CM50266 - Applied Data Science

Case Study 2 -
Electric Vehicle Support Infrastructure

Basic Analysis

Basic Cleanup and Summary Analysis

Clean up

The data was already in mint condition and didn't require much cleaning. However I did -

- Filter out the unnecessary columns .
- Filter out minor roads due to their missing values.

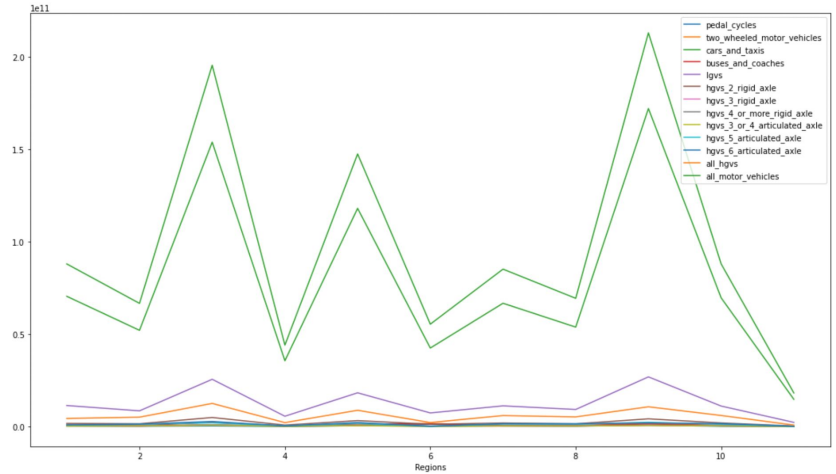
```
major_roads = list(np.where(np.array(raw_df['road_type']) == 'Major')[0])
cols = list(np.linspace(20, 32, 13))
cols = [2, 3, 15] + [int(a) for a in cols]
raw_df_summary = raw_df.iloc[major_roads, cols]
```

Vehicle usage (milage) by region

Zoomed out version

```
2 mv_summary_df.plot(x = 'Regions', y=list(raw_df_summary)[3:], figsize = (18, 10))
```

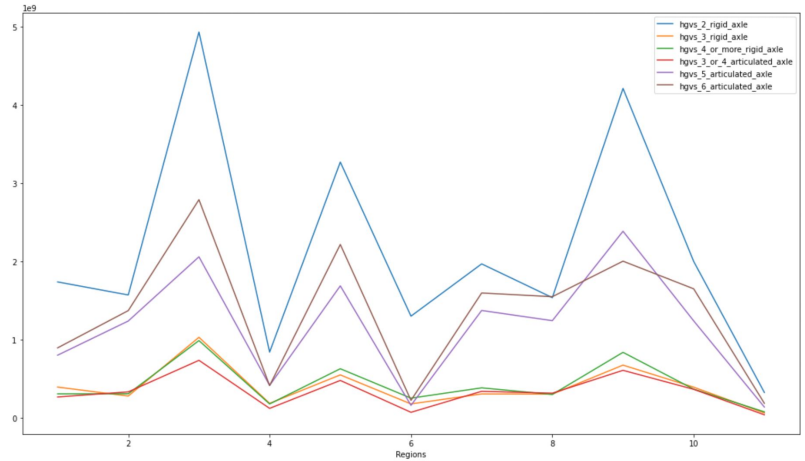
Out[6]: <AxesSubplot:xlabel='Regions'>



Zoomed In

In [7]:
```
1 mv_summary_df.plot(x = 'Regions', y=list(raw_df_summary)[8:14], figsize = (18, 10))
```

