Latest update: June 2009

Potentials and Cost of RES-E in the EU27+ Region

GreenNet-Incentives

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Outline

1. Introduction

- Extension/update of GreenNet-database
- RES-E technologies considered

2. Basic principles

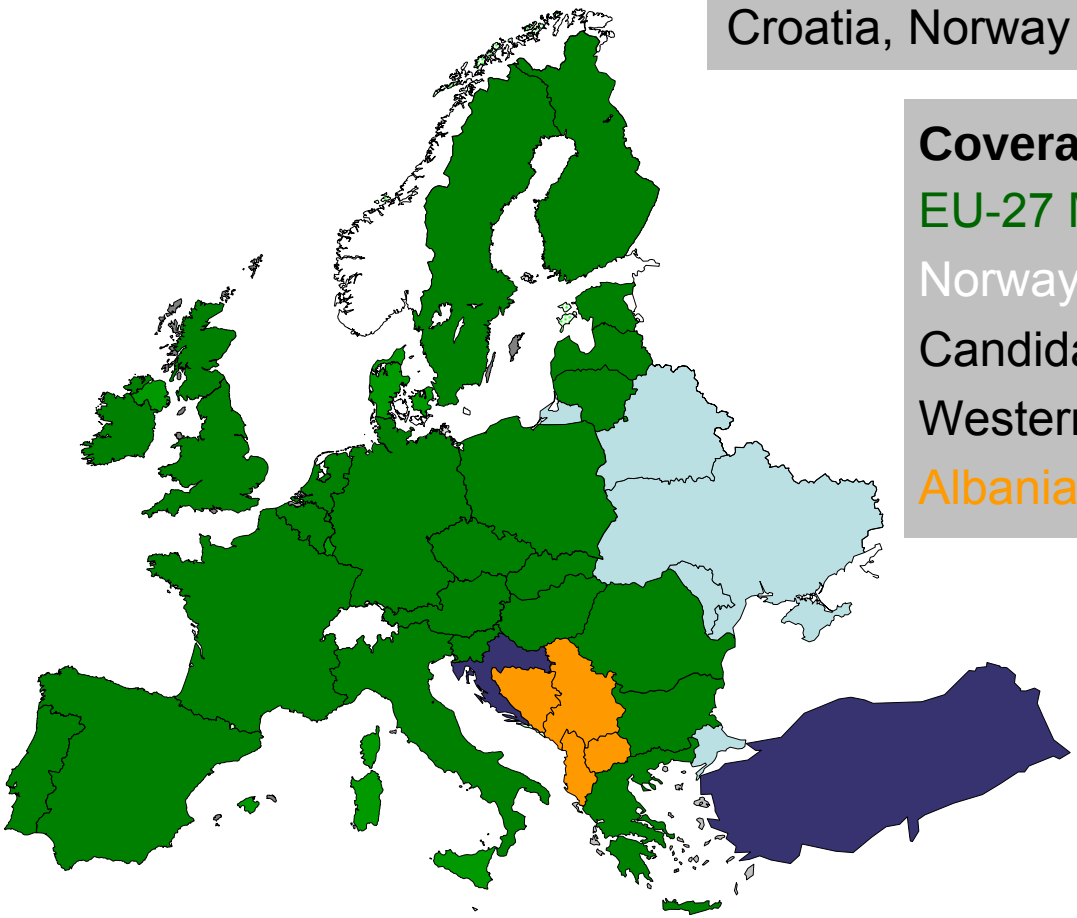
- Static cost resource curves
- Dynamic restrictions/experience curves
- Dynamic cost-resource curves

3. Results

- Status quo of RES-E in EU27 region
- Additional mid-term potentials
- Current bandwidth of cost
- Characterisation of selected “new” countries

1. Introduction: Extension of GreenNet database

Geographical coverage GreenNet-EU27
EU-27 Member States +
Croatia, Norway and Switzerland



Coverage GreenNet-Incentives
EU-27 Member States +
Norway and Switzerland +
Candidates: Croatia and Turkey +
Western Balkan: Bosnia Herzegovina, Albania, Serbia Montenegro, Macedonia

1. Introduction: Update of GreenNet database

- Update of achieved **potentials** and additional mid-term potentials against **basis year 2005** (the first simulation year will be 2006)
- **Cost** of RES-E **updated to 2005 level** (in €2005)
- Data is updated continuously 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

