energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

Executive Summary of the Daft Integrated Electricity Resource Plan for South Africa - 2010 to 2030

IRP 2010

The Inter Ministerial Committee (IMC) have approved this executive summary of the findings and conclusions drawn from scenario modelling process and the recommended Balanced Scenario which is the basis for the Draft IRP 2010 and that is to be used for public consultation.

Extract

The Balanced scenario provides for a 30% reduction in carbon emissions compared to the least Cost scenario and requiring only 8% additional funding compared to the least Cost scenario. The Balanced scenario also provides for localisation of renewable technologies. However, even the least Carbon scenario requires an additional R790b.

The Low Carbon scenario requires 50% more funding than the Balanced scenario whilst only yielding an additional 10% carbon reduction.

Clearly funding will remain one of the biggest binding constraints for the implementation of this or any future IRP.

03 September 2010

Compiled by the Department of Energy

based on inputs and recommendations by the

Interdepartmental Task Team

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

Long term planning, whilst essential, is fraught with uncertainty. This is more so today than ever before due to the pace of global change on the political, economic, social, technological and environmental fronts.

The biggest challenge in all long term planning lies in finding a sensible balance between the divergent views and expectations put forward by the different parties involved. These views fall broadly into two categories: desired/wished for (could be) outcomes and must be inputs or outputs, which are subject to various constraints. Such "could be" and "must be" parameters are the interdependent variables of planning.

Scenario planning is an effective tool to find this balance. A scenario is not a plan but rather a glimpse of an extreme future, where a particular outcome or input is amplified in a modelling process to observe the effect this has on the other interdependent variables. The balanced scenario is created by an assessment of all scenarios to establish a balance between desired future outcomes and the realities of known constraints. The balanced scenario is the basis for the ultimate government approved risk/policy adjusted plan.

The primary objective of the Integrated Resource Plan (IRP 2010) is to determine the long term electricity demand and detail how this demand should be met in terms of generating capacity, type, timing and cost. However, the IRP 2010 also serves as input to other planning functions, *inter alia* economic development, funding, environmental and social policy formulation. The accuracy of the IRP 2010 is improved by regular reviews and updates as and when things change or new information becomes available. For this reason all long term plans should be considered as indicative rather than "cast in concrete".

The proposed policy adjusted IRP aims to achieve a balance between an affordable price for electricity to support a globally competitive economy, a move to a more sustainable and efficient economy, a move to create local jobs, the demand on scarce resource such as water and the need to meet nationally appropriate emissions targets in line with global commitments. It supports the development of the Southern and Central African region by stimulating the development of hydro power projects in the region and provides a catalyst for further economic development due to increasing energy security.

The IRP describes the requisite capacity expansion plan for the country. As part of this expansion investment in generation technologies provides an opportunity for the development of local industry and skills. The development of the local industry has several beneficial impacts on:

- Jobs

- Local economy
- Balance of payment and
- Cost of the technology itself

As part of the process in modelling the technology scenarios to support the requisite expansion required, consideration was given to the issue of local potential to supply. While this consideration was not an integral part of the criteria (due to the high degree of unknown variables) it will be an important part of the economic impact modelling being undertaken by National Treasury, Department of Economic Development and the IDC.

The plan supports a GDP growth trajectory of on average 4.6% over the next 20 years. It requires 52248 MW of new capacity in order to meet the projected demand and provide adequate reserves. It assumes at least 3420 MW of demand side management programmes, as well as a gradual reduction in electricity intensity due to increased efficiency and a diversification to secondary and tertiary sectors in the economy. It however still assumes a significant primary sector built on the extraction and beneficiation of natural resources that the country is blessed with.

The scenario evaluation process confirmed that the "Revised Balanced Scenario" represents a fair and acceptable balance considering the divergence in stakeholder expectations and key constraints and risks for example:

- Affordability/Funding availability
- Reducing carbon emissions
- New technology uncertainties such as costs, operability, lead time to build etc
- Water usage
- Job creation
- Security of supply

The IMC is requested to approve the commencement of the last round of public consultation which will be based on the "Revised Balanced Scenario" as set out in this report.

2. THE IRP AND ITS PURPOSE

The Integrated Resource Plan is a 20 year electricity capacity plan. It aims to provide an indication of the country's electricity demand, how this demand will be supplied and what it will cost. It is not a plan that deals with the overall energy needs for the country nor does it deal with the wider infrastructure plan for the country. It is a key input into those plans and it is envisaged that there will be an iterative process in developing these plans. It tries to cater for a cone of demand and to be flexible within reason to changes in assumptions on demand and supply.

NB: An additional "Medium Term Risk Mitigation" plan must be submitted with IRP 2010 that deals with the immediate medium term serious short fall in supply capacity. The plan's purpose is to ensure avoidance of any form of power supply rationing or curtailment in the anticipated constrained period from 2010 to 2017, by making available sufficient demand side reductions and efficiencies and additional non-Eskom generation.

3. THE IRP DEVELOPMENT PROCESS

The Electricity Regulations on New Generation Capacity states that the process for developing the integrated resource plan shall include:

a) Adoption of the planning assumptions;
b) Determination of the electricity load forecast;
c) Modelling scenarios based on the planning assumptions;
d) Determination of the base plan derived from a least cost generation investment requirement;
e) Risk adjustment of the base plan, which shall be based on:
   i. The most probable scenarios; and
   ii. Government policy objectives for a diverse generation mix, including renewable and alternative energies, demand side management and energy efficiency; and
f) Approval and gazetting of the integrated resource plan.

While the IRP includes current policy imperatives into the planning process, the outputs can and will have an impact on further policy directions and other Ministries' strategies. This impact is particularly evident in the discussion on climate change mitigation strategies. The IRP process is a dynamic and iterative process, subject to ongoing review and update, however the long lead time on expansion means that vacillation on choice will lead to delays in capacity with a subsequent impact on economic growth and jobs.

The IRP development follows three major stages:

- Agreement on input parameters;
- Modelling scenarios and analysis; and
- Development of the IRP based on the outcome of the above analysis.

Consultation and the IRP Development Process

The Department of Energy undertook to launch a proactive Stakeholder consultation process to ensure that critical input could be sourced from a diverse constituency during the development of the plan, rather after the publication of the plan. This process was a 2 phased intervention, including:

- Consultation on input parameters to the IRP modelling; and
- Consultation on the Balanced Scenario and draft IRP.

The final Input Parameter Values that were used in the modelling were based on a consolidation of both government and broader stakeholder desired/wished for outcomes and the must be inputs/outputs as prescribed by legal, physical or moral limitations.

The first output of the modelling process is the Base or "Least Cost" Scenario, which considered only the direct costs of the options considered. It does not consider any externalities.

The additional scenarios considered externalities either as limits or explicitly modelled as additional costs for the affected technologies. The primary externality factor that was considered in IRP 2010 was constraints around carbon emissions.

The Balanced Scenario was developed based on the most probable scenario inputs or outputs: Government policy objectives for a diverse generation mix, including renewable and alternative energies; demand side management; and energy efficiency forecasts.

The Balanced Scenarios seek to achieve a trade-off between:

- Least cost investment;
- Climate change mitigation;
- Localisation and job creation;
- Regional development – i.e. in SADC;
- Diversity of energy sources; and
- Energy efficiency and demand-side management.

Given the inherent uncertainty in long term planning, the scenarios also considered sensitivities such as different demand forecasts.

The scenario outputs were analysed and reviewed by the interdepartmental task team and based on this input the "Balanced Scenario" was developed. Following the public consultation process the IRP 2010 will be finalised considering:

- Unrealistic expansion options;
- Security of supply (Reliability criteria);
- Any limits imposed by the Integrated Energy Plan, such as energy transport infrastructure, are not violated - for example load factors on gas turbines and dam capacities.

