Forecasting the Future of EVs: Predicting the Grid

UtilityAnalytics Summit
May 2022

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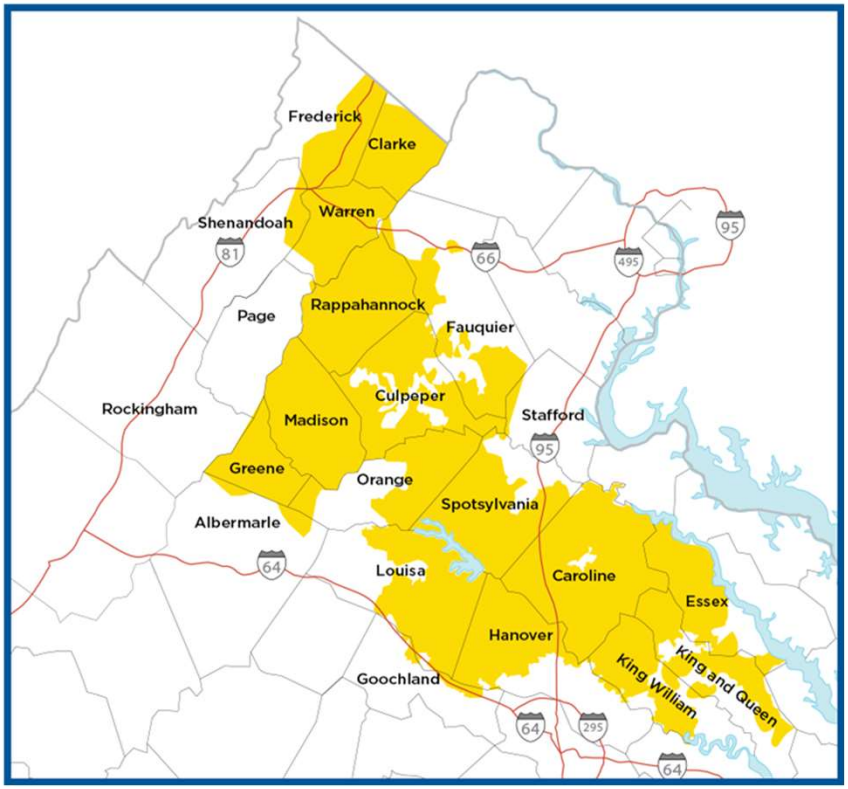
RAPPAHANNOCK ELECTRIC COOPERATIVE

RELIABLE • AFFORDABLE • FOCUSED ON YOU

- Distribution electric Cooperative in Virginia serving 22 Counties
- Just over 170,000 connections
- More than 17,000 miles of line
- 400+ Employees



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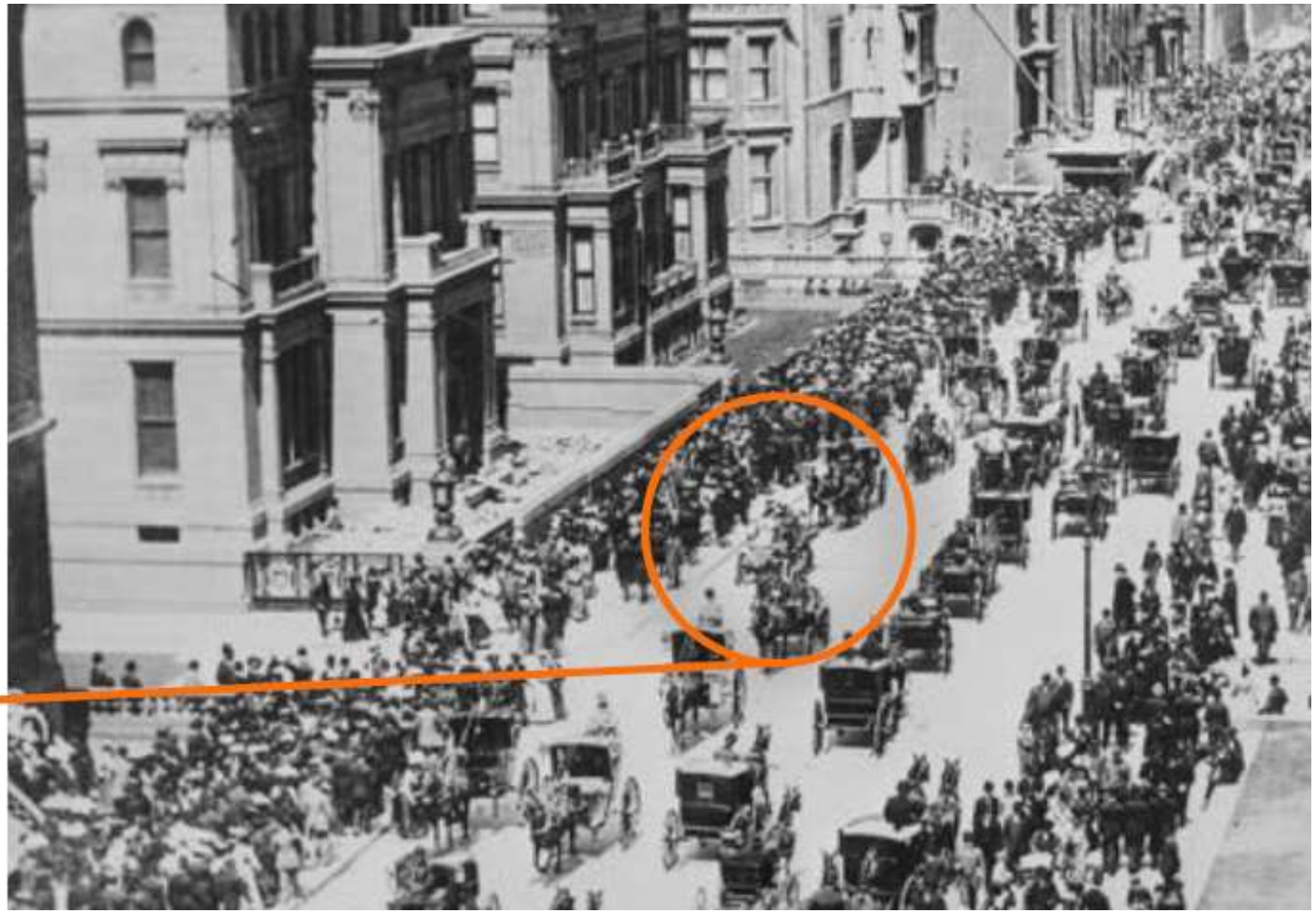
5th AVE NYC

1900

Where is the car?



