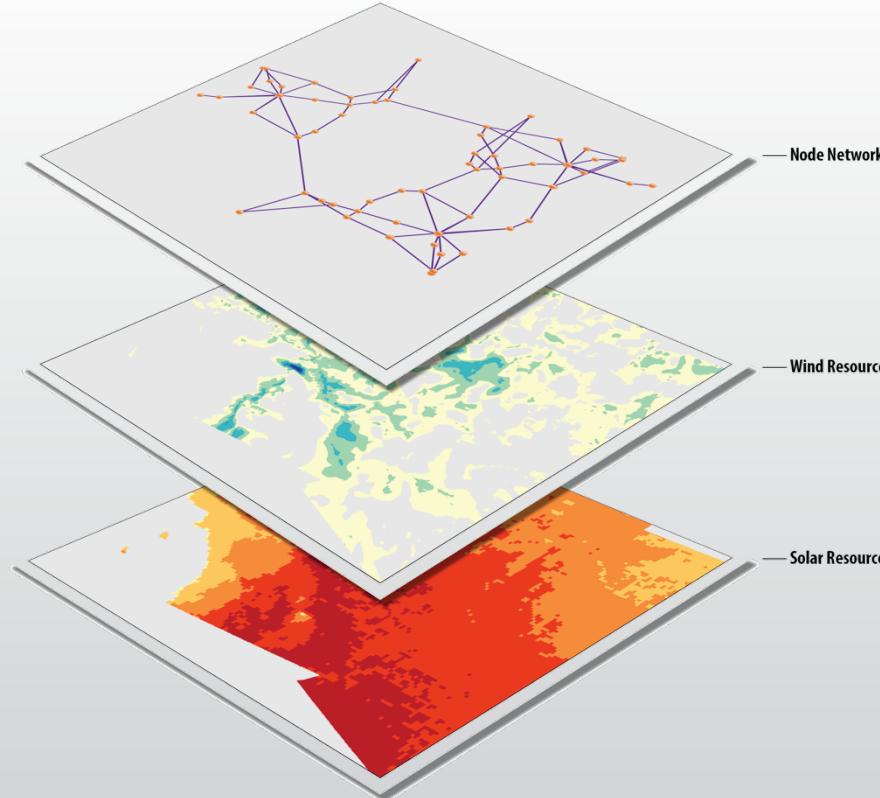


Reliability Test System of the Grid Modernization Laboratory Consortium (RTS-GMLC)



Clayton Barrows

National Renewable Energy Laboratory

<https://github.com/GridMod/RTS-GMLC>

1979 Reliability Test System

- ▶ RTS-79 "IEEE Reliability Test System", *IEEE PAS*, vol. 98, no. 6, pp. 2047-2054, Nov/Dec. 1979.
 - <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4113721>

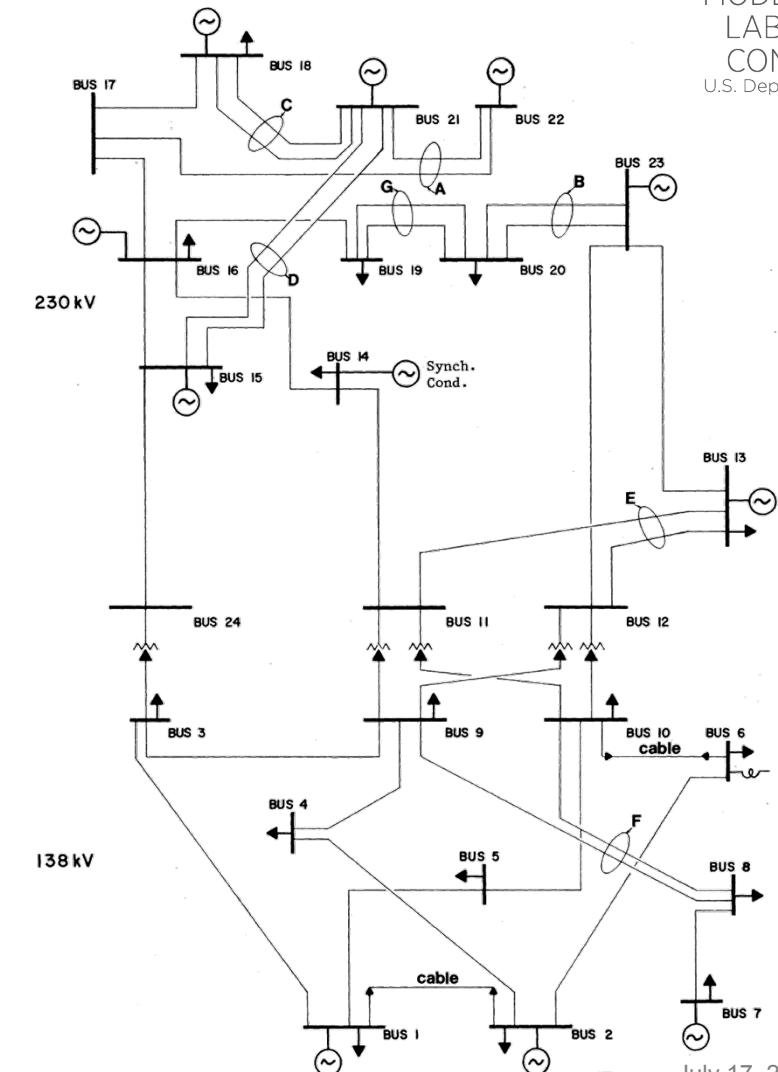


Figure 1 - IEEE Reliability Test System

1996 Reliability Test System

- ▶ RTS-96 “The IEEE Reliability Test System-1996. A report prepared by the Reliability Test System Task Force of the Application of Probability Methods Subcommittee”, *IEEE Transactions on Power Systems*, vol. 14, no. 3, pp. 1010-1020, Aug. 2002.
 - <http://ieeexplore.ieee.org/document/780914/?reload=true&arnumber=780914&tag=1>
 - Data available from UW Test Case Archive
 - http://www2.ee.washington.edu/research/pstca/rts/pg_tcarts.htm
 - Shortcomings:
 - Data errors
 - Intra-hourly information
 - Congestion
 - Outdated generation fleet (no Gas generation)

