”This way ahead”
a research on sustainable energy for Hungary

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This way ahead

an „almost best case" sustainable energy scenario until 2050

for a stable population (~10 million);
with constant living standards;
without economic growth.

2011

This Way Ahead 1.0

– A framework of a sustainable energy system in Hungary. (168 p.)

2014

This Way Ahead 2.0

– The way to a sustainable energy future (196 p.)

Main characteristics of the energy sector in Hungary

Huge environmental impact - (65-70% of the whole footprint)

~60% hydrocarbons; ~20% nuclear; ~10% coal; ~10% renewables

Worrying import dependency:

80-85% imported energy sources (including nuclear)

Outdated system:

centralized energy system with huge system losses

Missing knowledge

about sustainable energy (RES, storage, smart systems)

Official plan: National energy strategy - until 2030
published in 2012

Philosophy: „*to cover the increasing demand*” - focus on electricity production

A strategy without real attempts

- to decrease the ecological footprint of the energy sector;
- to decrease the import dependency;
- to influance the growing tendencies in energy and power consumption.

Good knowledge about the last century’s technologies

- without mentioning the „*ambient heat*” as an energy source

„…The other key component to achieve the 100% renewable scenario is a 30% decrease in primary energy demand which could completely redeem the nuclear energy by 2050. In our opinion, the 100% renewable concept is contrary to the general philosophy of renewable energy production.”

Background studies

Wind energy possibilities
according to the Renewable Energy Subcommittee of Energy Committee of Academy of Science (published in 2004)

Type of **excluded** areas	**Territory (km²)**
Inhabited areas	6650
Water areas	1753
Protected areas	8573
Forests	17468
Gardens, wineyards, orchards	2880
Railway lines	3949
Roads	2205
Electric grid	15419
High altitude areas, steep slopes	1860
Total excluded (with simple addition)	**60757**
Hungary total	**93030**

„There are minor overlaps amongst the above mentioned items. There are, however, ignored areas (airports, telecom towers, standalone buildings) as well, which counterbalance those overlaps."

Elementary mistakes:
- *Ignored GIS*
- *Confusions in nature and landscape protection categories*

Motivation
behind the „This Way Ahead" research project

Reseach interest

Inappropriate

- official energy strategy
- background studies

Educational interest:

Energy geography courses at the ELTE University (Budapest)

sustainable energy management I-II.

energy planning I-II.

„This Way Ahead” research & education project

Research question: would it be possible to create a 100% renewable energy system in Hungary?

Methodology: Computer based analysis on renewable energy potentials and energy system

Approach: Multidisciplinary – experts from several research areas

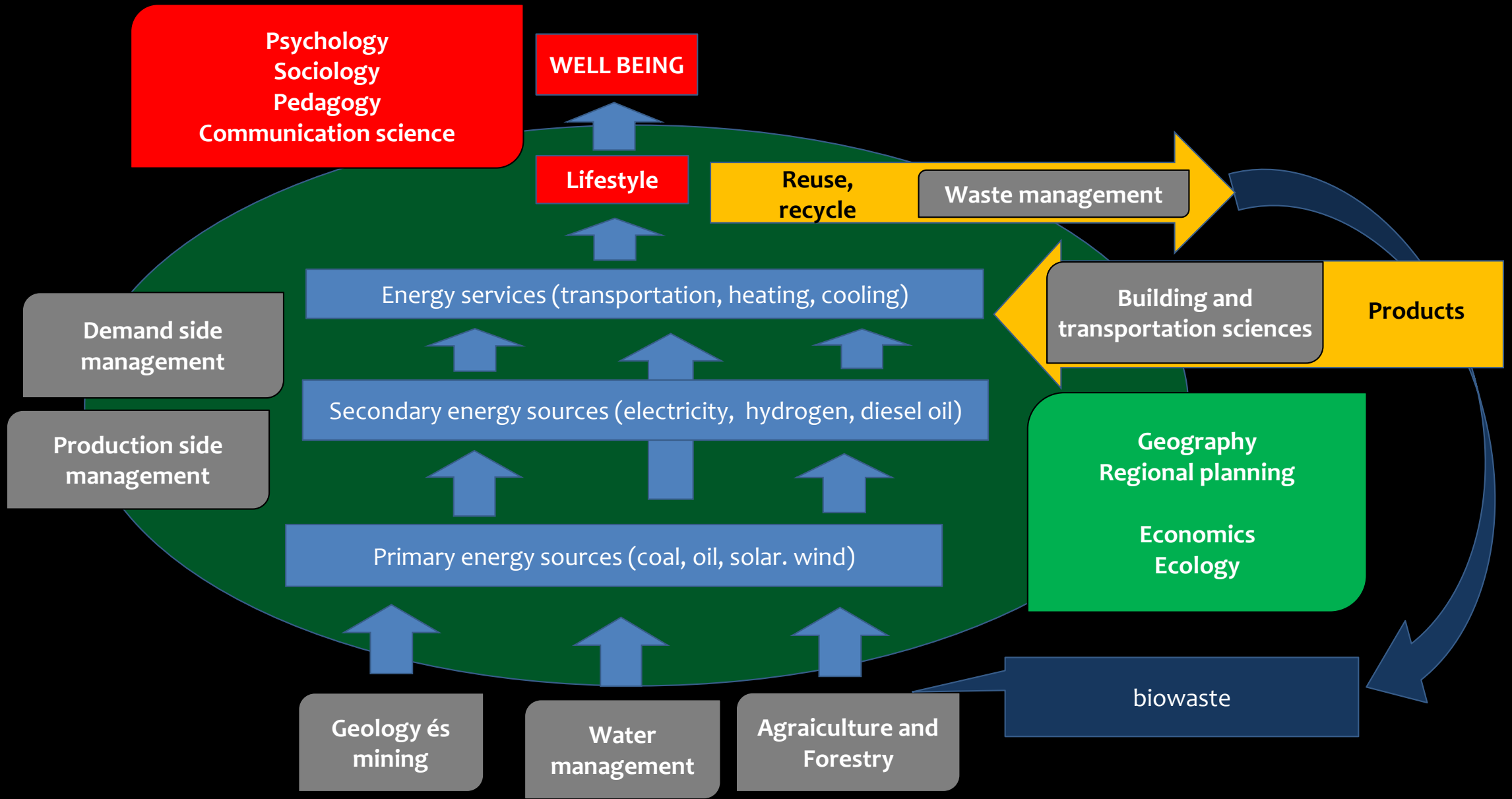
Main elements of the concept

- ***Sustainable* utilisation of renewable energy sources**
  - *Officially projected consumption by 2030: 1150 PJ* ⟷ *Sustainable potential ~300 PJ*

- ***Reduced consumption***
  - *Improvements on efficiency (technological aspect)*
  - *sufficiency in consumption (human aspect)*
    - *internal pressure (raising awareness, education)*
    - *external pressure (economic and legal regulation)*

- ***Cross-sectoral interconnections** – identifying and utilizing **synergies***
  - *multidisciplinary approach - focusing on locality*

Interconnections of the energy sector



List of the expert fields in „This Way Ahead”

- Geographers
  - regional analysts;
  - regional and urban planners;
  - environmental researcher;
- Environmental manager;
- Environmental physicist;
- Environmental engineer;
- Mechanical engineer;
- Electrical engineer;
- Agricultural engineer;
- Architect;
- Renewable energy expert;
- Economist;
- Psychologist

1st version:

23 authors (from 3 universities)

14 students

2nd version:

17 authors (from 4 universities)

9 students

3 main project STEPS

1) Calculating or estimating potentials - partly with GIS:
   - Potentials of RES
     - A theoretical technical potencials of RES;
     - A realistic socio-economic potencials of RES;
   - Potencials of energy efficiency.
2) Creating a scenario - with an MS Excel application (together with INFORSE):
   - for production and consumption;
   - by 2050 in five-year steps (production and comsumption).
3) Checking and setting balance - with EnergyPLAN (by INFORSE):
   - energy mix
   - storage + demand side management.

Calcultation of technical RE potentials (the example of wind energy)

- considering legal limitations
  - by the Environmental Ministry
  - by the National Housing and Construction Office

a) protected natural areas (local, national and international level);

b) protected landscapes (national and county level);

c) Environmentally Sensitive Areas (ESA);

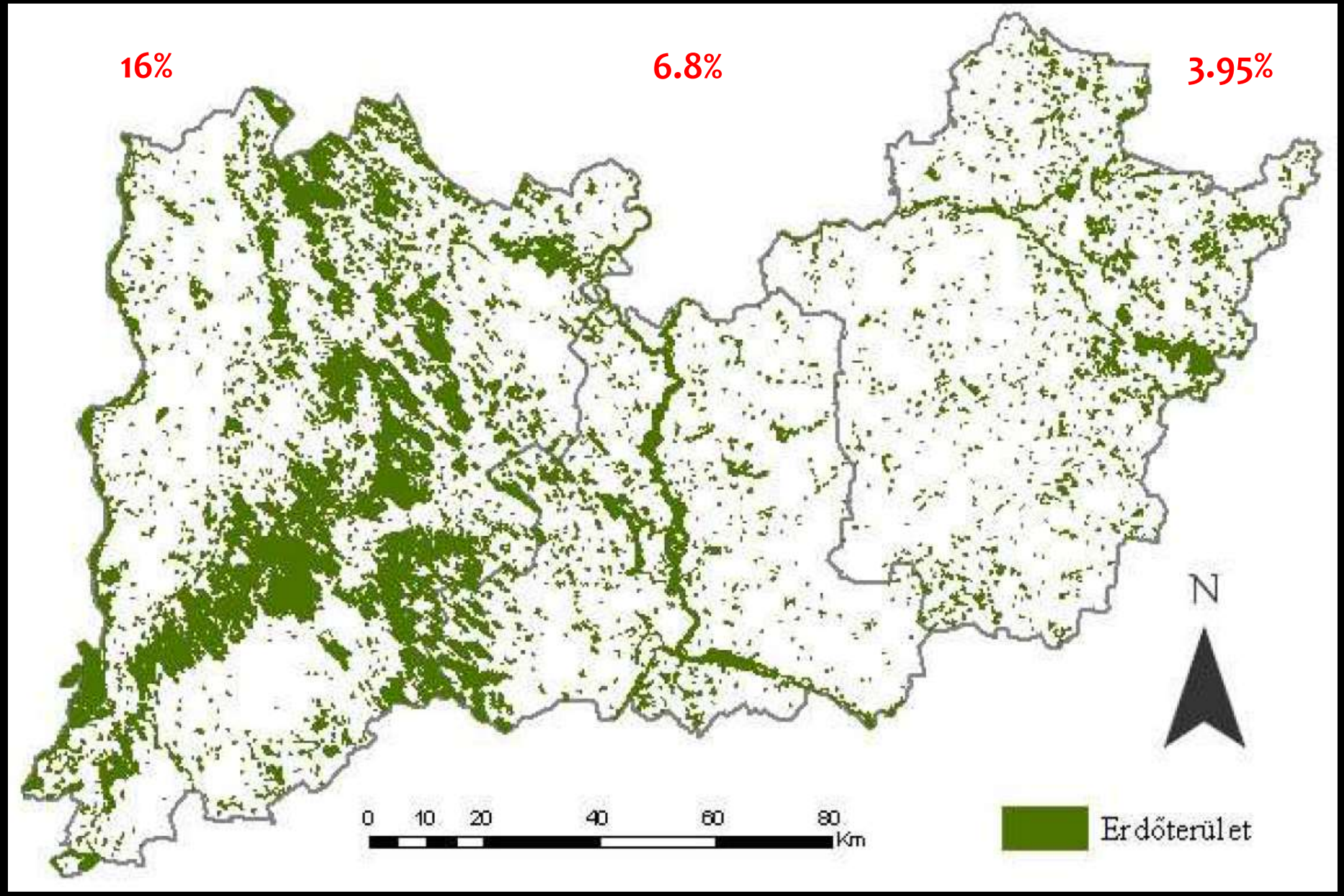
d) forests;

