Johannesburg, April 5th, 2019

WHAT ENERGY SYSTEM MODELS CAN TELL US ABOUT THE POTENTIALS AND LIMITS OF A LOW CARBON ECONOMY?

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WHAT ENERGY SYSTEM MODELS CAN TELL US ABOUT A LOW CARBON ECONOMY?

› Orientation Knowledge ?

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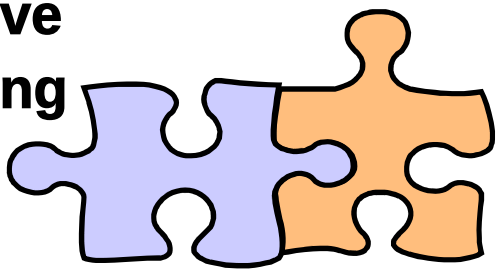
Gauteng Province as forerunner for climate protection

- **Gauteng Province is in the position to take the lead in the country in terms of moving the province to a low-carbon economy**
  - **by coupling continued economic growth**
  - **with a less carbon intensive economy**
  - **while meeting political and social objectives**

- **The EnerKey study looks at how Gauteng province can achieve these objectives through advanced local energy planning using the TIMES-GEECO model.**



TIMES-GEECO

(**G**auteng **E**nergy and **E**missions **C**ost **O**ptimisation Model)

Integrated Analysis using TIMES

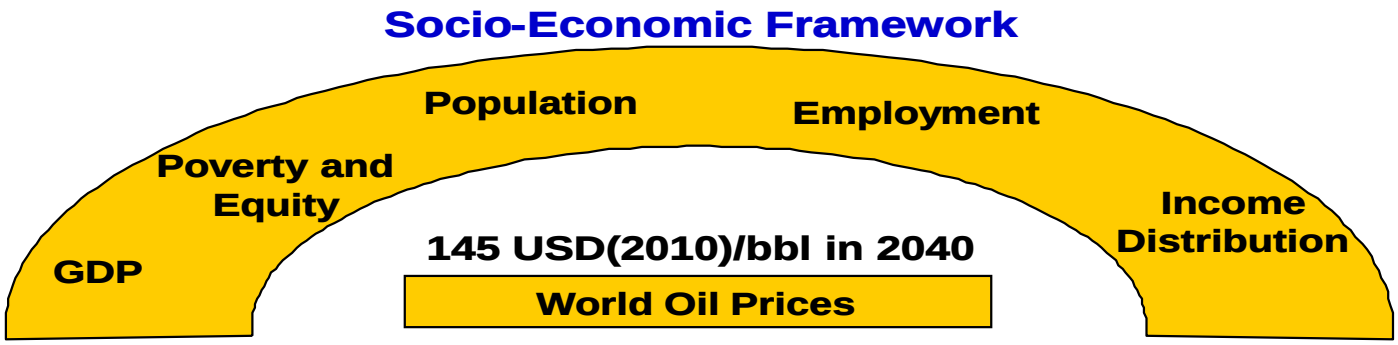
to show the sectoral development with respect to the development in the total energy system

to ensure optimal allocation of scarce resources under consideration of full costs as well as environmental and political targets

- Start from scratch
- Demand Sectors: Residential, Public Buildings, Industry, Commerce, Transport
- Integration into South African energy System where important linkages exist: e.g. Electricity Generation, Fuel Supply, Primary Energy Supply, RE potentials
- 3 Regions (Gauteng, South Africa, Import & Export)
- GHG emissions and Pollutants
- Including mitigation options in terms of alternative technologies for all sectors in focus
- Time horizon 2007 – 2040, 42 Time-Slices (7 daily, 2 weekly, 3 seasonal)

Capacity building through regular TIMES training courses

Opportunities for Gauteng province to become a forerunner in South Africa



Series of Energy Scenarios

Reference	Low Carbon Province		
Imple-mented Policies IPO	GIES CO_2 Targets		CO_2 Emission as required by science (LTMS) LRS
	Least Cost LGL	Solar Province LGS	

Framework assumptions 2007-2040:

Population: +83% Households: +115%

GDP: +277% Employment: +82% Gini coef.: -0.07

The implemented policies scenario (IPO)

- can be referred to as the reference scenario
- it incorporates mandatory targets and policies which will likely be implemented

The low-carbon required by science scenario (LRS)

- Most stringent GHG mitigation
- Corresponds to the regional contribution of Gauteng to South Africa's GHG mitigation target as outlined in the LTMS to not exceed 2°C of global warming

Options to move Gauteng Province to a low carbon economy

Residential

- Building standards differentiated by income groups
- CFL and LED Lighting
- SWH for medium and high income households
- Biomass for poor and low income

Transport

- Higher vehicle efficiency (hybrids), especially for busses, BRT, trucks
- Increased use of biofuels
  - Biodiesel from waste cooking oil
  - BTL from solid biomass

Industry & Commerce

- Solar Cooling and Heat Pumps
- Efficient Compressed Air Systems (CAS)
- Variable speed drives
- Retrofit of steel production technologies (best practice)

