Power Development Planning: Methodology and practical issues for Vietnam

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"Stakeholders Dialogue on Power Development Planning process"

Hanoi, 10 January 2014

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- Why Power Development Planning (PDP) – Rationale
- Methodology – traditional and new approaches
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  - *Multi-criteria objectives*
  - *Competitive Power market and smart technologies*

Why PDP - Rationale

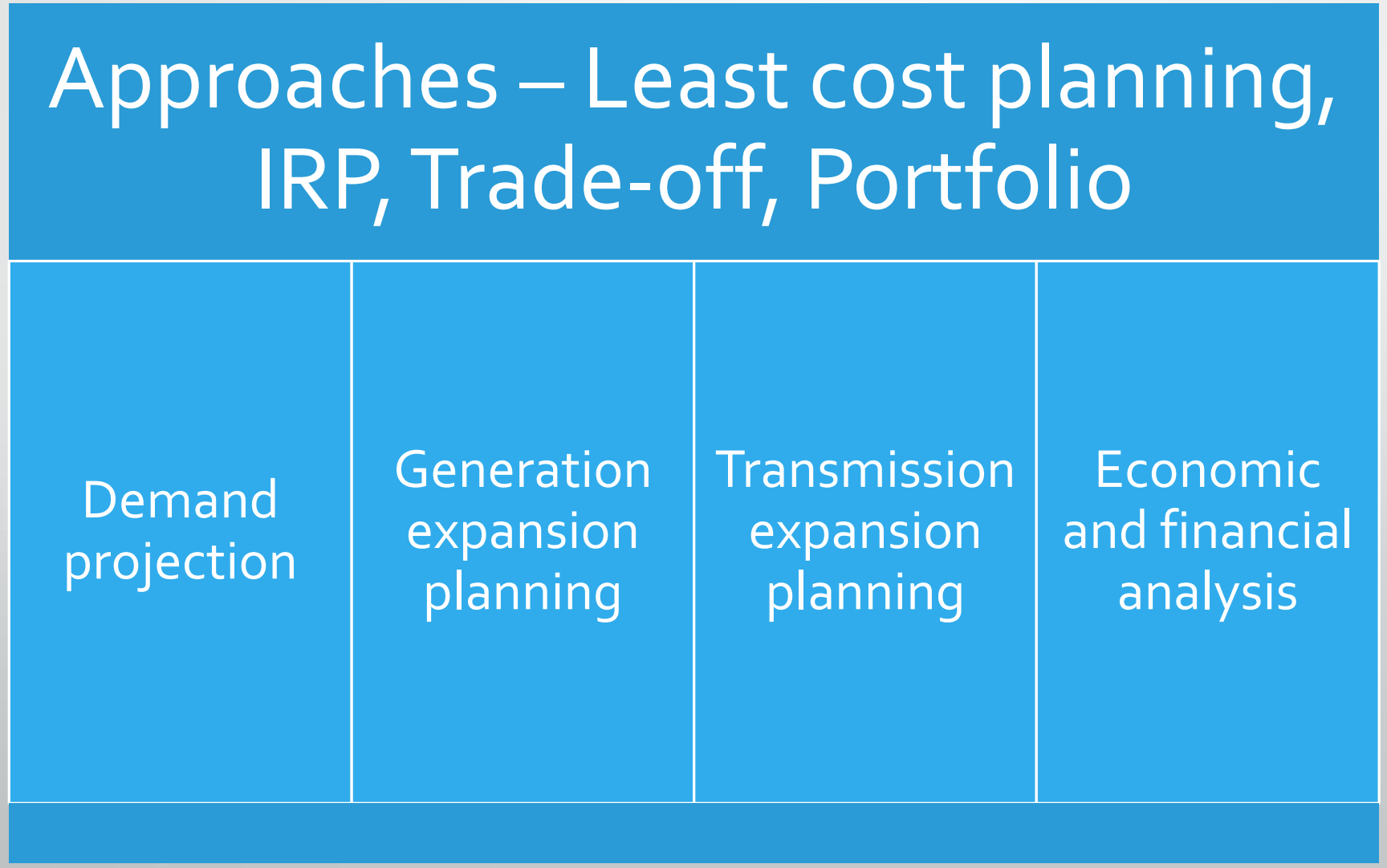
- **PDP is key for energy sustainable development**
  - Economic way of covering energy needs
  - Minimize financing risk: The equipment is capital-intensive, requiring careful analysis and decision
  - Efficient use of domestic resources
  - Enhancing energy security dimension: Access to energy; Reducing environmental impacts

- **Essential for sound decision-making and policy design**
  - Developing long-term strategies
  - Exploring and testing policy options
  - Identifying the investment and financing requirements

