

**Energy savings calculations**  
**Impact of a higher data granularity on top-down methodology**  
**The case of the French industry**

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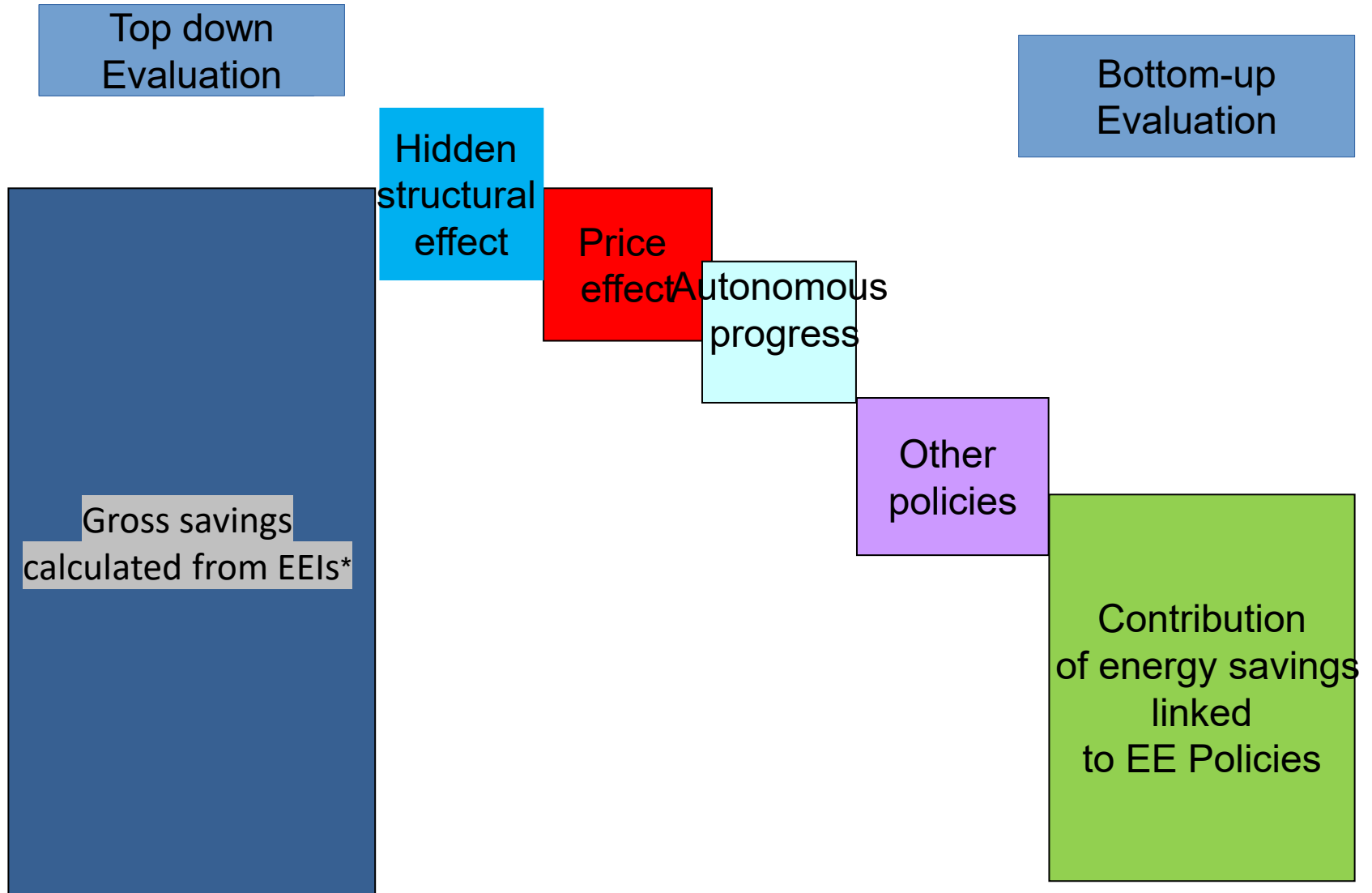
# Introduction/Objectives/Contents

The ADEME's industry department disposes of **two top-down monitoring systems** of energy efficiency policies both inspired by the ISO 50047 on energy saving calculations with a large difference about the **level of granularity of the energy end-uses data** (15 vs 243).

