Integrated Resource Planning Training for Decision Makers

Day 1, Session 1 – Importance of IRP training for decision makers

8 March 2021

ECONOMIC
CONSULTING
ASSOCIATES

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ECA

Agenda

- Welcome and introduction by SACREEE, SAPP, World Bank and SADC Secretariat
- Participant introductions
- ECA team
- Session 1: Importance of an IRP training course for decision makers
- Session 2: Generation and transmission planning – the heart of IRP

ECA is a worldwide economic consultancy firm specialising on the energy and water sectors

20+ years
in business

60+
assignments annually

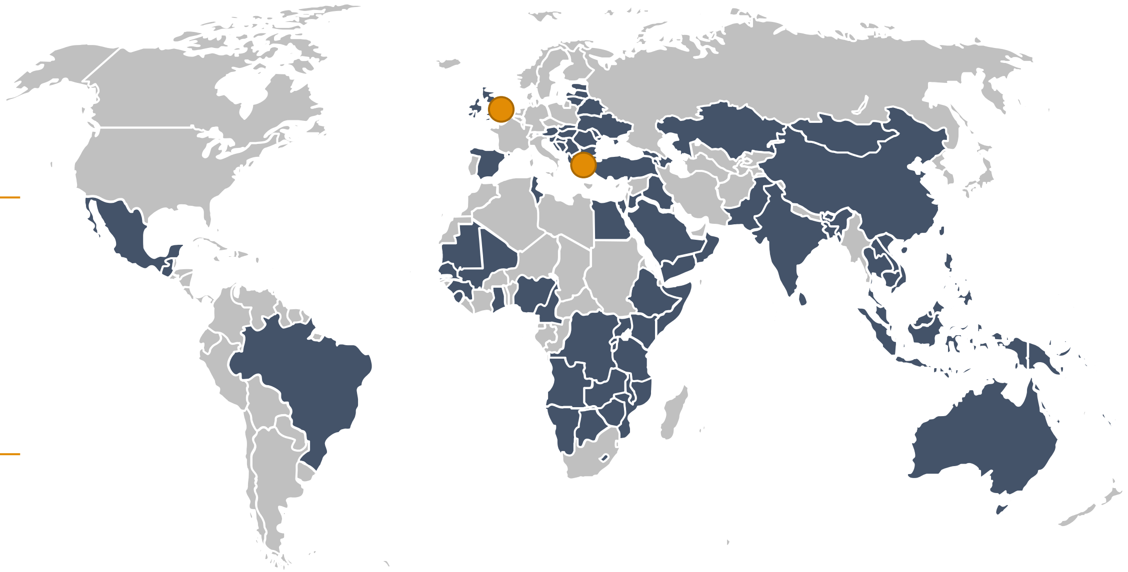
15+ years
average experience

26
Economists and Engineers

100%
Employee owned

40+
Regulators advised

2
Locations



65+
Countries worked in

30+
National utilities advised

ECA provides economic consulting advice in infrastructure services for governments, regulators, and investors worldwide

ECA recent experience in integrated resource planning

Gambia
- IRP Roadmap study (2020)

Zimbabwe
- Demand forecast and power Sector development plan (2014)

Botswana
- Renewable energy strategy and solar mapping (2016)

Namibia
- Integrated Resource Plan update (2020)

Eswatini
- Demand forecast and Least cost plan (2018)

Western Balkans
- Power generation development strategy (2018)

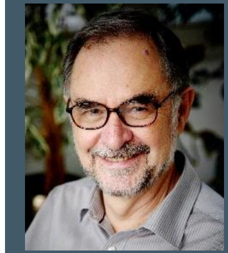
Malawi
- Update of the Integrated Resource Plan Study (2020)
- Integrated Resource Plan Study (2016)
- Geospatial electrification plan (2018)

SAPP
- Generation and Transmission Development Plan (2016-17)
- SAPP Pool Plan Dissemination (2018)
- Supply-demand model for SAPP countries (2019)
- SAPP Integration of RES Generation (2018)

