Energy Economics Group

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

RES in SEERMAP … some key inputs to the analysis

Authors: Gustav Resch, Lukas Liebmann, Albert Hiesl – all *Energy Economics Group, TU Wien*

Contact … Web: http://eeg.tuwien.ac.at
Email: resch@eeg.tuwien.ac.at

… developed initially in the period 2002 to 2004 within the research project ***Green-X*** (5th framework programme of the European Commission, DG RESEARCH)

www.green-x.at

▸ *Key assumptions*

To ensure maximum consistency with existing EU scenarios and projections the key input parameters of the Green-X scenarios are (as default) based on **PRIMES modelling** and the (updates of the) **Green-X database**.

Based on PRIMES*	***Defined for this study***
Energy demand by sector	RES policy framework
Primary energy prices	Reference electricity prices
Conventional supply portfolio and conversion efficiencies	RES cost & learning rates (Green-X database, incl. biomass)
CO_2 intensity of sectors	**RES potential** (Green-X database)
	Biomass trade specification
	Technology diffusion
	Financing conditions

Main input sources for scenario parameters

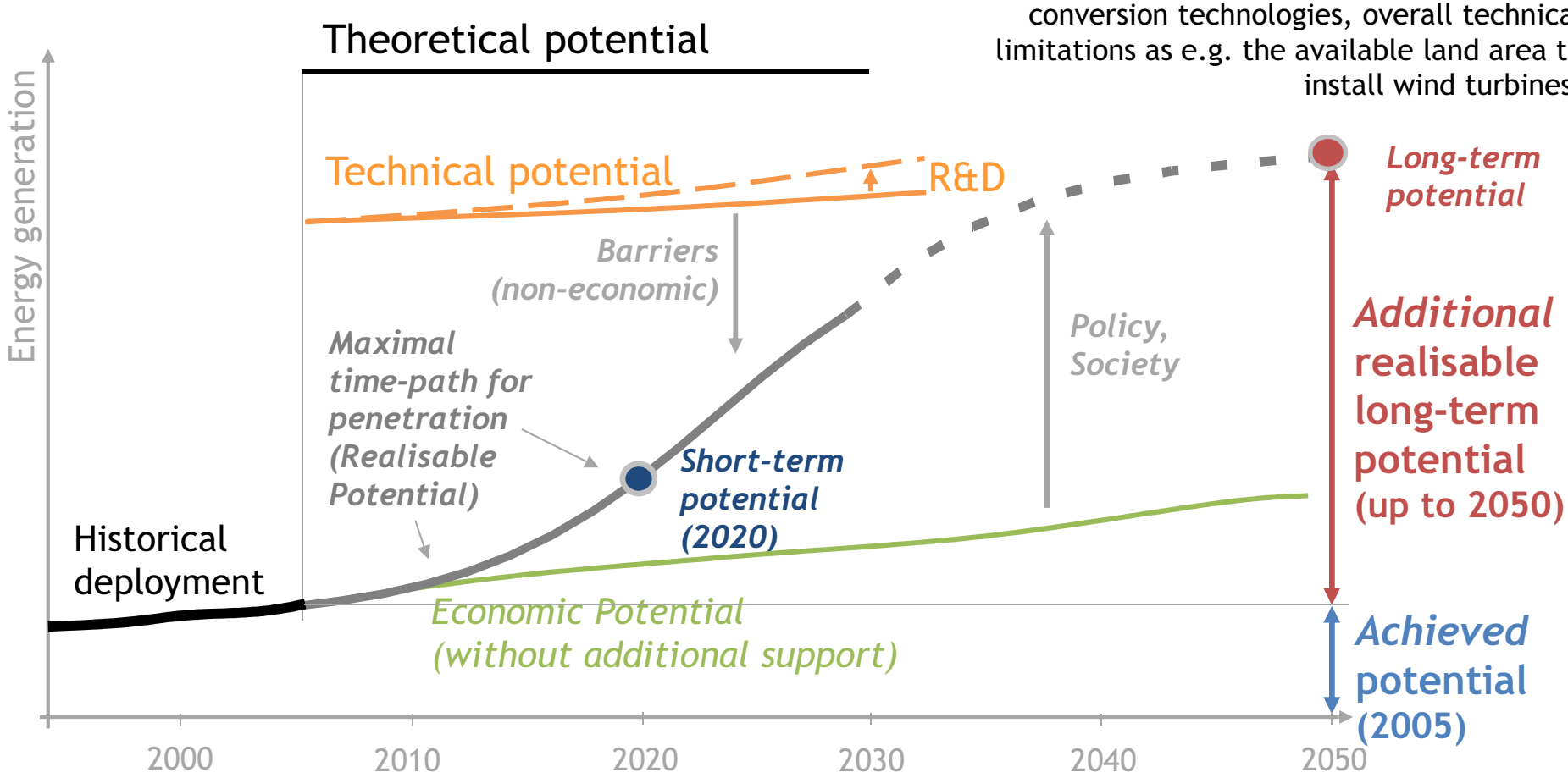
**Primes scenario used subsequently: Reference case (as of 2016)*

