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Abstract

The WAM+ energy use scenario relates to the energy scenarios published 2013 in WIFO's "Energy Scenarios 2030". The focus of the WAM+ scenario is on the long-term climate and energy policy perspective for Austria. WAM+ thus evaluates the effects of higher carbon and fossil fuel prices, which will become significant after 2020, on energy use and energy efficiency. In addition to the measures implemented in the WAM scenario (with additional measures), the following measures were addressed: 1. higher CO2 certificate prices in ETS sectors, 2. a CO2 tax on the non-ETS sectors, with the exception of transport, and 3. an additional mineral oil tax increase. Furthermore, a methodological refinement was implemented and four energy-intensive production sectors were analysed in a more disaggregated manner. The results show a potential for energy savings in terms of total final energy demand of 100 PJ in 2030 (with respect to WAM), while the average annual growth rate of GDP remains at about 1.49 percent. Strong additional price incentives in WAM+ are responsible for an increase in the energy efficiency of 1.3 percent on average p.a.

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Contents

Tables

Figures

1. The WAM+ Scenario

This report presents the WAM+ energy scenario, which relates to the energy scenarios published in Kratena et al. (2013) and UBA (2013), and in particular refers to the WAM[1] scenario. The WAM scenario describes the effects of climate and energy policy measures in Austria on energy demand until 2030. The main climate policy modeled in the WAM scenario deals with energy efficiency according to the objectives of the energy efficiency directive (2012/27/EU) and the discussions related to an Austrian energy efficiency act, targeting a reduction in energy use of 8.14 PJ or a 1.5% p.a. increase in energy efficiency. A further major policy implemented in the WAM scenario is an increase in the mineral oil tax of 6 cents per liter of diesel and gasoline in 2015 and 2019, respectively (UBA, 2013). In addition to the measures implemented in WAM, the WAM+ scenario evaluates the effects of a more stringent climate mitigation policy after 2020, thus placing the focus on the long-term climate and energy policy perspective for Austria. The climate mitigation measures to be implemented are:

- higher CO_2 certificate prices in ETS sectors during the 2020-2030 period
- introduction of a CO_2 tax on the non-ETS sectors in the same order of magnitude as the ETS scheme, with the exception of transport
- an additional increase in the mineral oil tax during the 2020-2030 period.

The WAM+ scenario thus assesses the impact on energy use and energy efficiency resulting from higher carbon and fossil fuel prices, which are assumed to become significant after 2020. Table 1 shows the assumptions concerning CO_2 and energy price developments in an overview of all scenarios. In WAM+, the CO_2 certificate price increases steeply to 70 €/t CO_2 in the 2020-2030 period, beginning with 20 €/t CO_2 in 2020. The imposition of the CO_2 tax on the non-ETS sectors (comprising the non-ETS parts of industrial and energy-producing sectors and the household and service sectors, but omitting the transport sector), follows the same CO_2 pricing pattern as the ETS scheme, rising to 70 €/t CO_2 in 2030. Furthermore, a significant rise in the mineral oil tax is assumed for diesel and gasoline fuels, while the spread between diesel and gasoline largely levels out (see Figure 1). In nominal terms, the fuel price increase lies at 56%/48% for diesel/gasoline during the 2015-2030 period, whereas fuel prices in real terms remain constant. The benchmark data for the increase in the mineral oil tax (including value added tax) amounts to 11 cents (2020) and 17 cents (2030) for diesel, and 6 cents (2020) and 9 cents (2030) for gasoline. This is equivalent to a price of about 41.5 €/t CO_2 and 64.2 €/t CO_2 for diesel and 25.9 €/t CO_2 to 38.8 €/t CO_2 for gasoline.

In order to reflect the impacts of assumed CO_2 and energy price increases on the final energy demand of the production sector in a more sensitive way, the energy-intensive production sectors "iron and steel/non-ferrous metals", "chemical and petrochemical", "non-metallic minerals", "pulp, paper and print" were disaggregated into energy-intensive and non-energy-intensive production sub-sectors beginning in 2012. The price elasticity of energy

[1] With additional measures.

