

***”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 economical 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Outdated system: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 influence 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 (km <sup>2</sup> )
Inhabited areas	6650
Water areas	1753
Protected areas	8573
Forests	17468
Gardens, vineyards, orchards	2880
Railway lines	3949
Roads	2205
Electric grid	15419
High altitude areas, steep slopes	1860
<b>Total excluded (with simple addition)</b>	<b>60757</b>
<b>Hungary total</b>	<b>93030</b>

„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

## Research 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

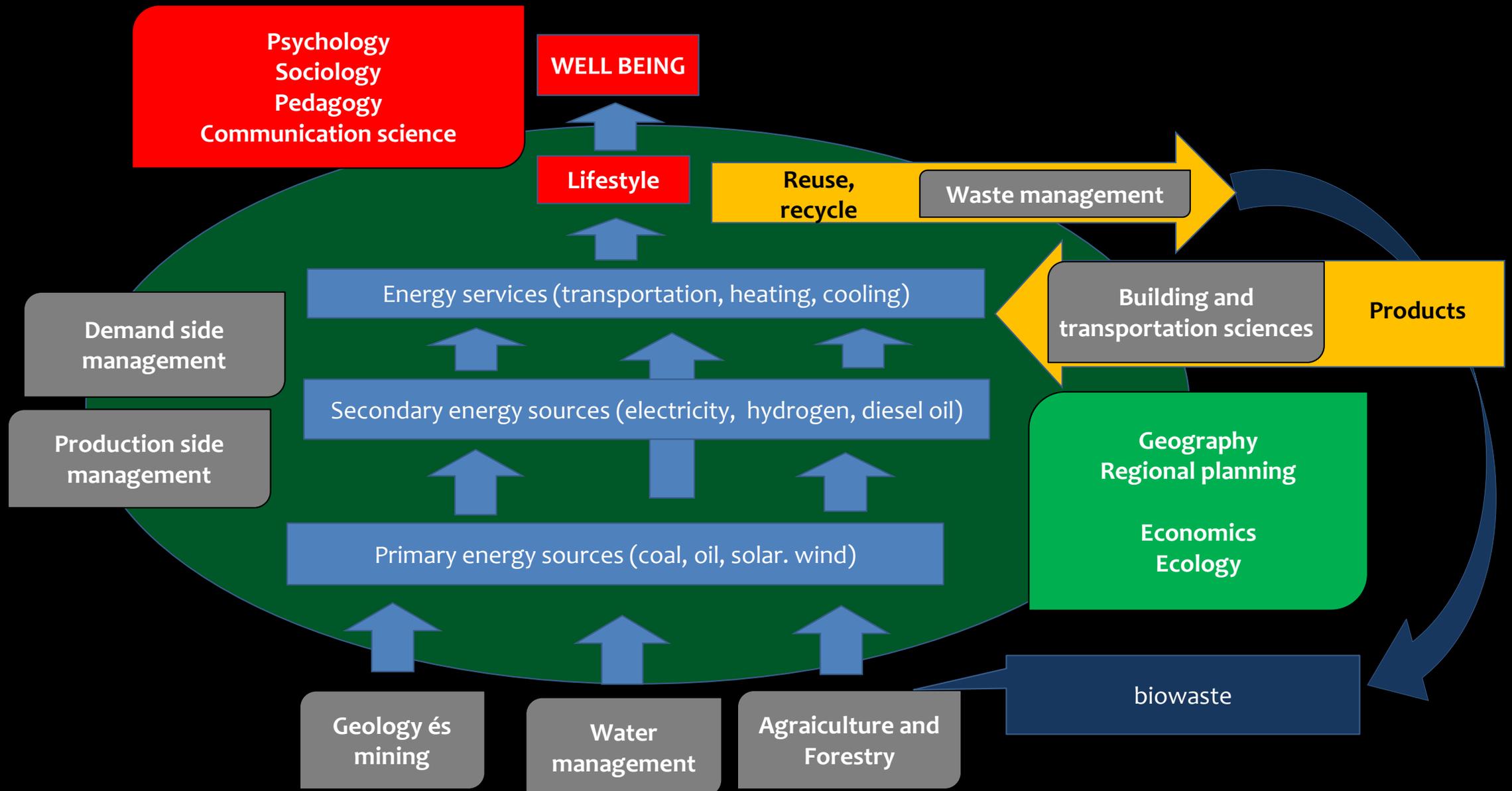
## ■ Reduced consumption

- Improvements on efficiency (technological aspect)
- sufficiency in consumption (human aspect)
  - internal pressure (raising awareness, education)
  - external pressure (economical 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 potentials of RES;
    - A realistic socio-economic potentials of RES;
  - Potentials 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 consumption).
- 3) **Checking and setting balance** - with EnergyPLAN (by INFORSE):
  - energy mix
  - storage + demand side management.

# Calculation 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);

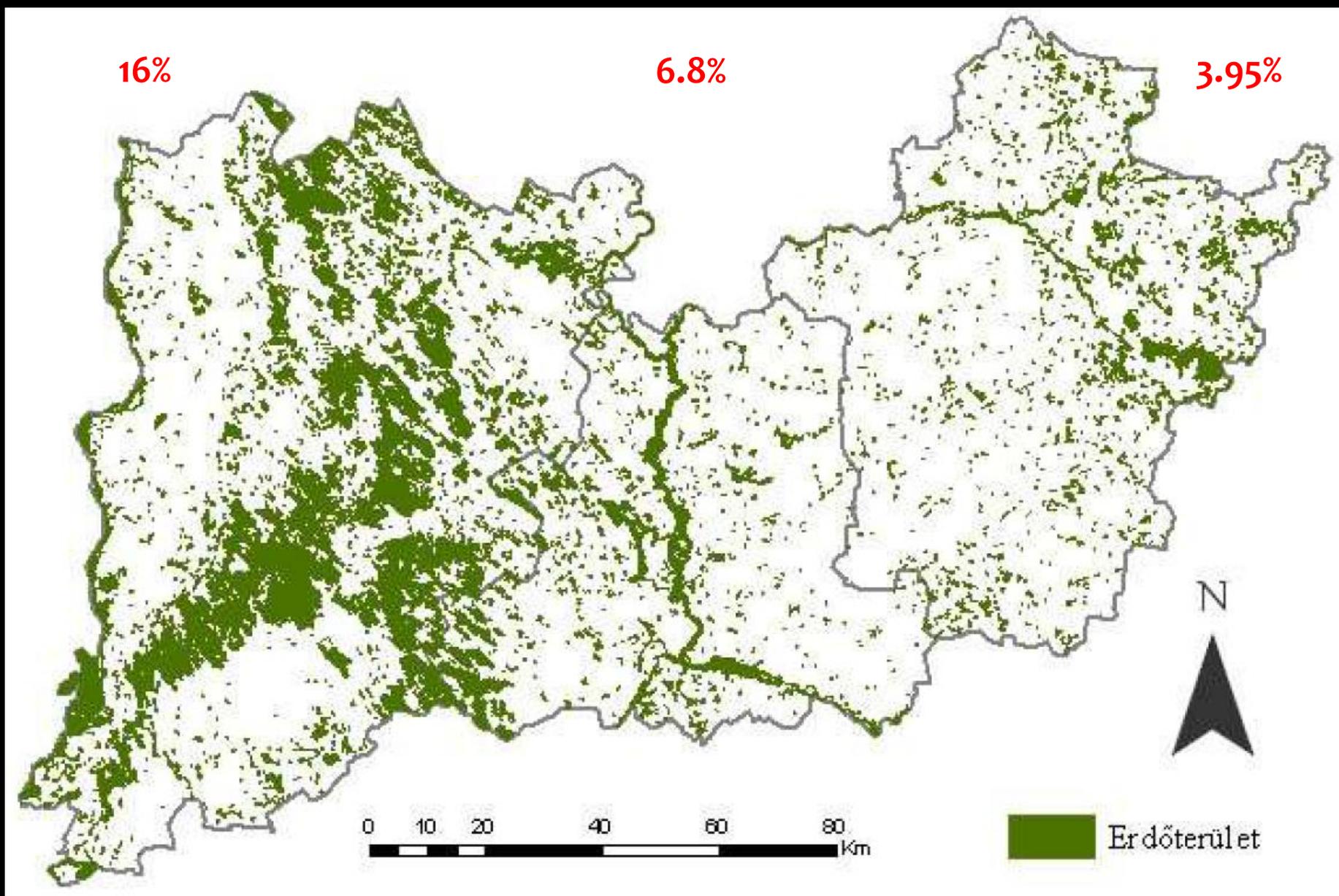
d) forests;

e) hydrographical elements;

f) roads, railways and airports;

