Electrification and coal phase-out in Germany: A scenario analysis

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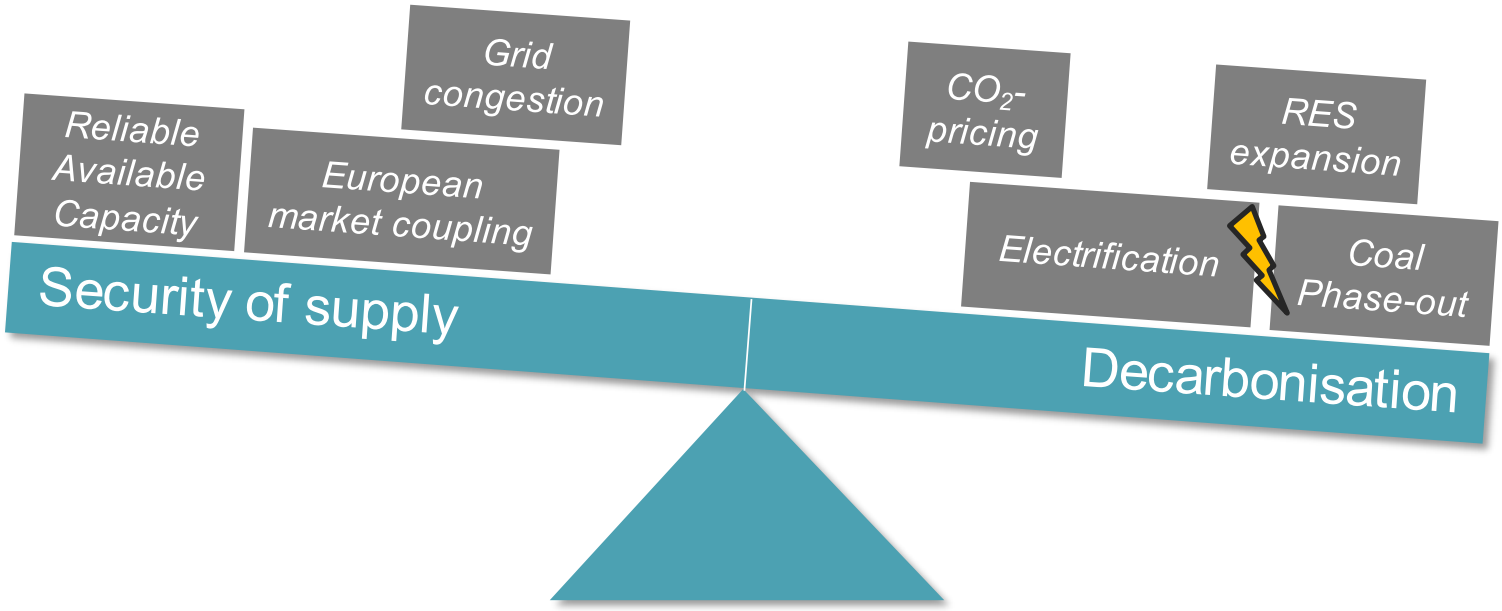
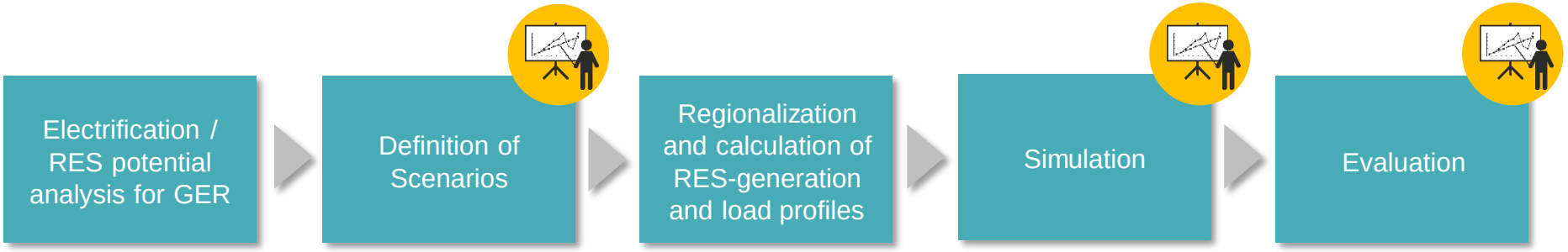
Forschungsstelle für Energiewirtschaft e.V. FfE

1. Motivation: Electrification dilemma



1. Motivation: Electrification dilemma
→ 2. Method: Energy system modelling

- ***What are the energy system effects of a lignite phase-out or an increasing CO_2-price in a high electrification and high RES scenario?***
- ***What role do Germany's neighboring countries play with respect to the procurement of supply security and emissions?***
- ***What are the operational characteristics and transmission grid repercussions of future peak-load generation units in an electrification regime?***



2. Method: Scenario Analysis

Reference Scenario [**Ref61**]

- no electrification
- low grid congestion

Parameter	*Unit*	*Value*	*Value*
Year	-	2015	2030
Electrical FEC (Domestic / Industry / SME / Transport / DistH / Grid losses)	TWh	129 / 225 / 150 / 11 / 1 / 26 Sum: 542	134 / 210 / 110 / 21 / 1 / 23 Sum: 499
Fuel Prices (Oil / Gas / Hard Coal / Lignite)	€/ MWh_{th}	35.9 / 21.8 / 8.8 / 1.5	52 / 29 / 9.5 / 1.5
CO_2-Price	€/t_{CO2}	7.6	30
Conventional Generation Capacities	GW_{el}	87 (of which 32.9 coal-fired)	59 (of which 23 coal-fired)
RES Capacity (Wind-Offshore / Wind-Onshore / PV)	GW_{el}	3.4 / 41.2 / 39.3	15 / 59 / 77
RES-Share	%	**33**	**61**

