

Pathways for sustainable energy: Croatian approaches to a global challenge

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THREE SCENARIOS



Modern Jazz

Market-driven approach to achieving individual access and affordability of energy through economic growth.

- Market mechanisms
- Technology innovation
- Energy access for all



Unfinished Symphony

Government-driven approach to achieving sustainability through internationally coordinated politics and practices.

- Strong policy
- Long-term planning
- Unified climate action



Hard Rock

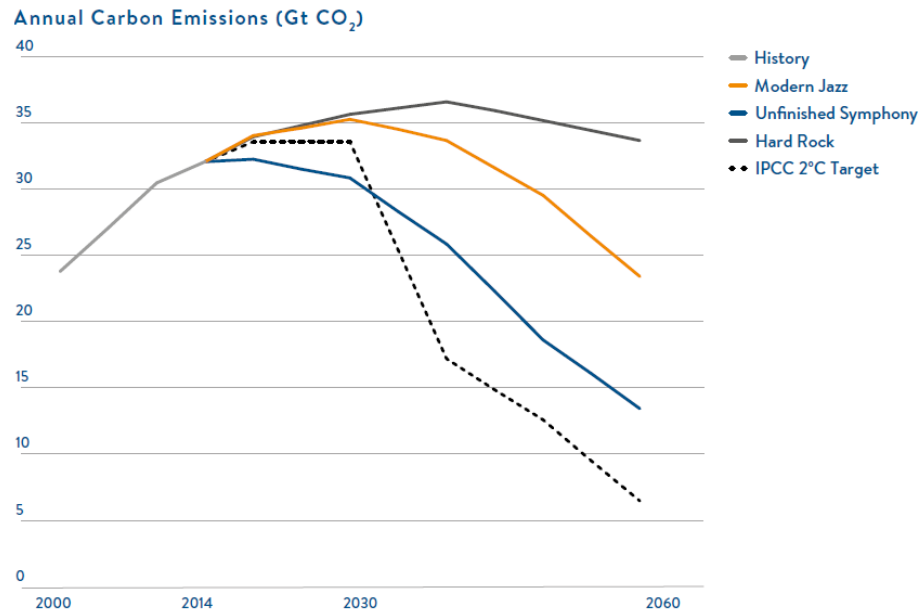
Fragmented approach driven by desire for energy security in a world with low global cooperation.

- Fragmented policies
- Local content
- Best-fit local solutions

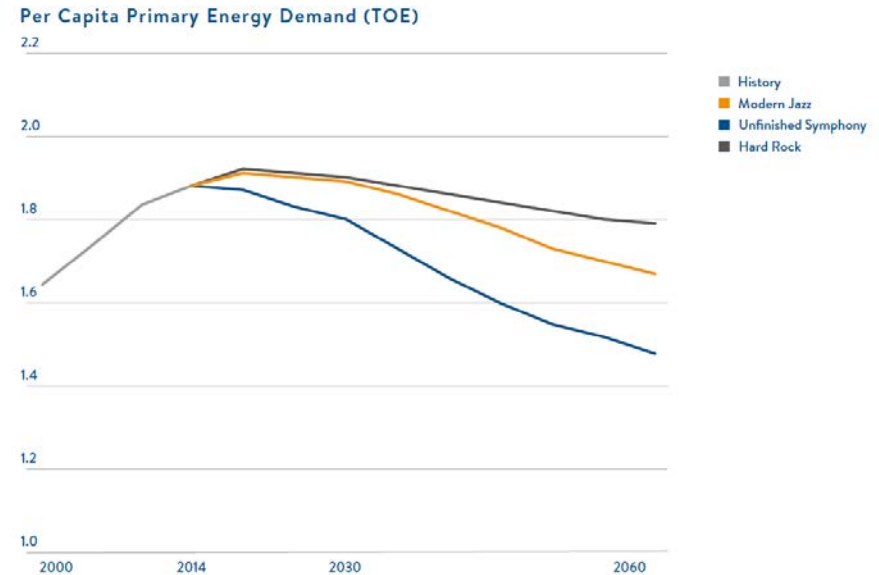
World energy council – world energy scenarios 2016



PEAKING CARBON EMISSIONS BETWEEN 2020 AND 2040



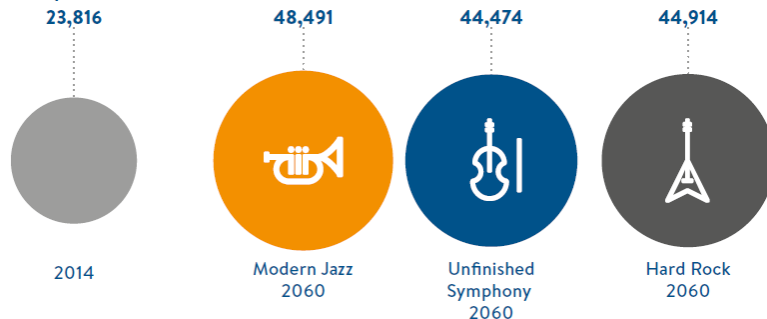
PEAKING IN PER CAPITA PRIMARY ENERGY DEMAND BEFORE 2030



Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy

DEMAND FOR ELECTRICITY WILL DOUBLE

Electricity Generation (TWh)



RAPID PENETRATION OF ELECTRIC VEHICLES

Electric Vehicles Share of Light-duty Vehicle Fleets



26% of 3.0 billion

Modern Jazz 2060



32% of 2.8 billion

Unfinished Symphony 2060

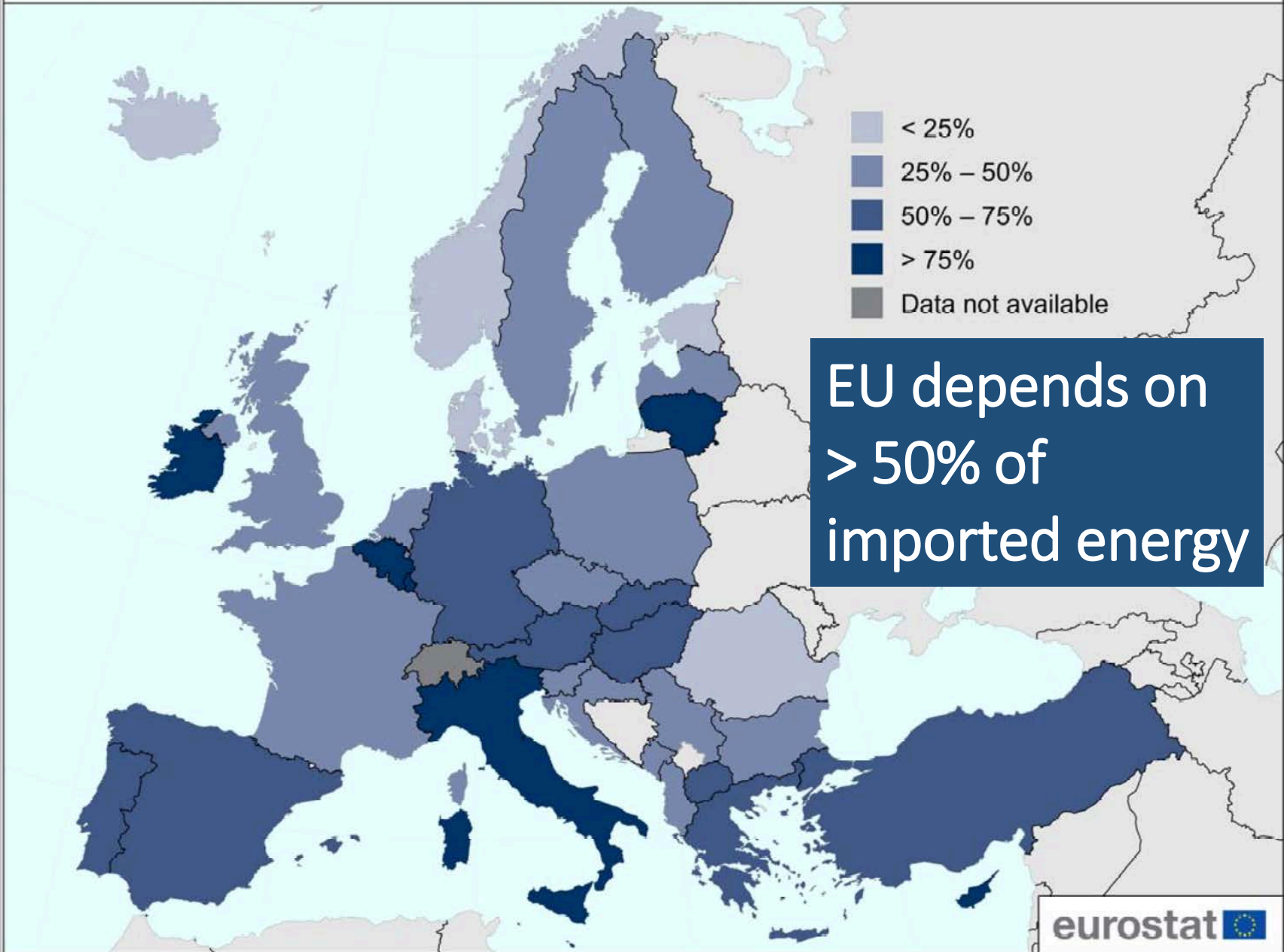


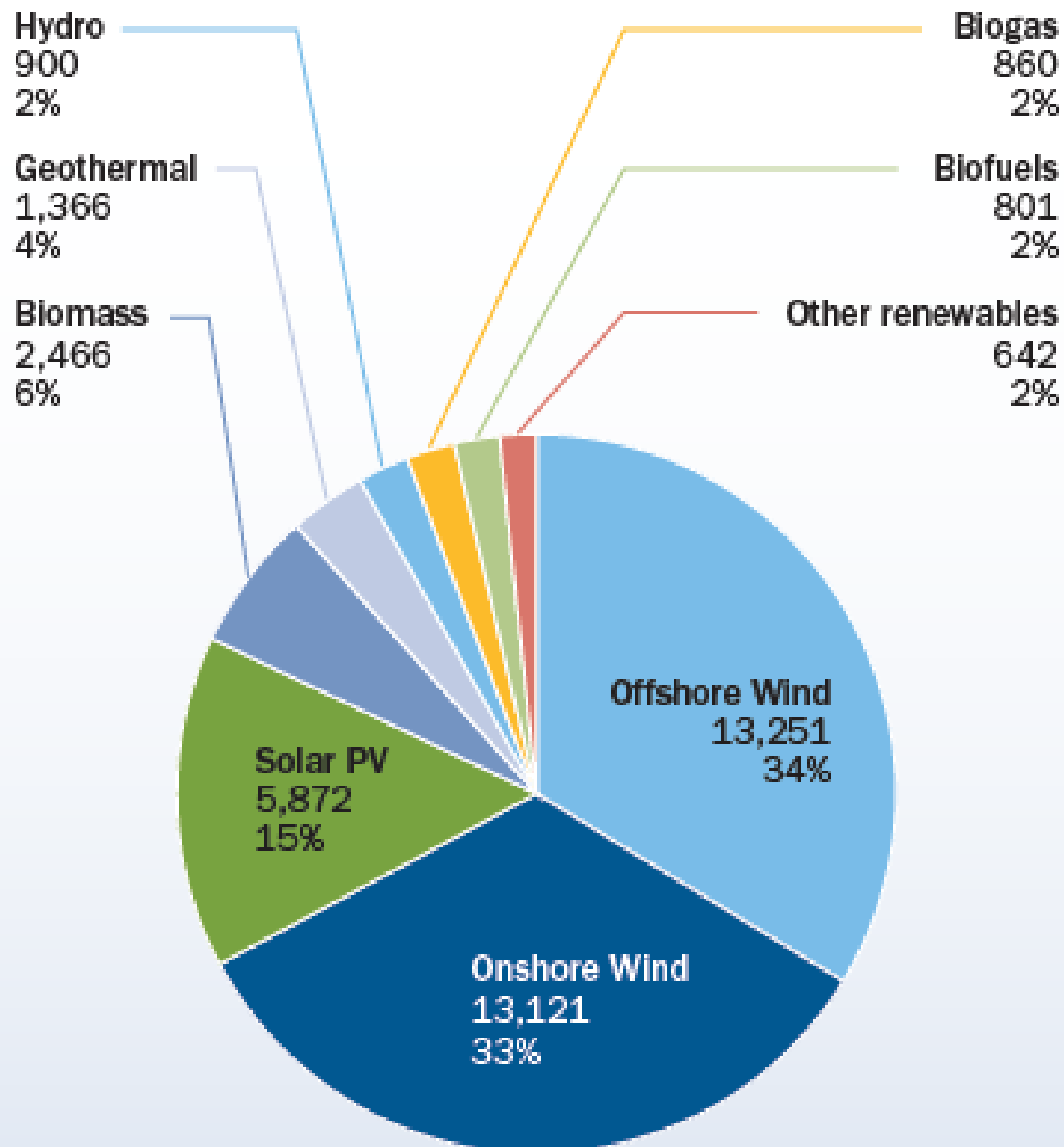
9% of 2.9 billion

Hard Rock 2060

Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy

Energy dependency, 2014

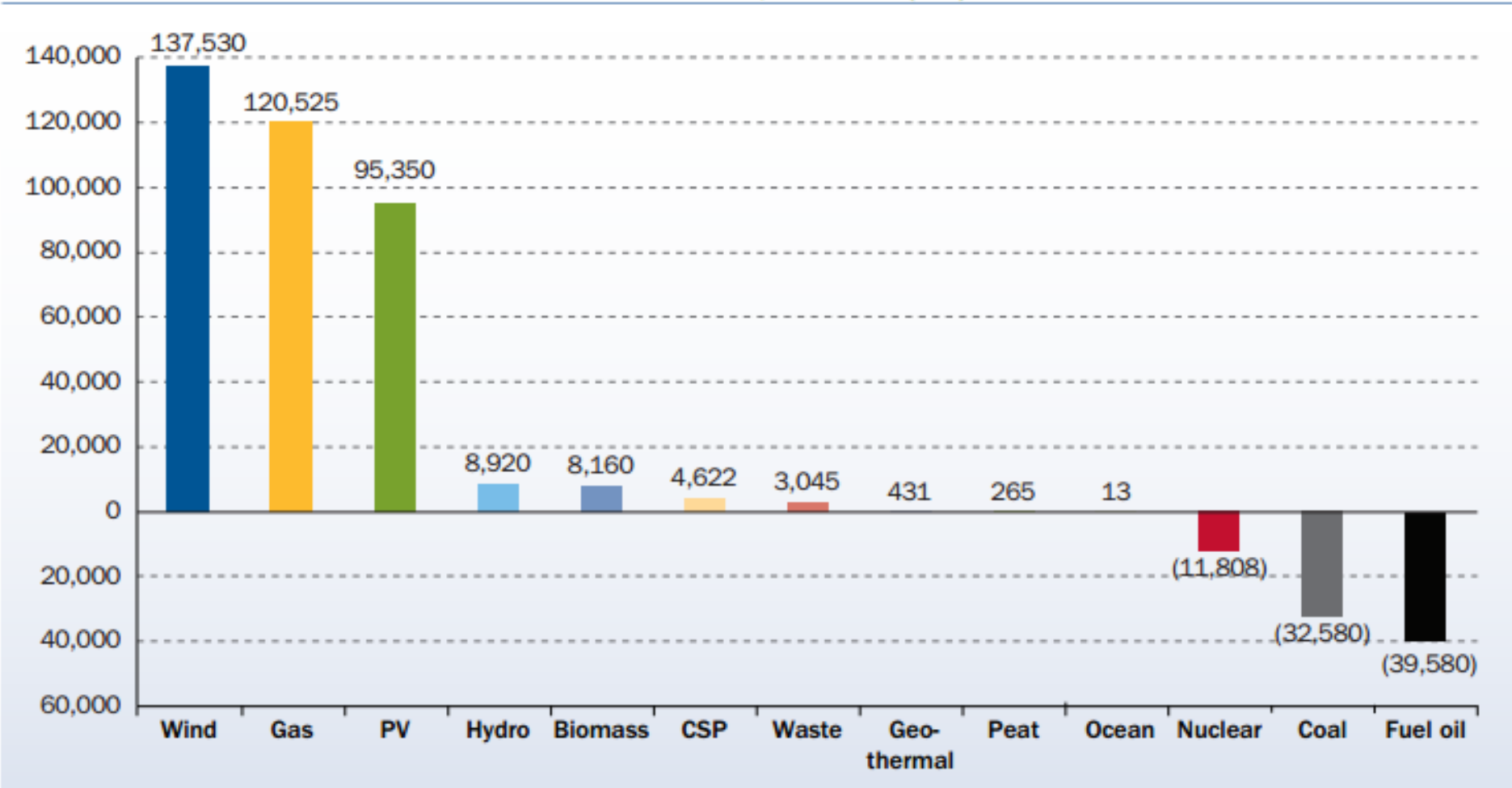




**RES
investments
(EU-28 in
2015)**

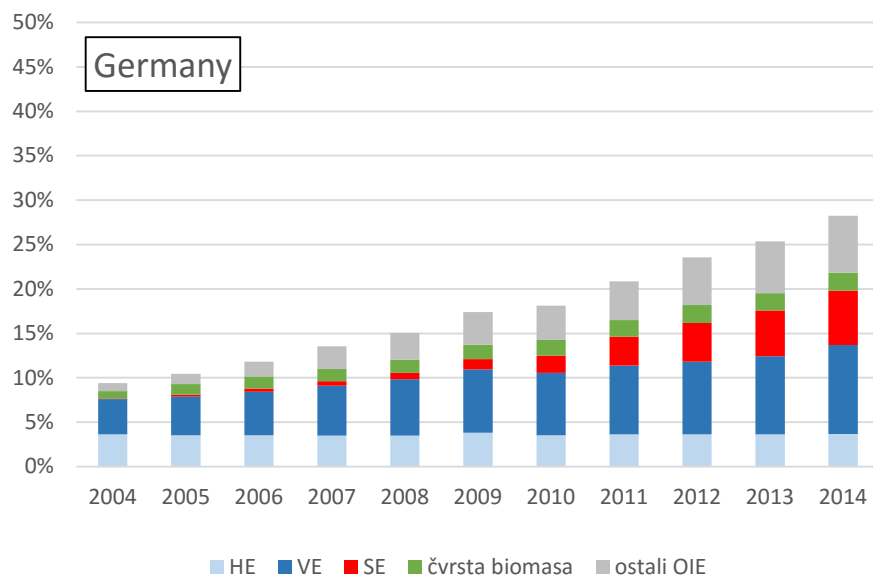
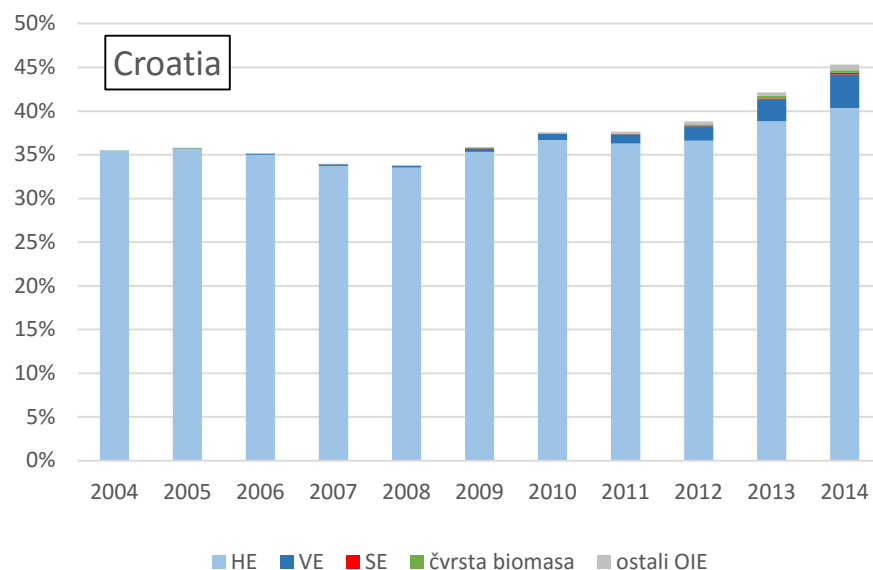
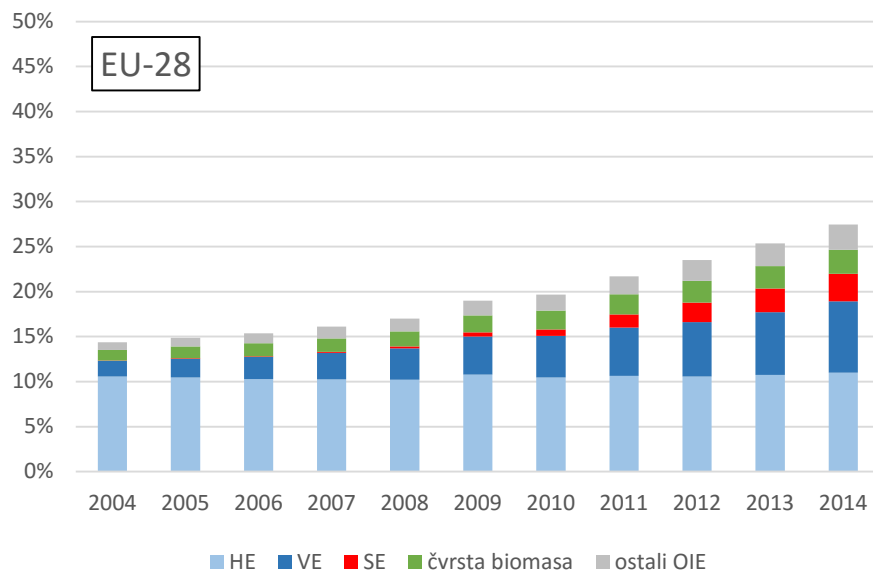
**VE – 26.4 b€
SE – 5.9 b€**