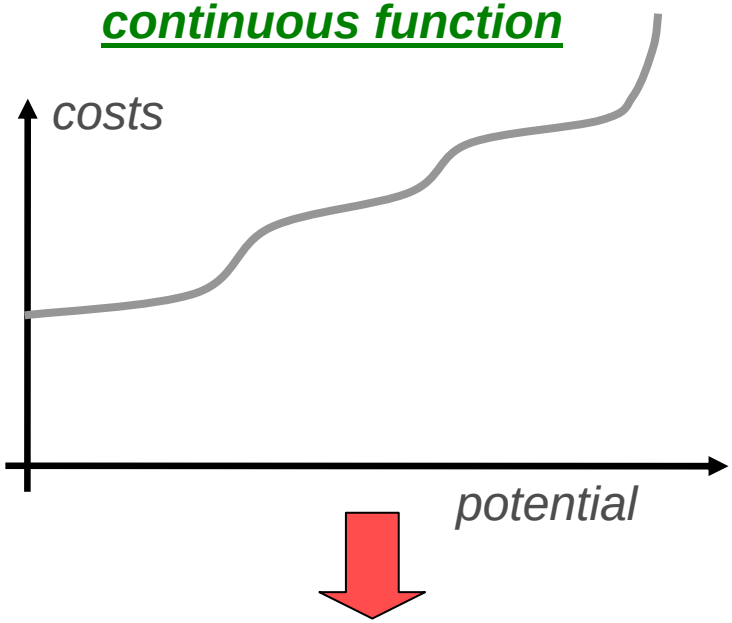
C … CHP

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.**

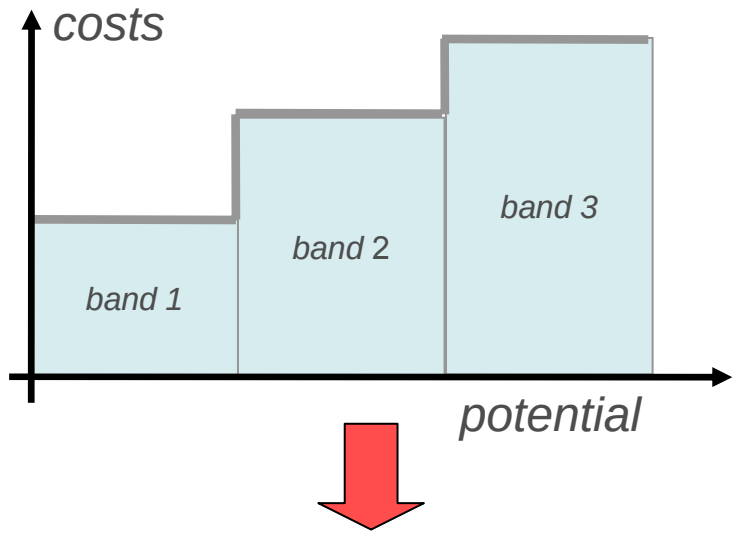
costs = f (potential); t = constant

continuous function



„…every location is slightly different“

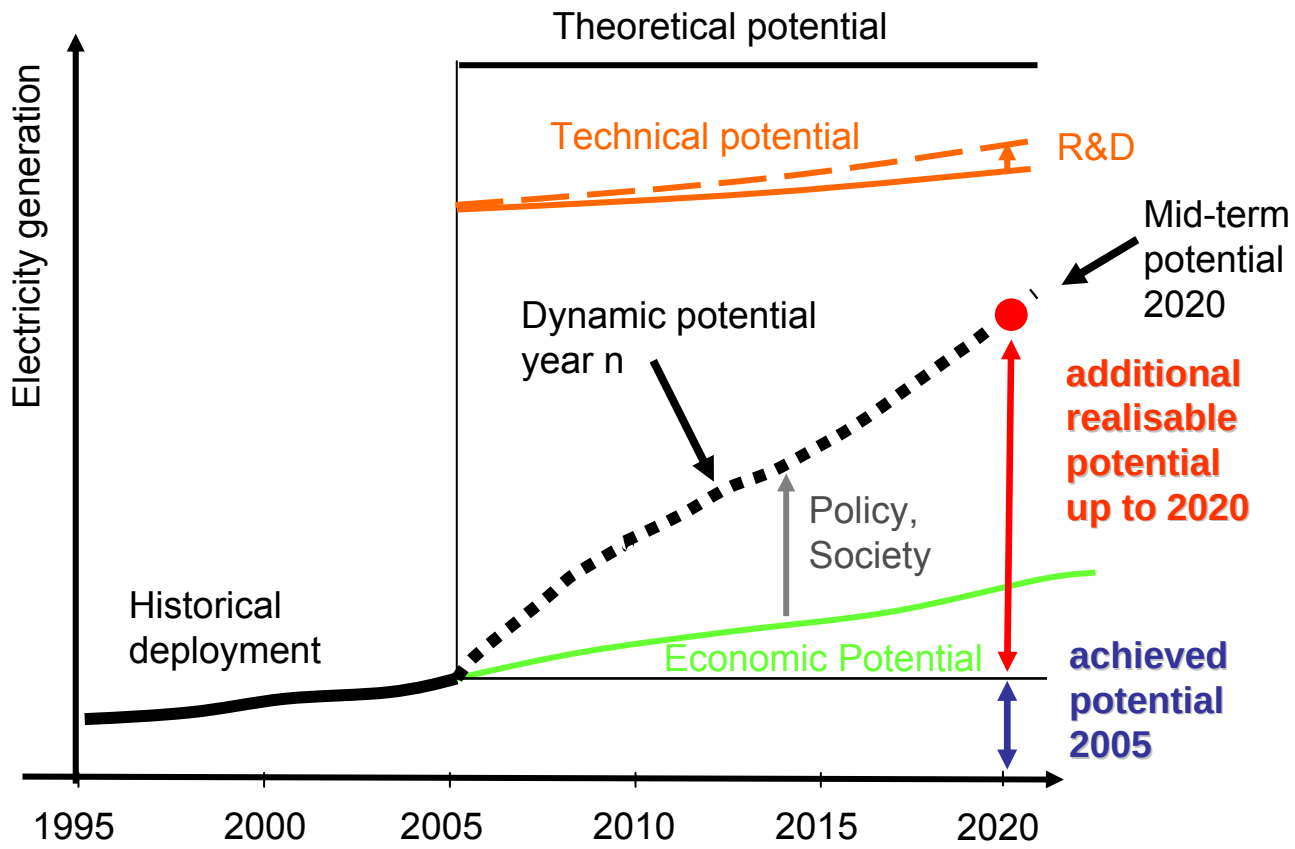
stepped (discrete) function



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

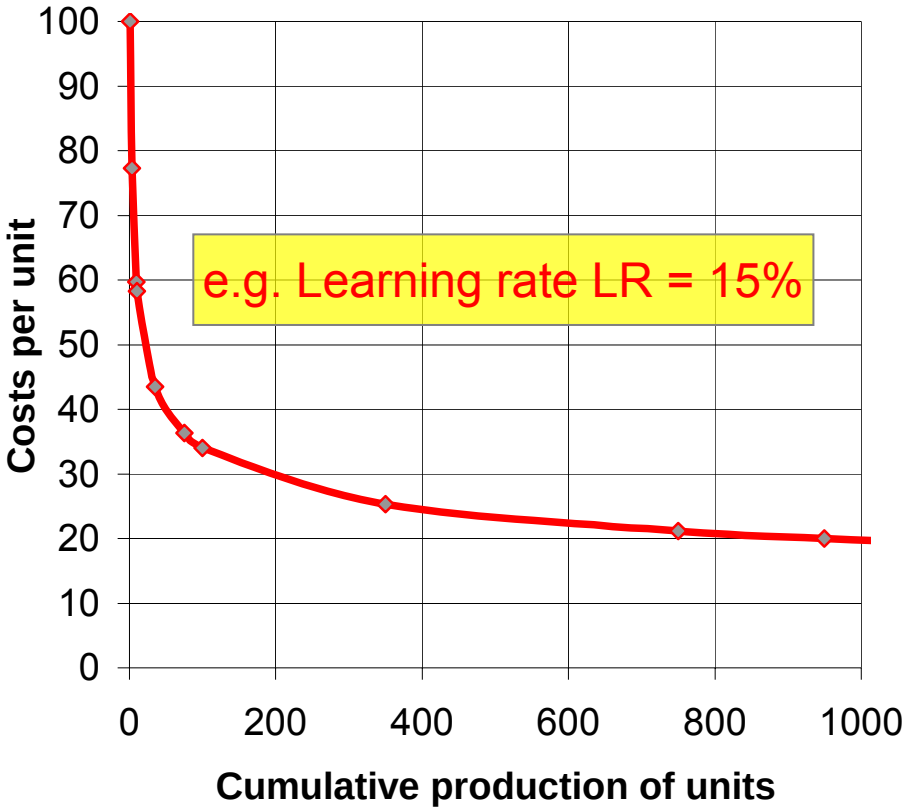
2. Basic principles: Experience curves

