Technical Education on Capacity Expansion Software

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TEAC Special Session - Order 1920

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Overview

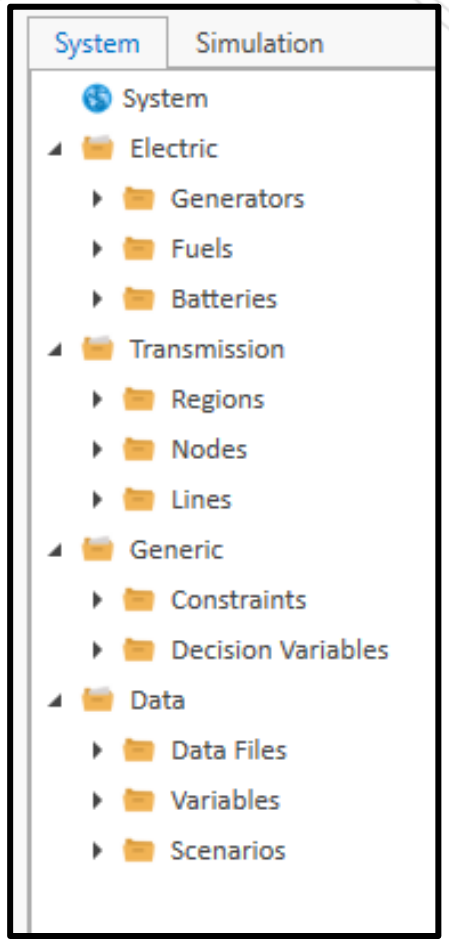
- PJM uses Energy Exemplar's Plexos software for capacity expansion
- This presentation provides high-level education on use of the software using an illustrative example
- Further education on policy and resource adequacy modeling will be provided in a subsequent meeting

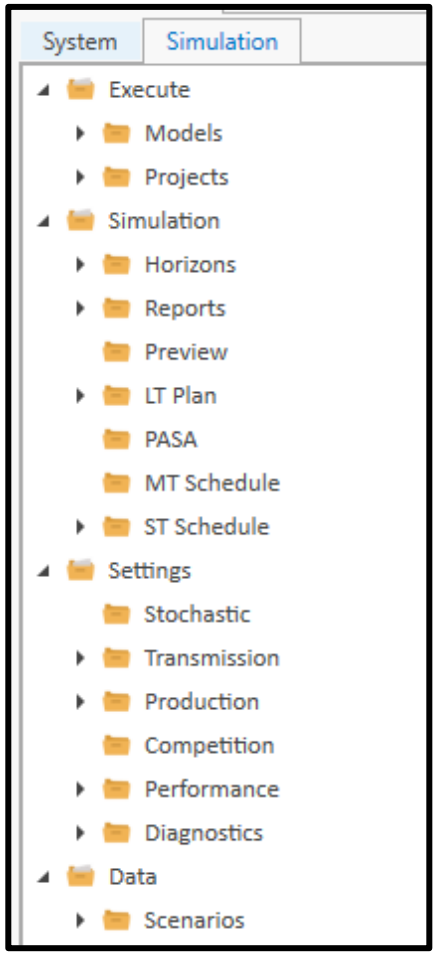
Agenda

- Introduction
- Setting up the database
- Simulation setup
- Running capacity expansion
- Reports
- Illustrative East – West example of PJM system
- Next steps

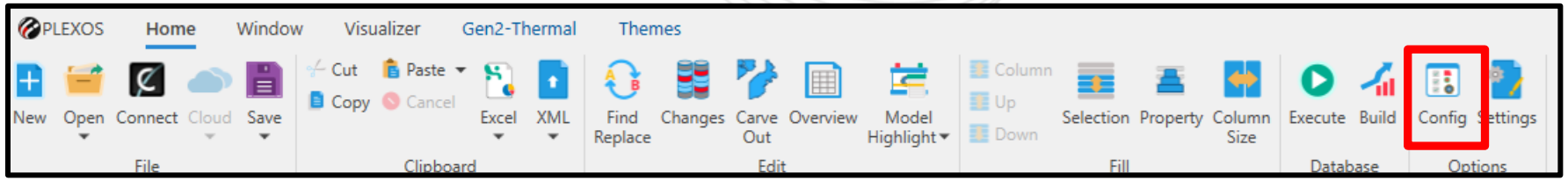
Introduction

- User Interface
  - System elements consist of various classes
  - Classes can be enabled/disabled using Config menu settings
  - Simulation elements consist of models and settings for running the models

