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Status of the Nuclear Power Program of the Czech Republic

Jozef Misak

3rd International Nuclear Conference

THE OPPORTUNITIES OF NUCLEAR ENERGY FOR THE DECARBONISATION OF ENERGY SECTOR IN EUROPE - TECHNOLOGY, PROJECTS, SERVICES

25-26 January 2024, Sofia

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OUTLINE OF THE PRESENTATION

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The presentation describes the current status and future plans for implementation of nuclear power in the Czech Republic and discusses the practical steps and challenges associated with implementation of the plans. It includes summary of the existing nuclear units, preparation for construction of new large power units, as well as development and plans for implementation of small modular reactors.

- Recent developments in energy sector
- Nuclear power in the Czech Republic
- New build plans in the Czech Republic
- SMR deployment in the Czech Republic
- Development of SMRs in the Czech Republic
- Summary

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RECENT DEVELOPMENTS

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SOURCES OF THE CURRENT ENERGY CRISIS IN EUROPE

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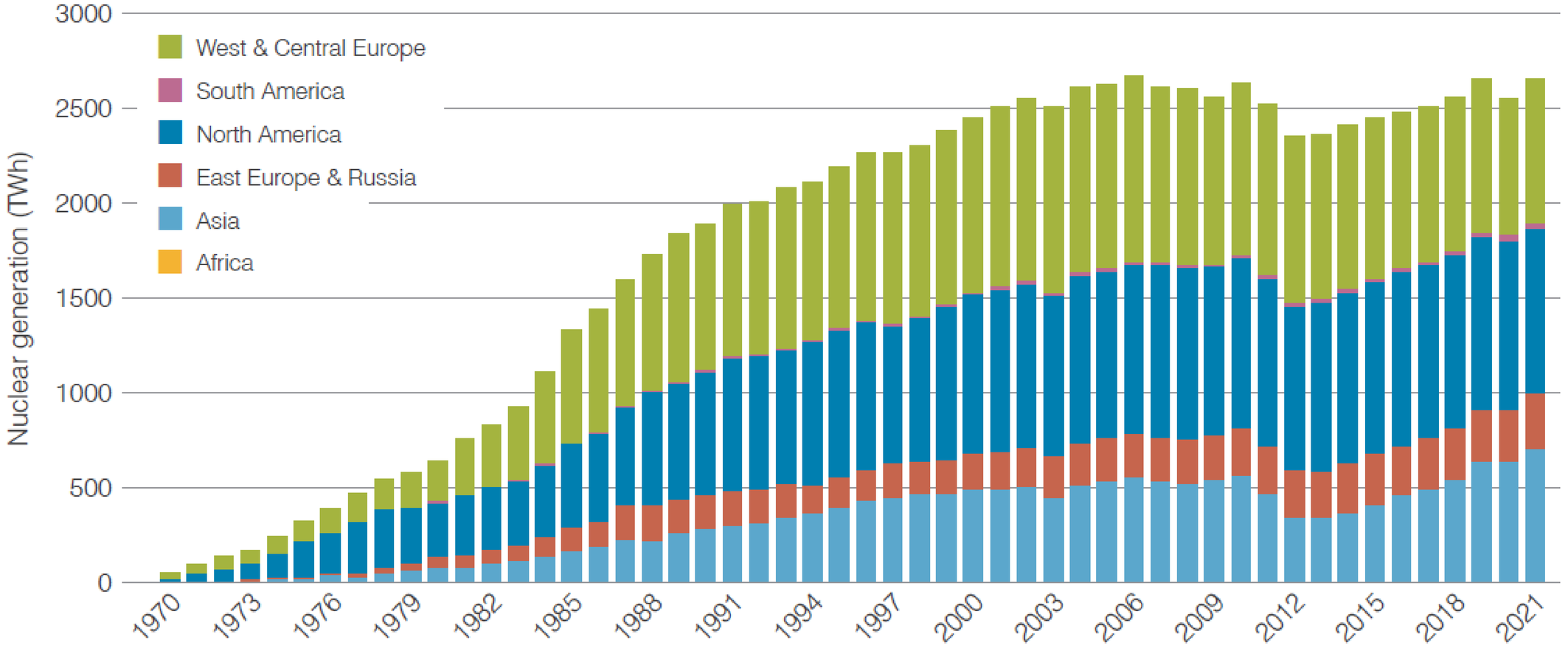
- Shutting down nuclear and fossil sources without adequate replacement
- Uncontrolled and volatile increase in the price of emission allowances
- Transition from coal to gas with increased gas consumption
- Uncontrollable production of electricity from intermittent renewable sources
- Recovery of the economy after the decline due to COVID 19 pandemic
- Reliance on gas not only for heating but also for electricity: high gas consumption
- Reduction in gas production in Europe, reduction in investment in fossil sources
- War in Ukraine

THE RESULTING RISKS

- Very high demands on the grid, endangering its stability especially in the winter
- Decrease of inertia in rotating machines and in grid stability
- Increase in gas and electricity consumption (reduced use of coal and electrification)
- High electricity and gas prices, the threat of energy poverty
- Strong dependence on gas imports
- Industry leaving out of EU looking for lower energy prices
- The risk of decline of the economy and living standard
- Threat to the social and political stability

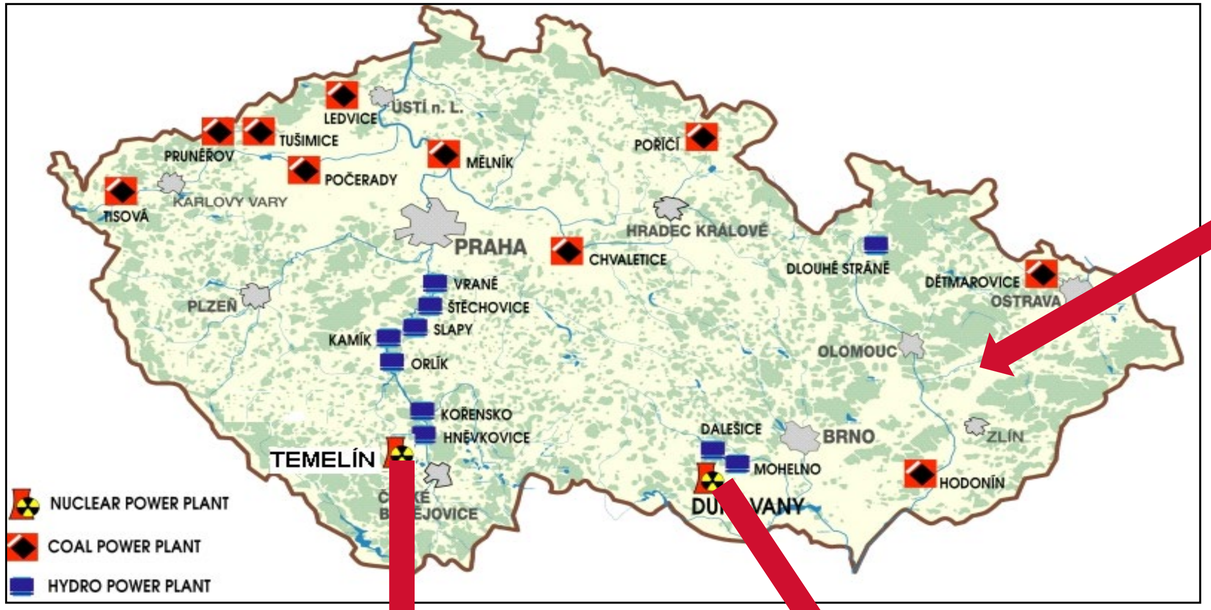
NUCLEAR POWER IN THE WORLD – CURRENT SITUATION

