ASSAf

ACADEMY OF SCIENCE OF SOUTH AFRICA

The Academy of Science of South Africa (ASSAf) was inaugurated in May 1996 in the presence of then President Nelson Mandela, the Patron of the launch of the Academy. It was formed in response to the need for an Academy of Science consonant with the dawn of democracy in South Africa: activist in its mission of using science for the benefit of society, with a mandate encompassing all fields of scientific enquiry in a seamless way, and including in its ranks the full diversity of South Africa's distinguished scientists. The Parliament of South Africa passed the Academy of Science of South Africa Act (Act 67 in 2001) *which came into operation on 15 May 2002. This has made ASSAf the official Academy of Science of South Africa, recognised by government and representing South Africa in the international community of science academies.*

Document title:
ASSAf Commentary on the Integrated Resource Plan for Electricity 2010 - 2030

Approved by:

Prof Robin Crewe
President: Academy of Science of South Africa

Date:
22 June 2011

TABLE OF CONTENTS

FOREWORD

The Department of Science and Technology (DST) approached the Academy of Science of South Africa (ASSAf) to provide formal comment on the Department of Energy's Integrated Resource Plan for Electricity (IRP2010). The purpose of the DST's request was that ASSAf should provide evidence-based commentary on the IRP in terms of its legislated mandate.

In order to provide a formal commentary on the IRP, ASSAf set up a panel consisting of selected Members from the Academy, who were either expert in the energy field or in related disciplines. The panel was augmented by three specialists who are not Members of ASSAf to provide input in areas where specific expertise was required. Members of the panel were:

- Prof Rashid Hassan – Professor and Director, Centre of Environmental Economics and Policy in Africa, University of Pretoria
- Prof Richard Fuggle – Emeritus Professor, Department of Environmental and Geographical Science, University of Cape Town
- Prof Rob Adam – Chief Executive Officer, South African Nuclear Energy Corporation (NECSA)
- Prof Robin Crewe – ASSAf President (Chair)
- Dr Van Zyl de Villiers – Group Executive, Strategy and Performance, NECSA
- Prof Xiaohua Xia – National Hub for Postgraduate Programme in Energy Efficiency and Demand-side Management, University of Pretoria.

The three external energy experts were:

- Dr Steve Lennon – Managing Director of the Corporate Services Division, Eskom
- Mr Hilton Trollip – Senior Research Associate, Institute for Democracy in South Africa

- Mr Richard Worthington – Climate Change Manager, World Wide Fund for Nature.

The outcome of the study was a list of key recommendations that the Department of Energy could use as a guide to ensure that the implementation of the IRP2010 is carried out effectively, and that a strategic and inclusive process is followed for the IRP2012.

Prof Robin Crewe
President: Academy of Science of South Africa

1. INTRODUCTION

The Academy welcomes the opportunity to comment on the Integrated Resource Plan for Electricity (IRP). The development of such a plan following consultation is welcomed. We also understand that integrated resource planning is a dynamic process, and new resources, new technologies and unpredictable geopolitical trends will necessitate the reconfiguration of the IRP over the 20 years of its implementation. For example, a decision to build the Grand Inga Dam in the Democratic Republic of the Congo could change the contribution of hydropower to the generation-mix significantly.

Nevertheless, we feel that the IRP can be improved upon, and would like to offer a range of comments in support of such a process. These comments relate to policy context, scientific methodology, benchmarking and implementation. They are made in the knowledge that the IRP is not an academic thesis, but a set of calculated scenarios moderated by consultation and the realities of challenging political decision-making.

2. POLICY CONTEXT

2.1 Alignment/compliance with other policies

New policy proposals by governments are customarily made in the context of their existing anchor policies. In the case of the IRP, there is a lack of visible linkages to and/or alignment with overall government economic policy as expressed in the New Growth Path (NGP), the Renewable Energy White Paper, the Nuclear Energy Policy, national climate change mitigation strategies, the National Energy Efficiency Strategy of 2005, and the Industrial Policy Action Plan (IPAP2).

