The role of renewables in the future European energy mix

Christian Panzer (TU Vienna - EEG)

Anne Held (Fraunhofer ISI)

SECURE Workshop – Moscow, July 2nd, 2010

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

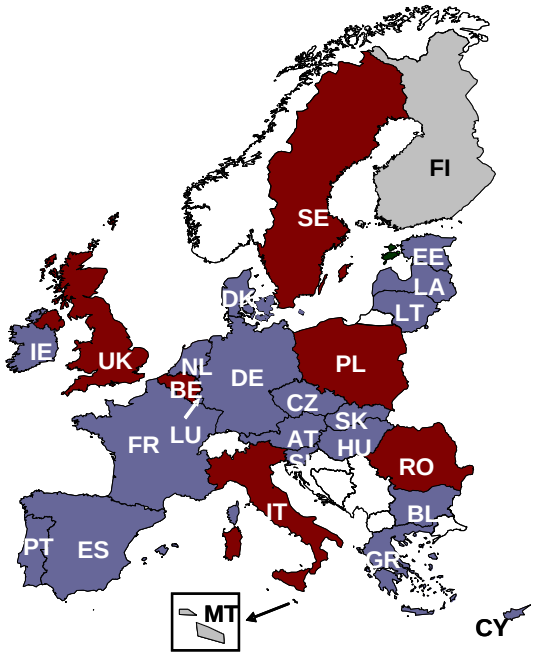
Outline

1. ***Methodology***
2. ***Background data and assumptions***
   - The current RES target in the EU
   - Potentials of RES technologies
3. ***Future pathway of RES generation within the EU***
   - RES technology portfolio development
   - Required investments and costs for the society
4. ***Implications for security of supply at an enhanced RES penetration***

Characteristics of RES – Policy background

Characterization of currently applied policy measures in the EU:

		Direct		Indirect
		Price-driven	**Quantity-driven**	
Regulatory	**Investment focused**	• Investment incentives • Tax credits • Low interest / Soft loans	• Tendering system for investment grant	• Environmental taxes • Simplification of • Connexion charges, balancing costs
	Generation based	• (Fixed) Feed-in tariffs • Fixed Premium system • Production tax incentives	• Tendering system for long term contracts • Tradable Green Certificate system	
Voluntary	**Investment focused**	• Shareholder Programs • Contribution Programs		• Voluntary agreements
	Generation based	• Green tariffs		

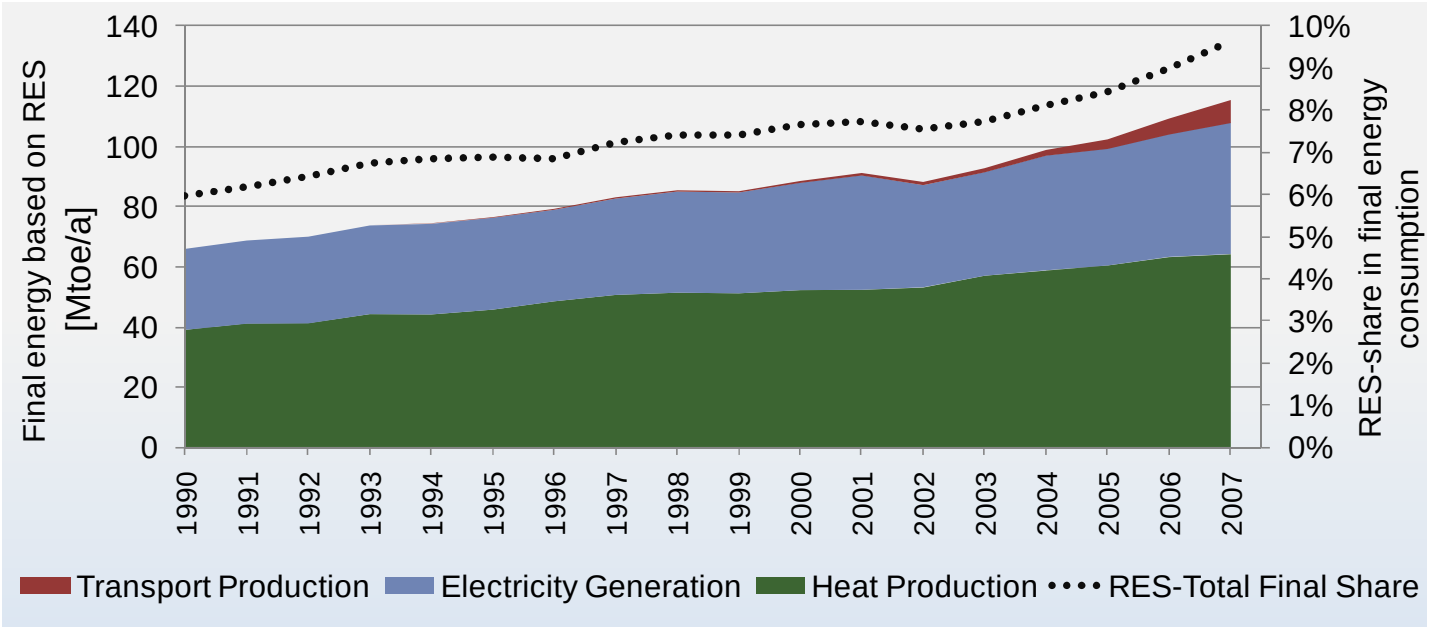


- Quota obligation
- Feed-in tariffs
- Tax and investment incentives

- 19 Member States apply Feed-In Tariffs in the electricity sector
- 6 Member States apply a quota system
- The heat sector is mostly dominated by investment incentives

Characteristics of RES – RES development total

Historic RES development in terms of gross final energy:



- Heat sector still dominates the RES contribution (57%)
- 38% renewable energy is generated in the electricity sector
- Transport sector plays a marginal role at a recently increasing share
- Generally, RES contributed to 9.7 % of gross final energy demand in 2007

Characteristics of RES – Identification of risks

Risk of RES technologies:

Long-term impacts

Economic

- Development of cost reduction
- Raw material prices (e.g. steel, silicon)
- Electricity generation costs

Climate change impacts

- Hydro: Changing utilisation
- Wind: Impact of storms
- Biomass: Change in BM-Potential

Import dependency

- CSP from North Africa
- Biomass imports (transport distance, state of aggregation)

Feedstock competition

- Biomass availability and prices
- Harvesting season

Operational impacts

Variability of RES-output

- Wind in particular on short-term (Remedies: Back-up capacity; Grid reinforcement; DSM)
- Solar (comparatively good correlation of peak load and demand)
- Hydro (Inter-annual variability)

Others

Technological risks

- Geothermal (Hot-Dry-Rock and Earthquakes → Basel)

Political risks

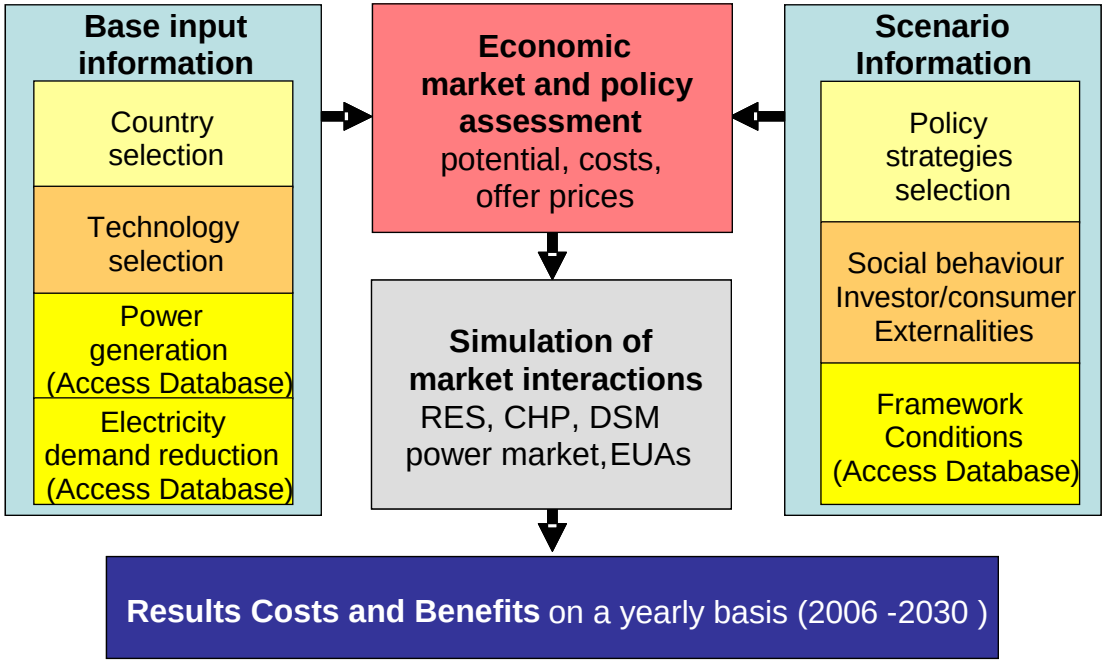
- Political factors hampering RES-development (Non-economic barriers, policy uncertainty)

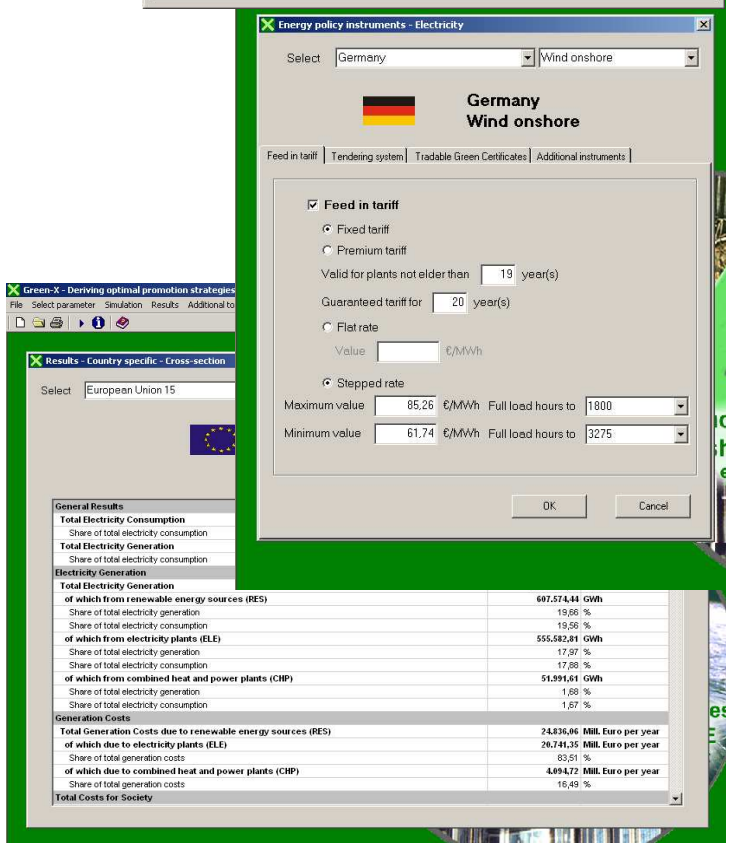
The *Green-X* model

secure
Security of Energy Considering its Uncertainty, Risks and Economic implications

