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Renewable energy policy in South Africa: policy options for renewable electricity

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Abstract

Investment in renewable energy and energy efficiency is important to reduce the negative economic, social and environmental impacts of energy production and consumption in South Africa. Currently, renewable energy contributes relatively little to primary energy and even less to the consumption of commercial energy. This article examines policy options for promoting renewable electricity. Feed-in tariffs guarantee prices for developers, but lack certainty on the amount of renewable electricity such laws would deliver under local conditions. Portfolio standards set a fixed quantity, which would guarantee diversity of supply. The question is whether the incremental upfront cost to be paid by society may be unacceptably high, compared to future health and environmental benefits. A renewables obligation combines the setting of a target with a tendering process, but may be bureaucratic to administer. Neither setting targets or regulating prices alone, however, will be sufficient. Power purchase agreements, access to the grid and creating markets for green electricity are some supporting activities that should be considered. Given that renewable electricity technologies have to compete with relatively low electricity tariffs, funding will be needed. Possible sources, both locally and internationally, are identified. The extent to which these are utilised will determine the future mix of renewable energy in South Africa.

Keywords: Renewable energy; Electricity; South Africa

1. Renewable energy and sustainable development

Energy is critical to virtually every aspect of the economic and social development of South Africa. Depending on the way it is produced, transported and used, however, it can contribute to both local environmental degradation, such as air pollution, and global environmental problems, principally climate change. Providing affordable, adequate, and reliable modern energy supplies to most South Africans remains a major challenge, even though access to electricity has increased from one-third to two-thirds of the population since 1994. Current methods of producing and using energy have environmental and health effects that increasingly endanger welfare, and the key challenge is to move to cleaner energy supply and more efficient use, while continuing to extend affordable access to modern energy services, in particular for poor rural and urban communities.

This paper examines policy options for promoting renewable energy in South Africa to achieve environmental goals, while not losing sight of social development objectives. As context, the current status of renewable energy in South Africa is outlined in Section 2. Three policy options from international experience are then outlined and compared for their applicability to the South African context. Implementation of policy options depends critically on enabling activities and funding to promote renewable electricity, and these issues complete the policy analysis in Sections 3–5.

1.1. Why use renewable energy?

The fundamental reason for using renewable energy is that it is, precisely, renewable. Renewable energy sources derive from energy flows through Earth's ecosystem (UNDP et al., 2000)—primarily from solar insolation, and to a lesser extent from Earth's

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geothermal energy. On a time-scale of human relevance, they will not be exhausted, unlike the effectively limited stocks of fossil fuels (coal, oil, gas), which have been laid down over geological time and are not being renewed at the rate at which they have been consumed since the Industrial Revolution. The World Energy Assessment found that, if applied in a modern way, renewable energy sources are "highly responsive to overall energy policy guidelines and environmental, social, and economic goals" (UNDP et al., 2000, 221). They can assist in diversifying energy carriers, improving access to clean energy sources, limiting the use of fossil fuels (thus saving them for particular applications), reducing pollution, and lowering dependency on imported fuels. Many renewables are particularly suited to off-grid applications and, certainly in South Africa, could improve the flexibility of the grid by distributing generation across the country, closer to some key loads.

Using renewable energy sources for electricity generation in South Africa would have tangible environmental benefits, given that 93% of electricity generation is currently based on coal (NER, 2000b). In 2001, Eskom power stations burned 94.1 million tons of coal and emitted 169.3 million tons CO_2, 2 154 tons N_2O, 1.5 million tons SO_2, 684 000 tons NO_x and 59 640 tons of particulates (Eskom, 2001). But how should 'renewable electricity' (meaning here electricity generated from renewable energy sources) be promoted, given the associated higher initial capital costs as well as the need to extend access to affordable energy services? Any energy source or technology must contribute to basic energy service needs—lighting, space heating, water heating, cooking and productive use. Renewable electricity that does not deliver services like cooking or productive use is limited in its contribution to sustainable livelihoods. Where technologies lock communities into lower levels of service, they should not be imposed on the poor. Environmentally sound solutions must also pass the test of cost-effectiveness.

1.2. Potential for renewable electricity

The theoretical potential for renewable energy in South Africa is enormous. About 280 TW reaches its land area (Eberhard and Williams, 1988) some 6500 times more than the licensed capacity of the country's power stations (43 GW) (see NER, 2000b). Howells (1999) estimates the potential of solar energy at 8500 000 PJ/yr—compared to final consumption of 587 PJ in 2000 (DME, 2002c) and the 621 PJ output of coal-fired power stations (NER, 2000b). Estimates of theoretical potential from various studies are reported in Table 1. There are significant differences in the estimates, with the DANCED study's estimates for wind and wood substantially lower than those of Howells, although the estimates for wind, wood and bagasse are at least of the same order of magnitude. Estimates of hydro potential vary by a factor of two. In any event, it is much smaller than the potential for importing hydro from Mozambique or the Democratic Republic of Congo. The most recent estimates of the potential of renewable energy are being compiled for the South African Renewable Energy Resource Database (SARERD) (www.csir.co.za/environmentek/sarerd/contact.html), but these are available in the form of GIS maps, not detailed data. The problem of converting much of these resources into economically exploitable forms of thermal and electrical energy is, however, significant. The diffuseness and intermittency of solar energy, for example, means that the technological, economic and market potentials for capturing it are less than the theoretical potential.

