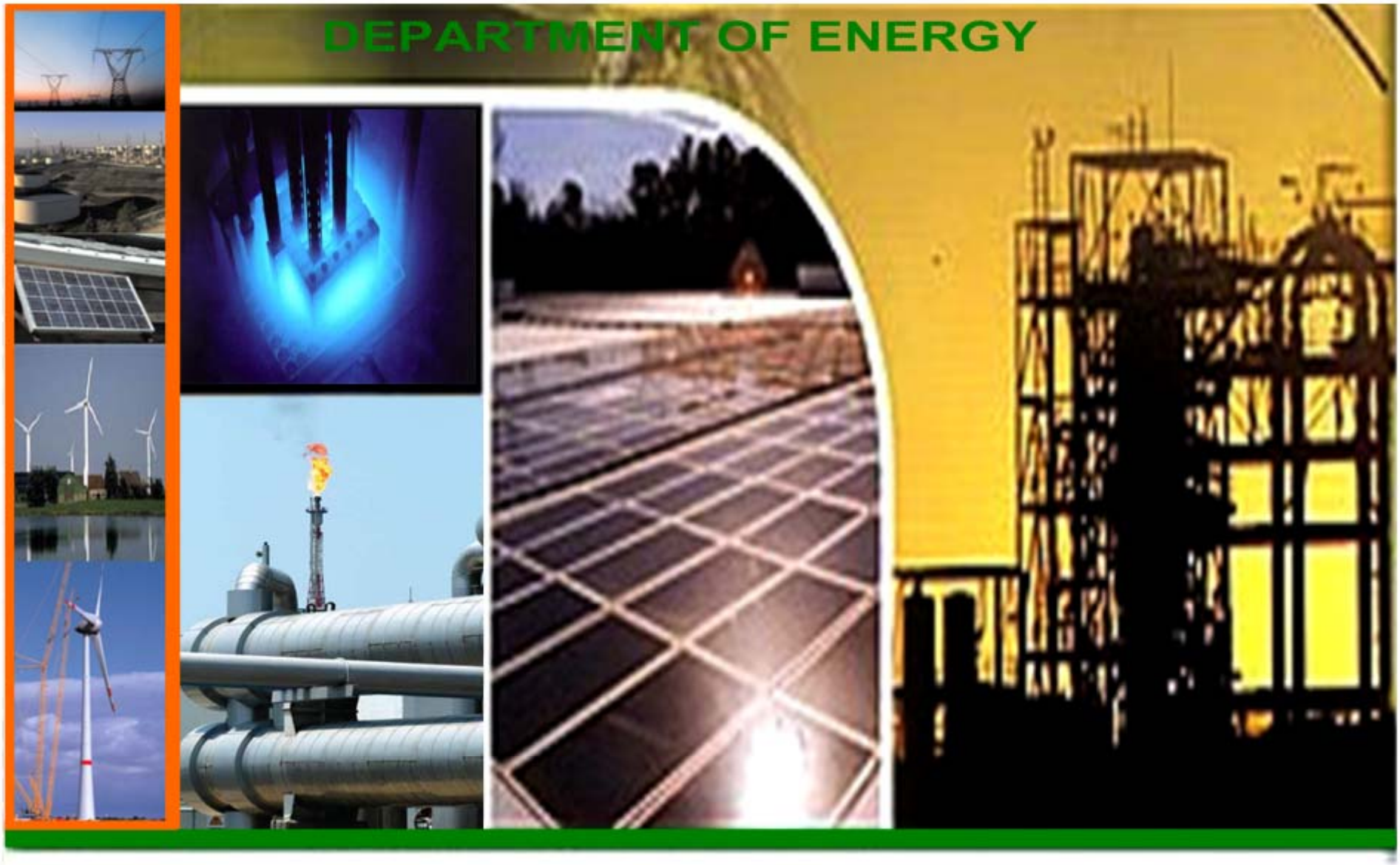

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Integrated Resource Plan

An introduction for the stakeholder consultation process

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Contents

- Context
- Generic Inputs
- Formulation of the problem
- Modeling Method
- Integrated Resource Planning Process
- Fact Base

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Context

- The Integrated Resource Plan in the South African context is not the Energy Plan – it is a National Electricity Plan.
- It is a subset of the Integrated Energy Plan.
- The IRP is also not a short or medium-term operational plan but a plan that directs the expansion of the electricity supply over the given period.

