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HEALTH, FOOD CHAIN SAFETY AND ENVIRONMENT

A Low-carbon roadmap for Belgium

Study realised for the FPS Health, Food Chain Safety and Environment

Industry sector – food processing document

This document is based on content development by the consultant team as well as an expert workshop that was held on the 16-08-2012

vito
vision on technology

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Content – Industry sector - food

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Executive summary

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Construction of different trajectories w.r.t. future production

- 3 trajectories for food production in Belgium have been modelled, which include a range between **~+120% to +0% of 2010 production levels (expressed in value added) in 2050**
  - The high growth trajectory assumes food production in Belgium captures an increasingly large share of the export market for emerging economies (adopting the same consumption habits as Western countries).
  - The low growth trajectory assumes a more stable path based on reducing waste and food sufficiency.
  - Energy expenditures are usually not the main cost factor in food production. In comparison with other industrial sectors, food production will not be affected as much by rising energy (or carbon) prices. However, for the same reason energy efficiency investments face significant hurdles.

Estimation of GHG reduction potential

- **GHG reduction potential (assuming constant production) amounts to 67% to 100% (level 3 & level 4 ambition).**
  - **Energy efficiency** can be improved and reduce emissions by **30% to 40%.**
  - **A fuel switch from liquid and solid fuels to gas** can be expected to be completed by 2025, leading to **3%** of additional emission reductions. The switch to gas has already largely occurred in the past two decades.
  - The substitution of **gas by biogas** allows for an additional **33% to 57%** of emission reductions.
  - Because of the many relatively small production sites, **CCS** is theoretically applied starting from ambition level 4. However, the 100% switch to biogas in level 4 makes the application of CCS unnecessary.

NOTES In the OPE²RA model a 4th trajectory is modelled where the output of food processing industry is correlated to the level of meat consumption (-2% to -25% food processing output in 2050)
Reduction potentials are for are ambition levels 3 and 4, expressed as a % of the 2010 GHG emission level except where explicitly mentioned otherwise.
The reduction in each step represents the additional reduction percentage after all the previous levers have been applied.
This is why : (1) The reductions of the actions add up to the total reduction of the sector (levers are applied in the sequential order represented here)
(2) Level 4 ambition can therefore be smaller in cases where more potential has been achieved with the previous levers
There is a double counting between the biomass potentials mentioned here and in the supply section, it is removed in the OPE²RA model

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A detailed analysis is performed for each industrial sector, the methodology is detailed in the general industry document (and not repeated in each sector document)

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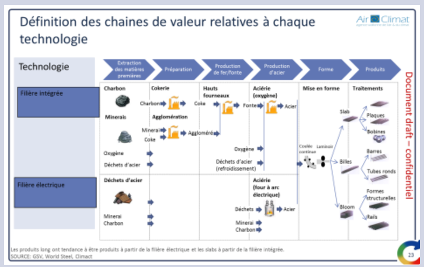
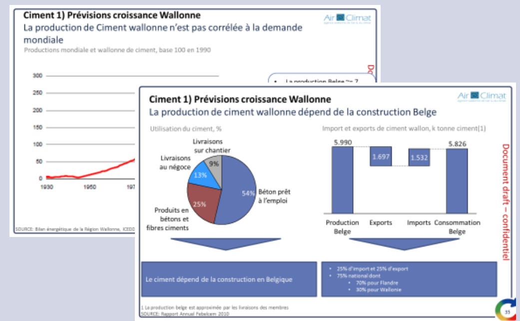
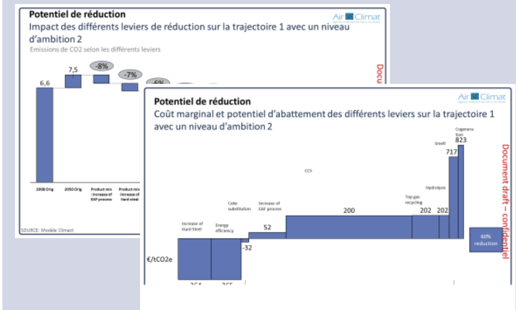
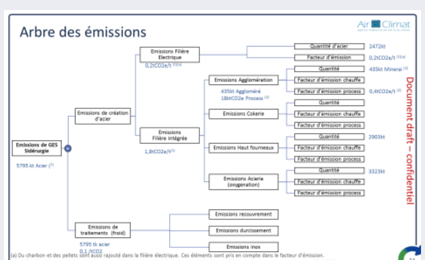
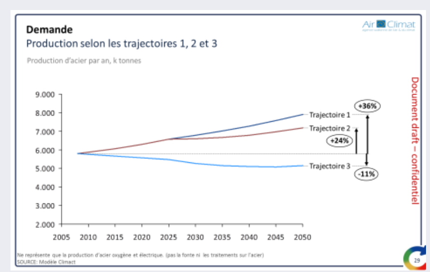
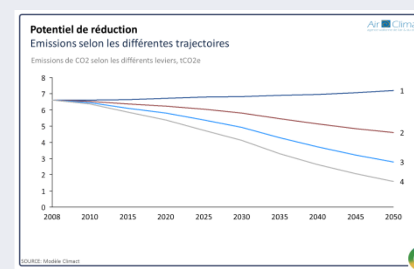
	Understanding the industry	Modelling demand trajectories	Modelling trajectories with intensity levels + CCS
Analyses	Definition of the value chain 	Analyses of growth and competitivity 	Potential of CO_2 reduction incl. costs 
Results	Modelling the emissions tree 	Demand trajectories 	Trajectories with different intensity levels + CCS 

SOURCE: Climact

The energy profile varies significantly between industrial sectors

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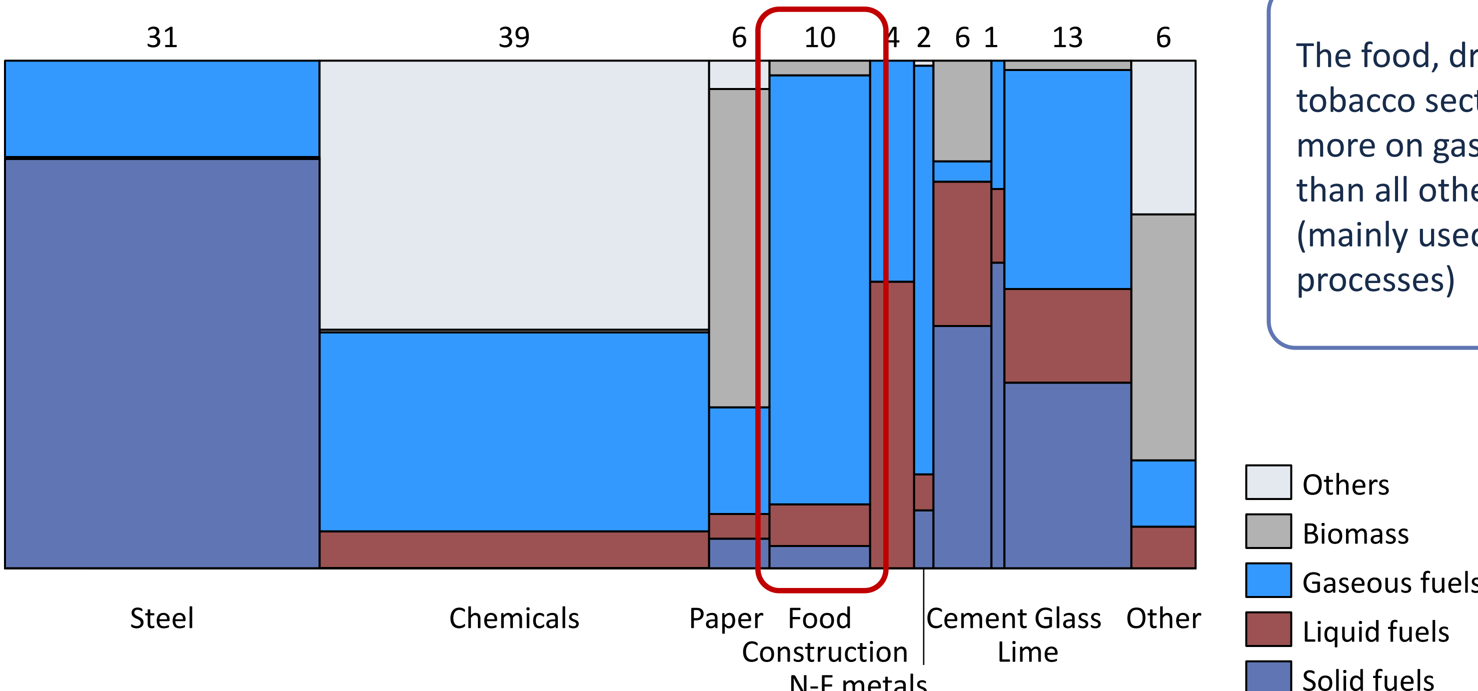
Distribution of "emission creating energy sources" per industry sector in 2010

Total primary energy consumption in 2010 = 119 TWh PCI [1,2]



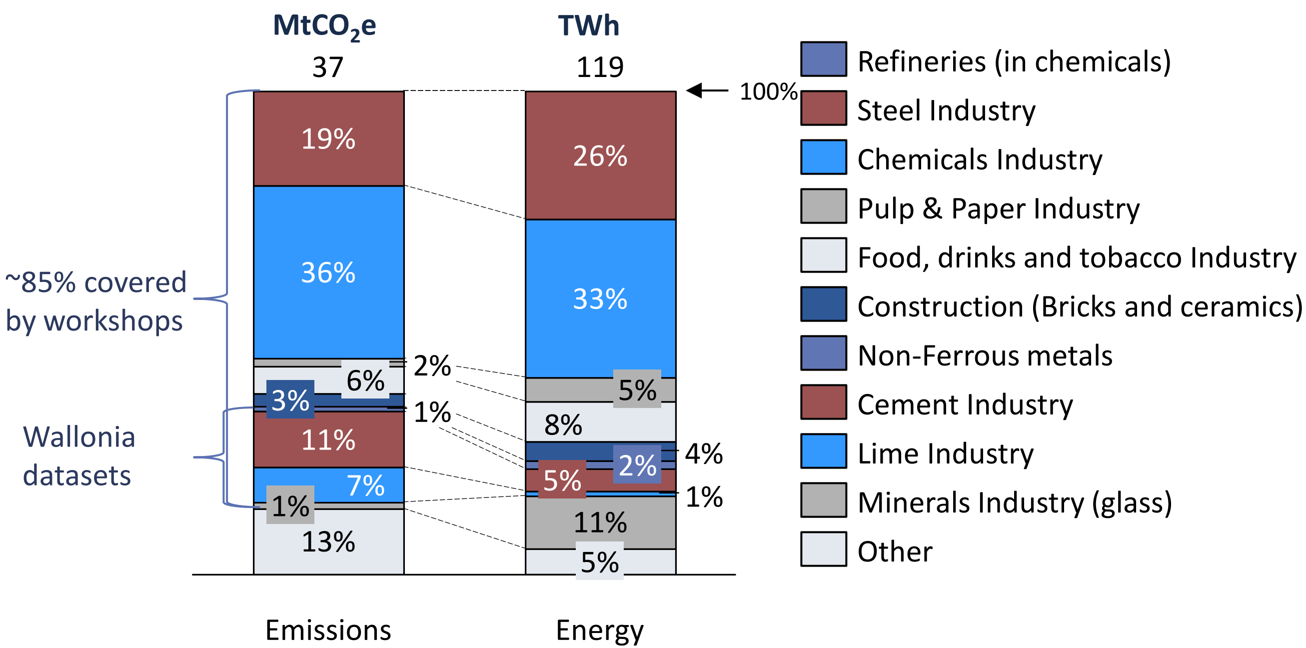
The food, drinks and tobacco sector is relying more on gaseous fuels than all other sectors (mainly used for heating processes)

