy use and production with climate data provides a tool which has very high educational value. Numerous data correlation and graphing exercises become available as well as very first hand conceptual link between climate and the data sets. This is of extremely high educational value.

The ambient noise logging research part of this project fits neatly into the major aim of the project relating to energy use and production. Professor Pan is heavily involved in noise research is keen to link the two projects. This will allow him to allocate senior engineering student project time to establishing the logging and web site systems.

In particular Prof. Pan is interested in the monitoring of environmental noise levels in different schools, as the recent research in Munich Airport study indicates that noise actually affects school students' reading comprehension, conceptual and information recall, and recognition in long term memory and prospective memory. On the other hand, the noise measurement must be linked with wind speed and temperature measurements, so that the effect of weather on noise can be evaluated as well.

Therefore, the environmental noise monitoring goes well with the proposed weather station and data logging systems. This would be the first attempt in the world!

On the education part, the dB time curve (even with frequency), and its relation to hearing loss and assigned classroom noise level are useful for school students and teachers to study the environmental noise, its monitoring, awareness of noise pollution, and relation to hearing loss and efficiency of study.

3.5 Project evaluation methodology

Please describe the methodology that will be used to evaluate the outcomes of the project.

Research papers, educational lesson plans, active web sites and web site hits will be measured. The project is likely to be emulated in other states of Australia and around the world.

3.6 Is the project dependent on any other sources of funding that are yet to be approved, or are there any other factors that may affect implementation of the project?

If yes, please provide details.

We will be applying for funding from the EPA, Worksafe, and Education Dept but the funding applied for here will be sufficient to establish the project's credentials and deliver a working network of web sites and logging systems.

4. STATEMENTS AGAINST THE ASSESSMENT CRITERIA

Please address the following questions which relate to the assessment criteria outlined in the Research and Development Project Guidelines. Note that all sections must be completed.

4.1 Potential to increase the wider use of renewable energy or energy efficiency

Please describe the extent to which the project will assist broad groups of WA energy consumers or suppliers to increase their use of renewable energy or adoption of energy efficiency.

The benefits to arise from providing a **significant input into the promotion and general awareness** of renewable energy and sustainable technology in Western Australia in particular in schools.

This will eventually lead to a general increase in the uptake of the technology and a **reduction in energy use and an increase in use of more sustainable practices** by younger generations as they become adults.

The noise research will be invaluable and ground breaking addition to our knowledge of how learning works and can be made more efficient.

The project will establish a new paradigm in how solar projects are conducted around the world and this will add greatly to the kudos of organisations in WA.

4.2 Benefits provided to the WA sustainable energy industry

Please describe the benefits that will be provided to the WA sustainable energy industry, including the number of industry members involved and the extent to which they benefit.

The benefits to arise from this project are to provide a significant input into the promotion and general awareness for young people of renewable energy and sustainable technology in Western Australia. In particular it will graphically demonstrate the links between climate, energy usage and habits, total energy used and the capacity to generate useful energy in the form of electricity.

It is envisioned the network of weather stations and data logging will eventually become Australia wide, although at this stage Western Australia is our target. On the central web site there will be a map of WA with a dot indicating active and/or live data logging sites. Clicking on any dot will bring onto the users screen detailed data from that site, current activities and information. There will be predesigned experimental and study projects, quizzes and worksheets for students and to assist teachers.

4.3 Greenhouse gas emission reductions

Please provide estimates of direct reductions in greenhouse gas emissions resulting from the project and the project's potential to reduce greenhouse gas emissions in the future. Please list any key assumptions made in estimating reductions in greenhouse gas emissions.

Reduction in green house gases will follow from an increased awareness of the issues involved in energy efficiency and sustainability and how the general public may alter their behaviour and choice in selecting equipment in the home or design of their home. For example choice of energy efficient equipment, recyclable equipment and materials, awareness of systems currently available to help them reduce, recycle and reuse etc.

It is clear that although computer programs like Nathers may give a good energy rating for a building, the energy used in the building depends largely on the habits and understanding of energy issues by the people using the building. This project will elucidate these issues to children in a very hands on and graphic way.

4.4 Other benefits

Please describe any other benefits that the project will provide (e.g. reductions in peak electricity demand attributable to the project or achievement of long-term behavioural changes).

A fully integrated system will be provided with technical problems will be solved by University, ATA and other interested parties. All software, training programs, web based and other assessment IP will be freely available – there will be no IP ownership as such. All source code for computer programs, technical data sheets, design information, printed circuit board artwork, calibration data etc will be available on the web site. A bulletin board will be established so that information may be effectively and freely distributed.

The project will establish a wide and robust network within schools to communicate sustainable and renewable energy concepts

4.5 Research and development of a new product, service or installation (if relevant)

(a) Market for new product, service or installation

Please describe the market for the new product or service and how the product or service will be competitive against any existing products or services. For individual installations, please describe the financial and technical viability of the installation.

(b) Pathway to commercialisation

Please describe what steps and resources will be required to make the product, service or installation a commercial reality.

