Tacoma Power 2022 IRP Workshop 2

2022 Load Assumptions

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The Plan

Base Case Load Forecast

Tacoma Power Load in IRP Model

Electro Fuel Load

Electrification Stress Test

BREAK

Ice Breaker

What is one thing you wish people knew about your industry?

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Tacoma Power Load Forecast

Bryce Wang, Christina Leinneweber

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Outline

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1. Introduction
2. Critical Drivers
3. Forecasting Methodology
4. Forecast Products

Critical Drivers

This is the section where we answer the question “what affects load?”

Many factors affect electric load and our forecast assumes specific values for these factors throughout the forecast horizon.

Load is most notably driven by the weather, the economy, and the demography of a service territory.

We purchase weather data from an independent firm that specializes in weather and environmental information.

We purchase economic and demographic data from an independent firm that specializes in long-term county-level economic and demographic data series.

Over the historical period, the economy has experienced change. Over the forecast horizon, the economy will continue to change.

	Compound Annual Growth Rate
	Forecast Horizon
Total Employment	1.59%
Total Population	1.09%
Employment Per Capita	0.63%

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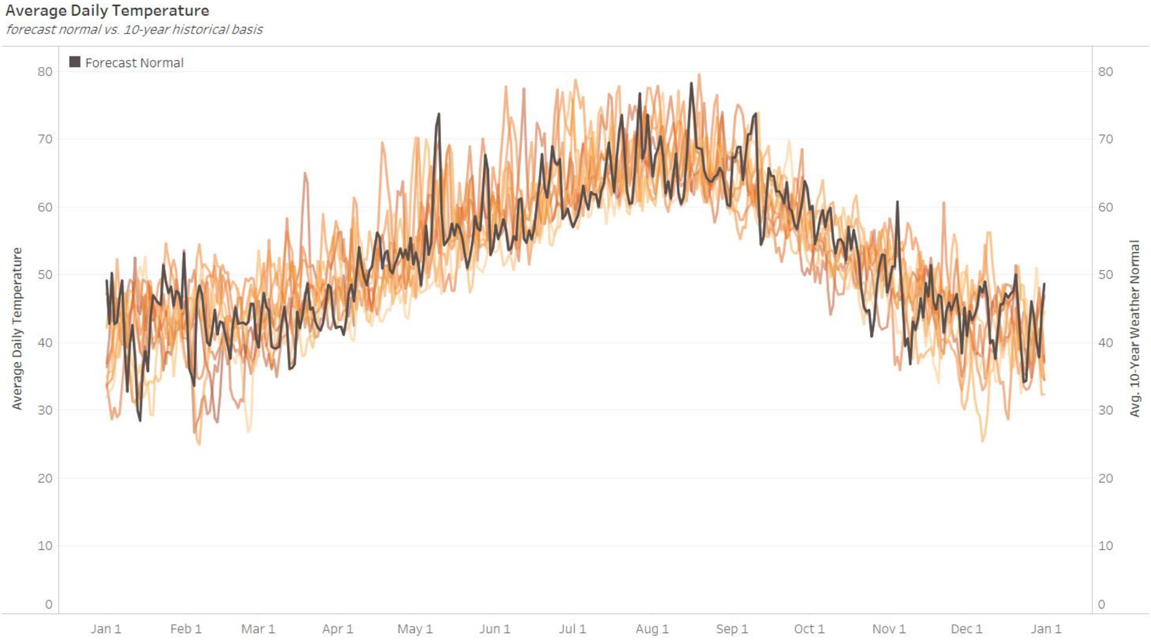
The 2021 Forecast Weather Normal is based on 10 years of historical weather.



Forecasting Methodology

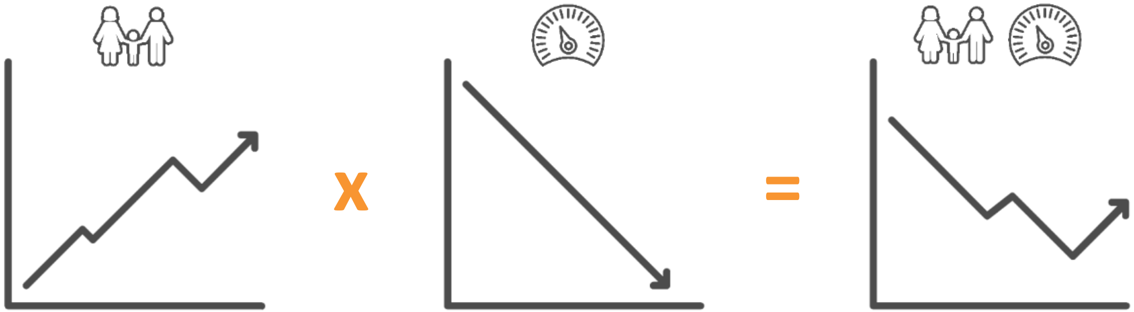
This is the section where we answer the question “how is the forecast derived?”

First, we forecast non-industrial load. Second, we add the load of individual industrial customers. Finally, we adjust for the anticipated effects of new programmatic conservation and changes to codes & standards.

Non-Industrial Load Forecast + **Industrial Load Forecast** = **System Load Forecast**

The forecasts of conservation and codes & standards are provided by Tacoma Power's Conservation Potential Assessment.

The non-industrial load forecast is the product of two separate forecasts.

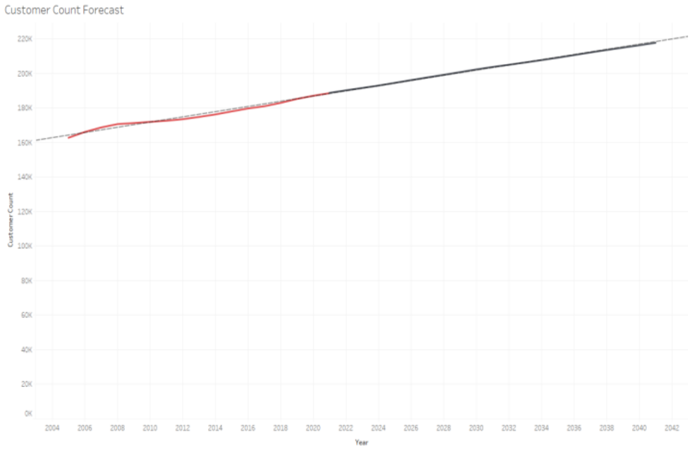


Non-Industrial Customer Forecast x **Non-Industrial Use-per-Customer Forecast** = **Non-Industrial Forecast**

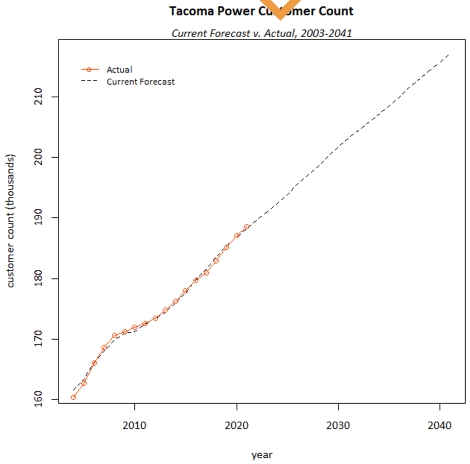
Non-Industrial loads are relatively weather-sensitive. Variability in weather can distort underlying trends in consumption. We adjust for weather-driven variability through a process called 'Weather Normalization'.

- # Customer numbers are expected to increase slightly.
- *Much of the construction activity in the service territory is renovation and infill, not increasing total net customer counts.*

DETAIL

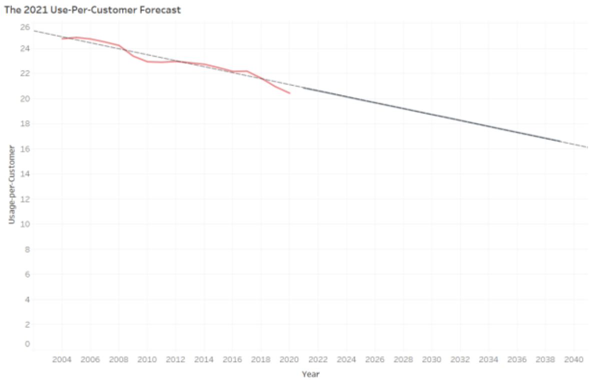


The trends of Avg. 2021 Forecast and Avg. Active Contracts for Year. Color shows details about Avg. 2021 Forecast and Avg. Active Contracts. The view is filtered on Year, which ranges from 2005 to 2041.

