GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

ECONOMIC EFFECTS AND SUSTAINABILITY IMPACTS OF REACHING 95% GHG MITIGATION UNDER DIFFERENT SCENARIOS FOR GERMANY

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Research Questions

- Analysis and comparative sustainability assessment of a spectrum of relevant transformation scenarios for Germany
- Economic, ecologic and social aspects are considered through a coupling of models – energy system, LCA, economics, conjoint analysis
- Identification and assessment of conflicting goals and trade-offs between different sustainability indicators which will occur during the transformation process

1. Scenario overview

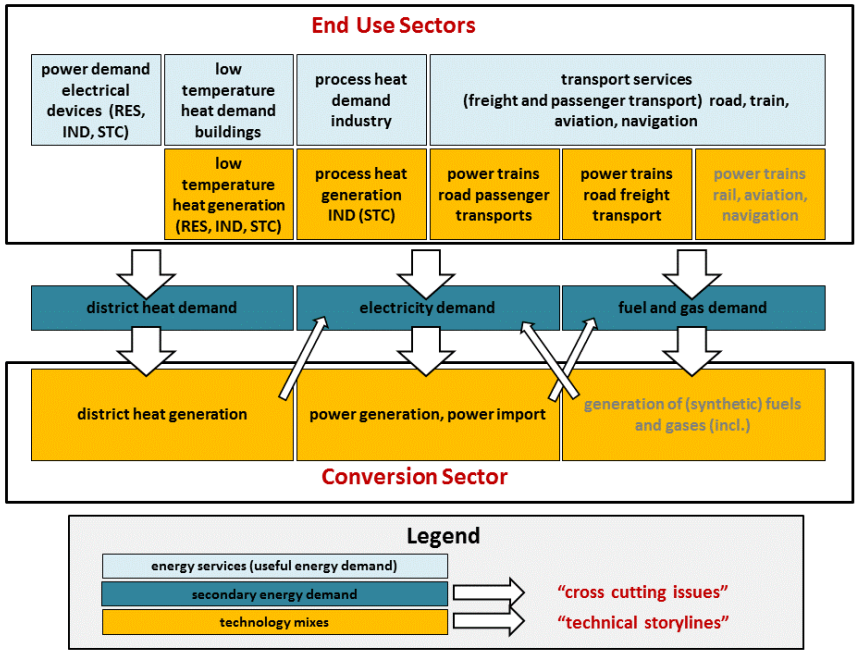
- Different institutions have developed energy transition scenarios over the last decade.
- They aim at between 80% and 95% emission reduction by 2050 compared to 1990
- They differ mostly in the technology mix and assumptions regarding heat and transport.

Title	Funding Agency	Research Institutions	Scenario Variant	Emission Reduction
Gesamtwirtschaftliche Effekte der Energiewende	BMWi-18	GWS, Prognos, DIW, FhG ISI, DLR	EWS	medium
Langfristszenarien für die Transformation des Energiesystems in Deutschland	BMWi-17	FhG ISI, ifeu, Consentec	Basis	medium
Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland	BMUB-12	DLR	A	medium
Klimaschutzszenario 2050	BMUB-15	Öko, FhG ISI, Ziesing	KSSz80	medium
Was kostet die Energiewende? Wege zur Transformation des deutschen Energiesystems		FhG ISE	80-g-H2-nb	medium
Klimaschutzszenario 2050	BMUB-15	ÖKO, FhG ISI, Ziesing	KSz95	high
GROKO II – Szenarien der deutschen Energie-versorgung auf Basis des EEG-Gesetzentwurfs	BEE-14	J. Nitsch	100	high
Den Weg zu einem treibhausgasneutralen Deutschland ressourcenschonend gestalten	UBA-17	ifeu, FhG IWES, CONSIDEO, Dr. Schoer SSG	GreenEE	high
Erneuerbare Gase – ein Systemupdate der Energiewende	INES-17	enervis energy advisors GmbH	OptSys	high
dena – Leitstudie integrierte Energiewende	dena-18	ewi Energy Research & Scenarios gGmbH	TM95	high

