The toolbox *Green*-X: Results of the model runs

Claus Huber, Thomas Faber, Gustav Resch
Energy Economics Group (EEG)

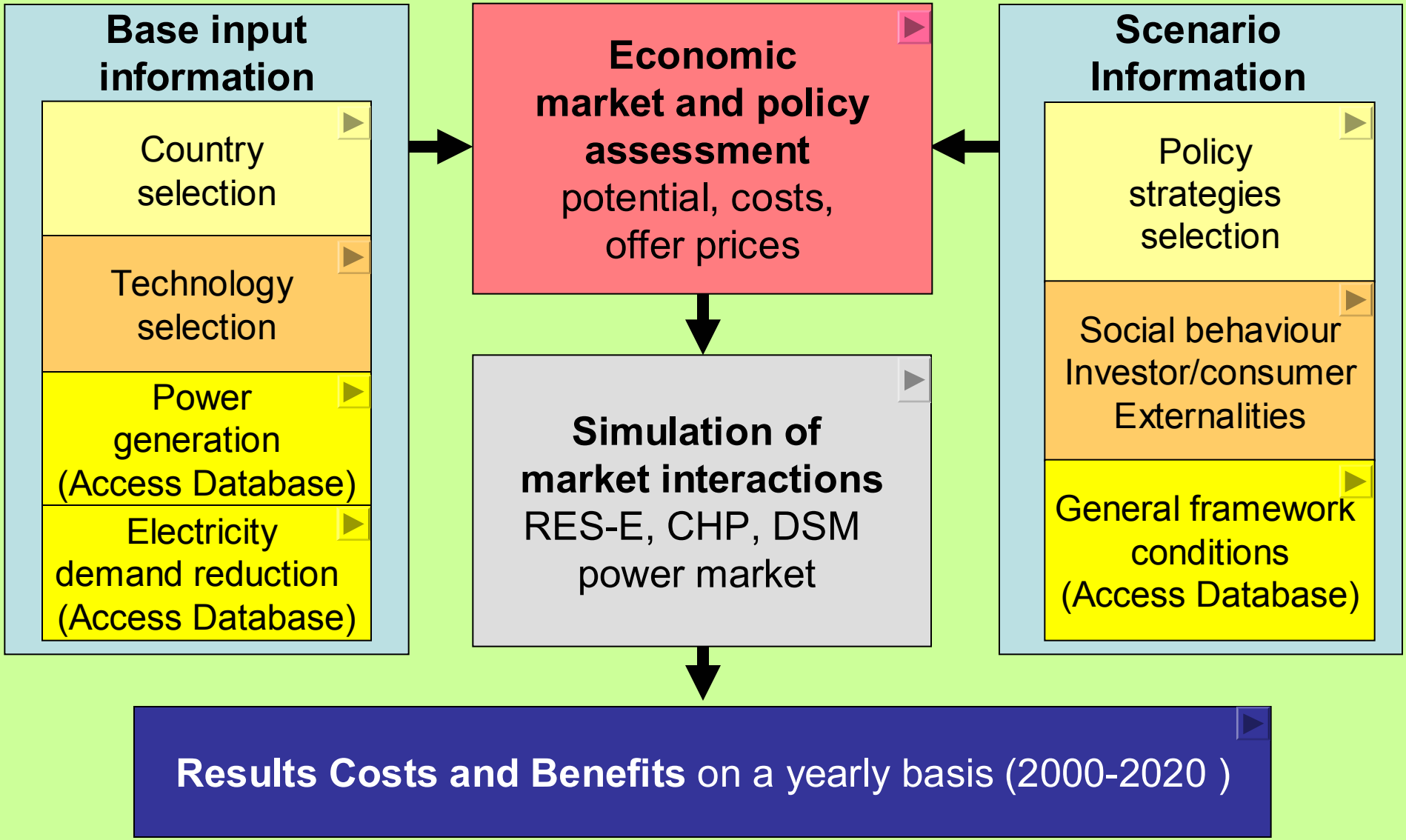
Overview

- Introduction
- Method of approach
- The toolbox ***Green*-X**
- General assumptions for the model runs
- Investigated scenarios
- Results of the model runs

Method of approach

Transfer costs for consumer (additional costs for society)	= PS + GC – p_C * Q

The toolbox Green-X



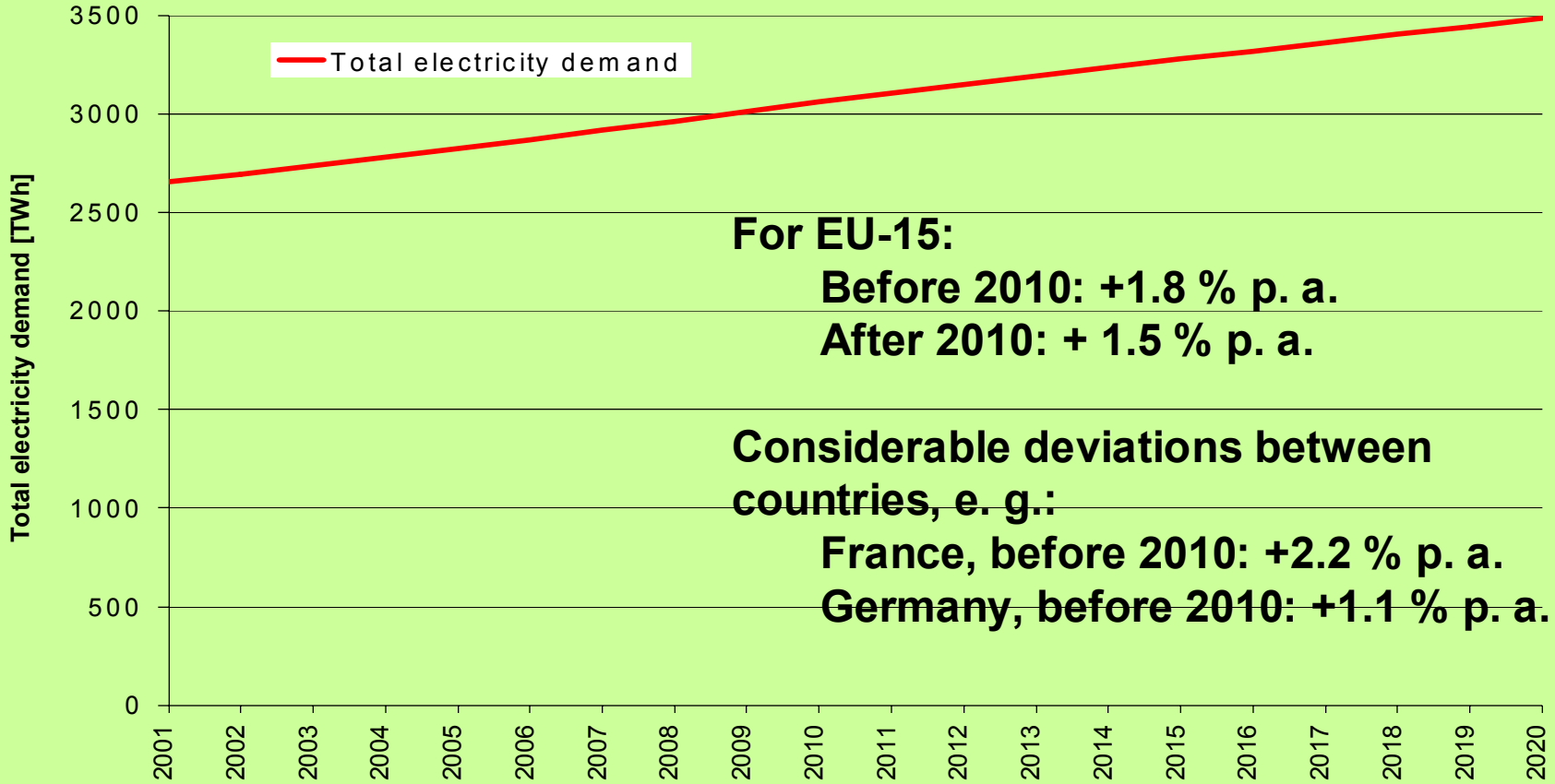
Results computer model Green-X

- The following results can be derived on country and technology level on a yearly basis up to 2020:
  - Total electricity generation (RES-E and conventional)
  - Electricity production / installed capacity by each technology
  - Import / export balances RES-E and conventional power
  - CO_2-emissions
  - Average costs of electricity generation on technology level
  - Influence of energy policy setting on
    - producer surplus and profit for investors / utilities
    - transfer costs for consumer / society

General scenario assumptions (1/7)

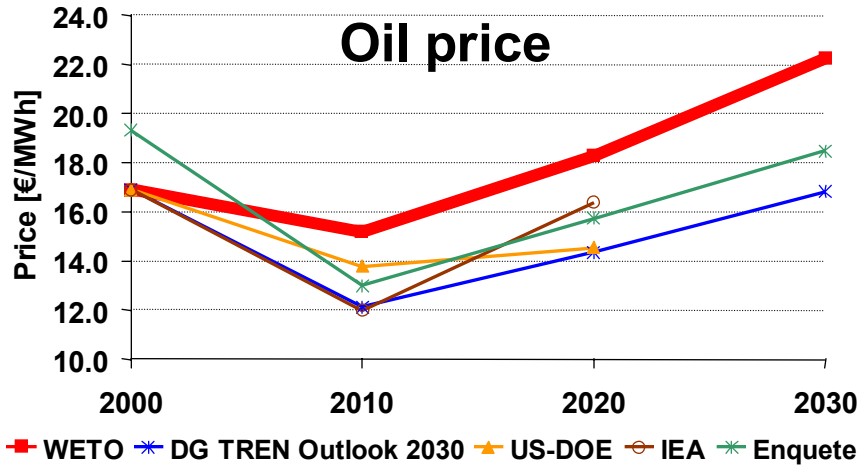
- Electricity demand

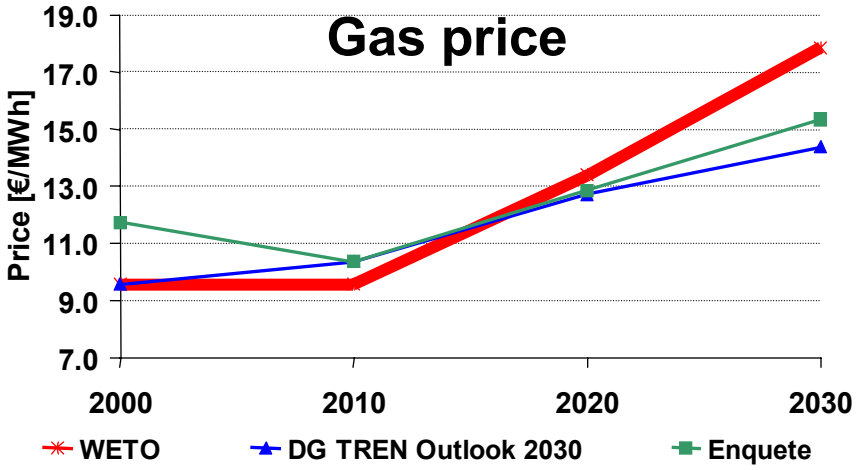
  according to DG TREN Outlook 2030: European Energy and Transport Trends to 2030 Outlook (Mantzos et. al 2003) – Baseline forecast

