

The impact of geopolitical developments on energy security and environment

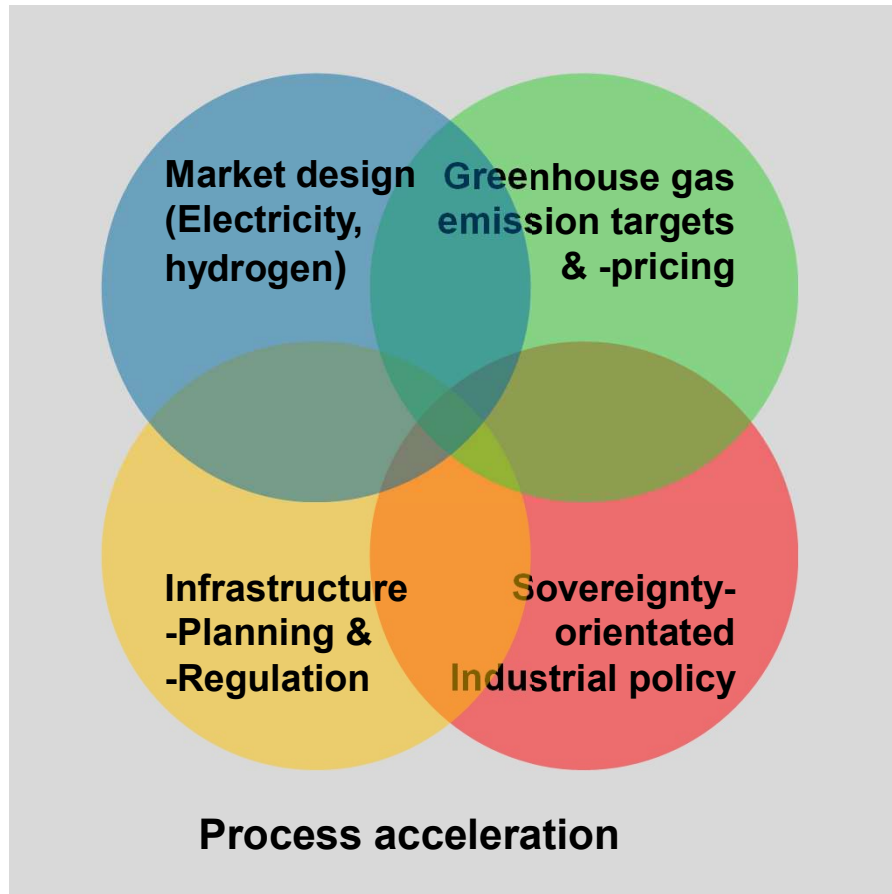
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The increasingly Europeanised market framework for the energy transition