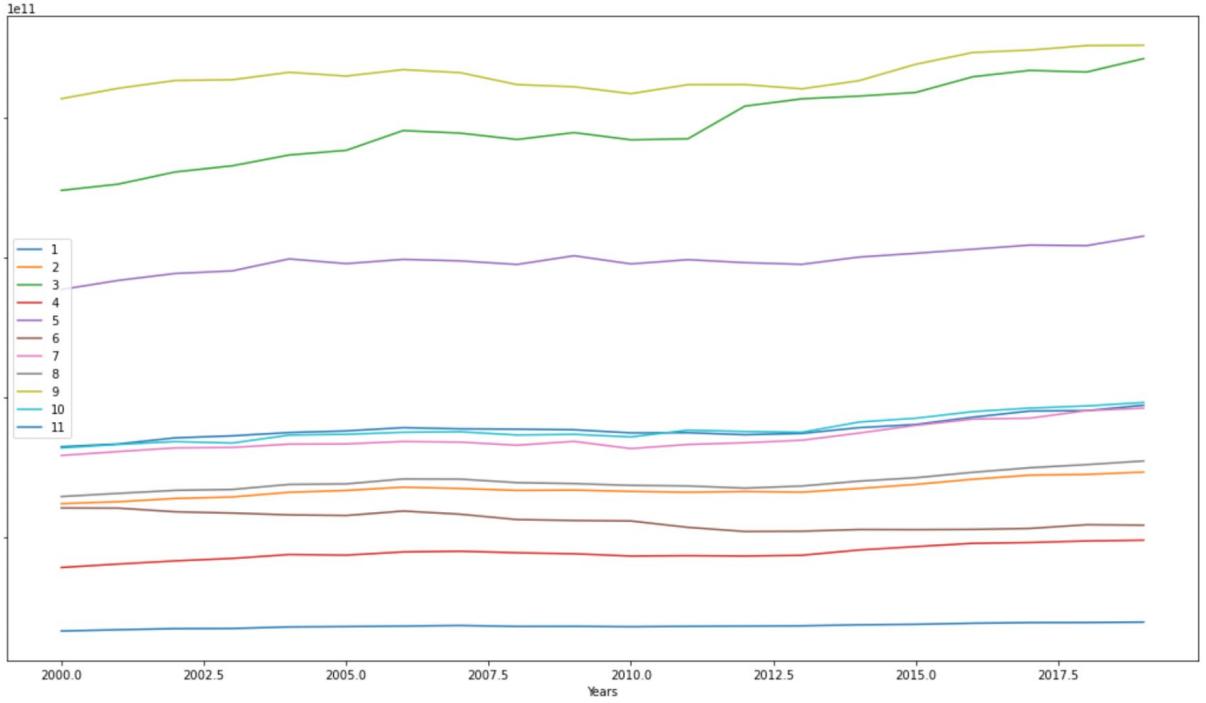
Out[7]: <AxesSubplot:xlabel='Regions'>



Annual trend in overall vehicle usage

```
2 amv_regional_df.plot(x = 'Years', y = regions, kind = 'line', figsize = (18, 10))
```

Out[10]: <AxesSubplot:xlabel='Years'>



Regression

Analysis and Prediction

Problem and Available options

Since the goal of this task was to estimate the likely changes over traffic in the UK over the next 30 years, it became a Time-series problem. Hence, the available pool of algorithms was small and the options were -