The systems, hardware and IP will be provided essentially free to schools. There may need to be a small fee allocated to provide ongoing support for the network.

5. PROJECT PERSONNEL AND APPLICANT EXPERIENCE

5.1 Key personnel involved in the project

Please provide details of key personnel involved in the project (including any contractors or consultants).

Name	Qualifications and experience	Role in the project
Jonathon Thwaites	See Attached	Convenor, Project Manager - ATA
Howard Flinders	See attached	Sustainable Schools – Education WA
Prof Jie Pan	See Attached	Director of Centre for Acoustics, Dynamics and Vibration, School of Mechanical Engineering, UWA

5.2 Details of the Applicant's history in completing similar projects

Please provide a brief description of similar projects previously performed by the Applicant, including outcomes.

In 2003 Jonathon Thwaites put forward a 3rd year Mechatronics project at the University of Western Australia to implement hardware and software to data log a weather station and to build the web interface to allow the weather station data to be seen in real time on the web and for archived data to be easily downloadable.

The project was taken up by a team of 4 students. They project managed the implementation and carried out development of all components of the system successfully. At the end of the year the weather station was operational and live on the web. (see attached report).

I have implemented 2 solar power stations with data logging and that data is available on my University web site: <http://www.sustainability.fm.uwa.edu.au/welcome>

I also assisted the Chrysalis Montessori School in implementing their solar power station in Osborne Park and provided technical advice on how the project should proceed.

In 2004 and 2007 I organised and staged the Perth Sun Fair for Western Australians.

- Organised the ATA Electric Bicycle Rally at the Curtin Technology Park in 2002.
- Organised ATA renovation of the Homestead Farm display at the Perth Zoo.
- Assisted with organizing the ATA/ANZSES solar house day in 2002, 2003.
- Organising Committee Medical Physics conference.
- Organising Committee Radiation Safety conference.
- Proprietor of own business – Medical Physics.
- Director and company founder of BioWorks bringing biodiesel to communities
- Management of small teams at SCGH, UWA and HDWA.
- In-depth knowledge of renewable energy and sustainable technology.
- Have been involved in investment industry for the past 20 years.
- Have been involved in communication and training sectors for the past 20 years.
- Regularly run ATA/WARFA/UWA Biodiesel workshops at the University of Western Australia.

The University of WA is a Greenhouse challenger, as part of the Federal Government initiative and runs numerous course modules on sustainability, environment and energy efficiency in its formal courses.

6. PROJECT BUDGET

Please provide details of actual or cash costs for the project. Do not include in-kind support (details of any in-kind support are required in Section 7).

Eligible project costs <i>Eligible costs include costs for the <u>sustainable energy</u> component of the project only. If the project involves a non-sustainable energy component, please include the costs for this under non-eligible costs.</i>	Expected actual cash expenditure (excl. GST)
Salaries <i>(include estimated hours and hourly rates for each of the key personnel identified under Section 5)</i>	
Project Officer - 1000 hours	\$19,000
Project Officer UWA - 400 hours	\$11,000
Consultants or contractors <i>(please include estimated hours and hourly rate/s)</i>	
UWA personnel – academic, workshop, technical, computing	
UWA students	
Equipment	
Consumables	\$1,000
Hardware, data logger, weather station, transducers, software etc	\$13,000
Other <i>(please describe)</i>	
Marketing	\$6,000
TOTAL ELIGIBLE PROJECT COSTS *	
\$50,000	
Non-eligible costs <i>(please describe costs for non-sustainable energy components of projects)</i>	
Total Non-eligible Costs	

7. PROJECT FUNDING SOURCES

Please provide details of all cash funding sources for the sustainable energy component of the project. Do not include any in-kind support.

Source of funds	Amount (excl. GST)
SEDO Grants Program	\$20,000
Applicant	
Other <i>(please list funding sources below)</i>	
EPA	\$20,000
Education Department	\$10,000
TOTAL FUNDING *	
\$50,000	

* Note the Total Eligible Project Costs in Section 6, the Total Funding in Section 7 and the Total Expenditure in Section 9 should be the same.

8. IN-KIND SUPPORT

Please provide details of any in-kind support donated to the project.

Type of in-kind support	Notional value
Voluntary assistance provided	
UWA Students	\$35,000
Donated equipment or services	
University of WA is providing: the labs, infrastructure, insurance, computing and internet services, electronics support and security support.	\$10,000
University of WA is also providing the experience and use of its Public Affairs organisation.	\$5,000
Other in-kind support <i>(please describe)</i>	
Total	\$50,000

9. PROJECT IMPLEMENTATION TIMETABLE

Please list specific tasks or activities that will be completed for each milestone of the project (a milestone is a key stage of the project). Milestones should be linked to the performance or completion of key activities outlined in Sections 3.2 and 3.4. Note that projects may involve less than five milestones, but should involve at least two.

Projects should typically be completed within 12 months of a grant being approved. The maximum duration that grants will be available for a project is 24 months.

