Electricity Planning in SADC – Status report in May 2021

Acknowledgments

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Executive Summary

The purpose of this report is to provide a snapshot of the *status quo* of power sector planning practices across the SADC region in mid 2021. Subsequent chapters present a short summary of the latest electricity expansion plan (if publicly available) as well as a high-level analysis of good practices and gaps in each Member State.

The analysis of **planning practices** across the SADC region has shown substantial variation in the breadth of electricity system planning. While some countries have managed to establish a well-defined process and have successfully developed either an Integrated Resource Plan (IRP) or a least cost expansion plan with a similar scope, others do not have an expansion plan in place.

The **governance structure** also shows a degree of variation across countries. Under the most common model, the Ministry of Energy assumes the planning responsibility and leads the consultation process with other stakeholders. This structure can be found in Angola, Malawi, Mozambique, Eswatini and Zambia. In South Africa, the Department of Energy within the Ministry of Energy holds the overall responsibility over power sector planning, but delegates the preparation of an IRP to Eskom, the state utility. Mauritius provides an example of a country where the planning responsibility is delegated to the Central Electricity Board (CEB), the state utility. In Namibia, the 2016 NIRP was managed by the Electricity Control Board (ECB), but the 2020 update is managed directly by the Ministry of Mines and Energy.

The **scope of electricity planning documents** varies amongst countries and includes generation only (South Africa, Namibia, Zimbabwe), generation and transmission (Malawi and Tanzania) or generation, transmission and distribution (Mozambique, Mauritius and Madagascar). The intention is to review the plans regularly. In some cases, there is a clearer indication of the time period between updates (e.g. at least every five years in Namibia) while other countries conduct reviews on an as needed basis whenever key assumptions change. The System Development Plan in Zimbabwe undergoes a major review every five years and, in addition, is updated annually to ensure accuracy of data and assumptions used. Smaller power systems found in the Seychelles and Mauritius tend to update their planning documents more frequently and to use internal resources for plan reviews.

Several **planning objectives** are common across SADC members and include renewables targets, cost reductions and sustainable use of resources. Differences in objectives are more apparent with respect to regional trade and self-sufficiency. Typically, the planning process would consider several scenarios that reflect various objectives, with the results providing insights on the trade-offs between objectives before the most appropriate sequence of investments is chosen as the agreed expansion plan. In addition to scenario development, risk analysis is also undertaken, primarily through sensitivity analysis, but probabilistic assessment techniques are also sometimes used.

Consultation with the relevant stakeholders is typically facilitated through consultation workshops or by requesting feedback on draft results. South Africa managed to establish a well-defined stakeholder management process which comprises consultation windows during which interested parties can provide their feedback on draft documents. Received comments and responses are later shared in the public domain, which increases transparency of the process and adds further credibility to the plan.

The transition from planning to implementation has been identified as one of the most challenging aspects of power system expansion. The responsibility for plan implementation typically rests with the relevant Ministry. A counter example is provided by the electricity sector in Eswatini where ESERA (the regulator) is responsible for plan implementation which is then monitored by the Ministry of Natural Resources and Energy. Some planning documents include an Action Plan which provides a priority list of investments to be facilitated in the short-term.

Zimbabwe follows the process of a bottom-up approval where the System Development Plan is first approved by the relevant internal division, the board of ZETDC and ZESA and the Ministry of Energy and Power Development. The Ministry, after consultations with other entities, submits the Plan to the Cabinet for approval. The Ministry of Energy and Power Development is responsible for plan implementation.

In South Africa, the responsibility for plan implementation rests with the Department of Energy and the National Energy Regulator of South Africa (NERSA). The Minister of Energy makes announcements on new generation capacity that is going to be developed. The role of NERSA is to ensure that there are relevant rules and licences in place to enable the implementation of the IRP. The procurement process is administered by different programmes (e.g. an auction-based Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) for new renewable projects).

1 Angola

1.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Action Plan of the Energy and Water Sector 2018-2022, based on Angola Energia 2025 (Angola Power Sector Long-term Vision) and the National Strategy for Renewable Energy	Action Plans are to be regularly updated (previous Action Plan was for the period 2013-2017). Next iteration will also involve updating the Vision.
2	Legal instrument defining electricity sector planning responsibility	Planning is undertaken by the Ministry of Energy and Water	
3	Scope	The Vision is a comprehensive analysis of demand and supply with a particular focus on renewable energy and access. The Action Plan focusses on the implementation over 2018-2022 of specific generation, transmission, distribution and off-grid projects and completion of the sector restructuring.	
5	Timeframe	The latest Action Plan covers the 5 year period 2018-2022, while the Vision is set to 2025	
6	Load forecast methodology	The Vision load forecast is based on assumptions about economic growth and the pace of electrification. The transmission company RNT bases forecasts on a time series approach (PARAMOD) using typical day-year hourly loads from each substation.	
7	Provisions for wholesale market development	Not considered, but sector is already unbundled as a precursor to subsequent market developments	
8	Off-grid electrification	Included in both the Vision and the Action Plan	

#	Item	Comments and last update	Additional comments and future intentions
9	Least cost generation planning software	Not specified. Levelised cost of energy used as base to develop multiple scenarios, with lowest cost traded against other policy objectives	
10	Transmission planning software	Not specified	
11	Environmental and social planning tools	Not discussed in detail, but Strategic Environmental Assessment emphasized for the crucial hydropower development projects.	
12	Renewable energy requirements	Basis of the Vision is the development of large-scale hydropower. The Renewable Energy strategy sets a target of 7.5% 'new' renewables by 2025 (800 MW).	
13	Demand side management	Efficiency factored into the demand forecasts	
14	Climate change mitigation	CO_2 emissions one of the criteria considered in the analysis of scenarios leading to the one chosen for the Vision	Angola's unconditional NDC is to reduce GHG emissions by 35% by 2030 compared with the business as usual (BAU) scenario. The conditional NDC is an additional 15%, bringing the total reduction in GHG emissions close to 50% by 2030.
15	Approach on regional trade	Opportunity to become an interconnected member of SAPP welcomed.	Opportunity to participate in SAPP competitive markets.
16	Approach to risk analysis	No formal approach specified.	
Planning processes			
16	Period between updates	Action Plans have a 5 year duration.	
17	Coordination of institutions directly involved	Electricity Law does not specify roles in formulating the plans but requires electricity sector entities (PRODEL, RNT, ENDE) to adhere to the plans once promulgated	Regulator IRSE oversees the sector and regulates the entities responsible for generation, transmission and distribution.
18	Involvement of electricity users	Not specified	
19	Involvement of other stakeholders	Not specified	

#	Item	Comments and last update	Additional comments and future intentions
20	Monitoring of plan implementation	Action Plan specifies setting up an information system for monitoring	
21	Capacity building	Not specified	

Source: Planning documents and discussions with key informants

1.2 Elaboration of key elements

It is unusual for a national power development plan not to be derived from power planning software that minimises costs both of investment and dispatch of available plant to meet demand for power and energy. A total of 20 scenarios were developed which weighted the following factors:

- Levelised Cost of Energy (to reduce overall costs)
- Investment level (to reduce demands on the national budget)
- Energy flow between systems or Incremental Cost of transmission
- CO2 emissions / environmental cost.

1.3 Assessment of good practices and gaps

Having a comprehensive long-term Vision for the power sector has formed a good basis for two five-year Action Plans to be formulated and implemented. Although the Vision is not an IRP as such, it has many of the characteristics of an IRP and the update of the Vision that is due before 2025 could be more firmly grounded in IRP principles.

Both the Vision and the Action Plan discuss attracting private investment into the electricity sector to reduce the investment burden on the government budget and bring in skills. Private participation in large-scale generation, renewable energy and off-grid electrification is envisaged. As private sector will be from outside the country as well as Angolan firms, it is useful that both planning documents have been published with an English translation in parallel with the original Portuguese.

2 Botswana

2.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Integrated Resource Plan for Electricity in Botswana	The full IRP has not been published. Only an abridged version is available in the public domain.
2	Legal instrument defining electricity sector planning responsibility	Ministry of Mineral Resources, Green Technology and Energy Security (MMGE) holds responsibility for electricity planning.	11th National Development Plan (NDP) guides the energy planning process in Botswana – the IRP is an integral part of this
3	Scope	Electricity	
4	Timeframe	The planning horizon is 2020-2040, although 2016 is used as the base year.	
5	Load forecast methodology	The methodology is not explained in the abridged version of the IRP. Three different scenarios are considered.	Three scenarios: i. Business-as-usual (BAU) with optimistic and rapid GDP growth ii. Alternative scenario (slower growth rate, especially due to reduction in role of diamond mining) iii. Energy demand management measures – same as BAU but with technological progress and energy efficiency measures
6	Provisions for wholesale market development	Competitiveness in the sector is listed as a key strategic objective, although no further elaboration is provided in the abridged version.	
7	Off-grid electrification	Not specified	

#	Item	Comments and last update	Additional comments and future intentions
8	Least cost generation planning software	Not specified	
9	Transmission planning software	Not specified	
10	Environmental and social planning tools	Considers environmental protection and social equity, although these are not elaborated on in the abridged version.	
11	Renewable energy requirements	One scenario (clean energy scenario) only allows low carbon coal options and requires RE to meet 20% of demand by 2030 and 35% by 2040. The diversification of electricity generation sources is also listed as one of the main supply side strategic objectives.	
12	Demand side management	Considers demand-side measures and energy efficiency improvements in accordance with Botswana's National EE Strategy. These measures are not further elaborated on in the abridge version.	
13	Climate change mitigation	The IRP assumes deployment of technologies with low emissions to mitigate climate change. The type of technologies is not elaborated on in the abridged version.	Botswana's Nationally Determined Contribution (NDC) is to reduce overall emissions by 15% by 2030 (from the base year of 2010).
14	Approach on regional trade	Allows for regional trade within SAPP. The IRP has a strong focus on self-sufficiency which is reflected in the preferred scenario (Energy Demand Measures- Self Sufficiency (EDM SS))	Self-sufficiency and becoming a net electricity exporter are listed as strategic objectives of the IRP. Under the selected scenario, Botswana will become a net electricity exporter from 2026.
15	Approach to risk analysis	Not specified	
Planning processes			
16	Period between updates	Not specified	This is Botswana's first IRP, there is no indication of when it will next be updated.
17	Coordination of institutions directly involved	Not specified	

#	Item	Comments and last update	Additional comments and future intentions
18	Involvement of electricity users	Not specified	
19	Involvement of other stakeholders	Not specified	Reference is made to stakeholder engagement in the supply-side analysis.
20	Monitoring of plan implementation	Not specified	
21	Capacity building	Not specified	

Source: Planning documents and discussions with key informants

2.2 Elaboration of key elements

The Integrated Resource Plan was published in late 2020 and is the first such document produced in Botswana. It covers the period from 2020 to 2040 and considers various demand and supply-side scenarios and outlines the least cost development plan.

Three scenarios are considered for both the demand and supply side analyses. The selected scenario for the demand side assumes business-as-usual (BAU) with technological progress and EE measures applied. The selected supply side scenario is centred around self-sufficiency and assumes that Botswana will meet become a net exporter of electricity by 2035. The choice of the preferred scenario is motivated by key strategic objectives of the IRP, which include diversification of electricity sources, competitiveness, security of supply, self-sufficiency and desire to become a net electricity exporter, and mitigation of environmental impacts.

The IRP has been developed in accordance with existing documents, such as the National EE Strategy and Botswana's SE4ALL Action Agenda. As part of the IRP, the Government has approved 7 electricity projects which will be implemented in the first seven years of the IRP and lead to an installation of 795MW, of which 485MW will be RE.