- TBATS
- SARIMA
- ARIMA
- LSTM

ARIMA - The saviour

ARIMA stands for AutoRegressive Integrated Moving Average

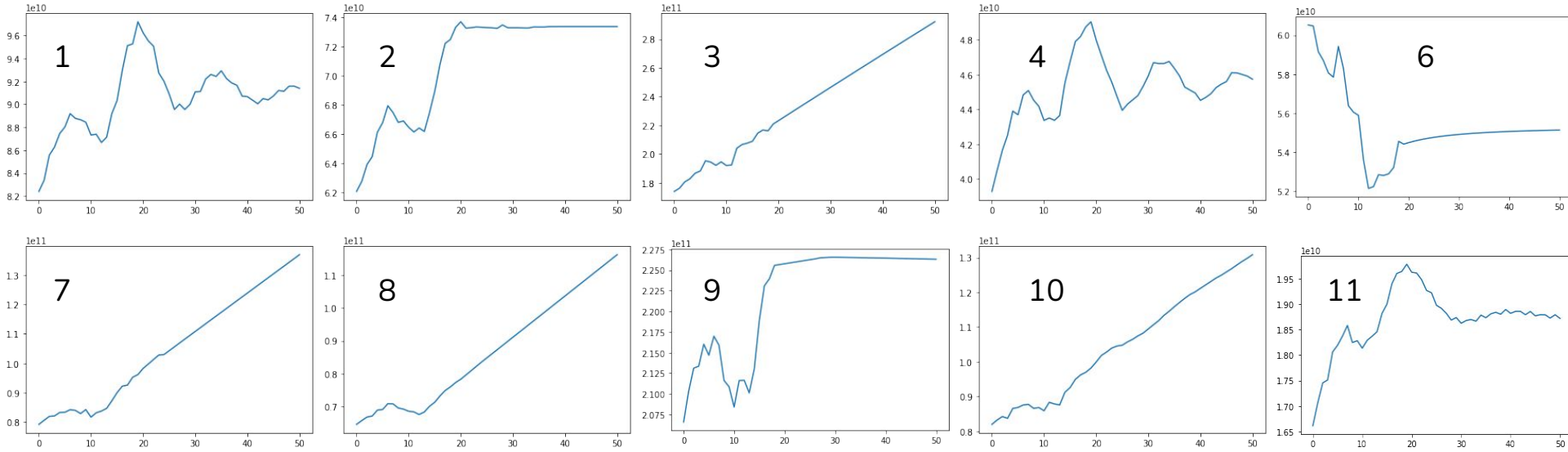
It was used because -

- It is a Moving Average model, meaning it accounts for each timestep using the predictions of timesteps before it
- One of the most popular algorithms out there
- Outputs a smooth curve, which is preferable in these cases

ARIMA forecasting

Regional prediction over 30 years

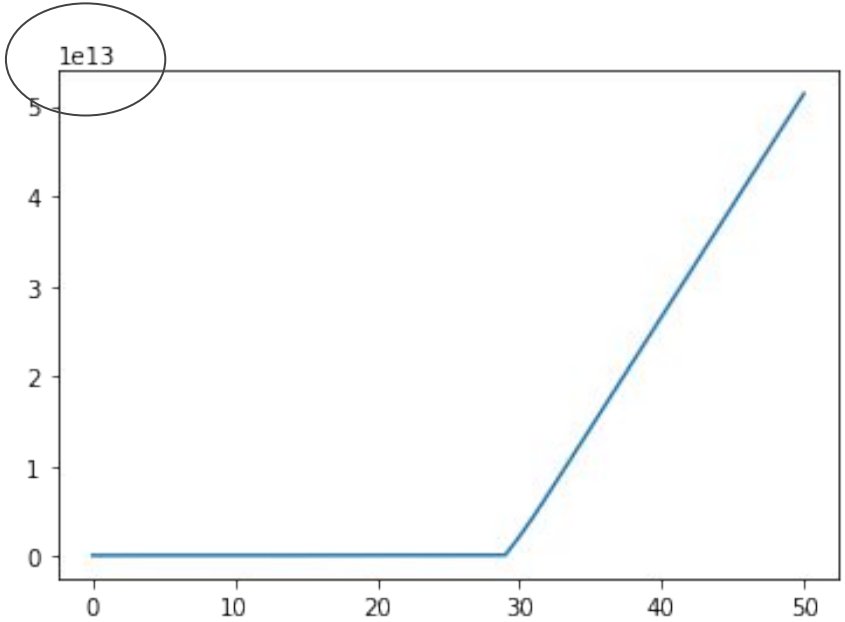
I decided to approach all regions individually initially to analyse patterns in data. The results were interesting to say the least.



ARIMA forecasting

Regional prediction over 30 years

Not all were successful though...