Energy supply

- Concentrated Solar Power (CSP): Parabolic Trough with storage
- Organic biomass (landfill, sewage) for electricity generation
- Carbon Capture and Storage (CCS) for power plants and synthetic fuels
- Nuclear energy (if considered)

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- Orientation Knowledge
  - Innovative Technologies
  - Energy Carriers

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INTRODUCTION

Energy Transition (or ‘Energiewende’ in German)

- Originally politically charged term of the German environmental movement (since 1970’s) for nuclear phase-out and conversion to renewable energy
- In 2010, the Energy Concept of German Government stated “Securing a reliable, economically viable and environmentally sound energy supply is one of the great challenges of the 21st century.”
- In 2011, German government initiated a radical change energy policy taking over the term “Energiewende”
- The long-term vision – the age of renewables to be achieved in 2050

Energy transition describes a set of policies and practices to phase out the use of fossil fuels and nuclear energy for electricity generation, heat and mobility and to rely more on renewable energy while improving energy efficiency.

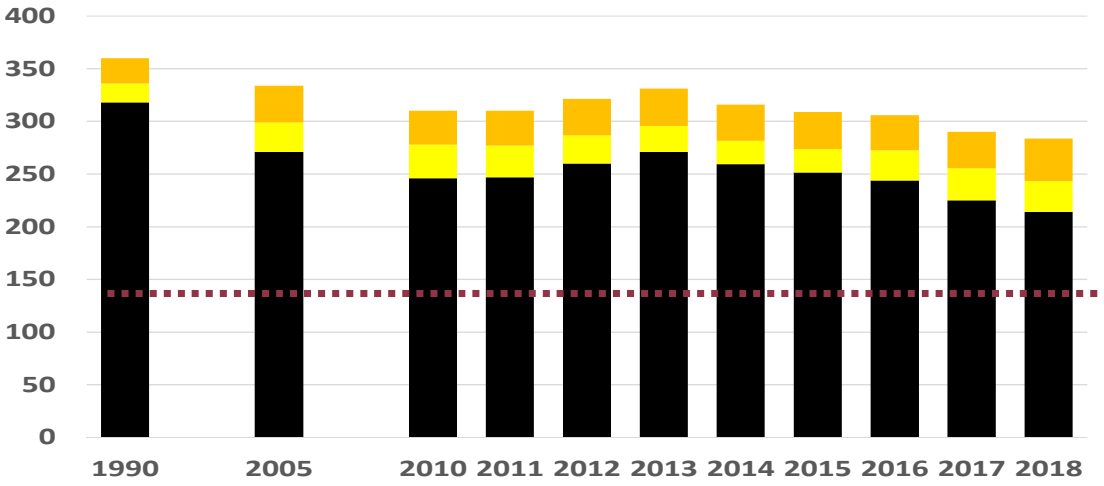
Climate targets & Coal commission

Germany‘s climate targets

Year	2020	2030	2040	2050
Red. ag. 1990	**40%**	**55% (61%*)**	**70%**	**80% to 95%**

*Energy industry (Electricity, District heating, Refineries etc.)

CO_2 emissions Electricity generation [Mt]



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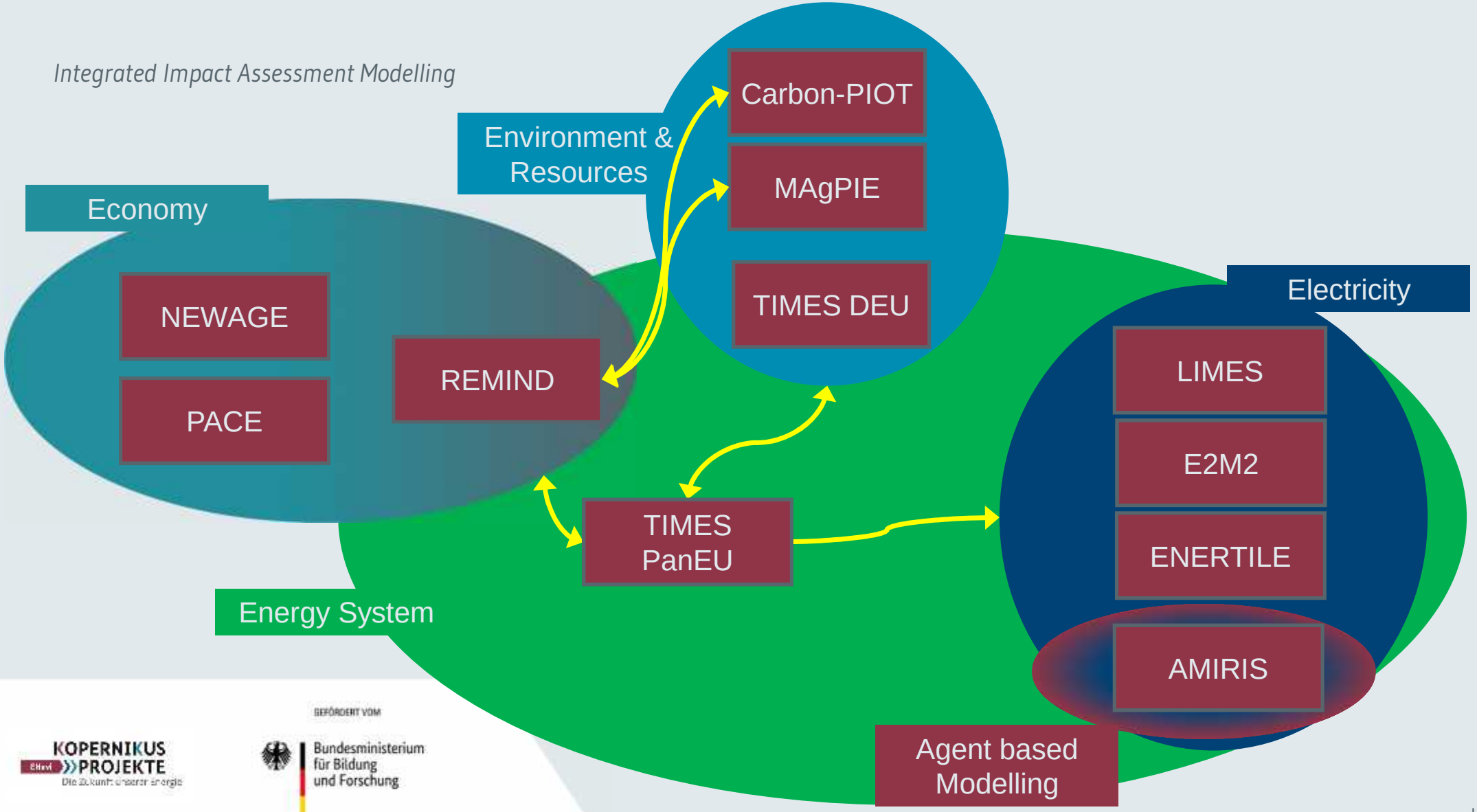
Coal commission