e) hydrographical elements;

f) roads, railways and airports;

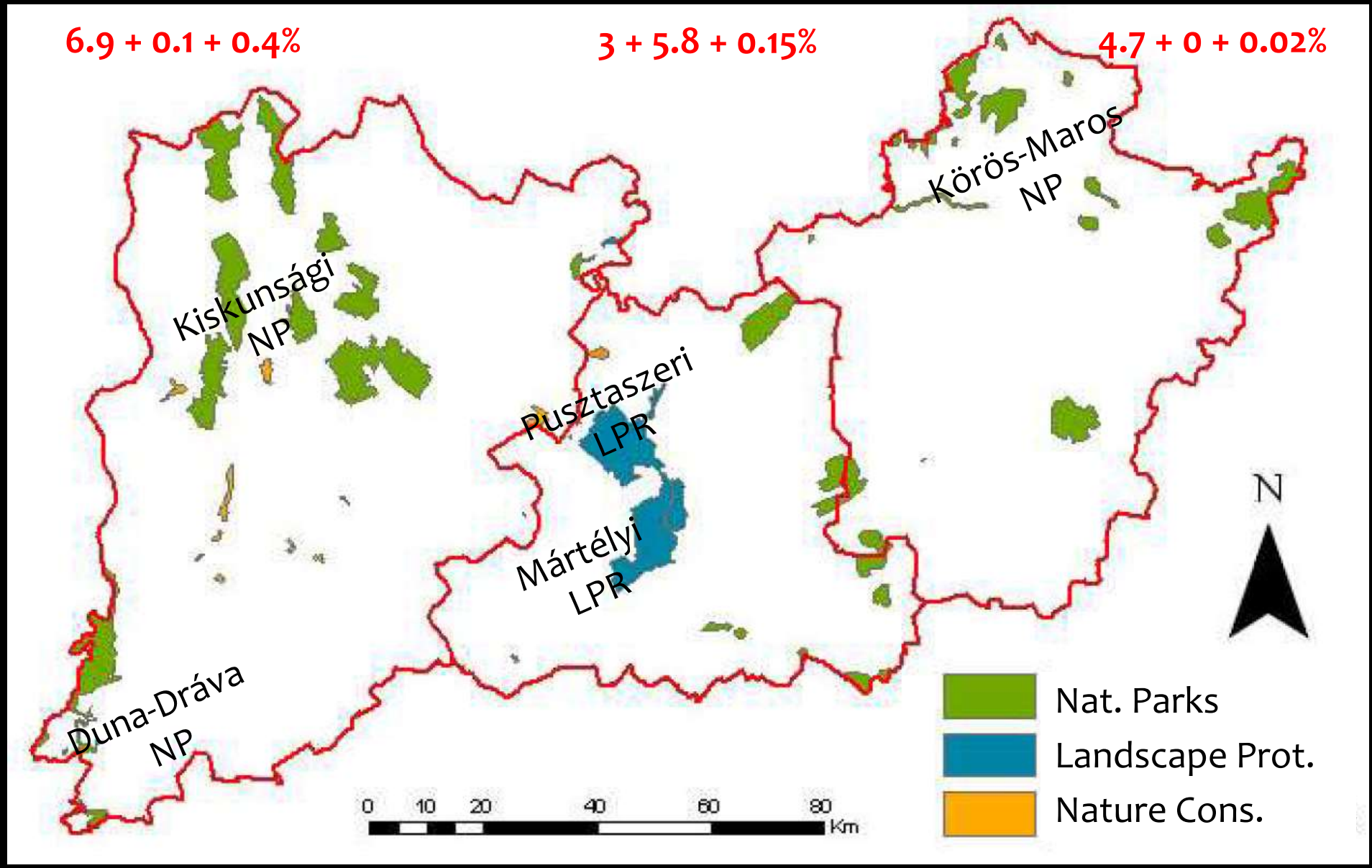
g) transmission lines (as vulnerable elements of the infrastructure).

Forests (3 counties of the Southern Great Plain)