Definition of the (additional) realisable mid-term potential (up to 2020/2030/2050)

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)

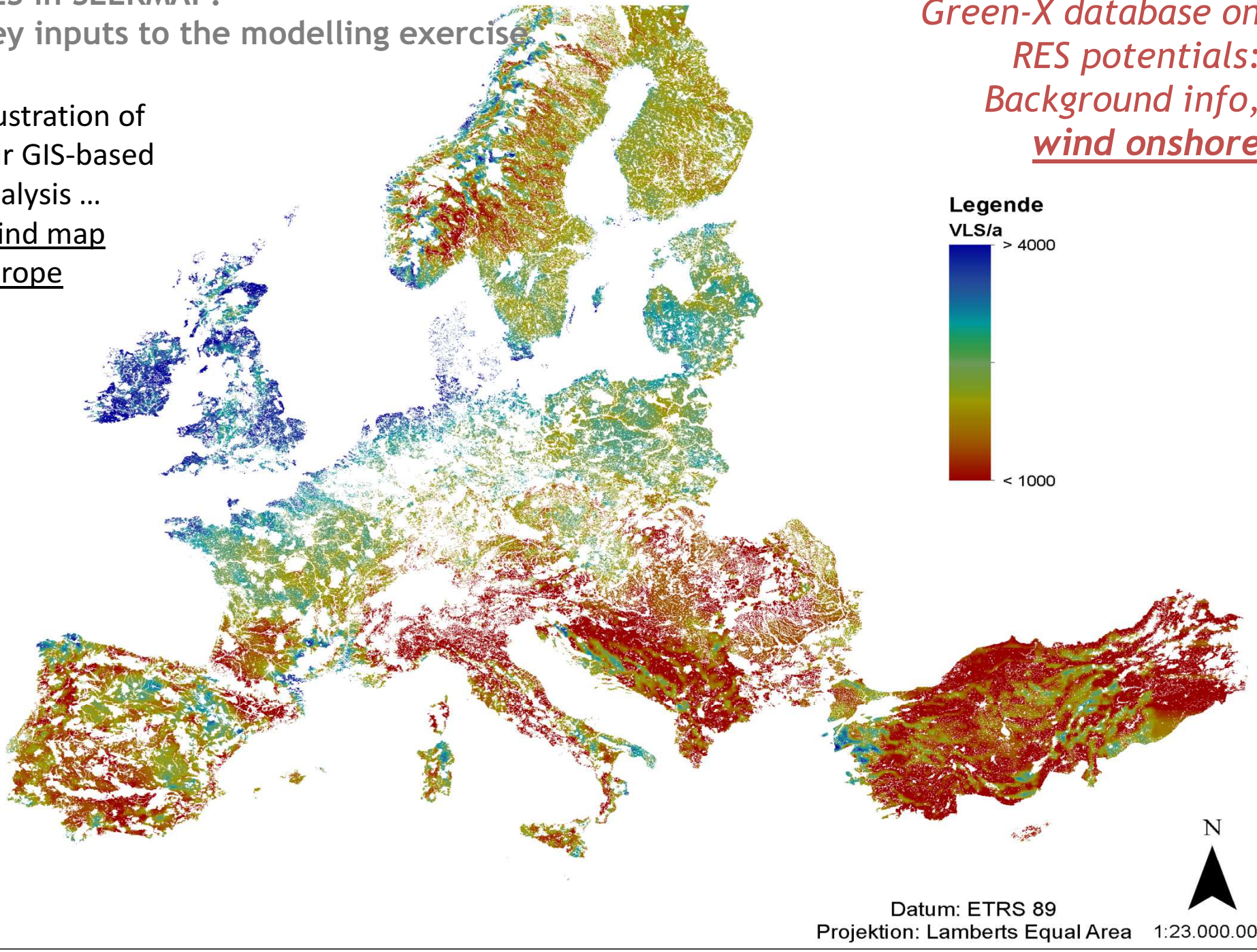


RES in SEERMAP:
Key inputs to the modelling exercise

Green-X database on RES potentials: Background info, ***wind onshore***

Illustration of our GIS-based analysis …

Wind map Europe



Artifical surfaces	0%
Arable land	25.0%
Permanent crops	15.0%
Pastures	20.0%
Heterogeneous agricultural areas 1	10.0%
Heterogeneous agricultural areas 2	10.0%
Heterogeneous agricultural areas 3 (agro-forestry)	5.0%
Forests	5.0%
Natural grasslands, moors	22.5%
Sclerophyllous vegetation & Transitional woodland-shrub	22.5%
Beaches, dunes, sands	10.0%
Bare rocks	0.0%
Sparsely vegetated areas	30.0%
Burnt areas & glaciers	0.0%
Inland wetlands	5.0%
Maritime wetlands	5.0%
Inland waters	0%
Marine waters	0%

