

POWER MARKET SIMULATION AND MODELING



EMP @ LUMS
JULY 17-22, 2018

www.cppa.gov.pk



AGENDA

1. General Optimization Modeling Tools
2. Introduction of SDDP and its Practical Demonstration
3. Progress & Results



General Optimization Modelling Tools



General Optimization Modeling Tools

Capabilities	Optgen	SDDP	NCP
Objective Function	Minimization of Total System Cost	Minimization of Total System Cost/Maximize expected revenues	Minimization of Total System Cost/Maximize expected revenues
Model Type	Planning	Dispatch	Dispatch
Planning Capability	Generation and Transmission	N/A	N/A
Stochastic	Yes	Yes	No
Optimization Technique	MIP Techniques	MIP Techniques	MIP Techniques
Scenario Oriented	Yes	Yes	Yes
International Experience	Yes	Yes	Yes
System Granularity	All	All	All
Simulation Horizon	Long Term	Mid Term	Short Term
Simulation Steps	Monthly to Yearly	Weekly or Monthly	From 15 mins to 1 hour
Reliability Consideration	Yes, Spinning Reserves and Operational Reserves	Yes, Spinning Reserves and Operational Reserves	Yes, Spinning Reserves and Operational Reserves



Introduction to SDDP tool

- SDDP: Stochastic Dual Dynamic Programing
 - State-of-the-art least-cost optimization technique
 - Global Footprints
- Operational cost optimization: future cost functions for each stage (week, month), so the expected operational cost can be minimized.
- Calculation of physical productions and economical parameters
- Short, mid and long term scope studies can be linked



Introduction to SDDP tool

- SDDP – integrated analysis of hydrothermal systems together with the transmission system.

- Individual representation of hydroelectric plants:
 - On cascade hydric balance.
 - Spillage, filtration and evaporation.
 - Variable production factor.
 - Alert volume, minimum security storage and flood control storage
 - Maximum and minimum total outflow constrains.

- Hydrology uncertainty calculated through a stochastic model that takes into account the temporal and spatial dependence.



Introduction to SDDP tool

- Thermal plant operation:
 - Multiple fuels.
 - Non linear efficiency curves.
 - Commitment units.
 - Generation constrains.
 - Fuel consumption constrains.
 - Gas Networks.

- The transmission net includes: Kirchhoff laws, quadratic losses (linearized), circuits limitations, importation and exportation constraints on each electric area, security constraints, etc.



Introduction to SDDP tool

- Renewable Energy Resources:
 - Wind, small hydro, solar, etc..
 - Based on scenarios.
 - Scenarios are sampled from the data selected.

- The renewable sources are not under the scheduling control. First, the renewable generation is discounted from the system load and then the scheduling problem is solved.