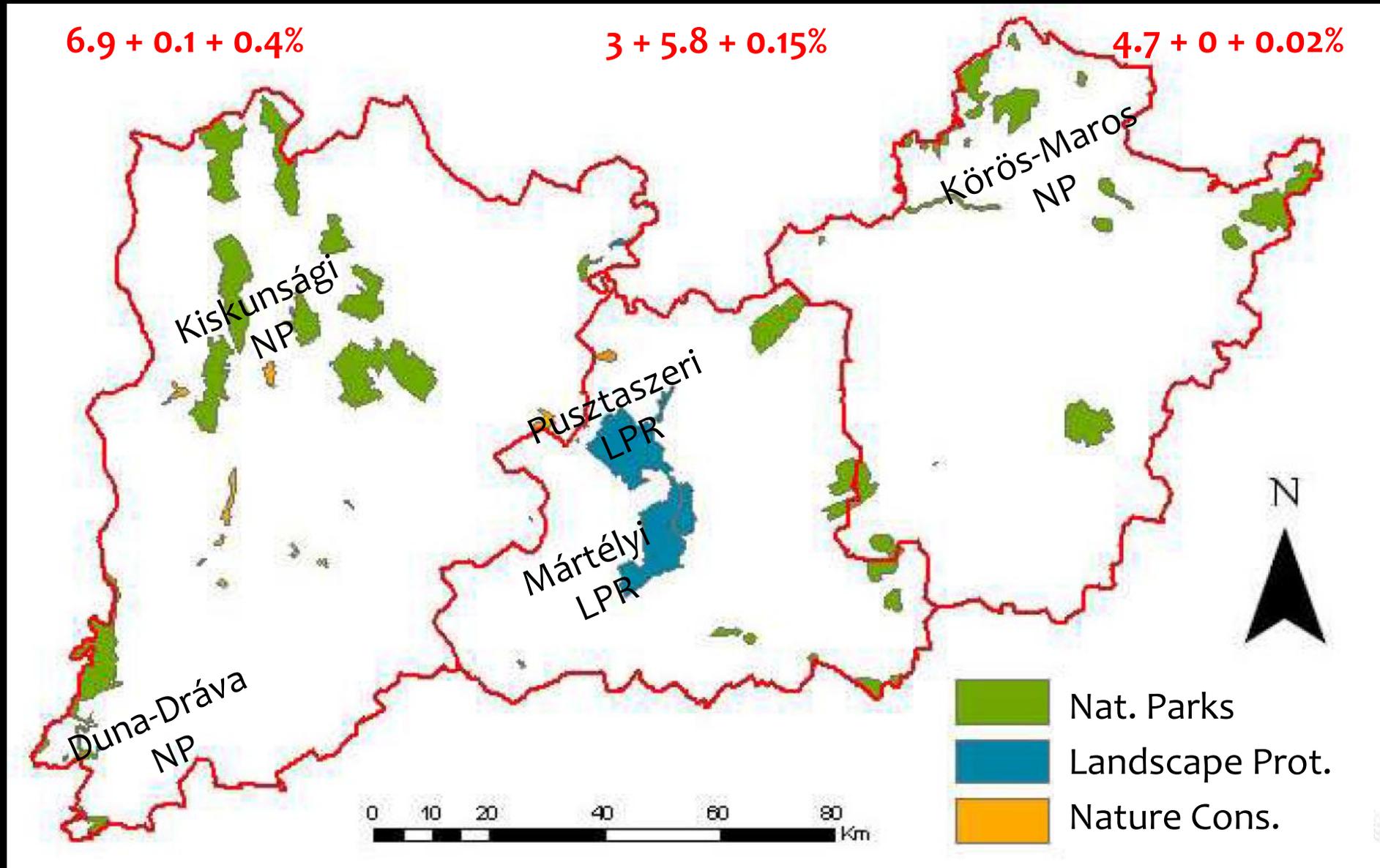
g) transmission lines (as vulnerable elements of the infrastructure).

# Forests (3 counties of the Southern Great Plain)

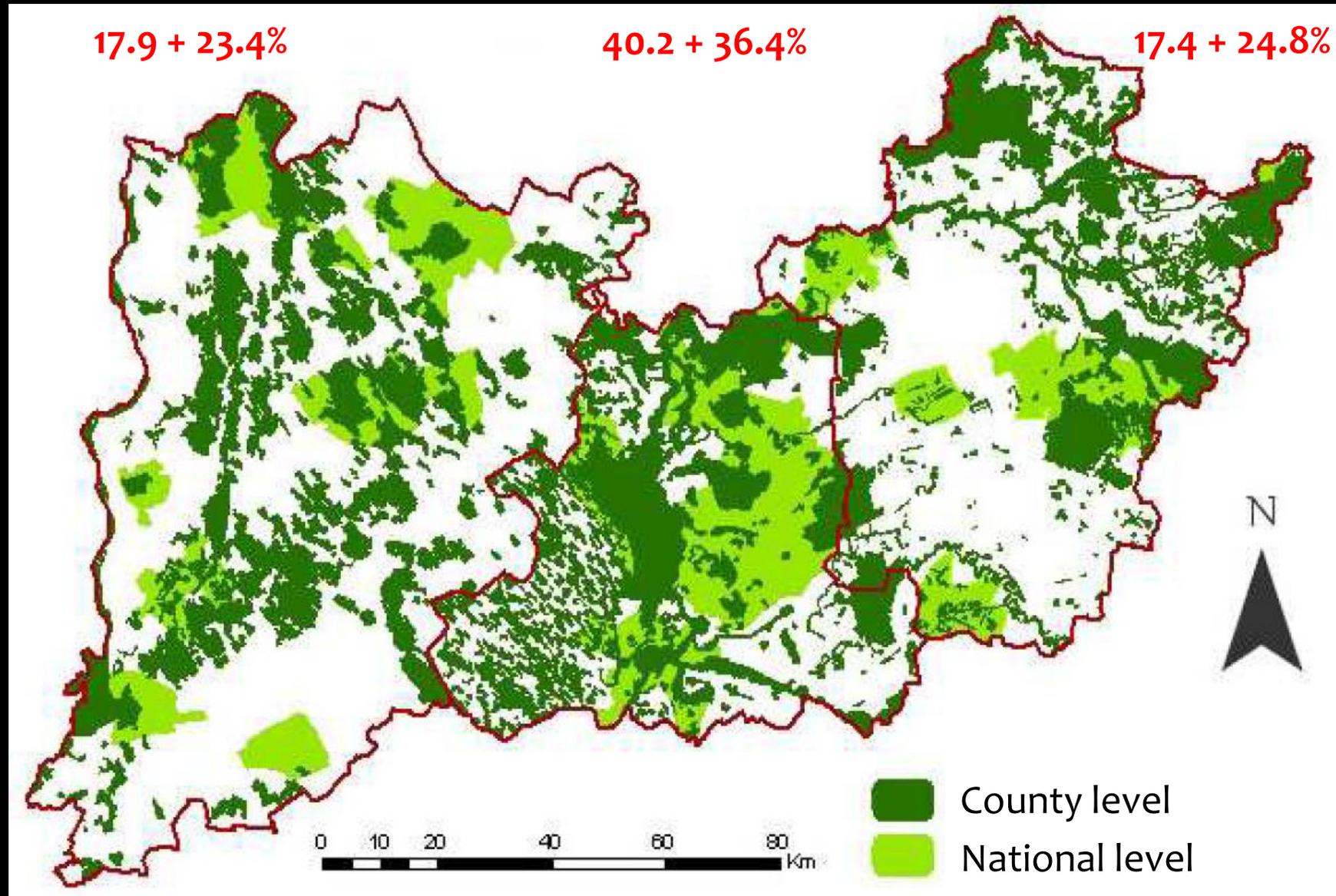


# Protected natural areas

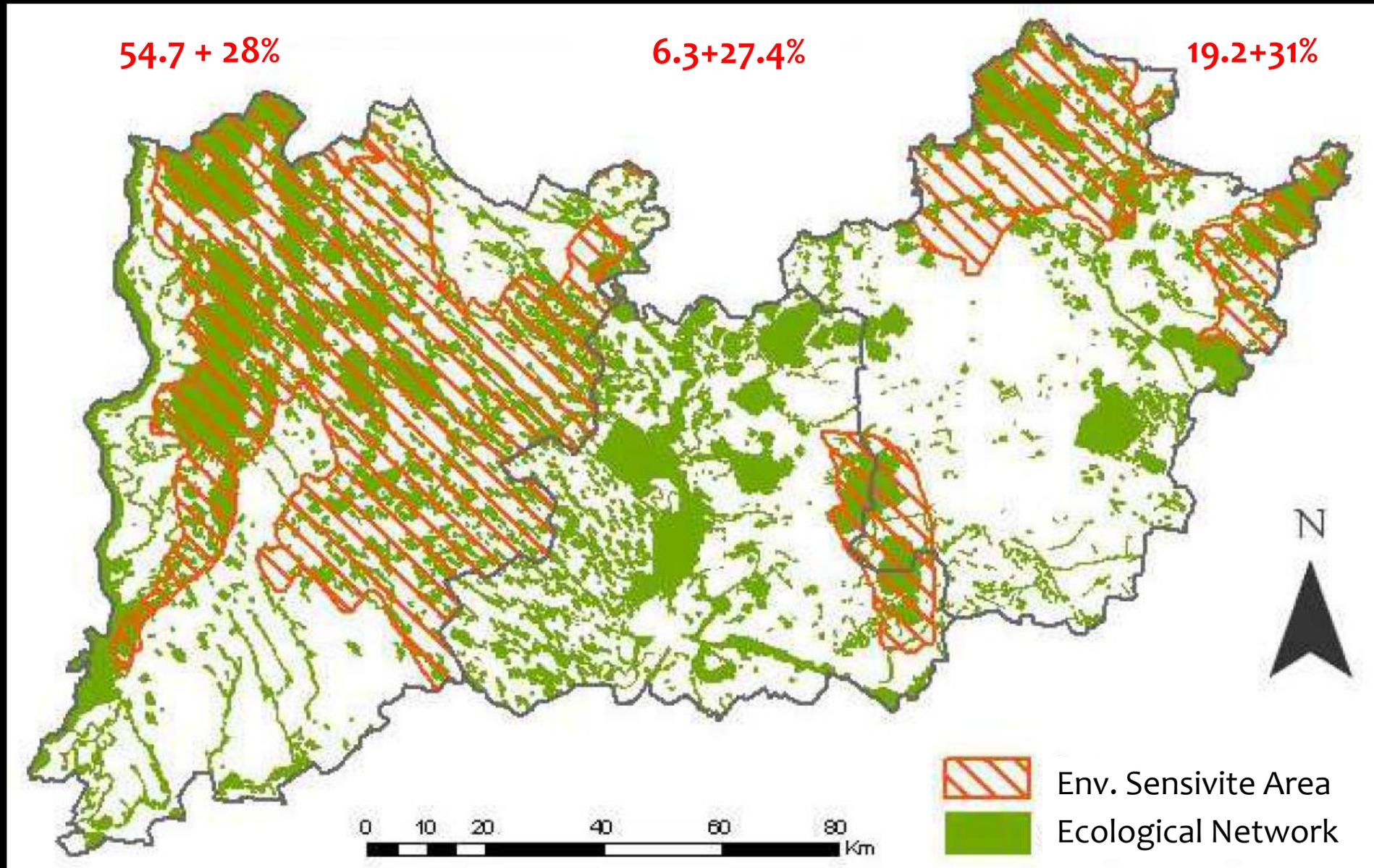
(IUCN Cat.: National Park; Landscape Protection Reserve; Nature Conservation Area)