- Measures to achieve the 2030 targets
- Coal phase-out schedule
- Accompanying measures

Integrated Impact Assessment Modelling



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SCENARIO ANALYSIS

Orientation	Measure	Base scenario (BEZUG)	Policy Packages			
			Phase-out (KAS)	Phase-out + (KAS+)	CO_2 Price + (COP+)	CO_2 Price (COP)
Regulatory	Regulatory mandatory coal phase-out with a specific phase-out schedule (KAS)	No	Yes	Yes	No	No
Market based	Expansion of renewable energies with tradable renewable energies quotas (EE)	No	No	Yes	Yes	No
	Cessation of certificates in the European ETS (Emissions Trading System) (ZS)	No	No	Yes	Yes	No
	Implementation of a CO_2 floor price in the ETS for installations in the German energy industry (COP)	No	No	No	Yes	Yes

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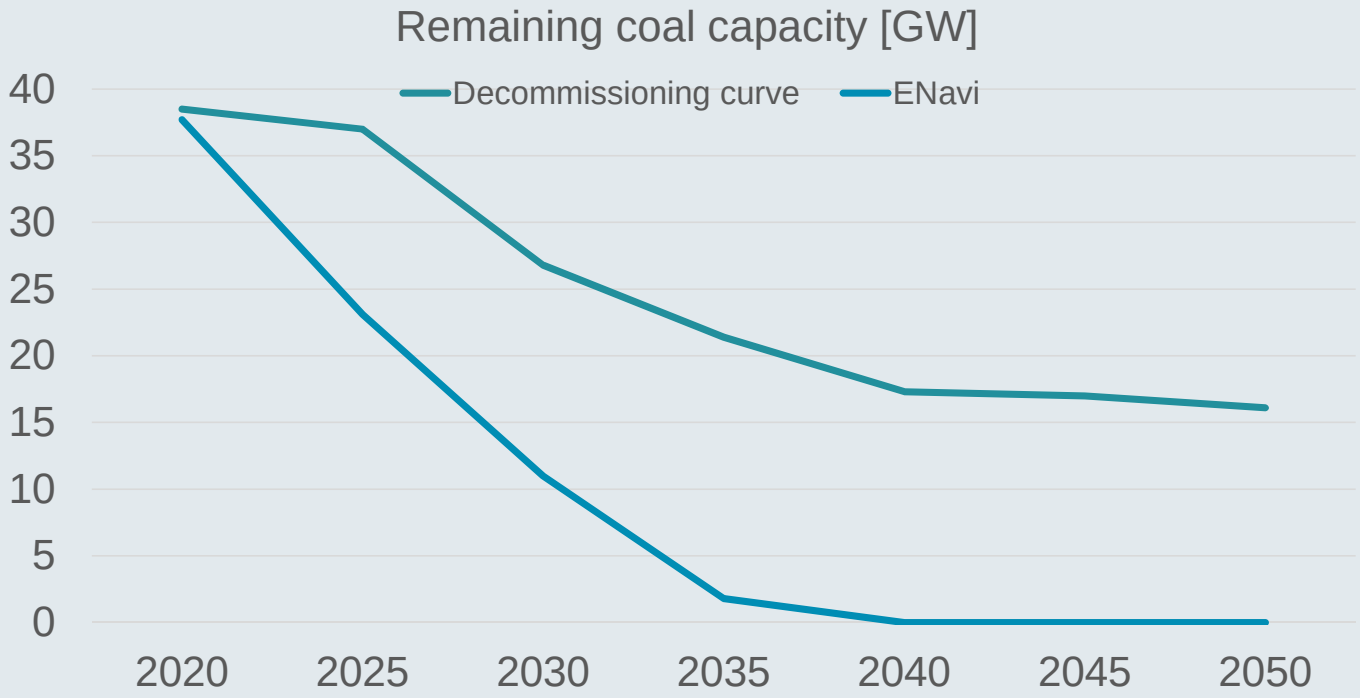
REGULATORY MANDATORY COAL PHASE-OUT SCENARIO (KAS)