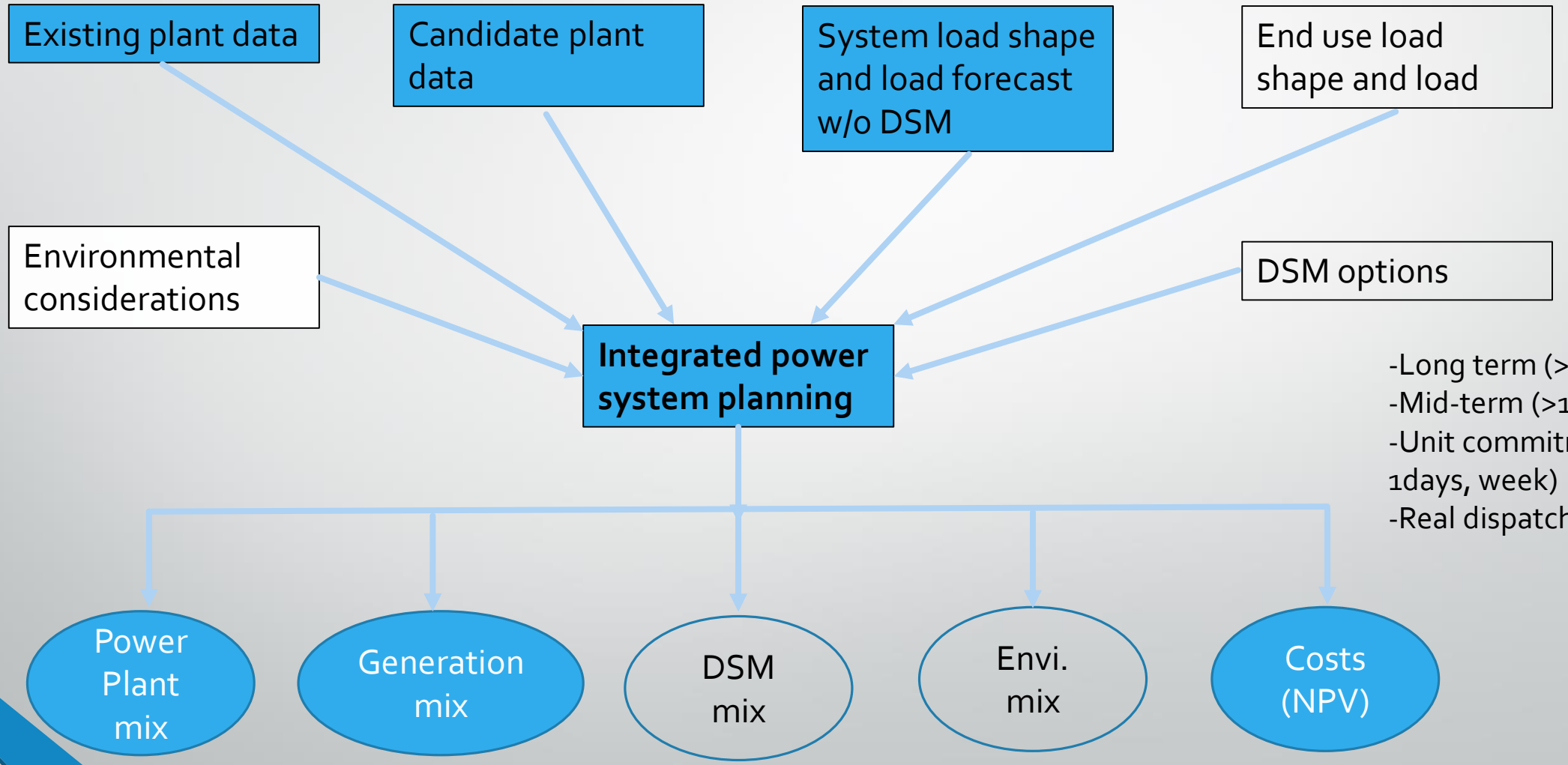
Why PDP – Common objectives

Objectives	
Reliable electric service	Increase efficiency
Electrification	Minimize costs
Minimize envi. impacts	Provide social benefits
Energy security	Provide local employment
Use of local resources	Acquire technology and expertise
Diversify supply	Retain flexibility

Power system planning process



Traditional and current practice in Power development planning



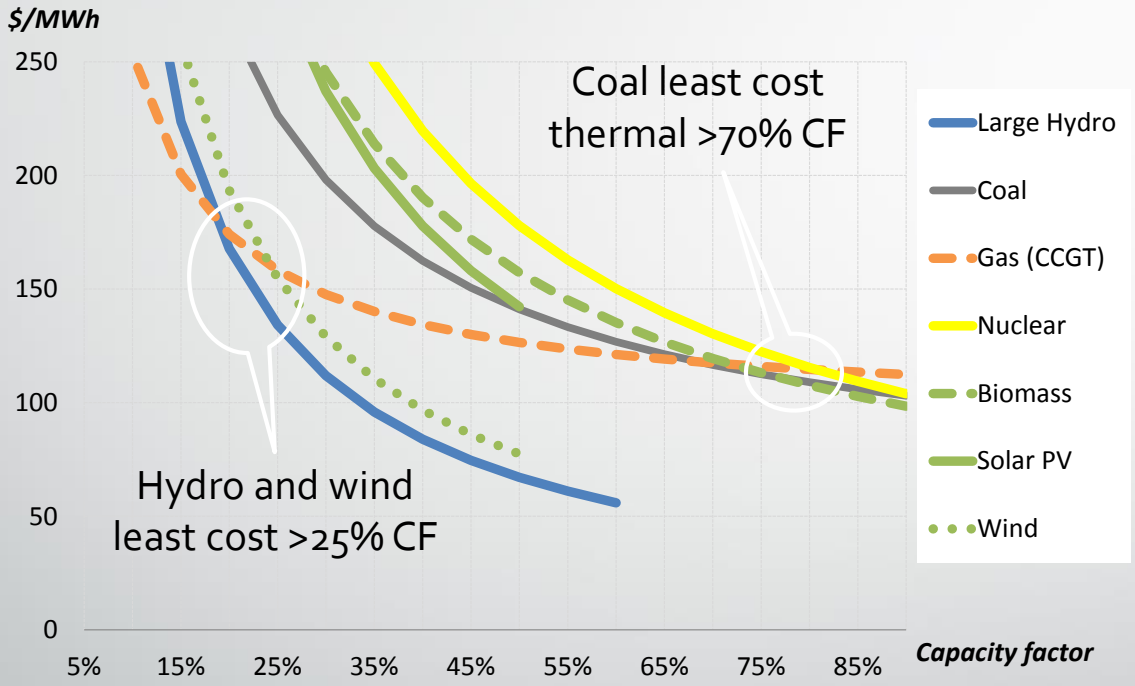
Key Drivers of Future Scenario Definitions

