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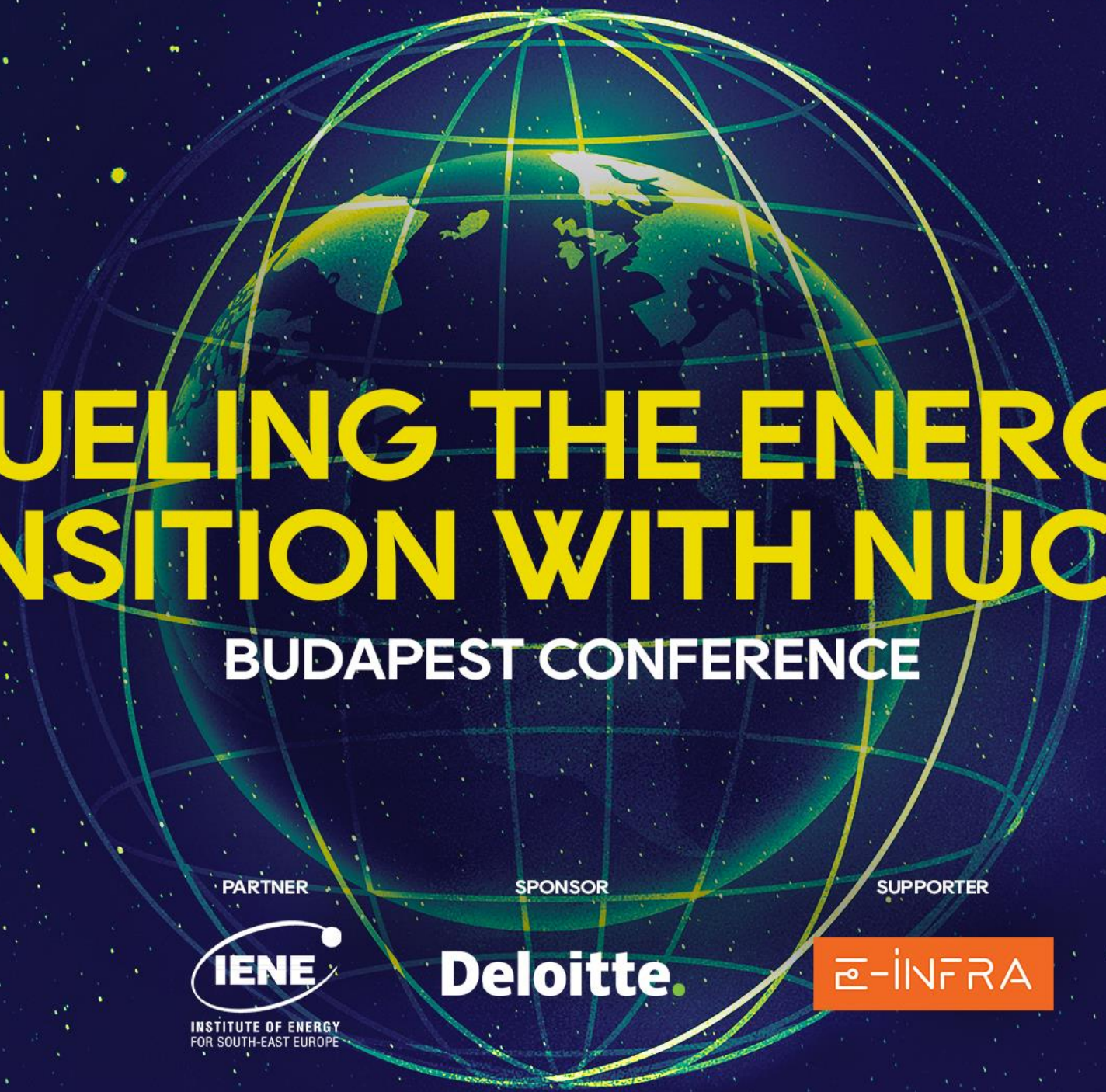

FUELING THE ENERGY TRANSITION WITH NUCLEAR

BUDAPEST CONFERENCE

PARTNER

IENE
INSTITUTE OF ENERGY FOR SOUTH-EAST EUROPE

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SUPPORTER

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Panel 3: The Nuclear Option for South East Europe

Chaired by Costis Stambolis

- Costis Stambolis, Executive Director, Institute of Energy of South East Europe
- Sasa Medakovic, Member of the Management Board, NEK Slovenia
- Ionut Purica, Executive Director, Romanian Advisory Center for Energy and Environment

Fueling the Energy Transition with Nuclear

A New Nuclear Watch Institute (NNWI) Conference
in Partnership with IENE

Budapest, June 20, 2023

The Nuclear Option for SE Europe

A Presentation by Mr. **Costis Stambolis**,
Chairman and Executive Director
Institute of Energy for SE Europe (IENE), Athens

INSTITUTE OF ENERGY
FOR SOUTH EAST EUROPE

The SE European Region Defined

Core countries

- Albania
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Cyprus
- Greece
- Hungary
- Israel
- Kosovo
- Montenegro
- North Macedonia
- Romania
- Serbia
- Slovenia
- Turkey

Peripheral countries

- Austria
- Egypt
- Italy
- Lebanon
- Moldova
- Slovakia
- Syria
- Ukraine

Source: IENE

Why is SE Europe Important?

- SEE is a region of **great strategic interest** to the rest of Europe both in the context of political stability and as an energy viaduct.
- As the latest energy crisis has clearly shown, following Russia's invasion of Ukraine, SE Europe has a major role to play in strengthening the **energy security** of the whole continent.
- In terms of energy consumption, the whole **SEE represents roughly 20% of total European energy consumption** - not an insignificant number.
- Although highly dependent on oil and gas imports, SE Europe has **tremendous potential of higher indigenous energy production**, especially gas, and could become net exporter (see hydrocarbon resources in the Black Sea, Adriatic, Ionian and the East Mediterranean).
- From an economic perspective, SEE, part of Europe's land mass together with Turkey present **serious investment and business opportunities,** especially in the energy sector as IENE's latest "SEE Energy Outlook" has shown (in 2017, the total energy investment potential for the 13-country group was estimated at €234,8 billion whereas in 2022 this figure had been revised upwards at €372,3 billion for the same country group).
- SEE is also **important from a nuclear perspective** since its has a well established network of nuclear power stations with plans already set in motion for further expansion.
- As the region has embarked on its arduous path towards decarbonisation and full decoupling from solid fuels by 2040, nuclear power has a key role to play, in conjunction with RES, **enhancing its move toward clean fuels.**

2020 Basic Energy Data for SE Europe, Including Turkey

Region	Final Oil Consumption (thousand tonnes)	Gas Inland Consumption (bcm/y)	Gross Electricity Production (TWh)
SE Europe	84,737.4 (20.6% of EU-27)	86.5 (21.6% of EU-27)	597.6 (21.4% of EU-27)
EU-27	411,530.4	399.6	2,786

Source: IENE study “SE Europe Energy Outlook 2021/2022”, Athens, 2022

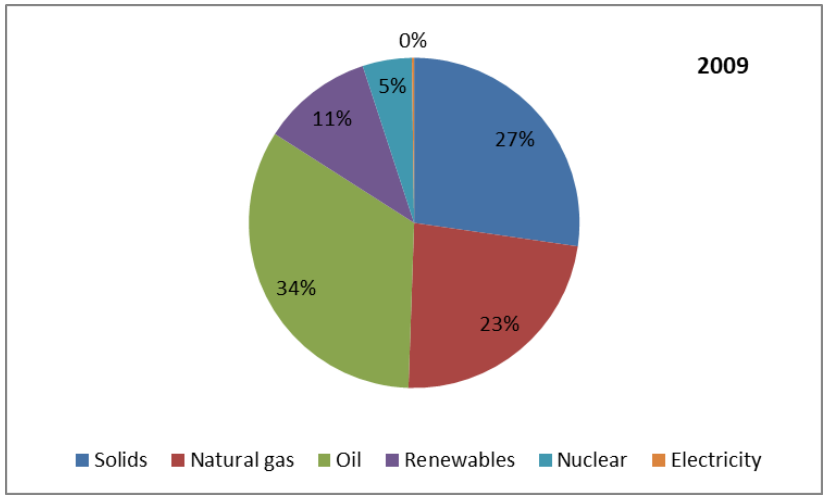
The magnitude of the region’s oil, gas and electricity consumption is not insignificant compared to the total numbers involved at EU level.

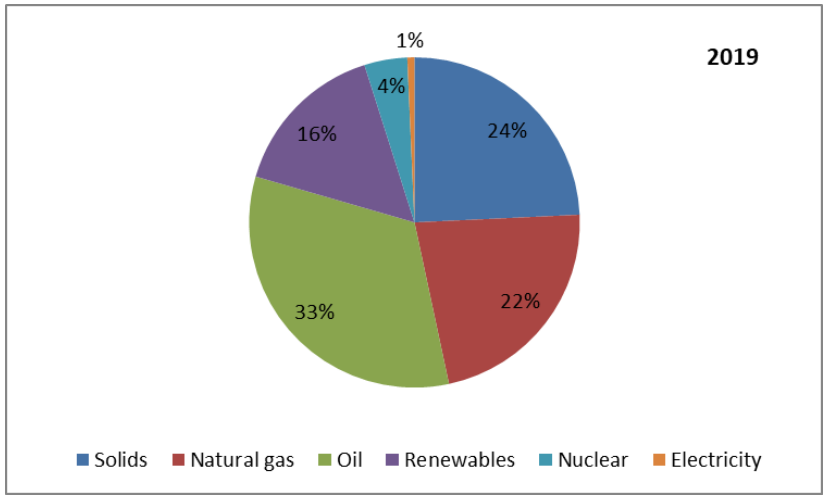
Key Regional Energy Issues

The following stand out as key issues of the regional energy landscape:

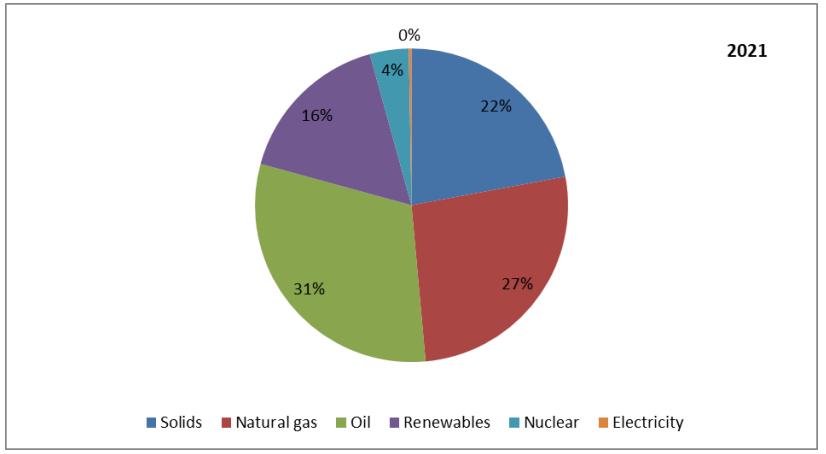
- A more balanced energy mix could be the answer to several key issues (i.e. energy security, decarbonisation)
- High oil and gas import dependence (87% for oil and 82% for gas in 2021)
- SEE's path towards decarbonisation is uncertain and fraught with difficulties
- Coal/lignite is and will continue for sometime to be relevant
- Marked divergence between EU and SEE energy strategies
- RES growth impeded due to past and present policy failures and electricity grid constraints
- SEE is more energy security vulnerable than the rest of Europe
- Gas has emerged as a strategic fuel during latest energy crisis, especially LNG
- Electricity's newcomer gas alters supply balance
- Lack of adequate electricity and gas interconnections
- **Nuclear remains a viable option for SEE power generation**

