

Analysing the energy consumption of residential buildings in Germany

Ivana Trajanovska, Pallavi Mitra and Bhaskar Kamble

09 Juli 2019

Purpose

- ▶ Analyze heating energy consumption by residential buildings in Germany from 2002 - 2018.
- ▶ Understand the impact of government measures in reducing energy consumption.

The topic is of high political significance in the context of international measures to reduce global warming.

The data

- ▶ The data come from the online portal of co2online gGmbH, where private individuals give information relating to the building's energy consumption for a year and features relating to the building (age, area, fuel type, refurbishment measures already carried out, etc.) in return for an evaluation of the building's energy efficiency and suggested refurbishment measures.
- ▶ Data from more than 2 million buildings from 2002 - 2018.

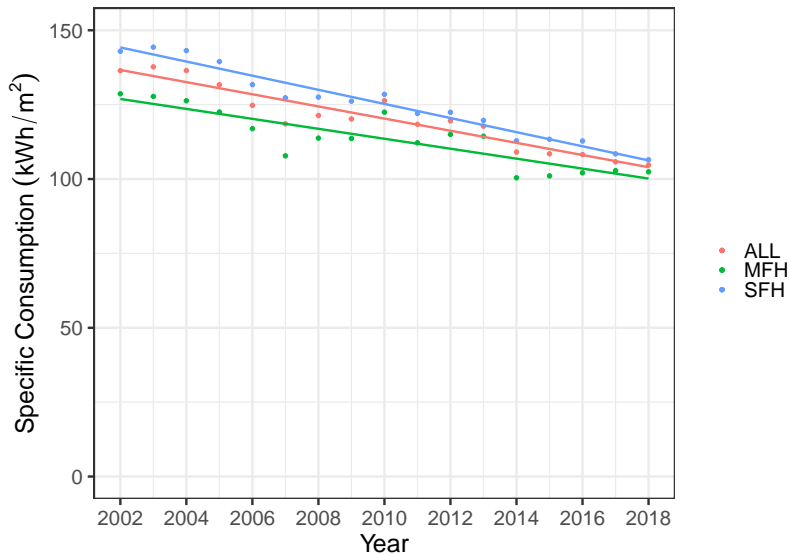
The data: Multifamily buildings

```
## 'data.frame':    376825 obs. of  10 variables:
## $ sto_plz          : int  24937 24943 24939 249
## $ bundesland       : chr   "Schleswig-Holstein"
## $ gebaeude_baujahr : int  1900 1950 1953 1967 1
## $ energietraeger    : chr   "waerme" "waerme" "wa
## $ abrechnungsjahr   : int  2008 2009 2011 2012 2
## $ gebaeude_nutzflaeche : num  300 722 899 756 2238
## $ verbrauch_gesamt_kwh : num  32000 95000 124000 81
## $ verbrauch_gesamt_kwh_spez: num  128 158 166 129 145
## $ Landkreis_von_GS  : chr   "Flensburg, Stadt" "F
## $ gtype             : chr   "MFH" "MFH" "MFH" "MF
```

The data: One- to two-family buildings

```
## 'data.frame':    1868149 obs. of  10 variables:
##  $ sto_plz                : int  24941 24937 24941 249
##  $ bundesland             : chr   "Schleswig-Holstein"
##  $ gebaeude_baujahr       : int  1967 1900 1986 1968 1
##  $ energietraeger         : chr   "heizoel" "waerme" "e
##  $ abrechnungsjahr        : int  2004 2004 2004 2003 2
##  $ gebaeude_nutzflaeche   : num   180 106 180 192 118
##  $ verbrauch_gesamt_kwh   : num  23184 10000 65000 230
##  $ verbrauch_gesamt_kwh_spez: num   155 114 433 144 184
##  $ Landkreis_von_GS      : chr   "Flensburg, Stadt" "F
##  $ gtype                  : chr   "SFH" "SFH" "SFH" "SFH"
```

Specific energy consumption in Germany (2002 - 2018)



