IEA Global Industry Dialogue
Expert Review Workshop
The European Chemical Industry perspective

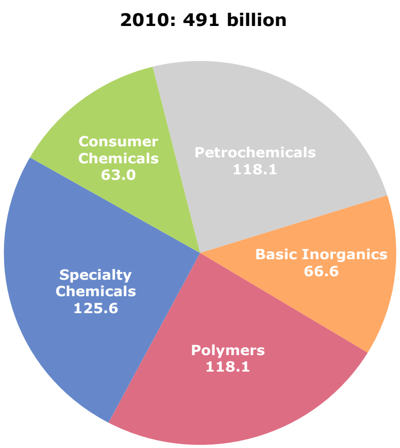
7 October 2013

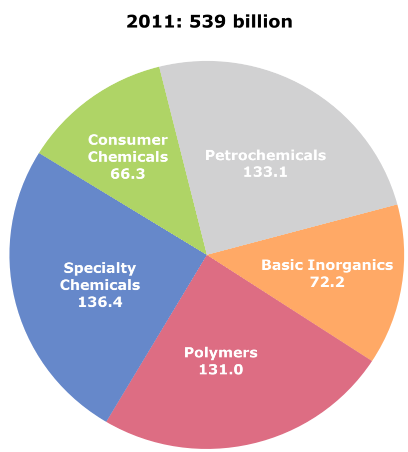
William Garcia

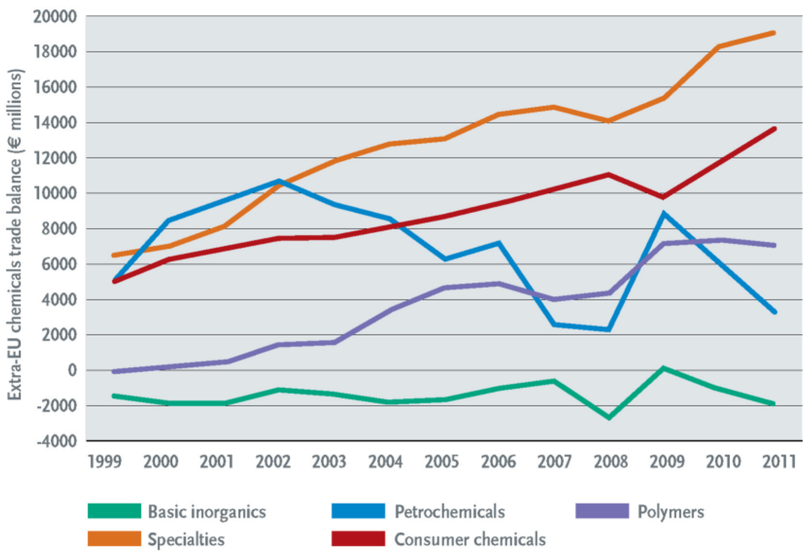
cefic

The European chemical industry in a nutshell

The EU chemical industry is a network of 26.000 companies, a direct employer to 1.2 M It contributes about €500 billion to the EU economy and €42 billion to its positive trade balance





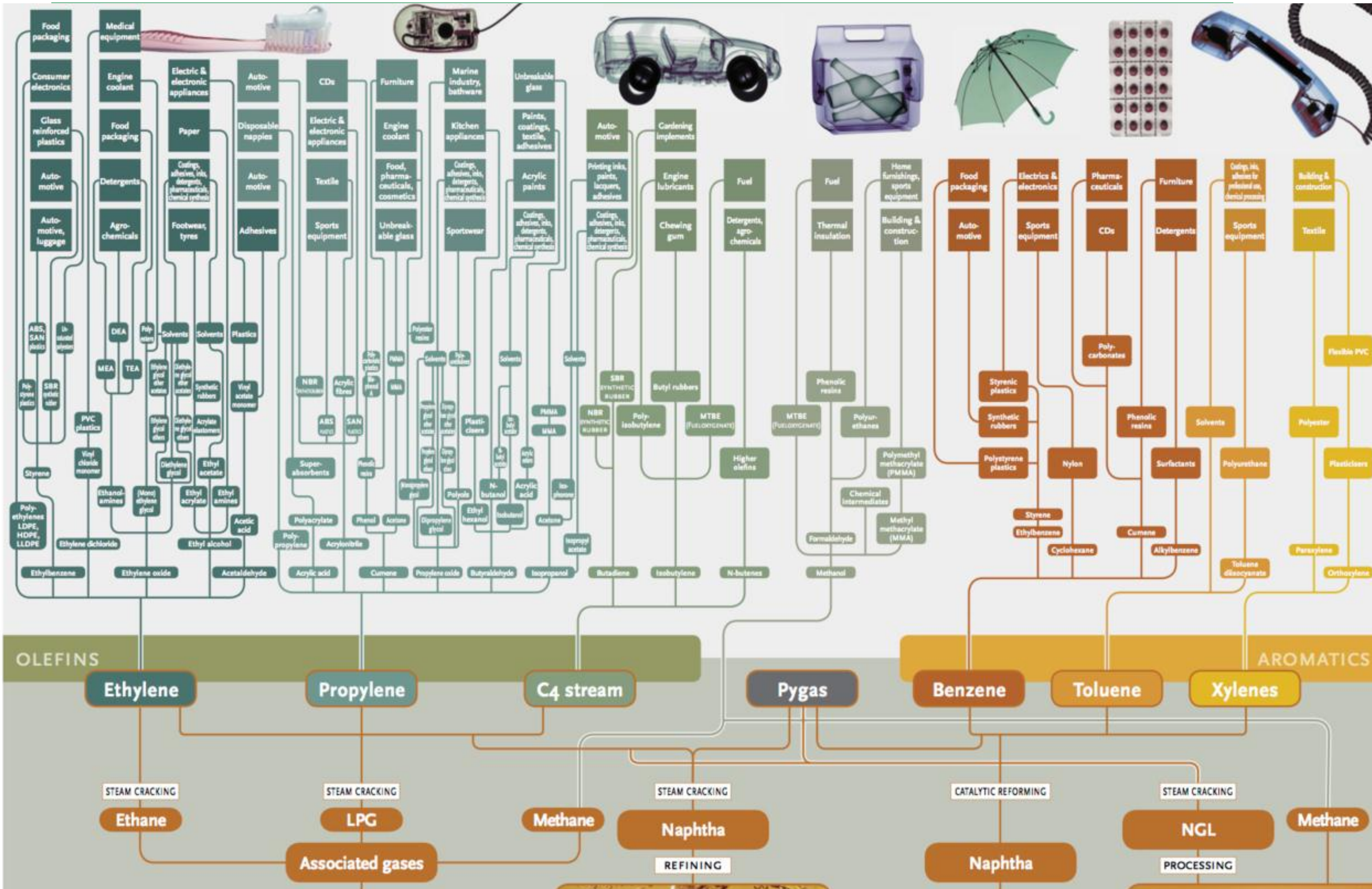


Source: Cefic, 2012
Facts-and-Figures

Sales 2010-2011

Trade 1999-2011

95% of Manufacturing Rely on Chemical Building Blocks



Why this roadmap ?

- **Cefic initiated the roadmap study to explore opportunities and risks for the European chemical industry**
- **Roadmap timeframe: 2020 – 2050**
- **Based on four scenarios: each differ in terms of policy targets in Europe and rest of world, energy and feedstock costs, and speed of innovation**
- **Cefic commissioned ECOFYS to perform analyses and bring forward key conclusions and recommendations from their independent viewpoint, all in close collaboration with sector**

FACTS AND FIGURES
European chemistry for growth :

"Unlocking a competitive, low carbon and efficient future"

William Garcia **7 Oct. 2013**

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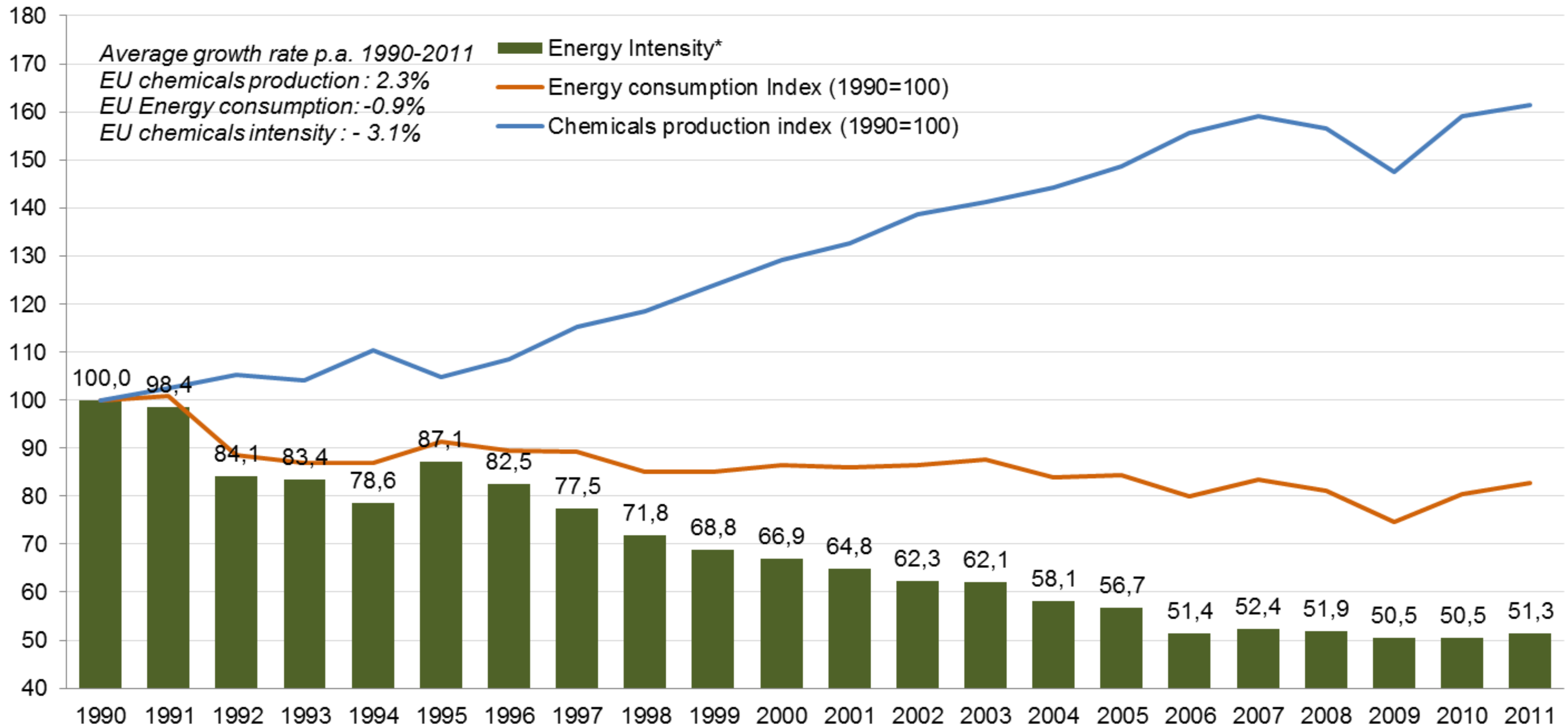
Energy Efficiency

The EU chemicals industry has reduced energy intensity by 48.7 per cent since 1990

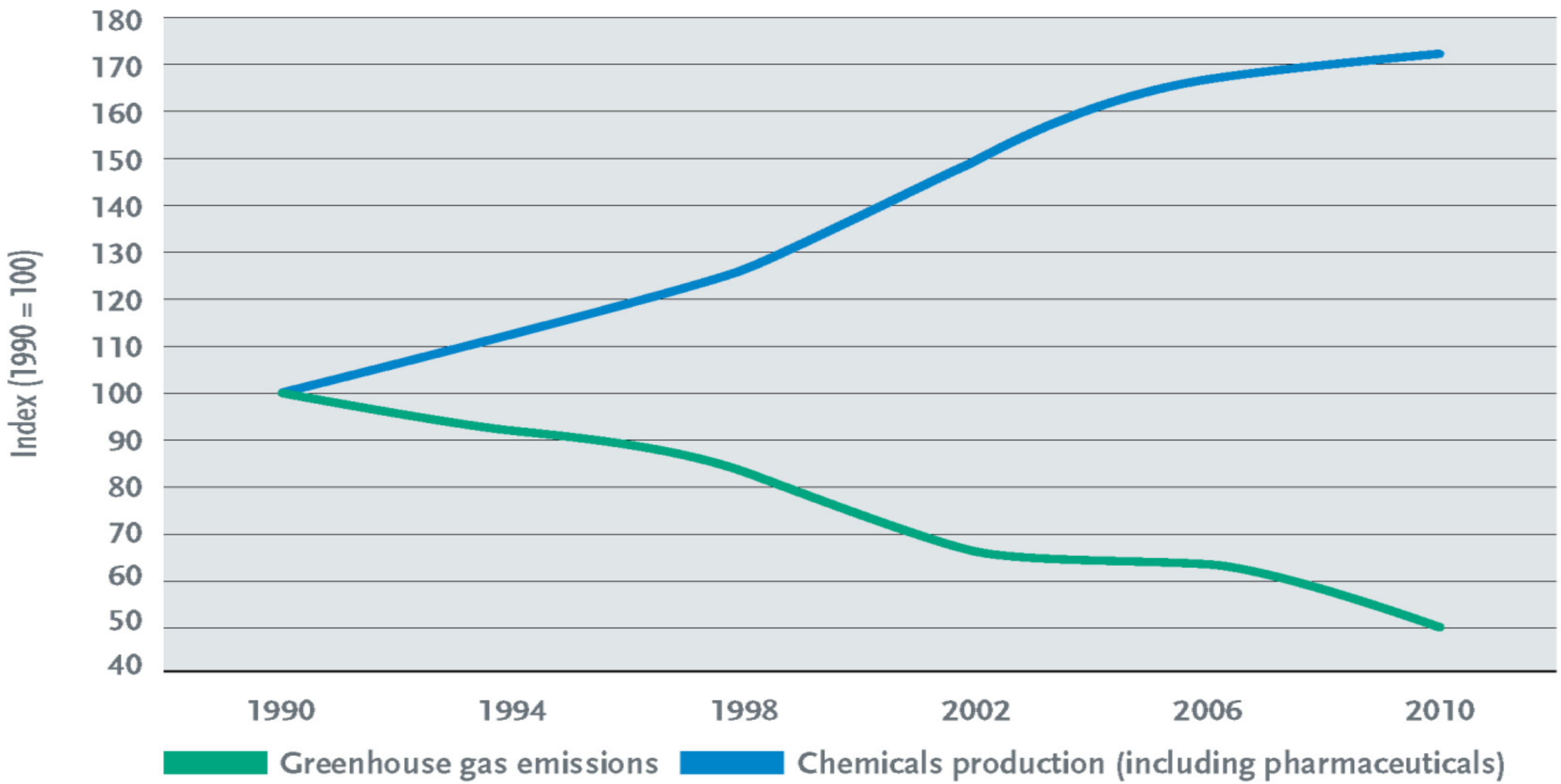


*Energy intensity is measured by energy input per unit of chemicals production (including pharmaceuticals)

