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South African National Energy Research Institute

## Energy Research Priorities in Relation to Implementation Challenges in South Africa

*Presentation to ENERKEY Workshop  
Johannesburg, 6<sup>th</sup> March 2007*

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# Characteristics of the Energy Sector

- Energy economy dominated by energy intensive industry and synthetic fuel production - energy intensive industries, largely coal dependent
- No major investment needed in new power generation or refining capacity in last 20 years
- Apartheid left majority of citizens without electricity
- Large electrification drive to attain universal access to energy
- Remote communities too expensive to electrify – But....
  - Photovoltaic (SHS) programme - largely unsuccessful (no thermal energy and high maintenance)
  - Paraffin – unacceptable deaths, injuries and damage to property



# Challenges Faced by the Energy Sector

- Energy economy dominated by energy intensive industry and synthetic fuel production
  - energy intensive industries, largely coal dependent
  - No consideration of energy efficiency as a means of reducing input costs
  - High greenhouse gas emissions relative to GDP and per capita



# Challenges Faced by the Energy Sector

- No major investment needed in new power generation or refining capacity in last 20 years
  - Prospect of power and fuel shortages more realistic in future
  - Long lead times for replacement technology
  - Environmentally friendly fossil fuel options more expensive
  - Skills depletion and loss of local manufacturing capacity



# Challenges Faced by the Energy Sector

- Legacy of Apartheid
  - Large number of disenfranchised members of society with little access to clean, safe and affordable energy services
  - Some communities too remote to be electrified
  - Energisation options introduced but largely ineffective
  - High unemployment rate amongst unskilled labour force