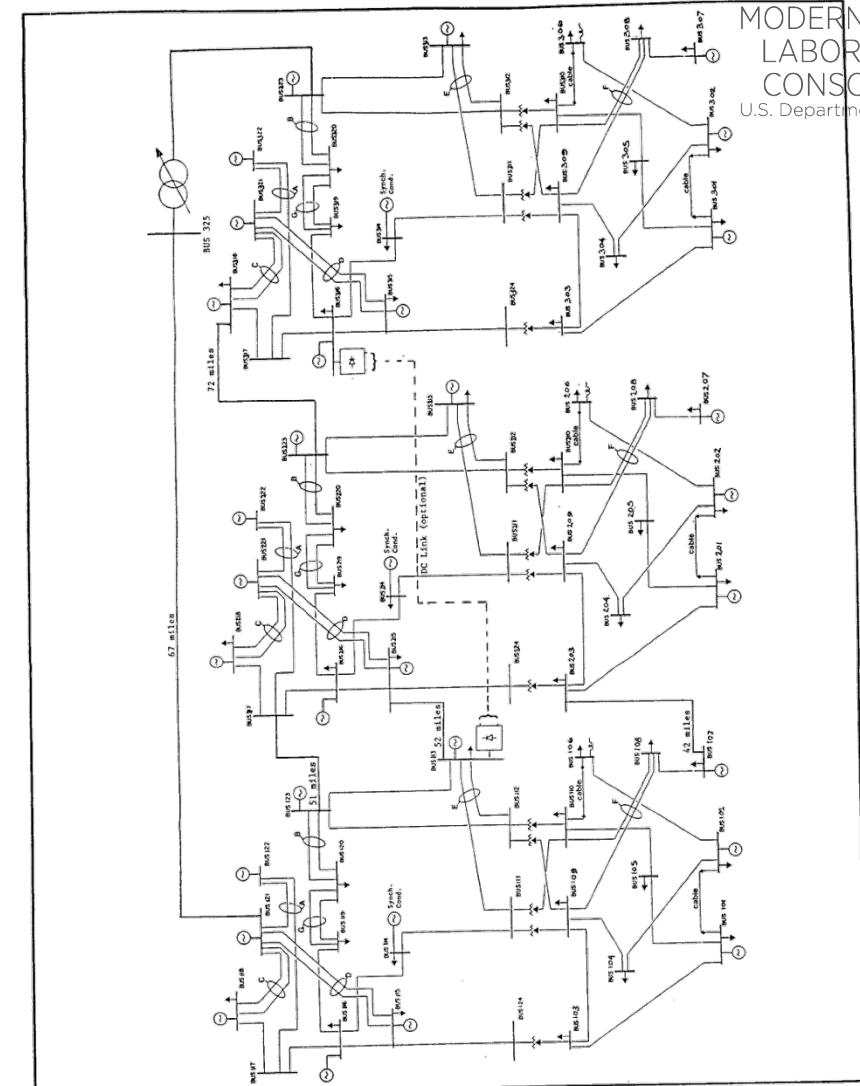


Figure 4 - IEEE Three Area RTS-96

July 17, 2017

► 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:
 - Add the following generating units in each region:

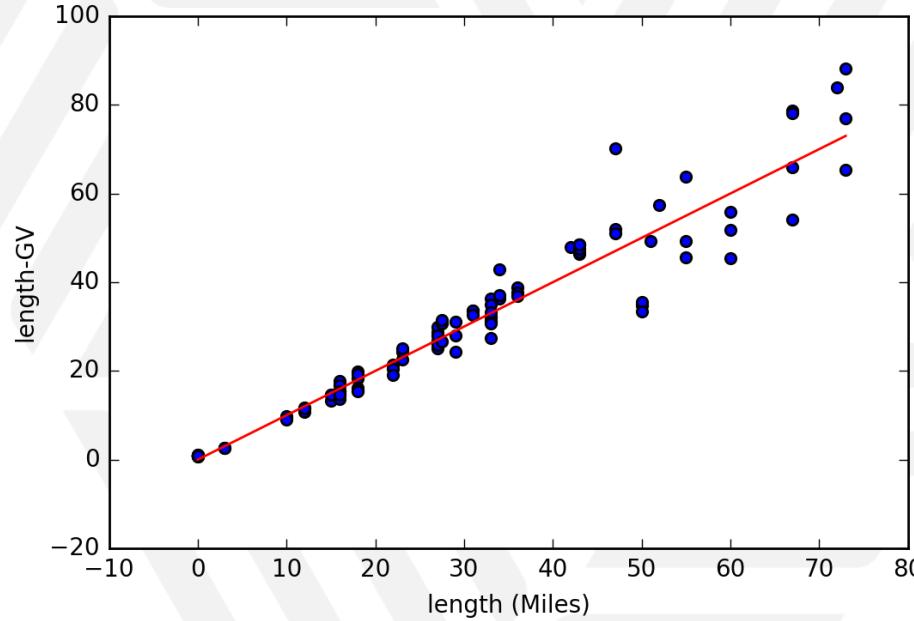
Bus	Demand
13	745 MW
14	80 MW
15	132 MW
19	75 MW
20	53 MW

Bus	Gen Capacity
1	100 MW
7	100 MW
15	100 MW
15	155 MW
23	155 MW

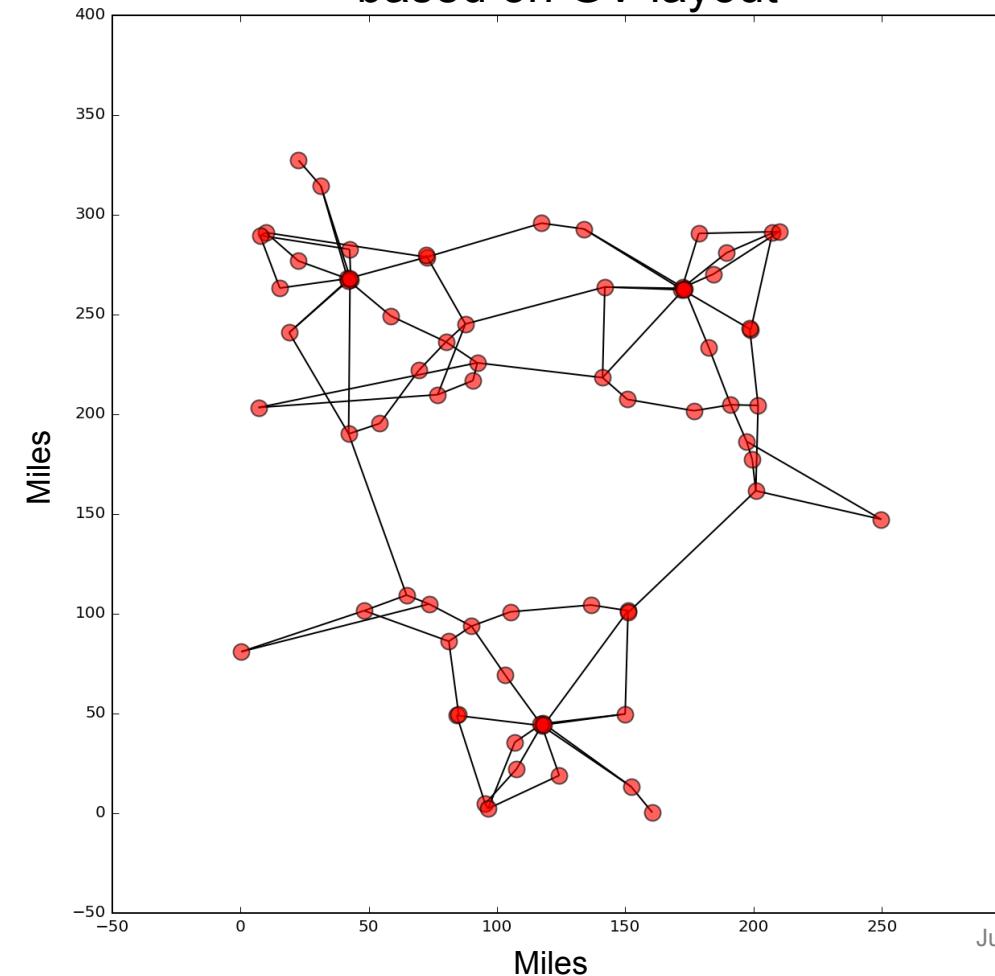
Line distances used to create relative node locations

- ▶ RTS-96 has published line lengths
 - Use GraphViz and networkx (python package) to determine relative node locations while attempting to respect line lengths.

