Policy instruments for a more sustainable waste management

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Abstract An on-going interdisciplinary Swedish research programme, Towards Sustainable Waste Management aims at assessing policy instruments that may contribute to a more sustainable waste management, shifting it towards the upper levels of the waste hierarchy - to waste prevention and material recovery. 15 policy instruments have been chosen for final assessment, ranging from administrative and fiscal instruments to information. Three existing quantitative tools are combined for the economic and environmental assessment of instruments: one macroeconomic model of the Swedish economy and, for Swedish waste management, one systems engineering model and one life cycle assessment tool. The set of tools allows us to analyse the potential economic driving forces of policy instruments introduced on a macroeconomic level as well as instruments introduced in the waste sector and, in addition, analyse the environmental effects.

1 Introduction

Waste management in many European countries has developed considerably since the mid-90's. In Sweden, only 1.4 % of the municipal solid waste (MSW) was landfilled in 2009 as compared to 39 % in 1994. While landfilling has decreased, recycling, incineration and biological treatment has increased significantly. This development means that Swedish waste management has climbed upwards in the waste hierarchy. Life cycle assessments (LCAs) indicate that the waste hierarchy is valid, as a rule of thumb, for the environmental ranking of MSW management options (e.g. [1]), which suggests that the changes that have occurred are environmentally beneficial.

However, it is clear that the quantities of generated waste have grown steadily. For example, the total quantity of MSW per capita increased by 60 % in Sweden and 54 % in EU-15 from 1980 to 2005. Waste generation in Swedish manufacturing industries increased approximately by 2/3 from 1993 to 2006 [2]. Growth of municipal waste generation in EU-27 has been slower than that of GDP, thus achieving relative decoupling for this waste stream, but the EU commitment to reduce waste generation is not succeeding [3]. With continuously increasing waste quantities, the total environmental impact of waste management risks to increase, both in terms of direct impacts from managing the waste and, even more, as indirect impacts from the production of all materials and goods that end up as waste.

To avoid increased environmental and economic impacts, measures are needed for improving waste management efficiency and for waste prevention. This requires not only waste management but also production and consumption practices, including resource use, to develop in a sustainable direction. Numerous factors could potentially contribute to such a development: increased consumer and company participation in recycling schemes and prevention activities, technological development, and institutional measures such as policy instruments to mention only a few.

In an on-going Swedish research programme, Towards Sustainable Waste Management (TOSUWAMA) [4], the goal is to assess how policy instruments may contribute to a more sustainable waste management. The focus is on shifting waste management towards the upper levels of the waste hierarchy to waste prevention and material recovery. Environmental, economic, cultural and social aspects of 15 policy instruments are studied by economists, ethnologists, environmental psychologists, systems analysts and futurologists in co-operation. In the final step of TOSUWAMA (to be finalised in 2012), the assessments will be integrated in an interdisciplinary synthesis, so that policy instruments for a more sustainable waste management can be suggested for the potential benefit of actual decision-making.

In this paper, we present the methodology applied for the economic and environmental assessment of policy instruments. We also present some preliminary results from our analysis: future waste quantities and the initial assessment of two policy instruments.

2 Policy instruments for a more sustainable waste management

The importance of waste prevention is emphasised in the European Union waste framework directive [5] as well as in the EU Sixth Environment Action Programme [6]. Swedish environmental quality objectives includes waste prevention as well as goals for biological treatment of food waste, overall recycling rates for household waste and phosphorus recycling [7]. Swedish waste policy is thus governed by a number of policy documents related to waste, but also to other sectors, including energy. Current policy instruments affecting Swedish waste management include e.g. a ban on landfilling of organic materials, a landfill tax, and extended producer responsibility of some product groups. Most currently used policy instruments are moving waste away from landfilling. Although there are policy documents supporting the waste hierarchy, there are few policy instruments for supporting waste minimization and increased recycling in place today.

