Potentials and Cost of RES-E in the EU25+ Region

Deliverable 3a

GreenNet-EU27

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Outline

1. Introduction

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- RES-E technologies considered

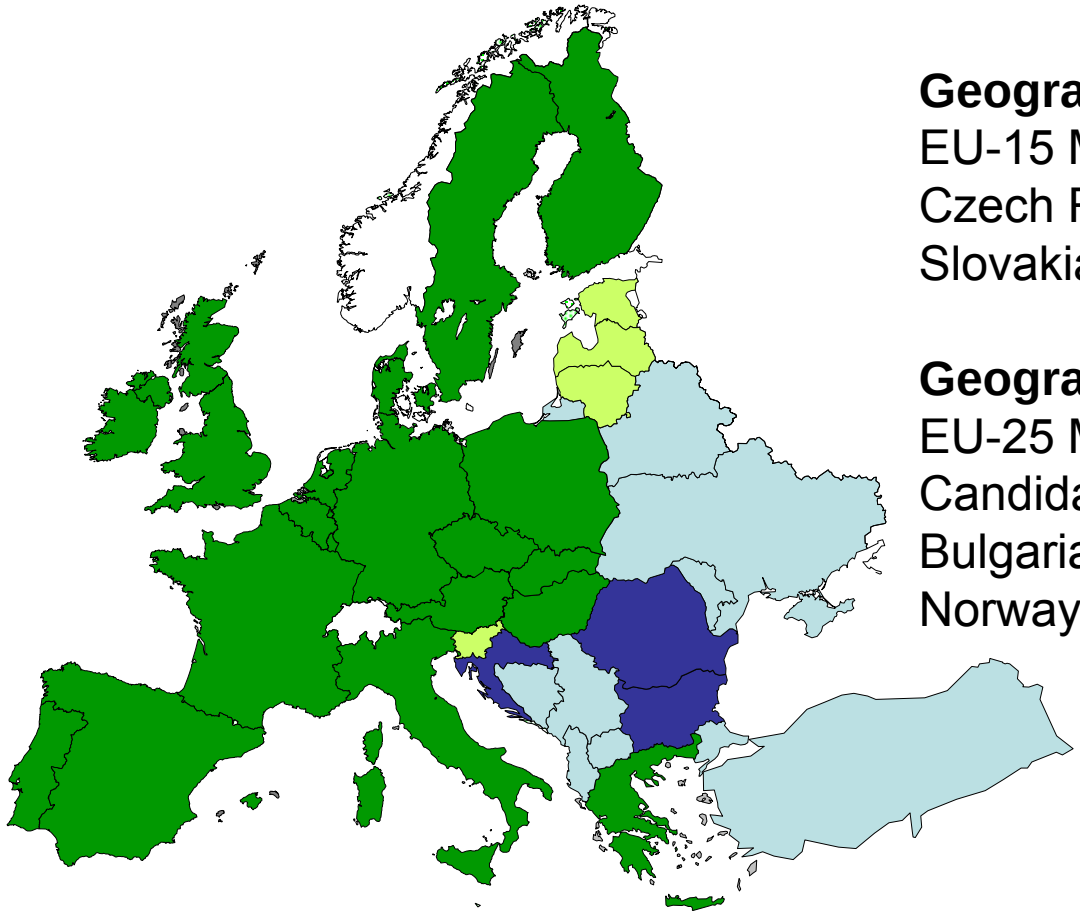
2. Basic principles

- Static cost resource curves
- Dynamic restrictions/experience curves
- Dynamic cost-resource curves

3. Results

- Status quo of RES-E in EU25+ region
- Additional mid-term potentials
- Current bandwidth of cost
- Characterisation of selected “new” countries

1. Introduction: Extension of GreenNet database



Geografical coverage GreenNet
EU-15 Member States +
Czech Republic, Hungary, Poland, Slovakia

Geografical coverage GreenNet-EU27
EU-25 Member States +
Candidate Countries
Bulgaria, Romania, Croatia +
Norway and Switzerland

1. Introduction: Update of GreenNet database

- Update of achieved **potentials** and additional mid-term potentials against **basis year 2004** (the first simulation year will be 2005)
- **Cost** of RES-E **updated to 2004 level** (in €2004)
- Data is updated continously to reach high quality of simulation results

1. Introduction: RES-E technologies considered

E & C	*1.*	*Biogas*	
E & C	*2.*	*Biomass*	*Forestry products,* *Forestry residues,* *Agricultural products* *Agricultural residues* *Biodegradable fraction of waste*
E & C	*3.*	*Geothermal electricity*	
E	*4.*	*Hydro power*	*Small scale hydro power (<10 MW)* *Large scale hydro power (>10 MW)*
E & C	*5.*	*Landfill gas*	
E & C	*6.*	*Sewage gas*	
E	*7.*	*Solar*	*Photovoltaics* *Solar thermal electricity*
E	*8.*	*Tidal (stream) energy*	
E	*9.*	*Wave energy*	
E	*10.*	*Wind*	*Wind on-shore* *Wind off-shore*

Abbreviation:

E … Electricity

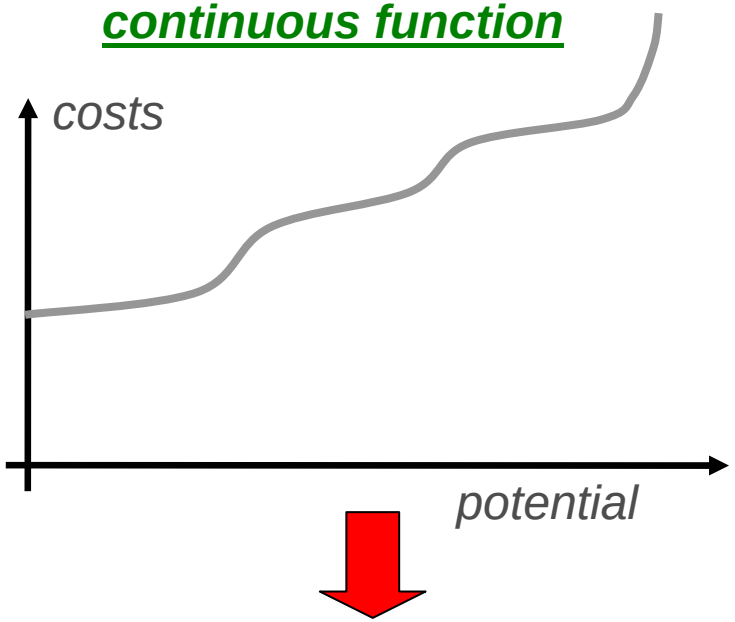
C … CHP

2. Basic principles: Static cost-resource curves

- Combines information on the **potential** and the according **costs** (of electricity for a specific energy source).
- All costs/potentials-bands are **sorted in a least cost way**
- For **limited resources** (as RES-E) **costs rise with increased utilization.**

