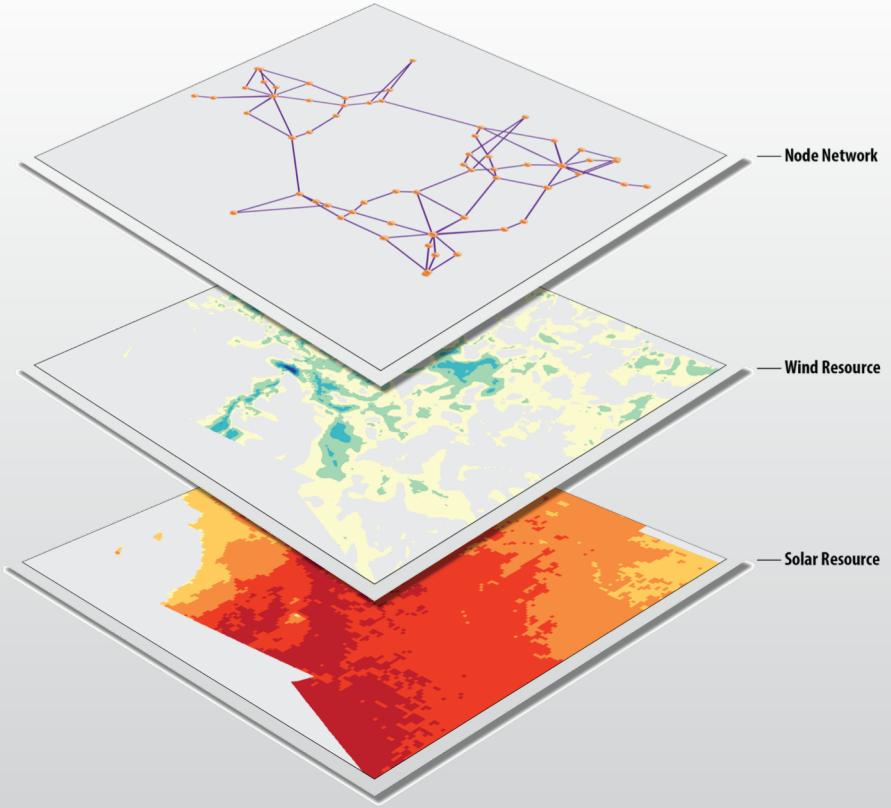
Reliability Test System of the Grid Modernization Laboratory Consortium (RTS-GMLC)



GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

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

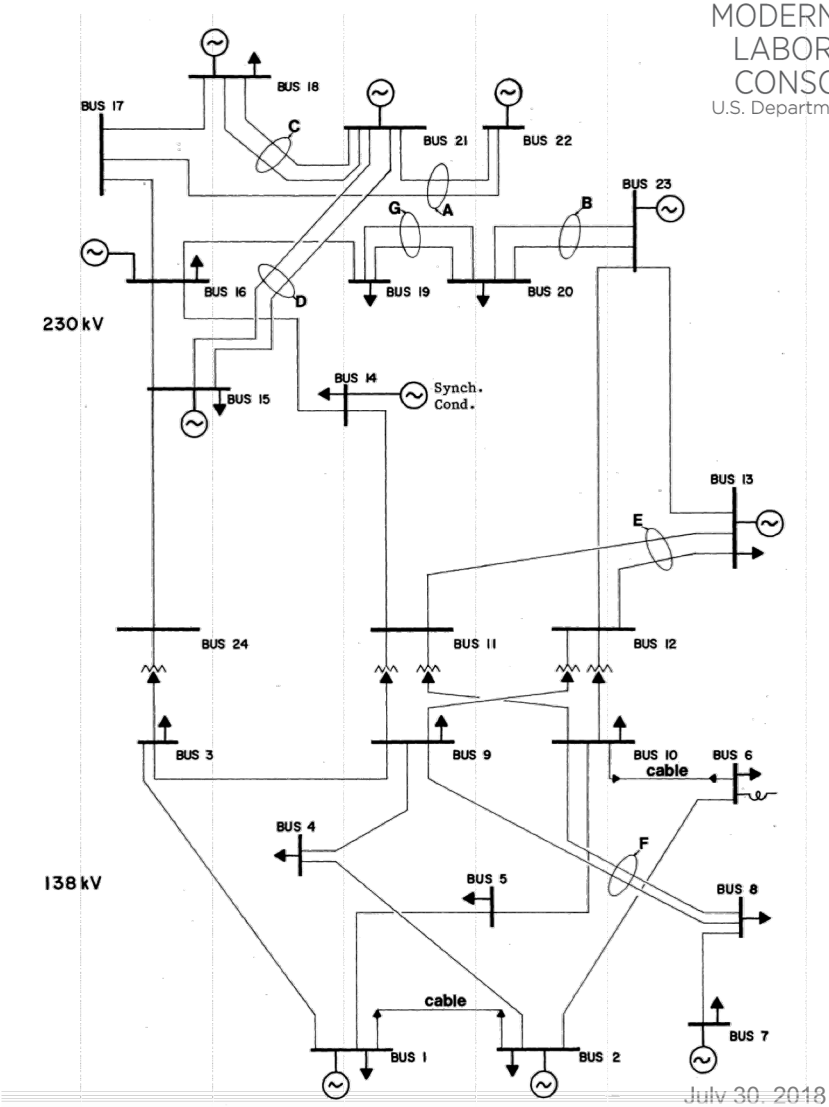


Figure 1 - IEEE Reliability Test System

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  - Outdated generation fleet (no Gas generation)