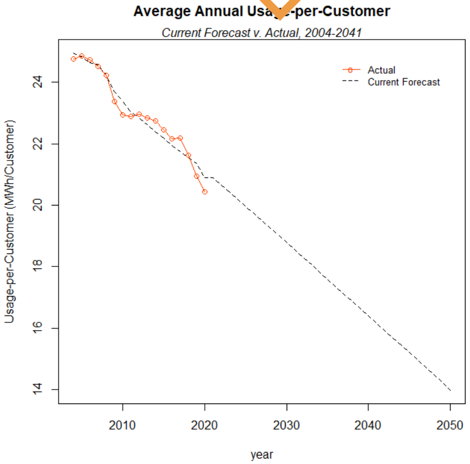


- Use-per-customer is expected to decrease.
- *Utilities across America are seeing flat or declining usage.*

DETAIL

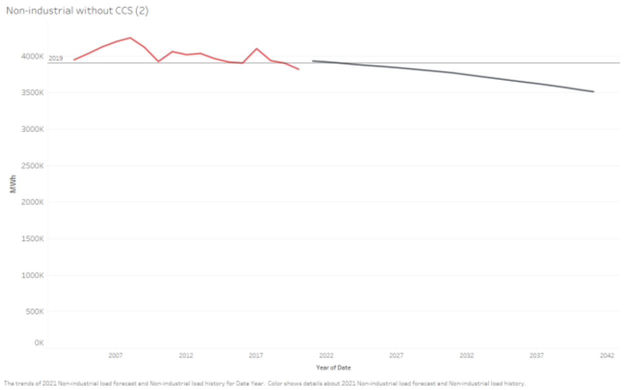


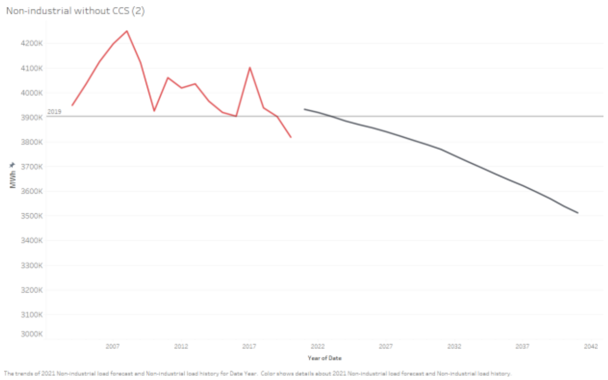
The trends of 2021 NUPC History and 2021 UPC without CCS for Year (Fcst 2021 Final File). Color shows details about 2021 NUPC History and 2021 UPC without CCS.



- When combined, the overall non-industrial load is expected to decline.
- *Utilities across America are seeing flat or declining usage.*

DETAIL





The industrial forecast is the sum of 11 forecasts for individual transmission-voltage customers.

$\sum_{k=0}^{11}$ Individual Industrial Load Forecasts **=**

Pre-Conservation Industrial Forecast

We create individual load forecasts for each of the industrial loads existing or expected within our service territory. Forecasts are based on historical records of consumption and account executive expectations.

Tacoma Power’s System Energy Load Forecast is the sum of the non-industrial forecast and the industrial forecast.

Non-Industrial Load Forecast

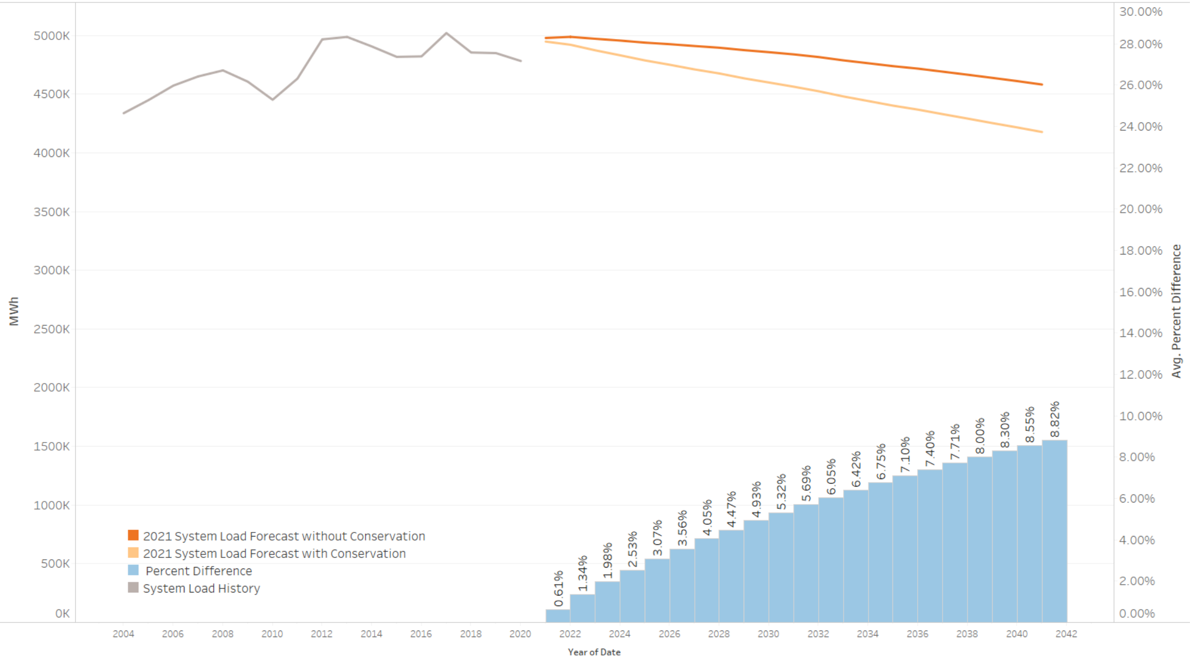
Industrial Load Forecast

System Load Forecast

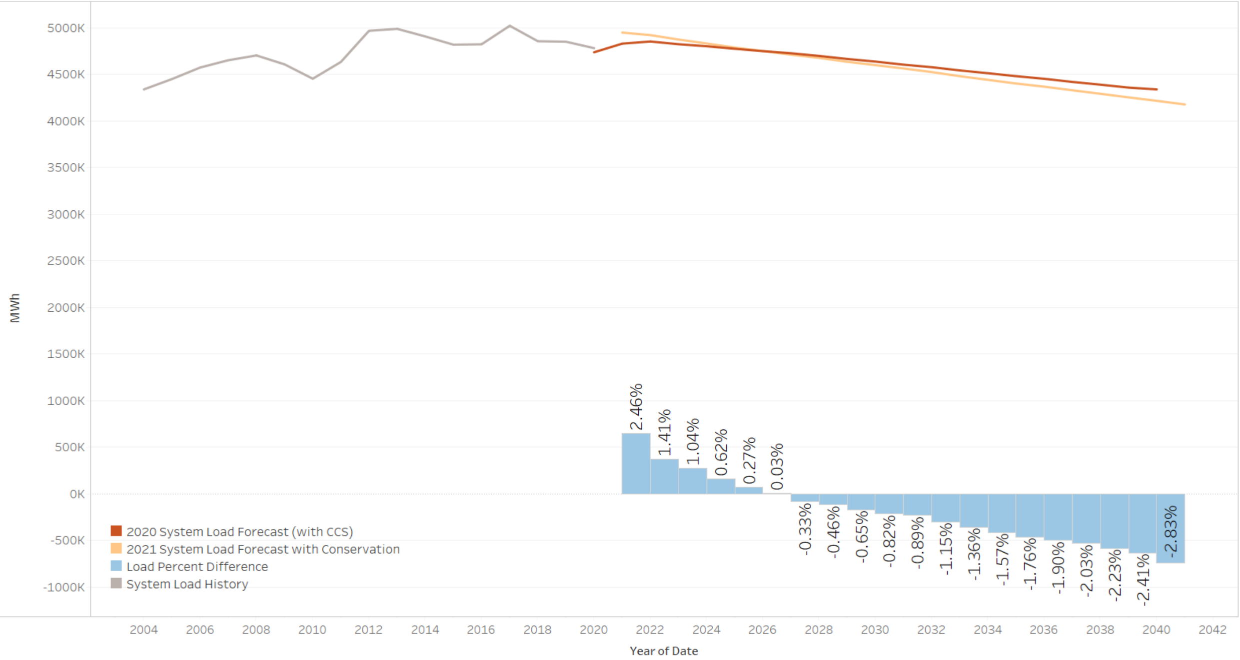
Forecast Products

This is the section where we discuss the results of the forecasting process.

System load is projected to decline even before adding the effect of programmatic conservation and codes & standards.



The load forecast for 2021 is very similar to the forecast for 2020.