The cold winter of 2010

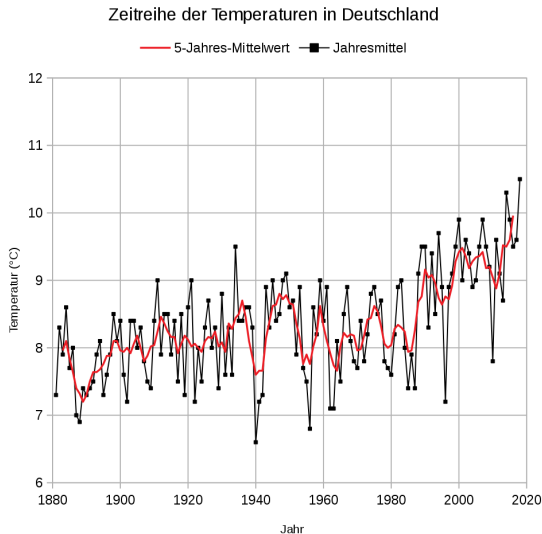


Figure 1: Temperatures in Germany from 1881 - 2018. Source: wikipedia

The cold winter of 2010

Wetterrückblick

Themen des Tages

Extremwetter

Rückblick

Astro

K

Donnerstag, 30.12.2010

Rückblick Dezember 2010

Sehr kalt und extrem schneereich



Mit Ausnahme des äußersten Südens und Südwestens von Deutschland ist der Dezember extrem kalt ausgefallen. Die Temperaturabweichung belief sich im Flächenmittel auf mehr als 4 Grad. In der Nordhälfte lag sie vielfach

zwischen 5 und 6 Grad, am Oberrhein und in Alpennähe war es mit einer negativen Abweichung von 1 bis 2,5 Grad am mildesten. Der strengste Frost im Flachland wurde am 30. mit **minus 23 Grad** im oberpfälzischen Grafenwöhr und mit minus 21,6 Grad im fränkischen Bamberg beobachtet, am wärmsten war es mit plus 15,4 Grad am 8. in München.



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Dezember 2010: Ein Land versinkt im Schnee

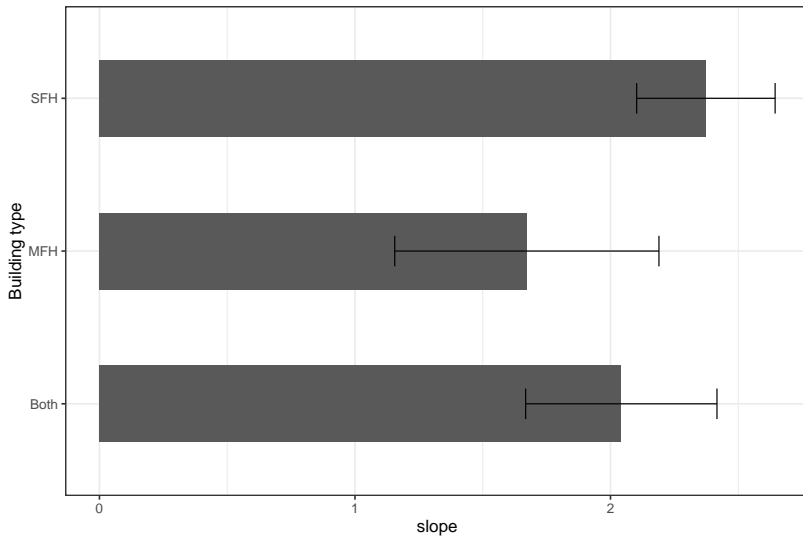
von [Thomas Sävert](#) / 3. Dezember 2016 / [Keine Kommentare](#)



