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MACROECONOMIC IMPACTS OF THE LOW CARBON TRANSITION IN BELGIUM

ANNEX 5 - LITERATURE

2050.be

TOWARDS A
LOW CARBON SOCIETY

Macroeconomic impacts of the low carbon transition in Belgium

Annex 5 – Context and main results from the literature

October 2016

A project by Climact, Thierry Bréchet, Federal Plan Bureau and Oxford Economics

CLIMACT sa

www.climact.com | info@climact.com | T: +32 10 750 740

Background

- The study analyses the macroeconomic impacts of the transition to a low carbon society by 2050 in Belgium
- The methodology is voluntarily broad and builds on three complementary models: HERMES, GEIM & OPEERA with multipliers
- Thematic workshops with stakeholders and experts have been organised
- Several documents are available:
  - Main findings
  - Report (methodology and results)
  - Annexes (1. Main results, 2. HERMES results, 3. GEIM Results, 4. OPEERA-IO results, 5. Literature Review)
- The study was commissioned by the Federal Public Service Health, Food Chain Safety and Environment and realised between January 2015 and September 2016
- The study was conducted by CLIMACT, the Federal Plan Bureau, Oxford Economics and Prof. Thierry Brechet

Background

- This document focuses on the literature review performed at different stages of the project
- The document divided into 5 chapters:
  1. The presentation of the context on basis of historical data
  2. The list of relevant studies
  3. The review of the 3 main dimensions used to characterised the scenarios analysed in the study
  4. The review of impacts on GDP and jobs from the literature
  5. The review of other impacts from the literature

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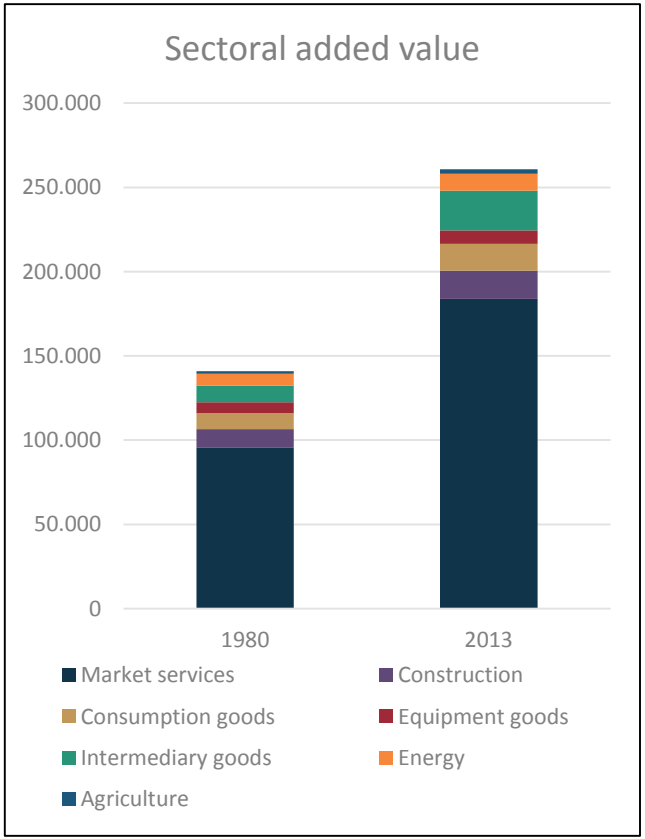
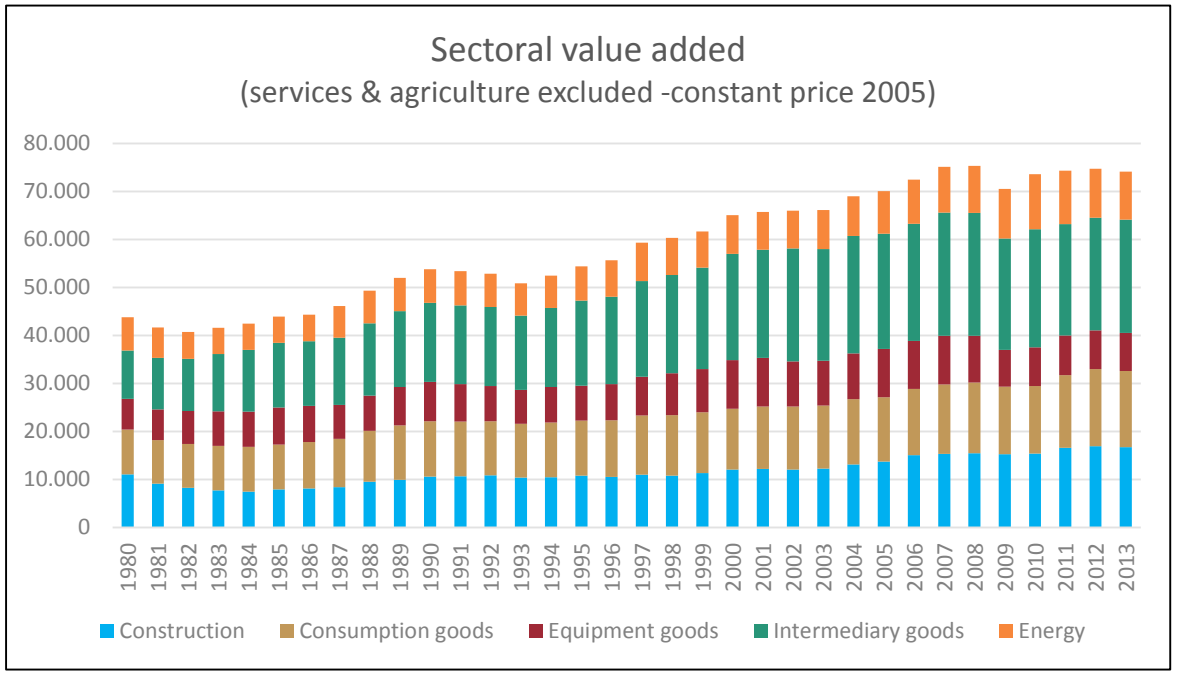
Context

Historical evolution of Belgian added value by sector 1980-2013



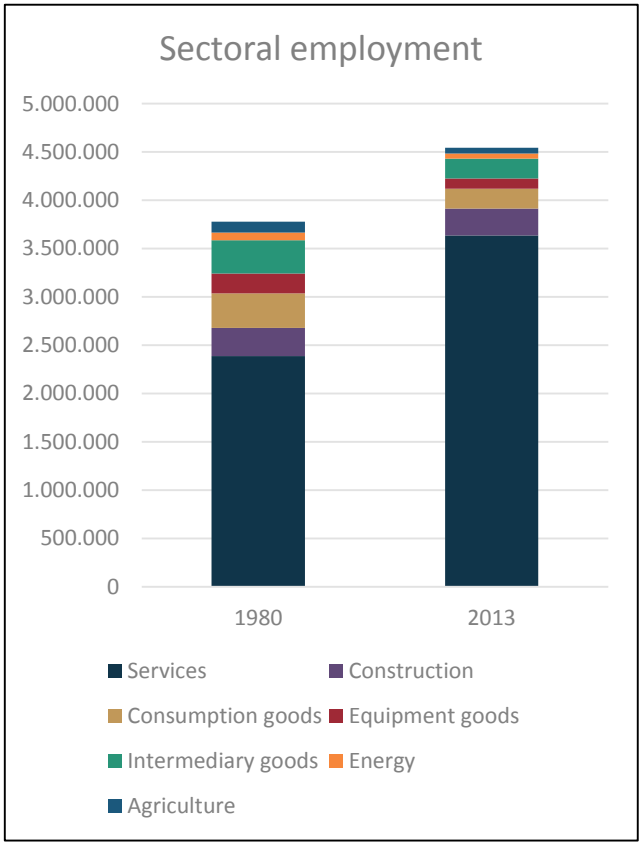
Economic growth (+80%) is mainly driven by market services