2.3 Assessment of good practices and gaps

The IRP appears to provide a comprehensive assessment of different demand and supply side scenarios. A merit of the IRP is that it has been developed in accordance with the national plans and policies which inform the development of Botswana's electricity sector, and considers DSM, EE,

environmental and social aspects. It is notable that the Government has approved energy projects in line with the IRP, which demonstrates that Botswana smoothly moved from the planning to implementation stage.

The IRP appears heavily focused around the objective of self-sufficiency and the desire to become an electricity exporter by 2035. Even though the opportunity to engage in regional electricity trade is noted, the selected expansion plan is structured to meet all domestic demand and export the surplus.

In contrast to other countries which already have an IRP, only an abridged version of the document is available in the public domain. There are certain benefits that can be realised when an IRP is made available. These could include increased interest from the private sector seeking to invest in power assets, better coordination between institutions and stakeholders and increased transparency.

3 Comoros

3.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Project d'assistance technique pour l'elaboration du plan directeur de production, de transport, de distribution de l'energie electrique et du developpement des energies renouvelables aux Comores (PATEPD)	Technical Assistance Project for the drafting of the Strategy Plan for the generation, transport, distribution of electricity, and renewable energy development.
2	Legal instrument defining electricity sector planning responsibility	The Department of Energy and Mines (DGME) is responsible for policy formulation and national energy planning.	
3	Scope	The document is a short planning study for the three Comoros islands. It includes a high-level demand forecast, supply options and technical, economic and financial analysis for the development of the generation, transport, and distribution of electricity.	
4	Timeframe	2020-2033	
5	Load forecast methodology	Load forecast is based on socioeconomic parameters: (i) the population growth rate, (ii) the GDP growth rate, (iii) the service rate, (iv) the initial state of household needs and (v) the state of professional needs. Three scenarios were modelled.	

#	Item	Comments and last update	Additional comments and future intentions
6	Provisions for wholesale market development	Not considered	
7	Off-grid electrification	Not considered	The country's electricity coverage raised from 84% in 2013 to more than 95% in 2019, and the objective for 2033 is 100%.
8	Least cost generation planning software	Not mentioned	
9	Transmission planning software	Not mentioned	
10	Environmental and social planning tools	Not mentioned	The potential social impact of developing biomass-fuelled generation is discussed in the plan.
11	Renewable energy requirements	No requirements are stated. The plan recognises the potential of HFO, solar, geothermal and biomass to meet the electricity demand by 2033.	
12	Demand side management	Not covered	
13	Climate change mitigation	CO_2 emissions are not tracked across the 3 scenarios	The conditional target is to reduce GHG emissions by 84% by 2030 compared with the BAU scenario.
14	Approach on regional trade	No regional trade is envisaged as the Comoros are characterised by 3 non-interconnected islands	
15	Approach to risk analysis	Not covered	
Planning processes			
16	Period between updates	It is not clear whether any plan was conducted before this one.	
17	Coordination of institutions directly involved	Not mentioned	
18	Involvement of electricity users	Not mentioned	
19	Involvement of other stakeholders	Not mentioned	
20	Monitoring of plan implementation	Not mentioned	

#	Item	Comments and last update	Additional comments and future intentions
21	Capacity building	Not mentioned	

Source: Planning documents and discussions with key informants

3.2 Elaboration of key elements

Only the draft summary document dated March 2019 was made available to the Consultant. It is understood that the final version of this planning document is still under development and will need to go through the validation process.

The overall responsibility for the power sector rests with the Ministry of Production, Environment, Energy, Industry and Handicrafts. Société Nationale de l'Electricité des Comores (SONELEC), the public utility, manages electricity generation, transmission and distribution. The power system in the Comoros comprises three islands that are supplied with diesel-fuelled generation. The installed capacity on each of the islands is insufficient to cover the load. The plan provides information on investment requirements until 2033:

- Energy generation program
- Electricity transport program
- Distribution restructuration program
- Rural satellite areas electrification program
- Electricity sales improvement program
- Solar powered public lighting program.

3.3 Assessment of good practices and gaps

The process followed to develop the expansion plan is not clear. The full report would be needed to provide a comprehensive assessment of the good practices and gaps.

The power sector in the Comoros is heavily reliant on imported fossil fuels. Several power generation assets are inefficient and will require replacement in the short-term. The cost of electricity generation is amongst the highest in Africa (approximately $0.33 per kWh[1]). Tariffs are below the recovery level and collection levels are low, resulting in high dependency on government transfers to fill the deficit.

Renewable energy generation is gaining more traction in the Comoros with several development agencies active in the sector. However, project implementation is problematic due to grid rehabilitation and generation investments facing significant delays. Building in-house electricity planning capacity is challenging with frequent rotations of senior energy experts.

[1] World Bank: Comoros Solar Energy Integration Platform, 2020

4 Democratic Republic of the Congo (DRC)

4.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Not aware of planning documents at the national level. Projects are being identified based on the urgency to provide reliable electricity access to the provincial capitals, starting from those with intense economic activity, mostly through the rehabilitation or construction of medium-size hydropower plants and hybrid solar PV systems. The World Bank, KfW, the African Development Bank, and the South African Development Bank are supporting these activities.	There is information that an equivalent to a power system master plan was developed in 2001, but the document is not available online. Energy planning at provincial level was to be supported by the AfDB (master planning), but the current status is unclear.
2	Legal instrument defining electricity sector planning responsibility	Electricity Law no14/011 (2014). The Ministry of Energy and Hydraulic Resources (MRHE) is responsible for planning and development of electricity and fuel products.	The electricity law of 2014 also grants provinces the role of planning electricity access within their boundaries. Provincial governments are in charge of granting concessions, licences and authorisations for electricity operators willing to develop projects within their perimeter of competence.
3	Scope	Not specified	
4	Timeframe	Not specified	
5	Load forecast methodology	Not specified	Cellule d' Appui Technique a l' Energie (CATE) is part of the Ministry of Energy and Hydraulics responsible for developing the demand forecast

#	Item	Comments and last update	Additional comments and future intentions
6	Provisions for wholesale market development	In 1994 the electricity business was opened to private sector. SNEL still provides approximately 95% of power generation	
7	Off-grid electrification	The National Agency for rural and peri-urban power services (ANSER) was set up to plan electrification.	ANSER still not fully operational.
8	Least cost generation planning software	Not specified	
9	Transmission planning software	Not specified	SNEL is the only TSO. Last system expansion plan was prepared in 2013 but is not available online.
10	Environmental and social planning tools	Not specified	
11	Renewable energy requirements	Not specified	
12	Demand side management	Not specified	
13	Climate change mitigation	INDC of 2015 issued by Ministry of Environment, identifying actions in agriculture, Forestry and Energy. NDC to be revised every 5 years.	DRC's conditional emission reduction target is 17% by 2030 compared to the BAU scenario.
14	Approach on regional trade	Not specified	
15	Approach to risk analysis	Not specified	
Planning processes			
16	Period between updates	Not specified	
17	Coordination of institutions directly involved	Not specified	
18	Involvement of electricity users	Not specified	
19	Involvement of other stakeholders	Development partners supporting implementation of electricity sector institutional reform.	USAID – setting up of ARE and ANSER AfDB - MERH governance improvement World Bank – electricity access scale up, focus on provincial capitals FCDO – solar PV procurement

#	Item	Comments and last update	Additional comments and future intentions
20	Monitoring of plan implementation	Not specified	
21	Capacity building	Not specified	

Source: Planning documents and discussions with key informants

4.2 Elaboration of key elements

It is not evident whether any form of a power development plan is currently being used in DRC. There is limited information indicating that such plan was developed in 2001, but the document is not available online. The Ministry of Energy and Hydraulic Resources holds responsibility for power expansion plans in accordance with the Electricity Law (2014).

Traditionally, Société Nationale d'Électricité (SNEL) held the responsibility for generation, transmission and distribution in the power sector. The Electricity Law (2014) changed the status of SNEL to a business corporation, which opened the way for competition in the electricity sector. SNEL still remains the largest power company, operating approximately 95% of installed capacity in the country. With the amended legal framework presenting an opportunity for increased private sector participation (PSP) in the future, there is an even greater need for an integrated resource planning tool that would guide the Government and potential investors in identifying priority investments.

There is no clear indication who bears responsibility for the development of demand forecast. The process is problematic due to population displacements and lack of updated population statistics. The uncertainty around the demand forecast is increased as the output of the mining sector tends to fluctuate depending on market outlook. Traditionally, Cellule d' Appui Technique a l' Energie (CATE), a unit of the Ministry of Energy and Hydraulics, seems to have been responsible for developing a demand forecast. No CATE demand forecast was available online to elaborate on the methodology used.

4.3 Assessment of good practices and gaps

The DRC has not yet developed an Integrated Resource Plan (IRP) and it is not clear whether any power development planning tool is used at all. Previous attempts to strengthen power system planning capabilities were mostly directed at a national level but proved ineffective. The share of population having access to electricity is approximately 9%[2] and is amongst the lowest in the world.

The lack of progress and significant underinvestment in the power sector resulted in calls to move power planning responsibilities to regional administration units rather than continuing the previous centralised approach based on large generation assets and expansion of the central grid[3]. The challenges in the power sector are magnified by the size of the country and the fragile state of the economy. The DRC is divided into 25 provinces and the capital of Kinshasa, and the number of provinces makes coordination on central level problematic. The same WB study recommends adjusting power development plans to account for country-specific risks to facilitate its implementation.

Institutional framework is still under development making cooperation between the relevant stakeholders difficult. In 2016, the Electricity Regulation Authority (ARE) was established to regulate the power sector and attract private sector participants to the power sector. The National Agency for Electrification and Energy Services in Rural and Peri-urban Areas (ANSER) was also created to increase electricity access in isolated rural areas, suburbs and areas with a low urbanisation factor. Neither entity is fully operational yet.

[2] https://www.iea.org/articles/democratic-republic-of-the-congo-energy-outlook
[3] World Bank. 2020. Increasing access to electricity in the
Democratic Republic of Congo. Opportunities and challenges. Washington, DC: World Bank

5 Eswatini

5.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	The Short-term Generation Expansion Plan (SGEP) with accompanying recommendations were published in October 2018	The generation expansion was developed in line with the Energy Masterplan published in October 2018
2	Legal instrument defining electricity sector planning responsibility	The Ministry of Natural Resources and Energy holds the planning responsibility for power sector development	
3	Scope	Electricity generation	The Energy Masterplan, covering the period from 2014 to 2034, provides an outlook for the whole energy sector (electricity and primary fuels)
4	Timeframe	15 years (2017-2032), although the implementation plan focuses on the immediate 5-year period (2017-2022)	
5	Load forecast methodology	Bottom-up approach using the Long-range Energy Alternatives Planning System (LEAP). Three demand scenarios were developed.	Four demand forecasts were reviewed and used to prepare an updated forecast. The Energy Master Plan forecast was used as the main forecast for the model with network losses and load factors sourced from other studies by the utility.
6	Provisions for wholesale market development		Eswatini Electricity Company (EEC) is the dominant supplier of electricity. There are two IPP companies.
7	Off-grid electrification	Not considered	
8	Least cost generation planning software	An in-house dispatch model	

#	Item	Comments and last update	Additional comments and future intentions
9	Transmission planning software	PSSE/DigSILENT	The EEC is the owner and operator of the electricity network.
10	Environmental and social planning tools	Not considered	
11	Renewable energy requirements		The 2018 National Energy Policy mentions a target of 50% of renewables in the energy mix, but this is not mentioned in the expansion plan
12	Demand side management	Not considered	
13	Climate change mitigation	Not considered	Considered in separate documents such as the Nationally Determined Contributions (NDC). Climate change mitigation actions include (among others) development of a GHG inventory and doubling the share of RES in the energy mix.
14	Approach on regional trade	One of the objectives of the expansion plan was to decrease Eswatini' s heavy reliance on power imports from Eskom	
15	Approach to risk analysis	Sensitivity analysis with regard to demand forecasts	
Planning processes			
16	Period between updates	Varies between three and five years. Next review is currently under development and will be published in 2021.	
17	Coordination of institutions directly involved	Ministry of Natural Resources and Energy coordinated the team which included EEC, ESERA, IPPs, CSER (Centre for Sustainable Energy Research)	
18	Involvement of electricity users	Key stakeholders from the Eswatini Electricity Industry (EEI) participated in the consultation process	
19	Involvement of other stakeholders	Consultations with energy stakeholders	

#	Item	Comments and last update	Additional comments and future intentions
20	Monitoring of plan implementation	ESERA is responsible for implementation of the SGEP. The implementation process is monitored by the Ministry	
21	Capacity building	Generation planning is conducted as an in-house exercise, with capacity building offered by the International Renewable Energy Agency (IRENA) in collaboration with the International Atomic Energy Agency (IAEA).	

