

# PREDICTING NATURAL GAS PRICES

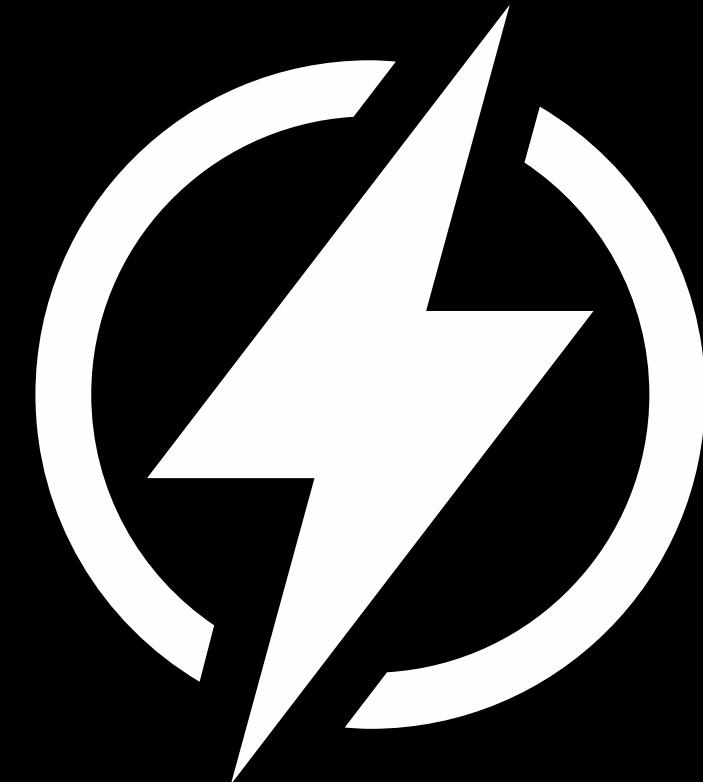


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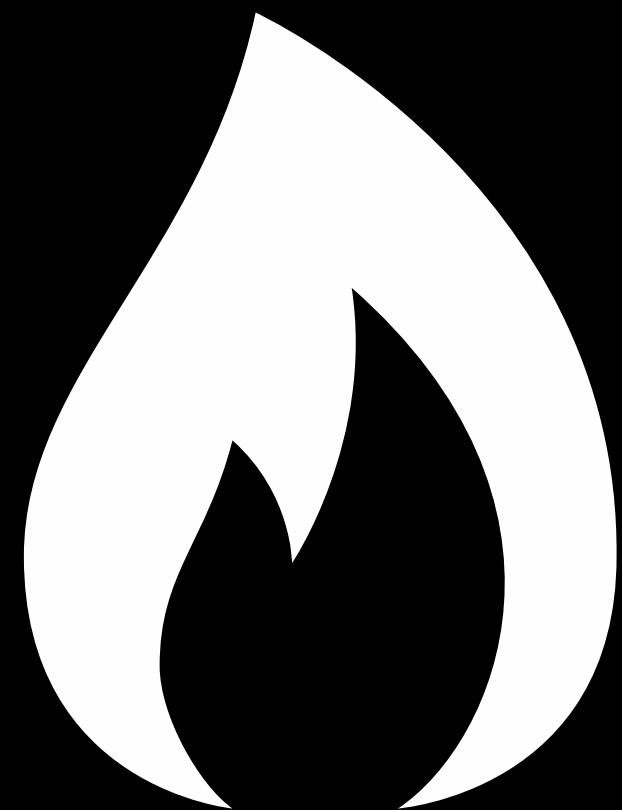
NICK KOLOWICH

FLATIRON DATA SCIENCE 2020

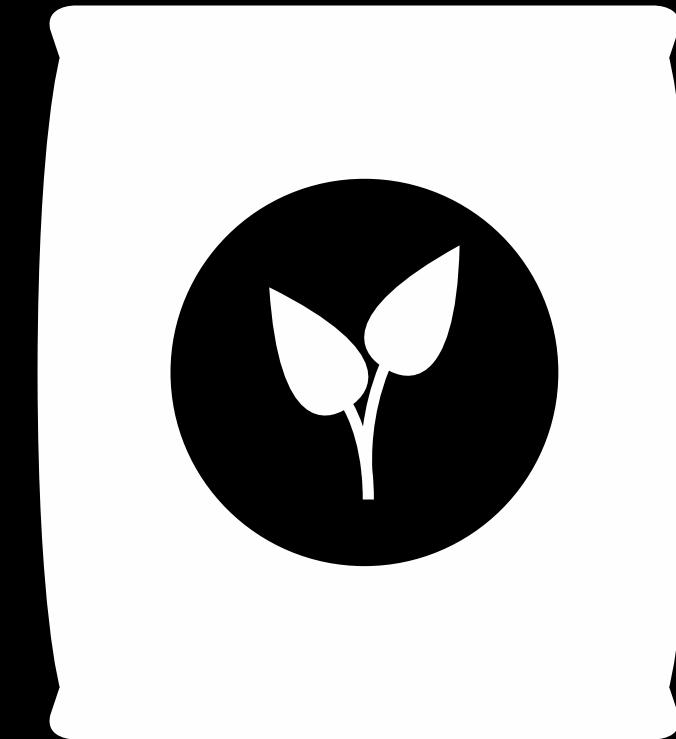
# HOW IS NATURAL GAS USED?



In 2020, accounted for  
41.1% of all  
electricity generated  
in the United States.