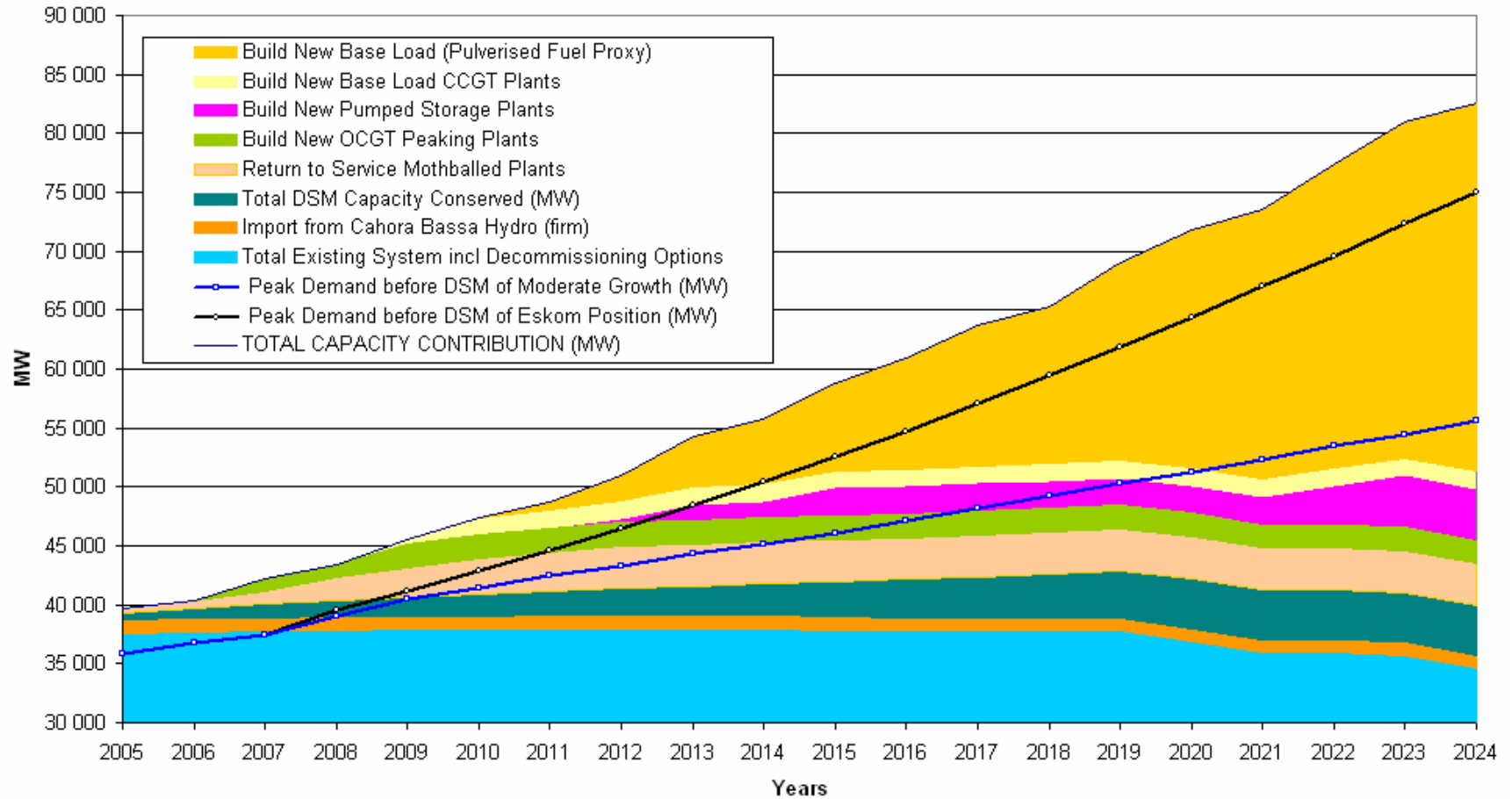


# Challenges Faced by Transport Sector

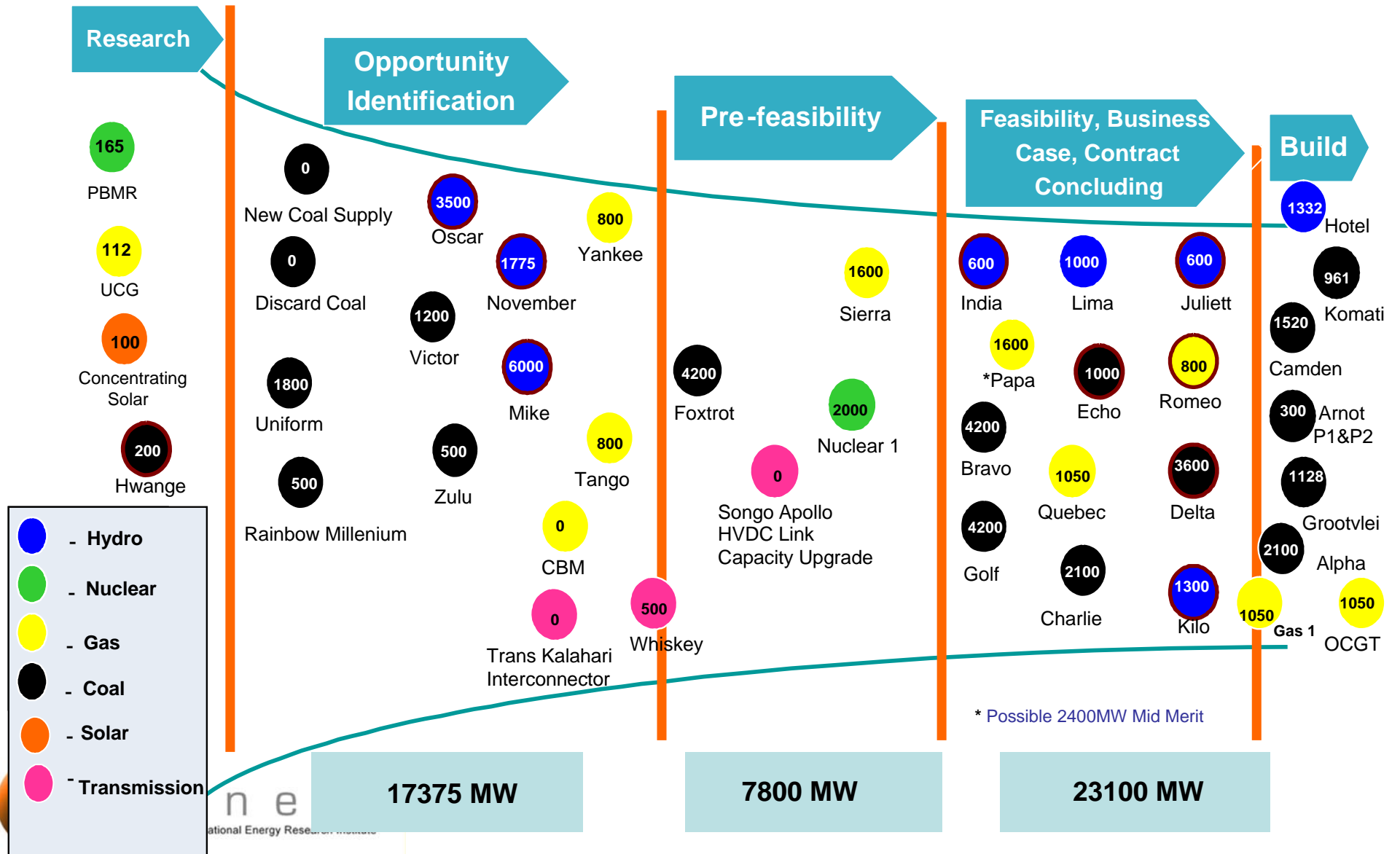
- High road usage
  - 8 million vehicles on roads at present
  - 15 million on roads by 2012
- Limited rail expansion plans
  - Opportunities exist for light/ultra-light rail
  - Opportunities for trams to be introduced
- Few options on demand side
  - Feebate system?
  - Energy efficiency measures
- Limited supply side options
  - Hybrid vehicle technology
  - Trams
  - Biofuels



