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Motivation

In the long-run (2050) low-carbon economy makes economic sense and is necessary

- Economic equilibrium models affirm value of low-carbon economy
- However, equilibrium models, scenarios and roadmaps must not be mistaken for a transition plan

Transition dilemma

- Incremental changes vs. disruptions of business models
- Strategy within or outside existing industry boundaries
- Policy aspiration level and policy risk

In the short-run (2030) concerns about cost-competitiveness dominate

- The shale gas price differential between US/EU
- Electricity cost differentials
- Demand growth within the existing business models driven by Asian emerging middle classes

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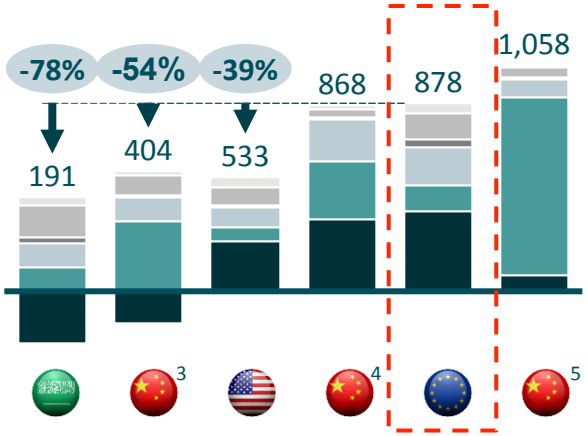
Production cost comparison

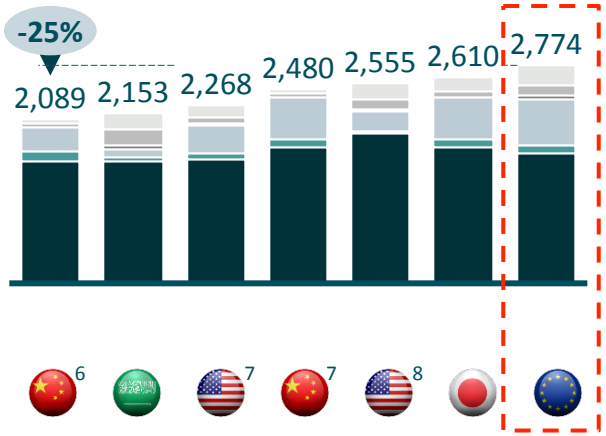
USD/ton (except carbon fiber)

SG&A
Labor
Electricity
Maintenance and plant overhead
Other variable cost[1]
Raw materials (net of by-product credits)

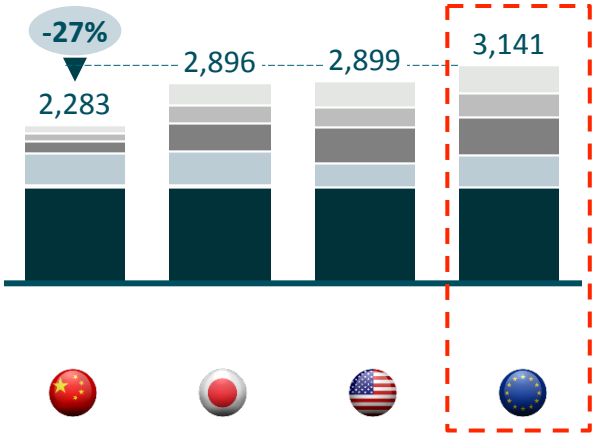
Energy intensive products: Polyvinyl chloride (PVC)[2]



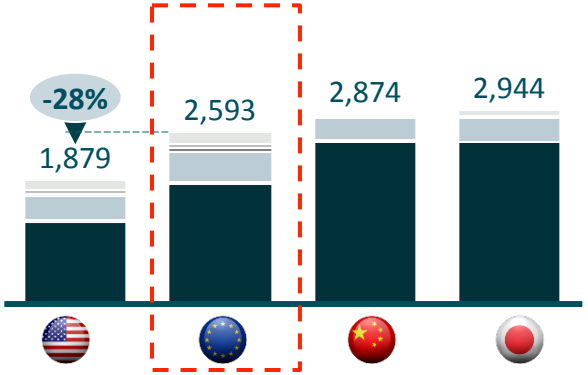
Feedstock intensive products: Polycarbonate