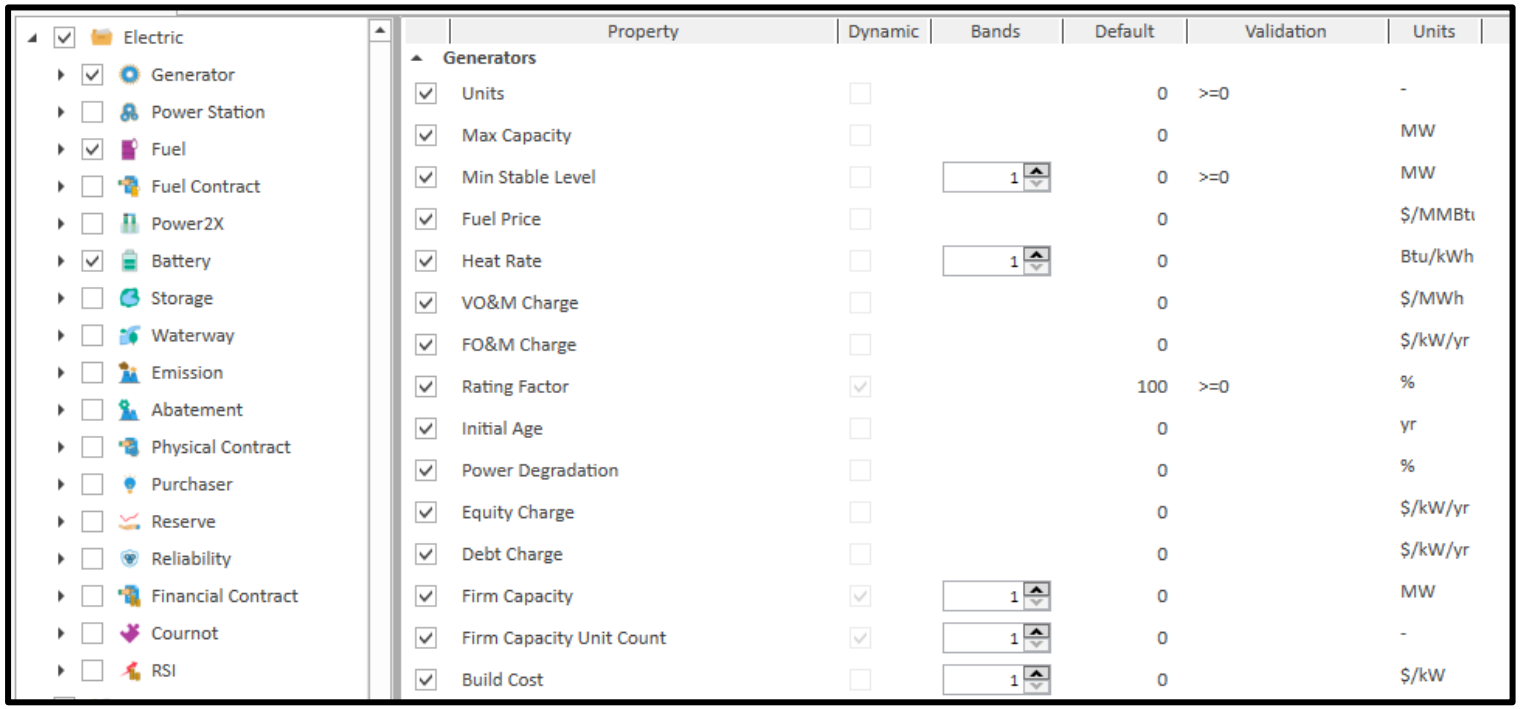




- Config menu on Home ribbon



- Includes all classes and their properties



- Each element can have memberships and properties

- Memberships relate classes to one another
  - Example: Emission.Fuels or Emission.Generators

