



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

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



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# ***Overview***

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

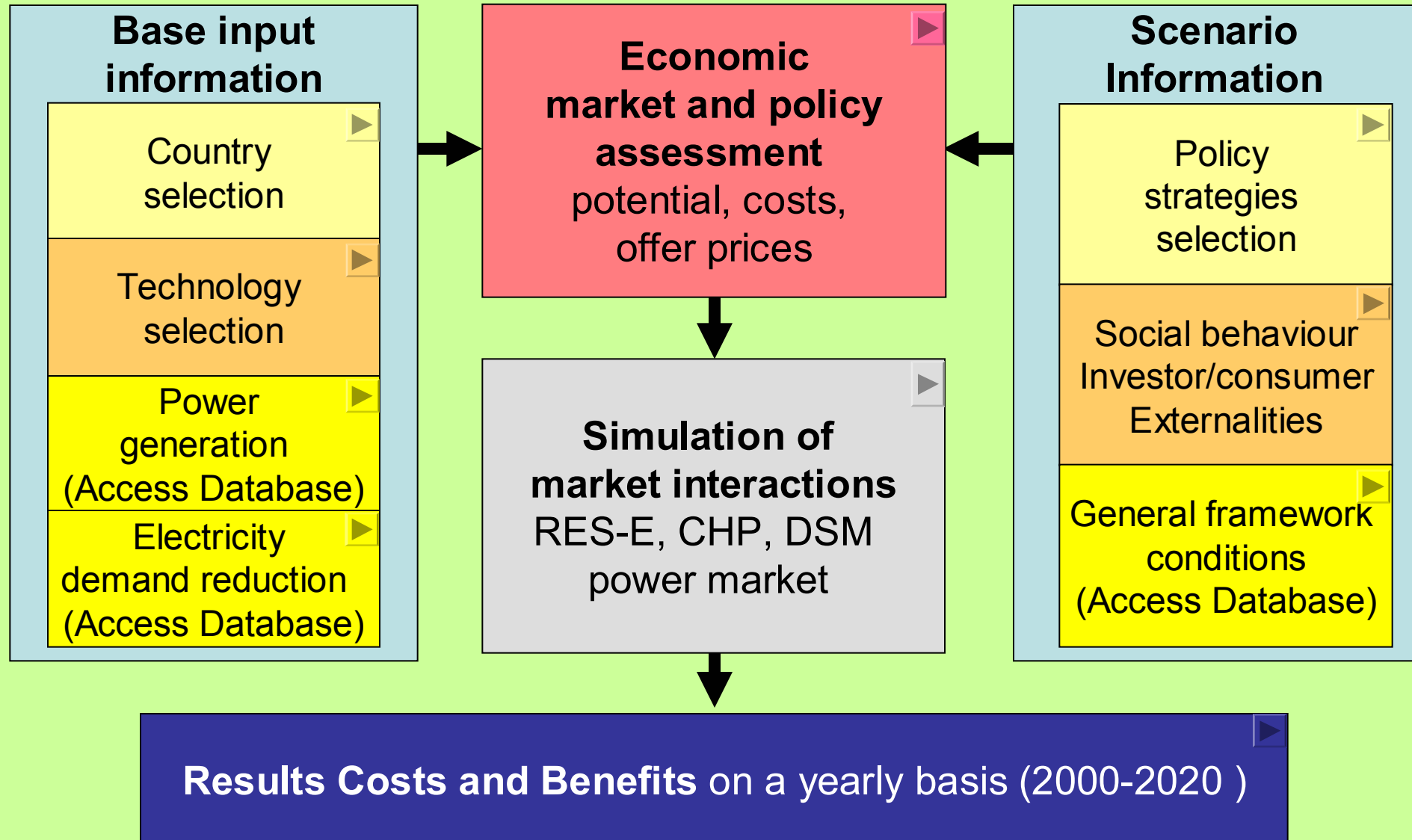


## ***Method of approach***

Transfer costs for consumer (additional costs for society)	= PS + GC - $p_c * Q$
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## *The toolbox Green-X*





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## *Results computer model Green-X*

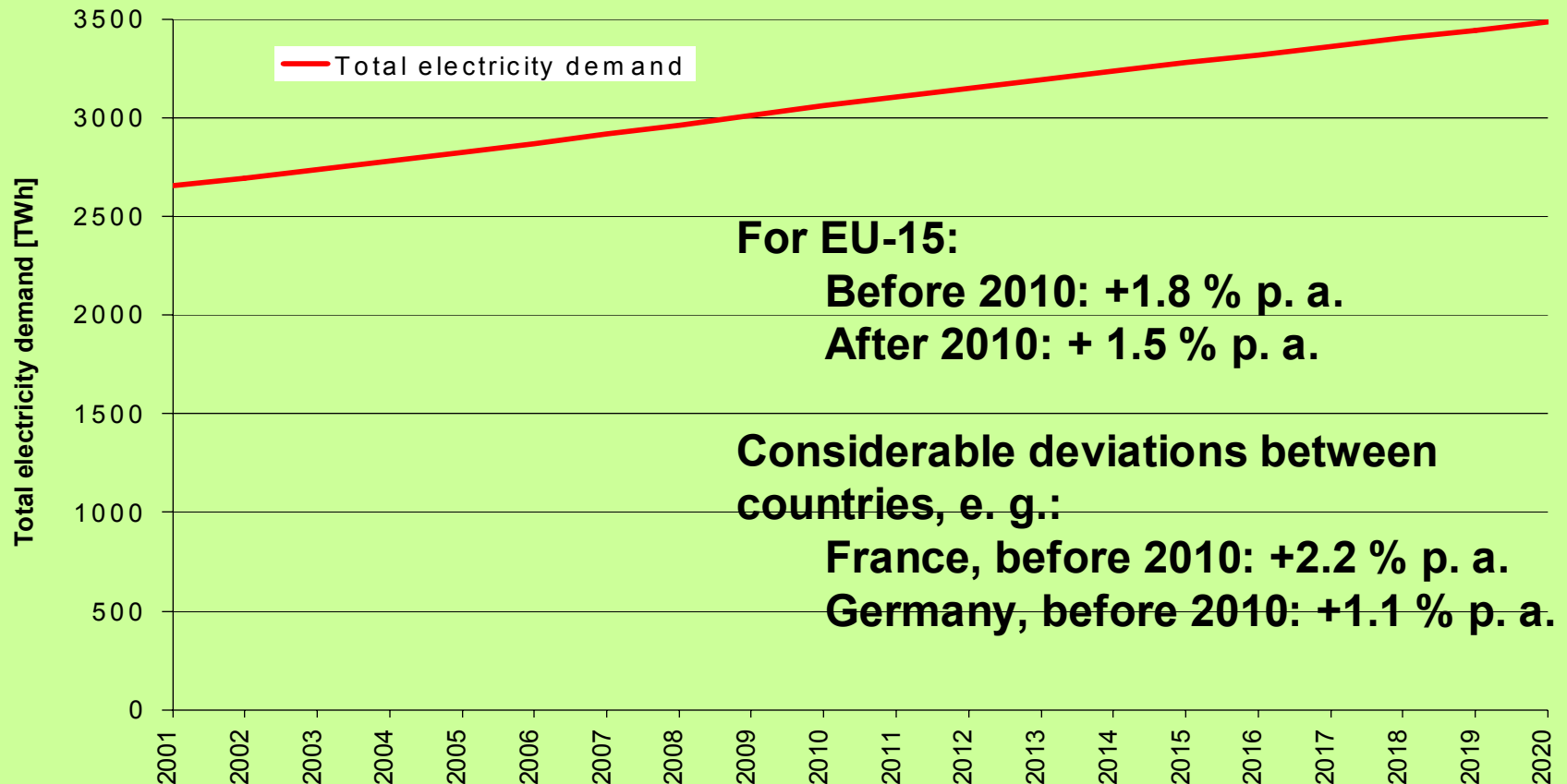
- The following results can be derived on country and technology level on a yearly basis up to 2020:
  - Total electricity generation (RES-E and conventional)
  - Electricity production / installed capacity by each technology
  - Import / export balances RES-E and conventional power
  - CO<sub>2</sub>-emissions
  - 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

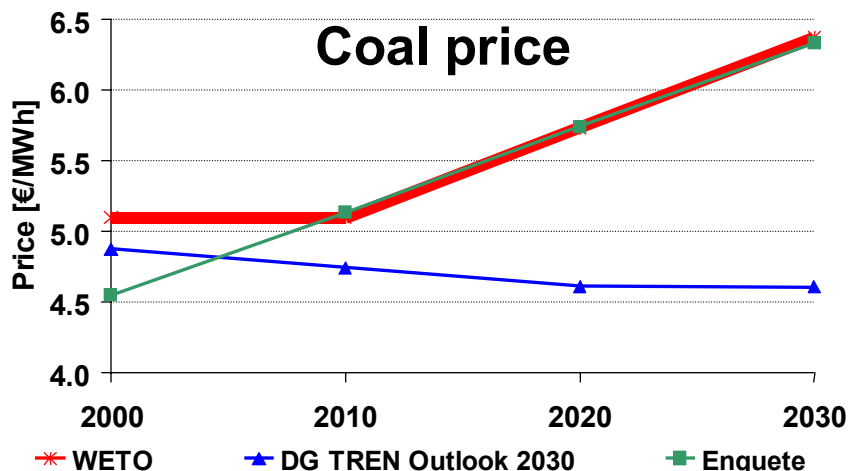
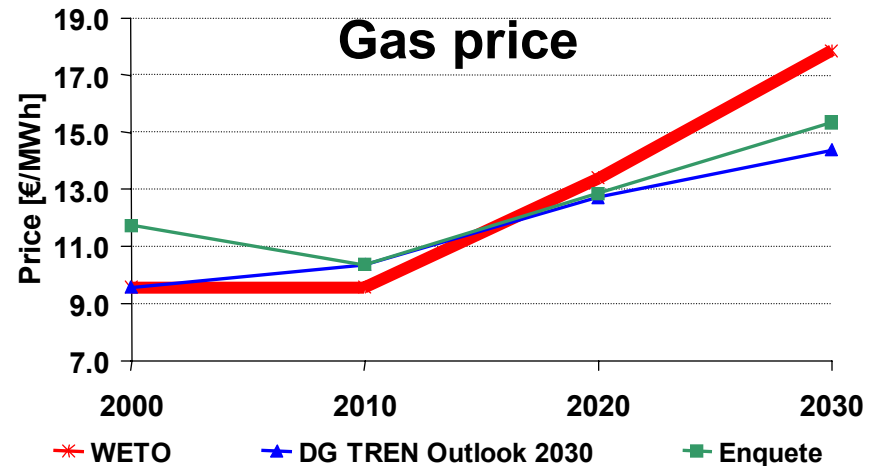
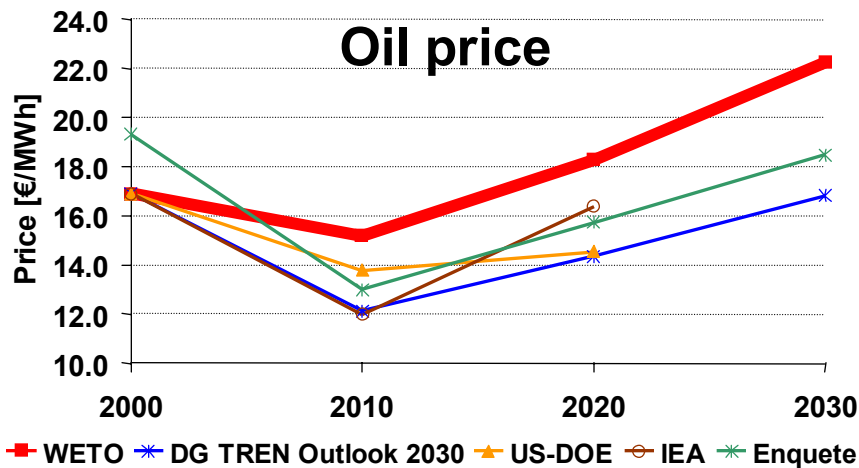
according to DG TREN Outlook 2030: European Energy and Transport Trends to 2030 Outlook (Mantzios et. al 2003) – Baseline forecast





# General scenario assumptions (2/7)

- Primary energy prices – fossil energy



**WETO: World Energy, Technology 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**

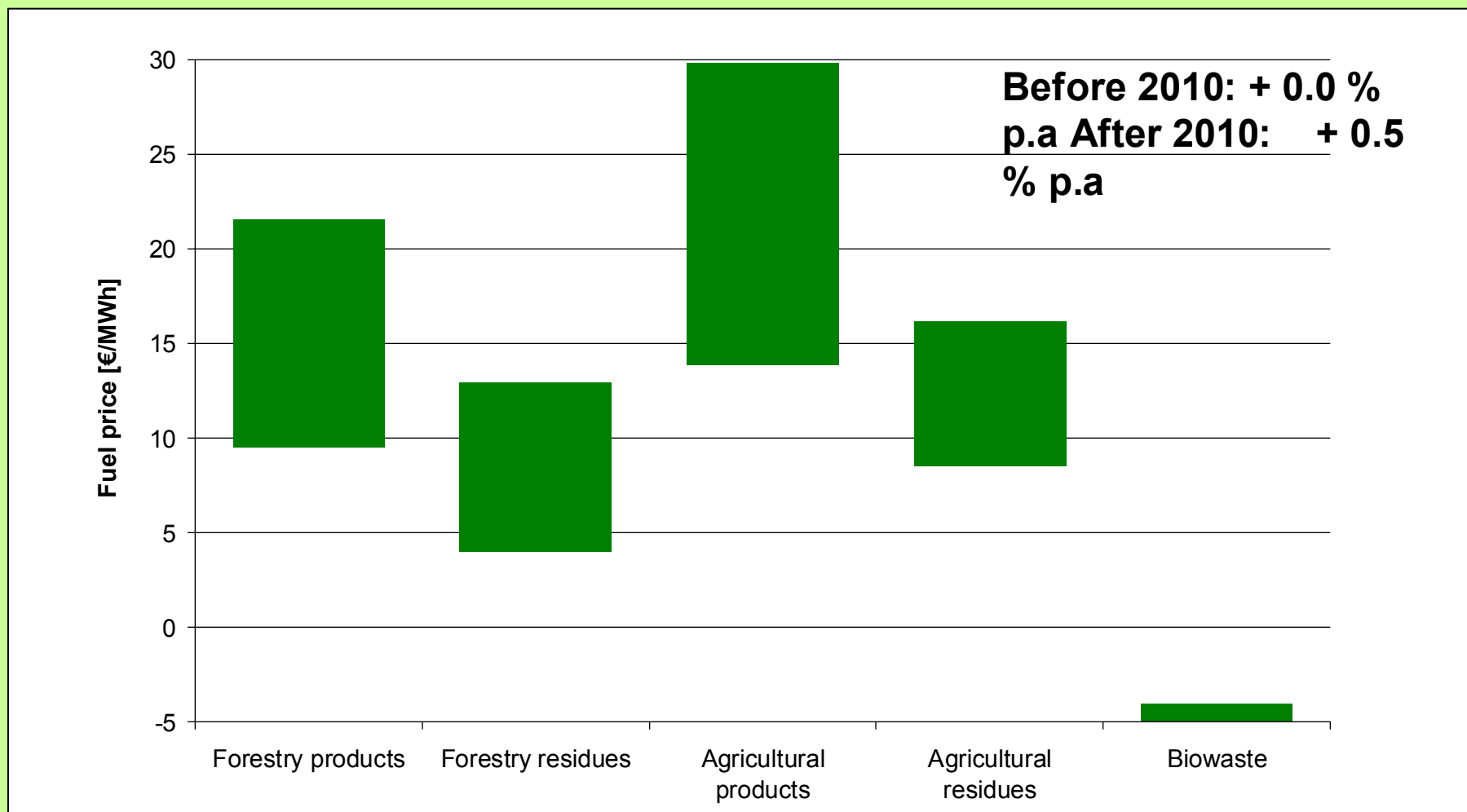
**IEA: World Energy Outlook to 2020 (2002)**

**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)

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

	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	$\beta$		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	$r = r_{pt} \cdot (1+r_t)$	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

<u>RES-E category</u>	<u>Applied approach</u>	<u>Assumptions</u>
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 experience 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*)



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## ***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)



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## ***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**

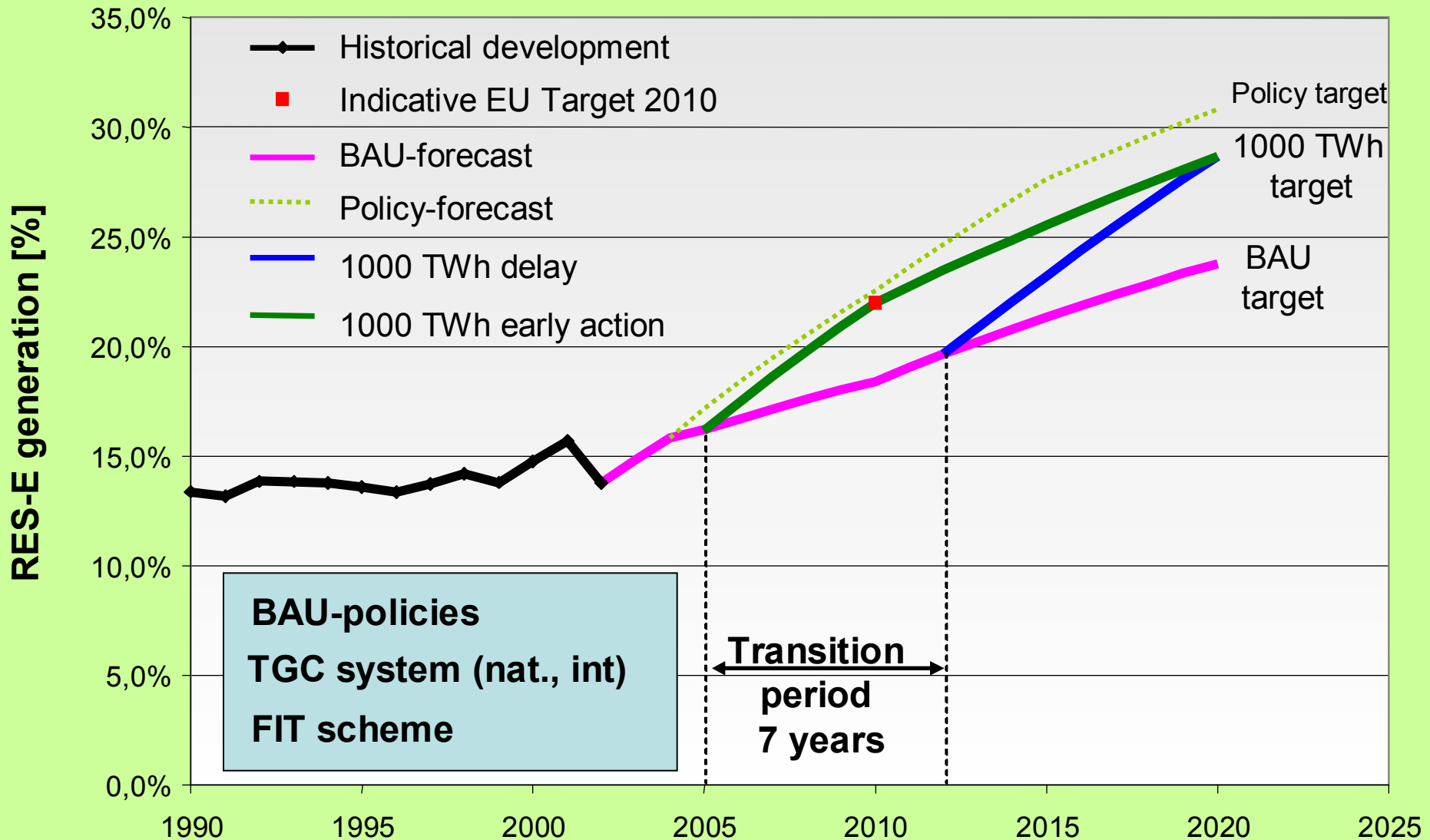
Taking account of the wide diversity of promotion schemes between Member States, the *Directive* states that ***it is too early to set a Community-wide framework regarding support schemes.***

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.

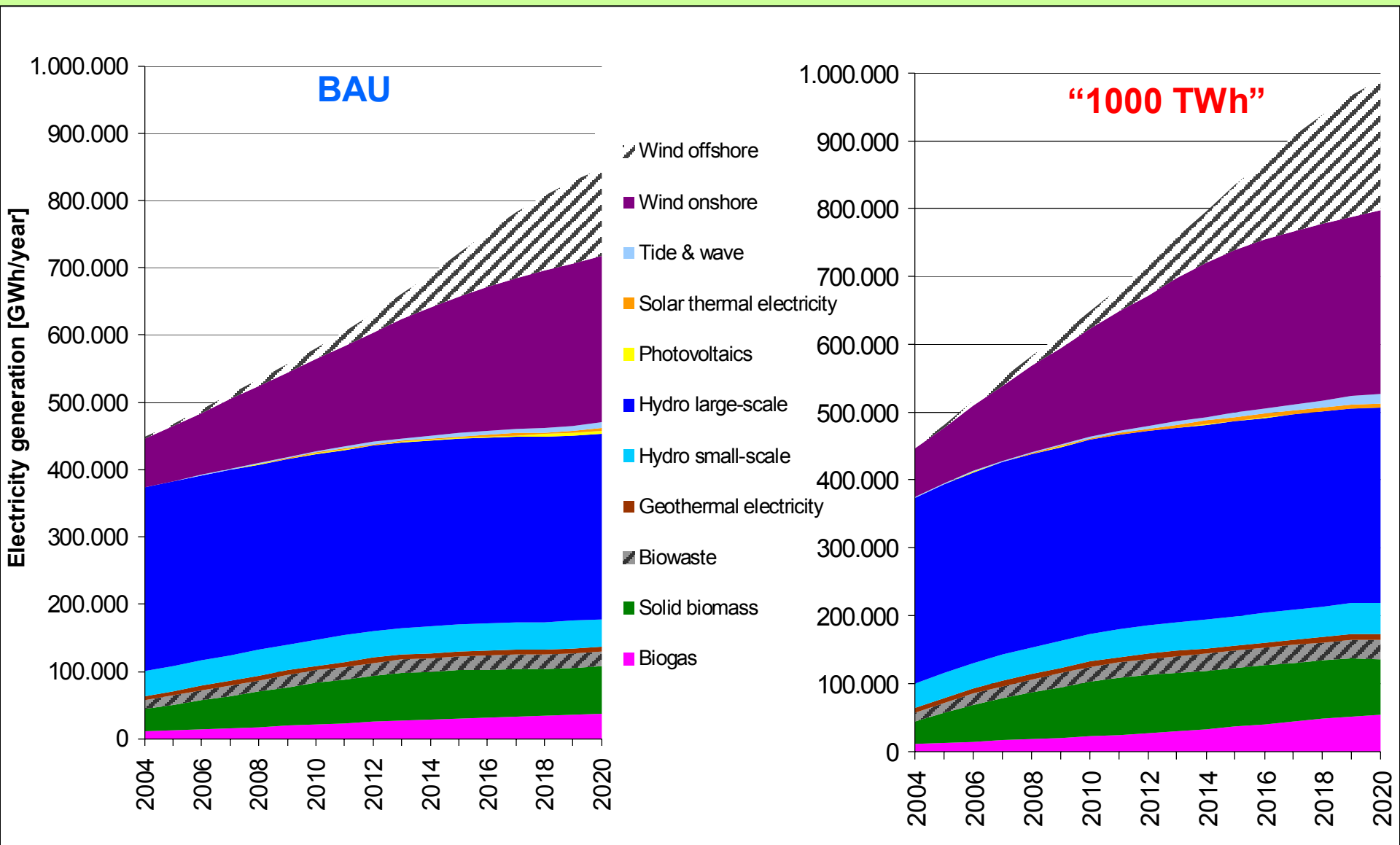


## Investigated cases (2/2)



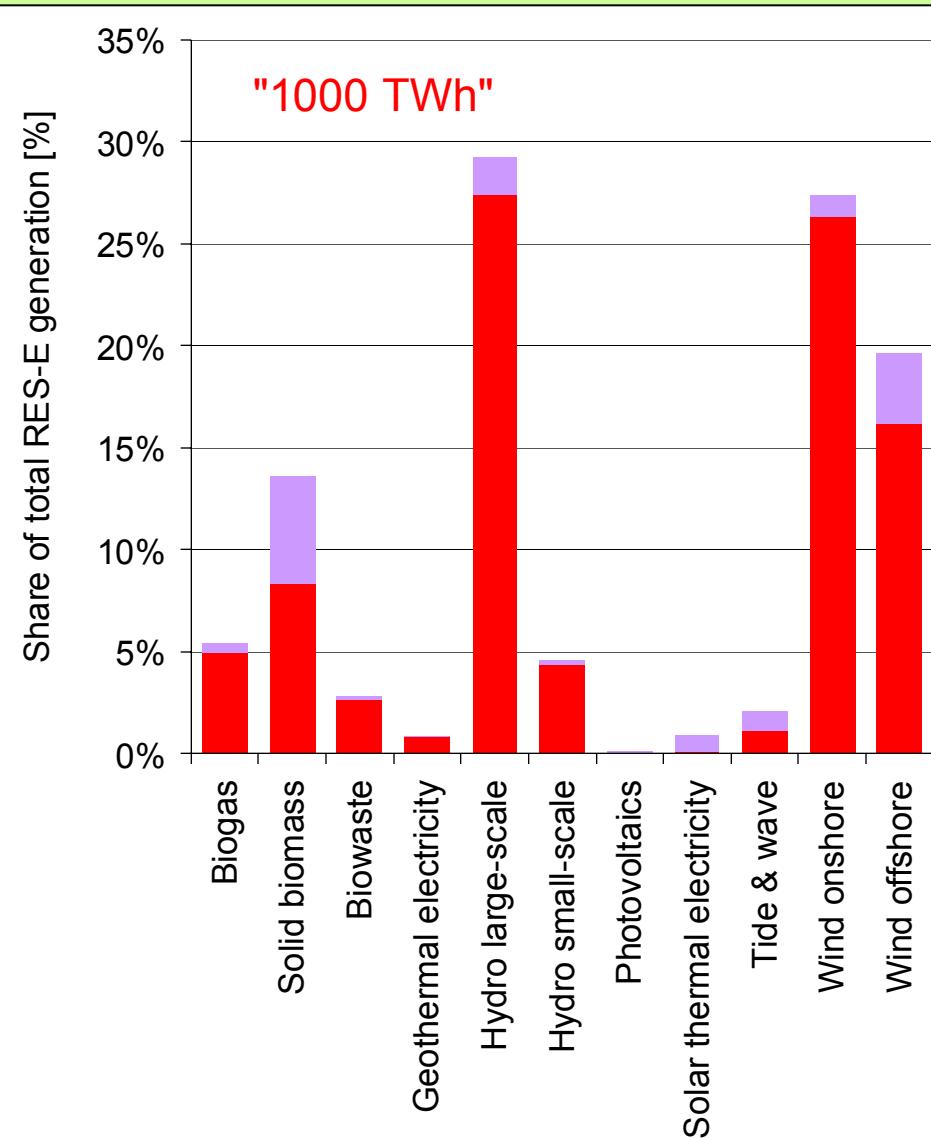
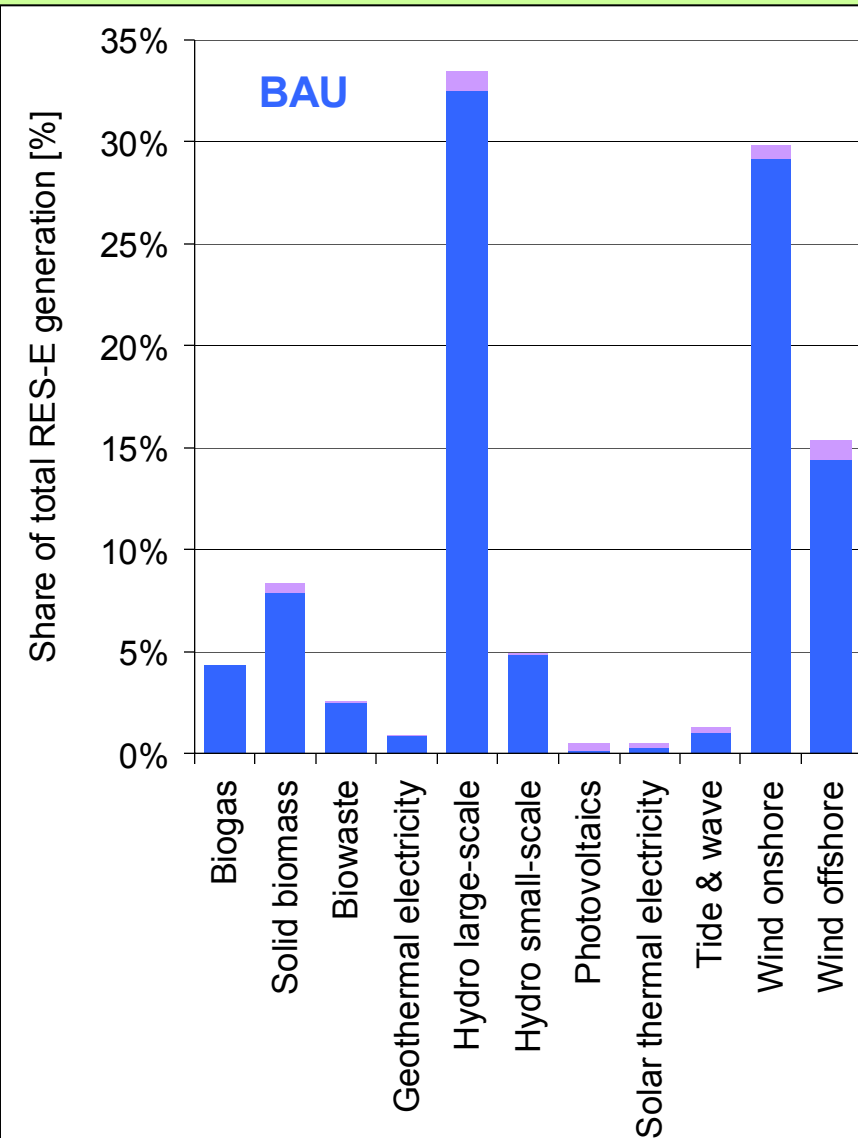


# RES-E deployment over time EU-15





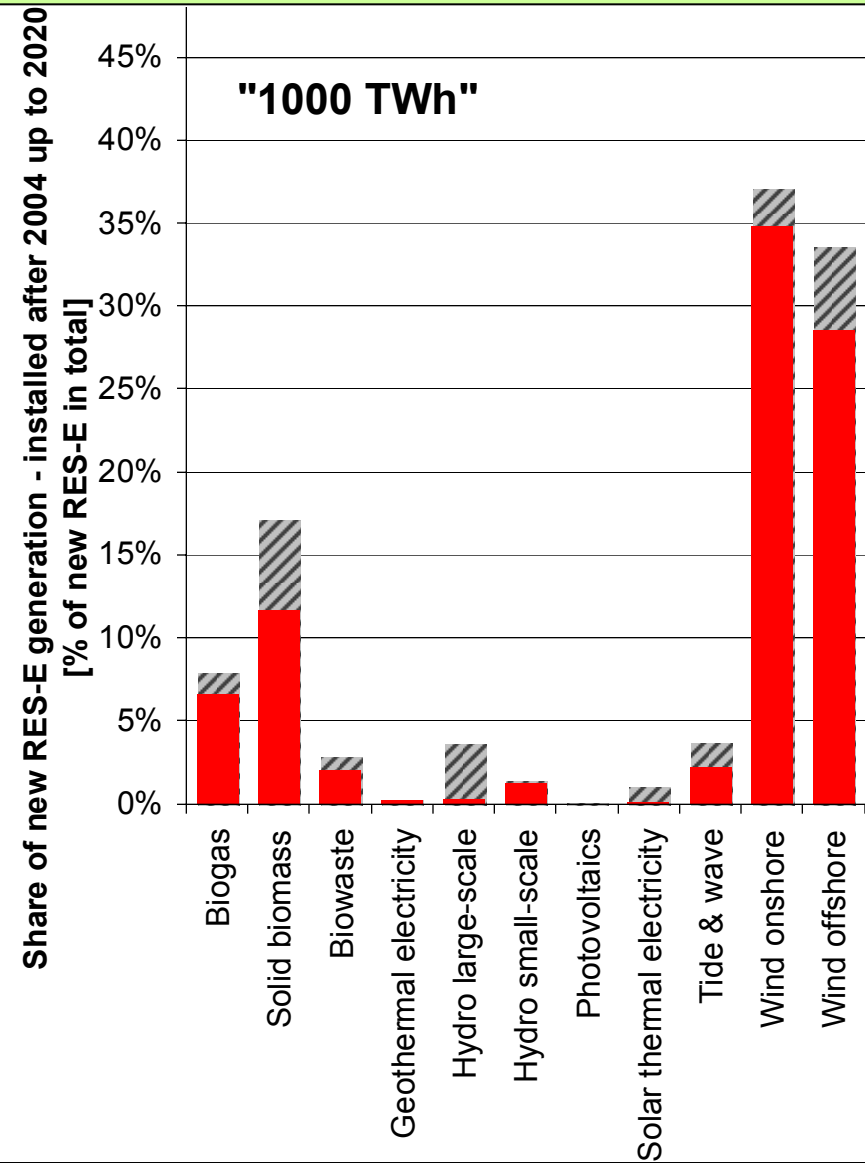
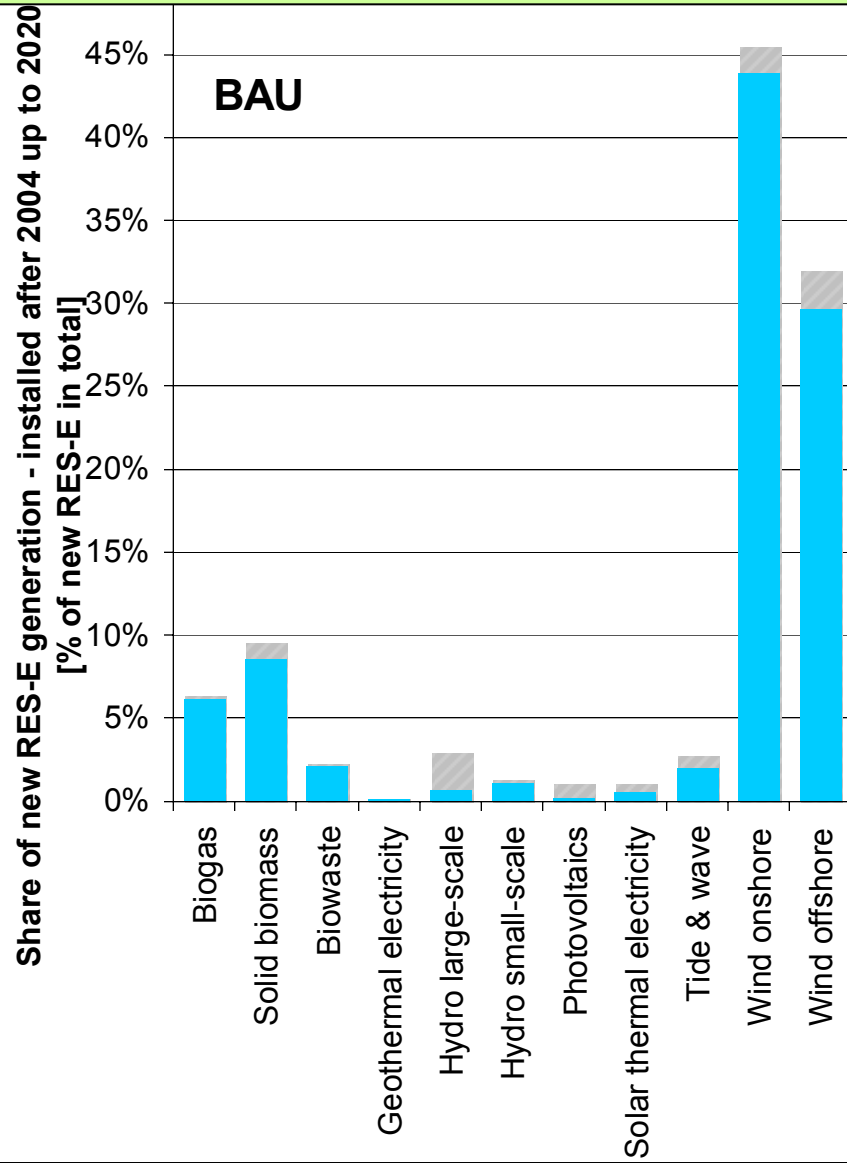
# Total RES-E generation EU-15 in 2020





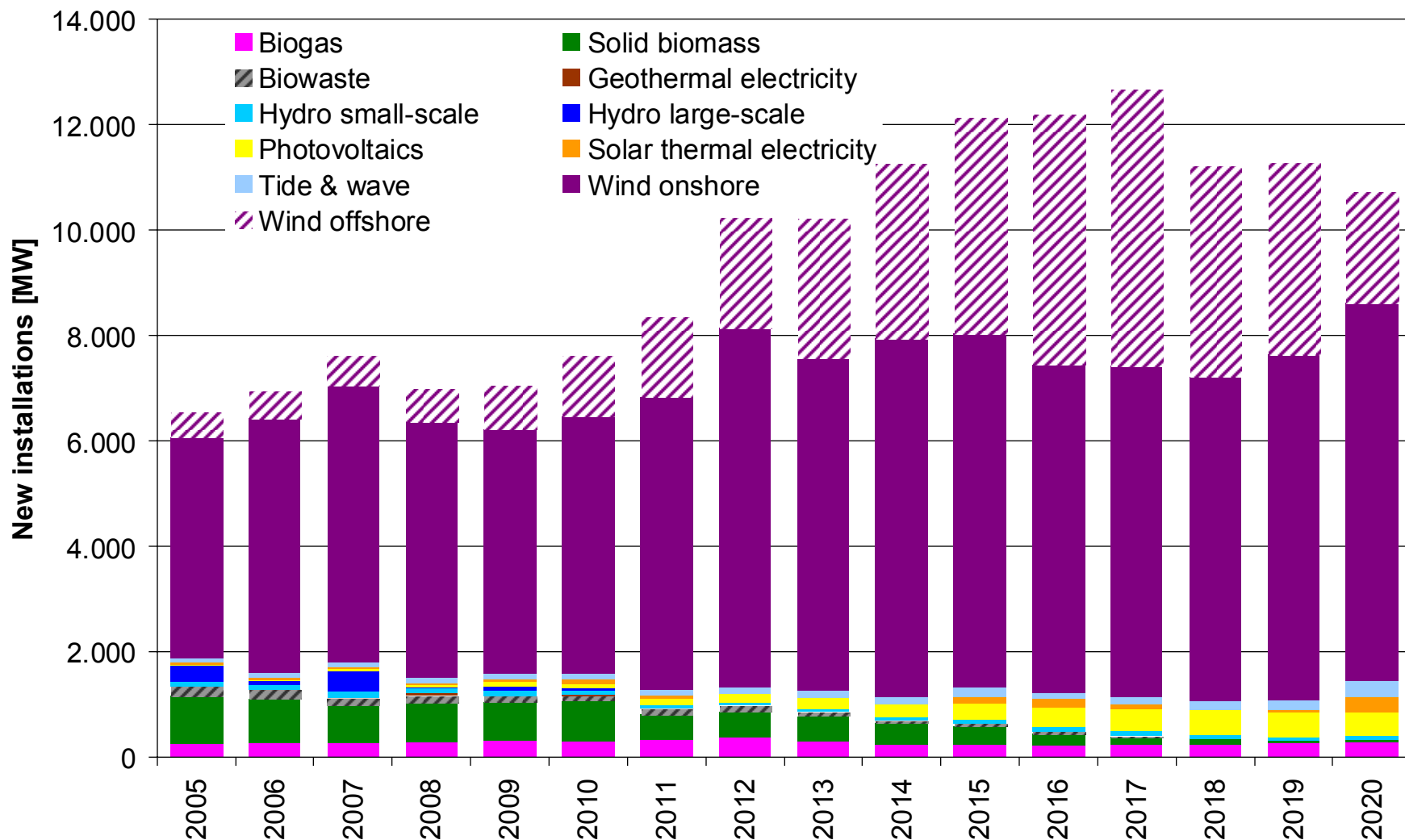


# New RES-E generation EU-15 in 2020





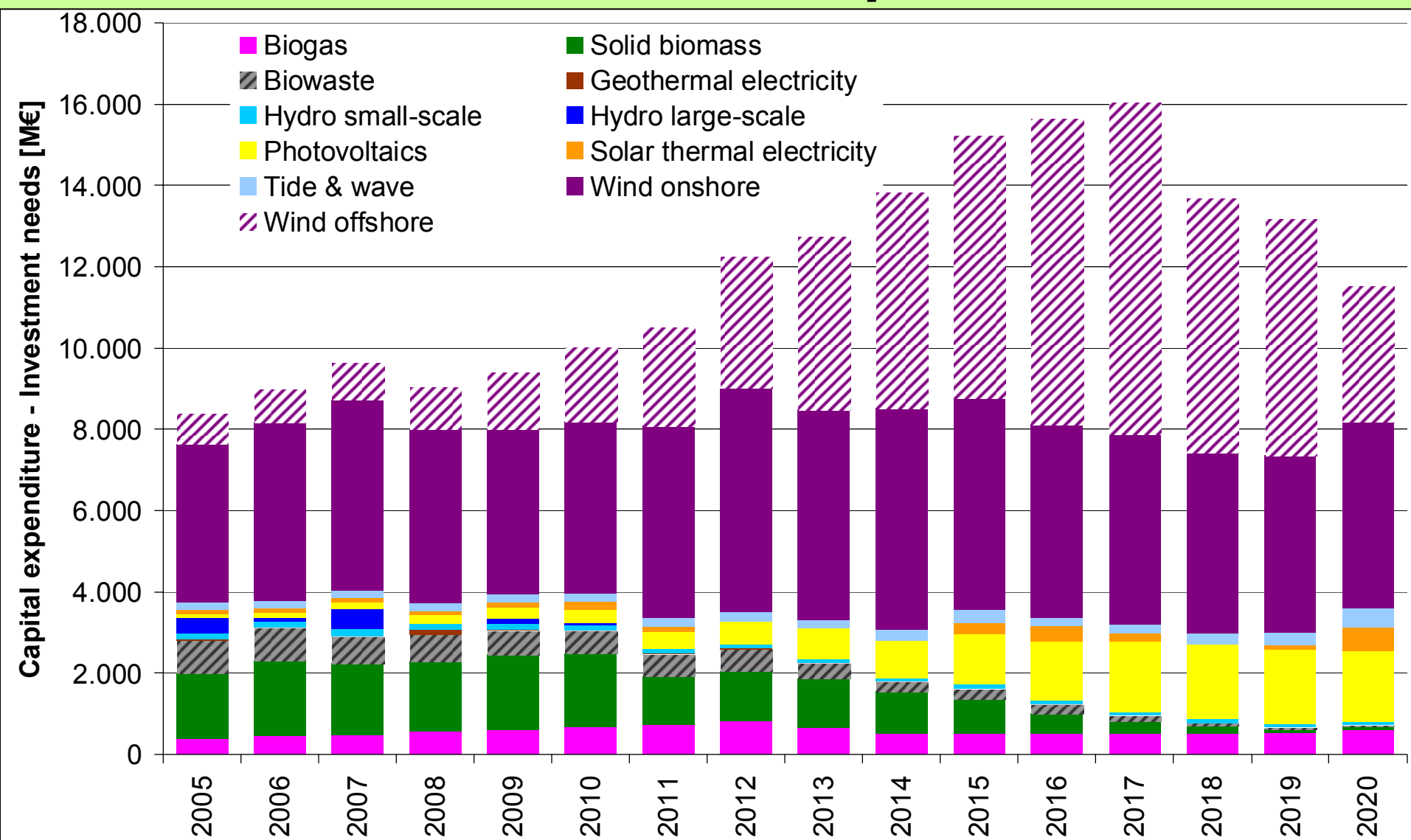
# *New RES-E installations up to 2020* BAU





# Investment needs up to 2020

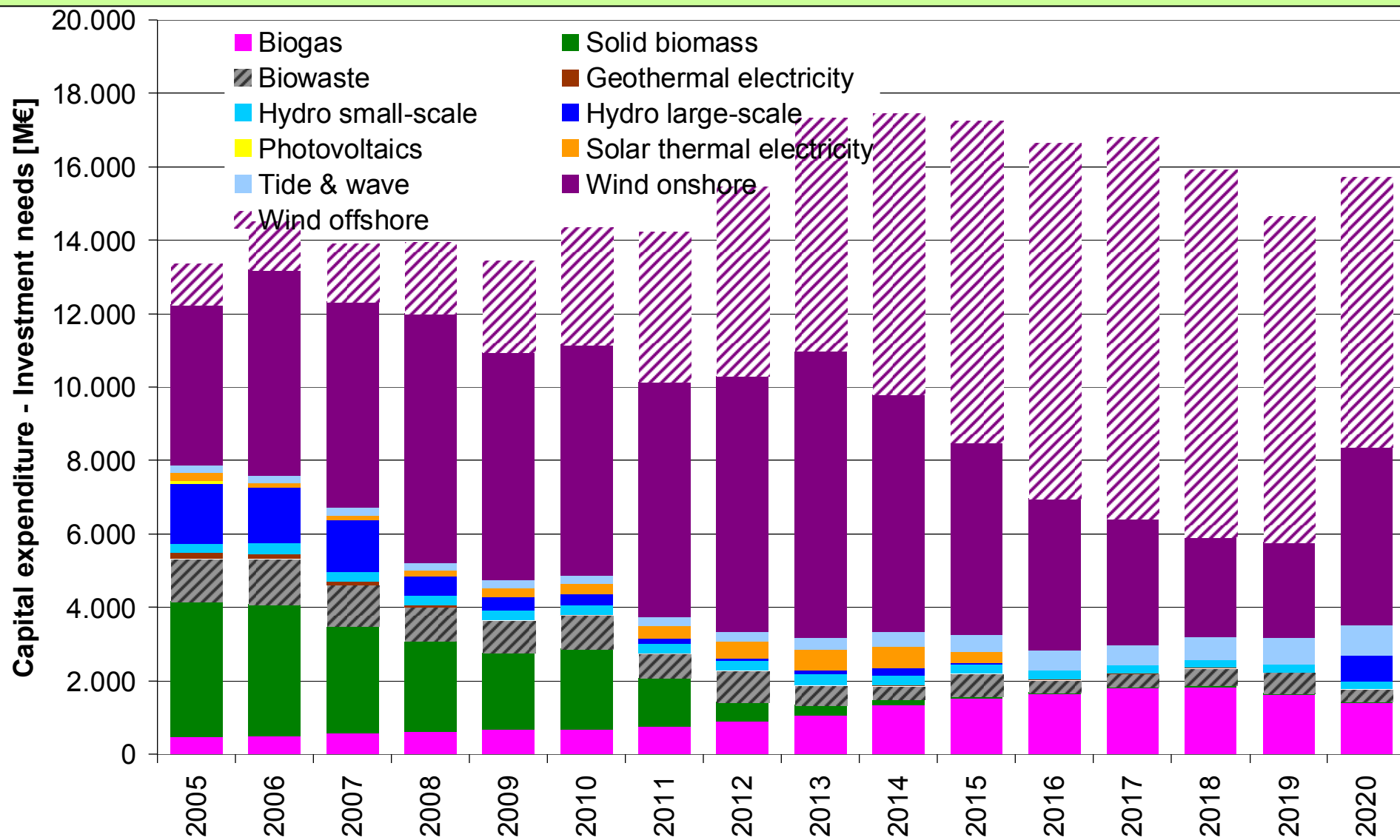
BAU





# Investment needs up to 2020

**“1000 TWh”**

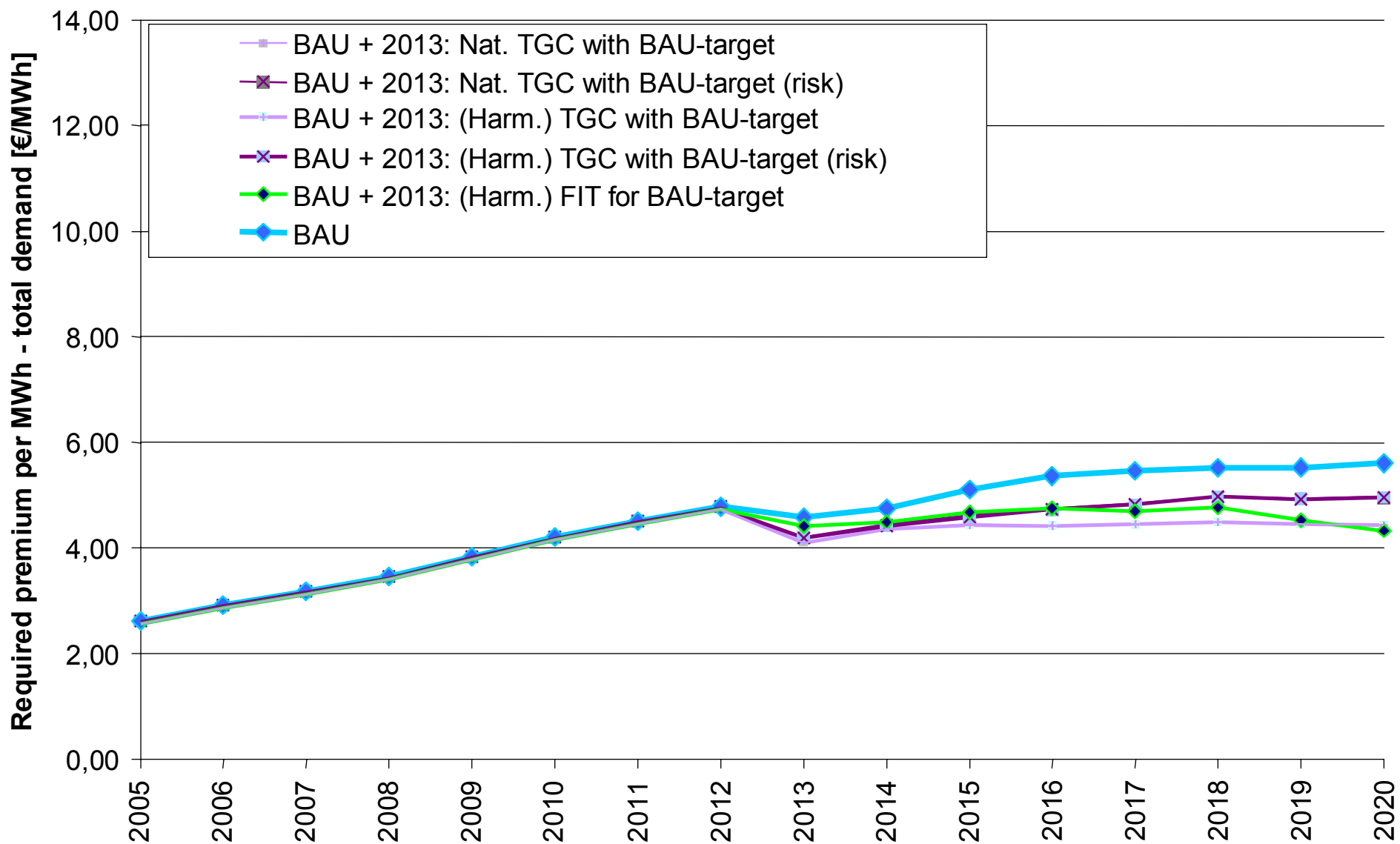






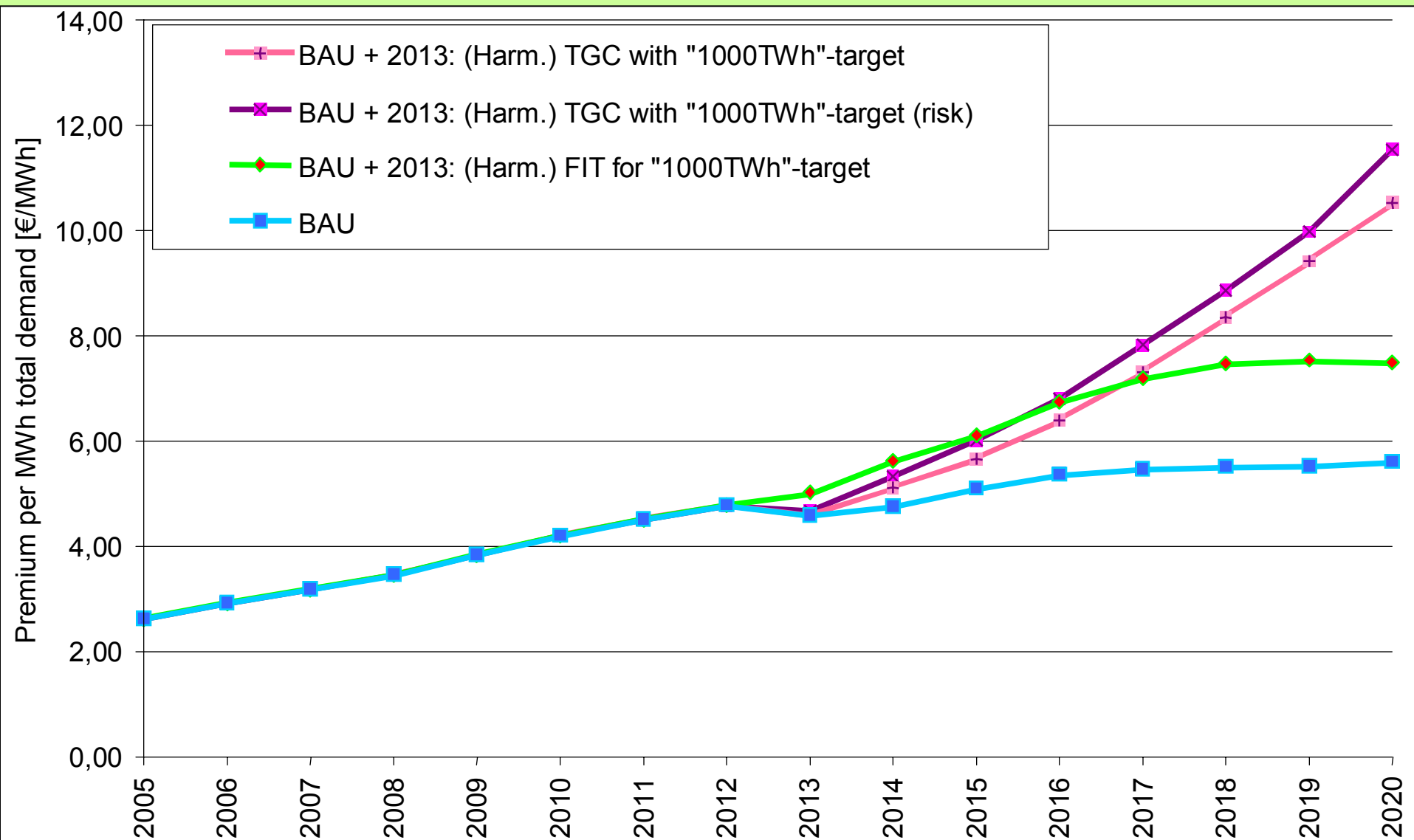


# Transfer costs for society (BAU-target)





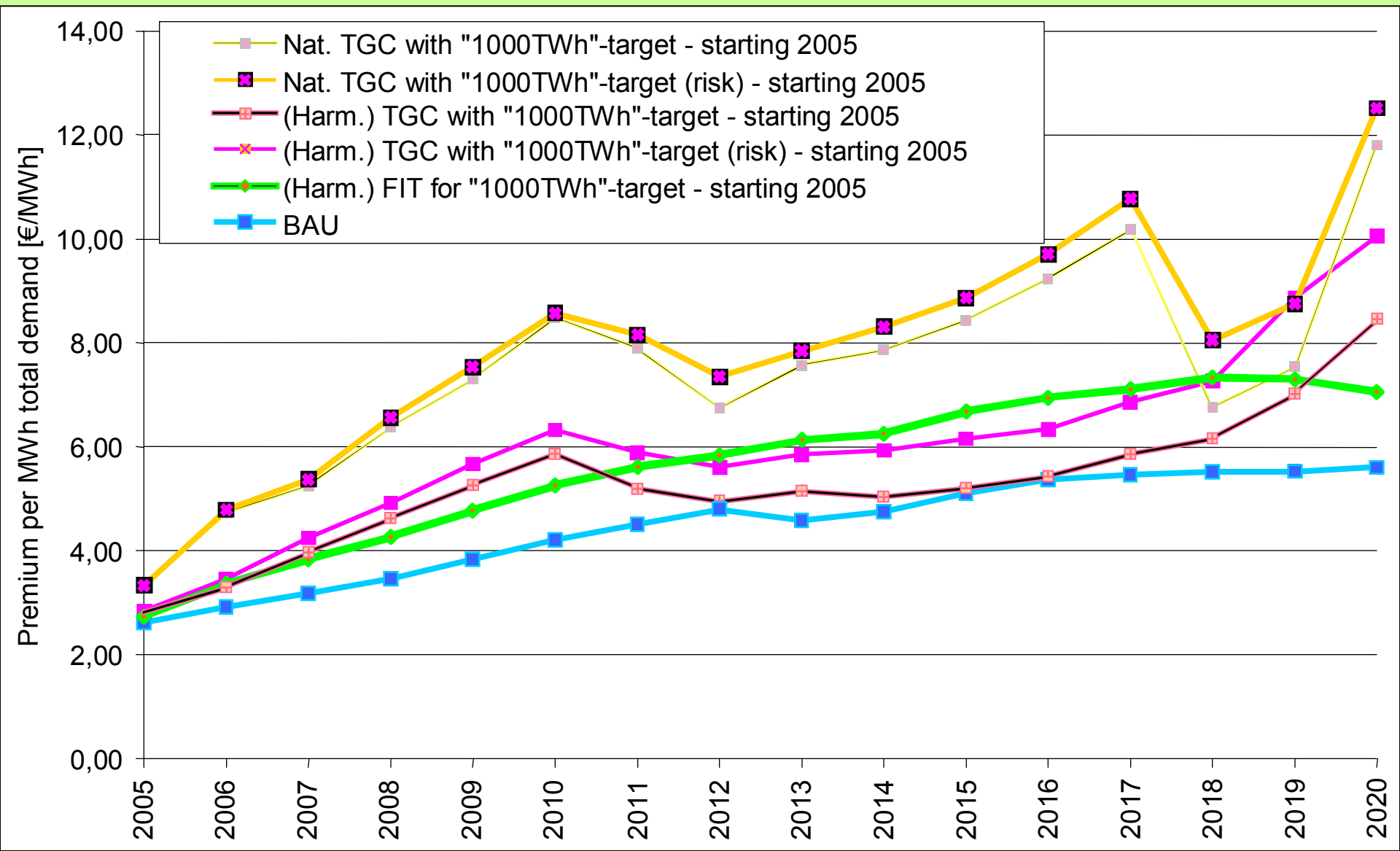
# Transfer costs for society (*BAU-1000TWh*)





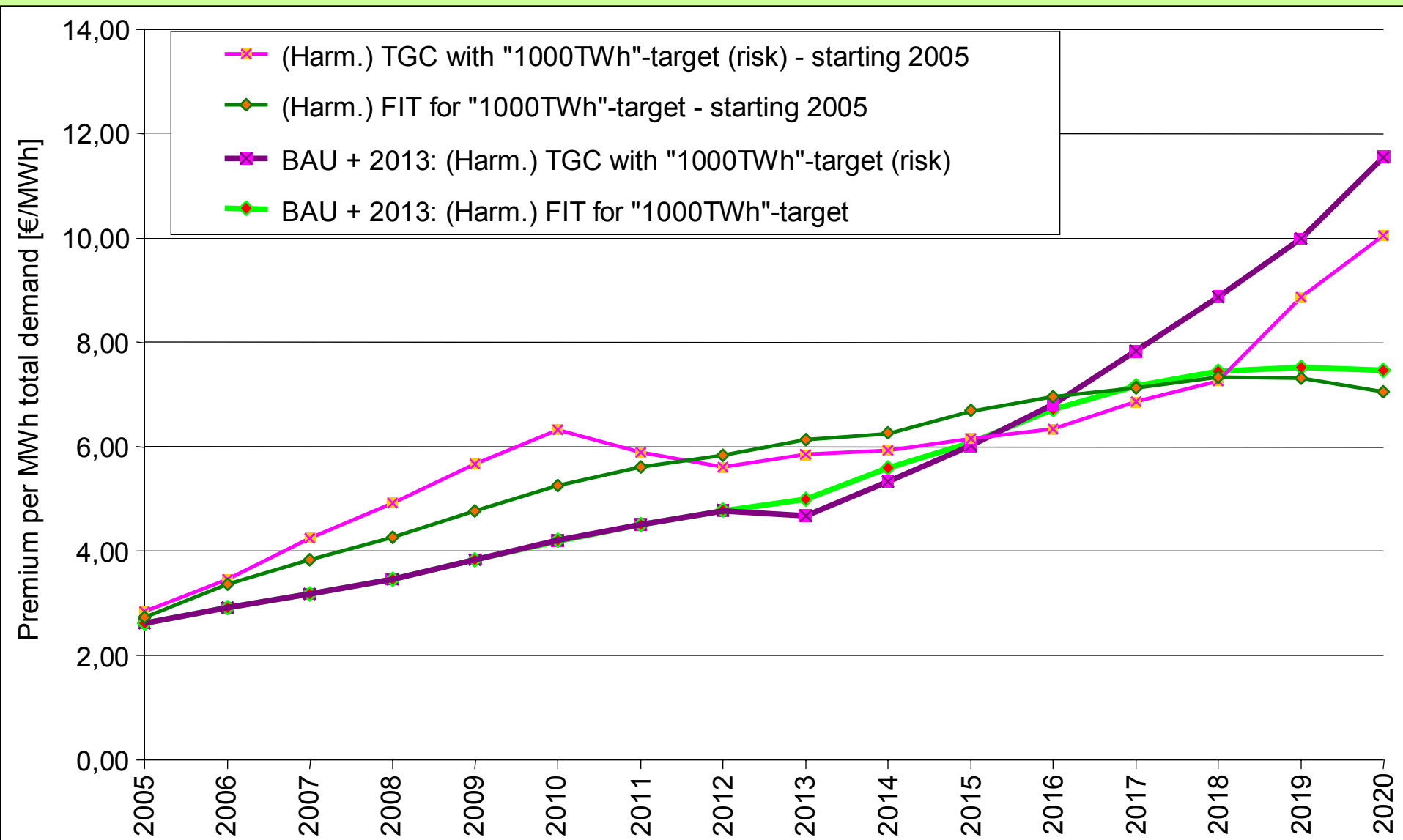


# Transfer costs for society (1000TWh)



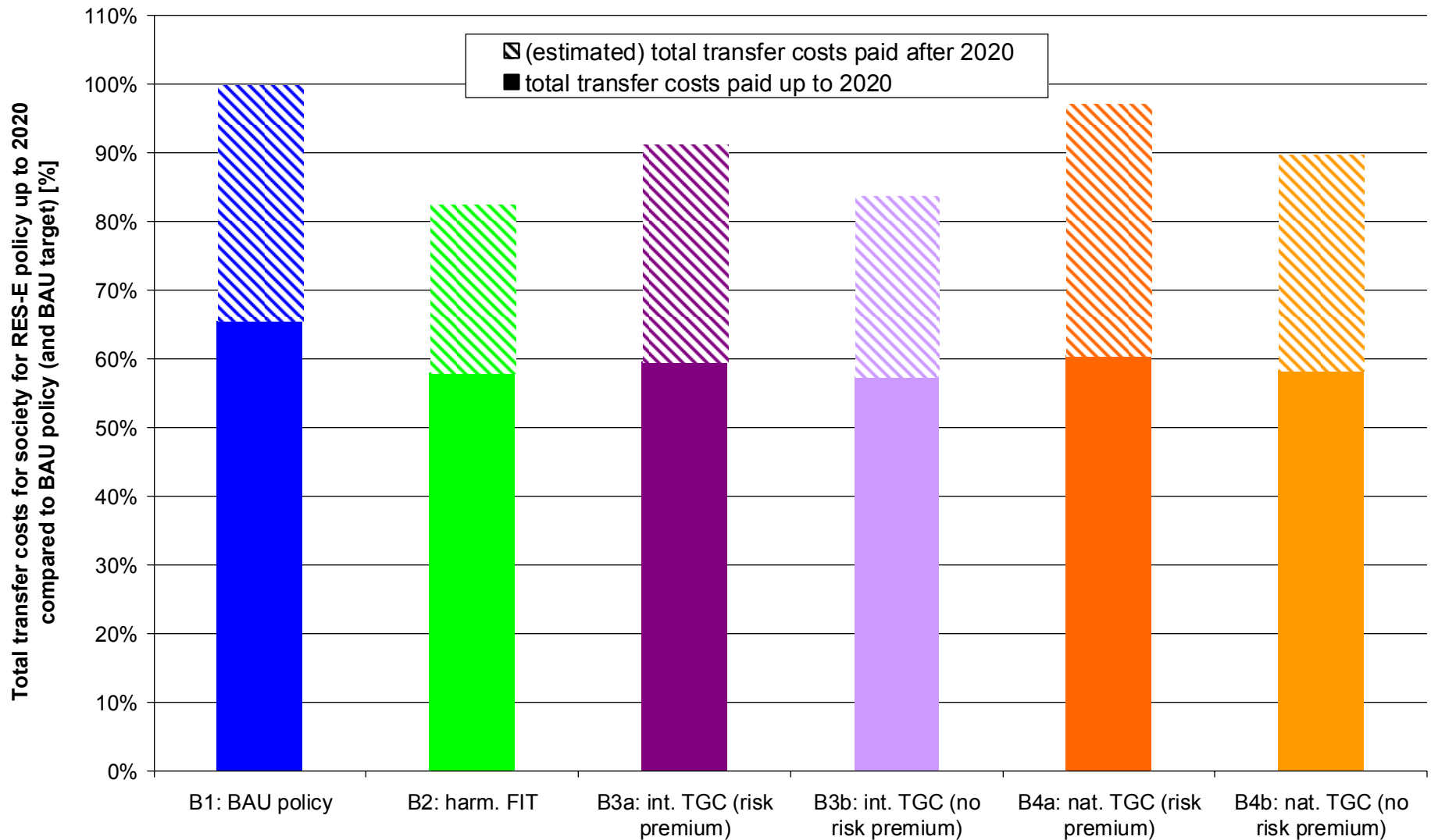


# Comparison *BAU-1000 TWh vs. 1000 TWh*



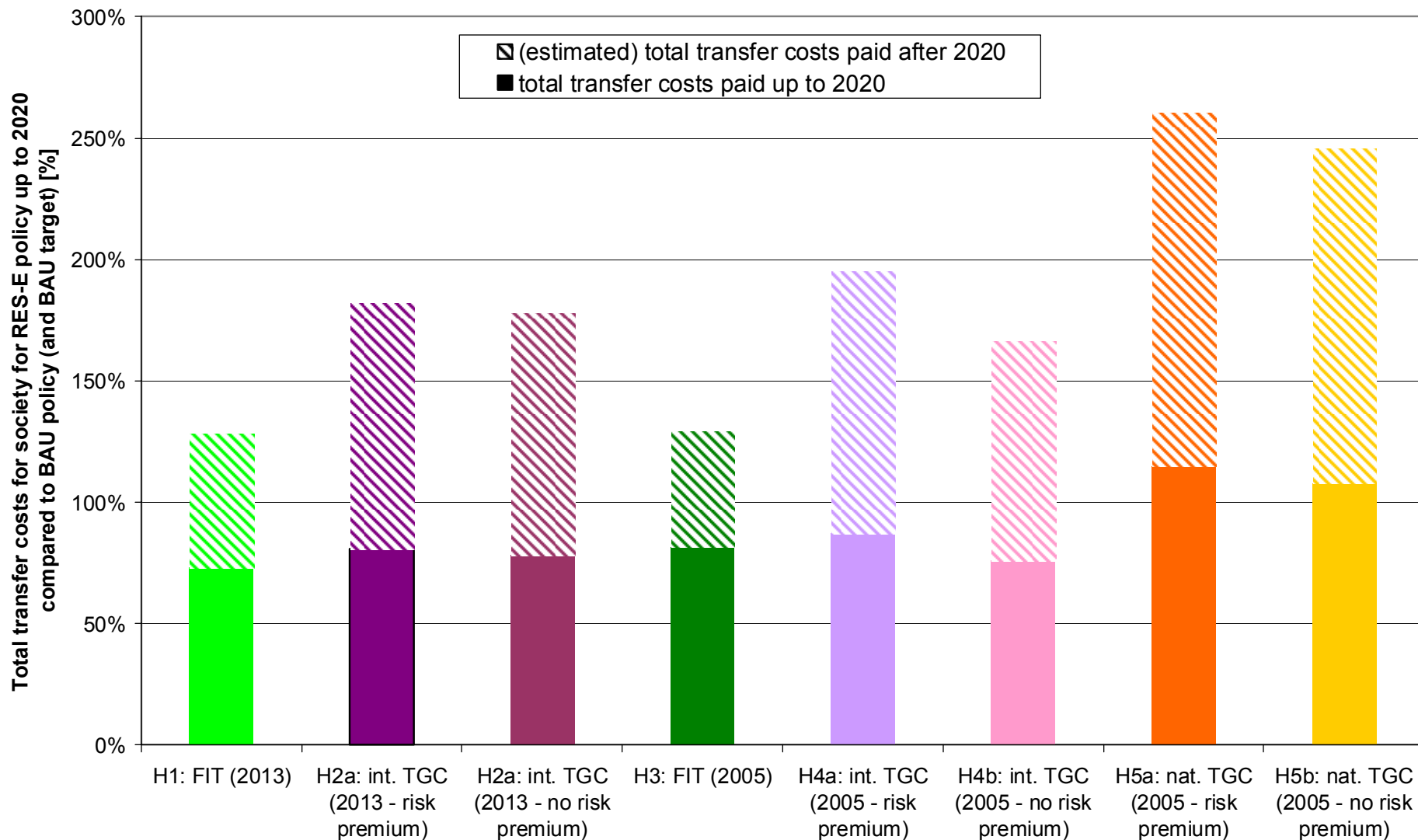


# Transfer costs for society – Comparison all cases



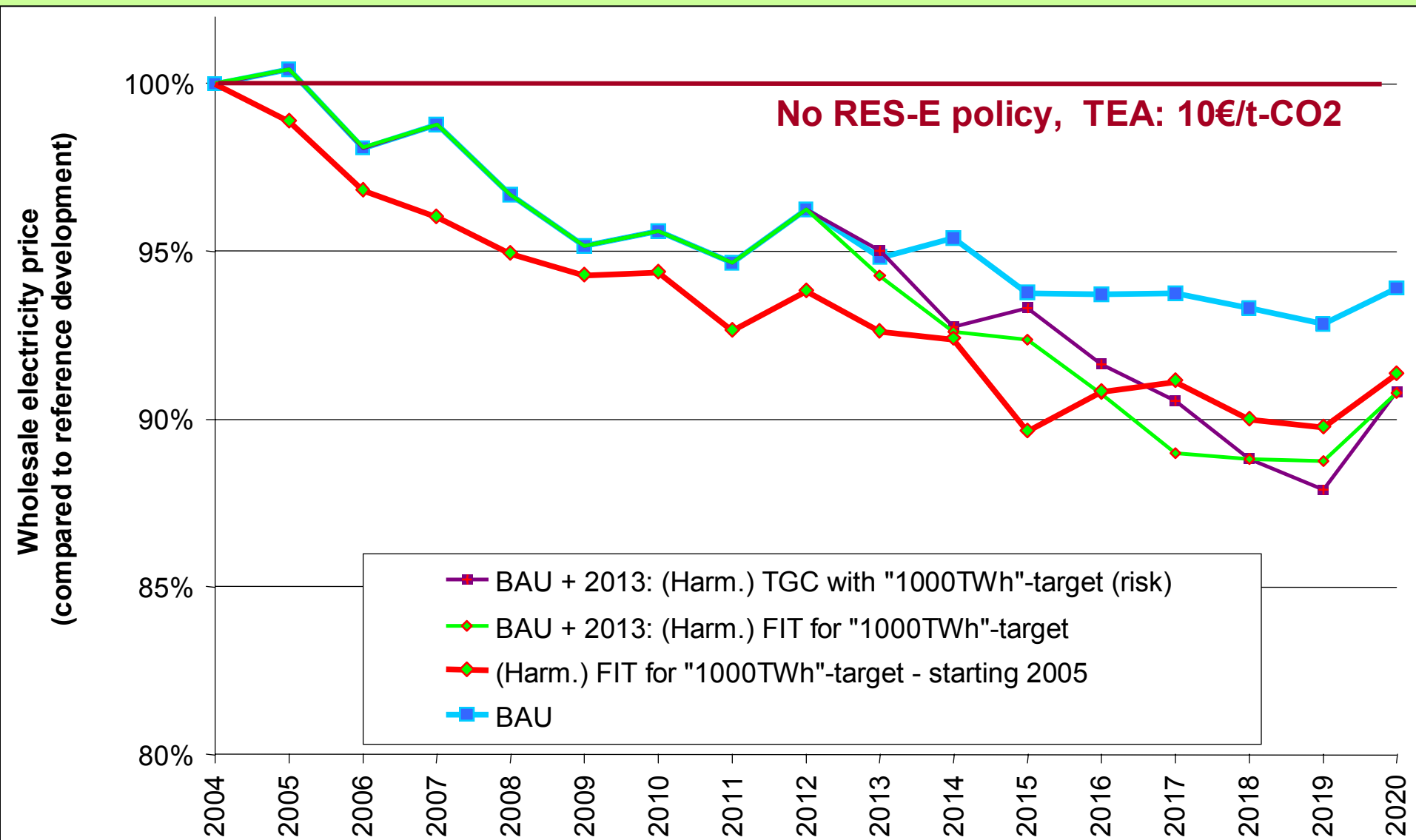


# Transfer costs for society – Comparison all cases



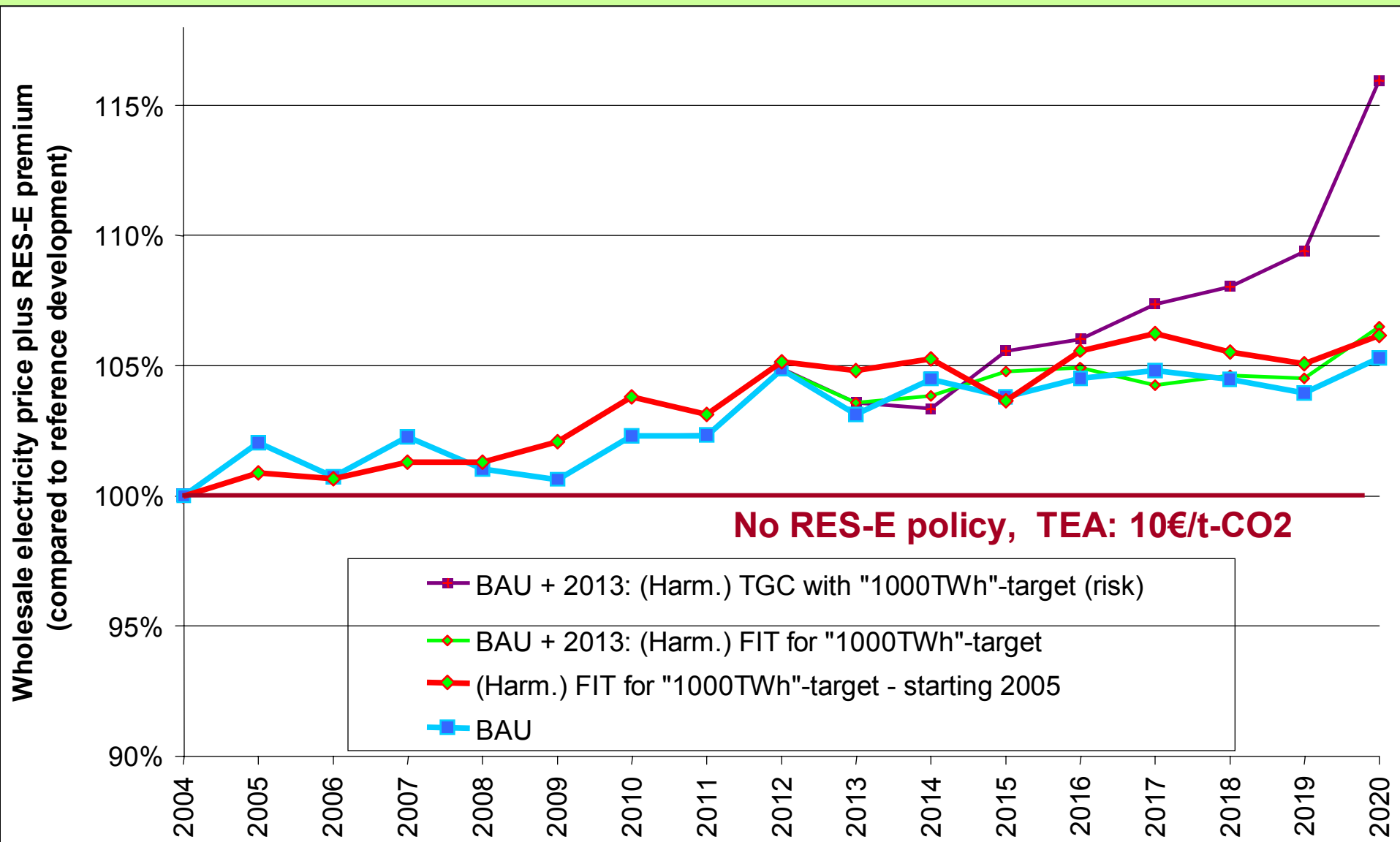


# Impact on whole sale electricity prices





# Impact on whole sale electricity prices





# Impact on GHG emissions