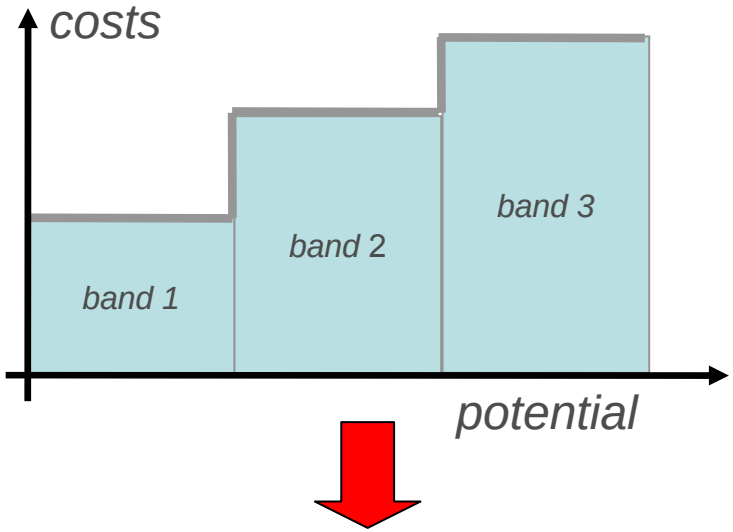
costs = f (potential); t = constant

continuous function



„…every location is slightly different“

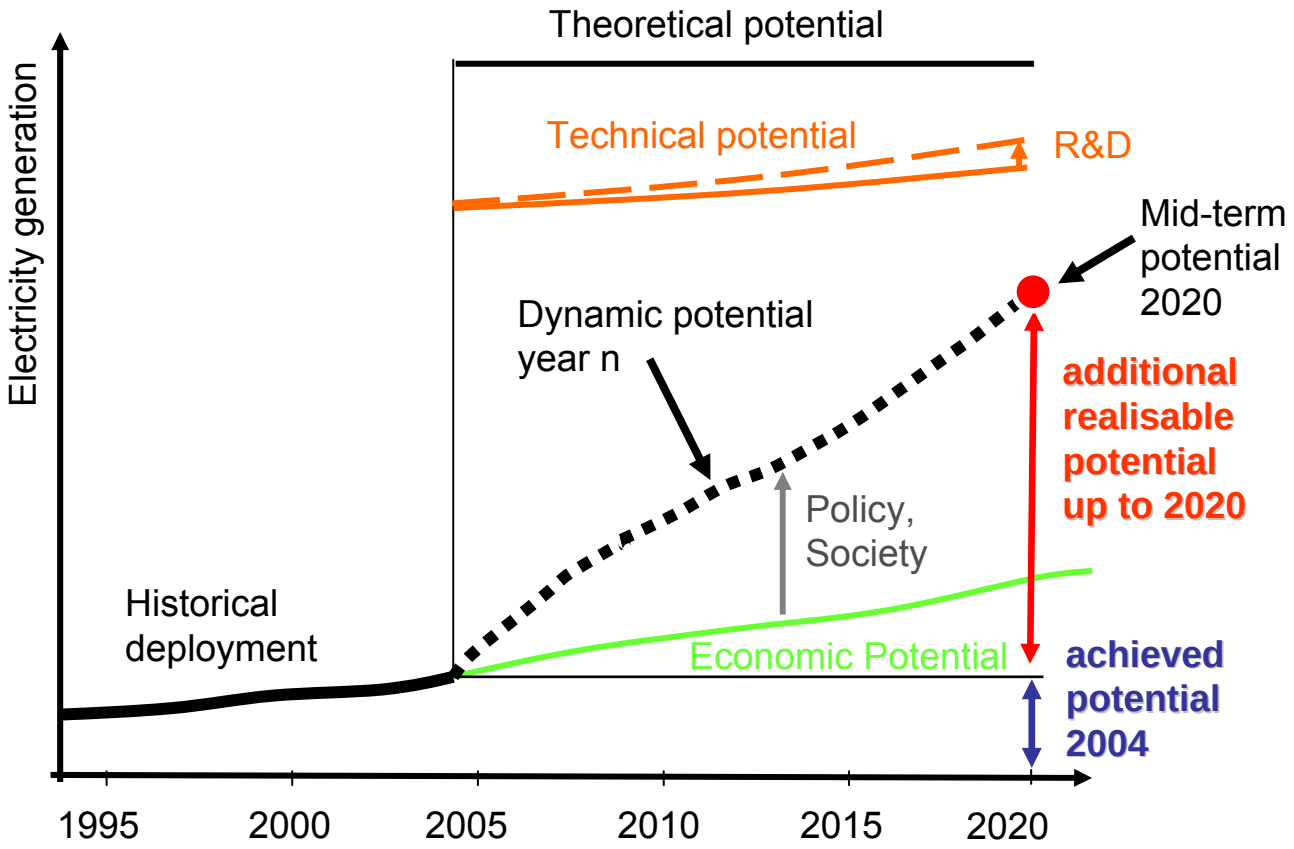
stepped (discrete) function



Practical approach: Sites with similar characteristics described by one band

2. Basic principles: Static cost-resource curves - Potentials

- **(Additional) realisable mid-term potential**



2. Basic principles: Dynamic restrictions - Potentials

➢Dynamic **limitation of annual realisable potential…**

Dynamic restricitons & their characterization		Techn.-specific	Country-specific	Band-specific	Linkage to policy	Impact on Costs	Impact on Potentials	Methodology to implement
Industrial constraints	Growth rate of industry	X					X	EU-wide limitation of annual installations…
	…							
Technical constraints	Grid constraints (i.e. extension necessary)	X	X	X		(X)	X	Band-specific limitation of annual installations, additional costs for grid extension…
	…							
Market & administr. constraints	Market transparency	X	X				X	…
	„bureaucracy“	X	X		X	(X)	X	…
	…							
Societal constraints	‘Willingness to accept‘	X	X	X	X		X	(Band-specific) limitation of annual realisable potential
	…							

2. Basic principles: Static cost-resource curves Marginal Costs

- **Costs of electricity**

$$C = \frac{I \cdot \alpha}{T} + C_{Var}$$

$$\alpha = \frac{z \cdot (1+z)^{LT}}{(1+z)^{LT} - 1}$$

C .... Costs of electricity per unit [€/MWh]
= LONG-TERM MARGINAL COSTS

I	....	Investment costs per kW [€/kW]
α	....	Capital Recovery Factor [1]
T	....	Full load hours [h/a]
z	....	Interest rate [1]
LT	....	Lifetime / depreciation time [a]

C_{Var} .... Variable costs per unit [€/MWh]
(incl. O&M, fuel costs)
= SHORT-TERM MARGINAL COSTS

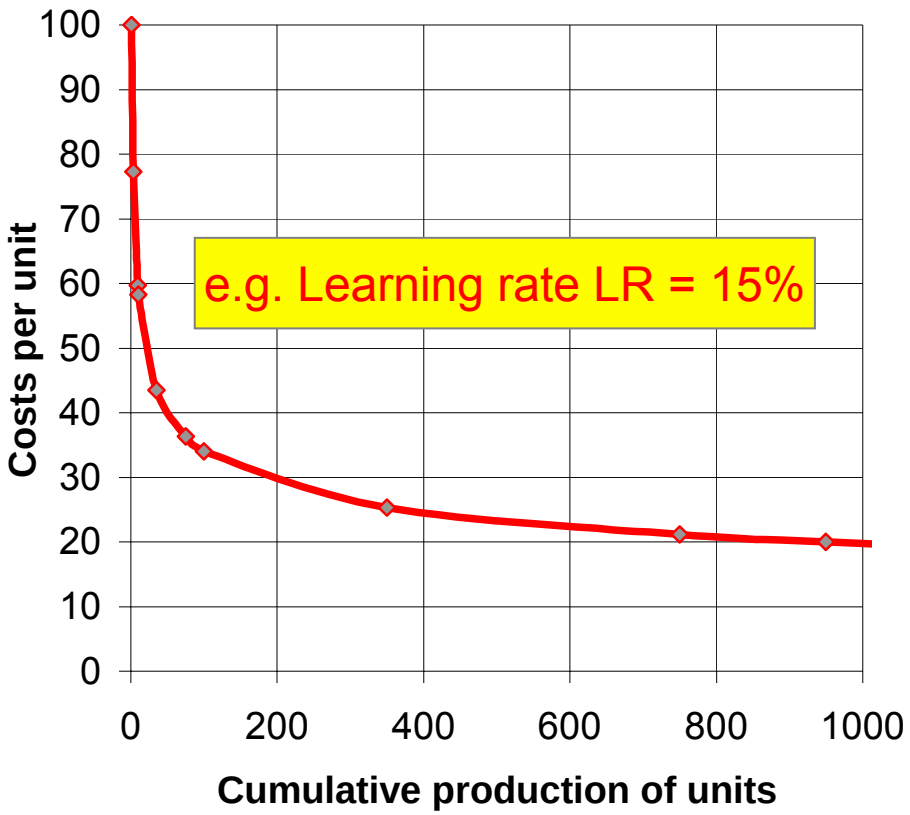
2. Basic principles: Experience curves

- describe **how costs decline with cumulative production**.
- costs decline by a **constant percentage with each doubling** of the units produced or applied.