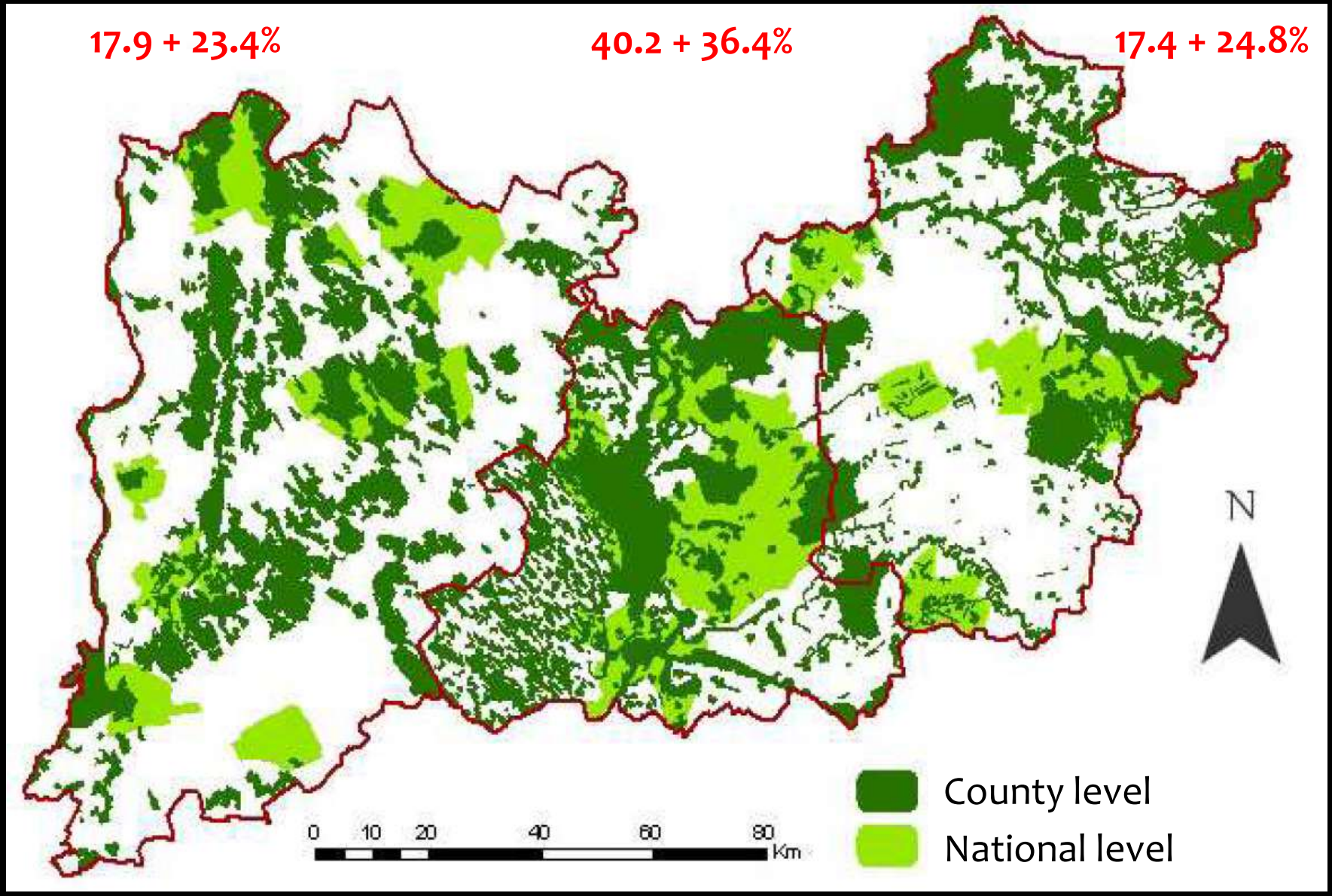


Protected natural areas

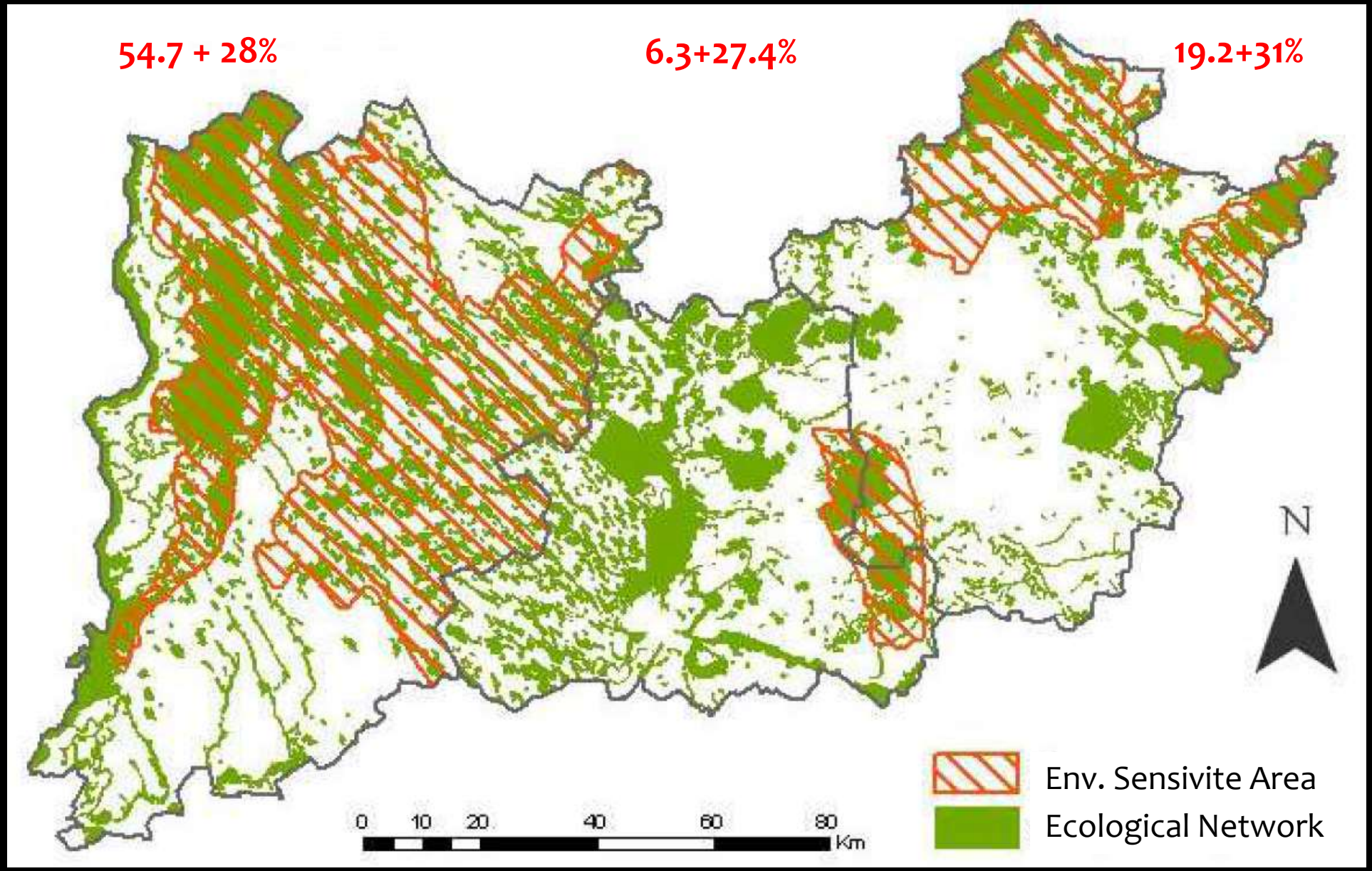
(IUCN Cat.: National Park; Landscape Protection Reserve; Nature Conservation Area)



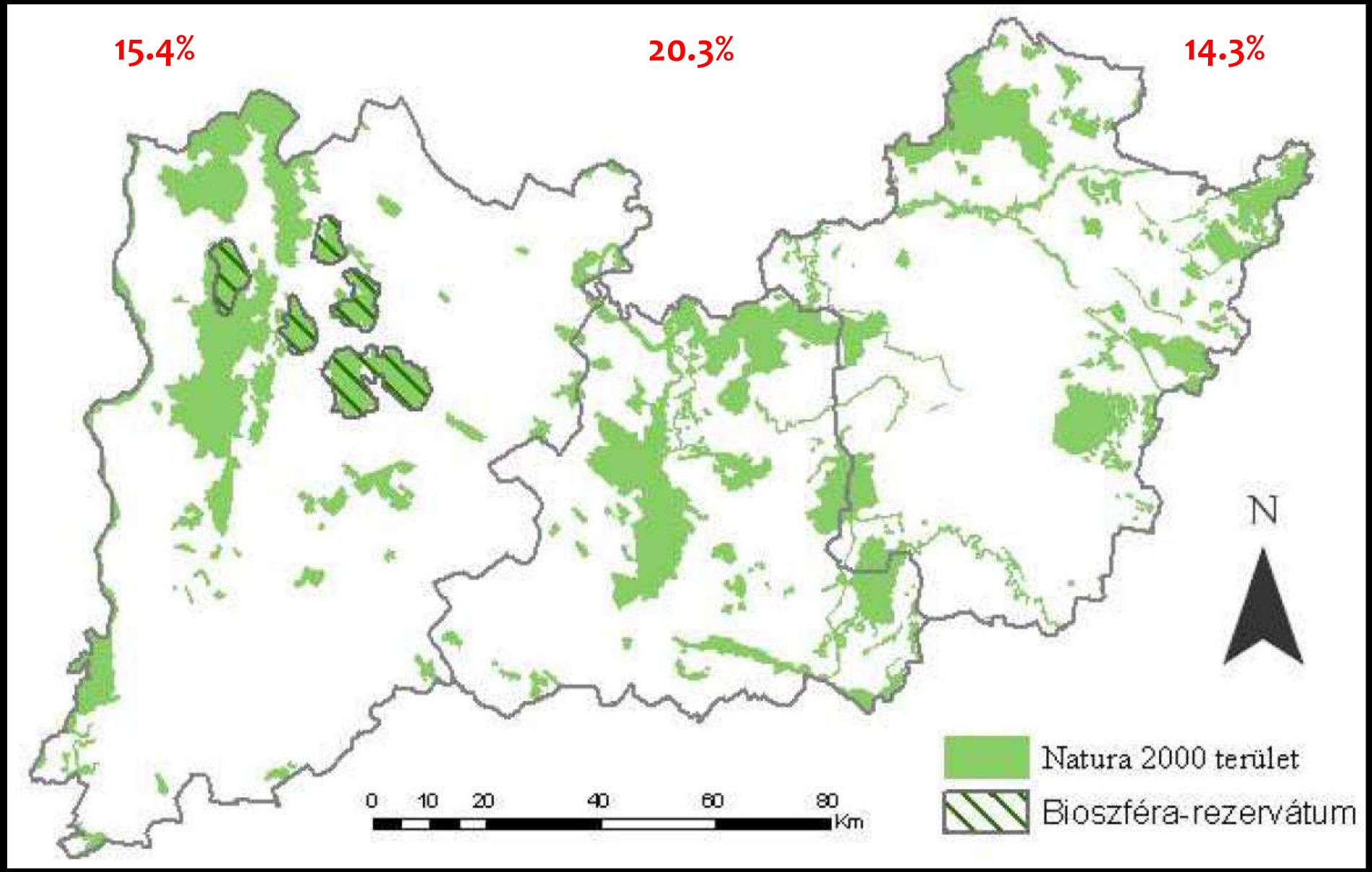
Protected landscapes (national and county level)



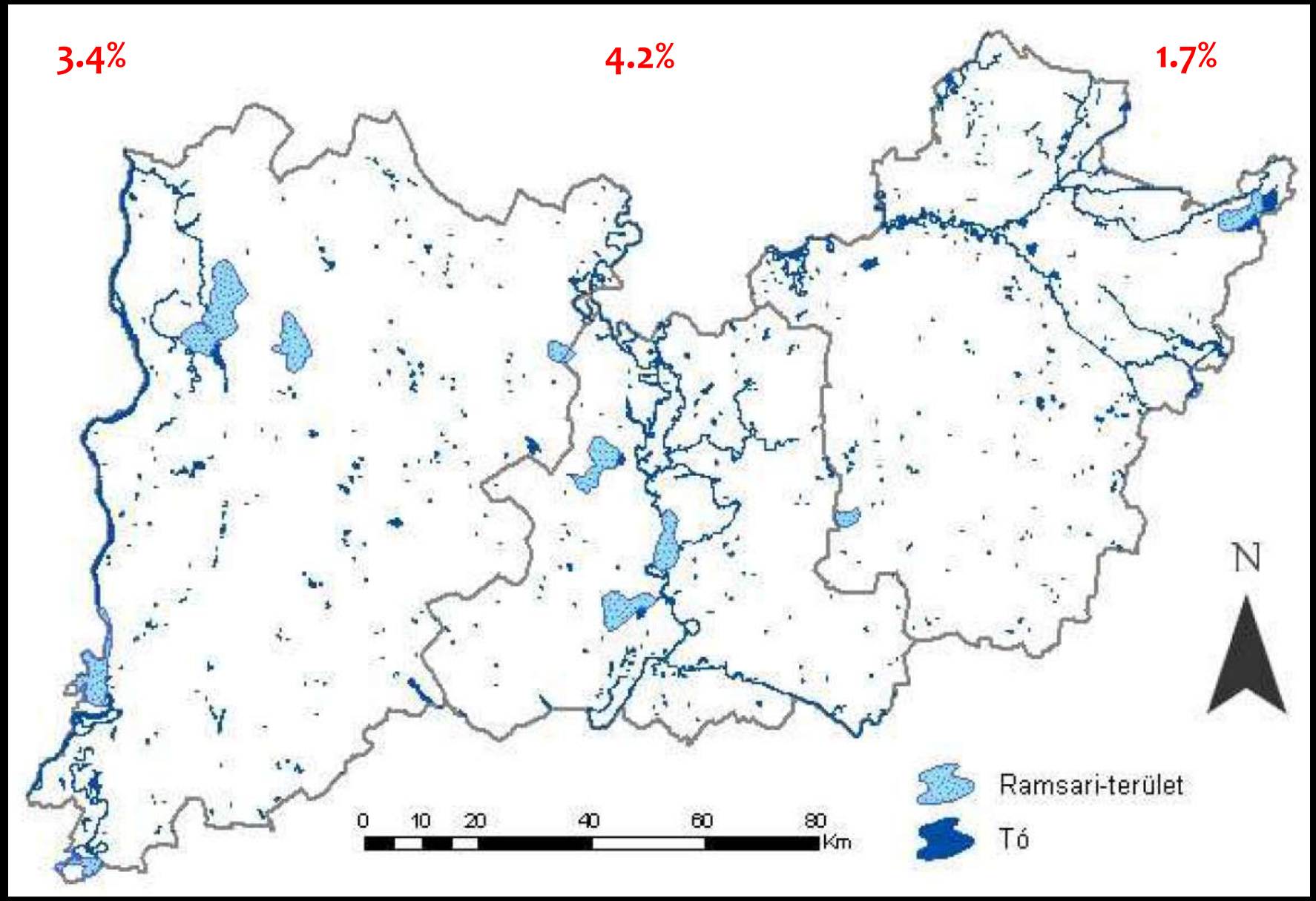
Environmentally Sensitive Areas and Ecological Network