Source: Planning documents and discussions with key informants

5.2 Elaboration of key elements

The Short-term Generation Expansion Plan is an integral part of the Energy Masterplan. The planning responsibility rests with the Ministry of Natural Resources and Energy. The SGEP covered the planning horizon of 15 years (2017-2032) with the focus on short-term generation planning over the next five years (2017 – 2022).

The focus of the expansion plan was on energy security. Eswatini is heavily reliant on imports with approximately 80% of its power supply covered by other countries, mostly from Eskom in South Africa. This high dependence means that Eswatini acts as a price taker in the market. The objective of the generation expansion plan was therefore to increase domestic capacity through the utilisation of Eswatini's renewable energy potential.

5.3 Assessment of good practices and gaps

Eswatini does not currently have a generation planning document equivalent to an Integrated Resource Plan (IRP). The Short-term Generation Expansion Plan seeks to provide short-term solutions to alleviate insufficient generation capacity and focuses on the immediate five years of the planning horizon. Some components that an IRP would normally include, such as demand side considerations, climate change mitigation measures and environmental and social planning tools are missing. The Eswatini Energy Regulatory Authority (ESERA), in consultation with the Ministry of Natural Resources and Energy, is responsible for launching tenders for procurement of new capacity.

6 Lesotho

6.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Lesotho Power Generation Master Plan was developed for the Lesotho Electricity Company (LEC) in 2010. A new Electrification Master Plan was approved by the Cabinet in 2019 but it has not reached the implementation stage yet. Lesotho does not currently have a planning document that would guide new investments in the power sector.	A Grid Development Plan (forming part of the Electrification Master Plan) was prepared in 2018 and covers a 20-year horizon from 2017 to 2036
2	Legal instrument defining electricity sector planning responsibility	The Department of Energy (DoE) within the Ministry of Energy and Meteorology is responsible for planning and implementation of projects.	
3	Scope	Not applicable as there is currently no power generation plan under implementation	
4	Timeframe	Not applicable as there is currently no power generation plan under implementation	
5	Load forecast methodology	Not applicable as there is currently no power generation plan under implementation	A demand forecast was prepared in 2018 as one of the inputs to the Grid Development Plan. It combines regression analysis based on GDP growth rates and spatial analysis to account for the future increase in customer numbers
6	Provisions for wholesale market development	There are currently no provisions for IPPs	

#	Item	Comments and last update	Additional comments and future intentions
7	Off-grid electrification		Off-grid electrification is covered in the Off-Grid Master Plan which together with the Grid Development Plan forms the overall Electrification Master Plan
8	Least cost generation planning software	Not applicable due to the lack of the least cost generation plan	
9	Transmission planning software	Not applicable due to the lack of the least cost generation plan	The Electrification Master Plan used DigSilent to perform network studies.
10	Environmental and social planning tools	Environmental and Social Impact Assessment (ESIA) is performed with respect to individual projects at the planning stage. The assessment considers carbon emissions, population displacement and other factors.	
11	Renewable energy requirements	Not applicable due to the lack of the least cost generation plan	
12	Demand side management		Energy efficiency measures are covered in the National Strategic Development Plan (NSDP), the Energy policy (2015-2025), the Sustainable Energy Strategy, the draft Country Action Agenda and the Nationally Determined Contributions (NDC)
13	Climate change mitigation		Lesotho's unconditional contribution is to decrease its greenhouse gas (GHG) emissions by 10% by 2030 compared to a business as usual (BAU) scenario. Conditional on external support, a combined emission reduction of 35% can be achieved by 2030.
14	Approach on regional trade	Diversification of supply options and self-sufficiency in meeting peak demand are listed under Lesotho's approach to regional trade	
15	Approach to risk analysis	Risk management options include: • Diversification of supply options	

#	Item	Comments and last update	Additional comments and future intentions
		• Self-sufficiency in meeting peak demand • Incorporation of reliability criteria as guided by SAPP	
Planning processes			
16	Period between updates	Not applicable due to the lack of the least cost generation plan	
17	Coordination of institutions directly involved	The relevant stakeholders include Lesotho Highlands Development Authority (LHDA), Lesotho Electricity Company (LEC), Lesotho Electricity and Water Authority (LEWA), Lesotho Electricity Generation Company (LEGCO). Consultation windows and stakeholder meetings (Energy Sector Coordination Forum (ESCF)) are organised to collect stakeholder feedback.	
18	Involvement of electricity users	Large industrial electricity users include manufacturing, textile and mining companies, breweries and flour mills. Stakeholder management process is undertaken through: • Public gatherings for communities • Workshops and consultation windows • Information sharing	
19	Involvement of other stakeholders	As above and through Energy Sector Coordination Forum	
20	Monitoring of plan implementation	Not applicable as currently there is no generation plan in place.	
21	Capacity building	Not applicable as currently there is no generation plan in place. National Energy	

#	Item	Comments and last update	Additional comments and future intentions
		Planning Team comprising key stakeholders for information sharing and energy modelling.	

Source: Planning documents and discussions with key informants

6.2 Elaboration of key elements

Lesotho does not currently have a planning document that would guide generation investments in the power sector. The vision for the power sector is presented in the Lesotho Energy Policy (2015-2025). The key policy objectives include:

- The development of an institutional and regulatory framework for the power sector,
- Improvement of availability and quality of data,
- Sustainable use of resources,
- Increased penetration of renewable energy sources (RES) and promotion of energy efficiency (EE) tools,
- Achieving security of supply,
- Increased access to electricity,
- Development of transmission and distribution infrastructure,
- Introduction of a competitive electricity market and transparent price-setting that would ensure price recovery.

The electricity sector is characterised by a heavy reliance on imports from South Africa and Mozambique. The only large-scale domestic generation asset is the Muela hydropower plant (72 MW) operated by the Lesotho Highlands Development Authority (LHDA). No IPPs operate in the power sector. The LEC is a state-owned monopoly responsible for electricity transmission, distribution and bulk electricity supply.

6.3 Assessment of good practices and gaps

The lack of an electricity planning document means that there is currently no expansion plan that would guide the sequence of investments in Lesotho. Given the heavy reliance on imports and limited domestic resources, a generation development plan could help mitigate some of the risks associated with the current situation and help determine the future investment sequence. The formulation of a clear strategy guiding the development of the power sector will become even more important given the policy objectives of security of supply, increased electricity access and promotion of RES and EE tools.

7 Madagascar

7.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Elaboration du plan de Développement de l'Electricité au Moindre Coût (PDMC)	Released in November 2018. The PDMC is complementary with the Energy Policy of Madagascar which covers existing regulatory framework and makes recommendations on regulatory and policy gaps in the area of renewable energy, energy efficiency, rural electrification, tariffs, subsidies, financing, capacity building, prioritisation and institutional coordination.
2	Legal instrument defining electricity sector planning responsibility	Ministry of Water, Energy and Hydrocarbons (MEH) holds the responsibility for electricity planning	
3	Scope	Electricity generation, transmission and distribution network served by JIRAMA. Considers consumers connected to the main grids and isolated systems.	
4	Timeframe	2018 - 2035	
5	Load forecast methodology	The general load forecast methodology of this study is based on the analytical approach, taking into account in particular the historical evolution of residential and industrial consumption as well as the electrification of new municipalities on the national territory.	

#	Item	Comments and last update	Additional comments and future intentions
		The demand forecast distinguishes between consumers connected to the main grid and consumers connected to isolated grids. Separate demand forecasts were conducted for the isolated grids.	
6	Provisions for wholesale market development	The market remains dominated by JIRAMA. The regulatory framework allows for participation of IPPs (Hydelec, HFF and Emma).	
7	Off-grid electrification	Considered within the PDMC under section 6: Electricity generation and distribution for isolated centres of JIRAMA investment plan. The development plan adopted for all other Isolated Centers is detailed in a common annex for each municipality.	
8	Least cost generation planning software	Hillmix (Least-cost optimisation using dynamic programming)	
9	Transmission planning software	PowerFactory from DIgSilent	
10	Environmental and social planning tools	Not considered	
11	Renewable energy requirements	No specific requirements are defined, however the formulation of sensitivities around the base case scenario is indicative of the importance of incorporating solar projects (e.g. Scaling Solar) into the plan.	
12	Demand side management	Not considered	
13	Climate change mitigation	Not considered	Madagascar's Intended Nationally Determined Contribution (INDC) is a 14% reduction in greenhouse gas emissions compared with business as usual (BAU) scenario by 2030.
14	Approach on regional trade	Not considered	

#	Item	Comments and last update	Additional comments and future intentions
15	Approach to risk analysis	Several sensitivities were run around key parameters, including changing the share of solar projects in the plan, demand up/down by 30% and a 2-year delay on major hydroelectric projects. The results were then analysed in terms of cost impact and confirmed the need for hydroelectric projects to be commissioned in due time.	
Planning processes			
16	Period between updates	Not clear but seemingly every 3 years.	The previous PDMC was issued in 2015 and the next one is likely to be issued in 2021.
17	Coordination of institutions directly involved	Several institutions were involved in preparation of the PDMC, including the Ministry of Energy and Hydrocarbons (MEH), the Electricity Regulatory Agency (ARELEC), the national utility (JIRAMA) and the World Bank,	
18	Involvement of electricity users	Not considered	
19	Involvement of other stakeholders	Not considered	
20	Monitoring of plan implementation	Not considered	
21	Capacity building	Not mentioned	

Source: Planning documents and discussions with key informants

7.2 Elaboration of key elements

The objective of the PDMC (Least-cost development plan) is to build a development plan at the lowest cost by 2035 that can be used by the government of Madagascar and other stakeholders to guide them with respect to the investment pipeline of priority projects.

The PCDM covers the whole value chain of the electricity sector: from demand forecast to supply options, transmission and distributions for the main interconnected network and off-grid energy access planning. The least-cost generation plan only simulates a limited number of years (from 2018 to 2024 and 2035) and the transmission plan only simulates three years (2021, 2024 and 2035) which are deemed to be key milestones in the generation plan. There is only one scenario represented for the generation plan with sensitivities around key parameters.

7.3 Assessment of good practices and gaps

The PDMC is focused on the supply side and development of a least-cost expansion plan. It does not consider demand side measures (DSM) and energy efficiency (EE), which would be typical for an Integrated Resource Plan (IRP).