This presentation of a **methodological nature** will compare and discuss the respective merit of two so-called “**decomposition analysis of energy demand variation**” which is broadly implemented worldwide.

2. The difference of granularity allows us to explore its impacts on energy savings calculation, on the type of indicators and discuss the importance of additional explanatory factors such as intra-sectoral structural changes, fuel substitution effect and climatic effect.

# Energy saving calculation Top-down Vs Bottom-up



\*already corrected from main structural effect

## changes

1. Construction of energy efficiency indicators (EIS) based on a **ratio** between energy consumption at the most detailed level possible, to activity data (Ton, IPI, VA)
2. These EEs must be established under the constraint of a **consistency in the level of classifications** between energy consumption data and economic activity data
3. These indicators, calculated at the finest level, are then **reaggregated** to assess, for example, the total savings of industry for a country.
4. Place the contribution of these energy savings into the total variation in energy demand over a given period. To do this, the **methodology of decomposition** is used (Laspeyres-Paschen, Duvisia etc?)

# Decomposition analysis : Application in Industry

1: To show the relative impacts of three main factors:

“**Activity effect**” assessing the level of activity changes

“**Structural effect**” assessing the structural changes of the industry,

“**Unit consumption effect**” or “energy savings effect”: assessing changes in unit consumption (i.e. ratio energy consumption per unit of output). This “**unit consumption effect**” will capture energy savings, due to energy efficiency improvements at the level of each branch but also other factors, such as **fuel substitution** between energy with different end-use efficiency, climate variations from one year to the other (“**climate effect**”), and changes in the products-mix within industrial branches (“**intra sectoral structural changes**”).

2: Energy savings resulting from this decomposition will depend on :

- the way the activity is measured (monetary units, such as value added, physical production or industrial production index);
- the level of disaggregation of the industry sector, i.e. the number of branches;
- the number of additional effects, in which the unit consumption effect is separated;

# Some equations to make serious

The **activity effect** captures the changes in the production. It is calculated by multiplying the energy consumption related to production index (previous year, t-1) by the variation of the production between t and t-1.

$$\text{Activity effect: } EQ_{t/t-1} = IPI_{t/t-1} * (C_{t-1}/IPI_{t-1})$$

EQ: activity effect; IPI: production index of industry; C: Energy consumption of industry

The **structural effect** is equal to the variation in energy consumption that would have taken place if the unit consumption of each branch had stayed “constant” (compared to the previous year t-1) minus the activity effect. The first component (named quantity effect) is calculated as the sum of the variation of the production index (between t and t-1) multiplying by the energy consumption per production index of the previous year (of the previous year t-1) for each branch.

$$\text{Structural effect: } SE_{t/t-1} = \sum (n_i=0 \Delta IPI_{t/t-1} * (C_{t-1}/IPI_{t-1})) - EQ_{t/t-1}$$

IPI: production index of industry; C: Energy consumption of industry

**Energy savings** in absolute values (ktoe, GWh) are calculated from ODEX, as follow, considering that ODEX represents the ratio between the energy consumption at year t (E) and a fictive consumption that would have happened without energy savings (ES):

