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Executive Summaries

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HOW TO EFFICIENTLY SUPPORT RENEWABLE ELECTRICITY – THE FUTURE TASK IN EUROPE

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OVERVIEW

Energy policy is the main driver for the enhanced deployment of electricity from renewable energy sources (RES-E) as observed in several countries worldwide. Now, to the first time in Europe, binding targets for renewable energy sources (RES), regardless the energy sector, have been set – 20% RES up to 2020 indicates a huge future challenge for upcoming years. Despite, efforts have to be taken in all three energy sectors, the electricity sector will play a major role in achieving the overall target. Hereby, efficient and effective support measures have to be implemented in order to accompany a strong increase in the share of RES-E with low transfer costs for the society. Several policy options will be discussed with respect to their effectiveness – the development of RES-E – and their efficiency – the associated costs to the development of RES-E[1].

Besides the Feed-In Tariffs and the quota systems based on Tradable Green Certificates (TGC), some flexibility mechanism are needed in order to support Member States with moderate RES potentials achieving their RES targets up to 2020. Since all these promotion schemes show different reaction in terms of RES deployment as well as the associated costs, the **core objective of this paper** is to depict the **pros and cons** of these **policy design options with respect to their impact on future growth** of RES and the **corresponding costs**, and finally draw recommendations for policy makers.

METHODS

The issue of effectiveness and efficiency of support schemes is discussed mainly based on the results of scenarios using the model ***Green*-X** funded by the European Commission (EC). It allows analyses for both, the EU as a whole as well as for every single member state. Within the model all relevant RES-E technologies – e.g. biomass, wind, geothermal, PV, solar thermal...) technologies as well as demand-side conservation measures are described for every EU country by means of static (and further-on dynamic) cost-resource curves. A static cost curve provides for a point-of-time a relationship between (categories of) technical potentials (of e.g. wind energy, hydro, biogas..) and the corresponding (full) costs of utilisation of this potential at this point-of-time.

To analyse various scenarios different policy schemes can be selected, (e.g. feed-in tariffs, tendering systems, investment subsidies, tax incentives, quotas, tradable certificates) and modelled in a dynamic framework. All the instruments can be applied to all RES technologies separately for the various energy sectors. In addition, general taxes can be adjusted and the effects simulated. These include energy taxes (to be applied to all primary energy carriers as well as to electricity and heat) and environmental taxes on CO_2-emissions as well as policies supporting demand-side measures. The corresponding costs and benefits for companies and consumers are an output.

RESULTS

Investigations have been carried out, that strengthening the national RES-E support schemes would allow on the one hand to meet the target of 20% RES by 2020 and on the other hand keep the annual consumer expenditures on a moderate level (see Figure 1). Comparatively and relatively high transfer costs appear by introducing a common quota system based on a uniform tradable green certificate scheme – although in this case only the most cost-efficient technologies would be installed, the hereby most expensive power plant determines the common

1 This assessment was conducted for the European Commission, DG TREN within the European research project OPTRES (www.optres.fhg.de) and futures-e (www.futures-e.org).

support level, increasing the transfer costs for the society dramatically (see Figure 1). However, a quota system based on a technology specific support measure almost equals the strengthened national policy system with respect to both, the transfer costs for the society and the achieved overall RES target. Strengthening national policy schemes implies on the one hand to adjust the support level appropriate and on the other hand to overcome non-economic market barriers (as grid connection issue, planning bureaucracy, etc…).

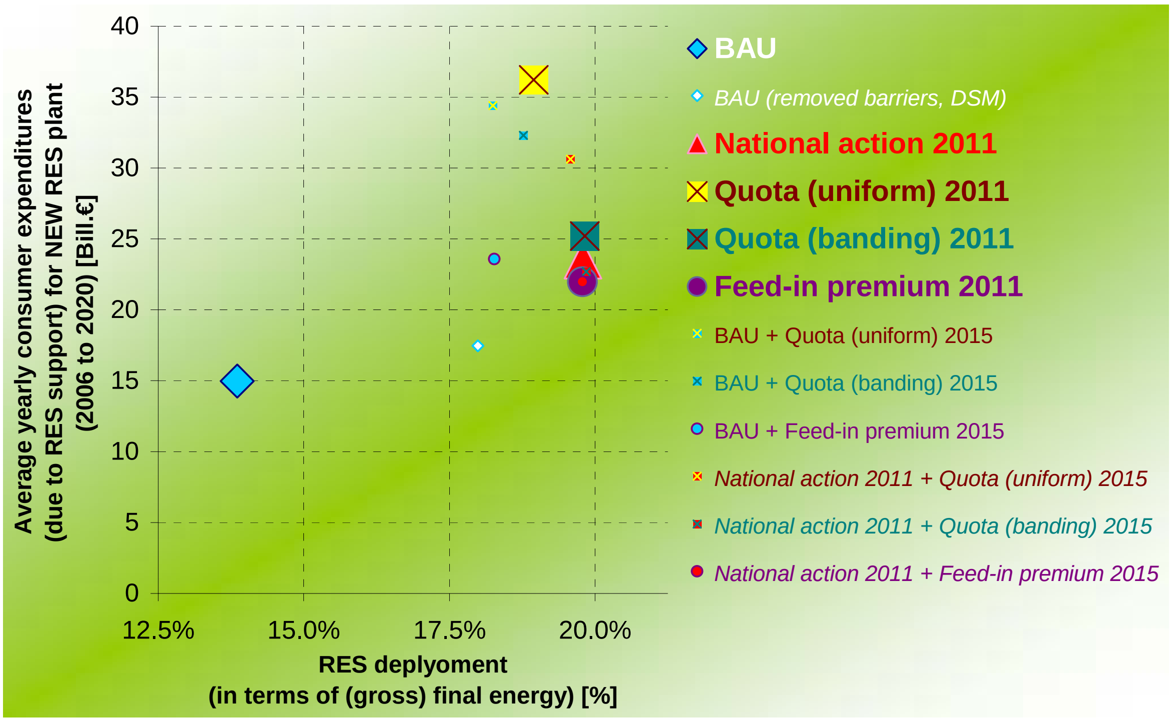

Figure 1: Comparison of average yearly transfer cost / consumer expenditure for new RES plants in relation to the achieved RES deployment – in terms of gross final energy – within the European Union (EU27)

CONCLUSIONS

The **key criterion for achieving an enhanced future deployment of RES-E in an effective and efficient manner,** besides the continuity and long-term stability of any implemented policy, **is the technology specification of the necessary support.** Concentrating on only the currently most cost-competitive technologies would exclude the more innovative technologies needed in the long run. In other words technology neutrality may be cost-efficient in the short term, but is more expensive in the long term. The major part of possible efficiency gains can already be exploited by optimising RES-E support measures at the national level – **about two thirds** of the overall **cost reduction potential** can be attributed to **optimising national support schemes**. Further efficiency improvements are possible through **guaranteed but strictly limited duration of support** as well as that **support schemes are targeting solely new RES installations.** Introducing a harmonized RES policy can only be favourable if it is designed technology-specific and, that a common European power market exists.

REFERENCES

Resch Gustav, C. Panzer, R. Haas, T. Faber, M. Ragwitz, A. Held, M. Rathmann, G. Reece, C. Huber: „20% RES by 2020 – Scenarios on future European policies for RES-E“. Project report of futures-e (www.futures-e.org), conducted for the European Commission „EACI – European Agency for Competitiveness and Innovations“. TU Vienna, Energy Economics Group in cooperation with Fraunhofer ISI, Ecofys, EGL. Vienna, Austria, 2009.