Table 1
Estimates of theoretical potential for renewable energy sources in South Africa

Resource	DANCED/DME (PJ/yr)	Howells	RE White Paper
Wind	6	50	21
Bagasse	47	49	18
Wood	44	220	
Hydro	40	20	36
Solar		8 500 000	
Agricultural waste		20	
Wood waste			9

Sources: Howells (1999) and DME (2000, 2002b).

1.3. Current policy

The major objectives of government energy policy were spelled out in the 1998 Energy White Paper as:

- increasing access to affordable energy services;
- improving energy governance;
- stimulating economic development;
- managing energy-related environmental impacts; and
- securing supply through diversity (DME, 1998).

Renewable energy sources can play a major role in managing energy-related environmental impacts, starting with local environmental issues. One such issue is outdoor air pollution. The Department of Environmental Affairs and Tourism has published sulphur dioxide standards, which are part of an initiative to establish a National Ambient Air Quality Standard (RSA, 2001). Renewable energy can contribute to reductions in local air pollution, with co-benefits of reducing emissions of greenhouse gases which contribute to climate change.

Securing energy supply through diversity is the goal that perhaps relates most obviously to renewable energy, as a source of a more diverse energy supply. However, the focus of diversification has been on gas rather than renewable energy sources.

Renewable energy has played only a small role in meeting the goal of access, marginalised to the particular niche of off-grid electrification. Grid electrification has been the primary focus for extending access. Building on the 3.4 million connections made since 1994 (NER, 2000a; Borchers et al., 2001), government plans to continue to electrify 300 000 homes per year as the electricity distribution industry restructures (PWC, 2000; Mlambo-Ngcuka, 2002). Renewable energy for bulk electricity generation is constrained primarily by high upfront costs.

To balance economic constraints, environmental effectiveness and diversity, the White Paper (DME, 1998) further outlined specific goals for renewable electricity:

- Ensuring that economically feasible technologies and applications are implemented through the development and implementation of an appropriate programme of action.
- Ensuring that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply options.
- Addressing constraints on the development of the renewable energy industry.

To supplement the Energy Policy White Paper, the DME in mid-2002 published a White Paper on 'the promotion of renewable energy and clean energy development'.[2] Renewable energy is defined as "solar energy, wind, and biomass, to produce electricity, fuel, liquid fuels, heat or a combination of these energy types", but in estimates of potential, hydro and landfill gas are also included (DME, 2002b). The draft policy paper sets a medium-term target (see Section 3.1) for renewable energy, but no long-term target.

2. Experience with renewables in South Africa

Renewable energy for electricity generation in South Africa has largely been confined to the off-grid sector. The most extensive use of renewable energy sources is traditional biomass, accounting for 4.4% of total primary energy supply (DME, 2002c).[3] Use of biomass in the form of bagasse for co-firing in privately owned power plants accounts for another 1.1% of total primary energy supply, making the total of biomass 5.5% of TPES. Except for a few small hydroelectric facilities and a small number of other renewable energy demonstration projects, biomass use has been the only significant source of renewable energy until very recently. Quantitative research on national biomass consumption, however, has been limited, with the DME Biomass Initiative being the most authoritative report (Williams et al., 1996).

2.1. Bio-fuels

For the commercial use of biomass, the liquid fuel sector seems most promising. The Minister of Finance in his budget speech of 2002 announced a reduction in the fuel levy on diesel produced from biomass by 30%. The Seed Oil Refinery is planning from 2001 to produce 60 000 tons of bio diesel per year (Bridge, 2001). PetroSA has produced an environmentally friendly product called eco-diesel, which is already available around Cape Town.

2.2. Renewable energy for grid electricity generation

To date, some small hydro facilities and co-fired bagasse plants provide the only renewable electricity. There are three hydro facilities smaller than 10 MW owned by Eskom (First Falls, Second Falls and Ncora) and one which is privately owned. Small hydro installations do not require large dams and are typically run-of-river—distinguishing them from large hydro and the environmental and social implications of large dams. Large hydro is usually considered a mature technology, while small hydro has more room for further technical development (UNDP et al., 2000). Small hydro makes up 68 MW of the total 668 MW of installed hydro capacity in SA.

There are currently five bagasse/coal-fired power stations, all run by private sugar companies, using sugarcane residues to generate electricity. Of net energy sent out, 73% is consumed in own use (calculated from NER, 2000b), and coal is used as a back-up fuel.

Further development of renewable electricity may emerge from research by Eskom into various renewable electricity technologies, under its South African Bulk Renewable Energy Generation (SABRE-Gen) programme. Eskom installed a 660 kW wind turbine in August 2002, with two more planned. Solar thermal technologies for bulk electricity are still only in the research phase, other than a 25 kW solar dish, which was erected at the DBSA headquarters in time for the 2002 World Summit on Sustainable Development.