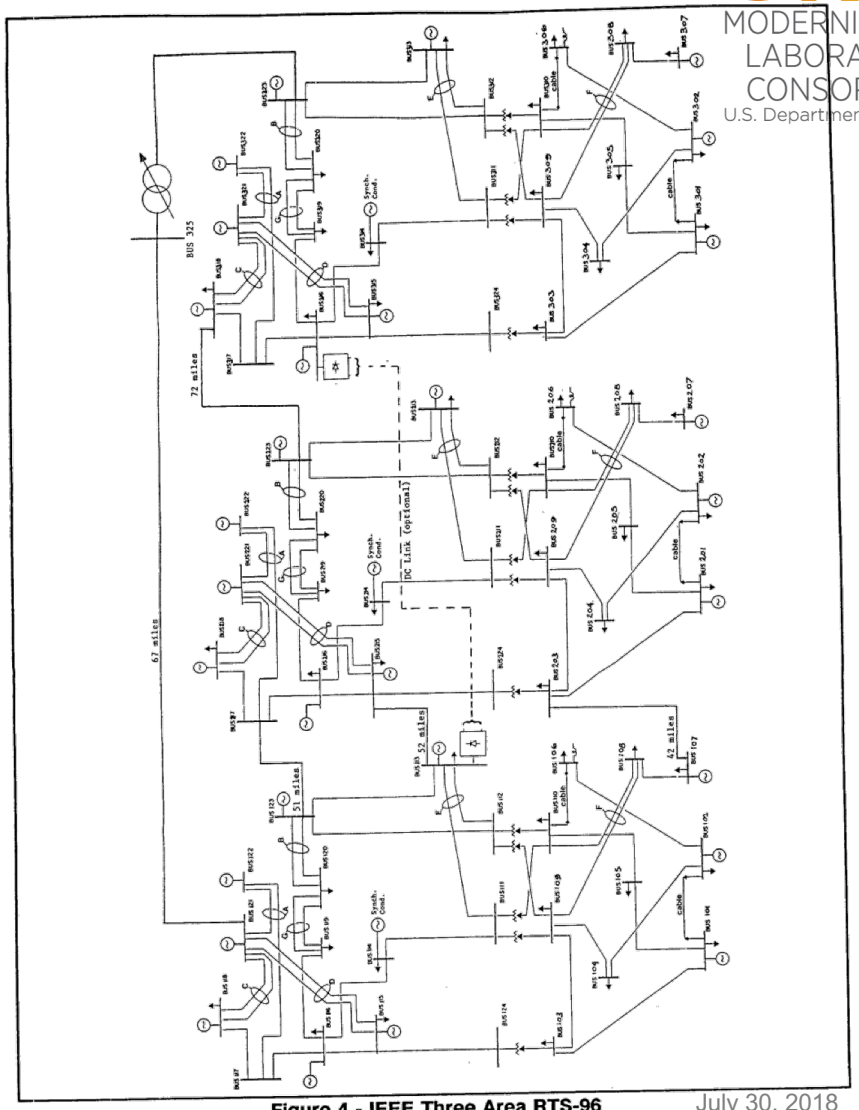


Figure 4 - IEEE Three Area RTS-96

NESTA

- 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:

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

  - Add the following generating units in each region:

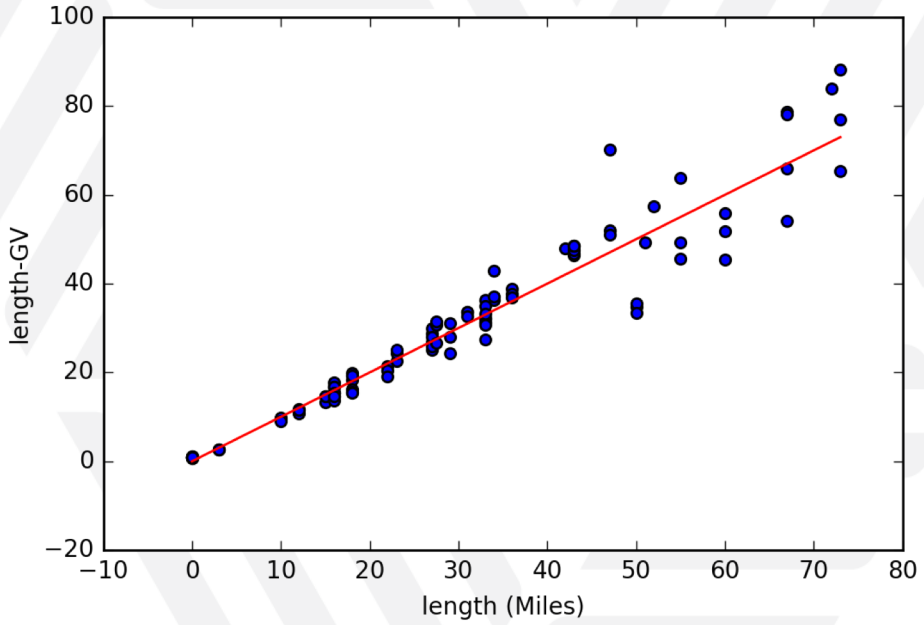
Bus	Gen Capacity
1	100 MW
7	100 MW
15	100 MW
15	155 MW
23	155 MW

