A Bottom-up Estimation of Heating and Cooling Demand in the European Industry

Matthias Rehfeldt, Clemens Rohde, Tobias Fleiter

Fraunhofer Institute for Systems and Innovation Research ISI

Felipe Toro, Felix Reitze

Institute for Resource Efficiency and Energy Strategies IREES

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Introduction

- Part of PhD project supervised by Ernst Worrell, University of Utrecht

- EU-project: Mapping and analyses of the current and future (2020 - 2030) heating/ cooling fuel deployment (fossil/renewables)
  - http://www.isi.fraunhofer.de/isi-de/x/projekte/mapping-heating_331945.php
  - https://ec.europa.eu/energy/sites/ener/files/documents/Report%20WP1.pdf

- Agenda
  - Motivation
  - Energy Demand Model FORECAST-Industry
  - Example Process
  - Bottom-up coverage
  - Results

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# Motivation

Country	Energy balance	Industry end-use balance
Germany	X	S H A P$_h$
France	X	A P
Italy	X	H
Austria	X	S H A P$_h$
United Kingdom	X	S A P$_{h/c}$
Switzerland	X	S H A P$_{h/c}$

Selected countries with end-use balances for space heating (S), hot water (H), appliances (A) and process heating/cooling (Ph/c)

- Disaggregation of Eurostat energy balance by end-use and temperature level
- Low availability of national industry end-use balances in the EU28+3
  - Best available shown left
- Use of energy demand simulation model FORECAST to complete data

- Recent comparable work
  - Pardo et al. 2013
  - Naegler et al. 2015

- Added value
  - Link technical and economical knowledge on process level
  - E.g. temperature level, production, value added
  - Yields sharper temperature profile
  - Results match top-down energy balance (Eurostat) on sector and energy carrier level

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Energy Demand Model FORECAST-Industry

www.forecast-model.eu
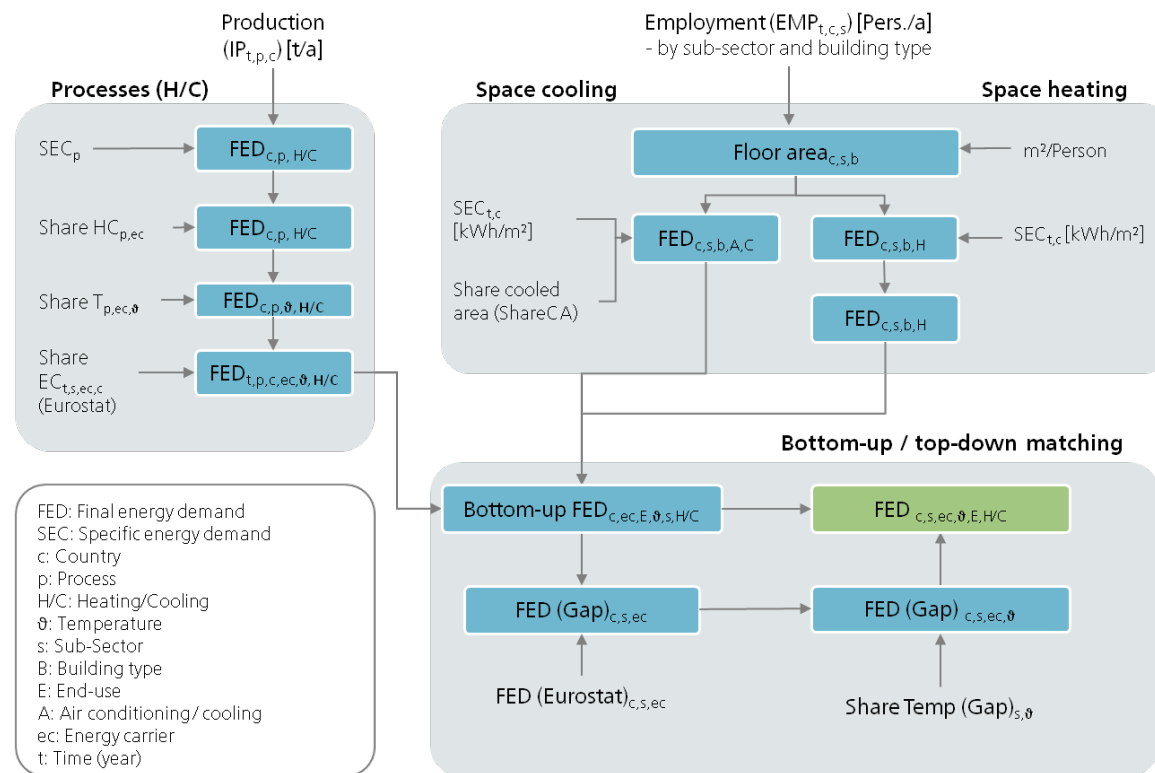
- Three major parts:

- Processes
  - Bottom-up calculation based on production

- Space heating/cooling
  - Bottom-up calculation based on floor area

  - Highest level of detail in the model

- Bu/td matching
  - Close gap between bottom-up and top-down

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Example Process: Clinker Calcination

Germany 2012:
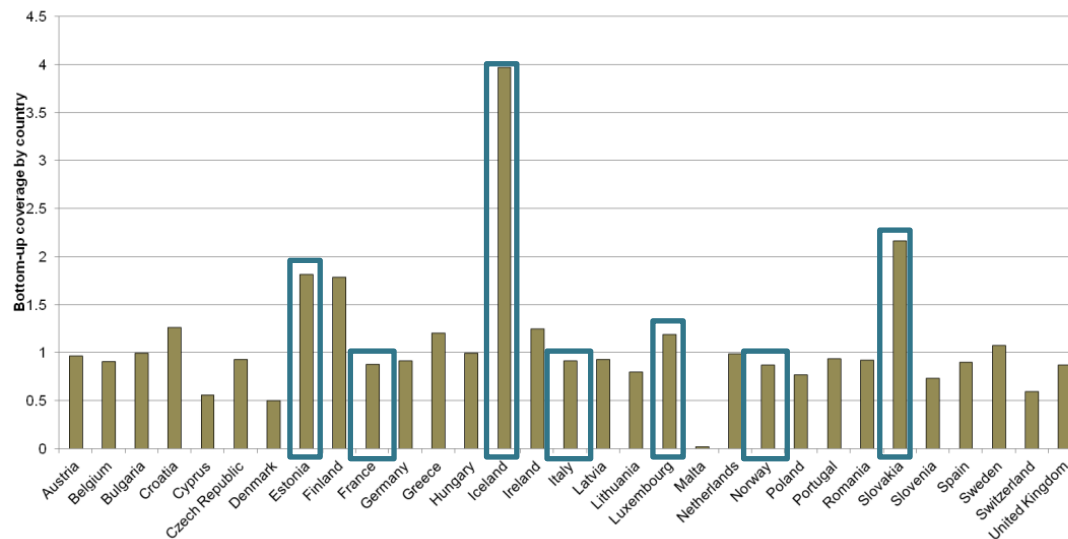23348 kt

{Subsector}　　100%

$$FED_{t,p,c,ec,\vartheta} = IP_{t,p,c} * SEC_p * ShareEC_{t,s,ec,c} * ShareHC_{p,ec} * ShareT_{p,ec,\vartheta} \qquad (1)$$

Process	Fuel use [GJ/t]	Electricity use [GJ/t]	15°C-75°C	75°C-100°C	100°C-125°C	125°C-150°C	150°C-200°C	200°C-500°C	500°C-1000°C	>1000°C
Clinker calcination-dry	3.50	0.14						0.10	0.60	0.30

200°C-500°C	8171.8 GJ
500°C-1000°C	49030.8 GJ
>1000°C	24515.4 GJ

- Final energy demand (FED)
  - Activity (production)
  - Specific energy demand
  - Energy carrier share {27x1}
    - Total share of subsector
  - Share of energy demand on heating
  - Temperature level

- Additional dimensions
  - Country
  - Energy carrier
- Similar methodology for space heat

