Material Efficiency & Resource Conservation

Martin Distelkamp
Bernd Meyer
Mark Meyer

GWS mbH

Quantitative and qualitative Effects of a forced Resource Efficiency Strategy

Executive Summary

Summary report of Task 5 within the framework of the
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Contact to the Authors:

Prof. Dr. Bernd Meyer

GWS mbH
49080 Osnabrück, Heinrichstr. 30

Tel.: +49 (0) 541 40933 -140, Fax: -110
Mail: meyer@gws-os.com

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Project Coordination:

Dr. Kora Kristof / Prof. Dr. Peter Hennicke

Wuppertal Institute for Climate, Environment and Energy
42103 Wuppertal, Germany, Döppersberg 19

Phone: +49 (0) 202 2492 -183 / -136, Fax: -198 / -145
E-Mail: kora.kristof@wupperinst.org
peter.hennicke@wupperinst.org

More information about the project
"Material Efficiency and Resource Conservation" (MaRess)
you will find on **www.ressourcen.wupperinst.org**

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Questions

What are the economic effects of a forced policy to raise resource efficiency? Which interrelations have to be considered in the macroeconomic context concerning the impacts of different policy instruments? Is a decoupling of economic growth and resource consumption possible in the long run? These are the questions that Task 5 has to answer.

Methodology

The methodology is to run simulations with a sectorally deep disaggregated economic environmental model that depicts the relations between economic development, resource consumption and emissions. A comparison is drawn between a model forecast that includes one or more policy activities and a reference forecast, in which these policy activities are not implemented. The comparison between both forecasts allows for the identification of all direct and indirect effects that are induced by the policy instruments.

To obtain empirically substantiated results, it is useful to work with a model whose parameters are estimated using econometric methods. The model PANTA RHEI fulfils this requirement. It has been used in many applications answering economic environmental questions. During the project it has been completed by a material module. The data base of the material module is a data set of the Wuppertal-Institute that links the different categories of material consumption with the economy in deep sectoral disaggregation.

The Reference

The reference is a forecast which in our case depicts the economy, resource consumption and emissions for each year till 2030. The preparation of the forecast requires assumptions about the development of variables that are not calculated by the model. In our case the further development of the world economy and the policy variables, especially the instruments of environmental policy, have to be fixed. The study discusses these questions in detail running scenarios with different assumptions. Two main results could be achieved: At first, it could be shown that the dynamic of material consumption, which could be observed in Germany during the last ten years, was driven by metals which are linked to the strong export development. Germany is exporting with big success investment goods as machinery and cars which consist preponderant of metals. Secondly, material consumption is also dependent from climate policy, which reduces the use of fossil fuels, coal, gas, and oil. Insofar the level of resource consumption in Germany in the reference is strongly depending on the assumptions about the further development of the world economy and the decisions on climate policy in Germany.

We assumed a moderate long run growth for the world economy which induces an average growth rate for German exports of about 3.2% p.a. With regard to climate policy we assume an engaged strategy that achieves a reduction of CO_2-emissions of 80% (compared to the historic value of the year 1990). For the last year of our simulation this means a reduction of 54%. Of course there is no specific decision about the chosen instruments for the whole time period. So we assumed that the already established policy instruments with the aim to enforce renewable energies and energy productivity in firms and households will be further developed so that the set targets will be reached. The selection of this reference scenario is supported by the fact that the government and the opposition in Germany conclude regarding the targets even though there is no consensus yet about the policy mix.

The Discussed Instruments

Analyzing all groups of instruments – economic instruments, information and consultation instruments and regulation by technical standards - the study covers a broad range. But it is not the aim of the study to discuss all instruments that play a role in the other Tasks of the MaRess project. This is not possible since many of the possible measures cannot be quantified. The idea is to include at least one instrument of each group that plays an important role in the other Tasks of the project as well.

From the group of **economic instruments** changes in value added taxes for transport services and the introduction of a resource tax for building materials have been elected.

The change of the rates of value added taxes concerns rail road transportation and air transport services. The tax rate for rail road transportation is lowered from the regular rate of 19% to the reduced rate of 7%. Contrastingly, the tax rate for air transport services is raised from 7% to 19%.

The effects of resource taxes are analysed for the extraction and import of building materials. It is assumed that in 2012 a tax of 2 € per ton of extracted and imported building material is introduced. The tax rate rises by 5% p.a. and reaches 4.80 € in 2030.