Our approach

- Re-model the scenarios to be able to identify effects

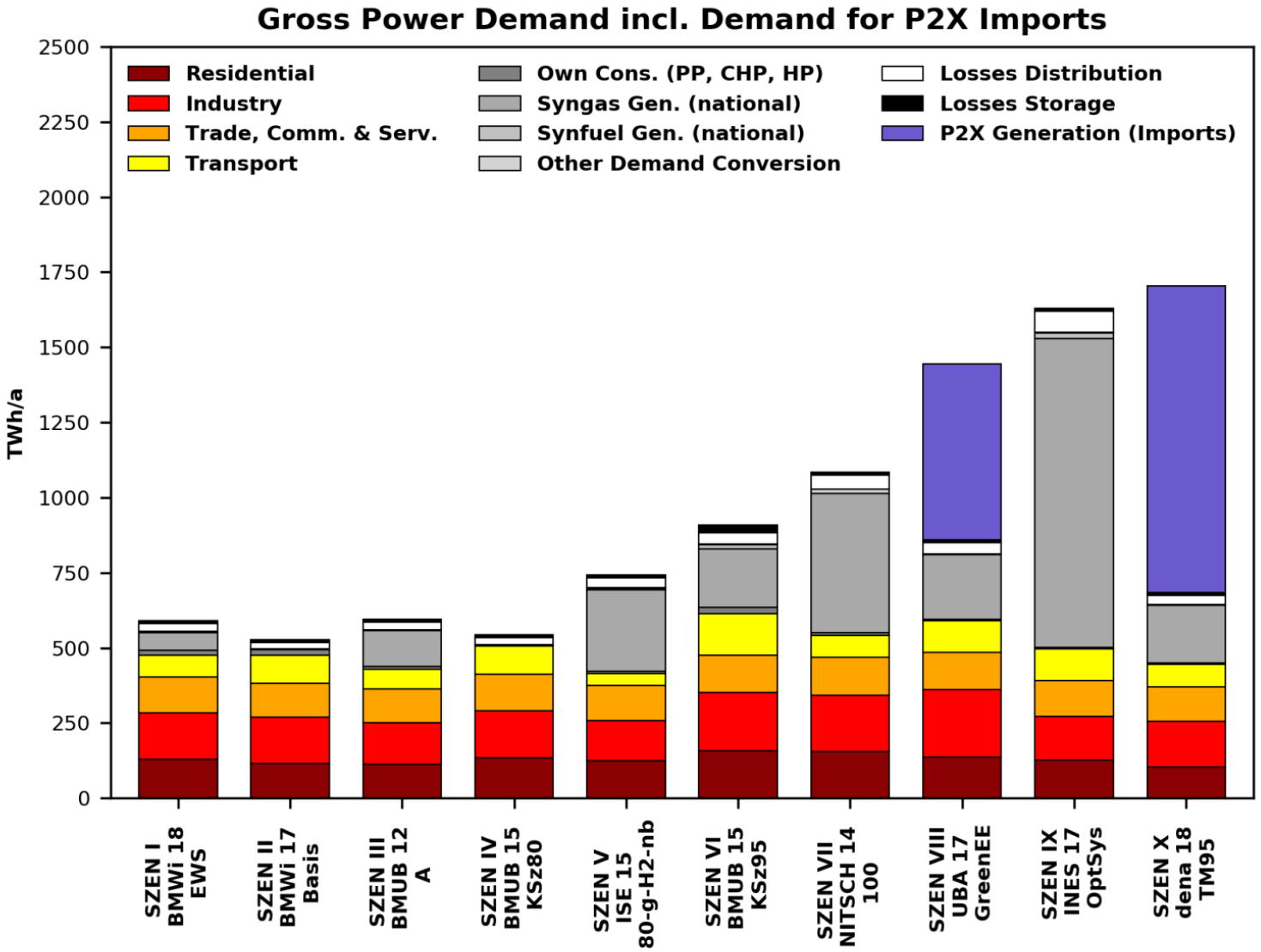
- harmonization of
  - ⇨ energy demand
  - ⇨ transport services
- identical assumptions with respect to
  - ⇨ full load hours
  - ⇨ efficiencies
  - ⇨ costs, ...
- (implicit) harmonization of
  - ⇨ GDP
  - ⇨ Population
- Advantage: results can be attributed to the difference in the energy system
- Disadvantage: efficiency gains are lost to a large extend.



