

# Research contributes to future energy security

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The University of Pretoria's focus on research into energy is holistically designed to be fully multidisciplinary and cuts across a number of departments and faculties at the University. The Institutional Research Theme on Energy (IRT on Energy) forms part of a process initiated at the University in 2010 to identify unique research strengths and support the development of interdisciplinary research groups clustered around these strengths.

By focusing on unique local opportunities and collaborative research, the University will be able to increase its international profile. The primary objective of these research focus areas is on strengthening activities in areas of immediate national need and ensuring that those fields that ultimately affect human welfare are developed. In this way, the University will be able to make a significant contribution to overcoming South Africa's challenges and developing human capital in our country.

The IRT on Energy focuses its research efforts on a number of carefully selected subthemes relevant to South Africa's future energy security, with a specific focus on electricity supply. It supports the relevant government policies and strategies pertaining to the wider energy theme in South Africa in order to ensure that the country is successful in bringing the goals of the Integrated Resource Plan of 2010 to fruition.

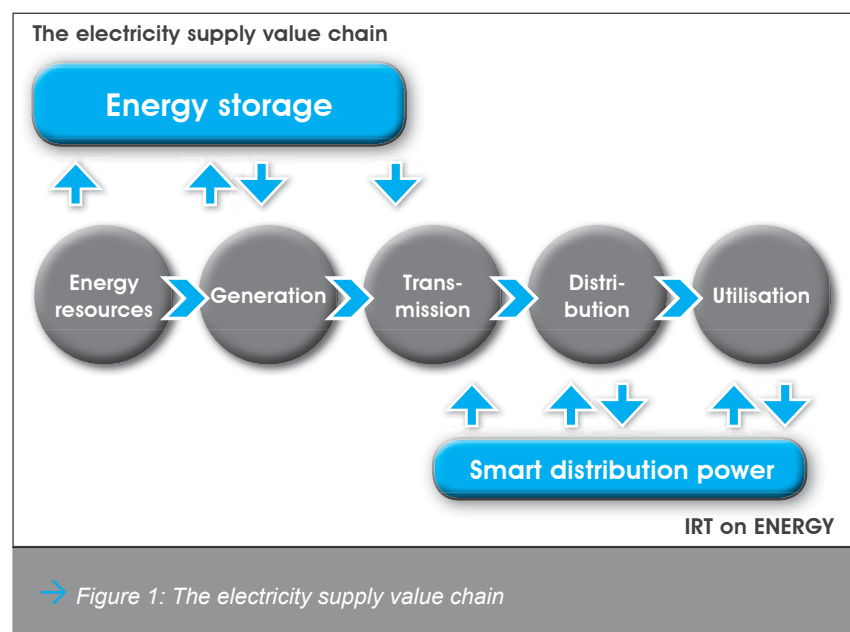
The selection of research subthemes is based on the energy value chain, which includes the influences of

climate awareness and renewable energy sources.

## Energy research focus areas

The IRT on Energy addresses the following subthemes:

- **Energy production:** There is a specific emphasis on clean coal, as well as nuclear and renewable energy technologies, such as solar and wind.
- **Energy distribution:** Two notable aspects that are addressed are smart grids and energy storage. Both these areas are growing in importance, as the contribution of renewables with their inherent random availability impact on the stability of the national grid.
- **Energy optimisation:** This is an area in which the University is particularly well placed, with its hosting of the South African National Energy Development Institute's (SANEDI) National Hub for Energy Efficiency and Demand-side Management. Specific areas being researched include thermal and process optimisation, energy efficiency,



→ Figure 1: The electricity supply value chain

demand-side management and plant lifetime extension.

- **Advanced materials:** In many instances, new energy technologies call for unique material attributes, notably in high-temperature applications. The University is particularly well positioned for such research thanks to direct spin-offs from research the University conducted for the former pebble-bed modular reactor project. Research projects include those involving silicon carbide (SiC), ceramics and high-temperature materials.
- **Policy, economics and society:** With the ever-increasing complexity of energy technologies, it has become mandatory to ensure that chosen energy sources not only fulfil their required energy production goals, but do so in a sustainable and economic manner. Research projects include those related to techno-economic modelling, project management, systems engineering and societal impacts.
- **Environment:** No argument for sustainable energy can be made without a serious focus on the environmental impacts of the chosen energy sources. The University is quite active in this field and has made some unique contributions in the minimisation and management of nuclear waste and reducing the carbon footprint.

### Departmental collaboration

A number of departments from the faculties of Engineering, the Built Environment and Information Technology, Natural and Agricultural Sciences, and Economic and Management Sciences make valuable research contributions towards the goals of the IRT on Energy.

These include Mechanical and Aeronautical Engineering, Electrical, Electronic and Computer Engineering, Materials Science and Metallurgical Engineering, Chemical Engineering, Physics, Chemistry and Economics, as well as the Graduate School for Technology Management and the Institute for Technological Innovation.

The IRT on Energy is a three-year initiative, which was launched in 2012 with funding from the University. A total of 10 new projects were funded in the first year, with nine of these projects continuing in the second year. In addition, four new projects were initiated. Current research projects include the following:

- Heat exchanger optimisation
- Energy efficiency
- Chemical process integration
- Smart grid optimisation
- Energy system assessment and modelling
- Silicon carbide for nuclear applications
- Glassy carbon physics
- Energy optimisation in renewable energy systems
- Electrical double-layer vanadium batteries
- Solar energy studies on carbon-based composites for energy storage
- Renewable and electrical lighting systems
- Nuclear waste minimisation
- Artificial photosynthesis

### Concentrated solar power and the development of solar fuel

Two important initiatives related to solar energy form part of the IRT on Energy.

The first initiative is the Clean Energy Research Centre and a project on concentrated solar power, which developed from research initiated in the Department of Mechanical and

Aeronautical Engineering. A total of 15 students (including seven PhD candidates) are currently involved in research pertaining to concentrated solar power. Collaboration in this regard is taking place with the Solar Thermal Energy Research Group (STERG) at Stellenbosch University and the Livermore Software Technology Corporation in the USA.

The second initiative, in collaboration with Prof Egmont Rohwer in the Department of Chemistry, involves the development of solar fuel from CO<sub>2</sub>. This is known as CO<sub>2</sub> cracking. In an attempt to reduce the human CO<sub>2</sub> footprint, the research team proposes using solar energy to convert atmospheric or technical CO<sub>2</sub> and water into methanol, a liquid fuel that is easy to store and transport using readily existing technology.

Other activities in which the IRT on Energy has been involved include the research and postgraduate programmes of the Eskom Power Plant Engineering Institute (EPPEI) Specialist Centre in Plant Asset Management in the Department of Mechanical and Aeronautical Engineering, as well as participation in the 5th International Conference on Applied Energy that was presented on the University's Hatfield Campus in collaboration with the SANEDI National Hub for Energy Efficiency and Demand-side Management from 1 to 4 July 2013.

According to Prof Tinus Pretorius, leader of the IRT on Energy, focus areas for future research will concentrate on the national and global energy crisis, and will include aspects such as renewable energy (storage and grid integration), nuclear materials, energy efficiency and energy modelling. ➔