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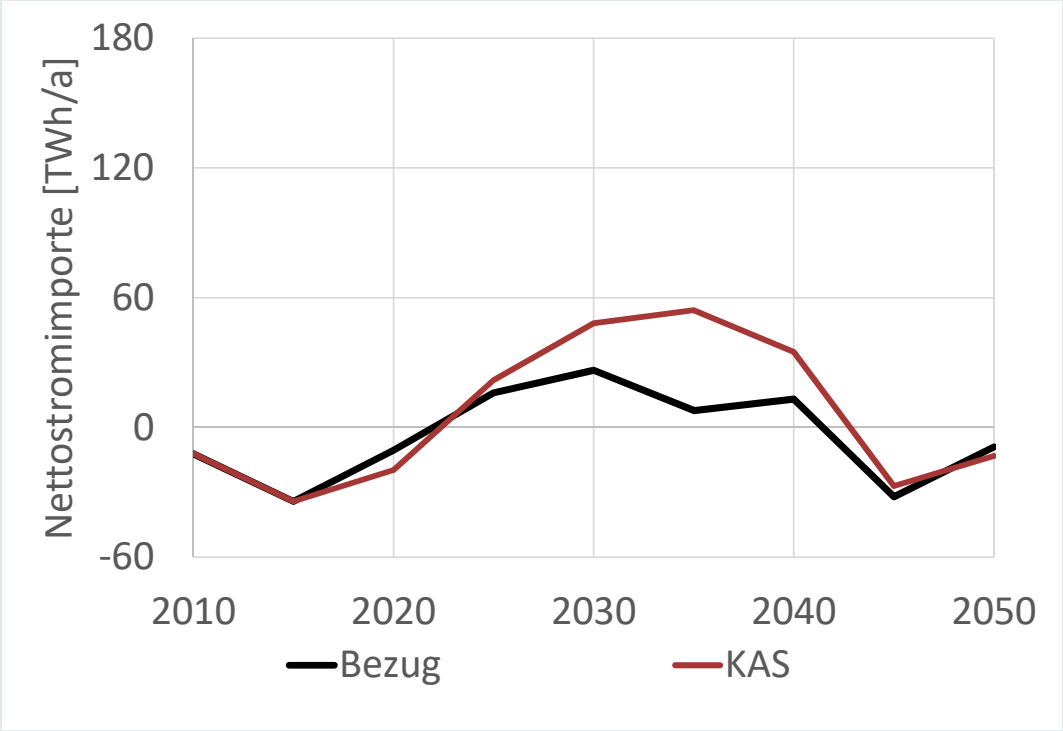
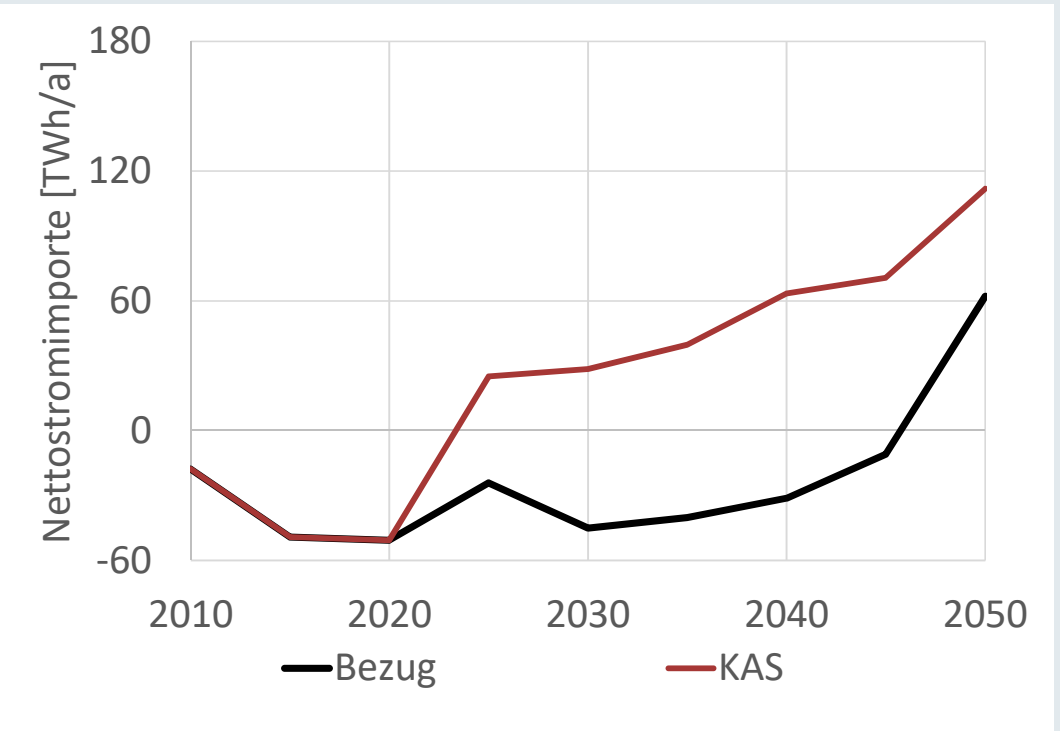
ELECTRICITY TRADE BALANCE