Constant RES-share electrification

RES-covered electrification

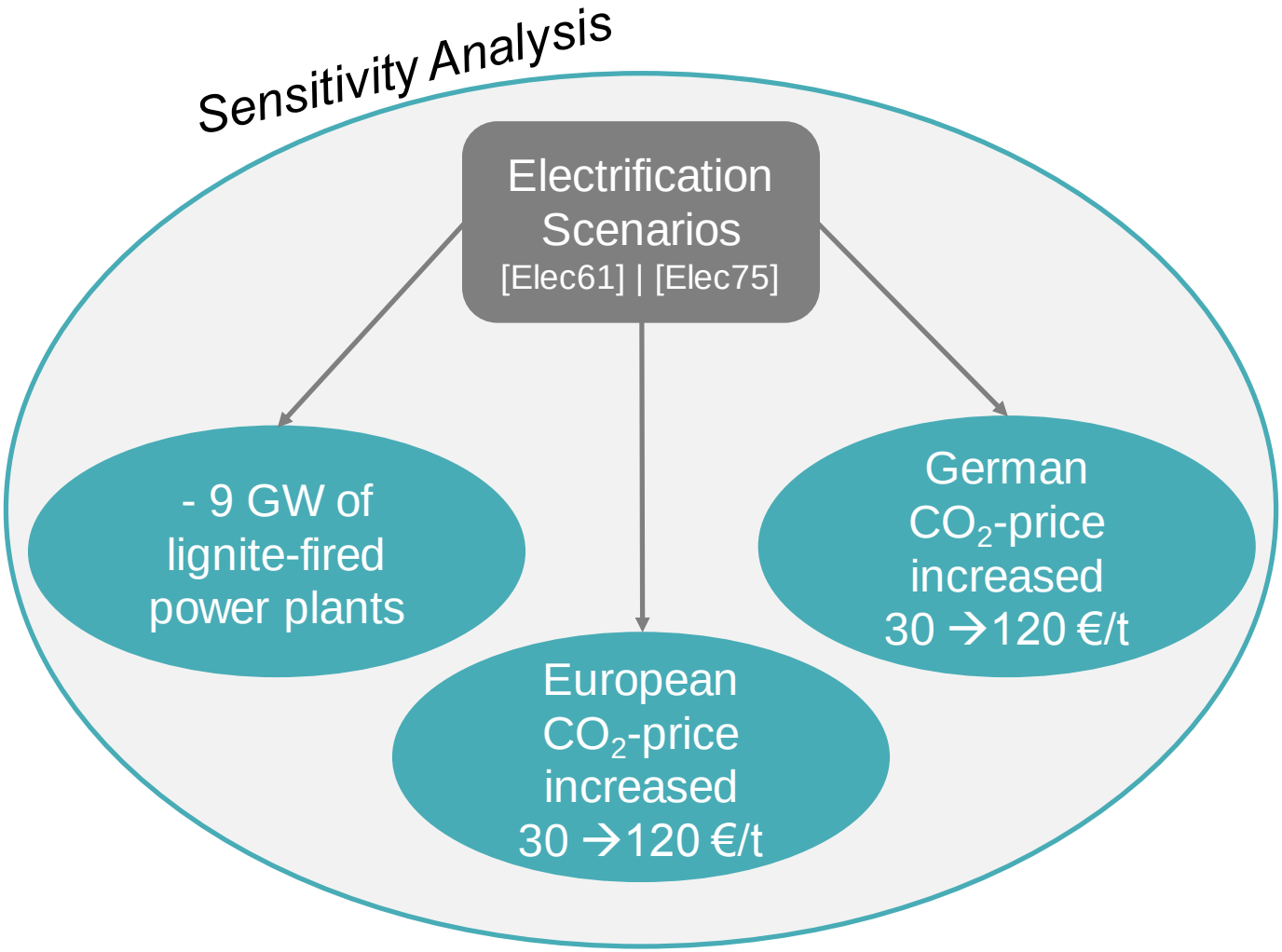
Electrification Scenario [**Elec61**]

Parameter	*Unit*	*Value*
Electrical FEC (Domestic / Industry / SME / Transport / DistH / Grid losses)	TWh	180 / 330/ 167 / 28 / 20 / 34 Sum: **759**
RES Capacity (Wind-Offshore / Wind-Onshore / PV)	GW_{el}	15 / 99 / 146
RES-Share	%	**61**

Electrification Scenario [**Elec75**]

Parameter	*Unit*	*Value*
Electrical FEC (Domestic / Industry / SME / Transport / DistH / Grid losses)	TWh	180 / 330/ 167 / 28 / 20 / 34 Sum: **759**
RES Capacity (Wind-Offshore / Wind-Onshore / PV)	GW_{el}	15 / 125 / 190
RES-Share	%	**75**