SE Europe's Energy Mix, Including Turkey, 2009, 2019 and 2021 - High Oil and Gas Import Dependence



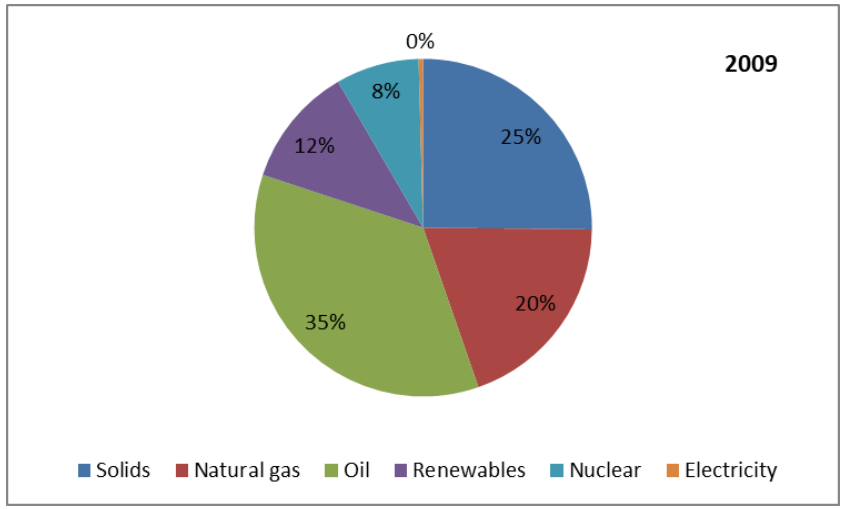


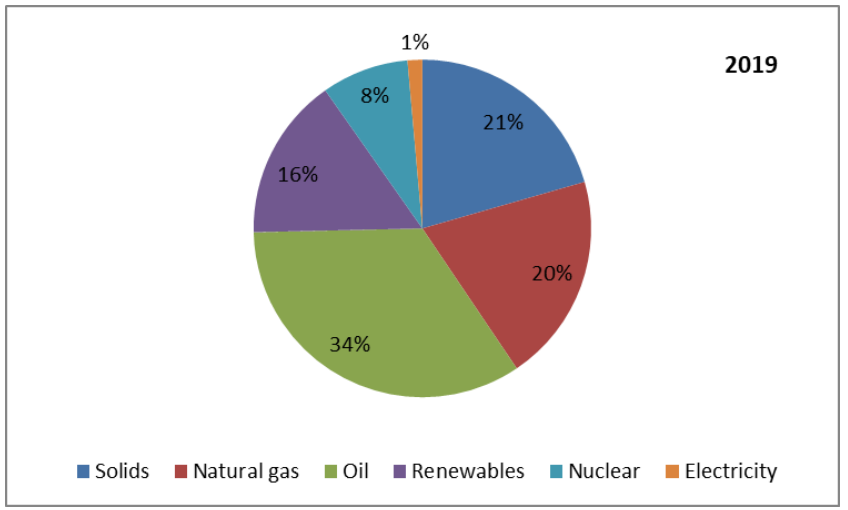
Over the last 10 years, we notice decreased solid fuel use, a marginal increase in gas consumption, a marginal drop in oil use, much higher RES deployment and less nuclear use.



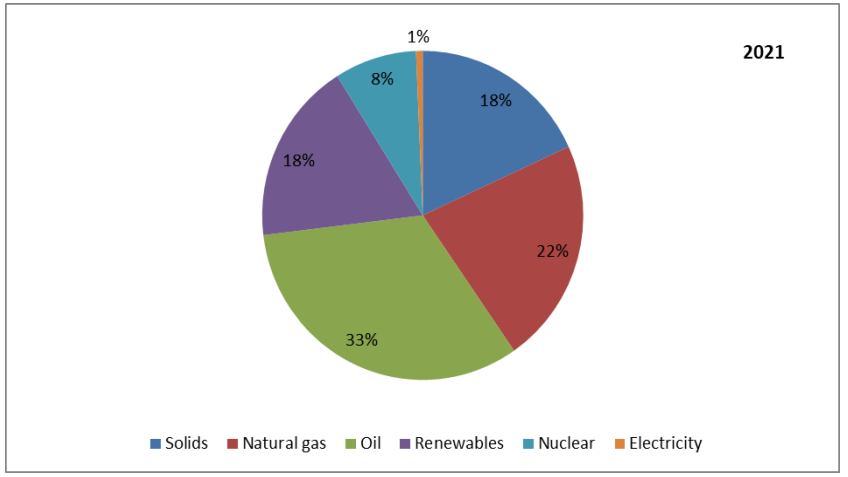
Source: Eurostat

SE Europe's Energy Mix, Without Turkey, 2009, 2019 and 2021 - High Oil and Gas Import Dependence





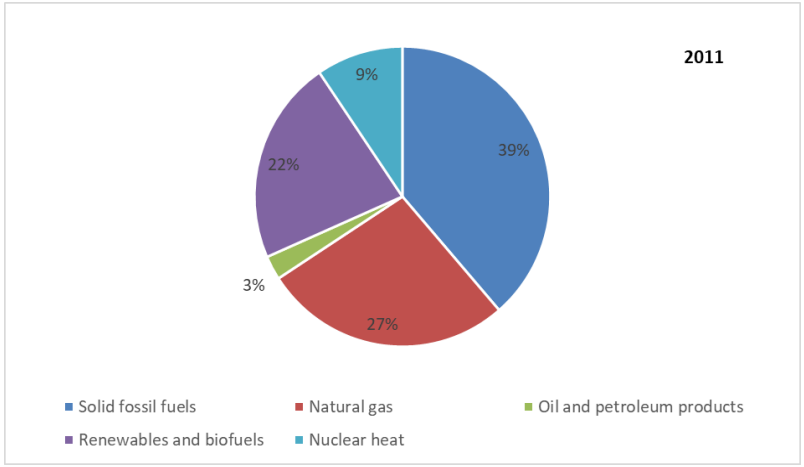
Over the last 10 years, we see considerably less solid fuel use, higher gas consumption, marginally less oil use, much higher RES deployment and steady nuclear use.

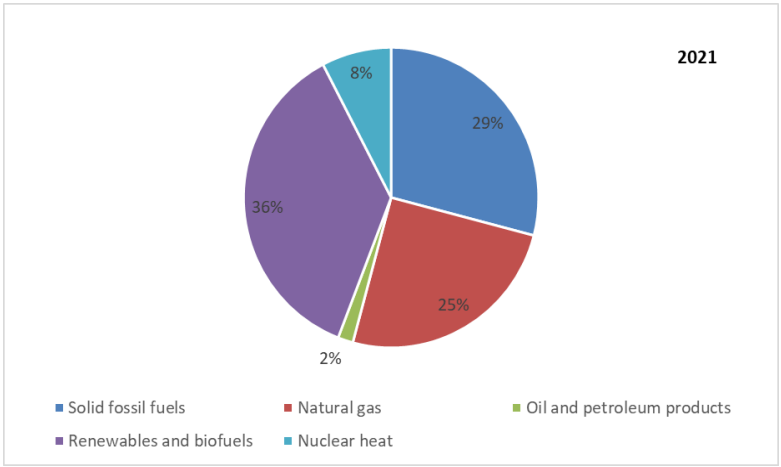


Source: Eurostat

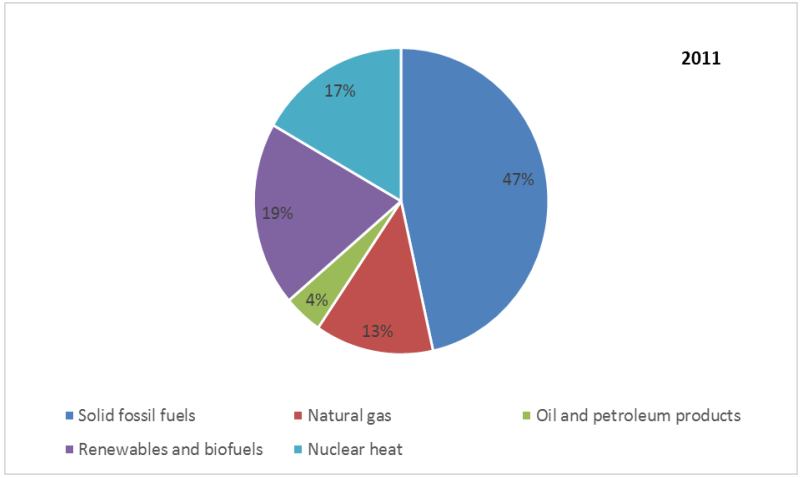
Power Generation Mix per Fuel in SE Europe (2011 and 2021), **With and Without Turkey**