LIMES



TIMES



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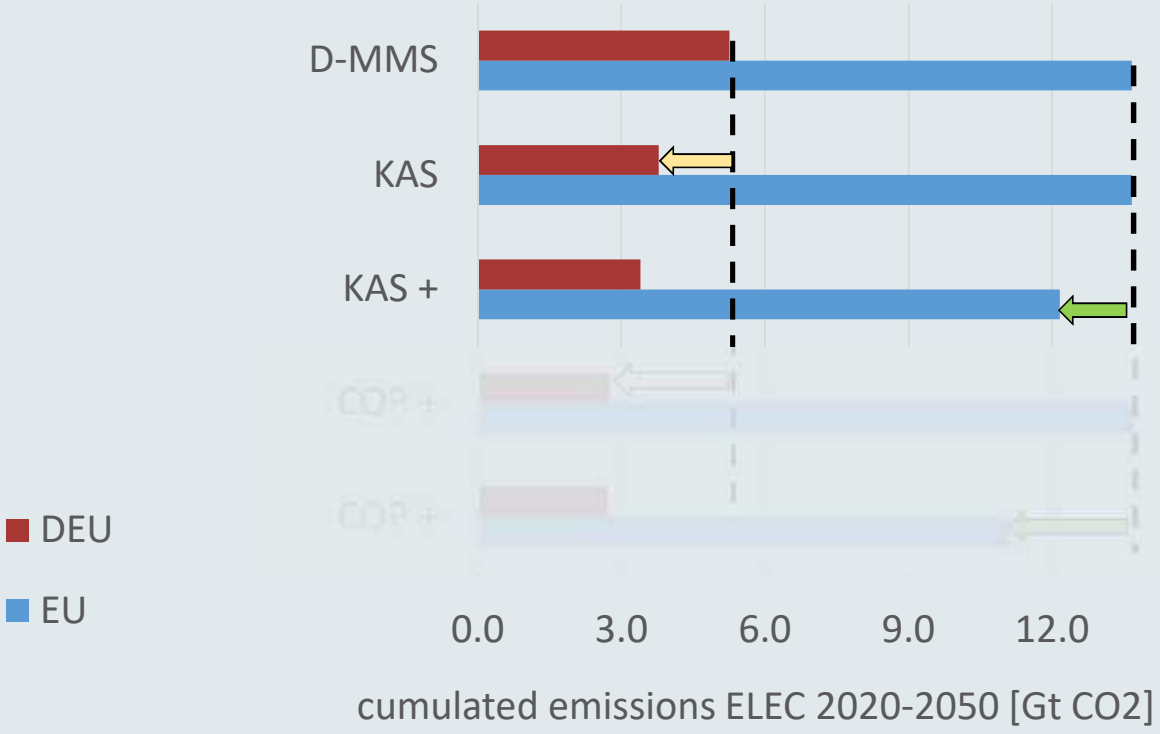
› **Coal phase-out** will lead to higher **electricity imports**

EMISSION REDUCTION – THE EUROPEAN DIMENSION



- KAS reduces **cumulated emissions of the German electricity sector** by **1/3**, COP by **50%**
- For the impact on European emissions, the **cessation of certificates** is crucial - otherwise most of the German emission reductions will be lost (**Water bed effect**)