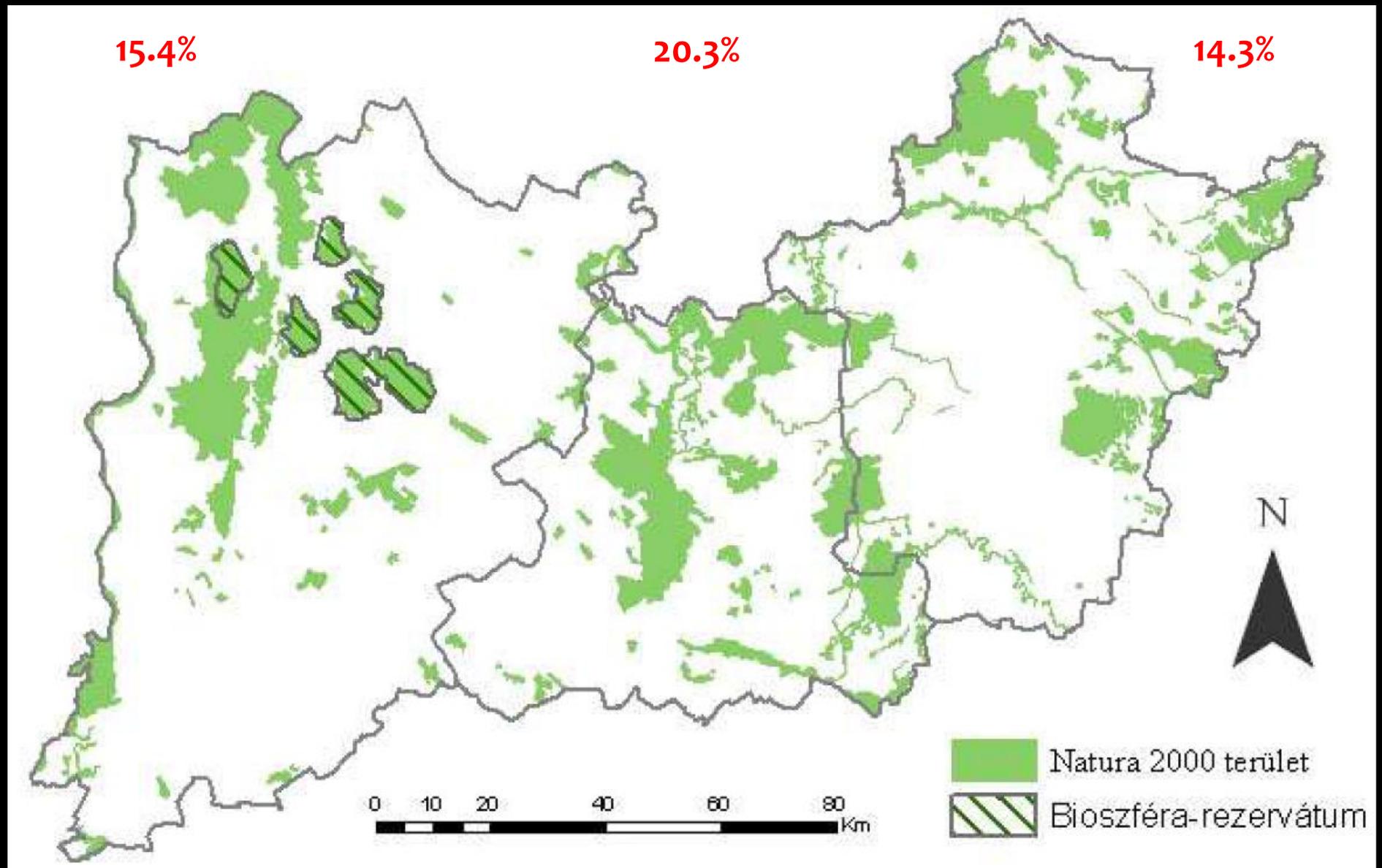
# Protected landscapes (national and county level)



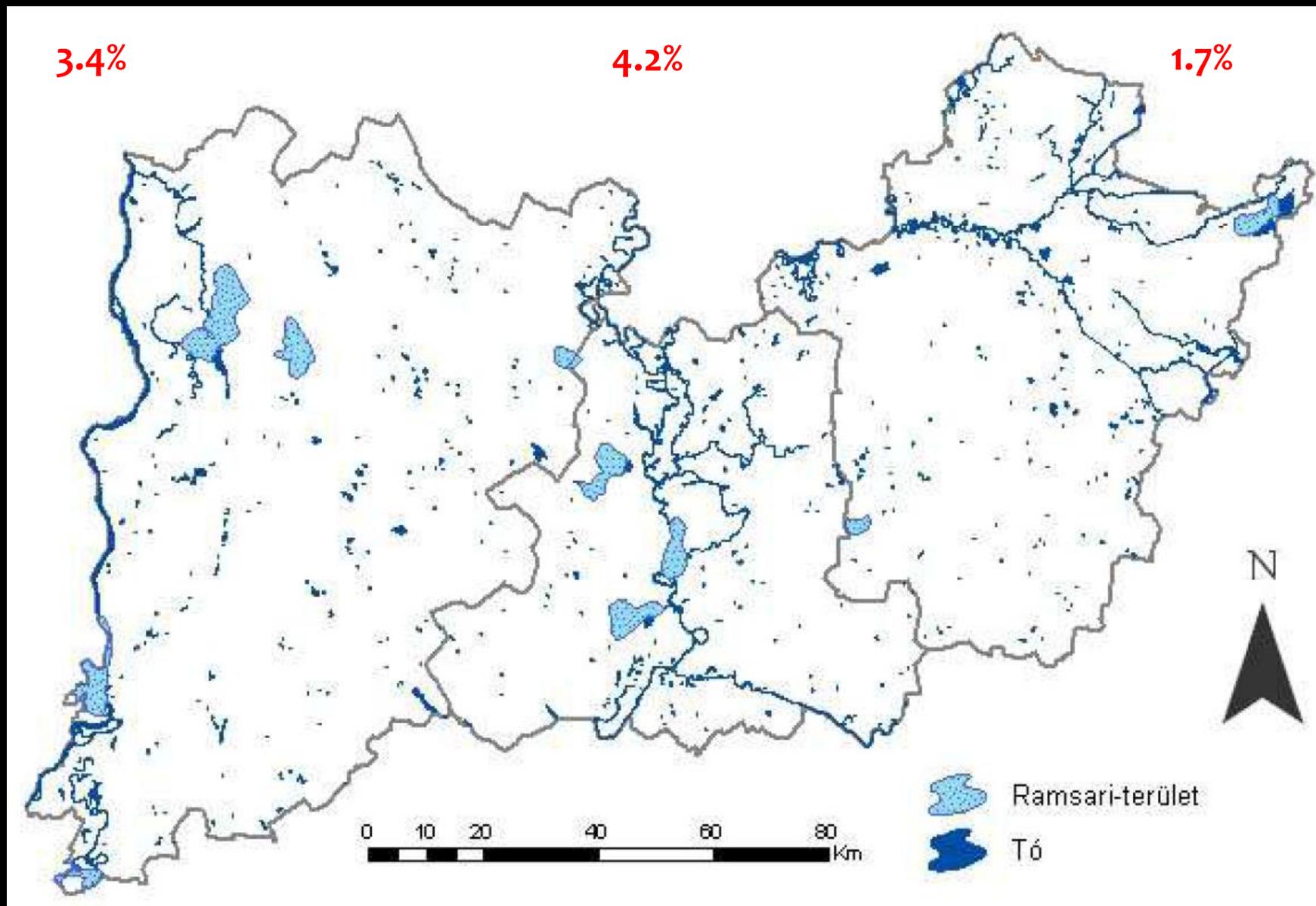
# Environmentally Sensitive Areas and Ecological Network



