

# OPF Automation Examples

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# OPF Automation Examples

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- Standardize settings with Auxiliary Files
- Hourly nodal market simulation with SimAuto



# Standardizing with Auxiliary Files

# What Can You DO with Auxiliary Files?

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- Quality Assurance: **Standardize** settings and controls for multiple cases and studies
- **Customize** Simulator environment
- **Document**
  - Describe an analysis procedure for a manager or client
  - Create a detailed project record
  - Enable reproducibility
- **Automate** detailed calculations and storage of the results
- Automate building and editing of a **one-line diagram**

# Standardize Settings

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- Aux Files may be used to standardize
  - Solution Options
  - Limit Monitoring
  - Contingency Options
  - Default Drawing Values for One-lines
  - ATC, OPF, PVQV Options
  - Many more

# Standardize Settings: Example

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- Open *ACTIVSg10kOPF.raw*
- Load *M09\_OPF Automation\aux2000Master.aux* to
  - Set power flow solution options
  - Set Limit Monitoring
  - Set OPF options
  - Load generator information
  - Set AGC to NO for all Hydro, Wind, Solar, and Unknown units
  - Designate Natural Gas units as OPF Fast Start
- Master file calls a series of files with names *aux20?0\*.aux*

# Master File



```
SCRIPT
{
// Custom filters and expressions (used in AGC actions below)
LoadAux("aux2010FiltersExpressions.aux", Yes);

// Power Flow Solution Options
LoadAux("aux2020SolutionOptions.aux", Yes);

// Limit Monitoring Settings
LoadAux("aux2030LimitMonitoring.aux", Yes);

// OPF Options
LoadAux("aux2040OPFOptions.aux", Yes);

// Contingency options and files
// LoadAux("aux2050Contingencies.aux", Yes); // COMMENT out if not needed for this project

// Generator Cost Files
LoadAux("aux2060GeneratorCostModels.aux", Yes);

// Generator AGC Settings
LoadAux("aux2070GeneratorAGC.aux", Yes);
}
```

# Standardize Settings: Tips

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- Use a master file to call secondary files (LoadAux)
  - Overall procedure can be maintained in the master file
  - Parameters subject to change over time (e.g. generator cost models) can be stored in the secondary files
  - Can suppress confirmation dialogs when creating new objects



# Standardize Settings: Tips

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- Use script actions to select all, change selected, then unselect all
  - Objects that need to be handled specially (e.g. study areas) can be identified by primary key or filter in specific statements
  - Improves compatibility with different cases having different objects and topology
- “Selected” field
  - Available for every object
  - Value is not saved with the case and always set to NO when a case is opened

# Standardize Settings: Tips

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- Build files by saving case info displays and settings to auxiliary files
  - Use text editor to review, make changes, and add comments
  - Can append new DATA sections to existing auxiliary files
  - Add SCRIPT sections where appropriate
  - Most Options dialogs in Simulator have a button for Saving to Aux
- DATA sections: save only key fields and the records and columns necessary to make needed changes
  - Example: if setting generator AGC status is the objective, do not include other fields such as Gen MW, Gen Max MW, etc.
  - Extra fields may be specific to one case and not appropriate for other cases
- Use comments to document