DLR energy model MESAP

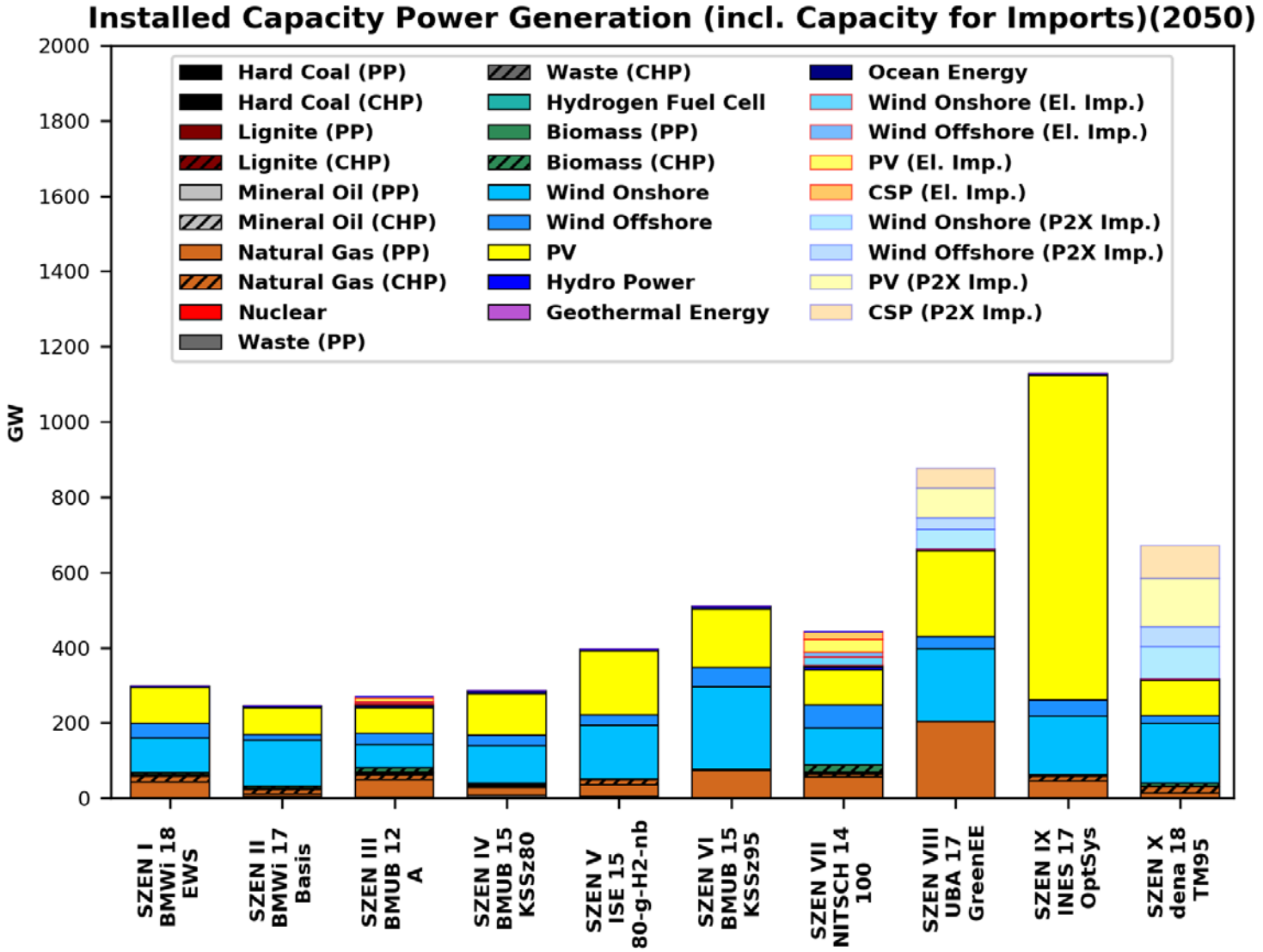
Source: T. Nägler, DLR

Shift to direct and indirect electrification



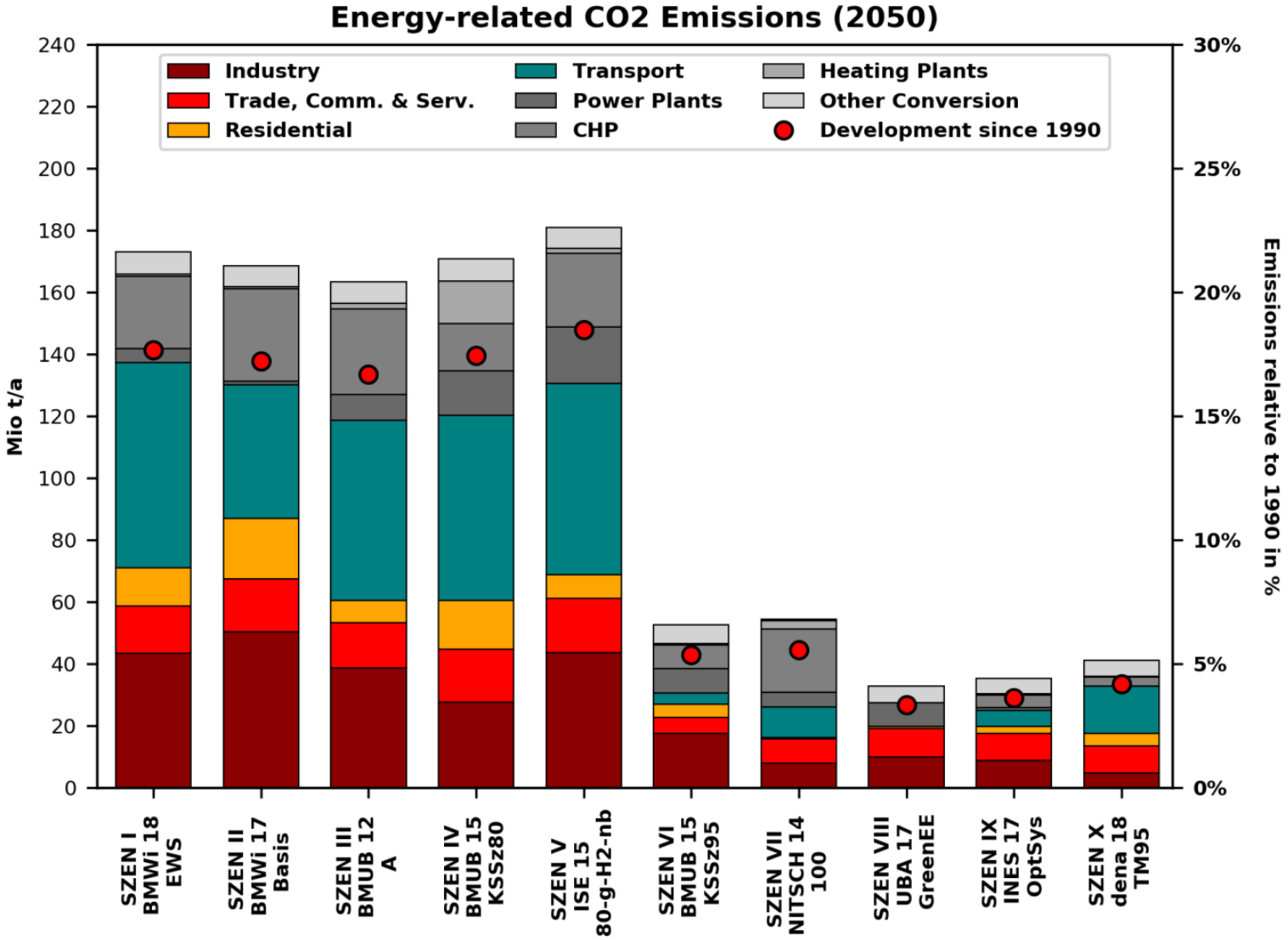
