Integrated Resource Planning Training for Decision Makers

Day 9, Session 17 – IRPs and regional power system integration

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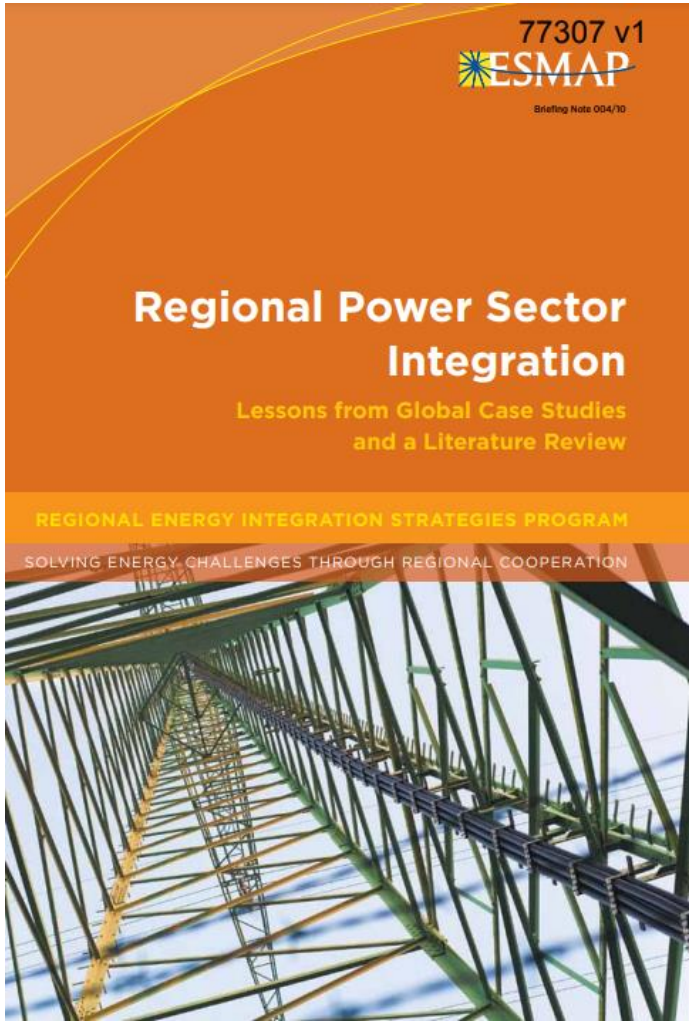
- Lessons from the 2017 Pool Plan
- Questions on future coordination of national IRPs and regional Pool Plans

Over-arching benefits of regional integration in the power sector

- Within the electricity sector
  - Technical benefits – frequency stability, security of supply through shared reserves
  - Planning benefits – greater flexibility in developing generation projects, ability to develop larger plants to take advantage of **economies of scale** (very significant in the electricity sector)
  - Financial benefits
    - Reduced investment and operational costs of meeting demand
    - Improved utility viability
    - Accelerated attainment of electrification targets
- Within the wider economy
  - Resources freed up for investment in the productive sectors
  - More competitive industries due to lower electricity tariffs
  - Electrification (esp. on-grid) gives multi-fold benefits at the household level, which also feed into the macro-economy
  - Enhanced employment and national income, CO2 savings



https://www.esmap.org/node/353

RGPSI as an IRP safety valve

- Recall from last week that getting power sector investments ‘wrong’ potentially very costly in terms of lost output and reduced economic growth:
  - **Over-investment** in electricity will reduce the resources available for investment in the productive sectors of the economy
  - **Under-investment** will result in shortages leading to load shedding and blackouts. Productive sectors have to sacrifice production or buy and run expensive stand-by generators
- If a country can import and export electricity, the risks are significantly diminished:
  - **Exports** - overestimating demand and installing more capacity than is needed domestically provides a surplus which can be exported into the region
  - **Imports** - underestimation of demand and installing less capacity than is needed does not lead to costly unserved demand if the country can import to cover the shortfall
- SAPP market cannot be taken for granted, especially on the export side
  - Cannot assume that an export market will exist and therefore autonomously plan to be an exporter
  - Export demand that is included in the IRP load forecast must be based on secure contracts or well founded export prospects