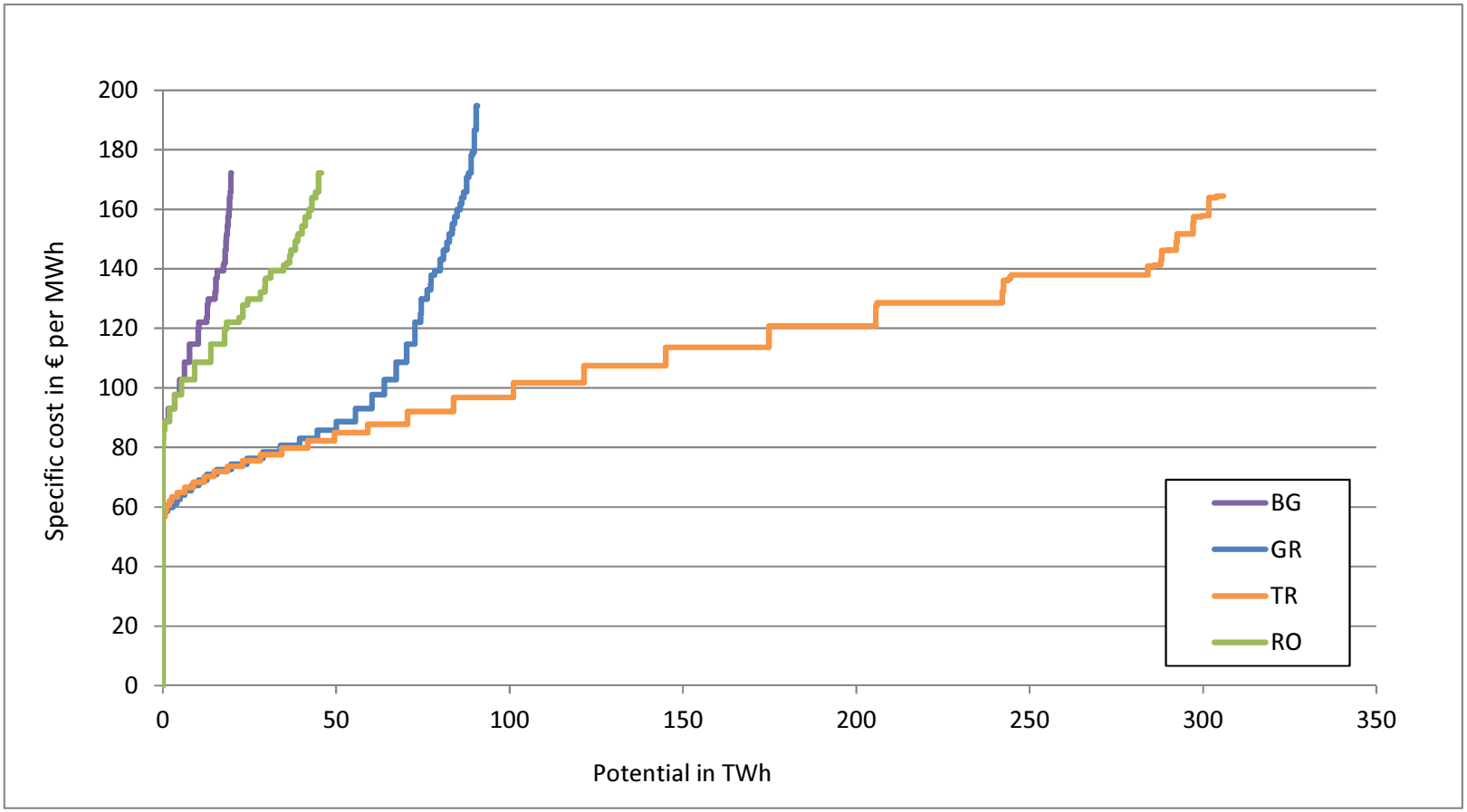
Applied Land use constraints: Suitability for wind power plants

*Green-X database on RES potentials: Background info, **wind onshore***

	GR	BG	RO	AL	BA	KO	ME	MK	SR
	Greece	Bulgaria	Romania	Albania	Bosnia H.	Kosovo*	Montenegro	FYR of Macedonia	Serbia
TOTAL POTENTIAL **with land use restrictions**, without power system constraints (Capacity potential) [MW]	54,754	16,412	57,427	9,707	15,983	2,114	6,242	5,386	31,593
RESTRICTED POTENTIAL **with land use restrictions, with default power system constraints** (Capacity potential) [MW]	36,976	10,110	17,922	2,423	4,243	2,023	1,064	1,587	7,293

