Arab Republic of Egypt

Ministry of Electricity & Renewable Energies

Incorporating VRE into Long-term Power System Planning of Egypt

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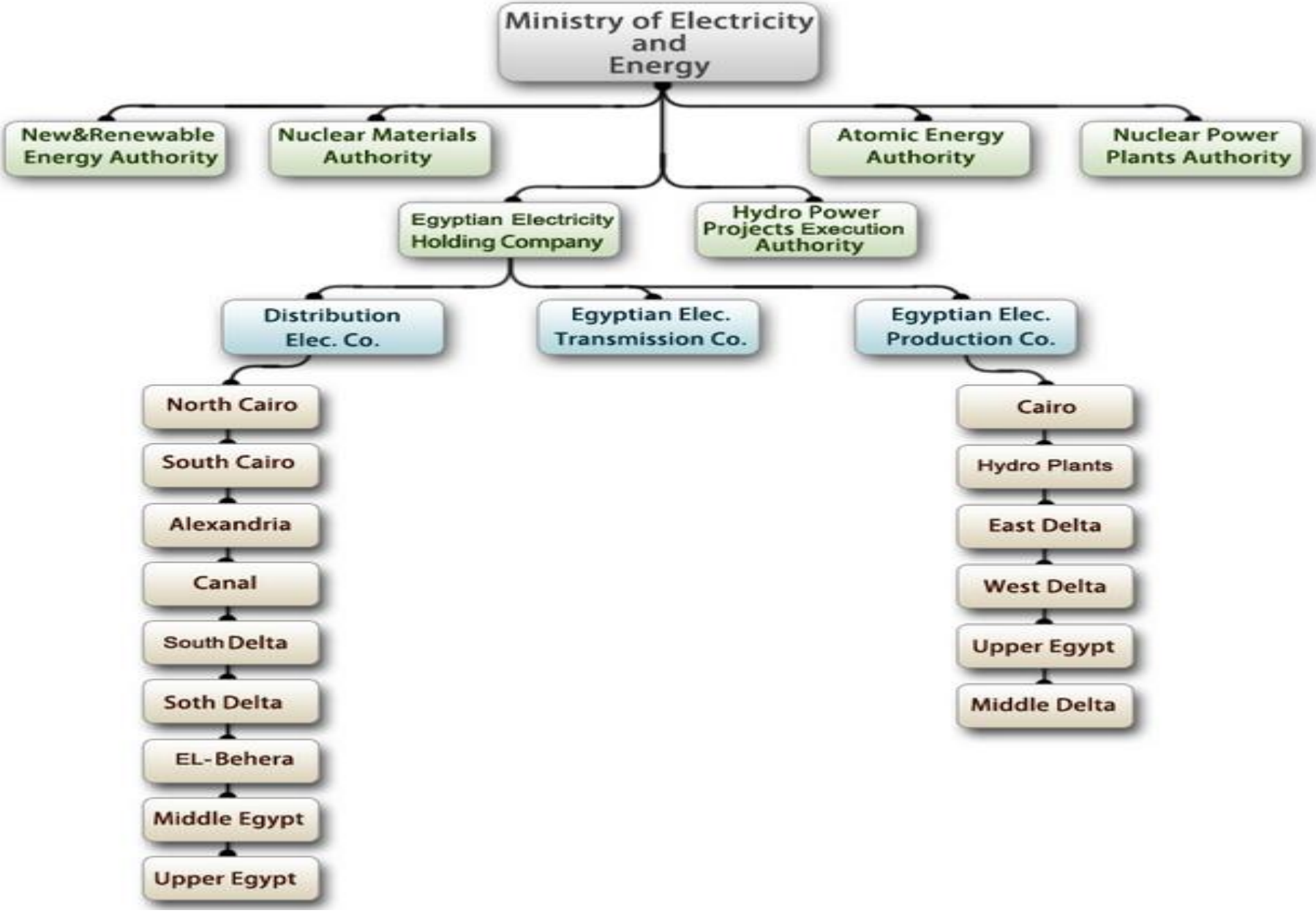
Presentation Outline

- MoERE Structure and Strategy
- Renewable Energies in Egypt
- Generation Expansion Planning process
- Incorporating VRE in long term Planning Process
- The need for accurate Geospatial data
- Generation Expansion Planning Models
- Future Planning Directions