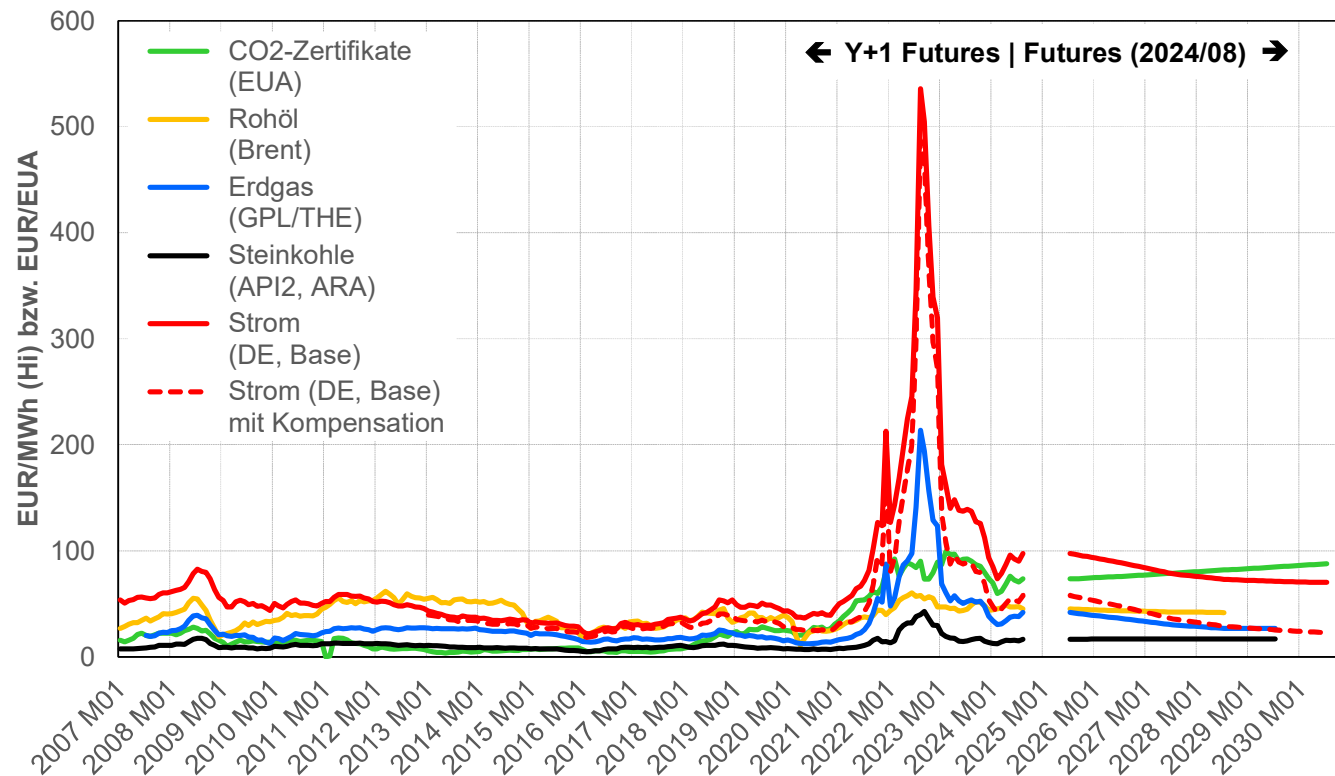
A holistic view of old and new needs for action and regulatory areas



- Process acceleration in all areas
- Greenhouse gas emission reduction
 - Climate neutrality targets and paths
 - Greenhouse gas pricing
 - Other emission reduction instruments
- Market design
 - for electricity (gas and hydrogen, CO2)
 - Refinancing instruments, localisation signals
 - European integration and security of supply
- Infrastructure
 - Target grid planning (for transmission and distribution grids)
 - Integrated design of electricity, hydrogen & CO2 networks
 - Municipal heat planning
- Industrial policy
 - Securing the European value chains
 - Improving competitive position of European suppliers
 - Energy costs and smart industrial electricity cost solutions

Natural gas, oil, electricity and CO2 prices (and costs) The 2022/2023 shock waves of geopolitics (partly caused by German energy policy)

Natural gas, oil, electricity wholesale & EUA prices & CO2 price compensation



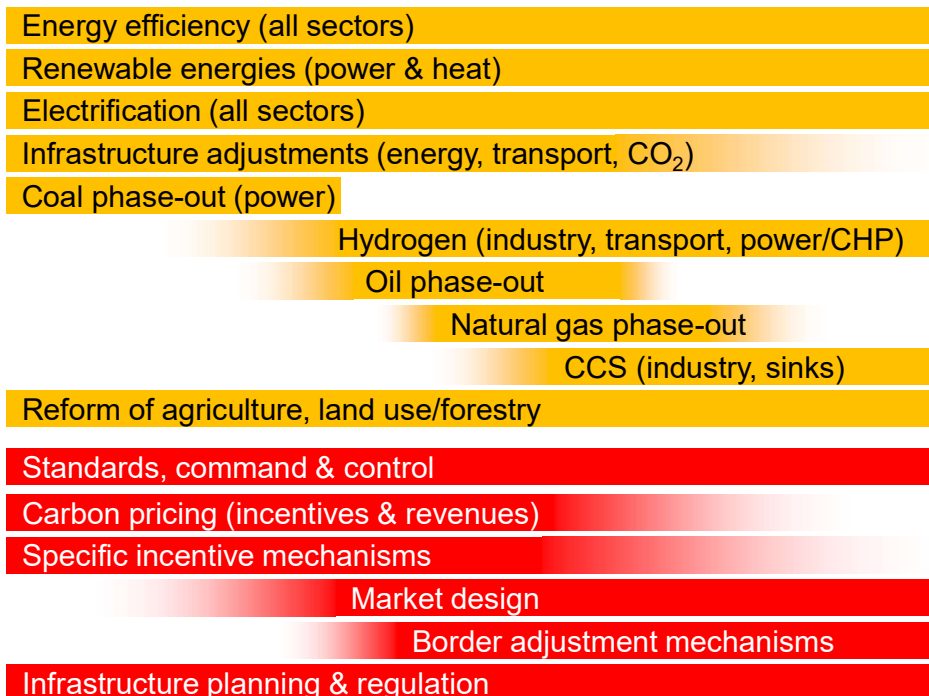
Sources: EEX, ICE, DEHSt, European Commission, own calculations