- Number of units: 436
- Installed power: 392 GWe
- Under construction: 60 units 67 Gwe
- The nuclear share of electricity production is slightly over 10 %



NUCLEAR POWER IN THE CZECH REPUBLIC

NPPs IN THE CZECH REPUBLIC

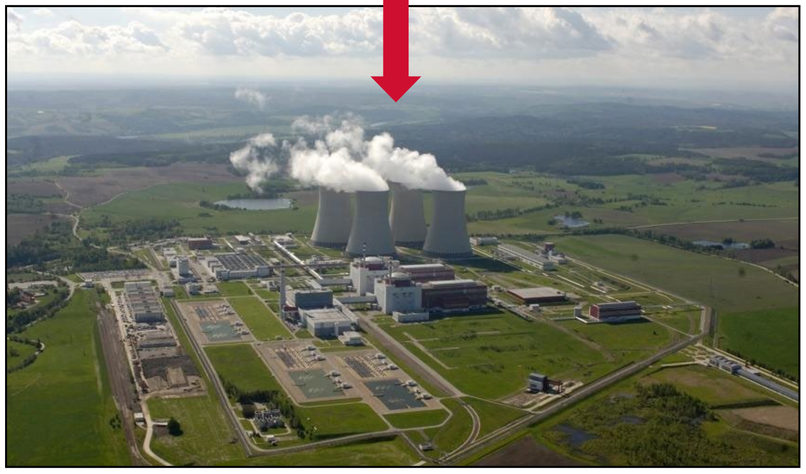


Temelin NPP

- 2 Units VVER 1000/V320
- Unit 1 - 2002
- Unit 2 – 2003
- Power upgrade to 104 %
  (3000 MWt => 3120 MWt)

Dukovany NPP

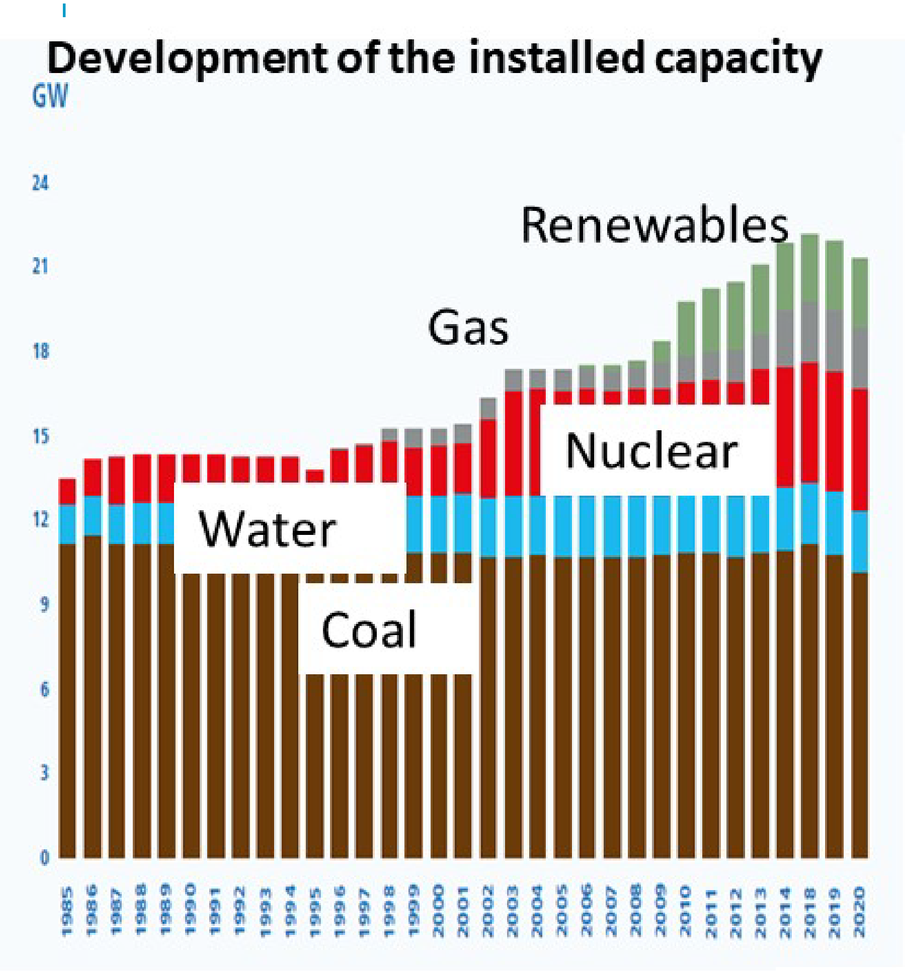
- 4 Units VVER 440/V213
- Unit 1 - 1985
- Unit 2 - 1986
- Unit 3 - 1986
- Unit 4 - 1987
- Power upgrade to 105 %
  (1375MWt =>1444 MWt)