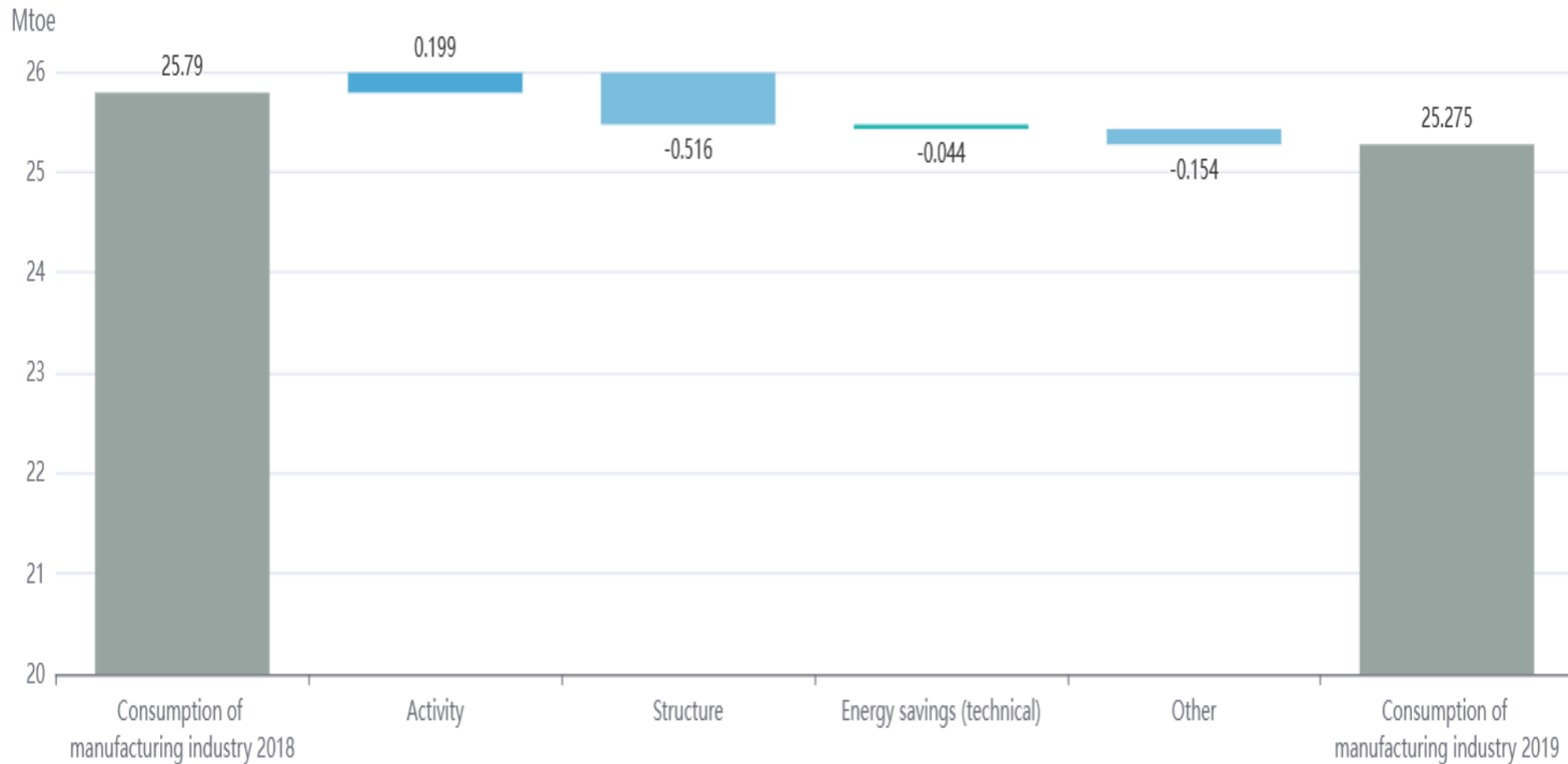
$$\text{Energy saving effect : } S = C_t * ((ODEX_t / ODEX_{t-1}) - 1)$$