Line distances used to create relative node locations

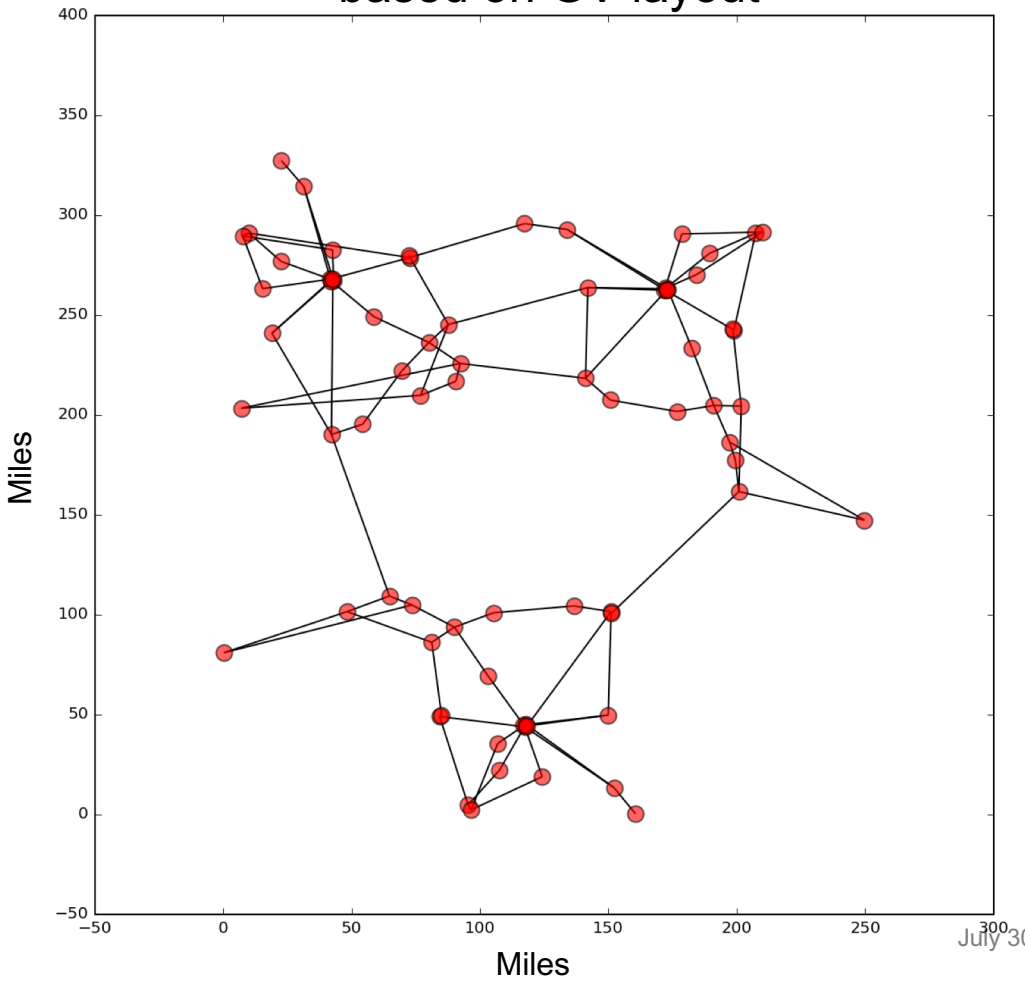
- RTS-96 has published line lengths

  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

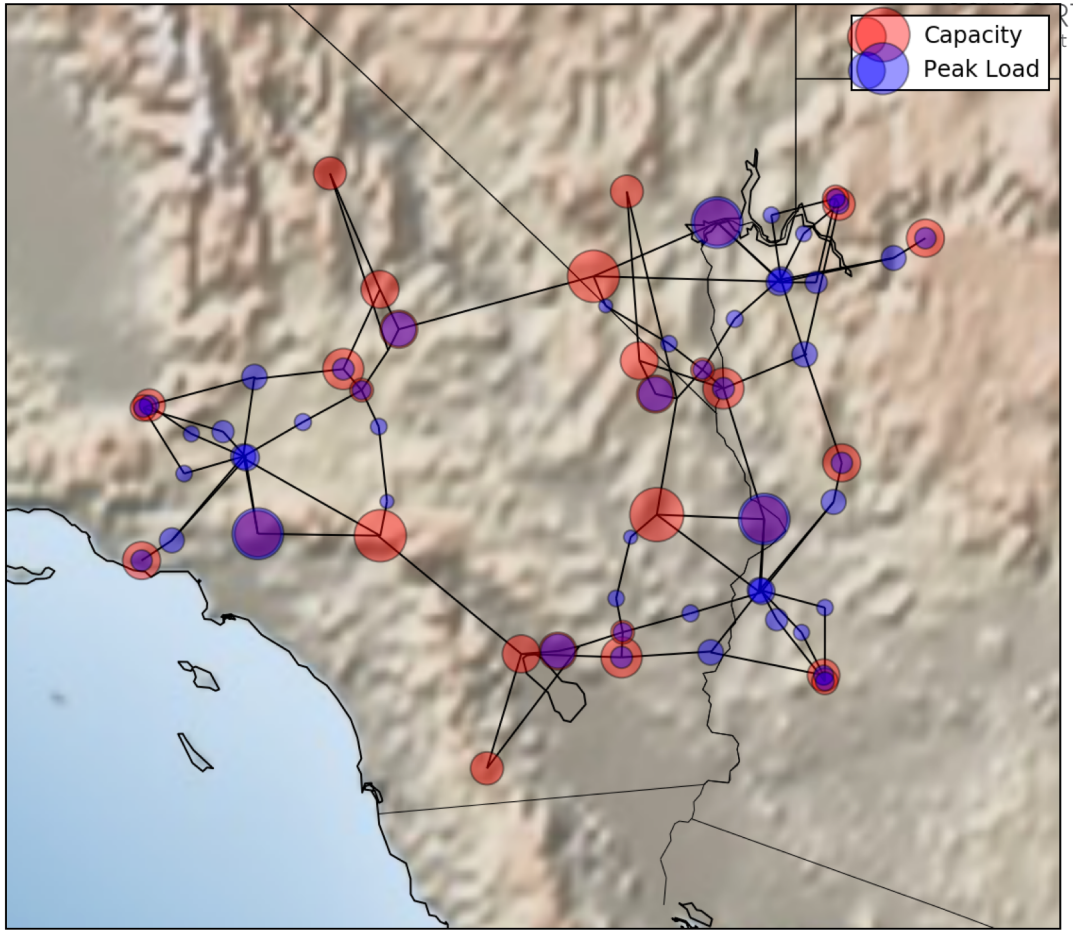


Relative RTS-GMLC node locations based on GV layout



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

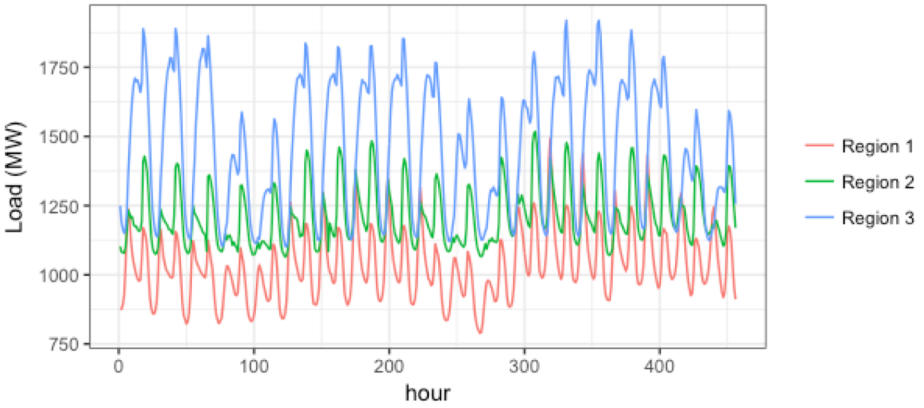


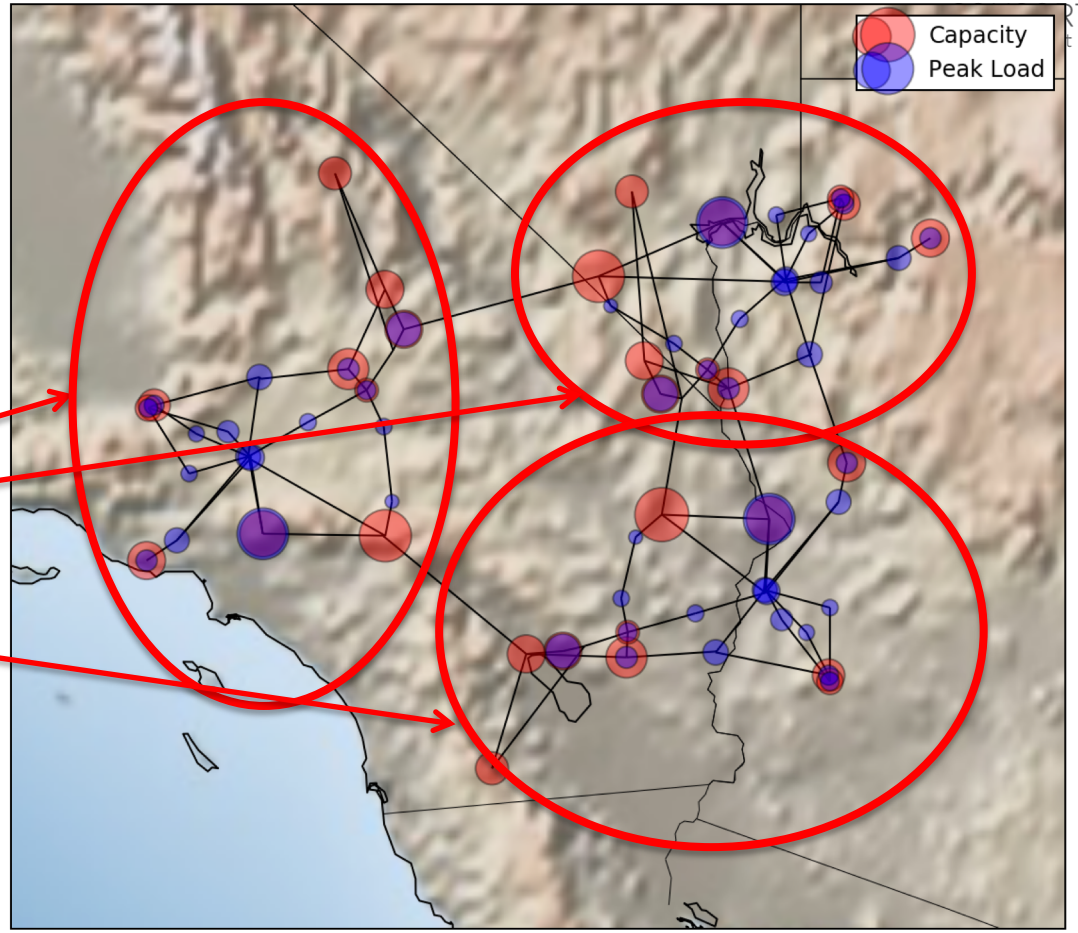
Not intended to represent existing infrastructure