On the positive side, the least-cost plan appears complementary with the New Energy Policy (NEP). In order to achieve the ambitious electrification and decarbonisation objectives (a 70% energy access rate by 2030 and 85% of power from renewable energy sources), it is important for institutions to collaborate with each other and design a governance framework that would clearly delegate responsibilities between various institutions.

Around 85% of electricity consumers in Madagascar is currently served by one of the three main national grids. The remaining population is served by isolated small and medium-sized grids. The PDMC considered separate demand forecasts for customers connected to the main grid and to each of the isolated grids. Power system modelling appears to be limited to key milestone years. It is not clear whether other years were included in simulations.

The PDMC could benefit from an action plan that would facilitate transition from the planning to implementation stage. While the investment plans consider total costs for the expansion plan, it would be helpful to identify priority projects that will be fast-tracked.

8 Malawi

8.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Integrated Resource Plan (IRP) for Malawi	The latest IRP was dated May 2017
2	Legal instrument defining electricity sector planning responsibility	Section 20B of the Electricity (Amendment) Act, 2016 assigned responsibility for preparing a national load forecast and a generation and transmission plan to the Single Buyer Licensee. Section 20 assigns responsibility to the Transmission licensee for undertaking transmission planning “in coordination with the Single Buyer licensee”.	The IRP was already in preparation by the Department for Energy (within the Ministry of Energy) at that date the Amendment was enacted. Typical practice would be to assign responsibility for the IRP to a transmission system operator, rather than the single buyer, or to a Ministry. At the time, the Transmission licensee, the Single Buyer and the System and Market Operator were all businesses within ESCOM. Subsequently, the Single Buyer was separated and made independent of ESCOM and governed by the Ministry. This effectively makes the Ministry indirectly responsible for future IRPs.
3	Scope	The national electricity supply industry (ESI). The plan was prepared from the national perspective and covers the whole of the integrated national grid covering generation and transmission and taking account of the plans of the Distribution licensee (ESCOM)	
5	Timeframe	The 2017 IRP covered a 23-year period between 2017 and 2040	

#	Item	Comments and last update	Additional comments and future intentions
6	Load forecast methodology	Linear regression analysis, conducted historically, to account for organic growth and step loads to incorporate large new customers. The electrification programme and the number of new connections was an exogenous assumption based on government policy. The impact of historical demand side management programs (DSM) and measures that were committed were incorporated in the load forecast.	DSM measures that were under consideration were analysed side-by-side with supply-side measures during the least-cost optimisation
7	Provisions for wholesale market development	Not considered as a competitive bilateral contract market was not proposed at that time	The intention, at least initially, was that there would be competition to sell electricity to the single buyer, but no competitive bilateral contract market
8	Off-grid electrification	The gradual connection of off-grid consumers to the national grid was analysed as part of the load projections	
9	Least cost generation planning software	PLEXOS for generation planning	Training was provided to the Department of Energy, ESCOM (transmission, system operation and single buyer) and to the regulator
10	Transmission planning software	PSS/E for transmission planning	Training was provided to the Department of Energy, ESCOM (transmission, system operation and single buyer) and to the regulator
11	Environmental and social planning tools	New investments were expected to comply with strict environmental and social standards for emissions to air and water, population displacement and compensation, and the capital and operating costs reflect this expectation. Further environmental and social impacts were not considered further. See below regarding renewable energy and climate change.	
12	Renewable energy requirements	A competitive tender for renewable energy had been implemented prior to the IRP which had resulted in a significant response. A cap was placed on the share	

#	Item	Comments and last update	Additional comments and future intentions
		of intermittent renewable energy in the constrained cases and renewable technologies were chosen by the least-cost planning software on least-cost grounds but subject to a cap based on technical constraints. One case analysed forced the commissioning of 165 MW of solar PV, 60 MW of wind and 100 MW of biomass on policy grounds.	
13	Demand side management	As noted above, the impact of historical DSM programs and measures that were committed were incorporated in the load forecast; and DSM measures that were under consideration were analysed side-by-side with supply-side measures during the least-cost optimisation	In practice the DSM options analysed side-by-side with generation options were limited to solar water heating as other measures had already been implemented.
14	Climate change mitigation	Climate change was not considered explicitly	No specific targets are mentioned. Conditional and unconditional climate change mitigation targets are listed as actions by sector.
15	Approach on regional trade	A constraint was placed on imports consistent with SAPP planning criteria that require the level of internal generation capacity to be equal or greater than 100 percent of peak demand (reserve margin = 0 percent). One of the cases/scenarios considered the present-valued cost if Malawi were to remain isolated from the rest of SAPP. A value-of lost-load was incorporated in the cost minimisation function to ensure that a reasonable level of system reliability would always be maintained under all cases examined.	
16	Approach to risk analysis	The IRP considered 5 main expansion scenarios/ cases. Sensitivity tests were conducted on various key uncertainties, including demand forecast, SAPP market prices, hydrology and the discount rate	

#	Item	Comments and last update	Additional comments and future intentions
Planning processes			
16	Period between updates	A mini-IRP had been undertaken by the Department of Energy in December 2015 covering the period 2016-2020. Before that another IRP had been prepared in August 2011.	Not specified
17	Coordination of institutions directly involved	The Department of Energy coordinated ESCOM (Transmission licensee, Distribution licensee, the System and Market Operator licensee and the nascent Single Buyer licensee) as well as the regulator and EGENCO (the government-owned generation company)	Future IRPs may be undertaken by the Single Buyer licensee under the direction of the Department of Energy
18	Involvement of electricity users	Stakeholder workshops involving ESI players	
19	Involvement of other stakeholders	Stakeholder workshops involving the regulator as well as other ministries and regulatory entities that are affected by energy (water, environment, finance, etc)	
20	Monitoring of plan implementation	The IRP was approved by the Ministry of Energy. Plan implementation is overseen by the Department of Energy	
21	Capacity building	One-week training workshops in PLEXOS and PSS/E	

Source: Planning documents and discussions with key informants

8.2 Elaboration of key elements

The purpose of Malawi's IRP is to provide a 20-year least cost electricity infrastructure plan to meet demand projections and ensure reliable and sustainable supply of electricity to be contracted by the Single Buyer and sold to ESCOM's electricity distribution business. While the document is long-term in its nature, the primary focus is on investments to be contracted in the next 2-5 years. Due to the long lives of most power assets, the long horizon is necessary to optimise investments incurred at different points of time.

The Malawi IRP is also potentially used by the Department of Energy within the Ministry of Energy, for policy analysis. Though not explicitly stated in the IRP, cases were examined that considered policies toward the continued dependence on hydropower along the Shire River and the use of renewable energy, other than hydropower, in the generation mix.

The IRP included 5 main expansion scenarios or cases. For each a least-cost investment plan was identified by PLEXOS based on the lowest present-valued costs. A base case was identified as the main investment plan using the base load forecast and the policy choices considered to be central. The alternative scenarios considered other policy choices relating to renewable energy or concerns over a return to the poor hydrological conditions that the country had experienced.

8.3 Assessment of good practices and gaps

Malawi legislation from 2004 requires the development of least-cost generation and transmission investment plans. The legislation does not refer to them as integrated resource plans, though in practice they have, for the past two decades or more, been referred to as integrated resource plans. Several IRPs have been developed since 2004 (in 2004, Stone & Webster prepared an IRP for the then Electricity Council).

Malawi introduced a single buyer model in 2016 and separated the single buyer from the incumbent utility (ESCOM). Generation was also separated from ESCOM. Despite the unbundling and the move away from a vertically integrated utility, the purpose of IRP remains to guide the generation and transmission investment plans, though now it is to be a power procurement plan to be implemented by the Single Buyer. The IRP, as before, also provides policy guidance to the Ministry and can be used as a guide for the regulator when licensing generation.

The plan also addresses policy choices including the choice between self-sufficiency and regional power system integration and between dependence on hydropower on the Shire River and diversification of energy sources.

9 Mauritius

9.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Integrated Electricity Plan (IEP) 2013-2022	The first IEP was developed in 2003 and was updated on an annual basis.
2	Legal instrument defining electricity sector planning responsibility	The Central Electricity Board (CEB) holds the planning responsibility for the electricity sector. Planning responsibilities are defined in the Central Electricity Board Act 1963.	
3	Scope	A comprehensive planning document, including generation, transmission and distribution.	The IEP was developed in line with the national strategies such as the Maurice Ile Durable (MID) and the Long-term Energy Strategy (LTES) 2009-2025. In addition, the Ministry of Energy and Public Utilities (MEPU) developed a Renewable Energy Master Plan and it is currently being revisited.
4	Timeframe	2013-2022	
5	Load forecast methodology	An energy forecast for each customer category was prepared using regression analysis. Three scenarios (low, base and high) were considered. For the peak demand forecast, data from electric feeders were used to establish a typical consumption profile. This was then combined with information on market size and network losses to develop a peak demand forecast under three scenarios (low, base, high).	The Model for Analysis of Energy Demand (MAED) was used to help analyse future energy demand.

#	Item	Comments and last update	Additional comments and future intentions
6	Provisions for wholesale market development	The CEB has Power Purchase Agreements (PPAs) with 3 Independent Power Producers (IPPs).	
7	Off-grid electrification	Not a significant share of overall supply.	
8	Least cost generation planning software	The Model of Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE).	MESSAGE is used in combination with other tools assessing the wider impact on the economy (eg FinPlan).
9	Transmission planning software	WASP	CEB owns the network system.
10	Environmental and social planning tools	The CEB needs to comply with the Environment Protection Act (EPA) 2002 which requires preparation and submission of the EIA report for generation and transmission assets. The CEB has plans to develop an Environment Management System and to consolidate its Environmental Reporting Programme to provide a structured approach for measuring environment impacts.	Overseen by the Ministry of Environment, Solid Waste Management and Climate Change. Following the successful outcome of a feasibility study, the next step is to secure environmental permits i.e., an EIA license. The EIA or Environment Social Management Plan (ESMP) tackles all environmental and social issues that are directly or indirectly related to the implementation of the project.
11	Renewable energy requirements	The target share of renewables in the energy mix is 35% and 40% by 2025 and 2030 respectively.	The Mauritius Renewable Energy Agency (MARENA) is responsible for the promotion of RES. The Agency developed the first Renewable Energy Strategic Plan (RESP) covering the years 2018-2023. An implementation plan providing the timescale for key activities was also developed. For the island of Rodrigues, the CEB is considering the use of Modern Control Systems to increase the share of renewables. The development of a wind atlas study and a bagasse-fuelled pilot project is under consideration in order to further increase the share of renewables in the energy mix.