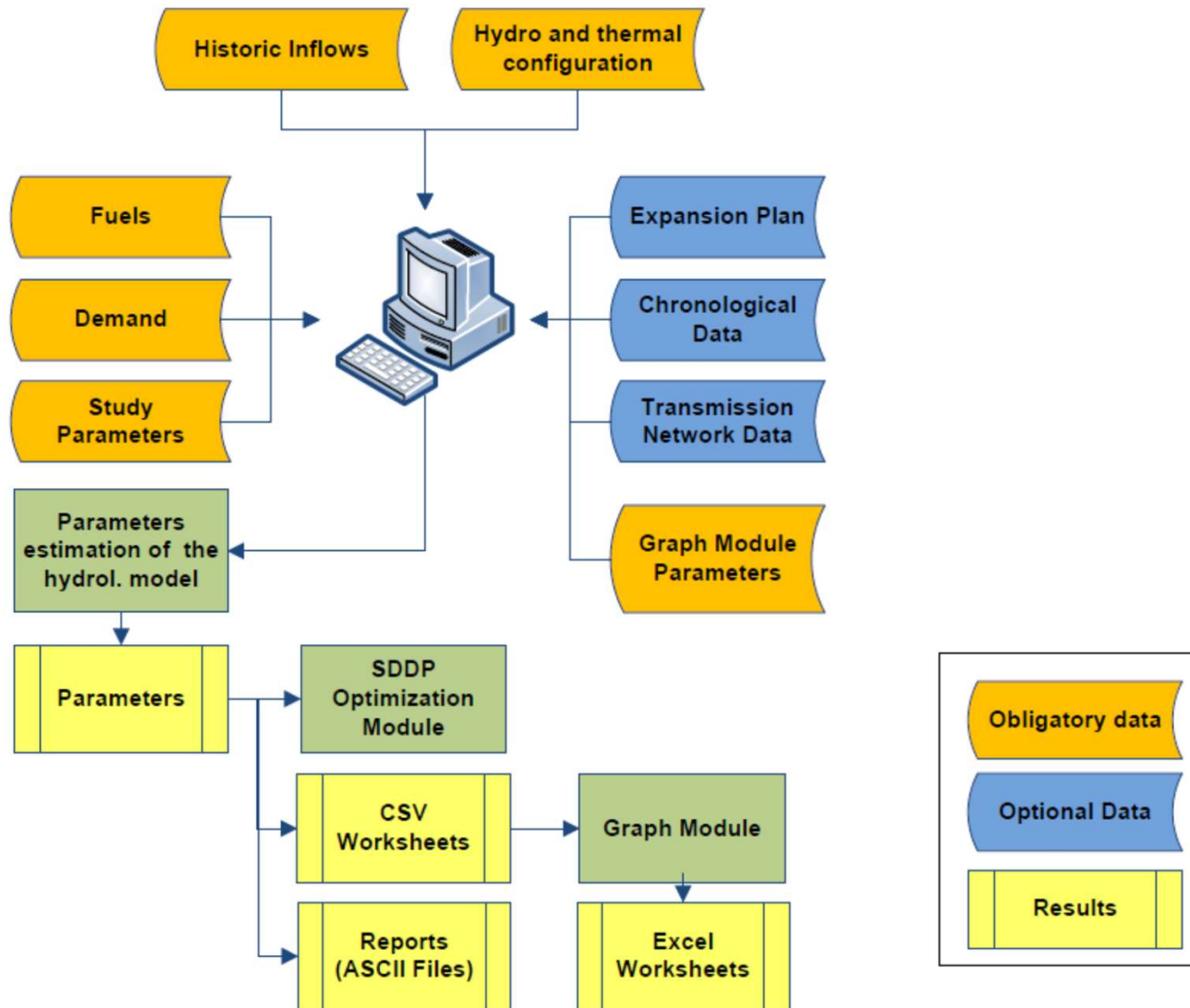


Introduction to SDDP tool

- Optimization of large-scale hydrothermal systems without taking into account the transmission constraints or including them in a very simplified way.
- Detailed representation of the transmission system, including the hydroelectric plants in a simplified way.



Introduction to SDDP





User Friendly GUI

- Runs on a PC.
 - Can benefit from parallel optimization
- Graphic interface compatible with Windows.
- More than a 100 worksheets detailed by stages, series and demand blocks in CSV format, which can be opened using Excel.
- Integrated model for results visualization and graphics generation.



Concepts

- Needs of Market Operator Vs Needs of System Operator
 - Hourly Data
 - Partial Load Adjustment Charges
 - Start-up Cost
 - Power Flow Analysis



Progress & Results



Progress

- **Capacity Building Sessions:**
 - **Session 1 : November 2017 at NPCC Office, Participants : NPCC and CPPA-G**
 - In this session , Mr. Daniel explained the basic understanding of security constraint economic dispatch (SCED) and during the session participants learned the mathematical techniques of SCED by using excel based solver.
 - **Session 2 : December 2017 at CPPA Office, Participants : NPCC and CPPA-G**
 - In this session Trainer gave training on Dispatch Optimization Techniques and Software Tools by introducing the SDDP tool
 - **Session 3 : February 2018 at CPPA Office, Participants : NPCC and CPPA-G**
 - In this session participants got the hand on experience of SDDP. With the help of Trainer, they populated the data of Pakistani system and executed the real simulation on SDDP



Progress

- **Data Base for SDDP**
 - Demand
 - Generation Plant
 - Prices
 - Transmission Data
 - Hourly Grid Data
 - Hydro Power Plant
 - Renewable Plant data
- **Results**



Thank You