AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

# What after coal? Nuclear Energy in Polish Energy transition

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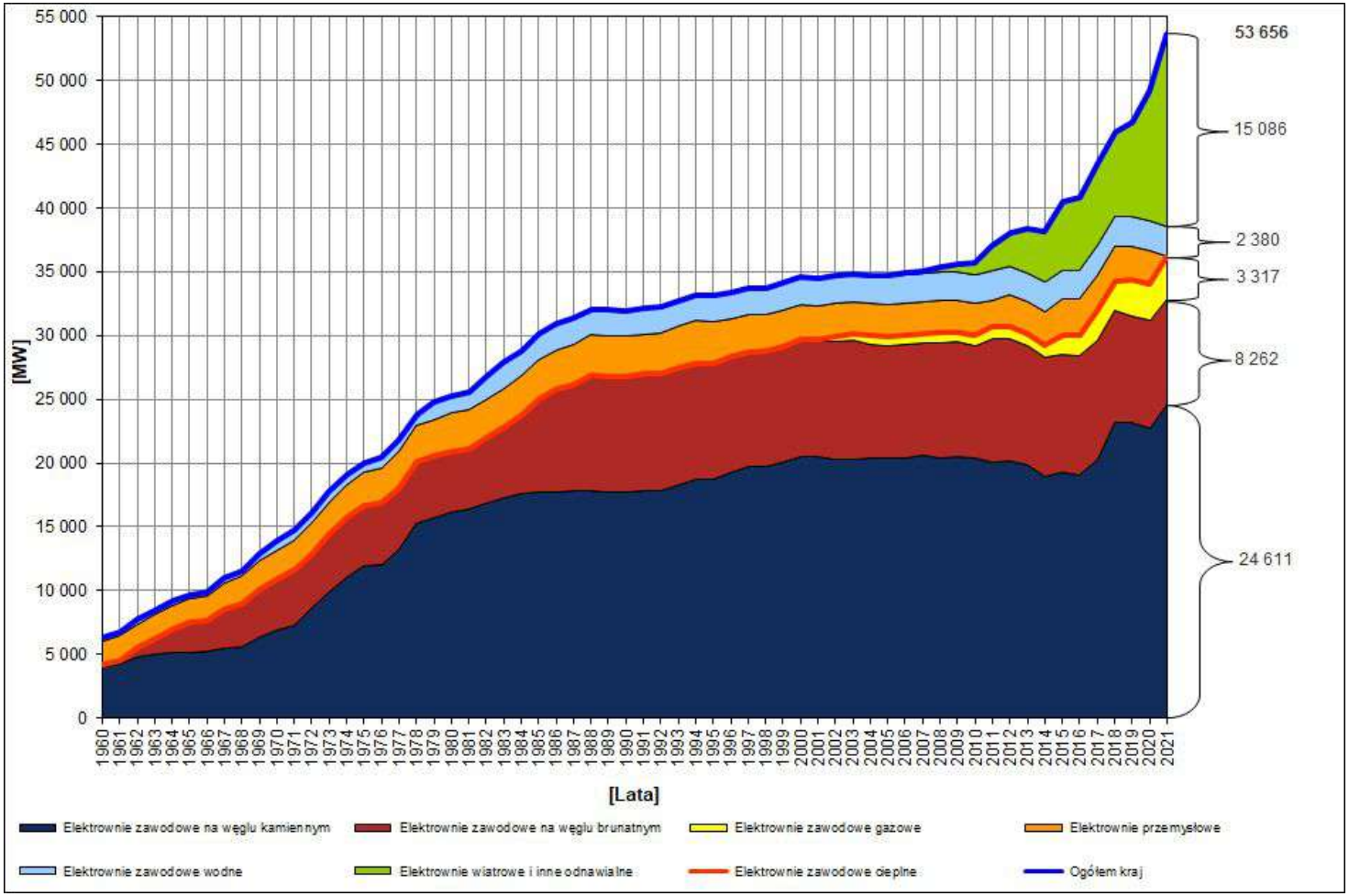
**Faculty of Energy and Fuels**
**Department of Sustainable Energy Development**