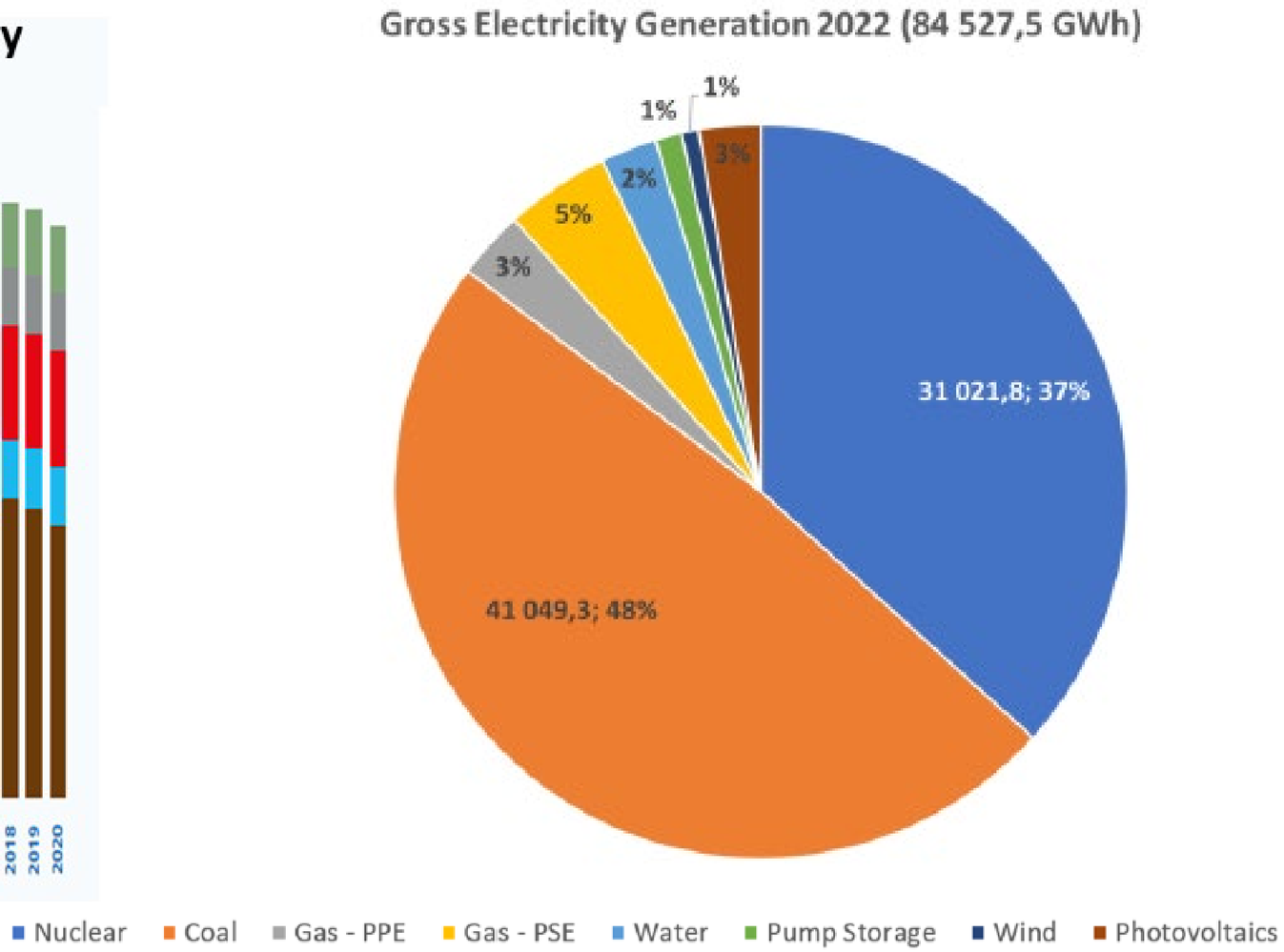


NUCLEAR FACILITIES

Site	Nuclear installation	No. of units	Type	Commis-sioning	Operator
Dukovany	NPP	4	VVER 440/213	1985-1987	CEZ
	Interim Spent Fuel Storage Facility	1		1995	CEZ
	Spent Fuel Storage Facility	1		2006	CEZ
	Radioactive Waste Disposal Facility	1		1995	SURAO
Temelin	NPP	2	VVER 1000/320	2000-2002	CEZ
	Spent Fuel Storage Facility	1		2010	CEZ
	Fresh Fuel Storage Facility	1		2000	CEZ
Rez	Research Reactor	1	LVR 15	1972	RC REZ
	Research Reactor	1	LR-0	1995	RC REZ
	Spent fuel and high level waste storage facility	1		1997	UJV REZ
Prague	Training Reactor	1	VR-1	1992	CVUT
Litomerice	Radioactive Waste Disposal Facility RICHARD	1		1964	SURAO

ROLE OF NUCLEAR POWER IN THE CZECH REPUBLIC





Ambition: All coal units to be closed until 2033

Source: www.eru.cz

DEVELOPMENT OF ELECTRICITY PRODUCTION AND CONSUMPTION (TWh) IN THE CZECH REPUBLIC (CEZ ESTIMATE)

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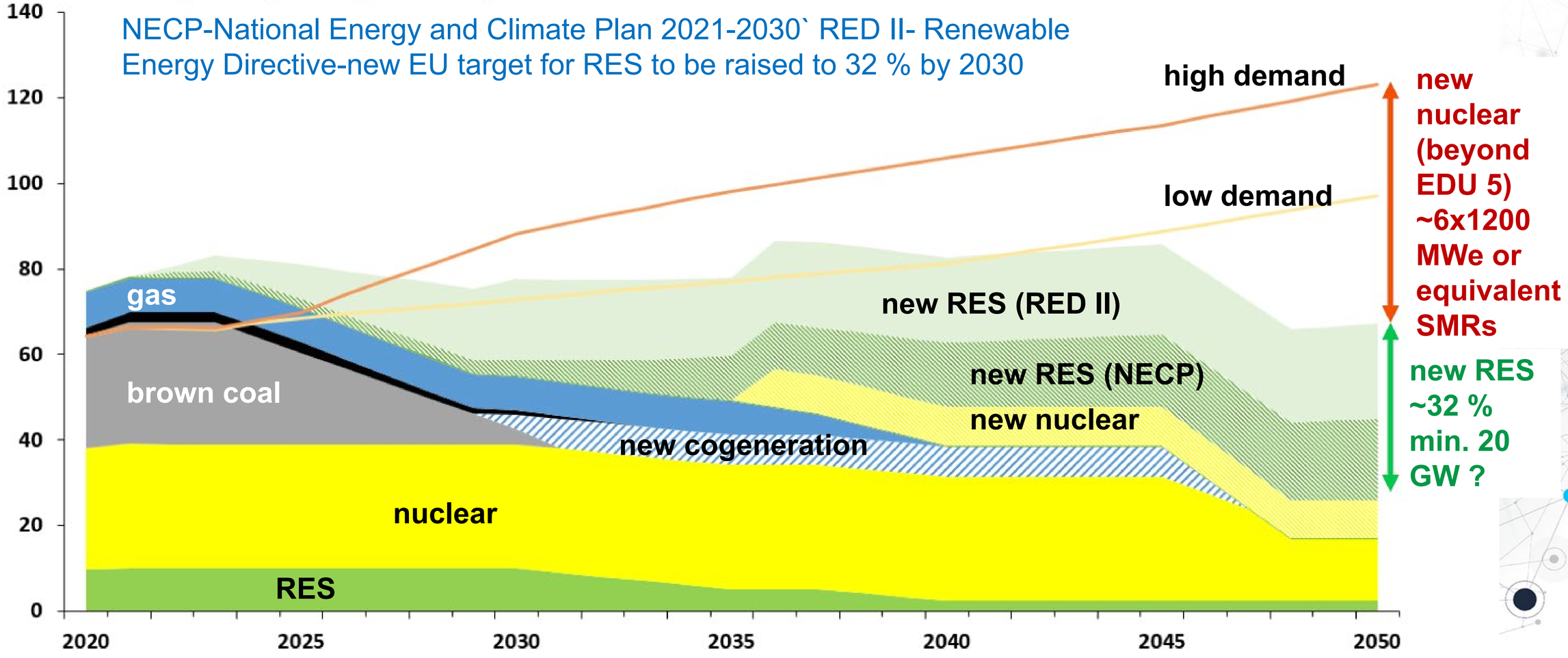
NECP-National Energy and Climate Plan 2021-2030` RED II- Renewable Energy Directive-new EU target for RES to be raised to 32 % by 2030



