**Grant Agreement no. 308371**
ENV.2012.6.3-2 - Policy Options for a Resource-Efficient Economy

- Collaborative project -

# D3.7a
# Report about integrated scenario interpretation GINFORS / LPJmL results

WP 3 – Scenarios and modelling of policy implementation for resource efficiency.

Due date of deliverable: Month 36

Submission date: 31 / 08 / 2015

Start date of project: 1st October 2012 Duration: 42 months

Lead beneficiary for this deliverable: GWS

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*The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 308371.*

| Dissemination Level | | |
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| **PU** | Public | X |

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# 1 Executive summary

The central research question of the POLFREE WP 3 is: How to reach the environmental targets of the vision for Europe till 2050 (Jäger, 2014)?

- $CO_2$ emissions reduction by 80% compared with 1990,
- Reduction of the cropland footprint by 30 % compared with 2005,
- raw material consumption 5 tons per capita,
- water exploitation index below 20% in all EU countries.

The modelling of target scenarios of EU environmental policy has been elaborated until now only for several aspects as climate policy for example with the AMPERE project (Kriegler et al., 2015) or for abiotic materials (European Commission, 2014), but the analysis of scenarios for all targets simultaneously mentioning the complex interrelations between them is new. How can the targets simultaneously be met and which socio-economic impacts will be induced?

The answers are given by an integrated assessment modelling exercise, in which the economic-environmental model GINFORS (GWS) was linked with the vegetation model LPJmL (PIK).

The economic-environmental models explain the economic development and its pressures on emissions and the extractions of biotic and abiotic materials. Integrated into the economic development GINFORS further determines water exploitation and the land use decisions depending from the production of crops. LPJmL gives the productivity of land use and the availability of water in relation to $CO_2$ emission paths generated by the economic development. The strength of the modelling approach is that it offers a comprehensive global analysis with a deeply detailed geographical, economic and environmental differentiation. It has a high degree of endogeneity that allows mentioning all rebound effects and the feedback of the services of nature on socio- economic relations.

The modelling work is embedded in a scenario framework (Jäger & Schanes, 2014) which defines in addition to the EU targets the cooperation in the other countries of the world and allocates plausible policy mixes (Wilts et al., 2014) to different assumptions on governance (O'Keeffe et al., 2014):

**Scenario 1**"**Global Cooperation**": All countries in the world share the already mentioned EU targets, which means that the NON-EU countries reduce their GHG emissions in a way that allows to restrict global warming to 2 degrees. Further all other mentioned targets of the EU are accepted by the NON-EU countries. A mix of policy instruments are installed globally that can be characterized as "Everything, but hard market interventions". It does not exclude economic instruments completely, but it does without those which need strong administrative interventions, which may not be accepted worldwide.

**Scenario 2 "EU Goes Ahead**": The EU countries meet their ambitious targets by a policy mix that is dominated by economic instruments. The instruments like taxes and subsidies mainly change on the supply side of the economy energy and material inputs and the entire structure of production of the economy. The NON-EU countries only implement some climate policy instruments so that the global target for 2050 is consistent with RCP 4.5, which allows for 2050 global emissions slightly above today's numbers.

**Scenario 3:“Civil Society Leads”**: The EU countries meet their ambitious targets by “bottom-up” instruments. This means that intrinsic motivation of agents is ruling structural change. On the demand side of the economy and the supply side of the labour market behavioural change of consumers and employees being part of the civil society induces structural change. The Non-EU countries behave as in Scenario “EU Goes Ahead” with a rather weak climate policy.

Further a **Reference scenario** has been constructed, which assumes globally the policy behaviour business-as-usual, which means for the EU the already implemented climate policy and no activities to reduce material extractions and for the Non EU countries no action at all. Compared to SSP scenarios economic growth is a bit lower. One reason is the resource prices development: Exogenous prices for fossil fuels (taken from the IEA ETP 6 degrees scenario) and for ores rise strongly. Further the endogenous prices for crops rise even stronger than that of fossil fuels: World population rises till 2050 by one third, economic growth in developing and emerging economies also drives food demand, and land for agricultural use as well as land productivity cannot be extended without bounds. Since price elasticities for food are low, the nominal consumption shares for food rise and reduce demand for other products. A second reason for a bit lower growth rates is the assumption of budget constraints in case of a rise of the public debt ratio. This seems to be necessary to get more realistic scenarios, which otherwise could not exclude the creation of a financial crisis.

The results of the simulations with the model GINFORS linked with LPJmL show that in all three alternative scenarios the targets more or less can be reached with positive impacts on the relevant socio-economic relations. In scenario Global Cooperation the global 2 degree warming target in addition to the mentioned EU targets will be met in the EU and also globally. The necessary investment in new technologies creates economic growth and more jobs globally and in the EU via less extraction of resources and falling resource prices. Of course the extracting and resource exporting countries are losers of this development.

In the scenarios *EU Goes Ahead* and *Civil Society Leads* the Non-EU countries reduce their engagement to only a moderate climate policy and no action in the field of biotic and abiotic material consumption.

In the *EU Goes Ahead* scenario the EU introduces primarily economic instruments in addition to regulations. The design especially of tax instruments is essential to avoid problems with international competitiveness: The first and simple approach is to tax only industries which are not in international competition. If an industry is supplying on international markets and it is charged by an environmentally motivated tax it is useful to compensate this industry directly with the tax revenue but to use for the allocation of the money to the firms a neutral key like gross production. The incentives for a structural change are high, because the charge rises the higher the damage of the environment by the firm is, whereas the subsidy is higher the better the environmental performance of the firm in question is. On an average industry level a cost neutral result can be expected. A third strategy in the design of taxation is to tax only final demand with the exclusion of exports. In this case imports of the good in question are taxed with the same rate as sales from domestic production. With that tax design scenario EU Goes Ahead yields higher GDP and employment figures for the EU than scenario *Global Cooperation*. The reason is that the EU realizes first mover advantages in the introduction of new technologies.

The scenario *Civil Society Leads* assumes that instead of taxes implemented in scenario *EU Goes Ahead* intrinsic motivation of consumers and employees induce structural change of the economy that is able to reach the ambitious environmental targets. It is assumed that several activities change the structure of consumption reducing environmentally harmful commodities like consumer durables. Further employees want to reduce the hours worked having a higher share of part time jobs to have more time for the family, engagement in society and leisure. In a last step the level of total consumption has been reduced till the targets could be met in 2050. The necessary reduction of total consumption means in the EU average to meet total consumption of 1995. Exports remain more or less at the level of the reference because they depend on the international competitiveness of the EU industries and the economic development abroad, which both are more or less independent from the consumer behaviour in the EU. Investment follows GDP which at the end means zero growth of GDP for the EU. Of course imports fall in comparison to the reference drastically because GDP is lower than in the reference. This means that the contribution of international trade to GDP continuously rises till 2050. The EU finances growth abroad. The assumed reduction of hours worked is 20 % which is just the endogenous reduction of GDP against the reference. This does not mean that the number of persons engaged is the same as in the reference, because the real wage rate is much lower than in the reference due to lower labour productivity development. The scenario *Civil Society Leads* has by far the highest employment figures of all scenarios. This fits with the preferences of civil society of this scenario whereas the lower GDP will not be counted in this “Beyond GDP” world.

The paper at hand describes the models and their link in chapter 2. In chapter 3 the policy assumptions and the assumptions for exogenous variables for the four scenarios will be discussed in detail and the results of the simulations will be presented. Chapter 4 gives some conclusions.

The main text focusses on the results for the EU and – where useful - the world total. But in the appendix results for 22 important economic and environmental indicators for the single countries and the region Rest of World (ROW) are documented.

# 2 The models and their link

## 2.1 The model GINFORS

### 2.1.1 The general modelling concept

GINFORS is a global model with a deep sectoral and regional structure of 38 countries and one region "Rest of World". The explicitly modelled countries are 27 EU countries and the most important trade partners of the EU including all OECD countries and the so called BRIC-countries (Brazil, Russia, India and China). The region "Rest of World" covers Africa, the Middle East, South and Middle America except Brazil and Mexico and many smaller countries in Asia and Europe.

The general assumption of all behavioural equations of the model is that decisions are subject to bounded rationality. Agents act on imperfect markets, have information deficits and are restricted by the market power of competitors on their market side and of actors on the other market side.

Nevertheless markets are cleared. Suppliers set their prices in relation to unit costs (mark-up hypothesis), demanders base their decisions on these prices and further determinants, and the suppliers finally produce the demanded volumes. This modelling of goods markets and the later discussed modelling of the capital markets and the not cleared labour markets identify the model as Neo-Keynesian.

Depicting the sectoral production structures and the bilateral trade relations allows the integration of a Multi-Regional Input Output Model (MRIO). This means that GINFORS is able to calculate all direct and indirect emissions and extractions of resources that are related to the economic activity of a country. Compared with standalone MRIO's the advantage is that the MRIO of GINFORS has variable endogenous structures and that it is framed by a closed macro-economic system.

Agents rely on adaptive expectations concerning future developments. This means that expectations are determined by historical developments.

The specification of behavioural equations is based on empirical information: Economic theory offers for each equation a set of competing hypotheses. The estimation of the equations by statistical methods allows choosing the best alternative. The central data base is the World Input Output Database (WIOD[1]) which delivers annual time series (1995-2009) of internationally adjusted input-output data, physical energy data and data on extraction of material. This data has been extended by time series data of flow of funds and population by the UN, monetary data by the IMF, data on land use and crop growth by the FAO.

The model has a high degree of endogeneity: Only population and the extraction prices of ores and fossils are exogenous.

As already mentioned the estimation of the equations and the selection of competing hypotheses gives empirical validation. In addition historical simulations are done with the model to test whether it is able to calculate the development for a longer period (Meyer & Meyer, 2013). Further long run simulations for future developments are calculated to test the models long run performance.

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[1] http://www.wiod.org/new_site/home.htm

### 2.1.2 The structure of the model

**Goods markets – supply side:**

For each of the 39 countries and each of 35 sectors the model calculates the following inputs:

- intermediate inputs of 59 different products,
- gross fixed capital formation and capital stocks,
- labor input in hours, persons and monetary terms,
- taxes on production,

and the following prices:

- producer prices,
- purchasers' prices (incl. taxes, subsidies and margins).

The different inputs are determined by level variables (like production etc.) and the relative prices of the inputs. Producer prices are driven by unit costs, which can be calculated from the relation between the sum of nominal inputs and the volume of production. Further expectations of inflation are influencing the price setting of firms. Purchasers prices add to the producer prices the net taxes and margins lying on the goods that have to be paid by purchasers.

**Goods markets - demand side:**

For each of the 39 economies and each of 35 sectors the model calculates the following demand volumes:

- intermediate demand of 59 product groups,
- final consumption expenditures by private households,
- final consumption expenditures by non-profit organizations serving households (NPISH),
- final consumption expenditures by the government,
- gross fixed capital formation and
- exports.

Determinants are typically relative prices and level variables like production (intermediate demand), disposable income of private households and the government. Production for each of the 59 product groups equals total demand minus imports, which are calculated via price dependent import ratios. Production of 59 product groups is then allocated to the 35 industries.

**Goods markets - equilibrium:**

In opposition to the neoclassical equilibrium of perfect markets the firms in GINFORS are no price takers, but price setting agents. The demanders react on these prices and the firms produce the demanded volume. In the iterative solution process unit costs and prices react on every change of production till the market clearing has been found. Only for agricultural products an exemption from this general approach has been made. Farmers are price takers and agricultural production happens on markets that are internationally cleared with a global price for every type of crop.

**Labour markets:**

For each of the 38 explicitly modelled countries and each of the 35 industries the labour markets consists of:

- labour demand in hours, persons and in monetary terms,
- wage rate.

Labour demand is depending from production and the real wage of the industry. The real wage rate is given as the relation of the nominal sectoral wage rate and the producer price of the industry. The nominal sectoral wage rate is driven by the aggregate wage rate (over all industries), the relation between the productivity of the industry and the macro-economy and the share of the number of employed people in the number of persons of the age group 15 – 65 years. The number of persons of this age group is exogenously given from the UN World Population Prospects. The labour market of a country is not cleared.

**Capital markets:**

In all 38 countries and ROW investment is determined for each of 35 industries by the capital requirement of production and the relative price of the capital stock. All variables interacting at the capital market are independent from each other. This means that domestic investment, surplus or deficit from international trade and savings of private and public households are adjusted in the equilibrium of the circular flow of income.

**International trade:**

International trade is depicted bilaterally on the level of 59 product groups between the exporting and the importing country. For each of the 59 product groups the model differentiates intermediates and finished goods. Insofar each of the 39 economies has 118 functions for the estimation of import shares, in which the relation of the average import price and the domestic price of the product are the arguments. The share of an exporting country in the imports of another country is determined by the relation of the export price of the product in the exporting country and the import prices for that product in the importing country. For each of the 118 product groups and each of the 39 countries there are 39 "trade share" functions, which alone gives 179478 price dependent equations.

This information about import and export shares allows calculating the exports for 59 product groups in 39 economies consistently by definition. The exchange rates between the currencies of the different countries are explained by the purchasing power parity theory, which is for long run developments the appropriate theory.

**Flow of funds:**

For 35 countries budget constraints are given for the institutional transactors

- corporations,
- government,
- private households and non-profit organizations serving households (NPISH),
- other countries.

This system is divided into the functional transactors

- income generation,
- distribution of primary income,
- secondary income distribution,
- final consumption,
- capital formation.

The flow of funds systems contains all variables of the social security system and it depicts the total tax system. It allows calculating disposable income figures for private and public households and the development of public debt and monetary wealth of private households.

**Energy and emissions:**

The energy module describes for 39 countries, 35 industries and private households the energy demand in TJ for the purposes:

- process energy,
- mobility,
- heating and cooling.

The intensity of energy use (physical consumption in relation to an activity variable) depends from the relative energy price in that sector and an autonomous trend. The structure of energy demand for 20 carriers is determined by their relative prices.

The supply of secondary energy in the form of mineral oil is given by the production of the mineral oil industry using crude oil as the central input.

Production of electricity is using fossil fuels, nuclear and the different types of renewable energies (water, sun, wind etc.). The share of nuclear and the sum of the different renewable energies are policy variables. The structure of the renewables in electricity production is endogenously determined by the development of unit costs of the different carriers.

The sum of fossil energy inputs in electricity production is defined as rest. Its structure for coal, oil and gas is depending from the relation of fuel prices.

$CO_2$ emissions are calculated using physical coefficients and the detailed information about energy carrier usage (in TJ) explained in the energy module. The emissions of 6 further air pollutants ($CH_4$, $N_2O$, $NO_x$, $SO_x$, CO, NMVOC, $NH_3$) is implemented but not yet activated.

**Resource modules:**

$GINFORS_3$ derives from the global economic development the monetary demand for abiotic materials oil, gas, coal, ores and non-metallic minerals as well as economic drivers for the explanation of demand for water and agricultural land. The supply of resources has to be given by natural science models, with which $GINFORS_3$ has to be linked. For abiotic resources (ores, fossils) this happens in the German UBA project SimRess by an exchange with the WORLD model (Sverdrup et al., 2012) and for water and the productivity of crop land in the project POLFREE by a link with the bio-physical model LPJmL. In the context of the POLFREE project therefore the extraction prices for abiotic resources (fossils, ores) have to be given exogenously.

**Abiotic materials:**

The extraction of the materials

- coal,
- gas,
- crude oil,
- ores,
- construction minerals,
- industrial minerals

in tons is driven for 39 regions by the production of the corresponding product groups in monetary terms at constant prices. Further the physical imports of these raw materials are determined by their monetary imports in constant prices.

The resources embedded in the imports of products can be calculated via the bilateral trade relations and the technologies used in the different producing countries, which both are endogenously explained in the whole system. Insofar it is possible to estimate for every country and every type of raw material the indicator “Raw Material Consumption” (RMC). It gives for the country and the material in question the directly and indirectly used resources without those embedded in the exports of the country.

**Water exploitation:**

GINFORS depicts the exploitation of water for the 39 regions for the industries agriculture, public water supply, electricity and others, which mainly consists of primary industries. Water availability is part of the link with LPJmL.

**Agricultural land use:**

For each of the 39 regions the economic system determines with the consumption demand of private households, the intermediate demand of the food industry and of other industries the total demand for agricultural products in monetary units. Hereby the demand for livestock products and that for crops is explained. The production of livestock products (meat, milk) drives the demand for feed crops.

Demand for feed, food, industrial and seed purposes explains the total demand for 13 types of crops in tonnes with relative prices as important drivers. These crops are:

- Temperate cereals,
- Rice,
- Maize,
- Tropical cereals,
- Pulses,
- Temperate roots,
- Tropical roots,
- Sunflower,
- Soybean,
- Groundnuts,
- Rapeseed,
- Sugarcane,
- Others.

For each type of crop the total monetary demand is confronted with the global supply in tonnes, and the global market clearing price in US-$ per tonne is endogenously explained.

In the different countries the production volume is confronted with the demanded volume in that country, which is generated by the global clearing price. The difference between both numbers is closed by international trade so that also the national markets are cleared for all 13 crop types.

On the basis of the prices for crops and the development of demand, farmers decide on land use for the 13 crops in the next period. If the total land use exceeds a threshold expansion rate, all land uses are adapted linearly.

The yield per hectare is very different for the 13 crop types in the 39 regions and depends from climate conditions and the availability of water for irrigation. This productivity of crop land use is exogenous for $\text{GINFORS}_3$ and taken from the vegetation model LPJmL in combination with country and crop specific trends that have been identified on base of long term historical observations (FAO-data for the years 1961 to 2012) as will be shown later.

## 2.2 The model LPJmL

LPJmL is a dynamic global vegetation model (Sitch et al., 2003, Bondeau et al., 2007, Gerten et al., 2004) originally developed to study the role of vegetation and soils in the Earth system, in particular with respect to their influence on the global cycles of carbon and water, biosphereatmosphere interactions, the effects of global environmental modification due to human activities, such as land use change and associated emissions of greenhouse gases.

The model builds upon the most important processes and principles of plant geography, physiology, biogeochemistry and biophysics to represent both natural and human modified ecosystems.

Space and time loops connect the various ecosystem processes, such as plant growth, competition, and population dynamics that occur on different time scales. Fast processes including photosynthesis and transpiration are calculated on daily time steps. Intermediate processes varying throughout the season include phenology, carbon allocation, and soil respiration and are represented with a time step of one month. The slowest processes represented in DGVMs, such as land use change and vegetation structure are calculated on an annual time step.

The world's diversity of plants is represented in the form of only a few functional types that differ in structure (trees versus herbaceous plants), photosynthetic pathway ($C_3$ or C4), leaf type (broadleaved or coniferous) and phenology (evergreen versus deciduous) and other physiological and structural characteristics. The spatial resolution of the simulations depends on the resolution of available climate, soil and land use information used to drive the model. A set of bioclimatic limits determines the spatial distribution of PFTs, based on the dependence of physiological processes related to plant growth and reproduction on climatic conditions. Multiple PFTs may co-exist and compete for light and water within grid cells.

Carbon assimilation by photosynthesis is calculated using the coupled Farquhar-Collatz approach and a two-layer water balance scheme enabling a realistic estimation of gross primary productivity (GPP) and plant respiration including the effects of drought stress on assimilation and evapotranspiration. Net primary production (NPP), the difference between GPP and autotrophic respiration, describes actual plant growth. Fixed carbon is then allocated to different biomass compartments representing leaves, sapwood, hardwood, and fine roots following a set of allometric and functional rules.

Compartment specific rates of tissue turnover and plant mortality determine the flux of dead biomass into separate above- and belowground litter pools from where it is ultimately transferred into a fast and slow soil carbon pool. Decomposition rates of litter carbon and soil organic matter is calculated as a function of soil temperature and moisture using a modified Arrhenius formulation that uses a realistic decline in Q10 values with temperature. Fire disturbances are simulated as a function of fuel load and litter moisture. LPJmL also contains a macro scale representation of the global water cycle, including interception, soil evaporation, the influence of snow and permafrost on the seasonality of runoff and lateral water transport between grid cells.

The representation of croplands and pastures uses 13 crop functional types (CFTs), corresponding to the World's major crop types, and two managed grass types, respectively (Bondeau et al., 2007). Table 1 provides an overview of all agricultural plant types in LPJmL. The most recent model version includes also three highly productive biomass functional types (BFTs) for bioenergy production, two tree species for temperate and tropical regions, and one fast growing grass ( Beringer et al., 2011). Tree BFTs were parameterized as temperate deciduous, to match the field performance of poplars and willows, and tropical evergreens, respectively, to reproduce growth and biomass production of appropriate Eucalyptus species. Energy trees are managed as short rotation crops and coppiced every 8 years. The implementation of energy grasses reflects growth and productivity characteristics of *Miscanthus* and switchgrass cultivars. Simulated grasses are harvested annually at the end of the growing season.

***Table 1: Overview of crop functional types (CFTs) in LPJmL***

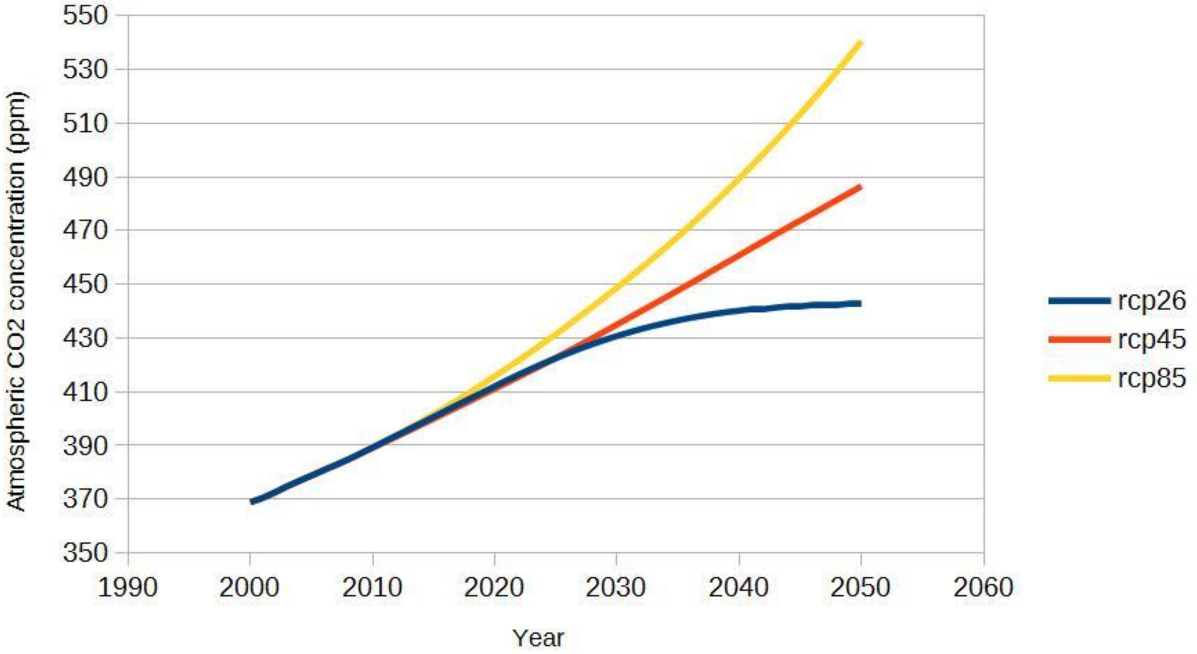
| **Crop functional types** |
| --- |
| 1. temperate cereals |
| 2. rice |
| 3. maize |
| 4. tropical cereals |
| 5. pulses |
| 6. temperate roots |
| 7. tropical roots |
| 8. oil crops sunflower |
| 9. oil crops soybean |
| 10. oil crops groundnut |
| 11. oil crops rapeseed |
| 12. sugarcane |

LPJmL is driven by monthly fields of temperature, precipitation, cloudiness, days with rain, and annual atmospheric $CO_2$ concentrations. For the POLFREE scenarios we used climate scenarios from the Max-Planck Institute for Meterology Earth System Model based on the Representative Concentration Pathways (RCPs) from the fifth IPCC Assessment Report (AR5). The different RCPs, RCP2.6, RCP4.5, RCP6, and RCP8.5 are named after their respective radiative forcing value in the year 2100 relative to pre-industrial values, i.e. +2.6, +4.5, +6, +8.5W/m$^2$, respectively. Each RCP was developed independently by different modelling teams based on integrated assessment models that project socio-economic and environmental change into the future.

The four scenarios were selected from the literature to cover the representative range of existing projections. RCP2.6 is a mitigation scenario the leads to a very low forcing level (~ 490 ppm $CO_2$ eq) required to reach the 2° target. RCP4.5 (~ 650 ppm $CO_2$ eq) and RCP6 (~ 850 ppm $CO_2$ eq) represent a medium level of climate change stabilization, and RCP8.5 (~ 1370 ppm $CO_2$ eq) leads to strong climate change due to continuously rising emissions (see Fig. 1 for the change in atmospheric $CO_2$ concentration for RCP2.6, RCP4.5, and RCP8.5).

For POLFREE, we simulated crop yields and water availability on the basis of RCP2.6, RCP4.5, and RCP8.5 climate scenarios, because RCP6 data was not available.

***Figure 1:*** ***Change in atmospheric CO2 concentration in RCP scenarios 2.6, 4.5, and 8.5 between the year 2000 and 2050***




Climate model outputs are often biased compared to observed climatology and these biases would lead to unrealistic results from LPJmL. Therefore, biases in those climate model data are corrected using observational data. Here we used the gridded Climatic Research Unit (CRU) TS (time-series) 3.21 datasets that provide monthly climate data over the period 1901-2012 on 0.5x0.5 degree grids, produced by the Climatic Research Unit (CRU) at the University of East Anglia for the bias-correction.

The physical cropping area of rain-fed and irrigated CFTs and the managed grasslands are prescribed using information on land use. Historic cropping areas are taken from the different datasets (Fader et al. 2010).

## 2.3 The link between GINFORS and LPJmL

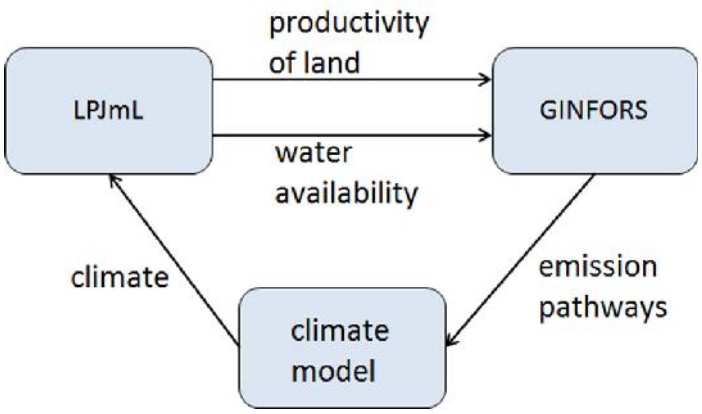
When the project started a two way link between both models seemed to be necessary, because of the interdependences between crop demand – determined in the economic models - and crop production – determined in LPJmL. Such a situation demands for a hard link, which means that both systems have to be solved simultaneously. The necessary adaptions in the modelling of the economic models had been developed (Distelkamp & Meyer, 2013, Reynes, 2013) and the technical solutions for the hard link had been found (Beringer et al., 2014, Hu & Reynes, 2014).

In a later stage of the project the idea came up that it might be useful to transfer the modelling of the land use decisions totally into the economic models. Land use for different kinds of crops is completely explained in GINFORS. Total water availability and the yields per hectare for irrigated and non-irrigated land depending from the basic natural conditions are input from LPJmL and do not need any feedback from GINFORS. Insofar an improvement could be realized in relation to the DOW plan: We found a solution with the same explanatory power, but with less computational effort.

LPJmL analyses the productivity of irrigated and non-irrigated soils and the availability of water for a big number of crops in dependency from the climate. The deep regional structure with 10*10 km units allows to aggregate the data to the geographic coverage of the 39 regions of GINFORS. Further it is no problem to aggregate the crop types of LPJmL to the 13 types of GINFORS. Also the different time scales are compatible in the sense that LPJmL data can be aggregated to GINFORS data: GINFORS is an annual simulation model, LPJmL operates on lower time scales. Further both models are solved successively timepoint by timepoint, which makes linking easy.

Figure 2 depicts the link between GINFORS and LPJmL and shows that implicitly three models are linked: LPJmL, GINFORS and a climate model. As already has been shown, each of the 4 scenarios produces an emission path, which is compatible with one of the RCP's (Representative Concentration Paths, van Vuuren et al., 2011). Reference: RCP 8.5, Global Cooperation: RCP 2.6, EU Goes Ahead and Civil Society Leads: RCP 4.5). The path of emissions is determined by the economic development and the choice of policies so that just that emission path and related to that the concentration path will be reached. The climate model calculates for the concentration path climate parameters which are input for LPJmL. Then LPJmL estimates water availability and productivity of different kinds of land use and gives this data to GINFORS.

***Figure 2: The link between LPJmL and GINFORS***



# 3 The Reference scenario

## 3.1 The assumptions for exogenous variables

**Population**

For population the medium variant of the UN World Population Prospect have been taken (United Nations, 2013). For all model regions a differentiation of three age groups is given in GINFORS: 0-14 years, 14 to 65 years, over 65 years. Total world population will reach in this forecast 9.5 billion people in 2050, which is an increase of about 30% in 35 years. The total growth rate is falling from 1.1% in 2014 to 0.4% in 2050. This development is accompanied by an aging process: The share of the over 65 rises and the share of the youngest group is falling.

**Extraction prices for fossil fuels**

We take the relative fossil fuel prices from the IEA Energy Technology Perspectives (ETP) 2015 ( IEA, 2015). The names of the ETP scenarios indicate the warming in 2150, whereas the warming degrees which we allocated to the RCP scenarios are related to the year 2100. Schaeffer & van Vuuren, 2012, compared the ETP and the RCP scenarios. They found out that the ETP 2DS scenario corresponds closely with the RCP3-PD(2.6) concentration path and that the ETP 4DS scenario is close to the RCP 4.5, whereas the ETP 6DS has a much lower concentration path than the RCP 8.5. Insofar it makes sense to take for our baseline the IEA world market energy prices from ETP 6DS, because we expect that the concentration path that is generated by our baseline is also far lower than that of RCP 8.5.

Till 2050 the real coal price rises by 25%, the real oil price doubles and the real gas price rises by 150%. The strong dynamics for the oil and the gas price are plausible since the baseline is defined for the absence of climate policy, which implicitly means that there is a high demand for fossil fuels which for oil and gas produces a high degree of scarcity. This implies – as we will see discussing the other scenarios – that the world market extraction prices for fossil fuels in the alternative scenarios will be lower.

**Extraction prices for ores**

A reference for long run developments of ore prices till 2050 could not be found. During the last 20 years the extraction prices in constant dollars for ores raised by 2.5% per year. It is assumed that in the coming 35 years there will be a rising scarcity for ores, which pushes the annual growth rate of the real price for ores to 4%.

## 3.2 The policy mix

The discussion of policy instruments is structured allocating the different instruments to their primary policy field. In the reference scenario some implementations of instruments have been chosen to control public debt. These are summarized under the policy field “fiscal policy”. These implementations have been maintained also in the target scenarios. Further in the target scenarios (see chapter 4 to 6) under the headline “fiscal policy” all those instruments will be discussed that are implemented to compensate for unwanted impacts of environmental policy measures like environmental tax reform or border tax adjustment. The environmental policy instruments are to be found under the headlines “climate policy” and “policy measures to enhance raw material efficiency”.

**Fiscal policy**

Generally all tax rates on income and wealth, goods purchases and production and also the rates for the contributions to social security are assumed to stay constant. But since financial markets react on rising debt/GDP ratios with turbulences which have severe impacts on the development of the real economy, our long run simulations cannot ignore the needs for active fiscal policy measures in order to regulate public debt. The following rules for public spending in the EU countries have been implemented: If the net borrowing/GDP ratio is higher than 3% or the debt/GDP ratio is higher than 1.3, public spending will be reduced and income taxes are raised. For Non EU countries the respective limits are 5% and 1.6. Despite these policy interventions the reference scenario anticipates rising or at least ongoing public deficit problems for some countries most prominently for Greece and Japan.

**Climate policy**

For the EU countries we assume – as already mentioned - a policy that meets the binding 20-20-20 targets for the year 2020. The policy instruments are the EU ETS equipped with a flexible supply of emission rights and quotas for renewable energies in electricity production. We assume that the carbon price per ton of $CO_2$-emissions will rise continuously up to 47 € in constant prices in 2050. For the share of total renewables and nuclear in electricity production in the short run the reference scenario follows the development of the reference scenario by the European Commission (European Commission, 2013). Beyond 2020 in the GINFORS Reference scenario for the EU27 there is no further increase in RES assumed. The long run development of nuclear shares is adjusted to the 6DS scenario of the IEA Energy Technology Perspectives (IEA, 2015) with two exemptions: for Belgium and Germany the decided fade out is considered. All other climate policy parameters are fixed to the levels of the year 2012.

For the Non-European countries we extrapolate the share of total renewables in electricity production as well as the share of nuclear based on the respective figures given in the 6DS scenario of the IEA Energy Technology Perspectives (IEA, 2015). "No active climate policy globally" means that we leave all other climate policy parameters at their level of the last historic data point of our data set which is the year 2009. All tax rates, carbon prices, subsidies and other economic instruments do not change over the whole simulation period till 2050.

**Policy to enhance raw material efficiency**

No instruments have been implemented.

## 3.3 The results of the simulation

In this chapter an overview will be given for the expected development of core economic and environmental indicators for the world and EU27 in the reference scenario.

### 3.3.1 The global results

**Global economic development**

Figure 3 shows the development of the world economy from 1995 to 2050. The average annual growth rate of GDP at constant prices in the last 20 years amounted to 2.6%. Till 2050 this number will reduce slightly to 2.2%. Strongly rising real prices for resources like fossil fuels, ores and crops are responsible for the weak growth. Per capita the annual average growth rate has been 1.2% from 1995 to 2015 and will rise from 2015 to 2050 slightly to 1.4%.

***Figure 3: Development of the global economy in the Reference***

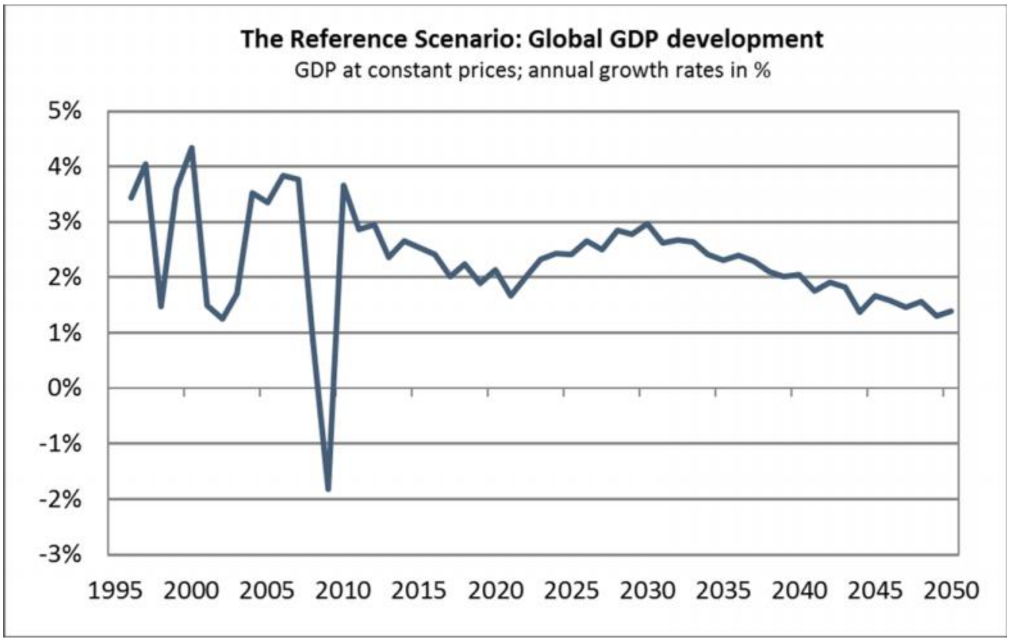
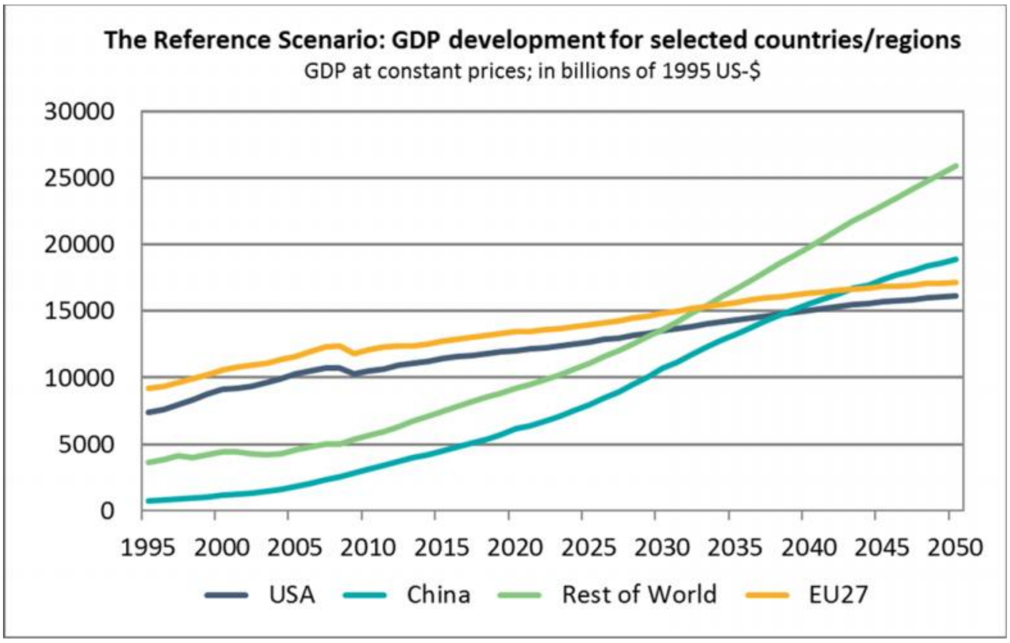



Figure 4 gives an overview of the regional development of the world economy. It shows the development of GDP in constant dollars for the EU, the USA, China and the region “Rest of World”, which consists of Africa, the Middle East, South America without Brazil and some central Asian developing countries. It makes sense to call them “Developing Countries”. All other countries of GINFORS are either EU, OECD or BRIC countries.

The development in China dominates Figure 4: In 2036 the Chinese GDP will catch the GDP of the USA and China will be the biggest economy in the world. In 2044 the Chinese economy will even pass the EU. But of course the growth rates of the Chinese GDP will continuously fall from about 8% in 2012 to 1.5% in 2050. The Developing Countries will expand with an annual average growth rate of 3.6%, whereas the EU and USA have by far lower average growth of slightly less than 1%.

***Figure 4: Development of GDP for selected countries/regions in the Reference***




The structural change of the world economy is shown by Table 2, which gives the shares of selected countries in the global real GDP:

***Table 2: The shares of selected countries/regions in global real GDP for the years 2015 and 2050 in the Reference Scenario (in %)***

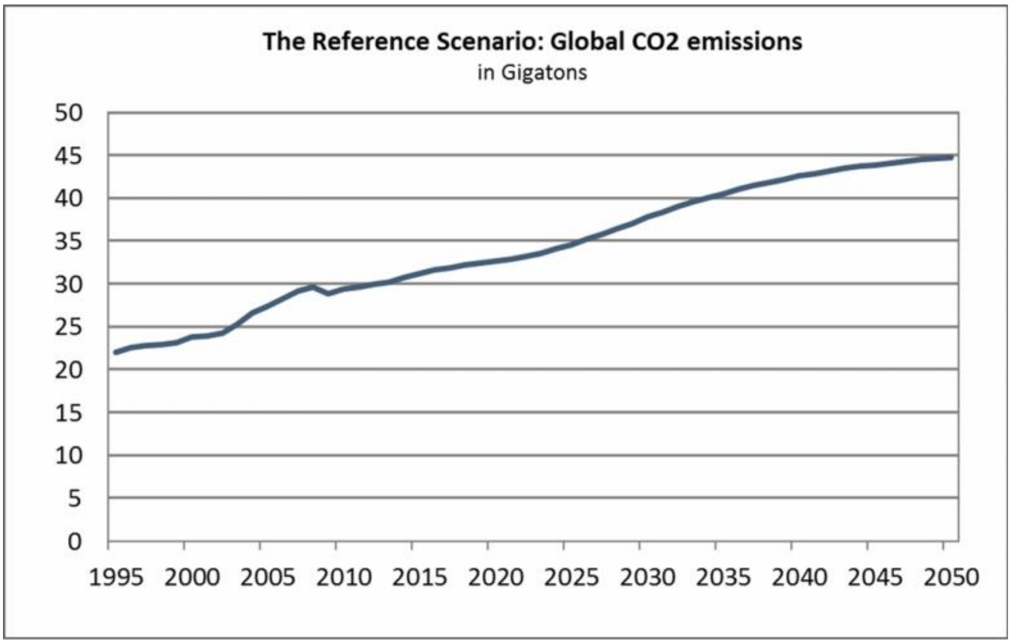
| | 2015 | 2050 |
|---|---|---|
| EU | 25.7% | 16.5% |
| USA | 23.0% | 15.5% |
| China | 9.1% | 18.2% |
| India | 2.7% | 5.5% |
| Developing Countries | 15.1% | 25.0% |
| Others | 24.4% | 19.3% |

China, India and the Developing countries represent today about one fourth of the world GDP and will raise this share up to half, whereas the EU and the USA together hold today of about 50% of world GDP and will reduce this share to less than one third.

**Global $CO_2$ emissions**

Figure 5 shows the development of global $CO_2$ emissions reaching 45.3 Gt in 2050, which is about 50% higher than today's emissions. The dynamics will be reduced compared to the development of the last 20 years, when the $CO_2$ emissions grew by 1.8% per year in the average. This rate will reduce to 1.1%. The reasons are the reduction of the global economic growth and a rise of energy efficiency due to the rise of energy prices.

***Figure 5: Development of global $CO_2$ emissions in the Reference***




The structure of global CO2 emissions for selected countries/regions is given in Table 3.

***Table 3: Shares in global $CO_2$ emissions for selected countries in the reference scenario (in%)***

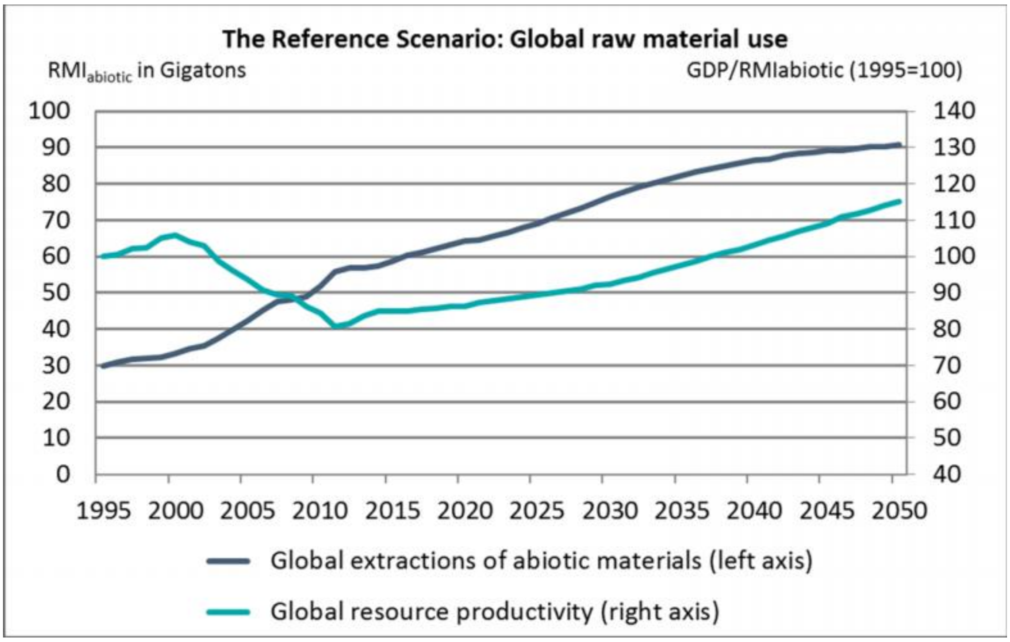
| | 2015 | 2050 |
|---|---|---|
| EU | 12.0% | 6.5% |
| USA | 15.6% | 9.7% |
| China | 13.7% | 29.9% |
| India | 5.6% | 10.7% |
| Developing Countries | 22.4% | 32.1% |
| Others | 18.5% | 11.2% |

In 2050 about three fourth of global emissions will be caused by countries which we today call emerging and developing economies. If they will not introduce ambitious climate policies, there will be no chance for reaching the global 2 degrees warming target.

**Global extractions of abiotic materials**

The development of the total of global used extractions in tons of abiotic materials is shown in Figure 6.

***Figure 6: Development of global raw material use and resource productivity in the Reference***




The annual growth rate of global total material extractions was 3.5% during the last 20 years in the average. This will reduce to an average of 1.3% for the next 35 years till 2050. This is caused to a large extend through the development of the most important component of material extraction – the construction minerals. The main driver for the high extraction rates of the construction minerals in the past has been the building boom in the recent past in China. Today the extractions of construction minerals in China are more than 50% of the world extractions. In the future this development will reach a peak and then a reduction will take place due to the population development in China. Overall the reference scenario expects an increase of global resource productivity (abiotic) of 35% within next 35 years.

***Table 4: The structure of global total material extractions in the reference scenario (in %)***

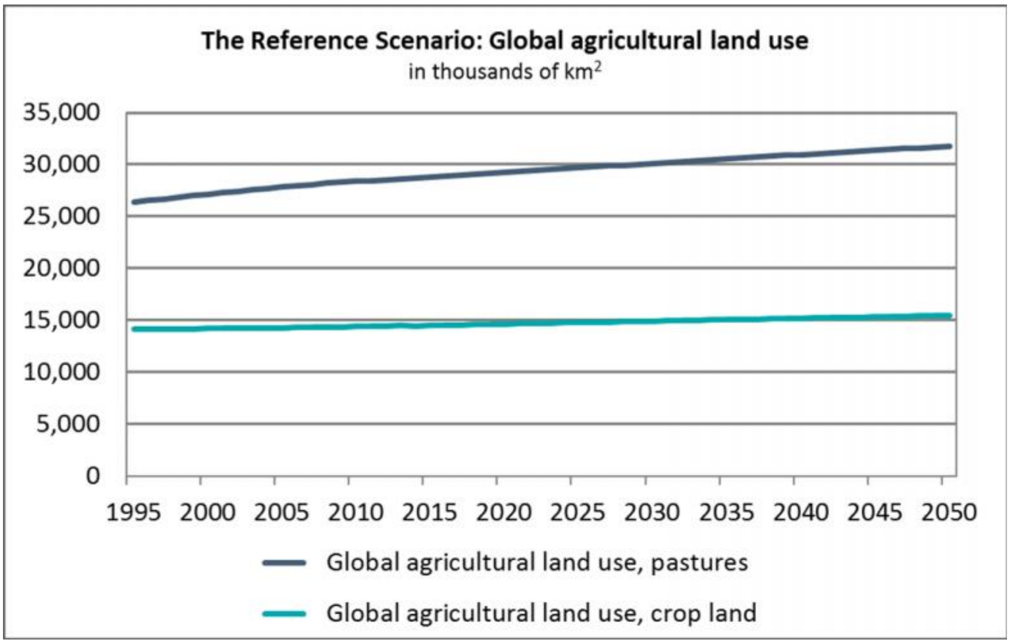
| | 2015 | 2050 |
|---|---|---|
| Fossil fuels | 24.5% | 21.5% |
| Non-metallic minerals | 62.0% | 57.3% |
| Ores | 13.5% | 21.2% |

The main impression of Table 4 is the reduction of the share of non-metallic minerals, which are dominated by construction minerals, and the rise of the share of ores. This may be interpreted as the outcome of a global shift from investment in real estate activities to investment in machinery and consumer durables.

**Global use of biotic resources**

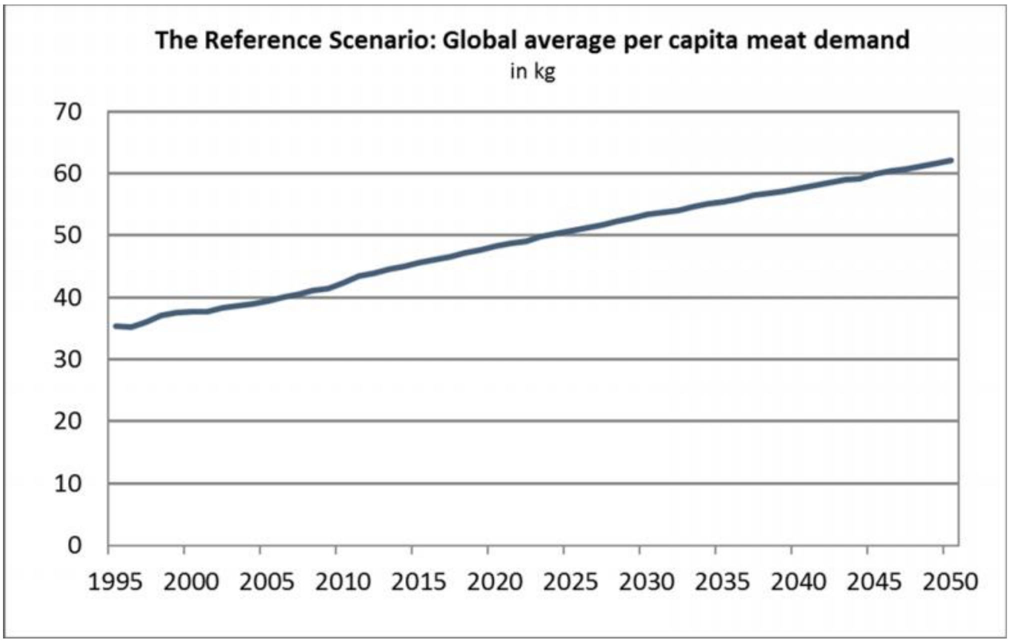
Figure 7 shows the development of agricultural land use till 2050 in thousands of hectares. Over the whole period the total of pastures rises 10.3%, cropland rises by about 6.7%, which gives for total agricultural land use an extension of 9.1%.

