PSERC Project S91
Generating Value from Detailed, Realistic Synthetic Electric Grids

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PSERC

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University Team

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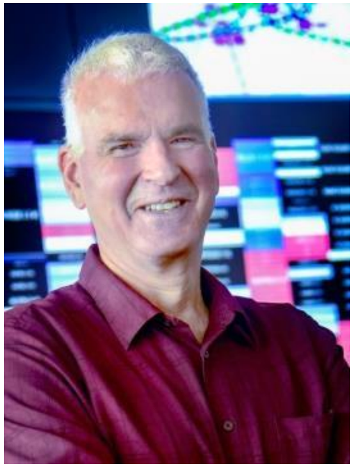
TAMU Team



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Sofia

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IAB Team Members

- Harvey Scribner and Casey Cathey (SPP)
- Mark Rothleder (CAISO)
- Bryan Palmintier (NREL)
- Di Shi (GEIRI),
- Evangelos Farantatos, Paul Myrda (EPRI),
- Cho Wang (AEP)
- Atena Darvishi (NYPA)
- Steven Judd (ISO-NE)
- Alex Lau and David Mercado (CenterPoint)
- Al Engelmann (ComEd)
- Yazhou Jiang and Anil Jampala (GE)
- Patrick Panciatici (RTE)
- Jianzhong Tong (PJM)
- Baj Agrawal (APS)
- Felica Ruiz (MISO)

Agenda

- Introductions
- Overview of the Project Progress
- Specific Tasks
- IAB Feedback

Summary and Tasks

- The goal of the project is to work closely with the industrial team to generate value from large-scale, detailed and realistic synthetic electric grids
  - The project builds on recent ARPA-E work by the PIs to develop grids that can be used for research, education, commercial development and public engagement
- The four project tasks are
  1. Developing customized grids
  2. Developing specific grid scenarios
  3. Exploring decision making with uncertainty
  4. Expanding the scope of synthetic grids for coupling with other infrastructures

Project Period and Funding

- The project period is the standard two years, from July 1, 2020 to August 31, 2022
- Total funding is 220K, with the amount split equally between the years
  - 110K per year
- Total funding per researcher is 27.5K per person per year
- TAMU has internal funds that will be used on this project; this includes funding for equipment, data sets, travel and consulting services

2021 North American Power Symposium

- For more than 50 years every fall power system researchers gather for the North American Power Symposium (NAPS)
  - The NAPS host site rotates among universities
  - NAPS 2019 was held in Wichita, KS
  - NAPS 2020 was suppose to be held in October at Arizona State University; but it is now virtual from April 11-14, 2021
- Texas A&M will be hosting NAPS 2021 in person on Nov 14-16, 2021 with Kate Davis the NAPS 2021 Chair
- We will be have a career fair type event and hope to have many PSERC companies in attendance!
- The draft website is na.eventscloud.com/website/22926/
  - Papers will be due in late summer

Project Papers

- All papers are available at
  - overbye.engr.tamu.edu/publications/
  - katedavis.engr.tamu.edu/publications/
  - directory.engr.wisc.edu/ece/Faculty/Roald_Line/
  - directory.engr.wisc.edu/ece/faculty/lesieutre_bernard
- Papers
  - Rhodes, Ntaimo and Roald, “Balancing Wildfire Risk and Power Outages Through Optimized Power Shut-Offs”, *IEEE Transactions on Power Systems*, in Press
  - Haseltine and Roald, “The Effect of Blocking Automatic Reclosing on Wildfire Risk and Outage Times”, North American Power Symposium (NAPS), 2020
  - Y. Liu, M. Gaskamp, Z. Mao, D. Wallison, K. Shetye, K. Davis and T.J. Overbye, “Evaluation of Performance Metrics for Electric Grid Operational Scenarios,” 2020 North American Power Symposium (NAPS), Tempe, AZ, USA, April 2021.

Project Papers, cont.

- Papers, cont.
  - W. Trinh, Z. Mao, T. J. Overbye, J. D. Weber, and D. J. Morrow, “Considerations in the Initialization of Power Flow Solutions from Dynamic Simulation Snapshots”, 2020 North American Power Symposium, Tempe AZ, April 2021.
  - D. Wallison, M. Gaskamp, Z. Mao, Y. Liu, K. S. Shetye, and T. Overbye, “Design Considerations for Operational Power Systems Scenarios,” 2021 North American Power Symposium, Tempe, AZ, April 2021.
  - T.J. Overbye, K.S. Shetye, J.L. Wert, W. Trinh, and A. Birchfield, “Techniques for Maintaining Situational Awareness During Large-Scale Electric Grid Simulations,” IEEE Power and Energy Conference at Illinois (PECI), Champaign, IL, April 2021.
  - K.S. Shetye, T.J. Overbye, H. Li, and J. Thekkemathiote, “Considerations for Interconnection of Large Power Grid Networks,” IEEE Power and Energy Conference at Illinois (PECI), Champaign, IL, April 2021.
  - J.L. Wert, K.S. Shetye, H. Li, J.H. Yeo, X. Xu, A. Meitiv, Y. Xu, T.J. Overbye, “Coupled Infrastructure Simulation of Electric Grid and Transportation Networks,” 2021 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), February 2021, Washington DC, USA.
  - T.J. Overbye, J.L. Wert, K.S. Shetye, F. Safdarian, A.B. Birchfield, “The Use of Geographic Data Views to Help With Wide-Area Electric Grid Situational Awareness,” 2021 IEEE Texas Power and Energy Conference, College Station, TX, Feb. 2021.

Project Papers, cont.

- Papers, cont.
  - H. Li, J. L. Wert, A. B. Birchfield, T. J. Overbye, C. M. Domingo, F. Postigo, P. Duenas, T. Elgindy, and B. Palmintier, “Building Highly Detailed Synthetic Electric Grid Data Sets for Combined Transmission and Distribution Systems,” *IEEE Open Access Journal of Power and Energy*, vol 7, pp. 478-488, November 2020.
  - B.L. Thayer, T. J. Overbye, “Deep Reinforcement Learning for Electric Transmission Voltage Control” 2020 IEEE Canada Electric Power and Energy Conference (EPEC), Edmonton, AB, November 2020,
  - J.L. Wert, Z. Mao, H. Li, T.J. Overbye, “Contouring Method Considerations for Power System Applications,” 2020 IEEE Electric Power and Energy Conference (EPEC), November 2020, Edmonton, AB.
  - B. Allison, T. Overbye and J. Weber, “Improved Generator Voltage Control in Power Flow Solutions”, 2020 North American Power Symposium, Tempe AZ, April 2021.
  - P. Dehghanian, J.H. Yeo, J. Wert, H. Li, K. Shetye, and T. Overbye, “Application of Transformer Impedance Correction Tables in Power Flow Studies,” 2021 North American Power Symposium (NAPS), Tempe, AZ, USA, April 2021.
  - T.J. Overbye, J. Wert, K.S. Shetye, F. Safdarian, A.B. Birchfield, “Delaunay Triangulation Based Wide-Area Visualization of Electric Transmission Grids,” Accepted for Kansas Power and Energy Conference, April 2021 [paper will be posted by April 15, 2021].
  - F. Safdarian, A. B. Birchfield, K.S. Shetye, “'Additional Insights in Creating Large-Scale, High Quality Synthetic Grids: A Case Study” Accepted for Kansas Power and Energy Conference, April 2021 [paper will be posted by April 15, 2021].

The Four Project Tasks and The Work Plan

1. Developing customized grids
2. Developing specific grid scenarios
3. Exploring decision making with uncertainty
4. Expanding the scope of synthetic grids for coupling with other infrastructures

Work Plan: (Q = quarter, KD=Davis, BL=Lesieutre, TO=Overbye, LR=Line Roald)

Task	**Researchers**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	***Q8***
1	BL, TO	x	x						
2	KD, LR		x	x	x	x			
3	KD, LR,TO				x	x	x	x	
4	KD, TO, BL	x	x	x	x	x	x	x	x

Task 1: Developing Customized Grids

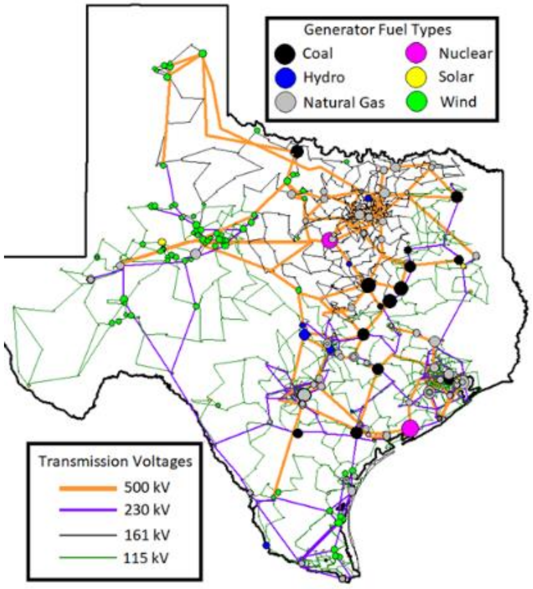
- For this task we will work with our IAB members to build grids on footprints of interest with desired characteristics
  - We have lots of experience doing this!
  - Particular idiosyncrasies can be included in these grids
- These grids can then be used as desired by the IAB members
  - Fully public or not
  - Used by local universities for research and education
  - Provided to potential vendors
- Expected grids sizes up to tens of thousands buses

Task 1: Progress

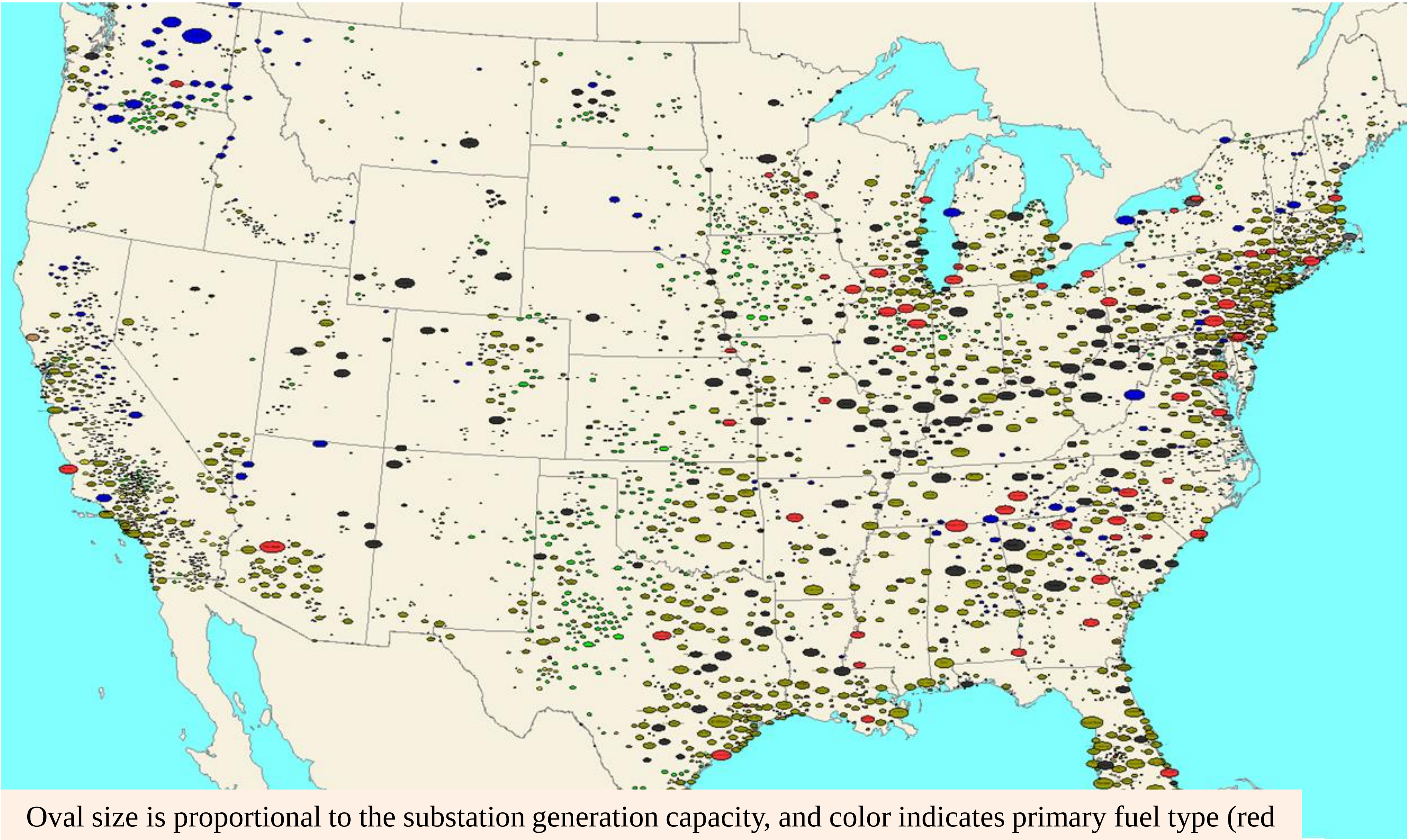
- We've been creating a variety of different grids, with sizes up to 80,000 buses
- These are now being used in several different venues, including work associated the PSERC project S-92G and with ARPA-E
- A key issue we've been dealing with is understanding what is going on in doing grid studies, what we're calling maintaining engineering study situational awareness

Creation of Synthetic Grids Overview

- Substation Planning
  - Start with public data for generation, load
  - Cluster substations, add buses, transformers
- Transmission Planning
  - Place lines and transformers
  - Iterative dc power flow algorithm
  - Match topological, geographic metrics
  - Contingency overload sensitivity
- Reactive Power Planning
  - Power flow solution (ac)
  - Voltage control devices



A Starting Point for All: Actual Generators



Oval size is proportional to the substation generation capacity, and color indicates primary fuel type (red nuclear, black coal, brown natural gas, blue hydro, green wind, yellow solar). Image shows public data from EIA Form 860; image created using PowerWorld Simulator.