The proposed Darling Wind Farm, a 5 MW facility on the West Coast, was named a National

[2] The first public draft was dated 21 June 2002, with a revised version 23 August 2002 (Ftp://http//:www.dme.gov.za/energy/pdf/White_Pa-ern.5pt}*Paper_on_Renewable_Energy.pdf*)

[3] Biomass is included in the category 'renewables and waste', reported at 237.4 PJ of a total TPES of 4298 PJ. The 1997 energy balance had the same category as 408.7 PJ of 4 423 PJ total. The figures should be used with caution.

Demonstration Project by the energy minister (Otto, 2000). The grid-connected wind power facility is designed for a capacity factor of 36% and an annual output of 31 500 MWh. There is a potential expansion of the facility to 10 MW. To be viable, the developers (Oelsner Group) say they require additional revenue of 38 c/kWh above the normal tariff. Eskom currently charges the Swartberg-Malmesbury municipality approximately 20 c/kWh, while Cape Town pays 11–12 c/kWh for bulk electricity.

2.3. Off-grid electricity

Currently, most use of renewable energy is off-grid photovoltaics, as well as solar cooking and water heating. Photovoltaic (PV) systems are used as stand-alone sources of electricity in areas remote from the grid, but are expensive compared with grid-connected electricity in South Africa. A number of projects have been implemented:

- The Schools and Clinics Electrification Programme provided off-grid energy services with solar home systems (SHSs) to community facilities. By 2000, 1852 schools had been connected, and an unspecified number of clinics (DME, 2001).
- A Shell/Eskom joint venture for SHS electrification built 6000 systems for residential use by 2000 (DME, 2001; Spalding-Fecher, 2002c); in 2002, indications were that 4700 of these systems were operational (Afrane-Okese, 2003 Personal communication). The size of the SHS market, outside of the major government programmes, was estimated at R28 million in 2000 (Spalding-Fecher, 2002a).
- Implementation of the off-grid electrification programme had been slowed down by negotiations among government, Eskom, and the concessionaires. It began in 2002, after DME agreed to the subsidy level (Kotze, 2001) and Eskom's role in the programme was clarified. Concessionaires have signed interim contracts, with NuonRAPS, EdF and Solar Vision each installing some 200 systems. The programme will target 350 000 homes for SHSs.

Given this limited experience with renewable electricity, the following sections examine a framework for making policy choices and implementing the chosen option. Policy options are derived from international experience, drawing on experience in industrialised countries. The applicability of these options to the South African context is analysed. To complete the policy framework implementation of policy options requires consideration of key enabling activities and funding.

3. Policy options for renewable electricity

Based on existing experience with renewables, this article seeks to explore options for government to promote renewable electricity on a larger scale than before.

3.1. Setting a target for renewable electricity generation

The major role that government can play in promoting renewable energy in the electricity sector is to set a target. The key idea is a requirement that a small but growing percentage of South Africa's electricity supply should come from renewable resources. Such a target is a key mechanism for levelling the playing field for renewables in a context where their environmental and social benefits are not given a value by the market. Government is already talking about such a target. The draft White Paper on Renewable Energy suggested that an additional 10 000 GWh of renewable energy contribution should be achieved over ten years, i.e. 1000 GWh/yr, to be produced mainly from biomass, wind, solar and small-scale hydro (DME, 2002a). An earlier draft had formulated the target differently, namely 'that renewable energy sources share of final energy consumption should increase from 9% (2 216 793 TJ or 53 Mtoe in 1999) to 14%, an increase of 5%, by the year 2012'. The Sustainable Energy and Climate Change Partnership has called for a South African commitment to '10% of electricity generation by renewable energy technologies (RETs) by 2012 and 20% by 2020' (SECCP, 2002).

Are such targets realistic? Dr. Steve Lennon, executive director of Resources and Strategy at Eskom, has said that "by 2020 renewables could account for about 4000 MW of South Africa's generating capacity—which would be between 5% and 10% of total output" (Darroll, 2001). A study by the University of Cape Town examined a range of targets for feasibility, and recommended a target of 15% of renewable electricity generation by 2020 (EDRC, 2003).

3.2. Policy instruments: fixing quantity or price

There are several policy instruments which can be used to implement such a target. Broadly speaking, there are two possible points of intervention for government policy: regulating the quantity of renewable electricity (by, for example, setting targets for renewable electricity), and fixing prices through regulating tariffs. The differences between these approaches are an example of the debate in environmental economics over whether to regulate quantity or fix prices (see, for example, Weitzman, 1974). Much of the literature in this field discusses the advantages and disadvantages of using economic instruments (e.g. taxation, subsidies, tradable permits) and/or regulatory instruments (e.g. standards, codes, targets) (Baumol and Oates, 1971). The context for the debate is the important shift in recent decades from traditional, prescriptive "command and control" policy tools in environmental policy to "economic instruments" (Tietenberg, 1992; Pearce and Warford, 1993; Eyre, 1997). The rationale for the shift has been reducing the cost of compliance by bringing the creative power of the 'market' to bear on pollution control.