***Figure 7: Development of global agricultural land use in the Reference***



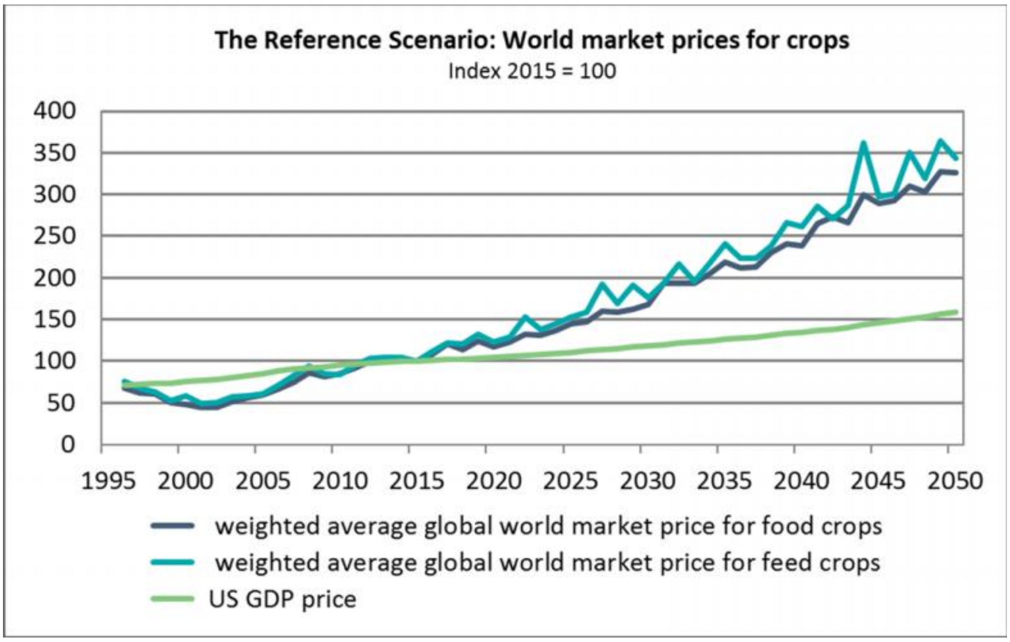

The global average per capita demand of meat in kg rises from 45.6 kg to 62.1 kg in 2050 (Figure 8). This is mainly the result of rising income in developing and emerging economies. Together with the global growth of population this process induces strongly rising demand for meat and rising use of cropland for feed. On the other side population growth and income growth also raises food demand for crops.

***Figure 8: Development of global average per capita meat demand in the Reference***




Since the extension of agricultural land use has its restrictions and also the rise of productivity in agricultural production has its limits, crop prices explode: Figure 9 shows the development of weighted (13 types of crops) world market crop prices in US dollars (2015=100) for food purposes and feed purposes in comparison with the price index of the US GDP (2015=100).

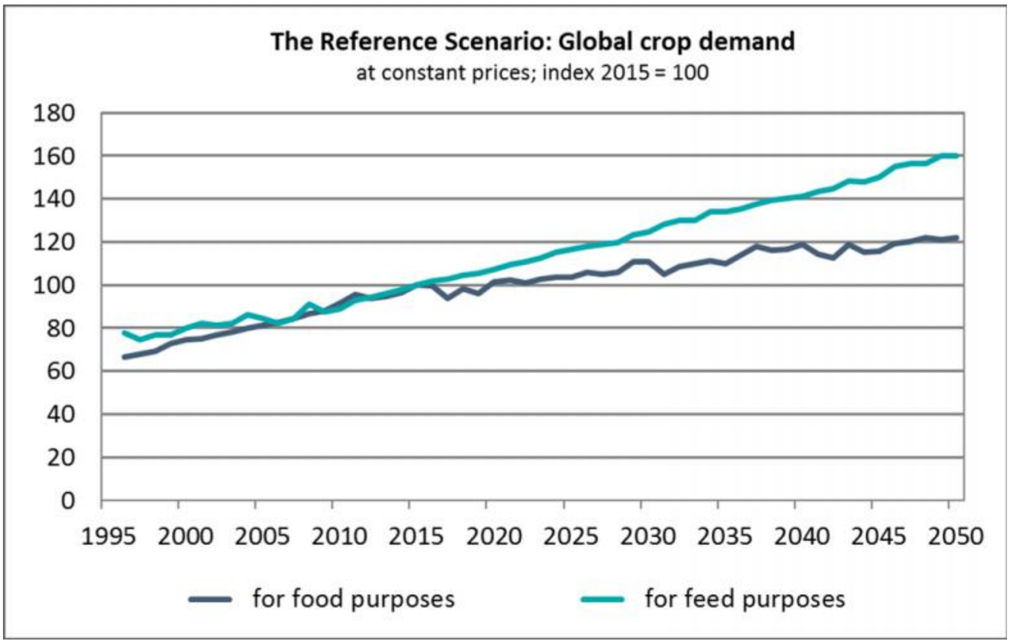
***Figure 9: Development of global average crop prices in the Reference***




Both crop prices follow the same long run path. The feed crop price is a bit more volatile. The **real** crop prices (in relation to the US GDP deflator) rise with an annual rate of 2.1%. This means that food becomes very expensive.

Figure 10 shows what this means for real crop demand for food and feed purposes: In the case of food there is only space for an expansion of real demand of 20 %, in the case of feed real demand rises over the whole period by two third, which means by 1.5% per year. Most extensions of the cropland and the total productivity rise of cropland are used to produce more feed.

***Figure 10: Development of global crop demand in the Reference***



The strong rise of crop prices induces higher prices for agricultural products and for food produced by the sector "food and beverage". This has further consequences for consumption demand: The real share of food and agricultural products in total consumption falls with higher levels of total consumption and income. Since the price elasticity is negative, a rising real price further reduces the real consumption share. The nominal share also falls with the level of total consumption, but it rises with the real price of food since its price elasticity is lower than one in absolute value. As Table 5 shows for selected countries, for the historic period the expected fall of the food share in total consumption can be observed. For the period after 2015 the rise of the real price is so strong that the effect of rising income is overcompensated by the price effect for the future period and the nominal share for food and agricultural products rises.

***Table 5: Share of food and agricultural products in total consumption expenditures of private households for selected countries***

| | | Reference scenario | |
|---|---|---|---|
| | **1995** | **2015** | **2050** |
| **Germany** | 15.3% | 14.4% | 14.5% |
| **Ireland** | 17.4% | 16.6% | 17.4% |
| **China** | 44.4% | 27.7% | 31.0% |
| **India** | 47.4% | 39.7% | 46.8% |

Rising shares for consumption of food and agricultural products depending from the drastic rise of the real price which we can observe for the average consumer have of course much more dramatic effects for the poor people than for the average. In the case of developing countries and emerging economies there might be a relative big number of households which need nearly all their income for food and agricultural products. In the past we observed falling shares for food. This change has negative impacts on economic growth.

### *3.3.2 The results for EU27*

**Economic development in the EU**

Economic growth in the EU (Figure 11) will be reduced compared to the development during the last twenty years. The average annual growth rate of real GDP is from 2015 to 2050 only 0.9%. The slow down happens mainly after 2030. The weak growth of the global economy is partly caused by dramatically rising real prices for the extraction of fossil fuels, ores and crops.

***Figure 11: Development of the EU economy in the Reference***

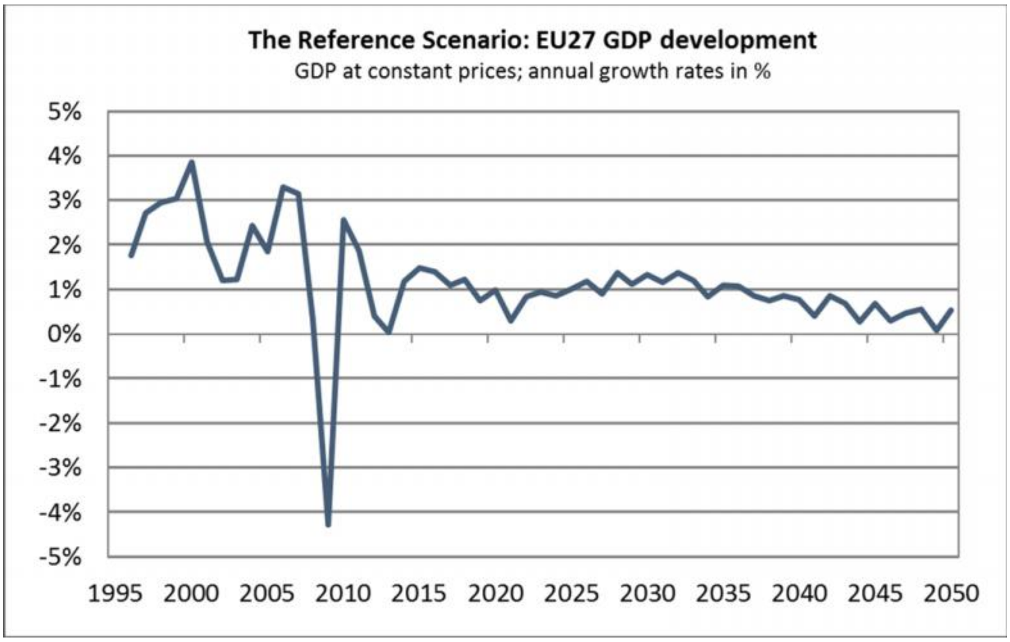
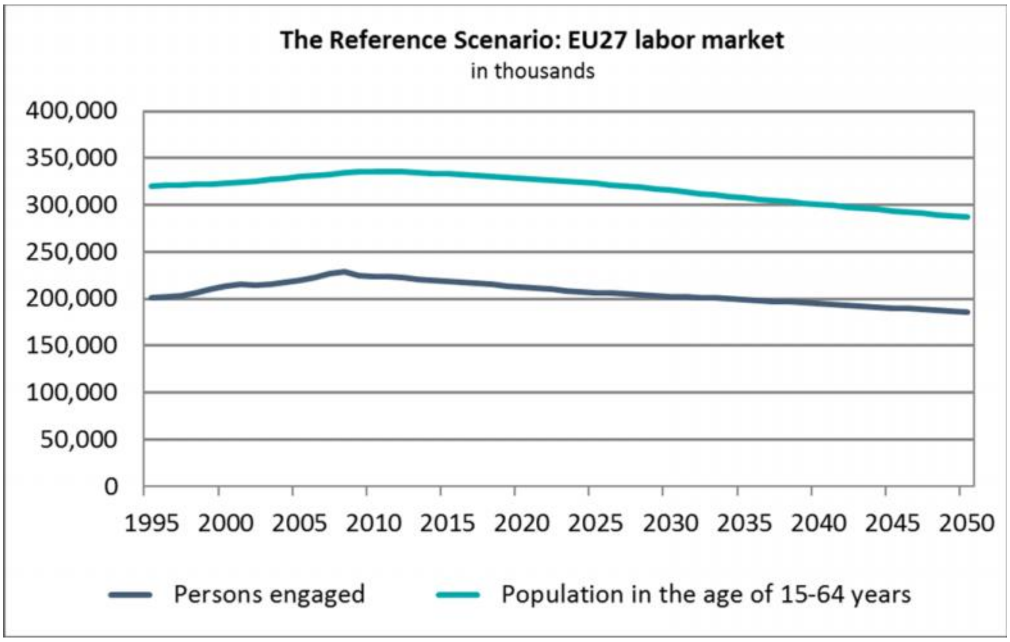



Figure 12 shows the development of the labour market in the EU. It is characterized by two impacts. On the one side labour demand will be falling since the growth of labour productivity will be higher than GDP growth. On the other side labour supply is also reducing in most countries since the number of persons of the age group of 15 to 65 is shrinking. Only in Austria, Luxembourg, Denmark, Sweden, France and the UK the opposite is the case. Figure 12 shows that the distance between both graphs will not change, which means that unemployment will in 2050 be the same as it is today: Today in the EU 66% of the age group 15 to 64 are employed, in 2050 this number will be 65%. This is not a satisficing perspective for the future. The situation will be very different in the countries. Some countries like Germany will have over-employment, others like France will suffer from ongoing unemployment. This may induce more migration inside the EU and is not depicted in the (exogenous) population prospects.

These results have been calculated with the assumption that part time working will not change.

***Figure 12: Development of the EU labor market in the Reference***



But to look at these aggregated macro-economic figures for EU27 only gives a brief overview. To provide an idea on the results for the structural and spatial changes that are hidden behind, the following table and figure show additional results of the Reference Scenario.

Table 6 shows the ongoing structural change of the EU27 industry based on two different features: the shares in the total employment (hours worked by persons engaged) and the shares in the total gross output. The former shows an ongoing shift to employment in service activities (especially in trade & repair, health & social work and other service activities). Coincidently the share of manufacturing in EU27 employment continues to decline. But as the columns on the right of table 6 show the manufacturing sectors remain highly relevant with regard to gross output (and value added creation).

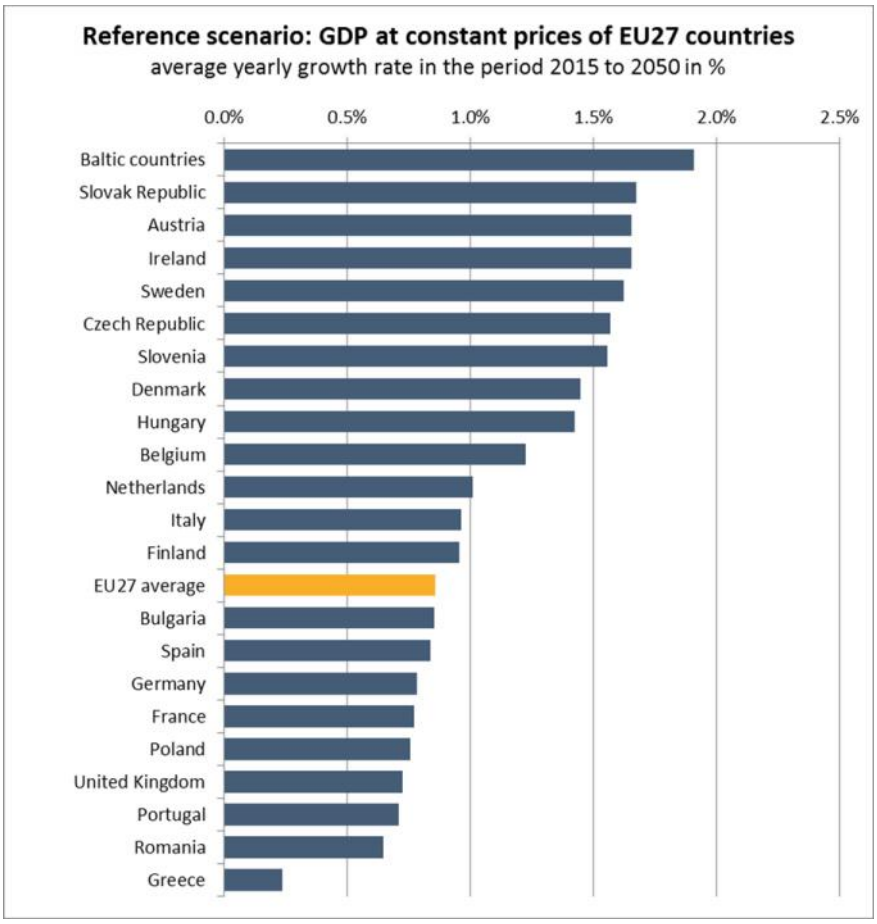
***Table 6: Structural change in EU27 in the Reference Scenario***

| Structural change in EU27 - shares of industries in total in % | hours worked by persons engaged | | | | gross output in current US-$ | | | |
|---|---|---|---|---|---|---|---|---|
| | historical data* | | Reference Scenario | | historical data* | | Reference Scenario | |
| | **1995** | **2009** | **2030** | **2050** | **1995** | **2009** | **2030** | **2050** |
| **Agriculture, Forestry & Fishing** | **10.2%** | **6.5%** | **4.8%** | **3.5%** | **2.9%** | **1.9%** | **1.9%** | **1.9%** |
| **Mining & Quarrying** | **0.7%** | **0.4%** | **0.2%** | **0.1%** | **0.8%** | **0.6%** | **0.6%** | **0.6%** |
| **Manufacturing** | **20.1%** | **15.6%** | **12.6%** | **9.8%** | **31.1%** | **25.8%** | **27.9%** | **27.2%** |
| Food, Beverages & Tobacco | 2.7% | 2.2% | 1.8% | 1.4% | 4.9% | 3.8% | 3.5% | 3.2% |
| Textiles & Leather | 2.6% | 1.4% | 0.6% | 0.2% | 1.9% | 1.0% | 0.9% | 0.8% |
| Wood prod.; Pulp & Paper | 2.3% | 1.7% | 1.4% | 1.1% | 3.1% | 2.2% | 1.9% | 1.7% |
| Coke, Ref. Petroleum & Nuclear Fuel | 0.2% | 0.1% | 0.1% | 0.0% | 1.0% | 1.5% | 1.8% | 1.6% |
| Chemicals & Chemical Products | 1.1% | 0.8% | 0.5% | 0.3% | 3.1% | 2.7% | 2.7% | 2.4% |
| Rubber & Plastics | 0.8% | 0.7% | 0.7% | 0.6% | 1.2% | 1.0% | 1.1% | 1.2% |
| Other Non-Metallic Mineral | 1.0% | 0.7% | 0.5% | 0.4% | 1.2% | 0.9% | 0.8% | 0.7% |
| Basic Metals & Fabricated Metal | 2.7% | 2.3% | 2.3% | 2.1% | 3.9% | 3.3% | 3.0% | 2.5% |
| Machinery, Nec | 2.1% | 1.6% | 1.2% | 0.9% | 2.9% | 2.5% | 2.8% | 2.7% |
| Electrical & Optical Equipment | 1.9% | 1.6% | 1.4% | 1.2% | 3.2% | 2.6% | 3.3% | 3.4% |
| Transport Equipment | 1.5% | 1.4% | 1.2% | 1.0% | 3.6% | 3.4% | 5.1% | 6.3% |
| Manufacturing, Nec; Recycling | 1.1% | 1.0% | 0.8% | 0.6% | 1.1% | 0.9% | 0.8% | 0.8% |
| **Electricity, Gas & Water Supply** | **1.0%** | **0.8%** | **0.6%** | **0.4%** | **2.5%** | **3.1%** | **2.4%** | **2.3%** |
| **Construction** | **7.4%** | **7.9%** | **6.9%** | **6.2%** | **7.4%** | **7.7%** | **6.3%** | **5.8%** |
| **Services** | **60.6%** | **68.9%** | **74.8%** | **79.9%** | **55.2%** | **61.0%** | **60.8%** | **62.2%** |
| Trade & repair | 14.7% | 15.2% | 17.7% | 20.0% | 10.5% | 10.1% | 9.8% | 9.5% |
| Hotels & Restaurants | 3.8% | 4.6% | 3.9% | 3.3% | 2.7% | 2.9% | 2.5% | 2.2% |
| Transport | 5.1% | 5.0% | 5.1% | 4.9% | 5.0% | 5.4% | 6.2% | 6.8% |
| Post & Telecommunications | 1.8% | 1.7% | 1.2% | 0.8% | 1.8% | 2.1% | 2.0% | 1.9% |
| Financial Intermediation | 2.9% | 2.9% | 3.0% | 2.8% | 4.6% | 5.7% | 5.1% | 4.9% |
| Real Estate Activities | 1.5% | 1.9% | 1.6% | 1.4% | 6.7% | 7.1% | 6.2% | 5.6% |
| Other Business Activities | 6.4% | 10.4% | 10.0% | 8.7% | 7.7% | 10.2% | 11.2% | 11.5% |
| Public Admin & Defence; Social Security | 6.9% | 6.7% | 6.0% | 5.3% | 5.0% | 4.8% | 4.6% | 4.8% |
| Education | 5.5% | 5.9% | 5.4% | 5.0% | 3.1% | 3.2% | 3.0% | 2.9% |
| Health & Social Work | 7.2% | 8.5% | 12.6% | 17.2% | 4.6% | 5.7% | 6.2% | 7.2% |
| Other Services | 4.8% | 6.1% | 8.2% | 10.5% | 3.5% | 3.9% | 4.2% | 4.8% |

* source: World Input Output Database (WIOD), 2012 release

Figure 13 shows, that the Reference scenario expects differences among EU27 countries with regard to economic growth. Some eastern European countries (the Baltic countries, the Slovak and Czech Republic, Slovenia and Hungary) but also some “old” EU member states (Austria, Ireland, Sweden, Denmark and Belgium) show above average growth rates, whilst for the Germany, France and the United Kingdom below average growth rates are predicted. The lowest economic growth (but still growth) in the Reference scenario is expected for Romania and Greece.

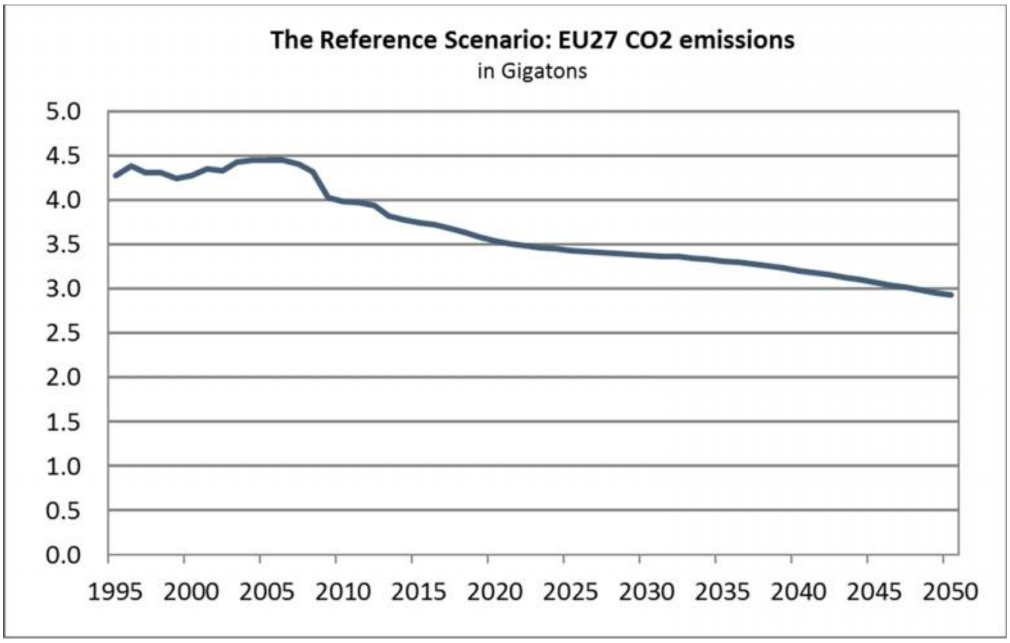
*Figure 13: GDP growth rates across EU27 in the Reference Scenario*




### $CO_2$ emissions in the EU

As already mentioned it is assumed that the development of renewables in electricity production and the supply of nuclear energy in the EU follows the EU reference scenario until 2020, but falls behind this in the long run. Further the ETS is reformed with a flexible supply generating a rising carbon price that reaches 47 € in real terms in 2050. These policies combined with high prices for fossil fuels and a low economic growth induces a reduction of $CO_2$ emissions as shown in Figure 14. The 20-20-20 targets for 2020 will be met.

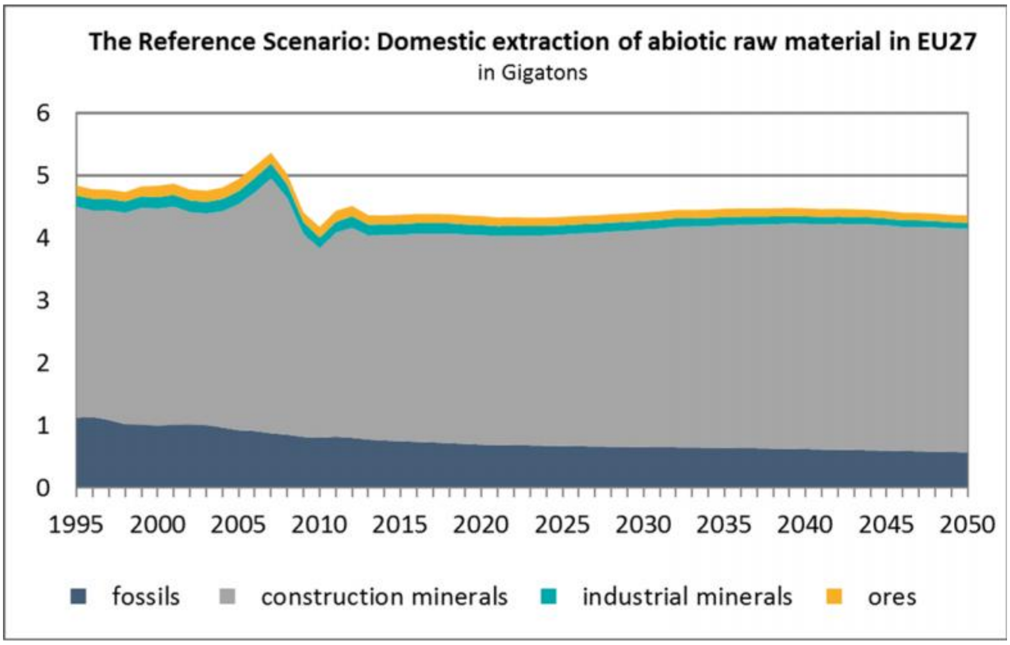
***Figure 14: Development of EU27 $CO_2$ emissions in the Reference***




### Extractions and use of abiotic raw material

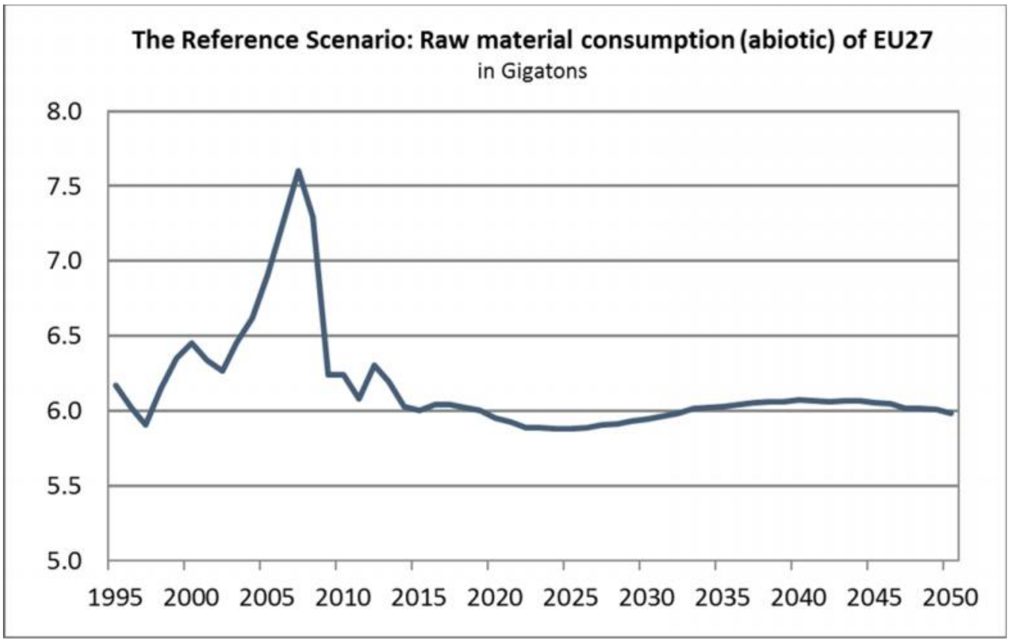
Figure 15 shows that in the EU domestic extraction is by far dominated by construction minerals, which slightly rise by 10 % over the whole period. With big distance to construction minerals fossil fuels are the second important group, but reduce permanently. Extractions of industrial minerals and ores do not play a role in the EU.

***Figure 15: Development of domestic raw material extraction in EU27 in the Reference***




Raw material consumption (measuring in addition to domestic extractions the imported materials and the material hidden in imported imports minus the materials being part of exports) is rather stable over the whole period from 2015 to 2050.

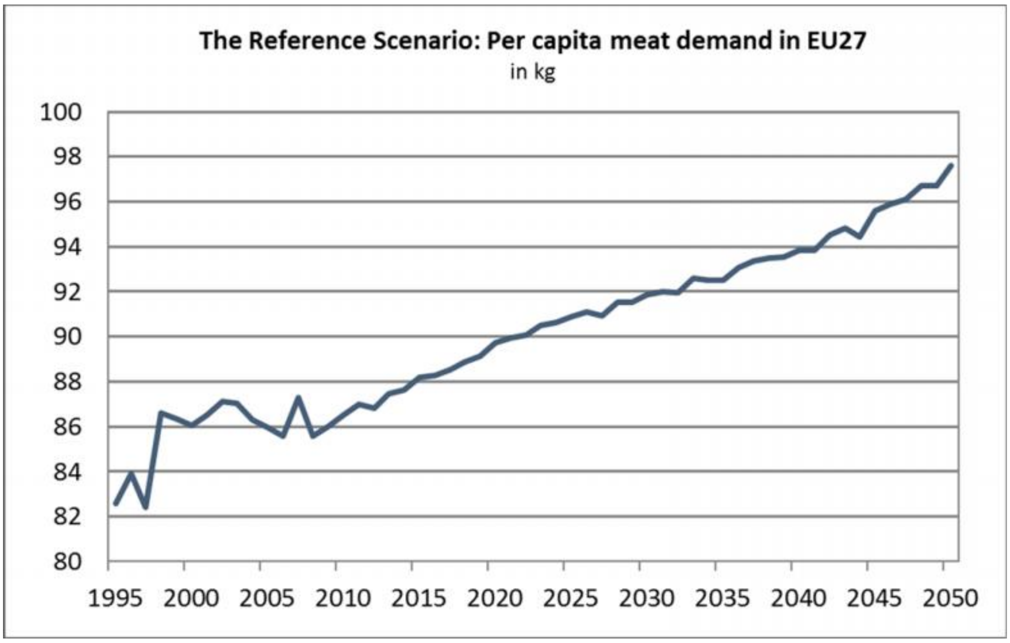
***Figure 16: Development of raw material consumption in EU27 in the Reference***




**Use of biotic resources in the EU**

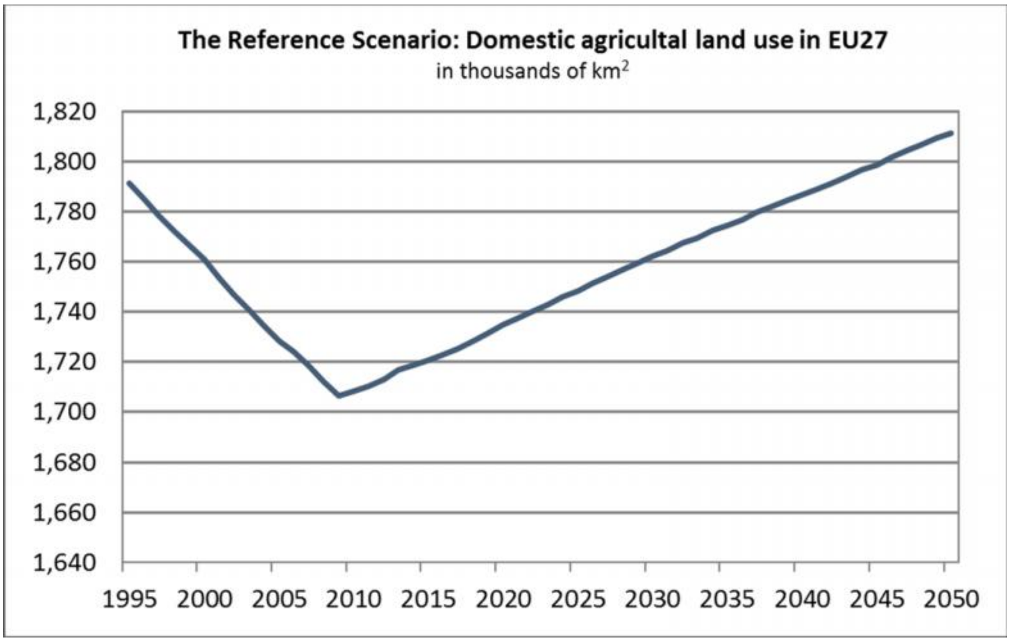
Meat demand in kg per capita is relatively high in the EU compared with the global average (Figure 17). It rises and will reach a level of 97 kg in 2050. But the levels are different in the EU countries and there may be a south/north fall in the levels. Further for all EU countries the levels are expected to rise till 2050.

***Figure 17: Development of per capita meat demand in EU27 in the Reference***




Agricultural land use will rise in the EU over the whole period with 5 %, which is less than in the global average. The level in 2050 is slightly above that of 1995.

***Figure 18: Development of domestic agricultural land use in EU27 in the Reference***



# 4 The scenario *Global Cooperation*

In this scenario all countries in the world share the already mentioned EU targets. That means that the Non-EU countries reduce their GHG emissions in a way that allows restricting global warming to 2 degrees. Further all other mentioned targets of the EU are accepted by the Non-EU countries. Globally a mix of policy instruments is installed that can be characterized as “Everything, but hard market interventions”. It does not exclude economic instruments completely, but it does without those which need strong administrative interventions.

## 4.1 The assumptions for exogenous variables

The assumptions concerning the development of population are the same as in the reference scenario.

The world market extraction prices for coal, oil and gas in 2009 US-$ are now less dynamic than in the baseline, because the demand for fossil fuels is much lower than in the reference scenario. We take the IEA ETP 2 DS prices for fossil fuels.

The coal price is now falling till 2050 by 40% against 2010 and 52% against the baseline in 2050. The oil price is in the scenario global cooperation in 2050 only 11% higher than in 2010 and against the baseline in 2050 it is 42% lower. The gas price will till 2030 be the same as in the baseline and will then reduce a bit. In 2050 the gas price will be 30% lower than in the baseline. As also the global demand for ores is considerable lower than in the reference we also reduced the assumption on world market prices for metal ores. Whilst in the reference we assumed a year by year increase of prices in constant US-$ of 4% in the global cooperation scenario we assume a decrease of this growth rate from 4% in 2015 to 0% in 2050. With other words: The reference scenario assumes a quadrupling of metal ore prices in constant US-$ within the next 35 years and the global cooperation scenario “only” a doubling.

## 4.2 The policy mix

A global commitment has been found to reach the 2 degrees target and the targets for resource use. This includes the installation of the following policy mix for all countries in the world.

### *4.2.1 Climate policy*

**Upstream carbon tax**

The carbon tax has to be paid by all purchasers of fossil fuels. The implementation as a goods tax is easily done without strong administrative efforts. Only the purchasers of coal, gas and crude oil have to pay the tax. Subsequently all prices for goods and services will be raised over all stages of production due to the direct and indirect contents of carbon that the product in question has. The global cooperation scenario assumes a linear increase of these tax rates up to 60% for coal and 40% for oil and gas in the year 2050.

**Renewables in electricity production**

The climate targets can only be met if a substantial decarbonisation of electricity production will be reached, which cannot be guaranteed by the implementation of the carbon tax. Three options are technically possible: Nuclear, CCS of fossil fuels (especially coal) and renewables. Nuclear seems not to be an alternative accepted by the public opinion in many countries because of its risks in processing and with the garbage. Cost minimizing approaches of pure energy modelling often give a mixture of all carriers with a substantial amount of CCS[2]. From the POLFREE perspective this is of course the result of a partial analysis because the effects on the resource targets are not mentioned. From a broader resource perspective CCS is problematic, because the use of fossil fuels rises by two reasons:

- A rise of the share of CCS means a rise of the extraction of fossil fuels.
- And in addition: The resource efficiency of CCS is lower than that of traditional power stations.

Further it is until now not clear what the costs will be, and whether the carbon will remain under the surface for thousands of years.

Since the production costs for electricity generated from renewable resources have in the past in most cases been higher than those of conventional power stations, there has been no market led incentive for investment into these technologies. Even if the renewables will be competitive one may doubt whether investors outside of the power sector will invest. Insiders of the power sector may be locked-in to old technologies for different reasons. With the introduction of subsidies several European countries successfully tried to push investment into these technologies. Two approaches can be distinguished – feed in tariffs and green certificates.

The general principle of the instrument feed in tariff is a guaranteed price for fixed periods for electricity production from renewable resources. This enables a greater number of investors like homeowners, landowners, farmers, municipalities and others to participate in this development Couture & Gagnon, 2010). The remuneration for the investors has to be paid by the demanders of electricity, which means higher prices for electricity. There is a big variety in the concrete design of the instrument: Instead of a fixed feed in tariff a fixed premium may be paid on top of the electricity market price. Further the remuneration may be directly paid by the government and financed by a tax on electricity demand. This is not the place to discuss all variations in detail. An overview on this is given by Couture & Gagnon, 2010.

To combine the property of security for investors with a better economic efficiency the Netherlands developed a tradable quota model of "green certificates", which has been adopted by several countries. The central idea is that the government obliges producers, distributors or demanders of electricity to hold a certain share of their electricity production, distribution or consumption in a certain time period as green electricity certificates, which are tradable. The producers of green electricity sell the certificates and the other participants of the electricity markets which have the obligation to hold the certificates can either produce the green electricity themselves or buy the equivalent certificates. For a more detailed discussion see Ringel, 2006.

We assume in our analysis that the suppliers of electricity have the obligation to produce a certain percentage by renewables. This total share of renewables is rising from its target values in 2020 to 90% in 2050. There remains a rest of fossil fuel production that may be necessary for safety reasons. The choice of the renewable technologies is depending from the historic structures and the development of the relative unit costs of the different technologies.

This modelling approach has the advantage that its results can be interpreted either as the outcome of a quota system or as a classic feed in tariff- system with the time paths of the unit costs of the different technologies and the mark-ups of the electricity sector as the guaranteed tariffs.

2 See for example Solano & Drummond, 2014.

The existing grids are not able to link the decentralized locations of the supply of renewable energy and the demand. Further an interregional exchange is necessary to equalize spikes in the development of supply and demand. For Germany a grid development plan electricity NEP, 2013, exists which calculates for the "Energiewende" in deep detail the amount of 20 to 40 billion €, which have to be invested till 2032. A rough estimate for the additional investment needs in grids for all countries up to 2050 has been implemented in the global cooperation scenario as an add-up of 5% on investments in renewables using this expertise.

**Mobility**

A radical reduction of GHG emissions, local air pollution, and traffic noise can be reached by e-mobility. One aspect of e-mobility – the development of railroad services - will be positively influenced by the carbon price.

For cars the technology alternatives hydrogen, fuel cells and the battery electric cars driven by regenerative energy are given. The European Technology Platform on Smart Systems Integration and the European Road Transport Research Advisory Council clearly prefer the electric car (ERTRAC & EPoSS, 2009).

Electric cars have still some handicaps compared with the conventionally driven cars: The batteries have a limited capacity, which gives them a range of about 150 km or even less and the time for charging the batteries is rather long. Further electric cars are still more expensive than the conventional ones and investments in the infrastructure will be necessary to have charging stations for the batteries.

The limited range and the long charging times are not a problem for short distance traffic in the cities. The use for traffic between the place of work and the home and for shopping purposes might be typical for electric cars. Also short distance traffic in the cities for firms to transport goods and persons is thinkable with electric cars. The literature discusses these potentials, but comes to the result that electric cars are still not competitive.[3] EWI, 2010, p. 12 concludes that electric cars will not be competitive before 2030. If they shall play a role before 2030 either direct subsidies have to be paid, or specific regulations have to be installed (EWI, 2010, p. 13). One regulation could be to allow only "low-emission" cars in the cities for free, but all other cars with the obligation of a **city tax**. Further their attractiveness rises with **free parking areas for electric cars** and the **allowance for them to use the bus tracks**, as introduced already in Norway. A lot of such regulations[4] in the cities, which at the end are to the expense of the conventional car traffic, could help to press the electric car into the market before 2030. EWI, 2010, assumes that till 2050 the electric car could have a market share of about 40% of the stocks of cars in Germany, if such policies will be installed. We assume that the regulations favouring electric cars in cities are introduced in all member states. This allows of course a great variety of concrete activities depending from the specific structures in the member states.

Further we assume the introduction of **binding emission standards for new cars** and taxation of fossil fuel burning engines, which is used for subsidies for the use of hybrid and electric cars, so that industries and households in total are not hit by this taxation. Further the use of electric cars is favoured in cities by **better parking conditions, exemptions from city taxes etc**. A complex policy program has to be established using economic instruments, information instruments and regulations.

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3 A comprehensive study is given with EWI, 2010, and the literature cited there.

4 A long list is given by ERTRAC & EPoSS, 2009, p. 14.

Of course the link from these policy assumptions to the energy structure of the land transport and private households mobility cannot be established explicitly, because the GINFORS database does not contain the needed technological information on car types, fuel consumption etc. We are only able to estimate the potential of this technology change in the sectoral, macroeconomic and global economic context. To avoid an overestimation of this potential, we assume that it does not induce effects on the level of final energy demand for mobility of the sector in question. This is a conservative assumption, because electric cars have lower final energy consumption than diesel or gasoline driven cars. So the technology change only influences the structure of final energy demand for mobility. To which extent the share of electricity rises and that of diesel and gasoline falls is depending from the intensity with which the policy instruments are implemented. In the Global Cooperation Scenario it is assumed that these additional instruments lead to an increase of the e-mobility share up to 80% in 2050 and thus significantly exceeds the EWI assumptions.[5] The necessary investment in charging stations could not be mentioned, so that the implicit assumption is that over the period of nearly 40 years the now not necessary reinvestment in filling stations for mineral oils and the tax revenue coming out of the taxation of oil engines corresponds with the new investments in charging stations. Our analysis does not describe the effects of a concrete action plan; it is an estimation of the potential that such a technology change has.

**Fade out of subsidies for air and water transport**

It is assumed that all subsidies on air and water transport are reduced linearly reaching a 100% reduction in 2030.

**Taxes on aviation**

For aviation the upstream carbon tax alone does not lead to a sufficient reduction in $CO_2$ emissions. In addition for this technology in contrast to other mobility modes there is no substantial progress with regard to carbon efficiency in the pipeline. Therefore the Global Cooperation Scenario assumes a linear increase in taxes on air transport services by 50% within the period up to 2050.

**Energy efficiency of buildings**

The upstream carbon tax has a direct influence on the energy efficiency of buildings as already discussed. But it seems to be clear that on this way it will not be possible to reach the technically possible standard of energy efficiency for the whole stock of buildings.

The EU roadmap and the energy concept of the German government for 2050 give the improvement of the energy efficiency of buildings an important role (Prognos, 2013). Based on this Prognos, 2013, modelled in deep detail for Germany a reference and two alternative scenarios describing the effects of rising renovation rates for buildings on their energy efficiency. Based on a concrete program of the public bank KFW (Kreditanstalt für Wiederaufbau) they further calculated the necessary investment in windows, insulation of walls and heating equipment and analysed the subsidies that may induce these investments.

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[5] The objective of the model based scenario work in POLFREE was to find one policy mix that leads to solution that is in line with the targets. Of course there exist an infinite number of settings for the strength of single policy elements within each of the policy mixes. Therefore a less ambitious expansion of e-mobility might be compensated by a more exhaustive use of taxation on fossils. But this exceeds the objective of the POLFREE project.

In the reference the renovation rate starts in 2011 with 1% and reduces quickly to 0.5% in 2050. In alternative scenario 1, which is more ambitious than alternative scenario 2, the renovation rate rises till 2021 up to 2.1% and stays there till 2050. The difference between the renovation rate of the reference and the renovation rate of the ambitious scenario is about 1.5%, which coincides with the push on refurbishment, which the Fraunhofer Institute calculated for its "High Policy Intensity Scenario" to renovate all buildings in the EU till 2050 (ECORYS & ECN, 2012, p.14). Prognos, 2013, calculates the necessary investment for Germany with 17.6 billion € in 2011, the number rises to a peak of 44.9 billion € in 2036 and reduces to 32.9 billion € in 2050, the final energy consumption for heating reduces against the baseline continuously and reaches a reduction of 43% in 2050.

The investment is induced by a credit program which includes a subsidy from the government. With this programme, KFW provides soft loans to local banks, which on-lend these funds to private homeowners, associations of homeowners and housing companies. The programme supplies a mixture of soft loans and grants. The more efficient the house becomes after the renovation, the less has to be repaid by the owner of the house. The European Commission evaluated this programme as "a good example of a national model for financing energy efficiency in buildings" (European Commission, 2013, p. 20). Prognos, 2013, p. 20, calculates over the period 2006 to 2010 an average leverage of 10 for the programme. This knowledge is used in the simulations to assess the impacts of the program on the renovation rate, the leverage of the subsidies to induce the necessary investment and the improvement rate of energy efficiency of buildings in the different countries. The implicit assumption is that in all Member States the investment in energy efficiency of buildings via higher renovation rates has the same relative effect on final energy consumption of the building sector as in Germany which is of course only a rough estimate. Two arguments favour this procedure: First Germany has the biggest stock of buildings in the EU and it is situated in the centre of Europe and insofar has an average climate. Secondly in Germany the energy efficiency of buildings is already relative high so that further improvements will be more costly than in other countries. Insofar our estimates for total Europe will be rather conservative. We should not expect to overestimate the effect of the assumed policy on energy efficiency of buildings in Europe.

### *4.2.2 Policy measures to enhance abiotic raw material efficiency*

**Regulation for the recycling of ores**

A negotiated agreement[6] to **push the substitution of ores by recycled material** is installed. Given the growing worldwide awareness of the scarcity of metals, it seems plausible that the metal producer countries facing the oligopoly of ores production could make an international negotiated sector agreement to strengthen their market power.[7] Furthermore international environmental policy is more and more favouring the sectoral approach, because the number of players is small,

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6 De Clercq, 2002, mentions three positive factors for the success of such an instrument, which are all given for the "basic metals" industry: A homogenous product, a small number of players, and an industry that is dominated by some or has a powerful association.

7 The chances for a global agreement are good, because two very important producers of basic metals have already installed general plans for the improvement of recycling: China introduced in 2008 the "Circular Economy Law", and Japan started in 2008 the "Second Fundamental Plan for Establishing a Sound Material- Cycle Society" (UNEP & CSIRO, 2011).

which favours the chance for agreements: Sectors are highly concentrated of both companies and countries as steel, aluminium, copper and the other non-ferrous metals (Bodansky, 2007).

Such an international negotiated agreement could contain measures to raise the availability of scrap by improvement of recycling technologies, product design, stakeholder cooperation, better use of old stocks of scrap, etc. (Gómez et al., 2007, Wilts et al., 2011). The agreement itself could also mean that the basic metal producing countries announce for the year 2050 the taxation of ores inputs in the production of basic metals, if the input coefficient in constant prices for ores exceeds in 2050 a certain target value. A threat with penalties will help to reach the targets (Price, 2005). The European basic metals industries reduce their inputs of ores and raise the inputs of secondary materials. Further the material intensities of imported products fall because basic metals produced abroad and the metal products produced with them have also less content of ores.

The target in our simulations is more or less arbitrary and justified only by actual recycling ratios. UNEP, 2011, cites the estimates of different authors for the RC ratio (recycled content in the fabricated metal flow): iron between 28% and 52%, aluminium 34%-36%, copper 32%. The POLFREE vision states a target of 70% recycled content for all metals – the technical feasibility until 2050 seems reasonable given that for many ferrous and non-ferrous metals already end-of-life recycling rates of 90% and higher are achieved, the challenge will be the establishment of efficient redistribution logistics (see UNEP, 2011). In the Global Cooperation Scenario we therefore assume, that around the world the recycling ratios for metals increase by 50% up to 2050.

**Regulation for the recycling of non-metallic minerals**

For construction minerals it is often argued, that technical limits for the use of recycled materials are already reached. This for example can be observed in Germany. But this argumentation is not valid around the whole globe. Economic data on the use of primary materials in the industry “Other non-metallic mineral” hints at potentials for an increase of recycling ratios even for non-metallic minerals in many countries. Therefore in the Global Cooperation Scenario it is assumed that in all countries, where a higher input of primary material in the production of non-metallic mineral products than in Germany can be observed, the regulation for the Recycling of Non-metallic minerals leads to a convergence to the German figures. Until 2050 the gap will halved.

**General assumptions concerning the modelling of recycling**

The modelling of recycling faces the problem which input substitutes the input of primary materials? Standard IO Tables (as used by GINFORS) do not differentiate between products produced from primary or secondary materials. Therefore the appropriate substitution happens in the diagonal elements of the IO Table.

In addition we have to make an assumption about the elasticity of substitution between the primary and the secondary product. A plausible assumption is that of cost neutrality of the substitution, which gives an elasticity of substitution of -1. This means that the inputs of secondary material (= diagonal element) in the industries in question would rise with the same amount with which the inputs of primary materials would be reduced.