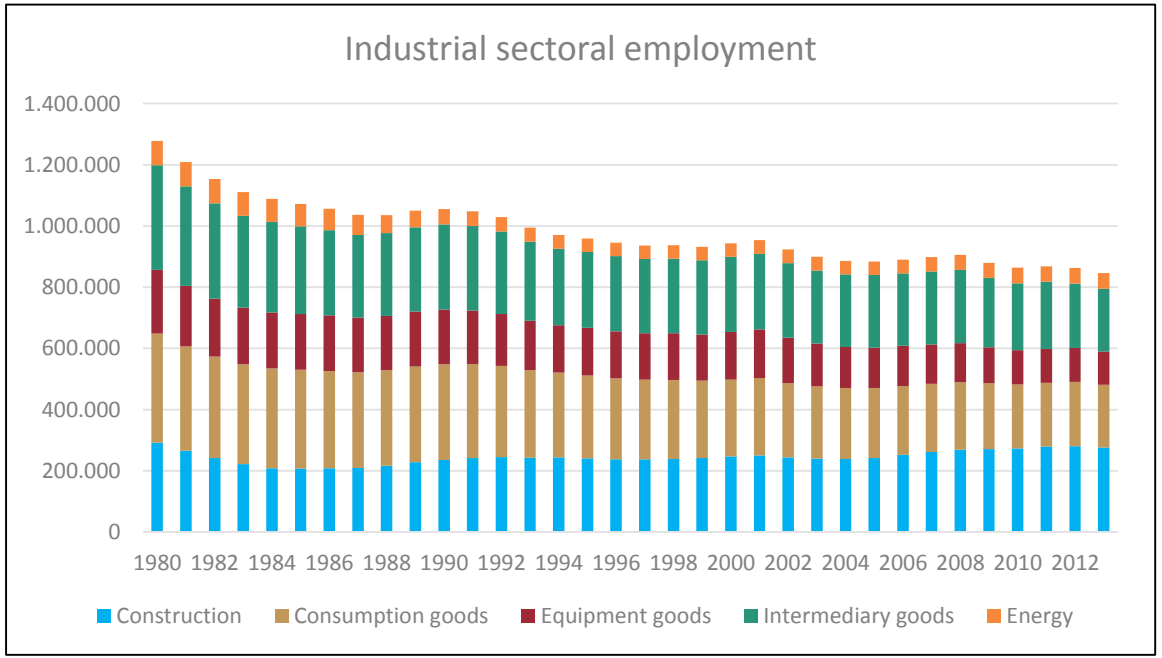
Source: Data from Federal Plan Bureau

Context

Historical evolution of Belgian employment by sector 1980 – 2013



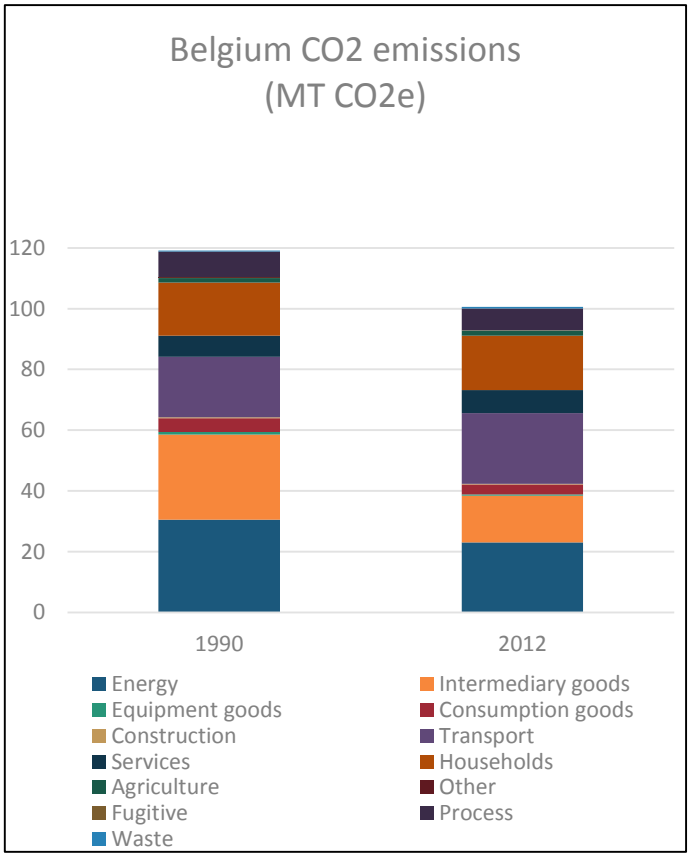
- **Employment (+20%) is driven by market services**
- **Industrial employment decreased since 1980 by 34%**



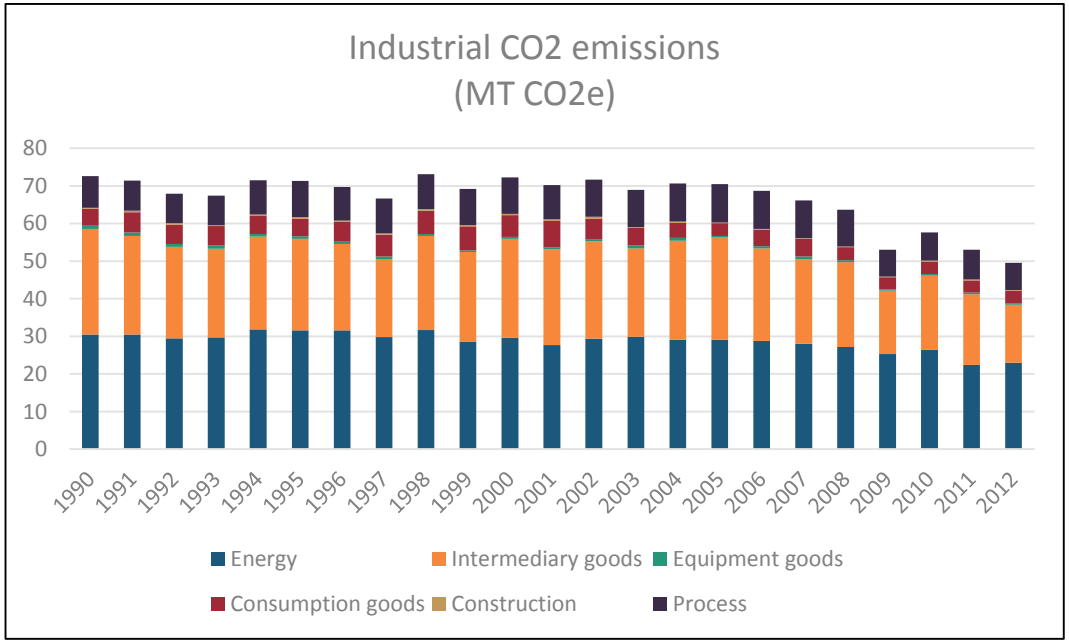
Source: Data from Federal Plan Bureau

Context

Historical evolution of Belgian CO2e emissions by sector 1990 – 2012



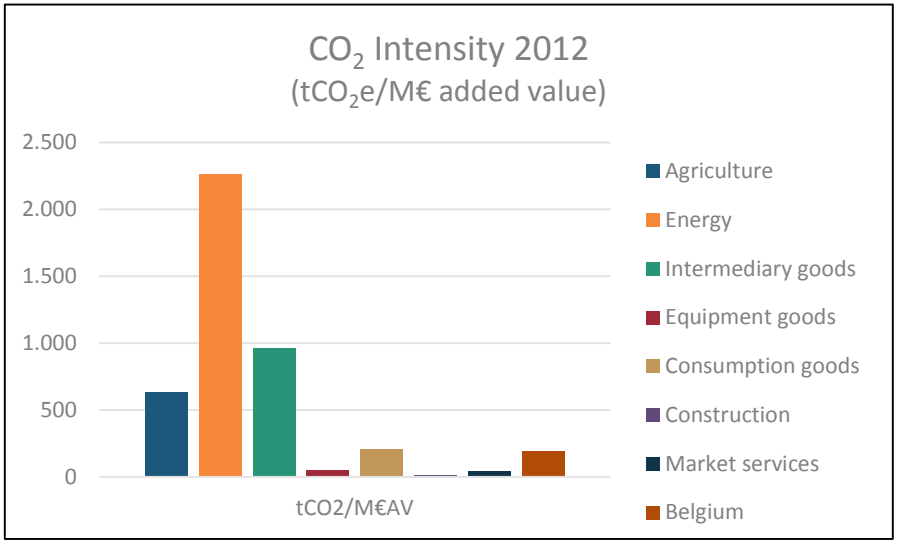
- **Industrial CO2 emissions are driven by energy and intermediary goods production sectors**
- **Industrial CO2 emissions started to decline in 2000 (with an exception in 2004), mainly driven by decrease in the Energy sector**