Mile-stone	Milestone tasks	Start date	Completion date	Expected actual cash expenditure to complete (excl. GST)
1	<p>Partnerships</p> <ul style="list-style-type: none"> Establish partnerships, commitments from each partner and deliverables for each partner in the project – this is underway now. 		March 08	\$3,000
2	<p>Review</p> <ul style="list-style-type: none"> Review data logging capabilities of existing inverters available for the PV systems Review available weather stations for cost, ease of use (data logging, wireless connection), robustness. Review general purpose data loggers for other sensors for cost, ease of coding, robustness. Review sensors that may be useful eg. current clamps, thermocouples etc 		May 08	\$7,000
3	<p>Implement hardware</p> <ul style="list-style-type: none"> Wire up sensors, weather station, inverter and log them – make sure all the hardware works properly <p>Implement a weather station and data logging software</p> <ul style="list-style-type: none"> Write software for the weather station to log the data and store it in a useful and easily accessible format (eg excel) Write software for the data logger to log the data and store it in a useful and easily accessible format for the other sensors (eg excel) Write software to put inverter data in a useful format Write software to bring together all data in a useful and uniform format for teaching and presentation. <p>Web interface –“get the information out there”</p> <ul style="list-style-type: none"> Write a web interface so the data is available on the web (preferably real time) 		June 08	\$15,000
4	<p>Support – make it a useful</p> <ul style="list-style-type: none"> Produce a manual with example source code for the weather station and other sensors (preferably visual basic) Provide technical data on the weather station and sensors. Provide a web page for data access, FAQ, and help line for schools Test trial the system and trouble shoot. 		Dec 08	\$10,000

5	Marketing – get it into schools and used <ul style="list-style-type: none"> • Presentation and workshops for school science and other teachers • Help with setting up systems if requested. • Liaise with Education dept, Solar Cities, SEDO • Establish logistics to maintain the project in the long term over many years with recurrent Federal AGO funding or otherwise. 		Mar 09	\$10,000
	Submit final report to SEDO		May 09	\$5,000
TOTAL EXPENDITURE *				\$50,000

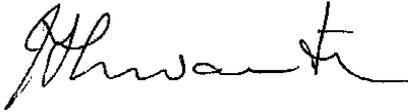
** Note the Total Eligible Project Costs in Section 6, the Total Funding in Section 7 and the Total Expenditure in Section 9 should be the same*

10. APPLICANT'S CERTIFICATION

In applying for funding under the SEDO Grants Program I agree that: **(please tick each item below)**

- This application is subject to the *SEDO Grants Program Research and Development Project Guidelines*, I have read the guidelines and I accept the terms and conditions set out in the guidelines.
- To the best of my knowledge the information provided in this application is current and correct.
- SEDO accepts no liability in respect of any claim or cause of action arising out of, or in relation to the project that is the subject of this application, and I will indemnify SEDO for any claim or liability arising out of or in relation to the project that is the subject of this application.

Signed:



Date: 30/8/2007

Name: Jonathon Thwaites

Position: Convenor ATA WA Branch

COMPLETED APPLICATIONS SHOULD BE SENT TO:
sgc@energy.wa.gov.au

Chrysalis Montessori School Solar Power Project

<http://www.scips-asta.edu.au/casestudies/chrysalis>

Chrysalis Montessori School children the solar power and weather station at UWA

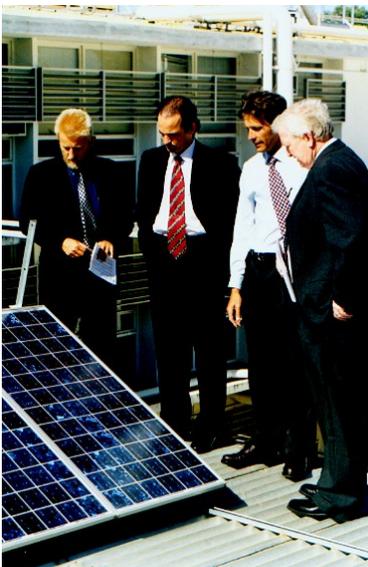


Chrysalis Montessori School children designing their solar power station

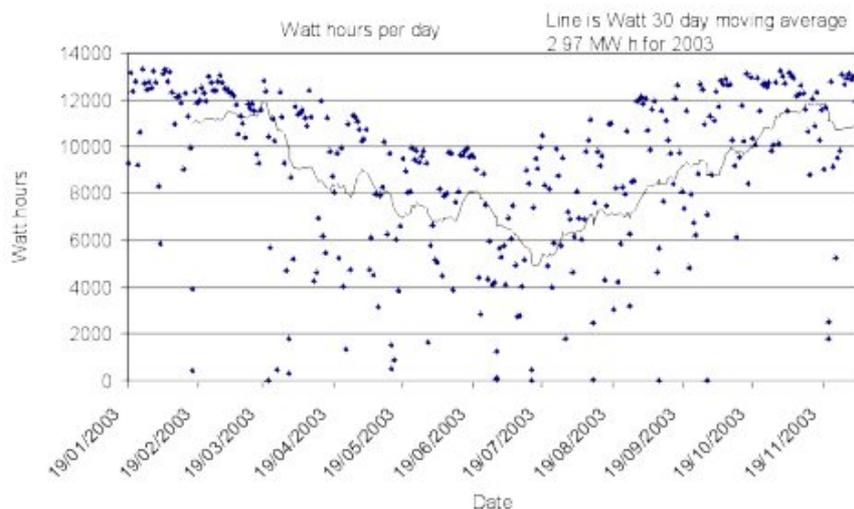


Solar Power Station at UWA

http://www.sustainability.ofm.uwa.edu.au/welcome/solar_power_uwa



The University of WA Vice Chancellor opens the 2.4 kW solar power station at UWA



Daily energy production from the power station. See:

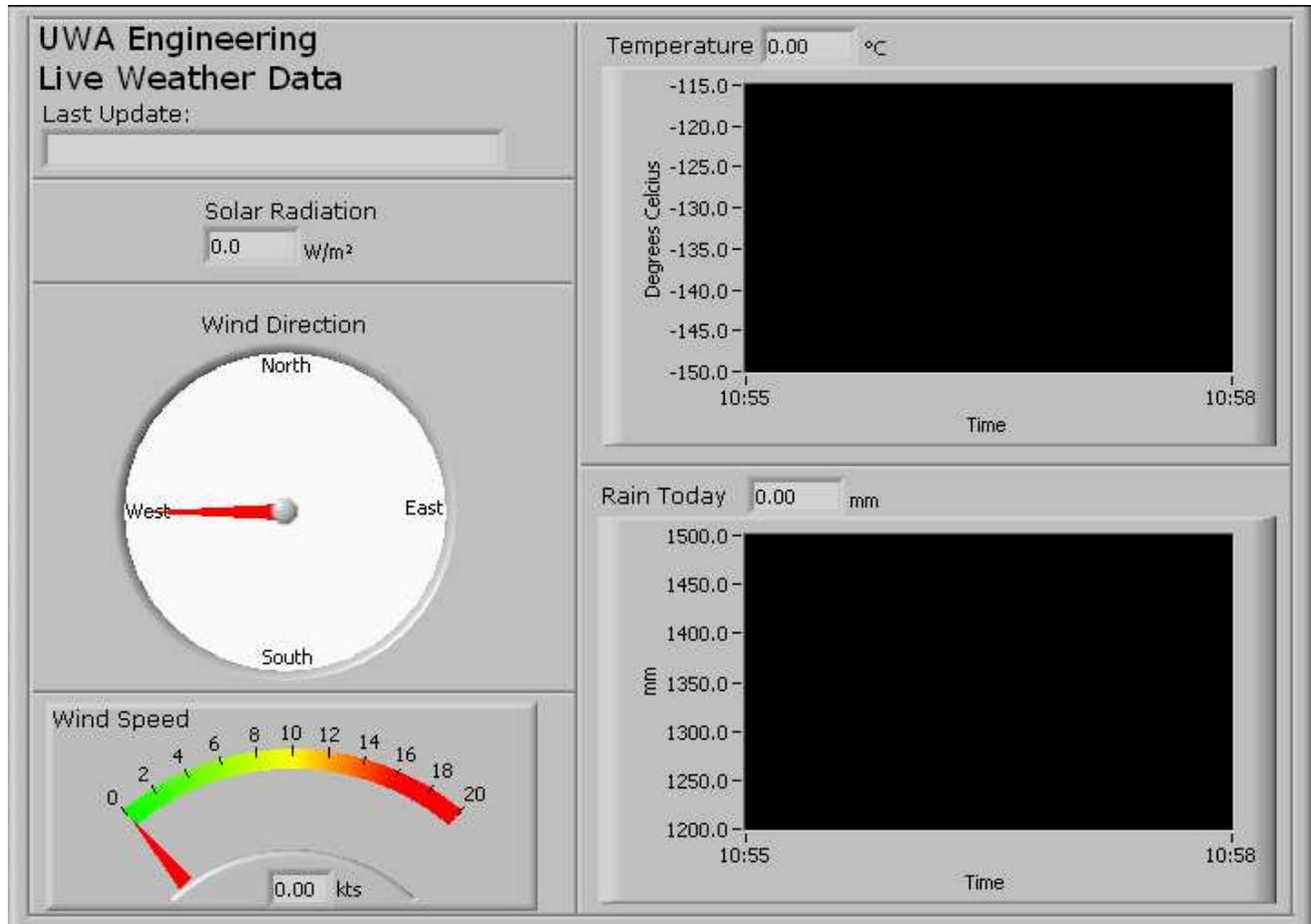
The weather station implemented at UWA by 4 Mechatronics students with live data presentation to the web.