SAPP-wide benefits of the 2017 Pool Plan

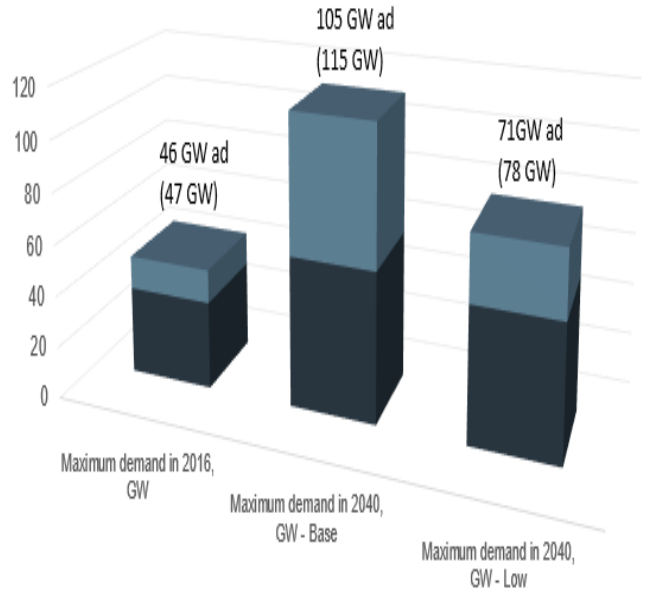
- For the region as a whole, the Pool Plan offers significant cost savings and reduced CO_2 emissions
- Some countries will inevitably benefit more than others:
  - Mozambique and DRC will become major exporters of power, this being a new source of foreign exchange earnings
  - As the biggest importer, South Africa will be a major beneficiary of low cost hydropower energy being available
- The underlying driver is **economies of scale** in large hydropower plants on the Congo, Zambezi and Rufiji Rivers
  - To access the benefits countries must be willing to import lower cost energy even though this may mean domestic power plants being idle / operating at low capacity factors
- **Relatively small transmission investments in regional interconnectors unlocks significant savings in generation investment costs**

Demand forecasts in the Pool Plan – 2 cases only

- ***Base demand forecast –*** annual average growth of 3.4% per annum
  - based on the national forecasts supplied by the utilities;
  - extended where necessary to 2040, with subsequent modifications being discussed and agreed with the utilities.
- ***Low demand forecast –*** *annual average growth of 2.1 % per annum*
  - adopted existing 'low' forecasts where these were available;
  - assessed the possible 'low' outcomes of risk factors in relation to key demand drivers such as economic growth and electrification rates;
  - in some cases, lower initial levels of unmet demand were also assumed.

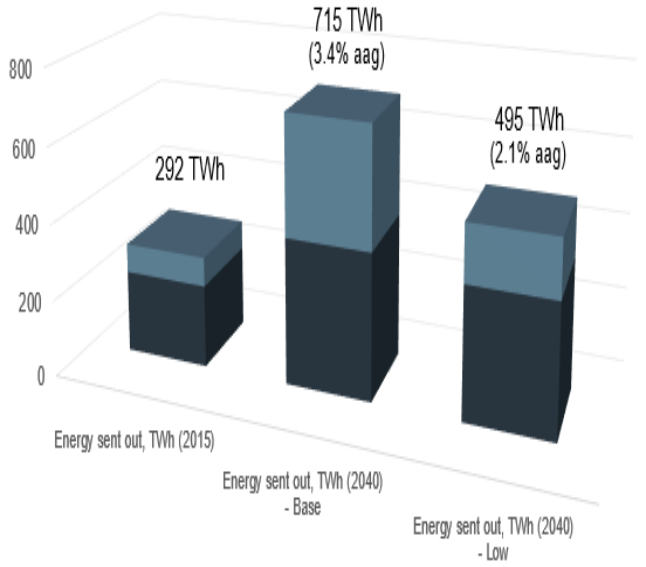
SAPP demand forecast (sent-out)