Simulation model for energy policy instruments in the European energy market

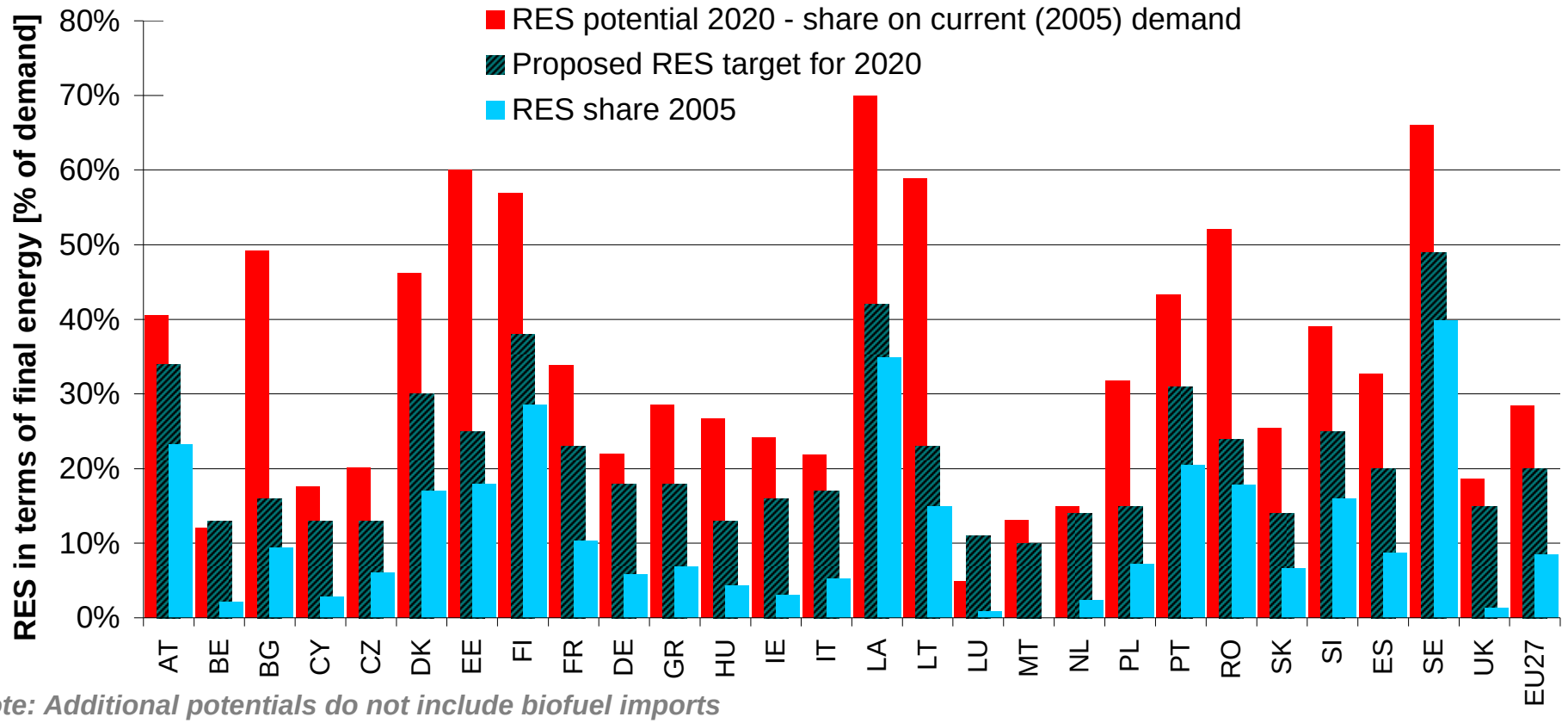
- RES-E, RES-H, RES-T and CHP, conventional power
- Based on the concept of dynamic cost-resource curves
- Allowing forecasts up to 2020/2030 on national / EU-27 level





<u>Reference clients:</u> 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.

National RES targets for 2020 the proposed definition

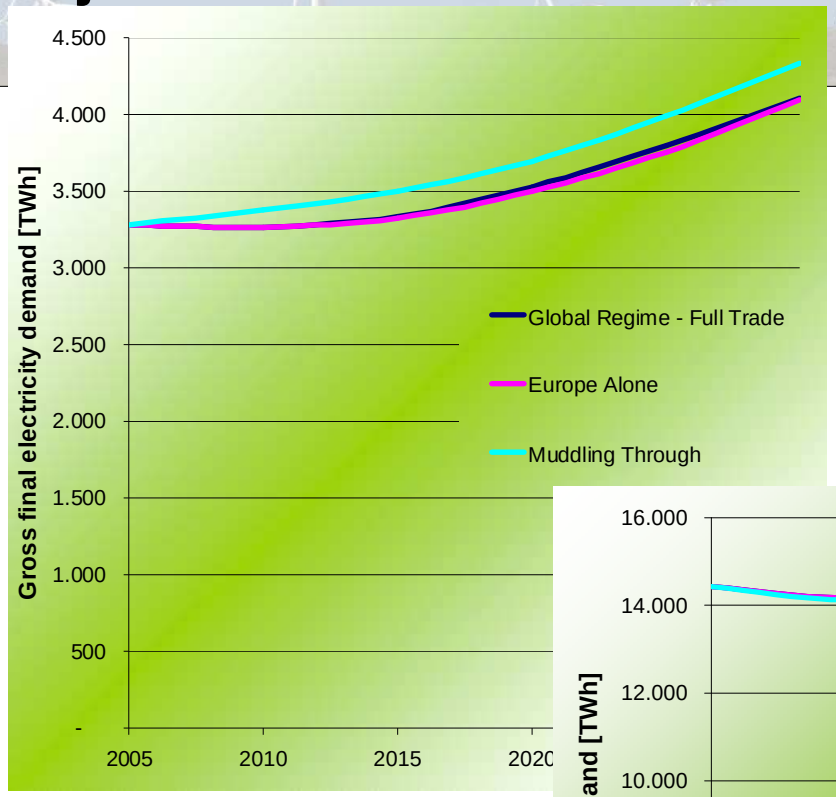


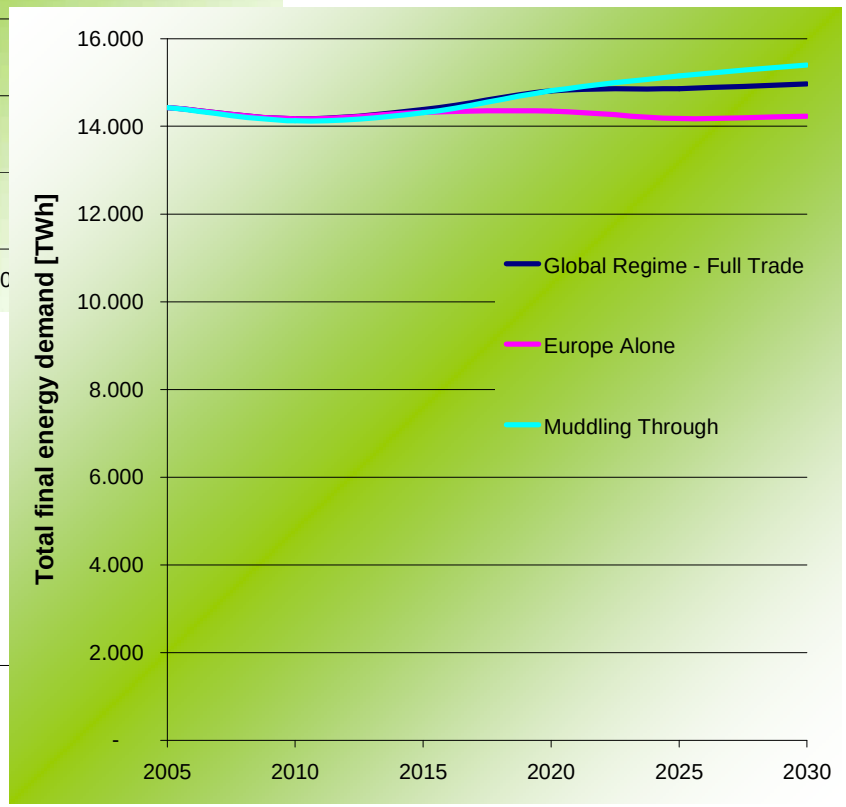
Note: Additional potentials do not include biofuel imports

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

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

Energy demand projections derived from POLES

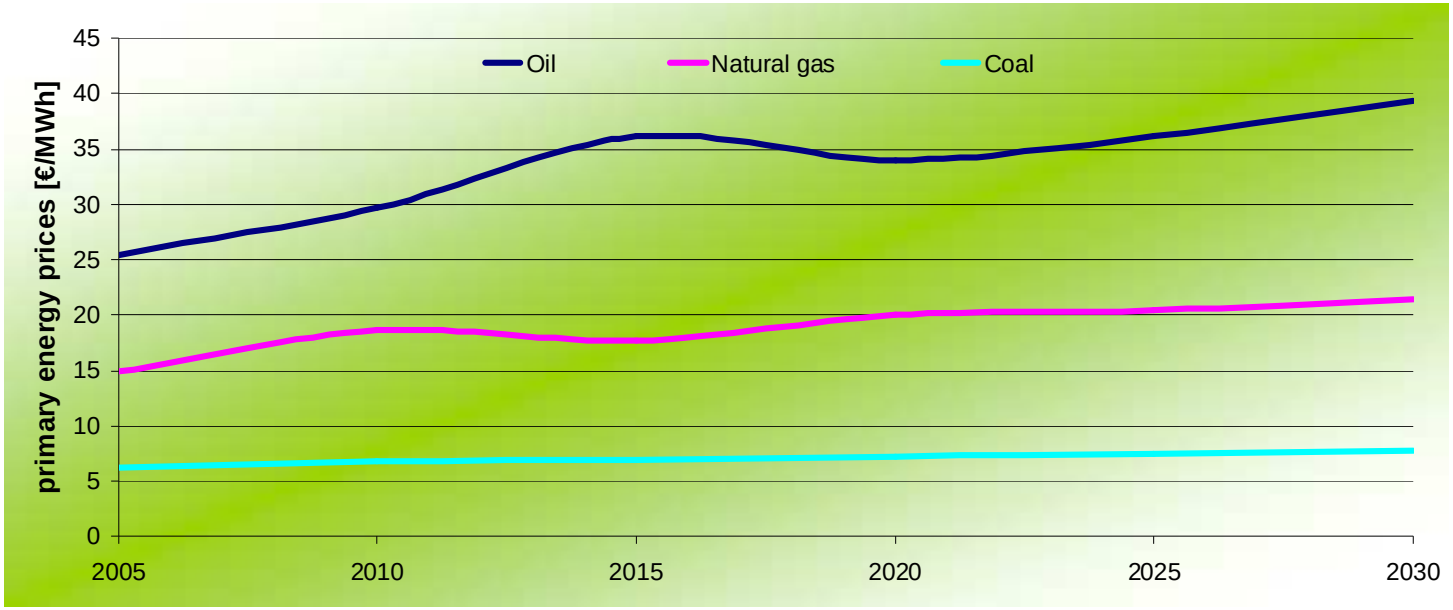




*Energy demands for all scenarios are taken from the **POLES** scenarios, but had to be **adjusted** (reduced) due to **statistical accounting methodologies** in order to consider the **European Directive** of 20% RES in 2020 on **gross final energy demand** correctly!*

Primary energy prices and CO2 prices – derived from POLES

Relatively low primary energy prices for all scenarios, with strongly varying CO2 prices in the different policy storylines