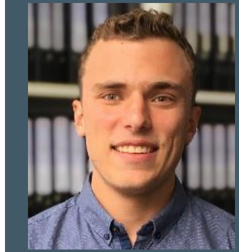
ECA Team


Paul Lewington

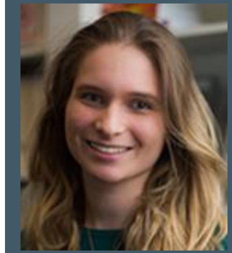

Grigorios Varympopiotis

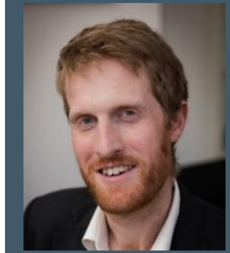

Peter Robinson


David Storey


Alex Schmid


Andrew Tipping


Marta Chojnowska


David Williams

Session 1 – Importance of an IRP training course for decision-makers

What is Integrated Resource Planning?

- A fundamental element of this course is for all participants to be thoroughly familiar with the 'jargon' that surrounds IRP.
- We have prepared a jargon-busting 'IRP glossary' and would suggest that each participant keep it close to hand, annotating it as we go along.
  - Rather than 'bald' definitions, it provides explanations of terms and groups common themes
  - See, for example, 'Discounting', 'Diversity' and 'Reliability'.
- First definition is IRP itself:
  - ***Integrated Resource Planning [IRP]:*** is an approach to national power system development planning that incorporates a holistic assessment of available energy resources and opportunities for demand management into deriving a least-cost combination of supply and energy efficiency measures to meet long term requirements for electricity services during a specified period, while furthering broad national objectives such as social equity and environmental sustainability.

How does IRP differ from traditional power system planning?

- The most important difference is that traditional power system planning took demand as a given and tried to minimise the supply costs of meeting electricity demand
- The IRP approach analyses and shapes ***demand as well as supply***: it may be more economic
  - to invest in energy efficiency measures and technologies than to invest in generation capacity (replacement of incandescent light bulbs with energy efficient ones is a notable example)
  - to reduce the system peak demand (which drives the overall investment level) by providing incentives to certain categories of consumer to shift their demand from the peak hours of the day to the off-peak.
- The integrated approach of IRP has also led to the incorporation of ***broad electricity policy objectives and national development goals***
  - Study TOR highlighted in this context "evolving renewable energy and energy storage technologies, energy efficiency, distributed energy resources, climate change impacts, goals for universal electricity access, climate change mitigation, and the potential for private sector investments".
- Another crucial aspect of IRP is that it should be a **process that engages and involves stakeholders** so that there is a commitment to implementing the IRB underpinned by broad-based understanding and buy-in

Why is power system planning so challenging?

- (1) Investments are large – risk of dampening growth in the economy either through:
  - creating excess capacity, which would entail displacing investments in productive sectors
  - OR underinvestment, resulting in electricity shortages which constrain production and reduce household welfare
- Electricity trade in SAPP provides a way of managing this.