The approved final draft IRP 2010 will then be subjected to a full production modelling test to ensure all operational risks have been considered. This must be done because the scenario models are basic and not as precise as the full production model.

An assessment of the plan's anticipated price path and investment requirements will be done. This assessment will also identify whether other policy objectives, not considered specifically in the scenarios, are met, such as competitiveness, social development issues, localisation etc. Furthermore the broader picture for other infrastructure development such as water, roads and transmission will be considered for each plan to identify potential implementation issues.

4. THE IRP SCENARIOS MODELLED

The Integrated Resource Plan (IRP 2010) modelling has produced a set of scenarios, including the base scenario, that result in a number of "optimised" generation portfolios, i.e. portfolios that meet the scenario objectives while optimising for least (direct) costs under these constraints.

It is important to note that each scenario is a test of input options, in particular policy options, and not a reflection of expected real-world conditions. A scenario is not a plan but rather a glimpse of an extreme future where a particular outcome or input is amplified in a modelling process to observe the effect this has on the other interdependent variables.

The actual IRP 2010 is derived by selecting specific aspects from the various scenarios that best fit the realities of known physical constraints, prescribed specific objectives or desired future conditions.

The inherent plan uncertainties can be reduced (but never eliminated) by repeating the IRP planning process going forward as and when new information becomes available. The scenarios modelled were:

1. Base Case 0.0 – which only considers the direct costs of each technology.
2. Base Case 0.1 – which considers the cancellation of Kusile power station.
3. Base Case 0.2 – which considers a delay in the construction of Medupi and Kusile power stations.
4. Emission Limit 1.0 (EM1) – which imposes an annual emission limit of 275 MT of carbon dioxide.
5. Emission Limit 1.1 – as above with the additional consideration of the cancellation of Kusile power station.
6. Emission Limit 2.0 (EM2) – which imposes an emission limit of 275MT of carbon dioxide by 2025 but allows emissions to go to higher levels prior to 2025.
7. Emission Limit 2.1 – as above with the additional consideration of the cancellation of Kusile power station.
8. Emission Limit 3.0 (EM3) – which imposes a tighter emission limit of 220 MT of carbon dioxide from 2020.
9. Emission Limit 3.1 – as above with the additional consideration of the cancellation of Kusile power station.
10. Carbon Tax 0.0 (CT) – which imposes carbon taxes escalated to 2010 Rands as contained in the LTMS documents.
11. Carbon Tax 0.1 – as above with the additional consideration of the cancellation of Kusile power station.
12. Regional Development 0.0 (RD) – which considers a broader range of regional supply options.
13. Regional Development 0.1 – as above with the additional consideration of the cancellation of Kusile power station.

14. Enhanced DSM 0.0 (EDSM) – which imposes an additional demand side management programme of 6TWhrs by 2015.
15. Enhanced DSM 0.1 – as above with the additional consideration of the cancellation of Kusile power station.
16. Balanced Scenario – based on initial discussions within the Department of Energy
17. Revised Balanced Scenario – based on workshops with the interdepartmental task team.

Appendix AA contains the detailed Scenario Data Tables.

The following is an overview of the results and indicators ensuing from the scenario studies.

4.1. Base Case

The Base Case (with Kusile and Medupi as per the original committed schedule) provides for imported hydro as the first base-load capacity in 2020 (after the committed programmes), followed by combined cycle gas turbines (CCGT) (fuelled by liquefied natural gas, or LNG), then imported coal and fluidised bed combustion (FBC) coal, before pulverised coal which forms the basis of all further base-load capacity. Additional peaking capacity is exclusively provided by open-cycle gas turbines (OCGT), fuelled by diesel.

CO_2 emissions continue to grow (albeit at a lower rate due to more efficient power stations replacing decommissioned older ones) to a level of 381 million tons at the end of the period (2030). Water usage drops from 336 420 million litres in 2010 to 266 721 million litres in 2030 (due to replacing older wet-cooled coal power stations with newer dry-cooled stations).

The cancellation of the Kusile project would require alternative capacity to be built in 2017, in this case FBC coal and CCGT, with additional projects brought on at least a year earlier in each case. This increases the cost to the economy from R789bn to R840bn (in present value terms), *but does not include* the net impact of the cost saving on the cancelled project and penalties relating to this cancellation. The present value (PV) costs indicated do not include capital costs for committed projects.

A delay in building Medupi and Kusile causes some projects to be brought forward, for example an FBC coal unit in 2015 and CCGT units in 2017/18, to cover the reduced capacity over the medium term, but other options are pushed further out in time as the last unit of Kusile is only commissioned by 2020. Security of supply is not dramatically impacted by the delay, as long as the identified mitigating projects can be built in the periods required.

4.2. Emission Limit 1

Imposing a limit on emissions (at 275 million tons of CO_2 throughout the period) shifts the base-load alternatives away from coal (in particular pulverised coal) to nuclear and gas.

Wind capacity is also favoured to meet the energy requirements over the period, especially as the emission constraint starts to bite in 2018. As the nuclear programme is restricted in terms of its build rate (one unit every 18 months starting in 2022), wind is required to reduce emissions in the interim. CCGT provides a strong mid-merit alternative until nuclear is commissioned, especially providing higher load factors than wind with some dispatchability. The total cost to the economy (excluding capital costs of committed projects) is R860bn, compared with R789bn for the base case, but with significantly lower water consumption (241 785 million tons in 2030).

The scenarios including the cancellation of Kusile allow for additional pulverised coal generation to be built later (in 2028) with more wind capacity before 2022. CCGT capacity is brought forward to fill the gap left by the cancellation of Kusile.

4.3. Emission Limit 2

The emission limit is retained at 275 million tons but is only imposed from 2025. Under these conditions the nuclear and wind build is delayed (nuclear by one year, wind by five years). The other capacity is similar to the base case until 2022 when low carbon capacity is required to ensure that the constraint can be met in 2025. Decommissioning of older power stations (6654 MW by 2025) provides an opportunity to return to the constrained level of emissions. The cost to the economy is lower than the Emission Limit 1 scenario at R835bn with a slightly higher average annual emission of 275 million tons (as opposed to 266 million tons).

4.4. Emission Limit 3

The tighter emission limit of 220 million tons is imposed from 2020. This requires a significant amount of wind capacity (17600 MW starting in 2015) and solar capacity (11250 MW commissioned between 2017 and 2021) to meet the constraint. In total 17,6 GW of wind, 11,3 GW of solar and 9,6 GW of nuclear are built, with no coal capacity included. CCGT is constructed as a lower emission mid-merit capacity along with 6,5 GW of OCGT peakers.

The cost to the economy is significantly higher at R1250bn with much lower average annual emissions (235 million tons) and water consumption (218 970 million litres in 2030).

4.5. Carbon Tax

The carbon tax scenario includes a carbon tax at the level of that discussed in the Long Term Mitigation Strategy (LTMS) document, starting at R165/MWh in 2010 Rands, escalating to R332/MWh in 2020 until the end of the period (2030) before escalating again to R995/MWh in 2040. This level of carbon tax causes a switch in generation technology to low carbon emitting technologies, in particular the nuclear fleet (starting in 2022) and wind capacity of

17,6 GW starting in 2020. The remainder is provided by imported hydro (1959 MW), OCGT (4255 MW) and CCGT (4266 MW) with some FBC coal after 2028 (1750 MW).

The cost to the economy (excluding the tax itself, which would be a transfer to the fiscus) arising from the changed generation portfolio is R852bn, with average annual emissions at 269 million tons and water consumption declining to 238 561 million litres in 2030.

4.6. Regional Development

While the base case only includes some import options (Mpanda Nkua, Import Coal and Cahorra Bassa North), the regional development scenario considers all listed projects from the imports parameter input sheet. These additional options provide good alternatives to local supply options at lower generation costs but require additional transmission capacity to transport the energy.

