Perspectives of Renewable Energy in the Danube Region

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The Limits to Wind Energy in Hungary
the Geographical Aspect

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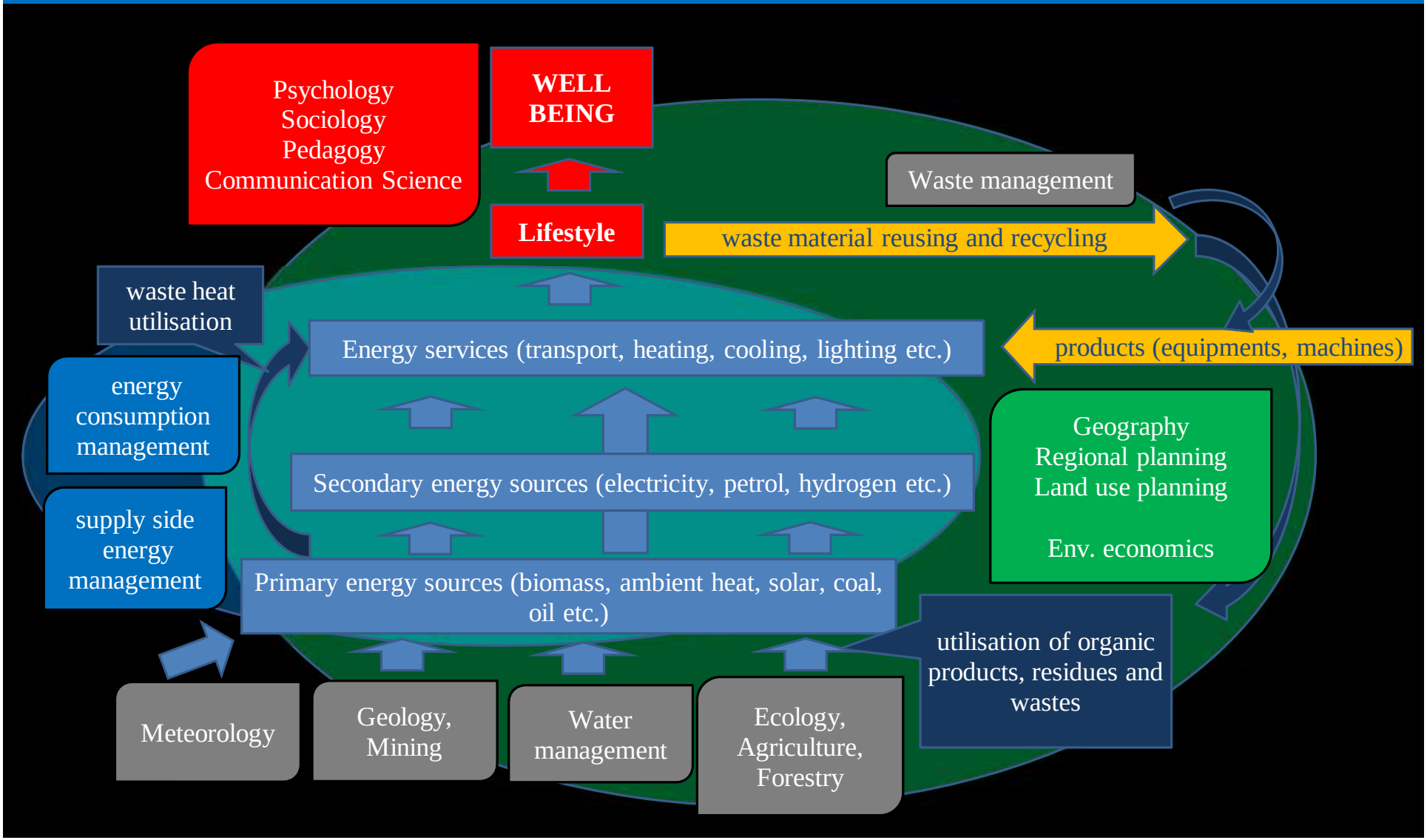
Growing importance of Geography in Energy Planning

- Scientific necessity in energy production
  - Huge → Small ecological footprint
  - Finite (nuclear, fossil) → Renewable energy sources
  - Import → local sources
  - Centralised → local energy systems

- More than 10 years research and teaching experiences in the ELTE University, Dept. Of Environmental and Landscape Geography
  - GIS-based energy potential calculations - since 2003
  - „This Way Ahead" energy planning research - since 2009

Main problem (in Hungary): **electricity production experts** are considered as the insiders of energy planning

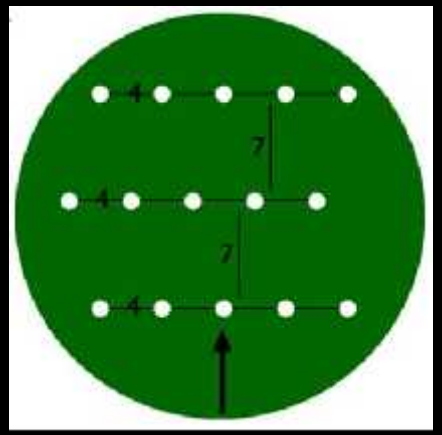


The main elements of our energy scenario research

- Calculating renewable energy potentials
  - with GIS
- Estimating efficiency potentials
  - (the technological factor)
- Estimating energy saving (sufficiency) potential
  - (the human factor)
- Creating a BEST CASE SCENARIO
  - computer based analysis (software developed by INFORSE-Europe)
  - in 5-years steps by 2050
    - demand
    - development of efficiency;
    - market penetration of renewables.