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5th AVE NYC

1913

Where is the horse?

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Data driven studies to answer key questions:

1

When, where, and what are the impacts to the grid from increased Electric Vehicle (EV) adoption and charging?

- How can we equip employees to plan for mitigation measures?

2

How much capacity do distribution transformers have remaining to support EV charging?

- How can we make this data readily available to employees to make decisions?

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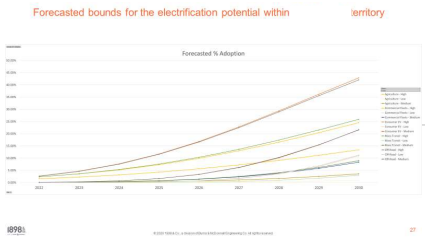
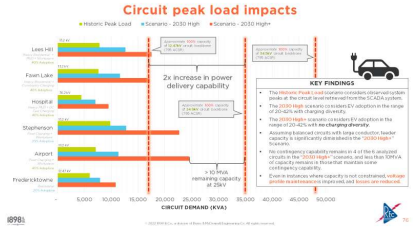
EV Market Potential and Adoption

Understanding the vehicle electrification potential across a territory frames the market size



Based on estimated duty cycles and expected EV charge power, energy and demand can be evaluated at a high level



Quantify the Market

Develop a high-level assessment of the electrification potential for different vehicles classes

Adoption Forecast

Develop potential adoption of vehicles over time

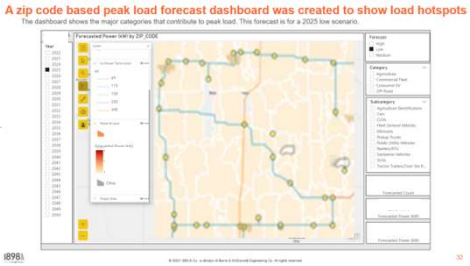
Estimate Energy & Demand

Estimate mileage and vehicle duty cycles to estimate energy

Grid System Impacts

Use loading forecast to estimate impacts for Transmission and Distribution Systems

Based on demographics, income, existing EV purchase trends and national EV purchase trends, adoption forecasts can be estimated



Output of the forecast to be used for system impact assessment

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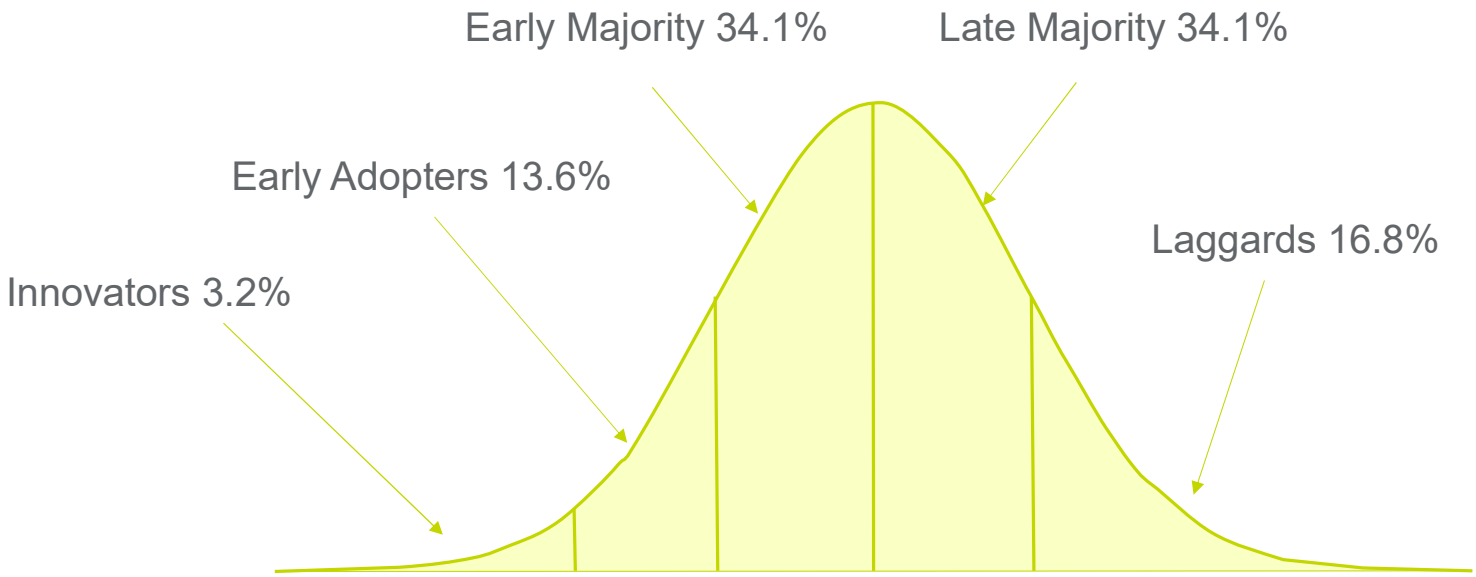
The adoption of new technology generally follows the diffusion of innovation theory