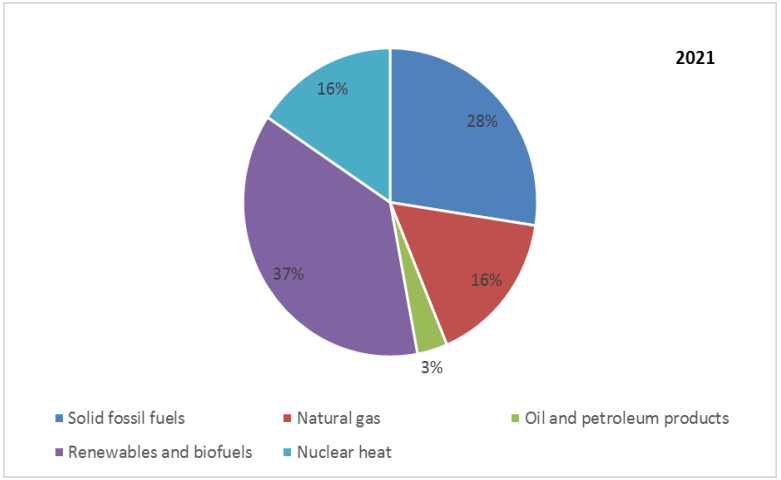
With Turkey





Without Turkey

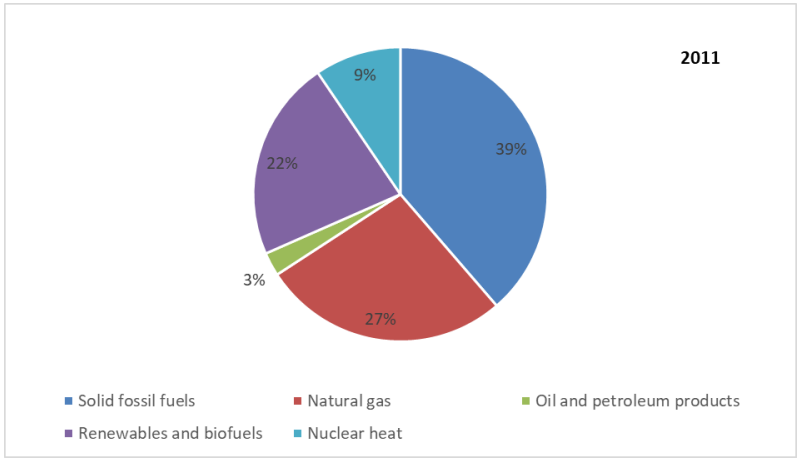


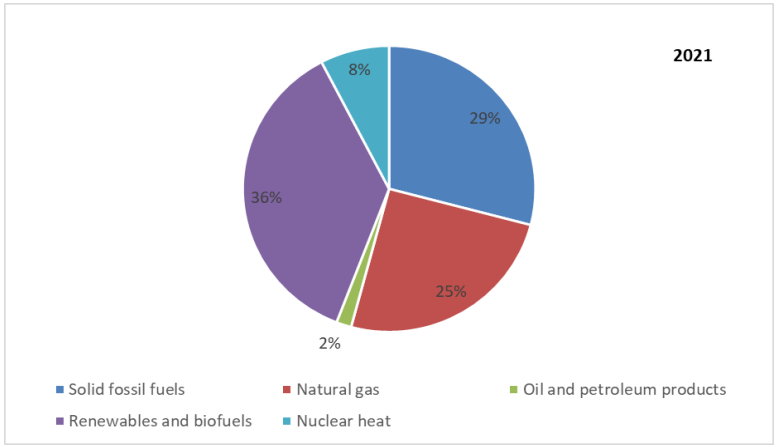


Sources: Eurostat, IENE

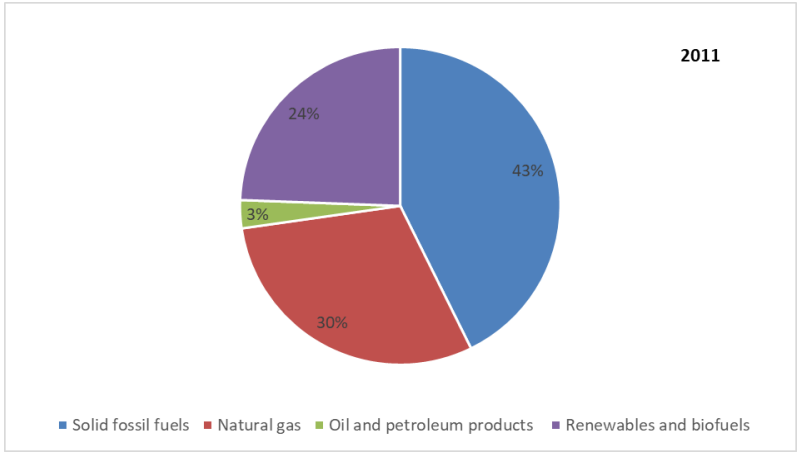
Power Generation Mix per Fuel in SE Europe (2011 and 2021), **Including Turkey and With and Without Nuclear Energy**

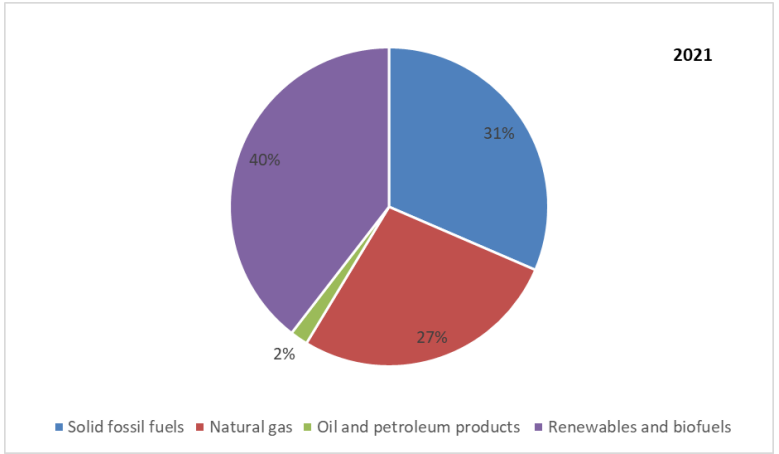
With Nuclear





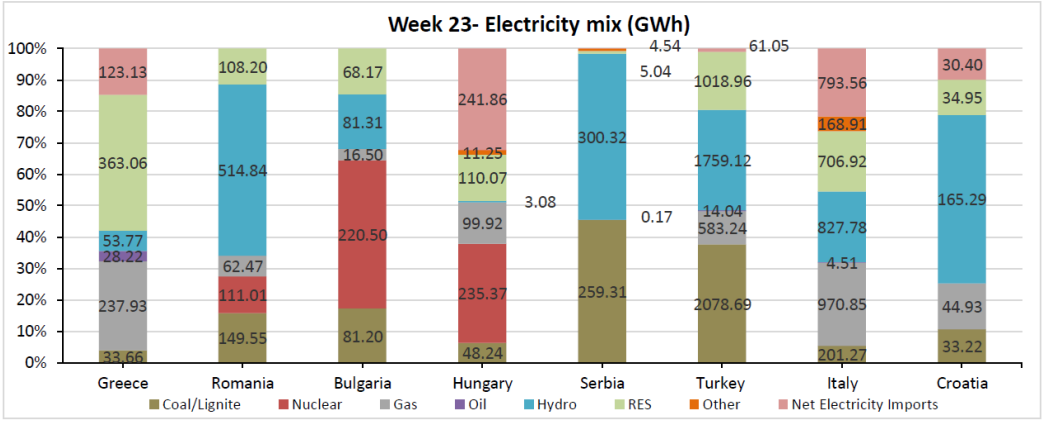
Without Nuclear



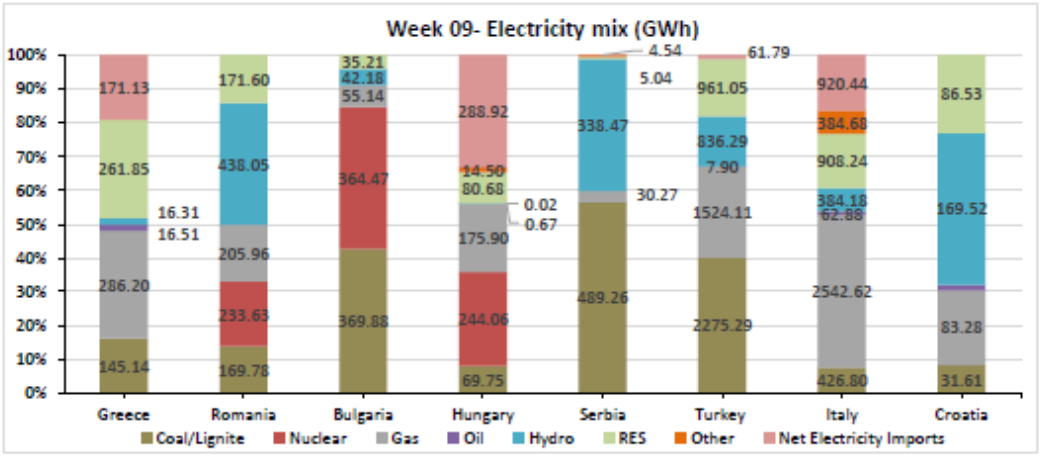


Sources: Eurostat, IENE

Power Generation Mix per Fuel in SE Europe (Week 9 and 23)



Note: (a) Hydro includes also discharges from pumped storage units (b) Net electricity imports of Serbia do not take in account exports towards Kosovo and Metohija (c) Greece's electricity mix includes the RES and conventional oil units of Crete as of Week 44 2021.



Note: (a) Hydro includes also discharges from pumped storage units (b) Net electricity imports of Serbia do not take in account exports towards Kosovo and Metohija (c) Greece's electricity mix includes the RES and conventional oil units of Crete as of Week 44 2021.

Source: IENE

The Nuclear Power Option for SE Europe

- Today, nuclear plants operate in 5 SEE countries (Bulgaria, Romania, Slovenia/Croatia, Hungary) with Turkey a newcomer from May 2023. Between them, they cover 8% of electricity consumption, all of it base load needs. In the context of much needed decarbonisation in SEE, there is huge scope for further power generation from nuclear power.
- On February 2, 2022, the European Commission presented a **Taxonomy Complementary Climate Delegated Act**, which may reignite nuclear projects in SE Europe. There appears to be **limited interest for new nuclear power plants in the region**. Only Romania and Turkey have specific plans.

Source: IENE study "SE Europe Energy Outlook 2021/2022", Athens, 2022

Operational Nuclear Power Plants in SE Europe

Country	Name	Type of reactor	Capacity (MWe)	Operation since
Bulgaria	Kozloduy 5	PWR	1003	1987
	Kozloduy 6	PWR	1003	1991
Hungary	Paks 1	PWR	479	1982
	Paks 2	PWR	477	1984
	Paks 3	PWR	473	1986
	Paks 4	PWR	473	1987
Romania	Cernavoda 1	PHWR	650	1996
	Cernavoda 2	PHWR	650	2007
Slovenia/Croatia	Krsko	PWR	688	1981

Note: Cernavodă NPP in Romania has the only PHWR CANDU reactors operating in Europe. Total capacity stands for 5,896 MWe.

