Repositioning electricity planning at the core: An evaluation of South Africa's Integrated Resource Plan

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ABBREVIATIONS

c/kWh	Cents per kilowatt-hour
COUE	Cost of unserved electricity
CSIR	Council for Scientific and Industrial Research
DoE	Department of Energy
DPE	Department of Public Enterprises
EIUG	Energy Intensive Users Group of Southern Africa
EPRI	Electric Power Research Institute
ESI	Electricity supply industry
GDP	Gross domestic product
GW	Gigawatt
IEP	Integrated Energy Plan
IPP	Independent power producer
IRP	Integrated Resource Plan
IRP 2010	Integrated Resource Plan for Electricity 2010-2030
ISMO	Independent Systems and Market Operator
kW	Kilowatt
LCOE	Levelised cost of electricity
MTRMP	Medium Term Risk Mitigation Project for Electricity in South Africa (2010 to 2016)
MYPD	Multi Year Price Determination
MW	Megawatt
NDP	National Development Plan: Vision for 2030
Nedlac	National Economic Development and Labour Council
NERSA	National Energy Regulator of South Africa
NGP	New Growth Path
R	South African rand (ZAR)
REIPP	Renewable Energy Independent Power Producer
SO	System Operator
TIPS	Trade and Industrial Policy Strategies
TWh	Terawatt-hour
US$	United States dollar (USD)

EXECUTIVE SUMMARY

Energy and electricity issues in particular have been high on the South African agenda since the 2008 crisis, which saw the country's national power utility Eskom implement rolling load shedding and cut supplies to a number of large customers, such as mines and minerals beneficiation plants. As South Africa experienced in 2014 the most stringent power cuts since 2008, reviewing the current electricity planning process is both a timely and necessary exercise. This review, based on an internationally-recognised framework, unpacks the key pillars of the Integrated Resource Plan (IRP) and reviews South Africa's performance. The objective is to provide a comprehensive overview of the key elements of successful electricity planning and to use this framework to reflect on the country's opportunities and challenges for optimal planning and implementation.

Ensuring a reliable and affordable supply of electricity is at the core of every country's development. National electricity planning, as part of energy policy, has emerged internationally as the most effective and efficient framework to shape the development of the electricity supply industry (ESI). Many governments globally have embedded electricity planning into a larger plan known as an Integrated Resource Plan. The design of an IRP aims at meeting the estimated demand in a specific period in the most affordable and efficient manner, also taking into account issues of equity, environmental protection, reliability and other country-specific goals. In brief, the IRP should provide a means for minimising the present and future costs of meeting energy demand considering the impacts on utilities, government, the environment and society.

In South Africa, electricity planning has been spearheaded by the Department of Energy (DoE) since 2009 through the elaboration of the country's own IRP. The IRP is one of the key energy planning processes in South Africa. In essence, it is a subset of the Integrated Energy Plan (IEP), which looks at guiding and developing energy policy and the framework for the regulation of the energy sector as a whole. The Integrated Resource Plan for Electricity 2010-2030 (IRP 2010) (DoE, 2011), South Africa's current and first fully-fledged IRP, adopted in March 2011 (and promulgated in May 2011), lays out the country's proposed generation fleet for the 2010-2030 period. It is considered a "living plan" and an update of the IRP 2010 was published in November 2013 for public comments (DoE, 2013a). The next fully-fledged iteration of the IRP process will, however, only occur once the ingoing IEP process is finalised (i.e. probably early 2015), so as to be adequately informed by the broader framework.

The role and importance of the IRP process cannot be overstated. Appropriate governance is instrumental in establishing an effective electricity market and achieving widespread access to sustainable and affordable energy. Planning directly impacts both electricity supply and pricing. The role of planning in the energy market and electricity supply of the country is instrumental in ensuring the adequate supply of electricity. This is also shaped by the structure of the electricity market in South Africa, which is dominated by the national state-owned utility. Planning impacts on security of supply in two key ways: first through the timing and scale of expansion and maintenance decisions, and second through delays in construction, as exemplified by the commissioning of the large-scale coal-fired power stations Medupi and Kusile. Both problems have impacted on the security of supply in South Africa, with evidence that the delayed, mammoth expansion plan started in the 2000s is not the first time that the lack of adequate planning has resulted in a flawed pattern of investments.

Beyond supply concerns, policy and planning decisions have had considerable detrimental consequences on electricity pricing. This is mainly due to a repeated pattern (in the 1970s and the mid-2000s) of Eskom's large and lumpy generation expansion investment decisions, and is compounded by expensive technology and construction choices as well as the transition towards cost reflective tariffs with the implementation of the multi-year price determination (MYPD) mechanism.

Electricity planning, or the lack thereof, has been at the core of these direct linkages in South Africa. Going forward, the institutionalisation of the IRP process is expected to maximise the positive interplay between planning, security of supply and affordable and stable prices in South Africa. Reviewing the country's planning process therefore constitutes a necessary step to achieving this ambitious objective.

As defined by the World Resources Institute and Prayas Energy Group (Dixit *et al*., 2014), an effective IRP is composed of 10 essential elements: 1) planning process; 2) plan objectives; 3) review of previous plans; 4) demand forecast methodology; 5) resource options assessment; 6) policy instruments to achieve objectives; 7) regulatory and institutional frameworks; 8) investment financing; 9) social and environmental considerations; and 10) promotion of innovation and anticipation of emerging challenges. This paper reviews South Africa's IRP on the basis of the 10-point framework with the objective of shedding light on the role and the implications of planning on the country's electricity supply and pricing. This represents the first attempt at applying this international framework to the South African context.

Overall, the South African IRP performs relatively well against the 10-criteria analytical framework, although some clear areas of improvements remain. The institutionalisation of the planning process since 2009, through the IRP, has brought considerable progress to electricity generation planning in South Africa and further ameliorations are expected with the next iterations of the IRP. Regular and timely updates of the IRP are therefore required to harness the full potential of the planning process. More effort and accountability is needed in this respect.

While South Africa has previously displayed an inability to capitalise on policy learnings in the energy space, the institutionalisation of the IRP process has started to address this shortcoming, notably with the 2013 update incorporating a review of assumptions and conditions in the IRP 2010. Unlike previous planning exercises, the IRP also achieves mobilising the necessary data and information from relevant stakeholders to conduct an adequate and meaningful planning process. The institutional arrangements around the planning process have indeed been improved under the leadership of the DoE, although much progress is needed to streamline the regulatory and institutional framework of the ESI as a whole. Information asymmetry problems (in favour of the utility), politicised decision-making processes, and a lack of clarity on the responsibility of each institution need to be addressed. Labour and civil society are also clearly missing from the decision-making process of the IRP and should be included for increased transparency.

At a policy level, the IRP has problematically been prioritised over its larger IEP due to the 2008 electricity crisis. This has had implications for the broader energy planning framework in the country, resulting in a project-based approach to planning instead of a broad-based, integrated approach based on longer-term sustainability and vision. This should be resolved with the completion of the IEP in the near future. This should also address the lack of articulation between the IRP and other higher-level policy and strategies. A long-term vision for the ESI beyond generation capacity should be developed in the country to replace the outdated 1998 Energy White Paper. This should include more clarity on the role of the private sector in the ESI, notably through the conclusion of the debate around the Independent System and Market Operator (ISMO) Bill. While it is arguably not the function of the IRP to design the institutional structure of the ESI as a whole, it is well positioned to bring more clarity and certainty in terms of regulation and the institutional framework and should formulate recommendations that address this.

The planning process rightfully prioritises security of supply as the core energy mandate of the IRP, followed by cost and climate change considerations. The potential to better align numerous, conflicting objectives of the IRP and consider other sectors and development goals exists. Notably, environmental and social impact assessments are globally missing and constitute one of the major downfalls of the IRP process. The constraint on greenhouse gas emissions appears insufficient to be compatible with South Africa's international commitment and environmental and social issues are only partially addressed (such as water usage) or lacking (such as air pollution, gender issues and rural development). Similarly, the economic and financial impacts of the proposed generation mix should also be given more attention. Even though the IRP provides a projection of expected electricity prices and a brief description of the potential financing sources, the IRP lacks a clear budget plan.

Altogether, while the overall supply mix remains contentious, sound scenario-based methodologies are used to determine most optimal choices for South Africa, and try to attain the best trade-off between least-investment cost, climate change mitigation, diversity of supply, localisation and regional development. The strength of the IRP lies in providing the policy options relevant to the electricity sector with a good degree of flexibility and adaptability. The risk assessment of implementing the plan, sensitivity analyses on assumptions, and the decisions trees included in the 2013 update provide useful insights to guide the implementation in terms of policy choices. The introduction of the principle of least regret decisions is a key development of the IRP that will improve the policy options and choices going forward. In addition, assumptions and data used in the IRP, although always debatable (particularly gross domestic product (GDP) growth forecast), are publicly disclosed and discussed as part of an effective consultation process, and the IRP planning process is clear and transparent in the demand forecast methodology and the consideration of all resources options, although more could be done to promote innovation. Nevertheless, further research on the price elasticity of demand should be conducted to better inform long-term forecasts. In addition, the IRP does not particularly deal with the implementation mechanisms required and the rules and regulations for implementing the IRP remain unclear. Similarly, potential constraints at a human and institutional level are not considered adequately.

In brief, the assessment provides a clear picture of the progress achieved in the last few years and the goals for the next iterations of the IRP. The assessment of the performance of the South African IRP against the proposed assessment framework, in both areas of success and progress, positions the current IRP as a good first attempt and a valuable starting point for the next iteration of the planning process. Going further, for the assessment to be complete, the implications of the performance of the IRP process for its ability to achieve its objectives are discussed.

Ultimately, like energy policy, the IRP is also tasked with too many conflicting objectives and therefore fails to contribute meaningfully on several fronts. The priority of the IRP rightfully remains the country's security of supply, although this has been compromised due to implementation problems. Besides electricity security, the impact of energy planning on other national objectives has thus been secondary and the priorities assigned to the IRP should be streamlined and sequenced to maximise positive spillovers. By trying to achieve too many objectives at the same time, electricity planning risks on failing on all, and greater prioritisation is needed. As such, the contribution of the IRP, and energy policy as a whole, to peripheral objectives (social, environmental, industrial) has been marginal and is expected to remain so until security of supply is achieved.

Going forward, further efforts to perfect the design of the IRP are needed, notably its regular and timely update. Ensuring that the IRP appropriately introduces the most recent and efficient technologies in line with the country's economic, social and environmental objectives should be one of the priorities. In addition, further integration with other national policies and strategies, and particularly the IEP and other energy-related plans, should be prioritised. Further work is required to conceptualise and establish the optimal policy and institutional arrangements and link the IRP exercise to an effective implementation plan as well as a monitoring and evaluation system. Much more effort is required to ensure the effective and timely implementation, monitoring and evaluation of the IRP. Without an adequate and enforceable execution plan, the IRP remains a theoretical exercise. In this respect, institutional and regulatory arrangements hampering the implementation of the IRP, notably in the short term, must be addressed as a matter of urgency. Only then will electricity planning be able to meaningfully contribute to the sustainable development of South Africa.

1. INTRODUCTION

Energy and electricity issues in particular have been high on the South African agenda since the 2008 crisis, which saw the country's national power utility Eskom implement rolling load shedding and cut supplies to a number of large customers, such as mines and minerals beneficiation plants. As 2014 saw the introduction of the most stringent power cuts since 2008, reviewing the current electricity planning process by analysing the compiling and implementation of South Africa's Integrated Resource Plan (IRP) is both a timely and necessary exercise. This review, based on an internationally-recognised framework, unpacks the key pillars of the IRP process and reviews South Africa's performance against this framework. The objective is to provide a comprehensive overview of the key elements of successful electricity planning and to use this framework to reflect on the country's opportunities and challenges for optimal planning and implementation.

Ensuring a reliable and affordable supply of electricity is at the core of every country's development. National electricity planning, as part of energy policy, has emerged internationally as the most effective and efficient framework to shape the development of the electricity supply industry (ESI). Electricity infrastructure projects (in terms of generation, transmission and distribution) are capital-intensive, long-term investments with relatively long lead and construction times and deeply-rooted consequences for local economic, social and environmental structures. Owing to the amount of investment required and the long latency between planning and delivery, the timing and scale of electricity infrastructure investments must be in line with the growth projections for the country and the needs of all users. By integrating and structuring electricity projects, planning aims to ensure security of supply, while minimising costs and considering the impacts on government, utility companies, business, labour, society and the environment.

Many governments globally have embedded electricity planning into a larger plan known as an Integrated Resource Plan. The design of an IRP aims at meeting the estimated demand in a specific period in the most affordable and efficient manner, also taking into account issues such as equity, environmental protection, reliability and other country-specific goals. In brief, the IRP should provide a means for minimising the present and future costs of meeting energy demand considering the impacts on utilities, government, the environment and society.

In South Africa, electricity planning has been spearheaded by the Department of Energy (DoE) since 2009 through the elaboration of the country's own IRP. The role of the IRP is to provide the roadmap for the technology choices and timeframes around which electricity planning and implementation is to take place. The IRP is one of the key energy planning processes in South Africa. In essence, it is a subset of the Integrated Energy Plan (IEP), which guides and develops energy policy and the framework for regulating the energy sector as a whole. It also guides the selection of the appropriate technologies for meeting energy demand in the country, and investments and infrastructure decisions. The IEP takes into account other high-level government policies, such the National Development Plan: Vision for 2030 (NDP) (NPC, 2011) and the New Growth Path (NGP) (EDD, 2010). However, the interaction between the IRP and IEP planning processes and the order in which these policy documents have been finalised remain a point of contention that will be explored in this paper.

Prior to the current IRP process, a traditional approach to planning in the electricity sector applied in South Africa. Three separate plans were developed respectively by the national state-owned utility Eskom (i.e. Integrated Strategic Electricity Plans), the then-Department of Minerals and Energy (i.e. Integrated Energy Plans) and the National Energy Regulator of South Africa (NERSA) (i.e. National Integrated Resource Plans) (Newbury & Eberhard, 2008). This approach, which was driven by the utility planner's projections of future demand and expansion of its supply to meet anticipated demand (Dixit *et al*., 2014), has been criticised for often resulting in excess electricity capacity and higher-than-necessary energy costs, as it has been the case in the history of South Africa's generation expansion decisions (Das Nair, Montmasson-Clair & Ryan, 2014).[1] This was compounded by a previous lack of investment in ESI and higher-than-anticipated growth in the early 2000s (Seymore, Akanbi & Abedian, 2012). Since 2009 and the shift in mandate to the DoE, the design and implementation of energy planning in the country, while remaining imperfect, have substantially improved.

South Africa's IRP, promulgated in its first version (IRP 1) on 31 December 2009 and revised on 29 January 2010, covered the 2009-2013 period and planned for the development of an IRP for the 2010-2030 period. The Integrated Resource Plan for Electricity 2010-2030 (IRP 2010) (DoE, 2011), South Africa's current and first fully-fledged IRP, adopted in March 2011 (and promulgated in May 2011), lays out the country's proposed generation fleet for the 2010-2030 period. The South African IRP is considered a "living plan" and an update of the IRP 2010 (DoE, 2013a) was published in November 2013 for public comments. The next fully-fledged iteration of the IRP process will, however, only occur once the ongoing IEP process is finalised (i.e. probably early 2015), so as to be adequately informed by the broader framework.

The IRP 2010 was adjusted from a cost-optimised scenario developed under a carbon emission constraint for the power sector, incorporating localisation objectives and bringing forward the roll-out of renewable energy technologies. In addition to all existing and committed generation capacity,[2] the plan includes 17.8 gigawatt (GW) of renewable energy-based generation, accounting for 42% of all new build generation to 2030 (42.6 GW). Nuclear energy (9.6 GW) and coal (6.3 GW) also account for substantial shares of the new generation capacity considered under the IRP. The plan additionally takes into account a total of 3 420 megawatt (MW) saved due to energy efficiency demand-side management.[3]

The IRP process is taking place on the back on security of supply issues and stringent electricity price increases. Following generation capacity constraints, the South African government, through Eskom, started in 2005 (i.e. before the design of the IRP 2010) a mammoth generation expansion programme valued at R340 billion (about US$31 billion),[4] excluding capitalised borrowing costs.

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[1] Annexure 1 conceptualises this history by summarising the key events in the ESI from 1970.

[2] In 2010, South Africa's total electricity supply stood at 41.8 GW (including imports). In addition, a total of 12.15 GW of supply capacity was already committed. Considering both existing and committed supply capacity, South Africa's ESI is heavily reliant on coal-fired power plants (at 90%), followed by hydroelectricity and nuclear energy (at about 5% each). This includes the two upcoming mega coal-fired power plants, Kusile and Medupi, accounting for an additional 4 800 and 4 788 MW respectively (DoE, 2011; EIA, 2014).

[3] See Annexure 2 for more details on the proposed generation plan under the IRP 2010 and the 2013 update.

[4] An exchange rate of US$1 for R11 is used in this paper, in line with the foreign exchange markets in November 2014.

By 2018/2019, the programme will add 17.1 GW of capacity to the 2005 nominal generation capacity of 36.2 GW (Eskom, 2013). The financing requirements of this major investment programme have contributed to pushing prices up, and is expected to result in a trebling of the average electricity price at 89.13 cents per kilowatt-hour (c/kWh) from 2009/2010 to 2017/2018 (NERSA, 2010; 2013).

In order to better grasp the implications for South Africa's economic, social and environmental structures of these recent (and future) investment decisions, reviewing and analysing the elaboration and implementation of the existing IRP is an essential exercise.

As defined by the World Resources Institute and Prayas Energy Group (Dixit *et al*., 2014), an effective IRP is composed of 10 essential elements: 1) planning process; 2) plan objectives; 3) review of previous plans; 4) demand forecast methodology; 5) resource options assessment; 6) policy instruments to achieve objectives; 7) regulatory and institutional frameworks; 8) investment financing; 9) social and environmental considerations; and 10) promotion of innovation and anticipation of emerging challenges.

This internationally-recognised 10-criteria framework is aimed at rendering decision-making processes more transparent and enabling greater engagement in the electricity sector.[5] It is targeted at building capacity of electricity sector stakeholders, including government agencies, regulators, utilities, the private sector, civil society and others, in terms of the design and participation in policy-making and implementation processes. The analysis is structured to capture the critical features and complexities around resource planning, and can be used as part of the planning process and in evaluating the IRP.

In this case, the evaluation is a focal point. This paper reviews South Africa's IRP on the basis of the 10-point framework with the objective of shedding light on the role and the implications of planning on the country's electricity supply and pricing. This represents the first attempt at applying this international framework to the South African context. The paper is structured as follows. Section 2 discusses the role and implication of planning for electricity supply and pricing in South Africa. Section 3 assesses the South African IRP process against the 10-criteria analytical framework. Section 4 reflects on the meaning of the assessment on the key objectives of energy policy. Section 5 concludes.