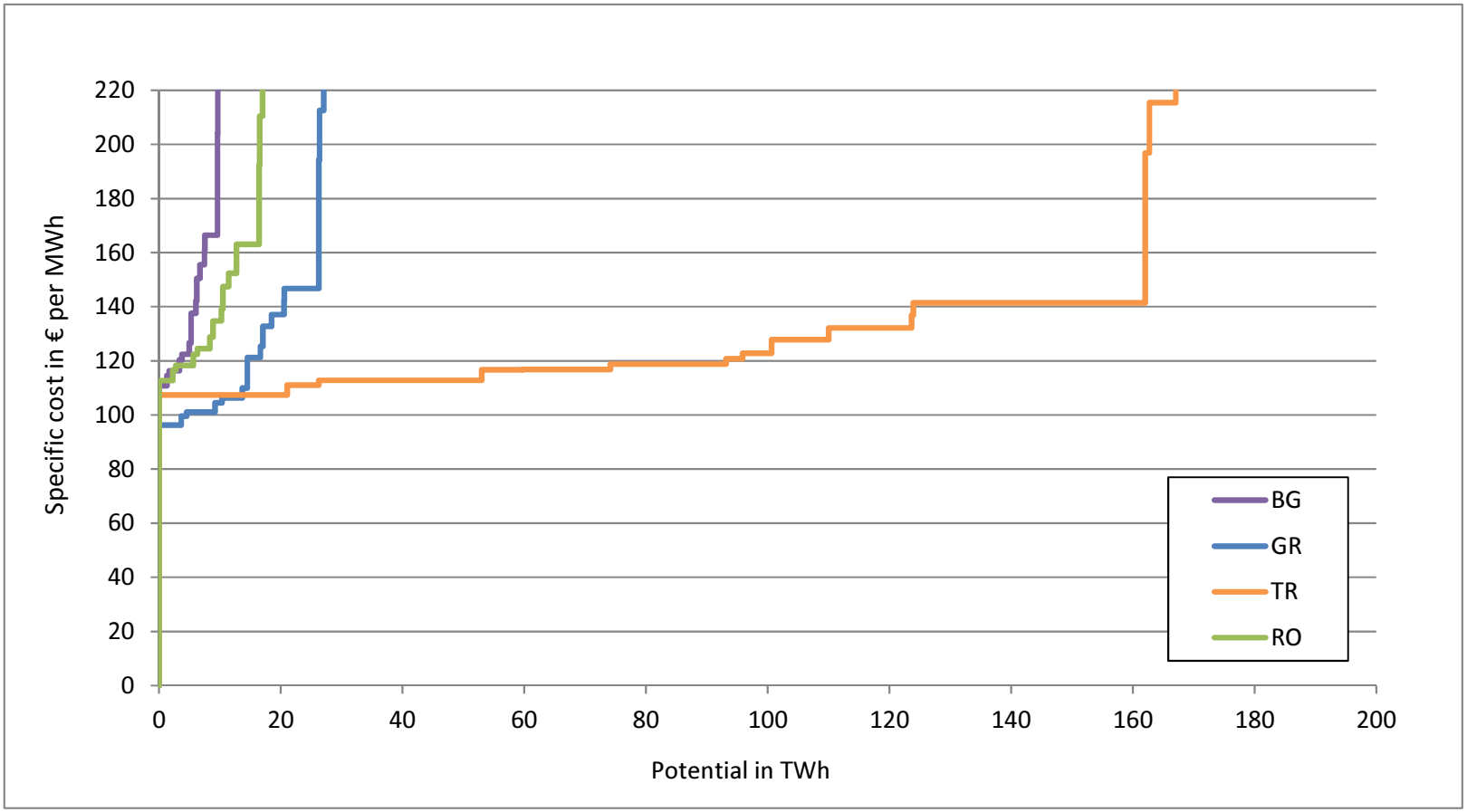
Long-term (2050) potentials for **Wind Onshore** in SEE countries

