Environmental assessment of waste management policies: a Waste Input-Output Analysis

Antoine Beylot[1], Jacques Villeneuve[1], Stéphane Vaxelaire[1], Cédric Roussel[2] and Jérôme Payet[2]

[1]BRGM, 3 av. C. Guillemin, 45060 Orléans, France
[2]CYCLECO, 1011 Avenue Léon Blum, 01500 Ambérieu-en-Bugey
E-mail contact: a.beylot@brgm.fr

1. Introduction

Life Cycle Assessment studies of waste management technologies are usually process-based, considering a fixed amount of waste to be treated (the Functional Unit). However, when environmentally assessing waste management policies in a context of economic variations, the interdependence between the flows of goods and waste in the economy needs to be taken into account. Developments in Waste Input Output Analysis (WIOA) are therefore crucial to consistently address such environmental issues.

The following study aims at i) compiling Waste Input Output Tables (WIOT) for France, combining data in monetary units and data in physical units and ii) investigating the environmental benefits of waste management policies on air emissions embodied in the final demand, in the specific case of France and in a context of economic growth. Final demand here refers to the final consumption expenditures by households, non-profit organizations and government. The calculations are performed using a specifically designed web tool enabling to analyze scenarios from the compiled French WIOT.

2. Materials and methods

Environmental Input-Output Analysis enables to derive the environmental burden (b) induced by a particular demand (y), considering A the technological requirement matrix and B the matrix of environmental interventions, according to the Leontief inverse matrix equation [1]:

$\mathrm{b} = B(I-A)^{-1}y$ (equation 1)

As a complement to standard Input Output Analysis, Waste Input Output Analysis distinguishes waste treatment activities with accounting for their different technological and environmental performances as a function of the nature of waste fractions (plastic, organic, paper, metals, etc.) [2]. In this study, Input-Output Analysis is not based only on flows of products in monetary units, but instead combines both flows in monetary units and flows in physical units in a so-called “mixed-unit” or “hybrid” framework. The matrices A, B and the vector y are compiled for France for the year 2004. The coefficients of matrix A and the values of vector y relative to service activities are directly extracted from Eurostat in monetary units. A, B and y are then completed with data on products uses, emissions and resource consumption in physical units mainly compiled from national statistics as in [3]. Coefficients of waste generation are finally deduced based on mass balance identities.

Three distinct scenarios are considered (Table 1), depicting and combining the projected upward trend of final demand from 2008 to 2020, the increase in recycling rates and the larger implementation of Best Available Techniques (BAT) for incineration. The scenarios including recycling, i.e. Scenarios 2 and 3, are based on the objectives set by European Directives on the one hand, and on the observed recycling rates in some activities (best performing as to recycling) on the other hand. Three types of gaseous emissions are assessed: fossil CO_2, NOx and SO_2.

Scenario 0	Initial state (2008)
Scenario 1	Evolution of final demand
Scenario 2	Evolution of final demand + Rise in the recycling rates of waste from economic activities and final demand
Scenario 3	Evolution of final demand + Rise in the recycling rates of waste from economic activities and final demand + Implementation of BAT for incineration

Table 1: Summary of scenarios

3. Results and discussion

The French final demand in 2008 induces the emission of 345,072 ktonnes of fossil CO_2, 1,546 ktonnes of NOx and 944 ktonnes of SO_2. The evolution of the final demand from 2008 to 2020 implies the rise in its corresponding embodied gaseous emissions, from 18 to 21% depending on the pollutant (Scenario 1; Figure 1). A larger implementation of recycling and Best Available Techniques for incineration results in the decrease in emissions, as observed when comparing Scenarios 2 and 3 with Scenario 1. The gaseous emissions induced by the final demand in Scenario 3 are 2 to 5% lower than in the case of Scenario 1, and 12 to 17% larger than in the case of Scenario 0, depending on the pollutant. The combined implementation of recycling and BAT therefore does not enable to overcome the increase in gaseous emissions induced by the evolution of the final demand. However, their implementation enables to limit the increase in emissions resulting from the evolution of the final demand, by 19% considering fossil CO_2 emissions up to 34% considering SO_2 emissions.