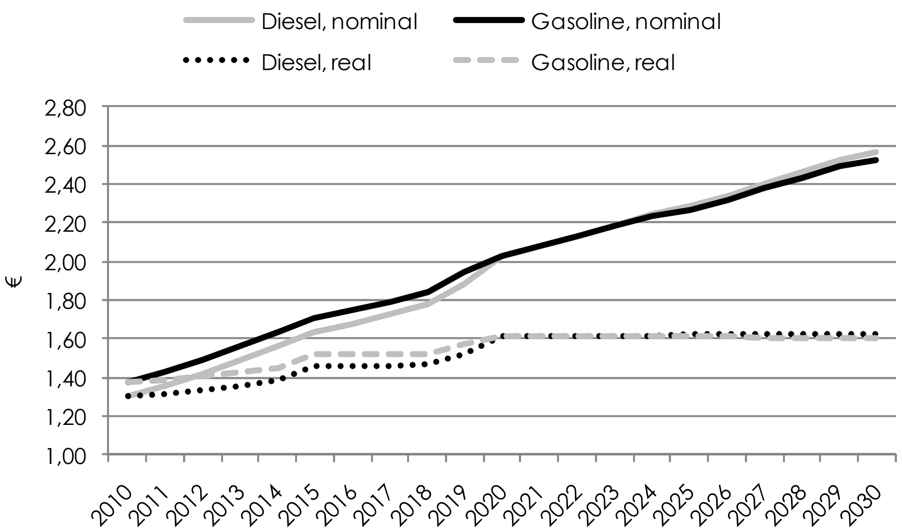
demand depends on the share of energy as a production factor; a higher share results in a larger demand reaction to energy price increases. Disaggregating these sectors thus leads to a more adequate energy demand reaction of the respective energy-intensive production sectors. Fossil fuel energy price increases also act as a trigger for fuel substitution and are responsible for repercussions on the energy efficiency of the respective production processes. The total energy demand of the 4 energy-intensive production sectors absorbs about 200 PJ of energy in 2010, amounting to about 60% of energy use in all production sectors.

Table 1: Scenario Overview

Scenario	WEM	WAM	WAM+
		Economic Growth	
Ø GDP - Growth p.a. 2012- 2030	1.50%	~1.5 %	1.49%
		Carbon and Energy Prices	
Price of CO_2-Certificates ETS Sectors	20 €/t CO_2 in 2020 30 €/t CO_2 in 2030	= WEM	20 €/t CO_2 in 2020 70 €/t CO_2 in 2030
CO_2 Tax non-ETS Sectors	n.a.	n.a.	20 €/t CO_2 in 2020 70 €/t CO_2 in 2030
Fuel Price Increase, nominal	n.a.	2015-2030 Diesel +45% Gasoline +43%	2015-2030 Diesel +56% Gasoline +48%
		Methodological Settings	
Energy efficiency coefficients of the ETS sectors	estimated econometrically	increased	= WAM
WAM+ Specific Implementations			Disaggregation of 4 energy intensive sectors
Other		= WEM	= WEM

Source: own calculations.

Figure 1: Fuel price development, 2010-2030



Source: own calculations, UBA.