http://www.sustainability.ofm.uwa.edu.au/welcome/weather_station

The weather station implemented at UWA



Live page data display for UWA weather station

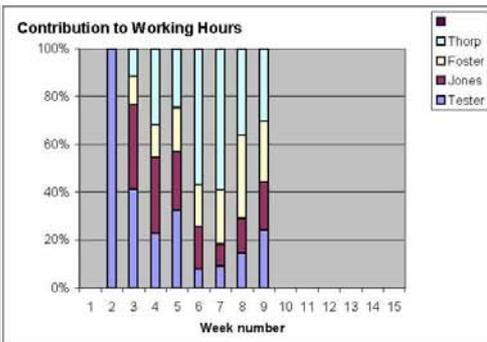
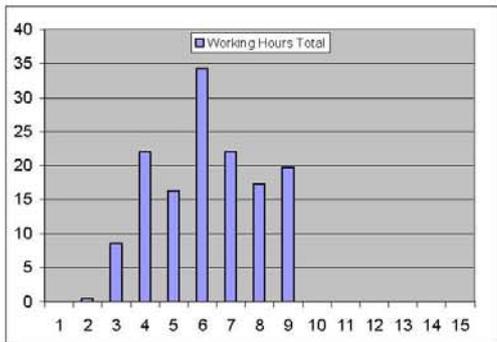


Mechatronics Systems 210 or Mechatronics Design 310
Planning Project Name: Weather Station Number 168

Working Hours Histogram Calculation

This worksheet calculates the total working hours on a weekly basis from the data in "Work Completed Record".
 Enter name of each team member in the header row. All the data is computed automatically from "Work Completed Record" entries.

Week# - 1	Total	Tester	Jones	Foster	Thorp	Total	Tester	Jones	Foster	Thorp	0
1	0	0	0	0	0	140.5	26.25	28.5	29	56.75	0
2	0.5	0.5	0	0	0	percentage	19	20	21	40	0
3	8.5	3.5	3	1	1						
4	22	5	7	3	7						
5	16.25	5.25	4	3	4						
6	34.25	2.75	6	6	19.5						
7	22	2	2	5	13						
8	17.25	2.5	2.5	6	6.25						
9	19.75	4.75	4	5	6						
10	0	0	0	0	0						
11	0	0	0	0	0						
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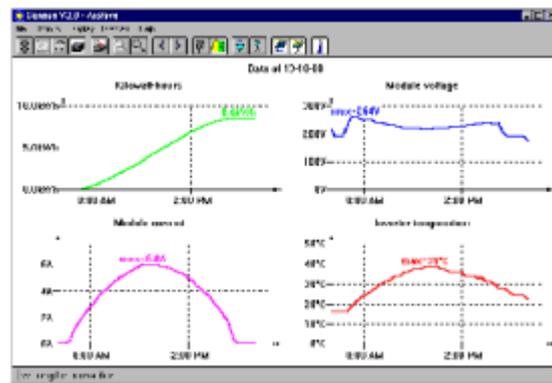
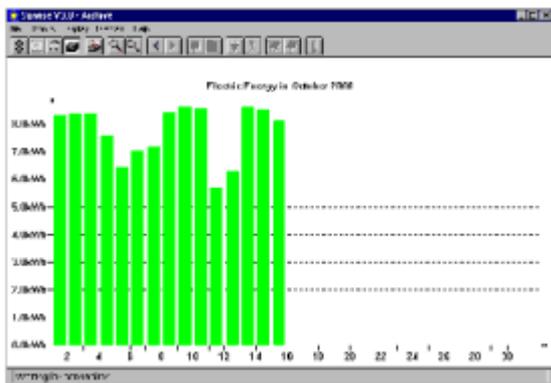
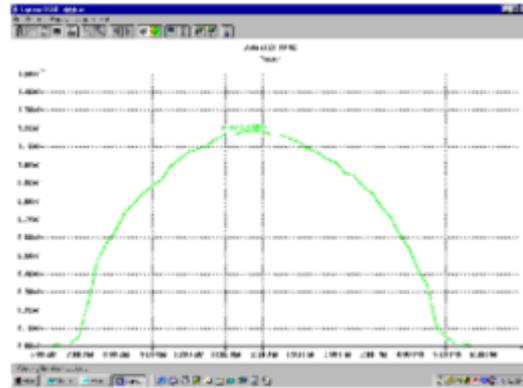
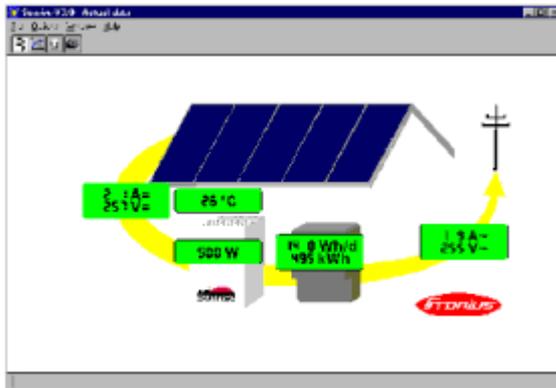
Solar Power Station at 255 Marmion St, Perth WA (Jonathon Thwaites' home)