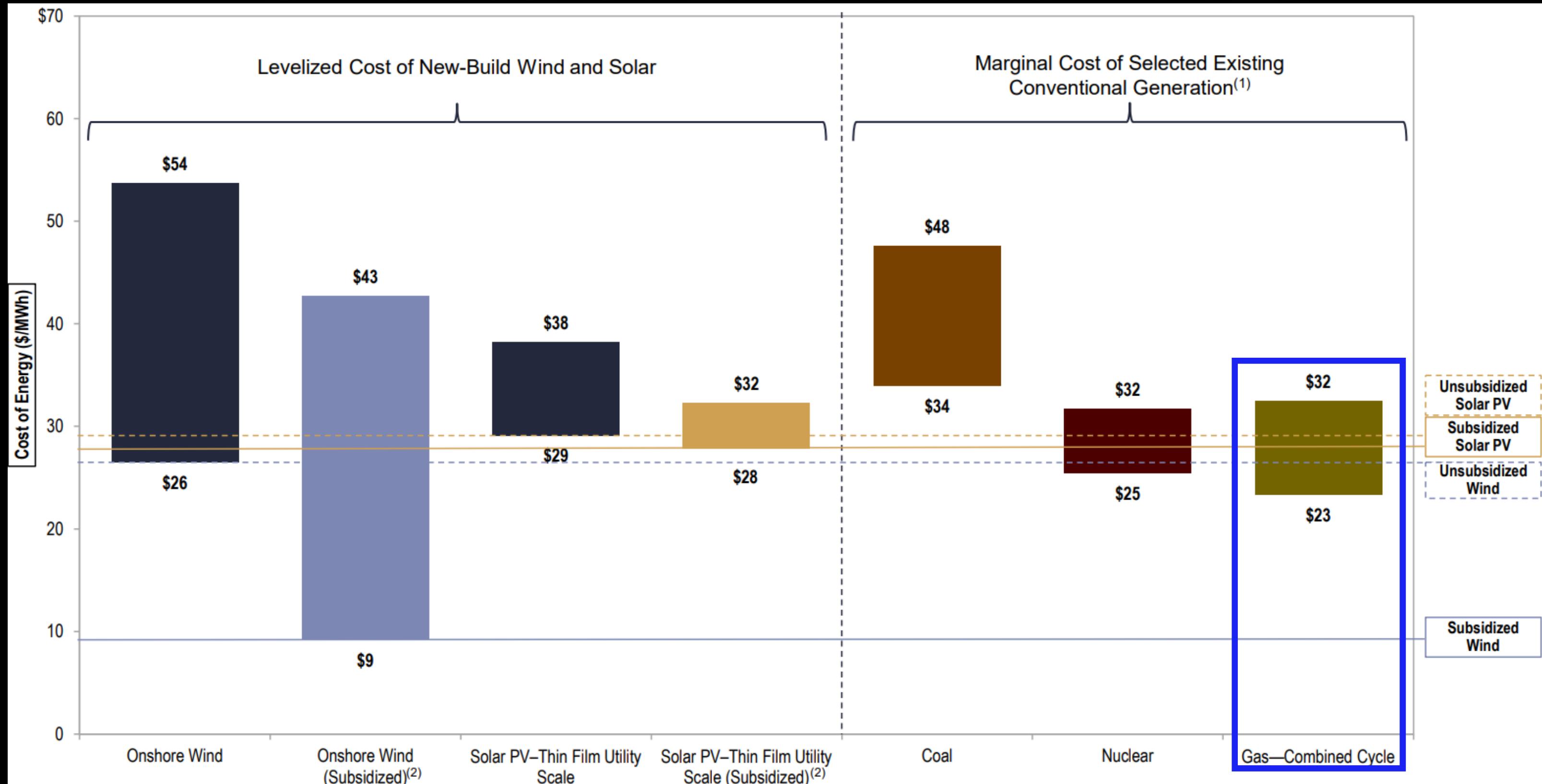


Directly heats more  
than 62 million homes.

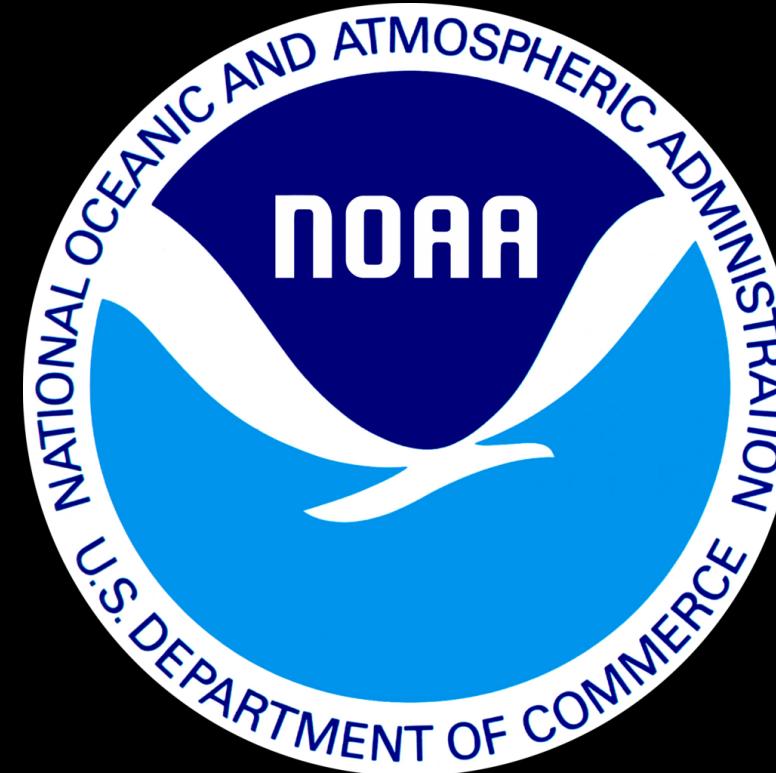


Creates about 500m  
tons of fertilizer per  
year, which fertilizes  
roughly 40% of the  
world's food supply.

# COST OF ENERGY BY SOURCE



# WHAT DRIVES THE PRICE OF NATURAL GAS?



Like most things, the price of natural gas is primarily driven by supply and demand.