- Each element has a set of properties
  - Example: Generator MaxCap, Fuel price

- Scenarios
  - Software terminology for tagging data properties
  - Each model consists of base data and data scenarios
  - You can tag data and properties using a scenario. Then use the scenarios to make changes to the base data or create multiple models

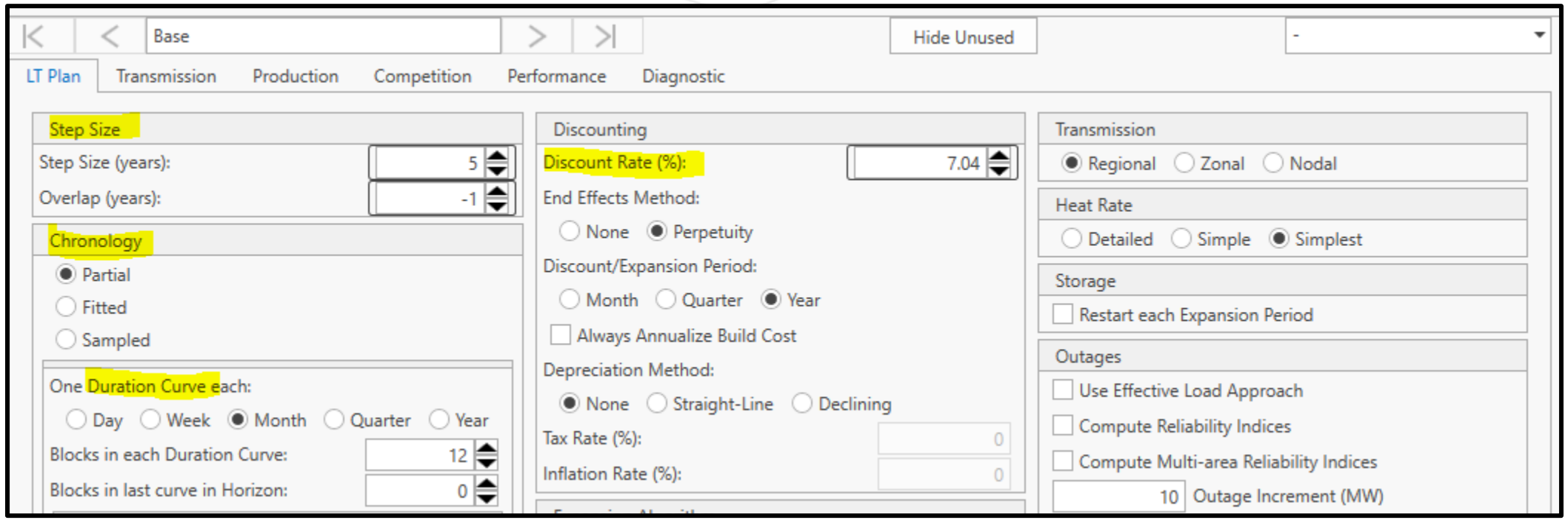
	Collection	Parent Object	Child Object	Property	Value	Data File	U..	Band	Date From	Date To	Timeslice	Action	Expression	Scenario
	Fuels	System	NGHenry	Price		Fuel Price-H	$/...	1				=		High Fuel
	Fuels	System	NGHenry	Price		Fuel Price-L	$/...	1				=		Low Fuel

Setting up the database

- LT Plan
  - LT Plan phase is used for long term capacity expansion
  - The objective is to minimize system cost
    - Fixed costs (Capital cost of new generation and FOM costs)
    - Production costs (Cost of operating the system given a set of existing generators and cost of unserved energy)
  - Decision variables are whether and when to build a generator candidate
  - Discount factors are used to represent all costs as present values