With C: Energy consumption; ODEX: Energy Efficiency Index; t: year

## Methodology of the two data set for the french industry

|                                 | <b>ODYSSEE</b>                                            | <b>CEREN</b>                                                | <b>Observations</b>                                        |
|---------------------------------|-----------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------|
| Scope                           | Industry or manufacturing                                 | Manufacturing,                                              | Excluding non energy-use                                   |
| <b>Number of sector</b>         | 13+2<br>(Water and cement)                                | 30 branches<br>243 Process/products                         | Odyssee: ISIC 2 Digits<br>CEREN : ISIC 4 Digit             |
| <b>Source</b>                   | Mainly Eurostat for energy and activity+ national sources | Administrative source for energy and activity + own surveys | Odyssee : homogeneous data with other MS and official data |
| <b>Frequency</b>                | Yearly                                                    | Yearly                                                      | CEREN (4 years rotating sampling for own surveys)          |
| <b>Number of effects</b>        | 4                                                         | 9                                                           |                                                            |
| <b>Savings</b>                  | Gross and technical                                       | Gross                                                       |                                                            |
| <b>Methods of decomposition</b> | Laspeyres and Pasche                                      | Laspeyres and Pasche                                        | In the future Divisia for both                             |

# Explanatory factors of the energy demand changes in industry (France, 2008-2019) : Source ODYSSEE



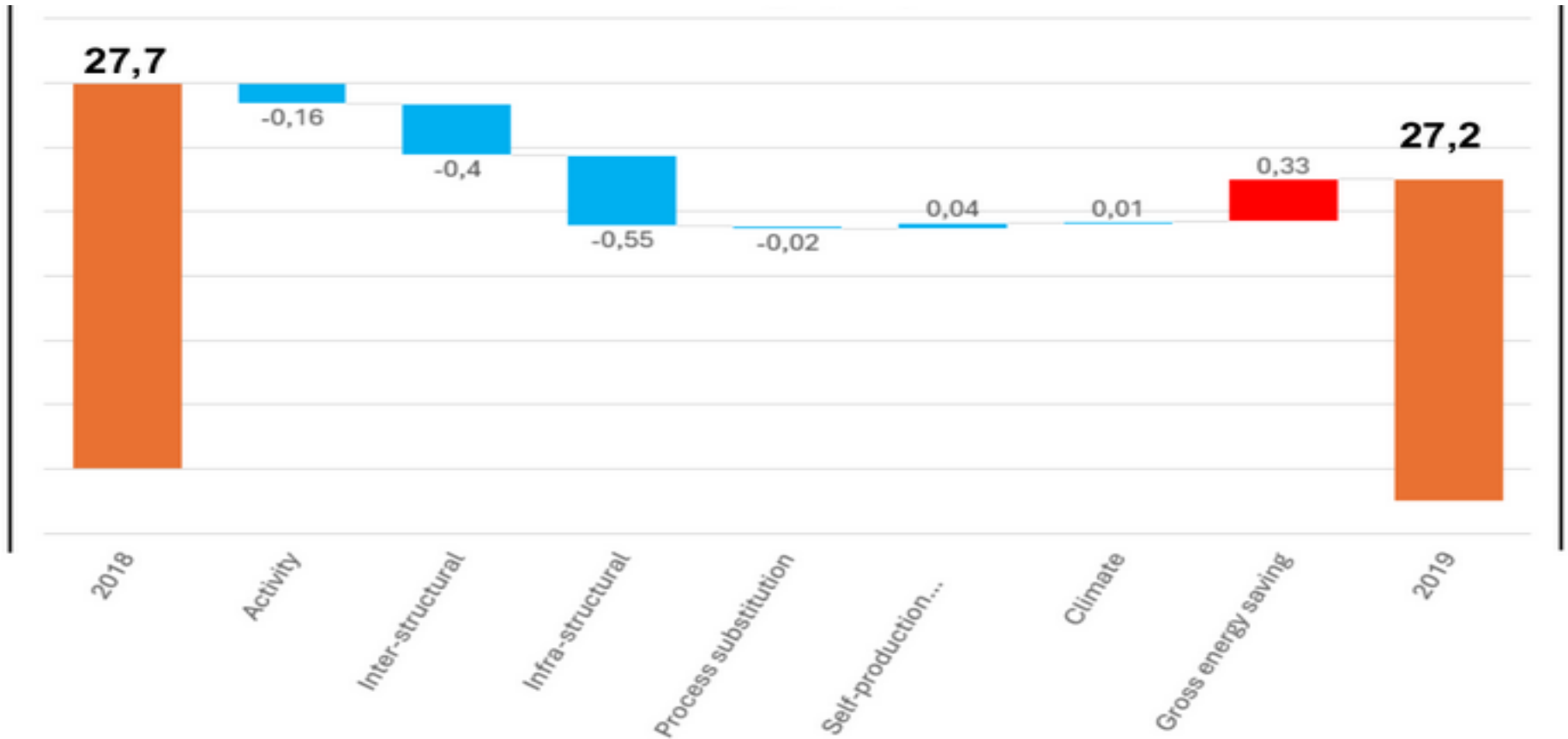
# An higher level of granularity (CEREN) allows additional explanatory factors to be deducted from energy savings