Load inputs into IRP Model

Danielle Szigeti

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Load inputs into IRP Model

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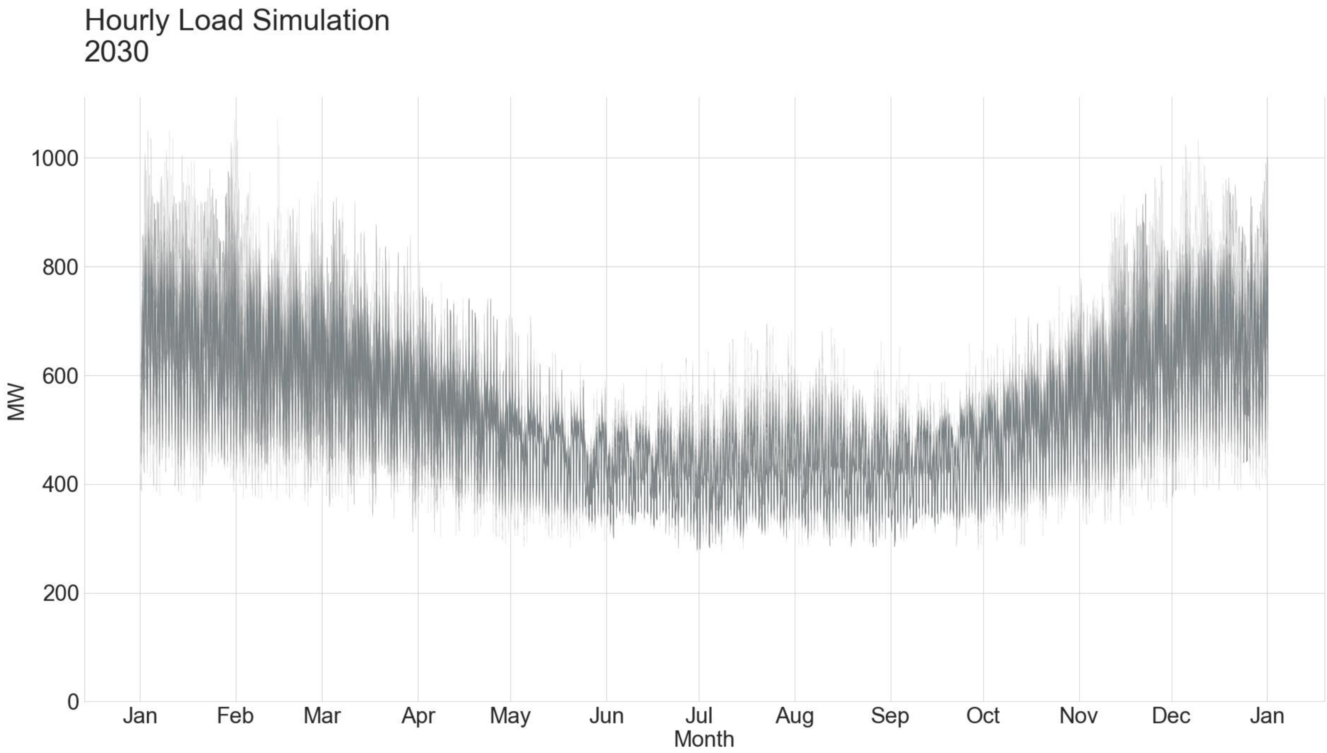
- 58 weather years (1950 - 2007)
- Applied those temperature conditions to IRP years (2022-2041)
  - Simulated loads using historical weather and recent historical load
- These hourly simulations are used as input into the system model, SAM

Hourly Simulation for 2030



Yearly Energy & Peak Across All Weather Years

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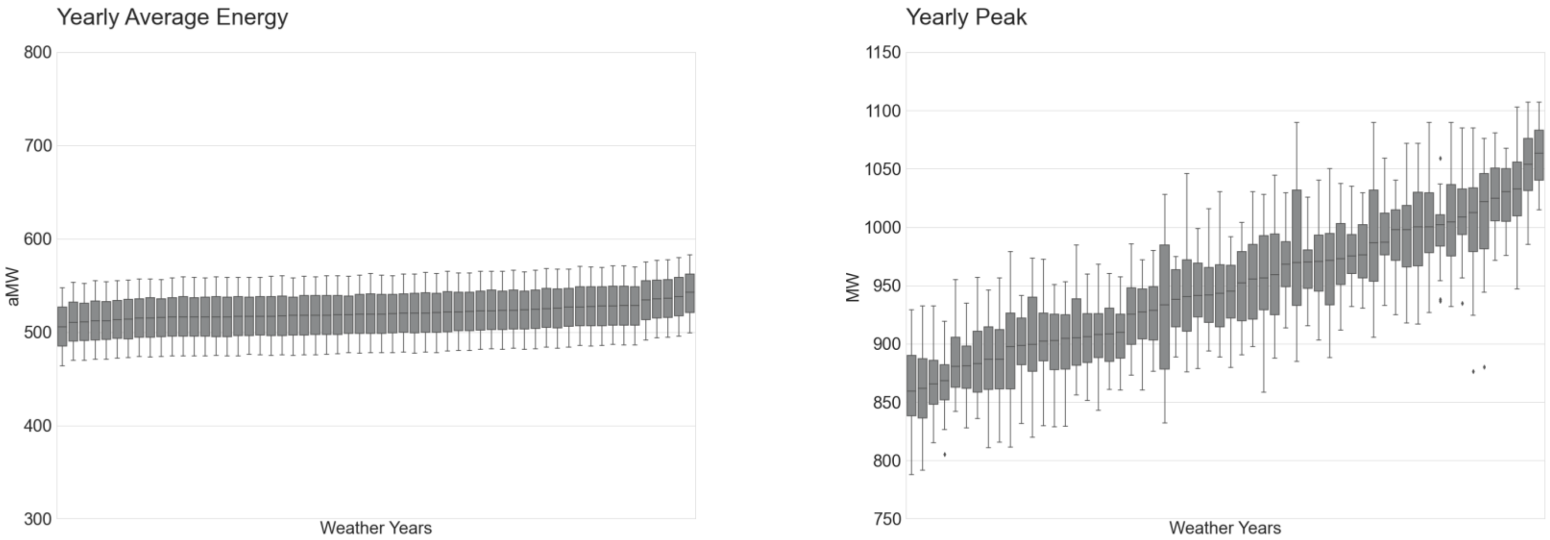

Monthly Energy

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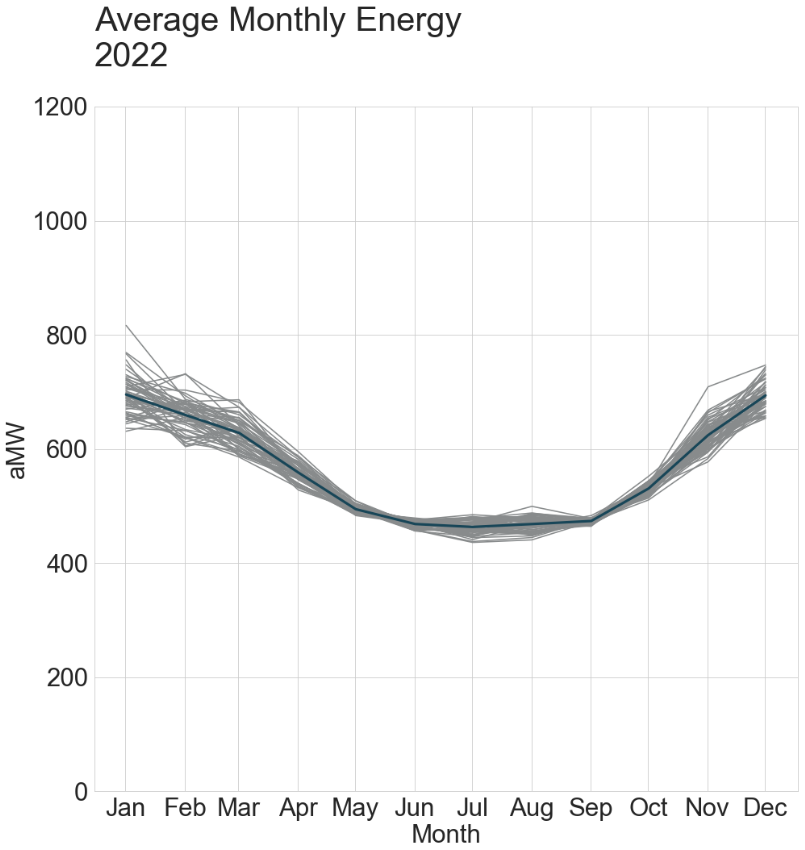
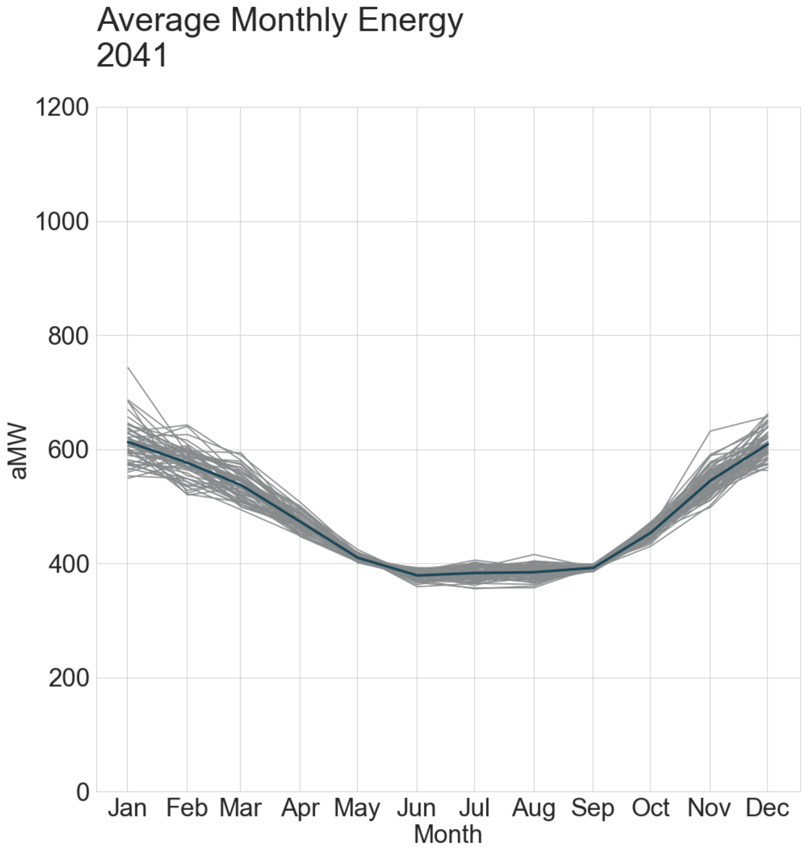
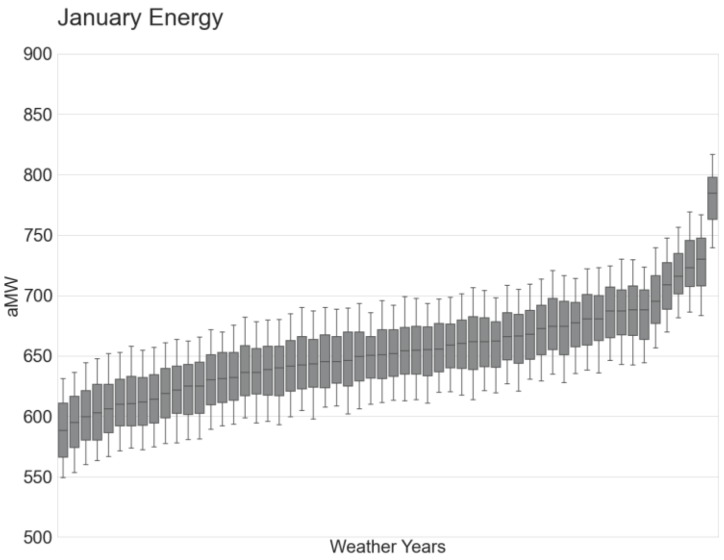
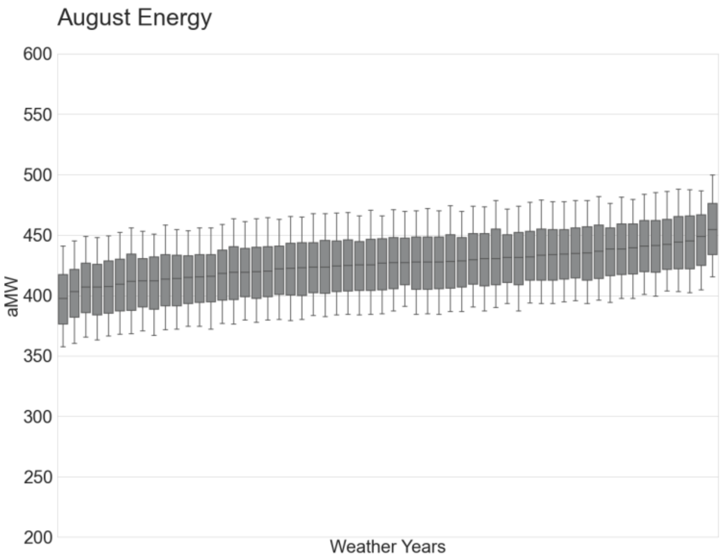