MoERE Structure

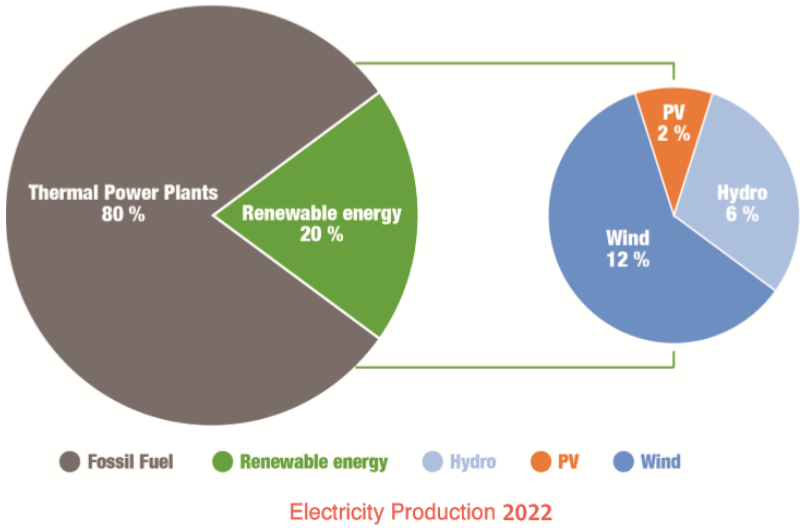


MoERE Strategy

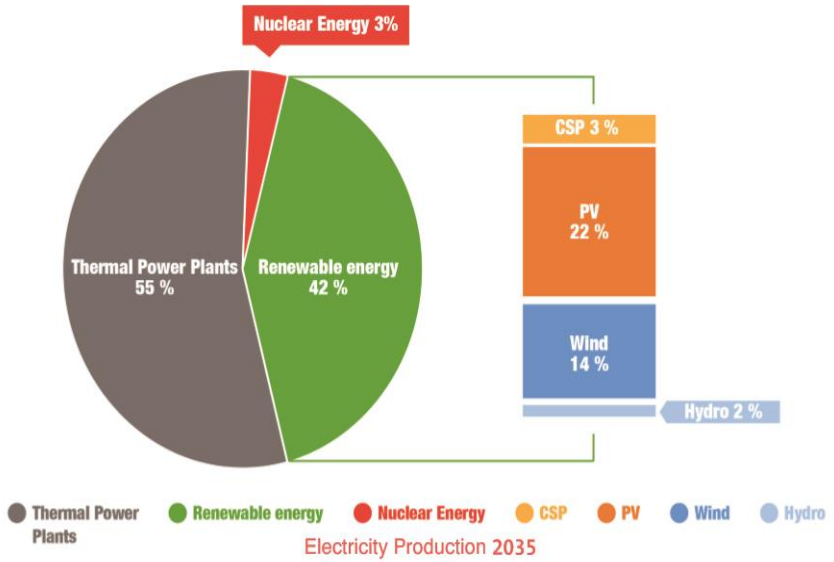
- Provide electricity with suitable price and best quality.
- Planning to meet the future electricity demand.
- Diversifying the electricity generation mix.
- Promoting the utilization of renewable energy.
- Promoting electricity interconnection.
- Improving energy Efficiency.
- Encouraging private sector participation.
- Environment conservation through adopting necessary measures on the supply side.

Renewable Energy National Strategy

- The Egyptian Renewable Energy National Strategy to Satisfy 20% of the generated electricity by 2022 and to reach about 42% by year 2035.
- Most of this expansion will be from wind and solar power.