The policy-adjusted IRP that was promulgated on 6 May 2011 in the *Government Gazette No 34263*, contains many references to an array of government policies being taken into account, but does not provide an overview of all relevant policies nor an account of how the objectives applied in the process were chosen from amongst the broader array of objectives in existing policy. It is not evident how this affected the weighting of different parameters during multi-criteria decision-making, i.e. whether some policies were regarded as of greater importance/impact than others. There are indications that some policies were introduced in a qualitative rather than a quantitative manner.

2.2 Macroeconomic considerations

The stated economic cost of the IRP is at least R867 billion (based on 2010 Rand value) over 30 years. Allocation of these costs and associated bene fits will have a large impact on the South African economy. It would have been useful, given the primary emphasis on jobs in all government policy development, for the scenarios to have been analysed for their job-creation potential. Employment creation was mentioned as being at the "centre of our economic policies" in the Presidential State of the Nation Address in 2009, and is mentioned as the current top priority in economic policy along with decreasing carbon intensity in the statement[1] on implementation of the NGP, namely:

"The new growth path sets out a vision: five million new jobs by 2020. It identifies twin goals: increasing the economy's labour-absorbing capacity and decreasing its carbon-emission intensity. These goals are central to our development as a country."

Quantitative employment data and modelling are a requirement for devising and assessing the best plans for implementing these twin goals. In addition to this quantitative macroeconomic (for example cost/benefit) analysis would also improve and strengthen the different scenarios. In addition, the potential impacts of the scenarios on upstream and downstream industries should be analysed, which could potentially encourage economic growth by identifying a wide range of industrial opportunities.

Macroeconomic analysis, including employment effects, should be carried out urgently and thoroughly. It should be utilised in the IRP2012 as a basis for formulating scenarios and deciding on the preferred scenario to align with other key policies.

[1] New Growth Path Economic Development Minister's Budget Speech 12 April 2011. This is a subsequent development to the IRP final report, so the comment relates to the seriousness of the original omission, given the prioritisation of this in 2009, and the need for this to be urgently addressed in the 2012 IRP.

2.3 Geopolitical strategy

It is not made clear how the IRP relates to South Africa's geopolitical strategy. For example, will a reduction in the planned use of coal for electricity generation be offset by diverting more coal to coal-to-liquid plants? This will indirectly enable the use of renewables and nuclear power to reduce South Africa's dependence on oil imports and on liquid hydrocarbons for transport.

2.4 Municipalities/Re-distributors

Because re-distributors account for 40% of electricity sold, they are an important factor in the design of the IRP and the consequent analysis and decision-making. Implementation of an IRP in the internationally and conventionally interpreted meaning of the term 'integrated resource planning' should involve the re-distributors integrally in planning and execution of the plan. There is little evidence of such involvement of re-distributors and no reference to municipal electricity and energy planning, whereas such plans are known to exist.

2.5 Revision of policy parameters and objectives

Policy parameters and objectives were revised during the IRP2010 process (as noted in section 4.1 on p.10), with only a partial reflection of the outcomes being illustrated. Most notably, an imperative for a 'continuing coal programme' has been introduced, although it is not listed as a policy issue, but rather noted under Policy Issue 2: Emission constraints.

2.6 Lack of prioritisation of objectives

The IRP2010 could have been strengthened if the objectives in the report were prioritised.

3. INTERNATIONAL BENCHMARKING AND REFERENCE TO PREVIOUS SOUTH AFRICAN EXPERIENCE

3.1 Alignment of IRP2010 with defining characteristics of integrated resource planning as interpreted in international best-practice

The IRP process in South Africa should be consistent with international norms, taking into account lessons learnt from international experience. Incorporating international norms will also ensure that stress-testing of the models is demonstrated. Integrated resource planning has been used elsewhere and chosen in legislation for South Africa, owing to the significant benefits it offers and the risks it mitigates. It is important to ensure, and to show through evidence, that it is properly employed. Future iterations of IRP should apply an integrated approach, based on international best-practice, including the modelling of demand and the costed modelling of investments in Energy Efficiency and Demand-side Management (EEDSM).

