UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Graduate School of
Technology Management

# Energy Systems Analysis Group

www.up.ac.za/gstm

@UPGSTM

Make today matter

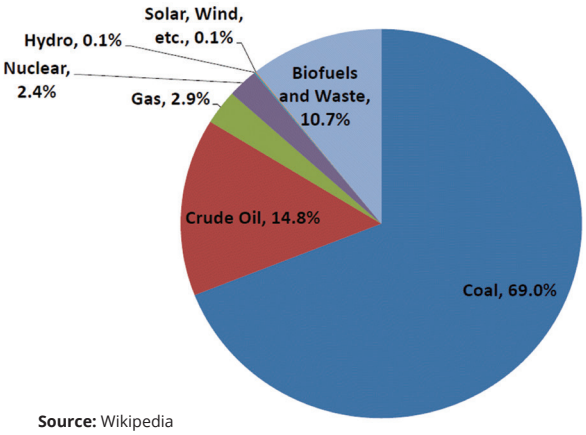
# Background

The energy sector in South Africa depends mainly on coal as its primary resource. The absence of local crude oil resources, the oil embargo of the 1970s and 1980s, and abundant reserves of high quality coal have led to an economy which uses coal in all energy subsectors, including as a source of electricity, a means of space heating, and as a feedstock for liquid fuel. The generation and distribution of electricity is undertaken almost exclusively by the state-owned utility company, Eskom, and the conversion of coal to liquid fuel by the private company, Sasol.

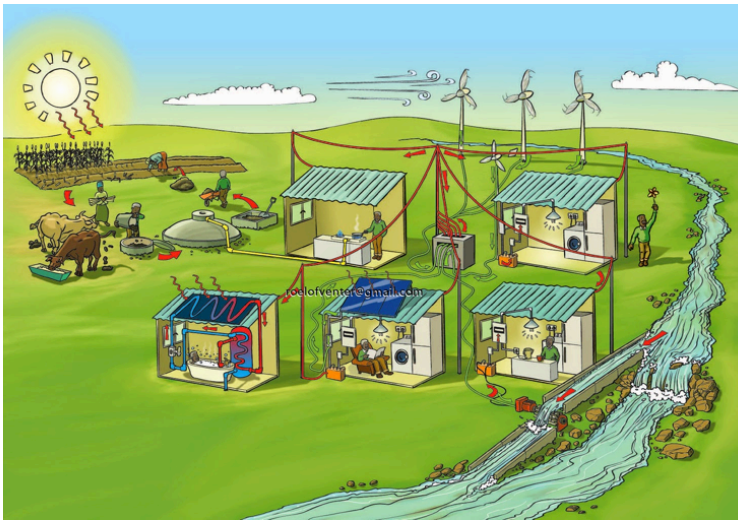
As the 6th largest coal exporting country and its domestic coal-dependance, South Africa's economy will be significantly affected by the decarbonisation of its energy sector and the decline of the global coal market. In frank terms, it is in South Africa's economic interests to mine coal, to burn coal as a means of generating electricity, to export coal and to use coal as a domestic heating fuel.

However recent Government policies, including the Nuclear Energy Policy and the various versions of the Integrated Resource Plan, have been aimed at taking the country towards a more sustainable energy future. All of these have in common the issue of energy security and its contribution to job creation, economic growth, research and human capacity/skills growth. These are also underpinned by the Department of Economic Development's National Development Plan 2030 (better known as the "NDP"), a first version which was implemented during February 2013.

**Total Primary Energy Supply in South Africa 2012 [% TPES]**




**Source:** Wikipedia



**Source:** http://roelofventer.blogspot.jp

Considering the importance of these policies, the need for energy security and the positive contribution of the energy sector to the national economy, it is clear that opportunities exist for energy-related research and the training of managers, scientists and engineers. The University of Pretoria has in the last few years been involved in a number of such research activities, notably with regards to energy efficiency, demand-side management, hydrogen economy, sustainability transitions, nuclear energy, advanced materials, renewable energy, thermoflow and engineering and technology management. This work, together with the existence at the university of the country's largest engineering faculty in South Africa and the Graduate School of Technology Management (GSTM), places the university in the unique position of being able to leverage its well-developed and highly rated scientific, engineering and management capabilities in support of the country's energy objectives.

