Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

The 2017 Update of the Vision Scenario. A long-term scenario analysis for the EU-28

A data analysis for the

Greens/EFA group in the European Parliament

Dr. Felix Chr. Matthes, Benjamin Greiner, Ruth Blanck, Dr. Wiebke Zimmer

Berlin, 20th September 2017

The Vision Scenario
Executive Summary

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **The Paris Agreement and its target to limit global warming to well below 2°C compared to pre-industrial temperature levels require a paradigm shift for climate and energy policy strategies: emissions budgets emerge as the new metrics for success**
- **A fair share of the EU in the global CO2 emissions budget would be approx. 7% of the remaining global budget of 890 Gt CO2 from 2015**
- **For staying within the limit of this CO2 emission budget the EU needs to reduce the recent emissions levels to almost zero by 2050 and start quickly with significant emission reductions within the next decade.**
- **All sectors must contribute but the sectors with the most significant shares in the total emissions (power sector, transport, buildings) need to contribute most.**
- **Achieving ambitious energy efficiency levels and phasing-in CO2-free energies (renewables, electricity, heat) rapidly is crucial for staying within the emissons budget.**
- **A 55% emission reduction, a share of approx. 40% renewables and an improvement of energy efficiency of approx. 45% for 2030 would allow a continuous and non-disruptive emission reduction pathway.**

The Vision Scenario
Background & introduction

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **The Vision Scenario is an illustrative and numerical long-term scenario analysis for the energy sectors and the greenhouse gas emissions (from all sectors except land use and land use change)**
- **It is based on comprehensive sustainability considerations**
  - deep decarbonization (based on a global emissions budget perspective)
  - risk minimization (ambitious nuclear phase-out trajectory)
  - broader sustainability aspects (availability of scare resources of sustainable biomass etc.)
- **The Vision Scenario for the EU-28 is contrasted with a Reference Scenario (Business-as- usual – BAU) which is based on the 2016 Reference Scenario of the European Commission**

The Vision Scenario
Key pillars

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **Staying within an Paris-compatible emissions budget**
- **Massive roll-out of energy efficiency measures for all sectors**
- **Massive increase of energy supply from renewable energy sources (with a strong focus on new renewables like wind and solar energy)**
- **Coal phase-out in Europe by 2035**
- **Nuclear phase-out in Europe with a maximum lifetime of 40 years for nuclear power plants**
- **Sustainability-based limits for the use of biomass**
- **Large-scale electrification of the transport sector**
- **Restricted use of carbon capture and storage (CCS) for CO2 emissions from industrial processes**
- **Limited import of novel motor fuels (power-to-liquid or equivalents) from abroad**

The Vision Scenario
Methodological framework

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **Öko-Institut's Scenario Integration Model for the EU-28**
  - top-down analysis of energy consumption and greenhouse gas emission dynamics for final energy consumption (except transport) and non-energy sectors
  - bottom up analysis for power and transport sector
  - energy efficiency first approach
- **Methodological approach**
  - technical analysis
  - economic optimization on a qualitative basis (essentially adopted from other modelling evidence)
  - (very) limited reflection of behavioural changes

The Vision Scenario
Data & information sources

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- Eurostat historical time series for energy data
- European Union greenhouse gas emission inventories
- Commission EU Reference Scenario 2016 (Primes 2016)
- Scenario analysis from the Energy Roadmap 2050 and the Roadmap for the Low-carbon Economy
- Entso-E data for the Ten Years Network Development Plans
- World Energy Outlook
- Greenpeace Energy [R]evolution scenario
- Deep decarbonization scenarios for EU Member States
- Sector specific projections and scenario data analysis

The Vision Scenario
Main assumptions

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **Socio-economic drivers for energy consumption and greenhouse gas emissions from Primes 2016**
- **Political framework**
  - climate impact based on the emission budget approach
  - coal phase-out by 2035
  - maximum lifetime of 40 years for nuclear
  - carbon capture and storage (CCS) for industrial process emissions and (potentially) negative emissions only
  - limit for the use of (sustainable) biomass of 15 GJ per capita
  - energy efficiency first approach

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

1. The overarching framework: the emission budget approach

The Vision Scenario is based on the emissions budget approach

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **The climate impact of energy and emission pathways can be assessed on the basis of cumulative CO2 emissions (as a proxy for CO2 concentrations in the atmosphere)**
- **The Intergovernmental Panel on Climate Change (IPCC) provides CO2 emission budget specifications that are widely used in analytical exercises on Paris-compatible pathways (e.g. by IEA/IRENA)**
- **The EU's fair share in the global emissions budget is based on the following considerations**
  - emissions budget from 2015: Paris Agreement = global consensus for limiting global warming to well below 2°C compared to pre-industrial levels (no reflection of historical emissions before 2015)
  - distribution of the global emissions budget is based on a per-capita (equity) approach, no grandfathering (recent emission levels, economic power etc.)
  - distribution of the global emissions budget on recent historical data and not on projections

The global CO2 emission budget
A novel approach ensuring consistency to "Paris"

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

	CO_2 emissions 1870 2010	Global CO_2 budget from 2011	2011 2014	Remaining
	Gt CO_2	Gt CO_2	Gt CO_2	Gt CO_2
1.5°C for 66% of model runs	1.914	400	160	240
1.5°C for 50% of model runs	1.914	550	160	390
1.5°C for 33% of model runs	1.914	850	160	690
2°C at 66% probability	1.914	1.049	160	**890**
2°C at 50% probability	1.914	1.159	160	1.000
2°C at 33% probability	1.914	1.449	160	1.290
3°C for 66% of model runs	1.914	2.400	160	2.240
3°C for 50% of model runs	1.914	2.800	160	2.640
3°C for 33% of model runs	1.914	3.250	160	3.090

The global CO2 emission budget
Distributing the global budget on a per-capita basis

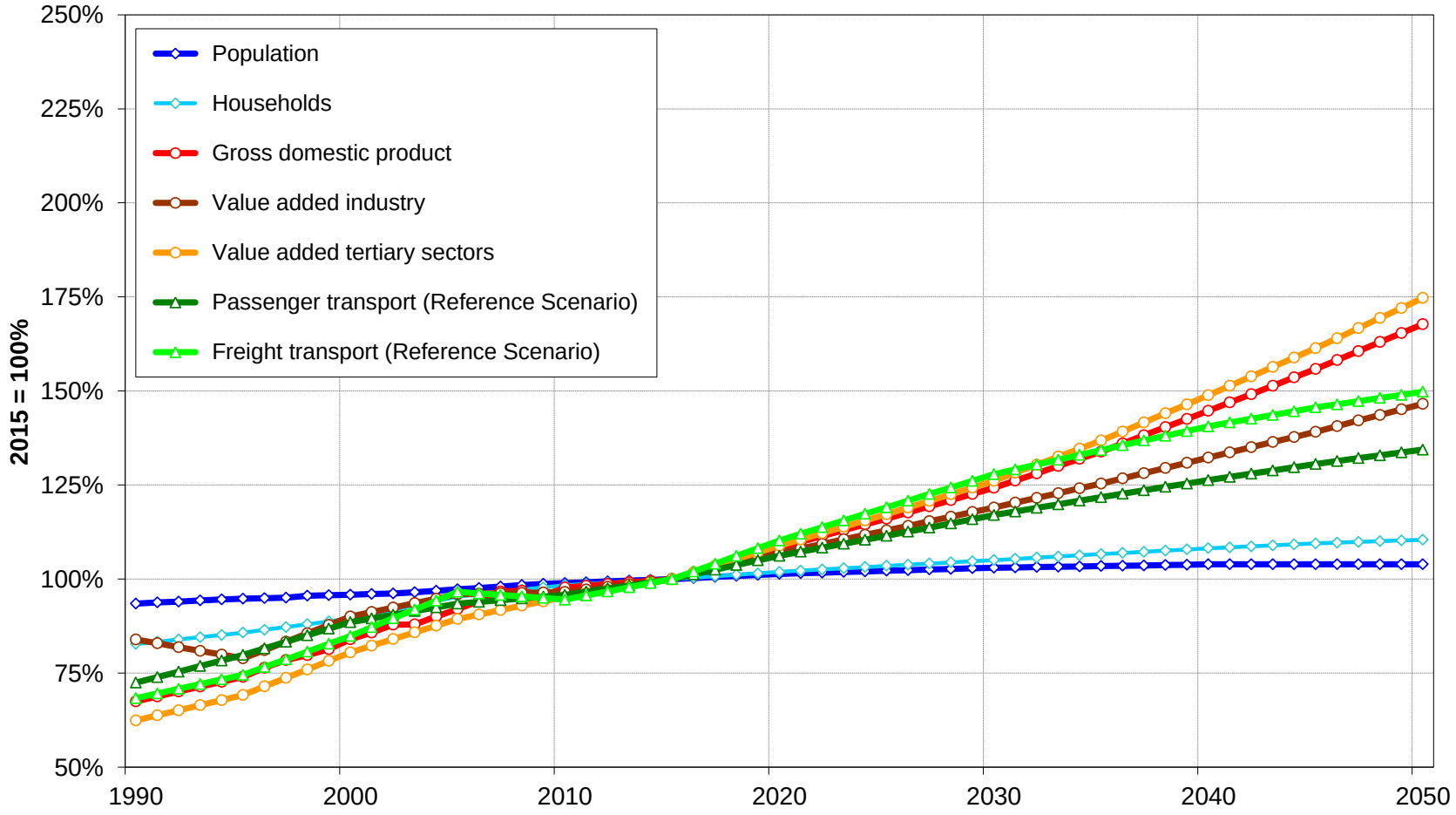
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