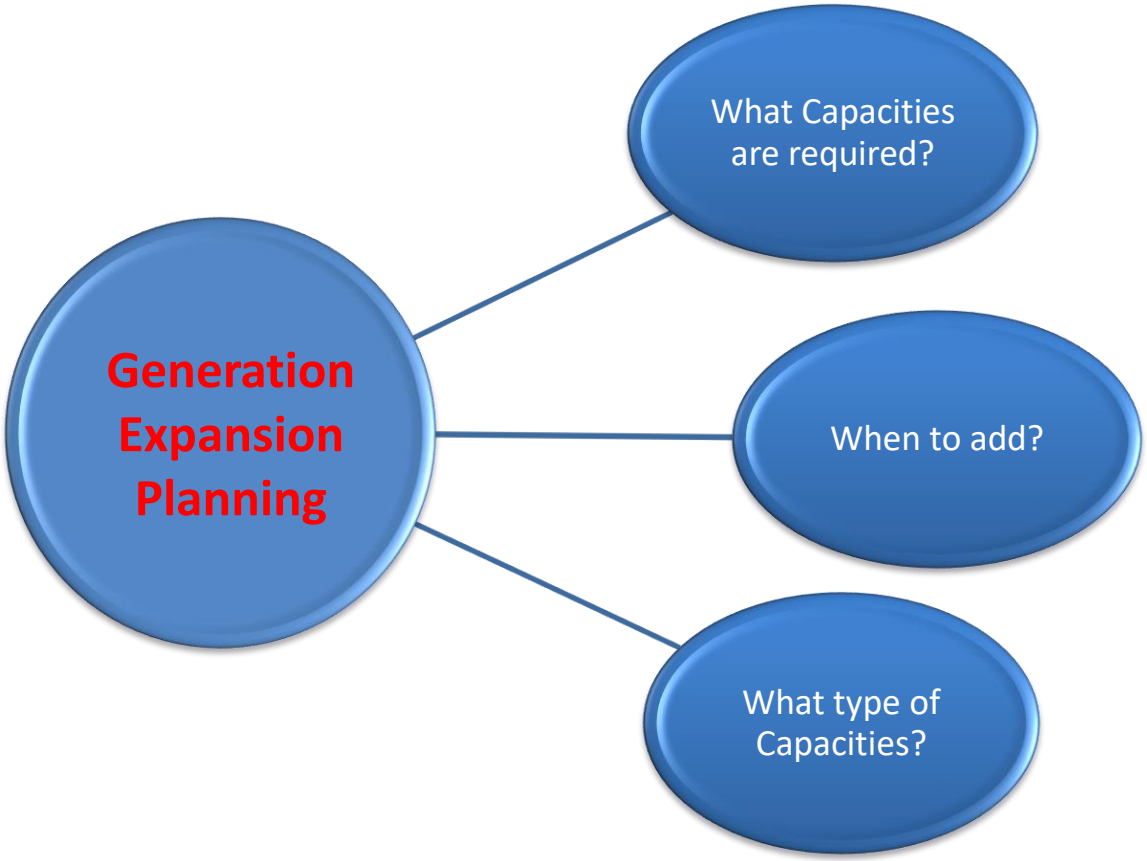
2022



2035

Generation Expansion Planning

- Optimizing the mix of new capacities to be added to the system in a way to meet the forecasted demand with least cost and maximum reliability.



Generation Expansion Planning

- The objective of GEP is to minimize the total system cost including investments of new units and system operating costs while satisfying the different technical constraints related to reliability, renewable energies penetration, generation mix...etc.
- GEP is a data rich process. The input data include demand forecast, demand and renewable generation patterns, technical and economic data for existing and candidate generation units.

Generation Expansion Planning & Related Factors

Incorporating VRE in Long-term Planning Process

- Variable Renewable Energies (VREs) are intermittent by nature.
- VREs are site specific hence their energy yield and generation profiles strongly depends on its location.
- Planning for the expansion of VREs will require enhancements in the following points:

  1- Securing accurate geospatial data with high temporal and spatial resolution.

  2- Improving the energy planning models to account for the VREs intermittency and its techno-economic impacts as well as the access to the transmission grid.