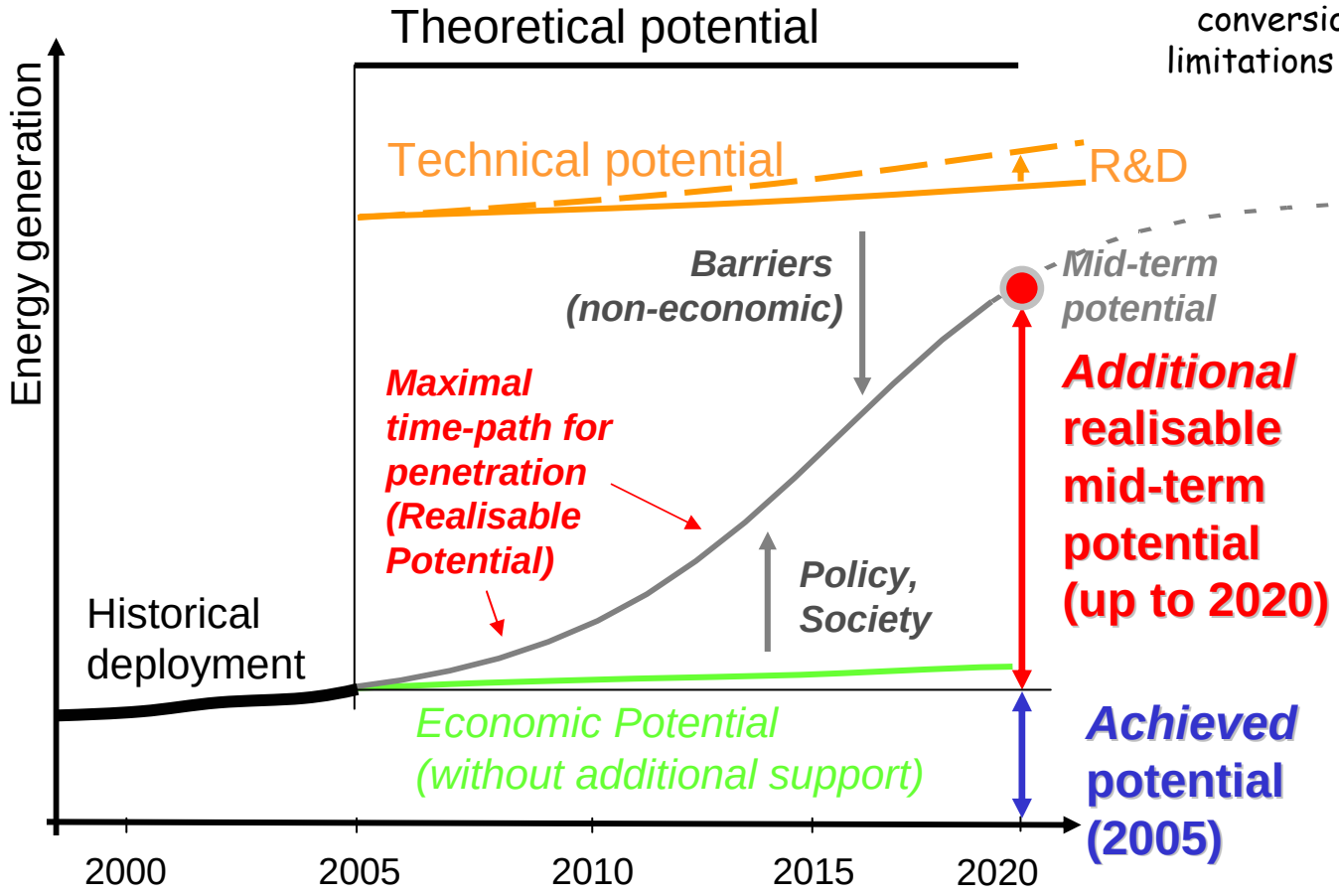
CO2 prices		2005	2010	2015	2020	2025	2030
Muddling Through	€/t	0,00	7,94	11,90	15,86	19,83	23,79
Europe Alone	€/t	0,00	7,75	18,62	45,05	66,71	88,51
Global Regime - Full Trade	€/t	0,00	6,96	12,99	26,01	45,70	62,02

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**.

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

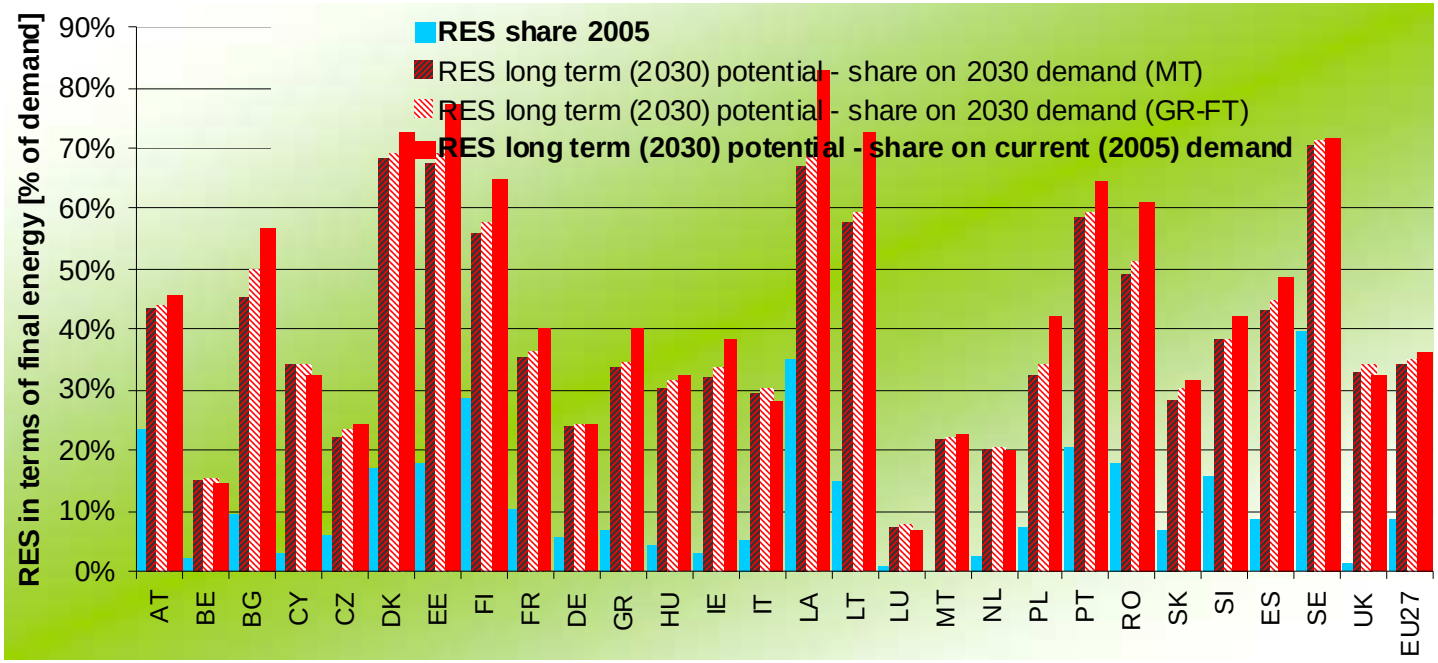
Fraunhofer ISI

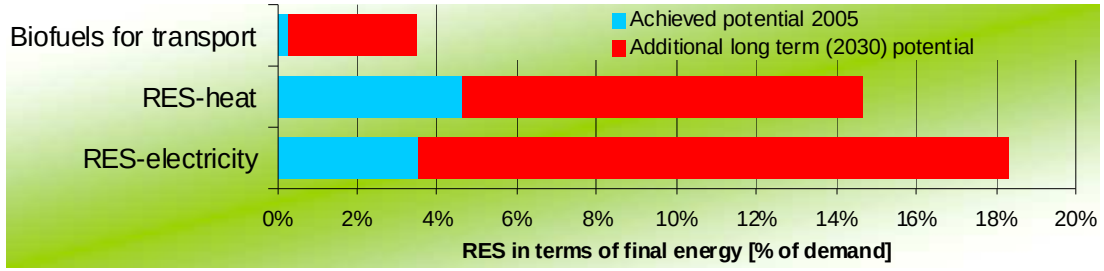
RES potentials – Total energy sector

Key parameter:

Derived from FORRES 2020 & follow-up projects

► *RES potentials*





TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

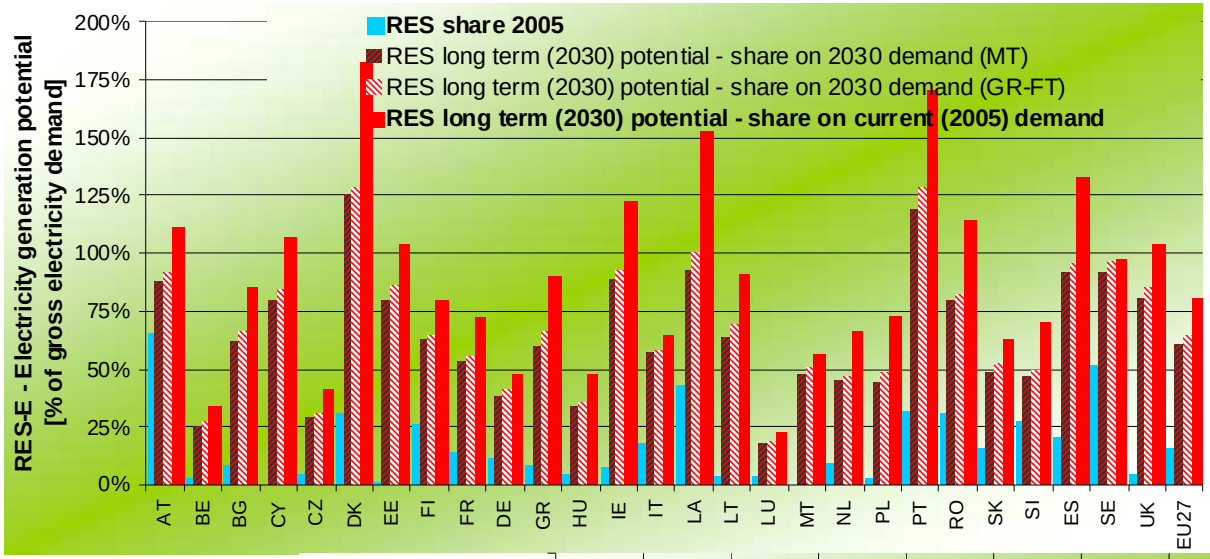
RES potentials – Electricity sector

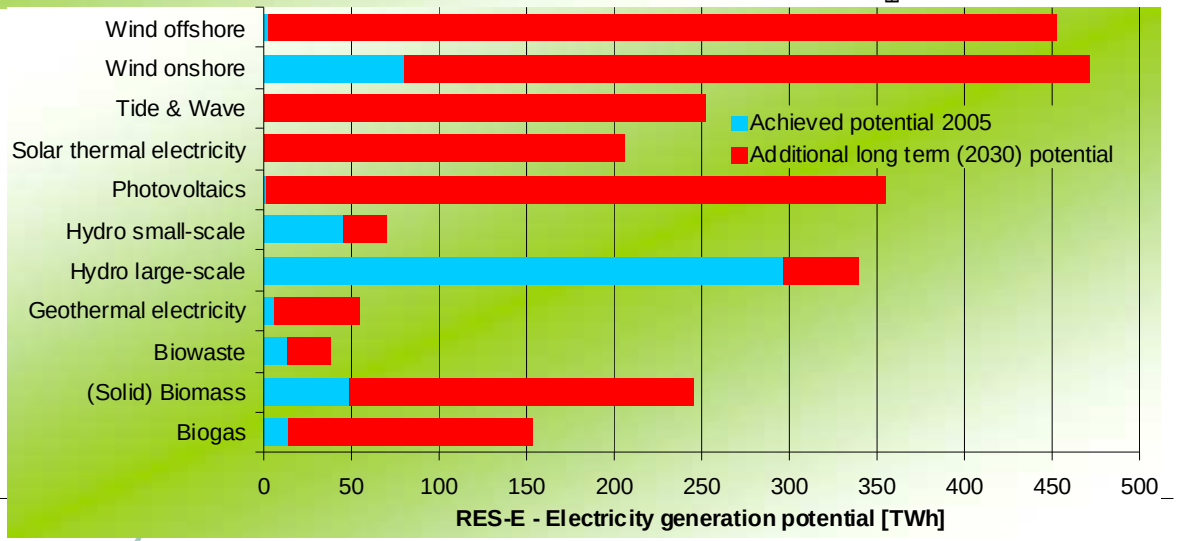
secure
Security of Energy Considering its Uncertainty, Risks and Economic implications