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

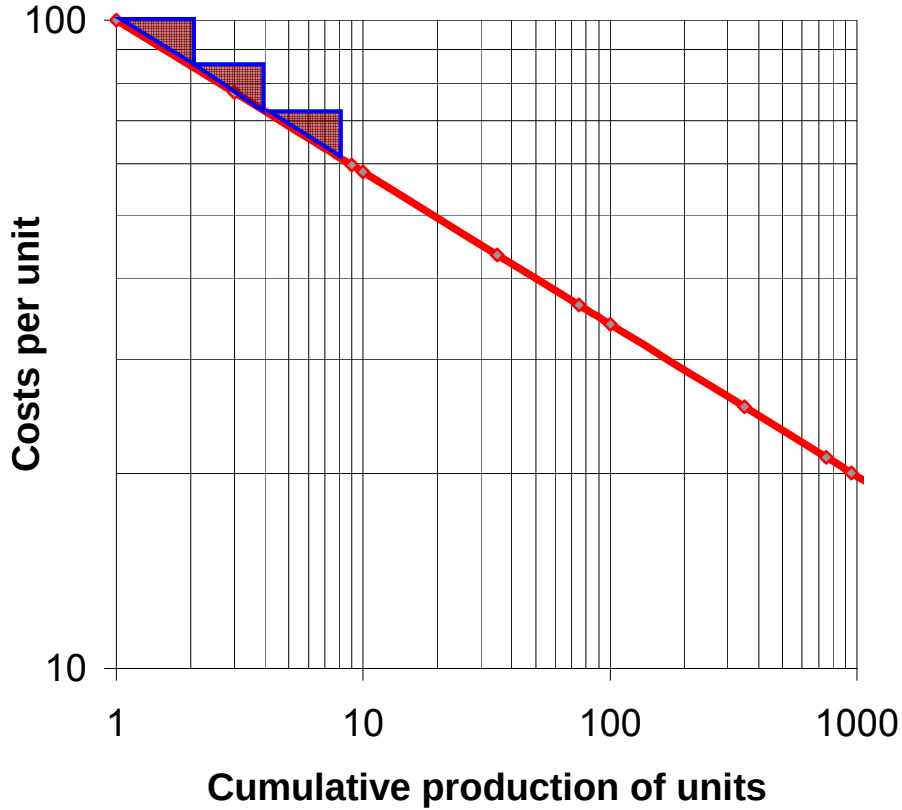
$$C_{CUM} = C_0 * CUM^b$$

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

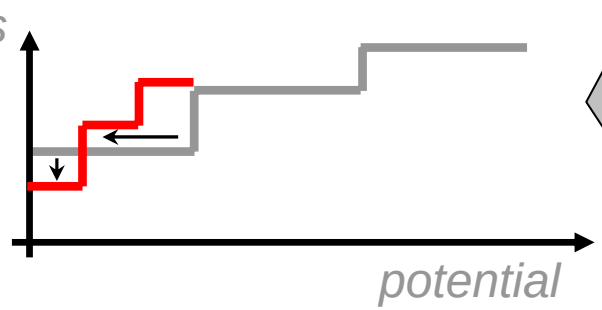


2. Basic principles: Dynamic cost-resource curves

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

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

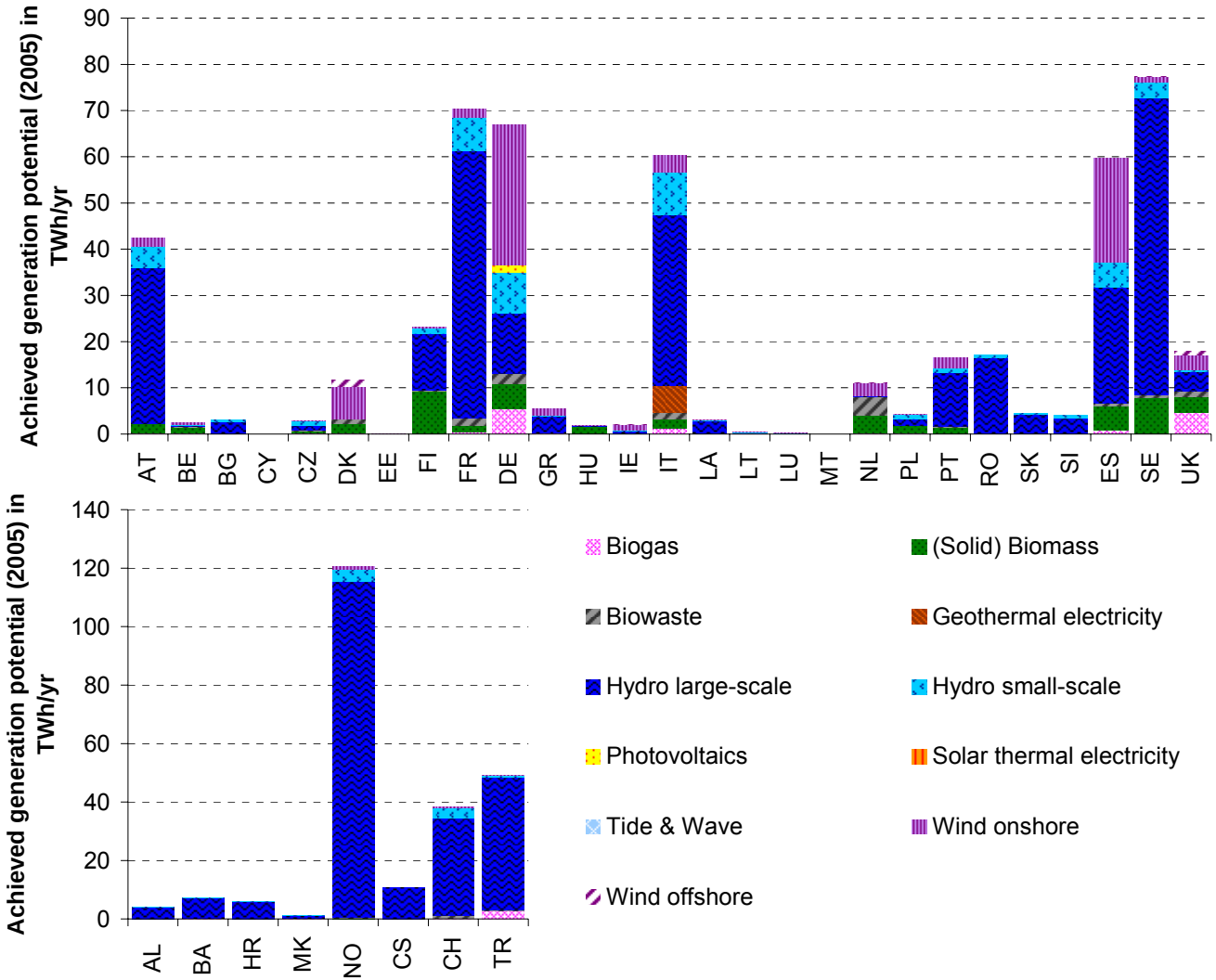
DYNAMIC
COST-RESOURCE CURVES
- by RES-E technology
- by country
- ***by year***