**Upstream tax on metal ores and non-metallic minerals**

Recycling of metals and non-metallic minerals is a most important task, but it does not guarantee to avoid the exhaustion of the resources, if the use of the products for which they are taken, is strongly rising. Therefore an upstream tax on metal ores and non-metallic minerals is introduced. The Global Cooperation Scenario assumes a linear increase of these tax shares up to 50% in 2050 for non-metallic minerals and up to 75% in 2050 for metal ores. The rationale for the higher tax share on metal ores is that the exogenous assumption about the development of world market prices is much lower in the Global Cooperation Scenario then in the Reference Scenario. Therefore the tax absorbs partly the price advantage.

**Public innovation fund for material efficiency**

There is bottom up information about abatement costs based on empirical research and the expertise of consulting firms. Arthur D. Little et al., 2005, Fischer et al., 2004, and Kristof et al., 2008, estimate the potential for material savings to range between 10% and 20%. Fischer et al., 2004, estimate that a 20% reduction of material cost is possible by an information and consulting program for firms with the costs of the savings of one year. So after one year firms have a permanent surplus and there is a reduction of material use which diminishes the pressure on nature – a typical win-win result. Oakdene Hollins, 2011, came to a similar result. The German official material efficiency agency demea (demea, 2010) reports that the small and medium sized firms joining their information and consulting program could on average raise their profits by 2.4% of their respective sales.

It is assumed that the government pays half of the consulting costs and that the program reduces the inputs of materials by 10% up to 2050.

### *4.2.3 Policy measures to enhance biotic resource efficiency*

**Regulation of water withdrawal**

It is assumed that the water withdrawal of agriculture is regulated so that the water abstraction share in all countries is below 20%.

**Information program for producers and consumers concerning food waste**

It is assumed that an information program up to 2050 is able to reduce 10% of the food waste in the production of food and beverages. In hotels and restaurants as well as for private households it is assumed that the impact on the reduction of food waste is even higher (linear increase to 20% in 2050).

**Meat demand**

A tax on meat is introduced, which doubles till 2050 the price of meat. Further it is assumed that an information program leads to a decrease of meat demand by 25% compared to the development without this information program that is reflected in the Reference Scenario.

**Information programme for efficiency of crop production**

It is assumed that via an information program it is possible to further increase the crop productivity of agricultural land for those crops/countries where we nowadays observe very low yields. These low yields on the one hand can be a matter of poor soil qualities but also can hint at the existence of yield gaps. Without the ability to go into details about the complex scientific discussion about the estimation of yield gaps (van Bussel et al., 2015) the Global Cooperation Scenario uses a simple and rather conservative assumption: Due to an information programme that helps farmers with low yields to improve their land management it is possible to reduce the difference of yields to those with average yields by 20% within the next 35 years.

**Nature conservation programme**

A global agreement on nature conservation is implemented. This agreement assures that deforestation due to the expansion of agricultural land is no longer allowed.

### *4.2.4 Fiscal policy*

**Environmental tax reform**

The upstream carbon tax and the upstream taxes on metals and non-metallic minerals will raise the price levels of all products and insofar reduce intermediate and final demand especially of firms and private households. On the other side the revenue of the government will rise and induce additional public demand. Both effects change the structure of the economy in a way, which is not intended by the environmental policy. Therefore a compensation of the taxes is necessary. An equivalent reduction of income taxes and social security contributions – the traditional compensations in climate policy ETR's – do not work in the resource context, because here the rebound effects are too big as simulations with GINFORS have shown.

An alternative - that is assumed in the *Global Cooperation* scenario - is the reduction of taxes on production, which gives a much more direct compensation and which reduces directly the price levels.

Further the fade out of subsidies on ores, coal, air transport and water transport is assumed.

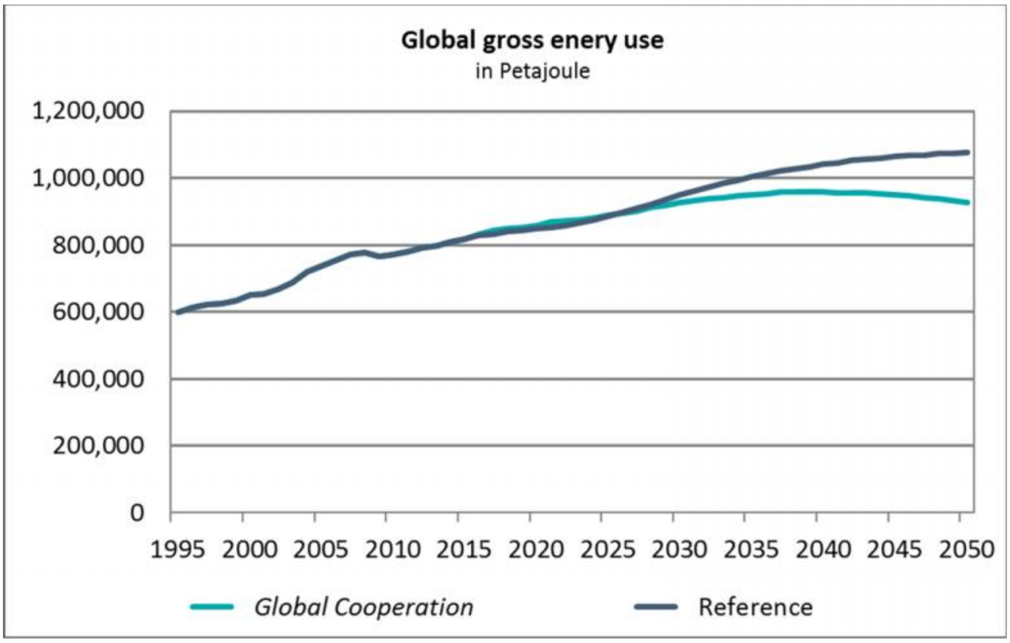
## 4.3 The results of the simulation

In this chapter the results of scenario *Global Cooperation* will be summarized in four blocks. First the impact of the policy mix on energy and emissions is discussed, followed by the extractions of abiotic materials, the use of biotic resources, land and water. In the last subchapter the economic effects are presented.

### *4.3.1 Energy and emissions*

In 2050 total gross energy use in scenario Global Cooperation is 7.5% lower than in the reference, but it is still growing (Figure 19). This is only a small contribution to reach the emissions target, which is not surprising, because only one instrument in the policy mix is focussing directly on energy efficiency – the energy efficiency program for buildings. The carbon tax also affects it, but this instrument is just able to compensate the lower extraction prices – compared with the reference - for fossil fuels. Further the recycling of metals and non-metallic minerals reduces the inputs of primary materials, but also the secondary materials need heat for their processing. Of course – metal inputs and the inputs of non-metallic minerals are reduced by taxation, but on the other side investment demand for the implementation of new technologies rises strongly, which compensates the efficiency effect.

***Figure 19: Scenario Global Cooperation – the impact on global gross energy use***




The just mentioned impact on global energy use is also given in the EU. But in this high income area the energy use for heating of buildings does not play that role as in the world average. Therefore Figure 20 shows a smaller reduction of only 3.4 of gross energy use in scenario *Global Cooperation* in comparison to the reference in the year 2050.

***Figure 20: Scenario Global Cooperation – the impact on gross energy use in EU27***

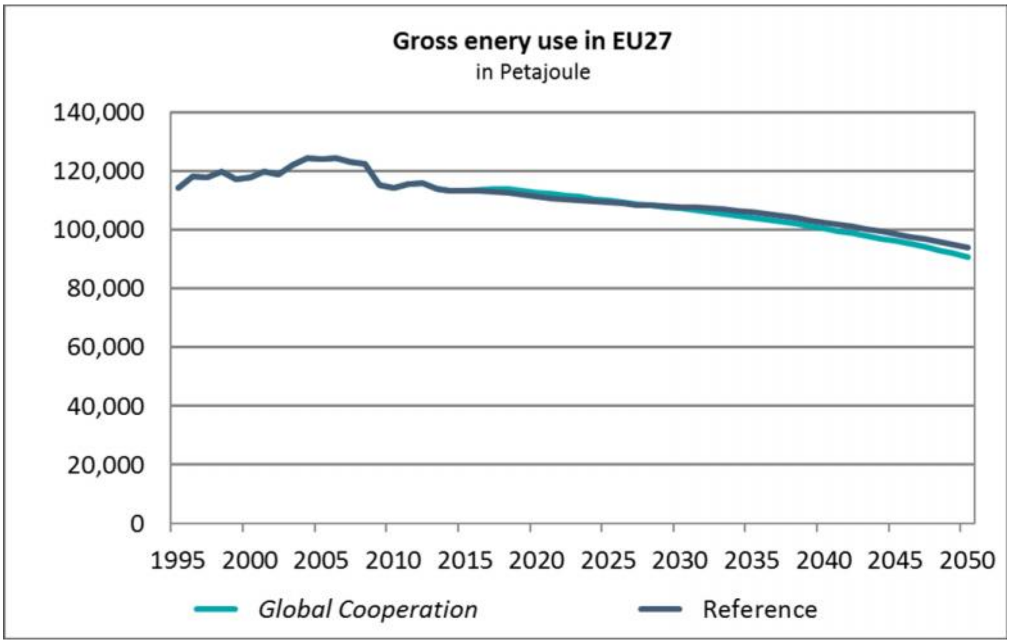



Table 7 shows the details of the structural change of global gross energy use, which is focussed by the policy mix. The main drivers of the observed reductions of fossil fuels are for coal and natural gas the rise of renewables in electricity production and the energy efficiency program for buildings, which also reduces light fuel mineral oil, and of course the carbon price. The main impact on the reduction of mineral oils, diesel and motor gasoline and for biofuels is the rise of electricity for e-mobility. The drastic reduction of mineral oils explains the strong negative impact on crude oil.

The demand for electricity rises strongly by 93%, which is mainly caused by e-mobility and the carbon price. Together with the quota for renewables this pushes the inputs of the different renewable technologies in electricity production. The share of nuclear in electricity production is assumed to be constant, but it is reduced, if its number is in conflict with the rising share of the total of renewables. Insofar the input of nuclear rises much less than electricity demand and production.

***Table 7: Scenario Global Cooperation – impact on the composition of global gross energy use***

| | Global gross energy use in the scenario ... in 2050 in TJ | | Deviation from the Reference scenario in % |
|---|---|---|---|
| | *Reference* | *Global Cooperation* | |
| Hard coal and derivatives | 217,983,538 | 67,226,996 | -69.2% |
| Lignite and derivatives | 10,766,593 | 2,415,820 | -77.6% |
| Coke | 3,514,326 | 3,155,496 | -10.2% |
| Crude oil, NGL and feedstocks | 196,586,921 | 83,018,992 | -57.8% |
| Diesel oil for road transport | 47,615,043 | 12,004,149 | -74.8% |
| Motor gasoline | 53,532,120 | 13,423,153 | -74.9% |
| Jet fuel (kerosene and gasoline) | 14,142,084 | 13,699,794 | -3.1% |
| Light Fuel oil | 25,113,442 | 11,819,436 | -52.9% |
| Heavy fuel oil | 30,099,132 | 13,182,391 | -56.2% |
| Naphta | 8,663,307 | 4,371,667 | -49.5% |
| Other petroleum products | 35,028,658 | 19,137,451 | -45.4% |
| Natural gas | 131,208,553 | 47,016,894 | -64.2% |
| Derived gas | 3,739,886 | 2,794,104 | -25.3% |
| Industrial and municipal waste | 1,573,630 | 1,216,708 | -22.7% |
| Biogasoline including hydrated ethanol | 5,675,784 | 3,809,512 | -32.9% |
| Biodiesel | 1,732,020 | 1,276,020 | -26.3% |
| Other combustible renewables | 48,348,512 | 34,003,601 | -29.7% |
| Electricity + Electricity for e-mobility | 142,988,781 | 275,827,113 | 92.9% |
| Heat | 11,826,075 | 7,254,798 | -38.7% |
| Biogas | 2,342,577 | 20,107,520 | 758.4% |
| Hydroelectric | 29,530,389 | 144,374,193 | 388.9% |
| Geothermal | 12,850,257 | 67,382,808 | 424.4% |
| Photovoltaic | 519,708 | 3,774,731 | 626.3% |
| Solarthermal heat | 434,986 | 2,885,540 | 563.4% |
| Solarthermal electricity | 14,305 | 124,005 | 766.9% |
| Wind power | 2,866,188 | 19,023,731 | 563.7% |
| Nuclear | 37,861,526 | 52,384,097 | 38.4% |

Table 8 shows similar results for the structural change of gross energy use in the EU. The change of nuclear is much lower than for the world average, because in the EU the phase out of nuclear in Germany has been mentioned. Further the reduction of the nuclear share in France is strong to allow for the rise of renewables.

***Table 8: Scenario Global Cooperation – impact on the composition of gross energy use in the EU***

| | Gross energy use in EU27 in the scenario ... in 2050 in TJ | | Deviation from the Reference scenario in % |
|---|---|---|---|
| | *Reference* | *Global Cooperation* | |
| Hard coal and derivatives | 5,141,889 | 1,555,320 | -69.8% |
| Lignite and derivatives | 2,779,036 | 270,492 | -90.3% |
| Coke | 135,075 | 126,819 | -6.1% |
| Crude oil, NGL and feedstocks | 19,771,068 | 8,824,058 | -55.4% |
| Diesel oil for road transport | 6,495,638 | 1,314,844 | -79.8% |
| Motor gasoline | 2,667,596 | 610,877 | -77.1% |
| Jet fuel (kerosene and gasoline) | 2,085,303 | 1,953,227 | -6.3% |
| Light Fuel oil | 2,225,417 | 1,175,710 | -47.2% |
| Heavy fuel oil | 2,006,101 | 951,502 | -52.6% |
| Naphta | 1,146,951 | 635,308 | -44.6% |
| Other petroleum products | 4,172,699 | 2,254,066 | -46.0% |
| Natural gas | 10,790,254 | 4,599,691 | -57.4% |
| Derived gas | 349,857 | 184,428 | -47.3% |
| Industrial and municipal waste | 524,956 | 475,708 | -9.4% |
| Biogasoline including hydrated ethanol | 317,431 | 266,483 | -16.1% |
| Biodiesel | 754,106 | 594,509 | -21.2% |
| Other combustible renewables | 2,532,641 | 1,859,290 | -26.6% |
| Electricity + Electricity for e-mobility | 12,296,131 | 25,499,252 | 107.4% |
| Heat | 1,872,840 | 1,200,795 | -35.9% |
| Biogas | 1,553,756 | 8,161,664 | 425.3% |
| Hydroelectric | 1,353,264 | 5,473,188 | 304.4% |
| Geothermal | 392,994 | 1,661,383 | 322.8% |
| Photovoltaic | 329,305 | 1,668,424 | 406.6% |
| Solarthermal heat | 209,967 | 1,025,633 | 388.5% |
| Solarthermal electricity | 6,946 | 37,096 | 434.1% |
| Wind power | 1,243,330 | 6,216,023 | 399.9% |
| Nuclear | 10,766,340 | 12,141,591 | 12.8% |

The impact of the energy efficiency development and the structural change of gross energy use on CO2 emissions is depicted in Figure 21 for the world and in Figure 22 for the EU.

***Figure 21: Scenario Global Cooperation – the impact on global $CO_2$ emissions***

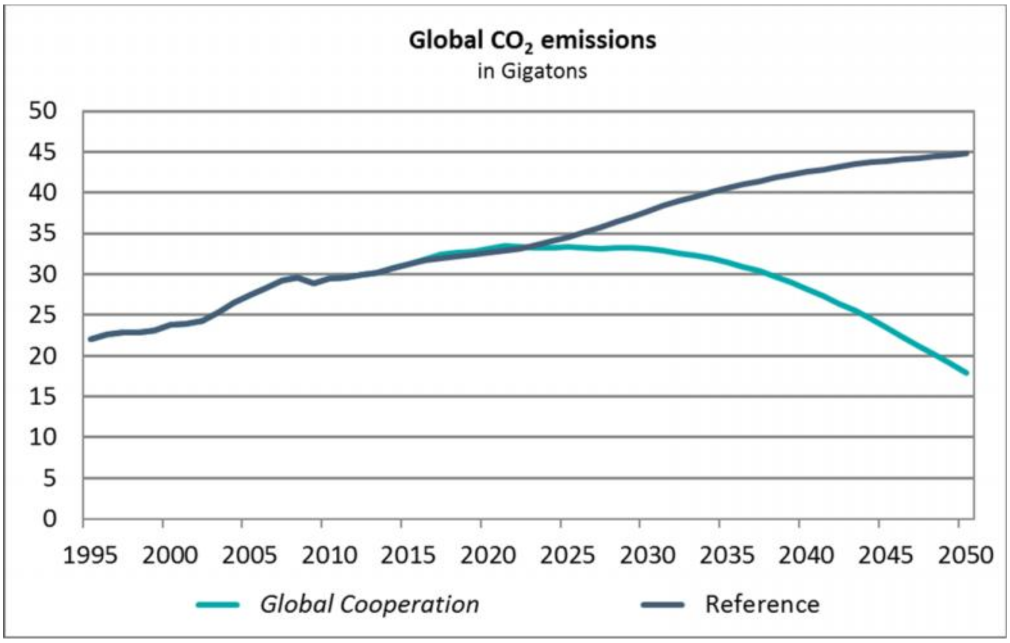
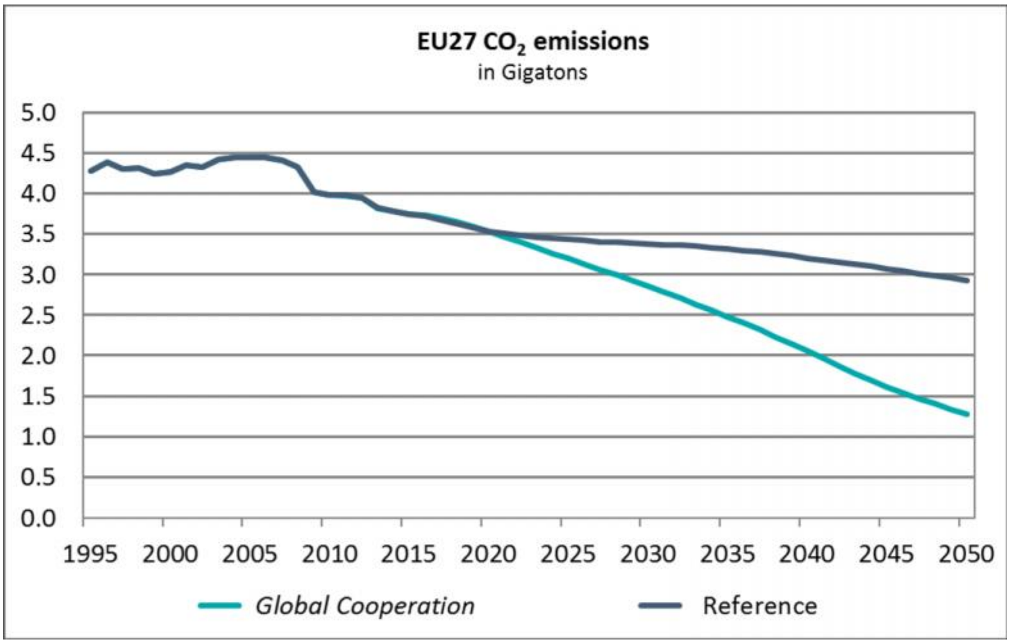



***Figure 22: Scenario Global Cooperation – the impact on EU27 $CO_2$ emissions***




The target of RCP 2.6 allows for 2050 global $CO_2$ emissions of 16 Gt. With emissions of 17.8 Gt the scenario *Global Cooperation* meets the target nearly. The target for the EU is a reduction of 80% in relation to the emissions of 1990, which means a level of about 1 Gt. The scenario *Global Cooperation* reaches 1.27 Gt, which is a reduction of 74 % against the level of 1990. So, more or less the EU target will be met.

### *4.3.2 Extraction of abiotic raw materials*

The extractions of abiotic raw materials are influenced in the *Global Cooperation* scenario mainly by regulations concerning the recycling of metals and non-metallic mineral products and the taxes on the use of metals and non-metallic minerals. Further the climate policy instruments reduce the extractions of fossil fuels. Figure 23 shows the impact of all instruments on the total global extraction used of abiotic materials in the reference and the scenario *Global Cooperation*. In 2050 *Global Cooperation* achieves a level of extraction that divided by the population number gives an extraction per capita of 4.1 tons, which is better than the target of 5.0 tons per capita.

***Figure 23: Scenario Global Cooperation – the impact on global extraction of abiotic raw materials***

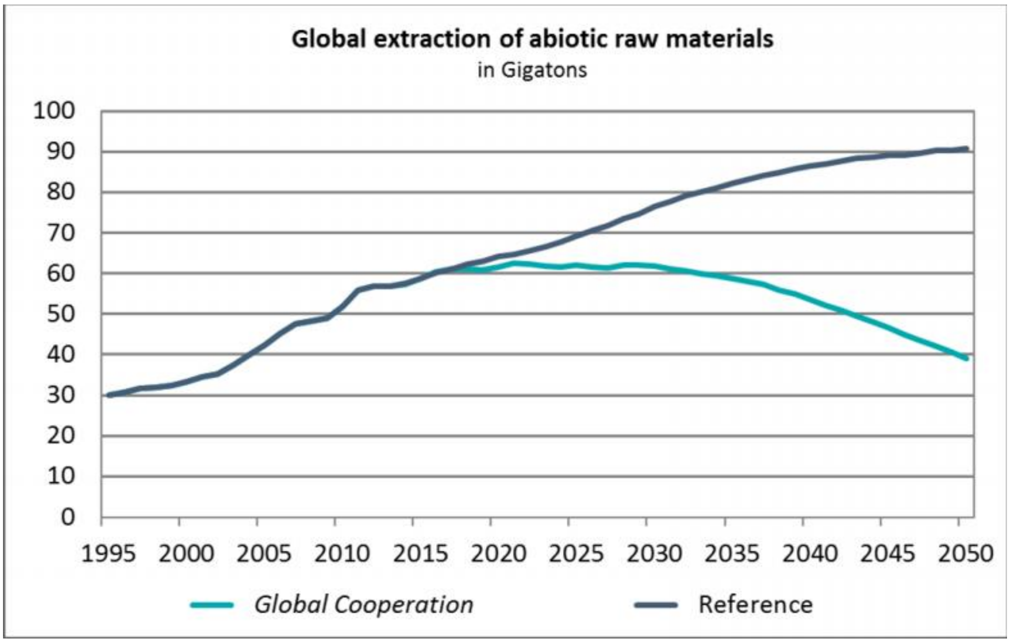



Table 9 shows for the year 2050 the global extractions for total fossil fuels, ores, construction minerals and industrial minerals in the reference and the scenario Global Cooperation. Total fossil fuels will be reduced mainly induced by climate policy instruments. The reductions of the extraction of ores and for non-metallic minerals is depending from recycling regulations, taxes on the use of these inputs and the public innovation funding for more material efficiency. The success is stronger for ores than in the case of non-metallic minerals for construction and industrial purposes, which can be explained by the higher recycling potential of ores. The extractions for ores reach the level of the year 1995.

***Table 9: Scenario Global Cooperation – the impact on global abiotic raw material extraction***

| | Deviation from the Reference scenario in the year 2050 in % |
|---|---|
| Fossils | - 69.7% |
| Ores | - 76.0% |
| Construction minerals | - 54.9% |
| Industrial minerals | - 49.4% |

The responsibility of the EU for total abiotic material extractions can be estimated with the indicator RMC, which gives the direct extractions plus those that are done abroad and embedded in the imports of goods and services minus those that are part of the exports of goods and services. The result for 2050 is 4.4 tons per capita, which is better than the target of 5.0.

### *4.3.3 Use of biotic resources, land and water*

Total agricultural land use is in the scenario Global Cooperation restricted by regulation to the actual levels in the different countries. Figure 24 shows the result for the world total, which is 6.8% below the level of the reference.

***Figure 24: Scenario Global Cooperation – the impact on global agricultural land use***

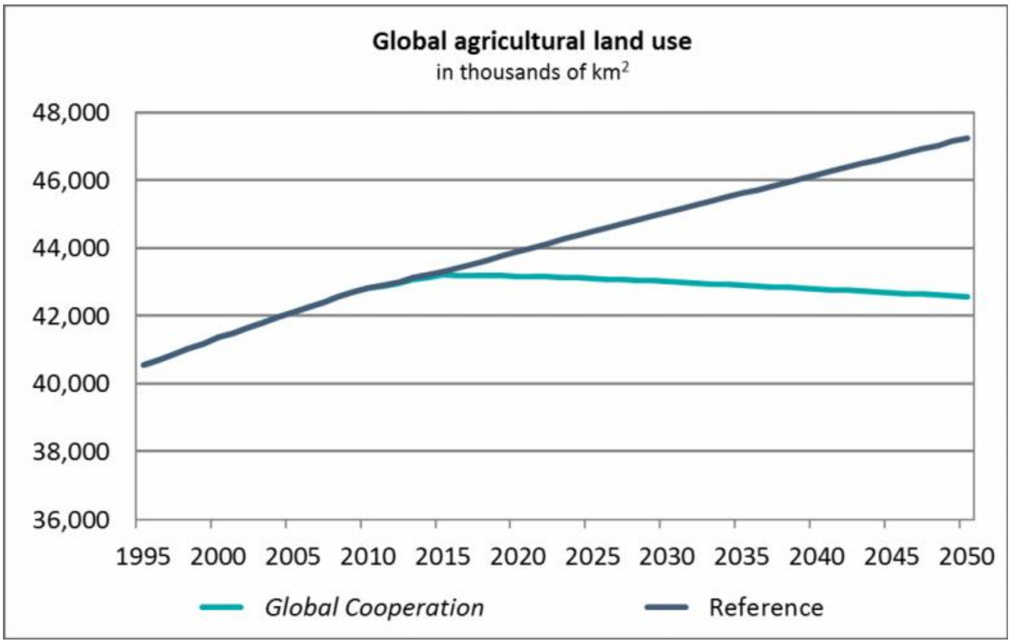
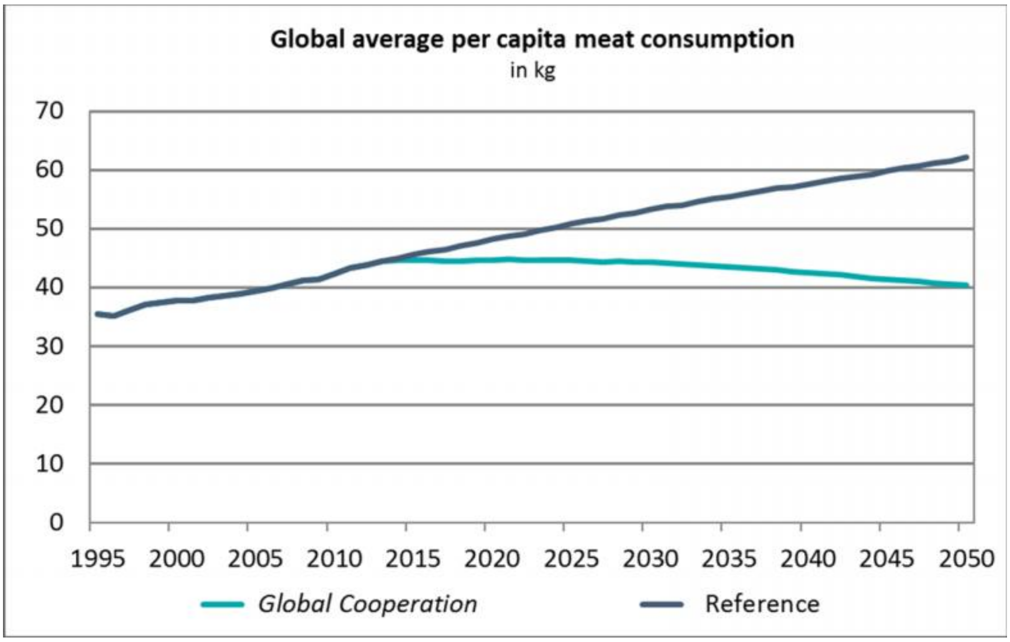


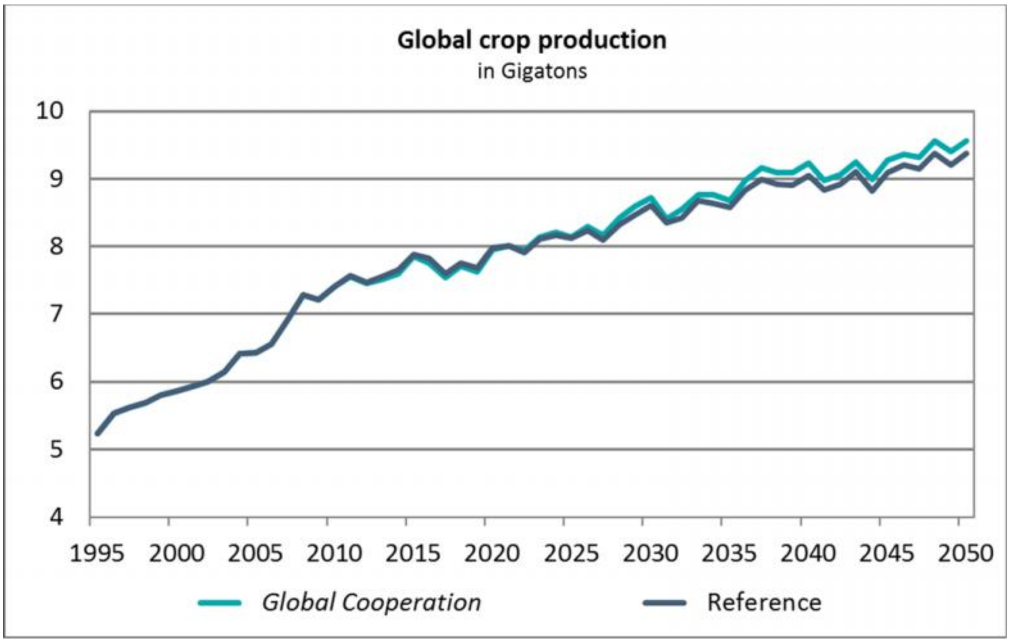

Figure 25 shows that the tax on meat demand together with the autonomous trend to less meat consumption is able to keep the global per capita consumption slightly below the actual levels. The rise of tax of 2% per year, which doubles the level of the tax till 2050, is only able to reduce meat consumption by 10%, because the price elasticity is very low. The main impact is coming from the autonomous reductions triggered by intrinsic motivation.

***Figure 25: Scenario Global Cooperation – the impact on global average per capita meat consumption***




Total global crop production is influenced mainly by two effects. The reduction of the yield gap in global crop production is a positive effect. On the other side agricultural land use is reduced. The net effect is positive with 2% (Figure 26).

***Figure 26: Scenario Global Cooperation – the impact on global crop production***




Meat production is reduced and therefore fewer crops are demanded for feed purposes. In addition the upswing of e-mobility reduces biofuel demand (and crop demand for processing purposes) and the food waste program diminishes crop demand for food purposes. In Figure 27 the impact on nominal food demand is depicted. In total a demand reduction of about one third is induced, which dampens the rising prices dynamics till 2050 by about 35% against the reference. Of course the movements for the 13 crops are very different because they are used not with the same structures for the different demand purposes. Total crop production for food purposes will be raised in comparison to the reference by 8.5%. In Figure 28 the weighted average of crop prices for food is depicted.

***Figure 27:** Scenario Global Cooperation – the impact on global demand for food crops at current prices*

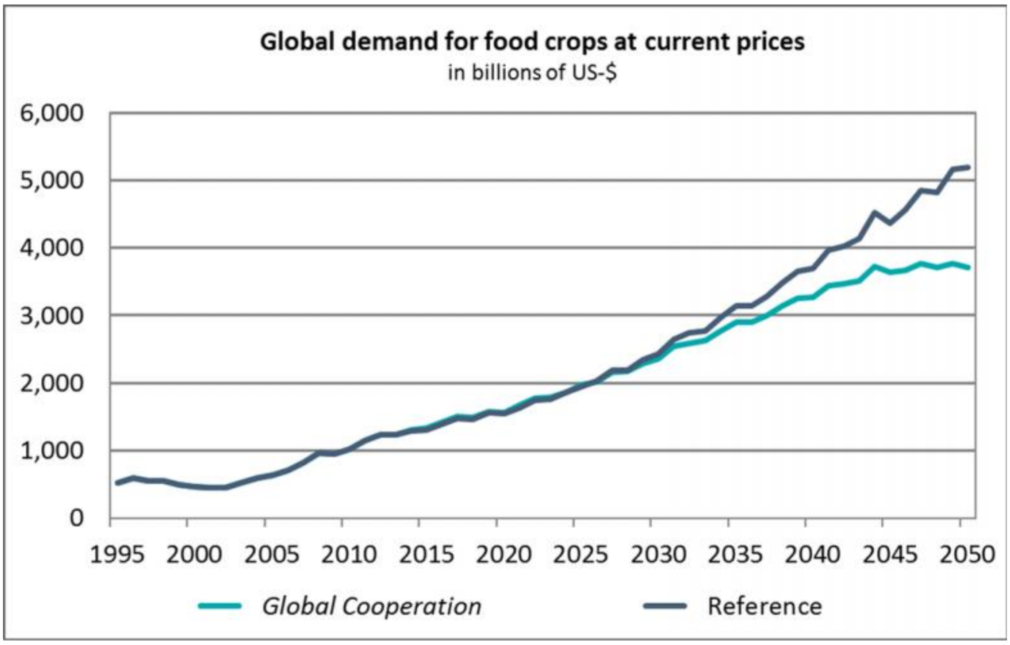
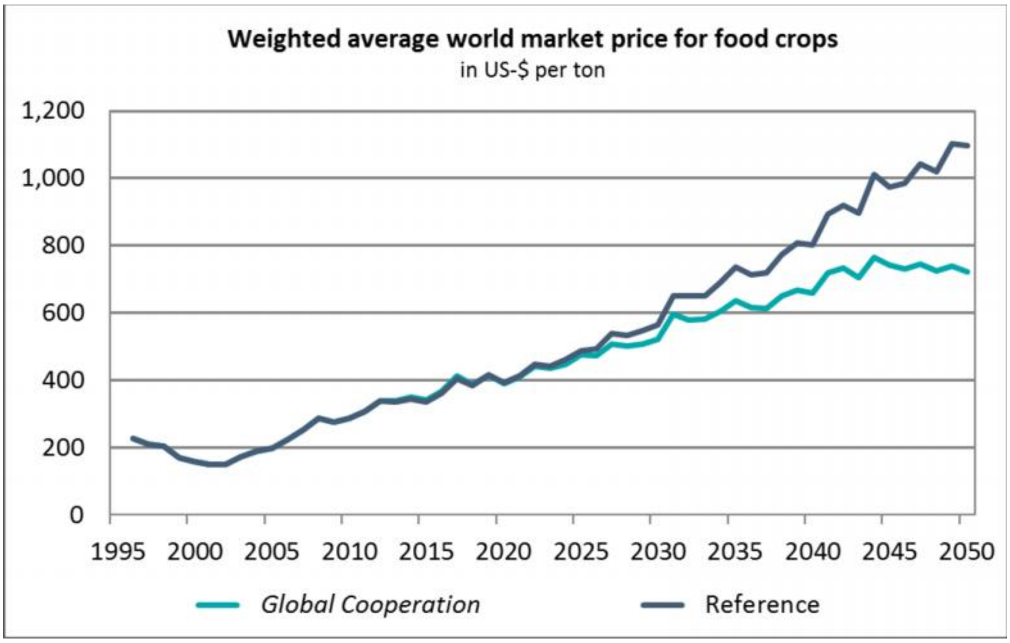


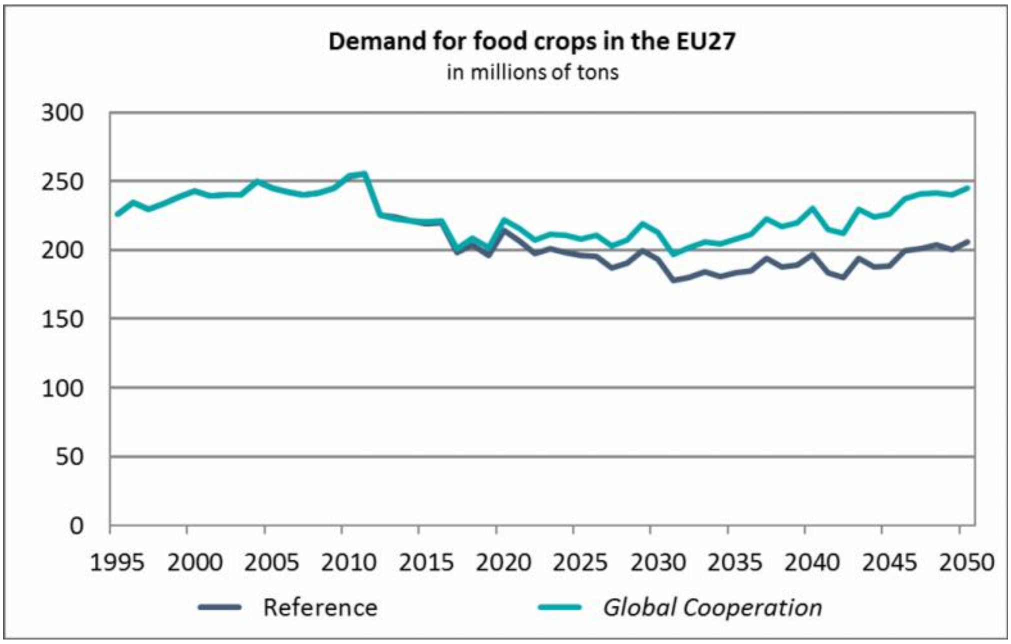

***Figure 28:** Scenario Global Cooperation – the impact on weighted average world market prices for food crops*




In the EU the same effects are in general acting, but the relative strengths of these effects are very different. First it has to be mentioned that the improvements of land productivity via the yield gap program are much lower than globally. Therefore the reduction of agricultural land use, which diminishes the use of crop land by 7%, is stronger than the positive effect of productivity gains on crop production. Total crop production is 4.2% lower than in the reference.

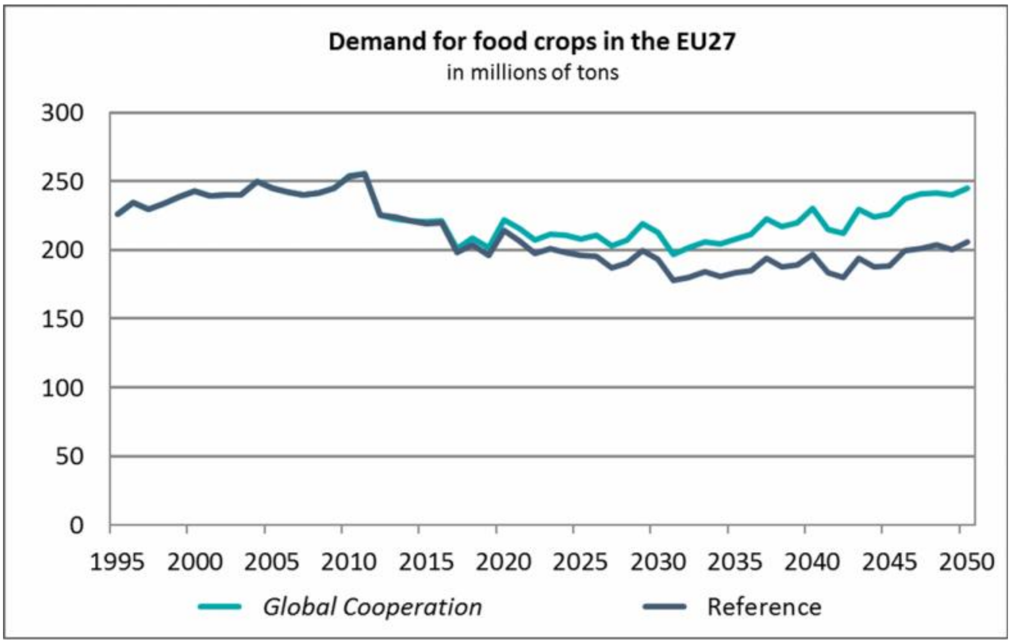
Secondly it has to be mentioned that crop production for feed has in the global average much less meaning than in the EU. Therefore the reduction of crop production for feed is in the EU much stronger than in the global average and the rise of crop production for food purposes is with +20% also stronger in the EU than in the global average (Figure 29). In this context we have to see that the reduction of feed demand is also induced by less exports of feed and that this will now be compensated by higher exports of food.

***Figure 29: Scenario Global Cooperation – the impact on food crop demand in the EU27***




Total domestic cropland use is 7% lower than in the reference, but shifts in international trade of crops compensates this more or less so that the per capita crop land footprint remains the same as in the *Reference* scenario (in 2050: 0.267 ha in the scenario *Global Cooperation* against 0.268 ha in the *Reference* scenario). Insofar the target of a 30 % reduction is only partly realized.

***Figure 30: Scenario Global Cooperation – the impact on average water exploitation index in EU27***



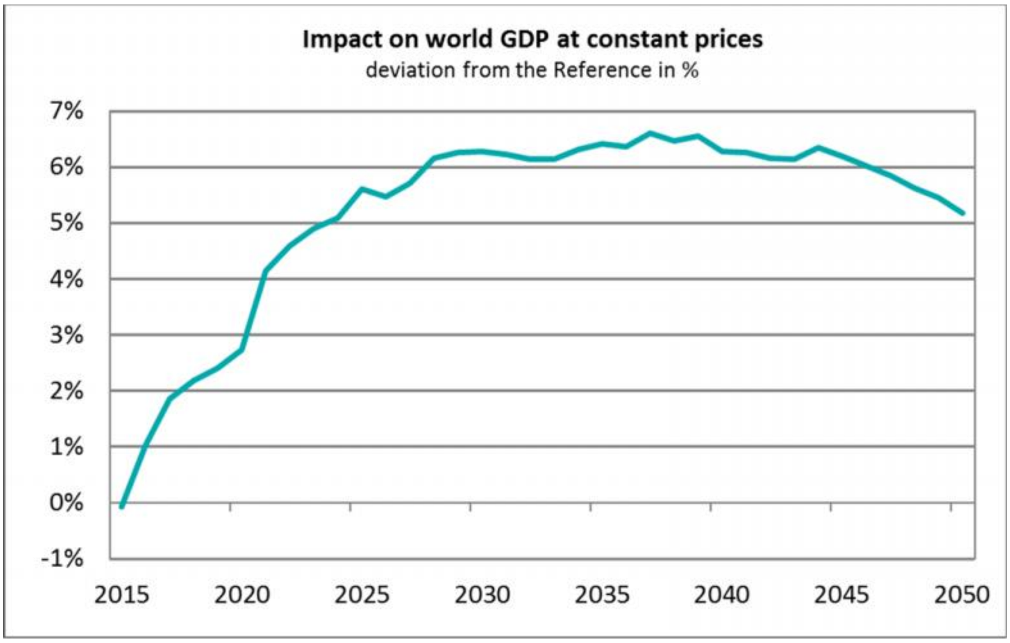

The water withdrawal index in the EU average is below the reference (Figure 30) and far below the target of 20 %. But the regulation of water withdrawal induces for the following countries a restriction for crop production: Belgium, Greece, Malta, Spain, Turkey, China, India, Japan and Korea. In these countries the water withdrawal of agriculture has been reduced to meet the target.

### *4.3.4 Economic Development*

The economic development is driven mainly by these impacts: The investment in new technologies for renewable energies, grids and the energy efficiency of buildings and recycling pushes the circular flow of income and thus raises growth. The long run rise of the capital stocks means higher capital costs and insofar higher prices. This has negative effects on GDP in later years. On the other side the lower material intensity of the global economy reduces costs and prices in manufacturing and the lower demand for fossil fuels and ores in addition drops extraction prices down.

For the global economy these impacts are clearly positive as Figure 31 shows: The deviation of global GDP in scenario Global Cooperation from the reference is positive and rises till 2030 and reduces then slightly reaching 5.2% in 2050.

***Figure 31: Scenario Global Cooperation – the impact on the global economy***




The substitution of raw materials like fossil fuels, ores and non-metallic minerals reduces costs in manufacturing and therefore gives positive impacts on GDP. The mining and quarrying sectors and the directly following stages of production suffer of course from the reduction of demand of their products, which gives negative impacts on GDP. For a country in question the GDP effect of material efficiency is depending from its position in the international division of labour. Those countries that are importing materials are winners and those that are exporting materials are losers. These effects are steadily rising from 2015 to 2050.

Russia is a typical resource extracting and exporting country, whereas Germany's economy is characterized by manufacturing and the imports of resources. Table 10 shows the simulated impacts: Russia has in 2050 a real GDP which is 27.7% lower than in the reference, whereas Germany is able to raise its GDP by 9.1%. It is also remarkable that Germany reaches most of the positive deviation already in 2030, which can be explained by the impacts of the policy mix on investment.

***Table 10: Scenario Global Cooperation – the impact on the economy for selected countries***

| | GDP at constant prices - deviation from the Reference scenario in % | |
|---|---|---|
| | 2030 | 2050 |
| Russia | -10.6% | -27.7% |
| Brazil | -2.6% | -16.5% |
| Canada | 2.7% | -7.0% |
| Germany | 8.3% | 9.1% |

In detail the indirect effects are very complex: Relative prices between the countries change, because the structures of production and consumption are very different. These changes have impacts on the structure of production and consumption and on international trade. Further income effects are induced.

Since mining and quarrying and the other basic industries have a less weight in the EU than in the global average, the EU has stronger advantages than the global economy: Its real GDP is in 2050 +8.0% higher than in the reference (Figure 32).

***Figure 32: Scenario Global Cooperation – the impact on the EU27 economy***

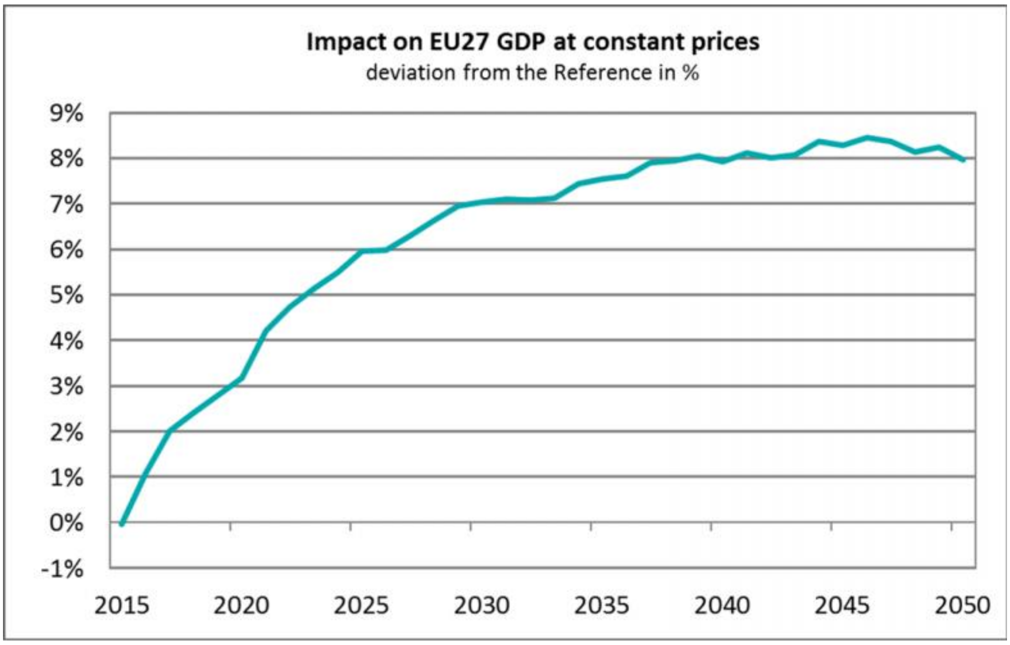



Figure 33 allows analysing the impact on the primary factors of production in the EU: Labour and capital. The deviation from the reference for investment is over the whole period with factor 2 higher than that of GDP, which means that investment ratios and capital intensity are much higher than in the reference. Employment is also positively affected, but the deviation from the reference is lower than that of GDP and of capital. The European economy is reducing its material intensity and raising the capital intensity of labour accompanied by gains in employment and economic growth.