Research

Predicting electric vehicle usage

Future Car Usage predictions

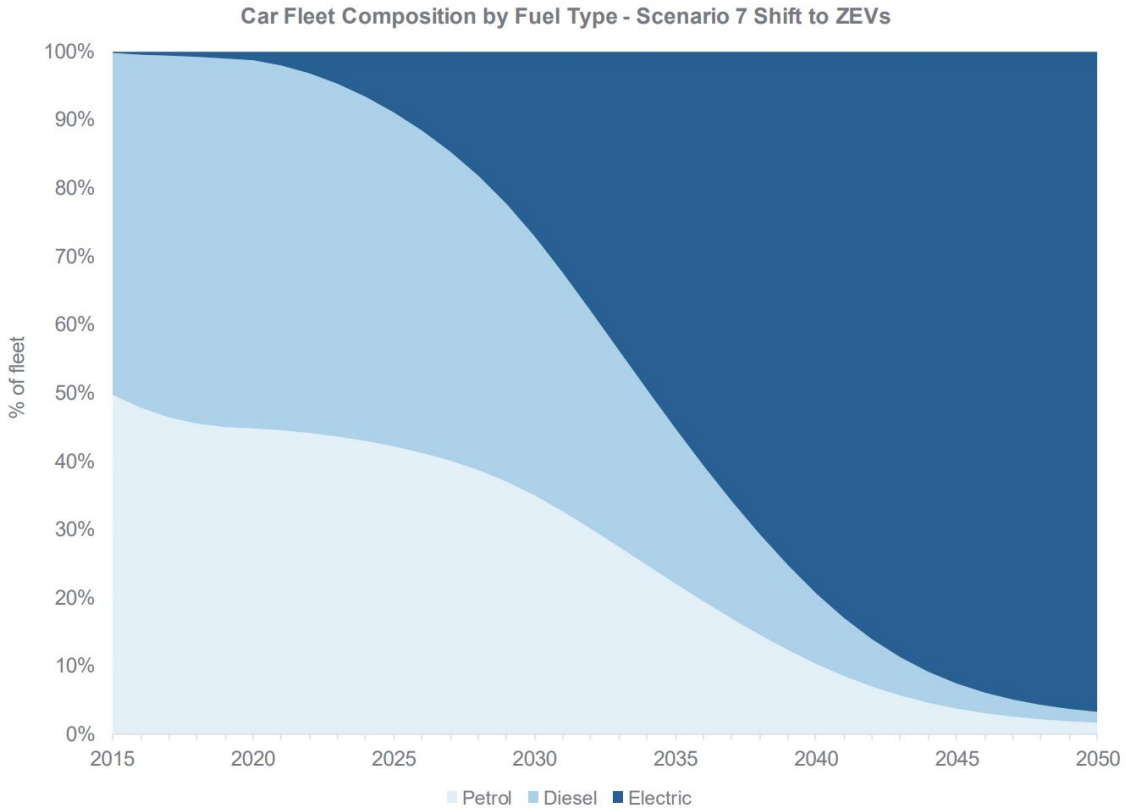
Things to notice -

- A gradual decline of diesel and petrol engines, and gradual rise of electric ones.

(This graph was made with several things in consideration, including but not limited to fuel prices, accessibility of charging ports, affordability and of course social reform due to climate change)