Source: Eurostat and Cefic Chemdata International

GHG emissions

The EU chemicals industry has reduced GHG emissions (Tier1) by 50 per cent since 1990



Development of chemicals production (production index based on value added) and greenhouse gas emissions (indexed, 1990 = 100, Cefic, 2012a)

Energy Matters for Chemicals Sector

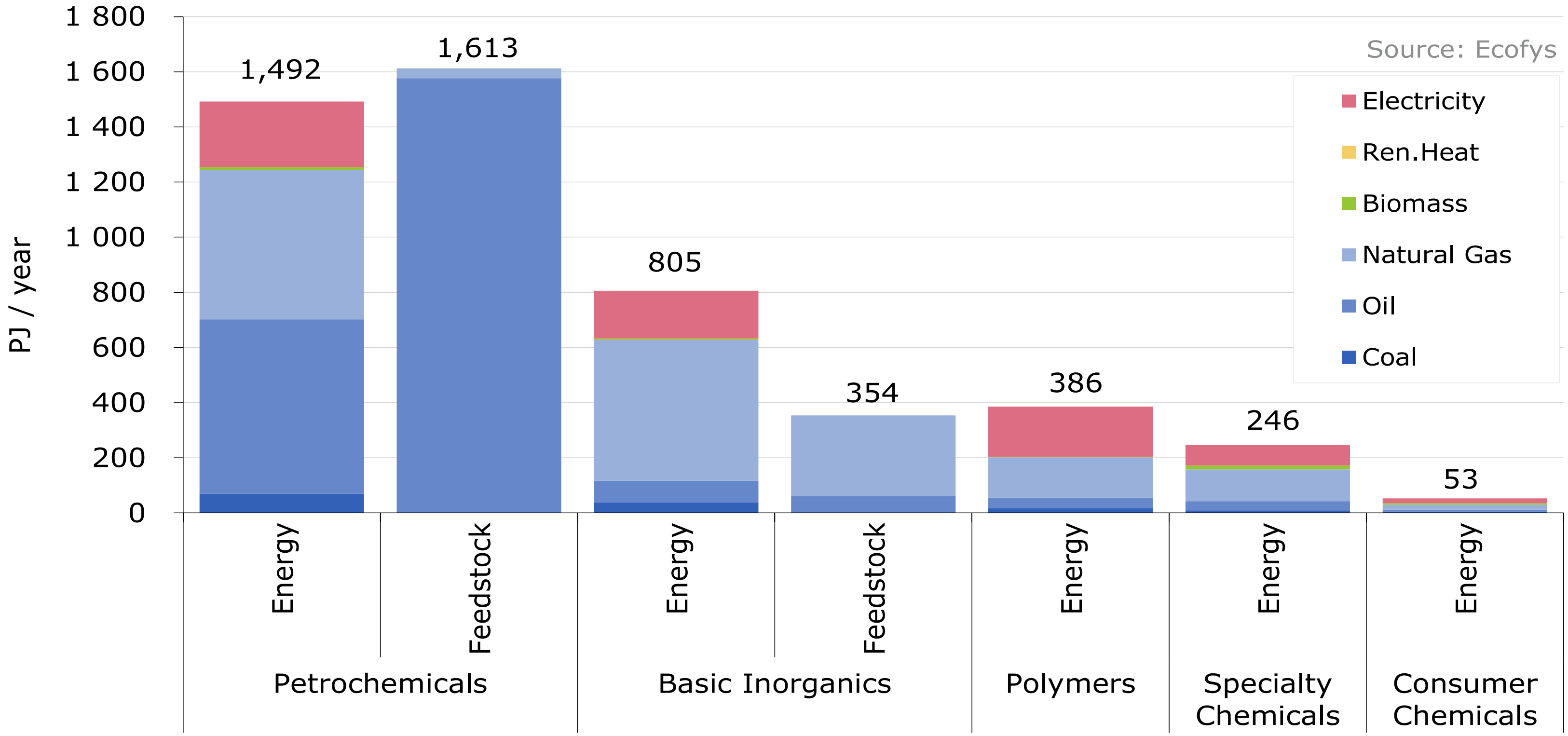
- **Used as feedstock AND to power plants**
  - Global energy demand 42 EJ/yr (two thirds feedstock)
  - 10% of global (30% of industrial) demand
  - Fastest growing industrial consumer

- **18 chemical building blocks account for 80% of energy demand**
  - Average energy costs about 50%, but key building blocks have cost impact of up to 85%

- **95% of manufacturing require chemistry inputs**
  - “Competitive Energy” biggest sector concern & growing issue for EU economy’s broader manufacturing base

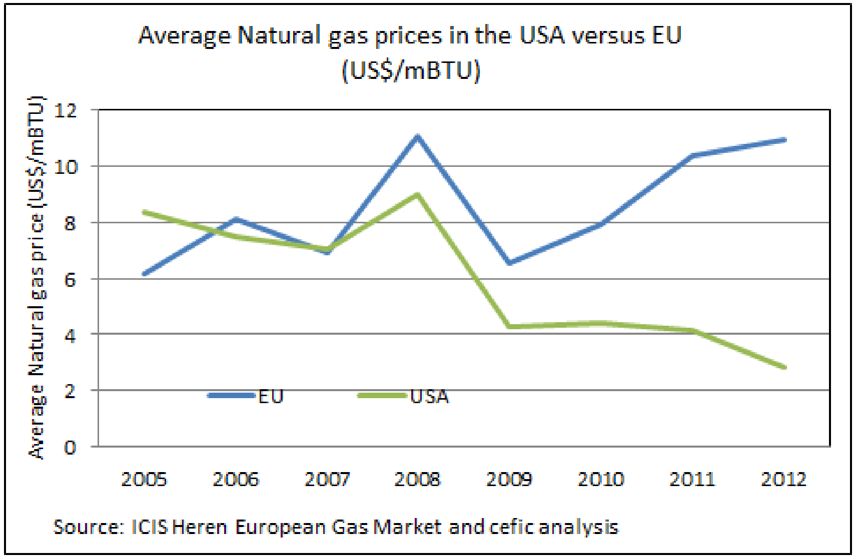
Energy consumption mix

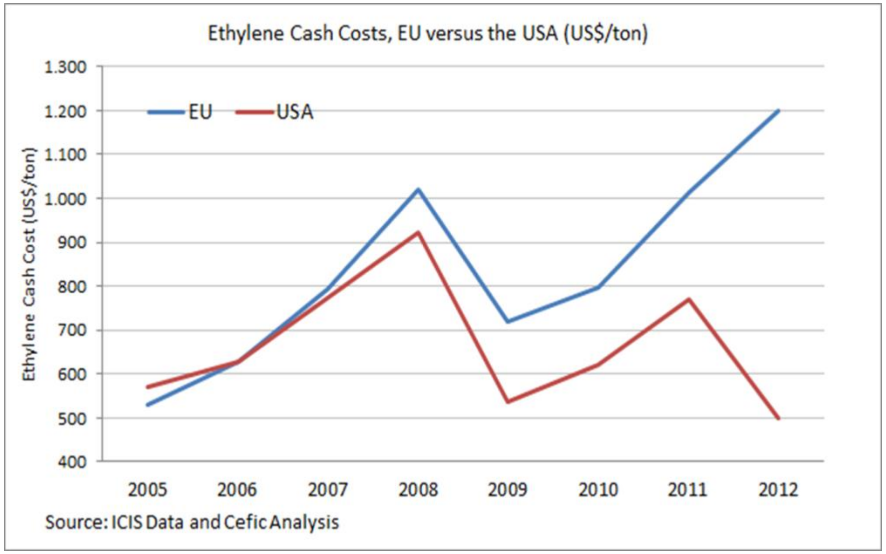
The EU chemicals industry is heavily dependent on gas and oil

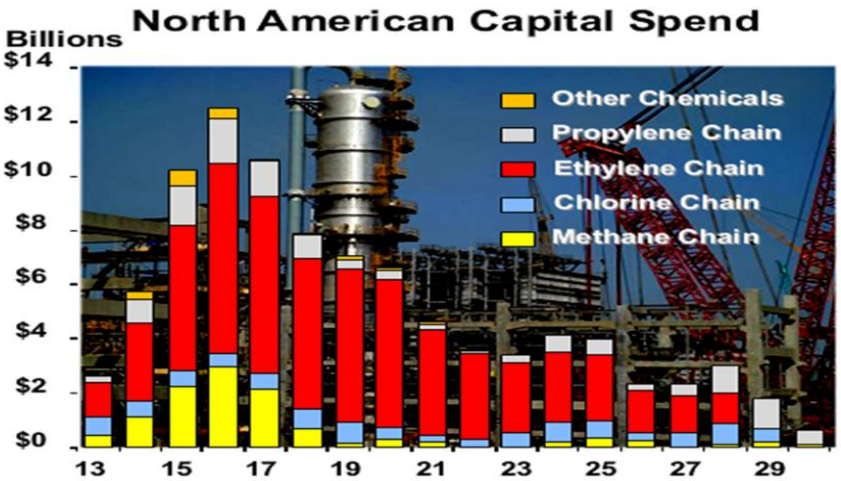


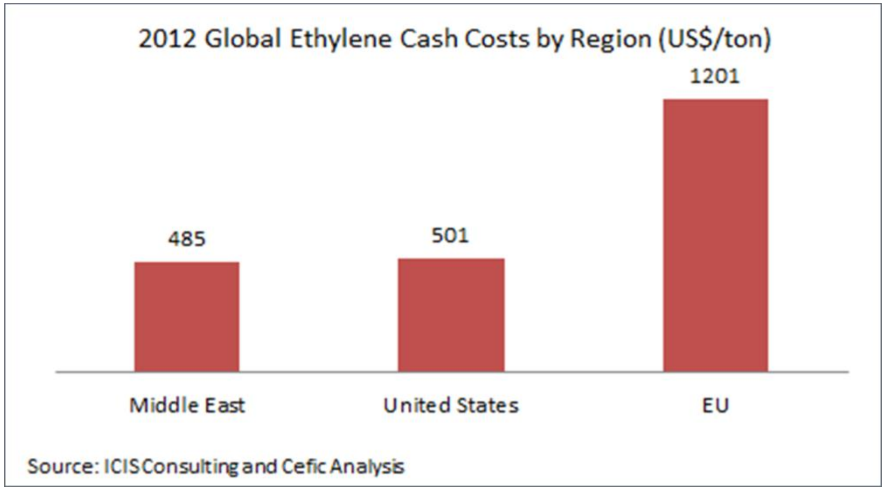
Energy consumption per chemical industry subsector, 2010- **source Ecofys**

Uncompetitive level playing field for the European chemical industry





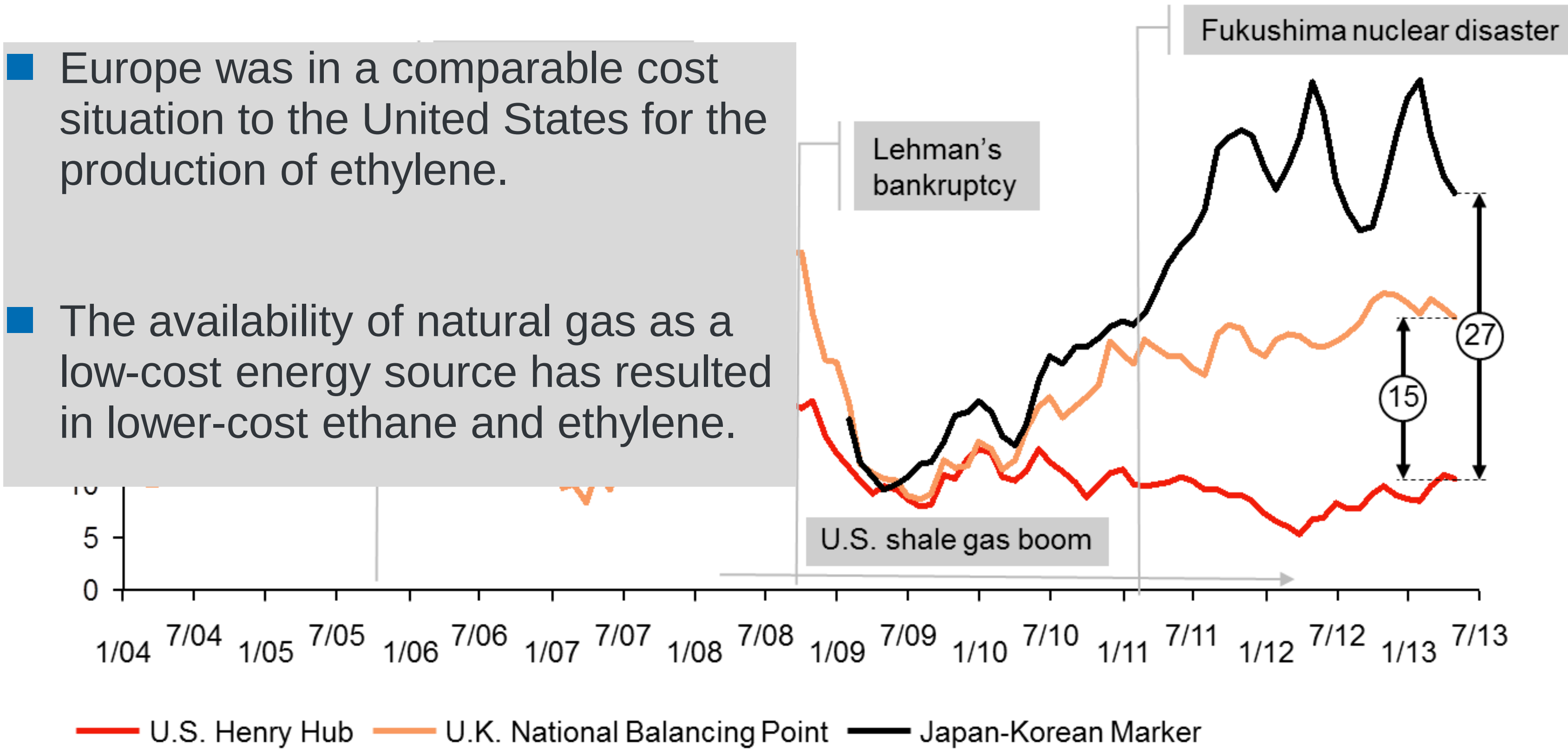




New World to 2020 requires new course of actions

Historic development of spot gas prices [€/MWh, nominal]

- Europe was in a comparable cost situation to the United States for the production of ethylene.
- The availability of natural gas as a low-cost energy source has resulted in lower-cost ethane and ethylene.