HOW TO EFFICIENTLY SUPPORT RENEWABLE ELECTRICITY – THE FUTURE TASK IN EUROPE

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… based on calculations made with the help of the computer model ***Green-X***

www.green-x.at

Content

1. *Introduction*

   … European RES Directive – 2020 targets

2. *Background* information

   … Short characterisation of the ***Green-X*** model,
   scenario assumptions and future pathways

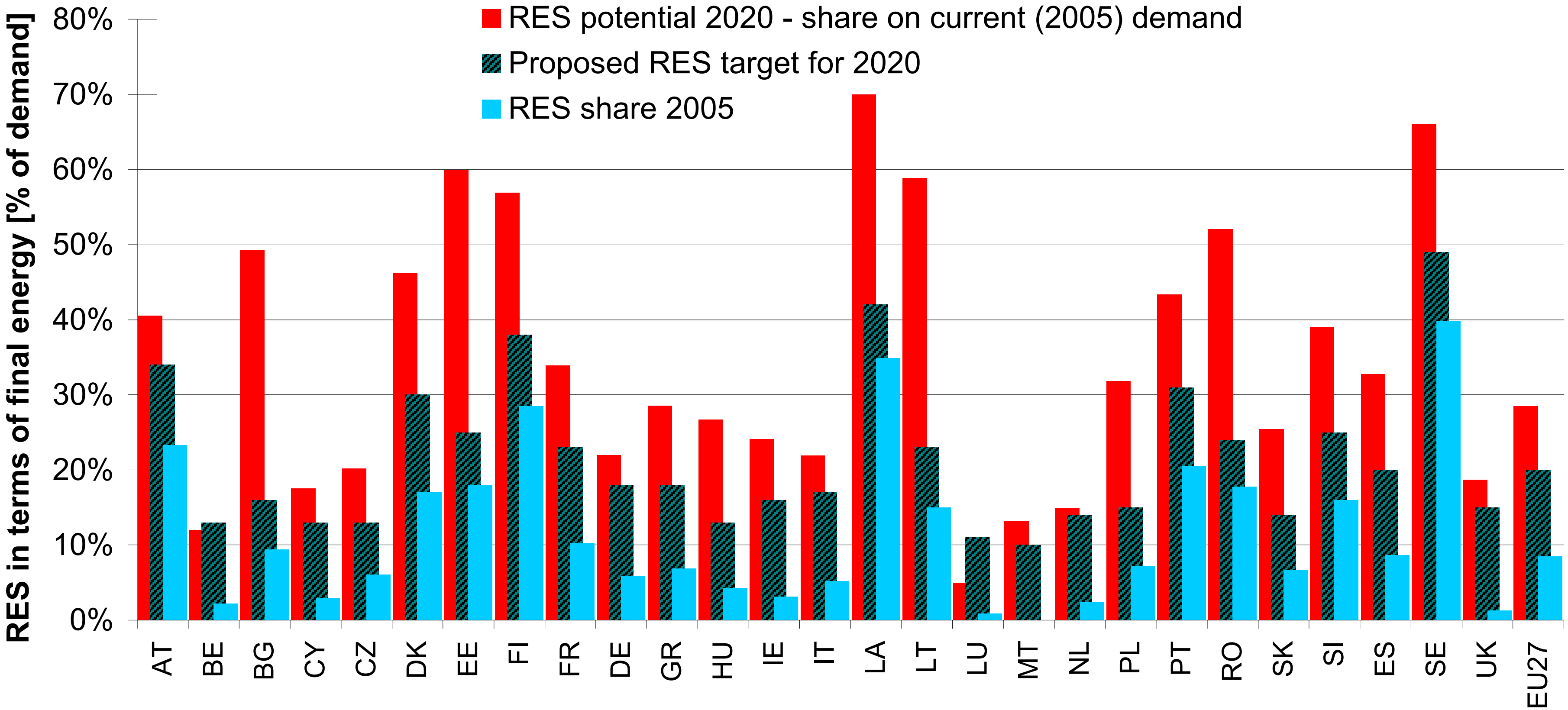
3. *Results* on the future deployment of RES in Europe

   … Results on RES deployment, investment needs, costs & benefits

4. *The policy context* – Assessment of future RES policy options

Concluding remarks

►National RES targets for 2020 – the binding goal!



Note: Additional potentials do not include biofuel imports

How the European Commission set the targets … **„FLAT RATE" & „GDP-Variation"**

… i.e.: $\text{RES-target}_{2020} = \text{RES}_{2005\%} + 50\% * \text{RES}_{\text{NEW}\,\%} + 50\% * \text{“}\text{RES}_{\text{NEW}\,\%}$ GDP-weighting"-"first mover bonus"

The Green-X model

Simulation model for energy policy instruments in the European energy market

- RES-E, RES-H, RES-T and CHP, conventional power
- Based on the concept of dynamic cost-resource curves
- Allowing forecasts up to 2020/2030 on national / EU-27 level

Base input information
- Country selection
- Technology selection
- Power generation (Access Database)
- Electricity demand reduction (Access Database)

→ **Economic market and policy assessment** potential, costs, offer prices ←

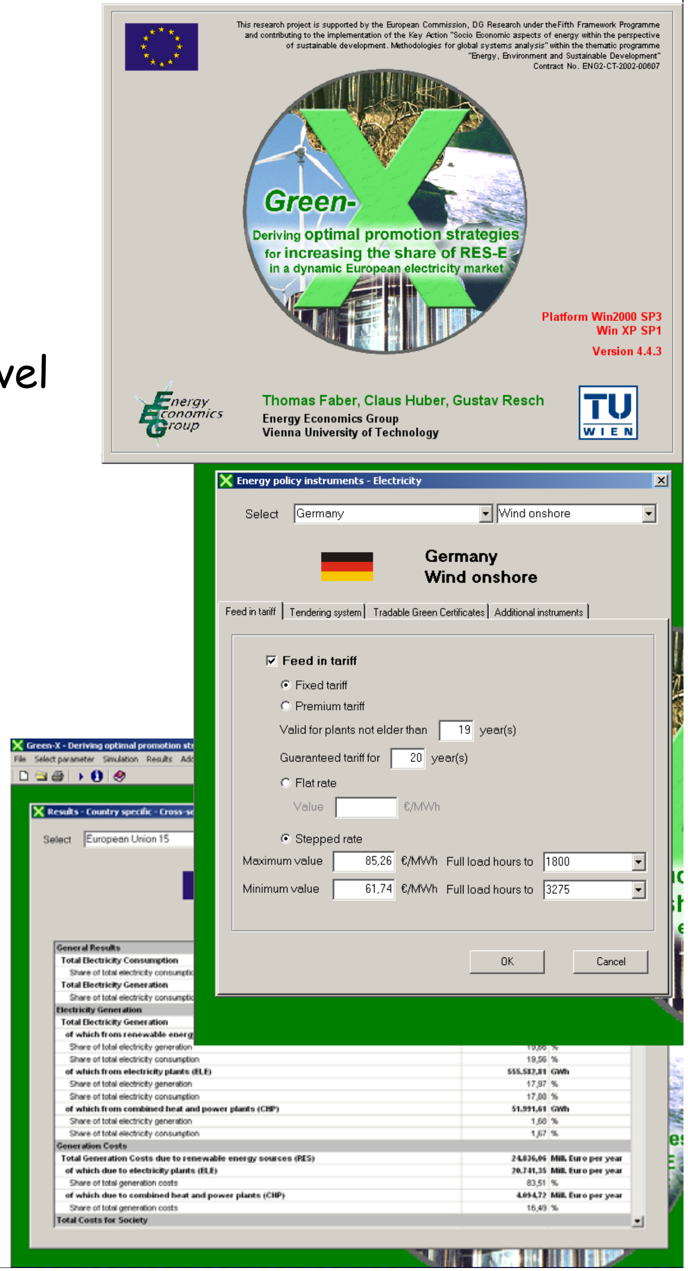
Scenario Information
- Policy strategies selection
- Social behaviour Investor/consumer Externalities
- Framework Conditions (Access Database)

↓

Simulation of market interactions RES, CHP, DSM power market, EUAs

↓

Results Costs and Benefits on a yearly basis (2006 -2030)



Reference clients: *European Commission (DG RESEARCH, DG TREN, DG ENV), Sustainable Energy Ireland, German Ministry for Environment, European Environmental Agency, Consultation to Ministries in Serbia, Luxembourg, Morocco, etc.*

(2) Background

futures-e

Technology diffusion

- … in accordance with general diffusion theory, penetration of a market by any new commodity typically follows an **'S-curve' pattern**
- … applied within the model to describe **the impact of non-economic barriers on RES-E deployment**