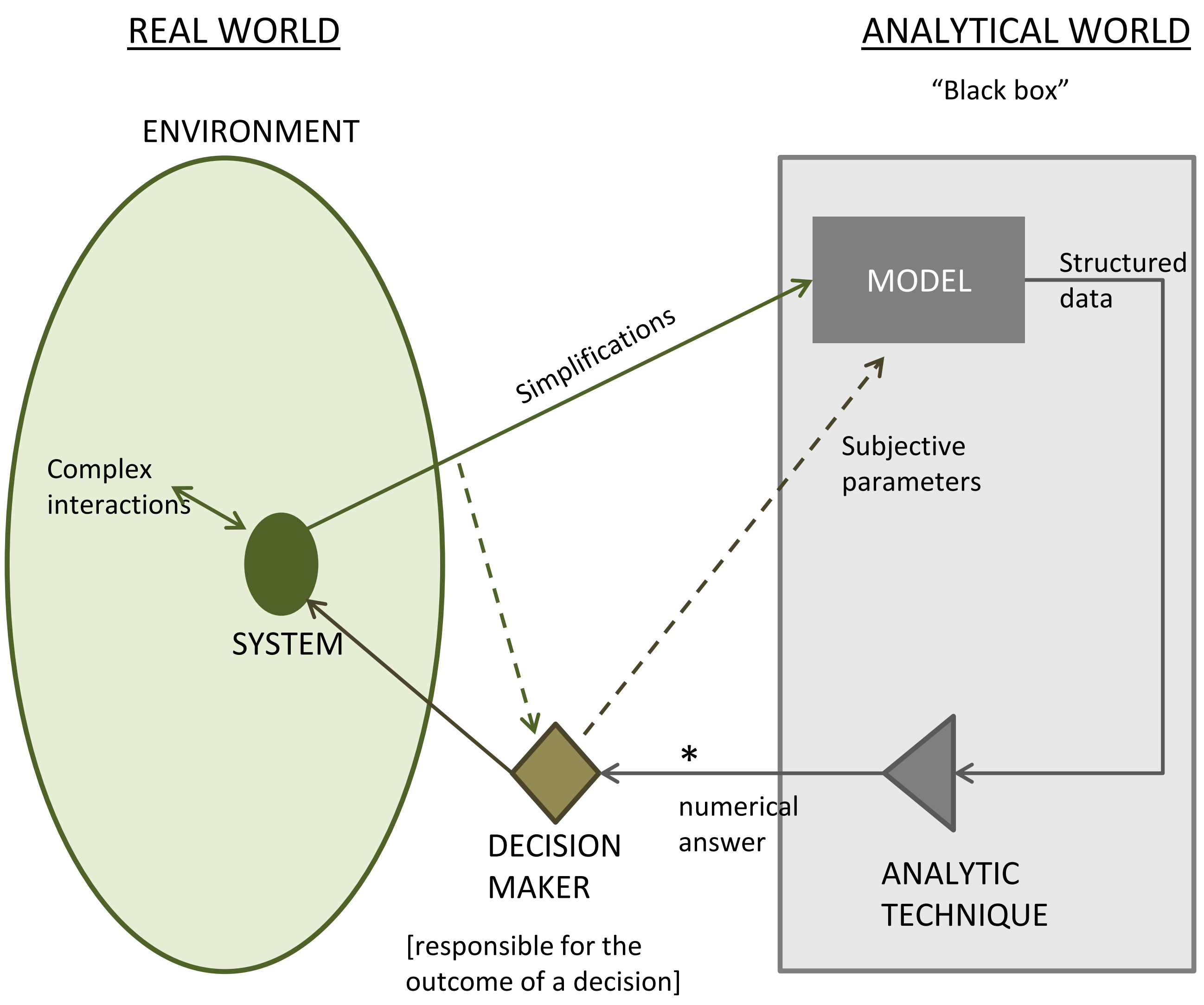
- (2) Demand that has to be met in an IRP has two dimensions: capacity and energy
  - ***Capacity*** is the ability to deliver ***power***, commonly measured in an IRP in MW.
  - ***Energy*** is the quantitative property that must be transferred to an object in order to perform work. Electrical energy is measured in kWh for households, but probably in GWh in an IRP.
  - ***Two simultaneous optimisations*** – minimising the cost of ***despatching*** available plant and minimising the costs of ***investing*** in plants with different characteristics
- Consumers ultimately want to consume energy, but their combined power demand (moderated by diversity & coincidence) defines the **peak load** that has to be planned for **(+reserve margin)**
  - Creating capacity is the most expensive component so minimising the peak load is a key element of an IRP

How do the decision-makers relate to the IRP technocrats?

- IRP involves technical work that requires sophisticated models, particularly for load forecasting, transmission planning and particularly **least cost generation planning**:
  - Optimisation software is needed to choose an investment sequence such that demand for capacity and energy is met at least total cost (capital, fuel and O&M costs), subject to constraints such as self-sufficiency and renewable energy penetration
  - ‘Bottom line’ is a summary net present value (NPV) for each of the **scenarios** (combinations of different parameter assumptions and different specifications of the policy constraints)
- The modelling work is carried out by technocrats in an ‘analytic world’ but the decisions and the responsibility for them rest with decision makers (DMs) who operate very much in the real world.
  - Decision makers need to understand the strengths and weaknesses of the modelling
  - If DMs don’t trust the results there is no point in doing the modelling
  - One way to bridge the gap is for the DM’s assumptions to be incorporated into the scenarios

What is the difference between a ‘good decision’ and a ‘good outcome’?

