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Assessing and promoting societal acceptance of new technology

The current understanding of social processes affecting the (non-) acceptance of renewable energy technologies is limited. Project managers often assume that stakeholders without a doubt will adopt and adapt their innovation. In practice, however, stakeholders such as users, NGOs or local public authorities might have different (and possibly conflicting) visions about the innovation and the future world into which the innovation should fit. If these divergent views are neglected project implementation might face severe societal resistance in the implementation phase. There is a need for empirically based analytical research to provide a better understanding of the complex interactions between stakeholders, which block or facilitate the adoption of alternative practices and of the institutional contexts favourable to technological innovation.

Many African countries are introducing renewable energy technologies to diversify supply, reduce GHG or make clean energy available to the poor. Dissemination of the renewable energy technologies is often slow such as wind energy and, in some cases, it is not generally accepted. Solar cookers, solar home systems and solar water heaters are renewable energy technologies which are not readily accepted by the market, although the degree of acceptance/ rejection is different. Solar cookers work and provide free energy, reduce wood consumption and collection and don't emit GHG but they are not accepted by the rural poor for whom they are intended.

The Energy Research Centre (ERC), University of Cape Town, has joined the *Create Acceptance Project,* which aims to improve the conditions of societal acceptance of renewable energy technologies and technologies for efficient use of energy. The project is developing a tool for assessing and promoting the societal acceptance of such technologies. The project builds upon a tool developed for technological innovations under a previous European Community project: Socrobust. This tool will first be assessed for suitability to contribute to societal acceptance of renewable energy technologies by mapping its potential and limitations. Secondly, the key elements of societal acceptance of these technologies will be determined by assessing the recent and past societal acceptance. The Socrobust tool platform will be enhanced into a multi-stakeholder tool by integrating knowledge gained and by designing the necessary instruments and procedures. Finally, validation and deployment of the multi-stakeholder tool will take place in selected demonstration projects, covering a wide range of renewable and new energy technologies in various regions in Europe and in South Africa. In South Africa the project will study the (non-) acceptance of solar water heaters and solar home systems (using photovoltaic panels).

The preliminarily selected demonstration projects are a hydrogen project in the Nordic countries, a biomass project in the East-Europe region, carbon capture and sequestration in the West-Europe region, a wind project in Hungary and a solar thermal

IN THIS ISSUE

Assessing and promoting societal acceptance of new technology . . . 1

Decision on new coal-fired plant appealed . . . 2

No blackouts with the Pebble Bed Modular Reactor . . . 3

Chalet capital cost and the environmental implications of installing a household off-grid energy system – Kariega Game Reserve, Eastern Cape . . . 5

Eskom and WWF launch Renewable Energy Research Fund . . . 11

Billion Kilowatt-hour Savings project kicks off . . . 11

The Vosman Basa njengo Magogo alternative fire lighting method implementation project . . . 12

Eskom boosts the Eastern Cape economy . . . 13

Climate negotiations in Nairobi . . . 14

Indaba 2006: 12th Southern African Coal Science & Technology Conference . . . 15

Biofuels Workshop and position paper . . . 16

Wind turbine supply contract for first African IPP wind farm signed . . . 17

5th World Wind Energy Conference 2006 . . . 18

Energy events 2007 . . . 19

project in the Mediterranean region.

The multi-stakeholder tool will become publicly available to energy managers, policy makers, technology developers, energy service providers and other users after conclusion of the project. The tool and information about the tool including a manual will be provided on the project's website. The dissemination of the multi-stakeholder tool and results of this project will aim to reach at least five targeted stakeholders in each of the participating countries involved in implementing renewable and new energy technologies.

The *Create Acceptance Project* started on 1 February 2006, and will run for two years. The project is coordinated by the Dutch Energy Research Centre of the Netherlands (ECN). Partners represent 11 institutions and nine European member states, Iceland and South Africa. *Create Acceptance* is sponsored by the European Commission within the Sixth Framework Programme Priority.

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Decision on new coal-fired plant appealed

Earthlife Africa Johannesburg has appealed against the positive Record of Decision (RoD), by the Department of Environmental Affairs and Tourism (DEAT), regarding the construction of the new coal-fired power station in Limpopo –previously known as Matimba B and more recently referred to as Project Alpha. The administrative appeal submitted to the minister contends that there are critical flaws in the Report of the Environmental Impact Assessment (EIR) submitted by the project proponents, as well as in the RoD itself.

The EIR fails to specify what pollution control equipment would be fitted at the new plant, which will have an eventual capacity of 4 800 MW and is one of three proposed new plants undergoing the EIA process. The report notes that, due to emissions from the existing Matimba power plant already exceeding air quality standards for sulphur dioxide emissions, it will not be possible for the new plant to conform to existing regulations. The report also failed to study the impacts of the pollution control equipment that is being considered, recommending further studies subsequent to completion of the EIA process.

The appeal also contends that a decision should follow, rather than precede, the adoption of new ambient air quality standards in terms of the Air Quality Act (2004), which have so far only been published for comment, as well as adoption of the margins of tolerance, or requirements for compliance, that will pertain to the standards. Issuing an approval that is conditional to compliance with standards, before promulgation of the standards and the parameters within which they will be enforced, could compromise the process for setting the standards and thus also the constitutional right to a clean and healthy environment.

Given the established political support for this project and its strategic significance as the first new coal-fired plant to be considered since the 1980s, it is important that a robust decision sets a good precedent. A decision that claims that the impacts of a project will be acceptable as long as it complies with prevailing legislation does not fulfill the objectives of the EIA process. The Record of Decision should be set aside at least until the further studies recommended in the report have been carried out, which requires that the project proponents specify what pollution control equipment they propose to achieve compliance.

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No blackouts with the Pebble Bed Modular Reactor

In the summer of 2005/6 there were a series of blackouts in the Cape. Most of these blackouts would not have occurred if the Koeberg Nuclear Power Station had had Pebble Bed Modular Reactor (PBMR) units instead of its existing pressurised water reactor (PWR) units. The PBMR is a revolutionarily simple reactor being developed in South Africa based upon a proven German design.

The fundamental reason for these blackouts was that there is insufficient generation capacity in the Cape and inadequate transmission lines to bring power down from the coal power stations in the north east. The peak demand for the Cape (Western, Eastern and Northern Cape) is over 5 500 Megawatts (MW) but the region only has one baseload power station, Koeberg Nuclear Power Station, which only has a capacity of 1 840 MW. A healthy electricity supply system has sufficient reserve capacity. South Africa's system has insufficient reserves and the Cape has none. So the slightest thing that goes wrong on this over-stretched system can cause blackouts, which is what happened last summer. Seven small faults, which would have been easily accommodated in a healthy system, plunged large areas of the Cape into darkness.

Five of the seven faults were electrical and had nothing to do with Koeberg's nuclear plant. They were faults on the transmission lines and in Koeberg's own electrical switchyard. In one of the two non-electrical faults, debris (including the famous bolt) was accidentally dropped into one of Koeberg's generators during planned maintenance and damaged it when started up. In another, the boron levels in one of the three boron accumulators were found to be 0.8% lower than specified; this presented no danger whatsoever but the unit was correctly shut-down in accordance with nuclear regulations.

Why would the PBMR have prevented most of the blackouts? The answer lies in the requirements of heat removal after a nuclear plant has been shut down. When you shut down a modern coal boiler, you immediately lose all heat and power. This is not true when you shut down a nuclear power reactor. The nuclear fission stops but there is still a large amount of heat left, about 5% to 10% of the total, because of radioactive decay. The fission products continue to produce substantial heat for a day or more after shutdown and this heat must be removed before it can make temperatures rise so high that they will damage the fuel and cause a 'melt-down'.

In PWR reactors such as Koeberg's, the fuel is slightly enriched uranium oxide clad in a zirconium alloy, the coolant is water and the moderator (which slows down neutrons to increase their chances of causing fission) is also water. The water in the reactor is at high pressure, about 150 bars, to keep it liquid. If it turns to steam, it will not remove heat so efficiently and the fuel might over-heat and be damaged. You therefore require safety systems that can remove heat from the reactor in case of an accident, even when fission has stopped altogether. These systems require pumps and the pumps require electrical power. The nuclear regulator insists that Koeberg, at all times, must have independent sources of power (power not coming from its own main generators) in case it has to shut down. There are three such sources: the national electricity grid; dedicated lines connected to Acacia Gas Turbine Station near Parow; and five stand-by diesel generators at the Koeberg site. If you lose one of these sources for a period of time, you are required to shut Koeberg down. So, electrical faults on the transmission lines from the north will force Koeberg to shut down, which has happened on several occasions.

In fact, even without any power at all, Koeberg could be shut down safely by using emergency water tanks but the nuclear regulator insists on power for shut-down because of the risk of over-heating the fuel.

With the PBMR, all of these considerations fall away. The PBMR can shut down safely, under all circumstances, without any power at all. Therefore, there will be no requirement for the PBMR to have external power sources. If the transmission lines from the north failed completely, PBMR units in Cape Town could keep running, providing the Cape with power.

The fundamental design philosophy of the PBMR is inherent safety or passive safety. No matter what human error or equipment failure that one has, you can never have an accident at the PBMR that would harm a single member of the public. Safety is built in and does not depend in any way on active safety systems. It is impossible for the fuel to overheat so that it damages itself.

The PBMR uses helium as a coolant. Since helium, a gas, carries less heat per unit of volume than water, this means the power density of the PBMR (kilowatts per litre) is much lower than that of a PWR, and therefore, when accidents happen, the effects are much slower. The fuel of the PBMR consists of tiny pellets of uranium dioxide, each one about 0.5 mm in diameter, looking rather like a fine grain of pepper. Each pellet is coated in several extremely strong and heat resistant barriers. One of these is silicon carbide, one of the hardest materials known. The coated pellets are then embedded in graphite 'pebbles', each about 60 mm in diameter, about the same size as a snooker ball. Graphite is able to withstand higher temperatures than any other substance known to man.