# Capacity Outlook



# Electrical Capacity Project Funnel



\* Brown outer circle indicates – out of Borders project

# National Government's Objectives

- **Major energy related priorities**
  - Universal access to energy by 2012
  - Ensuring energy security of supply
  - Transformation of the energy sector (Charters)
- **Deputy President to lead the programme of fastracking economic growth through several strategic projects**
  - Accelerated and Shared Growth Initiative of SA (ASGI-SA 2005)
  - Ties in to Government's Plan of Action to improve service delivery
  - Energy related strategic projects selected include
    - Accelerated electrification
    - Biofuels industry development
    - Beneficiation of raw minerals and materials



# Energy Policies of SA

- White Paper on Energy in SA (1998)
  - White Paper identified the following objectives:
    - Increasing access to affordable energy services;
    - Improving energy governance;
    - Stimulating economic development;
    - Managing energy-related environmental and health aspects; and
    - Securing supply through diversity (including renewables)
- White Paper on Renewable Energy (2003)
  - Approved by Cabinet in November 2003
  - Follows on the direction set by the Energy White Paper (1998)
  - White Paper calls for:
    - real, measurable increase in renewable energy use, based on prescribed target
    - Calls for strategies to be developed to promote specific areas where RE could be developed
    - Policy aimed to create an enabling environment for renewable energy, setting a platform for industry development.



# Renewable Energy Target

- *10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar & small-scale hydro. The renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels.*
- This is equivalent to replacing two (2x 660 MW) units of Eskom's combined coal fired power stations.

Or.

- 1100 million litres of diesel (14% of one year) replaced with biodiesel. This is in addition to the estimated existing 8-9% renewable energy contribution mainly from fuelwood and waste. More efficient and sustainable use of fuelwood and conversion of the waste for power generation will add to the target.

