Sustainable Solid Waste Management in the European Union: Four Countries Regional Analysis

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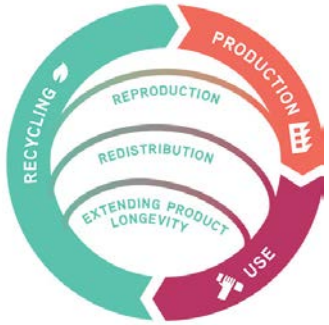
1. Theoretical background: From Waste Management to Sustainable Waste Management
2. Sustainable Waste Management transition at EU-Member States level
3. Analysis: SWM transition on EU-Member States' NUTS2 regional level
4. Data and Methods
5. Results

From Waste Management to Sustainable Waste Management

Linear Economy

Feedback loops Economy

Circular Economy

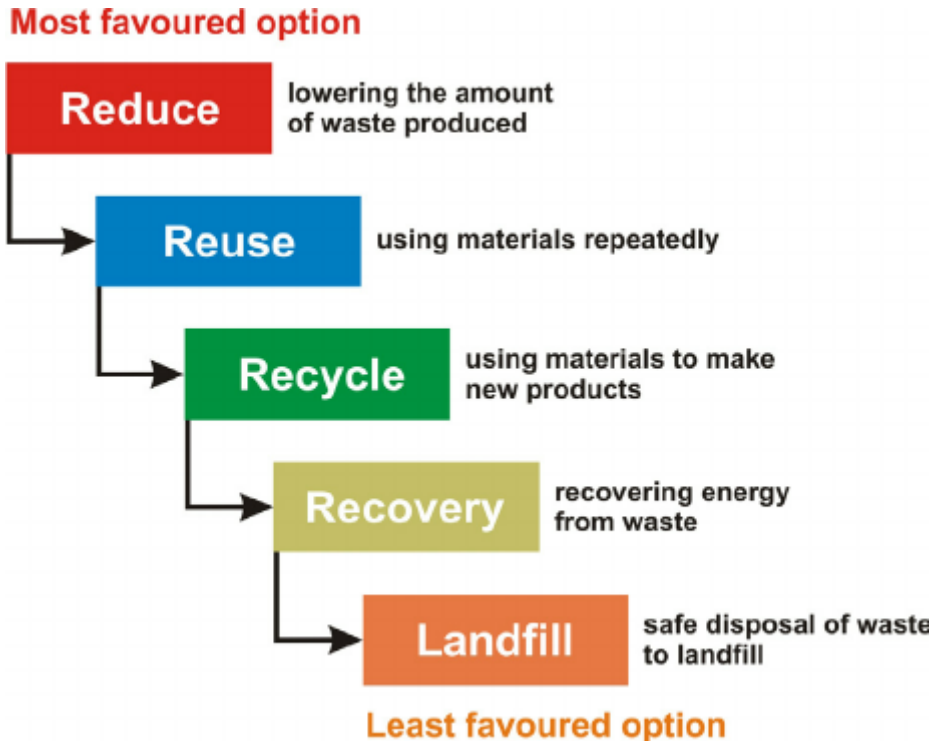


Waste into new resources

- **Resource recovery** → Enable to produce with otherwise wasted materials
- **Waste prevention** → Limit the generation of waste

From Waste Management to Sustainable Waste Management

2008 Waste Framework Directive



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From Waste Management to Sustainable Waste Management

Which is the stage of implementation of SWM policies in EU-MS?

In the literature:

Several authors have developed benchmarking techniques to assess MSs performances in municipal waste management, and investigated whether EU policies are supporting a convergence between successful/unsuccessful countries.

Marin et al., 2017 → combining incineration and recycling they find that convergence tends to be quite rapid, with all countries converging in 30 years or less to treatment options alternative to landfilling. This pattern is occurring faster in countries with stringent waste policies and with greater technological investments

Castillo-Giméneza et al.,2019a ; Castillo-Giménez et al., 2019b → brought to light EU-MSs convergence in performance in MSW. However, there are still notable differences in performance → In general,

- best performers are richer Northern and Central European countries that treat higher quantities of waste per inhabitant, mostly through recycling and composting and digestion.
- worst performers are low-income Eastern European countries that joined the EU from the 2000s onward, and treat smaller amounts of waste per capita, mostly through landfilling

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Analysis: SWM transition on EU-Member States' NUTS2 regional level

What about Sustainable waste management transition at regional level within EU-MS?