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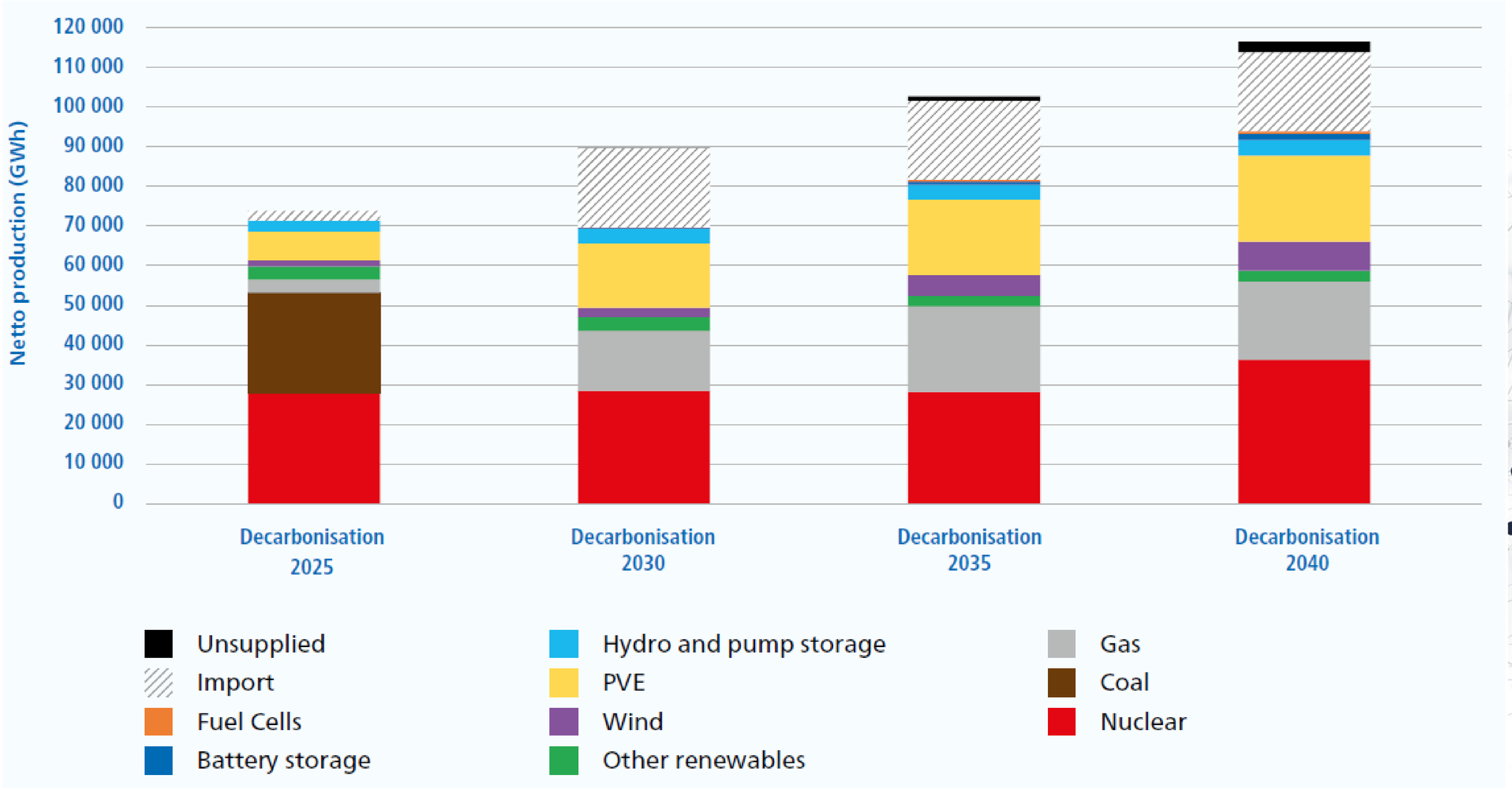
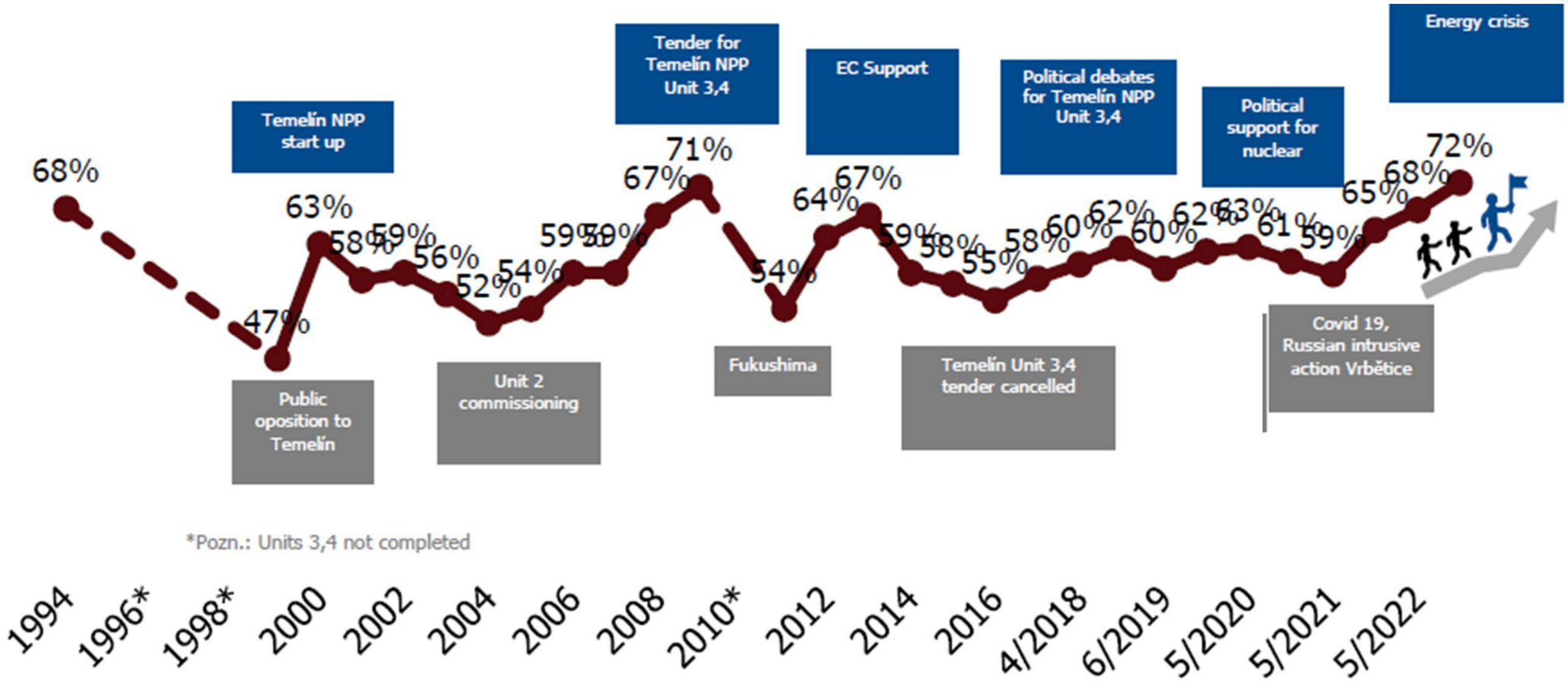
DEVELOPMENT OF POWER GENERATION IN DECARBONIZATION SCENARIO ACCORDING TO GRID OPERATOR (SOURCE: CEPS, A. S.)



PUBLIC SUPPORT OF NUCLEAR POWER IN THE CZECH REPUBLIC



PROGRAM STATEMENT OF THE GOVERNMENT (END OF 2021)

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- **Future energy mix – nuclear + decentralized renewables**
- **Long term operation of the current units**
- **Construction of the new nuclear unit in Dukovany**
- **Assessment of construction of more new units at Dukovany and Temelin site**
- Strengthening of R&D, international cooperation in the nuclear field
- Strategy for implementation of SMRs
- Continued works on deep geological repository

NEW ENERGY PLAN OF THE GOVERNMENT (18 OCT 2023)