	CO_2 budget globally from 2015	CO_2 budget EU-28		
		Emissions share 2015	Share in population	
			2015	2050
	Gt CO_2	Gt CO_2	Gt CO_2	Gt CO_2
1.5°C for 66% of model runs	240	21,7	16,6	12,9
1.5°C for 50% of model runs	390	35,2	27,0	20,9
1.5°C for 33% of model runs	690	62,2	47,7	37,1
2°C at 66% probability	890	80,2	**61,5**	47,7
2°C at 50% probability	1.000	90,1	69,1	53,6
2°C at 33% probability	1.290	116,2	89,2	69,2
3°C for 66% of model runs	2.240	202,0	154,9	120,2
3°C for 50% of model runs	2.640	238,0	182,6	141,7
3°C for 33% of model runs	3.090	278,6	213,7	165,9

2. The driving forces

Driving forces
Small population and strong economic growth

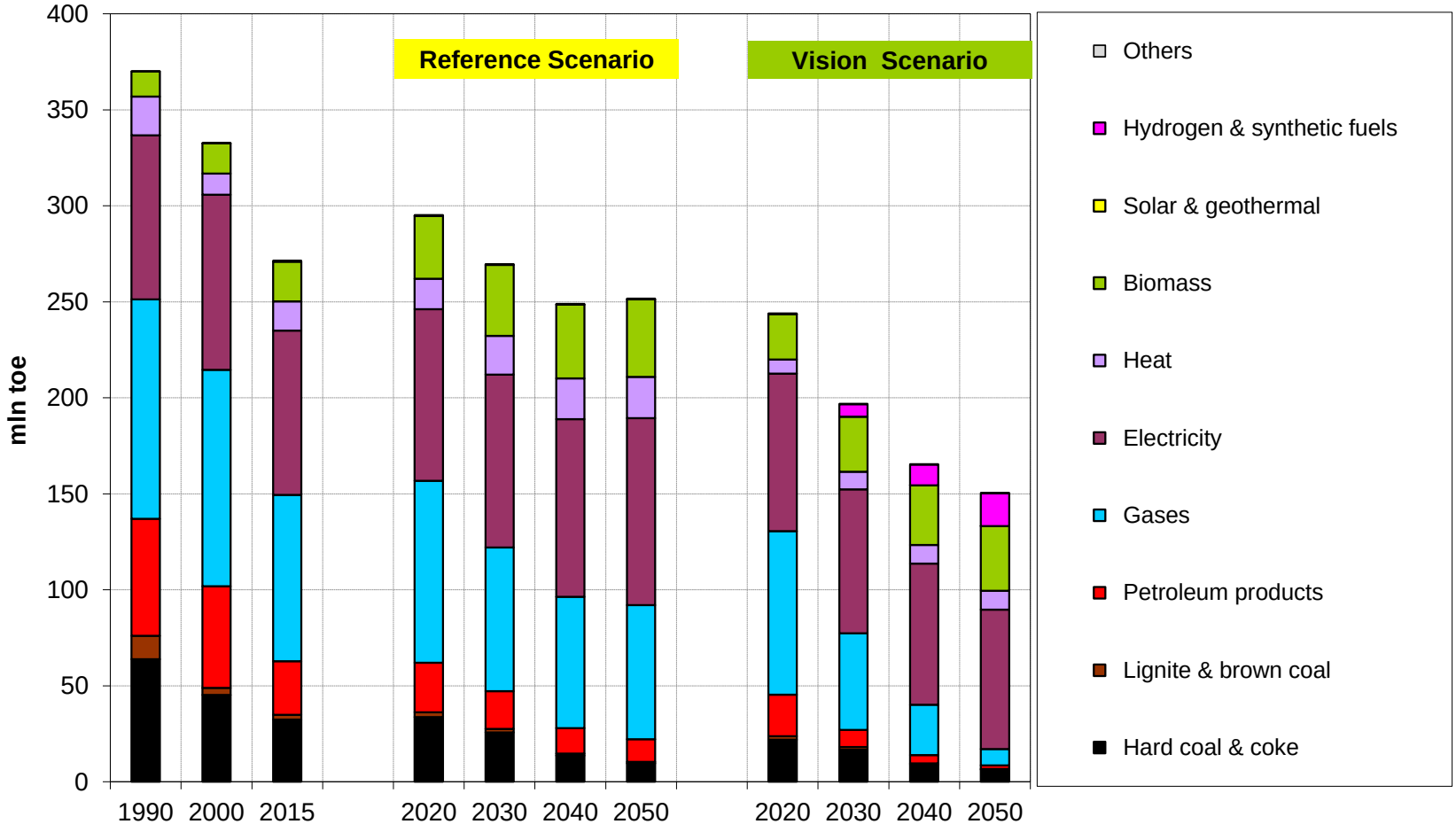
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



3. Final energy consumption

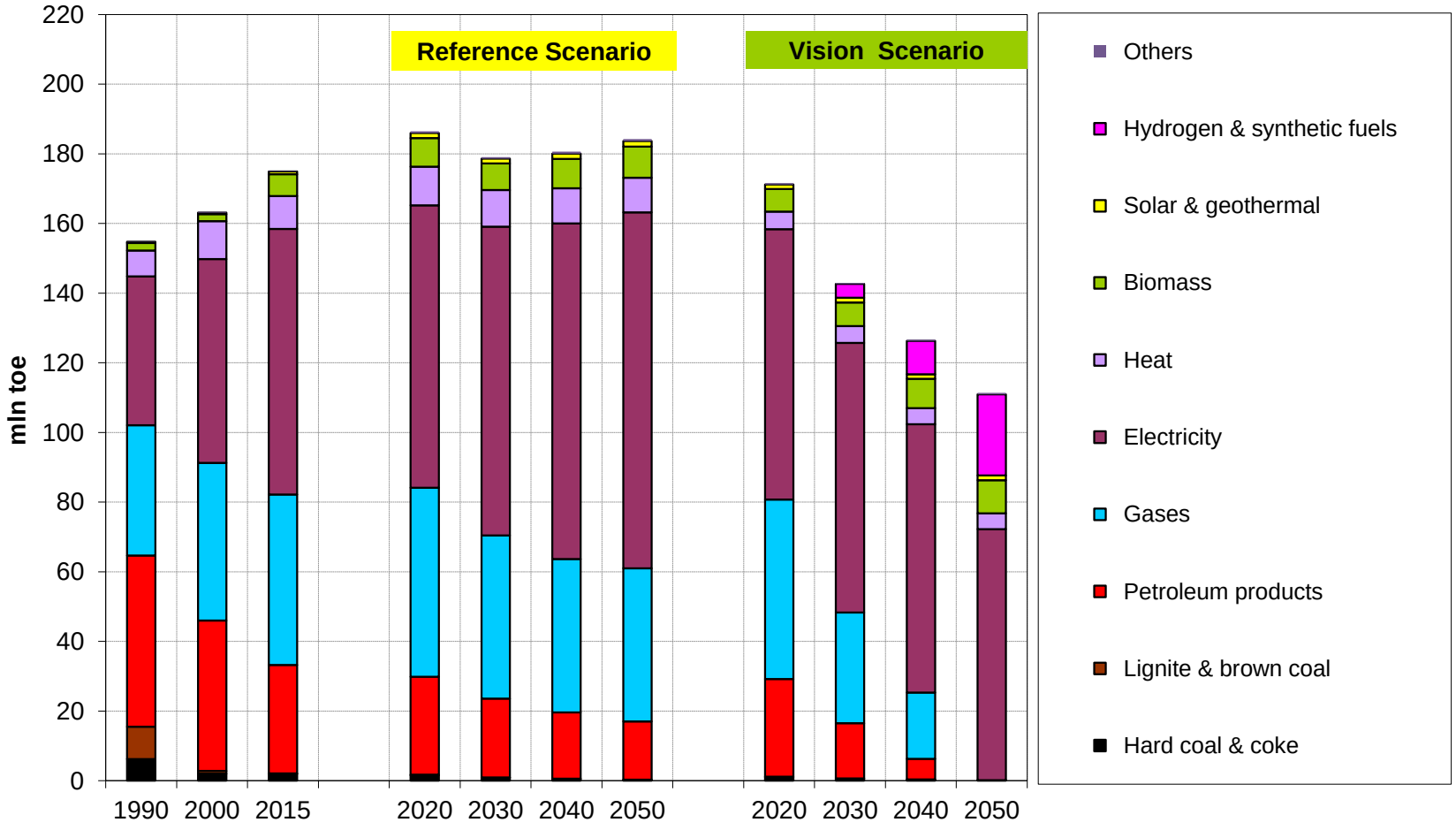
Final energy consumption: Industry
Efficiency, electrification, biomass & hydrogen