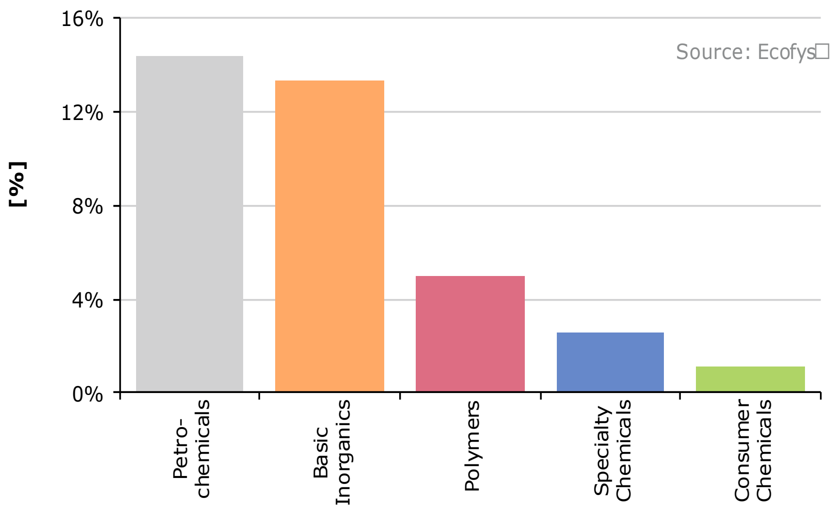


Source: E.ON

EU Energy & Policies costs

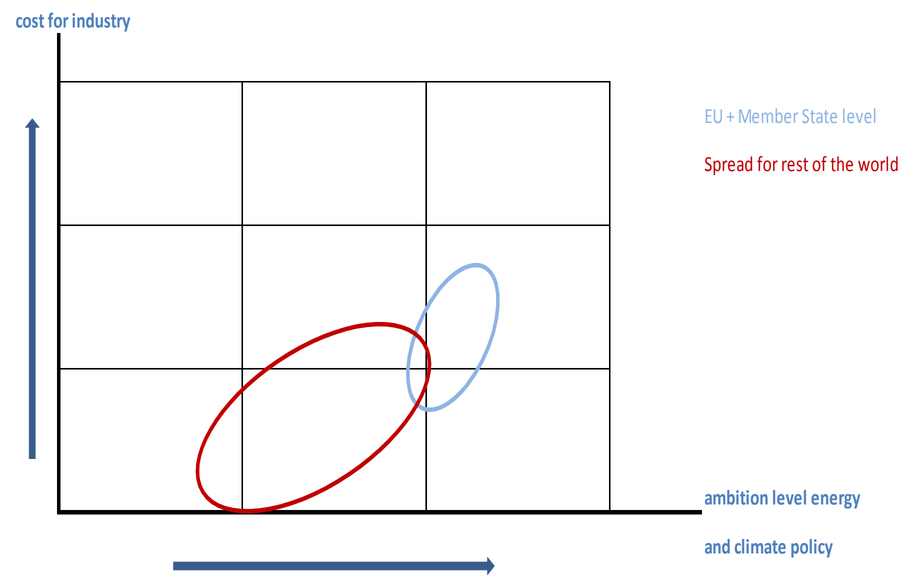
To stay competitive, the EU chemicals industry needs a access to more competitive energy mixes and policy environment

Energy costs



Energy costs as a proportion of sales for the five subsectors of the chemical industry subsectors in 2010

Policy costs



Policy ambition levels and associated costs in the European Union and in the rest of the world

Source Ecofys

The world has changed tracks from 2007 assumptions

2007	2013
Economic growth	Economic crisis: EU competence ?
Global agreement “by 2009”	Fragmented climate policies
Climate Change = “EU Leadership”	EU marginalised
“Depleting fossil energies: surging prices”	US shale gas revolution, EU investment leakage
Liberalising EU Energy market	Regulated Energy markets ?
Uniform pan-european RES policy well accepted by public	Scattered, unefficient and costly RES policy implementation leading to uncompetitive costs
“Rolling out CCS”	Lagging implementation of CCS
Nuclear energy part of the EU mix	Post Fukushima – less/no nuclear
ETS as ‘flagship’ policy tool to achieve target at low cost	“backloading, CSCF, carbon leakage list, LRF”, EU / national policy potpourri

Facts have changed and costs continue to rise…

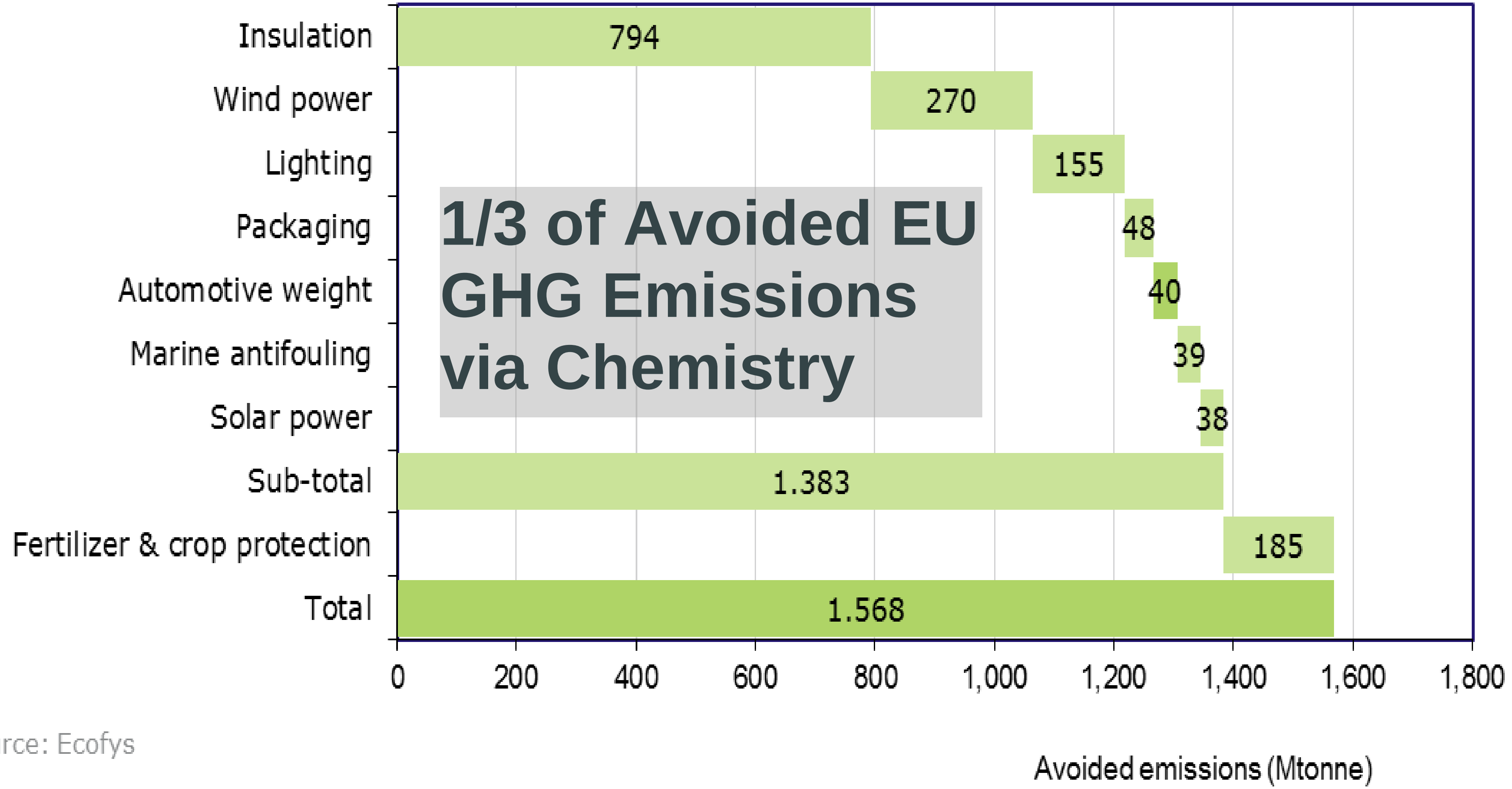
ROADMAP KEY FINDINGS
European chemistry for growth *:*

"Unlocking a competitive, low carbon and efficient future"

William Garcia **7 Oct. 2013**

Key findings

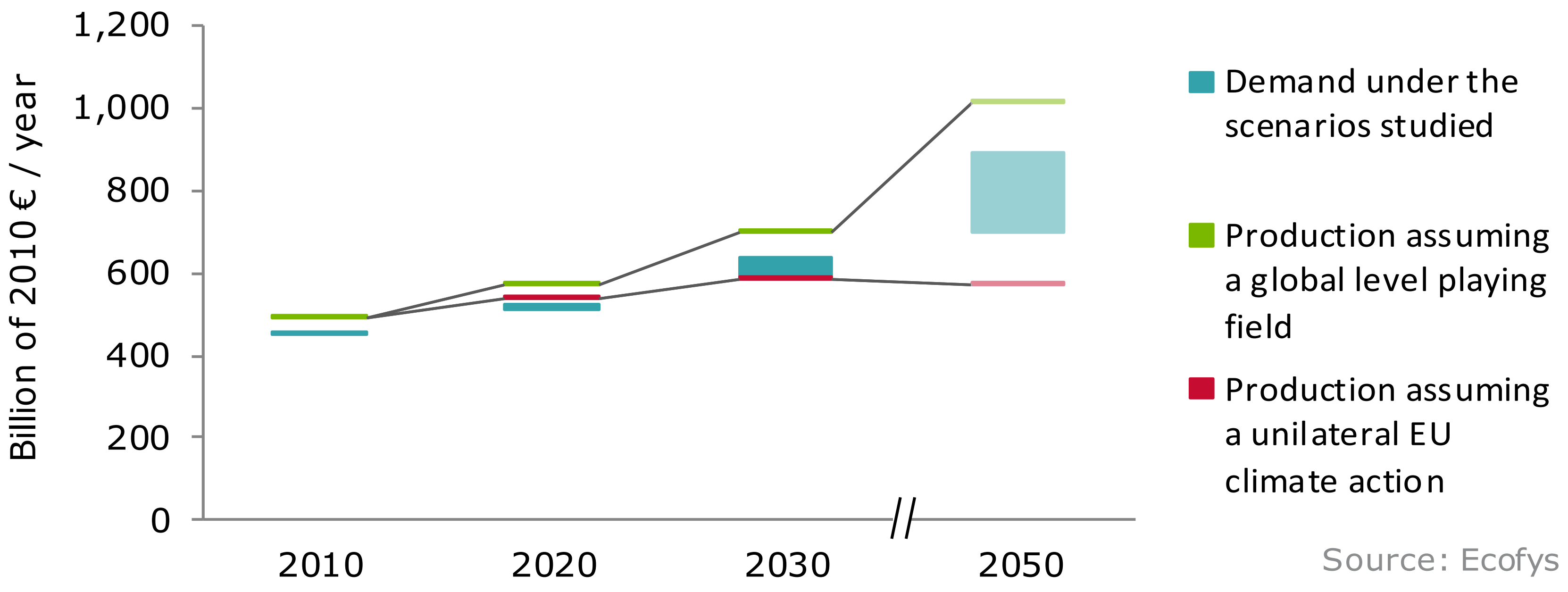
Chemical industry products enable significant improvements in energy efficiency and GHG emission reductions in all sectors.



Source: Ecofys

Key findings

EU production growth and EU demand.

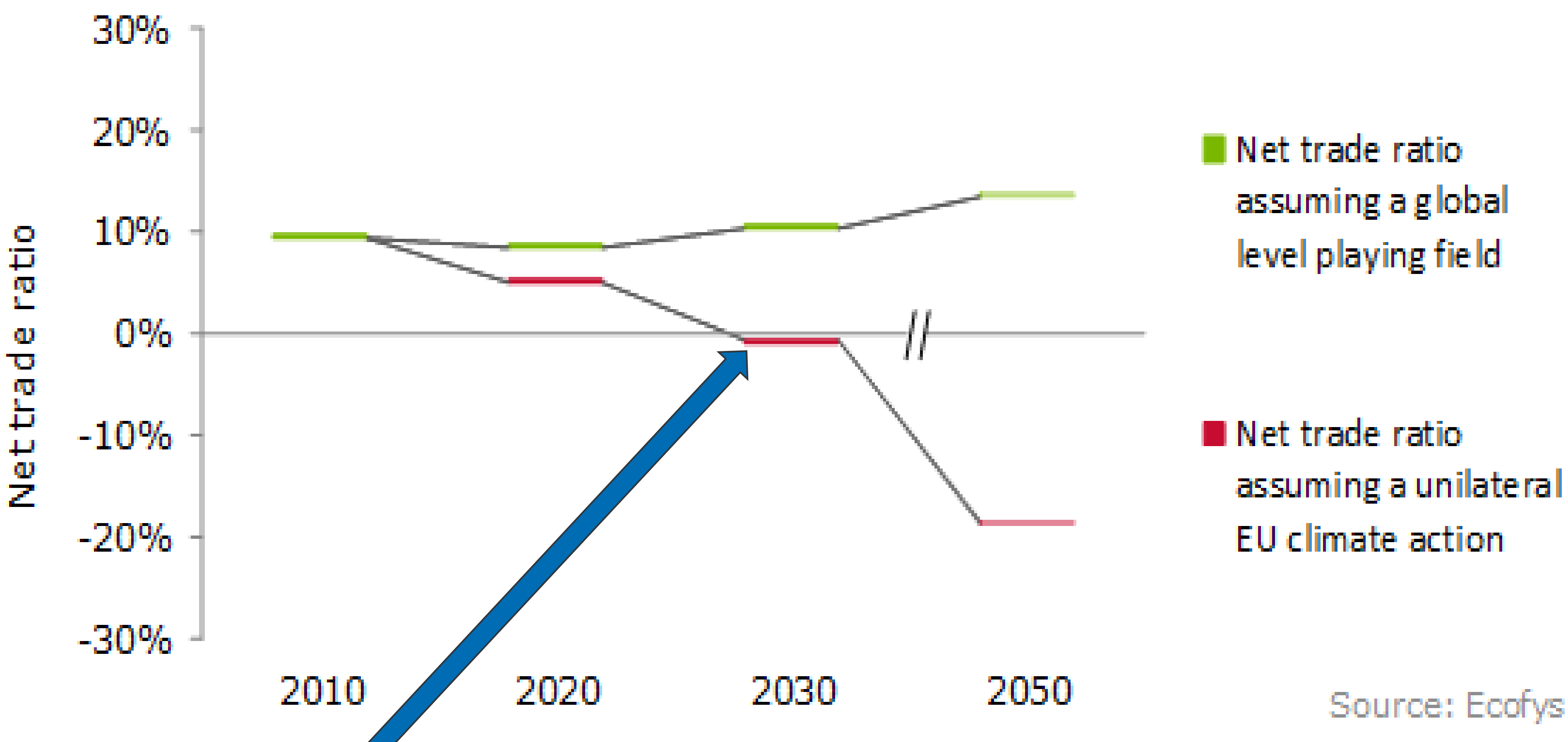


Consequences of Level Playing Field:

Growth & Jobs for EU industry

Key findings

Competitiveness of entire European chemical industry value chain **threatened** due to diverging energy and policy costs.

