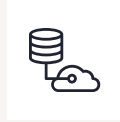


The slide features a light gray background with abstract geometric shapes in blue and dark blue at the top and bottom. On the left side, there are several thin, black, circuit-like lines with small circles at their ends, extending horizontally. On the right side, there are similar circuit-like lines, also extending horizontally.

US Wind Power Production Forecast

Evan Adinolfi

The Problem



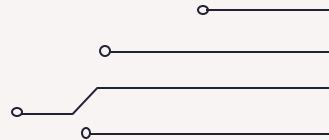
Forecast

The goal is to forecast the wind power production in thousand megawatts hours for the United States over the next year.



Why?

Wind power is one of the best sources of energy as it is efficient and renewable. Wind turbines offer a clean alternative to petroleum. The use of wind power is extremely important for slowing global warming and climate change.



The Data



Data

Wind power production of the United States in thousand megawatts hours



Time Frame

The data is monthly and collected from January 2001 until February 2023



Reliability

The data is from the Electric Power Monthly report, created by the US Energy Information Administration.

The Methodology



Naive

Takes the most recent data and forecasts the same numbers.



Exponential Smoothing

Gives more weight to more recent data and less weight to older, less relevant data.



Holt-Winters

Factors in the level, trend, and seasonality of the dataset.



ARIMA

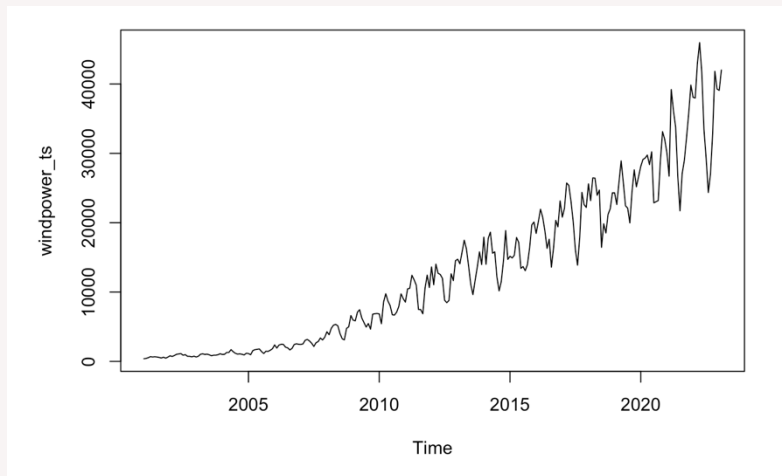
Flexible model that creates forecast from historical data and learns from errors.

Accuracy Measure

MAPE, mean absolute percentage error, will be used to select the best model.

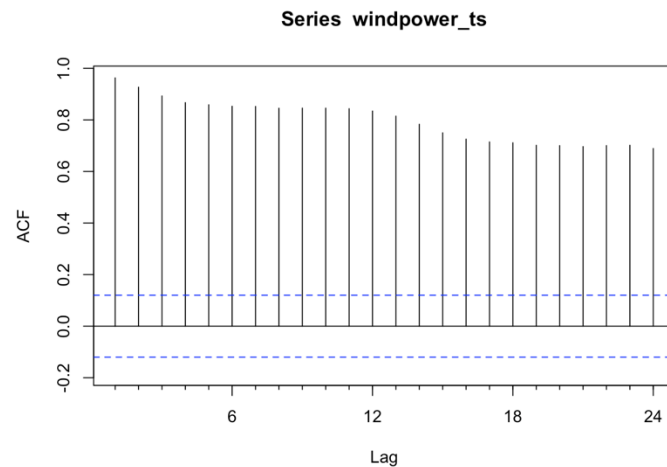
Data Exploration

Time Series Plot



- Shows seasonal fluctuations
- Tends to be a drop in production during the summer months due to warmer weather and weak wind currents