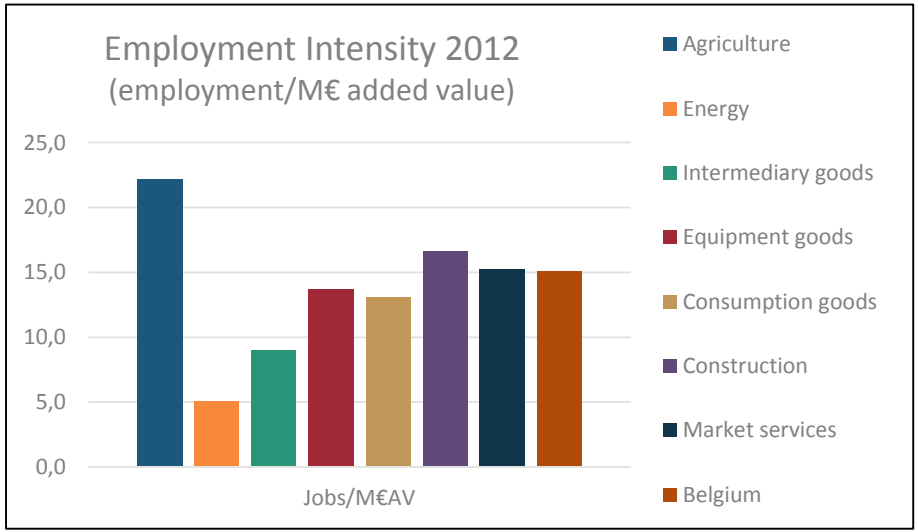
Source: Data from Federal Plan Bureau

Context

CO_2 and employment intensity 2012



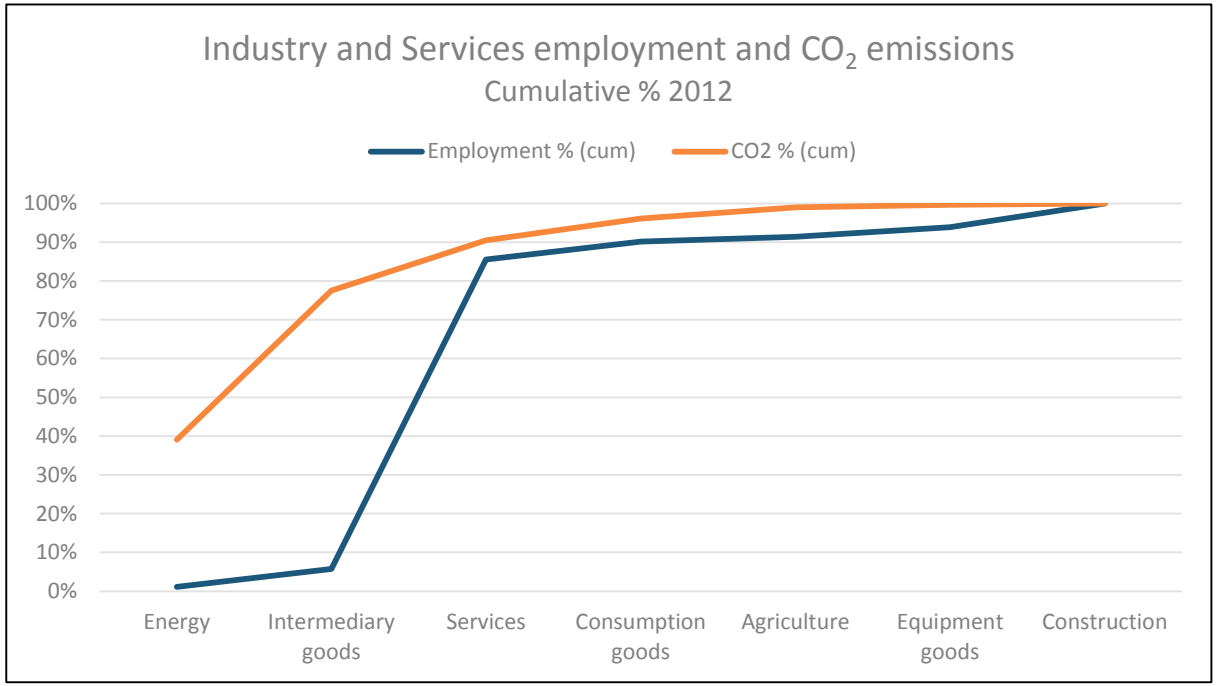
- **Energy and intermediary goods industries are the most CO2 intensive sectors**
- **Agriculture and construction sectors are the most employment intensive sectors**



Source: Data from Federal Plan Bureau

Context

Cumulative sectoral employment and CO_2 intensity

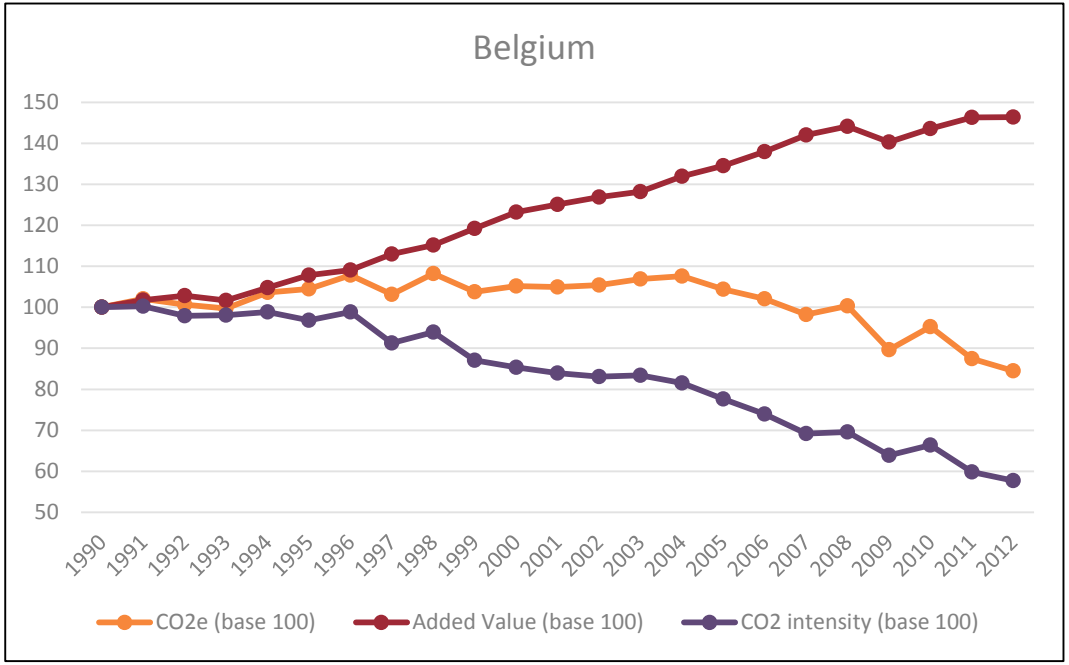


- The data only includes emissions related to industrial and services related sectors
- Energy and intermediary goods production represent 6% of Belgian jobs and 78% of Belgian emissions

