



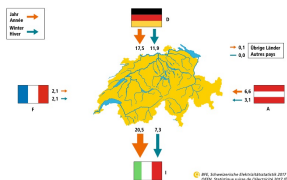
# CO<sub>2</sub> emissions of Swiss electricity in high temporal resolution

Elliot Romano, Université de Genève

## Description

### Context:

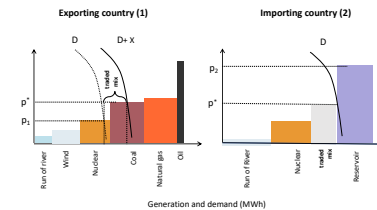
Figure 1: Swiss electricity imports/exports (2017) from/to neighboring countries



- Switzerland is highly dependent on electricity imports from neighboring countries, especially in winter, to satisfy its electricity demand.
- Some surrounding countries (i.e D) heavily rely on electricity generation stemming out of fossil fuel power plants.
- Assessment of CO<sub>2</sub> embedded in consumed electricity at a high-temporal resolution is relevant to assess the environmental impacts of new electricity usages, such as Heat-Pumps or Battery Electric Vehicles.

### Method:

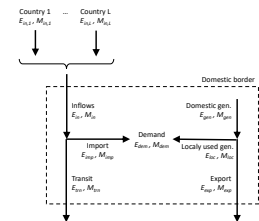
Figure 2: Swiss electricity imports/exports (2017) from/to neighboring countries



Legend:  
 $p_i$ : Stand-alone market price in country 1  
 $p^*$ : market price with trade between countries  
 $X$ : Exports from country 1 (traded mix)

- To assess the CO<sub>2</sub> embedded in consumed electricity, our methodology relies on the merit-order principle, trade mechanisms and the identification of the imports for demand.
- The method considers the impact of a country imports on the neighbors' generation fleets – i.e the additional power plants needed to be run in order to satisfy the demand tied to the exports (traded-mix).
- Our method differs from the most commonly-applied one (global-mix), which considers the mix of exported electricity having the same structure as the generation mix of the exporting country.

Figure 3: Transits, imports and inflows from/to neighboring countries



### Results:

Figure 4: Monthly evolution of the Swiss 2017 electricity imports and domestic generation (excluding exports), by technology

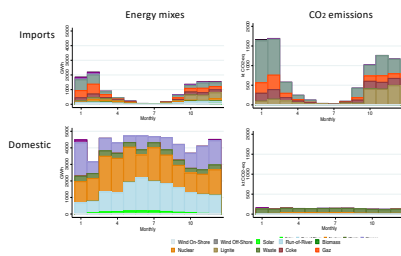


Figure 5: Average profile of the emission factor (left) and renewable energy fraction (right) of the Swiss electricity consumer mix (2017 – 2021), in daily values.

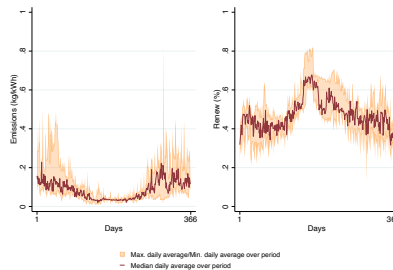
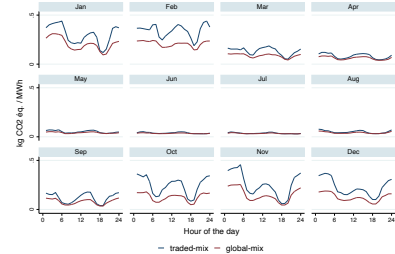


Figure 6: Hourly emission factors of "traded mix" and "global mix" approaches, averaged over the days of each month of 2017



- Our method identifies the energy mixes and embedded CO<sub>2</sub> emissions of imports and domestic generation (excluding exports), which both together satisfy the Swiss electricity demand.
- Our method computes the emission factors (annual average : 160g/kWh in 2017) and renewable share (annual average : 48% in 2017) at an hourly resolution. Our results depict the important seasonality of CO<sub>2</sub> emission factor over the year and across the day.
- In comparison to the global-mix approach, our method depicts higher emissions factor in winter and at nights. During those period, imports are satisfied by fossil fuel power plants.

## Added-Value

- High-temporal resolution of emission factors tied to consumed electricity in Switzerland
- Methodology based on market mechanism in order to identify the cross-border power plants providing the Swiss electricity imports.
- Renewable share of consumed electricity based on physical flows, rather than commercial certificates (labels).

## Challenges

- Development of a real-time CO<sub>2</sub> emission factor for Swiss consumed electricity. For more information visit : [horocarbon.ch](http://horocarbon.ch)