[5] While the 10-criteria framework developed by the World Resource Institute and Prayas Energy Group is not the unique assessment tool available (see, for example, The Tellus Institute, 2010; Wilson & Biewald, 2013), it has been chosen for its comprehensive, rigorous and practical design.

2. IMPLICATIONS OF PLANNING: HOW DOES PLANNING IMPACT ELECTRICITY SUPPLY AND PRICING IN SOUTH AFRICA?

Energy, and electricity in particular, is central to economic development and to fighting South Africa's triple challenge of poverty, unemployment and inequality. Appropriate governance, of which planning is a component, is instrumental in establishing an effective electricity market and achieving widespread access to sustainable and affordable energy in South Africa and globally. In the absence of effective competition (as a result of high barriers to entry and vertical integration into the natural monopoly parts of the value chain), government involvement in the ESI remains crucial and necessary. In addition, a strong regulatory environment, from a governance and content perspective, is essential to capture the economic efficiency benefits associated with introducing competition into specific areas (such as generation). Government's primary task is to design and implement robust institutional arrangements, well-designed policy frameworks and an independent regulator, including policies and directives stipulating how independent power producers (IPPs), Eskom and municipal distributors should be governed and also how they should account to the government (Newberry & Eberhard, 2008). In light of the structural impacts of regulation on electricity supply and pricing, the role of the DoE in steering this process is thus critical, particularly in the design and implementation of planning policies, such as the IEP and the IRP.

Planning directly impacts both electricity supply and pricing, through the selection of technologies, the scale of their application as well as the timing and costs involved in commissioning and building additional generation capacity. Planning involves not only decisions around new capacity but also the maintenance and decommissioning of existing and future power plants, as well as the financing and development of associated transmission and distribution networks. The broader considerations around social and environmental impacts of electricity planning and prices are also critical for a sustainable electricity supply.

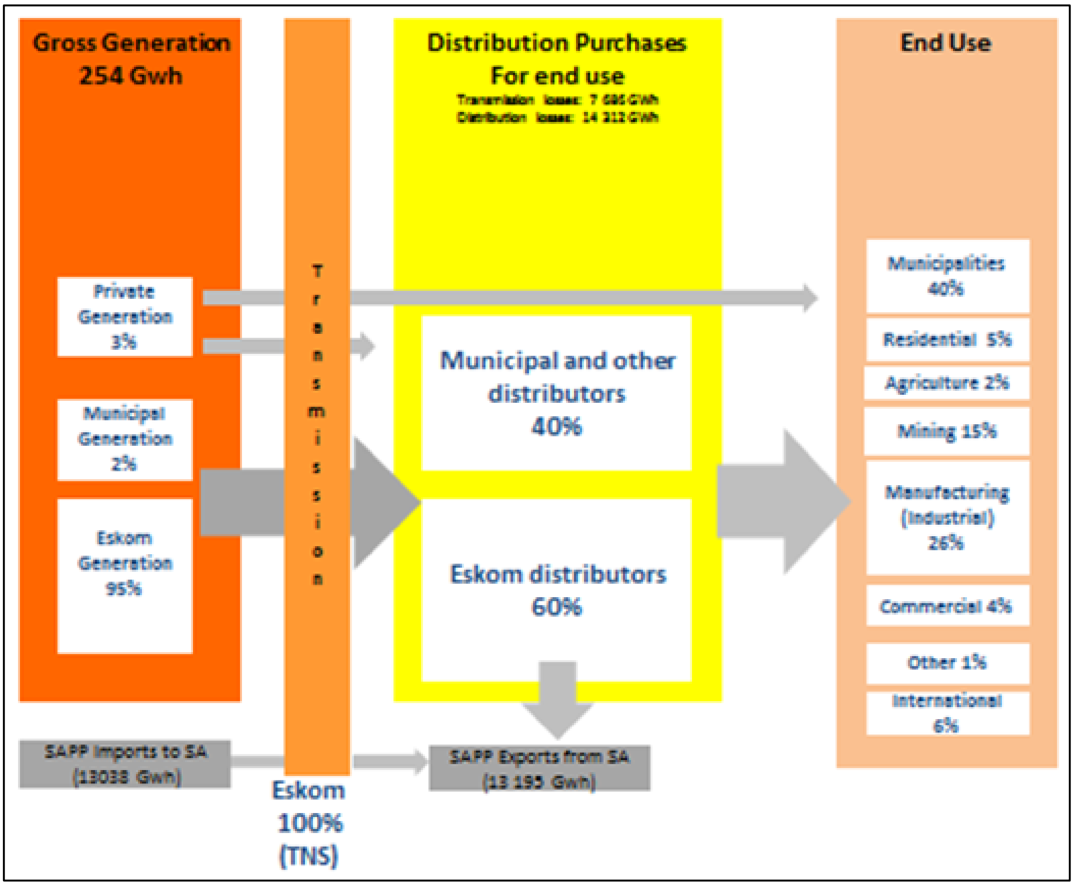
Impact on electricity supply

First and foremost, the role of planning in the energy market is ensuring the adequate supply of electricity. This is also shaped by the market structure of the electricity market in South Africa, which is dominated by the national state-owned utility. This monopolistic structure, a global feature of electricity industries prior to the 1990s, has persisted. As many other countries have reformed their ESI to introduce more competition, as explained in Box 2, South Africa has maintained the dominance of the national utility. Eskom operates across the entire electricity value chain, i.e. generation, transmission and distribution. As illustrated in Figure 1, Eskom generates 95% of the electricity consumed in the country with IPPs representing a small portion of electricity generation. In the medium term, a capacity target of an additional 42 GW by 2030 has been set to meet the demand of the ESI (DoE, 2013a).

Planning impacts on security of supply in two key ways: first through the timing and scale of expansion and maintenance decisions, and second through delays in construction. Both problems have impacted on the security of supply in South Africa. Evidence shows that the expansion plan started in the 2000s replicates the pattern witnessed in the 1970-1980s, when the lack of adequate planning resulted in a flawed pattern of investments.

Policymakers only realised from 2002 that installed generation capacity was insufficient to service current and future demand comfortably, while experts were unanimous that investment in additional capacity should have be initiated in the early 2000s to avoid the tightening of the supply-demand balance from 2006 and the associated significant load shedding. Indeed, the "forward reserve margin declined from about 30% in 1998, to 13.6% in 2002, and just over 10% in 2003, indicating a very tight demand-supply balance" (Kessides, Bogetic & Maurer, 2007). The delay in planning directly resulted in insufficient generation capacity and South Africa experiencing an unprecedented number of power outages from 2006 to 2008, with severe economy-wide implications for the country.

Figure 1: Structure and flow of electricity in South Africa in 2012

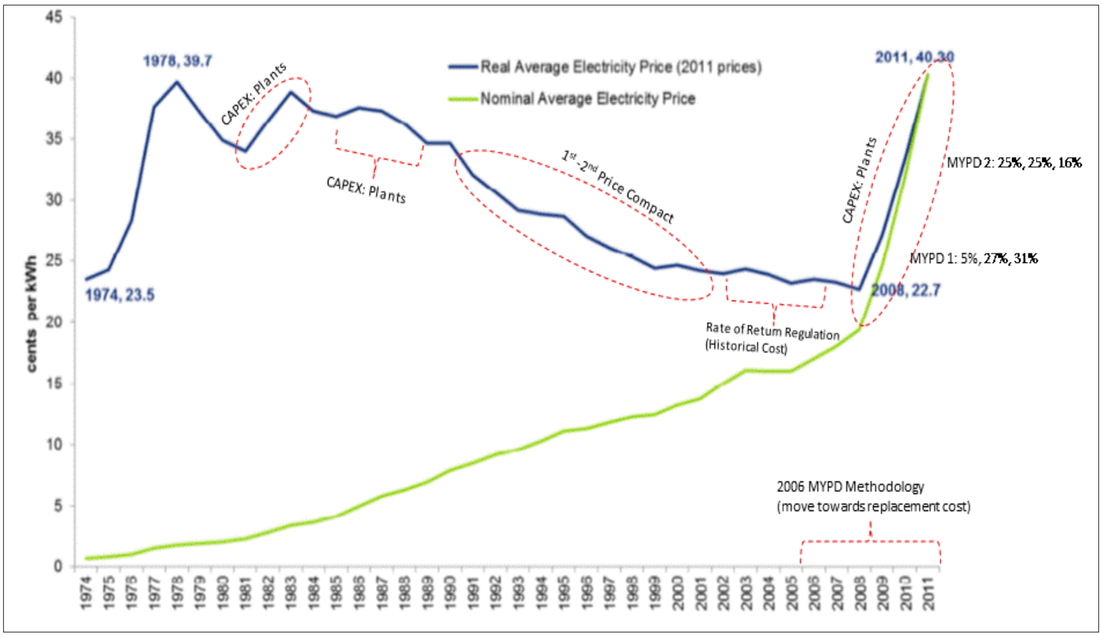


Source: Das Nair, Montmasson-Clair & Ryan, 2014

Note: SAPP: Southern African Power Pool; TNS: Transmission Network Services

Two key government actions led to insufficient generation capacity: (a) placing a moratorium on Eskom to build power plants as the government envisaged a competitive market with private sector participation and (b) delays in contracting with IPPs. Cabinet passed a resolution in 2001 prescribing that 30% of Eskom's generation capacity should be sold to the private sector. This initiative failed to gain momentum and, in 2004, cabinet decided that 30% of new generation should then be built by the private sector. Private investment failed to materialise because of high regulatory risk, the then-Department of Minerals and Energy's protracted procurement process and low electricity prices. Looming supply shortages and long lead times needed to build plants caused the government to lift the investment moratorium placed on Eskom. As the moratorium ended in 2004, Eskom had lost four crucial years of construction time between 2001 and 2004. This delay has had a significant impact on the ESI, placing great strain on the country's electricity supply and creating a backlog in generation capacity building. This history illustrates that, irrespective of demand forecast methodology and other planning tools prior to IRP, policy planning and implementation challenges, compounded by the persistent dominance of Eskom in the electricity market, had significant consequences on the timing of further capacity expansion.

Figure 2: Average real and nominal electricity prices in South Africa between 1974 and 2011 (in Rand cents per kWh)



Source: TIPS, based on Deloitte (2012) and Eskom's data

Note: The average price is calculated by dividing sales revenue by total electricity sold and hence includes special pricing deals.

Eskom subsequently embarked on a mammoth expansion programme in 2005. While new investment was urgently required (particularly in light of the strong economic growth at the time), the timing and scale of the decision repeats a pattern in electricity planning witnessed in the 1970s and 1980s in the country. Figure 2 illustrates the key planning decisions which led to a significant volatility in electricity prices over time. Eskom has a history of over-investing in capacity, relative to demand. In the 1970s, Eskom invested heavily in the construction of power stations, which resulted in excess generation capacity, and a significant reserve margin (Steyn, 2003).

In 1974, Eskom initiated its massive build programme and, between 1974 and 1978, electricity prices increased by approximately 70% to finance construction activities (Deloitte, 2012). Brownouts and blackouts continued despite the investment in additional capacity. Eskom misinterpreted the power shortages as a sign of insufficient capacity, when they were caused by project management problems that delayed the commissioning of plants. By the end of 1983, Eskom had commissioned an additional 22 260 MW of generation capacity doubling the operating capacity during that year. Additional capacity in the early 1980s pushed the reserve margin to around 40% in the early 1990s, compared to the industry standard of 20-25%. Even by conservative measures, based on the principle that the social cost of over-investment is small relative to the social cost of under-investment,[6] the scale of the capital expenditure programme between 1970 and 1980 was, according to a number of authorities, economically inefficient (Kessides, Bogetic & Maurer, 2007).

In addition to issues around the timing and scale of investment decisions, construction delays have had considerable impacts on the country's expansion programme and security of supply. The current expansion programme is largely dependent on the addition of two large coal-fired power stations, Medupi and Kusile,[7] which were originally scheduled to be finalised between 2014 and 2018. Despite the capital expenditure programme only beginning in 2006, construction is already three years behind schedule. The first unit of Medupi was scheduled to come online in April 2011, but has been pushed out to the end of 2014, whereas the completion of Kusile's first unit has been rescheduled from March 2012 to 2015. In 2013, Eskom cautioned end-users against a potential gap in supply[8] in 2014 resulting from construction delays at Medupi. This delay is partly due to the Medupi project having been commissioned without a final design or funding model in place (Steyn, 2012), laying the foundation for a series of work-related faults. Insufficient project planning can also partially explain the delays in formalising and approving the policy framework to support Eskom's construction activities.

Both the lack of planning and construction delays have had disastrous consequences on electricity supply due to a very tight power balance. This was illustrated again in November 2014 with the implementation of load shedding as a result of the unexpected collapse of one of the three coal storage silos at the Majuba power station. The 4 110-MW power plant lost significant capacity overnight due to this technical and operational failure, reducing its output from 3 600 MW to 1 800 MW and consequently functioning at only 600 MW the following day (Eskom, 2014a). While such an incident falls outside of the scope of normal risk considerations, particularly because the Majuba Power Station is one of the youngest commercially-operated power stations in Eskom's fleet, it has had a detrimental knock-on effect on the entire ESI due to the current very low reserve margin.

[6] The cost of having a cushion in place to ensure constant supply of electricity is considered as an insurance premium that end-users are prepared to pay to guard against not having access to electricity (i.e. the cost of unserved energy). As a result, "the optimal market equilibrium with respect to capacity and reserve margin is not reached much of the time" (Kessides, Bogetic & Maurer, 2007: 22).

[7] Medupi will produce 4 764 MW of power, making it the largest dry-cooled coal-fired power station in the world. Kusile will be the third largest coal-fired power station in the world, producing 4 800 MW of power from six units of 800 MW each.

[8] This supply gap will be temporary as Eskom expects more than 3 800 MW of new capacity online by 2015, from the Medupi, Kusile and Ingula power stations and the Sere wind farm.

Impact on electricity pricing

Beyond supply concerns, policy and planning decisions have had considerable consequences on electricity pricing in South Africa, through investment and technology choices, pricing regimes and the valuation of investments in the ESI. This is mainly linked to a repeated pattern (in the 1970s and the mid-2000s) of Eskom's large and lumpy generation expansion investment decisions and the move towards a cost reflective pricing methodology (due to political decisions to suppress electricity prices in the 1990s, the price path of electricity has historically not been in line with the cost of producing electricity). When new generation capacity needed to come online to cater for increased electricity demand, the price of electricity spiked substantially, with increases well above inflation. This has been exacerbated by costly construction delays in recent years.

Steyn (2003; 2006; 2012), Newbury & Eberhard (2008), Pickering (2010), Eberhard (2012) and Storer & Teljeur (2003) agree that the primary driver of electricity price movements historically has been Eskom's investment decisions (especially the type of technology selected and the scale of build), Eskom's financial policies, and administrated price-setting methodologies. Current price spikes are traced back to Eskom's sub-economic investment decisions in the late 1970s and the system which allowed the utility to externalise the cost of its poor investment decisions. Hence, the starting point to understand the dynamics driving the formation of prices in the future lies in analysing past price movements.

For several decades prior to 2008, South African households and industries paid extremely low prices for electricity as a result of a strategic decision by government to keep prices artificially low (selling excess capacity generated) and later not adjusting electricity prices to reflect true costs. However, the electricity supply interruptions in 2008 confirmed fears that underinvestment in electricity generation capacity by national power utility Eskom and weak management of coal stocks would have a strong negative impact on economic growth, and the need for additional generation capacity (Altman *et al.*, 2010).

At the same time, a new pricing approach was introduced in the form of the MYPD mechanism to ensure a smoother and more certain pricing path. In 2005, NERSA implemented its first MYPD process, covering the period from April 2006 to March 2009.[9] In line with government's 2008 Electricity Pricing Policy (DME, 2008) which states that tariffs would be cost-reflective in five years (i.e. 2013), NERSA then initiated a shift in pricing methodology, from historical costs to depreciated replacement costs.[10] Prior to the MYPD 2 (covering the 2010/2011-2012/2013 period), Eskom's regulatory asset base[11] was valued using the historical cost approach.

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[9] The regulator granted Eskom a price increase equivalent to the consumer price index plus 1% for the period, maintaining a pricing methodology still not cost reflective.

[10] While inflation-indexed regulated revenue is equal to historical cost regulation in terms of full lifecycle cost recovery, it is far superior in terms of tariff stability. Inflation-indexed financial reporting furthermore facilitates a more realistic assessment of a regulated entity's financial situation and constitutes a much improved indication of the requirement for future tariff adjustments (Joubert, 2012).

[11] In 2011, as part of the final review of the MYPD methodology, the regulatory asset base was defined as including existing assets Eskom uses to generate electricity, new investment in assets, any assets under construction as part of the new build and expansion programme, and working capital to meet short-term obligations (NERSA, 2011: 13).

After a multi-stakeholder investigation comparing the strengths and weaknesses of the historical cost method and depreciated replacement cost method, NERSA adopted the depreciated replacement cost method in 2008 in order to attain more cost reflective prices. This decision aimed to take into account that Eskom had initiated a massive capacity expansion programme valued at double the value of the assets on its balance sheet[12] and that revenue from electricity sales would need to fund a significant portion of the capital expenditure programme.

Box 1: Municipalities and their role in the South African electricity market

In addition to Eskom-related price increases, municipalities, which are among the largest buyers of bulk electricity in South Africa, on-selling to commercial and residential customers, allegedly add significant margins on electricity prices. Municipalities are responsible for the transmission of over 40% of electricity to end users. While Eskom is the provider of electricity to large customers and more rural and remote areas, municipalities supply a larger base of customers. This has negatively affected the competitiveness of smaller industries that rely on municipality-supplied electricity (such as the foundry industry and small fabricators). Between 25% and 60% of the total revenue earned by certain municipalities is alleged to be from the on-sale of electricity. Revenues from electricity thus form one of the main revenue streams for municipalities, creating perverse incentives to apply mark-ups on electricity prices at the expense of consumers and the development of local industry. In addition, the non-standardised cost accounting methods of municipalities, which informs the tariff application to NERSA, compounds this problem.

Based on the constitutional mandate, which grants municipalities the executive authority, and the right, to administer electricity reticulation, the Local Government Municipal Systems Act No. 32 of 2000 prescribes the principles for the determination of tariffs by municipalities, *de facto* allowing municipalities to set electricity prices within their jurisdiction. While the Municipal Finance Management Act No. 56 of 2003 Act provides for the National Treasury to monitor the pricing structure for the supply of electricity by municipalities, the Municipal Fiscal Powers and Function Act No. 12 of 2007 authorises local governments to impose surcharges over and above NERSA's price determination.