Information instruments are of a very different nature. An analysis of specific characteristics of such instruments is nearly impossible because the empirical information about its direct impacts is missing. Therefore, it is not possible to model these instruments. The alternative approach is to ask what are the differences between a situation in which the agents have perfect information compared to the situation of the reference scenario where, for example, many producers do not use the best practice technology concerning resource consumption because they do not know all alternatives that they have. So we ask for the potential of an information policy as a whole without relating it to a specific information instrument. For the firms there is empirical information for this potential based on the experience of consulting firms. Furthermore, the German Efficiency Agency DEMEA and the Efficiency Agency for North-Rhine-Westphalia have a

lot of information about the impact of consulting: What is the impact of the introduction of the “best practice” technology for resource consumption on material costs, capital costs and costs for consulting services? The consulting firms come to the result that in manufacturing on average 20% of material costs can be saved. To realize this potential additional costs arise which equal the savings of one year. One third of these costs are consulting services, two thirds are investments in equipment. We assume that it might be possible to introduce the best practice technology in 5% of all manufacturing firms per year so that in 2030 the potential of all manufacturing firms is exhausted.

As a **regulation instrument** we discuss the introduction of rules for the use of recycling in the production of non-ferrous metals. Here it is assumed that in final products a certain percentage of non-ferrous metals has to be of recycled material. The share of recycled non-ferrous metals rises linearly from the actual level so that it reaches factor three in relation to that level in 2030.

One can imagine that here intelligent forms of regulation come into practice which may be based on voluntary agreements or the top runner concept. Since all final products have to fulfill the standards, all imported products are included. This means that we have either branch-oriented international agreements about the production of non-ferrous metals or the importing firms have to prove that the imported products are in line with the standards.

This scenario is calculated in two variants. The econometrically estimated elasticity of substitution of non-ferrous metals by secondary products is about -0.4. This means that the substitution will cause costs. In the second variant it is assumed that in a world with permanently rising world market prices for metals there will be incentives to improve the recycling technology. Furthermore, with rising activities there will be learning effects. To catch the potential of these cost reducing factors we run the model in the second variant with an elasticity of substitution of -1 for non-ferrous metals versus secondary products.

The Results

The impact of **economic instruments** is analysed for a change in consumer taxation of traffic services and the introduction of a resource tax on building materials. The additional tax revenue will be compensated by a reduction of income taxes so that the total tax revenue is not affected. The rise of the taxes for goods itself has negative economic effects which are completely compensated by the positive effects of the reduction of income tax. The change in the rates of the value added taxes for traffic services (higher taxation of air services, lower rates for railway service) reduces energy consumption but not material consumption. The reduction of air transport of course reduces consumption of oil, but on the other side the higher demand for electricity induces also the consumption of coal and gas. The introduction of the taxation of building materials has severe impacts on material consumption. Domestic extraction of materials reduces the consumption of non-metallic minerals by 15.6% and the total domestic

extraction of materials by 9.7%. The total material requirement indicator TMR, which measures the sum of domestic extraction, imported resources and the contents of materials given directly and indirectly with the imported goods, reduces by 1.5% compared with the reference scenario in the year 2030.

Tab. 1 summarizes the results for the change of value added taxes for traffic services, the introduction of the tax on building materials and the compensation of income taxes.

Tab. 1: The impact of the analysed economic instruments on macro indicators in the year 2030

Deviations from the reference scenario

	real gdp	disposable income	employment	final energy demand	TMR
in percent	-0,06	0,07	-0,01	-0,3	-1,5
absolute	-1.5 bill. €	+1.5 bill. €	-5,400 Pers.	-25,784 TJ	-81.9 Mio t

Which results can be expected if all firms of the manufacturing sector will participate within the next 20 years till 2030 in an **information and consulting program** and achieve the "best practice" in respect to material consumption? The direct effects are clear: Those firms that use materials will enjoy a reduction of production costs, on the other side the producers of materials will lose shares in sales and production. Since markets are not perfect, the winners will reduce their prices but not to the same extent as the reduction of unit costs. This means that value added will rise in these firms. The extensive effect induced by the winners dominates by far: Rising value added pushes income and consumption, falling prices raise real income and improve international competitiveness with rising exports and falling imports. A further reduction of imports is given with the lower imports of resources. The total effect on real GDP is +14.2% in 2030 in comparison with the reference scenario.

Since resource productivity rises stronger than GDP, the level of TMR falls by 9.2% in 2030 compared with the reference scenario. The reduction of material consumption raises energy productivity indirectly by 13.8%. So final energy demand will in spite of the strong positive effect on GDP only be slightly above the low level of the reference scenario. The economic prosperity raises also the tax revenue. On the expenditure side of the budget of the government there will be reductions for social security payments following the higher employment. Furthermore, public consumption will grow less than the tax revenue because public services like defence, security, administration, education etc. will not rise that much as a consequence of dematerialization of the economy. These savings year by year reduce public debt. In 2030 it will be 10.2% lower than in the reference scenario. Tab. 2 summarizes the results of the impacts of the information and consulting program.