RTS-96 Published line length vs. GV output line length



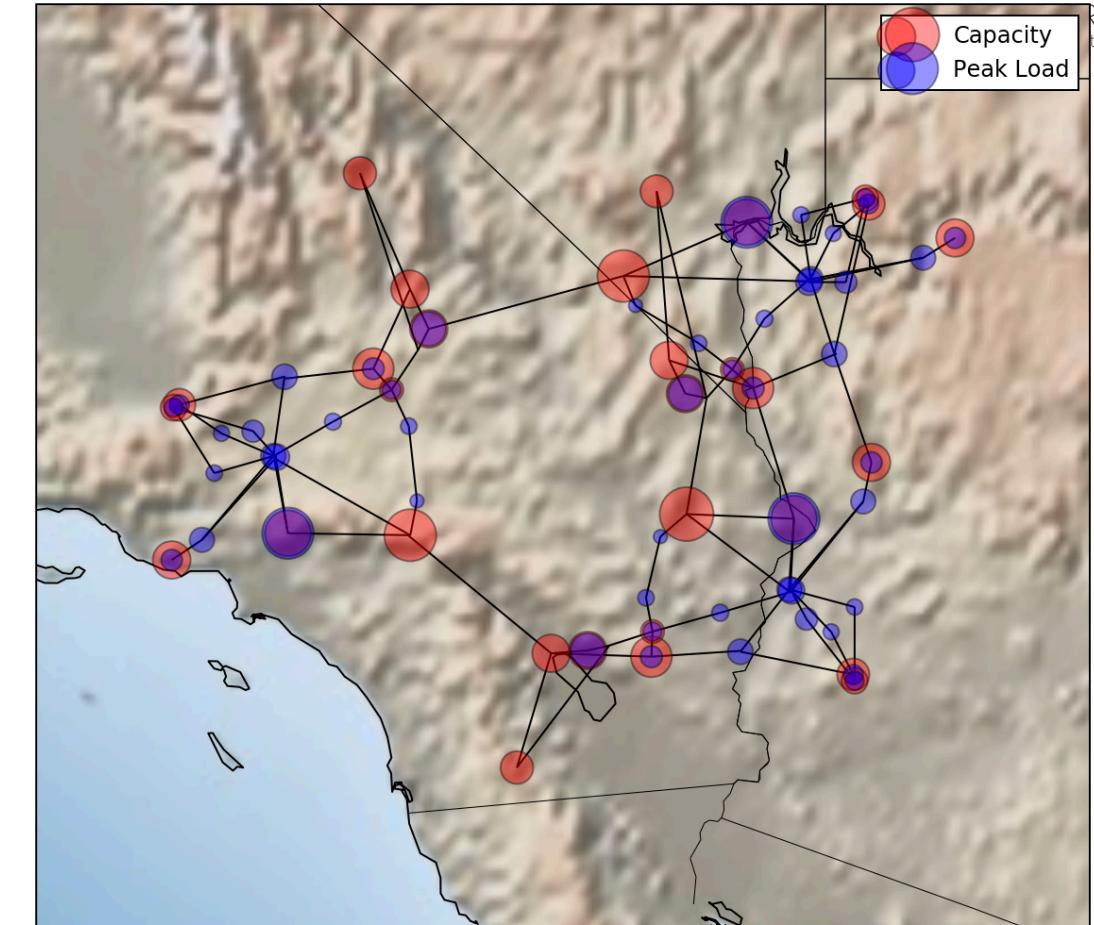
Relative RTS-GMLC node locations based on GV layout



Ensure geographic and temporal coincidence of weather driven data



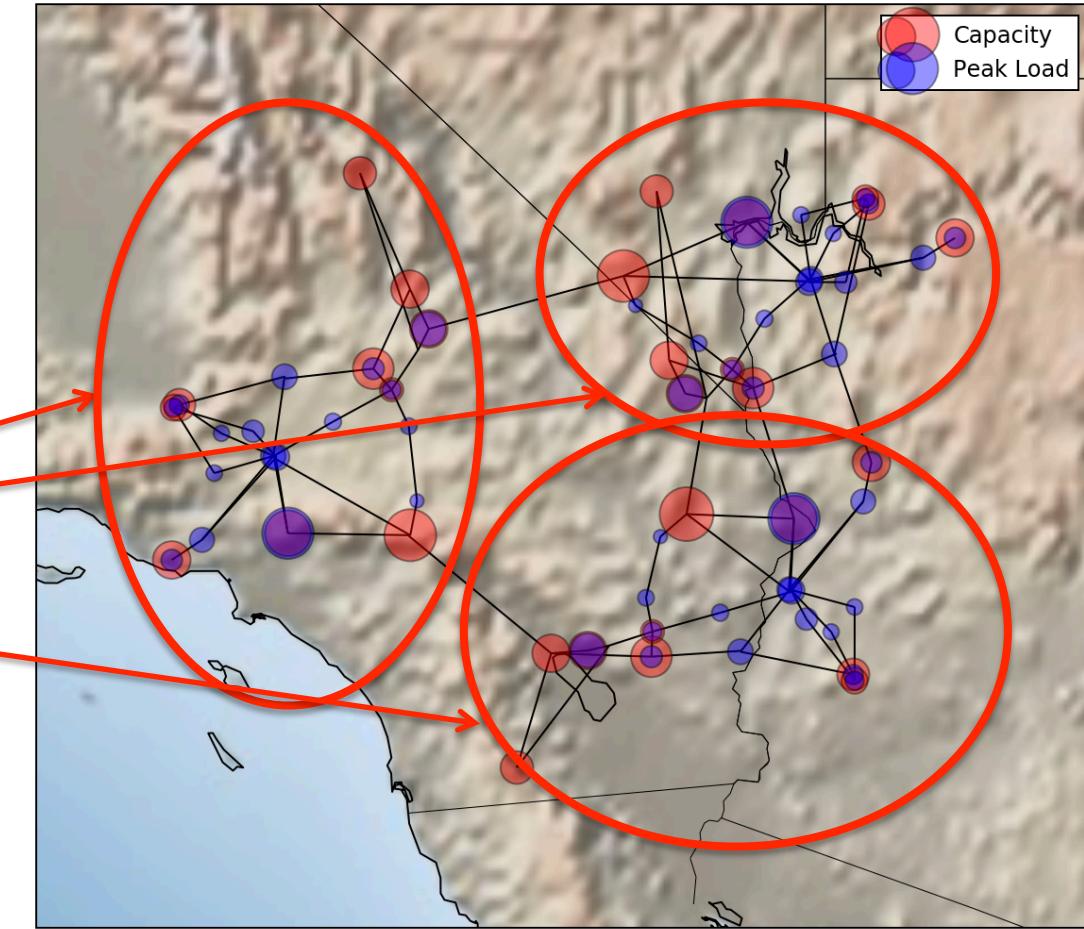
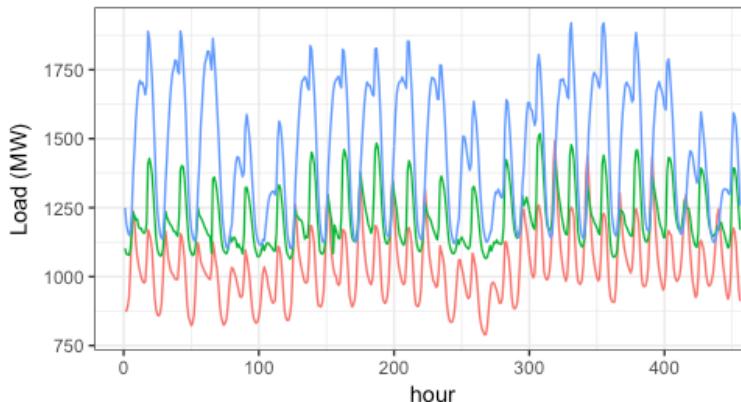
- ▶ Use RTS-GMLC relative node locations from GraphViz
- ▶ Arbitrary choice: geographic region in SW United States that roughly covers L.A. to L.V.
 - Good solar resource
 - Good wind resource
 - Available demand and hydro data profiles



Not intended to represent existing infrastructure

Ensure geographic and temporal coincidence of weather driven data

- ▶ Regional load profiles (hourly and 5-minute)
 - Load profile data from WECC TEPPC 2024 case used for the “Low Carbon Grid Study”
 - <http://www.nrel.gov/docs/fy16osti/64884.pdf>
 - 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