Zoomed View of Texas

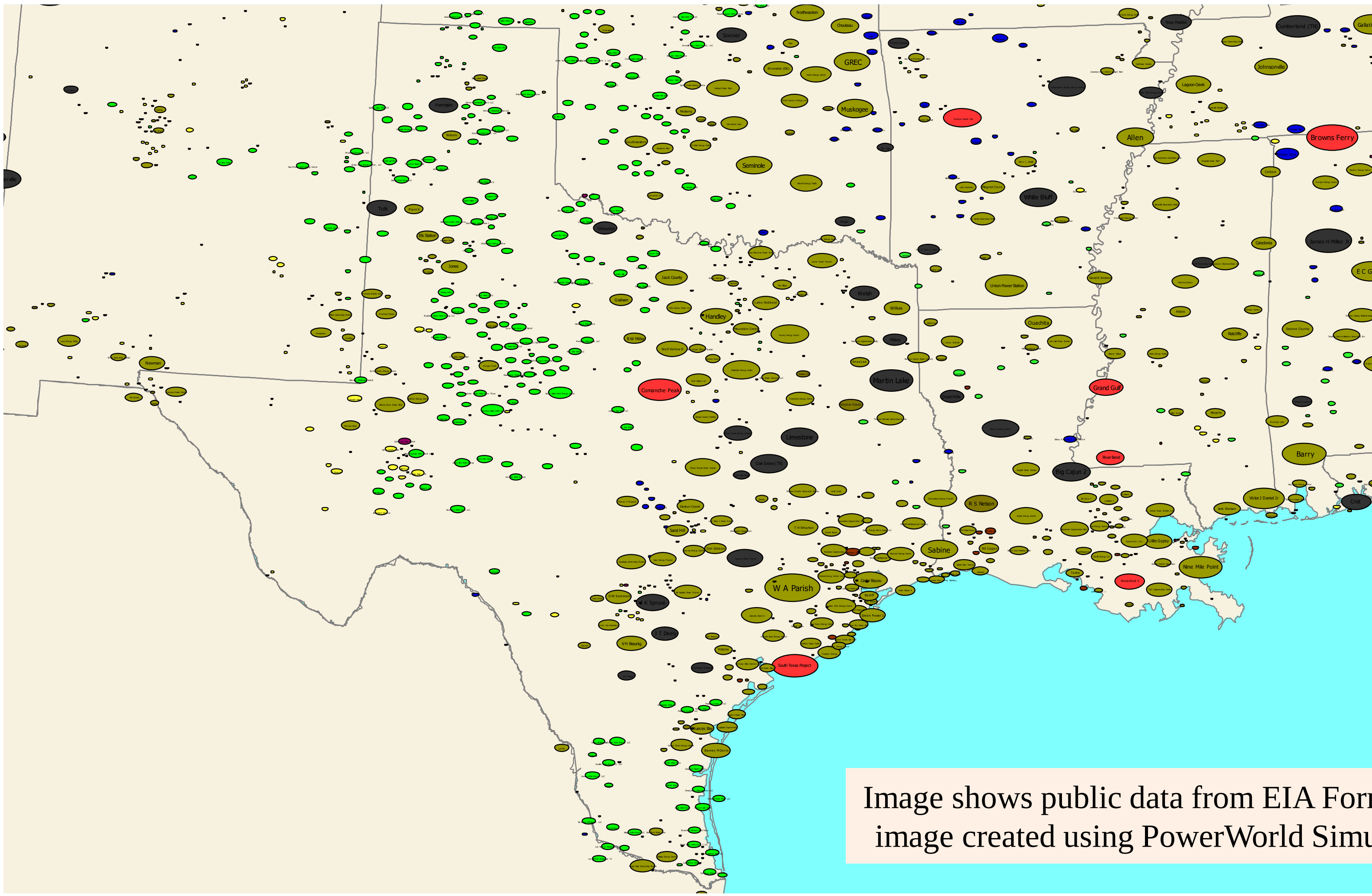
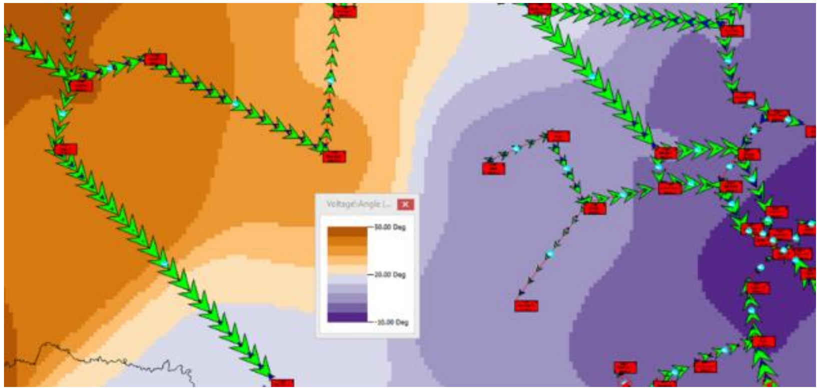


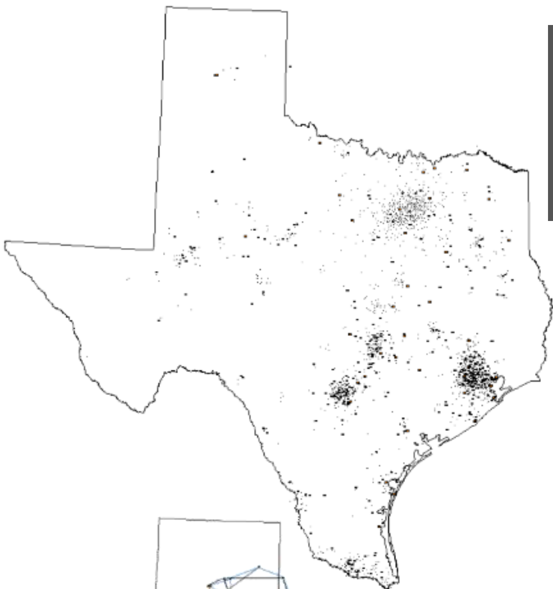
Image shows public data from EIA Form 860; image created using PowerWorld Simulator.

Transmission Planning Approach

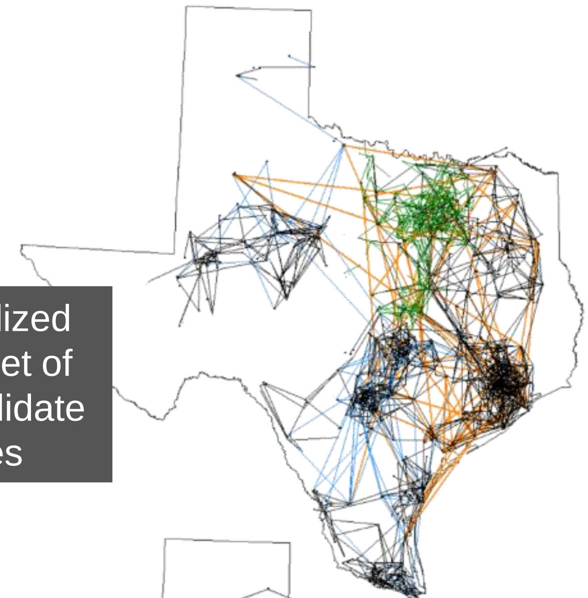
- Key Considerations
  - Geography drives transmission planning
  - Network topology parameters
  - Power flow feasibility in base and N-1 contingency conditions
  - Intractability: possible branches is n^2, possible combinations of branches is intractable
  - Many competing metrics to meet
  - Large grids have many overlapping voltage networks that connect at substations
  - Consideration of contingency conditions increases computation even more
  - Manual adjustments grow with system size
- Outline of Approach
  - Reduce search space from n^2 to $21n$ with Delaunay triangulation (up to 3rd neighbors = 99% of lines)
  - Geographic constraints by voltage level
  - Depth first search to check connectivity
  - Dc Power flow base case and N-1 contingency analysis, determine sensitivity of candidate lines to contingency overloads
  - Iterative process of random removal, analysis, targeted addition for each same-voltage subnet



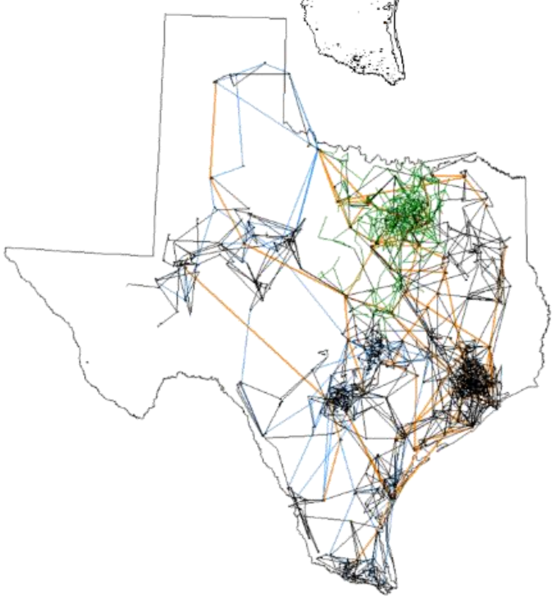
Stages of Transmission Planning Process



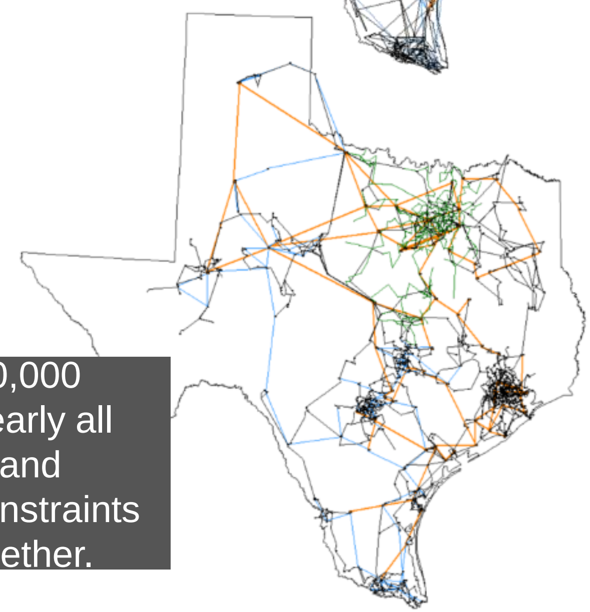
(1) The starting point is the geographic placement of substations



(2) The grid is initialized with a random subset of 1.2n of the 21n candidate transmission lines



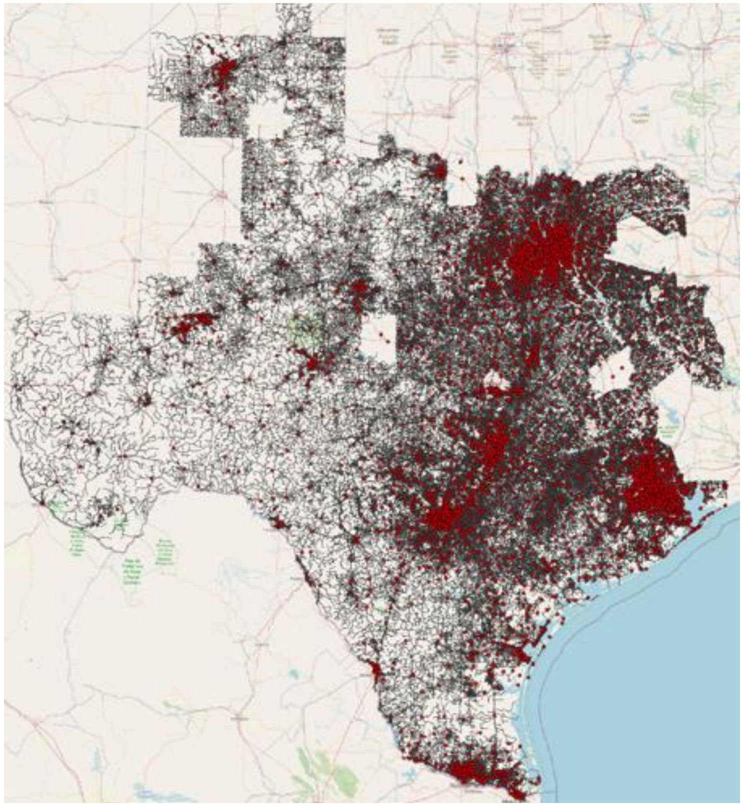
(3) After 100 iterations of random removal followed by targeted addition, the grid begins to match more geographic and reliability constraints



(4) After 10,000 iterations, nearly all reliability and geographic constraints are met together.