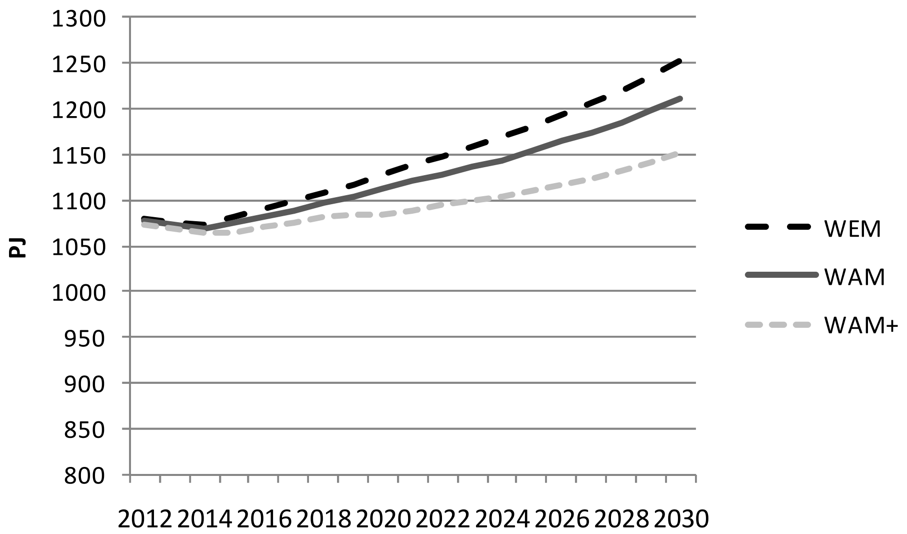
2. Results

In the WAM+ scenario, total final energy demand amounts to 1,083 PJ in 2020 and 1,152 PJ in 2030 (see Figure 2, Table 2). Thus, the disaggregated modeling of the energy-intensive production sectors (methodological settings), as well as the additional carbon and energy pricing (policy measures) in the second decade of the observation period, show a potential for energy savings in terms of total final energy demand of 44 PJ in 2020 and 100 PJ in 2030 (compared to WAM). In WAM+, average annual growth of total final energy demand lies at 0.4% between 2012 and 2030, constituting a reduced average annual growth rate of 0.26 percentage points in comparison to WAM. Furthermore, in terms of total growth, WAM+ shows a much lower rate, i.e. total final energy demand rises by 0.95% in the first decade (2012-2020) and 6.4% in the second decade (2020-2030), increasing by 7.41% in total. Growth rates of total final energy demand in WAM lie significantly above these rates (see Table 2).

Economic performance measured as GDP or value added is a key determinant of energy demand and therefore strongly correlated with energy demand and GHG emissions. However, despite substantially reduced energy use, the average annual growth in GDP lies at 1.49% p.a. in the WAM+ scenario, which is similar to the GDP growth in WAM and WEM[2] scenarios (see Table 3).

[2] With existing measures. The WEM scenario represents the baseline scenario for Austria, incorporating existing measures and policies on climate mitigation and energy use enacted before March, 8 2012 (see Kratena et al., 2013; UBA, 2013).

Figure 2: Total Final Energy Demand



Source: own calculations.

Table 2: Total Final Energy Demand in Figures

	in PJ		
	WEM	WAM	WAM+
2020	1,127	1,111	1,083
2030	1,251	1,210	1,152
Ø % Δ p.a. 2012-2030	0.83	0.66	0.4
% Δ 2012-2020	4.50	3.27	0.95
% Δ 2020-2030	11.06	8.92	6.40
% Δ 2012-2030	16.06	12.48	7.41

Source: own calculations.

Strong additional price incentives in WAM+ are not only responsible for reduced energy demand, but also for an increase in the energy efficiency of the energy-consuming capital stock and production processes. Energy efficiency is thus a factor for decoupling economic growth from energy use. However, rebound effects in energy demand due to lower costs per unit of energy service must be taken into account (see Kratena et al., 2013). An overview of growth rates in energy efficiency per production output in different economic sectors is given in Table 3. Growth in energy efficiency per output production is significantly higher in WAM+ than in WAM, mainly due to carbon and energy price incentives. In the model-based simulation of WAM+, energy efficiency improvements have c.p. positive impacts on GDP. But these positive impacts are compensated by higher carbon and energy prices that have a negative impact on GDP caused by a decline in income due to higher expenses for energy goods and services. In the sum, the effects of the assumed higher carbon and energy prices on Austria's GDP growth are low (see Table 1).

Table 3: Sectoral Growth in Energy Efficiency per Production Output

	WEM	WAM	WAM+
Iron and Steel & Non-Ferrous Metals	0.9	0.9	1.2
Chemical and Petrochemical	1.9	2.0	2.6
Non-Metallic Minerals	-0.5	0.1	0.6
Transport Equipment	0.1	2.7	3.0
Machinery	2.4	2.8	2.9
Mining and Quarrying	3.2	3.2	3.3
Food, Tobacco and Beverages	3.2	3.9	3.9
Pulp, Paper and Print	1.0	1.8	2.3
Wood and Wood Products	2.6	3.1	3.2
Construction	-0.4	0.5	1.6
Textiles and leather	6.1	6.1	6.1
Non-Specified Industry	-1.4	0.5	0.6