NOTE: (1) Excluding electricity consumption
(2) Amongst solid fuels, coke use in steel industry has two function (raw material and energy).Both are included in the analysis but only the 2nd creates emissions in the atmosphere

SOURCE: NIR CRF v1.4

Food industry represents 6% of emissions for 8% of the energy consumption

GHG emissions and energy consumption in Belgium 2010
($MtCO_2e$, TWh, %)



- Food represents 6% of emissions for 8% of the energy (because of fuel mix – cf. previous slide)
- Non metallic minerals (Cement, Lime and Glass) have high process emissions
- In steel, there would be less TWh if the coke used as reducing agent was not included in the analysis (cfr with the IEA data)

NOTE: (1) Excluding electricity emissions and consumption
(2) Amongst solid fuels, coke use in steel industry has two function (raw material and energy)
Both are included in the analysis but only the 2nd creates emissions in the atmosphere

SOURCE: NIR CRF v1.4

Food production in Belgium

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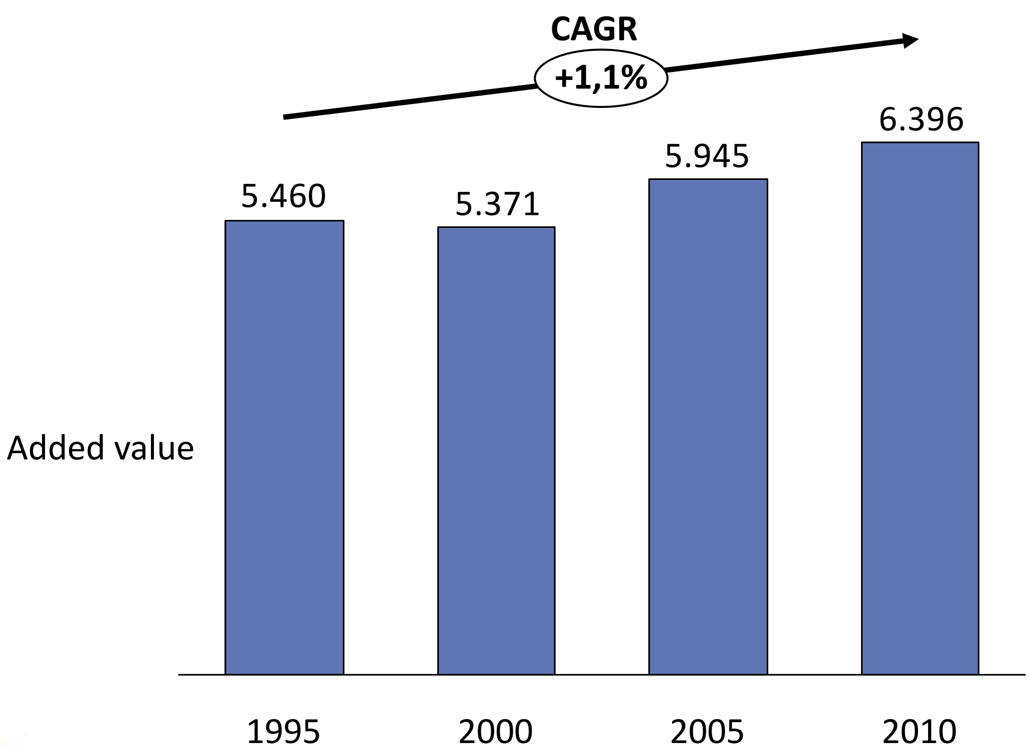
Value added as proxy for sectoral activity
(Meuro, 1995-2010)



Value added growth of 17% over 15 years
(CAGR = 1,1 %)

SOURCE: Federal Planning Bureau

Sector emissions decrease because of fuel switch towards gas

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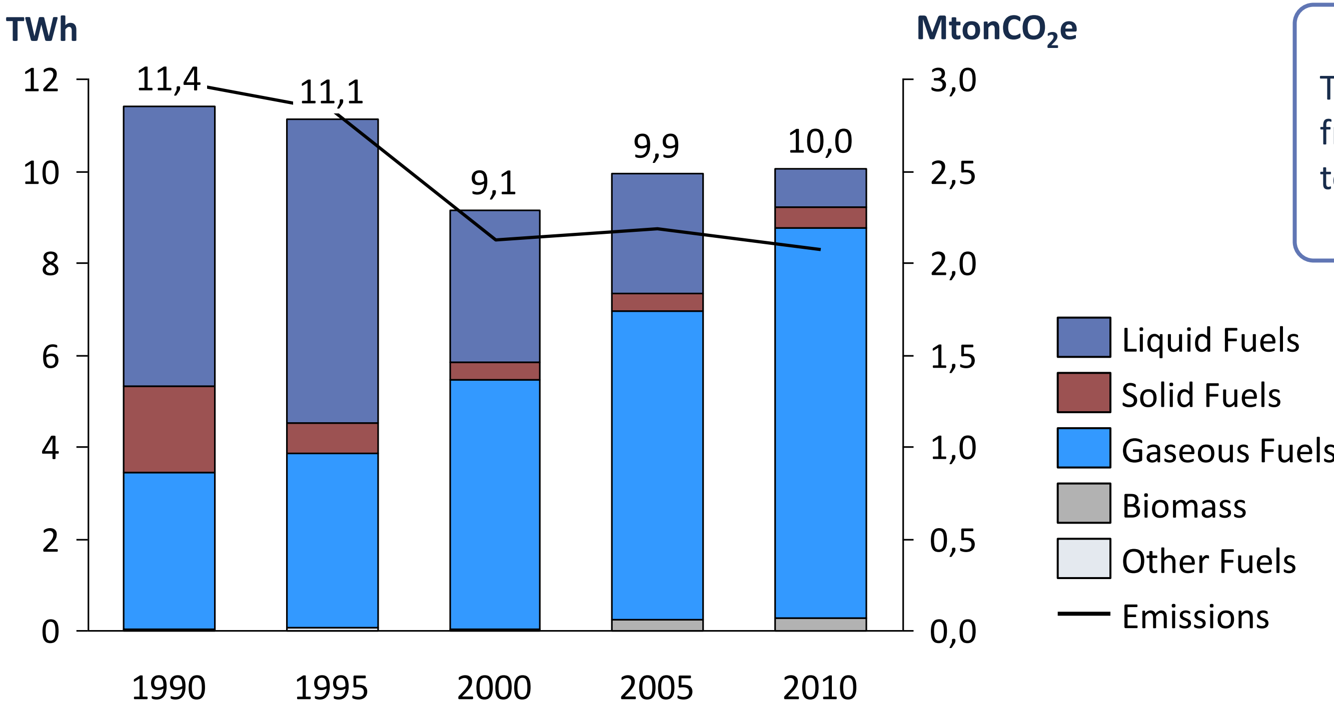
Food sector energy consumption and emissions
(TWh, MtonCO2e electricity excluded)



There is a major transition from solid and liquid fuels to gaseous fuels

NOTE CO_2 from Food and Drink Production (e.g. gasification of water) can be of biogenic or non-biogenic origin. Only information on CO_2 emissions of non-biogenic origin should be reported.
SOURCE : NIR CRF v1.4

Energy intensity of food production has decreased

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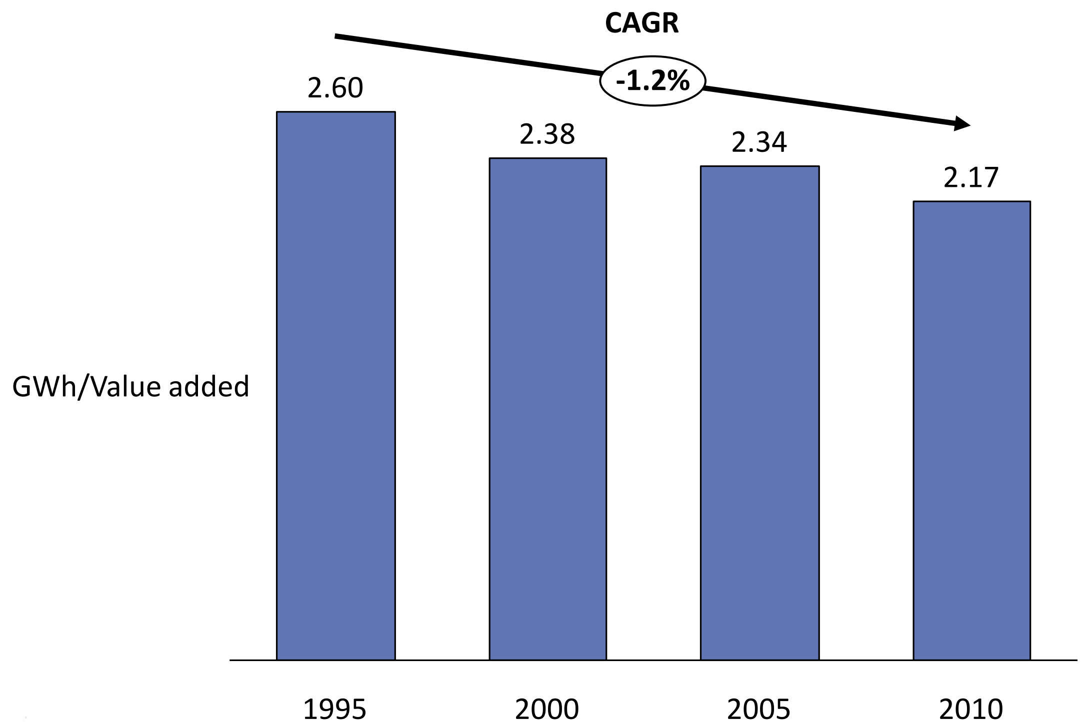
Energy use (electricity included)/Value added as proxy for sectoral activity
(GWh/Meuro, 1995-2010)