Source: World Nuclear Association

Nuclear Power Plants (Under Construction, Planned and Proposed) in Turkey

Country	Name	Type of reactor	Capacity (MWe)	Start construction	Planned operation
Turkey	Akkuyu 1	VVER	1200	April 2018	In operation
	Akkuyu 2	VVER	1200	April 2020	2024
	Akkuyu 3	VVER	1200	March 2021	2025
	Akkuyu 4	VVER	1200	(2022)	2026
	Sinop 1	ATMEA1	1150	uncertain	-
	Sinop 2	ATMEA1	1150	uncertain	-
	Sinop 3	ATMEA1	1150	uncertain	-
	Sinop 4	ATMEA1	1150	uncertain	-
	Igneada 1-4	AP1000x2, CAP1400x2	2x1250 2x1400	unknown	-

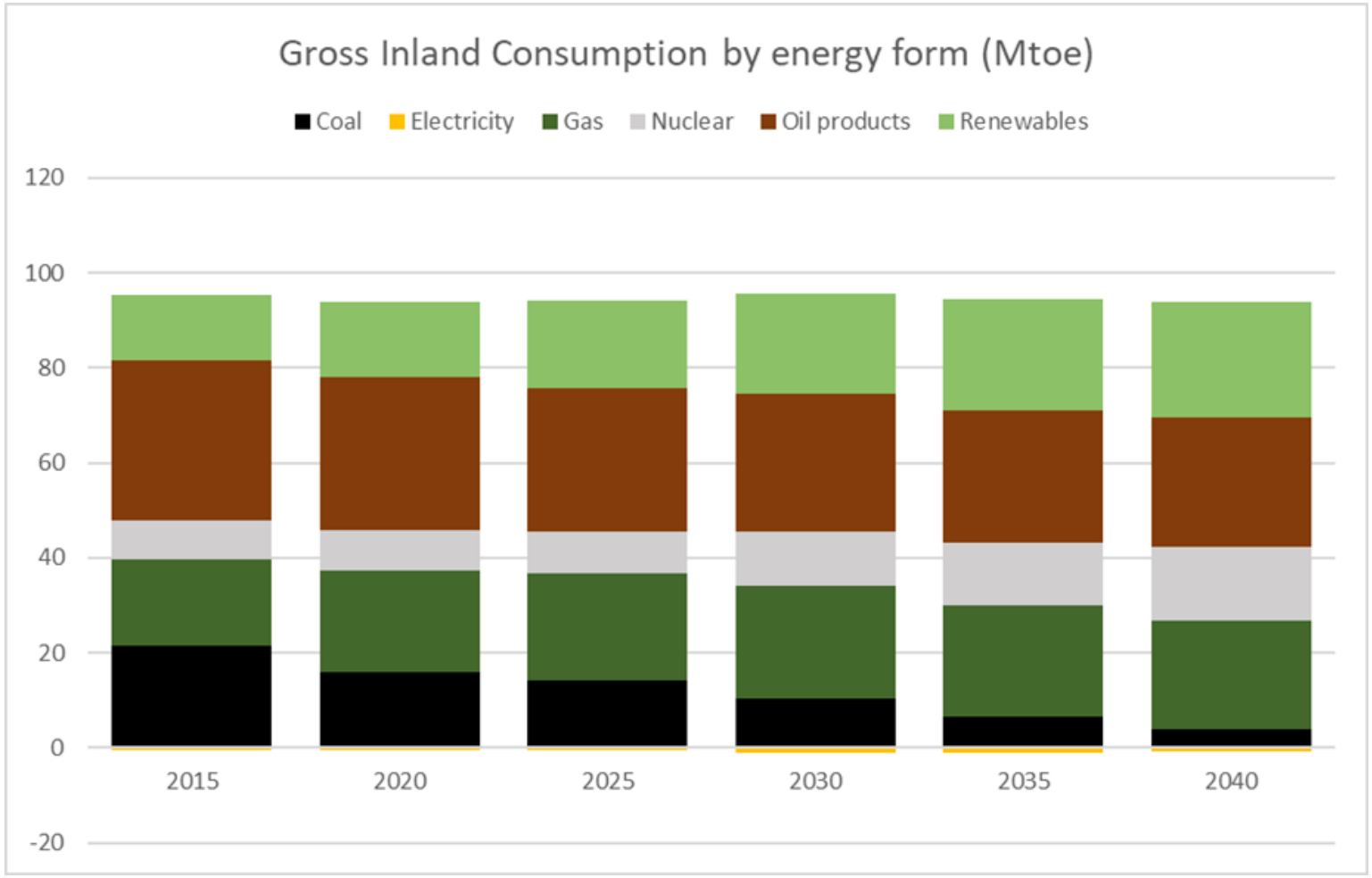
Note: Total capacity stands for 14,700 MWe.

Source: World Nuclear Association

Energy Demand and Supply Scenarios in SEE

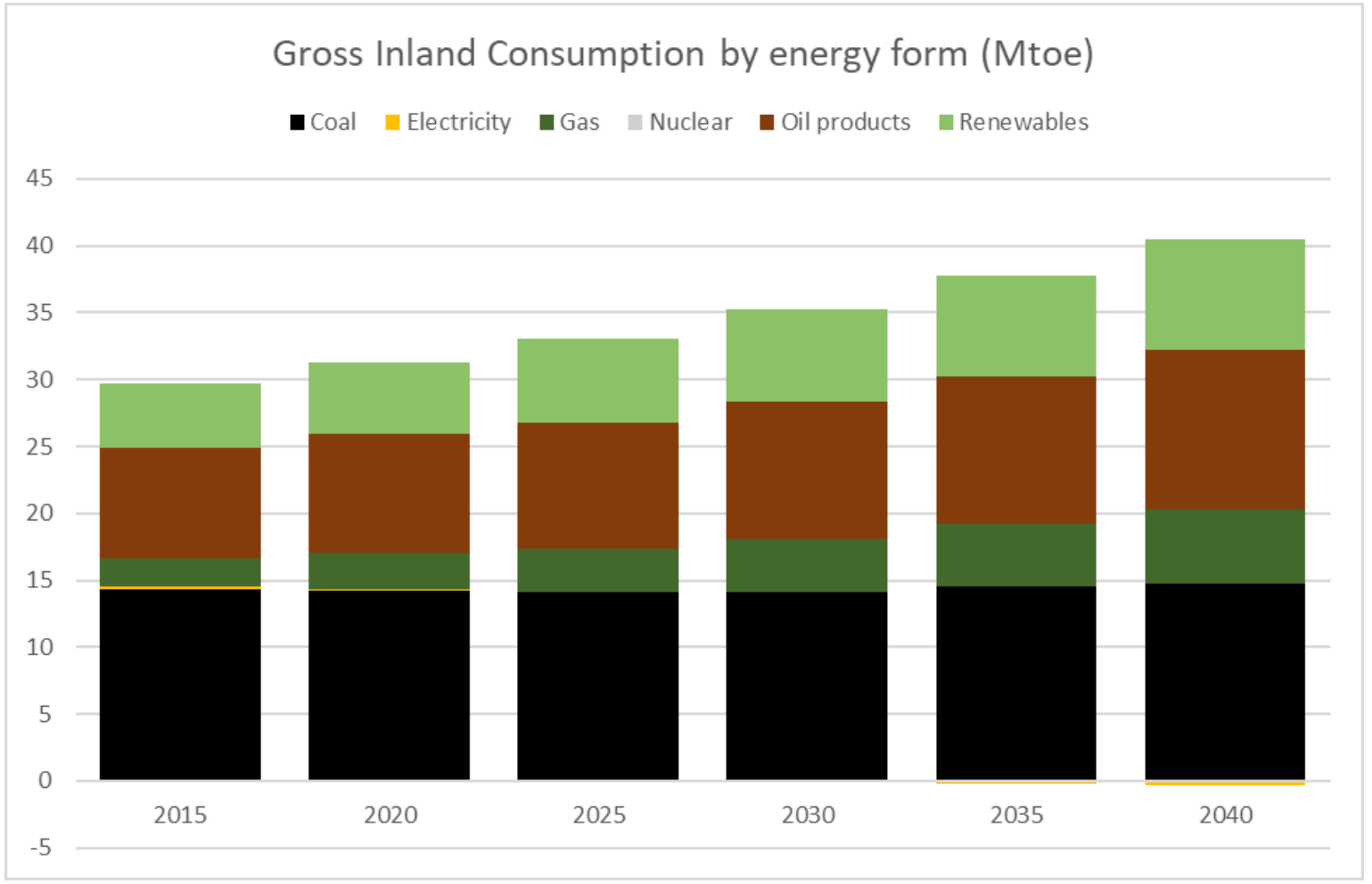
- The projections for the development of the energy systems of the SEE countries under **a "Baseline" scenario** approach was considered appropriate in order to present the possible future pathways paved by current policies.
- The **most recently available studies** and the **official country submissions of strategic documents** (such as the Integrated National Energy and Climate Plans) were used in order to collect and analyse these projections.
- The purpose is to present the evolution of the national energy systems corresponding to a **"where we are heading" storyline**, providing a simple but comprehensive picture of the energy and GHG emissions dynamics under the "current policy" efforts until 2040.
- **Results are presented per Group of Countries - EU Member States, West Balkans and Turkey**
- Looking at the projection of the gross inland consumption in the **EU member states of the SEE region** (Bulgaria, Croatia, Cyprus, Greece, Romania, Slovenia), the overall tendency shows a stabilisation and even a small reduction in the time horizon to 2040.
- The projection of Gross Inland Consumption in the **six Western Balkan countries** (WB6: Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia) presents a rather different story from that of the EU member states in the region.
- In **Turkey**, gross inland consumption is projected to increase by more than 50% between 2020 and 2040. The role of renewable energy is seen to increase notably, reaching 28% of the GIC in 2040, the amount of coal remains at the level of 50 Mtoe with its relative contribution being reduced to 23% in 2040 and the contribution of natural gas is decreased to 17% of the GIC. Nuclear energy appears for the first time in the GIC of Turkey after 2025 with the operation of the Akkuyu nuclear power plant and is increasing until 2050, following the nuclear expansion program of the country.