However, a critical factor that determines outcomes is whether the shape of the marginal costs curve is known. In South Africa, with little experience in implementing large-scale renewable electricity, these curves are not well known. Setting prices results in very different quantities in this situation—Fig. 1 shows that for the same price, two different marginal costs result in widely differing quantities. This simple representation has not addressed cost curves with very different shapes—e.g. flat or steep increases in marginal costs, which would further reinforce the point. The converse is also true—fixing the quantity of renewables can result in different prices, given differing costs. Fig. 2 illustrates this with a simple case of two marginal cost curves. In this case, technologies with higher cost curves might be excluded through the process of competition.

More recent studies on energy and climate change have shown that a combination of policy tools is likely to be the most effective in realising the greatest environmental and economic benefits (see also Weitzman, 1974; IEA and OECD, 2002; Krause et al., 2002). This is mirrored in the variety of international experience with policy instruments. Policies used in industrialised countries to promote renewable electricity include feed-in tariffs (FITs), renewables obligations

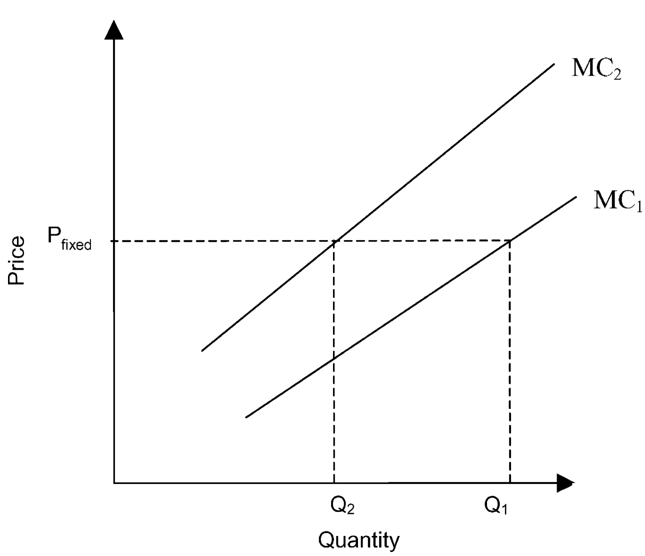

Fig. 1. Setting prices results in different quantities.

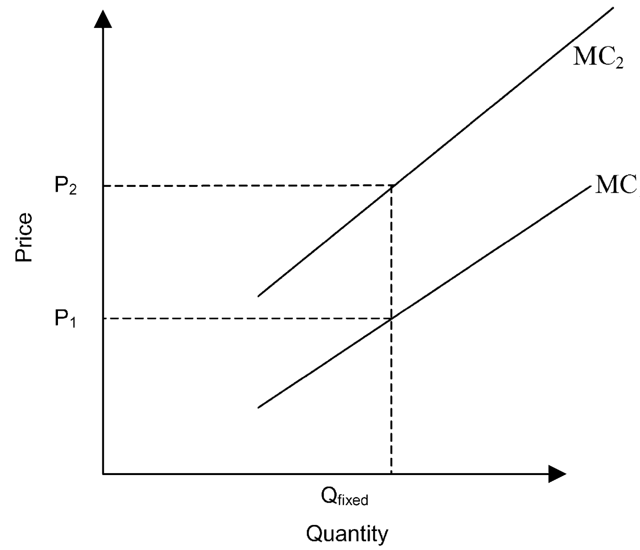

Fig. 2. Fixing quantities yields different prices.

and renewable portfolio standards. Germany has set tariffs for renewables under an electricity feed-in law, while the United Kingdom implemented a Renewables Obligation (RO, formerly non-fossil fuel obligation or NFFO) (Nedergaard, 2002). Several US states have introduced renewables portfolio standards.

3.2.1. Feed-in tariffs for renewables

An electricity FIT uses price as the policy instrument. Government sets a price for renewable electricity, usually differentiating tariffs between different technologies. Tariffs are set by an electricity feed-in law and are guaranteed for a specific period of time (Menanteau et al., 2003). The electricity feed-in law also requires distributors to buy all renewable electricity in their area. Germany's electricity feed-in law, for example, requires distributors to buy all electricity from renewable independent power producers (IPPs), but does not specify a percentage of renewable electricity to be achieved. Nonetheless, experience in Europe has been that this policy instrument has resulted in the greatest increases in capacity (Meyer, 2003; Midttun and Koefoed, 2003). The promise of good returns on investments due to relatively high, guaranteed prices is a major factor. In economic terms, the policy favours producer surplus.

Proponents argue that a grid-feeder law in South Africa would require less bureaucracy than a government-set target and allow more flexibility for small producers (Holm, 2002). It would provide greater security for developers of renewable electricity plants, by guaranteeing a market and a price. The costs of the policy must be covered by a cross-subsidy, either from the 'green' electricity customers or all taxpayers (Menanteau et al., 2003).