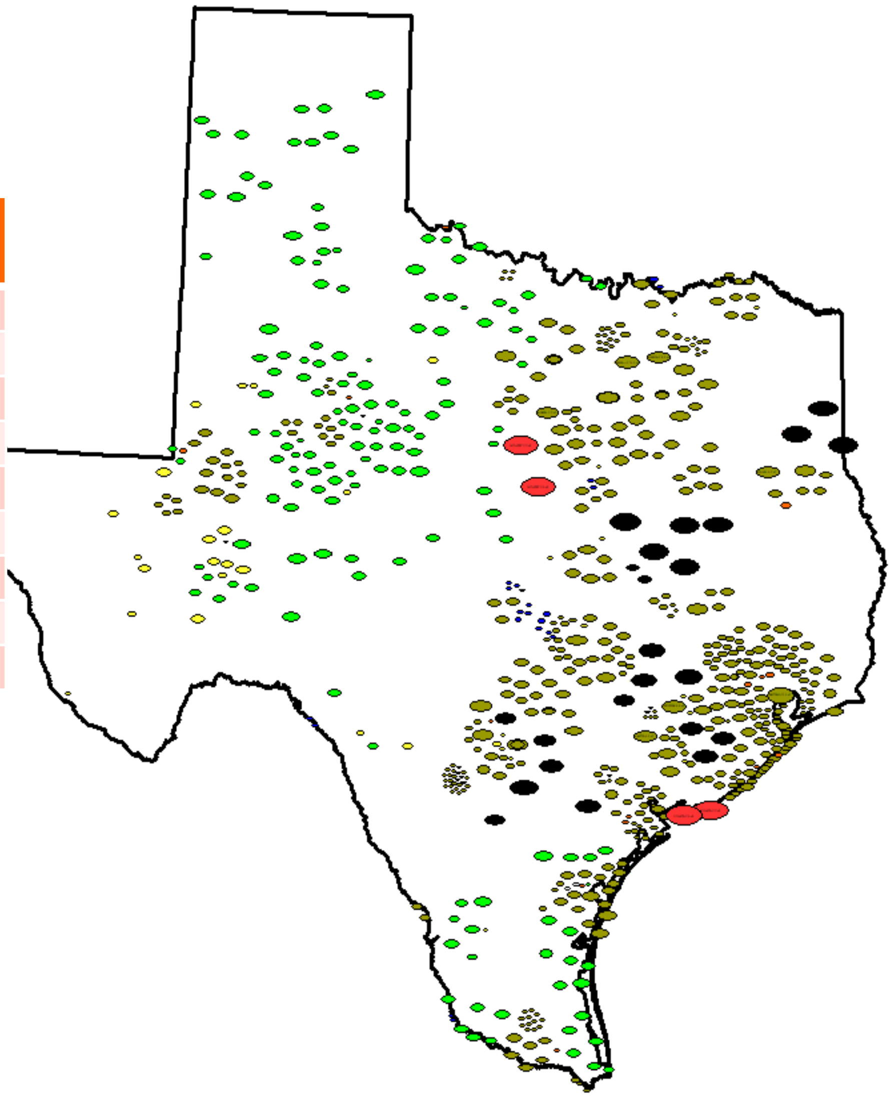
ERCOT Footprint 7000 Bus Grid

- This grid was developed using a 345/138/69 kV grid that will connect distribution substations being developed by the partner NREL team
  - NREL (and partners) are providing us with about 5000 distribution substations
  - We’re connecting them to existing generators (using 2019 EIA-860 data)
- This 7000 bus case was released on the Texas A&M website on February 5, 2021



7000 Bus Case - Generation

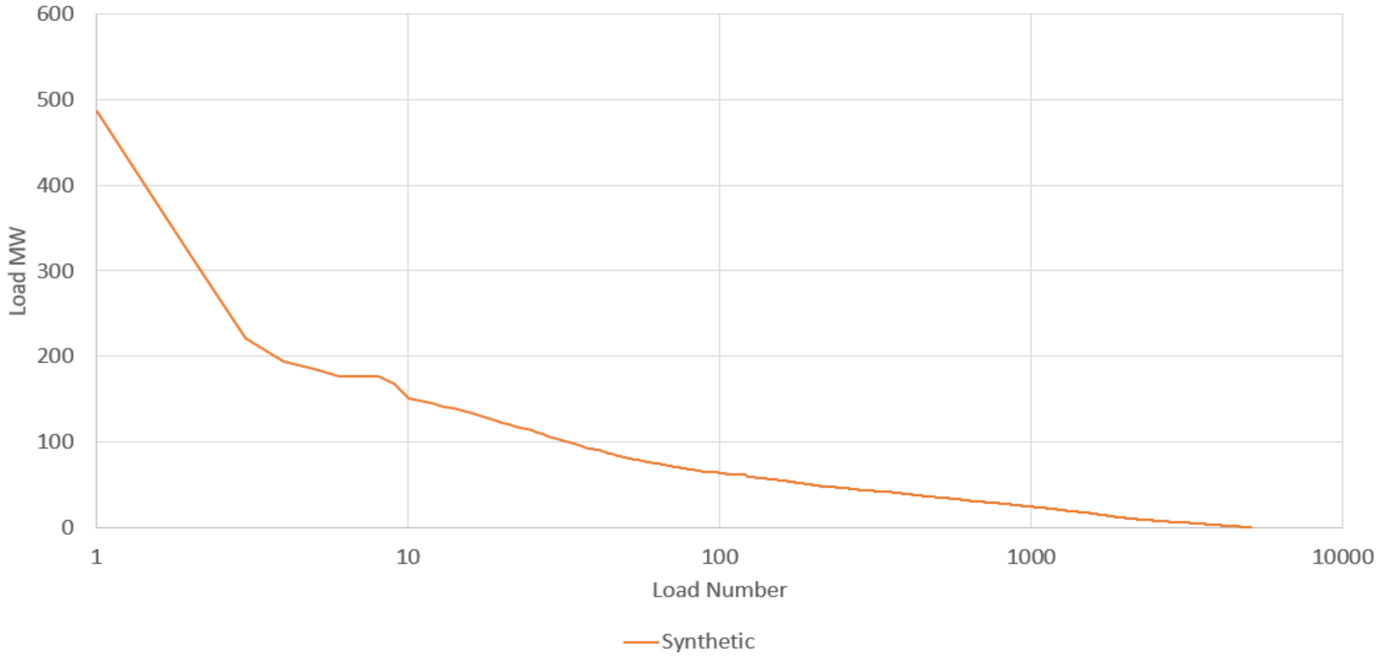
Fuel Type	Number of Units	MW Capacity Total
Natural Gas	475	56,539
Coal	23	14,407
Nuclear	4	4,960
Wind	153	25,702
Solar	36	2,335
Hydro	22	498
Petroleum	2	53
Other	16	420
Total	731	104,914



Each unit is linked to the associated EIA-860 generating unit

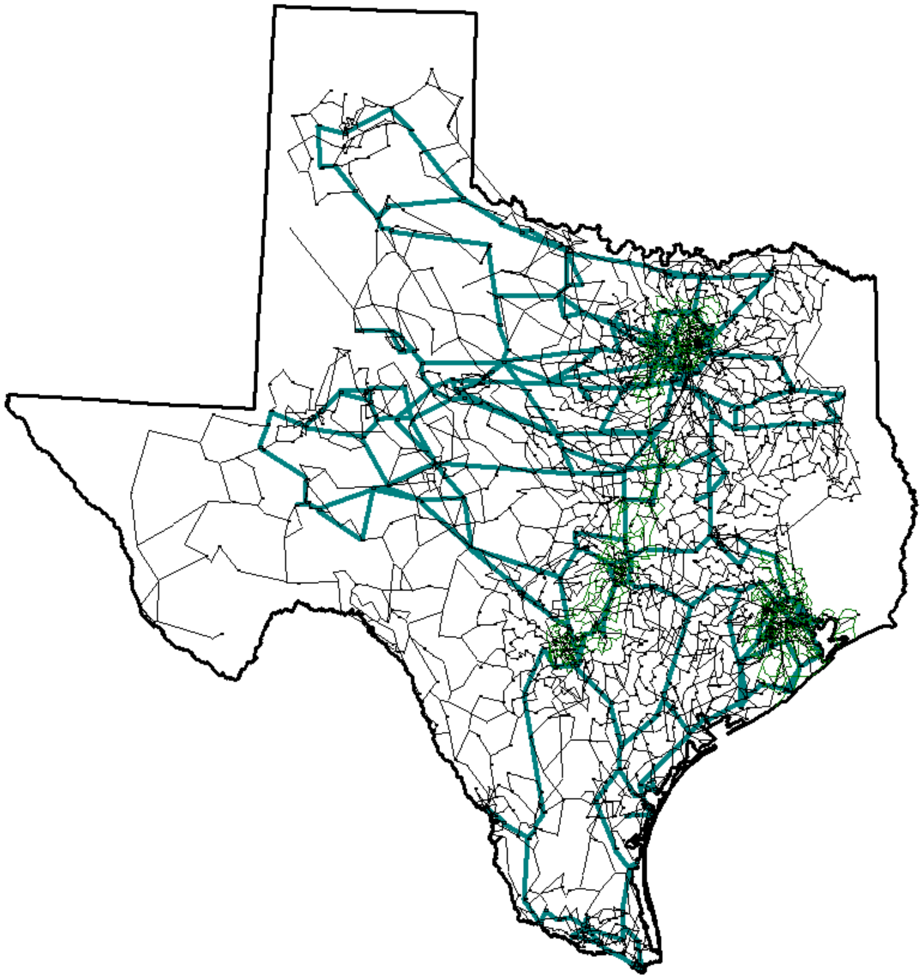
7000 Bus **Case - Loads**

- Additional large industrial loads have been added to match distribution of actual cases, assuming peak operational case
- Total of 74,277 MW of load



7000 Bus **Case – Network**

- 345 kV EHV network: total of 12,170 miles of lines
  - 479 MW/mile (rms)
- 138 kV network: total of 46,148 miles of lines
  - 82 MW/mile (rms)
- 69 kV network: total of 2577 miles of lines
  - 29 MW/mile (rms)



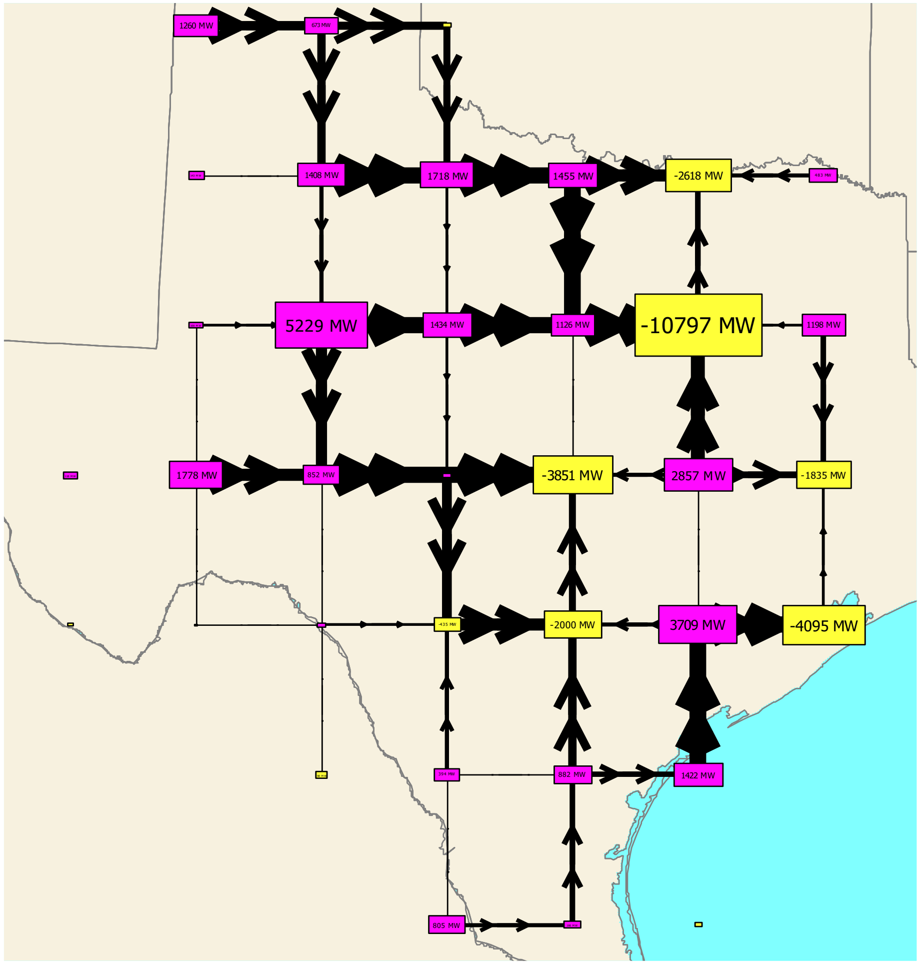
Loading values are the root-mean-square total of the power flowing on each mile of transmission for a given voltage level.