TO BE REVIEWED MID TERM-2008



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# Key Energy Strategies

- Renewable Energy
  - Grid-based Renewable Energy Deployment
  - Biofuels Industry Development
- Energy Efficiency
  - Public / Commercial Buildings
  - Industry
  - Residential
  - Power Generation
  - Transport



# Grid-Based Renewable Energy Deployment

- Limited project development to date
  - Klipheuvel Experimental Wind Farm
    - 3,2 MW – offtake by Eskom Distribution on cost neutral basis
  - Proposed Darling National Demonstration Wind Farm
    - Phase 1 – 5 MW
    - Project at advanced stage – EIA, PPA concluded
  - Numerous small mini-hydro schemes
    - Used mainly for grid stability
  - Proposed wave energy conversion projects
    - Stellenbosch Wave Energy Converter (W Coast)
    - Pelamis Wave Energy Project (S Coast)
  - Large scale imported hydropower
    - Cahora Bassa (~2000 MW)
  - Hybrid Mini-grid projects
    - Projects in Hluleka, Lucingweni (E Cape)



# Grid-Based Renewable Energy Deployment

- Strategy needs to address the impediments to further project development, such as:
  - Lack of market rules governing third party access to the national grid
  - Lack of incentives for purchasers of green power
  - Capital intensive nature of most renewable energy technologies
  - Lack of equitable cost structures for different energy carriers – no externalities factored in
  - Lack of incentive schemes for power producers, either tax concessions or subsidy schemes
  - Localised technology to suit local conditions (e.g. low wind speed turbines)