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



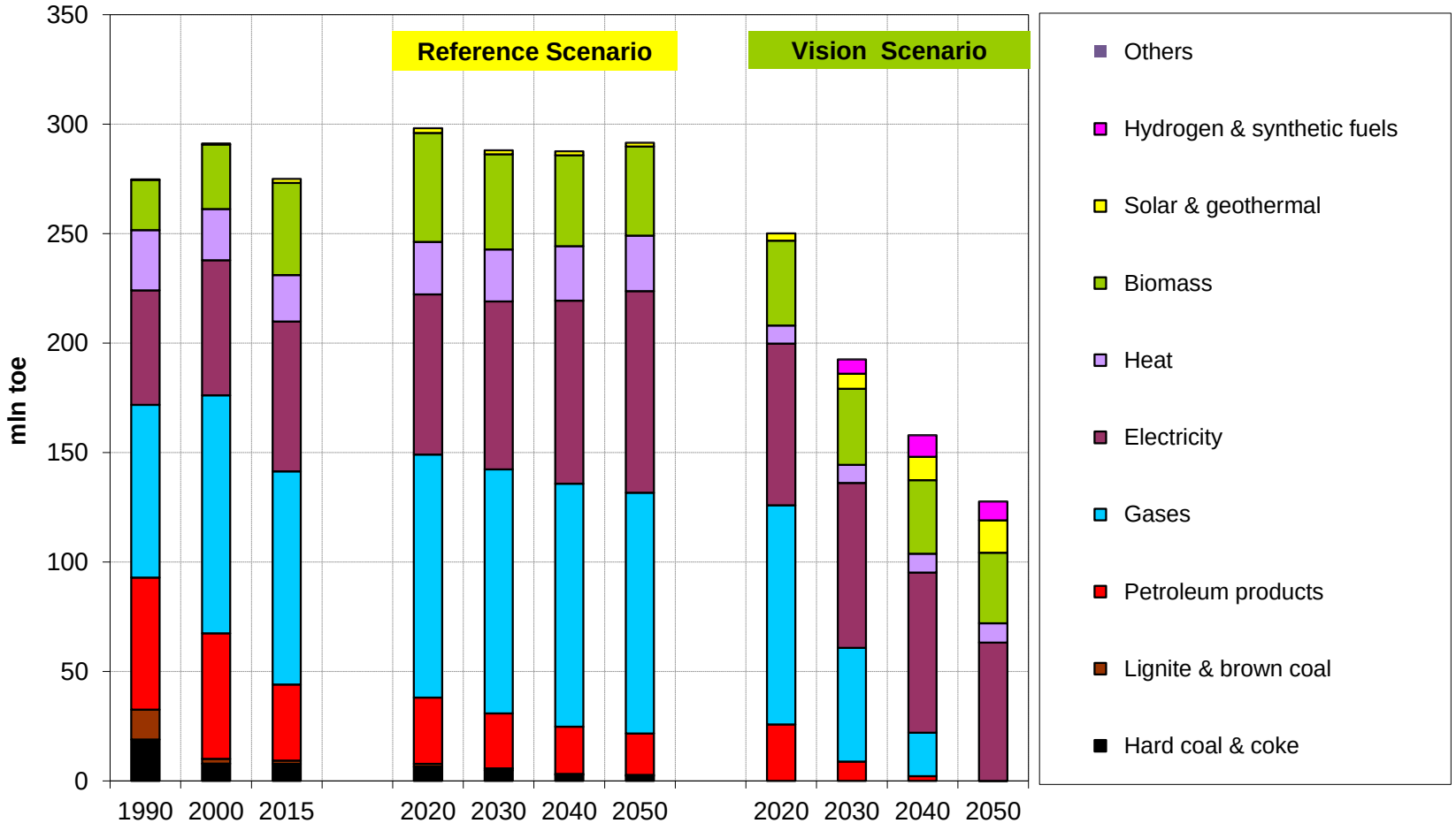
Final energy consumption: Tertiary sectors
Efficiency, electrification & hydrogen

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



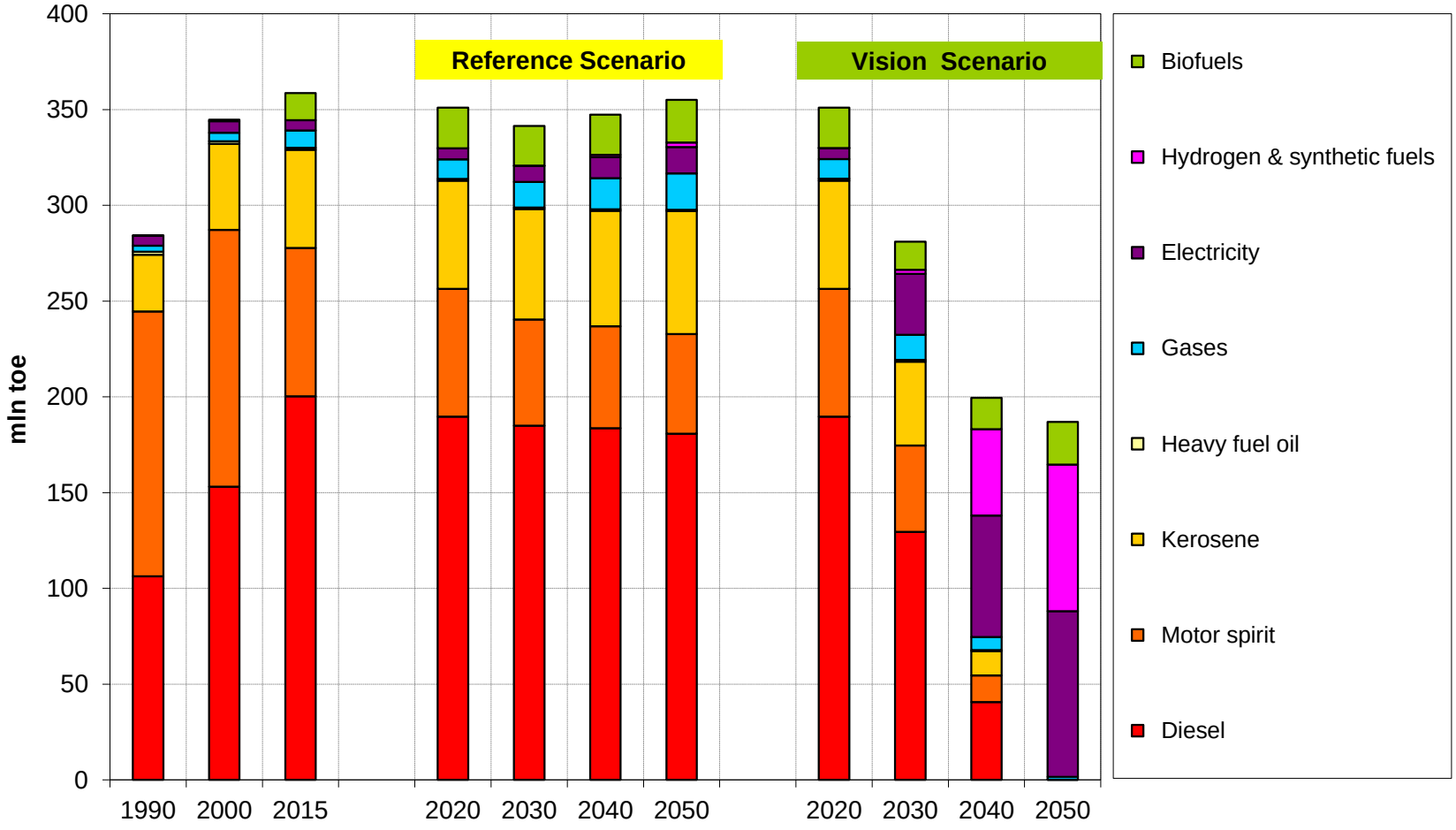
Final energy consumption: Households
Efficiency, electrification, biomass & solar heat