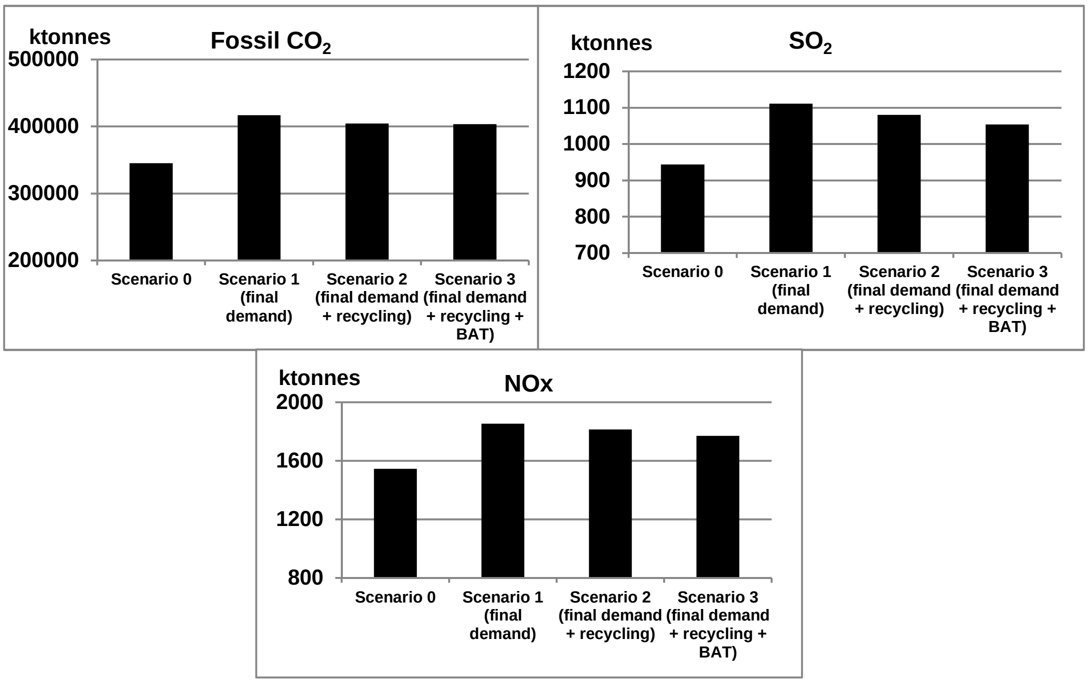

Figure 1: Emissions of fossil CO_2, SO_2 and NOx induced by the French final demand: comparison of scenarios

4. Conclusions and perspectives

Considering the case study, waste management therefore appears a key lever in the perspective of decoupling gaseous emissions embodied in the French final demand from the latter's evolution. Yet waste management policies only have limited effects relatively to the total gaseous emissions embodied in the final demand and may only be seen as one piece of a larger panel of policies.

Considering the method, developments in the approach for the compilation of Waste Input Output Tables, including data uncertainties (as initiated by Hernandez-Rodriguez et al., [4]), appear necessary in the future to improve the accuracy of such studies.

5. References

[1] Leontief W. 1966. Input-Output Economics. 1st Ed. Oxford University Press, New York.
[2] Nakamura S., Kondo Y. 2002. Input Output Analysis of Waste Management. Journal of Industrial Ecology Vol. 6, No.1, 2002, pp.39-64.
[3] Hafner G., Escalante N., Schuller H., Daxbeck H., Buschmann H., Brandt B., Brunner P. H., Massmann C., Villeneuve J., Lemiere B. 2010. Data Processing and Validation for Austria, Denmark, France and Germany. Deliverable n°3.1. FORWAST. Available at h ttp://forwast.brgm.fr
[4] Hernandez-Rodriguez G., Beylot A., Villeneuve J., Vaxelaire S. 2012. Estimating consistent Physical Supply-Use Tables (PSUTs) considering data uncertainties. 20th IIOA conference, Bratislava