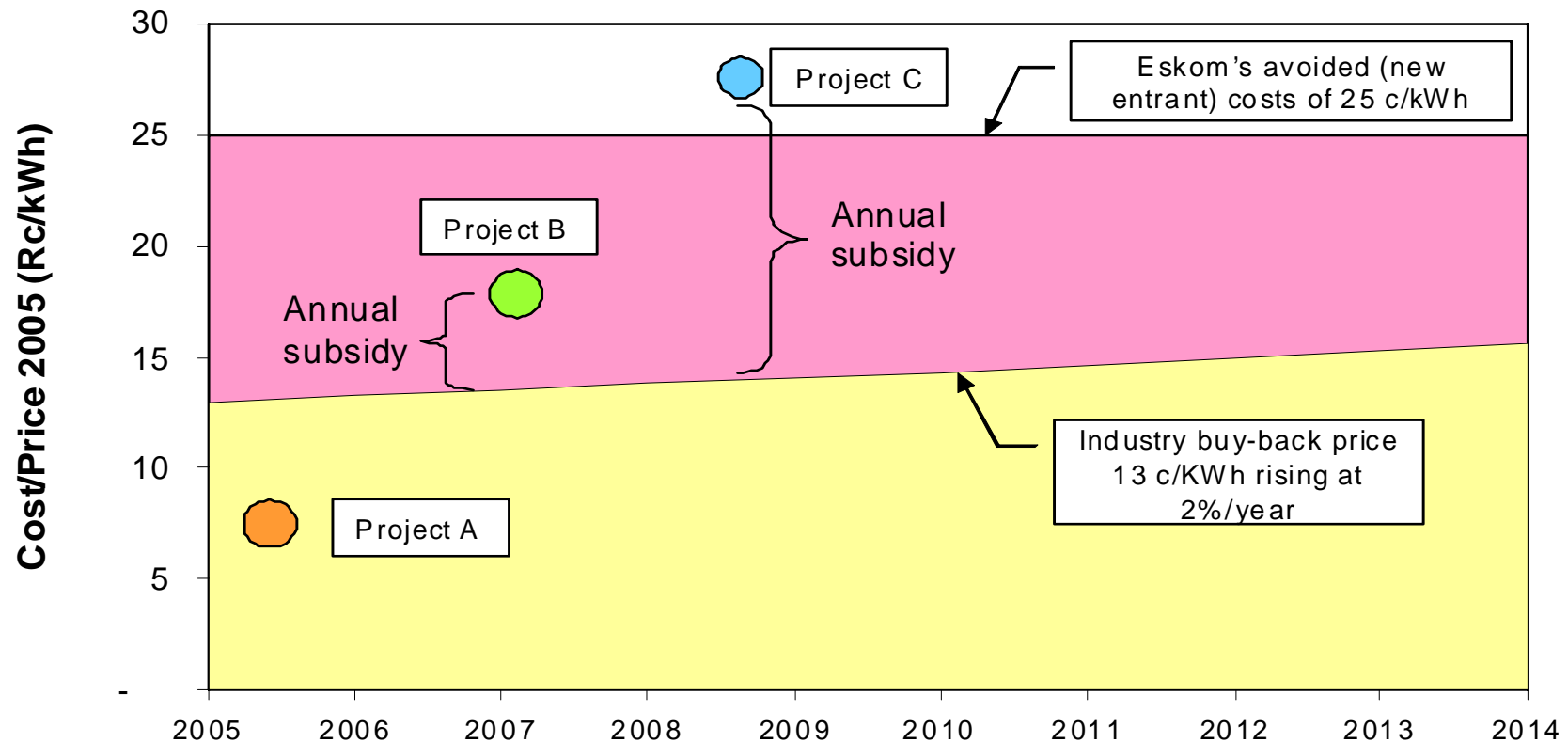
# Strategy fundamentals

- Propose top-up feed-in tariff for subsidising RE on the grid
- Propose open market for green power trading
- Propose modified network entry rules to ensure participation from independent power producers



# Illustration of proposed Feed-in Tariff

Illustration of degrees of competitiveness under current price arrangements



# Biofuels Industry Development

- Cabinet approved development of a biofuels strategy in December 2005, calling for government task team to undertake this activity
- CEF (Pty) Ltd, as responsible state entity tasked with supporting the state in strategy development and financing commercially viable projects
- Consultant appointed in 2006 to develop strategy for market development for bioethanol and biodiesel
- Draft strategy ready by November 2006
- Cabinet approved in November 2006 the release of the Draft strategy for public comment until March 2007



# Strategy Outline

- Bioethanol
  - Proposed 8% blend from mix of sugar cane and maize (corn) crops
  - Propose use of surplus crops
  - Recognises limits in available arable land
  - Targets emerging farmers mainly
- Biodiesel
  - Proposes 2% blend from variety of crops, including soya (main crop), rape/canola and olive oil
  - Propose phasing in of this blend, starting with 1% blend
  - Propose working with emerging farmers on land that is not competing with food crops for irrigation and nutrition
- General
  - Incentives are required to make biofuels industry viable
  - Regional approach should be adopted to maximise availability of feedstock



# Energy Efficiency Strategy

- National strategy approved by current Deputy President in March 2005
  - Strategy calls for 12% reduction in final energy demand by 2015
  - Target is average of sectoral targets for residential, commercial, industrial and transport
- Energy efficiency in households results not only in increased savings for households but also improved air quality and related health benefits
- Cabinet has also approved public buildings rollout programme in 2003, calling for government to lead by example
- Appliance labelling programme initiated – encourage consumers to choose appliances with efficiency in mind