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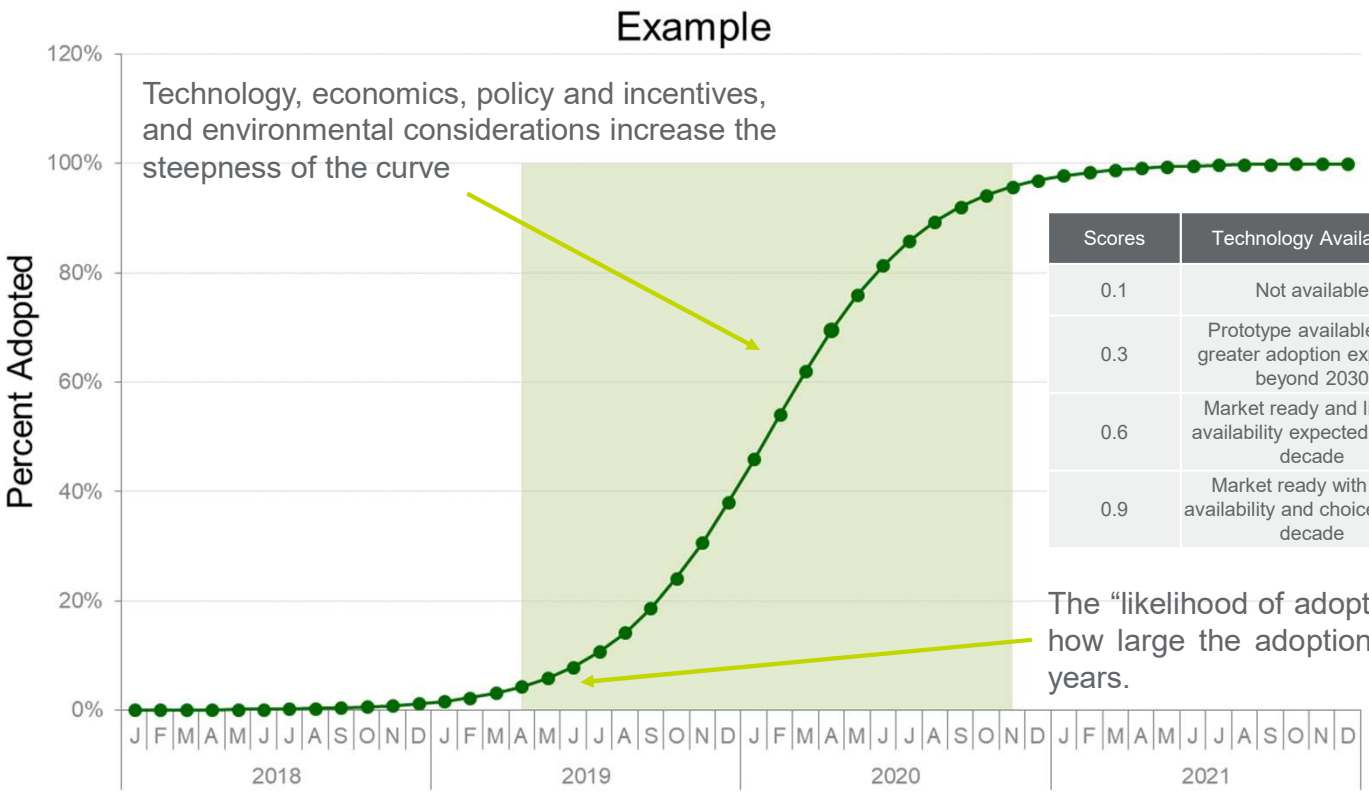
From the diffusion of innovation theory, we can develop curves that can model adoption over time



Scores	Technology Availability	Economic Benefit	Policy and Incentives	Environmental & Health Benefits
0.1	Not available	No economic benefit	Illegal or Negative Policy	-
0.3	Prototype available with greater adoption expected beyond 2030	No immediate economic payback but owner pursues conversion	No Incentive Policy or Partially Restrictive Policy	No Environmental Benefit
0.6	Market ready and limited availability expected in next decade	Economic payback possible	Policy Incentives	Environmental Benefit
0.9	Market ready with wide availability and choice in next decade	Improved economics over conventional ICE technology	Mandated / No other option / Will be new load	Great Environmental Improvement

The “likelihood of adoption” field determines how large the adoption will be in the early years.

Note: Assumed a start value of 0%. Expected market size accounts for some categories being already adopted. Other categories are at very low adoption levels.

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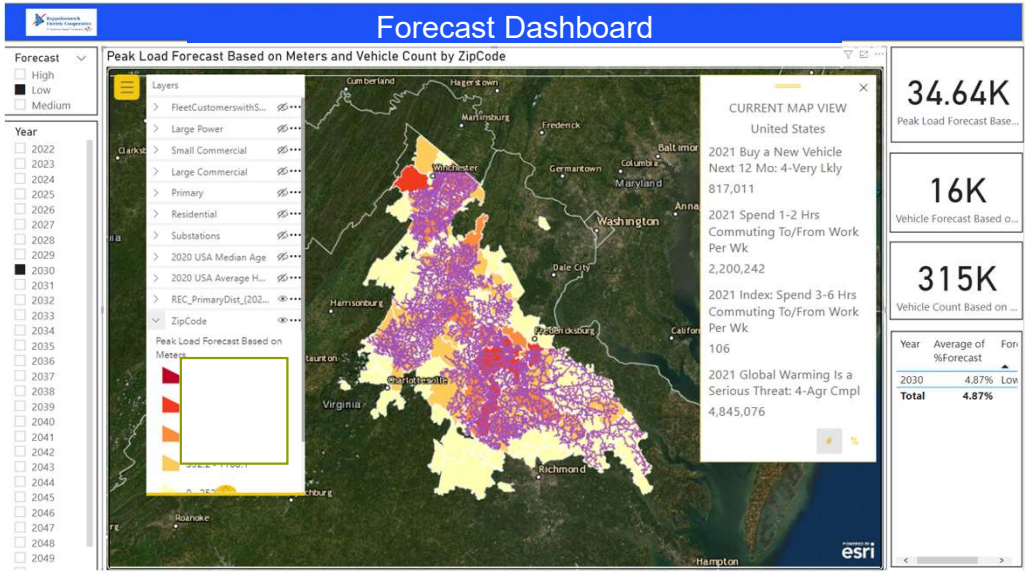
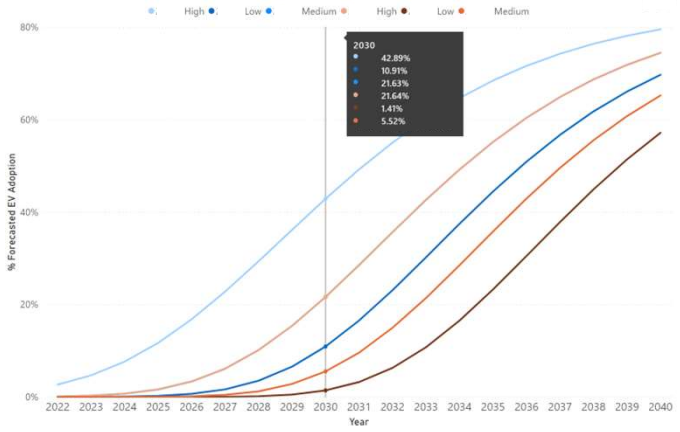
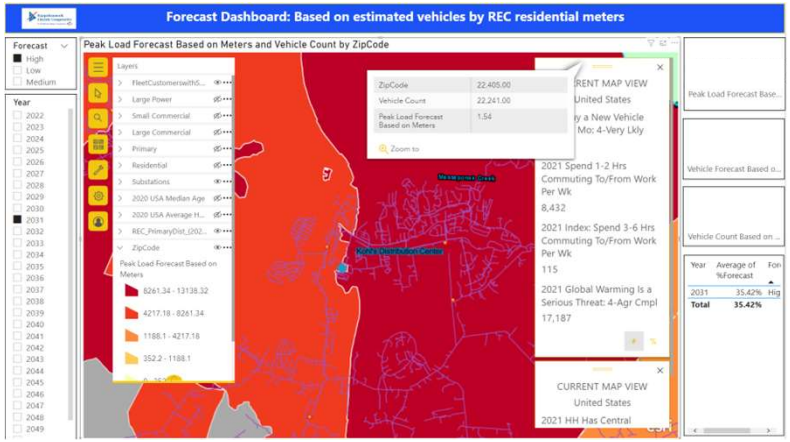
Zip code level EV forecast to identify “hot spots”