Why focusing on regional performance

Due to the decentralization of many environmental-related policies regions exerts a large influence and responsibilities in municipal waste management, which often reflects on national outcomes.

This results in a heterogeneous adoption of strategies and degree of implementation among EU-MSs, which require more investigation

Analysis: SWM transition on EU-Member States' NUTS2 regional level

Our research

We rely on the results presented in *Rogge and De Jaeger (2012)*

They benchmarked MSW management performance of EU NUTS2-regions, using the Benefit of-the-Doubt (BoD) techniques to create a performance indicator → regions of EU Northern countries i.e. Austria, Belgium and Germany generally perform better in MSW management, whereas Southern EU-MS i.e. Cyprus, Italy, Malta, France and Portugal, display lower scores.

We used Castillo-Giméneza et al., (2019a,b), approach → DEA techniques with the extent to rank and analyse the performance in the generation and treatment of MSW at regional level of the EU-18.

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Data and Methods

Dataset

- ✓ dataset of **municipal waste** collected from the Statistical Office of the EU, Eurostat by means of the REQ – Regional environmental questionnaire Data aggregation

- ✓ municipal waste generation and treatment data of 75 NUTS-2 regions: **16 regions in Germany**, **26 regions in France** (of which 5 are part of the Départements d'outre-mer), **21 regions in Italy**, and **12 regions in the Netherlands**.

- ✓ Municipal waste variables comprise **waste generation** as input, and waste treatment techniques as output i.e. **Disposal - landfill and other** (D1-D7, D12); **Incineration and Energy recovery** (D10, R1), **Recycling material**, **Recycling composting and digestion** (R2-R11),

- ✓ period from **2008-2013**

Data and Methods

Method

- ✓ This paper analyses and represents MSW management performances of EU-4 MSs at NUTS2 regional level through Data Envelopment Analysis (DEA)

- ✓ DEA is a mathematical programming technique, initially presented by Charnes et al. (1978), To compare the multi criteria decision making units and assess the performance.

- ✓ The Data Envelopment Analysis (DEA) is the most appropriate method also recognised by OECD (OECD, 2008).

- ✓ The basic DEA model proposed by Charnes et al. (1978) of Decision-making units is simply presented by:

$$\text{Efficiency} = \text{output/input}$$

- ✓ However, when there are several inputs and outputs, as in this case, the efficiency can be calculated by:

$$\text{Efficiency} = \text{weighted sum of outputs/ weighted sum of inputs}$$

Data and Methods

Method

- ✓ There are different ways to selects the optimum weightage in above expressions, DEA can be achieved by selecting a single value for benchmarking. For several decision-making units, the efficiency can be calculated the following expression:

$$max_{w,vh_o} = \frac{\sum_{j=1}^{n} w_j y_{jk_o}}{\sum_{j=1}^{m} v_i x_{ik_o}}$$

Subject to:

$$\frac{\sum_{j=1}^{n} w_j y_{jk}}{\sum_{j=1}^{m} v_i x_{ik}} \leq 1 \qquad k = 1, \dots, z \quad \forall_{j,i.}$$

z Number of units;
m Number of inputs;
n Number of outputs;
wj Weight given to input *j;*
vi Weight

- ✓ The methodology applied takes into consideration the methodology applied in Gastaldi et al. (2020). However the model has been simplified.

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Results

Figure 1: Cluster representation of Municipal solid waste management performance in the year 2008