# Energy Efficiency Programme

Sub Program	Output	Measure/ Indicator	04/05 Target	05/06 Target	06/07 Target
Promote energy efficiency	<ul style="list-style-type: none"> <li>•INDUSTRY</li> <li>•Deferred requirement for additional power generating capacity</li> <li>•Increased productivity within industries</li> <li>•Sectoral Targets established</li> <li>•COMMERCIAL</li> <li>•Deferred requirement for additional power generating capacity</li> <li>•Greater use of passive solar design to maximise environmentally friendly designs</li> <li>•Sectoral Targets established</li> <li>•RESIDENTIAL</li> <li>•Greater awareness amongst consumers</li> <li>•Better load management for utilities</li> <li>•Sectoral Targets established</li> </ul>	<ul style="list-style-type: none"> <li>❖ INDUSTRY</li> <li>❖ Greater correlation between GDP and energy intensity</li> <li>❖Energy management practices in place</li> <li>❖Technical standards &amp; norms in place</li> <li>❖COMMERCIAL</li> <li>❖More energy efficient designs for buildings</li> <li>❖Increased usage of solar water heating</li> <li>❖Incentives for Govt Departments</li> <li>❖Increased focus on HVAC systems</li> <li>❖ RESIDENTIAL</li> <li>❖Appliance Labelling Programme</li> <li>❖Household Tips</li> <li>❖Changes to Building Code</li> <li>❖Introduce mandatory solar water heating</li> </ul>	<ul style="list-style-type: none"> <li>❖ INDUSTRY</li> <li>❖Technical standards for non-utility boilers</li> <li>❖Training for energy auditors</li> <li>❖ COMMERCIAL</li> <li>❖Govt buildings rollout programme initiated</li> <li>❖Energy audit training</li> <li>❖RESIDENTIAL</li> <li>❖Appliance labelling programme launched (voluntary for first six months)</li> </ul>	<ul style="list-style-type: none"> <li>❖INDUSTRY</li> <li>❖Further technical standards for other equipment</li> <li>❖Energy Management systems introduced</li> <li>❖COMMERCIAL</li> <li>❖Other Govt buildings (not National) will be targeted</li> <li>❖Address thermal needs of buildings</li> <li>❖Address the building code changes that need to be made</li> <li>❖RESIDENTIAL</li> <li>❖Additional thermal insulation technology use</li> <li>❖Changes to Building Code to make solar water heaters mandatory</li> </ul>	<ol style="list-style-type: none"> <li>1. Monitor the implementation of the national average target of 12% reduction in final energy demand by 2013. Monitoring processes that were established in 2005/6 are in use.</li> <li>2. Identify higher cost interventions to continue the programme nationally</li> </ol>



# Linking national policy to energy R&D

- **Major national policy imperatives that impact on energy R&D drivers**
  - Achieving universal access to energy
    - Develop cleaner, safer and more affordable energy products
    - Ensure productive use of energy
  - Ensure energy security of supply
    - Diversify energy supply mix through renewable and alternative energy options
    - Introduce clean coal technologies (+ CCS)
  - Ensure transformation in the energy sector
    - Black and Women's economic empowerment
    - Develop human capital at tertiary institutions