Figure 1 shows the fuel structure of the PBMR.

The PBMR unit is deliberately kept rather small, and is only about 165 MW capacity. This is to ensure that the ratio of surface area to mass is sufficient always to allow enough heat to radiate away passively to prevent dangerous temperatures ever being reached. In the case of the worst accident, total loss of coolant at 100% power, the highest temperature the fuel would ever see is 1400 ºC. Damage to fuel only begins at 1600 ºC, and then only slowly.

No pumps or fans, no electric motors and no power are ever required to ensure safe shutdown of the PBMR.

Figure 2 shows the layout of a PBMR unit. Helium at 900 ºC leaves

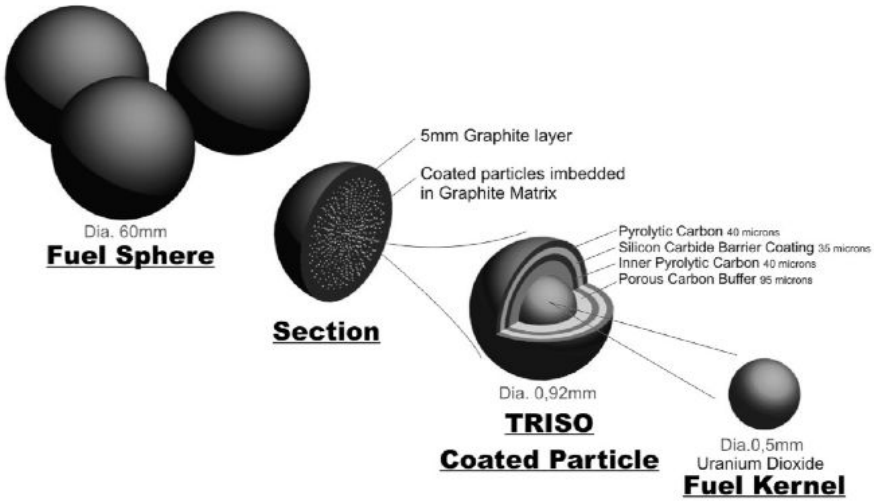

Figure 1: Fuel structure of the PBMR

the reactor and goes to turbines, which drives the generator through a gearbox. The exhaust gas goes through a recuperator (to lose heat), a pre-cooler, a low pressure compressor, an inter-cooler, a high pressure compressor, the recuperator again (to gain heat) and then returns to the reactor to be heated again. The heat sinks are the pre-cooler and the inter-cooler.

The high temperature of the PBMR's helium, 900 ºC, gives it a thermal efficiency of about 42%. This compares with 32% for the PWR, whose steam only reaches 340 ºC.

There are other advantages of the PBMR over the PWR. The PWR must be shut down for re-fuelling. The PBMR never has to shut down for refuelling. New fuel pebbles are added and old pebbles are removed on-line. Koeberg gets its 1 840 MW from two 920 units. If one of them goes down, then there is a big shock to the Cape grid. The equivalent power would come from twelve PBMR units. If one of them went down, the disturbance to the grid would be minor.

Koeberg's existing PWR units have run well over the last 20 years or more. It is unfair to blame Eskom for the blackouts in the Cape. The small errors and failures, mainly electrical, described by the National Energy Regulator of South Africa (NERSA) report, would not have caused power disruptions if there had been sufficient generation and transmission capacity. Nonetheless, PBMRs in their place would have done better and there would have been fewer blackouts, if any at all, if we had had them instead.

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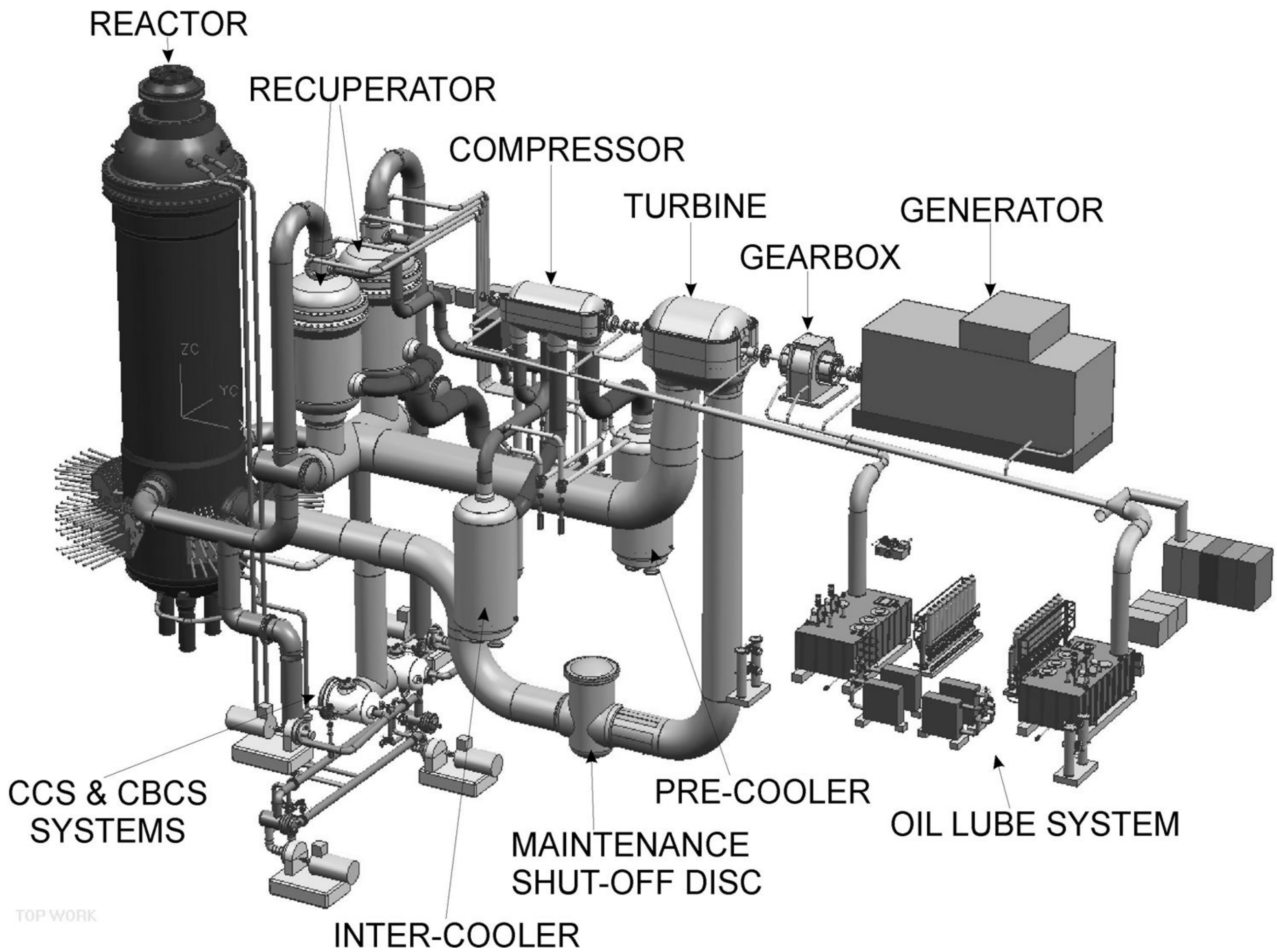

Figure 2: Layout of the PBMR power unit

Chalet capital cost and the environmental implications of installing a household off-grid energy system – Kariega Game Reserve, Eastern Cape

1. INTRODUCTION

The South African public has expressed much concern regarding the reliability of their grid electricity supply and the environmental damage caused through its production.

Two associated questions often brought up are:

1. What can members of the public do to reduce their reliance on the grid?

and

2. Can their homes be powered by cleaner fuels and at what cost?

Another relatively recent development is the significant growth in the number of nature conservation reserves, or game reserves, associated with the growth in eco-tourism.

Generally, these reserves not only showcase the natural environment but attempt to promote its conservation wherever possible. Unfortunately, energy supply is something often overlooked, especially when one considers that fossil-fuelled energy generation is the single largest pollutant of our environment and is a major cause of climate change and habitat destruction.

Reserves are in a relatively unique position whereby the use of cleaner and sustainable off-grid energy systems would:

- enable freedom from the national grid and a wider choice of lodging locations
- create the opportunity for an even more secluded and peaceful experience
- increase their conservation influence
- demonstrate the capabilities of cleaner energy technologies to guests

This project investigated the energy requirements of an existing self-catering reserve chalet, with similar requirements to a 4 person home, and the equipment required to deliver a more environmentally friendly supply.

The project delved further to ascertain an approximate distance from the national grid at which these cleaner energy systems become cost competitive to installing grid-systems and, further still, to illustrate the Green House Gas (GHG) emissions reduced by these systems as opposed to using grid fossil-fuelled electricity.

The existing chalet currently uses grid electricity and is located at Kariega Game Reserve, 10 km northeast of Kenton-on-Sea, in the Eastern Cape.

When inhabited by four people, the energy requirements of the existing chalet are considered to be similar to that of the average middle class South African home as mentioned. Therefore, the methodology and results from this project could be used to determine the equipment required and the cost involved in installing similar systems elsewhere.

Secondary project objectives were to determine the approximate distance whereat an off-grid energy system becomes economically competitive to the cost of lengthening the national grid, and to illustrate the benefits resulting from the use of a cleaner off-grid energy system.

The overall project consisted of two components in an Excel spreadsheet, which was used to determine the off-grid generation equipment required and this project.

The spreadsheet allows for changes in energy requirements, location and generation equipment. The flexibility of the spreadsheet creates a useful tool for determining the equipment required and the overall cost of off-grid energy systems.

2. PERFORMANCE REQUIREMENTS

The following sub-sections list the performance requirements of the system. The fulfilment of these requirements is crucial to the success of the system design, and they form the basis on which many of the decisions regarding component selection are made.

