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MODELLING OF BIOENERGY COMPETITIONS

Biomass for Bioenergy – Lessons from the Bioenergy Boom

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Leipzig, 24.11.2014

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RESEARCH QUESTION

Which bioenergy options are economically favourable in the future energy system, if GHG-emissions and learning effects are accounted for?

Scenarios:

- All available german biomass goes into either biofuels **or** power/heat.
- For both „worlds“ a BAU and a sustainable scenario („NACH“, more restrictions)

Qualitatively assessed technologies:

- Waste/Residual-streams
  Potential for Germany estimated
  (Manure/Waste-Biogas, Cascade use)
- „Foreseeable“ technology developments
  (pure heat, small stoves)
- EEG-power plants: 20 year guarantee

Explicitly modelled:

- **Power/Heat:**
  CHP & Gasification (Wood)
  Biogas & Biomethane (Maize)
  Veg. Oil CHP (Rape seed)
- **Fuels:**
  Gasification SNG/BTL (Wood/SRC)
  Bioethanol (Beet/Wheat/Straw)
  Biodiesel & HVO (Rape seed)
  Biomethane (Maize)

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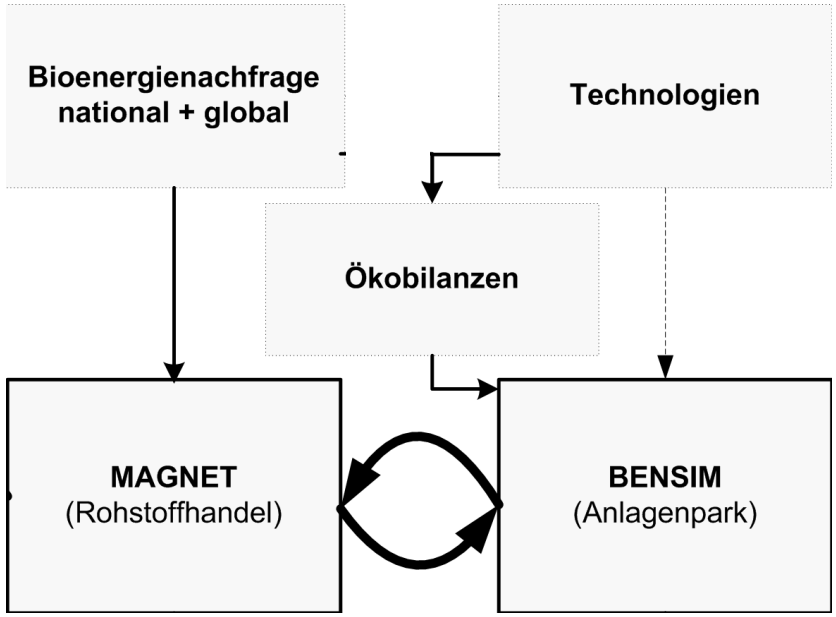
MODELLPARAMETER

Technologies (DBFZ/UFZ)

- Screening
- Costs
- Input/Output-Flows
- Learning rates
- Conversion efficiency developments
- Status Quo (EEG/DBFZ Database)



Feedstocks

- Biomass supply (Nitsch et.al. 2012)
- Price developments (MAGNET)
- Assumptions for wood, by-products etc. (DBFZ/UFZ)

LCAs

- GHG-emissions (ifeu)

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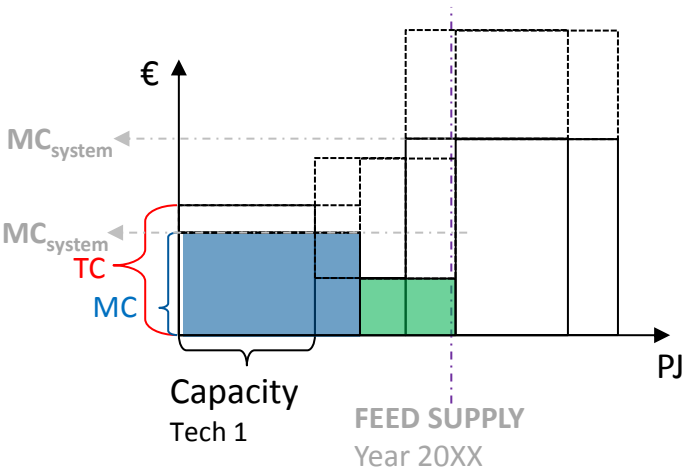
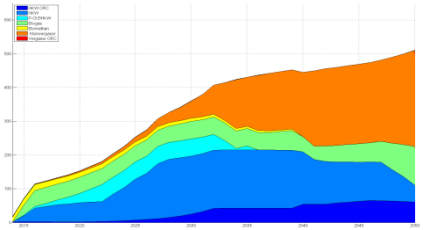
BENSIM - BioENergySIMulator