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EV Market: Vehicle Specifications

	Vehicle Type	Efficiency (kWh/mi)	Range (mi)	Battery Size (kWH)	Charge Rate (kW)
 Available	Class 1 Passenger Car & Small SUV	0.25-0.35	150-350	40-100	Level 2: 7-11 kW DCFC: 50-350 kW
				Typical Peak Residential Demand ~ 5-7kW	
 2022	Class 1 &2 Pickup Trucks and Large SUV	0.4-0.6	100-300	100-200	Level 2: 11-19.2 kW DCFC: 150-350 kW
 2022	Class 2/3 Light Duty Vehicles	0.5-1	120-150	67-140	Level 2: 19.2 kW DCFC: 50-150 kW
				Typical Depot: ~20-100kVa (Lighting/HVAC loads)	
 Available	Class 3-5 Buses/Utility Vehicles	1-1.5	105-205	110-230	Level 2: 13-19.2 kW DCFC: 50-150 kW
 Development	Class 6-8 Bucket Trucks	2-4	~90 (With Aux Power)	250-350	Level 2: 19.2 kW DCFC: 150 kW
 Pilot/Drayage in CA	Class 6-8 Trucks/Tractor Trailers	2+	125-250	230-500	Level 2: 19.2 kW DCFC: 50-250 -> 1MW+ in the future

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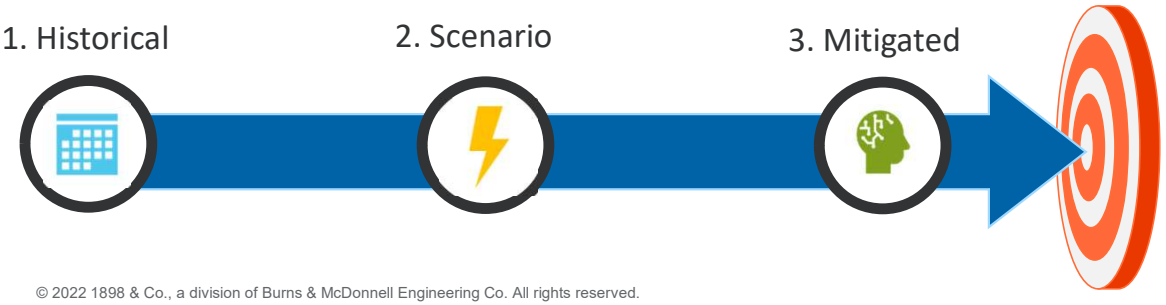
Power flow model development

BA0

- **Historical Model** – Capture historical peak load and establish baseline scenarios for EVs to be added to
- **Scenario Model** – Introduce EV charging load to the distribution system during historical peak load case to evaluate grid impacts
- **Project Model** – Develop projects to efficiently support EV charging load while maintaining operation within compliance ranges