Due to the high level of disaggregation available, **6 additional** explanatory effects are considered beyond energy savings

1. The **intra-structural** effects within branches;
2. the **inter-fuel** substitution effect;
3. The **process-mix** effect
3. the **self-production effect** which takes into account the variation of the share of autoproduced electricity;
4. the **climatic** effect (data are climate corrected).
5. The **scope** effect

It can be noted that CEREN provides figures of these effects **by fuel types**. This clearly can be very interesting for policies evaluation (i.e. energy savings obligation on specific fuels); for utilities and evaluation of GES savings.

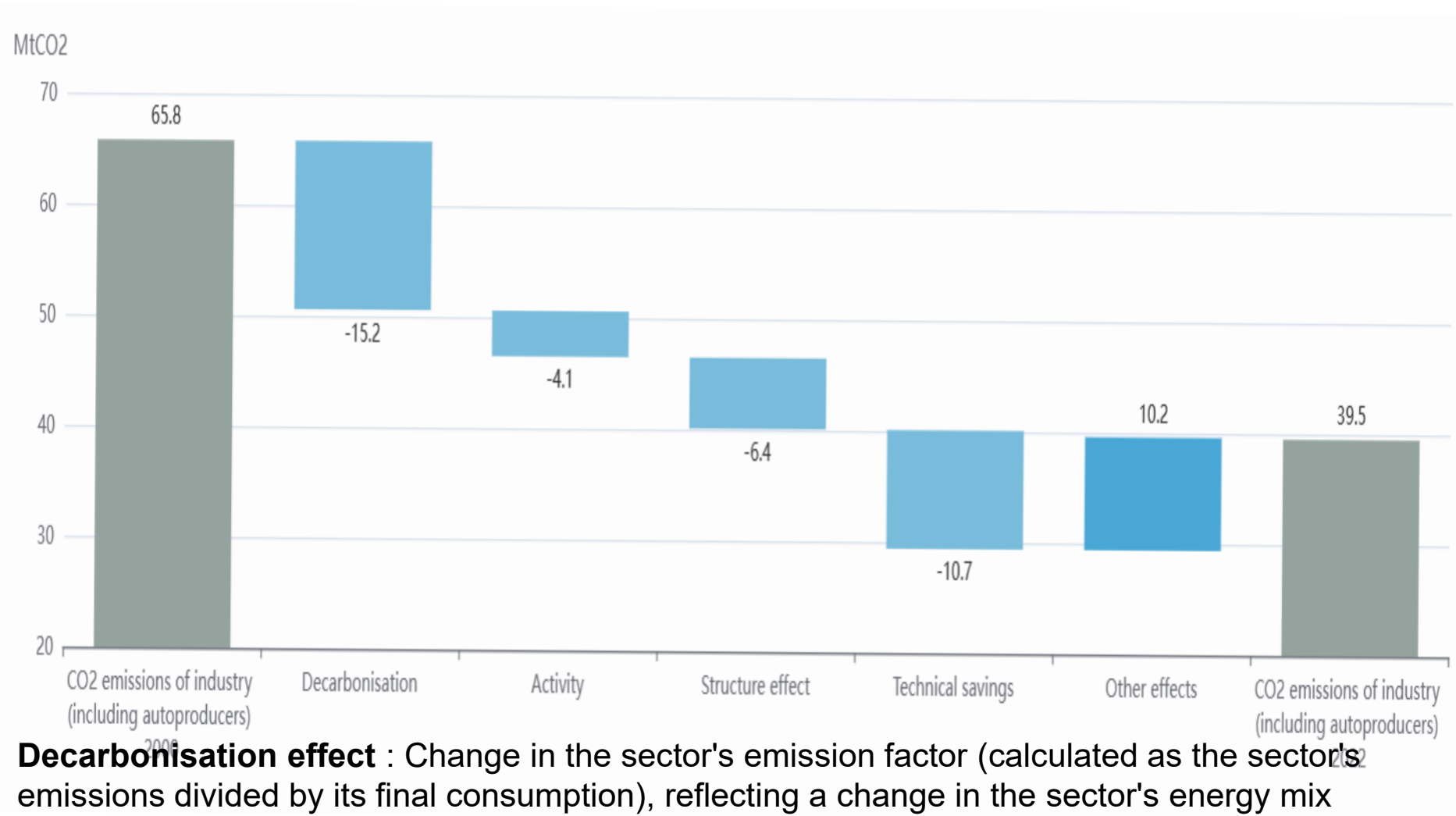
# The additional explanatory factors of the industrial energy demand changes allowed by a higher granulometry (France 2018-2019) : Source CEREN