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Final energy consumption: Transport
Modal split, efficiency, electrification & novel fuels

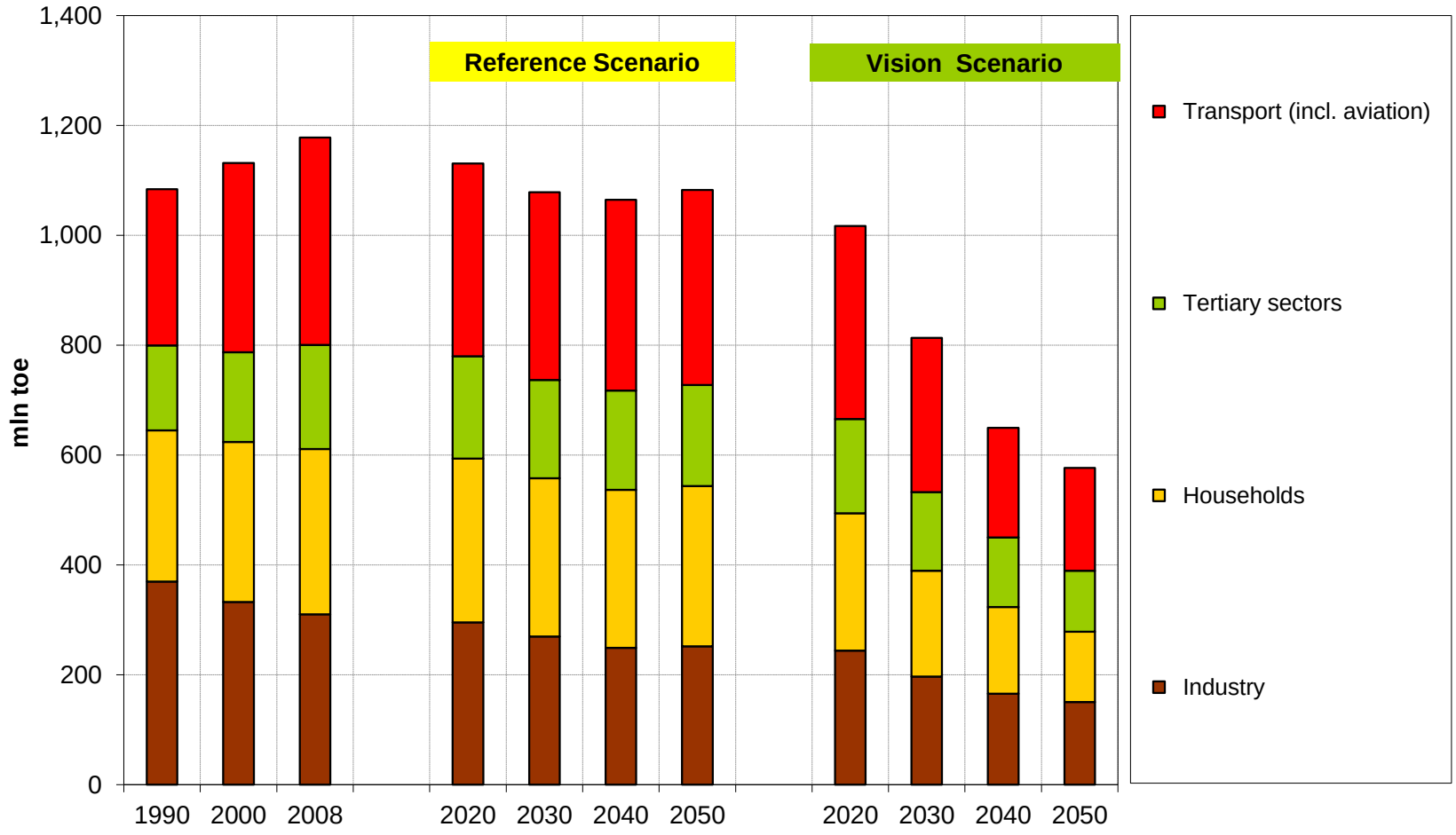
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Memo item: significant effects of electrification need to be considered for an appropriate assessment of final energy consumption levels

Final energy consumption: Total by sectors
Energy efficiency is key for all sectors

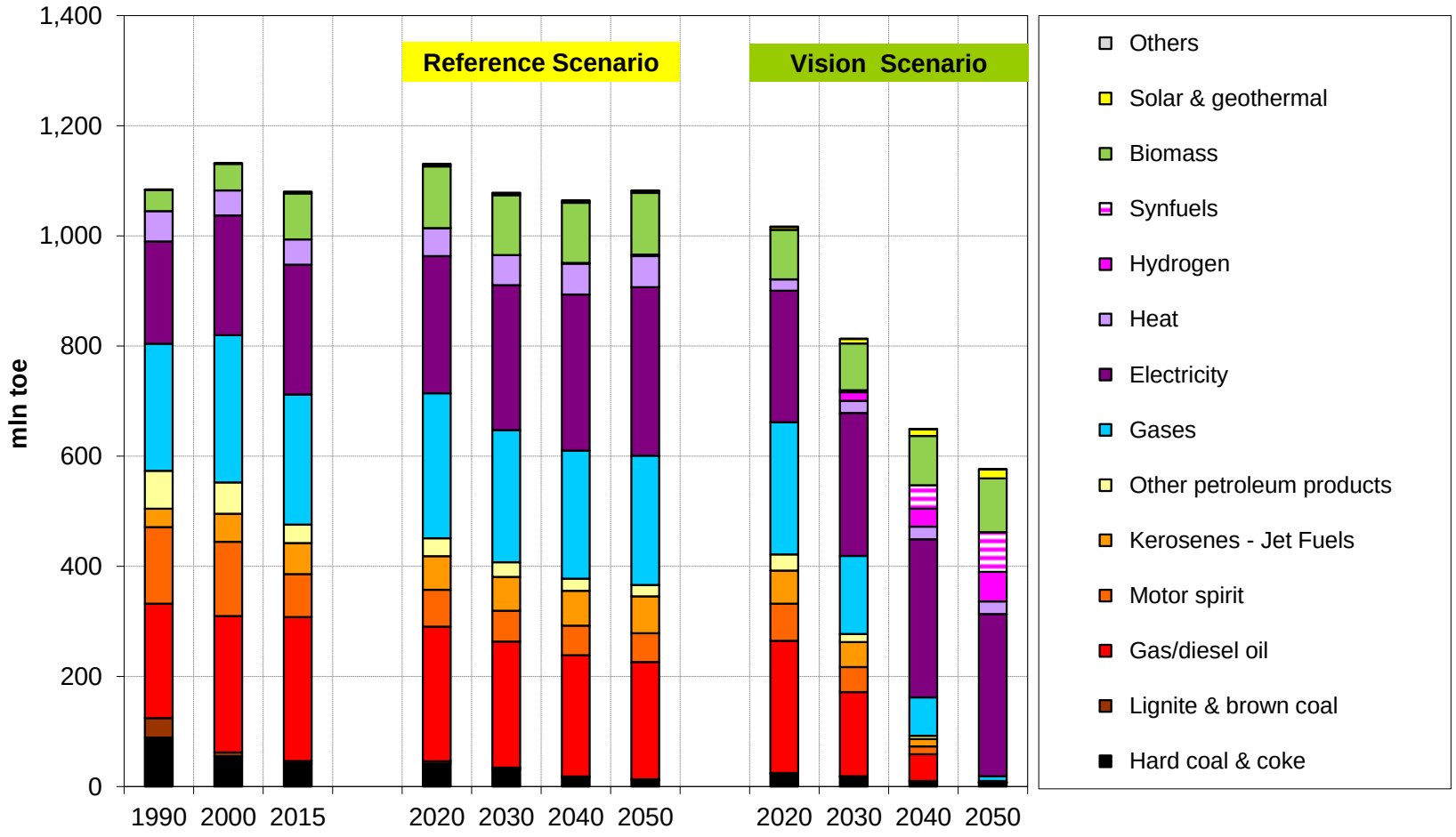
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Memo item: significant effects of electrification (especially in the transport sector) need to be considered for an appropriate assessment of final energy consumption levels