Key parameter:

Derived from FORRES 2020 & follow-up projects

► *RES potentials*





TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna University of Technology

Energy Economics Group

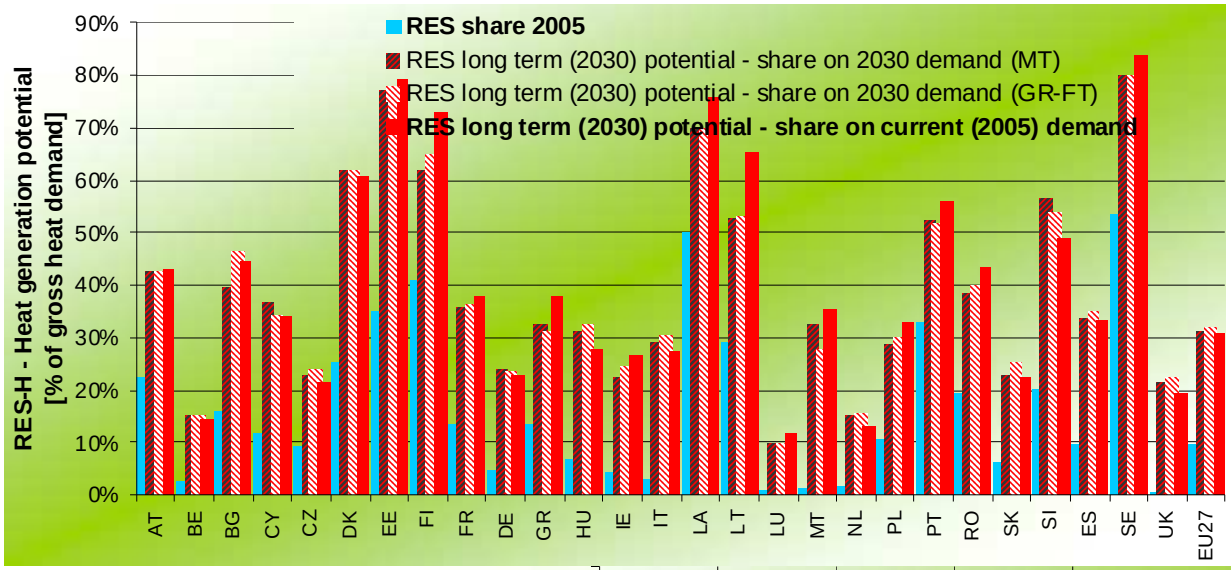
Fraunhofer ISI

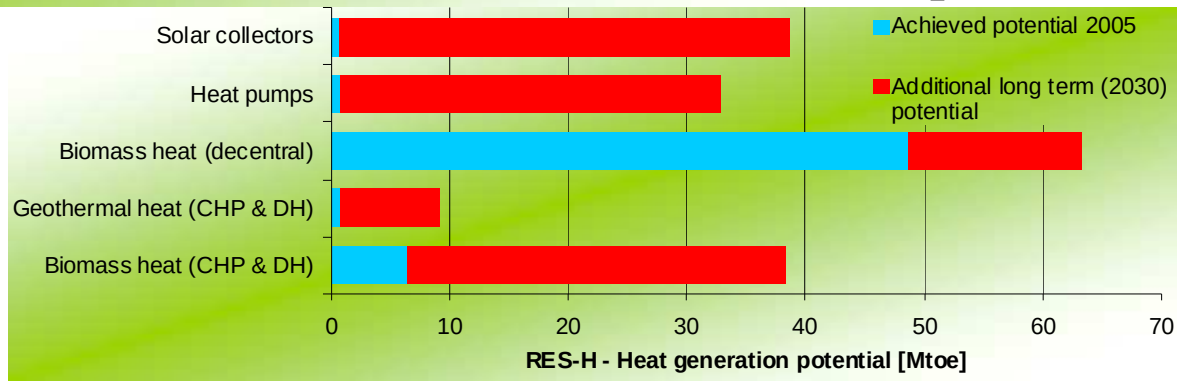
RES potentials – Heat sector

Key parameter:

Derived from FORRES 2020 & follow-up projects

► *RES potentials*



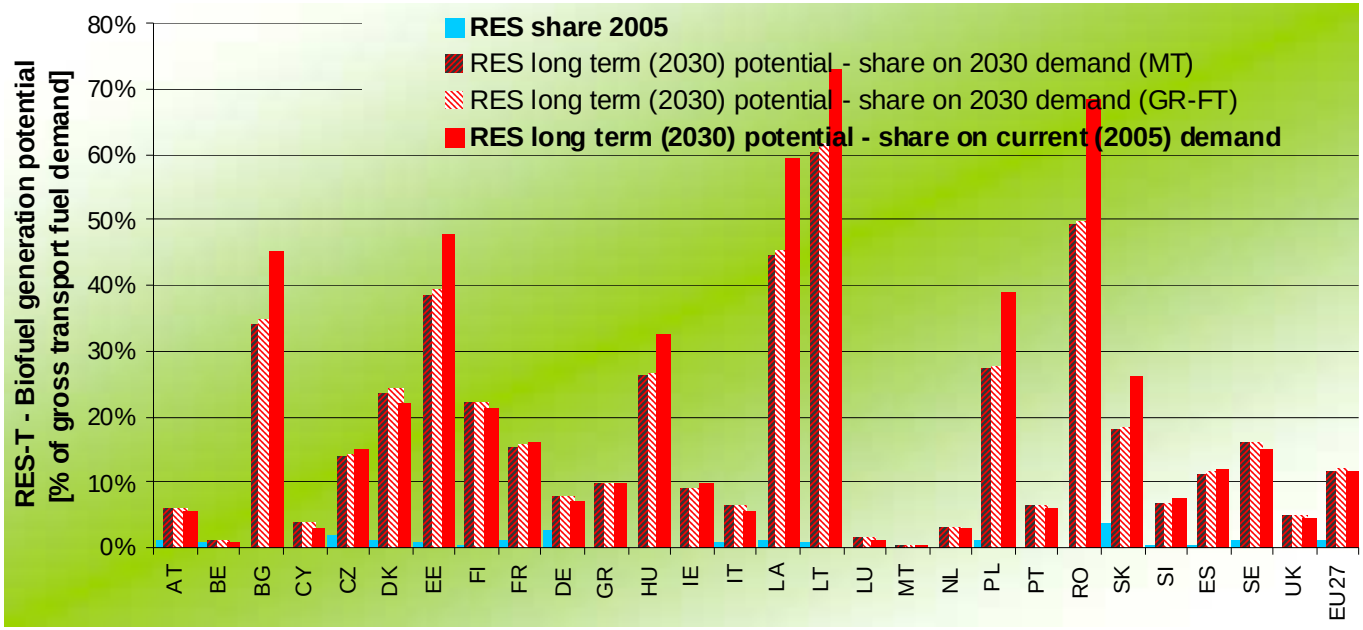


RES potentials – Transport sector

Key parameter:

Derived from FORRES 2020 & follow-up projects

► *RES potentials*



Scenario definition

Three main policy storylines have been investigated:

- ►**Muddling through:** Global Baseline RES development
- ►**Europe Alone:** Alternative RES development within Europe and baseline RES development in the RoW
- ►**Global Regime:** Alternative RES development on global scale

Strengthened national policy: Accelerated RES deployment, assuming that the European RES policy framework will be improved with respect to its efficiency & effectiveness (i.e. strengthened national RES support incl. flexibility mechanism for 2020 national RES target fulfillment). These changes will become effective by 2011 in order to meet the agreed target of 20% RES by 2020 and the ambition is continued beyond 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.

With respect to the Global Regime, sensitivity runs are carried out, highlighting the importance of efficient policy measures to be implemented. Consequently technology specific premium tariffs are considered as well as quota systems based on technology neutral Tradable Green Certificates schemes

Scenario results – *Muddling Through*

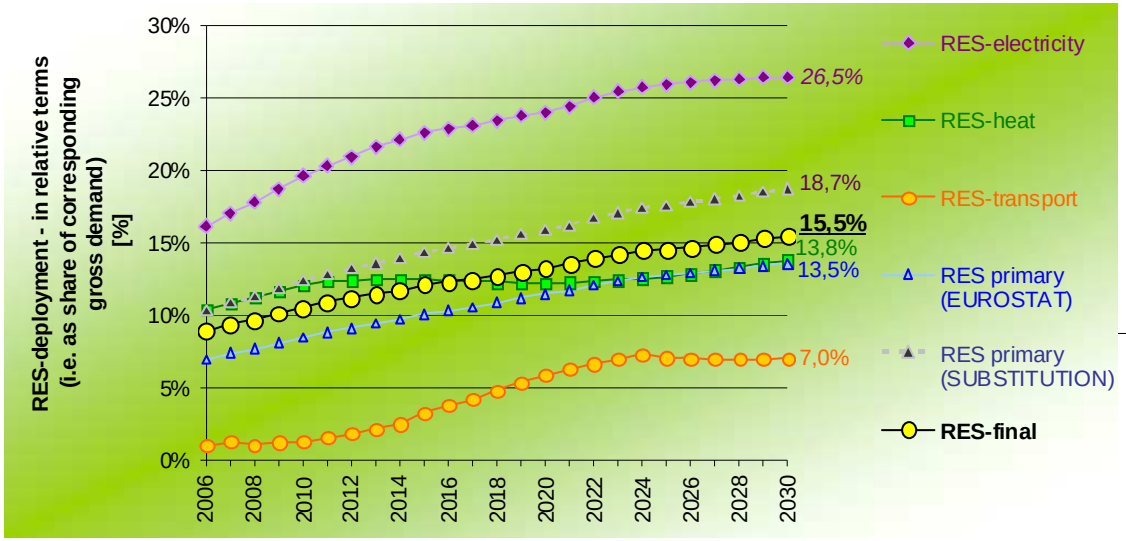
secure
Security of Energy Considering its Uncertainty, Risks and Economic implications

% deployment	European Union 27				
	2006	2010	2020	2030	
Share of RES-E on electricity demand	16%	20%	24%	26%	
Share of RES-H on heat demand	10%	12%	12%	14%	
Share of RES-T on transport fuel demand	1%	1%	6%	7%	
Share of RES on final demand	**9%**	**11%**	**13%**	**15%**	
Share of RES on primary demand	7%	8%	11%	14%	*(Eurostat convention)*
	10%	12%	16%	19%	*(Substitution principle)*

- *No target achievement*
- *Hardly any contribution in the heat sector*
- *Low increase of RES share beyond 2020*