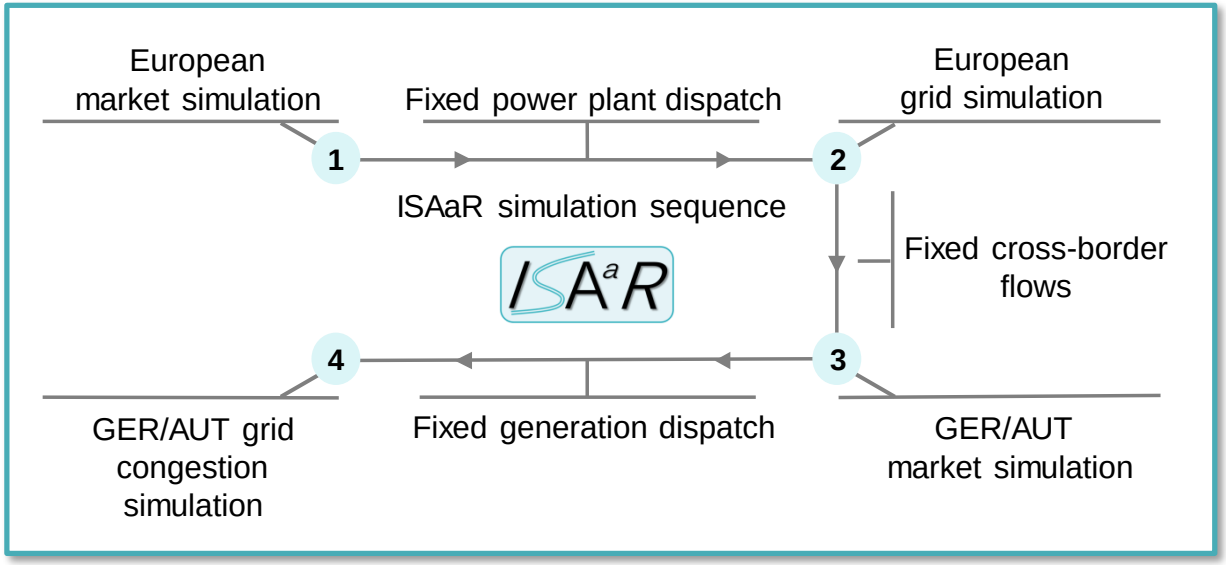
2. Method: Scenario Analysis



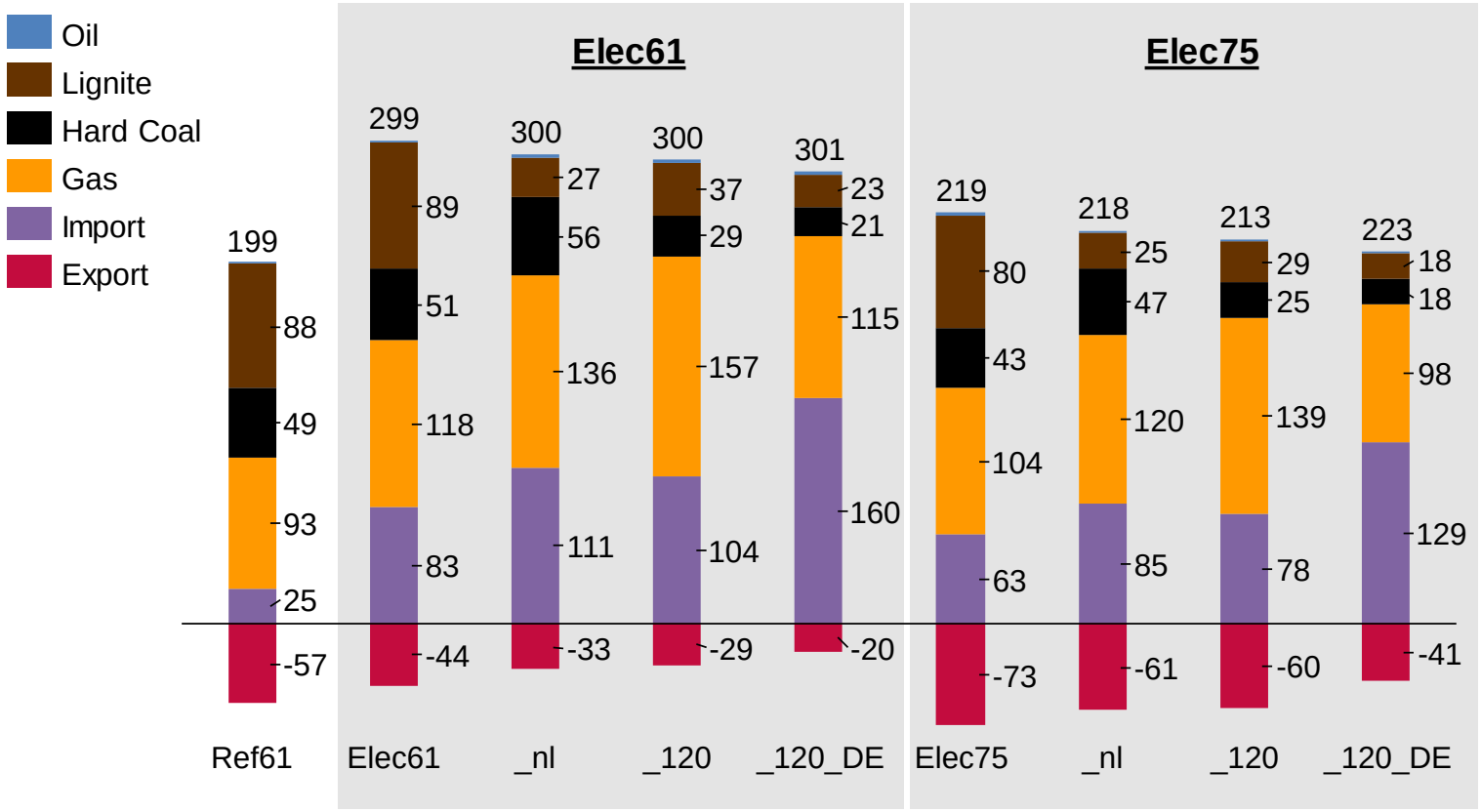
2. Method: Simulation Tool „ISAaR“

ISAaR: Integrated simulation model for plant dispatch and expansion planning with regionalization