Additionally, urbanisation and the migration of populations within the country have put a considerable strain on municipalities in providing electricity to local communities. It can be argued that rapid urbanisation and the massive challenge of infrastructure backlogs are significantly affecting the ability of municipalities to deliver electricity. This is compounded by a maintenance and refurbishment backlog estimated at R27 billion and growing at an estimated R2.5 billion per annum; and amounts owed to Eskom for electricity purchases totalling around R10.8 billion as at the end of June 2014. In the light of these challenges, improved planning and coordination that addresses the role of municipalities in electricity supply is critical.

Source: *Das Nair, Montmasson-Clair & Ryan, 2014*

[12] In 2006, the book value of Eskom's generation capacity was R24.7 billion (US$2.2 billion) for 39 810 MW, whereas the asset value of a single 4 000 MW plant was approximately R26 billion (US$2.4 billion) (Steyn, 2006).

This methodological change has had direct implications on electricity pricing due to the domination of the cost of generation assets (i.e. the regulatory asset base) in the price calculation. Joubert (2012) shows that operational[13] and fuel costs represent less than 35% of the total lifecycle cost curve of a baseload coal-based plant, whereas the depreciation charge and pre-tax return on assets account for the remaining 65%. Also, a qualitative study conducted by Steyn (2012) supports the view that capital programmes have been the most important factors driving the increase in tariffs. "[T]ariff increases required in the power sector are, in the first instance, driven by the nature of the capital programmes power sector companies or municipalities commit to, [and] these decisions will thus be pivotal for future tariffs and essentially become the main driver of sector performance" (Steyn, 2012: 13). Lastly, Deloitte (2012) also found that Eskom's investment activities and financial policies are the main driver of electricity prices in South Africa, emphasising that the regulatory asset base and the weighted average cost of capital are the most important components of the MYPD methodology influencing future electricity tariffs.[14]

As part of the move towards a more cost reflective methodology, NERSA has also implemented a clawback mechanism, which allows NERSA to normalise Eskom's revenues factoring under-recovered or over-recovered revenues over a given tariff period. This clawback mechanism, implemented through a Regulatory Clearing Account, has far-reaching impacts for energy users, relying on the MYPD process for clarity and predictability of the electricity price path. While it creates an avenue for Eskom to recover unexpected costs, it alters the price initially determined through the MYPD process and makes the pricing path less predictable. For example, NERSA granted Eskom a 4.7% tariff increase in 2014 to recover R7.8 billion (US$0.7 billion) in unexpected costs over the 2010-2013 period (against a request from Eskom of R18.4 billion (US$1.6 billion)). This clawback will be implemented over the period running from April 2015 to March 2016, over and above the increase of 8% determined by the regulator initially. Since the delays and cost overruns associated with the building of new generation capacity currently drive the use of the clawback mechanism, further unexpected increases may occur in the near future (NERSA, 2014).

Ultimately, the shift in methodology has had deep implications for Eskom's required revenue, which in turn impacted its application in the MYPD process in terms of the rate of return required, eventually affecting electricity prices. The expansion programme and the new pricing methodology have therefore shaped the price path of electricity in the last few years with significant price increases since 2007, leading to a public outcry by both residential and industrial customers alike. While NERSA should have phased in the revaluation of Eskom's regulatory asset base from historical to depreciated replacement cost by 2013, this process had not been completed as of 2014 due to the need to smooth the price increases over time and consequently electricity prices are not as yet fully cost reflective.

[13] According to Joubert (2012: 16-17), "operational cost however is mostly a fixed cost hence the absorption into a cost-per-unit could be vulnerable to fluctuations in total annual production volume. This too would in practice not present a major source of price instability due to the stable annual production volumes typical of base load power stations (and, at a total national generation system level, base load generation constitutes perhaps 90% of total generating capacity)."

[14] This is based on the argument that tariffs will continue to move towards more 'cost-reflective' levels.

In addition, selecting an inappropriate mix of technology, scale of plant and/or contractors can increase the cost of construction or cause delays which will ramp up the cost of supply, pushing up the price of electricity. Indeed, the levelised cost of electricity (LCOE) varies from one generation technology to another, as well as their cost structures. Technologies can be capital-intensive and have low variable costs, whereas other technologies might have higher variable and lower capital costs. As the selection of a technology affects primary energy and maintenance costs, the power station that costs the least to build might not generate the cheapest electricity.

Additionally, technologies have different social, environmental and quality of supply characteristics that are increasingly being factored (as additional costs) into investment decisions. Price increases associated with construction delays are also a reality, as exemplified by the Medupi coal-fired power station. In 2013, the provisional cost of Medupi stood at R105 billion (US$9.5 billion), excluding interest during construction, transmission costs and claims against contractors (Eskom, 2013). Interest is estimated at R30 billion (US$2.7 billion) and the cost of the flue-gas desulphurisation technology is about R10-R15 billion (US$0.9-US$1.4 billion). Hence, Medupi will probably cost between R145-R150 billion (US$13.2-US$13.6 billion), more than three times the original estimate of R52 billion (US$4.7 billion) announced in January 2007 (Urbach, 2013). The difference between the estimated and actual cost is a contentious issue, as Eskom's ability to include the cost increase in the regulatory asset base (and recover the cost through electricity tariff increases) depends on whether the cost increase is deemed prudent, and not whether the cost exceeds the original estimate. In any case, this is likely to push prices up in the coming years.

As illustrated by South Africa's history, electricity planning has therefore had direct implications for electricity supply and pricing. The time and scale of new generation building as well as construction delays (linked to technology and contractual choices) play a central role in achieving the country's security of supply, particularly in the short term. Along with the pricing methodologies, choices in technology options for electricity generation and the consequent investments over time also have real implications for electricity prices in the country, both in terms of level and stability. This is also compounded by the pricing mark-ups implemented by municipalities, as detailed in Box 1. Electricity planning, or the lack thereof, has been at the core of these direct linkages in South Africa.

Going forward, the institutionalisation of the IRP process is expected to maximise the positive interplay between planning, security of supply and affordable and stable prices in South Africa. Reviewing the country's planning process this constitutes a necessary step in achieving this ambitious objective.

3. A 10-CRITERIA ASSESSMENT OF SOUTH AFRICA'S INTEGRATED RESOURCE PLAN

Against the background detailed in the previous section, which established the centrality of planning in energy/electricity policy, an analytical assessment of South Africa's IRP is fundamental to determine the adequacy of the country's policies and strategies with government's objectives.

The analytical framework composed of 10 essential criteria developed by the World Resources Institute and Prayas Energy Group (Dixit *et al*., 2014) can be applied for this purpose.

The following elements of the South African IRP process are analysed: 1) planning process; 2) plan objectives; 3) review of previous plans; 4) demand forecast methodology; 5) resource options assessment; 6) policy instruments to achieve objectives; 7) regulatory and institutional frameworks; 8) investment financing; 9) social and environmental considerations; and 10) promotion of innovation and anticipation of emerging challenges.

A set of more detailed analytical highlights, which guide the assessment and the analysis, are then introduced under each criterion.

3.1. Planning process

The process for establishing the IRP is the first assessment criterion and the entry point to the analysis of the South African planning process. It encompasses six key areas of investigation: the institutional mandates and coordination among the various responsible agencies; the transparency of the process; the availability of assumptions, data and methodology for public scrutiny; the opportunity for public comments and inputs; the establishment of feedback and review mechanisms; and the existence of a long-term vision.

Under the leadership of the DoE, the institutional framework for electricity planning in South Africa and the coordination among relevant stakeholders have been substantially enhanced over the last few years. Prior to the 2009 Electricity Regulations on New Generation Capacity (which amended the Electricity Regulation Act No. 4 of 2006), planning and investment approval was scattered among several institutions with no clarity on responsibility and accountability. While the DoE, NERSA and Eskom all produced planning documents (i.e. the Integrated Energy Plan, the National Integrated Resource Plan and the Internal Strategic Electricity Plan respectively) dealing with new generation capacity, the hierarchy and relations between the three documents remained unclear (Pickering, 2010). The lack of clarity in the regulatory and policy framework in the electricity sector, and in some cases, contradictions in its various components, complicated the ability to assign responsibility, and eventually accountability to a specific entity, in turn leading to inefficiencies and sub-optimal decisions. This lack of regulatory clarity compounded the poor policy governance of the ESI for decision-making around new generation capacity planning and procurement systems, and resulted in an absence of decisions and inadequate investment in new capacity (which *inter alia* led to the 2008 load shedding crisis) (Newberry & Eberhard, 2008; Pickering, 2010).

Since the 2009 Electricity Regulations, the DoE has been tasked with developing both South Africa's IRP (focusing on electricity) and IEP (looking at the complete energy system). While spearheaded by the DoE, the production of the IRP involves a wide number of stakeholders. As illustrated in Annexure 3, the DoE relies heavily on the national utility and other government departments to gather all the necessary parameters for the development of the IRP.

In addition to a large number of data providers, the DoE relies on a multi-stakeholder Task Team to develop the IRP.[15] The composition of the DoE Task Team for the development of the IRP 2010 is detailed in Annexure 4. It is mainly dominated by non-regulatory stakeholders. Thus, energy-intensive users are directly involved in the planning process with seven of the 17 original task team members (i.e. more than 40%) related to the Energy Intensive Users Group of Southern Africa (EIUG).[16] Likewise, IPPs (through the South African Independent Power Producers Association) and large municipalities (with City Power Johannesburg) are part of the task team responsible for supervising energy planning in the country. Labour and civil society are, however, missing and should be directly included in decision-making processes. This would contribute to optimising the transparency of the planning process, particularly in the final decision-making. The IRP process has therefore managed to successfully mobilise relevant stakeholders so as to gather all the necessary information, and ultimately inform the country's electricity planning. The composition of the Task Team should nevertheless be revised to be more balanced and inclusive.

Complementing the wide array of stakeholders involved in the design and decision-making processes of the IRP, the planning process also includes extensive consultations with all interested parties. Indeed, the IRP 2010 was only promulgated in its revised version in May 2011, after two rounds of public engagement.

After a first round of consultation in June 2010, focusing on the input parameters for the modelling, the IRP 2010 was published for further comments in October 2010. The process gave all interested parties the opportunity to submit written comments (through a provided questionnaire or any other form) and to make a presentation at a series of workshops held in Durban, Cape Town and Johannesburg.[17] Public consultation and independent international consultant inputs resulted in modifications to the modelling exercise and new scenarios testing additional policy options and outcomes. A total of 479 submissions were received through the consultation process, including 5 090 specific comments. Comments resulted notably in further research (on technology learning rates[18] and the cost evolution of solar photovoltaic technologies), modified assumptions (on the cost of nuclear and biomass technologies) and additional scenarios (on fuel prices and demand projections).

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[15] This Task Team differs from Nedlac's Energy and Electricity Task team, which was formed in the wake of the 2008 energy crisis and also participated in the discussion around the IRP 2010.

[16] In 2010, Mike Rossouw (Xstrata), Ian Langridge (Anglo American), Brian Day (Exxaro), Piet van Staden (Sasol), Kevin Morgan (BHP Billiton), Roger Baxter (Chamber of Mines) and Shaun Nel (Gobodo Incorporated) were all related directly to the EIUG itself or to companies which were members of the EIUG.

[17] Final inputs on each parameter, including stakeholders' comments and the DoE's responses, were publicly released to ensure transparency and foster discussion.

[18] The factoring of learning rates, as well as the update of costs for some technologies had a noteworthy impact on the inclusion of renewable energy technologies in the energy mix (DoE, 2011: 33-38).

To allow meaningful engagement, the DoE published the complete set of assumptions and data used in the modelling exercise as part of the planning process for the IRP 2010. Although the model itself is not available to the public, extensive information is released for all stakeholders to be in a position to critically review and assess the outcomes of the IRP. For example, input data and assumptions on expected annual energy requirements (DoE, 2011: 50), annual maximum demand (DoE, 2011: 51), assumed demand-side management (DoE, 2011: 52) and technology costs inputs (DoE, 2011: 54) are all provided in the IRP document. Technical annexes also provide all the other used data on the key demand and supply parameter inputs for the IRP. These have been coordinated and made available by the DoE on its website. A total of 29 input parameters were identified as critical to the modelling process for the IRP. Factsheets were published for stakeholders, which included the nature, impact, value, ranges of values and other information on the parameter and its relevance and impact on the IRP. These were made available for stakeholders to review and consider prior to the modelling process. Once agreement on these parameter values was established, the final 24 input parameters, covering both demand- and supply-side inputs, were finalised and the relevant factsheets published on the department's website as well. Altogether, the consultation process and the publication of all assumptions and data used as part of the IRP process make the planning process greatly transparent. The final decision-making process remains nevertheless fairly closed and confidential and should be enhanced to include a greater variety of stakeholders.

Box 2: The reform of the electricity supply industry: The absence of clear long-term vision

The global rise of the free market ideology and technology progress, associated with the historical poor record of public enterprises, led in the 1980s to a push to reform ESIs around the world. Reform processes were undertaken with the idea of improving economic efficiencies by breaking away from natural monopolies and introducing competition and private participation, ultimately lowering the cost of electricity. Paul Joskow (2006) summarises the standard sequential seven-step model as follows: (1) corporatise the state-owned enterprise; (2) commercialise activities in the value chain; (3) design and implement a regulatory system; (4) unbundle activities in the vertically and horizontally integrated value chain to facilitate competition; (5) manage the divesture of state assets; (6) promote private sector participation; and (7) implement wholesale and then introduce retail competition, at least for industrial customers. Chile, the United Kingdom and Norway were among the first countries to follow such model, followed by many developed economies and around 70 developing and emerging countries by the end of 1990s (Nepal & Jamasb, 2013).

In South Africa, while the 1998 Energy White Paper reflects some principles of the standard textbook model (such as the liberalisation of distribution and the open access to the transmission system), this model was never really implemented. Instead, a hybrid model maintaining the dominance of the utility prevailed in the country, based on the theory of contestable markets and the political and social necessity to consider the economic growth and developmental objectives. The ESI has not been fully unbundled (both vertically and horizontally) and, as illustrated in Table 1, only some features of the standard model were implemented in South Africa, such as the corporatisation of Eskom, the introduction of competition in specific value chain components (such as in generation with IPPs) and the establishment of an independent regulator.

While the textbook approach generally implies clear policy choices on the relative roles of the utility and IPPs, and the establishment of appropriate regulatory and institutional arrangements for the procurement, contracting and dispatching of new generation capacity, this remains a confused and contested policy and institutional space in many developing countries including South Africa. In this case, the incumbent utility remains in a dominant position, arguably retaining its ability to invest in new generation capacity, while IPPs are introduced into the market, without clarity on the role they ought to play in the market (and often without support from the state-owned enterprise) (Gratwick & Eberhard, 2008). This hybrid structure creates challenges for the regulatory and institutional framework established in the country as part of the reform process, which requires assimilating the characteristics of South Africa’s hybrid market in order to support economic efficiencies. Indeed, hybrid markets “present an array of new challenges related to which institution is responsible for generation planning, how to allocate new investment opportunities, timely initiation of competitive bidding processes, institutional capacity to contract effectively and fair and transparent power dispatch arrangements” (Gratwick & Eberhard, 2008). The understanding and recognition of the market structure by regulatory institutions is therefore instrumental in their ability to efficiently and effectively drive and implement an investment strategy, i.e. a large factor determining electricity prices, as costs recovery is directly linked to pricing and investment choices.

Table 1: Comparison of the standard textbook model with South Africa's hybrid reform

Reform steps	Implementation activities	Situation in South Africa
Corporatisation of the state-owned enterprise	Transformation of the state-owned enterprise into a separate legal entity	Implemented: Eskom corporatised with the Eskom Conversion Act of 2001
Commercialisation of activities	Move towards cost reflective tariffs, transparent subsidies and improved revenues collection systems	Progress made: introduction of MYPD process and unbundling of tariffs structures
Design and implementation of a regulatory system	Establishment of an independent regulator and passage of legislation to provide a mandate/ framework for restructuring and private participation	Progress made: establishment of a regulatory system and authority of the regulator entrenched
Vertical and horizontal unbundling	Unbundling of the state-owned enterprise to facilitate competition and mitigate self-dealing, starting with transmission and establishing a system operator	Minimal progress made: ISMO has been established and ring-fenced within Eskom
Divesture of state assets	Divesture state ownership in part or full of generation assets to private sector	No progress made
Promotion of private sector participation	Introduction of IPPs under long-term power purchase agreements	Slow-paced progress made: procurement of renewable energy from IPPs
Implementation of wholesale and retail competition	Different market models exist. Retail competition might not be viable but industrial customers should be able to choose supplier	No progress made

Source: Das Nair, Montmasson-Clair & Ryan, 2014

Despite the institutionalisation of the IRP process, some information asymmetry issues remain, particularly in favour of the national utility. The failed balance of power within the ESI, along with the monopolistic structure of the sector, has opened the door for principal-agent issues, generating information asymmetries in favour of a handful of decision-makers and resulting in biased suboptimal (in terms of technology choice, timing, size, etc.) investment decisions (Steyn, 2013). As such, the primary source of data for the ESI is the vertically-integrated national utility. The historic dominance of Eskom as the main data custodian is a legacy issue that has created a challenge for stakeholders in the planning process, particularly for the DoE, to obtain the correct information needed for forecasting and planning. Similarly, NERSA's decisions are based on Eskom's data, and often NERSA does not independently verify Eskom's information. Another example is the progressive unbundling of different components of electricity pricing, needed to better understand the different drivers and impacts on electricity pricing. While this has improved over time, notably through the establishment of different ring-fenced divisions within Eskom (such as for pricing and distribution) and the implementation of the MYPD, further progress is required to ensure data transparency.

This shortcoming is expected to be addressed over time as the IRP process is perfected, provided the plan is regularly updated. While the IRP is meant to be revised every two years (or even annually according to the 2013 update), the process for future revisions of the IRP remains unclear. The update, published for public comments in November 2013, is not a fully-fledged new iteration of the IRP process but a review of the IRP 2010 allowing for updated assumptions and new scenarios. The next iteration of the IRP is only expected to commence in 2015 once the IEP has been finalised (DoE, 2013a: 10).

As the IRP process is being institutionalised, it should also include the development of a new, updated vision for the ESI. Despite the commissioning of several reports on potential market structure by government, Eskom, NERSA and EDI Holdings[19] over the years, no official view exists on the evolution of the ESI, as detailed in Box 2.

The vision expressed in the 1998 White Paper is now outdated and appears to contradict recent policy decisions made by Cabinet. On-going reforms, most notably the separation of the transmission grid and the System Operator (SO) from Eskom with the establishment of an Independent Systems and Market Operator (ISMO), as detailed in Section 3.7, are stalled as of November 2014. The reform of the ESI has been side-lined by the security of supply problem and Eskom's transmission and distribution assets will not be unbundled in the short or medium term before energy security is ensured. Government at the moment lacks a clear overarching vision of the future evolution of the sector, thus amplifying the unpredictability of the policy and regulatory environment in the country. Policy certainty and clarity on the structure towards which the ESI is shifting and on the role of each stakeholder in this remodelled system is instrumental to successful and effective regulation, sound investment strategies and adequate planning.