Including these options brings the total cost to the economy (excluding the transmission backbone requirement for these projects) to R783bn (R6bn cheaper than the base case). The imported coal and hydro options are preferred to local options, but imported gas is not preferred to local gas options.

4.7. Enhanced DSM

A test case scenario was run to see what the impact of additional DSM would be on the IRP. For this scenario an additional 6 TWh DSM energy was forced by 2015. The resulting reduction in cost was R12,8bn (R789,5bn of the base case less R776,7bn for the Enhanced DSM scenario) on a PV basis, indicating that if a 6 TWh programme could be run for less than this cost it would be beneficial to the economy.

4.8. Balanced Scenarios

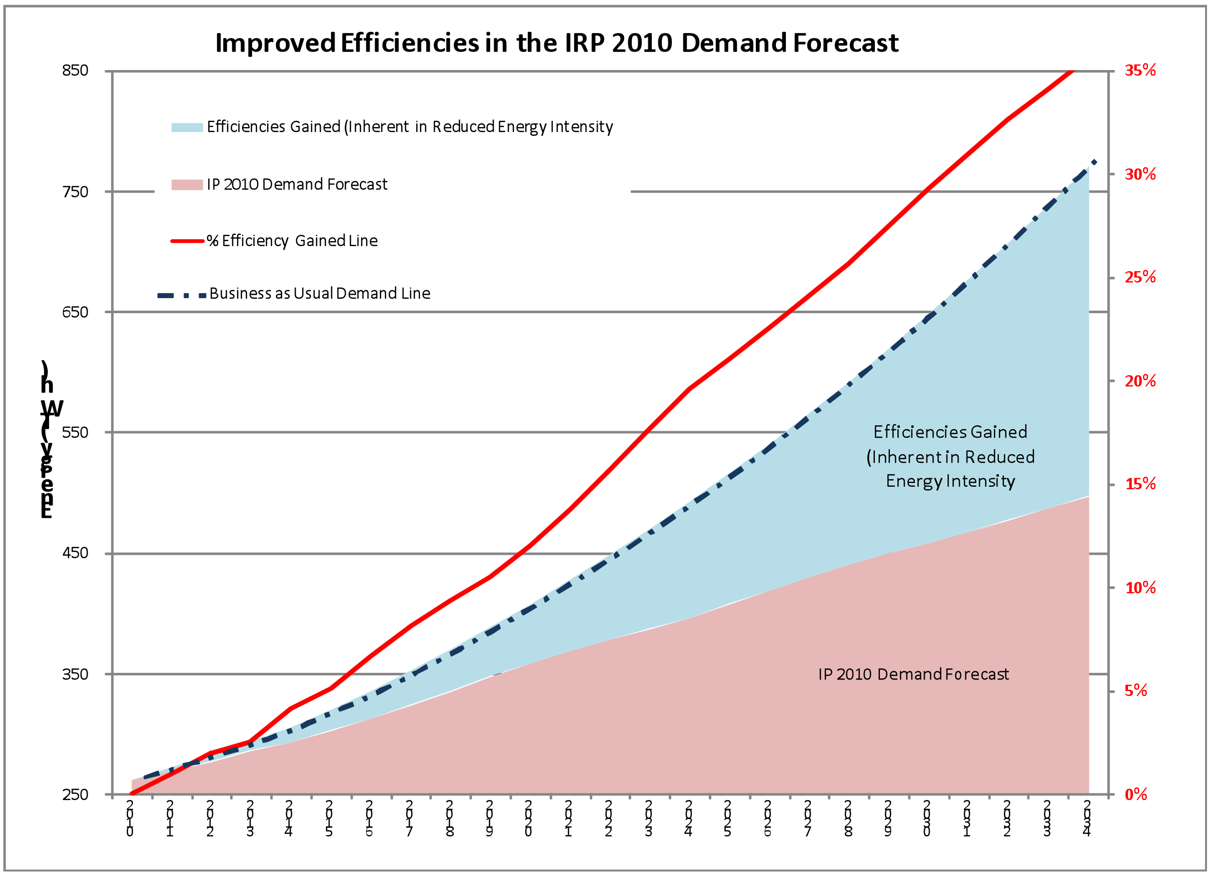
Two balanced scenarios were created considering divergent stakeholder expectations and key constraints and risks. The balanced scenarios represent the best trade-off between least-investment cost, climate change mitigation, diversity of supply, localisation and regional development. The CO_2 emission targets are similar to those in the Emissions 2 scenario.

The balanced scenarios include the Eskom committed build programme plus the MTPP and REFIT commitments. A significant amount of wind is built, as this is the cheapest renewable energy option. Care is taken to ensure a steady and consistent build up in wind capacity in order to stimulate localisation of manufacturing and job creation. A consistent, although more modest, commitment is given to the more expensive concentrated solar option (CSP) in order to develop local experience with this technology as well as costs. The renewable energy options continue after 2020, but are not specified according to technology type at this stage. These choices will be made when there is more local knowledge and experience of both wind and solar energy. Nuclear energy comes in as a baseload option from 2023 – but because this is 13 years away, this decision does not yet have to be made. The scenario also provides for substantial diversity, with gas and regional hydro and coal options also included. Allowance is also made for some short to medium term co-generation and self-build options to bolster security of supply concerns.

4.9. Energy Efficiency

It is important to highlight that the plan inherently contains significant energy efficiency savings which is accounted for in the demand forecasts.

The graph below illustrates that ~35% energy efficiency improvement is built into this IRP based on the reducing energy intensities which are used to determine the future energy demand.



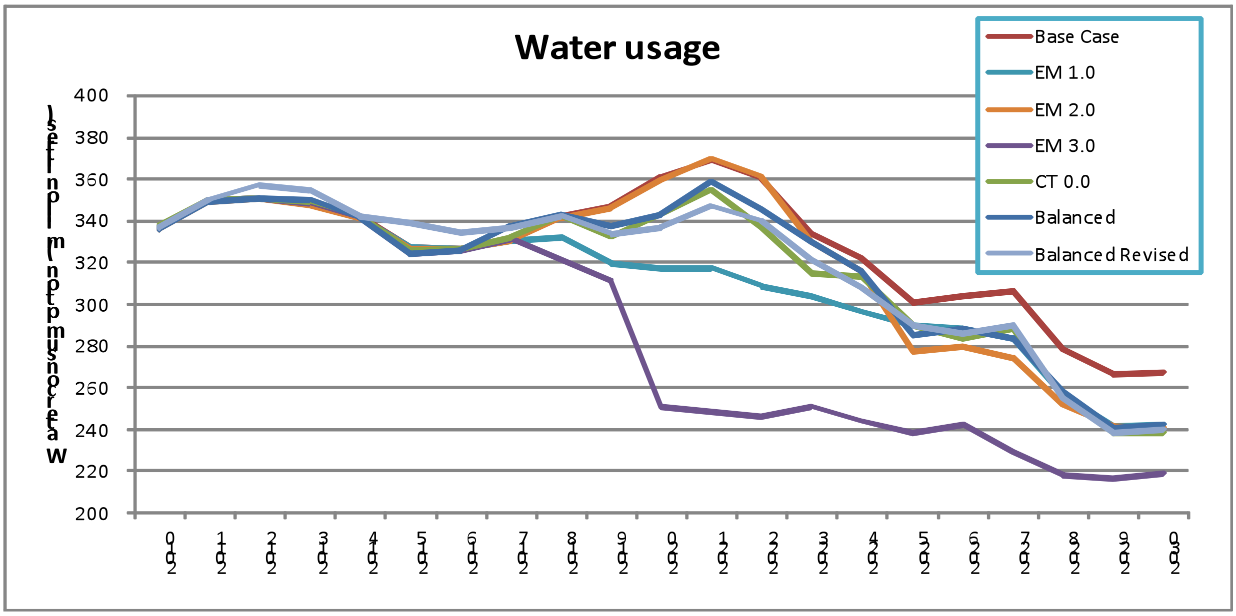
We can reasonably assume that for the next ~15 years most of the reduction in energy intensity is derived from improved energy efficiency, driven by increased electricity prices. After ~15 years any further reduction in energy intensity will then be driven by a changing economy model.