FIGURE 6: NET ELECTRICITY GENERATING INSTALLATIONS IN THE EU, 2000-2015 (MW)



In 2015 - 77% of electricity generating installations are RES (wind + solar)

RES-E (Eurostat):



EU and Germany

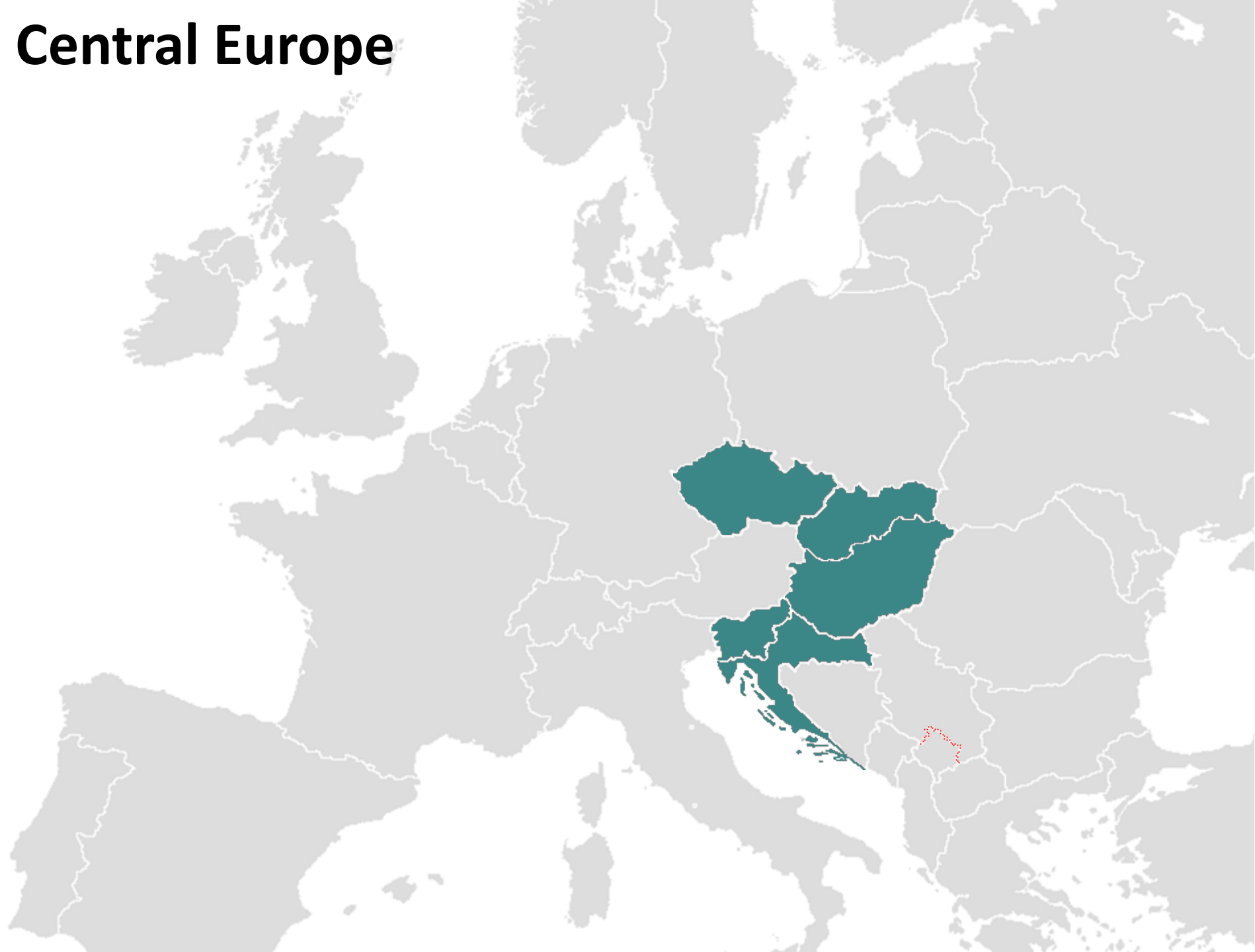
- HE stays the same
- VE constant growth
- SE rapid growth after 2010