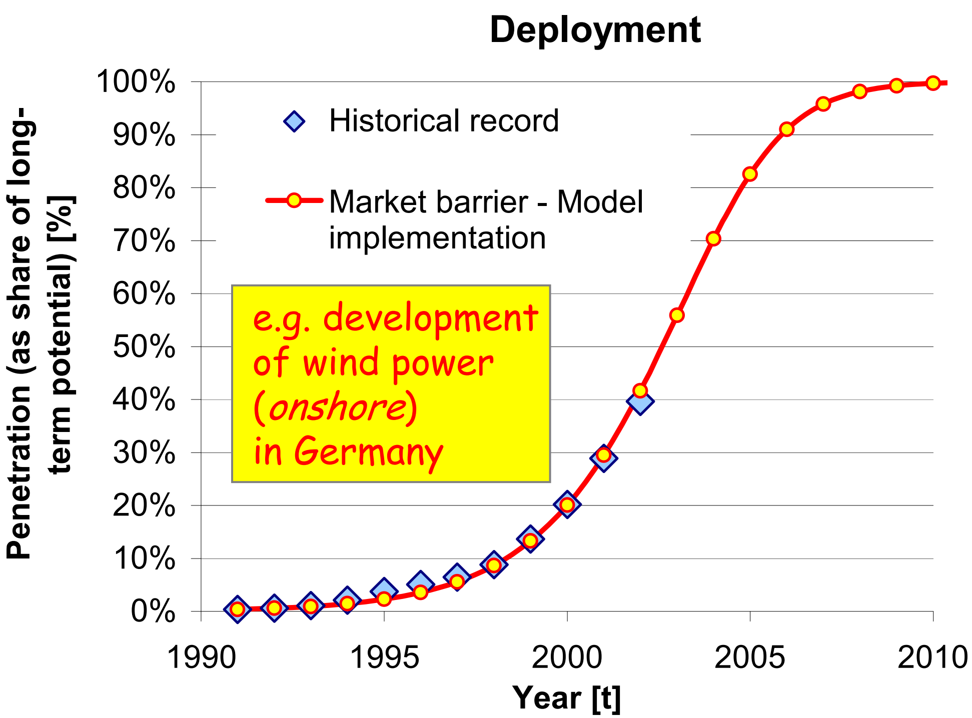
General diffusion theory

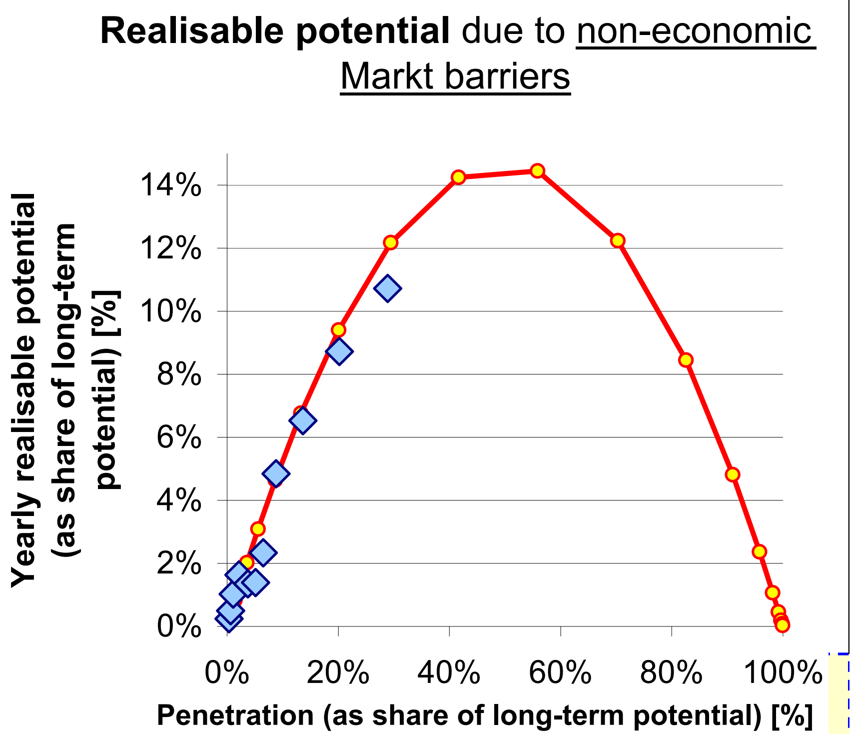
$$F = \frac{1}{1+e^{-d*(t-t_0)}}$$

F	Markt penetration
d	Diffusion rate
ΔP_{Mn}	Yearly realisble potential (according to market barrier)
P	Long-term realisable potential

Model implementation of dynamic non-economic market barriers

$$\Delta P_{Mn} = P * d * F * (1-F)$$





The Green-X approach:

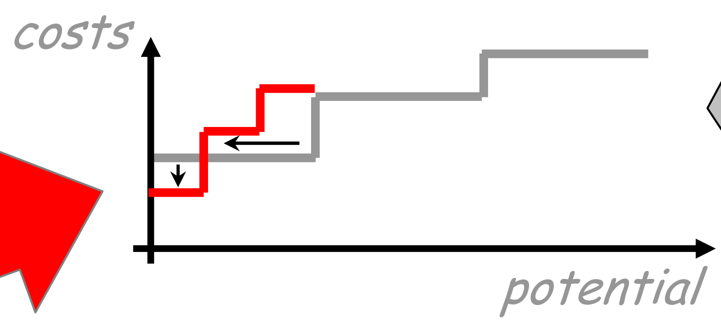
Dynamic cost-resource curves

Potentials
- by RES-E technology *(by band)*
- by country

Costs of electricity
- by RES-E technology *(by band)*
- by country

DYNAMIC

COST-RESOURCE CURVES
- by RES-E technology
- by country
- ***by year***



Dynamic aspects
- *Costs: **Dynamic cost assessment***
- *Potentials: **Dynamic restrictions***

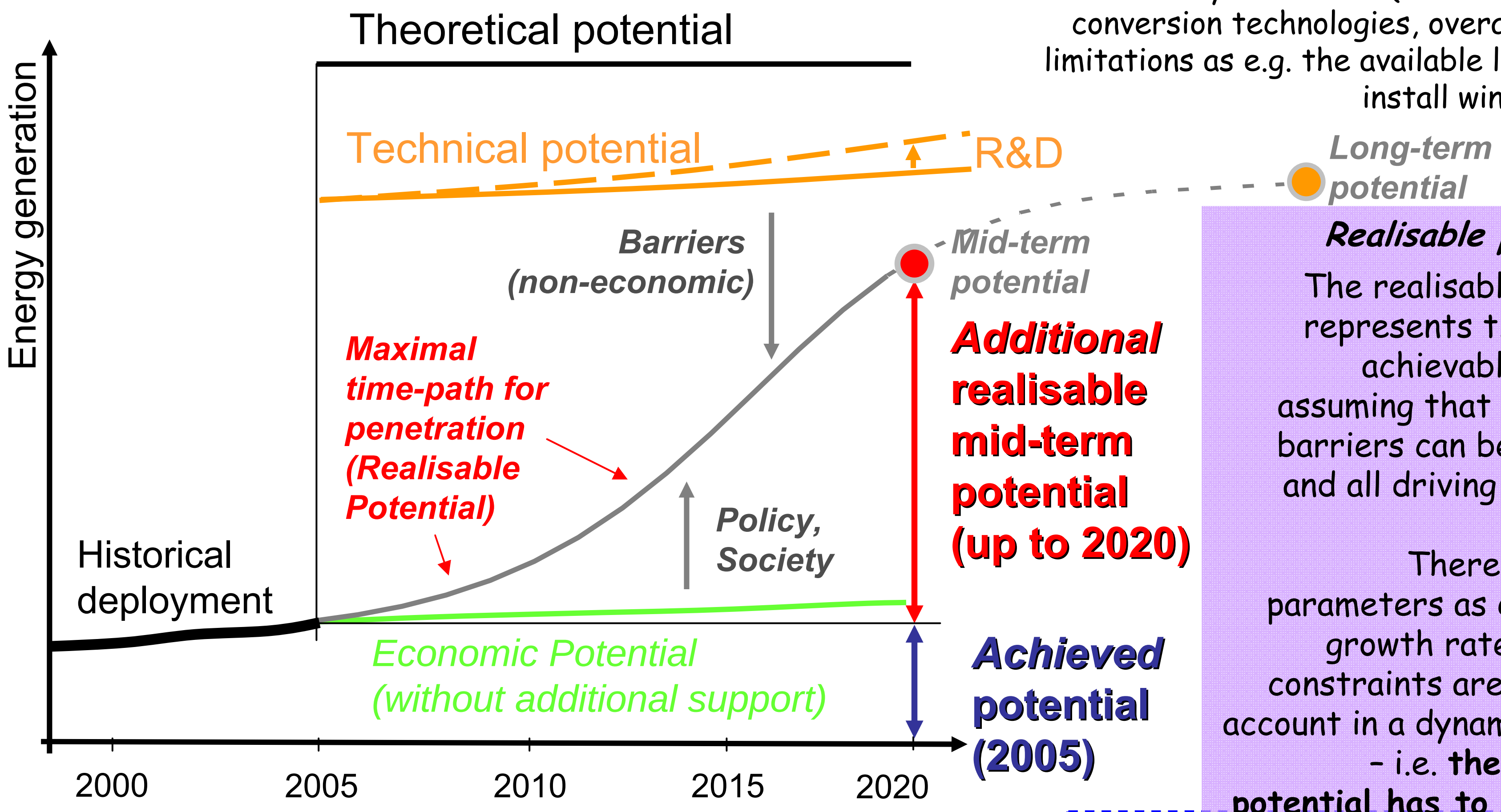
(2) Background: Potentials and cost for RES

Definition of the (additional) realisable mid-term potential (up to 2020)

Definition of potential terms

Theoretical potential … based on the determination of the energy flow.