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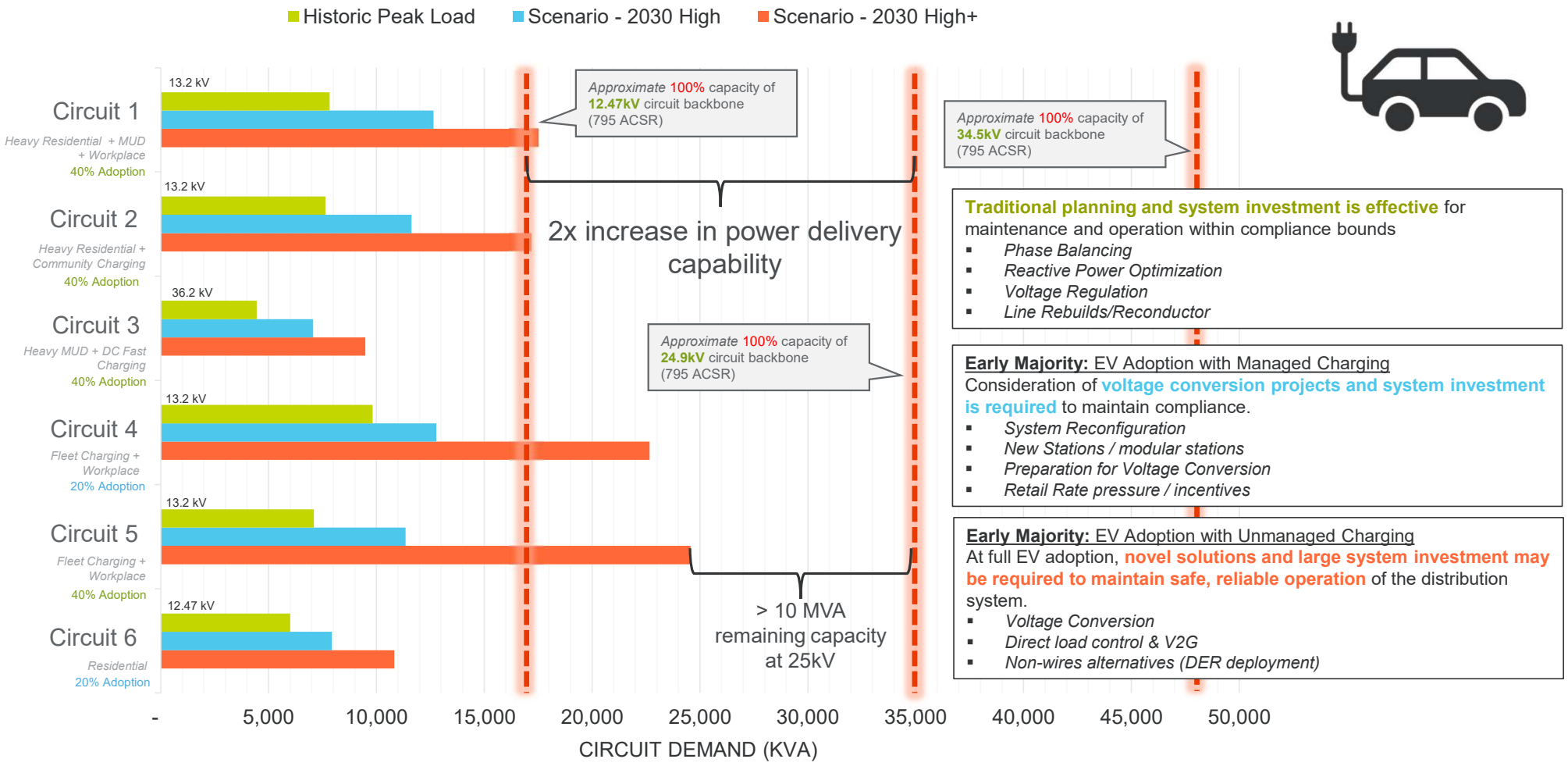
Slide 11

BA0 Historical: Establish baseline scenarios for EVs to be added to
Boyle, Carter A, 2022-05-05T00:32:14.087

LJ(0 0 done
Loyd, Joshua (Josh), 2022-05-05T02:15:29.952

LJ(1

Variable EV behavior yields variable grid strategy



Traditional planning and system investment is effective for maintenance and operation within compliance bounds

- *Phase Balancing*
- *Reactive Power Optimization*
- *Voltage Regulation*
- *Line Rebuilds/Reconductor*

Early Majority: EV Adoption with Managed Charging

Consideration of **voltage conversion projects and system investment is required** to maintain compliance.

- *System Reconfiguration*
- *New Stations / modular stations*
- *Preparation for Voltage Conversion*
- *Retail Rate pressure / incentives*

Early Majority: EV Adoption with Unmanaged Charging

At full EV adoption, **novel solutions and large system investment may be required to maintain safe, reliable operation** of the distribution system.

- *Voltage Conversion*
- *Direct load control & V2G*
- *Non-wires alternatives (DER deployment)*

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Slide 12

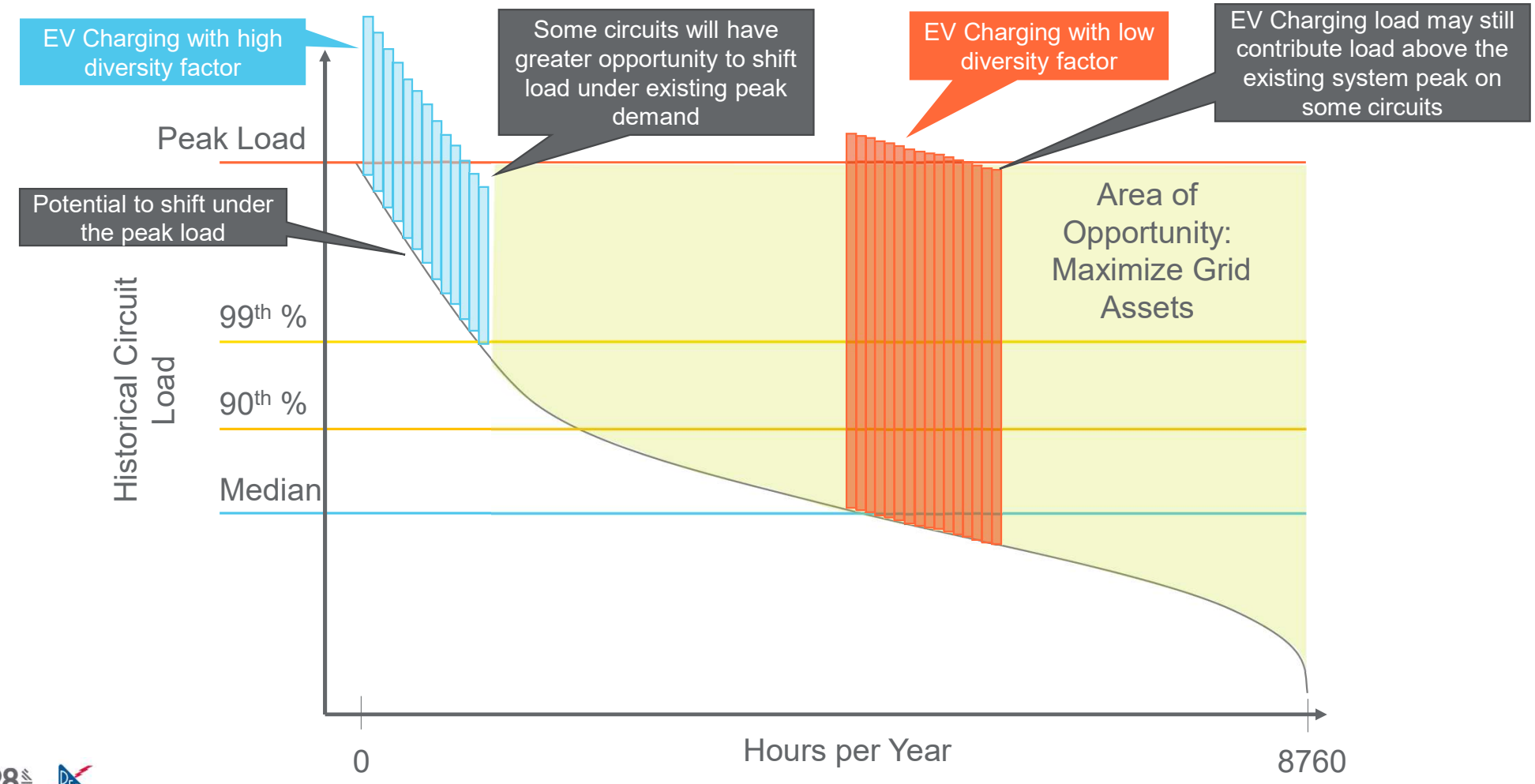
BA0 Really like this slide
Boyle, Carter A, 2022-05-05T00:51:04.414