2.1 Power requirements of the system

Each chalet is designed to cater for the needs of four persons and consists of a main bedroom with an en-suite bath-

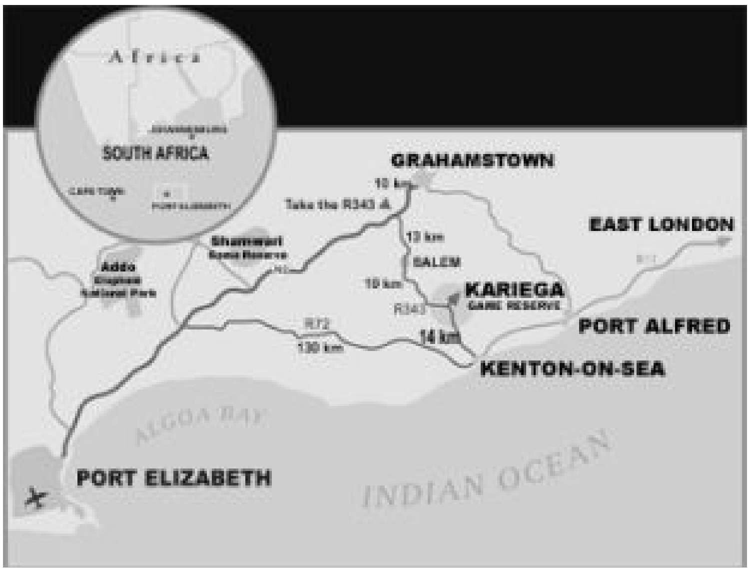

Figure 1: Geographic location of the Kariega Game Reserve

room and toilet, two smaller bedrooms, a separate bathroom and toilet, living room and kitchen.

The energy requirements of the chalet are:

Master bedroom energy requirements:
- Bedroom lights: 2×15W lights operating for an average of 3 hours per day (90 Whrs/day)

En-suite bathroom requirements:
- Bathroom lights: 1×15W lights operating for an average of 2 hours per day (30 Whrs/day)

Secondary bedroom 1 energy requirements:
- Bedroom lights: 4×15W lights operating for an average of 3 hours per day (180 Whrs/day)

Secondary bedroom 2 energy requirements / Study
- Study lighting: 2×15W lights operating for an average of 2 hours per day (60 Whrs/day)
- Personal Computer: 1×120W operating for an average of 2 hours per day (240 Whrs/day)

Separate bathroom and toilet requirements:
- Bathroom lights: 1×15W light operating for an average of 1 hour per day (15 Whrs/day)
- Toilet lights: 1×15W light operating for an average of 1 hour per day (15 Whrs/day)

Living room energy requirements:
- Living room lights: 2×15W lights operating for an average of 4 hours per day (120 Whrs/day)
- Hi-Fi system: 1×60W operating on full power for 2 hours per day (120Whrs/day)
  1×2W operating on standby for 22 hours per day (44Whrs/day)
- Television: 1×45W operating on full power for 2 hours per day (90Whrs/day)
  1×2W operating on standby for 22 hours per day (44Whrs/day)
- Space heating: Existing Jet Master fireplace (clean, sustainable firewood from Reserve)

Kitchen energy requirements:
- Stove (4 plate) and oven: 1 × 1 900W operating for an average of 3 hours per day (5 700 Whrs/ day)
- Kettle: 1×650W operating for an average of 15 minutes per day (162.5 Whrs/day)
- Family sized fridge and freezer: 1×500W operating for an average of 3 hours per day (1 500 Whrs/day)
- Microwave: 1×1200W operating on full power for 30 minutes each day (600 Whrs/day)
  1×2W operating on standby power for 23.5 hours each day (47 Whrs/day)
- Toaster: 1×750W operating for an average of 12 minutes each day (150 Whrs/day)
- Kitchen lights: 2×15W lights operating for an average of 4 hours per day (120Whrs/day)

Additional energy requirements:
- Additional lighting: 2×15W lights operating for an average of 4 hours per day (240Whrs/day)
- Water heater (150 litres): 1×3 000W operating for an average of 3 hours per day (9 000 Whrs/day)
- Additional appliances: 3×100W operating for 1 hour per day (300 Whrs/day)

The chalets total daily energy requirement is 18.87 kWh.

2.2 Material performance requirements of components used

Kariega Game Reserve is situated 10 km from the Indian Ocean, and components specified in the cleaner energy system must guarantee successful operation in South Africa's coastal environment.

Where necessary, components should be constructed of materials with the following characteristics:

- Toughness. Components exposed to the wind may experience sudden loading due to gusting winds. To withstand this load, the component material must display good toughness as a property.
- Good bending strength. Components exposed to the wind may experience bending stress due to wind force. Good bending strength is thus a desirable attribute of the material selected for such components.
- Thermal stress resistance. Exposed component materials must exhibit an ability to handle both high and low temperatures. A conceivable temperature difference is 70ºC resulting from heating to 60ºC and cooling to -10º C.
- Ultra Violet radiation resistance. Exposed components may be subjected to UV radiation; therefore materials used in these components should be UV stable to prevent deterioration and reduction of strength.
- Corrosion resistance. The coastal location of the park will expose certain components to corrosive coastal air and this can reduce the operational capability of these components and must be avoided.

2.3 Aesthetics

The appearance of the system is of relevance to the overall performance since the Reserve management would be unlikely to install a system that detracted significantly from the natural beauty of the area. All necessary effort should be made to minimise the effect of these components interfering with the appreciation of the natural environment that is inherent to game reserves.

2.4 Reliability and life cycle requirements

The system is to be used in a rural environment and should be able to handle the rough treatment it may encounter. The initial cost of the system will be high, however, the price should be kept as low as possible without sacrificing the expected reliability of each component over its required lifetime.

2.5 Ergonomics

As a system with which there is little direct human contact, ergonomics are not overly important. However, certain factors must be considered such as the ability to transport the various components to site and the ease with which the system can be assembled and installed. There should be no protrusions from the system that are unnecessary or dangerous, and that could foul the operators whilst maintaining or otherwise.

3. KARIEGA GAME RESERVE'S CLEANER ENERGY OPTIONS

The following sources of energy were considered for the Reserve's chalets:

1. Solar energy
2. Wind energy
3. Micro-hydro energy
4. Biogas energy
5. Liquid Petroleum Gas

Each energy source was assessed in two stages.

1. Initially and where possible, a 'Desktop' study was conducted into the availability of each of the above energy sources in the general Kar-

iega area; its macro-environment.

2. After the initial investigation, a site visit was conducted to assess the immediate area surrounding the chalets (micro-environment) and to confirm which energy sources were most suitable.

3.1 Kariega solar power

After evaluating the deductions made in both the 'Desktop' and 'On-site' assessments, it was concluded that the location of the Reserve and its chalets is well suited to the use of solar energy equipment.

3.11 Desktop Kariega solar study

The South African solar map indicates that the Kariega area is exposed to an average of between 4.75 sun-hours per day, the equivalent of 4.75 kWh/m^2 of incoming solar energy. This is a high amount of sunshine and highly suited to the use of solar capturing equipment.

3.12 Site visit to asses solar energy suitability

The performance of solar energy equipment is a function of the available sun-hours in the macro-environment, as well as the orientation of equipment with regard to the sun's path in the micro-environment.

Obstacles in the micro-environment that cause solar obstructions such as trees and buildings reduce the effectiveness of solar equipment. The location of the reserve's chalets is on hilltops in order to afford the best scenic views of the reserve. The low bushveld scrub and grasslands of the reserve hilltops will not shade solar panels placed on either the roof of chalets or on top of 2 metre high platforms.

PV modules and solar water-heaters operate most effectively when the incoming rays of the sun are perpendicular to the collector surface. As the rays deviate from being perpendicular, more and more of the energy is reflected rather than absorbed. The vast majority of the chalets are either north or south facing, with rooftops pitched at 15-30 degrees to the horizontal. This orientation is perfect for the capture of solar energy.

At the time of writing, the only solar energy equipment installed was a low-cost solar water-heater for the luxury lodge pool which is used only in winter. The design of the restaurant and conference centre incorporates passive solar concepts in order to minimize lighting and space-heating costs.

Figure 2: Pool solar water-heater

3.2 Kariega wind power

After evaluating the deductions made in both the 'Desktop' and 'On-site' assessments, it was concluded that the location of the Reserve and its chalets is well suited to the use of wind energy equipment.

3.21 Desktop Kariega wind study

This area is generally considered suitable for wind power, and data collected at the closest weather stations to the Kariega Game Reserve revealed that the average annual wind speed measured at 10 metres elevation at Port Alfred (12 km northeast) is 5.8 m/s and at Cape Padrone (13 km southwest) is 4.1 m/s.

These average wind speeds are some of the highest recorded in South Africa. However, the *South African Wind Atlas* clearly illustrates that there is a general reduction in wind speed as one travels inland from the sea and a site visit to assess the location of the chalets with respect to the predominant wind direction was required.

3.22 Site visit to assess wind energy suitability

The site visit revealed many operational wind-powered borehole pumps in the immediate area, suggesting significant wind power on exposed areas.

As mentioned before, the location of the reserve's chalets is on hilltops in order to afford the best scenic views of the reserve, and certain chalets have views of the sea. The relatively unobstructed path of the coastal wind suggests that the location of the Kariega chalets is suitable for the use of wind energy.

The hilltops of the reserve are pre-

Figure 3: Borehole water extracted using wind energy

dominantly grassland and bushveld scrub, which will not obstruct even small wind turbines if placed on towers 4 m high or more.

3.3 Kariega micro-hydro power
After evaluating the deductions made in both the 'Desktop' and 'On-site' assessments, it was concluded that the combination of the distance of the Reserve's chalets from the river and the rivers low energy potential make hydroelectric power an unsuitable form of energy generation at the Reserve.

3.3.1 Desktop Kariega hydroelectricity study
The Kariega River is 17 km long, and has a catchment area of 690 km^2. The small catchment area is the major contributing factor to the low flow rate of the river.