Methodology of calculting technical wind energy potential

- present technological level
  - 2-3 MW/turbine
    - rotor diameter: 100-120 m
  - land requirement value:
    - 8-10 MW/km^2 – optimal lay-out of turbines



- legal limitations (excluded areas, examples)

  a) protected areas (landscape, nature);

  b) infrastructure, settlement, industrial areas, farms;

  c) areas with high agricultural value;

  d) forests;

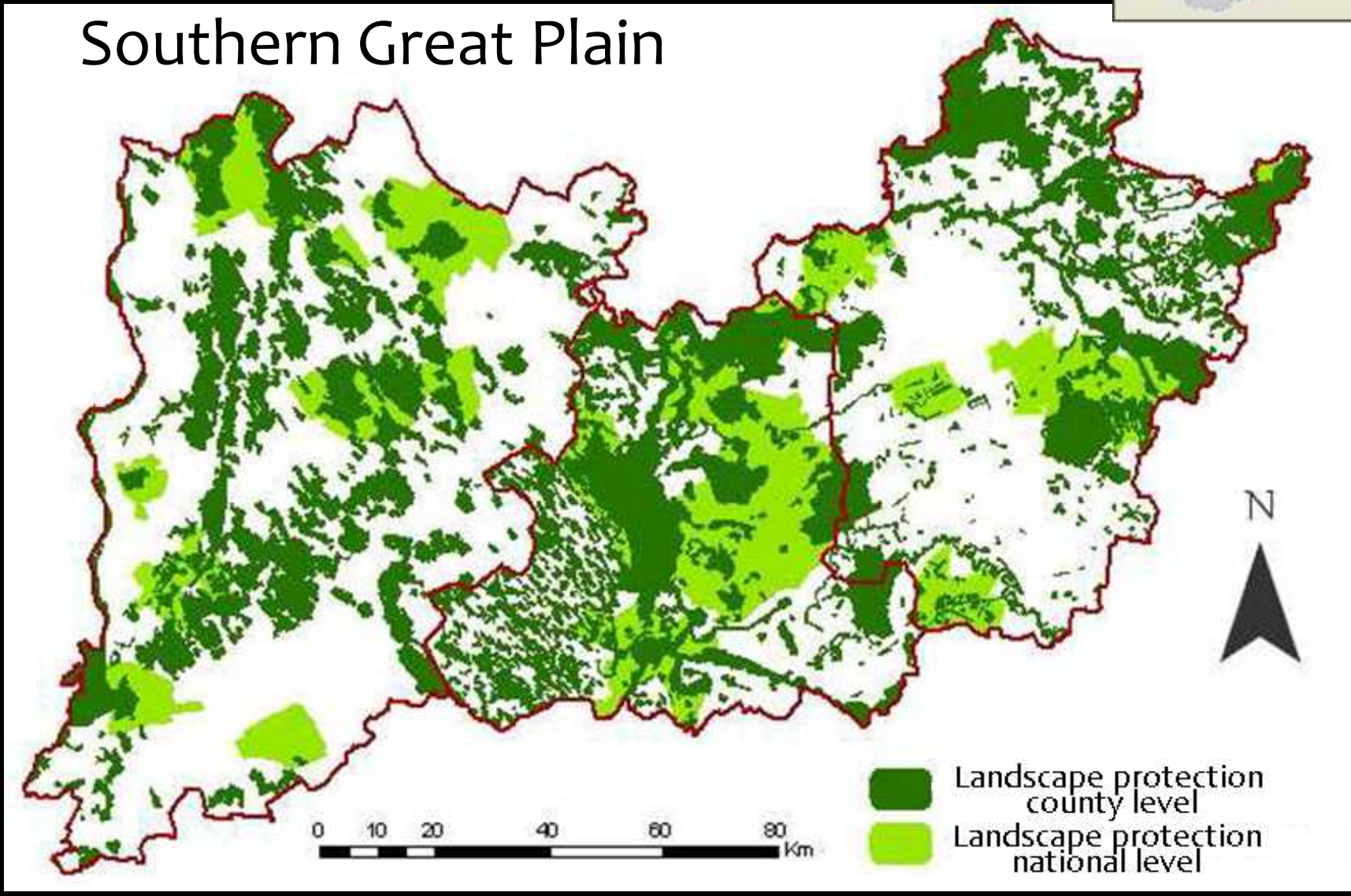
  e) hydrographical elements;