- Russian invasion of Ukraine with far-reaching consequences for security of supply and energy prices (prices for fuel, electricity and CO₂ have risen massively)
- Renewable shares are slowly lowering prices, CO₂ prices (for base price) are counteracting this partly
- 2020s remain critical in terms of prices (despite current declining price levels), uncertainties remain high
- Challenge of industrial policy: transformation support needed, but coexistence of old & transformative options (current shifts to other regions often not towards green production)

Transition to climate neutrality (Germany/Europe) in a changed geopolitical environment

All strategies remain robust, some implementation mechanisms/sequences may change

1990	DE: -35 (40*)%	2020	-30%	2030	-23%	2040	-12%	2050
	EU: -25 (30*)%		-30%		-23%		-22%	



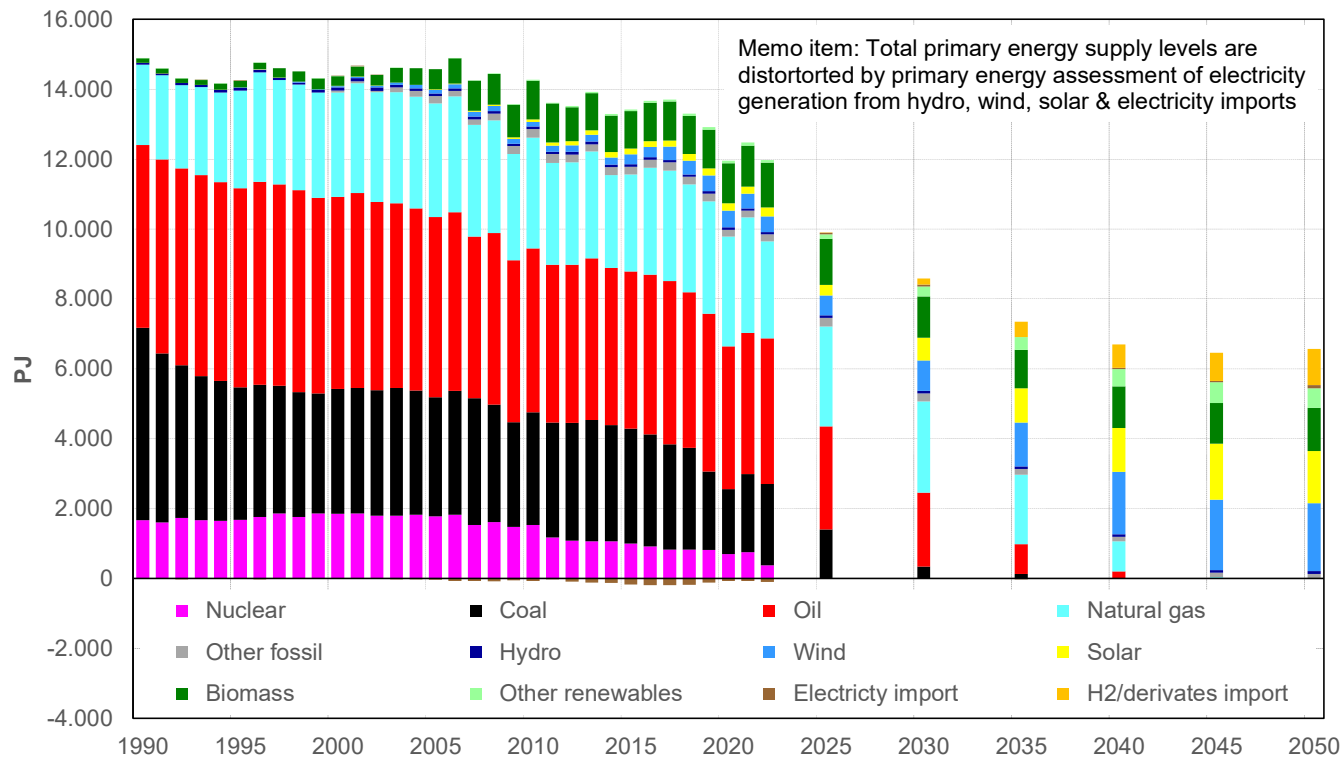
due to Covid-19 pandemic in 2020

Reminder:
The significant increase in importance of consumer-oriented and acceptance-sensitive fields of action and the OPEX-intensive transformation paths in industry marks the transition to a new phase of the energy transition to climate neutrality!

Six key strategic elements for a successful transformation to climate-neutrality

- Paving the way for transformative options
- Actively managing exit game for unsustainable options
- Initiating necessary infrastructure adjustments (expansion/ conversion/ decommissioning) with sufficient lead times
- Supporting timely ramp-up of the necessary value chains
- Making innovations available in time and avoiding the innovation dilemma
- Taking into account (international) learning and diffusion processes

A mainstream projection: There are and will be corridors, the ranges are relatively narrow The 10-43-17 archetype and the C²SIA tracks of managing structural change



Long-term system characteristics