*Figure 33: Scenario Global Cooperation – the impact on investment and employment in EU27*

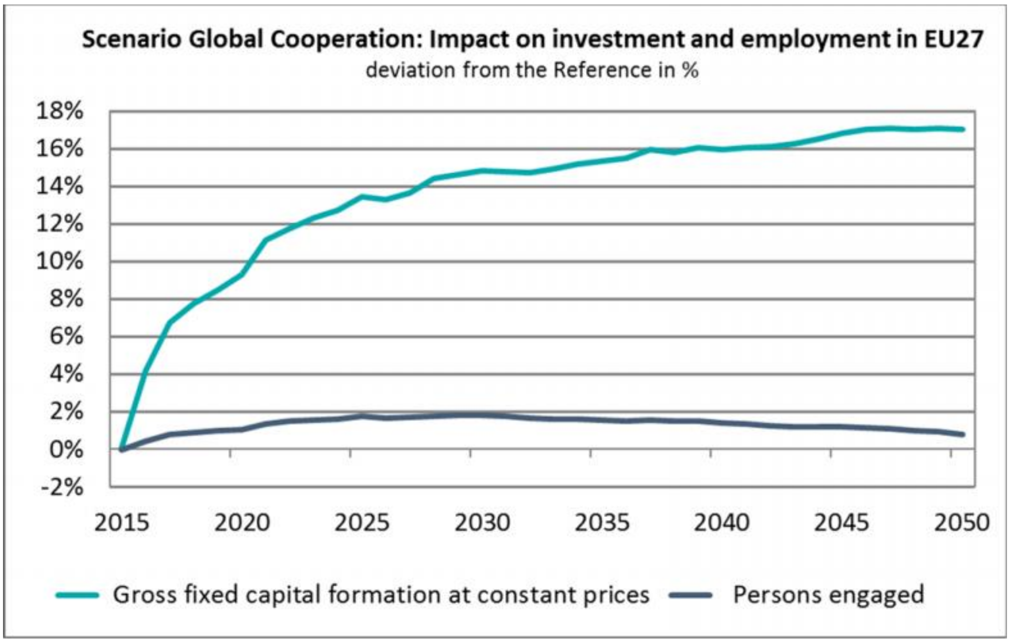
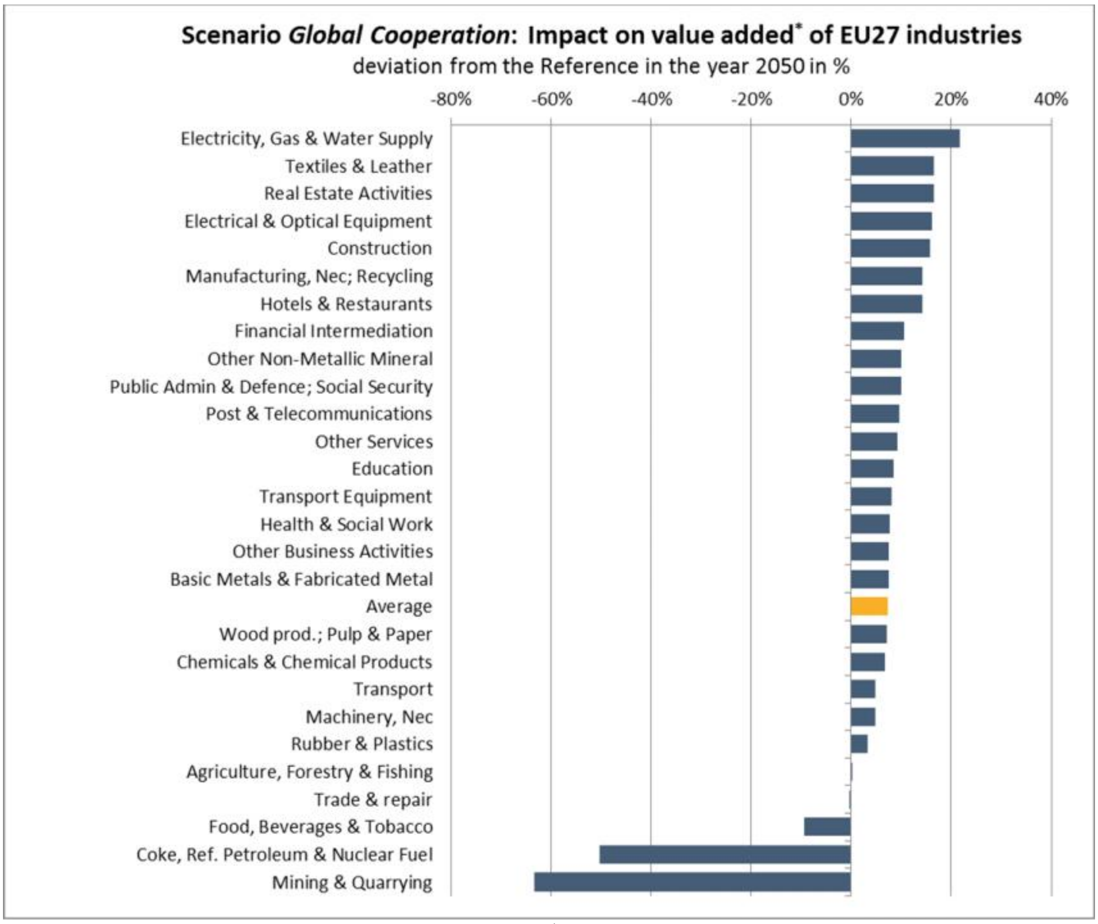



Figure 34 depicts the effects on the industry structure in the EU for the year 2050. Who are the winners, who are the losers? The mining and quarrying industry as well as the mineral oil production show losses of value added compared to the Reference. The same holds for the food and beverages industry, but to a much smaller extent. These industries are suffering from a diminished demand for their products in a resource efficient economy. But on the other hand it can also be seen that the majority of industries is winning.

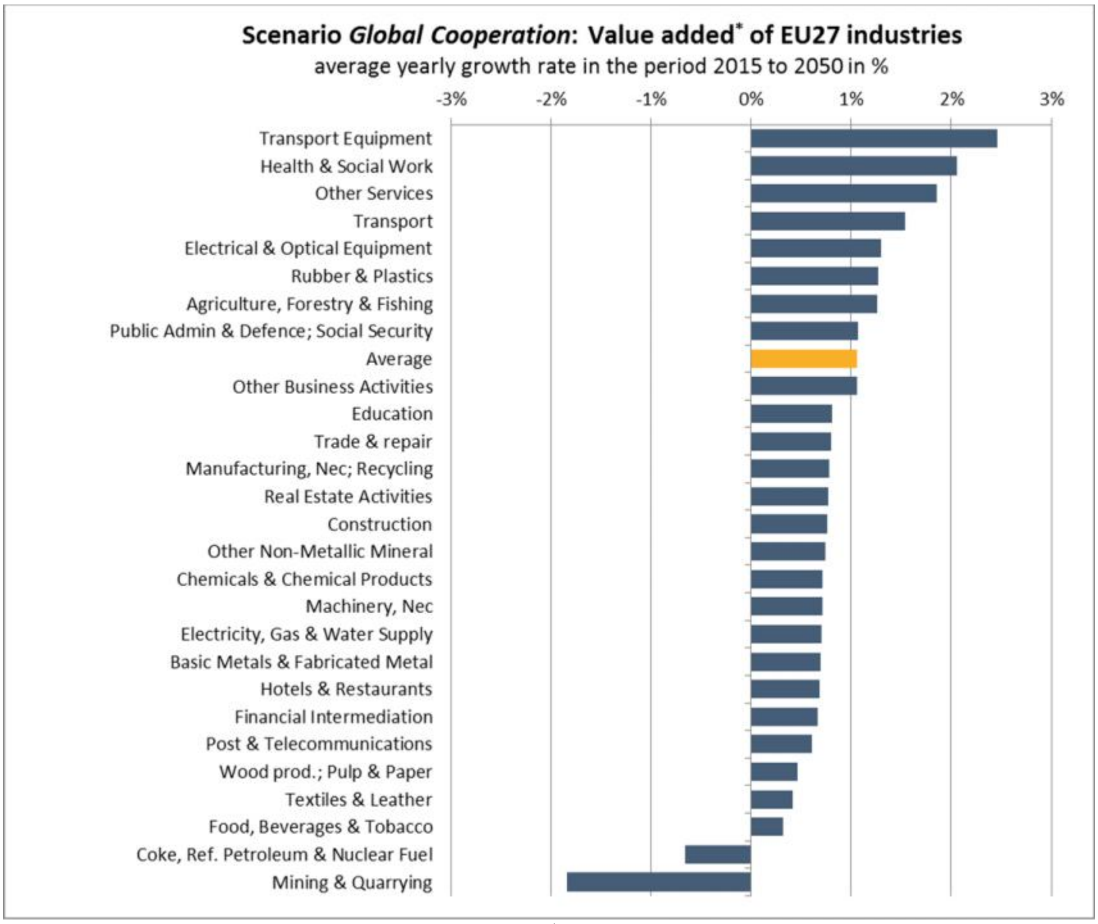
***Figure 34: Scenario Global Cooperation – the impact on value added of different industries in EU***




* Value added deflated by GDP price in 1995 US-$

But to look at the deviation from the Reference scenario is only one side of the coin. Therefore Figure 35 depicts the average yearly growth rates of value added in the period 2015 to 2050 for the different industries in EU27 in the scenario *Global Cooperation*. It can be observed, that for all industries besides “Mining & Quarrying” and “Coke, Ref. Petroleum & Nuclear Fuel” an increase of value added is expected. Even the food & beverage sector that is negatively affected by the policy mix still shows an increasing value added over time. On the top of Figure 37 appear the transport equipment (car) industry and the sector “Health & Social Work”, both industries that are gaining from the transition to a resource efficient economy, but not much more than the average of the whole EU27 economy. The biggest winner of the transition – the electricity supply – shows a growth rate of value added that is only slightly smaller than the average. This shows that in the Reference the expectations for value added growth of this sector are rather low (~ +0.2% p.a.) and now, in the scenario *Global Cooperation*, reach a reasonable level.

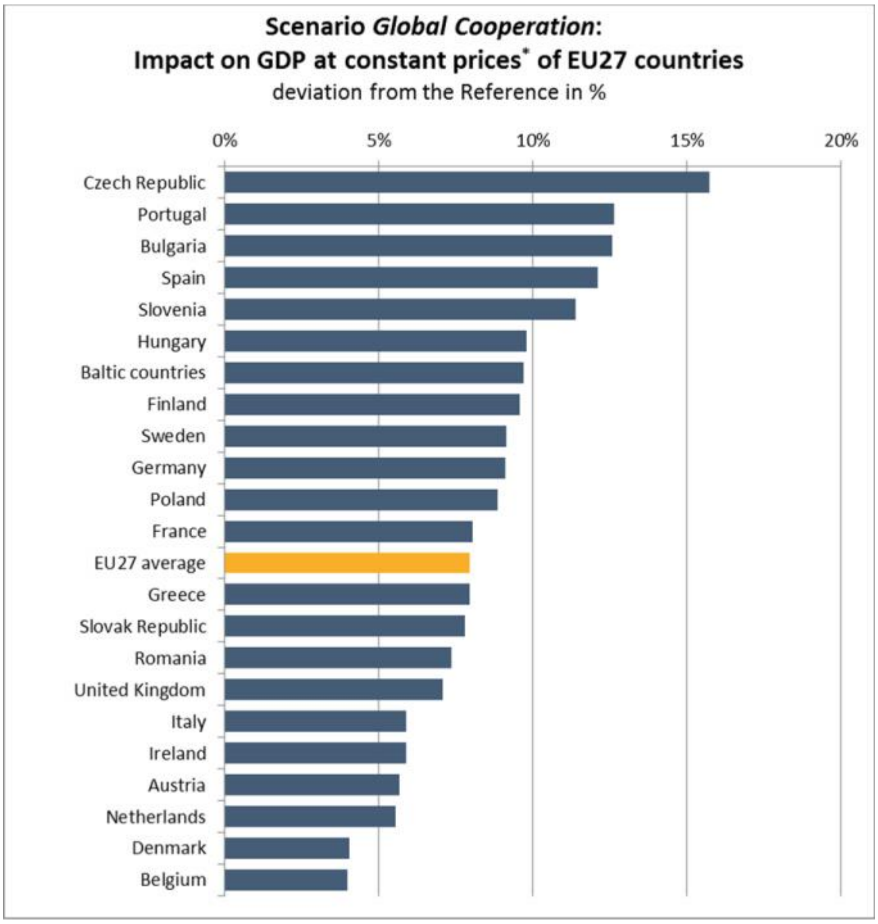
***Figure 35: Scenario Global Cooperation – the development of value added of different industries in EU***




* Value added deflated by GDP price in 1995 US-$

The last question to be answered with regard to the modelling results for the scenario *Global Cooperation* is the one on the differences of economic impacts at member state level within EU27. Figure 36 shows the impact on GDP in the year 2050 for the different countries. As we can see there is no single country that loose macro-economic growth. But there are differences in the strength of the macro-economic benefits. Especially some Eastern European countries (Czech Republic, Bulgaria and Slovenia) as well as Portugal and Spain are expected to gain from the transition above average. On the other hand Belgium, Denmark and the Netherlands are expected to gain least. The main reason behind these modelling results is the different industry structure in the countries. For example Belgium and the Netherlands are (more than other EU countries) involved in the global trade and processing of crude oil, a business that is suffering from the transition process. On the other hand in the Czech Republic the manufacturing of electrical and optical equipment as well as the manufacturing of transport equipment are more important than in other countries and for both sectors an above average positive impact is expected.

***Figure 36: Scenario Global Cooperation – the impact on GDP for different EU countries***



# 5 The scenario EU Goes Ahead

The EU countries try to meet their targets by a policy mix that is dominated by economic instruments. The NON-EU countries only implement some climate policy instruments so that the global target for 2050 is consistent with RCP 4.5, which allows for 2050 emissions slightly above today's numbers.

## 5.1 The assumptions for exogenous variables

The assumptions concerning the development of population and world market prices for metal ores are the same as in the reference scenario. The rationale behind the unchanged assumption for the metal ore price is that – as will be shown later on – the Scenario "Europe goes ahead" leads to a reduction of environmental indicators for the EU27. But it does not cause a reduction of global metal ore extractions.

**Extraction prices for fossil fuels**

The world market extraction prices for coal, oil and gas are now less dynamic than in the reference scenario, but higher than in the scenario "global cooperation", because the demand for fossil fuels is lower than in the reference, but higher as in the scenario "global cooperation. The prices for fossil fuels in the scenario EU Goes Ahead are given with the IEA ETP 4 DS prices, which correspond with the concentration and emission paths of RCP 4.5.

## 5.2 The policy mix

### *5.2.1 Climate policy*

**Regulation of renewables in electricity production**

The Regulation of renewables in electricity production in the EU countries is the same as in scenario "Global Cooperation". The share of renewables in electricity production for the EU countries does not differ from Global Cooperation. For all non-European countries it is assumed, that the ambition to green the electricity production is lower than in Europe. The quota for 2050 is 70%. The resulting investment needs for grids are identified and considered in the same way as in the Scenario Global Cooperation.

**ETS system**

The ETS system with the basic industries and electricity production as members needs in the case of a quota for renewables a supply management in reaction to the reduced emissions urged by the renewables quota to guarantee a rising substantial carbon price. As the actual problems in the ETS have shown, this anyway seems to be necessary. The reformed ETS system should be established in the EU countries only. The carbon price for the alternative scenarios rises linearly to 226 € in constant prices.

**Carbon tax with direct compensation**

Only in the EU countries all **sectors not covered by the ETS** will be confronted with a second carbon price in the scenario "Europe goes ahead". The firms have to buy pollution rights from the government due to their inputs of fossil fuels. This is guaranteed because the sellers of fossil fuels are only allowed to deliver, if they get from the buyer the pollution rights. In their yearly tax declaration the buyers of fossil fuels present their receipts of the payments for pollution rights. The financial authorities calculate the average payment for pollution rights per sales of the sector and pay due to the sales of the individual firms the average amount back. This means that at the end only those firms of the sector in question are taxed, which have an environmental performance below the average whereas those above the average are subsidized, and these effects rise with the distance from the average. So, there is a strong incentive to raise decarbonization without an effect on economic performance of the total sector. Also the administrative costs will be low, because the financial authorities only have to install the sales of the pollution rights and to organize the pay back per sector.

Since in spite of the selling of pollution rights by the government its budget is kept neutral by the pay back system and we have an implicit ETR. Further this instrument does not affect international competitiveness, because there are no costs for the total sector, which means that a border tax adjustment is not necessary.

To implement this policy measure in the Scenario it is assured that the demand for fossil energy carriers by the different industries does not consider only purchasers prices but also the “shadow prices” for the costs for the pollution rights. The carbon price rises linearly and reaches 446 € in constant prices in 2050. This instrument is implemented only in EU countries.

**E-Mobility**

For the EU countries the same policy measures with the same force as in the in the scenario Global Cooperation are assumed. In the non-EU countries the only policy measure that is also part of the “EU goes ahead” Scenario is the policy that leads to a rising share of e-mobility.

**Tax on air transport**

A linearly rising goods tax on air transport is implemented which reaches 60% in 2050.

**Subsidy on public land transport**

A subsidy on public land transport is introduced rising up linearly to 30 % of the producer price in 2050.

**Energy efficiency of buildings**

For the EU countries the assumptions are equal to those in the scenario Global Cooperation. The Non-EU countries do not participate.

### 5.2.2 Policy measures to enhance abiotic raw material efficiency

**Regulation of recycling for ores**

In EU countries the same implementation is given as in scenario Global Cooperation. Non-EU countries do not participate.

**Regulation of recycling for non- metallic minerals**

In EU countries the same implementation is given as in scenario Global Cooperation. Non-EU countries do not participate.

**RMC based tax on metal ores**

In the scenario EU goes ahead it is assumed that in all EU countries a tax on final demand on goods with a high content of metal ore is introduced. A tax on final demand does not hit the international competitiveness as domestically produced and imported goods are taxed in the same way.

To identify those goods with a high content of metal ore and to set the tax rates in a way that they give the appropriate price signal the results of the resource module of $GINFORS_3$ have been used. In this module a GRAM-algorithm (Giljum et al., 2009) is contained that calculates the global resource use of final demand for the different product groups.

According to these calculations the average global use of metal ores per US-$ final inlands demand in the EU27 amounts 0.72 kg (in 2009). Product groups with above average global metal ore use as well as the assumption about the mark-up on tax rates for these product groups in the year 2050 (linear increase in the period 2015 to 2050) are given in the following table.

***Table 11: Scenario EU Goes Ahead – markup on tax rates in EU27***

| | Mark-up on tax rate in the year 2050 in percentage points |
|---|---|
| Fabricated metal products, except machinery and equipment | 50 |
| Electrical machinery and apparatus | 47 |
| Machinery and equipment | 33 |
| Other transport equipment | 29 |
| Other non-metallic mineral products | 21 |
| Furniture, other manufactured goods | 19 |
| Furniture, other manufactured goods | 18 |
| Furniture, other manufactured goods | 17 |
| Construction work | 17 |
| Chemicals, chemical products and man-made fibres | 15 |
| Rubber and plastic products | 14 |
| Radio, television and communication equipment and apparatus | 14 |
| Medical, precision and optical instruments, watches and clocks | 14 |
| Collected and purified water, distribution services of water | 11 |
| Wood and products of wood and cork | 10 |

**Subsidies for goods with low RMC**

For goods with low RMC a subsidy is introduced that rises linearly up to 28% of the producer price in 2050.

**Upstream tax on non-metallic minerals**

For non-metallic minerals a taxation of final demand does not make sense as it would mainly mean to tax the demand for construction work with doubtful steering effects. On the other hand non-metallic minerals are hardly traded internationally. Therefore in the scenario EU goes ahead it is assumed that in the EU27 countries an upstream tax on non-metallic minerals, as already described for the scenario Global Cooperation, will be established. The tax rate will increase linearly up to 65% in 2050.

**Public innovation fund for raw material efficiency**

The innovation fund is assumed only for EU countries.

### *5.2.3 Policy measures to enhance biotic resource efficiency*

**Regulation of water withdrawal**

It is assumed that the water withdrawal of agriculture is regulated only in the EU countries.

**Information program for producers and consumers concerning food waste**

The program described for scenario Global Cooperation is implemented only in EU countries.

**Taxation of meat**

The taxation of meat is introduced only for EU countries. The same assumptions as in scenario Global Cooperation are given.

**Information programme for efficiency of crop production**

The information programme that helps farmers with low yields to improve their land management is only introduced for the crop production within the EU.

**Nature conservation programme**

The expansion of agricultural land is regulated only in the EU.

### *5.2.4 Fiscal policy*

For the RMC based tax on the global use of metal ores in final demand it is assumed that the tax revenue is used to reduce the tax rates on those product and service groups with low metal content.

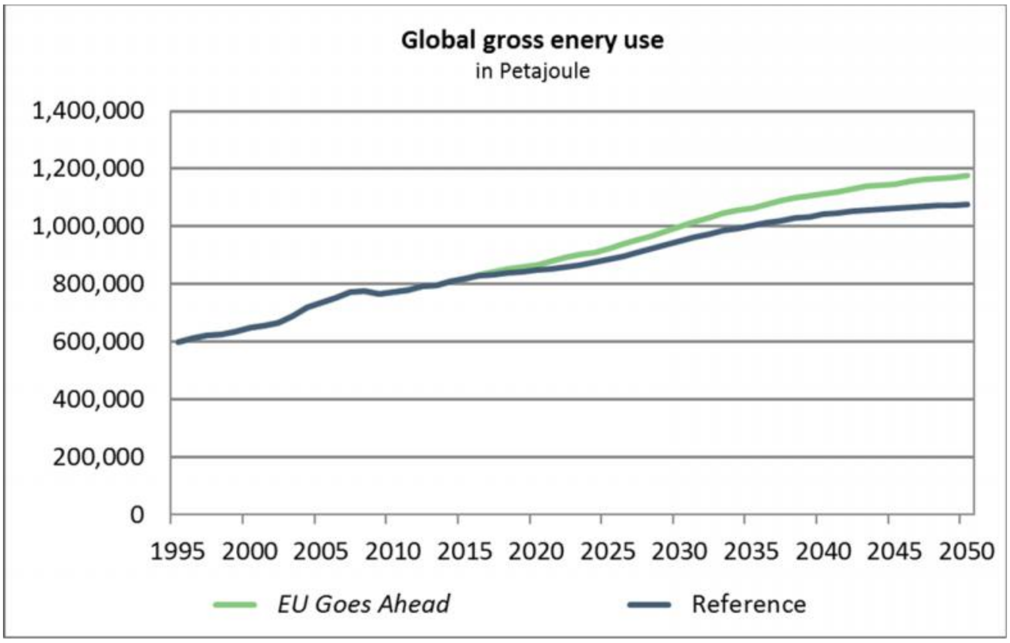
For the tax revenue of the upstream tax on non-metallic minerals the same compensation mechanism as in the scenario Global Cooperation is assumed.

## 5.3 The results of the simulation

### *5.3.1 Energy and emissions*

In the scenario *EU Goes Ahead* the Non- European countries only implement a moderate climate policy with a rise of the share of renewables in electricity production to 70% in 2050 and an introduction of e-mobility, which reaches a share of 80% for electricity use in mobility. Both activities are targeted on emissions, not primarily on energy use. But both activities push investment, which raises the demand for materials and thus for process energy in the basic industries in comparison to the reference. In contrast to the scenario *Global Cooperation* there is now no efficiency gain from recycling or material taxation, which could compensate the higher demand. Further in the scenario *EU Goes Ahead* fossil fuel prices are lower, which raises energy demand in comparison to the reference. Insofar it is not surprising that we now observe (see Figure 37) a global energy demand that in 2050 is 17% higher than in the reference.

***Figure 37: Scenario EU Goes Ahead – the impact on global energy demand***




The situation in the EU differs significantly from the global picture: Here we have the engaged climate policy with the more ambitious target of 90% renewables, e-mobility, energy efficiency of buildings, ETS system for basic industries and a strong carbon tax for the other industries. These instruments as well as recycling are also given in scenario *Global Cooperation*. The mentioned energy instruments affect more the structure and not the level of energy demand. One exemption is the subsidy for investments in the energy efficiency of buildings, which also has been implemented in Global Cooperation. But the upstream tax for non-metallic minerals and a RMC based tax on ores hidden in final demand products operate even more effectively in the compensation of energy demand induced by the rise of production of investment goods than in scenario *Global Cooperation*. The result for total gross energy use in TJ in the EU is depicted in Figure 38: In 2050 it is about 11% lower than in the reference and the effect is stronger than in *Global Cooperation*.

***Figure 38: Scenario EU Goes Ahead – the impact on energy demand in EU27***

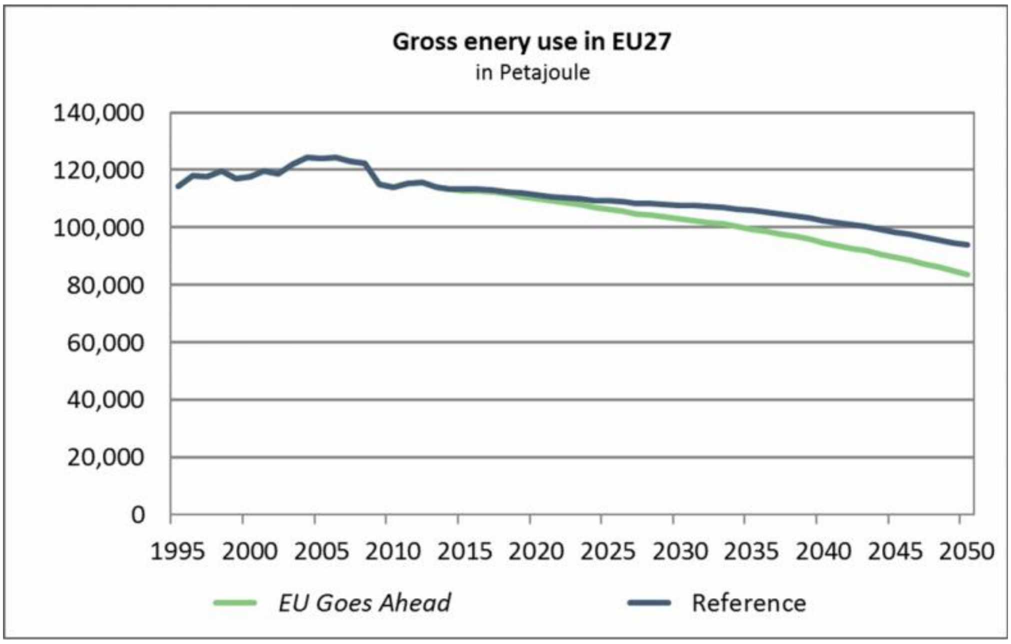



Table 12 shows the expected structural change for the different energy carriers, which is now different from that of scenario Global Cooperation (Table 7), because the Non EU countries only implement a moderate climate policy and have no actions on resource efficiency policy. The most important difference is now that on the one side the share of renewables in electricity production rises only up to 70 % in 2050. This means that the assumption of a constant share of nuclear gets less in conflict with the share of renewables. Since further mobility reaches as in scenario Global Cooperation an electricity share of 80 % we get a deviation from the reference for electricity production of still 97 %. Therefore the production of nuclear is by 76 % higher than in the reference. This still means that in the average the share of nuclear is smaller than in the reference.

***Table 12: Scenario EU Goes Ahead – the impact on the composition of global gross energy use***

| | Global gross energy use in the scenario ... in 2050 in TJ | | Deviation from the Reference scenario in % |
|---|---|---|---|
| | *Reference* | *EU Goes Ahead* | |
| Hard coal and derivatives | 217,983,538 | 160,647,929 | -26.3% |
| Lignite and derivatives | 10,766,593 | 6,724,844 | -37.5% |
| Coke | 3,514,326 | 3,801,657 | 8.2% |
| Crude oil, NGL and feedstocks | 196,586,921 | 120,090,240 | -38.9% |
| Diesel oil for road transport | 47,615,043 | 11,484,043 | -75.9% |
| Motor gasoline | 53,532,120 | 12,019,819 | -77.5% |
| Jet fuel (kerosene and gasoline) | 14,142,084 | 14,677,730 | 3.8% |
| Light Fuel oil | 25,113,442 | 25,358,521 | 1.0% |
| Heavy fuel oil | 30,099,132 | 29,964,997 | -0.4% |
| Naphta | 8,663,307 | 8,661,246 | 0.0% |
| Other petroleum products | 35,028,658 | 31,518,456 | -10.0% |
| Natural gas | 131,208,553 | 114,045,107 | -13.1% |

| | | | |
|---|---|---|---|
| Derived gas | 3,739,886 | 3,376,062 | -9.7% |
| Industrial and municipal waste | 1,573,630 | 1,570,152 | -0.2% |
| Biogasoline including hydrated ethanol | 5,675,784 | 5,161,604 | -9.1% |
| Biodiesel | 1,732,020 | 1,844,187 | 6.5% |
| Other combustible renewables | 48,348,512 | 48,153,513 | -0.4% |
| Electricity + Electricity for e-mobility | 142,988,781 | 281,890,817 | 97.1% |
| Heat | 11,826,075 | 11,514,716 | -2.6% |
| Biogas | 2,342,577 | 17,487,272 | 646.5% |
| Hydroelectric | 29,530,389 | 122,546,211 | 315.0% |
| Geothermal | 12,850,257 | 53,028,445 | 312.7% |
| Photovoltaic | 519,708 | 3,283,306 | 531.8% |
| Solarthermal heat | 434,986 | 2,494,419 | 473.4% |
| Solarthermal electricity | 14,305 | 103,350 | 622.5% |
| Wind power | 2,866,188 | 16,735,461 | 483.9% |
| Nuclear | 37,861,526 | 66,642,975 | 76.0% |

Table 13 gives the structural change for gross energy use in the EU. Now nuclear is more or less constant in spite of the 90% growth of electricity production, which shows a drastic reduction of the share of nuclear.

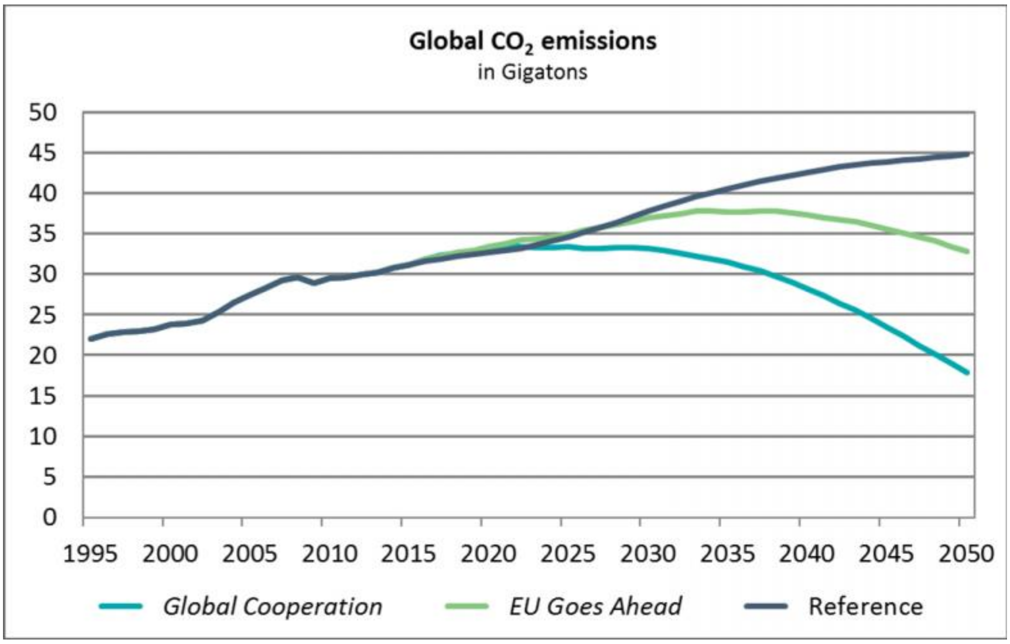
***Table 13: Scenario EU Goes Ahead – the impact on the composition of gross energy use in EU27***

| | Gross energy use in EU27 in the scenario ... in 2050 in TJ | | Deviation from the Reference scenario in % |
|---|---|---|---|
| | *Reference* | *Global Cooperation* | |
| Hard coal and derivatives | 5,141,889 | 1,357,726 | -73.6% |
| Lignite and derivatives | 2,779,036 | 244,344 | -91.2% |
| Coke | 135,075 | 107,849 | -20.2% |
| Crude oil, NGL and feedstocks | 19,771,068 | 8,595,583 | -56.5% |
| Diesel oil for road transport | 6,495,638 | 907,253 | -86.0% |
| Motor gasoline | 2,667,596 | 401,864 | -84.9% |
| Jet fuel (kerosene and gasoline) | 2,085,303 | 1,686,897 | -19.1% |
| Light Fuel oil | 2,225,417 | 1,084,533 | -51.3% |
| Heavy fuel oil | 2,006,101 | 859,888 | -57.1% |
| Naphta | 1,146,951 | 606,820 | -47.1% |
| Other petroleum products | 4,172,699 | 2,034,497 | -51.2% |
| Natural gas | 10,790,254 | 4,372,993 | -59.5% |
| Derived gas | 349,857 | 161,644 | -53.8% |
| Industrial and municipal waste | 524,956 | 471,732 | -10.1% |
| Biogasoline including hydrated ethanol | 317,431 | 274,765 | -13.4% |
| Biodiesel | 754,106 | 740,704 | -1.8% |
| Other combustible renewables | 2,532,641 | 1,793,076 | -29.2% |
| Electricity + Electricity for e-mobility | 12,296,131 | 23,448,020 | 90.7% |
| Heat | 1,872,840 | 1,115,022 | -40.5% |

| | | | |
|---|---|---|---|
| Biogas | 1,553,756 | 7,484,947 | 381.7% |
| Hydroelectric | 1,353,264 | 5,055,998 | 273.6% |
| Geothermal | 392,994 | 1,521,961 | 287.3% |
| Photovoltaic | 329,305 | 1,524,774 | 363.0% |
| Solarthermal heat | 209,967 | 949,117 | 352.0% |
| Solarthermal electricity | 6,946 | 33,625 | 384.1% |
| Wind power | 1,243,330 | 5,733,131 | 361.1% |
| Nuclear | 10,766,340 | 11,038,929 | 2.5% |

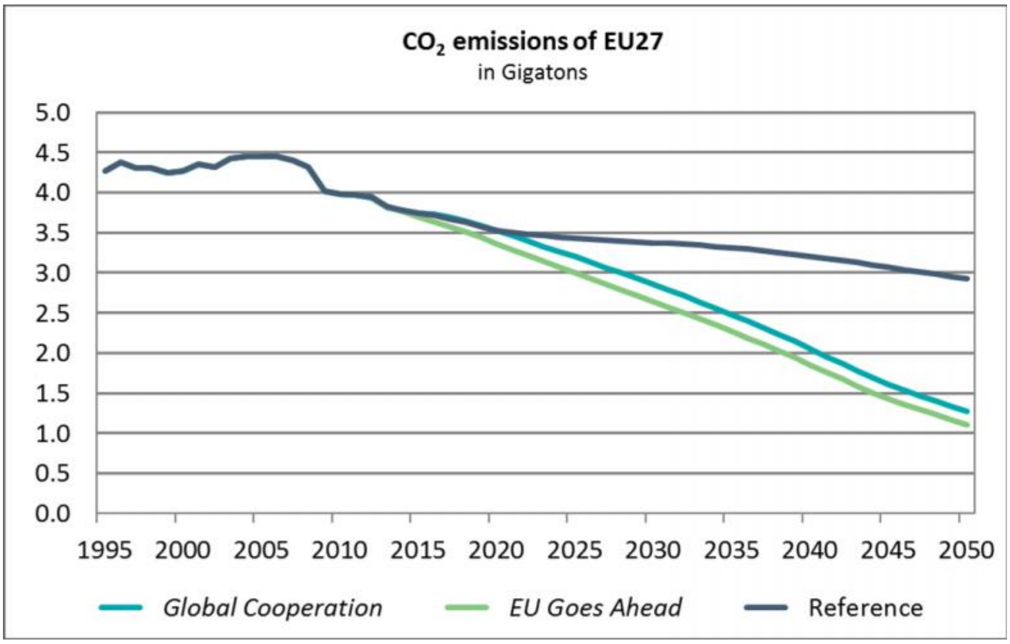
The just mentioned climate policy measures reduce global $CO_2$ emissions to about 33 Gt (Figure 39), which is below the target (RCP 4.5) of about 40 Gt.

***Figure 39: Scenario EU Goes Ahead – the impact on global $CO_2$ emissions***




In the EU the emissions reach 1.1 Gt in 2050 (Figure 40), which is very close to the target of 0.9 Gt. In terms of reduction the target is 80% and we reach 76.1%.

***Figure 40: Scenario EU Goes Ahead – the impact on $CO_2$ emissions of EU27***

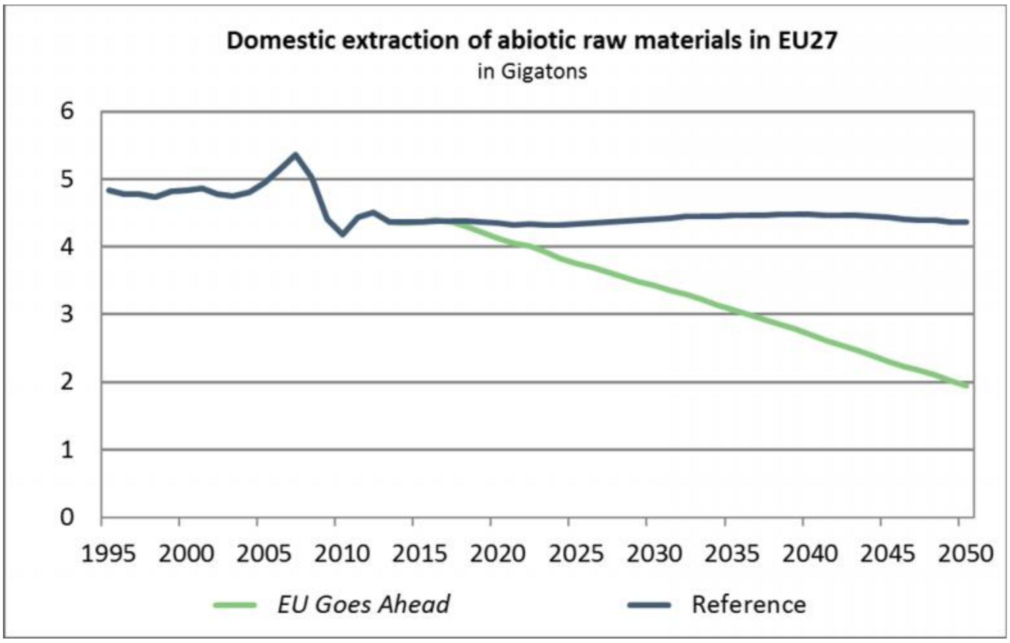



### 5.3.2 Extraction of abiotic raw materials

In the scenario *EU Goes Ahead* policy measures to enhance abiotic raw material efficiency are only implemented in the EU. The effect on global material extractions can be neglected, because the very small effect is compensated by rebound effects on the global scale.

The impact on domestic extraction in the EU, which is dominated by construction minerals, is depicted in Figure 41. Till 2050 it is reduced by 53.8% against the reference.

***Figure 41: Scenario EU Goes Ahead – the impact on domestic extraction of abiotic raw material in EU27***

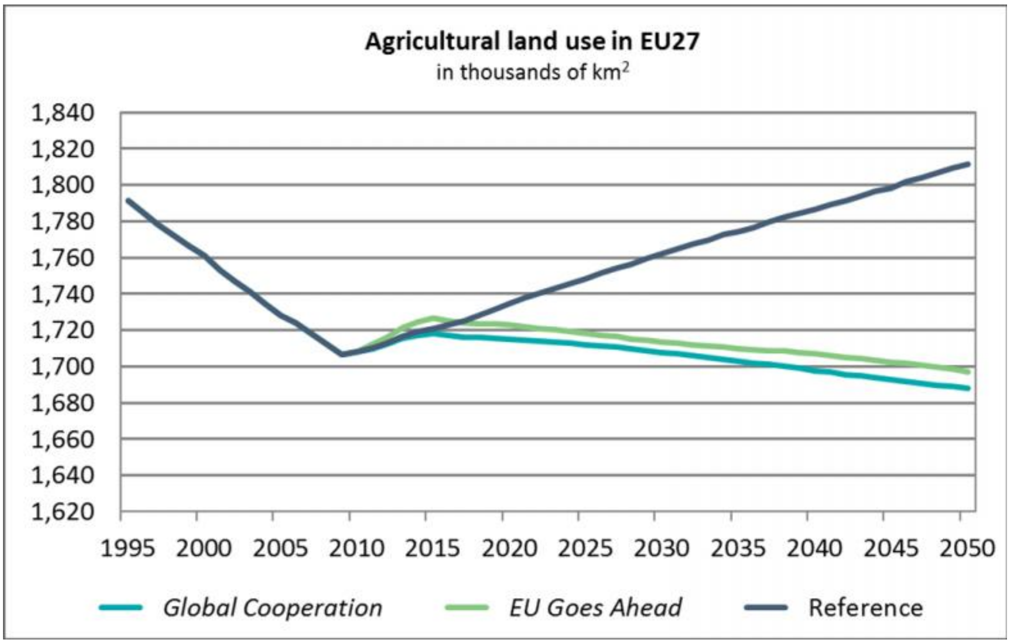


The indicator RMC per capita, which measures the direct extractions in the EU plus the materials hidden in imports minus those that are hidden in exports, has in 2050 for scenario EU Goes Ahead the number 5.6. This is more than the targeted 5.0, but if we mention that the actual value is 12.5 it might be accepted. The reduction is 55% instead of 60%.

### *5.3.3 Use of Biotic Resources, Land and Water*

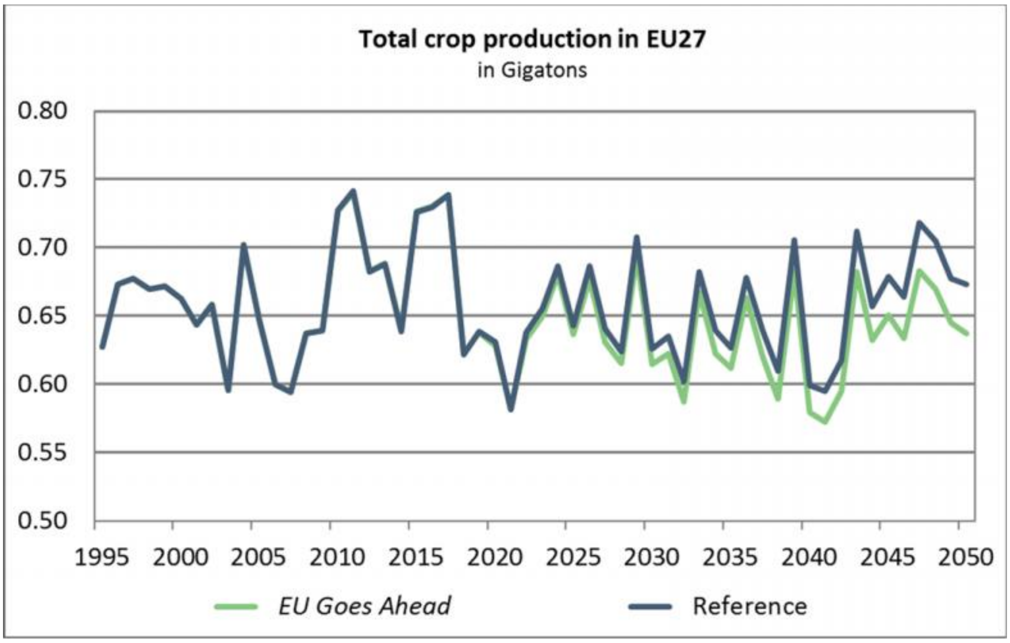
Agricultural land use in million hectares is in the EU restricted to the actual situation. As Figure 42 shows, this means a reduction against the reference of 6.3%.

***Figure 42: Scenario EU Goes Ahead – the impact on agricultural land use in EU27***



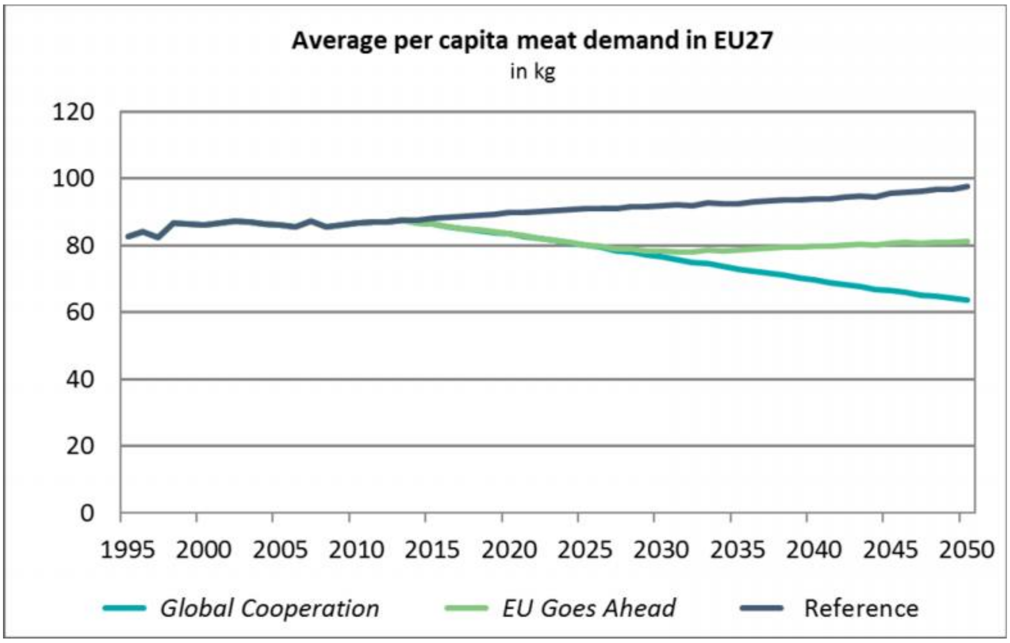

Total crop production in the EU reduces by 5.4 % (Figure 43), which is - as in the scenario *Global Cooperation* - close to the reduction of agricultural land use. So here also the program for the closure of the yield gap has only very small effects.

***Figure 43: Scenario EU Goes Ahead – the impact on crop production in EU27***



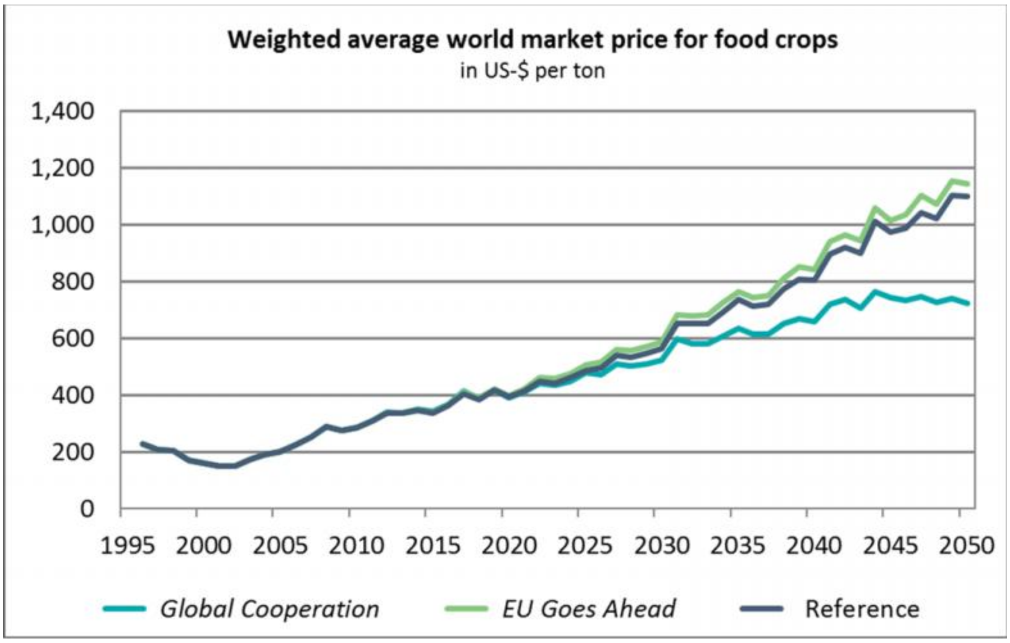

The livestock prices in the EU rise till 2050 by 70% linearly against the reference. Since the price elasticity is relatively low in addition an autonomous reduction based on intrinsic motivation of the consumers was necessary to reach the reduction of per capita meat consumption against the reference of 16%, which stabilizes meat consumption per capita in the EU more or less at the actual level (Figure 44). Since this is much less than the reduction in Global Cooperation also the reduction of crop demand for feed is less than in Global Cooperation. Further it has to be mentioned that exports into Non- EU countries are now not negatively affected.

***Figure 44: Scenario EU Goes Ahead – the impact on meat demand in EU27***



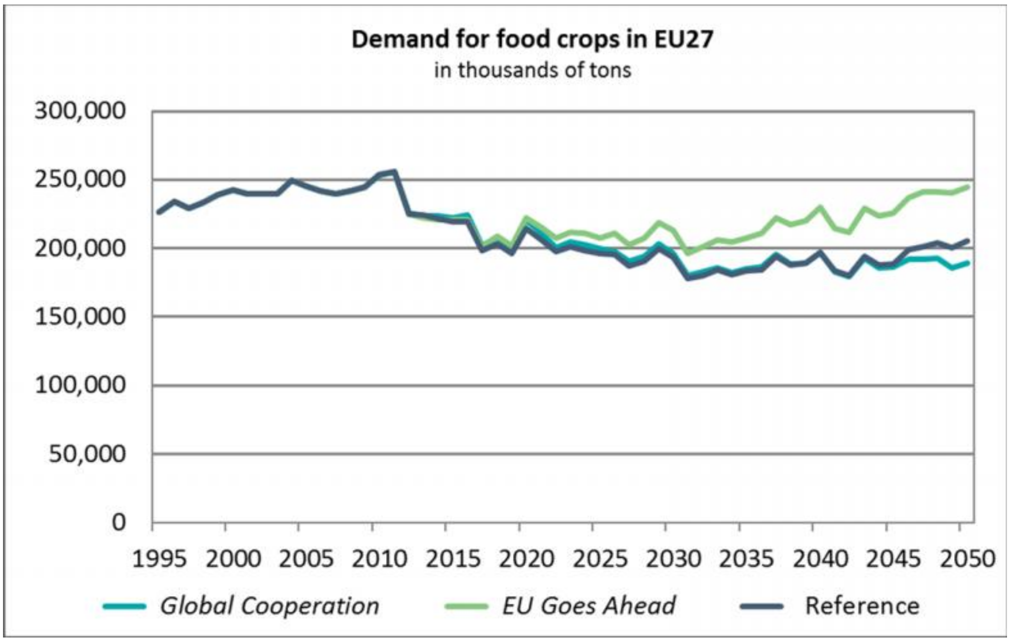
The weighted average of world market prices for crops is of course negatively influenced by the reduction of meat demand in the EU and the following reduction of crop demand for feed purposes, but the much stronger influence from the Non-European countries is now missing. In addition we will see later that the scenario *EU Goes Ahead* has stronger positive growth effects even than Global Cooperation. This explains why we now have even higher crop prices than in the reference, as Figure 45 shows for the weighted world market food prices.