Technical potential … based on technical boundary conditions (i.e. efficiencies of conversion technologies, overall technical limitations as e.g. the available land area to install wind turbines)



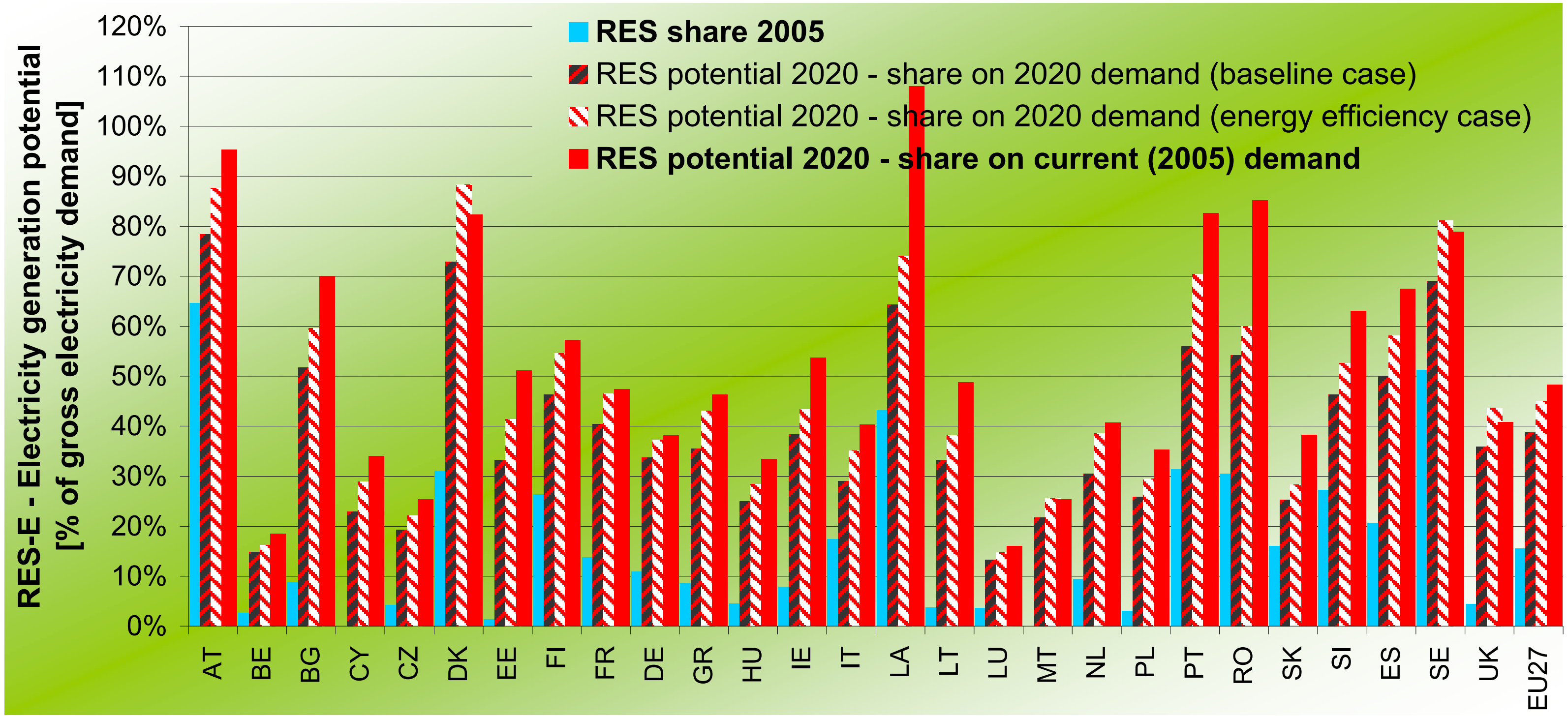
Realisable potential …

The realisable potential represents the maximal achievable potential assuming that all existing barriers can be overcome and all driving forces are active.

Thereby, general parameters as e.g. market growth rates, planning constraints are taken into account in a dynamic context – i.e. **the realisable potential has to refer to a certain year**.

(2) Background – realisable RES potentials

►How far can we go with the renewable energy sources within the electricity sector as applicable in the years up to 2020?



Achieved potential 2005 und additional realisable potential (up to 2020) for RES-E (in terms of final electricity demand) in the EU-27 *by country*

(2) Background – RES cost

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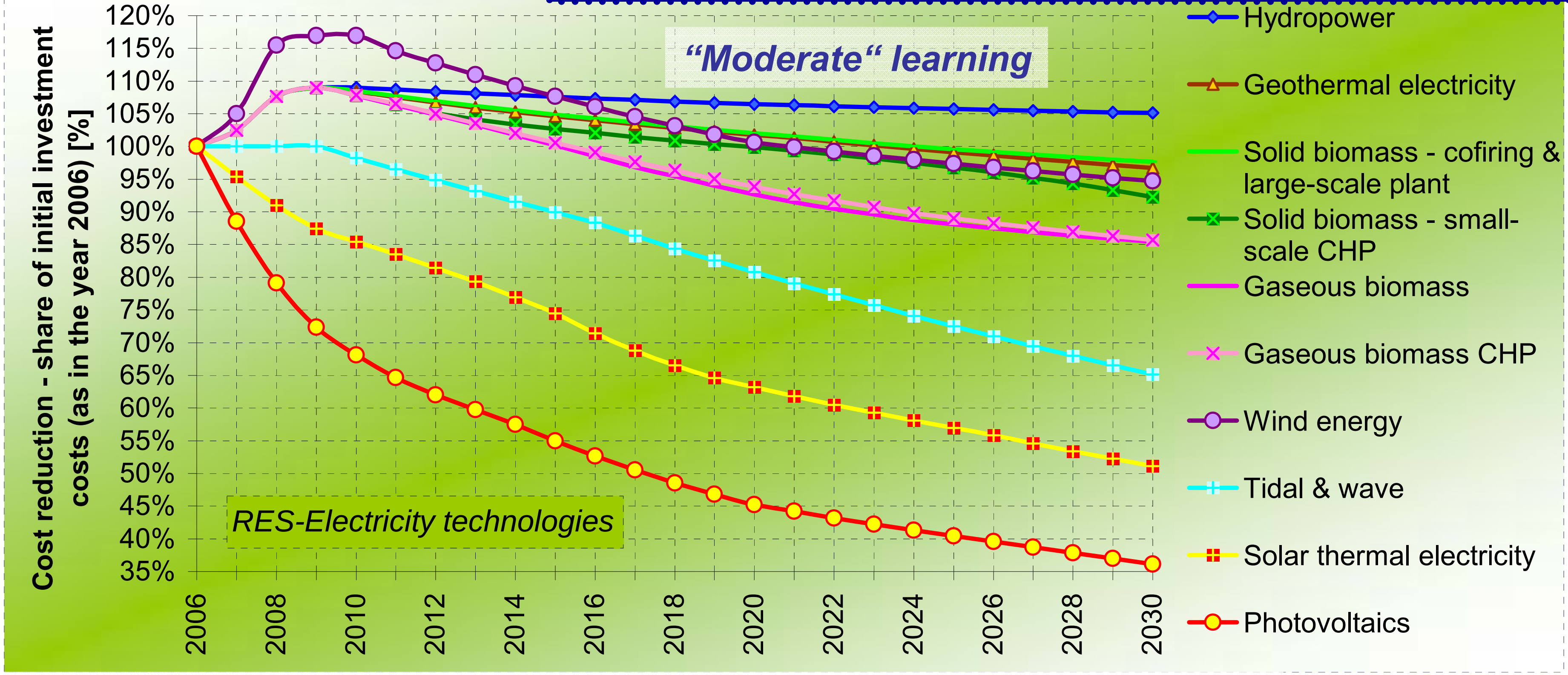
►RES cost

Assumptions on expected future technological progress (technological learning)



→High energy prices changed the overall situation

… Prior learning expectations will not be met with a continuation of high energy prices

(i.e. an increase of investment cost could be observed for almost all energy technologies in 2006 to 2008 caused by increasing energy and raw material prices)

Resulting (investment) cost reduction due to technological progress (learning) (according to the policy *scenario*)

► Overview on RE scenarios (Green-X)

Geographical scope: EU27 Member States
Time horizon: 2006 to 2020

►**BAU case:** RES policies are applied as currently implemented (without any adaptation) – business as usual (BAU) forecast and a baseline energy (electricity) demand scenario.