Setting up the database

- LT Plan



Setting up the database

- Config menu for Generator Expansion

Expansion			
Build Cost	Multi Band	$/kW	0
Retirement Cost		$000	0
One-time Cost		$000	0
Lead Time		yr	0
Project Start Date		-	1/1/2000
Commission Date		-	12/31/1899
Technical Life		yr	1E+30
WACC		%	10
Levelized Capital Carrying Rate		%	0
Economic Life		yr	30
Max Units Built		-	0
Max Units Retired		-	0
Min Units Built		-	0
Min Units Retired		-	0
Max Units Built in Year		-	1E+30
Max Units Retired in Year		-	1E+30
Min Units Built in Year		-	0
Min Units Retired in Year		-	0
Build Set Size		-	0
Hint Units Built		-	0
Capacity Price		$/kW/yr	0

Setting up the database

- Capacity expansion candidates
  - Units
  - Max Capacity
  - Build Cost
  - Project Start Date
  - Levelized Capital Carrying Rate
  - Max Units Built/ Max Units Built in Year
  - …

Property	Value	Data File	Units
Units	0		-
Max Capacity	150		MW
FO&M Charge	33.41		$/kW/yr
Rating Factor	100	wk_OH-Mansfield_PV_1-Axis_SolarShape	%
Firm Capacity	37.5		MW
Build Cost	0	Build_Cost	$/kW
Project Start Date	1/1/2024		-
Levelized Capital Carrying Rate	5.68		%
Economic Life	30		yr
Max Units Built	150		-
Max Units Built in Year	5		-

Setting up the database

- Load forecast input using data files

	Collection	Parent Object	Child Object	Property	Value	Data File	Units	Band	Date From	Date To	Timeslice	Action
▶	Regions	System	East	Load		EAST	MW	1				=
	Regions	System	West	Load		WEST	MW	1				=

  - Data file

Data File	Property ▲	Value	Filename	Units	Band	Date From	Date To	Timeslice	Action	Expressio
EAST	Filename		Load Forecasts\MH-East_2023-2039-new.csv		1	1/1/2023	12/31/2039		=	
WEST	Filename		Load Forecasts\MH-West_2023-2039-new.csv		1	1/1/2023	12/31/2039		=	

  - Source .csv file

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Year	Month	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2029	1	1	54792	54564	54396	54716	55630	57724	61010	63883	64529	64566	64186	63173	62232	61242
2029	1	2	54582	53879	53688	53858	54745	56997	60729	63577	63809	63119	62377	61247	60529	59549
2029	1	3	56116	55552	55359	55591	56634	58998	63390	66494	66651	65854	65026	63291	62027	61038
2029	1	4	55530	54802	54662	54901	55879	58348	62836	65950	65962	65173	64157	62884	61922	61034
2029	1	5	55370	54585	54237	54287	55116	57277	60946	64081	64419	63973	63491	62507	61370	60471
2029	1	6	54387	53685	53313	53307	53739	54838	56273	58031	59138	59877	59580	58797	57858	56883
2029	1	7	54102	53466	53274	53398	53725	54612	55712	57419	58470	58659	57980	57102	56390	55504
2029	1	8	55107	54963	54873	55385	56469	58899	63268	66500	67067	66824	66213	65120	64043	63017

Setting up the database

- Transmission links between zones

Line	Property	Value	Data File	Units	Band	Date From	Date To	Timeslice	Action	Expression
East to West	Min Flow	-10000		MW	1				=	
East to West	Max Flow	10000		MW	1				=	