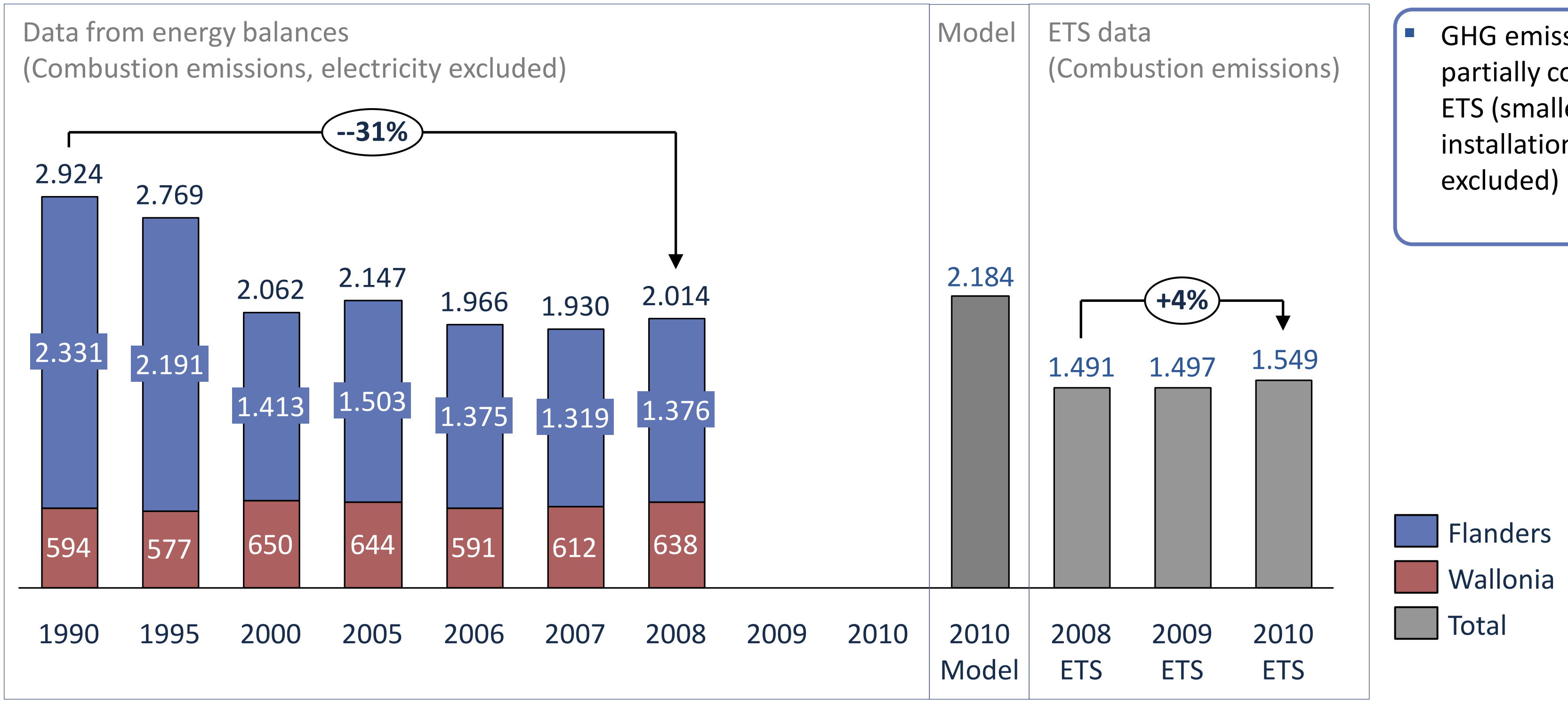


Energy intensity improvement of 16% over 15 years

SOURCE: Energiebalans Vlaanderen, Atlas énergétique Wallon

GHG emissions decreased since 1990, but remain more or less constant since 2000

GHG emissions in food sector (1990-2010)
(ktonCO_2e)



- GHG emissions only partially covered by ETS (smaller installations excluded)

SOURCE: Atlas énergétique wallon, MIRA kernset milieudata, ETS registry

The food industry is evenly spread amongst a large number of different sectors

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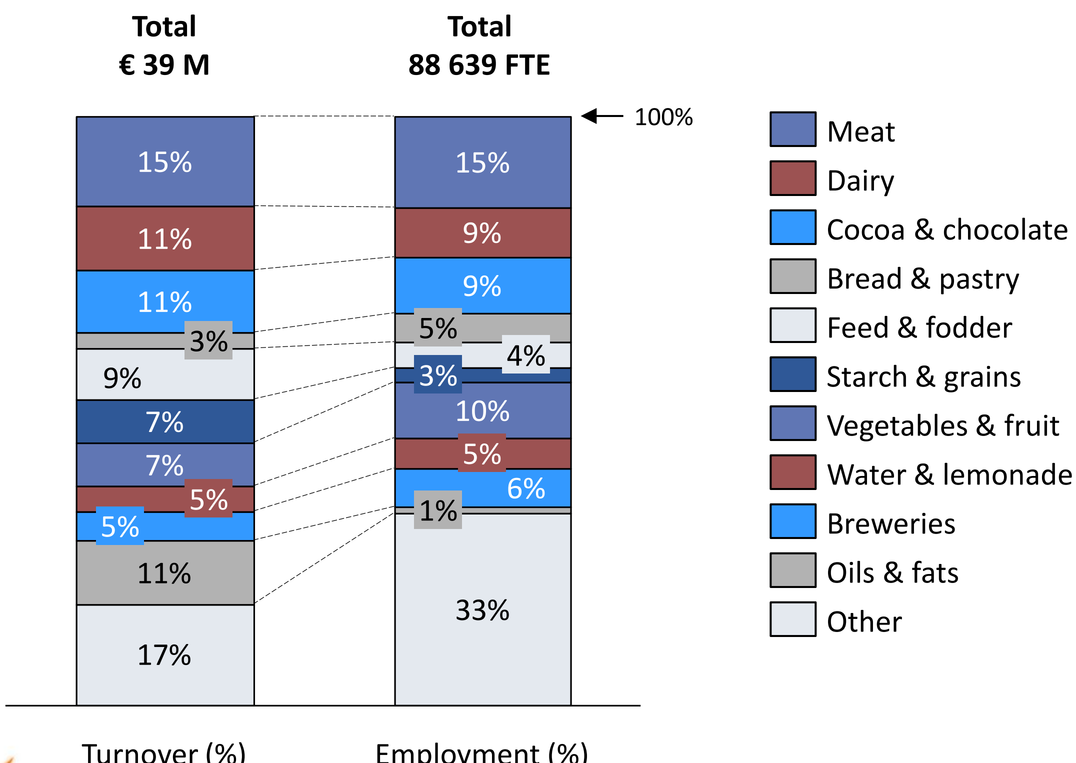
Repartition of turnover and employment amongst food sectors (%)



Additional information:

- Food industry is largest industrial sector in Belgium in terms of employment (total active population = 4.45 million)
- Majority of companies are small scale (only 6% of companies employs more than 50 people)
- Small companies realise 26% of turnover in food sector

SOURCE: Duurzaamheidsverslag 2011 FEVIA (data for 2010)

Production is fragmented amongst a variety of actors

Emissions per ETS site

	2008	2009	2010	%
Algist Bruggeman	0	0	9920	1%
Alpro	9648	7967	8530	1%
BENEO-Orafti	106104	102961	94583	6%
Belgomilk Kallo	30040	32807	26034	2%
Belgomilk-Ysco Langemark	33273	40449	46896	3%
Biowanze	1813	65151	74930	5%
Brouwerij Haacht	7914	5886	5834	0%
Campina	28289	27782	25121	2%
Cargill Antwerpen	26136	22386	23913	2%
Cargill France	16879	18095	15820	1%
Cargill Gent	32518	52194	50974	3%
Cargill Izegem	40260	34031	35603	2%
Citrique Belge	75329	69721	63209	4%
Clarebout Potatoes	30868	27331	33306	2%
Edel Grâce Hollogne	22618	22876	23954	2%
Farm Frites Belgium	41866	40411	40371	3%
Ferrero Arlon	10503	14672	15267	1%
Fraxicor	55	36	25	0%
Gramybel Mouscron	13677	14112	15625	1%
InBev Belgium Jupille	18116	17002	17444	1%
InBev Belgium Leuven	41211	32173	29578	2%
Inex	15951	14666	14112	1%
Inza	8377	7405	7644	0%
LU-General Biscuits België	13325	13244	14440	1%
Limelco	13157	11451	10593	1%
Lutosa Leuze-en-Hainaut	51774	48287	53190	3%
Mouterij Albert	29566	25128	28247	2%
Mydibel Mouscron	24236	25312	24861	2%
Oliefabriek Vandamme	11710	12199	11975	1%
Primeur - Vanelo	20031	19289	20817	1%
Raffinerie Tirlemontoise Hollogne	23731	100	61	0%
Raffinerie Tirlemontoise Longchamps	22851	23477	25004	2%
Raffinerie Tirlemontoise Wanze	61732	58802	63304	4%
Rendac	14511	10659	10955	1%
Rousselot	10336	9476	8455	1%
Scana Noliko	20667	23615	23319	2%
Sobelgra	18451	15998	20573	1%
Solarec Recogne	31138	29935	31575	2%
Spa monopole Spa	6812	10546	11333	1%
Struik Foods Belgium	0	2853	5693	0%
Sucrerie de Fontenoy	33545	44381	50429	3%
Suikerfabriek Moerbeke	4983	1251	0	0%
Tate & Lyle Europe	207152	197975	195471	13%
The Solae	35496	31316	38117	2%
Tiense Suikerraffinaderij - Tienen	142162	130219	140363	9%
Van Pollaert Gebr.	11501	12414	11743	1%
Veurne Snack Foods	21085	20891	22575	1%
Walhorn	20871	20827	22055	1%
Warcoing industrie	29629	27414	25623	2%
Total	1491897	1497173	1549464	

- Relatively big emitters: Tiense suikerrafinaderij and Tate & Lyle Europe (representing ~ 22% of ETS emissions in 2010)

SOURCE: ETS registry 2010

There is a variety of industrial processes in food production

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List of processes applied in the food industry

Process	Examples
Materials reception and preparation	storage, sorting/screening, peeling, washing, thawing, …
Size reduction, mixing and forming	cutting, slicing, chopping, mincing, pulping, mixing/blending, grinding/milling, forming/moulding, …
Separation techniques	extraction, centrifugation, sedimentation, filtration, distillation, bleaching, …
Product processing technology	soaking, dissolving, fermentation, coagulation, smoking, ageing, …
Heat processing	melting, blanching, cooking and boiling, baking, roasting, frying, …
Concentration by heat	evaporation, drying, dehydration, …
Processing by removal of heat	cooling, freezing, freeze-drying, ...
Post processing operations	packing and filling, storage under gas, ...
Utility processes	...