5. EVALUATING SCENARIOS

A set of criteria were proposed and discussed at a series of inter departmental workshops against which to assess a number of key parameters identified. These include:

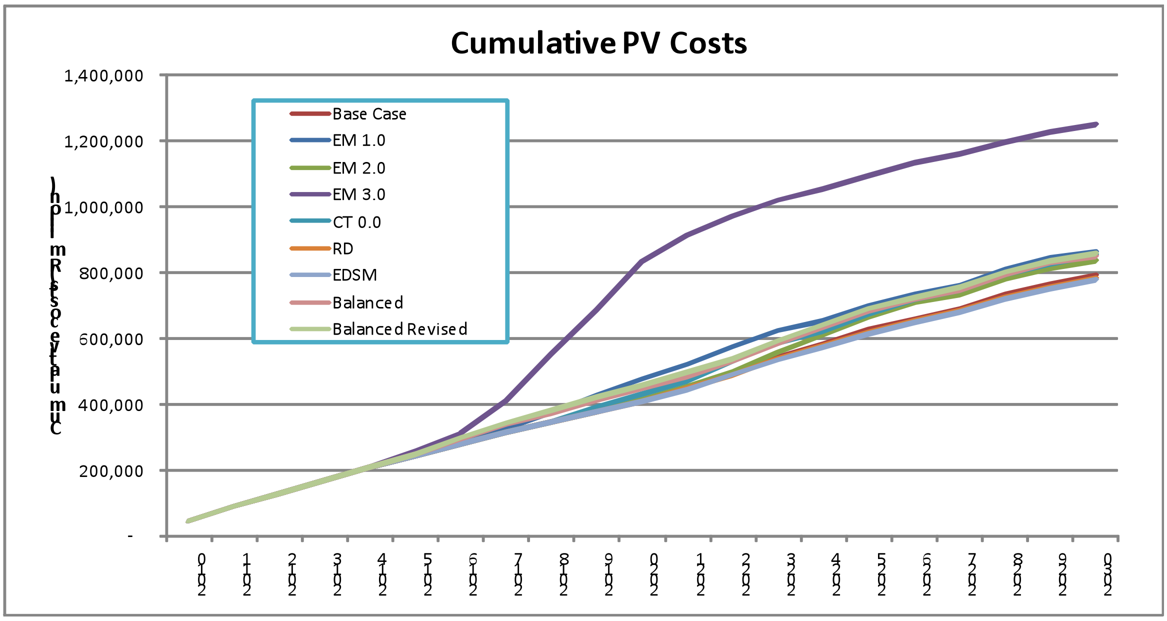
a) Water

The usage of water is quantified for each technology, according to the independent EPRI report and information from existing Eskom plant. The cost of water for existing plant and approved future plant is known and quantified. For plant that is recommended to be built in the proposed IRP 2010 only the usage of water is quantified given the fact that the location of the plant is not known at this stage in the development of the IRP.



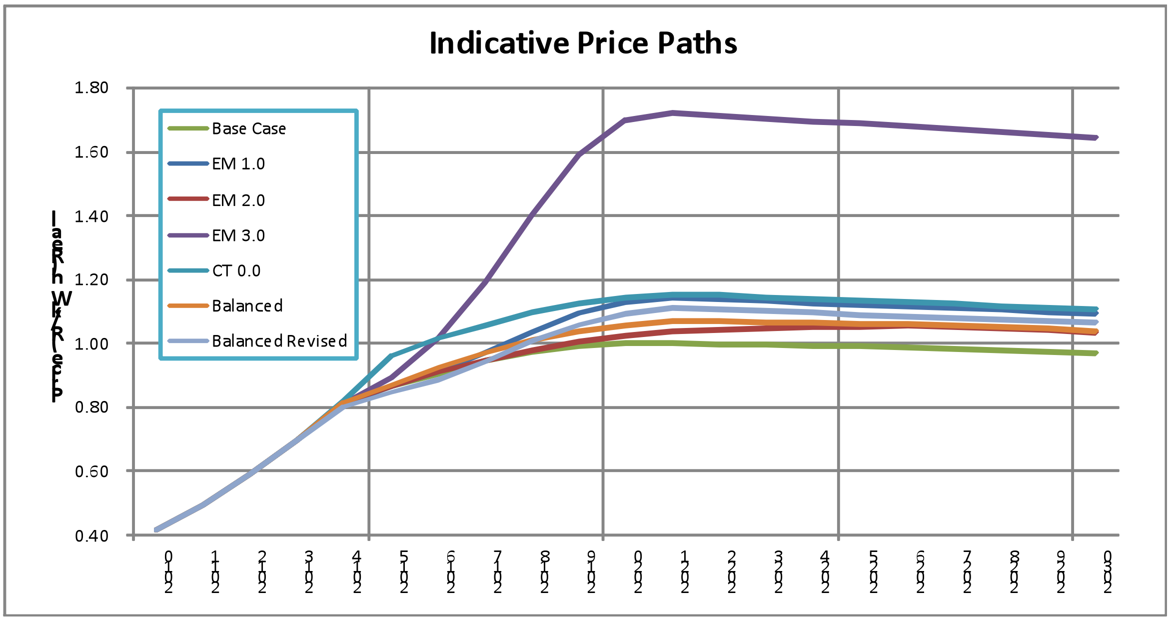
b) Cost

Each scenario will involve the construction of new generation capacity over the study period. For the current and approved projects the costs from the existing owner (Eskom, municipality or private supplier) will be used. For potential new projects the approved data set of option costs will be used. The criteria applied for this dimension should cover the direct costs associated with new generation capacity built under each scenario (including capital, operating and fuel costs) as well as existing plant (but excluding capital costs for committed plant) and will be summed to determine the total cost of the plan. This will be discounted to determine the present value of the plan and used as a comparator between the different scenarios.



Note: Present value (PV) costs are calculated in 2010 Rands (discounted at 8%) based on capital, O&M and fuel costs for all options (except capital costs for committed plant)

An alternative approach is to look at the future electricity price curves required to meet the generation costs incurred by the scenario portfolio. This model, similar to that applied in the Eskom MYPD decision by NERSA, provides an indicator of future costs to consumers for the electricity industry from each scenario portfolio.