Green-X database on RES potentials



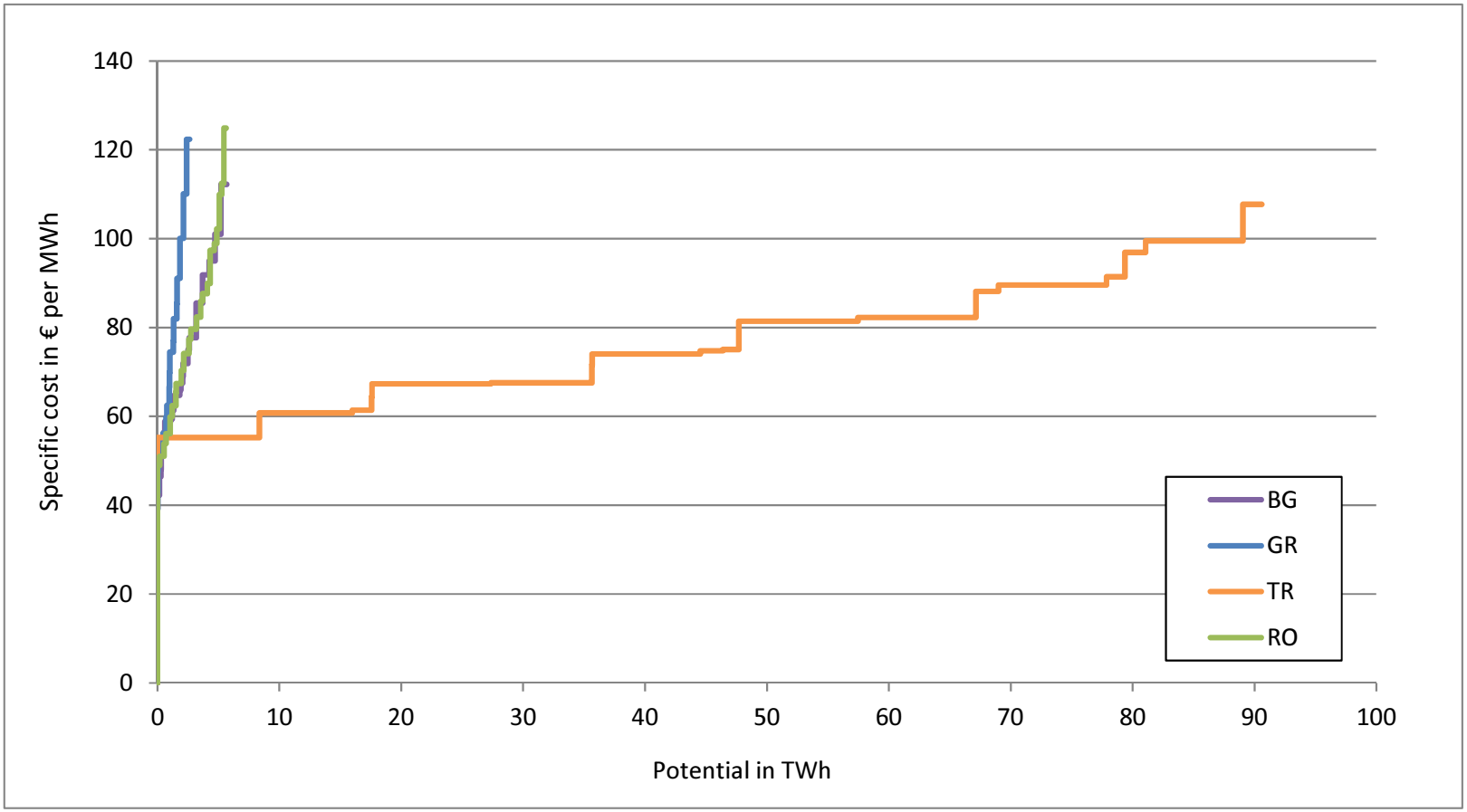
Additional long-term (2050) potentials for small- and largescale wind power
in GW