- 1,000 TWh renewable electricity for direct use (mainly wind & solar, land availability restrictions)
- 400 TWh imported hydrogen and hydrogen derivatives
- 300 TWh biomass (mainly cascade use)
- 100 TWh domestic hydrogen (and some hydrogen derivatives)
- 70 million tons CO₂ to be stored in geological formation

Managing broad structural change

- Coordination-intensive
- Capital-intensive
- New spatial patterns
- Infrastructure-intensive
- Acceptance-sensitive

After the wake-up call: New awareness on resilience (in a comprehensive sense) as a new challenge to sustainability strategies (and beyond)

	Raw material extraction	Raw material processing	(Sub-) Components	Goods
Photovoltaics		⊕ Polysilicon: China 79%	⊕ Ingots/wafers: China 97% ⊕ Cells: China 85% ⊕ Solar glass	⊕ Modules: China 75%
Wind power			⊕ Many components are sourced in China	⊕ Currently sufficient capacities in Europe, but declining competitiveness
Generators and motors (for wind power and electric mobility)	⊕ Light rare earths: China 58% ⊕ Heavy rare earths: China/Myanmar: 100%	⊕ Light rare earths: China 87% ⊕ Heavy rare earths: China 100%	⊕ Permanent magnets: China 94%	
Electromobility Lithium-ion battery	⊕ Lithium ⊕ Cobalt: Congo 72% ⊕ Manganese: South Africa 36% ⊕ Nickel: Indonesia 38% ⊕ Graphite: China 73%	⊕ Lithium ⊕ Cobalt: China 75% ⊕ Manganese: China 95% ⊕ Nickel: China 55% ⊕ Graphite: China 100%	⊕ Cathode material: China 71% ⊕ Anode material: China 91%	⊕ Battery cells
Electrolyzers	⊕ Iridium (PEMEL): ⊕ Production cannot be expanded. South Africa 85% ⊕ Scandium (HTEL, only after 2030/35)			
Heat pumps			⊕ Compressors (partly with permanent magnets)	
Green Steel	⊕ Iron ores in DRI quality			⊕ Plant engineering for direct reduction plants (DRI shaft furnace)

KEY ⊕ Concentration and market power ⊕ Short/medium-term excess demand ⊕ Permanent shortage
Criticality: ⊕ Very critical ⊕ Medium critical ⊕ Moderately critical