[19] EDI Holdings was a 100% state-owned company established in 2003 to restructure the electricity distribution industry in South Africa into regional distributors. It was closed down in 2011 as the restructuring process was terminated.

The IRP 2010 provides the generation mix for the 2010-2030 period and fails to conceptualise a long-term vision for the South African ESI. While the 2013 update spans across a longer timeframe (up to 2050), it also does not venture beyond the modelling of the optimal electricity mix. Although it might be argued that it is not the role of the IRP to draw a comprehensive picture of the ESI, the planning process is well positioned to propose a long-term vision for the sector, particularly with generation capacity, and should formulate recommendations for this, at least as it affects the realisation of its objectives.

In a nutshell – planning process: Planning around the IRP process has been substantially improved since 2009 as well as clarification of the DoE's mandate. The process is thorough and the institutional arrangement achieves the objective of mobilising all necessary data and information from relevant stakeholders. Labour and civil society are nevertheless missing from the decision-making process and should be included for increased transparency. In addition, information asymmetry problems, in favour of the utility, remain and should be addressed over time. The consultation process is extensive, and assumptions, data and methodologies are all available for public scrutiny, which provides the process with a good degree of transparency. Going forward, the IRP process should engage with the design of a long-term vision for the ESI beyond generation capacity planning and formulate recommendations for this, at least to the degree that it impacts on achieving its objectives.

3.2. Plan objectives

The second question to ask about the IRP is whether it sets adequate objectives. This revolves around clearly-stated objectives; well-defined and aligned priority areas; well-aligned short-, medium- and long-term goals; and explicit linkages with other sectors and development objectives.

A multi-criteria decision-making process was used to drive the IRP and intends to find a balance between economic growth, job creation, security of supply and sustainable development (DoE, 2011: 13). In addition to security of supply, the IRP evaluates possible supply mixes against a set of additional objectives (DoE, 2011: 25–26), considering a number of constraints and risks:

- reducing water usage;
- minimising the total cost to the economy;
- reducing greenhouse gas emissions;
- curtailing portfolio risk or uncertainty;[20]
- maximising localisation and job creation benefits; and
- enhancing regional development (i.e. imports).

[20] This criterion covers different dimensions, such as 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.

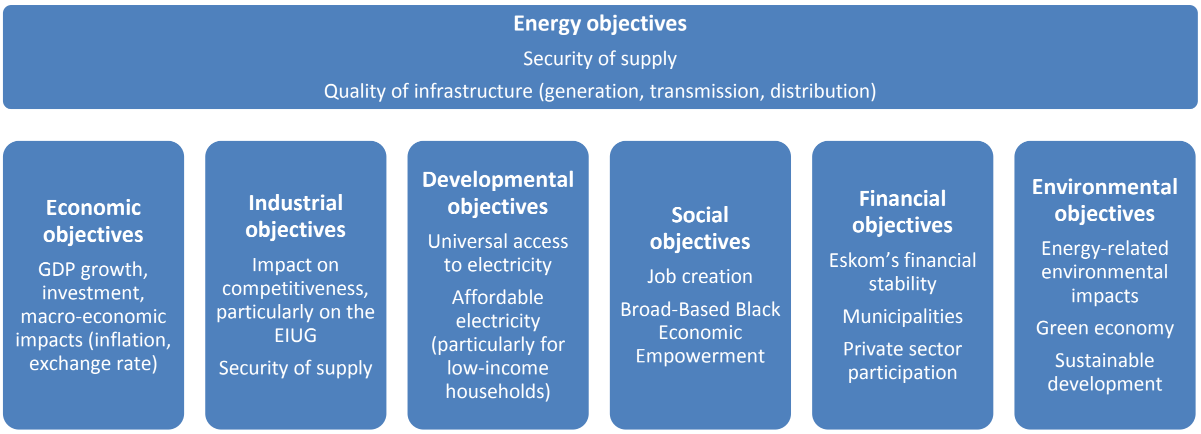
These ambitious (and potentially conflicting) objectives reflect the lack of clarity of the objectives to which the ESI is meant to contribute. Energy policy is a cornerstone of economic development and is intrinsically intertwined with other aspects of the economy. As illustrated in Figure 3, energy policy is *inter alia* aimed at addressing diverging priorities, from core energy objectives to economic and industrial development, to social and environmental concerns.[21]

The ability of energy policy, and of the regulating entities, to tackle all these irreconcilable issues, however, appears compromised. In the current order, the energy sector, notably from a planning perspective, is pulled in many directions trying to meet all the objectives while, in practice, trade-offs at the energy policy level are inevitable.

The fundamental energy security function must remain the most important priority. Should energy policy then be mobilised to achieve peripheral objectives, these should be focused and streamlined to maximise positive spillovers and chances of success, and manipulated with caution so as not to overshadow the primary objective of energy security. In the end, what these secondary objectives should be depends on the situation of the country and remains a debatable issue.

As such, the IRP attempts to prioritise. Ensuring security of supply remains the core priority of energy policy and is placed at the centre of the IRP. Each scenario is modelled to meet security of supply requirements, and then numerically graded based on the six above criteria. Criteria are given different weighting, with cost and climate change mitigation being prioritised, followed by uncertainty and localisation (DoE, 2011).[22] Effectively, in the current South African context, energy security at the most affordable overshadows all other objectives, limiting achievement on peripheral goals.

Figure 3: Diverging objectives related to energy policy



Source: Das Nair, Montmasson-Clair & Ryan, 2014

[21] This is also reflected in Eskom's current mandate. While security of supply (i.e. "keeping the lights on") is the primary mandate of the national utility, Eskom is also tasked with accommodating the market reform of the generation sector (i.e. enabling the entry of IPPs), keeping prices below double-digit increases, and, to some extent, acting as an agent of social and economic development by pursuing electrification.

[22] Four steps in the planning process involve: (a) the adoption of planning assumptions; (b) the determination of the electricity load forecast, (c) modelling and scenario planning based on the planning assumptions; and (d) the determination of the base plan derived from a least-cost generation investment requirement (DoE, 2010a).

To facilitate implementation and enhance the probability of meeting its objectives, the IRP is also structured around three periods:

- short term, which describes the choices that have already been made and the projects that will begin within the next four years;
- medium term, which develops options that are likely to be needed in the next period, i.e. five to 10 years from now; and
- long term, which develops a long-term picture considering potential risks and opportunities, and identifies and scopes a set of broad options (DoE, 2010a).

Although the IRP does bring forward the roll-out of renewable energy technologies to increase developmental objectives, the IRP does not particularly put into perspective its stated objectives from a timeframe point of view, with the exception of its core function (security of supply).

Indeed, as the IRP, which is a long-term plan, does not provide sufficient information on the short-term supply shortages faced by South Africa, it is complemented by a Medium Term Risk Mitigation Project for Electricity in South Africa (2010 to 2016) (MTRMP), with the sole purpose of "keeping the lights on" (DoE, 2011: 57). The MTRMP formulates an action plan, encompassing increased efforts in energy efficiency demand-side management, solar water heaters, demand response programmes for large and smaller customers, IPPs, co-generation and own generation, return-to-service of existing generation fleet and municipal generation. It also advocates the establishment of a "safety net" with emergency measures in case the proposed initiatives do not generate the expected outcomes. Constraints (such as funding, legislation and regulation, and logistics) are outlined and factored in to assess the potential for each option (DoE, 2011: 64–67). The MTRMP consists of two phases. The first phase, published to complement the IRP, provided the underpinning background and analysis for addressing the short- to medium-term supply shortfall in South Africa and formulated a workplan, validated through Nedlac, to be implemented by all stakeholders. The second phase, which consists of a detailed implementation plan (DoE, 2011: 73–74), has unfortunately only been very partially (and with delays) carried out at this stage, at the expense of electricity security in the country. This is not necessarily due to wrong policies but rather delays in implementing policy plans.

Similarly, the IRP does not directly establish the linkages between its prerogatives and the country's other sectors and development strategies. The linkages must, however, be explicitly drawn for the IRP to adequately achieve its objectives. Two recent examples, further detailed in Annexure 5, highlight the importance of appropriately balancing priorities and the difficulty, if not impossibility, of achieving all the objectives in South Africa. On the one hand, special electricity pricing agreements with aluminium producer BHP Billiton, which were used to achieve industrial policy objectives in the 1990s, have locked the ESI in a perilous situation over time, jeopardising security of supply. On the other hand, while the Renewable Energy Independent Power Producer (REIPP) procurement programme has been very successful in introducing renewable energy technologies and IPPs in South Africa, the multiple objectives assigned to the scheme have highlighted the difficulty in achieving, at the same time, price considerations, socio-developmental objectives and climate change goals. The compatible nature of the objectives assigned to the programme, and more broadly to policies and regulation, is therefore a key element of success.

As the IRP process (and more broadly economic regulation) is not an end in itself but a means to an end, regulatory decisions must ultimately make a positive difference to all stakeholders, providing confidence that policies are implemented in the best interest of industry, end-users and the economy as a whole (Van Basten, 2007a). Clarity is therefore required on the regulatory functions (assigned to NERSA) and broader economic and industrial policy objectives (defined by government). The final aim of regulation and the priorities assigned to the ESI must be clearly set out by government for regulation to be efficient and effective. In addition, these priorities should be clear, concise, compatible and within the scope of the industry and the regulatory entities. Having said this, the point is reiterated that economic regulation cannot happen in a vacuum and in a manner that is contradictory to other economic, social and development policies, particularly in a developing country like South Africa (Das Nair, Montmasson-Clair & Ryan, 2014).

In a nutshell – plan objectives: Although broad and potentially conflictual in nature, the objectives of the IRP are clear and the priority of security of supply is established. Cost and climate change considerations follow. Goals, and not only new generation building, should be better aligned with each other and with the short-, medium- and long-term sequencing of the IRP to ensure implementation and maximum impact. Direct linkages with other sectors and development objectives are not directly considered and should be factored in the IRP process.

3.3. Review of previous plans

The review of previous plans is the third necessary step in assessing the IRP. A backward-looking perspective is crucial to identify lessons learned from previous plans; review assumptions, policies, and institutional aspects of planning considered in earlier plans; and analyse gaps between expected and actual outcomes from earlier plans.

In the electricity space, government has historically not capitalised on policy and implementation learnings. The historical analysis of electrical generation building in South Africa highlights the repetition of a similar faulty pattern despite the commissioning of several assessments over time, as already mentioned in Section 2. As Steyn (2006: 1) emphasises, “Eskom simply has not been able to supply the right amount of power capacity since the late 1960s,” essentially due to the utility’s inability to address the uncertainty around future demand and the risks associated with technology and investment choices.

Between 1974 and 1978, electricity prices rose by 70% in real terms due to capacity shortage, along with increasingly frequent load shedding up to 1981. This was predominantly the result of a lack of adequate demand forecasting and appropriate planning. In response, Eskom started a large new-build programme. By 1983, the state-owned enterprise had 22.26 GW of generation capacity under construction or on order (Steyn, 2006). Failure to properly plan and oversee investment decisions resulted in an excessive capacity expansion programme and gross inefficiency in investment by Eskom (Kessides, Bogetic & Maurer, 2007). To service Eskom’s soaring debt, cost was passed on to consumers, leading to steep average nominal price increases in the 1980s (Steyn, 2003) while the utility benefited from a monopoly position, government guarantees, open-ended Reserve Bank forward cover and an exemption from taxes and dividends.

Repeating the pattern witnessed in the 1970-1980s, the South African government, through Eskom, started in 2005 a mammoth generation expansion programme valued at R340 billion (US$31 billion), excluding capitalised borrowing costs. By 2018/2019, the programme will add 17.1 GW of capacity to the 2005 nominal generation capacity of 36.2 GW (Eskom, 2013). This reaction to the exacerbated vulnerability of the system was moreover belated, thus not adequate to prevent the 2008 crisis. Although the programme considers the objectives of the IRP 2010, especially the need to diversify the technology and fuel mix of generation, technology choices were predominately influenced by the objective of “keeping the lights on” at the cheapest cost (at the time of decision-making). Hence, the programme favours large coal-fired generation plants. While the programme is a couple of years behind schedule, 6 017 MW of capacity had been added to the network by March 2013. As in the 1980s, the financing requirements of this colossal investment programme have contributed to pushing prices up, ultimately resulting in a trebling of the average standard price at 89.13 c/kWh from 2009/2010 to 2017/2018[23] (NERSA, 2010; 2013).

The IRP process, by being institutionalised, attempts to address the chronic problem of over-investment. The plan does not directly reflect on previous planning processes, or domestic and international experience, but the IRP Task Team is composed of experts and consultations with considerable experience in energy/electricity planning. For example, the IRP builds on the knowledge accumulated from the many reviews of the electricity sector and its regulation conducted in the last five decades and, most notably, the two official investigations carried out to improve Eskom’s operations (Rustomjee, 2013).

An investigation into electricity tariffs by the Board of Trade and Industries commissioned in 1977 called (without much success at the time) for stronger regulation of both Eskom and municipalities and a prioritisation of national capital projects from Eskom (Marquard, 2006; Rustomjee, 2013). In 1982, a Commission of Inquiry into the Provision of Electricity in South Africa (also known as the De Villiers Commission) proposed significant changes to the national electricity governance system which represented, according to Rustomjee (2013), the first significant shift in the relationship of power in favour of large industrial and municipal users over the utility. By 1985, large users (essentially the mining and mineral processing sectors) and municipalities were given seats on the Electricity Council (i.e. the equivalent of Eskom’s Board). This triggered a greater oversight of the utility and enabled main customers to exert influence on Eskom’s strategic direction, expenditure and income.

While these evaluations and assessments were insufficient to avoid the recent electricity crisis, and subsequent massive generation expansion programme and price increases, the move to consider other stakeholders’ interests and establish more stringent regulation has constituted a welcome (although still insufficient) step towards imposing a more efficient approach to investment and management (Das Nair, Montmasson-Clair & Ryan, 2014).

[23] This is the result of successive average standard price increases of 24.8% in 2010/2011, 25.8% in 2011/2012, 25.9% in 2012/2013, and 8% annually from 2013/2014 to 2017/2018.

In addition, the 2013 update does make the effort to review the assumptions and outcomes of the IRP 2010. The 2013 update builds on the IRP 2010 with the idea of improving the planning process and filling some of the gaps identified in the first iteration. For example, the 2013 update of the IRP recommends adjusting the current thinking against dollar-denominated contracts as this would jeopardise the feasibility of many generation options (particularly gas) (DoE, 2013a: 52). The 2013 revision also updates Eskom's energy availability factor (i.e. the performance of Eskom's fleet) to reflect the utility's new 80:10:10 strategy.[24] It moreover offers the possibility to extend the life of existing coal-fired power stations (DoE, 2013a: 19).

In addition, the update considers the progress made since the publication of the IRP 2010 and incorporates recent developments in the planning process. It covers new developments in technology and fuels options (locally and globally), updating some of the underlying assumptions based on new information. The update also develops a set of new scenarios, complementing those considering by the IRP 2010 (DoE, 2013a: 10-11; 69-90).

In a nutshell – review of previous plans: South Africa has historically displayed a chronic inability to capitalise policy learnings in the energy space, repeating a similar faulty generation building pattern. While the IRP process is driven by expert stakeholders with considerable experience and expertise, it does not particularly reflect on domestic and international experience. The institutionalisation of the IRP is aimed at addressing this shortcoming. The 2013 update started this dynamic by incorporating a review of assumptions and conditions considered in the IRP 2010. An analysis of the gaps between expected and actual outcomes from earlier plans should also be conducted in the next iterations of the IRP.

3.4. Demand forecast methodology

The demand forecast methodology is arguably the single most important determinant in the elaboration of the IRP and must be given full attention. Clearly defined and publicly available data, assumptions, and methodologies; an end-use projection approach; the consideration of demand variability; and periodic revisions of demand forecasts are required for an optimal demand forecast methodology.

The model used in the IRP for demand forecasting relies on a load forecasting methodology that is then used in an expansion planning model. A series of six demand forecasts from the utility's own SO and the Council for Scientific and Industrial Research (CSIR), a national scientific and technology research, development and implementation organisation, has been considered in both the IRP 2010 and the 2013 update. Both Eskom's SO and the CSIR produce low, moderate and high forecast for electricity consumption.

[24] Eskom approved in 2013 a new five-year generation strategy premised on an 80:10:10 principle. It implies an average plant availability of 80%, with unplanned outages and scheduled maintenance respectively limited to 10%.

The review process of the IRP 2010 called for a better alignment with national economic growth assumptions, even though the IRP 2010, which used the SO's moderate forecast in its final recommendation (the policy-adjusted IRP), predicted a gross domestic product (GDP) growth only marginally different (and higher than actual) from reality.

This was resolved, not without criticism, in the 2013 update, by aligning growth assumptions with government targets. In the 2013 update, both the CSIR and the SO's moderate 2012 forecast therefore consider an annual economic growth of 5.4%, in line with the expectation of the NDP.

Initially, the 2013 update considered four economic growth trajectories, along two parameters: weak or strong international economic growth; and business-as-usual domestic environment or successful policy intervention. The update is anchored on a base case following a high growth prospect (the CSIR moderate forecast) and a substantial reform of the economy (triggered by successful policies). The base case envisions a meaningful shift in economic development away from energy-intensive industries and a substantial reduction in income inequality supporting local demand (DoE, 2013a: 54-55). As such, the 2013 update is more aspirational than realistic, as the economy is unlikely to grow at this level and in such a pattern for the full period.

To determine future demand, the IRP process also considers the electricity intensity of the South African economy. The electricity intensity, which takes into account government's industrial policy and involves input from the Department of Trade and Industry, the National Treasury, the Economic Development Department and the DoE's planning division, defines electricity consumption relative to economic growth and is a very important parameter in determining future energy demand and output growth. The electricity intensity has historically been estimated at a ratio of 3:2 (3% GDP growth equating to 2% electricity growth). Over the next 15 years, the DoE, however, envisages a progressive shift to a 2:1 ratio (DoE, 2010b).

The price elasticity of demand, another critical criterion in determining final demand, is by contrast not considered appropriately in the IRP 2010 (DoE, 2011: 35). While the 2013 update attempted to address this shortcoming by assuming a progressive decline in electricity intensity of GDP, the DoE also acknowledges the difficulty to appropriately quantify the impact of prices on electricity demand in the future (DoE, 2013a: 15–16). This should be further investigated in the next iteration of the IRP process. Besides GDP-linked forecasting parameters, demand forecasting should also include parameters related to energy efficiency demand-side management. At the moment, such parameters are limited to Eskom-run programmes and are not integrated adequately in the planning considerations of demand forecasting.