**Budapest University of Technology and Economics**
**24.03.2022**

# Current Polish Energy mix

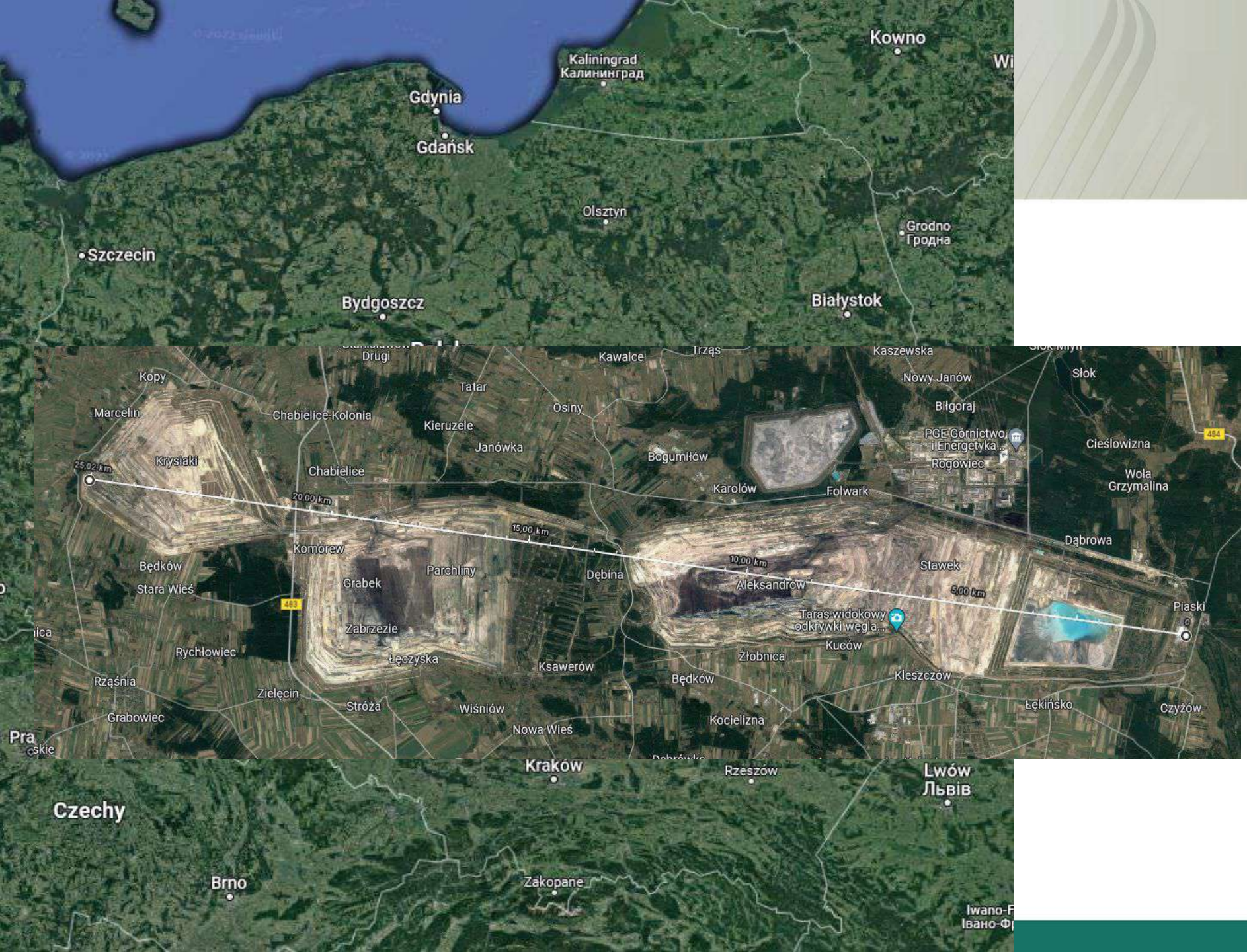
# Current Polish Energy mix



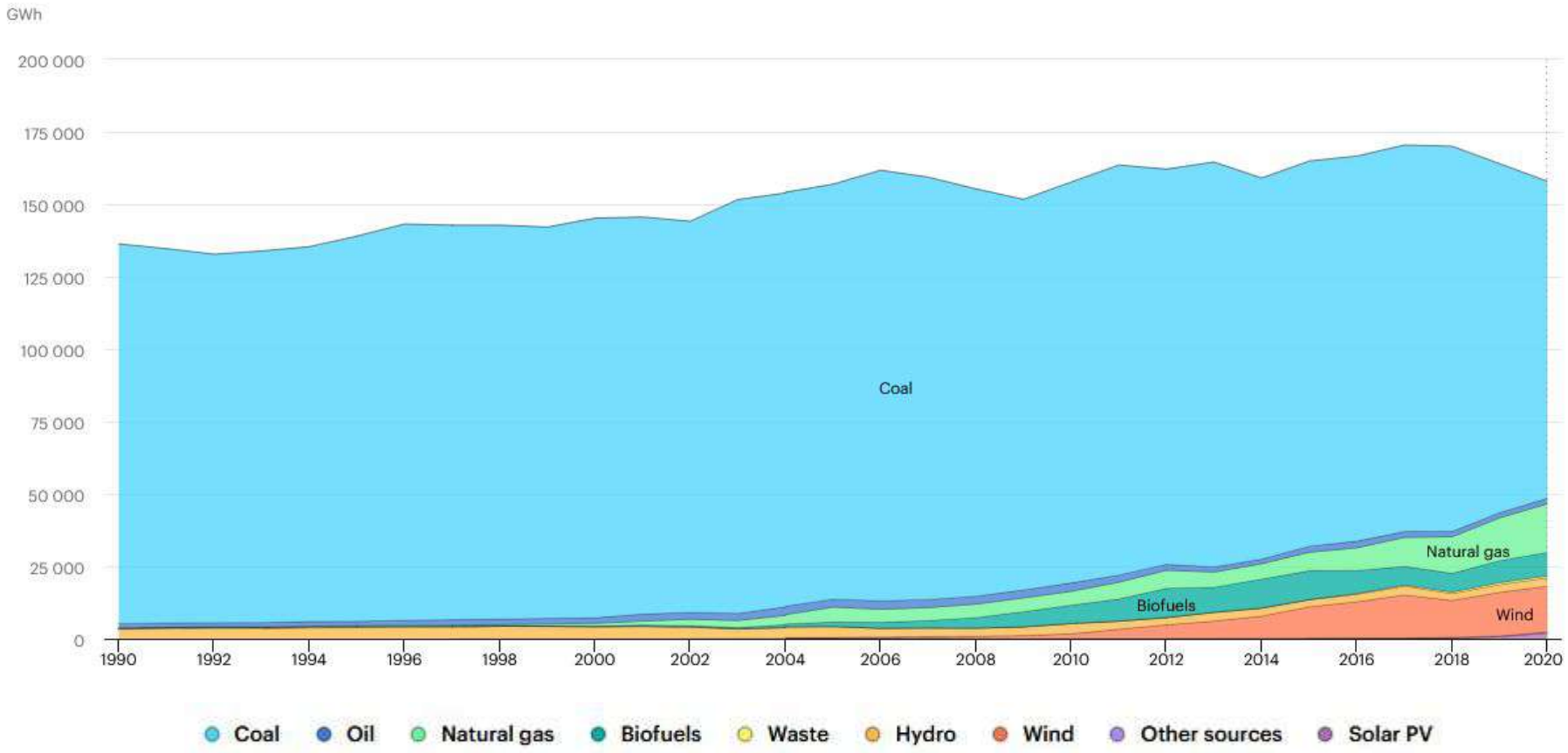

**Net capacity**

**Source: PSE 2022**


**Source: PSE 2022**


Kowno
Kaliningrad
Калининград
Gdynia
Gdańsk
Olsztyn
Grodno
Гродна
Szczecin
Bydgoszcz
Białystok
Drugi
Kawalce
Trząs
Kaszewska
Kopy
Tatar
Nowy Janów
Słok
Marcelin
Chabielice-Kolonia
Osiny
Biłgoraj
Kieruzele
Janówka
PGE Górnictwo i Energetyka...
Cieślowizna
Krysiaki
Bogumiłów
Rogowiec
Chabielice
Wola Grzymalina
Karolów
Folwark
25,02 km
20,00 km
15,00 km
10,00 km
5,00 km
Komorew
Dąbrowa
Będków
Parchliny
Dębina
Stawek
Grabek
Aleksandrów
Stara Wieś
Taras widokowy odkrywki węgla...
Piaski
Zabrzezie
Kuców
Rychłowiec
Łęczyska
Żłobnica
Ksawerów
Rząśnia
Będków
Kleszczów
Zielęcin
Stróża
Wiśniów
Łękińsko
Czyżów
Grabowiec
Kocielizna
Nowa Wieś
Kraków
Rzeszów
Lwów
Львів
Czechy
Brno
Zakopane