The tidal river mouth has a surface area of about 1.6 km^2 and an average depth of 2.4 metres and, during extremely dry seasons, the river acts as a negative estuary drawing in water from the sea which causes the river water to become extremely saline.

In order to store water for agricultural purposes, dams have been built along the length of the river, and these dams need to fill up before any significant amount of water can flow downstream.

3.3.2 Site visit to asses hydroelectricity suitability
As expected, the river has a very low flow rate. There is also no significant change in elevation over the course of the river in the Reserve.

3.4 Kariega biogas
The production of biogas using a biogas digester in the Reserve is not practical. The scattered nature of livestock in a game reserve would make the collection of animal waste extremely difficult and costly. In addition, in order to maintain the environment it is important that the nutrient content of the animal waste remains in the system.

The digester could be fuelled by human waste but the quantity would be insufficient; the general rule is "the waste of 6 persons is sufficient to produce the gas required for the cooking needs of 1 person".

The unpleasant smell of the high sulphur content gas will also be a deterrent to guests in the chalets.

3.5 Liquid Petroleum Gas
LPG is a fossil fuel and is therefore not considered sustainable in the long term. However, it is an accessible, portable and relatively clean burning fuel which could be used for the more energy intensive loads of the chalet such as cooking, refrigeration and heating.

Most importantly, it is able to produce the energy required at a far lower cost than is expected from the sustainable energy system.

4 MATCHING OF LOADS TO ENERGY SOURCES

The energy requirements of the chalet will be achieved using sustainable energy sources whenever practically possible.

Unfortunately, the most energy intensive loads will consume more energy than an affordable sustainable energy generation system that can be expected to produce. These energy intensive loads will utilise Liquid Petroleum Gas as their energy supply.

4.1 Water-heating
A passive, thermosyphon solar water-heater will supply hot water to the chalet. A backup gas water-heater can be used on days of low sunshine or on days of high, hot water demand.

4.2 Cooking and refrigeration
Unfortunately, it will be extremely expensive to produce sufficient sustainable energy to meet the energy requirements of the energy intensive equipment used for cooking and refrigeration.

Sustainably harvested wood and solar energy can be used for space heating, but is impractical for the day-to-day cooking of a modern high-paced lifestyle. Therefore, LPG will be used for cooking, refrigeration and for the backup gas water-heater.

4.3 Lighting
The wide variety of efficient lighting fittings available today can be installed in the chalet and powered by the chalets' sustainable energy system.

Passive solar design should be incorporated into future chalets to maximize the effect of natural light and to minimize the amount of additional lighting required.

4.4 Electrical appliances
Appliances such as a desktop PC, a small hi-fi system and television are not overly energy intensive and, if used efficiently, will not consume too much energy. These appliances can be included in the chalet's list of electrical appliances.

Appliances such as a kettle and toaster are energy intensive, however, when used efficiently operate for very short periods of the day. Due to their short daily operational periods, these appliances contribute relatively little to the overall consumption. Therefore, it is practical to include these items in the chalet's list of electrical appliances.

4.5 Additional loads
A small fossil-fuelled generator should be available and used when required to provide power to high energy intensive equipment and to recharge batteries during lengthy periods of low sunshine and wind.

5 FINAL DESIGN OF THE CHALET'S OFF-GRID ENERGY SYSTEM

The energy requirements of future off-grid chalets can be met using a combination of solar-electric, solar-thermal, wind and LPG powered components.

The combined set-up cost is R108 578; excluding the cost of a backup generator (see Figure 5).

5.1 Electricity generation system
The integrated electrical generation system can be expected to have the following power outputs:

- Maximum power output, excluding generator: 2.46 kW

Figure 4: View of the valley and sea from Kariega hilltop

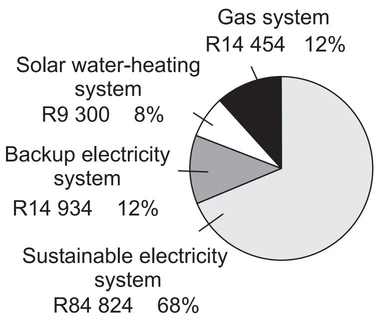

Figure 5: Composition of the chalet's complete energy system

- Maximum power output, including generator: 5.46 kW
- Annual power output, inc. 5% inverter inefficiency: 2 237 kWh
- Annual power output, inc. 25% battery and inverter inefficiency: 1 678 kWh

5.1.1 Sustainable electricity system

The two energy sources best suited to provide sustainable energy at the Reserve are solar and wind. Both sources can be converted into electricity, using wind turbines and PV modules respectively.

However, the cost of the equipment required differs as does the amount of power produced by each during the year. Currently, the purchase cost per Watt is less for wind turbines than PV modules, making wind turbines more economically attractive in areas with sufficient wind. Unfortunately, most parts of the world, including Kariega, experience periods when the level of either wind or sunshine is low, luckily both circumstances usually do not occur at the same time. Therefore, it is wise to utilise a combination of energy sources in order to ensure the batteries regularly recharge to the level required.

The advantages and disadvantages of various types of PV modules and wind turbines were compared before deciding which type would be used in the spreadsheet. The reasons for selecting the specific type of PV modules and wind turbine is their lower purchase cost per Watt compared to their competitors, the good technical support offered and their tried and tested use in South African conditions.

A spreadsheet was developed to aid in the formulation of the optimal mix of PV modules and wind turbines. It was decided that the optimal mix of components to provide electricity to a future off-grid Kariega chalet will be one 1000 Watt wind turbine and four 180 Watt PV modules.

The PV modules can be mounted on the chalet roof and the wind turbine mounted on a tower relatively close by:

- System cost, excl. cabling: R84 824 incl. VAT
- Fuel cost per year: R0.00 (free solar energy)

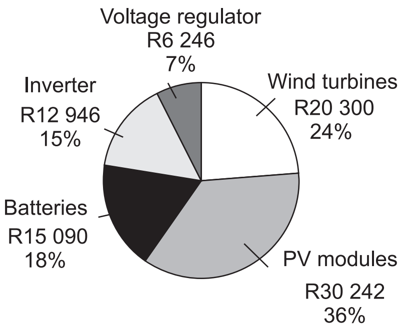

Figure 6: Composition of the chalet's sustainable electricity system

5.1.2 Backup electricity system

According to weather data provided by the South African Weather Bureau, the sustainable electricity system should provide more than sufficient electricity for the chalet's requirements.

However, unexpected lengthy periods of low sunshine and wind could cause the battery bank to totally discharge. Therefore, a 5 kW diesel generator should be available as backup to the sustainable electricity system. The annual duration of generator operation and its related fuel cost are both unknown:

- Diesel generator (1 × 5 kW), excl. cabling: R14 934.00 incl. VAT
- Fuel cost per year: unknown

5.2 Gas system

The chalet can utilise Liquid Petroleum Gas for cooking, refrigeration and for the backup water-heater:

- System cost, excl. piping R14 454 incl. VAT
- Fuel cost per year (360 kg LPG)R2 300 incl. VAT

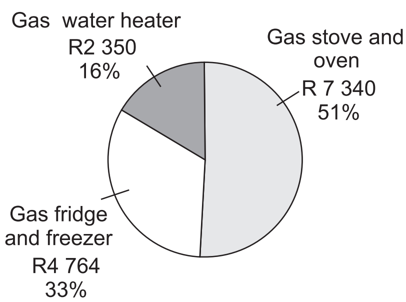

Figure 7: Composition of the chalet's gas system

5.3 Direct solar system

The chalet's hot water can be provided primarily by a solar water-heater installed on the roof of the chalet. The backup gas water-heater will supply hot water on days of low sunshine. The hot water will be stored in an insulated storage tank in the roof:

- solar water-heater, excl. piping: R9 300 incl. VAT
- Fuel cost per year: R0.00 (free solar energy)

6 ENERGY COSTS

The chalet's off-grid energy system would offset 6 888 kWh of grid electricity per year. However, 350 kg of LPG would need to be purchased per year to run the gas system.

The overall result is an expected R2 000 per year saving on energy costs.

7 EMISSIONS

The use of the chalet's off-grid energy systems as opposed to grid-electricity will offset GHG emissions by 15.396 tC0$_2$eq per year.

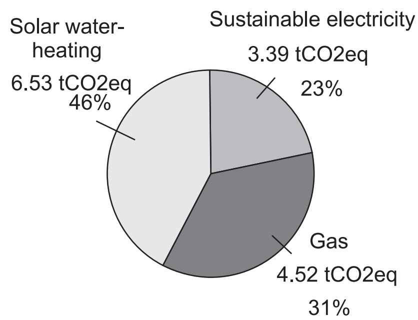

Figure 8: Kariega chalets GHG emission offsets

8 DISCUSSION

8.1 Cost of technologies

The cost of installing the off-grid energy system is approximately R108 578 per chalet. The cost of installing an equivalent grid connection is approximately R115 000 per km of easily accessible ground and an additional cost of R7 500 for components included in the off-grid energy system such as the oven, fridge and water-heater.

Therefore, at approximately 900 metres from the national grid it is cheaper to install the off-grid energy system, for a single chalet, than to connect to the grid.

The above is true for a single chalet but not necessarily for a group of buildings with a much higher total energy demand.

8.2 Cost of energy

Grid connected electricity is currently too cheap to warrant an off-grid energy system within a grid connected area. However, the cost of coal and coal-fuelled energy in South Africa will continue to increase, whereas the cost of sustainable energy generation technologies will increase at less of a rate and in certain cases decrease.

This is due to three major reasons:

1. Sustainable generation technologies have sustainable fuel sources and steady prices. In certain cases, free energy sources such as wind and the sun.
2. The expected increase in grid electricity demand will require an increase in grid generation capacity, which will have to be paid for by the grid electricity consumer, meaning an increase in the grid electricity price.
3. Manufacturing costs as well as the major research and development costs of sustainable generation technologies will decrease the more widely accepted and utilised they become.