EU Member States in SEE: Gross Inland Consumption by Energy Form (2015-2040)



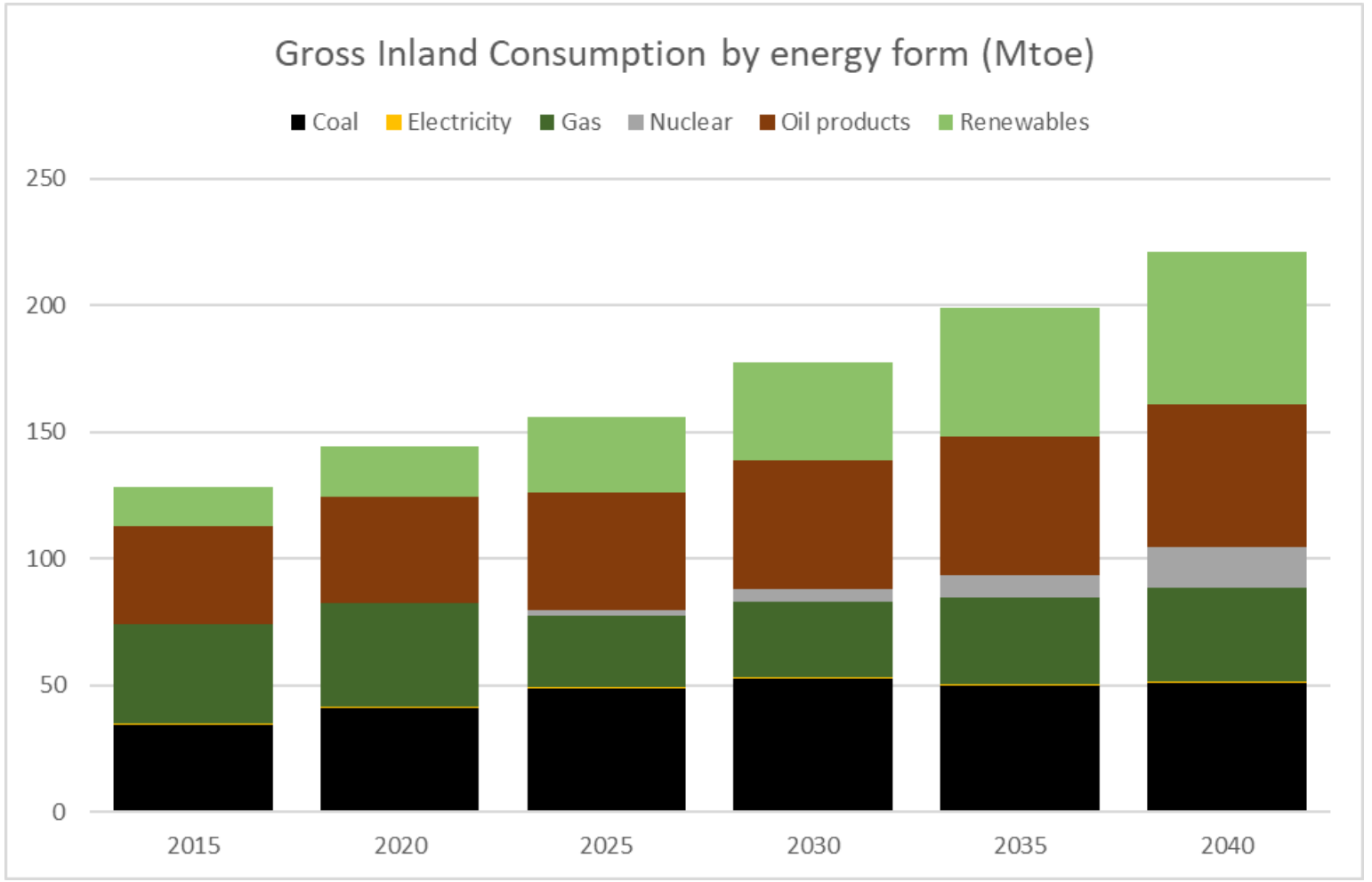
Source: IENE study “South East Europe Energy Outlook 2021/2022”, Athens, 2022

Western Balkans: Gross Inland Consumption by Energy Form (2015-2040)



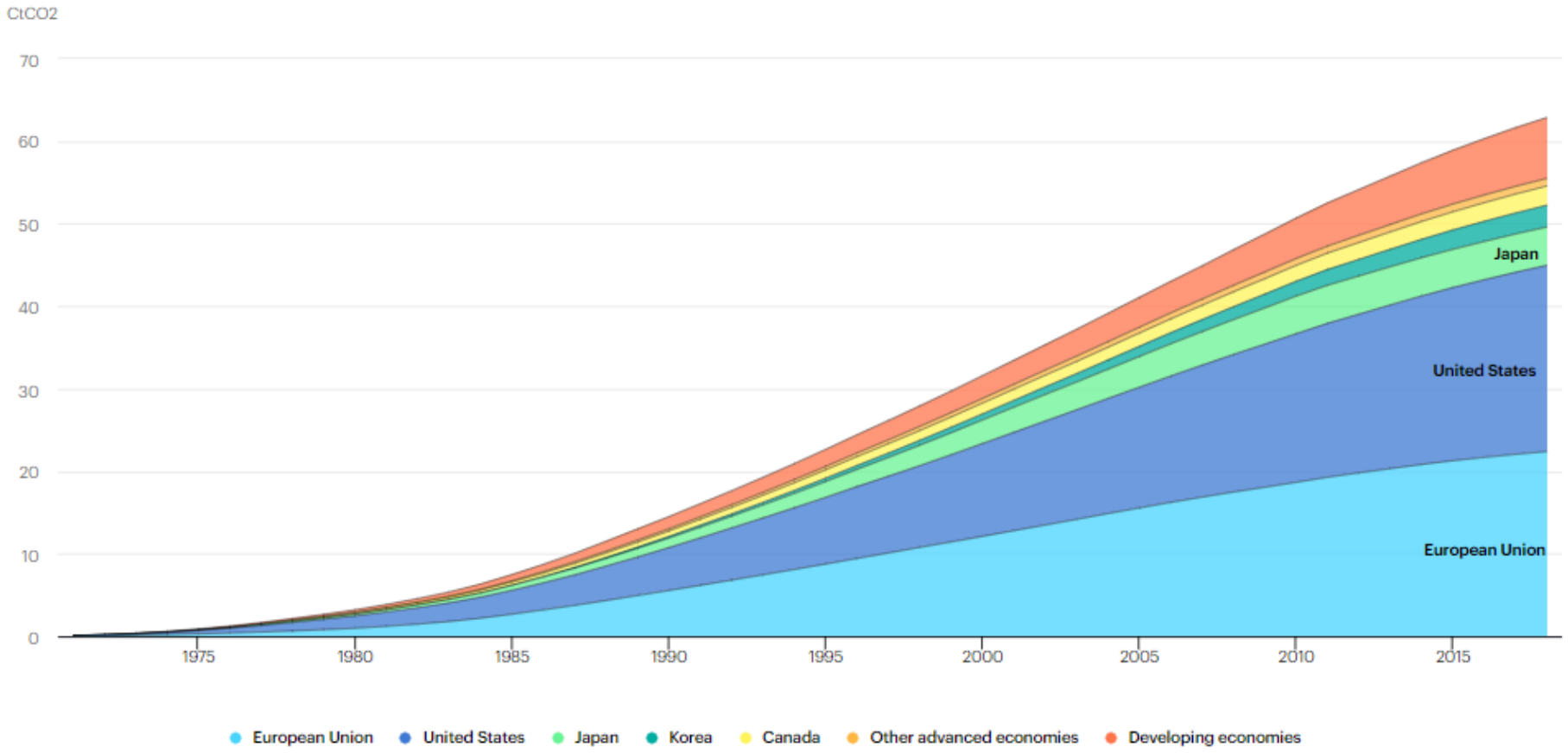
Source: IENE study “South East Europe Energy Outlook 2021/2022”, Athens, 2022

Turkey: Gross Inland Consumption by Energy Form (2015-2040)



Source: IENE study “South East Europe Energy Outlook 2021/2022”, Athens, 2022

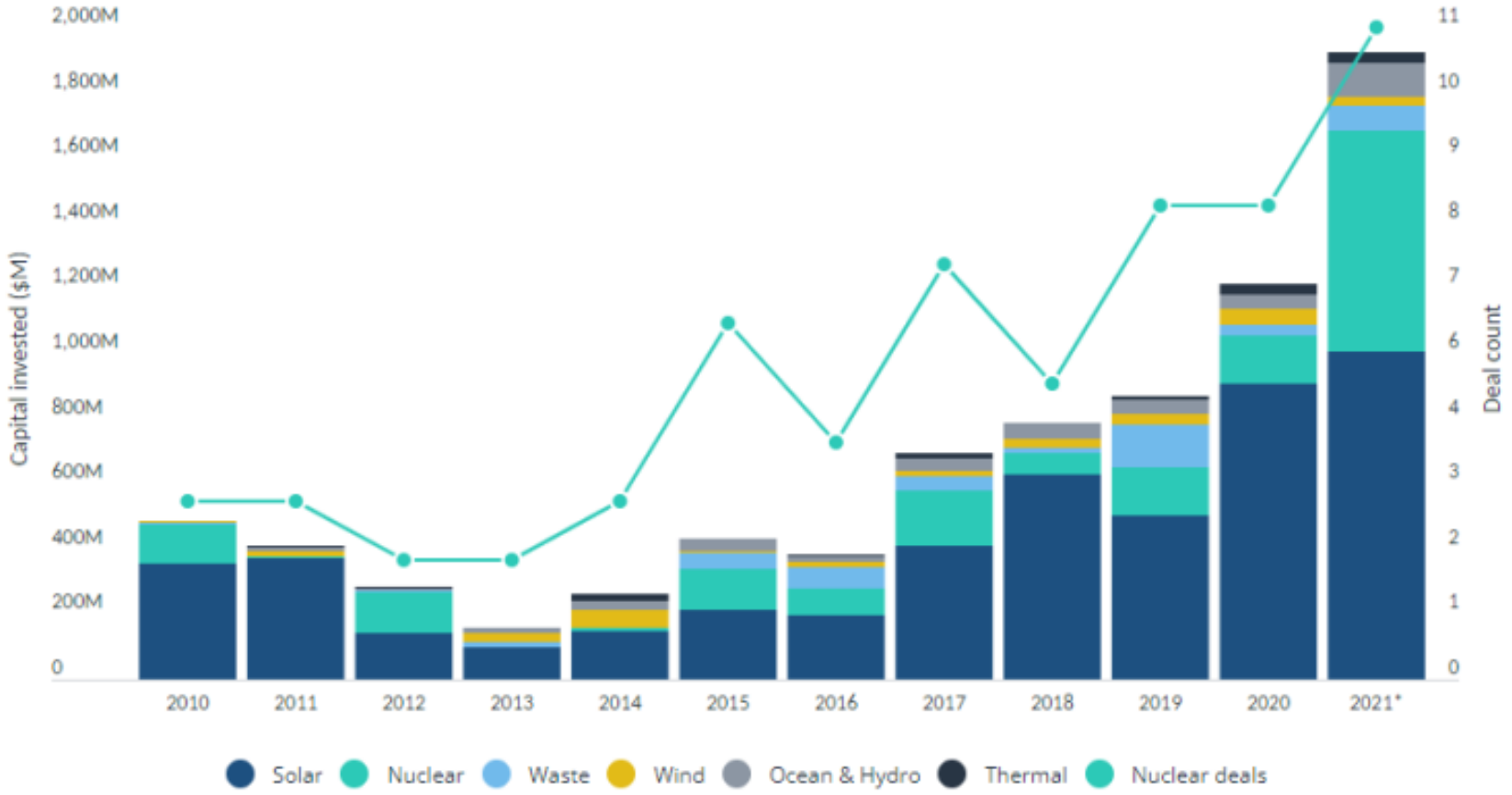
Cumulative CO2 Emissions Avoided by Global Nuclear Power in Selected Countries, 1971-2018



Source: IENE study “South East Europe Energy Outlook 2021/2022”, Athens, 2022

Nuclear Power on the Rise

Capital investments in nuclear increased dramatically in 2021. Around 60 GW of nuclear capacity was under construction at the start of 2021, and more than 100 GW of planned reactor projects after 2030.