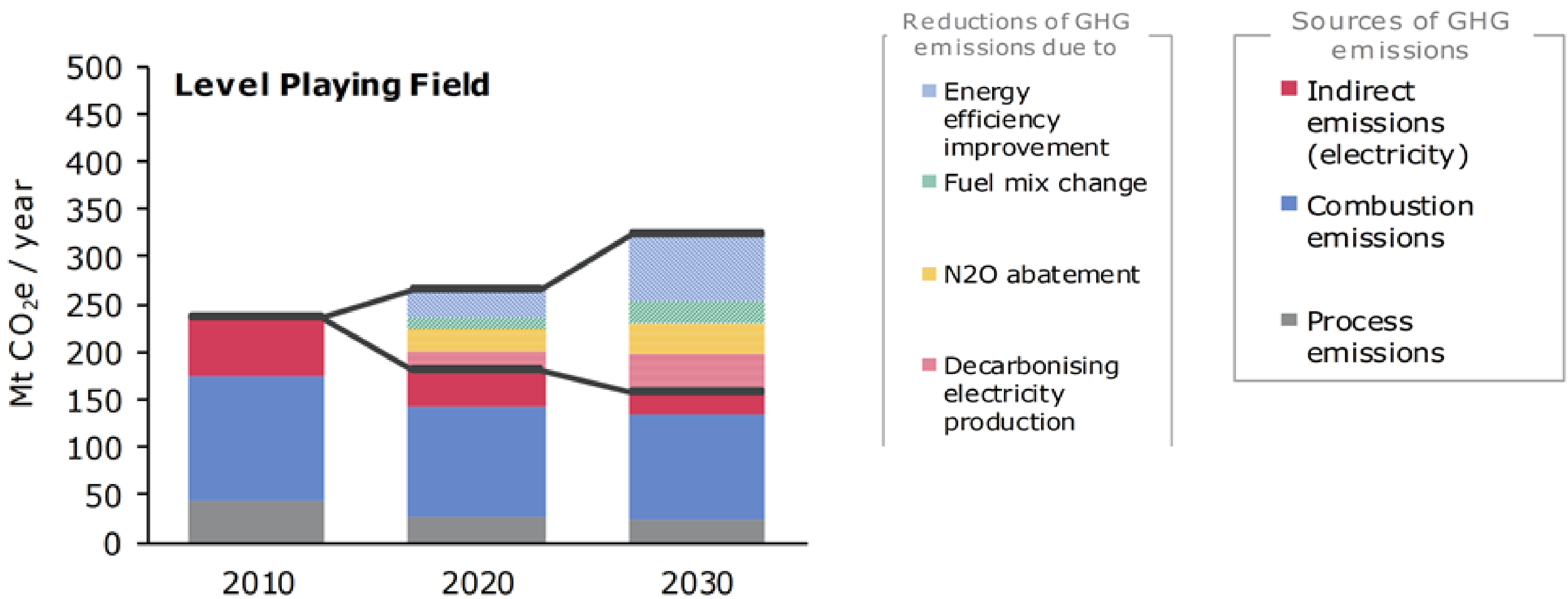


Consequences of Unilateral Action:

Exporting Production & Increasing Global GHGs

Key findings

In a global playing field scenario, energy efficiency, N2O abatement and changes in the fuel-for-heat mix could result in 15% absolute reduction of GHG emissions in 2030 vs. 2010 (e.g. 30% decrease in GHG emission relative intensity). All options rely on innovation.



Deeper reductions technically possible by power sector decarbonisation, CCS

POLICY ASKS TO 2030
European chemistry for growth *:*
“Unlocking a competitive, low carbon and efficient future”

William Garcia 7 Oct. 2013

Addressing the EU Policy makers: Key messages inspired from the Roadmap

- The EU chemicals industry (ECI) can make a significant contribution to the changes needed for a low carbon future. The ECI products enable energy efficiency and greenhouse gas emission reductions in all sectors.
- Energy is a fundamental input for the European economy and affordable energy is essential for economic growth. The energy costs in the European Union relative to those in competing regions are a key factor in global competitiveness since EU companies cannot pass on EU policy costs.
- The ECI acknowledges the EU vision of a sustainable, globally competitive low-carbon economy. The issue is not whether the European Union should aim for such a future but how?
- The European Union should continue to pursue a global agreement with equitable burden towards a global carbon price. In the absence of such an agreement, the European Union should pursue its objectives by measures that reduce the energy cost differential with its major competitors.
- The EU is at the crossroads. Short-term increases in the policy-driven cost of energy will inhibit investments needed to realise the longer-term benefits of innovation.
- Promoting innovation and market-driven competition would result in affordable energy, increasing investment and competitiveness.

Elements of Cefic position on integrated EU energy & climate policy

- **Energy: ensure predictability, security, affordability, coherence**:
  - ***3rd energy package towards the completion of the internal energy market,***
  - ***Diversify and use all energy sources*** *(including unconventional sources of energy),*
  - *Gradually* ***phase out subsidized*** *RES*
- **Climate : change course to apply a realistic climate approach to the EU, based on a substantial global agreement**
  - *In the absence of a global agreement, the Commission should provide a* ***realistic range for a pan-European climate goal****, taking scenarios into account.*
  - ***Support ETS beyond 2020****: Structural changes needed to introduce more flexibility and avoid short- term fixes like backloading*

Elements of Cefic position towards 2030

- **Enable economic growth: Inclusion of a 20% of industry share in GDP by 2020 and beyond**
  - *Keep the entire chemicals manufacturing chain in Europe*
  - *Move away from absolute energy consumption cap*

- **Focus on innovation: Build on sector specific knowledge and ability to deliver breakthrough technologies**

SHALE GAS - A GAME CHANGER

Impact for the European Chemical Industry

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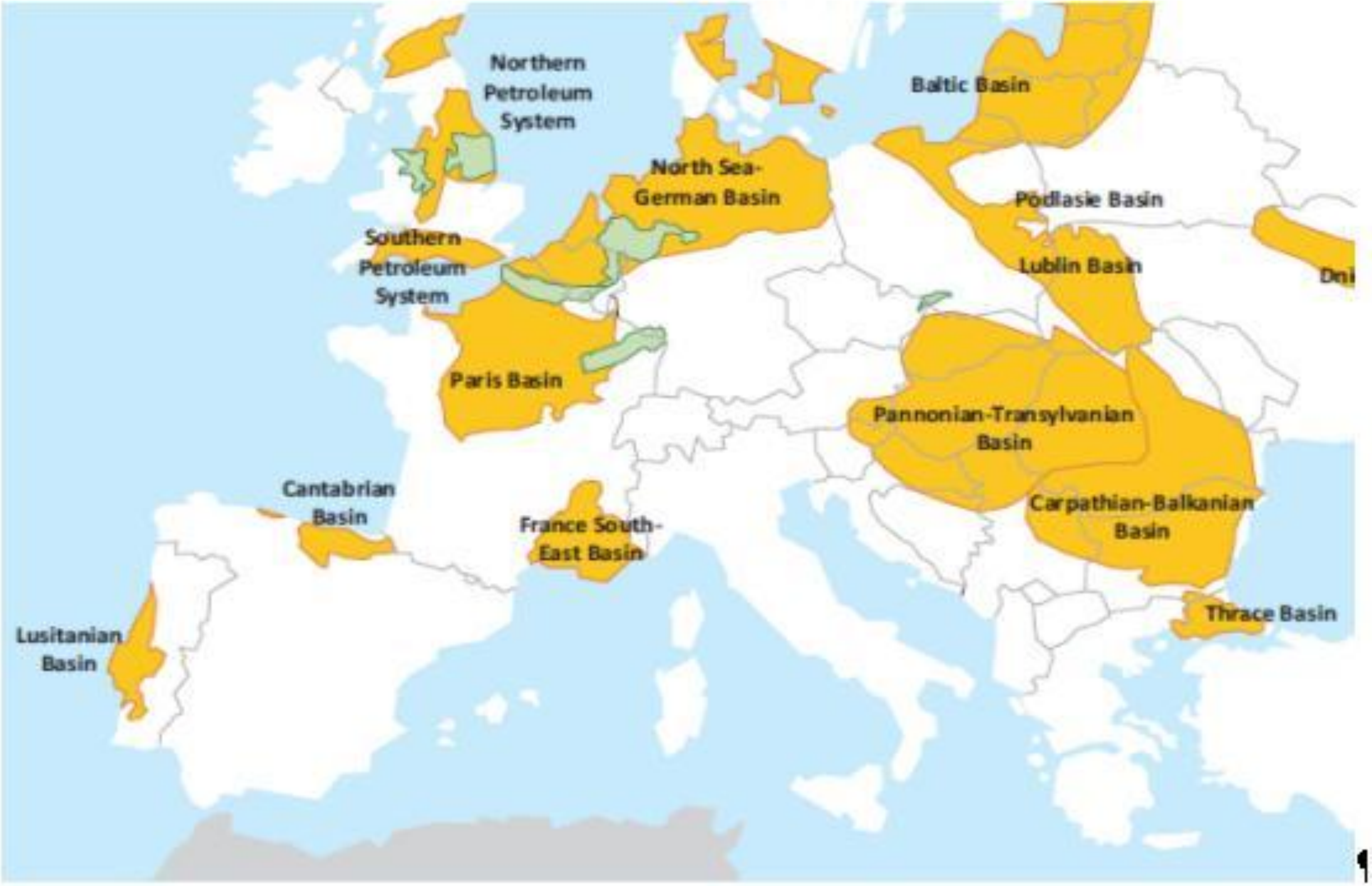
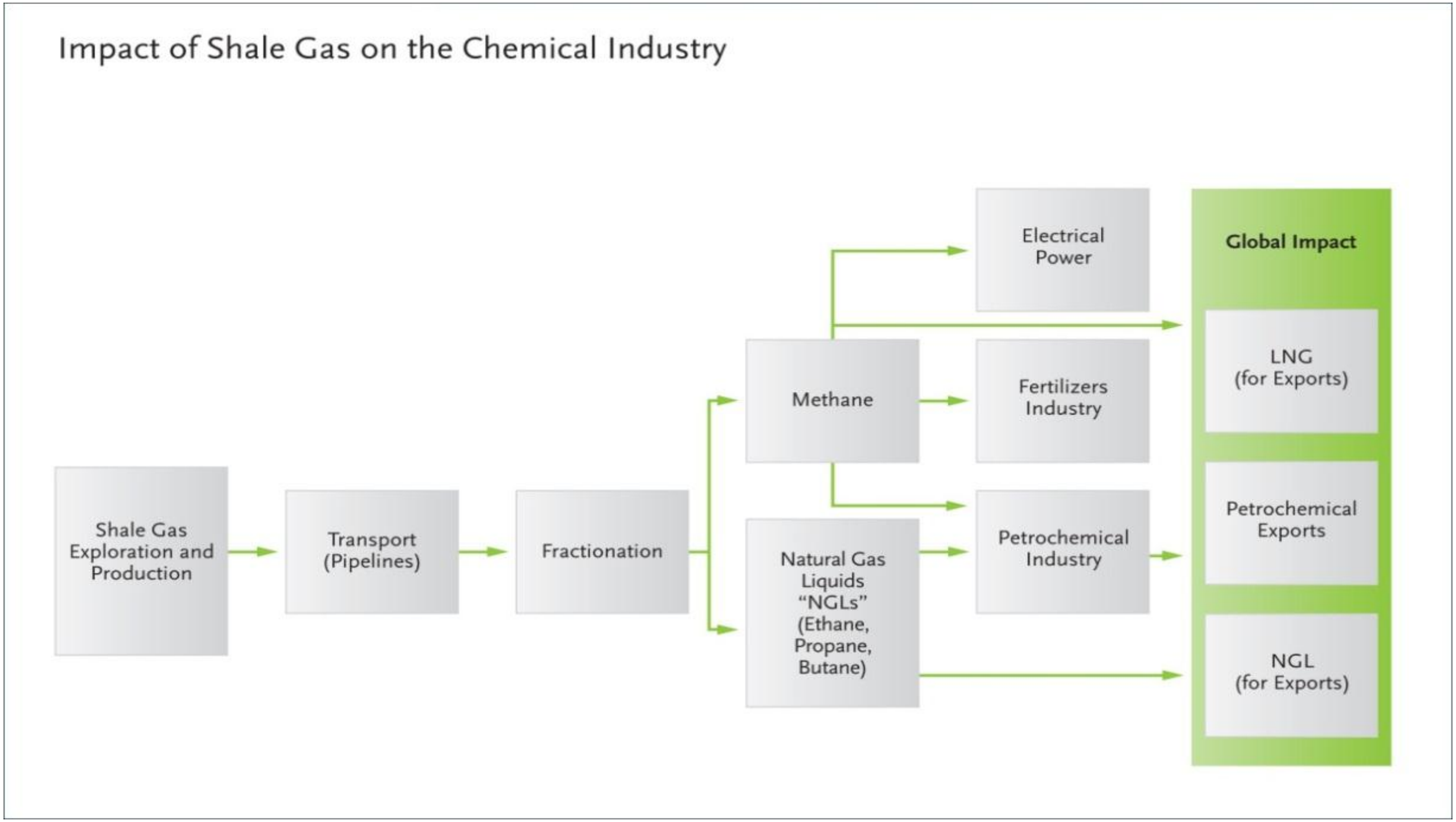
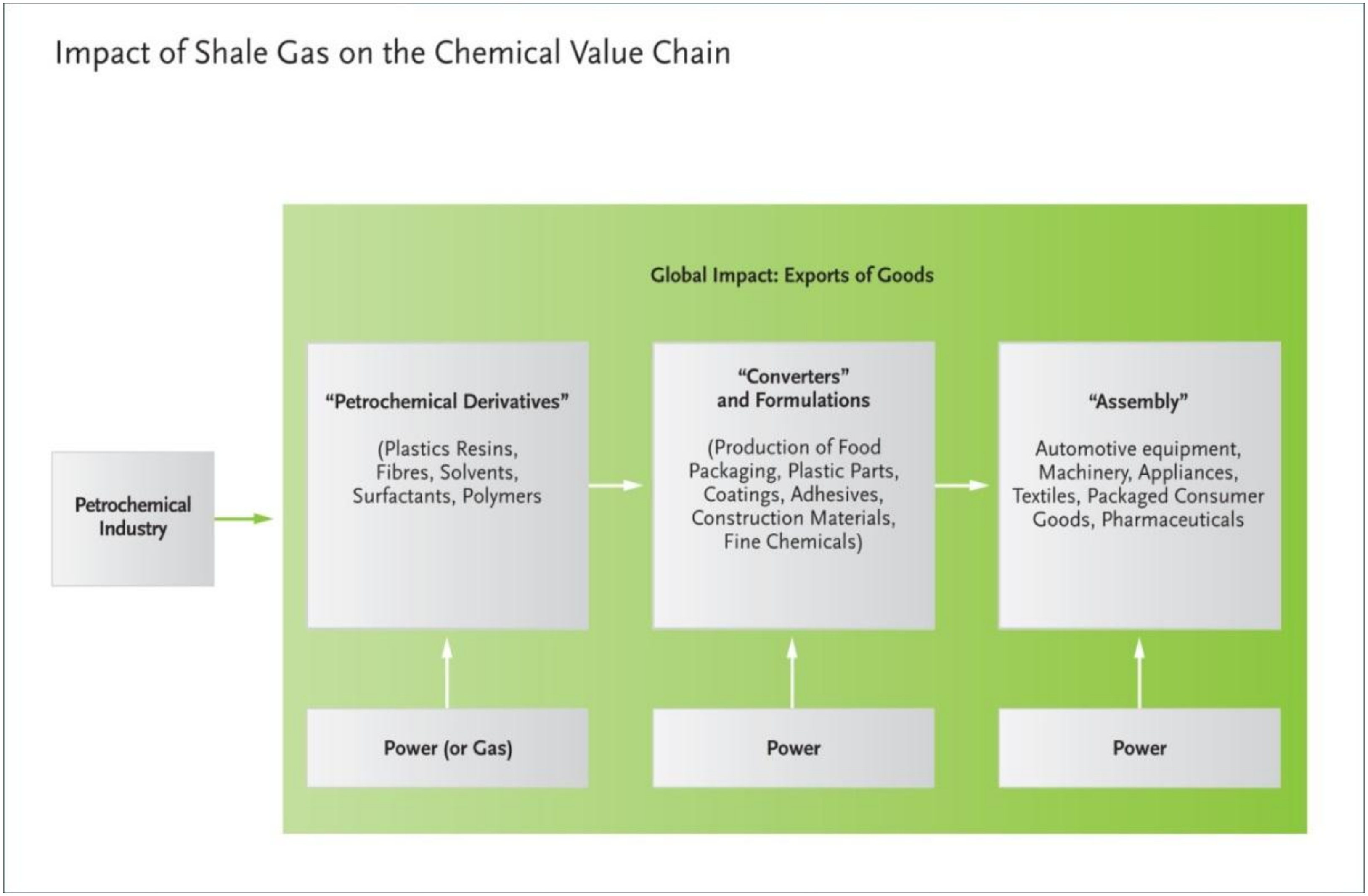
Europe has potential