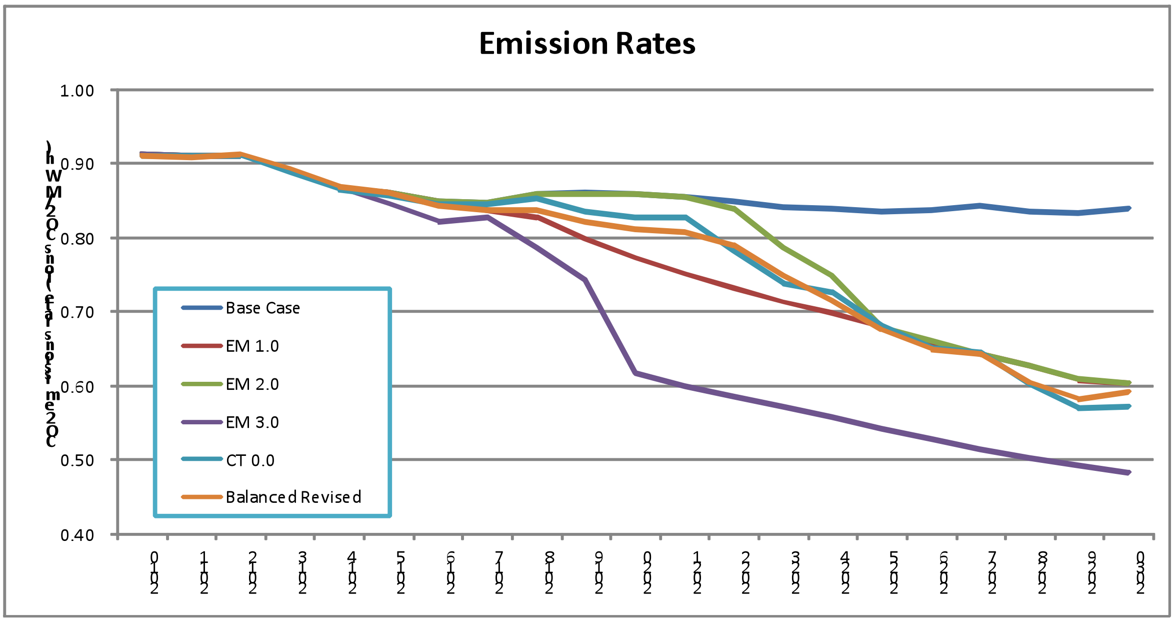
Note: The pricing curves apply the current Regulator pricing rules, and are calculated from a high level financial model using Eskom financial information from published annual statements for the past and the MYPD2 submission to the Regulator for the medium term future. Costs are escalated using the MYPD2 economic parameters. The prices are calculated using the approved rate of return methodology as adapted for the MYPD2 process, and the regulatory asset base was adjusted to reflect the approved asset values in the data base. Regulatory returns were set at the approved 8.17% and assets were depreciated over 25 years, indexing the values annually with the expected inflation rate.

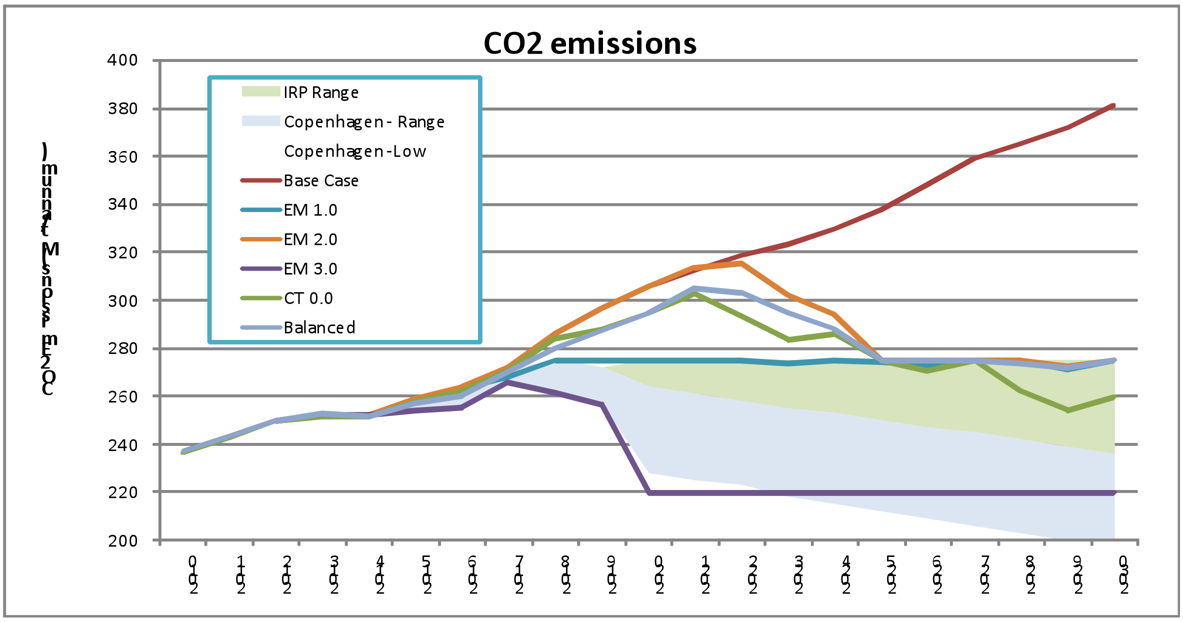
The base case was assumed to produce a price curve equivalent to the MYPD2 price curve. All other price curves for additional plans, scenarios and sensitivities were calculated by adding or subtracting the difference in capital spending, fuel cost and operating expenses to the base case schedules, resulting in a different price curve for each case according to the approved pricing rules, assuming all costs and expenses would be viewed as "efficiently incurred" expenses. The capital costs in the pricing model include allowance for owners' costs (assumed at 25% of the EPRI overnight capital costs). The Regulator's pricing rules do not allow interest during construction to be capitalised, instead work under construction earns a return.

For all new generation facilities the EPRI numbers from the IRP website were used. The full pricing model is based on public information to reflect the country plan results, intended to be published for public consumption.

c) Climate change mitigation

The Department of Environmental Affairs "Long Term Mitigation Strategy" (LTMS) provides guidance on the extent to which greenhouse gas (GHG) emissions should be restricted over time. For the purposes of the IRP the GHG emissions from existing and planned generation capacity can be quantified in the model and compared between scenarios. While certain scenarios may carry a specific limit to emissions, this criterion will compare the actual emissions between all scenarios.





d) Portfolio risk or uncertainty

An approach has been developed to identify and model risks associated with each of the scenario portfolios. There are different dimensions or sources of risk between the scenario portfolios, including (but not limited to):

- The validity of the cost assumptions for each technology;
- The validity of the lead time assumptions for each technology;
- The maturity of each technology;
- The security of fuel supplies for each technology; and
- Operational risks associated with each technology (including secondary life cycle effects), such as waste management, pollution and contamination.

Ideally these risks would carry cost elements which would enable incorporation into the IRP optimisation (through monetisation of the risk elements). However given the time constraints and dearth of data to support this process, this is not feasible at present. The second best approach would be to identify a probability distribution associated with the risks and use the standard deviation as a measure of risk and apply these across the identified dimensions. While this can be done for some of the risk dimensions, there is again a lack of information and time to produce such measures for every dimension. The third approach is to apply subjective expert judgement to each technology for every dimensions and derive a risk factor for each technology (and consequently, through capacity weightings, for each scenario portfolio). This methodology has been used for the IRP, with the resulting risk factor compared between the different scenarios.

e) Localisation benefit

A rating has been given to each scenario portfolio to indicate the extent to which this portfolio supports localisation of specific technologies and supporting industries. It is expected that the earlier a technology construction programme is triggered and the more steadily such technology capacity is added, the higher the potential to localise the technology industry. Thus a wind industry is supported by a regular build profile, starting earlier, and consequently a portfolio that incorporates such a build profile would have a higher score in this criterion. The application is however subjective.

f) Regional development

Workshops with government departments have indicated that this is an important criterion for the portfolios and that those portfolios that support increased import from regional options should have a higher score. Thus the portfolio with the higher percentage of imports (to the total capacity) scores higher on the regional development criterion. Technically speaking the total capacity is replaced in this calculation by the demand that must be met, so as to not penalise portfolios that build significant wind (which requires more capacity for each unit of demand due to the capacity credits applied to wind).

For the first three criteria (emissions, cost of plan and water) and the regional development criterion the measurement is provided by the optimisation results. The average domestic emissions figure is determined based on the emission contribution of each of the proposed projects and its expected output in each year. Similarly the cost of the plan is determined based on the capital, operating and fuel costs of each project (discounted to 2010 Rands), but specifically excludes the capital costs associated with existing power stations and the committed Eskom build. The water criterion is measured by summating the water requirements for the scenario portfolio for the entire study period.

The uncertainty factor criterion is measured using uncertainty factors for each technology and then applied, based on the relative capacity of each technology in the portfolio. The localisation criterion is based on a subjective score applied to the portfolios based on their perceived potential for localisation.