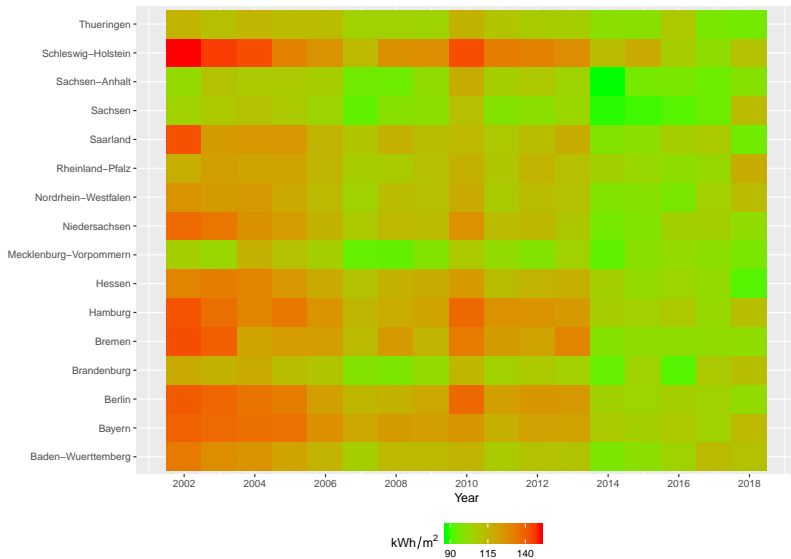
Insights

- ▶ The spike in 2010 corresponds to the cold winter of that year.
- ▶ One- to two-family houses have a larger specific energy consumption compared to multifamily houses.
- ▶ But their rate of decrease is faster than multifamily buildings.

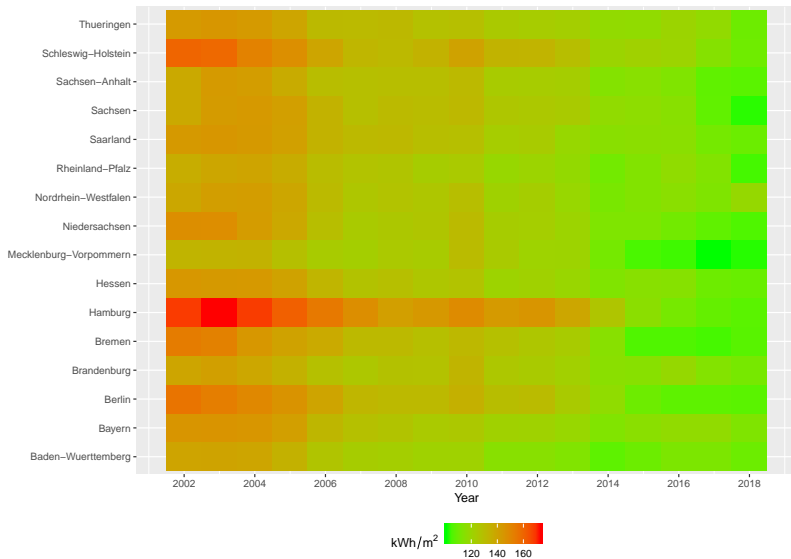
Rate of change of specific energy consumption in Germany (2002 – 2018)



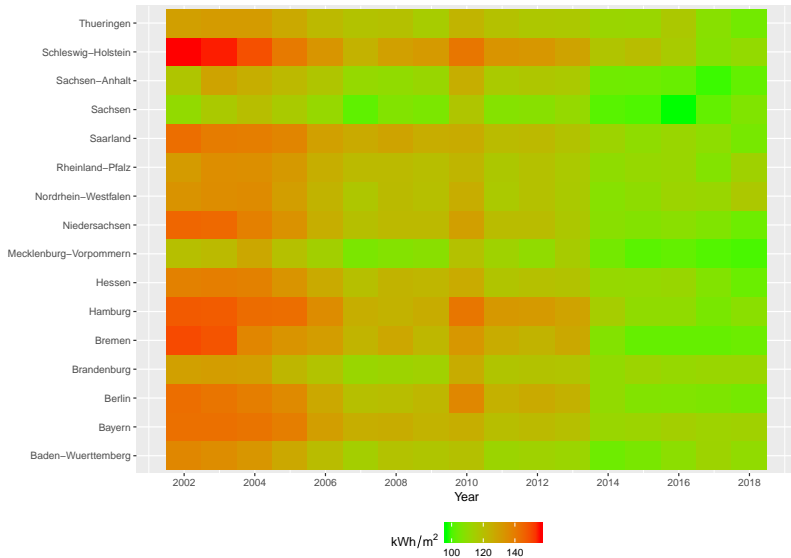
Heat map of states and years - Multifamily buildings