# One-line Diagrams

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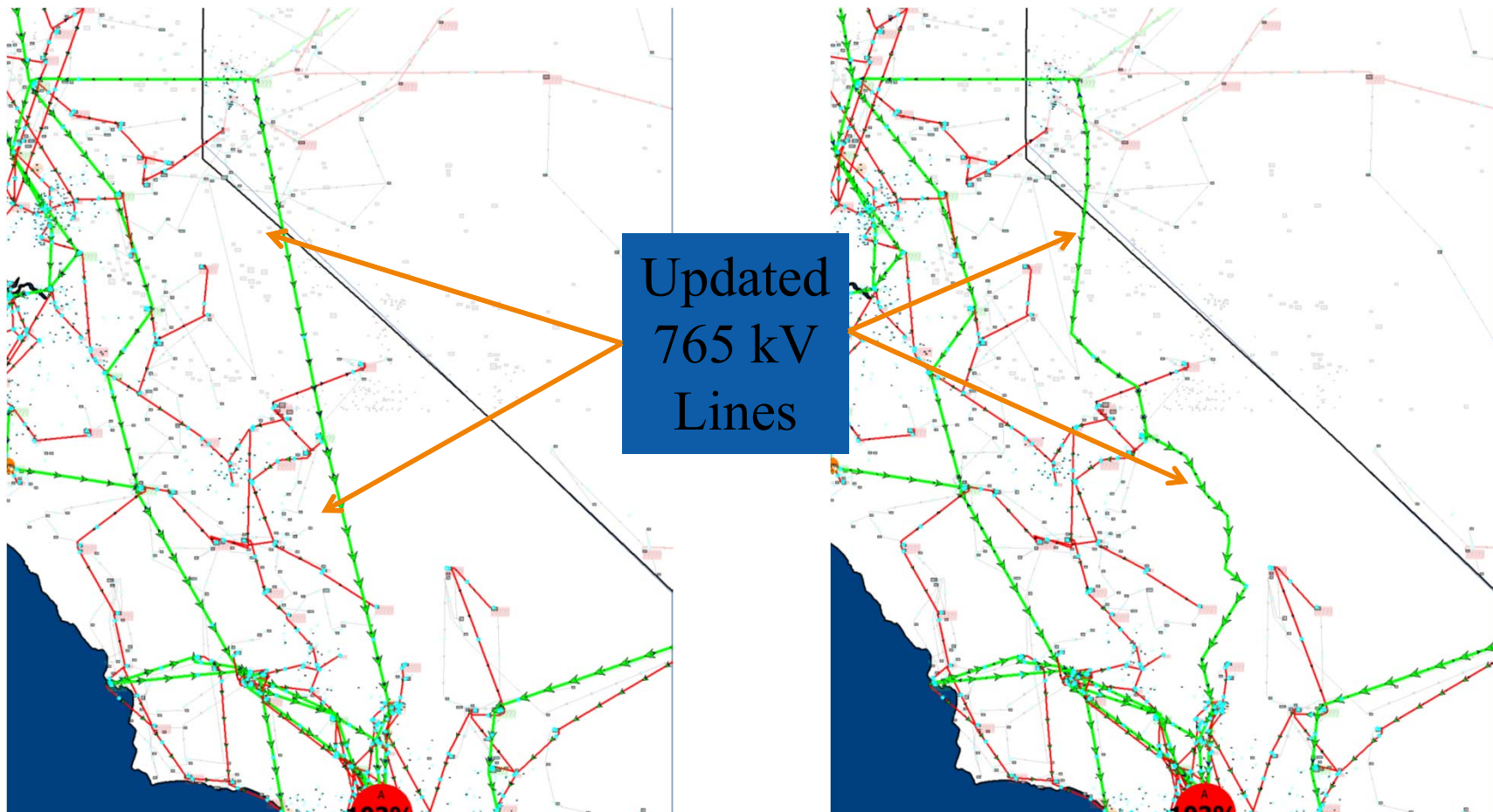
- Display Auxiliary File (\*.axd) format extends the power of Auxiliary Files to one-line diagrams
- Enables automated generation of one-line diagrams from an external scripting process
- Case Information Displays for one-line diagrams are accessed from **Onelines** → **All Display Objects...**
- Sample file – transmission line routing
  - *M09\_OPF Automation\CARouting.axd*
  - updates routing of two 765 kV lines between Sparks, NV and Mojave, CA in *ACTIVSg10kOPF.pwd*

# One-line Diagrams



Before Loading axd File

After Loading axd File



# Display Explorer



Display Explorer: Transmission Lines

Explore Fields

- Recent
  - All Objects
- Network
  - Buses
  - DC Transmission Lines
  - Generators
  - Loads
  - Series Capacitors
  - Switched Shunts
  - Three-Winding Transformers
  - Transformers
  - Transmission Lines
- Aggregations
- Background
- Branch Symbols
- Fields
- Geo Data View
- Other
- Pie Charts
- Text Links