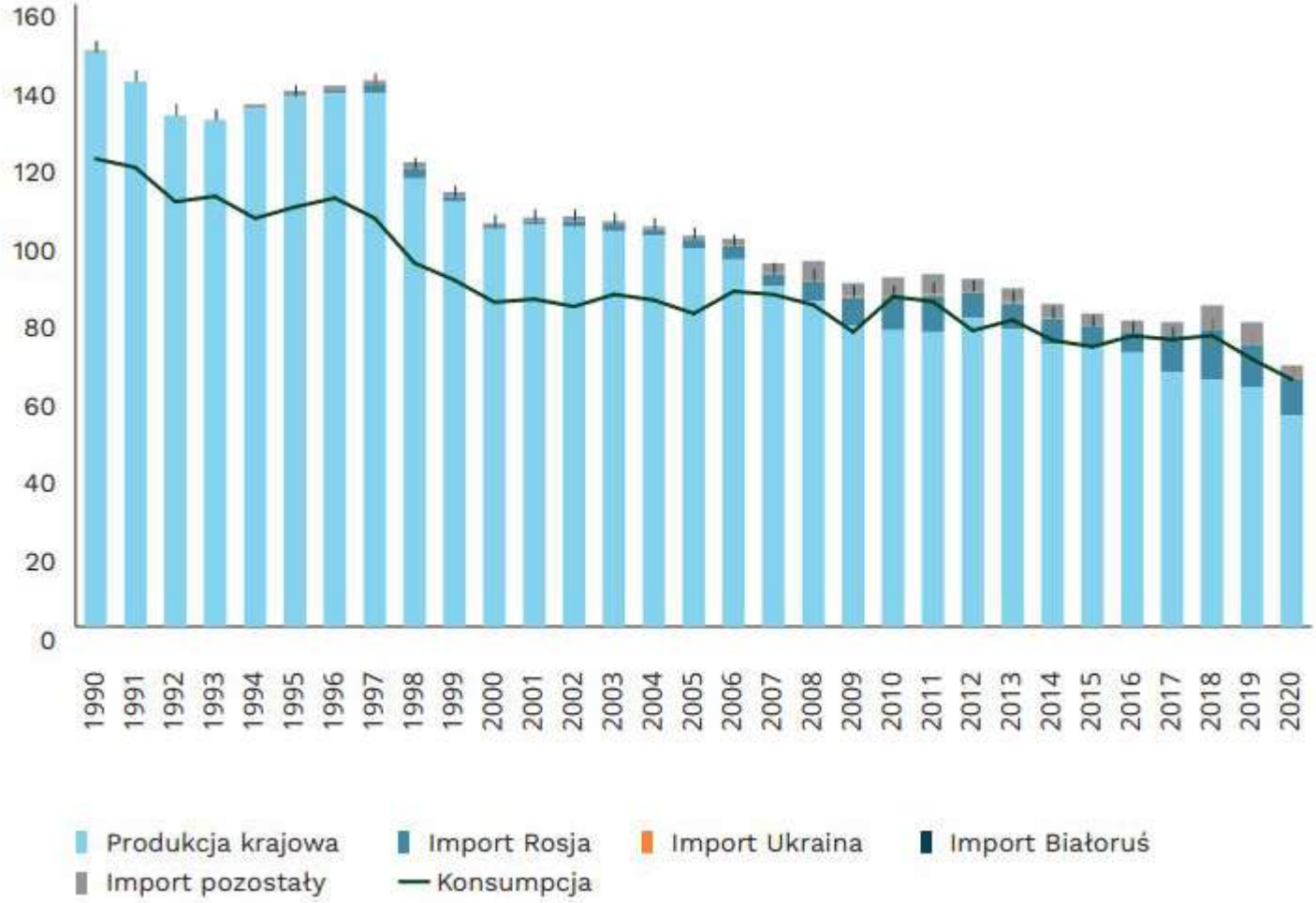
# Current Polish Energy mix




**Energy production**

**Source: IEA 2022**

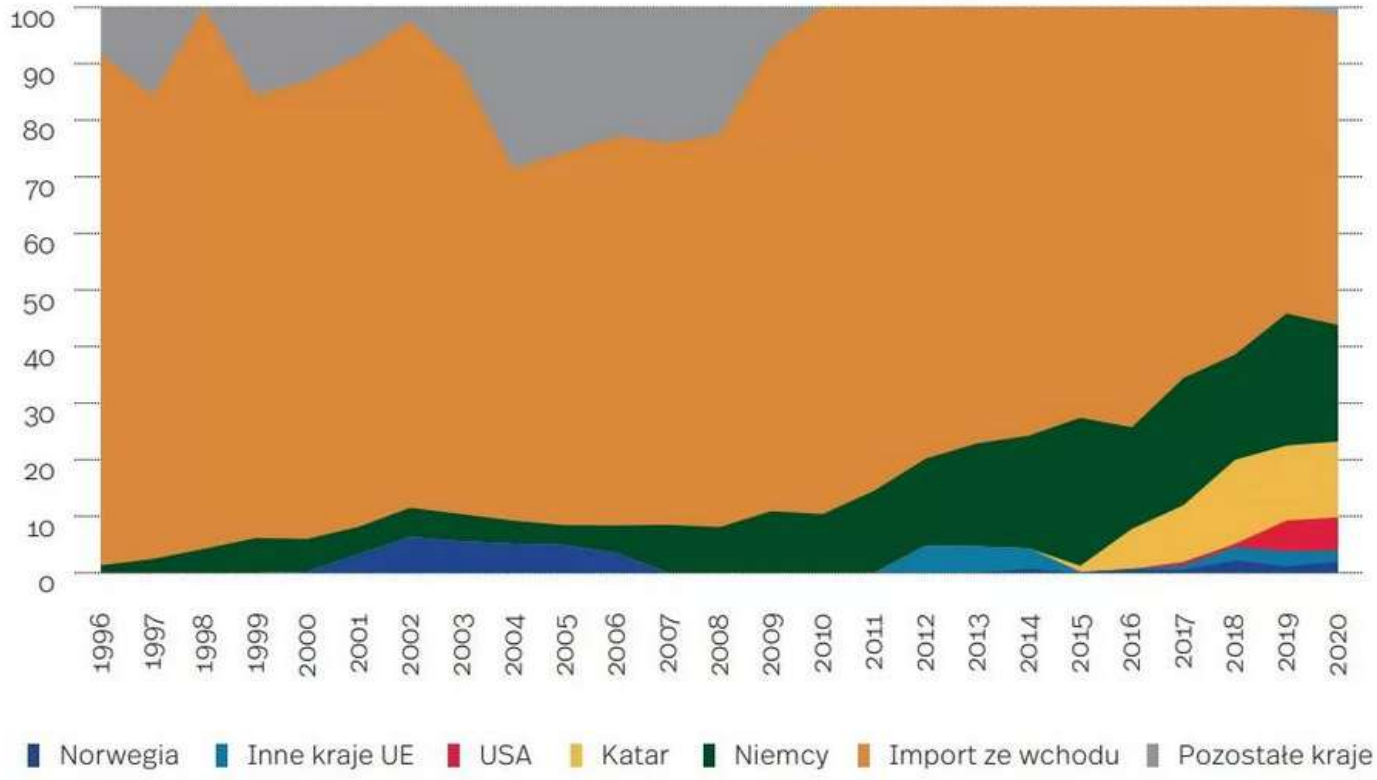
# Current Polish Energy mix




**Coal domestic production and imports (mln t)**

**Source: WNP 2021**

# Current Polish Energy mix




**Natural gas imports**

**Consumption in 2020: 213 TWh**

**Increase 2020/19: 4,4%**

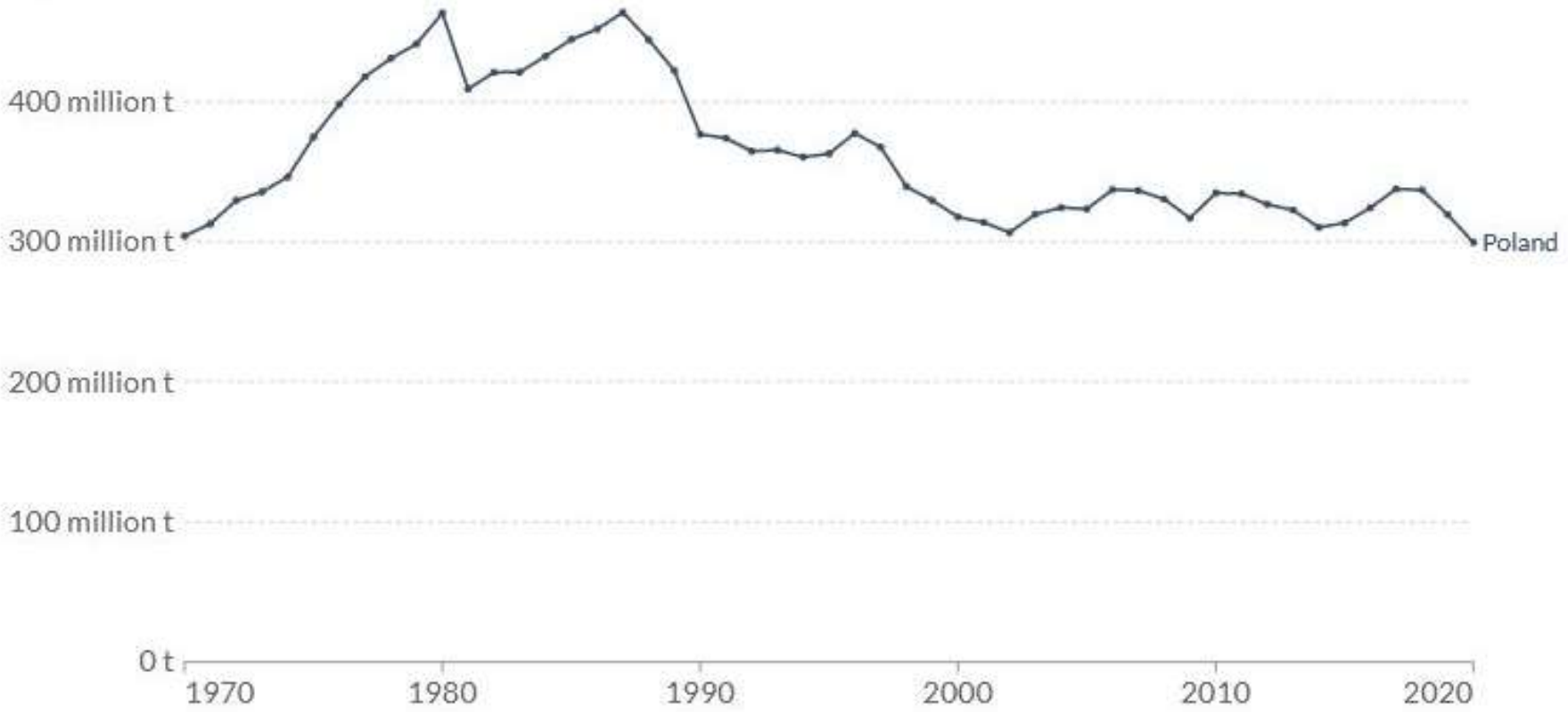
**Domestic production: 43,7 TWh**

**Source: PIE 2021**

# Current Polish Energy mix

**LNG terminal in Świnoujście**

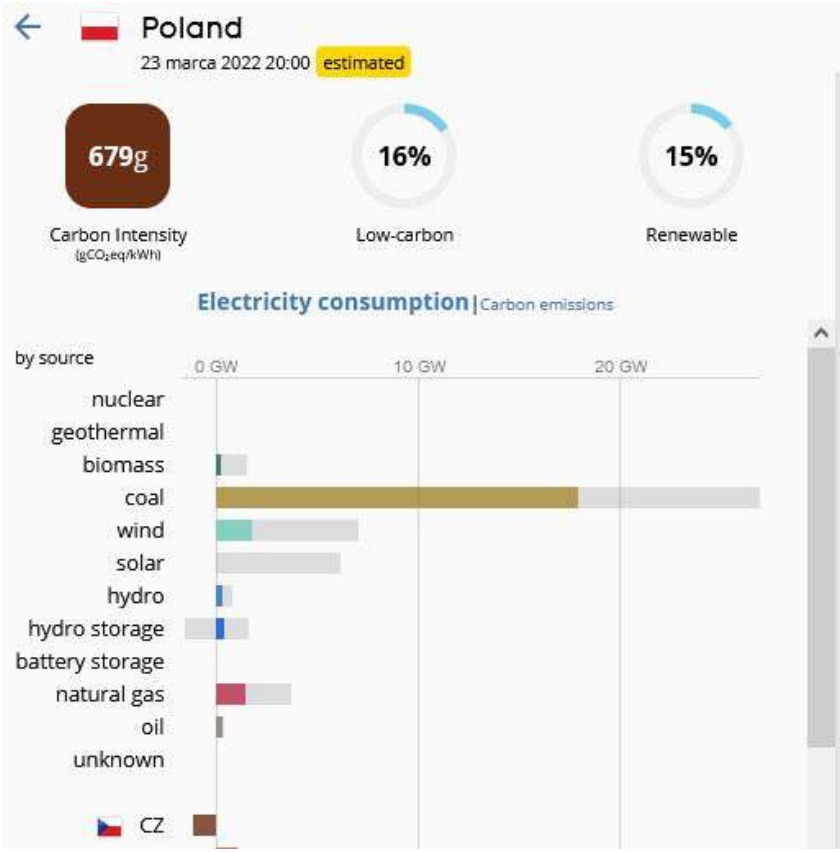
# Current Polish Energy mix

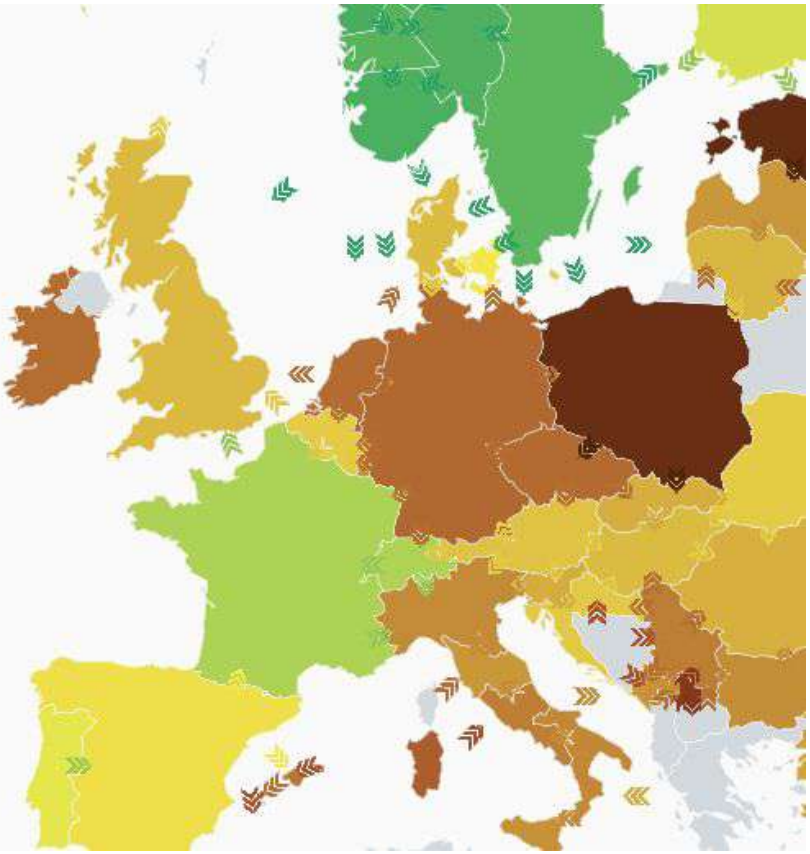



$CO_2$ emissions

Source: IEA 2022

# Current Polish Energy mix



$CO_2$ emissions

Source: Electicitymap.org 2022

# Current Polish Energy mix

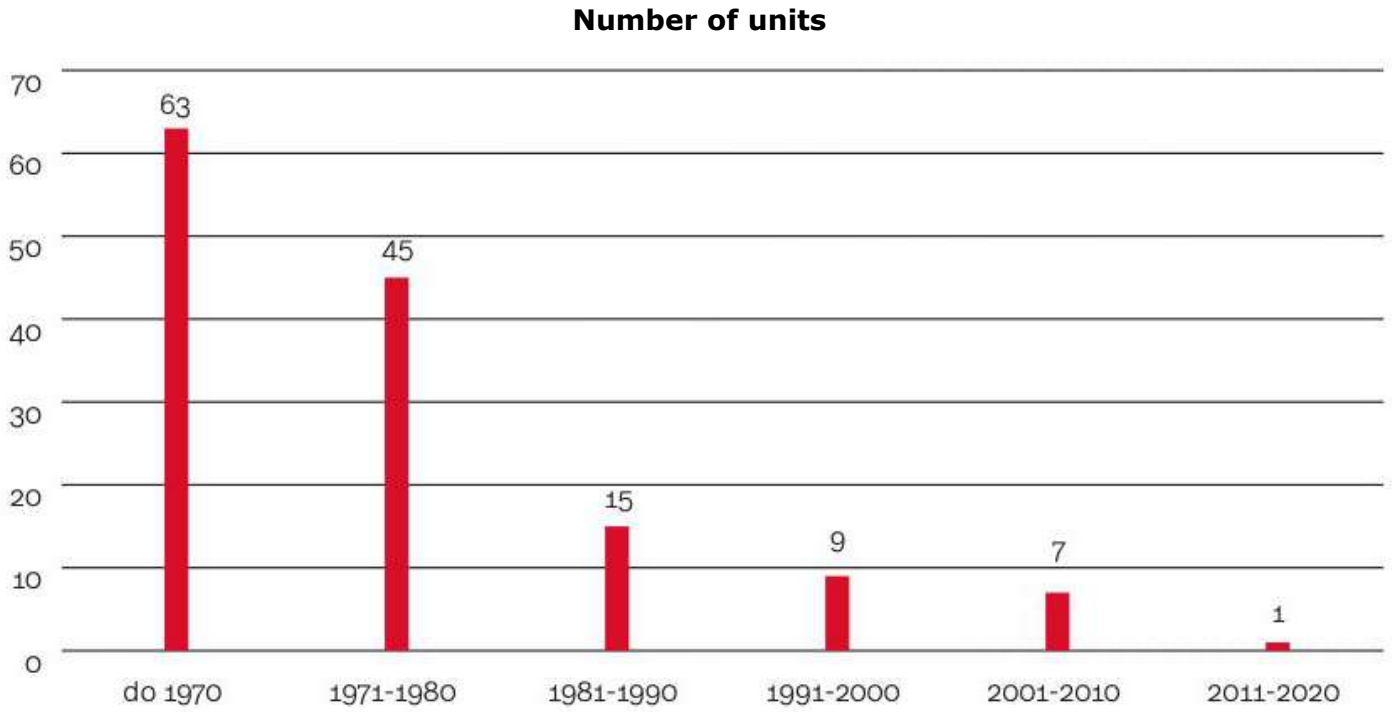