Graph take from -

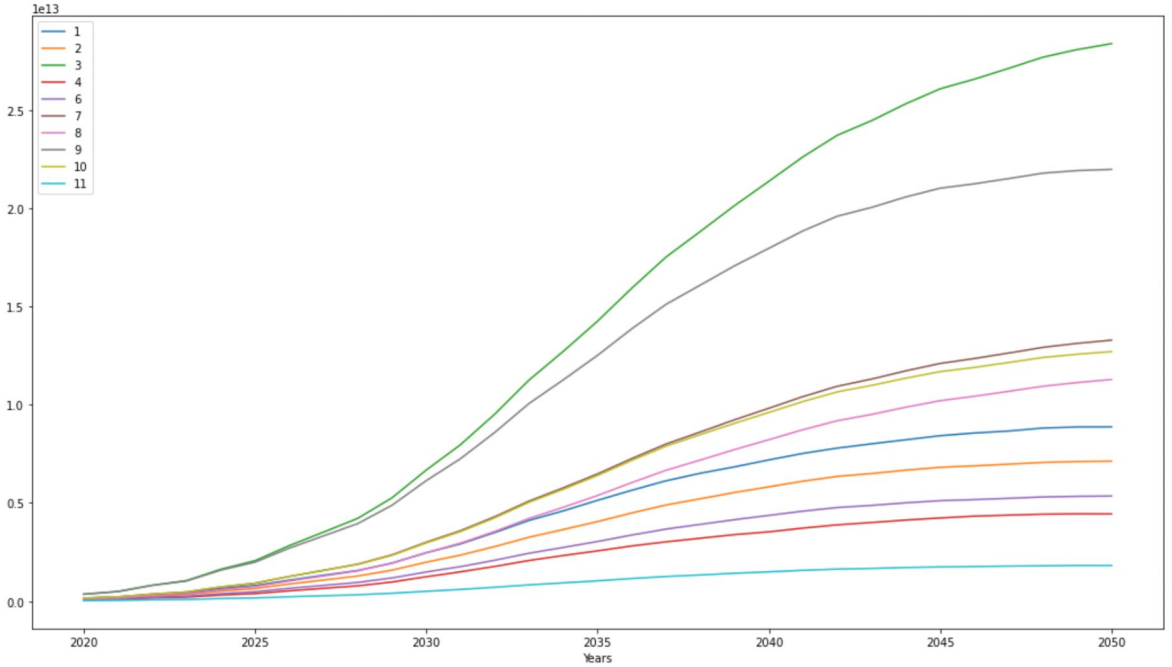
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873929/road-traffic-forecasts-2018-document.pdf



Estimate of the number of electric miles driven in the next 30 years

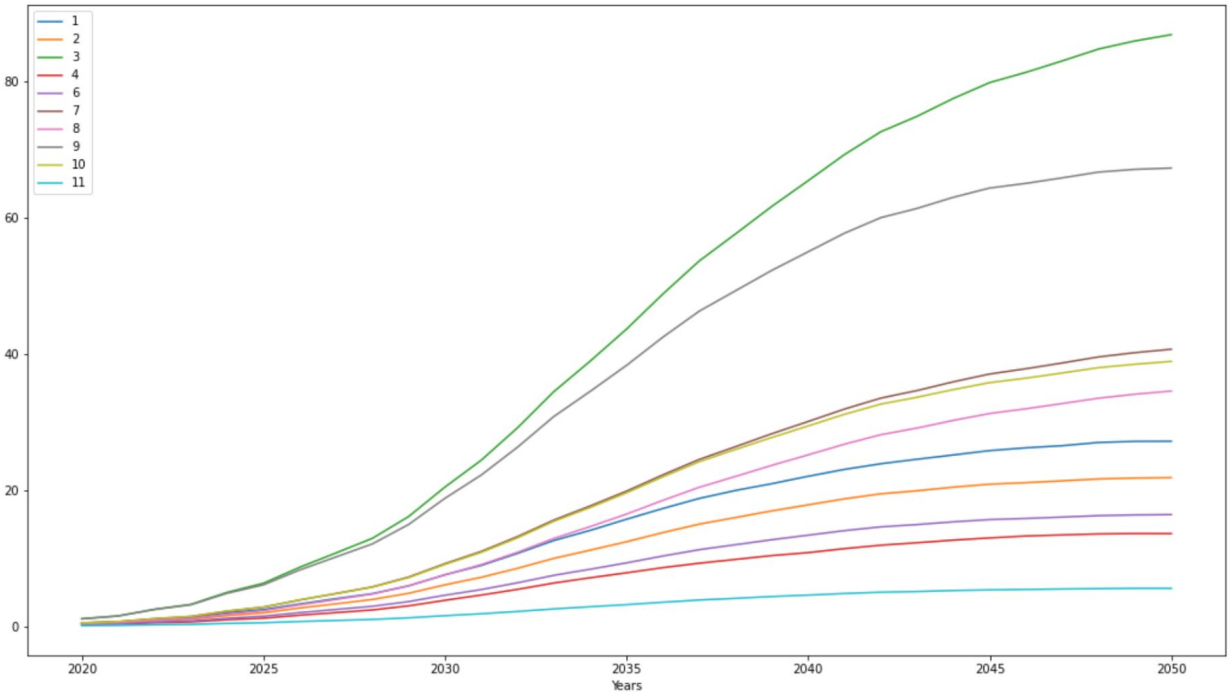
In [60]:
```
1 emiles_est_df.drop('5', axis = 1, inplace = True)
2 emiles_est_df.plot(x = 'Years', y = list(emiles_est_df)[1:], figsize = (18, 10))
```