***Figure 45: Scenario EU Goes Ahead – the impact on world market prices for food crops***




The rather small reduction of crop demand for feed crops means a rather low increase in demand for food crops as is shown in Figure 46. A demand for food crops of 1000 tons in EU27 equals more or less the number of the reference and is even in the last years lower whereas in the scenario *Global Cooperation* there was a positive deviation of 20%.

***Figure 46: Scenario EU Goes Ahead – the impact on the demand for food crops in EU27***




Domestic cropland use falls as in the scenario *Global Cooperation* by 7% compared with the reference. Due to positive impacts on the balance of trade (with crops) a further reduction of the average per capita crop land footprint in EU27 is achieved (in 2050: 0.248 ha in the scenario *EU Goes Ahead* against 0.268 ha in the *Reference* scenario) and the target of a 30% reduction against the historic value of 2005 is met.

The average water exploitation index in EU27 in the year 2050 is now 9.4% (Global Cooperation 9.6%), which means that with the reduction of water abstraction of agriculture in the countries mentioned in Global Cooperation, the target will be also met.

### *5.3.4 Economic Development*

The general story in the background is similar to the one of the scenario Global Cooperation:

The economic development is driven mainly by these impacts: The investment in new technologies for renewable energies, grids and the energy efficiency of buildings and recycling pushes the circular flow of income and thus raises growth. The long run rise of the capital stocks means higher capital costs and insofar higher prices, this has negative effects on GDP in later years. On the other side the lower material intensity of the global economy reduces costs and prices in manufacturing and the lower demand for fossil fuels and ores in addition drops extraction prices down.

The substitution of materials like fossil fuels, ores and non-metallic minerals reduces costs in manufacturing and therefore gives positive impacts on GDP. The mining and quarrying sectors and the directly following stages of production suffer of course from the reduction of demand of their products, which gives negative impacts on GDP. For a country in question the GDP effect of material efficiency is depending from its position in the international division of labour. Those countries that are importing materials are winners and those that are exporting materials are losers. These effects are steadily rising from 2015 to 2050.

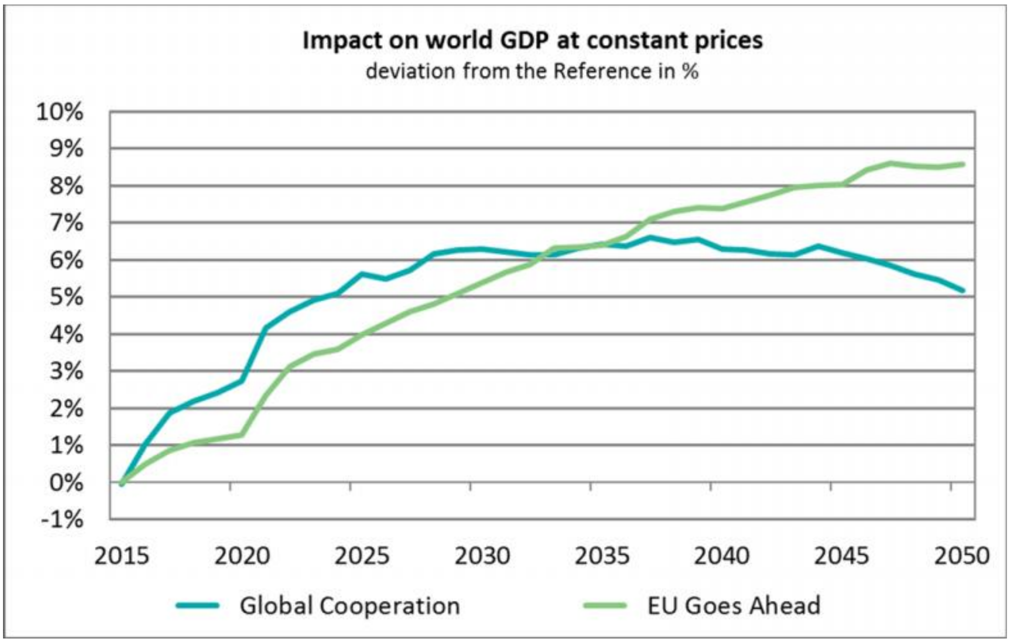
But now global climate policy is moderate and the Non- EU countries are not engaged in material efficiency policy, which means that the negative effects on the extracting economies are less than in the scenario Global Cooperation as Table 14 shows for selected countries.

***Table 14: Scenario EU Goes Ahead – the impact on the economy of selected countries***

| | GDP at constant prices - deviation from the *Reference* scenario in % in the year 2050 | |
|---|---|---|
| | Scenario *Global Cooperation* | Scenario *EU Goes Ahead* |
| Russia | -27.7% | -11.3% |
| Brazil | -16.5% | -0.8% |
| Canada | -7.0% | 2.0% |

For global real GDP this means that the deviation from the reference is with 8.6 % much higher than in Global Cooperation (Figure 47).

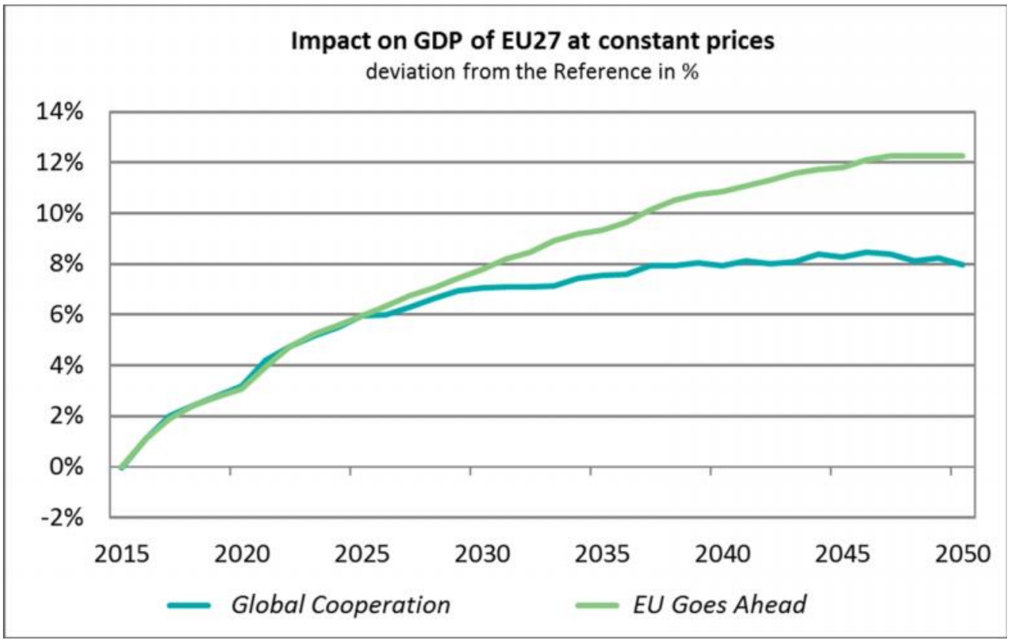
***Figure 47: Scenario EU Goes Ahead – the impact on the global economy.***




The central question for the scenario *EU Goes Ahead* is whether the engaged climate and material efficiency policy of the EU is economically feasible if in all other countries only a moderate climate policy and no actions in material efficiency policy are implemented. A look at Figure 48 gives the answer: yes, the deviation from the reference in 2050 is with 12.3 % much higher than in scenario *Global Cooperation*.

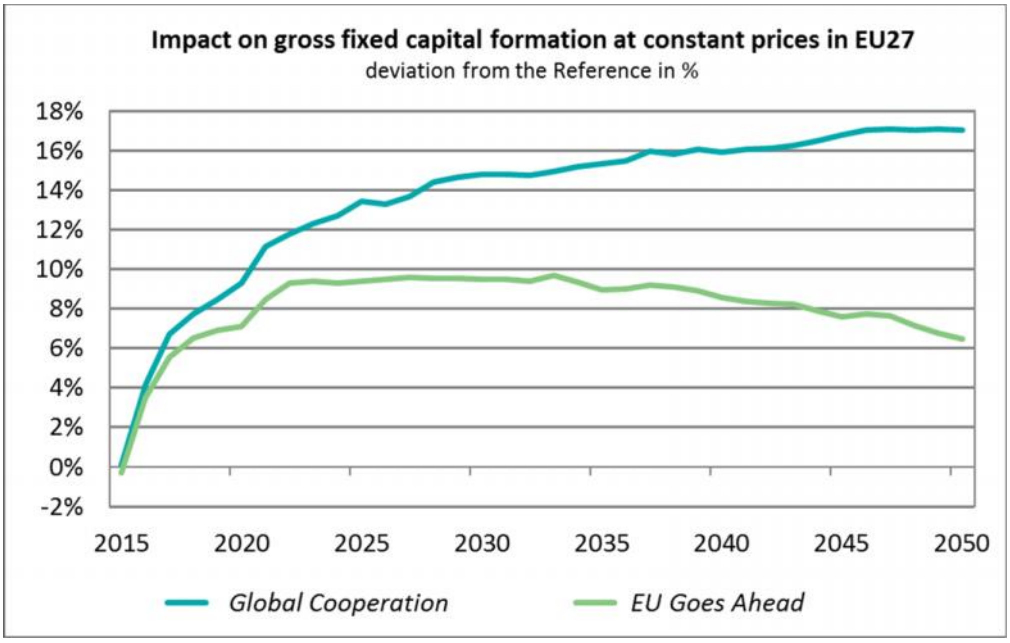
How can this be explained? First we have to see that we did not install the same policies in both scenarios. There are important differences concerning the taxation instruments. In the scenario *Global Cooperation* an upstream carbon tax was assumed for all industries. In the scenario *EU Goes Ahead* the ETS system for the basic industries and for the other industries a carbon tax has been installed with direct compensation. Direct compensation means that the tax revenue of an industry is given back to that industry using gross production of the firms for the allocation of money. This means that firms of that particular industry with high carbon intensities have higher costs, whereas firms with lower carbon intensities have lower costs. For the industry average costs are not affected and there is a strong incentive to reduce carbon intensity. So there will be no lack of international competitiveness from taxation.

***Figure 48: Scenario EU Goes Ahead – the impact on the economy of EU27***



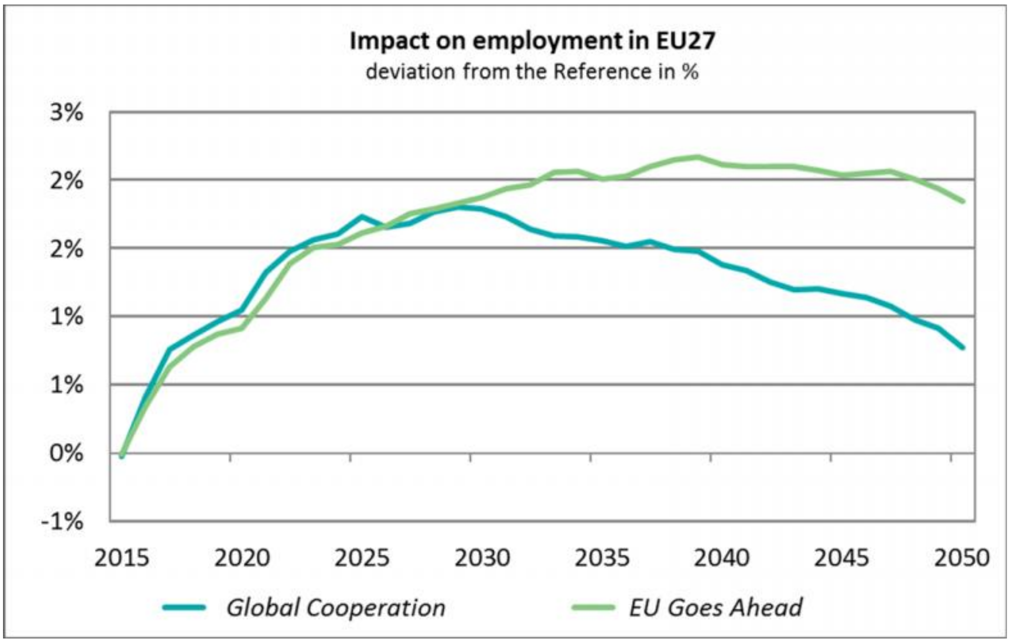

The tax on construction minerals does not affect international competitiveness, because construction minerals are only marginally traded. Further the use of construction minerals is concentrated in industries that are not in international competition. The RMC based tax on ores hits only final demand of goods that are directly and indirectly very material intensive. This tax hits demand coming from domestic production and also imported consumer durables. Insofar there is no effect on international competitiveness. Since the taxation is equipped with an environmental tax reform (ETR) there are also no negative effects from that side: As already said the carbon tax is directly compensated. The RMC tax on final demand is compensated by subsidies on environmentally harmless goods. Investment goods belong to the material intensive goods. Insofar it is plausible that the deviation from the reference for real investment demand are still positive but lower than in the scenario Global Cooperation as Figure 49 shows.

***Figure 49: Scenario EU Goes Ahead – the impact on investment in fixed assets in the EU***



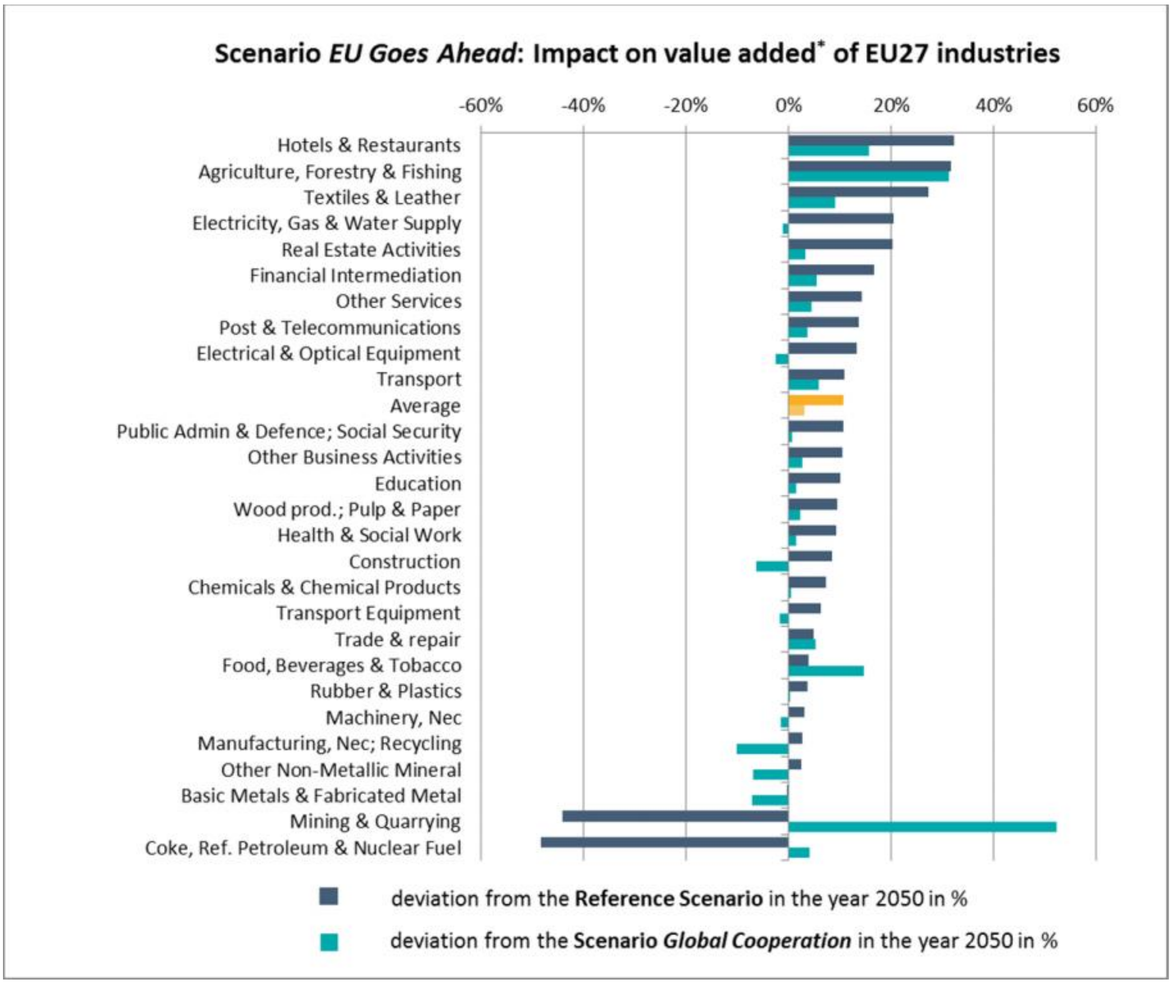

The subsidies on environmentally harmless goods raise the intermediate demand of firms and final demand of households especially for services and other goods which in most cases have labour intensive technologies. Insofar it is not surprising that the deviation from the *Reference* for employment is positive and bigger than in the scenario *Global Cooperation*. The positive impact on employment in 2050 amounts to 1.8 %. From 2030 to 2043 permanently 4 million additional jobs are created. In the last years this positive deviation reduces a bit.

***Figure 50: Scenario EU Goes Ahead – the impact on employment in the EU***




To summarize the impacts of the scenario on the different industries Figure 51 illustrates two different aspects. On the one hand (as in Figure 34 for the scenario *Global Cooperation*) the deviations against the Reference Scenario for the value added of the different industries in EU27 are shown. These are the dark blue bars in the figure. On the other hand one objective of the scenario *EU Goes Ahead* is to figure out whether it is favourable or not for the EU economy to lead the transition process. Therefore the turquoise bars in the figure compare the modelling results for the scenario *EU Goes Ahead* with those of the scenario *Global Cooperation*. As we can see in the average the European industries are gaining from the transition (+11%) and they are gaining even stronger than in the scenario Global Cooperation (+3%). If we look at the bottom of figure we can see that the industries that loose value added compared to the Reference are the same as in the scenario *Global Cooperation*: the mining and quarrying industry and the manufacturing of coke & refined petroleum. But the positive turquoise bars indicate that the losses especially for the mining & quarrying industry are reasonably smaller than in the scenario *Global Cooperation*. The figure also shows that for many industries the impact on value added is quite similar but a little bit more positive than in the scenario *Global Cooperation*. The biggest positive deviations from the previous scenario can be observed for those sectors that are involved in the food value chain (agriculture, manufacturing of food & beverages and hotels and restaurants).

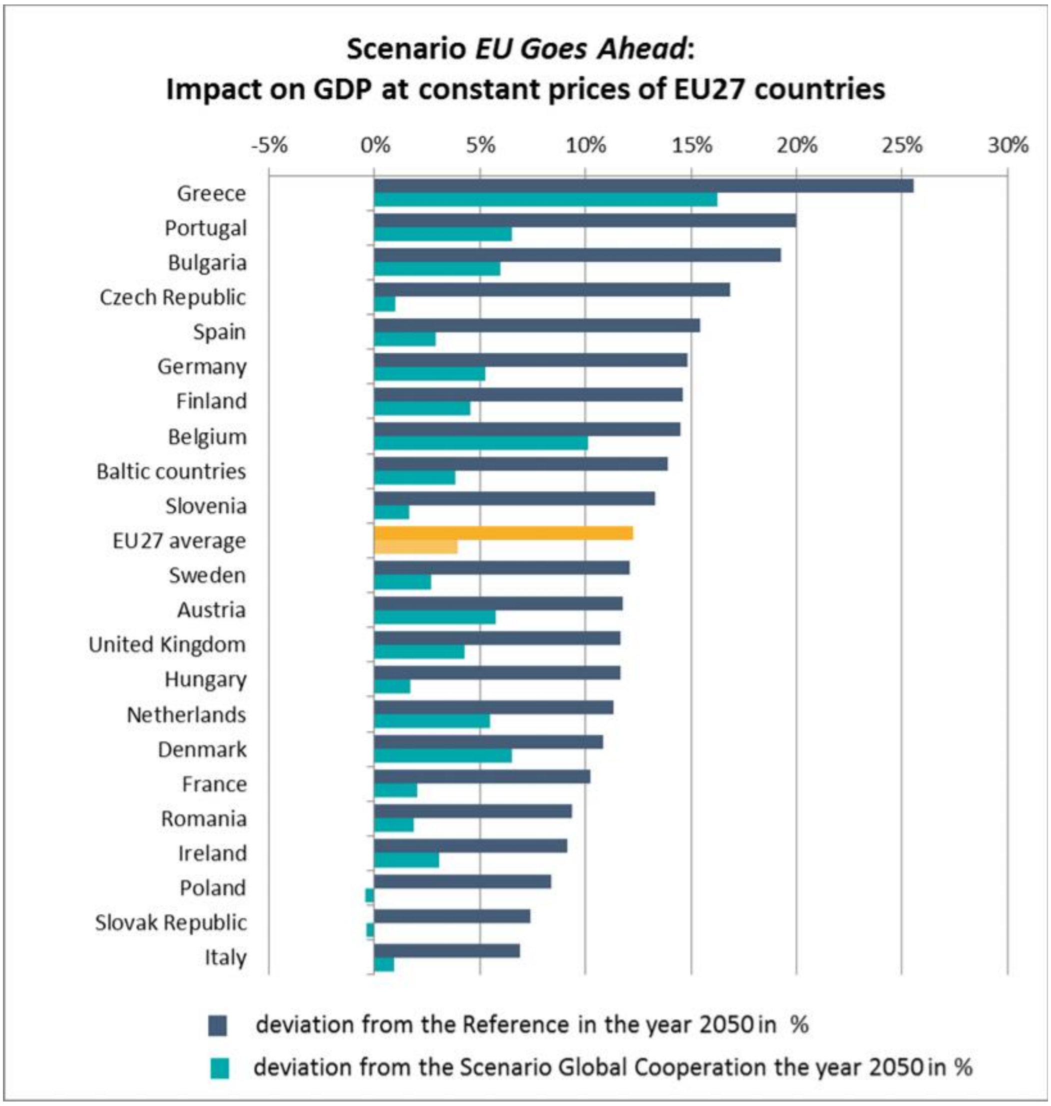
***Figure 51: Scenario EU Goes Ahead – the impact on value added of different industries in EU***




* Value added deflated by GDP price in 1995 US-$

As already exercised for the Scenario Global Cooperation the last figure on the results of the scenario shows the impact on macro-economic growth for the different EU27 countries. Compared to the modelling results for the Reference scenario in the year 2050 all EU countries show a positive impact of the transition process on GDP (see dark blue bars in the figure). For nearly all countries the economic impacts are bigger than those identified for the scenario Global Cooperation (see turquoise bars in the figure). Only Poland and the Slovak Republic cannot gain from the leading role of the EU according to the modelling results. Especially for Greece and Portugal the modelling results indicate that an ambitious policy to enhance resource efficiency is a way to overcome the current economic crisis.

***Figure 52:   Scenario EU Goes Ahead – the impact on GDP of EU countries***



# 6 The Scenario *Civil Society Leads*

In this scenario the EU countries try to meet their targets by "bottom-up" instruments. This means that intrinsic motivation of citizens rules structural change. The Non-EU countries behave as in the scenario *EU Goes Ahead*.

## 6.1 The assumptions for exogenous variables

All assumptions on exogenous variables are the same as in scenario EU Goes Ahead.

## 6.2 The policy mix

### *6.2.1 Climate policy*

**Regulation for renewables in electricity production**

As in scenario *EU Goes Ahead*.

**Reform of the ETS**

As in scenario *EU Goes Ahead*.

**Carbon tax with direct compensation**

As in scenario *EU Goes Ahead*.

**E-mobility**

As in scenario *EU Goes Ahead*.

**Autonomous reduction of air transport**

Consumers reduce the share of private consumption that they spend for air transport linearly till 2050 by 25%.

**Shared housing**

Different studies have shown the significant potentials of new modes of living, especially with regard to multi-generation houses (Mahdavi et al., 2012). Citizens that change their habits in this direction reduce their demand for living space by 50% and as a consequence also their energy demand for heating. In the scenario Civil Society Leads it is assumed that up to 2050 in the EU 20% change their habits in this way, with the appropriate impacts on investment in buildings.

### *6.2.2 Policy measures to enhance abiotic raw material efficiency*

**Regulation of recycling of ores**

As in scenario *EU Goes Ahead*.

**Regulation of recycling of non–metallic minerals**

As in scenario *EU Goes Ahead*.

**Public innovation fund for material efficiency**

As in scenario *EU Goes Ahead*.

**Mandatory eco-design standards for reuse and repairability**

Direct impacts of increasing the reuse and repairability by eco-design standards until 2050 are extremely difficult to estimate. The analysis of case studies for specific products shows significant potentials, inter alia by introducing product-service-systems with much higher incentives for more durable goods.

It is assumed that extending the average actual use phase of durables could lead to a reduced demand of durable goods (compared to the BAU scenario) of electrical machinery in households of 5 %. At the same time the demand for repair services including upgrading of more modular products could double until 2050.

**Autonomous reduction of demand for consumer durables**

This means especially the common use of the material intensive consumer durables which is organized privately outside the economy. The common use will raise the efficiency of the stocks of durables which finally reduces the demand for these products. Effects of such a systemic innovation could be significant but extremely hard to estimate (see several case studies e.g. Fischer et al., 2012). It is assumed that the overall reduction in the demand for durable goods compared to the reference scenario could be about 15%. Single case studies show much higher reduction potentials (e.g. RICOH´s document management services with expected material reductions of about 87.5% until 2050).

For cars, where the shared use already is not a niche market in many cities, the scenario assumes a demand reduction of 15% compared to the reference.

**Autonomous reduction of total final demand of private households**

The autonomous reduction of total consumption has been calibrated so that the targets could be more or less reached. For this purpose it was necessary to reduce exogenously total consumption year by year by -0.3%. Since over a period of 35 years a lot of negative effects on the other variables of the circular flow of income are induced, which feedback to an endogenous reduction of disposable income, total consumption at the end is reduced much more as will be shown later.

### *6.2.3 Policy measures to enhance biotic resource efficiency*

**Reduction of water withdrawal of agriculture**

To reach the water exploitation target of 20% it will be necessary in some countries to reduce the water withdrawal of agriculture.

**Information program for the reduction of the crop yield gap**

As in Scenario *EU Goes Ahead*.

**Autonomous reduction of meat consumption**

Given the increasing share of vegetarians in Europe it could be assumed that in 2050 50% of the population don´t eat meat. The scenario assumption is an autonomous reduction of meat consumption per capita of 50% till 2050.

**Autonomous reduction of food waste by consumers**

Assumptions for avoidable food waste and thus expected reduction of food demand differ significantly between studies, countries etc. On average it seems plausible to estimate a share of 40% avoidable food waste (as reported e.g. in Sweden) till 2050.

**Autonomous reduction of food waste by producers and hotels and restaurants**

For producers it is assumed that 10% of the food inputs are waste which can be avoided till 2050. For hotels and restaurants this number is 20%.

**Autonomous reduction of labour supply**

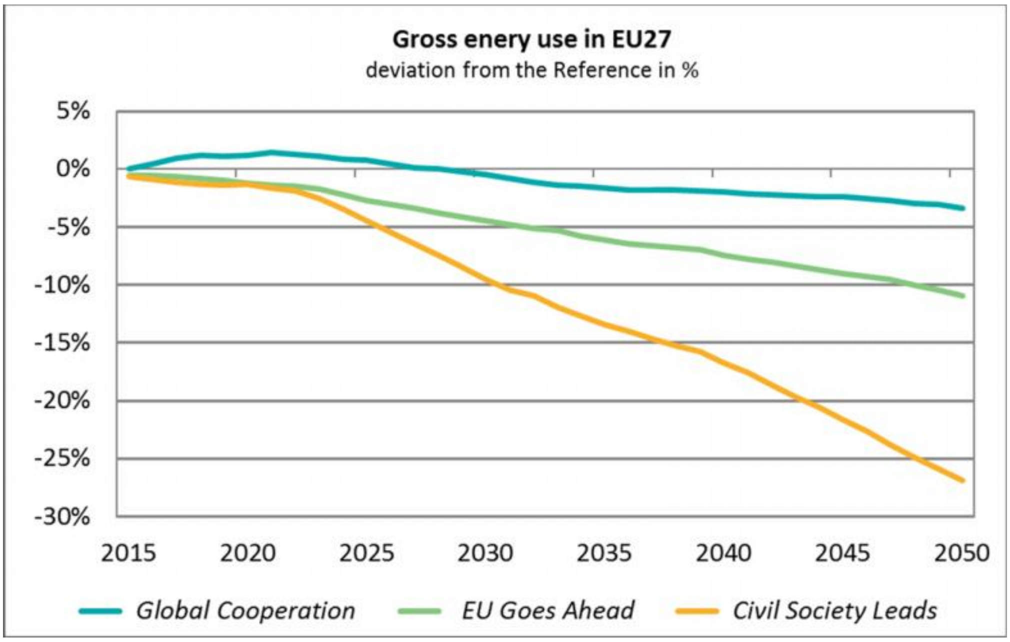
Based on a study that compared actual and desired working hours we could assume an autonomous reduction of 7.2 hours or 20% (Skinner et al., 2012).

## 6.3 The results of the simulation

### *6.3.1 Energy and emissions*

The climate policy assumptions of the scenario *Civil Society Leads* are very similar to those of the scenario *EU Goes Ahead*. How can the difference between both scenarios concerning for total gross energy use in EU27 be explained as it is shown in Figure 53 ? The deviation to the reference in the year 2050 is -11 % for the scenario *Global Cooperation* and -27% for the scenario *Civil Society Leads*. The main point is the zero growth development in *Civil Society Leads*, which is induced by the reduction of total consumption expenditures by private households of about -39% compared with the reference. In the scenario *Civil Society Leads* the average per capita consumption expenditure at constant prices falls back to the level of the year 1995.

***Figure 53: Scenario Civil Society Leads – the impact on energy demand in EU27***



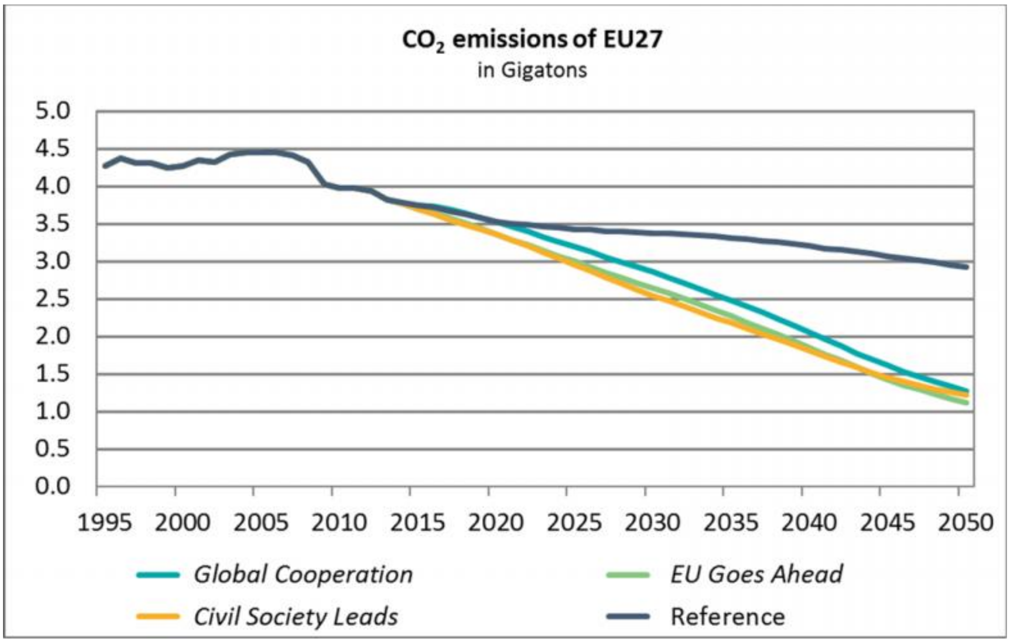

The composition of gross energy use is depicted in Table 13. Since energy policy is also implemented in the scenario *Civil Society Leads*, most effects are similar to the scenario *EU Goes Ahead*. The main difference between both scenarios is given with the impact on electricity production and on nuclear. Since the share of 90% for renewables in electricity production is reached in 2050 there will be conflicts with the assumption of constant shares for renewables in many countries which induces a reduction of the nuclear shares. Therefore together with the only moderate rise of electricity production – which is driven by the behaviour of consumers – the level of nuclear is reduced by 32%.

***Table 15: Scenario Civil Society Leads – the impact on the composition of gross energy use in EU27***

| | Gross energy use in EU27 in the scenario ... in 2050. Deviation from the Reference in % | | |
|---|---|---|---|
| | *Global Cooperation* | *EU Goes Ahead* | *Civil Society Leads* |
| Hard coal and derivatives | -69.8% | -73.6% | -72.4% |
| Lignite and derivatives | -90.3% | -91.2% | -91.2% |
| Coke | -6.1% | -20.2% | -17.6% |
| Crude oil, NGL and feedstocks | -55.4% | -56.5% | -58.9% |
| Diesel oil for road transport | -79.8% | -86.0% | -91.6% |
| Motor gasoline | -77.1% | -84.9% | -95.0% |
| Jet fuel (kerosene and gasoline) | -6.3% | -19.1% | -39.4% |
| Light Fuel oil | -47.2% | -51.3% | -19.0% |
| Heavy fuel oil | -52.6% | -57.1% | -35.5% |
| Naphta | -44.6% | -47.1% | -15.1% |
| Other petroleum products | -46.0% | -51.2% | -33.6% |
| Natural gas | -57.4% | -59.5% | -38.2% |
| Derived gas | -47.3% | -53.8% | -55.4% |
| Industrial and municipal waste | -9.4% | -10.1% | -7.0% |
| Biogasoline including hydrated ethanol | -16.1% | -13.4% | -65.6% |
| Biodiesel | -21.2% | -1.8% | -52.0% |
| Other combustible renewables | -26.6% | -29.2% | -3.6% |
| Electricity + Electricity for e-mobility | 107.4% | 90.7% | 24.7% |
| Heat | -35.9% | -40.5% | -12.2% |
| Biogas | 425.3% | 381.7% | 227.9% |
| Hydroelectric | 304.4% | 273.6% | 176.3% |
| Geothermal | 322.8% | 287.3% | 161.4% |
| Photovoltaic | 406.6% | 363.0% | 199.8% |
| Solarthermal heat | 388.5% | 352.0% | 199.0% |
| Solarthermal electricity | 434.1% | 384.1% | 204.0% |
| Wind power | 399.9% | 361.1% | 216.6% |
| Nuclear | 12.8% | 2.5% | -31.9% |

The impact on $CO_2$ emissions in the EU are very close to that of the scenario *EU Goes Ahead* as Figure 54 shows. The target is reached in 2050.

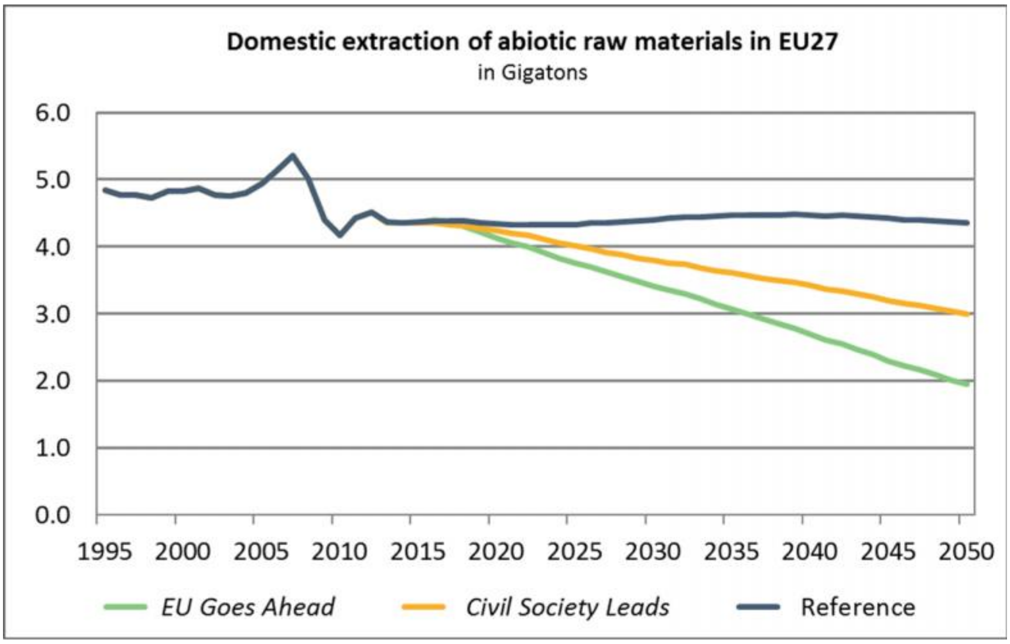
***Figure 54: Scenario Civil Society Leads – the impact on $CO_2$ emissions in the EU***




### *6.3.2 Extraction of abiotic raw materials*

The scenarios *EU Goes Ahead* and *Civil Society Leads* have the same assumptions about recycling of materials. In the scenario *EU Goes Ahead* the inputs of materials are further taxed and the structural change of production is the main power to reduce material inputs. In the scenario *Civil Society Leads* autonomous changes in the structure and the level of consumption have to fulfil this task. As Figure 55 shows this works only partly: In 2050 the domestic total abiotic extractions in the EU are only 33% lower than in the reference, whereas in EU Goes Ahead a reduction of 54% can be achieved.

***Figure 55: Scenario Civil Society Leads – the impact on domestic extraction of abiotic raw materials in the EU.***

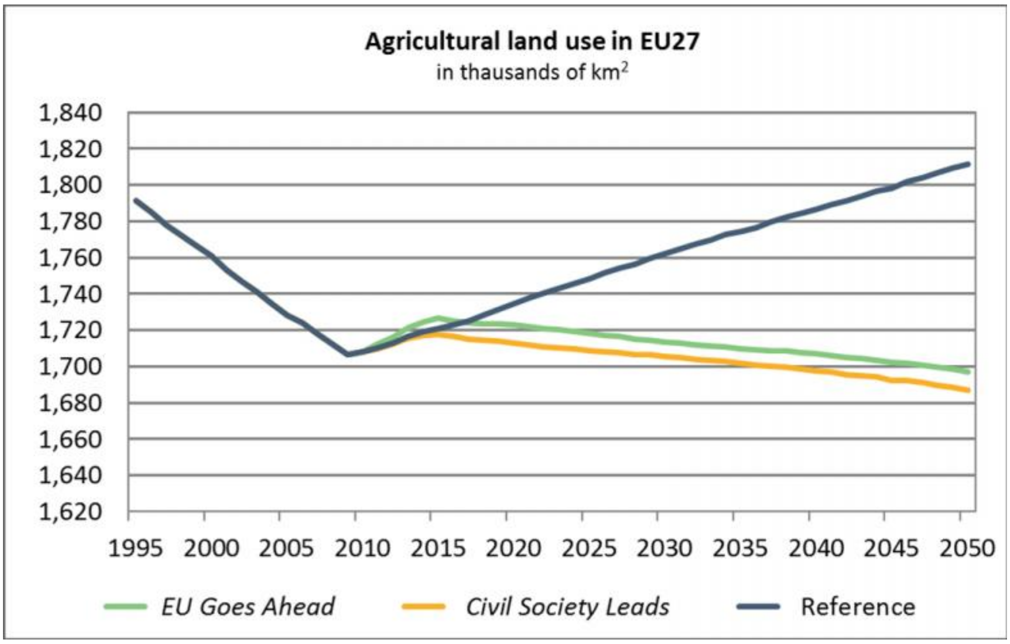


The indicator RMC accounts in addition to the domestic extraction the direct and indirect raw material imports and deducts the direct and indirect raw material exports. In the scenario *Civil Society Leads* this indicator reaches for the EU27 in 2050 a value of 6.9 tons per capita. In the scenario *EU Goes Ahead* this indicator is in 2050 with 5.6 tons per capita much closer to the target 5.0 tons per capita.

### 6.3.3 Use of biotic resources, land and water

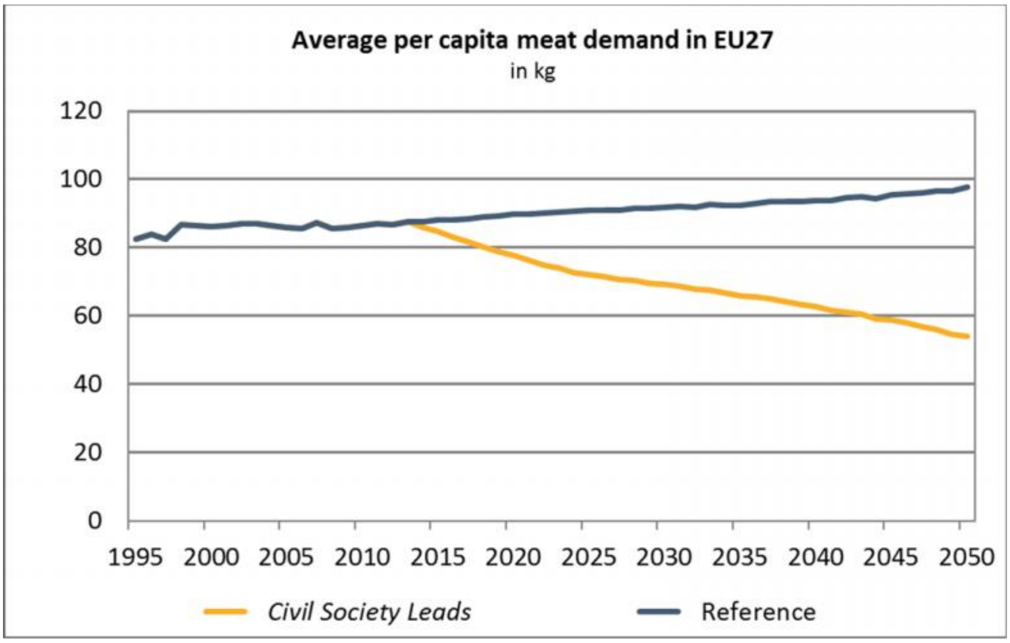
The agricultural land use in the EU27 is in the scenarios *EU Goes Ahead* and *Civil Society Leads* more or less the same: In both scenarios the target in fulfilled.

***Figure 56: Scenario Civil Society Leads – the impact on agricultural land use in the EU***



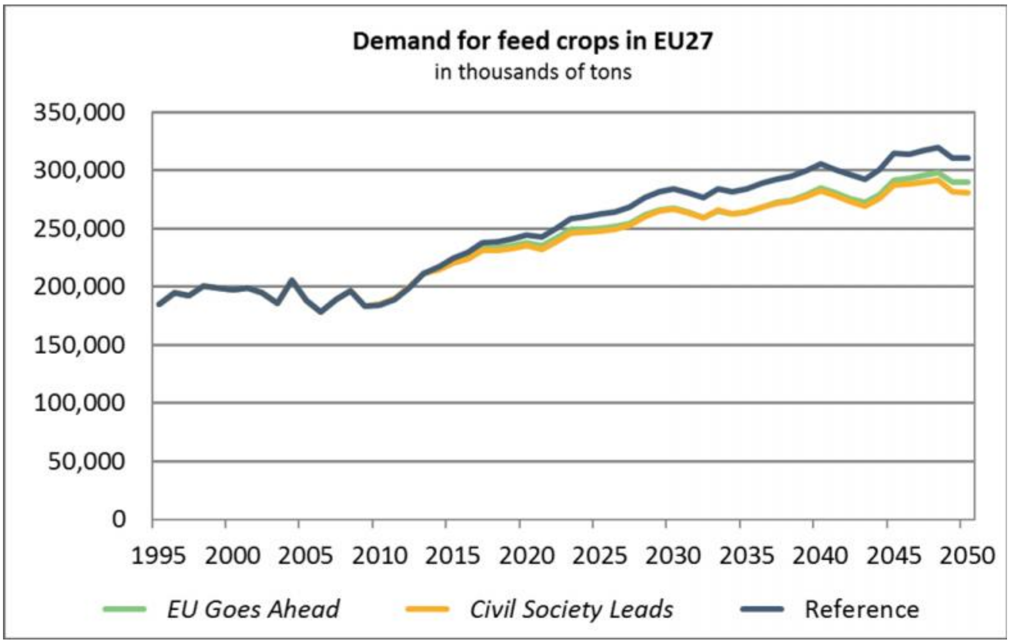

Per Capita meat consumption is in the scenario *Civil Society Leads* much stronger reduced than in the *EU Goes Ahead* scenario. For the EU27average up to 2050 a reduction to 54.7 kg per capita will be achieved in the scenario *Civil Society Leads*, in the other scenario 81.5 kg per capita are much closer to the reference.

***Figure 57: Scenario Civil Society Leads – the impact on average per capita meat demand in the EU***



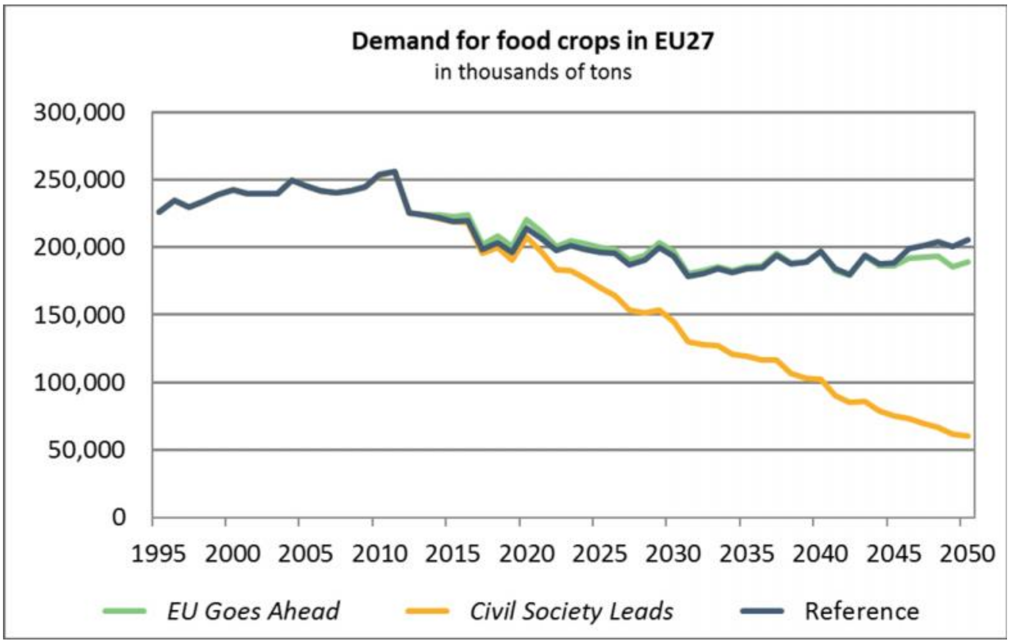

Less meat demand in the EU induces a reduced domestic demand for feed crops in comparison to the Reference (-10% in 2050). As Figure 58 shows, this reduction is a little bit stronger than in the scenario *EU Goes Ahead*.

***Figure 58: Scenario Civil Society Leads – the impact on demand for feed crops in the EU***



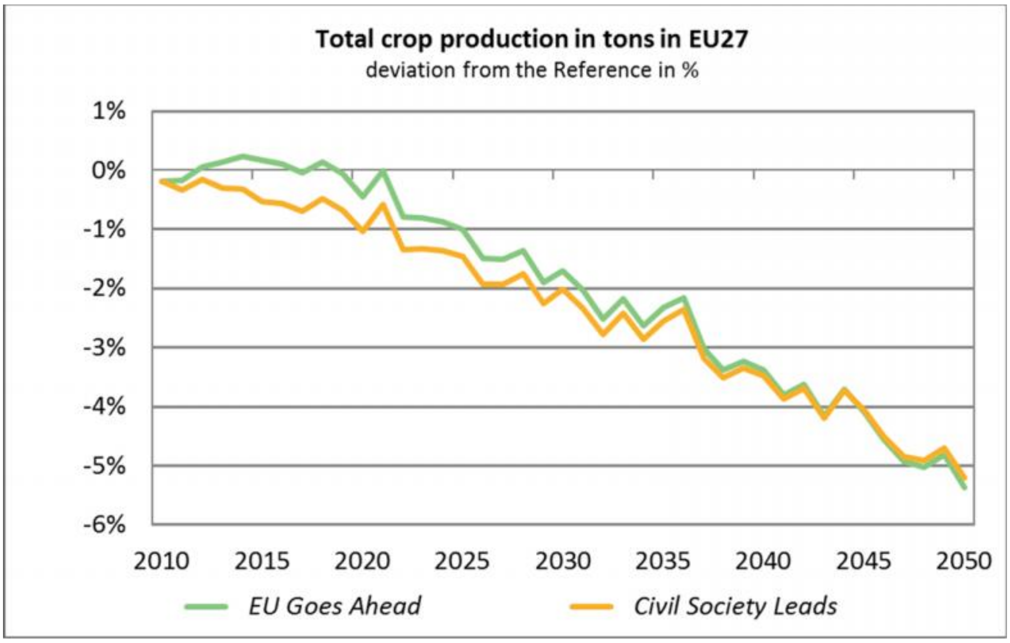

In 2050 demand for food crops in EU27 is -40% lower than in the Reference (Figure 59). This number equals the reduction of the level of consumption demand (-38%). This effect is contrary in comparison with the scenario *EU Goes Ahead*, where we observed a more or less unchanged demand for food crops to the Reference.