Planning Models Improvements

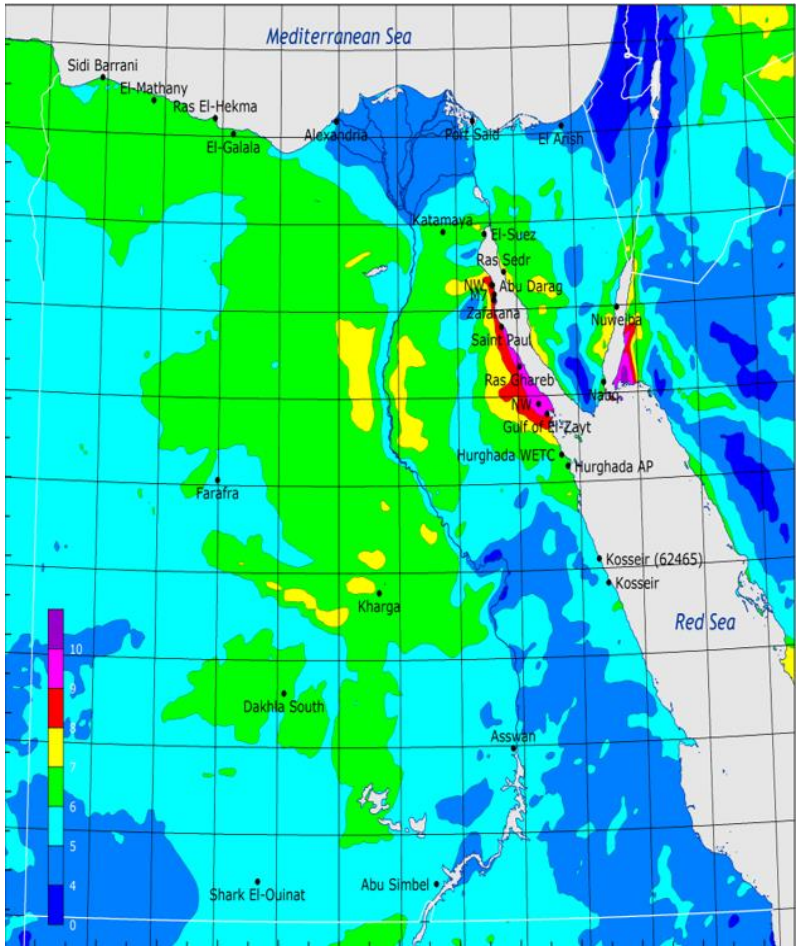
- Modernizing generation expansion planning models to cover the following aspects :
  - High spatial resolution
  - High System operation time resolution (time slices Vs. hourly resolution).
  - Power System Flexibility.
  - VRE firm capacity.
  - Reserve requirements
  - Site data and access to transmission grid.
  - Introduce the concept of integrated G&T planning.

The Need For Accurate Geospatial Data

- Maintaining accurate representation of the VREs characteristics in the planning models arises the need for accurate geo-spatial data.
- The sources of these data are:
  - The New and Renewable Energies Authority (NREA)
  - Wind and Solar Atlases for the country
  - Satellite data bases

Wind & Solar Atlas

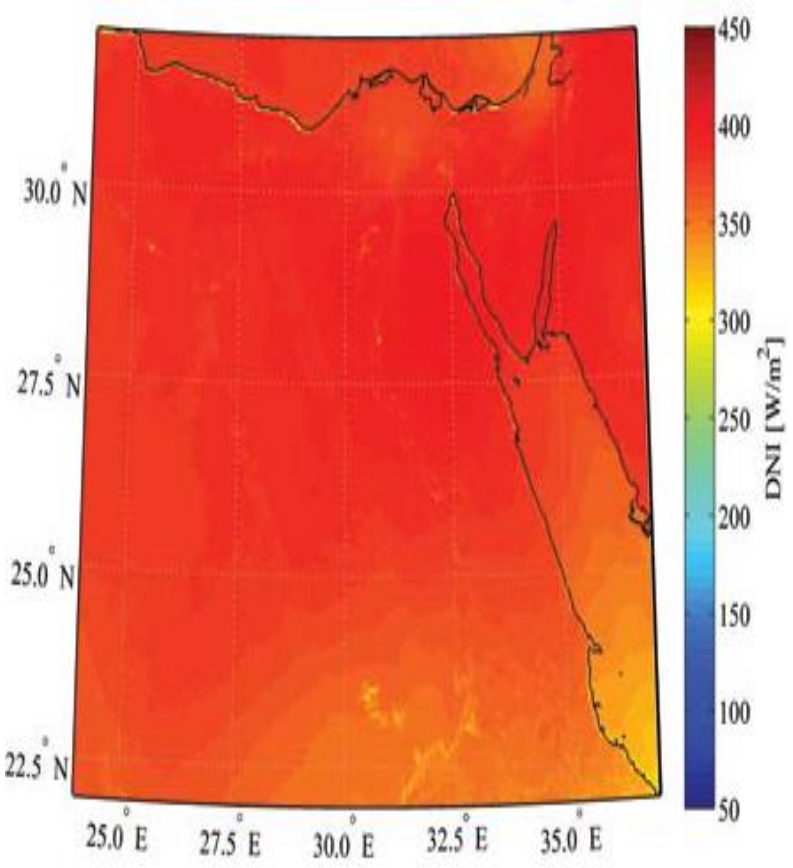
- Egypt has issued a wind atlas as well as solar atlas to highlight the available promising areas endowed with high wind speeds as well as huge solar irradiation.
- The wind atlas has shown that, wind speeds can reach between 7.5-10.5 m/s in the gulf of Suez and Nile borders.