http://www.sustainability.ofm.uwa.edu.au/welcome/solar_power_urban2

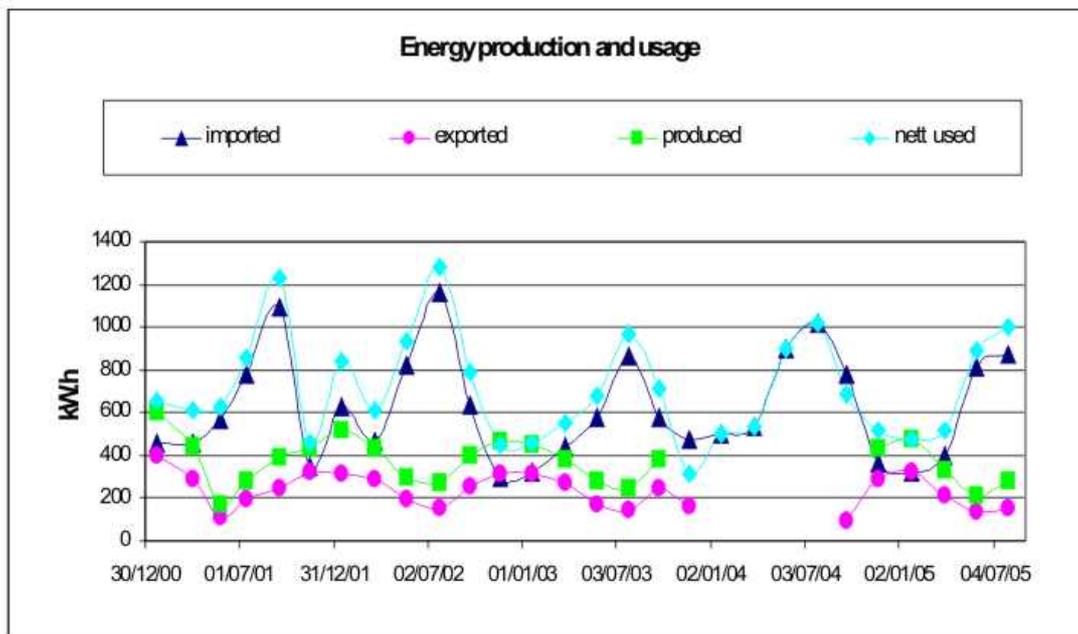
General view Solar Power Station at 255 Marmion St



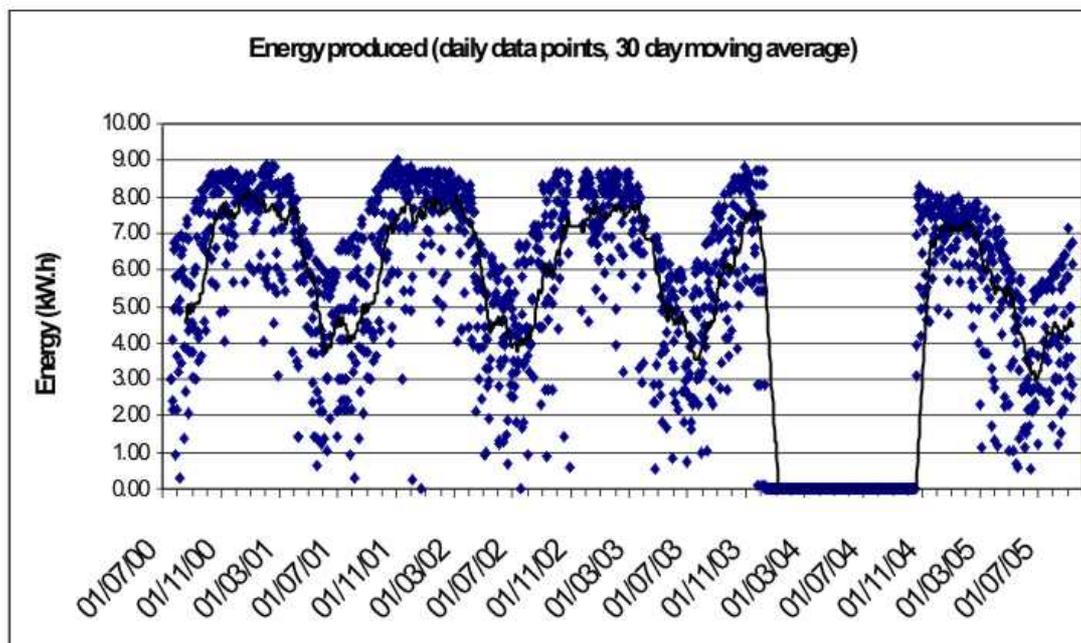
Data logging Solar Power Station at 255 Marmion St