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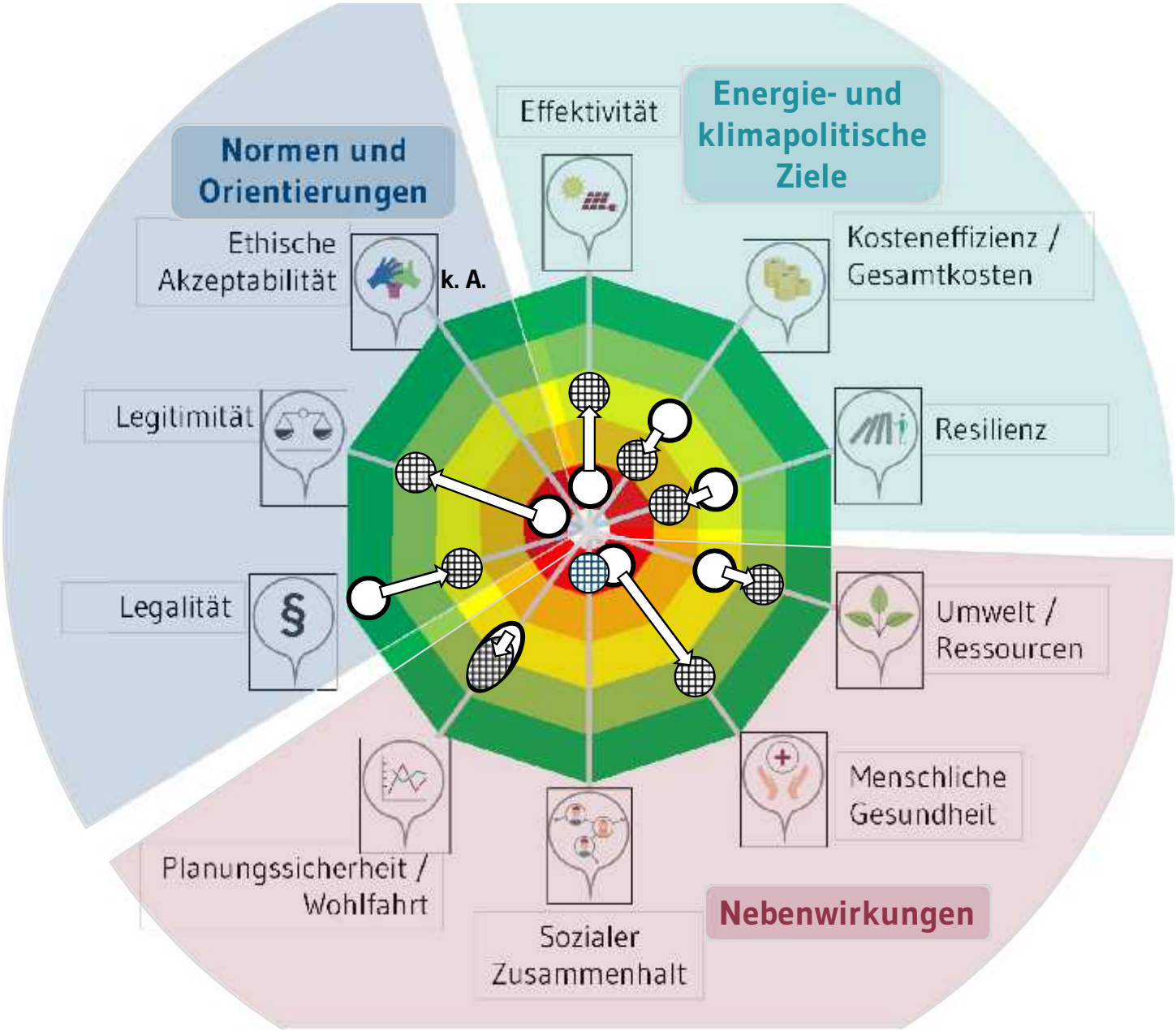
BASE SCENARIO ○
AND „KAS"-SCENARIO ▦

Trade-offs

- **Effectivity**
  national: increasing
  European: without change
- **Environment**
  Air pollution control: improving
  Water use: decreasing
  Land use: increasing
- **Health: improving**
- **Resilience: declining**
- **Cost-efficiency: declining**



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- Orientation Knowledge
  - Innovative Technologies
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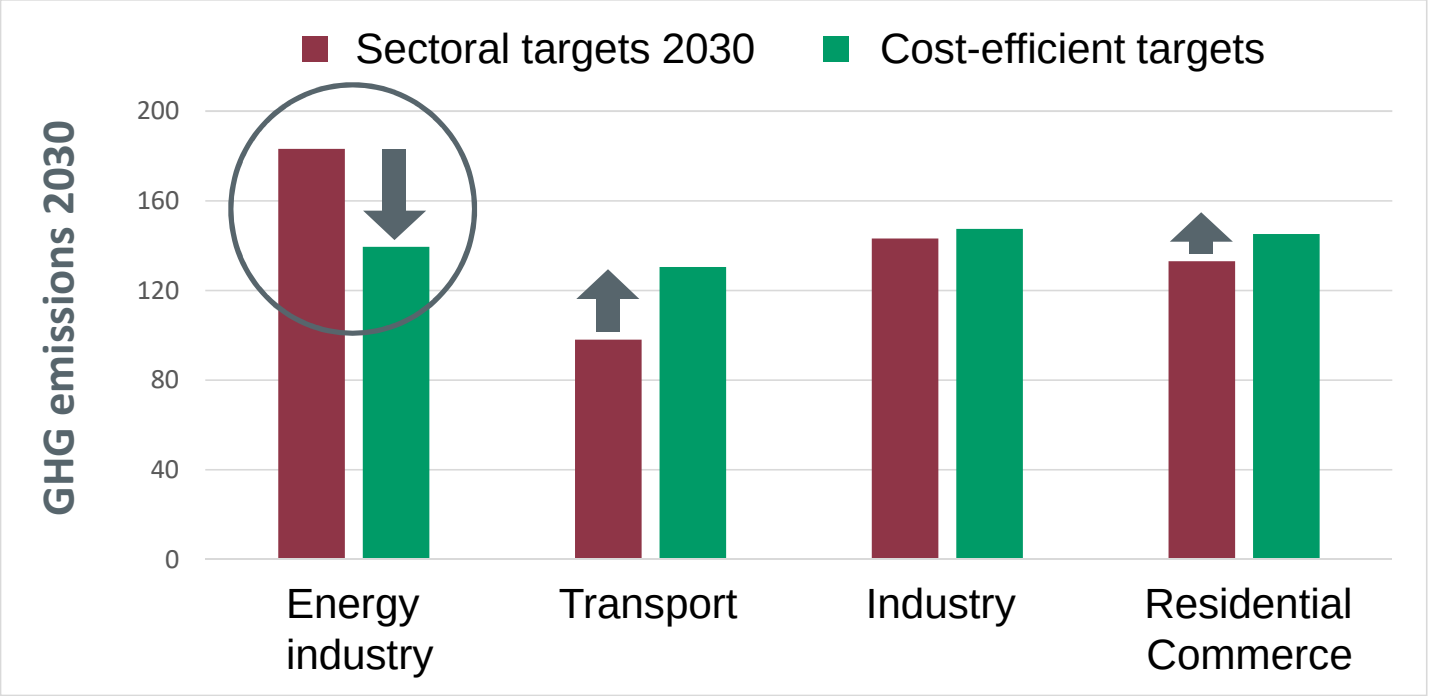
Effort Sharing: 2030 target for energy industry should be more ambitious, if GHG emission reduction in Germany should be achieved in a cost-efficient way