Therefore, the use of sustainable energy generation technologies will continually become more attractive.

8.3 Use of LPG and bio-diesel

LPG is used in the off-grid energy system, for the energy intensive loads namely cooking, refrigeration and the backup water-heater. The backup diesel generator could be used to supply electrical energy for these loads and bio-diesel could be used instead of conventional diesel. The use of a bio-diesel generator would make the entire system clean and sustainable (bio-diesel is considered sustainable and emission neutral).

However, bio-diesel is not readily accessible, and users of bio-diesel in South Africa generally process the fuel themselves. Currently, the processing of bio-diesel is not something the average homeowner or holidaymaker would consider but the Reserve could process bio-diesel themselves from old cooking oil and use it in their generators.

Bio-diesel should be considered as a fuel for the chalets' backup generator, but the user friendliness of LPG components is currently better suited than a bio-diesel generator for the chalets' energy intensive loads.

8.4 Emission credits

The use of the off-grid sustainable energy system as opposed to fossil-fuelled grid electricity will offset GHG emissions by 15.40 $tC0_2eq$ per year; the equivalent of 15.40 carbon credits. This is not a significant number in terms of carbon credit trading and it would be difficult to find a willing buyer for such a small number.

However, if a group of off-grid sustainable energy systems were to collectively pool their emission credits, it is possible they could sell these credits and in doing so recuperate some of the costs of the energy system.

9 CONCLUSION

The chalets energy requirement of 18.57 kWh per day will be met using a combination of solar-electric, solar-thermal, wind and LPG powered components, with the LPG system the only component of the overall system that is not sustainable. A bio-diesel generator could replace the LPG system, thus making the entire system sustainable. However, bio-diesel is not currently available at the Reserve and it cannot be assumed that the Reserve would be willing to process bio-diesel themselves and therefore the use of LPG is more practical.

The set-up cost of the chalet's off-grid energy system is R108 578. The cost of installing a typical home sized grid-connection, 1 km from the national grid is R122 280. Therefore, for a single chalet's energy requirement, it is currently cheaper to install the off-grid sustainable energy system at a distance of approximately 900 metres from the grid, than to connect to the grid. This is the maximum distance since it is based on a quote to install a cable over easily accessible pasture-type ground, requiring no substantial bush clearing.

The distance will decrease as:

1. the terrain becomes more inaccessible, requiring additional installation costs
2. future off-grid energy prices become more economically competitive to that of fossil-fuelled energy

The off-grid energy system will require only occasional maintenance and will significantly reduce the environmental impact of each chalet or building.

Guests would be able to enjoy a trouble free and far cleaner energy supply and their reserve experience would be increased by bearing witness to the capability of the off-grid energy technologies. Each guest's experience may even be more pleasurable knowing that their use of the chalet's clean energy technologies contributed to the conservation of the global environment that they have taken time to enjoy.

10 SUMMARY

1. The chalets energy requirement of 18.87 kWh per day will be met using:
   - 4×180 Watt PV modules
   - 1×1 000 Watt wind turbine
   - 4 × 530 Amp hour batteries (2 120 Amp hour battery bank)
   - 1 × 3000 Watt voltage regulator
   - 1× Solar water-heater (2.1 m^2 collector, 150 litre hot water storage tank)
   - Gas system consisting of a stove and oven, fridge and freezer, water-heater
2. The maximum distance at which the off-grid energy system becomes economically viable to a 60 Amp household grid connected system is approximately 900 metres.
3. Using current energy prices, the chalet's off-grid energy system will reduce energy costs by approximately R2 000 per year.
4. The use of the off-grid cleaner energy system as opposed to conventional grid-electricity will offset GHG emissions by 15.40 tons of carbon dioxide equivalent per year.

This article has been adapted from an Energy Project course component of a Master's Programme in Sustainable Energy Engineering, Energy Research Centre, Department of Mechanical Engineering, University of Cape Town.

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Eskom and WWF launch Renewable Energy Research Fund

In a boost for local innovators and sustainable development, a new joint initiative by Eskom and the World Wildlife Fund (WWF), was announced in October. R3 million per year for three years has been committed by Eskom for research into renewable energy in South Africa, which will be put into a fund and jointly administered by Eskom and the WWF.

The overall aim of the joint initiative is to promote, through funding local innovation, the development and uptake of renewable energy in South Africa. With the global renewable energy market expanding each year, alternative energy could prove a boon for local business as well as meeting imperatives like slowing climate change. The WWF and the power parastatal will jointly source and evaluate projects to be funded, oversee their management and progress and actively source complementary funding where appropriate.

Thulani S Gcabashe, Eskom's Chief Executive says: "The funds will be available specifically for renewable energy research projects undertaken outside of Eskom, supporting the development of the Renewable Energy sector". Gcabashe adds that Eskom is committed to assisting with growing this sector of the economy. Projects will be evaluated against a set of guidelines, which will amongst others, supplement and complement existing initiatives in support of the objectives of the national Renewable Energy Strategy driven by the Department of Minerals & Energy.

Tony Frost, WWF CEO, says: "Ventures which would qualify for funding include both on and off-grid applications, concept developments, feasibility studies and small-scale demonstration projects.

Frost adds that projects would be sought that carry direct community benefits, create additional jobs, have a high degree of local content, potential for replicability, national application, local manufacturing and export potential. "South Africa has a fine tradition of innovation that's been exported to the world, including the dolosse, CAT scan, Kreepy Krawly swimming-pool cleaner, oil-from-coal technology, the automated popcorn maker and Pratley's Putty. We're hoping that the fund will enable similar ingenuity to be focused on meeting our need for sustainable energy technology."

To avoid duplication and leverage efforts, an advisory committee of key players has been established and will include representatives from government (Departments of Minerals and Energy, Environmental Affairs and Tourism, Science and Technology amongst others), Academia, Business Associations and funders and investors in renewable energy projects.

While government has an important role in creating the enabling environment for large capital investments and the provision of public infrastructure, many of the innovations that make an energy transformation possible, will not come from the government, but from the people of South Africa. The Eskom/WWF Renewable Energy Fund is recognition of this reality and a contribution to growing South Africa's Environmental Goods and Services sector.

The scope and ambition of energy transformation sought nationally and internationally is enormous. This challenge can be met through commitment to innovation as demonstrated by Eskom and the WWF through this joint initiative.

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Billion Kilowatt-hour Savings project kicks off

On 29 September, the Billion Kilowatt-hour Savings project kicked off. This is an energy efficiency project aimed at saving a billion kilowatt-hours of electricity internally. This target also takes into consideration all energy efficiency projects implemented internally since 2000.

One billon kilowatts of electricity is a saving of about 3% of the total energy consumed by Eskom, and approximately 0.5% of energy sold in South Africa. This saving could result in reducing the required installed capacity by approximately 110 MW.

The saving of one billion kWh of conventional power will also result in preventing the emission of more than 950 000 tons of CO_2, with obvious positive spin-offs in terms of climate change, and the saving of half a million tons of coal and 1.26 million cubic metres of water per year.

This project will use the existing Eskom Demand Side Management (DSM) information.

The billion kWh Savings project was presented to EXCO on 1 November 2005, and received their full support.

It is managed by a Task team under the auspices of the Sustainability Liaison Committee, with input from all divisions, aimed at being of benefit to all Eskom and South Africa.

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The Vosman Basa njengo Magogo alternative fire lighting method implementation project

High levels of air pollution associated with household coal burning create human health problems and unnecessary expenses in terms of health costs to individuals, employers and the national government. In the interest of community development and social investment, Anglo Coal supported a project to popularise an alternative fire lighting method to reduce air pollution. Anglo Coal appointed Palmer Development Consulting (PDC) to implement a Basa njengo Magogo alternative fire lighting method demonstration project in Wards 7, 8 and 9 of the Vosman Township near Witbank, Gauteng.

The project aimed to demonstrate the Basa njengo Magogo (BnM) method to 10 000 households in the identified project area within the winter months of June, July and August 2006. Although Anglo Coal sells only to Eskom or export markets and no Anglo coal is used by households in Emalahleni, air pollution has been identified as an area of concern for both the company and the local community. Anglo Coal supports the project in the interest of community health and general environmental improvement of the area. The Basa njengo Magogo project is endorsed by the Department of Minerals and Energy, Department of Environmental Affairs and the Emalahleni Local Municipality.

Vosman township lies off the N4 highway just before Witbank. The area has a mix of formal and informal housing and although basic service delivery has been improved, specific parts of Vosman remain without electricity and proper housing. The project was implemented in Wards 7, 8 and 9 as mentioned, with Ward 7 being the largest and most informal. The area was selected for the project by the Municipality, Ward Councillors and Anglo Coal. Originally, only Wards 8 and 9 were earmarked for the project but to reach the target of 10 000 households, Ward 7 had to be included.

Households in Vosman obtain coal by purchasing from coal merchants as well as by collecting coal from a nearby old coal dump. Households don't admit freely to collecting coal from the dump as it is prohibited and they can be prosecuted. Collecting from the dump is also dangerous and households report hearing explosions (most possibly from methane gas) and the coal caving in. The quality of the collected coal is also very low since it is full of stones, very big in size, brittle and reportedly does not burn well and is difficult to light. Lastly, out of the 8 coal yards selling coal that were interviewed, 1 admitted selling coal from the dump site. However, the project team suspects that more merchants are selling coal from the dump or mixing it with coal bought elsewhere.

The 26 fieldworkers were divided into 9 groups, and each group had to do a minimum of 2 BnM demonstrations per day. At the end of the project, some groups made more than 2 demonstrations per day but at individual households, bringing the average number of people reached per demonstration down. In total 893 demonstrations were held over the demonstration period with an average of 12 people attending per demo. The majority of demonstrations were held in the street, although some demonstrations were held inside someone's house by special request.