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

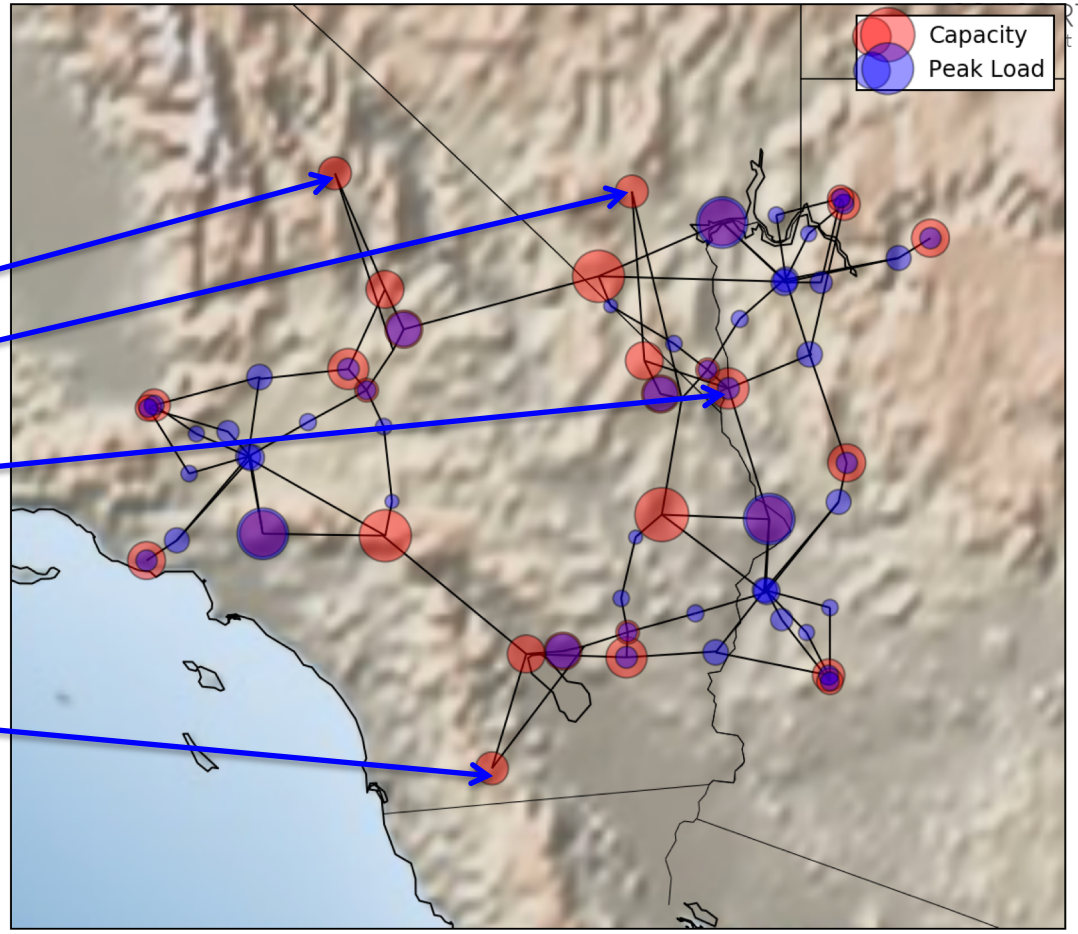




Not intended to represent existing infrastructure

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



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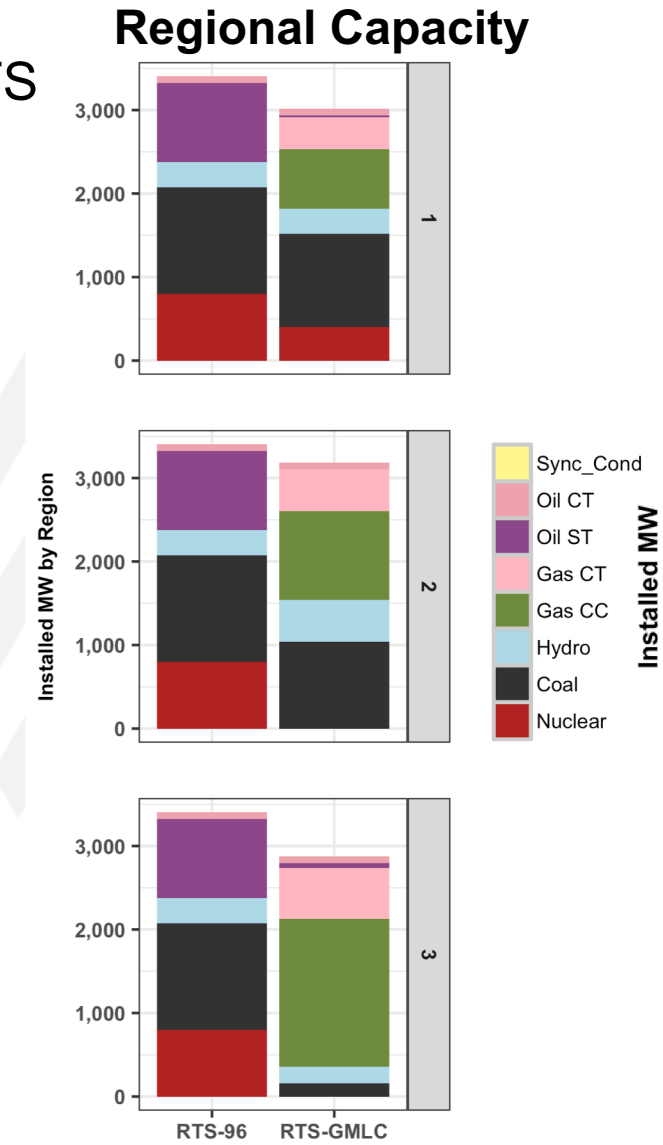
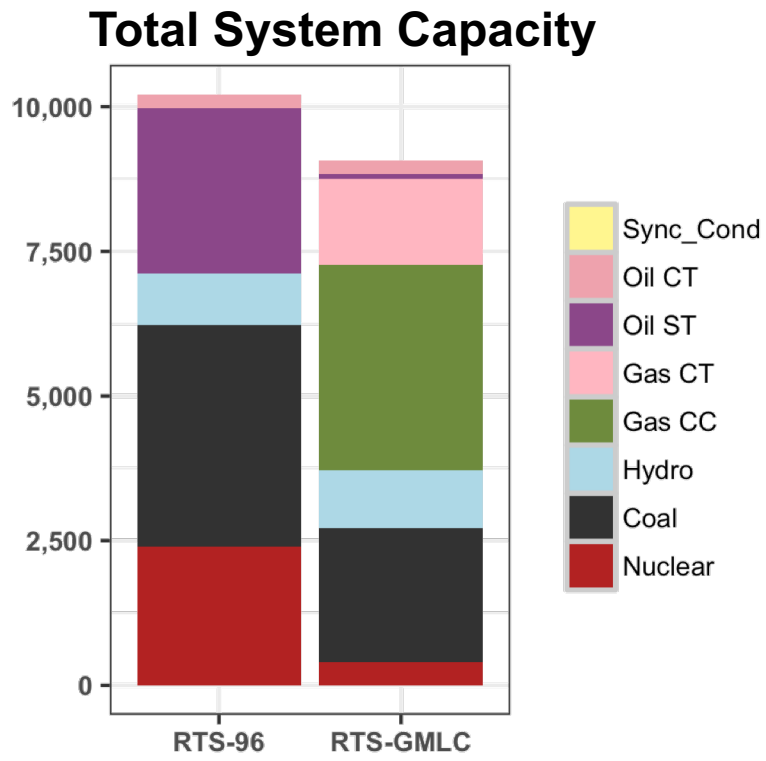
Updated conventional generation fleet