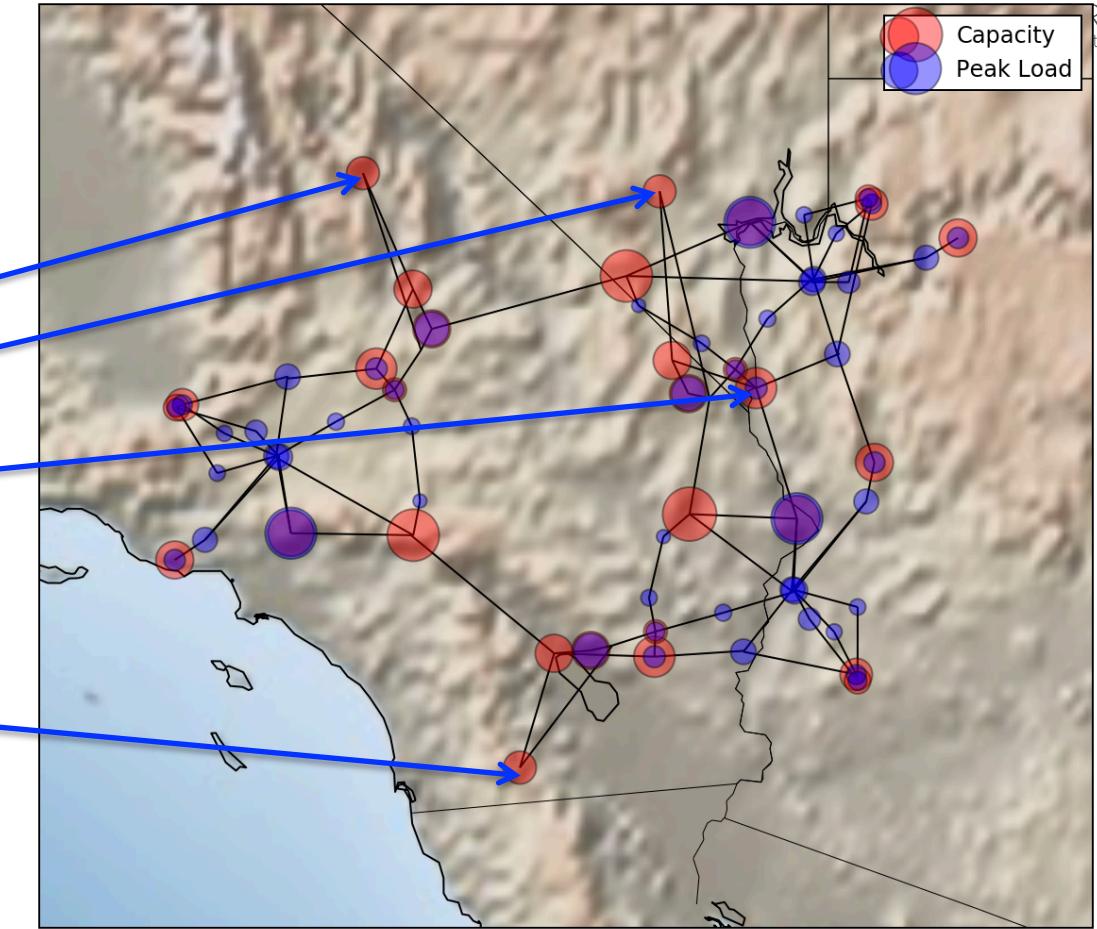


Not intended to represent existing infrastructure

Ensure geographic and temporal coincidence of weather driven data



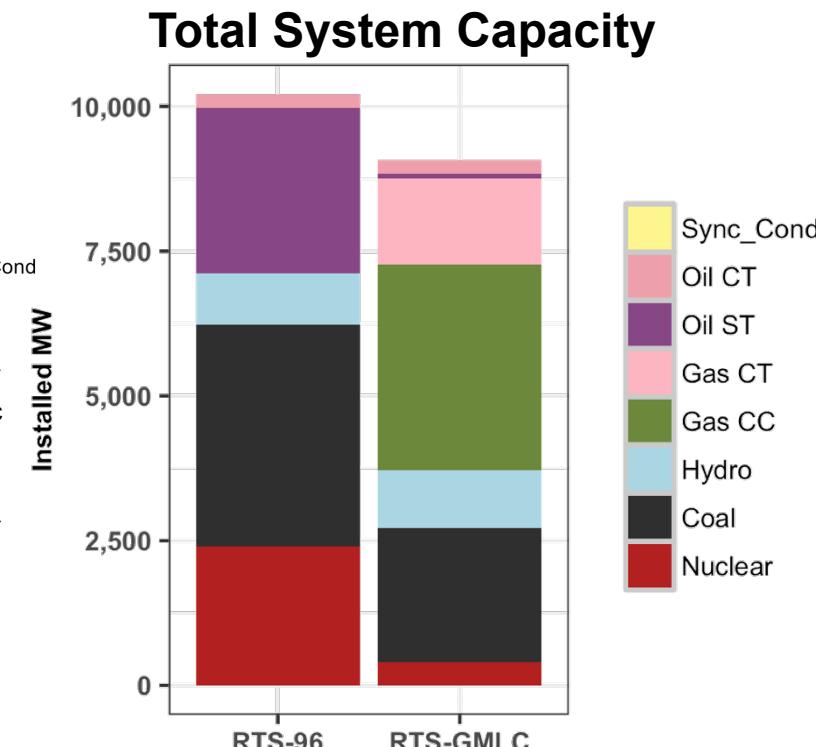
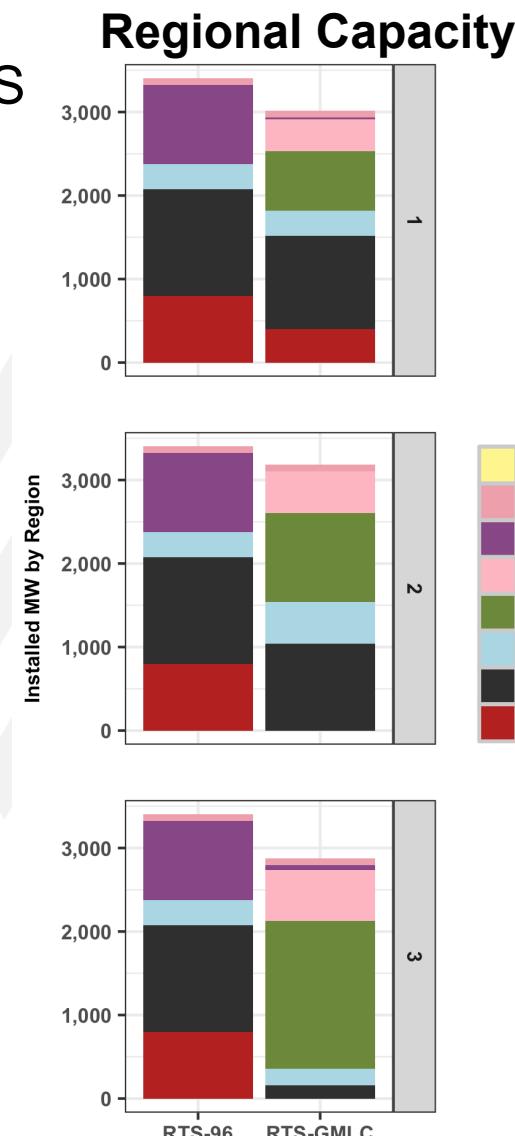
- ▶ Hourly hydro energy profiles
 - Hydro profile data from WECC TEPPC 2024 case used for the “Low Carbon Grid Study”
 - <http://www.nrel.gov/docs/fy16osti/64884.pdf>
 - Profiles normalized to RTS hydro generator capacities
- ▶ Devil Canyon Dam
- ▶ Davis Dam
- ▶ Parker Dam