In follow-up visits to households, 534 households responded positively to the question if the method was tried at home after the demonstration - 90% of the sample. Out of the 534 respondents who did try the method at home, 528 reported that they were successful and that the method worked – 99% were successful. In total, 66 respondents (or 11% of the sample) reported that they were not successful in using the method. The majority of respondents (465) saw a demonstration in the street, 106 saw a demonstration in a house, 6 saw it at a school and 1 person saw a demonstration at a coal yard.

In total, 555 interviews were conducted during the monthly follow-up visits. Some 535 respondents or 96% of the sample indicated that they were using the BnM method to make a fire. On the suggestion made by Anglo Coal, interviewers also had to indicate if they actually witnessed the household making a BnM fire or having just made a BnM fire. Interviewers reported that they actually saw the BnM method used in 487 of the households visited – or 87% of the sample interviewed.

A total of 12 396 households were reached during the demonstration period. Furthermore, during the household daily follow-up visit, households indicated that they would be willing to tell and show other people the method. In the monthly follow-up interviews, 389 respondents indicated that they have told someone about BnM, while 368 respondents indicated that they have shown someone how to make a BnM fire.

In terms of the frequency of household fires, 173 households or 31% of the sample reported no change in the frequency of their fires. A total of 124 households still make only one fire a day, while 49 households reported still making two fires per day. Therefore, 69% of the sample reported making fewer fires per day with the BnM method.

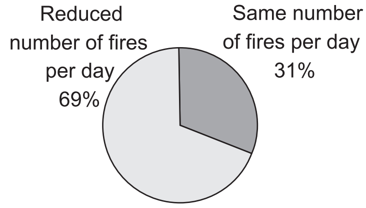

Figure 1: Fire making frequency of households

Households who purchase their coal in bags, reported the following savings per month.

Figure 2: Coal savings for households buying coal in bags

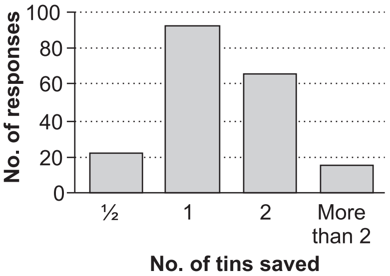

Figure 3: Coal savings for households buying coal in buckets

A small number of households (15) also reported saving 1, 2 or 3 wheelbarrows per month, but since this was only reported by such a small sample, it was only included in the total coal savings for the area.

In total, based on the weight of coal per bag, (around 30 kilograms) households saved on average 28 kilograms of coal per month (the equivalent of almost 1 bag) or in total more than 7 tonnes over the project period. Based on the weight of a bucket of coal, households saved 4.7 kilograms of coal per month (the equivalent of 1 bucket or tin of coal) and in total, households using tins saved 920 kilograms of coal over the project period. This would mean that households using coal bought in bags are saving almost R50 per month, while households using tins are saving almost R20 per month.

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Eskom boosts the Eastern Cape economy

Eskom has signed a multi-billion rand power supply agreement with Alcan, a Canadian aluminium producer. Alcan will build an aluminium smelter in the Coega Development Zone outside Port Elizabeth in the Eastern Cape.

In support of this national initiative, Eskom will be investing some R6.4 billion on its high voltage transmission infrastructure in order to supply the power needed for the smelter. Work has already commenced on the infrastructure upgrade which includes building seven substations. Eskom will also build about 1 300 km of a 765 kV and 141 km of 400 kV transmission lines respectively. The agreement between Eskom and Alcan will span over a period of 25 years.

'Here in the Eastern Cape, upgrades to the lines and infrastructure to cater for the power needs of the smelter will have positive spin-offs for the economy of the region. In addition to the economic boost to be provided by Alcan, the upgraded power supplies open the way for more investment in manufacturing and other job-creating industries in the Eastern Cape, which may otherwise have been limited by the unavailability of power', said Thulani Gcabashe, Chief Executive, Eskom, during the signing ceremony.

The Alcan project will be the first project to benefit from the DTI's Developmental Electricity Pricing Programme, which is designed to stimulate energy investment in South Africa. This project involves a number of role-players including the Department of Trade and Industry, the Industrial Development Corporation and the Coega Development Corporation. The negotiations for the power supply agreement began in 2001, and Eskom is pleased that the negotiations have now been successfully concluded.

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Climate negotiations in Nairobi

The climate negotiations held in Nairobi in November 2006 made modest, but important steps forward. Key outcomes were progress on adaptation, a greater focus on projects under the Clean Development Mechanism (CDM) in Africa, and a continuation of a two-track approach to future action on climate change.

Nairobi hosted the twelfth Conference of the Parties (COP) to the UN Framework Convention on Climate Change, as well as the second meeting of the Parties to the Kyoto Protocol. In addition, there were parallel meetings of regional governments (including the Western Cape) and many seminars and workshops around the conference.

Delegates meeting in Africa were reminded that climate impacts could include greater and more rapid sea level rise than previously projected; more frequent coastal storms, threatening the lives and livelihoods of coastal communities; substantial reductions in surface water resources; accelerated desertification in sensitive arid zones; and greater threats to health, biodiversity and agricultural production. Many actions to safeguard our citizens against these threats will also have immediate benefits in the face of ongoing climate variability that have direct impacts on peoples lives now.

The priorities identified by the Kenyan President of the COP were adaptation, the CDM, technology and future action.

KICK-STARTING CDM IN AFRICA

The 19 CDM projects in the pipeline in Sub-Sahara Africa accounted for only 1.5% of the total of 1 260 projects world-wide, with 13 located in South Africa, 2 in Nigeria and 1 each in the Ivory Coast, Tanzania, Equatorial Guinea and Uganda.

The Nairobi meeting recognised the need for more equitable regional distribution of CDM projects. Kofi Annan, the UN Secretary General, announced a Nairobi framework to support CDM in LDCs, Africa and Small Island Developing States. The challenge will be to ensure that this process is not top-down, but driven by African institutions.

INTRODUCING NEW THINKING ON TECHNOLOGY TRANSFER

Technology co-operation, development and transfer are fundamental to the overall climate change agenda. A key challenge for developing countries is to address the intellectual property rights barriers that still undermine access to environmentally-friendly technologies. Little progress was achieved in Nairobi, with a one-year extension of the existing mandate of the Expert Group on Technology Transfer (EGTT). At least the differences between the EGTT and a Technology Development & Transfer Board were spelled out clearly. The latter is intended to achieve some actual diffusion of technology. Some creative thinking will be needed to move forward in this critical area in 2007.

TAKING REAL ACTION ON ADAPTATION

Nairobi marked an important step in moving adaptation higher up on the climate agenda. The five-year programme of work on adaptation was finalized at this meeting after two years of hard negotiating. The programme will enable negotiators to expand their knowledge base and to begin next year with intensified scientific and technical work by adaptation experts. Further work will be needed and move from better understanding to implementation of concrete projects that address climate variability and change.

Agreement was reached in respect of the principles and modalities (rules) that will guide an Adaptation Fund. This fund will provide a means to assist those developing countries that are particularly vulnerable to the adverse effects of climate change. It is expected that the fund will be up and running by the end of 2007. A major political victory in Nairobi was the agreement that the decision-making of the Adaptation Fund will be based on the principle of one-country-one-vote, rather than the usual approach in which donor countries decide.

MAINTAINING THE POLITICAL MOMENTUM AND EXPANDING THE CREATIVE SPACE

Last year, a two-track process was launched in Montréal. Further commitments for Kyoto Parties are set in the Protocol track, while a Convention track considers long-term action, especially for developing countries. The Convention Dialogue, however, is not (yet) a negotiation.

In Nairobi, the Convention Dialogue once again provided an opportunity for constructive and creative ideas regarding future activities by all countries to intensify its efforts to address climate change. The challenge will be to turn creative ideas into practical action.

On the Protocol track, a work plan was agreed, setting steps for negotiating on further commitments by developed countries. Critical for the carbon market is that there should be no gap between the first and second Kyoto commitment period. Setting out a clear work plan makes clear the process for setting deeper emission reductions by developed countries beyond 2012. This sends a clear signal to carbon markets on the common resolve to secure the future of the Kyoto regime.

LOOKING TO NEXT YEAR

Overall, Nairobi can perhaps be described as a 'workhorse' conference. Big breakthroughs, like those in Montréal, do not happen every year. Good progress was made on a number of issues, notably African priorities on adaptation and the CDM.

Yet the pace of multi-lateral negotiations remains too slow to deal effectively and urgently enough with the problem on climate change.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) will release its Fourth Assessment Report. The report should provide a new sense of urgency. The balance of evidence is pointing to more serious impacts than previously thought.

At the same time, there are many mitigation options that can and should be explored. Increasingly, the IPCC is concluding that changing development paths is as important as setting climate targets. For South Africa, to shift its energy development to a more sustainable trajectory would be a meaningful contribution. The country needs to do its homework, and continue to engage in the multi-lateral arena.

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www.iisd.ca/climate/cop12/ (Earth Negotiations Bulletin more detailed summary)

Indaba 2006

12th Southern African Coal Science & Technology Conference

GLENHOVE CONFERENCE CENTRE, JOHANNESBURG, 10 - 11 OCTOBER 2006

I was invited to present a keynote address at the Indaba 2006 – 12th Southern African Coal Science & Technology Conference, Gelncove Conference Centre, Johannesburg.

I had to miss the plenary, *America's potential to replace imported petroleum by domestic coal-derived transportation fuel*, by Bill Hauserman, a consultant. However, I am told that the N Dakota synthetic gas plant, based slavishly on Lurgi gasifiers, would soon be followed by a Lurgi IGCC in Minnesota and another N Dakota plant making synfuels via Phillips-Conoco gasification (this is a development of the Dow gasifier) and Fischer-Tropsch. There was no doubt that, at crude prices foreseen, the process would be highly economic.