***Figure 59: Scenario Civil Society Leads – the impact on demand for feed crops in the EU***



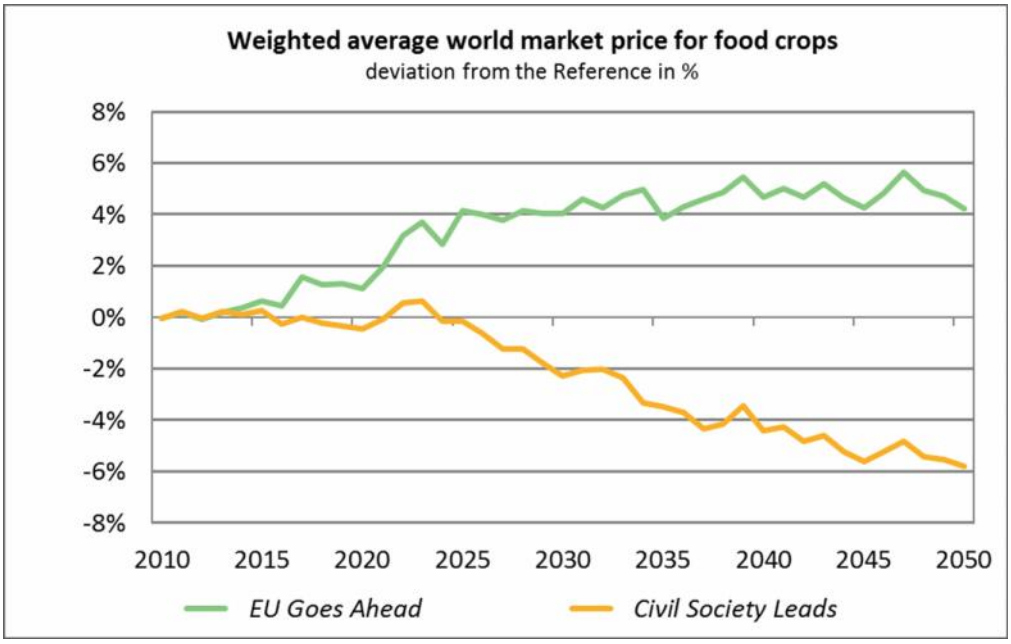

Farmers in the EU use the land that is not needed to meet domestic demand for exports. Therefore the impact on total domestic crop production in EU27 is more or less identical in the scenarios *EU Goes Ahead* and *Civil Society Leads* (Figure 60). As domestic demand for crops is lower in the *Civil Society Leads* than in the scenario *EU Goes Ahead* this implies that in the scenario *Civil Society Leads* the EU produces agricultural products to a much higher degree for exports.

***Figure 60: Scenario Civil Society Leads – the impact on crop production in the EU***



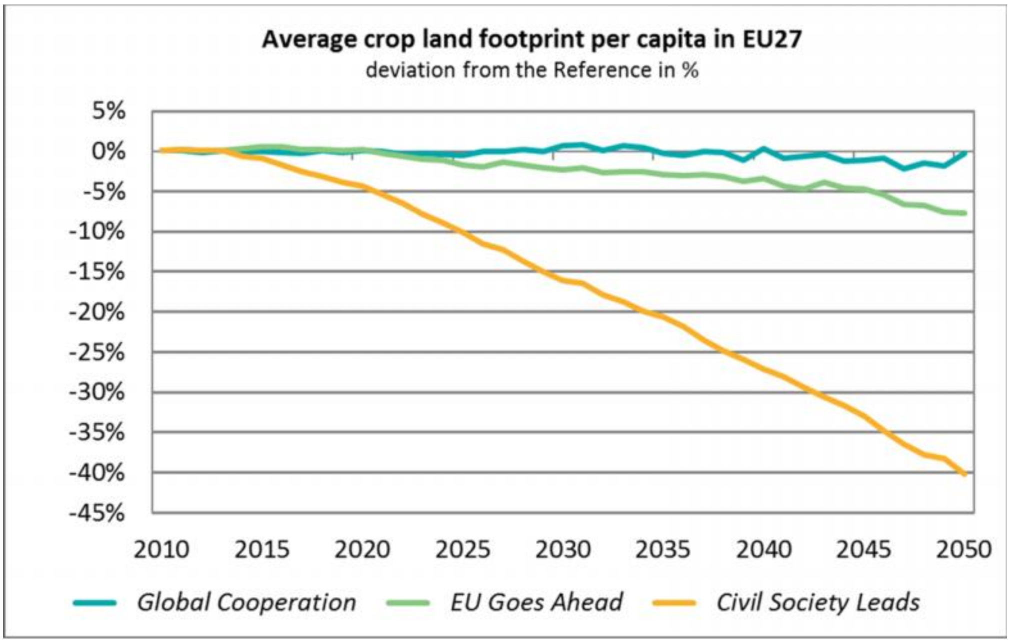

In the scenario *Civil Society Leads* the behavioural changes of EU citizens stabilize the global market for food as the price developments in Figure 61 show.

***Figure 61: Scenario Civil Society Leads – the impact on world market prices for food crops***




The impact on the average per capita cropland foot print of the EU is depicted for all transition scenarios in Figure 62. Only scenario the scenario *Civil Society Leads* shows a substantial negative deviation from the Reference which is in line with the above mentioned considerations.

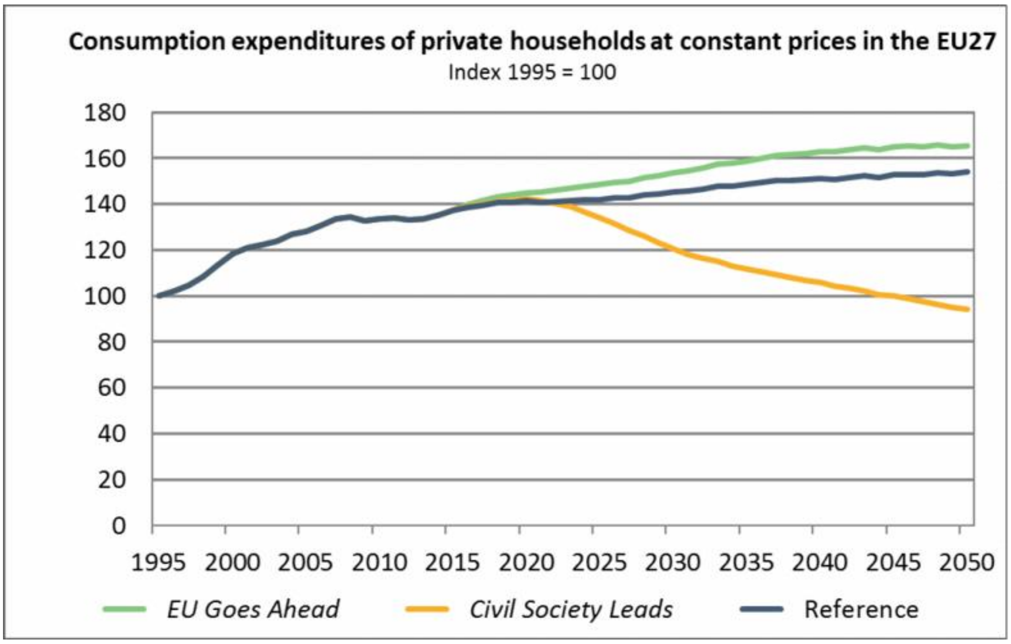
***Figure 62: Scenario Civil Society Leads – the impact on the average per capita crop land footprint in the EU***




### *6.3.4 Economic Development*

The dominating influence on the economic development in the scenario *Civil Society Leads* is related to the reduction of the level of total consumption. In the scenario *EU Goes Ahead* real private consumption rises in relation to the reference because disposable income of households expands. In the scenario *Civil Society Leads* the intrinsically motivated reduction of private consumption due to the economic cycle reduces income and leads to a change of the total consumption expenditures by private households in the EU that is higher than the direct impact of the assumption. The reduction of consumption in relation to the Reference up to 2050 arrives at 38% and the average consumption level falls back to the level of mid 90s.

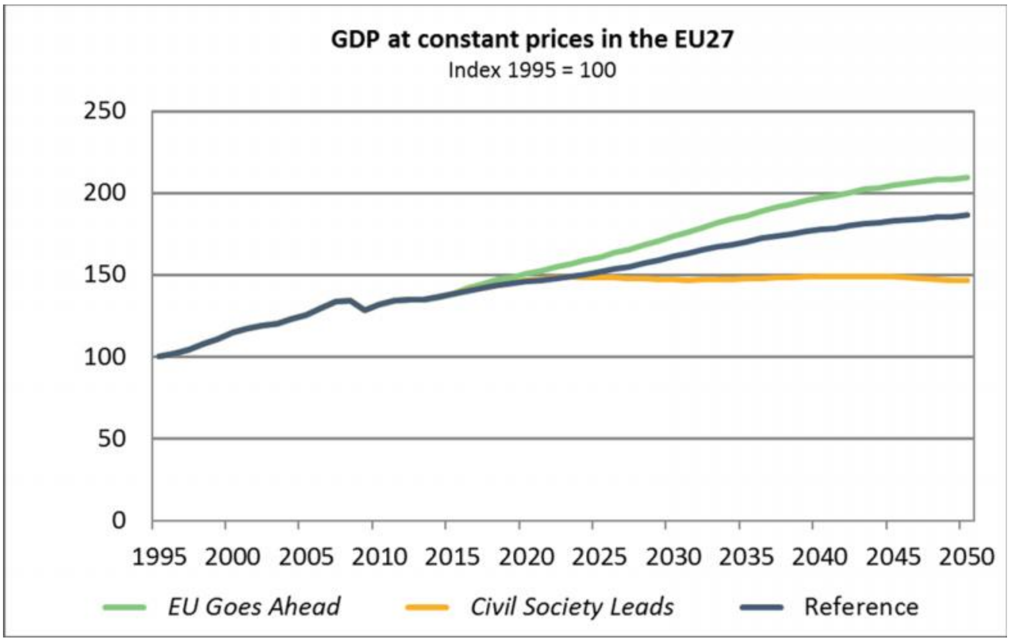
***Figure 63: Scenario Civil Society Leads – the impact on consumption expenditures by private households in the EU***




The reduction of private consumption has no influence on exports, which depend on the development of foreign countries and the international competitiveness of the domestic economy. Both are only slightly affected by the reduction of private consumption in the EU. Insofar exports of the EU remain relatively stable, but the imports of the EU are reduced by the diminishing private consumption. This means that the contribution of international trade to GDP is growing. The EU is much more involved in the global economy than in all other scenarios.

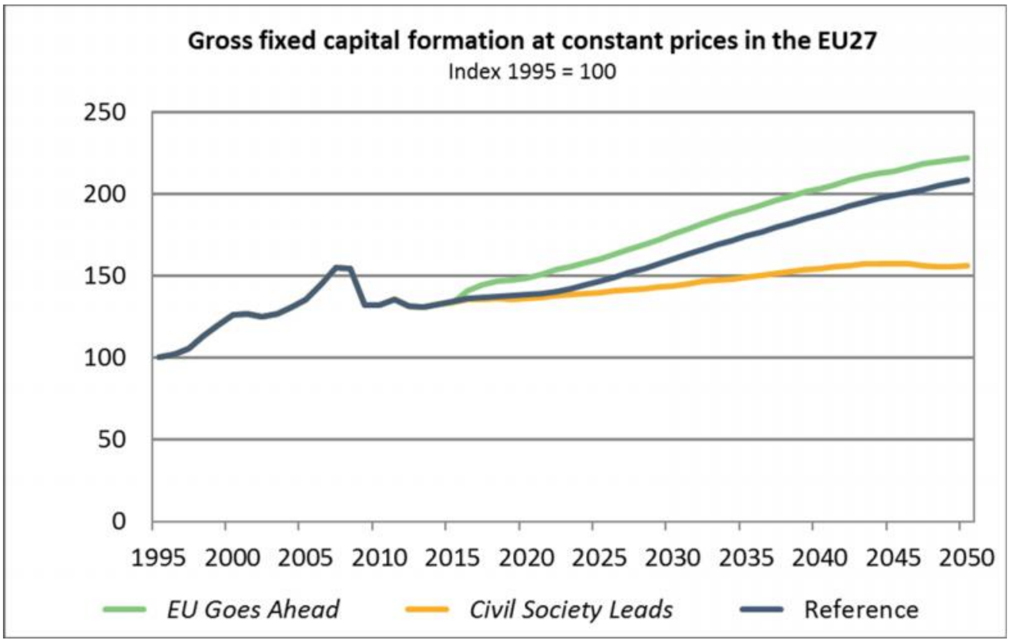
The stability of exports allows that the reduction of GDP against the reference is with 19.5% much lower than the reduction of private consumption (38%). Concerning GDP levels, the results imply zero growth.

***Figure 64: Scenario Civil Society Leads – the impact on GDP in the EU***




As Figure 65 shows the impact on gross fixed capital formation in the EU is little bit weaker than the impact on economic growth. This observation hints back to the conclusion that a target achievement for the RMC indicator solely based on behavioural changes of the European citizens is difficult. As long as production processes remain unchanged (to the Reference) and European industries maintain their strong position on global markets the investment needs to produce the goods for export demand continue to contribute considerably to the raw material use in the EU.

***Figure 65: Scenario Civil Society Leads – the impact on investment in the EU***




Employment is influenced by two effects: The GDP development and the reduction of hours worked per person, which is assumed to reach 20% compared to actual levels up to 2050. Since the GDP reduction is more or less the same as the reduction of labour supply per employee, it might be expected that the impact of both changes on the number of persons engaged is neutral. Figure 66 shows that this by far is not the case: in 2050 the number of persons engaged is 9.5% higher than in the reference. The explanation is that the real wage rate is lower than in the reference because labour productivity growth is reduced in relation to the reference. The scenario *Civil Society Leads* combines zero growth with a booming labour market. Employment is permanently above all other scenarios and reaches in 2050 a peak of additional 17 million jobs.

***Figure 66: Scenario Civil Society Leads – the impact on employment in the EU***

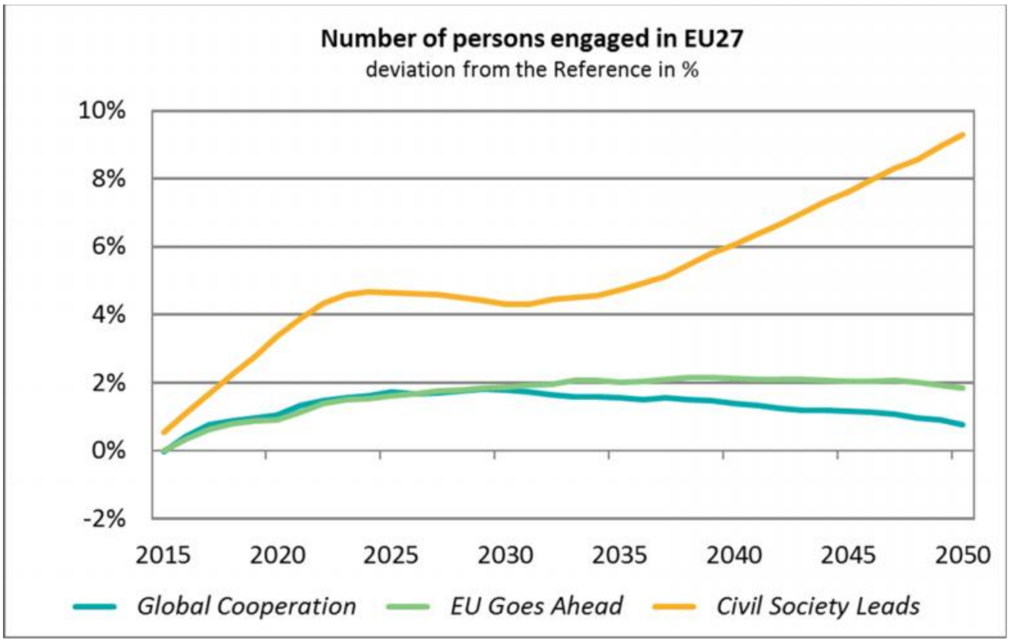
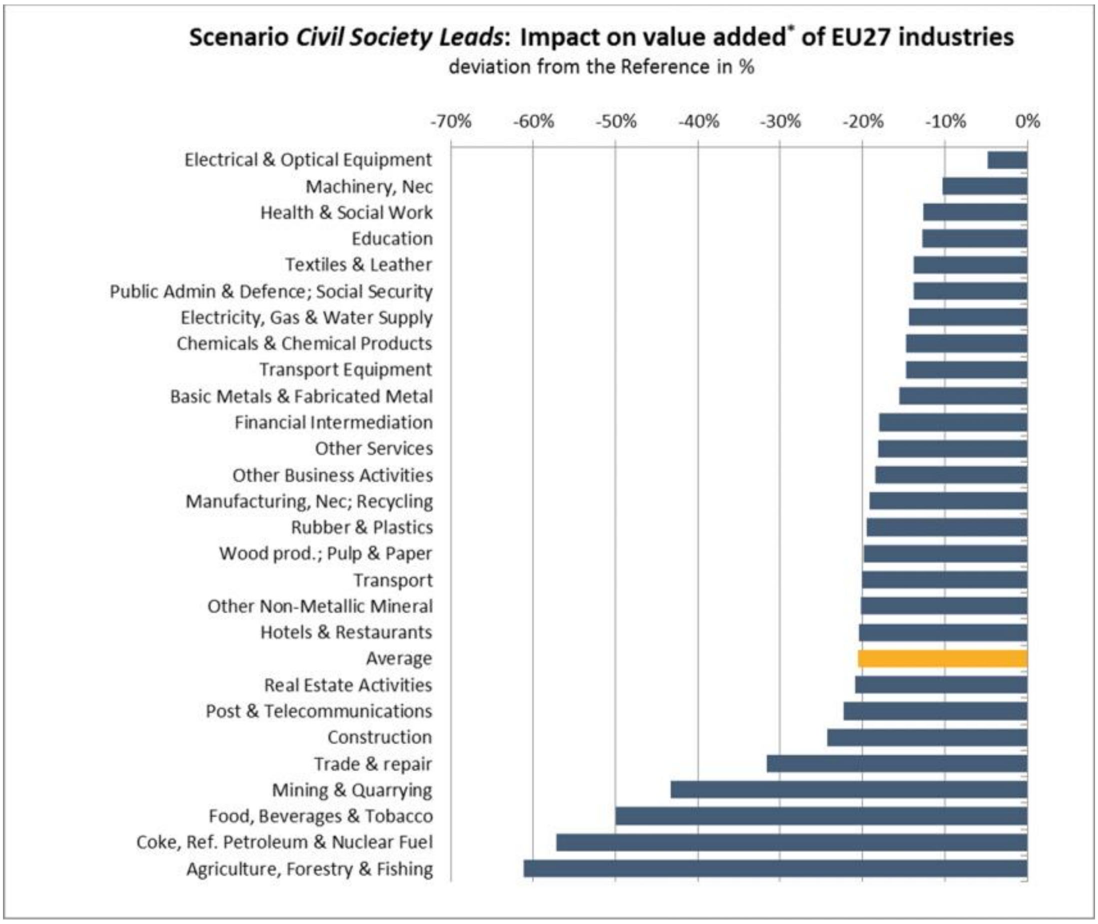



Figure 67 shows the impacts of the scenario *Civil Society Leads* on the value added of the different industries, if we compare the modelling results for the year 2050 with those of the Reference Scenario. First, we see that all industries are losing against the Reference. This is the case because the reduction of domestic consumption is not compensated by exports. But of course those industries that are highly involved in the global markets (and less dependent on domestic demand within the EU) like the manufacturing of electrical & optical equipment and of machinery are significantly less affected than the average. But to look at the deviations from the Reference Scenario again only shows one side of the coin. To illustrate whether the different industries only lose value added compared to the Reference or whether they lose or gain value added compared to nowadays levels Figure 68 compares the modelling results of the scenario Civil Society Leads for the year 2050 with the respective results for the year 2015.

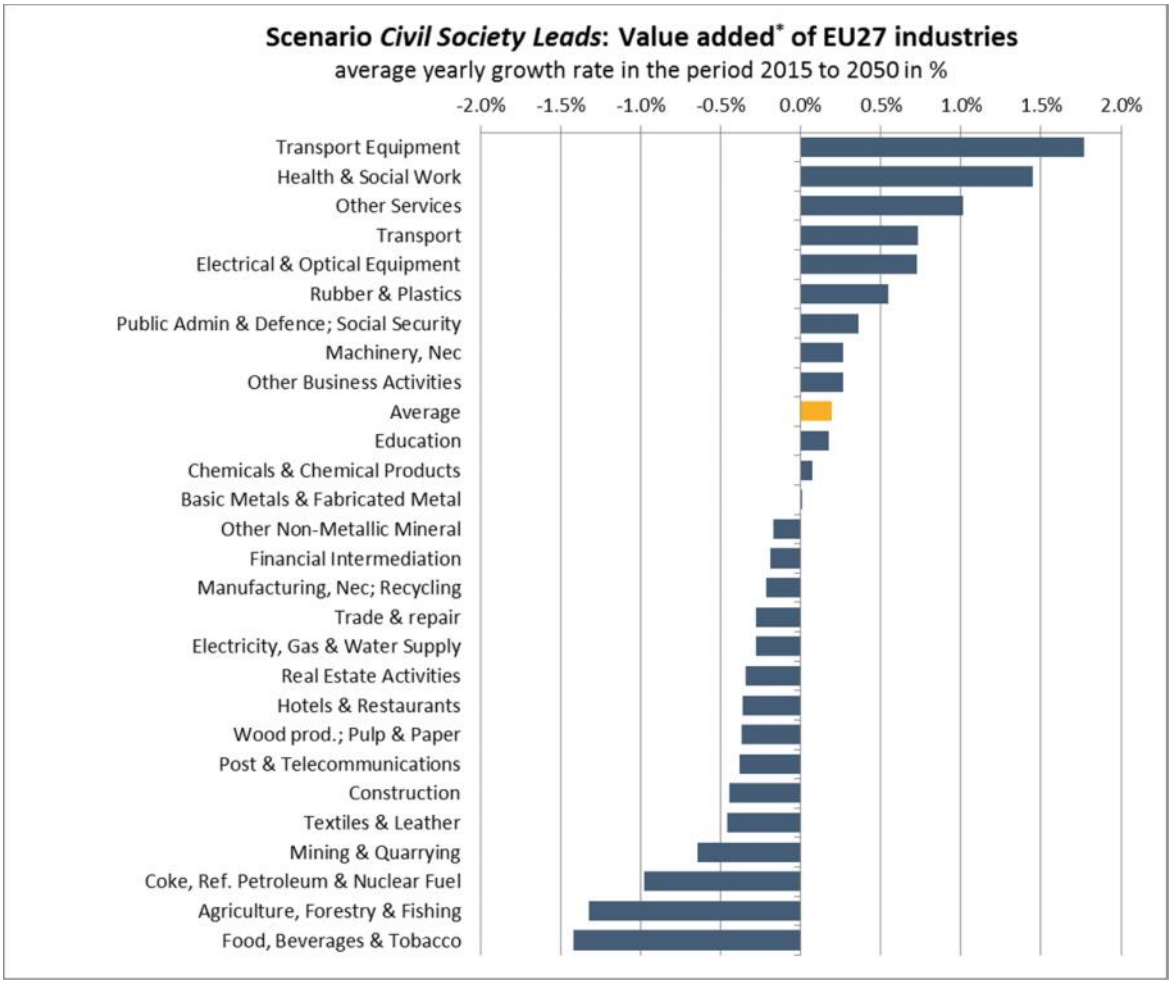
There we can see that even in a post-growth society the modelling results indicate that for some industries in the EU the value added still is expected to grow considerably. But on the other hand in this scenario we can also observe a couple of industries that are facing a notable decline of value added over time, a process that will certainly be not easily manageable for business as well as for politics.

***Figure 67: Scenario Civil Society Leads – the impact on value added of different industries in the EU***




* Value added deflated by GDP price in 1995 US-$

***Figure 68: Scenario Civil Society Leads – the development of value added of industries in the EU***



# 7 Conclusions and future steps

The future is open, but we know that severe challenges endanger mankind: Given today's structures of production and consumption, the expected population development and the dynamics of the economic system the induced climate change and extractions of resources will destroy services of nature for mankind in the future after 2050. What we see already now in our simulations is that the scarcity of agricultural land, water, metals and minerals will negatively feedback on the socio-economic relations via high resource prices. Further our simulations show that already before 2050 the availability of food especially for poor people will make problems.

We modelled this to know more about the interrelations of these developments and to know how this unpleasant future could be avoided. Instruments of the analysis have been the economic environmental model GINFORS and the vegetation model LPJmL which have been linked. GINFORS is able to describe the behaviour of consumers, producers and investors on a global scale with deep country, sector and factor differentiation and to depict the consequences of their actions on climate gas emissions, agricultural land use, water withdrawal and the extractions of fossil fuels, ores and non-metallic minerals. LPJmL calculates the productivity of agricultural land use depending from emission pathways and the availability of water. The scarcity of abiotic resources is mentioned by assumptions about their price development. With these ingredients a reference future has been calculated which in addition assumes that fiscal policy of the governments respects restrictions for their debt/GDP ratio.

The results confirm the expectations: An emission pathway will be generated which raises today emissions by 50% and creates global warming of 4 – 6 degrees. Global raw material consumption per capita will rise from 6.8 tons today up to 9.1 in 2050. The real oil price rises by 1.6%, the real ores prices by 4.0% in the average per year. The weighted average of real global crop prices rises per year by 2.1%. Since price elasticities for food are rather low this means that consumers have to pay rising shares of their disposable income for food, which induces social problems. The average yearly growth rate of real GDP will fall from 2.6% in the past 20 years to 2.1% in the next 35 years. For the EU the yearly average growth rate will fall from 1.5% in the last 20 years to 0.9% for the future till 2050.

Jäger & Schanes, 2014, assert that the damages of the environment with the negative feedback of services of nature on the economy and the high resource prices might be avoided, if the following four environmental targets are met till 2050: $CO_2$ emissions have to be reduced to a 2 degrees warming pathway, which means that global emissions have to be halved compared with the actual situation. For the EU an 80% reduction compared to the level of 1990 is consistent with the global figure. Raw material consumption per capita has to be diminished to 5 tons, the total cropland footprint per capita has to be reduced by 30% and the water exploitation index has to be lower than 20%.

In three alternative scenarios we analysed how these targets could be reached by policy intervention, but also by behavioural changes induced by intrinsic motivation.

In the scenario *Global Cooperation* all countries are committed to the above targets. A policy mix has been installed which mainly consists of economic instruments excluding hard market interventions and regulations implemented on the supply side of the economy. This mix has been described as "everything but hard market interventions": Climate policy is focussing on the inputs of fossil fuels and has four pillars: An upstream carbon tax for all industries, a regulation of the share of renewables in electricity production, a set of regulations and economic instruments favouring e-mobility and a subsidy for investment in the energy efficiency of the stock of buildings. The use of ores and non-metallic minerals is reduced by regulations on recycling and an upstream tax on ores and non-metallic minerals. Further a public innovation fund for the material efficiency is assumed and a regulation for water abstraction of agriculture is implemented. The agricultural land use is influenced by an information program to avoid food waste, a tax on meat consumption, an intrinsic motivated change of meat consumption, an information program to reduce the yield gap in agriculture and a regulation of food imports. Further an environmental tax reform has been installed to recycle the environmental taxes back to the economy by a subsidy on the use of environmentally harmless product groups.

The simulation results show that all targets can be reached globally and in the EU. The policy instruments induce strong investments in new resource efficient technologies. Compared with the reference scenario resource demand falls and diminishes resource prices including the food prices. Global real GDP is permanently higher than in the reference (in 2050: +5.2%) and the social problem based on food scarcity is defused. In the EU the impact on GDP is even stronger than globally (in 2050: +8.0%) and employment is improved in relation to the reference. The stronger economic performance of the EU compared with the global results is caused by the fact that the EU is primarily a user of resources and not a producer of mining and quarrying products. Countries highly engaged in these sectors like Russia or Canada of course suffer from the policy mix.

The scenario *EU Goes Ahead* assumes that the Non-EU countries are not committed to the mentioned targets and only install a moderate climate policy and nothing else whereas the EU tries to reach all four ambitious targets. The main change of the policy mix of the EU concerns now the taxation instruments to avoid problems with international competitiveness. The upstream carbon tax is substituted by an ETS system with a flexible supply for the basic industries. For the other industries a direct compensation of the tax has been installed with gross production as the key for the allocation of the tax revenue to the firms of the industry. So the net charge for firms of the industry in question depends on their $CO_2$-emissions. The higher, the more a firm has to pay. The lower, the more a firm gets from the government. In the industry average no charge is given. The upstream tax on non-metallic minerals is not a problem since the products made of these materials are barely in international competition. With metals the opposite is the case. Therefore the upstream tax on ores has to be substituted by a RMC based tax on final demand with the exception of exports. This tax hits final products with high RMC values from domestic production and also the imports. Since exports are free there is no influence on international competitiveness. The revenues of the tax on non-metallic minerals and of the RMC tax on final demand are compensated by a subsidy on products with low RMC values, so also in this scenario we implicitly have an ETR.

Because of the only moderate climate policy of the Non-EU countries the $CO_2$ emissions path globally generates in the long run a 4 degrees warming. In the EU all environmental targets will be met. Since the design of taxation avoids losses of international competitiveness, the EU is the only region in the world which rigorously improves its resource efficiency and reduces in this way costs of production. So the EU realizes a first mover advantage. GDP in the EU rises even stronger than in the scenario Global Cooperation. In 2050 the impact on GDP (+12.3%) is higher than in the reference.

In the scenario *Civil Society Leads* as in the scenario *EU Goes Ahead* only the EU tries to meet the ambitious environmental targets. But now structural change in resource use is mainly induced by intrinsic motivation of consumers and not by public policy. The assumptions on climate policy are the same as in *EU Goes Ahead*. On the one side consumers change their structure of consumption reducing purchases of products with high RMC values and favouring the others, which can be justified with different arguments. Of course this has its limitations, which means that total consumption has to be reduced till the targets are met. A further important change concerns labour supply. The European citizens want to have more time for the family, for engagement in society and for leisure. It is assumed that more part time working takes place which reduces the hours worked per person engaged by -20%.

As in the scenario *EU Goes Ahead* the Non-European countries only follow a moderate climate policy. So also in the scenario *Civil Society Leads* a $CO_2$ emission path will be generated, which implies a global warming of 4 degrees. But in the EU the emission target will be met. The RMC target can only partly be reached. Instead of 5 tons only a reduction to 6.9 tons per capita can be realized, which means that only 75% of the necessary reduction against the reference could be achieved. On the other side a great success is achieved concerning the cropland footprint which is reduced by -55% instead of the demanded -30%. The water exploitation target is met as in the other scenarios.

The reduction of total consumption to the level of the year 1995 diminishes GDP. On the other side exports are not affected, because they are depending from the competitiveness of the EU industries and the economic development abroad, which both are to a large extent independent from consumption in the EU. Since investment is related to gross production of the EU industries also this component of GDP does not follow the development of consumption. The result is more or less zero growth of GDP in the EU. Since imports are determined by GDP development a rising contribution of international trade to GDP is generated. Employment is by far higher than in the reference, because of two factors: The first is the reduction of working hours per person, which just compensates the reduction of GDP. The second is the fall of the real wage rate induced by the lower productivity of labour.

One simple result is whatever the EU is doing without global cooperation there are only small effects of EU policies on the global environmental targets.

The overall result of the study is that the ambitious environmental targets can be reached globally and in the EU with socio-economic gains. With the scenario *EU Goes Ahead* the study further shows that the EU could realize strong first mover advantages in GDP and employment, if an ambitious environmental policy is installed mainly based on economic instruments without any cooperation with the Non-EU countries. The scenario *Civil Society Leads* offers for resource policy an alternative approach that focuses on intrinsic motivation of civil society and insofar favours bottom up instruments like information programs and education instead of top down policy. If zero growth of GDP is accepted – which is the case in a “Beyond GDP” world – this scenario also is attractive because it creates 17 million new jobs. But on the other side the results have shown that without the implementation of instruments on the supply side resource efficiency of the needed degree can only be achieved by very hard reductions of the structure and the level of consumption.

Concerning the policy mixes the study offers a broad spectrum of instruments. In the case of climate policy the recommendation of the CECILIA2050 project[8] also was confirmed here: Install a carbon price and add further instrument implementation to decarbonise electricity production (with renewables), electrify road transport and improve the energy efficiency of buildings.

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[8] CECILIA2050 Policy Brief N. 3

For resource efficiency policy bottom up and top down instruments have been evaluated as useful instruments. Our results should be interpreted as a recommendation for the use of both instrument groups in one policy mix. If the EU goes alone bottom up policy is per se an instrumentation that has no effects on international competitiveness. The economic instruments – especially taxes – have to be designed carefully – as we could show – to avoid such effects.

The result of a good socio-economic performance of the scenarios without Global Cooperation is important because it gives arguments to implement these policies in spite of the fact that this will not solve the dramatic global environmental problems. The success of the EU will then motivate the other countries to follow.

A critical view on our study may come to the point that prices for abiotic resources are exogenous. This was necessary because the supply of abiotic resources is not modelled in GINFORS. Of course this could cause problems as these prices are important for the solutions. In the case of agricultural land use the supply side has been modelled in GINFORS and the missing link to crop production – the land productivity – as well as the availability of water could be closed by the link with the vegetation model LPJmL (PIK) in the project. For abiotic resources, the German UBA project SimRess is currently working on linking GINFORS with the WORLD model (Sverdrup et al., 2012).

Furthermore an extension of social variables would be useful. Especially different socioeconomic types of households and their income and consumption structures should be available. Such an extension would widen the applicability of the model very much.

# Publications resulting from the work described

Meyer, B. (2015). Die Modellierung der Großen Transformation. In M. Held, G. Kubon-Gilke, & R. Sturn (Eds.), Jahrbuch Normative und institutionelle Grundfragen der Ökonomik, Volume 15.

Distelkamp, M., Meyer, B., Meyer, M. and Beringer, T. (2015): On the road to a resource efficient Europe. Recent findings from POLFREE research. Paper to be presented at the Davos World Resources Forum 2015.

Meyer, M., Distelkamp, M., Meyer, B. (2015): Imperfect competition and the properties of macro-economic-environmental models. POLFREE special issue.

Meyer, B. (2016): Wie muss die Wirtschaft umgebaut werden? In: Wiegandt, K. (ed.): Die Zukunft der Erde . Fischer Taschenbuch, Frankfurt

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# Appendix

The following tables show results of the simulations for single countries/regions. In each case the main indicators for the evaluation of the macro-economic performance, the social development, the pressure on the environment and the use of eco-system services that are explained by the GINFORS/LPJmL model, are documented.

This documentation starts with the results for EU27. In the tables 16 to 46 the simulation results for 24 EU countries and seven selected non-EU countries/regions (Brazil, China, India, Japan, Russia, United States, Rest of World) are shown.[9]

[9] Due to a reduced reliability that is induced by small values the simulation results for Cyprus, Luxembourg and Malta are not documented in the Appendix.

***Table 16: Simulation results for EU27.***

| EU27 | | Reference Scenario | | | Scenario: *Global cooperation* | | Scenario: *EU goes ahead* | | Scenario: *Civil society leads* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 110.2 | 128.2 | 148.6 | 137.3 | 160.4 | 138.2 | 166.8 | 117.0 | 116.7 |
| **Gross disposable income** | 2005 = 100 | 109.4 | 115.6 | 120.2 | 121.6 | 127.6 | 123.8 | 133.5 | 107.9 | 100.7 |
| **Gross fixed capital formation** | 2005 = 100 | 99.0 | 118.0 | 153.6 | 135.5 | 179.7 | 129.2 | 163.5 | 106.0 | 115.3 |
| **Final consumption expend. by households** | 2005 = 100 | 107.2 | 113.3 | 120.2 | 117.8 | 124.1 | 119.9 | 129.2 | 94.0 | 73.4 |
| **Final consumption expend. by government** | 2005 = 100 | 109.2 | 123.6 | 143.0 | 131.6 | 155.5 | 129.6 | 156.2 | 117.3 | 116.3 |
| **Exports** | 2005 = 100 | 159.8 | 249.4 | 327.6 | 261.9 | 347.9 | 264.0 | 361.2 | 255.3 | 335.6 |
| **Imports** | 2005 = 100 | 121.7 | 167.4 | 227.7 | 175.0 | 240.0 | 171.0 | 222.6 | 148.2 | 169.3 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 507.3 | 515.0 | 508.1 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 218.32 | 202.65 | 185.70 | 206.27 | 187.14 | 206.44 | 189.13 | 211.39 | 202.97 |
| **Employment share** | in % | 65.5% | 64.2% | 64.7% | 65.4% | 65.2% | 65.4% | 65.8% | 67.0% | 70.7% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 120.5 | 157.3 | 217.5 | 158.8 | 186.2 | 170.8 | 255.4 | 155.2 | 212.5 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 3743.6 | 3375.1 | 2929.0 | 2855.6 | 1272.0 | 2641.8 | 1112.0 | 2543.4 | 1217.0 |
| **$RMC_{abiotic}$** per capita | in tons | 11.9 | 11.6 | 11.8 | 9.0 | 4.4 | 9.4 | 5.6 | 9.5 | 6.9 |
| **$RMC_{fossils}$** per capita | in tons | 3.9 | 3.4 | 3.1 | 2.8 | 0.8 | 2.9 | 1.2 | 2.7 | 1.1 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 6.5 | 6.4 | 6.3 | 5.0 | 3.0 | 4.8 | 2.6 | 5.4 | 4.3 |
| **$RMC_{ores}$** per capita | in tons | 1.5 | 1.8 | 2.3 | 1.2 | 0.6 | 1.7 | 1.8 | 1.5 | 1.5 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 122.1 | 138.0 | 157.1 | 190.9 | 447.9 | 178.7 | 319.7 | 148.8 | 192.7 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 11.6% | 12.2% | 11.9% | 9.9% | 9.6% | 9.8% | 9.4% | 9.7% | 9.0% |
| **Total crop production** | in mio. tons | 725.7 | 625.6 | 673.4 | 618.4 | 646.6 | 614.9 | 637.3 | 613.0 | 638.3 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 431.7 | 375.6 | 404.7 | 413.6 | 481.8 | 381.6 | 372.2 | 281.1 | 118.7 |
| **Per capita meat demand** | in kg | 88.2 | 91.9 | 97.6 | 76.5 | 63.8 | 78.3 | 81.3 | 69.3 | 53.9 |
| **Per capita crop land footprint** | 2005 = 100 | 77.1 | 77.4 | 75.8 | 77.9 | 75.5 | 75.6 | 69.9 | 64.9 | 45.4 |

***Table 17: Simulation results for EU27-countries: Austria.***

| **Austria** | | **Reference Scenario** | | | **Scenario** *Global cooperation* | | **Scenario** *EU goes ahead* | | **Scenario** *Civil society leads* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 117.6 | 151.8 | 209.0 | 161.2 | 223.8 | 162.9 | 233.9 | 140.4 | 177.0 |
| **Gross disposable income** | 2005 = 100 | 113.3 | 130.2 | 144.0 | 136.6 | 153.1 | 140.5 | 163.6 | 122.5 | 124.4 |
| **Gross fixed capital formation** | 2005 = 100 | 108.2 | 139.3 | 191.6 | 154.9 | 213.2 | 148.1 | 195.7 | 124.4 | 147.1 |
| **Final consumption expend. by households** | 2005 = 100 | 113.8 | 131.6 | 153.3 | 137.1 | 161.2 | 140.8 | 172.3 | 110.2 | 97.9 |
| **Final consumption expend. by government** | 2005 = 100 | 115.5 | 142.8 | 225.3 | 150.7 | 239.4 | 151.2 | 251.3 | 136.1 | 191.4 |
| **Exports** | 2005 = 100 | 125.0 | 184.7 | 261.0 | 193.7 | 274.0 | 192.3 | 273.9 | 178.1 | 242.9 |
| **Imports** | 2005 = 100 | 111.6 | 149.3 | 191.5 | 155.9 | 198.9 | 151.8 | 185.9 | 132.3 | 143.0 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 8.5 | 9.0 | 9.3 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 4.29 | 4.13 | 4.11 | 4.19 | 4.11 | 4.21 | 4.20 | 4.34 | 4.63 |
| **Employment share** | in % | 74.7% | 75.0% | 76.4% | 76.2% | 76.4% | 76.6% | 78.0% | 78.8% | 85.9% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 131.4 | 172.2 | 285.3 | 173.2 | 240.6 | 187.0 | 336.2 | 172.0 | 306.1 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$-Emissions** | in mio. tons | 63.5 | 61.3 | 57.8 | 54.5 | 37.7 | 51.2 | 33.9 | 49.8 | 35.4 |
| **$RMC_{abiotic}$ per capita** | in tons | 18.8 | 17.3 | 17.3 | 13.5 | 7.0 | 13.9 | 8.3 | 13.8 | 9.9 |
| **$RMC_{fossils}$ per capita** | in tons | 5.7 | 5.1 | 4.6 | 4.2 | 1.5 | 4.4 | 2.3 | 4.0 | 2.0 |
| **$RMC_{non\text{-}metallic\ minerals}$ per capita** | in tons | 10.5 | 9.2 | 9.0 | 7.3 | 4.3 | 6.8 | 3.2 | 7.4 | 5.6 |
| **$RMC_{ores}$ per capita** | in tons | 2.6 | 3.0 | 3.8 | 2.1 | 1.2 | 2.7 | 2.8 | 2.4 | 2.4 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 133.0 | 163.4 | 211.6 | 225.2 | 591.4 | 214.5 | 448.5 | 182.9 | 284.4 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 4.6% | 5.1% | 5.2% | 5.1% | 5.2% | 5.0% | 5.1% | 4.9% | 4.9% |
| **Total crop production** | in mio. tons | 10.0 | 7.5 | 8.5 | 7.3 | 8.0 | 7.3 | 7.9 | 7.3 | 7.9 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 435.8 | 381.7 | 413.5 | 430.1 | 498.2 | 400.9 | 400.2 | 285.3 | 116.7 |
| **Per capita meat demand** | in kg | 110.9 | 114.6 | 117.6 | 95.4 | 77.9 | 95.1 | 85.7 | 78.7 | 59.6 |
| **Per capita crop land footprint** | 2005 = 100 | 78.1 | 80.0 | 100.0 | 77.9 | 71.1 | 78.7 | 96.0 | 65.6 | 65.0 |

***Table 18: Simulation results for EU27-countries: Belgium.***

| Belgium | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 115.4 | 136.9 | 176.6 | 145.2 | 187.3 | 147.9 | 199.5 | 127.7 | 149.9 |
| **Gross disposable income** | 2005 = 100 | 117.1 | 125.4 | 133.4 | 129.8 | 136.9 | 133.3 | 148.0 | 118.8 | 119.3 |
| **Gross fixed capital formation** | 2005 = 100 | 121.8 | 144.5 | 198.9 | 159.7 | 221.5 | 154.2 | 209.0 | 132.5 | 162.4 |
| **Final consumption expend. by households** | 2005 = 100 | 119.0 | 128.6 | 137.1 | 132.5 | 140.3 | 135.7 | 150.7 | 107.6 | 88.4 |
| **Final consumption expend. by government** | 2005 = 100 | 110.8 | 132.7 | 216.1 | 140.2 | 226.6 | 141.0 | 241.7 | 127.8 | 186.8 |
| **Exports** | 2005 = 100 | 123.4 | 149.5 | 178.3 | 154.6 | 181.6 | 154.8 | 183.9 | 140.4 | 153.9 |
| **Imports** | 2005 = 100 | 121.9 | 139.7 | 162.0 | 143.3 | 163.2 | 140.2 | 155.7 | 123.5 | 120.7 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 10.9 | 11.4 | 11.8 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 4.49 | 4.18 | 4.07 | 4.25 | 4.07 | 4.28 | 4.18 | 4.40 | 4.59 |
| **Employment share** | in % | 64.2% | 61.6% | 60.7% | 62.6% | 60.7% | 63.0% | 62.4% | 64.9% | 68.5% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 149.9 | 189.1 | 294.7 | 185.1 | 230.9 | 204.4 | 332.8 | 184.6 | 282.8 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 98.3 | 87.3 | 82.8 | 75.1 | 52.4 | 69.9 | 49.8 | 68.8 | 54.3 |
| **$RMC_{abiotic}$** per capita | in tons | 10.2 | 12.0 | 16.4 | 10.0 | 9.6 | 11.7 | 13.9 | 10.9 | 13.6 |
| **$RMC_{fossils}$** per capita | in tons | 5.4 | 4.3 | 3.6 | 3.6 | 1.2 | 3.6 | 1.8 | 3.3 | 1.6 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 2.6 | 5.4 | 9.8 | 4.8 | 7.6 | 5.8 | 9.7 | 5.6 | 10.0 |
| **$RMC_{ores}$** per capita | in tons | 2.2 | 2.4 | 3.0 | 1.6 | 0.8 | 2.2 | 2.3 | 2.0 | 2.0 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 114.8 | 112.9 | 112.2 | 149.6 | 216.4 | 130.0 | 146.6 | 115.7 | 113.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 42.5% | 43.7% | 39.3% | 42.8% | 30.6% | 43.0% | 30.1% | 41.6% | 28.0% |
| **Total crop production** | in mio. tons | 20.4 | 14.4 | 15.6 | 15.4 | 15.9 | 14.0 | 13.6 | 14.0 | 13.7 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 441.2 | 451.4 | 695.8 | 515.1 | 864.9 | 456.3 | 644.2 | 369.7 | 312.2 |
| **Per capita meat demand** | in kg | 78.8 | 81.8 | 94.0 | 68.6 | 61.1 | 75.4 | 82.6 | 66.3 | 52.8 |
| **Per capita crop land footprint** | 2005 = 100 | 78.1 | 69.3 | 59.2 | 66.0 | 61.3 | 67.6 | 55.4 | 62.0 | 38.8 |

***Table 19: Simulation results for EU27-countries: Bulgaria.***

| Bulgaria | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 123.1 | 147.1 | 165.9 | 160.8 | 194.1 | 162.4 | 202.9 | 141.4 | 146.6 |
| **Gross disposable income** | 2005 = 100 | 137.7 | 147.4 | 162.7 | 158.6 | 179.1 | 160.6 | 189.4 | 141.1 | 138.8 |
| **Gross fixed capital formation** | 2005 = 100 | 102.9 | 150.5 | 216.8 | 166.0 | 247.2 | 157.8 | 224.0 | 143.5 | 182.8 |
| **Final consumption expend. by households** | 2005 = 100 | 119.3 | 134.5 | 147.0 | 143.1 | 159.3 | 145.0 | 168.8 | 114.2 | 92.8 |
| **Final consumption expend. by government** | 2005 = 100 | 111.3 | 144.0 | 181.3 | 156.9 | 203.2 | 158.5 | 225.6 | 141.4 | 156.8 |
| **Exports** | 2005 = 100 | 235.8 | 288.0 | 304.7 | 299.1 | 324.1 | 300.2 | 322.4 | 277.7 | 279.5 |
| **Imports** | 2005 = 100 | 160.1 | 203.4 | 240.2 | 209.3 | 242.7 | 205.8 | 231.0 | 181.1 | 176.4 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 7.2 | 6.3 | 5.1 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 3.25 | 2.86 | 2.43 | 2.89 | 2.42 | 2.90 | 2.47 | 3.03 | 2.74 |
| **Employment share** | in % | 67.7% | 71.6% | 83.0% | 72.1% | 82.4% | 72.4% | 84.1% | 75.7% | 93.6% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 114.9 | 145.0 | 178.1 | 148.0 | 164.6 | 159.0 | 216.7 | 147.6 | 188.5 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 42.9 | 40.2 | 35.2 | 31.2 | 8.5 | 29.5 | 7.6 | 28.1 | 8.2 |
| **$RMC_{abiotic}$** per capita | in tons | 9.7 | 10.7 | 12.6 | 8.7 | 5.5 | 8.7 | 6.4 | 9.4 | 8.5 |
| **$RMC_{fossils}$** per capita | in tons | 4.2 | 4.2 | 4.9 | 3.2 | 1.0 | 3.2 | 1.3 | 3.3 | 2.0 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 4.8 | 5.6 | 6.3 | 4.8 | 4.1 | 4.7 | 3.9 | 5.3 | 5.5 |
| **$RMC_{ores}$** per capita | in tons | 0.6 | 0.9 | 1.5 | 0.6 | 0.4 | 0.8 | 1.1 | 0.8 | 1.0 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 96.0 | 117.9 | 153.7 | 174.0 | 526.0 | 162.1 | 372.3 | 138.2 | 230.7 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 22.0% | 29.5% | 37.3% | 24.8% | 27.5% | 24.3% | 26.5% | 23.8% | 25.6% |
| **Total crop production** | in mio. tons | 10.8 | 4.2 | 4.2 | 4.2 | 4.1 | 4.4 | 4.1 | 4.4 | 4.1 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 372.5 | 423.3 | 648.5 | 440.2 | 689.7 | 400.0 | 506.4 | 349.1 | 296.9 |
| **Per capita meat demand** | in kg | 60.3 | 79.4 | 94.0 | 66.6 | 60.9 | 68.3 | 75.2 | 55.4 | 40.3 |
| **Per capita crop land footprint** | 2005 = 100 | 80.9 | 205.5 | 315.4 | 205.9 | 348.0 | 175.2 | 265.6 | 151.6 | 174.9 |