#	Item	Comments and last update	Additional comments and future intentions
12	Demand side management	The IEP lists demand-side options and considers their effect on electricity supply	Energy Efficiency measures are overseen by the Energy Efficiency Management Office.
13	Climate change mitigation	Modelling of emissions is performed under the Environmental Impact Assessment (EIA) component. The CEB has additionally prepared an environment-related action plan. The tools used include RETScreen, Homer, Air Quality Model and Message. Any new coal power plants have to adapt an equivalent of a pulverized-coal technology and are equipped with Continuous Emissions Monitoring Systems (CEMS). The CEB hopes to reduce CO_2 emissions by at least 20%.	Overseen by the Ministry of Environment, Solid Waste Management and Climate Change. CEB will implement the Environment Management System (EMS) tool and will consolidate its Environmental Reporting Programme (ERP) to remain compliant. The Climate Change Bill was approved in 2020. Mauritius' NDC include a 30% reduction in Carbon Dioxide Emissions by 2030 (including the transport sector). These are reflected in the electricity expansion plan as they are the drivers for targeting a 35% and 40% contribution of RE sources in the national energy mix in 2025 and 2030 respectively.
14	Approach on regional trade	Not applicable	
15	Approach to risk analysis	Sensitivity analysis with regard to the demand forecast and greenhouse gas emissions (GHG) Security of supply and reliability criteria: a 1% Value of Lost Load (VoLL) for a period of ten years is used. The figure reflects international best practice and is not based on economic analysis.	Uncertainty Management is mainly managed using different scenarios and assessing the respective outcomes using energy planning tools.
Planning processes			
16	Period between updates	The aim is to update the document annually.	
17	Coordination of institutions directly involved	Ongoing cooperation between the Ministry of Energy, CEB, the private sector and other stakeholders.	
18	Involvement of electricity users	Stakeholders are continuously being updated with regard to new projects under development. Moreover, consultation meetings with major customer categories such as industrial, hotels	

#	Item	Comments and last update	Additional comments and future intentions
		etc. are held to get a view of their future expansion plans and the impact on electricity sector. Consultation meetings with communities, Ministries and relevant Authorities prior to securing an EIA license for power plant projects are also held.	
19	Involvement of other stakeholders	Ongoing cooperation between the Ministry of Energy, CEB, the private sector and other stakeholders.	
20	Monitoring of plan implementation	At least twice a year and more frequently if required.	
21	Capacity building	Training delivered to the relevant staff.	

Source: Planning documents and discussions with key informants

9.2 Elaboration of key elements

The first Integrated Electricity Plan (IEP) was developed in 2002 and covered a ten-year period from 2003 to 2012. The document was updated annually to account for latest developments and changes in assumptions. The current IEP is the second expansion plan released by the Central Electricity Board (CEB). The focus of the plan reflected the Government's vision to make Mauritius a sustainable island. As the document specifies, "the primary objective of the IEP 2013-2022 is to create a sufficiently broad energy portfolio to safeguard the country against energy security concerns and price instability, while being sensitive to environmental imperatives[4]"

The main challenges that the CEB is currently facing include replacement of old thermal generators and increasing the share of renewables in the power mix. The IEP includes an Action Plan which summarises key developments that are needed to move the power sector forward.

[4] Mauritius Integrated Electricity Plan 2013-2022

9.3 Assessment of good practices and gaps

The IEP has most characteristics that an Integrated Resource Plan (IRP) would typically have. The IEP is a ten-year planning document which is updated annually to account for latest developments in the electricity sector. This is a good approach suitable for smaller electricity systems with in-house planning expertise. Publication of updated versions of the document would further raise confidence amongst potential investors and other relevant stakeholders.

The scope of the IEP includes both generation and the network system. The executive summary of the IEP includes a summary of the implementation status of the previous IRP and key achievements that were accomplished over the past ten years. These include projects on the supply side (such as new capacity additions) and demand side (distribution of Compact Fluorescent Lamps). A short-term Action Plan summarising key future activities is also included.

10 Mozambique

10.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Integrated Master Plan Mozambique Power System Development (February 2018) developed with JICA support over an 18 month period.	The utility, Electricidade de Moçambique (EDM), used the Master Plan to prepare its EDM Strategy 2018-2028.
2	Legal instrument defining electricity sector planning responsibility	MIREME is responsible for policy formulation and national energy planning.	
3	Scope	Comprehensive generation, transmission and distribution Master Plan.	
5	Timeframe	The Master Plan covers the period 2017-2042.	Previous Master Plan study, completed in 2009, covered the period 2010-2030
6	Load forecast methodology	Separate regression analysis for general customers and medium/large customers, modified with addition of large new loads, electrification plans and demand side management.	
7	Provisions for wholesale market development	Domestic market not considered, but SAPP market discussed.	
8	Off-grid electrification	Included as part of electrification startegy	
9	Least cost generation planning software	WASP (Wien Automatic System Planning)	
10	Transmission planning software	PSS/E	

#	Item	Comments and last update	Additional comments and future intentions
11	Environmental and social planning tools	Strategic Environmental Assessment (SEA) using JICA Guidelines for Environmental and Social Considerations	
12	Renewable energy requirements	Solar and wind 10% of peak demand (despite these energy forms not providing firm capacity). 20% considered as a sensitivity case.	
13	Demand side management	Demand response and energy efficiency discussed but without a specific plan was not factored into the demand forecasts	
14	Climate change mitigation	CO_2 emissions of different scenarios tracked and emissions included in monitoring	Mozambique's commitment to emission reduction is conditional on financial and technological assistance and targets the total reduction of about 76,5 $MtCO_2$ eq in the period from 2020 to 2030.
15	Approach on regional trade	Potential for Mozambique to be a major exporter of power explored. Base assumption is 20% of peak demand for export, 40% also analysed.	
16	Approach to risk analysis	Risks of high levels of exports and of solar/wind generation considered	
Planning processes			
16	Period between updates	Period between last 2 plans was 9 years.	Final chapter has a proposal for technical assistance for regular updating of the Master Plan
17	Coordination of institutions directly involved	EDM was the lead institution for the formulation of the Master Plan. EDM established a Joint Coordination Committee (JCC) consisting of representatives of public sector institutions to manage the formulation of the national power system development master plan and ensure it reflects national power development policy	Joint Study Team (JST) was also formed as a subsidiary, more operational body to JCC.
18	Involvement of electricity users	Opportunity to comment on drafts at various workshops during the study	

#	Item	Comments and last update	Additional comments and future intentions
19	Involvement of other stakeholders	Public sector stakeholders involved via JCC	
20	Monitoring of plan implementation	Not detailed	
21	Capacity building	JICA team provided capacity-building throughout, including some full-time training in Japan	

Source: Planning documents and discussions with key informants

10.2 Elaboration of key elements

An important element of the 2018 Master Plan is the interconnection of the regional grids (Northern, Central and Southern). Interconnectors with Malawi, Zambia, South Africa (via Zimbabwe) and Tanzania are also important elements. Mozambique's current position means that the power system is to a significant extent controlled via the SAPP control areas. In future there are significant challenges in exercising control over a more integrated national system that is also increasing trade with its neighbours. Section 6.3 of the Master Plan has a detailed discussion of power system operation requirements.

10.3 Assessment of good practices and gaps

The 2018 Integrated Master Plan Mozambique Power System Development is a report on a comprehensive 18-month study. It contains valuable guidance on a number of important topics, such as demand side management, as well as the results of the formal planning process in the form of recommended generation, transmission and distribution projects.

The process was dominated by the utility EDM and the stakeholder involvement was concentrated on arms of government. Future updates should be more inclusive in the involvement of stakeholders and could adopt other IRP principles including a more thorough incorporation of DSM into the plan itself. There was a gap of nearly a decade between Master Plans and it would be beneficial to establish a locally managed and executed process of making more regular updates of the Master Plan.

11 Namibia

11.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	National Integrated Resource Plan 2016	NIRP is being updated in 2020-2021 (2020 NIRP)
2	Legal instrument defining electricity sector planning responsibility	The 2016 Electricity Bill empowers the Ministry of Mines and Energy (MME). NIRP 2016 was managed by the Electricity Control Board (ECB)	NIRP Update is being managed directly by MME
3	Scope	Namibia Electricity Supply Industry (ESI). The plan was prepared from the national perspective and covers the whole territory of Namibia	The update will follow the same approach as the 2016 NIRP
5	Timeframe	The 2016 NIRP covered a 20-year period between 2016 and 2035	The timeframe will cover the planning period from 2021 to 2040
6	Load forecast methodology	Linear regression analysis to account for organic growth and step loads to incorporate large new customers and the impact of demand side management programs (DSM) and behind the meter solar PV systems.	Review of NamPower's national load forecast prepared on the basis of trend analysis plus step loads
7	Provisions for wholesale market development	Not considered	Modified Single Buyer (MSB) being introduced. Need to forecast national load, not just demand satisfied by national utility.
8	Off-grid electrification	Not considered	Intention is to consider off-grid electricity that may become grid-connected during the planning period.
9	Least cost generation planning software	The 2016 NIRP was prepared using the Consultant's in-house generation planning software.	Wairoa (ECA proprietary software), to be handed over with training to an MME representative

#	Item	Comments and last update	Additional comments and future intentions
10	Transmission planning software	NamPower is the Transmission System Operator (TSO). Transmission planning was not specifically undertaken. Transmission connection costs were incorporated in the generation costs.	The Transmission Master Plan Update was prepared by NamPower in 2019 and will be an input to the 2020 NIRP. DIgSilent PowerFactory was used.
11	Environmental and social planning tools	Not discussed in detail. An environmental cost of air pollution was factored into the cost optimisation function.	New investments are expected to comply with strict environmental and social standards for emissions to air and water, population displacement and compensation, and the capital and operating costs reflect this expectation. Further environmental and social impacts not considered further. See below regarding renewable energy and climate change.
12	Renewable energy requirements	A 70% target for RES had been proposed in Namibia's Intended National Determined Contribution, but contingent on funding. Alternative renewable energy penetration scenarios were considered among the cases examined. Investment plans with more RES were preferred to those with less.	The Renewable Energy Policy specifies the Government targets related to renewable energy sources (RES). The document states a target of 70% or more of electricity generated in the country to come from RES by 2030.
13	Demand side management	A list of current and planned programmes and their forecast effect on electricity demand. Demand-side measures were treated as a reduction in load.	An update and review of measures mentioned in the 2016 NIRP. Demand-side measures to continue to be treated as reductions in load.
14	Climate change mitigation	An economic cost of N$60 per tonne of CO_2 equivalent emissions was levied on thermal power plants	Intended Nationally Determined contributions to be satisfied through RES target of 70%. CO_2 emissions to be estimated and the cost of achieving alternative emission reduction levels analysed.
15	Approach on regional trade	In line with the 1998 White Paper on Energy Policy. The 2016 NIRP stated that the aim of the Government was to have 100% of peak demand and at least 75% of energy demand supplied from domestic generators by 2010. In the 2016 NIRP the target date was 2021. This target was not realised at the time of updating the 2016 NIRP.	This requirement was not included in the 2017 National Energy Policy but heavy reliance on imports remains a concern.

#	Item	Comments and last update	Additional comments and future intentions
16	Approach to risk analysis	The 2016 NIRP considered 11 main expansion scenarios. Sensitivity tests were conducted on various key uncertainties, including demand forecast, capital cost, fuel cost, discount rate and CO_2 emission offset allowance.	A similar approach will be followed in the 2020 NIRP Update.
Planning processes			
16	Period between updates	MME Strategic Plan for 2017/18 to 2021/22 and the 2016 NIRP state that the document should be updated at intervals not exceeding 5 years	At least every five years but sooner if required
17	Coordination of institutions directly involved	In the 2016 NIRP Update, ECB coordinated MME, NamPower and REDs	In the 2020 NIRP Update MME is coordinating ECB, NamPower and REDs, A Project Management Unit of these key stakeholders established
18	Involvement of electricity users	Two stakeholder workshops	Draft reports are circulated amongst key stakeholder who are given a chance to comment on key findings. These include representatives of the ESI (NamPower, Regional Electricity Distributors (REDs), the ECB, governments officials and stakeholders from the energy sector.
19	Involvement of other stakeholders	Same as above	Draft reports are circulated amongst key stakeholder who are given a chance to comment on key findings. These include representatives of the ESI (NamPower, Regional Electricity Distributors (REDs), the ECB, governments officials and stakeholders from the energy sector. Two national stakeholder workshops will be organised to disseminate the finding of the updated IRP.
20	Monitoring of plan implementation	An implementation plan forms part of the IRP	As in the 2016 NIRP
21	Capacity building	Two one-week training workshops	Training on IRP planning to be delivered to selected MME, NamPower, ECB and REDs staff

Source: Planning documents and discussions with key informants

11.2 Elaboration of key elements

Namibia is currently in the process of updating its National Integrated Resource Plan (NIRP). Compared with the 2016 version, which was developed for the Ministry of Mines and Energy (MME), but with project management overseen by the Electricity Control Board (ECB), the 2020 NIRP is being managed by MME.