Country breakdown	% RES-E			% RES-H			% RES-T			% RES-final		Proposed RES targets	
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2020	2020*		
Austria	64%	63%	61%	29%	28%	32%	1%	4%	5%	28,9%	28,9%	34%	85%
Belgium	6%	10%	11%	4%	4%	3%	0%	0%	0%	4,3%	4,3%	13%	33%
Denmark	34%	34%	43%	31%	34%	36%	0%	0%	0%	22,7%	22,7%	30%	76%
Finland	28%	24%	25%	46%	43%	47%	0%	0%	0%	29,4%	29,4%	38%	77%
France	18%	22%	24%	17%	16%	19%	2%	10%	12%	16,2%	16,2%	23%	70%
Germany	14%	15%	13%	6%	7%	10%	1%	7%	7%	8,8%	8,8%	18%	49%
Greece	12%	19%	22%	17%	21%	25%	1%	6%	7%	15,1%	15,1%	18%	84%
Ireland	13%	21%	35%	5%	6%	8%	2%	6%	8%	9,1%	9,1%	16%	57%
Italy	21%	29%	29%	4%	5%	7%	1%	5%	6%	10,3%	10,3%	17%	60%
Luxembourg	4%	4%	4%	2%	2%	4%	1%	3%	6%	2,9%	2,9%	11%	27%
Netherlands	10%	9%	9%	3%	3%	3%	1%	4%	5%	4,6%	4,6%	14%	33%
Portugal	40%	45%	54%	38%	28%	22%	1%	5%	6%	24,2%	24,2%	31%	78%
Spain	34%	45%	56%	12%	15%	18%	1%	5%	6%	19,3%	19,3%	20%	96%
Sweden	52%	56%	63%	60%	51%	43%	1%	7%	8%	42,2%	42,2%	49%	86%
United Kingdom	10%	18%	24%	3%	4%	4%	1%	3%	5%	7,1%	7,1%	15%	47%
Cyprus	1%	2%	3%	17%	19%	23%	1%	2%	4%	6,1%	6,1%	13%	47%
Czech Republic	6%	12%	15%	10%	7%	5%	2%	8%	8%	8,6%	8,6%	13%	66%
Estonia	3%	4%	11%	38%	36%	39%	0%	1%	1%	17,5%	17,5%	25%	70%
Hungary	5%	7%	7%	8%	7%	9%	2%	7%	7%	7,0%	7,0%	13%	54%
Latvia	36%	38%	35%	51%	38%	28%	0%	1%	1%	26,7%	26,7%	42%	64%
Lithuania	4%	5%	11%	31%	30%	34%	0%	3%	11%	15,6%	15,6%	23%	68%
Malta	0%	1%	1%	5%	7%	9%	1%	3%	5%	2,6%	2,6%	10%	26%
Poland	6%	12%	15%	11%	11%	11%	4%	14%	13%	11,6%	11,6%	15%	77%
Slovakia	20%	23%	24%	7%	7%	7%	0%	0%	0%	9,2%	9,2%	14%	66%
Slovenia	27%	32%	30%	25%	28%	39%	0%	0%	1%	20,3%	20,3%	25%	81%
Bulgaria	10%	10%	13%	17%	19%	25%	1%	3%	6%	11,6%	11,6%	16%	72%
Romania	31%	30%	30%	21%	18%	18%	0%	1%	6%	16,9%	16,9%	24%	70%
EU 27	**19,6%**	**24,0%**	**26,5%**	**12,1%**	**12,2%**	**13,8%**	**1,3%**	**5,9%**	**7,0%**	**13,2%**	**13,2%**	20%	66%

* considering an equal biofuel 2020-target in size of 10% for all Member States ("biofuel equalisation")



Fraunhofer ISI

Scenario results – *Europe Alone*

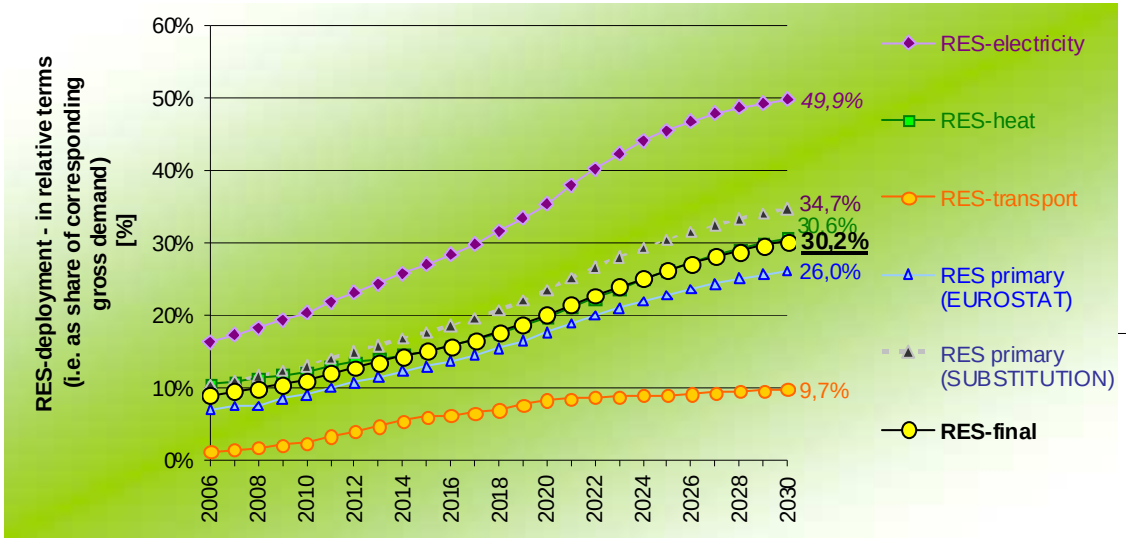
secure — Security of Energy Considering its Uncertainty, Risks and Economic implications

% deployment	European Union 27				
	2006	2010	2020	2030	
Share of RES-E on electricity demand	16%	20%	35%	50%	
Share of RES-H on heat demand	10%	12%	20%	31%	
Share of RES-T on transport fuel demand	1%	2%	8%	10%	
Share of RES on final demand	**9%**	**11%**	**20%**	**30%**	
Share of RES on primary demand	7%	9%	18%	26%	*(Eurostat convention)*
	10%	13%	23%	35%	*(Substitution principle)*

- *Exact target achievement in 2020*
- *Well contribution in all three energy sector*
- *Ambitious increase of RES share beyond 2020*

Country breakdown	% RES-E			% RES-H			% RES-T			% RES-final		Proposed RES targets	
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2020	2020*		
Austria	69%	83%	88%	29%	37%	46%	1%	5%	7%	**37,5%**	**38,2%**	34%	112%
Belgium	6%	13%	20%	4%	8%	13%	0%	9%	11%	**9,2%**	**9,2%**	13%	**71%**
Denmark	35%	43%	89%	31%	38%	52%	0%	11%	18%	**30,1%**	**29,4%**	30%	**98%**
Finland	29%	35%	45%	45%	55%	71%	0%	5%	8%	**40,2%**	**40,6%**	38%	107%
France	19%	31%	47%	16%	26%	37%	4%	10%	8%	**22,7%**	**21,9%**	23%	**95%**
Germany	14%	32%	39%	6%	15%	23%	4%	8%	10%	**16,7%**	**16,7%**	18%	**93%**
Greece	13%	26%	49%	16%	23%	31%	2%	8%	8%	**18,9%**	**19,2%**	18%	106%
Ireland	14%	40%	88%	5%	11%	19%	2%	9%	11%	**15,7%**	**15,9%**	16%	**100%**
Italy	21%	30%	34%	4%	11%	27%	2%	7%	9%	**14,2%**	**14,6%**	17%	**86%**
Luxembourg	4%	10%	16%	2%	6%	9%	1%	6%	7%	**6,2%**	**7,4%**	11%	**67%**
Netherlands	10%	23%	41%	2%	6%	13%	1%	6%	8%	**10,1%**	**11,0%**	14%	**79%**
Portugal	41%	59%	87%	38%	40%	54%	1%	1%	1%	**31,4%**	**34,0%**	31%	110%
Spain	34%	59%	86%	12%	20%	34%	2%	7%	4%	**25,2%**	**26,0%**	20%	130%
Sweden	55%	64%	80%	58%	53%	60%	3%	9%	11%	**46,1%**	**45,5%**	49%	**93%**
United Kingdom	11%	34%	53%	3%	8%	20%	1%	7%	10%	**13,8%**	**14,5%**	15%	**97%**
Cyprus	1%	17%	41%	15%	23%	32%	1%	4%	8%	**11,9%**	**13,4%**	13%	103%
Czech Republic	7%	19%	22%	10%	16%	22%	4%	9%	9%	**14,9%**	**14,8%**	13%	114%
Estonia	3%	14%	38%	37%	50%	79%	0%	4%	8%	**28,1%**	**30,1%**	25%	121%
Hungary	6%	21%	25%	8%	17%	28%	3%	12%	18%	**16,4%**	**15,3%**	13%	118%
Latvia	38%	60%	74%	52%	61%	78%	0%	7%	15%	**44,7%**	**45,3%**	42%	108%
Lithuania	5%	15%	44%	32%	48%	61%	3%	15%	42%	**30,4%**	**27,5%**	23%	119%
Malta	0%	16%	22%	4%	11%	22%	1%	5%	8%	**9,3%**	**10,3%**	10%	103%
Poland	6%	20%	33%	12%	20%	30%	6%	16%	23%	**19,1%**	**17,2%**	15%	115%
Slovakia	20%	32%	36%	8%	17%	27%	0%	7%	12%	**18,4%**	**18,5%**	14%	132%
Slovenia	29%	45%	41%	24%	41%	55%	0%	2%	5%	**29,5%**	**31,9%**	25%	128%
Bulgaria	10%	20%	33%	18%	32%	44%	2%	12%	14%	**22,5%**	**21,5%**	16%	134%
Romania	32%	48%	58%	21%	25%	35%	1%	20%	25%	**28,8%**	**26,5%**	24%	111%
EU 27	**20,4%**	**35,3%**	**49,9%**	**12,1%**	**19,7%**	**30,6%**	**2,3%**	**8,3%**	**9,7%**	**20,1%**	**20,1%**	20%	100%

* considering an equal biofuel 2020-target in size of 10% for all Member States ("biofuel equalisation")



Fraunhofer ISI

Scenario results – *Global Regime / Full Trade*

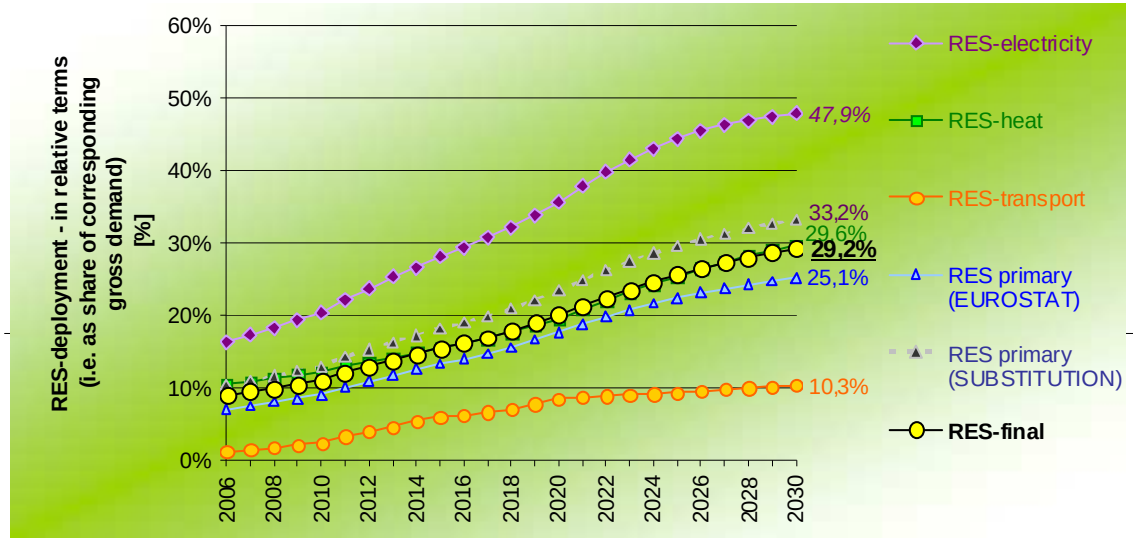
secure
Security of Energy Considering its Uncertainty, Risks and Economic implications

% deployment	European Union 27				
	2006	2010	2020	2030	
Share of RES-E on electricity demand	16%	20%	36%	48%	
Share of RES-H on heat demand	10%	12%	19%	30%	
Share of RES-T on transport fuel demand	1%	2%	8%	10%	
Share of RES on final demand	**9%**	**11%**	**20%**	**29%**	
Share of RES on primary demand	7%	9%	18%	25%	*(Eurostat convention)*
	10%	13%	23%	33%	*(Substitution principle)*

