A methodology for modelling the Non-Energy Intensive Industry

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Context

- The industry can be divided in two large families of energy consumers:
  - The energy-intensive industry (EI)
  - The non-energy intensive industry (NEI) named also Diffuse Industry (DI)
- Nowadays, the weight in energy consumption of NEI sectors increases more and more in developed countries.
What is the NEI sector?

- An approach of segmentation EI/NEI sectors
  - Three approaches have been commonly adopted:
    - Single out few major energy-intensive sectors and treat the remainder as non-energy intensive sectors;
    - Define the intensiveness of a sector via its process characteristics or via other "known" definitions, such as light and heavy industry;
    - Establish a limit that differentiates NEI from EI sectors by defining relevant multicriteria indicators based on their characteristics.

- Characteristics of diffuse industry
  - A considerable number of end products and processes
  - A considerable number of production sites
  - Less quantity of energy consumed per production site
  - Less energy intensity
Segmentation of the industry

We use three main criteria to establish this limit:

- The first criteria makes use of the existing differences in magnitude of energy intensity across manufacturing sectors;
- The second criteria characterizes the NEI sectors by their share of energy costs in value of production.
- The third criteria will focus on the quantity of energy consumed by production site;

We could consider that NEI sector should have both:
- a share of energy costs in production value below 3%,
- an energy intensity below 4 GWh/Meuros and
- an energy consumed per site below 10 GWh/site.
Modelling the NEI sector

Methodology

How to model the NEI in TIMES?

The Non-Energy Intensive Sector

Diversity of end products and unit operations is extremely large

Developing energy end use estimates by generic process units

Definition of energy end uses families

Developing a process flow and estimates of energy use by process step
Definition of energy end uses families

1) Dry
- Drying liquid, solid or paste products
- Evaporation
- Concentration

2) Heating liquid and gases
- Sterilization, pasteurization
- Heating liquid or gas products
- Production of hot water for cleaning
- Heating bath, surface treatments

3) Heating metal before deformation
- Reheating of ferrous products
- Reheating of non-ferrous metals

4) Heat treatment
- Quenching
- Roasting
- Baking

5) Chemical reactions
- Electrolysis
- Oxidation
- Reduction
- Singeing
- Buckling
- Fermentation

6) Mechanical process
- Motive power
- Pumping
- Compressed air
- Ventilation

7) Fusion
- Maintaining molten metal
- Distillation of metals

8) Process Cooling
- Refrigeration
- Freezing

9) Space heating
- Space heating
- Air conditioning

10) Lighting

11) Other operations
- Assembly
- Filtration
- Treatment of sewage
- Heating of non metals solid products

Modelling the NEI sector

A generic RES for all NEI sector

END USES

NACE 4
NACE 3

Dry
Heating Liquid
And Gases
Heat Treatment
Chemical
Reactions
Mechanical
Process
Cooling
Space
Heating
Lighting
Fusion
Heating metal
Before deformation
Other
processes

Share of End use
by sub-sector

Share in total value added of 15.1
Share in total value added of 15.7
Share in total value added of 15
Electricity Technologies For Drying

Natural Gas Technologies For Drying

Liquefied Petroleum Gas Technologies For Drying

Domestic fuel Technologies For Drying

Heavy fuel Technologies For Drying

Coal Technologies For Drying

Specials Technologies For Drying

Heat Technologies For Drying

Total quantity of end use DRY needed from all energy

Competition inter-energy in an End use from price scenario

Electricity DRY Technology

Electricity DRY Technology A

Electricity DRY Technology B

Electricity DRY Technology C

By Electricity technology Efficiency Investment cost

Total quantity of end use DRY needed from Electricity

Competition Intra-energy in an End use
Conclusion

- The bulk of manufacturing industry (80% ie 187 sectors) belongs to NEI industry from the study of segmentation in France.

- A modelling by energy end uses is suitable for NEI industry because of huge number of end products and processes.

- Reproducibility of the RES by using family end use for studying aggregating sector in NEI industry instead of each sector specifically like in EI industry.

- The first steps show a competition in the energetic mix and technologies in end uses and the importance of structural effect.
Modelling the NEI sector

- The structural effect

The structural effect can be defined as the influence on aggregate energy consumption of the change in economic share of sub-sectors "intensive" and "less intensive"

Cause mechanically an increase either stronger or more contained of this aggregate energy consumption

Problem in the accurate evaluation of the impact of new technologies on the energy efficient economy in the NEI sector

\[ I_s = \sum_{i=1}^{n} \frac{E_i}{VA_i} \times \frac{VA_i}{E_s} = S_s \times I_{s0} + S_i \times I_s \]

\[ \Delta I = I_s - I_{s0} = S_{s0} \times I_{s0} + S_{s0} \times I_{s0} - S_{s0} \times I_{s0} - S_{s0} \times I_{s0} \\
= S_{s0} \times I_{s0} - I_{s0} + S_{s0} \times I_{s0} - I_{s0} + (S_{s0} - S_{s0}) \times I_{s0} + (S_{s0} - S_{s0}) \times I_{s0} \]

\[ \Delta I = \sum_{i=1}^{n} S_i (I_s - I_{s0}) \]

Technological Effect

Structural Effect

Thank you for your attention…
Modelling the NEI sector

- The basic structure of Reference Energy System for the NEI sector
We consider that NEIs should have both a share of energy costs below 35% an energy intensity below 3.5 GWh/Meuros and an energy consumed by site below 6 GWh/site (in FRANCE).
About energy intensity?

Myriad of goods that have not necessarily physical links which could be used for an aggregation

- Energy consumed per Economic unit output
- Energy consumed per Physical unit output
- Energy consumed per unit of value added
- Energy consumed per unit of value of production