OPF Automation Examples

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OPF Automation Examples

- Standardize settings with Auxiliary Files
- Hourly nodal market simulation with SimAuto
Standardizing with Auxiliary Files
What Can You DO with Auxiliary Files?

- **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

• 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

- Open *Eastern.pwb*
- 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, and Unknown units
  - Designate Natural Gas units as OPF Fast Start
- Master file calls a series of files with names *aux20\?0*.aux*
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

• 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

• 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

• 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

- 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\EasternLineRouting.axd`
  - updates routing of 345 kV lines between Homer City and Stolle Road and Homer City and Watercure in **EasternBus.pwd**
One-line Diagrams

Before Loading axd File

After Loading axd File

Updated 345 kV Lines
Display Explorer
Hourly Markets with SimAuto Automation Server
OPF Automation with SimAuto

• 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

• 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
- Status updates in the Message Log
Hourly Inputs: Area Load

• 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

- 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

- 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
- \textit{SimID} field corresponds to the current Simulation ID
- \textit{AuxFileName} and \textit{EffectiveDate} are additional key fields
- When the simulation period matches or crosses each \textit{EffectiveDate} during the simulation, the corresponding file will be loaded
Optional Constant Hydro Price

- 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.

```plaintext
<table>
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<th>SimID</th>
<th>ForecastDateTime</th>
<th>BusNum</th>
<th>GenID</th>
<th>GenMW</th>
<th>BusMCMW</th>
<th>Click to Add</th>
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