- *Exact target achievement in 2020*
- *Use of flexibility mechanisms*
- *Ambitious increase of RES share beyond 2020*

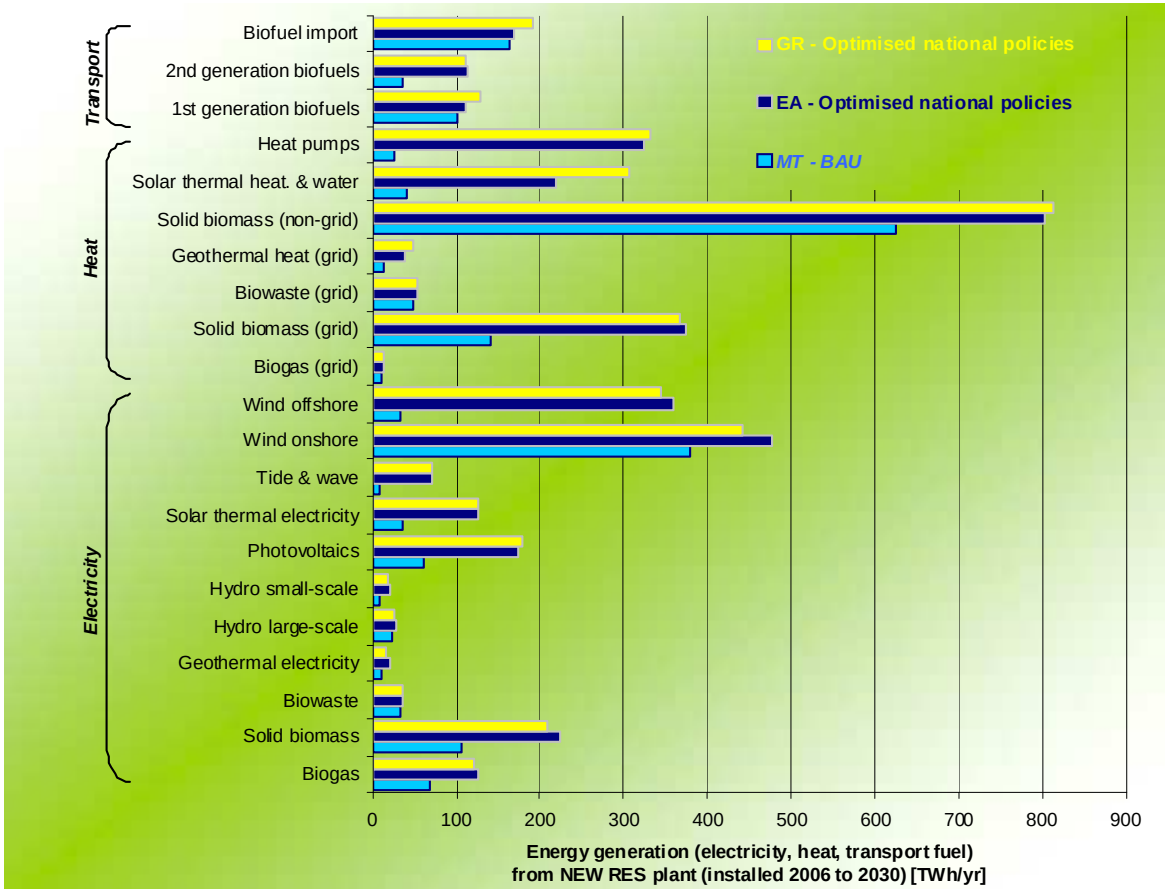
Country breakdown	% RES-E			% RES-H			% RES-T			% RES-final		Proposed RES targets	
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2020	2020*		
Austria	69%	81%	87%	29%	37%	45%	1%	6%	7%	**37,4%**	**38,0%**	34%	112%
Belgium	6%	12%	15%	4%	8%	14%	0%	9%	10%	**8,9%**	**8,9%**	13%	**68%**
Denmark	35%	51%	102%	31%	38%	49%	0%	11%	20%	**32,0%**	**31,4%**	30%	105%
Finland	29%	37%	43%	45%	54%	68%	0%	5%	8%	**40,2%**	**40,7%**	38%	107%
France	19%	28%	42%	16%	25%	37%	4%	11%	8%	**21,8%**	**21,0%**	23%	**91%**
Germany	14%	35%	37%	6%	14%	24%	4%	8%	12%	**17,3%**	**17,2%**	18%	**96%**
Greece	13%	25%	46%	16%	24%	29%	2%	8%	10%	**18,5%**	**18,8%**	18%	105%
Ireland	14%	40%	84%	5%	11%	19%	2%	9%	10%	**15,2%**	**15,5%**	16%	**97%**
Italy	21%	30%	31%	4%	11%	26%	2%	7%	9%	**14,0%**	**14,4%**	17%	**85%**
Luxembourg	4%	9%	15%	1%	5%	9%	1%	6%	7%	**5,8%**	**7,1%**	11%	**65%**
Netherlands	10%	31%	40%	2%	7%	14%	1%	6%	8%	**12,1%**	**13,1%**	14%	**93%**
Portugal	41%	56%	79%	38%	40%	51%	1%	5%	1%	**31,9%**	**33,0%**	31%	106%
Spain	34%	60%	90%	12%	20%	32%	2%	7%	6%	**25,3%**	**26,1%**	20%	130%
Sweden	55%	63%	77%	58%	52%	58%	3%	9%	13%	**45,6%**	**45,2%**	49%	**92%**
United Kingdom	11%	32%	51%	3%	9%	18%	1%	7%	10%	**13,5%**	**14,3%**	15%	**96%**
Cyprus	1%	16%	35%	15%	25%	29%	1%	4%	7%	**12,2%**	**13,7%**	13%	106%
Czech Republic	7%	18%	21%	10%	16%	22%	4%	8%	10%	**14,8%**	**14,8%**	13%	114%
Estonia	3%	22%	42%	37%	50%	75%	0%	4%	7%	**30,0%**	**32,1%**	25%	129%
Hungary	6%	20%	23%	8%	17%	26%	3%	12%	18%	**16,2%**	**15,2%**	13%	117%
Latvia	37%	55%	72%	51%	60%	76%	0%	8%	13%	**43,5%**	**44,0%**	42%	105%
Lithuania	4%	16%	43%	32%	47%	59%	3%	15%	41%	**30,2%**	**27,4%**	23%	119%
Malta	0%	16%	22%	4%	11%	18%	1%	5%	8%	**9,0%**	**10,1%**	10%	101%
Poland	6%	19%	32%	12%	20%	28%	6%	15%	21%	**18,8%**	**17,1%**	15%	114%
Slovakia	20%	33%	36%	8%	18%	27%	0%	7%	11%	**19,0%**	**19,3%**	14%	138%
Slovenia	29%	44%	41%	24%	39%	53%	0%	2%	5%	**28,8%**	**31,3%**	25%	125%
Bulgaria	10%	20%	30%	18%	31%	43%	2%	12%	13%	**22,1%**	**21,1%**	16%	132%
Romania	32%	46%	57%	21%	24%	32%	1%	20%	25%	**27,7%**	**25,5%**	24%	106%
EU 27	**20,3%**	**35,6%**	**47,9%**	**12,1%**	**19,5%**	**29,6%**	**2,3%**	**8,5%**	**10,3%**	**20,0%**	**20,0%**	20%	**100%**

* considering an equal biofuel 2020-target in size of 10% for all Member States ("biofuel equalisation")



Fraunhofer ISI

Comparison – Development of different policy storylines



Due to ***higher CO2 constraints*** for Europe, ***electricity wholesale prices*** in the Europe Alone scenario are ***higher*** and hence a ***stronger RES-E contribution*** is expected than at global, common CO2 constraints

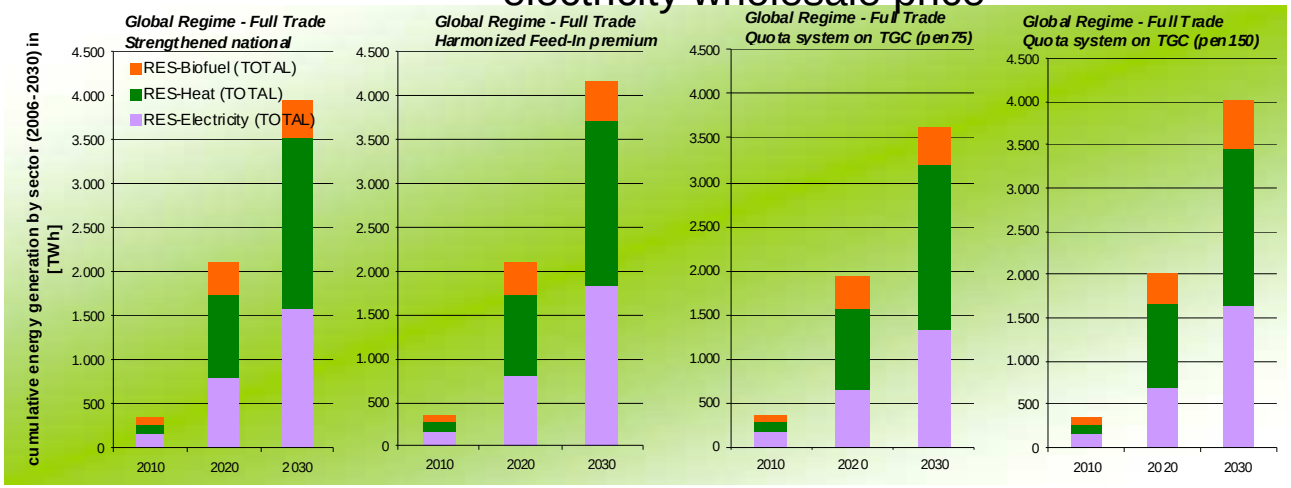
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

Policy sensitivity – Different policy support measures

- *Strengthened national policy:* National policy implementation in order to meet the 20% RES target
- *Harmonized premium feed-in tariff:* Common premium on top of the electricity wholesale price in order to meet the 20% RES target
- *Quota system based on technology neutral, tradable green certificates:* Quantity driven with a maximum price on top of the electricity wholesale price