# RESEARCH AREAS AND STUDY LEADERS


In support of this the GSTM some years ago established a small but active Energy Systems Analysis Research Group. The group is led by three experienced academics, supported by a number of research students.

*Dr Jörg Lalk (PrEng)*

**Dr Lalk is a professional electrical engineer with electrical and electronic engineering degrees** from the Potchefstroom University for CHE (BSc and BEng Hons), University of Pretoria (MEng) and a PhD with a focus on systems design from Cranfield University, United Kingdom. In addition he has completed the UNISA/ WIPO Specialisation Programme in Intellectual Property Law as well as the MIT Sloan School of Management's Programme on Developing and Managing a Successful Technology and Product Strategy. He is member of the International Council on Systems Engineering (INCOSE) and senior member of the Institute of Electrical and Electronic Engineers (IEEE). He is a past-president of the INCOSE South Africa Chapter and the serving INCOSE Associate-Director for Technical Review (international).

He has some 32 years industry experience and held various senior management and systems engineering positions in the aerospace, automotive, ICT, energy (nuclear) and consulting industries. His current research focus is on systems engineering and energy research, the latter with specific focus on techno-economic analysis, the application of novel intelligent Kalman filter techniques applied to energy planning analysis and the application of systems engineering in energy.

*Dr George Alex Thopil (PrEng)*

**Dr Thopil is a registered professional engineer and has a Bachelor's and Master's degree in electronic engineering from VTU, India and Stellenbosch University respectively.**

He holds a PhD in engineering management with a focus on energy and environmental policy, from the University of Pretoria. Additionally he has completed his professional education in energy, sustainability and life cycle assessment, from MIT, USA. He is currently chair of the Engineering Management Society, South Africa chapter. He is also a member of IEEE and a senior member of SAIEE. He is employed at the Graduate School of Technology Management at the University of Pretoria where his research focus is mainly on the topics of energy and environmental policy, energy efficiency and impact assessment of energy technologies. He also lectures and consults on a part-time basis on topics of energy and life cycle analysis.

*Prof David Walwyn (PhD)*

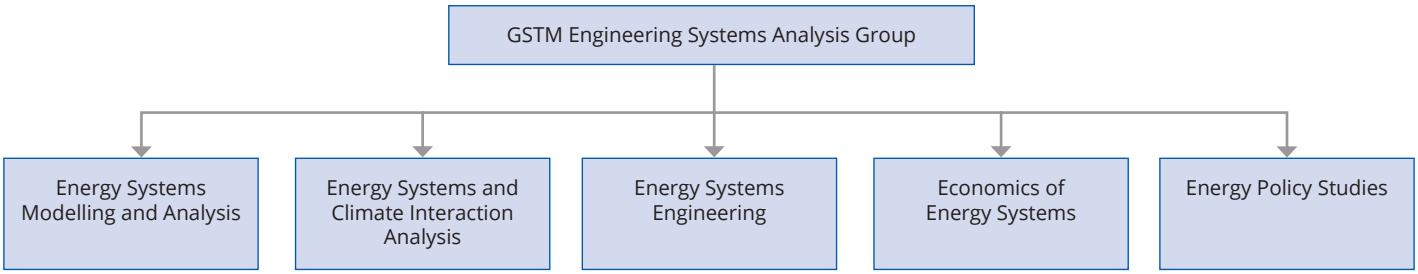
**Prof Walwyn is a chemical engineer with a PhD from the Cambridge University in organic chemistry.** His research interests cover sustainability transitions, renewable energy, health economics, science policy, research methodology, research management and localisation.

He currently teaches research project and engineering economics. He supervises at least 15 Masters students each year on the management of innovation and technology programme offered by the University of Pretoria, and has two PhD students. He has published widely in the area of science and technology policy, renewable energy, research management, health sciences, performance indicators for research organisations and biotechnology (1 patent, 31 articles in peer-reviewed journals, 5 book chapters and 36 conference papers and presentations). Further details of his academic publications are available at:

https://www.researchgate.net/profile/David_Walwyn?ev=hdr_xprf
and
https://scholar.google.co.za/citations?hl=en&user=0VwjoFsAAAAJ

