Reliability Test System of the Grid Modernization Laboratory Consortium (RTS-GMLC)

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https://github.com/GridMod/RTS-GMLC
1979 Reliability Test System

1996 Reliability Test System

  - Data available from UW Test Case Archive
    - [http://www2.ee.washington.edu/research/pstca/rts/pg_tcarts.htm](http://www2.ee.washington.edu/research/pstca/rts/pg_tcarts.htm)
- Shortcomings:
  - Data errors
  - Intra-hourly information
  - Congestion
  - Outdated generation fleet (no Gas generation)
The NICTA Energy Systems Test Case Archive (NESTA)

- https://github.com/NICTA/nesta
- Fixes some data errors
- Introduces some congestion via the changes documented in Hedman et.al (http://smartgridcenter.tamu.edu/ratc/web/wp-content/uploads/2014/10/J7.pdf)
  - Remove the following transmission lines: 111-113, 211-213, and 311-313
  - Reduce the capacity of lines 114-116, 214-216, and 314-316 to 350 MW, each
  - The bus load for nodes 13, 14, 15, 19, and 20 should be changed to the following in each region:

<table>
<thead>
<tr>
<th>Bus</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>745 MW</td>
</tr>
<tr>
<td>14</td>
<td>80 MW</td>
</tr>
<tr>
<td>15</td>
<td>132 MW</td>
</tr>
<tr>
<td>19</td>
<td>75 MW</td>
</tr>
<tr>
<td>20</td>
<td>53 MW</td>
</tr>
</tbody>
</table>

- Add the following generating units in each region:

<table>
<thead>
<tr>
<th>Bus</th>
<th>Gen Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 MW</td>
</tr>
<tr>
<td>7</td>
<td>100 MW</td>
</tr>
<tr>
<td>15</td>
<td>100 MW</td>
</tr>
<tr>
<td>15</td>
<td>155 MW</td>
</tr>
<tr>
<td>23</td>
<td>155 MW</td>
</tr>
</tbody>
</table>
 RTS-96 has published line lengths

- Use GraphViz and networkx (python package) to determine relative node locations while attempting to respect line lengths.

**Relative RTS-GMLC node locations based on GV layout**

RTS-96 Published line length vs. GV output line length
Ensure geographic and temporal coincidence of weather driven data

- Use RTS-GMLC relative node locations from GraphViz
- Arbitrary choice: geographic region in SW United States that roughly covers L.A. to L.V.
  - Good solar resource
  - Good wind resource
  - Available demand and hydro data profiles

Not intended to represent existing infrastructure
Regional load profiles (hourly and 5-minute)
- Load profile data from WECC TEPPC 2024 case used for the “Low Carbon Grid Study”
- Profiles normalized to peak regional RTS demand values

LA Division of Water and Power – Region 3
Nevada Energy – Region 2
Arizona Public Service Company – Region 1

Not intended to represent existing infrastructure
Hourly hydro energy profiles
- Hydro profile data from WECC TEPPC 2024 case used for the “Low Carbon Grid Study”
- Profiles normalized to RTS hydro generator capacities

- Devil Canyon Dam
- Davis Dam
- Parker Dam

Ensure geographic and temporal coincidence of weather driven data

*Not intended to represent existing infrastructure*
Updated conventional generation fleet

► Added two new generator types to the RTS dataset:
  ■ 25 MW NG-CT
  ■ 125 MW NG-CC

► New generator parameters are based on:
  ■ Average values from WECC TEPPC 2024 case
    • Heat rates, FOR, POR, MTTR, MUT, MDT, Ramp rates, MSL
  ■ Wartsilla, Gas Power Journal, Siemens, GE:
    • Startup parameters

► Replaced some existing oil and coal generation with NG-CC and NG-CT generators
Updated heat rates from U.S. fleet operating information

- U.S. EPA Continuous Emissions Monitoring Systems (CEMS) data

<table>
<thead>
<tr>
<th>Generator Type</th>
<th>Fuel Type</th>
<th>Heat Rate Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler</td>
<td>Coal</td>
<td>718</td>
</tr>
<tr>
<td></td>
<td>Diesel Oil</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Natural Gas</td>
<td>224</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>8</td>
</tr>
<tr>
<td>Combined Cycle</td>
<td>Coal</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Diesel Oil</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Natural Gas</td>
<td>710</td>
</tr>
<tr>
<td>Combustion Turbine</td>
<td>Diesel Oil</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td>Natural Gas</td>
<td>1006</td>
</tr>
<tr>
<td>Stoker</td>
<td>Wood</td>
<td>8</td>
</tr>
</tbody>
</table>
Updated Heat Rates

► New heat rates improve optimization performance

■ Convex
  • Eliminates binary variables and constraints required to represent non-convex cost curves

■ Diverse
  • Reduces degeneracy and improves solver efficiency
Wind and Solar data

► Western Wind and Solar Integration Study phase 2
  ■ Hourly Day Ahead forecasts representing “best available” 24-hour ahead forecast
  ■ 5-minute Real Time “actual” profiles
  ■ 80 m hub height adjusted wind turbine outputs
  ■ WRF re-analysis wind and DA solar profiles
  ■ Satellite RT solar profiles
Wind and Solar data

► Random sampling of WWSIS-2 Wind, Utility-PV, and Rooftop-PV sites to achieve desired capacity

► Connection to closest RTS node location:
  ■ Rooftop-PV only connected to load buses

Not intended to represent existing infrastructure
Production cost models approach scheduling problems with a variety of methods. By defining the basic parameters of the RTS production cost simulations, we can provide a concrete benchmarking case for new methods and approaches.

<table>
<thead>
<tr>
<th>Simulation Parameters</th>
<th>DAY_AHEAD</th>
<th>REAL_TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periods/Step</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>Period Resolution</td>
<td>3600</td>
<td>300</td>
</tr>
<tr>
<td>Date From</td>
<td>1/1/24 0:00</td>
<td>1/1/24 0:00</td>
</tr>
<tr>
<td>Date To</td>
<td>12/31/24 0:00</td>
<td>12/31/24 0:00</td>
</tr>
<tr>
<td>Look Ahead Periods/Step</td>
<td>24</td>
<td>2</td>
</tr>
<tr>
<td>Look Ahead Resolution</td>
<td>3600</td>
<td>300</td>
</tr>
<tr>
<td>Reserve Products</td>
<td>(Flex_Up, Flex_Down, Spin_Up, (Spin_Up, Reg_Up, Reg_Up, Reg_Down)) Reg_Down</td>
<td></td>
</tr>
</tbody>
</table>
Day-Ahead Results

https://rawgit.com/GridMod/RTS-GMLC/master/RTS_Data/FormattedData/PLEXOS/PLEXOS_Solution/RTS_final_DA.html
Real-Time Results

https://rawgit.com/GridMod/RTS-GMLC/master/RTS_Data/FormattedData/PLEXOS/PLEXOS_Solution/RTS_final_RT.html
Clayton.barrows@nrel.gov  -  https://Github.com/GridMod/RTS-GMLC