7K Statistics and Validation Example

Number of buses	**6,717**
Number of substations	4,894
Number of areas	8
Number of transmission lines	7,173
Number of transformers	1,967
Number of loads	5,095
Number of generators	731
Number of shunts	634
Total design load (GW)	75 GW

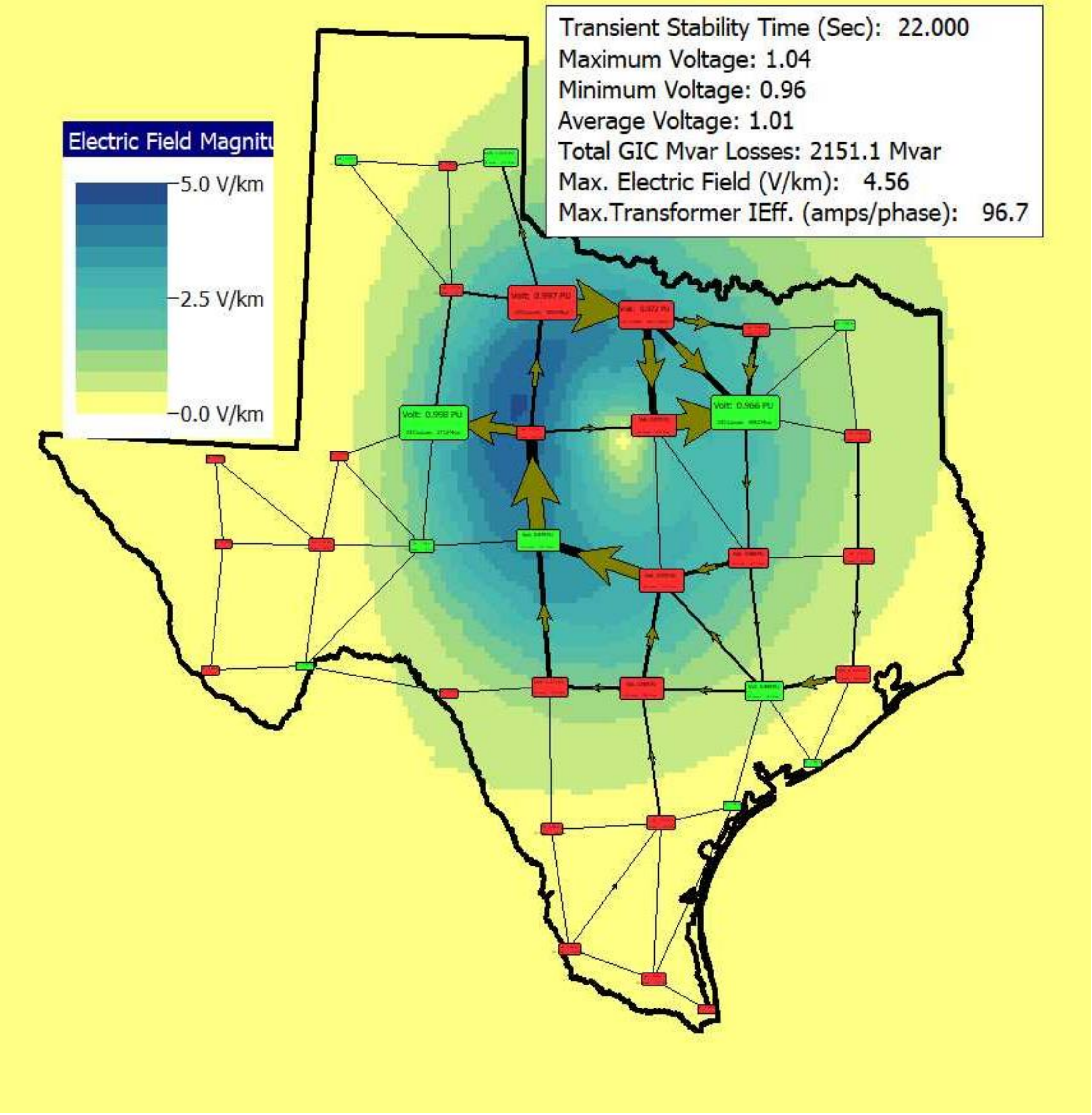
Validation Metric	Criteria	ERCOT Case
Buses per substation	Mean 1.7-3.5	1.4
Substations containing buses in kV range	<200 kV, 85-100%	99%
	>201 kV, 7-25%	5.3%
Substations with load	75-90%	92.5%
Load per bus	Mean 6-18 MW	11.1 MW
Load power factor	Mean 0.93-0.96	0.968
Substations with generators	5-25%	6.68%
Generator MW maximum Capacities	25-200 MW, 40+%	63.20%
	200+ MW, 2-20%	20.52%
Shunt capacitors and reactors.	10-25% of subs shunts	11.4%
	30-50% above 200 kV	37.8%

Visualization of Net System Flows

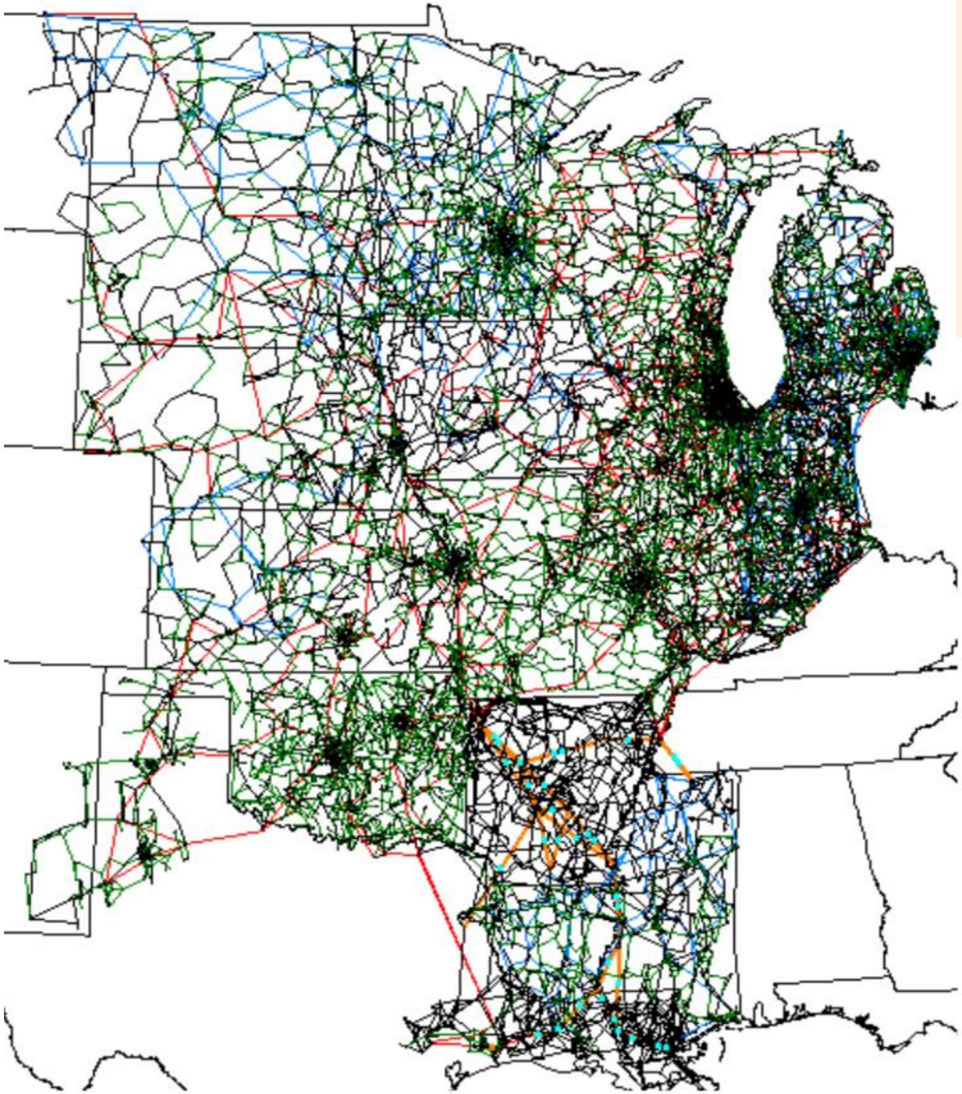


This display summarizes the system with the rectangles showing the net MW injection (magenta is generation) and the arrows show the MW line flows

