Sustainable Energy Briefing 5:
The potential contribution of renewable energy in South Africa

Sustainable Energy Briefing 4 highlighted the importance of integrated energy planning, noting that it involves 3 phases:

- Developing a Reference Energy System, which shows what our energy system looks like and details how we got here
- Energy forecasting and scenarios, which involves predicting what our future demand for energy will be, and then exploring different ways of meeting this demand – in a way that benefits society as a whole
- Planning – where policy makers make decisions about how we can reach the best possible future for society.

SECCP recently commissioned independent research that made forecasts about South Africa's future energy demand, and how this could be met, particularly by renewable energy.[1] This research is unique in that instead of making forecasts 20 years into the future, the researchers plotted the various contributions renewable energy can make over 45 years.

Why Renewable Energy?

Renewable energy offers South Africa a number of benefits; most notably that it can reduce our reliance on fossil fuels such as coal and oil

- Current energy supply in South Africa is primarily coal-based and, although these resources will last for more than a century if used at current rates, large power plants will need to be replaced over the next 30 years.
- Coal has many other uses, and we need to conserve this resource for future use.
- Coal and other fossil fuels, including oil, produce Carbon dioxide when they are burned to produce energy. Climate change caused by human-generated Carbon dioxide and other greenhouse gases represents an extremely serious environmental threat to the world as a whole. Human-induced climate change is already being blamed for the higher-than-usual incidence of extremely damaging weather experiences (e.g. storms and droughts).
- Local air pollution is strongly related to energy supply options, with coal and oil products being major contributors to urban and rural air pollution and acid rain. Human health effects of air pollution include damage to childhood development and the respiratory system, including increasing incidence of asthma.

Other advantages of renewable energy include employment creation[a], proximity to point-of-use and, in many cases, less reliance on concentrated sources of energy (and political power). Greater use of renewable energy would also reduce South Africa's economic vulnerability to the variable and escalating costs of imported fuels. International and local communities are increasingly trying to find ways to shift economies towards greater reliance on renewable energy. Clear policy and regulation, including environmental fiscal reform, is needed to provide increased support for an expanded role for renewable energy in the economy, since we can't rely on voluntary schemes such as the 'Clean Development Mechanism' to prompt a significant departure from business as usual.

Current and future energy demand

South Africa has an energy-intensive economy, currently using more than 4 000 Petajoules[b] primary energy per annum. The economy relies on low-cost electricity and coal to power energy-hungry industries such as mining and metals processing. The renewable contribution to energy supply is relatively limited, with biomass being estimated to contribute 9 to 14 percent of energy needs (often not sustainably) and hydropower about 1 percent.

[a] See Sustainable Energy Briefing 2: The Employment Potential of Renewable Energy, which shows that 36 000 new direct jobs would be created if just 15% of South Africa's electricity were generated from renewable energy.

[b] One Petajoule is equivalent to 277 777 777 kWh – an enormous amount of energy

In the next 50 years, as economic development takes place, energy demand is expected to grow significantly. However the population growth rate is expected to reduce during the next 50 years. This, coupled with a greater awareness of energy efficiency and a shift away from an energy-intensive economy could reduce the rate of increase in energy demand. The researchers have therefore used a total energy demand of 6 700 PJ by 2050 against which to explore the potential contribution of renewable energy. This is just an illustrative scenario, since concerted attention and incentives for energy efficiency could deliver the same outputs from far less energy input.

Scenarios for Future Energy Supply

The researchers developed three scenarios for energy supply in 2050: *business as usual*, progressive *renewable*, and a *high renewable* scenario.

Business as usual scenario
The 'business as usual' scenario assumes very little support from decision-makers for renewable energy technologies. The scenario clearly shows that if SA continues along the current path, it will still need a lot of money and resources to meet the demand for energy e.g. it would need to build an Eskom 6-pack every 30 months during the years up to 2036.