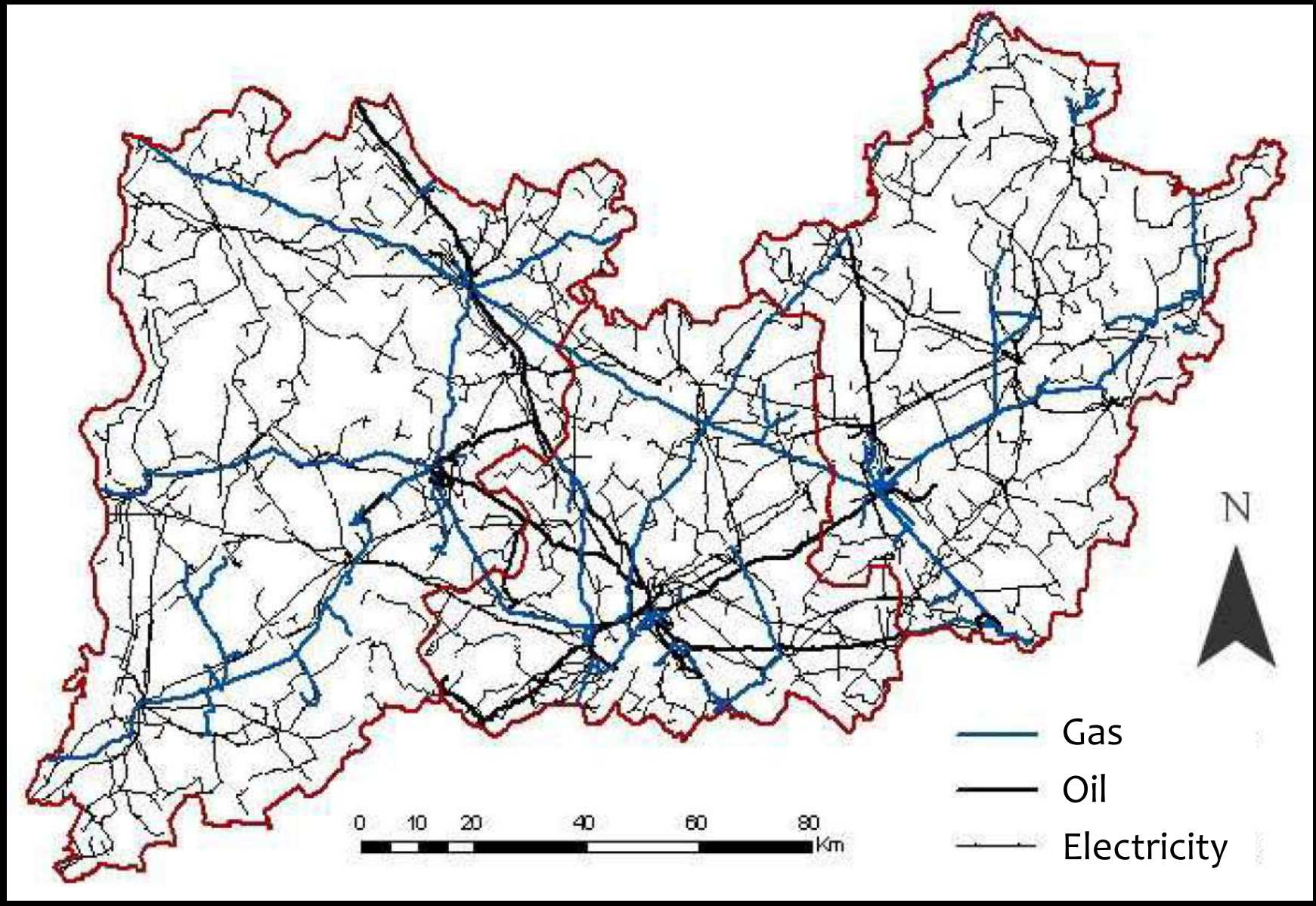
EU **Natura 2000** areas and UNESCO **Biosphere Reserves**



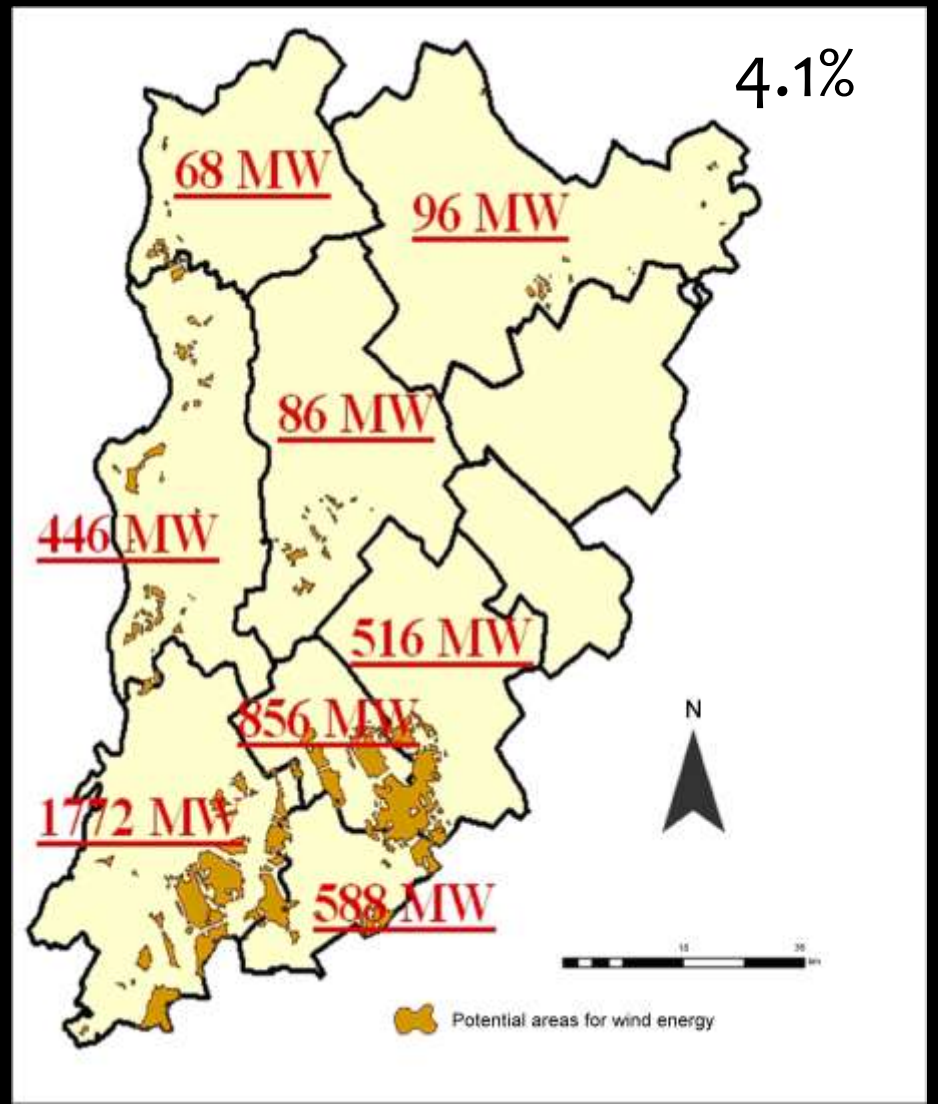
Ramsar-areas, lakes

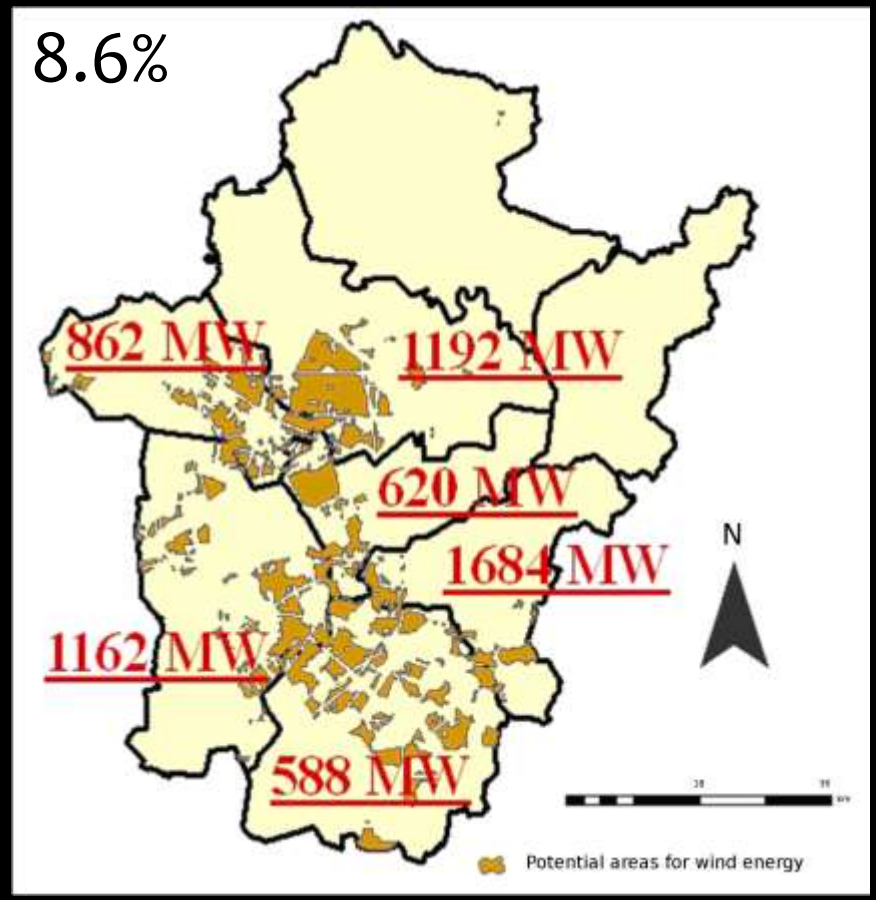


Transmission lines



Result of the screening:
Potential areas for wind energy
(examples of 2 Hungarian counties in the field of wind energy)