Context

- The Long-term Electricity Planning goal is to ensure sustainable development considering:
  - Technical constraints
  - Economic constraints
  - Social constraints
  - Externalities
- What is its purpose?
  - In theory, identification of the requisite investments in the electricity sector that maximize the national interest.
  - In practice - identification of the investments in the electricity sector that allows the country to meet the forecasted demand with the minimum cost to the country.

The IRP needs to answer the following questions

- What are the electrical energy requirements for South Africa to achieve the aspiration of sustainable economic growth?
- By when is the capacity needed?
- What is the appropriate mix of technologies to meet these needs that ensures South Africa can meet its commitments to climate change initiatives, ensures adequacy of supply, affordability, impacts the local manufacturing base, maintains a competitive position in the global arena and ensures sustainable use of local and regional resources?

The IRP needs to answer the following questions

- What are the linkages and dependencies on other resources such as water, primary energy sources, skills, sorbents, transmission infrastructure and land?
- What will it cost to meet these needs and how will it be funded? What will be the impact on future electricity prices and will they remain competitive?

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The IRP needs to answer the following questions

- What will it cost to meet these needs and how will it be funded? What will be the impact on future electricity prices and will they remain competitive?
- What is required to implement this plan, what is the level of confidence in achieving this, what are the commitments required and who are these required of?

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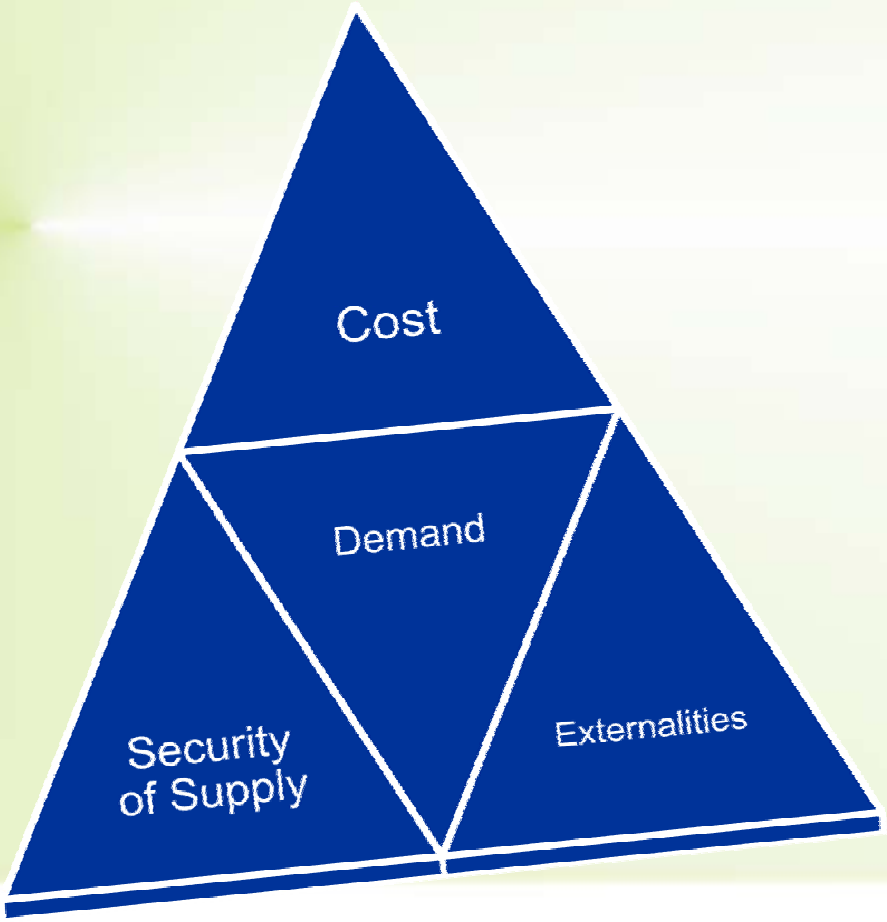
Balancing the equations