3.2.2. Renewable electricity portfolio standards

The policy instrument that most directly sets the quantity of renewable electricity is a portfolio standard. In this policy option, government sets a target through a renewable electricity portfolio standard (REPS), while electricity distributors have flexibility in how to meet the requirement. International experience with REPS is probably greatest in some states of the USA (Rader and Norgaard, 1996; Rader and Hempling, 2001), where laws setting targets for the renewable share of generation capacity have been passed in Arizona, Connecticut, Maine, Arizona, Massachusetts, Nevada, New Mexico, New Jersey, Pennsylvania, Texas (2000 MW under Governor Bush) and Wisconsin (Wiser et al., 2002); bills are pending in Kansas, Nebraska, Iowa, and Vermont.

A REPS entails the following:

- *A purchase requirement*: Government sets targets for the share of electricity distributed, as a percentage of sales for each distributor.
  - With a single utility, the REPS would amount to the same as the renewable set-aside capacity of renewable power, e.g. 200 MW annually for five years, just under 2% of current capacity (DME, 2000).
  - In a restructured market, distributors may well issue tenders for renewable electricity, not unlike the NFFO.
  - Setting targets is considered more effective in achieving a particular quantity of renewable energy (Menanteau et al., 2003).
- *Resource eligibility*: Eligible renewable electricity technologies would include: solar thermal, wind, small hydro (<10 MW),[4] solar PV, landfill gas for power generation, biomass, wave, tidal. An explicit definition avoids the situation of the NFFO, which applied to nuclear technologies as well. Only domestic South African renewable resources would be eligible, since the increased costs are paid for by local consumers through the increased electricity prices. This excludes the option of importing large hydro, and avoids the debate over its sustainability. The alternative would be to set a required minimum for wind, solar thermal, biomass, small hydro, etc., and effectively sub-divide the REPS into specific targets by renewable energy source.
- *Trading of credits*: Economic instruments can be used to allow distributors to achieve the target at least cost, increasing the flexibility of the policy. As the industry is restructured into several regional distributors, individual distributors can be required to either achieve this percentage individually, or buy credits from others who achieve more than their target. A REPS would be particularly important once the restructuring process in the electricity industry extends to wholesale competition, to create an incentive for individual private generators to invest in renewables in a competitive market.

An attractive feature from government's perspective is that the REPS requires no upfront government expenditure. Ultimately, however, the costs are likely to be passed on to consumers or taxpayers as in the other cases. In the context of the restructuring of the electricity distribution industry in South Africa, a REPS might need to ensure that large customers have the same percentage target as the new regional electricity distributors.

If the trading aspect is introduced, the policy instrument becomes comparable to a system of green certificates. While having the advantage of guaranteeing a quantity of renewable electricity, REPS face issues of ensuring compliance. Other critiques suggest that there are no incentives to improve beyond the standard set (Menanteau et al., 2003).

3.2.3. Renewables obligation

Another way of fixing the quantity of electricity generated is a renewables obligation. The obligation 'sets aside' a quantity of electricity generation, which is put to tender. Competition focuses on the price per kWh (Menanteau et al., 2003), so that a price is determined through bidding. This differs, however, from the FIT, where government sets the price upfront. The price is guaranteed for the contract period once the tender process is completed. The additional costs are finally borne by green customers or taxpayers.

The UK introduced a NFFO programme in 1990 to promote renewable energy technologies and to pay the costs of nuclear stranded assets. In 2000, this was reframed as a renewables obligation (UK, 2001b). In this mechanism, the renewables capacity would be secured through contracts with renewables generators at premium rates (Nedergaard, 2002). Key elements include the following:

- The government issues an order for a fixed amount of electricity from renewable sources (x MWh).
- It invites tenders, which have to meet specifications.
- Developers submit bids for proposed projects within each technology category such as biomass, wind, etc., and the projects with the lowest per-kWh price are awarded power purchase contracts.

[4] Large hydro-power is a mature technology, which provides 3.5% of net electricity sent out in SA (NER, 2000b). Most hydro-electricity used in SA is imported, with some from Eskom and small contributions from private and municipal plants. It is often used for generating peak electricity, since potential energy can be stored in dams and released when needed most. There are limited opportunities for environmentally sensitive expansion of large hydropower within South Africa (see map in DME et al., 2001).

- Specific technologies are excluded from the obligation as they approach competitiveness in the open market.
- Once a tender is successful, purchase of power is secured.
- Technologies can be excluded when they become cost-competitive.
- The regional utilities are obliged to purchase power from NFFO-awarded generators at a premium price. The difference between the premium price and the average monthly power pool purchasing price is subsidised through the Fossil Fuel Levy as administered by the Non-Fossil Purchasing Agency (UK, 2001a).

One drawback in the UK experience was that the NFFO led to bureaucratic and expensive bidding processes with a "lumpiness" in installations, since many installations follow a NFFO tranche (DME, 2000). Furthermore, by framing the obligation as 'non-fossil', renewable energy technologies would potentially be required to compete with nuclear power—as indeed happened in the UK. The re-casting of the NFFO as to a more specific renewables obligation has addressed this issue.

3.3. Comparing options

The three options outlined above each have advantages as well as drawbacks. Some of the factors which might influence the choice of policy instrument are summarised in Table 2.