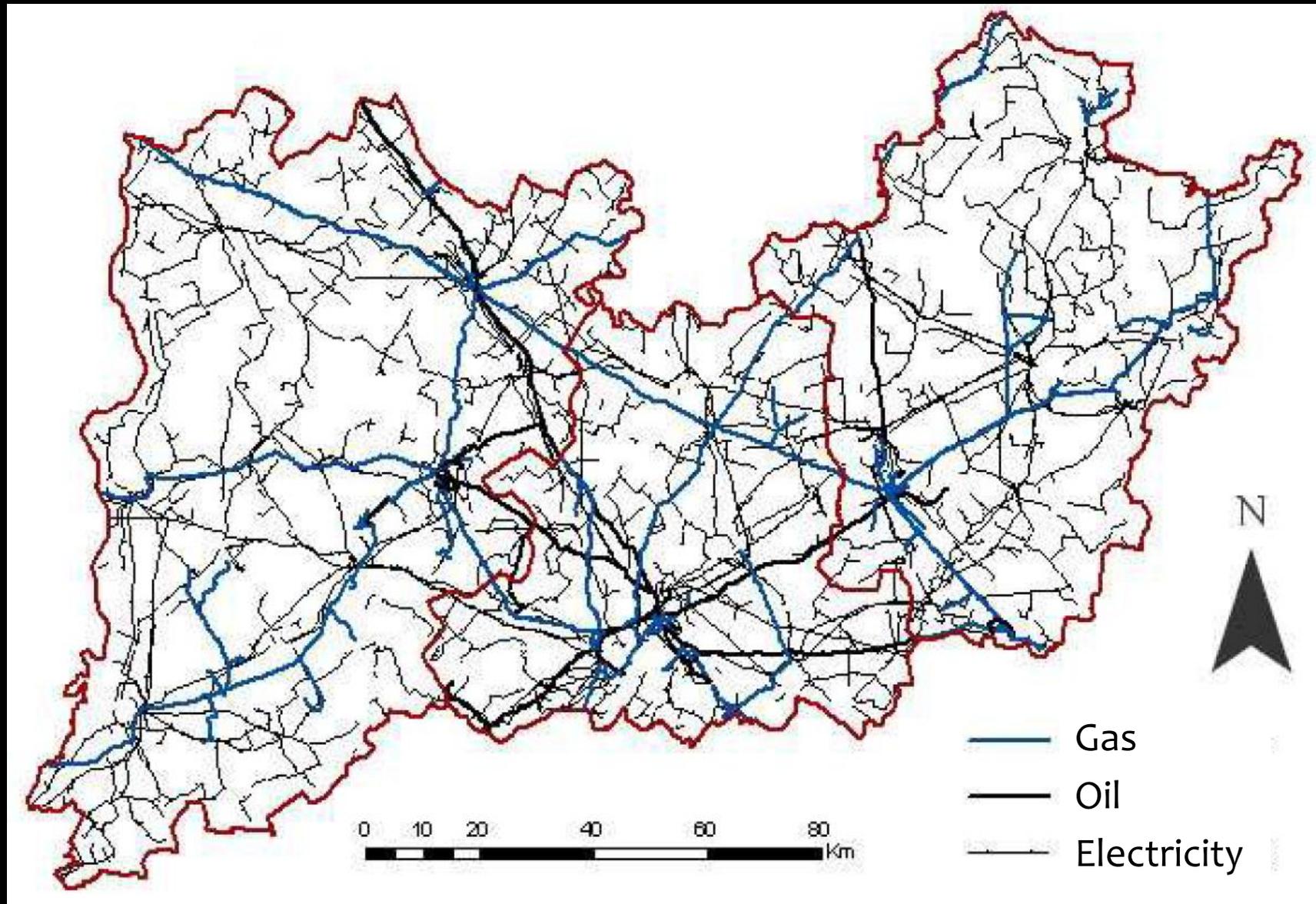
# EU Natura 2000 areas and UNESCO Biosphere Reserves



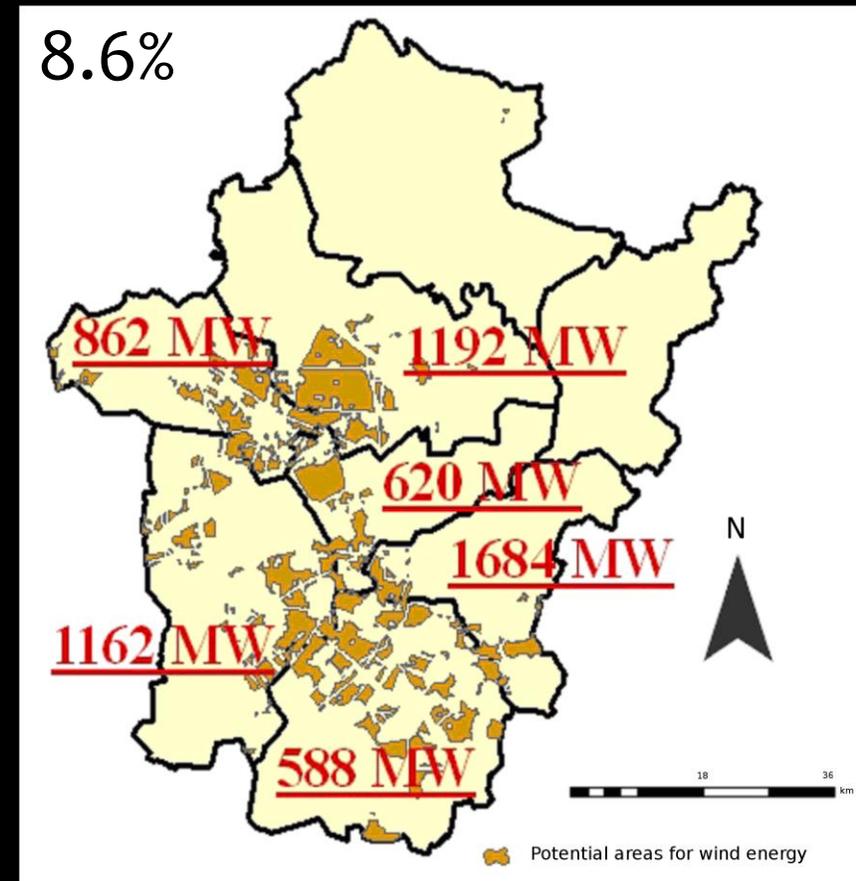
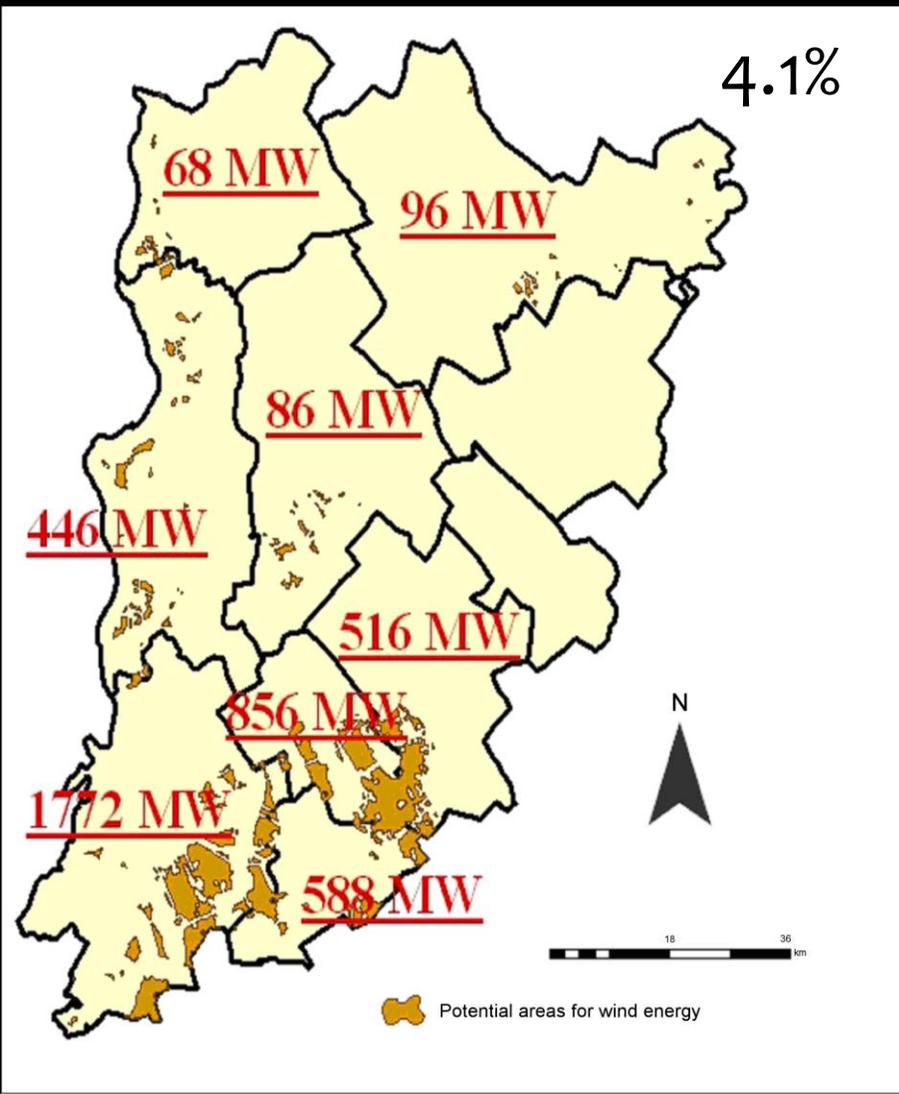
# Ramsar-areas, lakes