Simulation of the myopic least-cost bioenergy supply in Germany until 2050

ENERGY CARRIER $= \sum €$ → **MARKET SIMULATION** → **SUPPLY DEVELOPMENT**

- + Investment
- + O&M
- + Feedstock
- + Power/Heat
- + Transport/Logistics
- - By-products
- - GHG-credit





1. Decommissioning of old plants
2. If $TC_{tech} < MC_{system}$ → Invest unto equilibrium (max. 30% per technology/year)
3. Production in order of MC
4. Learning effect → Investment cost reductions

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SCENARIOS

BENSIM-RELEVANT ASSUMPTIONS

NACH compared to BAU:

- Feedstock prices increase more
- GHG-price increases faster
- R&D faster

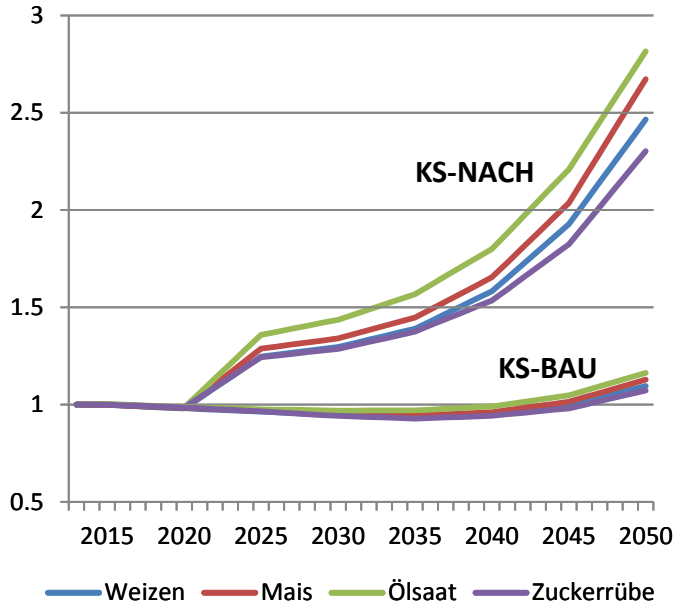
POWER:

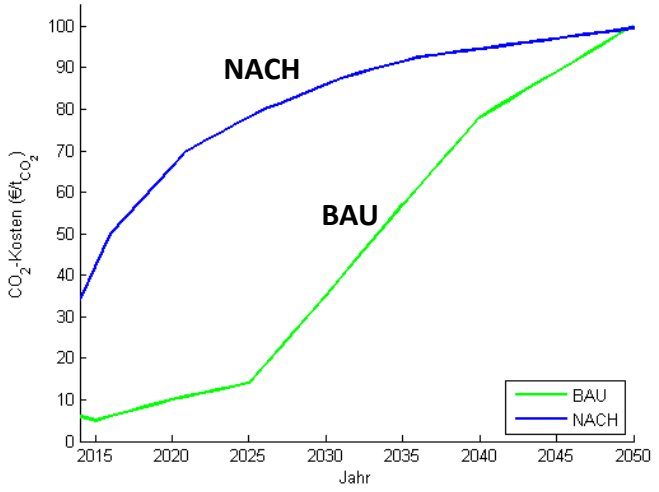
- Full-load hours 5000 h/a
- Heat is by-product (price increasing 2%/a)

FUEL:

- Power/Heat inputs for 1. Gen. from renewables → RED-goals (60% GHG-reduction)
- Infrastructure costs for gaseous fuels higher (IEA, 2013)