3.2 Utilisation of existing South African knowledge and experience

The IRP2010 is not the first South African Integrated Resource Plan. In 2004 the highly detailed National Integrated Resource Plan 2 (NIRP2) was published, and in 2008 the Third National Integrated Resource Plan (NIRP3) for South Africa was in process.

It would have been useful if the IRP2010 referred to these previous plans, as the assessment of the performance of previous plans allows for the incorporation of lessons learnt into the current IRP. Furthermore, the links between the previous plans and the current plan should be made explicit.

3.3 Portfolio risk analysis

There have been major advances internationally in the application of portfolio risk analysis to energy planning, and it would enhance the planning of the IRP if the portfolio effect is taken into account.

3.4 Discount rates

While the significance of the choice of discount rates was noted in earlier documentation and a commitment was made to undertaking sensitivity studies to determine the impact of the choice of discount rate, this appears to have been omitted, despite the significance of this issue being highlighted internationally (for example, by the International Energy Agency (IEA, 2010)).

The IRP2012 should provide modelling outcomes with the application of 'social' discount rates (for example, as recommended by the IPCC (IPCC, 2007)), at least for base-case/cost-optimised and recommended scenarios, to inform a policy-adjusted plan. In addition, a system-wide planning approach should be applied.

4. IMPLICATIONS FOR RELATED TARGETS

The IRP document needs to substantiate the claim that the recommended plan is consistent with the Copenhagen Accord commitment, which was subsequently formalised in the Cancun Agreements. The 34% contribution of non-fossil fuels towards the generation-mix does not represent a 34% reduction in 2020 levels of greenhouse gas emissions from the 'Business as Usual' scenario, which was the Copenhagen target (Department of Environmental Affairs, 2010).

Various important priority areas for which near to medium-term quantitative targets or generic objectives have been set by government (for example, the reduction of CO_2 emissions, job creation, localisation and regional integration) feature as criteria and constraints in the IRP. To ensure that there is a consistency between the outcomes of different policy statements, the IRP document needs to clearly demonstrate that selected scenarios match national development targets.

The Summary (p. 6) states that in the Policy-adjusted Scenario: "The emission constraint of the [Revised Balanced Scenario] RBS (275 million tons of carbon dioxide per year after 2024) is maintained." While emissions (and water use) of the Policy-adjusted Scenario are not given, in Table 14 of the IRP document emissions are provided for the Revised

Balanced Scenario and they peak at 296 MT/annum in 2021 and 2022, far off target from the national commitment for 2020. According to the results of the Long-term Mitigation Scenarios (LTMS), the shape of the emissions trajectory in the IRP2010, will exert severe pressures on other sectors of the economy to achieve overall South African emissions limits. Furthermore, it appears that the latest document seeks to revise South Africa's commitment to a reduction in carbon intensity of electricity supply, to be achieved by 2030 (for example, Figure 8, p. 42).

The document is also silent on the conditionality included in the Copenhagen commitment, namely that this commitment is subject to "the provision of financial resources, the transfer of technology and capacity-building support from developed countries" (Copenhagen Accord, Appendix II, 2009).

It would be beneficial if the IRP2010 is aligned with the South Africa Renewable Initiative's (SARi) target of 15% of electricity from renewable resources by 2020 (SARi, 2010), which was presented as a key initiative in the President's speech delivered to the UN High-level Panel on Sustainable Growth. Similarly, it would be more consistent if the IRP2010 was aligned with Minister Peters' public pronouncements on a 5 000 MW solar plant in the Northern Cape[2].