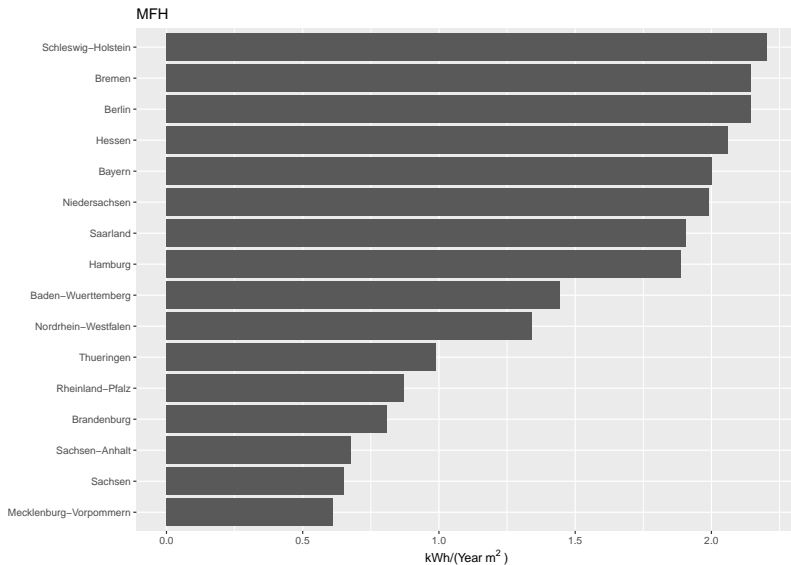
Heat map of states and years: 1-2 family buildings



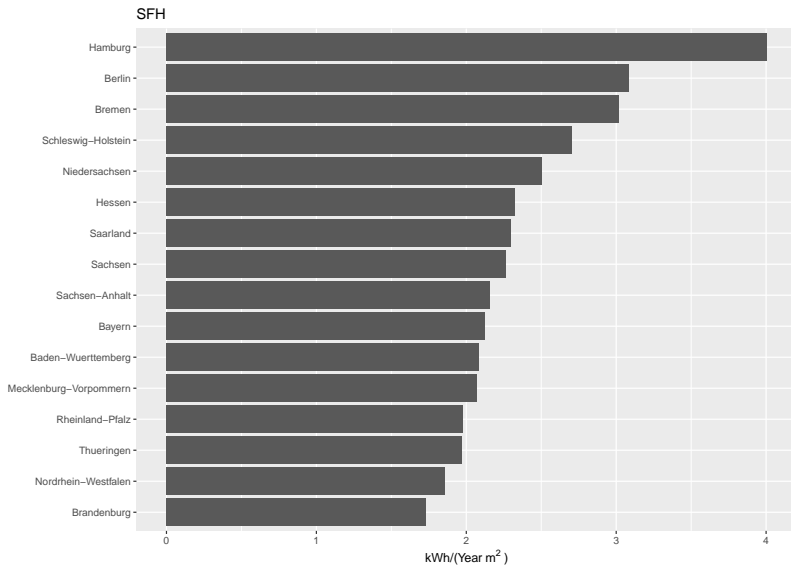
Heat map of states and years: MFH + SFH combined