Source: IRENA

Discussion (I)

- In SE Europe, there are five countries (Bulgaria, Hungary, Romania, Slovenia and Croatia) that currently operate nuclear power plants (NPPs), while Turkey is expected to build no fewer than 3 NPPs over the next decade.
- Nuclear power remains a viable option for growth because it offers important baseload capacity and supports the EU's decarbonization policies. The zero emissions from operating NPPs contribute to the region's efforts to curtail GHG emissions. This means that nuclear energy has an important role to play in the SE European energy and electricity mix over the next decades.
- In the aftermath of the tragic accident at Fukushima NPP in March 2011 and operational security reviews, which have since been conducted by the SEE countries that host NPPs, the use of nuclear power in the region is unlikely to diminish over the next decade. Neither Bulgaria nor Romania nor Hungary are likely to shut down the Cernavoda, Kozloduy 5-6 and Paks 1, 2, 3, and 4 power plants respectively on account of safety concerns.
- The same applies for Croatia and Slovenia, which, between them, share the Krško NPP. Both governments are very well aware of the fact that a decrease in the participation of nuclear power in their electricity generated portfolio cannot be easily replaced by renewables or be compensated by an increase of coal generated electricity due to the equally burdensome environmental costs. If they are to reduce the participation of nuclear power in their total electricity mix, both states have as an alternative the increase of imported gas, magnifying their already high dependence on gas.

Discussion (II)

- Theoretically, the participation of nuclear generation in the regional electricity mix is set to diminish significantly as the rising demand of Bulgaria and Romania will be covered by increased volumes of natural gas and, to a lesser extent, RES. However, this might change as both Romania and Turkey are definitely going ahead with plans to increase their nuclear installed capacity, which will result in two major nuclear power generation complexes with 6 GW of new installed capacity to be operated by 2030.
- The installed nuclear capacity of SE Europe, Including Turkey, will have increased substantially by the end of this decade as some 6,700 MWe of new plants will have been added to the region's existing nuclear power capacity of 7,096 MWe. With the new capacity coming from Hungary, Romania and Turkey. The almost doubling of SEE's nuclear power potential by 2030 will no doubt contribute substantially to the decarbonisation effort. Such a positive development should be viewed in the context of the ongoing massive expansion of renewables capacity in all countries in the region. Hence nuclear power can work in tandem with RES and can have a major effect in decarbonising SEE's electricity infrastructure.
- In view of the fact that investment in the nuclear power sector is of strategic importance and the long time framework required, such decisions should not be subverted by short-term political priorities against regional, economic and safety considerations. In this sense, the Fukushima anti-nuclear rationale does not appear to hold in the case of SE Europe. For countries already involved in nuclear power development (ie Bulgaria, Hungary, Croatia, Slovenia, Romania, Turkey) the road ahead is unlikely to be obstructed by revised risk assessments.
- Developing further nuclear power generation in the region will be a real challenge as not all countries favour this option.
- Detailed studies need to be undertaken to identify the real potential pitfalls of nuclear energy but also to assess the compatibility of nuclear and RES in the context of achieving actual decarbonisation in the electricity sector.

INSTITUTE OF ENERGY
FOR SOUTH-EAST EUROPE

JOINT NUCLEAR PROGRAMS – SUCCESSFUL STORY

Saša Medaković

www.nek.si

In times of energy crises and lack of resources, we, Slovenia and Croatia, as a countries pour in primary energy sources, we have a need to ensure to our citizens and industry sustainable source of reliable, secure, economically and environmentally acceptable electricity.
We decided to joint our effort and do it together.
We decided to jointly invest in two nuclear power plants!

Stane Kavčič and Dragutin Haramija,
October, 1970

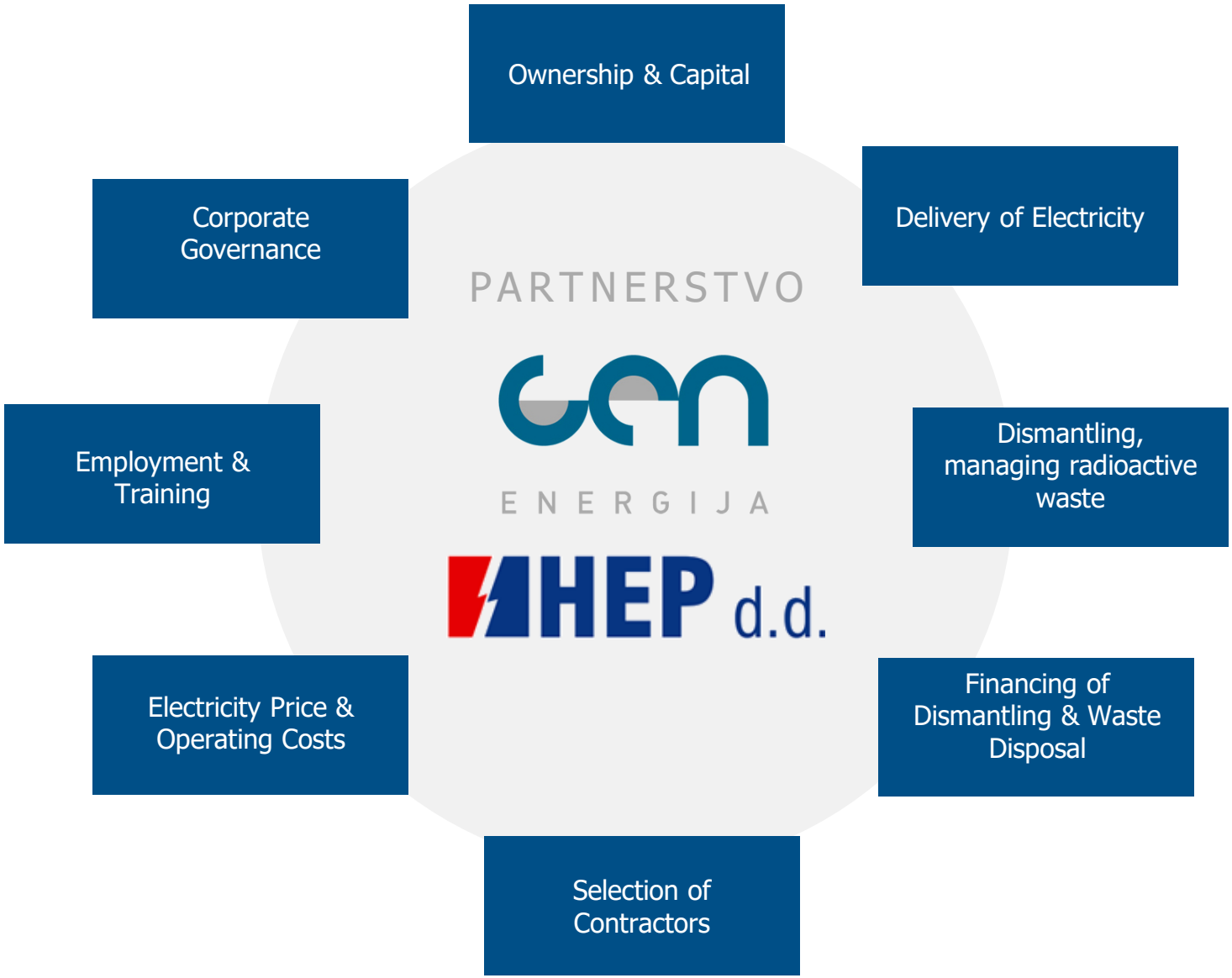
Why joint venture?

- **Neighboring countries with relatively small electrical grids and good interconnections**
- **Sharing resources**
- **Sharing risks**
- **Shorten time needed for fulfilling prerequests for placing orded for NPP**
- **Increasing grid stability and energy consumption capabilities**

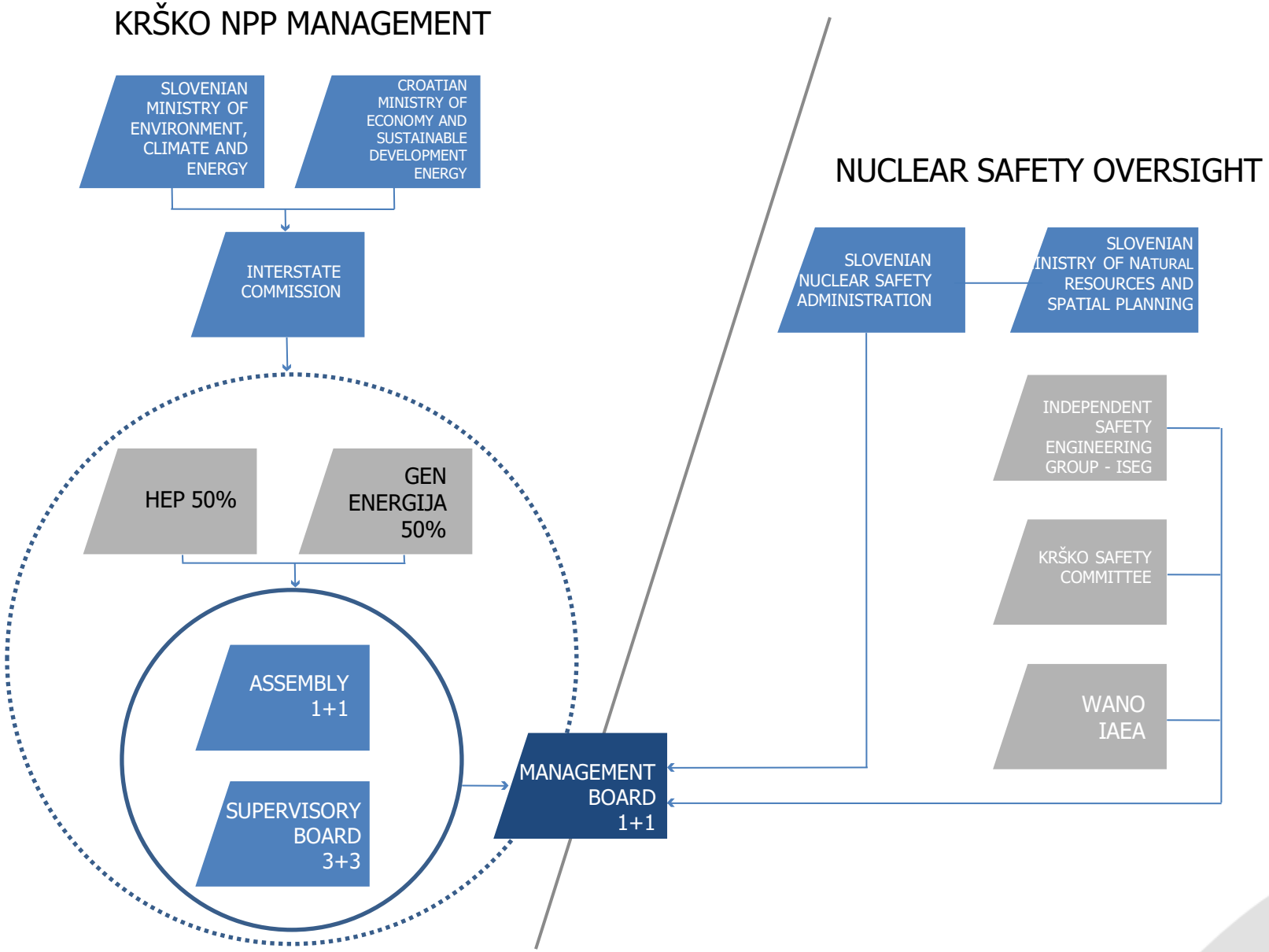
Krško in Brief

- Owners: **GEN-energija 50%, HEP 50%**
- Operator: **Krško Nuclear Power Plant**
- NSSS Supplier: **Westinghouse**
- Reactor Type: **PWR, 2-loop**
- Engineering: **Gilbert Architect Engineer**
- Construction Permit: **1975**
- First Criticality: **1981**
- Commercial Operation: **1983**
- Bilateral Agreement: **2003**
- Renewed Operating License: **2012**
- Operating Life Time: **40+10+10+… years**
- No. of Employees: **~648**
- Gross Plant Output: **~734 MW**