Technical wind energy potential
FINAL RESULT for Hungary:

Potential land area:

~5400 km^2

~6% of the territory

Potential wind turbine capacity:

~48800 MW (using 8-10 MW/km^2)

Potential energy yield:

~ 350 PJ/year (recent gross electricity consumption: 150 PJ)

Calculation of socio-economic RE potentials
(the example of wind energy)

- Finding a region
  - with outstanding performance in the field;
  - with similar natural conditions.
- Calculating specific indicators
  - capacity per inhabitants;
  - capacity per km^2;
- Applying the resulted figures for Hungarian conditions;
- Using corrections with GDP/capita

RESULTS: Socio-economic potential

(an example of the international comparison in the field of **wind**)

	East Germany	Hungary
Population	16.5 million	9.95 million
Territory	108582 km²	93030 km²
Wind capacity (2015)	**15700 MW**	330 MW
Capacity indicator: (kW/capita)	0.95 kW/capita	Potential: 9500 MW
Capacity indicator: (kW/km²)	144,6 kW/km²	Potential: 12500 MW

Potentials 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 (48800 MW)	70-90 (9500-12500 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
Σ	**~1000**	**~300**

Efficiency and sufficiency potentials

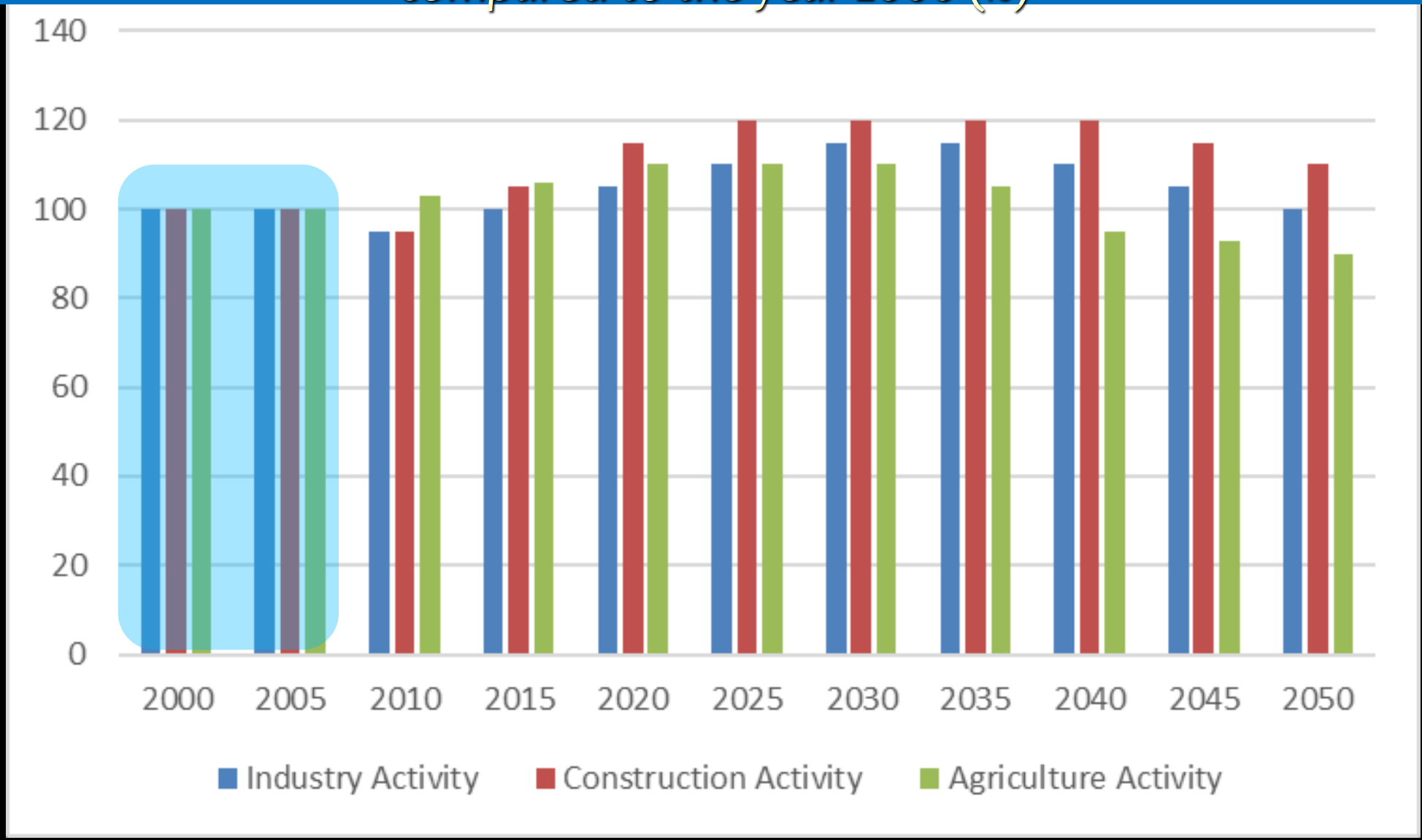
Desktop study

Experts involved:

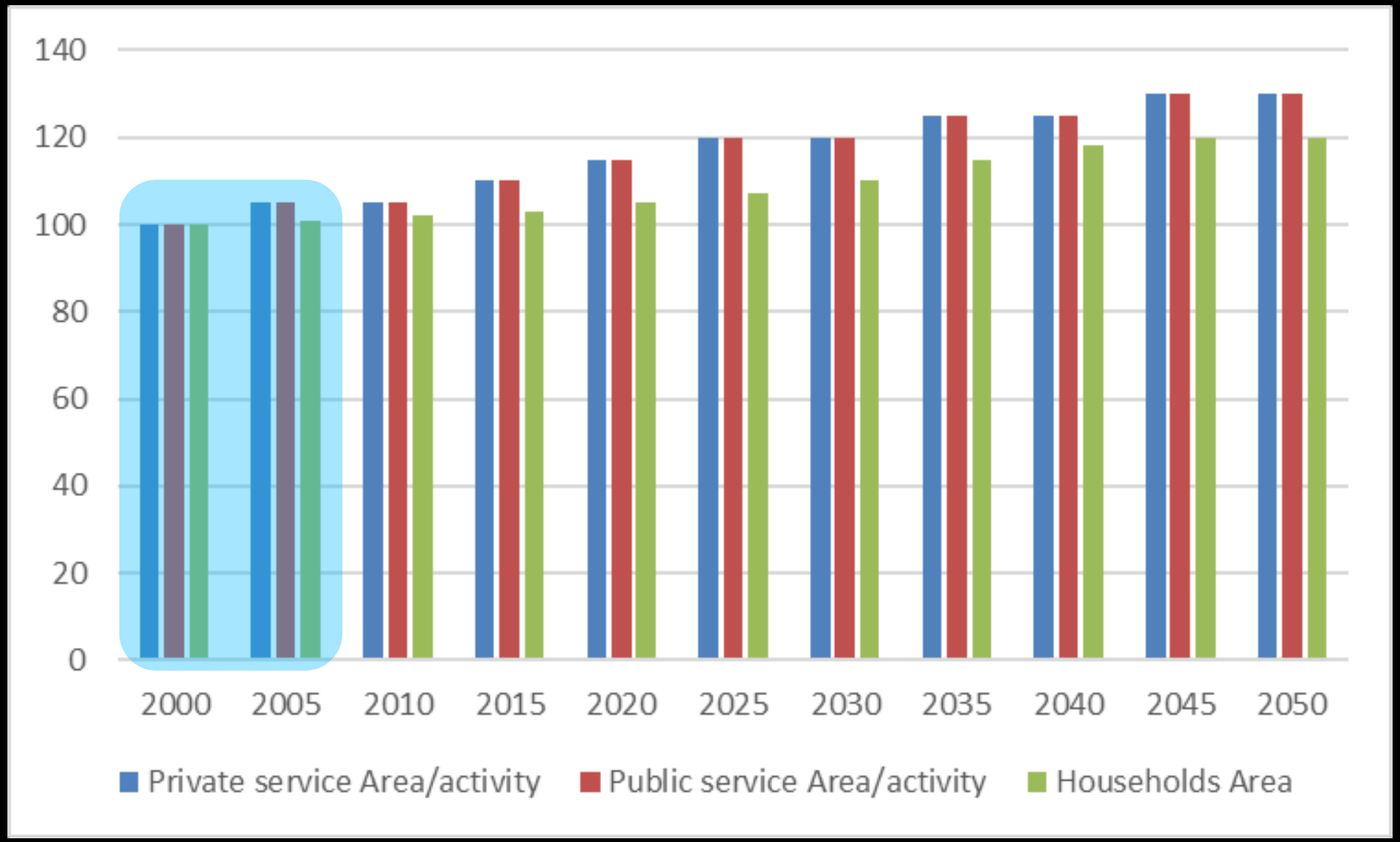
- architect,
- transportation engineer,
- mechanical engineer;
- electrical engineer.