- 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

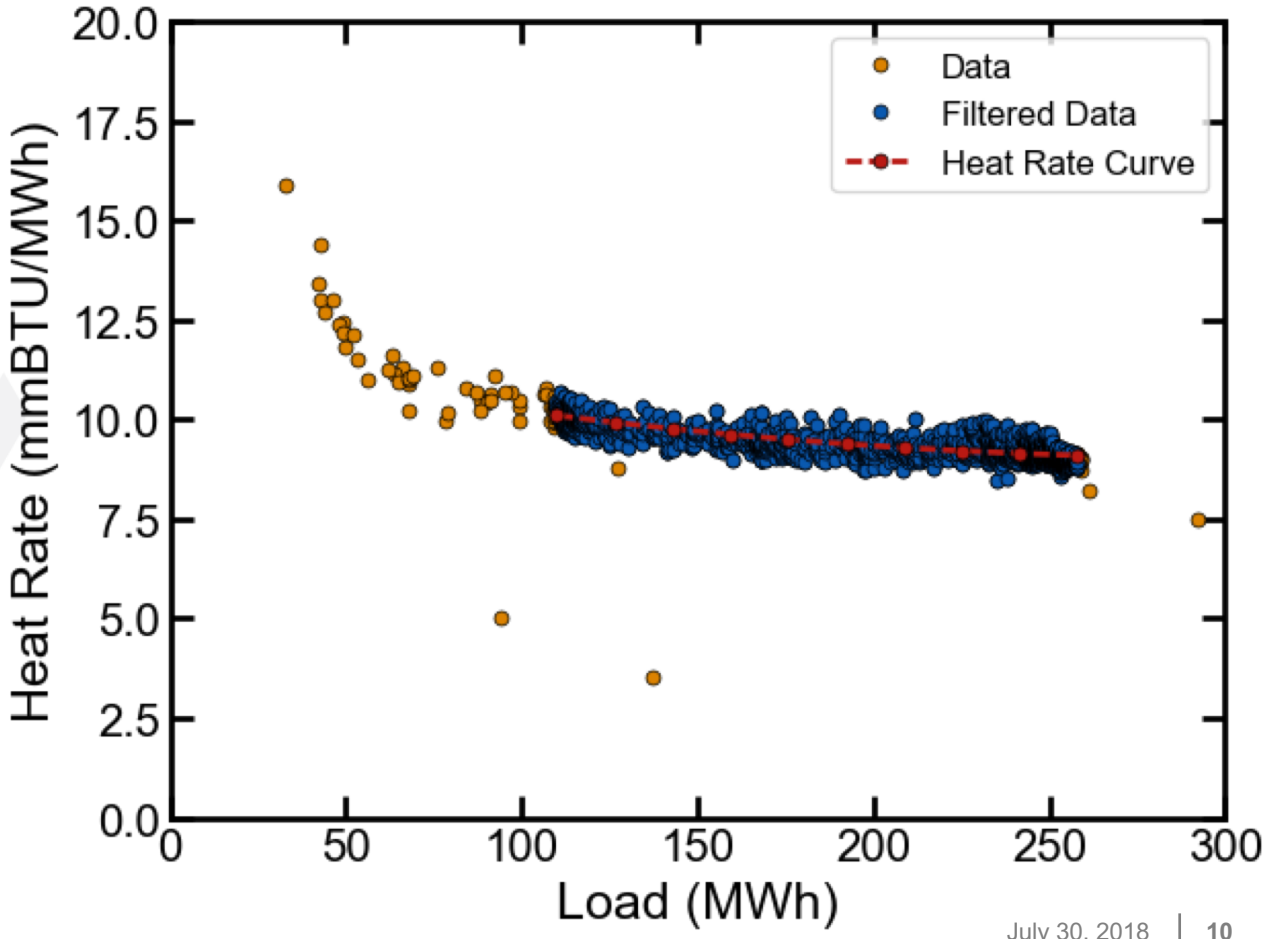




Updated heat rates from U.S. fleet operating information

- 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

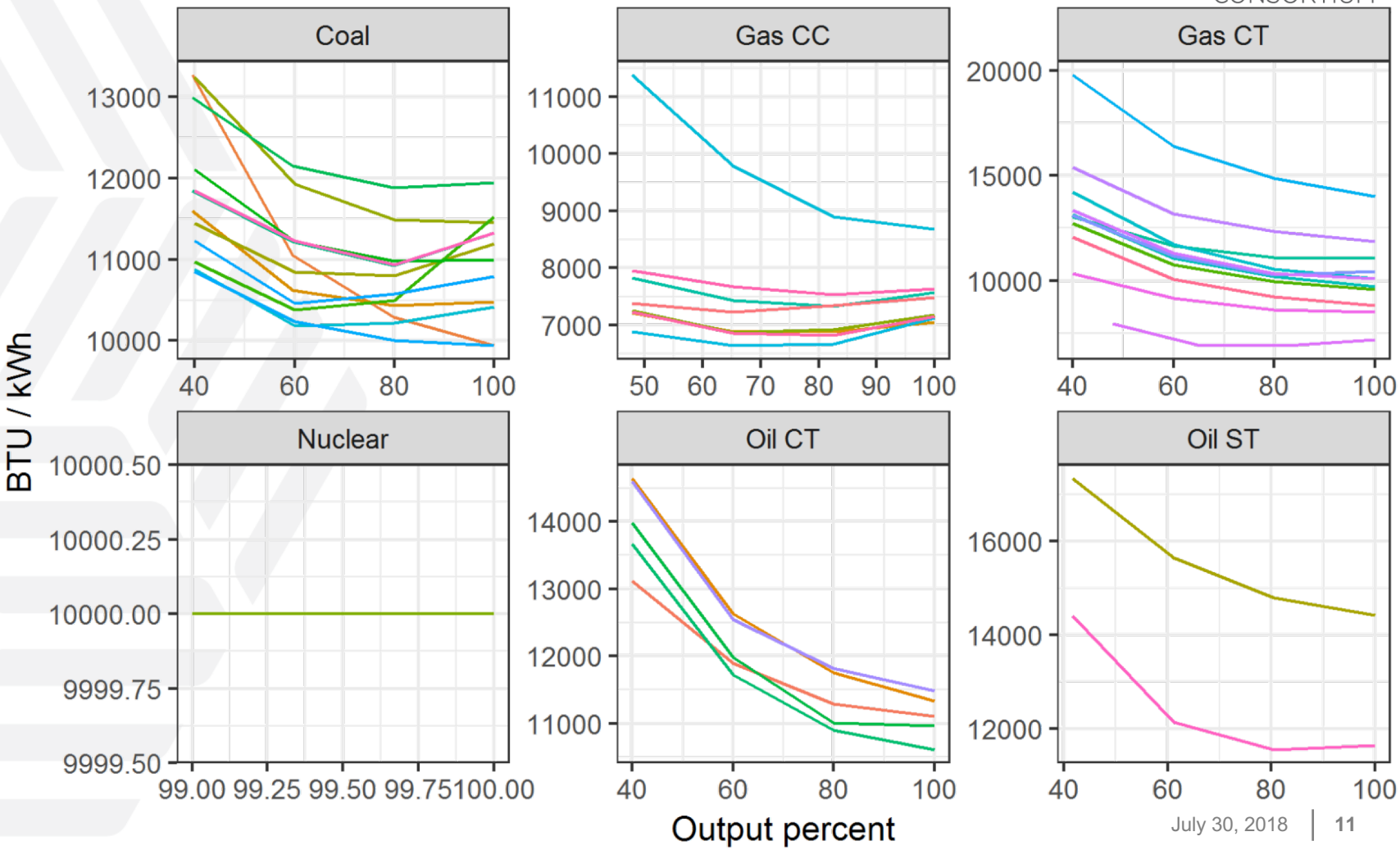
- New heat rates improve optimization performance