Jan/Aug Energy Across All Weather Years





Monthly Peak

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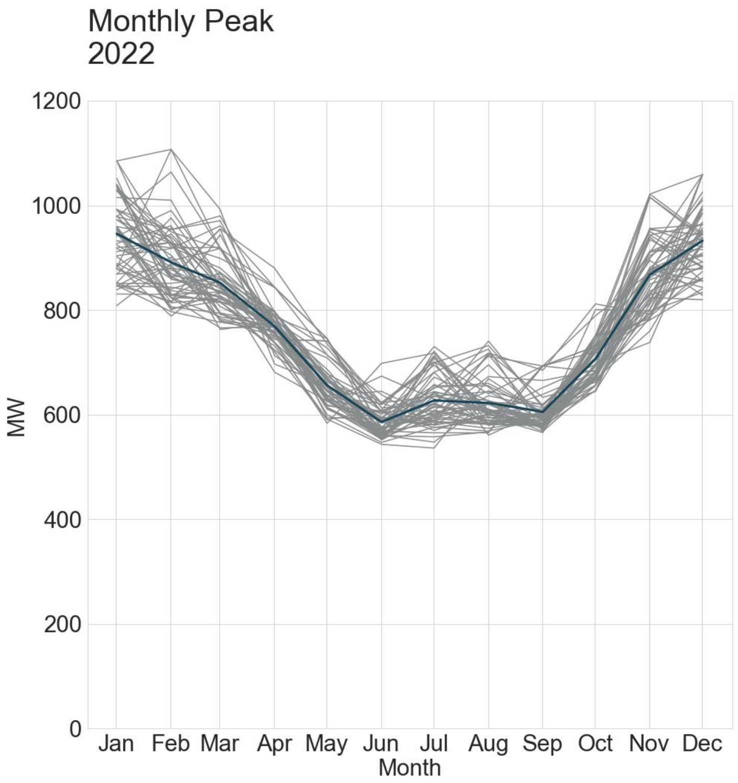
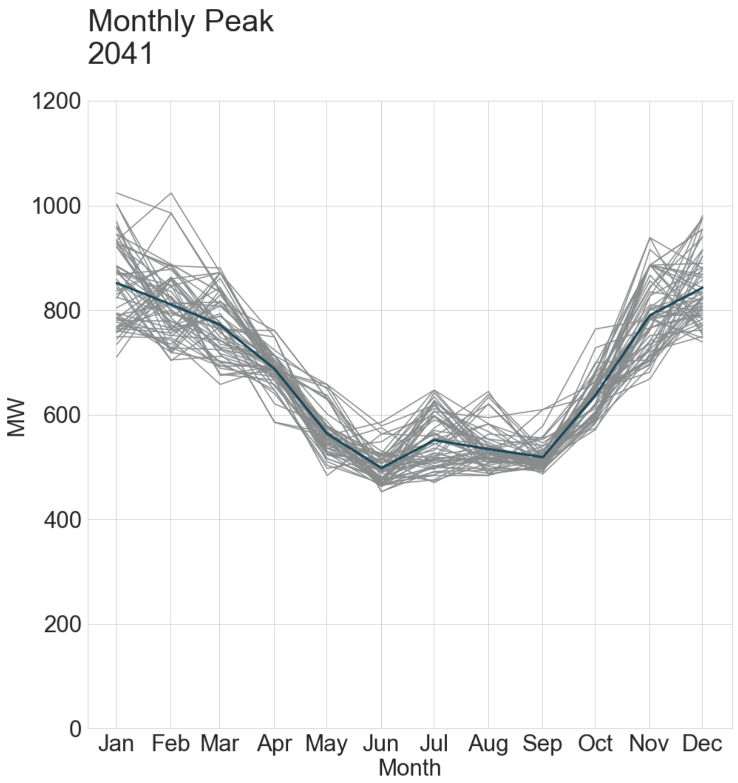
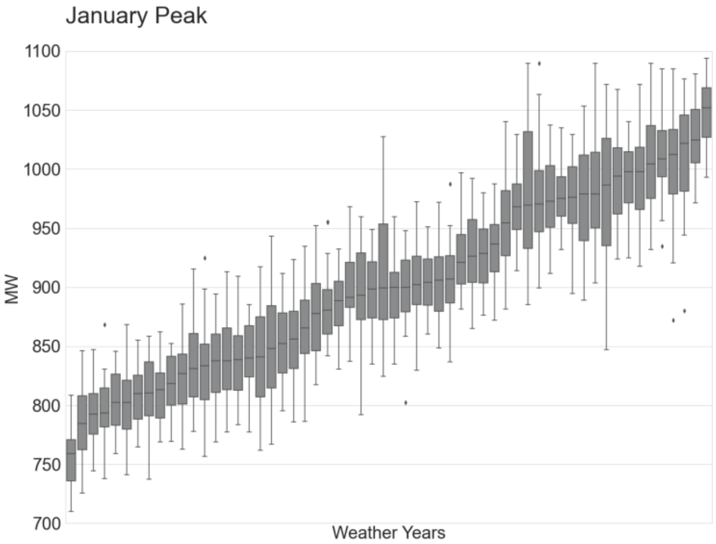
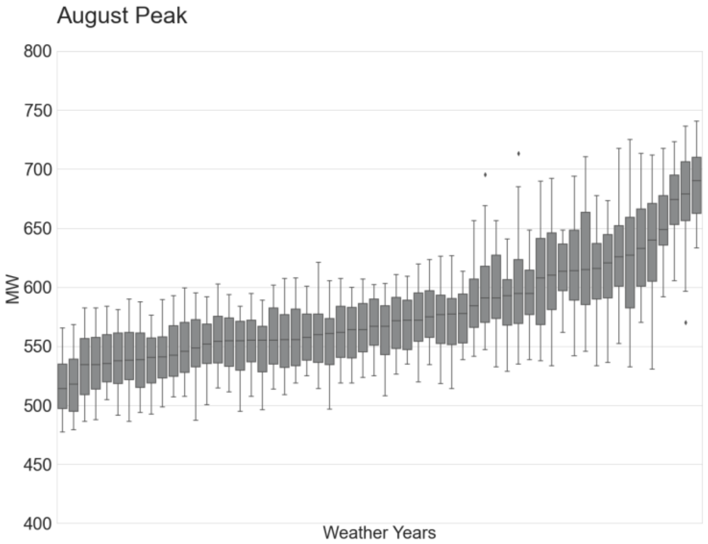