Impact of shale gas on the EU Chemical Industry



Impact down the Value Chain



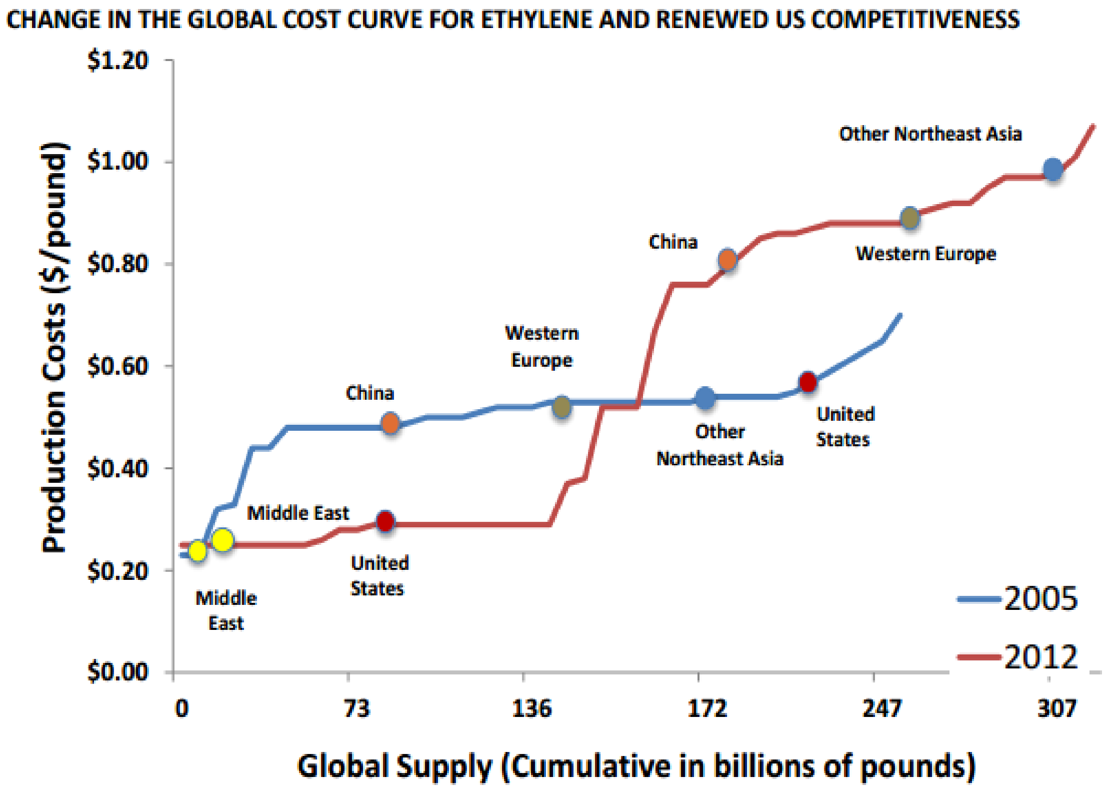
Impact on Petrochemicals and Fertilizers

- New Ethylene capacity in the US: +38% in 3-5 years
- US volumes of ethylene derivatives moving to Asia, Latam; impact on European exports
- EU naphta crackers disadvantaged vs. US ethane crackers

- New urea capacity in the US: 5-7 mio tons in 3 years
- US fertilizer import displacement; volumes likely to go to Europe
- Over supply situation expected by 2016

Low US Ethane Costs boost US Crackers' competitiveness

- The cost curve is built on the cumulative petrochemical capacity from the lowest cost producers (in the Middle East) to the highest cost producers (in Northeast Asia).
- US ethane-based ethylene producers have moved to the lower end of the global cost curve, after only the Middle East and Canada.

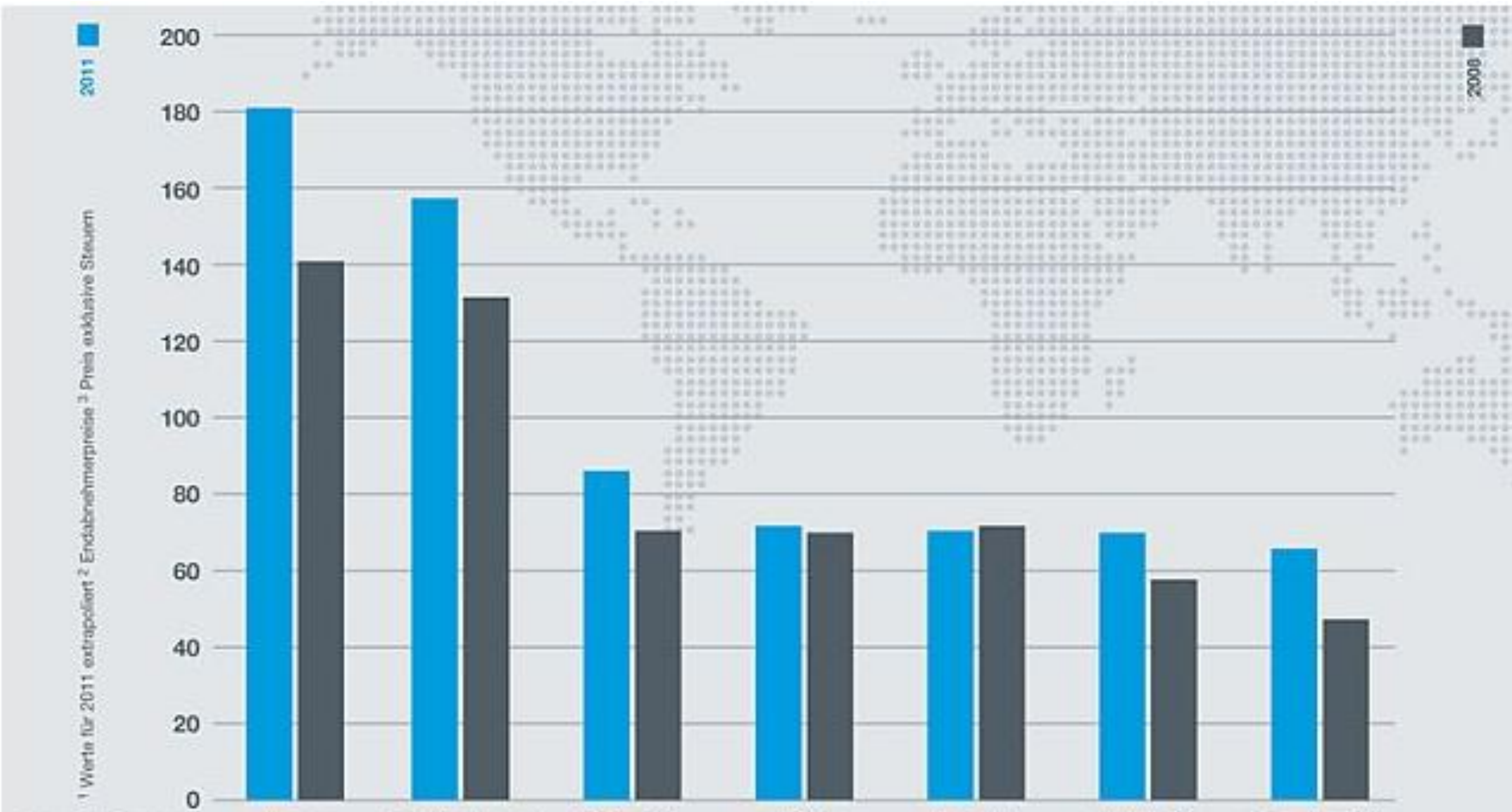


Source: ACC: Shale Gas Study, May 2013

Comparing Global Electricity Prices

Cost Advantages for US Industry

Average electricity price for industry in $ per Mwh (Source: BDI)

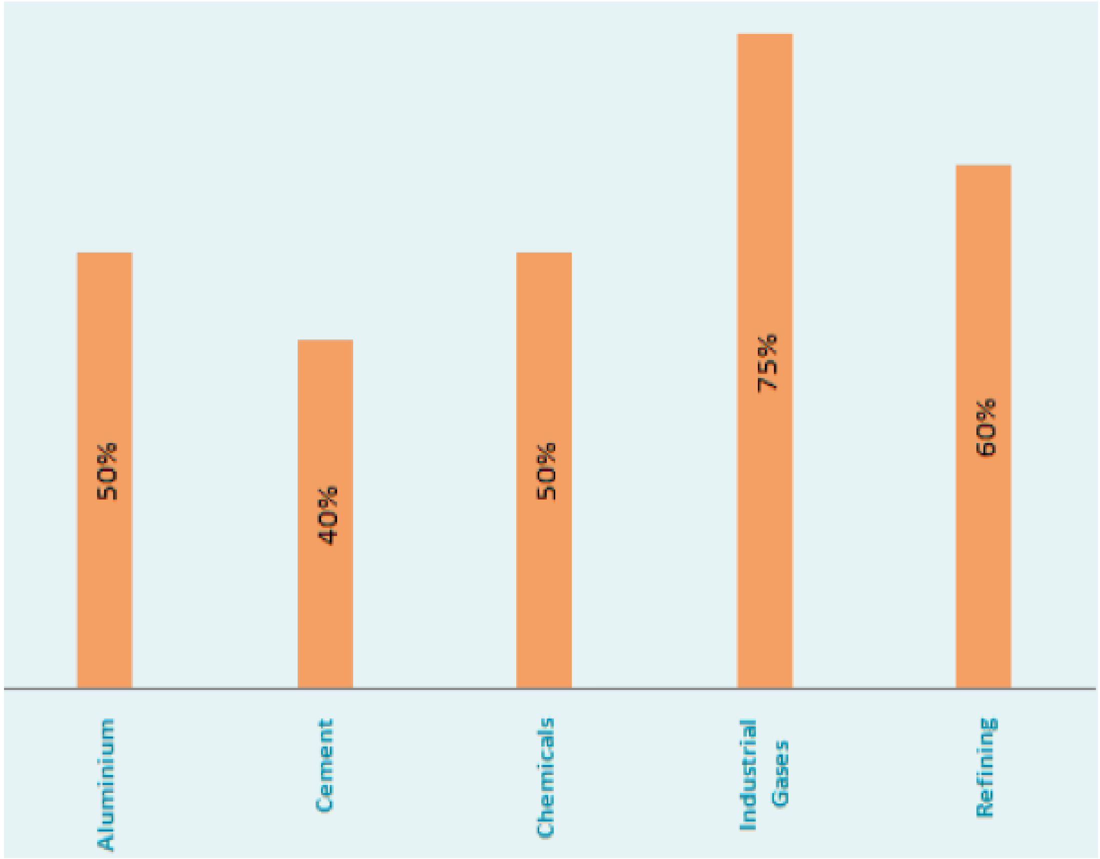


Japan Germany China USA Canada India Russia

Cost Advantages for US Industry

Negative Impact for EU Energy intensive Sectors

Energy cost as % of production costs in energy-intensive industries



Source: ERT

- In the chemicals sector, competition with the U.S., with relatively equivalent labour costs, is intensifying due to significant differences in energy prices.
- According to US EIA the industries which are affected mostly by lower gas prices are bulk chemicals and primary metals.

Low electricity prices for industry impact on future investment decisions.