Convex

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

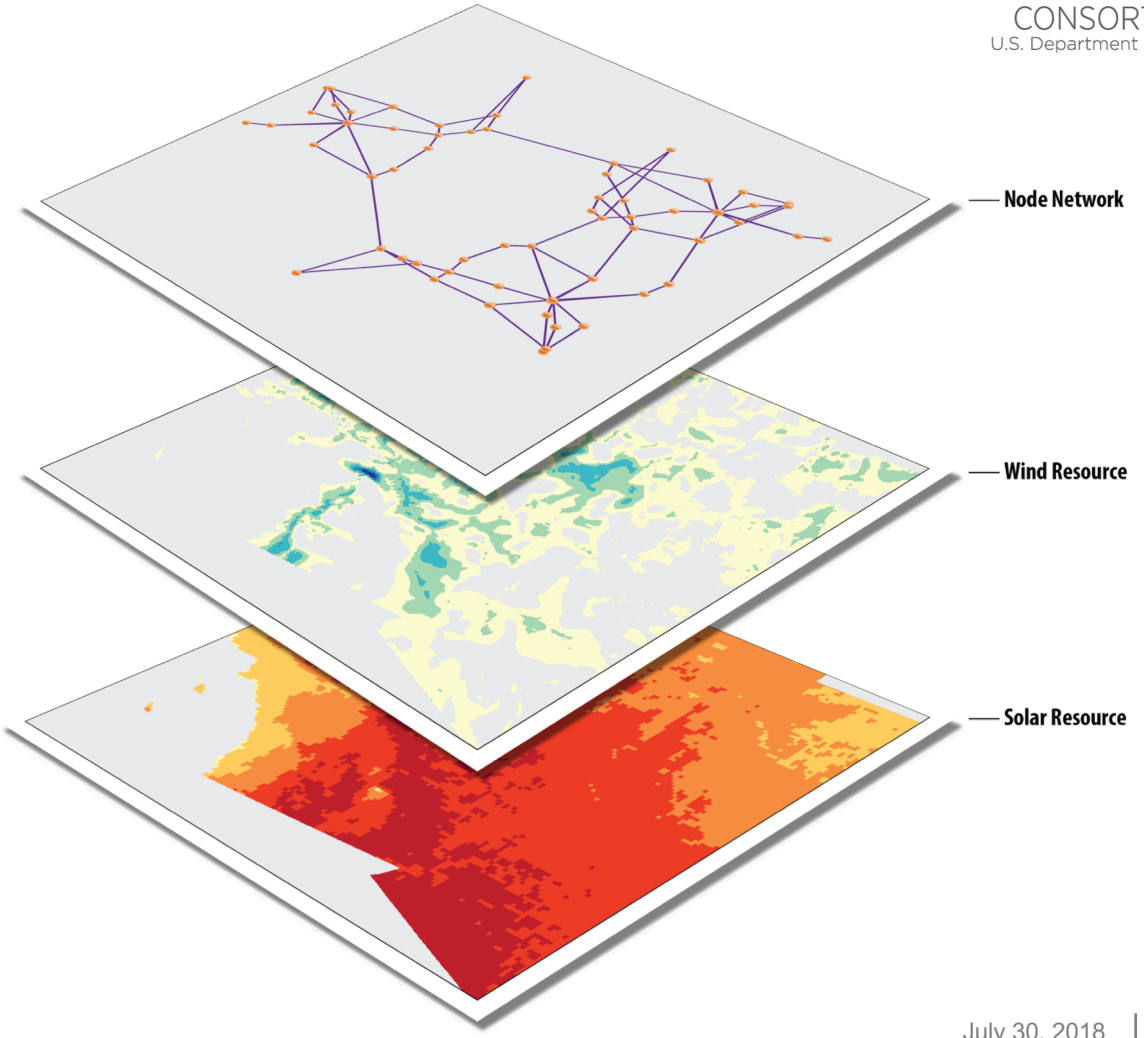
Diverse

- Reduces degeneracy and improves solver efficiency



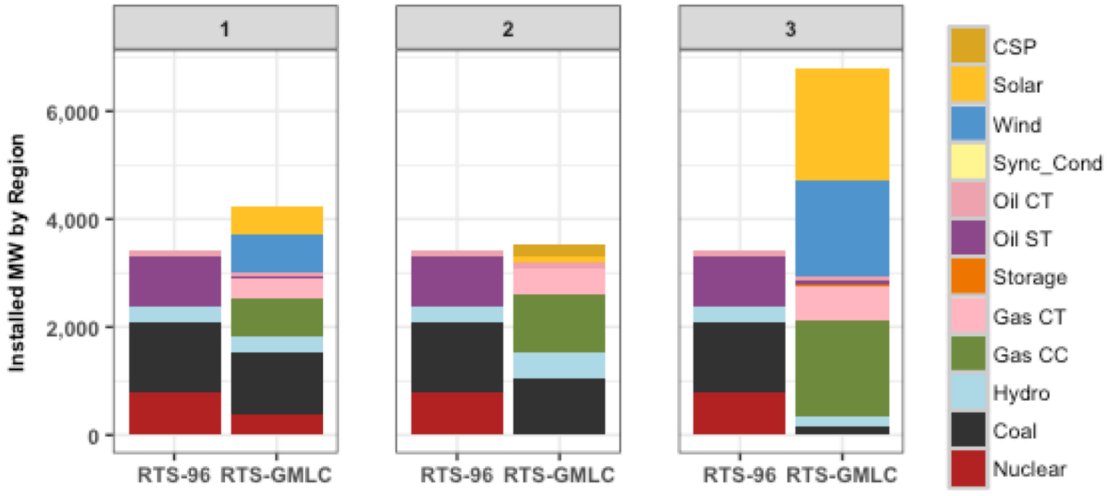
Wind and Solar data

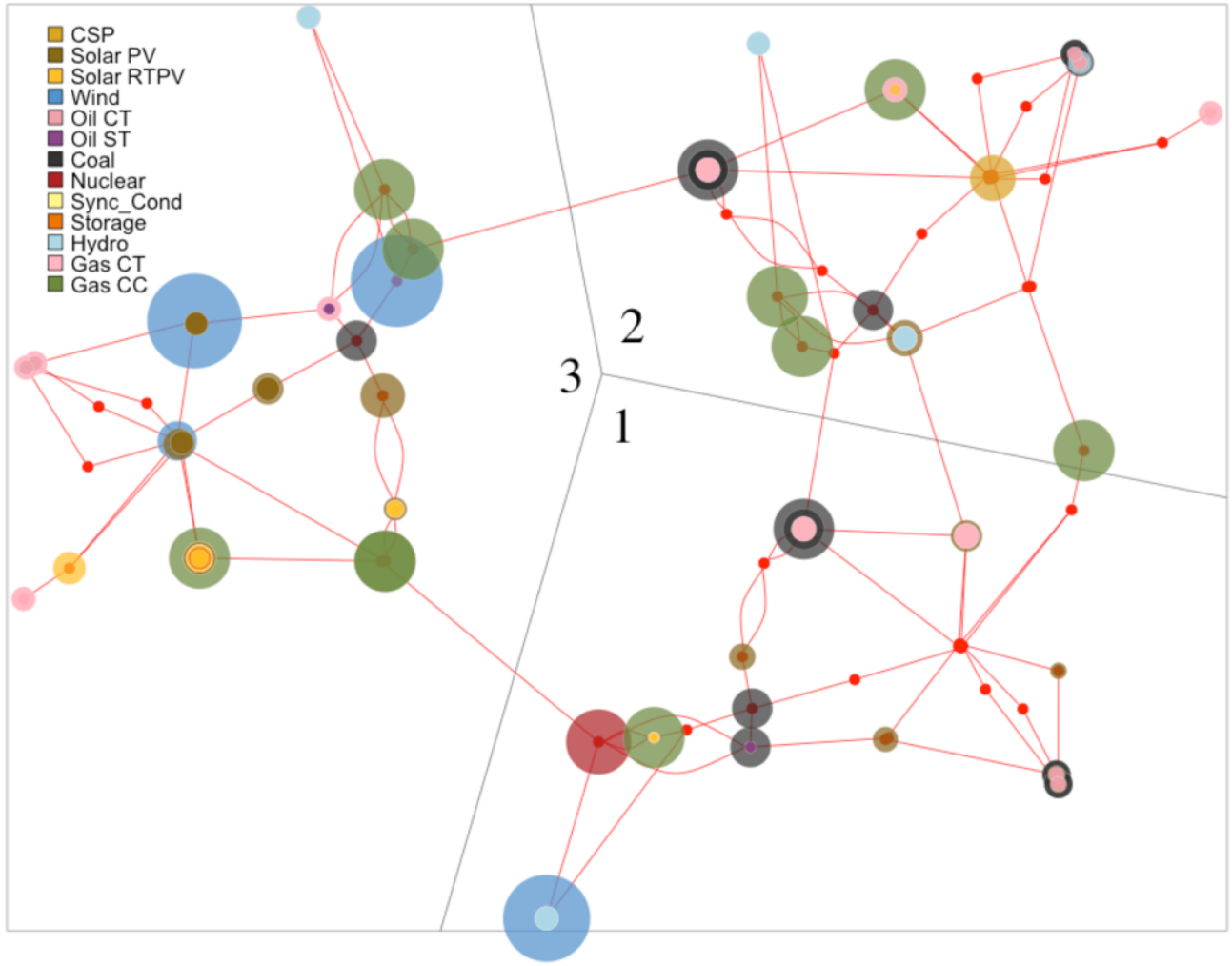
- Western Wind and Solar Integration Study phase 2
  - http://www.nrel.gov/docs/fy13osti/55588.pdf