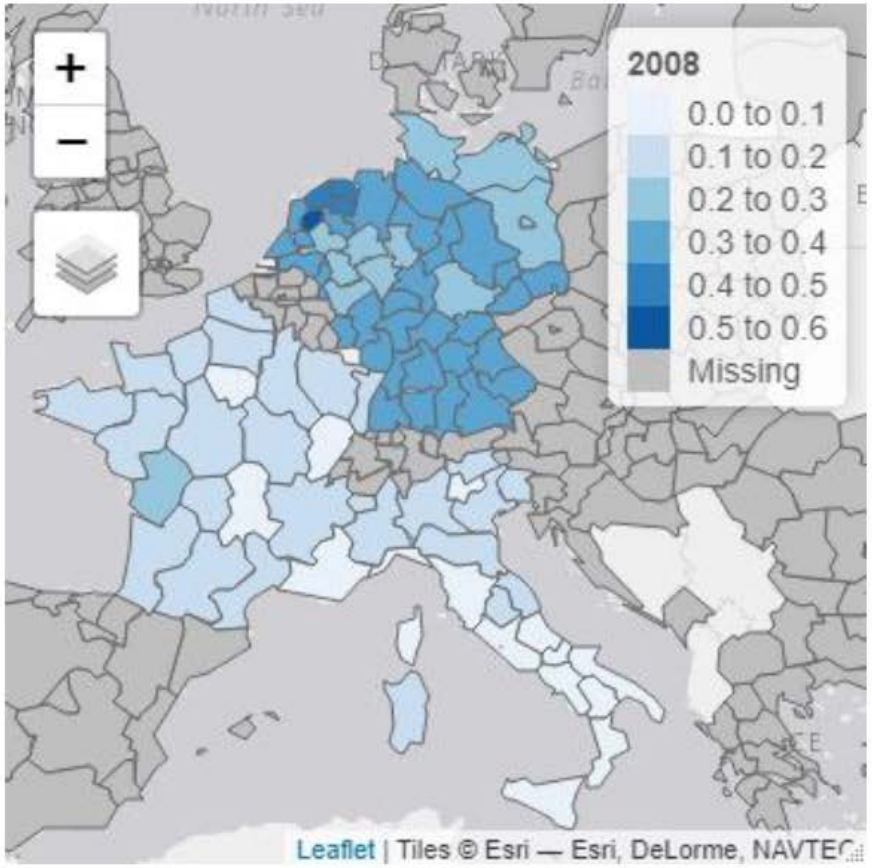
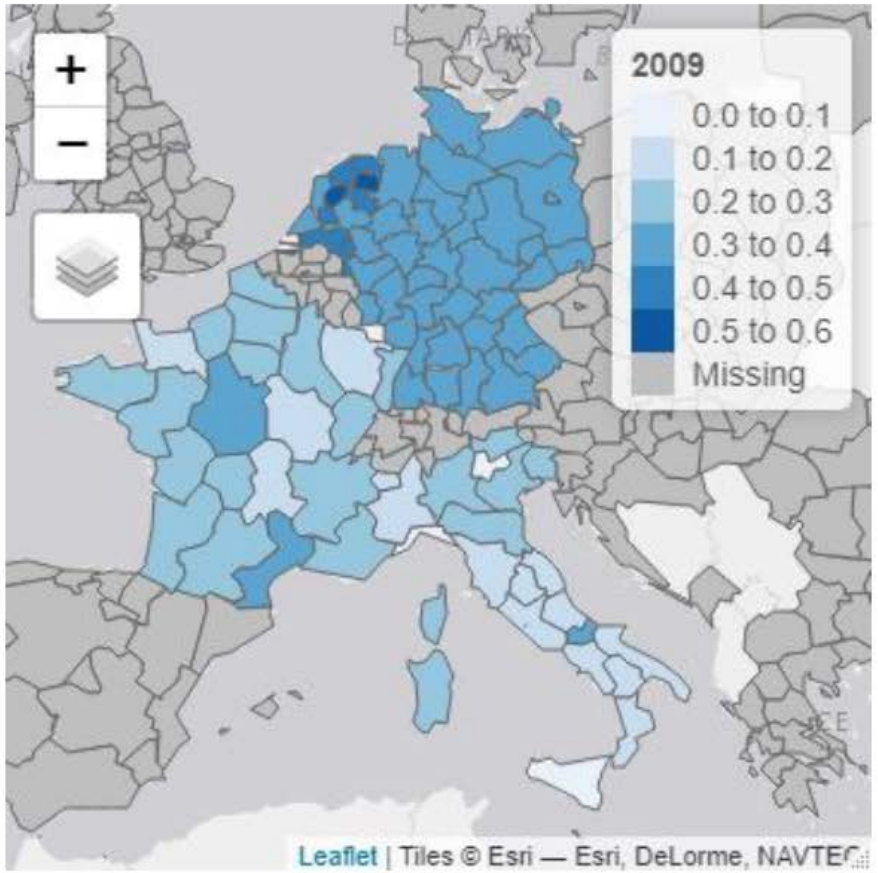


