

## TIG-6 Reports for AGEG Meeting # 5, 20 – 21 November 2008

1. TIG #6: Geothermal Power Conversion – See:

[http://www.pir.sa.gov.au/geothermal/agaeg/technical\\_interest\\_groups/group\\_6](http://www.pir.sa.gov.au/geothermal/agaeg/technical_interest_groups/group_6)

2. TIG Leader(s) names with affiliation and email address:

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3. TIG Members names with affiliation:

To be updated

4. Scope of TIG

**Objective:** Mirrors IEA Geothermal Research Annex VI (Ormat, Italy, Australia). Develop scenarios as a basis for comparison of cycles, plant performance and availability, economics and environmental impact and mitigation. The output would be a database and guidelines of best practice.

List of Sub-TIG Topics

Original Sub-TIG Topics	Proposed Sub-TIG Topics (see the attached document)
Thermodynamic Power Cycles	Thermodynamic Power Cycles (for both water based and CO <sub>2</sub> based EGS)
	Working Fluids (Power Cycles)
Plant Performance and Availability	Plant Performance and Availability
	Hybrid Systems & Cascade End Use
	Expander / Turbine
	Heat Exchanger
Economics	Economics
Environmental Impact & Mitigation	Environmental Impact & Mitigation

What's not (and why)?

There are some overlaps and synergies between the proposed "Hybrid Systems & Cascade End Use" and "Direct Use of Geothermal Energy" which is the subject of TIG-7. At present, the collaboration between TIGs 6 and 7 in this area is outside the scope of both interest groups. Closer collaborations is recommended.

5. Lessons learnt

what has worked well?

AGEG supported projects have proved to be good initiatives addressing a number of key issues specific to power conversion.

what can work better?

The communication between TIG-6 members and exchange of ideas / information has not been ideal in the past year and can be significantly improved in the coming year.

ideas for improving performance

- Development of an online forum for information exchange
- Formal face to face meetings in the form of workshops at least once and preferably twice a year

## 6. Initiatives

### Complete:

- Development of sub-TIG topics
- Development of a set of proposed sub-TIG topics for discussion
- Assessment of several research projects relevant to sub-TIG topics

### In Progress

Research projects funded through AGEF (see the attached table as well as individual progress reports)

### Planned

- Improve exchange of information and communication among TIG members
- Closer collaboration with other TIGs particularly TIG-7

## 7. Tabulation of projects

Proforma information for research relevant to TIGS (and there will be overlaps between TIG information where studies straddle TIG Topics e.g. studies on induced seismicity will be of interest to TIG 1 (Land Access) and TIG 4 (EGS), etc. This should catch all research endeavours that are destined for public records – including UQ, GeothermWA, University of Adelaide, GA, CSIRO, PIRSA, etc, etc

Theme	Project Name	Summary of key project objectives, Key Contact and Links to Details	Research Partners
AGE TIG 6 Engineering Power Generation	Preliminary assessment of the impact of geo-fluid properties on power cycle design	<p><b>Key Project Objectives:</b> Study the relationship between the effect of non-condensable gas, fouling and corrosion caused by geofluid properties on surface heat exchangers and the heat transfer efficiency of the exchangers.</p> <p><b>Budget:</b> \$85,729 (\$6,784 from PIRSA Tied Grant; balance from sponsor participants)</p> <p><b>Progress to Date:</b> This project has three aims. The first aim is to assemble the available data of water composition and quality from AGE TIG 6 members. The second aim of this project is to identify a worst-case scenario for non-condensable gases, pH and fouling potential and to undertake a preliminary design of components needed to treat them. The third aim is to identify opportunities for cost-savings and research through such means as materials selection, cathodic protection and coatings. The first of these aims has been revised and work on it is now complete, while work on the second and third aims is in progress (see the attached progress report for details).</p> <p><b>Key Contact:</b> Peter Ashman, <a href="mailto:peter.ashman@adelaide.edu.au">peter.ashman@adelaide.edu.au</a></p> <p><b>For further information - visit:</b> To be updated</p>	<ul style="list-style-type: none"> <li>◆ U Adel. (Ashman, Gamboa &amp; Nathan)</li> <li>◆ Petratherm (Reid)</li> <li>◆ Pac Hydro (Teoh)</li> <li>◆ Eden Energy (Jeffress)</li> <li>◆ Greenrock (Larking)</li> <li>◆ PIRSA (Malavazos)</li> </ul>
AGE TIG 6 Engineering Power Generation	Preliminary assessment of the potential for underground cooling on power cycle design	<p><b>Key Project Objectives:</b> Test the cost-saving potential of using the thermally cool and stable soil layer to cool surface geothermal exchangers, pipework and plant. Compare different underground cooling systems with air cooling systems in Australian conditions.</p> <p><b>Budget:</b> \$44,550 (\$22,275 375 from PIRSA Tied Grant; balance from sponsor participants)</p> <p><b>Progress to Date:</b> This project has four aims of which two are the subject of this progress report. The first aim was to undertake a review of the types of cooling systems presently available with the objective to collect relevant data to support the proposed under-ground heat exchanger. The second objective is to reduce the infra-structure and running cost of these cooling systems. This project is progressing according to schedule and will be finished on time. Of the original four aims of the project the two outlined above have been fulfilled thus far (see the attached progress report for details).</p> <p><b>Key Contact:</b> Bassam Dally, <a href="mailto:Bassam.Dally@adelaide.edu.au">Bassam.Dally@adelaide.edu.au</a></p> <p><b>For further information - visit:</b> To be updated</p>	<ul style="list-style-type: none"> <li>◆ U Adel. (Dally, Nathan &amp; Ashman)</li> <li>◆ Pac Hydro (Teoh)</li> <li>◆ Petratherm (Reid)</li> <li>◆ Eden Energy (Jeffress)</li> <li>◆ Greenrock (Larking)</li> <li>◆ Geothermal Res (Johnson)</li> <li>◆ KUTh (Ward)</li> <li>◆ PIRSA (Malavazos)</li> </ul>
AGE TIG 6 Engineering Power Generation	State of the Art in Power Cycles for geothermal applications and bottoming cycles	<p><b>Key Project Objectives:</b> Make a detailed comparison of the performance and operating conditions of selected existing geothermal power plants with the range of conditions expected to apply in South Australia. Develop a detailed model of the Kalina cycle using HYSYS and compare with existing models - ORC and SC.</p>	<ul style="list-style-type: none"> <li>◆ U of Newcastle (Doroodchi)</li> <li>◆ U Adel (Nathan &amp; Ashman)</li> <li>◆ Pac Hydro (Teoh)</li> <li>◆ Petratherm (Reid)</li> <li>◆ Eden Energy (Jeffress)</li> <li>◆ Greenrock (Larking)</li> <li>◆ PIRSA (Malavazos)</li> </ul>