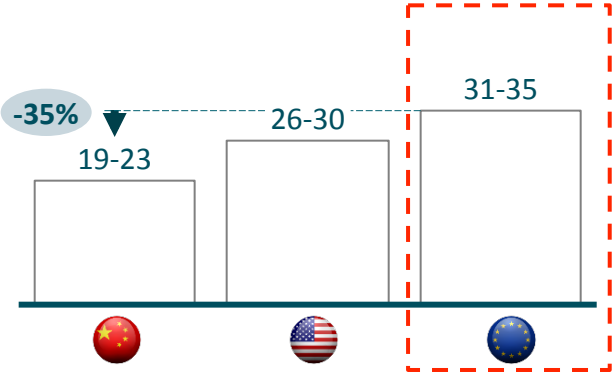
Regional products/processing: Rigid polyurethane



Customer/service intensive products: Polyalphaolefins



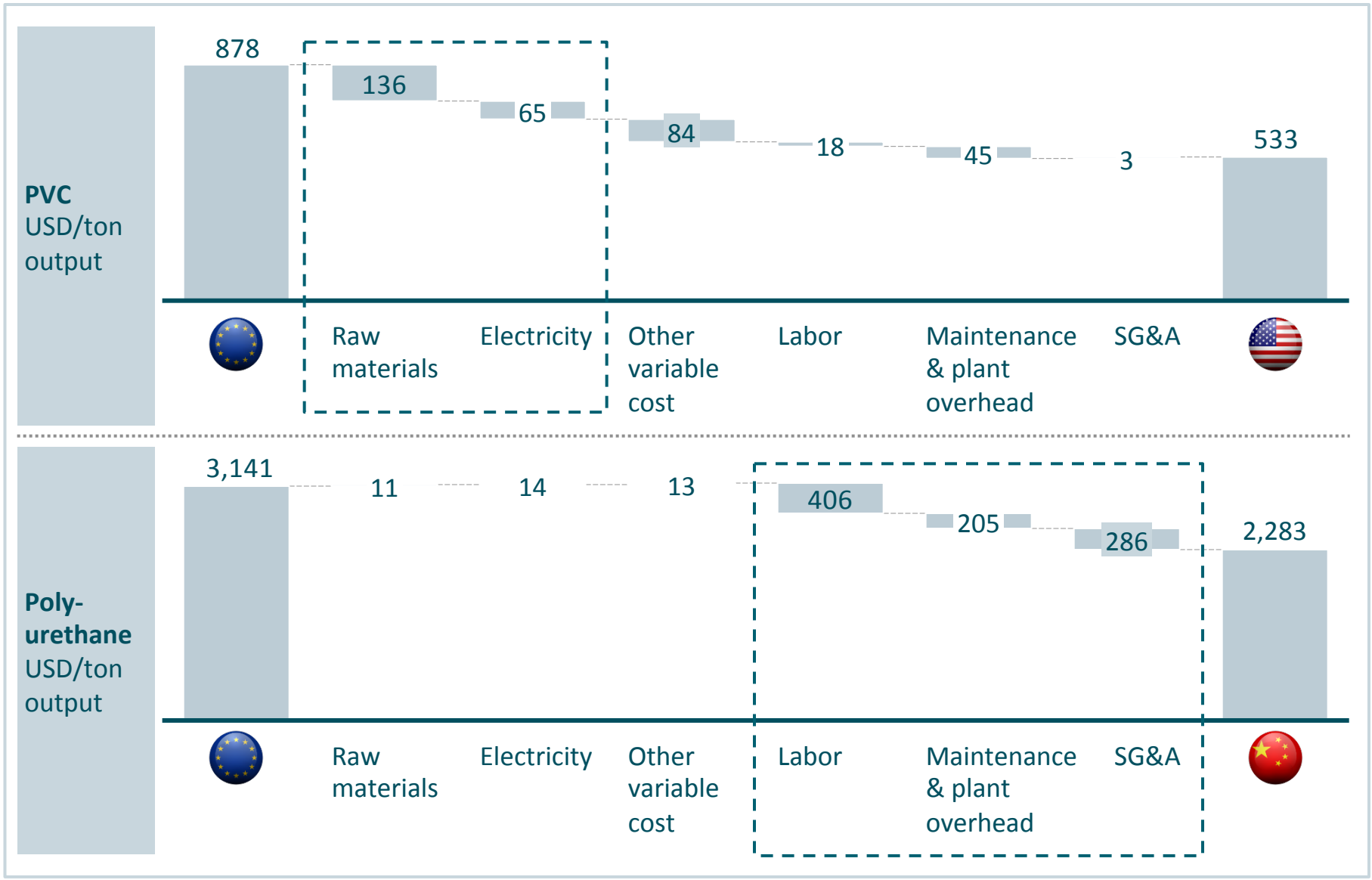
Innovation/high-value products: Carbon fiber[9] USD / kg



Europe generally has a cost disadvantage compared to other regions, mostly driven by raw materials and electricity vs. the US and Saudi Arabia, and by labor, maintenance and SG&A vs. China