This raises major environmental and economic warning flags. It also highlights the opportunity that we have as a country to prepare for the capacity crunch, and to have alternative solutions in place for implementation on a large scale. The renewable energy contribution in this scenario would be limited to a maximum of 4 percent.

Progressive renewable scenario
In the 'progressive renewable' future the researchers tried to grow renewable energy (RE) as realistically as possible, though the growth rate of about 20% per annum. In this future, renewable energy plays a moderate role in electricity generation by 2020 (about 13.3 percent contribution) and contributes about 70 percent by 2050.

Both the above scenarios illustrate how short time really is, particularly in light of the required growth rates for emerging industries such as solar PV, wind and solar thermal electricity. Effective large-scale industries will take time to develop and at a 20 % annual growth rate it will take several years before they can start to add energy capacity to the grid on the scale required.

The researchers also found, somewhat surprisingly, that renewable energy options are likely to be the most cost-effective options for energy supply in the future, if rapid local development starts now. Fossil fuel pricing is particularly difficult to predict (e.g. oil price in 2004/5), but if prices do continue to rise, it will not be long before solar thermal electricity generation technologies in particular present a large-scale, economically competitive power supply option.

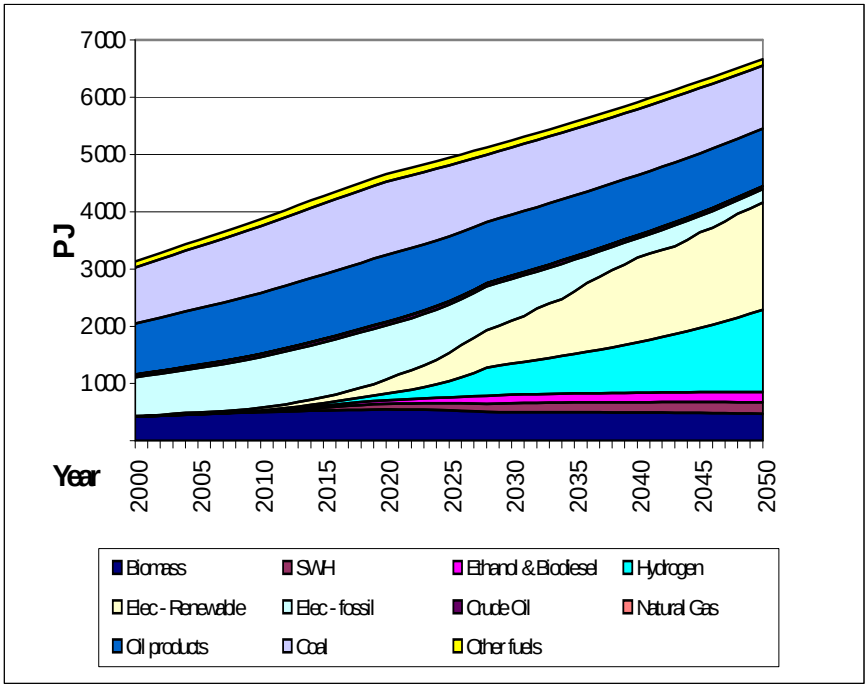
High renewable scenario
A third scenario called the 'High renewable' scenario was then developed. This scenario looks at the options to achieve a net reduction in fossil fuel consumption by 2050, and could be considered as a climate change driven scenario. It differs in two primary ways from the 'Progressive renewable' scenario:

- it is assumed that a larger proportion of the current non-electrical energy demand in South Africa (e.g. transport, coal or oil based process energy supply in industry) can be met by electricity (produced using *renewable* resources).
- it is assumed that Hydrogen can be generated from renewable resources on a large scale, starting within two decades. This can be stored and transported and used as required, much like coal, oil and natural gas – thereby replacing a significant part of the remaining non-electrical demand.

In this scenario, the researchers modeled significant growths of RE – showing that it would be possible for between 90% of South Africa's electricity and 60% of South Africa's total energy mix to be generated from

RE sources. To achieve such a long-term transition requires that South Africa start to develop the foundations in the short term. While considerable costs will be involved, they will be investments in the local economy that have massive social and environmental benefits.