LJ(1 Planning criteria that doesn't allow it to get to 100%
Loyd, Joshua (Josh), 2022-05-05T14:33:05.563

LJ(1 0 Planning limit 50-80% before triggering upgrades
Loyd, Joshua (Josh), 2022-05-05T14:33:28.771

BA0

By shifting the EV charging peak, an opportunity exists to maximize grid assets



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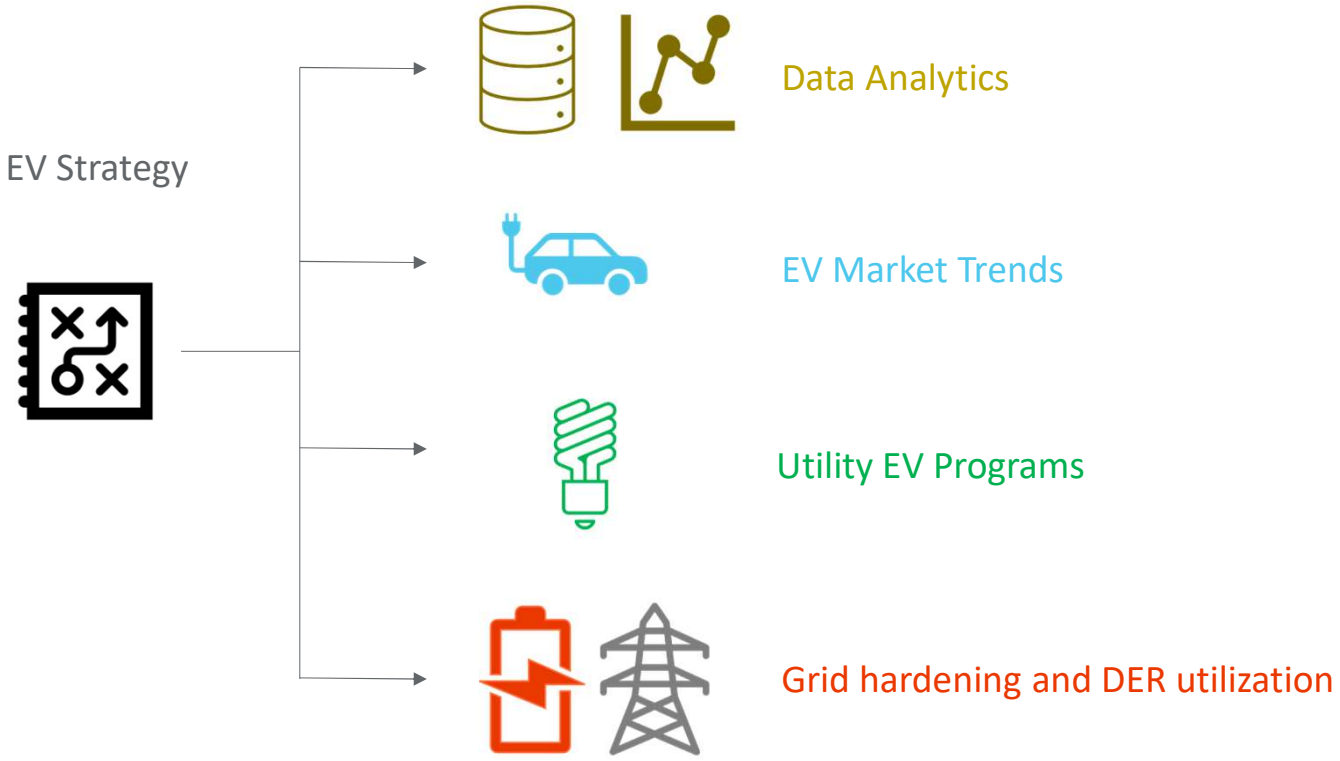
Slide 13

BA0 This slide takes a little digesting. Making the labels for what is on the graph different from the explanations of the graph will probably make the purpose a little more... Salient :)

Boyle, Carter A, 2022-05-05T00:56:14.063

How to prepare for potential EV Adoption?

Data collection, analysis, and collaboration are necessary to proactively evaluate, plan, and prepare for materializing impacts from EV charging.



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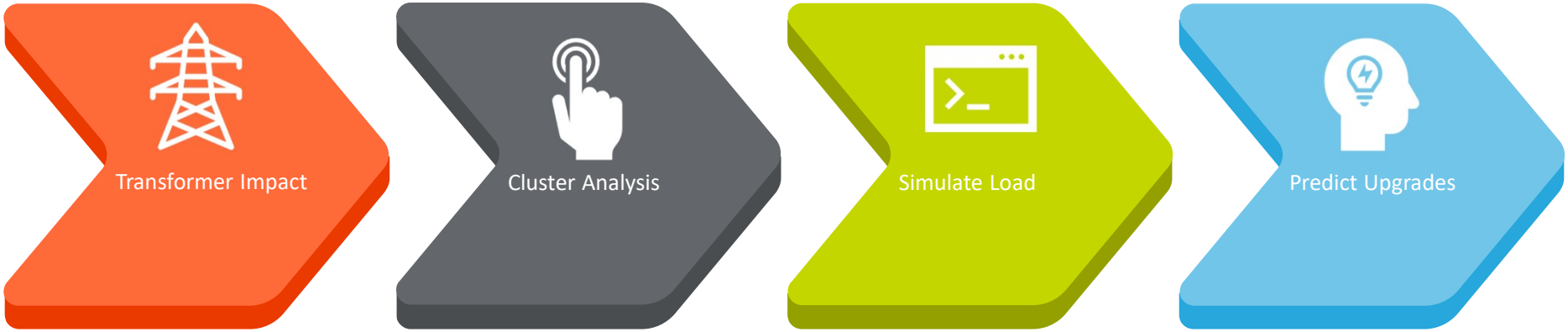
Next Steps