Thank You

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Backgrounders

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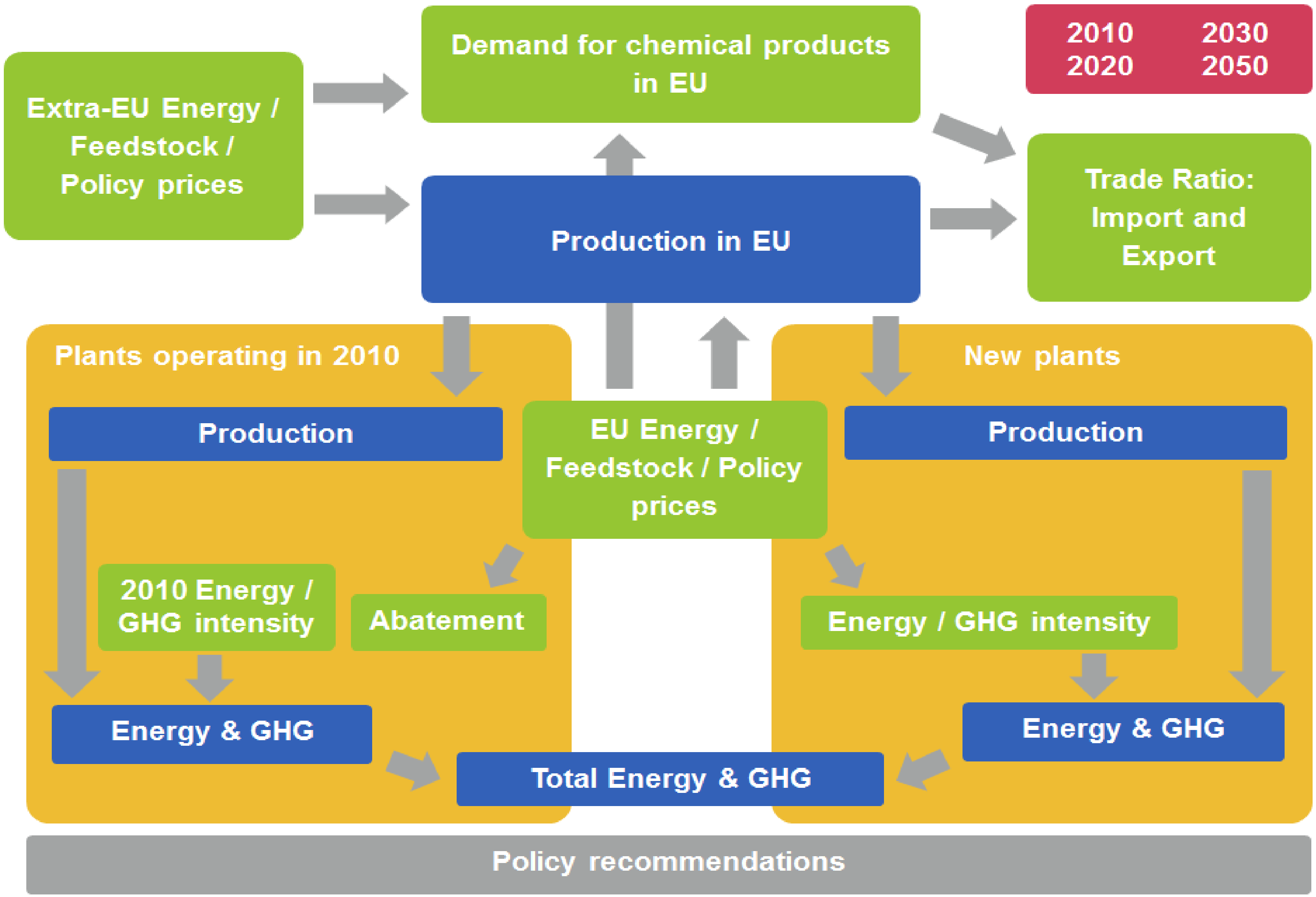
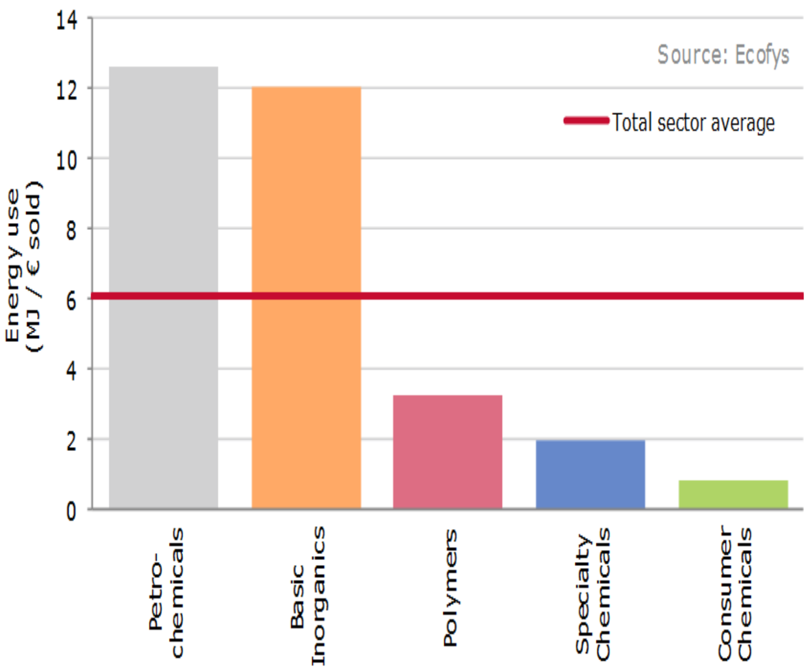
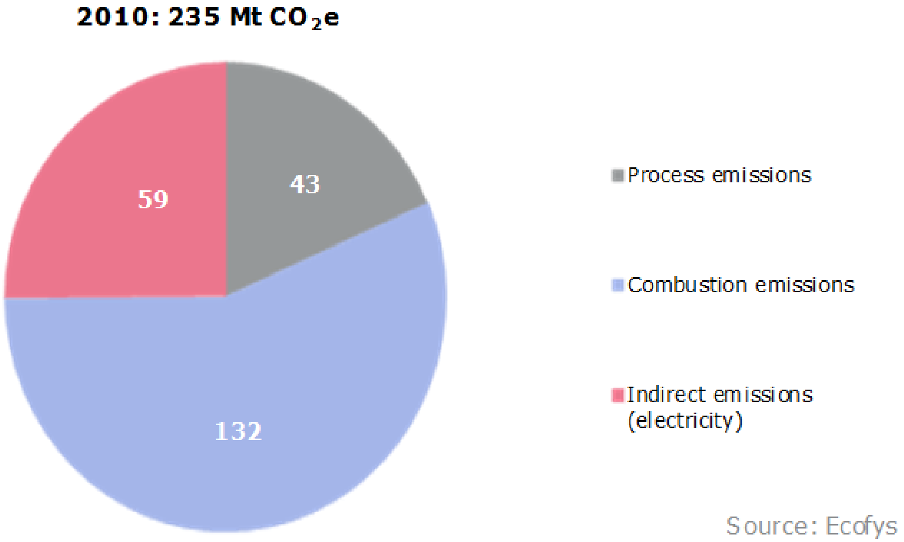
Cefic Roadmap data flow diagram



Roadmap Energy and GHG emissions 2010 baseline





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Cefic Roadmap Scenario narratives (1)

	Continued Fragmentation	Isolated Europe	Differentiated Global Action	Level Playing Field
Economy-wide GHG emission reduction target in Europe by 2050 compared to 1990	An economy-wide 40% target, 46% for industry.	An economy-wide 80% target, similar for industry.	An economy-wide 80% target, similar for industry.	Global ambition in line with 2 °C target (50% reduction), uniform global carbon price signal determines where abatement takes place.
Level of harmonisation	No global climate change agreement, continued fragmentation of worldwide energy and climate policies with low global and less ambitious EU ambitions.	No global climate change agreement, continued fragmentation of worldwide energy and climate policies the EU is the only region with ambitious climate ambitions.	Global commitment in line with 2 °C target. Country ambition levels and policies differentiated with limited global convergence.	Global climate change agreement in line with 2 °C target. Uniform global carbon price signal, e.g. via fully linked emissions trading systems.
Main features of the energy and climate policies in Europe	The current EU Policy Initiatives are implemented. Actions beyond the current initiatives are not undertaken.	On top of the current EU policy initiatives, Europe’s abatement is driven by carbon pricing for all sectors of the economy where all energy sources can compete on a market basis with no specific support measures for energy efficiency and renewables.		

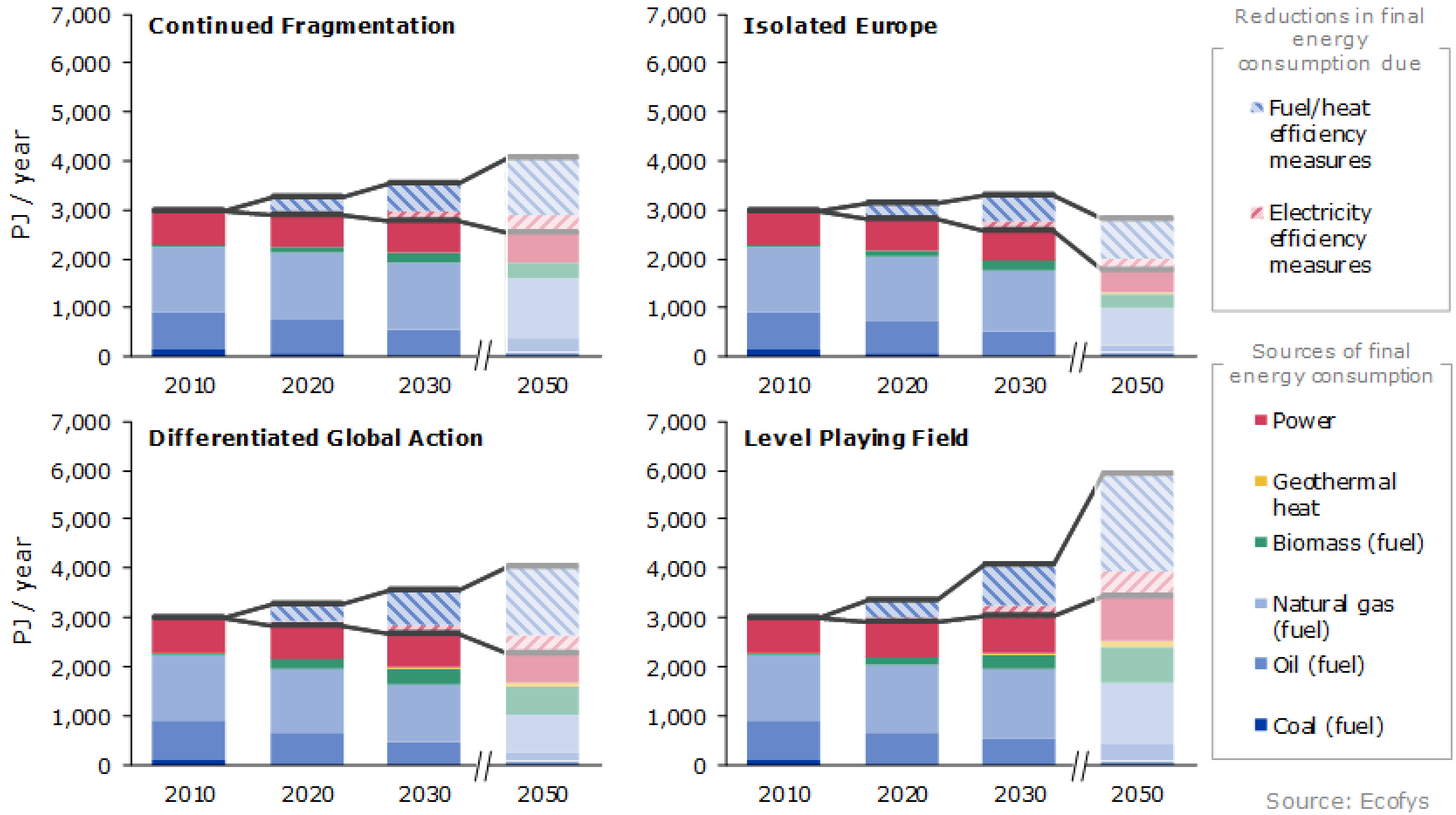
Cefic Roadmap Scenario narratives (2)

	Continued Fragmentation	Isolated Europe	Differentiated Global Action	Level Playing Field
Fossil fuel prices	Strong increase in global energy use resulting in increasing fossil fuel prices. No convergence in fossil fuel prices.		As a result of global action, fossil fuel use and price increases are limited. No convergence in fossil fuel prices.	
Industrial electricity prices	Electricity price of 107 € / MWh in 2030, stabilisation afterwards, continued differences in electricity price with rest of the world. Industry pays ~65% of average retail electricity price.	Electricity price of 132 € / MWh in 2030, stabilisation afterwards, continued differences in electricity price with rest of the world. Industry pays ~80% of average retail electricity price.	Electricity price of 96 € / MWh in 2030, stabilisation afterwards, continued differences in electricity price with rest of the world. Industry pays ~60% of average retail electricity price.	Electricity price of 128 € / MWh in 2030, stabilisation afterwards; converging electricity prices globally. Industry pays ~80% of average retail electricity price.
CO_2 prices (in constant 2010 € / t CO_2)	2030: 33 2050: 53	2030: 44 2050: 221	2030: 54 2050: 276	2030: 37 2050: 194

Cefic Roadmap Scenario narratives (3)

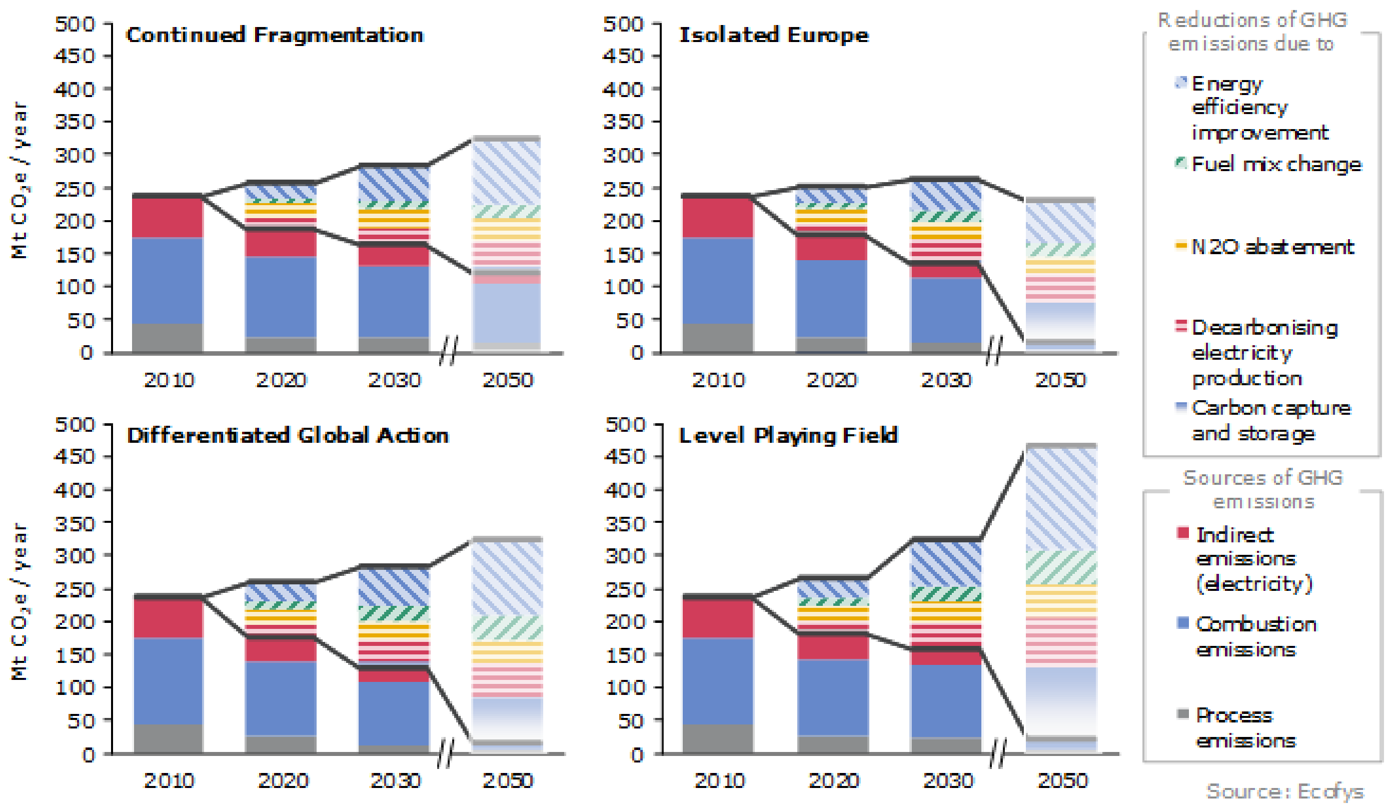
	Continued Fragmentation	Isolated Europe	Differentiated Global Action	Level Playing Field
Scope of carbon pricing, allocation and differences with rest of the world	Existing ETS scope. Continued, but declining free allocation for direct emissions in the 2030–2050 period, no free allocation for power sector. No effective CO_2 price signal in rest of the world.	ETS and non-ETS sectors have equal CO_2 prices from 2020 onwards. No free allocation after 2020. No effective CO_2 price signal in rest of the world.	ETS and non-ETS sectors have equal CO_2 prices from 2020 onwards. Continued, but declining, free allocation for direct emissions, no free allocation for the power sector CO_2 price difference taking free allocation of allowances into account with the rest of the world at most 30 € / t CO_2.	ETS and non-ETS sectors have equal CO_2 prices from 2020 onwards. No free allocation after 2020. Uniform, global CO_2 price signal.
Innovation	Low. Predominantly small incremental innovations without major development and deployment of breakthrough technologies.	Medium. Innovation in Europe is somewhat accelerated due to the high CO_2 prices in this scenario.	High. Global action has a positive stimulus on the development and deployment of breakthrough technologies resulting in significant technology spillovers between world regions.	