Through FITs, government fixes the price of renewable electricity. The FIT is likely to promote investment, given the security of guaranteed prices that power producers would enjoy. The renewable energy industry tends to favour this option. While FITs have resulted in large quantities of renewable electricity in Europe, it is not self-evident that this would be true in South Africa, however: for developing countries, with severe budget constraints, the key limitation will be government's ability to pay for relatively high tariffs. FITs guarantee prices for developers, but would not provide certainty on the amount of renewable electricity that such a tariff would deliver in South African conditions. Given that the marginal costs of local renewable electricity production are not well known, the quantity produced by the change in price is not certain. The use of economic instruments generally ensures that the objective is achieved at the lowest cost (Baumol and Oates, 1971), but the quantity of renewables achieved is hard to predict without a marginal cost curve.

Portfolio standards set a fixed quantity, which would guarantee diversity of supply. The question is whether the incremental upfront cost to be paid by society may be unacceptably high, compared to future health and environmental benefits. A potential shortcoming of the REPS is that it often lumps all renewable energy technologies together, discouraging development of the less mature technologies (DME, 2000). There is no reason why this should necessarily be so, however, as targets for different renewable energy sources can be differentiated. This would involve some judgement by government as to which technologies hold the most promise.

A renewables obligation combines the setting of a target with a tendering process. The incentive to reduce costs is much stronger in this system (Menanteau et al., 2003). It has advantages in using the tendering process to promote competition among renewable electricity technologies, without having to make a selection in advance. In practice, however, the institutional capacity to administer the tendering process may be a major constraint.

3.3.1. Matching options to policy objectives and context

The key issue in choosing an appropriate tool is a clear policy objective. If the objective were, for example, to deliver least-cost electricity, no electricity would currently be renewable. If the objective is to promote renewable electricity, but budget constraints are prioritised, fixing prices through a feed law would help minimise costs. If environmental objectives are paramount, regulating quantities through a portfolio standard gives the greatest certainty to decision-makers.

The options are not necessarily mutually exclusive. In TX, for example, a REPS was implemented through

Table 2
Comparison of policy options to promote renewable electricity

	Renewable electricity portfolio standard	Feed-in tariffs	Renewables obligation
Ensures quantity of renewable energy and diversity of supply?	Yes	No	Yes
Promotes investment by guaranteeing prices?	No	Yes	Yes
Does not require government to pick a winner?	Depends whether target is differentiated	If price is differentiated by technology	Yes
Requires government investment	No	Yes	Yes

PPAs which effectively set a price and guaranteed take-off, much like a feed law (Langniss and Wiser, 2003). Policy-makers in South Africa will need to choose between the options and combine elements most suitable for local conditions. Local issues that need to be taken into account in applying policy instruments from other countries include the goal of universal access to commercial energy services, constraints on government budgets and the relatively low price of electricity.

However, the South African context differs significantly from the context in which most policy options for renewable electricity have been developed, those of industrialised countries. Relevant differences include the fact that despite a major electrification drive, about a third of the population remains without access to electricity (NER, 2001). Universal access is a policy goal, whereas in North America and Europe it is reality. In the context of significant unmet demand for electricity, keeping electricity affordable is a major policy goal, as reflected in the 1998 White Paper. This poses a challenge for the diffusion of renewable energy given its higher upfront costs. South Africa, as for many other developing countries. The fact that many municipal distributors in South Africa are not financially viable only heightens this tension. While all countries face budget constraints, the development needs of a country like South Africa make such limits even more acute. Institutional capacity to implement complex policy options is also limited. Such differences in context need to be taken into account in choosing a policy option for South Africa.

3.3.2. What might be the best policy for South Africa?

Given historically low electricity tariffs, the subsidy required to make renewable electricity competitive is substantial. Experience of the first wind farms suggests that the tariff required to make investment profitable is around 50 c/kWh, much higher than the tariff paid by municipalities to Eskom at 11 c/kWh (Spalding-Fecher, 2002b). Given the objective of affordable energy, this is a high incremental cost.

If government guarantees a price through a FIT, it will be asked by utilities to compensate for any additional costs. If government simply sets targets, industry has to find the least-cost way of meeting these, but are likely to pass on increased costs to consumers. Given that government budget constraints, it will be hard pressed to agree to large expenditure on guaranteeing renewable electricity tariffs. Getting the prices right, as would be required for government to determine the FIT, will be difficult—since there are few renewables, there is virtually no information on their marginal cost curve locally. However, the large expenditures on subsidies for renewables are likely to be prohibitive. Even a relatively low subsidy of 10 c/kWh, applied to 15% of electricity generation[5] would require tens of millions of rands. Any implication of passing on costs to consumers and raising tariffs would run counter to the goal of affordability.

The approaches that explicitly fix the quantity of renewable energy seem to have an advantage in the South African context. As Menanteau et al. note, "quantity-based approach is the more effective in controlling the cost of government incentive policies" (2003). Given the significant demands on the government budget for other social expenditure, approaches that do not require direct government expenditure have an advantage. This would suggest that a REPS would be an appropriate choice.