**Air quality index**

**Source: Airly.pl 2022**

# Key challenges for Polish energy sector

**30% of installed power over 50 years old**
**35% of installed power 40-50 years old**

## Ageing fleet




**Source: CIRE 2021**

# Key challenges for Polish energy sector

**Ageing fleet**

**High CO2 emissions**

**Security of supply**

# Energy Policy of Poland until 2040

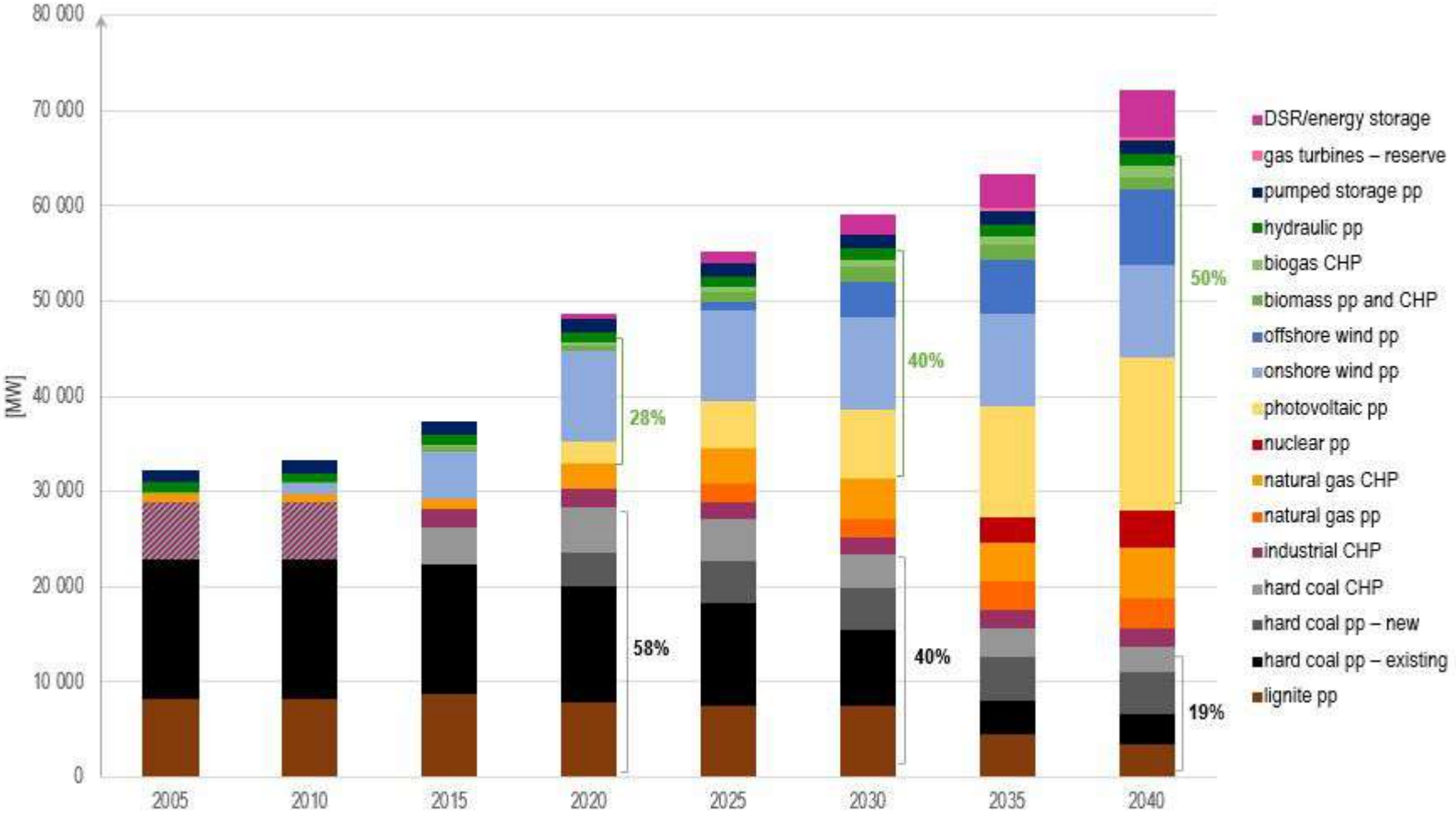
# Energy Policy of Poland until 2040


**Adopted in February 2021**

# Energy Policy of Poland until 2040

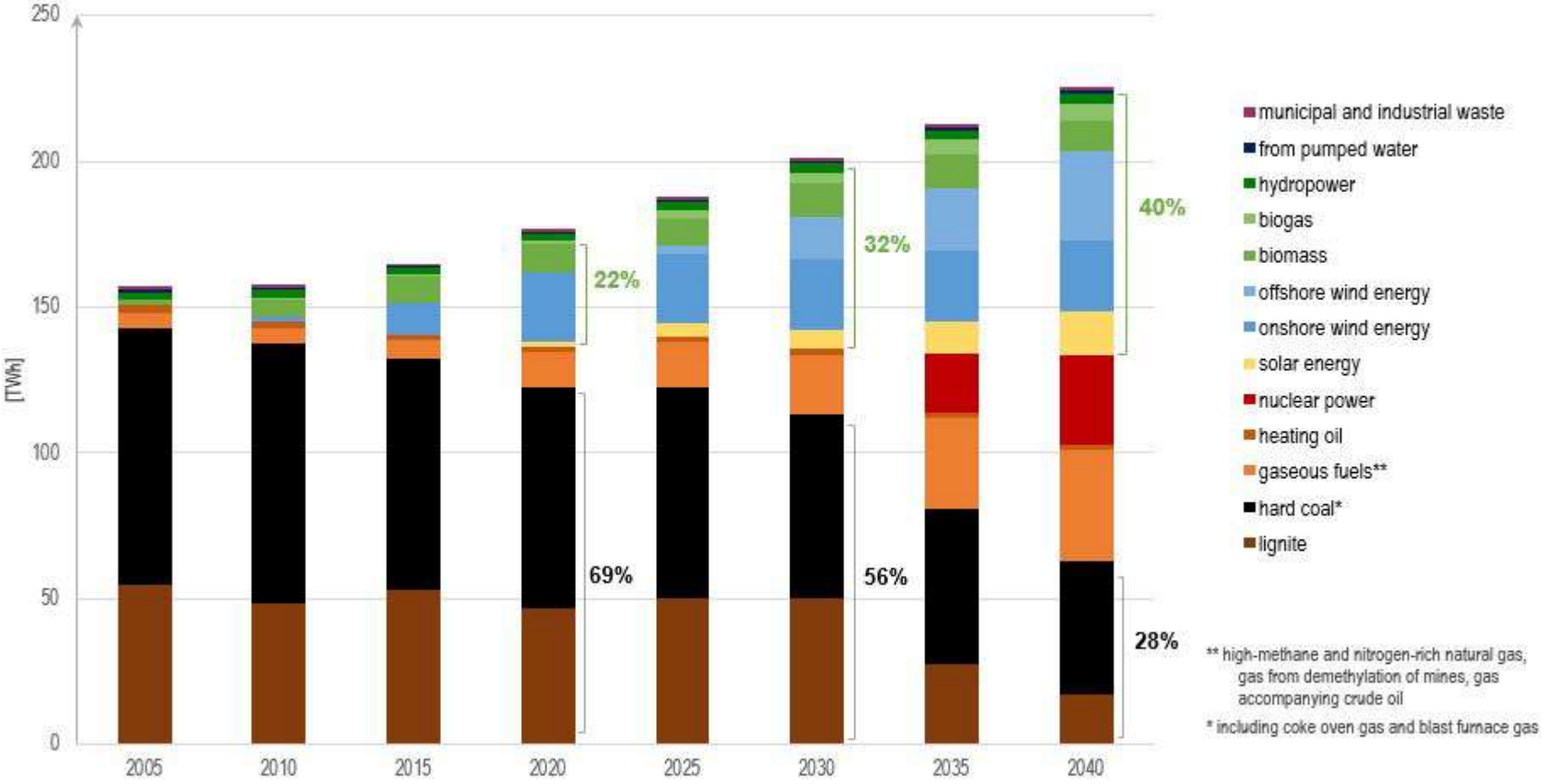
| | | |
|---|---|---|
| Specific Objective 1.<br>**Optimal use of own energy resources** | Specific Objective 2.<br>**Expansion of electricity generation and grid infrastructure** | Specific Objective 3.<br>**Diversification of supply and development of network infrastructure for natural gas, crude oil and liquid fuels** |
| Strategic Project 1.<br>**Transition of coal regions** | Strategic Project 2A.<br>**Capacity market,**<br>Strategic Project 2B. **Implementation of smart grids** | Strategic Project 3A.<br>**Construction of the Baltic Pipe**<br>Strategic Project 3B.<br>**Construction of Line 2 of the Pomeranian Pipeline** |
| Specific Objective 4.<br>**Development of energy markets** | Specific Objective 5.<br>**Implementation of nuclear power** | Specific Objective 6.<br>**Development of renewable energy sources** |
| Strategic Project 4A.<br>**Implementation of the Action Plan** (to increase cross-border electricity transmission capacity)<br>Strategic Project 4B. **Gas hub,**<br>Strategic Project 4C. **Development of electromobility** | Strategic Project 5.<br>**Polish Nuclear Power Programme** | Strategic Project 6.<br>**Implementation of offshore wind energy** |
| Specific Objective 7.<br>**Development of district heating and cogeneration** | Specific Objective 8.<br>**Improvement of energy efficiency** | |
| Strategic Project 7.<br>**Development of district heating** | Strategic Project 8.<br>**Promoting energy efficiency improvement** | |