Not intended to represent existing infrastructure

Updated conventional generation fleet

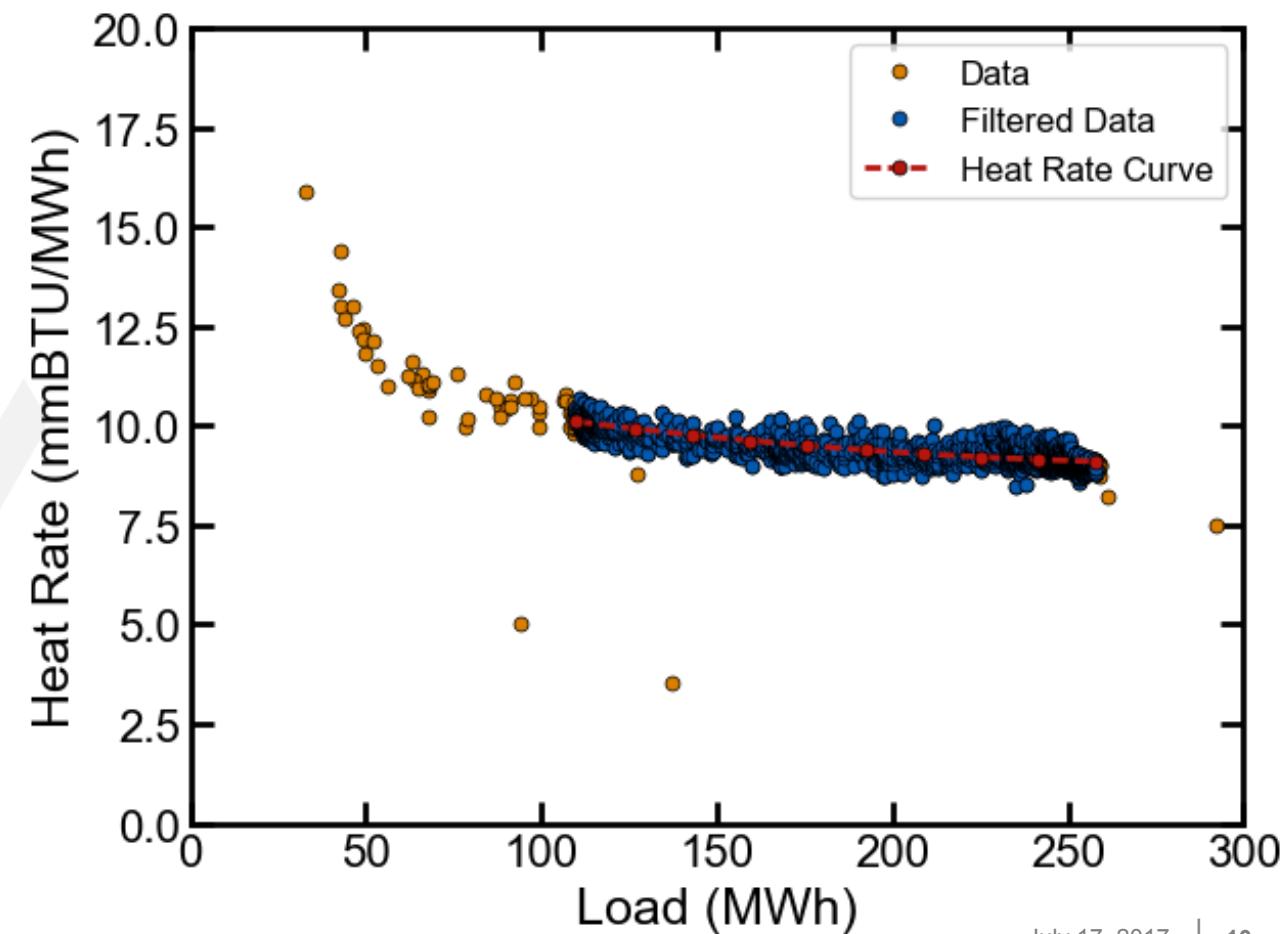
- ▶ Added two new generator types to the RTS dataset:
 - 25 MW NG-CT
 - 125 MW NG-CC
- ▶ New generator parameters are based on:
 - Average values from WECC TEPPC 2024 case
 - Heat rates, FOR, POR, MTTR, MUT, MDT, Ramp rates, MSL
 - Wartsilla, Gas Power Journal, Siemens, GE:
 - Startup parameters
- ▶ 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

Generator Type	Fuel Type	Heat Rate Samples
Boiler	Coal	718
	Diesel Oil	35
	Natural Gas	224
	Wood	8
Combined Cycle	Coal	2
	Diesel Oil	6
	Natural Gas	710
Combustion Turbine	Diesel Oil	123
	Natural Gas	1006
Stoker	Wood	8



Updated Heat Rates

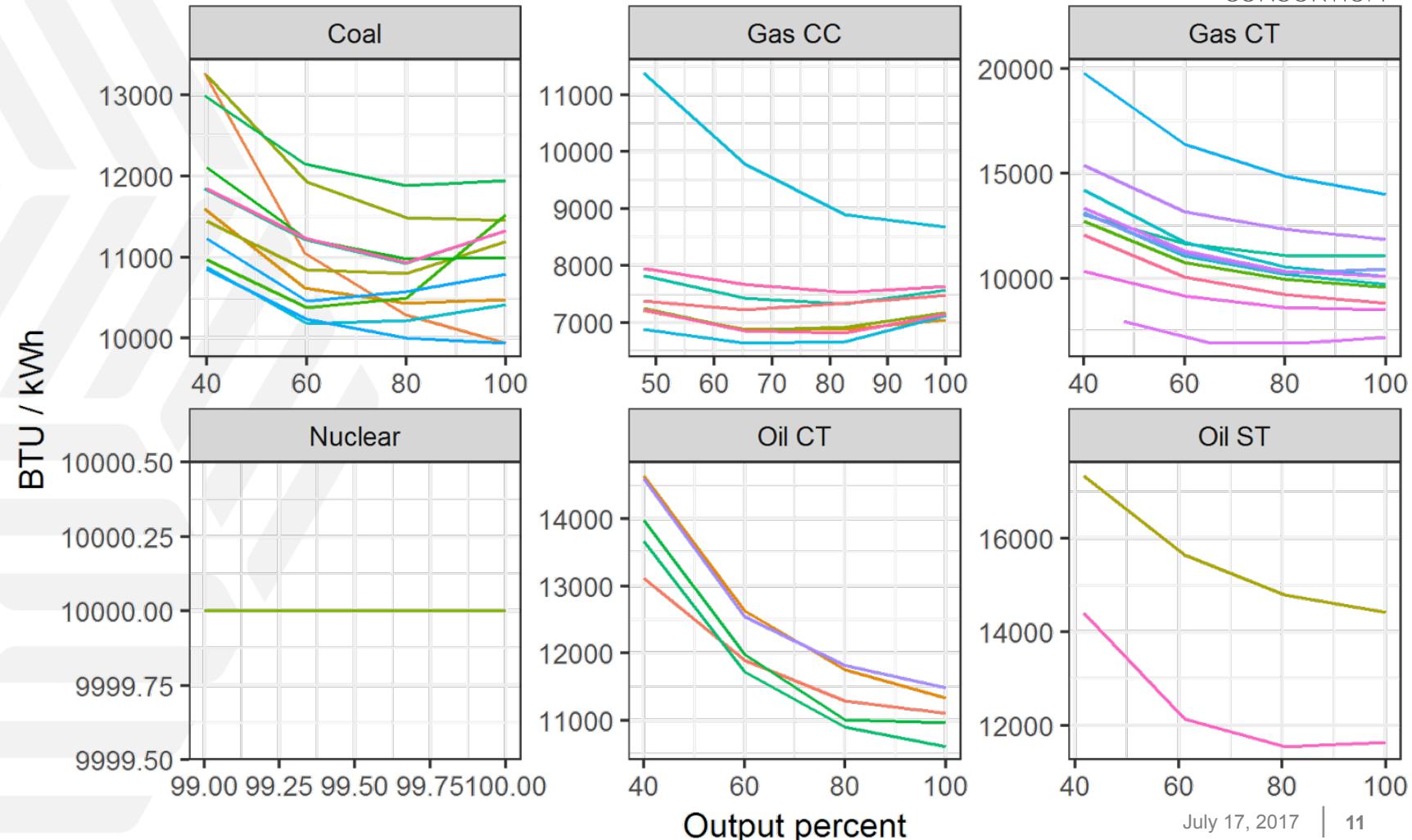
- ▶ New heat rates improve optimization performance