## Other possible explanatory factors effect in industry

1. **Decarbonisation effect** : Recently implemented in ODYSSEE
2. **The scope effect** : To account for changes in industrial establishments, such as closures or modifications to main activities sectors (partly Applied by CEREN)
3. **Sufficiency effect**: Implemented by ADEME on forecasting (ADEME's 2050 Vision)
4. **Quality of product effect** : change in the quality of product (ex paper). Can be implemented partly by CEREN)
5. Etc (**Capacity production effect, resources effect, price effect**)

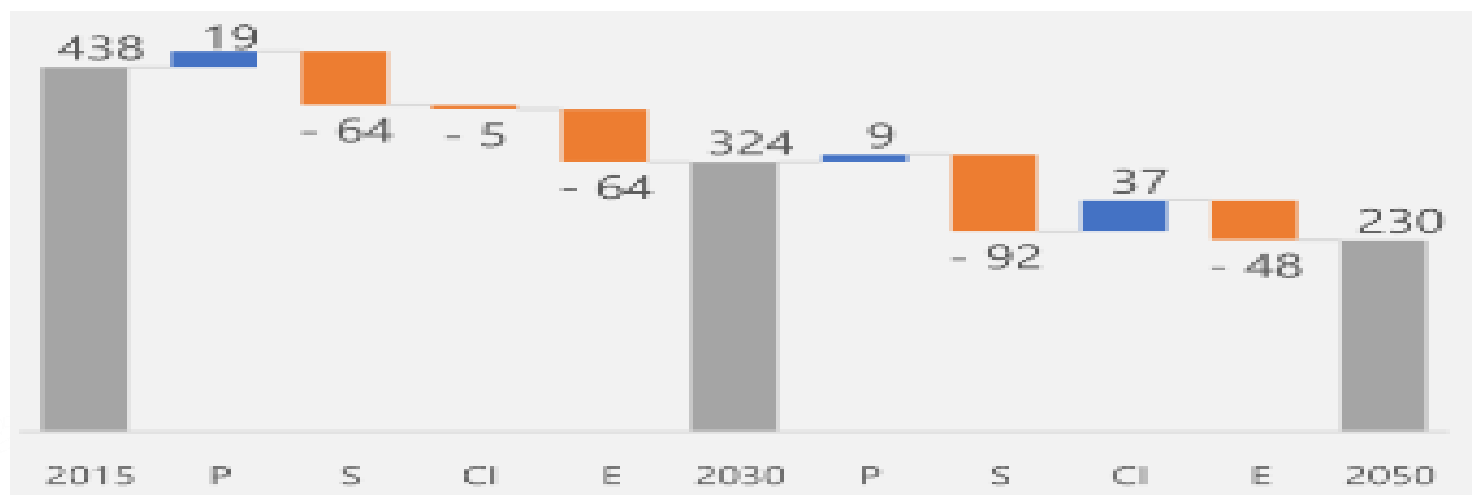
# Explanatory factors of the CO2 emissions changes for in Industry (France 2000-2022) Source ODYSSEE