(€/GJ)	CH_4	Ethanol	Diesel	BTL
Transport	2.38	2.58	1.24	2.41
Lagerung	3.41	0.08	0.06	0.05
	5.79	2.66	1.30	2.47





RESULTS

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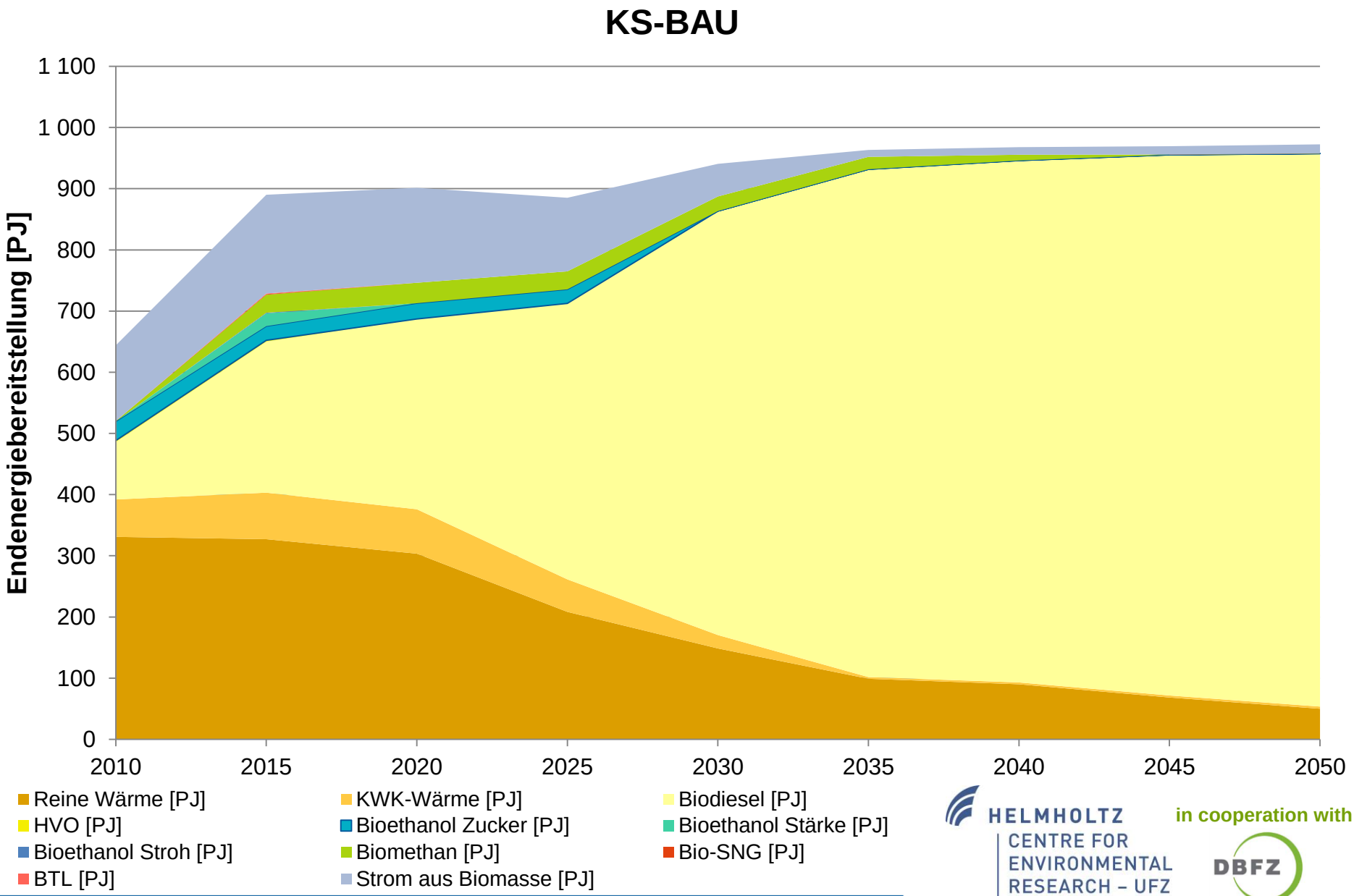
BIOFUELS – “BAU”