Wind Atlas

Wind & Solar Atlas– Cont.

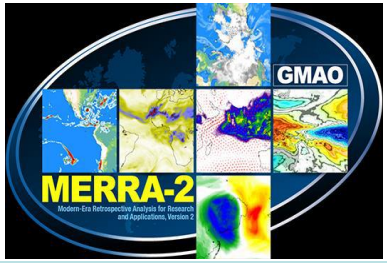
- The solar atlas highlights the climatology of the solar resources in the country and its application for solar-based electricity power plants and grid integration strategies.
- Egypt is one of the countries of the solar belt area with average direct vertical solar radiation in the range of 2000 - 3200 kWh / m 2 / yr and shining period of 9-11 hours/day.



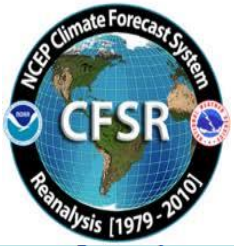
Solar Atlas

Satellite data bases

- If observed records of renewable generation aren't available for the energy planner, some global databases do exist and can provide accurate historical records of renewable generation.
  - MERRA2 database
  - CLIMATE FORECAST SYSTEM REANALYSIS (CFSR)
  - ECMWF database



https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/



https://climatedataguide.ucar.edu/climate-data/climate-forecast-system-reanalysis-cfsr

ECMWF

https://www.ecmwf.int/en/forecasts/datasets/archive-datasets/reanalysis-datasets/era5