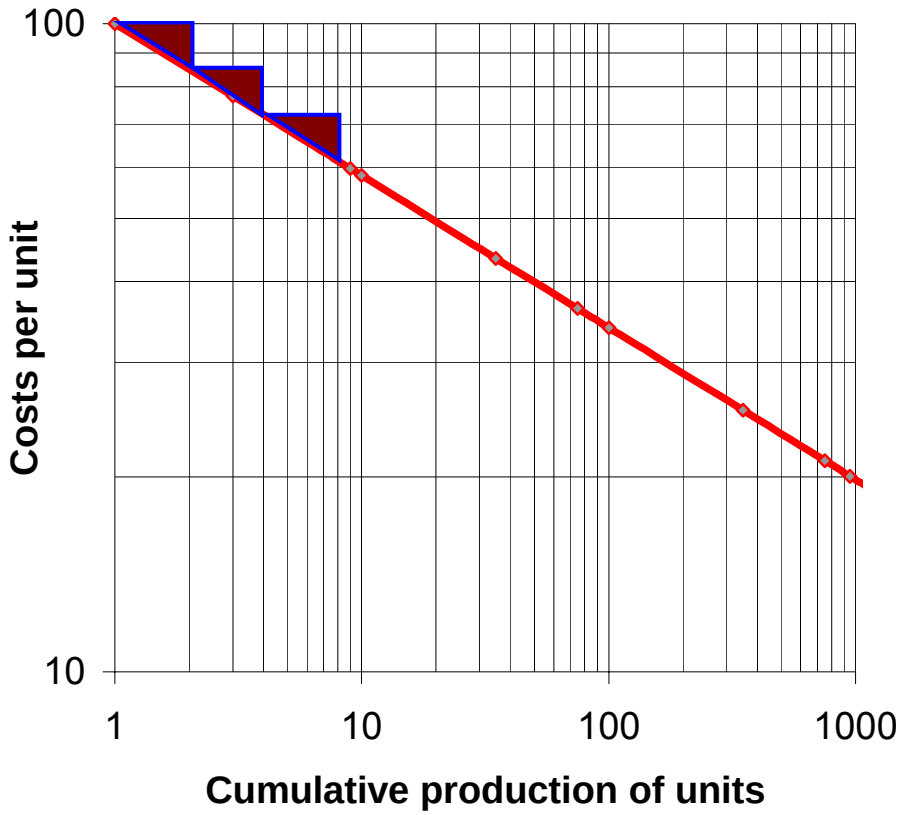
$$C_{CUM} = C_0 * CUM^b$$

C_{CUM}	Costs per unit
C_0	Costs of the first unit
CUM	Cumulative production
b	Experience index
LR	Learning rate (LR=1-2^b)

linear scale



log-log scale

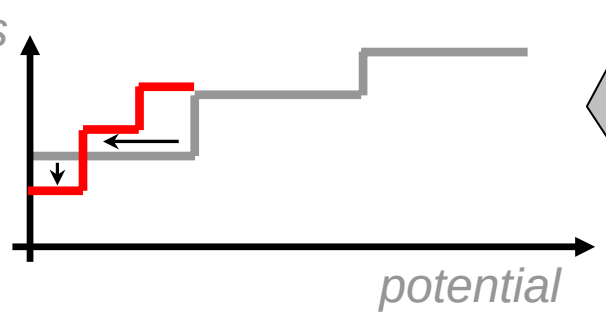


2. Basic principles: Dynamic cost-resource curves

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

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

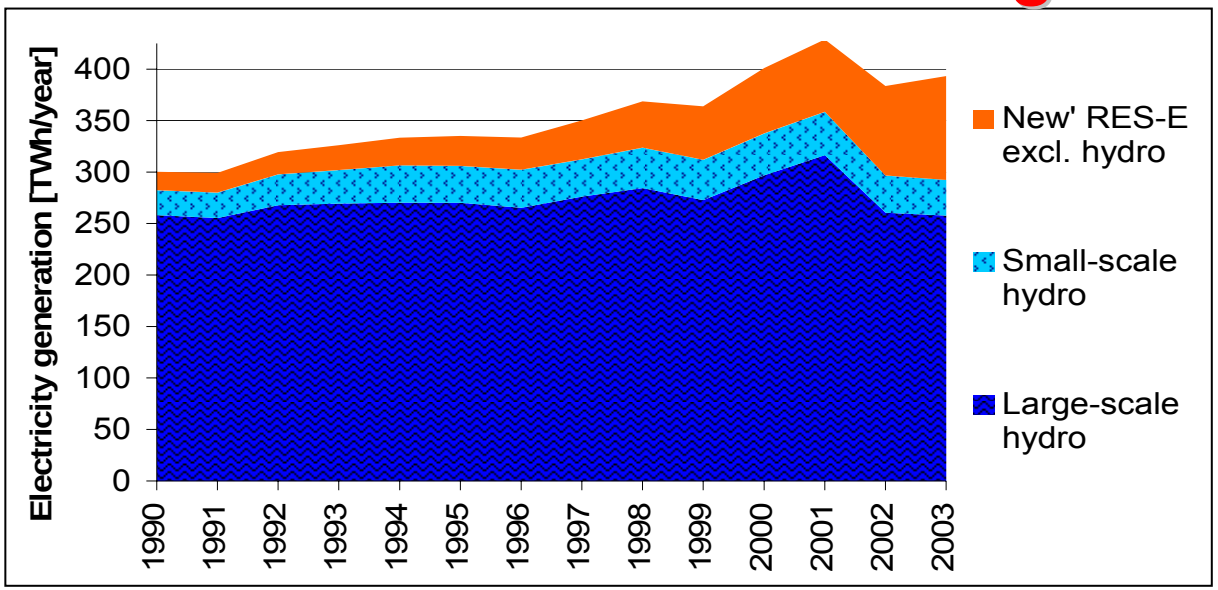
DYNAMIC
COST-RESOURCE CURVES
- by RES-E technology
- by country
- ***by year***