		<p><b>Budget:</b> \$83,710 (\$41,855 from PIRSA Tied Grant; balance from sponsor participants)</p> <p><b>Progress to Date:</b>  The aims of the project are: (i) to compile a detailed comparison of the performance and operating conditions of selected existing geothermal power plants (based on relevance and/or availability of data) with the range of conditions expected to apply in South Australia; (ii) to develop a detailed model of the Kalina cycle using HYSYS; and (iii) to combine the existing models (SC in Newcastle and flash/ORC in Adelaide) with the new Kalina model to undertake a direct comparison of the system requirements for each selected cases of operating conditions of relevance to SA. The progress to date has been solid and on time despite the initial delay in approval of funding. A comprehensive literature review of existing power cycles suitable for power generation from low grade heat resources has been completed. It has been demonstrated that Kalina cycle provides relatively higher efficiencies than other existing conventional geothermal power cycles however it suffers from mechanical complexity. Detailed models of Kalina cycle and ORC have been developed using HYSYS simulation package. A comparison study of the performance of these cycles at a typical South Australian conditions is underway. The performance of these cycles will be then studied against that of the supercritical cycle developed by the researchers at the University of Newcastle. The project is expected to be completed on schedule (see the attached progress report for details).</p> <p><b>Key Contact:</b> Elham Doroodchi, <a href="mailto:Elham.Doroodchi@newcastle.edu.au">Elham.Doroodchi@newcastle.edu.au</a></p> <p><b>For further information - visit:</b> To be updated</p>	
<p>AGEG TIG 6 Engineering Power Generation</p>	<p>Development of a geothermal power plant cost estimator - Stage 1: basic estimates</p>	<p><b>Key Project Objectives:</b>  Develop a model to estimate costs of geothermal power generation (South Australian conditions). The model will provide input options for key variables such as well depth, ambient conditions, geofluid temperature etc.</p> <p><b>Budget:</b> \$40,979 (\$8,610 from PIRSA Tied Grant; balance from sponsor participants)</p> <p><b>Progress to Date:</b>  The aim of the present investigation is to develop the first stage of a cost estimator for power generation under conditions typical of those that apply in South Australia. In particular the project aims to provide a method to adapt results obtained from the existing MIT cost estimator to account for the effects of ambient temperature on performance using air-cooled condensers. It should be noted that the commencement of the project has been delayed due to the late confirmation of funding. Also, the part-time nature (0.2 FTE) of the appointment has resulted in the need to prioritise the Research Officer's tasks on other programs to date. Nevertheless, some significant progress has been made. Importantly the Research Officer, Mr David Battye, has been appointed. The first stage of the work has been to develop models to estimate the performance of ambient temperature on the performance of a range of geothermal cycles. This work has been completed, and was presented in the recent AGEG conference by Mr Battye. The other components of the proposed work are scheduled for completion in mid-2009 (see the attached progress report for details).</p> <p><b>Key Contact:</b> Gus Nathan, <a href="mailto:gus.nathan@mecheng.adelaide.edu.au">gus.nathan@mecheng.adelaide.edu.au</a></p> <p><b>For further information - visit:</b> To be updated</p>	<ul style="list-style-type: none"> <li>◆ U Adel.(Nathan)</li> <li>◆ Petratherm (Reid)</li> <li>◆ Eden Energy (Jeffress)</li> <li>◆ Greenrock (Larking)</li> <li>◆ PIRSA (Malavazos)</li> </ul>