Source: T. Nägler, DLR

Technology mixes



Source: T. Nägler, DLR

Direct energy related CO2 emissions

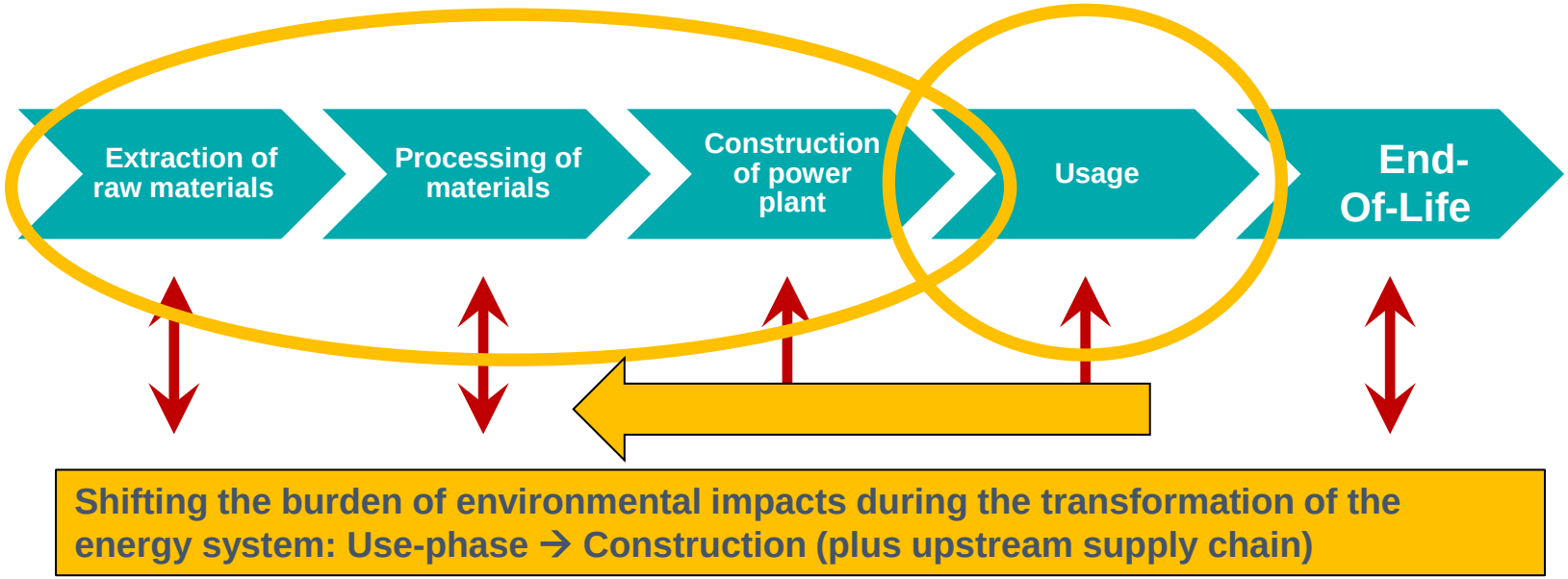


Source: T. Nägler, DLR

2. Ecologic and economic impacts

Ecologic effects

Account for environmental impacts from *all* phases of a product's life cycle including upstream and downstream processes