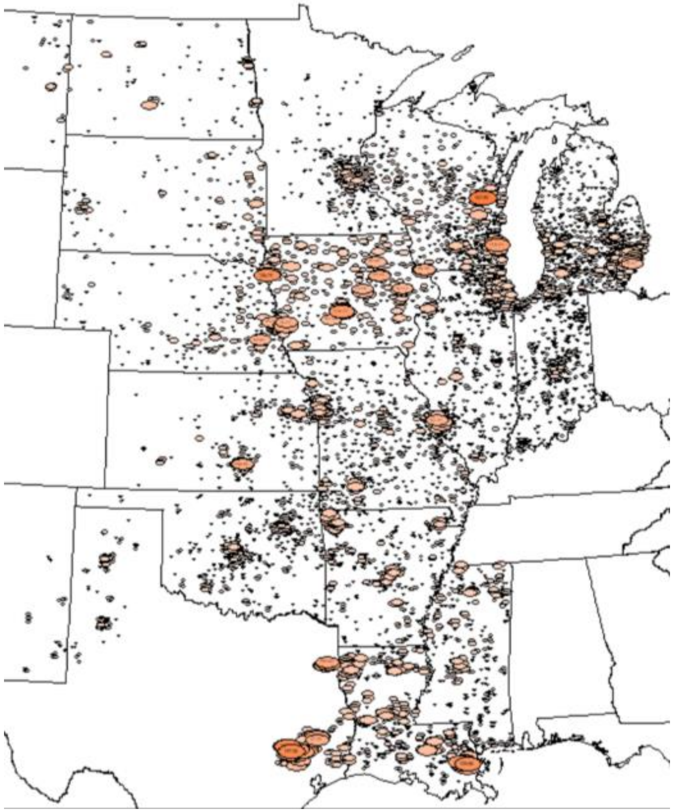
7000 Bus Case Application: EMP



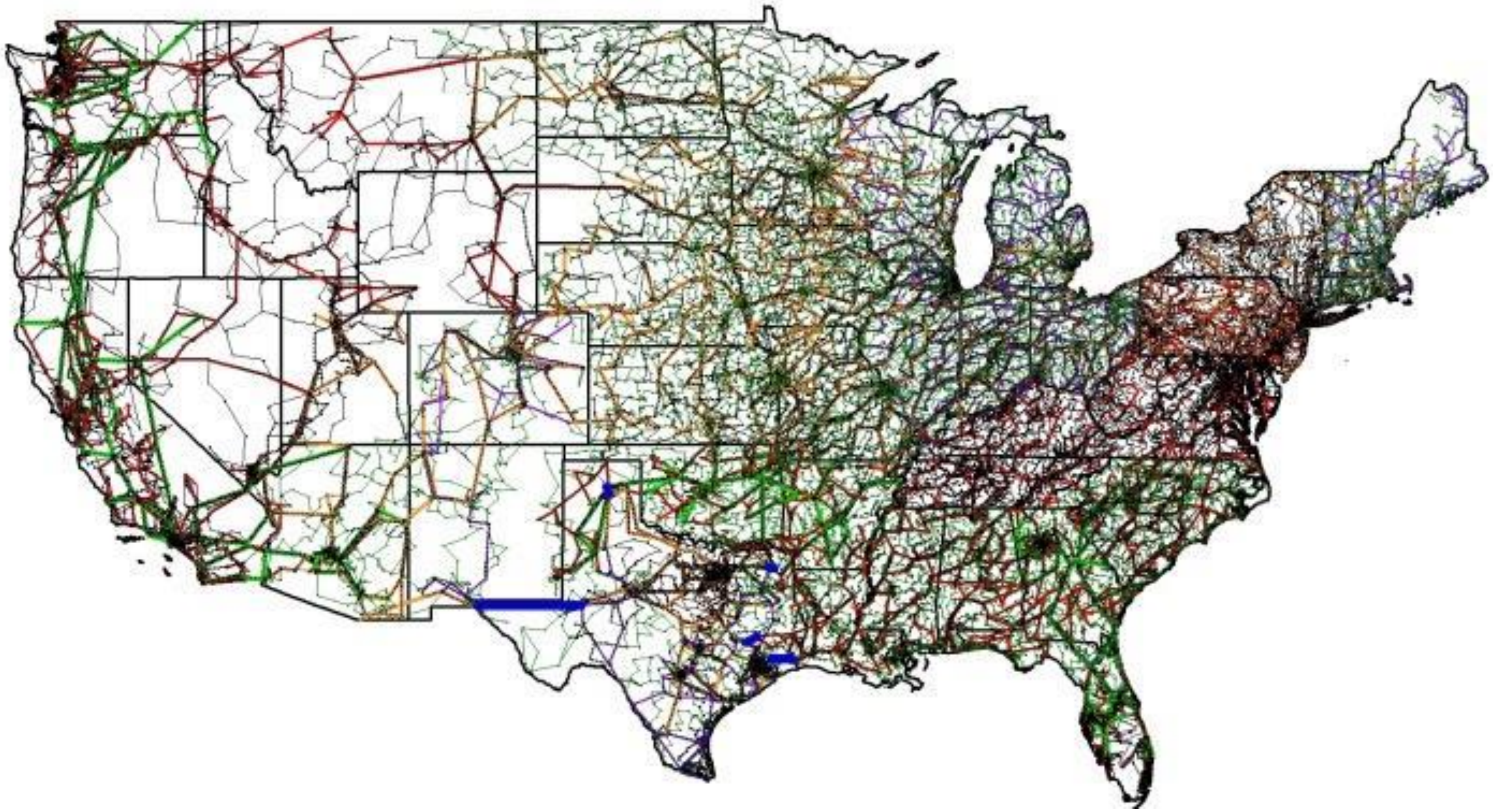
27,000 Bus SPP/MISO Grid



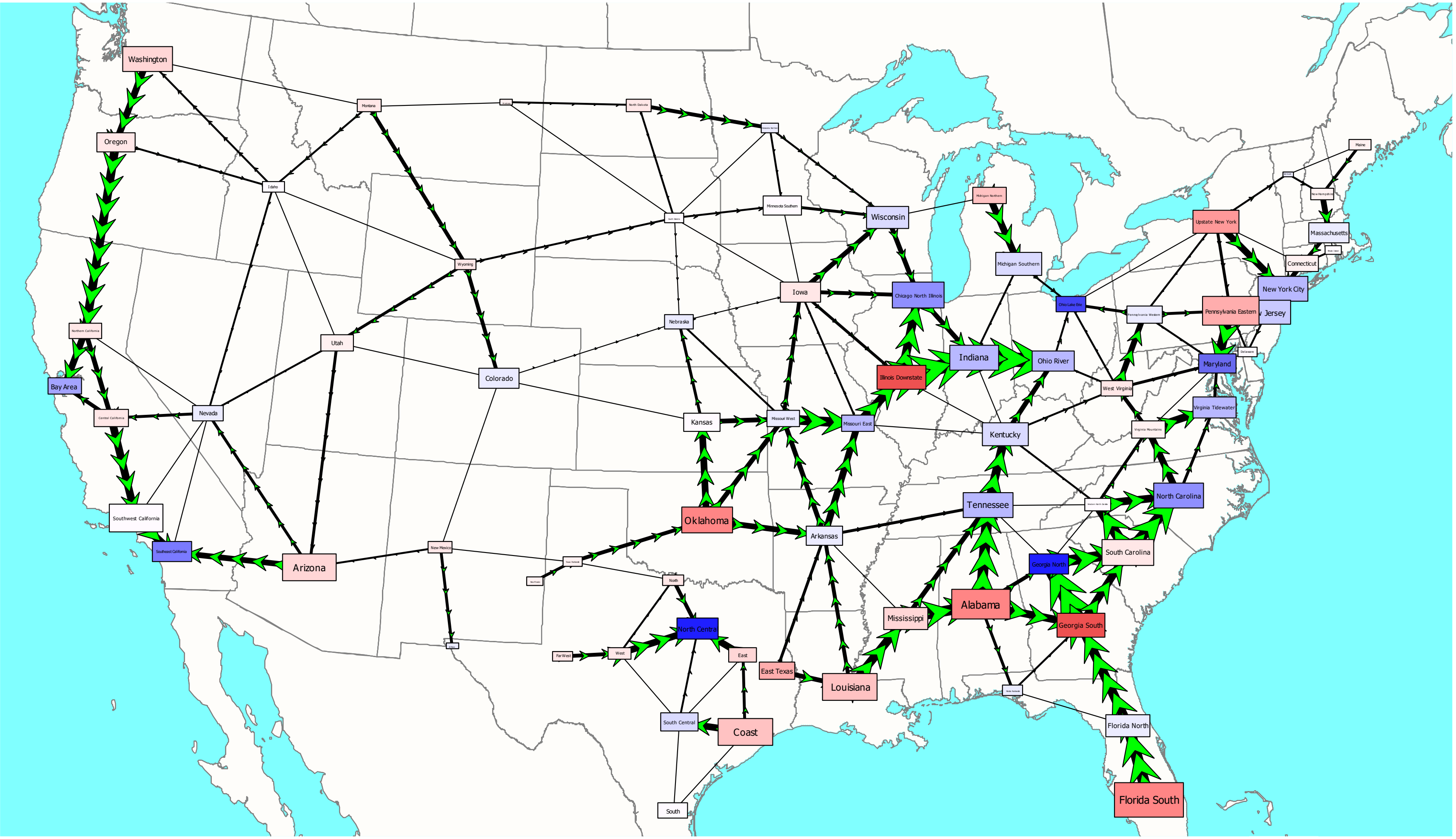
The system is designed with the voltages that actually exist in the various footprints; all transmission lines are synthetic



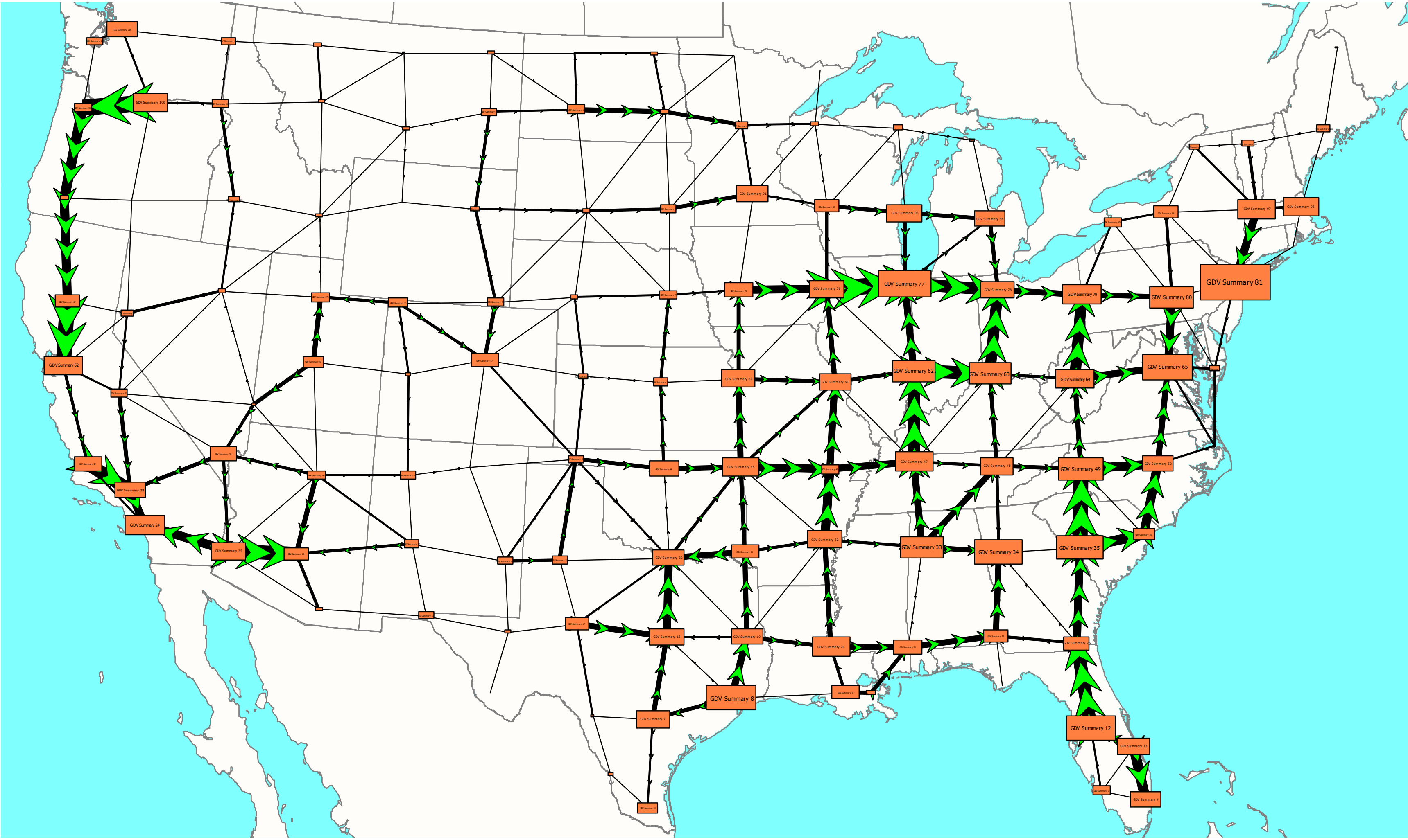
New Visualization Example with 82K Classic



Seeing the 82K Bus System Differently

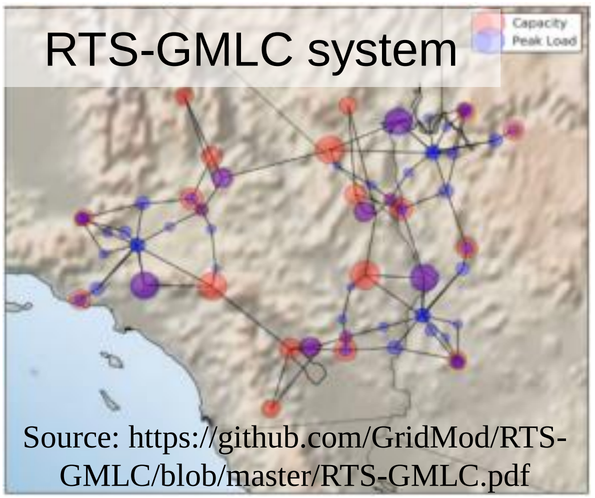


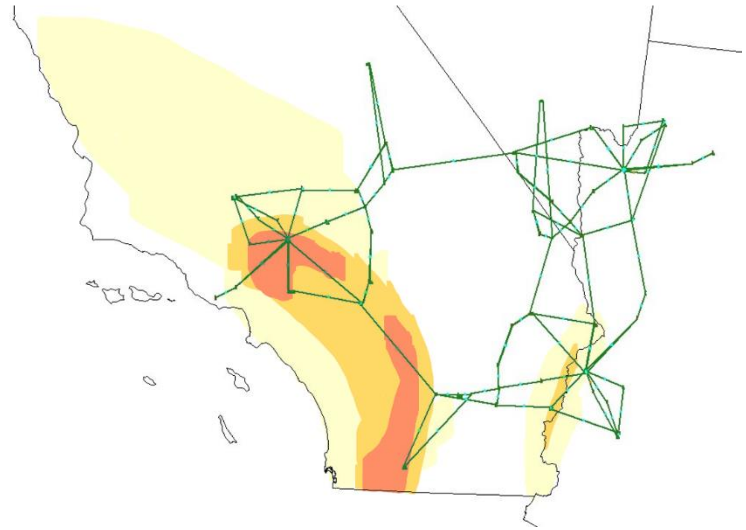
Or An Alternative for the 82K



Task 2: Developing Specific Grid Scenarios

- Developing scenarios for wildfire risk assessment





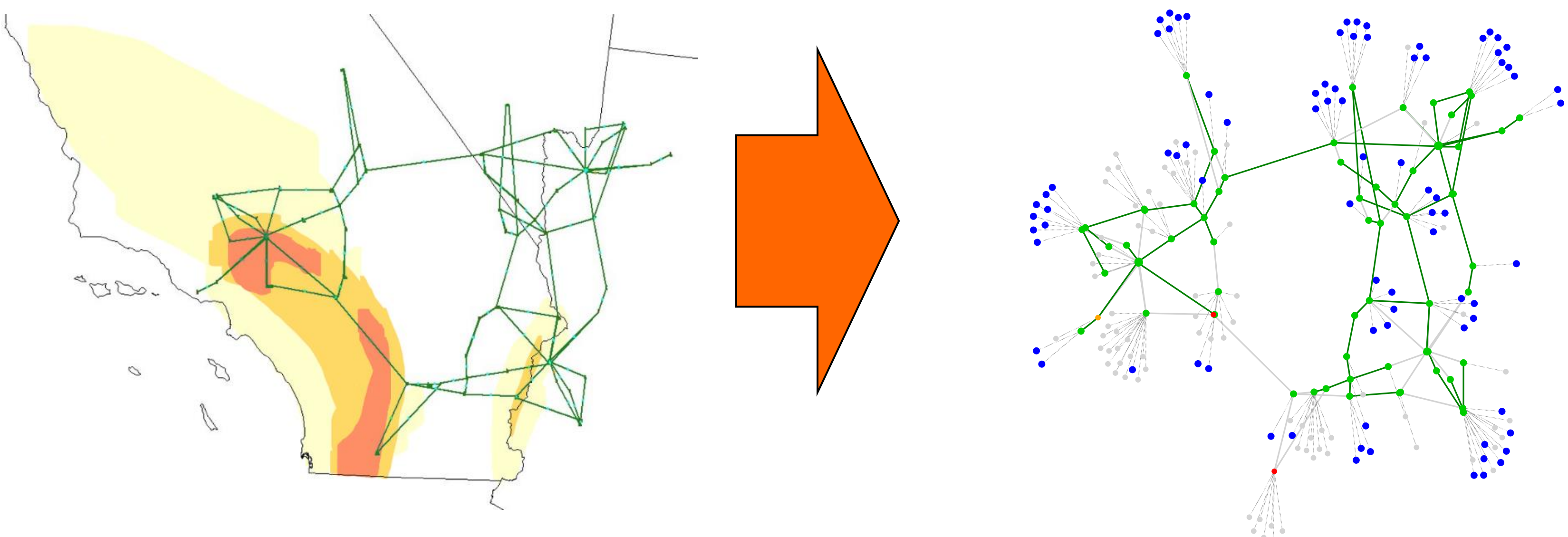
Low Risk
Medium Risk
High Risk
Very High Risk

Use geolocated grid to combine with geographic wildfire risk information

Rhodes, Ntaimo and Roald, "Balancing Wildfire Risk and Power Outages Through Optimized Power Shut-Offs", *IEEE Transactions on Power Systems*, in Press

Task 3: Risk-based Decision Making

- Developing scenarios for wildfire risk assessment



Use geolocated grid to combine with geographic wildfire risk information

Optimize public safety power shut-offs to minimize risk while maximizing load delivery