  f) unsuitable areas from technological point of view

- buffer zones
- too small areas

Landscape protection

Southern Great Plain



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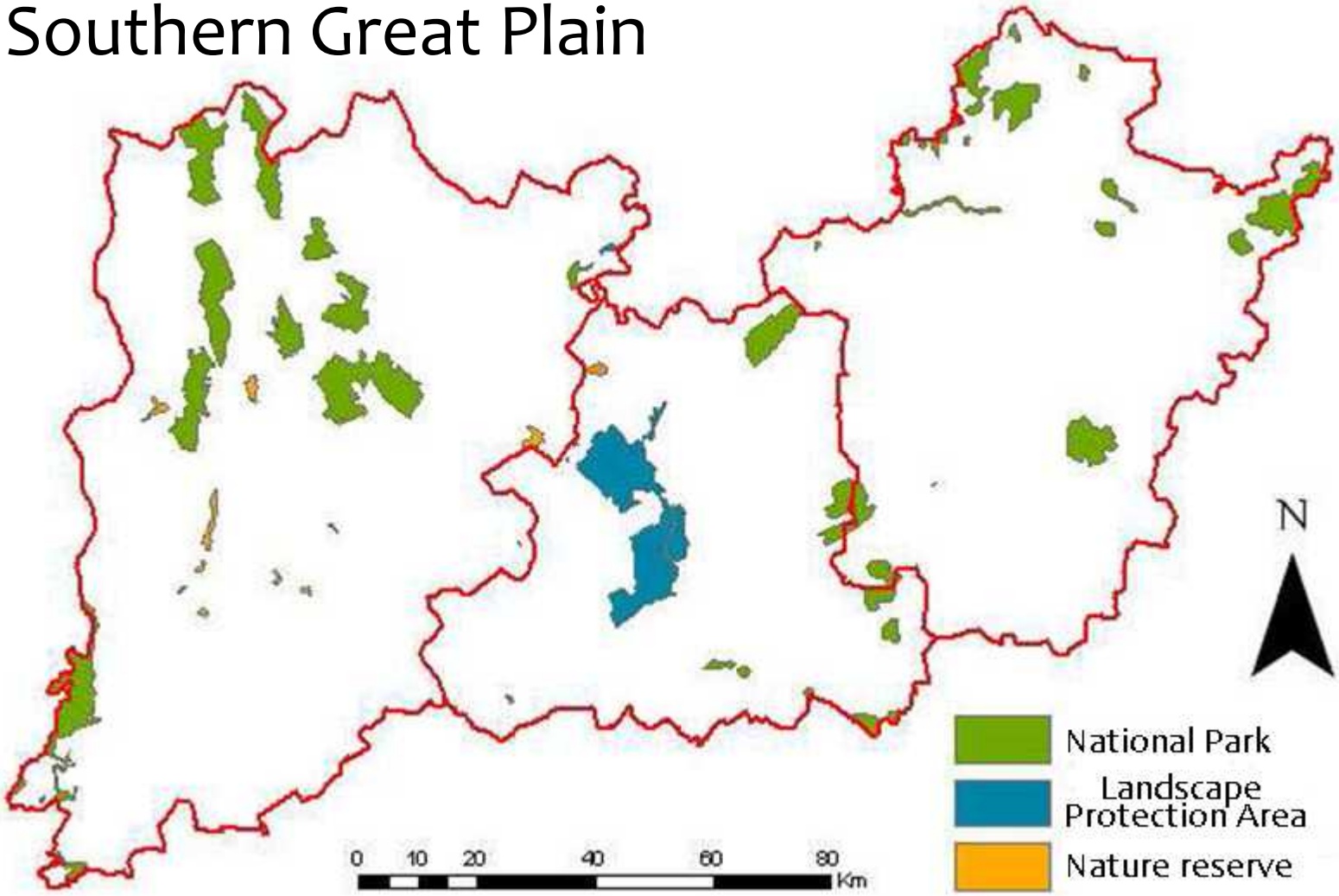
Protected natural areas

Southern Great Plain



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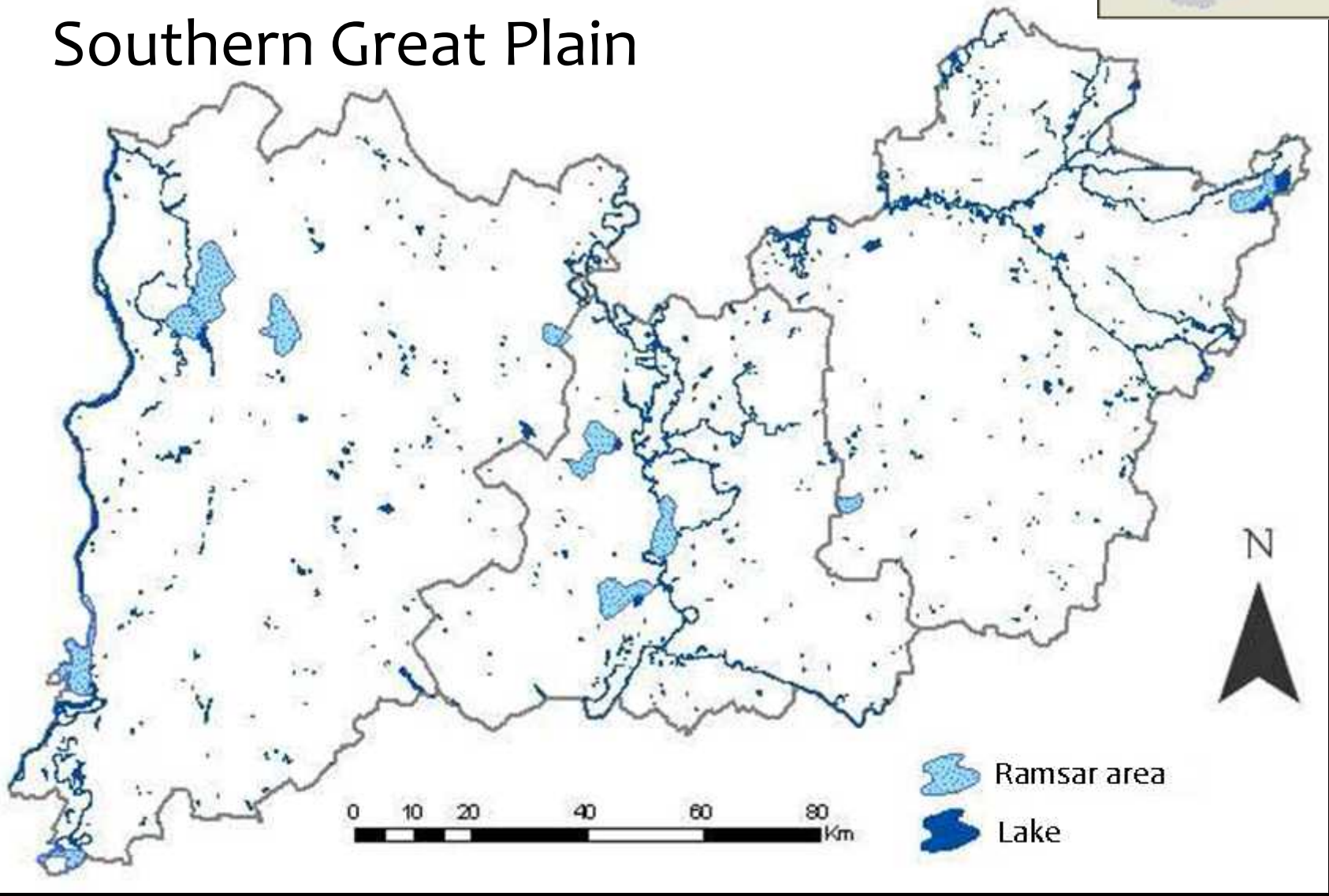
Water bodies