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

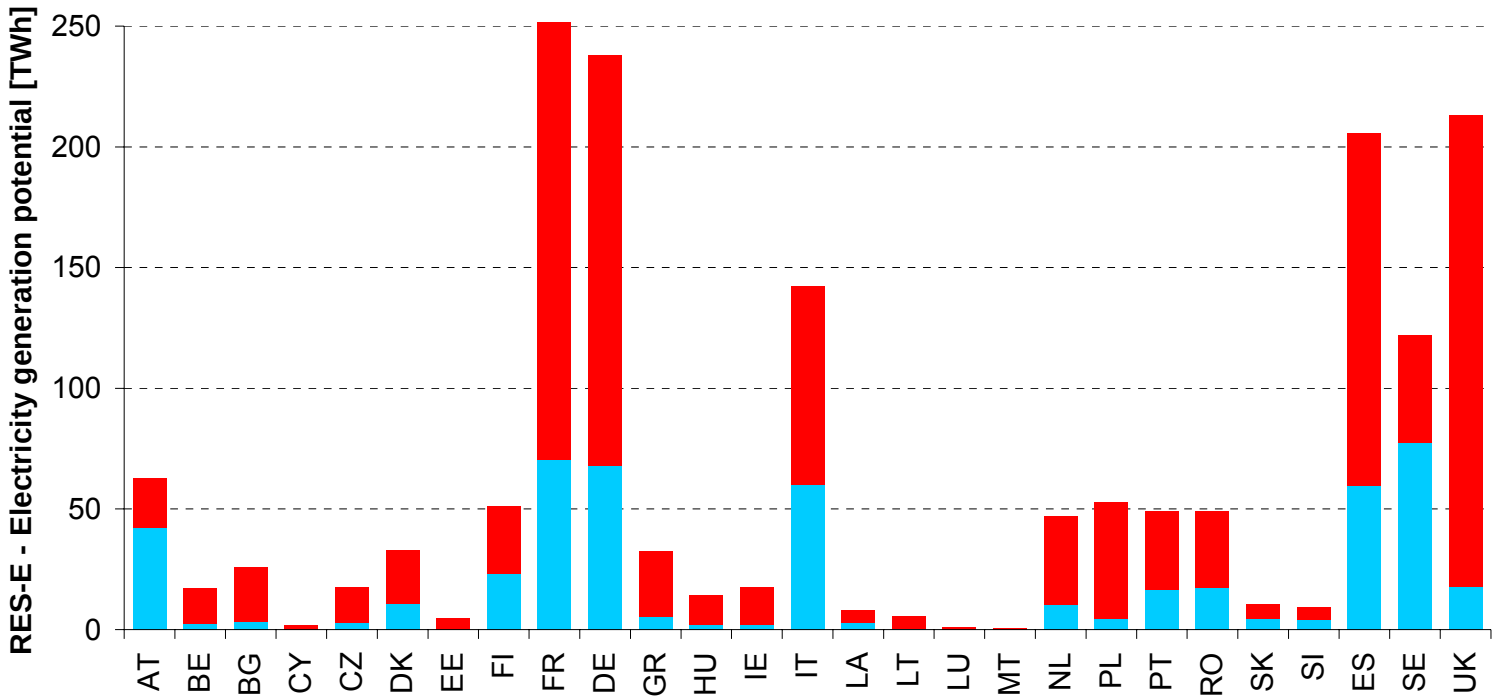
A *dynamic cost-resource curve*
represents a tool to **provide the linkage** between both approaches described before,
i.e. the dynamic cost assessment as e.g. done by application of **experience curves**
and the formal description of costs and potentials by means of **static cost-resource curves**.

3. Results: Achieved RES-E potential 2005 in EU-27+ countries



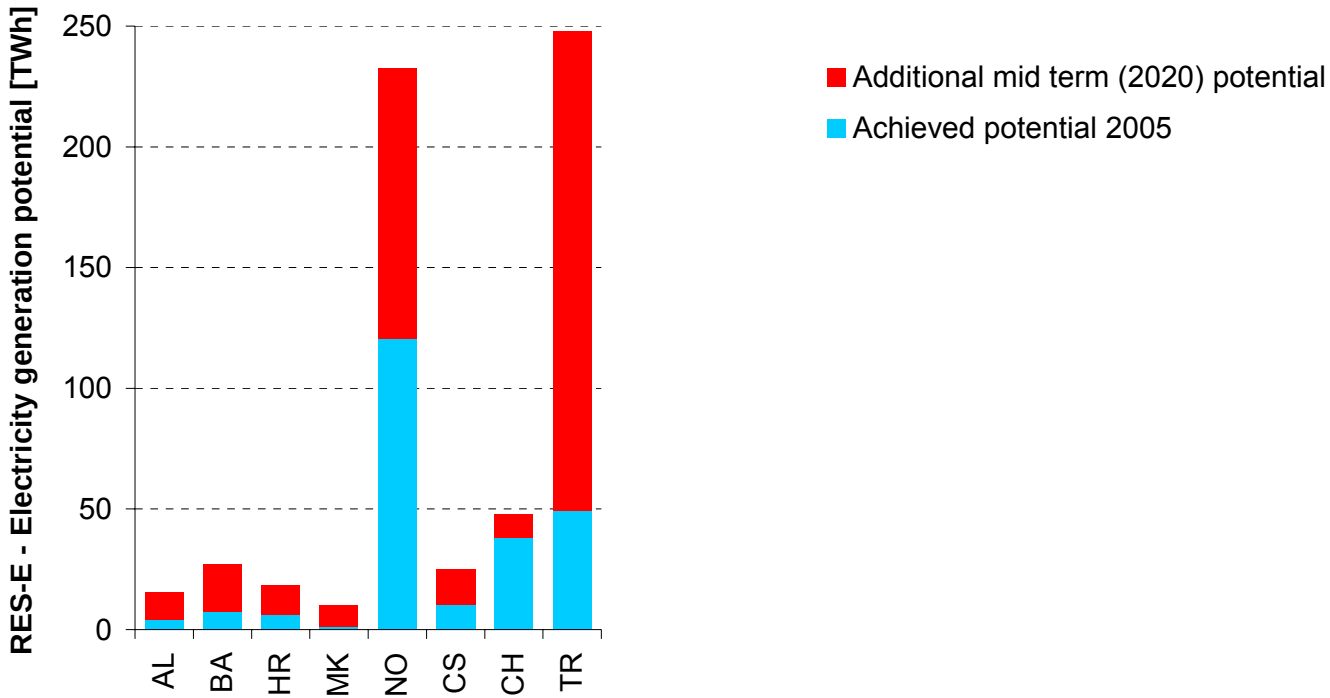
3. Results: Achieved and additional RES-E mid-term potentials *EU-27, country level*

- Already achieved potential for RES-E generation equals 509 TWh (2005)
- Additional realisable potential up to 2020 is 1175 TWh (about 35,8% of gross electricity consumption in 2005)