***Table 20: Simulation results for EU27-countries: Czech Republic.***

| Czech Republic | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 134.7 | 188.8 | 232.3 | 203.4 | 264.7 | 200.8 | 262.0 | 177.8 | 203.6 |
| **Gross disposable income** | 2005 = 100 | 111.9 | 134.0 | 134.6 | 145.6 | 162.7 | 144.1 | 157.0 | 129.7 | 126.0 |
| **Gross fixed capital formation** | 2005 = 100 | 104.4 | 148.4 | 202.3 | 167.2 | 240.2 | 154.5 | 202.7 | 138.8 | 167.1 |
| **Final consumption expend. by households** | 2005 = 100 | 116.5 | 137.6 | 140.2 | 147.5 | 163.7 | 146.6 | 161.0 | 117.5 | 94.8 |
| **Final consumption expend. by government** | 2005 = 100 | 102.9 | 160.9 | 174.2 | 173.7 | 206.2 | 171.6 | 208.4 | 156.6 | 155.1 |
| **Exports** | 2005 = 100 | 173.9 | 251.9 | 323.7 | 265.9 | 342.6 | 260.6 | 329.9 | 238.5 | 285.0 |
| **Imports** | 2005 = 100 | 144.2 | 199.1 | 242.4 | 211.2 | 258.2 | 204.0 | 236.5 | 182.4 | 195.1 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 10.7 | 11.0 | 11.1 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 5.20 | 4.97 | 4.39 | 5.08 | 4.51 | 5.06 | 4.49 | 5.25 | 4.96 |
| **Employment share** | in % | 71.6% | 70.2% | 68.0% | 71.8% | 69.8% | 71.5% | 69.6% | 74.2% | 76.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 133.6 | 182.3 | 256.9 | 180.5 | 214.5 | 194.5 | 298.3 | 180.9 | 263.5 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 100.1 | 98.4 | 84.6 | 83.6 | 24.1 | 76.6 | 20.4 | 73.1 | 21.3 |
| **$RMC_{abiotic}$** per capita | in tons | 12.6 | 13.1 | 12.4 | 10.2 | 3.9 | 10.3 | 4.2 | 10.7 | 6.1 |
| **$RMC_{fossils}$** per capita | in tons | 5.3 | 5.4 | 5.0 | 4.2 | 0.6 | 4.4 | 1.0 | 4.2 | 1.0 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 6.2 | 6.2 | 5.6 | 5.1 | 2.9 | 4.6 | 1.8 | 5.4 | 4.0 |
| **$RMC_{ores}$** per capita | in tons | 1.2 | 1.4 | 1.7 | 1.0 | 0.5 | 1.3 | 1.3 | 1.2 | 1.1 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 135.5 | 180.8 | 235.5 | 254.5 | 899.2 | 237.2 | 607.2 | 208.2 | 391.4 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 14.1% | 11.1% | 13.4% | 11.3% | 13.5% | 11.0% | 12.4% | 10.8% | 11.9% |
| **Total crop production** | in mio. tons | 14.6 | 11.8 | 14.0 | 11.2 | 13.1 | 11.5 | 13.4 | 11.5 | 13.5 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 317.6 | 324.9 | 348.5 | 370.4 | 478.1 | 342.9 | 372.2 | 241.7 | 96.4 |
| **Per capita meat demand** | in kg | 89.0 | 95.2 | 101.9 | 79.7 | 66.0 | 79.2 | 83.8 | 70.5 | 56.7 |
| **Per capita crop land footprint** | 2005 = 100 | 71.8 | 72.4 | 64.6 | 76.9 | 75.8 | 72.4 | 63.6 | 59.3 | 31.8 |

***Table 21: Simulation results for EU27-countries: Denmark.***

| **Denmark** | | **Reference Scenario** | | | **Scenario** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ***Global cooperation*** | | ***EU goes ahead*** | | ***Civil society leads*** | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 103.0 | 126.8 | 170.4 | 134.3 | 181.4 | 136.9 | 192.9 | 119.1 | 146.1 |
| **Gross disposable income** | 2005 = 100 | 101.1 | 111.2 | 127.5 | 115.4 | 129.7 | 118.5 | 140.2 | 106.7 | 115.6 |
| **Gross fixed capital formation** | 2005 = 100 | 99.2 | 134.8 | 205.5 | 152.8 | 236.3 | 147.5 | 220.4 | 123.9 | 170.5 |
| **Final consumption expend. by households** | 2005 = 100 | 102.1 | 110.4 | 125.8 | 114.0 | 127.8 | 116.8 | 137.4 | 93.5 | 82.4 |
| **Final consumption expend. by government** | 2005 = 100 | 110.3 | 133.2 | 209.2 | 139.8 | 218.4 | 141.1 | 231.5 | 128.3 | 183.0 |
| **Exports** | 2005 = 100 | 128.8 | 177.9 | 230.5 | 184.6 | 237.5 | 185.5 | 244.0 | 173.1 | 213.5 |
| **Imports** | 2005 = 100 | 122.7 | 159.6 | 208.5 | 166.1 | 213.5 | 162.5 | 204.0 | 145.5 | 167.3 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 5.7 | 6.0 | 6.4 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 2.70 | 2.64 | 2.70 | 2.68 | 2.72 | 2.70 | 2.78 | 2.80 | 3.09 |
| **Employment share** | in % | 74.4% | 72.4% | 70.9% | 73.7% | 71.3% | 74.1% | 72.9% | 76.7% | 81.0% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 111.4 | 146.3 | 214.8 | 147.7 | 181.0 | 157.7 | 245.7 | 144.9 | 213.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 91.9 | 91.7 | 82.6 | 76.0 | 42.1 | 69.1 | 37.4 | 76.1 | 54.0 |
| **$RMC_{abiotic}$** per capita | in tons | 16.6 | 14.8 | 15.1 | 11.1 | 4.9 | 11.3 | 5.4 | 12.0 | 9.2 |
| **$RMC_{fossils}$** per capita | in tons | 5.8 | 4.7 | 4.2 | 3.5 | 1.0 | 3.6 | 1.6 | 3.3 | 1.4 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 8.7 | 7.7 | 7.6 | 6.0 | 3.1 | 5.5 | 1.3 | 6.7 | 5.5 |
| **$RMC_{ores}$** per capita | in tons | 2.1 | 2.4 | 3.2 | 1.6 | 0.8 | 2.2 | 2.4 | 2.0 | 2.2 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 118.9 | 148.8 | 195.7 | 210.8 | 644.0 | 203.5 | 484.5 | 169.2 | 266.9 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 13.6% | 8.3% | 6.2% | 8.3% | 6.3% | 7.9% | 5.0% | 8.1% | 5.9% |
| **Total crop production** | in mio. tons | 18.3 | 16.9 | 17.8 | 16.6 | 16.4 | 16.2 | 16.2 | 16.1 | 16.2 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 546.4 | 493.7 | 510.8 | 546.6 | 595.5 | 530.5 | 526.9 | 411.9 | 272.0 |
| **Per capita meat demand** | in kg | 97.0 | 97.1 | 101.4 | 81.2 | 67.9 | 80.1 | 82.5 | 70.2 | 54.0 |
| **Per capita crop land footprint** | 2005 = 100 | 81.6 | 100.8 | 82.8 | 101.2 | 80.7 | 104.9 | 83.4 | 95.8 | 67.0 |

***Table 22: Simulation results for EU27-countries: Estonia.***

| Estonia | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 124.9 | 180.0 | 260.6 | 201.3 | 302.0 | 199.4 | 307.8 | 177.9 | 253.7 |
| **Gross disposable income** | 2005 = 100 | 133.9 | 163.8 | 181.9 | 176.7 | 206.5 | 180.4 | 209.5 | 162.0 | 173.8 |
| **Gross fixed capital formation** | 2005 = 100 | 85.6 | 122.6 | 171.9 | 157.3 | 246.4 | 150.4 | 238.1 | 135.4 | 200.8 |
| **Final consumption expend. by households** | 2005 = 100 | 116.6 | 133.0 | 139.3 | 141.7 | 154.2 | 144.6 | 158.5 | 116.1 | 97.1 |
| **Final consumption expend. by government** | 2005 = 100 | 132.0 | 185.5 | 287.4 | 206.8 | 335.9 | 208.2 | 355.0 | 185.8 | 273.9 |
| **Exports** | 2005 = 100 | 133.9 | 193.6 | 260.4 | 200.9 | 267.4 | 199.1 | 263.3 | 185.6 | 237.8 |
| **Imports** | 2005 = 100 | 130.1 | 166.3 | 192.5 | 176.0 | 207.4 | 175.3 | 201.0 | 156.2 | 163.2 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 1.3 | 1.3 | 1.2 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 0.61 | 0.59 | 0.56 | 0.61 | 0.58 | 0.61 | 0.58 | 0.64 | 0.68 |
| **Employment share** | in % | 70.1% | 74.6% | 82.5% | 77.2% | 85.7% | 77.3% | 85.7% | 81.0% | 99.7% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 90.0 | 119.0 | 194.0 | 119.6 | 162.3 | 125.9 | 210.9 | 120.9 | 208.4 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 14.1 | 14.0 | 13.5 | 11.3 | 3.4 | 10.7 | 3.1 | 10.4 | 3.6 |
| **$RMC_{abiotic}$** per capita | in tons | 12.4 | 13.8 | 15.9 | 10.8 | 5.3 | 10.4 | 4.8 | 12.2 | 10.7 |
| **$RMC_{fossils}$** per capita | in tons | 2.7 | 2.6 | 2.4 | 2.2 | 0.7 | 2.4 | 1.1 | 2.2 | 1.1 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 8.7 | 10.0 | 11.9 | 7.7 | 4.1 | 6.9 | 2.3 | 8.9 | 8.3 |
| **$RMC_{ores}$** per capita | in tons | 0.9 | 1.2 | 1.5 | 0.8 | 0.5 | 1.2 | 1.4 | 1.1 | 1.4 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 178.2 | 239.7 | 331.5 | 354.8 | 1193.6 | 344.3 | 1023.8 | 273.9 | 490.4 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 9.2% | 10.9% | 9.1% | 10.4% | 6.5% | 10.4% | 6.3% | 10.2% | 6.3% |
| **Total crop production** | in mio. tons | 1.4 | 1.6 | 1.7 | 1.5 | 1.7 | 1.6 | 1.7 | 1.6 | 1.7 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 422.3 | 485.9 | 589.9 | 548.0 | 797.7 | 519.2 | 628.6 | 392.5 | 295.8 |
| **Per capita meat demand** | in kg | 68.8 | 80.3 | 93.5 | 66.4 | 61.2 | 76.6 | 86.9 | 64.9 | 52.1 |
| **Per capita crop land footprint** | 2005 = 100 | 75.2 | 80.8 | 94.0 | 81.9 | 97.6 | 79.9 | 83.9 | 67.5 | 51.2 |

***Table 23: Simulation results for EU27-countries: Finland.***

| Finland | | Reference Scenario | | | Scenario: *Global cooperation* | | Scenario: *EU goes ahead* | | Scenario: *Civil society leads* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 111.0 | 129.8 | 154.9 | 139.9 | 170.1 | 140.5 | 175.7 | 122.1 | 134.0 |
| **Gross disposable income** | 2005 = 100 | 123.8 | 135.0 | 145.3 | 142.9 | 156.0 | 144.9 | 161.7 | 130.4 | 133.4 |
| **Gross fixed capital formation** | 2005 = 100 | 101.4 | 106.5 | 119.3 | 123.8 | 135.4 | 117.7 | 124.9 | 95.6 | 89.4 |
| **Final consumption expend. by households** | 2005 = 100 | 122.3 | 131.4 | 141.1 | 138.0 | 150.0 | 139.8 | 155.3 | 111.5 | 92.5 |
| **Final consumption expend. by government** | 2005 = 100 | 112.9 | 132.8 | 193.2 | 142.3 | 208.7 | 141.2 | 211.4 | 128.2 | 171.1 |
| **Exports** | 2005 = 100 | 118.3 | 163.0 | 196.6 | 172.7 | 212.4 | 172.1 | 214.8 | 161.7 | 193.3 |
| **Imports** | 2005 = 100 | 124.0 | 154.3 | 180.1 | 162.0 | 187.6 | 158.6 | 179.5 | 139.7 | 143.0 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 5.5 | 5.6 | 5.7 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 2.45 | 2.31 | 2.22 | 2.36 | 2.25 | 2.36 | 2.28 | 2.45 | 2.53 |
| **Employment share** | in % | 71.2% | 70.3% | 67.3% | 71.9% | 68.3% | 71.9% | 69.3% | 74.4% | 76.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 108.1 | 141.1 | 202.6 | 144.6 | 180.4 | 154.3 | 246.4 | 141.4 | 212.4 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 59.4 | 55.0 | 48.2 | 46.3 | 18.3 | 44.1 | 17.0 | 41.2 | 16.2 |
| **$RMC_{abiotic}$** per capita | in tons | 23.1 | 19.7 | 17.8 | 15.2 | 5.5 | 14.9 | 5.7 | 15.5 | 8.9 |
| **$RMC_{fossils}$** per capita | in tons | 6.7 | 5.8 | 5.2 | 4.6 | 0.9 | 4.7 | 1.4 | 4.2 | 1.2 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 14.2 | 11.7 | 10.1 | 9.1 | 4.0 | 8.2 | 2.6 | 9.6 | 6.2 |
| **$RMC_{ores}$** per capita | in tons | 2.2 | 2.2 | 2.5 | 1.4 | 0.6 | 2.0 | 1.8 | 1.7 | 1.5 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 132.4 | 166.4 | 221.0 | 240.1 | 798.3 | 229.0 | 579.7 | 193.1 | 340.2 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 1.8% | 1.7% | 1.5% | 1.7% | 1.5% | 1.7% | 1.5% | 1.7% | 1.4% |
| **Total crop production** | in mio. tons | 6.9 | 8.0 | 7.3 | 8.1 | 7.5 | 8.2 | 7.5 | 8.1 | 7.5 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 362.0 | 309.5 | 316.1 | 348.5 | 393.4 | 320.9 | 296.5 | 232.3 | 82.6 |
| **Per capita meat demand** | in kg | 76.4 | 80.1 | 93.9 | 66.5 | 61.1 | 74.6 | 79.2 | 65.1 | 50.6 |
| **Per capita crop land footprint** | 2005 = 100 | 87.1 | 72.8 | 72.5 | 72.6 | 69.1 | 71.2 | 63.8 | 61.2 | 41.6 |

***Table 24: Simulation results for EU27-countries: France.***

| France | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 110.3 | 125.9 | 144.4 | 135.8 | 155.9 | 136.0 | 158.8 | 112.9 | 107.8 |
| **Gross disposable income** | 2005 = 100 | 118.6 | 127.6 | 131.3 | 135.3 | 138.9 | 136.8 | 142.4 | 118.3 | 106.9 |
| **Gross fixed capital formation** | 2005 = 100 | 110.9 | 129.3 | 164.7 | 151.9 | 194.9 | 146.4 | 181.0 | 114.1 | 118.7 |
| **Final consumption expend. by households** | 2005 = 100 | 115.5 | 128.3 | 139.6 | 134.8 | 146.4 | 136.3 | 150.4 | 105.5 | 83.2 |
| **Final consumption expend. by government** | 2005 = 100 | 104.1 | 109.0 | 117.0 | 117.1 | 127.8 | 115.1 | 123.9 | 102.6 | 91.1 |
| **Exports** | 2005 = 100 | 118.9 | 160.8 | 203.8 | 168.4 | 212.9 | 167.3 | 213.4 | 155.4 | 187.0 |
| **Imports** | 2005 = 100 | 112.2 | 139.6 | 168.6 | 146.7 | 178.7 | 142.6 | 164.4 | 119.4 | 117.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 64.5 | 68.8 | 72.7 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 25.52 | 23.55 | 21.57 | 24.22 | 21.88 | 24.20 | 22.04 | 24.44 | 23.10 |
| **Employment share** | in % | 62.6% | 57.7% | 51.6% | 59.3% | 52.3% | 59.3% | 52.7% | 59.9% | 55.2% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 117.8 | 144.0 | 193.6 | 148.3 | 165.2 | 157.9 | 225.2 | 141.0 | 183.5 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 373.3 | 332.5 | 284.7 | 269.2 | 142.3 | 246.9 | 117.4 | 244.0 | 148.0 |
| **$RMC_{abiotic}$** per capita | in tons | 11.3 | 9.9 | 9.1 | 7.7 | 3.6 | 7.8 | 4.4 | 7.7 | 5.1 |
| **$RMC_{fossils}$** per capita | in tons | 4.1 | 3.2 | 2.6 | 2.4 | 0.8 | 2.4 | 1.1 | 2.1 | 0.9 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 5.6 | 5.0 | 4.5 | 4.1 | 2.3 | 3.8 | 1.7 | 4.2 | 3.0 |
| **$RMC_{ores}$** per capita | in tons | 1.6 | 1.7 | 2.0 | 1.1 | 0.5 | 1.6 | 1.5 | 1.3 | 1.1 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 128.2 | 151.7 | 177.1 | 216.0 | 492.8 | 204.0 | 370.9 | 170.0 | 219.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 16.4% | 24.9% | 16.9% | 21.3% | 17.0% | 21.2% | 16.4% | 20.6% | 15.3% |
| **Total crop production** | in mio. tons | 155.6 | 126.5 | 111.1 | 124.2 | 99.9 | 124.6 | 101.4 | 124.3 | 101.5 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 414.0 | 372.7 | 388.2 | 410.2 | 462.2 | 381.9 | 360.0 | 272.7 | 97.7 |
| **Per capita meat demand** | in kg | 89.2 | 92.5 | 97.2 | 76.7 | 63.4 | 77.3 | 82.5 | 69.7 | 56.4 |
| **Per capita crop land footprint** | 2005 = 100 | 74.8 | 69.1 | 75.5 | 71.6 | 66.5 | 68.3 | 70.0 | 57.3 | 44.7 |

***Table 25: Simulation results for EU27-countries: Germany.***

| Germany | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 116.7 | 135.6 | 153.4 | 146.9 | 169.6 | 147.3 | 175.5 | 125.2 | 123.5 |
| **Gross disposable income** | 2005 = 100 | 108.9 | 115.1 | 121.9 | 120.7 | 126.7 | 123.0 | 133.9 | 107.7 | 101.3 |
| **Gross fixed capital formation** | 2005 = 100 | 124.7 | 145.2 | 180.1 | 168.4 | 212.8 | 159.1 | 190.3 | 130.4 | 131.6 |
| **Final consumption expend. by households** | 2005 = 100 | 111.7 | 115.0 | 126.0 | 119.8 | 130.2 | 121.8 | 137.0 | 95.0 | 75.7 |
| **Final consumption expend. by government** | 2005 = 100 | 115.5 | 128.8 | 166.5 | 138.7 | 184.3 | 138.9 | 193.8 | 122.5 | 135.6 |
| **Exports** | 2005 = 100 | 132.8 | 184.5 | 211.5 | 196.1 | 228.9 | 194.3 | 227.3 | 180.3 | 198.3 |
| **Imports** | 2005 = 100 | 140.3 | 172.3 | 211.6 | 179.9 | 220.1 | 174.7 | 204.6 | 152.7 | 155.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 83.2 | 81.0 | 73.5 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 40.77 | 38.17 | 35.08 | 39.08 | 35.48 | 39.12 | 36.07 | 39.85 | 38.01 |
| **Employment share** | in % | 74.3% | 78.8% | 83.8% | 80.7% | 84.8% | 80.8% | 86.2% | 82.3% | 90.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 129.9 | 177.8 | 233.7 | 181.1 | 201.1 | 192.9 | 268.4 | 174.2 | 225.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 735.4 | 637.8 | 542.9 | 531.7 | 197.9 | 498.1 | 176.1 | 467.0 | 177.6 |
| **$RMC_{abiotic}$** per capita | in tons | 14.5 | 13.3 | 14.1 | 10.5 | 5.1 | 11.0 | 7.1 | 10.8 | 7.9 |
| **$RMC_{fossils}$** per capita | in tons | 5.9 | 5.0 | 4.8 | 4.0 | 1.3 | 4.1 | 2.0 | 3.9 | 2.0 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 6.3 | 5.7 | 5.6 | 4.7 | 2.8 | 4.4 | 2.2 | 4.8 | 3.5 |
| **$RMC_{ores}$** per capita | in tons | 2.3 | 2.6 | 3.8 | 1.8 | 1.0 | 2.5 | 2.9 | 2.2 | 2.4 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 121.3 | 146.1 | 173.5 | 206.4 | 556.1 | 188.4 | 350.5 | 161.4 | 229.4 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 18.7% | 17.7% | 20.1% | 18.0% | 18.3% | 17.6% | 17.6% | 17.2% | 16.4% |
| **Total crop production** | in mio. tons | 124.9 | 111.1 | 142.0 | 109.8 | 136.7 | 108.2 | 132.7 | 107.9 | 133.1 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 377.1 | 324.5 | 382.7 | 361.1 | 452.0 | 335.8 | 373.0 | 243.6 | 94.4 |
| **Per capita meat demand** | in kg | 91.1 | 93.2 | 94.9 | 78.2 | 64.2 | 77.4 | 79.9 | 70.0 | 53.0 |
| **Per capita crop land footprint** | 2005 = 100 | 81.4 | 79.6 | 80.7 | 76.0 | 78.3 | 76.2 | 75.2 | 68.4 | 52.5 |

***Table 26: Simulation results for EU27-countries: Greece.***

| Greece | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 82.7 | 86.7 | 89.9 | 91.8 | 97.5 | 96.1 | 108.0 | 78.6 | 72.6 |
| **Gross disposable income** | 2005 = 100 | 67.5 | 59.4 | 52.1 | 63.1 | 56.9 | 67.5 | 65.2 | 53.8 | 41.2 |
| **Gross fixed capital formation** | 2005 = 100 | 38.7 | 47.0 | 59.8 | 51.7 | 68.8 | 49.9 | 62.9 | 42.4 | 47.4 |
| **Final consumption expend. by households** | 2005 = 100 | 76.1 | 66.4 | 54.8 | 69.8 | 58.7 | 73.8 | 66.3 | 54.3 | 34.2 |
| **Final consumption expend. by government** | 2005 = 100 | 65.0 | 65.4 | 85.2 | 71.0 | 95.0 | 78.3 | 119.7 | 60.3 | 63.8 |
| **Exports** | 2005 = 100 | 155.0 | 208.7 | 234.2 | 216.2 | 244.5 | 218.5 | 250.6 | 204.0 | 219.9 |
| **Imports** | 2005 = 100 | 73.7 | 77.6 | 74.7 | 80.5 | 77.5 | 79.9 | 72.9 | 66.3 | 53.1 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 11.4 | 11.2 | 10.9 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 3.70 | 3.13 | 2.72 | 3.18 | 2.72 | 3.26 | 2.88 | 3.20 | 2.85 |
| **Employment share** | in % | 49.7% | 44.9% | 46.1% | 45.5% | 46.2% | 46.7% | 48.8% | 45.9% | 48.3% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 85.8 | 105.1 | 163.4 | 105.8 | 149.0 | 117.6 | 214.5 | 105.1 | 161.3 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 66.7 | 49.3 | 36.8 | 47.2 | 15.0 | 45.4 | 13.6 | 40.1 | 11.2 |
| **$RMC_{abiotic}$** per capita | in tons | 10.5 | 9.0 | 8.2 | 8.0 | 2.4 | 8.3 | 3.3 | 7.4 | 3.2 |
| **$RMC_{fossils}$** per capita | in tons | 6.5 | 5.3 | 4.7 | 5.5 | 1.4 | 5.4 | 1.8 | 4.5 | 1.2 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 3.0 | 2.6 | 2.4 | 1.9 | 0.8 | 1.8 | 0.7 | 2.0 | 1.3 |
| **$RMC_{ores}$** per capita | in tons | 1.0 | 1.0 | 1.1 | 0.7 | 0.3 | 1.0 | 0.9 | 0.8 | 0.7 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 132.6 | 160.0 | 192.4 | 195.8 | 695.7 | 195.0 | 532.3 | 175.6 | 367.0 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 17.8% | 37.8% | 39.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% |
| **Total crop production** | in mio. tons | 18.4 | 23.5 | 24.3 | 23.4 | 25.1 | 22.8 | 23.5 | 22.7 | 23.7 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 429.1 | 329.8 | 273.0 | 367.5 | 187.9 | 352.3 | 157.4 | 197.1 | 0.0 |
| **Per capita meat demand** | in kg | 81.6 | 85.9 | 93.8 | 71.3 | 61.1 | 76.1 | 81.0 | 67.8 | 54.2 |
| **Per capita crop land footprint** | 2005 = 100 | 61.7 | 48.4 | 51.8 | 46.7 | 36.8 | 47.5 | 36.9 | 36.5 | 19.2 |

***Table 27: Simulation results for EU27-countries: Hungary.***

| Hungary | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 116.4 | 158.5 | 191.2 | 168.1 | 204.2 | 167.5 | 209.8 | 152.5 | 172.9 |
| **Gross disposable income** | 2005 = 100 | 103.1 | 124.3 | 129.4 | 133.0 | 146.9 | 132.7 | 145.2 | 122.5 | 123.9 |
| **Gross fixed capital formation** | 2005 = 100 | 100.2 | 147.8 | 208.3 | 163.3 | 243.4 | 152.6 | 211.5 | 140.4 | 179.9 |
| **Final consumption expend. by households** | 2005 = 100 | 107.0 | 124.9 | 130.2 | 132.2 | 144.3 | 132.4 | 144.8 | 108.4 | 90.2 |
| **Final consumption expend. by government** | 2005 = 100 | 107.9 | 142.3 | 146.1 | 153.2 | 166.0 | 151.0 | 166.8 | 138.9 | 130.1 |
| **Exports** | 2005 = 100 | 161.2 | 245.7 | 311.8 | 260.2 | 329.6 | 255.5 | 323.2 | 237.6 | 285.3 |
| **Imports** | 2005 = 100 | 143.8 | 213.3 | 265.3 | 228.1 | 291.4 | 220.3 | 268.2 | 199.3 | 223.9 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 9.9 | 9.5 | 8.9 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 4.08 | 3.78 | 3.43 | 3.85 | 3.48 | 3.84 | 3.49 | 4.02 | 3.94 |
| **Employment share** | in % | 61.0% | 61.3% | 64.7% | 62.4% | 65.6% | 62.3% | 65.8% | 65.3% | 74.3% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 149.1 | 185.7 | 261.4 | 184.1 | 220.6 | 199.0 | 304.4 | 184.4 | 265.4 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 47.9 | 44.3 | 40.0 | 36.5 | 14.9 | 33.2 | 13.5 | 32.1 | 14.2 |
| **$RMC_{abiotic}$** per capita | in tons | 6.3 | 6.4 | 6.8 | 4.7 | 1.9 | 4.7 | 2.1 | 5.1 | 3.5 |
| **$RMC_{fossils}$** per capita | in tons | 2.4 | 2.3 | 2.1 | 1.8 | 0.5 | 1.9 | 0.7 | 1.8 | 0.6 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 3.1 | 3.1 | 3.3 | 2.2 | 1.0 | 1.9 | 0.3 | 2.5 | 1.9 |
| **$RMC_{ores}$** per capita | in tons | 0.7 | 1.0 | 1.3 | 0.7 | 0.4 | 0.9 | 1.1 | 0.8 | 0.9 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 193.6 | 255.9 | 309.4 | 368.0 | 1136.3 | 338.7 | 711.5 | 297.4 | 472.6 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 5.4% | 5.5% | 5.2% | 5.7% | 5.5% | 5.6% | 5.3% | 5.6% | 5.0% |
| **Total crop production** | in mio. tons | 19.8 | 6.2 | 3.1 | 5.8 | 3.0 | 6.0 | 3.0 | 6.0 | 3.0 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 347.7 | 288.7 | 309.0 | 316.9 | 363.7 | 291.7 | 285.1 | 238.0 | 127.4 |
| **Per capita meat demand** | in kg | 82.9 | 87.2 | 93.4 | 73.0 | 60.5 | 76.6 | 79.9 | 67.7 | 50.8 |
| **Per capita crop land footprint** | 2005 = 100 | 90.6 | 217.1 | 280.6 | 254.2 | 386.9 | 225.1 | 278.3 | 195.9 | 174.3 |

***Table 28: Simulation results for EU27-countries: Ireland.***

| Ireland | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 107.5 | 148.8 | 190.9 | 156.4 | 203.8 | 156.6 | 207.9 | 142.0 | 167.6 |
| **Gross disposable income** | 2005 = 100 | 111.5 | 117.3 | 122.6 | 123.5 | 130.6 | 125.3 | 136.2 | 113.1 | 110.0 |
| **Gross fixed capital formation** | 2005 = 100 | 45.5 | 65.0 | 109.7 | 73.6 | 132.5 | 69.9 | 117.9 | 61.1 | 89.9 |
| **Final consumption expend. by households** | 2005 = 100 | 111.6 | 115.9 | 130.6 | 121.0 | 137.7 | 122.8 | 144.0 | 98.6 | 85.3 |
| **Final consumption expend. by government** | 2005 = 100 | 106.2 | 170.0 | 277.4 | 179.2 | 295.0 | 175.2 | 292.5 | 165.5 | 244.8 |
| **Exports** | 2005 = 100 | 141.4 | 203.5 | 246.0 | 213.4 | 257.3 | 212.4 | 260.5 | 198.1 | 227.3 |
| **Imports** | 2005 = 100 | 118.9 | 156.2 | 189.8 | 164.9 | 200.4 | 162.9 | 198.0 | 147.4 | 162.3 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 4.7 | 5.4 | 6.0 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 1.80 | 1.78 | 1.78 | 1.81 | 1.79 | 1.81 | 1.81 | 1.90 | 2.05 |
| **Employment share** | in % | 58.1% | 52.2% | 51.9% | 52.9% | 52.2% | 52.9% | 52.7% | 55.6% | 59.6% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 121.3 | 188.4 | 298.7 | 188.9 | 249.3 | 202.0 | 338.7 | 189.3 | 305.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 42.5 | 36.0 | 35.7 | 32.5 | 16.7 | 29.1 | 14.3 | 29.0 | 16.7 |
| **$RMC_{abiotic}$** per capita | in tons | 19.1 | 17.7 | 19.9 | 14.8 | 9.9 | 14.1 | 9.0 | 14.9 | 12.4 |
| **$RMC_{fossils}$** per capita | in tons | 7.5 | 5.7 | 5.3 | 5.3 | 2.5 | 5.1 | 3.0 | 4.8 | 2.9 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 9.8 | 10.2 | 12.6 | 8.2 | 6.6 | 7.4 | 4.3 | 8.5 | 7.9 |
| **$RMC_{ores}$** per capita | in tons | 1.8 | 1.7 | 2.0 | 1.3 | 0.8 | 1.7 | 1.7 | 1.5 | 1.5 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 147.1 | 201.3 | 232.5 | 253.7 | 540.7 | 254.8 | 496.6 | 224.2 | 324.9 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 2.6% | 2.9% | 2.6% | 2.9% | 2.6% | 2.8% | 2.5% | 2.8% | 2.5% |
| **Total crop production** | in mio. tons | 2.7 | 3.1 | 3.5 | 3.0 | 3.1 | 3.0 | 3.3 | 3.0 | 3.3 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 475.8 | 331.3 | 275.3 | 369.7 | 370.5 | 340.8 | 278.8 | 288.0 | 174.0 |
| **Per capita meat demand** | in kg | 90.4 | 93.1 | 98.6 | 77.9 | 65.2 | 77.1 | 83.0 | 69.7 | 55.2 |
| **Per capita crop land footprint** | 2005 = 100 | 80.0 | 60.5 | 44.1 | 60.1 | 47.9 | 59.2 | 43.0 | 56.0 | 34.6 |

***Table 29: Simulation results for EU27-countries: Italy.***

| Italy | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 97.4 | 116.2 | 136.2 | 121.5 | 146.2 | 120.8 | 146.1 | 104.3 | 104.7 |
| **Gross disposable income** | 2005 = 100 | 95.2 | 102.9 | 102.4 | 107.3 | 109.8 | 108.7 | 112.4 | 94.7 | 82.1 |
| **Gross fixed capital formation** | 2005 = 100 | 75.4 | 99.2 | 143.8 | 104.4 | 151.2 | 97.6 | 130.7 | 88.3 | 104.9 |
| **Final consumption expend. by households** | 2005 = 100 | 94.9 | 107.3 | 112.8 | 111.2 | 119.6 | 112.6 | 122.7 | 87.8 | 66.5 |
| **Final consumption expend. by government** | 2005 = 100 | 95.0 | 111.3 | 120.4 | 116.5 | 128.7 | 112.8 | 123.3 | 105.0 | 94.6 |
| **Exports** | 2005 = 100 | 111.6 | 153.1 | 199.1 | 159.1 | 208.6 | 157.6 | 207.9 | 147.7 | 185.0 |
| **Imports** | 2005 = 100 | 94.6 | 124.7 | 151.1 | 127.8 | 151.1 | 123.9 | 137.5 | 105.6 | 98.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 61.2 | 61.2 | 60.1 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 23.98 | 22.43 | 20.33 | 22.64 | 20.28 | 22.59 | 20.27 | 23.11 | 21.56 |
| **Employment share** | in % | 61.1% | 61.2% | 63.9% | 61.8% | 63.7% | 61.7% | 63.7% | 63.1% | 67.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 127.5 | 173.6 | 266.5 | 173.9 | 235.5 | 185.9 | 318.6 | 173.3 | 287.2 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 392.6 | 367.9 | 313.0 | 321.8 | 158.0 | 305.9 | 142.0 | 293.1 | 152.7 |
| **$RMC_{abiotic}$** per capita | in tons | 10.0 | 10.4 | 10.5 | 8.1 | 3.9 | 8.1 | 4.3 | 8.2 | 5.4 |
| **$RMC_{fossils}$** per capita | in tons | 4.0 | 3.9 | 3.4 | 3.3 | 1.1 | 3.2 | 1.3 | 2.9 | 1.0 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 4.8 | 4.9 | 5.1 | 3.8 | 2.2 | 3.5 | 1.6 | 4.1 | 3.2 |
| **$RMC_{ores}$** per capita | in tons | 1.3 | 1.6 | 2.0 | 1.0 | 0.6 | 1.4 | 1.4 | 1.2 | 1.1 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 133.1 | 150.2 | 177.5 | 204.0 | 527.2 | 195.6 | 404.7 | 166.9 | 244.0 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 20.1% | 31.0% | 20.8% | 20.0% | 19.4% | 20.0% | 18.9% | 20.0% | 18.7% |
| **Total crop production** | in mio. tons | 42.0 | 37.8 | 39.2 | 37.5 | 37.7 | 36.7 | 37.2 | 36.5 | 37.2 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 451.8 | 397.7 | 408.0 | 429.4 | 463.3 | 389.7 | 334.5 | 292.5 | 100.0 |
| **Per capita meat demand** | in kg | 92.5 | 95.7 | 99.5 | 79.2 | 64.0 | 78.8 | 81.4 | 71.0 | 56.2 |
| **Per capita crop land footprint** | 2005 = 100 | 76.8 | 66.1 | 58.4 | 64.6 | 57.4 | 62.1 | 50.4 | 53.2 | 31.7 |

***Table 30: Simulation results for EU27-countries: Latvia.***

| Latvia | | Reference Scenario | | | Scenario: *Global cooperation* | | Scenario: *EU goes ahead* | | Scenario: *Civil society leads* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 114.6 | 153.8 | 212.8 | 163.5 | 235.4 | 165.3 | 241.8 | 144.8 | 186.9 |
| **Gross disposable income** | 2005 = 100 | 118.7 | 133.9 | 153.0 | 140.4 | 169.2 | 143.6 | 172.4 | 129.5 | 141.8 |
| **Gross fixed capital formation** | 2005 = 100 | 79.0 | 116.6 | 185.7 | 129.5 | 210.8 | 122.6 | 189.9 | 111.4 | 162.9 |
| **Final consumption expend. by households** | 2005 = 100 | 121.8 | 123.3 | 137.0 | 128.3 | 149.1 | 131.2 | 152.8 | 104.9 | 90.8 |
| **Final consumption expend. by government** | 2005 = 100 | 104.8 | 149.5 | 230.9 | 158.5 | 249.4 | 160.2 | 265.9 | 144.6 | 200.4 |
| **Exports** | 2005 = 100 | 133.4 | 199.2 | 273.9 | 206.0 | 288.8 | 206.4 | 289.5 | 191.0 | 251.8 |
| **Imports** | 2005 = 100 | 112.6 | 139.9 | 182.1 | 144.9 | 189.6 | 141.5 | 175.6 | 126.6 | 142.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 2.2 | 2.0 | 1.8 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 0.93 | 0.88 | 0.84 | 0.90 | 0.85 | 0.90 | 0.86 | 0.94 | 0.96 |
| **Employment share** | in % | 63.8% | 69.6% | 76.4% | 70.9% | 77.4% | 71.0% | 78.0% | 73.8% | 87.3% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 96.5 | 131.4 | 191.1 | 130.7 | 158.4 | 142.2 | 224.5 | 130.5 | 193.4 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 8.3 | 8.1 | 7.8 | 6.6 | 3.1 | 6.2 | 2.8 | 6.0 | 3.0 |
| **$RMC_{abiotic}$** per capita | in tons | 11.4 | 13.7 | 17.0 | 10.5 | 6.6 | 10.0 | 5.7 | 11.1 | 9.9 |
| **$RMC_{fossils}$** per capita | in tons | 2.6 | 2.6 | 2.7 | 2.1 | 0.8 | 2.1 | 1.1 | 2.1 | 1.3 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 8.3 | 10.3 | 13.1 | 7.9 | 5.5 | 7.2 | 3.7 | 8.3 | 7.8 |
| **$RMC_{ores}$** per capita | in tons | 0.6 | 0.8 | 1.2 | 0.5 | 0.3 | 0.7 | 0.9 | 0.6 | 0.8 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 86.5 | 106.1 | 134.9 | 146.6 | 387.9 | 151.0 | 404.9 | 121.2 | 197.8 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 1.2% | 1.4% | 1.4% | 1.4% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% |
| **Total crop production** | in mio. tons | 4.0 | 5.0 | 5.8 | 4.9 | 5.3 | 4.9 | 5.5 | 4.9 | 5.5 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 467.9 | 483.7 | 629.8 | 535.7 | 854.3 | 494.4 | 614.8 | 370.6 | 251.2 |
| **Per capita meat demand** | in kg | 69.1 | 79.7 | 93.6 | 66.1 | 61.3 | 76.6 | 84.1 | 63.5 | 48.4 |
| **Per capita crop land footprint** | 2005 = 100 | 75.0 | 82.3 | 117.1 | 80.4 | 120.1 | 81.3 | 106.2 | 70.4 | 66.3 |

***Table 31: Simulation results for EU27-countries: Lithuania.***

| **Lithuania** | | **Reference Scenario** | | | **Scenario** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ***Global cooperation*** | | ***EU goes ahead*** | | ***Civil society leads*** | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 121.4 | 181.8 | 252.6 | 197.8 | 285.3 | 197.5 | 286.2 | 174.9 | 223.7 |
| **Gross disposable income** | 2005 = 100 | 145.9 | 181.9 | 201.7 | 190.2 | 213.5 | 191.5 | 210.6 | 178.6 | 186.3 |
| **Gross fixed capital formation** | 2005 = 100 | 91.4 | 142.0 | 216.7 | 162.8 | 255.1 | 155.8 | 231.9 | 144.4 | 200.7 |
| **Final consumption expend. by households** | 2005 = 100 | 136.0 | 163.4 | 177.6 | 169.7 | 186.1 | 170.8 | 184.9 | 140.5 | 116.6 |
| **Final consumption expend. by government** | 2005 = 100 | 106.5 | 184.6 | 268.9 | 198.3 | 291.2 | 202.3 | 312.3 | 179.6 | 229.5 |
| **Exports** | 2005 = 100 | 163.6 | 233.5 | 306.6 | 240.3 | 321.5 | 237.5 | 313.5 | 220.1 | 273.1 |
| **Imports** | 2005 = 100 | 163.5 | 209.2 | 245.0 | 212.5 | 245.9 | 209.6 | 232.6 | 187.1 | 185.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 3.2 | 3.1 | 2.8 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 1.36 | 1.34 | 1.30 | 1.36 | 1.30 | 1.37 | 1.33 | 1.43 | 1.50 |
| **Employment share** | in % | 61.2% | 69.0% | 77.4% | 70.0% | 77.7% | 70.3% | 79.2% | 73.4% | 89.2% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 88.8 | 123.6 | 195.9 | 122.3 | 161.9 | 133.3 | 227.5 | 122.6 | 193.2 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 16.7 | 17.0 | 15.9 | 12.6 | 6.6 | 11.5 | 6.0 | 11.2 | 6.0 |
| **$RMC_{abiotic}$** per capita | in tons | 8.8 | 9.5 | 9.9 | 7.9 | 5.4 | 8.3 | 6.9 | 8.2 | 7.0 |
| **$RMC_{fossils}$** per capita | in tons | 3.0 | 2.8 | 2.6 | 2.1 | 0.8 | 2.2 | 1.2 | 2.2 | 1.2 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 5.0 | 5.7 | 6.0 | 5.1 | 4.3 | 5.1 | 4.7 | 5.2 | 5.0 |
| **$RMC_{ores}$** per capita | in tons | 0.8 | 1.0 | 1.3 | 0.6 | 0.3 | 0.9 | 0.9 | 0.8 | 0.9 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 107.7 | 166.5 | 260.6 | 228.7 | 629.2 | 216.2 | 468.8 | 188.8 | 335.3 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 9.5% | 10.1% | 9.0% | 10.5% | 6.8% | 10.3% | 6.6% | 10.3% | 6.5% |
| **Total crop production** | in mio. tons | 12.6 | 11.3 | 12.4 | 10.7 | 11.1 | 10.9 | 11.6 | 10.9 | 11.6 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 575.7 | 742.4 | 1052.3 | 856.8 | 1468.7 | 792.3 | 1113.7 | 562.0 | 349.0 |
| **Per capita meat demand** | in kg | 84.5 | 95.4 | 101.5 | 79.6 | 67.6 | 79.3 | 84.3 | 69.6 | 52.7 |
| **Per capita crop land footprint** | 2005 = 100 | 69.1 | 95.8 | 122.2 | 102.4 | 157.9 | 97.8 | 126.9 | 80.1 | 64.7 |

***Table 32: Simulation results for EU27-countries: Netherlands.***

| **Netherlands** | | **Reference Scenario** | | | **Scenario** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ***Global cooperation*** | | ***EU goes ahead*** | | ***Civil society leads*** | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 117.1 | 147.8 | 166.5 | 154.7 | 178.3 | 157.1 | 187.0 | 137.6 | 142.6 |
| **Gross disposable income** | 2005 = 100 | 106.8 | 128.7 | 124.2 | 136.7 | 133.6 | 140.8 | 144.4 | 121.2 | 109.7 |
| **Gross fixed capital formation** | 2005 = 100 | 94.5 | 133.8 | 174.0 | 150.2 | 201.8 | 147.2 | 193.4 | 120.6 | 138.3 |
| **Final consumption expend. by households** | 2005 = 100 | 100.1 | 122.3 | 120.0 | 128.7 | 127.5 | 132.1 | 137.1 | 101.9 | 76.9 |
| **Final consumption expend. by government** | 2005 = 100 | 127.5 | 146.5 | 115.4 | 153.4 | 123.9 | 152.4 | 124.1 | 140.9 | 102.2 |
| **Exports** | 2005 = 100 | 135.7 | 171.8 | 203.7 | 176.0 | 209.6 | 176.0 | 211.0 | 162.5 | 178.3 |
| **Imports** | 2005 = 100 | 122.6 | 151.8 | 160.4 | 158.3 | 166.1 | 155.9 | 159.3 | 136.2 | 121.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 16.8 | 17.2 | 16.9 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 8.48 | 8.17 | 7.27 | 8.26 | 7.28 | 8.33 | 7.50 | 8.58 | 8.23 |
| **Employment share** | in % | 77.4% | 79.6% | 75.2% | 80.5% | 75.3% | 81.1% | 77.5% | 83.6% | 85.0% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 142.4 | 173.3 | 239.7 | 167.9 | 196.3 | 181.5 | 276.7 | 173.5 | 249.0 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 211.9 | 194.6 | 166.5 | 167.5 | 81.1 | 155.7 | 72.5 | 154.2 | 81.4 |
| **$RMC_{abiotic}$** per capita | in tons | 11.2 | 11.7 | 12.1 | 10.1 | 6.6 | 10.9 | 7.8 | 10.0 | 8.0 |
| **$RMC_{fossils}$** per capita | in tons | 4.9 | 4.6 | 4.0 | 3.9 | 1.0 | 4.0 | 1.5 | 3.5 | 1.0 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 4.6 | 4.9 | 5.5 | 4.7 | 4.9 | 4.7 | 4.2 | 4.7 | 5.2 |
| **$RMC_{ores}$** per capita | in tons | 1.8 | 2.3 | 2.6 | 1.5 | 0.7 | 2.2 | 2.1 | 1.9 | 1.7 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 104.5 | 132.2 | 157.9 | 173.0 | 399.2 | 161.1 | 277.8 | 145.7 | 207.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 13.9% | 14.0% | 13.7% | 14.0% | 12.7% | 13.9% | 12.6% | 13.5% | 11.7% |
| **Total crop production** | in mio. tons | 33.8 | 30.7 | 29.4 | 29.9 | 27.8 | 30.1 | 27.0 | 30.0 | 27.1 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 347.3 | 281.6 | 256.2 | 318.7 | 336.1 | 296.4 | 264.3 | 231.1 | 133.8 |
| **Per capita meat demand** | in kg | 88.8 | 93.0 | 98.7 | 77.0 | 63.9 | 78.0 | 83.2 | 69.5 | 55.4 |
| **Per capita crop land footprint** | 2005 = 100 | 69.8 | 54.4 | 36.8 | 54.6 | 41.1 | 53.3 | 36.0 | 50.4 | 30.9 |

***Table 33: Simulation results for EU27-countries: Poland.***

| Poland | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 146.5 | 174.4 | 190.9 | 186.0 | 209.5 | 184.8 | 207.3 | 157.9 | 148.0 |
| **Gross disposable income** | 2005 = 100 | 131.9 | 132.5 | 131.9 | 138.0 | 139.6 | 137.9 | 137.8 | 121.8 | 106.0 |
| **Gross fixed capital formation** | 2005 = 100 | 142.5 | 178.2 | 218.4 | 202.2 | 251.2 | 189.2 | 220.1 | 163.7 | 168.6 |
| **Final consumption expend. by households** | 2005 = 100 | 127.8 | 127.8 | 125.8 | 132.2 | 131.9 | 132.2 | 130.5 | 103.7 | 72.5 |
| **Final consumption expend. by government** | 2005 = 100 | 129.8 | 175.9 | 182.9 | 189.5 | 204.5 | 185.9 | 202.4 | 167.8 | 147.1 |
| **Exports** | 2005 = 100 | 193.6 | 264.5 | 313.3 | 277.7 | 334.5 | 273.6 | 321.7 | 247.1 | 267.7 |
| **Imports** | 2005 = 100 | 149.0 | 188.1 | 216.6 | 196.3 | 225.6 | 187.9 | 200.7 | 165.0 | 158.1 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 38.3 | 37.5 | 34.2 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 15.15 | 13.62 | 11.65 | 13.81 | 11.73 | 13.75 | 11.66 | 14.19 | 12.65 |
| **Employment share** | in % | 56.8% | 57.7% | 59.7% | 58.4% | 60.1% | 58.2% | 59.8% | 60.1% | 64.9% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 118.3 | 156.9 | 209.6 | 160.3 | 186.1 | 171.4 | 251.5 | 158.7 | 224.3 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 336.1 | 322.2 | 277.9 | 275.4 | 106.2 | 257.0 | 95.0 | 251.7 | 108.3 |
| **$RMC_{abiotic}$** per capita | in tons | 17.8 | 19.5 | 22.4 | 15.0 | 9.2 | 15.0 | 9.9 | 15.4 | 12.1 |
| **$RMC_{fossils}$** per capita | in tons | 4.2 | 4.3 | 4.2 | 3.3 | 0.8 | 3.4 | 1.4 | 3.4 | 1.8 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 11.5 | 13.3 | 16.0 | 10.4 | 7.9 | 9.9 | 6.9 | 10.4 | 8.8 |
| **$RMC_{ores}$** per capita | in tons | 2.0 | 1.9 | 2.2 | 1.3 | 0.5 | 1.8 | 1.6 | 1.6 | 1.4 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 104.1 | 116.1 | 124.5 | 163.0 | 366.3 | 155.1 | 281.2 | 131.8 | 178.0 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 16.2% | 17.2% | 13.7% | 16.8% | 10.9% | 16.7% | 10.6% | 16.4% | 10.3% |
| **Total crop production** | in mio. tons | 81.3 | 66.4 | 83.3 | 64.8 | 78.7 | 64.4 | 77.4 | 64.1 | 77.5 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 568.3 | 533.3 | 664.2 | 586.0 | 831.4 | 540.0 | 638.2 | 382.0 | 203.5 |
| **Per capita meat demand** | in kg | 82.1 | 85.6 | 93.3 | 71.4 | 60.5 | 76.7 | 80.0 | 67.3 | 51.1 |
| **Per capita crop land footprint** | 2005 = 100 | 74.1 | 84.9 | 88.8 | 86.7 | 95.9 | 84.3 | 87.4 | 69.6 | 51.7 |