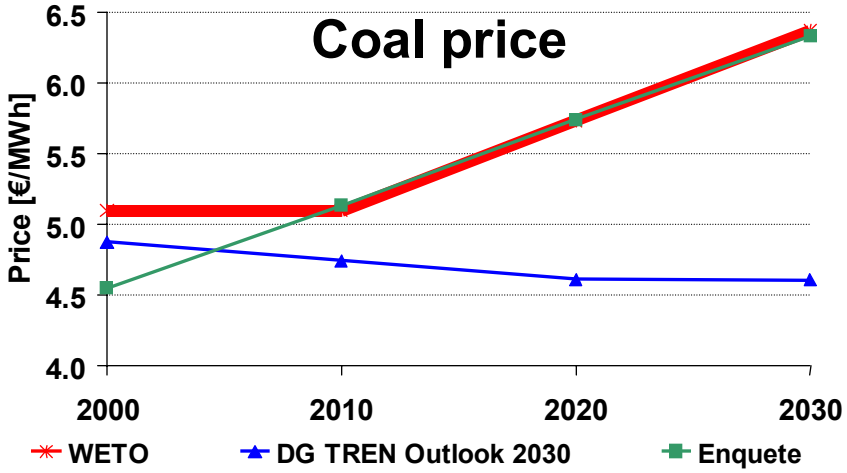


General scenario assumptions (2/7)

- Primary energy prices – fossil energy







WETO: World Energy, Techonology and Climate Policy Outlook by ENERDATA et al. on behalf of DG Research (2003)

DG TREN Outlook 2030: European Energy and Transport Trends to 2030 by Mantzos et al. (2003)

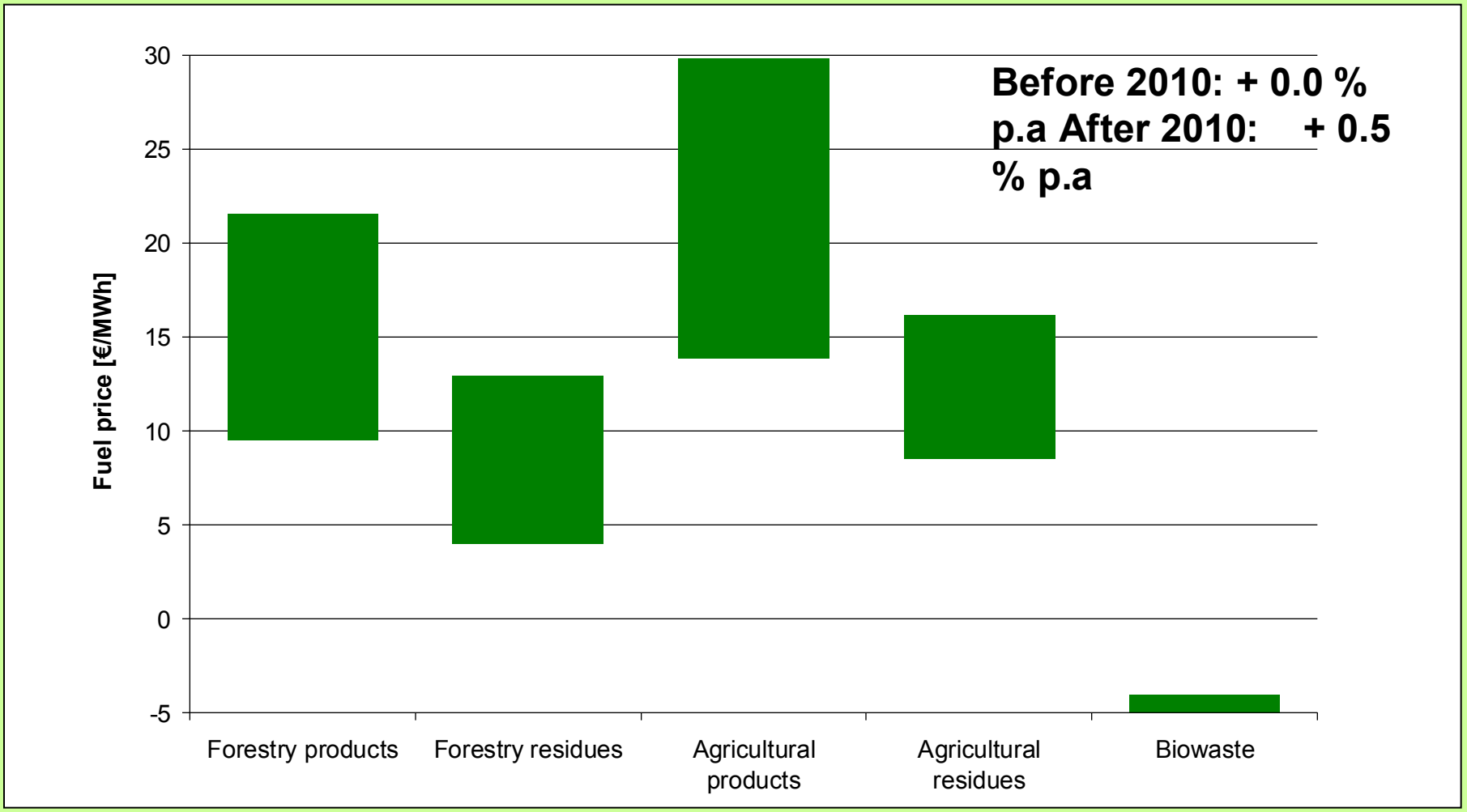
US-DOE: International Energy Outlook 2002, Reference Case projection

IEA: World Energy Outlook to 2020 (2002)

Enquete: Analysis grid for the German Enquete Commission on Sustainable Energy Policy (2002)

General scenario assumptions (3/7)

- Primary energy prices bioenergy: country-specific prices



General scenario assumptions (4/7)

- Weighted average costs of capital (WACC)

$$WACC = gd \bullet rd + ge \bullet re = gd \bullet [rfd + rpd] + ge \bullet [rfe + b \bullet rpe] \bullet (1 + rt)$$

	Abbreviation / calculation	Default risk assessment		Higher risk assessment	
		Dept (d)	Equity (e)	Dept (d)	Equity (e)
Share equity / debt	g	75.0%	25.0%	75.0%	25.0%
Nominal risk free rate	r_n	4.1%	4.1%	4.1%	4.1%
Inflation rate	i	1.9%	1.9%	1.9%	1.9%
Real risk free rate	$r_f = r_n - i$	2.0%	2.0%	2.0%	2.0%
Expected market rate of return	r_m	4.3%	7.1%	4.3%	11.0%
Risk premium	$r_p = r_m - r_f$	2.3%	5.1%	2.3%	9.1%
Equity beta	β		1.6		1.6
Tax rate (corporation tax)	r_t		30.0%		30.0%
Post-tax cost	r_{pt}	4.3%	10.2%	4.3%	16.6%
Real cost	$r = r_{pt} * (1+r_t)$	4.3%	13.2%	4.3%	21.5%
Weighted average cost of capital	*WACC*	6.5%		8.6%	

General scenario assumptions (5/7)

- Future cost projections – technological learning

Dynamic cost assessment

RES-E category	Applied approach	Assumptions
Biogas	Experience curve (global)	LR (learning rate) = 5%
Biomass	Experience curve (global)	LR = 5%
Geothermal electricity	Experience curve (global)	LR = 5%
Hydropower	Expert forecast	No cost decrease in considered period
Photovoltaics	Experience curve (global)	LR = 15% up to 2010, 10% after 2010
Solar thermal electricity	Experience curve (global)	LR = 15% up to 2010, 10% after 2010
Tidal & wave	Expert forecast	Cost decrease: -5%/year up to 2010, -1%/year after 2010
Wind on- & offshore	Experience curve (global)	LR = 9%

In case of appliance of the expereince curve approach (global learning system): Forecasts of the future development by RES-E category are taken ...

for EU-10+ … from the project "FORRES 2020" (see *Ragwitz et.al., 2004*)

for the rest of the world … from IEA - World energy outlook 2004 *(forthcoming)*

General scenario assumptions (6/7)

For all investigated it has been assumed:

- Stable planning horizon, i.e. investors have knowledge about applied policy mechanism in the future
- Continuous RES-E policy / long term RES-E targets
- Clear and well predefined tariff structure / yearly quota
- Reduced investment costs over time (technological learning)
- Reduction in barriers and high public acceptance in the long term (depending on the target)

General scenario assumptions (7/7)

For all investigated with the exception of BAU, it has been assumed:

- New support mechanism refer to new capacity only;
  This means already supported RES-E technology remains in their support instrument
- For new support mechanism:
  Restriction of the duration in which investors can receive the (additional) financial support

Investigated cases (1/2)

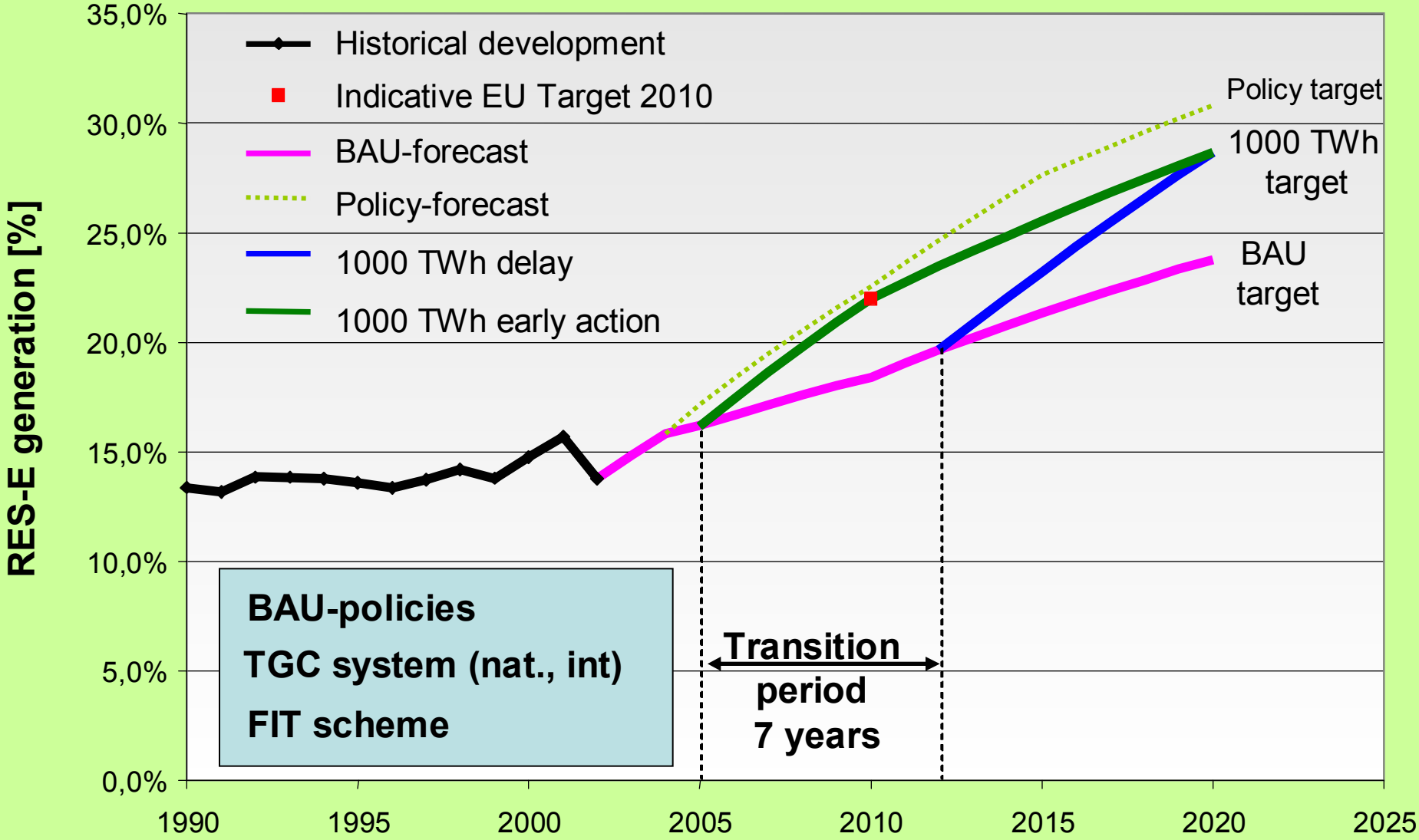
National Support Schemes and EU Community Framework

Taking account of the wide diversity of promotion schemes between Member States, the ***Directive*** states that ***it is too early to set*** a Community-wide ***framework regarding support schemes***.