## Weather data gathered from NOAA

Degree days, the weather variable, serve as a proxy for demand.

### Heating Degree Days

Primarily observed in the winter, indicative of furnaces being used & electricity being generated to heat homes.

### Cooling Degree Days

Typically peak during the summer, air conditioning is required, which is very energy intensive.

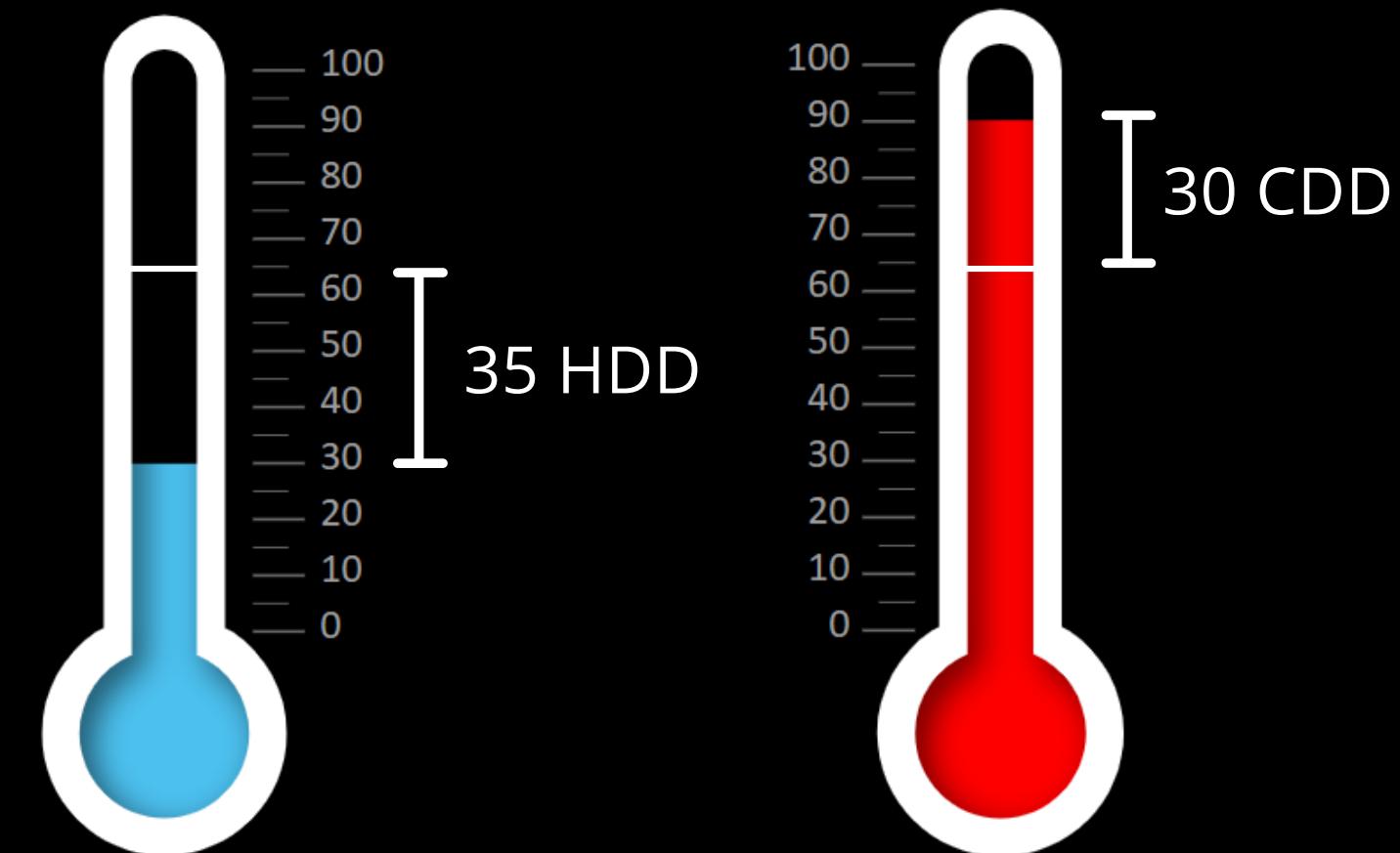
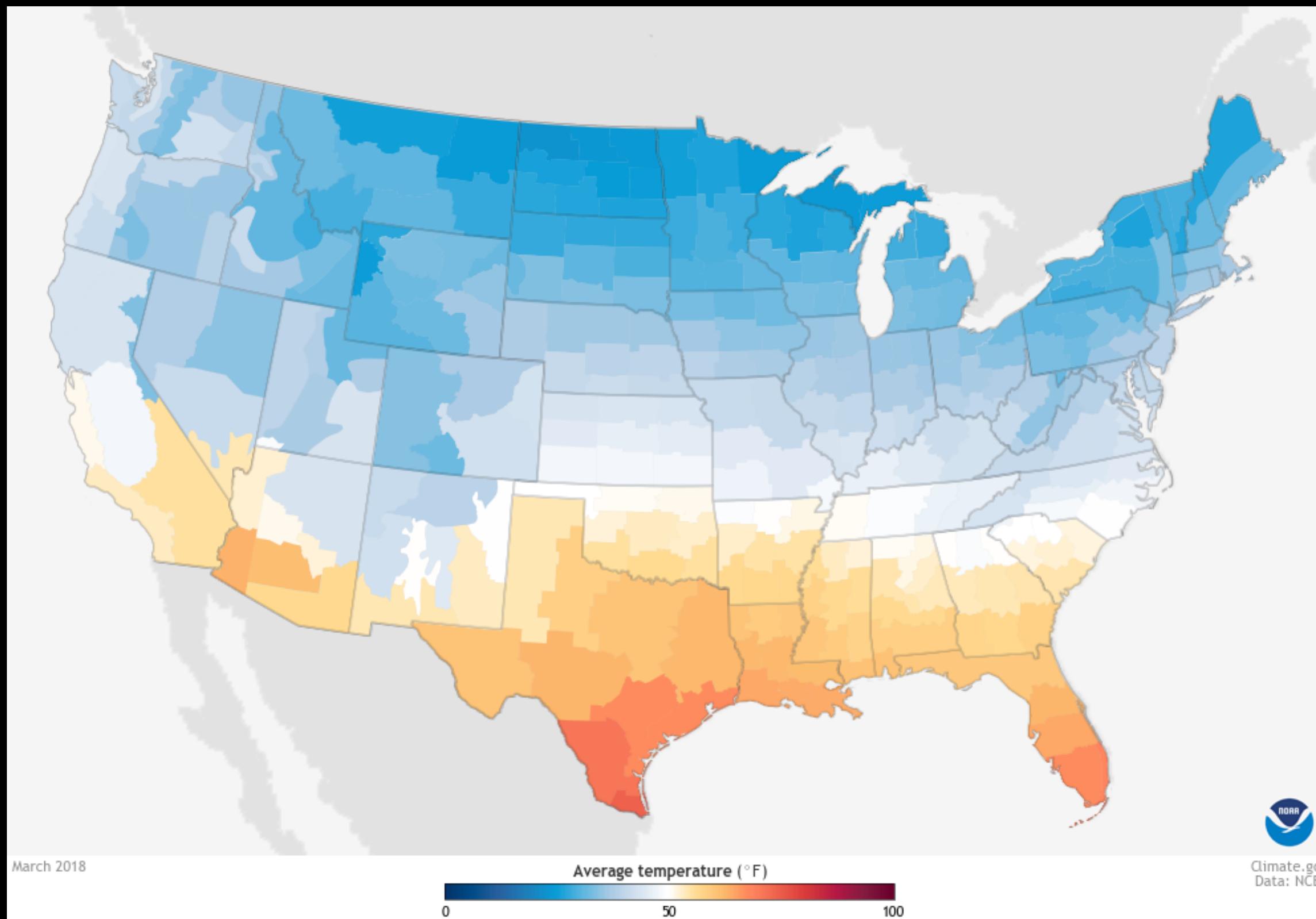
## Underground storage data obtained from the EIA