Figure 2: Cluster representation of Municipal solid waste management performance in the year 2009



Results

Figure 3: Cluster representation of Municipal solid waste management performance in the year 2010

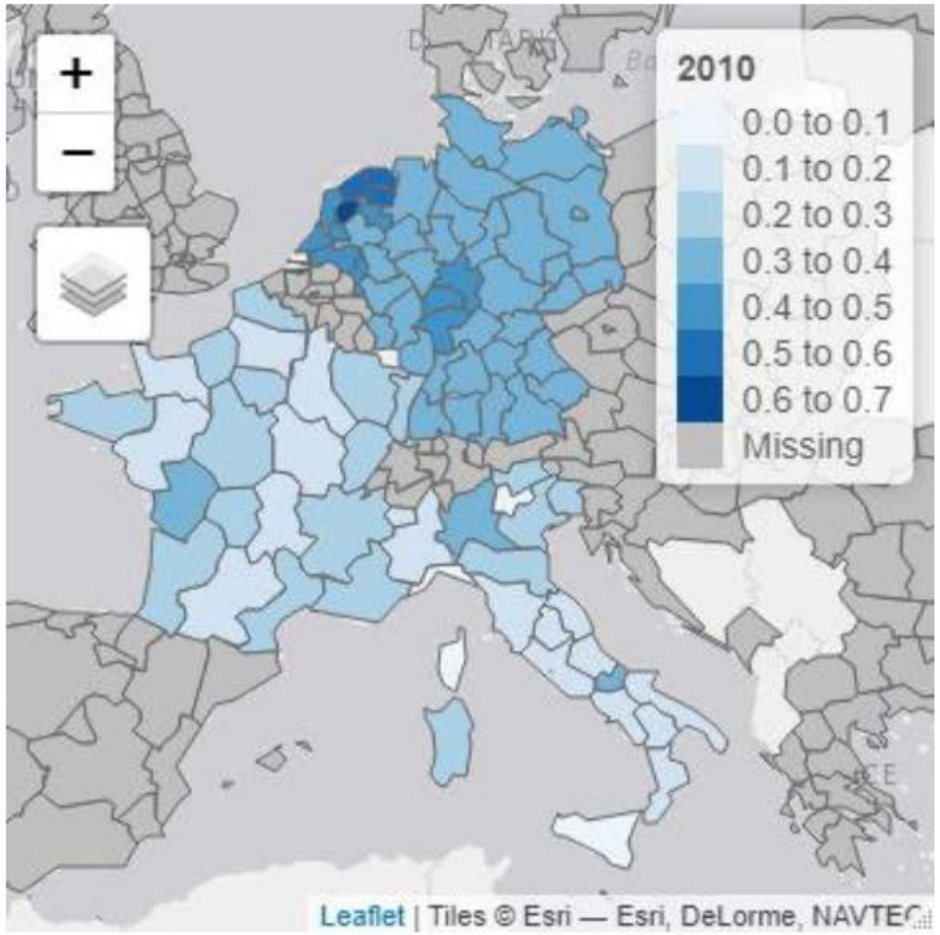
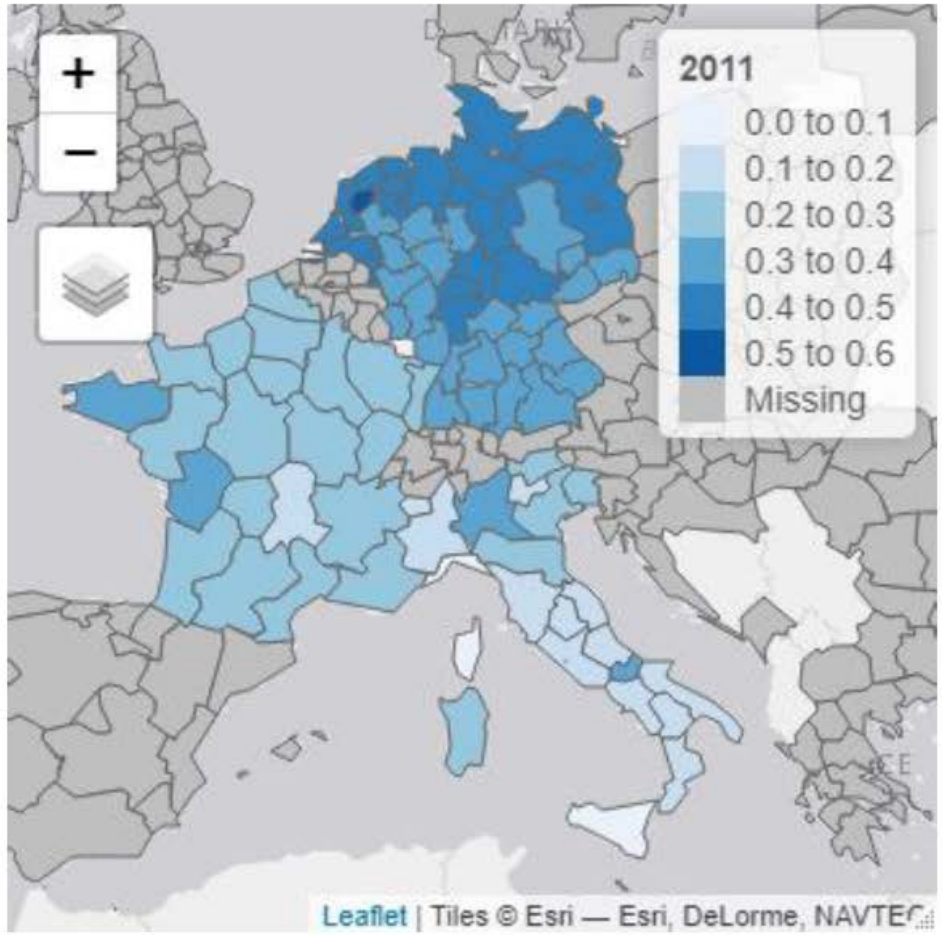