Source: Data from Federal Plan Bureau, 2012

Context

Historical evolution of Belgian Economy CO_2 intensity 1990-2012



There is an absolute decoupling between economic growth and sectoral carbon emissions between 1990 and 2012

- **Total value added: +46%**
- **Total CO2 emissions : -16%**
- **CO2 intensity: -42%**

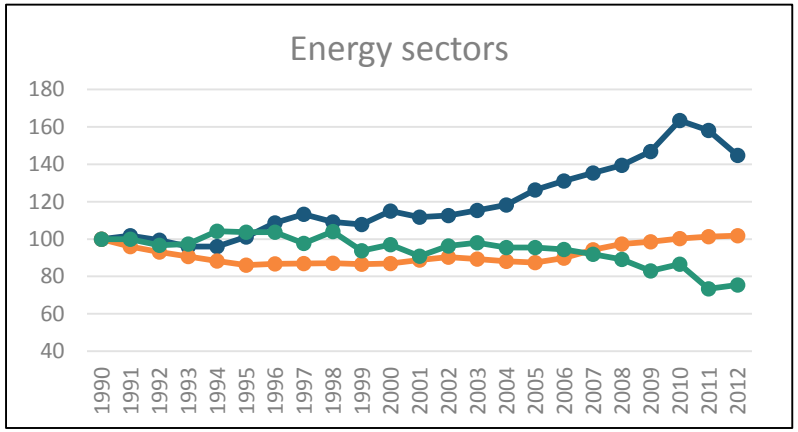
Source: Data from Federal Plan Bureau

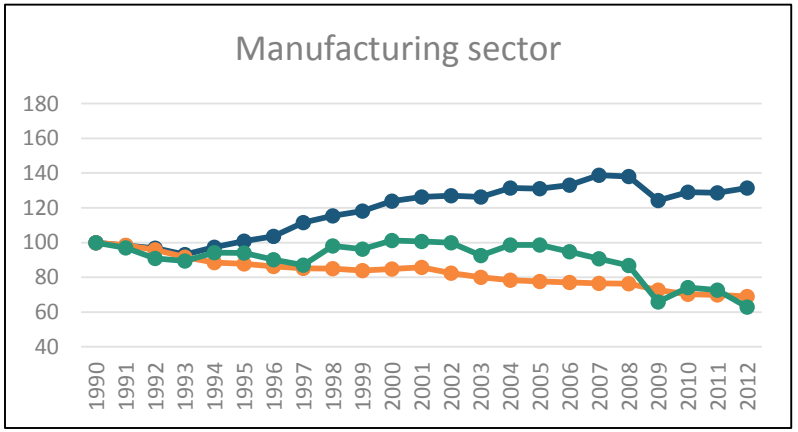
Context

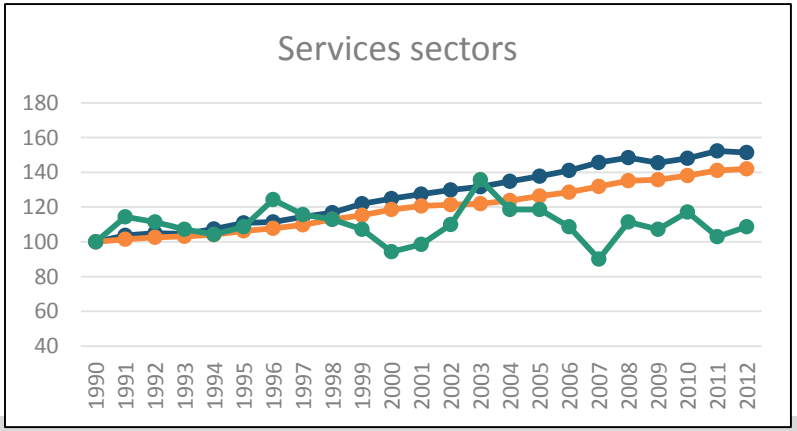
Historical evolution of Belgian Sectoral CO_2 intensity 1990 – 2013

Added Value (€2005)
Employment
CO2

Absolute decoupling is also the rule in most sectors







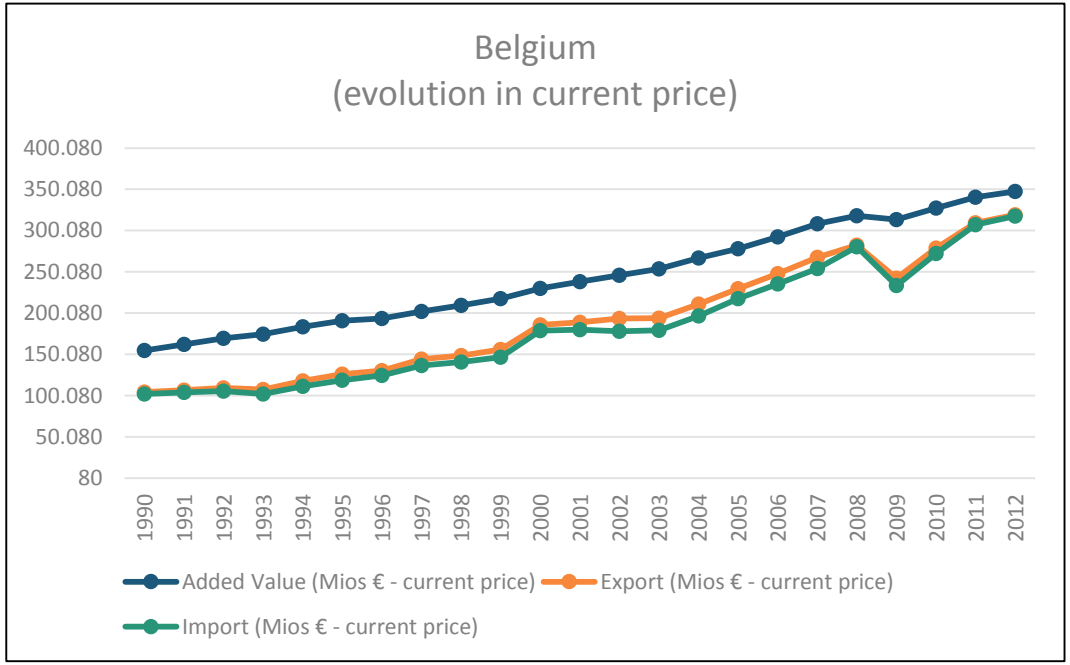
Source: Data from Federal Plan Bureau

Context

Historical evolution of Belgian of External trade openness

Added Value
Exports
Imports

(Mios Eur Current price)