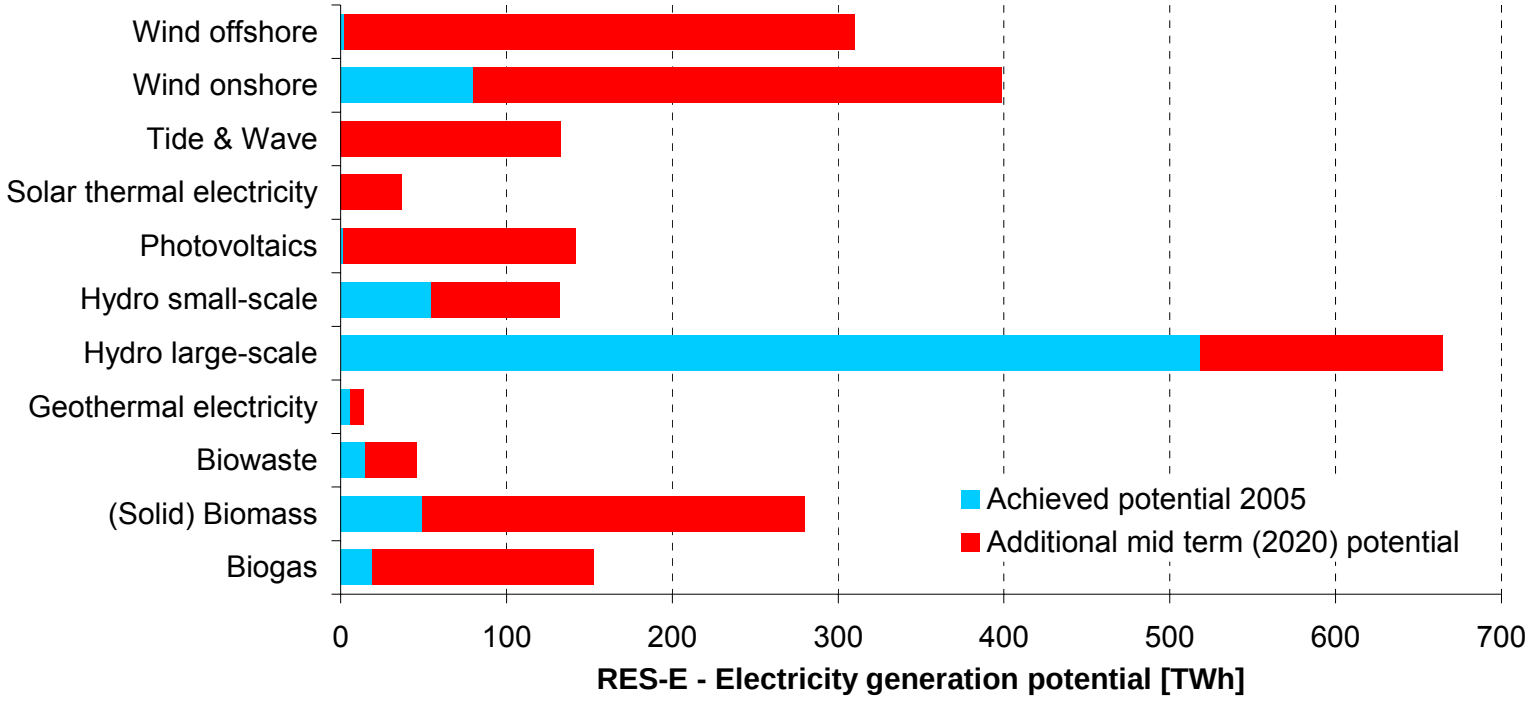
3. Results: Achieved and additional RES-E mid-term potentials *remaining countries*

- Achieved potential (2005) for the 8 remaining countries is 238 TWh; the additional realisable potential up to 2020 is 387 TWh
- Norway has highest achieved potential of all covered countries (120 TWh)



3. Results: Achieved and additional RES-E mid-term potentials *EU-27+*, *technology level*

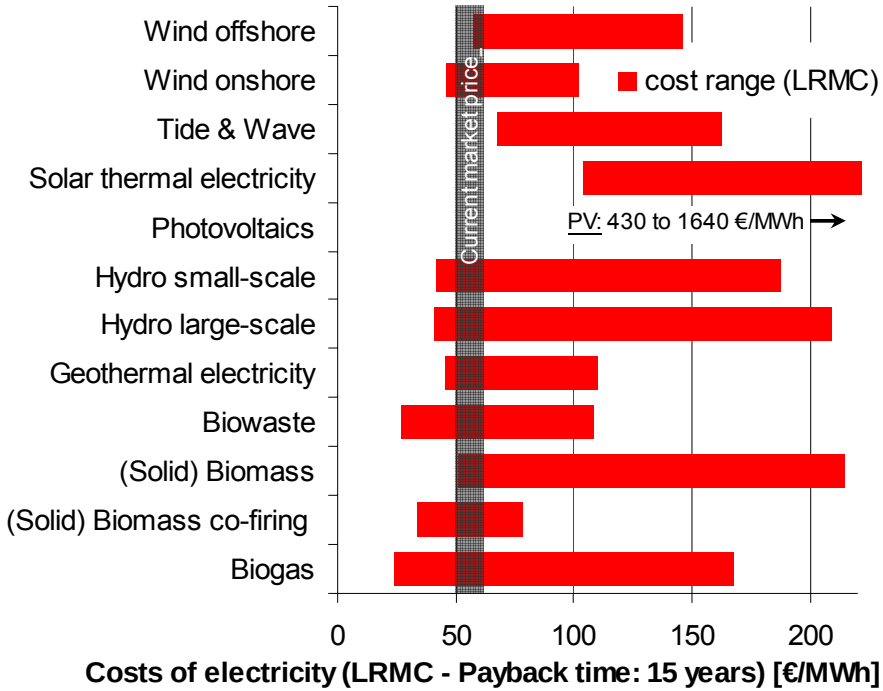
- Hydro power (573 TWh) and wind onshore (81 TWh) are currently dominating RES-E technologies
- Highest future potentials expected for wind onshore (319 TWh) and offshore (308 TWh) and solid biomass (230 TWh)