The 2013 update does factor the trade-offs associated with planning for a low-growth path, which might lead to electricity remaining a constraint on development, and planning for a high-growth path, which might result in over-capacity and stranded investment. As such, the 2013 update proposes a flexible approach that favours least regret decisions[25] (DoE, 2013a: 24).

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[25] Under this approach, flexibility in decisions is the priority, suggesting that commitments to long range large-scale investment decisions should be avoided.

The publication of the IRP 2013 update and the revisions it proposes have triggered a wide array of comments on various aspects of the draft revision (Creamer, 2014). The revision of future demand (although downward) and the underlying economic growth forecast have been characterised by Professor Anton Eberhard, University of Cape Town Energy Research Centre director and National Planning Commission member, as remaining highly aspirational in nature, with South Africa's economy growing far slower and electricity demand having declined to 2006 levels.

At the same time, the EIUG advocates for a "more realistic return-to-growth profile", while the Nuclear Industry Association of South Africa and the South African Independent Power Producer Association caution against artificially low demand from large power consumers. Indeed, the demand in 2030 is projected to be in the range of 345-416 terawatt-hour (TWh) as opposed to 454 TWh expected in the existing IRP, resulting in a reduction of the required installed capacity in 2030 from 89.5 GW to 81.4 GW. This might, however, underestimate the suppressed demand created by the existing electricity shortage.

In addition to future demand, the IRP process considers the cost of unserved electricity (COUE), a value (in Rand per kWh) used to determine the cost of energy not supplied either during an unplanned outage or for a short period of time. Ideally, the COUE should be balanced with the incremental cost of supplying the energy not served. The impact of this measure on electricity planning is significant as the measure assesses the impact of not providing electricity – failing to plan adequately to meet electricity demand in other words. The COUE for the IRP is estimated at an average R75/kWh (DoE, 2010c), highlighting the extremely high cost associated with under-capacity. This measure is an economic evaluation calculated by NERSA. It entails an economic analysis of investments affecting the reliability of supply as well as the cost to customers of unsupplied electricity. Part of the calculation assumes that the COUE will vary for different customers/sectors and puts a shadow price on what it would cost customers if they fail to be supplied. A description of the COUE is made publically available by the DoE as a factsheet on the supply input parameters of the IRP 2010. The implications of unserved electricity (versus oversupply) are far-reaching in terms of the loss of potential production and output of the economy. Nevertheless, this remains an economic valuation not directly linked to the actual price of electricity (i.e. not to be conflated with the cost of oversupply), and merely an indicator of the cost of undersupply.

Overall, demand forecasts are meant to be reviewed periodically at the same time as the whole plan. More regular updates of the demand assumptions (such as every one or two years), along with timely and on-budget new generation building, are nevertheless necessary to ensure appropriate levels of production.

In a nutshell – demand forecast methodology: The IRP planning process is clear and transparent in the demand forecast methodology used and the public availability of data for the plan provides a good degree a transparency. The assumptions on national economic growth rate (particularly the aspirational 5.4% per annum) remain an important bone of contention. The 2013 IRP update does, however, factor the trade-offs associated with planning for both a low- and high-growth path. More regular updates of the demand forecast are needed, along with new iterations of the IRP. The level of future demand by larger industrial users remains an area of disagreement, as is the reality of the aspirational shift to a less energy-intensive economy in the future.

3.5. Resource options assessment

On the supply side, the assessment of resources options is the most important criterion of a successful IRP process. The planning must consider: all possible demand and supply options; the technical, economic and achievable potentials of all options; and integrate environmental and social impacts and objectives into least-cost calculations.

The IRP process does consider all potential technology options in the planning, on both demand and supply sides. It covers traditional fossil fuels (coal, diesel and gas), nuclear energy, renewable energy (solar, wind, hydro, and landfill), co-generation, imports and demand-side management. Nevertheless, the potential for own generation and co-generation remains largely unconsidered due to its uncertain nature (DoE, 2011: 38).

In the IRP 2010, cost data for most technologies were based on the July 2010 United States of America-based Electric Power Research Institute (EPRI) report. Information for nuclear, solar photovoltaic, sugar bagasse, pumped storage, and regional hydro, gas and coal options were provided separately by various stakeholders. The 2013 review of the IRP includes updated cost information, including the April 2012 updated data from EPRI.

The updated version of the IRP relies on revised assumptions of economic growth, future demand, technology options and costs, the performance of Eskom's fleet and the potential for extending the economic life of the existing fleet. The 2013 update also considers new developments in technology and fuel options (locally and globally, particularly for nuclear energy, renewable energy and gas), scenarios for carbon mitigation strategies and the impact on electricity supply beyond 2030, and the affordability of electricity and its impact on demand and supply beyond 2030.

Throughout the IRP process, the technical, economic and achievable potential of each option is assessed. In the MTRMP, the DoE paid particular attention to assessing the potential of proposed solutions. Each option was evaluated to identify its maximum potential within the short-term timeframe of the MTRMP. In addition to technical considerations, the MTRMP factors a number of constraints (such as funding, legislation and funding) to determine the "constrained potential" of each option. It also identifies the "highly constrained potential" of every option, i.e. the "the stretched opportunity believed to be possible, making realistic assumptions on future funding" (DoE, 2011: 64). Some exceptions remain, however. While some own-generation and co-generation projects were included in the IRP (as part of the MTRMP), their impact was not considered on water, prices and greenhouse gas emissions (DoE, 2011: 8). Overall, while the IRP does factor water usage and greenhouse gas emissions in its review of technologies, the modelling does not cover socio-environmental externalities of technologies, as further detailed in Section 3.9.

To assess the potential of each technology, the IRP 2010 considers a set of scenarios covering different constraints for greenhouse gas emissions, regional development, energy efficiency and demand-side management. Two balanced scenarios representing "the best trade-off between least-investment cost, climate change mitigation, diversity of supply, localisation and regional development" were also modelled. The economic impact is assessed for each scenario, as well as its water and climate impact (DoE, 2011: 23–25). Following consultations, six additional scenarios were developed (DoE, 2011: 38–47): an adjusted emission scenario (i.e. a new base scenario) incorporating the updated input data; a high efficiency scenario with increased energy efficiency and demand-side management; a risk adverse scenario limiting imports and renewable energy; a peak oil scenario considering escalated diesel, gas and coal prices; and an earlier coal scenario allowing more coal capacity and looser GHG emission targets. The update also develops a new base case and considers a new set of 14 scenarios based on alternative government policies and differences in future economic and resource developments (DoE, 2013a: 10-11; 69-90).

Box 3: The place of nuclear in the energy mix and planning

South Africa has two nuclear reactors (for a total of 1 800 MW) at Koeberg in the Western Cape, supplying 5% of electricity output. While the IRP 2010 prescribes the commissioning of additional 9 600 MW of nuclear energy-based generation capacity, the 2013 update suggests that new nuclear baseload capacity would not be required before 2025, if not 2035, and that alternative options, such as regional hydropower, could fulfil the requirements. Overall, the update proposes to decrease generation capacity for nuclear energy from 11.4 GW in the current IRP to 6.6 GW. Studies commissioned by the National Planning Commission and the DoE between 2010 and 2012 also both advised on deferring the building of nuclear plants.

While nuclear energy has been part of the planned electricity mix since the first version of the IRP 2010, the role of nuclear energy remains a contentious debate in South Africa (as in the rest of the world). Media reports concerning potentially the largest and most expensive energy-related deal in the history of South Africa have recently sparked debate about the place of nuclear in the energy mix of the country, as well as the attached planning and procurement processes.

Globally, the nuclear industry is in decline as the shutdown of ageing plants outnumbers the amount of new plants coming online. Operating and construction costs have also been rising for the industry, according to the latest World Nuclear Industry Report (Schneider & Froggatt, 2014). The share of nuclear technologies in the energy mix globally peaked at 17.6% in 1996 and declined to 10.3% in 2013. Investments in renewable energy have begun to fill the gap with global investments in renewable energy technologies making up 57% of energy investments, followed by fossil fuels at 40% and then only nuclear at 3%. This is primarily due to the rise of nuclear investment costs over the last decade from US$1 000 per installed kilowatt (kW) to US$8 000. As such, an important revision to the IRP 2010 was a revaluation by 40% of the cost of nuclear energy.

The revised base case in the 2013 draft update proposes only 6 660 MW of nuclear capacity (including the Koeberg power plant of 1 800 MW) by 2030, instead of the 11 400 MW under the current IRP. This is partly due to the recommendation of US$6 500/kW price cap for any new nuclear capacity. With the capital costs associated with the new nuclear plant being planned for Hinkley Point in the United Kingdom are around US$7 900/kW, well above the suggested cap, the future role of nuclear energy in South Africa remains a highly political rather than rational issue. However, in addition to contesting the assumptions about LCOEs of various technologies and fuel sources, the Nuclear Industry Association of South Africa argues that the price cap places too much emphasis on the overnight costs and should be replaced by a cap on the LCOE determined by the combined effects of weighted average cost of capital, overnight costs, external costs and system costs. Nevertheless, the proposal to delay and scale back nuclear as well as to set a capital-cost cap has been heralded as a sound one by most analysts, particularly in light of the current project management issues at Medupi and Kusile, as well as the future role of gas (Creamer, 2014).

Despite the international decline of nuclear energy and the ongoing update of the IRP, South Africa is in intensive discussions with several potential providers to commission 9.6 GW of further nuclear energy-based generation capacity, with costs estimated between R400 billion (US$36.4 billion) and R1 trillion (US$90.9 billion). Nuclear expansion will not be funded off the balance sheet of Eskom and the funding of this expansion will be one of the most costly investments for the country.

South Africa has signed Inter-governmental Agreements on Strategic Partnership and Cooperation in Nuclear Energy and Industry with South Korea, Russia and France, and similar agreements with other countries, such the United States of America, China and Japan, are expected. The partnerships, of a potential value of US$10 billion, are however not a "done deal" at this stage (DoE, 2014a). A bidding process still needs to be finalised for contracts to be established. Questions around localisation, financing, funding, skills development, the fuel cycle and uranium beneficiation strategies, also need to be finalised (Vicente & Wild, 2014).

In addition, the National Nuclear Regulator would still need to hold public hearings on nuclear safety aspects and assess the choice of technology (but not the company selected). This will only happen once a licence application is submitted. The DoE has set aside a R850-million (US$77.3-million) budget for research and development into nuclear energy with a special focus on safety matters. The minister declared that "[r]egulations for the handling of hazardous materials, in terms of international obligations, and the development of nuclear policies and legislation to ensure the peaceful use of nuclear energy will also be pursued" (DoE, 2014b).

In the meantime, South African President Jacob Zuma established in June 2014 a new Subcommittee on Energy Security replacing the cabinet body responsible for nuclear procurement (known as the National Nuclear Energy Executive Coordinating Committee). The committee, chaired by the President and comprising ministers of Energy, Public Enterprises, Finance, State Security and Defence and International Relations, is tasked with ensuring the country's long-term security of supply. It is reviewing all possible power options, including, but not only, nuclear energy, highlighting again the highly political nature of the ongoing debate on the country's energy mix.

Source: TIPS, based on DoE, 2014a, DoE 2014b, Faull, 2014 and Vincente & Wild, 2014

Like every assessment, the underlying review of technologies is open for criticism and has spurred many diverse reactions. On the one side, consensus seems to emerge on the performance of Eskom's fleet and the proposal that an IPP procurement programme be pursued for fluidised-bed-combustion coal generation instead of another mega-project. On the potential life extension of Eskom's fleet, while caution was raised on the economic viability and feasibility of retrofitting flue-gas desulfurisation at the plants as well as securing adequate coal sources, security of supply purposes may well command the lifetime extension of existing power plants and outshadow other considerations. On the other side, assumptions in the 2013 update about LCOEs of various technologies and fuel sources have received mixed reactions from interested stakeholders. For example, the Nuclear Industry Association of South Africa argues that the price cap on nuclear energy places too much emphasis on the overnight costs and should be replaced by a cap on the LCOE determined by the combined effects of weighted average cost of capital, overnight costs, external costs and system costs. Similarly, the new allocation for gas (despite having increased from 2 370 to 3 550 MW) has been deemed as conservative by some industry players in light of recent discoveries in Mozambique. Revisions to the mix of renewable energy technologies, which put greater emphasis on solar over wind, have also received mixed reactions, partly due to aggressive learning curves for solar technologies. Additionally, according to the South African Wind Energy Association, the modelling underpinning the IRP does not take into account the financial space that IPPs provide by building power plants on their own balance sheet, discarding the success of IPPs in delivering projects (Creamer, 2014).

In a nutshell – resource options assessment: The consideration of all resource options for electricity generation is thoroughly incorporated in the IRP, taking into account a range of technologies, their associated costs and technical requirements. The data and working assumptions for these options are also made publically available. Throughout the IRP process, the technical, economic and achievable potential of each option is assessed. Scenario-based methodologies are used to determine the most optimal choices for the country, trying to attain the best trade-off between least-investment cost, climate change mitigation, diversity of supply, localisation and regional development. Economic analyses are included for these options, however, environmental and social impact assessments are missing. The overall mix of technologies remains a contentious issue as well as the impact of the remaining lifespans of current plants on future generation decisions. Thus, the IRP must provide accurate and up-to-date information, particularly on these aspects, in order for the right choices and timing of resource options to be made.

3.6. Policy instruments to achieve objectives

To efficiently implement the IRP, appropriate policy instruments are another prerequisite that must be evaluated. Particularly, the IRP must: provide a clear articulation between various policies; conduct a sensitivity analysis; clearly indicate the assumptions and underlying data used in policy analyses; include some flexibility of policies; and consider policies interlinked with affected and relevant sectors.

The IRP provides a schedule of decisions which have to be confirmed in the near future for the objectives of the plan to be met. The plan puts forward clear explanations on the urgency of some decisions, such as for the commissioning of coal fluidised bed combustion capacity, the first part of the nuclear fleet and gas-driven power plants (i.e. combined cycle gas turbines), the procurement of renewable energy-based generation capacity, and the importing of hydro-electricity (DoE, 2011: 15–17). It also highlights decisions that have to be confirmed in the next iteration of the IRP (originally planned for 2012 and thus behind schedule at this stage), such as the medium-term procurement of renewable energy-based generation capacity and new coal fluidised bed combustion capacity (DoE, 2011: 17), and decisions on longer-term investments, which can be altered, modified or replaced in the coming iterations of the IRP (DoE, 2011: 17).

In the final version of the IRP 2010, the DoE clarified, with limited justification though, a number of policy questions as part of the IRP process by making some policy choices explicit, i.e.:

- committing to a full fleet of 9.6-GW nuclear generation capacity;
- maintaining (i.e. not loosening) the emission constraints;
- allowing for import options (coal and hydro), but counting coal import as part of the domestic coal fleet (particularly in terms of greenhouse gas emissions); and
- maintaining (i.e. not increasing) commitments in terms of energy efficiency demand-side management (DoE, 2011: 11–12).

In several instances, security of supply considerations have also been prioritised in the design of the plan. For example, combined cycle gas turbine options have been introduced earlier than recommended by the optimised plan in order not to compromise supply (DoE, 2011: 13).

Some policy considerations meant to facilitate the implementation of the IRP are also outlined. They include: the need to factor in the impact of learning rates (for renewable energy technologies); the need to consider the price impact of the first solar photovoltaic capacity; the need to consider net metering for all consumers (and its impact, notably on subsidies); the necessity to be unrestrictive in terms of energy efficiency and own generation; and the need to balance capital requirement for the IRP between the private sector (30% of the capacity) and the public sector (DoE, 2011: 20–21).

However, the IRP does not cover (and it is arguably not its purpose) the coordination and alignment of the large legislative and legal framework governing the ESI. As one of the key documents of this regulatory framework, the IRP should nevertheless consider its interaction with other legislation and the broader policy context. The IRP, which constitutes the key implementing document for the generation stage, does not operate in isolation and should formulate recommendations in this respect. Other policy instruments that also impact on the IRP include the broader IEP process, South Africa’s national climate change policy, and other national development and economic growth policies.

First, the IRP is meant to fall under the IEP process. Due to the 2008 electricity crisis, the IRP was, however, prioritised over the IEP, which is meant to inform the interactions between electricity and other energy carriers. The IEP indeed provides a platform to integrate planning processes in each of the energy carriers and considers feedback loops between different processes. The IEP is expected to be finalised in 2015. As such, the 2013 IRP update, to some extent, and the next fully-fledged iteration of the IRP will be informed by the IEP process.

Second, a variety of policies have an impact on the IRP. Specifically at the generation stage, the introduction of IPPs into the market, particularly for the generation of electricity based on renewable energy, remains the main development impacting on the IRP. The Electricity Regulation Act No. 4 of 2006, as amended by the 2009 Electricity Regulations on New Generation Capacity, regulates the entry of IPPs into the market. Coupled with the 2003 White Paper on Renewable Energy, which set a contribution target of 10 000 gigawatt-hour of renewable energy to final energy consumption by 2013, the 2009 regulations paved the way for the introduction of renewable energy and IPPs in the country. In 2011, the IRP then enacted the scale-up of renewable energy, planning for the installation of 17.8 GW of new capacity from solar and wind energy from 2010-2030. After years of uncertainty and inconsistency, procurement processes were finalised in 2011 with the launch of the REIPP procurement programme (Montmasson-Clair, Moilwa & Ryan, 2014). A similar programme for baseload generation capacity is also being designed at the moment by the DoE and the National Treasury.

The shift to a low-carbon and environmentally-friendly energy mix, in line with the country-wide transition to a green economy, also affects the design of the IRP. As such, the IRP 2010 was developed under a carbon emission constraint of 275 million tons per year from 2025 for the electricity sector, and provides for a reduction of the share of coal-based electricity from 90% in 2010 to 65% in 2030. In addition, power plants are meant to comply with environmental requirements as set by the National Environmental Management Act No. 107 of 1998 and other key legislation (such as the Air Quality Act No. 39 of 2004 and the National Water Act No. 36 of 1998). While these considerations have been factored in the IRP process, they remain insufficient, as explained in Section 3.9.

Cross-cutting regulations may also directly affect the IRP process. As discussed in Section 3.1, the 1998 White Paper on Energy Policy has had some structural implications for the ESI, particularly at the generation stage. The Electricity Regulation Amendment Act No. 28 of 2007 is another example. It provided for the Minister (of the then-Department of Minerals and Energy) to make regulations on activities related to energy planning (such as new generation capacity, the types and share of each energy source, and the participation of the private sector). The amendment is not well crafted as it gives “very little guidance as to how future planning and allocation decision making would be undertaken” (Pickering, 2010: 40), potentially creating a dual decision-making system.