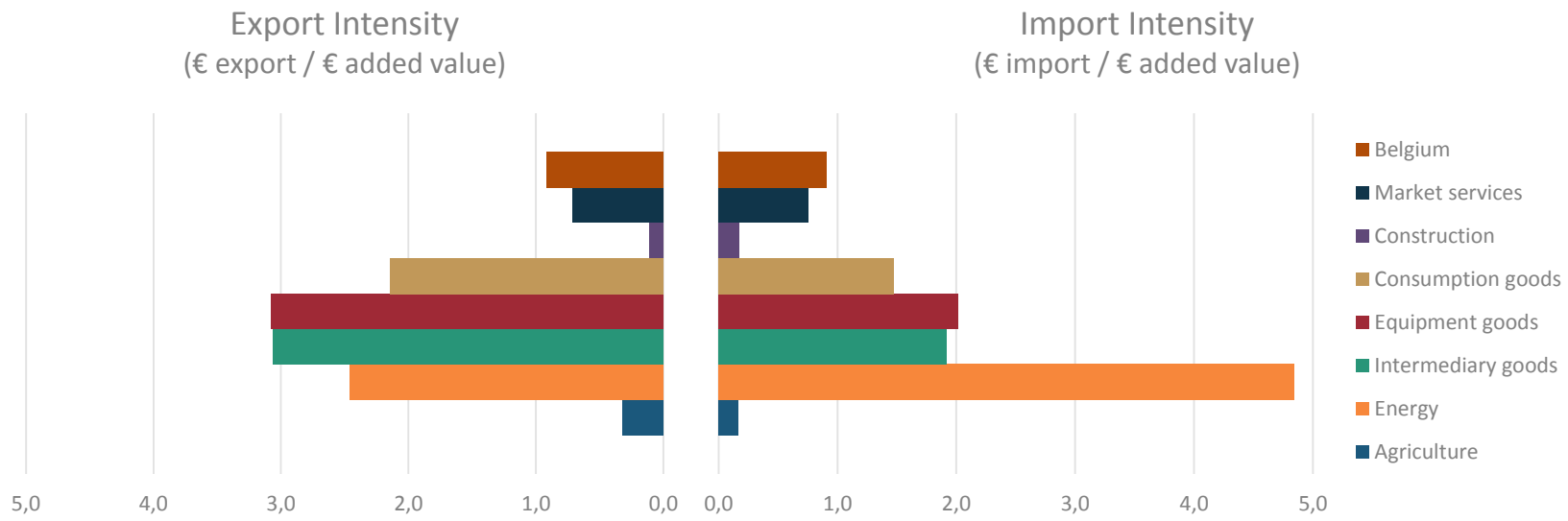


- Exports and imports have increased in parallel and faster than total Belgian added value
- Exports and imports represent ~ 90% of added value in 2012 (66% in 1990)

Source: Data from Federal Plan Bureau

Context

External trade openness by sector in 2012



Belgian economy is heavily dependent on external trade
Patterns significantly differ among sectors

Source: Data from Federal Plan Bureau

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Relevant studies on macroeconomic impacts

Growth, employment and competitiveness

Not exhaustive

The most relevant references within a collection of 150+ identified studies have been selected by the consortium.

The most relevant references are highlighted below.

	Growth, Employment & Competitiveness
WORLD	•Better growth, better climate - Chapter 5: Economics of change (New Climate Economy, 2014) •Climate Smart Development, adding up the benefits of actions that helps build prosperity, end poverty and combat climate change (with Oxford Economics, 2014) •Do environmental policies matter for productivity growth (OECD, 2014) •Moving to a Low Carbon Economy - The Financial Impact of the Low Carbon Transition (Climate Policy Initiative 2014) •The economic impact of taxing carbon (Oxford Economics, 2014) •Carbon pricing and its future role for energy-intensive industries (climate strategies 2013)
EU	•A. Impact assessment – Energy roadmap (European Commission, 2011) •B. Impact assessment - A policy framework for climate and energy in the period from 2020 up to 2030 (European Commission, 2014) •C. Employment Effects of selected scenarios from the Energy roadmap 2050 (Cambridge Econometrics, 2013) •D. Report on potential co-benefits of mitigation for Europe (Capros, 2013) •E. European decarbonisation pathways under alternative technological and policy choices (Capros, 2014)
BELGIUM	•Impact of the EU Climate-Energy Package on the Belgian energy system and economy (BFP 2011) •2030 Climate and Energy Framework for Belgium - Impact assessment of a selection of policy scenarios up to 2050 (BFP, 2015) •Walking the green mile in Employment (BFP, 2013) •Green tax shift in a federal state - a regional CGE analysis for Belgium (Flemosi 2013)

Relevant studies on macroeconomic impacts

Sectors

Not exhaustive

	Energy Intensive Industry	Power
WORLD	•Carbon pricing and its future role for energy-intensive industries (climate strategies 2013) •Cement Technology Roadmap 2050 (IEA, 2009)	•Putting renewables and energy efficiency to work - how many jobs can the clean energy industry generate in the US (Wei 2010) •Whos Winning The Clean Energy Race (PEW 2013) •Energy (r)evolution (Greenpeace 2012)
EU	•Steel roadmap for a low carbon europe 2050 (Eurofer 2013) •Steel's contribution to a low-Carbon Europe 2050 (BCG, 2013) •Unfold the future – 2050 Roadmap to a low carbon bio-economy (CEPI, 2011) •Routekaart 2030 Nederlandse glasindustrie (VNG, 2012) •UK glass manufacturing sector decarbonisation roadmap to 2050 (British Glass, 2014) •Europe's low-carbon transition: Understanding the challenges and opportunities for the chemical sector (ECF, 2014)	•Energy Roadmap 2050 (EC 2013) •BP energy outlook Regional insights EU 2035 (BP, 2014) •EU Energy, Transport and GHG emissions – Trends to 2050 (EC, 2013) •Eurogas, Long-term outlook for gas to 2035, 2013
BELGIUM	•Le paysage énergétique Belge - perspectives et défis à l'horizon 2050 - Description d'un scénario de référence pour la Belgique (BFP 2014)	•Macro-economic impact of the RES sectors in Belgium (EY, 2014)

Relevant studies on macroeconomic impacts

Sectors

Not exhaustive

	Transport	Construction	Other industry and services
WORLD	•Literature review on employment impacts of GHG reduction policies for transport (CE Delft 2012)	•Cities and the Low Carbon Transition (Bulkeley, 2011)	•''Green growth'' From a growing eco-industry to economic sustainability (Janick 2012)
EU	•EU Energy, Transport and GHG emissions – Trends to 2050 (EC, 2013) •ECF, Fuelling Europe's Future: How auto innovation leads to EU jobs, 2013 •White Paper – Roadmap to a Single European Transport Area: Towards a competitive and resource efficient transport system (EC, 2011)	•Low Carbon Construction (Innovation & Growth Team 2010) •A guide to developing strategies for building energy renovation (BPIE, 2013) •The macroeconomic benefits of energy efficiency –The case for public action (E3G, 2012)	
BELGIUM	•Dépenses des ménages et transport - Analyse thématique (BFP, 2014)		•La revolution technologique en Belgique (ING, 2014)

Relevant studies on macroeconomic impacts
Other impacts

Not exhaustive

Co-benefits	
Air pollution	• The co-benefits to health of a strong EU climate change policy (Holland – EMRC, 2008) • Acting now for better health (Holland, 2010) • Le coût de la pollution de l'air (OCDE, 2010) • Assessing the missed benefits of countries' national contributions (New Climate Institute, 2015) • Moving towards ambitious climate policies: Monetised health benefits from improved air quality could offset mitigation costs in Europe (Schucht et al., 2015) • An integrated approach to energy sustainability (McCollum et al, 2011) • External Costs of Transport in Europe (CE Delft, 2011) • How Much Carbon Pricing is in Countries' Own Interests? The Critical Role of Co-Benefits (IMF, 2014) • Schwanitz et al - Potsdam (2014)
Congestion and road accidents	• External Costs of Transport in Europe (van Essen, H, et al. - CE Delft, 2011) • Measuring road congestion in EU et BE (Christidis et al JRC, 2012)
Living environment	• Multiple Benefits of Energy efficiency (IEA, 2014)
Healthy diet	• Modelling the health impact of environmentally sustainable dietary scenarios in the UK (Scarborough et al., 2012) • Growing greenhouse gas emissions due to meat production (UNEP, 2012)

Relevant studies on macroeconomic impacts
Methodological aspects

Not exhaustive

Methodology	Model description
• Climate Policies - A Burden, or a Gain (T Bréchet 2014) • Introduction to the AMPERE model intercomparison studies on the economics of climate stabilization ( ) • Low-Carbon Policy Making vs. Low-Carbon Policy Modelling - State-of-the-Art and Challenges (Gershi 2014) • Modelling the Long Run Transition to a Low-Carbon Economy - The Contribution and Limitations of Models and Roadmaps (NESC 2013) • Green growth and the efficient use of natural resources (Reilly Green 2012) • Méthodes quantitatives de gestion environnementale (T Bréchet 2003)	• European decarbonisation pathways under alternative technological and policy choices - A multi-model analysis (Caprosa 2014) • Description of models and scenarios used to assess European decarbonisation pathways (Capros 2014) • Decarbonisation holds challenges and opportunities for Europe (AMPERE 2014) • Transition towards a low carbon society in 2050 - status of long term modelling in BE (VITO 2012) • The Economics of Low Stabilization - Model comparison of mitigation strategies and costs (Edenhofer 2010) • A new version of Hermes model (BFP 2013) • Analyse des répercussions macroéconomiques de l'organisation d'une Coupe du Monde FIFA en 2018 en Belgique (BFP 2010) • GEIM description (Oxford Economics 2014) • Mitigation strategies and energy technology learning - an assessment with the POLES model (Criqui 2014) • Emplois et scenario negaWatt – analyse input/output (Quirion 2013)

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Learnings from literature

3 dimensions are considered in most low carbon scenarios:

1. The inclusion of specific **low carbon measures and actions** based on low-carbon levers such as changes in energy production technologies, electrification of transport or improvement of energy efficiency and the related required level of expenditures (capital expenditures (or investments), operation and maintenance expenditures and fuel expenditures)

2. The assumptions on the **carbon price** and the related accompanying **fiscal policy :** how the carbon price revenues are recycled (reinjected), or not, in the economy

3. The definition of the **international context to fight climate changes and** to limit increase of temperature to 1.5 to 2°C.