Underground storage will serve as the supply input.

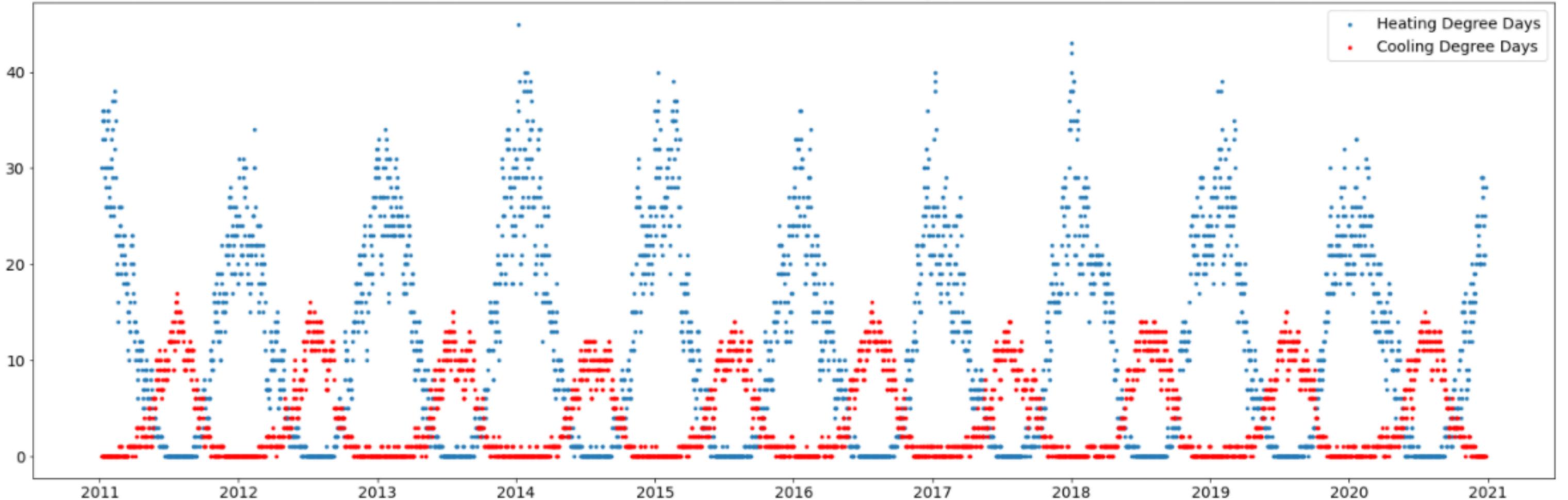
## WHAT ARE DEGREE DAYS?

65°F is the temperature which requires no heating/cooling.

Each 1° difference is counted as a degree day.



### Population Weighted Degree Days



The index is derived from daily temperature observations at nearly 200 major weather stations in the contiguous United States.

- Daily temperature is recorded at several locations within each state.
- These state totals are used to calculate regional totals based on population proportionality.
- Information from the 9 regions is averaged to come up with one HDD/CDD value per day for the continental US.