Electrical energy balance at Solar Power Station at 255 Marmion St



Daily energy production at Solar Power Station at 255 Marmion St



Registered solar power station No.1 in WA creating RECs - Solar Power Station at 255 Marmion St

Accreditation Code	Registered Name	Station	Fuel Source	State	Accreditation Date
SRPVWA01	Jonathon Thwaites	Rooftop PV	Photovoltaic	WA	27/04/2001
SRPVWA02	Angus King	Rooftop PV	Photovoltaic	WA	01/04/2001
SRPVWA03	Noranda Primary School	Noranda Primary School	Photovoltaic	WA	24/09/2001

CURRICULUM VITAE

PERSONAL DETAILS

Name Jonathon Harry Thwaites
Address 255 Marmion St, Cottesloe 6011, Western Australia
Date of birth March 17th 1958
Drivers licence A and B(truck)
Nationality Australian

TERTIARY EDUCATION

Master's Degree (Medical Physics) University of Surrey (England) Graduated 1987
Bachelor of Applied Science (Physics) W.A. Institute of Technology Graduated 1981

OTHER COURSES AND QUALIFICATIONS

Master's Degree (Medical Physics) University of Surrey (England) Graduated 1987
Bachelor of Applied Science (Physics) W.A. Institute of Technology Graduated 1981

EMPLOYMENT HISTORY

July 1998 – Present **Radiation and Safety Officer**
Safety and Health, University of Western Australia

Duties: Provision and daily maintenance of professional radiation protection service for the University of Western Australia.

Director, Consulting Physicist and Proprietor
Medical and Scientific Services Pty Ltd, ACN 077 846 845

Duties: Provision of a consulting services to Public and Private Hospitals and businesses in Western Australia on Radiation Safety and Medical Physics. Radiation Safety Officer for Hollywood Private and Mount Hospitals - 200 bed hospitals in Perth.

Director **BioWorks Australia Pty Ltd ACN 116 6332 136**

Bringing biodiesel manufacturing capacity to local communities. Established in November 2005. www.bioworks.com.au

Founding member and President of Alternative Technology Association W.A.

Duties: Organisation of the first electric bicycle rally in Perth, refurbishment of the Homestead farm at the Perth Zoo, Implementation of commercial wind power cooperatives in WA. I have installed a 1.5 kW PV system on my home and 2.4 kW PV system at UWA with a grid connect inverters – I make my own electricity. Biodiesel Workshops at University of Western Australia. Run the Perth Sun Fair at UWA in 2004, 2005 and soon in 2006.

2005 – Present **Radiation and Safety Officer**
Mount Hospital (300 bed private hospital in Perth Western Australia)

Duties: Provision and daily maintenance of professional radiation protection service for the Hospital

2005 – Present **Radiation and Safety Officer**
Hollywood Private Hospital (300 bed private hospital in Perth WA)

Duties: Provision and daily maintenance of professional radiation protection service for the Hospital

May 2001 - December 2001 **Locum Senior Radiation Physicist**
Department of Medical Physics and Bioengineering, United Bristol Health
Trust,
National Health Service

Duties: Quality assurance for medical imaging equipment in the UBHT, computer programming.

Sept 1994 – June 1998

**Senior Radiation Physicist
Dept. of Medical Technology and Physics, Sir Charles Gairdner Hospital**

Duties: Provision of a comprehensive Quality Assurance program for imaging equipment, radiation safety programs and radiotherapy procedures in the Hospital. Radiation Safety Officer for the PathCentre. Provision technical and scientific advice to my Head of Department and the Executive Director of the Hospital on all radiation matters and policy.

**Jan 1994 - Sept 1994
& Mar 1988 - Mar 1990**

**Acting Radiation Protection Officer
University of Western Australia and the Queen Elizabeth II Medical Centre**

Duties: Chief officer whilst my immediate supervisor was on leave or acting in charge at the Radiation Health Section of the Health Department of WA.

To direct and control the Radiation Protection Office in providing a professional radiation protection service for the Queen Elizabeth II Medical Centre and the University of Western Australia. Executive Officer for the University and Medical Center Radiation Safety Committees.

The determination and implementation of radiation safety policy for the University and Medical Centre. Control of internal licensing and other recording systems for client institutions. Quality assurance on imaging equipment at the Sir Charles Gairdner Hospital.

Liaison with unions, management and the media for the client institutions on radiation safety matters.

**Mar 1982 - Mar 1988
& Mar 1990 - May 1994**

**Assistant Radiation Protection Officer
University of Western Australia and the Queen Elizabeth II Medical Centre**

Duties: Assist in providing a professional radiation protection service to the University of Western Australia and the Queen Elizabeth II Medical Centre, which together comprise around 6000 employees, 700 patients and 12,000 students. Expected to operate at a high level of independence, being responsible for making decisions without prior consultation with the Radiation Protection Officer.