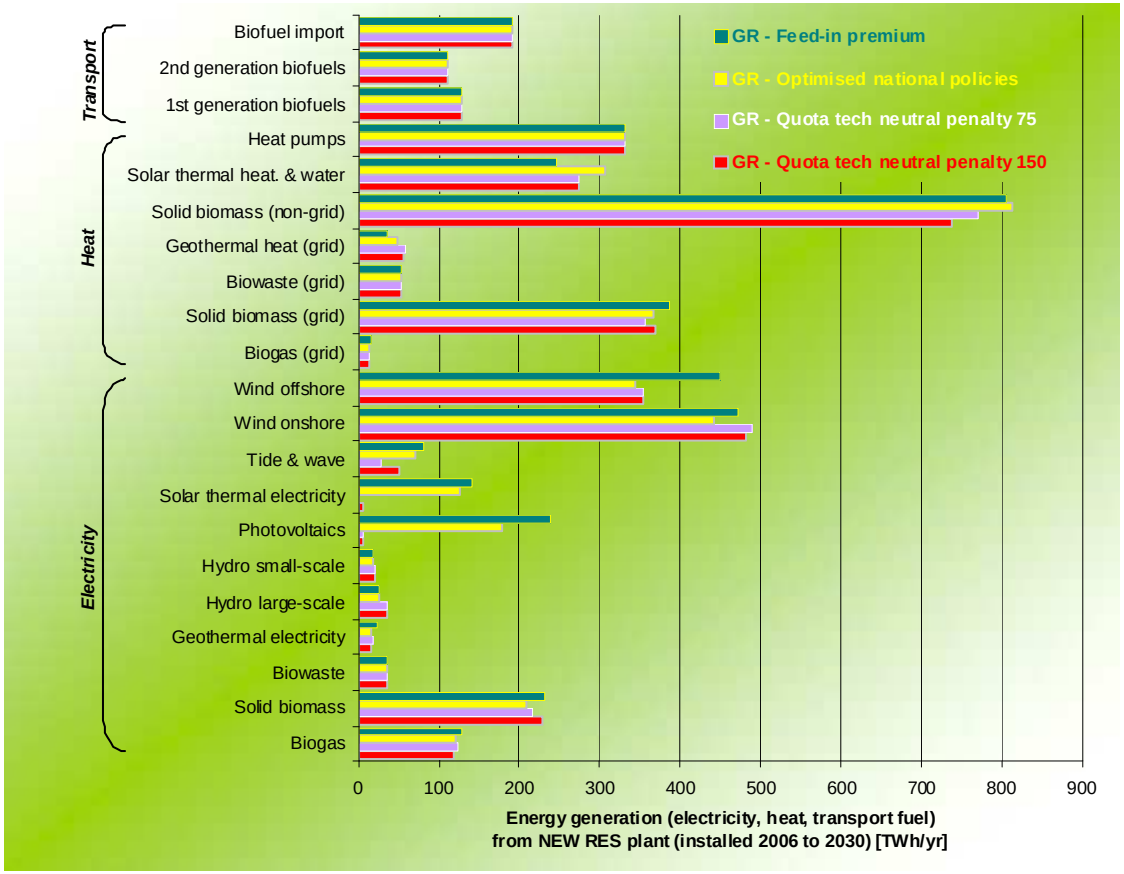
Less RES generation in the electricity sector at ***technology neutral support measures***, leading to ***fail the 20% RES by 2020 target,*** regardless the maximum certificate price. Strong deviations in 2020 and especially strong beyond 2020

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

Policy sensitivity – Different policy support measures



Strong deviations of RES generation for currently *novel, more expensive technologies* which are *needed* for challenging future RES targets (*wind offshore, PV, solar thermal electricity*)

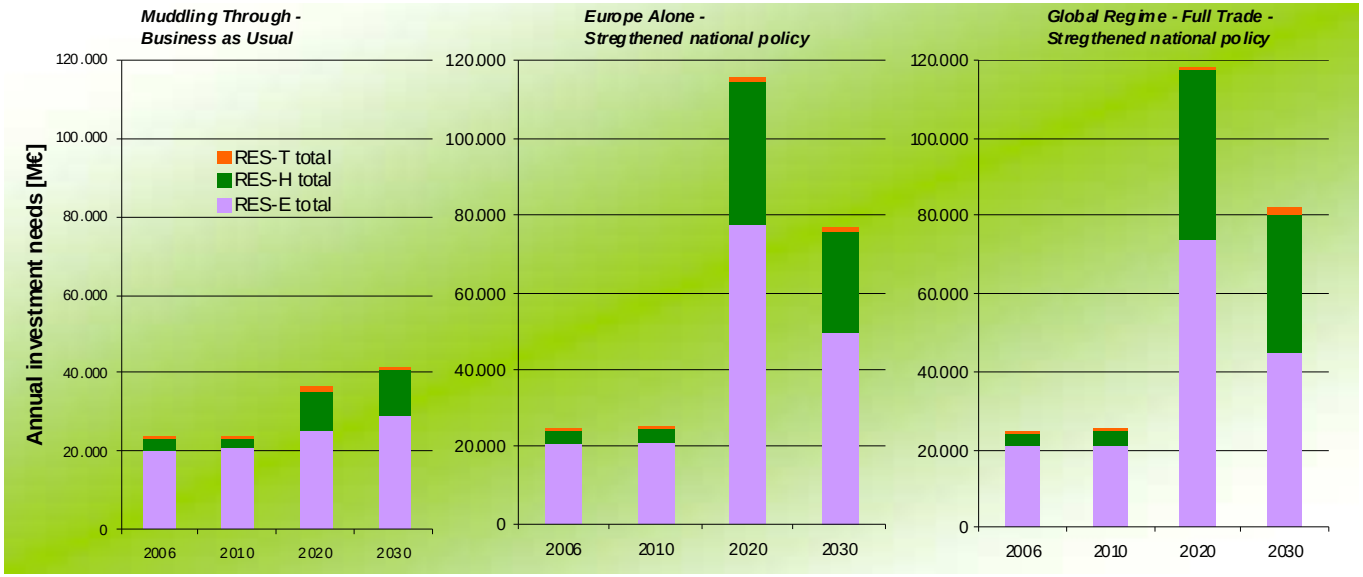
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

Costs of enhanced RES deployment

Required investment in order to meet the enhanced RES deployment in 2010, 2020 and 2030



Only moderate increases are expected in the Business as Usual case

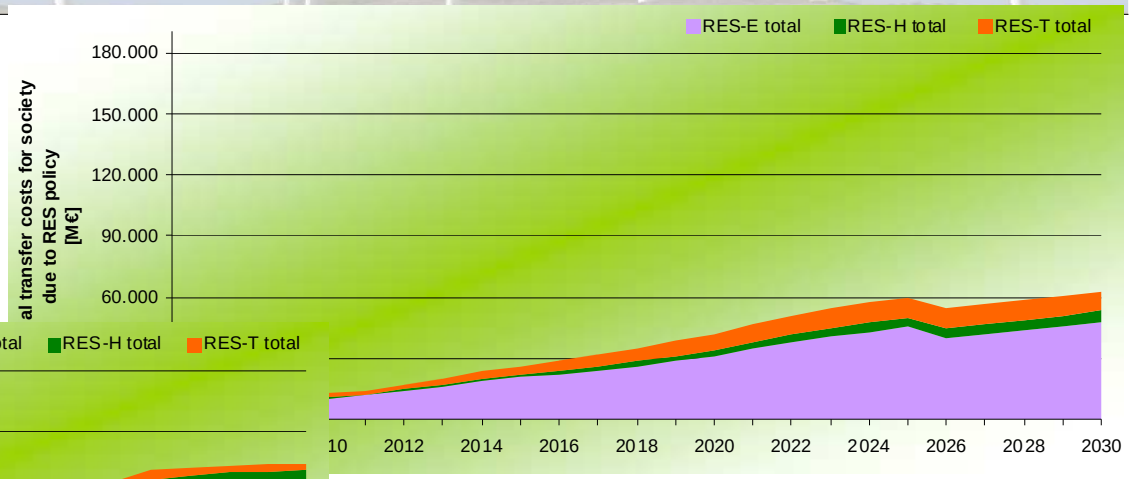
A *tripling of investments* is expected within the *next 10 years* in order to *meet the target ->*
Need for *efficient* and *effective policy measures* to *limit consumer expenditures*

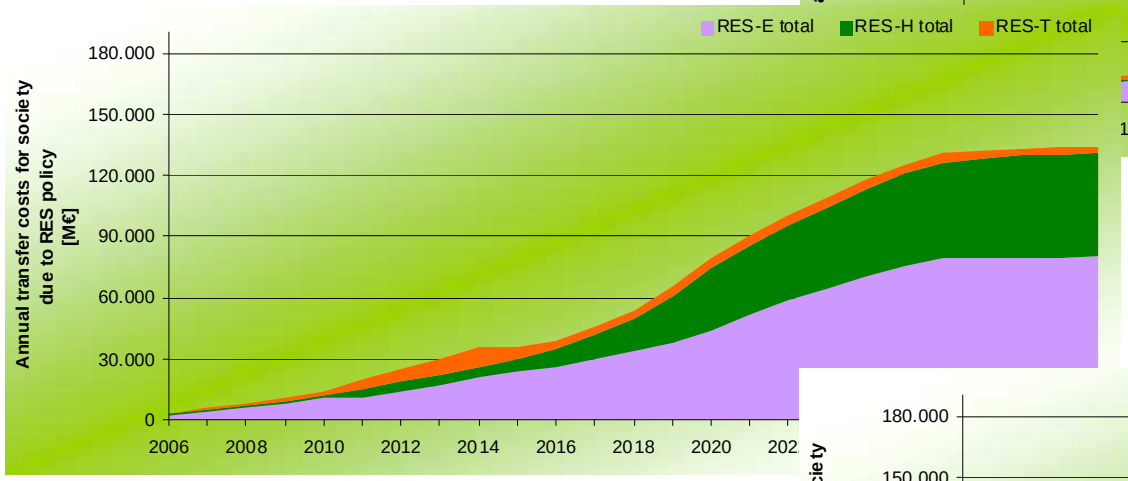
Less investments have to be taken *beyond 2020* due to *learning effects* and decreased costs

Costs of enhanced RES deployment

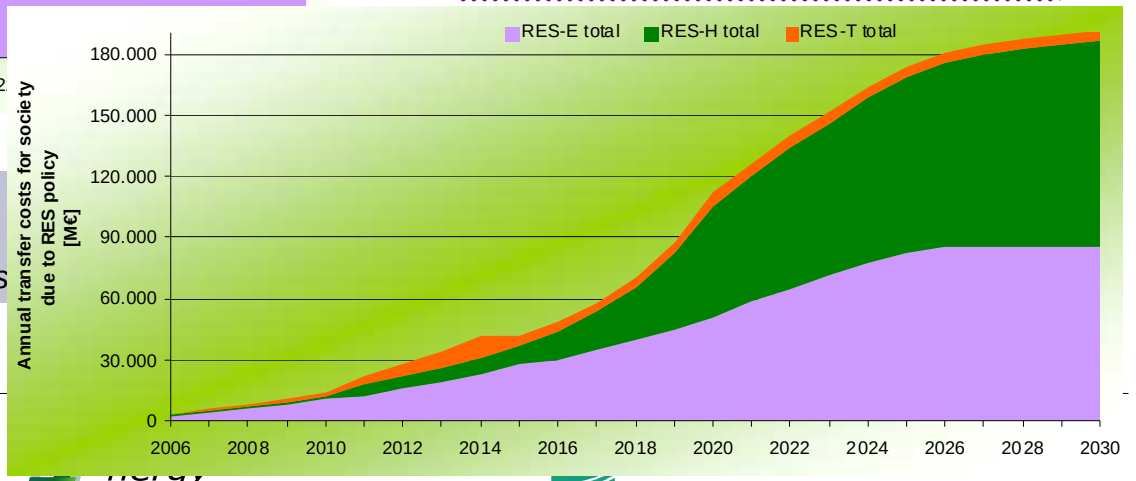
secure
Security of Energy Considering its Uncertainty, Risks and Economic implications