- Assess distribution transformer Impacts
- Leverage analysis from individual circuits to perform a cluster analysis
- Continue to simulate increased load from EV charging
- Identify equipment upgrades before compliance tolerance is exceeded

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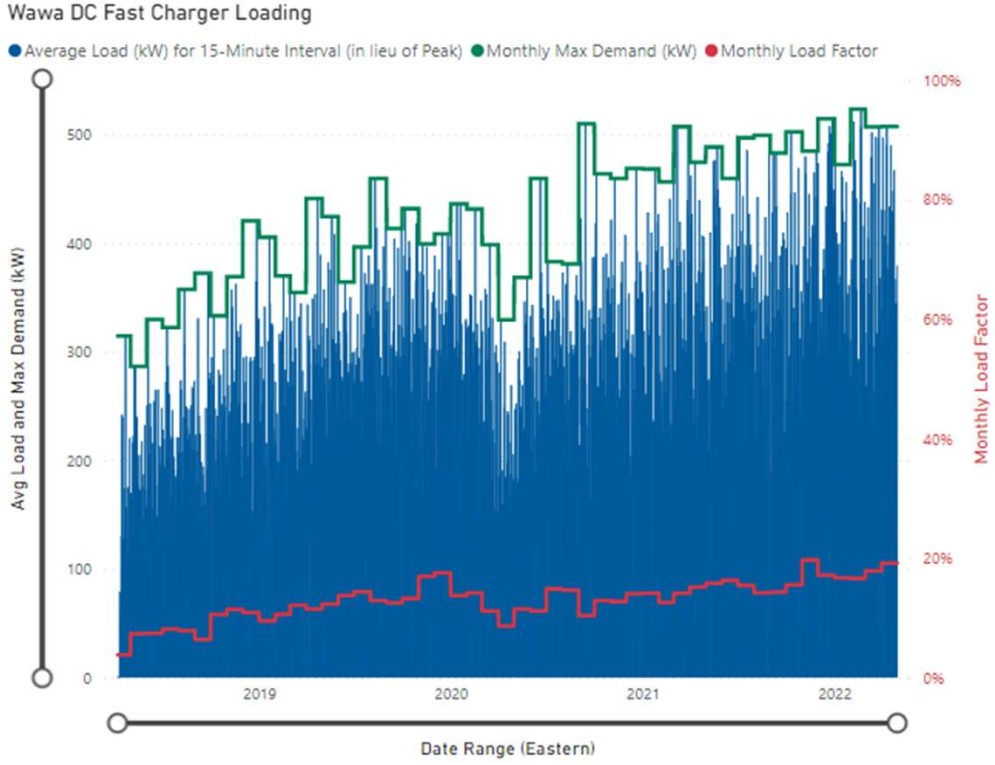
DC Fast Charging Analysis

Date Range (Eastern)

4/6/2018 4/30/2022



Wawa DC Fast Charger Load Factor Data

YYYY-MM	Consumption (kWh)	Max Demand (kW)	Load Factor
2022-04	70,043.59	507.38	19.17%
2022-03	67,453.26	507.18	17.88%
2022-02	58,402.22	523.30	16.61%
2022-01	58,693.48	472.51	16.70%
2021-12	65,601.48	514.64	17.13%
2021-11	68,748.79	484.75	19.70%
2021-10	58,014.21	502.37	15.52%
2021-09	49,810.09	483.07	14.32%
2021-08	52,661.33	499.25	14.18%
2021-07	57,103.10	497.02	15.44%
2021-06	53,885.48	459.65	16.28%
2021-05	57,382.60	488.51	15.79%
2021-04	51,834.15	474.59	15.17%
2021-03	53,280.08	507.31	14.12%
2021-02	38,501.54	456.38	12.55%
2021-01	49,280.76	468.27	14.15%
2020-12	49,064.16	468.83	14.07%
2020-11	42,146.50	459.49	12.74%
2020-10	44,557.31	463.94	12.91%
2020-09	38,013.61	509.82	10.36%
2020-08	41,512.00	380.96	14.65%
2020-07	42,347.51	382.88	14.87%
2020-06	36,973.83	459.46	11.18%
Total	**41,674.92**	**427.05**	**13.01%**

Data is available for all previous months. On the first day of each month, data for the previous month will be available upon data refresh