Creating scenarios

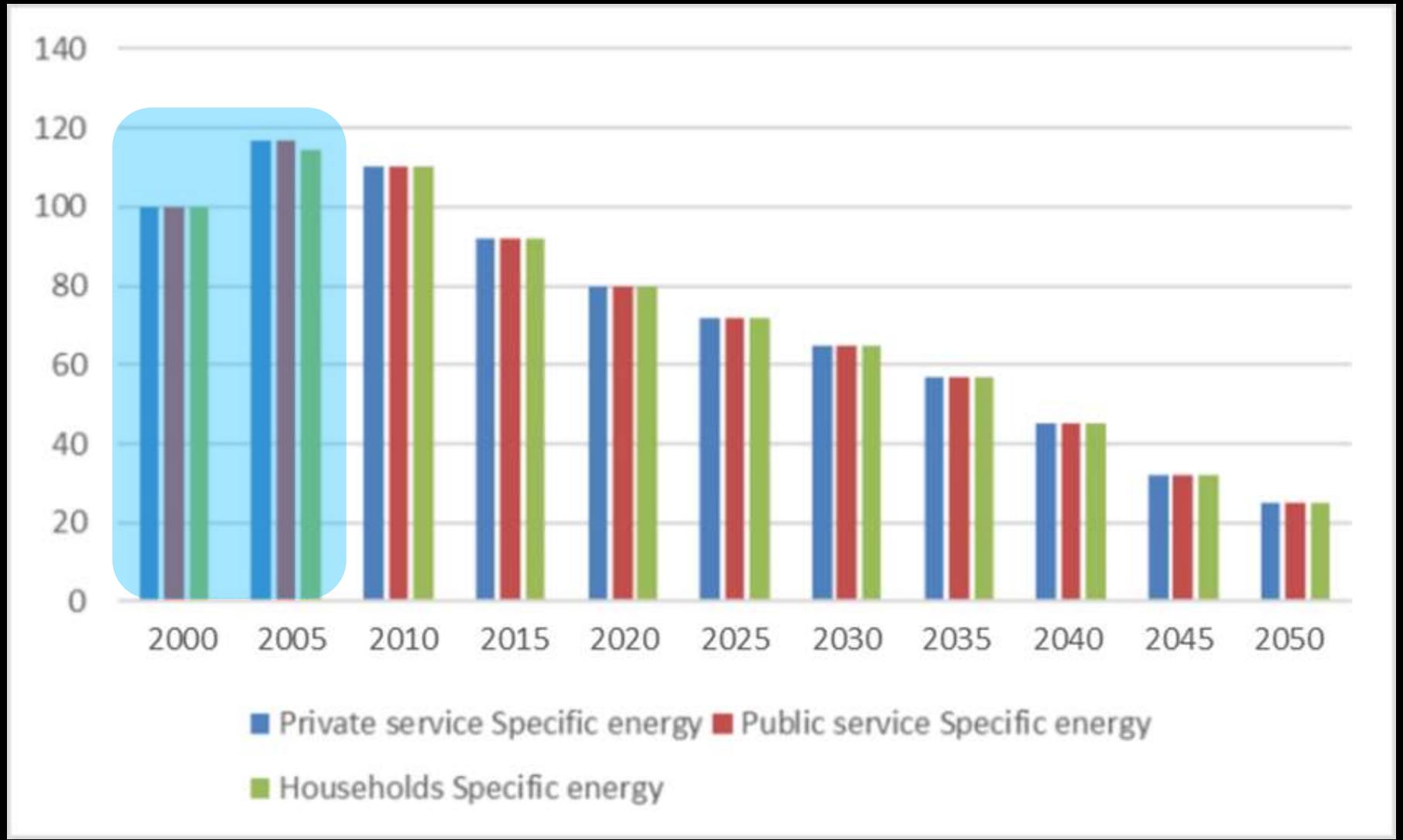
PRODUCTION ACTIVITIES
Heat and fuel demand
compared to the year 2000 (%)



BUILDINGS
heated floorspace
compared to the year 2000 (%)

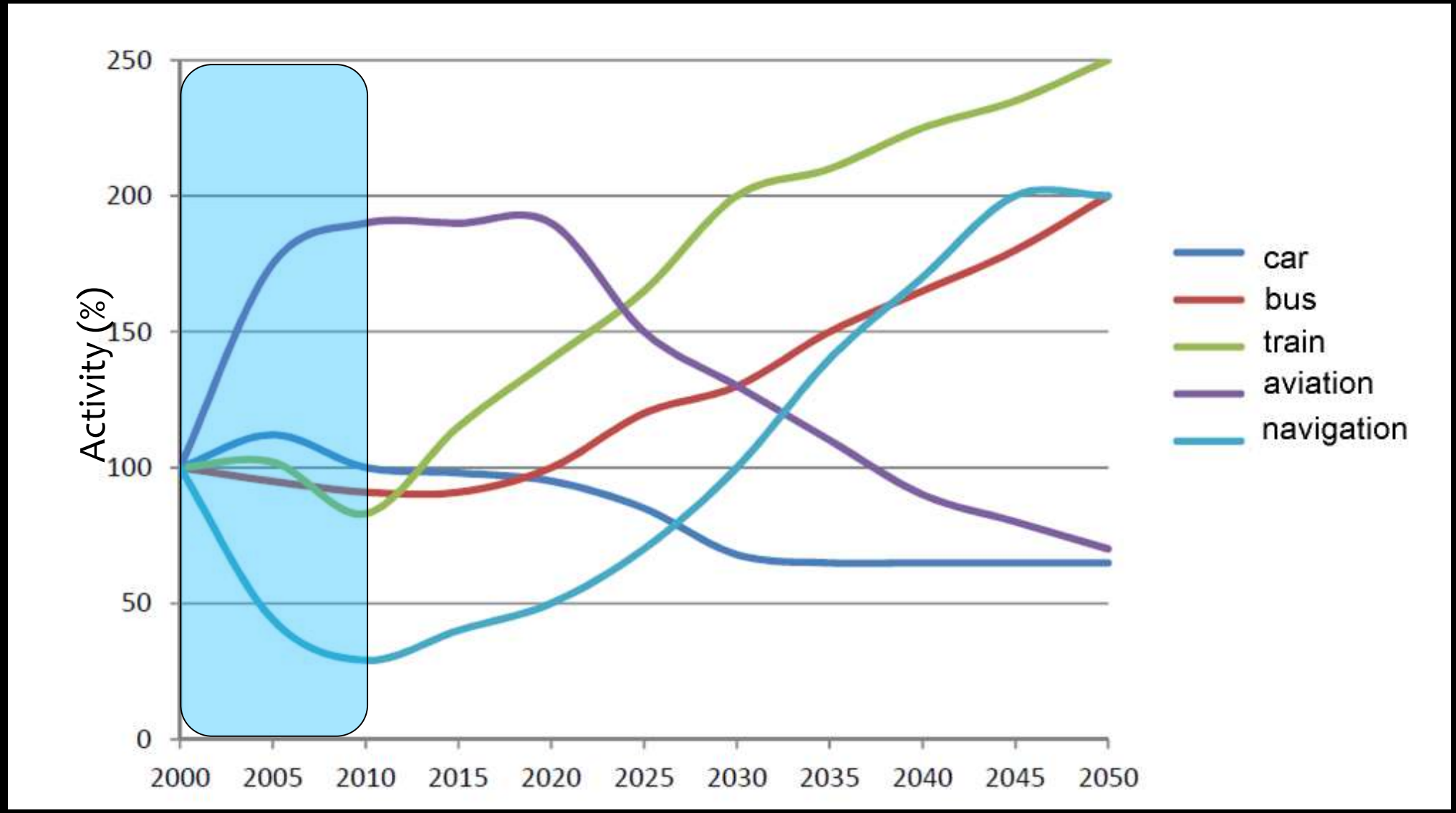


BUILDINGS
Heating efficiency – energy demand
compared to the year 2000 (%)



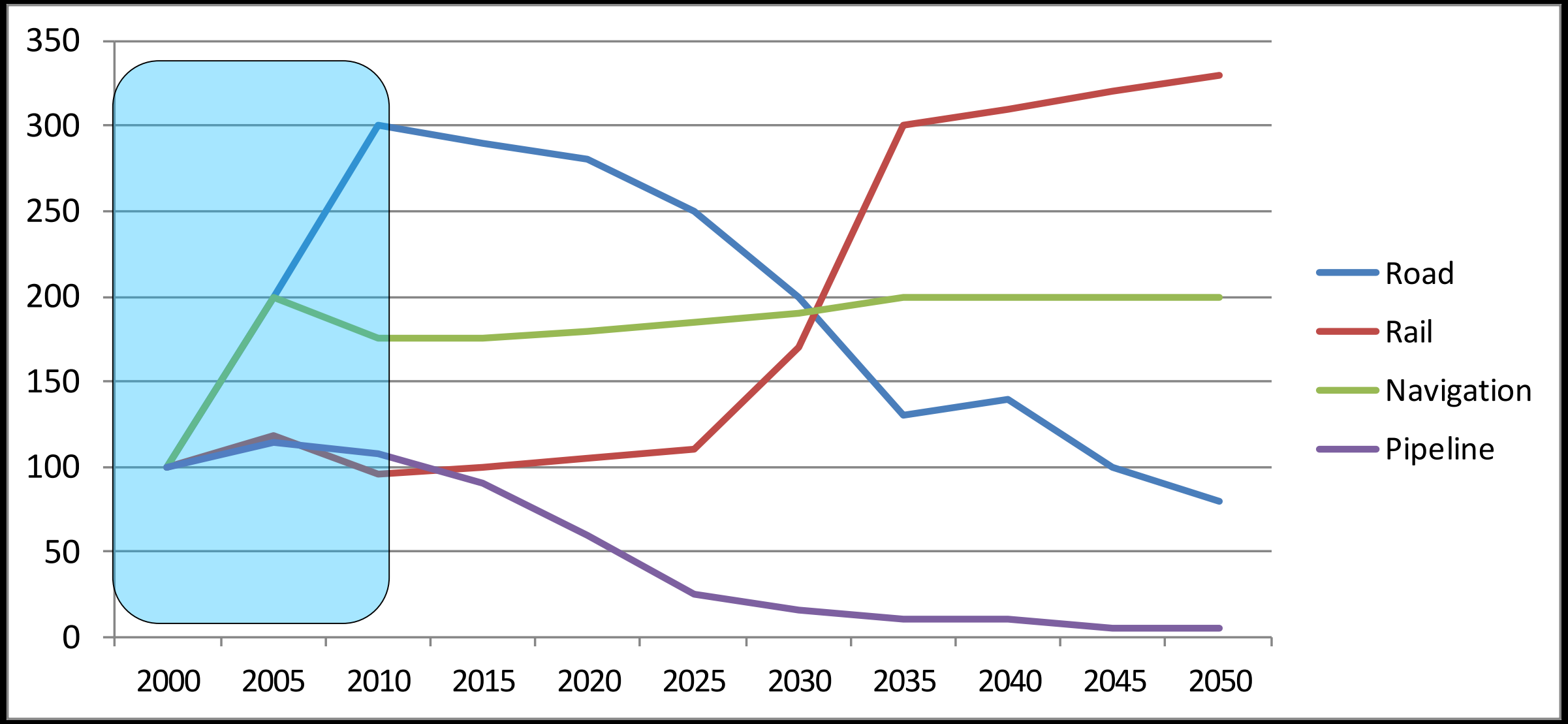
TRANSPORTATION

Activity in personal transportation - km compared to the year 2000 (%)