The first session was devoted to combustion. The keynote address was by Ray Everson from North-West University, who spoke on *Reaction kinetics of inertinite-rich coal particles at fluidised bed combustion conditions*. Thermogravimetric studies over the temperature range 450 to 900°C showed short duration charring prior to combustion. The charring created cracks and fissures that enhanced diffusion of gases and reaction of the coal. This enabled the inertinite-rich coals to burn reasonably completely even at 900°C, although it still took nearly 4 minutes to burn out a 150ÿm particle. This does not matter in a fluidised bed, but would clearly be a problem in a conventional PF boiler.

Other papers in this session covered NOx generation in pulverized fuel boilers (Gerry Hesselmann of Mitsui Babcock, Scotland); optimisation in industrial firetube boilers (Hand Verbanck, Alsthom John Thompson, Cape Town); and fluidised-bed boilers (Adam Luckos, Montek). A particularly interesting finding was that low NOx burners almost invariably give rise to a high carbon loss in the ash. The fact that circulating fluidised bed combustors up to 460 MWe were already in operation, with 800MWe planned, was an indication of how this technology was maturing. A 360 MWe pressurized fluidised bed system, with an 80:20 split between steam and gas cycle generation, was under construction with an anticipated thermal efficiency above 45%.

The second session was on environmental matters. The keynote address followed the combustion theme, *Combustion of coal and its role in waste to energy*, by Dilip Bapal, of Thermax India. Co-firing of a surprising range of industrial wastes with coal was perfectly possible. The wastes included coffee grounds (85% moisture), bagasse (70% moisture), coffee husks (78% moisture), pineapple waste (70% moisture) and spice wastes, and had enabled significant carbon credits to be gained. Agro wastes tended to be drier but more fibrous and have a low-softening ash, which gave rise to agglomeration, slagging and the fouling of heat exchangers. Thermax was one of the five largest suppliers of boilers in the world, and had an extensive reference list of successful installations. Other papers were on carcinogens in coal tar (Nelia Basson, Sasol) and the trade-off between externalities and sustainable development (Gina Downes, Eskom).

The session continued after lunch, where I gave the keynote, *Carbon storage: a significant factor in controlling atmospheric carbon.* I was rather nervous about one aspect – I had concluded that the development of oxy-fuel combustion systems was such that no reliable costs could be developed for capture and storage systems based on this core technology. I need not have worried – my findings were vindicated in a later paper *Options for coal-based power generation without CO_2 emissions,* by Gerry Hesselmann. Another paper in this session was an excellent review of European developments in capture and storage, by Rosa Menéndez of the Spanish National Coal Research Institute (NCAR), whom I had met last year in Oviedo where NCAR is based. The session concluded with a paper by David French, of CSIRO Australia, on the presence of selenium in coal.

We then moved on to metallurgical aspects of coal. The keynote address was *Liquid and premium cokes obtained from the co-coking process* by Harold Schobert of Penn State. Co-coking involves adding coal to the feed to a crude oil refinery coker. The volatiles from the coal add to the liquid yield and, in particular, boost the production of liquids in the jet-fuel boiling range. There are hopes for a range of high-value uses for the coke, but I did not manage to get a sensible answer to the question of whether these hopes had any chance of success in view of the addition of ash with the coal. Kgutso Mokoena of Sasol gave an excellent account of work to convert low-value medium temperature coal-tar pitch into higher value products by heat treatment. While not yet at commercial scale, it is clear that there are real prospects for a commercial process emerging. The presenter of the final paper on coking coals, from India, did not appear, which was a pity, as the abstract of his contribution sounded very promising.

The day ended with a short poster session with five posters, two of which I found of particular interest:

- A paper from Wits on the use of microwave power to reduce the sulphur content of coal; and
- A paper from North-West on the pelletization and drying of fine coal. Strong pellets could be made if there was not too much water, and the pellets could then be dried to low final moisture content and maintain their integrity.

Discussion and networking were encouraged by having a cocktail party at the same time as the poster session.

The next day started with a Keynote by Prof Rafael Kandiyoti from Imperial College, looking at structural changes in coal as a function of the rate of heating. Coking coals release hydrogen at an early stage in the heating process, and this hydrogen stabilizes the species that permit coke formation. Transitional coals (those that are weakly coking) lack this donatable hydrogen, but strong hydrogen donors can make good that lack. The results suggest methods for producing strong cokes from weakly coking coals and also give insights into coal liquefaction.

Roelof Coetzer of Sasol then gave a straightforward paper on the application of statistical design of experiments to the understanding of gasifier performance. He was followed by John Bunt, also of Sasol, who described what happened when they studied the reaction zones in a full-scale gasifier during shutdown. While there was a sharp separation between the drying and the pyrolysis zones, the bottom of the pyrolysis zone merged with the gasification zone and the gasification zone merged with the oxidation zone. The session ended with an excellent presentation by Sasol's Ed Koper on the selection of gasifiers for indirect coal-to-liquid processes, although he also touched on their application in direct liquefaction in producing the hydrogen needed. In discussion it transpired that he had recently visited the Shenhua direct liquefaction plant that is currently under construction in China, and which will be the world's first commercial direct liquefaction plant.

After morning tea, Chris Higman of Syngas Consultants, Germany, gave an excellent assessment of integrated gasification – combined cycle power plants. Operational experience gained over the past 15 years had shown unexpectedly low reliability and availability. Gasifiers were achieving performance significantly below what they were achieving in chemical and other industries. He described two major programmes focusing on the reasons for this poor performance.

Harold Schobert then returned to present one of his student's papers on the use of coal in a refinery. Again, I did not find it very satisfactory – the yields from adding coal were not great, and the process consumed a solvent oil, making it uncertain whether the reported yields were from the coal or the added oil. David Morgan from the University of Pretoria then spoke on Refcoal, the product of dissolving the coal organic matter in alkaline dimethylformamide. Dissolution of over 90% was achieved, and the product was separated from the ash by centrifugation followed by polishing filtration. The solvent could be recovered and reused. The product coked well, and gave excellent carbons and graphites. This session closed with a Sasol paper given by Setobane Mangena on the release of trace quantities of Al, Si and Fe during gasification, all of which gave operational problems during the Phenosolvan treatment of the gas liquor.

The final session was devoted to coal beneficiation. Johan Korte of the CSIR gave an excellent description of the problems of density cleaning of coal at densities below 1.5 t/m^3. Recovery efficiency suffers, particularly when dealing with fine coal. He suggested some steps to improve performance. Heleen Rautenbach of Kumba then spoke on Kumba's decision to use a dense medium cyclone in preference to spirals to produce a 10% ash coking coal and 35% ash power-station coal, with a small gain in coking coal and overall yield that was, nevertheless, high enough to justify the additional capital and operating expense. She was followed by Eskom's Edgar Bradley, who showed how roller ring mills outperformed ball mills in grinding coal for feeding large boilers. Dawid Kruger, of North West University, discussed the preparation of activated carbon from coal for use in the platinum industry. Although the product had a lower capacity than conventional activated carbon, he hoped the lower cost would offset this disadvantage. Ernst Venter of Kumba closed the session with an interesting review of South Africa's coal resources, and the shifts that are likely to happen during the next few decades as coal becomes in much shorter supply. There will be huge expansion of the Waterberg field, which by the end of the century should be a single pit some 30 km long, 5km wide and 120m deep on average. We will continue our reliance on coal as a primary source of energy, but the cost will increase rapidly, driving power costs up to levels comparable with other industrial nations.

The abstracts and the list of delegates are available, and the proceedings are available on CD ROM.

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Biofuels Workshop and position paper

The Energy Policy Unit (EPU), Earthlife Africa Johannesburg, participated in a national Biofuels Workshop convened by the Southern African arm of Citizens United for Renewable Energy and Sustainability (CURES), a coalition joined by the participants of the South African civil society Energy Caucus in February 2004, during preparation for the Bonn*renewables*2004 Conference. The Bonn conference delivered on the promise of the German government, at the closure of the Johannesburg World Summit on Sustainable Development (WSSD) of 2002, to provide an opportunity for willing countries to agree to more concrete measures for developing renewables than were contained in the Johannesburg Programme Of Implementation (JPOI). This was in response, at least in part, to the failure to get agreement on global renewable energy targets. A follow-up Beijing Conference was held last year.

Co-ordination of CURES in Southern Africa is provided by EcoCity Trust, with Annie Sugrue leading a fundraising initiative and convening the Biofuels Workshop. Consultation led to a draft position paper that was discussed over two days and finalized in the following weeks. This will be submitted to government as a contribution to the National Biofuels Strategy, a draft of which had been promised for public comment by the Department of Minerals and Energy (DME) by the end of October. The pros and cons of biofuels are considered in detail, with concise policy suggestion on various issues.

There has recently been massive interest in biofuels, due to oil prices, long- as well as short-term energy security concerns and low (and subsidized) agricultural commodity prices – not only in South Africa and not always fitting renewable energy characteristics. A key aim of the CURES position paper is to strike a balance between public and business interests that are giving rise to polarized positions on biofuels. Opposing views arise from the potential for both poverty-relieving bottom up development, with community participation and massive job creation, as well as for industrialised production requiring massive hydro-carbon (petroleum product) inputs and often involving displacement and/or impoverishment of local communities, land degradation, biodiversity loss and no net reduction in greenhouse gas emissions.

South Africa has substantial potential for sustainable biofuels production that would have positive outcomes for all concerned, including contributing to all objectives of the White Paper on Energy Policy of 1998. However, such options do not promise the same return on investment, under prevailing market conditions, as most projects are currently attracting investment or exciting transnational corporations. Input-intensive mono-crop production could be largely a 'greenwash' exercise, whereby the harvesting of solar energy through biomass barely balances total fossil fuel use, including fertilizers and pesticides, coal-fired electricity for irrigation and diesel-transport for highly centralized refining and then distribution. Counting also carbon dioxide released through land use change, there could even be an increase in greenhouse gas emissions with some crops – hardly a greener option.