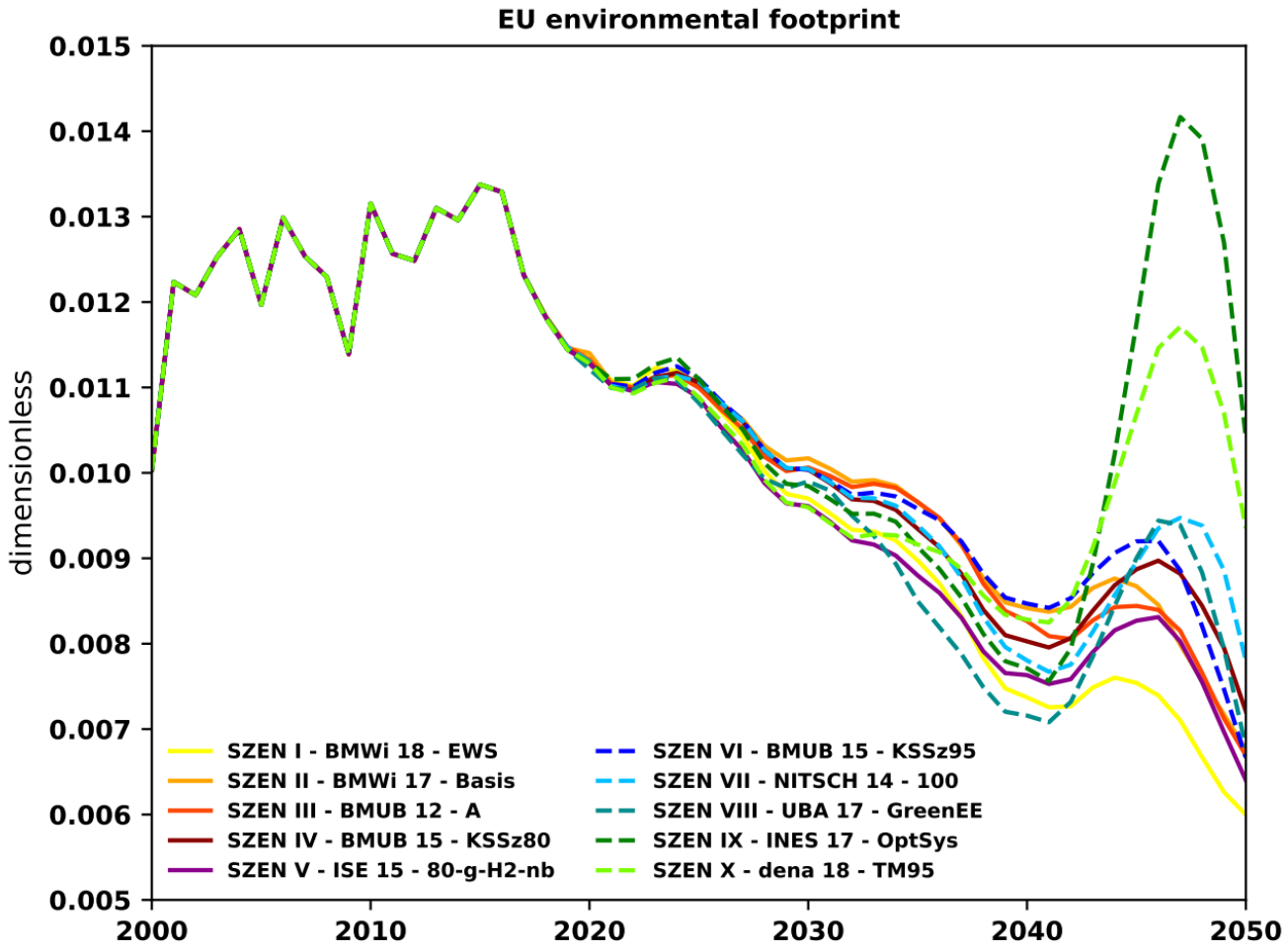


EU Environmental Footprint

Weighted, standardized indicator, EU method.

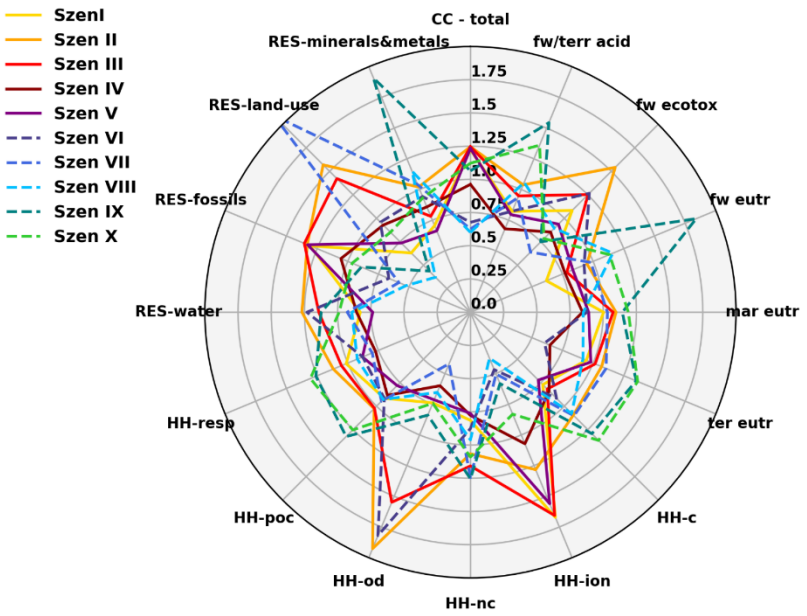
Smaller values= better.

- Less ambitious scenarios do not perform better here = ambition is possible from ecologic indicators and
- Scenarios with high shares of indirect electrification peak between 2040 and 2050, due to PV to produce synfuels.



Impacts in year 2050 relative to average impact 2050

- Categories are:
- Freshwater, resource depletion, human health and climate change
- Scenarios with high shares of PV have high index on land use
- So are scenarios with high biomass shares
- Whole value chain is considered
- Types of battery matter, types of storage, cars and their fuels.