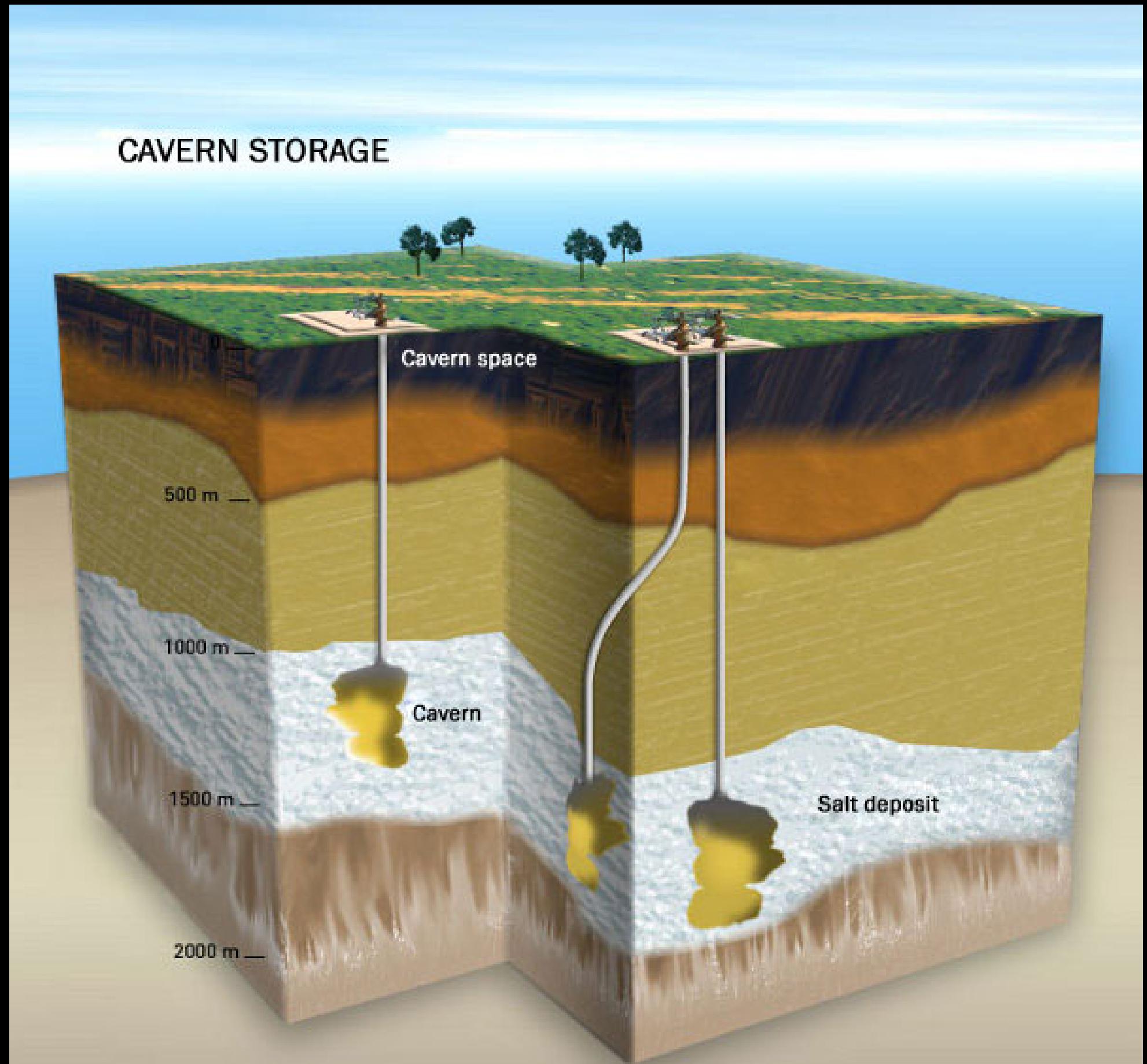
## MID ATLANTIC REGION

- New Jersey 21.21%
- Pennsylvania 30.96%
- New York 47.83%



# HOW IS NATURAL GAS STORED?

- Because of its crystalline structure, salt is extremely impermeable to gas.
- Underground salt caverns are drilled and water is pumped into it, dissolving the salt.
- The brine is extracted, leaving a hollow chamber, and natural gas is injected.
- A certain threshold of "cushion gas" must be maintained, typically 33% of storage capacity.





*a subterranean salt mine drilled using the brine technique*

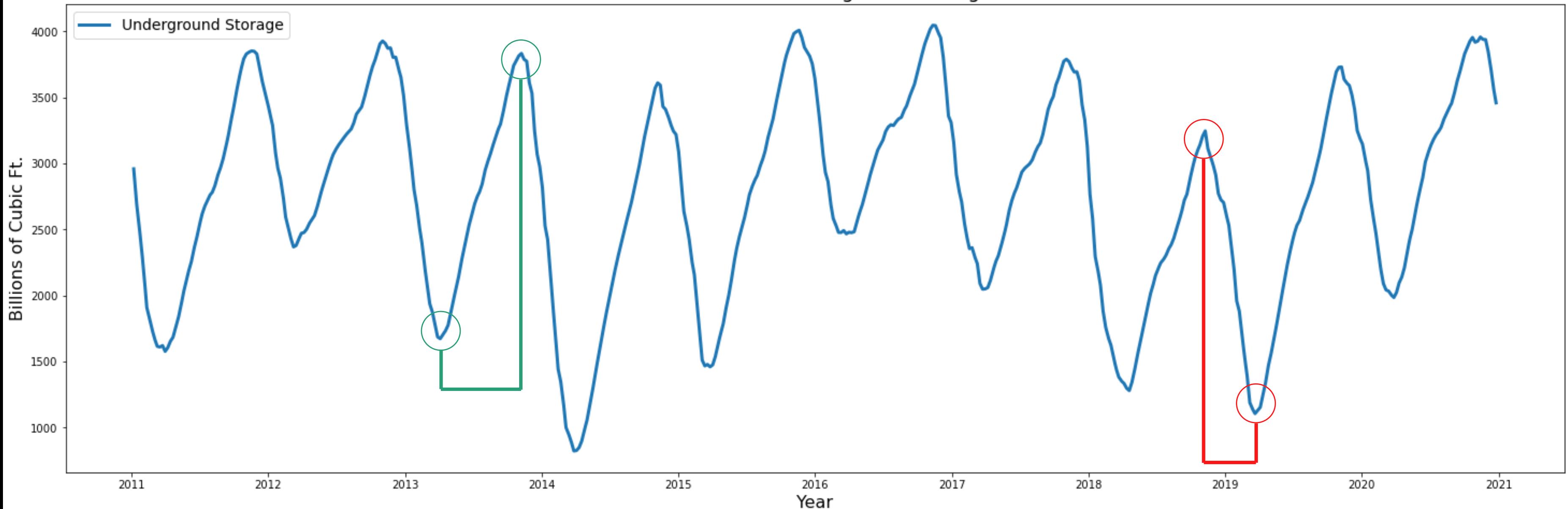
## STORAGE SEASONALITY

Gas is typically injected during the low demand "shoulder seasons," spring and fall.