NOTE: Results modeled based on market prices of utilities and benchmarked data by process and country; 1 Includes mainly fuel for heat and steam, but also catalysts, additives etc.; 2 Raw material costs can be negative as chlorine production generates by-product revenue from caustic soda; 3 Inland carbide with electricity from coal; 4 Ethylene with electricity at market price; 5 Coastal carbide with electricity at market price; 6 Asahi - buy BPA; 7 Phosgene - buy BPA; 8 Phosgene – buy phenol; 9 Estimate. SOURCE: McKinsey margin models

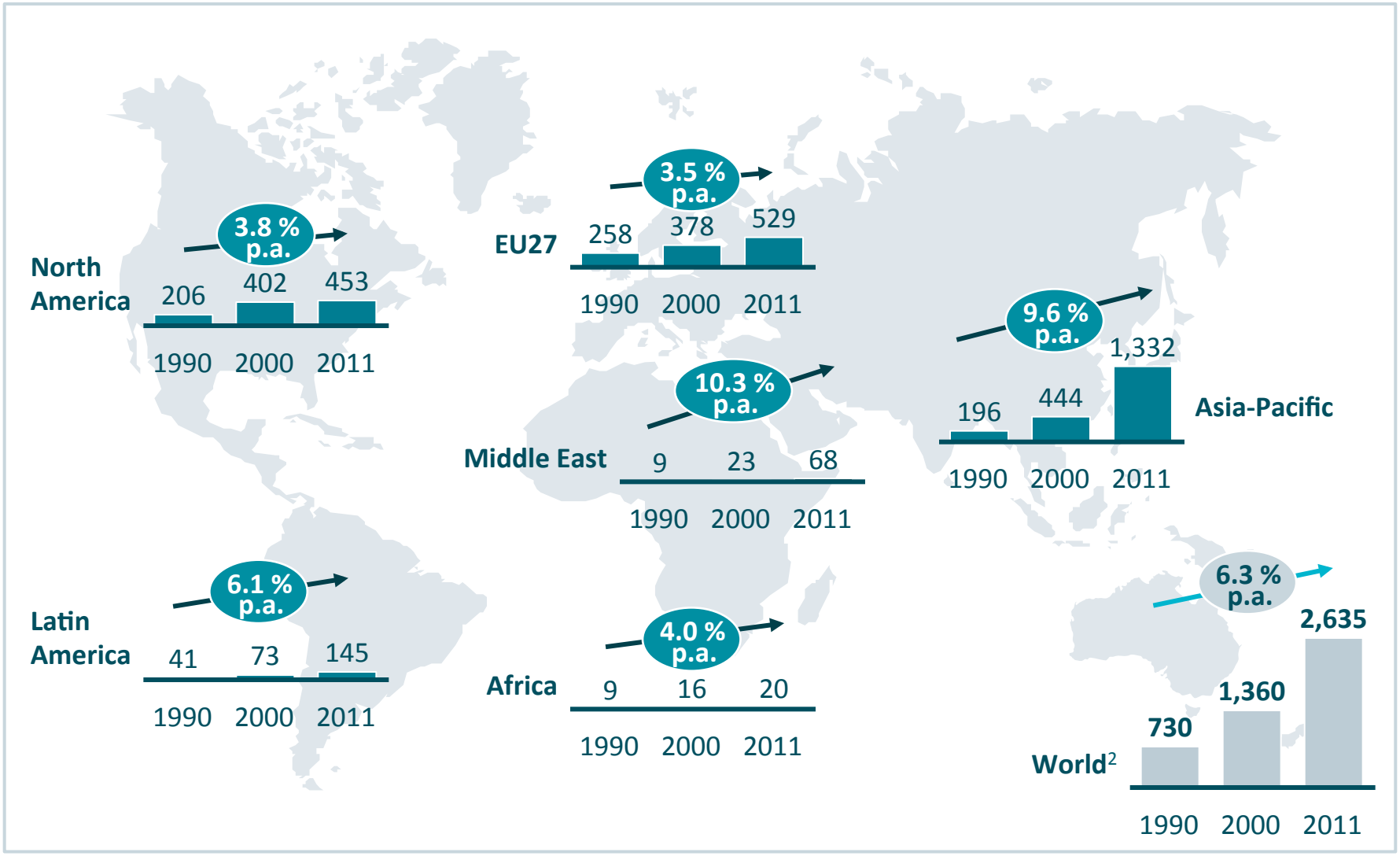
Examples of cost differences between Europe and other regions