Out[60]: <AxesSubplot:xlabel='Years'>



Estimated electricity consumption (in TWh/Miles)

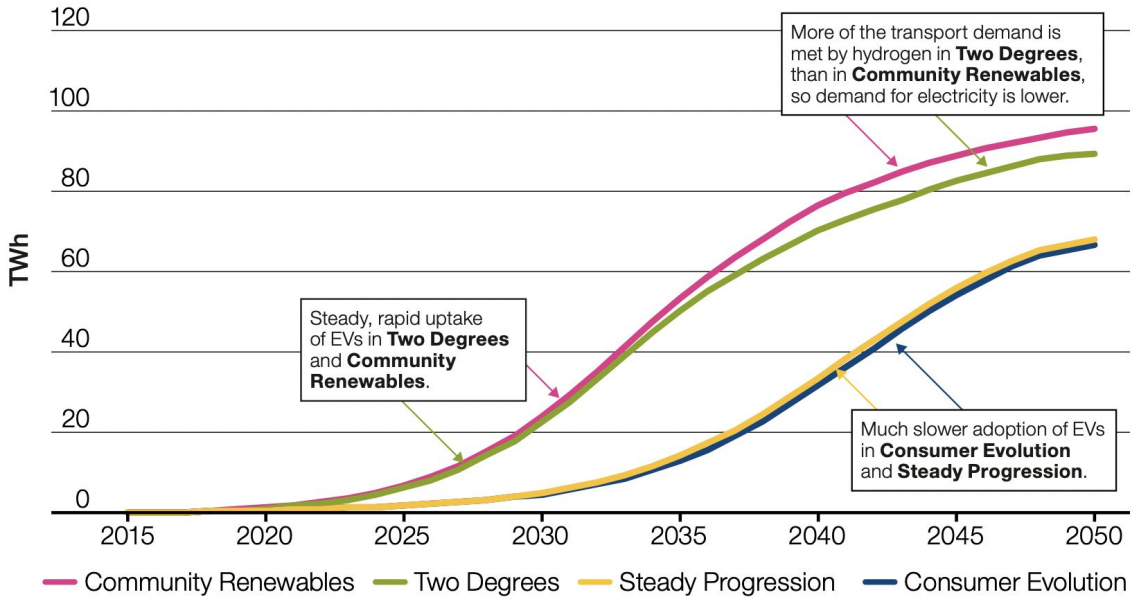
```
In [70]: 1 electric_est_df.plot(x = 'Years', y = list(electric_est_df)[1:], figsize = (18, 10))
Out[70]: <AxesSubplot:xlabel='Years'>
```



Comparison- National Grid ESO

Figure 4.20

Annual road transport electricity demand – TWh/year



Graph taken from https://www.nationalgrideso.com/document/170756/download

Recommendation

Smart ways to tackle a new problem

A new challenge

Into the future?