# A new explanatory factor : The sufficiency effect

Explanatory factor of energy demand changes in the french industry

Sufficiency and energy efficiency scenarii (Source: Ademe's Vision 2050).



## Explanatory factors of the French industry consumption variation (2018-2019)

1.

| Mtoe                                  | CEREN        | ODYSSEE       |
|---------------------------------------|--------------|---------------|
| Energy consumption variation          | -0,41        | -0,49         |
| Activity effect                       | 0,16         | 0,15          |
| Structural effect (between branches ) | -0,40        | -0,46         |
| Structural effects (within branches ) | <b>-0,55</b> |               |
| Process substitution                  | -0,02        |               |
| Substitution auto production          | 0,04         |               |
| Climatic effect                       | 0,01         |               |
| Balance ("gross savings")             | <b>0,33</b>  | <b>-0,267</b> |
| Technical Savings                     |              | -0,04         |

## Results analysis of the comparison according to the level of granulometry

1. - The activity effects are oriented in a similar direction (Positive) and show a comparable magnitude (around 0.16-0.2);
- Despite an important difference of disaggregation (15 vs 30 branches), the inter-branch structural effects are also comparable. They contribute to reduce the consumption.
- Interesting enough is the evaluation of the intra-branch structural effect with amount -0.5 Twh, **This effect has the same impact as the inter-branch effect.**
- The main difference is visible on the « gross » energy savings effect assessment with a « non-saving » level for CEREN (0.3) and some energy savings or ODYSSEE (- 0.28Twh) confirmed by technical savings (-0.4).
- Finally, the 4 additional effects provided by CEREN are negligible. The shortness of the prior analysis may explain this.

# Conclusions

1. **The assessment of energy savings through the « top down » approach depends on the methodology used.** This statement is clearly confirmed by our analysis based on the comparison of two sources of data for the french industry with an important difference of the level of disaggregation.
2. The advantage of the ODYSSEE approach is to calculate the « **technical saving**» that can be considered more informative than the gross saving which can strongly evolve year by year. ODYSSEE also allows a **comprehensive benchmarking** using mainly official data from Eurostat illustrated by the ODYSSEE « Scoreboard » and a user-friendly interface allowing to play with the period of analysis.
3. **A national monitoring**, illustrated in this article by the «CEREN approach» based on a more disaggregated set of data, allows a more specific and customized methodology of energy saving calculation.
4. **Four “new” explanatory factors** have been performed of which of a particular interest the **intra-branches structural effect and the process-mix effect**. A longer period of analysis would demonstrate the quantitative importance of their impact.
5. Countries should encourage a more detailed data collection (by products, process etc.). However, due to the surveys costs, the **focus should be made on energy consuming sectors** (for instance, chemical and agro-food in France or on the paper industry in Finland), because it will lead to the most important impact on energy saving assessment.
6. This comparative analysis will be shortly largely improved since we will dispose of 4 more years of data collection and CEREN will benefit of a data collection set of **4000 process/products** allowing very detailed sectoral assessments.

Thank you for your attention

For more informations et comments, please contact

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