- Demand and Energy
  - Growth Rate
  - Demand Response and Energy Efficiency
- Generation Resources
  - Wind Capacity Credits
  - Generation Status and Retirements
  - Must Run and Minimum Operating capacity
  - New Generation Alternatives and associated Capital Investments
- Fuel Prices
- Environmental Externalities Costs
- Economic Variables
  - Inflation Rate, Discount Rate
  - Retirement values
- Reserve Margins
- Energy Policy and Legislation
  - RE (Wind, other RE) Penetration Levels
  - Carbon Reduction

Reliability in power system planning

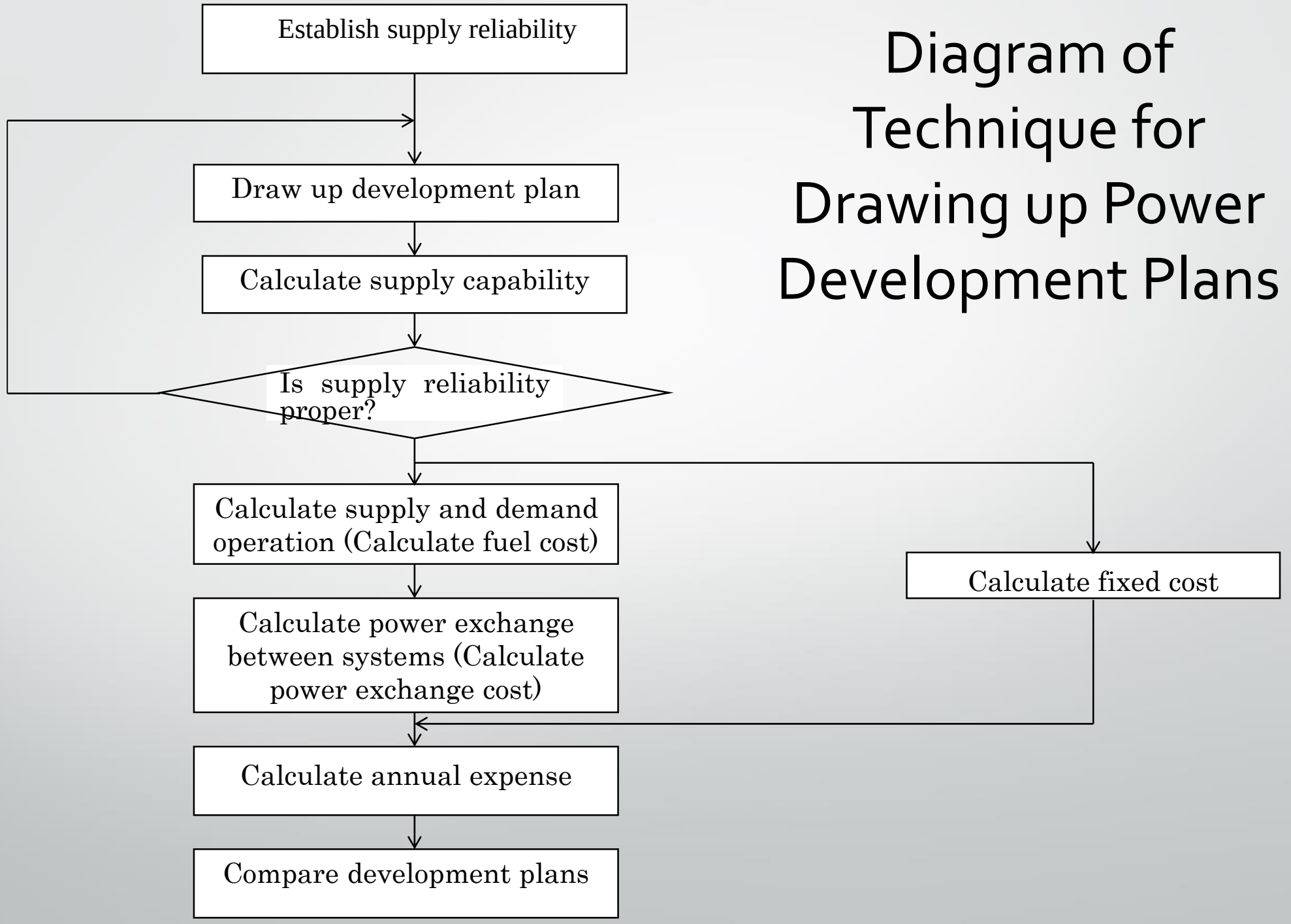
- Reserve margin (RM) = (Inst. Capacity – Annual peak load)/Annual peak load
- Loss of largest unit (LLU): compares the system reserve with the largest installed unit. LLU = (Inst. Capacity – Annual peak load)/Cap. of the largest unit
- Loss of Load Expectation (LOLE) = number of days/y or hours/y on which available generating capacity is insufficient to serve the daily peak load. Also known as "Expected loss of system peak".
- **Loss of Load Probability (LOLP)** = proportion of days/y or hours/y on which available capacity is insufficient to serve all the daily peak or hourly load (1-3 days/y).
- Expected Energy not Served (EENS), or expected unserved energy (EUE) = expected amount of energy which is not served over a given interval due to insufficient capacity.
- Loss of Energy Probability (LOEP) = EENS / Total electricity demanded