►**Strengthened national policies:** Accelerated RES deployment, assuming that the national **RES policy framework will be improved with respect to its efficiency & effectiveness**.
These changes will become effective by 2011 in order to **meet the agreed national targets of 20% RES by 2020**. Improvements refer to both the financial support conditions (if necessary) as well as to non-financial barriers (i. e. administrative deficiencies etc.) where a rapid removal is also preconditioned.

Additional cases for the policy assessment are carried out:
Harmonized technology-specific or uniform RES support

►Core Objective - *Method of approach*

Support instruments have to be

- ***effective*** for **increasing the penetration of RES-E** and
- ***efficient*** with respect to **minimising the resulting *public costs*** over time.

Public costs or ***transfer cost for consumer / society*** (due to the promotion of RES-E) are defined as direct premium financial transfer costs from the consumer to the producer due to the RES-E policy compared to the case that consumers would purchase conventional electricity from the power market.

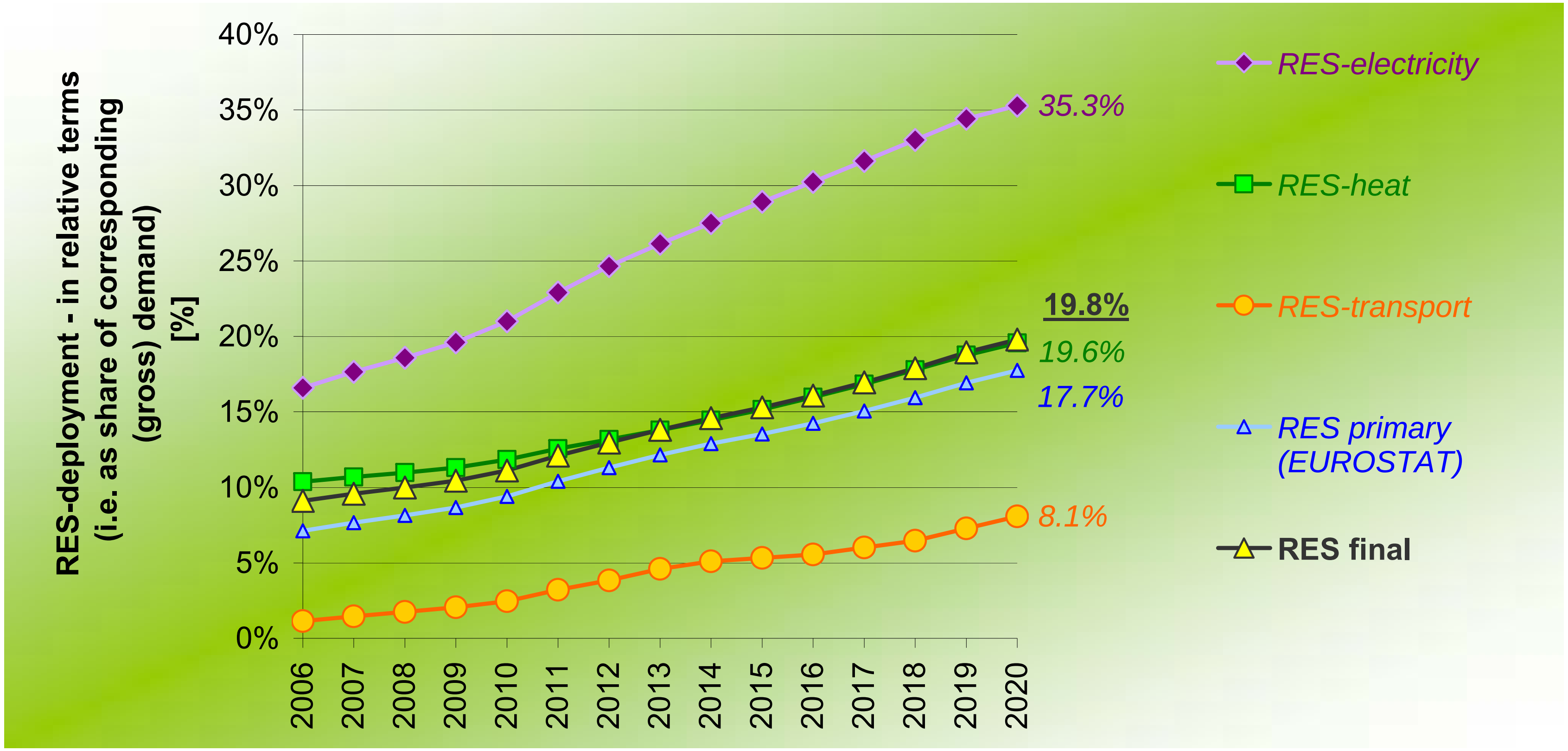
This means that these costs do not consider any indirect costs / benefits or externalities (environmental benefits, change of employment, etc.).

The *criteria used for the evaluation of various instruments* are based on:

- ***Minimise generation costs***
- ***Lower producer profits***

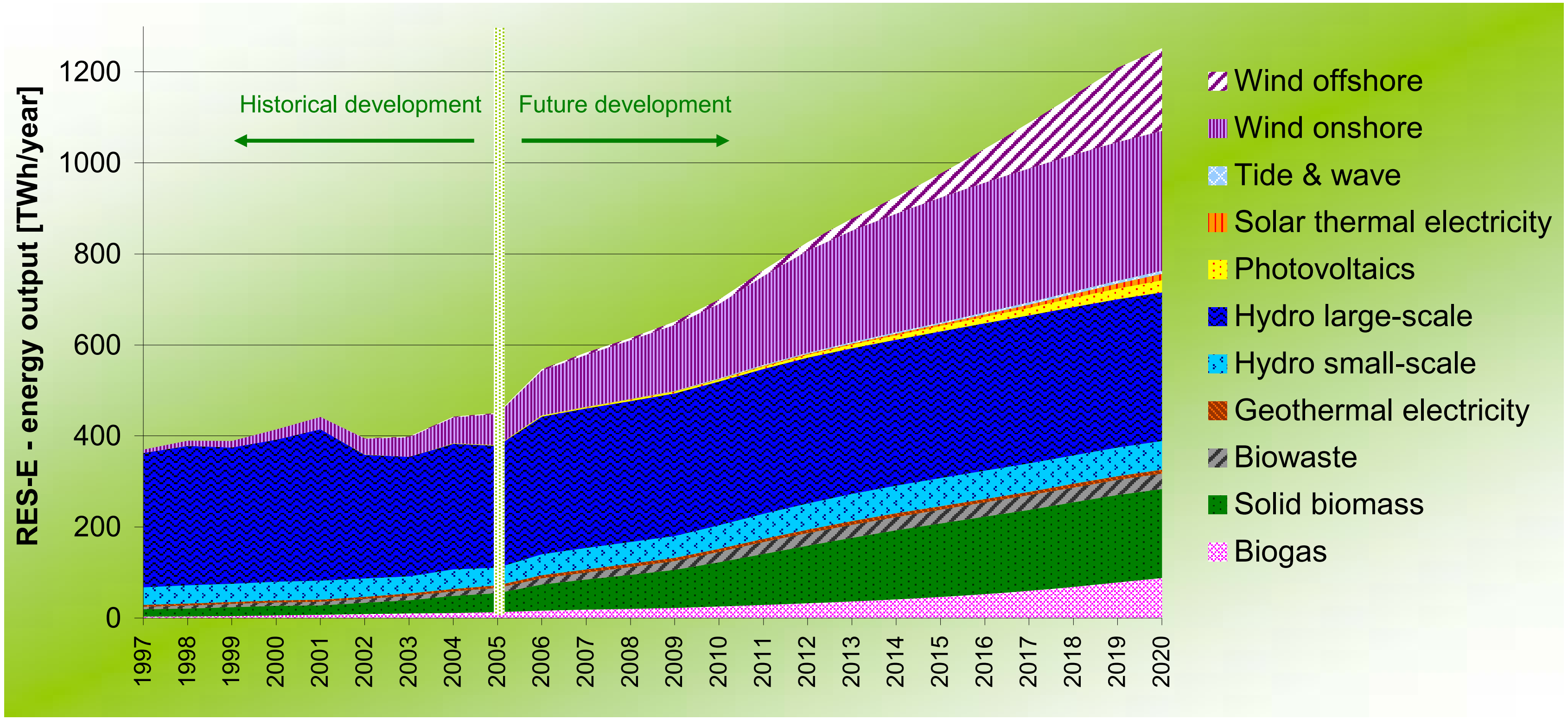
(3) Results – *RES deployment*

► Sectoral contributions to achieve 20% RES by 2020?