Croatia

- VE grows from 2010 – 2016
- SE is insignificant
- Unpredictable future



Central Europe



Czech Republic

- 2/3 fossil
- Only 5% hydro



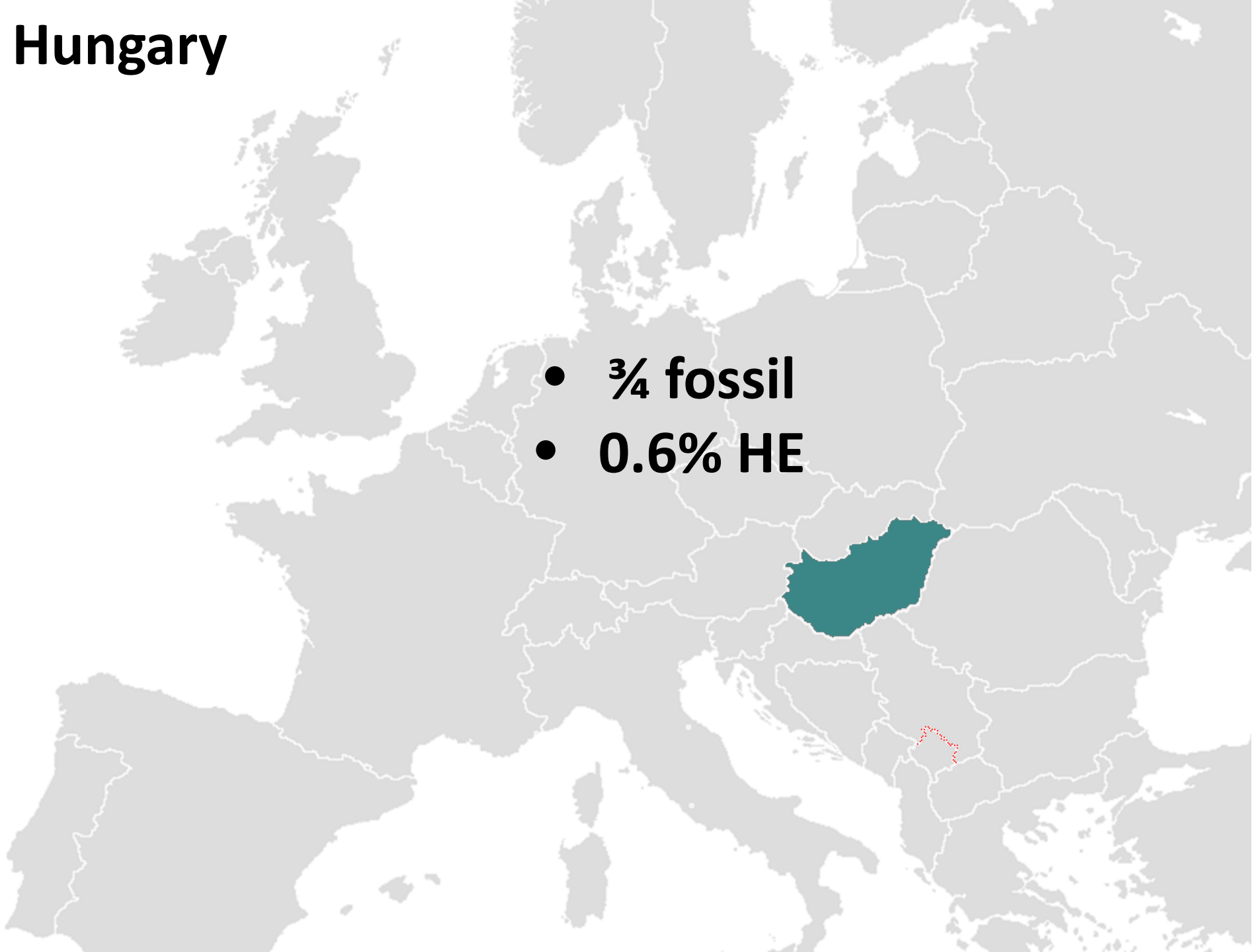
Slovakia

- well interconnected
- 45% fossil
- NE



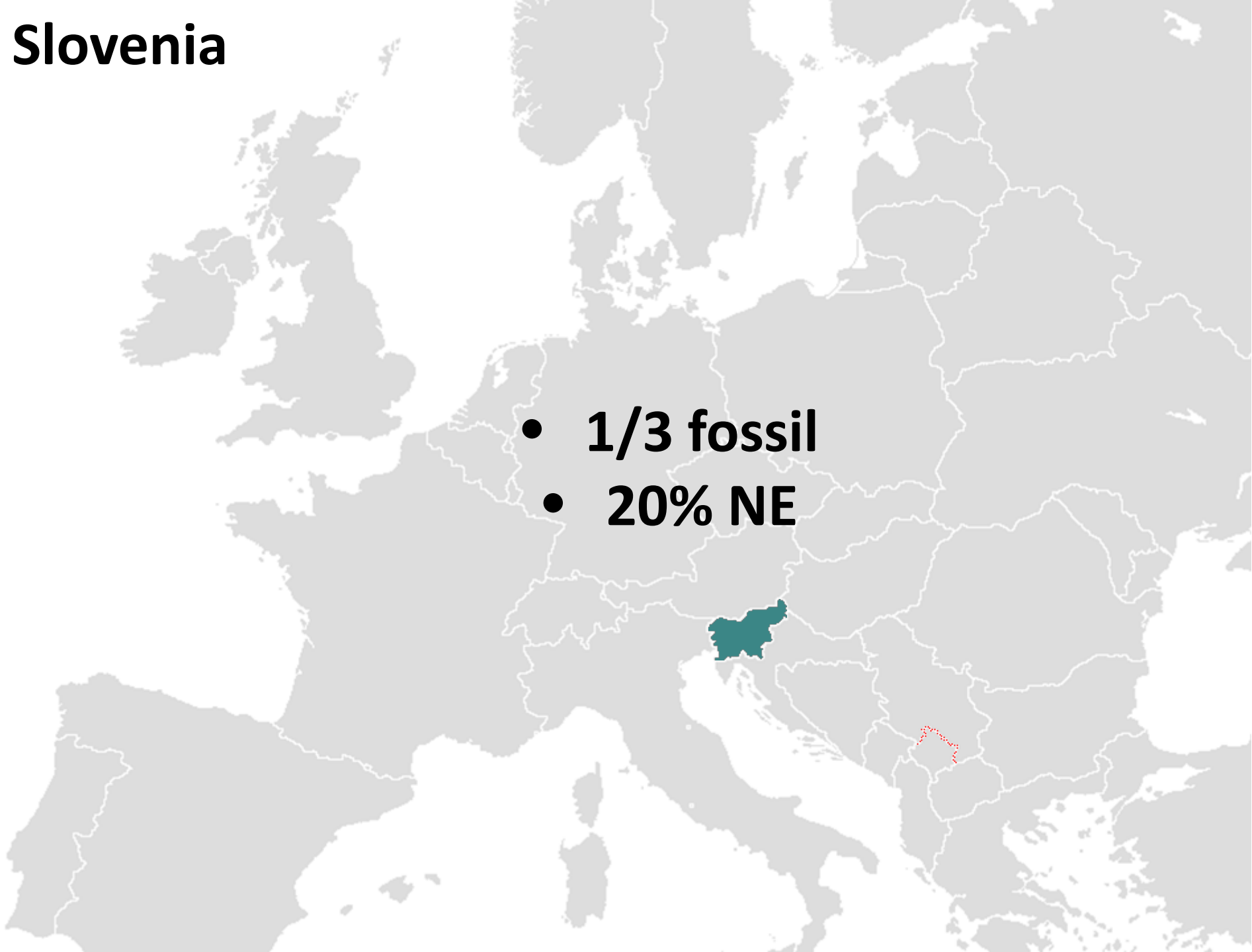
Hungary

- $\frac{3}{4}$ fossil
- 0.6% HE



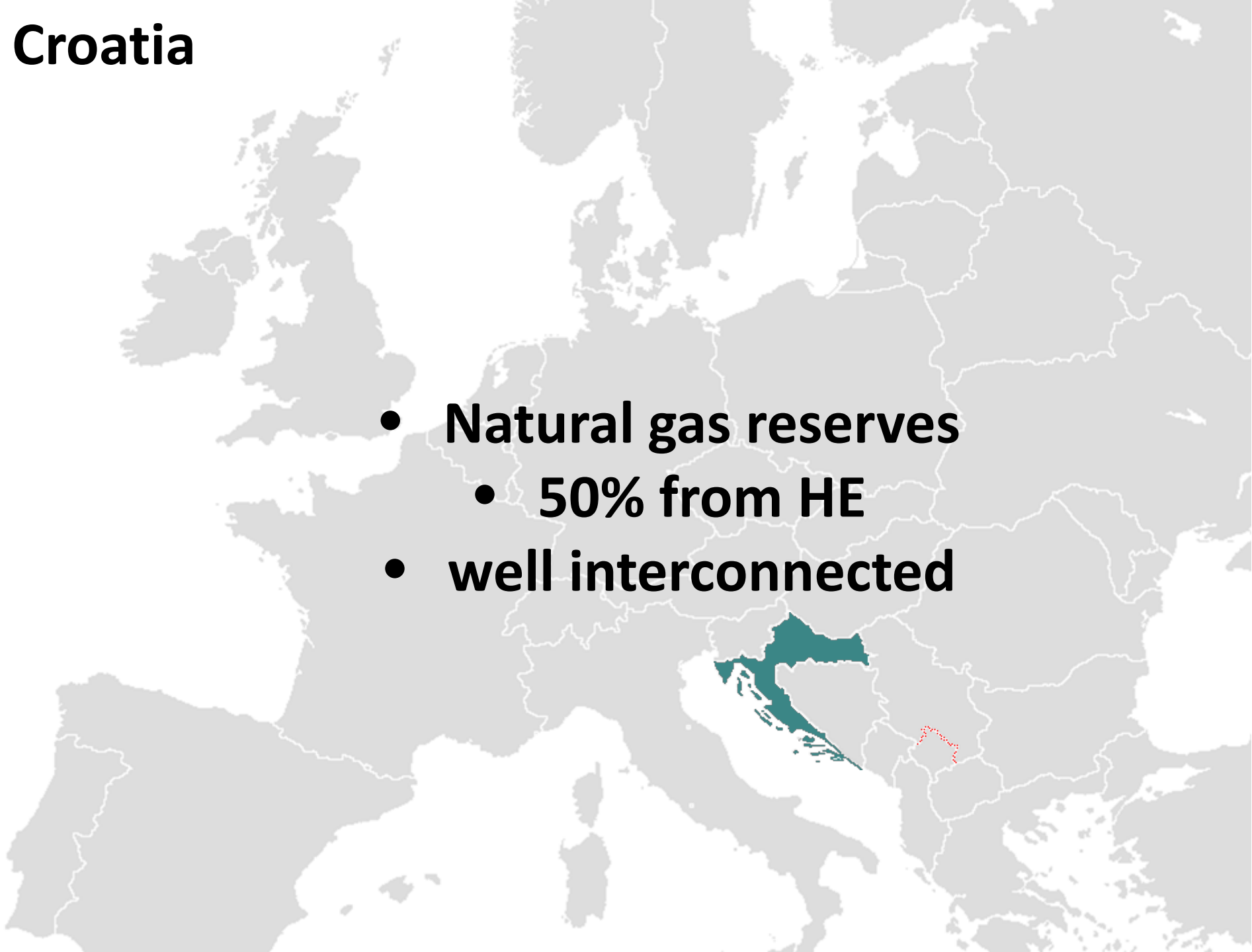
Slovenia

- 1/3 fossil
- 20% NE



Croatia

- **Natural gas reserves**
 - **50% from HE**
- **well interconnected**

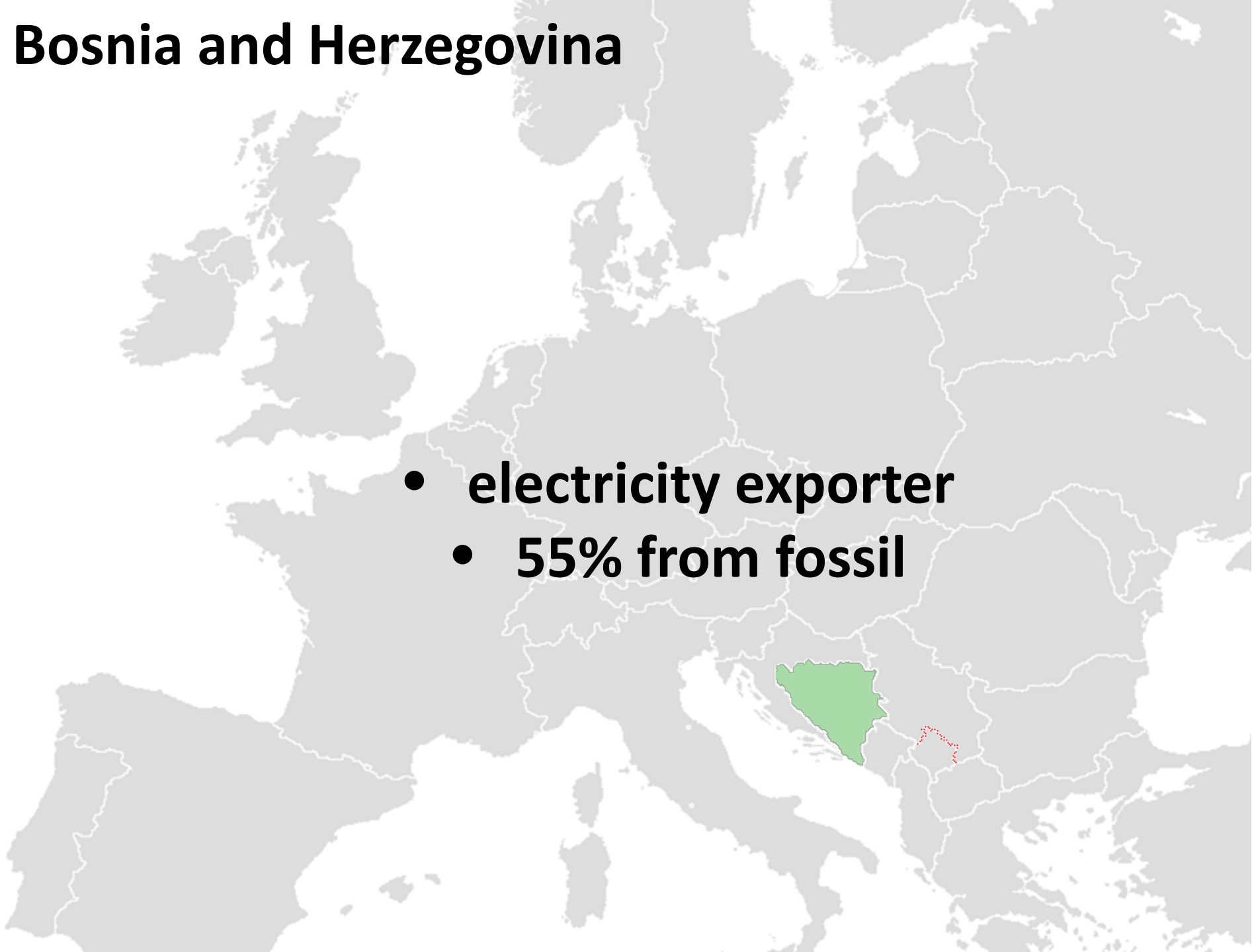


Western Balkans



Bosnia and Herzegovina

- electricity exporter
- 55% from fossil



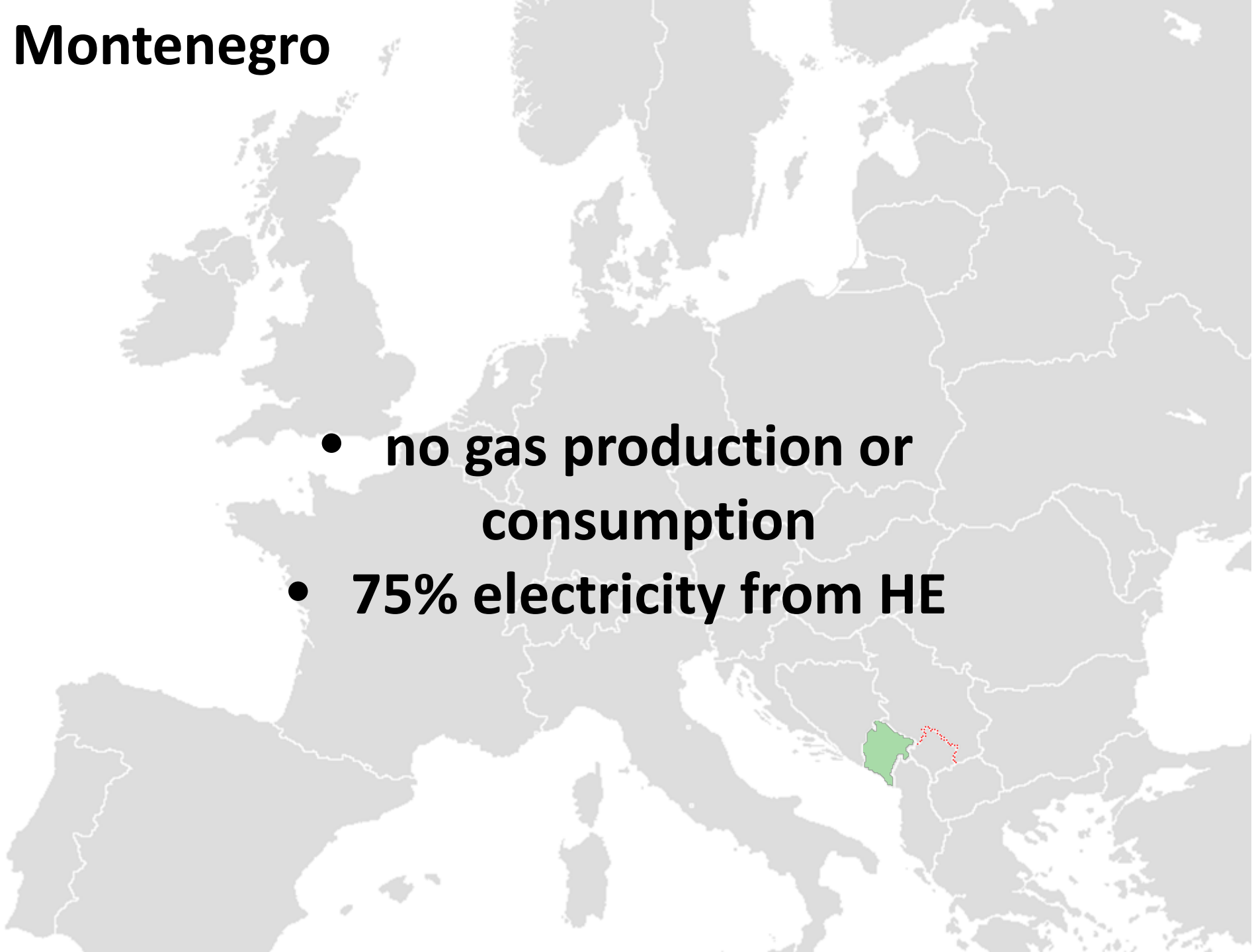
Serbia

- 60% from fossil



Montenegro

- no gas production or consumption
- 75% electricity from HE



Kosovo

- no production or consumption of natural gas
- electricity exporter



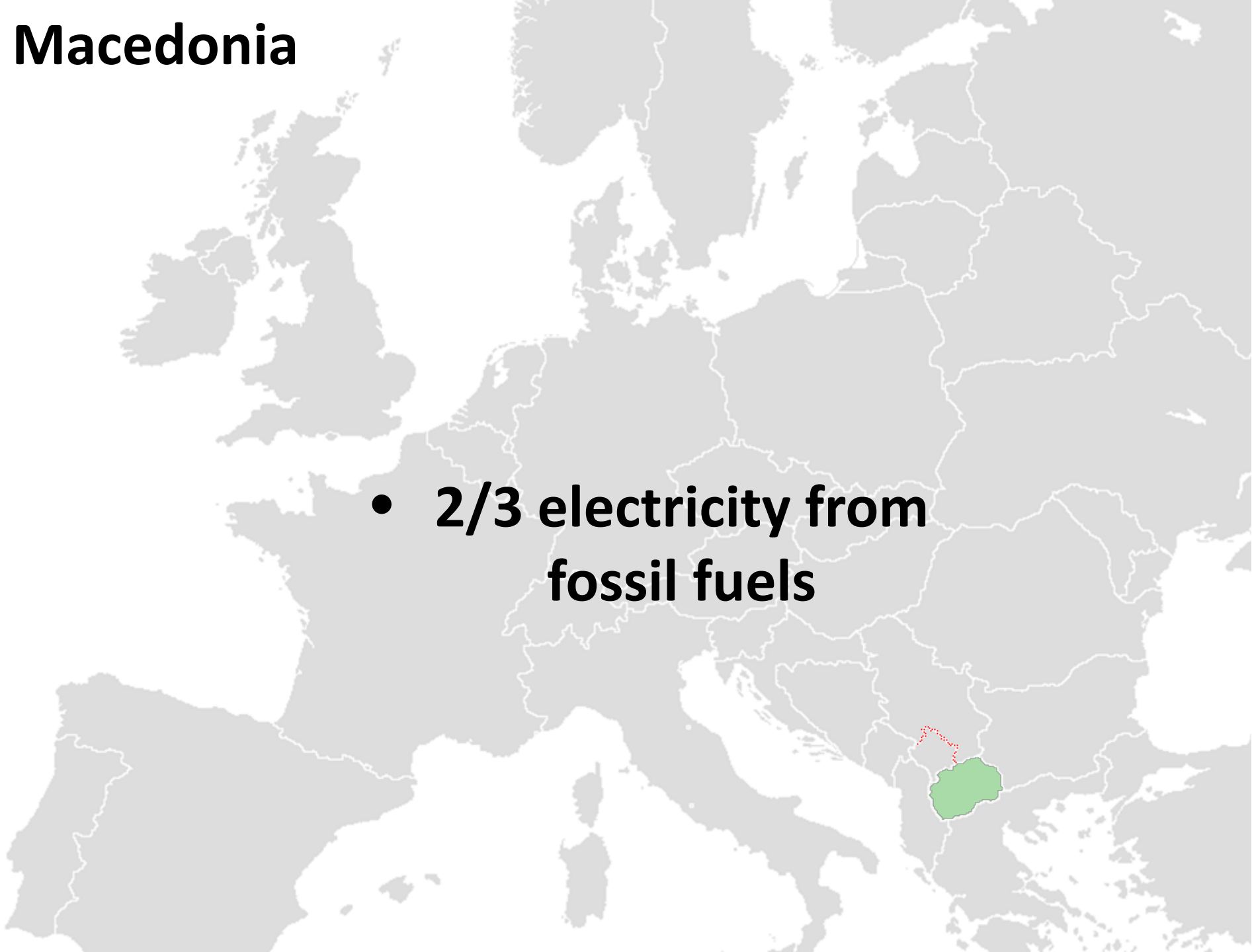
Albania

- huge import of electricity
- no import of crude oil or natural gas
 - 95% HE
- no renewables