The 15 policy instruments chosen for final assessment in TOSUWAMA range from administrative and fiscal instruments to information and focus on the higher levels of the waste hierarchy [8]. Initially, suggestions for policy instruments were gathered through workshops with stakeholders and literature studies. Further prioritization was based on a number of criteria including economic, environmental and social aspects. The instruments that will be further evaluated are:

1) Information to citizens and companies
2) Improved control by authorities
3) Tax on raw materials
4) Differentiated VAT, with lower VAT on services
5) “Junk mail, please!” (delivered only if affirmative)
6) Weight based waste collection fee
7) Environmentally differentiated waste collection fee
8) Developed waste collection systems
9) Ban on incineration of recyclable materials
10) Including waste in green certificates for electricity production
11) Tax on incineration of waste from fossil fuels

12) Tax on incineration of waste
13) Recycling certificates
14) Tax on hazardous substances in products
15) Labelling of products and goods with hazardous substances

Scenario analysis is used to deal with the uncertainties inherent in the long-term future [9]. Each policy instrument is assessed in a reference case and four alternative scenarios for the year 2030 with assumptions on the degree of global cooperation and the degree of political market control from a resource and environmental perspective. The qualitatively described scenarios are translated into quantified assumptions regarding e.g. economic growth, primary product prices, oil, prices, CO2 permit prices and waste intensities for households and industry [10]:

1) Reference case (closely related to official projections of the Swedish economy)
2) Global sustainability (globalisation and strong political market control)
3) Global markets (globalisation and low political market control)
4) Regional market (regionalisation and low political market control)
5) Sustainable course in Europe (regionalisation and strong political market control)

3 Integrated approach for quantitative analysis of policy instruments

Policy instruments that could contribute to a more sustainable waste management could be introduced on a macroeconomic level (such as tax on virgin materials and lower VAT on services) as well as directly in the waste management sector (such as ban on incineration of recyclable materials). The linking of a macroeconomic model and, for waste management, a systems engineering model and a LCA model allows us to consider several effects when designing policy instruments intended to prevent waste generation or direct waste management in a more sustainable direction: (1) the macroeconomic effects, such as GDP growth and structural changes, (2) the effect on economical driving forces for technological development of waste management and (3) environmental impacts resulting from such effects. Furthermore, the approach makes it possible to capture the interaction between waste quantities and waste management costs when assessing future waste quantities.

The three quantitative tools is used for economic and environmental assessment of nine of the chosen instruments, while the remaining six instruments are assessed using qualitative methods (see e.g. [11-12]). Assessments cover most generated waste flows from households and industry in Sweden (mining waste being one of the main exceptions). The three existing tools that have been refined and combined for the purposes of the assessment, see Figure 1, are:

1) the Environmental Medium term EConomic model (EMEC), a computable general equilibrium (CGE) model of the Swedish economy [13-14]
2) NatWaste, a systems engineering model of the Swedish waste-management system [15], and
3) SWEA, a LCA tool for Swedish waste management [16].

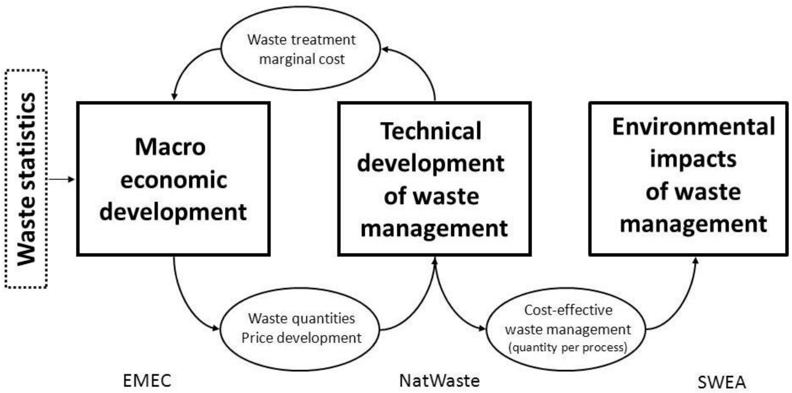

Fig.1: Integrated concept for analysis of policy instruments

The top-down CGE model EMEC and the bottom-up systems engineering model for waste management NatWaste are soft linked in the aspect that the values of some variables solved for in one model are transferred into the data set of the other model in an iterative process, see Figure 1. NatWaste calculates the cost-effective mix of waste-treatment methods with and without the introduction of policy instruments. Thus, NatWaste has the role of feeding EMEC with the prices, or marginal costs, of waste disposal services. All other prices of commodities and production factors are given by the solution of EMEC. Firms and households react by reducing waste generation when the prices of waste disposal services increase, and thus EMEC has the role of returning to NatWaste the wastes generated in the economy given the prices of waste disposal services and factors for the price development of inputs to and outputs from the waste management (e.g. material and energy prices). The convergence of this iterative process is granted, as the unit costs of waste treatment will not increase when the generation of waste decreases. The last step in the process is to feed the cost-effective set up of waste management as calculated by NatWaste into SWEA for analysing environmental impacts.