The purpose of the NIRP is to provide a 20-year least cost electricity infrastructure plan to meet demand projections and ensure reliable and sustainable supply of electricity. While the document is long-term in its nature, the primary focus is on investments made in the next 2-5 years. Due to the long lives of most power assets, the long horizon is necessary to optimise investments incurred at different points of time.

The introduction of the MSB framework entails significant changes for the electricity industry and its key stakeholders. NamPower, the appointed TSO, will no longer be the sole entity responsible for the generation business and its perception of future loads will therefore be limited. This change increases the importance of the NIRP as a document for policy making. NamPower will need to use the plan as an input to NamPower's transmission investment plan and as a guide to its generation investments (to be approved by MME and licensed by ECB).

The NIRP includes 11 main expansion scenarios. Each scenario is assessed against the following six attributes:

- self-sufficiency
- indigenous resources
- renewable energy
- foreign exchange
- government investment
- development/operating complexity

11.3 Assessment of good practices and gaps

Namibia is one of the relatively few countries in the SADC region to have formally adopted Integrated Resource Planning. The IRP was first developed in 2013 and the 2020 Update is going to be the second revision. The country is therefore able to build on lessons from the 2013 IRP and the 2016 Update.

New priorities are being incorporated – renewable energy, climate change and the first steps in introducing a wholesale electricity market. The plan is also addressing in a realistic and balanced manner the choice between self-sufficient utilisation of indigenous energy resources and taking advantage of lower cost energy, shared reserves and other benefits of regional power system integration. To the extent that the MSB framework means that some investments in the ESI are no longer 'planned', the purpose of the NIRP has to be subtly changed.

Namibia's NIRP also considers whether the plan can readily be implemented. These are all matters of concern to other SADC countries and the Namibian NIRP approach has useful lessons for neighbouring countries in the region.

12 Seychelles

12.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Electricity Master Plan (EMP) for Seychelles	First master plan for the Seychelles. "The Master Plan's objective is to perform a holistic plan for the electricity sector in the Seychelles, in order to reach its Renewable Energy generation target of 5% by 2020 and 15% by 2030,…"
2	Legal instrument defining electricity sector planning responsibility	Energy Act 2012 outlines responsibilities in the sector. Planning responsibility is held by both the utility, Public Utilities Corporation, and the Seychelles Energy Commission.	The Seychelles Energy Commission (SEC) has a regulator role including overview of the Public Utilities Corporation (PUC). PUC is under the authority of the Ministry of Environment, Energy and Climate Change (MEECC). The Master Plan was funded by the European Commission and Indian Ocean Commission. Its recipients are the MEECC, SEC and PUC.
3	Scope	Electricity	PUC expressed preference for a more comprehensive master plan, however, due to the relatively short timeframe of the study, the scope had to be reduced.
4	Timeframe	Covers the period 2019 (baseline analysis) to 2030	
5	Load forecast methodology	Multivariable linear regression analysis. Electricity demand is regressed using Real GDP and population for different consumer categories. Total future electricity demand is contemplated on the basis of the historic	Nine scenarios are considered – high, moderate and low GDP elasticities to reflect different rates of decoupling, with each of these refined using three RGDP growth scenarios (high, moderate and low).

#	Item	Comments and last update	Additional comments and future intentions
		composition and distribution among the consumer categories. Peak load is regressed using electricity demand and a standard daily load profile based on historic observations of 2018. The daily load profile of each island is estimated at short-, medium- and long term. Daily average load profiles were distinguished between weekdays and weekends as the baseline assessment indicated a significant deviation. Annual Load Duration Curves were not analysed in the Master Plan.	
6	Provisions for wholesale market development	Not considered	
7	Off-grid electrification	Off-grid electricity production is not reflected in the forecast. This is considered supressed demand.	
8	Least cost generation planning software	Not clear	
9	Transmission planning software	DPlan2	PUC use DlgSILENT PowerFactory for network analysis.
10	Environmental and social planning tools	Environmental and social impact evaluations conducted for all projects, considering both construction and operation.	
11	Renewable energy requirements	EMP is strongly focussed on the target to achieve 5% renewable energy by 2020 and 15% renewable electricity by 2030	In 2020 State of the Nation Address, President Faure announced the national renewable energy target for 2030 is to rise from 15 to 30%
12	Demand side management	Demand-Side management measures are not considered in the projection due to data scarcity and limited information on the large industrial	

#	Item	Comments and last update	Additional comments and future intentions
		consumers who would have the potential to change their demand pattern at the request of PUC.	
13	Climate change mitigation	High-level evaluation of averted CO_2 equivalent emissions	Seychelle's Intended Nationally Determined Contribution (INDC) comprises a 29% reduction of greenhouse gas (GHG) emissions compared to the baseline scenario by 2030. NDC intentions include a penetration of EVs to 30% of the private vehicle fleet. The impact of this is modelled.
14	Approach on regional trade	Not applicable	
15	Approach to risk analysis	Not considered	
Planning processes			
16	Period between updates	This is the first Master Plan.	
17	Coordination of institutions directly involved	Consultant carried out various meetings and consultations with relevant stakeholders (PUC, SEC, MEECC), however the level of coordination on institutional level appeared insufficient,	
18	Involvement of electricity users	Not considered	
19	Involvement of other stakeholders	Not considered	
20	Monitoring of plan implementation	Not considered	
21	Capacity building	One goal of the Master Plan development is to provide PUC and SEC with knowledge, tools and capacity to regularly review the Master Plan with their own resources. This capacity building also aims to improve the operation, management and overall performance.	

Source: Planning documents and discussions with key informants

12.2 Elaboration of key elements

This is the first master plan for the Seychelles. It aims to perform a holistic analysis for the utility, energy commission (regulator), and the ministry. The EMP was completed under an Indian Ocean Commission (IOC) project funded by the European Union. Although the utility sought a more comprehensive master plan, the timeframe of the IOC programme left only a short period of 4-6 months to complete the EMP. As a result of these time constraints, the focus of the Master Plan is on renewable energy and particularly how the country's targets of 5% RE generation by 2020 and 15% by 2030, as outlined in the Seychelles energy policy, can be met. Non-renewable generation options are excluded from the analysis despite the PUC's plan to bring them online.

As opposed to using a software to optimise generation planning according to least cost principles, the Master Plan considers different scenarios based on specific renewable generation mix scenarios. For example, for the island of Mahe the following scenarios are considered for each level of hypothesised demand growth:

- Scenario 1: Renewable goals are met through large deployment of roof top PV
- Scenario 2: Renewable goals are met through a waste to energy plant, several PV farms and growth of roof top PV
- Scenario 3: Renewable goals are met through a waste to energy plant, a biodiesel generator and endogenous growth of roof top PV

12.3 Assessment of good practices and gaps

The Master Plan appears focused on renewable energy sources and associated policy targets. It provides a detailed examination of the potential of different renewable sources to meet RE targets and includes screening curves to consider the impact of variable RE generation on the load throughout the day. Non-renewable power plants were excluded from the analysis.

The impact of demand side measures was difficult to quantify and was not included in the demand forecast. A notable inclusion is the analysis of the impact of electric vehicles (EV) and the impact that increased EV uptake would have on the load. The Master Plan also considers the environmental and social impacts of different measures, including both the construction and operation phase.

The main shortcomings of the Master Plan relate to insufficient institutional coordination, the least cost planning process (and the lack of generation planning software) and the treatment of non-renewable technology options. The demand forecasting component could also be improved by including an analysis of load duration curves.

13 South Africa

13.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Integrated Resource Plan 2019	The previous IRP was developed in 2010 and was updated in 2013. The review process for the 2019 IRP was initiated in 2016.
2	Legal instrument defining electricity sector planning responsibility	Department of Mineral Resources and Energy holds responsibility for publishing an IRP. The legal basis is section 35(4) of the Electricity Regulation Act, 2006 (Act No. 4 of 2006) read with item 4 of the Electricity Regulations on New Generation, 2011. Eskom manages the development of the IRP on behalf of the Department of Energy. The demand forecast was developed by the Council for Scientific and Industrial Research. The final IRP has to be adopted by the South African Cabinet.	
3	Scope	Electricity	The National Development Plan (NDP) 2030 provides a long-term strategy for the country. The IRP is one of the three sector plans (the other two are the Liquid Fuels Master Plan and the Gas Master Plan) which forms the basis for development of the Integrated Energy Plan (IEP).
4	Timeframe	2018-2030	

#	Item	Comments and last update	Additional comments and future intentions
5	Load forecast methodology	Regression analysis was used to investigate statistical relationship between key variables and electricity consumption in 5 sectors (agriculture, transport, domestic, commerce & manufacturing and mining). Three scenarios (upper, median and low) were developed to analyse the impact of changes to the GDP growth rate and to the energy intensity of the economy.	
6	Provisions for wholesale market development	Not considered. The IRP looks at balancing supply and demand irrespective of the market structure.	
7	Off-grid electrification	Not considered	
8	Least cost generation planning software	Plexos	
9	Transmission planning software		Transmission planning is conducted by Eskom and dealt with in other reports. The IRP considers these plans and uses high-level estimates from recent average costs for transmission network costs.
10	Environmental and social planning tools	The social and economic impact of decommissioning certain Eskom power plants was not assessed under the IRP as it is considered an implementation issue.	Environmental and social planning was considered in a separate report “Socio-economic Impact Assessment System” (draft published in 2018).
11	Renewable energy requirements	An annual build limit on renewables is applied to provide a consistent pipeline of new investments. The IRP assumed a limit of 1000MW for PV and 1600MW for wind per year.	
12	Demand side management	Embedded generation, solar water heating and fuel switching are recognised in the IRP. Their impact on electricity demand was not modelled	

#	Item	Comments and last update	Additional comments and future intentions
		separately, but was assumed to be covered by the low forecast scenario.	
13	Climate change mitigation	Externality costs associated with emissions of NO_x, SO_x, PM and Hg were assessed using the cost of damage approach. Externality costs associated with CO_2 emissions are accounted for by imposing constraints in the model using the Peak-Plateau-Decline (PDP) method. An alternative scenario was developed using a carbon budget approach. No specific targets are specified. Coal power plants under Eskom's fleet have to meet the minimum emissions standards in line with the National Environmental Management Act: Air Quality (Act No. 39 of 2004)	In line with the Paris Agreement on Climate Change and South Africa's Intended Nationally Determined Contribution (INDC) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2016. The Government of South Africa committed to keep its greenhouse gas emissions in a range between 398 and 614 Mt CO2–eq by 2025 and 2030.
14	Approach on regional trade	No specific targets are included. The IRP states that South Africa will participate in the development of cross-border infrastructure needed for regional trading.	
15	Approach to risk analysis	Seven main scenarios were considered in the development of the IRP. The IRP uses conventional risk mitigation measures which include close monitoring of model assumptions to ensure they are not outdated and frequent performance assessments of existing power plants. In terms of generation dependency, South Africa will not import power from one source beyond its reserve margin.	
Planning processes			
16	Period between updates	The IRP is envisaged as a "living document" to be updated regularly. The aim is every two	