Macedonia

- **2/3 electricity from fossil fuels**

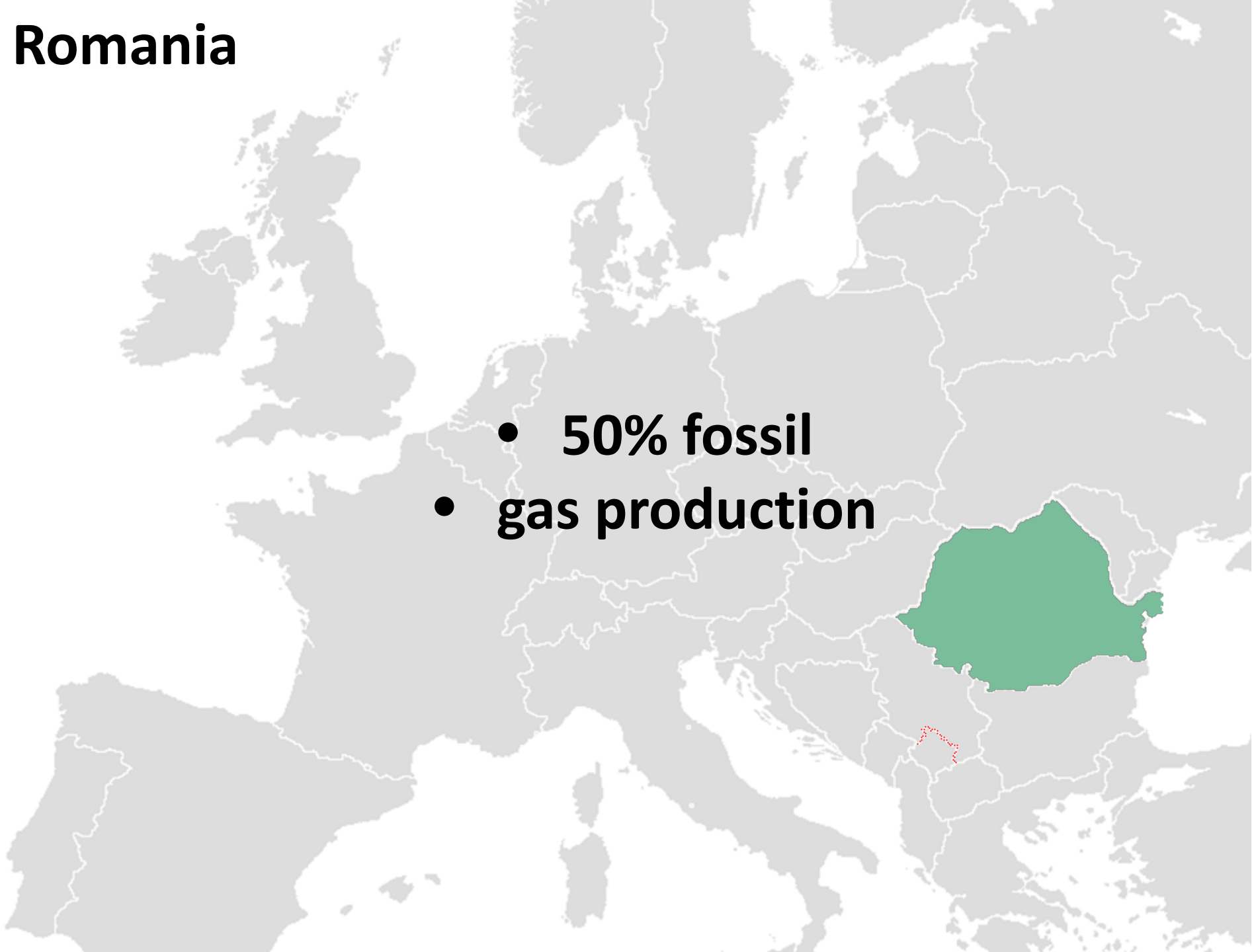


Eastern Europe



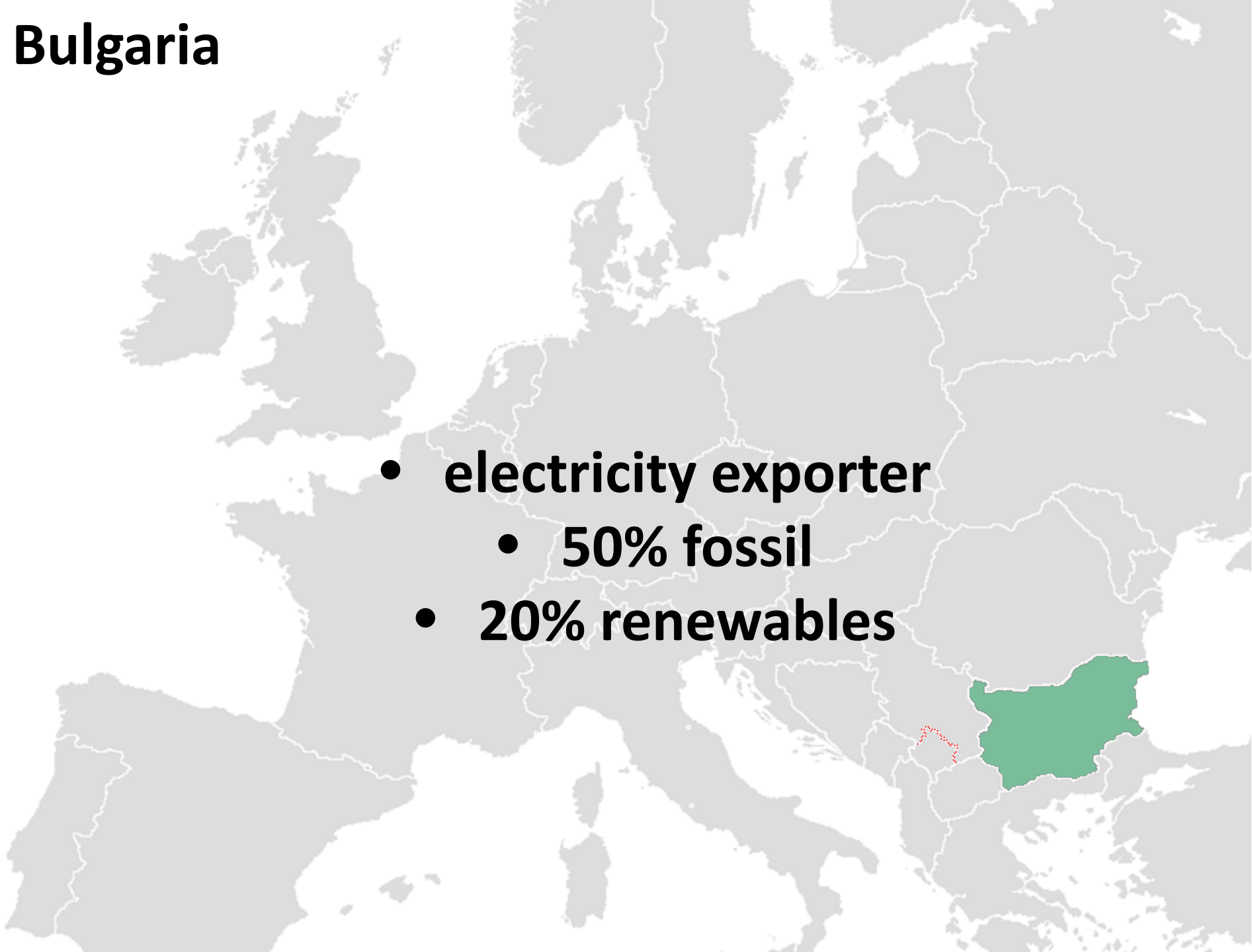
Romania

- 50% fossil
- gas production

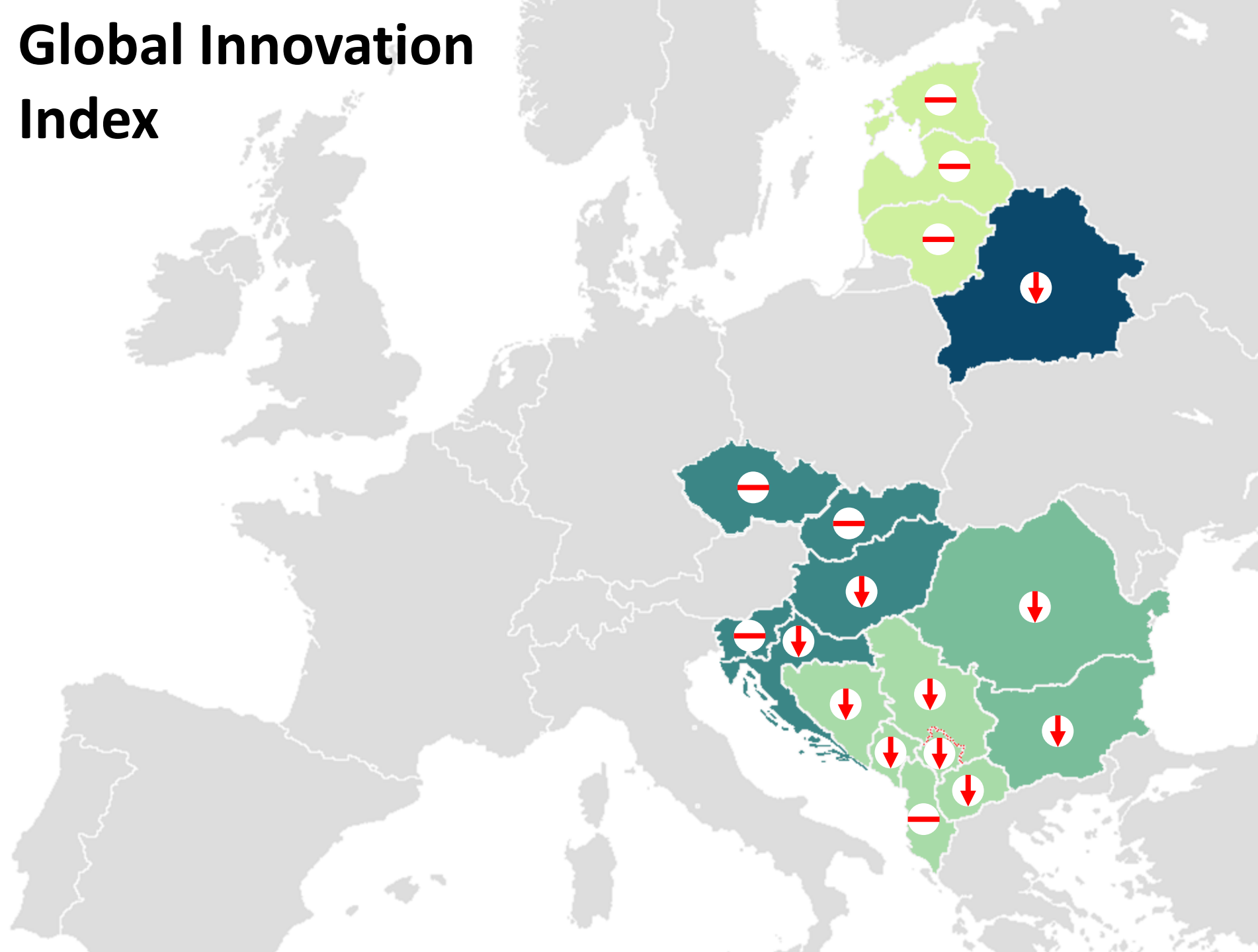


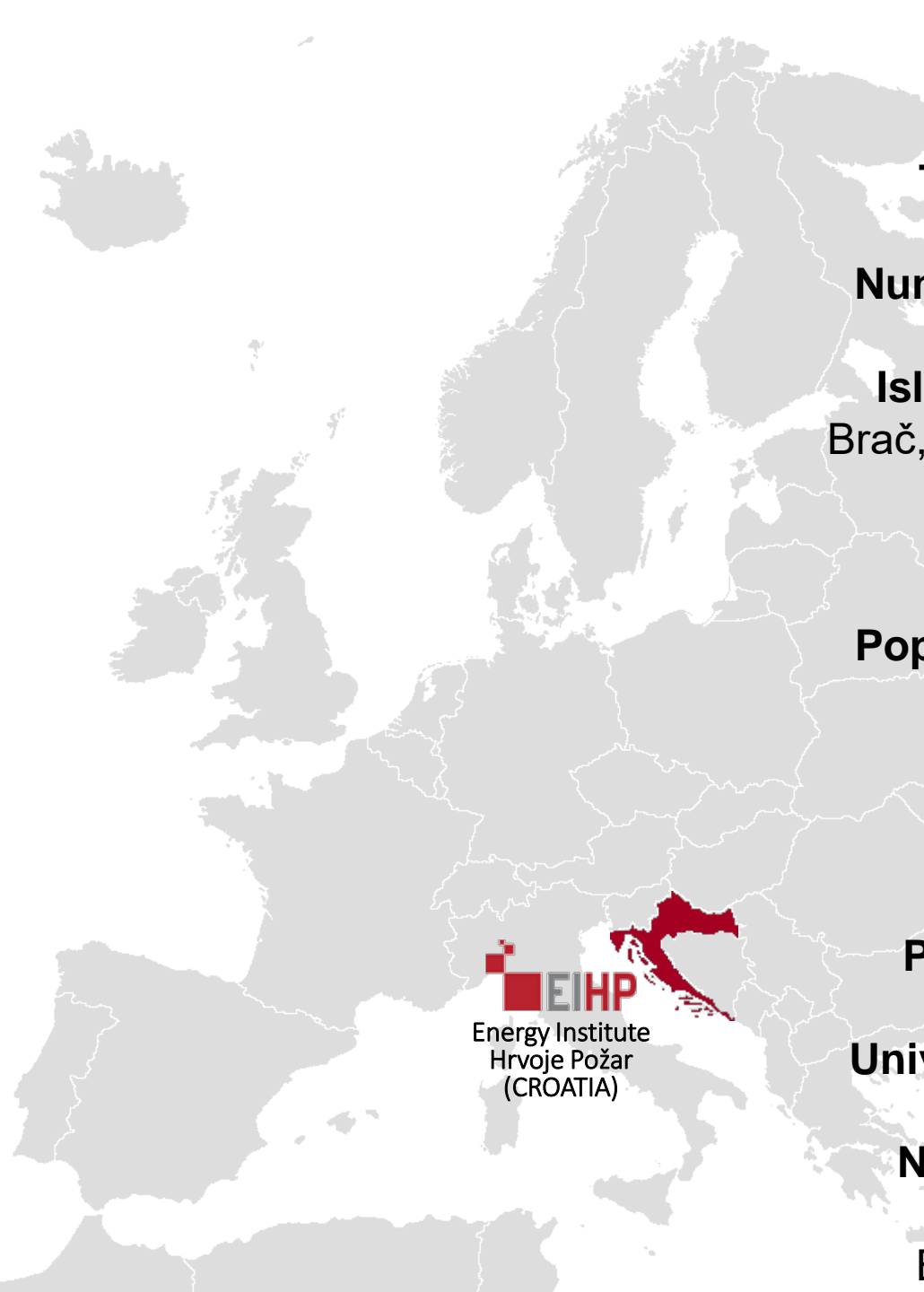
Bulgaria

- **electricity exporter**
 - **50% fossil**
 - **20% renewables**



Global Innovation Index






Energy Institute
Hrvoje Požar
(CROATIA)

Area: 56,594 km²

Length of sea coastline with islands: 5,835.3 km

The highest mountain: Dinara (1,831 m)

Number of islands (47 inhabited): 1,185

Islands over 100 km²: Krk, Cres, Brač, Hvar, Pag, Korčula, Dugi otok, Mljet

Population (2011 Census): 4.437,460

Population density per km²: 78.5

Capital: Zagreb (779,145 inhabitants)

Language: Croatian

Script: Latin

Currency: Kuna (HRK)

Political system: Parliamentary democracy

Universities: Zagreb, Split, Rijeka, Osijek, Zadar, Dubrovnik, Pula

National parks: Plitvička jezera, Krka, Paklenica, Mljet, Risnjak, Brijuni, Kornati, Sjeverni Velebit

- low emissions of greenhouse gases per capita
- vulnerable to climate change
- actively participates in the efforts of EU and the world for the preservation of the climate system
- part of the UNFCCC (since 1996) Croatia has committed to keep the greenhouse gas emissions to the 1990 level



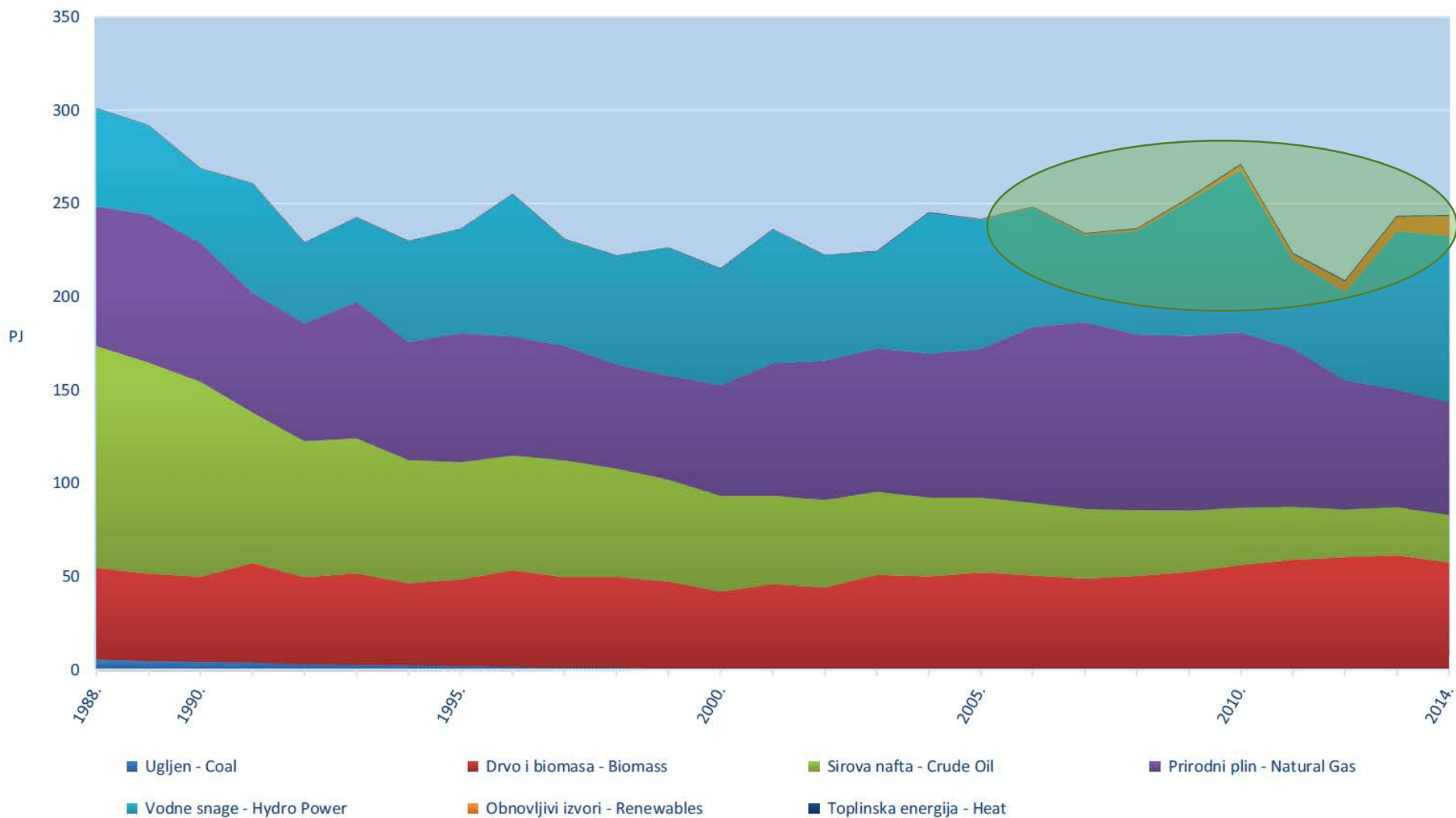
Source: Wikipedia



Source: Šibenikin

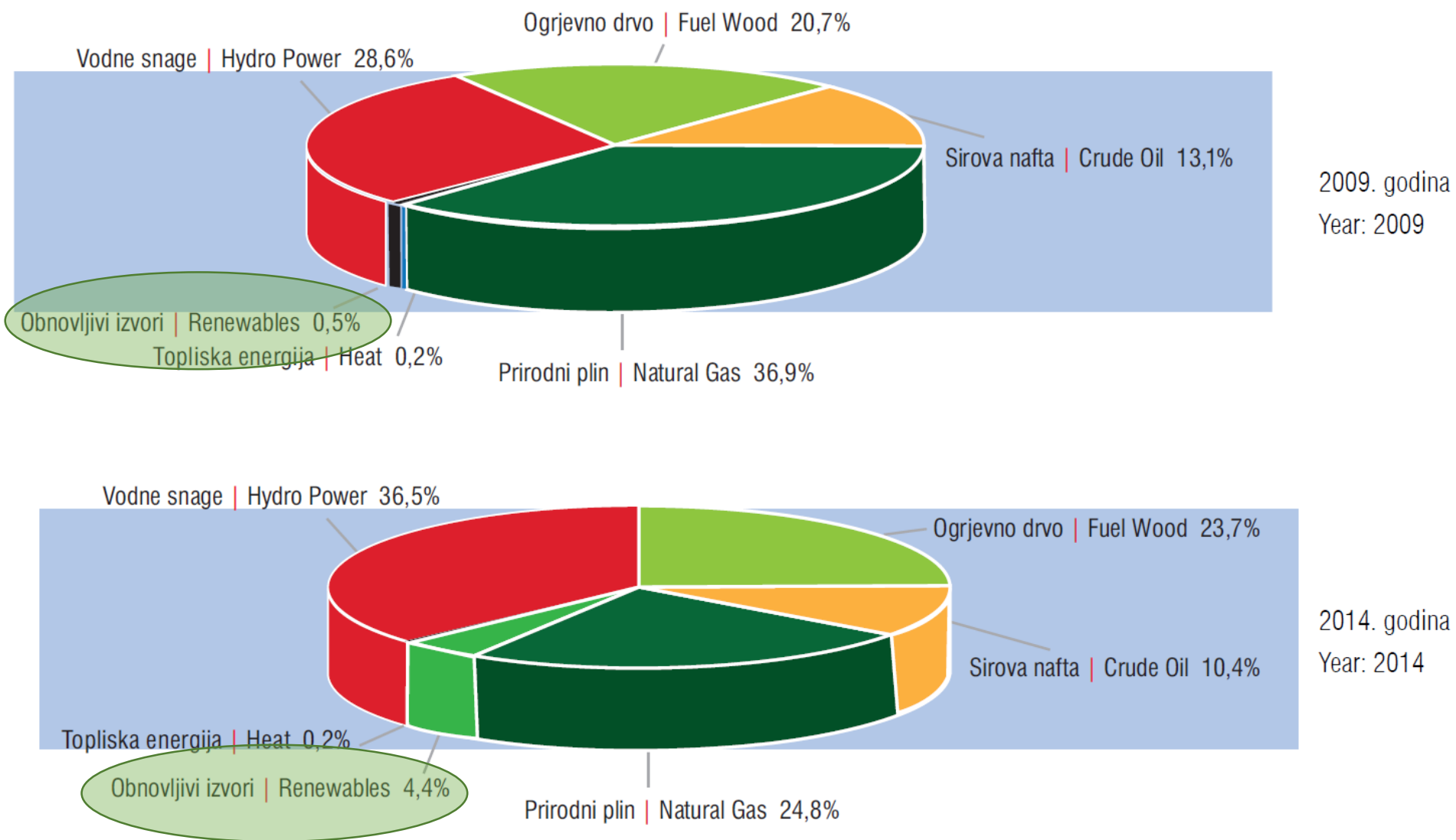


Source: Youtube



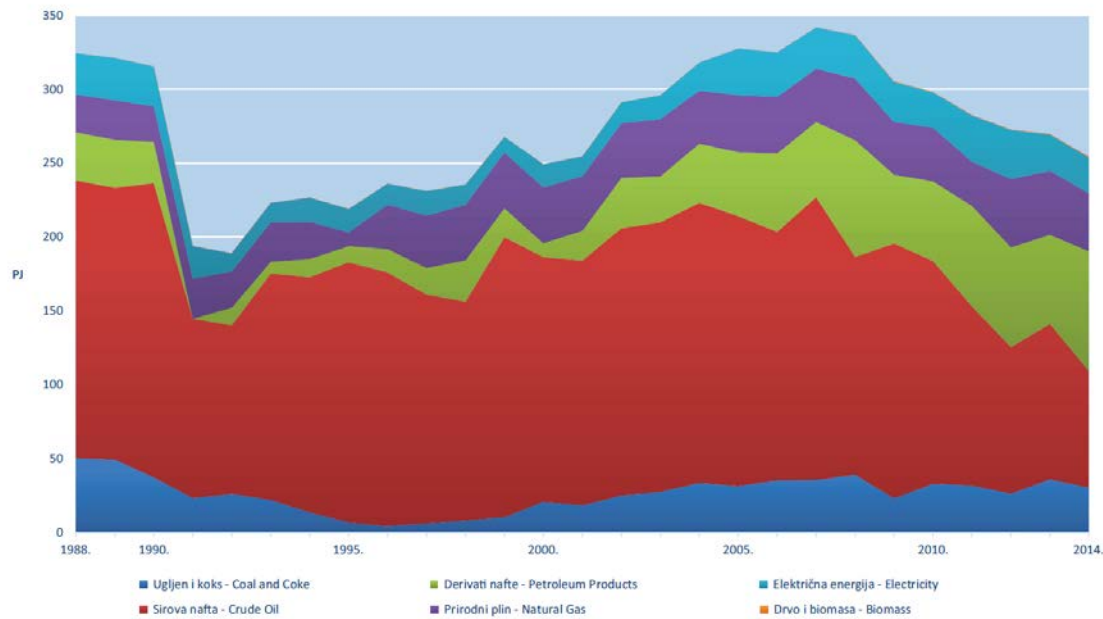
Slika | Figure 2.2.1. Proizvodnja primarne energije | Primary energy production

Izvor | Source: EIHP

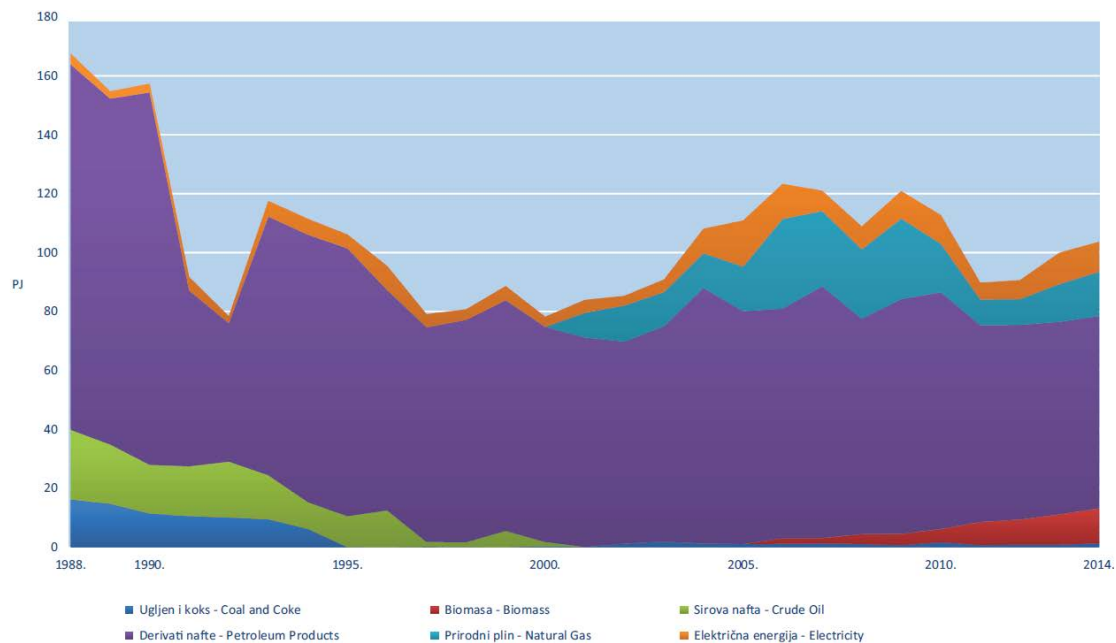


Slika | Figure 2.2.2. Udjeli u proizvodnji primarne energije | Shares in primary energy production