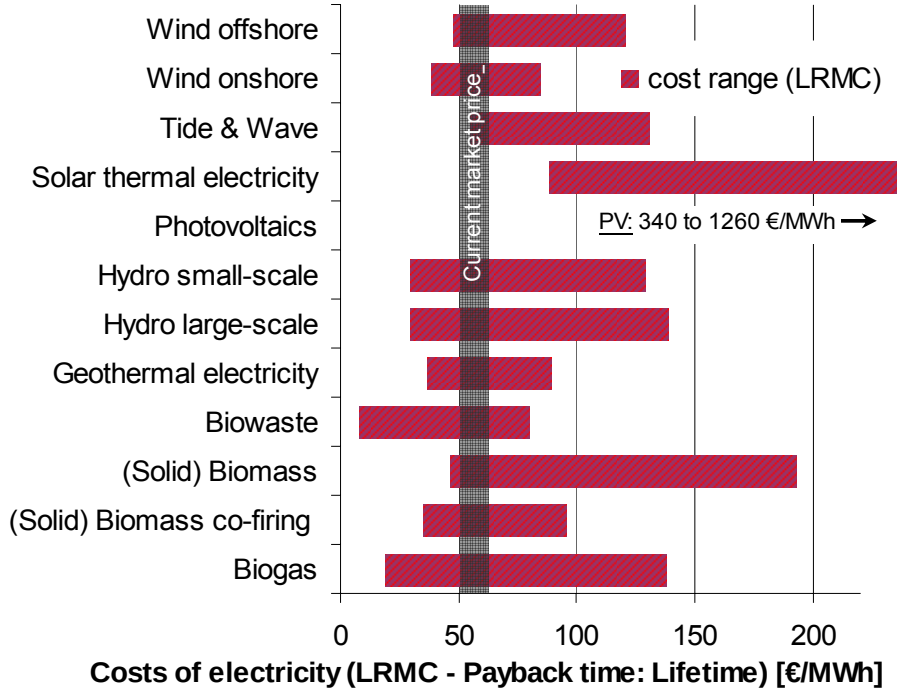


3. Results: Bandwidth of LRMC for RES-E generation in 2005

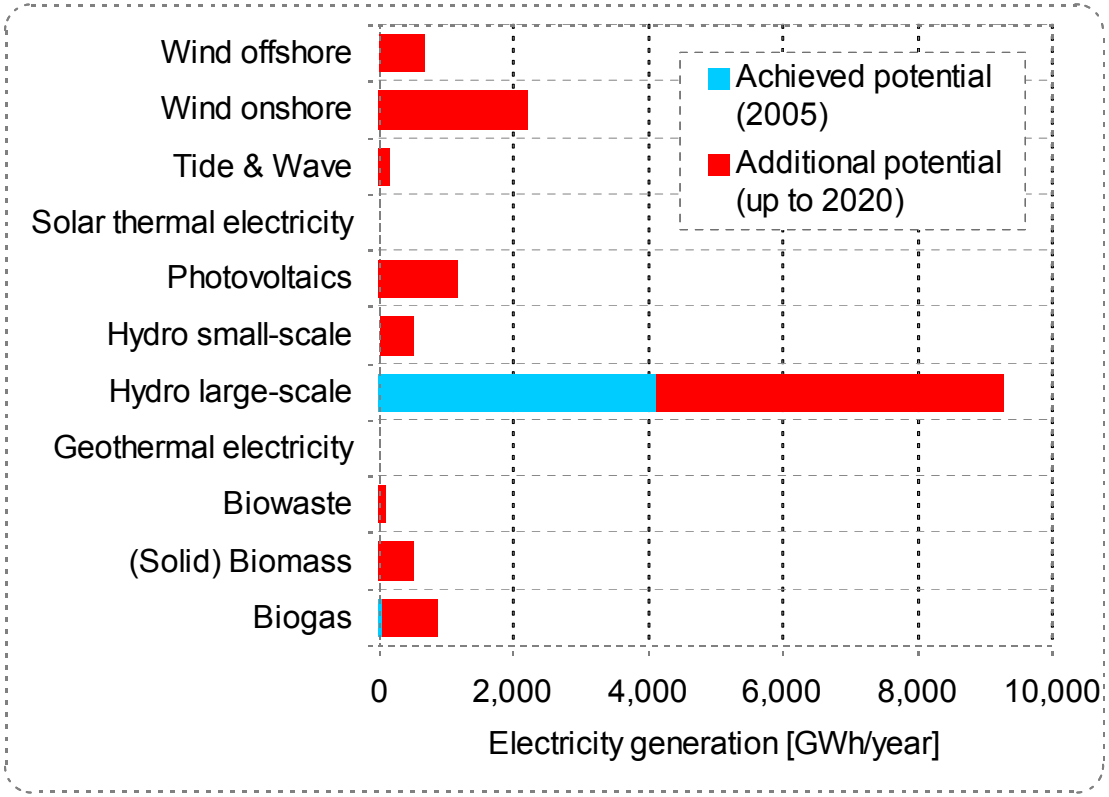
Broad range of cost for several RES-E represents