Corresponding consumer expenditures = policy costs





Tripling the investments only leads to less than a doubling of policy costs



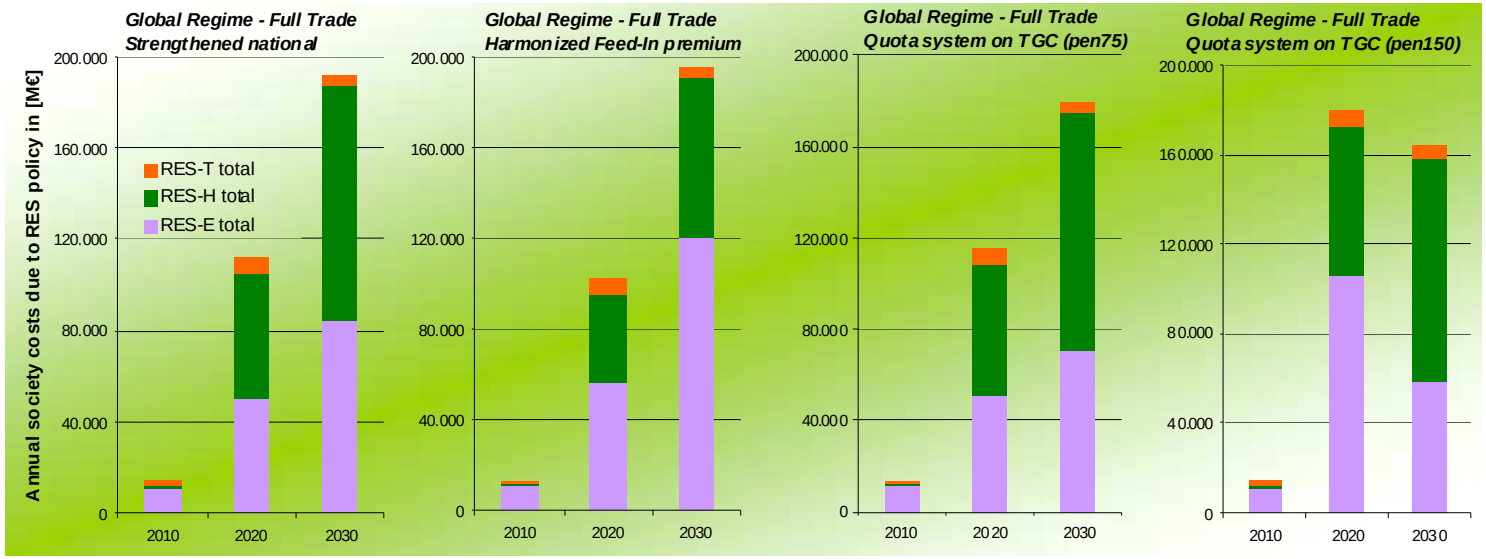
Higher policy costs in the Global Regime than in the Europe Alone scenario, due to less CO2 constraints in the EU and consequently lower energy wholesale prices

TU WIEN
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

Sensitivity cases : Costs of enhanced RES deployment according to the different policy options

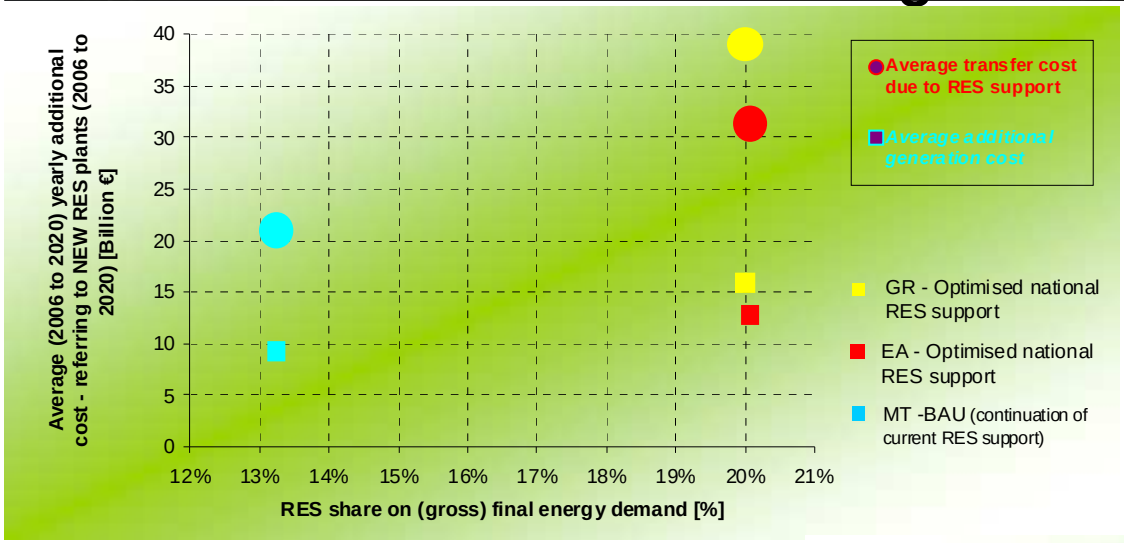


Only technology specific support options *meet the 20% RES in 2020* target (left figures)

Nevertheless, technology specific options *result in lower consumer expenditures* (2020) due to enhanced RES support

Increasing the limit of *certificate prices* hardly increases the RES generation but *tremendously increase the policy costs*, hence the consumer expenditures (2020)

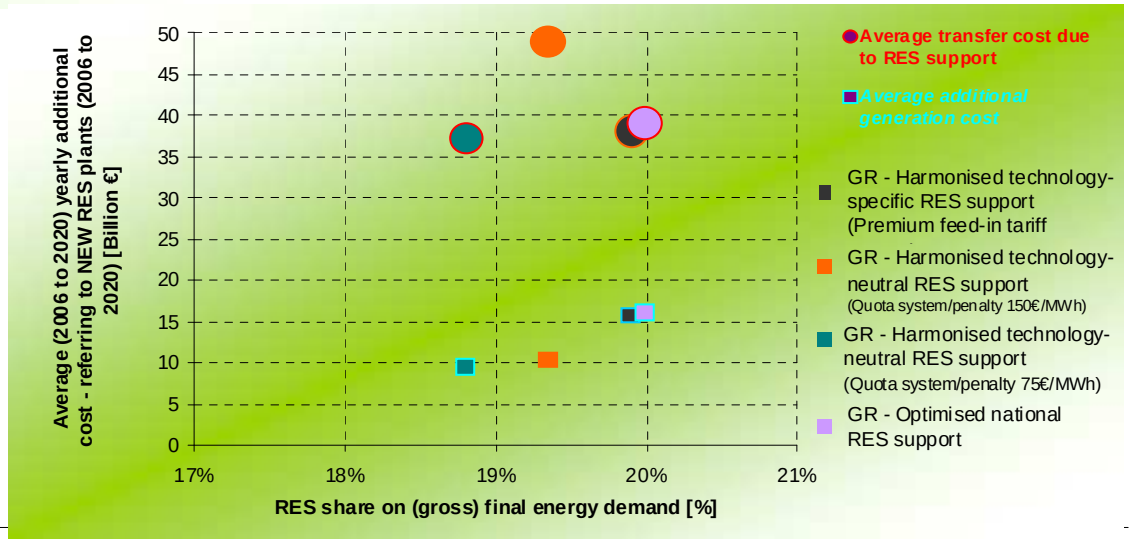
Sensitivity cases : Costs of enhanced RES deployment according to the different policy options



Business as Usual fails to meet the target at high consumer costs

Strengthened national policy options meet the target at only moderately higher consumer costs

Technology specific support is deeply recommended in order to increase ambitious shares of RES and avoid big producer surpluses causing higher consumer expenditures and less social acceptance of RES



TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

Contribution of RES to decreasing import dependency

Muddling Through:

267 Mtoe avoided fossil fuel consumption in 2030 due to domestic RES generation, meaning 78 billion Euro

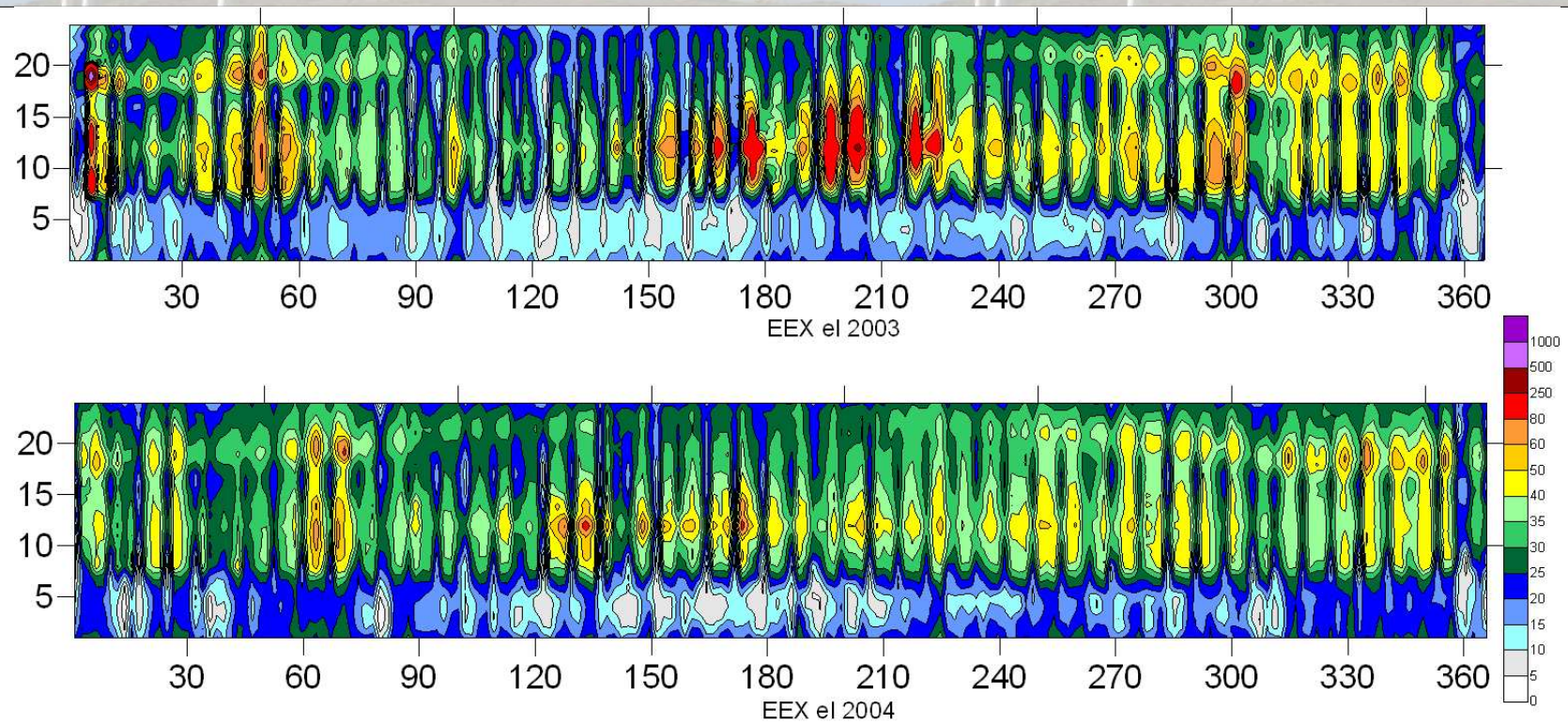
Europe Alone:

540 Mtoe avoided fossil fuel consumption in 2030 due to domestic RES generation, meaning 146 billion Euro

Global Regime – Full Trade:

539 Mtoe avoided fossil fuel consumption in 2030 due to domestic RES generation, meaning 145 billion Euro
Mainly impacting (reducing) the coal imports among fossil imports.

Risks of Security of Supply at enhanced RES penetration – hot summers!



EEX spot-market prices in 2003 and 2004

- **High demand (cooling appliances,…)**
- **Less RES generation (water, wind, biomass,…)**
- **Resulting high peak prices**

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Energy Economics Group

Fraunhofer ISI

Conclusions – General implications for security of energy supply

- An increased use of RES in the electricity, transport and the heating sector may contribute considerably to decreasing import dependency
- Additional benefits of RES with regard to the achievement of climate change targets
- But: Decrease in import dependency involves certain transfer costs for society
- Economic risk: competitiveness of RES is expected to improve in the future
- Other threads resulting from the specific character of RES (variable power output) seem to be still manageable → May require certain changes in system operation and infrastructure

Contact

Christian Panzer

e-mail: panzer@eeg.tuwien.ac.at

Energy Economics Group (EEG)
Vienna University of Technology
Gusshausstraße 25-29/E373-2
1040 Vienna, Austria
http://eeg.tuwien.ac.at

Anne Held

e-mail: anne.held@isi.fraunhofer.de

Fraunhofer Institute for Systems
and Innovation Research (ISI)
Breslauer Straße 48
76139 Karlsruhe, Germany
www.isi.fraunhofer.de

Thank you for your attention!