- Convex

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

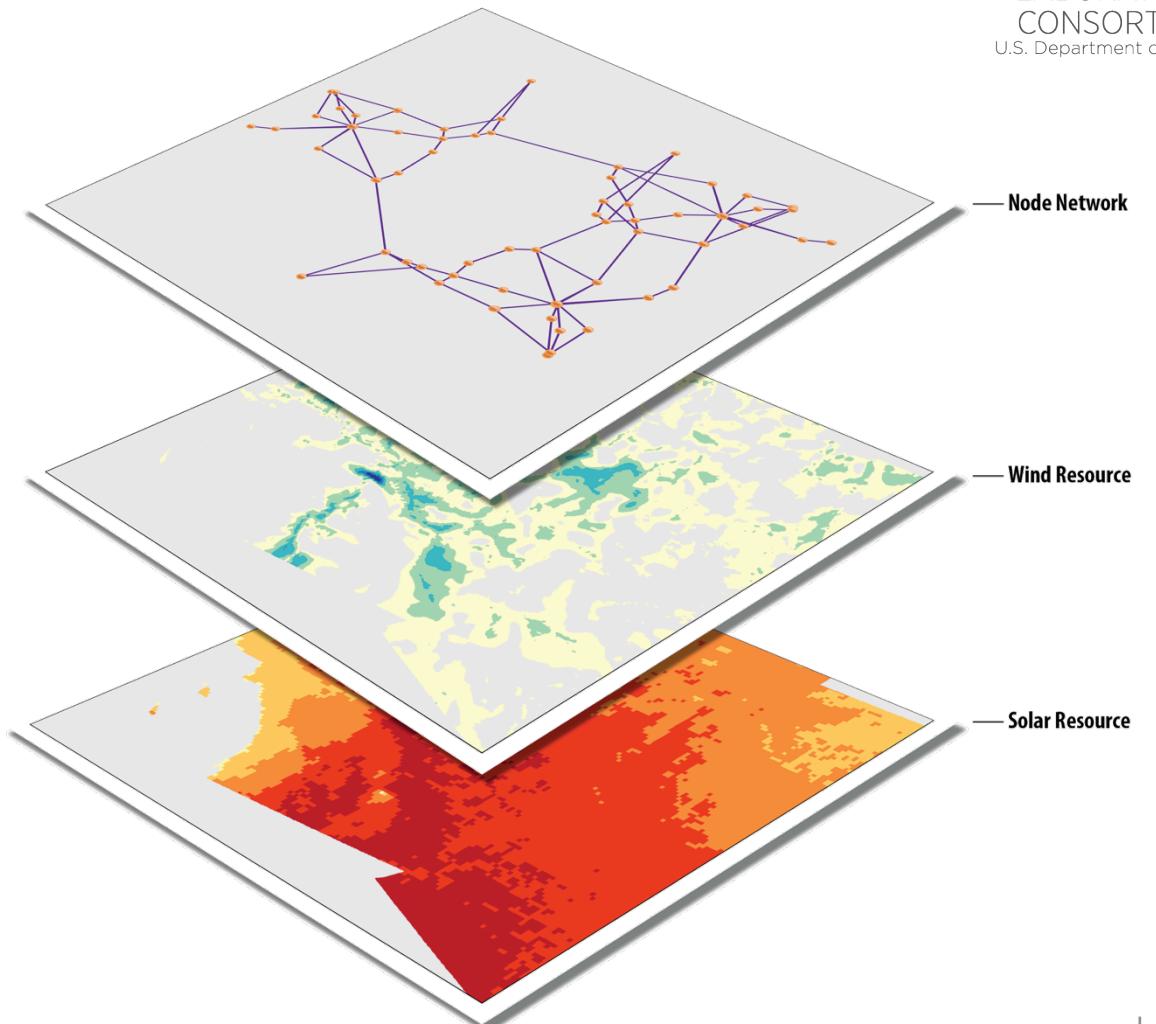
- Diverse

- Reduces degeneracy and improves solver efficiency



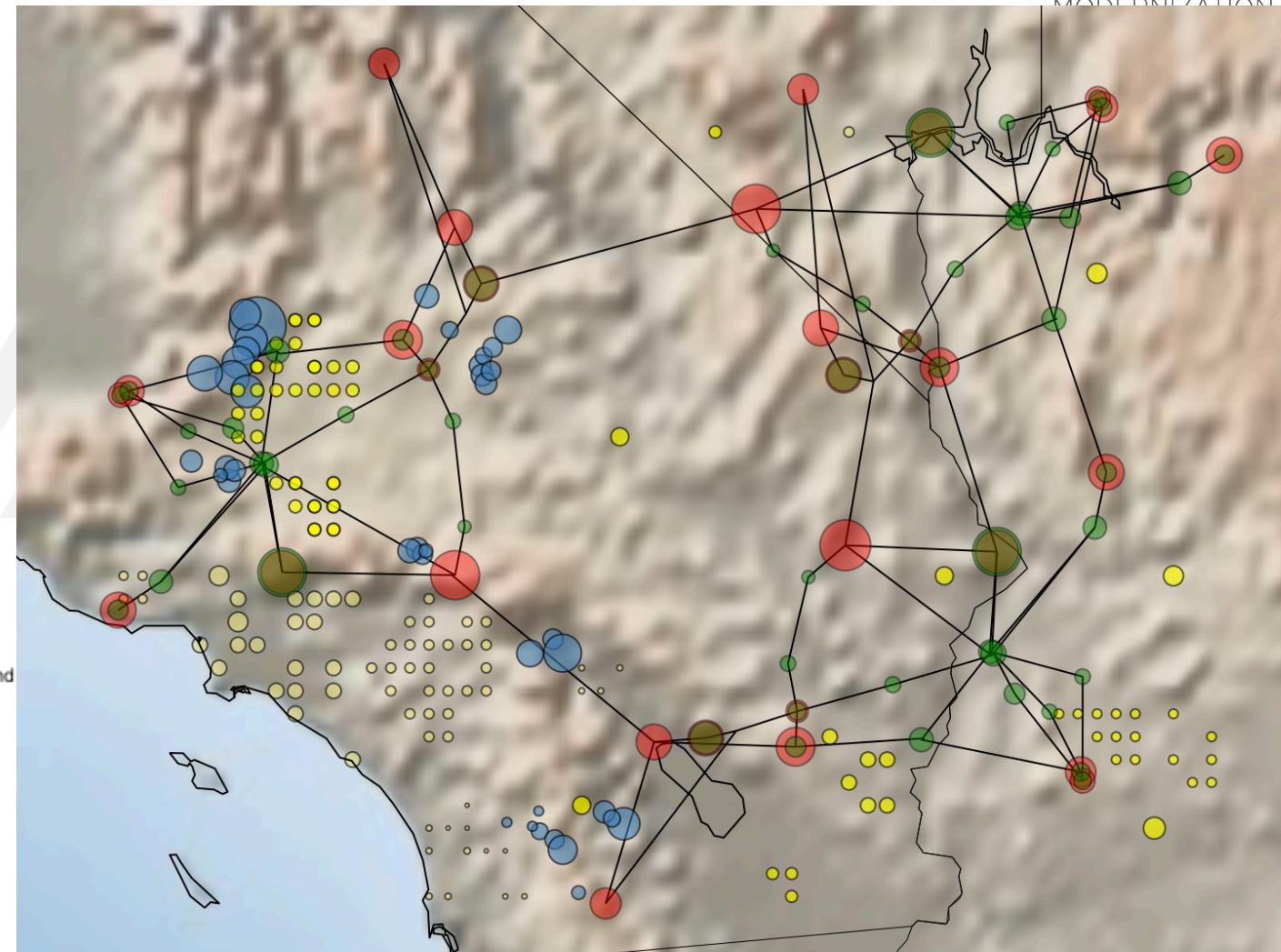
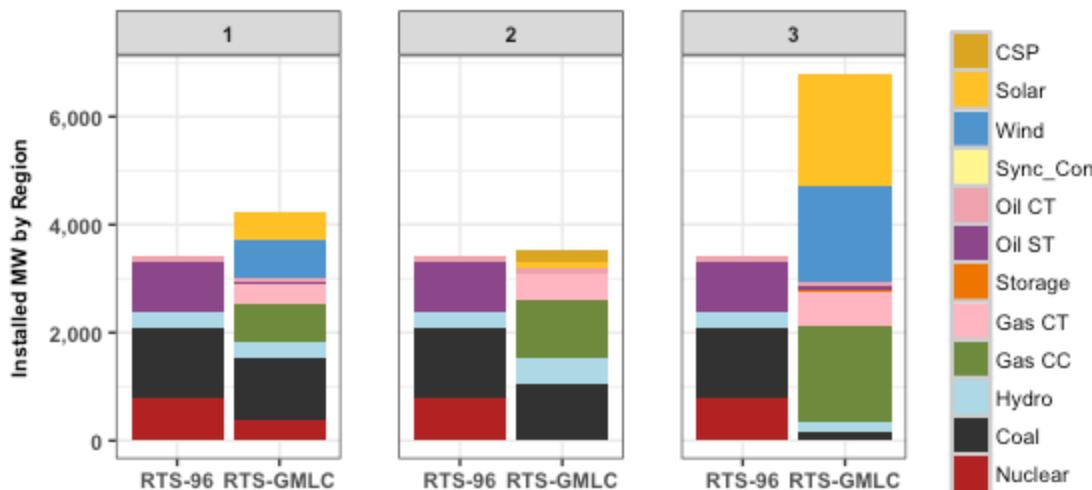
Wind and Solar data