The additional heating demand, especially during winter, causes gas to be withdrawn from storage

# STORAGE SEASONALITY

Natural Gas in Underground Storage



Injection season lasts from  
April through October

Withdrawal season is typically  
between November through March

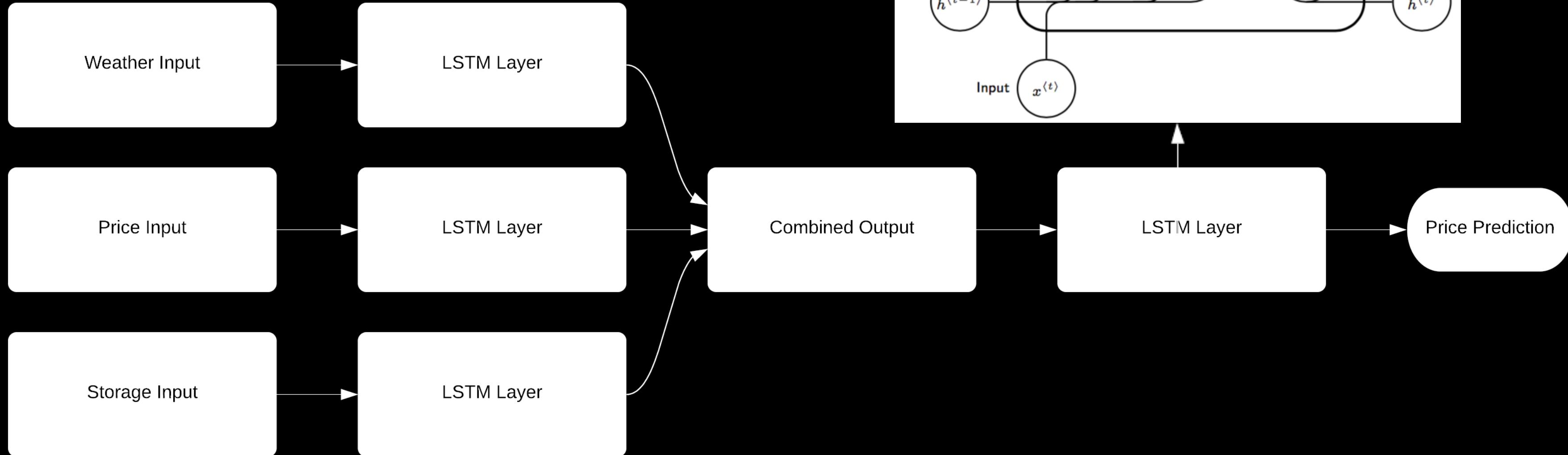
# RECURRENT NEURAL NETWORK

# WITH LSTM CELLS USING



First, the data is divided into 3 cotemporal series.

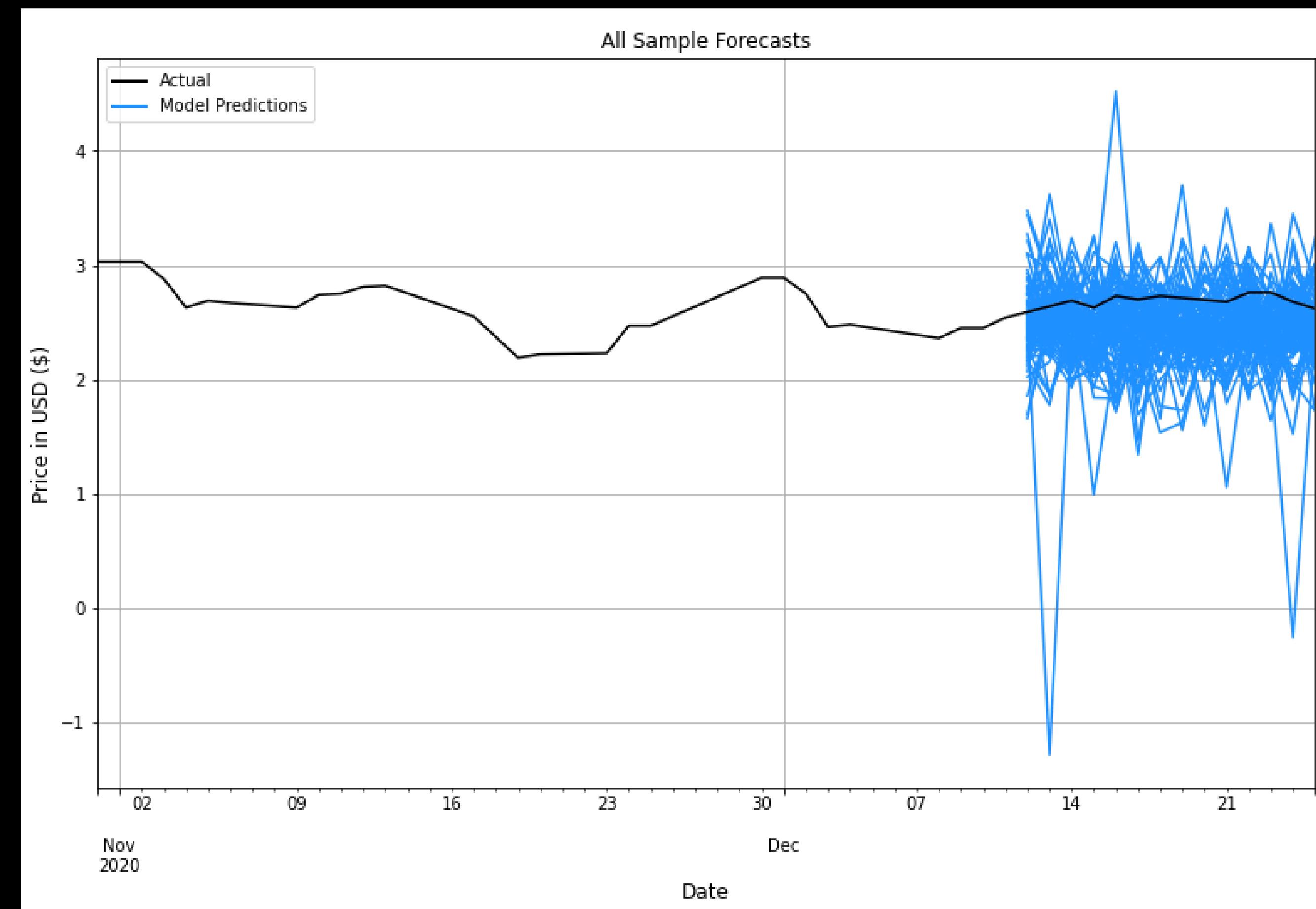
Then it is passed into the network through layers to form a "many-to-one" model.