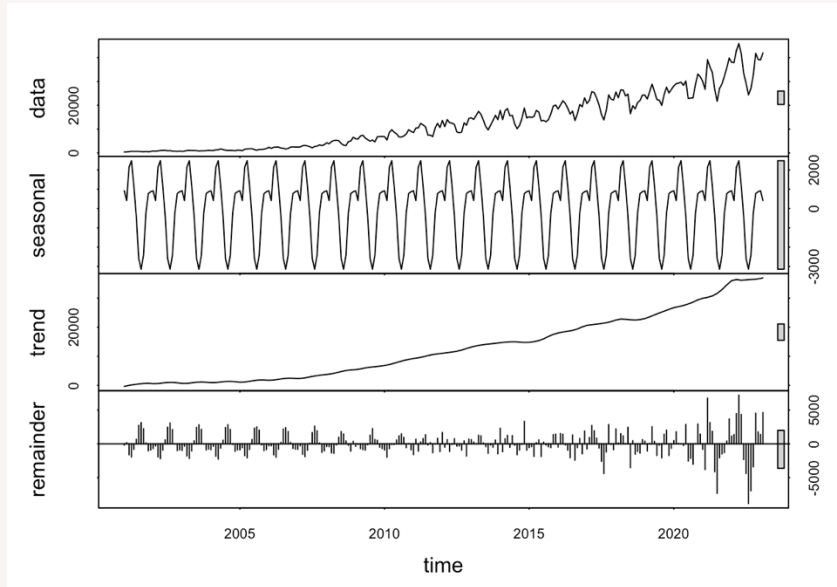
ACF of Time Series



- Shows trend in the time series

Data Exploration

Decomposition

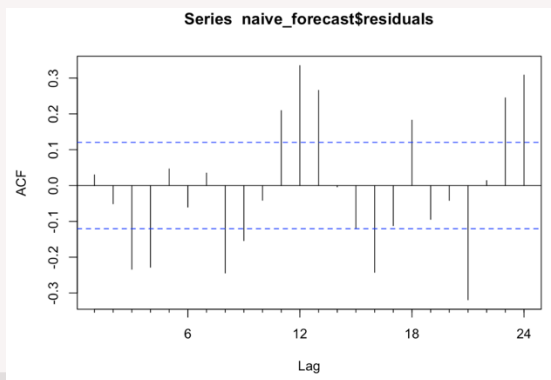
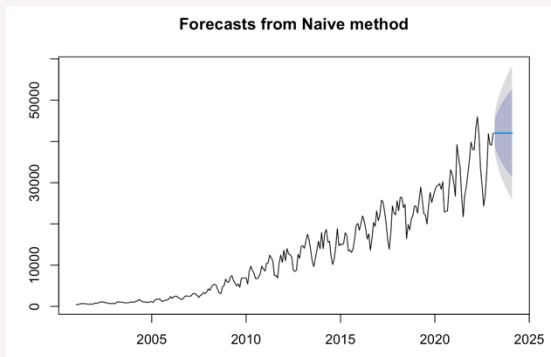


- Confirms there are seasonal fluctuations in the time series
- Trend line steadily increases over time

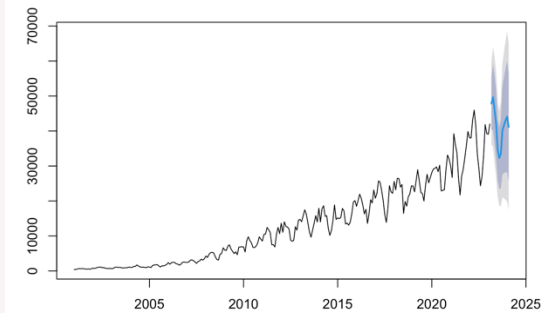
Data Exploration

Naïve Forecast

- Forecasts a straight line
- A lot of noise shown in the ACF of residuals

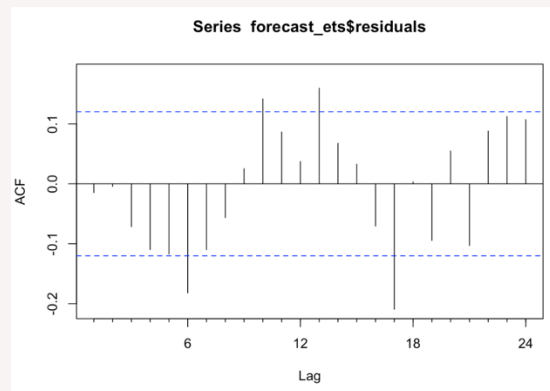


Forecasts from ETS(M,Ad,M)