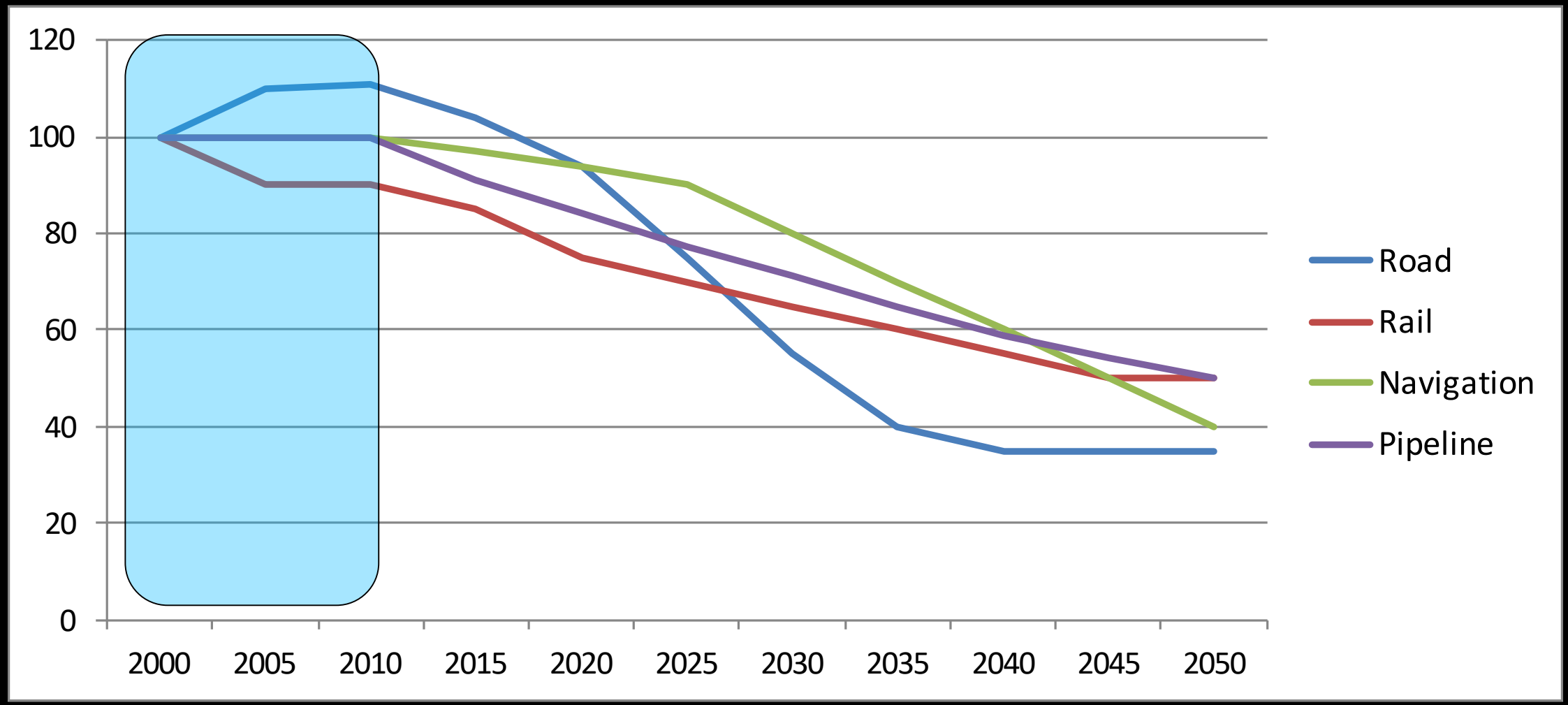
TRANSPORTATION

Activity of freight – tonna/km compared to the year 2000 (%)

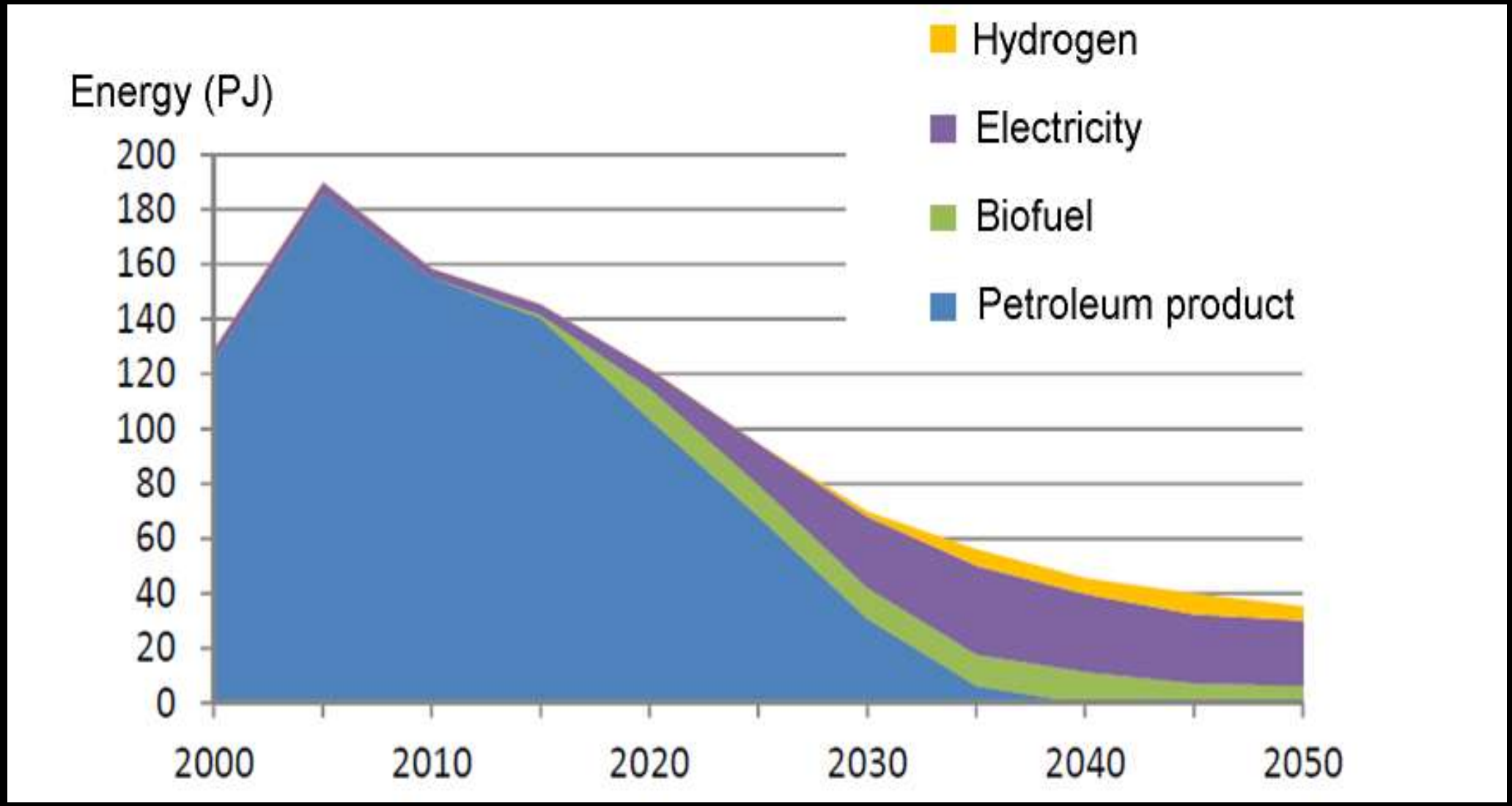


TRANSPORTATION

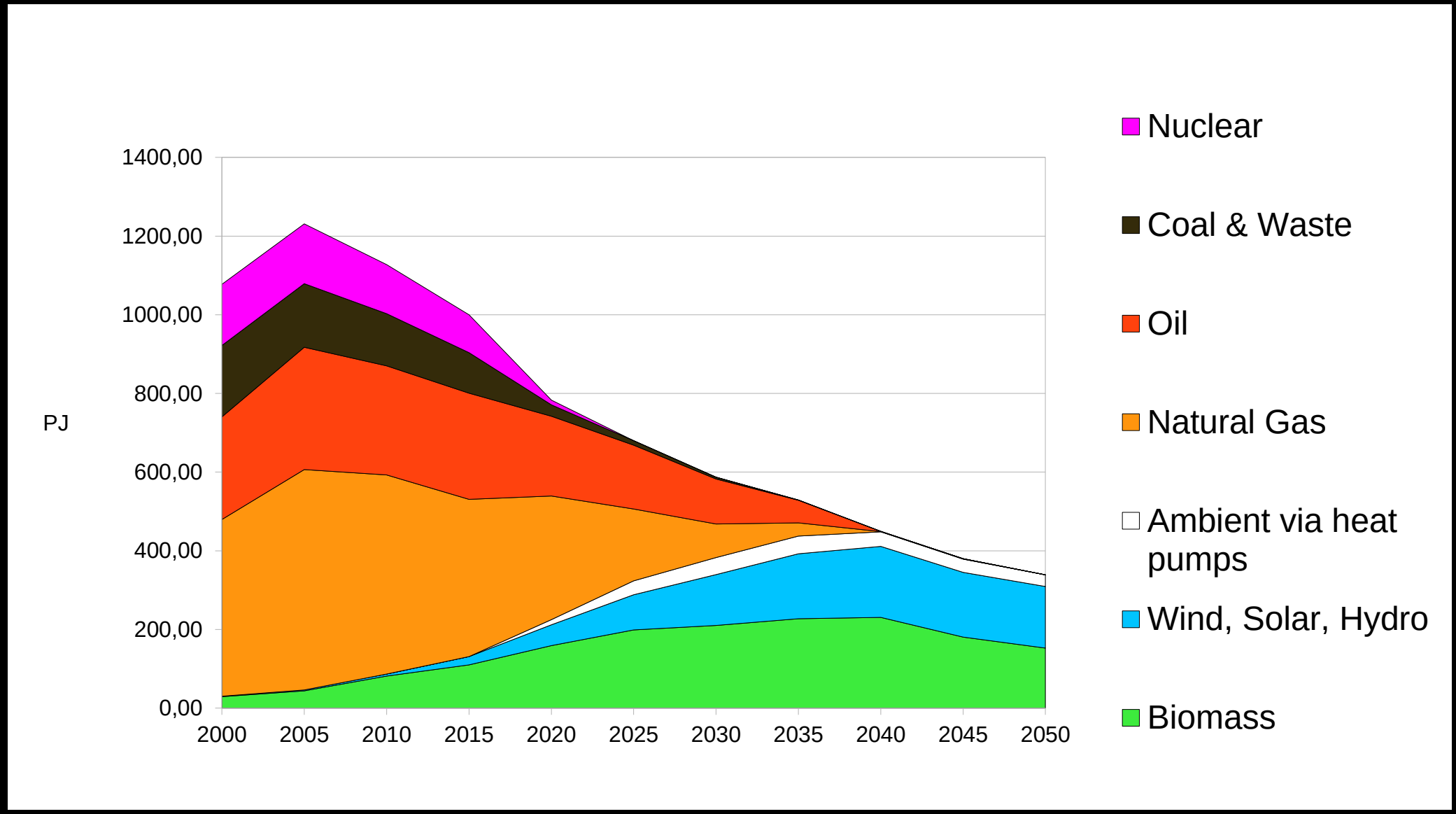
Energy efficiency of methods in freight (energy use/km in %)