The dimensions are defined in the following slides based on literature review

1 Specific low carbon measures and actions

Macro-economic models often rely on bottom-up models to define some of the key assumptions for mitigation measures and actions chosen and implemented in the EU.

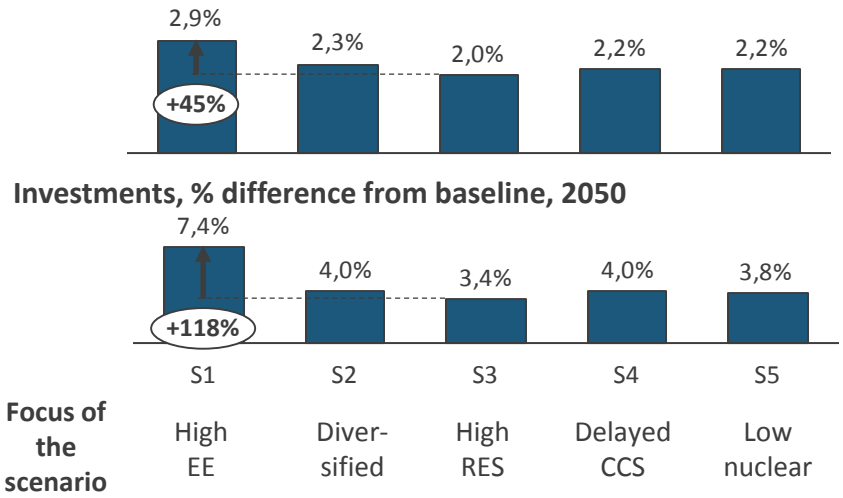
The main options are:

- developments in the **power generation** sector, in terms of capacity, generation, fuel consumption, investment in renewable energy sources, electricity prices
- investment in **energy efficiency** (in industry, transport or building)
- **fuel switching** in the transport sector
- increased **vehicle efficiency.**

These assumptions lead to certain impacts on GDP and employment through potentially **higher investments** (e.g., high EE), competitive advantage and **higher export** (e.g., clean tech) and **higher electricity prices** (e.g., high RES) passed on to households/businesses.

Two effects operate at the same time, a demand push effect based on new investments and a demand pull effect due to budgets allocation.

ILLUSTRATION of the impact from various scenarios focused on testing complementary measures



- S1 comes out with **better GDP and investments figures with much larger scale of investment** required for EE to meet the targets
- GDP impacts are lowest (but still positive) under S3, as **higher RES leads to higher electricity** prices. The higher consumer price level offsets some of the positive impact of the employment effects on household income and consumption.

Source: Cambridge Econometrics 2013

2.1 Carbon price

In macro macro-economic modeling literature, **the carbon tax can be considered as a policy instrument** (when testing its economic impact) **or as a result** (when endogenously defined based on different carbon emissions reductions constraints) of the analysis.

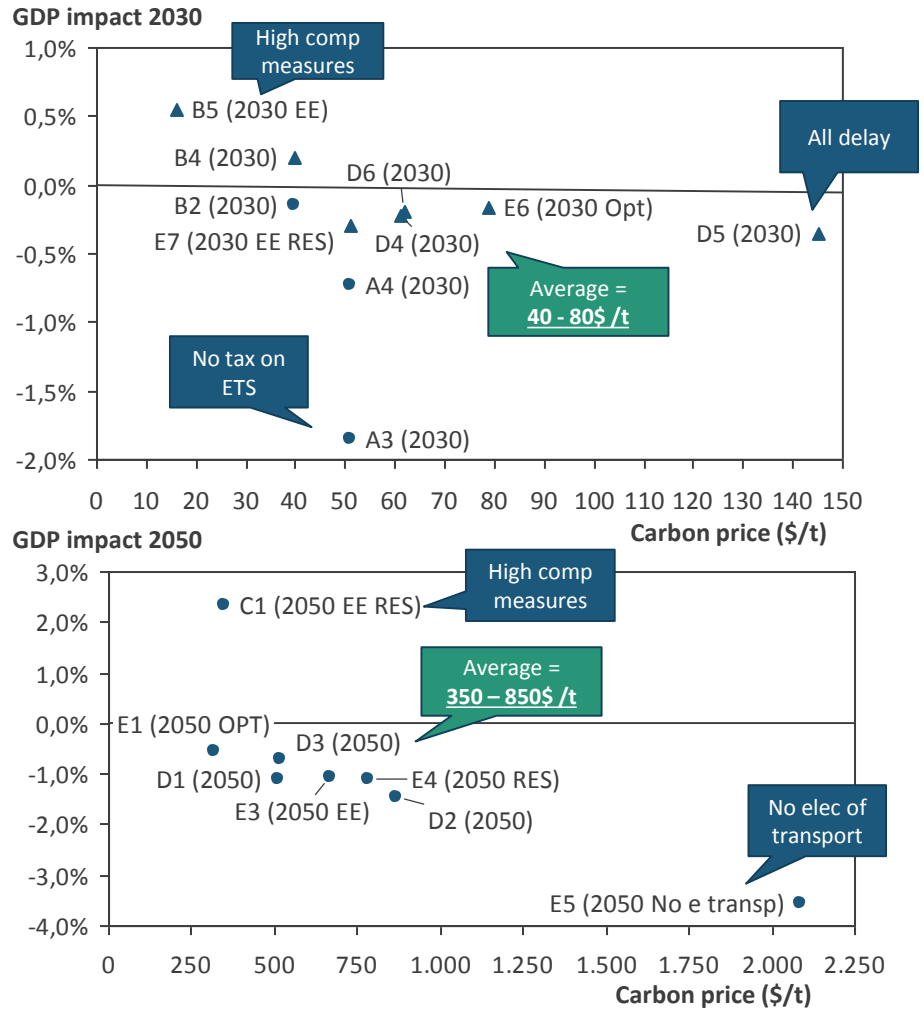
When considered as a result of the macro modeling, the **carbon price ranges between 16 and 145 $/t in 2030 and between 317 and 2.086 $/t in 2050**, depending of the policy scenario used and the level of ambition.

The graph illustrates that higher carbon constraints generally leads to higher impacts on EU GDP.

However, other elements need to be taken into account when defining carbon price mechanisms:

- The **scope** of the carbon constraint (power sector only, ETS only, non-ETS included)
- The **allocation mechanism** used (free allocation, auctioning) or **carbon tax** coverage
- The **recycling mechanism** (discussed in next slide)

ILLUSTRATION of some results of the impact of **carbon price on GDP** from various literature references*



*Various literature references listed in slide above.