SOURCE: McKinsey margin models

Historical growth of the chemical industry across regions

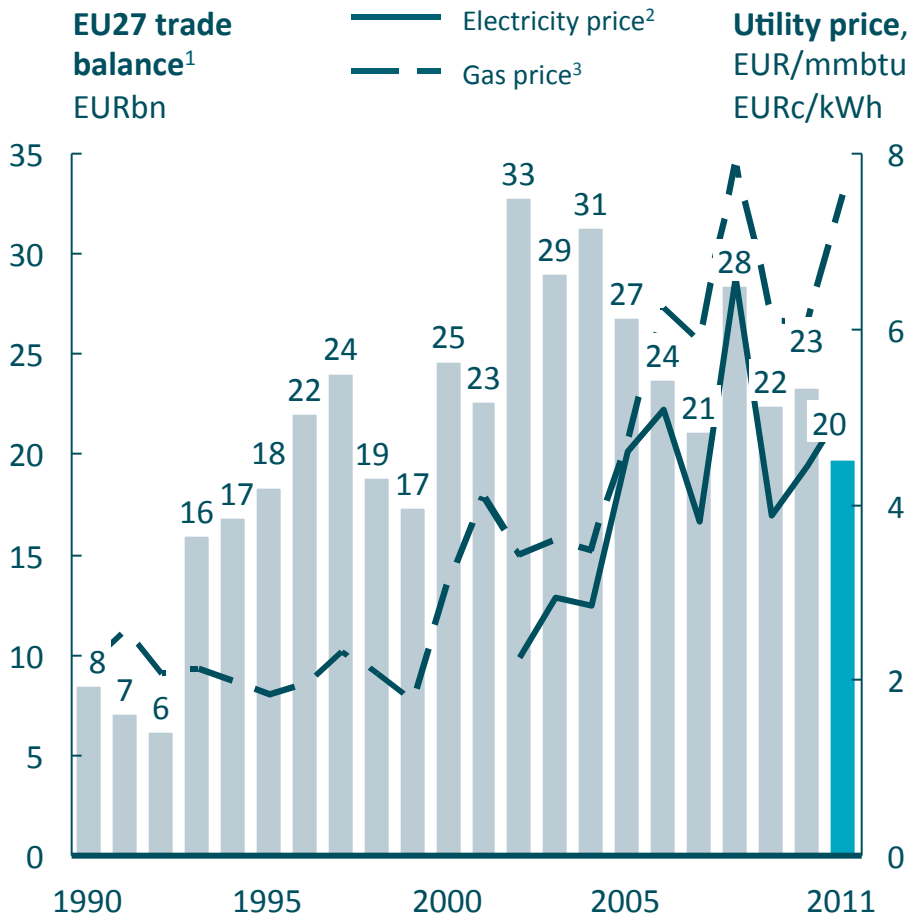
Total gross output[1], EURbn, nominal



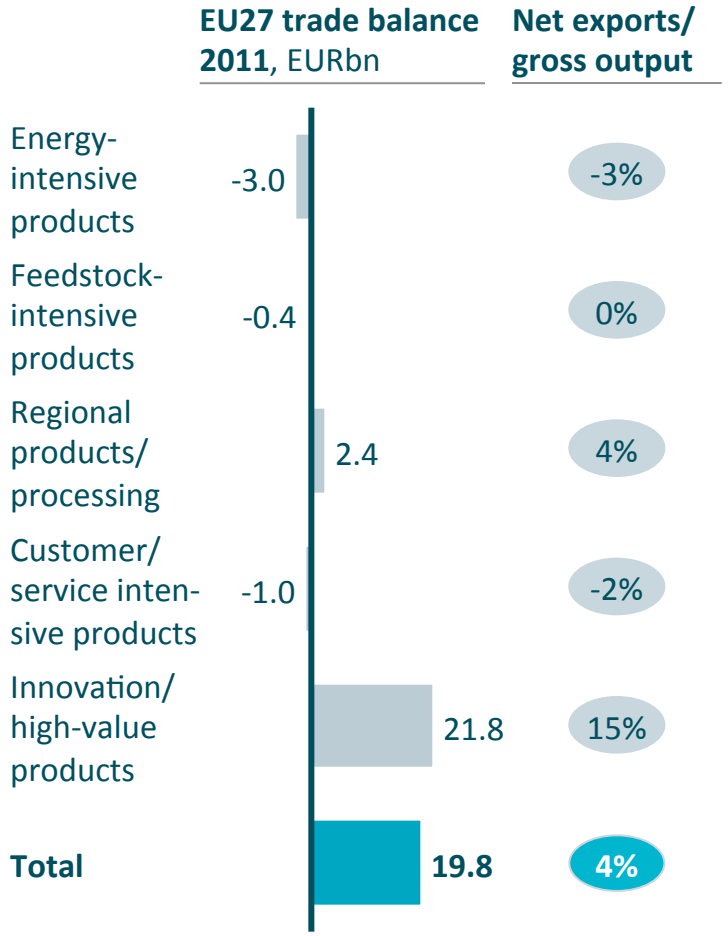
1 Total chemical industry excluding pharmaceuticals; 2 Also includes European non-EU27 countries (not shown on page)
SOURCE: IHS Economics