5. IMPLEMENTABILITY

5.1 Implementation plan

Although implementation is arguably not an explicit concern in the IRP document, the move away from coal towards nuclear and renewables must bring with it new vehicles to finance and to implement the programmes.

The proposed timelines for both decision-making and implementation are quite challenging, as will be the resourcing of the IRP as far as both financing and human capital are concerned. Therefore, there is an urgent need for all government departments and other relevant

[2] BuaNews, 2010. SA woos investors in solar energy. http://www.southafrica.info/business/investing/opportunities/solarpark-291010.htm.

entities (such as regulators) to develop a comprehensive and integrated implementation plan to ensure that these challenges are tackled effectively and timeously. For the next decade, the proposed roll-out of additional generating capacity will lead to a manageable (but not overly conservative) reserve margin, which means that any significant slippage would cause substantial risk to the achievement of the expected economic growth, if it is not off-set by better performance in energy efficiency and conservation. A specific implementation challenge will be the investment and time required for the upgrading and expansion of transmission and distribution infrastructure to provide for the existing backlogs, drastically increased total generating capacity, as well as distributed and intermittent future generation as foreseen in the Policy-adjusted IRP. Other components of national infrastructure will also require dedicated investment and expansion (for example, water supply, coal-mining and transportation, local manufacture and other components of localisation).

A number of risks have been identified in section 6.6 – 6.9 of the Policy-adjusted IRP. In addition to those addressed elsewhere in this commentary, the performance of new generation plants, the impact of variable capacity on system security and stability, and the non-realisation of learning rates are regarded by the panel as especially important from an implementation point of view. This might, for example, have a significant impact on future security of supply and on the levelised costs of electricity generation (LCOE) from different sources as demonstrated in Figure 7 (p. 41) and Table 17 (p. 42).

5.2 Localisation

Several nations, most notably Korea and China, have successfully used their need for electricity as a catalyst for job creation, skills development, industrialisation and the development of a globally competitive manufacturing capacity (Jiabao, 2009 and Kong, 2000). This can be accomplished by developing a good localisation strategy, to maximise the national benefits of the investments detailed in the IRP.

The IRP seems to imply a piecemeal approach – especially in the renewables and nuclear areas, which will not easily facilitate localisation. A good localisation strategy will maximise the sustainable impact on the South African industry in the areas of industrialisation, skills and supplier development and job creation. A localisation strategy should aim to address the support of local emerging suppliers at all levels of engagement

and to create local suppliers that are globally competitive (Gcabashe, 2003).

Studies to identify the 'critical mass' necessary for localisation need to be undertaken. This could apply to clusters of technology – e.g. wind, solar thermal, solar PV and nuclear. This implies that commitments be made to a certain minimum capacity and that those commitments be leveraged to facilitate the establishment of a local industry. Clearly this also requires the alignment of industrial incentive schemes, as well as energy policy and the regulatory environment. In addition, and in parallel to a localisation strategy, the technology support infrastructure needs to be developed.

6. SCIENTIFIC METHODOLOGY

6.1 Assumptions

While the EEDSM contribution has grown exponentially for the past five to eight years, the IRP2010 assumes a fixed EEDSM contribution from year 2017. EEDSM and its costs need to be modelled to ensure that the scenarios can be effectively assessed.

There may be a lack of correlation of demand as a function of economic growth and DSM functions. It is understandable that the supply-side can be regarded as a function of economic growth, but the demand-side can also be economic growth dependent because technology advances that accompany economic growth contribute to a healthier and more sensible lifestyle, thus boosting better demand-shaping.

6.2 Evidence base of the demand forecast

It is in the nature of a complex model that solutions are often not unique. Several sets of inputs can often generate the same output. The connection between evidence and conclusion in the IRP is not clear in this regard.

Not enough supporting evidence is presented for assessing the use of the Eskom System Operator (SO) Energy Forecast rather than the Council for Scientific and Industrial Research (CSIR) report (CSIR, 2010), which assumes substantially lower demand. The single 'Low-growth' scenario done following the second consultation and the consideration of the results of the low-growth scenario do not address large potential impacts of a possible over-estimation of demand.