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Formulation of the Problem

- PRIME OBJECTIVES OF THE ELECTRICITY GENERATION SYSTEM:
  - To satisfy the demand instantaneously for each eventuality
  - Within a defined level of reliability
    - Loss of Load Probability (LOLP)
    - Cost of Unserved Energy
  - At the least cost
    - Expansion plan Min [NPV (Investments +fixed cost variable cost+ cost of failure+ cost of externalities)]

IRP Development Process Diagram

Fact Base
- Input Parameters

Constraints
- Policy
- External constraints

Scenarios
- Base Scenario
- Potential options
- Adjusted options
- Recommended option for IRP 2010

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The Models require the following Minimum Inputs for each scenario

- General Inputs
  - Discount rate
  - Cost of unserved energy
  - Reliability criteria
- Demand Inputs
  - Demand forecast
- Supply Inputs
  - Lifecycle costs of technologies
  - Load factors for technologies
- Externalities
  - Cost of carbon

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Generic Inputs

In developing an IRP there are many variables which need to be exogenously determined (inputs). Most important ones are:

- Fuel prices projections
  - Crude oil barrel, ton of coal, m3 of Natural gas
- Description of the existing generation mix
  - Capacity, fuel, efficiency, FOR , POR, decommissioning date, C02 emissions, fixed cost and variable cost, required reliability
- Investment criteria :
  - Discount rate
- Demand projection (s)
  - Annual peak load in MW & Energy in GWh

Demand Forecast

Parameters

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Demand Inputs

Different demand scenarios based on different assumptions:

- Explanatory variables (determinants of electricity demand)
  - Gross Domestic Product (GDP)
  - Output from specific industries, in particular manufacturing and mining (gold, PGM, iron, coal)
  - Energy intensity = relationship between production output and electricity demand.
  - Electrification
  - Population growth

Demand Inputs

Different demand scenarios based on different assumptions:

- Additional considerations:
  - Electricity Prices (elasticity)
  - Weather effects (especially temperature)
  - Viable substitutes to electricity
  - Technology impacts (Smart Grids & electric cars?)
  - Known large-scale projects
- Demand side management (DSM) programmes
  - Expected energy impact
  - Expected demand profile impact
  - Costs (fixed and variable)

Generation Mix

Parameters

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Supply Inputs

- Potential technologies
  - Coal, Nuclear, Gas: CCGT and OCGT, Renewable technologies (Wind, Solar, Biomass and Geothermal), Hydro and **Pumped Storage etc**
- Plant Costs (Exchange Rate required)
  - Investment (Total overnight costs, Expense schedule, Lead-times)
  - Refurbishment
  - Decommissioning

Supply Inputs

– Fuel

- Cost in each year for economic life of plant or price at reference date plus expected escalation during economic life of plant
- Fuel energy content (where applicable) and availability

  (water)

– Operation and Maintenance (O&M)

- Cost in each year for economic life of plant or price at reference date plus expected escalation during economic life of plant

Supply Inputs

- Plant Availability Data
  - Maintenance (or Planned Outage), Unplanned Outages
- Plant Technical Parameters
  - Plant Economic life, Efficiency(ies) and/or Heat Rate(s), Plant Load factor
- Plant Water Usage
  - The water usage per unit of energy output for each Plant Technology Type.
- Plant Sorbent Usage

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Supply Inputs

- Plant Emissions
  - The costs of pollution control equipment, waste management and any required health and environmental protection measures
  - Pollution Control Technologies included in, and the impact thereof on
    - Plant cost, Plant availability and Plant technical parameters