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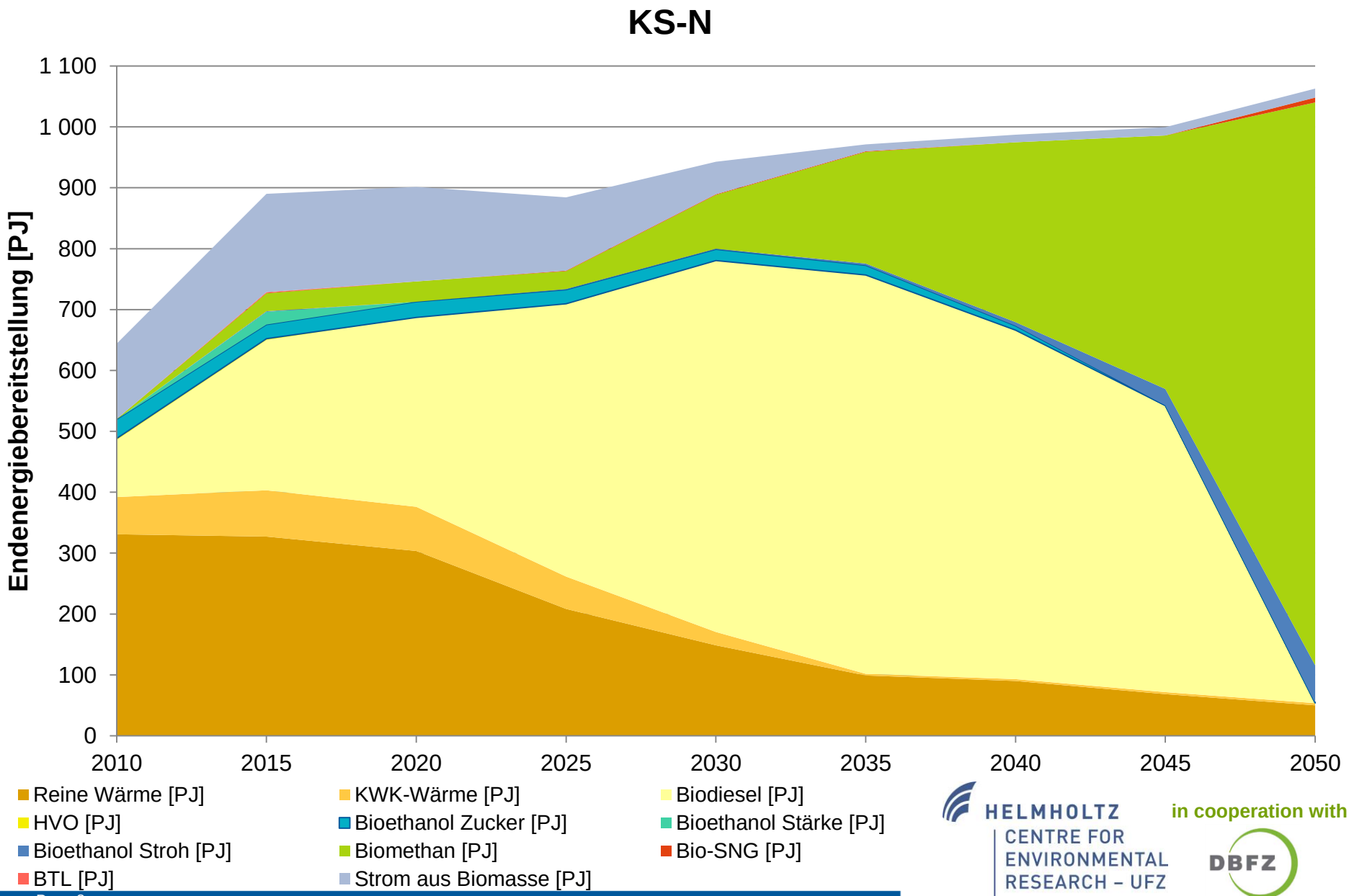
BIOFUELS – “NACH”