- Fuel input using data files

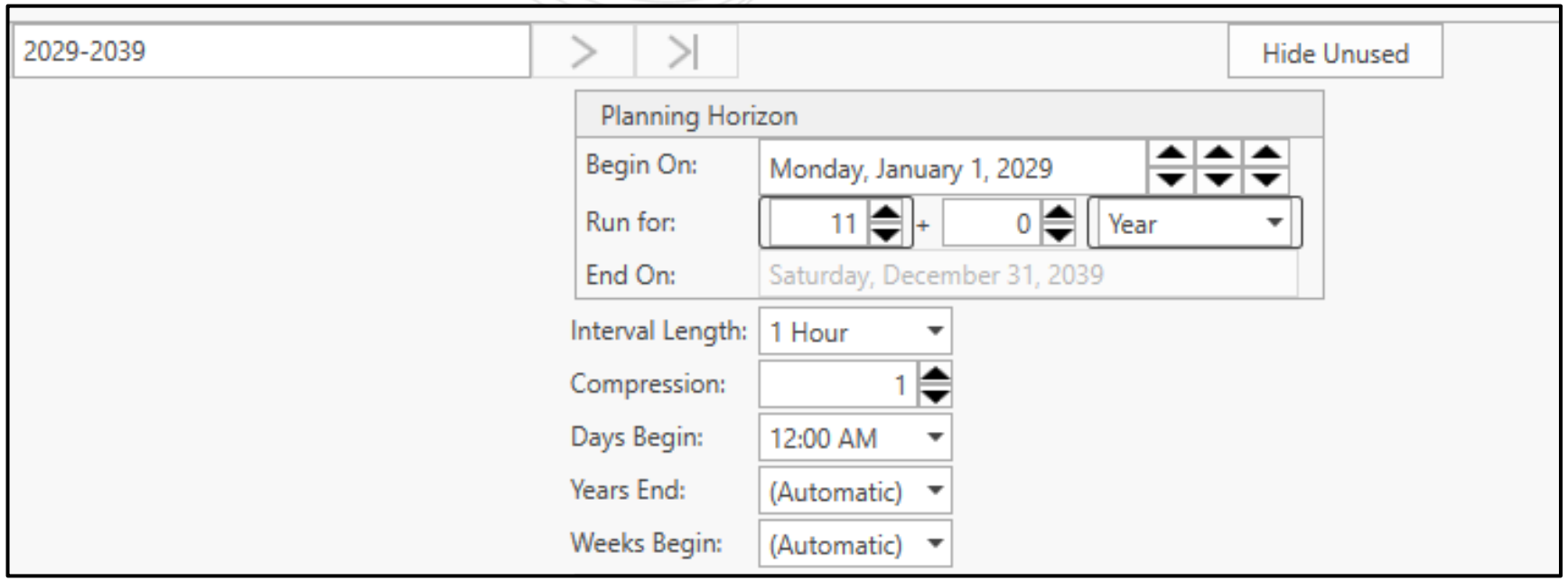
	Collection	Parent Object	Child O...	Property	Value	Data File	Units	Band	Date From	Date To	Timeslice	Action
▸	Fuels	System	NGHenry	Price		MH-Fuel Price	$/MMBtu	1				=
	Generator.Fuels	Gen1-Thermal	NGHenry	Transport Charge	0		$/MMBtu	1				=
	Generator.Fuels	Gen2-Thermal	NGHenry	Transport Charge	0		$/MMBtu	1				=

- Battery expansion candidates

Collection	Parent Object	Child Object	Property	Value	Data File	Units
Batteries	System	BSEx1	Units	0		-
Batteries	System	BSEx1	Capacity	200		MWh
Batteries	System	BSEx1	Max Power	50		MW
Batteries	System	BSEx1	Charge Efficiency	80		%
Batteries	System	BSEx1	Discharge Efficiency	80		%
Batteries	System	BSEx1	FO&M Charge	30		$/kW/yr
Batteries	System	BSEx1	Max Units Built	5000		-
Batteries	System	BSEx1	Build Cost		build cost	$/kW
Batteries	System	BSEx1	Economic Life	30		yr