Southern Great Plain



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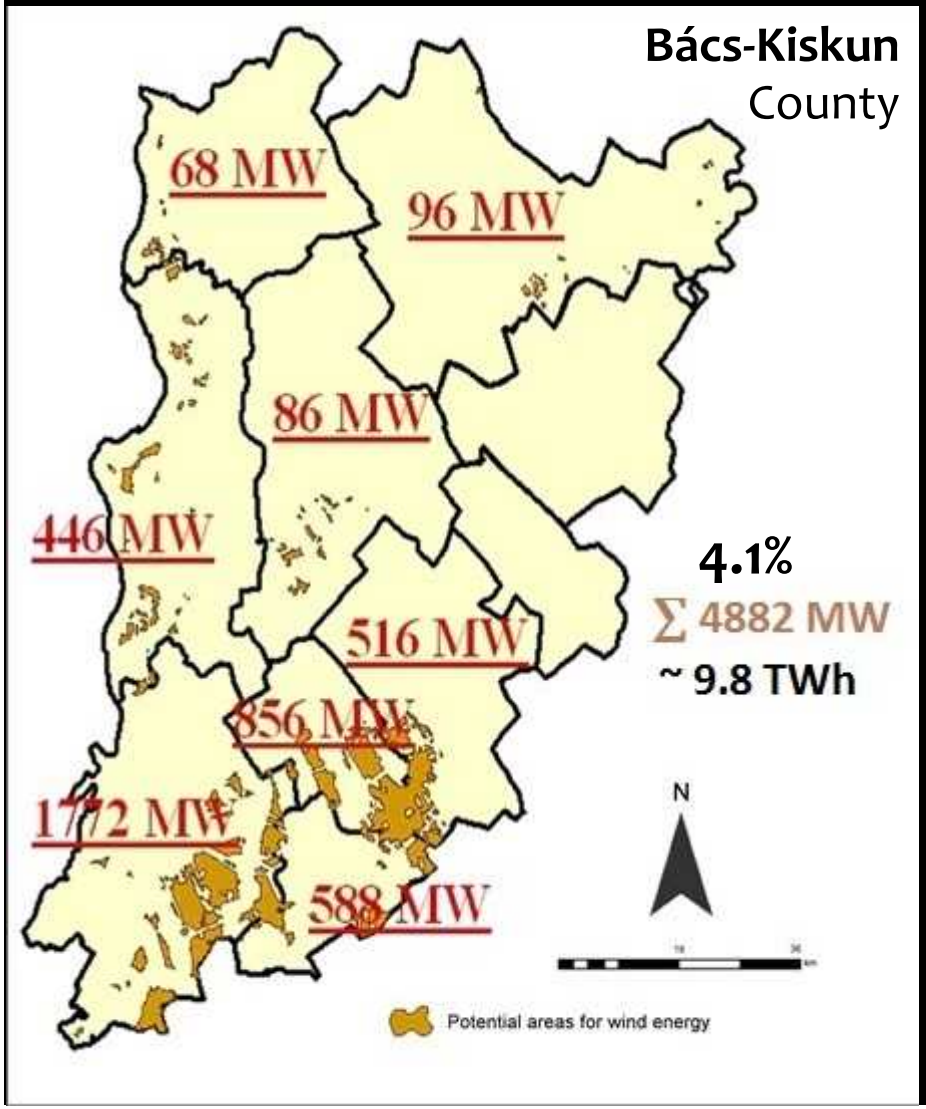
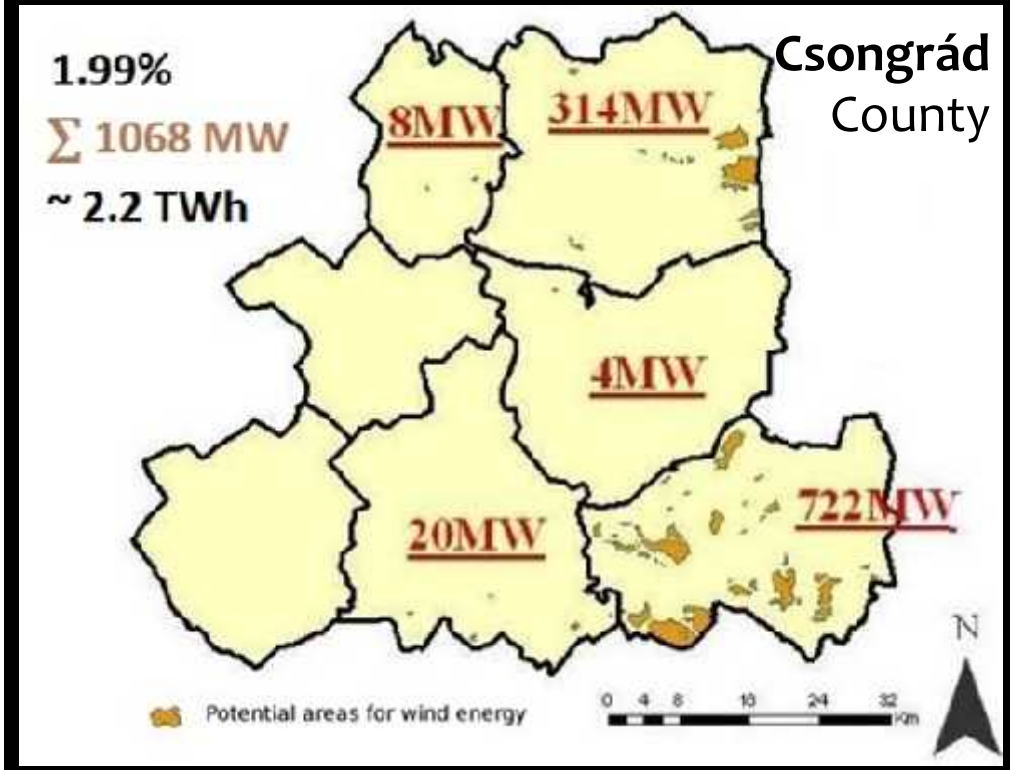
Results of the screening: Potential areas for RE applications
(examples of 2 Hungarian counties)