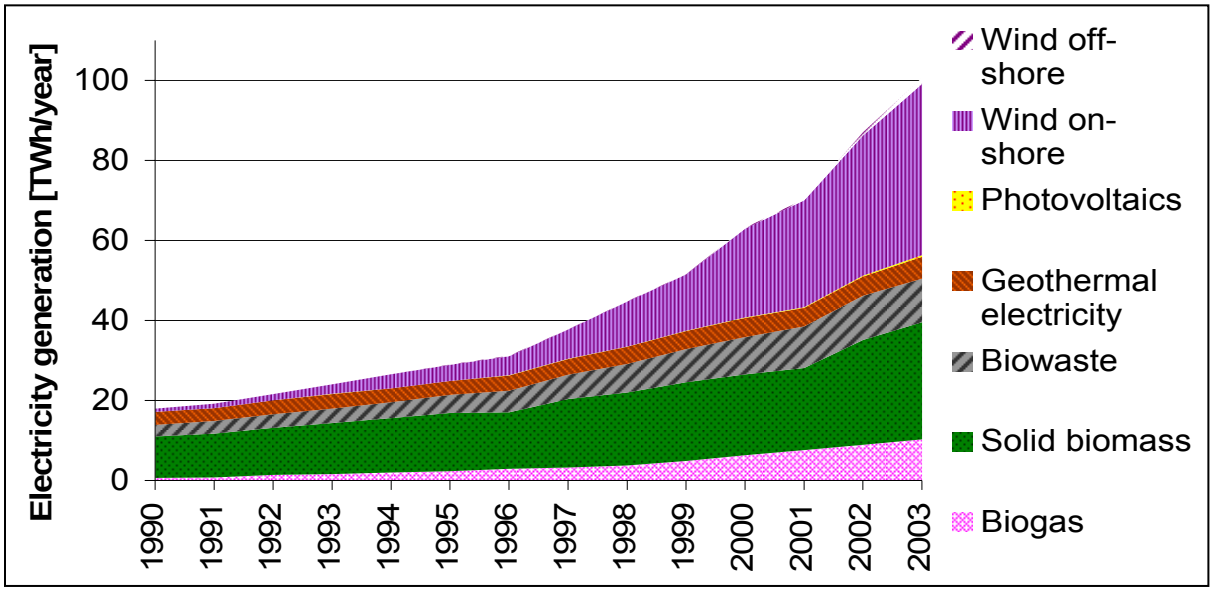


Dynamic aspects
- *Costs:* ***Dynamic cost assessment***
- *Potentials:* ***Dynamic restrictions***

A *dynamic cost-resource curve*
represents a tool to **provide the linkage** between both approaches described before,
i.e. the dynamic cost assessment as e.g. done by application of **experience curves**
and the formal description of costs and potentials by means of **static cost-resource curves**.

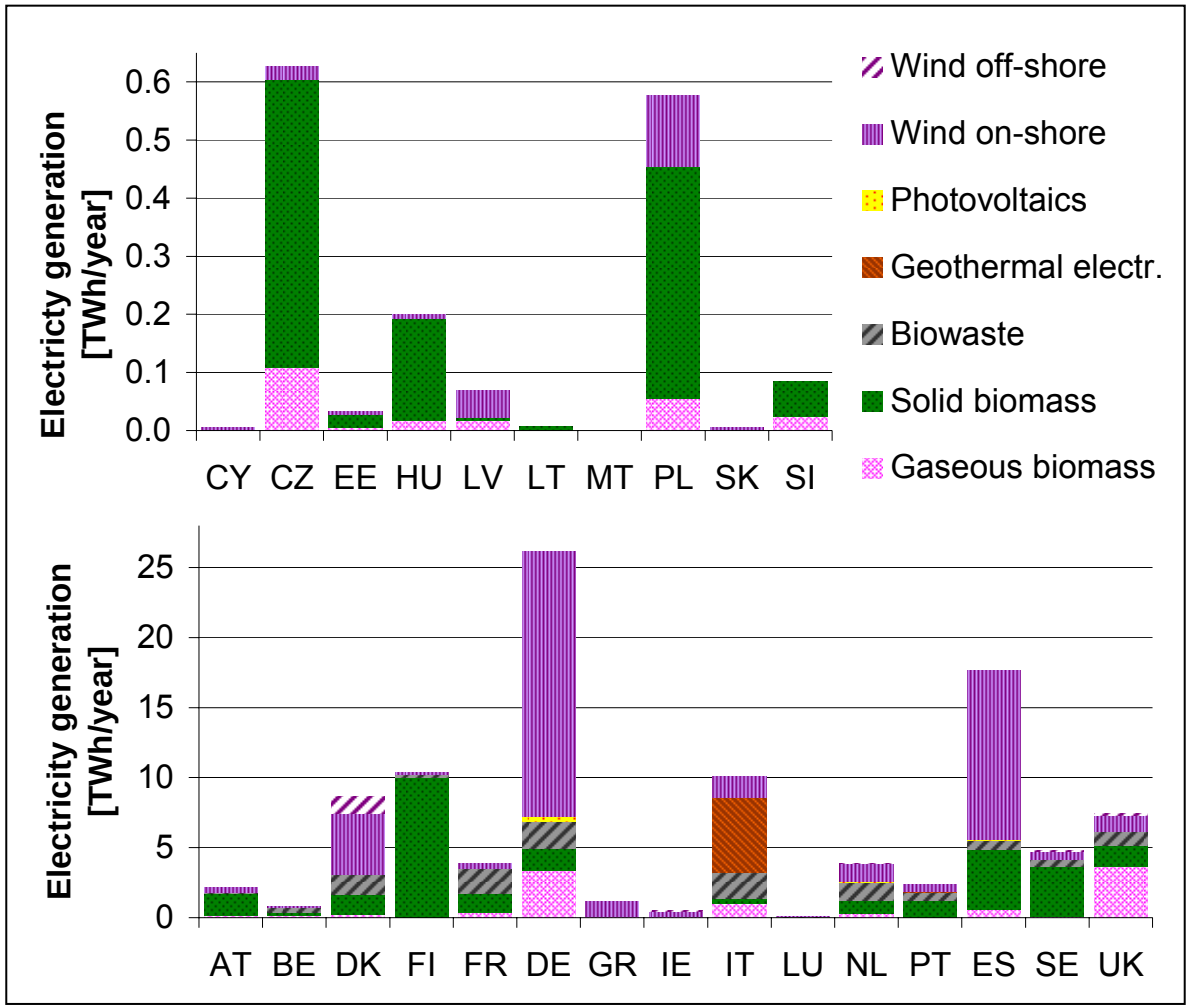
3. Results: Historical RES-E generation in EU-25





- Production from hydro power remains stable over last decade (250 - 300 TWh/yr)
- Production from new RES-E increases from 20 to 100 TWh/yr
- Fastest growing technology is wind onshore, followed by biogas and biomass

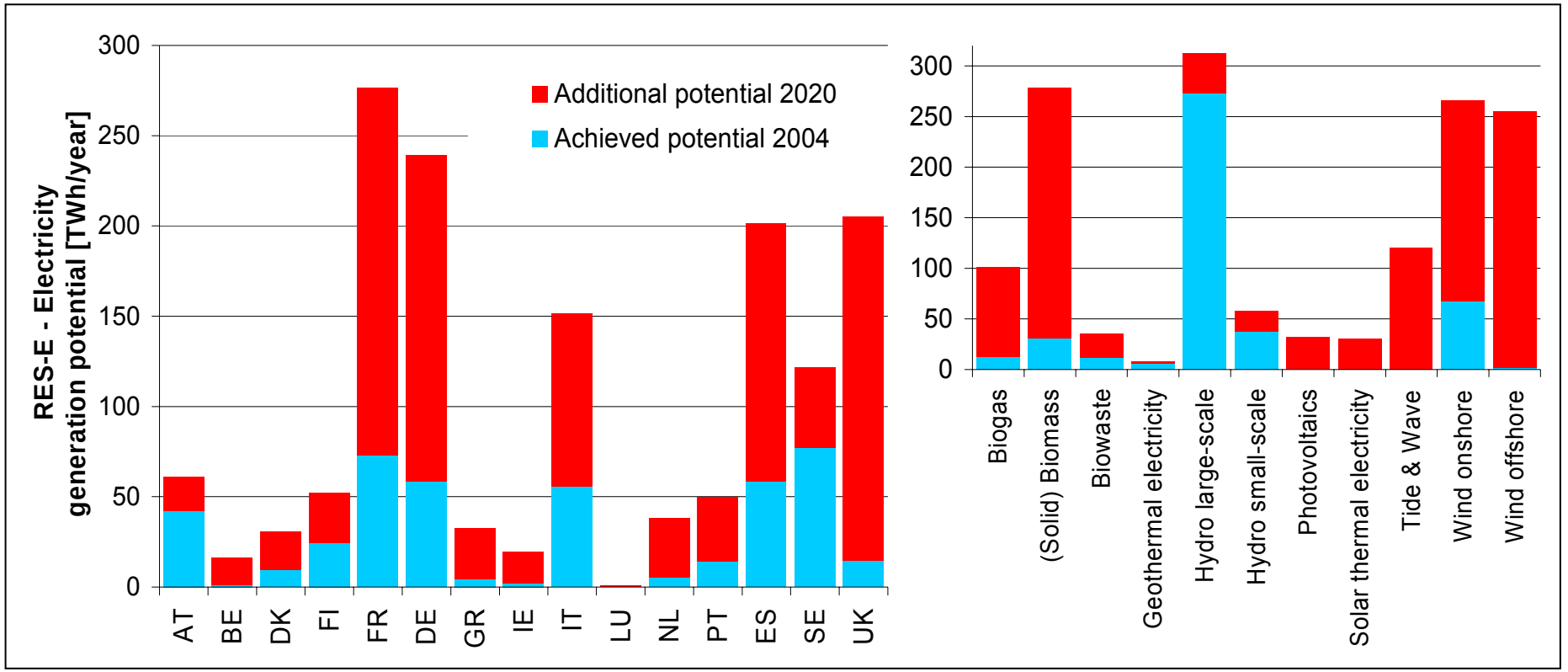
3. Results: RES-E electricity generation in 2003 (only new RES-E)