2.2 Carbon revenue recylcing policy

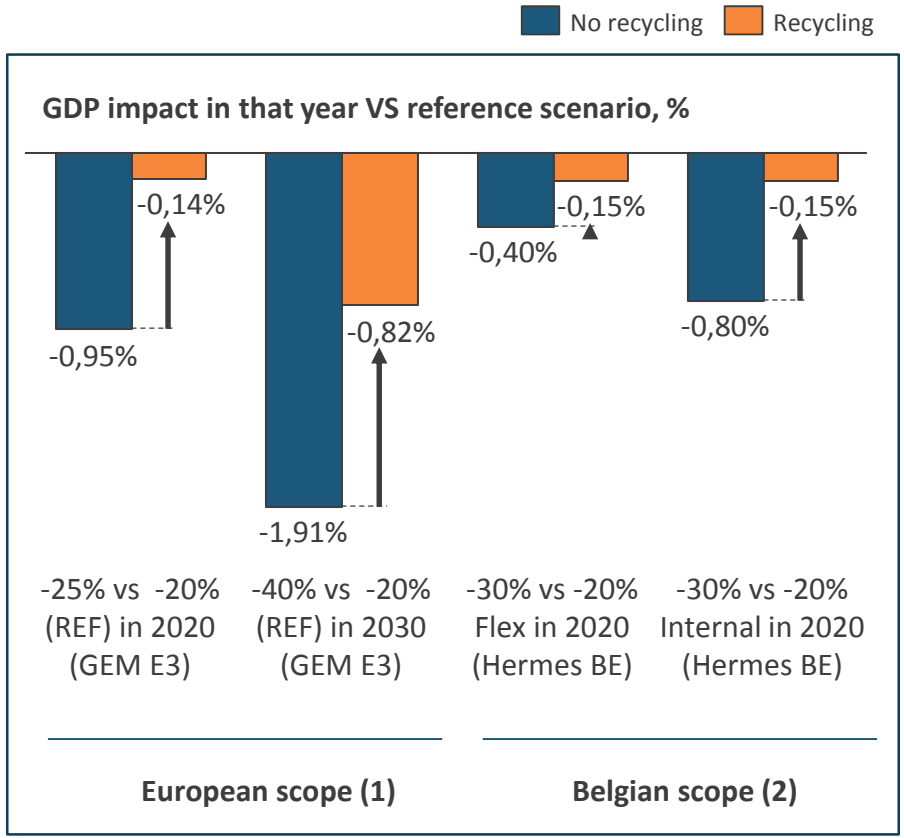
Recycling (tax shift) is a powerful instrument for policy makers to limit negative impacts or foster positive ones in the economy

Beyond defining which sectors are being taxed, how is this tax revenue being used by policy makers:

- Reducing debt
- Subsidy for consumers (or lump sum recycling)
- Reduction in direct or indirect taxes
- Labour cost reduction
- Etc.

The literature highlights that **reducing labor taxes has generally positive impacts on** activity and employment
Other recycling measures (lump sum or indirect taxes) can help pursuing other policy objectives (redistribution, competitiveness, etc.)

ILLUSTRATION of some results of the impact of carbon tax recycling policy



Source: (1) A Roadmap for moving to a competitive low carbon economy in 2050 + Impact assessment (EC 2011) - (2) Impact of the EU Climate-Energy Package on the Belgian energy system and economy (BFP 2011)

3 International context to fight climate changes

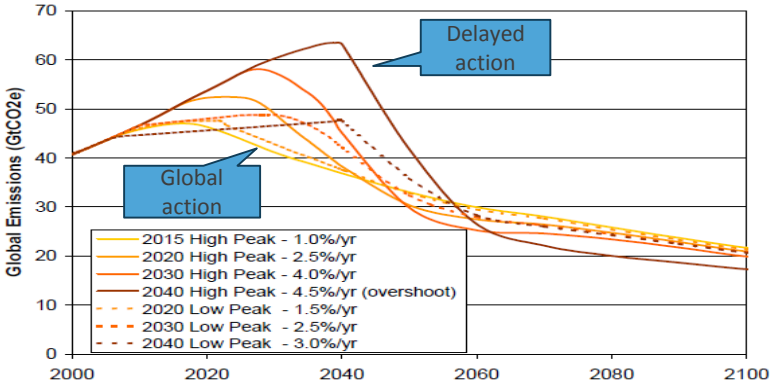
The international context on climate action has an important influence on potential economic impacts.
The literature assesses different low carbon scenarios for EU and the rest of the world. The Ampere project related references gives the most extensive definition of 4 potential low carbon scenarios generally used in the literature:

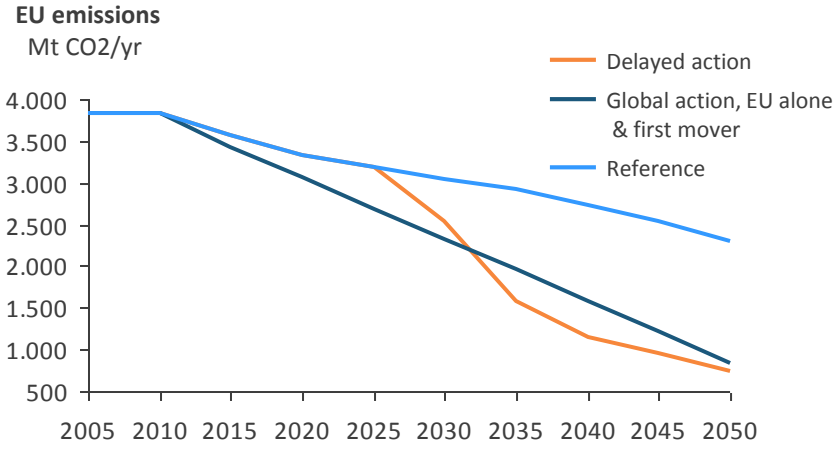
Reference scenario: climate policy is limited to current commitments of the different countries and regions of the world

Potential low carbon scenarios:

1. **Delayed action scenario** = EU and the rest of the world only jointly start strong climate action as from 2030
2. **EU Alone scenario** = unilateral action from EU is taken and the world fails to follow suit before 2050
3. **EU first mover scenario** = the world joins the EU efforts after 2030
4. **The global action scenario** = all countries undertake strong emission reduction effort for achieving the 450ppm stabilization target

ILLUSTRATION of main international climate action scenarios*





Sources: STERN REVIEW: The Economics of Climate Change (for Global emissions)
AMPERE data base (for EU emissions) https://tntcat.iiasa.ac.at/AMPEREDB/dsd?Action=htmlpage&page=welcome