#	Item	Comments and last update	Additional comments and future intentions
		years, but this timeline was not adhered to before.	
17	Coordination of institutions directly involved	Department of Energy delegates the responsibility to develop the IRP to Eskom. The National Energy Regulator of South Africa (NERSA) is responsible for the development of regulations that implement the IRP.	
18	Involvement of electricity users	A consultation period took place between Dec 2016 and Mar 2017. There was a 60-day consultation period following the release of a draft IRP in 2018.	
19	Involvement of other stakeholders	A consultation period took place between Dec 2016 and Mar 2017. There was a 60-day consultation period following the release of a draft IRP in 2018.	
20	Monitoring of plan implementation	The plan is implemented following Ministerial Determinations which are issued under the prevailing Electricity Regulations. These Determinations facilitate the procurement of the required capacity and hence give effect to the planned infrastructure.	
21	Capacity building	Not specified	

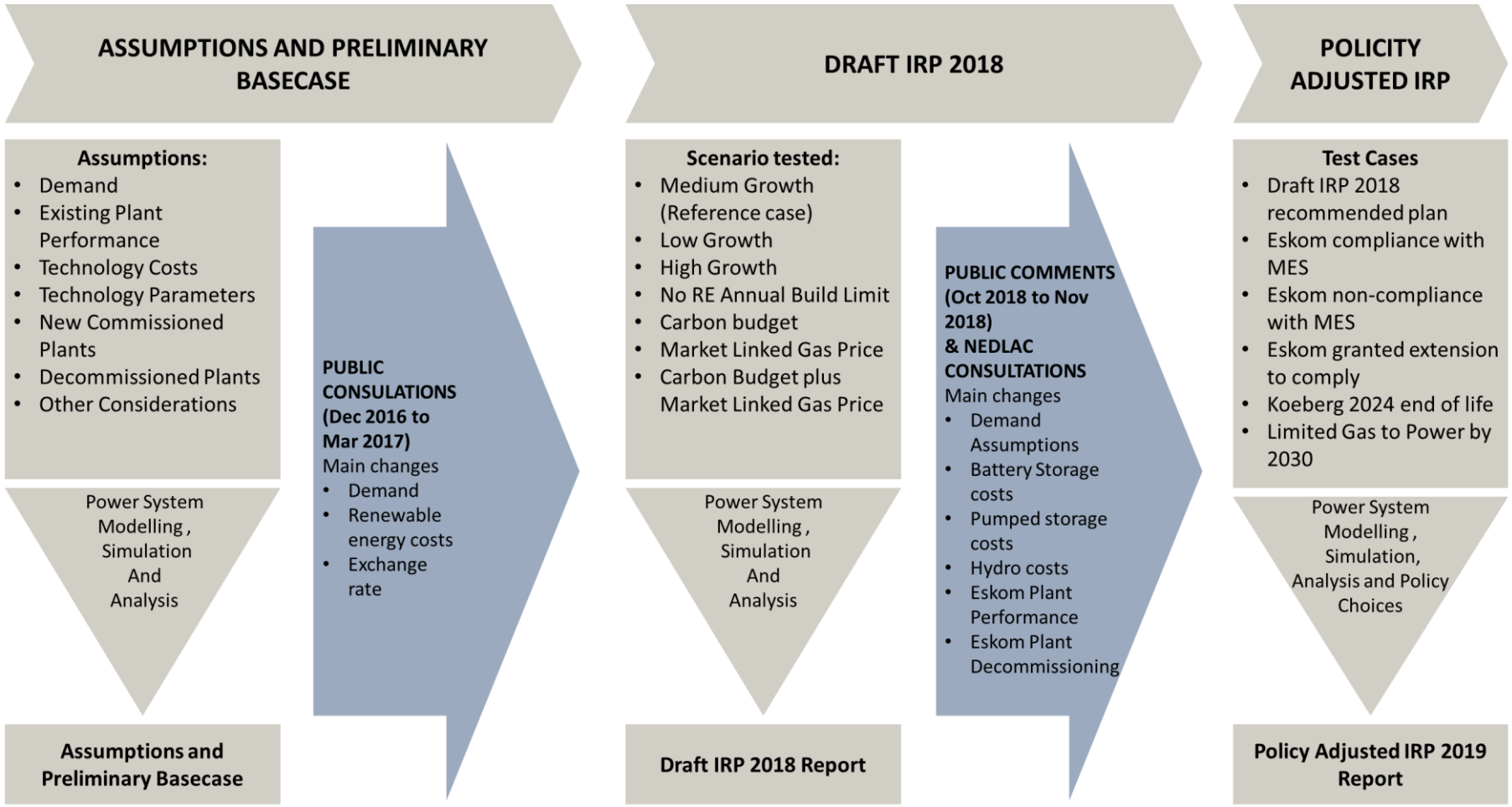
Source: Planning documents and discussions with key informants

13.2 Elaboration of key elements

The first IRP in South Africa was developed in 2010 and since then the Department of Mineral Resources and Energy updated the IRP twice in 2013 and 2019. The review of the 2019 IRP started in 2016 with the development of a preliminary base case and was not completed until 2019 when the final version of the new IRP was released. While the Department of Energy held the ultimate responsibility for the development of the IRP, Eskom was

tasked with the management of the process. The 2019 IRP followed a well-established review process which included a formal process of stakeholder engagement. A summary is presented in Figure 1.

Figure 1 IRP Update Review Process



Source: Integrated Resource Plan 2019

The first round of consultations took place after publication of assumptions and release of a preliminary base case scenario. Justified changes were then made to the model inputs and additional scenarios were tested by power system modellers. The process was concluded with the release of a draft IRP when the public was given a chance to comment on the document for a period of 60 days (concluded in November 2018). A report containing a summary of comments and how they were accounted for in the IRP was included as an appendix to the report. The final stage included policy adjustment of the IRP directed by the South African Cabinet. No further consultations with the public took place following the release of the Policy Adjusted IRP.

13.3 Assessment of good practices and gaps

The electricity IRP, along with the Gas Master Plan and the Liquid Fuels Master Plan, provide sector planning tools which feed into the development of the Integrated Energy Plan. Development of the IRP followed a well-defined process which included extensive stakeholder engagement and public consultations. Comments from the public with associated responses were published as an appendix to the main document. There is also a legal requirement for the final IRP to be published in the Government gazette.

The period between updates is not as clear. The IRP is developed as a “living” document supposed to be revised every two years. The first IRP was developed in 2010 and the first update report was published in 2013. The review process for the 2019 IRP started in 2016. This is a long time during which assumptions could have become outdated and new technologies were developed.

The draft 2018 IRP identified the preferred technology required to meet electricity demand. The final stage of IRP development adjusted the plan in line with Government policies related to climate change mitigation, affordability and diversity. Stakeholders have been concerned about the protracted delays in an IRP process that was started in 2016 and only concluded at the end of 2019. The requirement that the final IRP be passed by the Cabinet is part of the reason for this, as a political consensus has to be reached on contentious issues such as the balance between coal, renewables and nuclear in South Africa’s generation mix.

NERSA is responsible for implementation of the IRP by developing a regulatory framework that adheres to the plan. Applications from Independent Power Producers (IPPs) are reviewed in terms of consistency with the IRP. Additionally, the DoE publishes Ministerial Determinations which form the basis for the proposed capacity plan.

14 Tanzania

14.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	Power System Master Plan 2016 Update developed over a 30 month period from June 2014 to December 2016.	The first Power System Master Plan (PSMP) was prepared in 2008 and was updated in 2009, 2012 and 2016
2	Legal instrument defining electricity sector planning responsibility	Planning was led by the Ministry of Energy and Minerals (which was split in 2017 into the Ministry of Energy and the Ministry of Minerals)	
3	Scope	Covers generation and transmission planning	
4	Timeframe	The Master Plan covers the period 2016-2040	
5	Load forecast methodology	Energy consumption for each sector is forecast using econometric equations. Additional loads are added from power export, industrial renovation, backup for captive generators for large scale industries, and step loads from rural factories and mining sites.	
6	Provisions for wholesale market development	Not specified	
7	Off-grid electrification	Considers connections of some off-grid regions	
8	Least cost generation planning software	WASP (Wien Automatic System Planning)	
9	Transmission planning software	PSS/E	
10	Environmental and social planning tools	No specific tools mentioned. Generation and transmission sectors need to adhere to the	

#	Item	Comments and last update	Additional comments and future intentions
		National Environmental Policy (1997), Environmental Management Act (2004), National Environmental Action Plan (NEAP,, 2013), and related sectorial polices and legal instruments	
11	Renewable energy requirements	Not specified	
12	Demand side management	Target energy efficiency effect rate is set to reach 0.5% per year after 2026. This is calculated as part of the load forecast.	
13	Climate change mitigation		Greenhouse gas emissions under the power generation mix target are reported. Relative to the BAU scenario, Tanzania targets greenhouse gas emission reductions between 10% and 20% by 2030.
14	Approach on regional trade	The Update identifies a need to increase the exchange capacity between Tanzania and other countries in order to export surplus power during wet years. Six new interconnectors were planned for the upcoming five-year period.	
15	Approach to risk analysis	Sensitivity analysis of demand forecast and different fuel and O&M costs. Development of six expansion scenarios. Risk to IPP investors considered.	
Planning processes			
16	Period between updates	Gap between the 2012 Update and the 2016 Update was four years.	
17	Coordination of institutions directly involved	Update was developed by the Ministry of Energy and Minerals (MEM), National Bureau of Statistics (NBS),Rural Energy Agency (REA),Tanzania Electric Supply Company (TANESCO),Tanzania Petroleum Development	

#	Item	Comments and last update	Additional comments and future intentions
		Corporation (TPDC),Energy and Water Utilities Regulatory Authority (EWURA) and Japan International Cooperation Agency (JICA) with the consultant, Yachiyo Engineering Co., Ltd.	
18	Involvement of electricity users	Not detailed	
19	Involvement of other stakeholders	Comments were incorporated from stakeholders in the development of the Update	
20	Monitoring of plan implementation	The Update recommends the Government to establish a monitoring and evaluation unit consisting of inter-ministerial members to accelerate the planned projects.	
21	Capacity building	The Plan recommends that the core team responsible for future Plans should be retained and that further capacity should be built, including training the core team, procuring modelling packages and sharing of experiences with institutions involved in similar planning works.	

Source: Planning documents and discussions with key informants

14.2 Elaboration of key elements

The Power System Master Plan was published in December 2016, following on from the previous 2012 Update. The 2016 Update assesses generation and transmission requirements for the period 2016-2040 as well as the connection of off-grid regions and possibilities for power exchange with neighbouring countries. The Update includes a revised load forecast, analysis of the environmental and social considerations for proposed projects and an economic and financial analysis.

The generation expansion plan considers six scenarios and is analysed using WASP (Wien Automatic System Planning Package) software.

14.3 Assessment of good practices and gaps

Although the Power System Master Plan is not an IRP, the Plan considers an analysis of both supply and demand sides. The assumptions on the demand side set a target, however it is not clear what measures will be used to achieve a decline in the energy consumption or a shift in the demand pattern.

The PSMP is an expansion plan of generation, transmission and distribution sector. The primary objective of the Plan is the provision of stable electricity supply. The PSMP includes a set of recommendations which identifies actions necessary to move the power sector forward to achieve this objective. This set of recommendations should guide the preparation of the future implementation plan.