- Electricity production from new RES-E moderate in EU-10 Member States
- Countries dominated by wind onshore are Denmark, Germany and Spain
- High solid biomass share in Finland, Sweden, Czech Republic, Hungary and Poland
- Highest absolute biogas electricity generation in UK and Germany

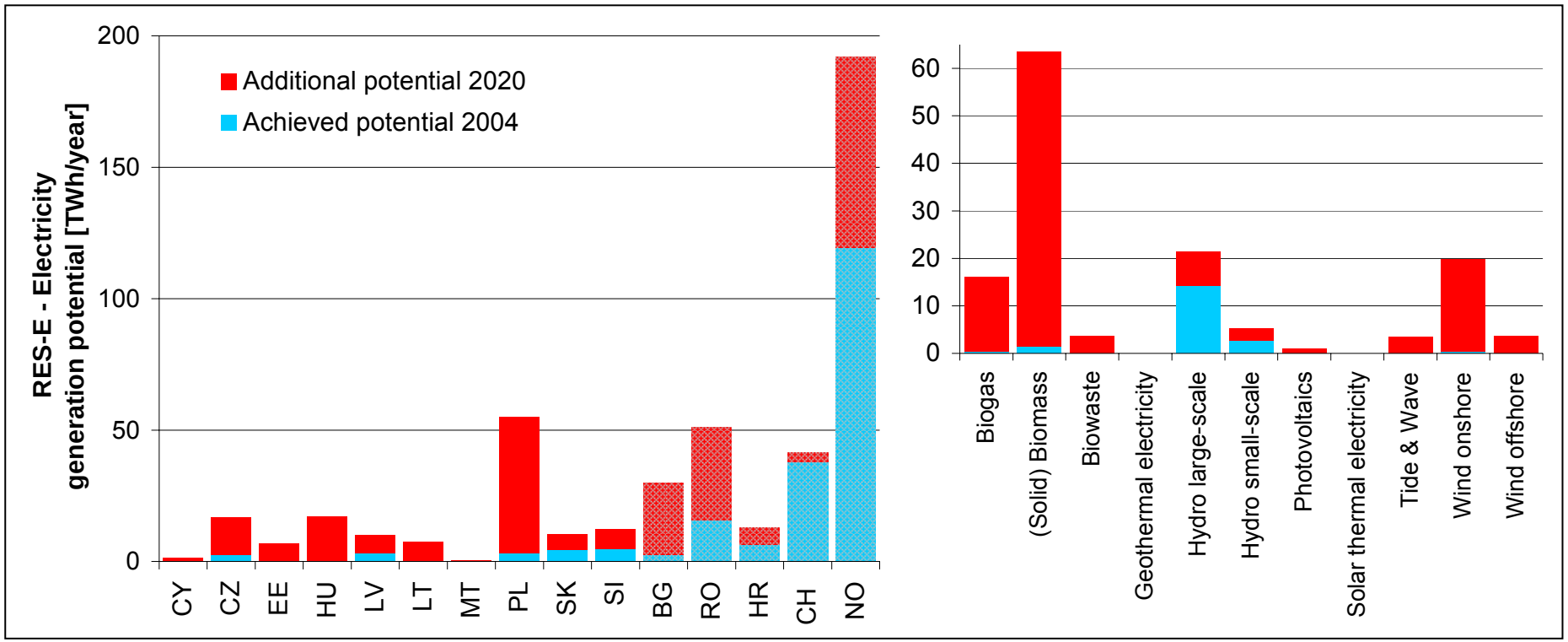
3. Results: Achieved and additional RES-E mid-term potentials *EU-15*

- Already achieved potential for RES-E generation equals 441 TWh (2004)
- Additional realisable potential up to 2020 is 1056 TWh (about 38% of gross electricity consumption in 2004)



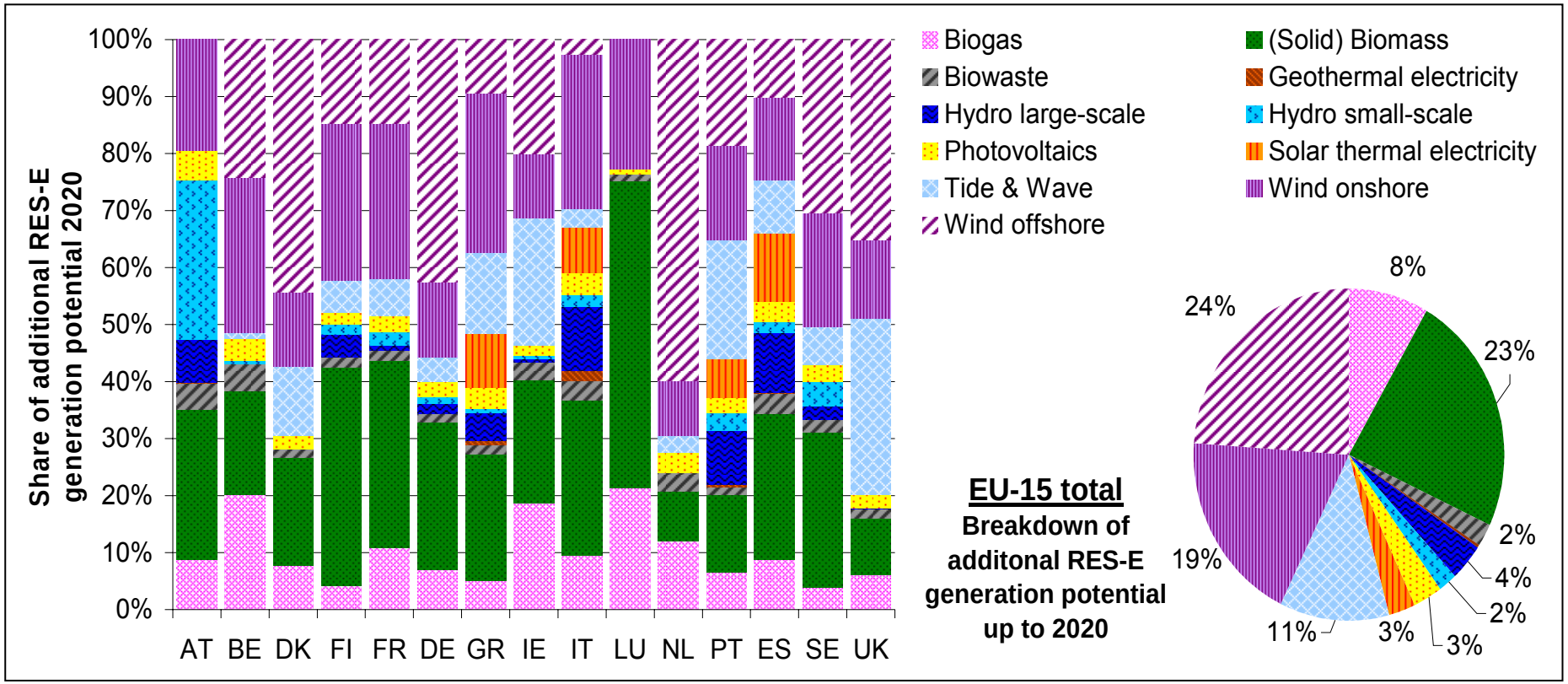
3. Results: Achieved and additional RES-E mid-term potentials *EU-10*