- Reason: Mitigation costs in other sectors are higher

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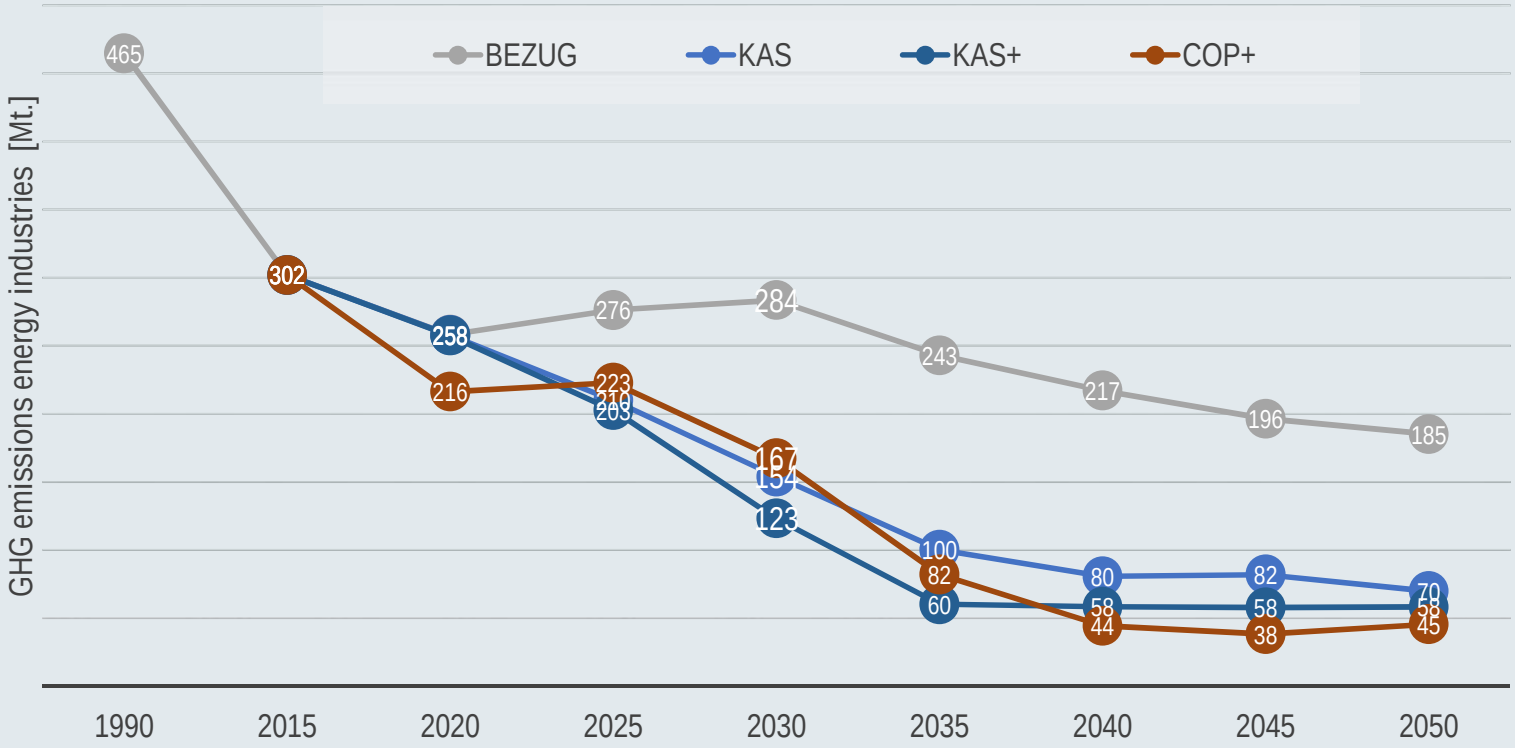
GHG EMISSIONS ENERGY INDUSTRY IN GERMANY



- KAS results in 154 Mt GHG emissions in 2030
  → Sectoral target (183 Mt) will be achieved
- In 2050 the GHG emissions of energy industry in Germany will become 70 Mt
  → Sectoral target (31 Mt) will not be reached.