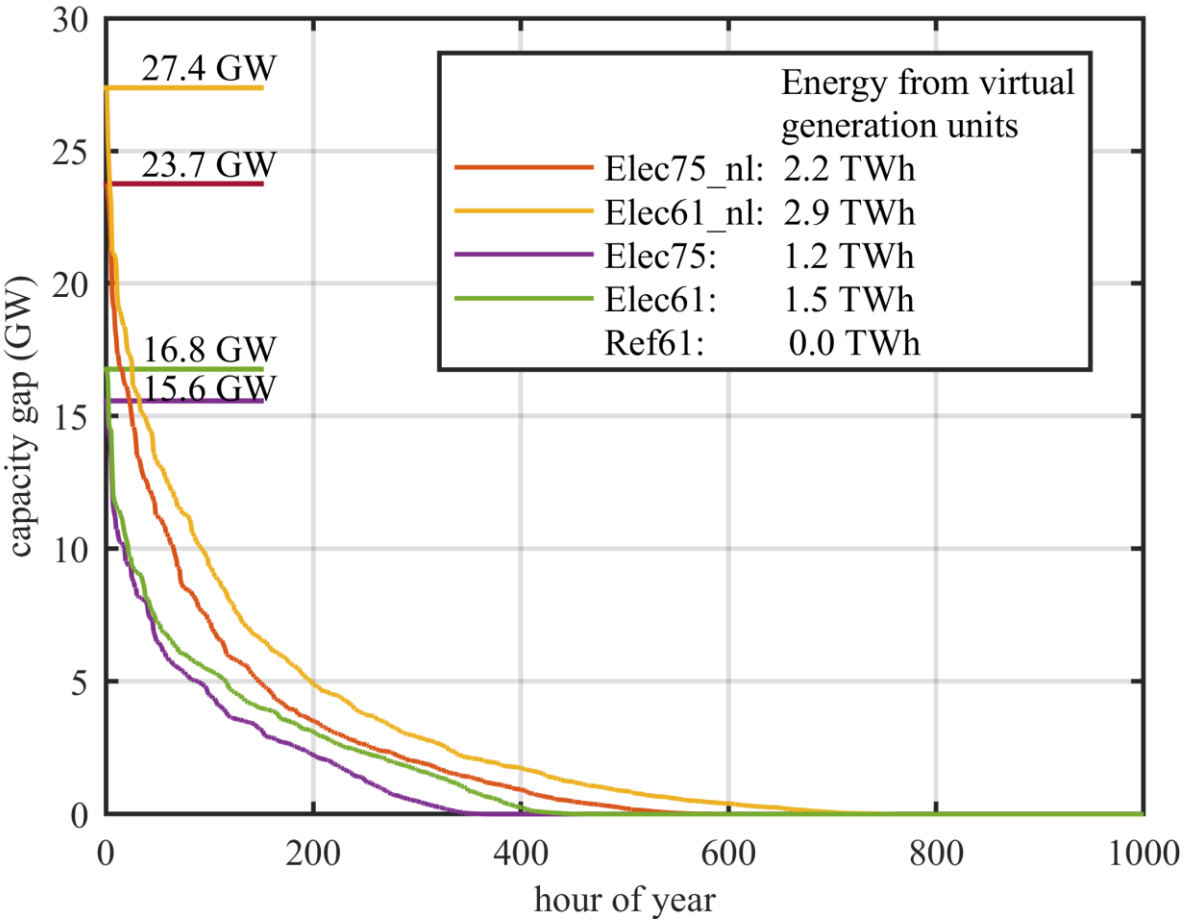
- European Energy System Model, regional resolution: NUTS3/Communities
- Grid Model: Transmission grid level, 496 nodes in GER/AT; ~1500 Europe
- Linearized load flow calculation according to PTDF method; "n-1" safe operation due to a max. AC line loading of 70%.



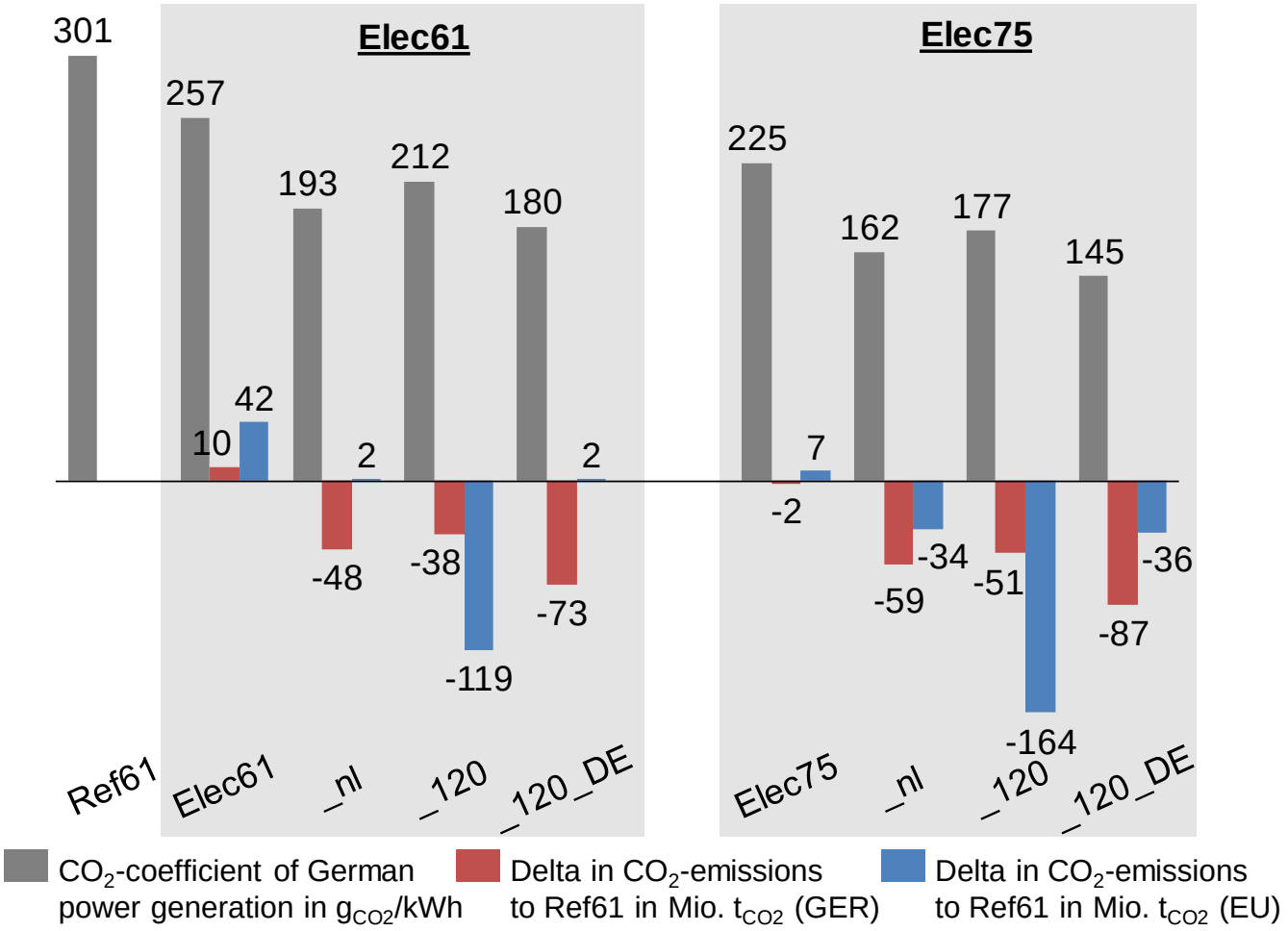
3. Results: Increase of gas-fired generation & higher imports