# Our Research Focus

**The group focuses on a number of important themes within the overall national energy picture.**



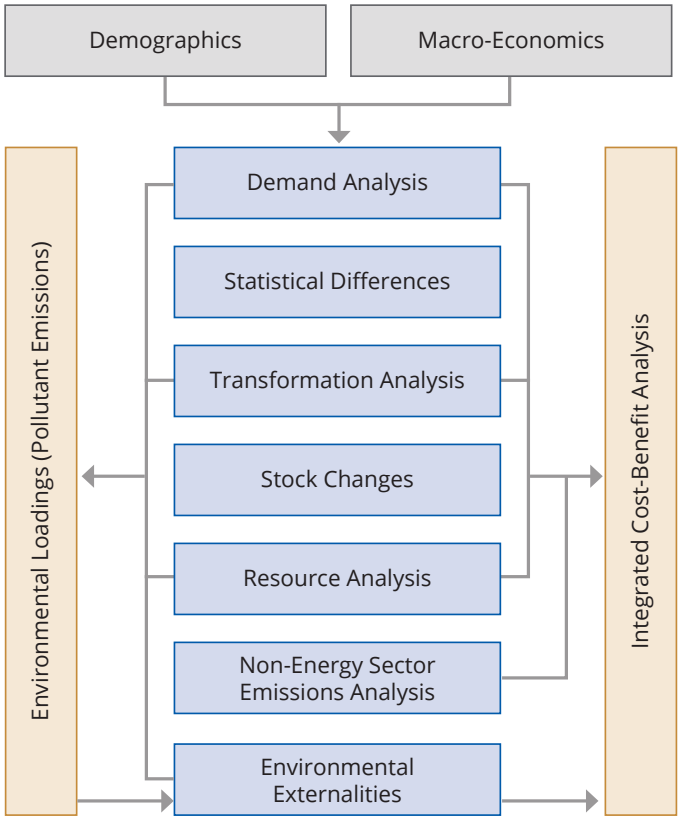

In addition to the above themes we also do research on systems engineering (as applied to energy systems), as well as advanced energy prediction models, energy policy, energy justice, energy costing models and tools, transitions in energy-based socio-technical systems, multi-level perspectives and technological innovation systems.

# Our Facilities and Tools

In support of this the group has available a number of high-end work stations in support of appropriate energy modelling and simulation. These work stations are all available with some of the "best-of-breed" energy modelling tool sets such as Matlab (including relevant toolboxes such as ), HOMER, LEAP (Long Range Energy Alternatives Planning scenario-based tool) OSeMOSYS (Open Source energy MOdelling SYStem), PLEXOS (Integrated energy modelling tool; work stations will only be made available with PLEXOS upon request and motivation by students as a specific agreement on its use is required from the tool vendor/developer) and WAsP (industry standard wind energy resource modelling).

These work stations are available to students who can spend a reasonable amount of time on campus or are full time students. In certain cases some of the tool sets are also available as academic licenses for use by individual students on their own computers (this requires an application by the student to the tool set vendor who may make such a license available on a time restricted, typically 6 months at a time, basis).

Some of our current student research projects focusing on desalination and carbon tax analysis make extensive use of our Matlab and LEAP tools.




**Source:** LEAP Tool Calculation Model, https://www.energycommunity.org

# Our Past and Present Research Projects

Since 2012 we saw a growing trend in students wanting to do energy research, some of the selected projects/topics of individual students are listed below.

## PAST STUDENT RESEARCH PROJECTS

Since its establishment the group has seen more than 70 student research projects successfully concluded. Several examples follow:

- M Ward. Effect of surface solar radiation on PV performance (MTM)
- N. Thomas. Demand side management: An investigation of the attitudes that drive energy efficient behavior in South African residential households (MEM)
- H Segwagwa. The potential impact of South Africa's proposed nuclear build programme on the broader socio-economic indicators (MPM)
- A Ameen. Wind energy development in sub-Saharan Africa: An application of the SATSA framework (MPM)
- M Mamogobe. Impacts of climate change on renewable energy technologies (MPM)
- R Clarke. Integration of energy simulation tools (MTM)
- J Motaung. Investigating the effect of regulation enforcement on energy efficiency in South Africa (MEM)
- P Kanelombe. Impact of climate change on renewable energy in Namibia (MTM)
- L Netsianda. An investigation of technical and business solutions to mitigate tower member theft (MTM)
- R Singh. An Investigation into the Drivers and Barriers to Energy Efficiency within Medium and Large Manufacturing firms operating within the eThekwini Municipal Area (MTM)
- N Badal. A study of gross energy intensity trends and analysis for a single ethylene production plant (MTM)
- M Masukume. Investigation of the feasibility of renewable energy private sector investment in South Africa (MPM)
- M Khan. Why South Africa's vertically integrated electricity supply industry continues and how to introduce practical power sector restructuring and reforms (MEM)
- F Cronje. Techno-economic modeling and analysis of ocean energy development in South Africa (MEM)
- L Kapolo. Lack of investment in large scale generation plants in the Southern African Power Pool: A question of policy, political will, pricing or planning? (MTM)
- E Nyandoro. Risk management in long-term energy plans (MEM)
- D Mvura. Determination of costs and barriers to the uptake of new energy technologies to meet IRP2010 requirements (MEM)
- B Petersen. An evaluation of power quality programmes for major electrical utilities within South Africa (MEM)
- N Bongelo. Development and assessment of electrical cable ageing management strategies for the Koeberg operating unit (MTM)
- N Nkwana. The impact that organizational culture has on project success and failure: A study of the Pebble Bed Modular Reactor project (MTM)
- F Blignaut. Delivering business value through the implementation of Enterprise Mobility – The case of Eskom (MTM)
- I Govender. Critical Analysis of the Implementation of a Biogas to Electricity Project (MPM)
- H Amsterdam. Waste to electricity policy opportunities for South Africa (MEM)
- P Naicker. Assessment of criteria for renewable energy sectors in South Africa for the purpose of ranking technologies (MEM)
- H Visser. Determining the variable LCOE for biomass power plants in South Africa (MTM)
- M Begemann. Behaviour of residential consumers and the effect of this on load management potential in the South African residential sector (MEM)
- N Mahlangu. Estimation of externalities within Concentrated Solar Power in South Africa – A life cycle analysis (MTM)
- W van der Westhuizen. A life cycle estimation of externalities from on shore wind power in South Africa (MPM)
- A Papadouris. The Future of Renewable Energy Desalination Technologies: A Strategic Technology Management Evaluation (MTM)
- Mothiba, E. Design of an innovation policy mix to stimulate job creation in renewable energy.
- Naidoo, S. Rebalancing innovation policy mix to improve support for South Africa's manufacturing sector.
- Magadimisa, M. An investigation of the South Africa's REIPPPP's Local Content Requirement for Solar PV.
- Van Niekerk, D. Development of Photovoltaic Innovation System in South Africa.
- Potts, S. Analysis of concentrated solar power using the framework of technological innovation systems.

## RESEARCH COLLABORATIONS

The group collaborates with a number of overseas institutions in support of its own research:

- Slovak University of Technology, Bratislava, Slovakian Republic
- Victoria University of Wellington, New Zealand
- Science Policy Research Group, University of Sussex

In addition, the group participates in a number of local and international working groups:

- Power and Energy Working Group, International Council of Systems Engineering (INCOSE)
- Systems Engineering Case Study Working Group (INCOSE)
- South African Energy Modelling Alliance

# Research Opportunities

The group has opportunities for masters and doctoral research projects in any of the research themes of the GSTM Energy Systems Analysis Group. We are specifically looking for students who:

- Have strong analytical skills
- Have a systems view yet remain cognisant of the details
- Are excellent two-way communicators inclusive of excellent English writing skills
- Are naturally curious and self-driven
- Are committed to deliver high-quality results on time
- Are interested in sustainability transitions and renewable energy

We are also looking for a few students who possess the characteristics above and in addition have strong mathematical and statistical skills. These students will be tasked to do their research on Advanced Energy Prediction Algorithms and Advanced Energy Costing Models. Students who, in addition, also have a strong software background are also required to participate in a project on the integration of energy modelling toolsets.

# Contact Us


**Dr Jörg Lalk**
Room 4-9
4th Floor
Engineering 2 Building

Email: jorg.lalk@up.ac.za

**Prof David Walwyn**
Room 2-18
2nd Floor
Engineering 2 Building

Email: david.walwyn@up.ac.za

**Dr George Alex Thopil**
Room 4-16
4th Floor
Engineering 2 Building

Email: george.alexthopil@up.ac.za


Make today matter

www.up.ac.za/gstm

@UPGSTM