Rhodes, Ntaimo and Roald, “Balancing Wildfire Risk and Power Outages Through Optimized Power Shut-Offs”, *IEEE Transactions on Power Systems*, in Press

Task 3: Risk-based Decision Making

- Developing scenarios for wildfire risk assessment

Multi-objective optimization:

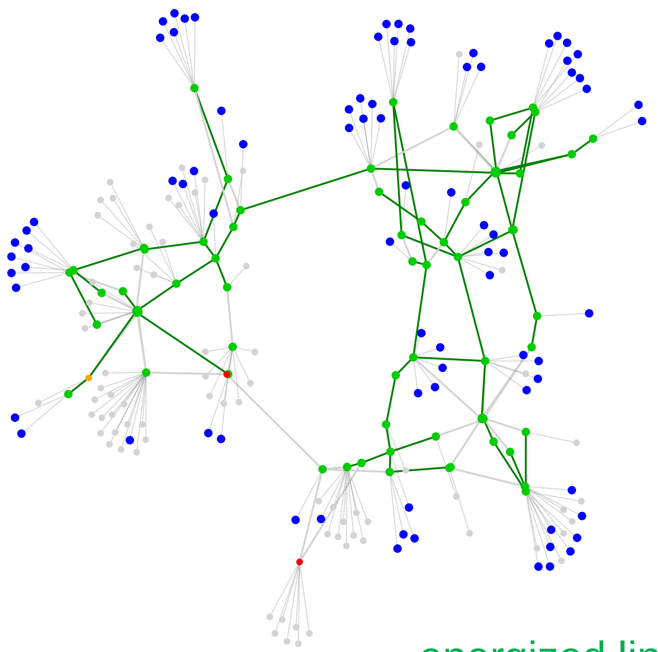
$$\max \quad (1-\boldsymbol{\alpha})D_{Tot} - \boldsymbol{\alpha}R_{Fire}$$

Focus on serving load

Total risk: 319.5 **(-57%)**

Load served: 8540 MW **(-0.1%)**

Solve time: 0.34 sec



energized line/node
energized generator
deenergized line
node with load shed

Rhodes, Ntaimo and Roald, "Balancing Wildfire Risk and Power Outages Through Optimized Power Shut-Offs", *IEEE Transactions on Power Systems*, in Press

Task 3: Risk-based Decision Making

- Developing scenarios for wildfire risk assessment

Multi-objective optimization:

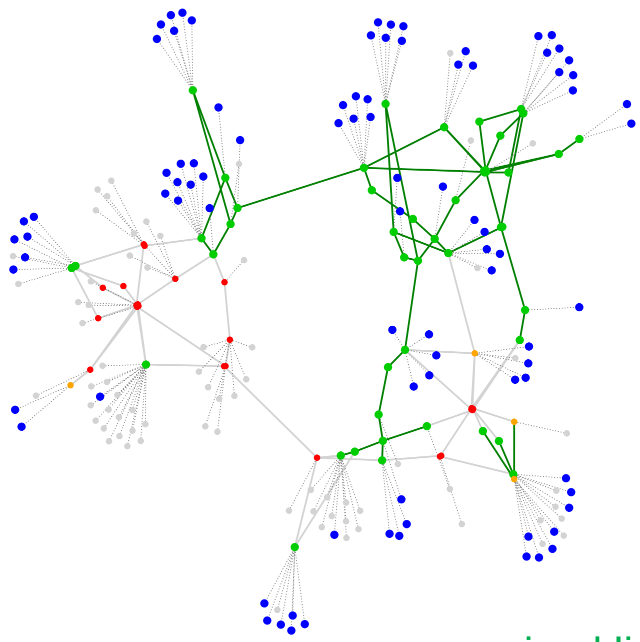
$$\max \quad (1-\boldsymbol{\alpha})D_{Tot} - \boldsymbol{\alpha}R_{Fire}$$

Focus on minimizing risk

Total risk: 57.4 **(-92%)**

Load served: 7210 MW **(-15.7%)**

Solve time: 0.33 sec



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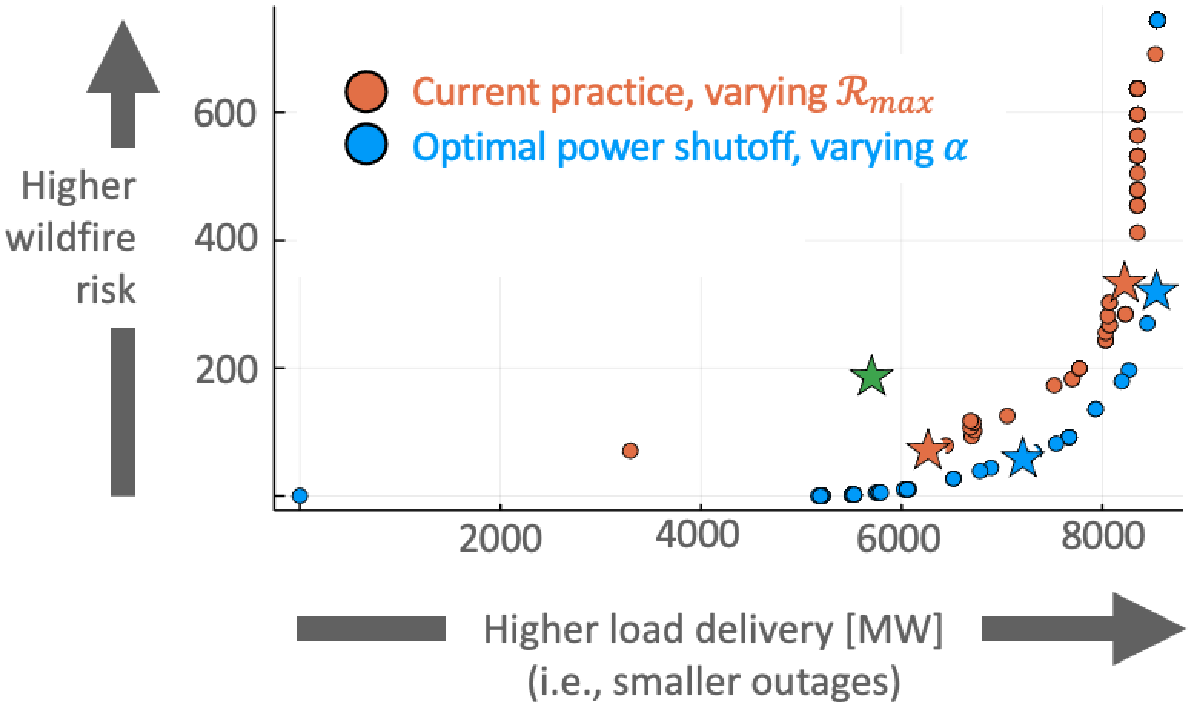
Task 3: Risk-based Decision Making

- Developing scenarios for wildfire risk assessment



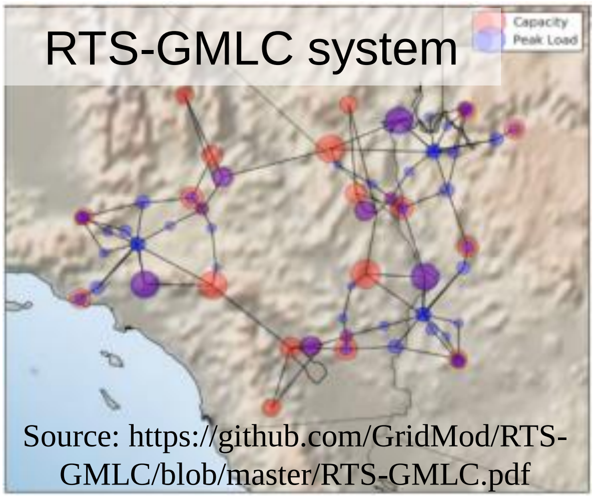
Pareto curve for different tradeoffs.

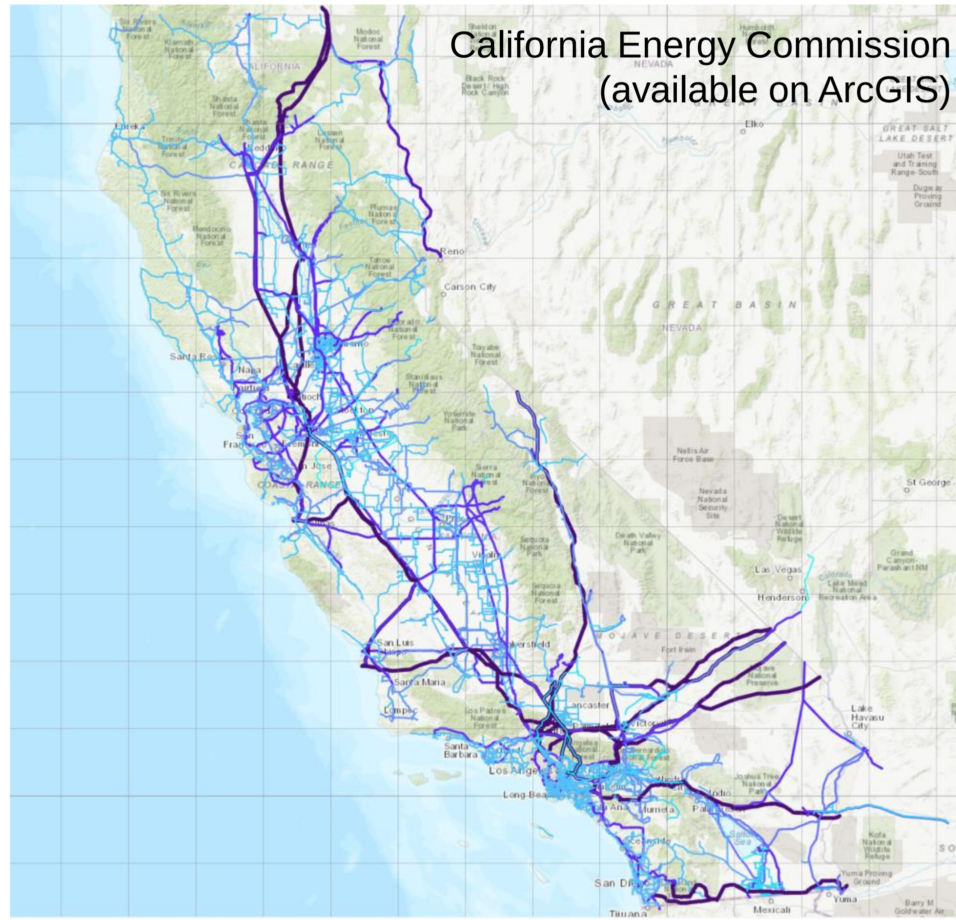
Accounting for **both** both wildfire risk and load shed achieves **lower risk and smaller outages**

Rhodes, Ntaimo and Roald, "Balancing Wildfire Risk and Power Outages Through Optimized Power Shut-Offs", *IEEE Transactions on Power Systems*, in Press

Task 2: Developing Specific Grid Scenarios

- Developing scenarios for wildfire risk assessment





How about wildfire risk assessment for the actual California grid???

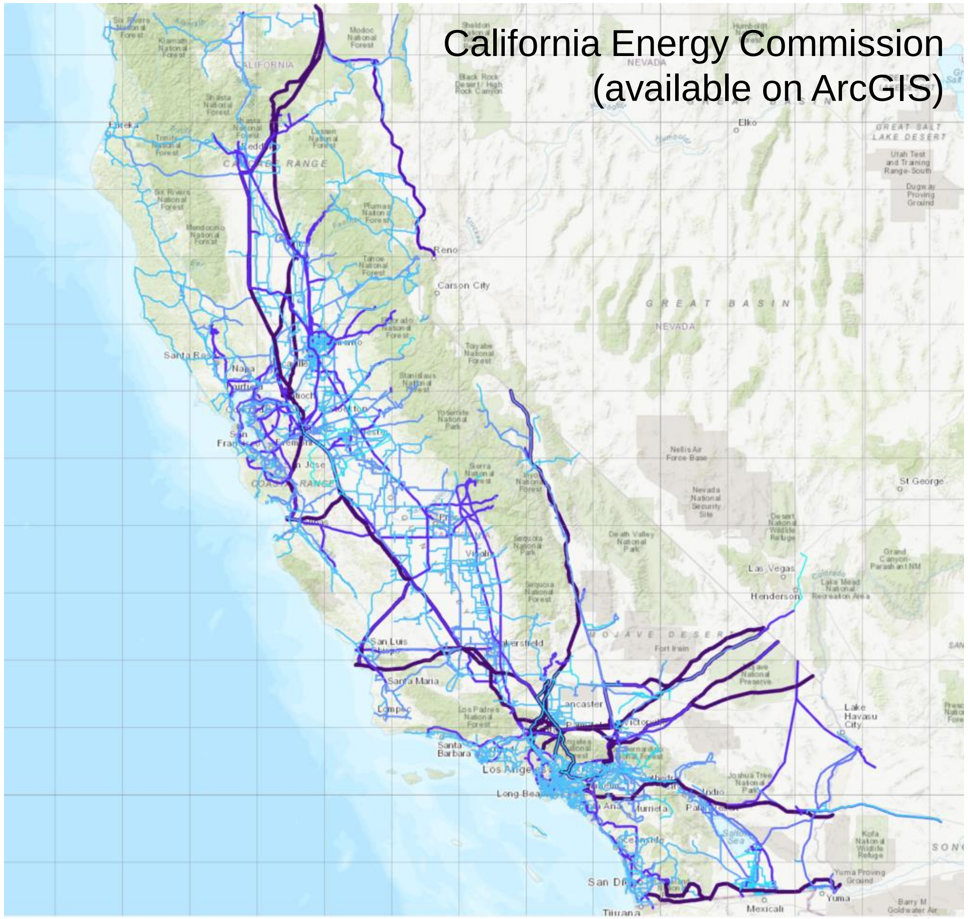
Task 2: Developing Specific Grid Scenarios