In turn, the IRP must consider its impact on the ESI as a whole, notably on other stages of the industry (namely transmission and distribution). For example, the IRP does not consider the ownership of capacity (i.e. Eskom or IPPs) as this is deemed to be separately determined by the DoE. Network issues, around transmission and distribution costs, distributed generation and smart grids, are also not covered in the IRP (DoE, 2011: 36). This limitation is partially addressed in the 2013 update which conducts a transmission impact assessment of different scenarios. The assessment identifies five transmission power corridors which will be required to enable key generations scenarios, the physical amount of infrastructure and the timing varying from one scenario to another (DoE, 2013a: 91–106).

Similarly, the IRP does not directly interact with policies in other sectors, despite the intertwined nature and the countless backward and forward linkages of energy planning with other policies. The IRP is, for example, affected by a number of policies (such as the South African Coal Roadmap) and impacts on a number of national strategies (such as the Department of Mineral Resources's Beneficiation Strategy for the Minerals Industry of South Africa).

Acknowledging these policy-related factors of uncertainty, the IRP provides a sufficient degree of flexibility in the medium to long term. It phases in decision-making processes (based on a short-, medium- and long-term pattern), thus allowing for changes to be made at a later stage. For example, the IRP does not prescribe the renewable energy technologies to be used after 2020 so as to offer flexibility in the longer term.

In addition, the IRP identifies a set of risks to be considered (and mitigated) when implementing the plan, as well as their likelihood and possible impact. It considers risks associated with: the diversification away from historical sources to new technologies and fuel sources (the benefits of diversification are also emphasised); over-estimated demand forecasts; higher-than-anticipated nuclear costs; delays in building IPP-operated coal units; under-performing new generation capacity; the impact of variable capacity on system security and stability; reduced learning rates; increasing fuel costs (particularly in the case of coal); uncertainties around the import of hydro-electricity; and unmet energy efficiency demand-side management assumptions (DoE, 2011: 17–19).

To mitigate these risks, the IRP factors in three strategies: proper system adequacy tests (beyond reserve margin); the early roll-out of renewable energy to enhance localisation, along combined cycle gas turbines and coal options to ensure dispatchable capacity; and the possible life extension of older coal-fired power stations (DoE, 2011: 20). Adequacy tests have also been conducted as part of the 2013 update for some of the additional scenarios (DoE, 2013a: 107-114). In addition, the 2013 update includes a sensitivity analysis on a set of its assumptions, specifically investigating higher nuclear costs, higher coal prices, restrained learning rates and the policy commitment to a concentrated solar power park (DoE, 2013a: 39-42).

The 2013 update does further consider factors of future uncertainty and proposes a more flexible approach (rather than the relative fixed approach espoused by the IRP 2010). The update prioritises a high degree of flexibility so as to favour decisions of least regret. To guide decision-making, the update introduces decision trees for some technologies (nuclear, new coal, combined cycle gas turbine, and concentrated solar power) which show different pathways depending on events and choices made. Decision trees consider “a number of scenarios based on changes in underlying assumptions as well as policy direction” (DoE, 2013a: 42).

In a nutshell – policy instruments to achieve objectives: The IRP has been prioritised over the larger IEP. This has had implications for the broader energy planning framework in the country, resulting in a project-based approach to planning instead of a broad-based, integrated approach based on longer term sustainability and vision. While the IRP has provided a clear plan and implementation for specific projects, it lacks a clear articulation of its relationship with other higher-level policy and national strategies. The strength of the IRP lies in providing the policy options relevant to electricity with a good degree of flexibility and adaptability. The risk assessment of implementing the plan, sensitivity analyses on assumptions, as well as decisions trees included in the 2013 update provide useful insights to guide the implementation in terms of policy choices. In addition, the introduction of the principle of least regret decisions is a key development of the IRP that will improve the policy options and choices going forward.

3.7. Regulatory and institutional frameworks

Adequate regulatory and institutional frameworks underpin the timely implementation of the IRP and are the seventh assessment criterion. As such, the IRP must address: the required provisions to support its objectives; the constitution of a clearly designated network of institutions responsible for implementation; and a monitoring mechanism to ensure transparency and accountability.

The IRP does not particularly deal with the implementation mechanisms required, and the rules and regulation for the implementation of the IRP remain unclear, as raised during the consultation process (DoE, 2011: 36). Indeed, while it does indicate decisions which need to be made within certain timeframes, the plan does not provide appropriate details about the implementation.

For example, the introduction of an unbundled (i.e. outside of Eskom) ISMO to invest, operate and maintain the country’s high voltage transmission grid is not addressed in the IRP, despite constituting a critical building block of its implementation. Going forward, the introduction of an unbundled ISMO may fully empower IPPs to sell electricity (notably, but not only, from renewable energy sources) directly to third-party consumers (such as mining and industrial complexes) and is arguably critical to the success of the IRP (Unlimited Energy, 2013). The ISMO Bill is meant to consolidate conflicting policy discourses on the role of the future ISMO and address discrepancies by establishing the ISMO as a national public entity, responsible for: (a) generation resource planning in accordance with the IRP; (b) transmission service and implementation; (c) buying power from generators, including Eskom, co-generators and IPPs; (d) system operations and expansion planning; and (e) electricity trading at a wholesale level. However, the current version of the Bill has been stalled in Parliament since March 2011, and does not cater for the transfer of transmission assets from Eskom to the ISMO, an essential aspect to avoid conflicts with the utility (Montmasson-Clair, Moilwa & Ryan, 2014).

The IRP does not either delve into the institutional framework required to implement the plan, despite the urgency for further clarity and coherence. At the moment, the regulatory framework of South Africa's electricity sector comprises a wide array of stakeholders, from government departments, to the independent regulator, to regulated entities and end-user consumers. While not central to the direct regulation of the sector, economic ministries, such as the National Planning Commission, the Department of Trade and Industry and the Economic Development Department, provide the overall framework in which the electricity sector is to operate. The regulation and operation of the ESI have substantial macroeconomic, industrial and developmental impacts beyond the energy sector and must be aligned to broader governmental priorities, particularly for economic growth strategies, job creation, local manufacturing capability, and poverty and inequality eradication.

The core regulation of the ESI mainly rests in the realm of four state entities: the DoE, the Department of Public Enterprises (DPE), the National Treasury and NERSA. While the DPE (which has 100% shareholding in the utility) governs Eskom through an annual shareholder compact which documents the mandated key performance measures and indicators to be attained by the utility (DPE, 2012), the DoE, through its Minister, has the mission to "regulate and transform the sector for the provision of secure, sustainable and affordable energy" (DoE, 2013b). The DoE is directly responsible for ensuring security of supply and energy planning (i.e. the IEP and the IRP). As such, it is also tasked with the introduction of IPPs, the roll-out of renewable energy, maintaining the upkeep and access to energy infrastructure and gathering energy data and information. National Treasury plays the multiple roles of ensuring the country's macroeconomic stability and the policy coherence in the energy sector, providing finance or guarantees to both Eskom and the municipalities, and delivering technical assistance to the DoE. Last but not least, NERSA is the institution responsible for the direct regulation of the energy sector in South Africa and operates as the custodian and enforcer of the regulatory framework. The regulator is mandated to regulate market entry (licensing) as well as oversee the conduct of and tariffs for, electricity sector participants.

In addition to these four key institutions, a wider array of institutions interact in the ESI, from environmental ministries (namely the Department of Environmental Affairs and the Department of Water Affairs) to regulated entities (Eskom and IPPs) and main electricity consumers (municipalities and industrial users).

Ultimately, the state holds the four distinct roles of shareholder (through the DPE), policymaker (through the DoE), regulator (through NERSA) and project developer (through Eskom) (Steyn, 2013). As such, "[g]overnment has not found a definite solution to its multiple roles as shareholder, industrial and social policymaker or reconciled this with the state's decisions to allocate economic regulatory function to an independent regulator" (Storer & Teljeur, 2003). Institutional arrangements in the ESI are of a particularly intertwined and thorny nature, calling for the role attributed to each stakeholder to be clarified. The vast number of stakeholders involved in the regulation of the ESI, often with competing interests, influences both directly and indirectly the governance and decision-making processes in the sector. The complex (and sometime opaque) relationships, and their nature (i.e. power relations), between these various entities shape the policies regulating the electricity sector as well as their implementation.

The current governance system of the ESI is indeed characterised by competitive power relations or a failed balance of powers, created by confusion in the responsibility of various institutions, ultimately limiting the effectiveness of the system (Van Basten, 2007b). The effective implementation of the legislative framework has therefore proven difficult. Gaps and incoherencies in the regulatory system have left roles and powers of key stakeholders (such as NERSA, Eskom and the DoE) poorly defined, allowing parties to act opportunistically to protect their interests, sometimes at the expense of other stakeholders (Steyn, 2012). This has led to an unclear division of roles, political interference in independent decision-making processes and information asymmetry problems (Das Nair, Montmasson-Clair & Ryan, 2014).

While policymakers should provide the frame within which the regulator is to operate, NERSA's independent decision-making power should be protected. The tendency of the South African government to attempt to interfere (both directly and indirectly) in independent decision-making processes and the improper division of responsibilities between entities have contributed to blurring the lines of the division of powers and prevented the implementation of a proper monitoring mechanism.

For example, political pressures have created considerable challenges for NERSA to fulfil its mandate, set in the 2008 Electricity Pricing Policy, of moving prices towards long-run marginal costs (DME, 2008). This has jeopardised the viability of the ESI system by preventing the implementation of cost-reflective tariffs, thus limiting Eskom's ability to fund the ongoing expansion programme and receive a return on assets as per legal requirements and NERSA's own regulatory methodology. The circumvention of NERSA's authority to review the commissioning of new power plants (through licensing) is another illustration of external intervention. As such, Eskom's investment plans are submitted to Cabinet for approval before NERSA's formal evaluation and public comment/review (Steyn, 2012). In the same way, while the REIPP procurement programme spearheaded by the DoE and National Treasury has been a successful initiative, it *de facto* removes NERSA's ability to review applications for generation licence independently (Montmasson-Clair, Moilwa & Ryan, 2014).

Similarly, inconsistencies, if not a complete change of position over time, on the role of the private sector in the South African ESI are a clear illustration of the need to provide long-term clarity to the sector. Constant twists in the allocation of responsibility to build new generation capacity, associated with the role granted to IPPs in the country, have created policy uncertainty and made it difficult for stakeholders to plan and adapt, contributing to the electricity crisis (Das Nair, Montmasson-Clair & Ryan, 2014).

Although the IRP has introduced some certainty for the next two decades, improving the institutional arrangements and processes that shape decisions to invest in generation technologies appears as a medium-term challenge for South Africa going forward. "Eskom is a business in flux: the uncertainty of its future mandate[, notably in terms of generation building and transmission,] is preventing it from planning ahead effectively, while its reduced income will require some re-engineering of the business and reprioritisation over the next five years" (Eskom, 2013).

While the overall regulation of the ESI is beyond the scope of the IRP process, further emphasis should be given to the impact that the current regulatory and institutional arrangements have on the ability of the IRP to reach its objectives. Recommendations (as far as generation is concerned) should be formulated in the IRP to streamline and improve the regulatory and institutional framework.

In a nutshell – regulatory and institutional frameworks: The institutional and regulatory framework governing the ESI (and generation planning in particular) remains an important issue to be addressed. The current governance system is characterised by competitive power relations or a failed balance of powers, created by confusion over the responsibility of various institutions. The state holds the four distinct roles of shareholder, policymaker, regulator and project developer, and decision-making processes appear somewhat politicised and inconsistent over time. The introduction of IPPs in the renewable energy space is, however, a positive sign of the ability to introduce a regulatory framework to encourage the participation of the private sector, although this was essentially a programme-driven initiative. Issues concerning the transmission and distribution network are unresolved, with the ISMO Bill still stalled in Parliament. The IRP does not particularly deal with the implementation mechanisms required and the rules and regulation for implementing the IRP remain unclear. While it is arguably not the role of the IRP to design the institutional structure of the ESI as a whole, it is well positioned to bring more clarity and certainty to the regulation and institutional framework. The main challenges remain the multitude of stakeholders and interests, the required policy coordination for decision-making, and the need to ensure the effective enforcement of regulation and active participation of institutions in monitoring and evaluation.

3.8. Investment financing

The financing aspect of electricity planning process should not be neglected so as to ensure appropriate implementation. The IRP should include: an evaluation of the scale of investment; an assessment of the mechanisms to obtain financing; a clear budget plan available to the public; a clearly communicated and publicly available tariff impact report; and a study on the potential to phase out fossil fuel subsidies.

The scale of investment is assessed in each scenario considered by the IRP. The total cost of the new build generation capacity is one of the six variables (in addition to security of supply) against which each scenario is being assessed as part of the planning process.

As part of the consultation process, an assessment of anticipated future funding requirements for new generation capacity per year (in real teams) was conducted. As such, the South African government considered *inter alia* the extent and timing of the new build programme required to meet demand as well as the nature of the entities responsible for new capacity (DoE, 2010d). Most of the financing evaluation is, however, conducted at the utility level by Eskom which, as already mentioned, engaged in a R340-billion (US$31 billion) new build programme constituting the bulk of the IRP. Eskom also assessed the cost associated with purchasing electricity from renewable energy IPPs and obtained some revenues for the regulator in this respect.

However, the IRP does not speak in clear terms on the role of funding and financing aspects of electricity expansion in the country. A factsheet describing the input parameter of finance for the IRP is provided as background information for stakeholders, but only describes in brief terms the potential sources of financing for IRP-related implementation, such as debt raised from various markets/lenders with implicit or explicit government support; regulatory revenue and tariffs and equity raised from government directly or state-owned financial institutions (both locally and internationally) or from the private sector (DoE, 2010d). The role of credit rating agencies is also highlighted in the parameter sheet, emphasising the need of the borrower's ability to service and redeem debt while maintaining a healthy balance sheet. These rating agencies have a direct and material impact on the borrower's ability to raise funding without sovereign guarantee and the associated cost of debt funding.

Domestically, the potential to phase out fossil fuel subsidies and its implications are not assessed as part of the IRP. The International Energy Agency has identified around US$1.4 billion in consumer subsidies for 2011 in South Africa, essentially for coal-fired electricity, representing an average subsidisation rate of 4.6%. Although fossil-fuel subsidies have been significantly reduced in the country over the past few years (from more than US$8 billion in 2007), and include a share for the support of low-income households, more efforts is required in this respect (IEA, OPEC & World Bank, 2010; Koplow & Kretzmann, 2010; IEA, 2012).

Altogether, the IRP considers the price implications of the chosen electricity mix. It factors in the changes to asset valuation applied by NERSA as well as capital expenditure in transmission and distribution infrastructure. Projections also include a range in which average price can vary based on assumptions on capital expenditure for the non-generation part of the ESI and the depreciation period (from 25 to 40 years) (DoE, 2011: 48). The 2013 update also models the cost and price implications of the various scenarios considered (DoE, 2013a: 20-21; 67-68). The IRP, however, does not provide a fully-fledged budget plan linked to its recommended investments, and essentially rely on Eskom's estimates and NERSA's tariff decisions in this respect.

In a nutshell – investment financing: Even though the IRP provides a description of the potential sources of financing for the ESI, the plan lacks a clear budget for financing the plan. The scale of investment required is assessed according to scenario planning methodologies; however, much of the financing information and data is based on the business considerations of Eskom (and its performance compact with the DPE), as well as decision-making processes of the National Treasury. Public information on the financial planning of new generation expansion programmes appears lacking. This information is made available only in applications to NERSA in the MYPD process, at which stage the implementation of electricity planning is already underway. Notably, the potential for phasing out of fossil fuel subsidies and its implications are not assessed as part of the IRP, which is a missed opportunity for considering a more sustainable electricity sector.

3.9. Social and environmental considerations

Social and environmental considerations must also be factored into the planning process in order to construct a sustainable IRP and this constitutes a critical analytical criterion. In this respect, the IRP should include: comprehensive and publicly available social and environmental impact assessments; mitigation strategies, including protecting livelihoods and mitigating tariff impacts; and considerations of gender impacts and other social issues.

The oversight of obvious remarks and the non-inclusion of both social and environmental considerations in the IRP appear to be one of the major downfalls of the IRP in its process, development and publication.

Climate change considerations are featured moderately in terms of input parameters for climate change and the introduction of a carbon tax (planned for 2016 by the National Treasury). The IRP 2010 was adjusted from a cost-optimised scenario developed under a carbon emission constraint of 275 million tons per year from 2025 for the electricity sector, incorporating localisation objectives and bringing forward the renewable roll-out. As raised earlier, the IRP has therefore somewhat factored in its planning process the transition to a low-carbon and environmentally-friendly energy mix, in line with the country-wide transition to a green economy, and the IRP 2010 provides for a reduction of the share of coal-based electricity from 90% in 2010 to 65% in 2030. In addition, power plants are meant to comply with environmental requirements as set by the National Environmental Management Act No. 107 of 1998 and other key legislation (such as the Air Quality Act No. 39 of 2004 and the National Water Act No. 36 of 1998). However, the 2013 IRP update acknowledges that the cap of 275 million tons of carbon dioxide-equivalent per annum for electricity which is set in the IRP 2010 is clearly insufficient for the sector to be in line with the country’s commitment on greenhouse gas emissions. While keeping this target as its base, the 2013 review also proposes two more aggressive scenarios aimed at setting the electricity sector on a genuine low-carbon development path compatible with the country’s objectives, which suggest drastic changes to the supply mix.

In addition, a study on socio-economic impacts is lacking, as highlighted during the consultation process (DoE, 2011: 35). A comprehensive and holistic evaluation and consideration of the social and environmental dimensions of the IRP are severely lacking in both the IRP 2010 and its subsequent update. For instance, discount rates used in the modelling do not factor social considerations appropriately, including inter alia issues around poverty, gender and energy access. Also, while the 2013 update does acknowledge the environmental impacts (particularly air pollution) of its proposal to extend the lifespan of old coal-fired power stations, it does not consider it as a constraint.

While the IRP process considers water usage in its decision-making, water does, however, not appear as a decisive criterion in the IRP process and remains the sole socio-environmental impact (with greenhouse gas emissions) being considered by the IRP.

Gender considerations are not covered in the IRP, which led gender-based institutions to ultimately reject the plan. At the public hearing forum on the IRP, gender institutions shared their views on the IRP document. A joint presentation[26] on the issues explained that the IRP fails to acknowledge its impacts on women and poverty.

Energy access is perceived as a technical problem with a mainstream focus on energy security, predominantly for the industry-based economy. Plans for access to electricity by rural communities and the necessary resources for this provision were deemed insufficient. While the IRP does bring forward the roll-out of renewable energy to increase localisation and job creation objectives, the IRP also fails to recognise the jobs that could be created from alternative energy generation sources, such as biomass, wind and solar compared to coal. Furthermore, the consultation process was criticised for being exclusionary, as it did not include roadshows (except for Johannesburg, Cape Town and Durban) or any other form of access to the plan than through literature (GENSA, GenderCC & CGE, 2010).