Deployment of RES-E, RES-H, RES-T and *RES in total* as shares of corresponding gross demands up to 2020 within the European Union (EU27) (according to the "*strengthened national policy*" scenario)

▶ **RES contribution** to achieve 20% RES by 2020 within the electricity sector



Historical and projected future deployment of RES in the electricity sector up to 2020 within the European Union (EU27)

(according to the *"strengthened national policy"* scenario)

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(3) Results – *RES deployment*

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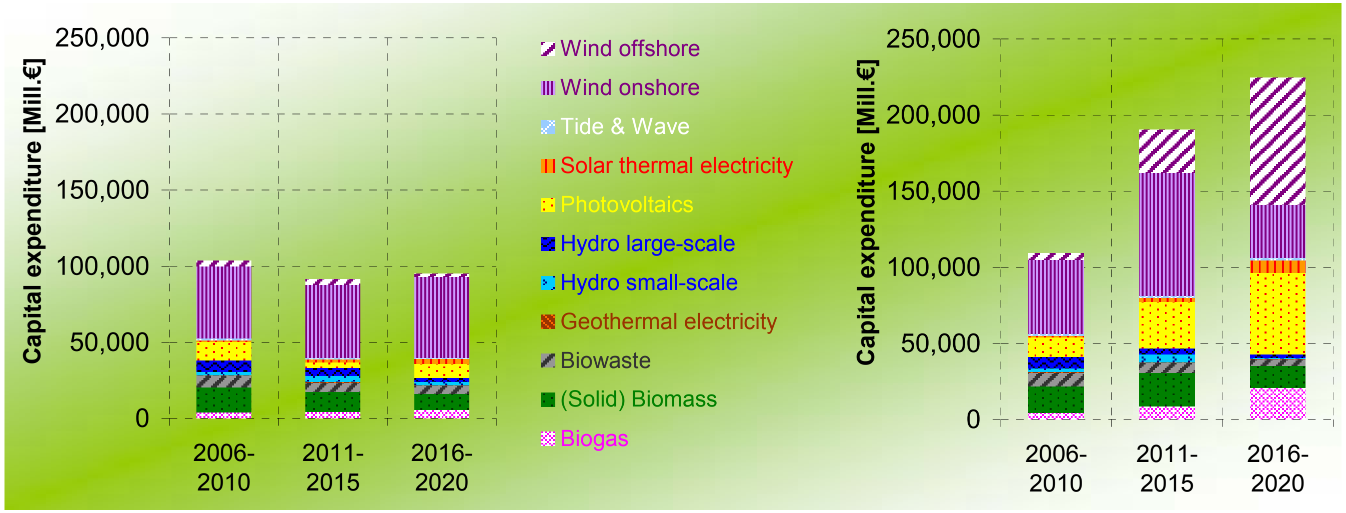
► RES-E contribution and associated capital expenditures…

Breakdown by RES-electricity category			New RES-E installations							
			BAU (Business as usual)				Strengthened national policies			
		[Unit]	2006-2010	2011-2015	2016-2020	2006-2020	2006-2010	2011-2015	2016-2020	2006-2020
Biogas	BG	MW	1,588	1,700	2,341	5,629	1,803	3,364	7,330	12,498
(Solid) Biomass	BM	MW	7,612	7,013	6,054	20,679	8,498	11,577	8,803	28,878
Biowaste	BW	MW	1,479	1,158	1,011	3,648	1,661	1,222	790	3,674
Geothermal electricity	GE	MW	147	118	60	325	148	128	90	365
Hydro large-scale	HY-LS	MW	6,876	3,064	1,391	11,331	6,991	2,432	1,378	10,802
Hydro small-scale	HY-SS	MW	1,424	2,389	958	4,771	1,631	2,745	552	4,928
Photovoltaics	SO-PV	MW	2,834	1,096	2,580	6,510	2,963	8,366	17,372	28,700
Solar thermal electricity	SO-ST	MW	367	560	1,348	2,274	390	963	3,498	4,850
Tide & Wave	TW	MW	404	517	285	1,206	416	564	775	1,755
Wind onshore	WI-ON	MW	33,951	33,038	39,334	106,324	34,717	56,436	27,000	118,152
Wind offshore	WI-OFF	MW	1,727	1,735	942	4,404	2,149	12,817	37,851	52,817
RES-E TOTAL	RES-E	MW	58,409	52,389	56,304	167,101	61,365	100,614	105,440	267,419



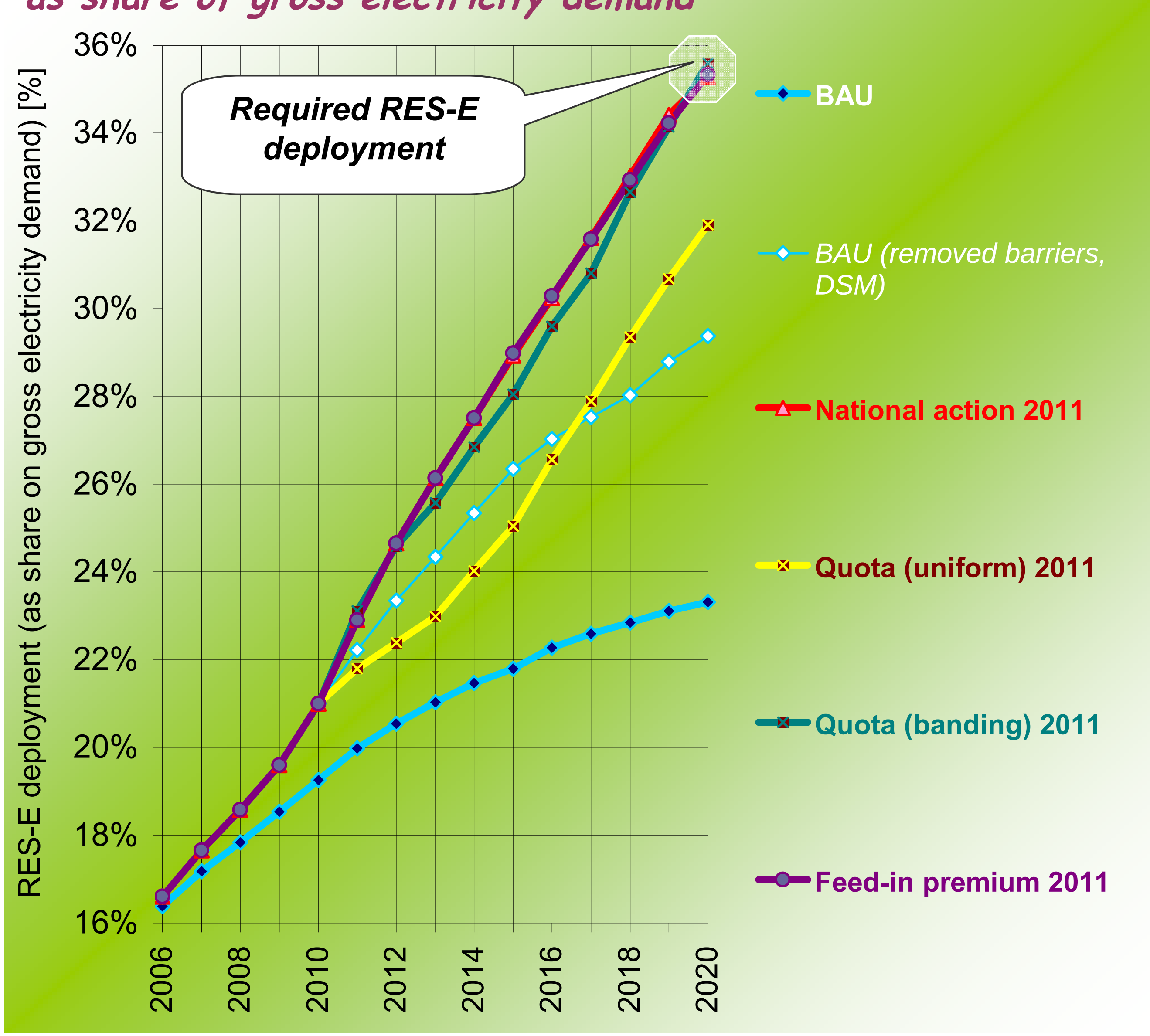
Tremendous increase in wind offshore and PV in terms of installed capacity and capital expenditures