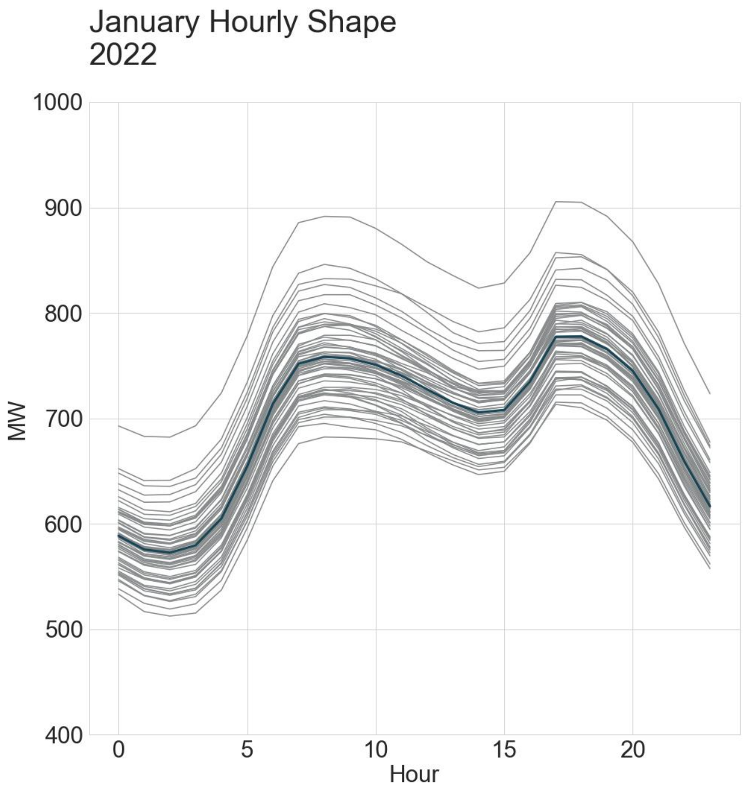


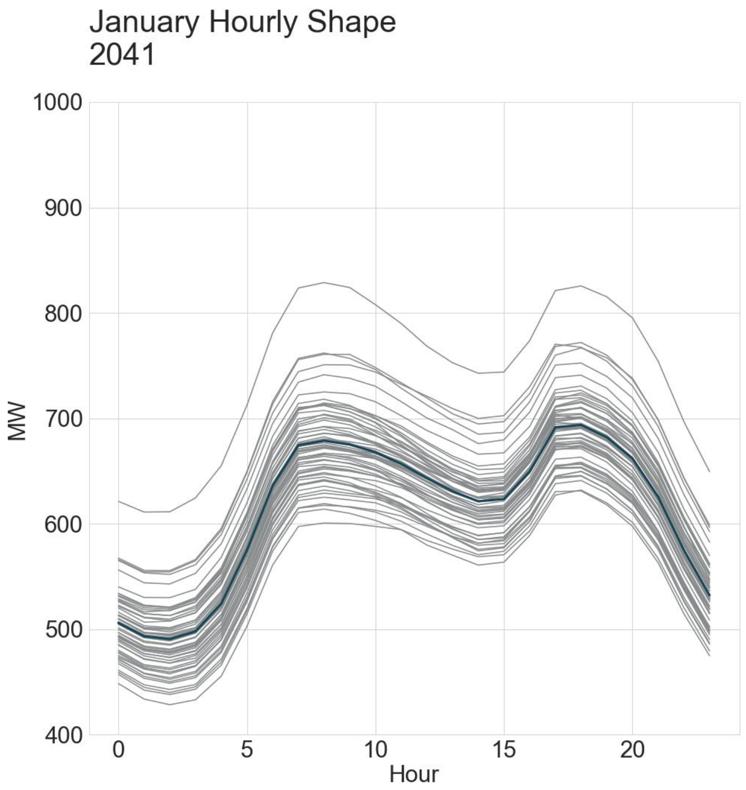
Jan/Aug peak Across All Weather Years



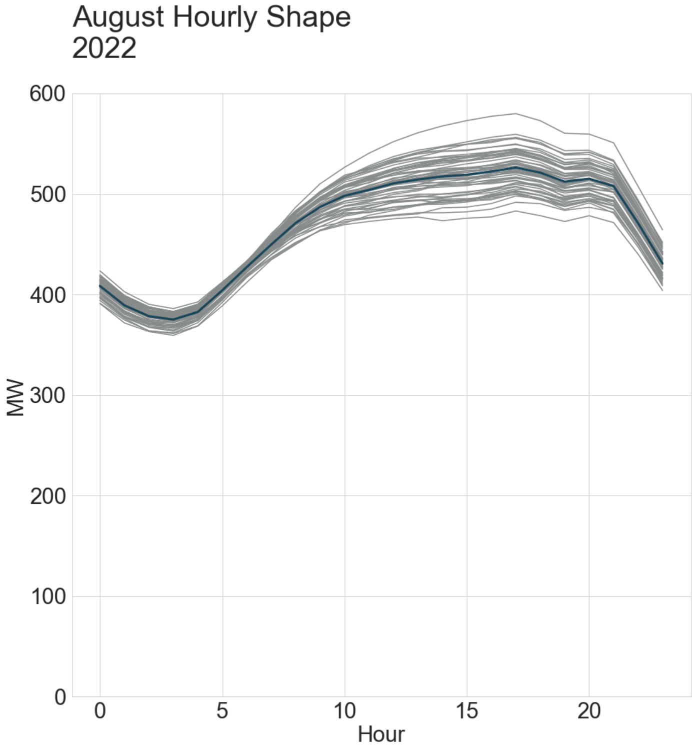


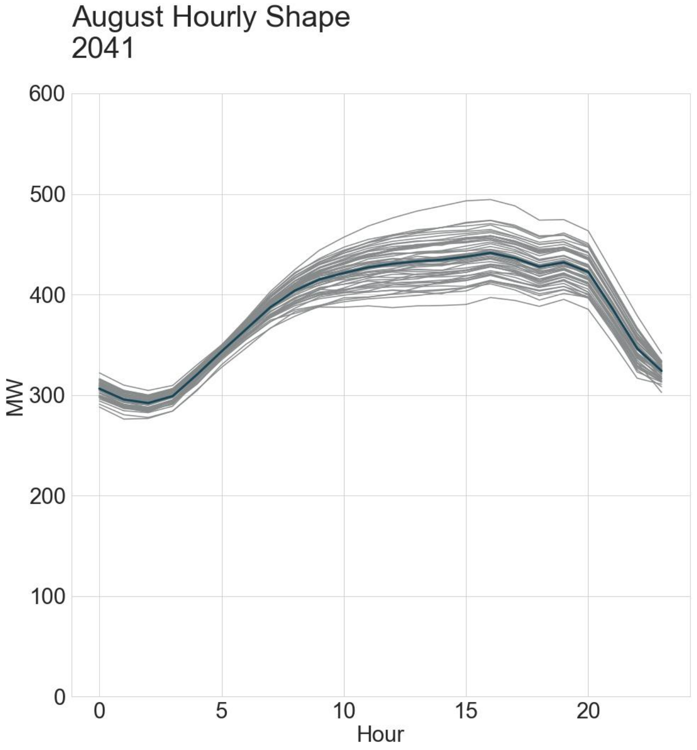
January Shape





August Shape





Electrofuels

Michael Catsi

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“I believe that water will one day be employed as fuel,
that hydrogen and oxygen which constitute it,
used singly or together,
will furnish an inexhaustible source of heat and light,
of an intensity of which coal is not capable.”

Mysterious Island, Jules Verne, 1874

What are Electrofuels?

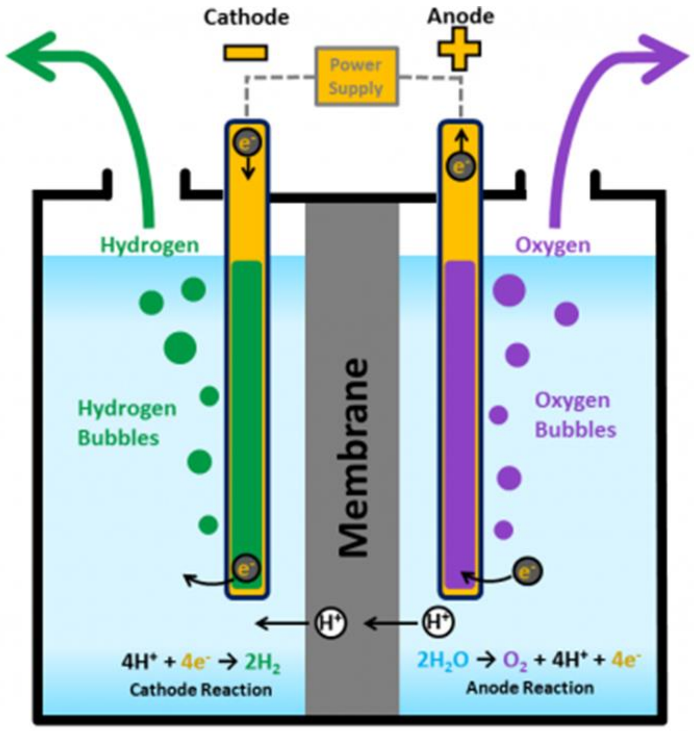
A high-value, storable, energy product created from hydrogen generated by renewable power like hydro, wind, or solar.

