Emission Reduction from Renewable Energy in Virginia and North Carolina

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Introduction

High tech companies have stimulated the adoption of 750 MW nameplate capacity of new renewable electricity generation capacity in North Carolina and Virginia. I estimate the reduction in annual greenhouse gas emissions from using renewables instead of building an equivalent amount of natural gas generation.

The result of my calculations is a reduction of annual emissions by 387,000 metric tons of CO_2e

Methods

```
library(pacman)
p_load(tidyverse, magrittr, lubridate, readxl, broom, janitor)

data_dir = here::here("data")
```

First, we download the data file from EPA (2018) with generation, capacity factors, and emissions factors for each generating plant in each state.

```
egrid_file <- file.path(data_dir, "egrid2016_data.xlsx")
egrid_url <- "https://www.epa.gov/sites/production/files/2018-02/egrid2016_data.xlsx"
if (! file.exists(egrid_file)) download.file(egrid_url, egrid_file, mode = "wb")
```

Since almost all new fossil fuel generation capacity is natural gas, assume that if the renewable generating capacity were not installed, an equivalent amount of natural gas capacity would have to be added to supply the data centers.

For our analysis, we break out the renewable and natural gas plants in Virginia and North Carolina.

The table columns we use are: * `pstatabb`: Two-letter state abbreviation. * `plfuelct`: Fuel category (`SOLAR`, `WIND`, or `GAS` for our cases). * `capfact`: Capacity factor for that generating plant * `namepcap`: Nameplate generating capacity (MW) for that plant. * `plngenan`: Annual generation for that plant (MWh). * `plco2eqa`: Annual GHG emissions for the plant (short tons CO_2e). * `plc2erta`: Annual GHG emissions rate for the plant (pound CO_2e per MWh).

```
egrid <- read_excel(egrid_file, "PLNT16",
                    skip = 1, na = c("", "NA", "N/A", "na", "n/a")) %>%
  clean_names()

renewables <- egrid %>%
  filter(pstatabb %in% c("NC", "VA"), plfuelct %in% c("SOLAR", "WIND")) %>%
  select(pstatabb, plfuelct, capfac, namepcap, plngenan, plco2eqa, plc2erta)
```

```
natgas <- egrid %>%
  filter(pstatabb %in% c("NC", "VA"), plfuelct %in% c("GAS")) %>%
  select(pstatabb, plfuelct, capfac, namepcap, plngenan, plco2eqa, plc2erta)
```

Now we calculate the equivalent amount of natural gas that would have to be installed to replace renewables with a nameplate capacity of 750 MW. We calculate the average capacity factor for each type of electricity (the eGRID 2016 numbers apply to 2016, which was a leap year, so we use 366 days for the length of the year).

The capacity factor is calculated as

$$\text{capacity factor} = \frac{\sum_{p \in \text{plants}} \text{annual generation (MWh)}}{\text{hours in a year} \times \sum_{p \in \text{plants}} \text{nameplate capacity (MW)}}.$$

The capacity factors are:

- Renwwables 14.1%
- Natural gas: 32.0%

The emissions factor is calculated as

$$\text{emissions factor} = \frac{\sum_{p \in \text{plant}} \text{annual GHG emissions (tons)}}{\sum_{p \in \text{plant}} \text{annual generation (MWh)}},$$

which gives an emissions factor for natural gas of 0.417 metric tons CO_2e/MWh.

The generating capacity of natural gas that would be required to substitute for 750 MW nameplate capacity of renewables would be

$$\text{cap}_{\text{gas}} = \text{cap}_{\text{renweables}} \times \frac{\text{cap factor}_{\text{renewables}}}{\text{cap factor}_{\text{gas}}}$$

and the annual GHG emissions that would result would be

$$\begin{aligned} \text{emissions} &= \text{emissions factor}_{\text{gas}} \times \text{cap}_{\text{gas}} \times \text{hours per year} \\ &= \text{emissions factor}_{\text{gas}} \times \text{cap}_{\text{renweables}} \times \frac{\text{cap factor}_{\text{renewables}}}{\text{cap factor}_{\text{gas}}} \end{aligned}$$