The levers applied in this sector will need to remain relatively generic to encompass the variety of the industry

SOURCE: BREF document food industry

Emissions tree based on generic processes

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Based on grouping of process technologies

CO_2 emissions food industry

Electricity consuming cross-cutting technologies

Mainly cooling and pumps & motors

Emission factor depends on electricity generation (attributed to electricity sector)

Heat generation cross-cutting technologies

Boilers, ovens, distillation, CHP,…

Emission factor depends on type of fuel used (attributed to food industry)

Growth prospects Belgium

Food sector is very dependent on export

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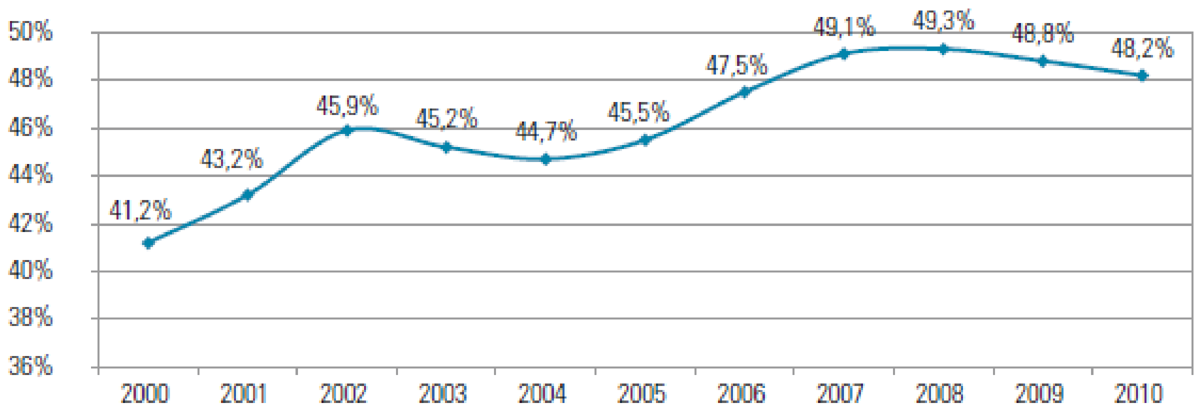
Export (% of turnover)



- 69% of export to UK, Germany, France, the Netherlands
- Growing importance of export outside of EU (13% of turnover in 2009)

SOURCE: Duurzaamheidsverslag 2011 FEVIA

Growth prospects Belgium

Trends apparent at world, EU and Belgian level

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World

- Shift toward consumption of higher value food products
- Middle income countries (e.g. China, Mexico) increasingly follow consumption patterns in Western countries
- Food production follows population growth
- Changes in consumption patterns driven by income growth and demographic factors

EU[1]

- Mature market
- Exceptionally diverse compared to other industrial sectors
- Some geographical concentration still apparent (e.g. fish processing, olive oil)
- Other activities found in all countries (sugar production/ refining, grain milling, dairy industries)
- Export out of Europe is important part of business, mainly to USA (+ Japan, Russia), but decreasing
- Export to emerging markets increasing

Belgium[2]

- Mature market
- Highly specialised sector
- Large share of SMEs (except in drinks (outside of breweries) and sugar production & refineries)
- Export to EU countries very important
- Positive (and growing) trade balance
- Role of emerging markets

SOURCE: (1)BREF document food industry; (2) CRB studie concurrentievermogen Belgische voedingsindustrie

Parameters influencing demand up to 2050 for some representative sectors

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Parameter	Drinks	Vegetables & fruit	Meat
• Growth prospects	• CAGR European population towards 2050: 1% • CAGR GNP: 1,6% [1] • Food industry (2010-2050) : +1,3% average[2]		
	• Potential for growth in export market[3]	• Growing sector, potential for further growth in added value [3]	• Rather stable, low value added[3]
• Infrastructure needs	• Proximity of markets • New export markets • Need for more productivity and specialised personnel		
• Correlation to Belgian production	• Well developed market which will remain more or less stable[3]		
• Modification expected in mix of products	• Partial shift to high added-value and specialised products[3] • Importance of certification (safety of the food chain)		

SOURCE: (1) Federal Planning bureau, (2) GEM-E3 projections, (3) CRB studie concurrentievermogen Belgische voedingsindustrie

Important market trends towards 2050

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- Consumer expectations & behaviour
  - Health of food: transition to less meat consumption is expected (120 g/day is recommended)
  - More prepared food
  - ‘Novelties’
- New food sources (e.g. insects?, artificial meat?)
- Efforts to avoid ‘food crises’ (e.g. dioxin)
- Efforts to avoiding waste in the food production lifecycle
- Influence of retail sector will remain high
- Productivity growth in mature markets is needed
- Variability and price fluctuations of raw materials
  - Possible influence of climate change !
  - Expected increase in competition for biomass (used for food, feed, energy, materials)

SOURCE: CRB studie concurrentievermogen Belgische voedingsindustrie

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Growth prospects Belgium

3 trajectories influencing energy demand will be modelled

Possible growth scenarios

European population: 1%

GNP: 1,6% (1)

GEM-E3(2010-2050) projection

- 1,3% average growth in value added(2)

In the OPE²RA model, a Trajectory 4 is modeled based on a correlation between meat consumption and food processing output

	Food industry output
Trajectory 1	• CAGR +2% (+120% by 2050) • High growth assumption
Trajectory 2	• CAGR +1,3% (+68% by 2050) • Reference growth assumption
Trajectory 3	• CAGR 0% • Low growth assumption

SOURCE: (1) Federal Planning bureau, (2) GEM-E3 projections

Growth prospects Belgium

Production according to trajectories 1, 2 et 3

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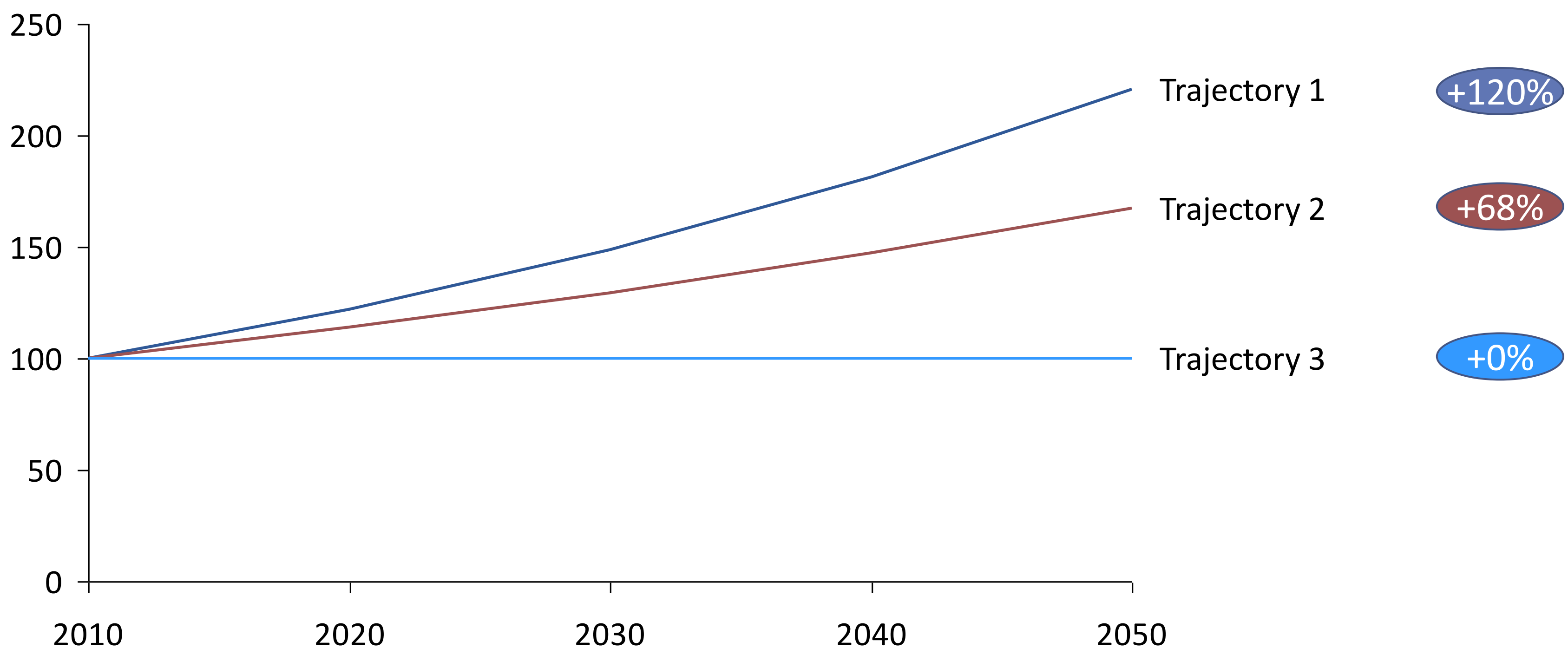
Production of food

(value added with base 100 in 2010)

Delta 10-50,%



Reduction potential

Reduction levers are additional and applied in the following order

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Methodology

Product mix
- Augmenting the proportion of product which require less CO_2 for production

[Beyond scope] Supply chain management
[Beyond scope] Sustainability of biomass
[Beyond scope] Consumer behaviour

Energy efficiency
- Reduce mechanical and thermal losses
- Recuperate thermal energy (CHP)