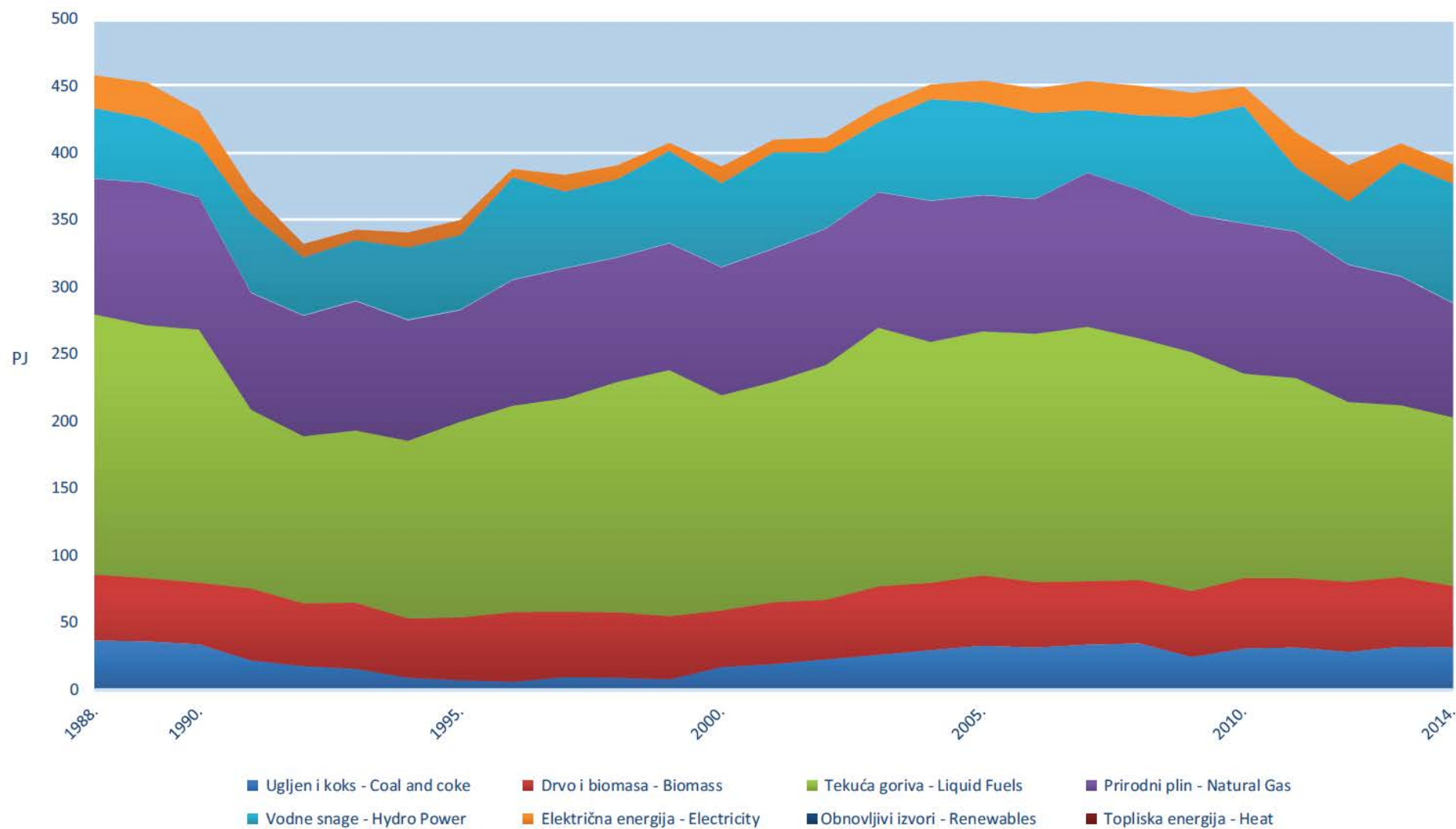
Izvor | Source: EIHP



Slika | Figure 2.3.1. Uvoz energije u Hrvatsku | Energy import in Croatia
Izvor | Source: EIHP

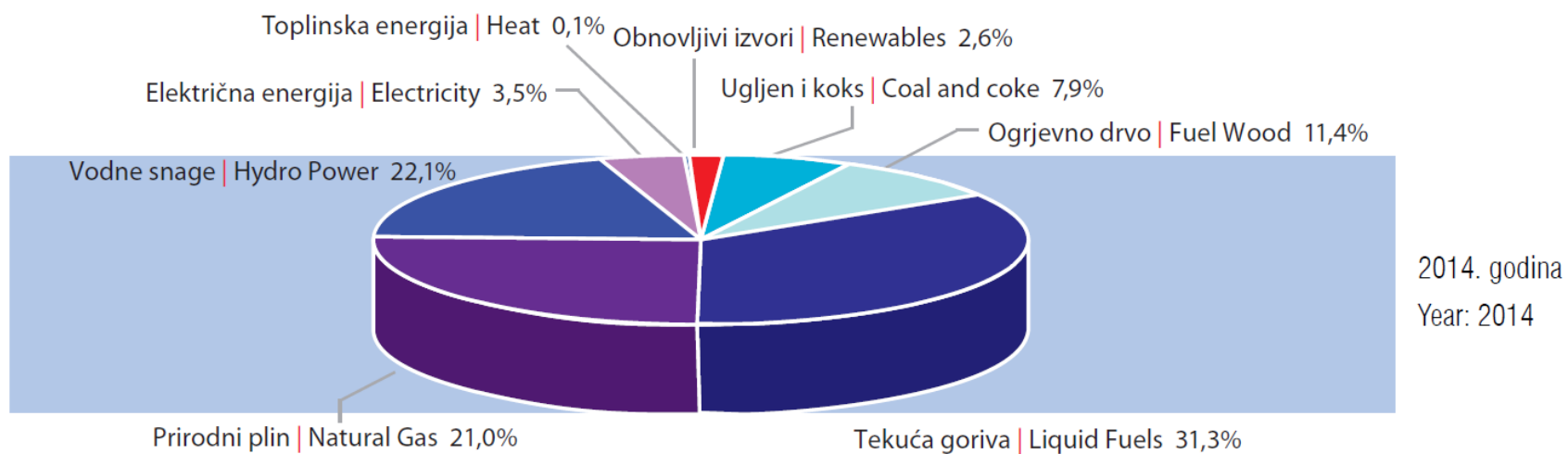
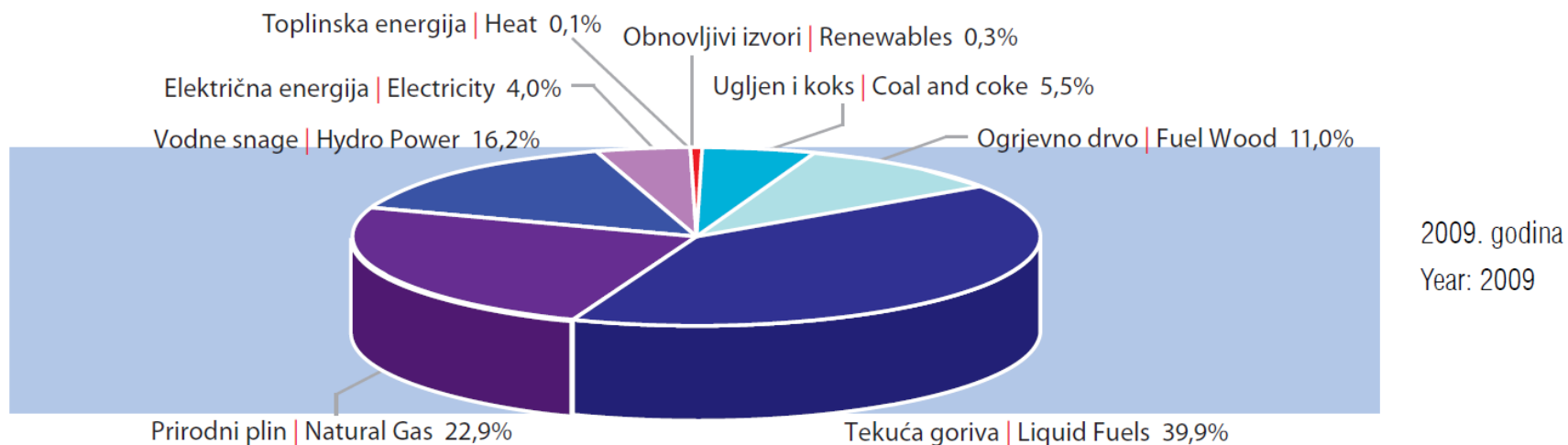


Slika | Figure 2.3.3. Izvoz energije iz Hrvatske | Energy exports from Croatia
Izvor | Source: EIHP

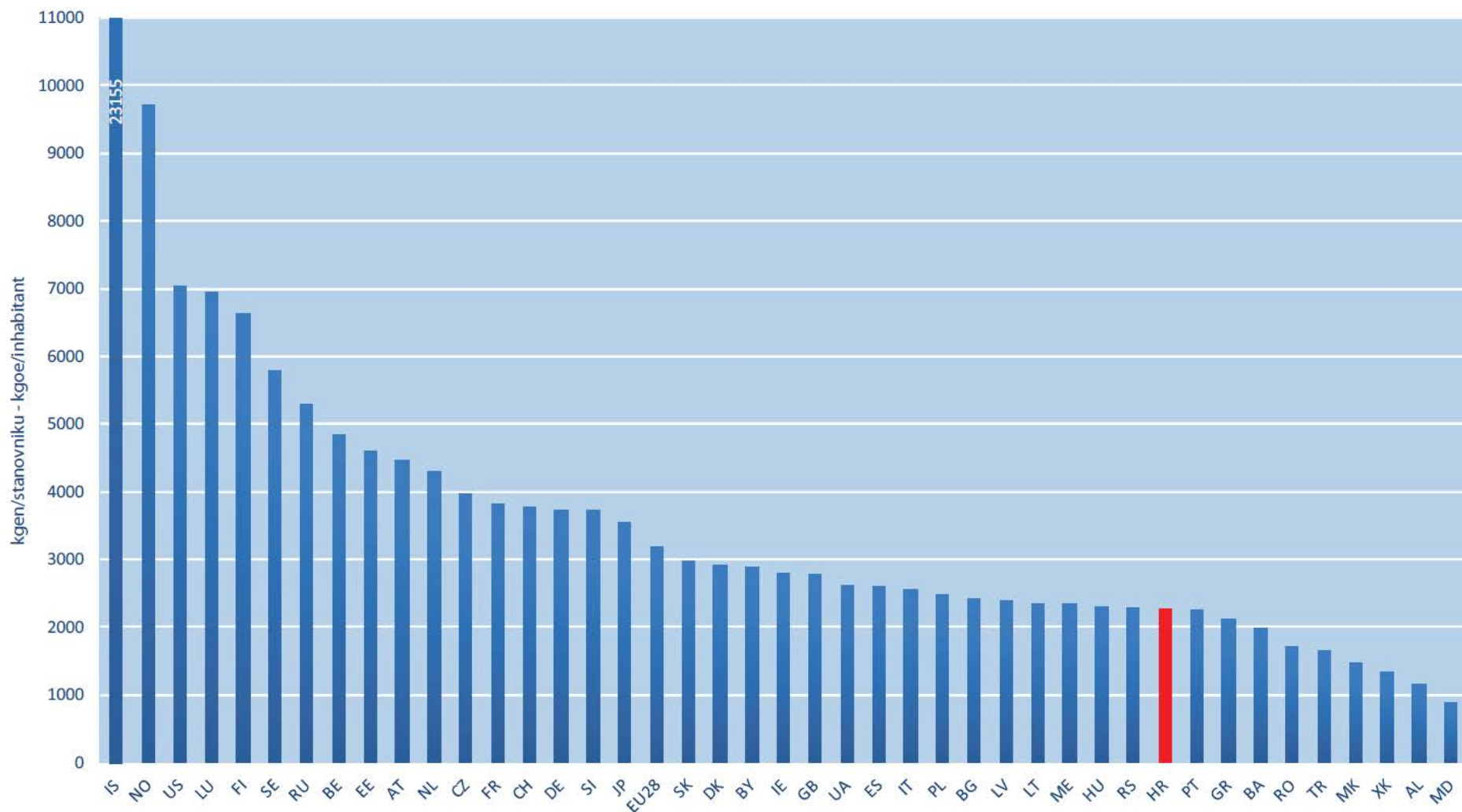


Slika | Figure 2.4.1. Ukupna potrošnja energije u Hrvatskoj | Total Primary Energy Supply in Croatia

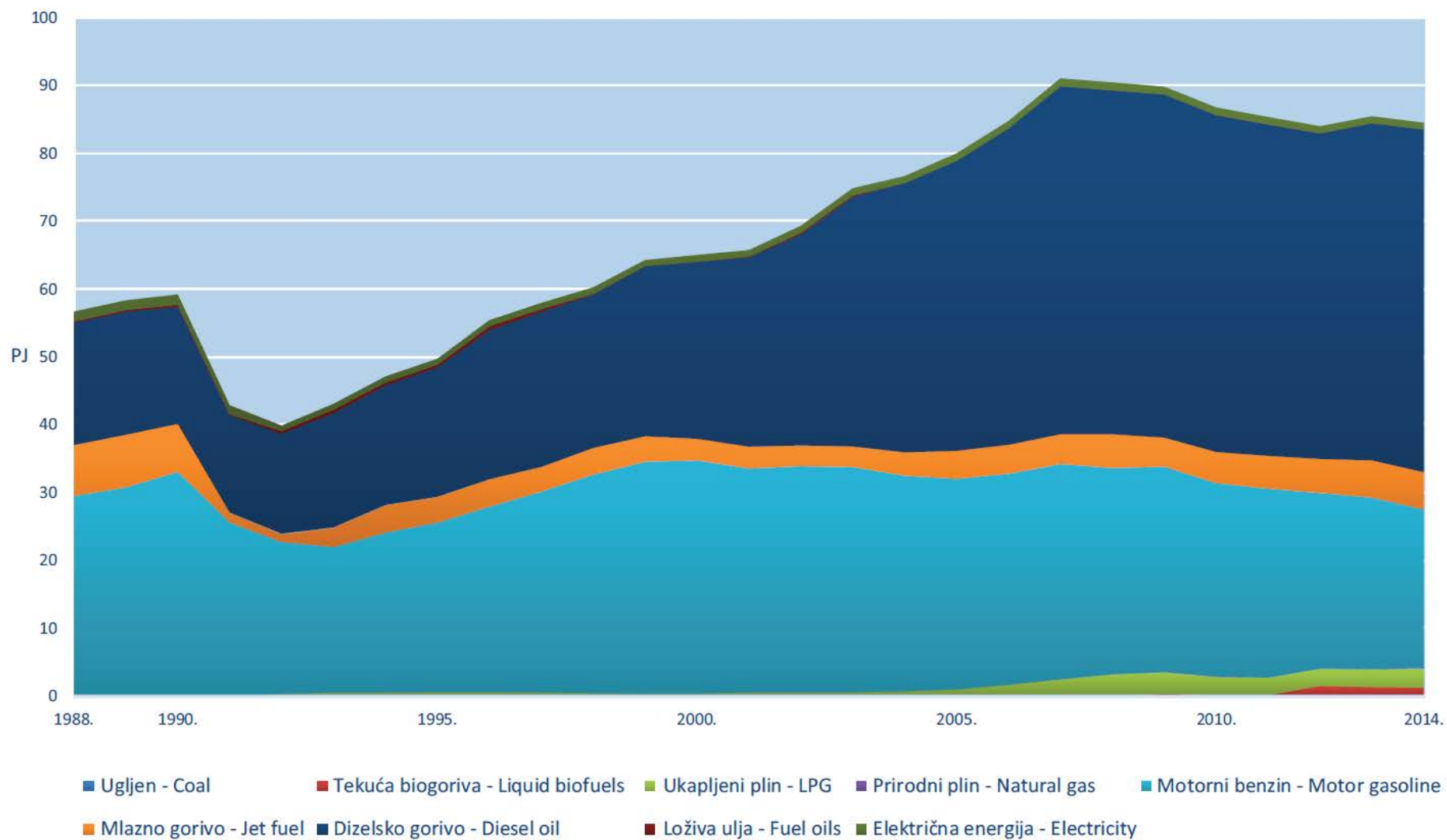
Izvor | Source: EIHP



Slika | Figure 2.4.2. Udjeli u ukupnoj potrošnji energije | Shares in total primary energy supply
Izvor | Source: EIHP



Slika | Figure 2.4.3. Ukupna potrošnja energije po stanovniku | Total primary energy supply per capita
Izvor | Source: EIHP

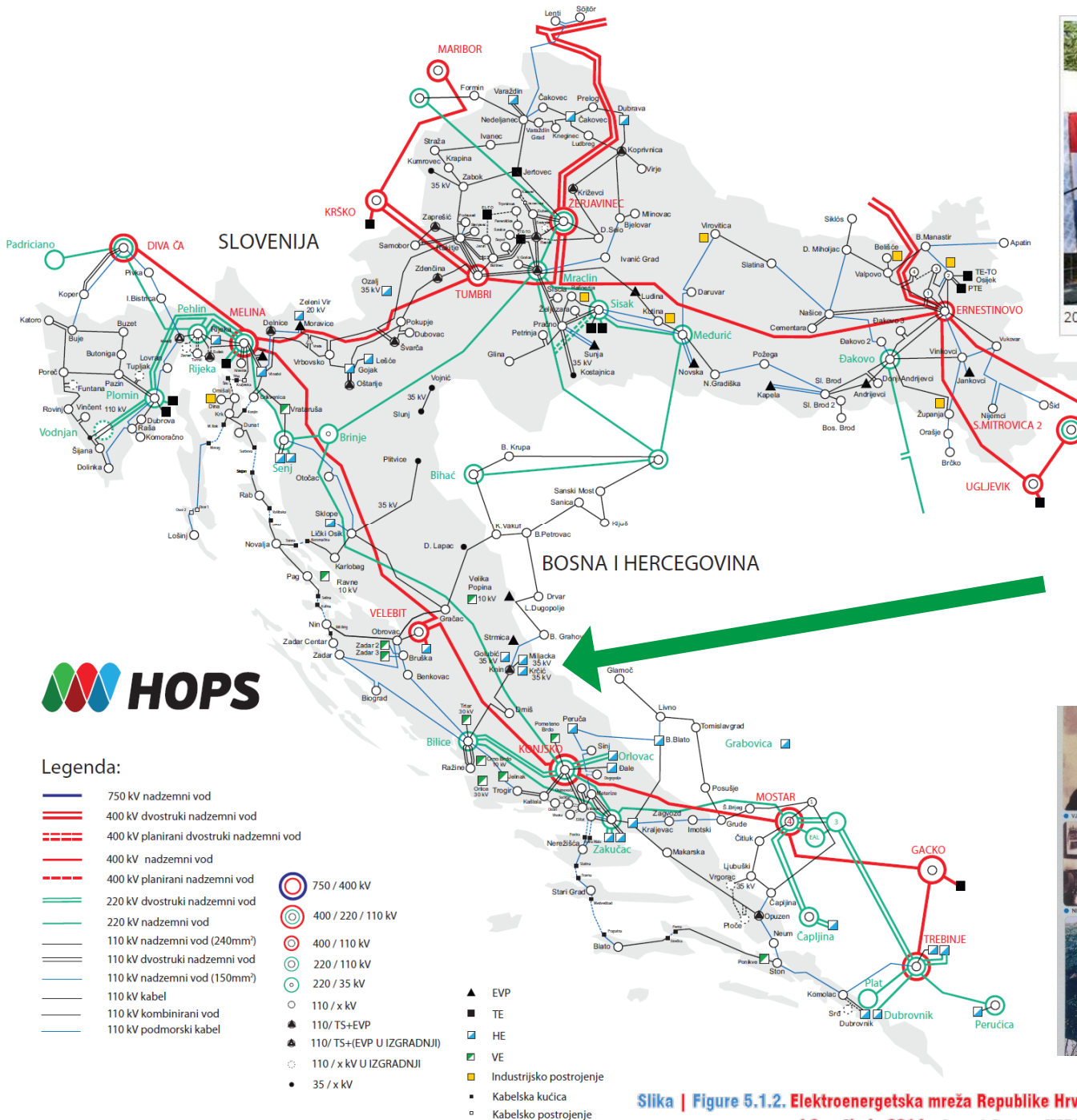


Slika | Figure 2.13.1. Potrošnja energije u prometu | Final energy consumption in transport