# Energy Policy of Poland until 2040




**Net capacity**

# Energy Policy of Poland until 2040




**Electricity production**

# History of Polish nuclear programme

# First nuclear programme

**Office of Government Plenipotentiary for Use of Nuclear Energy established in 1956**

**Plans form early 1960s:**

**1966-1970:**
**5 research reactors**
**Pilot power plant 5-25 MWe**

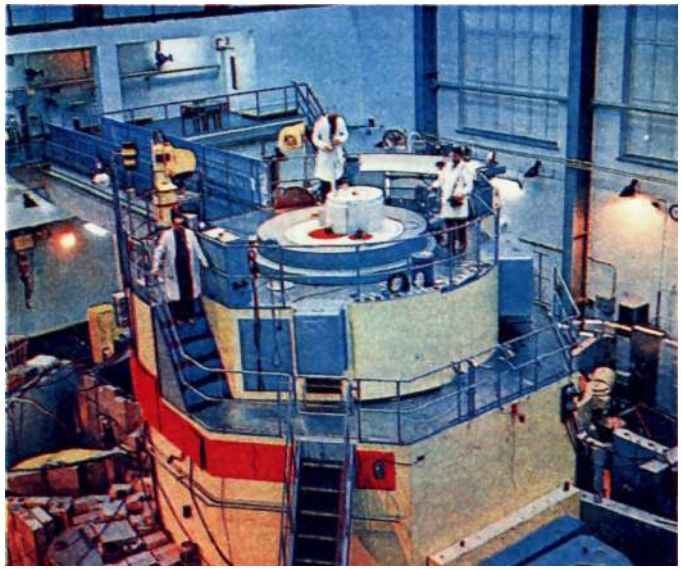
**1971-1975:**
**3 research reactors**
**Pilot FBR 5 MW**
**2 NPPs 200-300 Mwe**
**Nuclear powered ship**

**1976-1980:**
**Pilot HTR 20 MWe**
**2 NPPs 400-600 Mwe**
**2 Nuclear powered ships**

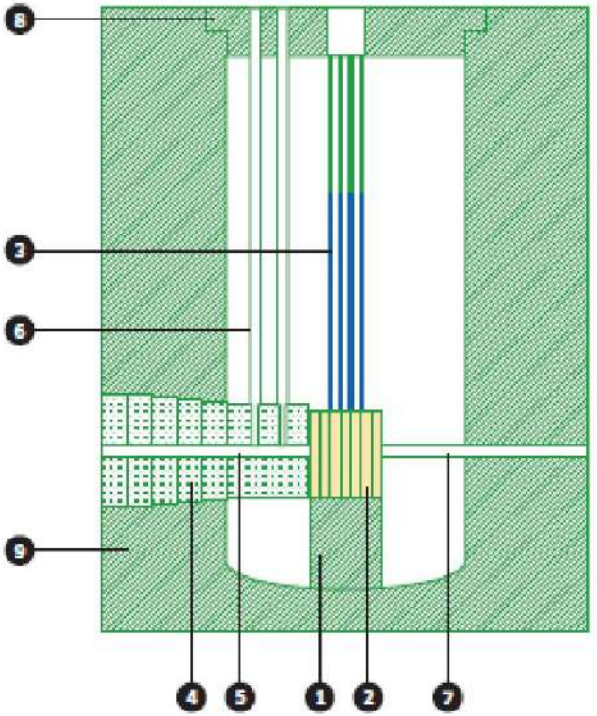
# First nuclear programme

## EWA Reactor

1958
10 MW



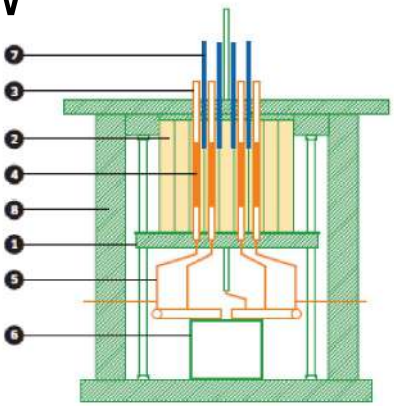
1. Core support
2. Reactor core
3. Control rod channels
4. Thermal column
5. Horizotal channel ø 100 mm in thermal column
6. Vertical channel ø 80 mm in thermal column
7. Horizotal channel ø 100 mm
8. Cover plate
9. Shielding