- Developing scenarios for wildfire risk assessment

Idea: Supplement publicly available grid data with synthetic data

Available:
- Geographic info
- Voltage level
- Generation (partial)

Missing:
- System topology (line connections)
- Line parameters
- Load/generation



Task 2: Developing Specific Grid Scenarios

- Develop and evaluate cyber-physical grid scenarios that consider DERs and threats involving them
- Use large scale synthetic models of Task 1, particularly coupled T&D models mentioned earlier, and expand them as necessary
- Develop specific hazard and threat scenarios for DERs
- Model interconnected cyber systems
- Generate and analyze data on these threats to develop defenses

Task 2: Developing Specific Grid Scenarios

- Idea is to better answer how to measure and control DER impact on resilience (in a cyber-adversarial environment)
- Student: Shashwat Tripathi (MS)

Task 3: Develop Scenarios to Explore Decision Making with Uncertainty

- Synthetic grids in our testbed allows us to explore user actions taken by different roles (i.e., operators) in a “sandbox” environment
- Using our CIR cyber-physical testbed, we will be researching ways to model and mimic operator actions, i.e., using deep reinforcement learning
  - Inferencing/predicting/recommending adversary/defender actions under uncertainty
  - Develop decision making algorithms
  - Experiments and evaluation of decision support algorithms for the DER hazard scenarios we will be developing in Task 2

Task 3: Develop Scenarios to Explore Decision Making with Uncertainty

- Use our cyber-physical testbed capabilities to help develop a sharable/remotely accessible platform for testing and comparison of these types of approaches for the community

Task 3: Develop Scenarios to Explore Decision Making with Uncertainty

- Conduct live exercises in our testbed, leveraging the models and tools developed in this project
- Allow different classes of users (i.e., this could range from undergraduate students all the way up to experienced operators) hands-on opportunities to interact with these models
  - (Note- I'd like to relate this back to potential work with the human factors experiments faculty member we'd met with a while back on this)
- Generate and analyze data to understand how decisions are made

Task 4: Coupling Synthetic Grids With Other Infrastructures

- Infrastructural dependency modeling for hazards
- Modeling cyber-physical interconnections
  - Cyber communications and control that directly support power systems
  - How to generate and store and manage these in a generic way for any case and scenario
- Extending to other dependencies that may impact power systems under hazards
  - Generation units and their dependencies
  - Natural gas
  - Transportation

Task 4: Coupling Synthetic Grids With Other Infrastructures

- Work on interdependency modeling will relate to the scenarios developed under Task 2
- Specifically, we will consider what infrastructure needs to be modeled to assess research questions about DERs and impact described earlier
- What are the interconnection points between these different infrastructural models?
- How do we properly store and share the information in multi-infrastructure power system models?

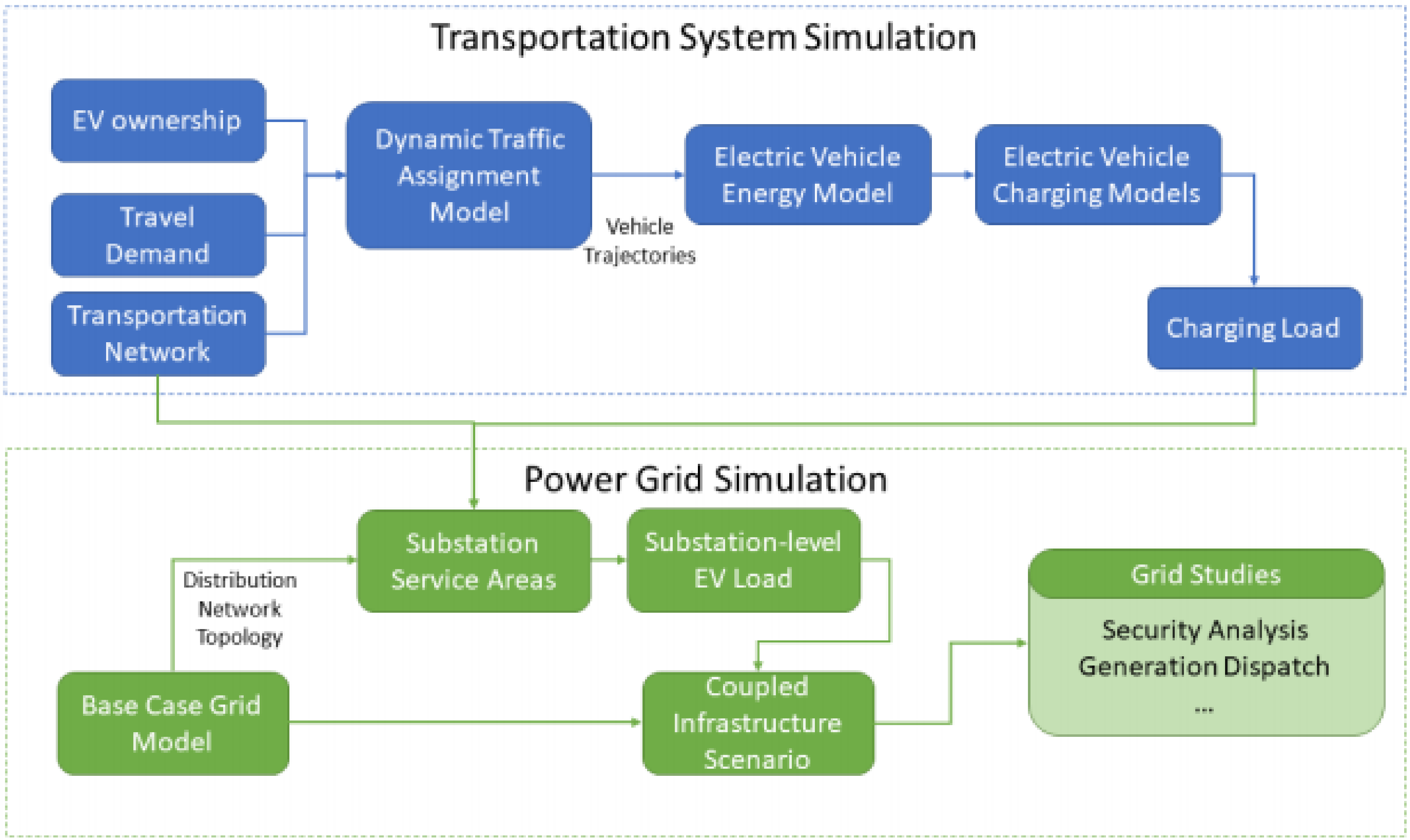
Task 4: Coupling Synthetic Grids With Other Infrastructures

- In this portion of the task we plan on exploring coupling our synthetic grids with other infrastructures
- This leverages the actual, parcel-level geographic coordinates in the highly detailed electric grids
  - Real and synthetic metadata can be used, such as the number of people at a location, the presence of electric vehicles, or the amount of distributed solar
- Our first focus will be on transportation

Task 4: Coupling Synthetic Grids with Transportation

- EV charging is the point of coupling
- EV consumption, charging patterns calculated with detailed traffic assignment and vehicle models
  - Light-duty vehicles completed
  - Ongoing work on fleet/freight
- Synthetic transmission networks with distribution topology can help map these loads to transmission substations
  - Algorithm implemented on Travis and Harris counties
  - In progress: Regional models, corridor modeling

Task 4: Coupling Synthetic Grids with Transportation

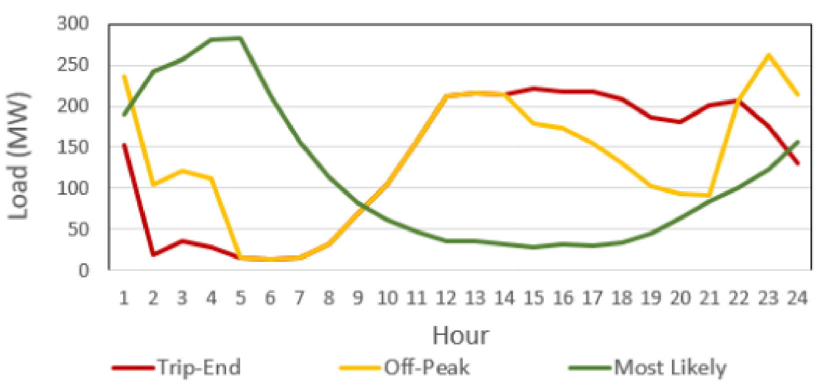


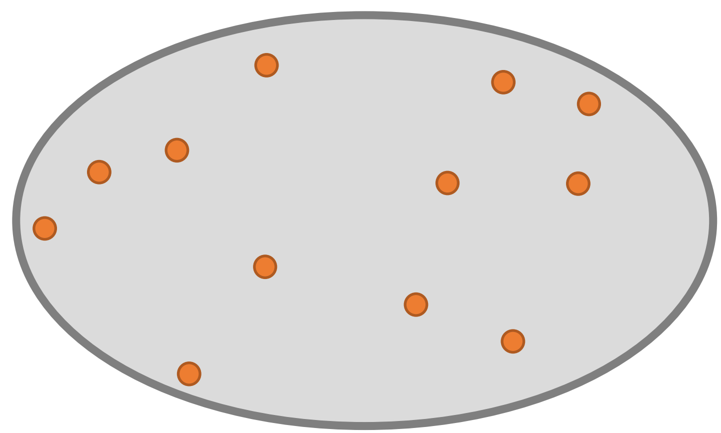
Task 4: Coupling Synthetic Grids with Transportation

Transportation Data

- Charging Scenarios
  1. Trip-End
  2. Off-Peak
  3. Most Likely

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1		A_NODE	A_LATITUT	A_LONGIT	Code	NodeA	NodeB	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
2	1	6003	30.42971	-95.3089	L(R:P2RDT	P2RDT681	P2RLV111	62.42297	62.98929	64.44821	64.83978	49.67	38.6534	30.71768	26.57155	18.59679	11.39413	8.150731	6.544
3	2	6018	30.51107	-95.4914	L(R:P2RDT	P2RDT114	P2RDT125	24.52217	22.26184	21.03688	24.08721	3.408617	10.43527	16.11052	44.28017	27.15319	27.59401	40.563	49.21
4	3	6020	29.60402	-96.0546	L(R:P2RDT	P2RDT209	P2RDT237	0	0	0	0	0	0	0	0	0.124707	0.002028	0	
5	4	6022	30.32626	-95.2129	L(R:P2RDT	P2RDT141	P2RDT129	0.819822	0.819822	0.819822	0.819822	0.551508	0.423417	0.378056	0.783917	0.469758	0.15804	0.291517	0.290
6	5	6044	29.40992	-96.0612	L(R:P1RDT	P1RDT251	P1RDT249	3.735583	4.319533	3.41687	5.773033	4.83191	12.32063	24.21392	53.52691	28.86022	29.16427	37.17694	43.32
7	6	6045	30.33803	-95.8663	L(R:P2RDT	P2RDT903	P2RDT127	1.373829	0.947623	0.901285	2.409191	1.567463	5.284711	12.42985	26.45445	15.01726	13.15154	13.52467	17.85
8	7	6049	30.26138	-95.8304	L(R:P8UDT	P8UDT143	P8UDT126	27.69624	27.77627	27.68839	27.80525	21.83069	16.28627	15.00071	16.59569	10.07472	5.601773	4.788288	4.417
9	8	6054	29.31204	-95.9015	L(R:P1RDT	P1RDT843	P1RDT900	71.99948	71.94987	71.95313	72.03036	56.42665	44.29153	34.86411	30.81337	20.05579	12.51488	9.494717	8.037
10	9	6055	30.27586	-95.9716	L(R:P2RDT	P2RDT187	P2RDT180	13.12653	13.25044	13.16321	13.23668	10.33716	8.919482	7.3912	8.482583	5.298116	2.909354	2.951753	2.816
11	10	6059	29.49983	-96.0312	L(R:P1RDT	P1RDT249	P1RDT247	24.65962	24.95968	25.42363	25.5001	20.06965	15.26704	11.75691	9.666474	6.649982	4.829607	3.27645	3.419
12	11	6060	29.77043	-96.0384	L(R:P2RDT	P2RDT233	P2RDT233	0.137562	0.137562	0.137562	0.137562	0.093754	0.079683	0.058999	0.048967	0.039342	0.033862	0.023696	0.008
13	12	6061	30.27345	-96.0422	L(R:P2RDT	P2RDT196	P2RDT201	3.979017	4.101817	3.982317	4.176361	3.08787	9.318506	14.71742	36.2525	19.81118	21.86378	26.27853	34.
14	13	6068	28.97664	-95.7768	L(R:P1RDT	P1RDT642	P1RDT120	0	0	0	0	0	0	0.372936	0.673233	0.419131	0.462386	0.860127	0.159
15	14	6069	29.06278	-95.84	L(R:P1RDT	P1RDT329	P1RDT116	0.730784	0.730784	0.730784	0.730784	0.534286	0.38116	0.290491	0.210129	0.108926	0.072699	0.049241	0.028
16	15	6070	28.91808	-95.6921	L(R:P1RDT	P1RDT100	P1RDT129	0.128718	0.002948	0.181936	0.173754	0.438026	1.422556	3.03218	6.710844	3.30317	1.375338	2.071211	3.034