- ▶ Western Wind and Solar Integration Study phase 2
 - <http://www.nrel.gov/docs/fy13osti/55588.pdf>
 - 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

Github.com/GridMod/RTS-GMLC

GridMod / RTS-GMLC

Code Issues 8 Pull requests 0 Projects 0 Wiki Settings Insights

Unwatch 14 Star 10 Fork 2

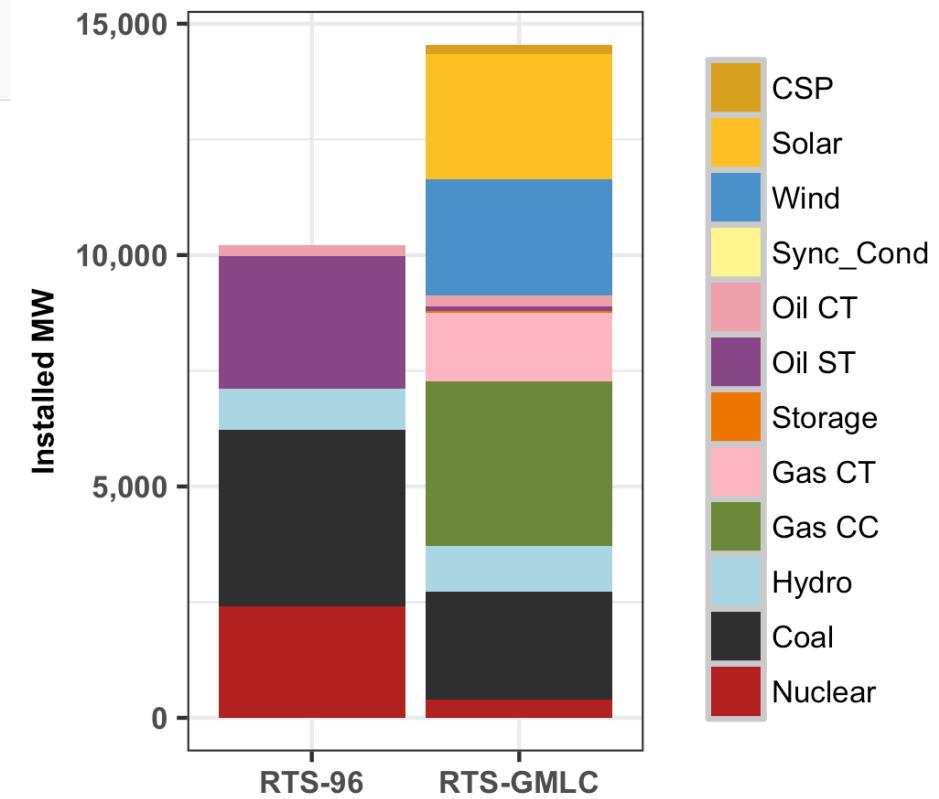
Reliability Test System - Grid Modernization Lab Consortium

267 commits 2 branches 1 release 5 contributors

Branch: master New pull request Create new file Upload files Find file Clone or download

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- RTS_Data add MAGMA outputs for 6/30 RTS solutions 4 days ago
- .gitignore fixing gitignore 3 months ago
- .gitmodules rearranging the solution files and html submodule 2 months ago
- README.md Update README.md 2 days ago
- RTS-GMLC.pdf adding overview deck 5 months ago
- RTS-GMLC_updates.md Update RTS-GMLC_updates.md 5 months ago
- node_re_basemap.png adding a node location picturer 5 months ago



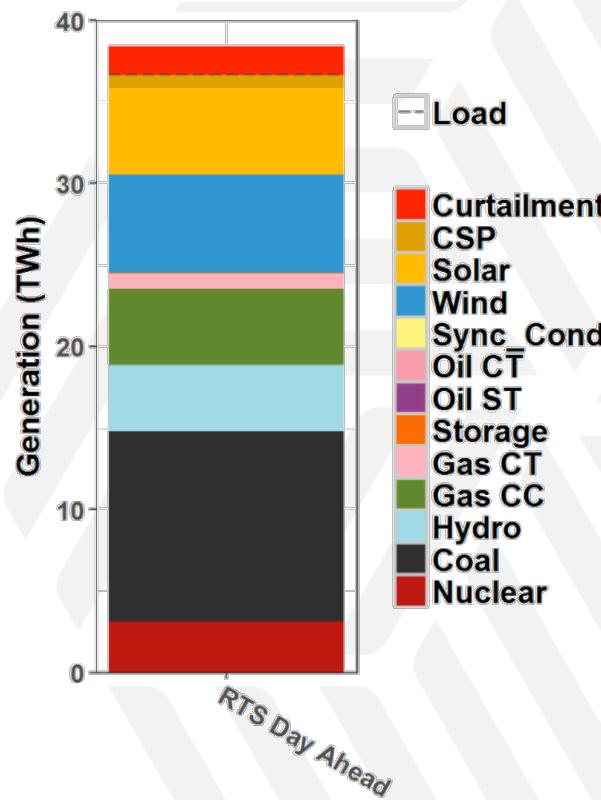
Production Cost Model Problem Definition

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.