In a nutshell – social and environmental considerations: The social and environmental dimensions of the IRP are limited to climate change considerations (and water use to some extent), lacking an adequate analysis of the social impacts of the ESI, particularly in the impacts on rural communities and gender issues. In addition, the constraint on greenhouse gas emissions appears insufficient to be compatible with South Africa's international commitment and must be revised accordingly. Environmental aspects, such as the water use and water quality issues associated with energy production, vital to a better understanding of the country's water-energy nexus, need a lot more attention. Even though the IRP process involves public consultation and stakeholder engagement, the final design and implementation should include robust and clear social and environmental impact assessments. While mitigation strategies are captured as input parameters through climate change considerations and the introduction of a carbon tax in the country, these do not factor into a wider socio-economic impact assessment, notably in terms of price and access to electricity.

3.10. Promotion of innovation and anticipation of emerging challenges

The last aspect of an adequate IRP is the promotion of innovation and anticipation of emerging challenges. The IRP should then: promote innovation and strategies for technology improvements; provide measures to address technological advancements (including energy efficiency, transmission, renewable energy, pollution reduction); consider human capacity building (technical, policy, and regulatory); and institutional capacity building for decision-makers and implementers.

While the South African IRP does consider to some extent a number of areas of innovation and improvements, the promotion of innovation and anticipation of emerging challenges is largely not addressed by the IRP process, particularly for capacity building, both at an individual and institutional level.

[26] The Gender and Energy Network of South Africa, Gender CCSA-Women for Climate Justice, and the Commission on Gender Equality made a joint presentation at the Johannesburg public hearing on the IRP in December 2010.

The IRP puts forward only a short research agenda to be investigated for the next iteration of the IRP. The IRP considers the need for more research in: distributed generation, smart grids and off-grid generation; underground coal gasification and carbon capture and storage; the incorporation of uncertainty and risk in the IRP process and the scenarios used, notably the use of different discount rates for technologies; the need to develop a longer-term vision (2050) along the IEP, notably in terms of objectives and vision for emissions and the energy industry; the impact of extensive decommissioning of the existing coal fleet between 2030 and 2040; the price sensitivity of demand and possible substitutes to electricity; and the potential and challenges of some technologies (cost of coal and nuclear; management of nuclear waste; potential of small hydro, regional hydro (Inga); biomass, storage and energy efficiency) (DoE, 2011: 21-22). The 2013 update re-emphasises the need to look at the per-unit costs of energy efficiency demand-side management programmes and the opportunities beyond Eskom's programmes (DoE, 2013a: 38).

In a nutshell – promotion of innovation and anticipation of emerging challenges: The promotion of innovation and the anticipation of emerging challenges are largely not addressed in the IRP. This aspect of the planning process is limited to a research agenda which is easily dated and consequently may be irrelevant for the planning process. Capacity building at both a technical (human capital) and institutional level are areas requiring more attention in the IRP. The potential for leapfrogging other countries in the area of innovation in energy sources should be driven by the IRP. Understanding and implementing the latest technology in terms of energy efficiency, transmission, renewable energy and pollution reduction can go a long way in ensuring the sustainability of the ESI. A planning process that is coordinated with technology and innovation policy, prioritising research and development and the right institutions for technology transfer and adoption are critical. Without sufficient measures to pioneer this space, the planning process risks adopting sub-optimal technologies and systems in the electricity sector.

3.11. Summary of the assessment

Overall, the South African IRP performs relatively well against the applied 10-criteria analytical framework, although some clear areas for improvement remain. The institutionalisation of the planning process since 2009, through the IRP, has brought considerable progress to electricity generation planning in South Africa and further ameliorations are expected with the next iterations. Regular and timely updates of the IRP are therefore required to harness the full potential of the planning process. More effort and accountability is needed in this respect.

While South Africa has previously displayed an inability to capitalise on policy learnings in the energy space, the institutionalisation of the IRP process has started to address this shortcoming, notably with the 2013 update incorporating a review of assumptions and conditions considered in the IRP 2010. Unlike previous planning exercises, the IRP is mobilising the necessary data and information from relevant stakeholders to conduct an adequate and meaningful planning process.

The institutional arrangements around the planning process have indeed been improved under the leadership of the DoE, although much progress is needed to streamline the regulatory and institutional framework of the ESI as a whole. Information asymmetry problems (in favour of the utility), politicised decision-making processes, and a lack of clarity on the responsibility of each institution are outstanding points to be addressed. Labour and civil society are also missing from the decision-making process of the IRP and should be included for increased transparency.

At a policy level, the IRP has problematically been prioritised over its larger IEP due to the 2008 electricity crisis. This has had implications for the broader energy planning framework in the country, resulting in a project-based approach to planning instead of a broad-based, integrated approach based on longer-term sustainability and vision. This should be resolved with the completion of the IEP in the near future. This should also address the lack of articulation between the IRP and other higher-level policy and strategies. A long-term vision for the ESI beyond generation capacity should be developed to replace the outdated 1998 Energy White Paper. This should include more clarity on the role of the private sector in the ESI, notably through the conclusion of the debate around the ISMO Bill. While it is arguably not the function of the IRP to design the institutional structure of the ESI as a whole, it is well positioned to bring more clarity and certainty in terms of regulation and the institutional framework and should formulate recommendations that address this.

In terms of the core energy mandate of the IRP, the planning process rightfully prioritises security of supply, followed by cost and climate change considerations. The potential to better align numerous, conflicting objectives and consider other sectors and development goals exists. Notably, environmental and social impact assessments are globally missing and constitute one of the major downfalls of the IRP process. The constraint on greenhouse gas emissions appears insufficient to be compatible with South Africa's international commitment, and environmental and social issues are only partially addressed (such as water usage) or lacking (air pollution, gender issues and rural development). Similarly, the economic and financial impacts of the proposed generation mix should also be given more attention. Even though the IRP provides a projection of expected electricity prices and a brief description of the potential financing sources, the IRP lacks a clear budget plan.

Altogether, while the overall supply mix remains contentious, sound scenario-based methodologies are used to determine the most optimal choices for South Africa, while trying to attain the best trade-off between least-investment cost, climate change mitigation, diversity of supply, localisation and regional development. The strength of the IRP lies in providing the policy options relevant to the electricity sector with a good degree of flexibility and adaptability. The risk assessment of implementing the plan, sensitivity analyses on assumptions as well as decisions trees included in the 2013 update provide useful insights to guide the implementation of policy choices. The introduction of the principle of least regret decisions is a key development of the IRP that will improve the policy options and choices going forward.

In addition, assumptions and data used, although always debatable (particularly GDP growth forecast), are publicly disclosed and discussed as part of an effective consultation process, and the IRP planning process is clear and transparent in its demand forecast methodology and consideration of all resources options, although more could be done to promote innovation. Nevertheless, further research on the price elasticity of demand should be conducted to better inform long-term forecasts. In addition, the IRP does not particularly deal with the implementation mechanisms required and the rules and regulation for implementation remain unclear. Potential constraints at a human and institutional level are also not considered adequately.

In brief, the assessment provides a clear picture of the progress achieved in the last few years and the goals to achieve in the next iterations of the IRP. The assessment of the performance of the South African IRP against the proposed assessment framework, both in the areas of success and progress, positions the current IRP as a good first attempt and a valuable starting point for the next iteration of the planning process. Going further, for the assessment to be complete, the implications of the performance of the IRP process for its ability to achieve its objectives must be discussed.

4. WHAT DOES THE ASSESSMENT MEAN FOR SOUTH AFRICA'S DEVELOPMENT?

Building on the 10-criteria assessment framework and its findings about the IRP process in South Africa, the IRP can be put into perspective against the objectives of energy policy. As conceptualised by Das Nair, Montmasson-Clair & Ryan (2014) and illustrated in Figure 3, energy policy aims to achieve a varied set of objectives. The primary mandate of energy policy, and electricity planning, remains its core energy-related objective, i.e. ensuring security of supply. Energy policy in South Africa is also assigned a set of peripheral objectives on many fronts, from economic and industrial, to developmental, social and environmental, and financial considerations.

4.1. Energy objectives

Considering first the core energy mandate of electricity planning, which is to ensure security of supply and quality infrastructure, the IRP performs well in theory. Security of supply is at the core of the IRP process and constitutes the priority of electricity planning in South Africa. All the scenarios modelled as part of the IRP 2010 and the 2013 update are only considered and assessed once they meet their electricity supply target. Policy choices forced into the planning process, with regards to nuclear energy, gas and renewable energy, for example, are also underpinned by security of supply considerations. Besides, while the IRP 2010 does plan for a realistic growth path, the 2013 update proposes a valuable, complementary analysis of a more aspirational development, associated with useful decision trees optimised for least-regret decisions.

In addition, the IRP does address its insufficiencies on the short-term electricity crisis by complementing its framework with a MTRMP aimed solely at "keeping the lights on". The IRP also places a lot of emphasis on curtailing portfolio risk and uncertainty. While the IRP introduces new sources of energy, it grants credit and significant importance to mature technologies. Practically, technological uncertainty is one of the main determining criteria in the modelling exercise.

In practice, implementing the IRP and the MTRMP appears more problematic. The urgent measures recommended by the MTRMP have largely not been implemented or have suffered substantial delay. For example, the development and promulgation of a legal framework to promote non-Eskom generation is still outstanding at this stage (Das Nair, Montmasson-Clair & Ryan, 2014; Montmasson-Clair, Moilwa & Ryan, 2014). The consequence of this delay has meant the lack of meaningful participation of the private sector in the electricity market and the continued dominance of Eskom.

At the same time, Eskom's demand-side management incentive programmes were put on hold in September 2013 due to funding constraints, and only partially reinstated in July 2014 (Eskom, 2014b). The Energy Conservation Scheme, which forms part of the required "safety net" and has been developed by the utility, has not yet been implemented.

Altogether, a lack of clarity persists around the implementation of the IRP in the medium to long term. While the short-term roll-out of renewable energy has largely been a success, further certainty should be given on the long-term continuity of the programme. In the same vein, the procurement of baseload power and co-generation capacity from IPPs is still lagging and should be fast-tracked. Decision-making processes around the future of gas and the commissioning of nuclear energy remain unclear and should be integrated so as to avoid stranded investment and over-capacity.

4.2. Economic objectives

Besides its core energy mandate, the IRP must also consider its overall impact on macroeconomic conditions in South Africa. This is a prime consideration in the development of the IRP, which places the cost of the generation pathways as the primary criterion (along with climate change) after security of supply to evaluate scenarios. A more thorough assessment beyond the cost of the investment plan, including impacts related to exchange rate, foreign currency, trade flows, should be conducted to better understand the overall economic consequences of the IRP. Large-scale energy-related procurement programmes can have noteworthy macro-economic consequences, as illustrated by the impact of the REIPP procurement programme on South Africa's financial variables, such as the exchange rate (Papapetrou, 2014).

While the IRP 2010 was criticised for considering relatively unambitious growth paths and potentially constraining growth in the long term (by not properly considering the amplitude of the existing suppressed demand), the 2013 update addressed this shortcoming by designing an electricity plan based on an aspirational 5.4% per annum growth rate. The update also prioritises a high degree of flexibility so as to favour decisions of least regret, and tailor investment decisions as closely as possible to the actual need of the country.

4.3. Industrial objectives

Industrial objectives, along with economic implications, are deeply rooted in the electricity planning process. The IRP is tasked with ensuring security of supply at the least cost possible, and aims to limit electricity price increases.

Indeed, it would seem counterproductive to assume a position in which energy policy would be divorced from other economic and social development objectives of a country, particularly a developing country like South Africa. Promoting small businesses, increasing competition and stimulating downstream beneficiation and the resultant employment spinoffs, have all been integral components of industrial policy over the years. Therefore, energy-related decisions, most notably for planning, are significant for the successes of other policies and an approach that does not take into account the impact of electricity-related decisions on other policies is arguably too narrow in its mandate (Das Nair, Montmasson-Clair & Ryan, 2014).

The actions and decisions in the ESI have direct implications on other policies. For instance, although pricing issues are outside of the scope of the IRP, they provide a conclusive example of the direct link between energy policy and other government objectives. The long-term contracts with a few selected heavy electricity users at favourable rates (such as BHP Billiton's case discussed in Annexure 5) provided an advantage to incumbent firms in key input industries, which contributed to creating and sustaining their dominance, as well as presenting barriers to entry to potential new entrants which could not secure such rates. There have been numerous competition-related problems that other economic regulators, such as the Competition Commission and Competition Tribunal of South Africa, have been confronted with relating to abuse of dominant positions by incumbents. While not attributing the sole reason for dominance of incumbents to favourable electricity prices, privileges and subsidies offered to only a select or favoured group of firms (and not to several competing firms in an industry) have negatively impacted competitive outcomes (Das Nair, Montmasson-Clair & Ryan, 2014).

In essence, the IRP, by focusing on achieving security of supply, answers the primary energy-related concern of industry and one of the main constraints to the growth of the South African industrial sector. As shown by Montmasson-Clair & Ryan (2014) in the case of mining value chains, electricity interruptions and more broadly security of supply represent a larger concern for mining-related companies in South Africa than electricity price increases.

In addition, although the IRP does not directly consider the impact of planning decisions on the competitiveness of the South African economy, it factors into its modelling the price effect of the different scenarios considered. In reality, the existing backlog in generation capacity and the size of new build required to restore sufficient supply and reserve margin nevertheless command further electricity price increases. This is compounded by the change in pricing methodology, as illustrated in Section 2, and the pricing behaviour of municipalities, discussed in Box 1, which are outside of the realm of energy planning.

4.4. Financial objectives

Complementing economic, and to some extent industrial policy objectives, energy policy has financial obligations. The financial stability of the ESI is of utmost importance. Investment decisions must consider the role and ability of Eskom, the private sector and municipalities in funding capital-intensive electricity infrastructure.

The IRP does not address these concerns, even though it attempts to minimise the cost of electricity generation to the economy. The IRP process does not tackle the financing of the required investment. In addition, the planning process does not incorporate specific provisions to deal with unforeseen expenditure, such as the collapse of a coal storage silo in November 2014 at the Majuba power station. The IRP should in future incorporate the significant economic impact and consequences of such major operational failings (particularly on newer generation fleet) and provide a thorough review of whether the immediate and medium-term management of the unforeseen damage was adequate and efficient.

The financial sustainability of the utility is monitored by the DPE and is not the responsibility of the planning process. However, the impact of the suggested investment on the state-owned enterprise should be kept in mind when designing the electricity generation plan. The IRP only incorporates policy decisions (on renewable energy and nuclear capacity for example). It does not prescribe whether Eskom and IPPs should build the required generation capacity, and refrains from suggesting a preferred structure.

Similarly, the IRP does not look at the impact that the proposed changes to electricity generation would have on South African municipalities. For example, as municipalities derive up to 60% of their revenues from the on-sale of electricity, a transition to a more decentralised ESI based on embedded generation (such as individual rooftop solar photovoltaic capacity) would have substantial consequences on the funding model of municipalities.

4.5. Development objectives

Energy policy has a mandate to address developmental objectives, such as universal access to electricity and affordable pricing, particularly for low-income households. Although the planning exercise contributes to the ultimate goal of achieving universal access to electricity in the country by ensuring sufficient generation capacity, development objectives are not paid enough attention in the IRP.

The IRP does not deal with the distribution stage of the ESI, and it is arguably not within its scope. However, by failing to incorporate development objectives in terms of access to electricity, the IRP interprets its mandate too narrowly. Indeed, the IRP essentially caters for the industrialised and densely-populated areas, neglecting the access to electricity of other parts of the country. Further integration with government’s Integrated National Electrification Programme should be pursued going forward. Development objectives, such as poverty reduction and inequality eradication, are within the objectives of the ESI, and should be considered in the IRP process.

While issues of pricing are not within the ambit of the IRP and are determined by the energy regulator, the IRP could nevertheless do a lot more to consider the pricing impact of its proposed generation building plan on different customers. In the current IRP process, only an average estimate of the possible pricing pathway resulting from the commissioning of new generation capacity is presented. South Africa’s electricity prices are, however, extremely diverse, differentiating between urban and rural areas, small and large customers, as well as the time of use. A free basic electricity allowance is also provided to poor households. The impact of the pricing pathways can therefore differ substantially from one customer to another and this variance should be acknowledged and assessed as part of the IRP process.

4.6. Social objectives

On top of underlying developmental objectives, energy policy also targets social objectives, such as localisation, job creation and the economic empowerment of previously disadvantaged groups in South Africa.

The IRP explicitly targets social objectives, with the aim of enhancing localisation and job creation. The localisation potential (and associated employment benefits) constitutes one of the criteria against which scenarios are being evaluated. Altogether, job creation and localisation, although high on the government agenda are, however, not part of the main objectives of the IRP in its current form. The localisation criterion is not a particularly discriminating condition for the assessment of scenarios. Ultimately, localisation and employment considerations have been forced in the proposed generation building plan by bringing forward the roll-out of renewable energy, which has socio-economic objectives attached to it (Montmasson-Clair, Moilwa & Ryan, 2014). The impact, however, remains marginal compared to the overall scale of the ESI in South Africa.

Other social issues, such as rural development and gender implications, are not considered in the IRP, as highlighted in Section 3.9, and should be integrated in the design of the IRP going forward.

4.7. Environmental objectives

Owing to the considerable weight of the energy sector in South Africa's greenhouse gas emissions, which accounted for 61% of the country's total emissions (DEA, 2013), and the other negative externalities of fossil fuel-based electricity generation, environmental considerations are central to energy policy.

The IRP process acknowledges this reality by building in an emission cap for the electricity sector and placing the reduction of greenhouse gas emissions as its main assessment criterion (along with the total cost to the economy) after security of supply. The IRP 2010 also plans for a reduction of the share of coal-based electricity generation from 90% in 2010 to 65% in 2030, notably through the ramp up of renewable energy technologies and nuclear energy. The 2013 update, however, recognises that the IRP 2010 cap is insufficient to reach South Africa's international climate change mitigation commitment.[27] Further efforts and a strong policy drive on this issue are therefore required in the next iterations of the IRP to adequately set the electricity sector and South Africa on a green growth path.

Other environmental externalities, with the exception of water usage, are not considered in the IRP process and an appropriate environmental impact assessment should accompany the IRP. And while reducing water consumption is one of the objectives of the IRP and water usage is indeed one of the evaluation criteria, it does not bear a lot of weight in the decision-making process.

Ultimately, environmental issues, including climate change, should be given more substantial consideration so that the electricity sector can meaningfully contribute to South Africa's transition to a green economy and the country's goal of achieving a sustainable development path.