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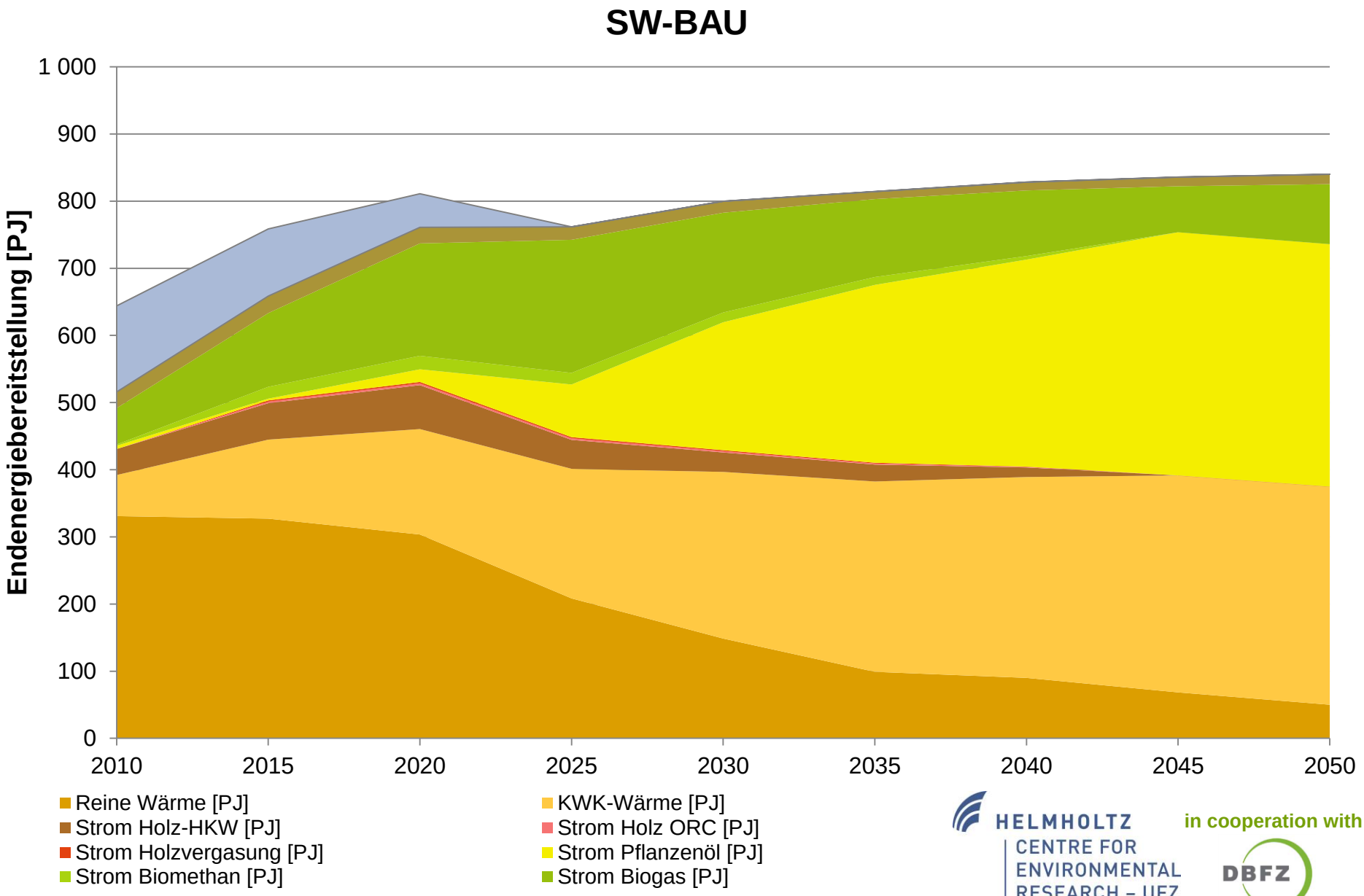
POWER – “BAU”