Green-X database on RES potentials



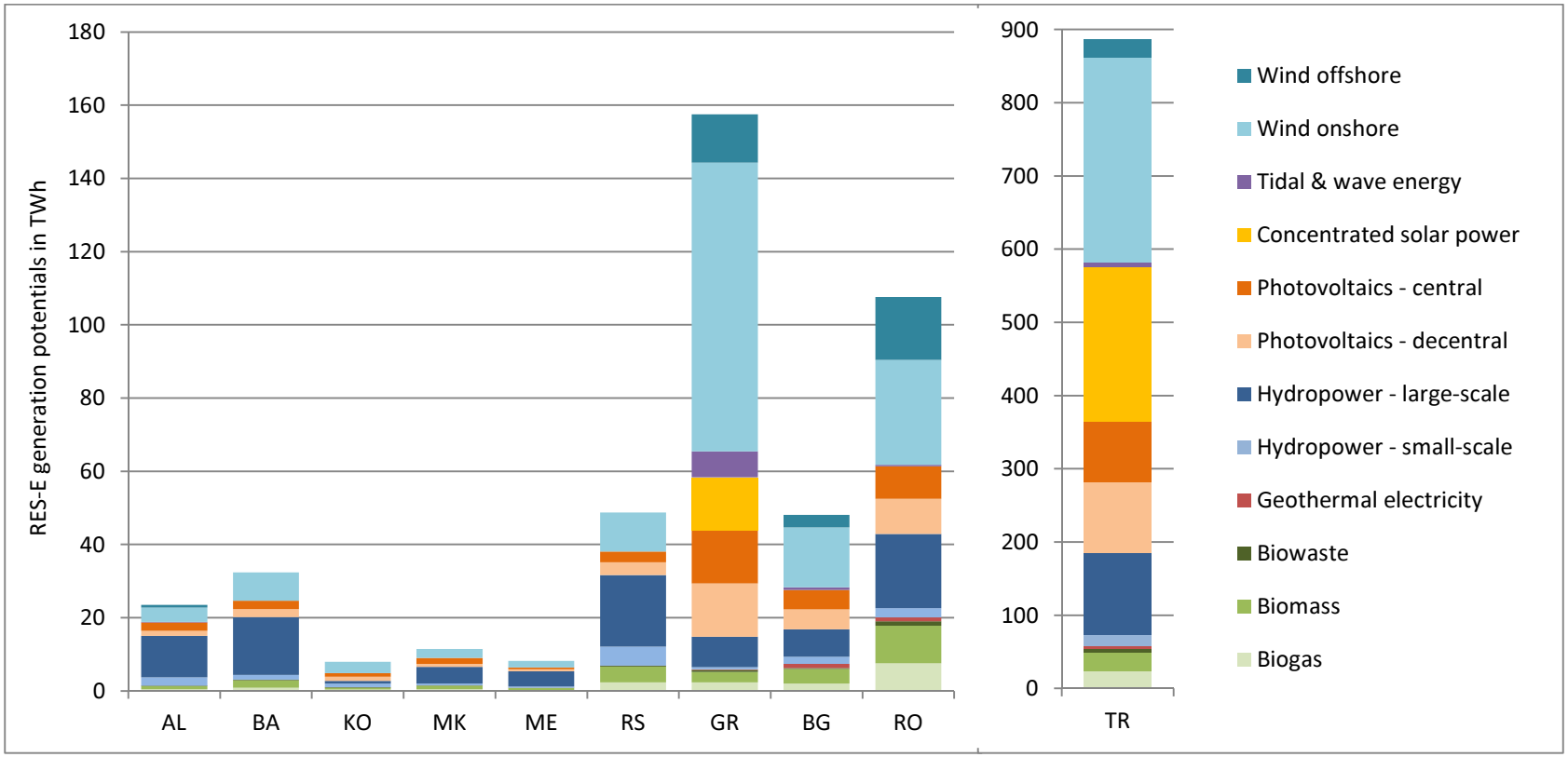
Additional long-term (2050) potentials for central and rooftop mounted photovoltaics
in GW

Green-X database on RES potentials



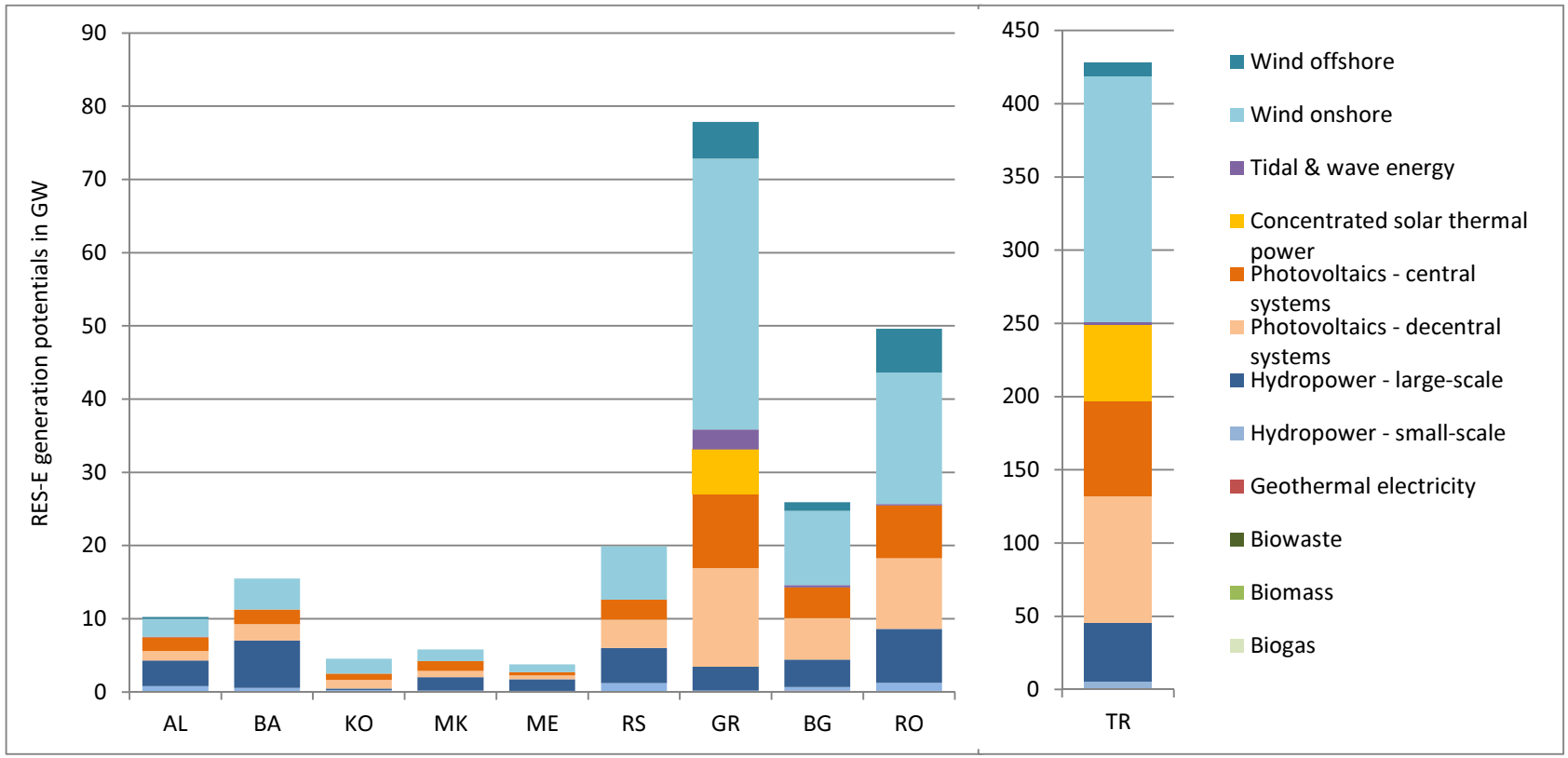
Additional long-term (2050) potentials for on- and offshore hydropower
in GW