6.2.1 Credibility and impact of the demand forecast

The conflicting interests of the electricity supply-side industry and energy-intensive users on the one hand, and other electricity users and the national economy need to be addressed. Addressing these conflicting interests is a well-known phenomenon, specifically documented by Steyn (2006). The IRP2010 implies that investment in over-capacity is less of a risk than jeopardising security of supply. Given the recent experience in South Africa of the effects of under-capacity, this is understandable. However, the IRP is required to present decision-makers with information to carry out the necessary trade-offs between these risks, not to minimise one at the expense of the other.

6.2.2 Side-effects of the impact of over-capacity

The IRP2010, if implemented as per plan, could lead to over-capacity. Over the next 20 years sufficient flexibility must be built into implementation in order to manage this possibility. In this regard, each iteration of the IRP process needs to carefully consider trends of demand and supply and manage the conflicting dynamics of this risk accordingly.

6.3 Quality of data and information

Data on which plans are formulated must be transparent and accurate to ensure that the best decisions and technology choices are made. The IRP2010 uses a range of data, which in some cases would have been more useful if the sources were given.

For example, the report titled "Power Generation Technology Data for Integrated Resource Plan of South Africa" provided by the Electric Power Research Institute (EPRI), which contains the detailed data used for most of the modelling of costs, states in bold in the Executive Summary that: "Site specific and company-specific conditions dictate design and cost variations that require a much higher level of effort and is not reflected here"[3]. Furthermore, where one large deviation is made from EPRI data (in the costing of PV and consequently in the decision to increase PV from zero in the RBS to 8.4 GW in the final IRP2010, which is 18% of the new

[3] EPRI, 2010: Power Generation Technology Data for Integrated Resource Plan of South Africa.

build requiring capital expenditure of R73 billion), this is done based on a radical revision of costing. According to the information in the final IRP2010, the sole and only basis of the new information on PV is 'external consultants'. This is not an acceptable basis for modelling results affecting decisions of this importance. Similarly, the increase of 40% in nuclear capital cost is not adequately explained.

6.4 Disclosure of model used and repeatability

The IRP should disclose the optimising model used so that an independent party can repeat the modelling as is best-practice to ensure the repeatability and accuracy of results.

6.5 Modelling of transmission and distribution costs

The IRP can be improved by modelling the transmission system. The IRP did take transmission system costs into account, but only in an *ad hoc* way for imports. This impacts on the assessment of relative costs of generation technologies.

The distribution system should also be modelled as it could make an essential and fundamental difference in the evaluation of energy efficiency and distributed renewable energy solutions.

The modelling of transmission and distribution costs is required to properly formulate least-cost scenarios and to formulate and assess constrained and policy-adjusted scenarios. Without it, the model and the IRP methodology cannot accurately take into account the interests of important stakeholders, such as re-distributors and their customers that account for 40% of electricity supplied, and the benefits of key technologies, especially but not limited to investments in EEDSM and distributed generation technologies.

The response given in the IRP2010 final report to the stakeholder inputs that these should be modelled, is not sound. Figure 10 (p. 50) in the IRP2010 final report indicates significant transmission and distribution costs, which accords with the known large differential between generation costs and user prices. If these costs cannot be modelled, what data was used to generate Figure 10?

6.6 Link between costs and prices

Electricity price data results are presented, claiming that transmission and distribution costs have been included. These are presumably based on in-house Eskom data and modelling that are not described or disclosed. This does not achieve an acceptable level of transparency for a scientific assessment of the validity of the results.

Furthermore, a projected price path for South Africa is compared to projected price paths for other emerging economies, but no source, methodology or reference is provided for the projections, making the comparison difficult to interrogate.