6. RATING THE SCENARIOS

Each of the scenarios provides the same reliability, since the model optimises between the cost of new generation and unserved energy. Thus security of supply is not treated as a criterion.

The criteria and associated metrics provide a framework in which the balanced scenario can be assessed for "goodness of fit". The principle is to achieve the best fit considering the divergent stakeholders' objectives. The table below contains the criteria metric values for each of the scenarios

Criteria metric scores for each scenario

Scenario	CO_2 emissions (million tons) av. p/a	Price path peak (cents/kWh)	Av. water consumption (million litres)	Uncertainty factor	Localisation potential	Regional development (% capacity imports)
Base Case 0.0	303	100	327	6.87	2	6.87
Emission 1.0	266	111	310	6.12	4	6.87
Emission 2.0	276	102	319	6.12	4	6.87
Emission 3.0	236	146	283	5.21	4	3.85
Carbon Tax 0.0	269	120	316	5.34	4	5.1
Regional Development 0.0	301	101	326	6.99	2	10.4
Enhanced DSM	299	104	324	6.86	2	6.87
Balanced	272	106	318	6.05	6	4.68
Revised Balance	271	103	318	6.22	8	8.63

Note: The above scores are comparable only in columns were the metric is the same and not across rows. For this purpose a multi-criteria decision making (MCDF) framework was adopted, details of which are described in the next section.

7. SCORING THE SCENARIOS

Using a rigorous multi-criteria decision making (MCDF) framework it is possible to describe, numerate and score the preferences and values of the stakeholders with respect to each of the criteria. This provides a foundation to assist in choosing a single portfolio as the preferred option. In addition it is possible to identify next-best alternates that can undergo additional stress testing to incorporate concerns regarding robustness to sensitivities.

An important step in the MCDF process is to determine weightings for each of the criterion. This provides the mechanism to score the scenario portfolios across the different criteria. Applying the agreed weighting for each criterion and value function returned the results contained in the table below.

Plans	Av. Annual CO_2 emissions	Price path peak	Water	Uncertainty	Localisation potential	Regional development	TOTAL
Base Case 0.0	-	21.74	-	2.73	-	6.08	30.54
Emission 1.0	12.41	18.03	5.24	16.14	6.47	6.08	64.36
Emission 2.0	9.43	21.17	2.53	16.14	6.47	6.08	61.81
Emission 3.0	21.74	-	10.87	19.57	6.47	-	58.65
Carbon Tax 0.0	11.50	13.86	3.50	19.26	6.47	2.77	57.36
Region Development 0.0	0.67	21.36	0.37	-	-	10.87	33.27
Enhanced DSM	1.54	20.31	0.94	3.04	-	6.08	31.91
Balanced	10.46	19.88	2.74	16.71	11.02	1.85	62.65
Revised Balance	11.01	20.90	2.92	14.73	15.22	8.85	**73.63**
Swing Weighting (/100)	21.74	21.74	10.87	19.57	15.22	10.87	100.00

The MCDF scores clearly demonstrate the extent to which the revised Balanced Scenario represents a fair and acceptable balance across the key criteria.

The MCDF also serves as a basis for debate on policy choices.

8. RECOMMENDED BALANCED SCENARIO

The balanced scenarios (the original balanced scenario and the Revised Balanced Scenario) were developed from workshops with government departments considering the results of all scenarios and the MCDF analysis.

The initial balanced scenario was based on the Emission 2 scenario which combined the interests of affordability (or least-cost) with an emission target that complied with LTMS requirements. It was decided, however, that the wind build programme started too late and was not sufficient to ensure a local industry to support this. Thus the wind programme was forced to start in 2014 (following the initial outlays from the renewable feed-in mechanism) at a steady construction for each year. In addition the build programme for Eskom's new coal-fired power stations were delayed – by twelve months for Medupi and by 24 months for Kusile. Costs for future coal were decreased from R300 a ton to R200 a ton, while LNG prices were increased to R80/GJ. Imported coal costs were changed from the generic costs of pulverised fuel without FGD to the cost inclusive of FGD.

Following discussions with government stakeholders it was decided that firstly, the emissions from imported coal should be excluded from domestic emissions accounting, and secondly, that a solar build programme was required alongside wind at a lower level initially, considering the fact that this technology is relatively new and still evolving. The current solar programme (as part of the renewable feed-in mechanism) was moved one year later to lay the foundation for this new programme which would continue at 100 MW for each year. After 2020 the renewable programme continues as a proxy for either wind, solar or other renewable technologies which are viable at that point. Also additional regional options were included as per the Regional Development scenario, and some CCGT capacity was forced to allow for a domestic contingency for import and renewable options.

The MCDF process confirmed that this Revised Balanced Scenario represents an appropriate balance between the different stakeholder expectations considering a number of key constraints and risks, for example:

- Affordability/Funding availability
- Reducing carbon emissions
- New technology uncertainties such costs, operability, lead time to build etc
- Water usage
- Localisation and job creation
- Southern African regional development and integration
- Security of supply

Another consideration included in the Revised Balanced Scenario is the support for the development of a local industry for renewable technologies, in particular wind and solar. By bringing the construction programme for these technologies forward and maintaining a stable roll-out programme, an opportunity is provided for localisation, not only in the construction of the equipment, but in the development of skills to support the renewable programme. By not specifically categorising the renewable technologies after 2020, a window is provided for government to direct alternative renewable technology development to meet government objectives.

The total wind capacity added by 2019 is 4500 MW, solar capacity by 2019 is 600 MW, and the total renewable capacity added from 2019 to 2030 is 7200 MW. By forcing the earlier adoption of renewable technologies the country is able to achieve a lower GHG emission peak (296 million tons in 2022, as opposed to 315 million tons in the Emission 2 scenario) at only a marginal increase in cost to the economy.

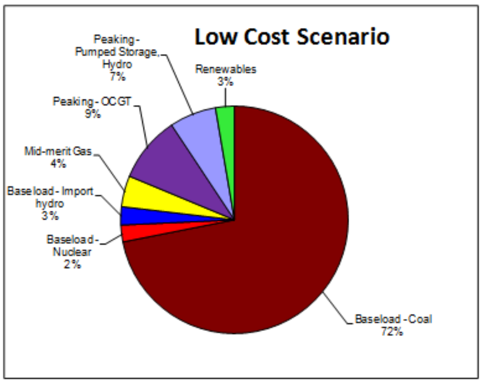
The Revised Balanced Scenario provides ample opportunity for private investment in electricity generation from the renewable programmes to the CCGT and regional options. The decision as to who builds this capacity must still be made as part of the feasibility assessment after the finalisation of the IRP 2010.

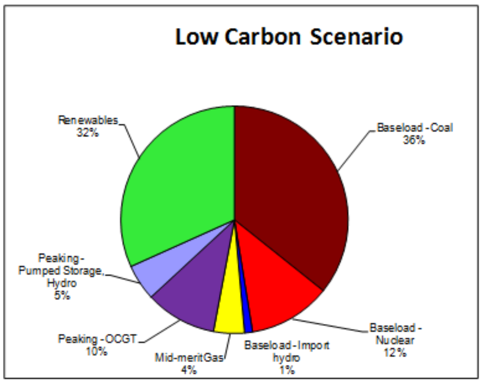
As part of the medium term business mitigation strategy a number of own generation or co-generation options have been identified before 2017. These options have been included in the Revised Balanced Scenario as additional capacity forced in as per the medium term schedule, in order to maintain some continuity between the plans. However these options have not been included in the calculations on water, prices or emissions.