Green-X database on RES potentials



Total long-term (2050) potentials for RES-E technologies
in TWh

Green-X database on RES potentials



Total long-term (2050) potentials for RES-E technologies
in GW

Country: **Bulgaria**

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

RES-electricity technology categories (Green-X)	Subcategories included	**Long-term (2050) realisable potential (Green-X database)** Electricity generation [GWh]	Capacity equivalent (approximation°) [MW]
Biogas*	Incl. agricultural digestion, sewage gas, landfill gas	1,999	
Biomass *	Solid biomass, incineration; incl. CHP, cofiring, "electricity only" plants	3,971	
Biowaste	Biodegradable fraction of MSW	266	
Geothermal electricity	Incl. also enhanced geothermal systems	1,162	180
Hydropower - small-scale	Up to 10 MW	1,930	506
Hydropower - large-scale	Above 10 MW	7,488	3,750
Photovoltaics - decentral systems	Small-scale rooftop systems, or building-integrated (facade, roof)	5,470	5,629
Photovoltaics - central systems	Large-scale free field systems	5,268	4,221
Concentrated solar thermal power		0	0
Tidal & wave energy		732	330
Wind onshore**	Based on GIS modelling with consideration of technical (power system) constraints and land use constraints	16,385	10,110
Wind onshore potential without power system constraints**	Based on GIS modelling (with land use constraints)	26,607	16,412
Wind offshore		3,424	1,200
RES-e total		**48,096**	
For comparison: gross electricity demand 2005		*36,385*	

Remarks:

* for biomass and biogas the expressed electricity generation potential serves only as a rough indication, reflecting rule-of-thumb preallocation to different uses (heat, electricity, transport) of the underlying potential for bioenergy feedstock

** potential used in Green-X modelling, based on GIS modelling with consideration of technical (power system) constraints and of land use limitations

*** potential based on GIS modelling without consideration of technical (power system) constraints but with land use limitations

° approximation of the capacity equivalent potential. This may change due to technological progress (e.g. change in wind turbine design)

Country: **Greece**

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

RES-electricity technology categories (Green-X)	Subcategories included	**Long-term (2050) realisable potential (Green-X database)** Electricity generation [GWh]	Capacity equivalent (approximation°) [MW]
Biogas*	Incl. agricultural digestion, sewage gas, landfill gas	2,299	
Biomass *	Solid biomass, incineration; incl. CHP, cofiring, "electricity only" plants	2,924	
Biowaste	Biodegradable fraction of MSW	500	
Geothermal electricity	Incl. also enhanced geothermal systems	221	38
Hydropower - small-scale	Up to 10 MW	574	150
Hydropower - large-scale	Above 10 MW	8,252	3,275
Photovoltaics - decentral systems	Small-scale rooftop systems, or building-integrated (facade, roof)	14,601	13,449
Photovoltaics - central systems	Large-scale free field systems	14,497	10,087
Concentrated solar thermal power		14,466	6,111
Tidal & wave energy		7,109	2,753
Wind onshore**	Based on GIS modelling with consideration of technical (power system) constraints and land use constraints	78,893	36,976
Wind onshore potential without power system constraints**	Based on GIS modelling (with land use constraints)	n.a.	n.a.
Wind offshore		13,173	5,000
RES-e total		**157,506**	
For comparison: gross electricity demand 2005		*63,196*	