(according to the "*strengthened national policy*" scenario compared to "*BAU*")

(4) Results / Policy Assessment

Total electricity generation from RES (EU27)

as share of gross electricity demand



Overview on assessed policy scenarios

MAIN CASES

BAU - continuation of current national RES policies

BAU with removed barriers and active DSM

Strengthened national RES support

Harmonised uniform RES support by 2011 (quota)

Harmonised technology-specific RES support by 2011 (quota with banding)

Harmonised technology-specific RES support by 2011 (feed-in premium)

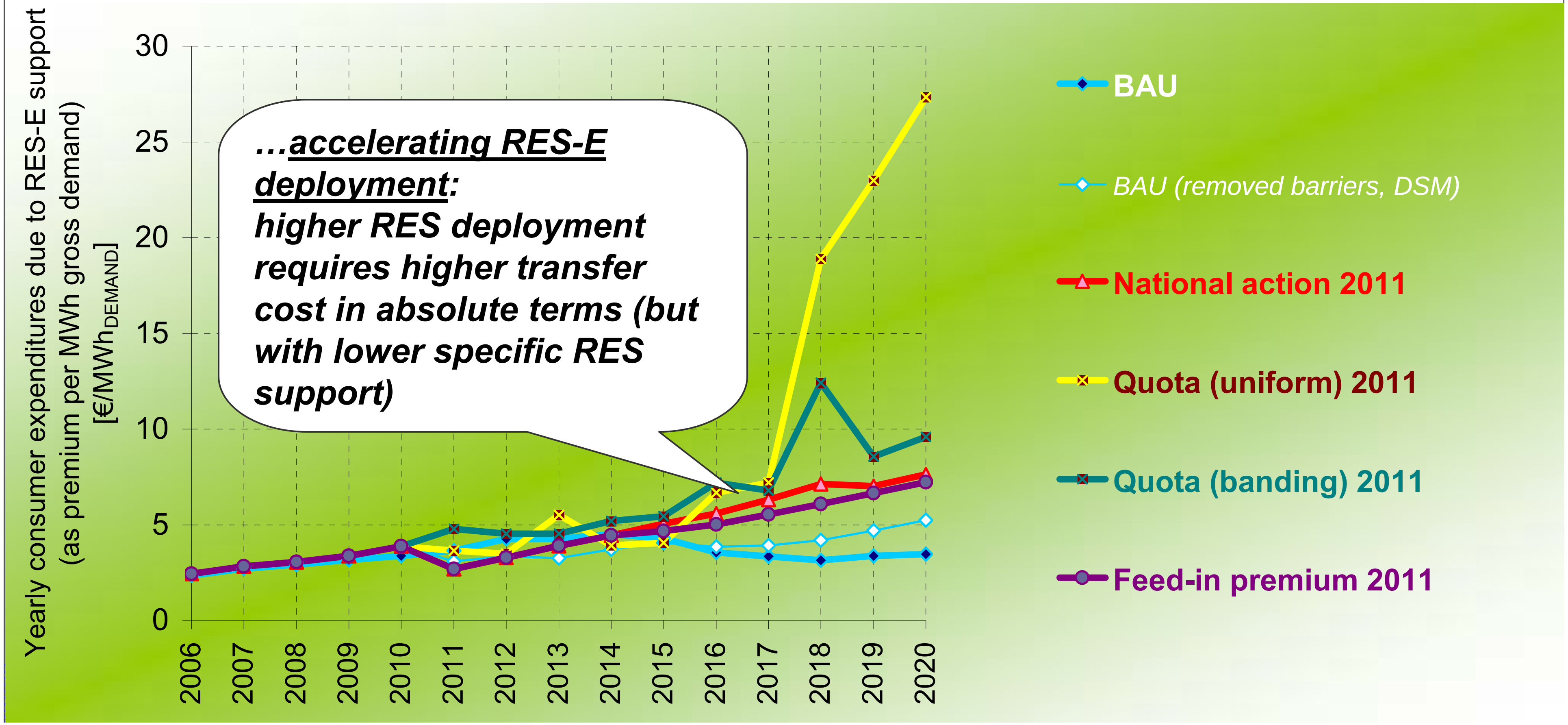
Overview on assessed policy scenarios

MAIN CASES

Transfer costs for consumer

(due to the support of RES-E)

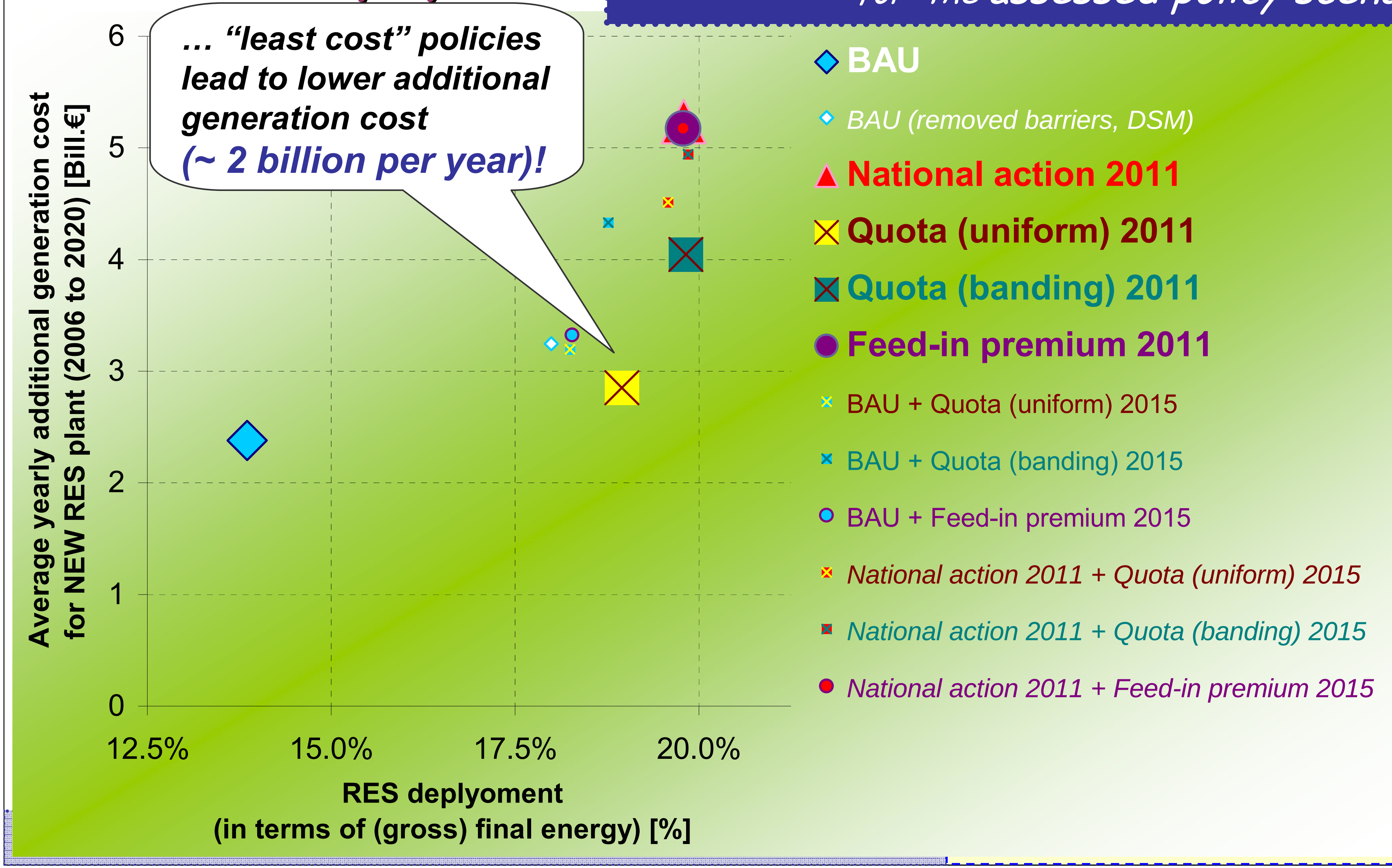
Transfer costs for consumer / society (sometimes also called additional / premium costs for consumer / society) are defined as ***direct premium financial transfer costs from the consumer to the producer due to the RES-E policy compared to the case that consumers would purchase conventional electricity from the power market.***