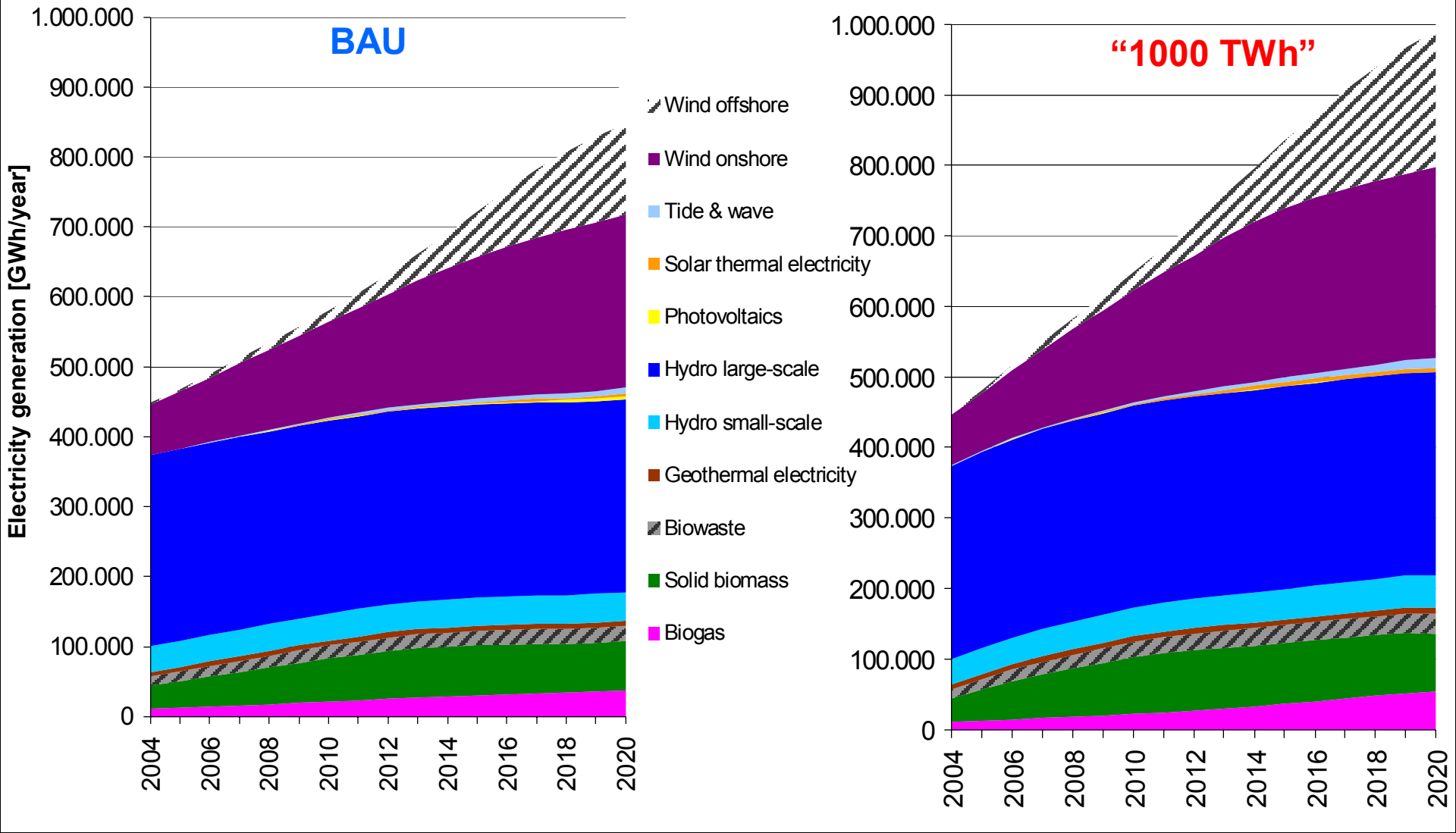
By ***10/27/2005***, the Commission should present a report on the experience gained with the application and coexistence of different support schemes in the Member States. The report may be accompanied by a **proposal for a Community framework for RES support schemes** *(art.4.2).*

However, the directive also stipulates that such a proposal for a harmonised support framework should allow a ***transition period of at least 7 years (thereafter)*** in order to maintain investors' confidence and avoid stranded costs.

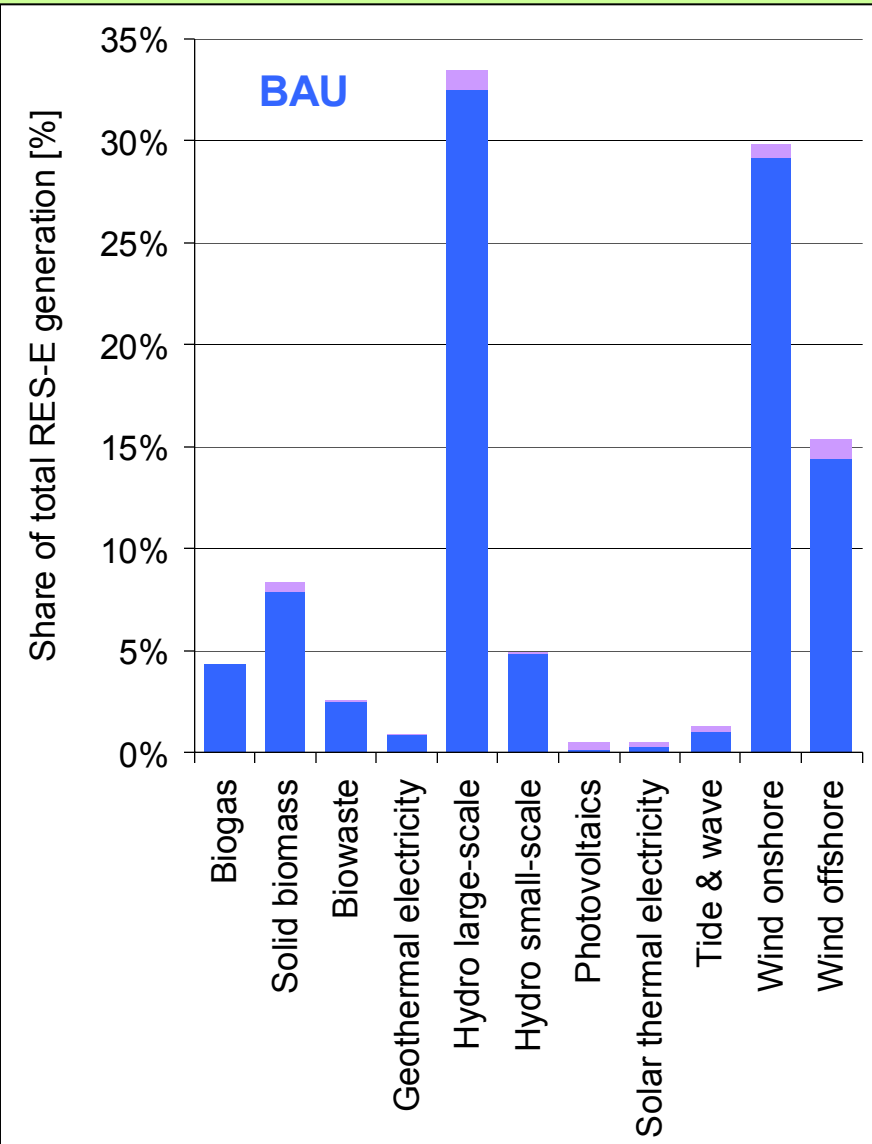
Investigated cases (2/2)

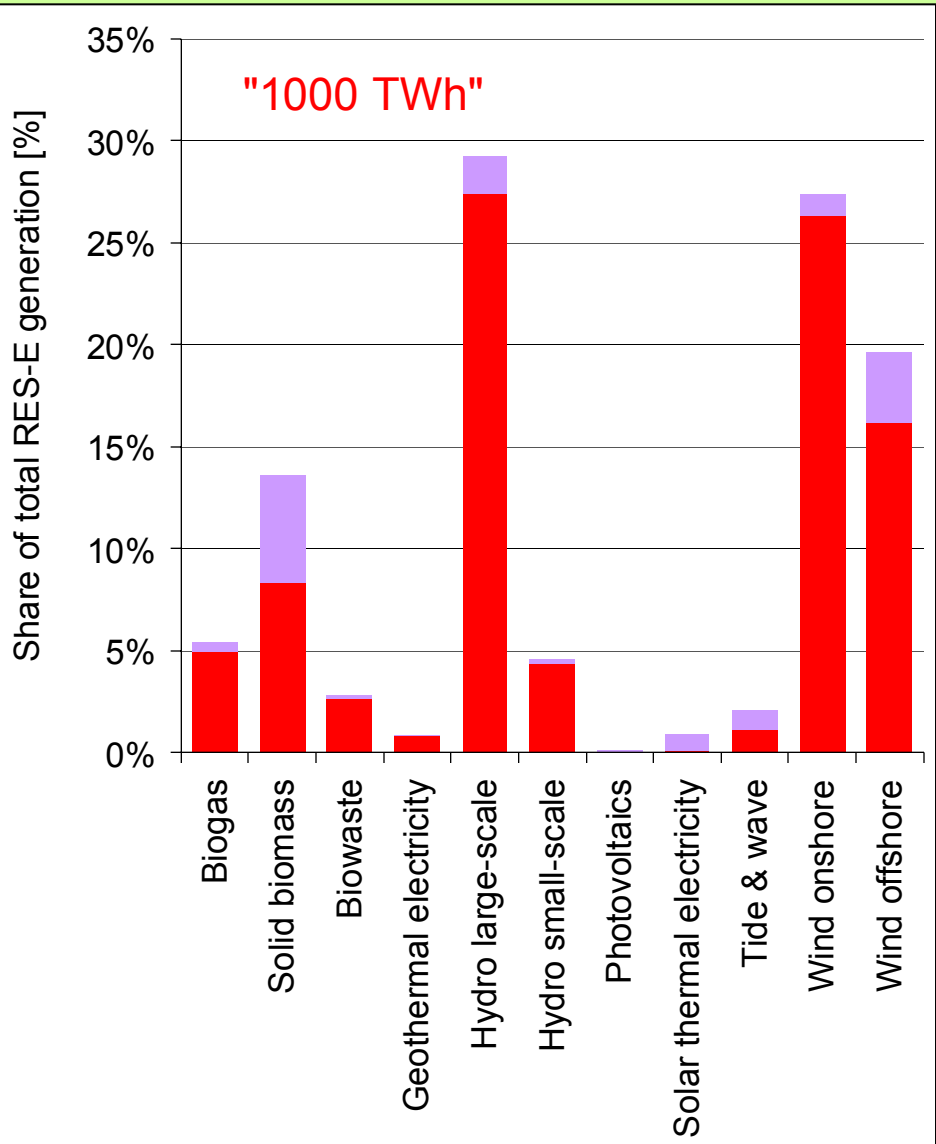


RES-E deployment over time EU-15

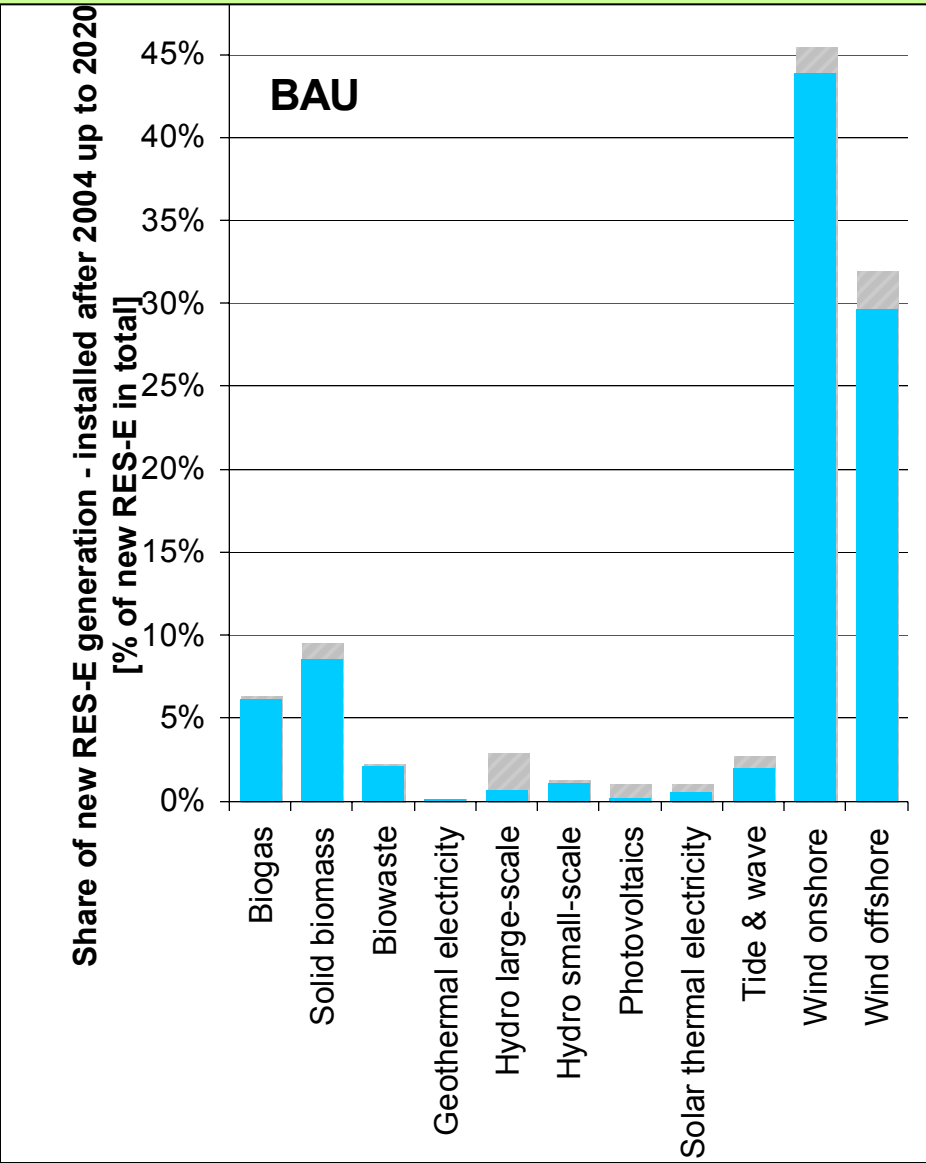


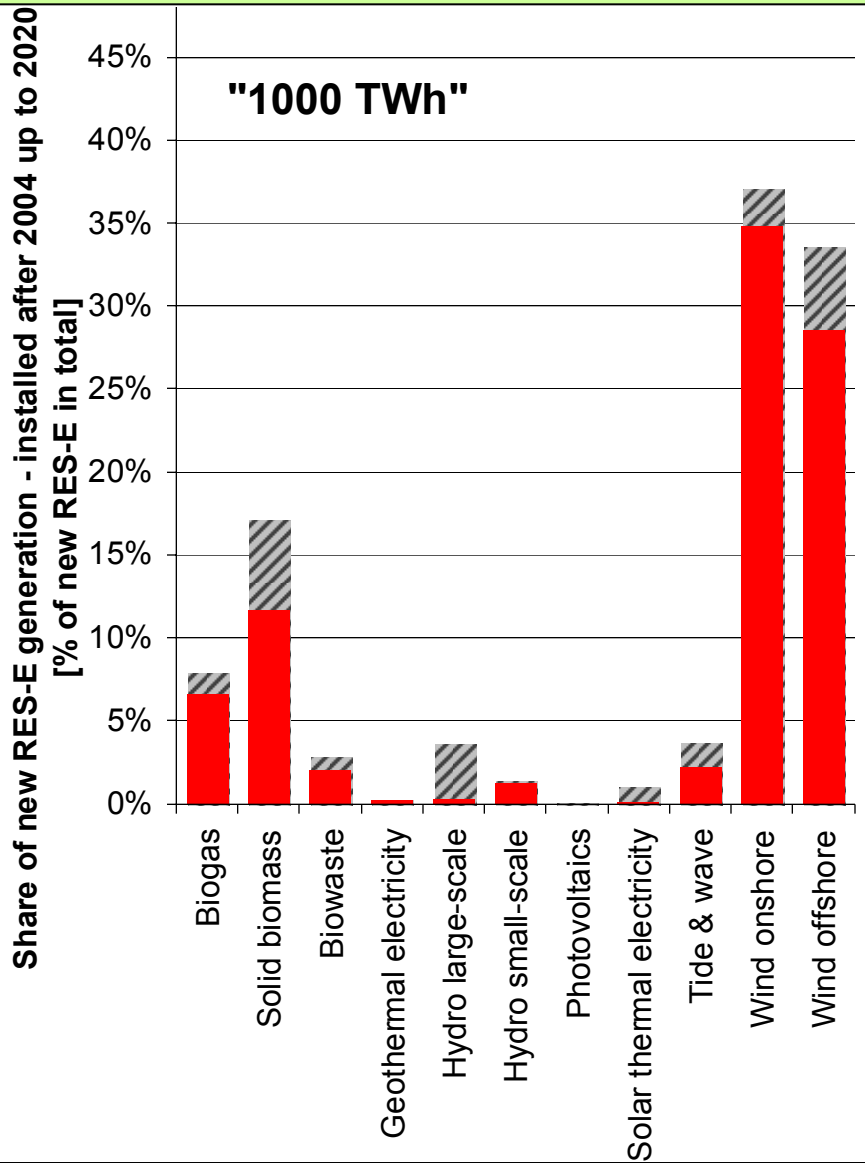
Total RES-E generation EU-15 in 2020



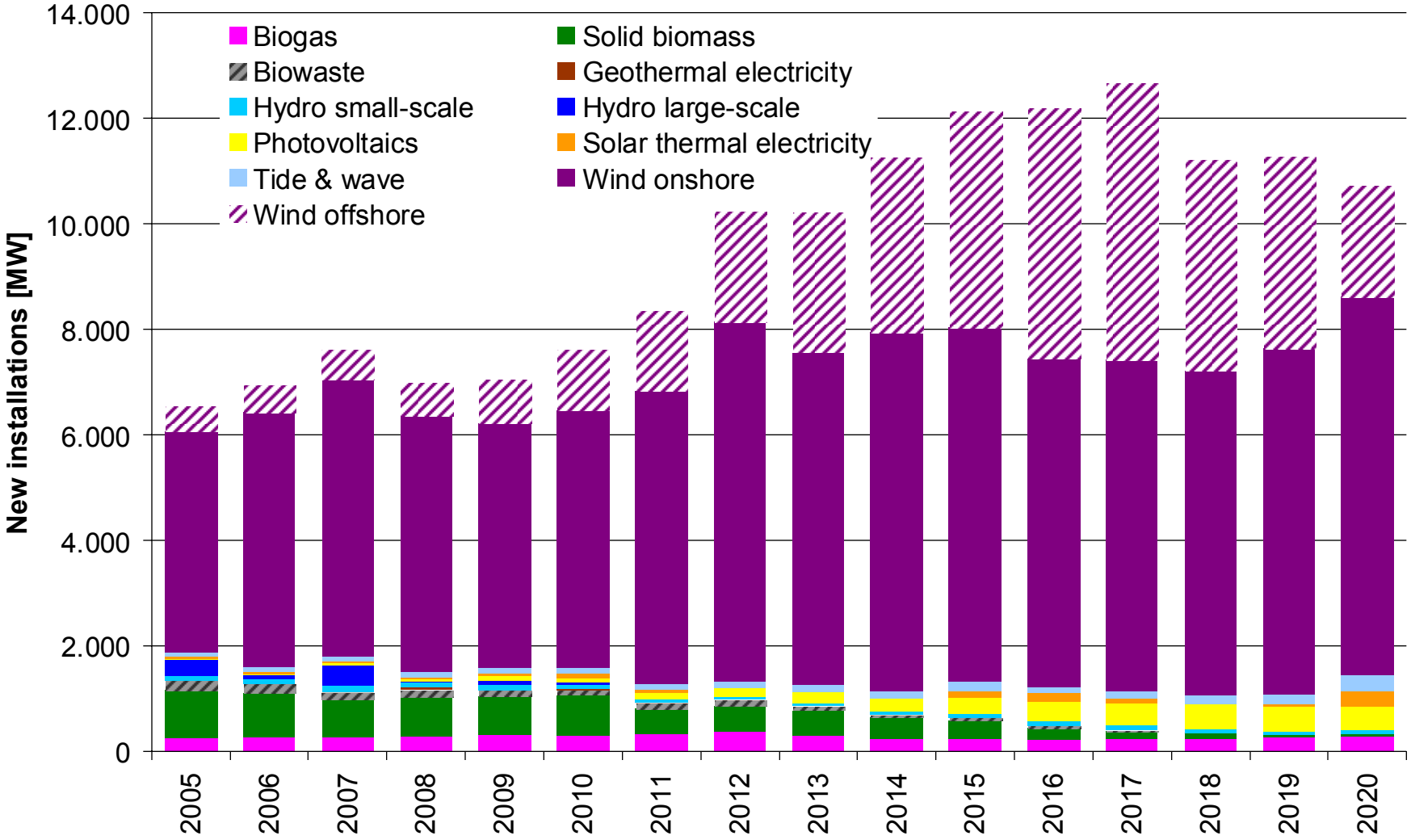


New RES-E generation EU-15 in 2020



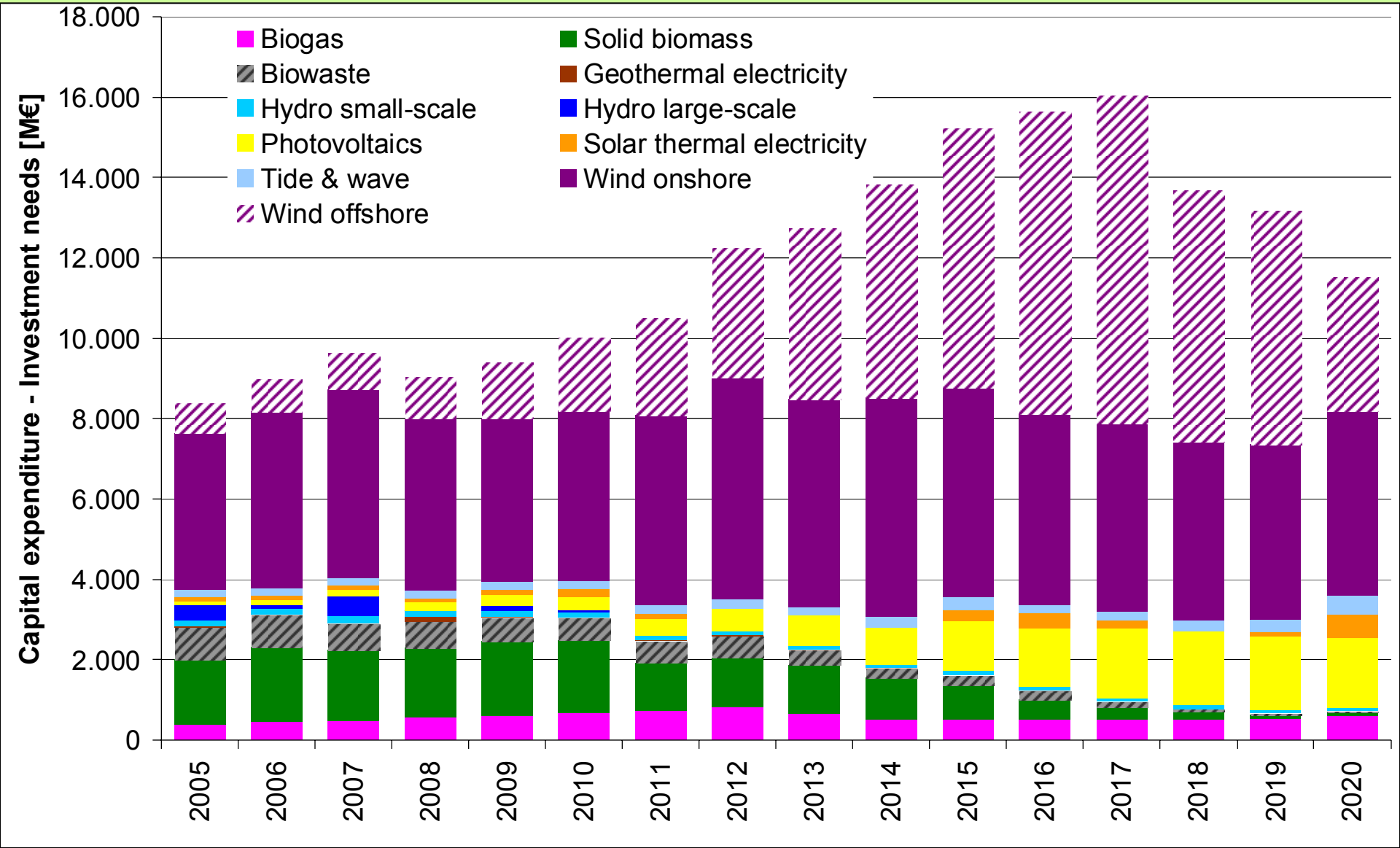


New RES-E installations up to 2020 BAU



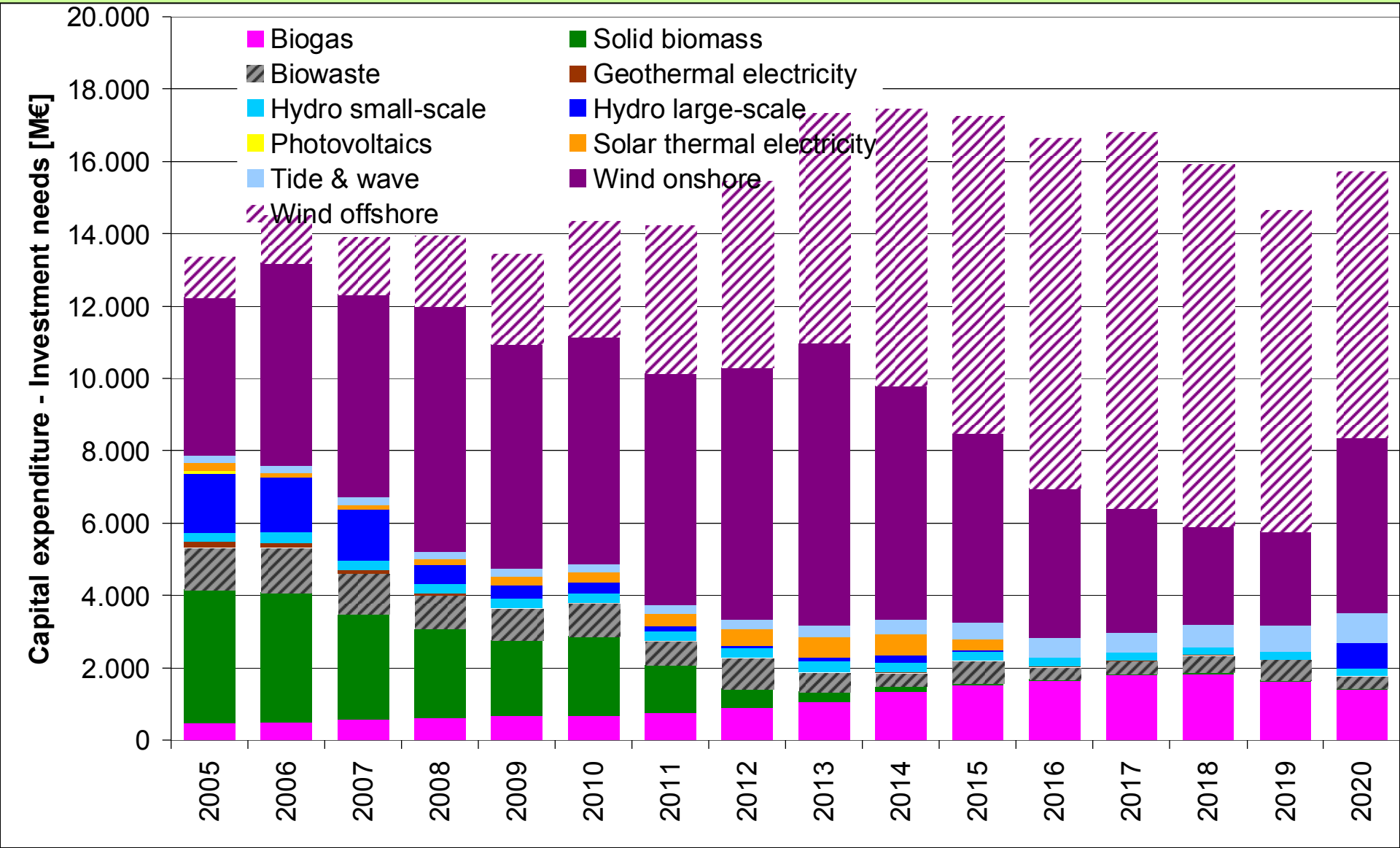
Investment needs up to 2020

BAU



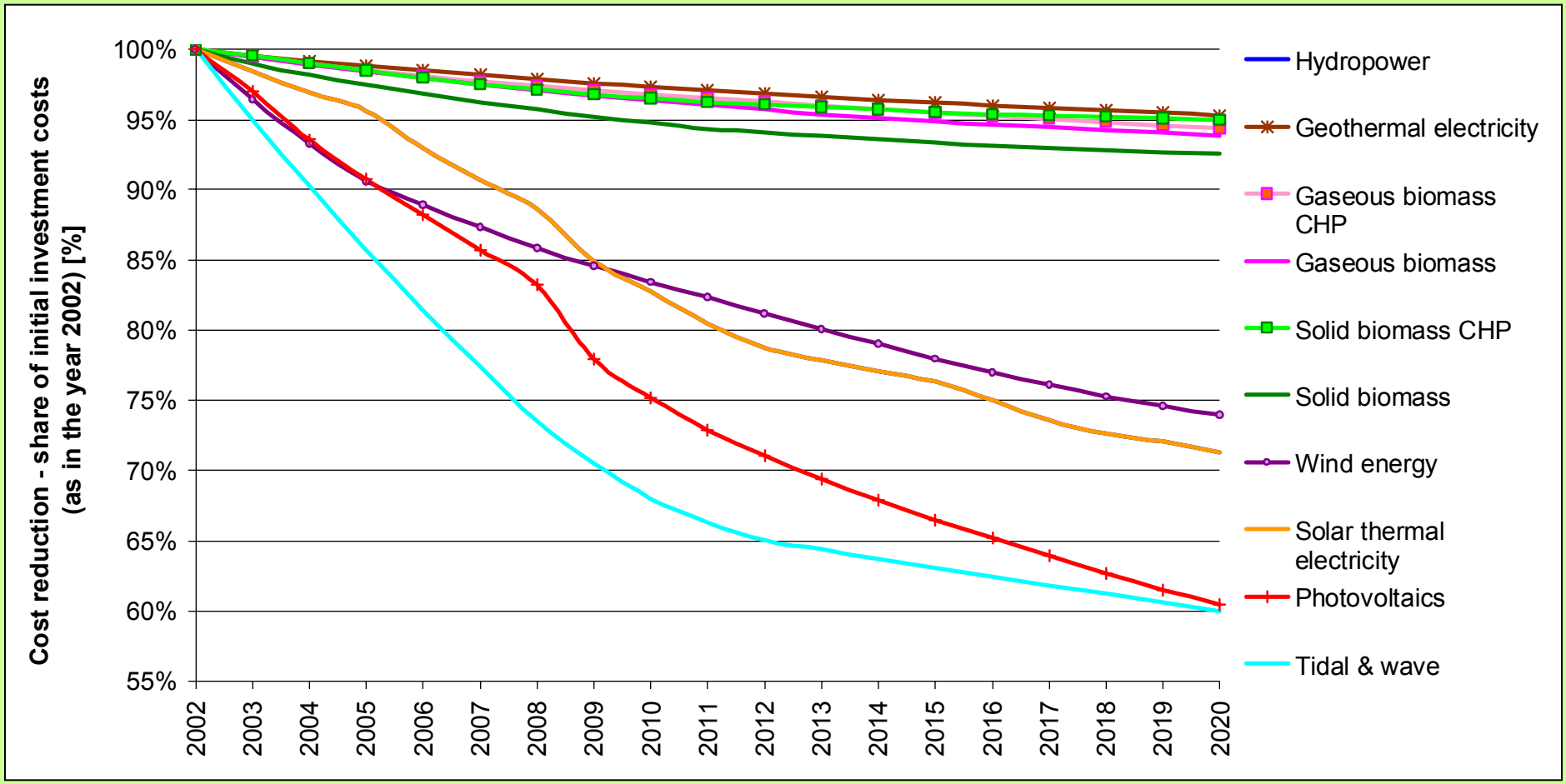
Investment needs up to 2020

"1000 TWh"



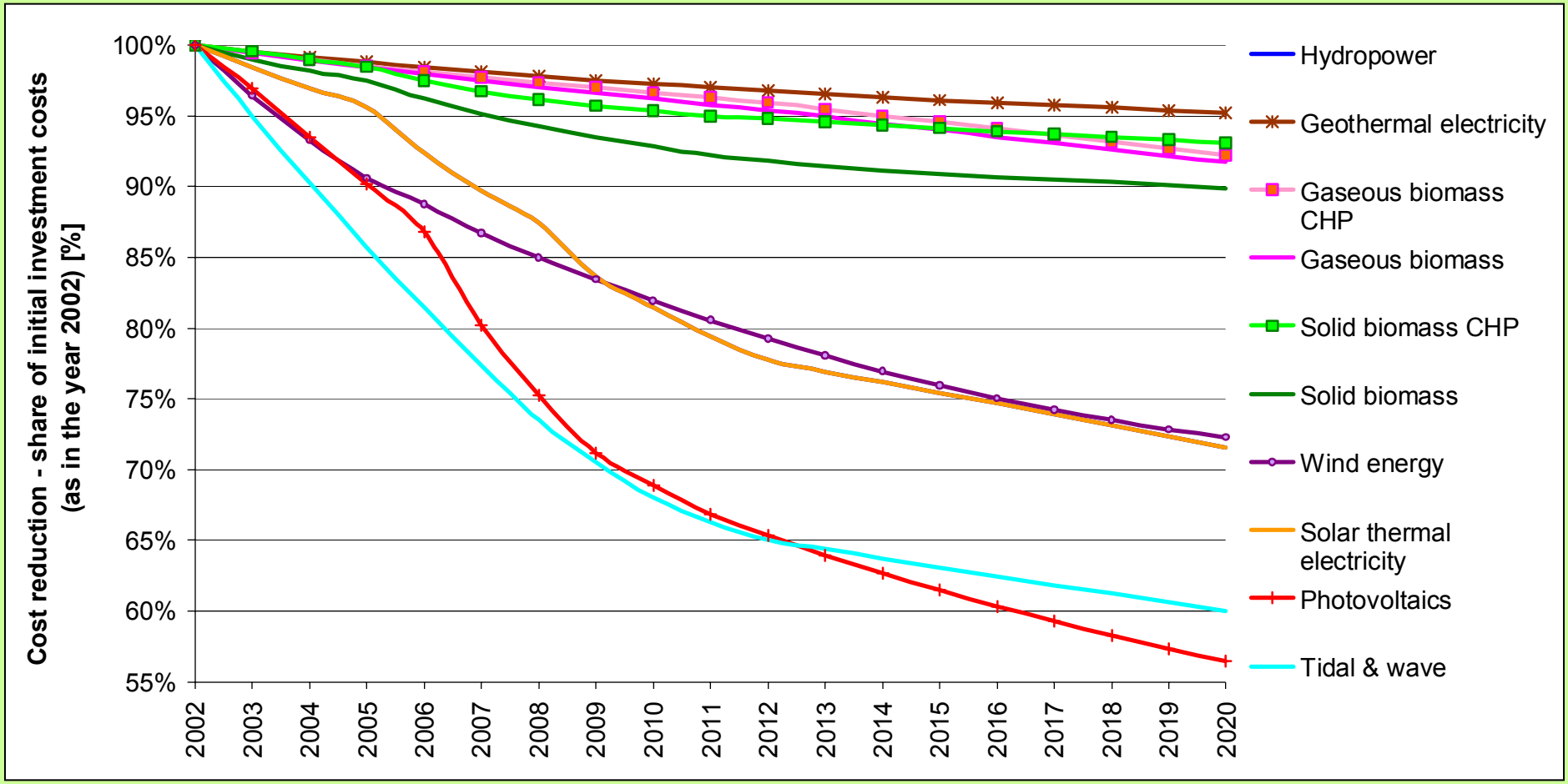
Cost reduction due to technological learning (2002-2020)

…in case of BAU-development

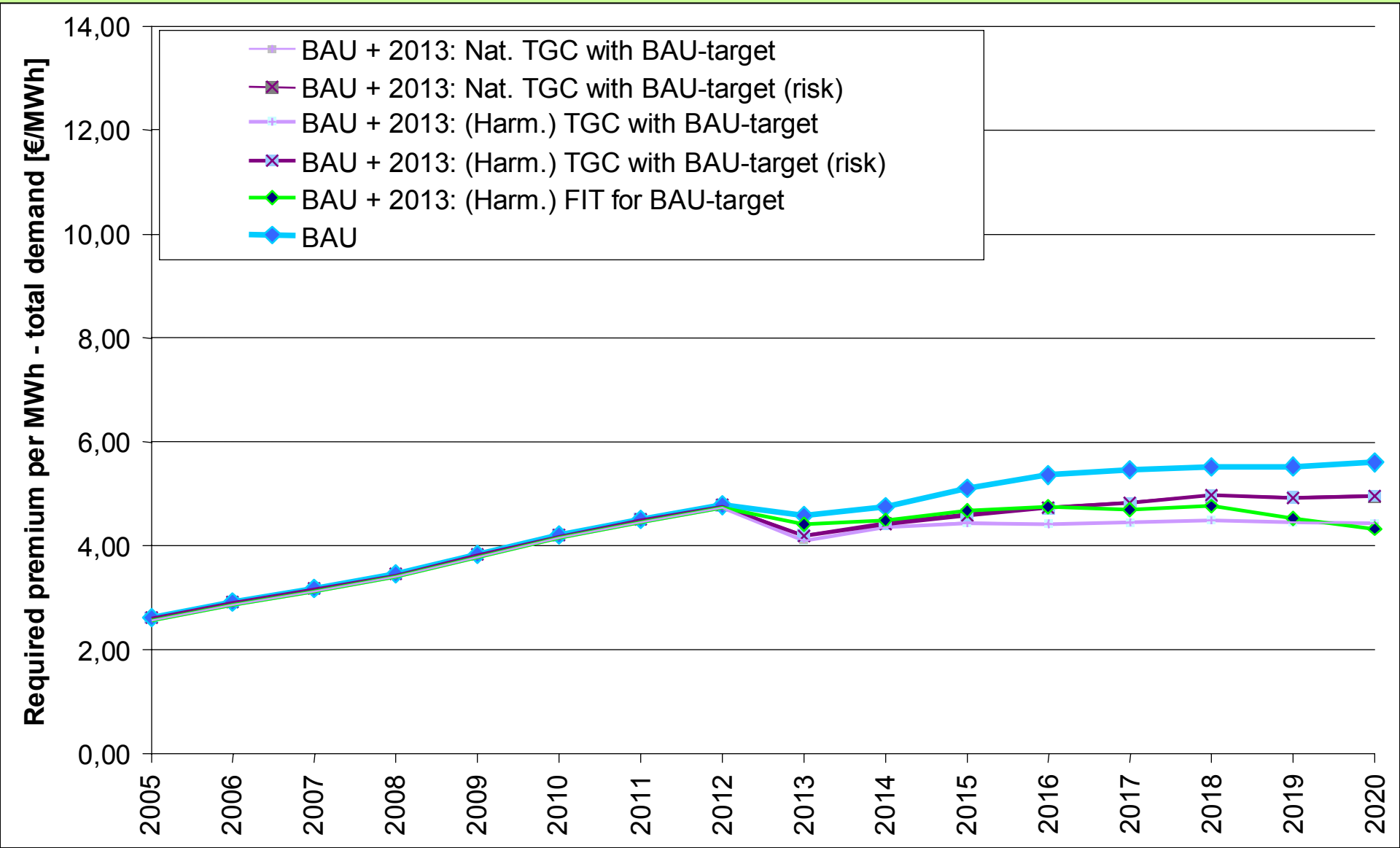


Cost reduction due to technological learning (2002-2020)

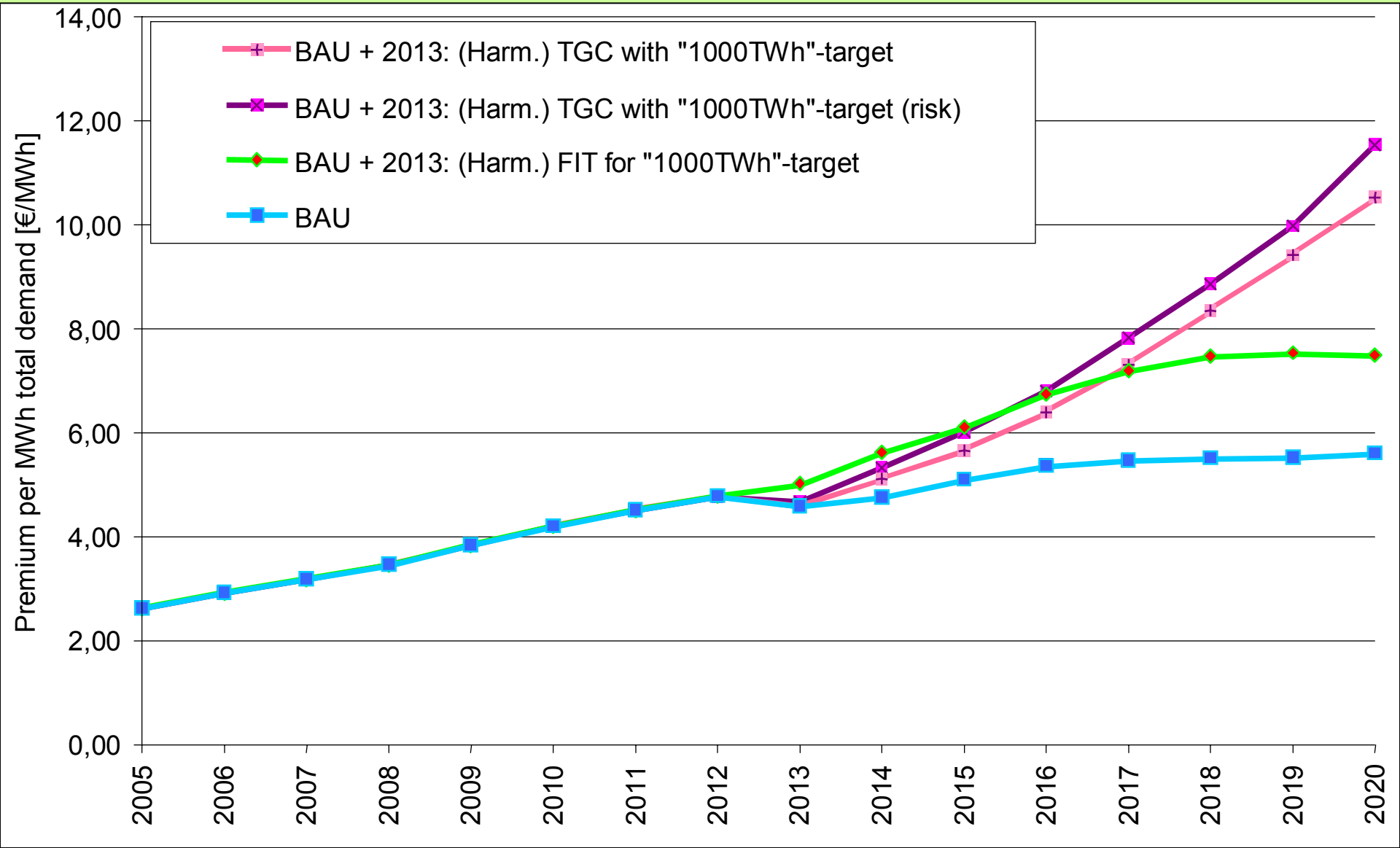
…in case of "1000 TWh"-development



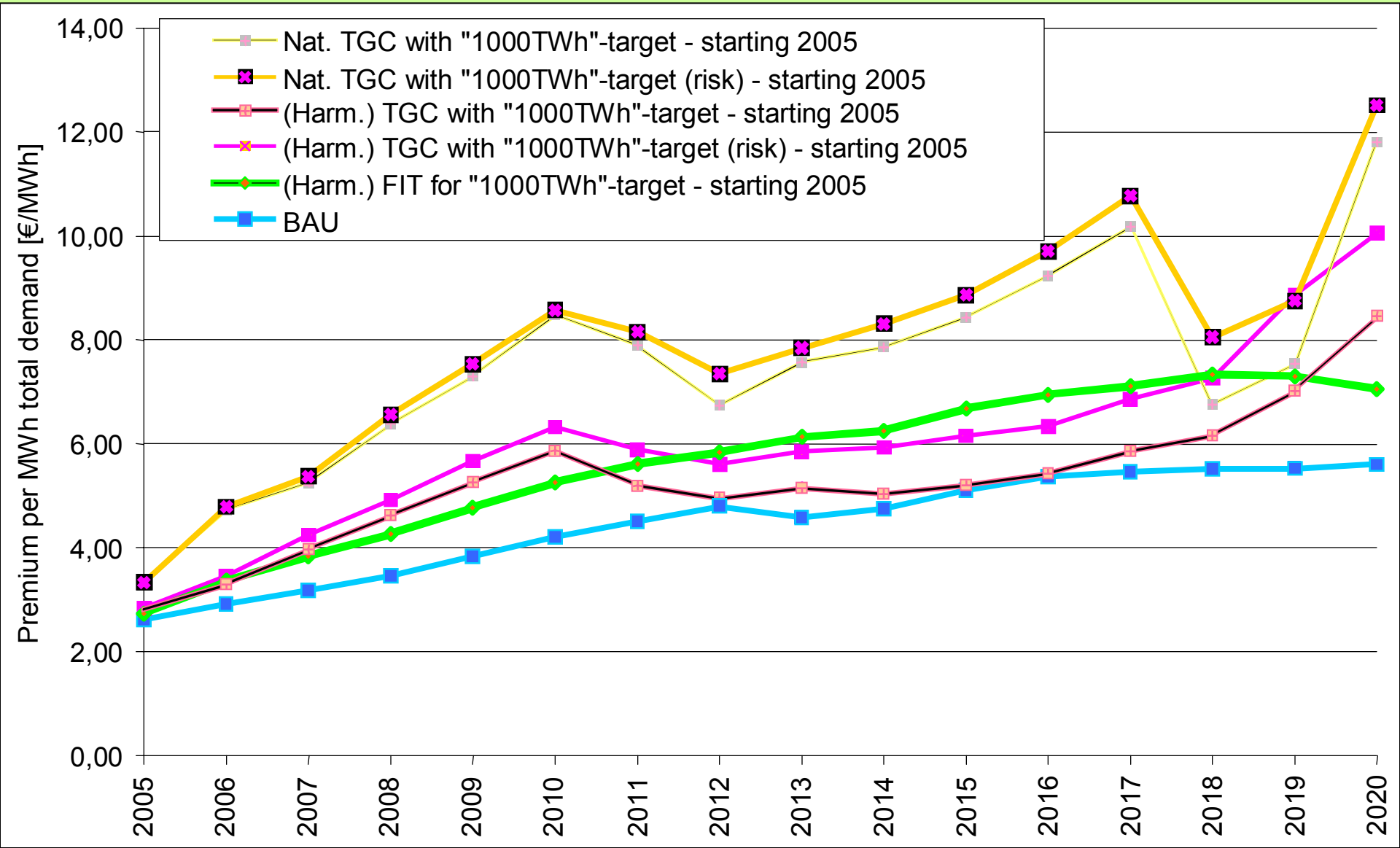
Transfer costs for society (BAU-target)



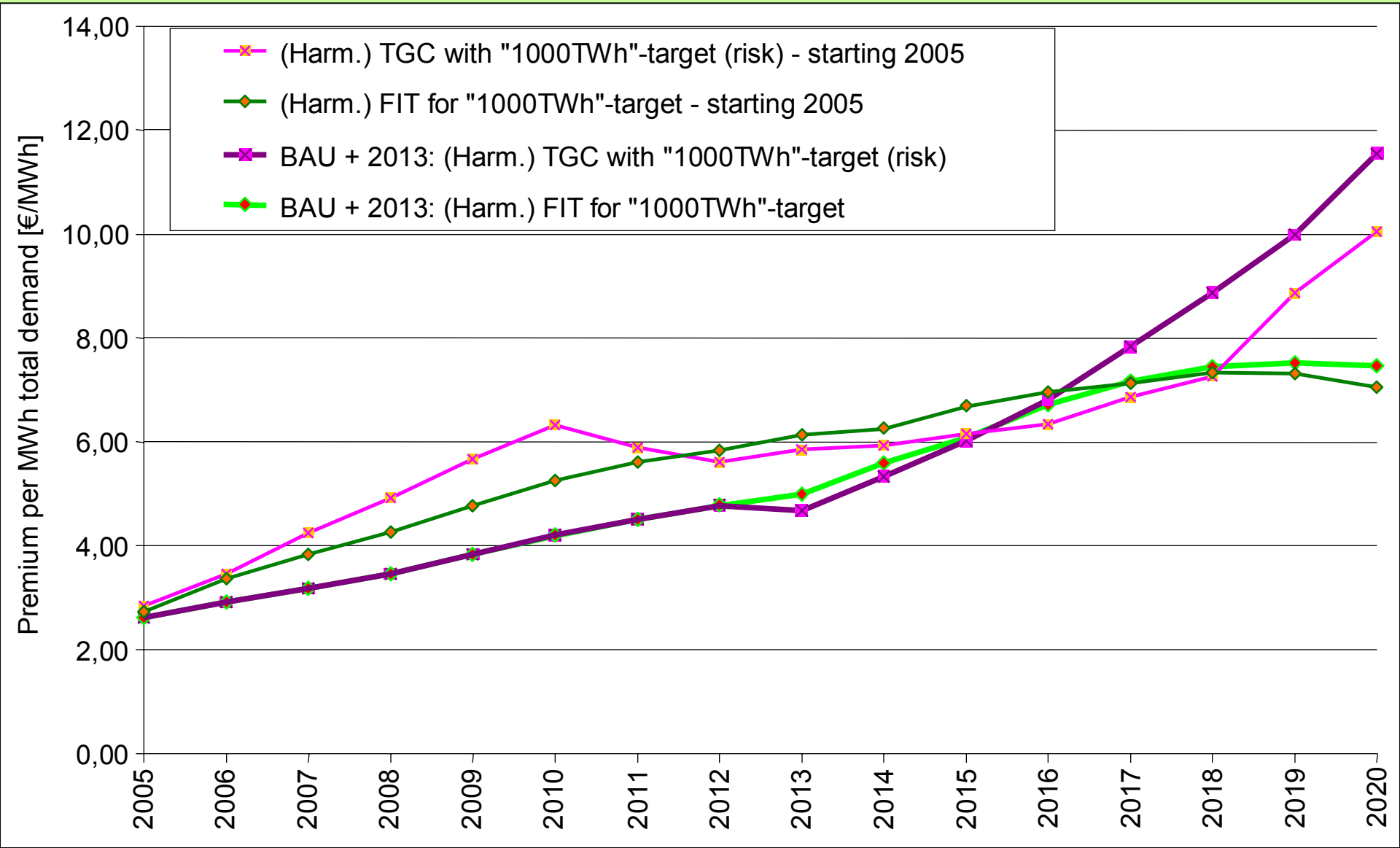
Transfer costs for society (BAU-1000TWh)



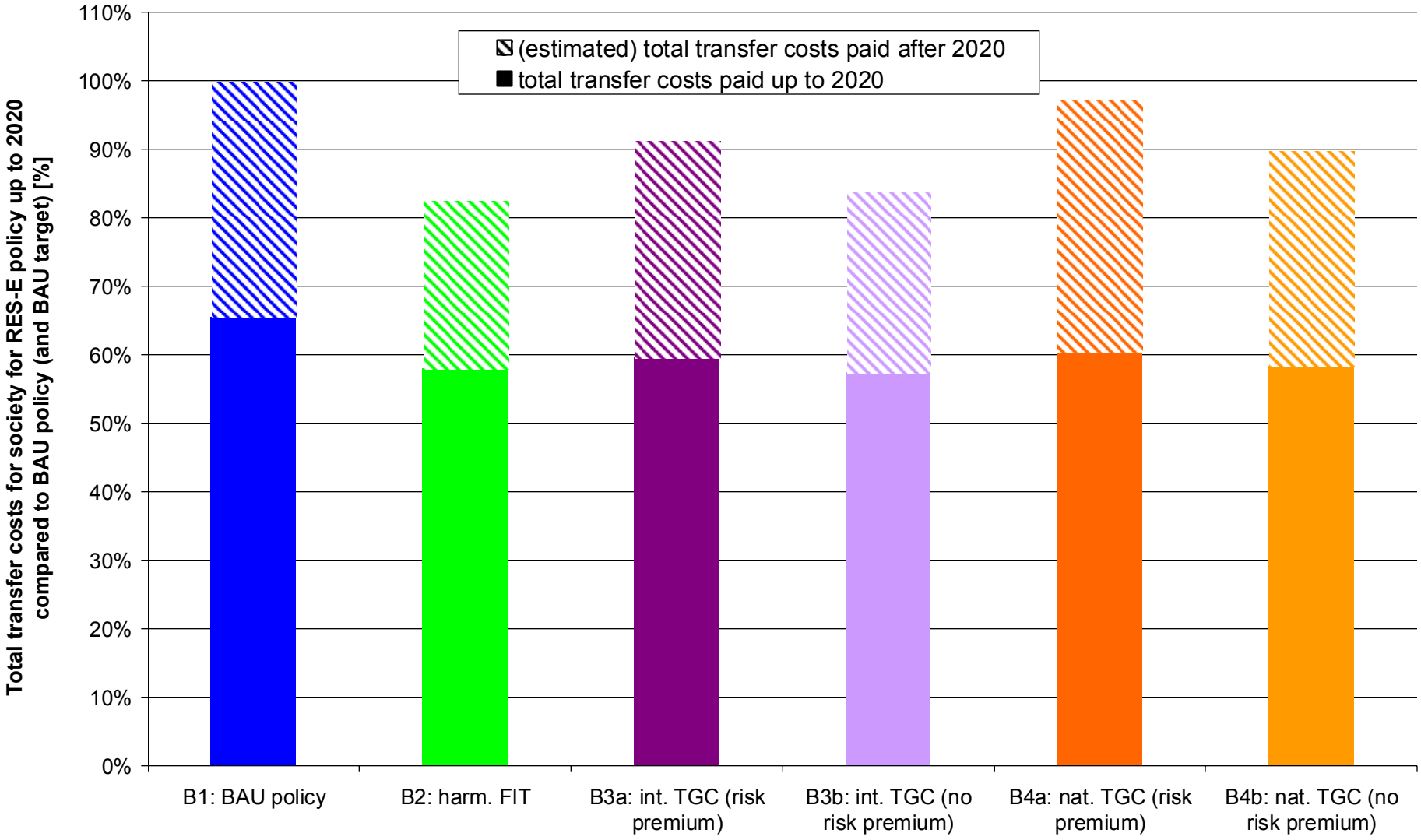
Transfer costs for society (1000TWh)



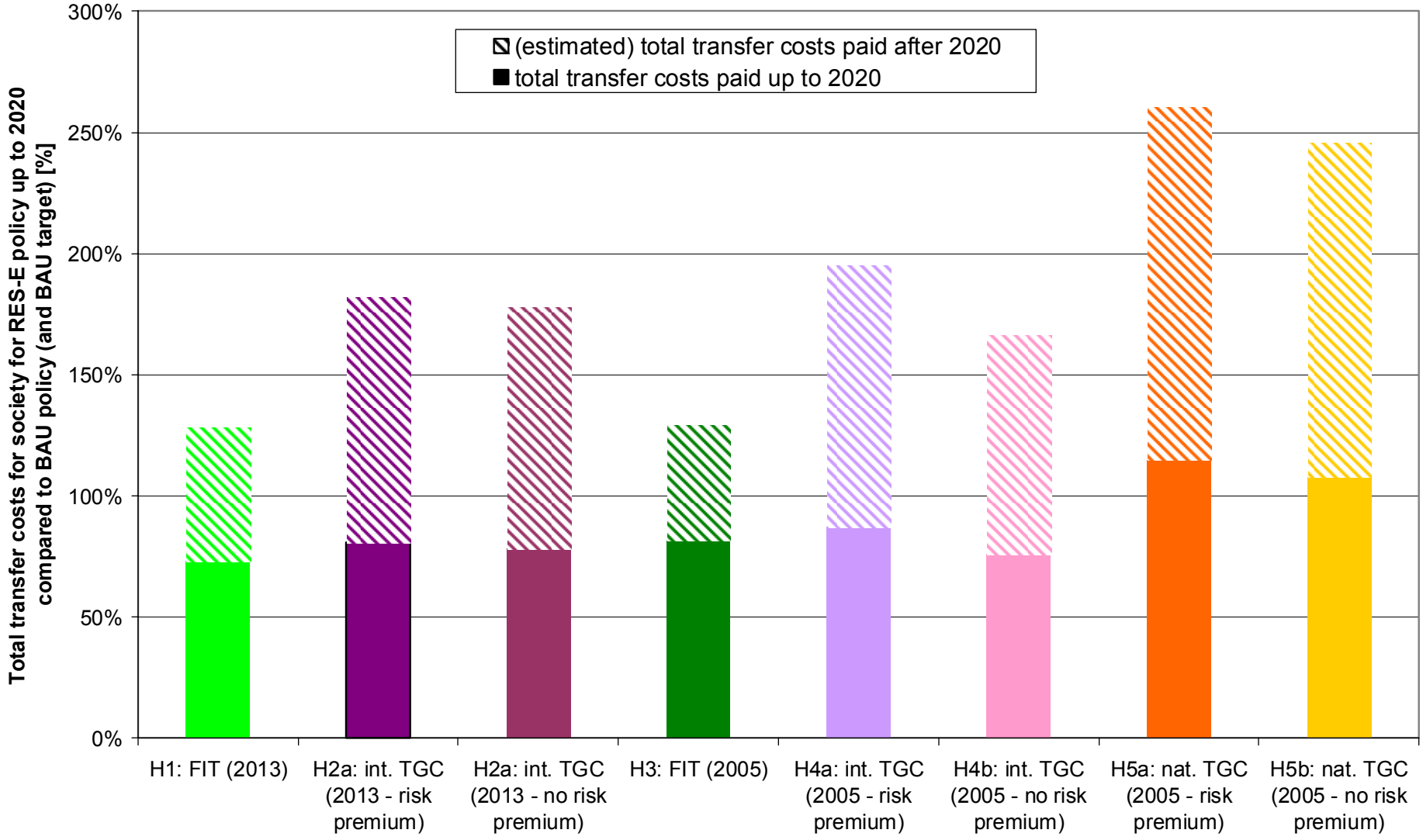
Comparison BAU-1000 TWh vs. 1000 TWh



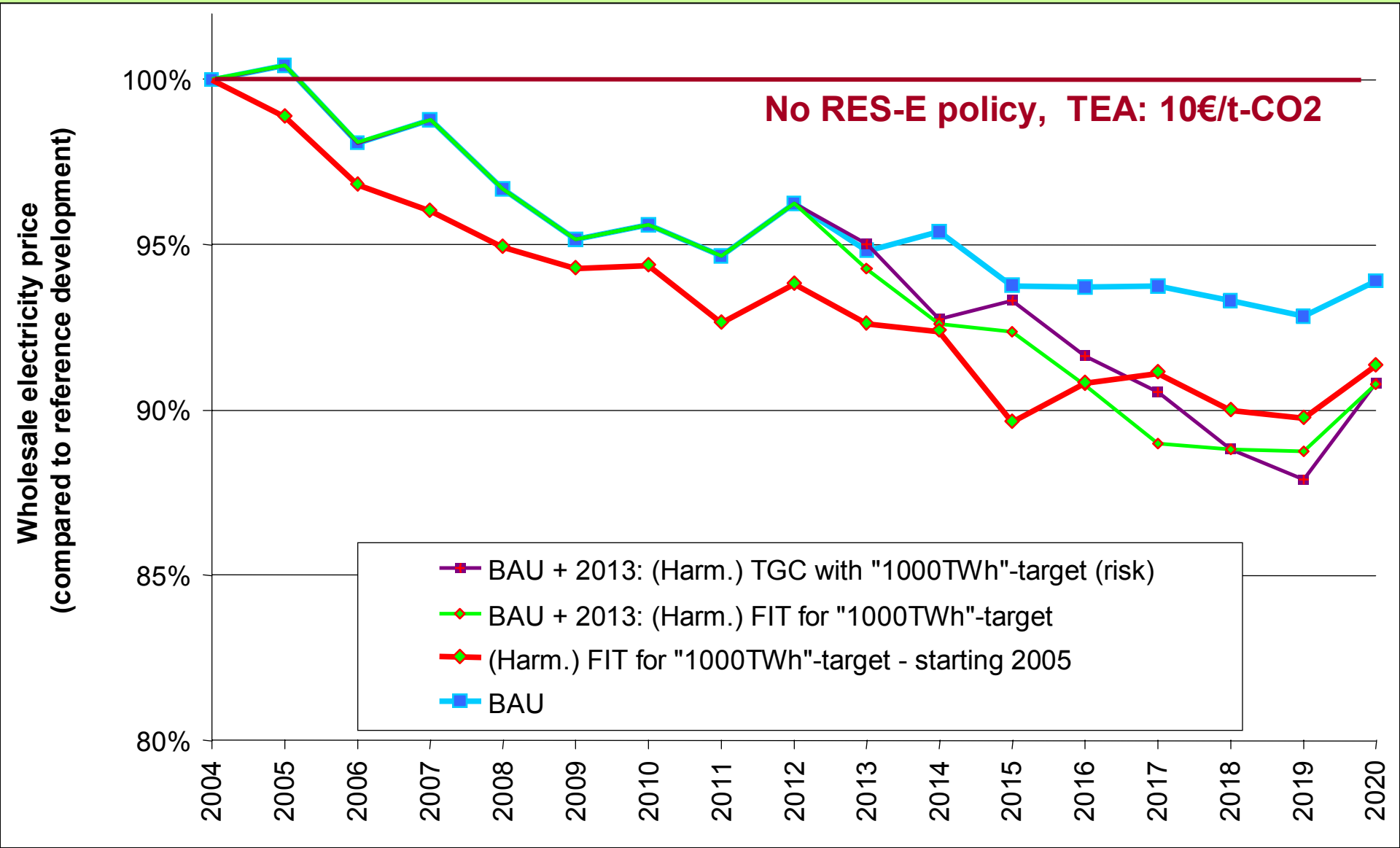
Transfer costs for society – Comparison all cases



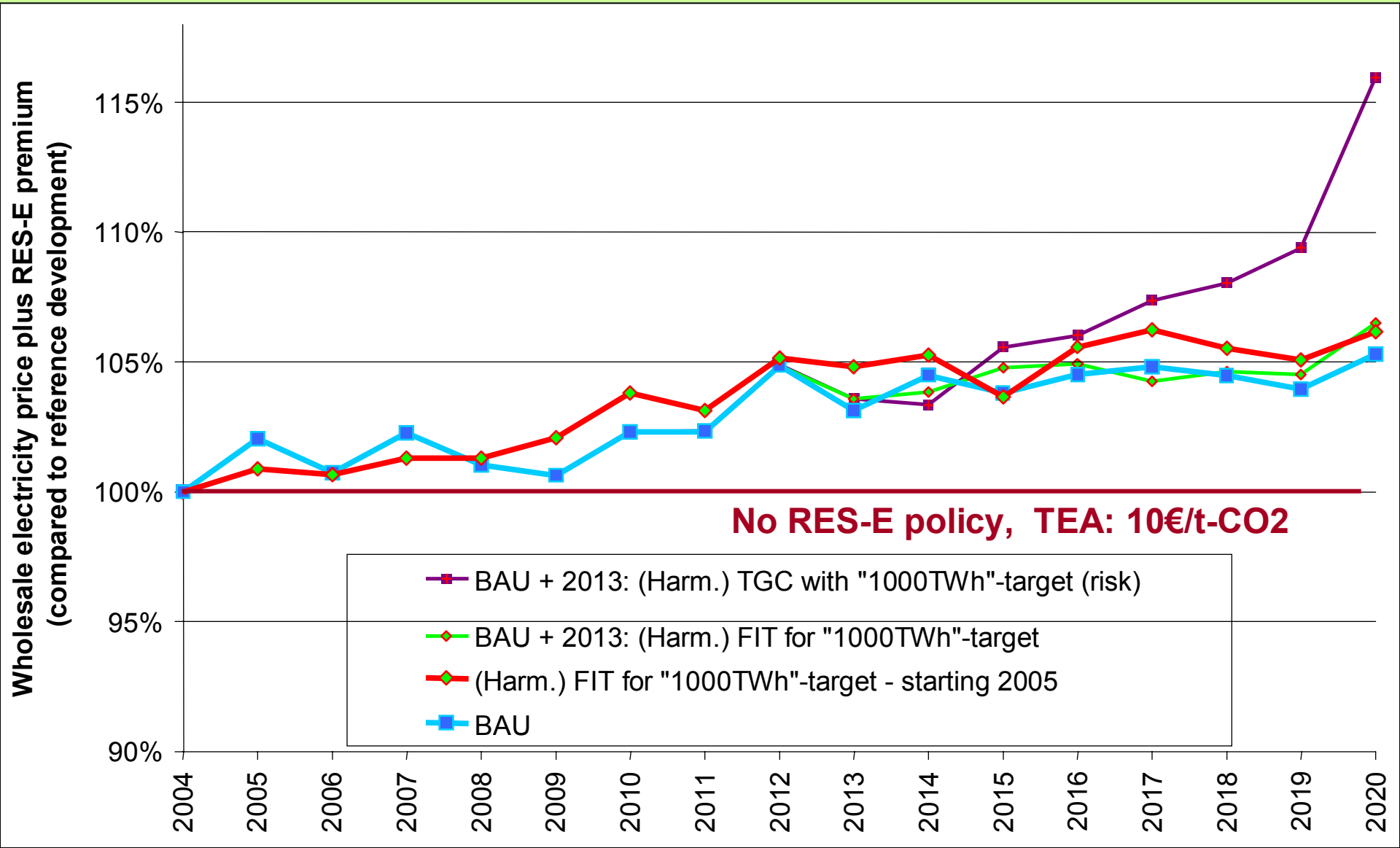
Transfer costs for society – Comparison all cases



Impact on whole sale electricity prices



Impact on whole sale electricity prices



Impact on GHG emissions