Carbon-neutral or zero-carbon

Electrofuels include the production of green hydrogen through electrolysis.

- Uses water and green power to produce hydrogen and oxygen.
- The oxygen is vented and the hydrogen collected and stored as a gas or liquefied.

Electrofuels also include liquid hydrogen carriers e.g. green ammonia and formic acid.



Hydrogen Color Spectrum

- Hydrogen (H_2) is the lightest and most abundant element in the universe
- Hydrogen has the highest energy per mass of any fuel

GREEN
Hydrogen produced by electrolysis of water, using electricity from renewable sources like hydropower, wind, and solar. Zero carbon emissions are produced.

TURQUOISE
Hydrogen produced by the thermal splitting of methane (methane pyrolysis). Instead of CO_2, solid carbon is produced.

YELLOW
Hydrogen produced by electrolysis using grid electricity.

BLUE
Grey or brown hydrogen with its CO_2 sequestered or repurposed.

PINK/PURPLE/RED
Hydrogen produced by electrolysis using nuclear power.

BLACK/GRAY
Hydrogen extracted from natural gas using steam-methane reforming.

WHITE
Hydrogen produced as a byproduct of industrial processes.

BROWN
Hydrogen extracted from fossil fuels, usually coal, using gasification.

Why Hydrogen?

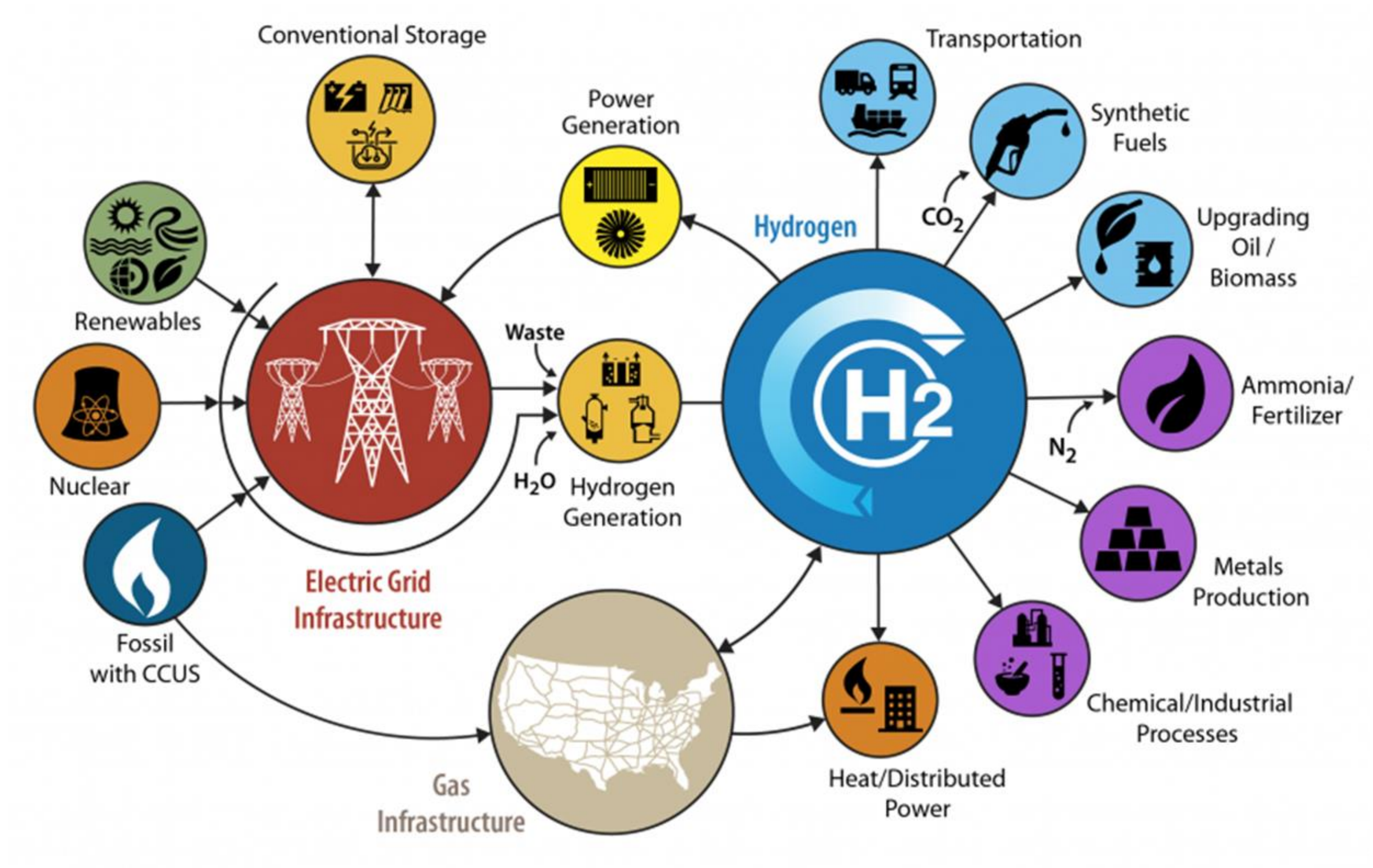
- To address climate change, specifically GHG emissions, it is critical to decarbonize transportation fuels, energy generation and storage, and industrial processes.

- Electrification of transportation has its limitations, especially in heavy-duty cycle needs e.g. class 8 trucks, maritime vessels, planes, trains.

- H_2 fuel cells fill the gap where batteries are not the most effective means of power.

- Range anxiety and recharging times are a concern, whereas H_2 powered transportation has the range and refueling time that we see in vehicles today.

Production and Uses of Hydrogen



NREL – Decarbonizing Transportation Vision

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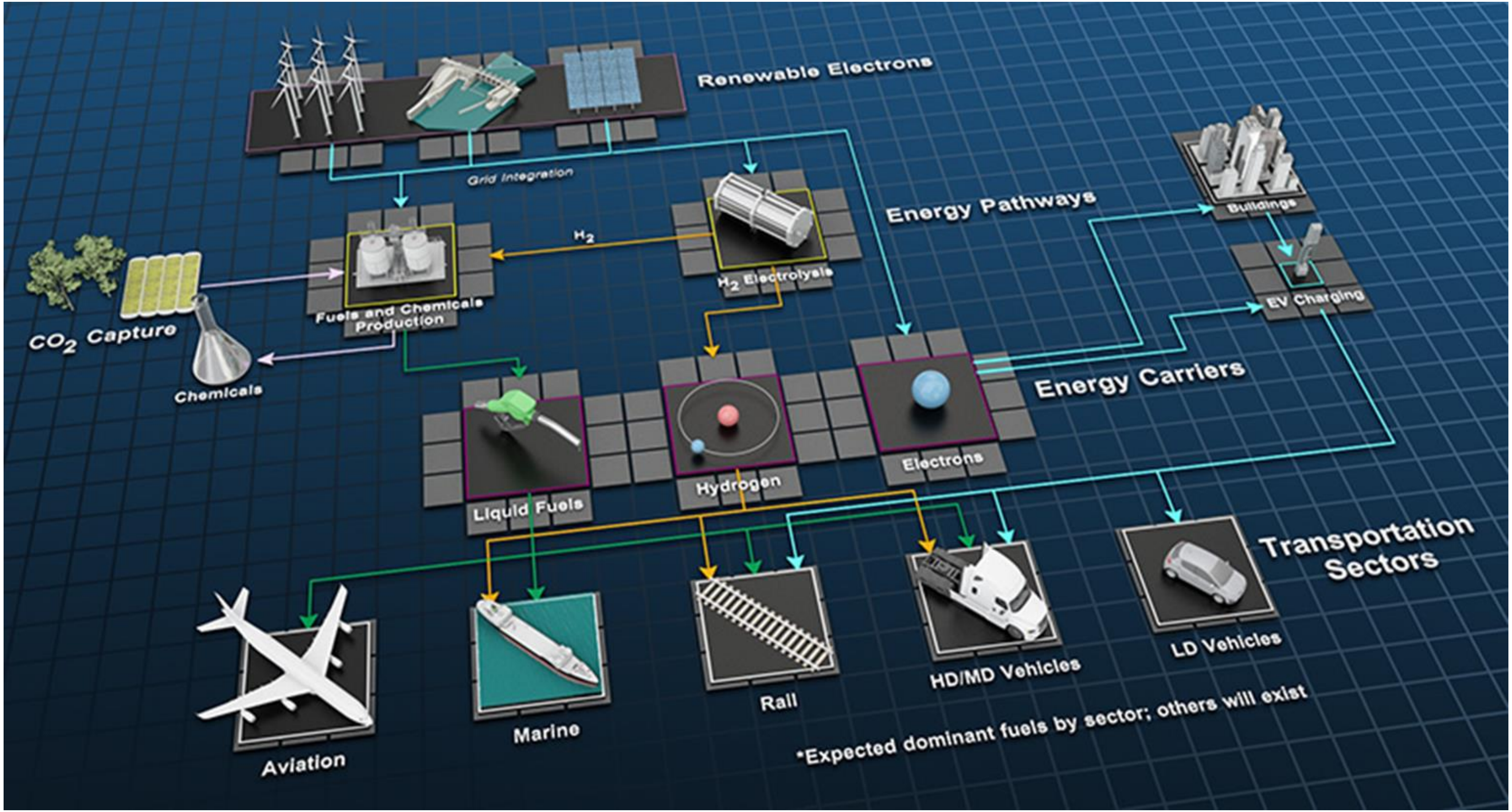

How Safe is Hydrogen?