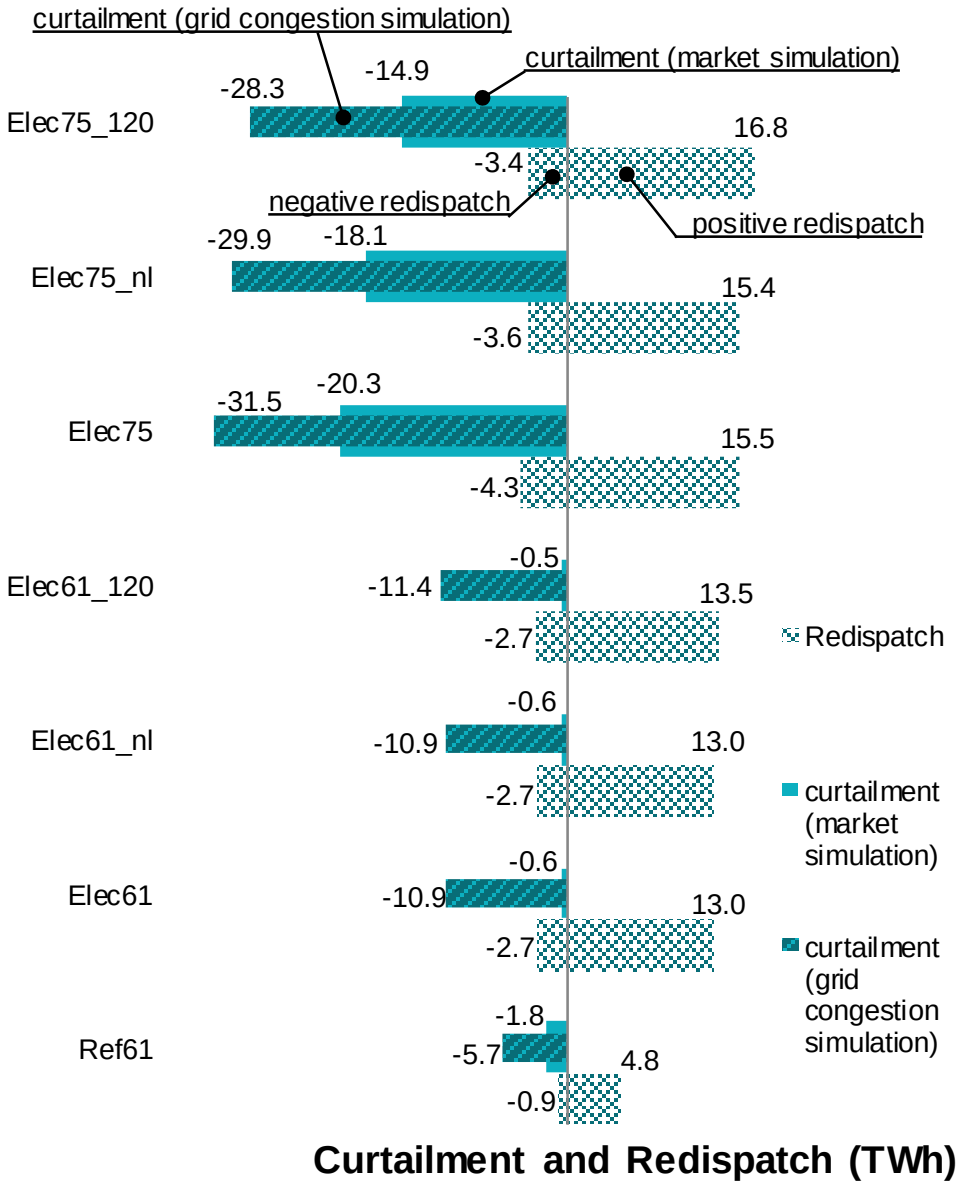
3. Results: High capacity gap but low full load hours