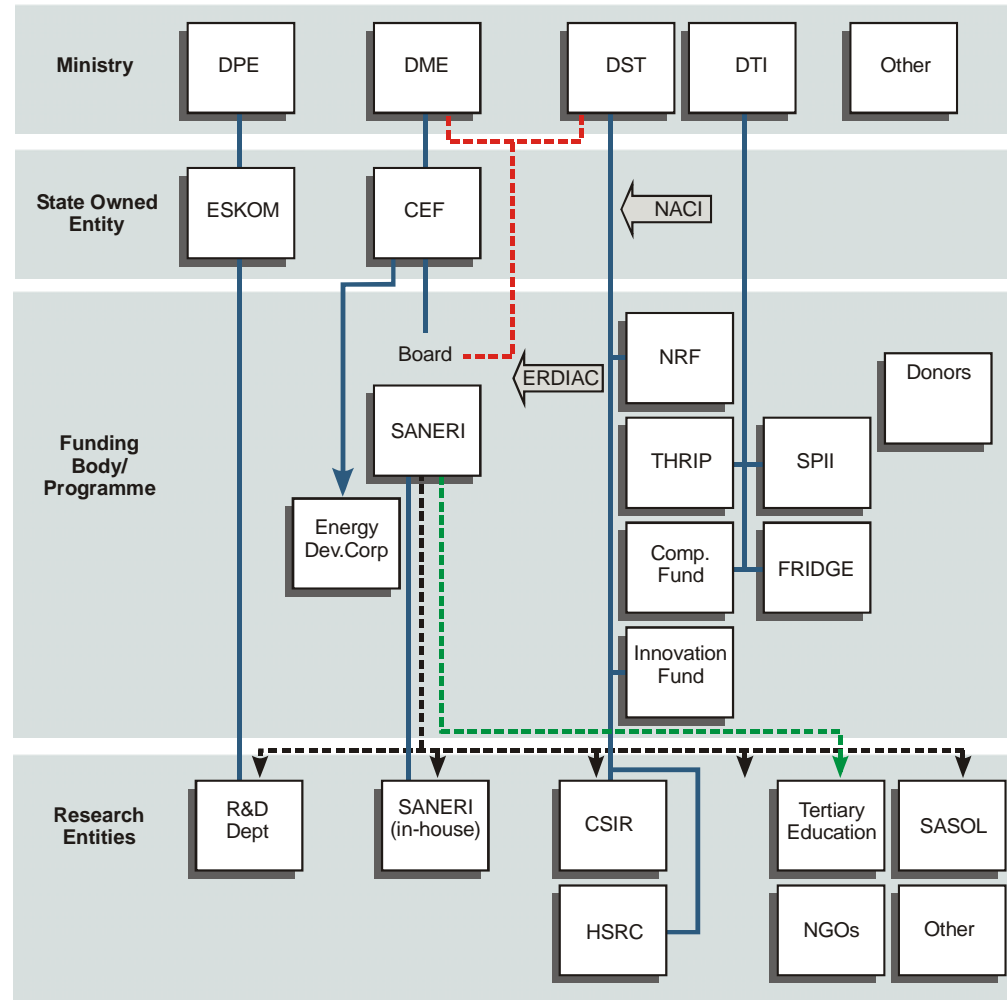
# Background to SANERI establishment

- Established in response to concerns from government regarding perceived threat to indigenous energy research capacity
- Established under Ministerial Directive in October 2004 as subsidiary of CEF (Pty) Ltd
- Reports to both DME (strategy) and DST (funding) in terms of governance
- Has mandate to conduct own research or solicit work from external parties



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# SANERI's position in the national energy R&D institutional and governance system



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## Legend:

Policy directives,  
nomination of Board



NERI Agency Role



Advisory Body



NERI Human  
Capacity  
Development Role



# State Funding of SANERI

- SANERI is 100% state funded at present, receiving grants via DST
- An amount of R42 million has been made available in 2007/8 for activities related to:
  - Flagship project development
  - Chairs of Energy Research Programme
  - Bursary Support Programme
  - Establishment costs
- SANERI mandated to leverage additional funds through grants, royalty income and through collaborative projects



# SANERI Key Objectives

- Ensure long term health of energy research capacity in the country and assist in stimulating a culture of innovation in the energy research environment
- Support the 3 pillars of the National R&D Strategy (2002)
  - Enhanced innovation, including mastering technological development
  - Human resource development and transformation
  - Governance
- Support goals of National Energy R&D Strategy (Draft, 2007)
  - Development of Human Resources
  - Economic Empowerment
  - Stimulate innovation
  - Commercialise energy R&D
- Address deficiencies in current race, gender and age profile of postgraduate students, academia and scientists
- Stimulate socio-economic upliftment through improved access to modern, clean and affordable energy services
- Support economic growth through development of **flagship projects** that will ultimately result in commercial rollout
- Support international collaboration with a view towards development of cooperative partnerships and leveraging additional funding for research projects



# Key Challenges Faced by SANERI

- Low PIER&D spend in SA – about 0.8% of GDP is spent on R&D, of which about 6% is Energy
- Low contribution from Black scientists – measured in publications where about 8% is produced from Black Scientists
- Percentage women in energy R&D sector is low, about 26.5% in 2004, which is well below equity targets of government
- Challenge of meeting ASGI-SA goals with consequent increase in demand of natural resources and energy
- Access to modern, clean and affordable energy remains a challenge for about 30% of South Africans
- Long-term funding is not secure, proposed budget allocation of ~ €4.5 million for 2007/8 not adequate for future research needs