Trade balance of European chemical industry by value

Historical trade balance and utility price trends



Trade balance by segment



Europe maintains a trade balance surplus in chemicals corresponding to ~4% of total domestic production

1 Total chemical industry excluding pharmaceuticals; 2 Wholesale price for Germany; 3 Average German import price
SOURCE: IHS Economics; Enerdata

Assessment of competitiveness by region

Level of competitiveness: High Medium Low

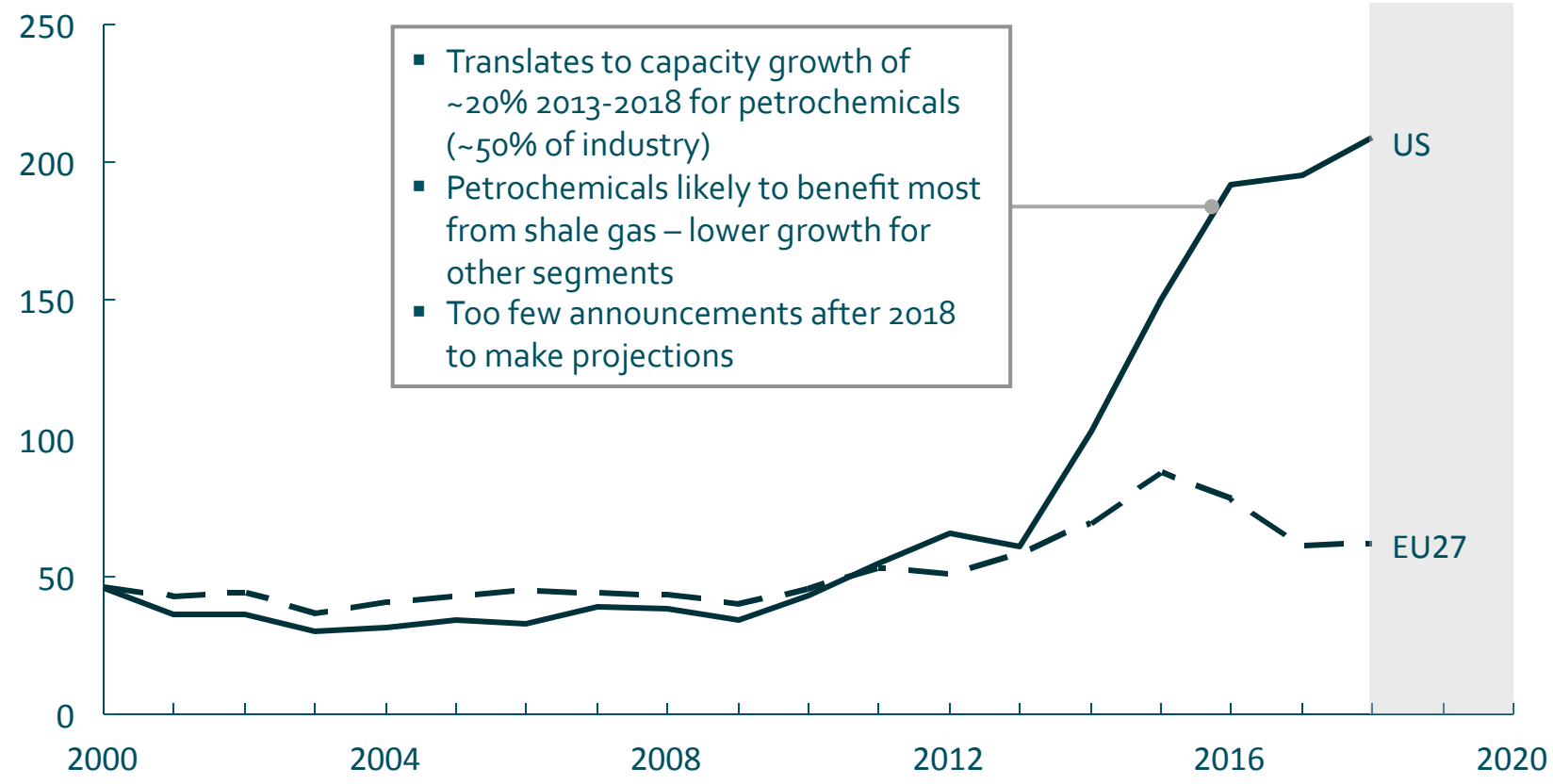
	Conventional economics		Other crucial factors		
Region	**Cost position**	**Local demand growth[1]**	**Access to skilled labor,** skilled labor[2]/ education[3]	**Business climate,** ease of doing business[4]/ corruption[5]	**Integration/ resilience**
EU27	25-50% disadvantage compared to other regions	1-3%	17 / 14	21 / 12	Overall, highly integrated and mature industry
US	10-40% advantage vs. Europe	2-4%	6 / 25	4 / 19	Highly integrated and mature industry, new investments ongoing
China	Higher cost than EU for some products, up to 50% lower cost for others	>10%	44 / 54	96 / 80	Less mature industry, not yet fully optimized
Saudi Arabia	Cost advantage (up to >50%) for bulk chemicals	~8%	31 / 39	26 / 63	Less mature industry, more narrow range of chemicals produced