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- H_2 has been in industrial use for more than 50 years and codes, standards, and design practices have been developed to enable its safe use.
- 70 million metric tons are produced each year and growing.
- Like other fuels, H_2 must be used with care in systems designed around its unique properties.
- H_2 presents less risk than other fuel sources as it is nontoxic, is lighter than air, and dissipates rapidly when it is released.

- Center for Hydrogen Safety https://www.aiche.org/chs

Why Create an Electrofuels Tariff?

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- In most years, Tacoma Power has an annual surplus of power
- Our power is 97% carbon free ➔ green H_2 production
- Instead of selling the surplus into the wholesale market; create a retail opportunity and reduce volatility
- Creates an entirely new green and sustainable industrial sector
- Proximity to the port is critical for economies of scale and adoption
- Aligns with
  - TPU Strategic Directives 5,6,9 & 11
  - City of Tacoma Climate Action Plan

How Does the Tariff Work?

- Tacoma Power supplies up to 65MW of non-firm power
- With advance notice, this power can be interrupted up to 15% of total annual hours
- Most electrolyzers can shut down in minutes and ramp up as quickly
- This ability to curtail power during high power prices and high demand events, minimizes market purchases and mitigates high power costs being passed through to ratepayers.
- This flexibility has significant value to the utility, in response, we have reduced the effective cost of power for these projects.

Proposed Projects

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- Green H_2 production facilities – gaseous and liquefaction
- Green ammonia - a carbon-free fuel for marine vessels and fertilizer
- Experimental formic acid - power backup and shore power
- H_2 fuel cell electric vehicle (FCEV) manufacturers
- H_2 powered passenger ferries and aircraft
- Sustainable Aviation Fuel (SAF)
- Distribution and Refueling Stations


Quality Fuels
Hydrogen


ZERO EMISSION
HYDROGEN FUEL CELL · HYBRID-ELECTRIC DRIVE
ZERO EMISSION


STILL
corstyrène


HYDROGEN
HYDROGEN
G-HFZA
ZEROAVIA
ZEROAVIA

QUESTIONS

Electrification Stress Tests

Ryan Fulleman

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Introduction

Background

Early steps at simulating electrification impacts

- More planned for this and future IRP's

What is an electrification stress test?

- Conversion of nonelectric end uses
- 8760 load shapes added to modeled system loads
- Not a forecast of what we think will happen

We are going to review

- Key assumptions we are making
- Load we could see given those assumptions

Initial Findings

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Electrification Stress Test Loads

- Could add 30 – 200 aMW per month, on average
  - Largest load impacts are in the winter months
- Typically concentrated in evening
- Demand impacts vary by temperature and assumption
  - Across 10^{th} – 90^{th} percentile of daily peak load, up to 50 – 600 MW could be added

Takeaways

- Impacts vary across weather simulations
- Current stress test loads may not display full range and magnitude of impacts
- Continue to refine inputs

Process

Defined 4 Stress Tests:

- Scenarios x 2: High Demand or Low Demand
- Saturation x 2: 100% or 50%

Electrification and Load Research studies

- Residential and Commercial sector analyses
- Heat pump simulation study
- Pacific Northwest National Lab Grid Capacity for EV Study, Part 1 (2017)

Collected and Analyzed Load Data

- Modeled weather sensitive loads using weather from 1950 – 2007
- Collected hourly weather normal device energy usage

Assumptions

Residential Electrification Assumptions

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Use	Technology	High Demand	Low Demand
Heating & Cooling	Code Heat Pump	100%	0%
Heating & Cooling	High Capacity Heat Pump	0%	100%
Water Heating	Greater than 55 Gal Electric resistance water heater	90%	0%
Water Heating	Greater than 55 Gal Heat Pump Water Heater	10%	100%
Water Heating	Less than 55 Gal Electric resistance water heater	90%	0%
Water Heating	Less than 55 Gal Heat Pump Water Heater	10%	100%
Appliances	Electric resistance clothes dryer	100%	0%
Appliances	Heat Pump Clothes Dryer	0%	100%

Transportation Electrification Assumptions

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Use	Technology	High Demand	Low Demand
Light Duty Vehicle	Level 1 Home Charging	10%	10%
Light Duty Vehicle	Level 2 Home Charging	90%	90%
Light Duty Vehicle	Level 1 Workplace Charging	0%	0%
Light Duty Vehicle	Level 2 Workplace Charging*	-	-
Medium Duty Vehicle	MDV Level 1 Workplace Charging	60%	60%
Medium Duty Vehicle	MDV Level 2 Home Charging	40%	40%

**Level 2 Workplace Charging Data not available*

Commercial Electrification Assumptions

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- One demand scenario available for commercial sector
  - Could not create High and Low scenarios
  - Includes relevant uses across business types

Business Types
Restaurant
Retail
Warehouse
Office
Grocery
Assembly
School
Lodging
Mixed Commercial/Other

Use
Cooking
Heating & Cooling
Water Heating

Limitations

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Data

- Majority of inputs are not weather simulated
  - Only residential HVAC and EV charging impacts vary by temperature
- One scenario for commercial electrification
- Port electrification not included
- Industrial electrification not included
- Limited data for workplace and medium duty vehicle EV charging

Stress Test Loads

Monthly Energy

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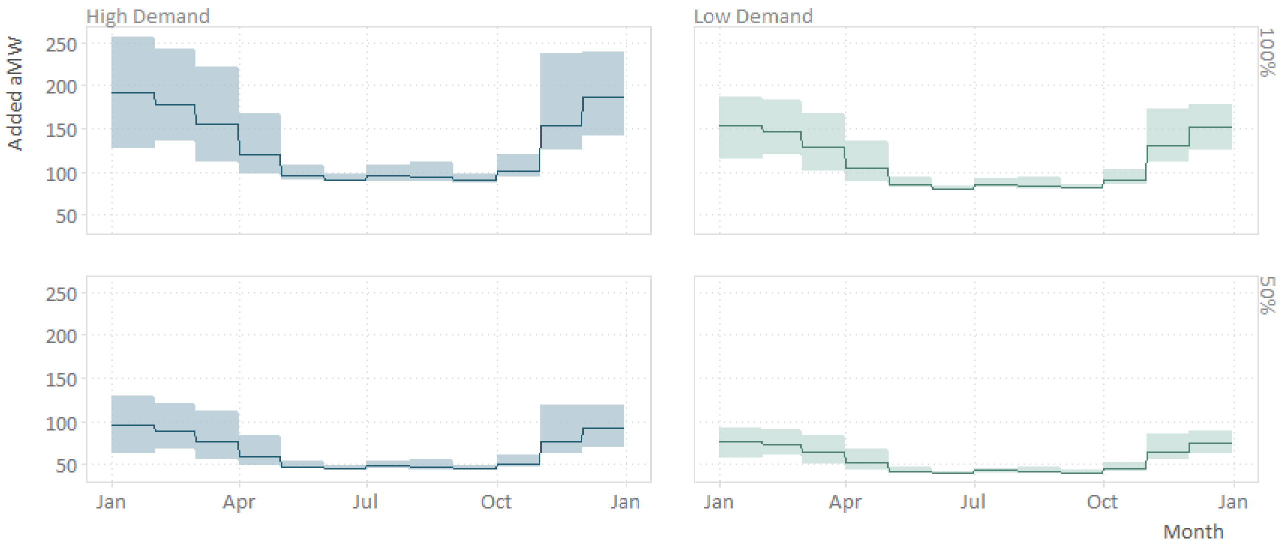

- On average, electrification could add approximately 30 - 200 aMW per month
  - Roughly up to 10% - 30% increase from 2041 load forecast monthly aMW
- Winter months see greatest increase on average
- Large range of possible impact
- Impacts sensitive to weather and stress test assumptions