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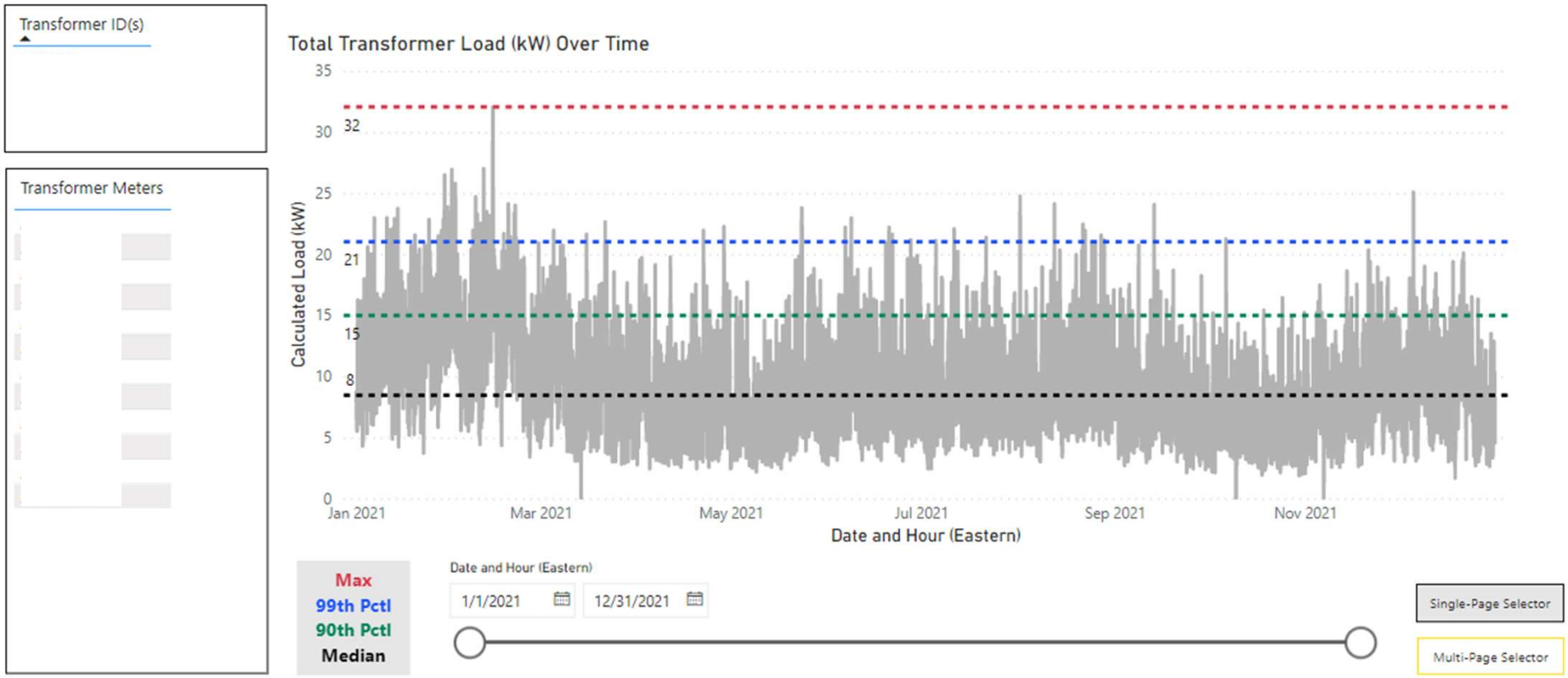
Distribution Load Transformer Analysis



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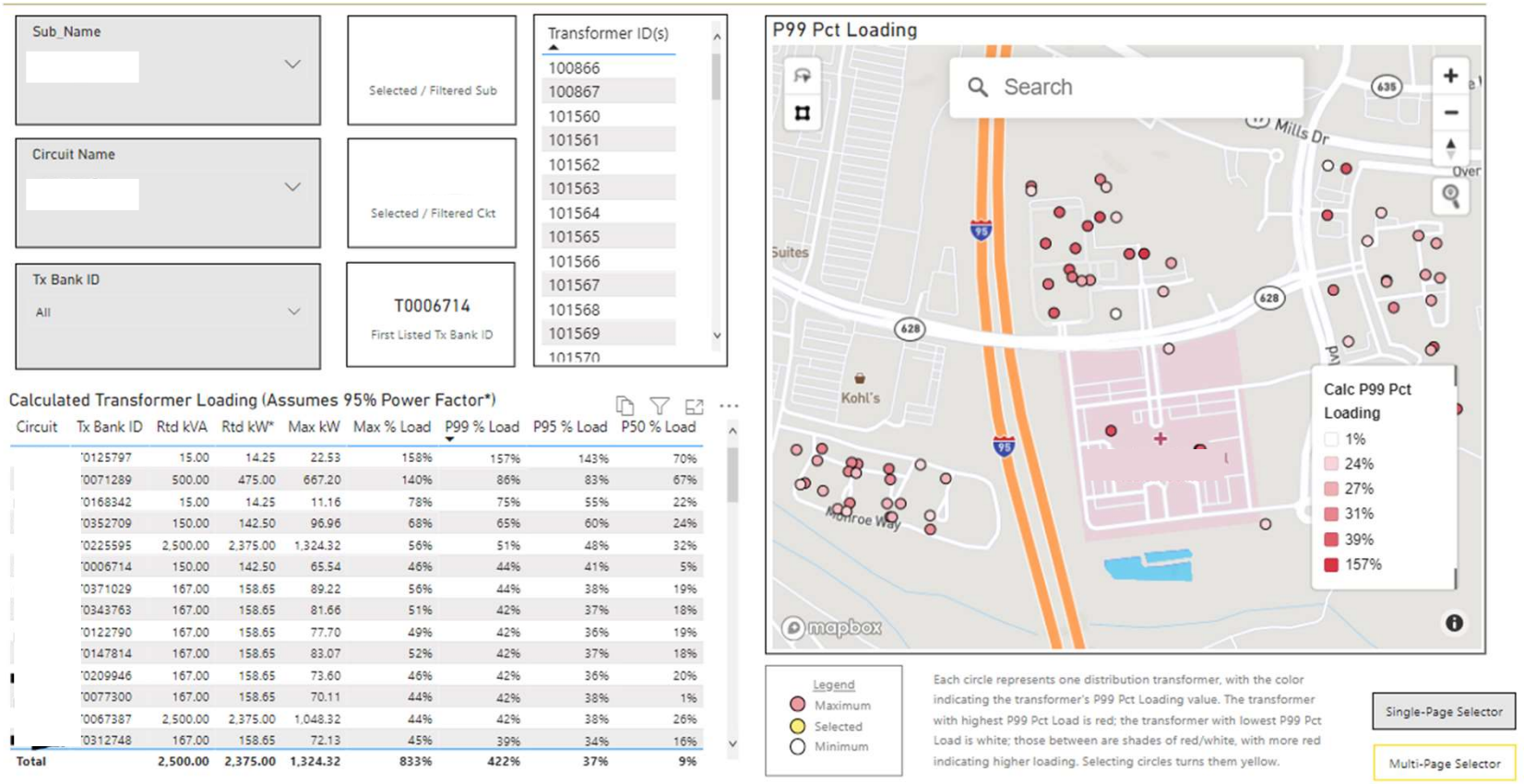
Distribution Transformer Loading Heat Chart



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Questions?
Thank You

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