Tab. 2: The impact of the information and consulting program on macro indicators in 2030

Deviations from the reference scenario

	real gdp	public debt	employment	final energy demand	TMR
in percent	+14.2	-10.2	+1.9	+0.42	-9.2
absolute	+374.7 bill. €	- 226.0 bill. €	+696,100 Pers	+33,147 TJ	-506.4 Mio t

In both variants of the **recycling** scenario the economic effects on GDP and employment are positive because expenditures for imported resources are substituted by domestic value added. In the following section we discuss only the further results for the variant with a elasticity of substitution of -1.

GDP rises by 0.04% or 1 bill. € and employment in 2030 is by 10,600 persons higher than in the reference scenario. Public debt falls by 2.5 bill. €.

TMR is 8.9% lower in 2030 compared with the reference scenario. In this scenario the impact is concentrating on the consumption of metals. Their TMR reduces by 23.5%. A central role is given to the huge rucksacks which lie on the indirect imports of non-ferrous metals being part of the goods imports.

Tab. 3 summarizes the impact of the recycling scenario on important indicators.

Tab. 3: The impact of the recycling of non-ferrous metals on important indicators in 2030

Deviations from the reference scenario

	real gdp	public debt	employment	final energy demand	TMR
in percent	+0.04	-0,1	+0.03	+0.01	-8.9
absolute	+1.0 bill. €	-2.5 bill €	+10,600 Pers.	+916.0 TJ	-489.8 Mio t

The Potential of a forced Strategy for the Improvement of Resource Efficiency

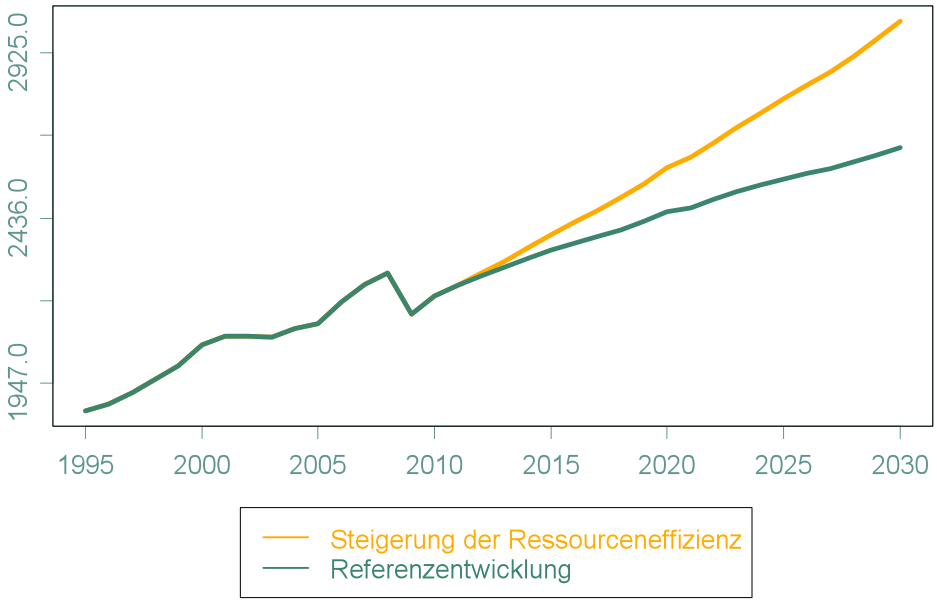
So far it could be shown which impacts the different instruments have. The study did not ask for completeness, but it intends to give examples for the groups of instruments and their effects. Insofar the aim of the following chapter is not to present a concrete policy proposal. The idea is to give an estimate for the potential that a forced strategy for the improvement of resource efficiency can have. In this respect the chapter has more the character of a sensitivity study. All discussed policy instruments could be implemented and be part of a policy proposal. Therefore, it makes sense to ask for the impacts, if all instruments are integrated in one total scenario.

The analysis of the single instruments has shown that especially the information and consulting program has a high potential for an economic expansion induced by the rebound effect of dematerialization. As already said: Rising material efficiency reduces

production costs and prices, and this development improves international competitiveness and value added in Germany. The aggregated price index of gross production falls by 4.3%. The nominal wage rate remains more or less constant because the influences of falling prices and rising productivity compensate each other in their effect on wage bargaining. Therefore, the real wage rate rises with the absolute rate of price changes. The expansive effects on demand are much stronger than the contractive effects coming from the firms which produce materials. In this context the reduction of resource imports coming also from other scenarios plays an important role.