# 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<sup>2</sup>

~6% of the territory

Potential wind turbine capacity:

~48800 MW (using 8-10 MW/km<sup>2</sup>)

Potential energy yield:

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

# Calculation of socio-economical 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<sup>2</sup>;
- 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 km <sup>2</sup>	93030 km <sup>2</sup>
Wind capacity (2015)	<b>15700 MW</b>	330 MW
Capacity indicator: (kW/capita)	0.95 kW/capita	Potential: 9500 MW
Capacity indicator: (kW/km <sup>2</sup> )	144,6 kW/km <sup>2</sup>	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 km <sup>2</sup> )	
Biogas	80	
Ambient heat	100 ??	85 (in comp. with Sweden)
Hydro	2	2
$\Sigma$	~1000	~300

# Efficiency and sufficiency potentials

Desktop study

Experts involved:

architect,  
transportation engineer,  
mechanical engineer;  
electrical engineer.

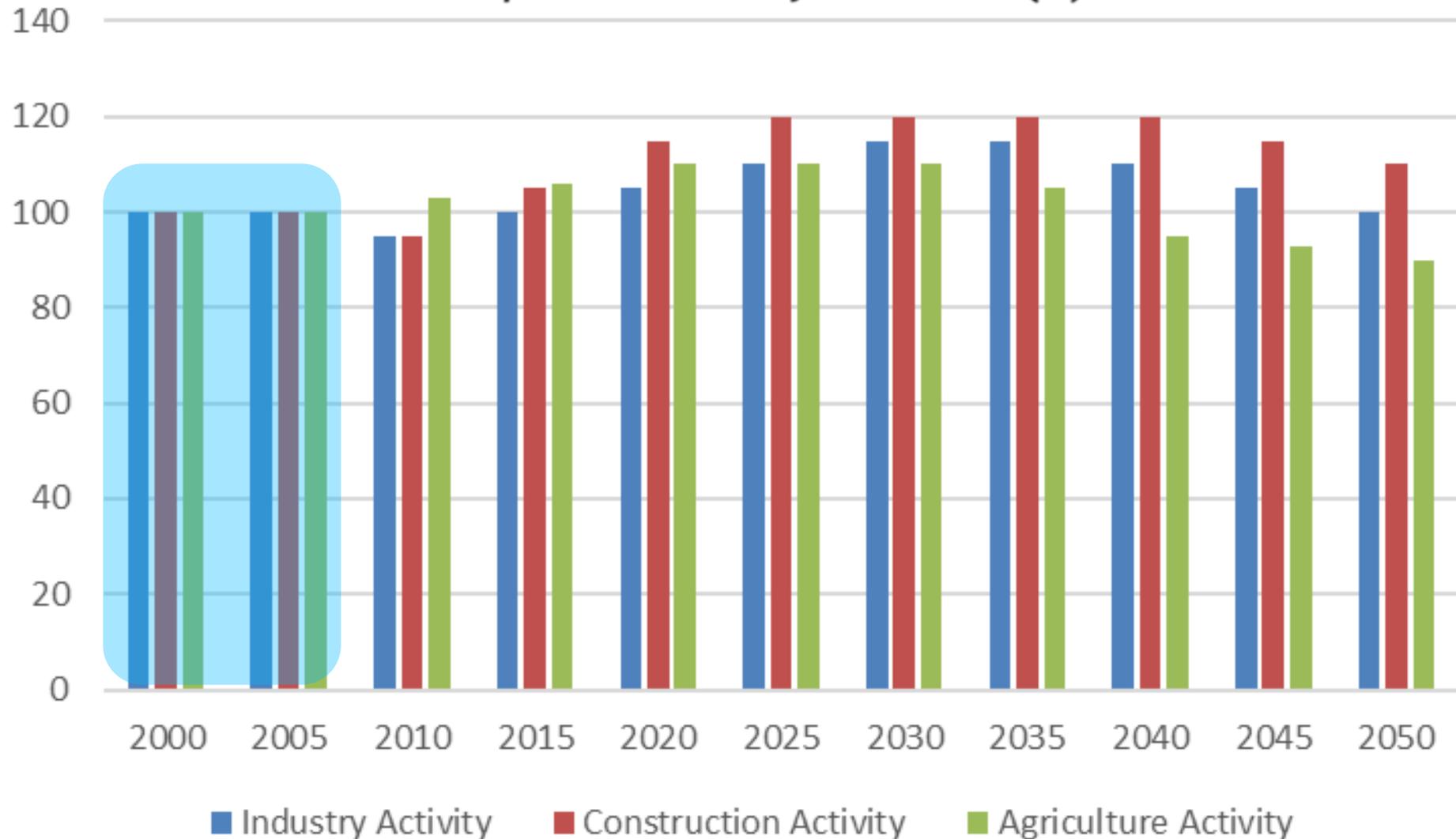


# Creating scenarios

# PRODUCTION ACTIVITIES

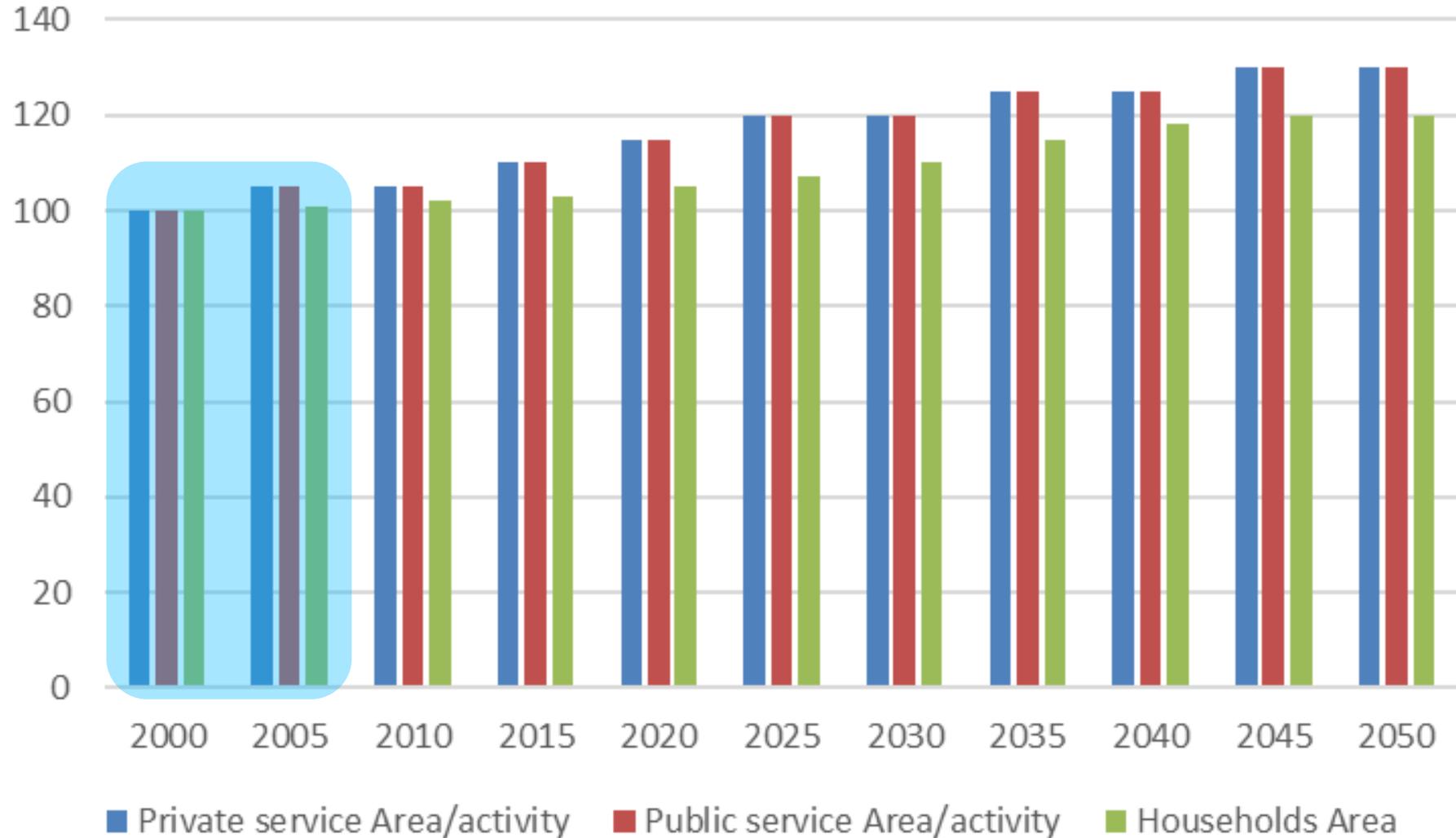