6.7 Economic modelling: Non-transparent and unjustified 'upper-limit cost constraint'

An (implicit) foundation of the suitability of the acceptable scenario(s) is an electricity price level. However, this price level is never explicitly stated, nor is the justification for the choice of this level presented, nor the methodology for assessing scenarios against this level. This is one of the most important parameters in the IRP modelling and decision-making process but is dealt with inadequately. As a result, it is not possible to assess either the rigour of how the price level was selected or the effect of other potential price-level choices on all sectors of the economy.

7. CONNECTION BETWEEN EVIDENCE AND CONCLUSION

7.1 Use of multi-criteria decision-making framework (MCDMF) in the final policy-adjusted IRP

The RBS was arrived at through stakeholders considering the outputs of the modelling done before technology learning, increased nuclear costs and significantly decreased PV costs were introduced. The MCDMF was not re-run following the introduction of these changes. It is likely that the RBS would have been different if based on scenarios using these altered values. What was the point of generating the new values if they were not going to form part of the MCDMF? Furthermore, a MCDMF has not been run on the scenarios generated after the second consultation process.

7.2 Statistical validity and uncertainties

By the nature of the process, the compilation of an IRP is subject to various assumptions, risks and uncertainties. These are stated in general terms and assumptions are justified accordingly, but there is a concern that risks and uncertainties were not considered on a consistent level and to sufficient depth.

Examples of shortcomings in the validity of analysis include:

- Sensitivities and uncertainties appear not to have been subjected to proper statistical analysis. No error bars are presented. (This is elaborated on in section 7.3.)
- The costing methodology for scenarios as a whole is unclear. The inclusion of the Emissions 3 scenario, with a high level of redundant plant (70% reserve capacity in the early 2020s), still implies a prohibitive cost for emissions mitigation beyond an arbitrary threshold.

7.3 General lack of modelling of uncertainty

The use of sensitivity studies to explore uncertainties appears to have been abandoned throughout the process.

The following dimensions of risk associated with the selected portfolios were identified in the IRP:

- the validity of cost assumptions for each technology;
- the validity of lead-time assumptions;
- the maturity of each technology;
- security of fuel supplies;
- operational risks.

However, all generating technologies were not scored for all five dimensions, which create the impression that some were regarded as having no risk attached to them and leaves the assessment of portfolio risk open to manipulation. The stated practice of applying selective expert judgement is open to bias.

The large (and unknown) uncertainties in much of the key input data must lead to uncertainties in results. The optimising model makes binary either/or decisions based on whether the cost of one solution, in one year, is marginally greater than another. This decision can cascade down the years, potentially altering the entire plan. These features of the data and modelling are not mentioned or catered for either in the textual description of possible limitations in the modelling, in the presentation of the results, or in the very limited sensitivity analysis that has been carried out.

It is of utmost importance that a comprehensive risk/uncertainty analysis is performed, based on a clear basis for consideration and scoring of the uncertainties as identified. Uncertainties should be reduced further by performing a thorough sensitivity analysis of the main parameters that determine the outcomes of modelling. For cost estimates, this would include capital cost, fuel costs, operation and maintenance costs and full external costs.

7.4 Specific concern with respect to coal price

Currently coal prices for electricity are considered to be low and non-market-related. However, the IRP2010 recognises the high risk of significant coal price increases and the large contribution of coal costs to total system electricity cost. Efforts should be made to model coal-price sensitivities more comprehensively, to formulate appropriate mitigation options and to feed required and relevant information into the decision-making process.

7.5 Selection criteria and scoring

Selection criteria and the way in which scores are derived must be clearly defined. While direct water-use is considered, there is a need to consider other impacts. The treatment of localisation would require an organised quantitative analysis. The IRP2010 appears to make no distinction between the job-creation potential of different technologies, nor is any consideration paid to the significance of the scale of deployment of technologies, as four quite divergent scenarios receive an equal score. The scoring methodology is clearly not robust, because when a score is not given, it effectively serves as a zero-rating.