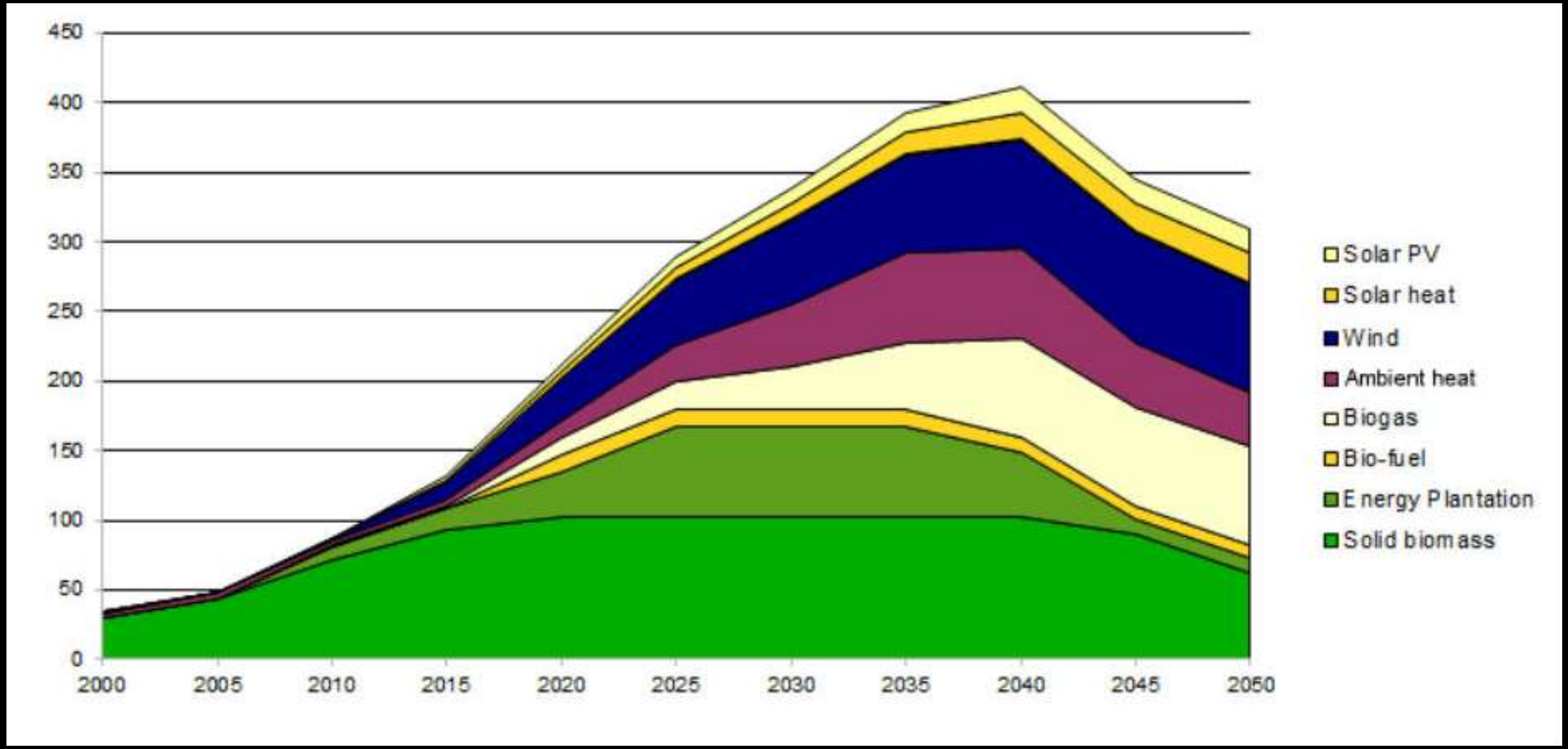
TRANSPORTATION
Energy consumption
of the transportation sector by sources



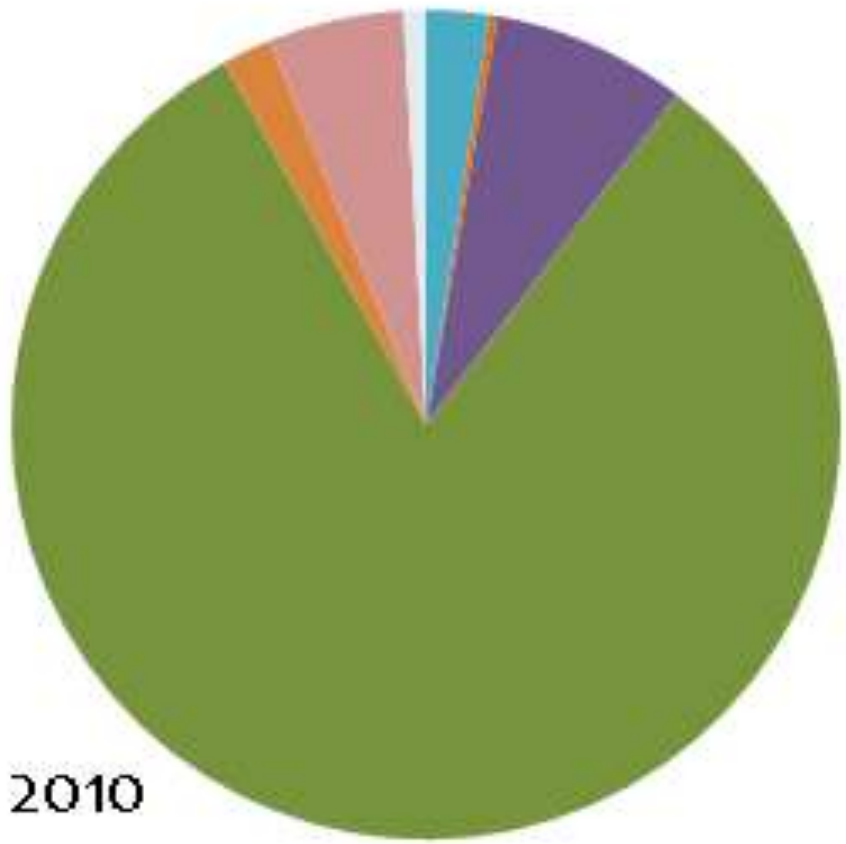
PRIMARY ENERGY SUPPLY
according to „This Way Ahead" 2000-2050



RENEWABLE ENERGY SUPPLY
according to „This Way Ahead" 2000-2050

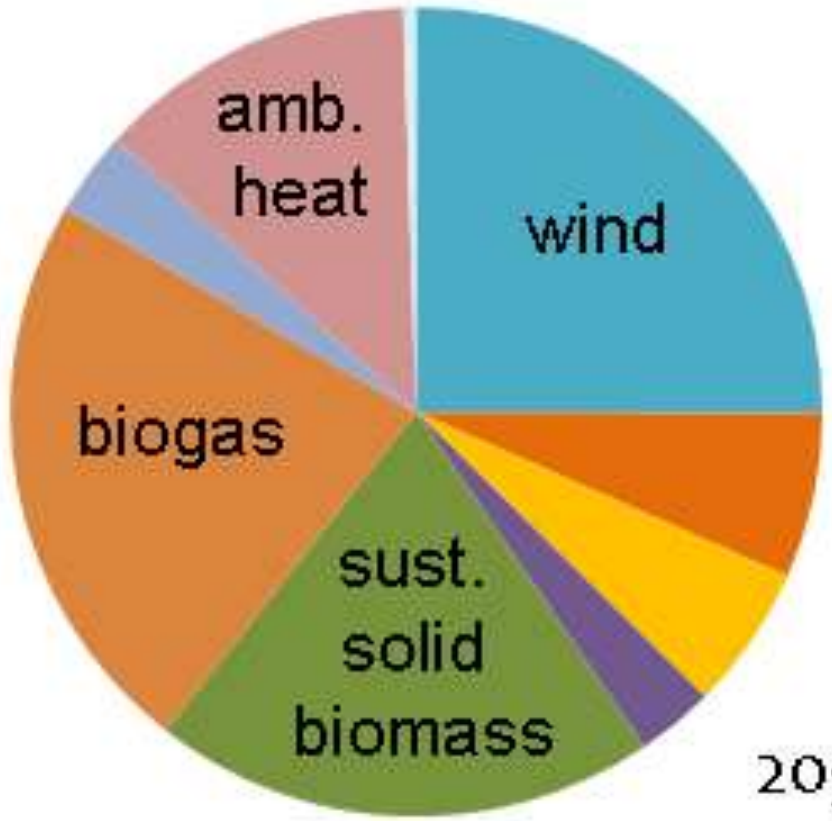


Renewable energy mix in 2010 and 2050



2010

- Wind
- Solar Thermal
- Solar PV
- Biofuel
- Sustainable biomass
- Biogas
- Energy plantation
- Ambient heat
- Hydro



2050

Main outcomes

Phasing out of fossil and nuclear sources would be possible in Hungary with

- a new energy **policy**
- a new, holistic approach in energy **planning**
  - strong co-operation between university departments and other existing institutes
  - new research institutes (focusing on sustainable energy)
- radical developments in engineering **training**

- reduced energy consumption (by 70%)
- diverse renewable energy and storage mix
- flexible pricing and DSM.