Energy efficiency
CHP
BAT application

Process improvements
- Modification of processes (not modelled)

Modification of cooling processes (less CFCs)

Fuel switching
- Towards fuels which emit less CO_2

Fuel vs. gas
Fossil fuels vs. biogas

End of pipe
- Carbon capture and storage

CCS

Energy efficiency (1/3)

Reduce mechanical and thermal losses

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Actions

- Potential of cross-cutting measures in existing installations (efficient motors, steam systems, CHP) [1]:
  - 10% in electricity use
  - 6.5% in fuel use
- Replacement of production stock by BAT technology is possible in 2050 (2 investment cycles on average) [2]

Assumptions

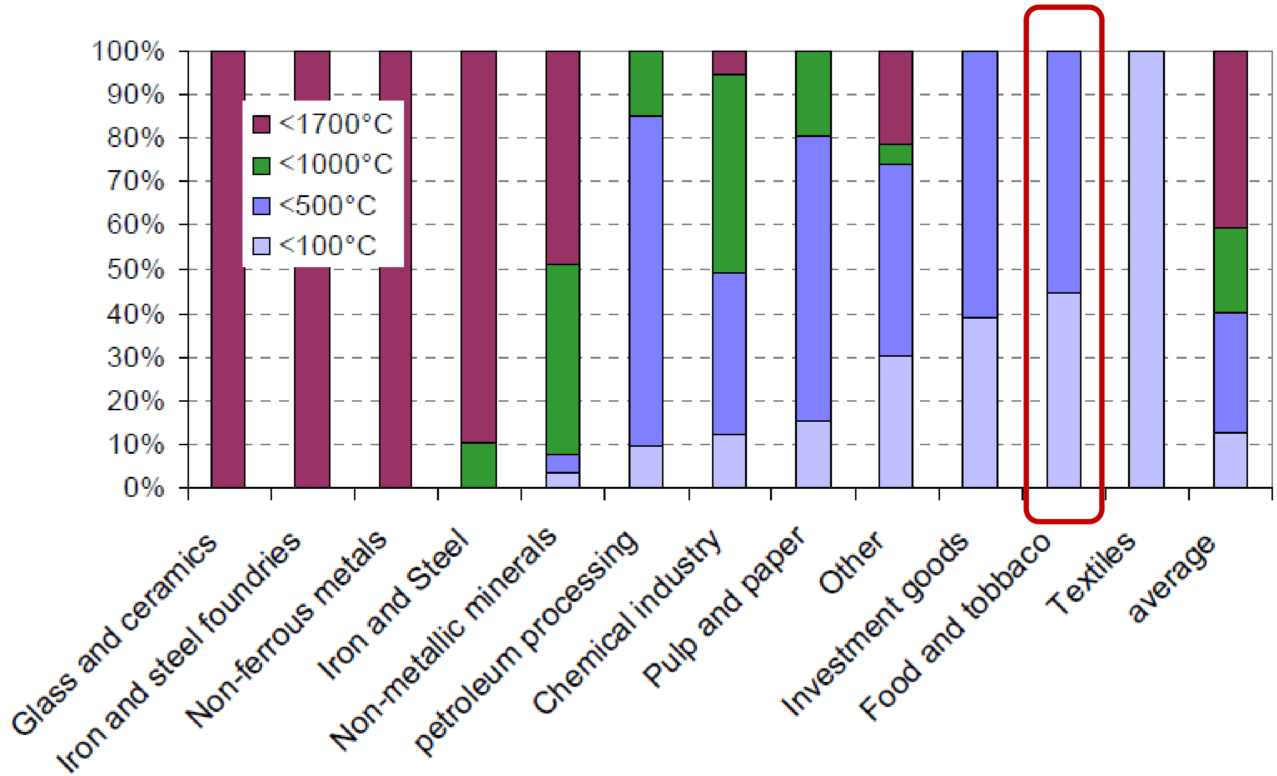
- average lifetime production stock:25 years [1]
- annual replacement rate: 4% [1]
- BAT is 30% more efficient [1]
- all production stock replaced by 2030 [1]

SOURCE: (1) SERPEC study, (2) BREF document

Energy efficiency (2/3)

CHP potential

Share of total heat demand in different temperature ranges (%)



- Technical CHP potential is large because of heat demand between 100°C-500°C (application of gas turbines and motors)
- Implementation in Belgium so far limited
- Included in 'cross-cutting measures' (SERPEC study)

SOURCE: SERPEC study

Energy efficiency (3/3)

Reduce mechanical and thermal losses (including CHP)

Level 1	Level 2	Level 3	Level 4
• **Minimum effort** (following current regulation)	• **Moderate effort** easily reached according to most experts	• **Significant effort** requiring cultural change and/or important financial investments	• **Maximum effort** to reach results close to technical and physical constraints
• **10% efficiency improvement overall**	• **20% efficiency improvement overall**	• **30% efficiency improvement overall**	• **40% efficiency improvement overall**

SOURCE: SERPECCC study, consultation FEVIA

Fuel switching (1/2)

100% switch to gas is realistic (already implemented for about 90%)

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Level 1	Level 2	Level 3	Level 4
• **Minimum effort** (following current regulation)	• **Moderate effort** easily reached according to most experts	• **Significant effort** requiring cultural change and/or important financial investments	• **Maximum effort** to reach results close to technical and physical constraints
• **No additional switch to gas**	• **100% switch from solid and liquid fuels to gas by 2025**	• **100% switch from solid and liquid fuels to gas by 2025**	• **100% switch from solid and liquid fuels to gas by 2025**

SOURCE: consultation FEVIA

Fuel switching (2/2)

No technical constraint on switch to biogas

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Level 1	Level 2	Level 3	Level 4
• **Minimum effort** (following current regulation)	• **Moderate effort** easily reached according to most experts	• **Significant effort** requiring cultural change and/or important financial investments	• **Maximum effort** to reach results close to technical and physical constraints
• **No switch to biogas**	• **No switch to biogas**	• **50% switch to biogas**	• **100% switch to biogas**

SOURCE: consultation FEVIA; 100% switch to biogas in line with assumption used in the study "Towards a 100% RES for Belgium in 2050"

Reduction potential: CCS (3/3)

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Level 1	Level 2	Level 3	Level 4
• **Minimum effort** (following current regulation)	• **Moderate effort** easily reached according to most experts	• **Significant effort** requiring cultural change and/or important financial investments	• **Maximum effort** to reach results close to technical and physical constraints
• **No CCS**	• **No CCS**	• **No CCS**	• **85% of CO_2 captured and stored**

SOURCE: VITO & Climact analysis

Reduction potential:

Maximum reduction potential for different levers, horizon 2050

Levers in the Food sector

Type of lever	Improvement	Reduction potential (2050) in %				Cost	Description
		1	2	3	4		
Energy efficiency	Energy efficiency measures (audits, environmental management systems, drying innovations)	-10% overall	-20% overall	-30% overall	-40% overall	0 (capex paid back by reduced energy expenditures)	Replacement of all production technology by BAT in 2030 (level 4) (1)
Alternative combustibles	Switch fuel towards gas	0%	100% in 2025	100% in 2025	100% in 2025	Cost of combustibles	Assumption of continuing shift towards gas
	Switch fossil fuels towards biomass	0%	0%	50%	90%	Cost of combustibles	Switch to biomass is technically possible; biomass use for energy should be considered only as last option.
End of pipe	CCS	0%	0%	0%	85%	€100/tCO_2e	Many relatively small sources Application later than in other industries

NOTE: Assuming all regions of the world perform a similar effort

SOURCE (1) SERPEC study, (2) VITO study "Energetisch potentieel WKK"

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Reduction potential

Emissions according to different trajectories

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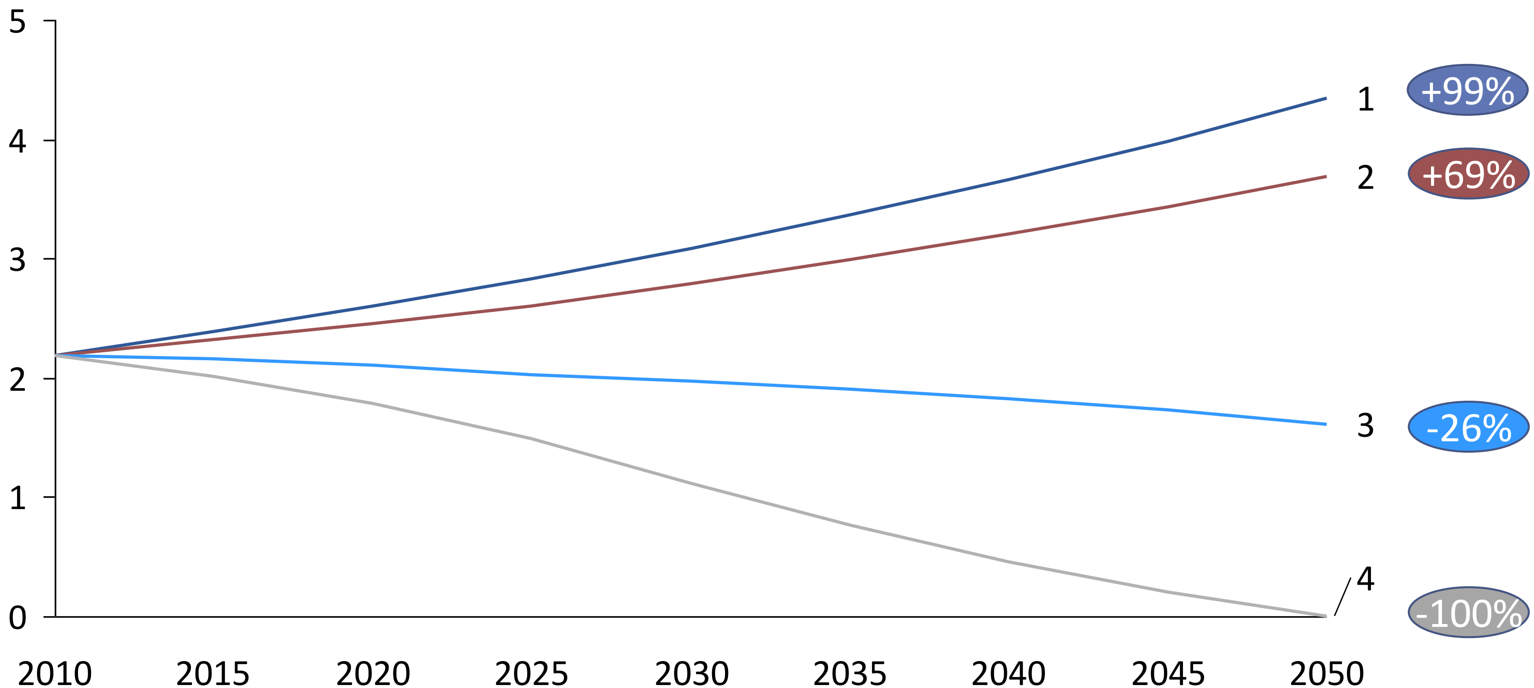
Trajectory 1 (high growth) GHG emissions for different ambition levels
(MtonCO_2e)

Delta 10-50,%



SOURCE: OPE²RA model

Reduction potential

Emissions according to different trajectories

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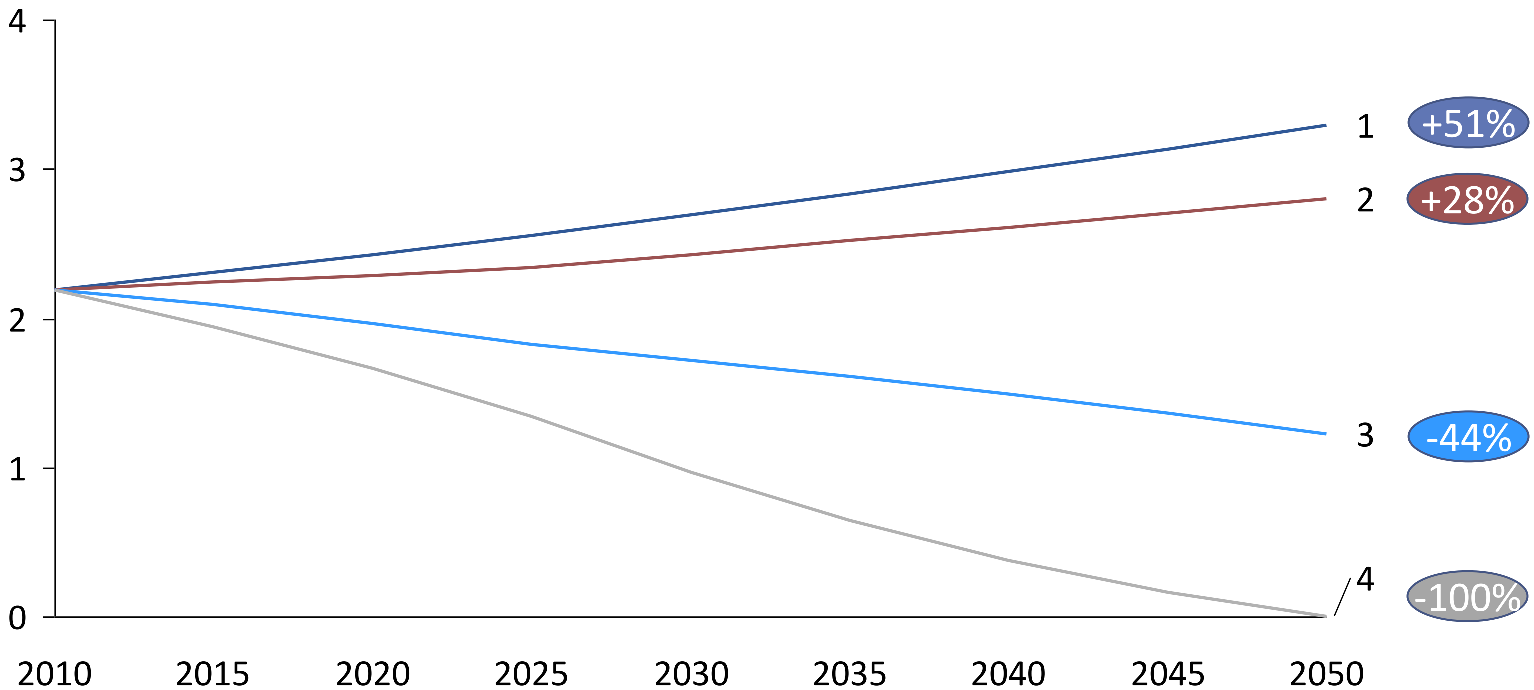
Trajectory 2 (medium growth) GHG emissions for different ambition levels
($MtonCO_2e$)

Delta 10-50,%



SOURCE: OPE²RA model

Reduction potential

Emissions according to different trajectories

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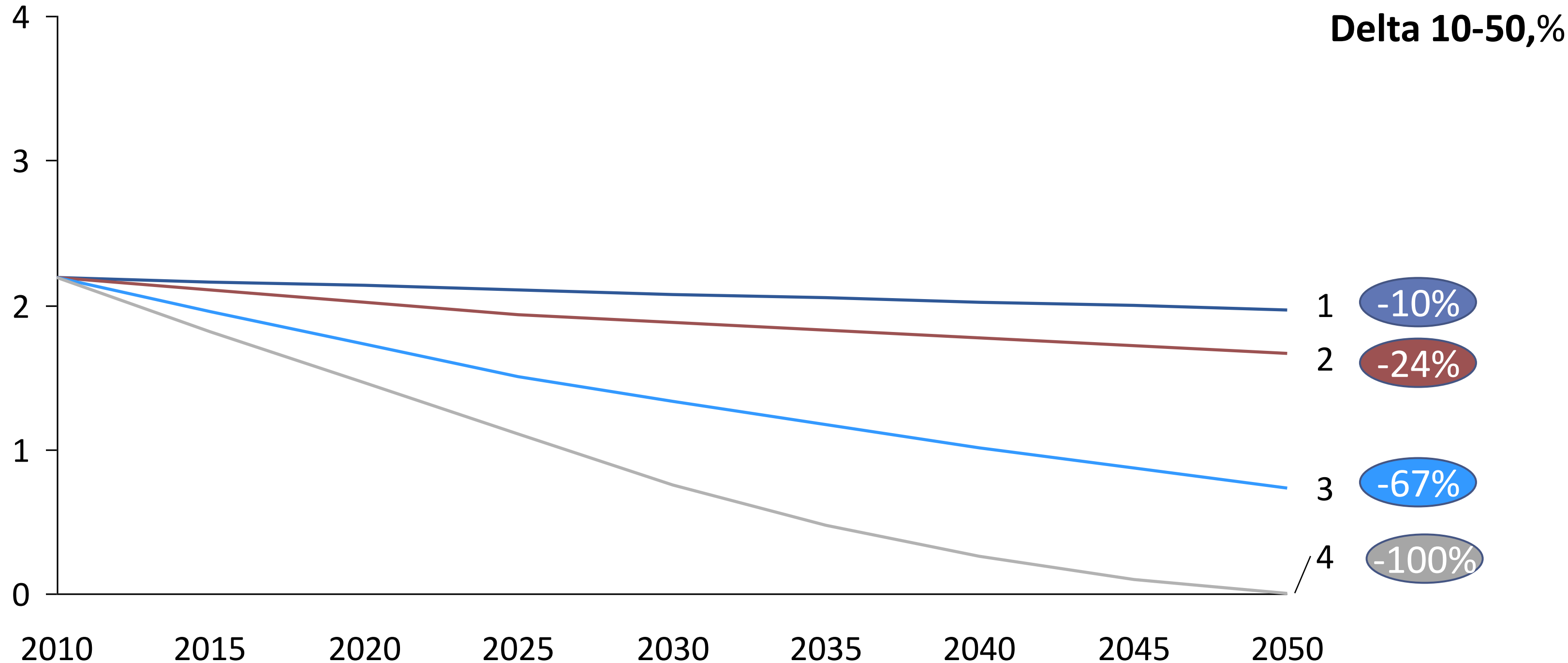
Trajectory 3 (low growth), GHG emissions for different ambition levels
(MtonCO_2e)

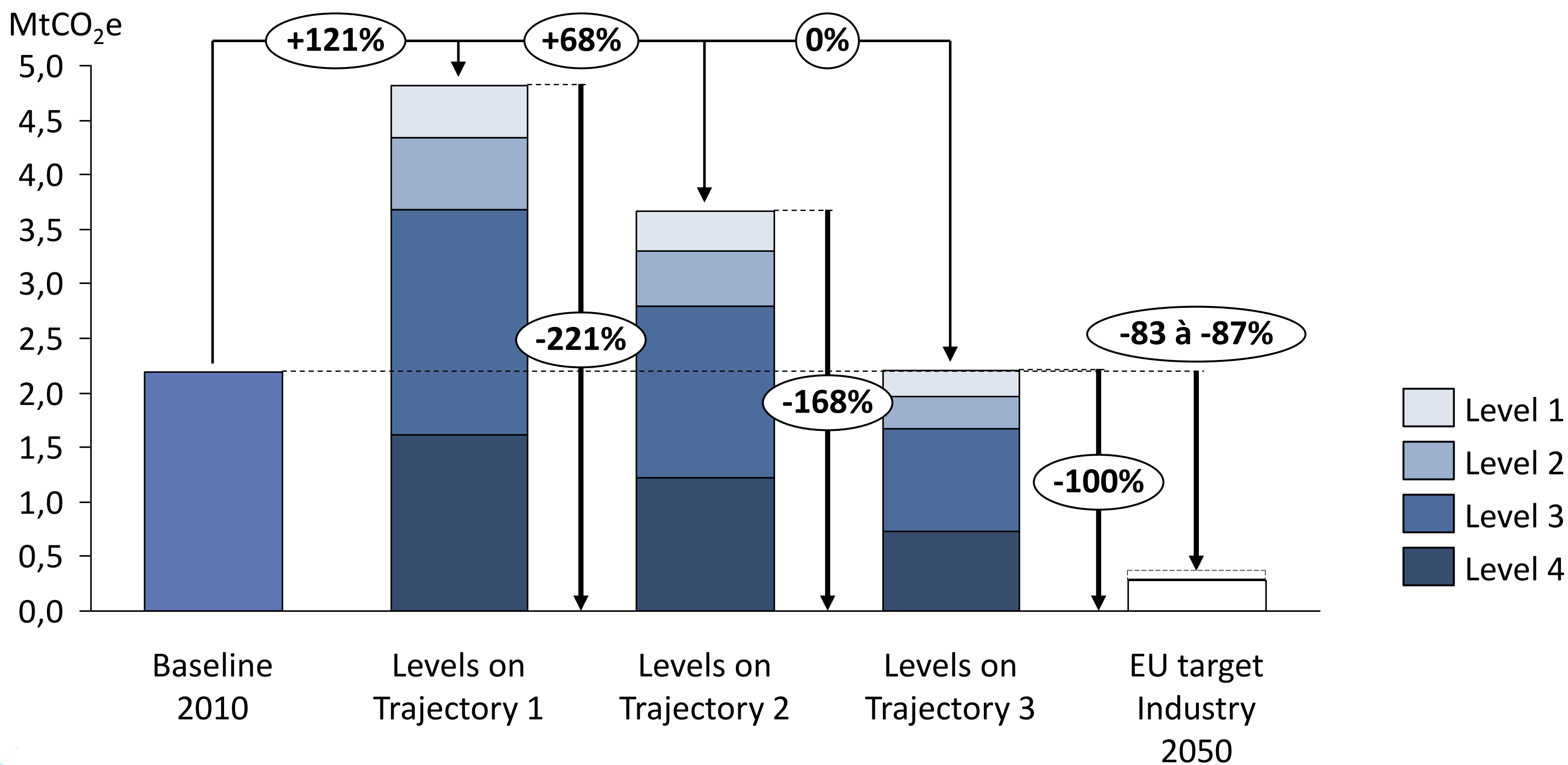


SOURCE: OPE²RA model

Reduction potential

Switch to biomass is needed to reach European targets

GHG emissions for different trajectories and ambition levels
(MtonCO_2e and % change (% of 2010 level))



SOURCE: OPE²RA model

Reduction potential

Details for trajectory 2 with ambition level 2

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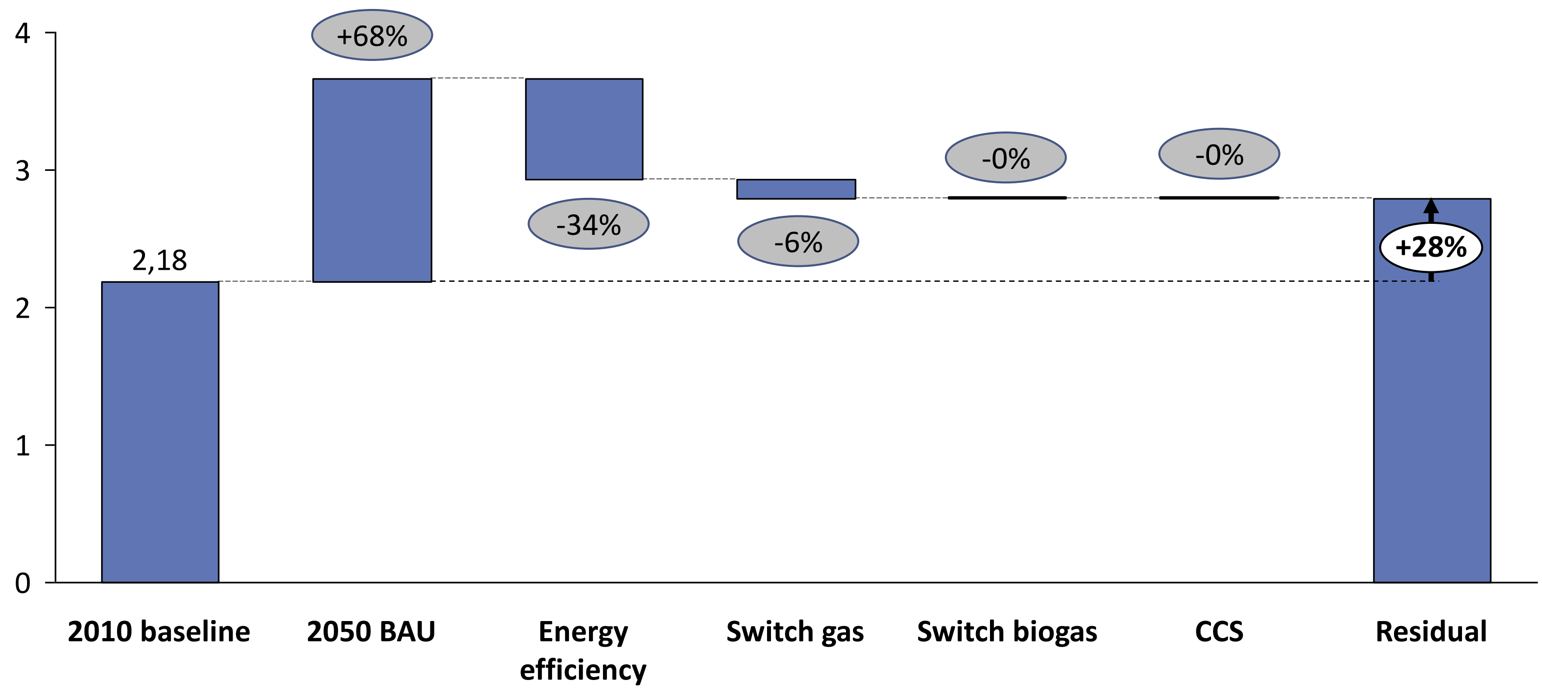
GHG emissions in 2050 using different levers
(% of 2010)



NOTE: Percentage reductions are calculated vs the 2010 baseline
SOURCE: OPE²RA model

Reduction potential

Details for trajectory 2 with ambition level 4

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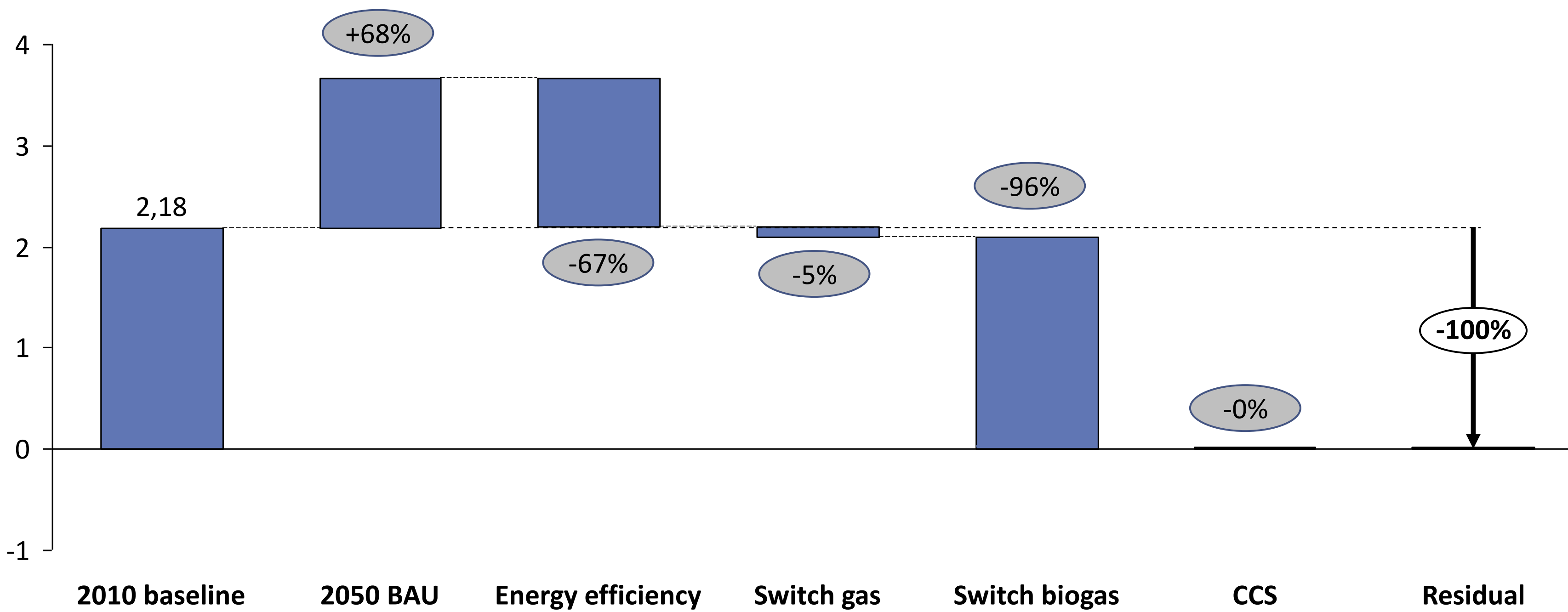
GHG emissions in 2050 using different levers
(% of 2010)



NOTE: Percentage reductions are calculated vs the 2010 baseline
SOURCE: OPE²RA model

Cost

Marginal cost and abatement potential for different levers under trajectory 2 with ambition level 4

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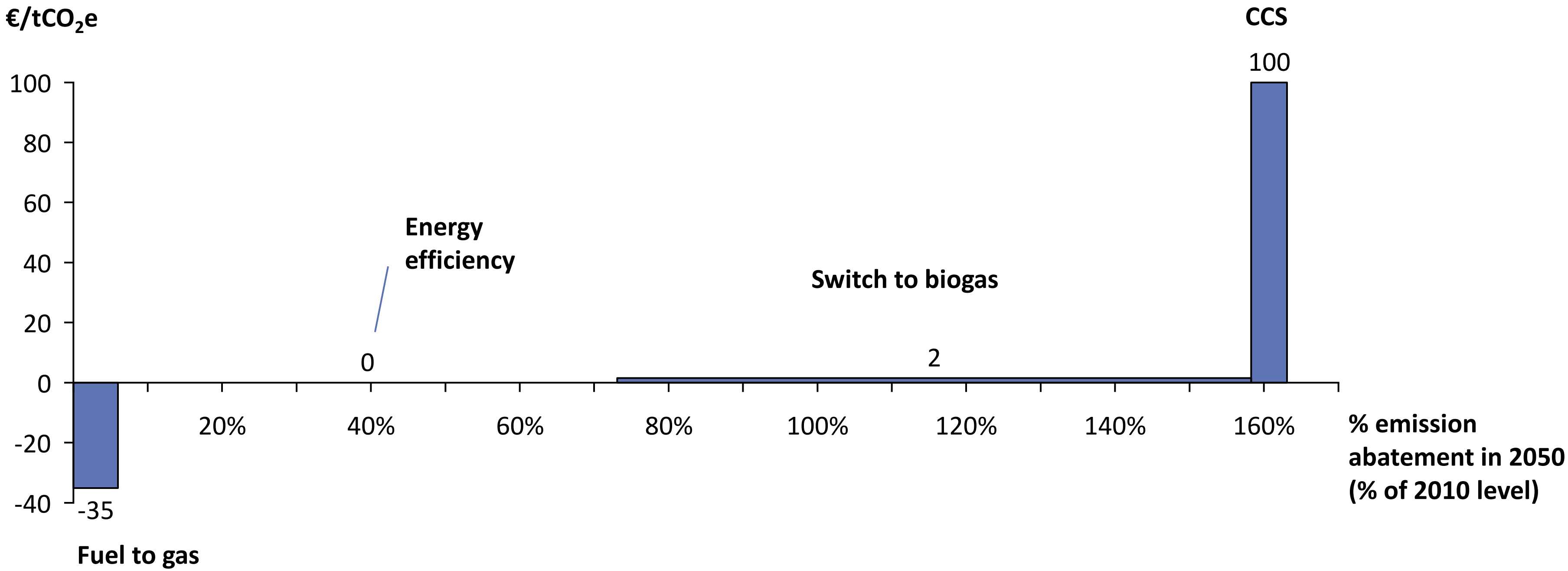
GHG abatement curve for the year 2050 (trajectory 2, ambition 4)