- Already achieved potential for RES-E generation equals 19 TWh (2004)
- Additional realisable potential up to 2020 is 119 TWh (about 36% of gross electricity consumption in 2004)



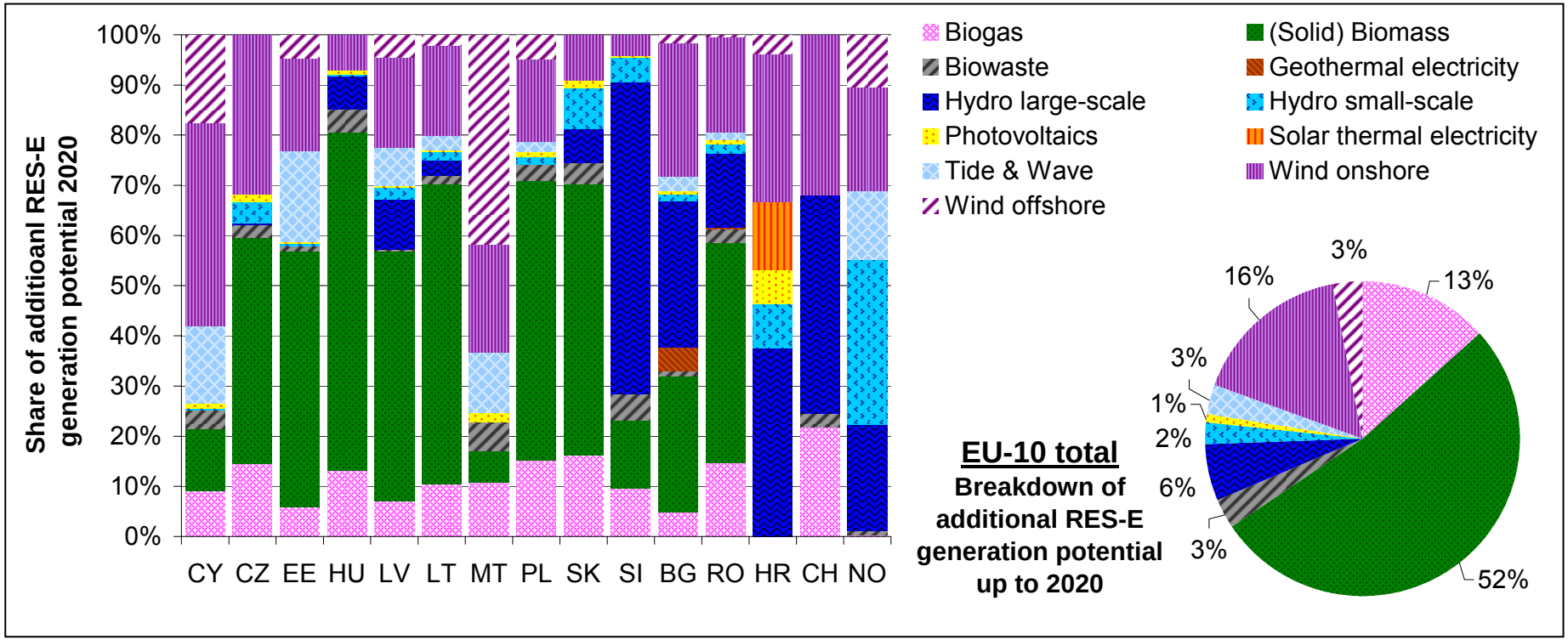
3. Results: Additional RES-E mid-term potential (up to 2020) in EU-15

- The largest potential is available in the sector of wind energy (43%) followed by solid biomass (23%), biogas (8%) as well as promising future options such as tidal and wave (11%) or solar thermal energy (3%)



3. Results: Additional RES-E mid-term potential (up to 2020) in EU-10

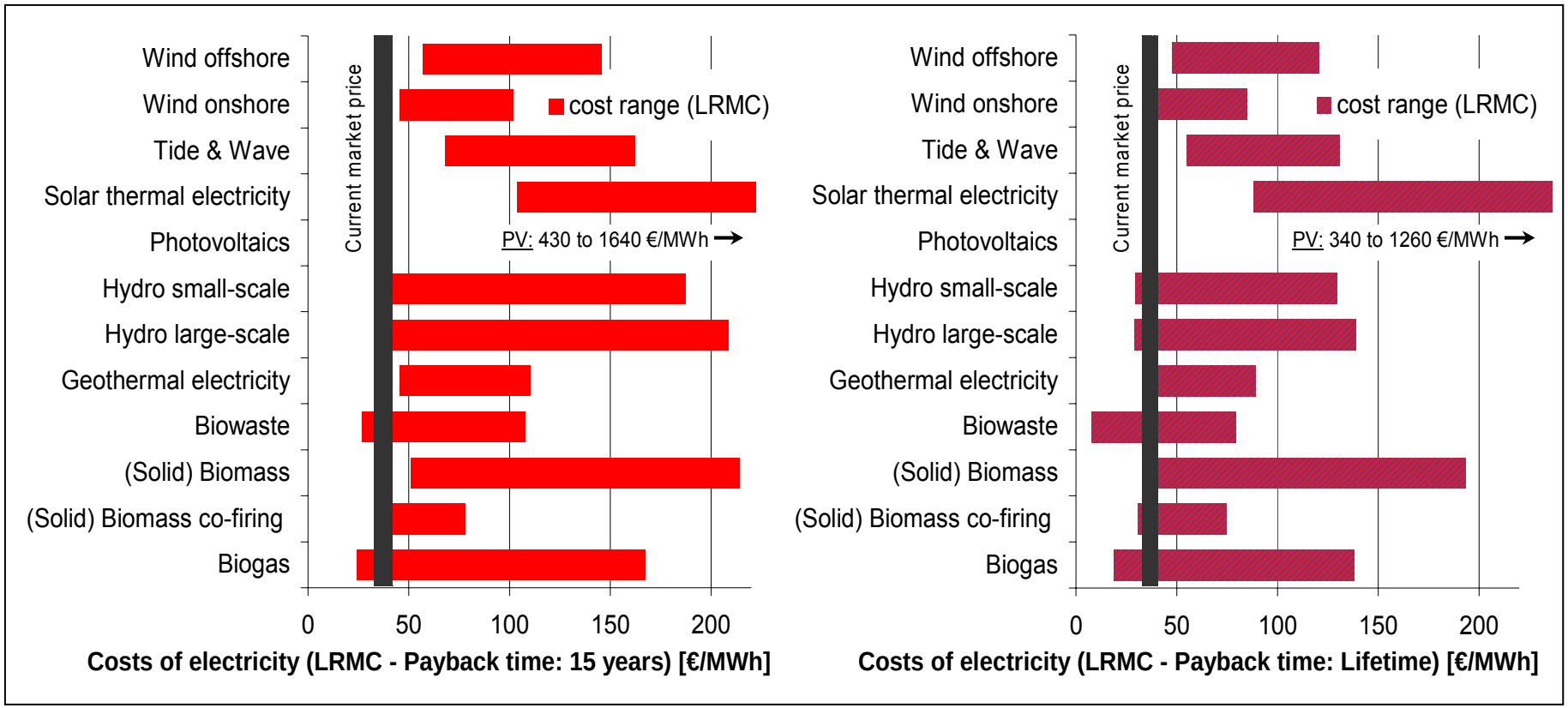
- Largest potentials exist in the sectors of solid biomass (52%) and wind energy (19%), followed by biogas (13%)
- Refurbishment and construction of large hydro plants is supposed to be significant (6%)