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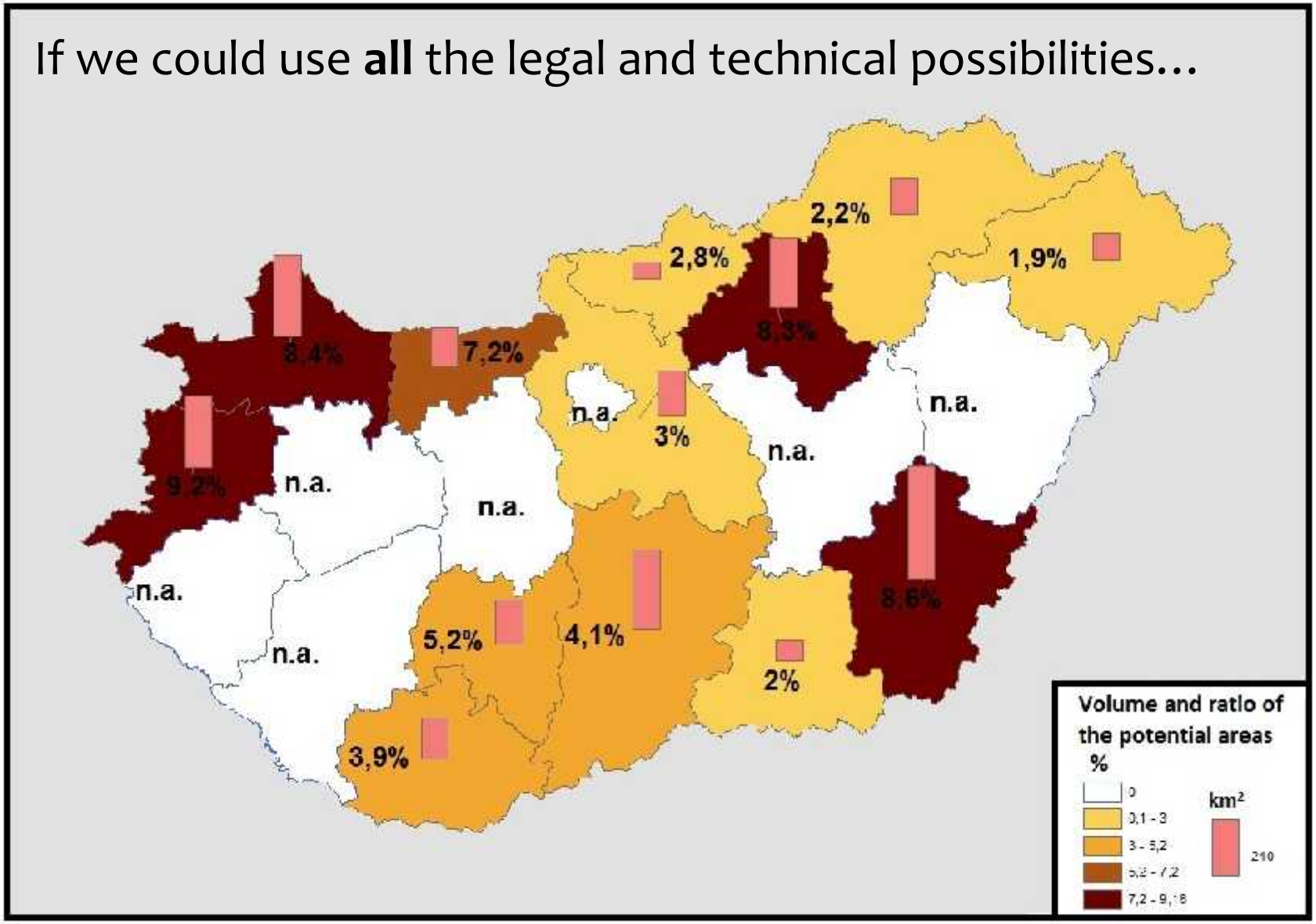
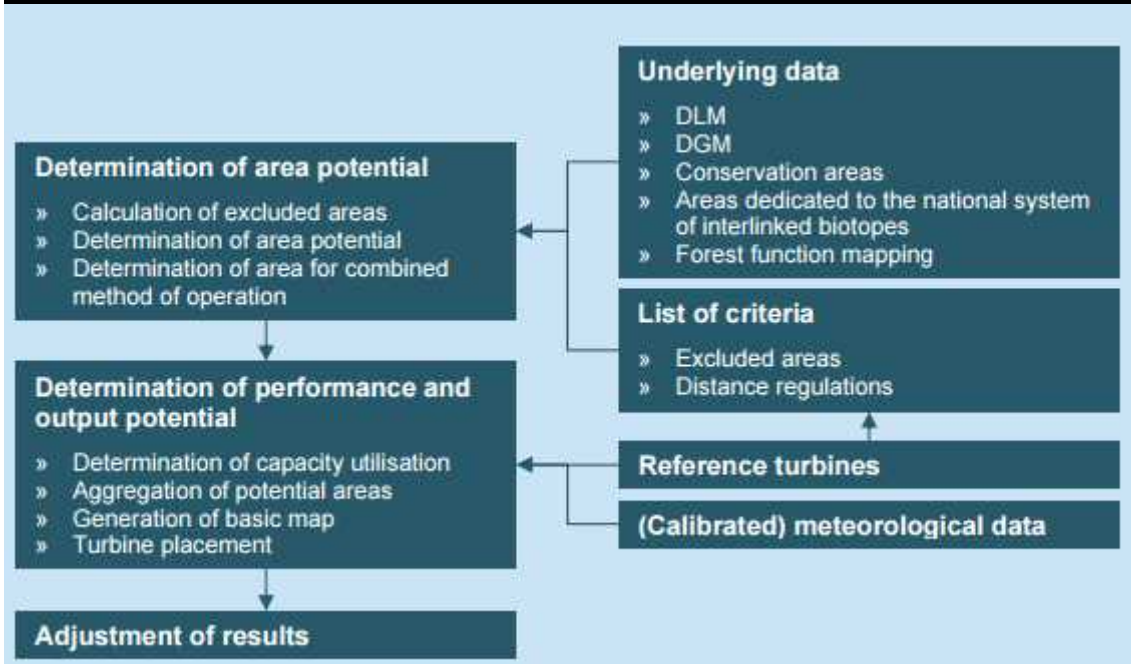
Results (technical pot.): 5.13% for Hungary
47 700 MW → 96 TWh