Izvor | Source: EIHP



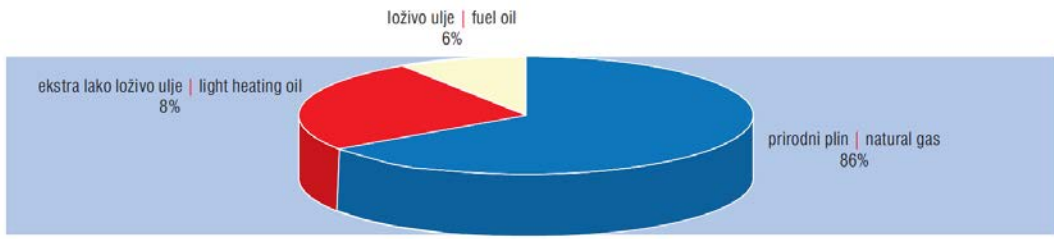
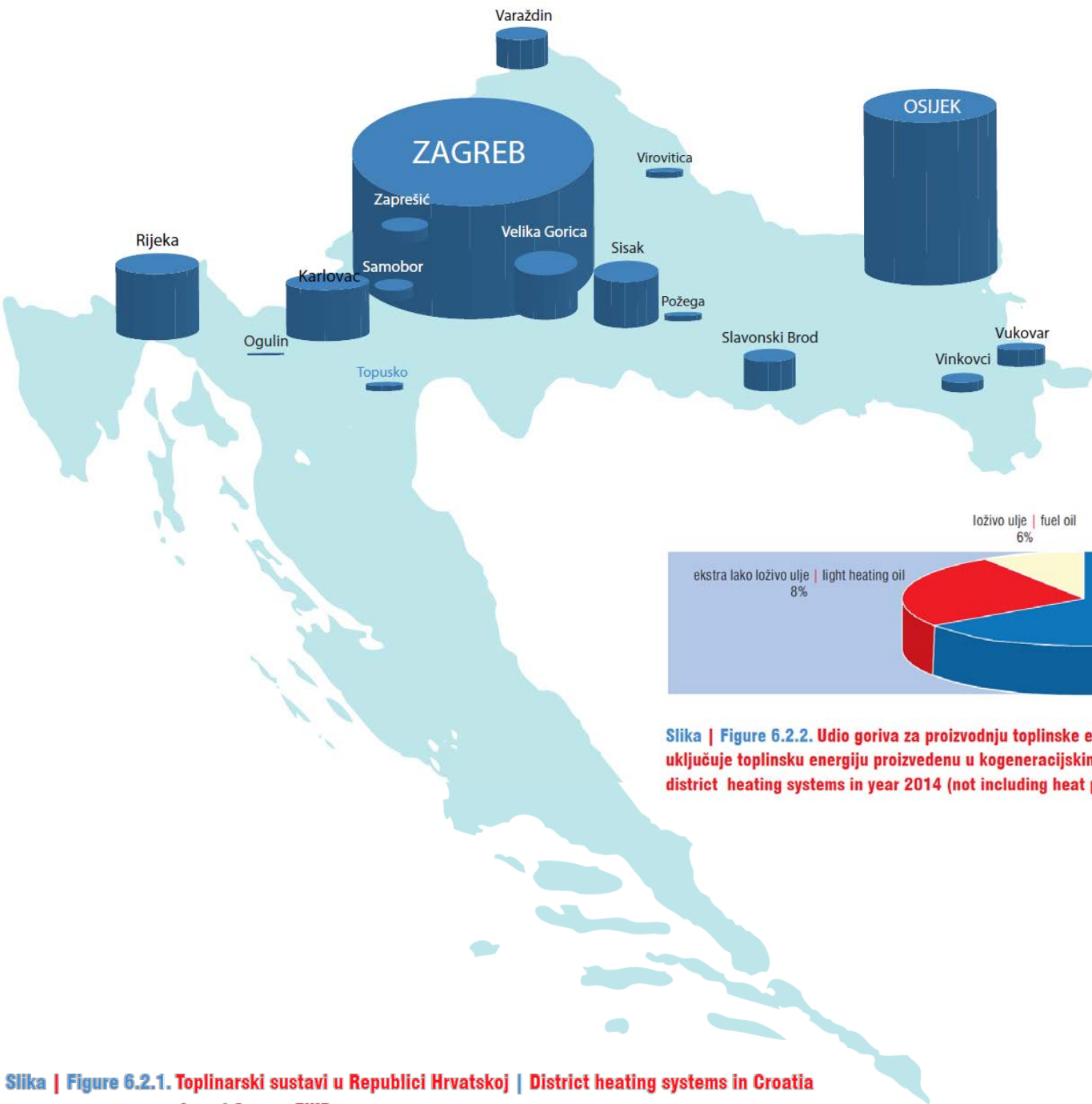
Slika | Figure 4.2.3. Plinski transportni sustav u Republici Hrvatskoj | Transport system of natural gas in the Republic of Croatia – Izvor | Source: PLINACRO



28 August 1895
Krka-Šibenik power system
 was one of the first commercial power systems and one of the first integrated multiphase alternating-current systems in the world

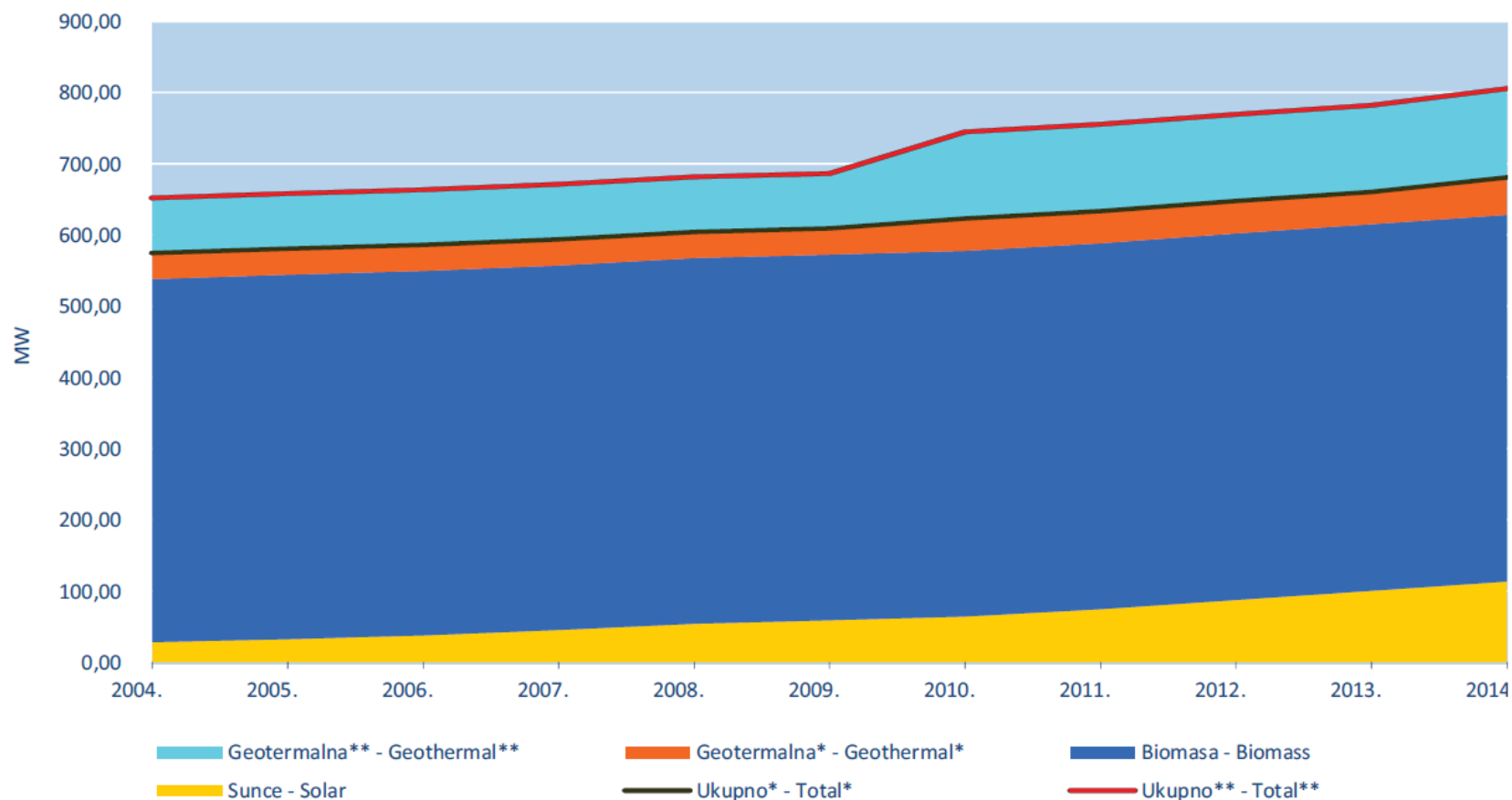


Slika | Figure 5.1.2. Elektroenergetska mreža Republike Hrvatske u 2014. godini | Electric network of the Republic of Croatia in 2014 – Izvor | Source: HOPS | H-TSO



Slika | Figure 6.2.2. Udio goriva za proizvodnju toplinske energije u toplinarskim sustavima u 2014. godini (ne uključuje toplinsku energiju proizvedenu u kogeneracijskim postrojenjima) | Fuel share for heat production in district heating systems in year 2014 (not including heat produced in CHP plants) - Izvor | Source: EIHP

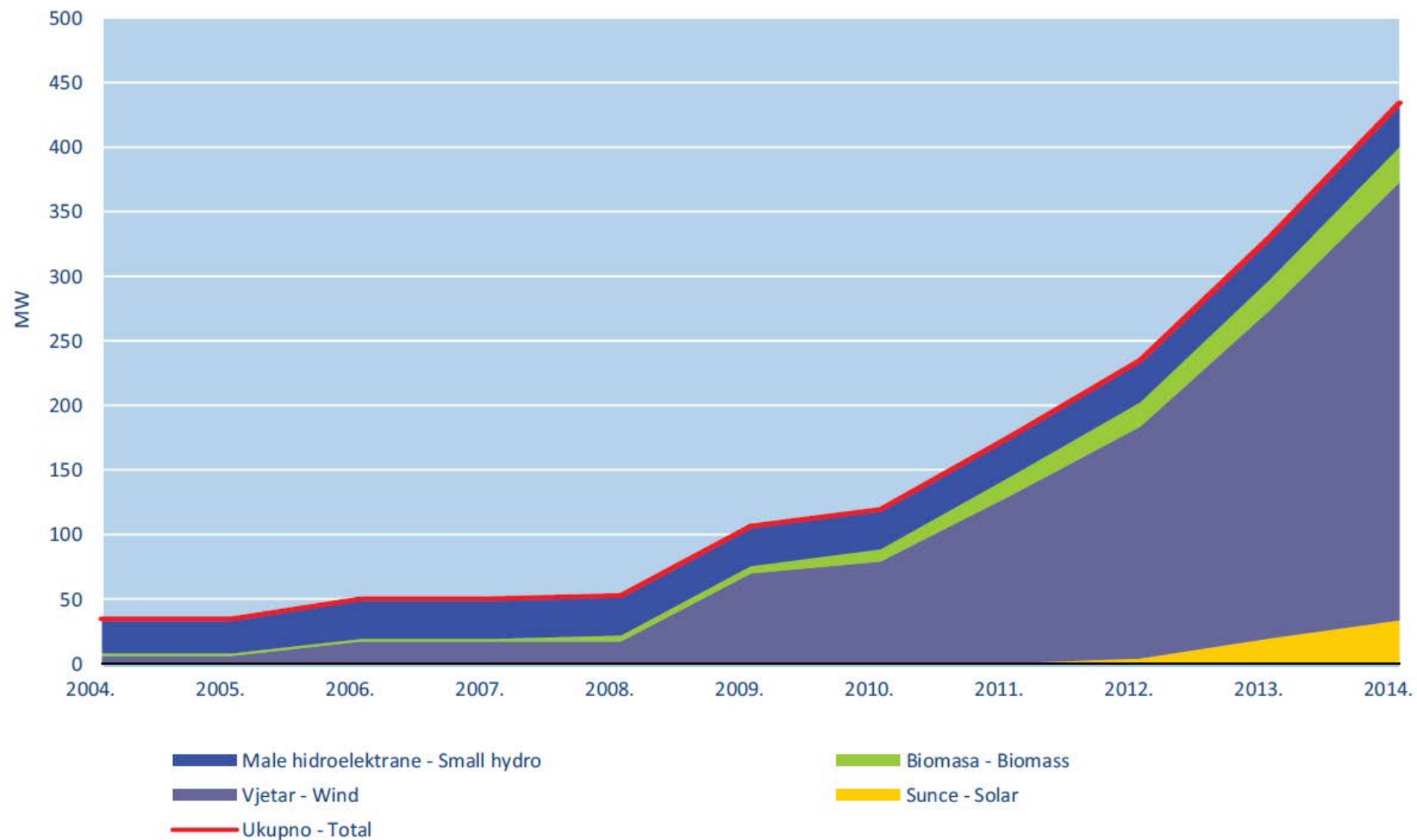
Slika | Figure 6.2.1. Toplinarski sustavi u Republici Hrvatskoj | District heating systems in Croatia
Izvor | Source: EIHP



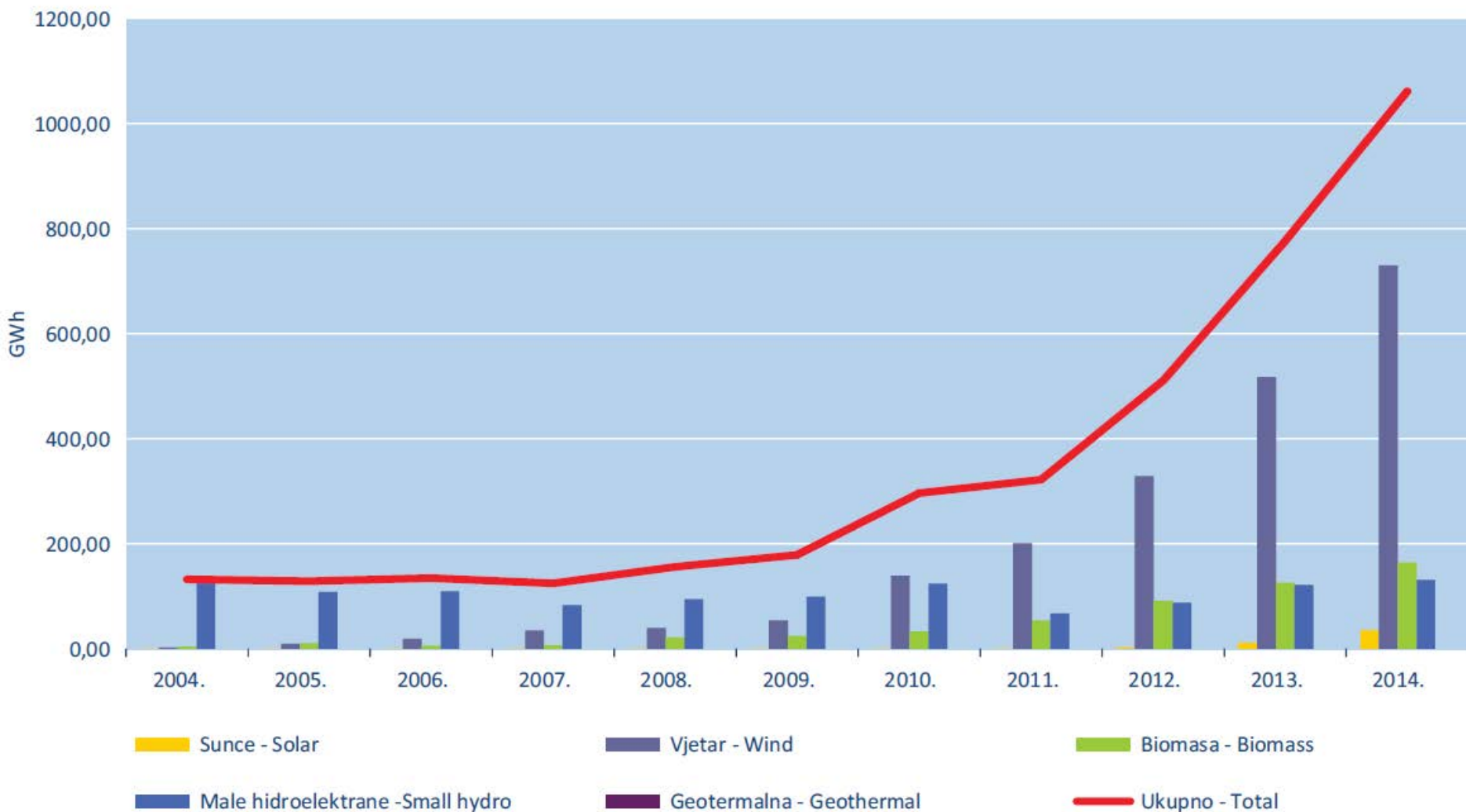
* geotermalna toplinska energija za grijanje prostora | geothermal heat for space heating

**uključujući i geotermalnu toplinsku energiju za grijanje tople vode za kupanje | including geothermal heat for hot water and bathing

Slika | Figure 8.2.1. Instalirani kapaciteti za proizvodnju toplinske energije iz obnovljivih izvora u Hrvatskoj | Installed capacities for RES-H generation in Croatia – Izvor | Source: EIHP



Slika | Figure 8.2.2. Instalirani kapaciteti za proizvodnju električne energije iz obnovljivih izvora u Hrvatskoj |
Installed capacities for RES-E generation in Croatia – Izvor | Source: EIHP



Slika | Figure 8.3.1. Proizvodnja električne energije iz OIE u Hrvatskoj u 2014. godini | RES-Electricity generation in Croatia for 2014 – Izvor | Source: EIHP

Commitments



- **Croatia is a member of the UNFCCC** (United Nations Framework Convention on Climate Change) **since 1996** and signatory to the Kyoto Protocol Annex I and Annex B
- Croatia was committed to reduce greenhouse gas emissions by 5% in the period from 2008 to 2012 – goal achieved!
- Commitments for the second commitment period (2013 – 2020) of the Kyoto Protocol and concrete measures:
 - Reducing greenhouse gas emission by 20% or as a conditional target by 30% by 2020, given the level of emissions in 1990
 - **Reducing greenhouse gas emission by 40%** in the period 2020-2030
 - Achieving the goal of **27% share of renewable energy sources** in the total energy consumption
 - Reforming the emissions trading system (ETS) and preparing national plans
 - **Increasing the energy efficiency**, target by 2030 is **27%**
- European Commission adopted a plan to transform the Union into a competitive low-carbon economy by 2050, which aims at **reducing the greenhouse gas emission by 80-95% by 2050 in relation to 1990**

- LCD Strategy is a strategic document of socio economic development
- Its implementation extends horizontally across many sectors of the economy and activities such as energy, industry, agriculture, forestry and waste management
- It has to take into account sociological peculiarities, political and business culture of stakeholders, existing level of knowledge, awareness and desire to act in the climate change policy

Strengthen the awareness and knowledge



- Are we sufficiently aware of the consequences of global warming or greenhouse effect?
- What does climate change mean for a man and environment in which he lives?
- What is a low-carbon competitive economy and where do EU countries stand today, with regard to the requirements and obligation?
- What are all the legal regulations that have been implemented to mitigate and adapt to climate change?

The Low-Carbon Development (LCD) Strategy provides a comprehensive framework of measures and actions to mitigate and adapt to climate change, taking into account the financial, energy and economic indicators of the country, but also legal obligations of Croatia as a member of the UNFCCC and Kyoto Protocol

Focus on energy efficiency and renewables could create **80,000 jobs** and help to comply with climate change commitments.

The ministry says Croatia has launched numerous energy efficiency and renewables projects to create green jobs and contracts, reduce CO₂ emissions and protect the environment.

- From 2012 to 2015, the **energy renovation of 14,440 family houses** was launched, **worth more than HRK 1 billion**, and of **372 multi-family residential buildings**, worth more than **HRK 380 million**.
- The Environment and Nature Protection Ministry and the Environment and Energy Efficiency Fund have also launched **seven measures for cleaner transportation**, including **subsidies on the purchase of electric and hybrid vehicles**.

Agriculture plays an important role in a low carbon economy through the use of renewables (**biofuels and biomass**) for production.