The data on waste fractions interchanged between EMEC, NatWaste and SWEA, complies with the waste types defined in the European Waste Statistics Directive (EWC-Stat) [17]. The EWC-Stat waste fractions, however, are too aggregated for a meaningful analysis of waste management options performed with NatWaste and SWEA. The EWC-Stat waste fractions, therefore, are disaggregated into sub fractions to fit the waste management options in NatWaste and SWEA [10].

4 Preliminary results from the quantitative analysis of policy instruments

4.1 Future waste quantities and decoupling from economic growth

The growth of MSW quantities in EU-27 has been slower than that of GDP, i.e. there has been a relative decoupling of waste generation from GDP [3]. Some projections of future waste quantities made for the EU by use of econometric models do indicate relative decoupling of waste from GDP and household consumption, as referred to in [10]. Besides econometric models, CGE models have been applied for analysing the relation between economic activity and waste generation (as referred to in [10]).

Future waste quantities and their decoupling to economic growth were assessed for a reference case and the four alternative scenarios to 2030. The models EMEC and NatWaste were applied as described in section 3, which allowed us to consider, in more detail, the interaction between waste generation and waste management costs (waste disposal prices) when assessing future waste quantities.

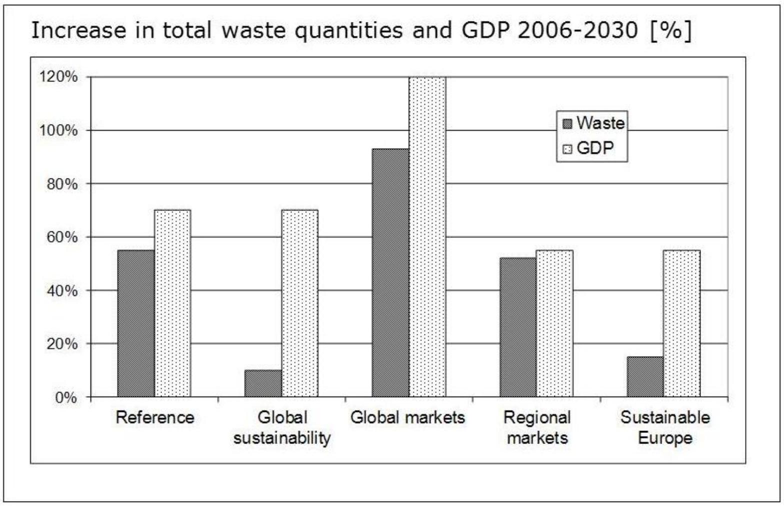

Fig.2: Increase in generation of non-hazardous waste and GDP from 2006 to 2030 [%] [10].

The results show a relative decoupling of waste generation in all scenarios, i.e. total waste quantities increase at a lower rate than GDP, see Figure 2. Absolute decoupling, which require total waste quantities to stabilize or to reduce, does not take place in any of the scenarios. This means that the present Swedish Environmental quality objective of stabilizing waste quantities is not met in any of the scenarios with total waste generation levels of 110 per cent up to nearly 200 per cent of that in 2006 [10].

The impact of economic growth on the waste generation is clear when comparing the waste bars of the scenario 'Global markets' with those of other scenarios. This scenario, with a yearly rate of economic growth being at least 1½ times that of any other scenarios, results in bars exceeding those of other scenarios when it comes to both total waste and most of the different types of waste. Technological changes resulting in less waste-intensive production processes and behavioural changes making household activities less waste intensive, as assumed in the scenarios 'Global sustainability' and 'European sustainability', obviously have a strong waste-reducing effect as can be concluded by comparing the waste bars of these two scenarios with those of other scenarios [10]. Waste grows at a lower rate in the scenario 'Global sustainability' than in the scenario 'European sustainability'. This observation indicates, that the generation of waste is more affected by decreasing waste intensities than by economic growth, as waste intensities decline more but economic growth is higher in the scenario ‘Global sustainability’ than in the scenario ‘European sustainability’ [10].

4.2 Policy instrument: Differentiated VAT

A differentiated value added tax (VAT) with a relatively lower tax level on services could shift household's consumption from goods to services, and thereby decrease waste generation if services are less waste intensive [8]. The effect on the Swedish economy and future waste quantities of this policy instrument is studied in the EMEC model. The results refer to expected impacts in the year 2030 of introducing the instruments today, assuming that the economy has reverted long-term equilibrium. The effect of introducing the instruments is analysed for the reference scenario and the four alternative scenarios.