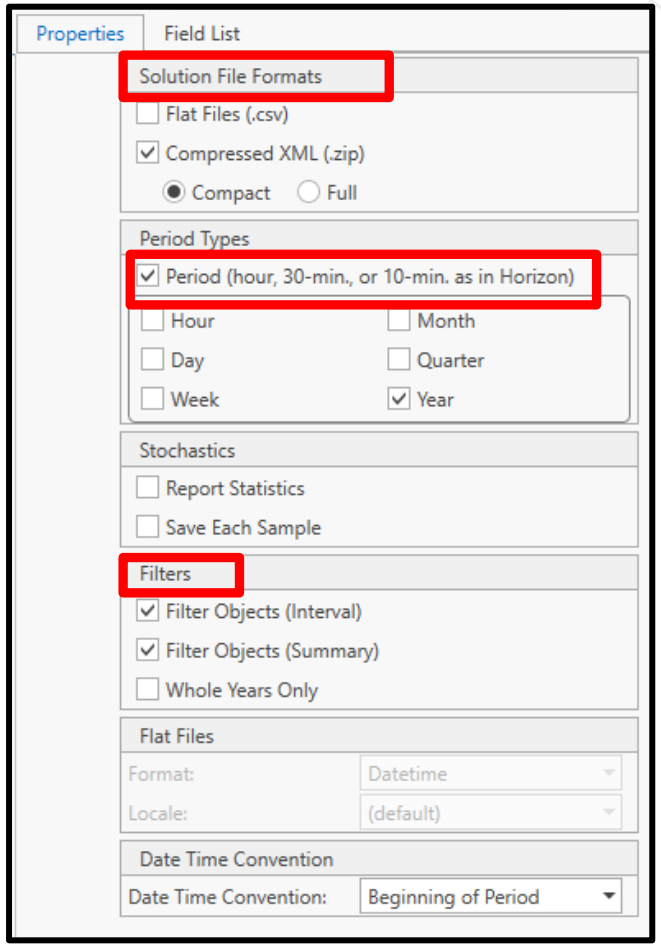
Simulation setup

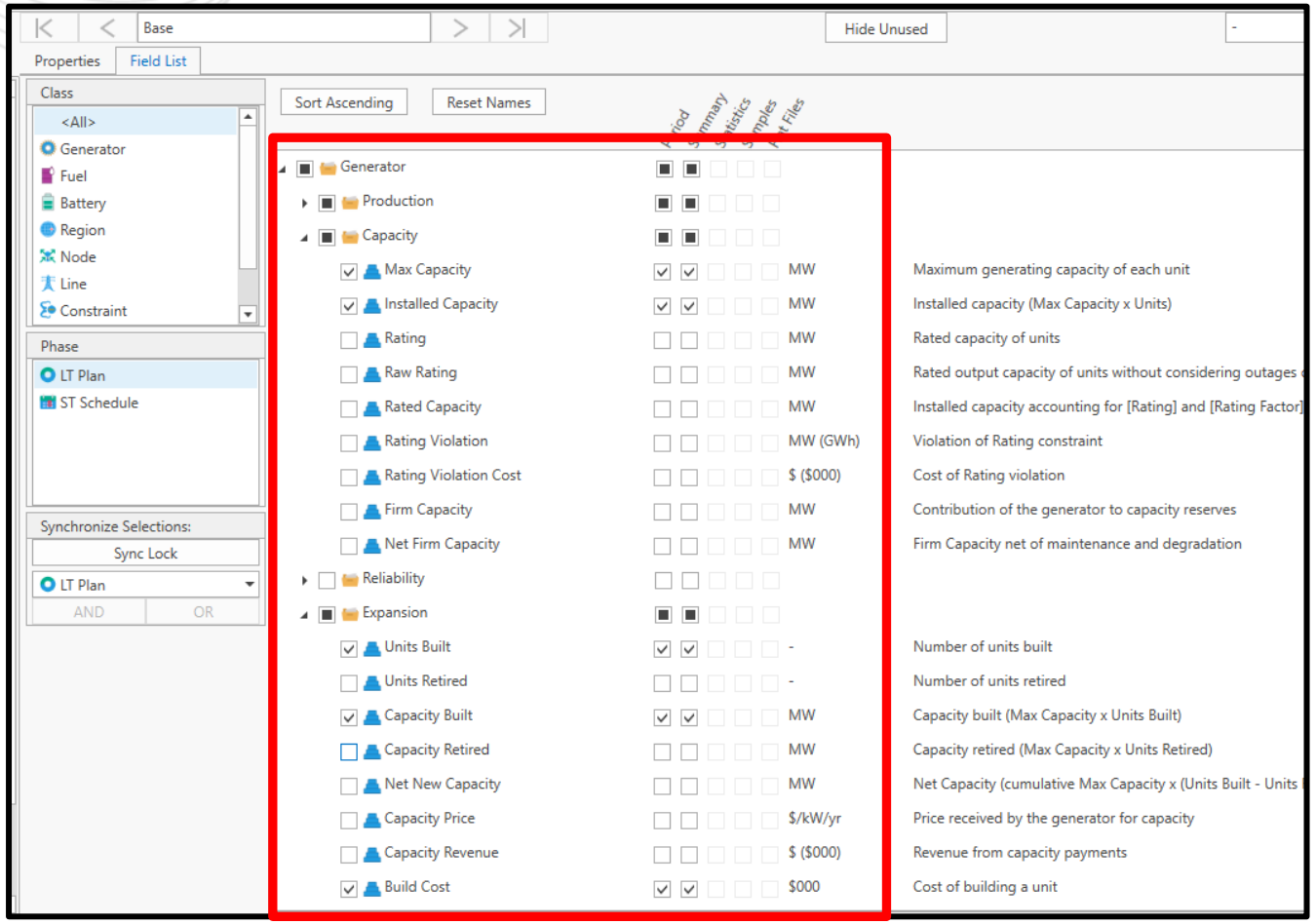
- Simulation Horizon



Simulation setup

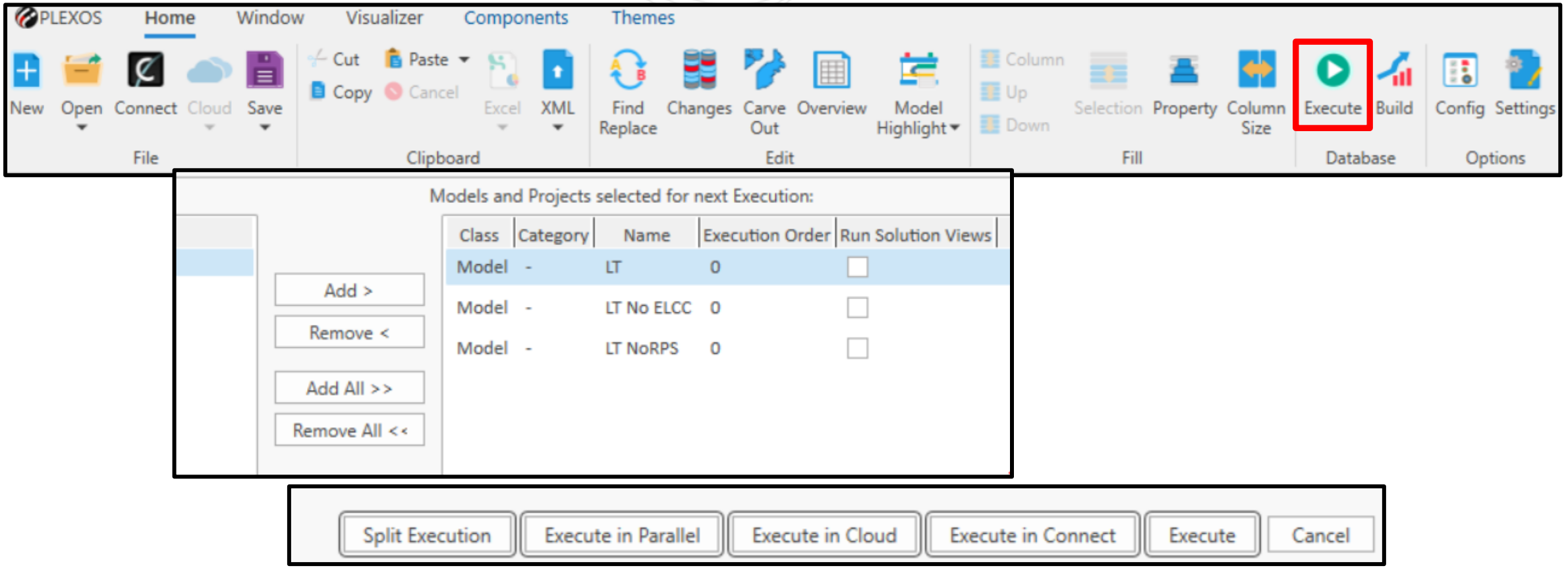
- Reports