Some measures with the largest potential in year 2030

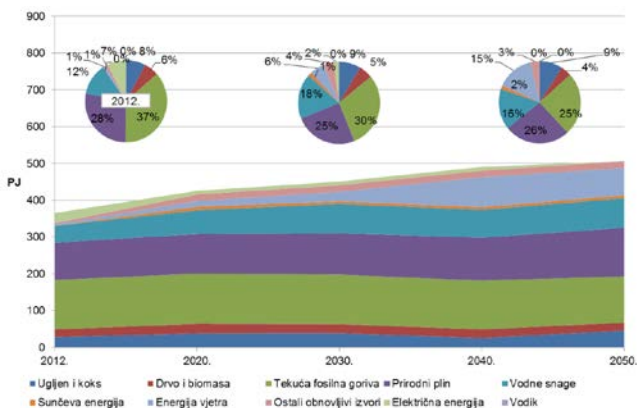


First few measures with largest greenhouse gas emission savings potential

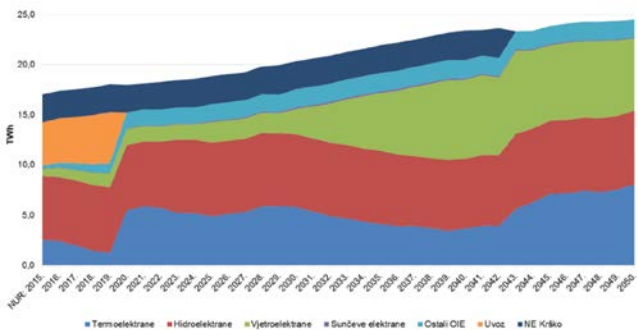
1. Wind power plants	11.6%
2. Deep energy refurbishment of residential buildings	10.0%
3. Energy efficiency measures in industry	7.3%
4. Deep energy refurbishment of non-residential buildings	4.5%
5. Plug-in hybrid cars in transportation sector	3.3%
6. Biofuels in transportation sector	2.8%
7. Solar heat systems in residential buildings	2.7%
8. Heat pumps in buildings	2.6%
9. Intermodal passenger transport	2.2%
10. Solar power plants	2.2%
11. Fuel switch in industry	2.1%

Three scenarios

Low carbon – referent NUR

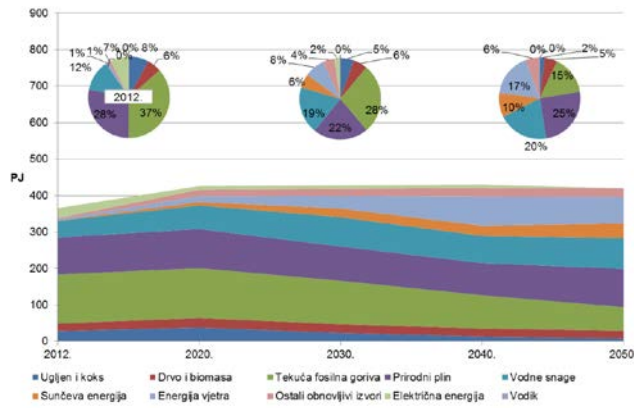


Slika 5.2-1: Ukupna potrošnja energije po gorivima (NUR scenarij)

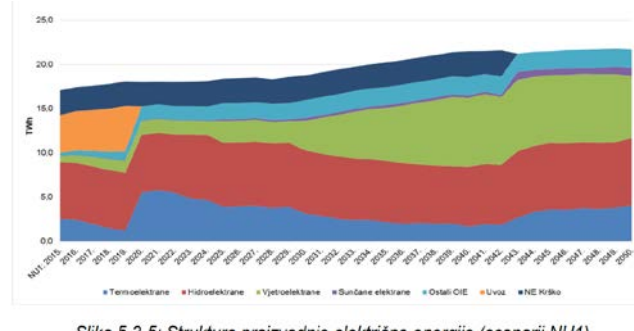


Slika 5.2-5: Struktura proizvodnje (NUR scenarij)

Low carbon – NU1

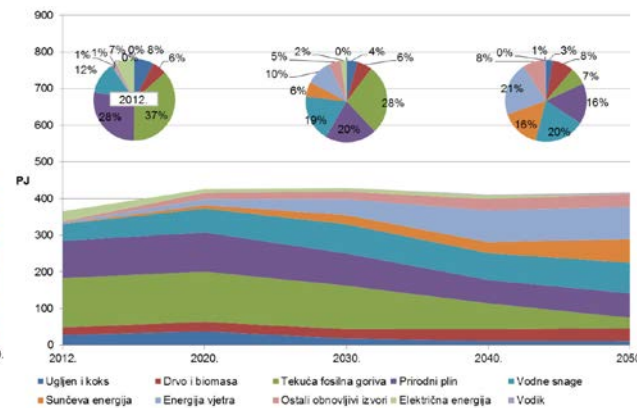


Slika 5.3-1: Ukupna potrošnja energije po gorivima (scenarij NU1)

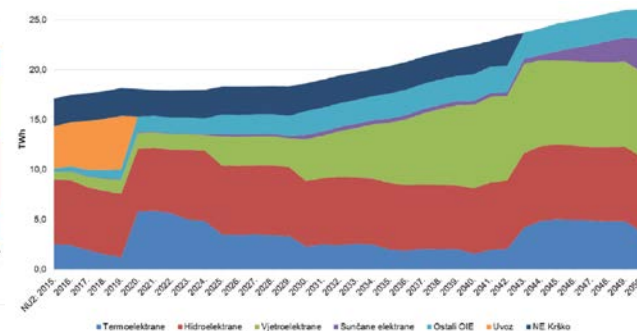


Slika 5.3-5: Struktura proizvodnje električne energije (scenarij NU1)

Low carbon – NU2



Slika 5.4-1: Ukupna potrošnja energije po gorivima (scenarij NU2)



Slika 5.4-5: Struktura proizvodnje električne energije (scenarij NU2)

- Energy efficiency in buildings
- Renewable energy sources for electricity production
- Efficient transport, subsidies for electric vehicles
- Combined heat and power systems (biomass and biogas)
- Solar energy systems for heating
- Development of smart grids
- Intermodal passenger transport in cities (cycling!)
- Use of agricultural residues and short rotation coppice (SRC)
- Carbon removal by sinks (afforestation and reforestation)

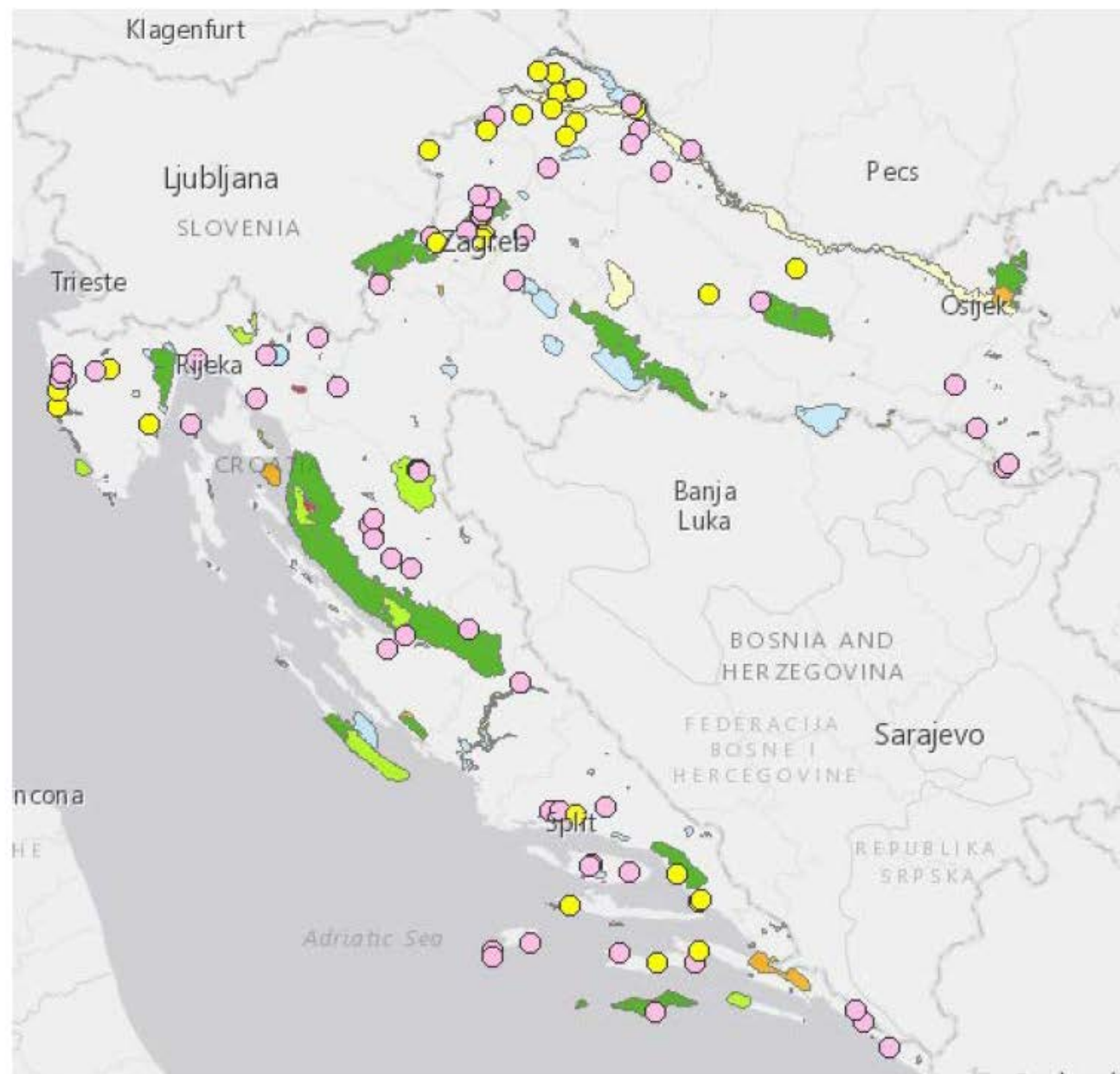
Zaštićena područja RH

ZP_tocke

- park šuma
- posebni rezervat
- spomenik parkovne arhitekture
- spomenik prirode
- značajni krajobraz

ZP_poligoni

- nacionalni park
- park prirode
- park šuma
- posebni rezervat
- regionalni park
- spomenik parkovne arhitekture
- spomenik prirode
- strogi rezervat
- značajni krajobraz



Source: [Croatian low-carbon Development Strategy](#)

Slika 6.1-2: Zaštićena područja Republike Hrvatske³¹

My view of the future of sustainable energy



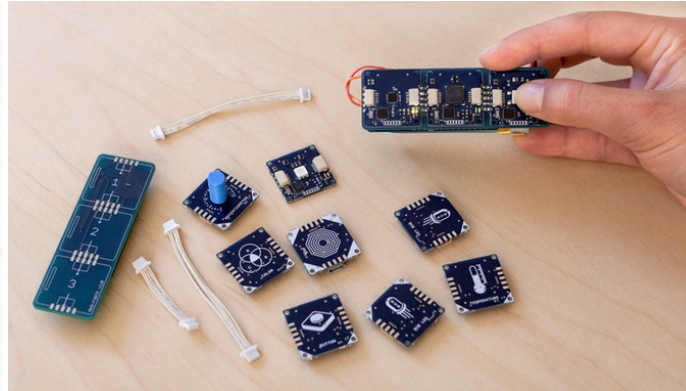
INOVATION

START-UPS

PRIVATE INVESTMENTS



Source: www.solarcity.com



Source: ESLOV IoT Invention Kit

Bill Gates, Mark Zuckerberg & More Than 20 Other Billionaires Launch Coalition To Invest In Clean Energy



Kerry A. Dolan, FORBES STAFF WRITER
I track the world's wealthiest people and their philanthropy. [FULL BIO](#)



Bill Gates (Photo by J. Cozzolino/WireImage)

A day before the start of the United Nations climate talks in Paris, Bill Gates is announcing the Breakthrough Energy Coalition, a group of more than 20 billionaires who have agreed to invest in innovative clean energy. "Our primary goal with the Coalition is as much to accelerate progress on clean energy as it is to make a profit," Gates says in a post on his website.

Gates and world leaders will also be announcing an initiative called Mission Innovation, which Gates describes as "a commitment by more than ten countries to invest more in research on clean energy." The 20 countries include the U.S., Brazil, China, Japan, Germany, France, Saudi Arabia, South Korea and many others. Each country pledges to double government investment in clean energy innovation and to be transparent about its clean energy research and development efforts.

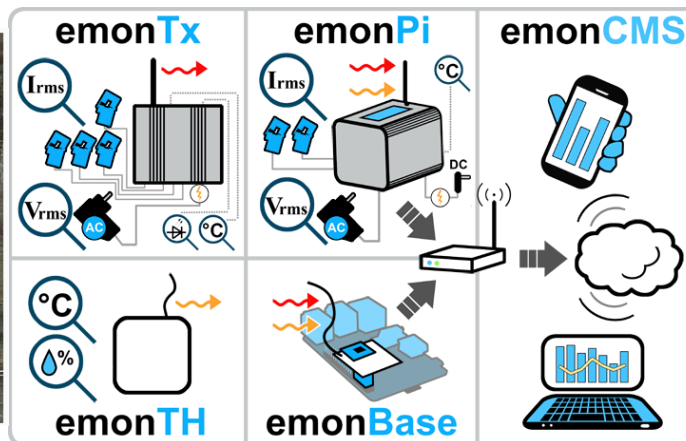
Bill Gates has invested in clean energy in the past, but this is his most public statement to date. He is joined in the Breakthrough Energy Coalition by some billionaires who have been outspoken and committed to clean energy, including former hedge fund manager Tom Steyer and venture capitalists Vinod Khosla and John Doerr; all three men live in California. The coalition also includes members not closely tied to clean energy, including Nigerian cement titan Aliko Dangote (who is also Africa's richest man), Indian industrialist Mukesh Ambani and Chinese e-commerce mogul Jack Ma, the CEO of Alibaba.

On his Facebook page, Facebook founder and CEO Mark Zuckerberg writes, "Priscilla and I are joining Bill Gates in launching the Breakthrough Energy Coalition to invest in new clean energy technologies."

Update Nov. 30, 6pm ET: Bill Gates told CNN that some of the coalition members will invest directly in energy technologies and others will invest through a fund that the coalition will create. Gates said that other people will likely join the coalition. Gates expects the coalition to fund over 100 companies over the next decade.



Source: www.tesla.com/gigafactory



Source: www.openenergymonitor.org

Source: www.breakthroughenergycoalition.com

Disruptors

Incumbents

Transport

Automotive
Sector

Shopping

Hotels

Banking

Music
industry

Mobile
Communication

Disruptors

UBER



Source: The World Energy Council and Accenture Strategy

Thank you!

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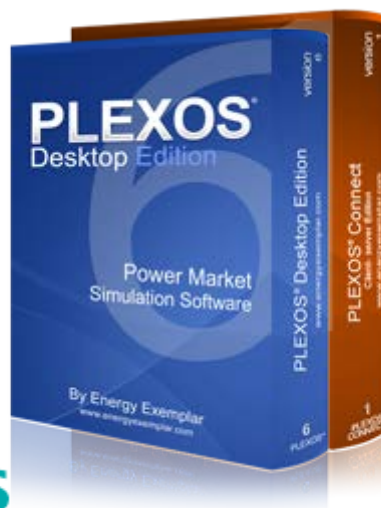
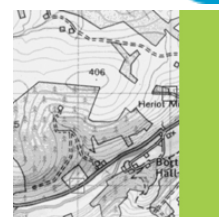
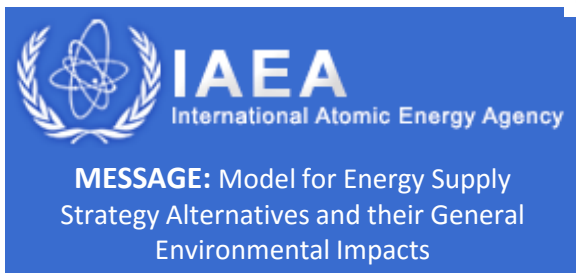
- 
- A world map with several countries highlighted in red, including Mexico, Brazil, Argentina, and various countries across Africa, the Middle East, Europe, and Asia.
- electricity
 - oil & gas
 - renewables
 - energy efficiency
 - regulatory

- national strategies
- project feasibility and bankability
- energy balances and statistics
 - corporate restructuring
 - mergers and acquisitions