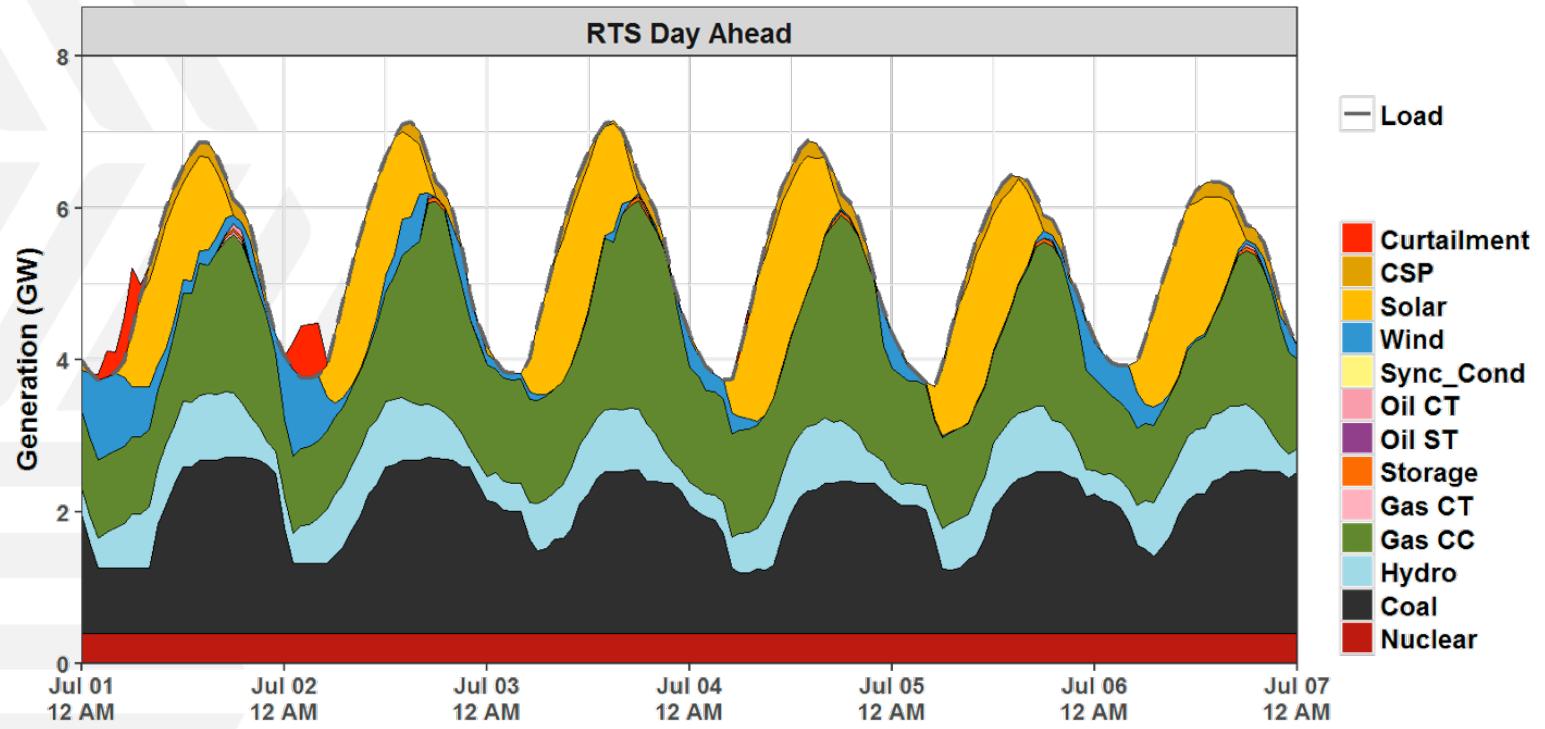
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Periods/Step	24	1
Period Resolution	3600	300
Date From	1/1/24 0:00	1/1/24 0:00
Date To	12/31/24 0:00	12/31/24 0:00
Look Ahead Periods/Step	24	2
Look Ahead Resolution	3600	300
Reserve Products	(Flex_Up, Flex_Down, Spin_Up, (Spin_Up, Reg_Up, Reg_Up, Reg_Down) Reg_Down)	

Day-Ahead Results

Total Generation



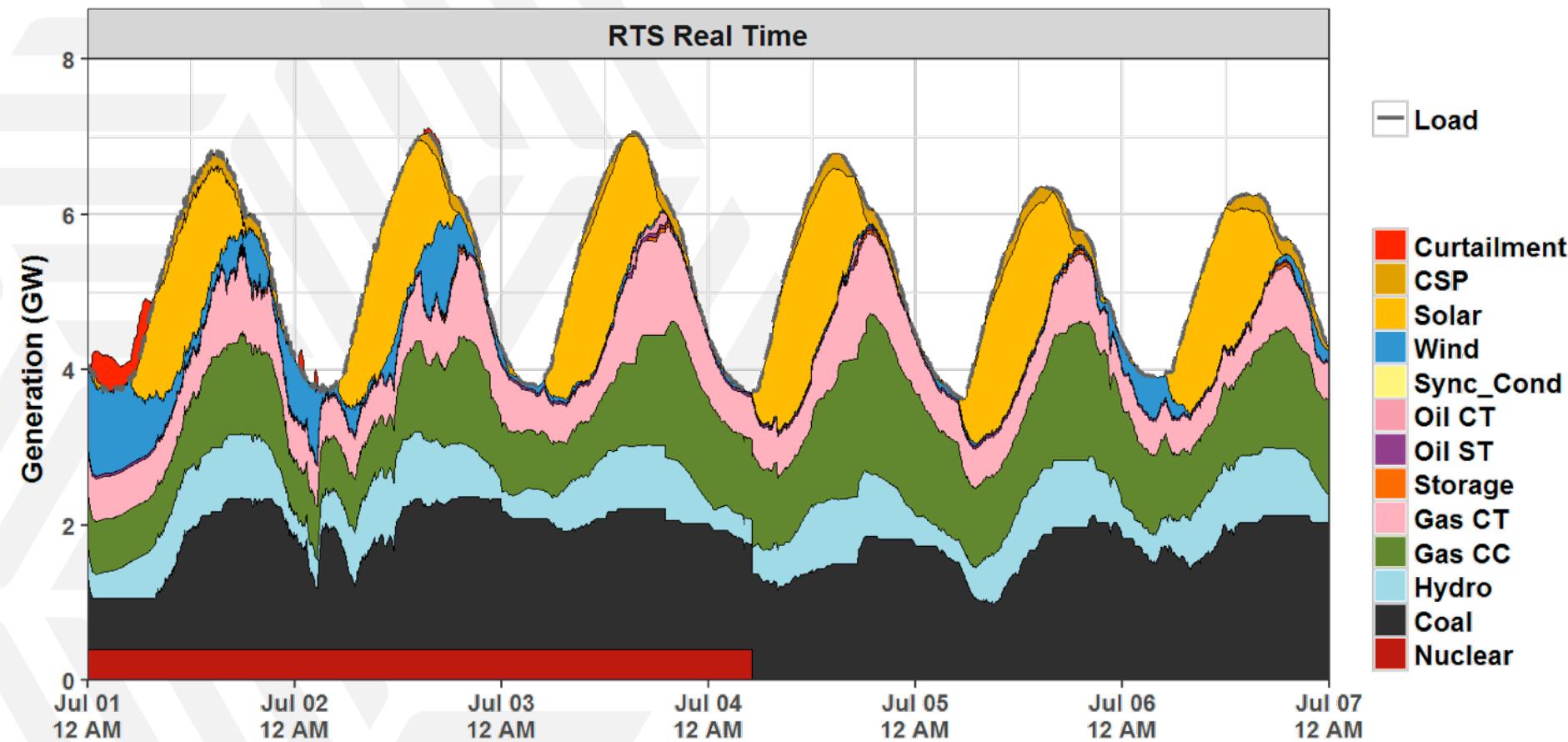
Summer Week



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

Real-Time Results

Summer Week



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>

GridMod / RTS-GMLC

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README.md	Update README.md	2 days ago
RTS-GMLC.pdf	adding overview deck	5 months ago
RTS-GMLC_updates.md	Update RTS-GMLC_updates.md	5 months ago
node_re_basemap.png	adding a node location picturer	5 months ago