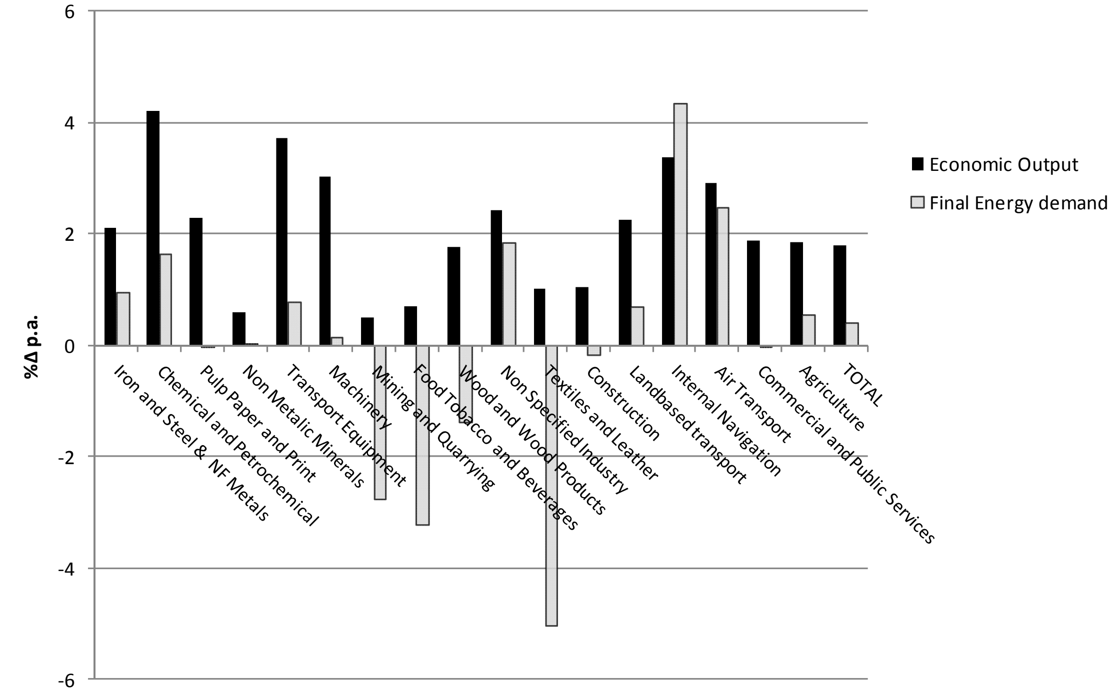
Source: own calculations.

Figure 3 shows the average annual change in sectoral output and final energy demand in the production sectors. Of the four energy-intensive production sectors, the "iron and steel/non-ferrous metals" and "chemical and petrochemical" sectors show average annual growth in both output and energy demand, although energy demand rises at a lower rate (relative decoupling). In contrast, energy demand in the energy-intensive sectors "non-metallic minerals" and "pulp, paper and print" remains constant, while output is on the rise. Absolute decoupling (negative annual average energy demand and positive output) prevails in the "mining and carrying", "food, tobacco and beverages", "wood and wood products", "textiles and leather", "construction" and "commercial and public services" sectors. In the sum of all production sectors, energy use and output growth are positive, but average annual energy demand rises at a much lower rate (relative decoupling).

The development of Austria's energy intensity per unit of GDP is depicted as a time series from 1977 until 2030 in Figure 4. Energy intensity shows a continuous decline over the entire observation period. However, growth rates in average annual energy efficiency[3] vary across time. While energy efficiency grew at 0.9% p.a. between 1970 and 1990, the 1990 to 2010 period showed a much smaller improvement in energy efficiency of only 0.3% p.a. In contrast, WAM+ scenario simulations show that significant carbon and energy pricing can trigger a higher growth in energy efficiency of 1.3% p.a. between 2010 and 2030. The scenario-based calculation comes close to the objective of the 1.5% p.a. increase in energy efficiency stipulated by the EU directive on energy efficiency; however, these are not comparable, because the energy efficiency directive does not, for instance, address the transport sector.

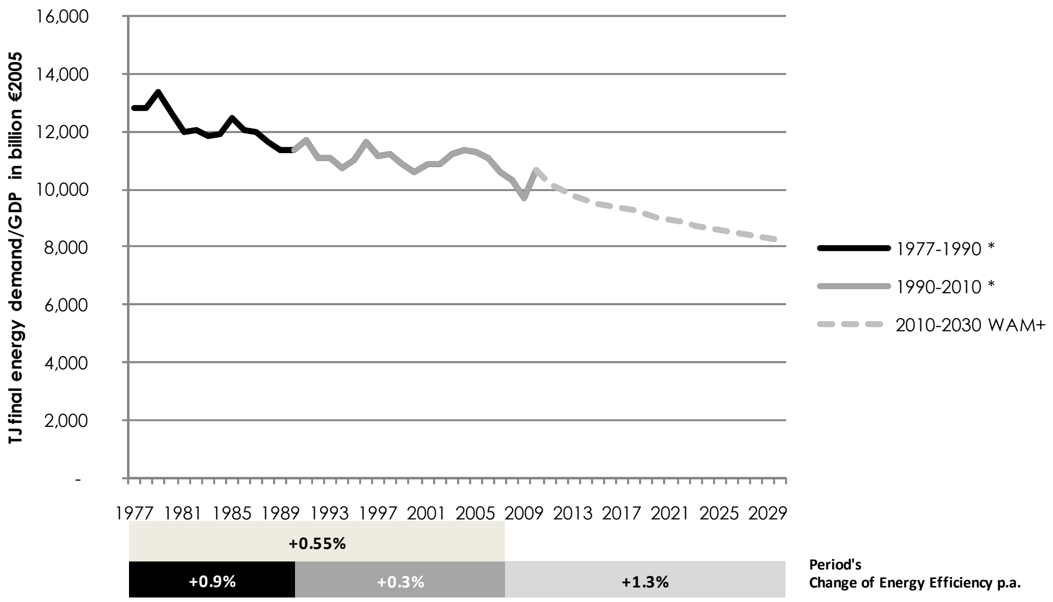
[3] Energy efficiency is reciprocal to energy intensity.