Externalities

Parameters

Externalities, Constraints and Policy

- Emissions - Co2, other particulates
- Water
- Tranmission issues
- Finance / Funding
- Policy Directions on technology - Nuclear, coal and Renewables
- Plant Sorbent Usage restrictions

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Key IRP Outcomes

- **Price Cone**
  - RSA Ave Price Cone
  - Gx Price Cone
- **Carbon Impacts and effects**
  - Emission Constrained
  - Cost of Carbon
- **Security of Supply**
  - Adequacy
  - Cost of Unserved Energy (used to estimate the economic impact on customers of planned and unplanned outages)
- **Generation Mix**
  - Technology

Reviewing Output and Making Recommendations

- Review each Scenario modelled
  - Output needs to be scrutinised to:
    - Unrealistic expansion options
    - Review Reserve Margin, (Reliability Criteria)
    - Review load factor (Gas turbines – fuel logistics), pumped storage operations, energy limits
    - Review practicalities – The Expansion Plan is a simplification of the problem.
- Test the plan with a production study

Reviewing Output and Making Recommendations

- Cost the plan and estimate the tariff impact
  - Even if the costs are benchmarks (or not final)
- Review if Policy objectives are met
  - Competitiveness, Social development issues, localization etc
- Review against the broader picture of infrastructure development
- Recommend the most suitable for IRP 2010

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Key Policy Areas

- Nuclear Policy
- Renewable Energy Policy
- Climate Change and Emissions Policy
- Imports (Regional Development) Policy
- Diversity of energy sources (Mix)
- Energy Efficiency Policy/Strategy
- Adequacy (Reliability) criteria for generation
- Industrial Development Policy

Key Scenarios

- Scenarios that require investigation
  - Demand scenarios
  - Supply option scenarios
  - Economic impact scenarios
  - Climate change scenarios
  - Regional development scenarios (electricity import & export scenarios)

IRP 2010 Scenarios

- Baseline / Reference case
- Carbon - emission constrained
- Carbon – carbon taxed
- Generation diversity
- Policy, Risk & Constraint adjusted (IRP 2010 recommended)
  This scenario will include sufficient detail on issues for immediate policy implementation such as:
  - Non Eskom generation
  - Critical decision milestones
  - Critical actions for the ministries
  - Inputs to national planning

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Scenario Selection Criteria

- As discussed the role of scenarios is to determine the impacts of certain decisions on the 3 major criteria:
  - Costs
  - Externalities
  - Security of Supply
- Critical criteria for selecting the optimal portfolio:
  - Optimed cost portfolio of generation expansion
  - Security of supply
  - Climate change and sustainability (includes water utilisation)
  - Regional integration and imports
  - Funding and finance requirements
  - Local economic impact

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Integrated Resource Planning Consultation Process

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3 Major IRP consultation points

Policy, Facts, Information

Method

IRP Key Required Outcomes *(Per Scenario)*

Input Parameters

- Parameter Sheets
- Process

Scenarios

- Using input parameters
- Develop scenarios

IRP 2010 Outcomes

- Price cone
- Security of supply
- Multiplier effects
- Carbon effects
- Gx diversity

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IRP Development Timeframes

- IRP2010 Draft Input Parameter Sheets available on the web for public input – MAY 2010
- Closing date for 1st round of public input – 11 JUNE 2010
- Complete modelling of scenario's and 1st draft of IRP2010 – JULY 2010
- Cabinet approve IRP2010 to gazette for public participation – JULY 2010
- IRP2010 gazetted for public participation – AUGUST 2010
- Cabinet approve final IRP2010 to be promulgated – SEPTEMBER 2010

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Way Forward

- All comments received will be reviewed and considered
- The criteria for evaluating comments will be published on the website
- Once input parameters have been agreed within Government – these will be published on the website
- The comments will be grouped and addressed in broad answers
- **Remember this phase of the discussions and consultation is about Inputs – other phases will address the consultation on other comments and submissions**

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Conclusion

- We need to complete the fact base before we can model
- The model produces scenarios which can then be interrogated
- At scenario point choices need to be made and those choices require explanation
- Scenario of choice is further developed into the plan.

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