# First nuclear programme

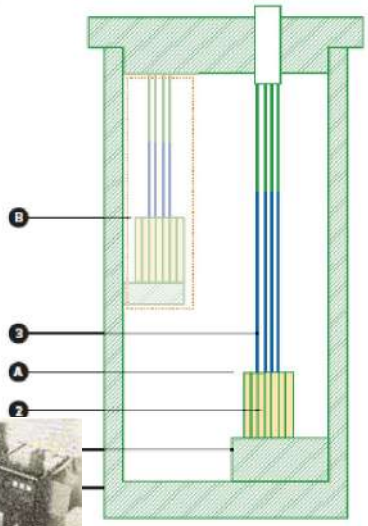
## ANNA Reactor

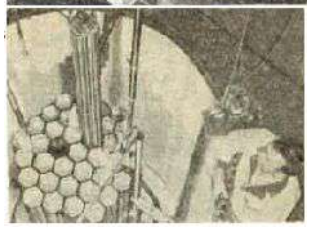
1963
100 W



## MARYLA Reactor

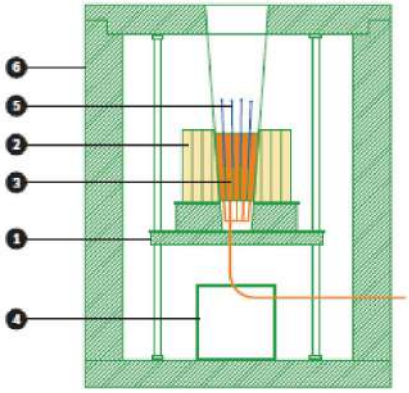
1963
250 W

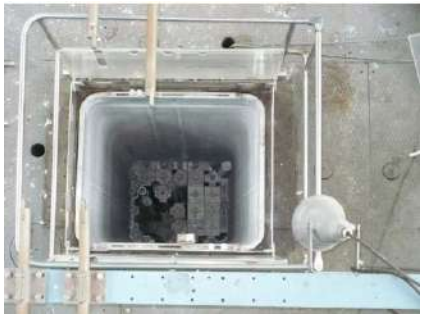




## AGATA Reactor

1973
10 W

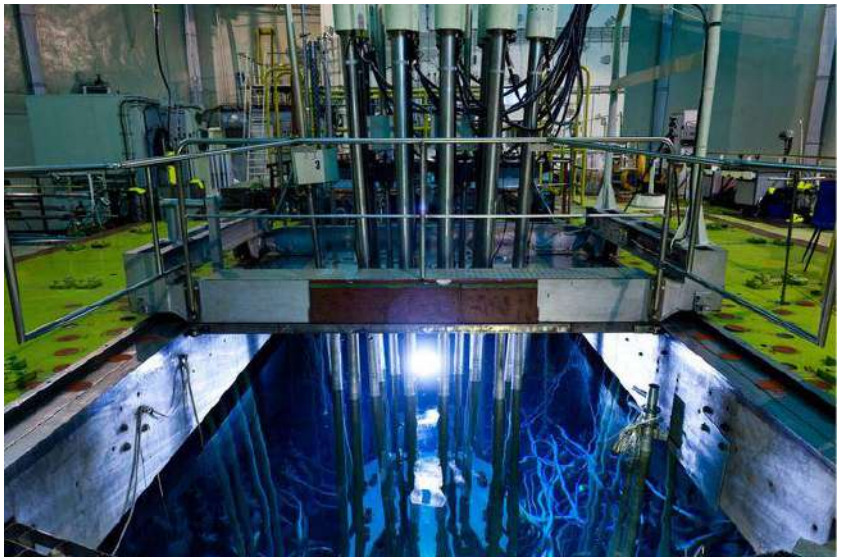


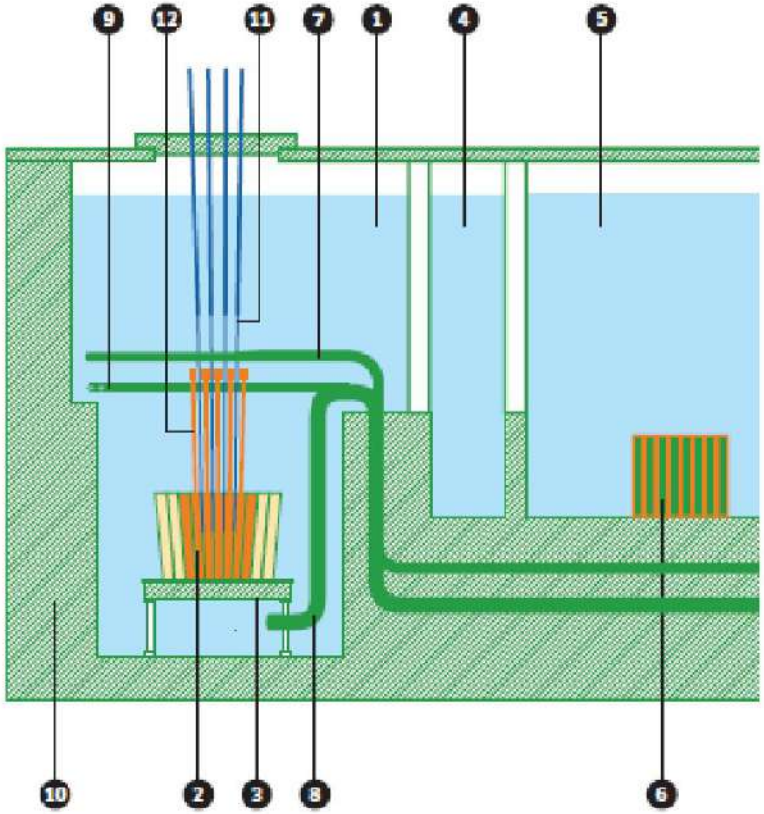


# First nuclear programme

## MARIA Reactor

1974
30 MW





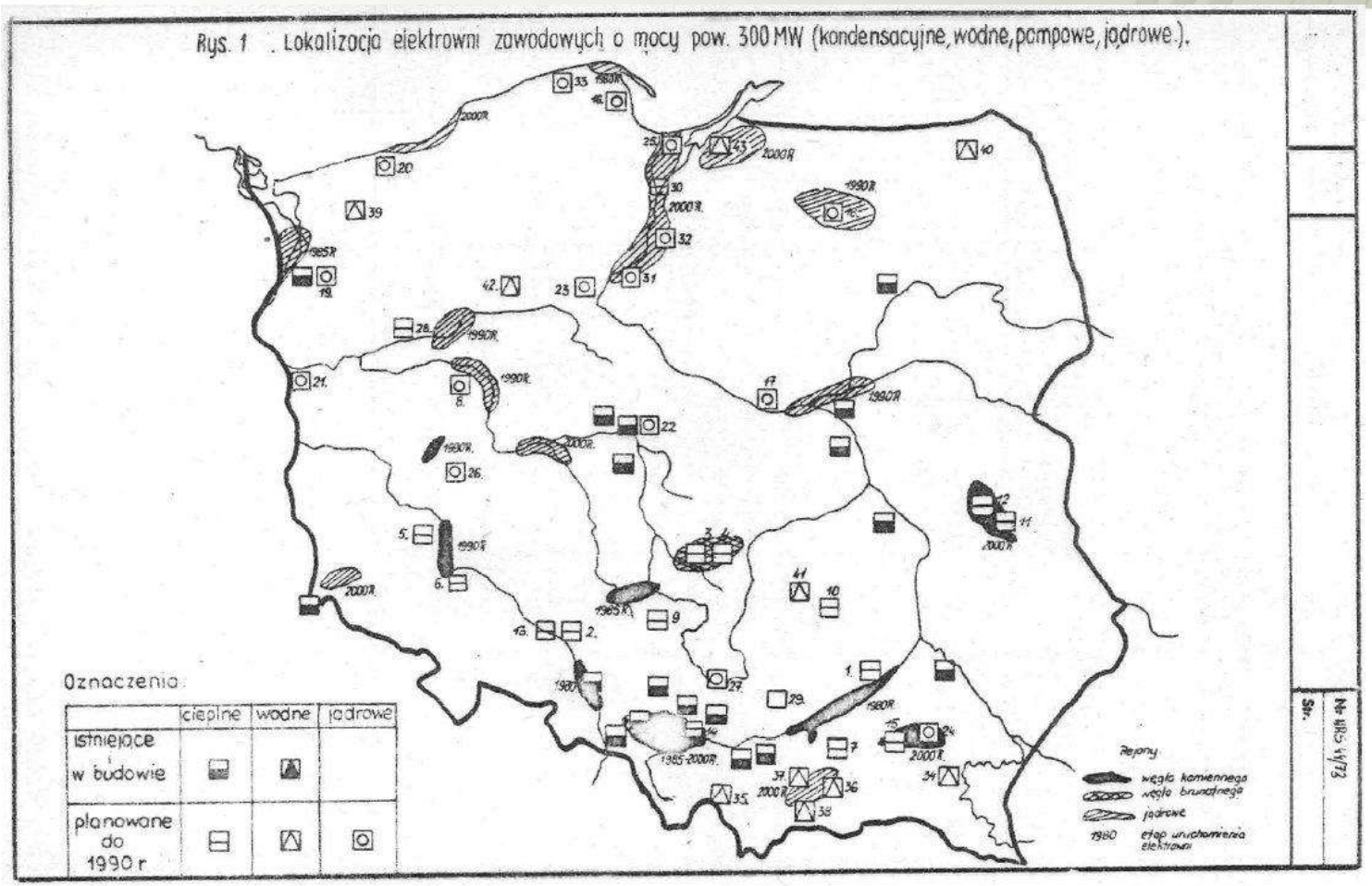