€/tCO_2e, % emission abatement in 2050 (% of 2010 level)



NOTE: Hypothesis of cost neutral energy efficiency measures

SOURCE: OPE²RA model

Content – Industry sector - food

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CO_2 emissions along food industry life cycle

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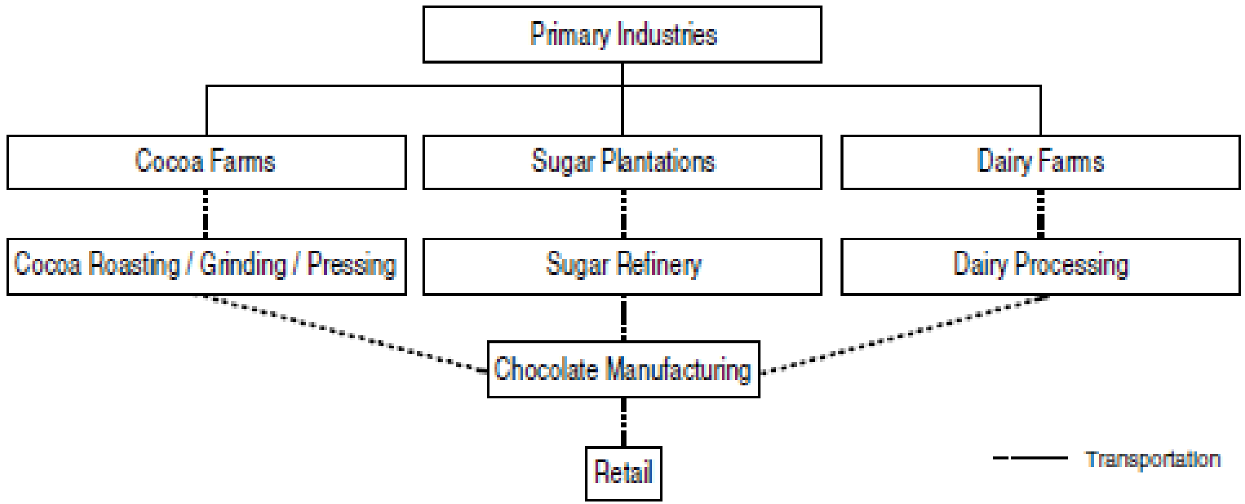
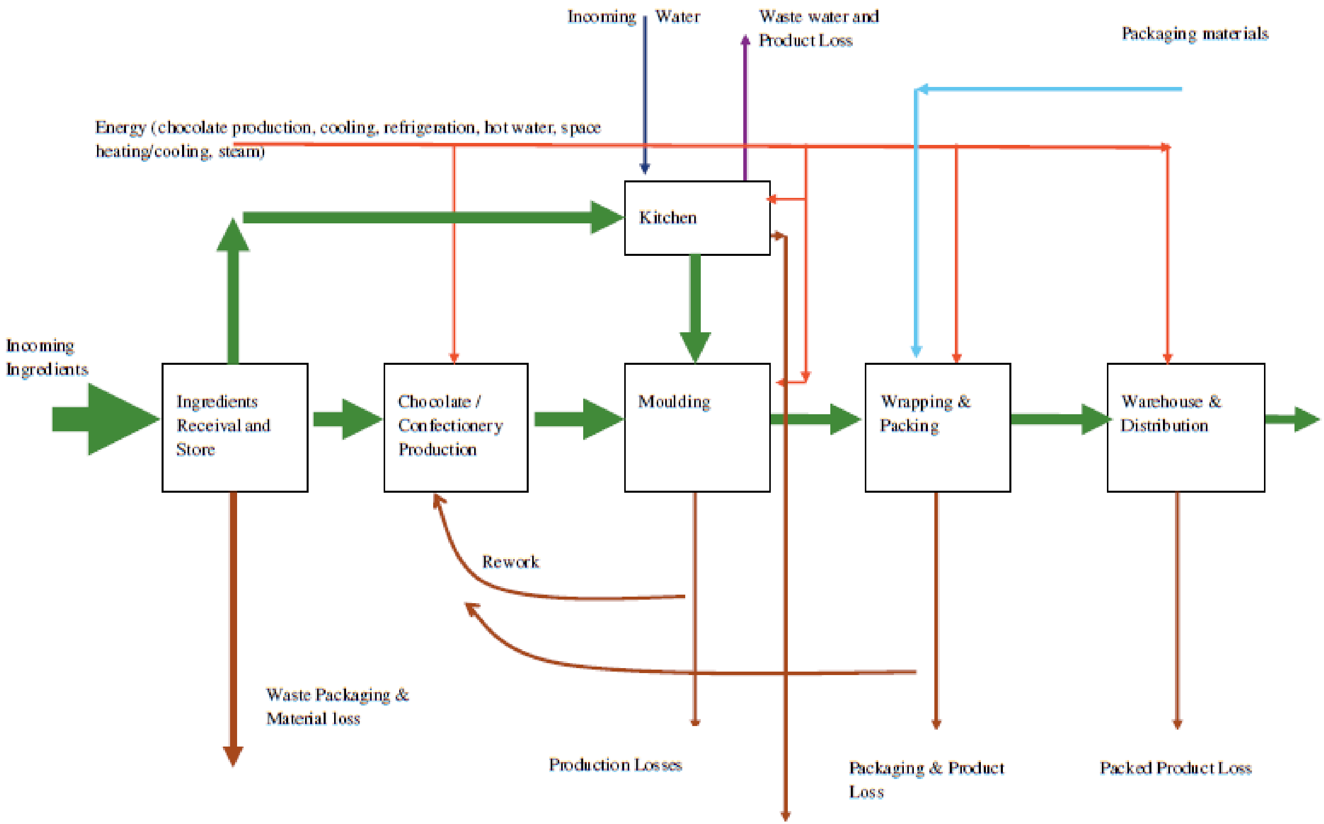
Example of chocolate industry (simplified)



Food processing flow

Example of chocolate industry



Variety of electricity demand in food sector

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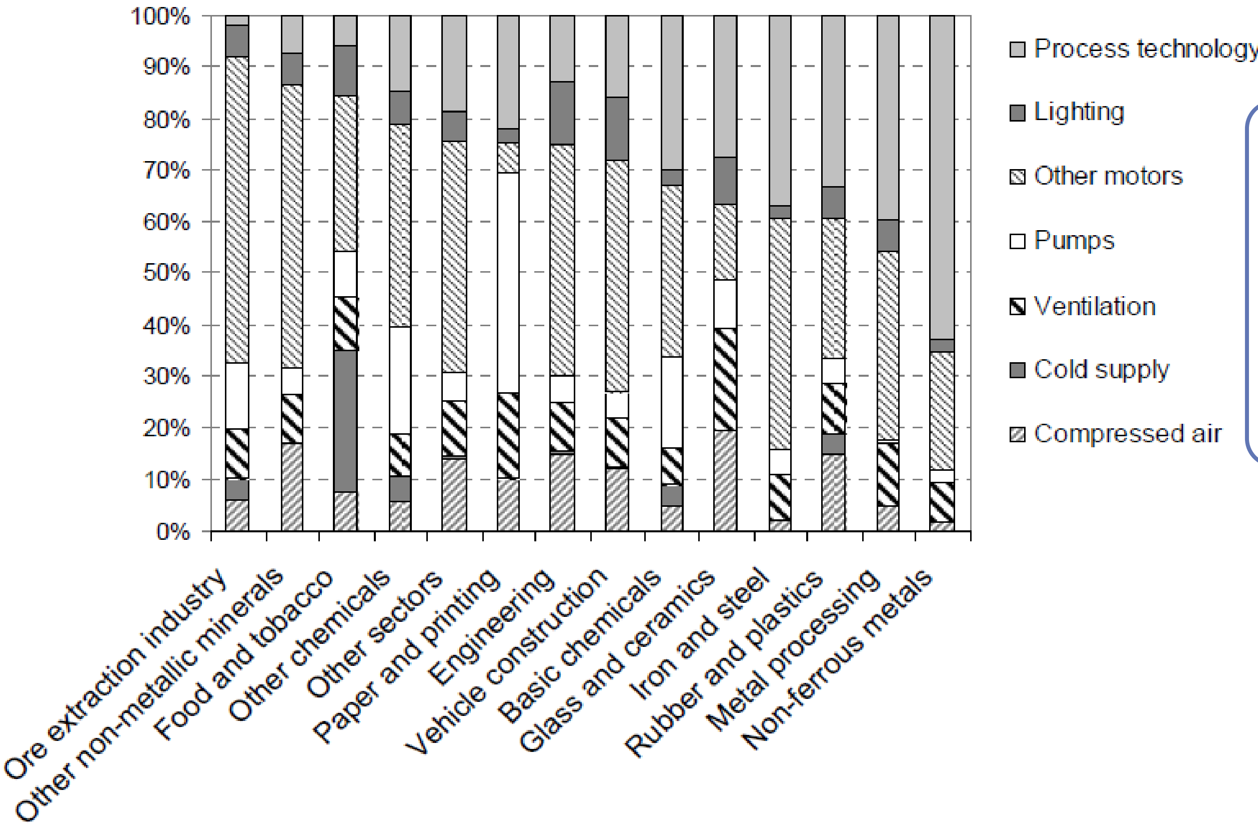
Electricity demand mainly for cold supply and pumps & other motors
(%)



Share of cold supply is expected to be higher than European average in Belgium because of specialisation in frozen foods

SOURCE: Fraunhofer Institute et al., study on energy savings potentials in EU member states

Thank you.

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