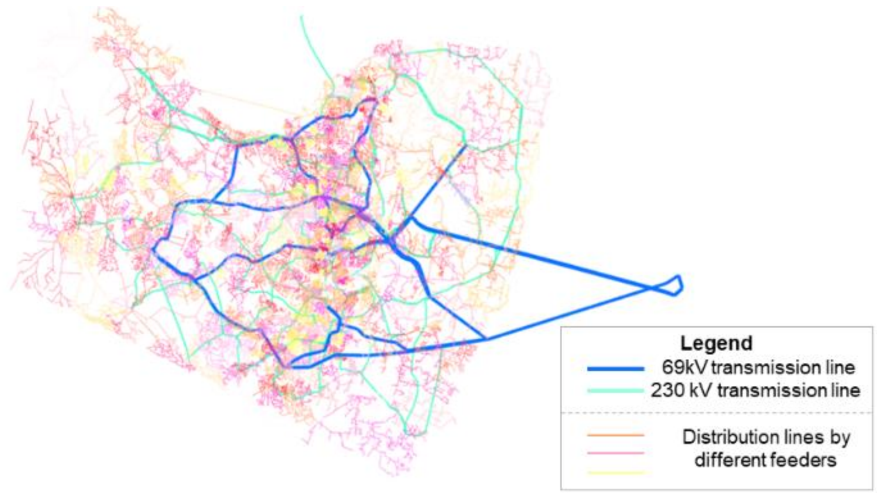


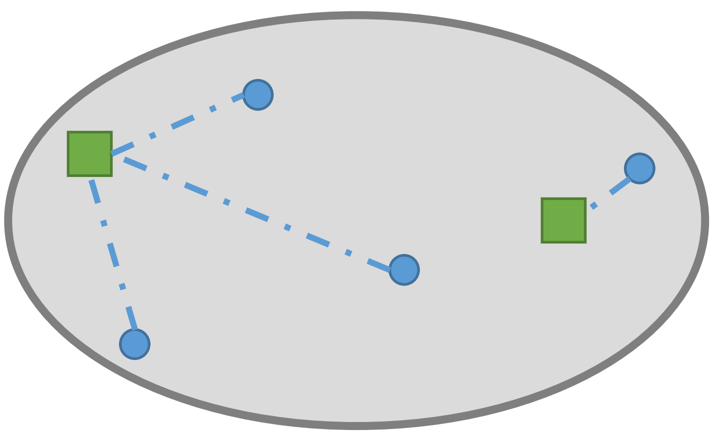
Task 4: Coupling Synthetic Grids with Transportation

Grid Data

Distribution Data

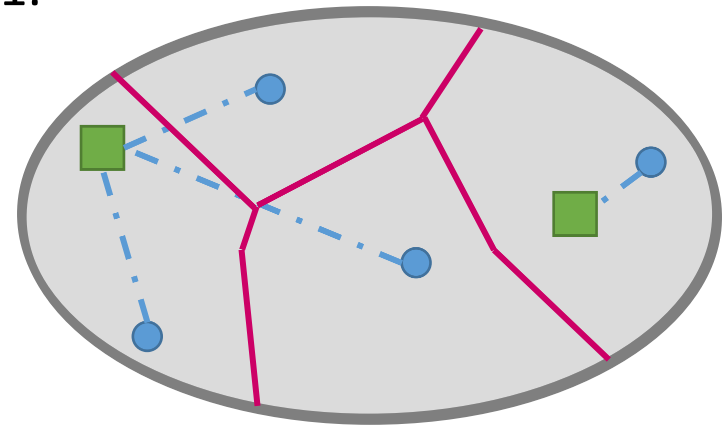
	A	B	C	D	E	F
1	Area	TransmissionSub	DistributionSub	NodeName	lon	lat
2	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm7	-89.381	29.766
3	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm8	-89.3809	29.766
4	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm9	-89.3816	29.766
5	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm10	-89.3758	29.771
6	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm11	-89.3756	29.77
7	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm13	-89.3754	29.771
8	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm14	-89.3751	29.771
9	p39u	p39uhs4_1247_69	p39uhs4_1247	p39udm18	-89.3753	29.770
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]





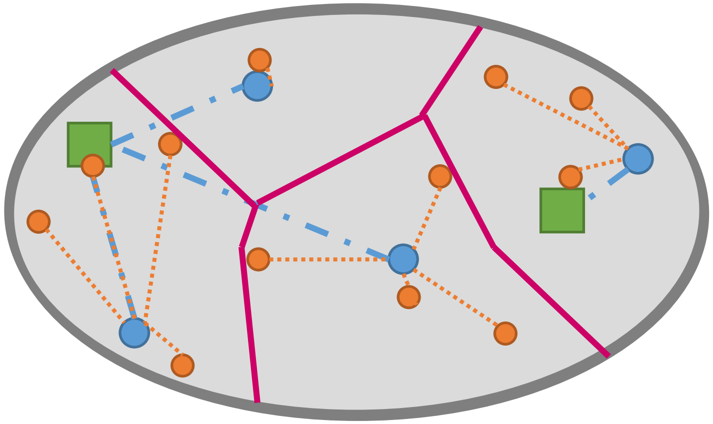
Task 4: Coupling Synthetic Grids with Transportation

1.



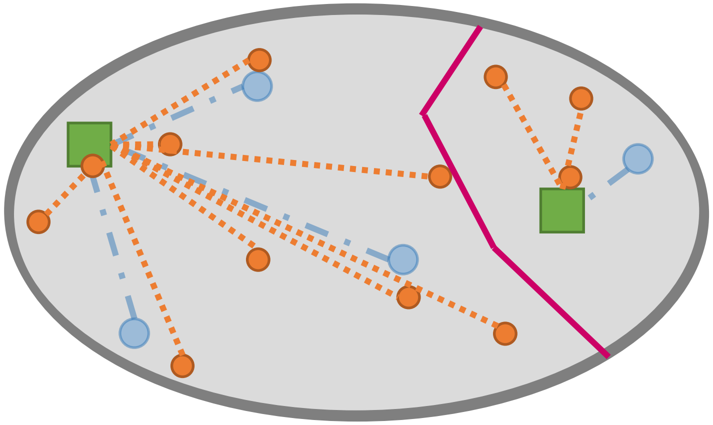
Establish Distribution-Level Service Areas

2.



Assign Transportation Nodes (i.e. Charging Locations) to Distribution Nodes

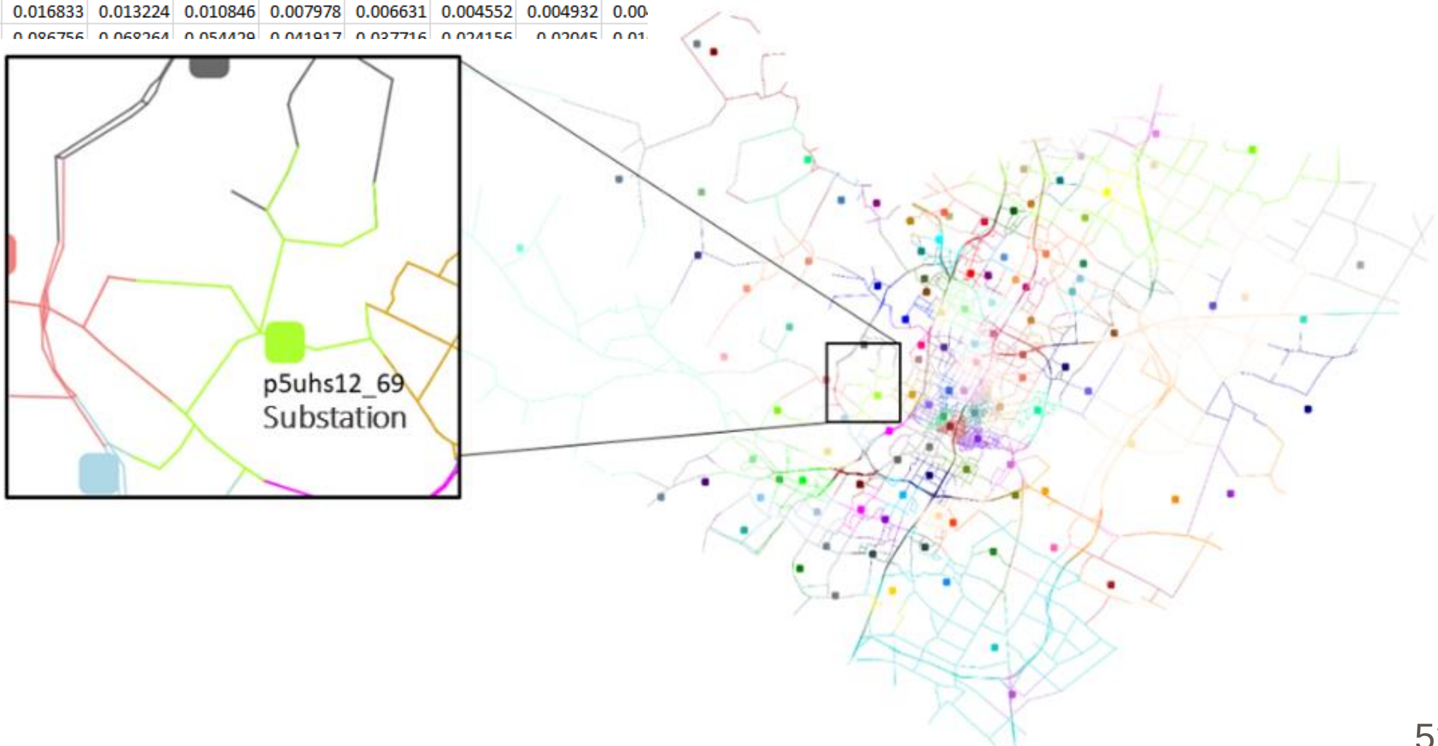
3.



Represent EV Charging Load on Transmission level

Task 4: Coupling Synthetic Grids with Transportation

A	B	C	D	E	F	G	H	I	J	K	L
Substation	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Alvin 2	0.007805	0.007805	0.007802	0.007802	0.006071	0.004567	0.004127	0.005049	0.002325	0.003139	0.00
Alvin 3	0.025254	0.025443	0.026434	0.026657	0.020666	0.015127	0.011869	0.011147	0.007296	0.004653	0.00
Baytown 1	0.044917	0.045142	0.046371	0.046585	0.036145	0.028458	0.022522	0.024204	0.016509	0.01106	0.00
Baytown 2	0.118035	0.119249	0.122134	0.123636	0.09621	0.073917	0.062246	0.055513	0.03903	0.023366	0.
Baytown 3	0.001902	0.001927	0.002171	0.001953	0.001443	0.001143	0.001193	0.001553	0.000991	0.00061	0.00
Baytown 5	0.099986	0.101197	0.104299	0.105323	0.082132	0.064804	0.048005	0.039155	0.027334	0.019299	0.01
Baytown 6	0.069873	0.0701	0.071225	0.071874	0.055035	0.042725	0.034157	0.029084	0.0205	0.013567	0.0
Channelview 1	0.007823	0.007792	0.007815	0.007756	0.006326	0.004992	0.003683	0.002996	0.00196	0.001696	0.00
Channelview 2	0.00712	0.007023	0.007459	0.007409	0.005794	0.004354	0.003717	0.004449	0.002793	0.001665	0.00
Cleveland	0.279484	0.28061	0.284848	0.285594	0.223263	0.173035	0.144768	0.147837	0.098856	0.056466	0.04
Deer Park 1	0.132612	0.134815	0.139772	0.140925	0.110293	0.085116	0.063249	0.048244	0.035421	0.02431	0.01
Eldon	0.057975	0.058292	0.058703	0.058878	0.046008	0.035389	0.027874	0.021646	0.015985	0.010518	0.0
Feeeport 2	0.425974	0.427259	0.445633	0.447492	0.34739	0.266418	0.202715	0.15553	0.113179	0.080811	0.06
Freeport 1	0.016251	0.016592	0.016682	0.016833	0.013224	0.010846	0.007978	0.006631	0.004552	0.004932	0.00
Freeport 2	0.083937	0.084905	0.085825	0.086756	0.068264	0.054429	0.041917	0.037716	0.024156	0.02045	0.01



Task 4: Coupling Synthetic Grids with Transportation

- Leveraging PSERC funding to apply to other grants on Transportation Electrification
  - NSF Sustainable Regional Systems Research Networks (SRS RN) – Planning grant in with TAMU, UTSA, TTU, Rice University (Jan 2021)
  - NSF Harnessing the Data Revolution, Institutes for Data-Intensive Research in Science and Engineering (HDR DIRSE)
  - ARPA-E OPEN (April)
  - DOE Vehicle Technologies Office (April)

The Simulation Environment at Texas A&M

Summary

- The goal of the project is to work closely with the industrial team to generate value from large-scale, detailed and realistic synthetic electric grids.
- The four project tasks are
  1. Developing customized grids
  2. Developing specific grid scenarios
  3. Exploring decision making with uncertainty
  4. Coupling the synthetic grids with other infrastructures
- The project is off to a great start, and we're very excited to be doing this project and to have such a strong PSERC IAB team!

Thank You! Questions and Discussion