7.6 Application of the MCDMF

The draft IRP states that the "process should include a broad range of stakeholders". The record and documentation of the process used to design and to apply the MCDMF is not complete or clear. The MCDMF could be improved if it clearly indicates who was involved and how the process was conducted. An account of how criteria were selected and the number of additional criteria, and more disaggregated criteria, that were proposed in the stakeholder consultation process should be ac-

counted for. This would ensure that the outputs of the process are acceptable and accurate.

Lack of information on some critical elements of the multi-criteria decision -making (MCDM) procedure does not allow knowledge-based assessment of its adequacy. Of particular importance here is the basis for the weighting of scores for each criterion. These are inherently too subjective and highly sensitive to which stakeholder groups may have been involved in the process. One does not have enough information in the available documentation to make a proper judgement on adequacy. The same applies to the uncertainty factor used for evaluating considered risks.

8. SEPARATION OF WORK STREAMS

Best-practice scenario-based modelling and decision-making requires that the scenario-building, modelling and decision-making activities are separated, with transparent management of the boundaries between the activities. There is no evidence for this in the IRP documentation. On the contrary, it would appear that all aspects of integrated resource planning were performed by one team in a single set of processes.

It is not possible to say with confidence that the distribution of work among specialist teams executing certain activities in parallel, with some outputs then serving as inputs to subsequent processes, would have resulted in another outcome, but it is recommended that such an approach be followed during future revisions of the IRP. A separate research stream is also required.

9. 'NON-SCIENTIFIC' ISSUES

Some issues are less amenable to clear-cut commentary based on evidence and scientific reasoning. For example, if a solution requires a strong element of political will to transform organisational culture, or such transformation might encounter significant resistance, the viability of that solution becomes more a matter of opinion than clear-cut, evidence-based reasoning.

Despite these issues not strictly fitting the brief, panel members believe that there are a number of such issues that need to be flagged.

9.1 The efficacy of the governance environment and/or regulatory system to ensure implementation of the IRP

By way of example, IRP1, published in the *Government Gazette* on 29 January 2010, required the completion of several projects within specific timelines – in particular renewables projects such as the Sere wind project and REFIT-funded projects. These projects have to date not been commissioned.

This raises questions as to the credibility of the IRP and the ability of NERSA and/or the DoE to enforce requirements that the IRP be implemented.

9.2 Status and effectiveness of relevant legislation and regulations

The non-performance of the REFIT mechanism to date, the underperformance of EEDSM, and the withdrawal of the draft EEDSM regulations and the publication of revised New Generation Regulations (the regulations governing the IRP) in the middle of the IRP process are all reasons for serious concern.

10. RECOMMENDATIONS

- We recommend that the DoE utilises the extensive international and South African experience and knowledge in conducting the next revision of the IRP. Furthermore, the IRP must be aligned with existing policies, plans and strategies.

- We recommend that the design of the project for the next revision of the IRP, slated for 2012, and associated research, knowledge, and human resource mobilisation, begin immediately and that gathering of important information and data-sets, such as those required for more effective assessment of EEDSM and more accurate costing data, begin immediately.

- We recommend that this project design be informed by a commissioned review, to incorporate the learning from the IRP2010, previous IRPs and the first IEP of 2004. The project should then establish institutional continuity and programmatic development of IRP capacity in the various organisations and stakeholders involved.

- We recommend that work commences as soon as possible to elaborate, with stakeholder participation, the opportunities and challenges

for transmission and distribution development, optimum system management for stability of supply and the potential for regional integration. In parallel, there is a need to explore the implications of the availability of various and emerging funding and cooperation opportunities, including the international support needs recognised in international climate negotiations. Consideration of financing options should also explore the significance of different capacity allocations, i.e. to Eskom *vs* IPPs.

- We recommend that, in preparation for IRP2012, objectives such as, for example, the positive economic impact of scenarios, including the impact on employment, be established in advance.