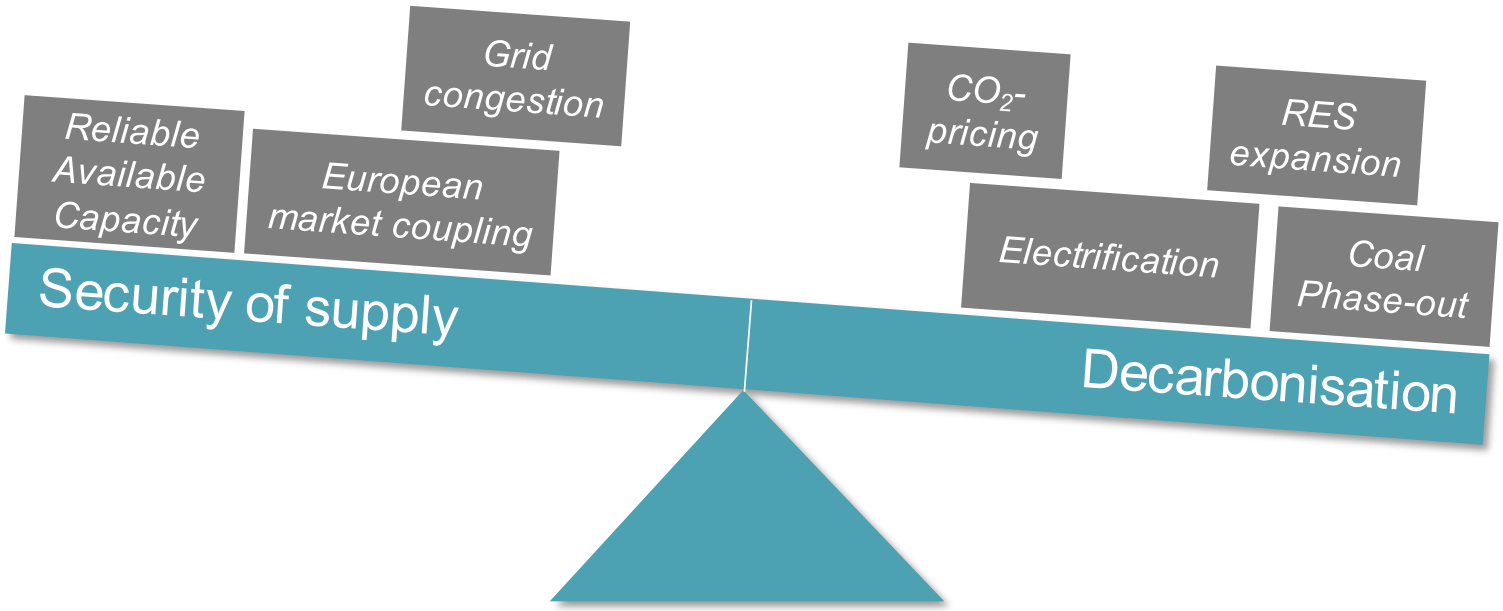
3. Results: Emission coefficient of power generation



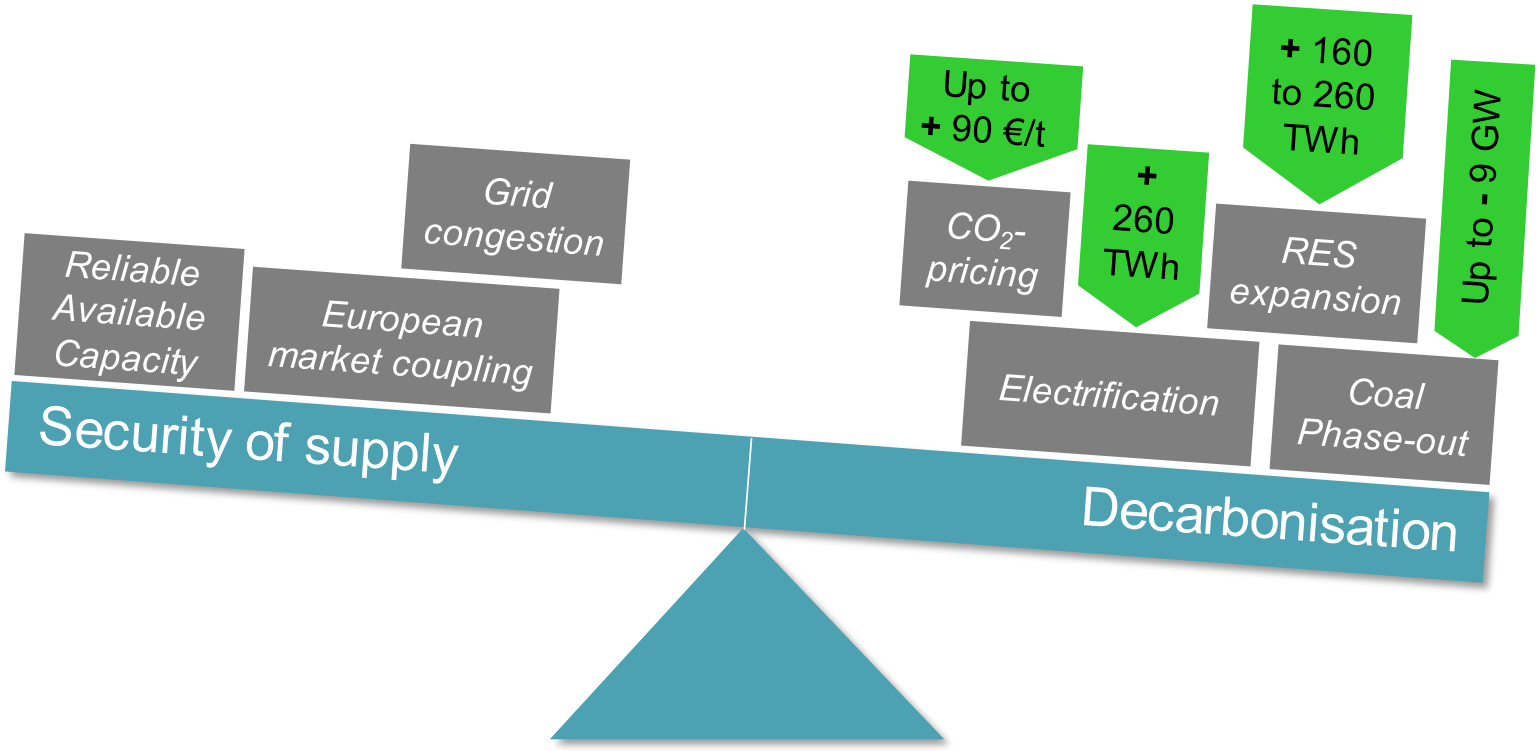
3. Results:


curtailment (grid congestion simulation)
curtailment (market simulation)
negative redispatch
positive redispatch
Elec75_120
-28.3
-14.9
16.8
-3.4
Elec75_nl
-29.9
-18.1
15.4
-3.6
Elec75
-31.5
-20.3
15.5
-4.3
Elec61_120
-0.5
-11.4
13.5
-2.7
Elec61_nl
-0.6
-10.9
13.0
-2.7
Elec61
-0.6
-10.9
13.0
-2.7
Ref61
-1.8
-5.7
4.8
-0.9
Redispatch
curtailment (market simulation)
curtailment (grid congestion simulation)
Curtailment and Redispatch (TWh)