***Table 34: Simulation results for EU27-countries: Portugal.***

| Portugal | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 94.8 | 110.7 | 121.4 | 118.7 | 138.3 | 119.9 | 144.0 | 99.7 | 95.7 |
| **Gross disposable income** | 2005 = 100 | 98.9 | 105.1 | 105.7 | 111.9 | 116.2 | 114.3 | 122.7 | 98.0 | 89.2 |
| **Gross fixed capital formation** | 2005 = 100 | 66.7 | 91.3 | 129.8 | 101.6 | 149.8 | 97.6 | 139.8 | 83.3 | 103.9 |
| **Final consumption expend. by households** | 2005 = 100 | 103.6 | 111.4 | 112.4 | 117.5 | 121.7 | 120.0 | 129.0 | 92.6 | 70.5 |
| **Final consumption expend. by government** | 2005 = 100 | 95.1 | 107.8 | 112.5 | 115.7 | 127.8 | 111.6 | 122.9 | 101.4 | 89.1 |
| **Exports** | 2005 = 100 | 124.2 | 166.1 | 195.1 | 173.5 | 209.0 | 174.2 | 212.7 | 156.2 | 172.8 |
| **Imports** | 2005 = 100 | 97.0 | 119.2 | 139.7 | 124.0 | 141.6 | 121.4 | 134.1 | 102.5 | 96.9 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 10.7 | 10.5 | 9.9 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 4.54 | 4.15 | 3.61 | 4.21 | 3.65 | 4.24 | 3.73 | 4.29 | 3.88 |
| **Employment share** | in % | 64.0% | 62.9% | 67.9% | 63.8% | 68.6% | 64.2% | 70.1% | 65.0% | 72.9% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 103.1 | 132.6 | 169.0 | 132.7 | 155.4 | 145.1 | 221.4 | 131.8 | 181.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 55.0 | 50.6 | 41.7 | 46.6 | 23.1 | 43.4 | 20.2 | 39.8 | 17.8 |
| **$RMC_{abiotic}$** per capita | in tons | 14.2 | 15.0 | 14.9 | 12.4 | 7.9 | 12.2 | 8.0 | 12.4 | 9.6 |
| **$RMC_{fossils}$** per capita | in tons | 2.6 | 2.6 | 2.3 | 2.2 | 0.8 | 2.2 | 1.0 | 1.9 | 0.7 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 10.9 | 11.5 | 11.4 | 9.6 | 6.8 | 9.2 | 6.2 | 9.8 | 8.3 |
| **$RMC_{ores}$** per capita | in tons | 0.7 | 0.9 | 1.1 | 0.6 | 0.3 | 0.8 | 0.8 | 0.7 | 0.6 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 98.0 | 110.5 | 131.3 | 145.6 | 296.0 | 147.4 | 288.9 | 119.9 | 160.5 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 6.8% | 7.4% | 6.0% | 7.2% | 5.6% | 7.2% | 5.5% | 7.2% | 5.5% |
| **Total crop production** | in mio. tons | 6.0 | 7.3 | 8.3 | 7.5 | 9.4 | 7.3 | 8.9 | 7.3 | 8.9 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 499.1 | 416.0 | 402.0 | 452.2 | 446.2 | 423.2 | 365.2 | 311.8 | 115.3 |
| **Per capita meat demand** | in kg | 97.3 | 100.8 | 104.2 | 83.8 | 68.0 | 83.6 | 82.0 | 72.6 | 56.7 |
| **Per capita crop land footprint** | 2005 = 100 | 79.8 | 70.3 | 69.2 | 67.4 | 59.9 | 66.3 | 59.2 | 55.5 | 39.8 |

***Table 35: Simulation results for EU27-countries: Romania.***

| Romania | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 124.1 | 138.5 | 155.6 | 149.2 | 180.5 | 148.6 | 184.6 | 126.7 | 130.8 |
| **Gross disposable income** | 2005 = 100 | 123.3 | 122.2 | 121.8 | 124.7 | 127.7 | 124.1 | 125.2 | 113.2 | 102.0 |
| **Gross fixed capital formation** | 2005 = 100 | 139.1 | 194.3 | 269.1 | 206.4 | 285.7 | 191.3 | 244.8 | 175.1 | 209.0 |
| **Final consumption expend. by households** | 2005 = 100 | 119.7 | 110.2 | 108.3 | 112.0 | 112.6 | 111.6 | 110.9 | 90.0 | 64.9 |
| **Final consumption expend. by government** | 2005 = 100 | 140.0 | 160.7 | 165.3 | 172.5 | 199.7 | 171.8 | 214.3 | 152.5 | 147.4 |
| **Exports** | 2005 = 100 | 167.0 | 227.2 | 258.2 | 239.4 | 280.6 | 239.7 | 282.2 | 216.5 | 236.1 |
| **Imports** | 2005 = 100 | 148.9 | 179.4 | 206.1 | 182.2 | 206.3 | 176.0 | 185.6 | 157.2 | 150.0 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 21.2 | 19.9 | 17.5 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 8.21 | 7.07 | 5.91 | 7.04 | 5.77 | 7.00 | 5.74 | 7.32 | 6.36 |
| **Employment share** | in % | 56.0% | 53.5% | 58.6% | 53.2% | 57.1% | 52.9% | 56.8% | 55.4% | 63.0% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 100.0 | 129.2 | 178.6 | 131.4 | 163.8 | 139.6 | 214.6 | 130.2 | 195.1 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 92.0 | 86.8 | 74.5 | 70.0 | 21.4 | 62.6 | 18.3 | 59.9 | 21.0 |
| **$RMC_{abiotic}$** per capita | in tons | 8.0 | 7.5 | 7.4 | 5.0 | 1.2 | 5.0 | 1.3 | 6.0 | 3.8 |
| **$RMC_{fossils}$** per capita | in tons | 2.9 | 2.5 | 2.2 | 1.8 | 0.2 | 2.0 | 0.4 | 1.9 | 0.4 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 4.4 | 4.2 | 4.1 | 2.7 | 0.7 | 2.3 | 0.1 | 3.5 | 2.7 |
| **$RMC_{ores}$** per capita | in tons | 0.7 | 0.8 | 1.1 | 0.5 | 0.3 | 0.7 | 0.7 | 0.6 | 0.6 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 114.2 | 138.9 | 183.3 | 225.3 | 1270.8 | 211.7 | 869.9 | 155.2 | 288.9 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 3.2% | 3.2% | 3.1% | 3.2% | 2.8% | 3.1% | 2.7% | 3.1% | 2.6% |
| **Total crop production** | in mio. tons | 32.4 | 20.0 | 20.7 | 20.8 | 22.4 | 20.9 | 23.0 | 20.9 | 23.0 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 520.5 | 435.6 | 513.2 | 453.6 | 594.4 | 409.2 | 427.6 | 321.6 | 161.4 |
| **Per capita meat demand** | in kg | 70.0 | 79.6 | 93.1 | 66.8 | 60.4 | 75.7 | 80.8 | 63.4 | 48.4 |
| **Per capita crop land footprint** | 2005 = 100 | 86.6 | 125.6 | 113.8 | 125.9 | 112.3 | 125.0 | 95.8 | 104.0 | 59.8 |

***Table 36: Simulation results for EU27-countries: Slovak Republic.***

| Slovak Republic | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 150.2 | 211.5 | 268.6 | 227.4 | 304.3 | 225.9 | 293.6 | 199.7 | 231.1 |
| **Gross disposable income** | 2005 = 100 | 139.3 | 183.8 | 203.7 | 197.0 | 223.1 | 195.5 | 218.9 | 174.9 | 175.8 |
| **Gross fixed capital formation** | 2005 = 100 | 90.8 | 137.8 | 203.9 | 164.8 | 250.8 | 153.1 | 212.8 | 137.1 | 173.4 |
| **Final consumption expend. by households** | 2005 = 100 | 132.8 | 168.0 | 182.8 | 177.4 | 196.8 | 177.6 | 195.3 | 141.3 | 114.5 |
| **Final consumption expend. by government** | 2005 = 100 | 128.4 | 193.8 | 217.1 | 209.7 | 250.4 | 211.0 | 255.4 | 189.3 | 189.6 |
| **Exports** | 2005 = 100 | 160.7 | 233.0 | 307.9 | 245.3 | 334.6 | 240.3 | 315.1 | 220.6 | 274.3 |
| **Imports** | 2005 = 100 | 125.3 | 177.0 | 222.1 | 189.1 | 238.1 | 182.0 | 217.7 | 160.4 | 173.3 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 5.5 | 5.4 | 5.0 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 2.12 | 2.06 | 1.86 | 2.11 | 1.91 | 2.09 | 1.88 | 2.19 | 2.13 |
| **Employment share** | in % | 54.2% | 57.9% | 63.5% | 59.4% | 65.0% | 59.0% | 64.2% | 61.6% | 72.7% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 111.0 | 143.5 | 209.5 | 145.5 | 189.5 | 153.9 | 241.6 | 149.8 | 244.0 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 38.8 | 40.8 | 36.5 | 36.3 | 21.8 | 33.2 | 18.4 | 32.2 | 18.8 |
| **$RMC_{abiotic}$** per capita | in tons | 9.5 | 10.3 | 10.7 | 8.3 | 4.2 | 8.4 | 4.8 | 8.6 | 6.1 |
| **$RMC_{fossils}$** per capita | in tons | 4.1 | 4.3 | 3.9 | 3.3 | 0.7 | 3.3 | 1.1 | 3.1 | 1.0 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 4.3 | 4.5 | 4.7 | 3.9 | 2.8 | 3.5 | 2.0 | 4.2 | 3.8 |
| **$RMC_{ores}$** per capita | in tons | 1.1 | 1.5 | 2.1 | 1.1 | 0.6 | 1.5 | 1.7 | 1.3 | 1.4 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 158.7 | 206.2 | 270.1 | 281.1 | 826.8 | 265.7 | 548.0 | 233.7 | 379.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 1.3% | 1.4% | 1.3% | 1.4% | 1.4% | 1.4% | 1.3% | 1.4% | 1.2% |
| **Total crop production** | in mio. tons | 6.5 | 3.7 | 4.4 | 3.5 | 4.2 | 3.6 | 4.4 | 3.6 | 4.4 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 393.0 | 493.2 | 672.6 | 548.8 | 871.6 | 500.7 | 627.0 | 360.8 | 170.3 |
| **Per capita meat demand** | in kg | 68.6 | 79.7 | 94.0 | 66.2 | 60.6 | 76.6 | 80.5 | 63.2 | 46.0 |
| **Per capita crop land footprint** | 2005 = 100 | 99.5 | 167.2 | 196.4 | 177.3 | 238.7 | 164.7 | 193.5 | 139.0 | 123.9 |

***Table 37: Simulation results for EU27-countries: Slovenia.***

| Slovenia | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 114.3 | 154.5 | 196.4 | 165.3 | 223.6 | 165.1 | 224.9 | 148.0 | 179.5 |
| **Gross disposable income** | 2005 = 100 | 103.3 | 120.6 | 126.9 | 126.5 | 134.0 | 127.7 | 135.2 | 114.7 | 109.6 |
| **Gross fixed capital formation** | 2005 = 100 | 78.2 | 114.4 | 171.9 | 123.4 | 191.1 | 115.3 | 164.5 | 106.7 | 144.3 |
| **Final consumption expend. by households** | 2005 = 100 | 108.6 | 126.9 | 133.9 | 132.2 | 140.3 | 133.8 | 144.0 | 107.5 | 86.8 |
| **Final consumption expend. by government** | 2005 = 100 | 112.3 | 148.0 | 150.2 | 156.3 | 166.7 | 156.5 | 171.9 | 144.5 | 134.3 |
| **Exports** | 2005 = 100 | 136.6 | 198.3 | 271.4 | 209.2 | 300.1 | 204.2 | 285.3 | 190.4 | 251.8 |
| **Imports** | 2005 = 100 | 116.8 | 155.8 | 192.6 | 160.7 | 197.7 | 154.7 | 176.4 | 137.3 | 143.6 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 2.1 | 2.1 | 2.0 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 0.91 | 0.86 | 0.78 | 0.87 | 0.79 | 0.87 | 0.79 | 0.91 | 0.89 |
| **Employment share** | in % | 65.1% | 67.7% | 70.5% | 68.5% | 71.4% | 68.4% | 71.4% | 71.6% | 80.7% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 122.1 | 167.3 | 248.1 | 166.3 | 218.9 | 178.6 | 302.7 | 171.5 | 280.5 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 16.8 | 17.0 | 17.0 | 8.7 | 4.6 | 7.7 | 3.8 | 7.5 | 4.0 |
| **$RMC_{abiotic}$** per capita | in tons | 11.9 | 12.7 | 13.8 | 8.8 | 5.5 | 8.8 | 6.0 | 9.3 | 7.9 |
| **$RMC_{fossils}$** per capita | in tons | 4.5 | 4.4 | 4.2 | 2.4 | 0.8 | 2.4 | 1.1 | 2.2 | 1.0 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 6.1 | 6.6 | 7.3 | 5.3 | 4.0 | 4.9 | 3.2 | 5.8 | 5.5 |
| **$RMC_{ores}$** per capita | in tons | 1.3 | 1.7 | 2.3 | 1.2 | 0.7 | 1.5 | 1.7 | 1.4 | 1.5 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 143.3 | 174.1 | 206.1 | 268.8 | 622.8 | 255.0 | 464.8 | 221.6 | 316.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 3.3% | 3.5% | 3.5% | 3.5% | 3.5% | 3.4% | 3.3% | 3.4% | 3.1% |
| **Total crop production** | in mio. tons | 1.0 | 1.0 | 1.1 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 462.4 | 450.2 | 502.5 | 521.8 | 643.3 | 474.9 | 469.4 | 339.4 | 128.6 |
| **Per capita meat demand** | in kg | 90.5 | 98.3 | 104.8 | 81.4 | 67.9 | 81.4 | 84.3 | 71.6 | 58.2 |
| **Per capita crop land footprint** | 2005 = 100 | 76.2 | 68.7 | 65.5 | 70.4 | 71.5 | 67.0 | 61.2 | 55.3 | 33.6 |

***Table 38: Simulation results for EU27-countries: Spain.***

| Spain | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 103.3 | 124.9 | 138.4 | 134.4 | 156.4 | 134.5 | 159.3 | 108.6 | 99.2 |
| **Gross disposable income** | 2005 = 100 | 103.4 | 114.8 | 116.4 | 122.6 | 128.2 | 125.5 | 135.0 | 102.9 | 88.7 |
| **Gross fixed capital formation** | 2005 = 100 | 65.8 | 84.0 | 109.3 | 95.7 | 130.4 | 91.1 | 117.4 | 71.9 | 76.5 |
| **Final consumption expend. by households** | 2005 = 100 | 101.8 | 118.8 | 121.8 | 125.6 | 131.9 | 128.4 | 139.3 | 95.7 | 70.5 |
| **Final consumption expend. by government** | 2005 = 100 | 110.4 | 135.0 | 141.9 | 144.4 | 158.9 | 135.2 | 141.6 | 124.7 | 105.4 |
| **Exports** | 2005 = 100 | 131.3 | 174.9 | 213.7 | 181.6 | 225.4 | 181.2 | 226.4 | 161.6 | 180.6 |
| **Imports** | 2005 = 100 | 91.9 | 118.4 | 136.5 | 123.1 | 138.6 | 119.0 | 125.1 | 99.3 | 87.8 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 47.1 | 48.1 | 48.0 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 17.28 | 16.62 | 15.31 | 16.93 | 15.51 | 16.94 | 15.63 | 17.03 | 16.10 |
| **Employment share** | in % | 55.3% | 54.9% | 61.6% | 55.9% | 62.4% | 56.0% | 62.9% | 56.3% | 64.7% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 118.7 | 155.6 | 215.4 | 155.4 | 192.9 | 171.6 | 278.5 | 151.3 | 220.1 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 255.4 | 228.5 | 192.1 | 198.2 | 79.3 | 184.0 | 69.0 | 165.8 | 65.8 |
| **$RMC_{abiotic}$** per capita | in tons | 9.2 | 8.9 | 8.0 | 6.5 | 1.9 | 6.6 | 1.9 | 6.9 | 4.2 |
| **$RMC_{fossils}$** per capita | in tons | 2.9 | 2.6 | 2.1 | 2.1 | 0.5 | 2.1 | 0.7 | 1.8 | 0.5 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 5.3 | 5.1 | 4.5 | 3.6 | 1.1 | 3.3 | 0.2 | 4.2 | 2.8 |
| **$RMC_{ores}$** per capita | in tons | 1.1 | 1.3 | 1.5 | 0.8 | 0.3 | 1.1 | 1.0 | 1.0 | 0.8 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 162.6 | 193.4 | 233.4 | 288.2 | 1100.0 | 271.8 | 751.4 | 210.3 | 304.5 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 39.4% | 40.0% | 40.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% |
| **Total crop production** | in mio. tons | 44.6 | 46.0 | 45.7 | 47.6 | 48.3 | 47.8 | 48.0 | 47.6 | 48.1 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 433.2 | 377.8 | 354.6 | 412.6 | 409.4 | 375.3 | 301.0 | 279.5 | 97.5 |
| **Per capita meat demand** | in kg | 98.5 | 102.2 | 107.4 | 85.2 | 69.6 | 84.5 | 84.1 | 73.2 | 58.2 |
| **Per capita crop land footprint** | 2005 = 100 | 75.5 | 62.8 | 55.8 | 65.5 | 49.8 | 62.2 | 50.0 | 50.7 | 31.6 |

***Table 39: Simulation results for EU27-countries: Sweden.***

| Sweden | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 121.4 | 165.9 | 213.3 | 177.0 | 234.7 | 177.2 | 238.2 | 160.0 | 194.0 |
| **Gross disposable income** | 2005 = 100 | 130.3 | 156.6 | 184.8 | 163.6 | 195.3 | 165.8 | 201.7 | 154.6 | 178.5 |
| **Gross fixed capital formation** | 2005 = 100 | 114.4 | 164.6 | 256.5 | 182.9 | 288.3 | 176.1 | 267.4 | 158.6 | 229.9 |
| **Final consumption expend. by households** | 2005 = 100 | 122.4 | 147.8 | 173.6 | 153.5 | 181.9 | 155.6 | 188.3 | 128.1 | 119.3 |
| **Final consumption expend. by government** | 2005 = 100 | 115.7 | 153.9 | 236.0 | 162.6 | 257.6 | 161.9 | 260.4 | 151.1 | 217.2 |
| **Exports** | 2005 = 100 | 134.0 | 194.5 | 243.6 | 206.1 | 264.1 | 204.3 | 261.7 | 191.7 | 234.7 |
| **Imports** | 2005 = 100 | 137.0 | 183.5 | 247.7 | 191.5 | 258.4 | 187.2 | 245.4 | 168.4 | 201.8 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 9.7 | 10.7 | 11.9 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 4.64 | 4.63 | 4.61 | 4.72 | 4.69 | 4.72 | 4.73 | 4.95 | 5.38 |
| **Employment share** | in % | 76.4% | 72.4% | 65.3% | 73.8% | 66.5% | 73.8% | 67.0% | 77.5% | 76.2% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 120.7 | 162.2 | 214.8 | 163.9 | 182.8 | 175.4 | 250.6 | 159.2 | 208.3 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 56.4 | 57.7 | 55.5 | 47.5 | 27.5 | 44.3 | 24.1 | 43.4 | 24.9 |
| **$RMC_{abiotic}$** per capita | in tons | 14.9 | 14.9 | 15.6 | 11.1 | 4.6 | 12.3 | 8.1 | 12.0 | 8.8 |
| **$RMC_{fossils}$** per capita | in tons | 5.0 | 4.7 | 4.5 | 3.6 | 1.1 | 3.7 | 1.7 | 3.4 | 1.3 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 6.4 | 5.9 | 5.2 | 4.7 | 2.5 | 4.5 | 2.1 | 5.2 | 3.9 |
| **$RMC_{ores}$** per capita | in tons | 3.6 | 4.3 | 5.9 | 2.7 | 1.0 | 4.0 | 4.4 | 3.4 | 3.6 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 125.6 | 163.4 | 203.6 | 242.8 | 769.9 | 212.9 | 415.2 | 195.9 | 315.7 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 1.4% | 1.1% | 1.2% | 1.1% | 1.2% | 1.1% | 1.2% | 1.1% | 1.2% |
| **Total crop production** | in mio. tons | 12.6 | 12.3 | 12.6 | 11.8 | 11.7 | 11.9 | 11.7 | 11.9 | 11.7 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 421.0 | 376.6 | 366.3 | 420.9 | 459.0 | 391.0 | 357.3 | 296.8 | 110.4 |
| **Per capita meat demand** | in kg | 83.6 | 83.9 | 93.7 | 70.0 | 60.7 | 74.6 | 76.6 | 66.0 | 48.8 |
| **Per capita crop land footprint** | 2005 = 100 | 81.9 | 88.2 | 81.0 | 88.6 | 85.7 | 88.7 | 75.7 | 78.7 | 51.5 |

***Table 40: Simulation results for EU27-countries: United Kingdom.***

| United Kingdom | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 107.6 | 115.2 | 138.5 | 121.9 | 149.1 | 123.2 | 156.2 | 105.7 | 112.5 |
| **Gross disposable income** | 2005 = 100 | 109.2 | 97.2 | 101.3 | 101.5 | 108.2 | 104.1 | 115.3 | 91.7 | 88.1 |
| **Gross fixed capital formation** | 2005 = 100 | 96.3 | 99.3 | 125.5 | 111.0 | 143.2 | 107.9 | 136.6 | 89.3 | 93.5 |
| **Final consumption expend. by households** | 2005 = 100 | 104.8 | 97.3 | 107.6 | 100.9 | 113.9 | 103.1 | 120.8 | 81.0 | 67.5 |
| **Final consumption expend. by government** | 2005 = 100 | 108.5 | 119.4 | 149.7 | 125.3 | 156.3 | 120.7 | 149.0 | 113.2 | 122.2 |
| **Exports** | 2005 = 100 | 122.0 | 171.4 | 220.8 | 179.0 | 230.4 | 179.2 | 235.8 | 166.9 | 207.1 |
| **Imports** | 2005 = 100 | 113.0 | 125.0 | 150.7 | 129.2 | 154.3 | 126.1 | 145.6 | 108.8 | 105.2 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 63.8 | 68.6 | 73.1 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 30.95 | 27.82 | 26.29 | 28.30 | 26.50 | 28.38 | 26.87 | 29.19 | 29.15 |
| **Employment share** | in % | 75.2% | 66.2% | 61.1% | 67.3% | 61.6% | 67.5% | 62.5% | 69.4% | 67.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 134.5 | 179.3 | 261.7 | 180.3 | 221.6 | 195.3 | 313.2 | 176.1 | 261.5 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 512.5 | 419.1 | 367.4 | 354.1 | 158.6 | 312.1 | 129.3 | 306.0 | 146.6 |
| **$RMC_{abiotic}$** per capita | in tons | 7.1 | 5.2 | 4.8 | 4.0 | 1.3 | 4.6 | 2.8 | 4.1 | 2.2 |
| **$RMC_{fossils}$** per capita | in tons | 4.2 | 2.9 | 2.4 | 2.4 | 0.5 | 2.4 | 0.8 | 2.2 | 0.6 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 1.5 | 1.1 | 0.9 | 0.8 | 0.4 | 1.0 | 0.9 | 0.9 | 0.7 |
| **$RMC_{ores}$** per capita | in tons | 1.4 | 1.2 | 1.4 | 0.8 | 0.4 | 1.1 | 1.1 | 1.0 | 0.9 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 133.3 | 152.0 | 181.7 | 210.9 | 618.6 | 181.0 | 286.7 | 162.1 | 219.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 6.6% | 7.3% | 6.7% | 7.3% | 6.7% | 7.3% | 6.6% | 7.1% | 6.2% |
| **Total crop production** | in mio. tons | 44.1 | 48.3 | 56.3 | 47.1 | 53.4 | 46.7 | 52.2 | 46.5 | 52.3 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 426.0 | 307.6 | 297.7 | 341.3 | 351.1 | 317.4 | 280.6 | 235.1 | 85.0 |
| **Per capita meat demand** | in kg | 86.4 | 87.6 | 93.6 | 73.0 | 60.7 | 76.4 | 79.2 | 67.8 | 51.4 |
| **Per capita crop land footprint** | 2005 = 100 | 73.4 | 61.0 | 52.9 | 58.5 | 47.6 | 59.1 | 48.8 | 51.7 | 31.1 |

***Table 41: Simulation results for selected non-EU27 countries/regions: Brazil.***

| Brazil | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 139.3 | 183.8 | 299.0 | 180.9 | 259.2 | 184.2 | 298.7 | 181.4 | 287.3 |
| **Gross disposable income** | 2005 = 100 | 146.4 | 167.2 | 220.2 | 160.9 | 183.8 | 167.1 | 221.9 | 164.8 | 214.3 |
| **Gross fixed capital formation** | 2005 = 100 | 172.9 | 312.4 | 582.9 | 305.3 | 479.7 | 308.2 | 564.3 | 302.2 | 539.6 |
| **Final consumption expend. by households** | 2005 = 100 | 152.2 | 171.8 | 224.3 | 166.3 | 191.9 | 171.7 | 225.7 | 169.8 | 219.0 |
| **Final consumption expend. by government** | 2005 = 100 | 142.8 | 210.7 | 447.4 | 212.4 | 398.9 | 212.1 | 449.8 | 210.1 | 434.1 |
| **Exports** | 2005 = 100 | 94.4 | 125.5 | 163.8 | 123.6 | 155.0 | 129.4 | 170.0 | 122.9 | 153.8 |
| **Imports** | 2005 = 100 | 197.5 | 273.4 | 383.9 | 258.2 | 312.9 | 270.1 | 377.1 | 263.9 | 357.8 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 203.3 | 222.6 | 231.3 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 103.02 | 100.68 | 105.88 | 97.91 | 94.83 | 99.92 | 104.70 | 99.29 | 103.07 |
| **Employment share** | in % | 73.6% | 66.8% | 73.8% | 64.9% | 66.1% | 66.3% | 73.0% | 65.8% | 71.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 105.0 | 136.1 | 197.8 | 136.9 | 175.1 | 141.4 | 213.7 | 134.2 | 195.2 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 327.9 | 306.2 | 247.2 | 234.0 | 128.8 | 245.2 | 183.1 | 240.6 | 180.1 |
| **$RMC_{abiotic}$** per capita | in tons | 4.9 | 4.9 | 5.5 | 3.1 | 1.2 | 4.6 | 4.9 | 4.5 | 4.8 |
| **$RMC_{fossils}$** per capita | in tons | 1.1 | 1.0 | 0.9 | 0.8 | 0.3 | 0.8 | 0.6 | 0.8 | 0.6 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 2.9 | 2.8 | 2.9 | 1.9 | 0.8 | 2.7 | 2.8 | 2.6 | 2.7 |
| **$RMC_{ores}$** per capita | in tons | 0.8 | 1.1 | 1.6 | 0.5 | 0.0 | 1.1 | 1.5 | 1.0 | 1.5 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 85.5 | 93.5 | 128.3 | 146.5 | 584.2 | 94.8 | 131.4 | 95.0 | 131.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 0.8% | 0.7% | 0.8% | 0.7% | 0.7% | 0.7% | 0.8% | 0.7% | 0.8% |
| **Total crop production** | in mio. tons | 1012.4 | 1067.5 | 1030.3 | 1082.5 | 1058.3 | 1066.3 | 1030.2 | 1068.2 | 1034.1 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 495.8 | 338.3 | 274.8 | 337.0 | 199.0 | 326.7 | 264.2 | 326.6 | 268.5 |
| **Per capita meat demand** | in kg | 88.7 | 91.1 | 98.2 | 75.8 | 62.2 | 90.6 | 96.3 | 91.2 | 98.2 |
| **Per capita crop land footprint** | 2005 = 100 | 86.0 | 65.0 | 59.0 | 60.9 | 47.6 | 64.1 | 56.7 | 64.4 | 57.6 |

***Table 42: Simulation results for selected non-EU27 countries/regions: China.***

| China | | Reference Scenario | | | Scenario: Global cooperation | | Scenario: EU goes ahead | | Scenario: Civil society leads | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 234.9 | 518.3 | 881.9 | 566.4 | 1034.3 | 551.3 | 965.3 | 537.7 | 918.9 |
| **Gross disposable income** | 2005 = 100 | 210.8 | 357.3 | 486.2 | 364.0 | 496.8 | 381.4 | 533.7 | 376.3 | 520.7 |
| **Gross fixed capital formation** | 2005 = 100 | 290.3 | 658.6 | 1135.6 | 746.0 | 1370.8 | 738.1 | 1328.4 | 720.3 | 1267.1 |
| **Final consumption expend. by households** | 2005 = 100 | 214.0 | 425.1 | 674.4 | 432.6 | 685.5 | 448.7 | 730.3 | 444.0 | 715.2 |
| **Final consumption expend. by government** | 2005 = 100 | 263.8 | 1064.1 | 1959.2 | 1160.5 | 2278.3 | 1116.2 | 2139.5 | 1100.1 | 2046.4 |
| **Exports** | 2005 = 100 | 329.5 | 589.1 | 912.3 | 630.7 | 1022.2 | 615.8 | 969.0 | 590.0 | 892.7 |
| **Imports** | 2005 = 100 | 391.8 | 826.0 | 1313.4 | 886.8 | 1420.5 | 902.8 | 1495.7 | 877.8 | 1413.5 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 1381.9 | 1429.6 | 1360.8 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 803.08 | 842.25 | 794.51 | 837.16 | 777.91 | 862.71 | 820.33 | 858.82 | 812.13 |
| **Employment share** | in % | 81.5% | 87.9% | 96.3% | 87.3% | 94.3% | 90.0% | 99.5% | 89.6% | 98.5% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 104.6 | 169.8 | 258.7 | 179.4 | 245.9 | 177.5 | 277.6 | 167.9 | 251.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 8019.1 | 11589.0 | 13396.6 | 10172.5 | 5504.5 | 11588.6 | 10001.0 | 11340.1 | 9575.0 |
| **$RMC_{abiotic}$** per capita | in tons | 17.2 | 25.0 | 31.4 | 20.0 | 12.5 | 26.8 | 33.2 | 26.5 | 32.3 |
| **$RMC_{fossils}$** per capita | in tons | 2.6 | 3.8 | 4.5 | 3.5 | 1.7 | 4.1 | 3.6 | 4.0 | 3.4 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 11.9 | 16.5 | 19.5 | 13.4 | 9.4 | 17.6 | 21.0 | 17.4 | 20.6 |
| **$RMC_{ores}$** per capita | in tons | 2.6 | 4.7 | 7.4 | 3.1 | 1.4 | 5.2 | 8.6 | 5.1 | 8.2 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 107.1 | 162.3 | 231.1 | 224.1 | 703.8 | 162.5 | 243.8 | 161.3 | 239.8 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 27.2% | 26.6% | 29.3% | 20.0% | 20.0% | 26.7% | 28.9% | 26.6% | 28.8% |
| **Total crop production** | in mio. tons | 1555.6 | 1736.4 | 2084.3 | 1720.6 | 2018.0 | 1734.9 | 2067.3 | 1735.1 | 2069.1 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 921.8 | 1037.3 | 1153.0 | 1065.4 | 1215.5 | 1041.4 | 1147.4 | 1063.1 | 1206.1 |
| **Per capita meat demand** | in kg | 73.1 | 96.3 | 115.2 | 81.0 | 77.0 | 96.8 | 115.1 | 98.5 | 118.9 |
| **Per capita crop land footprint** | 2005 = 100 | 109.1 | 119.3 | 117.9 | 116.2 | 113.8 | 120.8 | 120.4 | 123.5 | 125.5 |

***Table 43: Simulation results for selected non-EU27 countries/regions: India.***

| India | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 194.9 | 404.8 | 879.0 | 426.5 | 867.5 | 439.1 | 1012.9 | 431.2 | 983.0 |
| **Gross disposable income** | 2005 = 100 | 167.9 | 290.9 | 494.4 | 295.5 | 463.3 | 313.2 | 561.2 | 312.1 | 564.0 |
| **Gross fixed capital formation** | 2005 = 100 | 209.1 | 548.2 | 1412.4 | 600.8 | 1435.5 | 620.9 | 1711.1 | 607.1 | 1651.6 |
| **Final consumption expend. by households** | 2005 = 100 | 180.0 | 331.2 | 594.7 | 335.5 | 561.6 | 352.0 | 661.4 | 350.9 | 663.4 |
| **Final consumption expend. by government** | 2005 = 100 | 205.3 | 462.0 | 1209.8 | 454.7 | 970.8 | 494.1 | 1367.6 | 487.8 | 1323.3 |
| **Exports** | 2005 = 100 | 251.9 | 434.3 | 729.6 | 459.1 | 778.0 | 455.6 | 782.3 | 433.4 | 710.8 |
| **Imports** | 2005 = 100 | 188.2 | 359.4 | 635.5 | 360.9 | 567.6 | 387.2 | 710.2 | 378.2 | 684.7 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 1301.3 | 1495.9 | 1638.6 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 476.56 | 515.42 | 540.69 | 505.80 | 490.10 | 529.00 | 564.89 | 528.38 | 563.86 |
| **Employment share** | in % | 55.5% | 50.7% | 48.7% | 49.8% | 44.1% | 52.1% | 50.9% | 52.0% | 50.8% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 139.9 | 181.5 | 255.8 | 181.6 | 222.6 | 189.9 | 276.5 | 180.8 | 253.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 1861.7 | 2908.8 | 4861.1 | 2491.4 | 1402.8 | 2943.7 | 3425.3 | 2889.0 | 3315.8 |
| **$RMC_{abiotic}$** per capita | in tons | 2.2 | 2.7 | 3.5 | 2.1 | 1.1 | 2.8 | 3.2 | 2.7 | 3.2 |
| **$RMC_{fossils}$** per capita | in tons | 0.6 | 0.9 | 1.3 | 0.7 | 0.3 | 0.9 | 1.1 | 0.9 | 1.0 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 1.4 | 1.6 | 1.6 | 1.2 | 0.8 | 1.5 | 1.5 | 1.5 | 1.5 |
| **$RMC_{ores}$** per capita | in tons | 0.2 | 0.3 | 0.5 | 0.2 | 0.1 | 0.3 | 0.6 | 0.3 | 0.6 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 140.3 | 201.7 | 316.5 | 277.6 | 1021.0 | 216.8 | 390.9 | 215.6 | 389.2 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 32.3% | 31.7% | 35.1% | 20.0% | 20.0% | 31.7% | 35.1% | 31.8% | 35.2% |
| **Total crop production** | in mio. tons | 802.8 | 966.0 | 968.7 | 937.0 | 908.8 | 970.3 | 966.3 | 971.0 | 968.4 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 363.0 | 363.5 | 365.9 | 378.0 | 361.9 | 369.4 | 372.2 | 377.4 | 389.6 |
| **Per capita meat demand** | in kg | 5.1 | 7.0 | 10.0 | 5.8 | 6.2 | 7.1 | 10.1 | 7.2 | 10.5 |
| **Per capita crop land footprint** | 2005 = 100 | 80.4 | 68.8 | 68.9 | 66.0 | 63.8 | 70.4 | 71.2 | 71.7 | 74.3 |

***Table 44: Simulation results for selected non-EU27 countries/regions: Japan.***

| Japan | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 107.8 | 128.0 | 166.9 | 139.8 | 188.5 | 134.8 | 184.7 | 132.8 | 177.7 |
| **Gross disposable income** | 2005 = 100 | 105.8 | 115.6 | 131.8 | 124.5 | 149.7 | 121.7 | 148.3 | 120.4 | 143.9 |
| **Gross fixed capital formation** | 2005 = 100 | 96.1 | 117.5 | 163.9 | 134.6 | 195.1 | 124.3 | 181.1 | 122.4 | 174.4 |
| **Final consumption expend. by households** | 2005 = 100 | 106.5 | 109.4 | 121.3 | 116.6 | 135.4 | 114.2 | 134.3 | 113.2 | 130.9 |
| **Final consumption expend. by government** | 2005 = 100 | 103.0 | 121.1 | 182.0 | 131.0 | 202.1 | 125.6 | 199.1 | 124.5 | 193.0 |
| **Exports** | 2005 = 100 | 119.5 | 194.0 | 273.9 | 209.1 | 296.3 | 208.3 | 302.8 | 201.5 | 283.8 |
| **Imports** | 2005 = 100 | 101.5 | 124.7 | 153.7 | 129.4 | 161.0 | 130.2 | 164.3 | 127.8 | 157.1 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 125.9 | 119.7 | 107.4 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 57.46 | 54.23 | 53.42 | 55.73 | 54.87 | 55.18 | 55.15 | 54.90 | 54.44 |
| **Employment share** | in % | 74.9% | 79.0% | 97.2% | 81.2% | 99.8% | 80.3% | 100.3% | 79.9% | 99.0% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 164.6 | 223.1 | 339.9 | 225.3 | 287.3 | 234.8 | 370.6 | 220.9 | 333.3 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 1072.9 | 914.5 | 835.4 | 763.8 | 319.6 | 862.3 | 465.7 | 849.6 | 448.2 |
| **$RMC_{abiotic}$** per capita | in tons | 12.9 | 11.5 | 12.0 | 9.3 | 4.1 | 11.2 | 9.5 | 11.1 | 9.3 |
| **$RMC_{fossils}$** per capita | in tons | 7.1 | 5.9 | 5.6 | 5.0 | 1.8 | 5.6 | 3.3 | 5.5 | 3.2 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 3.5 | 3.1 | 3.0 | 2.4 | 1.4 | 3.0 | 2.8 | 3.0 | 2.8 |
| **$RMC_{ores}$** per capita | in tons | 2.3 | 2.6 | 3.3 | 1.8 | 0.9 | 2.6 | 3.4 | 2.6 | 3.3 |
| **Resource productivity (GDP/$RMI_{abiotic}$)** | 2005 = 100 | 107.1 | 137.3 | 188.9 | 186.3 | 597.7 | 145.5 | 247.1 | 145.2 | 246.3 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 40.0% | 40.0% | 32.8% | 20.0% | 20.0% | 40.0% | 33.0% | 40.0% | 32.9% |
| **Total crop production** | in mio. tons | 41.0 | 40.1 | 41.5 | 41.0 | 42.1 | 40.5 | 41.6 | 40.5 | 41.6 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 300.3 | 210.7 | 183.0 | 231.9 | 222.0 | 210.6 | 188.2 | 214.1 | 191.8 |
| **Per capita meat demand** | in kg | 52.0 | 68.5 | 93.8 | 57.0 | 60.8 | 68.3 | 91.4 | 69.4 | 90.4 |
| **Per capita crop land footprint** | 2005 = 100 | 82.8 | 71.9 | 65.1 | 67.4 | 63.4 | 72.1 | 66.3 | 74.4 | 68.1 |

***Table 45: Simulation results for selected non-EU27 countries/regions: Russia.***

| Russia | | Reference Scenario | | | Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Global cooperation* | | *EU goes ahead* | | *Civil society leads* | |
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 142.9 | 186.1 | 237.8 | 166.5 | 173.3 | 180.3 | 213.3 | 177.1 | 203.6 |
| **Gross disposable income** | 2005 = 100 | 183.8 | 186.8 | 185.8 | 156.6 | 124.0 | 177.2 | 160.5 | 175.0 | 155.6 |
| **Gross fixed capital formation** | 2005 = 100 | 190.0 | 276.2 | 400.7 | 239.0 | 262.1 | 263.9 | 336.4 | 257.3 | 318.3 |
| **Final consumption expend. by households** | 2005 = 100 | 179.5 | 171.2 | 162.2 | 148.0 | 115.7 | 164.1 | 144.1 | 162.2 | 139.7 |
| **Final consumption expend. by government** | 2005 = 100 | 148.7 | 341.6 | 516.4 | 309.8 | 367.6 | 333.5 | 472.3 | 329.4 | 452.3 |
| **Exports** | 2005 = 100 | 98.9 | 121.4 | 149.3 | 116.8 | 136.4 | 119.8 | 143.8 | 115.1 | 132.9 |
| **Imports** | 2005 = 100 | 191.5 | 222.8 | 254.5 | 192.7 | 176.9 | 212.8 | 220.3 | 208.2 | 208.7 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 141.4 | 132.7 | 120.1 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 76.80 | 71.01 | 63.13 | 65.99 | 53.03 | 69.47 | 59.49 | 68.99 | 58.47 |
| **Employment share** | in % | 77.0% | 81.1% | 83.8% | 75.4% | 70.4% | 79.4% | 79.0% | 78.8% | 77.7% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 94.1 | 120.8 | 169.8 | 127.0 | 162.1 | 127.7 | 188.7 | 121.0 | 171.6 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 1867.5 | 1706.5 | 1377.1 | 1193.5 | 439.7 | 1471.8 | 789.0 | 1440.6 | 756.6 |
| **$RMC_{abiotic}$** per capita | in tons | 8.0 | 8.1 | 8.5 | 4.2 | 0.5 | 7.6 | 6.7 | 7.5 | 6.5 |
| **$RMC_{fossils}$** per capita | in tons | 2.5 | 2.3 | 2.0 | 1.3 | 0.2 | 2.0 | 1.0 | 1.9 | 1.0 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 4.6 | 4.7 | 5.2 | 2.5 | 0.2 | 4.6 | 4.6 | 4.5 | 4.5 |
| **$RMC_{ores}$** per capita | in tons | 0.9 | 1.1 | 1.4 | 0.5 | 0.1 | 1.0 | 1.1 | 1.0 | 1.0 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 122.8 | 166.2 | 230.7 | 240.1 | 1096.8 | 174.0 | 274.2 | 174.8 | 274.0 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 1.4% | 1.4% | 1.4% | 1.3% | 1.2% | 1.4% | 1.3% | 1.4% | 1.3% |
| **Total crop production** | in mio. tons | 204.2 | 241.3 | 281.7 | 244.5 | 290.4 | 241.3 | 282.1 | 241.6 | 282.6 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 608.5 | 534.0 | 602.9 | 488.9 | 440.3 | 500.3 | 533.5 | 524.3 | 638.2 |
| **Per capita meat demand** | in kg | 69.3 | 80.8 | 93.6 | 66.4 | 60.3 | 78.9 | 91.3 | 78.5 | 90.2 |
| **Per capita crop land footprint** | 2005 = 100 | 93.3 | 80.1 | 71.0 | 72.4 | 54.1 | 74.8 | 65.1 | 79.1 | 74.2 |

***Table 46: Simulation results for selected non-EU27 countries/regions: United States.***

| United States | | Reference Scenario | | | Scenario: *Global cooperation* | | Scenario: *EU goes ahead* | | Scenario: *Civil society leads* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 113.4 | 138.8 | 175.3 | 148.4 | 184.5 | 143.9 | 186.3 | 141.4 | 177.5 |
| **Gross disposable income** | 2005 = 100 | 115.8 | 120.3 | 117.5 | 127.7 | 122.2 | 124.4 | 124.1 | 122.5 | 119.1 |
| **Gross fixed capital formation** | 2005 = 100 | 104.7 | 144.6 | 212.5 | 162.0 | 224.8 | 150.5 | 222.6 | 148.1 | 212.7 |
| **Final consumption expend. by households** | 2005 = 100 | 115.8 | 124.0 | 123.6 | 130.5 | 127.9 | 127.6 | 129.8 | 125.9 | 125.0 |
| **Final consumption expend. by government** | 2005 = 100 | 101.1 | 126.5 | 181.3 | 135.0 | 189.0 | 129.8 | 190.6 | 128.6 | 183.4 |
| **Exports** | 2005 = 100 | 138.3 | 250.9 | 413.0 | 263.6 | 435.6 | 264.6 | 447.4 | 254.6 | 414.9 |
| **Imports** | 2005 = 100 | 113.5 | 144.7 | 169.3 | 152.0 | 170.2 | 148.9 | 173.9 | 146.0 | 165.3 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 323.0 | 360.3 | 398.3 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | 146.76 | 142.96 | 140.68 | 146.05 | 140.35 | 144.49 | 142.23 | 143.59 | 139.89 |
| **Employment share** | in % | 69.1% | 65.2% | 58.7% | 66.6% | 58.5% | 65.9% | 59.3% | 65.5% | 58.3% |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 123.7 | 166.9 | 237.9 | 169.9 | 206.4 | 175.2 | 260.0 | 165.2 | 235.2 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 4905.0 | 4597.3 | 4324.7 | 4050.2 | 1112.5 | 4435.1 | 2202.8 | 4372.2 | 2126.6 |
| **$RMC_{abiotic}$** per capita | in tons | 19.1 | 17.0 | 16.7 | 13.9 | 6.0 | 16.7 | 13.9 | 16.6 | 13.5 |
| **$RMC_{fossils}$** per capita | in tons | 9.0 | 7.8 | 7.7 | 6.7 | 2.5 | 7.5 | 5.2 | 7.4 | 5.1 |
| **$RMC_{non-metallic\ minerals}$** per capita | in tons | 7.7 | 6.7 | 6.1 | 5.5 | 2.8 | 6.6 | 5.7 | 6.5 | 5.6 |
| **$RMC_{ores}$** per capita | in tons | 2.4 | 2.6 | 3.0 | 1.7 | 0.6 | 2.6 | 3.0 | 2.6 | 2.9 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 127.8 | 152.0 | 174.8 | 203.5 | 536.9 | 160.3 | 220.2 | 159.4 | 217.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 19.3% | 19.3% | 18.0% | 19.2% | 16.1% | 19.7% | 18.1% | 19.7% | 18.0% |
| **Total crop production** | in mio. tons | 791.7 | 953.4 | 1052.9 | 910.1 | 953.0 | 948.2 | 1047.2 | 949.4 | 1049.2 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 406.4 | 292.4 | 248.2 | 317.7 | 243.7 | 291.5 | 251.9 | 300.1 | 279.1 |
| **Per capita meat demand** | in kg | 122.1 | 126.1 | 131.7 | 104.6 | 86.4 | 125.5 | 130.4 | 126.0 | 131.5 |
| **Per capita crop land footprint** | 2005 = 100 | 70.9 | 57.0 | 50.0 | 58.2 | 50.3 | 57.2 | 50.9 | 58.2 | 54.0 |

***Table 47: Simulation results for selected non-EU27 countries/regions: Rest of World.***

| Rest of World | | Reference Scenario | | | Scenario: *Global cooperation* | | Scenario: *EU goes ahead* | | Scenario: *Civil society leads* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Indicators | Dimension | 2015 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| **1. Economic performance (in constant prices)** | | | | | | | | | | |
| **GDP** | 2005 = 100 | 164.8 | 300.0 | 569.0 | 309.7 | 588.0 | 309.4 | 596.5 | 298.9 | 552.8 |
| **Gross disposable income** | 2005 = 100 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Gross fixed capital formation** | 2005 = 100 | 190.9 | 374.0 | 588.7 | 404.7 | 704.4 | 386.2 | 627.9 | 378.5 | 598.9 |
| **Final consumption expend. by households** | 2005 = 100 | 187.7 | 345.6 | 668.4 | 356.6 | 690.2 | 356.4 | 701.2 | 344.7 | 649.0 |
| **Final consumption expend. by government** | 2005 = 100 | 162.9 | 283.9 | 559.5 | 286.6 | 548.3 | 289.9 | 581.2 | 280.4 | 536.0 |
| **Exports** | 2005 = 100 | 131.5 | 231.4 | 372.5 | 241.0 | 385.0 | 244.9 | 403.3 | 234.0 | 369.9 |
| **Imports** | 2005 = 100 | 177.6 | 330.4 | 535.7 | 350.2 | 592.3 | 345.2 | 576.5 | 334.6 | 537.4 |
| **2. Social development** | | | | | | | | | | |
| **Population** | in mio. | 3011.6 | 3774.0 | 4774.7 | unchanged (exogenous) | | | | | |
| **Employment** | in mio. | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Employment share** | in % | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Average food crop price in relation to GDP-price** | 2005 = 100 | 119.8 | 146.8 | 183.8 | 148.6 | 166.4 | 155.0 | 203.4 | 146.8 | 185.1 |
| **3. Environmental pressure variables** | | | | | | | | | | |
| **$CO_2$**-Emissions | in mio. tons | 7032.9 | 9971.9 | 14394.8 | 9342.9 | 6775.4 | 10286.4 | 12702.7 | 10010.7 | 11910.8 |
| **$RMC_{abiotic}$** per capita | in tons | 3.3 | 3.6 | 3.7 | 3.3 | 2.4 | 3.6 | 3.5 | 3.6 | 3.4 |
| **$RMC_{fossils}$** per capita | in tons | 0.7 | 0.8 | 0.8 | 0.8 | 0.4 | 0.8 | 0.7 | 0.8 | 0.6 |
| **$RMC_{non\text{-}metallic\ minerals}$** per capita | in tons | 2.2 | 2.4 | 2.2 | 2.1 | 1.7 | 2.3 | 2.1 | 2.3 | 2.1 |
| **$RMC_{ores}$** per capita | in tons | 0.3 | 0.5 | 0.6 | 0.4 | 0.3 | 0.5 | 0.7 | 0.5 | 0.6 |
| **Resource productivity ($GDP/RMI_{abiotic}$)** | 2005 = 100 | 125.4 | 165.7 | 238.1 | 201.4 | 496.1 | 170.6 | 265.3 | 167.9 | 256.1 |
| **4. Eco System Services** | | | | | | | | | | |
| **Water exploitation index** | in % | 10.4% | 10.8% | 11.6% | 10.0% | 10.1% | 10.7% | 11.6% | 10.7% | 11.6% |
| **Total crop production** | in mio. tons | 2296.8 | 2504.8 | 2726.4 | 2684.2 | 3114.9 | 2502.9 | 2733.1 | 2505.3 | 2738.4 |
| **Total domestic crop use for food and waste purposes per capita** | in kg | 460.8 | 432.1 | 402.8 | 465.6 | 471.8 | 431.9 | 399.8 | 429.4 | 395.1 |
| **Per capita meat demand** | in kg | 28.9 | 37.6 | 50.3 | 30.8 | 32.2 | 37.2 | 49.2 | 37.5 | 50.0 |
| **Per capita crop land footprint** | 2005 = 100 | 90.7 | 79.3 | 69.3 | 76.2 | 64.1 | 79.0 | 68.7 | 79.4 | 69.2 |