- We recommend that the collection of better data on technology costs, on the implementation record, on the potential of energy efficiency and DSM programmes in South Africa, on the implementation of renewable energy programmes, and on the costs of transmitting and distributing electricity from different technologies in different parts of the country should begin in the immediate term so that adequate data are available to inform the next iteration of the IRP. These data-collection exercises should be implemented in partnership with independent research institutions, and potentially in collaboration with international organisations, such as UNEP and UNIDO, which are already working to support South Africa to manage its energy challenges. The studies should be subject to rigorous peer review to ensure robustness.

- We recommend, given the data and skills shortages in the area in South Africa, that the DoE, in collaboration with the DST, initiate an industry–academia collaborative R&D programme to support best-practice Integrated Energy Planning and Integrated Resource Planning in South Africa. This could be done via the DST's Research Chairs programme.

- We support the proposals for a research agenda to inform future IRP revisions, as outlined in Chapter 7 of the Policy-adjusted IRP. It is further recommended that research is initiated on the full direct and indirect life-cycle costs of all technologies in the proposed IRP-generating mix, in order to ensure that appropriate and informed comparisons are made regarding capital, operating and maintenance and external costs, subsidies and incentives, as well as Levelised Cost of Electricity for the different technologies.

REFERENCES

Copenhagen Accord 2009: Appendix II, Nationally appropriate mitigation actions of developing country Parties, Non-Annex I Actions.

CSIR (Council for Scientific and Industrial Research), 2010: Forecasts for electricity demand in South Africa (2010 – 2035) using the CSIR sectoral regression model, CSIR and Eskom, http://www.doe-irp.co.za/IRPPrm/CSIR_model_IRP%20forecasts%202010_final_v2.pdf.

DEA (Department of Environmental Affairs), 2010: National Climate Change Response Green Paper, Government Gazette, 25 November 2010, http://www.info.gov.za/view/DownloadFileAction?id=135920.

Gcabashe, T. 2003: The South African Power Project (TSAPRO). Unpublished manuscript, submitted to the Department of Public Enterprise

IEA (International Energy Agency), 2010: *Projected Costs of Generating Electricity – 2010 Edition*, IEA,

IPCC, 2007: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jiabao, G. 2009: Build-up in an All-round Way the Internal Dynamism of China's Economic Development. Speech presented at the World Economic Forum Annual Meeting of New Champions 2009, Dalion, China.

Kong, T. 2000: *The Politics of Economic Reform in South Korea: A Fragile Miracle*. Routledge, London and New York

SARi, 2010: *Unlocking South Africa's Green Growth Potential - The South African Renewables Initiative,* Department of Trade and Industry, Pretoria.

Steyn, G. 2006: *Investment and Uncertainty: Historical experience with power sector investment in South Africa and its implications for current challenges*.

LIST OF ACRONYMS

CSIR	Council for Scientific and Industrial Research
CSP	Concentrated solar power
DoE	Department of Energy
DSM	Demand-side management
EEDSM	Energy efficiency and demand-side management
EIA	Environmental impact assessment
EPRI	Electric Power Research Institute
GW	Gigawatt
GWh	Gigawatt-hour
IEP	Integrated Energy Plan
IPAP2	Industrial Policy Action Plan 2010/11 – 2012/13
IPP	Independent power producer
IPCC	Intergovernmental Panel on Climate Change
IRP	ntegrated Resource Plan for Electricity
LCOE	Levelised cost of electricity generation
LTMS	Long-term Mitigation Scenarios
MCDMF	Multi-criteria decision-making framework
MDG	Millennium Development Goal
MT	Megatonne
MW	Megawatt
NERSA	National Energy Regulator of South Africa
NGP	New Growth Path
NIRP	National Integrated Resource Plan
O&M	Operation and maintenance
PV	Photovoltaics
R&D	Research and development
RBS	Revised balanced scenario
REFIT	Renewable Energy Feed-in Tariff
SARi	South Africa Renewable Initiative
SO	System operator
UN	United Nations
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation