Climact support to the DECC models

Wallonia (2011-2012), Belgium (2012-2013), Flanders (2014), Balkans (2012-ongoing), Algeria (2014-ongoing), Global calculator (2014-ongoing)

& highlights on the Manufacturing sector

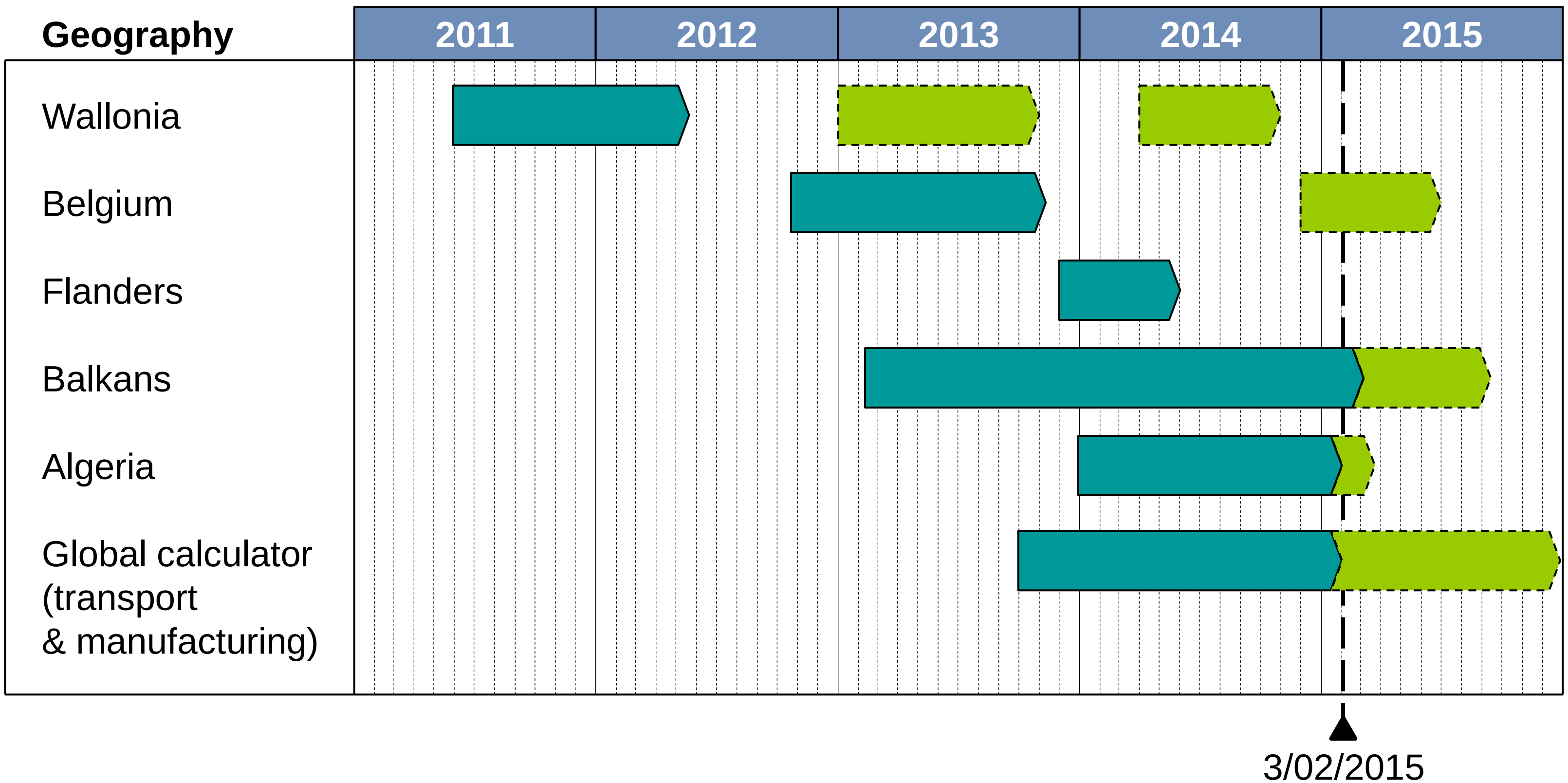
Taipei February 11 2015

Agenda

Background

Manufacturing

Climact supports the DECC in objectivising the energy & climate change debate



Prior diving in manufacturing, let's step back on 2 dimensions, these geographical areas are different and the work is not a single shot

Climact perceives very different stakes from one geography to another

Stake examples per geographies

Belgium (federal) **Wallonia & Flanders** (regions)	• Is -80% to -95% making sense? • What is the impact of raising intermittency, should the effort be on technologies or behaviour changes • What is the burden size on non-ETS?
Balkans (Albania, Bosnia, Croatia, Kosovo, Macedonia, Montenegro, Serbia)	• Should we be against the gas pipelines, against hydro? • How does corruption affect my pathways
Algeria	• Should we extract fossil fuels now ? • Is gas low carbon?
Global calc	• What is the global picture? • How do the sectors impact one another? • Can we board companies as ambassadors of low carbon pathways

The flexibility of the excel is very useful to enable this

Climact perceives an evolving need, information access drives need for new information

CLIMACT

Recent requests for additional information

- What is the job impact of the transition (ongoing in Belgium)
- What is the impact on resources (mini assessment for global calculator)
- What is the impact on my industrial sector (5 sectors roadmaps ongoing)
- What is the public cost of my pathway (subsidies, job impact, trade balance impact)
- Is gas good or bad for the transition (ongoing EU)
- Links between different countries to obtain regional perspective
- What is the water impact
- What is the air quality impact
- What is the cost of externalities

The open source dimension will play a role here

Agenda

Global Calculator

Background

Manufacturing

High level choices

Impact per lever

Global calculator provided an opportunity to revisit the manufacturing modelling

Global Calculator

The “Global” perspective enables to Include imported/exported emissions

The “new” project provided an opportunity to refresh the tool’s structure

The “Global calculator”, it’s purpose and structure will be mostly covered by Tom Counsell & Tom Bain on Wednesday

Global calculator partners

Department of Energy & Climate Change
WORLD RESOURCES INSTITUTE
eit Climate-KIC
CLIMATE MEDIA FACTORY
北京人文创新国际能源科技中心 Energy R&D International
LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE
Imperial College London
EY Building a better working world
国家发展和改革委员会能源研究所 Energy Research Institute, National Development and Reform Commission
iea International Energy Agency

The consultation approach was a key component (1/4): the cross-sector workshop

Global Calculator

Federations and organisations

WBCSD, Cement sustainability Initiative
- Roland Hunziker

Worldsteel Association
- Henk Reimink, Clare Broadbent

CEFIC
- Peter Botschek, Isabelle Chaput (alumni)

CEPI
- Marco Mensink

Zero Emissions Platform (ZEP)
- Gert-Jan van der Panne

European Wood Federation (CEI Bois)

Institute of Industrial perspective (alumni)
- Julia Reinaud

World Aluminium
- Chris Bayliss

The following persons/organisations were provided with an opportunity to review the model assumptions

Academic, consultancies & research groups

- **Dechema** Florian Ausfelder
- **Fraunhofer institute,** Marlene Arens
- **Steel VDEh** Marten Sprecher
- **Tsinghua University**
- **UK Engineering** and Physical Sciences Research Council (EPSRC), author of With both eyes open, Jonathan M Cullen
- **LBNL** (China Energy Group)
- **BEE** (India)
- **TERI**

Companies in other sectors

- **Dow** Michael Mazor
- **Vinci**
- **Toyota**
- **Bombardier**
- **GE**

NGOs & cooperation agencies

- **Greenpeace**, Jan Vande Putte
- **WWF**
- **GIZ**

NOTE: (1) The stakeholders do not validate or endorse the assumptions described in this document, the assumptions are the sole choice of the Global Calculator team

The consultation approach was a key component (2/4): the steel workshop

Global Calculator

Iron & steel specific

Worldsteel Association
- Clare Broadbent, Eldar Askerov

European Steel Technology Platform
- Jean-Pierre Birat

Eurofer
- Jean Theo Ghenda

Steel Institute VDEh
- Marten Sprecher

Fraunhofer institute
- Marlene Arens

ArcelorMittal
- Jean-Sebastien Thomas, Karl Buttiens

Tata Steel

All sectors (interaction planned later)

Think tanks
- WBCSD
- GIZ

Academic
- Tsinghua University
- UK Engineering and Physical Sciences Research Council (EPSRC), author of With both eyes open, Jonathan M Cullen
- LBNL (China Energy Group)

NGOs
- Greenpeace
- WWF

The following persons/organisations were provided with an opportunity to review the model assumptions

NOTE: (1) The stakeholders do not validate or endorse the assumptions described in this document, the assumptions are the sole choice of the Global Calculator team

The consultation approach was a key component (3/4): the chemicals workshop

Global Calculator

Chemicals specific experts

International Council of Chemical associations
- Rachelina Baio

CEFIC (European Chemical Industry Council
- Peter Botschek
- William Garcia, Isabelle Chaput (cross sectoral)

CPCIF (China Petroleum and Chemical Industry Federation)
- Dr. Ye Jianhui

Japan PetroChemical Industry Association

Dechema
- Alexis Bazzanella, Florian Ausfelder

Steel Institute VDEh
- Marten Sprecher

BASF
- Susan Kuschel, Charlene Wall-Warren

Dow Chemicals
- Mark Weick, Keith (K) Kenebrew, Michael (MH)

The following persons/organisations were provided with an opportunity to review the model assumptions

All sectors (interaction planned later)

Think tanks
- WBCSD
- GIZ

Academic
- Tsinghua University
- UK Engineering and Physical Sciences Research Council (EPSRC), author of With both eyes open, Jonathan M Cullen
- LBNL (China Energy Group)

NGOs
- Greenpeace
- WWF

NOTE: (1) The stakeholders do not validate or endorse the assumptions described in this document, the assumptions are the sole choice of the Global Calculator team

The consultation approach was a key component (4/4): the cement workshop

Global Calculator

Cement specific

WBCSD, Cement sustainability Initiative
- Roland Hunziker

US Portland cement association
- David D. Shepherd

Cembureau:
- Alessandro Sciamarelli
- Claude Lorea
- Jessica Johnson,

Japan Cement Association

Cement, Concrete & Aggregates Australia

Lafarge
- Mr. Vincent Mages

Italcementi
- Ms. Manuela Ojan

Cimpor
- Mr. Paulo Rocha

The following persons/organisations were provided with an opportunity to review the model assumptions

All sectors (interaction planned later)

Think tanks
- WBCSD
- GIZ

Academic
- Tsinghua University
- UK Engineering and Physical Sciences Research Council (EPSRC), author of With both eyes open, Jonathan M Cullen
- Fraunhofer institute
- LBNL (China Energy Group)

NGOs
- Greenpeace
- WWF

NOTE: (1) The stakeholders do not validate or endorse the assumptions described in this document, the assumptions are the sole choice of the Global Calculator team

Most referred to analysis has been taken into account to make this model

Global Calculator

Main sources used for the manufacturing analysis

Sector	Organisation	Source
Steel	World Steel Association	• World Steel in Figures 2013 • Steel Statistical year book 2013 • Sustainable steel: Policy and indicators 2013 • Steel's Contribution to a Low Carbon Future • The three Rs of sustainable steel (Reduce, Reuse, Recycle), 2010
	Eurofer	• Low Carbon Steel Roadmap 2050 (IEA involved, led by BCG and German Steel Institute)
	EU JRC	• Prospective Scenarios on Energy Efficiency and CO2 Emissions in the EU Iron & Steel Industry
	UN work	
	ULCOS	• Official website
	Midrex	• MidrexStats2011-6.7.12
	IEA	• 2013 Key world energy statistics • 2012 technology perspectives
	Cambridge	• With both eyes open
		• NTNU & Cambrige University (2014 04 10 International Materials Education Symposium)
	US Environmental Protection Agency	• Available and emerging technologies for reducing greenhouse gas emissions from the iron and steel industry. North Carolina: US EPA, , 2010

Manufacturing is modelled through 3 main lever groups, split into 8 lever families

Global Calculator

	Lever groups	Lever families	Lever descriptions
1	**Product demand**	1. Reduce demand [1] & increase lifetime [2]	• End consumer demand of products • Solutions for sharing the product amongst different users
2	**Material demand per product**	2. Smart design 3. Materials switch 4. Materials recycling	• Amount & type of materials required to supply the products (includes new product types and substitution materials) • Materials recycling potential
3	**Carbon intensity of material production**	5. Process change 6. Fuel switch 7. Energy efficiency 8. Carbon capture and storage	• Production CO_2 intensity of various improvements levers in each industry (~60improvements types)

NOTES: (1) These levers don't apply in the materials analysis when the product demand is defined by the other sectors
(2) For consumer goods: cars & household goods

An innovative characteristic of this modelling is that the materials demand is derived from the product demand

Global Calculator

Value chain

Illustrations

Products

Materials

Steel | Cement | Alu minium | Chemicals | Pulp & paper | Timber | Other

Taking advantage of the global scope, the materials analysis can include embedded emissions and resources impact

Most of the product demand is driven by the activity in the other sectors

Agenda

Global Calculator

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High level choices

Impact per lever

Figures of July 2014

Global Calculator

An innovative characteristic of this modelling is that the materials demand is derived from the product demand (1/2)

Steel driving products
(2011)

Steel

1518 Mt steel
2991 M tCO_2e
1,97 tCO_2e/t steel

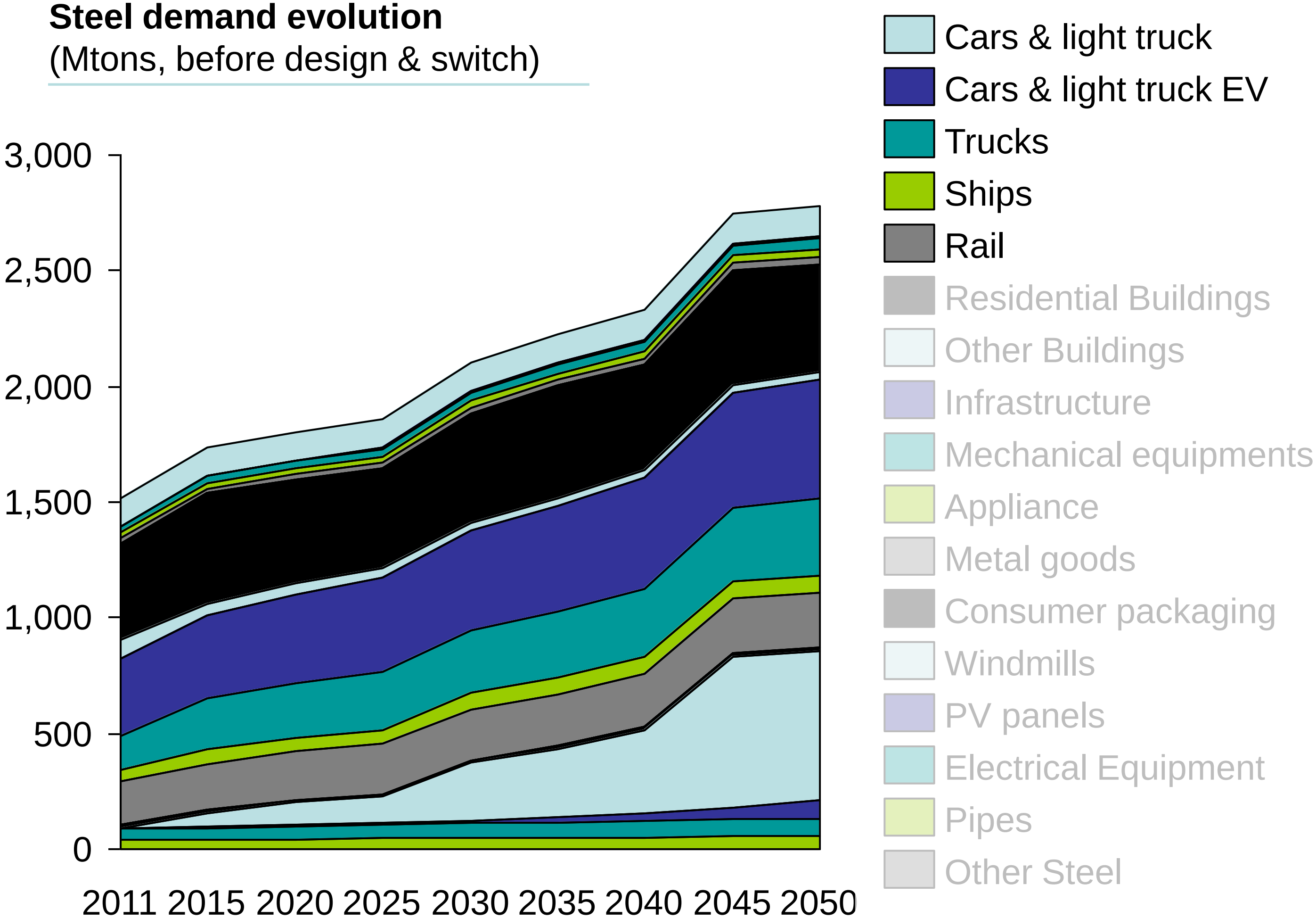
Transport	13%: 194 Mt steel	**Cars & light trucks**	8%: 123 Mt steel
		Trucks	2%: 28 Mt steel
		Ships	2%: 23 Mt steel
		Rail	1%: 20 Mt steel
Industrial equipment	16%: 246 Mt steel	Electrical equipment	3%: 46 Mt steel
		Mechanical equipment	10%: 153 Mt steel
Construction	55%: 832 Mt steel	Infrastructure	22%: 332 Mt steel
		Residential Buildings	28%: 422 Mt steel
		Other Buildings	5%: 77 Mt steel
Metal products	16%: 247 Mt steel	Metal goods	13%: 193 Mt steel
		Consumer packaging	1%: 11 Mt steel
		Domestic appliances	3%: 43 Mt steel
Energy	0,6%: 10Mt steel	Windmills	0,4%: 6 Mt steel
		PV Panels	0,02%: 0,3 Mt steel
		Pipes	3%: 40 Mt steel

NOTES: (1)There are other products, these have been diluted amongst the existing categories
(2) Half the "Construction" steel is used for rebar with cement

SOURCES: With both eyes open, Copyright 2012 UIT Cambridge Ltd, adapted by Climact to 2011 figures

An innovative characteristic of this modelling is that the materials demand is derived from the product demand (2/2)

Steel demand evolution
(Mtons, before design & switch)



Steel example in a pathway with ambition 3

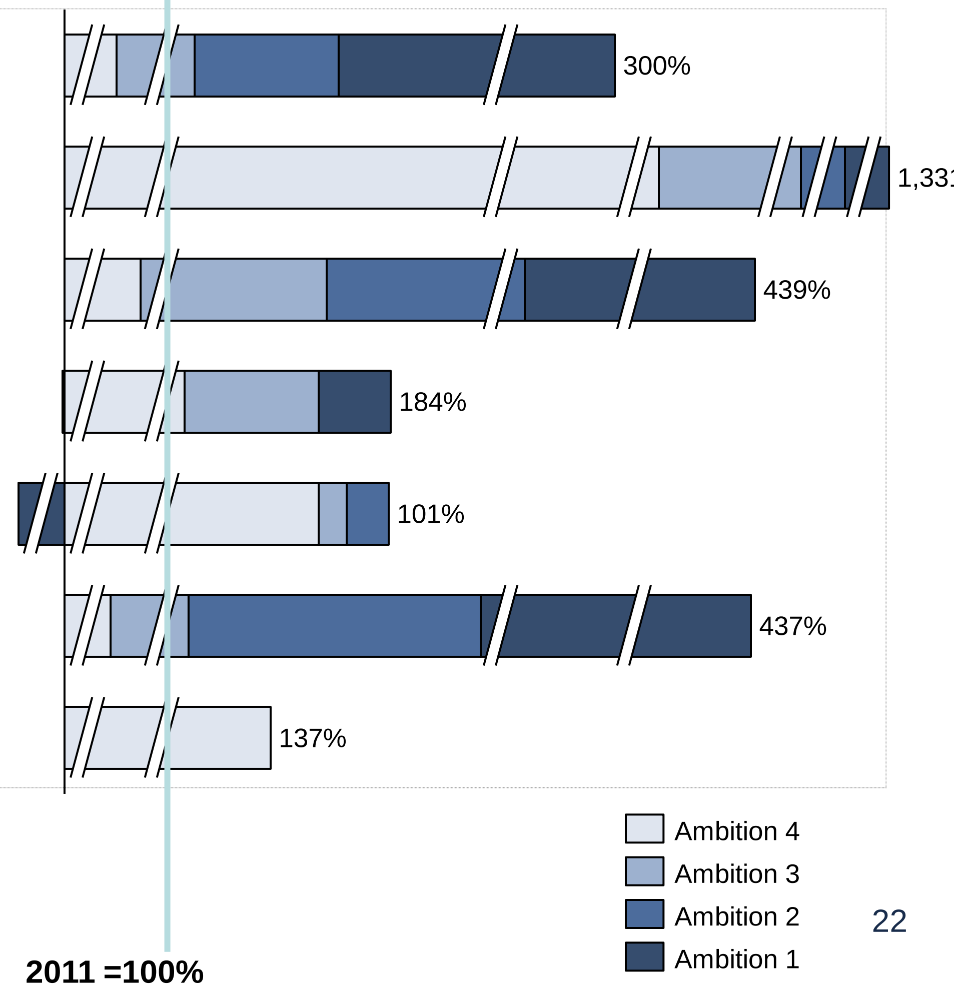
- Product demand determines material demand
- How should product demand be determined?

SOURCE: Global Calculator model

The lever choices in the other sector generate various product evolutions

Group	Product	2011 demand (units)	
Transport	Cars & light truck	111,3	Million units
	Cars & light truck EV	1,5	Million units
	Trucks	5,7	Million units
	Ships	1	K units
	Rail	5	K units
	Airplanes	35	K units
	Batteries	/	Million units

2050 demand per ambition[1] (% evolution vs 2011)

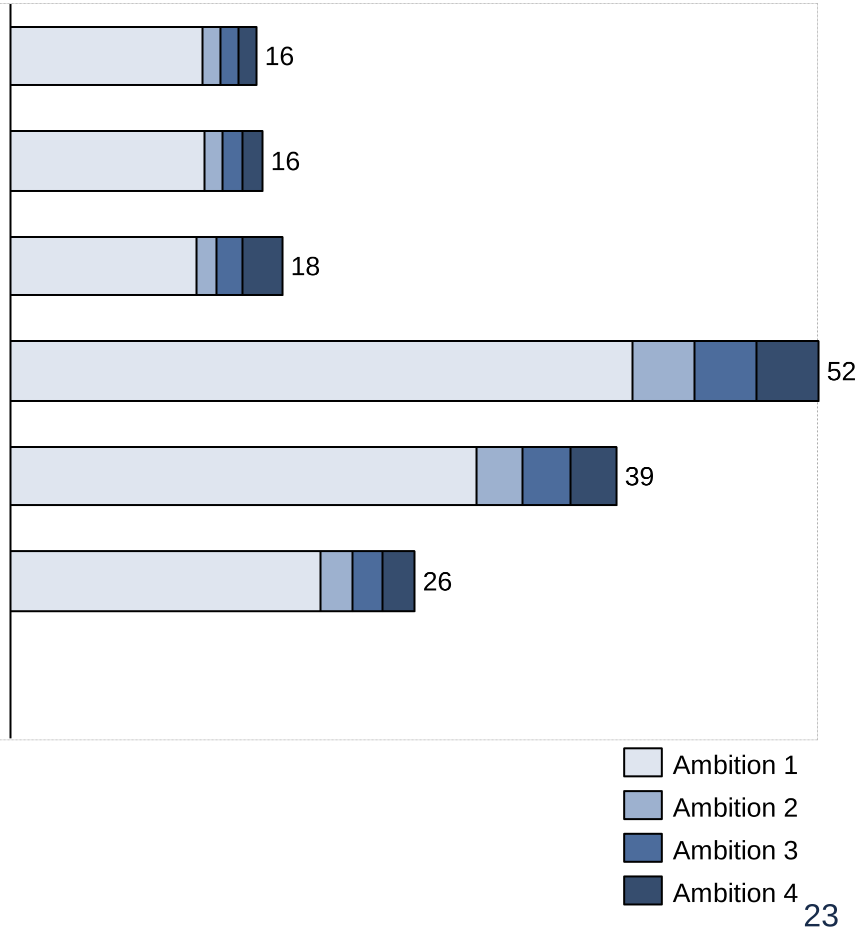


NOTE (1) Population follows the average UN projection in all ambitions

The lifetime of the products also highly impact the product demand

Group	Product	2011 lifetime (years)
Transport	Cars & light truck	12,2
	Cars & light truck EV	12,4
	Trucks	12,4
	Ships	40
	Rail	30
	Airplanes	20
	Batteries	/

Lifetime per ambition (years)



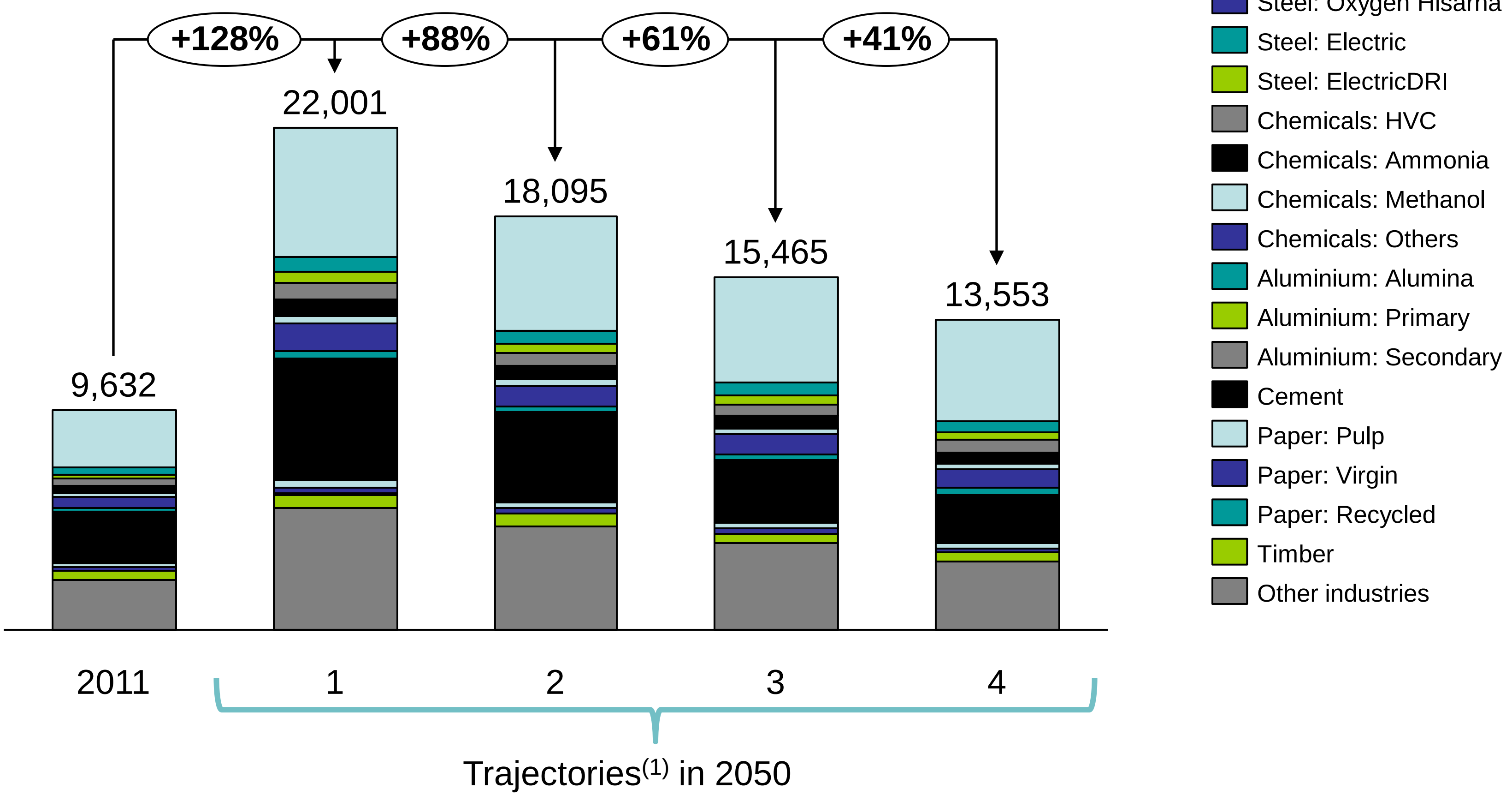
NOTE (1) Population follows the average UN projection in all ambitions

Figures of July 2014

Total
GHG Emissions in trajectories 1, 2, 3 & 4

Global Calculator

Total GHG emissions per year, by technology
(M tons CO_2e[(2)])



NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions
SOURCE: IEA ETP 2012, Global calculator model

Material demand / product: Design, Switch & Recycling

Levers are assessed in each industry

List of actions & levers assessed

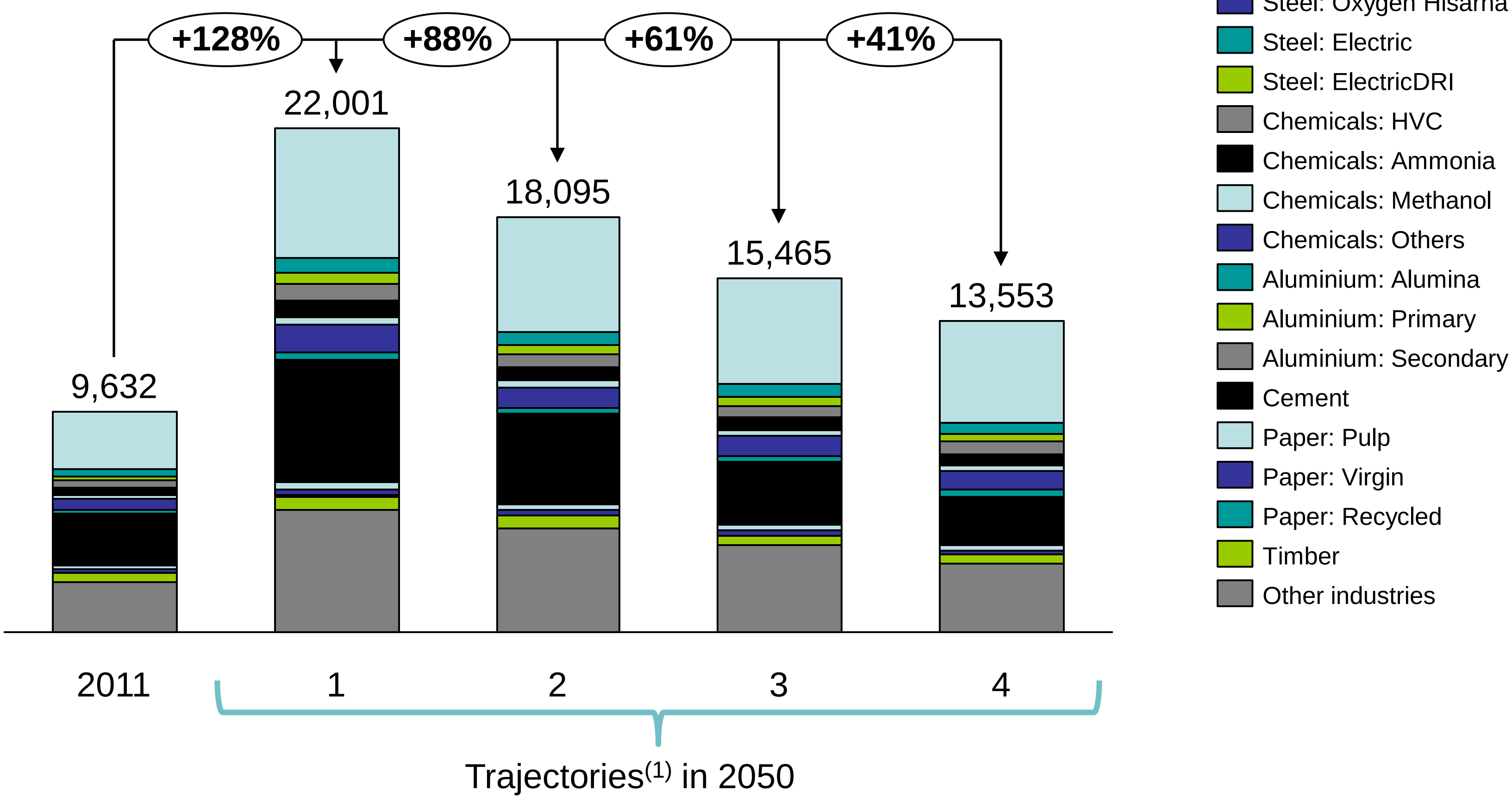
Industry groups		Design	Switch	Recycling
Steel		• Product Design • High strength steel	• In vehicles : To aluminium & to plastics (fibres) • In buildings/Infrastructure : to timber	• Product recycling • % scrap based (for each various technologies exist)
Chemicals	All	• Product design	• /	• Product recycling • Material recycling
	High value		• Substitutes steel, aluminium & cement in vehicles & buildings/infrastructure	• Green chemistry
	Ammonia	• Fertilizers composition	• /	
	Methanol		• /	
	Other	• Green chemistry	• /	
Aluminium		• Product design	• In Planes: To plastic (fibres)	• Product recycling • Material recycling
Cement		• Product design	• In buildings/Infr. : To plastics & to timber	• Composed/metallurgical cement
Pulp & paper				• More recycled paper • Other cellulose sources • Bio-refineries
Timber		• Product design	• Switch from steel &cement	

SOURCE: Climact

Total

GHG Emissions in trajectories 1, 2, 3 & 4

Total GHG emissions per year, by technology
(M tons CO_2e[(2)])



NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions

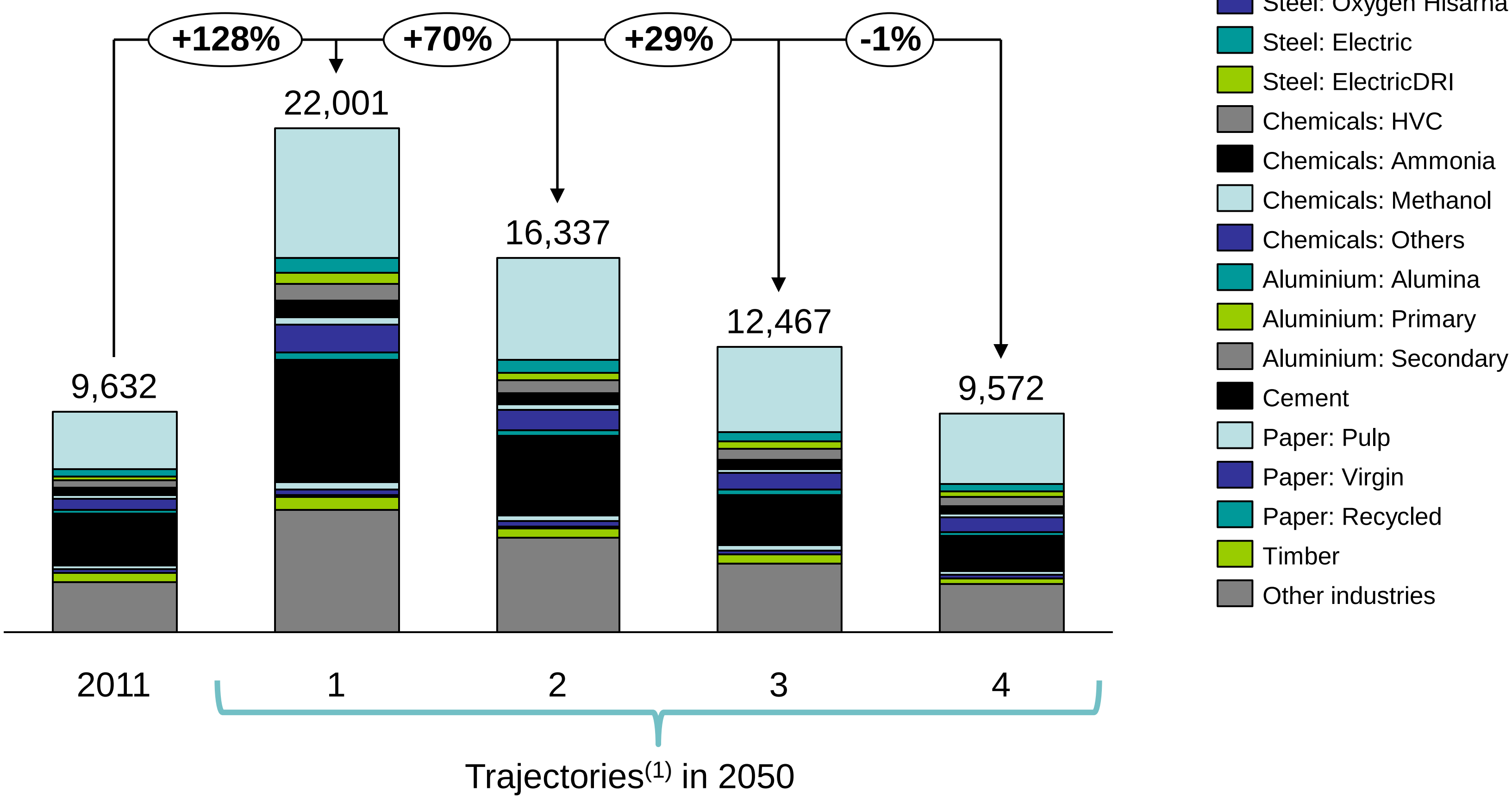
SOURCE: IEA ETP 2012, Global calculator model

Total

GHG Emissions in trajectories 1, 2, 3 & 4

Total GHG emissions per year, by technology

(M tons CO_2e)



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SOURCE: IEA ETP 2012, Global calculator model

Figures of July 2014

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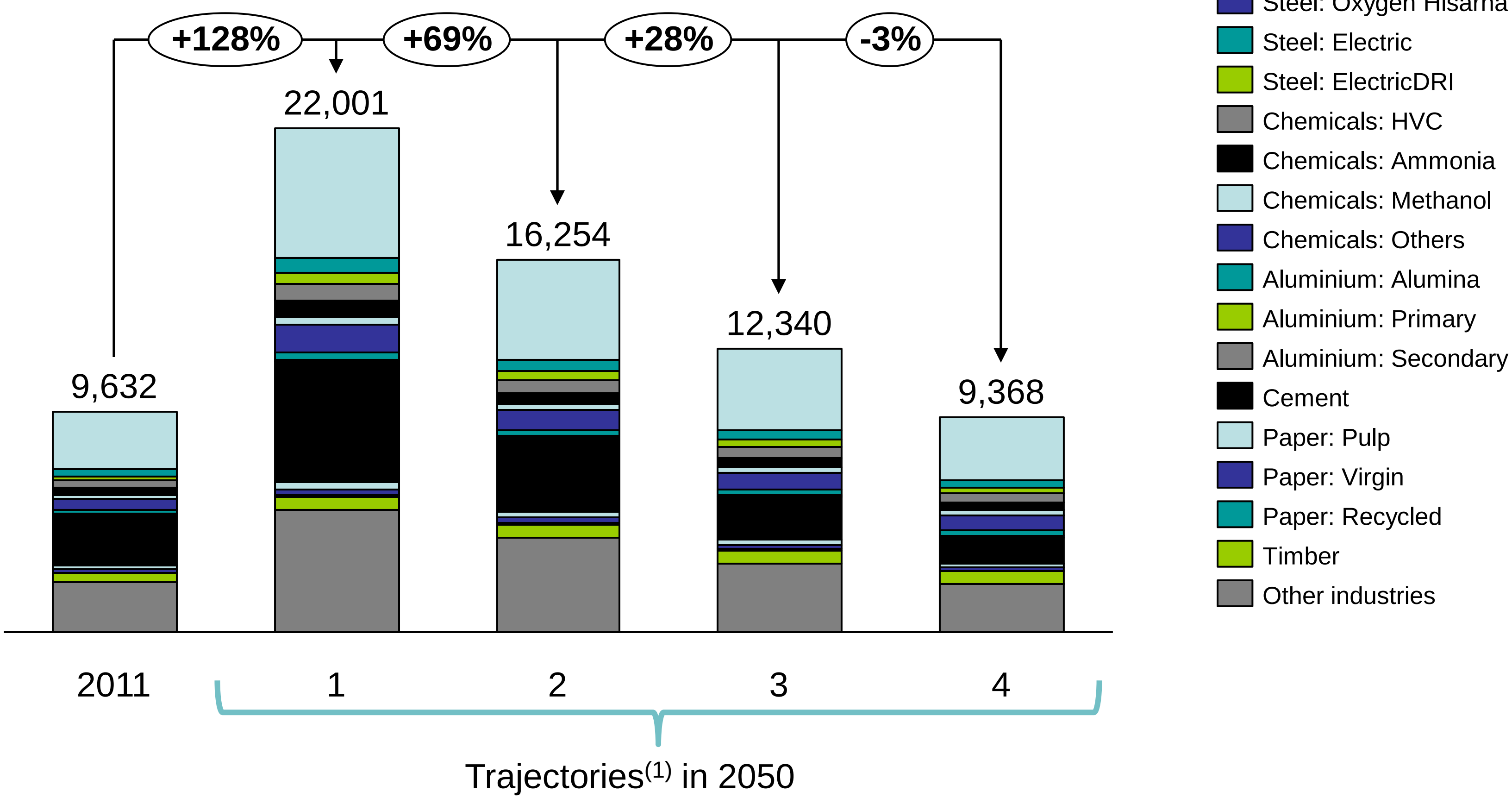

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SOURCE: IEA ETP 2012, Global calculator model

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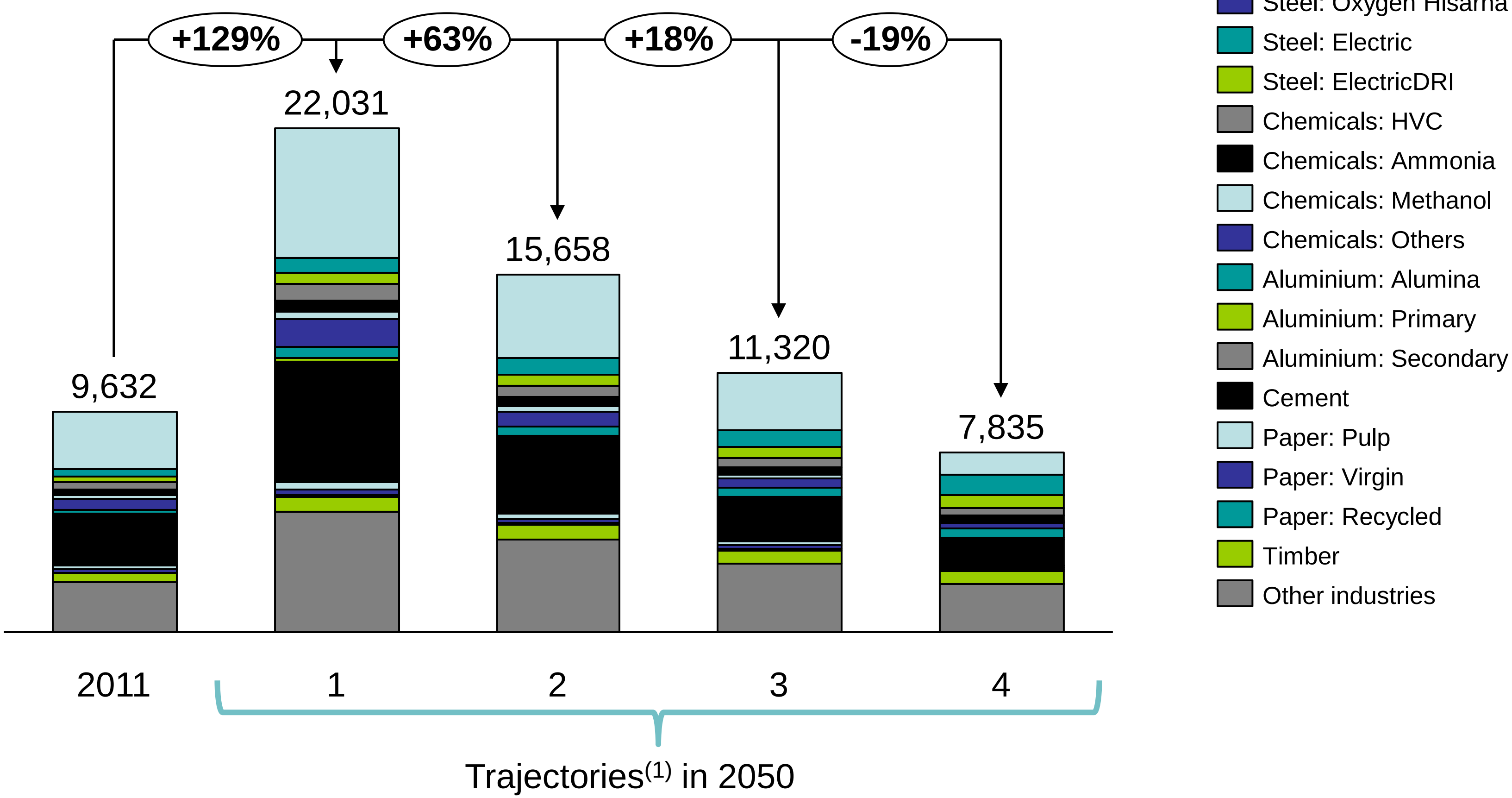


NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions
SOURCE: IEA ETP 2012, Global calculator model

Carbon intensity of material production

An additional ~50 levers then reduce the carbon intensity

Global Calculator

List of actions & levers assessed

Industry groups		Process improvements	Alternative fuels	Efficiency	CCS
Steel		• Carbon material reduction • Portion of Classic BOF/ Top gas recycling & Hisarna/ EAF DRI/ EAF scrap • Smelt reduction, Hydrogen, Electrolysis	• Coke to gas injection • Coal PCI to biomass	• Material efficiency • Energy efficiency • CHP	• CCS
Chemicals	All	• Process intensification • Catalyst optimization	• Oil to gas	• Clustering and sustainable integration • CHP	• CCS
	High value	• Included in energy efficiency		• Energy efficiency	• CCS
	Ammonia	• Included in energy efficiency		• Energy efficiency	• CCS
	Methanol			• Energy efficiency	• CCS
	Other	• Included in energy efficiency • Selective catalytic reduction	• Hydrogen production by electrolysis • Natural gas or biomass	• Energy efficiency • Switch Mercury to membrane	• CCS
Aluminium		• Included in energy efficiency	• Gas injection	• Material efficiency • Energy efficiency	• CCS
Cement		• Dry process	• Coal & oil to waste & biomass	• Energy efficiency • CHP /heat recovery	• CCS
Pulp & paper		• Black liquor gasification • Drying innovation	• Coal & oil to gas • Coal & oil to biomass	• Energy efficiency • CHP	• CCS
Timber		• /	• /	• /	• /

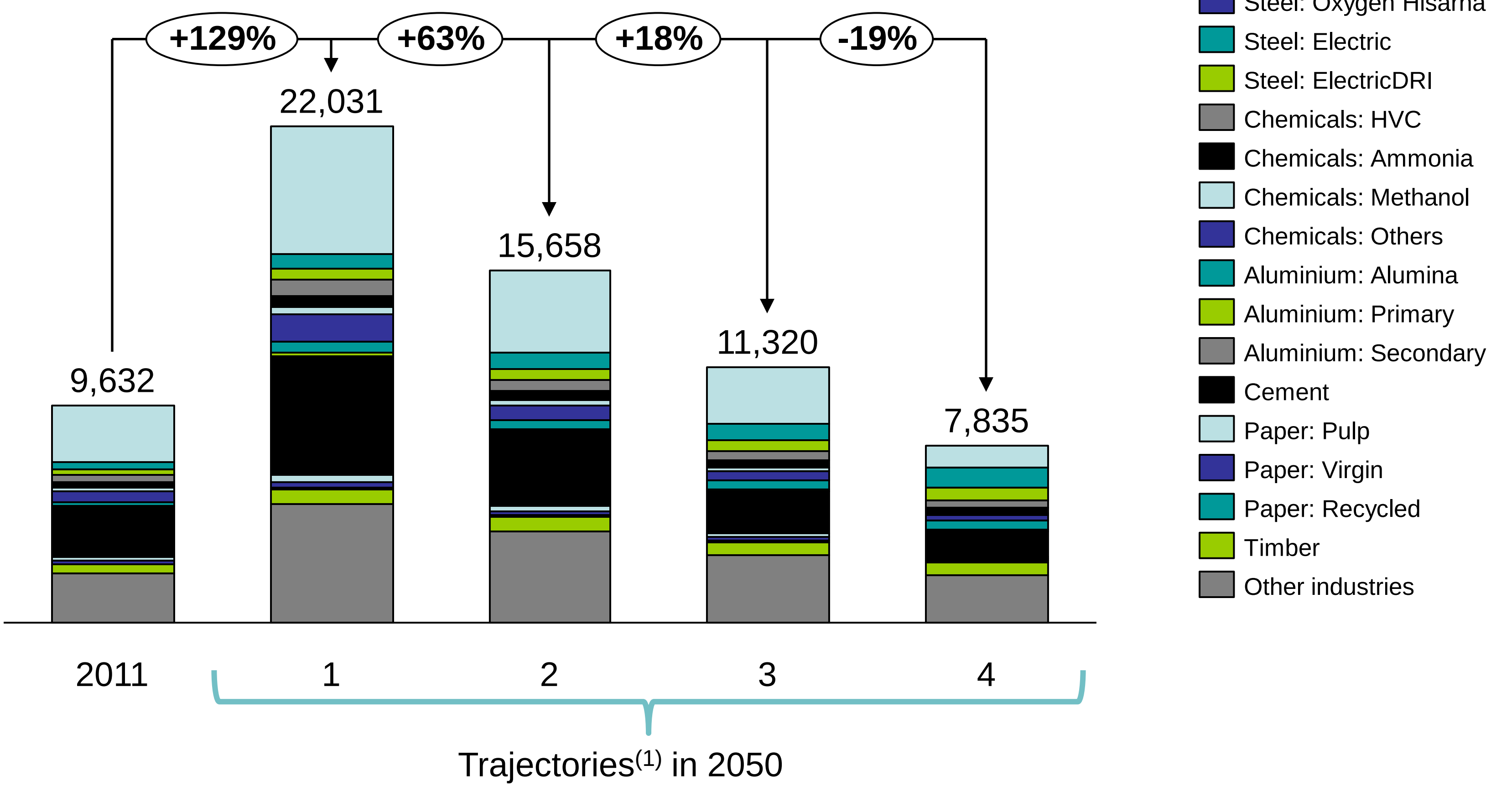
SOURCE: Climact

Figures of July 2014

Global Calculator

Total
GHG Emissions in trajectories 1, 2, 3 & 4

Total GHG emissions per year, by technology
(M tons CO_2e)



NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions
SOURCE: IEA ETP 2012, Global calculator model

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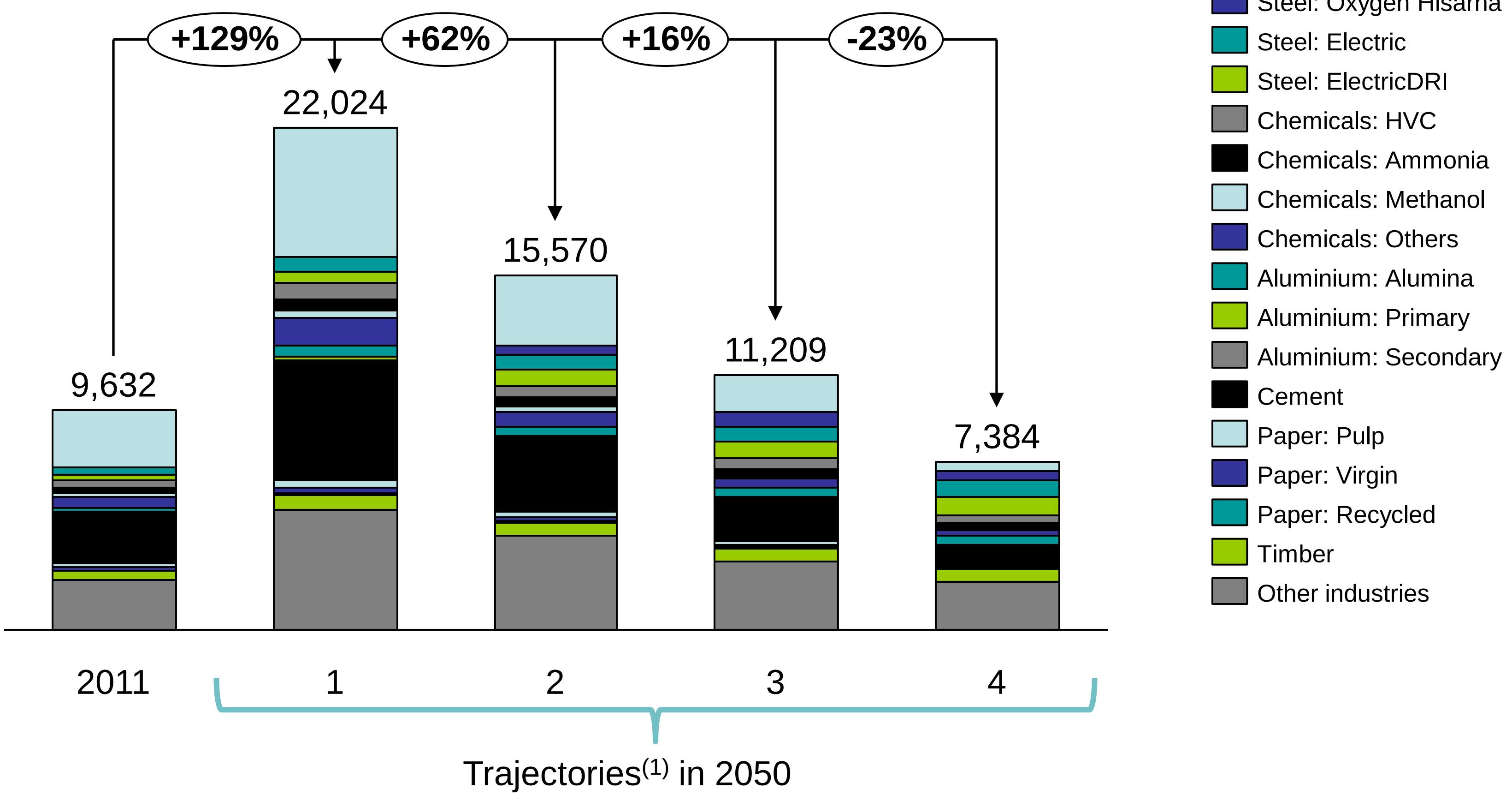

NOTE: (1) The population follows the average UN projection in all four trajectories
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SOURCE: IEA ETP 2012, Global calculator model

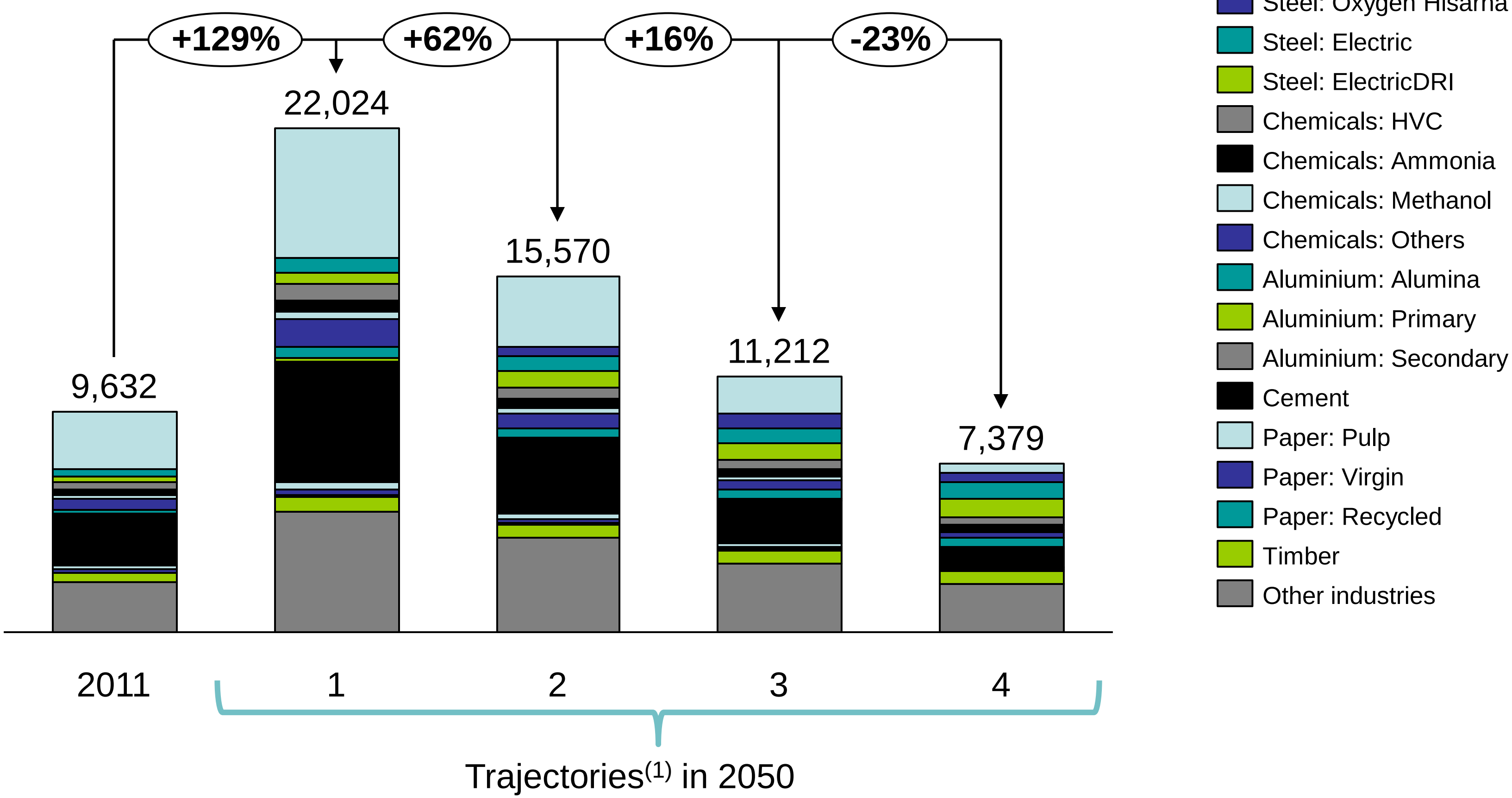
Figures of July 2014

Total

GHG Emissions in trajectories 1, 2, 3 & 4

Global Calculator

Total GHG emissions per year, by technology
(M tons CO_2e)



NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions

SOURCE: IEA ETP 2012, Global calculator model

Figures of July 2014

Global Calculator

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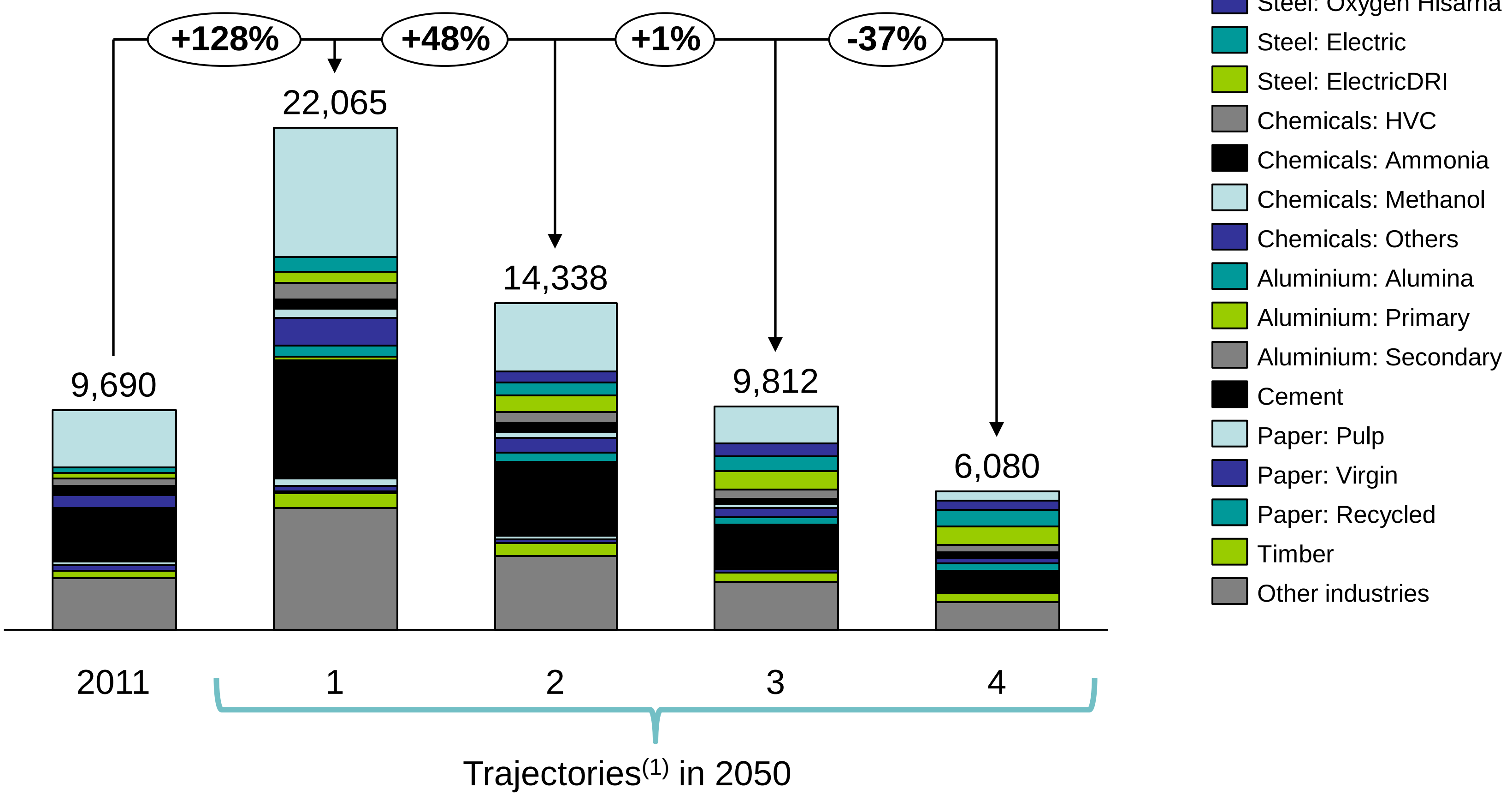

NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions
SOURCE: IEA ETP 2012, Global calculator model

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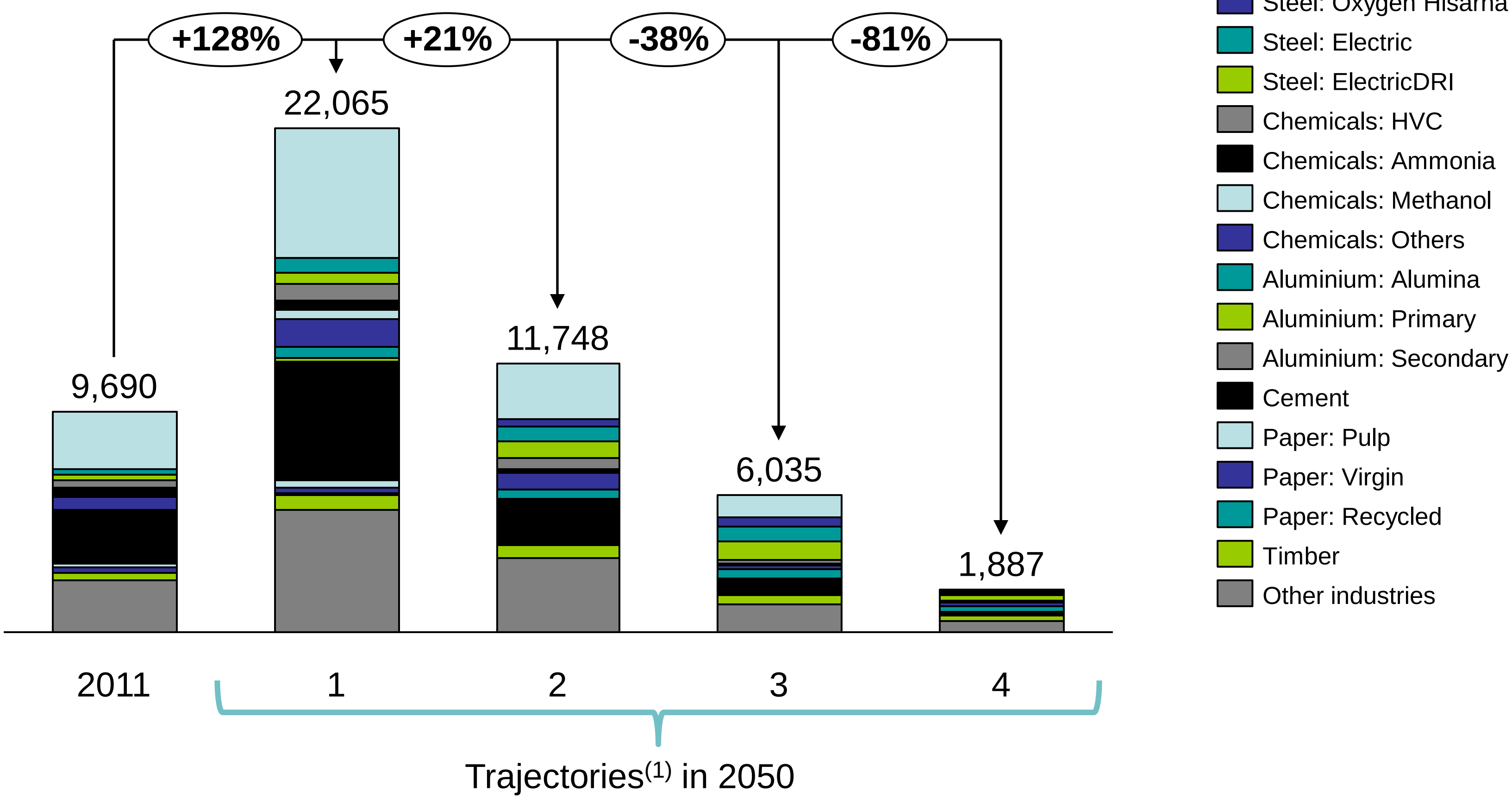
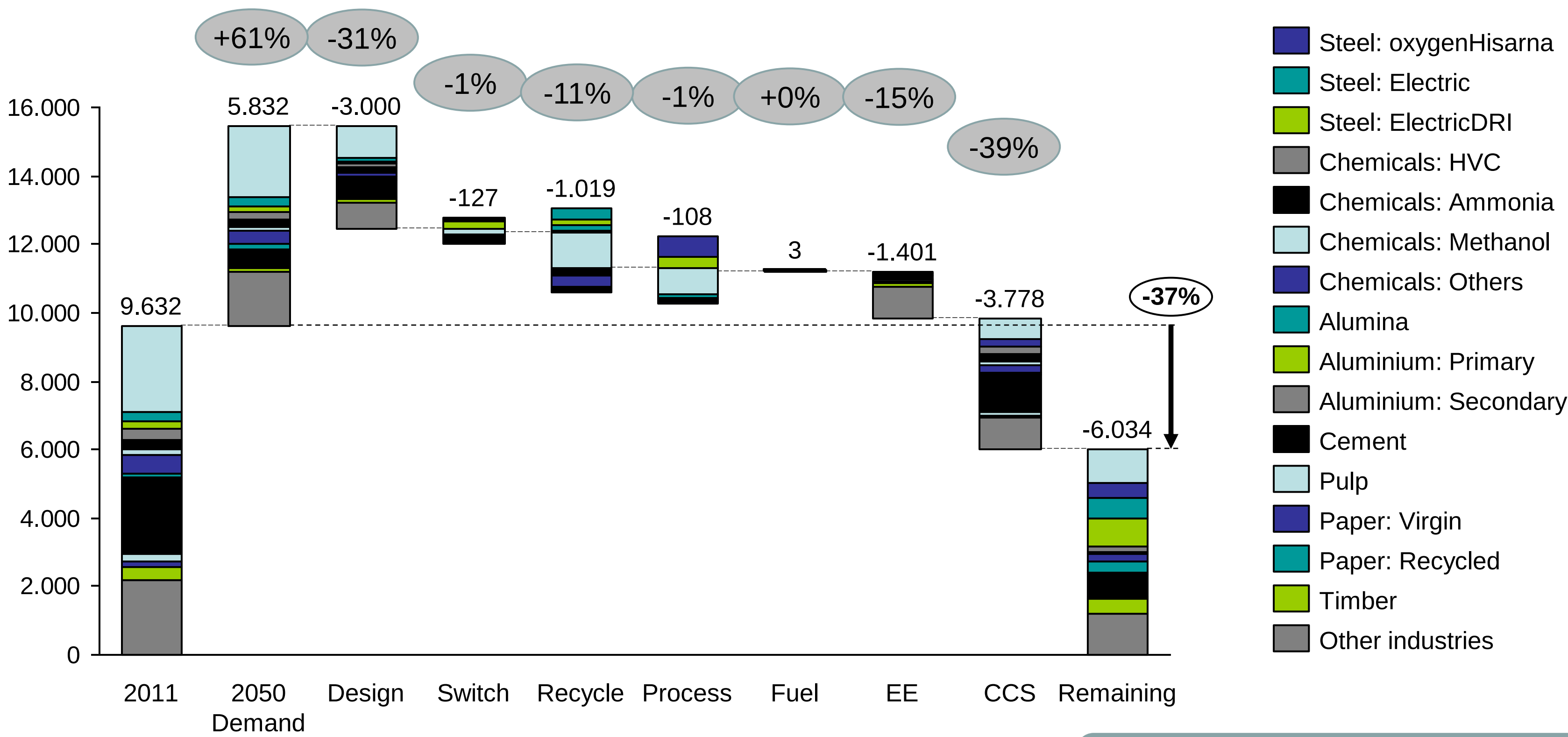


NOTE: (1) The population follows the average UN projection in all four trajectories
(2)Assuming biomass emits, not including electricity related emissions
SOURCE: IEA ETP 2012, Global calculator model

What are the key messages on GHG emissions mitigation

Total GHG emissions in 2050, for ambition level 3[1,2], using different levers[3]
($MtCO_2e$, % of 2010)



In real life, these levers are not applied separately

NOTES: (1) The population follows the average UN projection in all four trajectories
(2) Excluding biomass related reductions & electricity related emissions
(3) Other sectors are impacted by these transitions (e.g. additional emissions are created in the aluminium and plastics sectors)
Percentage reductions are calculated vs the 2010 baseline

SOURCE: IEA ETP 2012, Global calculator model

Thank you.

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