Show Only Objects Selected

How to list grouped objects

- List objects only
- List groups only
- List both objects and groups

Save Complete Display to AXD

Open New Explorer

Transmission Lines (filtered) All Objects

Records Set Columns Filter Advanced Transmission Line Find... Remove

	From Number	To Number	Circuit	Auxiliary ID	X/Longitude Location	Y/Latitude Location	Thickness	Color	Anchored	Stack Level	Same Level Display Priority (for INPUT only)
1	1	2	1	1	-75.61778117	40.51198488	2		YES	Middle	NO
2	1	8	1	1	-75.61778117	40.51198488	2		YES	Middle	NO
3	1	9	1	1	-75.61778117	40.51198488	2		YES	Middle	NO
4	1	23	1	1	-75.61778117	40.51198488	2		YES	Middle	NO
5	2	6	1	1	-74.76749302	40.56505748	2		YES	Middle	NO
6	2	7	1	1	-74.76749302	40.56505748	2		YES	Middle	NO
7	3	4	1	1	-77.07003447	39.17446488	2		YES	Middle	NO
8	3	25	1	1	-77.07003447	39.17446488	2		YES	Middle	NO
9	4	13	1	1	-76.52865900	39.68022281	2		YES	Middle	NO
10	4	26	1	1	-76.54387187	39.68178808	2		YES	Middle	NO
11	5	9	1	1	-79.06000181	40.39100366	2		YES	Middle	NO
12	5	11	1	1	-79.06000181	40.39100366	2		YES	Middle	NO
13	5	26	1	1	-79.06000181	40.39100366	2		YES	Middle	NO
14	6	17	1	1	-74.51340121	40.42210068	2		YES	Middle	NO
15	6	28	1	1	-74.51340121	40.42210068	2		YES	Middle	NO
16	7	8	1	1	-75.34499959	40.27600244	2		YES	Middle	NO
17	7	15	1	1	-75.34499959	40.27600244	2		YES	Middle	NO
18	8	16	1	1	-75.51163726	40.45738415	2		YES	Middle	NO
19	9	11	1	1	-77.19694665	40.44872250	2		YES	Middle	NO
20	9	16	1	1	-77.18160645	40.44720810	2		YES	Middle	NO
21	9	21	1	1	-77.19694665	40.44872250	2		YES	Middle	NO

Search Search Now Options



# Hourly Markets with SimAuto Automation Server

# OPF Automation with SimAuto

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- Microsoft Access-based sample application
- Supports multiple study scenarios
- Inputs
  - Case file
  - Master settings auxiliary file
  - Hourly schedules
    - Loads by area
    - Fixed (non-AGCable) generation (e.g. wind, solar farms)
    - Auxiliary files with other time-dependent settings (e.g. generator bids)
  - Fixed bid (\$/MWh) for hydro units (optional)

# OPF Automation with SimAuto

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- Hourly Results: retrieved for generators that match user-specified filter
  - MW dispatch
  - LMP at terminal bus



# User Interface



Supports multiple studies

Input file details

Generation and Load inputs

Start and end times

Optionally save pwb file for each solution

The screenshot displays a web-based user interface for OPF automation. It features several input fields and controls:

- Simulation ID:** A text input field containing the number '2'.
- Description:** A text input field containing 'High wind, light load B7'.
- Directory (if other than current):** An empty text input field.
- Case Name:** A text input field containing 'B7OPF.pwb'.
- Pre-Simulation AUX:** A text input field containing 'aux0100B7Master.aux'.
- Gen Results Filter:** An empty text input field.
- Fixed Generation Scenario:** A dropdown menu set to '3'.
- Load Forecast Scenario:** A dropdown menu set to '2'.
- Set Hydro Cost:** A checked checkbox.
- Hydro Cost (\$/Mwh):** A text input field containing '\$50.00'.
- Start Date/Time:** A dropdown menu set to '11/4/2013 7:00 AM'.
- End Date/Time:** A dropdown menu set to '11/4/2013 7:00 AM'.
- Archive Solution Cases:** A checked checkbox.
- Message Log:** A text area containing the message: 'Simulation finished for 11/4/2013 7:00 AM to 11/4/2013 7:00 AM.'

On the right side, there is a 'View Hourly Inputs' section with three buttons: 'Aux Files', 'Fixed Gen', and 'Load'. At the bottom right, there are two buttons: 'Run OPF Simulation' and 'View Results'. The bottom status bar shows 'Record: 14', '2 of 3', 'No Filter', and a search field.