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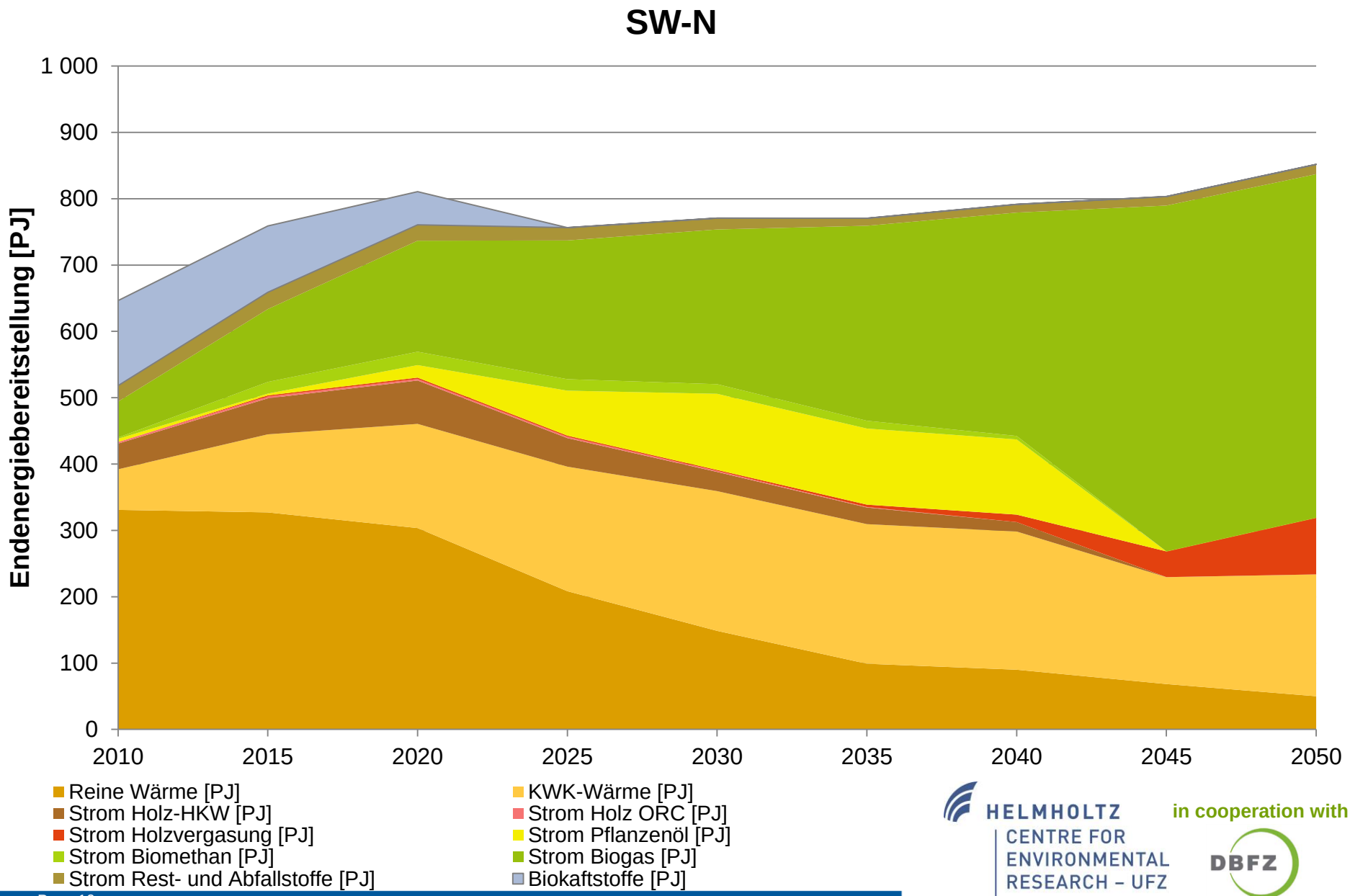
POWER – “NACH”



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ANALYSIS & REFLECTIONS

Vegetable oil and biogas based options are and remain cheaper than wood based options as both fuels and power (assuming flexible demand)

Sensitivity analysis shows that „2nd generation“ biofuels are unlikely to become competitive in Germany and if so, CH_4 is the better option

Feedstock prices dominate the sensitivity. Learning and GHG have marginal effects on the competition *between* bioenergy options.

- GHG-emissions similar for all fuel pathways – in stark contrast to EU RED policy

We should minimize pressure on land use.

If we want bioenergy from dedicated crops → CH_4

- Suitable with flexible demand
- Gas-powered mobility should be stimulated

Increasing efficiency in food sector is a prerequisite

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THANK YOU!

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