- Decision makers (DMs) bear the responsibility for impacts in the real world
  - DMs have no control over risks and uncertainties which can have a crucial bearing on the impacts
  - We say that the DM made a ‘good decision’ when the outcome is good and ‘bad decision’ when the outcome is bad
- But in reality a ‘**good decision**’ is one that is made conscientiously by the DM, working with the technocrats to make full use of their capabilities
- This course provides a unique opportunity for DMs to position themselves to make good decisions
  - but unfortunately doing so cannot guarantee good outcomes



Conclusions on decision makers and IRPs

- The preparation of an IRP provides a valuable opportunity for decision makers to explore and understand important policy trade-offs as part of the power planning process
- To get the most out of IRP processes, decision makers must be able to communicate effectively with the technocrats – cue our jargon-busting Glossary
- Decisions and outcomes
  - A good decision in the sense of a conscientious, fully informed decision should also be one in which DMs are involved in defining scenarios, making modelling assumptions and assigning parameter values
  - To increase the probability of a good decision leading to a good outcome careful attention needs to be paid to:
    - analysing uncertainties and risks (we will cover some standard and sophisticated approaches in this course)
    - devising mitigation strategies.
- Regional power sector integration is a key mitigation strategy for national IRPs.

Glossary – enhanced entries covering economic and engineering IRP terminology

Tariff: the price of electricity charged by a supplier to a consumer. There are several related definitions which are useful to have in mind for tariff-setting:

- ***Allowed or required revenue***: the level of revenue that a regulator would consider reasonable for a utility to recover from the tariffs it charges its customers.
- ***Building block approach***: a systematic approach to estimating allowed revenue with 3 main elements – operation and maintenance costs, return of capital (also known as depreciation or capital maintenance) and return on capital (to allow for investment).
- ***Regulatory asset base (RAB)***: the value of existing and proposed new assets that is relevant to calculating the allowed revenue. The RAB will usually be somewhat different to the asset base that is reflected in the utility's financial accounts.
- ***Tariff level:*** the average level of tariff which is determined by the required or allowed revenue
- ***Tariff structure***: the ratios of charges (fixed and consumption-related) between customer categories and ratio of charges within each category. To achieve economic efficiency, tariff structures should reflect marginal costs.
- ***Cost recovery tariffs:*** revenues from tariffs fully recover efficient costs (ie, the allowed or the required revenue)
- ***Cost reflective tariffs***: the tariffs charged to different customers reflect difference in the cost of service between those customers.
- ***Time of use pricing:*** tariffs which vary by the time of day. For example, night-time tariffs may be lower due to the lower demand.
- ***Seasonal time of day pricing:*** tariffs which vary by the time of day and season, reflecting different levels of demand resulting from heating and cooling.

Tariffs may recover costs while not being cost reflective across different customer categories (for example if cross-subsidies have deliberately been introduced to meet social objectives).

Reliability of a power system is its ability to ensure continuity of supply. The reliability of an existing power system is assessed through quality of service measures (*see **Quality of service***). When planning the expansion of a power system, there are a number of reliability-related terms which are used:

- **Loss of load probability (LOLP)**: a measure of the probability that a system's load will exceed the generation and firm power contracts available to meet that load. The reliability criterion of a system can be specified as a maximum LOLP.
- **Reserve margin:** amount of capacity over and above the expected peak demand (usually expressed as a percentage of peak demand). For stand-alone systems 15% would be a common reserve margin, but consideration also needs to be given to the largest single generation unit on the system. In interconnected systems, reserves can be shared and a lower national reserve margin can be adopted for planning purposes (or, equivalently, a lower LOLP).
- **Expected Energy Not Served (EENS):** the amount of electricity demand that is expected not to be met by supply in a given year.
- **N-1 reliability level:** specifies that the system should be able to meet peak demand even if one transmission line, main transformer or main generator is out of service.
- **Cost of unserved energy:** economic cost arising from customers being denied access to electricity. Strictly the cost is related to the time of day and season when the demand for electricity is not met, but is typically calculated as an average value (the amount of energy that is not provided multiplied by the value of lost load).
- **Value of Lost Load (VoLL)** The value of lost load is a measure of the economic cost arising from demand for electricity not being met. VoLL is typically an order of magnitude higher than the prevailing tariff (eg $1/kWh when the tariff is 10 c/kWh). It is often imputed from data about the economy, but can be empirically determined through surveying customers about their willingness to pay to avoid a disruption in their electricity supply.

IRP study TOR

Integrated Resource Planning (IRP) Training for Decision Makers

The Model TOR are to be treated as guidelines for formulating precise ToR for the particular IRP assistance that is needed from outsider consultants. Precise TOR will result in well formulated proposals being submitted.

Course content - Policy and regulatory issues cross-cutting with the tools for IRP planning

Decision-making under uncertainty: sensitivity tests and more sophisticated additional tools to analyse **risk and risk mitigation**

- Load forecasting techniques
- Limits to planning tools like LCOE
- Optimising generation despatch
- Optimising G&T investments
- Analytic tools for SECT impacts

- Tariff-setting for efficiency and equity
- Renewable energy targets (NDC related)
- Demand side management and energy efficiency
- Regulations on distributed generation
- Opening market to wholesale competition
- Regional power sector integration

SECT = social, environmental and climate change tools

Course timetable

IRP training course schedule
March 2021

CAT	Monday 8	Tuesday 9	Wednesday 10	Thursday 11	Friday 12
9:00-9:15	*Welcome from SACREEE, SAPP & WB. Participant and presenter introductions*	*Key points from Monday. Q&A on readings and exercises*	*Key points from Tuesday. Q&A on readings and exercises*	*Key points from Wednesday. Q&A on readings and exercises*	*Key points from Thursday. Q&A on readings and exercises*
9:15-10:15	1. Importance of IRP training for decision makers (Peter)	3. Load forecasting - bottom up and top down (David/Greg)	5. Load forecasting - further exercises and case studies (Marta and Alex)	7. Efficiency measures to reduce energy demand growth (Dave)	9. LCOE assessment of competing technologies (Greg)
10:15-10:30			Break		
10:45-11:45	2. Generation and transmission planning - the heart of IRP (Greg)	4. Malawi case study (Paul)	6. Tariff policy and demand side management to reduce peak demand (Peter)	8. Distributed generation implications for load forecast (Andrew)	10. Criteria for generation planning (Peter)
11:30-12:00	*Introduction to Glossary and Model TOR. Readings for Tuesday*	*Reading and exercises for Wednesday*	*Reading and exercises for Thursday*	*Reading and exercises for Friday*	*Reading and exercises for second week*

CAT	Monday 15	Tuesday 16	Wednesday 17	Thursday 18	Friday 19
9:00-9:15	*Key points from first week. Q&A on readings and exercises*	*Key points from Monday. Q&A on readings and exercises*	*Key points from Tuesday. Q&A on readings and exercises*	*Key points from Wednesday. Q&A on readings and exercises*	*Key points from Thursday. Q&A on readings and exercises*
9:15-10:15	11. Optimisation of despatch and of investment projects (Greg)	13. Stakeholder participation - South Africa case study (Alex)	15. Implications for IRP of wholesale market (Paul)	17. IRPs and regional power system integration (Peter)	19. Commissioning an IRP and being ready for the next update (Marta)
10:15-10:30			Break		
10:45-11:45	12. RE resource assessment and implications of RE targets (Dave)	14. Social, environmental and climate change aspects (Andrew)	16. Namibia case study (Marta)	18. Decision making under uncertainty (Greg)	20. Course recap and final Q&A (Peter and Greg)
11:30-12:00	*Reading and exercises for Tuesday*	*Reading and exercises for Wednesday*	*Reading and exercises for Thursday*	*Reading and exercises for Friday*	

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