NOTE: Europe represented by Germany in rankings; 1 Calculated as production minus net exports between 2011-2016 using data from IHS Economics; 2 Rank in "Availability of scientists and engineers", World Economic Forum (WEF); 3 Rank in "Quality of the Educational System", WEF; 4 Rank in the World Bank's ease of doing business index 2013; 5 Rank in Transparency International's corruption perception index 2013
SOURCE: World Bank Doing Business 2014; IHS Economics; WEF Global Competitiveness Report 2013-2014; Transparency International

Investment trends for Europe and the US

Actual and announced investments compared to existing production volume[1]

Petrochemicals only, USD/ton



1 Data for petrochemicals only, excludes inorganics and specialties. Includes new investments and maintenance capex (maintenance calculated as 1.5% of replacement value), excludes cost of plant conversion (Europe has heavily converted chlorine plants and the US has converted crackers)

SOURCE: McKinsey models

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Key abatement levers across the value chain

Use bio-ethylene as feedstock

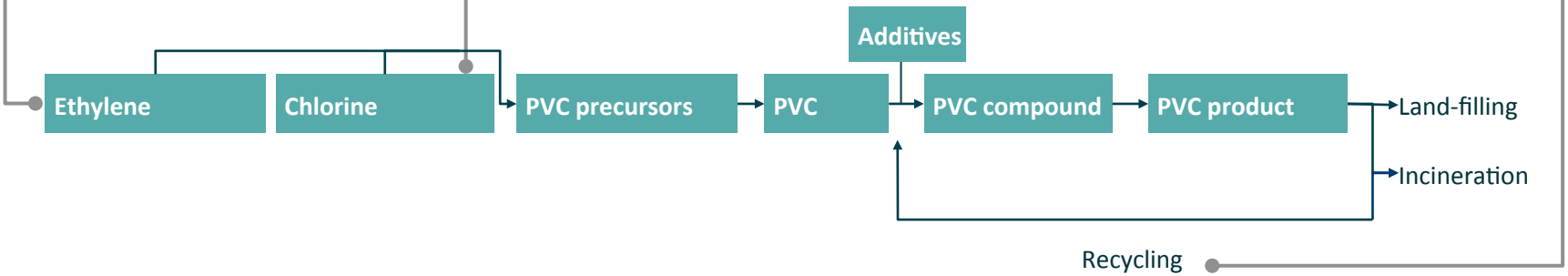
- Can technically substitute petrochemical based ethylene completely
- Bio-ethylene based on ligno-cellolosic biomass required, with uncertain feasibility in near to mid-term horizon
- Breakthrough dependent on local conditions, technology mature and economic viability

Implement new technology in chlorine electrolysis

- Continue shift from mercury cell electrolysis towards more energy efficient membrane cell and ODC electrolysis
- Compared to mercury cell, membrane cell has ~25% lower emissions. In ODC technology emissions are ~40% lower than mercury cell emissions

Increase recycling rates with focus on pipes, fittings and window frames

- Composite structures containing at least 70% of PVC can be recycled using, e.g., the VinyLoop[1] process
- Availability of used PVC a short term barrier given lifetimes of up to 50 years and more
- Large potential from installed base in the coming decades from lead and cadmium free production since the 1980's