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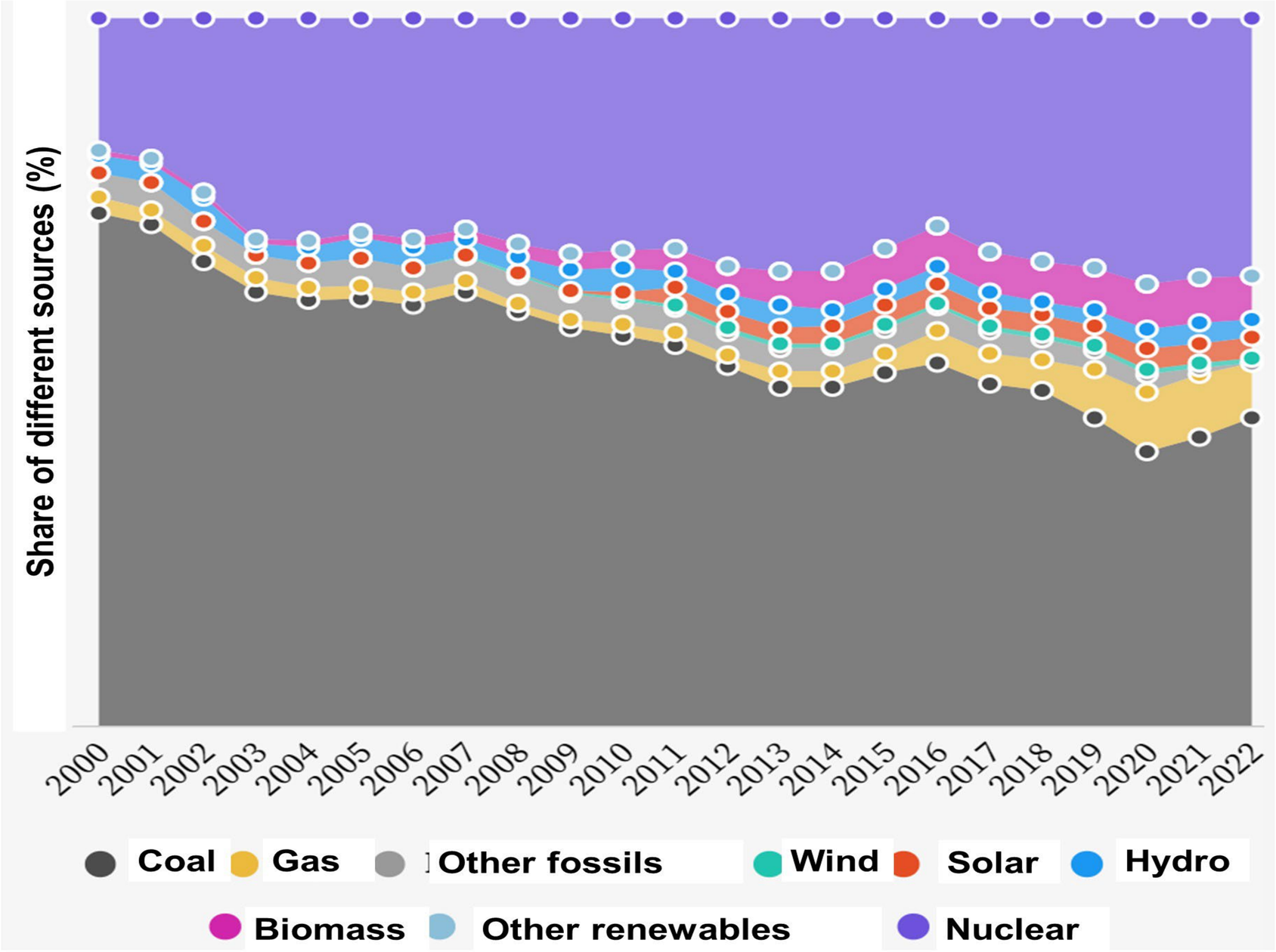
- Estimated increase in electricity consumption till 2030 ~ 10 %
- End of coal burning for electricity 2033
- Increase of renewable sources in total consumption from current 18 % to 30 % till 2030: 10.1 GW in PV, 1.5 GW in wind plants
- Till 2040, increase of nuclear in electricity production from 40 to 60 %: 2 large units in Dukovany, 2 in Temelin
- Temporarily, increased share of electricity production from the gas, and from the import
- Use of nuclear power for heating of large cities (Ceske Budejovice, Brno)
- Needed investment till 2030 ~20 mld EUR to energy sources
- Sent to EC for consultations, final version to be ready by mid of 2024

DEVELOPMENT OF THE CZECH ENERGY MIX



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NEW NUCLEAR BUILD

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Elektrarna Dukovany II, a. s. (EDU II)

- subsidiary company of CEZ, a. s.
- established in 2015
- at present 165 employees

100 % ← **CEZ, a. s. (CEZ Group)**

Dukovany II

- focus on 1 reactor unit up to 1200 MWe
- 60 years projected lifetime
- generation III+, PWRs

Elektrarna Temelin II, a. s. (ETE II)

- focus on new large reactors at Temelin

Development of SMR

- SMR – Temelin + new sites

NPP DUKOVANY II PROJECT

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- Investor – NPP Dukovany II, a. s., (EDU II) - 100 % of shares owned by CEZ, a. s., operator of existing units and owner of the site
- 1 new unit with capacity up to 1200 MWe
- Contractual arrangement between the state and the investor: Contract for Difference (contractual obligation to share the risk resulting from fluctuations of the price of electricity)
- First Implementing Contract signed in 2020 – obligation of the parties for the first stage - preparation and selection of the supplier – until 2024

Future contractual arrangement defined in Act 367/2021 Coll. on measures for the transition of the Czech Republic to low-carbon energy

DUKOVANY 5 PROJECT DEVELOPMENT

Year	Step	Note
2010-2011	Feasibility Study	Atmea 1000, Kepco APR1400, Mitsubishi EU APWR 1700, Westinghouse AP 1000, Areva EPR1600 and ASE MIR 1200
2012-2014	Site related studies	raw water consumption, transportability, or power grid connection max. power output set up to 1200 MW
2017	EIA	Environmental Impact Assessment documentation was submitted to the Ministry of the Environment of the Czech Republic
2019	EIA Statement	Ministry of Environment issued Binding Statement
2015	Site License Documentation	EDU II obtained the License for the siting of two units of the new Nuclear Power Plant at Dukovany Site from the State Office for Nuclear Safety on 8th March 2021.
2019-2021	Site Permit Documentation	Application for site permit to Ministry of Regional Development was submitted by CEZ in May 2021 – Decision yet pending
2020-2021	BIS	Preparation of Bid Invitation Specification. 3 bidders (EDF, Westinghouse, KHNP)
2022-2024	Tender process	Final bids expected by September 2023 Preferred bidder selection March 2024
2024	Contract signature	By end of 2024

DUKOVANY 5 PROJECT DEVELOPMENT

Year	Step	Note
2025-2027	Construction License Documentation	According to Atomic Law.
2028	Construction License	Application to the State Office for Nuclear Safety
2026-2028	Construction Permit Documentation	According to Building Act.
2029	Construction Permit	Application for construction permit to Ministry of Industry and Trade
2030	Construction Start	First Concrete
2035-2036	Active testing & commissioning	**Additional Licenses** First physical start-up of a nuclear installation with nuclear reactor; - First power-generation start-up of a nuclear installation with nuclear reactor; - Commissioning of a nuclear installation without nuclear reactor: - Operation of a nuclear installation
2036	Commercial Operation	

TENDER FOR EPC SUPPLIER STARTED

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- Bids submitted by November 30, 2022, under evaluation at present

Bidder	Country of origin	Type	Installed capacity
Westinghouse Electric Company LLC	USA	AP 1000	970 MW
Korea Hydro & Nuclear Power Company	Korea	APR 1000+	1100 MW
Électricité de France	France	EPR 1200	1200 MW

DUKOVANY PROJECT – PRINCIPAL MILESTONES

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Current status: Evaluation of the offers ongoing according IAEA methodology, 280 CEZ experts involved, special confidentiality arrangements, results to be presented to the government on 15 February, government to decide at beginning of May 2024