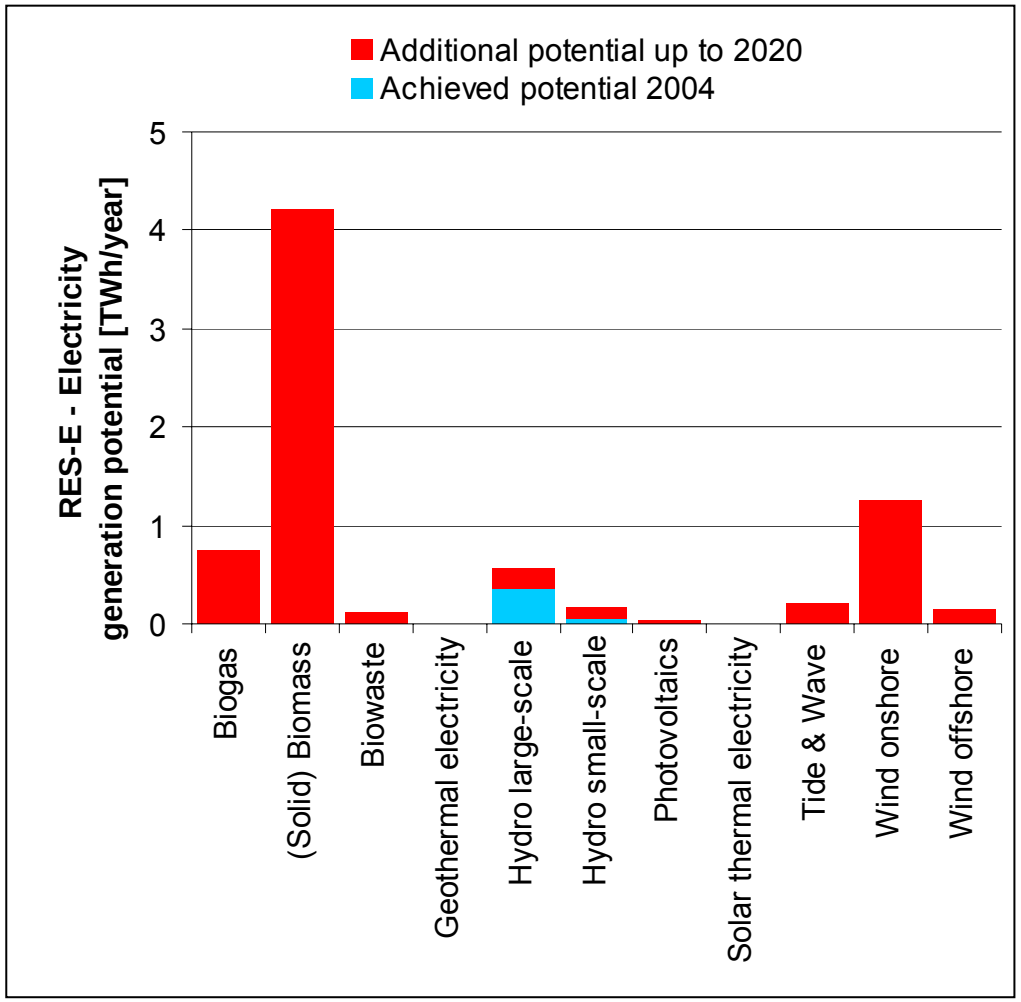
3. Results: Bandwidth of LRMC for RES-E generation in 2004

Broad range of cost for several RES-E represents

- resource-specific conditions as are relevant e.g. in the case of photovoltaic and wind energy
- Depends on technological options available e.g. co-firing vs. small CHP for biomass