Switch to green energy throughout the value chain

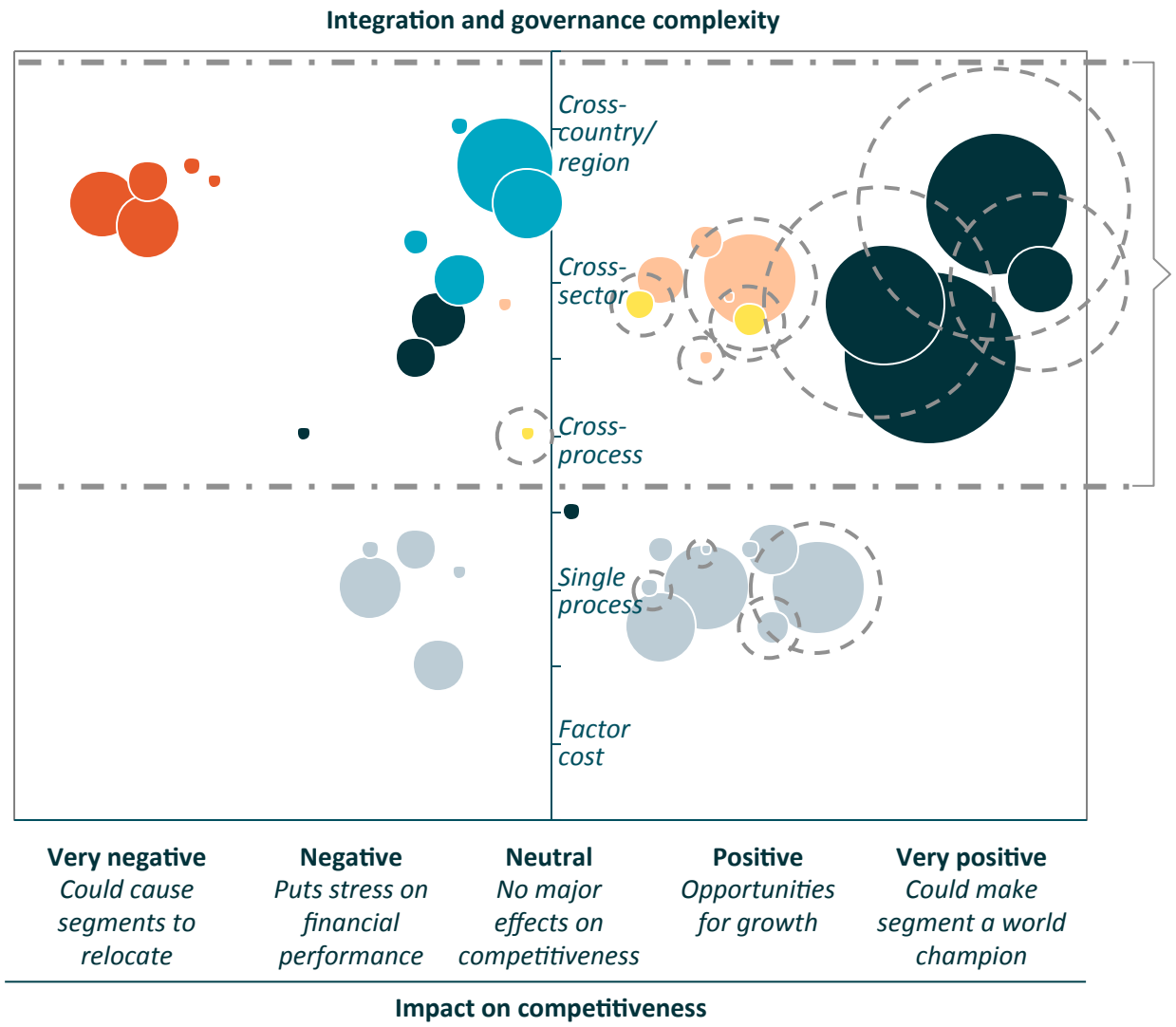
- Non-fossil energy share of total electricity production to be increased from today's 46% to ~70%[2], reducing CO_2 emissions from electricity generation by ~50%

Improve process and energy efficiency

- Continuous efficiency improvements in multiple process steps leading to a 25% reduction by 2030 (~2% p.a.)
- Examples may include improved polymerization techniques and decomposition of GHGs

1 Partnership between Solvay and Serge Ferrari; 2 Based on Enerdata Emergence case
SOURCE: Analysis based on industry reports and interviews