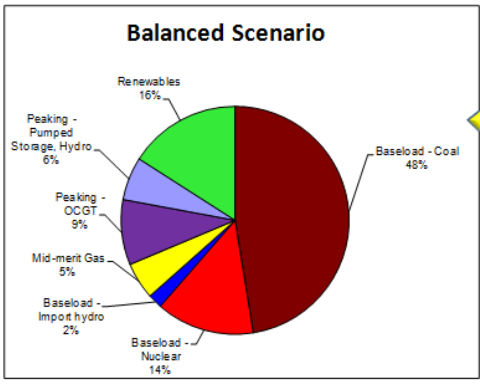
The Balanced Revised Scenario follows the original decision that transmission infrastructure would not be included in the cost determination for different projects. However it is clear that the regional options are significantly impacted by the transmission infrastructure required to transport the power to South Africa. While there are debates regarding the actual costs of this infrastructure and what proportion would be met by domestic consumers, it is evident that options further from South Africa’s borders are penalised relative to closer options. In this regard, the import hydro options identified in the Balanced Revised Scenario could end up more expensive than the coal options which are not built in this scenario. Thus it is possible that impart coal can be favoured over the other regional projects purely on the transmission infrastructure costs, and should not be penalised by carbon emissions as these do not count toward the domestic target. This would require a modification to the scenario (with regional hydro being delayed accordingly.

The graphs on the following pages serve to illustrate the extent to which the Revised Balanced Scenario represents an appropriate balance as compared to the two extreme scenarios of "Low Cost and Low Carbon".

A Diversified Generation Mix by 2030 – Balancing Risk, Cost and Carbon







New Capacity Allocation

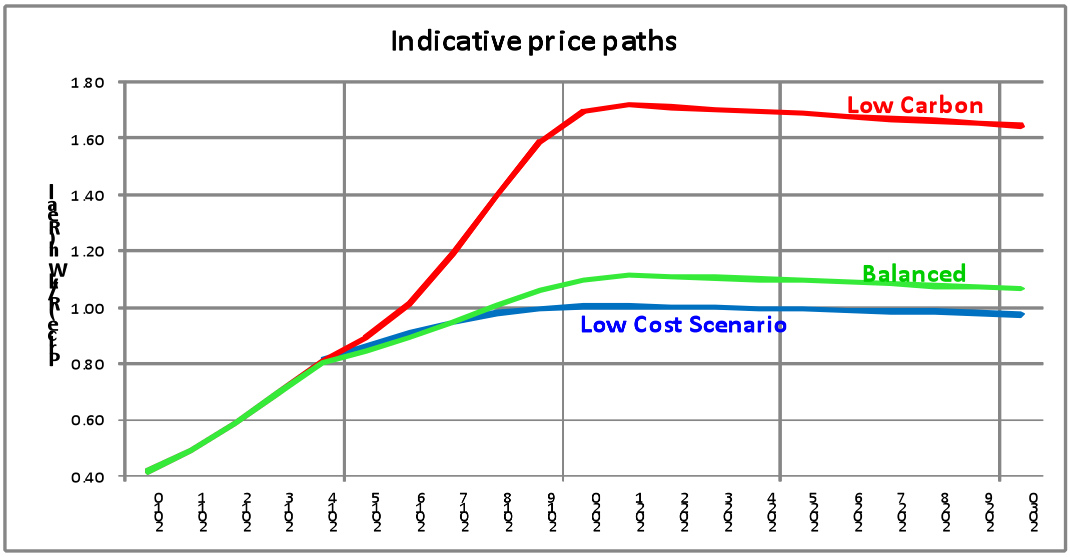
Technology	Allocation
Renewables	33%
Baseload - Nuclear	25%
Peaking - OCGT	14%
Mid-merit Gas	11%
Baseload - Coal	9%
Baseload - Import hydro	4%
Peaking - Pumped Storage	4%

The generation mix for the Balanced Scenario shows a progressive shift away from coal towards renewables.

The possibility of the emergence in future of clean coal technologies cannot be ignored.

NB: IRP 2010 only sees the retirement of ~25% of the existing Eskom generating fleet and whilst this plan clearly shows a shift towards renewables the full extent of this shift can only be demonstrated with a 50 year plan.

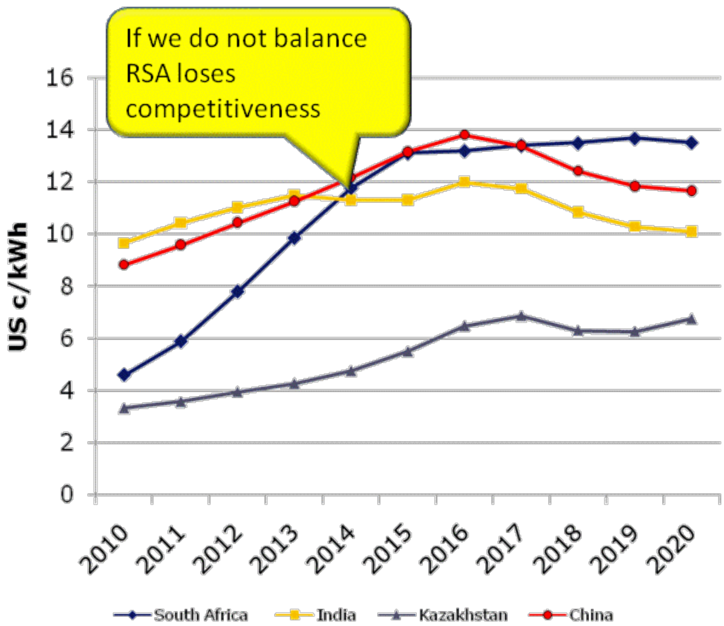
Affordability/Price (Indicative Price Paths)



The balanced scenario was able to achieve a price path very similar to the low cost scenario.

Notwithstanding, it is important to note that even at a 100c/kWh real price by 2020 will put South Africa in the top quartile (See next graph) of countries who are our competitors in the beneficiation of minerals.

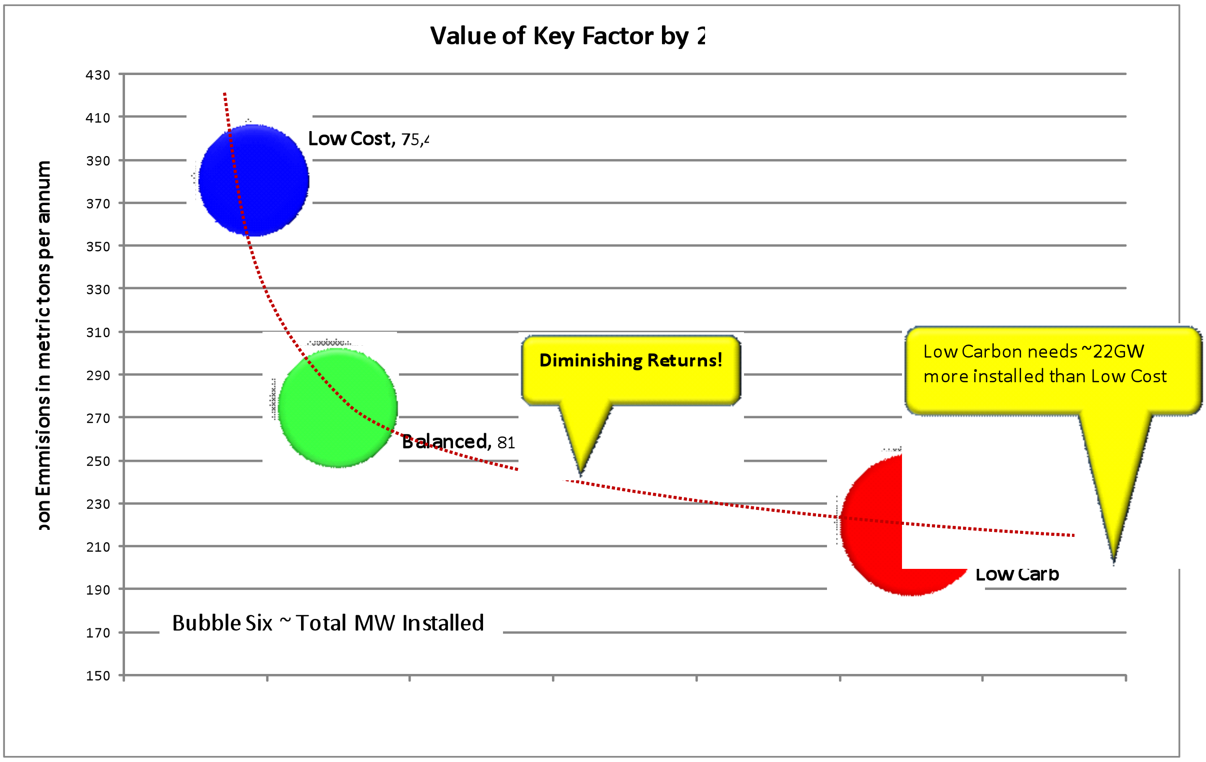
RSA beneficiating competitiveness (Industrial electricity pricing comparison 2010-2020)