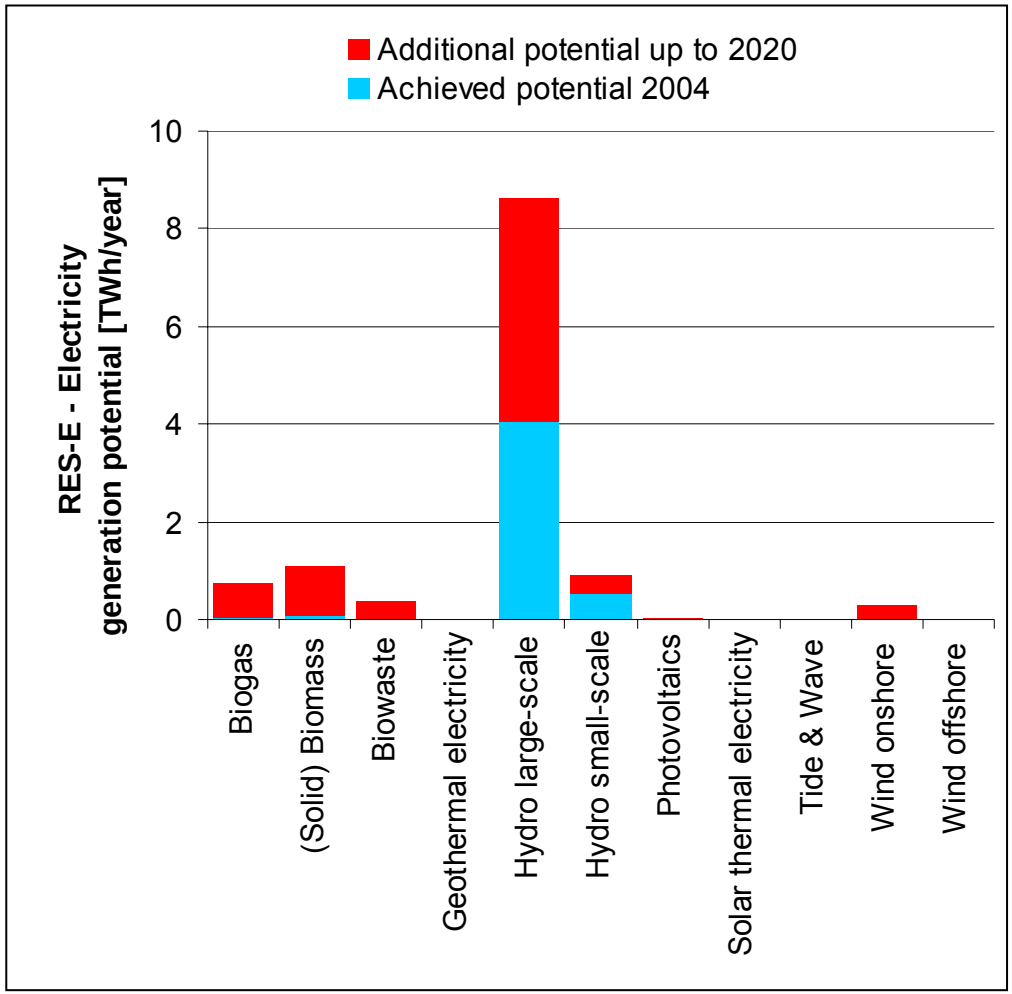


3. Results: Lithuania – achieved and additional RES-E mid-term potentials



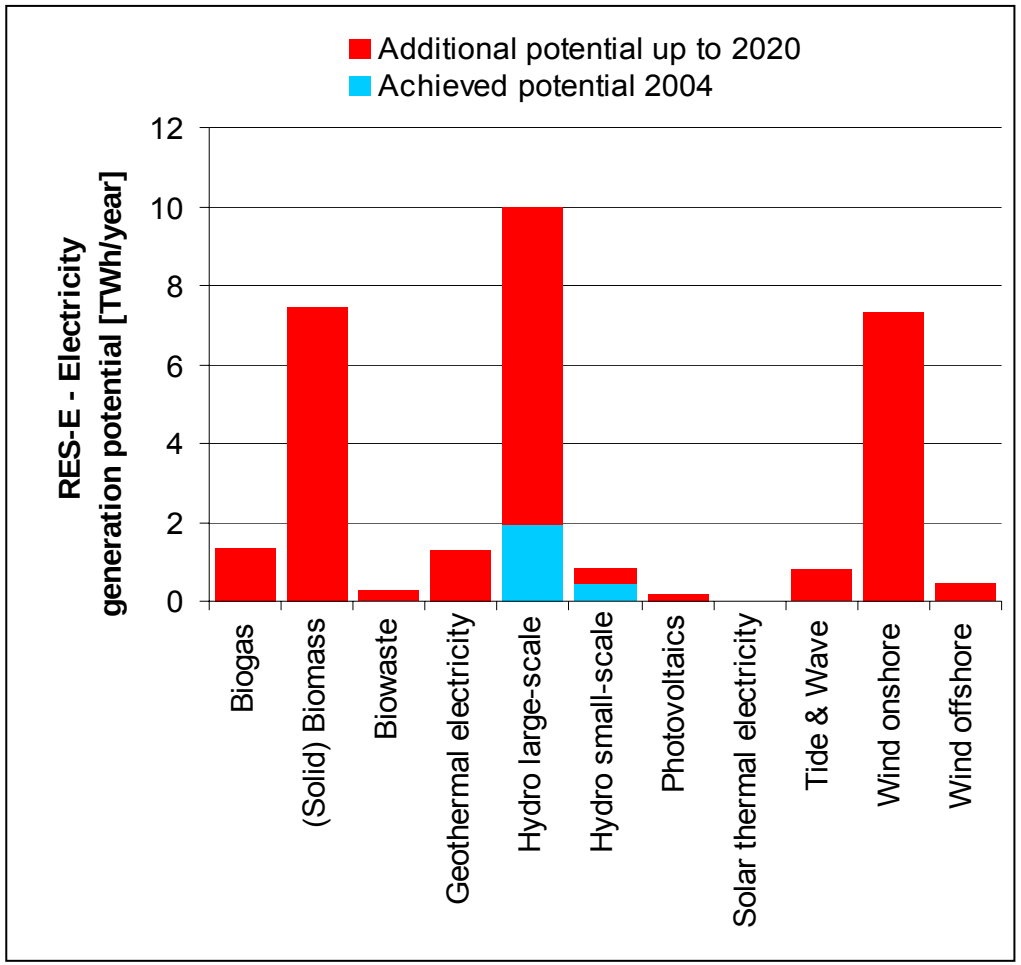
- Since mid 1980s electricity supply dominated by Ignalina nuclear power plant (up to 88 % of total production)
- RES-E target for 2010: 7% (hydro 132 MW, wind 200 MW, biomass 33 MW)
- Since 2002 FIT for hydro, wind and biomass guaranteed for 10 years
- 101 MW large-hydro and 19 MW small-hydro installed, first small wind projects in 2004

3. Results: Slovenia – achieved and additional RES-E mid-term potentials



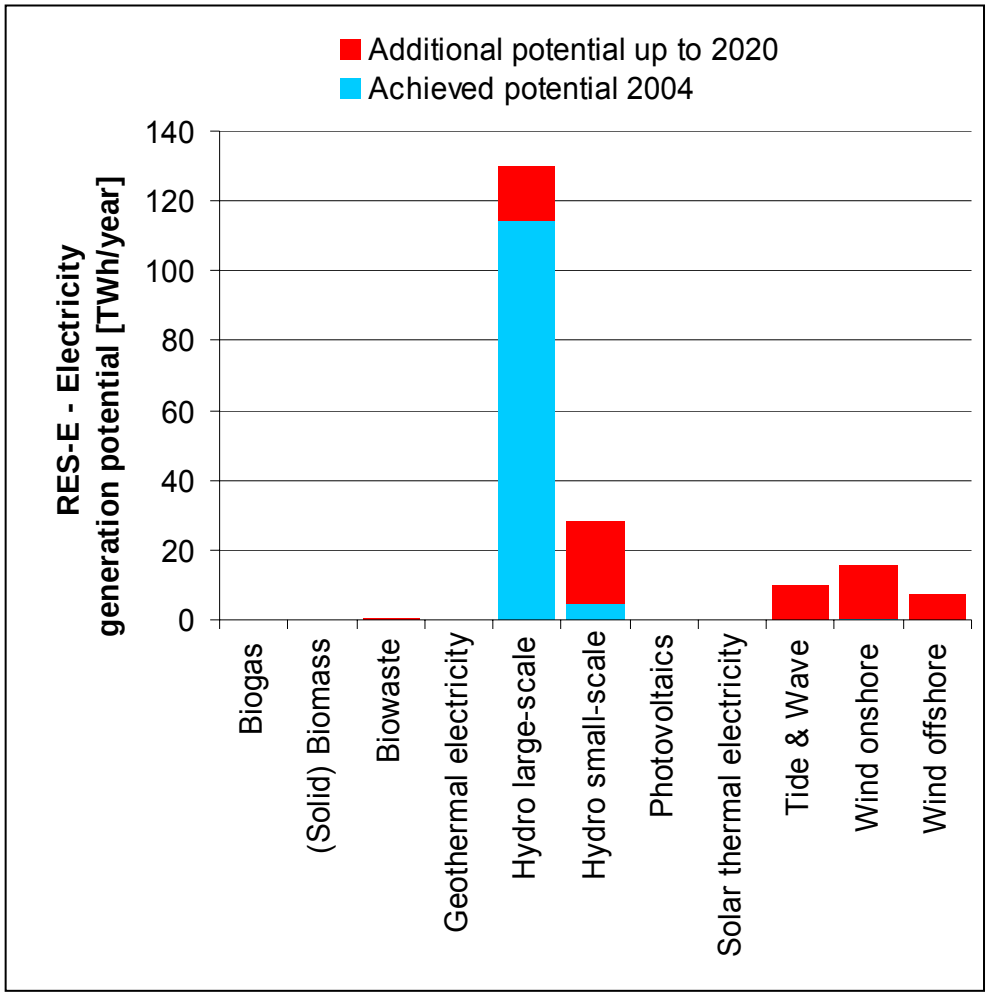
- Electricity supply mainly relying on coal (36%), nuclear (37%) and hydro (23%)
- RES-E target for 2010: 33.6%
- Attractive FITs for hydro biomass, biogas, wind and solar as main promotion scheme since 2004. Tariffs adopted on yearly basis
- Refurbishment of existing hydro power plants and new projects planned with extra total capacity of 350 MW

3. Results: Bulgaria – achieved and additional RES-E mid-term potentials



- Electricity supply mainly relying on coal (46%) and nuclear (41%)
- RES-E target for 2010: 11%
- Currently implemented promotion schemes for RES-E are FITs, tax incentives and purchase obligations
- Installation of 500 MW of wind power planned in Black Sea Region

3. Results: Norway – achieved and additional RES-E mid-term potentials



- Highest achieved RES-E potential in Europe with 120 TWh/yr in 2004
- 98.9% of total inland production from hydro power
- Considerable future potentials for wind and hydro power
- Promotion schemes in use are tax exemptions for hydro and a tendering system for wind onshore
- By end of 2004 concessions for more than 1000 MW wind onshore capacity granted