Final energy consumption: Total by fuels
Efficiency & the full range of CO2-free energies

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

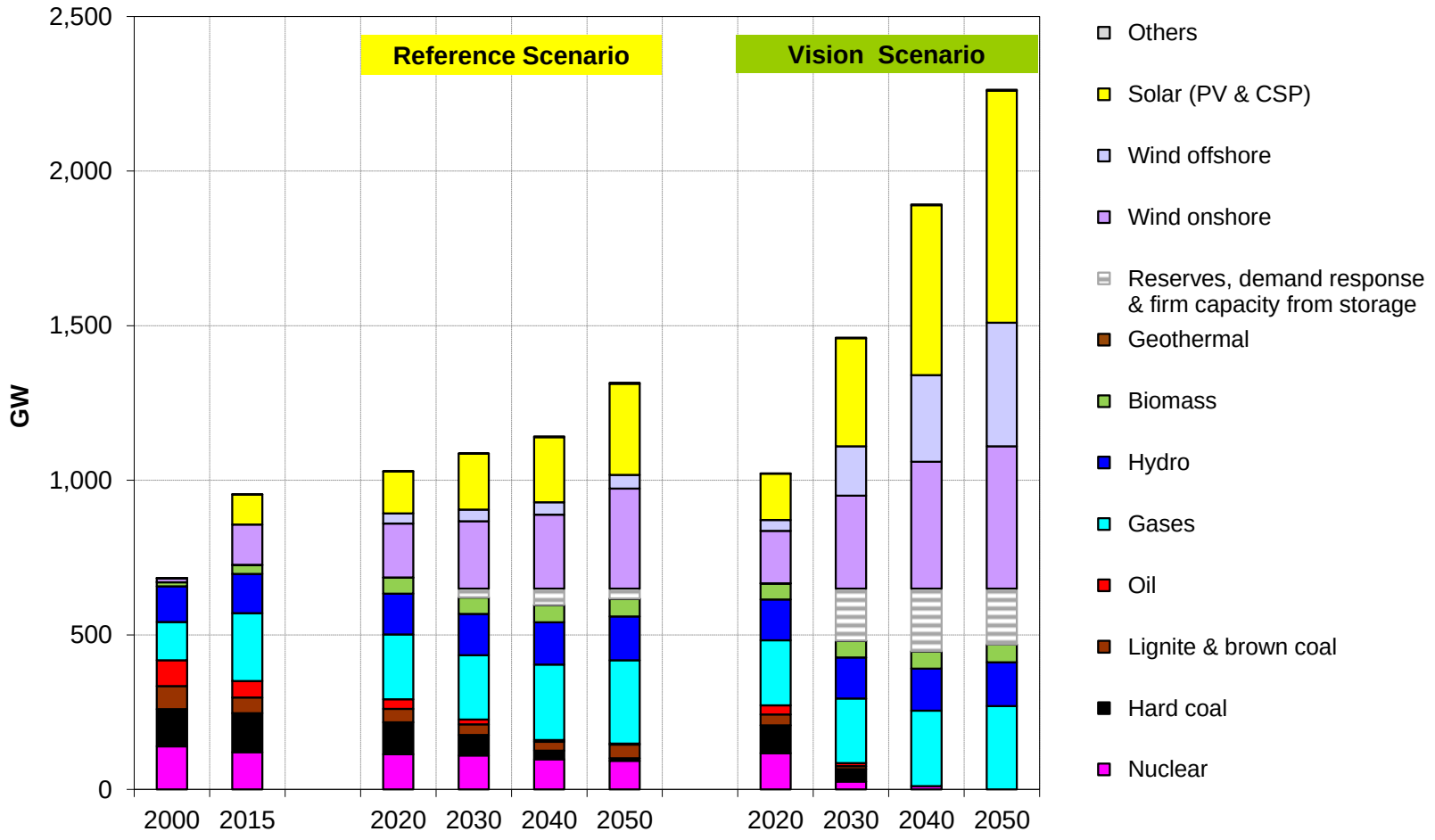


Memo item: significant effects of electrification (especially in the transport sector) need to be considered for an appropriate assessment of final energy consumption levels

4. Power sector

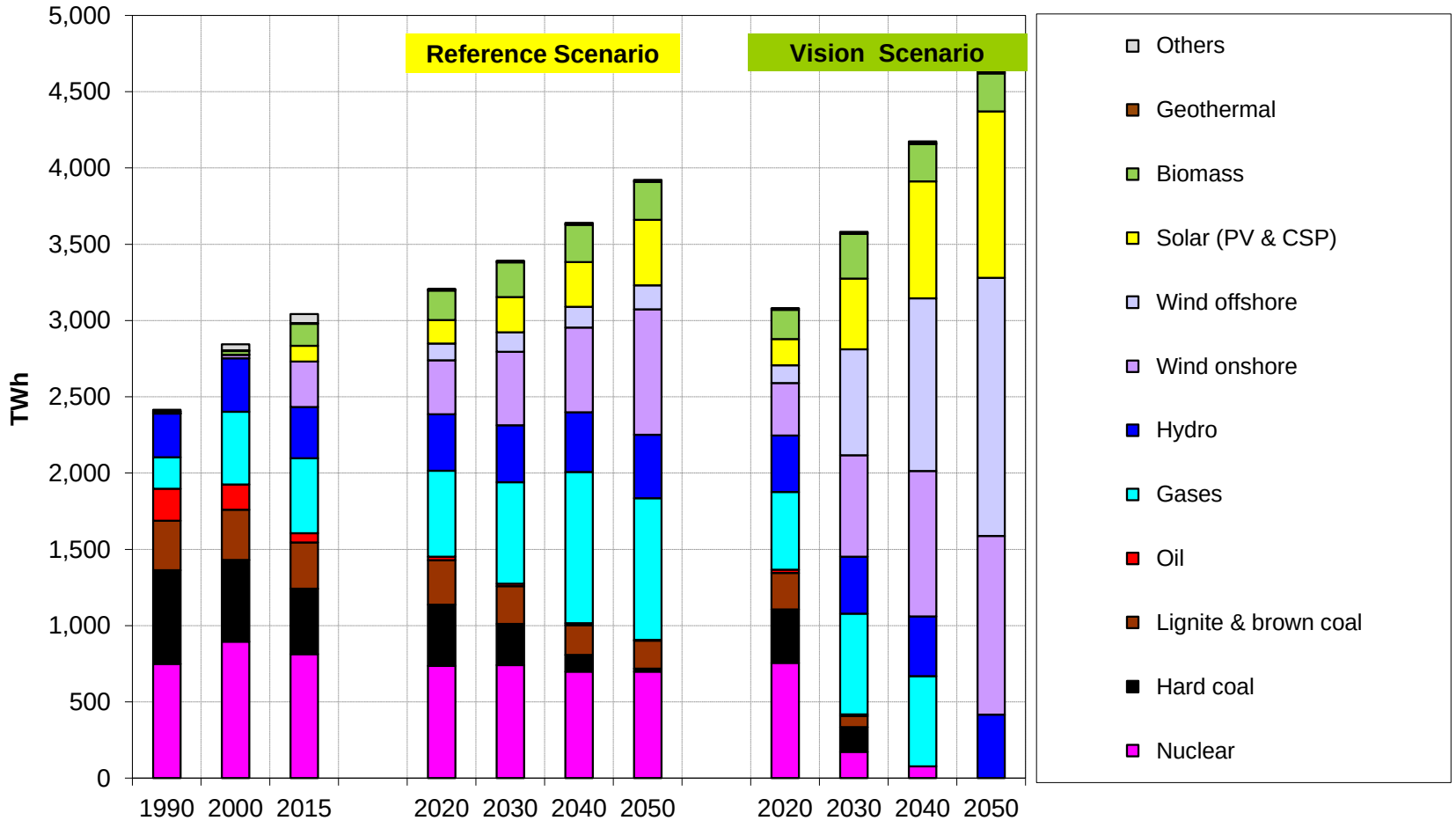
Power sector: Net generation capacities
Solar, wind & a wide range of flexibility options

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Power sector: Net (primary) electricity generation
Coal & nuclear phase-out & transition to wind & solar