Example screening curves



- Renewables can be competitive with thermal generation
- But lower capacity factors means more is needed to replace a given amount of thermal capacity
- And these curves ignore the need for back-up generation or any additional transmission costs of renewables

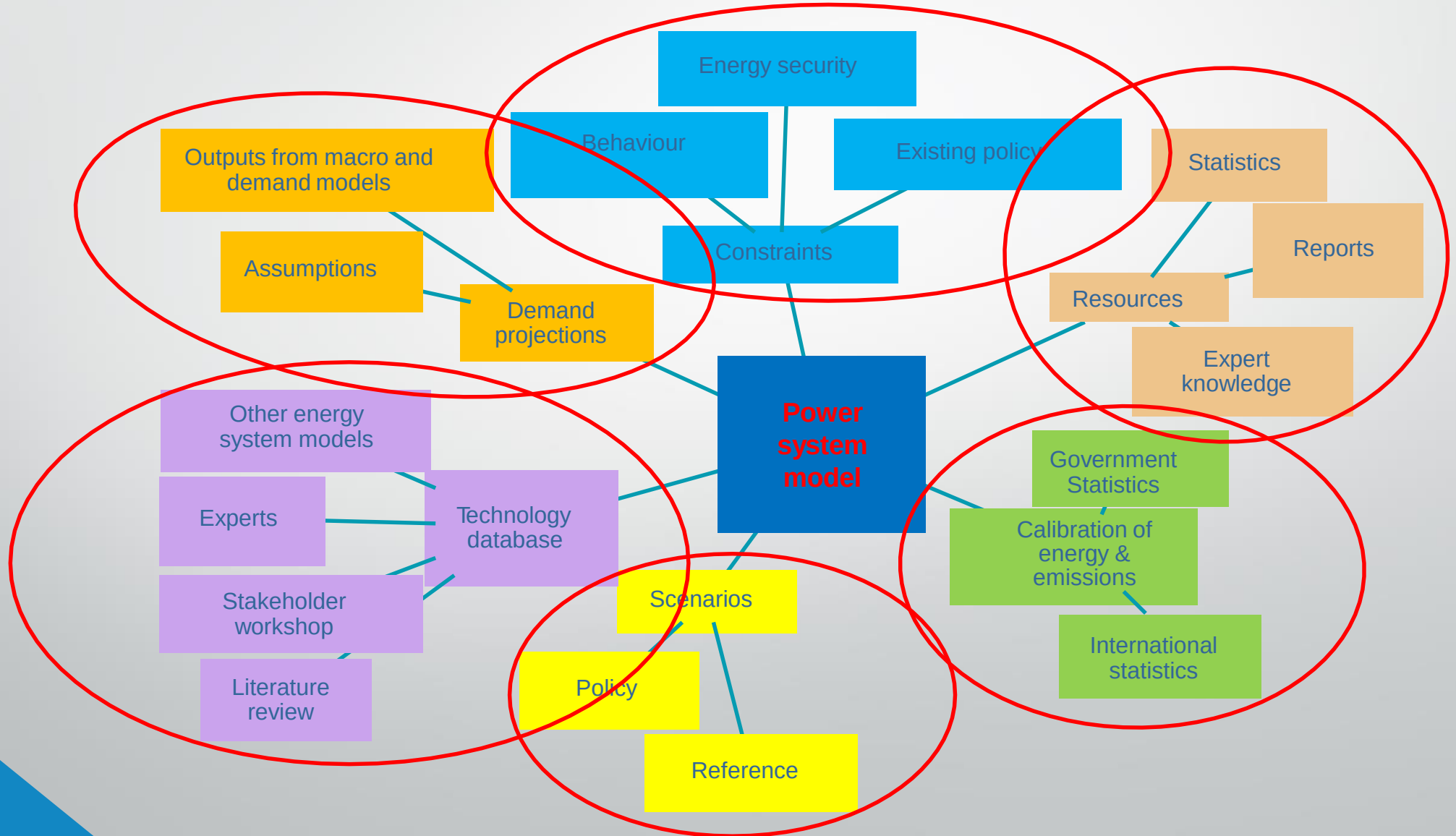
Diagram of Technique for Drawing up Power Development Plans



Why are we modelling?