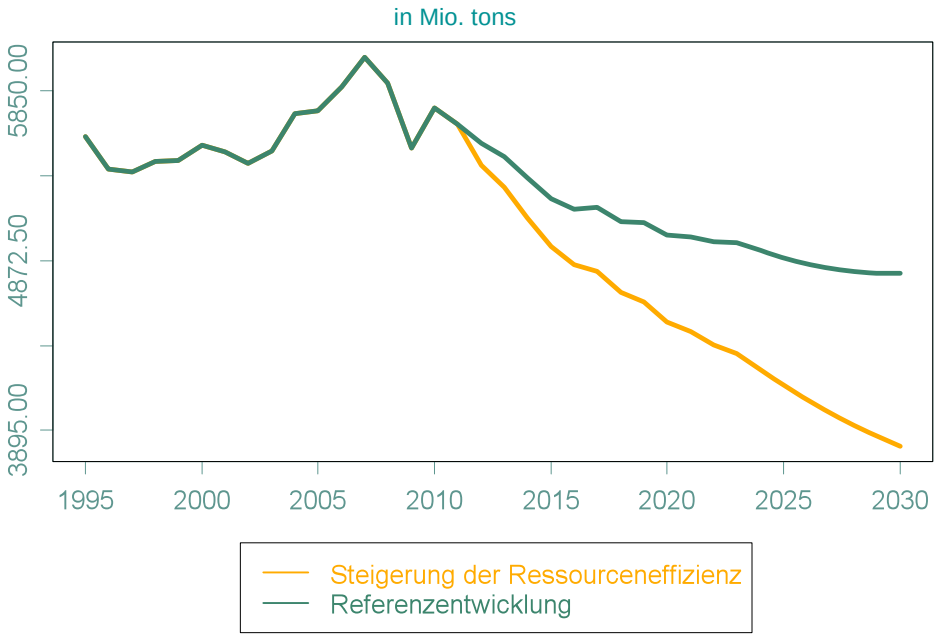
The other instruments have a smaller effect on value added, income and GDP. Tax changes are on average neutral because the rise of good taxes is completely compensated by a reduction of income taxes. The regulation of recycling of non-ferrous metals has little positive effects on GDP because imports of resources are substituted by domestic value added.

Fig. 1: GDP in billion € and constant prices



The results of the simulation studies can be summarized as follows: An engaged climate policy in Germany will be able to combine a permanent economic growth with a reduction of CO_2 -emissions by 54% in relation to the historic values of the year 1990 and an absolute decoupling of resource consumption from GDP can be reached in the long run. Based on this reference scenario the following **potential** for a forced resource policy consisting of economic instruments, information and consulting instruments, and regulation can be estimated in relation to the reference scenario for 2030: A rise of GDP in constant prices of 14% (+372 bill. €) will be possible (Fig. 1), employment will be 1.9% higher (+680,000 persons), public debts will shrink by 11% (-251 bill. €), total material consumption will be reduced by 20% (-993 Mill. t) (Fig. 2) and CO_2-emissions remain at the low level of the reference in spite of the strong rebound effect. Resource productivity will be doubling from 2010 to 2030.

Fig. 2: Total Material Consumption (TMC) in Germany



The information instruments which realise the efficiency potentials of the given technologies in manufacturing sectors have the advantage that they prevail easier in the policy process than other instruments. Their potential is mighty. In our simulations the positive economic effects and about half of the environmental impact are related to them. Whether this potential can be fully exhausted depends on the number of firms that can be reached by the program.

In the long run the “low-hanging fruit” will not be enough. A resource-saving technical progress has to be generated. Here recycling gives an interesting perspective especially for Germany. For the example of non-ferrous metals it could be shown that the potential for dematerialization is rather high because compared to other countries Germany has a very large sector that produces investment goods mainly for the world economy. Therefore, the consumption of metals is very high in Germany and follows the economic dynamic of the world economy. Combining this situation in Germany with the scarcity of metals and the rising world market prices, recycling is also a major topic from an economic viewpoint. But there is also a high potential for the recycling of building materials.

The use of economic instruments has the advantage that price effects induce a lot of substitution effects over all stages of production and also in the sphere of consumption. But if international competitiveness is affected negatively, it is problematic to prevail it in the policy process. For the three tax instruments, which we discussed in the project, the changes of value added, tax rates for air transport and railway transport this is not the case.