Monthly Energy by Sector

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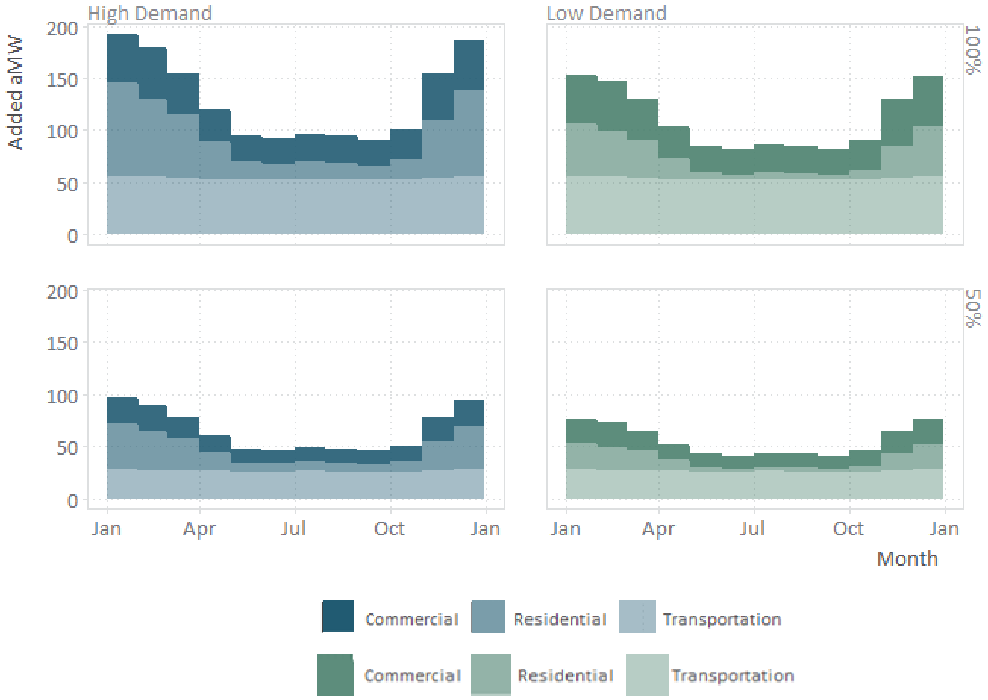
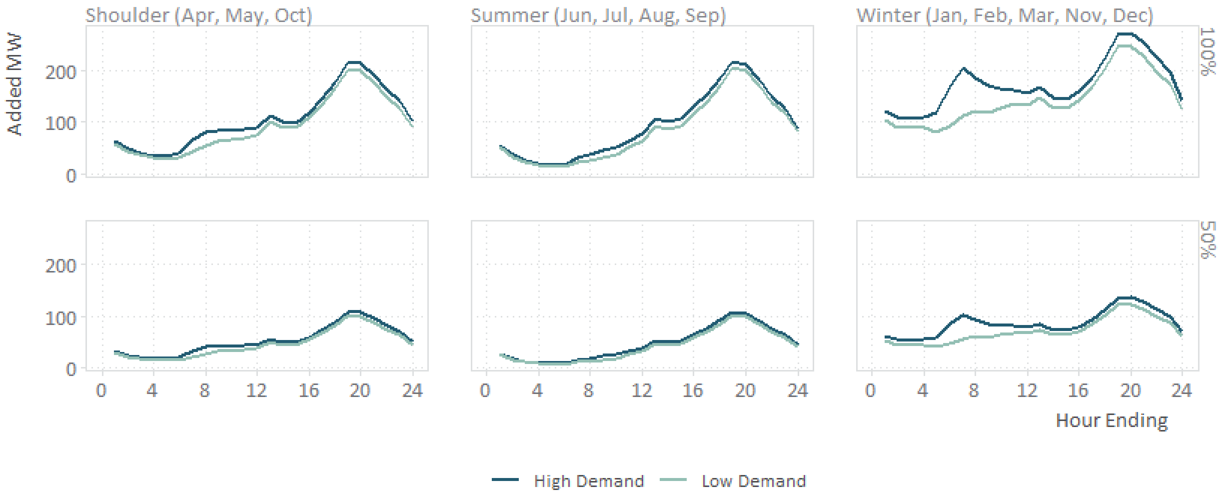
- Seasonal residential and commercial loads
  - Primarily heating & cooling loads
- Transportation flat across year
  - Greatest total aMW across year



Hourly Load

- On average, this added load peaks in the evening
- Similar pattern in Summer and Shoulder seasons
- Winter loads show increased morning load, which is mitigated in Low Demand scenario



Percent of Hourly Load by Sector

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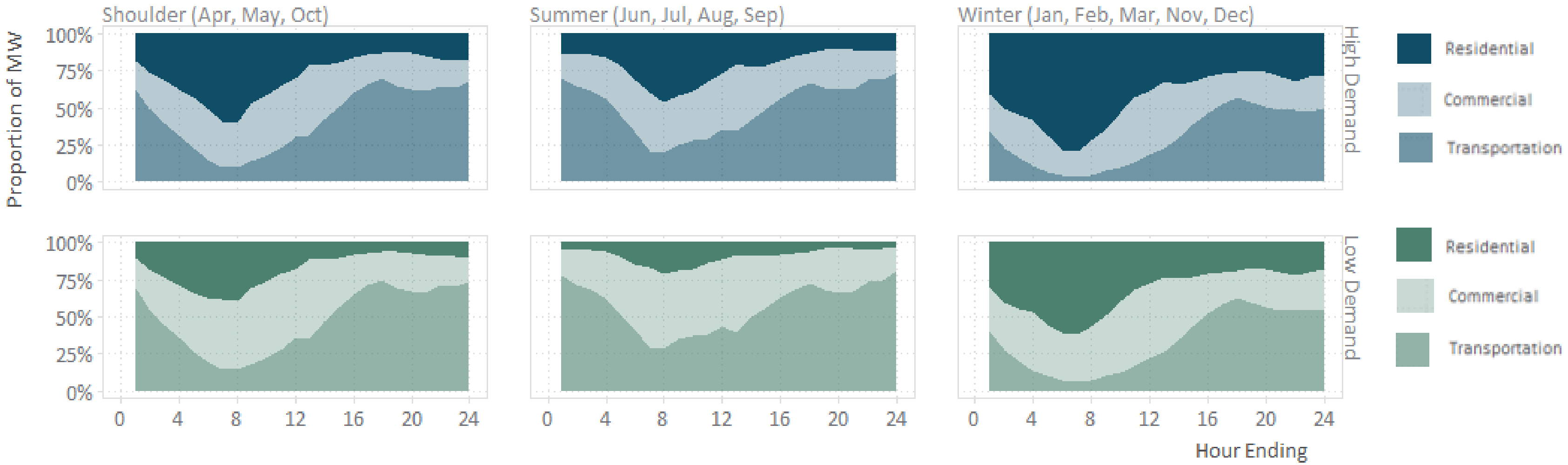
- Proportion of load by sector in each hour
- On average, new electrification load comes from Residential sector in the morning, and Transportation in the evening
- Given the previous slide we conclude that on average, the Transportation sector may be the primary contributor to average daily evening peaks



Demand

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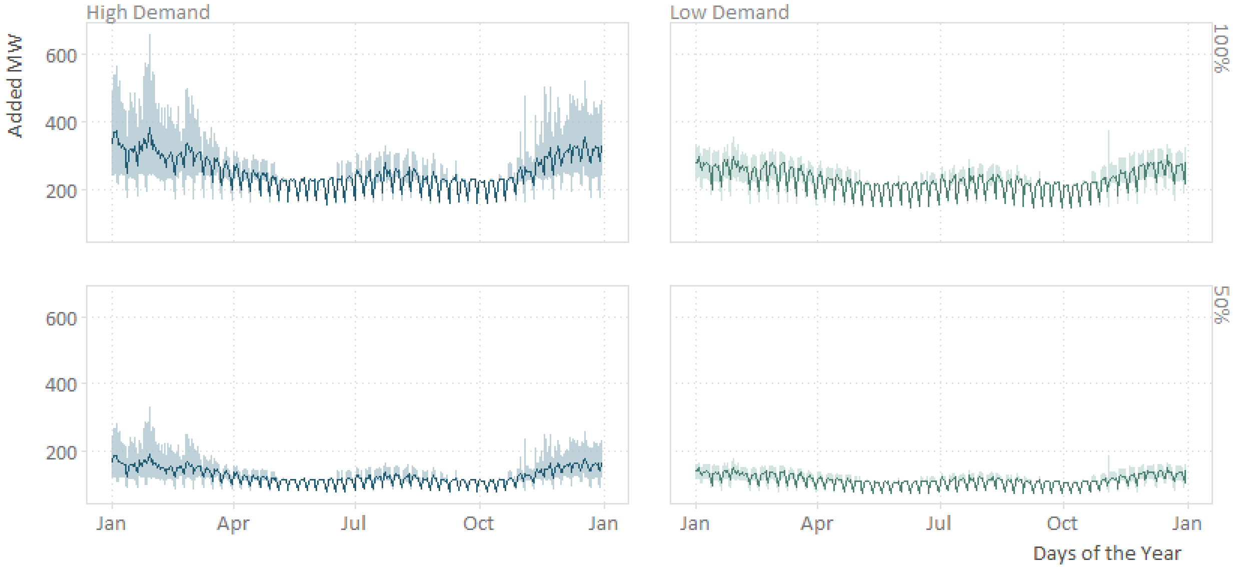
- Average and range of max demand per day plotted below
- Range of 10th percentile to 90th percentile simulations shown as shaded regions
  - Variability due to temperature dependent loads and weather events
- Additional demand reaching as high as roughly 600MW, as low as 50MW
- High variability in cold or hot periods more prevalent in High Demand scenario



Next Steps & Wrap Up

Rachel Clark

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Workshop schedule

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December 20, 2021

- 2022 IRP plans & input updates

March 2, 2022

- Key changes and model updates: Load
- Special focus on vehicle and building electrification stress test

APRIL
Written description of key resource assumptions available for feedback

June 30, 2022

- Preliminary analysis results & recommendations
- Feedback on preliminary action items

July 19, 2022

- Updated results & recommendations

Final Thoughts

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Is there any information you're not getting from these workshops that you would like addressed at future workshops?

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