The renewables obligation represents something of a compromise, in that it sets a quantity but allows competitive bidding to set the prices. The key constraint is probably institutional capacity, if the government can build the capacity to administer such a process, this may become an option. A critical challenge for such an approach would be to prevent collusion between suppliers to drive prices up.

Neither setting quantities or regulating prices alone, however, will not be sufficient. To implement a policy option, government needs to create enabling conditions for the development of renewable electricity.

4. Enabling environment for renewable energy

Key to creating an enabling environment is to allow renewable electricity technologies to compete on a level playing field with alternative options. Means of doing this include power purchase agreements (PPAs), non-discriminatory access to the grid, and funding for research, demonstration and development. Such factors could lend critical support from government to an embryonic renewables industry.

Policy interventions take place in the context of reform of the electricity supply industry. The way in which restructuring happens in the electricity sector will significantly affect delivery of services, as well as the future role of energy efficiency and renewable energy (Winkler and Mavhungu, 2001). Opportunities exist for IPPs to sell renewable energy, but entry into the market is difficult. While the sector is dominated by a regulated monopoly, Eskom, one might argue that much of the targets could be achieved through integrated resource planning and integrated energy planning. However, with restructuring of the supply side, the nature of regulation needs to change, with government playing an active role in protecting social and environmental goods.

[5] The recommended target and a relatively modest level of subsidy for biomass in 2020 in the UCT study (EDRC, 2003). Electricity consumption in 2020 is assumed at 266 TWh.

4.1. Power purchase agreements

One measure to remove the barrier of discriminatory third party access to the grid is to offer PPAs to small-scale renewable IPPs, giving them a fixed contract and agreed price over a period of years, which would reduce risk and offer certainty that they can sell their power. In the context of power sector reform in SA, some observers suggest that establishing long-term agreements for IPPs could tie government and consumers into non-competitive prices for years to come (Eberhard, 2000; Clark, 2001). They are, however, essential if renewable IPPs are to have security that they will be able to recoup their high initial investment costs (Winkler and Mavhungu, 2002). Indeed, PPAs need to be specifically structured to reflect the cost structure of renewables. A DANCED/DME study recommended that government should develop "an interim regulation regarding conditions for the grid-connection of power from small and distributed generators to facilitate the implementation of the set-aside programme" (DME, 2000, 162).

To avoid the lock-in to fixed prices, it might be desirable to limit PPAs to small-scale projects, such as renewable energy projects smaller than 50 MW (and energy efficiency equivalent to less than 10 MW). The assumption would be that as renewable IPPs become commercialised and grow they are able to compete with other technologies, but that while the technologies are still going through learning curves and reducing costs, they need the security of fixed contracts.

4.2. Non-discriminatory access to the grid

Another regulatory requirements for renewable power generation is non-discriminatory access to the grid. Given the market power of Eskom, emerging IPPs need assurance that they will have access to the grid, especially in the context of restructuring (Winkler and Mavhungu, 2001). It would be desirable if the principle were embodied in the Energy Bills to be debated in parliament during 2003. In the longer term, a technical standard for a national grid connection code could be established. The standard would be specific to the size and type of the resource supplying electricity. This could include synchronisation conditions and rules for sharing the connection installation costs (DME, 2000). If the proportion of renewable energy in the grid grew substantially, some balancing of power and storage would become necessary; however, this is not expected in the short- to medium-term.

In the SA context, one of the main barriers to access to the grid is the result of the pricing of electricity generated by IPPs. The associated directive on the pricing of electricity produced by a self-dispatched non-Eskom generator (<50 MW) sets the price equal to that paid to a generator its production was purchased by Eskom (Schäffler, 2000). Such pricing ties IPPs to the marginal costs of Eskom and does not sufficiently take into account the benefits of distributed generation. These benefits include the reduction of transmission losses, delaying investment in transmission and distribution system capacity increments and improving the quality of electrical supply in the vicinity of the distributed generator. Given that most generation capacity in SA is concentrated in the NorthEast of the country, the potential benefits from generation in the Southern and Western parts are significant (Schäffler, 2000; Brebøl et al., 2003).

4.3. Renewable energy trading and tariff structure

To facilitate the growth of a market in renewable electricity, a trading and tariff structure is important. A useful first step is establishing principles that internalise the external costs for all electricity. Most important is a transparent process for setting such tariffs, but some that have been suggested include full cost accounting, including external costs; costing based on the long-run marginal cost of electricity; compensating IPPs close to loads for avoided line losses (DME, 2000; Morris, 2002). The effect of applying such a list of criteria would be that the inclusion of externalities would reflect the true costs of non-renewable energy sources, making renewable electricity relatively more cost-competitive.

A second step would specify criteria for "green" electricity. One proposal is that the additional value of renewable electricity could be reflected in green certificates (Morris, 2002). This approach was piloted when supplying the World Summit on Sustainable Development with "green power". Criteria set to qualify as renewable energy included disclosure of resources the electricity is derived from, and assessing sustainability of the conversion. After the Summit, the National Electricity Regulator (NER) indicated a commitment to regulating the development of a green electricity market. Several companies and government agencies have already listed on the NER web-site (www.ner.org.za/gwatts/green_watts_certificates.htm). Green electricity is included as a core responsibility in its three-year business plan.