## Heat and fuel demand

*compared to the year 2000 (%)*



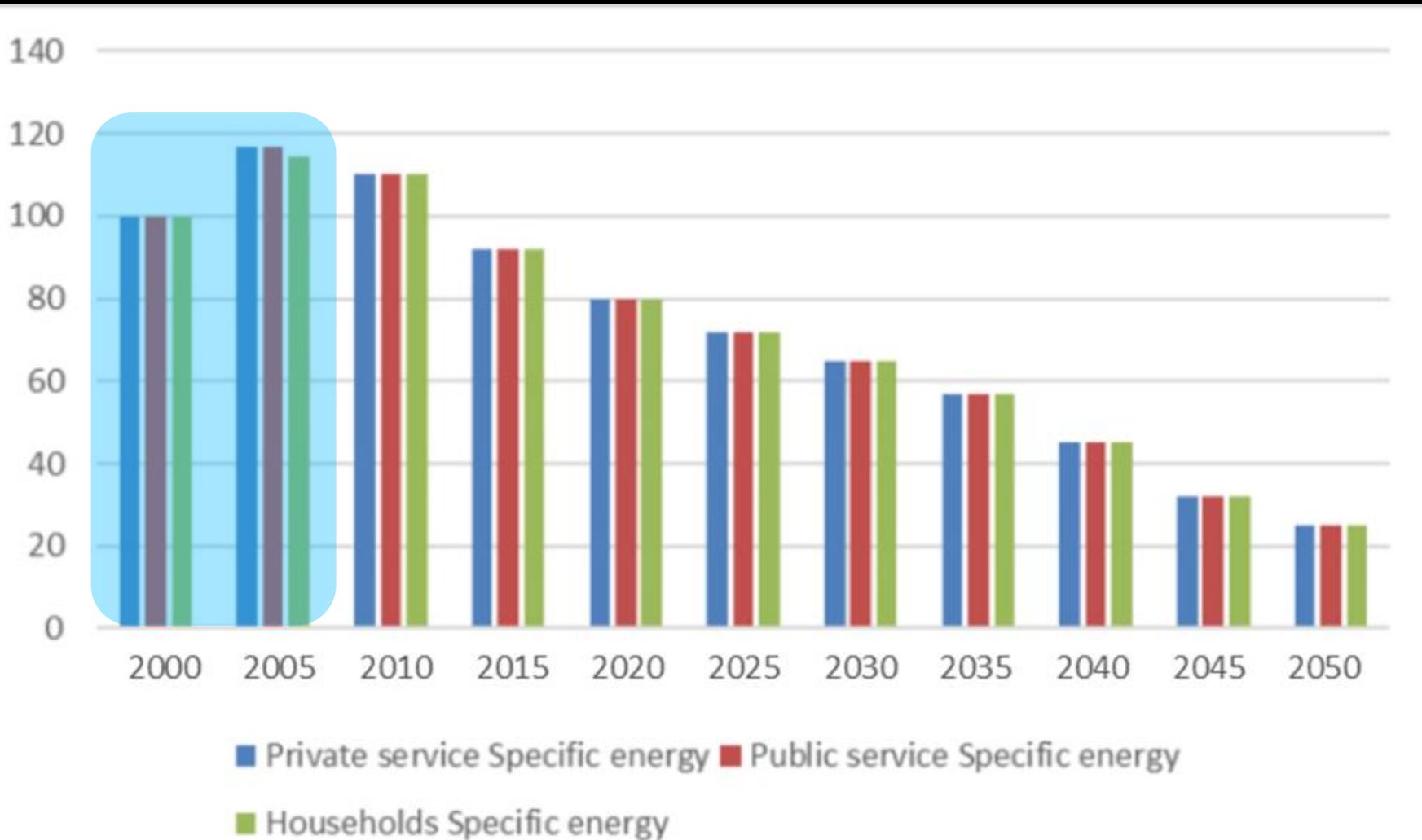
# BUILDINGS

## heated floorspace compared to the year 2000 (%)



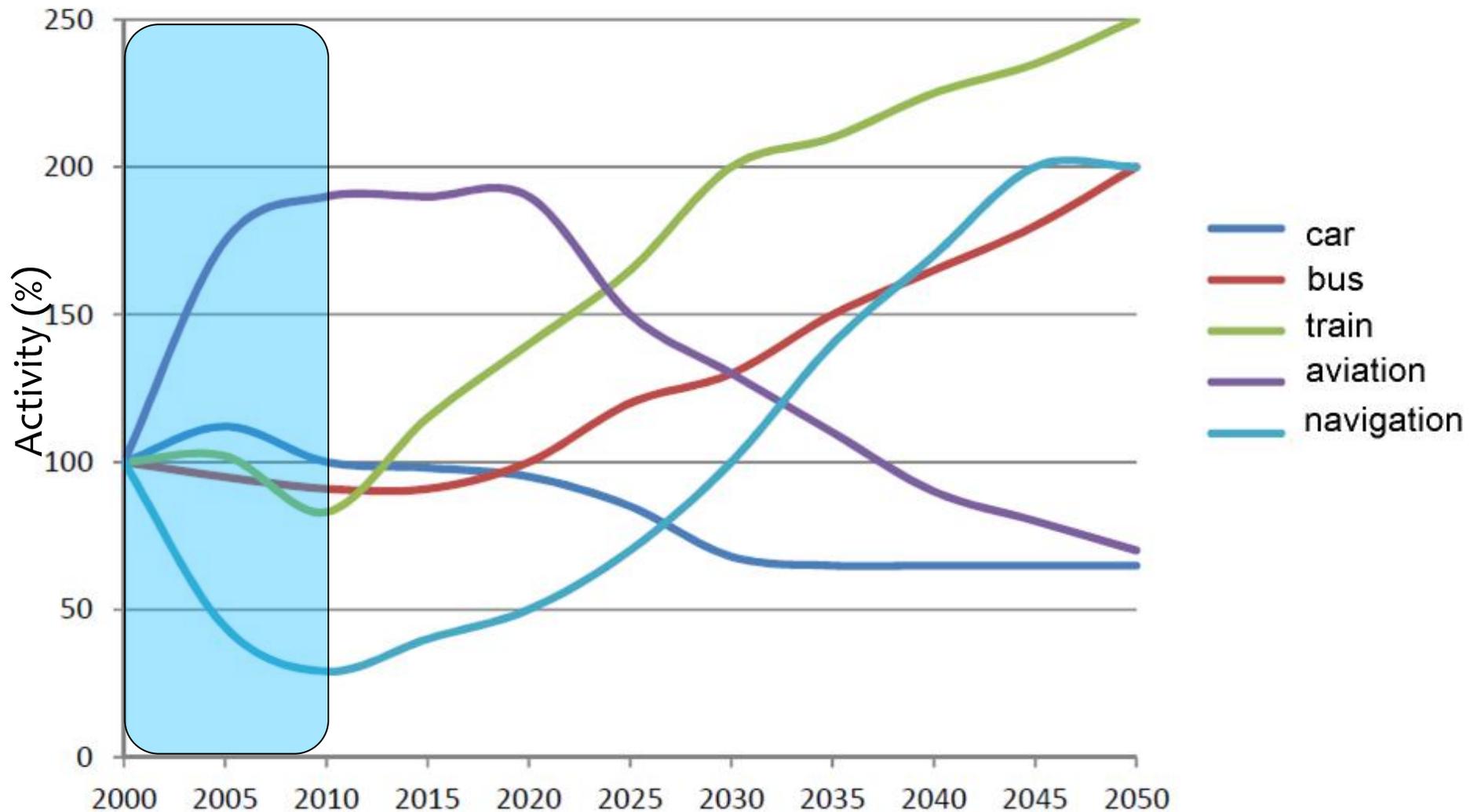
# BUILDINGS

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



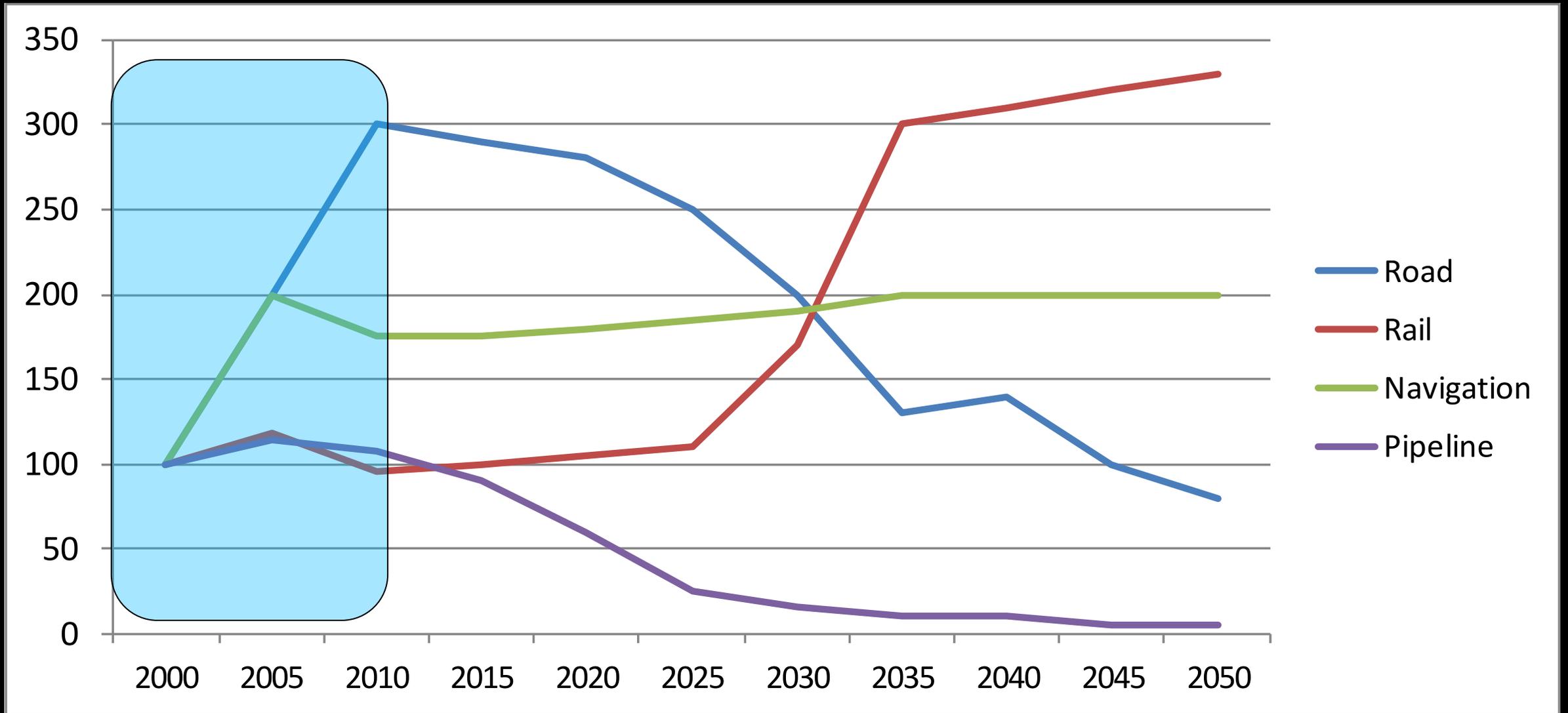
# TRANSPORTATION

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



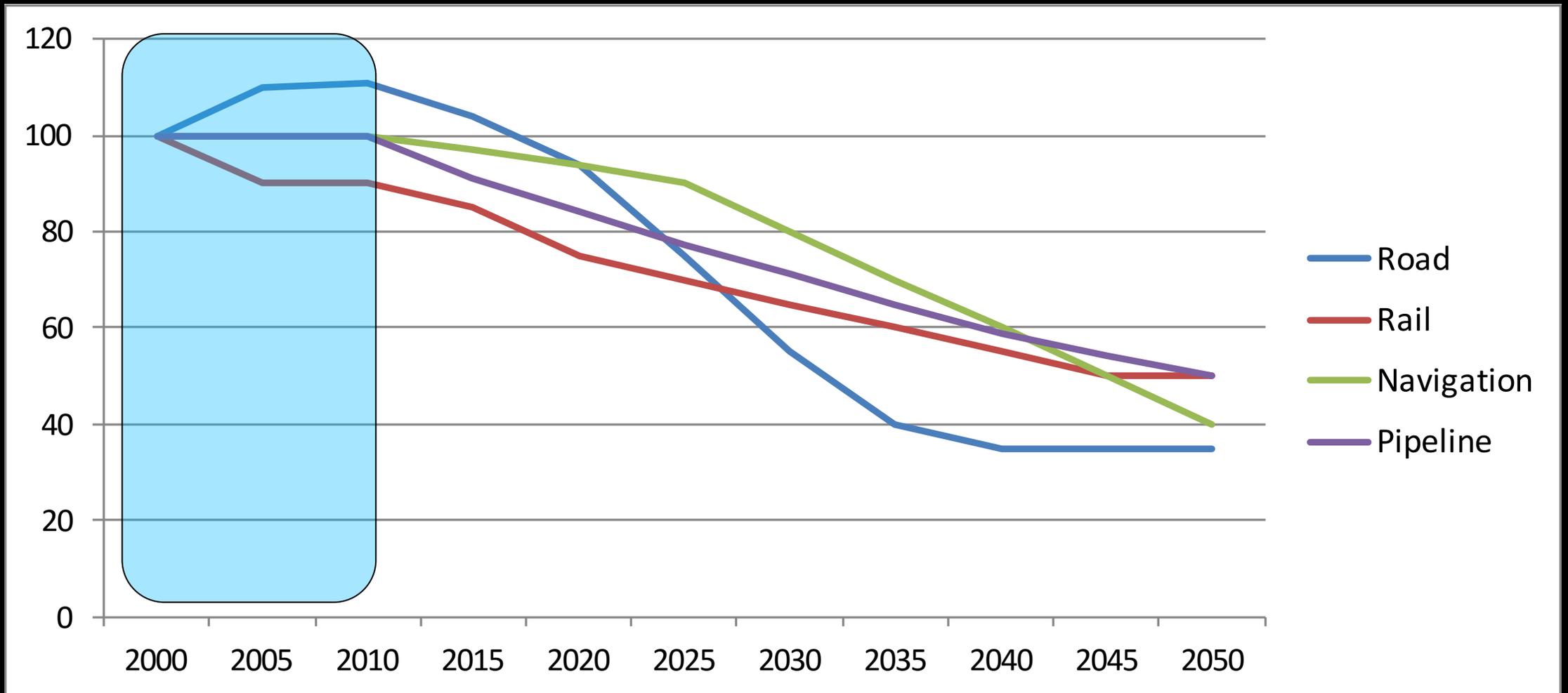
# TRANSPORTATION

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