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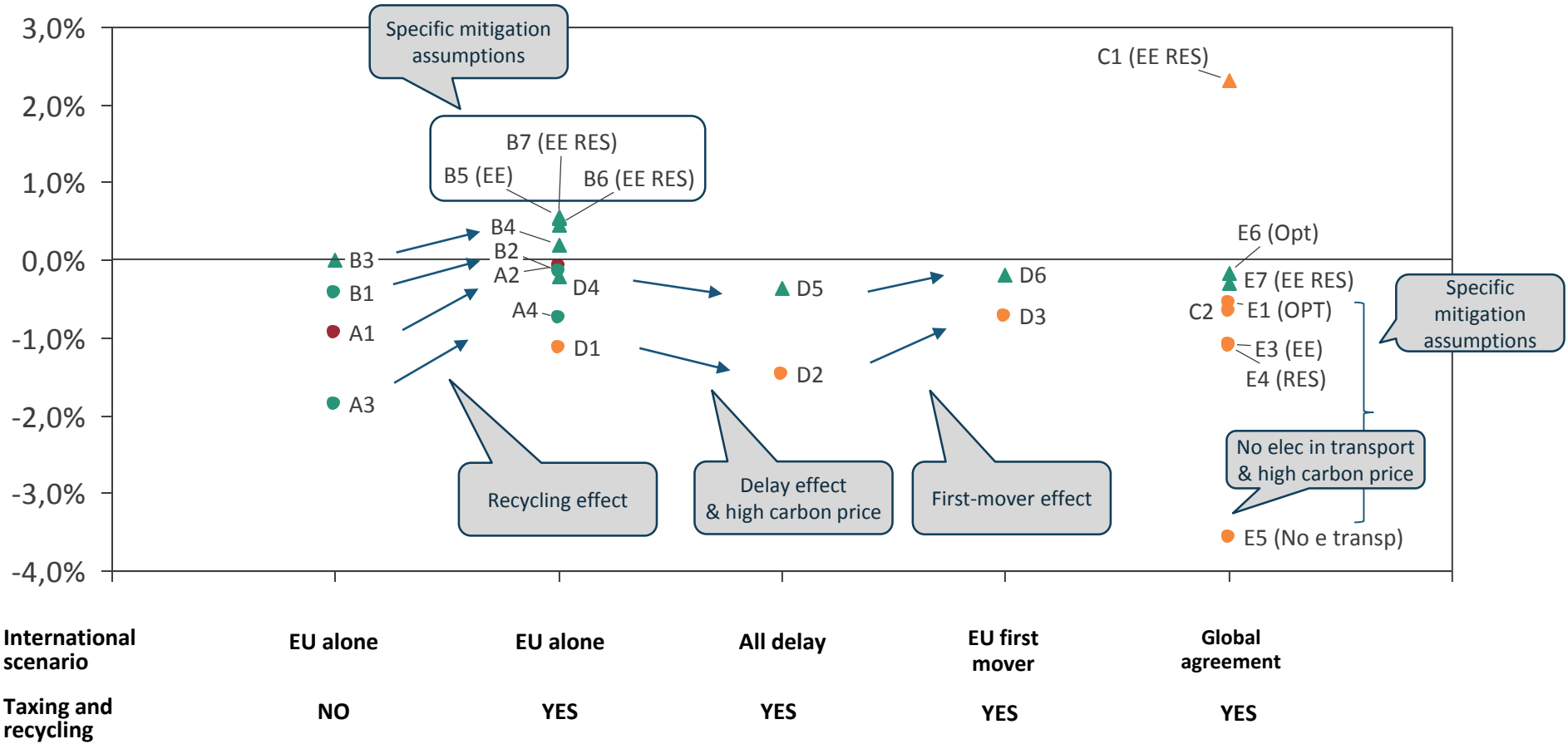
Impact on GDP

The GDP impact of low carbon scenarios compared to baseline ranges from -2% to +2% of GDP)

Type of model:
- Computable General Equilibrium
- Econometric

Timeframe:
- 2020
- 2030
- 2050



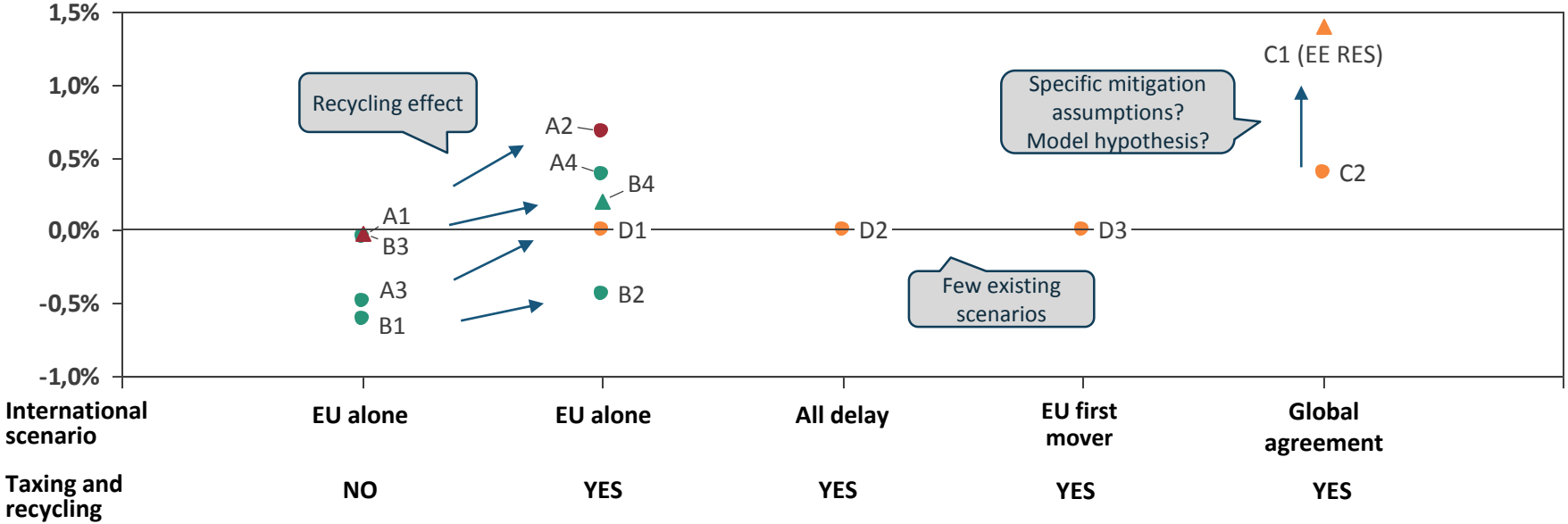
International scenario	**EU alone**	**EU alone**	**All delay**	**EU first mover**	**Global agreement**
Taxing and recycling	**NO**	**YES**	**YES**	**YES**	**YES**

Impact on jobs

The employment impact in 2050 compared to baseline arranges from -0,5% to +1% of employment

Type of model:
- Computable General Equilibrium
- Econometric

Timeframe:
- 2020
- 2030
- 2050



The impact on employment also depends of the following key drivers:

- the **labour intensity** assumed for the sectors that contribute to the decarbonised energy system,
- the extent to which decarbonisation is supported by **domestically produced or imported goods** and services,
- the **response of the labour market** (e.g., response in wage demand),
- the assumptions on the **availability of skill levels** : increase in the demand for people to work in relatively high skilled jobs. Impact on job content: eg. employees need to be able to apply their existing skill sets within a green environment

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Other impacts: impacts of climate non-action

Potential impacts of climate change are not included in 'business-as-usual' scenarios

1) Cost of damages from climate change

- IPCC(1) highlights the potential negative impacts linked to rising temperatures (such as increased damages from floods, water restriction, extreme heat events and wildfires, etc)

2) Impact of climate change on economic growth

- OCDE(2) highlights the potential negative impacts of climate changes on economic growth (such as productivity of various sectors, damages to capital, changes in demand for healthcare or energy)

Literature provides evaluation of the potential costs related to those impacts. Uncertainties and methodological limitations remain important.

(1) IPCC (2007), AR4, Chapter 5.7. (2) OECD (2015), "The Economic Consequences of Climate Change".

Other impacts: co-benefits of climate action

Implementing low carbon scenarios could bring additional benefits

Evaluation of potential monetary impact

Air pollution

- Fossil fuel use is the main factor of air pollution and impacts public health
- Climate policy can enable **savings in air pollution policies and public health**

up to **~4% of GDP** (BE)(1)

Congestion and road accidents

- Growth of congestion and accidents impact **productivity of the overall economy**
- Climate policy is expected to encourage the shift to more collective transport

up to **~3 to 4% of GDP** (BE)(2)

Living environment

- Weak insulation and ventilation of homes has impact on **health and comfort of inhabitants**
- Climate policy is expected to accelerate the retrofit of large number of houses and buildings with higher standard of energy efficiency

up to **~1 to 2% of GDP** (EU)(3)

Healthy diet

- Unbalanced healthy diet is source of diseases (cardiovascular and cancer)
- Climate policy is expected to encourage a shift from animal proteins towards a mix of sustainably produced animal and vegetal proteins

up to **~6% of GDP** (UK)(4)

Sources: (1) OCDE (2014) – (2) van Hessen et al. (2011) + Christidis et al (2012) – (3) IEA (2014) – (4) Scarborough et al. (2012)

Francis Bossier – fb@plan.be
Thierry Bréchet - thierry.brechet@uclouvain.be
Pascal Vermeulen – pv@climact.com
Julien Pestiaux – jpe@climact.com
Thibaud Lemercier tl@climact.com