The EPU supported a workshop presentation on the potential of algae for producing oil, which can be used locally with minimal treatment to meet a wide range of energy needs and can contribute to biogas production in biodigesters (which can also use agricultural by-product and human waste). Decentralised algae production fits well with a holistic understanding of sustainable agriculture. A model was proposed for community based development, with minimal requirements for generating cash to pay external service providers, while providing great opportunities for healthy and rewarding productive activity.

As with all biomass production in South Africa, water use is an important issue and availability and competing uses will be a constraint, just as it should be on thermal power production (as in coal and nuclear plants) where vast amounts of water are evaporated for cooling. The attraction of small-scale production and localized use, at least for the majority of South Africans, is that it can be integrated with other local livelihood options and avoid the negative impacts on food security and the expansion of corporate ownership or control of land and related resources that accompanies most of the more commercialised approaches.

The CURES position paper, *Towards a Southern African NGO position on Biofuels,* can be found on their website below.

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Wind turbine supply contract for first African IPP wind farm signed

The first phase of the first African wind farm operated by an independent power producer will be equipped with four 1.3 MW wind turbines of the German wind turbine manufacturer, Fuhrländer. The supply contract for the wind farm in Darling, Western Cape, has recently been signed by Joachim Fuhrländer, CEO of Fuhrländer AG, and Hermann Oelsner, CEO of Darling Wind Farm Pty Ltd, in Waigandshain, Germany.

The planning process of the wind farm started in 1995. After another, major wind turbine producer announced in late 2005 that it could not fulfil the former contract to deliver the four wind turbines to South Africa, Fuhrländer AG took the opportunity to step into the project. In August 2006, the power purchase agreement with the City of Cape Town was signed thus closing the financial set-up. The construction work of the wind farm will still start within 2006, and the wind farm is expected to be in operation in July 2007.

Hermann Oelsner, CEO of Darling Wind Farm Pty Ltd: 'We appreciate very much that Fuhrländer is showing such strong commitment to developing wind energy in Southern Africa by offering the turbines at very favourable and flexible conditions. I am convinced that this strong engagement will pay back when the wind industry in the region will take off in the coming years, not at least caused by the current electricity crisis in the Western Cape.'

Stefan Gsänger, WWEA Secretary General: 'A wind farm with four wind turbines appears small compared with some projects in the established wind markets in other parts of the world – however, we expect that the functioning of the first IPP wind farm in Africa will pave the way for many further projects and will demonstrate that wind energy is an excellent option for the whole African continent.'

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5th World Wind Energy Conference 2006

NEW DELHI, INDIA
6 - 8 NOVEMBER 2006

The World Wind Energy Association (WWEA), in association with the Indian Wind Energy Association (InWEA), acknowledged and welcomed the presence of those 900 delegates and exhibitors attending this Conference from wind and associated renewable energy technologies. The interests involved included all those occupied with sustainable wind, solar, hydro, and geothermal technology development, design, manufacture, operation and implementation.

This Conference had recognised two basic themes.

The first is the importance of achieving independence through wind and all the renewables through combining as appropriate to achieve the best resource and efficiency as well as the continued strength which comes from associating four of the major technologies: wind, solar, hydro, and geothermal and their international industry associations in the International Renewable Energy Alliance (IREA). The WWEA renews its commitment to the IREA and the joint representation which it provides at the highest international levels, including the forthcoming COP 12, REN 21 and the CSD 15.

The Conference welcomed the attendance by representatives of the allied associations and their participation in a panel session which defined and elaborated the advantages of cooperation in the rapid extension and deployment of renewable energy technologies. In particular, the Conference welcomed the decision of the International Geothermal Association to accept the invitation to join the IREA, which now comprises the four major international renewable associations.

The Conference further recognised the support of the Indian and other national governments and international organisations supporting the Conference, and applauded their continued support and vision for the renewable energy industry, in particular the wind industry. The Conference endorsed the goal of further and sustained development of global deployment of wind energy technologies.

The Conference noted the strong endorsement given to the development of renewable energy including wind power by His Excellency the President of India, Dr Abdul Kalam. In opening the conference, the President said: "The crying need therefore is to look for renewable energy that alone can ensure sustainable development." The President called for a "review of policies towards renewable energy in general and wind power, solar power and bio-fuels in particular". He said "a comprehensive renewable energy policy with mandatory and time- bound provisions is an urgent need of the hour." The President also called for "a policy and concerted plan of action" to tap these "practically inexhaustible sources of energy" into a "mode of emergency mission".

The Conference welcomed the President's call for action and urges the world to respond positively and expeditiously. In doing so, the Conference noted the President's emphasis upon the importance of rural electrification and accordingly commits its efforts and resources to assisting in the achievement of that along with the other urgent objectives outlined in the President's address.

The Conference confirmed that the world wind energy community must facilitate strong cooperation and cohesion between associations, industry, governments and communities to succeed in continuing to grow the renewable energy industry to capitalise on the very significant opportunities for job growth, exports and economic activity, and encourages government leadership and vision in the creation of market environments that, most appropriately, in each type of society, economy and environment, sustain development in the renewable energy industry to the benefit of all mankind.

The Conference recognised the worldwide challenge of capacity building and the creation of awareness to energy independence and the need for institutional networking towards that end.

The Conference welcomed the development of a Memorandum of Agreement with the International Association for Wind Engineering (IAWE) and looks forward to close cooperation in the achievement of mutual objectives.

The Conference, last year, welcomed the commitment by the International Energy Agency to renewable energy technologies and the role they can play in sustainable development. The reference by the G8 of the responsibility for developing the Gleneagles Agreement on energy supply and particularly renewable energy development has now become a major task of the IEA and the Conference and its allied partners have committed to providing maximum assistance towards a rapid result. The Conference voices the concern that the recent World Energy Outlook report appears to divert attention from the primary means of achieving the objectives of 1. security of supply, 2. security of climate and 3. the implementation of the Millennium Development Goals and questions the relevance of the proposed priorities.

The Conference further recognised that governments, industry, communities and investors require consistent and compelling drivers to ensure sustainable growth and rapid uptake of wind energy technologies on a global scale, and that, implicit within this growth, is the need for industry competitiveness and long-term independence.

In addition to this, and in the pursuit of renewable energy resources, the Conference resolved to pursue the following objectives, policies and actions:

1. Remove all subsidies and enforce the internalisation of all externalities to achieve a level playing field;
2. Until this is achieved, pursue compensatory regulatory frameworks that encourage renewable energy developments, and that provide sufficient financial security to promote long-term investment;
3. Increased interaction of global networks and alliances that contribute to greater cooperation and prioritisation between renewable energy technologies, accompanied by a new independent international

agency as proposed by the World Council on Renewable Energies (WCRE);

4. Financial and technological support, through institutions such as the World Bank, Asian Development Bank and other international and national organisations, and for developing nations to facilitate the greater uptake of sustainable and renewable energy technologies, through new dedicated institutions and funds such as the proposed International Renewable Energy Agency and the establishment of an International Renewable Energy Development Fund;
5. The continued support for the WWEA Sustainability and Due Diligence Guidelines;
6. To note that the next World Wind Energy Conference will be held in Mar del Plata, Argentina, in October 2007 and to encourage all members of the Associations, others involved in wind power development, operation and financing as well as the exhibitors to further the cause of wind power development and the expansion of the role of Renewable Energy by participating in the Argentinean Conference.

Finally, this Conference resolved to continue its commitment to working for the alleviation of world poverty through achievement of the Millennium Development Goals as a means of achieving these fundamental objectives.

The WWEC 2006 Conference Chairpersons include:

- Dr. Anil Kane, President - World Wind Energy Association
- The Hon. Peter Rae AO, Senior Vice President - World Wind Energy Association
- Prof. Erico Spinadel, President - Argentine Wind Energy Association

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(President of India)

Energy events 2007

FEBRUARY 2007

22 – 24

BIOFUELS CONFERENCE
Indaba Hotel, Gauteng, South Africa

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MARCH 2007

19 – 30

INTERNATIONAL TRAINING PROGRAMME ON TRANSBOUNDARY WATER RESOURCE MANAGEMENT
South Africa

Website: www.siwi.org/courses/coursesgeneral.html

APRIL 2007

10 – 13

DOMESTIC USE OF ENERGY CONFERENCE
Cape Peninsula University of Technology, Cape Town, South Africa

Contact: DUE Secretariat
E-mail: due@cput.ac.za
Website: www.cput.ac.za/conf

11 – 12

GIS FOR ENVIRONMENTAL AND LAND-USE MANAGEMENT CONFERENCE
Cape Town, South Africa

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16 – 19

AFRICA POWER AND ELECTRICITY CONGRESS AND EXHIBITION 2007
Sandton Convention Centre, Johannesburg, South Africa

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www.terrapinn.com/2007/powerza/

MAY 2007

29 – 30

INDUSTRIAL AND COMMERCIAL USE OF ENERGY CONFERENCE
The Vineyard Hotel, Newlands, Cape Town, South Africa

Contact: ICUE Secretariat
E-mail: icue@cput.ac.za
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30 – 1 June

POWER LIFESTYLE SMART LIVING EXPO
Cape Town, South Africa

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JUNE 2007

11 – 15

INTERNATIONAL TRAINING PROGRAMME ON TRANSBOUNDARY WATER RESOURCE MANAGEMENT
Sweden

Website: www.siwi.org/courses/coursesgeneral.html

AUGUST 2007

12 – 18

PROGRESS AND PROSPECTS ON WATER: STRIVING FOR SUSTAINABILITY IN A CHANGING WORLD
Stockholm, Sweden

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www.worldwaterweek.org
www.siwi.org/downloads/WWW-ymp/1st_annoncement%2007_web. pdf

15 – 17

SUSTAIN
Sandton Convention Centre, Johannesburg, South Africa

Contact: Tel: (011) 886 3734
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Energy Management *News*

The newsletter is published quarterly by the Energy Research Centre (ERC) of the University of Cape Town. (ERC is an amalgamation in 2004 of two organisations at the University: the former Energy Research Institute and the Energy and Development Research Centre.)

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