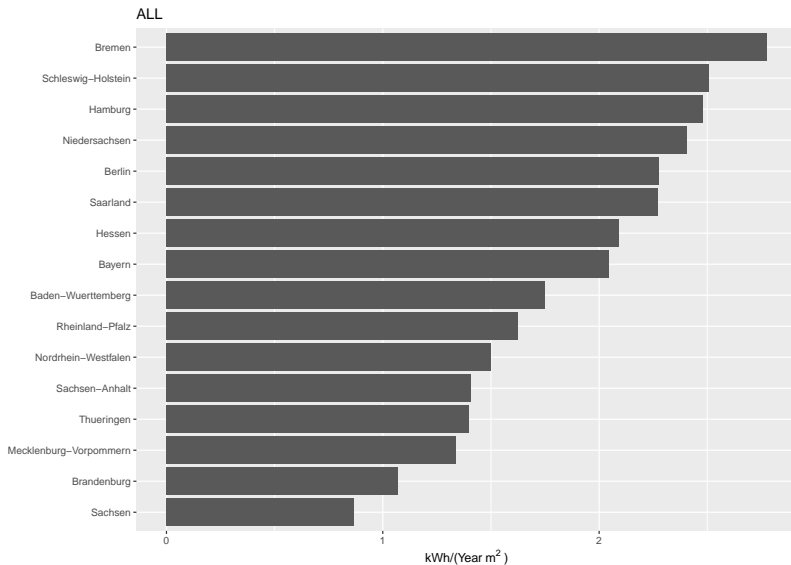
Slopes for the States - MFH



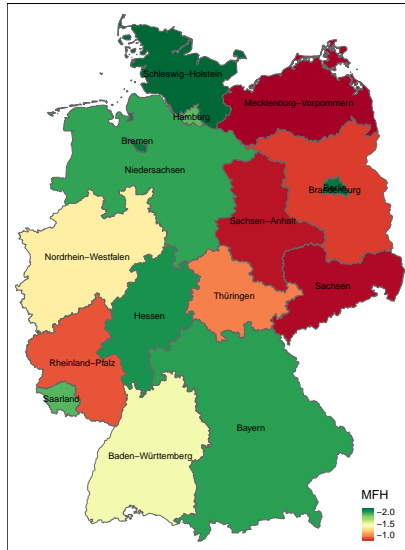
Slopes for the states - SFH



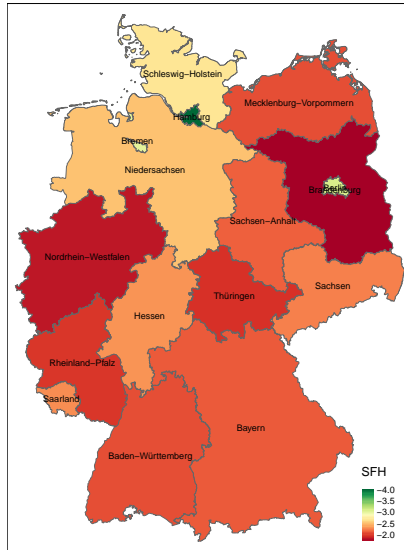
Slopes for the states - ALL



Slopes for multifamily houses for the federal states in Germany



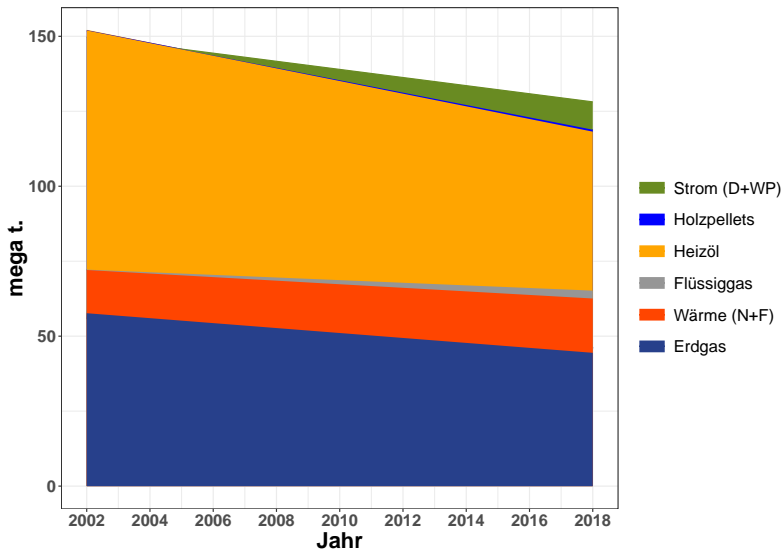
Slopes for 1-2 family houses for the federal states in Germany



Slopes for both (MFH + 1-2FH) combined for the federal states in Germany

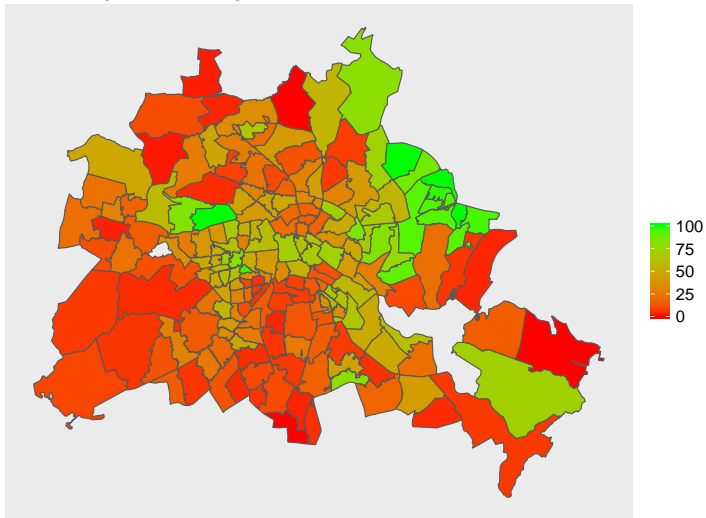


CO2 Emissionen (1-2FH + Mehrfamilienhäuser)