Agreement between Slovenia and Croatia



Independent Functions of Management & Supervision



Our Vision & Mission

Vision

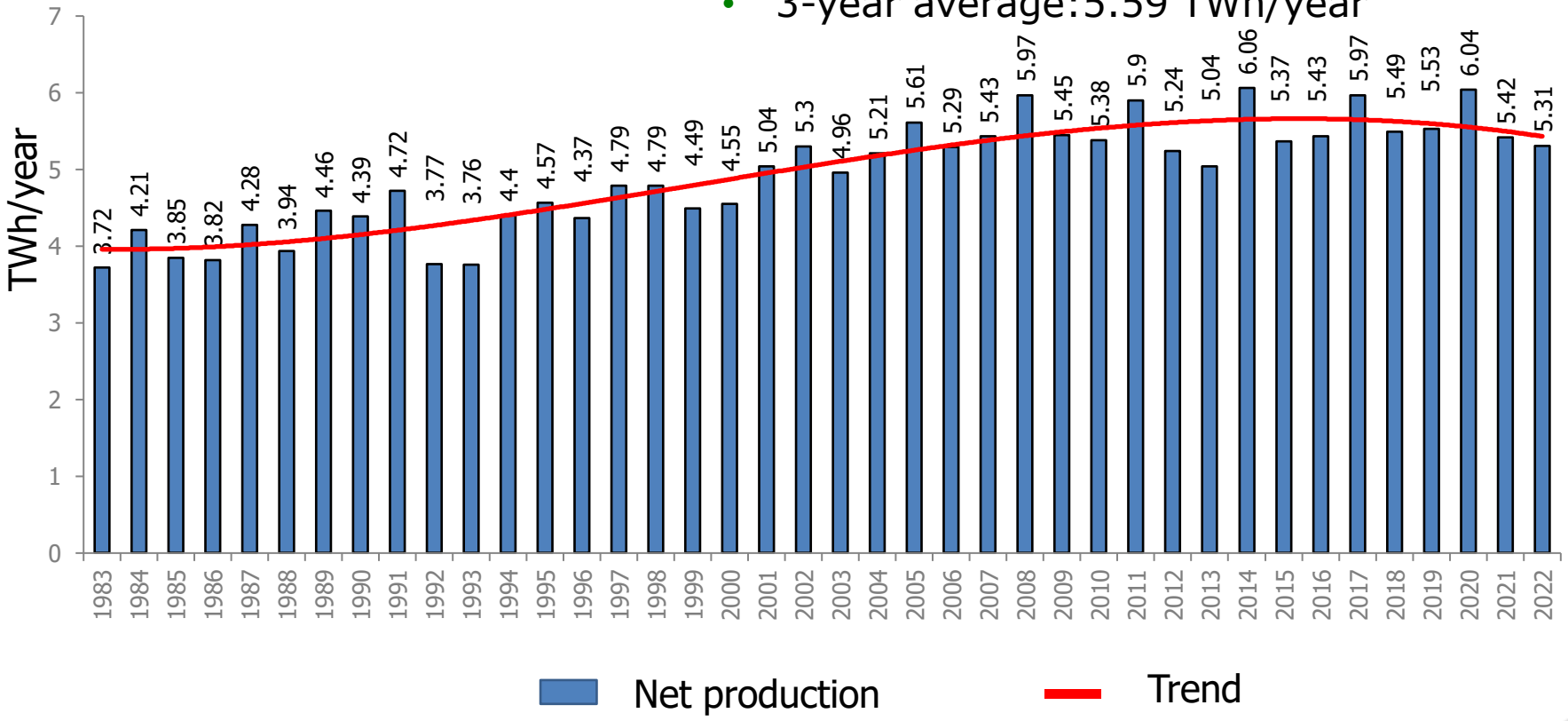
Biti zgled jedrske varnosti
in odličnosti na globalni ravni
(World-wide leader in nuclear safety and excellence)

Mission

Positive Production Trend

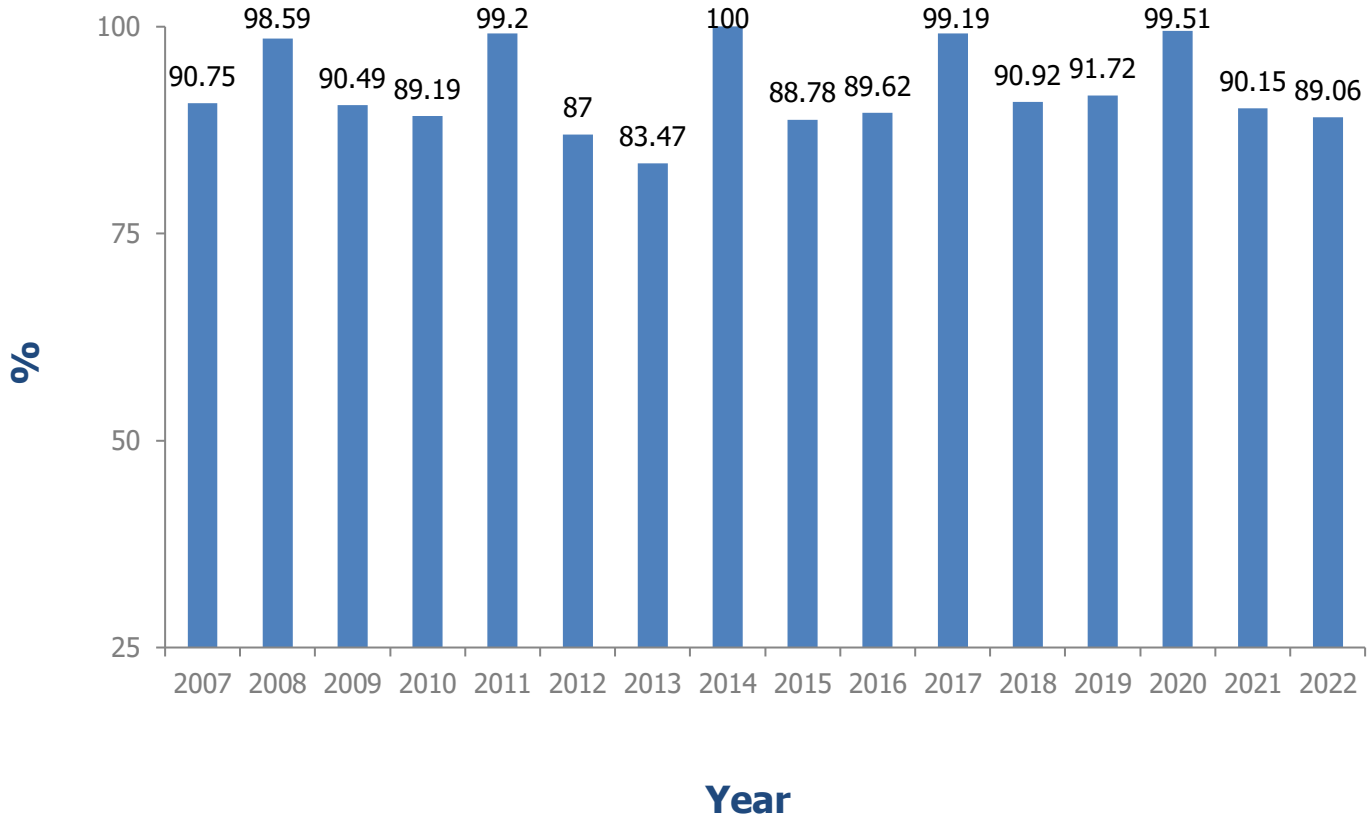
A result of work process optimization, 18 month fuel cycle, good material condition, and employee commitment