- 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



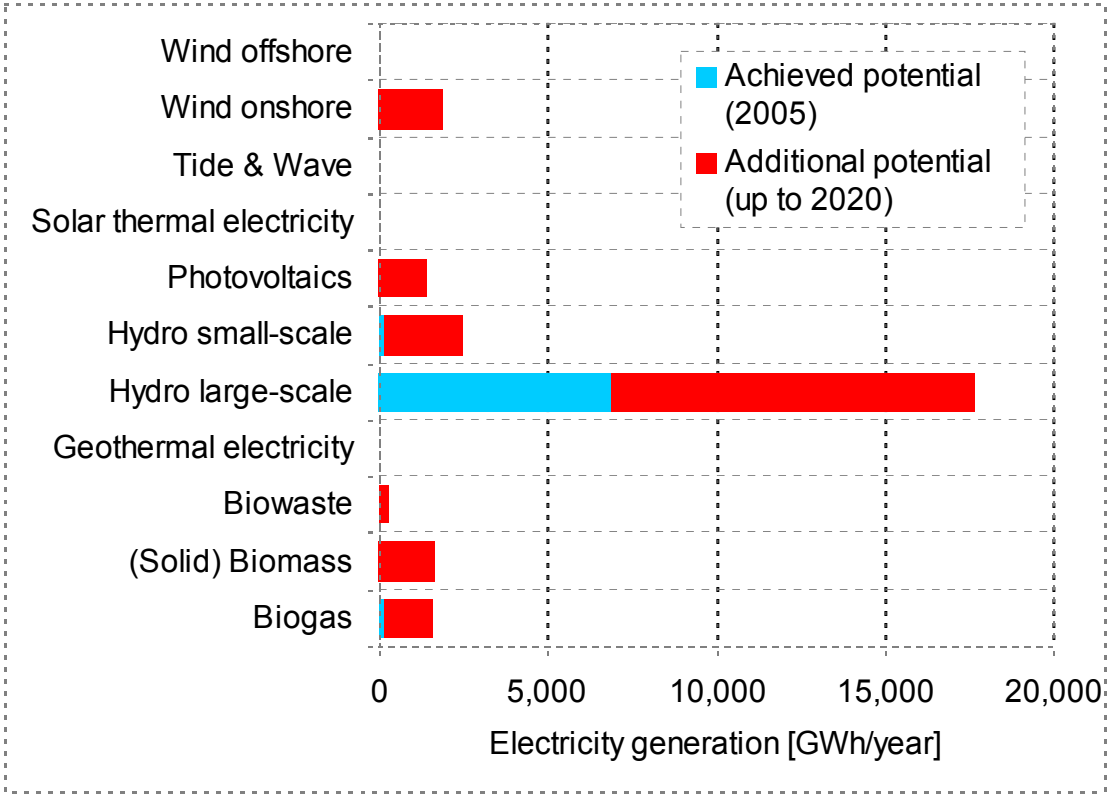


3. Results: Albania – achieved and additional RES-E mid-term potentials



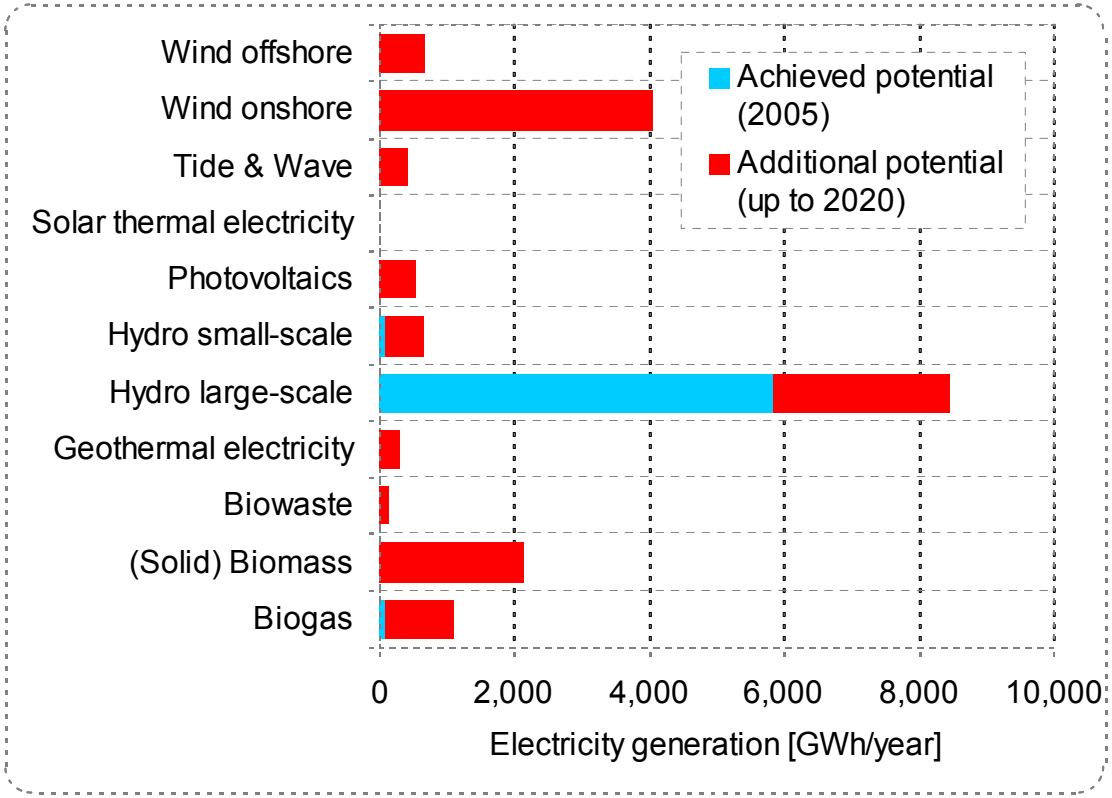
- Electricity supply relying on hydro power (98%)
- RES-E targets set on technology level:
  Wind 1.5 % in 2017
  Small hydro 3.3 % in 2017
- No RES-E support scheme in place
- Several hydro power projects realised and planned (>1000 MW total), 500 MW wind farm planned (generation should be exported to Italy via sea cable)

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



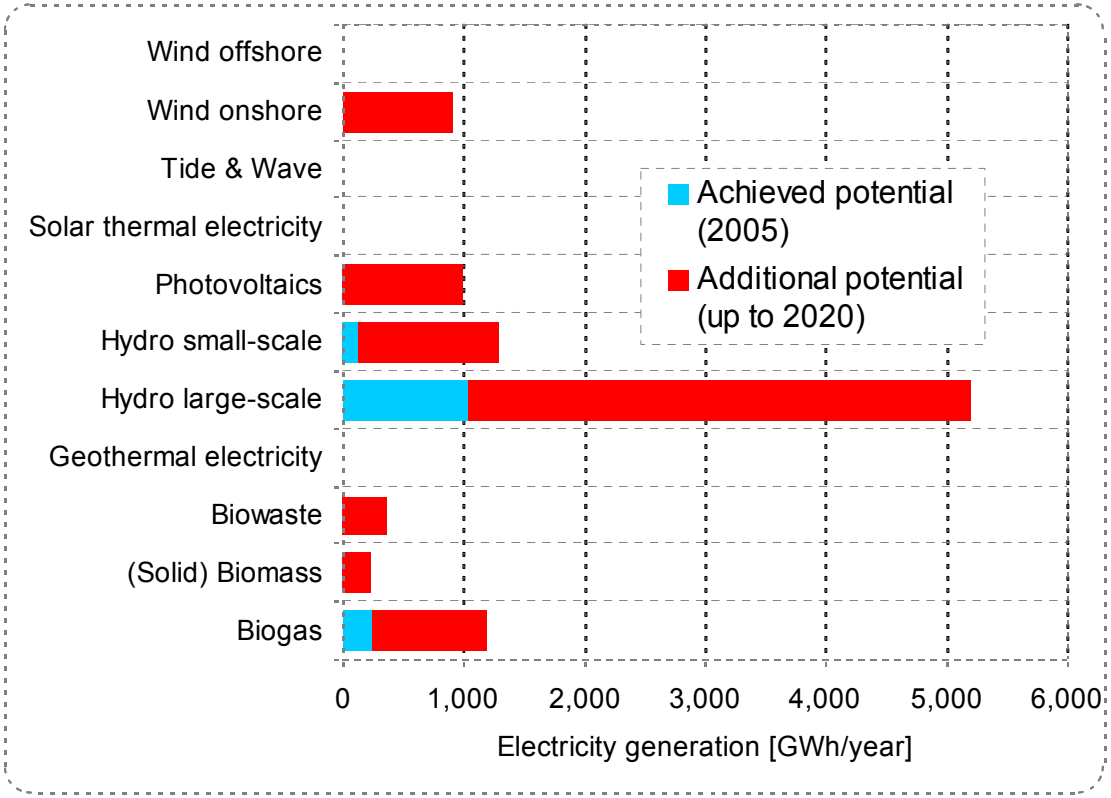
- Electricity supply mainly relying on coal (52%) and hydro (47%)
- Feed-In tariff for RES-E defined as percentage of household electricty price (small scale hydro: 80 %, wind power: 100 %)
- Several hydro power projects planned (both small and large-scale)