- The power system modelling enables us to define different 'states of the system' or power development paths and, thereby, assess:
    1. whether the current path is least-cost when all social and environmental factors are considered?
    2. whether alternative development paths could benefit the country?

Not only modeling, but also data analysis



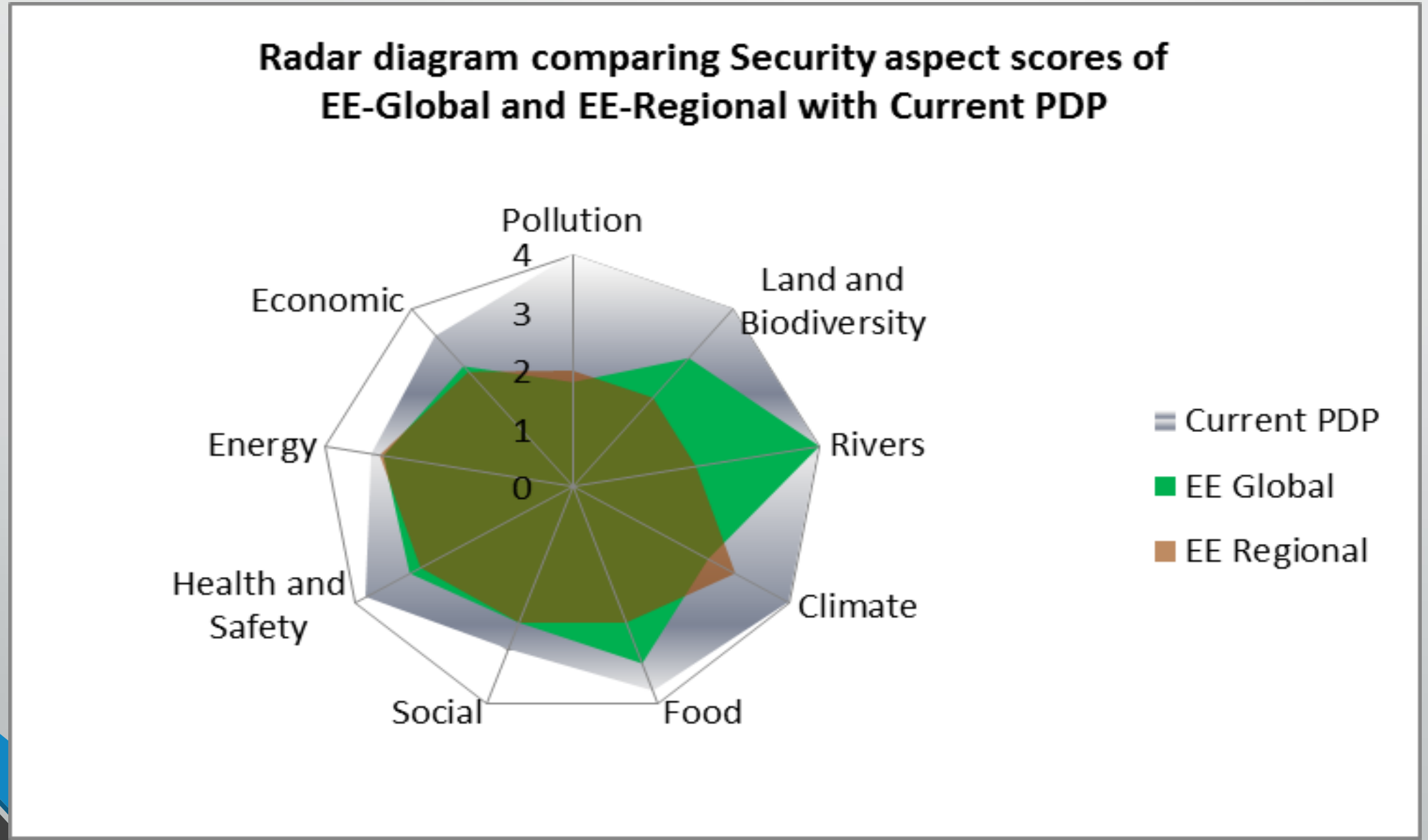
Emerging approaches in Power system planning

- Security dimensions
- Trade-off curves
- Risk and uncertainties : Portfolio analysis

Security dimensions

1. Several new emerging studies attempt to include security dimensions into PDP:
   - Energy security
   - Ecological security
   - Climate security
   - Food security
   - Social security
   - Health and safety security
   - Economic security
2. In a deterministic utopia and under presumption that all externalities can monetize, the calculation of NPV provides unambiguous comparisons of alternatives
3. However they are difficult to precisely quantified