Cefic Roadmap: Resulting final energy use and energy efficiency improvements 2010–2050 (in PJ / year)



> Upper lines reflect energy use with projected production and 2010 energy intensity

Cefic Roadmap: Resulting GHG emissions and contributions of GHG emission reductions 2010–2050 (in Mt CO_2e / year)

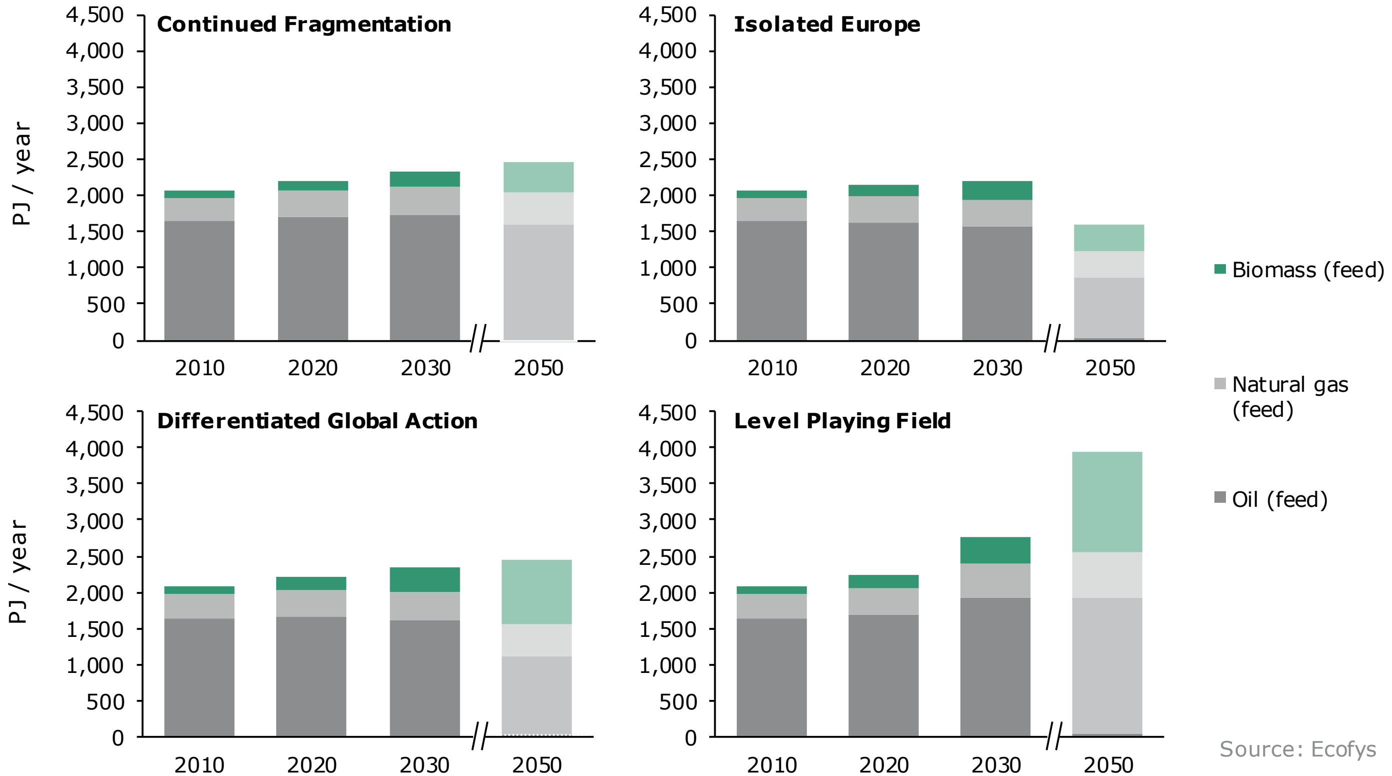


- > Upper lines reflect GHG emissions with projected production and 2010 GHG emission intensity;
- > Emissions are scope 1 and 2 only and for that reason exclude upstream emissions from fossil fuel exploration and production, emissions from the cultivation of biomass and emissions related to end-of life treatment of chemicals outside the scope of the chemical industry.

Cefic Roadmap : projected energy and emission profile – summary

- By 2030, final energy use (excluding feedstock) decreases slightly in the Continued Fragmentation and Differentiated Global Action scenarios;
- The same is valid for the Isolated Europe scenario, but this scenario shows a sharp decline in energy use beyond 2030;
- Energy use is growing by 1% from 2010 to 2030 in the Level Playing Field scenario, caused by the increased European production in this scenario and a continued net export position of the European chemical industry;
- By 2030, three options (energy efficiency improvements, a change in the fuel mix for heat generation and N_2O emission abatement) together, which remain under control of the chemical industry itself, have the potential to reduce GHG emission intensity by about 40% as compared to a situation without further improvements in the GHG intensity beyond 2010;
- By 2050, this is about 55%;
- Compared to 2010 levels, these options would reduce GHG emissions by 15% in 2030 with stabilisation around these levels towards 2050;
- Deeper reductions are possible by decarbonising electricity production and by CCS (with many challenges and barriers);

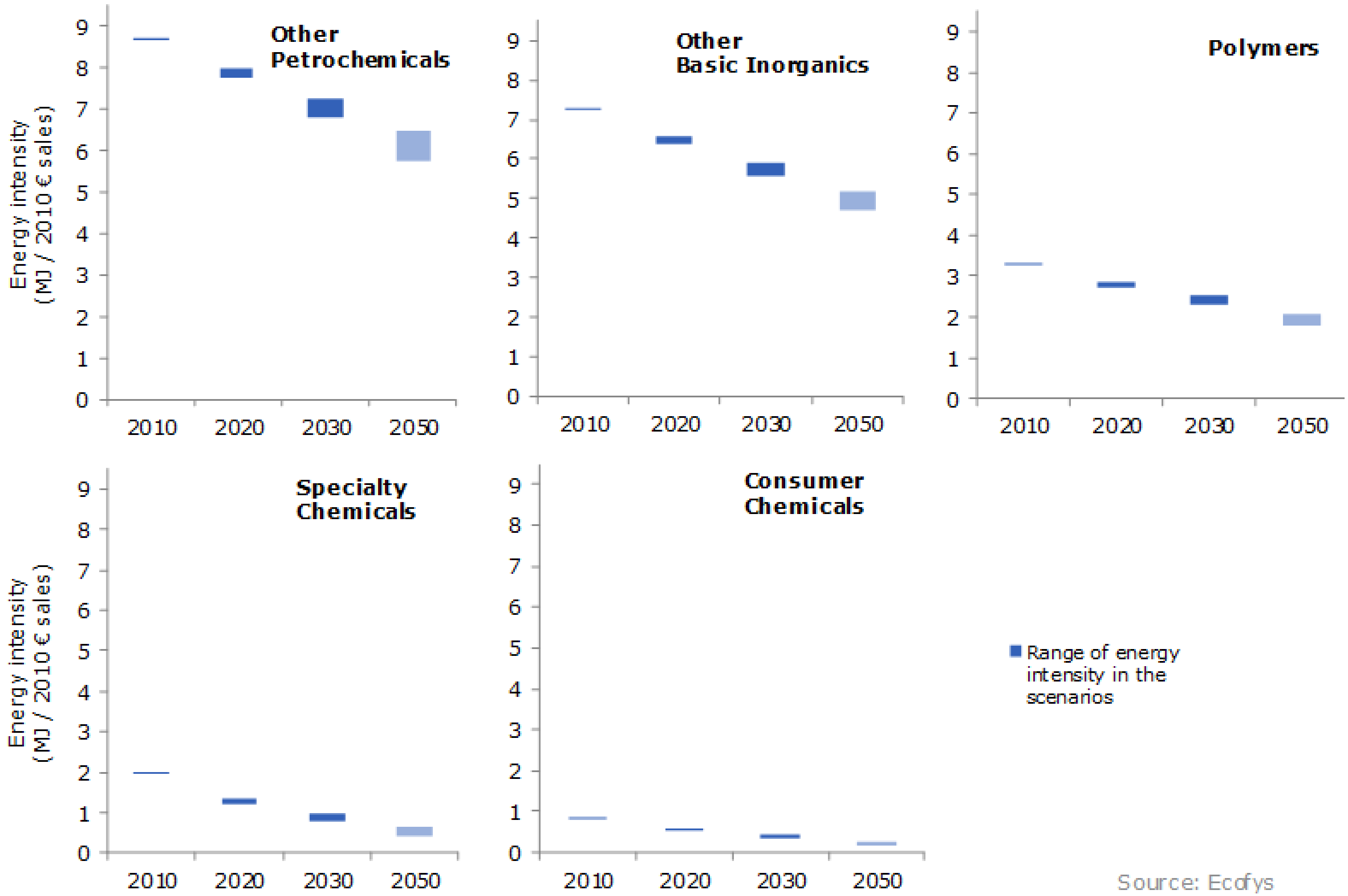
Cefic Roadmap: Bio-based feedstock – scenario results



Source: Ecofys

- Bio-based feedstock use most dominant in Specialty and Consumer Chemicals;
- In the Continued Fragmentation and Isolated Europe scenarios the driving forces are the development of bio-based routes and increase in the oil price relative to the biomass price;
- In the Differentiated Action and Level Playing Field scenarios, bio-based routes are expected to be quicker developed and used due to the CO_2 price signal.

Cefic Roadmap: process efficiency improvement results per subsector (see DISCLAIMER on next page)

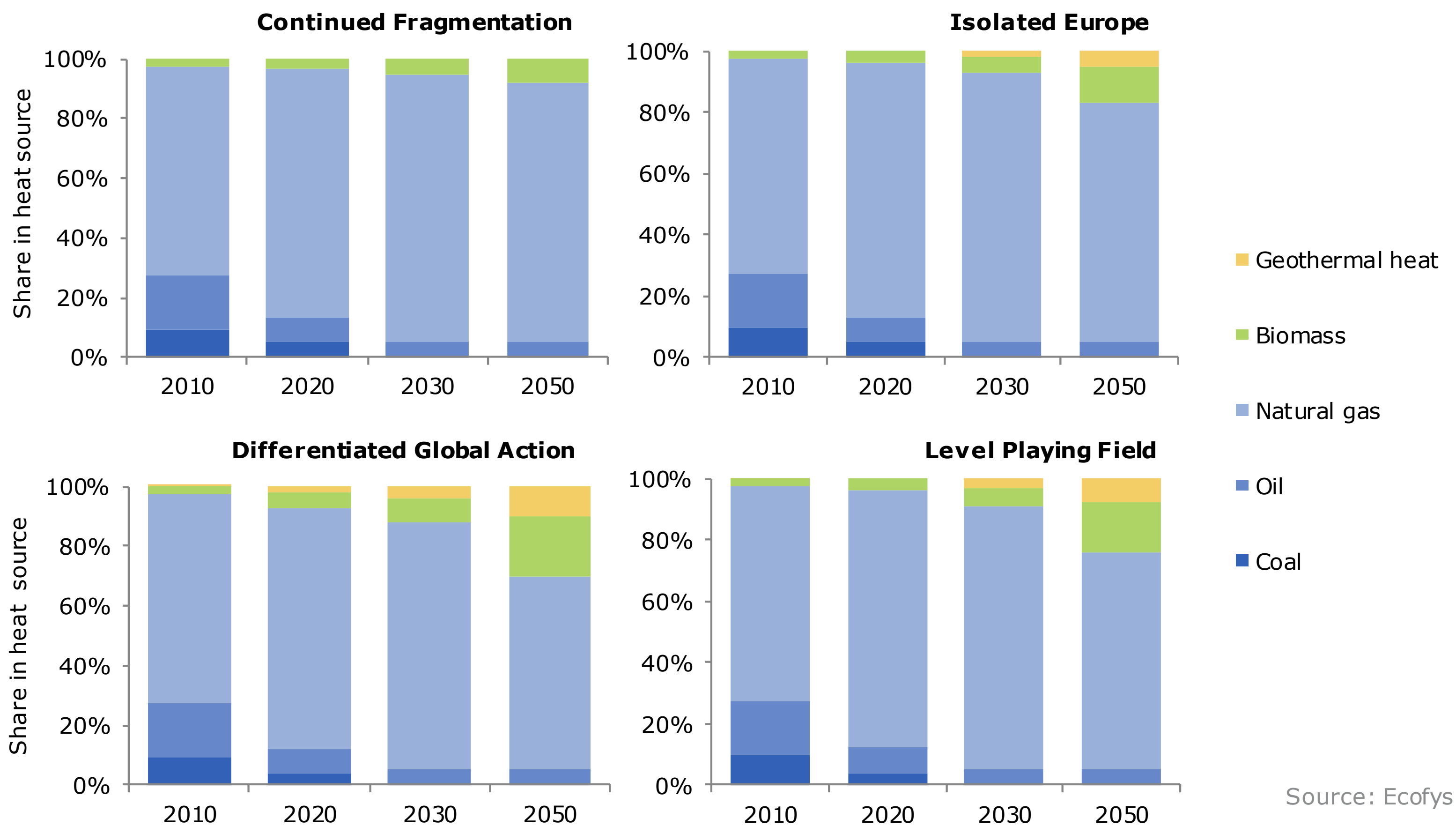


Source: Ecofys

DISCLAIMER: process efficiency improvement results per subsector

- When interpreting the results on the previous slide, take into consideration:
  - Not based on individual product assessment, all products in subsector assumed to have similar potential;
  - These potentials are NOT autonomous developments, but – especially for "Consumer Chemicals" and "Specialty Chemicals" require significant innovation and deployment of new technologies;
  - Underlying information is stronger for subsectors "Other Petrochemicals", "Other Basic Inorganics" and "Polymers" than for subsectors "Consumer Chemicals" and "Specialty Chemicals";
  - Improvement potential for "Consumer Chemicals" and "Specialty Chemicals" includes effect of likely increased selectivity and thereby reduced upstream energy use.