Crucial parts of value chains (not only for the transformation) depend on key resources and strategic goods

- Partly high concentration of production and/or processing of strategic resources and/or goods in few countries (i.e. China)
- Some of them with specific geopolitical interests which should be perceived as potential threats (not only for energy transformation)

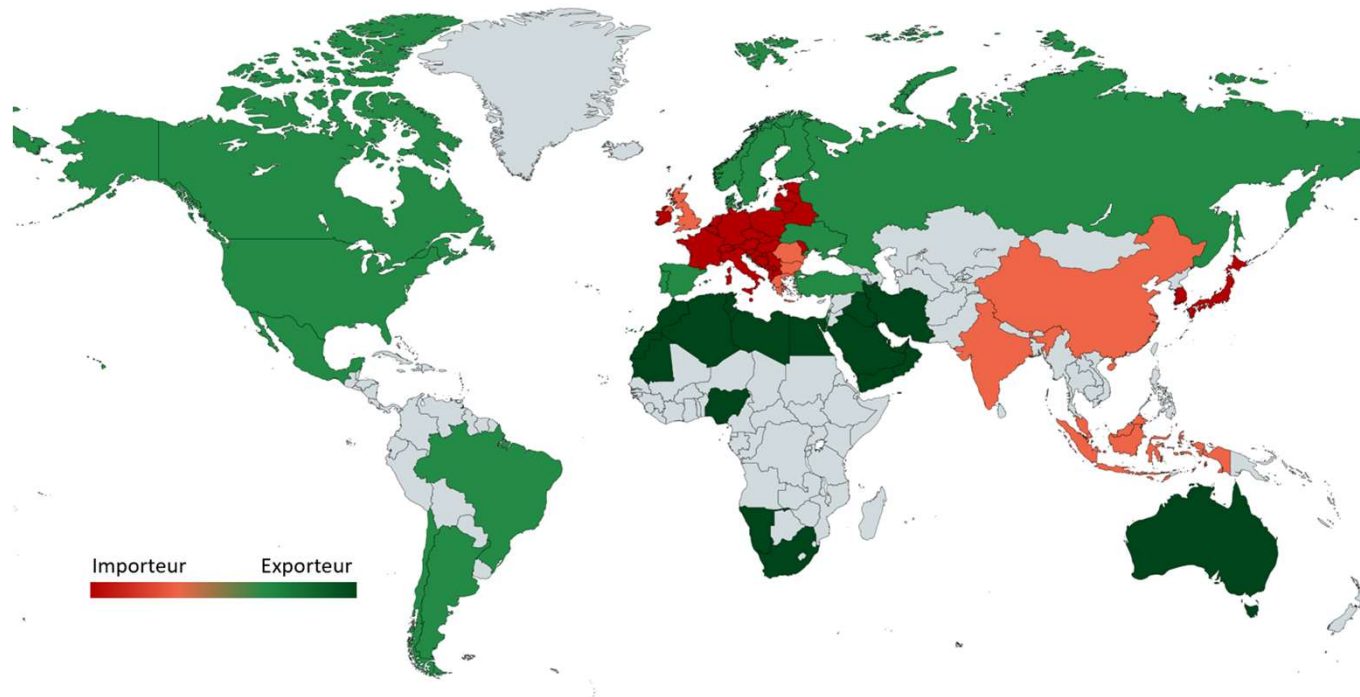
Six main counter-strategies

- Lowering short-term vulnerability (energy/resource efficiency, stockpiling)
- Safeguarding crucial cores of industrial production within Germany and/or Europe
- Diversifying the supplies of resources and strategic goods (as well as interim production steps as processing etc.)
- Going for new technologies or circular strategies that can lower the longer-term demand for resources
- Avoiding (new) lock-in effects (economic, political and contractual) and stranded assets
- International cooperation and creating new alliances