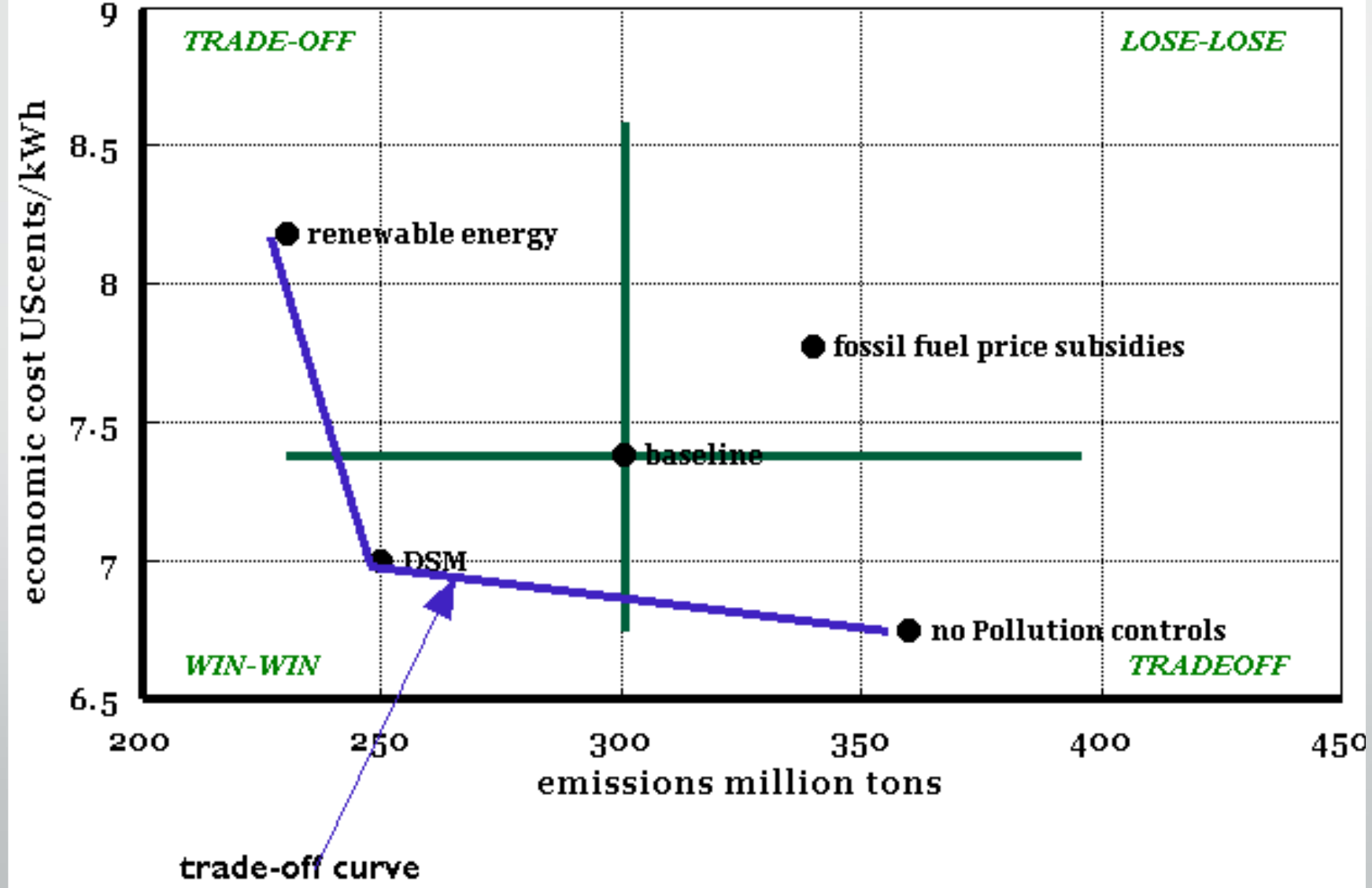
Security dimensions – Example from GMS PDP



Trade-off analysis in PDP

1. Trade-off curves are simply XY plot of attributes.
2. Typically it shows quadrants relative to baseline scenario
3. A useful tool to evaluate the trade-off between attributes is the trade-off curve: X-Y plot illustrating the position of alternatives, allowing decision makers insight into the cost implication of meeting non-cost goals.
4. However these studies are rare and controversial (World Bank study for Sri Lanka (2010), Nguyen A.T. study for Vietnam (1999).