  - Hourly Day Ahead forecasts representing “best available” 24-hour ahead forecast
  - 5-minute Real Time “actual” profiles
  - 80 m hub height adjusted wind turbine outputs
  - WRF re-analysis wind and 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





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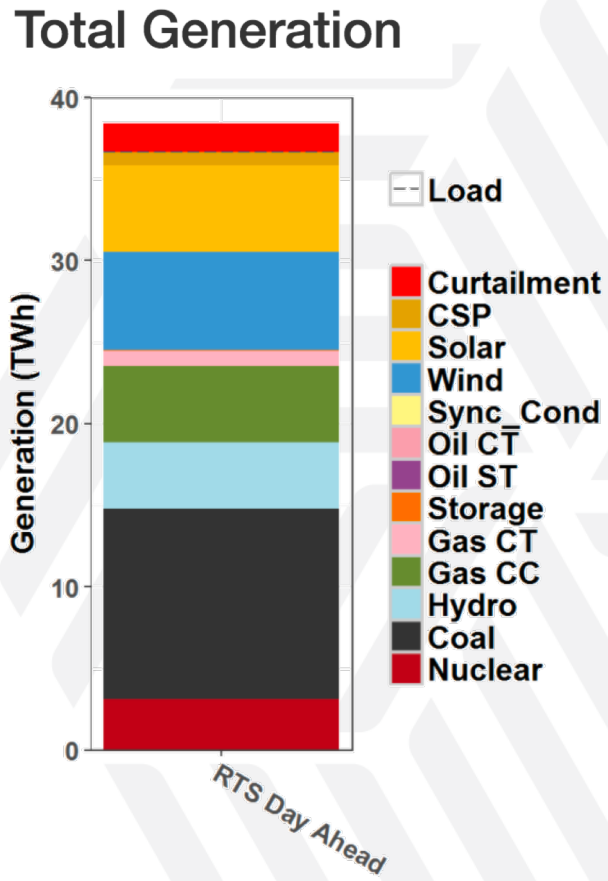
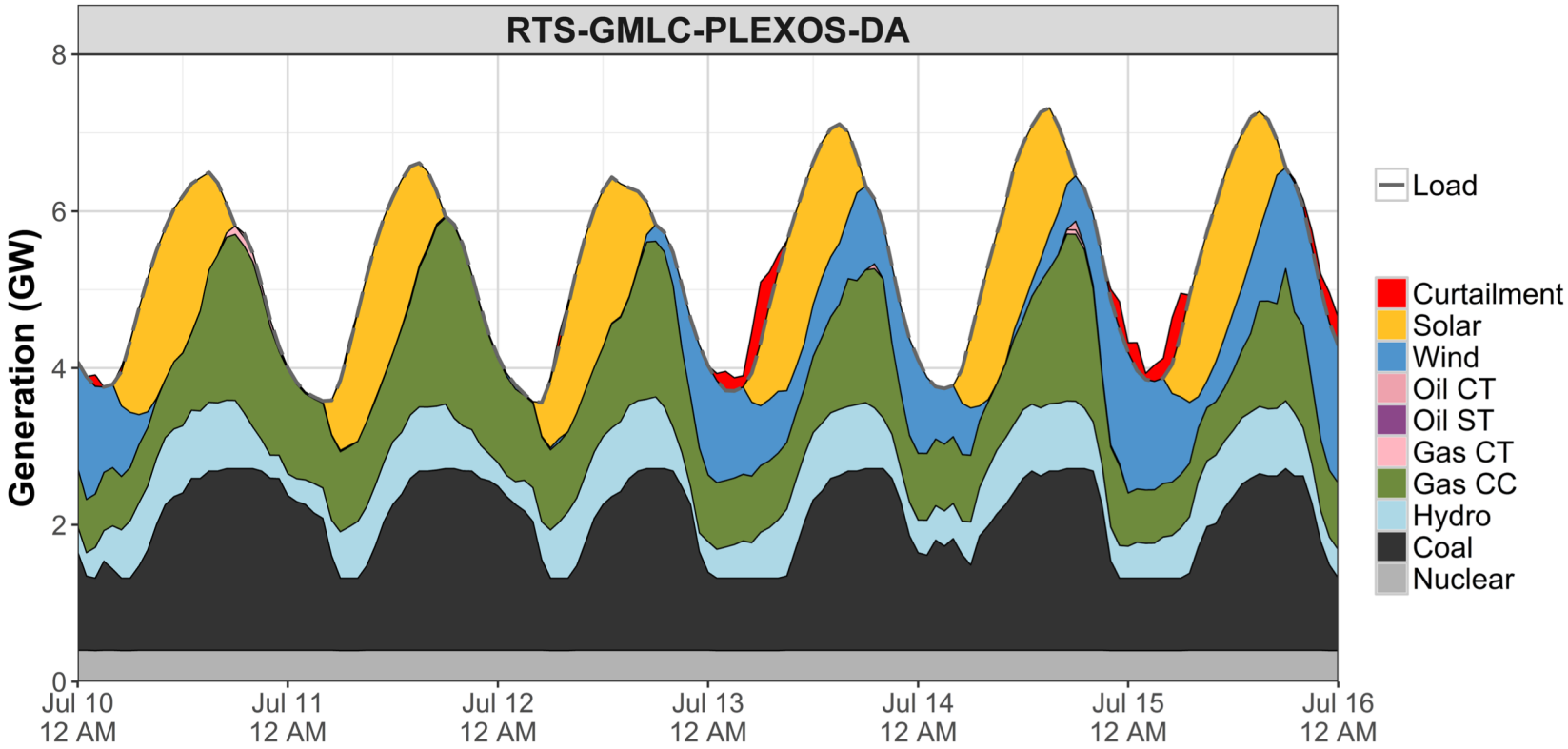
Production Cost Model Problem Definition