(4) Results / Policy Assessment

► Costs of (an enhanced) RES deployment

Average (2006 to 2020) yearly additional cost (generation & policy cost (consumer expenditures) referring to the required new RES deployment (2006 to 2020) (EU27) for the assessed policy scenarios



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(4) Results / Policy Assessment

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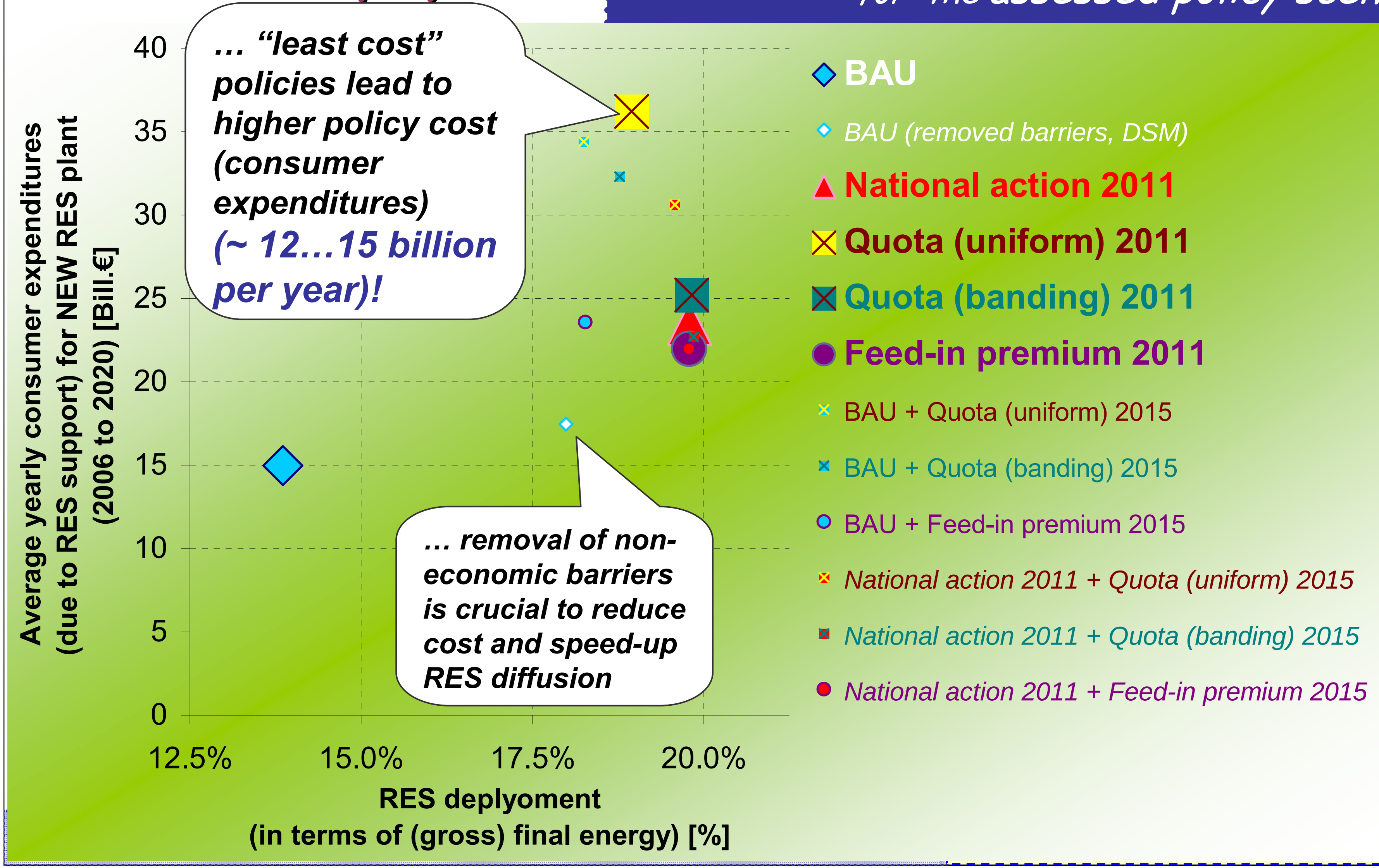
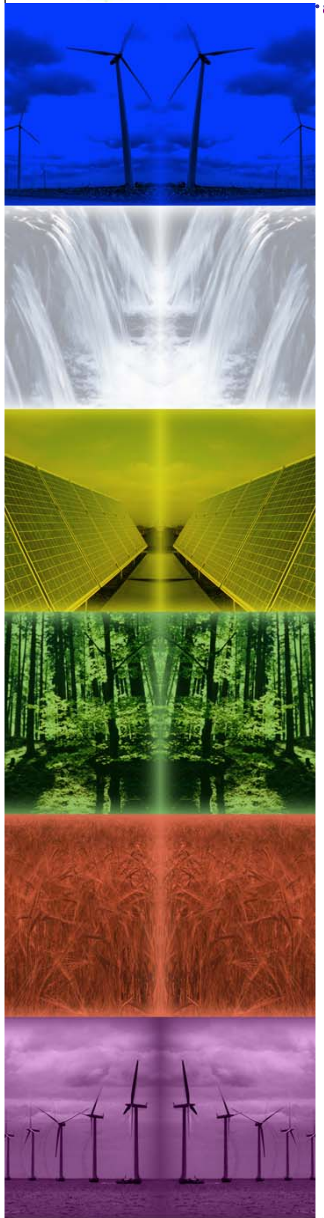


Concluding remarks



- *RES policies should be supported by a strong energy efficiency policy.*
- *The RES policy framework needs an integrated perspective on the use of biomass.*

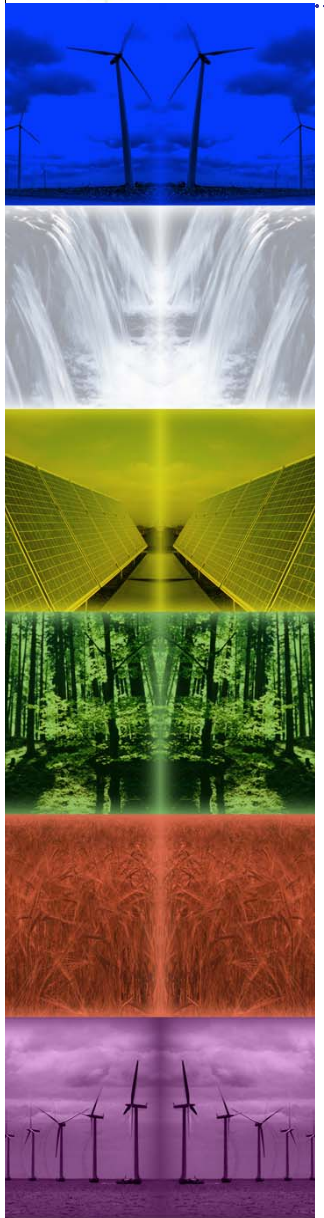
  Biomass is a crucial element of RES policy, used in all three sectors
- *Efforts are needed in all Member States*

  *All modelling exams clearly illustrate → **Each MS has to contribute**!*
- ***A wide range of technologies has to be supported***

  *Even in a pure „least cost" case → **a broad portfolio of RE technologies is needed to achieve the 20% target**!*

  *Costs vary over time, but even more between RES technologies → **Any future policy framework has to address this sufficiently by providing***

  technology specific support to the various RES options.



The** discussion on adequate flexibility for target achievement **should <u>not</u>** lead to quick and too simplistic policy answers **that directs us into a 'wrong' policy direction and hinder the move towards

effective & efficient RES support

Thanks for your attention!

In case of questions / remarks …

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