- 2024 – selection of the EPC supplier, contract to be signed
- 2028 – permitting finalized, start of construction
- 2030 - first concrete
- 2035 - start of active testing
- **2036 – commissioning**

ADDITIONAL UNITS IN NPP DUKOVANY AND NPP TEMELIN

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- The ongoing tender includes a non-binding option for additional units at Dukovany (1 additional unit) and at Temelin (1-2 additional units)
- The government in its program defined the task to prepare necessary analyses for decisions regarding construction of additional units). As one of the important inputs it will be the indicative offer submitted by the Bidders in the Tender for the new Dukovany unit
- The government will decide on the time schedule, investment, financial and business model in 2023 – 2024

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SMR DEPLOYMENT IN THE CZECH REPUBLIC

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NUCLEAR IN UPDATED STATE ENERGY POLICY

Ministry of Industry and Trade will update the State Energy Policy (SEP) and National Action Plan of Nuclear Energy (NAP) in 2023

- Plan to include construction up to 4 large reactors for electricity generation
- Plan to include SMRs for electricity, heat, and H_2 generation

SMRs are not substitution of large reactors

- Supplementation of energy mix to substitute coal power plants and large central heating plants

Regions are interested to include SMRs in their regional energy policy

- South Bohemian Region (“South Bohemian Nuclear Park”), Moravian-Silesian Region, North Bohemian (Usti and Labem) Region

Objectives

- Commissioning of SMR ETE in 2032
- Commissioning of additional units in non-nuclear sites after 2037

SMR DEVELOPMENT PROGRAM IN CZECH REPUBLIC

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Project SMR Temelin

- **Feasibility study** (completion 12/2022)
- **Business plan** (approval 12/2022)
- **Due diligence** and follow-up communication with potential suppliers - visits to EdF, KHNP, NuScale, GEH, Holtec, RR, WEC
- **Technical information of potential SMR designs**
- **Site investigation**
  - Geology
  - Water management
  - Grid connection
- **Preparation for EIA study** (2023)
- **Initiation of activities for permitting and licensing** (2023)
- **Decision on supply model,** start of selection of SMR technology

Project SMR in the Czech Republic

- **Pre-feasibility study** ongoing
- Assessment of suitability of the sites
  - Study of available information to assess the suitability of the sites
- **Preliminary selected 5 non-nuclear sites for the preparation and construction of SMR**
  - Collecting the documents and selecting the most suitable non-nuclear sites for the location of SMRs
  - Prioritization of sites
- **Preparation of preliminary feasibility studies**

CEZ SMR DEVELOPMENT PROGRAM

Main goal of Program acceleration – implementation of SMR technologies in CR

- Stage I: To put First SMR (pilot) unit in Temelin site into commercial operation till latest 2034
- Stage II: Continue construction of SMRs in other 2-3 sites (owned by CEZ) in CR

MoU signed and used for exchange of information

- CEZ x NuScale
- CEZ x GE Hitachi
- CEZ x Rolls Royce
- CEZ x KHNP (SMART100)
- CEZ x WEC (AP300)
- CEZ x EDF (NUWARD)

20 September 2022 – establishment of a company South Bohemian Nuclear Park, s.r.o.

CEZ SMR DEVELOPMENT PROGRAM

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SMR Designs under evaluation