Figure 1: High Renewable Scenario: Total energy supply mix



As shown in Figure 1, renewable energy has the potential to meet 60% of South Africa's total energy mix by 2050. In particular, the researchers grew the potential of biomass and hydropower, while noting that there are environmental and human rights constraints that would need to be taken into account.

The illustrative increase in supply allows scope for economic growth, particularly given South Africa's enormous potential for efficiency improvements.

The researchers regard achieving the *progressive renewable* scenario to be very challenging. For South Africa to make the necessary shifts in the energy economy to achieve something like the *high renewable* scenario would be significantly more difficult. However, if the total energy requirement of the country is allowed to increase to 6 700 PJ by 2050 then investments in energy supply will in any event be very large. It is possible to develop the economy using approaches that do not require such an increase in energy consumption, and if energy efficiency can be effectively promoted at all levels, then the average annual growth in energy demand could be reduced, or even pushed into the negative. This would obviously make it far easier to reduce the total fossil fuel contribution, without stretching the renewable energy resources and technology production facilities as much as indicated in the *progressive or high renewable* scenarios.

Conclusions:

The researchers concluded their findings with four points:

First, they highlight that this research provides clear evidence that there are sufficient renewable energy resources in South Africa to provide for 13 to 20 percent of the electrical demand by 2020, and easily 70 percent or more by 2050.

Second, they identify two key weaknesses in existing energy plans:

1) Very little long-range planning is being undertaken in South Africa. Given the possible large-scale changes in the energy supply system indicated in the scenarios, they feel that this is a critical oversight.
2) Although the recent National Electricity Regulator's (NER) Integrated Resource Plan did take some account of large-scale renewable generation potential, it seems to have been done as an afterthought. It appeared to rely on a very limited range of technologies and cost/resource analysis that lacked detail. Electricity and energy planning should anticipate longer-term cost and policy trends, and seek to integrate sustainable energy planning more fully into the process.

Third, the three scenarios illustrate how short time really is, particularly in light of the required growth rates for emerging industries such as solar photovoltaic (PV), wind and solar thermal electricity. Effective large-scale industries will take time to develop. Even at a 20% annual growth rate, it will take several years before these industries can really start to add generation capacity to the grid on the scale required.

There is an interesting development of the technology selection process in the scenarios. Initially, lower cost options, such as biomass, landfill gas and selected wind sites, are more attractive than solar and large-scale wind. However, because these low-cost options have a limited resource base, it is very important to balance development efforts – first harvesting the lowest cost resources, but at the same time developing the necessary technical capacity to harness the larger scale solar and wave technologies.

Finally, although not specifically explored in detail, energy efficiency is clearly identified as a crucial element in energy planning. If the South African economy is allowed to grow in such a way that energy intensity per unit of GDP remains similar to current levels, it will have adverse environmental and economic implications. Even the current growth rates used by the Department of Minerals and Energy and the NER for planning would result in a tripling of energy demand if extended through to 2050. The scenarios explored in the report assume that total energy increases by slightly more than double by 2050. It would be prudent to use energy efficiency measures that allow economic growth, but with more limited energy demand growth.

This Briefing summarises three energy scenarios for South Africa in 2050. They show that if we continue with business as usual, the economic as well as social and environmental costs are significant. Although economically costly, the progressive renewable and high renewable scenarios offer numerous social and environmental benefits. It's up to policy makers to make decisions based on these forecasts on how South Africa can reach the best possible future for society as a whole.

[1] Banks, D. and Schäffler, J. (2005) The potential contribution of renewable energy in South Africa, commissioned by the Sustainable Energy and Climate Change Project of Earthlife Africa-Johannesburg, funded by DANIDA. Copies can be downloaded from www.earthlife.org.za/seccp - follow the link to <Research>