[27] South Africa has pledged to peak its greenhouse gas emissions between 2020 and 2025 at respectively 34% and 42% below a business-as-usual trajectory, plateau for approximately a decade and decline in absolute terms thereafter, subject to the adequate provision of financial resources, technology transfer and capacity building support provided by developed countries (UNFCCC, 2011).

5. CONCLUSION

The IRP process has introduced substantial ameliorations in electricity planning in South Africa, compared to the disorganised experience of the past century. Owing to the centrality of electricity planning in ensuring adequate supply as well as affordable, stable and predictable pricing, the IRP process has the potential to make a ground-breaking contribution to the South African economy, contributing beyond its core energy mandate.

Based on the evaluation conducted against a 10-criteria analytical framework, the IRP 2010 and its 2013 update constitute a valuable first attempt as a fully-fledged IRP for electricity in South Africa. The IRP process is considerably more robust and transparent than previous planning exercises. Under the leadership of the DoE, the IRP successfully gathered the stakeholders, data and information necessary for a meaningful planning process. The public availability of methodologies, data and assumptions used as part of the modelling process and the effective consultation bring transparency and confidence in the IRP process. Altogether, the scenario-based approach used since the IRP 2010 and the introduction of a path of least regret decision in the 2013 update also offer assurance in the ability of the IRP process to appropriately drive electricity planning in South Africa.

Clear areas of improvement nevertheless remain. Most particularly, social and environmental considerations are largely not considered in the planning process, potentially undermining South Africa's transition to a green economy and goal of addressing the triple challenge of poverty, unemployment and inequality. The inclusion of labour and civil society in the final decision-making process, currently dominated by government and the private sector, could provide an adequate platform to address this issue. In addition, further consideration should be given to the financial (and ultimately pricing) impact of the proposed generation mix, in collaboration with the finalisation of the transition to cost reflective tariffs.

The performance of the IRP is also hampered by a series of issues affecting the ESI as a whole. The lack of clarity on the role of various stakeholders, the persistence of information asymmetry in favour of the national utility and principal-agent problems (notably the politicisation of decision-making processes), as well as the absence of an up-to-date long-term vision for the ESI have the potential to jeopardise the successful implementation of the IRP. Practically, concrete and transparent implementation mechanisms should accompany the development of the plan to ensure its effective execution. For example, the debate about the ISMO Bill and the role of the private sector in the South African ESI should be fast-tracked so as to provide clarity and certainty to all stakeholders.

Ultimately, like energy policy, the IRP is also tasked with a too many conflicting objectives and therefore fails to contribute meaningfully on several fronts. The priority of the IRP rightfully remains the country's security of supply, although this has been compromised due to implementation problems. Besides electricity security, the impact of energy planning on other national objectives has thus been secondary and the priorities assigned to the IRP should be streamlined and sequenced to maximise positive spillovers.

By trying to achieve too many objectives at the same time, electricity planning risks failing on all, and better prioritisation is needed. As such, the contribution of the IRP and energy policy as a whole, to peripheral objectives (such as social, environmental, industrial, etc.) has been marginal and is expected to remain so until security of supply is achieved.

Going forward, further effort is needed to perfect the design of the IRP, notably its regular and timely update. Ensuring that the IRP appropriately introduces the most recent and efficient technologies in line with the country's economic, social and environmental objectives should be one of the priorities. In addition, further integration with other national policies and strategies, and particularly the IEP and other energy-related plans, should be prioritised. Further work is required to conceptualise and establish the optimal policy and institutional arrangements and link the IRP exercise to an effective implementation plan as well as a monitoring and evaluation system.

Much more effort is required to ensure the effective and timely implementation, monitoring and evaluation of the IRP. Without an adequate and enforceable execution plan, the IRP remains a theoretical exercise. Institutional and regulatory arrangements hampering the implementation of the IRP, notably in the short term, must be addressed as a matter of urgency. Only then will electricity planning be in a position to meaningfully contribute to the sustainable development of South Africa.

ANNEXURE 1: TIMELINE OF KEY EVENTS IN THE ELECTRICITY SUPPLY INDUSTRY

Period	Key event
1970s	In 1974, Eskom initiated its massive build programme and, between 1974 and 1978, electricity prices increased by about 70% to finance construction activities. Brownouts and blackouts continued despite the investment in excess additional capacity. Eskom misinterpreted the power shortages as a sign of insufficient capacity, when they were caused by project management problems that delayed the commissioning of plants.
1980s	By 1983, Eskom had 22.26 GW of generation capacity under construction or on order. Failure to properly plan and oversee investment decisions resulted in excessive capacity expansion and inefficient investment. To service soaring debt, cost was passed on to consumers, leading to steep average nominal price increases in the 1980s while the utility benefited from a monopoly position, government guarantees, open-ended Reserve Bank forward cover and an exemption from taxes and dividends.
1990s	Special electricity pricing agreements with aluminium producer BHP Billiton, which were used to achieve industrial policy objectives in the 1990s, have had detrimental unintended consequences in the longer run.
2001 - 2004	Eskom corporatised with the Eskom Conversion Act of 2001. Additional capacity should have been initiated in the early 2000s to avoid the tightening of the supply-demand balance from 2006. However, two key government actions led to insufficient generation capacity in these years: (a) placing a moratorium on Eskom building power plants as the government envisaged a competitive market with private sector participation and (b) delays in contracting with Independent Power Producers. Cabinet passed a resolution in 2001 prescribing that 30% of Eskom's generation capacity should be sold to the private sector. This initiative failed to gain momentum and, in 2004, cabinet decided that 30% of new generation should then be built by the private sector. Private investment failed to materialise because of high regulatory risk, the then-Department of Minerals and Energy's protracted procurement process and low electricity prices. Looming supply shortages and long lead times needed to build plants caused the government to lift the investment moratorium placed on Eskom. As the moratorium ended in 2004, Eskom had lost four crucial years of construction time between 2001 and 2004.
2005	In 2005, government, through Eskom, embarked on a mammoth generation expansion programme valued at R340 billion (about US$31 billion), excluding capitalised borrowing costs. This is mainly dependent on the addition of two large coal-fired power stations, Medupi and Kusile. However, completion of both Medupi and Kusile has been substantially delayed with escalating costs.

2006 - 2008	The delays in planning directly resulted in insufficient generation capacity with an unprecedented number of power outages from 2006 to 2008, with severe economy-wide implications for the country.
2008	The 2008 crisis saw Eskom implement rolling load shedding and cut supplies to a number of large customers, such as mines and minerals beneficiation plants. In line with government's 2008 Electricity Pricing Policy, which states that tariffs would be cost-reflective in five years (i.e. 2013), NERSA initiated a shift in pricing methodology, from historical costs to depreciated replacement costs. The new pricing policy implemented included that revenue from electricity sales would need to fund a significant portion of the capital expenditure programme. (As in the 1980s, the financing requirements of the current investment programme have contributed to pushing prices up, ultimately resulting in a trebling of the average standard price at 89.13 c/kWh from 2009/2010 to 2017/2018)
2009 - 2010	Since 2009, electricity planning has been spearheaded by the Department of Energy, with the process being institutionalised through the Integrated Resource Plan. Prior to the 2009 Electricity Regulations on New Generation Capacity (which amended the Electricity Regulation Act No. 4 of 2006), planning and investment approval was scattered among several institutions with no clarity on responsibility and accountability. South Africa's IRP promulgated in its first version (IRP 1) on 31 December 2009 and revised on 29 January 2010, covered the 2009-2013 periods and planned for the development of an IRP for the 2010-2030 periods.
2011	The Integrated Resource Plan for Electricity 2010-2030 (IRP 2010), South Africa's current and first fully-fledged IRP was adopted in March 2011. This is a living plan and will include regular updates. The IRP is a subset of the Integrated Energy Plan (IEP), which develops energy policy and the framework for the regulation of the energy sector as a whole. However, at a policy level, the IRP has problematically been prioritised over its larger IEP due to the 2008 electricity crisis. The Renewable Energy Independent Power Producer (REIPP) procurement programme was launched in August 2011. Despite some constraints, the clear definition of the priorities assigned to the procurement of renewable energy from IPPs has facilitated achieving several objectives.
2013	An update of the IRP 2010 was published in November 2013 for public comment. The IRP 2013 update incorporates a review of assumptions and conditions considered in the IRP 2010. The next iteration of the IRP process will, however, only occur once the ongoing IEP process is finalised. This is expected to be completed in 2015.
2014	Most stringent cuts since the 2008 crisis. Security of supply remains paramount, marginalising other objectives (such as social, environmental and industrial) in the IRP. Medupi and Kusile were scheduled to be finalised between 2014 and 2018. The first unit of Medupi was scheduled to come online in April 2011, but this was extended to the end of 2014. Completion of Kusile's first unit has been rescheduled from March 2012 to 2015.

Source: TIPS

ANNEXURE 2: CHANGES TO THE PLANNED GENERATION MIX OVER TIME

In 2010, South Africa's total electricity supply stood at 41.8 GW (including imports). In addition, a total of 12.15 GW of supply capacity was already committed. Considering both existing and committed supply capacity, South Africa's ESI is heavily reliant on coal-fired power plants (at 90%), followed by hydroelectricity and nuclear energy (at about 5% each). This includes the two upcoming mega coal-fired power plants, Kusile and Medupi, accounting for an additional 4 800 and 4 788 MW respectively (DoE, 2011; EIA, 2014).

In addition to all existing and committed power plants, the IRP 2010 includes 17.8 GW of renewables (8.4 GW of solar photovoltaic, 8.4 GW of wind and 1 GW of concentrated solar power), accounting for 42% of all new build generation to 2030 (42.6 GW). Nuclear energy (9.6 GW) and coal (6.3 GW) also account for substantial shares of the new generation capacity considered under the IRP. The plan also takes into account a total of 3 420 MW saved due to energy efficiency demand-side management (DoE, 2011).

The 2013 IRP update advocates that:

- New nuclear baseload capacity would not be required before 2025, if not 2035, and that alternative options, such as regional hydropower and shale gas, could fulfil the requirements. Overall, the update proposes to decrease generation capacity for nuclear energy from 11.4 GW in the current IRP to 6.6 GW.
- The procurement for a new set of fluidised bed combustion coal generation should be launched for a total of 1000-1500 MW capacity, instead of pursuing the route of another large project (the so-called Coal 3 power station).
- Regional hydropower projects in Mozambique and Zambia, as well as regional coal options, should be pursued.
- Regional and domestic gas options should be pursued and shale exploration stepped up.
- The current renewable energy programme should be continued, with additional annual rounds (of 1 000 MW capacity for solar PV; 1000 MW for wind and 200 MW for CSP), with the potential for hydropower at competitive rates.
- A standard offer approach should be developed to purchase energy from embedded generators at a set price.
- Additional analysis on the potential of extending the life of Eskom's existing fleet should be undertaken.
- Funding and appropriate mandate for energy efficiency and demand side management programmes be formalised and secured (DoE, 2013a).

ANNEXURE 3: LIST OF PARAMETERS FOR THE DEVELOPMENT OF THE IRP 2010 AND DATA PROVIDERS

Parameter	Nature	Data owner
Demand forecast (energy and maximum demand)	Demand input	Eskom (System Operations and Planning division)
Gross domestic product	Demand input	National Treasury
Electricity intensity (short-term)	Demand input	Department of Trade and Industry, National Treasury, Economic Development Department, National Planning Commission
Electricity Intensity (long-term)	Demand input	Department of Trade and Industry, National Treasury, Economic Development Department, National Planning Commission
Price elasticity of demand	Demand input	National Treasury
Demand side management	Demand input	DoE
Energy efficiency	Demand input	DoE
Demand market participation / demand response	Demand input	Eskom
Energy conservation	Demand input	DoE, NERSA
Own generation	Demand input	DoE
Cost of unserved energy	Supply input	NERSA
Reserve margin	Supply input	DoE with input from NERSA and Eskom (System Operations and Planning division)
Discount rate	Supply input	National Treasury, DPE
Renewable energy	Supply input	DoE, Department of Environmental Affairs
Exchange rate	Supply input	National Treasury
Cogeneration	Supply input	DoE
Nuclear	Supply input	DoE
Imports	Supply input	Eskom
Generation life cycle cost	Supply input	DoE with input from Eskom (System Operations and Planning division), Department of Science and Technology
Generating plant location	Supply input	DoE
Generation mix	Supply input	Eskom (System Operations and Planning division)
Funding and financing	Supply input	National Treasury
Climate change	Externality	Department of Environmental Affairs

Carbon tax	Externality	Department of Environmental Affairs, National Treasury
Water	Externality	Department of Environmental Affairs, DoE
Distribution infrastructure	Externality	Electricity distribution sector with direct influence from NERSA (via tariffs)
Base scenarios	Output	DoE
Generation cost cone	Output	DoE, NERSA
Rate of inflation	Output	National Treasury

Source: TIPS, based on DoE, 2010b and DoE, 2010e

ANNEXURE 4: COMPOSITION OF THE IRP 2010 TASK TEAM

Name	Capacity/Area of expertise	Affiliation (in 2010)
Nelisiwe Magubane	DoE (Director-General and sponsor)	DoE
Ompi Aphane	DoE	DoE
Thabang Audat	DoE	DoE
Ria Govender	DoE	DoE
Kannan Lakmeeharan	Eskom (IRP)	Eskom
Callie Fabricius	Eskom (planning)	Eskom
Mike Rossouw	Regulatory and energy planning	Xstrata
Ian Langridge	IPP and energy planning	Anglo American
Brian Day	Demand models and climate change	Exxaro
Piet van Staden	Demand and IPP	Sasol
Kevin Morgan	REDs and demand management	BHP Billiton
Paul Vermeulen	Municipal	City Power Johannesburg
Doug Kuni	IPP and energy planning	South African Independent Power Producer Association
Roger Baxter (withdrew)	Economist	Chamber of Mines
Anton Eberhard	Energy policy, planning, regulation, investment	University of Cape Town
Shaun Nel	Project manager	Gobodo Incorporated

Source: TIPS, based on DoE, 2010f

ANNEXURE 5: ILLUSTRATIONS OF THE DIFFICULTY TO ACHIEVE SEVERAL OBJECTIVES THROUGH ENERGY POLICY

Two recent energy-related examples, related to special pricing agreements (TIPS, 2013) and the REIPP procurement programme (Montmasson-Clair, Moilwa & Ryan, 2014), can exemplify the difficulty of using energy policy to achieve a set of diverse objectives.

First, while bringing undeniable short-term benefits to the country at the time of signature, special pricing agreements entered with aluminium producer BHP Billiton have had detrimental unintended consequences on the country in the longer run. BHP Billiton obtained favourable long-term special pricing agreements with Eskom in the late 1990s for the implantation of its aluminium smelters in the country. South Africa having no other comparative advantage, the aluminium smelting industry owned by BHP Billiton was then located in the country purely owing to the access to cheap and plentiful electricity. In line with industrial policy at the time, these pricing agreements, an element of energy policy, were made to stimulate investment in aluminium refining in South Africa. Further benefits that were anticipated included the development of a downstream aluminium industry and the generation of both direct and indirect jobs on a significant scale, the substitution of significant import of aluminium by domestic production and a contribution to the balance of payments.

When the agreements were considered, the country's energy policy faced a different set of priorities as Eskom had an estimated 30% surplus of generating capacity. By entering into long-term contracts for a sizeable share of the country's electricity consumption,[28] the South African government, via Eskom and the National Electricity Regulator (the predecessor of NERSA), however, locked the country into a perilous situation. While these contracts did serve a purpose at the time of signature, benefitting to revenue generation, industrial development and job creation, they triggered another set of problems in the longer run. By dissuading the excessive use of electricity and the introduction of energy-efficient technologies, these pricing agreements contributed to making South Africa one of the most energy- and carbon-intensive economies in the world. Favourable electricity pricing also served to entrench BHP Billiton's dominant position, giving the company a significant cost advantage over its rivals. This has also contributed to slow down the diversification of the South African economy away from these energy and resource-intensive products. Since the 2008 load shedding crises, and in the current context of electricity shortage and increasing electricity prices, these contracts have also offered these industries preferential conditions at the expense of the rest of the economy. In this case, macroeconomic considerations, industrial development and job creation were prioritised as the objectives of energy policy. While energy security, the primary objective of energy policy, was not a concern at the time, decision-makers failed to consider the long-term impact of special pricing agreements on the country's security of supply. Likewise, other objectives, such as sustainable and social development were not considered in the decision to grant these favourable contracts and were arguably negatively impacted by them.

[28] BHP Billiton's consumption alone accounts for about 5.5% of the country's generation capacity.

Another illustration of the requirements to conjugate multiple objectives through energy policy is the REIPP procurement programme launched by the South African government in August 2011. In addition to contributing to the country's energy security, the programme aims to achieve several environmental and social objectives. Despite some constraints, the clear definition of the priorities assigned to the procurement of renewable energy from IPPs has however facilitated achieving several objectives (Montmasson-Clair, Moilwa & Ryan, 2014).

Recognising that Eskom alone does not have the capacity to meet the country's electricity demand and ensure energy security (given Eskom's financial constraints and the urgency to meet electricity demand), the South African government has used renewable energy technologies as a springboard for the entry of the private sector on the generation market. The development of renewable energy is also a clear priority of the South African government's climate change mitigation and green economy strategies.[29] The energy sector, through both renewable energy and energy efficiency improvements, constitutes a cornerstone of this mitigation effort.

In the short term, the introduction of IPPs and nascent renewable energy technologies has, however, created additional costs for the utility (due to the need to subsidise such nascent technologies in the short term), which have been reflected in recent electricity tariff increases. In the medium to long term, the development of renewable energy-based electricity will contribute to reduce the cost of electricity in South Africa, as renewable energy technologies are becoming increasingly competitive and cost-effective alternatives to traditional fuels and technologies. In addition, the national utility will benefit from IPPs building new plants and generation capacity at their own cost and financial risk, and allegedly faster and more cheaply (Yelland, 2009).

The creation of a renewable energy industry in the country is additionally meant to contribute to local economic development objectives (such as job creation, community ownership and black economic empowerment). Renewable energy projects are thus evaluated on their price competitiveness (for 70% of the total) and a set of economic development criteria (for the remaining 30%). While competition occurs primarily on price, the programme brings positive economic and social developments. These remain nevertheless secondary in the programme, whose primary goal is to procure clean (and ultimately affordable) electricity. In addition, local content requirements, which are leveraged to generate employment and develop domestic capacity, involve short-term trade-offs. As the localisation of green technologies raises the costs of goods, local content requirements can hinder the shift to sustainable development if not in line with the country's capacity and capability, and impede the decrease in prices.

[29] South Africa has pledged to peak its greenhouse gas (GHG) emissions between 2020 and 2025 at respectively 34% and 42% below a business-as-usual trajectory, plateau for approximately a decade and decline in absolute terms thereafter, subject to the adequate provision of financial resources, technology transfer and capacity building support provided by developed countries (UNFCCC, 2011).

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