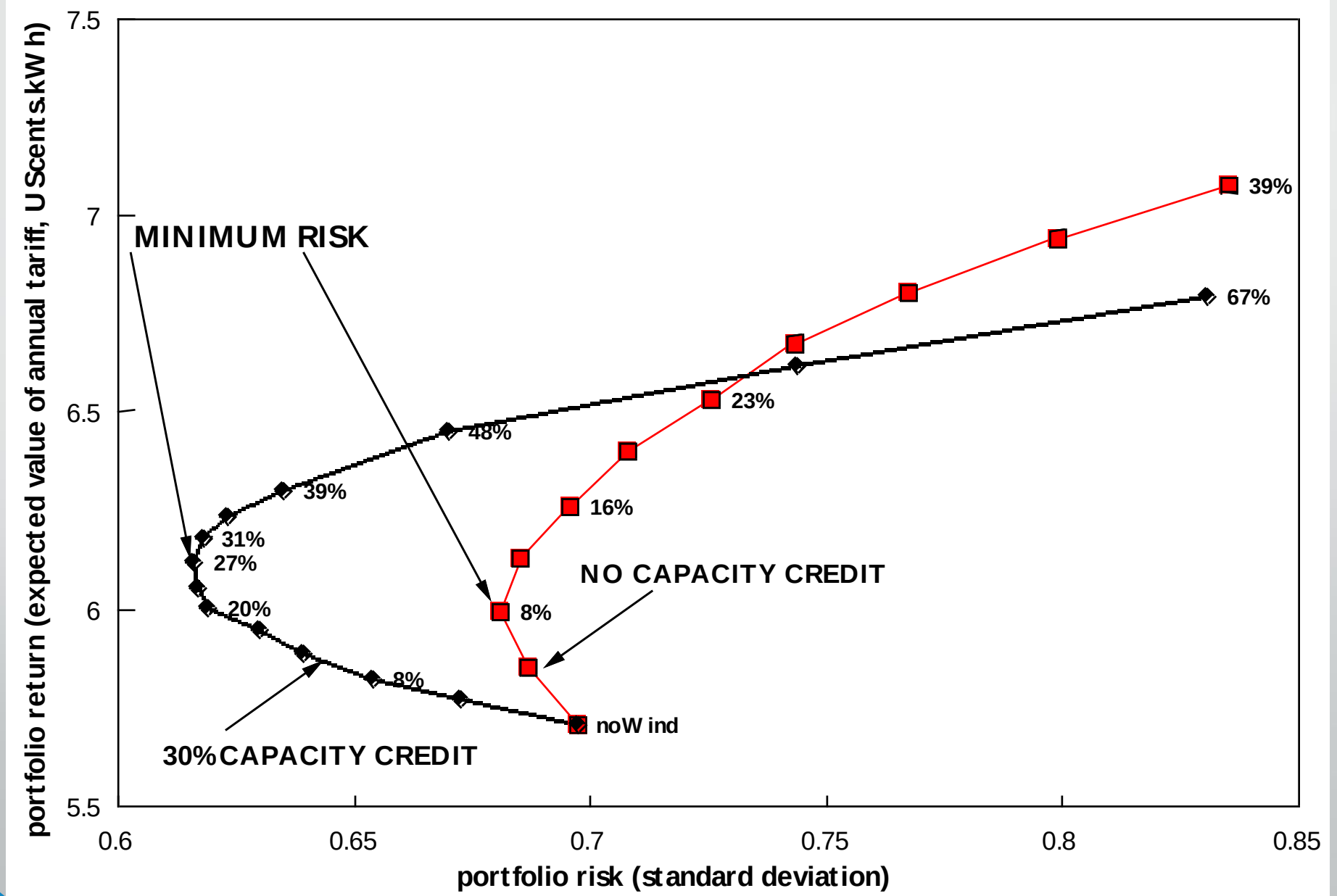
Trade-off analysis – example of trade-off curve



Portfolio analysis

1. This is an trade-off between risk and return.
2. The view that at least for the case of known unknowns, the most logical way to quantify risk is the probability of economic return falling below the hurdle rate.
3. Use Monte Carlo simulation for quantitative risk assessment: Calculate the probability distribution of ERR (NPV) as a function of uncertainty in input assumptions
   ➔ Trade-off plot of mean-variance financial portfolio analysis
4. Requires huge iterations

Portfolio analysis – example on risk v. return



Practical making of Vietnam PDP

Framework for PDP in Vietnam

- Regulation base for PDP
  - Electricity Law (28/2004/QH11, and amended 24/2012/QH13)
  - Decision 42/2005 by MOI, which is under revision. But do not expected any radical change.
- In Vietnam, PDP establishes for 5-10 year period, usually with outlook for next 10 years.

Methodology features of PDP making in Vietnam

- Central planning
- Least cost
- Using STRATEGIST, PDPAT II as modelling tool for evaluation of least cost plans
- Divide in 3 sub-regions, with two 500 kV interconnection tie lines
- Develop power center close to demand center, reduce transmission system
- Cooperation with International expert on technical assistant

Power supply development multi-criteria

- Reduce hydro power capacity→ reduce the depending on hydrology conditions
- Power demand-supply balance in each area, develop power center close to load centre, reduce long transmissions
- Increase 5 -7% adding of install capacity to reduce the risk because of projects delay
- Fuel supply ability (coal, gas)
- Develop small hydro power for local demand, avoid gather center.
- Encourage RE
- Promote Pumped Storage hydropower plants in South area
- Develop nuclear power to reduce the depending on fossil fuel and reduce GHG emission
- Increase power import from neighbor countries

Mathematical formulation

Input data

Cost data,
Efficiencies
Full load hours
Emission factors
Demands …

Objective function:	**Minimizing discounted system costs =** • **Sum of Import/Extraction costs,** • **Variable and fixed O&M costs** • **Investment costs, ….**
Model equations:	- Transformation relationship (e.g. efficiency relationship for power plant) - Energy and emission balances - Inter-temporal constraints on new capacity additions (e.g. early investments needed for using technology on larger scale in later periods) - Capacity-activity constraint (e. g. available capacity limits elec. gen of power plant) - Cumulated constraints over time (e. g. available fossil resources) - Peaking constraint (Ensuring reserve capacity at peak load) - Load curve equations - Storage equations (e.g. pumped storage) - Scenario specific constraints (e. g. bound on CO_2 emissions, quota for renewables)