- Cumulative: over 200 TWh (Commercial Operation)
- 3-year average:5.59 TWh/year



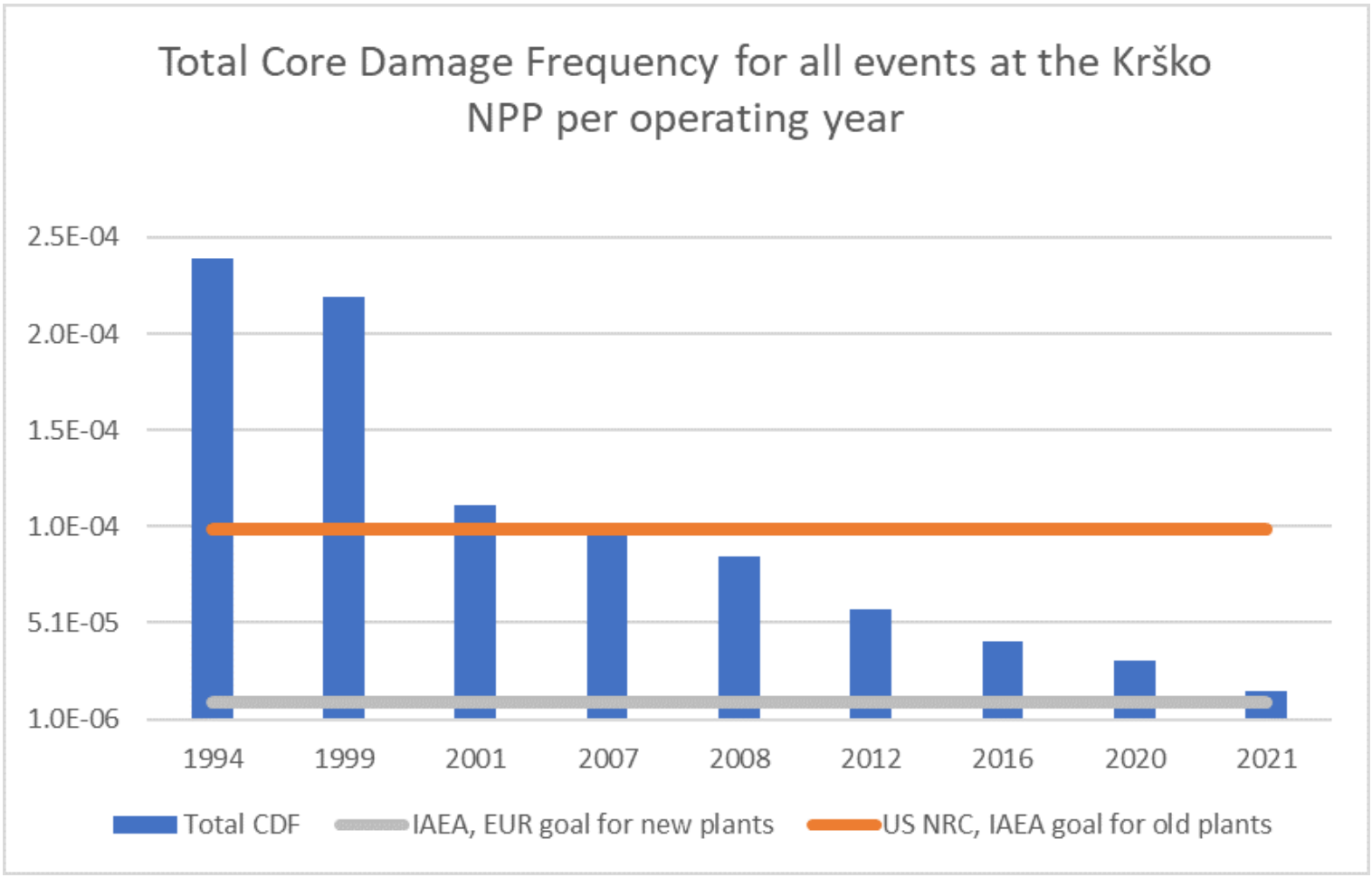
Performance Indicators

Unit Capability Factor



Unit capability factor is defined as the ratio of the available energy generation to the reference energy generation over the period of 12 months.

Reducing the Risk of Core Damage Frequency (CDF)



Conclusions

- The use of nuclear energy is supported by the **INTEGRATED NATIONAL ENERGY AND CLIMATE PLAN OF SLOVENIA AND CROATIA**

- We are meeting the necesary preconditions for long-term nuclear future:
  - **safe and reliable nuclear operating history;**
  - **well established nuclear infrastructure;**
  - **highly motivated and competent professionals;**
  - **proactive and learning organization;**
  - **continuous improvements in all areas.**

- NEK as a joint production facility covers about 20 percent of Slovenia's electrical energy needs and 16 percent of Croatia's electrical energy needs per year. With the reliability and competitiveness of production compared to other sources, we make a significant contribution to the favorable position of the Slovenian and Croatian economies and to an acceptable level of energy independence of both countries.

- The implemented model ensured a long-term stable environment and synergy that proved to be, along with a positive ambition, a key element for the success of the nuclear energy program.

Thank you for attention!

A: **Vrbina 12, 8270 Krško, Slovenia**

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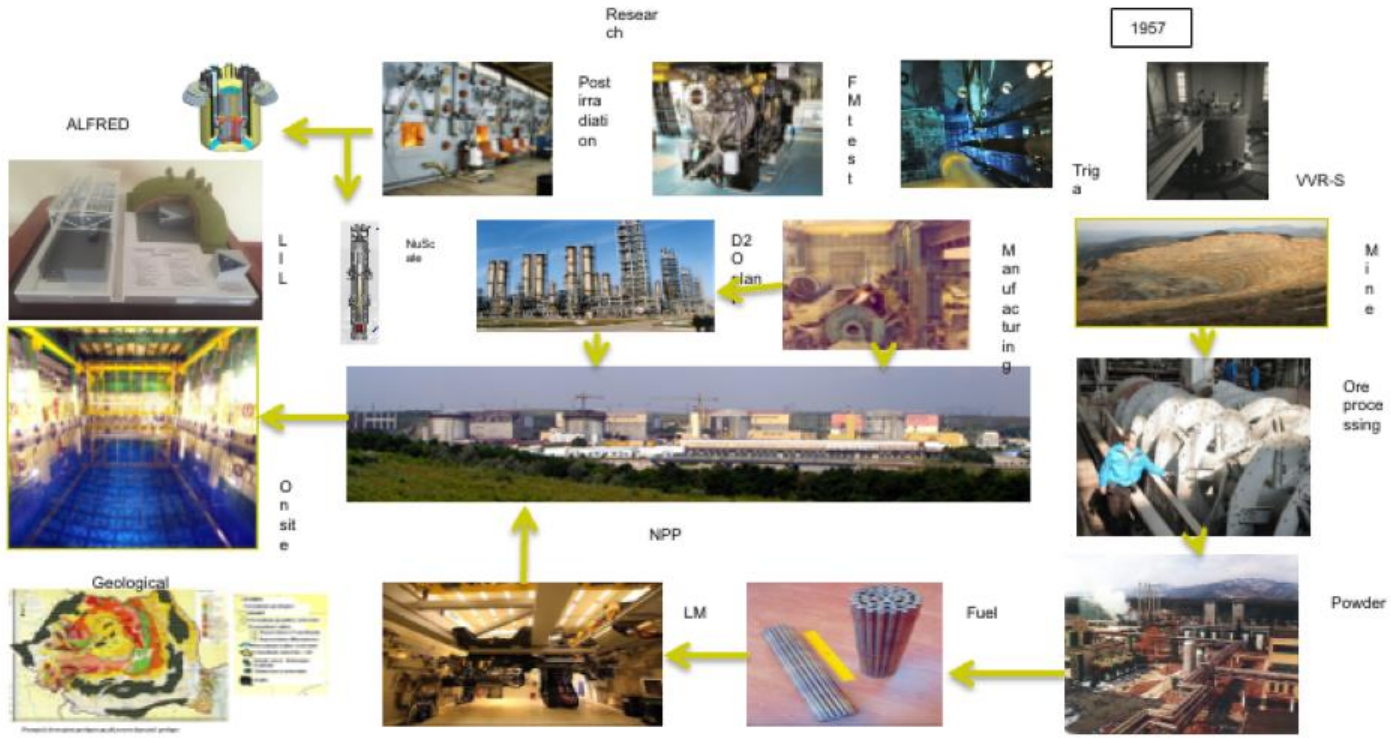
The Nuclear Option for South East Europe

Ionut Purica
Executive Director
Advisory Center for Energy and Environment, Romania

Romanian nuclear fuel cycle

Nuclear fuel cycle in Romania – The position of ALFRED and Nuscale SMRs

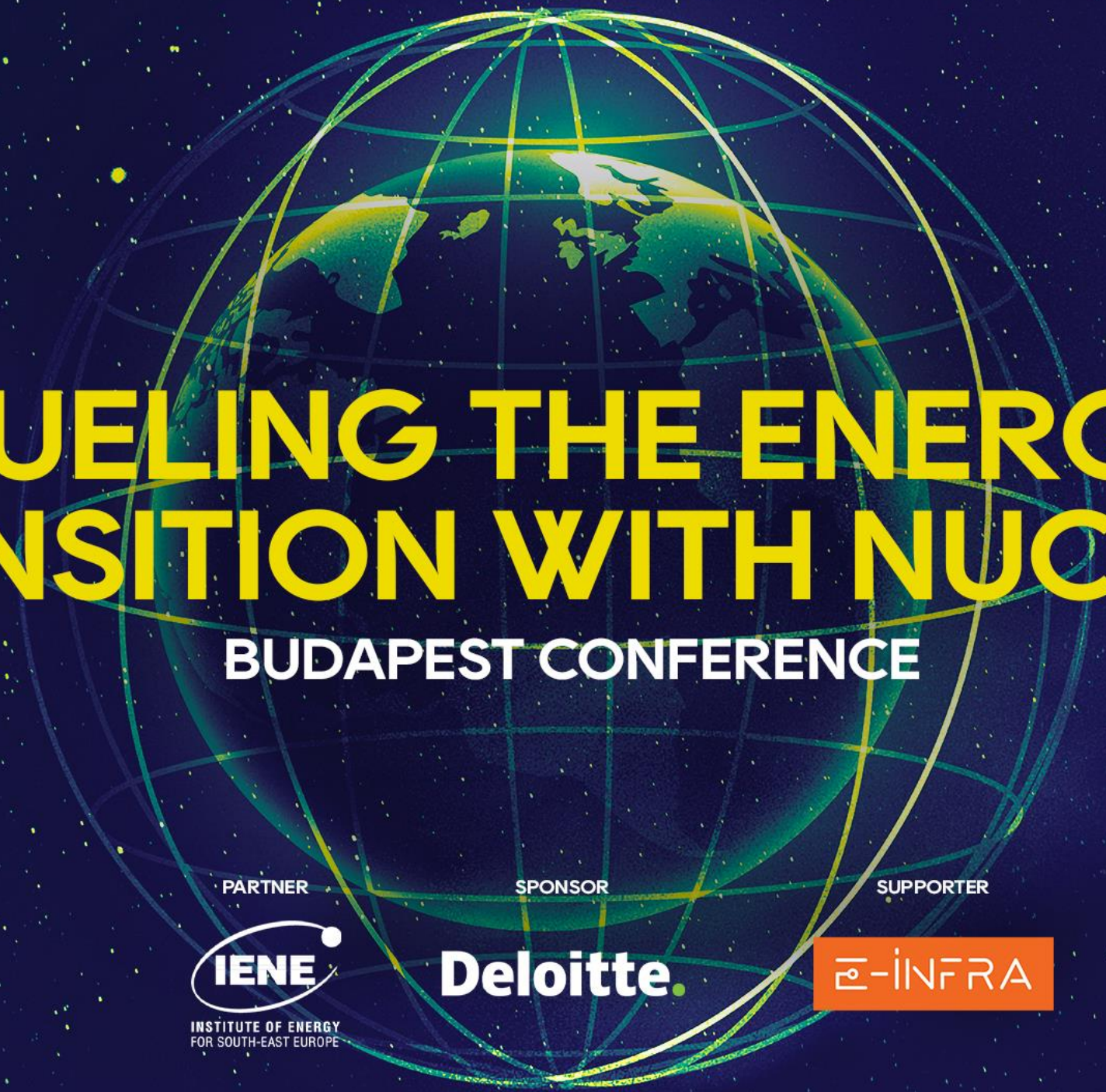


Panel 3: The Nuclear Option for South East Europe

Chaired by Costis Stambolis

- Costis Stambolis, Executive Director, Institute of Energy of South East Europe
- Sasa Medakovic, Member of the Management Board, NEK Slovenia
- Ionut Purica, Executive Director, Romanian Advisory Center for Energy and Environment

NNWI



FUELING THE ENERGY TRANSITION WITH NUCLEAR

BUDAPEST CONFERENCE

PARTNER

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INSTITUTE OF ENERGY FOR SOUTH-EAST EUROPE

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