Remarks:

* for biomass and biogas the expressed electricity generation potential serves only as a rough indication, reflecting rule-of-thumb preallocation to different uses (heat, electricity, transport) of the underlying potential for bioenergy feedstock

** potential used in Green-X modelling, based on GIS modelling with consideration of technical (power system) constraints and of land use limitations

*** potential based on GIS modelling without consideration of technical (power system) constraints but with land use limitations

° approximation of the capacity equivalent potential. This may change due to technological progress (e.g. change in wind turbine design)

Country: **Romania**

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

RES-electricity technology categories (Green-X)	Subcategories included	**Long-term (2050) realisable potential (Green-X database)** Electricity generation [GWh]	Capacity equivalent (approximation°) [MW]
Biogas*	Incl. agricultural digestion, sewage gas, landfill gas	7,577	
Biomass *	Solid biomass, incineration; incl. CHP, cofiring, "electricity only" plants	10,240	
Biowaste	Biodegradable fraction of MSW	1,223	
Geothermal electricity	Incl. also enhanced geothermal systems	1,046	162
Hydropower - small-scale	Up to 10 MW	2,500	1,093
Hydropower - large-scale	Above 10 MW	20,252	7,378
Photovoltaics - decentral systems	Small-scale rooftop systems, or building-integrated (facade, roof)	9,629	9,627
Photovoltaics - central systems	Large-scale free field systems	8,858	7,220
Concentrated solar thermal power		0	0
Tidal & wave energy		465	210
Wind onshore**	Based on GIS modelling with consideration of technical (power system) constraints and land use constraints	28,619	17,922
Wind onshore potential without power system constraints**	Based on GIS modelling (with land use constraints)	89,283	57,427
Wind offshore		17,151	6,000
RES-e total		**107,560**	
For comparison: gross electricity demand 2005		*56,500*	

Remarks:

* for biomass and biogas the expressed electricity generation potential serves only as a rough indication, reflecting rule-of-thumb preallocation to different uses (heat, electricity, transport) of the underlying potential for bioenergy feedstock

** potential used in Green-X modelling, based on GIS modelling with consideration of technical (power system) constraints and of land use limitations

*** potential based on GIS modelling without consideration of technical (power system) constraints but with land use limitations

° approximation of the capacity equivalent potential. This may change due to technological progress (e.g. change in wind turbine design)

Country: **Turkey**

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

RES-electricity technology categories (Green-X)	Subcategories included	**Long-term (2050) realisable potential (Green-X database)** Electricity generation [GWh]	Capacity equivalent (approximation°) [MW]
Biogas*	Incl. agricultural digestion, sewage gas, landfill gas	22,799	
Biomass *	Solid biomass, incineration; incl. CHP, cofiring, "electricity only" plants	26,780	
Biowaste	Biodegradable fraction of MSW	4,251	
Geothermal electricity	Incl. also enhanced geothermal systems	4,200	651
Hydropower - small-scale	Up to 10 MW	15,000	5,112
Hydropower - large-scale	Above 10 MW	112,058	40,179
Photovoltaics - decentral systems	Small-scale rooftop systems, or building-integrated (facade, roof)	96,471	86,443
Photovoltaics - central systems	Large-scale free field systems	83,439	64,832
Concentrated solar thermal power		210,317	51,827
Tidal & wave energy		5,893	2,100
Wind onshore**	Based on GIS modelling with consideration of technical (power system) constraints and land use constraints	281,061	167,512
Wind onshore potential without power system constraints**	Based on GIS modelling (with land use constraints)	327,422	185,386
Wind offshore		24,933	9,200
RES-e total		**887,202**	
For comparison: gross electricity demand 2005		*160,794*	

Remarks:

* for biomass and biogas the expressed electricity generation potential serves only as a rough indication, reflecting rule-of-thumb preallocation to different uses (heat, electricity, transport) of the underlying potential for bioenergy feedstock

** potential used in Green-X modelling, based on GIS modelling with consideration of technical (power system) constraints and of land use limitations

*** potential based on GIS modelling without consideration of technical (power system) constraints but with land use limitations

° approximation of the capacity equivalent potential. This may change due to technological progress (e.g. change in wind turbine design)