BWRX-300 (USA, 300/870 MWe/MWt), BWR GE Hitachi

NuScale (USA 12 modules – 600 – 924 MWe), PWR

NuScale

Nuward (2 x 170/ 2 x 540 MWe/MWt), PWR

EdF

SMART100 (Korea, 2x107/2x365 MWe/MWt), PWR

KHNP

SMR-160 (USA, 1x160/525 MWe/MWt), PWR

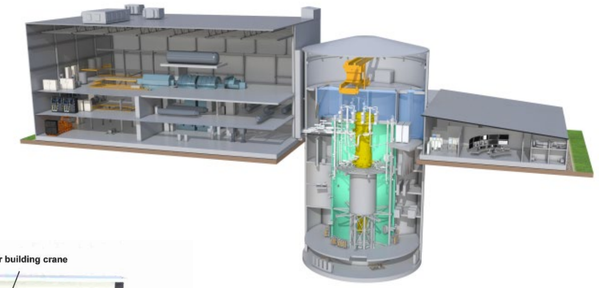
Holtec

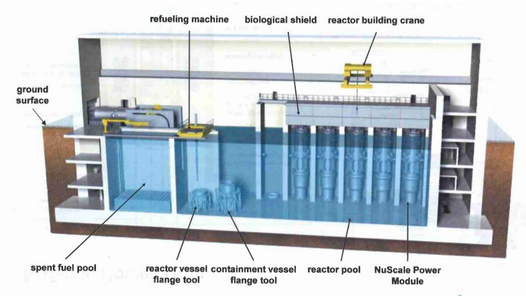
UK SMR (UK, 470/1276 MWe/MWt), PWR

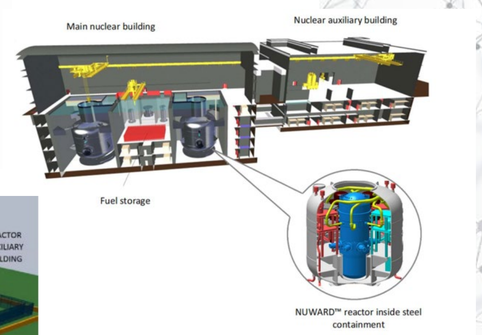
Rolls Royce

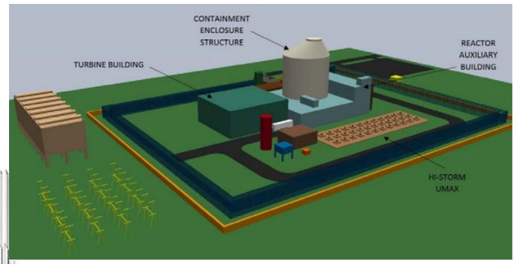
WEC SMR (USA, 1 x 300/900 MWe/MWt), PWR

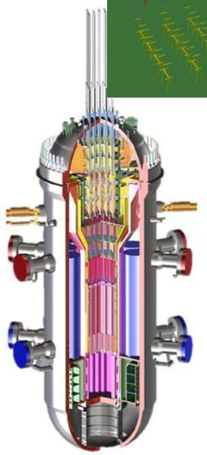
Westinghouse

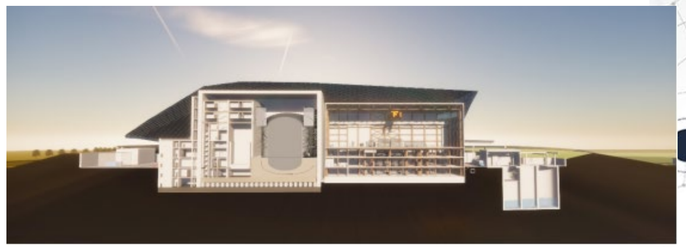












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CEZ SMR DEVELOPMENT PROGRAM

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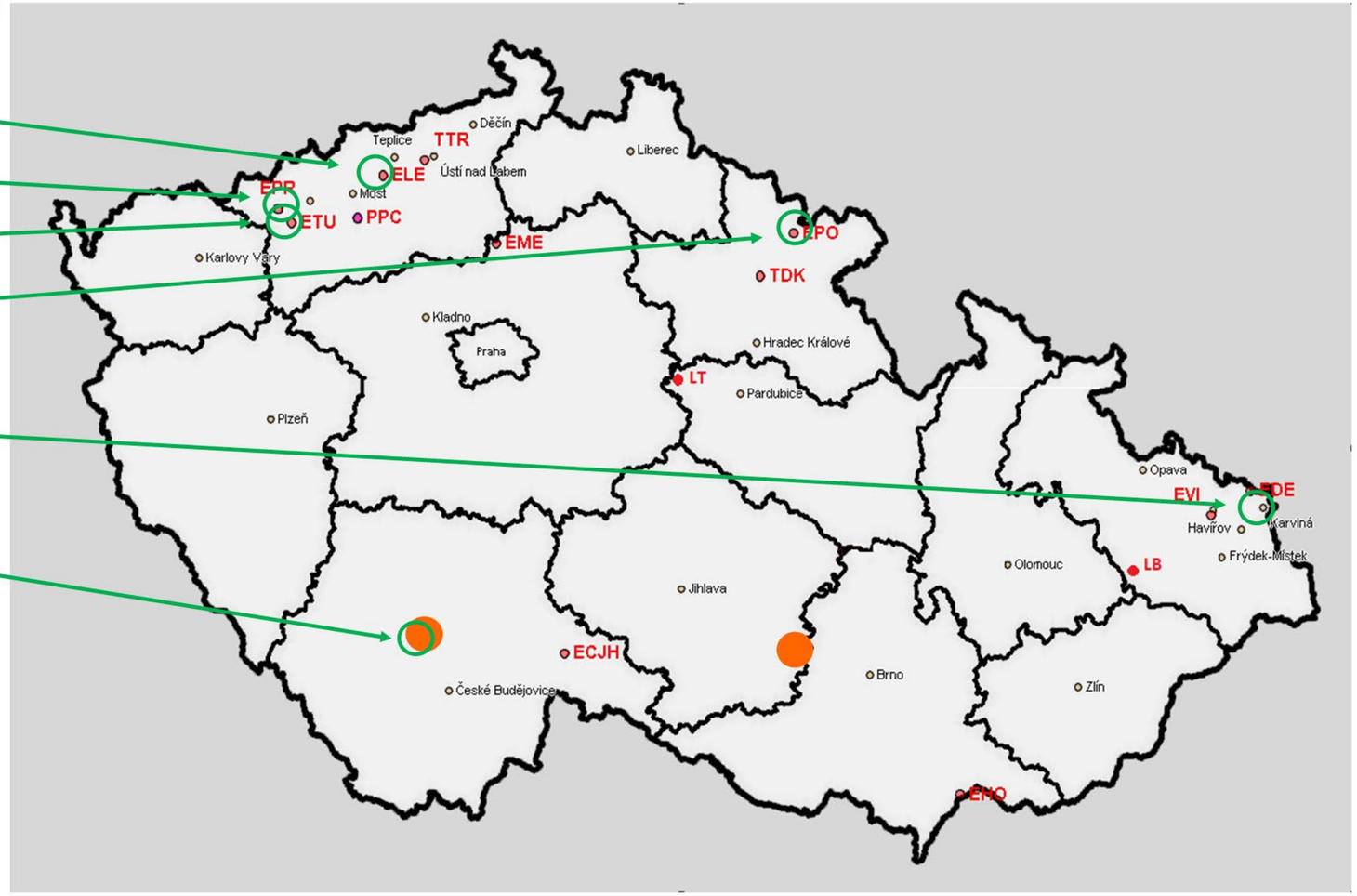
Pre-selected sites for SMRs

- Ledvice
- Prunéřov
- Tušimice
- Poříčí
- Dětmarovice
- Temelin



Current NPPs

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TEMELIN SITE FOR SMR CONSTRUCTION

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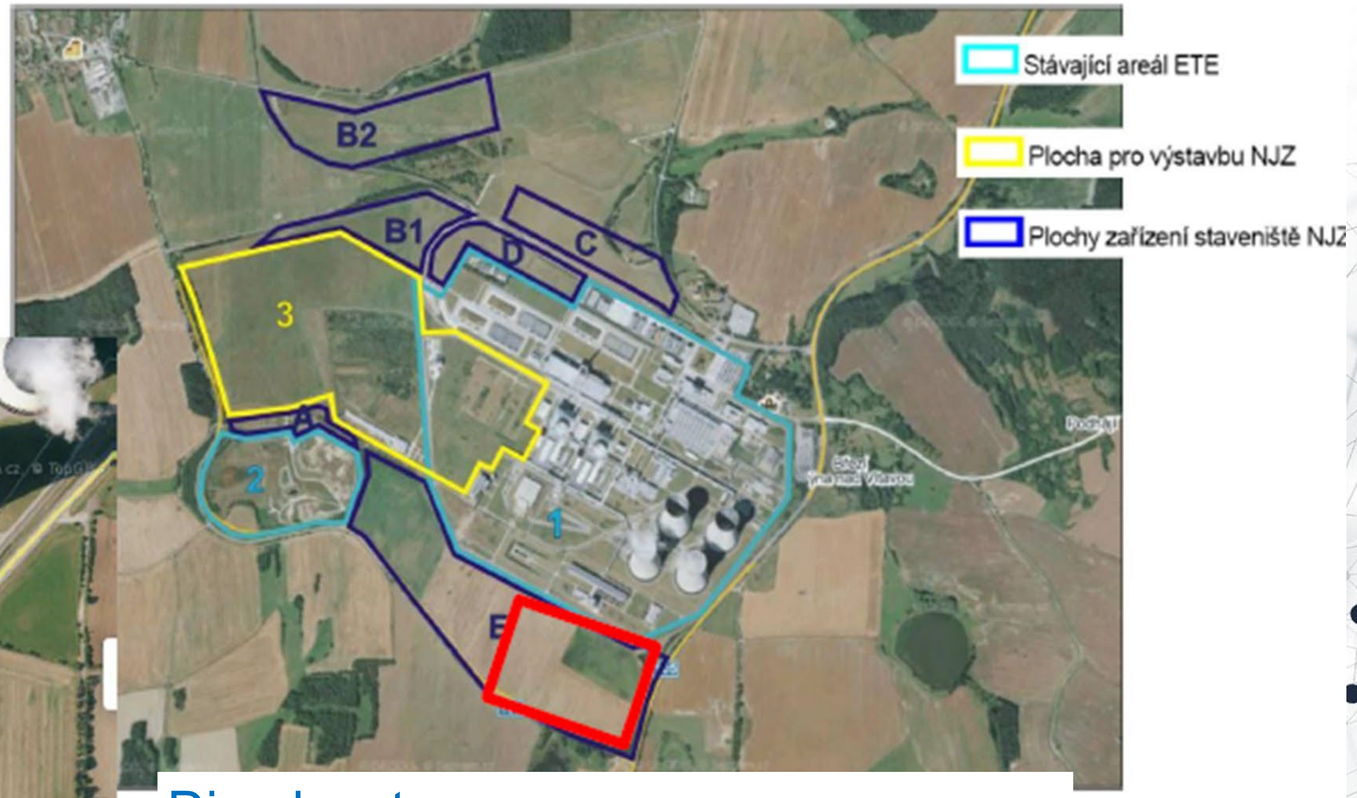
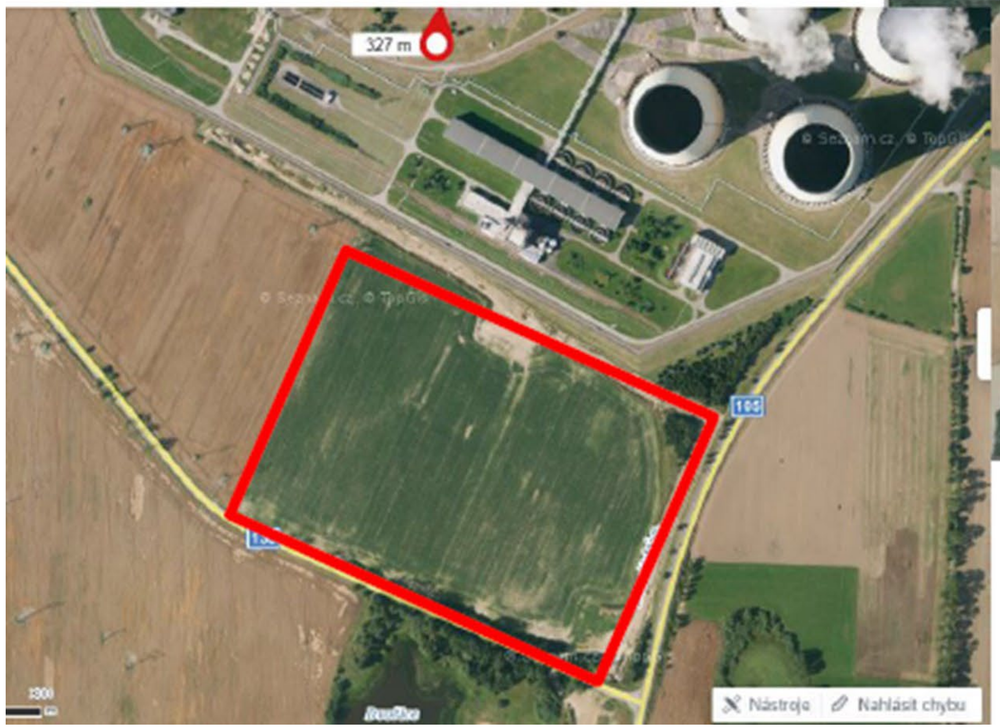
Advantages:

- Close vicinity to existing NPP
- Available area 19 ha
- Convenient geological conditions
- Public support





Disadvantages:

- Potential collision with construction of ETE 3,4
- Limited area

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DEVELOPMENT OF SMR IN THE CZECH REPUBLIC

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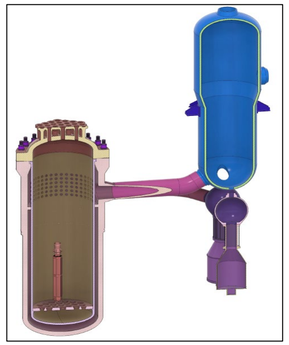
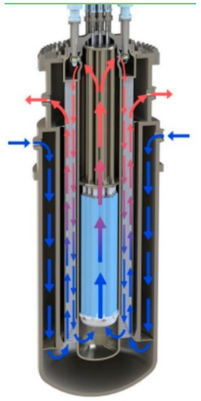
Activities on development of Czech own designs of SMR ongoing

- **PWR projects**
  - DAVID (Witkovitz Group), PWR, 175 MW, vessel-in-vessel ,off-site refueling
  - CR-100 (UJV Group), 100 MWt, SMR based on VVER fuel
- **HWR project**
  - TEPLATOR (West Bohemia University), 200 MW, only heating source, heavy water reactor (use also spent fuel assemblies)
- **Advanced Reactors**
  - Energy Well (CV Rez), 20 MW, cooling by liquid salt, solid fuel
  - ALLEGRO / HeFASTo (V4G4 CoE – UJV Rez + CV Rez), 75 / 200 MW, fast helium cooled reactor



CR-100



DAVID

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DEEP GEOLOGICAL REPOSITORY ROADMAP –NATIONAL POLICY AND GOVERNMENT RESOLUTIONS

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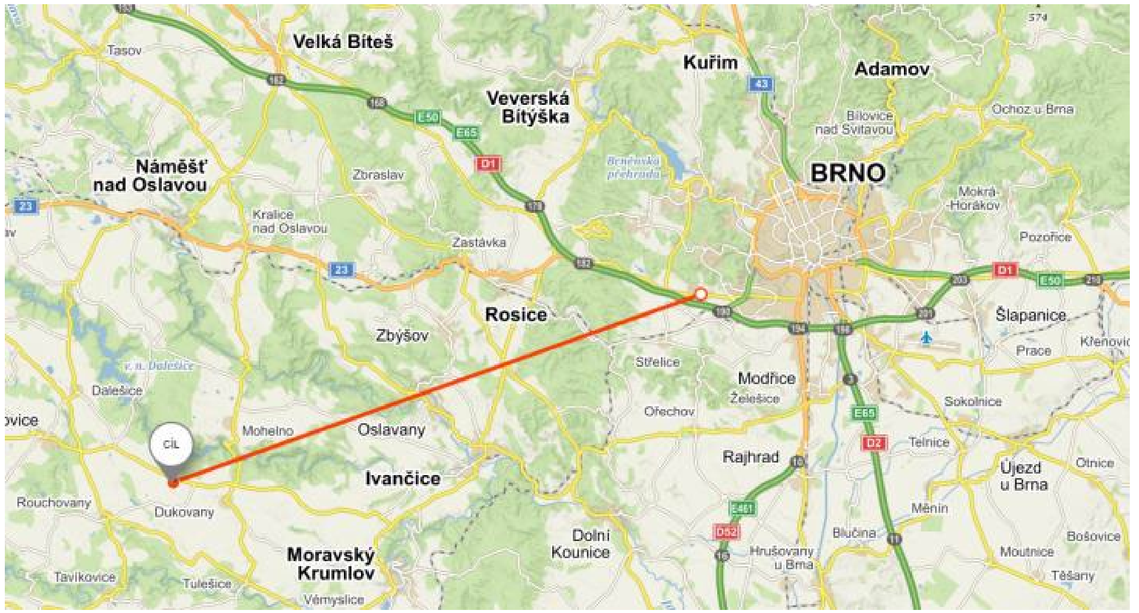
- 4 studied sites,
- Key milestones (National policy, Government Resolutions):
  - 2025+: update of the National Policy
  - 2021-2028: site characterization & site selection (transparent through Advisory Board of Experts of SURAO)
    - ✓ Biological monitoring ongoing+ Geological survey (proposal)
  - 2030+: Site characterization at depth
  - 2040: construction permit
  - EU Taxonomy (proposal by Government): available 2050

NPP DUKOVANY DISTRICT HEATING OF BRNO

- Central heating plants in Brno use natural gas
- The current energy situation led to renewed interest in the possibility of heating from EDU (1st mentioned in 1980s)
- Main engineering works begin in 2024 and the project should be completed by 2030.
- Benefits for climate policy and EDU II political support
- Complicated route (about 40-50 km)



SUMMARY

- Nuclear power demonstrated the capability of effective transition to low-carbon electricity production
- Recent developments demonstrated that without nuclear power transition from fossil fuels is not feasible
- The ideological campaign caused slowing down the development of nuclear power in resulted in lack of energy sources and significant loss of industrial capacities
- The current updated energy concept of the CR envisages roughly half share of nuclear power in electricity production, construction of several large nuclear units are needed
- SMRs have significant potential to complement energy mix mainly due to their multipurpose applications
- SMRs are not considered in CR as a replacement for large units, but complementing the energy mix as a suitable replacement for coal units and for large central heating plants

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THANK YOU FOR YOUR ATTENTION

Jozef.Misak@ujv.cz
Phone: +420 602 293 882

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