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A Low-carbon roadmap for Belgium

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

Industry sector - ceramic manufacturing document

This document is based on content development by the consultant team as well as an expert workshop that was held on the 30-08-2012

vito
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Executive summary

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

- Since bricks constitute the major part of the output of the Belgian ceramics sector, 3 trajectories for bricks production in Belgium have been defined, which include a range between **~+70% to ~+20% of 2010 production levels in 2050**
  - The high growth trajectory assumes the construction of 56.000 new buildings per year, in line with the roadmap for the residential and commercial buildings sector.
  - The low growth trajectory assumes a recovery to pre-crisis level of 40.000 new buildings per year.
  - Brick production is correlated to building activity in Belgium, with imports assuming a minor role because of high transportation costs. Carbon leakage becomes a risk only in scenarios assuming a high carbon price is imposed in Europe vs. the rest of the world.

Estimation of GHG reduction potential

- **GHG reduction potential (assuming constant production) ranges between 45% and 95% (level 3 & 4 ambition).**
  - **Energy efficiency** can be improved and reduce emissions by **15% to 23%** (CHP potential is very limited)
  - **A fuel switch from liquid and solid fuels to gas** can be expected to be completed by 2020, leading to **1%** 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 **30% to 42%** of emission reductions.
  - Because of the many relatively small production sites, **CCS** is applied starting from ambition level 4. The application of CCS is needed to reduce emissions by a further **30%**. Without CCS, process emissions cannot be reduced.

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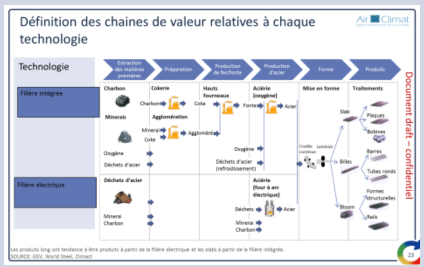
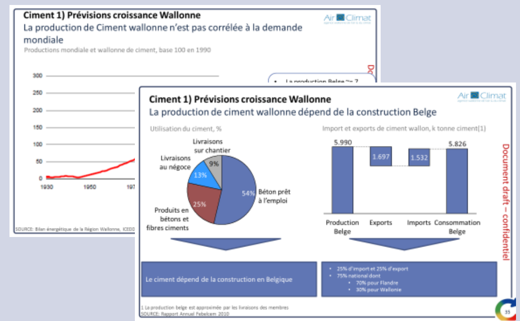
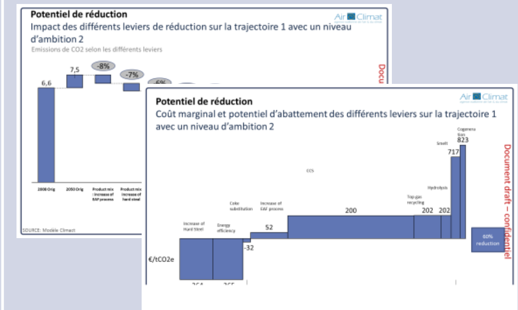
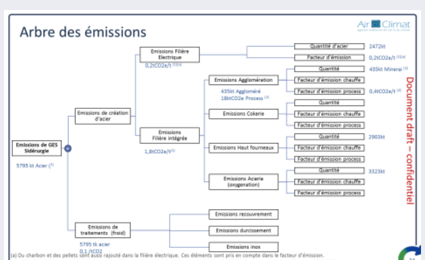
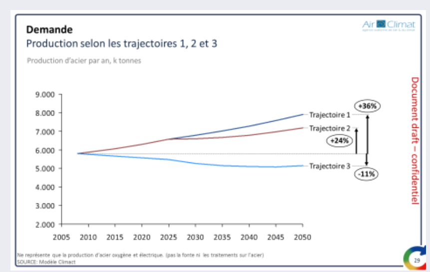
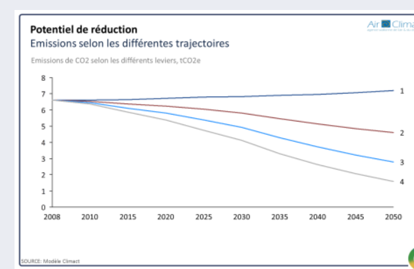
	Understanding the industry	Modelling demand trajectories	Modelling trajectories with intensity levels + CCS
Analyses	Definition of the value chain 	Analyses of growth and competitivity 	Potential of CO_2 reduction incl. costs 
Results	Modelling the emissions tree 	Demand trajectories 	Trajectories with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

SOURCE: Climact

Ceramics represents 1% of emissions for 2% of the energy consumption

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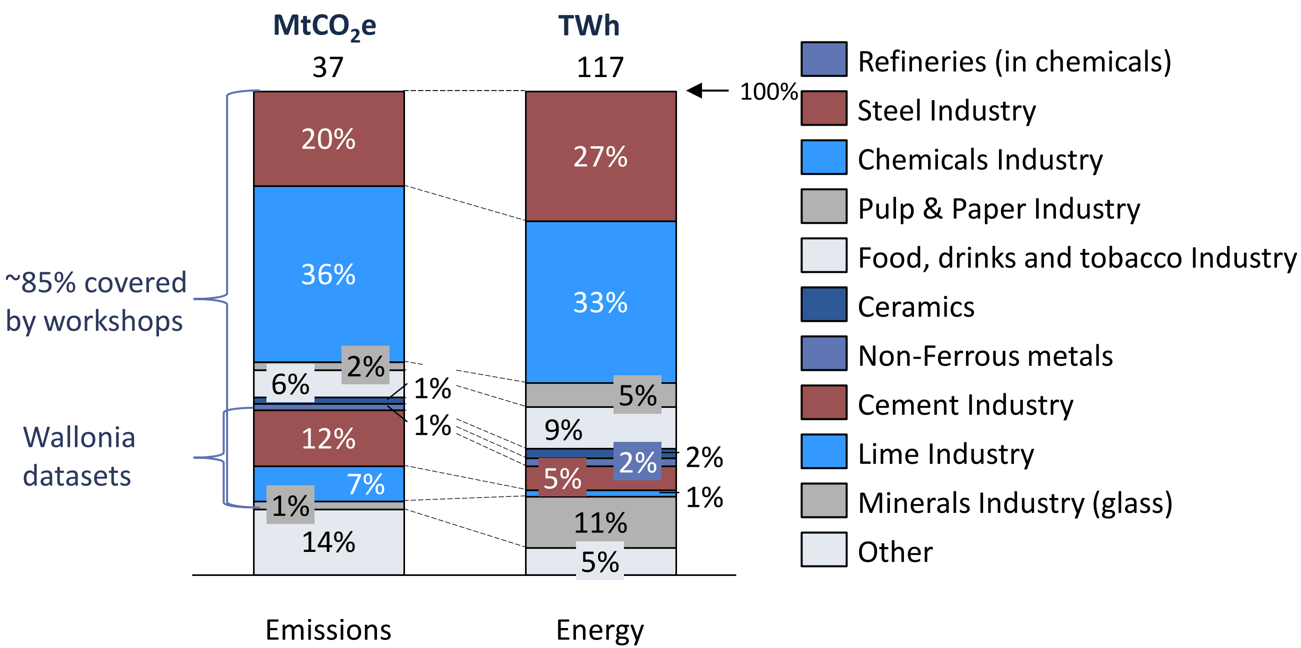
GHG emissions and energy consumption in Belgium 2010
($MtCO_2e$, TWh, %)



- Ceramics represents 1% of emissions for 2% of the energy
- 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

Ceramics industry produces a variety of products

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Ceramic products in Europe

1. bricks and roof tiles
2. wall and floor tiles
3. refractory products
4. expanded clay aggregates
5. vitrified clay pipes
6. table- and ornamental ware
7. sanitary ware
8. technical ceramics
9. inorganic bonded adhesive

Belgian ETS companies

1. bricks and roof tiles
2. clay aggregates
3. vitrified clay pipes
4. refractory products

- **Bricks and roof tile** companies are **majority** in benchmarking covenant and ETS registry
- **Brick production** will be used as **proxy** for ceramics sector activity

SOURCE: BREF document ceramics industry

Brick production in Belgium reveals a decline accompanied by a slow recovery after economic crisis

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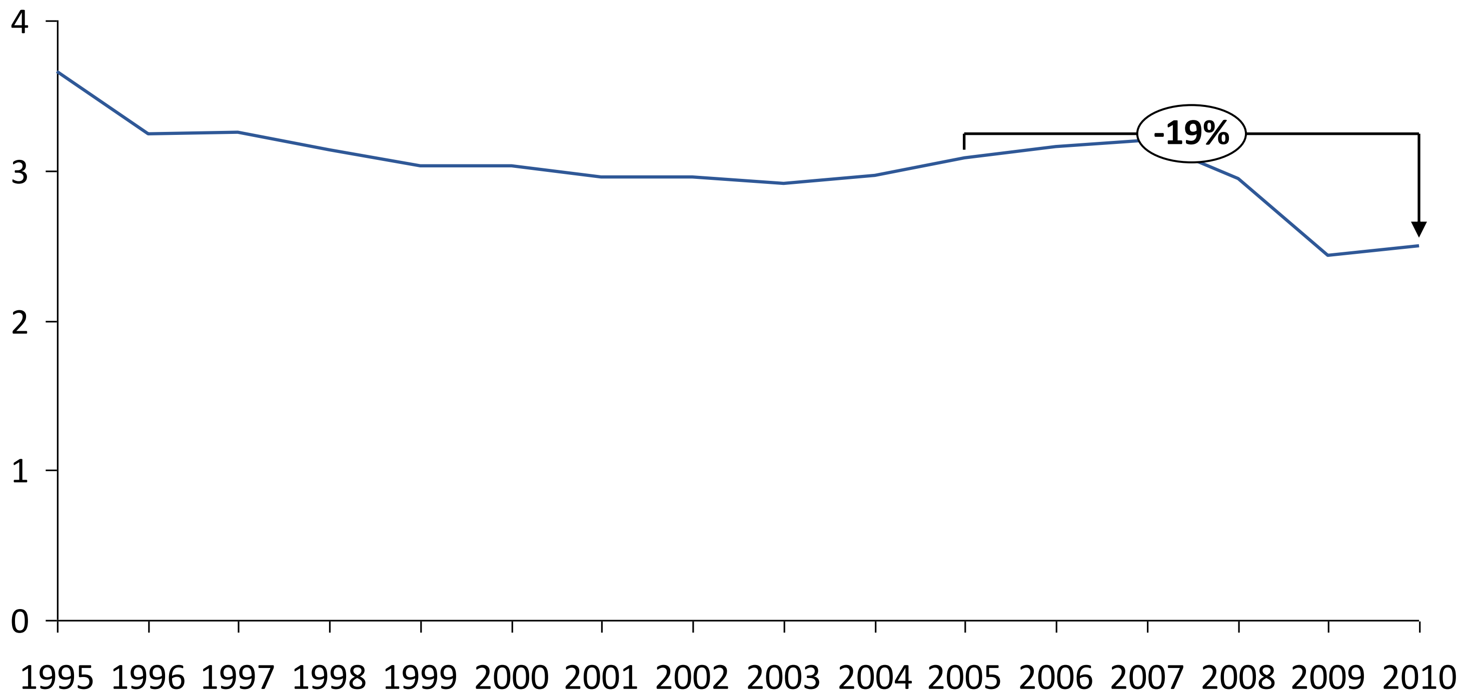
Brick production (1995-2010)
(Mton)



SOURCE: data Baksteenfederatie

Energy demand in ceramics is correlated to brick production

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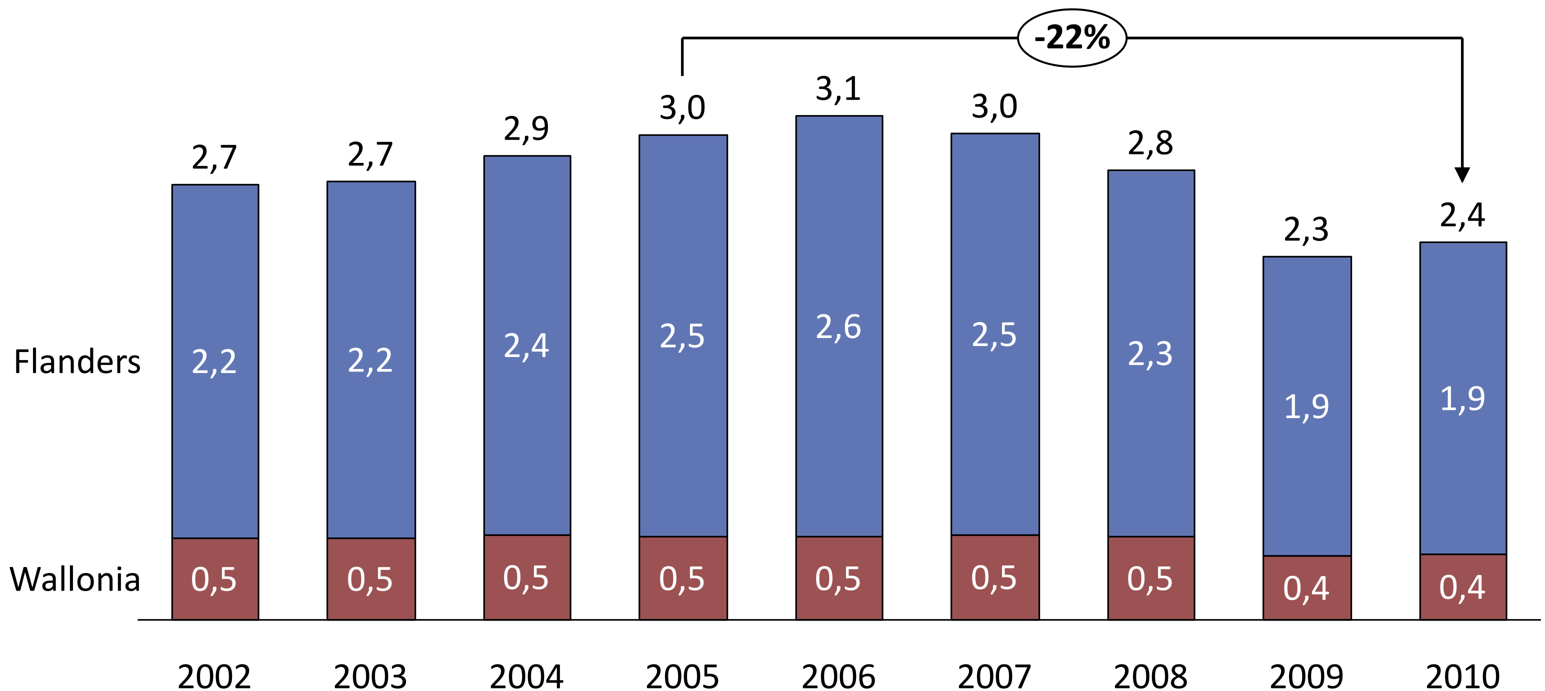
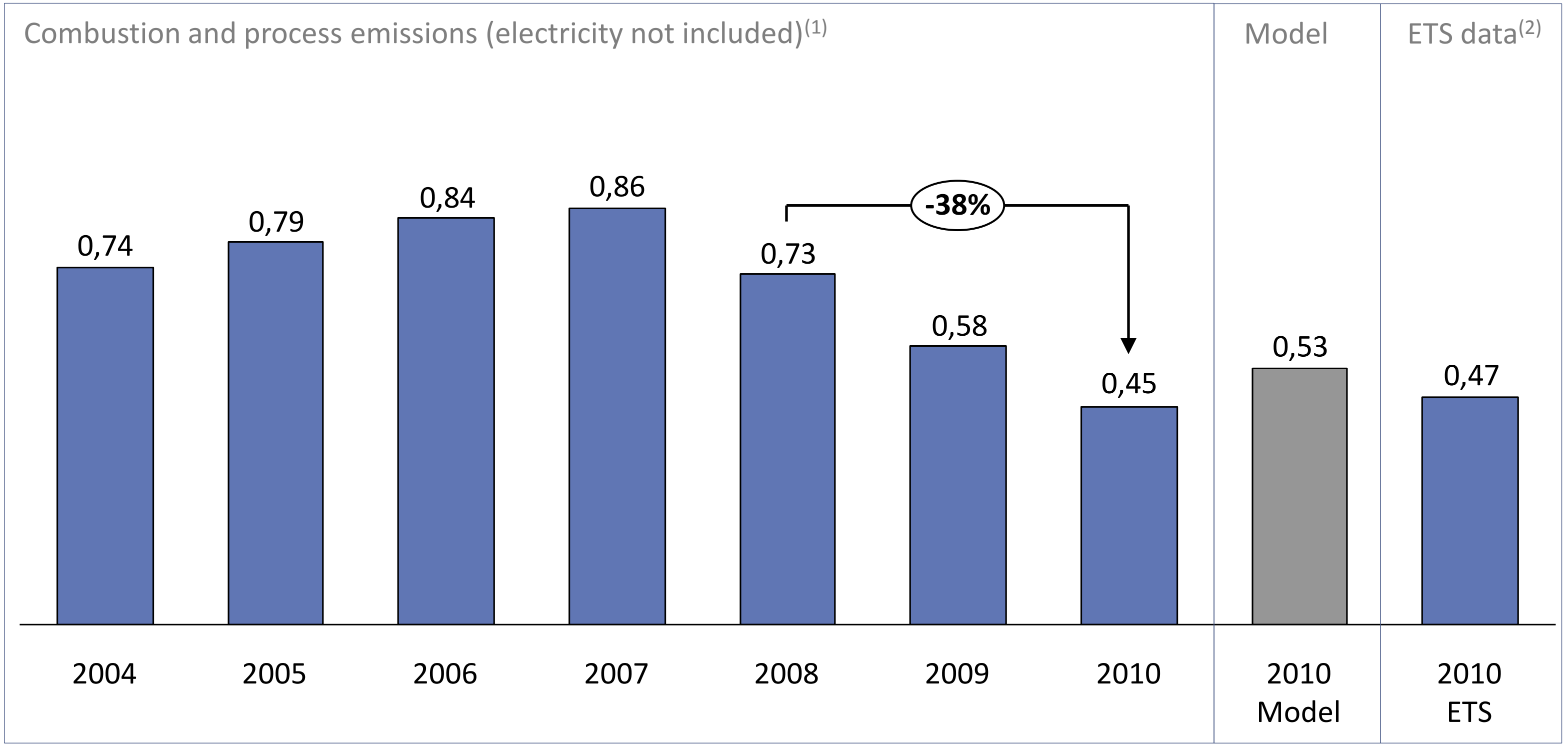
Energy demand in ceramics manufacturing (including electricity)
(primary TWh/yr)



NOTE: Energy demand reported as primary energy demand (primary demand electricity = final demand electricity * 2,5)
SOURCE: Benchmarking covenant (Vl.), Accord de branche (Wal.)

Emissions have remained rather stable (2004-2008) but drop following crisis

Emissions in the ceramics sector
($MtCO_2e$)



NOTE: 'Primary inputs' fuel modelled as gaseous fuel to match 2010 emissions as closely as possible
SOURCE: (1) Extrapolation of benchmarking data for Flemish industry to Belgium; (2) ETS registry

Energy consumption in Belgian bricks & ceramics industry

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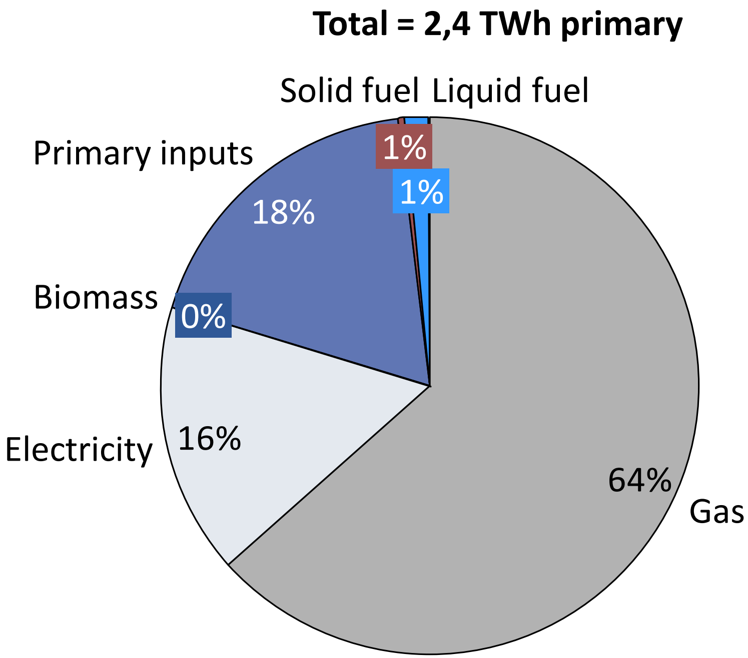
Distribution of energy sources in 2010
(%)



- Gas and electricity are dominant energy sources
- Use of heavy fuel oil, coke and coal is limited to brickworks

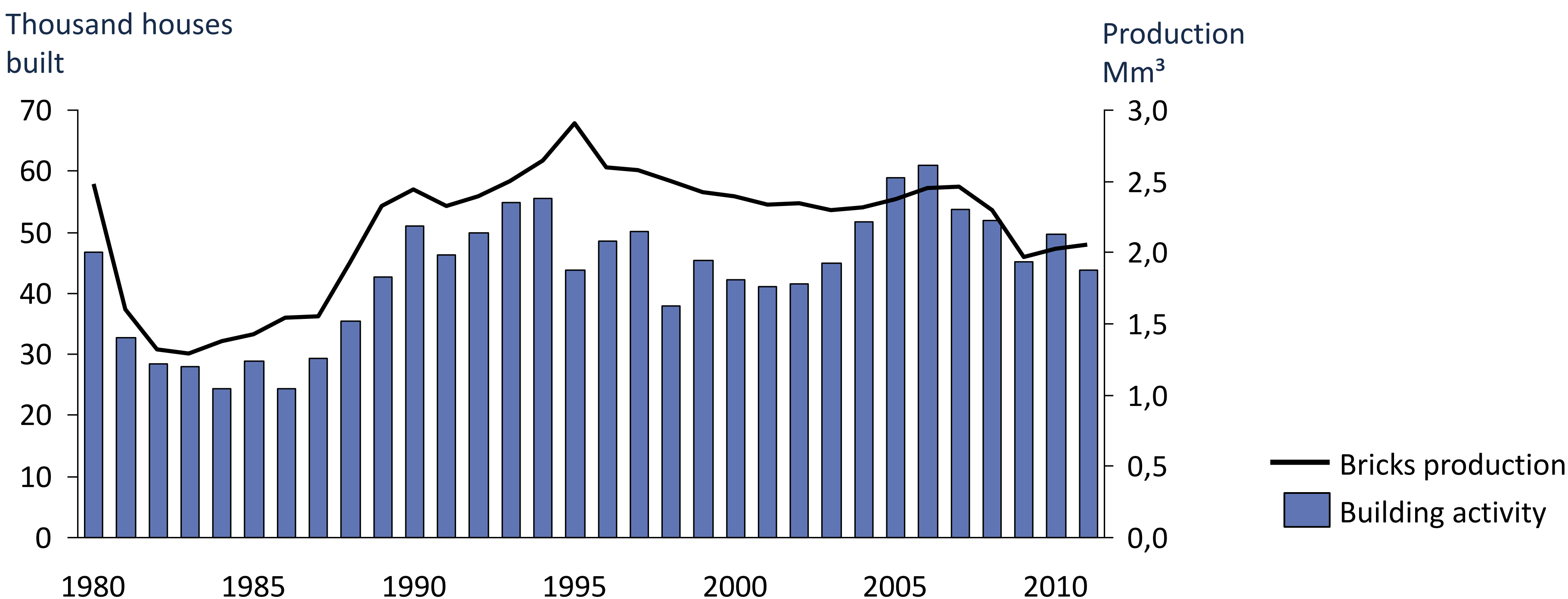
SOURCE: Energiebalans Vlaanderen, extrapolation to Belgium

Growth prospects Belgium

Brick production coupled to building activity

Brick production and building activity

(Mm³, thousand houses built)



SOURCE: Baksteenfederatie

Growth prospects
Trends apparent at world, EU and Belgian level

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World

- Not relevant because of high transport costs for export
- However, this could change in the future if production costs in Europe are significantly higher than in the rest of the world (e.g. carbon leakage)

Neighbouring countries

- Export limited to neighbouring countries: the Netherlands, Germany, France and the UK
- Repartition of export products:
  - 40% blocs
  - 55% facing bricks
- Sharp competition because of low product differentiation in bricks, hence lower export
- More differentiation possible in facing bricks and roof tiles

Belgium

- Number of small companies expected to decrease further
- Production of bricks strongly correlated to building activity in Belgium
- Export to neighbouring countries is rising but subject to fluctuations (1)

NOTE: (1)Therefore export not taken into account as driving factor for production projections
SOURCE: BBT voor de kleiverwerkende nijverheid (VITO)

Parameters influencing demand up to 2050

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Parameter	Bricks & ceramics
• Growth prospects	• CAGR European population towards 2050: 1% • CAGR GNP: 1,6% (1) • CERAMICS industry (2010-2050) : 1,1%(2)
	• Correlation to Belgian construction activity
• Infrastructure needs	• Proximity of markets (primary materials, Belgian construction, export to neighbours) • Export market dependent on economic conjuncture • Productivity is important (low product differentiation possible)
• Correlation to Belgian production	• Slow recovery after economic crisis
• Modification expected in mix of products	• None

SOURCE: (1) Federal Planning bureau, (2) GEM-E3 projections, (3) BBT studie kleiverwerkende nijverheid (VITO)

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Growth prospects Belgium

3 trajectories influencing energy demand will be modelled

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Possible growth scenarios

European population: 1%

GNP: 1,6% [1]

Federal Planning Bureau (2010-2050)

- 1,1% [2]

Correlation with construction activity:

- 56 000 new houses/year needed in scenarios for building sector [3]

	Bricks output (ton)
Trajectory 1	• Increase to production level of 4,2 Mton by 2025; CAGR = 0% afterwards (+68% in 2050) • Corresponds to 56 000 houses/yr
Trajectory 2	• Increase to production level of 3,6 Mton by 2025; CAGR = 0% afterwards (+44% in 2050) • Corresponds to 48 000 houses/yr
Trajectory 3	• Recovery to 2005 level by 2015 (~ 3Mton); CAGR = 0% afterwards (+20% in 2050) • Corresponds to 40 000 houses/yr

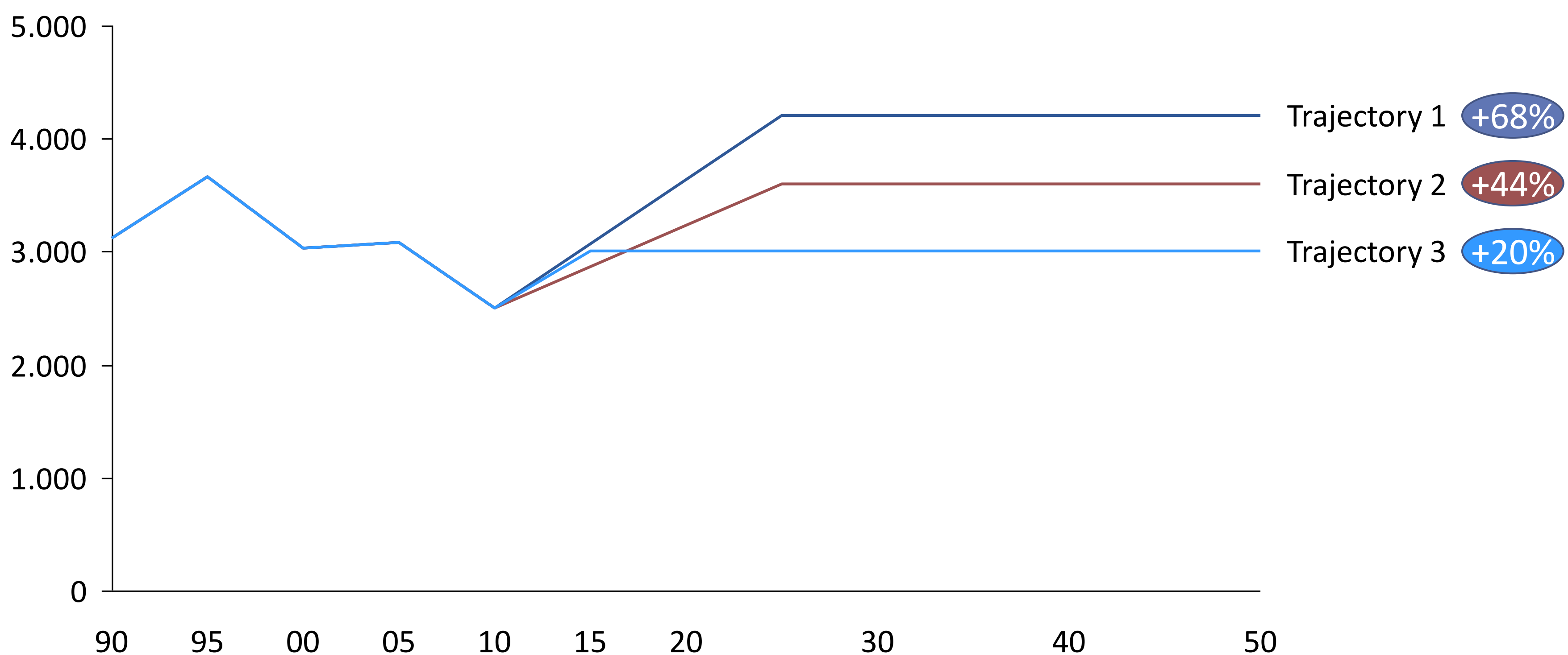
SOURCE: (1) Federal Planning bureau, (2) GEM-E3 projections, (3) Roadmap consultation households & services sector

Growth prospects Belgium

Production according to trajectories 1, 2 et 3

Production of ceramics
(ktons)

Delta 10-50,%



Reduction potential

Reduction levers are additional and applied in the following order

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Methodology

Product mix	Energy efficiency	Process improvements	Fuel switching	End of pipe
• Augmenting the proportion of product which require less CO_2 for production	• Reduce mechanical and thermal losses • Recuperate thermal energy (CHP)		• Towards fuels which emit less CO_2	• Carbon capture and storage
Biomass can reduce energy intensity of blocks by 10-15%. Limited additional potential (1)	Energy efficiency (better kilns)		Fuel vs. gas	CCS
[Beyond scope] Switch to other building materials	CHP		Fossil fuels vs. biomass	

SOURCE: (1) Sector consultation (block represent some 40% of the production)

Energy efficiency (1/3)
Reduce mechanical and thermal losses

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Key data for kiln improvements in ceramics sector

	Reference energy use kilns (Gj/tproduct)	**Best practice kilns** (Gj/t product, % improvement)	**Portion of EU ceramic market** (%)	**Additional investment cost** (€/t product)
Bricks and roof tiles	2,31 in EU 2,07 in BE	1,7 (-18% forBE)	60%	30
Wall and floor tiles	5,6	4,0	30%	
Refractory products	5,6	4,7	5%	

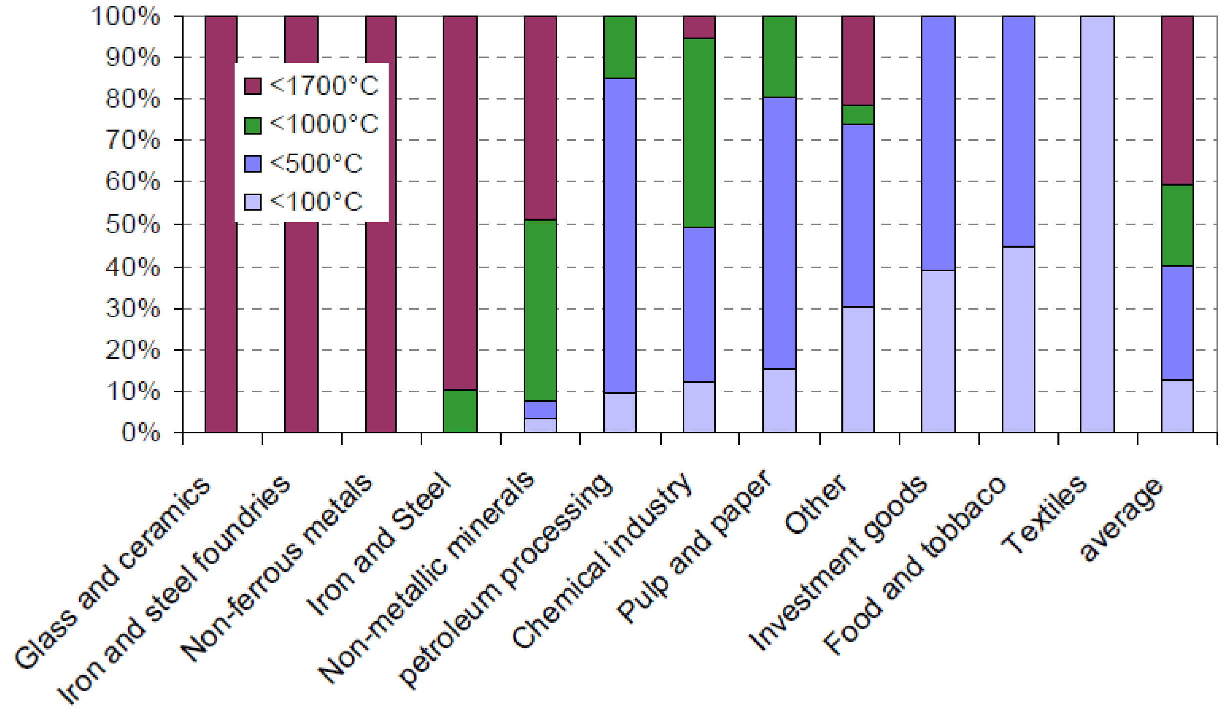
- Specific energy use for Belgian bricks and roof tiles: 2,07 GJ/ton
- Depends on product mix:
  - blocks can be <1,7 GJ/t
  - roof tiles are higher

SOURCE: SERPEC study, communication Belgische baksteenfederatie

Energy efficiency (2/3)

CHP potential

Share of total heat demand



- CHP potential limited because of demand for high-temperature heat (on average between 950°C and 1200°C)
- CHP can be used in drying section (but with limited potential)

SOURCE: SERPEC study

Energy efficiency (3/3)

Reduce mechanical and thermal losses

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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
• **5% efficiency improvement**	• **10% efficiency improvement**	• **20% efficiency improvement**	• **30% efficiency improvement**

NOTE: Assumption: Capex + Fuel savings = O Euro (capital expenditures are repaid by fuel savings over the lifetime of the energy efficiency investment)
SOURCE: SERPEC study, expert consultation ceramics kilns

Fuel switching (1/2)

Switch to gas is feasible provided a connection to gas grid is made

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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 to gas starting from 2020**	• **100% switch to gas starting from 2020**	• **100% switch to gas starting from 2020**

NOTE: The kilns are currently mainly on gas unless there is no connection available, more connections are expected in 2050. Furthermore, coal is currently used for aesthetical aspect of facing bricks

SOURCE: Sector consultation

Fuel switching (2/2)

100% switch from gas to biogas is theoretically possible, but dependent on price and availability

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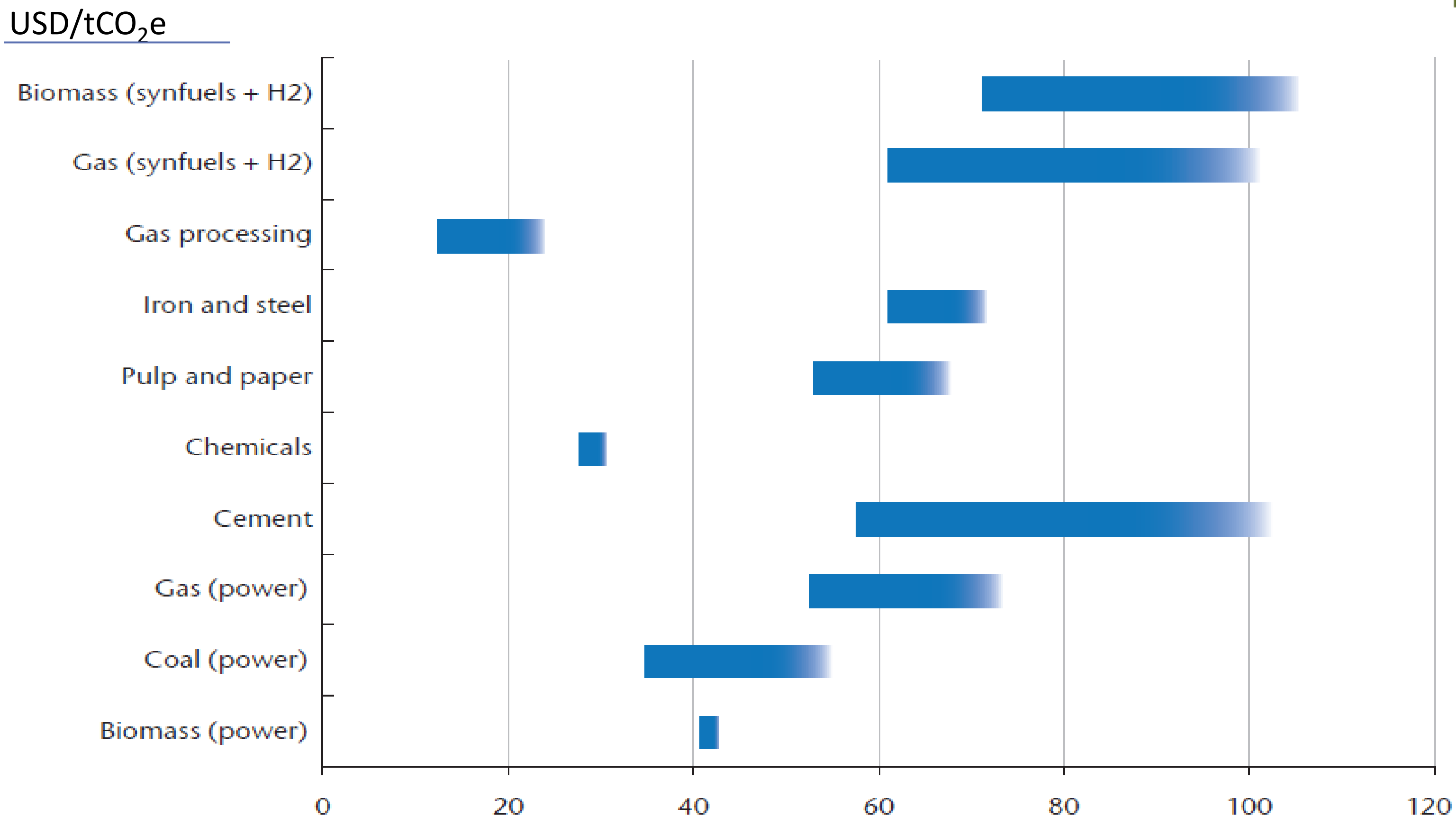
Level 1	Level 2	Level 3	Level 4
• **Minimum effort** (following current regulation)	• **Moderate effort** easily reached according to most experts	• **Significant effort** requiring cultural change and/or important financial investments	• **Maximum effort** to reach results close to technical and physical constraints
• **No biogas**	• **25% switch from gas to biogas**	• **50% switch from gas to biogas**	• **100% switch from gas to biogas**

NOTE: There is limited existing experience. There is a pilot in Italy, but it is still experiencing some issues.
SOURCE: Sector consultation

Reduction potential: CCS (1/3)

Industrial costs



SOURCE: IEA

Reduction potential: CCS (2/3)

CCS potential is based on size of installations

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Industry	ton CO2eq by production site category			Total	Level 1	Level 2	Level 3	Level 4
	<0,3 M	0,3-1 M	>1 M					
Iron & steel	1.291.469	787.034	4.386.583	6.465.086	0%	68%	80%	85%
Non ferrous metals	310.098	-	-	310.098	0%	0%	0%	85%
Chemical	1.777.925	1.185.959	3.088.691	6.052.575	0%	51%	71%	85%
Refineries	54.765	521.974	5.784.870	6.361.609	0%	85%	85%	85%
Lime	363.771	1.517.514	1.240.023	3.121.308	0%	40%	85%	85%
Glass	457.924	601.861	-	1.059.785	0%	0%	57%	85%
Cement	155.095	695.438	3.998.520	4.849.053	0%	82%	85%	85%
Food	981.850	-	-	981.850	0%	0%	0%	85%
Pulp & paper	768.785	-	-	768.785	0%	0%	0%	85%
Bricks & ceramics	**567.888**	**-**	**-**	**567.888**	**0%**	**0%**	**0%**	**85%**
Total	6.729.570	5.309.780	18.498.687	30.538.037	0%	59%	73%	85%
Coverage level 1								
Coverage level 2			■					
Coverage level 3		■	■					
Coverage level 4	■	■	■					

SOURCE: ETS registry (Belgium), analyse VITO&Climact

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: Analysis VITO & Climact

Reduction potential:

Maximum reduction potential for different levers, horizon 2050

Ceramics sector

Type of lever	Improvement	Reduction potential (2050) in %				Cost	Description
		1	2	3	4		
Energy efficiency	Energy efficiency measures (improved kilns)	5% efficiency increase	10% efficiency increase	20% efficiency increase	30% efficiency increase	0 (capex = fuel savings)	Replacement of all production technology by BAT in 2030 (level 4) (1)
	CHP	0	0	0	0		Unfavourable temperature ranges(2)
Alternative combustibles	Switch fuel towards gas	No additional switch to gas	100% in 2020	100% in 2020	100% in 2020	Cost of combustibles	Assumption of continuing shift towards gas
	Switch gas to biogas	0%	25%	50%	100%	Cost of combustibles	100% is theoretically possible, actual application depends on availability and cost
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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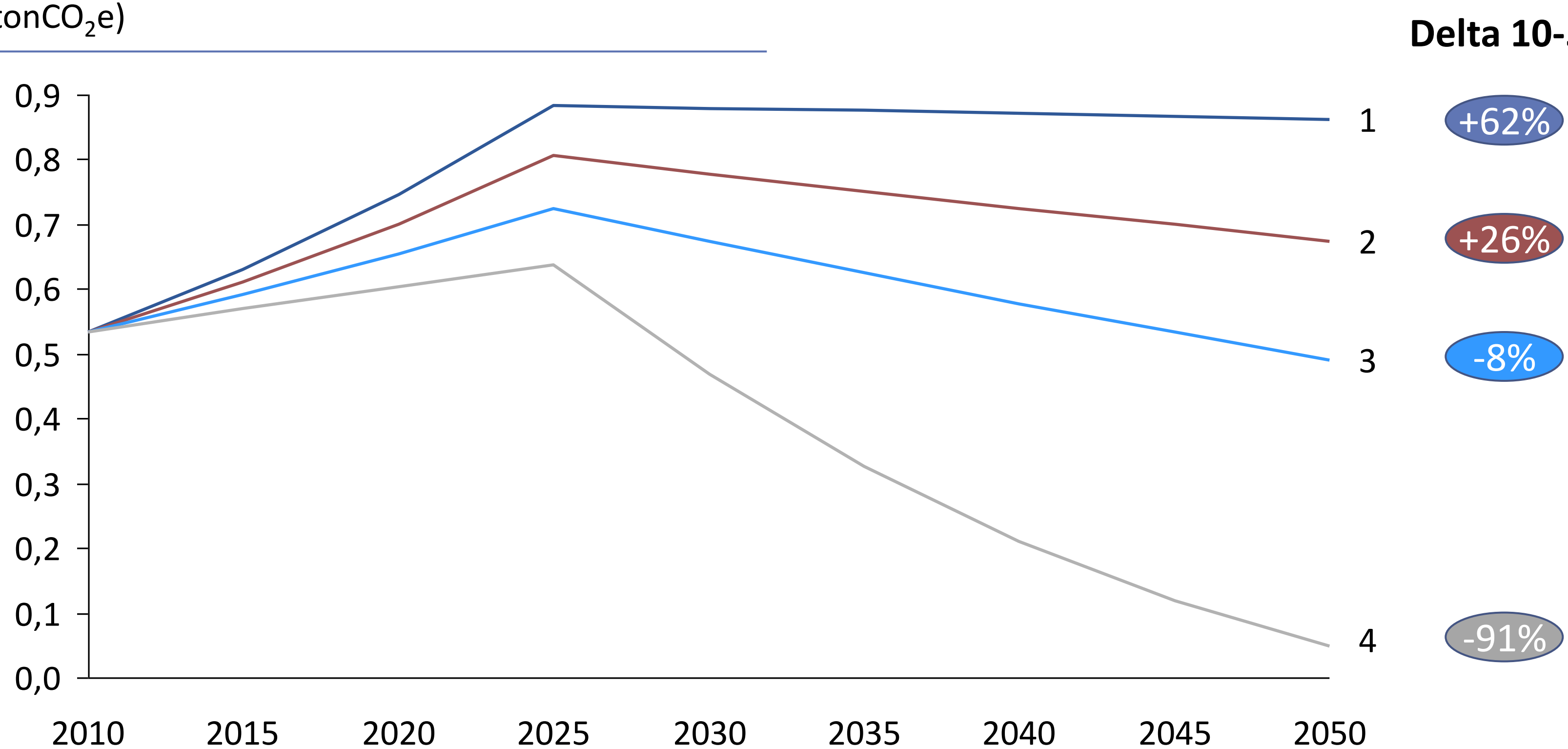
Trajectory 1 (high growth) GHG emissions for different ambition levels
($MtonCO_2e$)

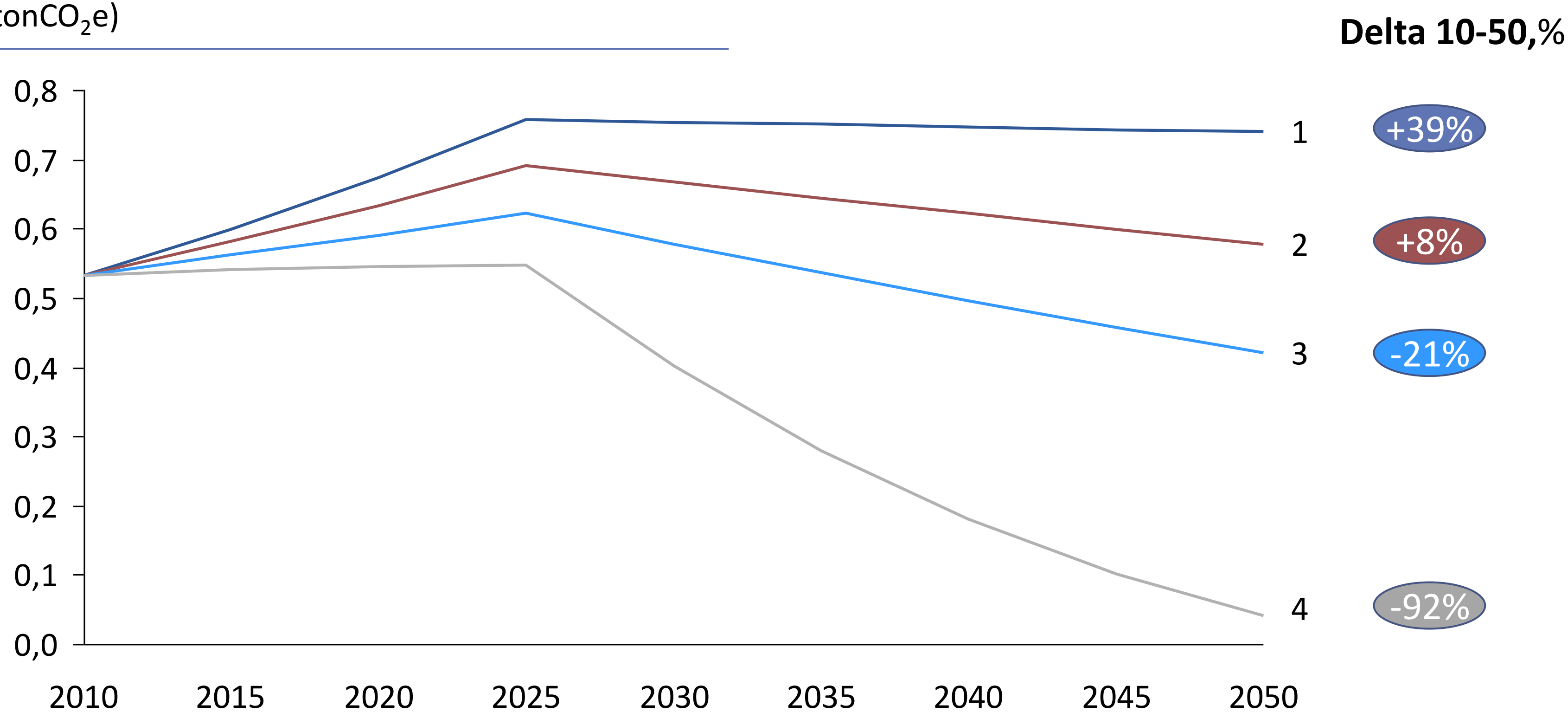


SOURCE: OPE²RA model

Reduction potential

Emissions according to different trajectories

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

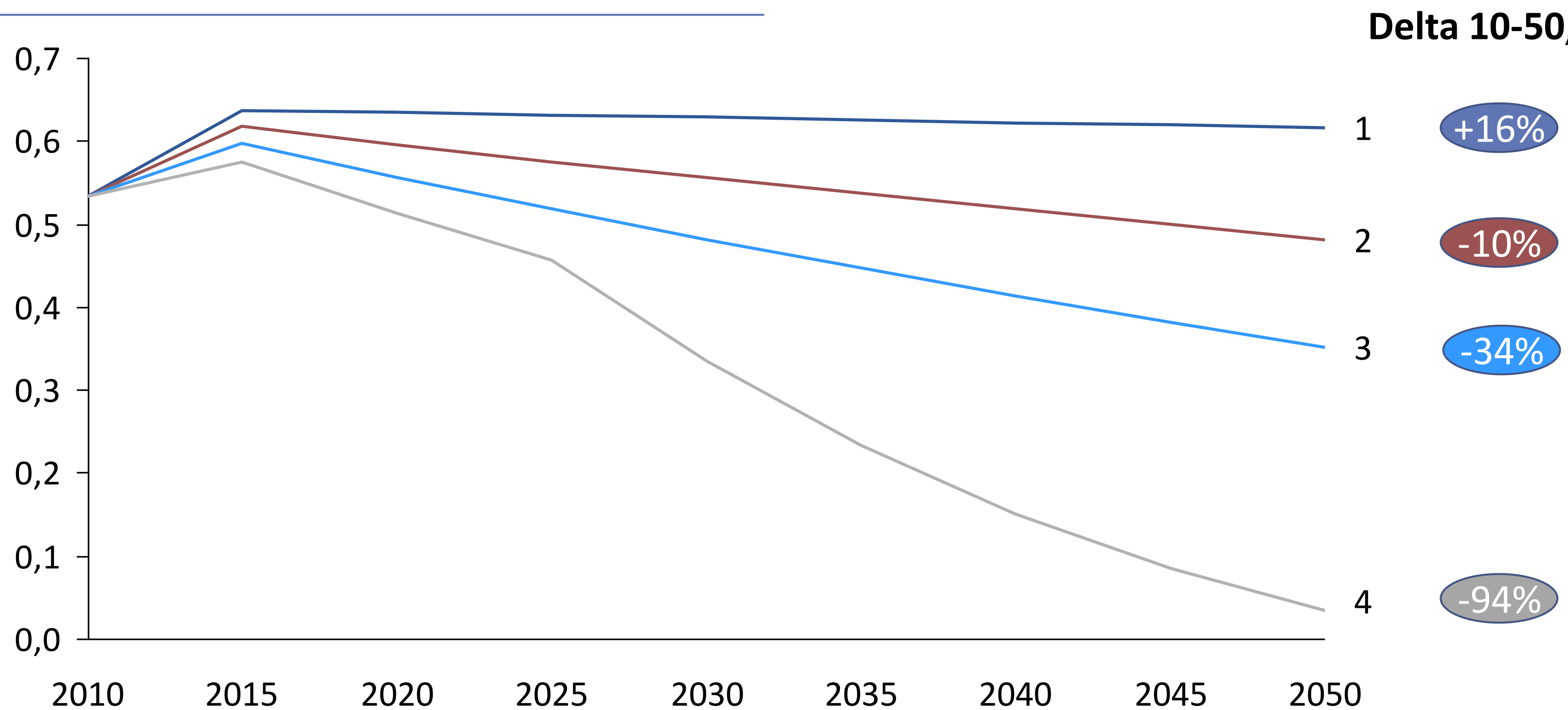


SOURCE: OPE²RA model

Reduction potential

Emissions according to different trajectories

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



SOURCE: OPE²RA model

Reduction potential

CCS is needed to reach European targets (capture of process emissions)

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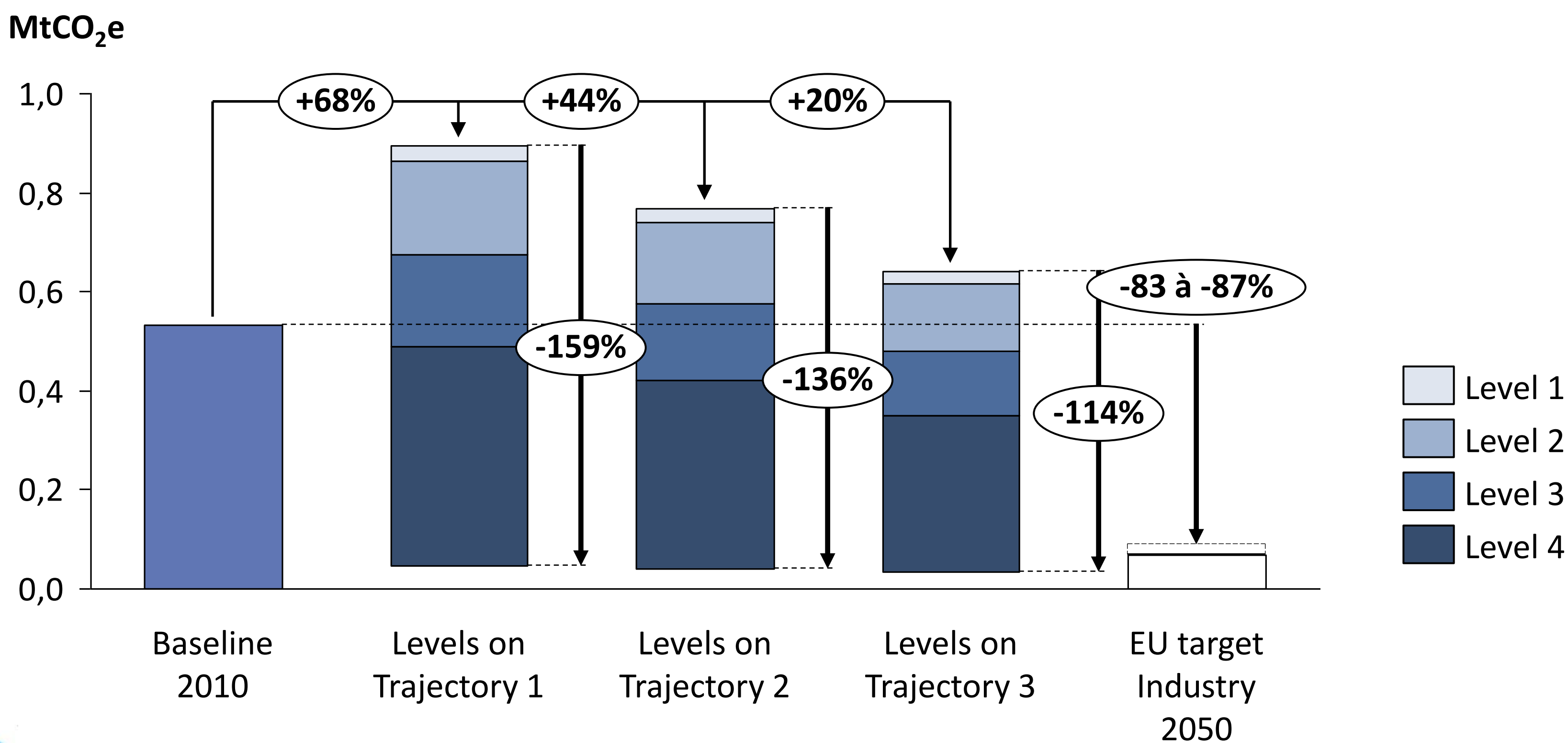
GHG emissions for different trajectories and ambition levels
(MtonCO_2e and % change as % of 2010 level)



SOURCE: OPE²RA model

Reduction potential

Details for trajectory 1 with ambition level 2

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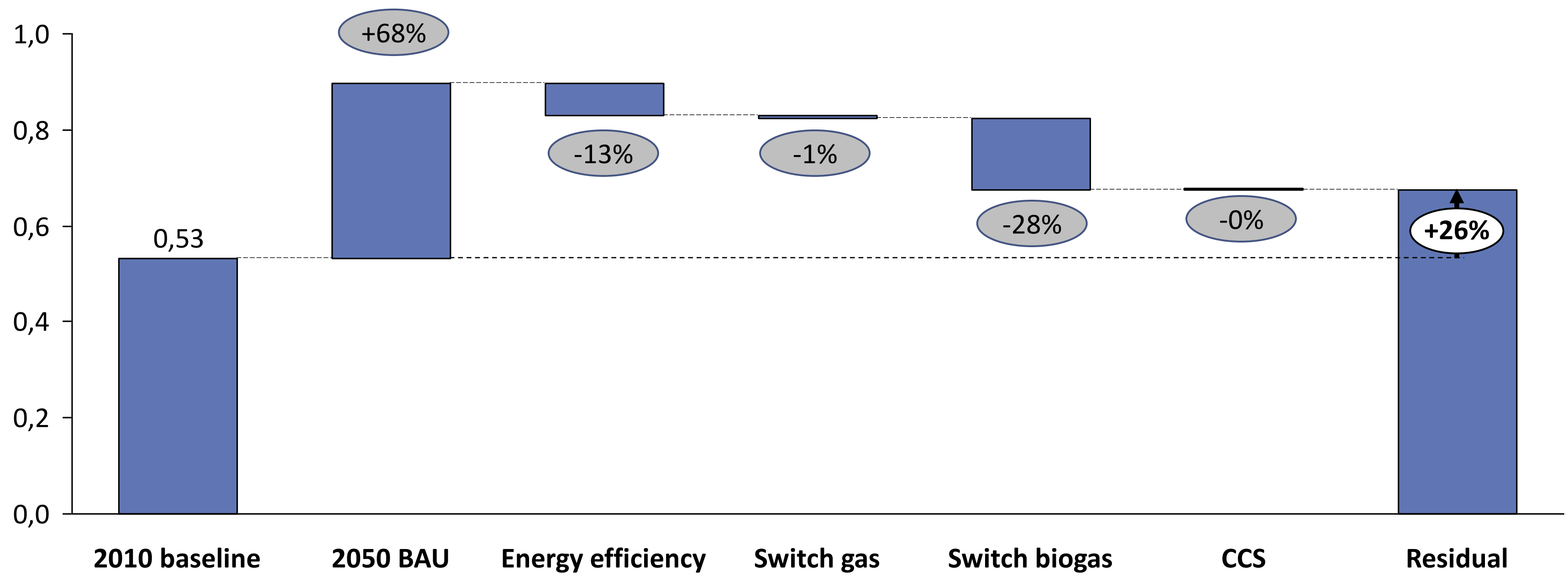
GHG emissions in 2050 using different levers
(% of 2010)



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

Reduction potential

Details for trajectory 1 with ambition level 4, without CCS

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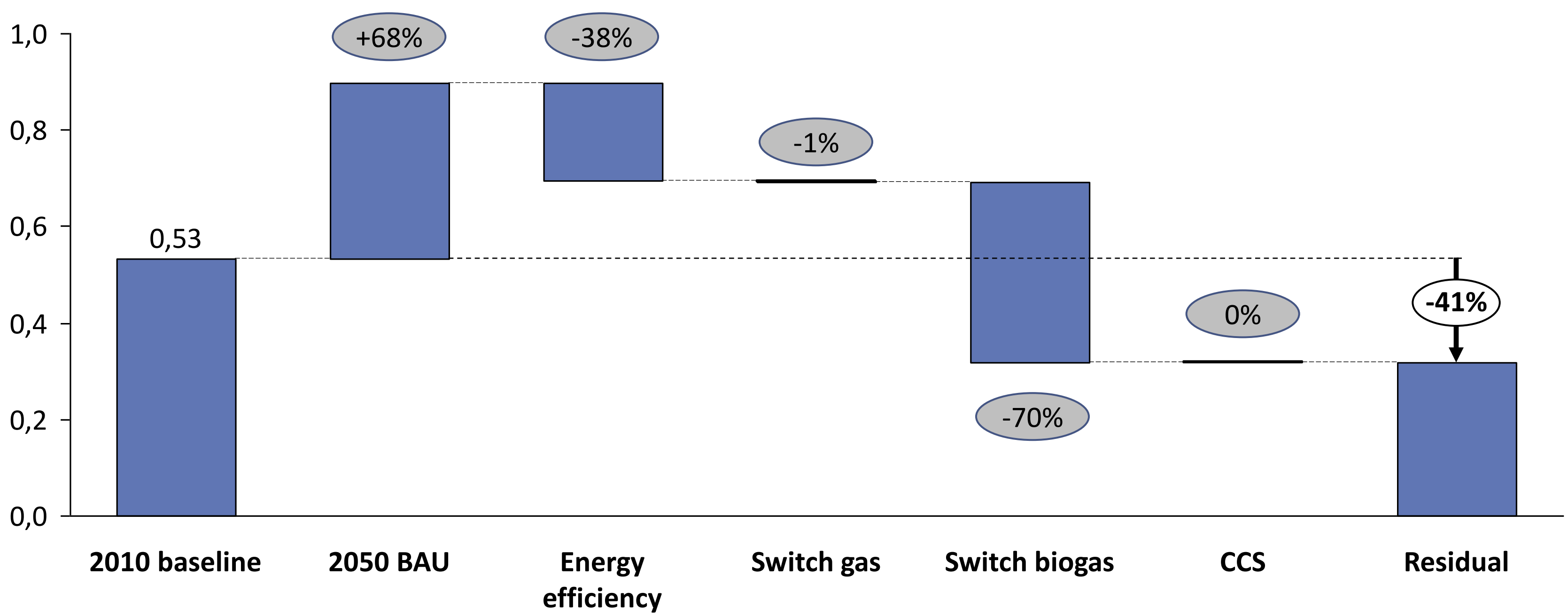
GHG emissions in 2050 using different levers
(% of 2010)



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

Reduction potential

Details for trajectory 1 with ambition level 4, with CCS

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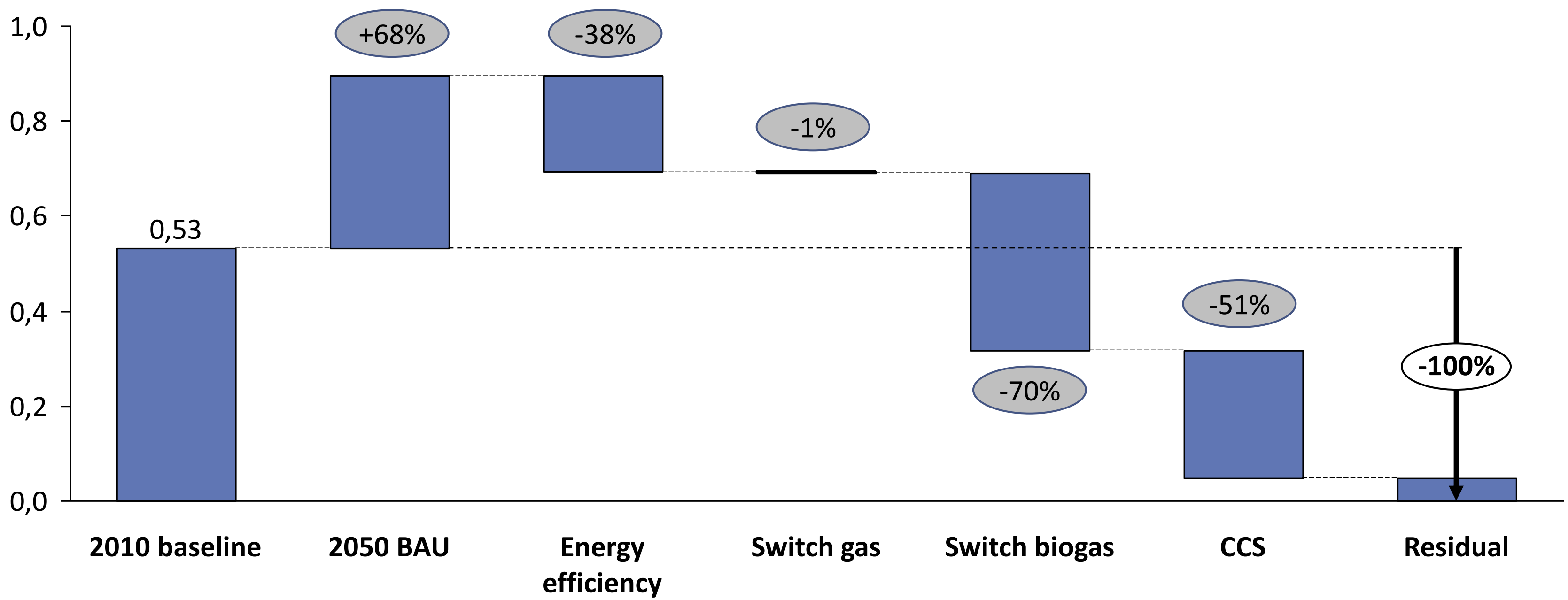
GHG emissions in 2050 using different levers
(% of 2010)



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

Cost

Marginal cost and abatement potential for different levers under trajectory 1 with ambition level 4

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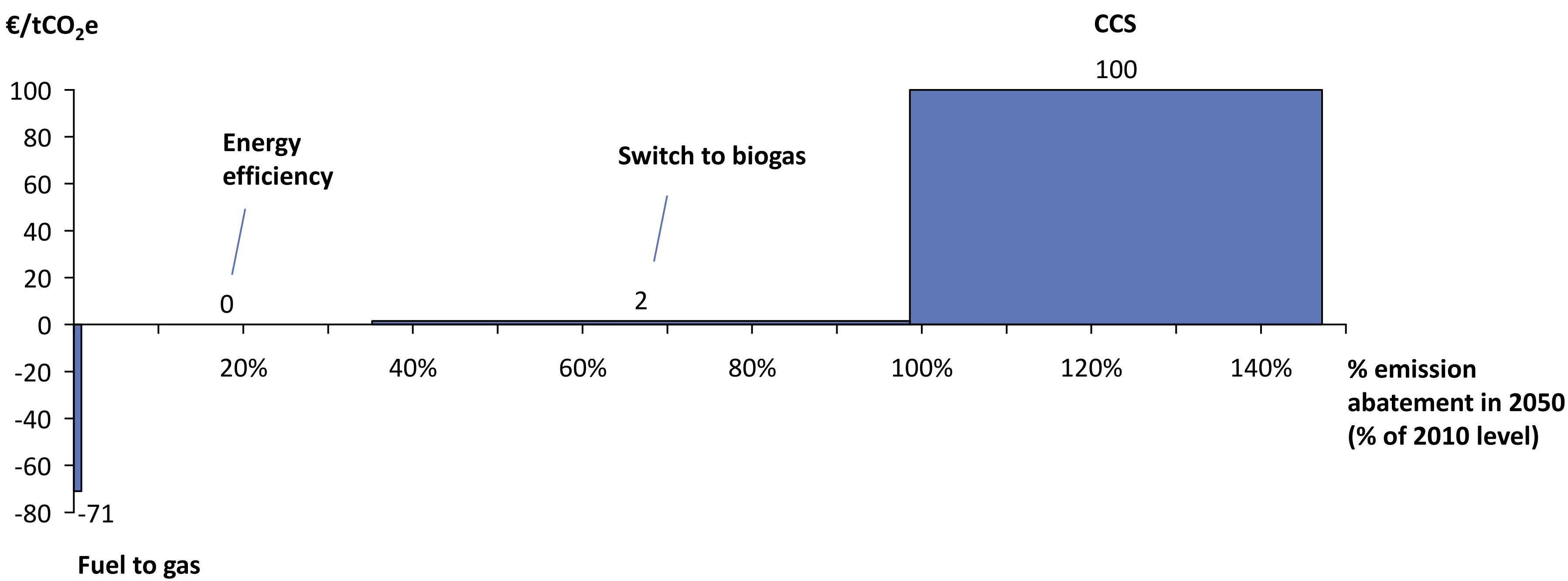
GHG abatement curve for the year 2050 (trajectory 2, ambition 4)

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



NOTE: Hypothesis of cost neutral energy efficiency measures
SOURCE: OPE²RA model

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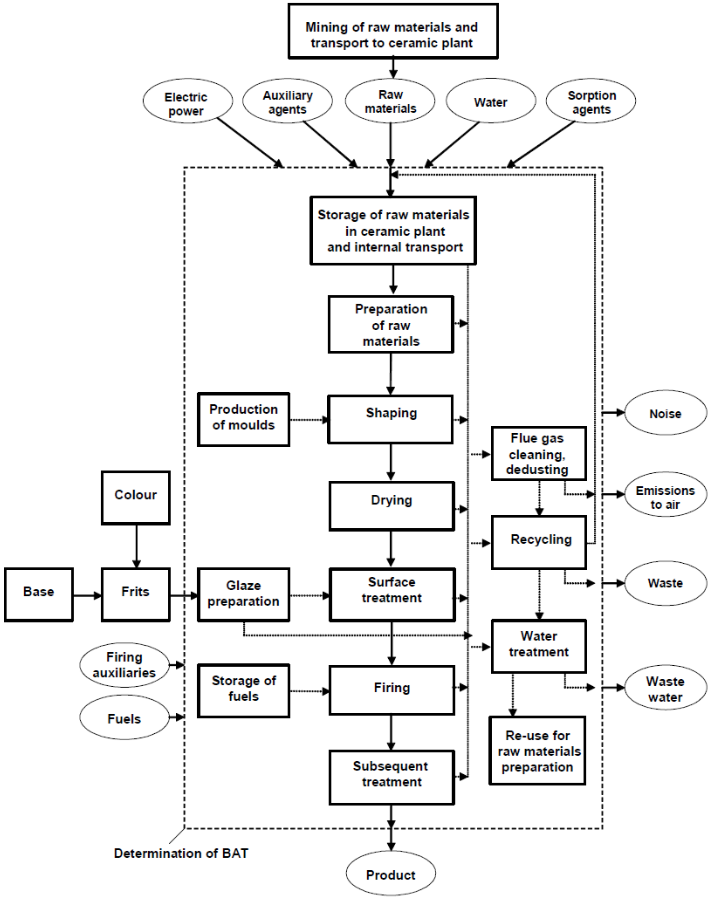
General process flow for ceramics production



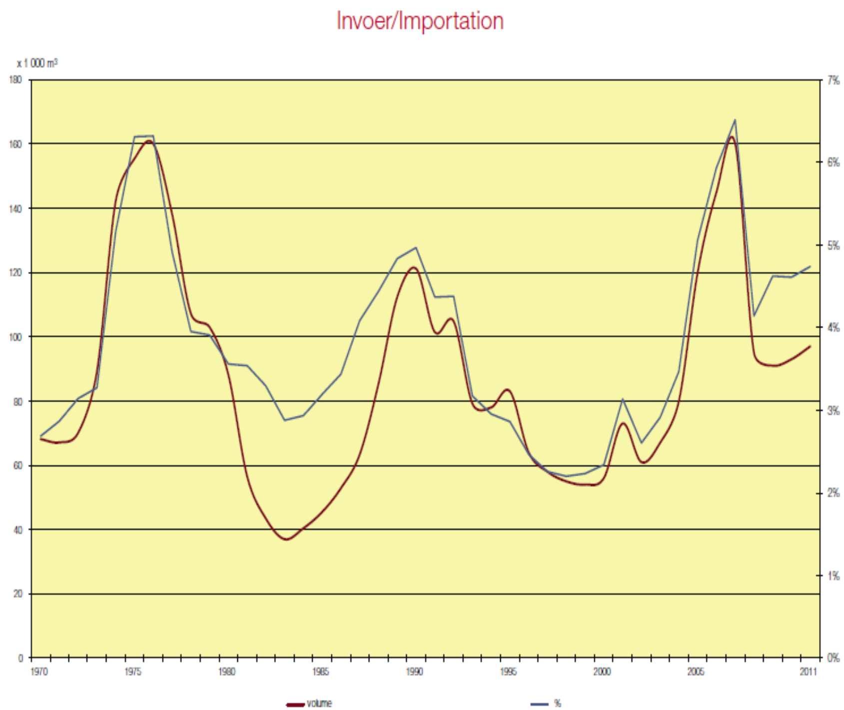
- Firing is responsible for >70% of energy use
- Drying is also energy-intensive, but uses recovery heat from oven
- Focus of GHG reduction measures will be on more efficient ovens

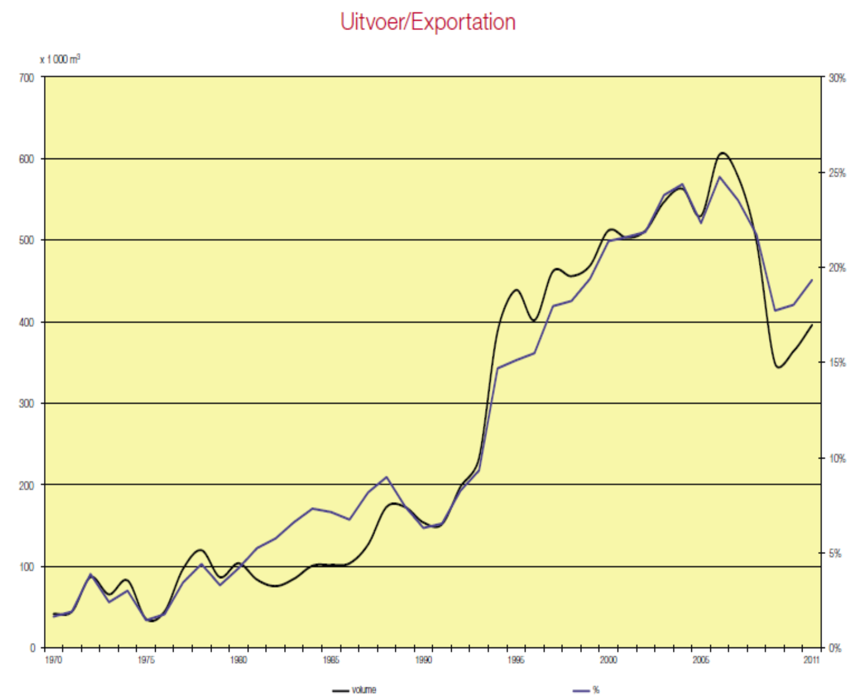
SOURCE: BREF document

Growth prospects Belgium

Import / Export activity

Import/Export, % of production and absolute numbers (m³)





- Export depends on building activity in neighbouring countries
- Export levels expected to increase in coming years

SOURCE: Jaarverslag 2011 - Baksteenfederatie

ETS details for ceramics production sites

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Company/Group	Production site	GHG emissions (kton)		
		2008	2009	2010
Ampe	Ampe	21,9	24,8	18,6
Argex	Argex	56,2	48,6	45,4
Dakpannenfabriek Pottelberg	Dakpannenfabriek Pottelberg	31,0	26,6	27,5
Desimpel	Kortemark	29,8	20,8	20,0
	Terca Peruwelz	17,9	16,1	18,8
	Terca Wanlin	6,5	5,2	4,2
Desta	Desta	6,9	7,0	7,1
Floren en Cie	Floren en Cie	5,0	4,8	3,5
Keramo Steinzeug	Keramo Steinzeug	17,7	9,9	8,9
Ploegsteert	Barry	10,0	9,0	8,8
	Afma Ploegsteert	11,3	10,4	11,7
	Bristal Ploegsteert	8,2	7,3	6,4
	Warneton (La Lys)	5,8	4,8	5,6
Preiss-Daimler Refractories SA	Preiss-Daimler Refractories SA	11,2	4,3	2,8
SVK	SVK	0,7	0,5	5,5
Steenfabriek Heylen	Steenfabriek Heylen	14,3	10,3	9,4
Steenfabrieken A. Nelissen Haesen	Steenfabrieken A. Nelissen Haesen	30,4	23,7	23,9
Terca	Beerse	60,8	42,0	51,2
	Nova	27,6	25,4	19,9
	Quirijnen	10,8	6,7	6,9
	Rumst	31,5	20,1	17,7
	SAS	6,3	0,0	0,0
	Schouterden	5,1	5,0	4,0
	Steendorp	45,7	29,5	14,0
	Tessenderlo	27,4	25,9	17,0
	Warneton	11,0	2,0	0,0
	Zonnebeke	29,9	28,9	23,0
Tuileries du Hainaut Mouscron	Tuileries du Hainaut Mouscron	13,1	11,3	12,4
Vande Moortel	Vande Moortel	27,7	24,0	23,7
Vandersanden	Hekelgem	4,2	2,7	3,0
	Lanklaar	29,3	27,4	21,8
	Spouwen	31,3	28,9	27,7
Total	**Total**	**646,4**	**513,8**	**470,4**

Includes all ceramics (not just bricks and tiles)

SOURCE: ETS registry, Belgium

Thank you.

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