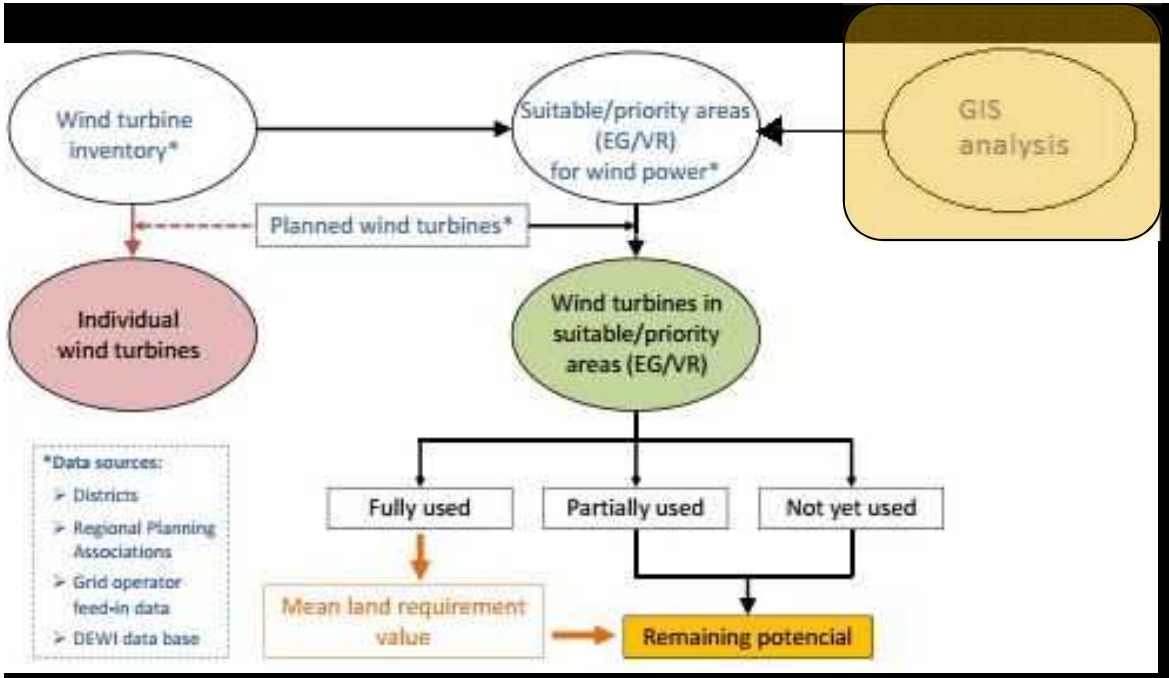
International comparison



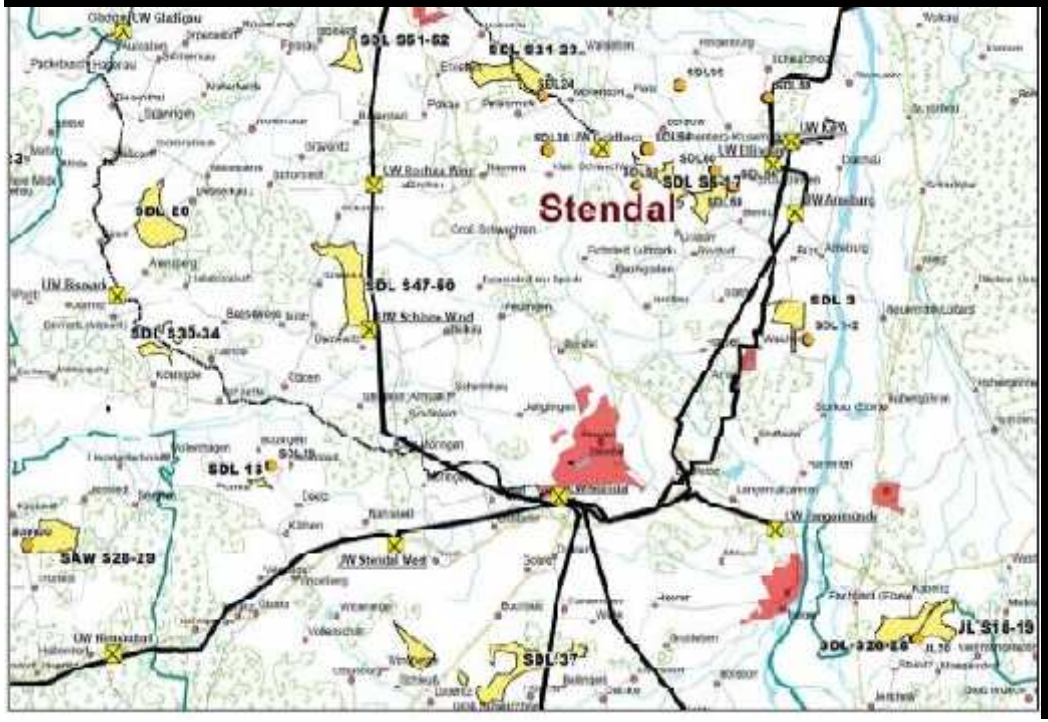
	Area potential		Capacity potential	Output potential	Mean full load hours
	[km²]	Share	[GW]	[TWh]	[h/a]
North Berlin, Brandenburg, Bremen, Hamburg, Mecklenburg-Western Pomerania, Lower Saxony, Saxony-Anhalt, Schleswig-Holstein (■ 38.9 % of German territory)	22,851	16.4 %	526	1,378	2,621
Central Hesse, North Rhine-Westphalia, Rhineland-Palatinate, Saxony, Thuringia (■ 30.7 % of German territory)	11,200	10.2 %	287	728	2,540
South Baden-Württemberg, Bavaria, Saarland (■ 30.4 % of German territory)	15,310	14.1 %	375	791	2,108
Germany overall	49,361	13.8 %	1,188	2,898	2,440

GIS-based methodology used by the German Federal Environment Agency (Lütkehus, I. – Salecker, H. [2014])

Results: 13.5% suitable area for wind applications



Methodology used in Saxony-Anhalt, Germany for estimating the technical wind energy potential (Neddermann, B. et al. [2014])



Turbine capacity:
3,5 MW

Land requirement value:
~25 MW/km^2

Methodology of calculating socio-economic potential

East Germany as a realistic model

- Leading in wind energy
  - 14 048 MW (1990 → 2014)
- Similar features in
  - common socialistic history
  - territory size and terrain
  - population density
  - power consumption
  - (wind climate)

1. calculation of the „per capita" socio-economic potential
2. calculation of the „per km^2" socio-economic potential
3. setting of the average value
4. correction with GDP/capita

Results of the socio-economic potential

installed capacity per capita in East Germany	population of Hungary	„per capita" socio-economic potential of Hungary
0,861 kW/capita	9 908 798 inhabitants	8 531 MW

installed capacity per km² in East Germany	territory of Hungary	„per km²" socio-economic potential of Hungary
129 kW/km²	93 030 km²	12 041 MW

Final socio-economic potential: **10 286 MW±15%** → 20,7 TWh±15%

Lower GDP/capita ➡ longer implementation time, achievable **by 2050**

What does it mean?