Decision/Output variables

Process activities
Power/emission flows
New capacities
Prices

SEA OF THE PDP

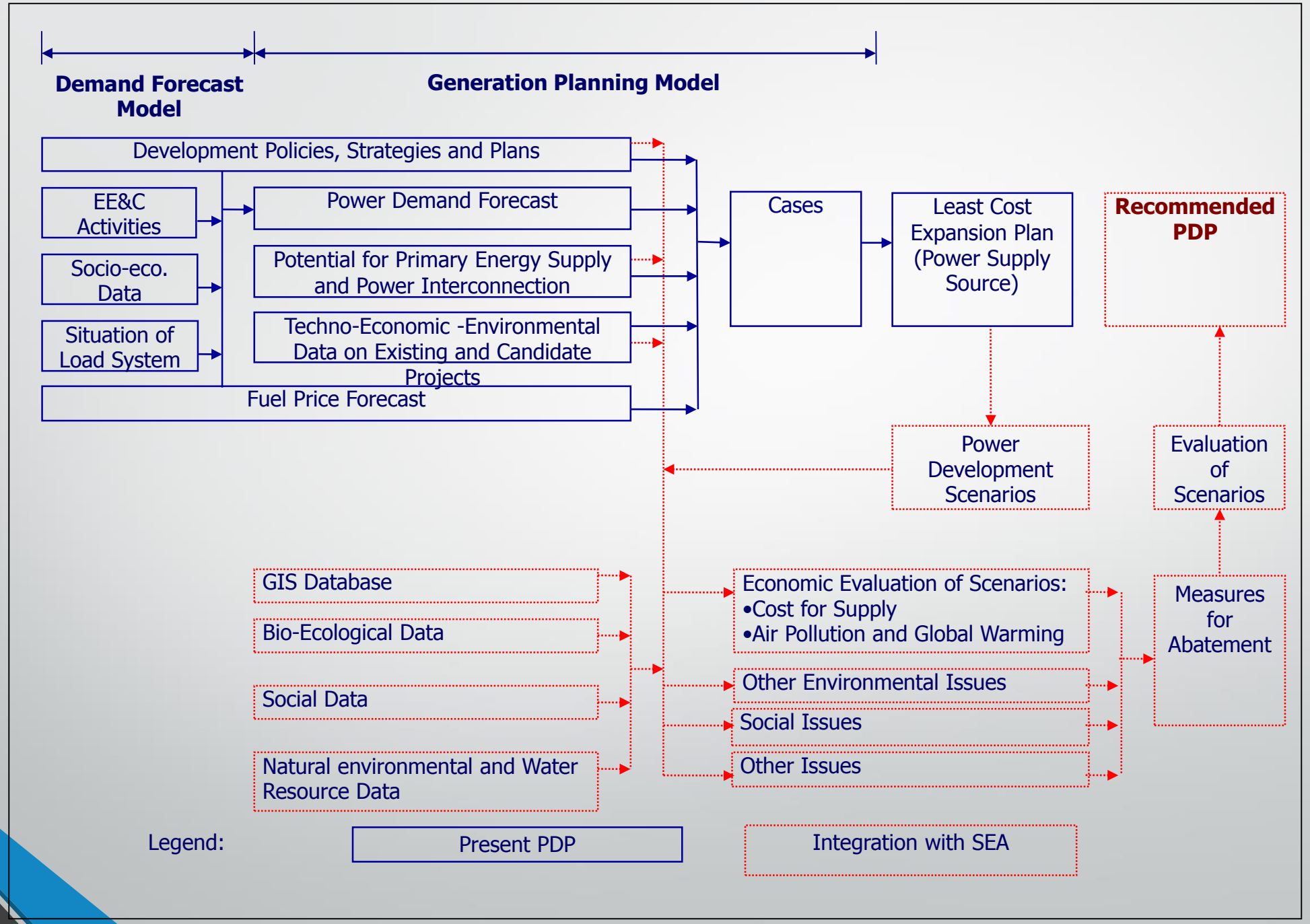
- The current SEA is the first time that social and environmental issues have been fully integrated into the preparation of the PDP
- It is one of the first fully integrated SEAs in the preparation of a national sector strategic plan in Viet Nam
- It is based on international best practice, adapted to a Vietnamese context and to reflect the national SEA Guidelines as prepared by MoNRE
- It builds in the lessons learnt in the pilot SEA for hydropower in PDP

SEA Approach

The valuation and internalization into the overall cost calculations for supply options of all measurable costs and benefits from different proposed sources of power generation.

Based on quantitative and objectively verifiable indicators

Weightings of valuations made to reflect (a) key national policy and development objectives and (b) the opinions and knowledge of key stakeholders


Demand Forecast Model
Generation Planning Model
Development Policies, Strategies and Plans
EE&C Activities
Socio-eco. Data
Situation of Load System
Power Demand Forecast
Potential for Primary Energy Supply and Power Interconnection
Techno-Economic -Environmental Data on Existing and Candidate Projects
Fuel Price Forecast
Cases
Least Cost Expansion Plan (Power Supply Source)
Recommended PDP
Power Development Scenarios
Evaluation of Scenarios
GIS Database
Bio-Ecological Data
Social Data
Natural environmental and Water Resource Data
Economic Evaluation of Scenarios:
•Cost for Supply
•Air Pollution and Global Warming
Other Environmental Issues
Social Issues
Other Issues
Measures for Abatement
Legend:
Present PDP
Integration with SEA

Issues for Vietnam PDP in future – open for discussion

- RE and storage choice
- Risk and uncertainties
- Multi-criteria objectives
- Competitive Power market and smart technologies.

Thank you for your attention

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(It is better to be roughly right than precisely wrong—or not to make any "PDP" at all)