# PEEKING UNDER THE HOOD

Gluon-TS uses probabilistic forecasting.

It generates an ensemble of predictions which are used to establish confidence intervals.

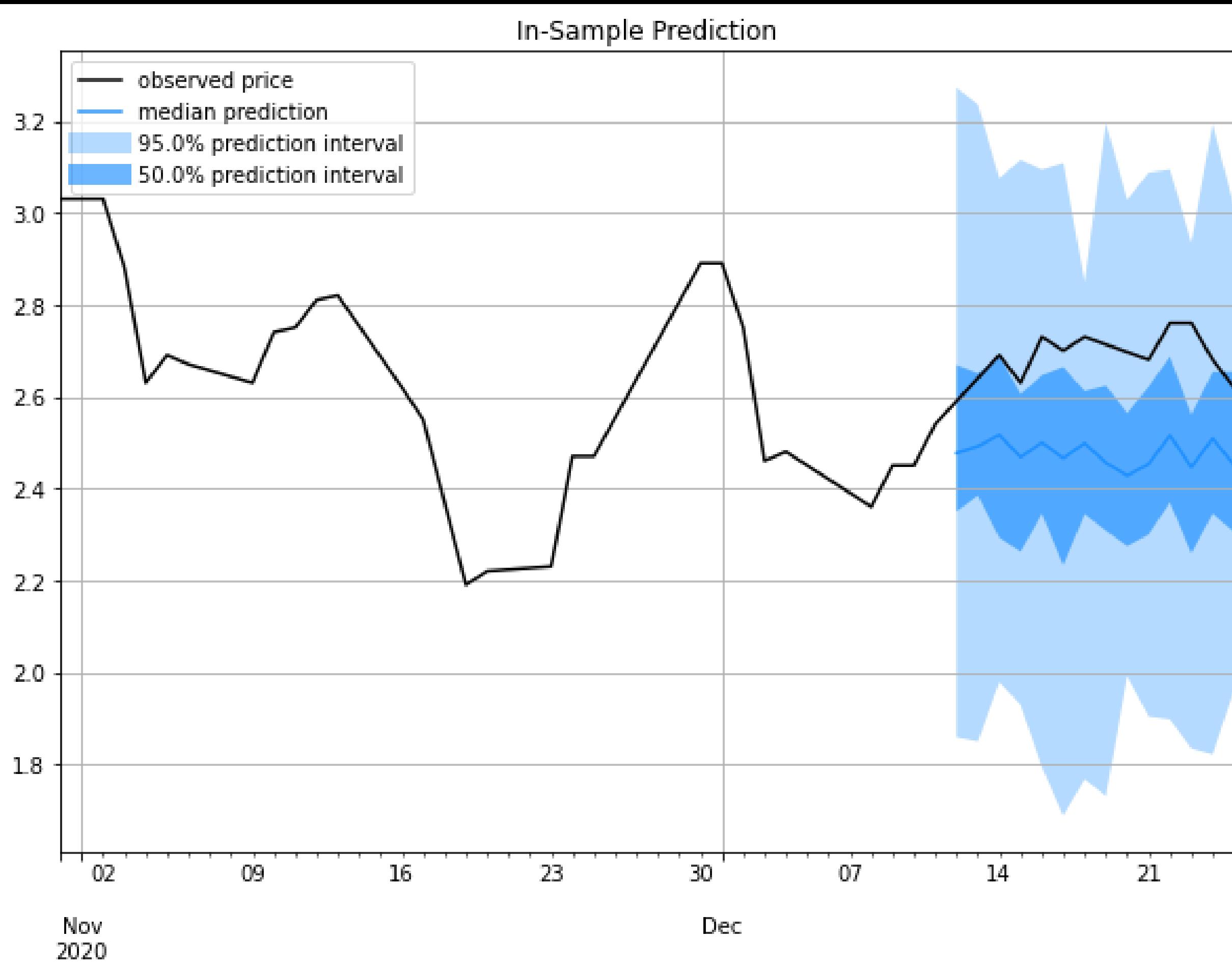


## CHECKING MODEL ACCURACY

A median prediction value is selected from the forecast ensemble, and the conf. intervals bands are based on the distribution of samples

All of the observed values fall well within the 95% conf. interval.