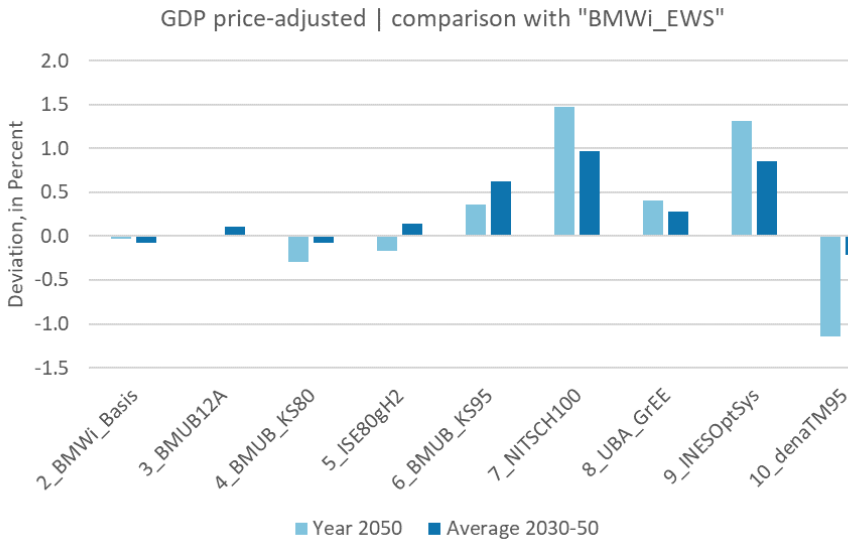
Economic effects

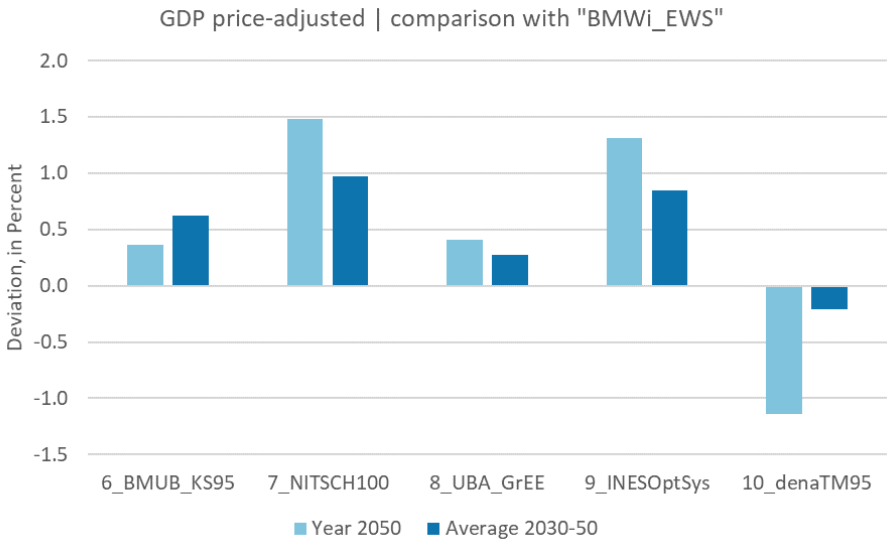
- Main drivers of the economic effects are investment, prices and trade
- In absolute terms, GDP effect is highest in scenario 7 and 9, as are employment, imports and investment.
- The price effect is highest in scenario 7
- The differences between the scenarios are not very high.

		GDP	Investment, Construction	Investment, Equipment	Imports	Consumer Price Index	Employment
		price-adjusted, Bn Euro				2015 = 100	1 000
	Scenario	Average of the years 2030 to 2050					
Szen1	1_EWS	3751.9	275.4	545.4	2728.7	147.9	43879.5
Szen2	2_BMWi_Basis	3748.8	273.4	542.1	2724.2	147.8	43869.9
Szen3	3_BMUB12A	3755.8	276.1	549.3	2730.1	148.0	43888.1
Szen4	4_BMUB_KS80	3749.0	275.4	541.9	2723.6	147.4	43889.8
Szen5	5_ISE80gH2	3757.0	280.3	556.0	2740.4	147.7	43936.3
Szen6	6_BMUB_KS95	3775.1	285.0	557.9	2735.9	147.8	43982.8
Szen7	7_NITSCH100	3788.4	292.1	570.8	2752.8	148.3	44009.1
Szen8	8_UBA_GrEE	3762.2	281.5	552.7	2735.2	148.0	43946.5
Szen9	9_INESOptSys	3783.7	294.7	575.6	2762.0	147.6	44047.7
Szen10	10_denaTM95	3743.9	275.7	546.4	2733.9	147.8	43875.0