Status updates in the Message Log

# Hourly Inputs: Area Load

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- Table *tblHourlyInputsAreaLoadForecast*
- Click “Load” button in the “View Hourly Inputs” group to view
- *ScenLoadID* field corresponds to the selected Load Forecast Scenario on the main form
- *Forecast Date/Time* and *AreaNum* are additional key fields
- *Load* field contains corresponding area load in MW (application will scale load Mvar to keep power factor constant)

# Hourly Inputs: Fixed Generation

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- Table *tblHourlyInputsFixedGeneration*
- Click “Fixed Gen” button in the “View Hourly Inputs” group to view
- *ScenGenID* field corresponds to the selected Fixed Generation Scenario on the main form
- *Forecast Date/Time*, *BusNum*, and *GenID* are additional key fields
- *GenMW* field contains corresponding generator output in MW

# Hourly Inputs: Other Parameters

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- Additional parameters that change with time may be stored in auxiliary files
- These examples contain generator bids for AGCable generation
- Click “Aux Files” button in the “View Hourly Inputs” group to view
- *SimID* field corresponds to the current Simulation ID
- *AuxFileName* and *EffectiveDate* are additional key fields
- When the simulation period matches or crosses each *EffectiveDate* during the simulation, the corresponding file will be loaded

# Optional Constant Hydro Price

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- If “Set Hydro Price” is checked, then the bids for all hydro units will be set to “Hydro Cost (\$/Mwh)” for all simulation periods
- This cost could be set to a value that results in a desired hydro energy dispatch over the course of the simulation
- Bids for all generators (including hydro) could also be specified in case file, the “Pre-Simulation AUX File,” or in any of the time-dependent auxiliary files

# “Run OPF Simulation” Process: Initialization



- Initialize SimAuto connection
- Read hourly generation, load, and auxiliary file lists into arrays
- Open Case (SimAuto *OpenCase* function)
- Load Pre-Simulation AUX file (*ProcessAuxFile*)
- Initialize tables for storing results
- Load all other auxiliary files with effective dates prior to the Start Date/Time (*ProcessAuxFile*)

# “Run OPF Simulation” Process



- For all time points between Start Time and End Time
  - Load any auxiliary files that have not yet been loaded and with effective dates less than or equal to the Current Time (*ProcessAuxFile*)
  - Set fixed generator MW values (*ChangeParametersMultipleElement*)
  - If “Set Hydro Price” is checked, set bids for all hydro units to “Hydro Cost (\$/Mwh)” (*RunScriptCommand*)
  - Set area Loads (*ChangeParametersMultipleElement*)
  - Solve LP OPF (*RunScriptCommand*)
  - If “Archive Solution Cases” is checked, save a pwb file (*SaveCase*)
  - Retrieve generator dispatch and LMPs (*GetParametersMultipleElement*) that match optional filter
- Next Time Point

# View Results



- Click “View Results” to see table of hourly generator dispatch and generator bus LMPs

SimID	ForecastDateTime	BusNum	GenID	GenMW	BusMCMW	Click to Add
2	11/4/2013	1	1	268.37999821	-313.31845093	
2	11/4/2013	2	1	150	-345.62722778	
2	11/4/2013	4	1	0	-218.51441956	
2	11/4/2013	6	1	100	-216.52980042	
2	11/4/2013	7	1	90.83973765	50	
2	11/4/2013 1:00:00 AM	1	1	294.70999241	5.45372725	
2	11/4/2013 1:00:00 AM	2	1	150	1.15716934	
2	11/4/2013 1:00:00 AM	4	1	39.17000592	16.76480293	
2	11/4/2013 1:00:00 AM	6	1	0	17.00006866	
2	11/4/2013 1:00:00 AM	7	1	96.28503919	50	
2	11/4/2013 2:00:00 AM	1	1	321.02999687	5.80661583	
2	11/4/2013 2:00:00 AM	2	1	150	1.38924813	
2	11/4/2013 2:00:00 AM	4	1	11.50352582	16.76480293	
2	11/4/2013 2:00:00 AM	6	1	0	17.15202332	
2	11/4/2013 2:00:00 AM	7	1	113.0650878	50	
2	11/4/2013 3:00:00 AM	1	1	347.35000134	-309.94833374	
2	11/4/2013 3:00:00 AM	2	1	150	-346.7963562	