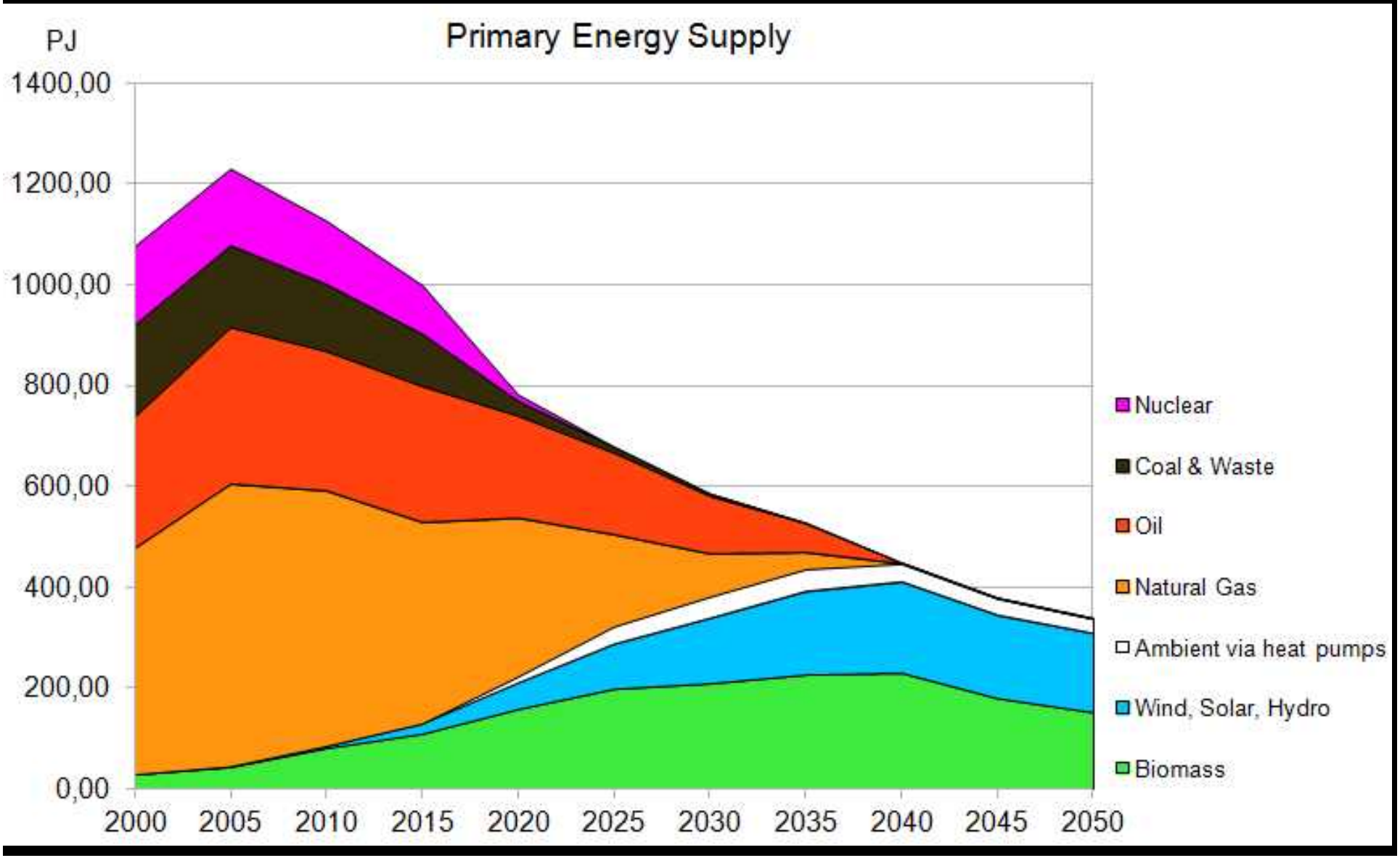
	East Germany 2014	Hungary 2015	Renewable Energy Utilization Action Plan 2020	Hungary „This Way Ahead" 2050
Wind turbine installed capacity	**14 048 MW**	**329 MW**	**750 MW**	**10 286 MW**

The East German example proves that it is a real option to create such a big wind turbine capacity.

Sustainable utilisation of renewable energy sources

	technical potencial (PJ/year)	socio-economical potencial (PJ/year)
Solar	268 (157 power + 111 heat) (33500 MW hybrid collector)	37-56 (28-47 power + 9 heat) (in comp. with Bavaria and Austria)
Wind	350-450 (50000-60000 MW)	90-100 (12000-13000 MW) - in comp. with Eastern-Germany
Biofuel (EU Directive)	12	90 (in comparison with data from MeckPomm and Sweden)
Sustainable biomass production	100	
Energy crops	65 (5000 km2)	
Biogas	80	
Ambient heat	100 ??	85 (in comp. with Sweden)
Hydro	2	2
S	**~980-1080**	**~300-320**

Primary energy supply (2000-2050)
„This Way Ahead – **Vision Hungary 2050**” scenario



Energy Management and the Human Factor
2008

The first 100% renewable energy scenario for Hungary

Erre van előre 1.0
Vision Hungary 2050
This Way Ahead 1.0
2011

Erre van előre 2.0
This Way Ahead 2.0
2014

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