# Thematic Areas addressed by SANERI (proposed)

- **9 thematic areas identified**
  - Energy infrastructure optimisation
  - Energy Efficiency and DSM
  - Understanding the impact of energy use on the environment
  - Stimulating socio-economic development through the productive use of energy
  - Cleaner fossil fuels, including clean coal technology
  - Renewable energy
  - Alternative energy, including hydrogen economy and fuel cells
  - Energy planning and modelling and
  - Energy policy research



# Human Resource Development and Transformation

- Proposed introduction of research programmes and chairs at suitable tertiary institutions, such as
  - Renewable Energy and Sustainable Energy Programme (Stellenbosch)
  - Advanced Fossil Fuel Use
  - Clean Energy and Household Energy Provision
  - Biofuels
  - Liquid Fuel Optimisation
  - Hydrogen Economy
  - Fuel Cell Development



# Cooperative Research Activities

- Intention is to leverage additional funding and stimulate local capacity building through strategic alliances with leading PIER&D centres
- Identify possible synergies and collaborative projects with leading centres such as
  - UK ERC
  - ECN (Netherlands)
  - NEDO (Japan)
  - Oak Ridge National Laboratories (US)
  - NREL (US)
  - Sandia National Labs (US)
  - EPRI (US)
  - CRIEPI (Japan)
  - RISØ National Laboratories (Denmark)
  - CSIRO (Australia)
  - TERI (India)
  - Fraunhofer Institute (Germany)
  - This list is not exhaustive as many other collaborative partners are being identified at present



# Energy R&D Priorities

- Biofuels
  - Feedstock trials (e.g. algae, sweet sorghum)
  - Fuel quality testing
  - Vehicle performance tests
  - Enterprise model development – small industry participation
  - Biofuel applications in households, e.g. ethanol gel



# Energy R&D Priorities

- Household Energy Provision
  - Development of cleaner burning, safer appliances for domestic cooking, water and space heating
  - Fuel quality testing
  - Gelling paraffin
  - Development of low smoke fuels and cleaner burning techniques for coal fires, e.g. Basa njengo magogo
  - Biofuel applications in households, e.g. ethanol gel



# Energy R&D Priorities

- Grid-connected Technologies
  - Resource assessments (ongoing)
  - Pilot and Demonstration projects
  - Potential for local design and manufacture of components, e.g. heliostats for CSP
  - Potential for development of low-wind speed turbines
  - Potential for development of advanced hybrid mini-grid technology
  - Integrate RE into building design, beyond passive solar design



# EE Research Priorities

- Development of sector-specific implementation strategies (support DSM programme)
  - Further studies are required to develop short, medium and long term implementation plan for the following sectors:
    - Transport, including alternative fuels sources and demand side efficiency
      - possible fee-bate system
      - Road to rail modal transfer
      - Biofuels industry development in Public Sector
      - Hybrid vehicle introduction
    - Power generation sector, particularly existing Eskom power stations
    - Increased focus on residential awareness raising
- Promoting energy efficiency in SA
  - Studies are required to:
    - Enhance the role of appliance labelling in other areas, e.g. vehicles, motors, fans, pumps, etc
    - Supporting development of accredited programmes to register energy efficiency practitioners, e.g. ESCOs
    - Determining appropriate fiscal and tax incentive-based schemes for the promotion of use of energy efficient technology in industry



# Current Research Programmes

- Renewable Energy
  - Eskom / WWF Renewable Energy Research Fund
  - CEF 500 SWH Programme
- Fossil Fuels
  - Coal 2020 Initiative
  - CSIR Clean Coal (FBC) Programme
- International
  - REEEP
  - GVEP
  - Enerkey
  - Global Research Alliance



# Thank You

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*Mobile Base Station at SANAE, powered by PV and wind energy*



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