Source: XTA Commissioned Frost and Sullivan Model

There is a real risk that if mineral beneficiation in South Africa stagnates or contracts due to high prices, this will lead to stranded new generating capacity which in turn will cause prices to rise even higher for remaining consumers to make up the loss of revenue.

Balancing Affordability, Price and Carbon (Diminishing returns on carbon reduction)

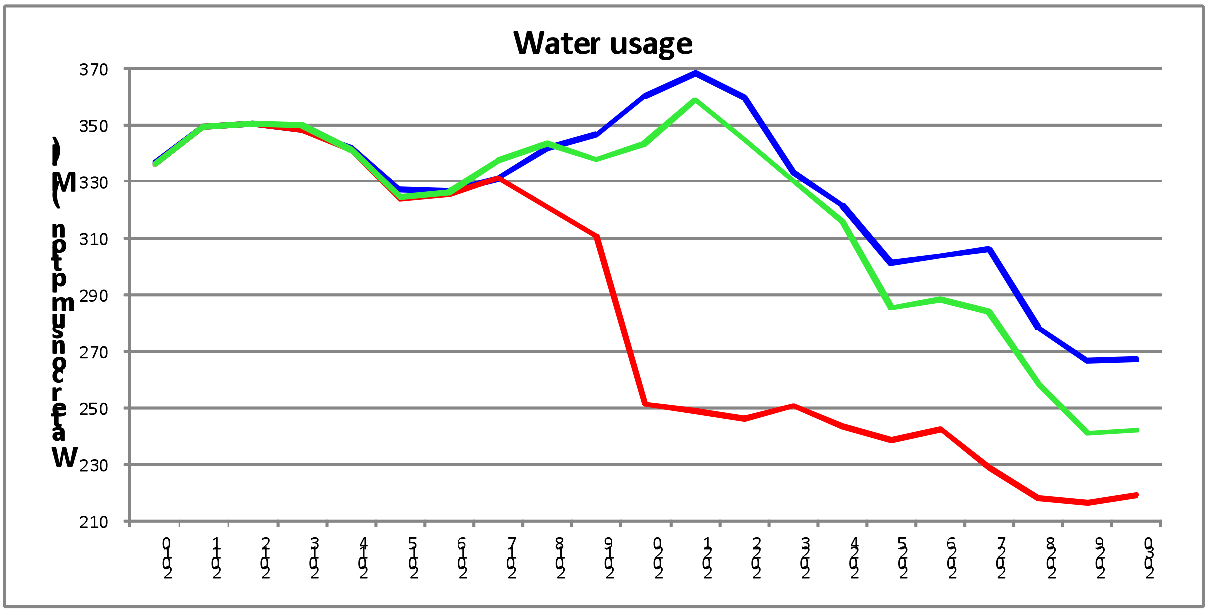


The graph above clearly shows the inherent diminishing returns on carbon reduction.

Nonetheless, it is possible that the high cost of carbon reduction today could come down in the future.

The Revised Balanced Scenario provides for an expansion plan that balances the requirements for reduced greenhouse gas emissions with future electricity prices, requirements for localisation and regional development, amongst other criteria. This provides a basis to reach the upper bound of the range of emission targets for the electricity sector, but does not provide for the full scope of the Copenhagen targets. The Copenhagen commitment included the proviso that these commitments must be met with international financing. The Revised Balanced Scenario provides a good foundation to meet the minimum or starting position for a low carbon future, but international financing support will be required to enable South Africa to develop more renewable options and thus meet the commitments.

Water (Total water consumption trends)



The water consumption by the electricity industry is reduced over the period by each programme, including the low cost scenario.

As mentioned earlier it must be borne in mind that IRP 2010 only sees the retirement of ~25% of the existing Eskom generating fleet and whilst this plan clearly shows a shift towards lower water consumption the full extent of this shift can only be demonstrated with a 50 year plan.

9. CONCLUSIONS

Government targets for emission reduction create the situation where the lower cost scenarios are not favoured as these continue the "business as usual" trend of carbon emissions. In order to meet these targets, a scenario that reduces absolute, as well as relative, carbon emissions was modelled. However it is important that these reductions in carbon emissions should be offset against the additional cost to the electricity consumer that would result from more expensive capacity. The Revised Balanced Scenario provides for a significant reduction in carbon emissions while allowing only a marginal increase in the price to the electricity consumer. Importantly the Revised Balanced Scenario provides for localisation of renewable technologies by establishing the grounds for a stable programme of capacity increase from renewable technology in the medium term.

This increase in renewable capacity does not come at the expense of security of supply as additional capacity is constructed to cater for lower capacity credits from renewable energy. Regional development does pose a minor risk to security of supply, especially where options are clustered around one source of fuel/power (e.g. the increased reliance on the Zambezi River) and too concentrated in one neighbouring country.

Due to the nature of the electricity industry, it is important that least-regret decisions are taken to secure supply for the next 10 years while technology evolution and growth trajectories are monitored and plans are modified as options appear. The following decisions need to be made this year:

- A commitment to current build programme by Eskom (12 GW).
- The conclusion of the first phase of the renewable energy feed-in tariff programme (up to 1025 MW).
- The support of co-generation and own generation options in the next 7 years to support security of supply and shift to lower intensity economy (up to 1500 MW).
- The conclusion of the Department of Energy Open Cycle Gas Turbine project (1000 MW).
- The renewable energy programme consisting of on-shore wind of up to 4.3 GW by 2019 and solar power of up to 600 MW by 2019. Choices after 2019 will be based on technology maturity and pricing. This will be supported by smaller projects in other renewable technologies such as landfill and mini-hydro projects.
- A commitment to regional development by developing the Mpanda Nkua project in Mozambique and being the counterparty to the power purchase agreement.
- Feasibility studies to develop a gas infrastructure in South Africa to support power generation and other uses.

- While nuclear power has been included from 2023, the decision to go for this option must be finalised as quickly as possible.
- Procurement process to support the commitment to a nuclear fleet programme by 2022.

The Revised Balanced scenario provides for some additional capacity until 2022 to cater for delays in implementation or cancellation of some of the programmes. However large scale deviations from the plan, in particular the nuclear fleet programme, pose a significant risk to security of supply. After finalising the IRP a mitigation strategy will be developed to consider alternatives. The IRP is regularly revised and changes can be incorporated if identified in time.

10. RECOMMENDATION

The scenario evaluation process confirmed that the “Revised Balanced Scenario” represents a fair and acceptable balance considering the divergence in stakeholder expectations and key constraints and risks, including:

- Affordability/Funding availability
- Reducing carbon emissions
- New technology uncertainties such costs, operability, lead time to build etc
- Water usage
- Job creation
- Security of supply

The IMC is requested to approve the commencement of the last round of public consultation, based on the “Revised Balanced Scenario” as set out in this report.