- 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.

Simulation Parameters	DAY_AHEAD	REAL_TIME
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, Reg_Up, Reg_Down)	(Spin_Up, Reg_Up, Reg_Down)

Day-Ahead Results



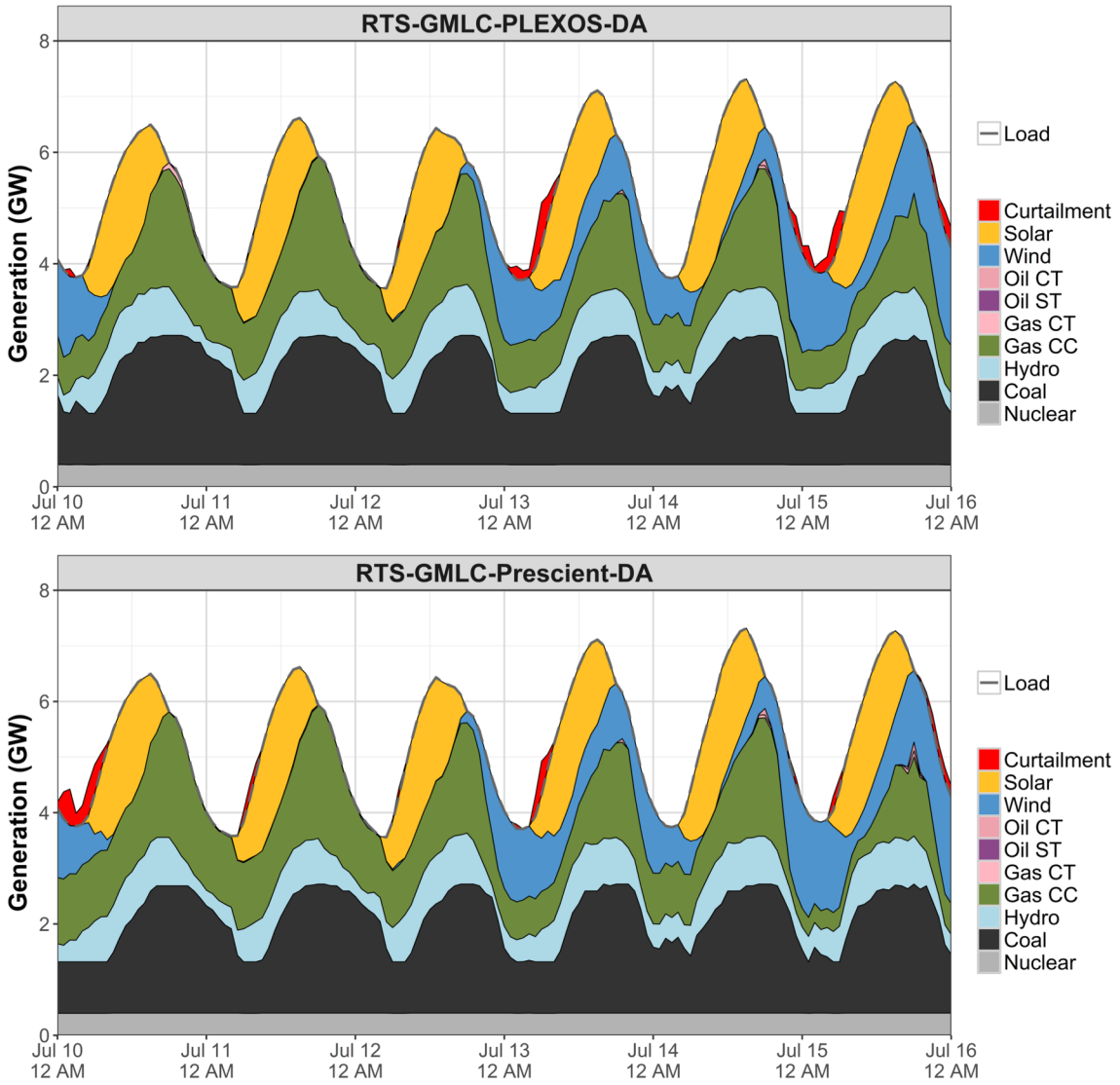


https://rawgit.com/GridMod/RTS-GMLC/master/RTS_Data/FormattedData/PLEXOS/PLEXOS_Solution/RTS_final_DA.html

Versions and Benchmarking

RTS-GMLC contains system data in **eight** different formats:

- MATPOWER
- PowerWorld
- PSS/E v31 and v33
- PLEXOS
- Prescient
- RTS3 (Gene Preston)
- CDM (SourceData/*.csv)



Clayton.barrows@nrel.gov - https://Github.com/GridMod/RTS-GMLC

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claytonpbarrows committed on GitHub Update README.md — Latest commit aaba021 2 days ago

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