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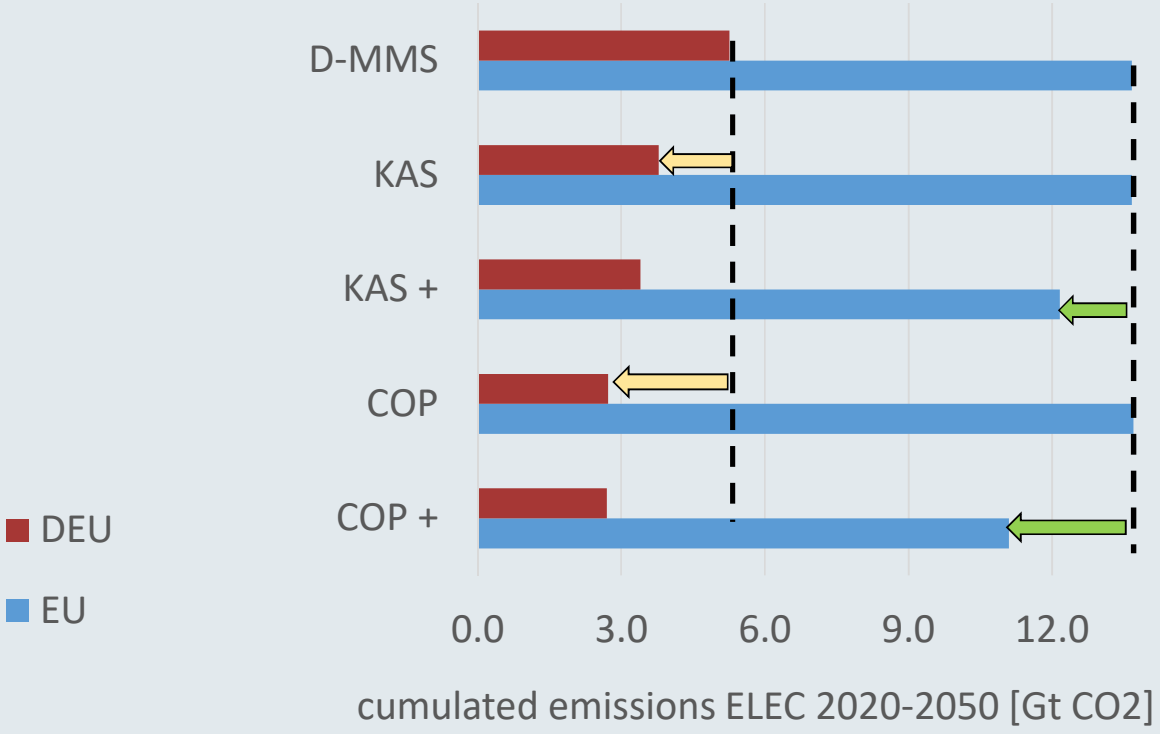

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- For the impact on European emissions, the **cessation of certificates** is crucial - otherwise most of the German emission reductions will be lost (**Water bed effect**)
- CO2 floor price (COP) shows a **higher effectivity**

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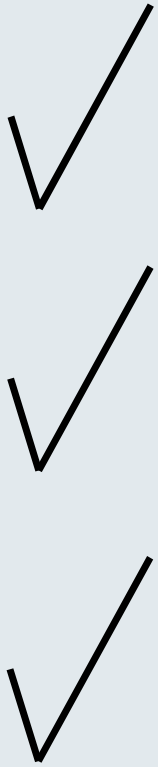
  - Effort Sharing
  - Right Timing
  - Policy Packages



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CONCLUSION

Regulatory mandatory **coal phase-out** in Germany results in:

- **Rebound effects** in electricity generation
  - Increased use of existing coal power plants (short-term)
  - Substitution by natural gas
  - Natural gas is used for district heating generation
- Higher **electricity imports**
- Transfer of emission levels to other European countries **(water bed effect)**

Coal phase-out shows positive short-term effects but it is not persistent.
Numerous side-effects and trade-offs exist.
CO_2 floor price shows higher cost efficiency with higher effectivity.

Opportunities for further integrated modelling applications for Gauteng / SA

- **Extensions of the TIMES-GEECO model / scenario calculations**
- **Cellular (distributed) systems and feedback on overall system**

  e.g. Hospital / Industrial area / Gated community / University campus

  - How to supply the energy demand with minimal import dependency?
  - Focus on: solar energy/other renewables, CHP, best practice technology options etc.
  - Very high temporal resolution (shorter time horizon)
  - Impact on the regional and national energy system
- **Transfer of TIMES-GEECO to further provinces / metros in South Africa**
- **National applications considering regional resource availability**
  - National energy system model with sub-national regions (possibly down to municipal level)
  - Considering available regional resources, local energy targets, socio-economics…
  - Aligning national, provincial and local energy planning and climate protection strategies
- **Green economy as double dividend for national/regional low carbon development** (coal question?)
- **South Africa as part of a world energy model and / or a global economic model**

Thank you for your attention!

IER

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