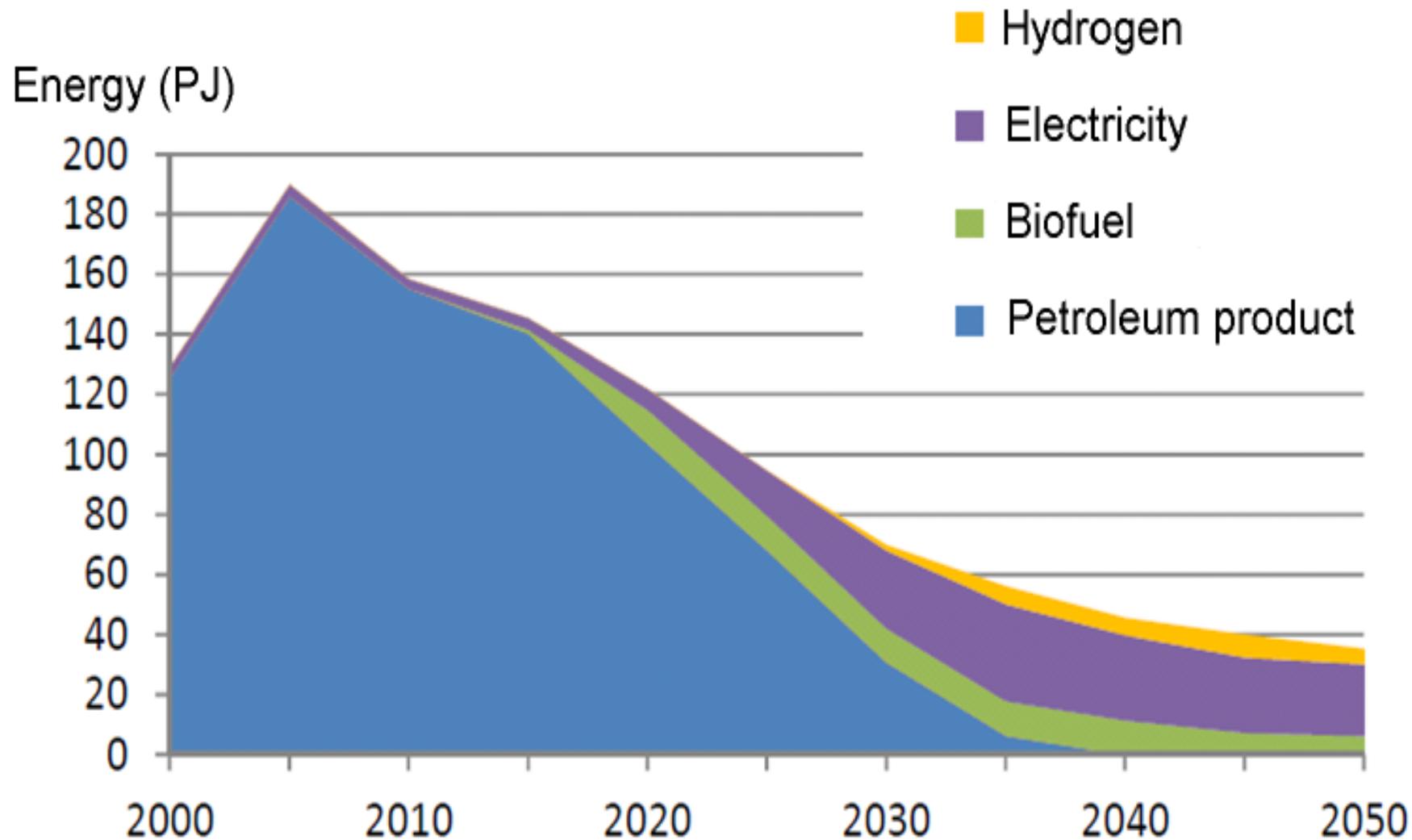
# TRANSPORTATION

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



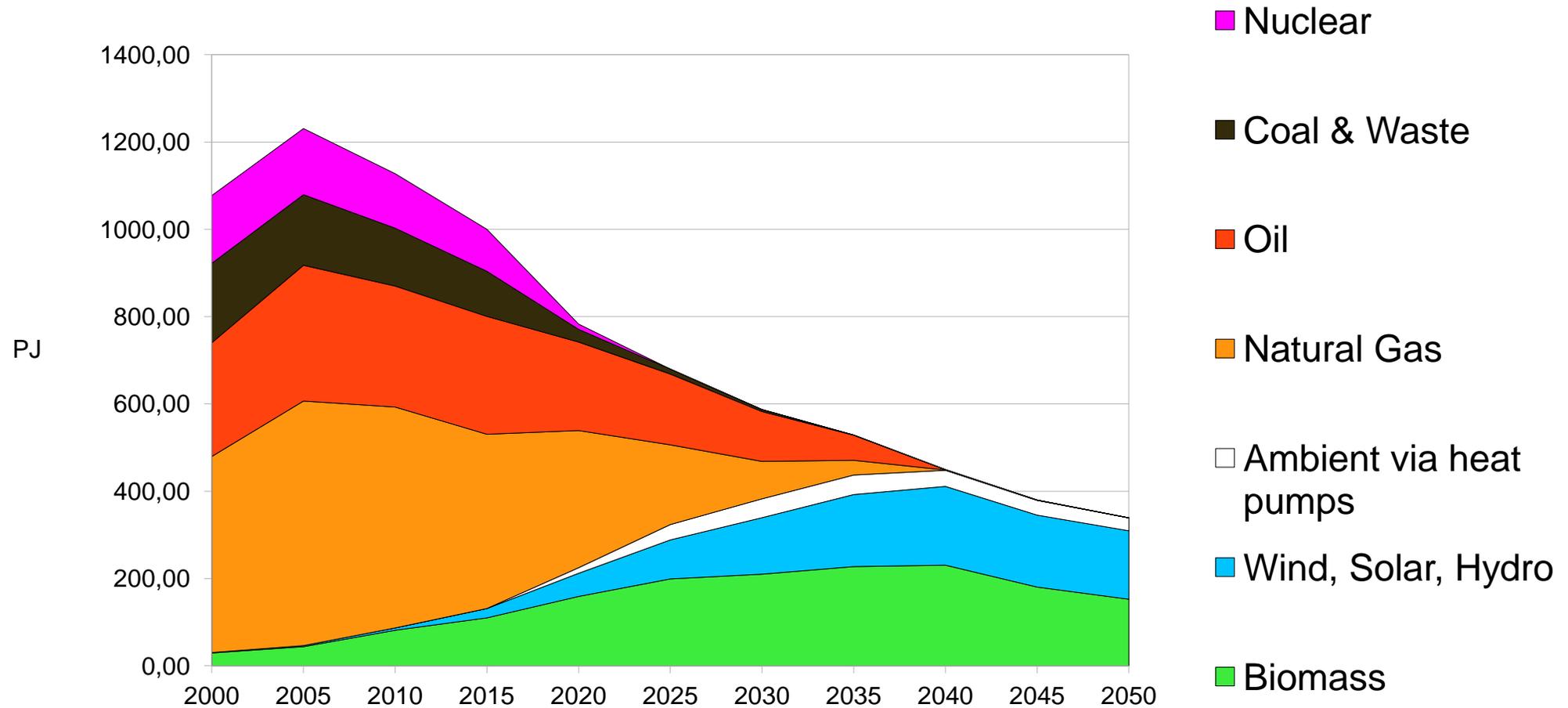
# TRANSPORTATION

## Energy consumption of the transportation sector by sources



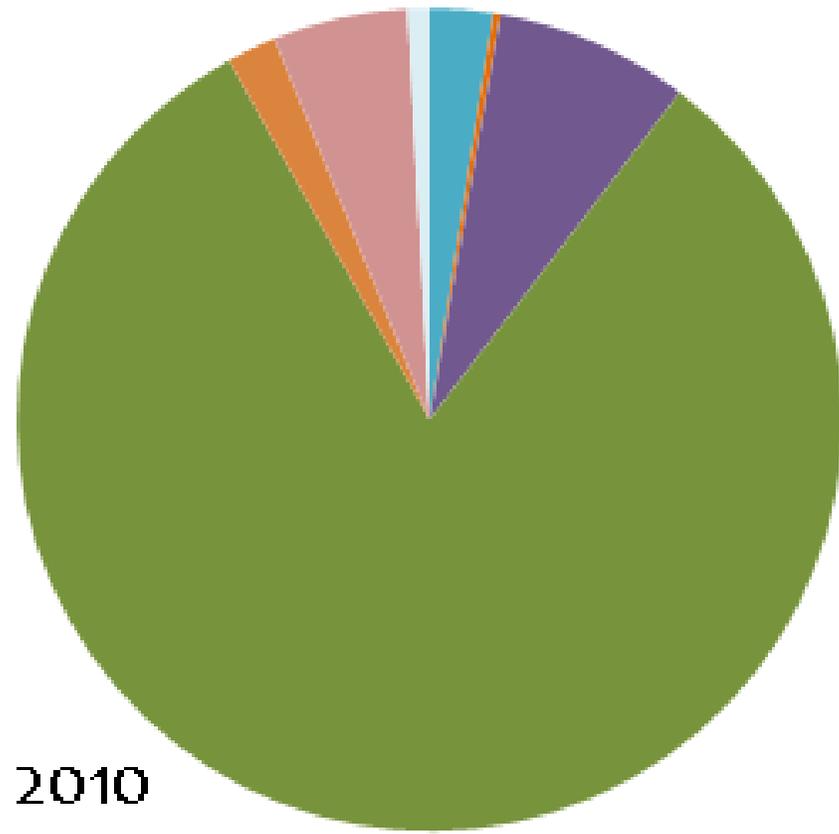
# PRIMARY ENERGY SUPPLY

according to „This Way Ahead” 2000-2050

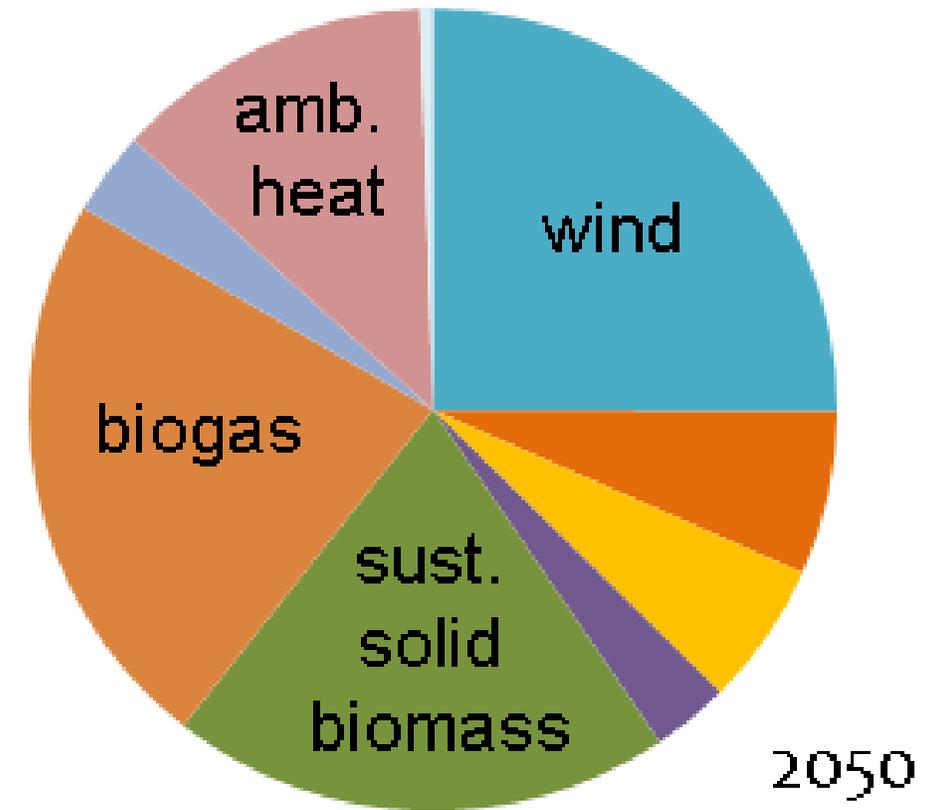




# Renewable energy mix in 2010 and 2050



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



# 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.