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Bottom-Up Coverage

- More usual: Bu energy demand below td
  - Not considered processes
  - Higher SEC than assumed
  - Otherwise missing data

- Resulting gap assumes generic temperature profile
  - Less detailed

- Matching bottom-up and top-down values
  - Bottom-up coverage important
  - Mostly 70%-95%
  - Smaller countries often overestimated (Slovakia, Luxembourg, Estonia, Iceland)
    - Floor area for space heating demand
    - Allocation issue in steel sector (e.g. coke oven/ stack gas credits)
    - Reporting issues
    - Special economic structure

Results
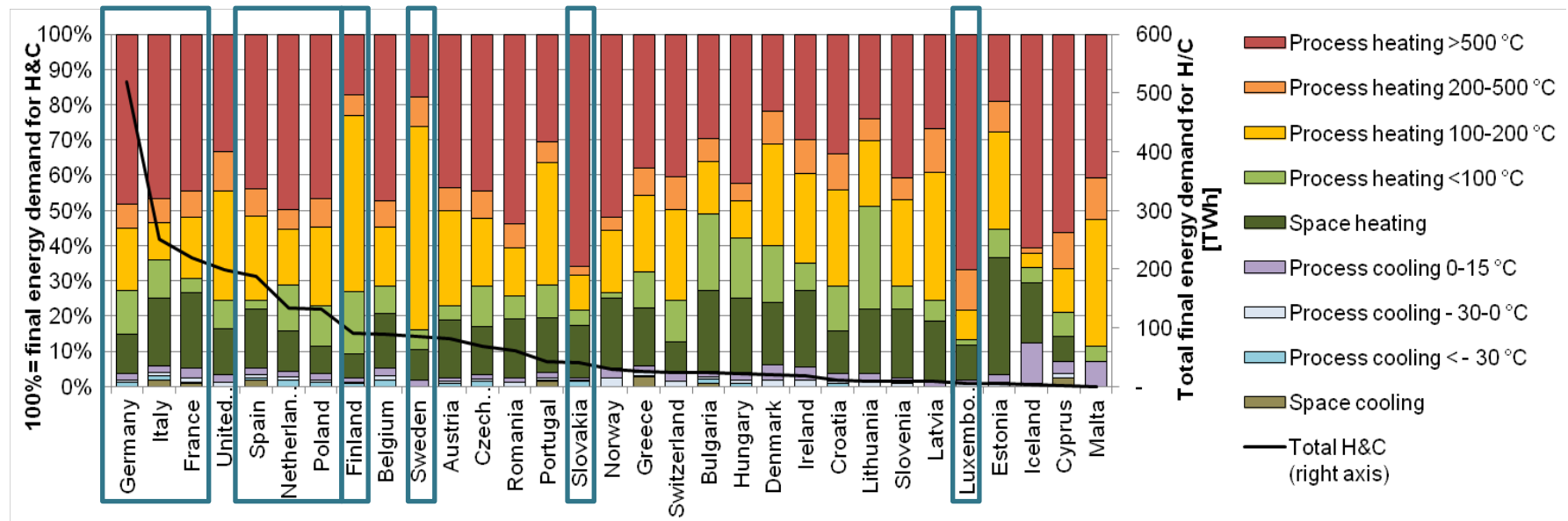
- Temperature share left ordinate, total H/C demand right ordinate
- Germany, Italy, France, Spain, Netherlands and Poland with high energy demand and similar profile
  - Good proxy for aggregated EU profile
  - Notable differences in individual countries
    - Finland, Sweden with high importance of pulp and paper
    - Slovakia, Luxembourg: steel sector

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Summary

- **Main features:**
  - Process level bottom-up calculation
    - Technological explicitness
    - Production data on product/ process level
  - Matches top-down energy balances (Eurostat)
    - Suitable for cross-country comparison
  - High level of detail
    - Persistent effort to update data needed
    - Heavily depending on bottom-up data quality

- **Possible discussion**
  - Energy carrier share taken from subsector rather than process level
  - BU-coverage higher than 1
  - Assumption process=process

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