6. MEMBERSHIP OF PROFESSIONAL BODIES

- Australian Institute of Physics
- Australian Radiation Protection Society
- Australian College of Physical Scientists and Engineers in Medicine
- Health Physics Society - USA
- Hospital Physicists Association - England
- President Alternative Technology Association WA Branch
- Australian and New Zealand Solar Energy Society

7. PRIZES

- Australian College of Physical Sciences in Medicine travel award 1995
- Student fellowship award to the International Photodynamic Therapy Association 1996
- Australian College of Physical Sciences in Medicine travel award 1996
- Studentship from the European Federation of Medical Physicists (Nice summer school) 1997

8. LICENCES

- Qualified Expert in radiation as defined in the W.A. Radiation Safety Act and Regulations
- Licensed Compliance tester for diagnostic x-ray machines
- Deputy medical physicist on the statutory authority - The Radiological Council, 1996 to 1999
- RANZSR mammography QA accreditation

9. PUBLICATIONS

1. RCY Cheung, JH Thwaites and RI Price. Factors affecting calculation of the modulation transfer function of a digital imaging system. In preparation for publication. To be presented at ACPESM November 1998.
2. JH Thwaites, C Jacob, BJ Cobb. The introduction of compulsory compliance testing of diagnostic x-ray equipment in Western Australia. Presented at the National Annual General Meeting of the Institute of Physics and Engineering Sciences in Medicine, Dundee, Scotland, September 1997.
3. Poster - JH Thwaites and P Rattray. A large patient dose survey in a cardiac catheterisation suite. Presented at the National Annual General Meeting of the Institute of Physics and Engineering Sciences in Medicine, Dundee, Scotland, September 1997.
4. Poster - G Moore, JH Thwaites, Monte Carlo Simulations in Radiation Physics, Applications of EGS4. ACPESM November 1995 meeting of the W.A. branch.
5. Poster - JH Thwaites, B Laurence, R Jones and T Deans. Treatment of Bile Duct Carcinoma using Photodynamic Therapy. To be presented in Melbourne at the Biennial International Photodynamic Therapy Meeting. 10th to 14th March 1996.
6. JH Thwaites, MW Rafferty, N Gray, J Black, B Stock. A patient dose survey for femoral arteriogram diagnostic radiographic examinations using a dose-area product meter. *Physics in Medicine and Biology – Phys. Med. Biol.*, 41 pp 899-907 1996.
7. JH Thwaites and DG Blair. Cantilever coupled impedance matching readout for resonant bar gravitational wave antennae. *Measurement Science and Technology*, vol 6, pp 1437-1441, 1995.
8. Poster - JH Thwaites, MW Rafferty, N Gray, J Black, B Stock. A patient dose survey for femoral arteriogram diagnostic radiographic examinations using a dose-area product meter. ACPESM November 1995 meeting of the W.A. branch.
9. L Munslow-Davies, M Malaxos, M Rafferty, J Thwaites, H Upton and R Holme. Caesium -137 industrial gauge contamination incident.
10. J Thwaites, Six years experience with an urban photovoltaic system, *Solar Progress* 28(2), July 2007
11. Regionalised Biodiesel Manufacturing in Australia, J Thwaites, Feb 2007

10. GRANTS

• Health Department of Western Australia Study grant for Masters Degree in Medical Physics	1986	\$12,000
• Australian Partnerships Research (Industry) Research grant for PhD Gravitation Wave Detector	1996	\$49,500
• Alternative Energy Development Board of Western Australia (Govt of Western Australia) Upgrade the Homestead farm sustainable living display at the Perth Zoo	1999	\$21,000
• Australian Greenhouse Office (Australian Federal Govt) Install 2.4 kW Grid connected PV solar power system at UWA	2002	\$10,000
• Sustainable Energy Development Office (Govt of Western Australia) Perth Sun Fair, March 2004	2003	\$5,000
• University of Western Australia (Vice Chancellor's discretionary fund) Perth Sun Fair, March 2004	2003	\$5,000
• Alternative Technology Association Perth Sun Fair, March 2004	2003	\$5,000
• University of Western Australia (Vice Chancellor's discretionary fund) Perth Sun Fair, April 2005	2004	\$5,000
• Sustainable Energy Development Office (Govt of Western Australia) Perth Sun Fair, April 2005	2004	\$15,000
• Lotterywest, Perth Sun Fair, April 2005	2005	\$20,000
• Alternative Technology Association Perth Sun Fair, April 2005	2005	\$5,000
• Lotterywest, Perth Sun Fair, April 2006	2006	\$20,000
• Alternative Technology Association Perth Sun Fair, April 2006	2006	\$10,000
• University of Western Australia (Vice Chancellor's discretionary fund) Perth Sun Fair, April 2006	2006	\$5,000
• Lotterywest, Perth Sun Fair, April 2007	2007	\$20,000
• Sustainable Energy Development Office (Govt of Western Australia) Perth Sun Fair, April 2005	2007	\$10,000
• Alternative Technology Association Perth Sun Fair, April 2007	2007	\$5,000
• University of Western Australia (Vice Chancellor's discretionary fund) Perth Sun Fair, April 2007	2007	\$5,000