Mapping of abatement opportunities by competitiveness impact and complexity

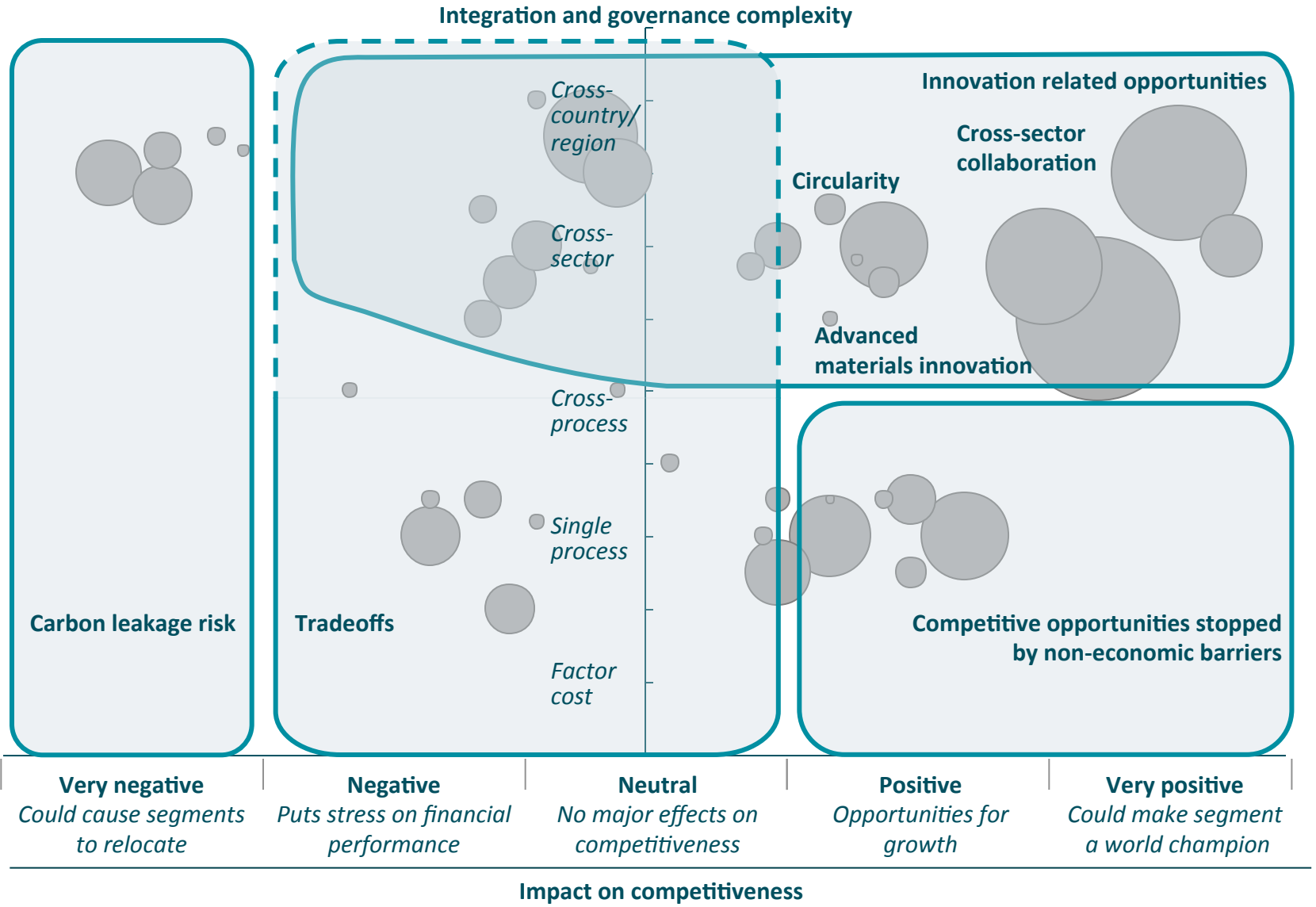


- Recycling/re-use
- Process and energy efficiency
- Shift to renewable feedstock
- Shift to green energy
- Enabling downstream emissions reductions
- CCS
- Product/materials substitution
- Global potential

- >80% of total potential (including scope 1, 2 and 3 emissions) requires integrated action[1]
- Substantial potential from other levers beyond traditional process efficiency
- Additional opportunity to contribute to *global* emission reductions
- Despite low competitiveness, there is significant potential even in bulk segments (PVC and polycarbonate) that would not harm competitiveness

1 Given the highly varying emission baselines for the five chemicals and thus varying absolute abatement potentials for the different levers, the analyses have been normalized to provide indicative ranges of the total opportunity. For the scope 3 opportunity, global multiplier effects are excluded in this calculation

Industrial themes for the chemical industry



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The policy framework and the transition

Main focus today

Reduce own emissions and resource use in the current industrial structure

- E.g., process and energy efficiency

Reshape industrial system to reduce own emissions and resource use

- E.g., circularity, cross-sector collaboration

Provide advanced markets for novel low-carbon solutions

- E.g., fuel efficiency standards for vehicles

Develop global solutions through innovation oriented policy

- E.g., advanced materials innovation

Should Europe broaden its focus?

Thank you!

http://europeanclimate.org/europes-low-carbon-transition-understanding-the-chemicals-sector/

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