Creating markets for green electricity is a challenge in a developing country like South Africa. The willingness to pay a premium for green electricity is likely to be low in a context where there are protests about the affordability of current tariffs. Initial markets would be large municipalities (starting with municipal buildings), provincial governments, national departments (DME, DEAT, NER), environmentally conscious companies and a small group of residential customers. In the South African context, however, these are likely to remain niche markets at least in the short to medium-term future.

5. Funding for renewable energy

Renewable energy technologies, being relatively new, show rapidly decreasing costs. Learning by experience reduces costs (Arrow, 1962), and this general finding has been found true for energy technologies as well (IEA and OECD, 2000). These can be assessed by learning ratios, measuring the reduction of cost per installed capacity for each doubling of cumulative capacity. Typical learning ratios for renewables range between 10% and 30%, much higher than for mature technologies that have already achieved most of their cost-savings. Despite the declining costs of renewables, however, they generally remain more expensive than alternatives. (Internationally, gas turbines are promoted as the cheapest route, although in South Africa it is coal-fired electricity.)

5.1. Cost of electricity

Eskom's industrial and residential electricity tariffs are amongst the world's lowest (SANEA, 1998).[6] There are several reasons for this, specific to the South African context. Firstly, South Africa took advantage of large economies of scale in coal mining and power generation, and the power stations are situated near the mines and benefiting from long term coal contracts (Chalmers, 2001; Chamber of Mines, 2001). Secondly, municipal distributors and large industrial and mining customers contribute more than 80% of Eskom's sales, which reduces overhead costs per unit of sales (NER, 2000b). Thirdly, large investments made in previous decades led to significant overcapacity, so that Eskom has been able to pay off debt, reduce financing costs, and price electricity at a very low marginal cost (Davis and Steyn, 1998; Van Horen and Simmonds, 1998; Eberhard, 2000). In addition, Eskom has received benefits such as free forward exchange cover from government (Davis and Steyn, 1999; Steyn, 2000). Some of these revenues have been used for public expenditure, but usually on social goods such as national electrification rather than environmental benefits. The challenge for renewable electricity is that these factors have enabled Eskom to keep tariffs low.

5.2. Potential sources of funding

Globally, the costs of renewables should be 'bought down' primarily by a major increase in renewable energy investment in the North. While costs remain high, an obvious source of funding is incremental funding from international sources, including financing from utilities with green energy targets, or concessionaire financing through the Global Environmental Facility, Clean Development Mechanism, the World Bank's Prototype Carbon Fund, development banks, or venture funds that could reduce the cost of capital for renewables. However, to make the industry sustainable financially, domestic sources need to be considered as well. Within South Africa, a non-bypassable systems benefit charge could be levied and provide funding for renewable energy and energy efficiency. Such charges operate in several US states and are usually introduced with retail competition. Essentially, a small charge is added to customers' electricity bills, and the revenue collected is spent on specified items, such as energy efficiency, renewable energy, or research and development (Clark, 2000). In the current context, where many distributors are not financially viable, additional charges will be politically difficult to motivate.

The renewable energy programmes could potentially be funded by revenues from taxes and dividends. Previously tax-exempt, Eskom officially became a tax-payer in 2000 and will soon be making its first payments (Chalmers, 2001). This will raise new revenues of the order of R1.5 billion per year. Renewable energy and energy efficiency would compete with funding for electrification and, possibly, demands from local government. Finally, a once-off source of income to government from the sale of assets from privatisation could be used as a basis for funding renewable energy capacity. However, renewable electricity would have to compete with other development needs for any domestic funding, given the reluctance of the Treasury to 'ring-fence' any revenues.

To implement policy to promote renewables in South Africa, an enabling environment needs to be created. PPAs, access to the grid and creating markets for green electricity are some supporting activities that should be considered. The final key requirement will be funding, but, as suggested, there are possible sources both locally and internationally. The extent to which these are utilised will determine the future mix of renewable energy in South Africa.

6. Conclusion

Investment in renewable energy and energy efficiency is important to reduce the negative economic, social and environmental impacts of energy production and consumption. South Africa has some experience with renewable energy, though largely limited to traditional biomass and off-grid applications. Renewables make a negligible contribution to bulk electricity supply.

[6] Whether these tariffs are *affordable* for low-income residential customers is a separate matter.

Government is beginning to set targets for renewable energy in the short-to-medium term. More ambitious long-term targets are feasible, aiming at 15% renewable electricity by 2020. To achieve such targets, a choice needs to be made between different policy instruments, drawing on experience in industrialised countries—FITs, renewables obligations and portfolio standards.

Adapting these instruments to local conditions means taking into account affordability of tariffs, budget and institutional constraints, limited green markets and the need to extend access. In the South African context, it seems more desirable to directly set a quantity and to limit government expenditure on renewables. Government's primary role should be to set the target, and to let the emerging renewable industry find the most cost-effective way of meeting it. A portfolio standard, possibly combined with elements of tendering, is therefore the recommended policy option.

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