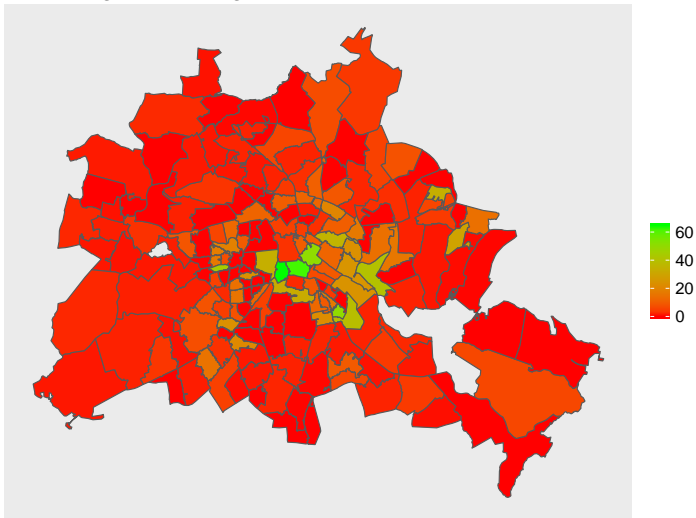
Multifamily buildings

Percentage of buildings in Berlin with district heat



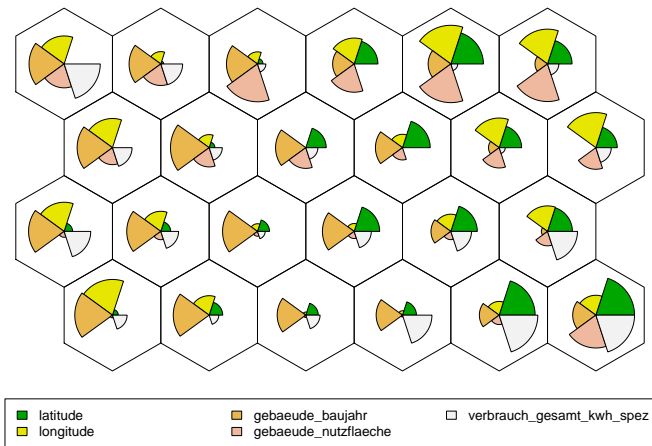
1-2 Family buildings

Percentage of buildings in Berlin with district heat



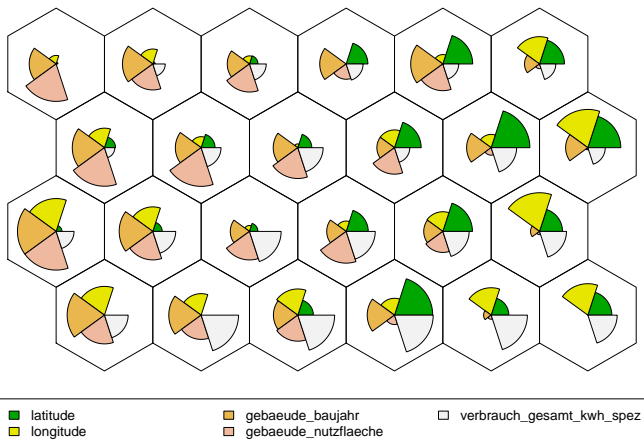
SOM - MFH

Codes plot



SOM - SFH

Codes plot



General Conclusions

- ▶ One- to two-family buildings consume more energy than multi-family buildings. But their rate of decrease is faster.
- ▶ The rate at which the specific consumption is decreasing is the most rapid for Schleswig-Holstein in case of multifamily buildings.
- ▶ The rate at which the specific consumption is decreasing is the most rapid for Hamburg in case of one- to two- family buildings.

Conclusions from the SOM

- ▶ A lot of the districts that are far north have higher consumption.
- ▶ Middle eastern districts also had larger consumption.
- ▶ There were interesting discoveries that some districts far north have lower consumption
- ▶ Also, districts that belonged to Baden-Württemberg had newer buildings and a very small consumption