Exponential Smoothing Forecast

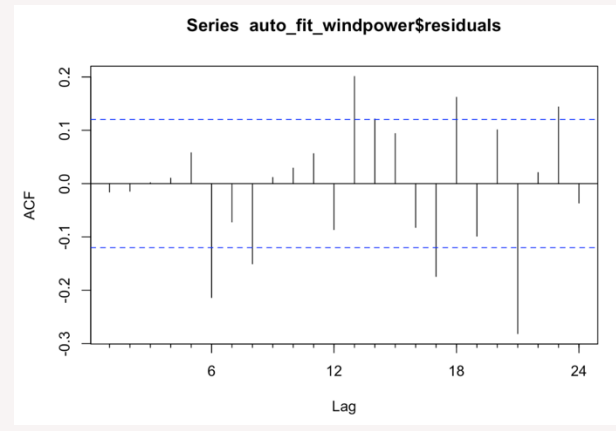
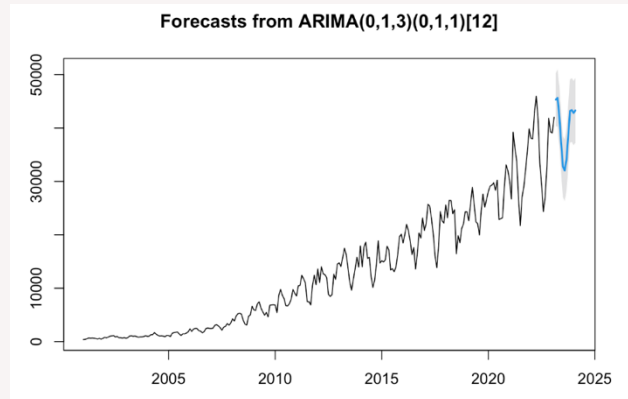
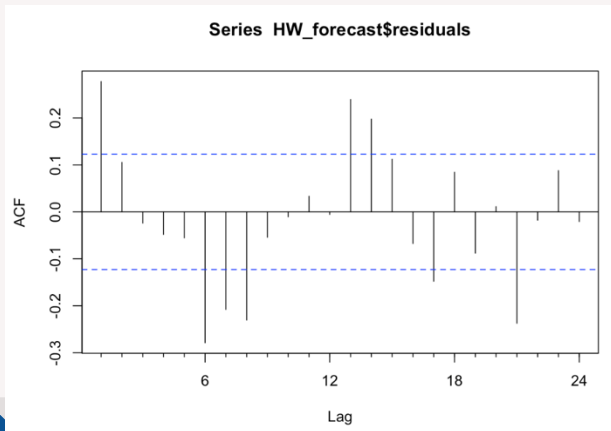
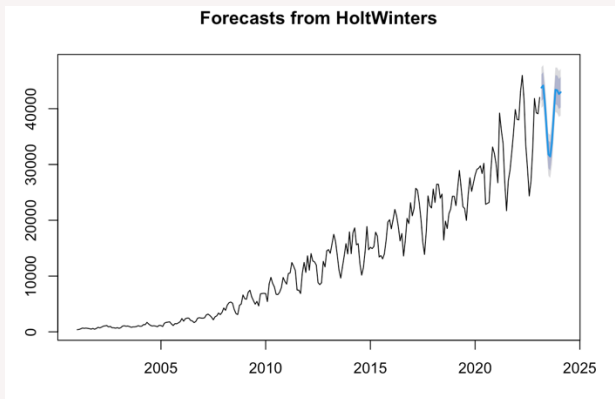
- Forecast follows recent trend and seasonality
- Minimal noise



Data Exploration

Holt-Winters Forecast

- Forecast is similar to recent trend
- Some noise seen in the ACF of residuals



ARIMA Forecast

- Forecast very similar to Holt-Winters
- Not much noise except for a few significant points

Judgement

Method	Forecast Data	ACF show trend in residuals?	How large are errors?	MAPE
Naive	Forecasts a 42,015 thousand MWh of wind production for each month of the next year	No	Histogram shows many large errors	12.81
Simple Smoothing	Forecasts a sharp decrease in wind power production and then it increases again to 41,142 thousand MWh within the next year	No	Histogram of residuals shows all errors are within 0.4 values of zero	8.98