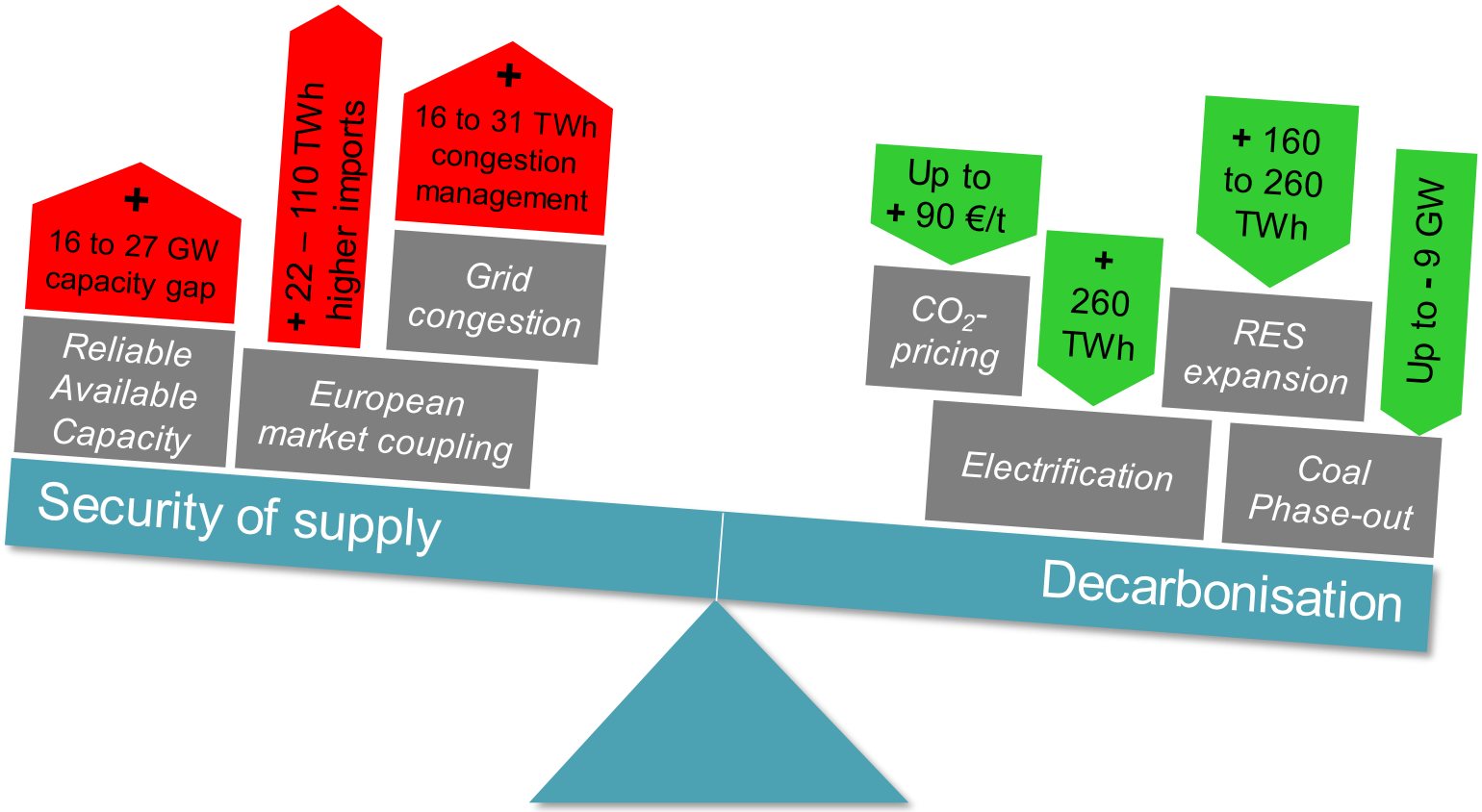
4. Conclusion: Electrification dilemma



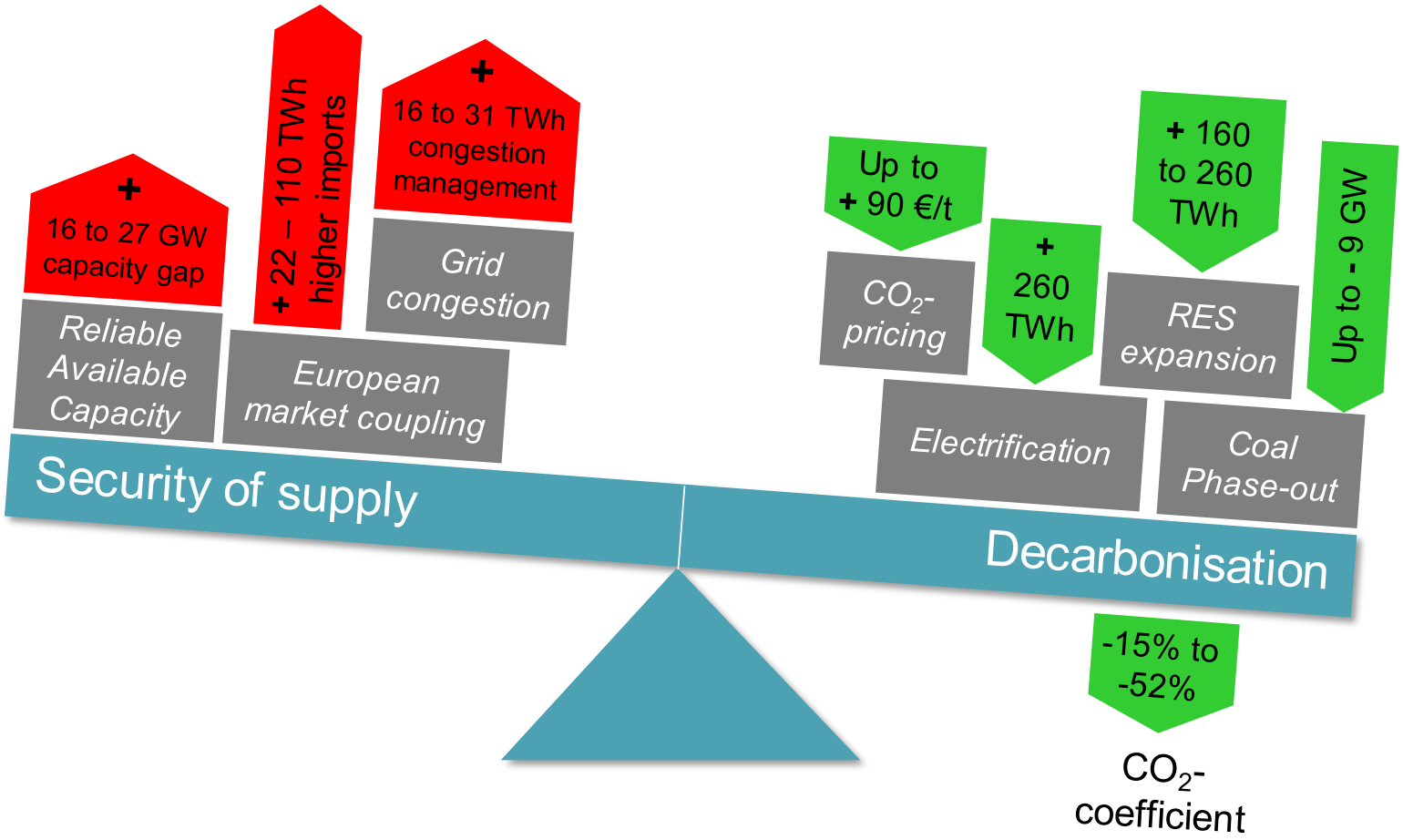
4. Conclusion: Investigated decarbonisation scenarios