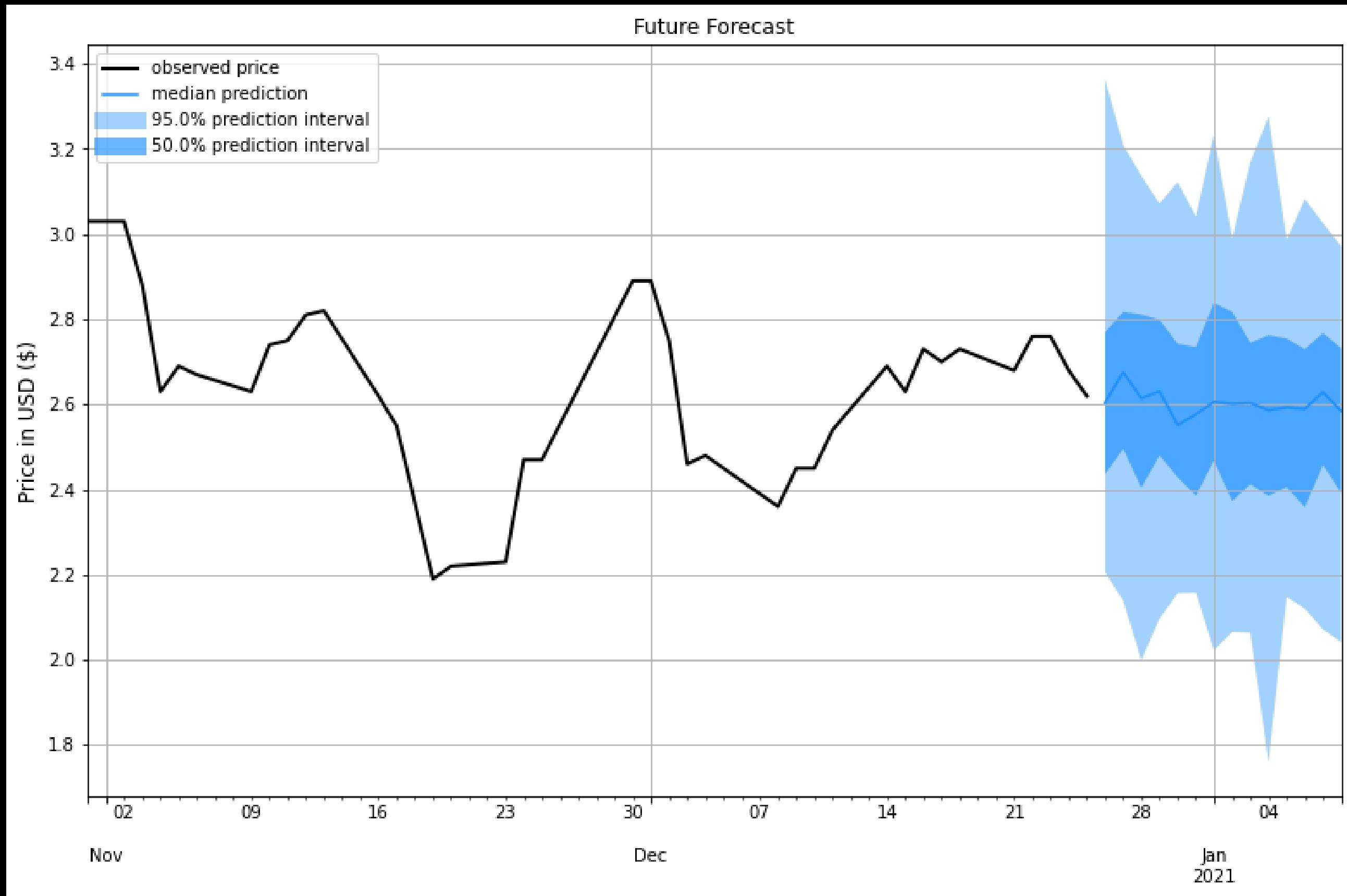
Model Error  
RMSE: 0.2201



# USING THE MODEL TO FORECAST

By using scraped two week forecasted HDD/CDD values & EIA storage forecasts...

We can extend this price forecast into future!



## FUTURE WORK

### Additional Data

incorporate additional exogenous variables, such as interest rates or trader positioning from CFTC data.

### Increase Granularity

increase the frequency of the data, examine hourly data instead of daily to improve near term forecasts.

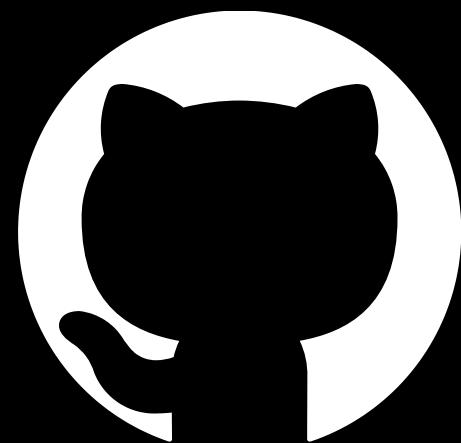
### Connect to an API

add the ability to pull real-time price data from an API, to be able to generate forecasts going forward.

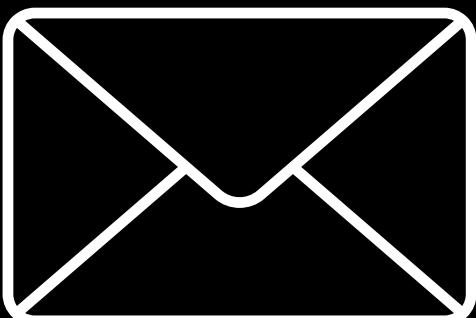
### Hyperparameter Tuning

use AWS to fine tune the hyperparameters and improve the model.

# THANK YOU!



<https://github.com/Nick-Kolowich>



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