The effective tax rate on services is cut by half (exempting transport services). An additional condition is that governmental finances should not be affected. The results depend on the way the tax cut is financed. If it is financed by decreasing government transfers to the households, the consumption of services increases by about 4 per cent. Consumption of goods falls, but total consumption expenditures is almost unchanged. Household's waste generation falls by about 1 per cent. An alternative way of financing the tax cut would be to increase the VAT on goods. In this case, the change in the consumer price of services relative to that of goods is greater and waste generation falls by about 1.5 per cent. In both cases, the total consumption expenditures are nearly unchanged and households' real income decreases only marginally. The income decrease is explained by structural changes in the economy, a shift from production of goods to services with comparatively lower productivity. The decrease in waste generation is nearly equal in all scenarios in relative terms, i.e. around 1 % [18].

4.3 Policy instrument: Ban on incineration of recyclable materials

A general perception of the Swedish waste management system is that it builds on well-developed source separation and recycling. Despite this, considerable amounts of waste are still landfilled or incinerated. This is confirmed by a recent review of more than 240 Swedish waste component analyses which concludes that

60% of mixed waste from households could instead be recovered for material recycling or biological treatment [19].

The aim of a ban on incineration of recyclable materials would be to promote increased material recycling. The effect on waste management cost and environmental impacts of this policy instrument was studied in the NatWaste and SWEA models [20]. The formulation of the instrument was extended to also include a ban of landfilling of recyclable materials. The analysis refers to the costs and environmental impacts in the reference case for the year 2030, comparing a situation with and without a ban on incineration and landfilling of recyclable materials in mixed waste. The waste types covered were "Household and similar wastes" and "Mixed and undifferentiated waste" (EWC-Stat nomenclature [17]).

The impacts of increased recycling were calculated from a life cycle perspective, in terms of the cumulative energy demand and global warming potential. In line with waste management LCA methodology, processes in the waste management system were included, but also generation of process energy and avoided processes as a result of recovered energy and materials from waste. Costs were calculated from a business economic perspective.

The results show a potential for increased recycling of 32% of the total amount of these mixed waste types in 2030 (2.7 Mtonnes) of which 2/3 shifts from incineration to recycling and 1/3 from landfilling to recycling. If this shift was realized in 2030, this would correspond to overall savings of 69 PJ energy and 4.2 Mtonnes of CO2-equivalents. Increased recycling of plastics, but also paper appear as being of highest priority from an energy and climate point of view, with the assumptions made for average electricity and heat production in 2030. This is despite the fact that waste paper can been seen as a renewable fuel. The calculated business costs of waste management would increase, mainly because of increased collection costs [20]. Considered as a means of reducing emissions of greenhouse gases, the recycling costs seem to be high in comparison with many other mitigation measures [21], but they are comparable with mitigation costs for greenhouse gas emissions from transports [22-23].

5 Conclusions and discussion

In this paper, parts of the on-going Swedish interdisciplinary research programme TOSUWAMA are presented. The goal is to assess how policy instruments may contribute to a more sustainable waste management. As a final step of TOSUWAMA in 2012, the assessments of environmental, economic, cultural and social aspects of policy instruments will be integrated in a synthesis, so that policy instruments for a more sustainable waste management can be suggested for the potential benefit of actual decision-making.

The methodology applied for the economic and environmental assessment of policy instruments is a combination of existing tools originating from different academic disciplines. The linking of these tools allows us to perform a broad analysis, which is required for the large scope of policy instruments suggested in TOSUWAMA. However, the linking process is a complex task which requires careful harmonisation for ensuring sufficient consistency between the models. Since the scope of the issues investigated is large and complex, it is important to find a good balance between accuracy, data collection efforts and flexibility. Close cooperation between the researchers is crucial in all steps of the analysis.

The analysis of future waste generation until 2030 shows relative, but not absolute, decoupling from economic growth. This means that stabilisation of waste quantities does not occur in any of the scenarios with total waste generation levels of 110 % up to nearly 200 % of that in 2006.

Several studies have shown that environmental benefits of waste prevention could be considerably larger than those of material recycling, biogas production and other energy recovery from waste [24-27]. This suggests that small scale waste prevention could reduce environmental effects as much as large scale waste management improvements. Our analysis shows that the differentiated VAT appears to have little effect on total waste reduction. But even a smaller change can be important for reducing environmental impact, which we will explore in our continued work. Furthermore, a differentiated VAT could be part of a combination of several policy instruments for achieving stronger waste reductions. Another initial conclusion from our analysis of instruments is that there is a clear potential of reducing the environmental effects of Swedish waste management through increased material recovery. A ban on incineration of recyclable materials could be one way of realizing this shift, but it could of course be realized in other ways as well.

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