Judgement

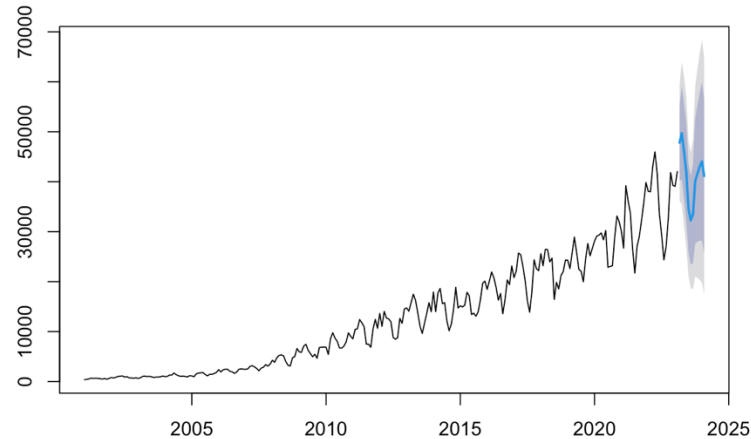
Method	Forecast Data	ACF show trend in residuals?	How large are errors?	MAPE
Holt-Winters	Forecasts a steep drop to 31,432 in August 2023, but then a sharp rise to 42,952 thousand MWh in February 2024	No	Errors are mostly small, but some errors greater than 5000 values off, according to the histogram	10.90
ARIMA	Forecasts a sharp drop to 32,039 in August 2023, and a rise to 43,288 thousand MWh in February 2024	No	Most errors are close to zero, but some are 5000 values off, which is large	9.23

RECOMMENDATIO N

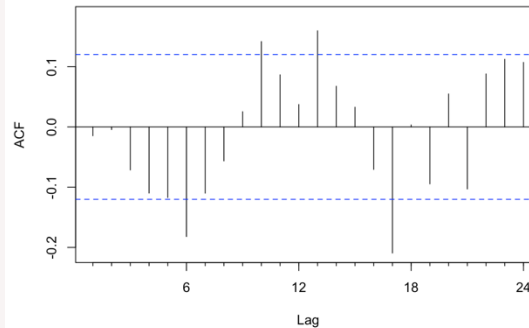
EXPONENTIAL SMOOTHING

- Forecast follows most recent trend of time series data
- No trend in residuals, minimal noise
- Smallest errors out of all the models
- Lowest MAPE out of all the models

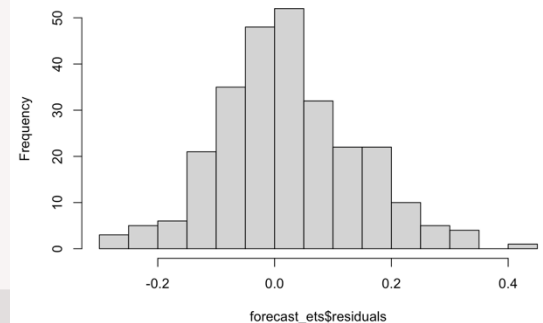
Forecasts from ETS(M,Ad,M)



Series forecast_ets\$residuals



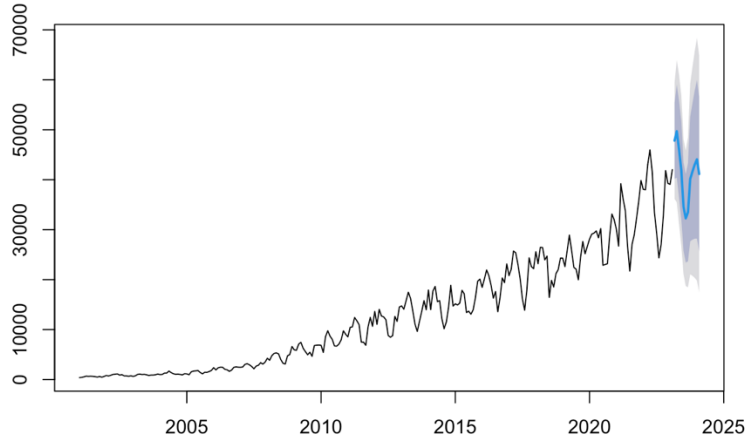
Histogram of forecast_ets\$residuals



Forecast and Conclusion

Forecast

Forecasts from ETS(M,Ad,M)



Conclusion

Wind power production will have a steep drop starting in May of 2023, and then sharply increase in the beginning of 2024 before it drops again to 41,142. Recent trends in the data suggest wind power production will continue to fluctuate like this but gradually increase over time. Wind power may not be the most effective source of energy since it will continue to have seasonal variations.