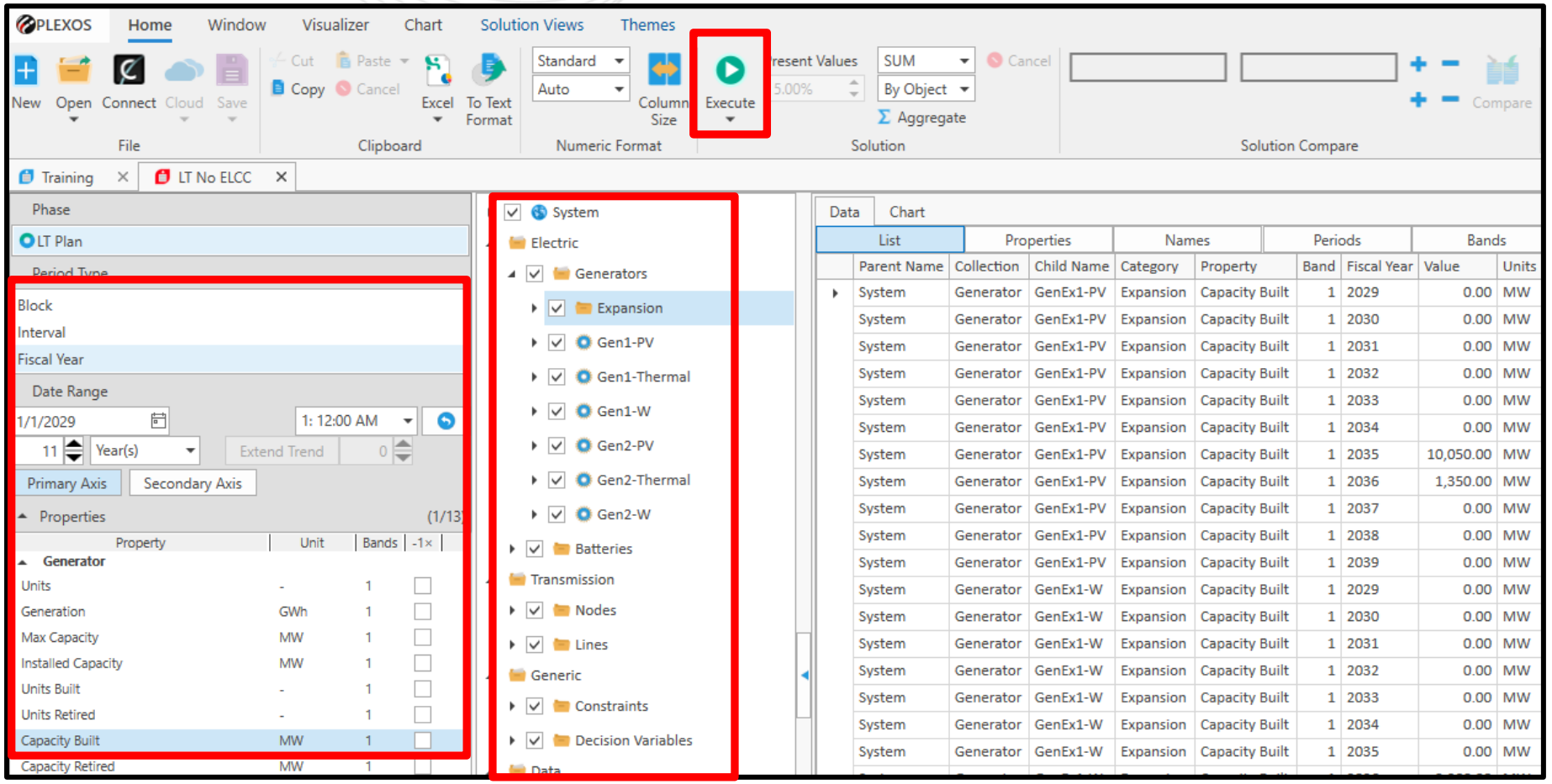


Running capacity expansion model

Select “Execute” from the ribbon



- Output Interface



Illustrative East – West example of PJM system

- Demo in Software

Next steps

- Technical Education
  - Modeling Policies
  - Modeling Resource Adequacy

Contact

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Sources for Techno-Economic Inputs

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