15 Zambia

15.1 Summary table of power sector procedures and processes in Zambia

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	The latest published power sector planning study is the Power System Development Masterplan for Zambia (PSDMP) developed in 2010 by the Japanese International Cooperation Agency (JICA) for the Ministry of Energy and Water Development	The Ministry of Energy initiated the development of an IRP last year with support from USAID and WWF. The Terms of Reference (TOR) for the study are currently being finalised. DIFID committed to providing technical assistance in the development of the IRP.
2	Legal instrument defining electricity sector planning responsibility	The Department of Energy within the Ministry of Energy (MoE). Power sector planning responsibility comes from the mandate of the Ministry and has not been delegated to any other entity. This was issued in Gazette Notice No. 863 of 2016.	
3	Scope	The national electricity supply industry (ESI). The 2010 plan was prepared from the national perspective and covers the whole of the integrated national grid including the areas supplied by ZESCO (the national vertically integrated utility), Copperbelt Energy Corporation (CEC) and North Western Energy Corporation Limited (NWEC) an electricity distributor in the North Western Province of Zambia	
5	Timeframe	2010-2030	
6	Load forecast methodology	Econometric (regression) analysis conducted using data for the period 1999-2006 to account for organic	

#	Item	Comments and last update	Additional comments and future intentions
		growth, and step loads particularly from mining industry. The electrification programme and the number of new connections was an exogenous assumption (described as a growth in the "electrification ratio").	
7	Provisions for wholesale market development	Not considered as a competitive bilateral contract market was not proposed at that time	Recent developments in the power sector include: 1) Implementation of a GET FiT programme, which aims to procure and support Independent Power Producer (IPP) projects up to 20 MW. First competitive solar auction was organised in 2016. 2) Introduction of an open access regime which is hoped to facilitate trading on SAPP level. The relevant legal documents are the Electricity Act 11/19 and the Energy Regulation Act 12/19
8	Off-grid electrification	Not considered at the time	
9	Least cost generation planning software	ArcGIS	
10	Transmission planning software	PSS/E (Power System Simulator for Engineering) for transmission planning, marketed by Siemens, was initially used. Transmission system planning was subsequently moved to DIgSilent Power Factory	
11	Environmental and social planning tools	The PSDMP conducted an "*Environmental and Social Consideration (ESC) study in accordance with the JICA Guidelines*". This ESC listed potential environmental and social impacts, with 4 classifications ranging from negligible to significant. It was stated that this approach has elements of a Strategic Environmental Assessment (SEA).	
12	Renewable energy requirements	Though renewable energy investments, other than medium and large hydro, were discussed, none were	

#	Item	Comments and last update	Additional comments and future intentions
		selected as part of the least cost investment plans. A policy of promoting renewable energy, other than hydropower, was not obviously considered.	
13	Demand side management	Demand side measures were not discussed	
14	Climate change mitigation	Climate change issues were mentioned, though not analysed quantitatively. Definition of scenarios could be considered to attempt addressing climate change mitigation by including a coal-focused scenario and comparing it with a hydropower-focused scenario. The greenhouse gas (GHG) emissions were not quantified.	Zambia Intended Nationally Determined Contribution (INDC) is a 47% reduction in GHG emissions by 2030. This is subject to the availability of international financial support.
15	Approach on regional trade	Scenarios were examined to consider self-sufficiency with no new imported generation, and with full dependence on imports to satisfy Zambia's needs. The transmission investments were costed but the overall present-value system costs were not. The two main PSDMP investment plan scenarios do not appear to have proposed imports as a source of electricity.	
16	Approach to risk analysis	As noted above, the PSDMP considered 2 main expansion scenarios/ cases - one focusing on substantial investment in coal while the other focused on substantial investment in hydropower. This could be considered to be addressing risks relating to hydropower dependency and hydrological uncertainty and risks around climate change.	
Planning processes			
16	Period between updates	The PSDMP has not been updated since 2010	The TOR for the first IRP is currently being finalised
17	Coordination of institutions directly involved	The Ministry of Energy and Water Development coordinated ZESCO (national utility) and Copperbelt Energy Corporation Plc (CEC)	

#	Item	Comments and last update	Additional comments and future intentions
18	Involvement of electricity users	Consumer groups involved in the development of the PSDMP included the Consumer Unity Trust Society, the Manufacturing Association of Zambia and the Chamber of Mines	
19	Involvement of other stakeholders	A technical team comprising relevant stakeholders participated in the development of the last PSDMP	
20	Monitoring of plan implementation	The MoE holds the responsibility for implementation of the PSDMP, however there is no clear implementation process in place. ZESCO-led projects are mostly pursued by the utility and are not led by the Ministry	
21	Capacity building	Training workshops targeted at ZESCO mostly	

Source: Planning documents and discussions with key informants

15.2 Elaboration of key elements

The PSDMP covered a 20-year period from 2010 to 2030. It was conducted for the Ministry of Energy and Water Development and was intended to guide the investment in generation and transmission by ZESCO or the procurement of power generation capacity and energy from IPPs. It is understood that the PSDMP used ArcGIS for generation planning, however ArcGIS is predominantly a geographic information system (GIS) tool. The PSDMP appears to include 2 main expansion scenarios or cases, one focusing on substantial investment in coal while the other focused on substantial investment in hydropower.

15.3 Assessment of good practices and gaps

Zambia is currently in the process of preparing its first IRP. This presents an opportunity to develop a power sector expansion plan that would incorporate a holistic assessment of available energy resources and demand-side measures. The Terms of Reference for the study are currently being finalised. This is a welcome development as the current PSDMP is dated and in need of an update.

The load forecast was conventional and professional. The methodology used to conduct the generation investment plan was unclear. The total investment costs over the planning horizon (to 2030) were provided for each of the two main cases examined, but the present-value system costs were not clearly shown in the report. The present-value of the overall system costs are required to identify the least-cost investment.

The stakeholder consultation process included engagements with representatives of large electricity consumers and a technical group comprising other relevant stakeholders. The Ministry of Energy is responsible for the monitoring of plan implementation, however there is no clear implementation mechanism that would ensure alignment between the MoE and ZESCO.

Many of the options or issues that would be expected in an IRP today – relating to DSM measures, renewable energy, climate change, and the role of regional trade – were absent or only treated at a cursory level. However, this partly reflects the level of understanding of these measures and options in 2010.

16 Zimbabwe

16.1 Summary table of power sector procedures and processes

#	Item	Comments and last update	Additional comments and future intentions
Planning procedures			
1	Official name of latest planning documents	System Development Plan (2017)	Previous version was developed in 2015
2	Legal instrument defining electricity sector planning responsibility	Electricity Act Chapter 13:19, responsibility of primary transmission licensee	
3	Scope	Electricity generation only. Investment costs are inclusive of transmission costs.	
5	Timeframe	2018-2037	
6	Load forecast methodology	A combination of end-use and trend analysis	Developed in a separate document (National Electricity Load Forecast (NEF)). The last update of NEF (dated June 2019) used Matlab to conduct econometric analysis. Older versions used a bottom-up approach and the MAED model.
7	Provisions for wholesale market development	The market remains dominated by the Zimbabwe Power Company (ZPC). The regulatory framework allows for participation of IPPs	Primary transmission licensee is the system and market operator
8	Off-grid electrification	Considered in a separate planning document (Zimbabwe Rural Energy Master Plan, updated in 2015)	
9	Least cost generation planning software	Wien Automatic System Planning (WASP) package (an IAEA generation expansion software) and MASSAGE software;	2014 version used UPLAN-E; PLEXOS now available for future studies

#	Item	Comments and last update	Additional comments and future intentions
10	Transmission planning software	PSS/E	SinCal and Digisilent were used historically
11	Environmental and social planning tools	Not considered	SAPP Pool Plan 2017 tool for future plans
12	Renewable energy requirements	No specific requirements are defined, however the formulation of scenarios is indicative of the importance of incorporating RES into the plan	Renewable Energy Policy launched in 2020 now has explicit targets for renewable energy
13	Demand side management	DSM measures are mentioned as a recommendation and include: direct load control, load limiters, commercial/industrial programs, frequency regulation, time of use pricing, demand bidding, smart metering and appliances	
14	Climate change mitigation	No specific climate change mitigation measures are mentioned	The conditional nationally determined contribution is defined at 33% below the business as usual (BAU) GHG emissions
15	Approach on regional trade	Considered in planning criteria	
16	Approach to risk analysis	4 key generation options scenarios (optimum solution, strong solar PV penetration scenario, strong renewable energy & electric vehicles penetration scenario, strong renewable energy penetration scenario with delayed growth of electric vehicles). Sensitivity tests were conducted to investigate changes in underlying assumptions. The SDP does not specify which assumptions these are.	2014 version specifies sensitivity analysis with regard to the following inputs: • Technical (a higher load growth, delays in the in-service dates of some of the key projects) • Economic (increase in capital costs, changes in the discount rate) • Financial (increase in capital costs, depreciation of currency, higher interest rates, reduction in the load forecast after commitment to plan has already been made, increase in self-financing ratio)
Planning processes			
16	Period between updates	Reviewed and updated periodically whenever there are changes in key assumptions	Annual review; major update every five years

#	Item	Comments and last update	Additional comments and future intentions
17	Coordination of institutions directly involved	The process of approval is a bottom-up approach and goes through the following entities: the System Development Division, the Management Board of ZETDC, the ZESA Holdings Board, the Ministry of Energy and Power Development. The Ministry, after consultations with the Ministry of Finance and Economic Planning and other relevant government departments and agencies , ZERA, REA and other stakeholders submits the Plan to the Cabinet for approval.	The planning process is now formally coordinated by the Ministry of Energy and Power Development which chairs a steering committee comprising relevant stakeholders
18	Involvement of electricity users	Stakeholder consultation workshops	Stakeholder consultation workshops
19	Involvement of other stakeholders	Stakeholder consultation workshops	Stakeholder consultation workshops
20	Monitoring of plan implementation	Ministry of Energy and Power Development is responsible for plan implementation	
21	Capacity building	Not specified	

Source: Planning documents and discussions with key informants

16.2 Elaboration of key elements

The System Development Plan (SDP) was last updated in September 2018 and covers the period 2018-2037. Its purpose is to develop the least-cost generation expansion plan by assessing the relevance of existing and committed generation options, investigating and selecting candidate power plants and comparing the costs of various options. The Rural Electrification Masterplan complements the SDP as it considers the potential future electricity demand of unconnected rural customers in Zimbabwe.

The System Development Plan uses the demand forecast sourced from the National Electricity Forecast (NEF) Report. Over time the methodology to derive the load forecast seems to have changed from a predominantly bottom-up approach using the MAED model to a top-down regression analysis using Matlab.

The definition of scenarios seems to be indicative of the Government's focus on renewable energy sources. Although no specific targets are defined, 3 out of 4 scenarios are based around renewable energy technologies (strong PV penetration scenario, strong renewable energy and electric vehicles penetration scenario and strong renewable energy scenario with delayed growth of electric vehicles).

16.3 Assessment of good practices and gaps

Zimbabwe does not currently have a generation planning document that would be referred to as an Integrated Resource Plan. However, the System Development Plan follows the high-level principles of integrated resource planning as it considers both demand and supply side options. The 2015 (2014?) SDP considers the effect of DSM measures on electricity demand. The updated 2017 version lists the relevant DSM options, but does not mention to what extend these are expected to decrease electricity demand.

Development of a thorough planning document that provides a path to increase capacity in a sustainable manner, while also satisfying the policy objectives such as affordability is fundamental to facilitate power market development. The generation market remains dominated by ZPC and is characterised by insufficient generation capacity. Significant regional trade, through both bilateral and competitive markets, covers shortfalls. Even though a significant portion of the demand is not met, political instability and economic turmoil led to underinvestment in the power sector. The 2018 SDP included a "Key recommendations" section that provided an action plan for the power sector, however the implementation of the plan remained problematic.

As the country has taken steps to open for competition in the generation sector, investors will need access to a document that will clearly state how much more capacity is needed and what rate of return they can expect to get. Furthermore, the expansion of regional trade opportunities within SAPP and between SAPP and EAPP will increase the country's importance as the geographical centre of the pool.