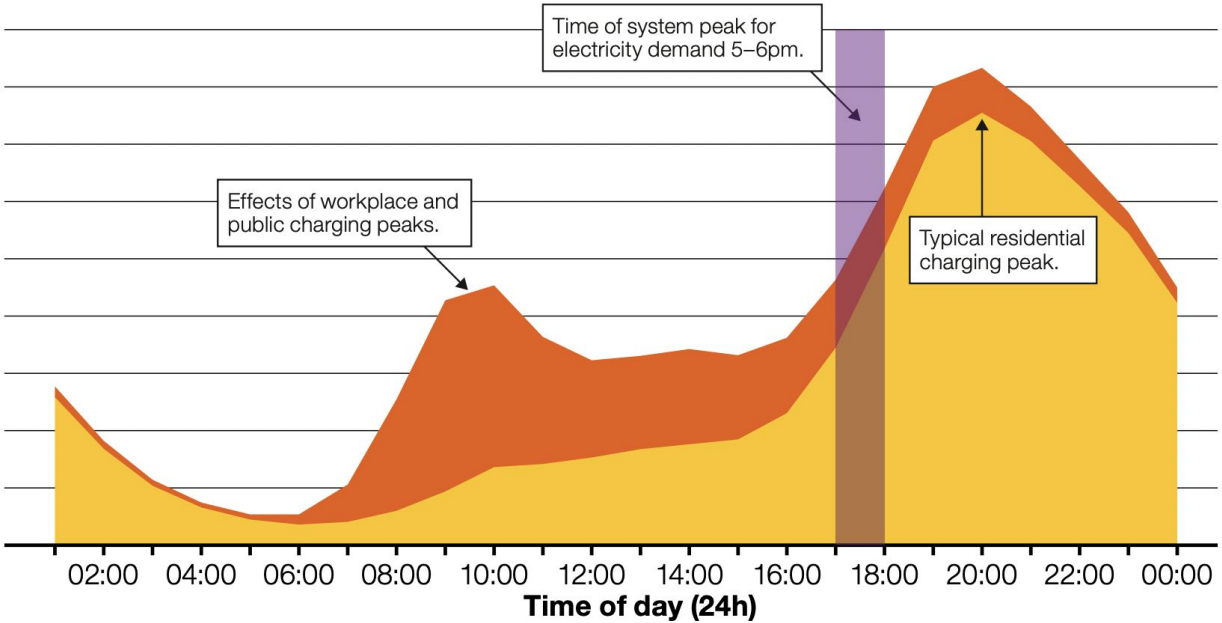
As growth in electric vehicle ownership begins to drive up the proportion of overall demand that the transport sector is responsible for, the peak in EV charging could, in time, result in a new overall system peak later in the evening, or at an entirely different time. There are many uncertain factors that could influence this:

- Will residential charging continue to be the preferred method of charging going forward as the electric vehicle market grows?
- How will developments in charging infrastructure modify charging behaviour going forward?
- How will time-of-use and other charging tariffs influence consumer behaviour?
- How will smart charging, vehicle-to-grid (V2G) and vehicle-to-home (V2H) affect patterns of electricity demand and supply?
- Will there be significant uptake of autonomous vehicles and ride sharing business models?

https://www.nationalgrideso.com/document/170756/download

Figure 4.28

Typical weekday profile (based on EV charging project data 2017/18)