Relative GDP, five 95 %-scenarios

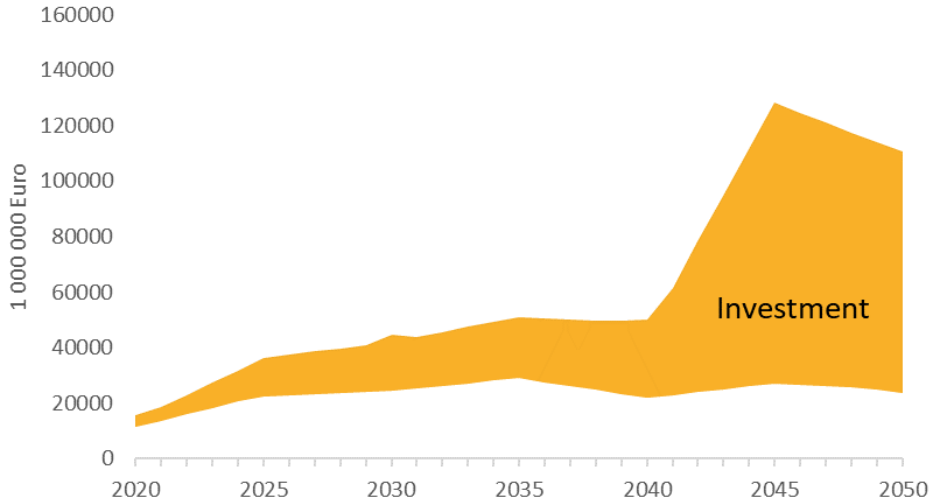
- If we treat the Energy Transition scenario of the Ministry of Economic Affairs and Energy as a reference, the 95% scenarios are almost all more beneficial than the 80% scenarios
- Scenario 10 is an exception with less growth at the end and on average

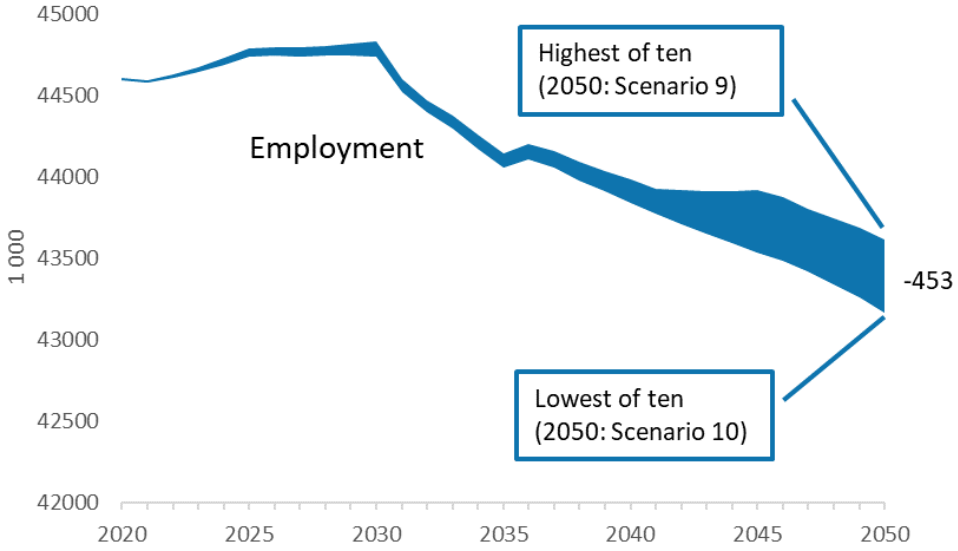




How different are the scenarios?

- Until 2040, investment does not differ largely
- Some scenarios show large increases of investment towards the end
- This is reflected in employment if investment goes to domestic sectors





Results for sectors

	Agriculture	Mining, Energy and water supply	Industry	Construction	Trade, Transport, Tourism, IT	Financial sector, enterprise services	Public und private services
Scenario	Relative difference to Scenario 1_EWS, 2050, Percent						
6_BMUB_KS95	-0.07	0.26	-0.17	1.42	-0.02	0.37	0.14
7_NITSCH100	-0.18	-1.46	-0.47	6.15	0.04	0.81	0.16
8_UBA_GrEE	-0.08	0.32	-0.12	2.25	-0.01	0.50	0.08
9_INESOptSys	-0.19	0.27	-0.40	6.52	0.14	1.13	0.48
10_denaTM95	0.12	-2.34	0.27	-1.11	-0.10	-0.66	-0.19

- Two 95% scenarios exhibit higher losses in the energy sector
- Four show higher impact in construction
- On average: Economic effects are small!

3. Conclusion

Conclusion

- The ecologic evaluation shows larger differences between the scenarios than the economic evaluation
- All scenarios exhibit positive economic effects
- High reliance on hydrogen import lowers the positive impacts; IEA (WEO2019) sees no advantage in hydrogen imports, because few countries have comparative advantages.
- From an economic standpoint, ANY energy transition towards low-carbon is beneficial and leads to more wealth and growth than remaining in the conventional world
- Comprehensive sustainability analysis is necessary to include all environmental aspects beyond CO2

Thank you for your attention.

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