Generation Expansion Planning Models Utilized by EEHC

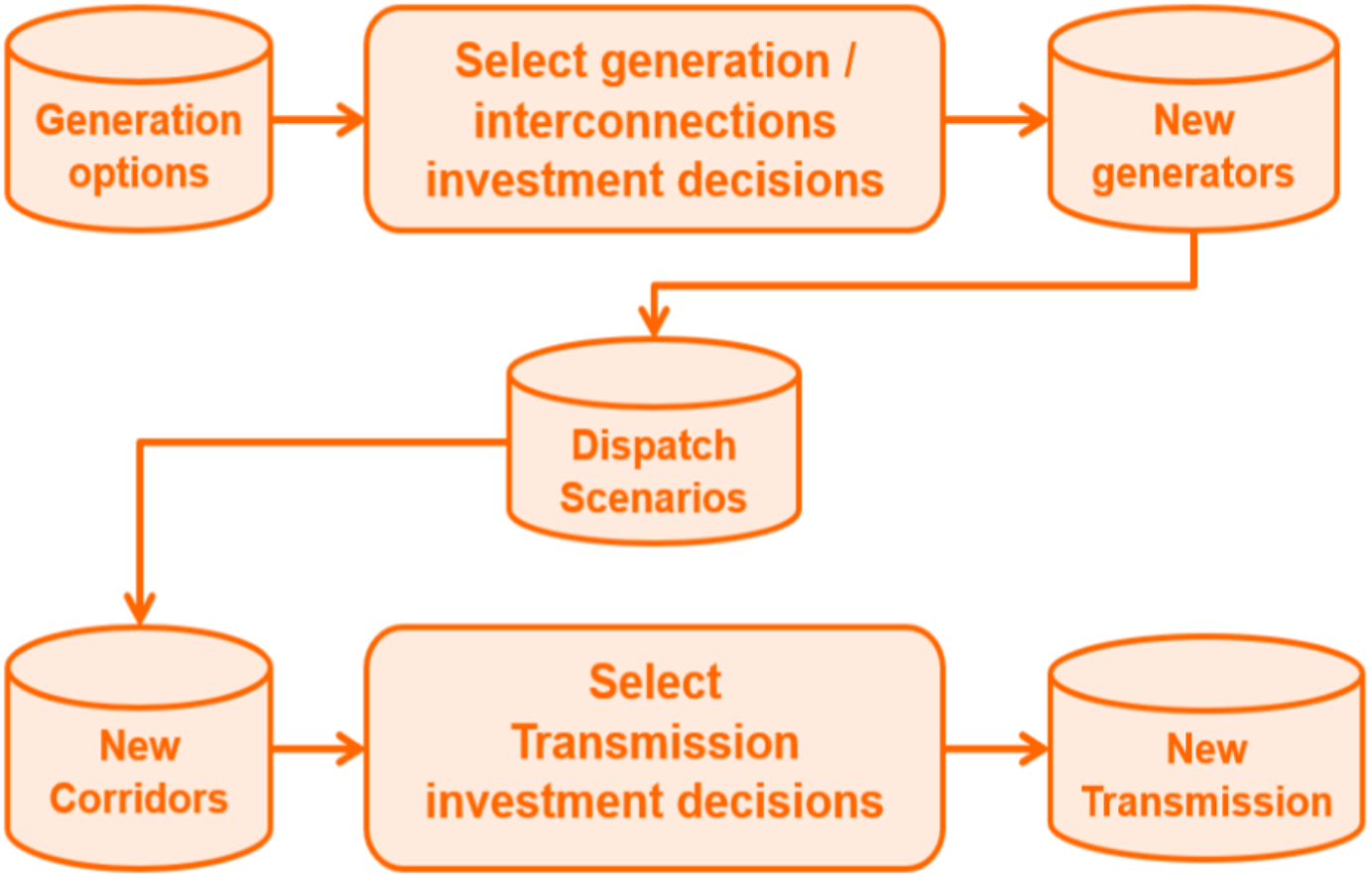
EGEAS Model

- Developed by the EPRI institute, USA
- The model can capture a wide range of generation technologies including thermal , hydro generation and variable renewable energies.
- The model is also capable of simulating energy storage and electrical interconnection.
- Variable renewable energies are modeled using hourly per unit generation data (resource or site specific) as well as other technical and economical parameters.

EGEAS Model – Cont.

- The model is capable of modeling the renewable energies firm capacity as a percentage of its installed capacity. This firm capacity is assumed to be available during the system peak load period and contributes to the system reserve margin.
- The model has limited representation of the operational constraints of power plants (ramp rates, min Up/Down times, min generation..).
- Doesn’t consider access to transmission grid.

Hierarchical G→T Planning Overview



PSR Planning tools

- This suite of planning tools is adapted to the optimization of integrated energy systems (G&T) under uncertainty and taking into account the different economic and technical limits such as availability of renewable resources, fuels and transport restrictions in transmission lines and pipelines.
- The various models use stochastic optimization techniques (SDDP) to solve operational and planning problems.

PSR Planning tools

- The PSR models' objective function is the minimization of the total present value of the G&T cost which includes the capital fixed charges for the new G&T candidates and the related operating costs to meet the system demand forecast.
- The optimization for new G&T candidates will be based on a coupled decision to minimize the overall capital and operating costs.

PSR Planning tools – Cont.

- The planning suite includes the tools:

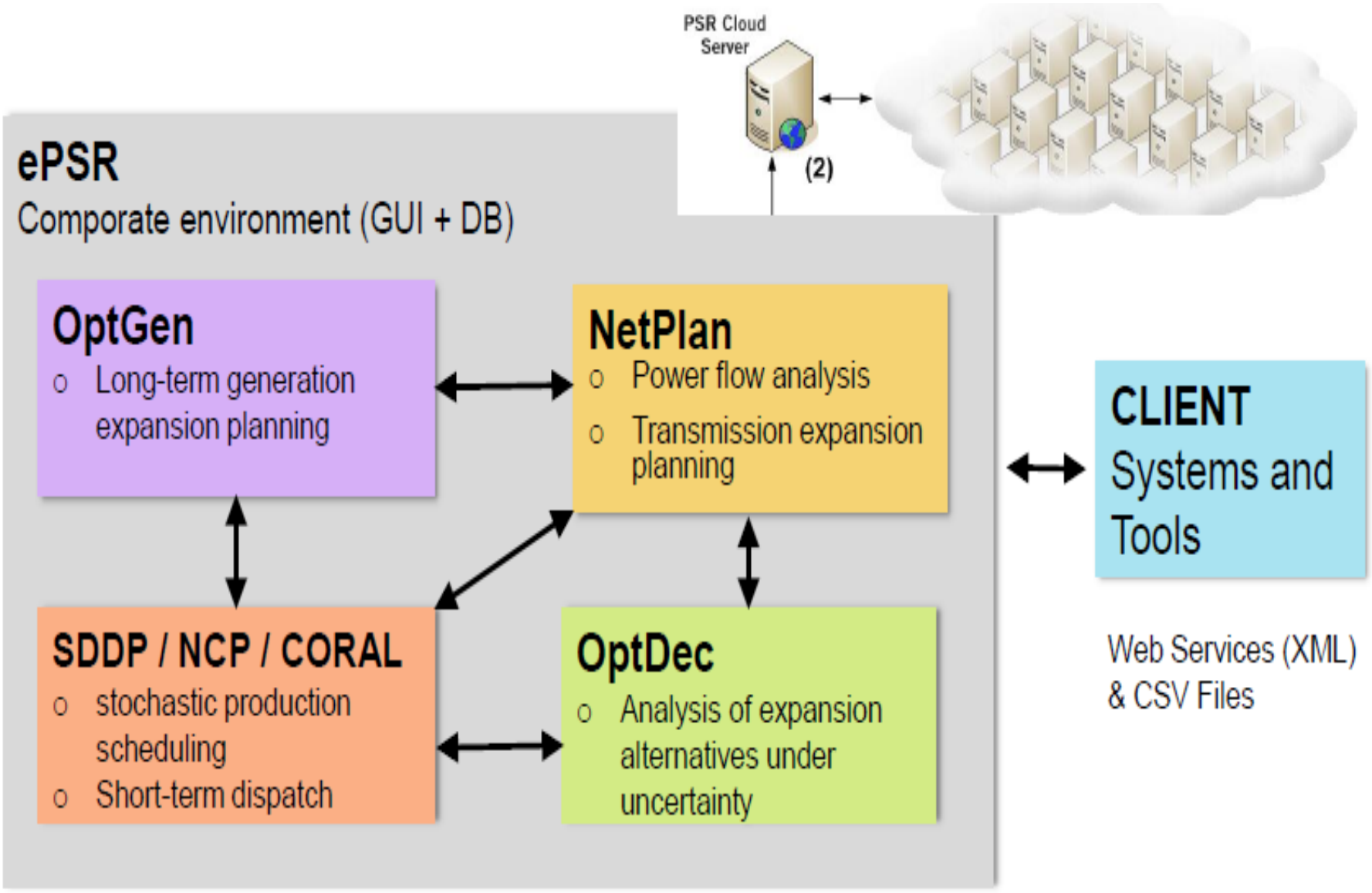
  -OptGen: Optimal mid & long term G&T Expansion Planning tool.

  -SDDP: Optimal mid & long term stochastic production scheduling & costing tool.

  -NCP: Optimal short term production scheduling tool.

  -NetPlan: Transmission network planning and analysis tool.

PSR Integrated G&T Planning



PSR Planning tools – Cont.

- Modeling the chronological hourly characteristics of VRE for each individual site and the access to the transmission grid.
- Modeling the locations of existing / candidate generation projects and also demand centers inside the transmission grid.
- Modeling the firm capacity of VRE.
- Modeling the stochastic nature of VRE.
- Detailed modeling of hydro generation.
- Modeling the detailed operation limits and flexibility characteristics of generation units into the generation expansion planning process.
- Modeling storage technologies and electric interconnection.

Future Planning Directions

- Continue enhancing the modelling of variable renewable energies in the generation expansion planning models.
- Inoroporating the new concepts related to the firm capacity, power system flexibility into the the planning models.
- Continue securing accurate sources of geo-spatial data for energy planners especially in the developing countries.
- Providing training for energy planners on the use of geospatial databases and planning issues related to the VREs expansion.

Conclusion

- Egypt long term strategy aims to diversify the electricity generation mix by including different technologies and energy sources including renewable energies.
- Egypt is endowed with huge renewable resources.
- Most of the future renewable expansion is from variable types.
- The planning models applied are updated to account for the challenges of integrating variable renewable energies.

Thank You

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