SAPP peak demand forecast



	Maximum demand in 2016, GW	Maximum demand in 2040, GW - Base	Maximum demand in 2040, GW - Low
Rest of SAPP	13	55	26
South Africa	34.0	58.2	52.4

SAPP energy demand forecast



	Energy sent out, TWh (2015)	Energy sent out, TWh (2040) - Base	Energy sent out, TWh (2040) - Low
Rest of SAPP	76	319	151
South Africa	216	382	344

Note: assumptions adopted for diversity are 1.03 at the start of the planning period (2015), rising to 1.10 by 2040. Diversity is Ratio of the Sum of Individual Country Maximum Demands to the Regional Coincident Demand (regional demand at the time of the South African Peak). An increase in diversity is predicted because:

- *the relative importance of South African demand in the total is forecast to decline over the period;*
- *two of the countries which will be joining the interconnected grid lie in different time zones to the majority of members (Angola and Tanzania).*

Pool Plan objectives, criteria and components

- SAPP Pool Plan for the period to 2040 is to identify a core set of generation and transmission investments of regional significance "that can provide adequate electricity supply to the region under different scenarios, in an efficient and economically, environmentally and socially sustainable manner and support enhanced integration and power trade in the SAPP region."
- PP incorporates 2011 SAPP Generation Planning Criteria:
  - ***Security criterion*** requires the minimum level of generation capacity for each member to be equal to or greater than 100% of demand.
  - R***eliability criterion*** defines the reserve capacity obligation for each member (10.6% of annual peak demand for predominantly thermal systems and 7.6% for mainly hydro systems and weighted average for mixed systems).
- SAPP permits the Reliability Criterion to be met through a country contracting reserve auxiliary services from others.

- **Component A / Benchmark Case** – combination of national power expansion plans

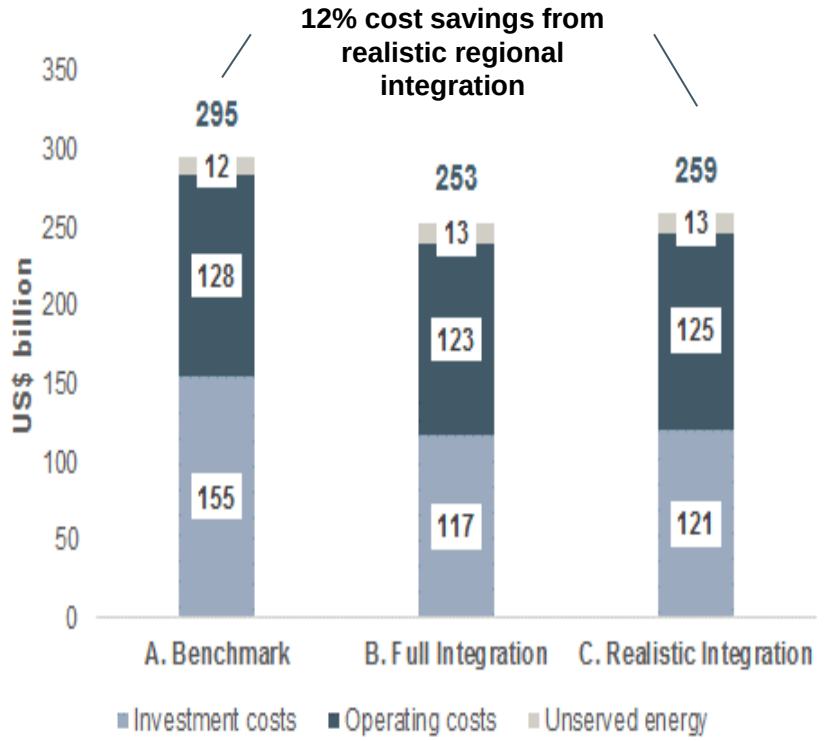
- **Component B / Full Integration Case** –the region is treated as though it is a single.