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

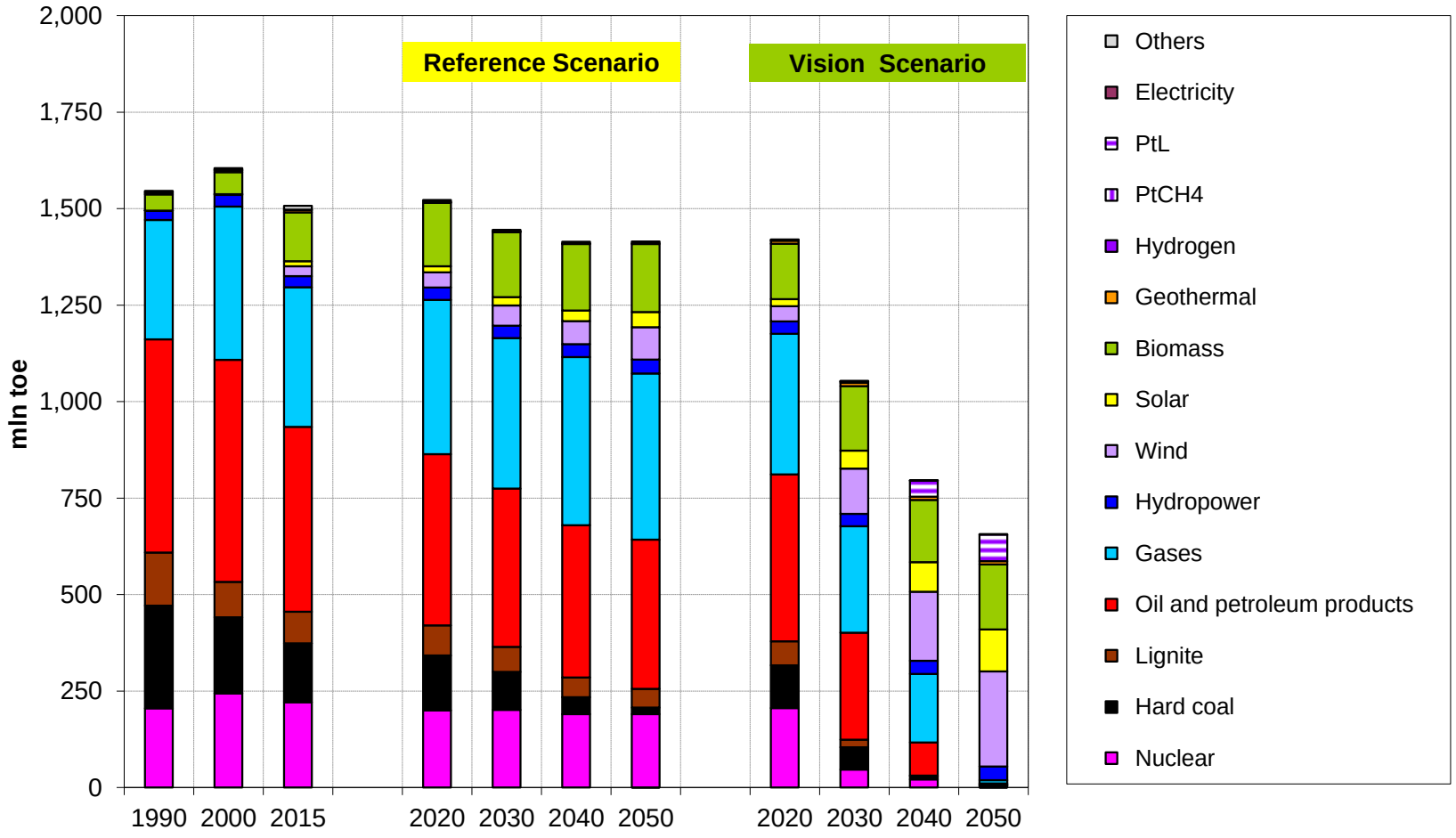


Memo item: The diagram does not include electricity output of storage options. Primary electricity generation must also cover storage systems losses (batteries, hydrogen etc.)

4. Primary energy supply

Primary energy supply (w/o non-energy uses)
System transformation towards renewables

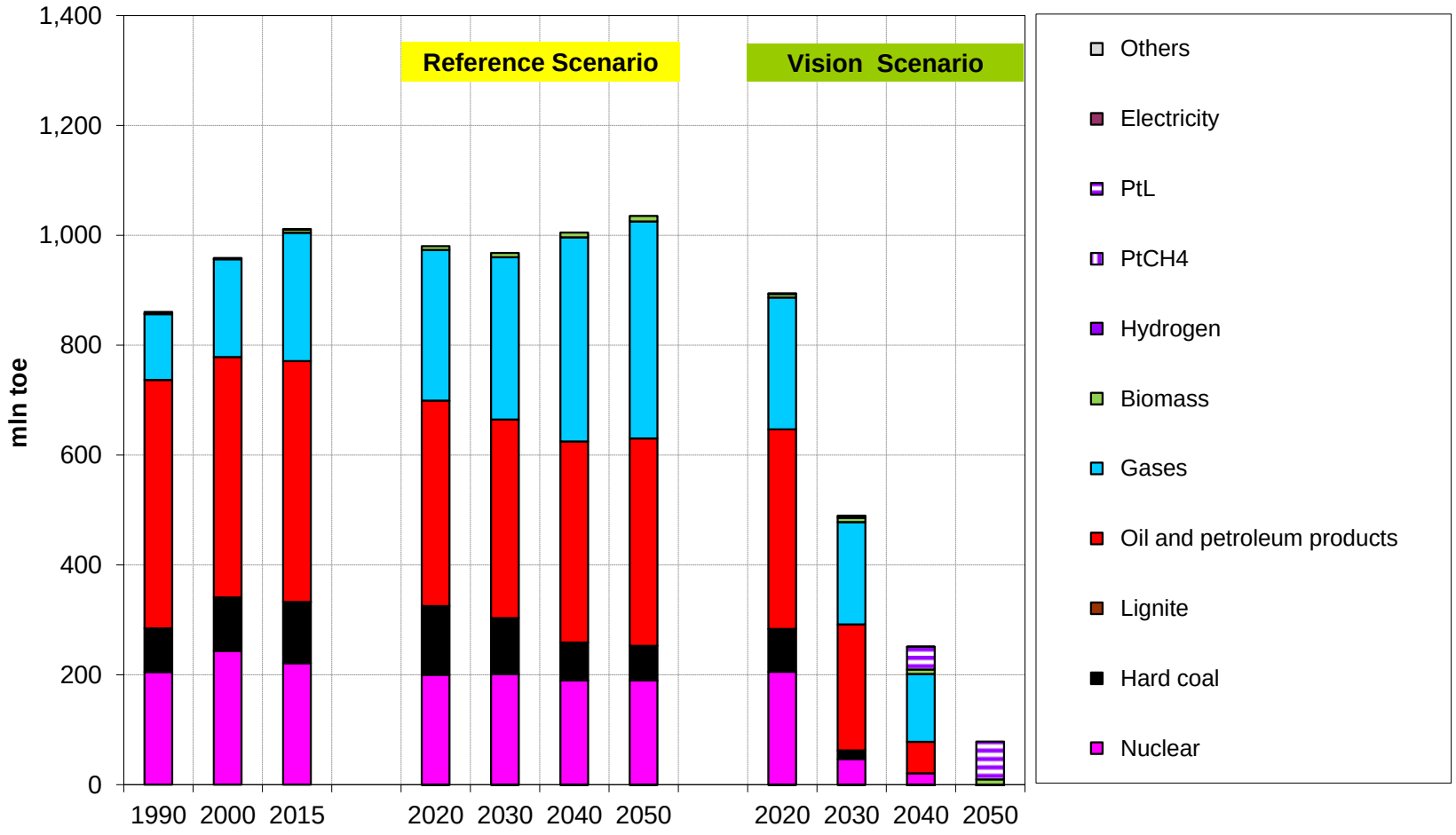
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Memo item: significant effects of statistical accounting rules for wind and solar need to be considered for an appropriate assessment of primary energy supply levels

Primary energy imports (w/o non-energy uses)
Some primary imports remain (for novel fuels)