Figure 3: Average Annual Change in Sectoral Output and Final Energy Demand, 2012-2030



Source: own calculations.

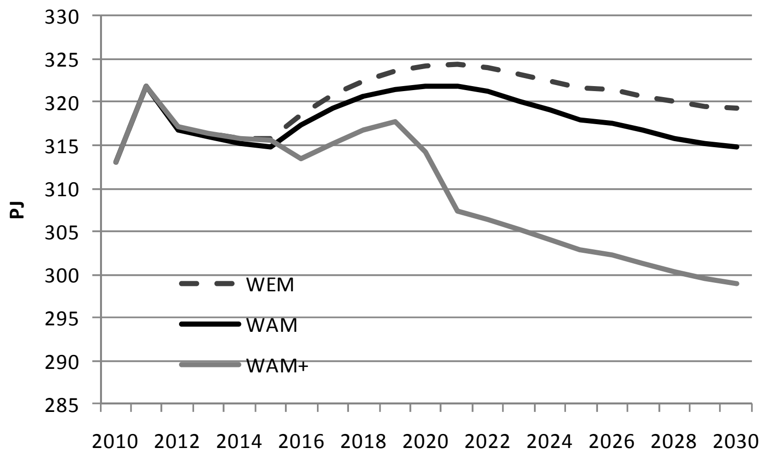
Figure 4: Energy intensity of Austria's Economy, 1977-2030



Source: own calculations, Statistik Austria

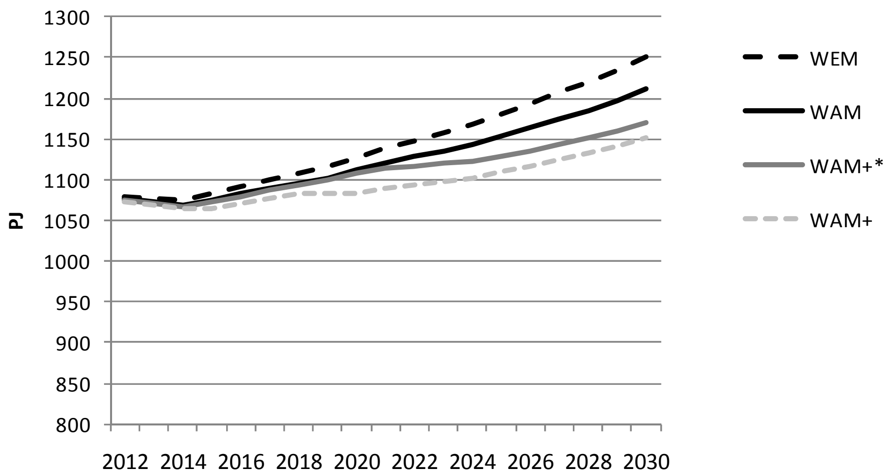
The impact of an increased mineral oils tax (Table 1and Figure 1) on fuel demand is depicted in Figure 5. It shows that in WAM+ fuel demand is reduced by 7.6 PJ in 2020 and by 15.7 PJ in 2030 with respect to WAM. Figure 6 highlights the separate economy-wide effects of carbon pricing in the ETS and non-ETS sectors (WAM+*) on the one hand, and the effects of an additional increase in the mineral oil tax and the disaggregation of four energy-intensive sectors on the other. Thereafter, total final energy demand is reduced by 24.9 PJ in 2020 and 18 PJ in 2030, due to both methodological and transport-related climate measures. The higher fuel prices not only influence the demand for fuel itself, but also the demand for other goods and services, as higher fuel prices c.p. reduce the income of households and firms, and this has repercussions on overall demand for goods, services and production factors.

Figure 5: Impact of Mineral Oil Tax Increase on Fuel Demand



Source: own calculations.

Figure 6: Impact of Mineral Oil Tax Increase on Final Energy Demand



Source: own calculations. WAM+* includes carbon pricing in ETS and non-ETS sectors only.

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