- **Component C / Realistic Integration case** – constrained case: at a minimum, fulfils SAPP security and reliability planning criteria and large thermal plants continue to operate at minimum capacity factors.

Main results for the 3 components

- Component C cost is only 2% higher than Component B - realistic scenario still delivers most of the regional integration benefits
- Main savings are in generation investment costs ($37 billion)
- Transmission investments which make trade possible are very small ($1.1 billion in A and $3.3 billion in C)
- National plans, with tendency to over-investment, will be less bankable than regional strategy
- ***Component C was adopted as the 2017 Pool Plan***

Present value of costs to 2040



Installed capacity in 2040 143 GW in A
127 GW in B and 130 GW in C

Generation Planning Process – Sensitivity Analyses

- Component C – the adopted Pool Plan
  - **Inga HPP** development postponed for five years
    - increase in total costs of only $1.8 b (0.7%)
  - **Dry hydrology**
    - increase in total costs of $17.2 b (6.7%).
  - Total **imports to South Africa limited** to 2800 MW
    - increase in total costs of $6.0 b (2.3%).
  - Increased **renewables** (as per IRENA SAPP report from 2013)
    - increase in total costs of $10.7 b (4.1%)
  - **Low demand** projection (33% than base case)
    - very significant, resulting in a reduction in total costs of $58.9 b (22.8%).

2017 Pool Plan study conclusions

- Conclusions
  - Component C - Realistic Integration Scenario - captures most of the regional integration benefits
  - The Realistic Regional Integration scenario is also robust
  - Changes in the demand forecast have the biggest impact on the generation investment
- The Realistic Regional Integration Case (Component C) has been adopted as the SAPP Pool Plan 2017
- Recommendations for member countries
  - Incorporate 2017 Pool Plan perspectives into national power development plans
  - Invest in transmission lines to remove existing bottlenecks and create merchant interconnector capacity to promote trade

SAPP Pool Plan Ministerial Decision on 2017 PP: June 2018

SADC Ministers Responsible for Energy:

1. Adopted SAPP Pool Plan of 2017 as a guiding document to guide development of power generation and transmission in the Region
2. Directed the SADC Secretariat in collaboration with SAPP CC to convene dissemination workshops at national level on SAPP Pool Plan 2017 as it is expected to add value in the review and development of national integrated resource plans;
3. **Urged Member States to develop their National Integrated Resource Plans taking into account the SAPP Pool Plan 2017**
4. Urged Member States to invest and develop interconnector corridors to enhance flexible power trading in the Region; and
5. Commended the World Bank and other Cooperating Partners for their support to develop the SAPP Pool Plan which will be incorporated in the remaining action plans of the Energy Sector Plan of the Regional Infrastructure Development Master Plan (RIDMP) 2018-2027.

SAPP Pool Plan recommendations and questions

- General recommendations that need to be institutionalised – picked up in Session 19
  - Improve data collection and create functional databases in Departments of Energy, utilities and at SAPP Coordination Centre
  - Undertake more frequent and detailed reviews of demand forecasts
  - Ensure proper training of present and futures cohorts of Ministry and utility officials in:
    - GIS skills and use of the social / environment screening tools
    - Management of planning data (including GIS databases)
    - Demand forecasting

- **Questions**
- For continental members: what is your country's policy position on self-sufficiency in (a) meeting peak demand (b) energy?
- Are the opportunities offered by SAPP membership incorporated into your country's planning process?
- How should national IRP planning and SAPP-wide planning be coordinated as markets deepen and trade grows in the region?

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