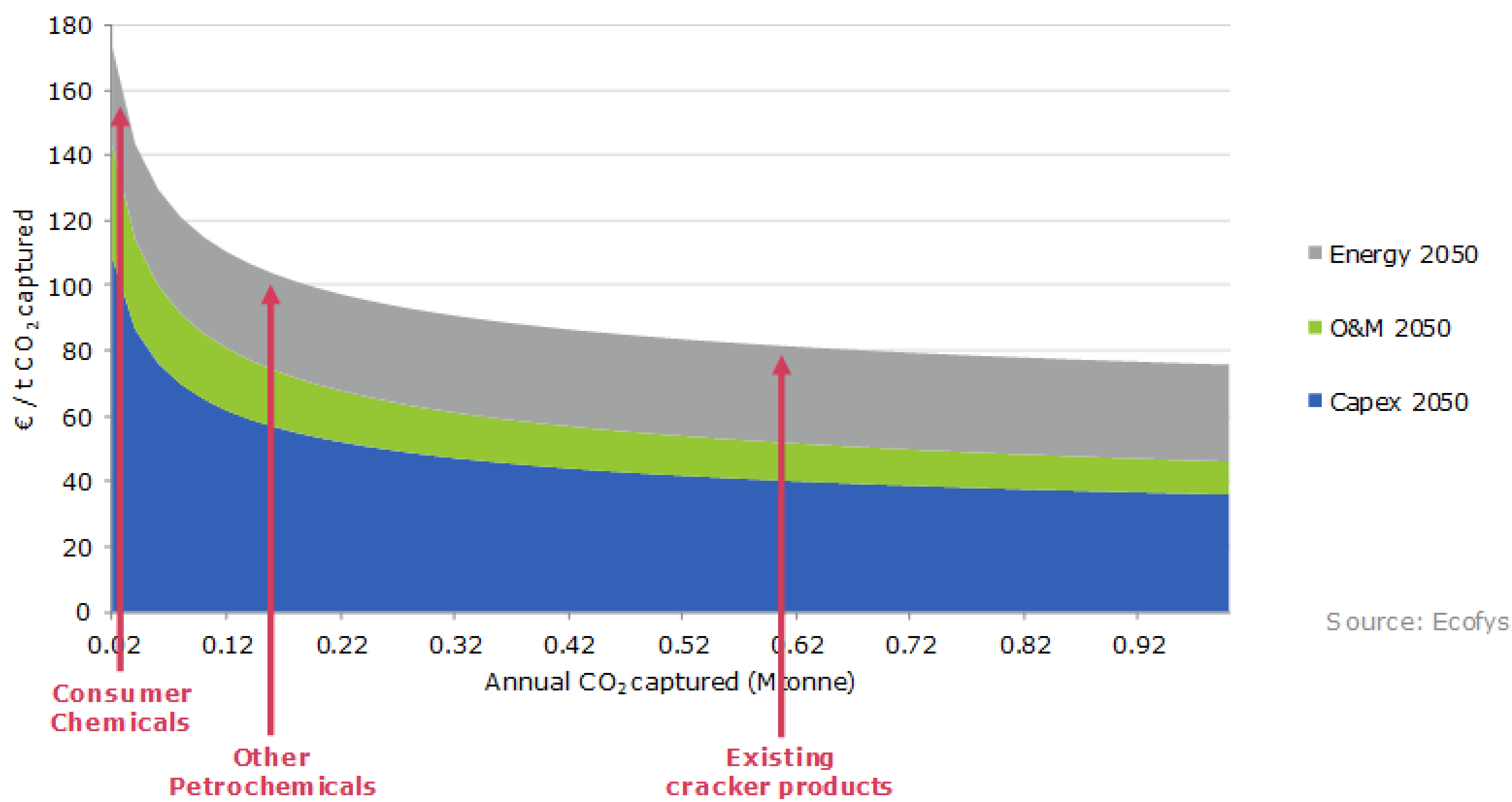
Cefic Roadmap: heat sources assumed in the four scenarios



Source: Ecofys

> This figure refers to generic subsectors only and excludes increase of bio-based production.

7F End-of-pipe abatement – 2050 annualised investment costs for combustion sources



> Investments (Capex) annualised with IRR=12%, 15 years

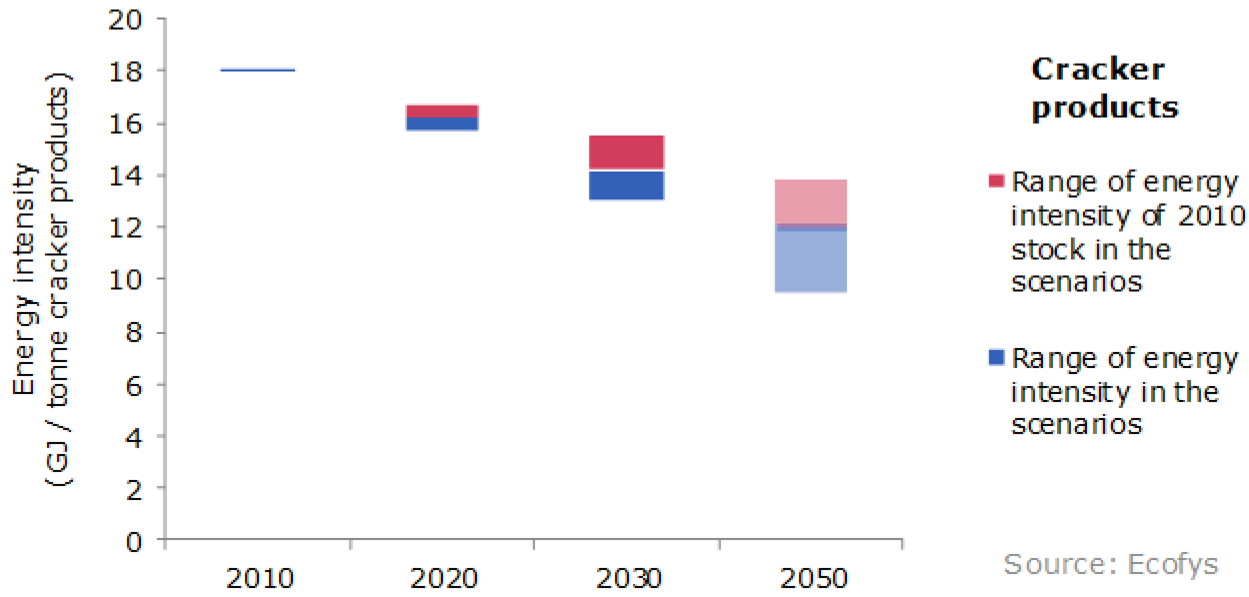
> Large influence of the type of subsector

> Cost uncertainty is substantial

7F End-of-pipe abatement – explanation of scenario choices

- In CF scenario, no CCS applied (neither existing nor new stock);
- Until 2030, assumed CO_2 prices do no yield economically attractive abatement of CO_2 via CCS;
- By 2050 – in all decarbonisation scenarios – CCS is, to various degrees, attractive for all subsectors, however:
  1. Estimated costs of CCS only become reality if CCS is applied on a large scale;
  2. Some sites have site specific limitations towards the use of CCS;
  3. Many public acceptance and legal issues need to be overcome;
  4. Additional energy use related to CCS remains a drawback and will continue to play a role in the public debate on CCS.
- Provided that most of these barriers could ultimately be overcome towards 2050, 90% CCS is assumed for Petrochemicals, Other Basic Inorganics, Polymers, cracker products and ammonia;
- For Specialty Chemicals and Consumer Chemicals, 75% CCS due to limited plant size is assumed;
- For Isolated Europe this is a positive assumption, since CCS in this scenario will result in significant additional costs compared to non-EU producers.

Cefic Roadmap: Cracker products – scenario results (1)



> Energy intensity develops best in the Level Playing Field scenario, due to the highest share of new stock, and due to the implementation of the ethanol-to-ethylene route, which has a relatively low energy demand;

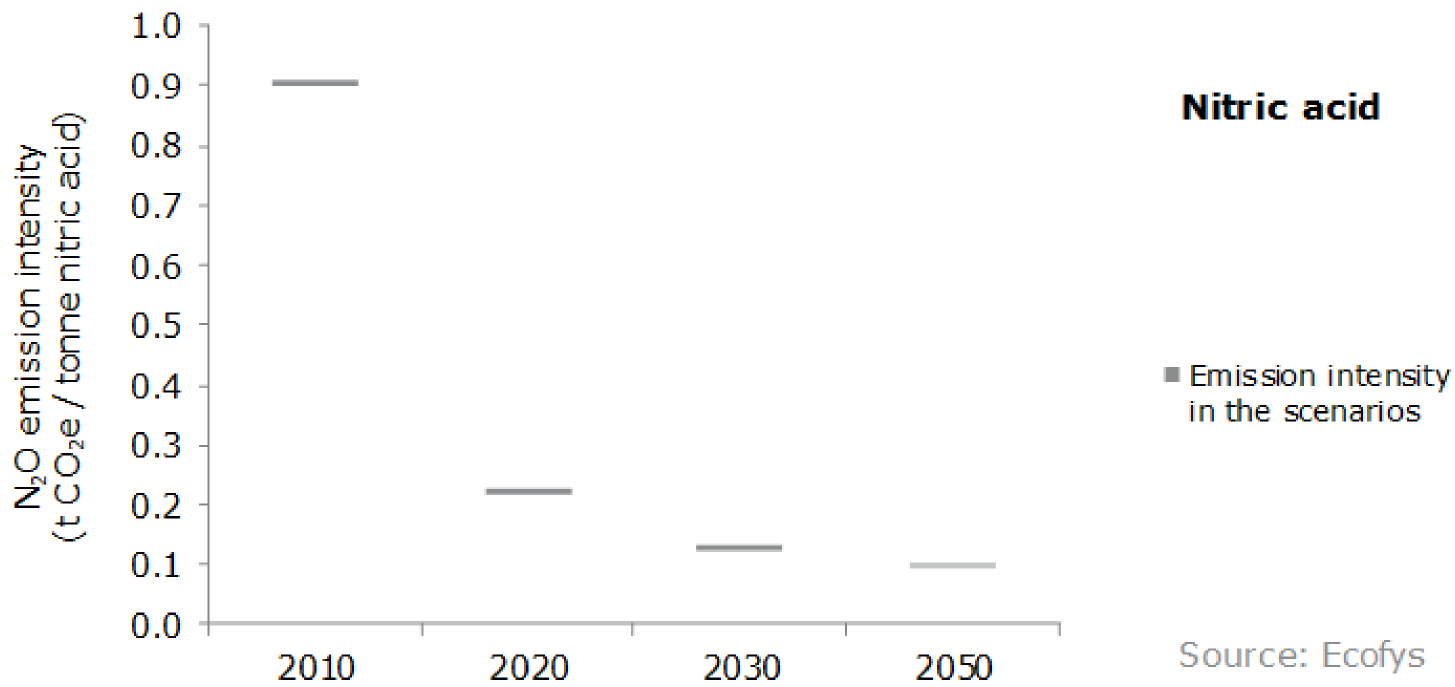
> Energy intensity improvement in the Isolated Europe scenario is lowest, as the share of new and thus improved plants is lowest;

> Energy use would be higher if production of ethanol from biomass had been included. This energy use is assumed to take place outside the European Chemical Industry. This only affects the lower line of the graph in 2050;

Cefic Roadmap: Cracker products – scenario results (2)

- In the Continued Fragmentation scenario, the energy efficiency of stock operating in 2010 is expected to improve by 14% (2030) and by 23% (2050) compared to 2010. In the Differentiated Global Action scenario, this is 21% (2030) and 34% (2050);
- Improvement rates for the other scenarios are in between;
- For new stock an improved traditional cracker is the dominant technology, combined with CCS to a significant extent after 2030 in the Isolated Europe scenario, and combined with CCS and ethanol and woody biomass as feedstock after 2030 in the Differentiated Global Action and Level Playing Field scenarios;
- CCS: Maximum penetration of 90% in 2050;
- Production projections were made for the subsector Petrochemicals as a whole, not specifically for cracker products. Production projections for cracker products are thus assumed to be identical to those of the subsector Petrochemicals. In practice, it is expected that in the Continued Fragmentation, Isolated Europe, and Differentiated Global Action scenarios, part of the existing cracker capacity will close and that no new installations will be built to replace it:
  - In the absence of any investments in new installations, production would gradually decline towards 2050;
  - This would lead to a development of the energy intensity equal to that for stock operating in 2010, hence to a much lower decrease in energy intensity.

Cefic Roadmap: Nitric acid – scenario results (1)



- All plants are expected to have installed abatement technology with an average emission of 90% below the 2010 level;
- By 2020 all plants are expected to have installed abatement technology with an average emission level of 0.7 kg N_2O per tonne of nitric acid, decreasing further to an average of 0.4 kg in 2030 and 0.3 kg in 2050;

Cefic Roadmap: Nitric acid – scenario results (2)

- Investment costs for N_2O abatement, expressed in their equivalent CO_2 abatement costs, range from 7 to 190 € / t CO_2e, depending on the type of measure, the current layout of the plant and temperatures of the tail gas;
- In general, these measures are cost-effective and their implementation does not depend on the scenario;
- New nitric acid plants built after 2020 can achieve capture rates of 95% for inbuilt technology and 99% for end-of-pipe technology, which corresponds to emission levels of approximately 0.4–0.1 kg respectively of N_2O per tonne of nitric acid produced. An average capture rate of 96% is taken into account for new stock;
- The very small difference observed between the scenarios is due to shares of stock operating in 2010 and new stock not being the same in all scenarios;
- In this Roadmap, it is assumed that N_2O emissions from the production of other chemicals (adipic acid, glyoxal and glyoxylic acid and caprolactam) follow the same reduction pathway as the N_2O emissions from nitric acid production.

The world changes, EU 2030 strategy needs "update"…

2013	Course correction towards 2030
Fragmented climate policies	Align first with major emitting economies
US shale gas revolution, EU investment leakage	Foster creation of a real integrated pan European energy market- Explore all energy opportunities
Regulated Energy markets	Innovate, first make RES competitive, develop cross-border connections
Energy uncompetitive costs	Affordable energy and competitive costs for industry and consumers
Lagging CCS roll out	Avoid declare CCS as the only alternative to GHG emissions reduction. Foster emerging innovative processes like H2 or CCU beyond 2030.
Post Fukushima – less nuclear energy in the EU mix	Use all sources, avoid costly exclusions
Many attempts to higher cost of CO2 in the EU (backloading, CSCF, carbon leakage list,	Review ETS towards low-cost, dynamic tool, no more multitude of overlapping targets

Cefic key messages on ETS post 2020

Support ETS beyond 2020:

- Dynamic Allocation based on actual production:
- Actual instead of fixed (‘frozen’) historic production level
- “True up” (s. Australian scheme)

- Cap (‘total’) for entire economy, relative cap for industry corresponding to actual growth

- ETS visibility beyond 2020, therefore no «excess allowances» issue

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Cefic key messages on ETS post 2020

Support ETS beyond 2020:

- New Entrants Reserve (NER) serves as allowances source for growth and as sink in times of recession; NER left-over transferred to next trading period (not lost, not auctioned off)
- Benchmarks based on weighted average to avoid carbon leakage
- Complementary unrestricted indirect allocation to provide predictability and to avoid carbon leakage

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Cefic key messages on ETS post 2020

Support ETS beyond 2020:

- Allocation based on actual production
  - No over-allocation, no excessive scarcity: no dramatic CO2 price shifts
  - Must Enable efficient growth (current rules insufficient)
  - No underallocation for most efficient manufacturing:
    - =Cross-sectoral reduction factor and linear curve = threat
- Not solved by proposed EC options!
- Minimizes carbon leakage – in contrast to current ETS design

New ideas and cooperative approach appreciated:

- flexibility and convergence of ETS and EU and national policies with global developments

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