Expertise



SQL Server



PSS®E

SIEMENS

High-Performance Transmission Planning Application for the Power Industry



International
Organization for
Standardization

RELUX®
light simulation tools

Clients



Partners



Pioneer in integrated consulting services



The energy to lead



RES and EE - EU projects



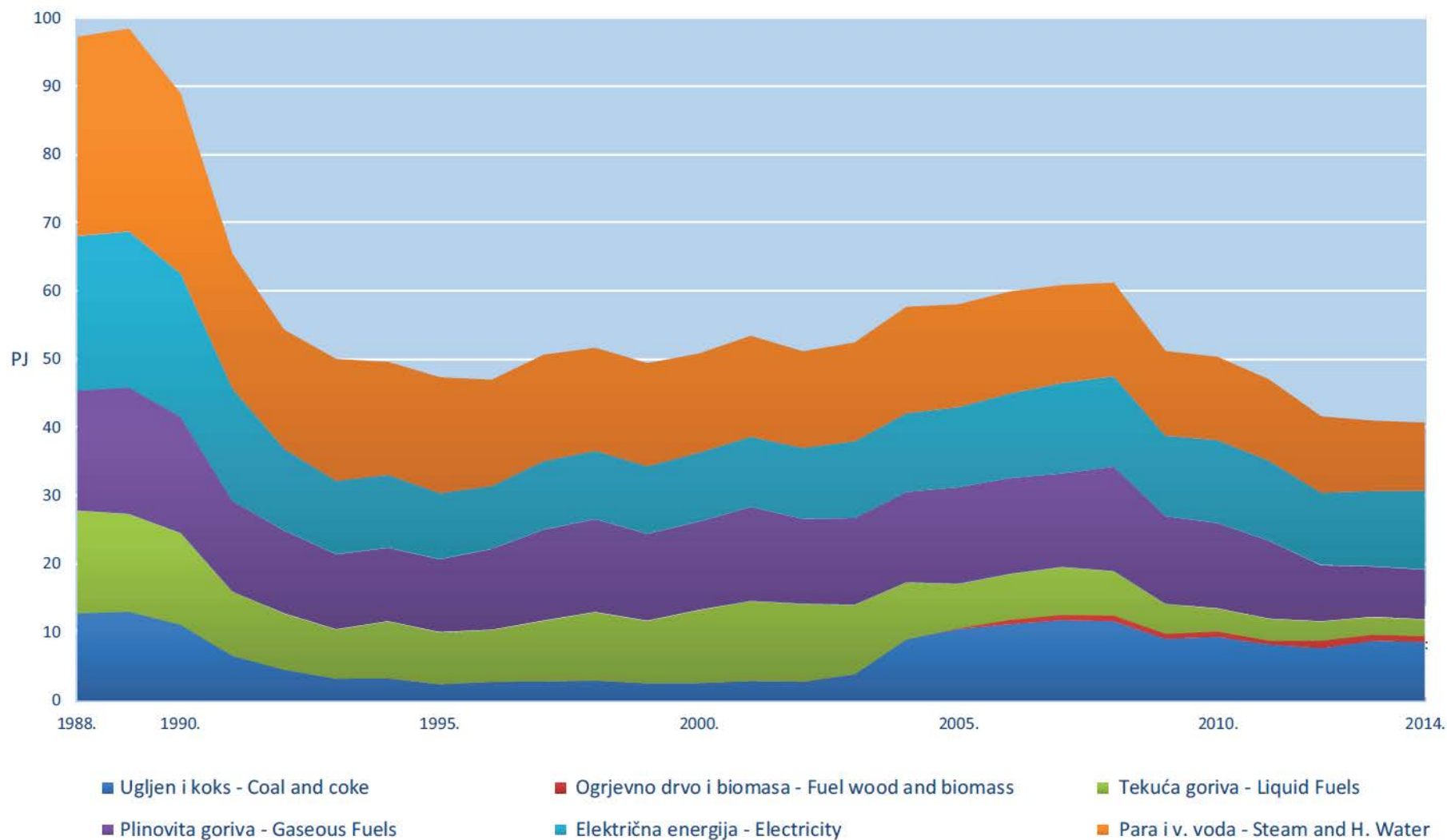
RES and EE - Horizon 2020 projects



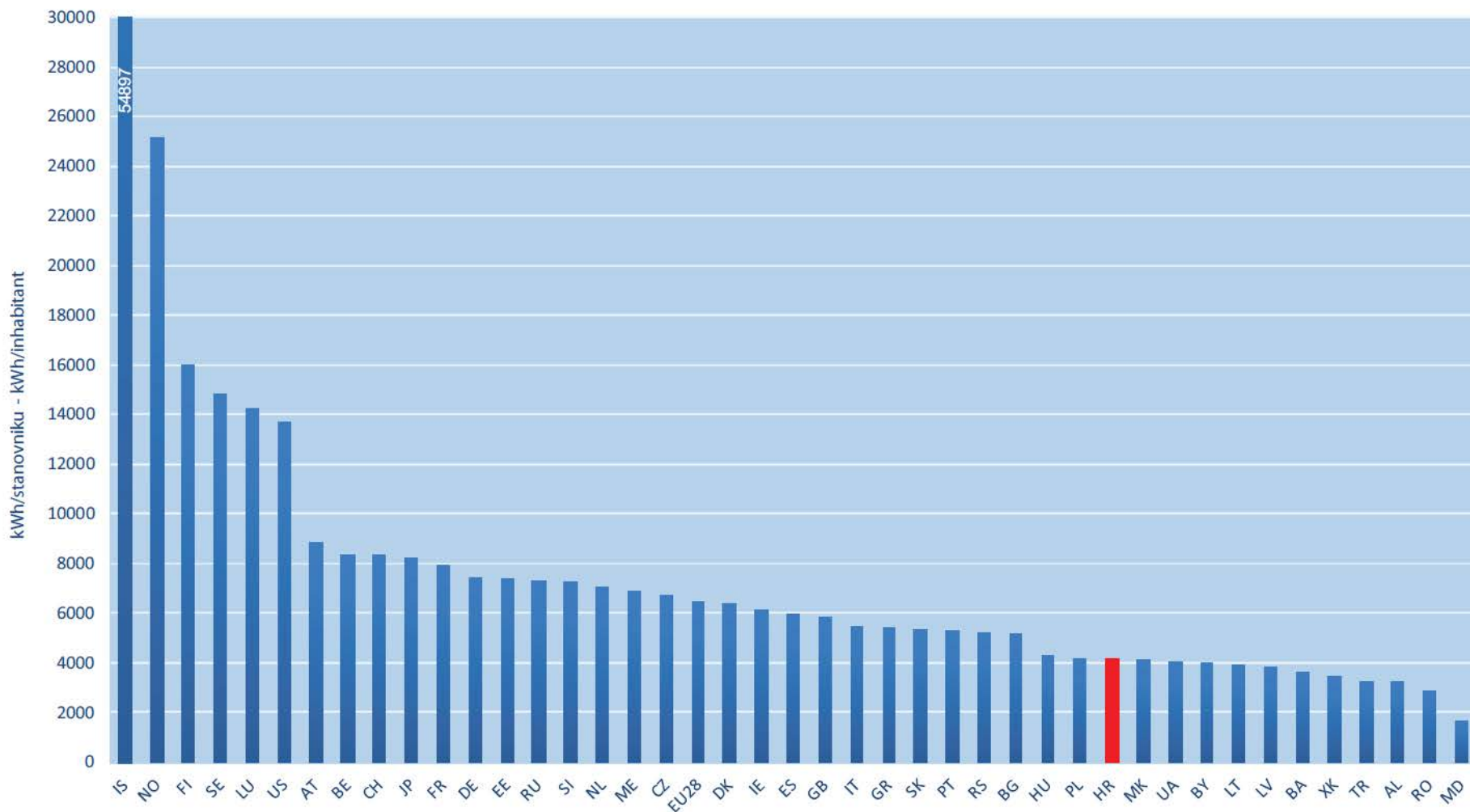
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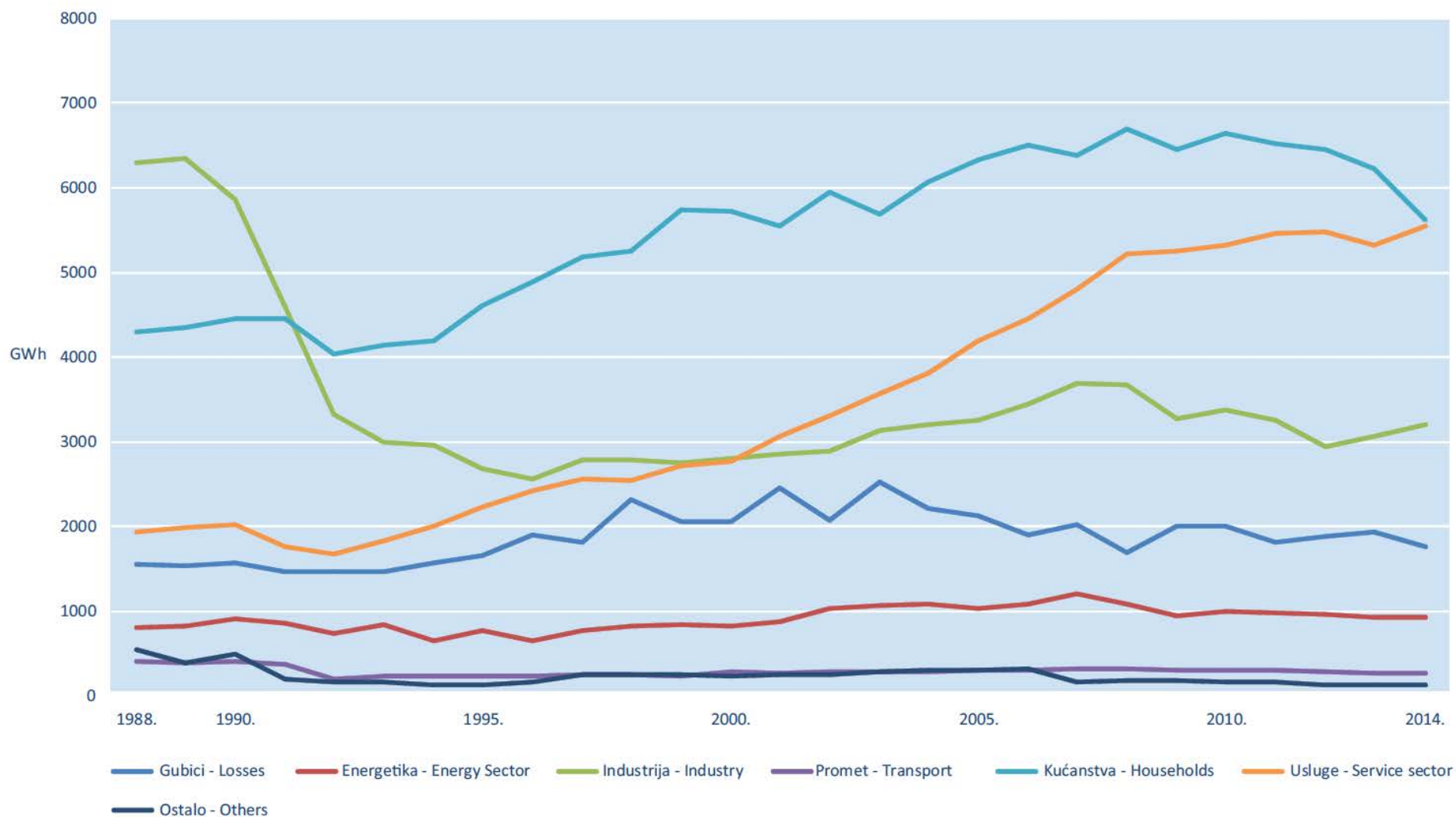


Slika | Figure 2.12.1. Neposredna potrošnja oblika energije u industriji | Final energy consumption in industry by energy forms - Izvor | Source: EIHP



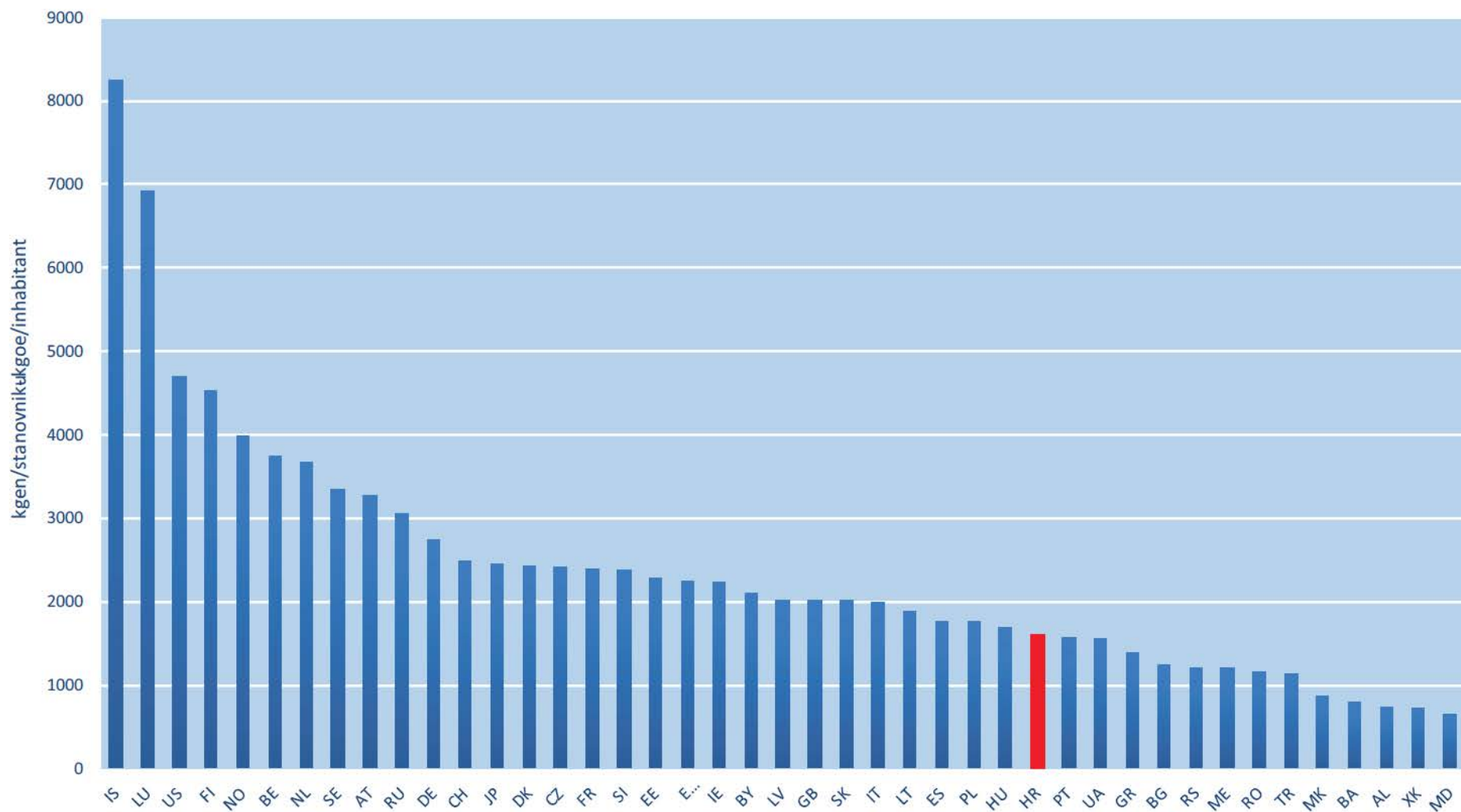
Slika | Figure 2.8.5. Bruto potrošnja električne energije po stanovniku | Gross electricity consumption per capita

Izvor | Source: EIHP



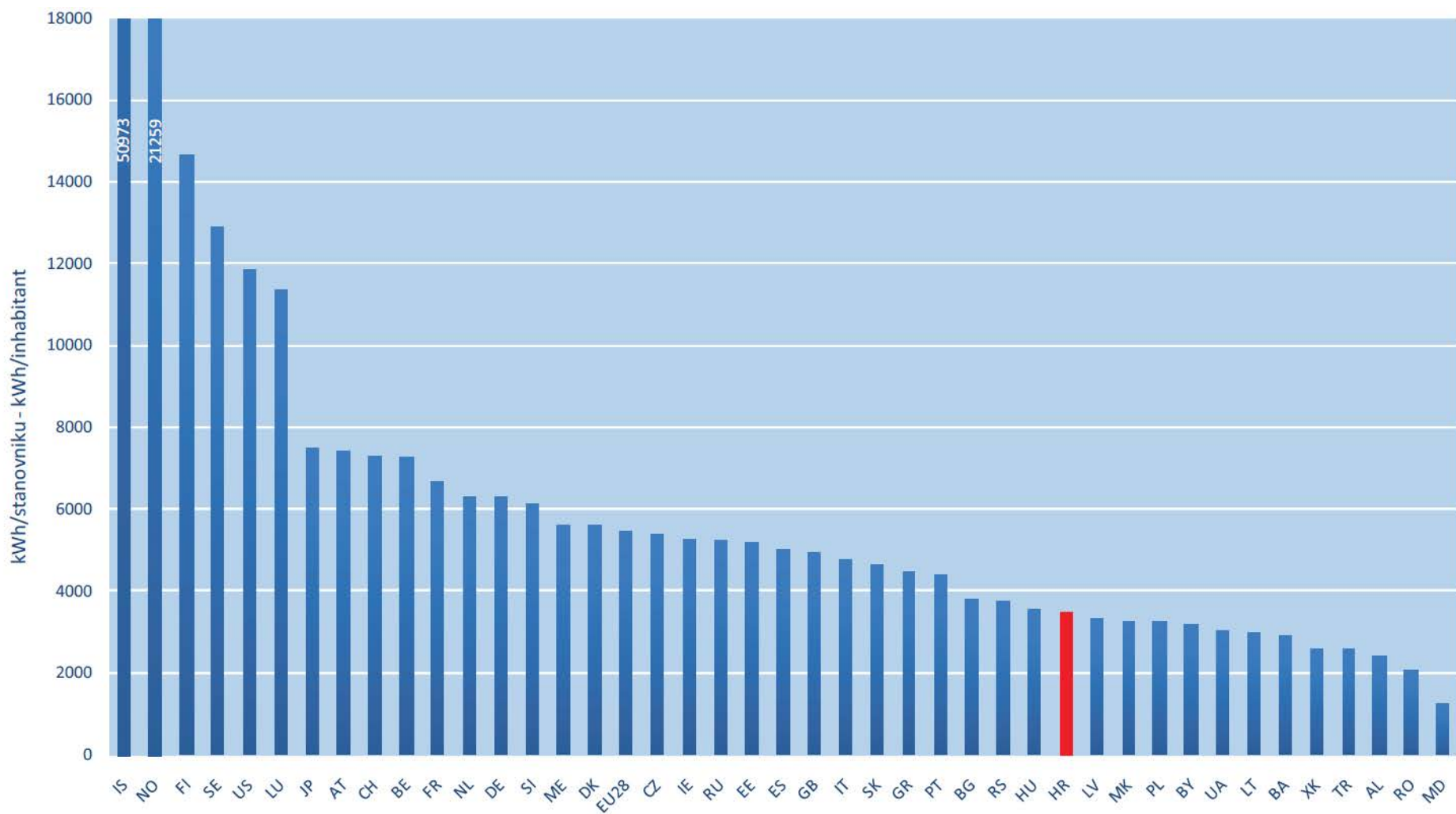
Slika | Figure 2.8.3. Potrošnja električne energije u pojedinim sektorima | Electricity consumption by sectors

Izvor | Source: EIHP

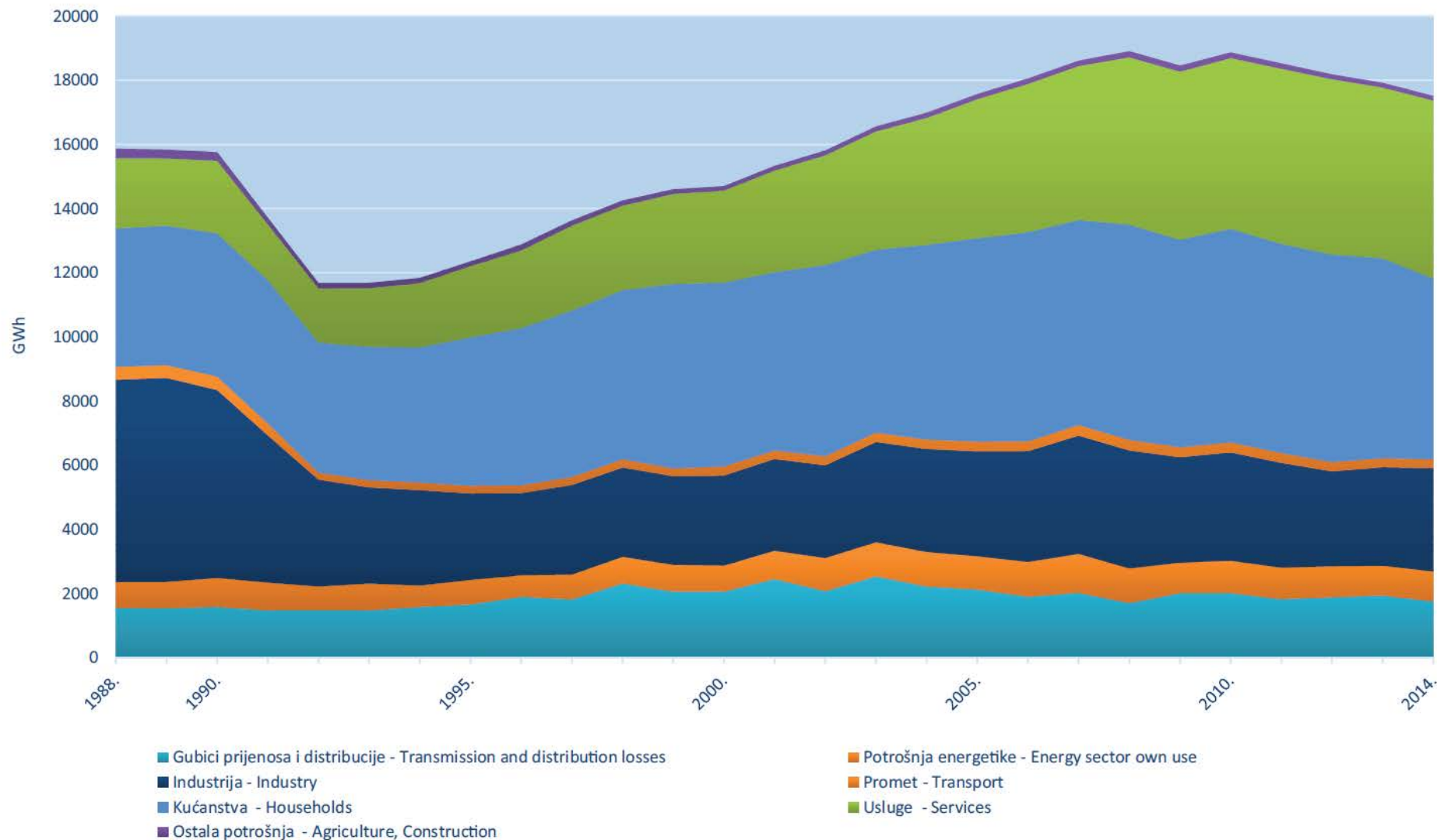


Slika | Figure 2.11.3. Neposredna potrošnja energije po stanovniku | Final energy consumption per capita

Izvor | Source: EIHP



Slika | Figure 2.11.4. Neposredna potrošnja električne energije po stanovniku | Final electricity consumption per capita - Izvor | Source: EIHP



Slika | Figure 5.2.2. Struktura potrošnje električne energije u Republici Hrvatskoj | Electricity consumption in the Republic of Croatia – Izvor | Source: EIHP