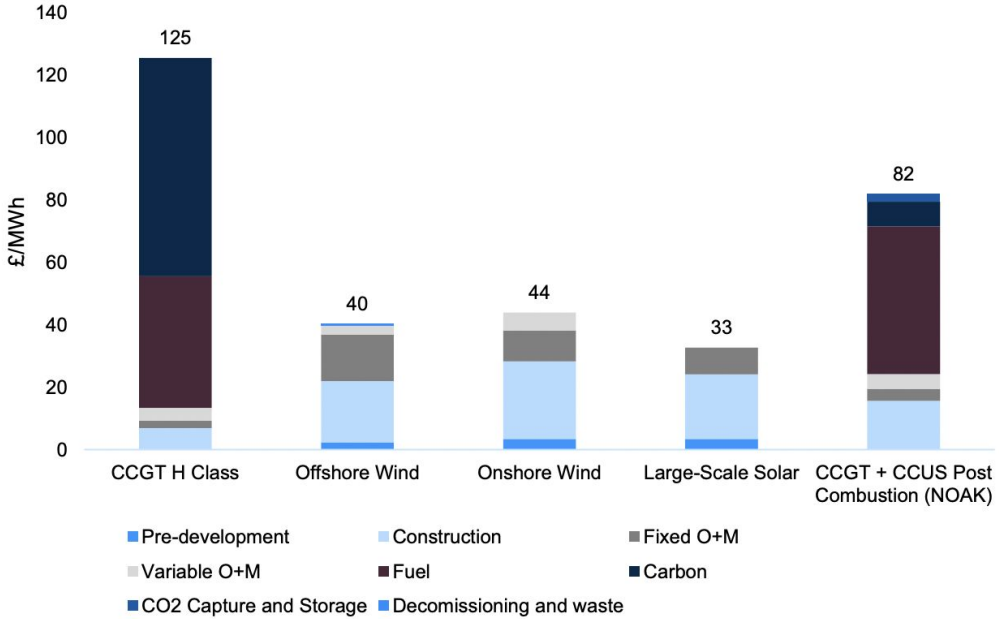


Cost for implementing generation technologies

This Graph offered by the Department of Business, Energy and Industrial Strategy accounts for not just the financial cost, but also the environmental cost.

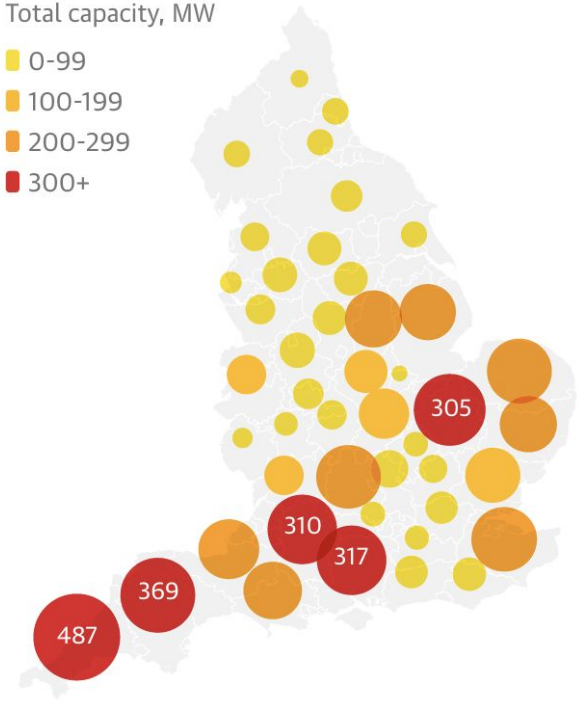
Graph from BEIS - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf

Chart 4.13: Levelised Cost Estimates for Projects Commissioning in 2040, £/MWh, in real 2018 prices

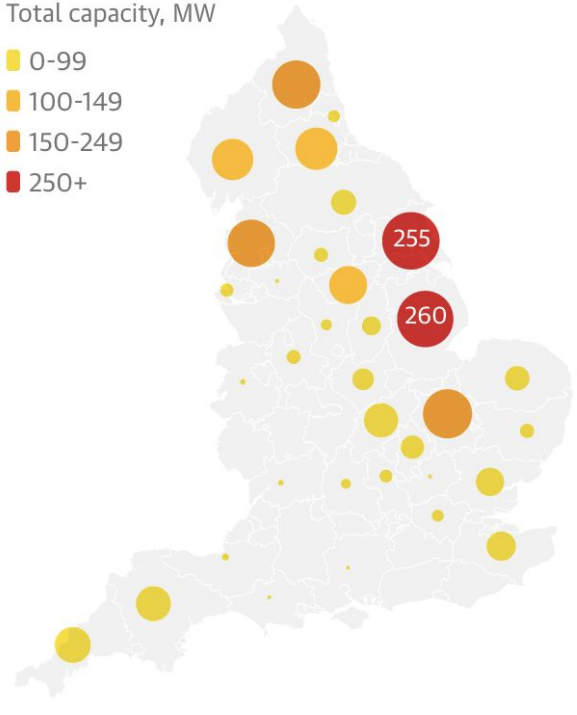


Smart planning

Cornwall is the top county in the UK for solar power production ...



... while East Riding produces the most wind power



Conclusion

There are two main solutions -

- Optimize energy production and
- Optimize energy distribution