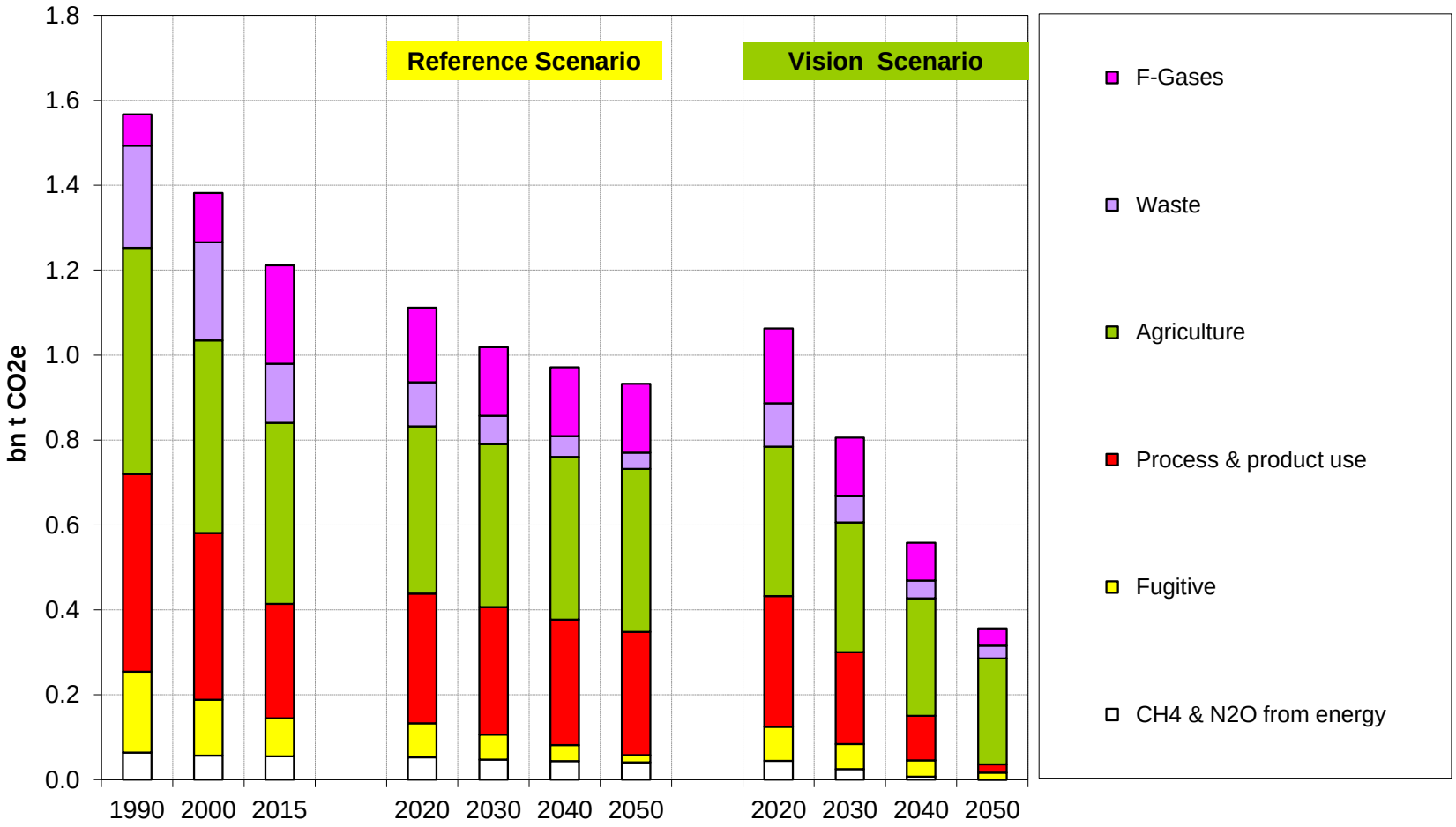
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



5. Non-energy and non-CO2 greenhouse gas emissions

Non-energy & non-CO2 GHG emissions
Technologies, management & consumption patterns

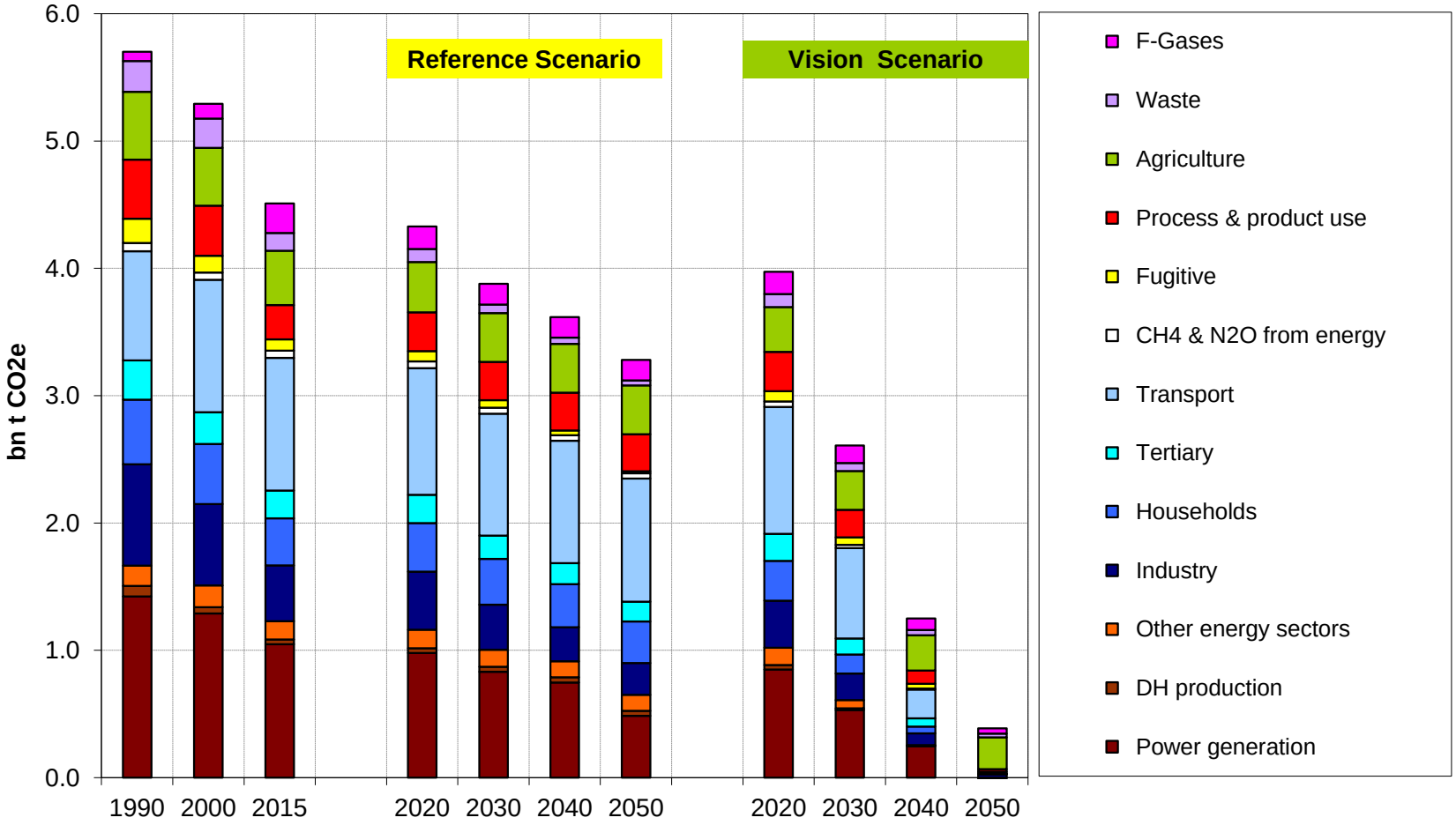
Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



5. Total greenhouse gas emissions

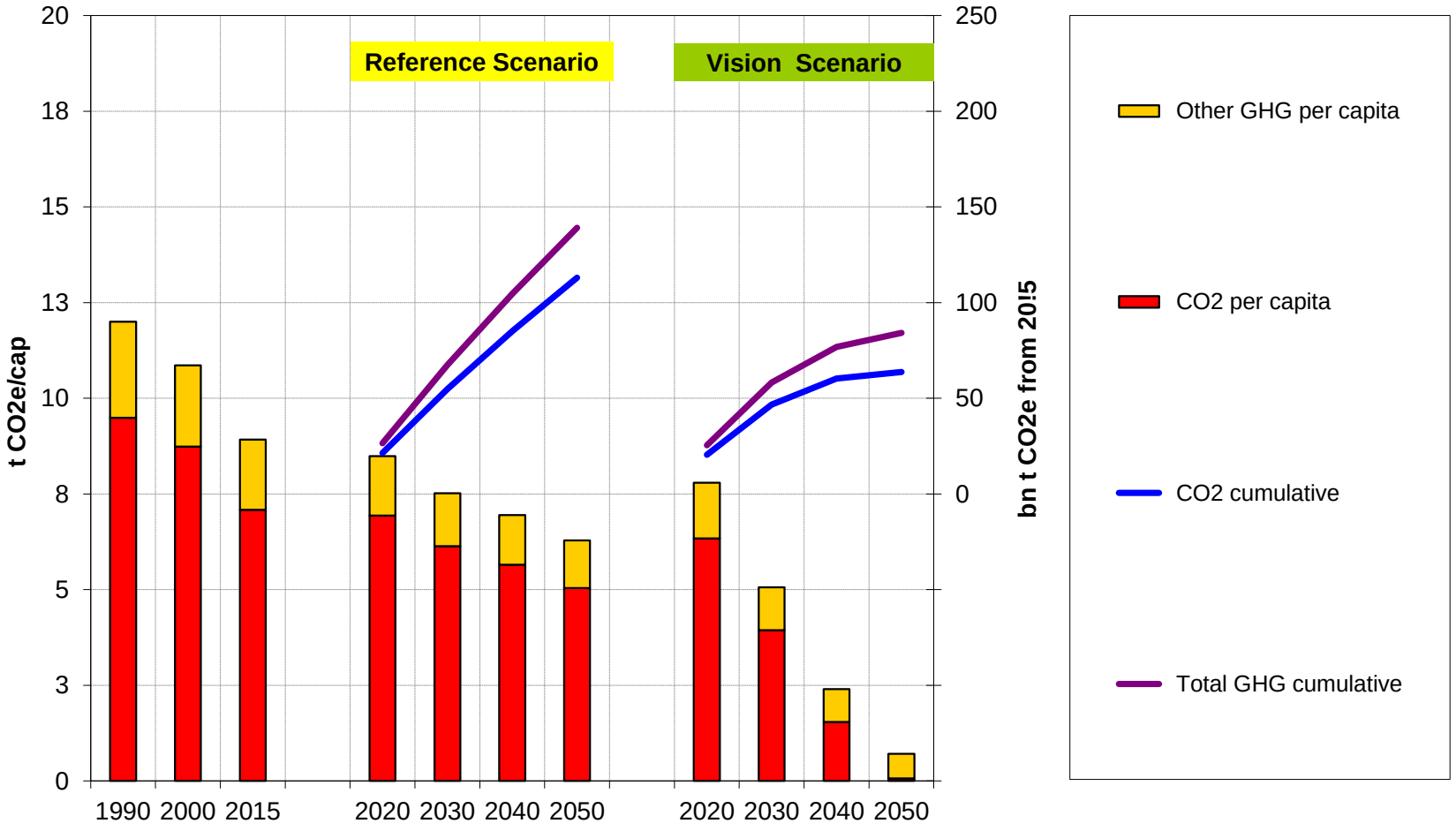
Total CO2- & GHG emissions
Deep emission reductions for all sectors

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



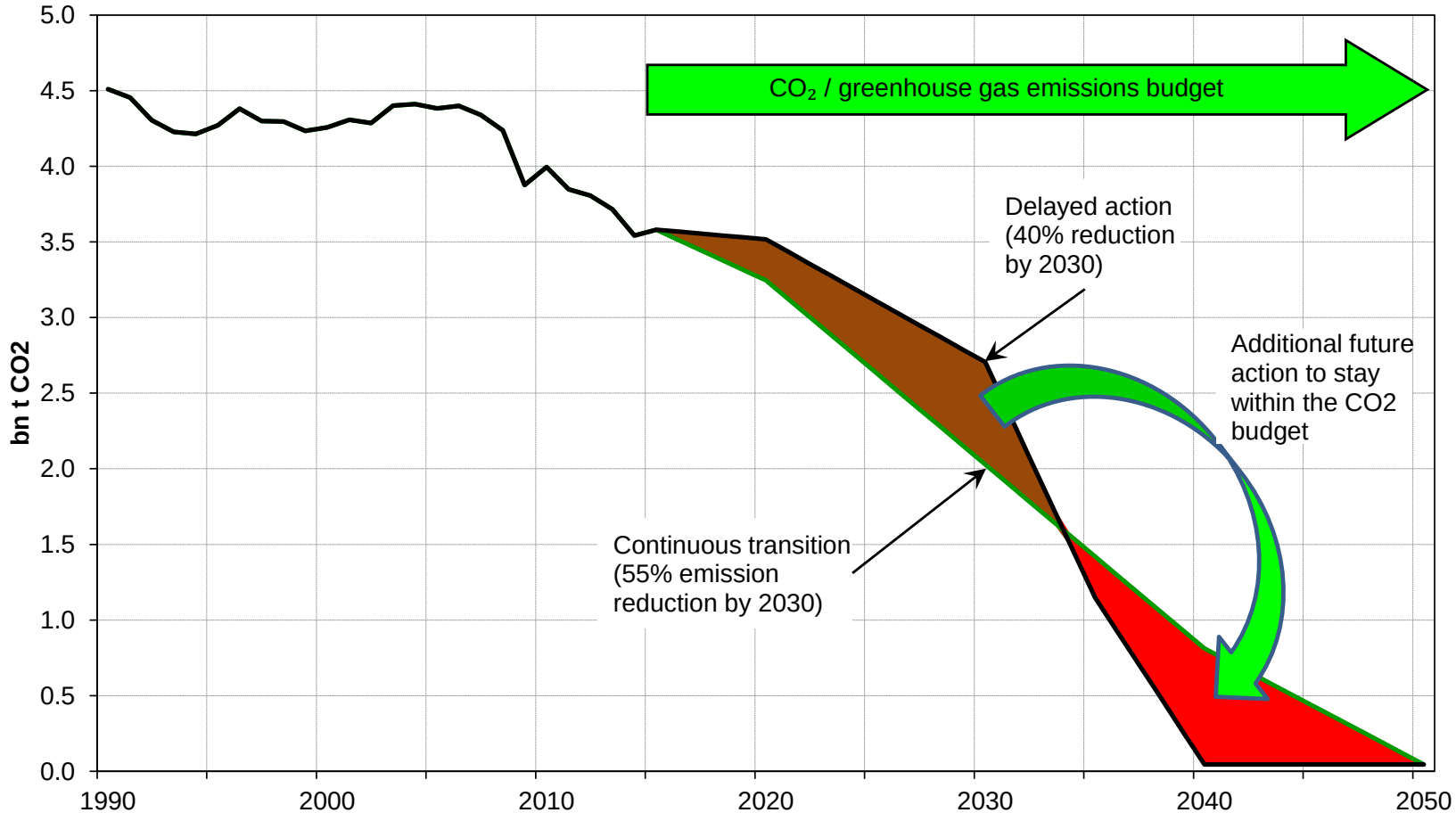
Specific & cumulative CO2- & GHG emissions
Fast emission reductions for all sectors

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



Continuous transition of the system is beneficial
More ambitious targets ease future adjustments

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



6. Implications for targets for greenhouse gas emission reductions, energy efficiency & renewables

Selected results from the Vision Scenario
Target-related indicators

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

	Reference Scenario					Vision Scenario			
	2015	2020	2030	2040	2050	2020	2030	2040	2050
Share of renewables									
Power generation	29%	37%	43%	45%	53%	39%	70%	84%	100%
District heat*	26%	24%	23%	22%	22%	27%	60%	84%	96%
Final energy*	15%	19%	22%	24%	27%	19%	37%	65%	96%
Industry	*18%*	*24%*	*30%*	*34%*	*38%*	*24%*	*47%*	*67%*	*88%*
Tertiary	*18%*	*23%*	*28%*	*31%*	*36%*	*23%*	*48%*	*69%*	*99%*
Households	*25%*	*28%*	*29%*	*30%*	*33%*	*29%*	*55%*	*78%*	*100%*
Transport	*4%*	*7%*	*7%*	*8%*	*9%*	*7%*	*14%*	*57%*	*99%*
Primary energy	15%	17%	19%	21%	13%	20%	40%	70%	98%
Energy Efficiency	Change from Primes Baseline 2007**								
Primary energy	-	-18%	-23%	-	-	-23%	-44%	-	-
Primary energy imports***	17%	13%	13%	14%	17%	13%	10%	7%	7%
GHG emissions	Change from 1990								
Total****	-21%	-24%	-32%	-37%	-42%	-30%	-54%	-78%	-93%
CO2****	-21%	-22%	-30%	-35%	-42%	-28%	-55%	-82%	-99%

Notes: * The share of renewable energy sources includes indirect contributions from electricity, heat, hydrogen & synfuels. The statistically unaccounted ambient heat delivered by heat pumps represents additional contributions to the final energy supply from renewables. - ** The 2007 Primes Baseline projection for the EU-27 was adjusted for Croatia. - *** Excluding primary energy for non-energy uses, nuclear fuel was fully considered as imported primary energy. - **** Including international aviation and excluding LULUCF.

For a more continuous & consistent transformation towards a 2°C-compatible economy higher ambition levels of energy & climate policy are needed