Global energy transformation will change international trade flows

Energy commodities, transformation-related commodities and strategic goods

Case study: Net export and import positions for (green and low-carbon) hydrogen



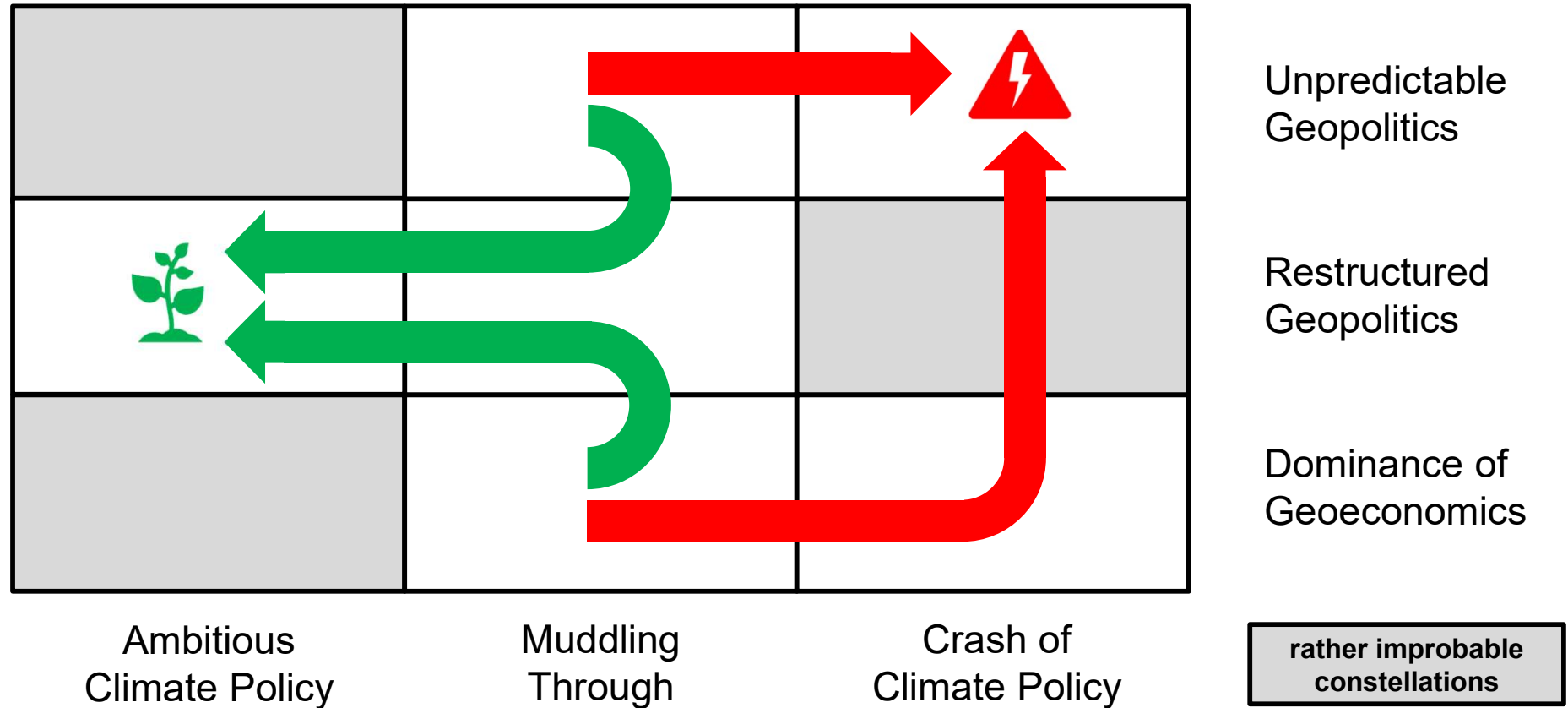
Source: German Expert Commission for the Monitoring of the Energy Transition

Significantly changing patterns for the global economy (not only but also due to the transformation)

- Key regions will be (more or less) self-sufficient for commodities (and technologies?)
- Few regions will be significantly import-dependent for commodities (not only energy!)
- Regions with abundant clean energy resources will attract new parts of the value chains
- Global technology market for clean/resource-efficient technologies will grow, distribution of market shares is open
- Home markets will be crucial
- These are crucial coordinates for international cooperation

The new era of geopolitics

Energy transformation depends crucially on it – and may contribute to it



Thank you very much

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