3. Results: Croatia – achieved and additional RES-E mid-term potentials (update)



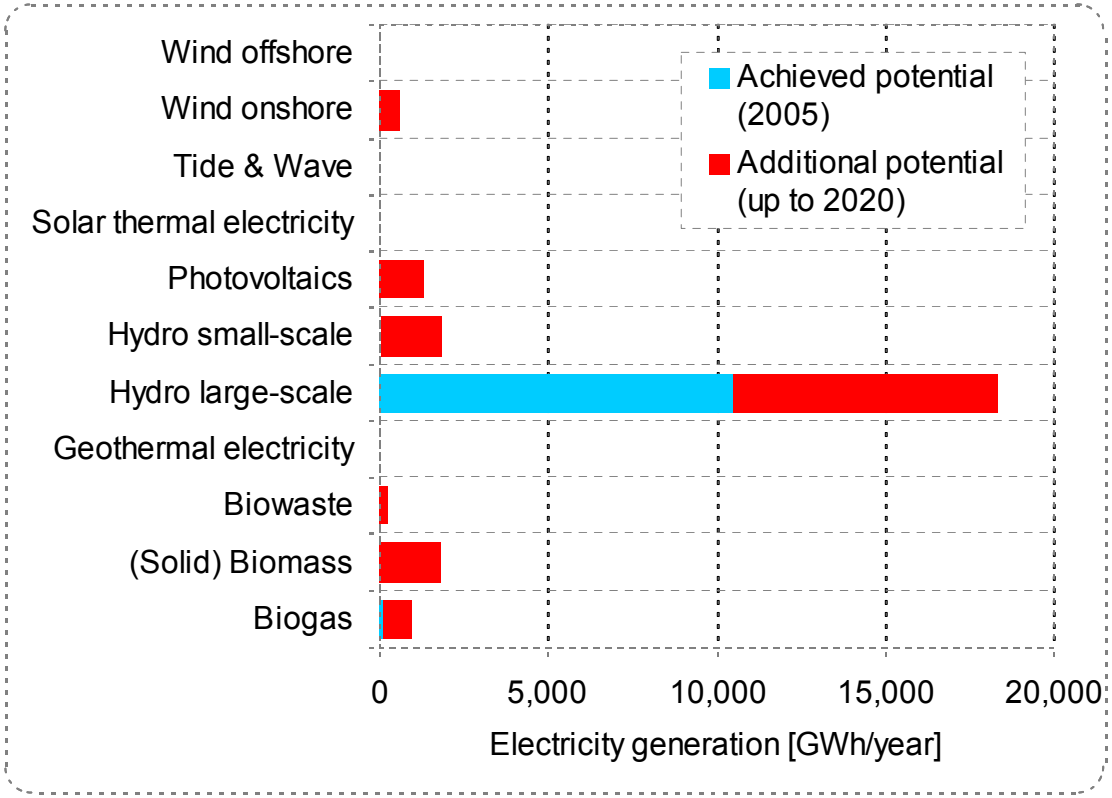
- Hydro power is important source of electricity (38 % of gross demand in 2005)
- First wind farms in operation, several large hydro and wind onshore projects in planning phase (both approx. 200 MW total capacity)

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



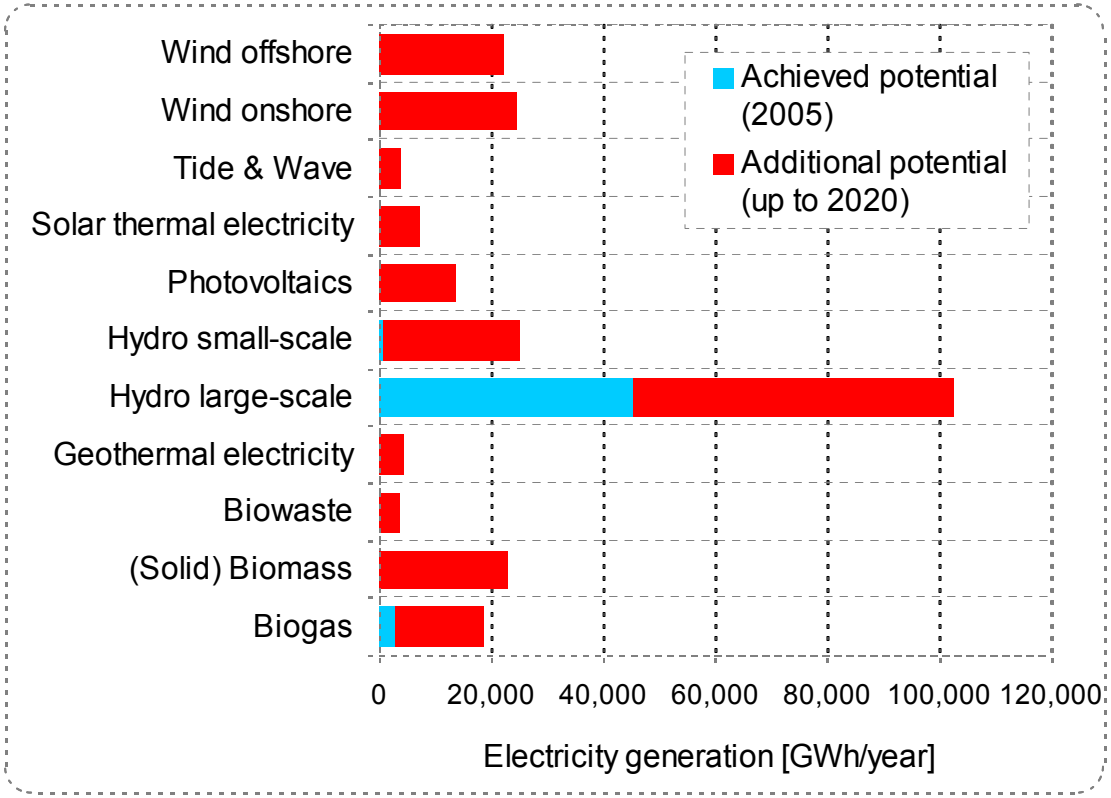
- Electricity supply in 2006 relying on coal (58% of gross demand), imports (23%) and hydro (19%)
- Considerable future potentials for hydro power and biomass
- Feed-in tariff scheme in preparation
- Hydro power (large and small-scale) realised and planned (> 600 MW total)
- Wind power and PV potential not assessed so far

3. Results: Serbia & Montenegro – achieved and additional RES-E mid-term potentials



- Electricity supply mainly relying on coal (66%) and hydro (31%)
- Considerable future potentials for wind onshore and large hydro power
- Feed-in tariff scheme in preparation in Montenegro
- Currently hydro projects (> 500 MW) and wind power projects (> 25 MW) in planning phase

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



- Electricity supply mainly relying on gas (45%), coal (27%) and hydro (24%)
- Relatively low FIT for wind power since 2005
- Installed wind power capacity increased from 50 to 146 MW in 2007