Figure 4 : Cluster representation of Municipal solid waste management performance in the year 2011



Results

Figure 5: Cluster representation of Municipal solid waste management performance in the year 2012

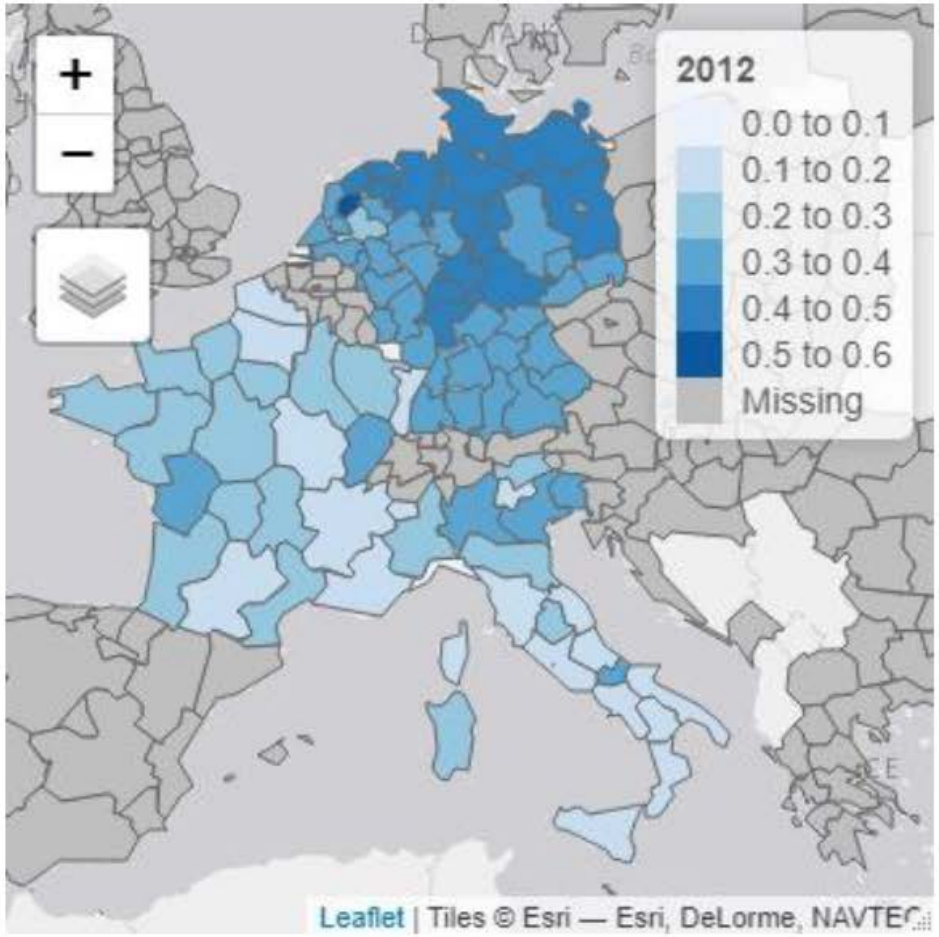
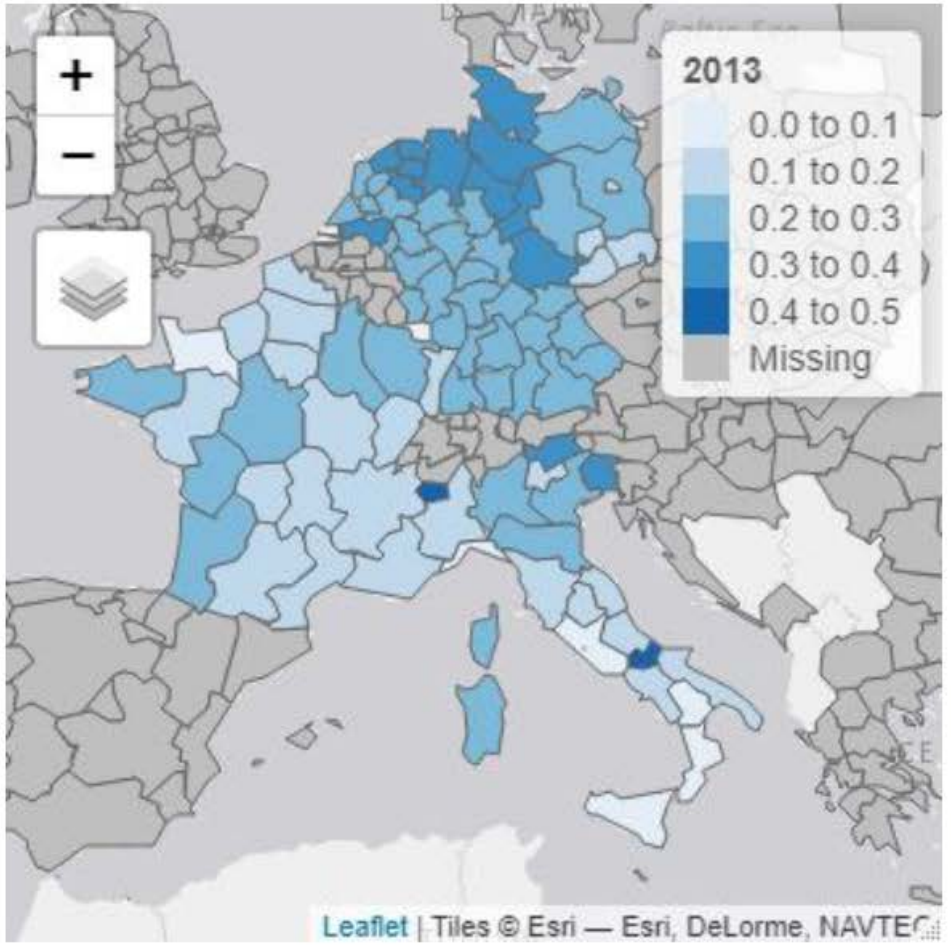


Figure 6: Cluster representation of Municipal solid waste management performance in the year 2013



Results

The DEA analysis reveals that the best MSW management performance in the period 2008-2013 is generally led by Dutch regions, respectively followed by German, French and Italian's regions

Comparing MSs regions' in the period 2008-2013:

- the highest value has been registered in Flevoland (the Netherlands) with a rate of 0.64957 in 2010.
- the lowest value has been observed in Course (France) with a rate of 0.029217, in 2011.
- Exceptionally, in 2013 the best results have been accomplished in an Italian region, namely Molise. Notwithstanding, Italian regions are generally positioned in the lowest rankings throughout the period 2008-2013.

High performance is especially observed in regions with low inhabitants and low waste generated. Here, the amount of waste diverted into landfill is low, by contrast waste incineration, energy recovery, recycling rates are high. On the other side, the analysis demonstrates that French and Italian regions generally lag behind.


THANK YOU