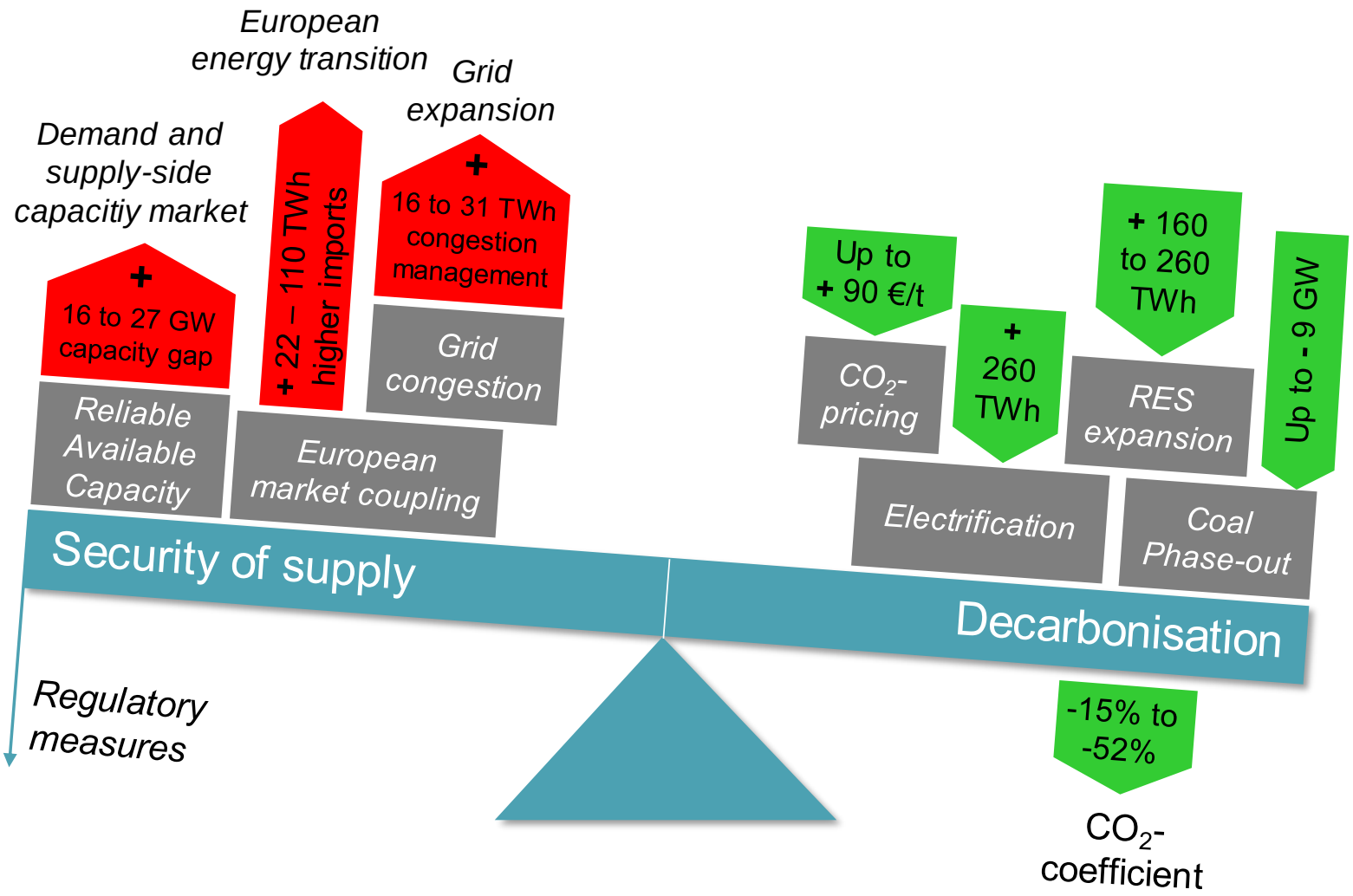
4. Conclusion: Energy system repercussions



4. Conclusion: Overall reduction of CO_2-coefficient



4. Conclusion: Regulatory measures



Thanks for your attention

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