# Second nuclear programme

**Office of Nuclear Energy established in 1973**

**Nuclear regulatory body (PAA) established in 1982**

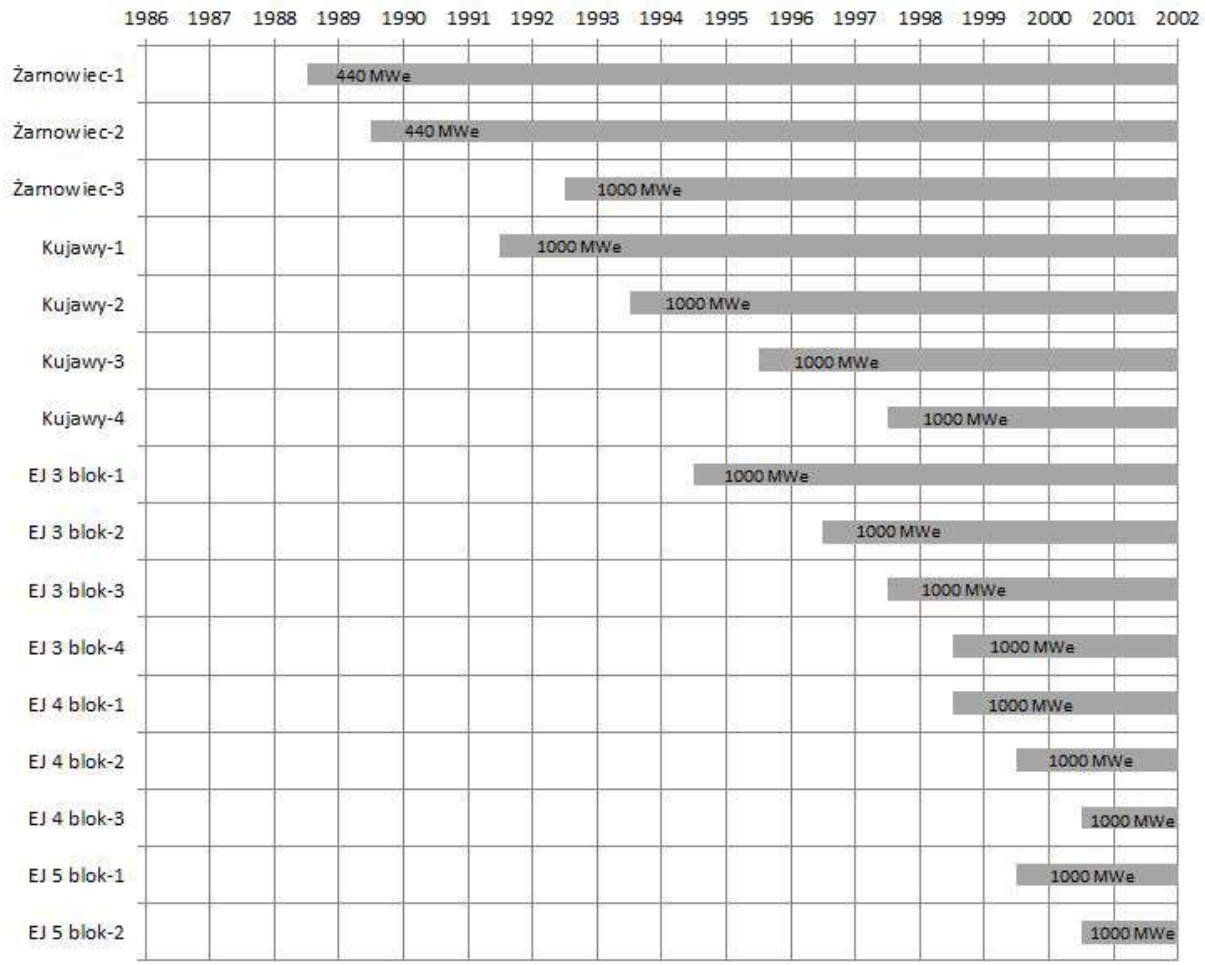
**Atomic law established in 1986**

# Second nuclear programme



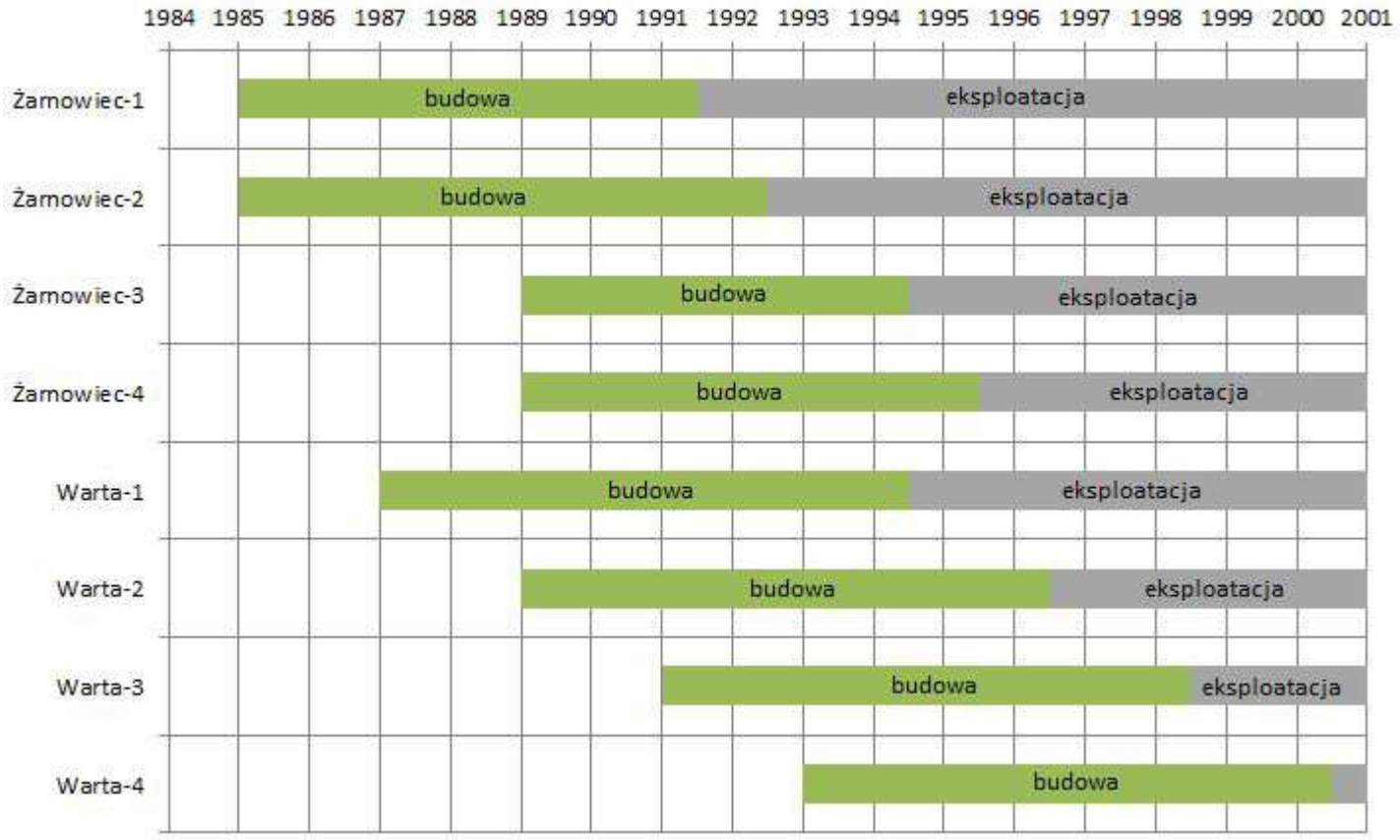

1973 map with potential sites

# Second nuclear programme




**1981 startup schedule**

# Second nuclear programme




**1988 construction and startup schedule**

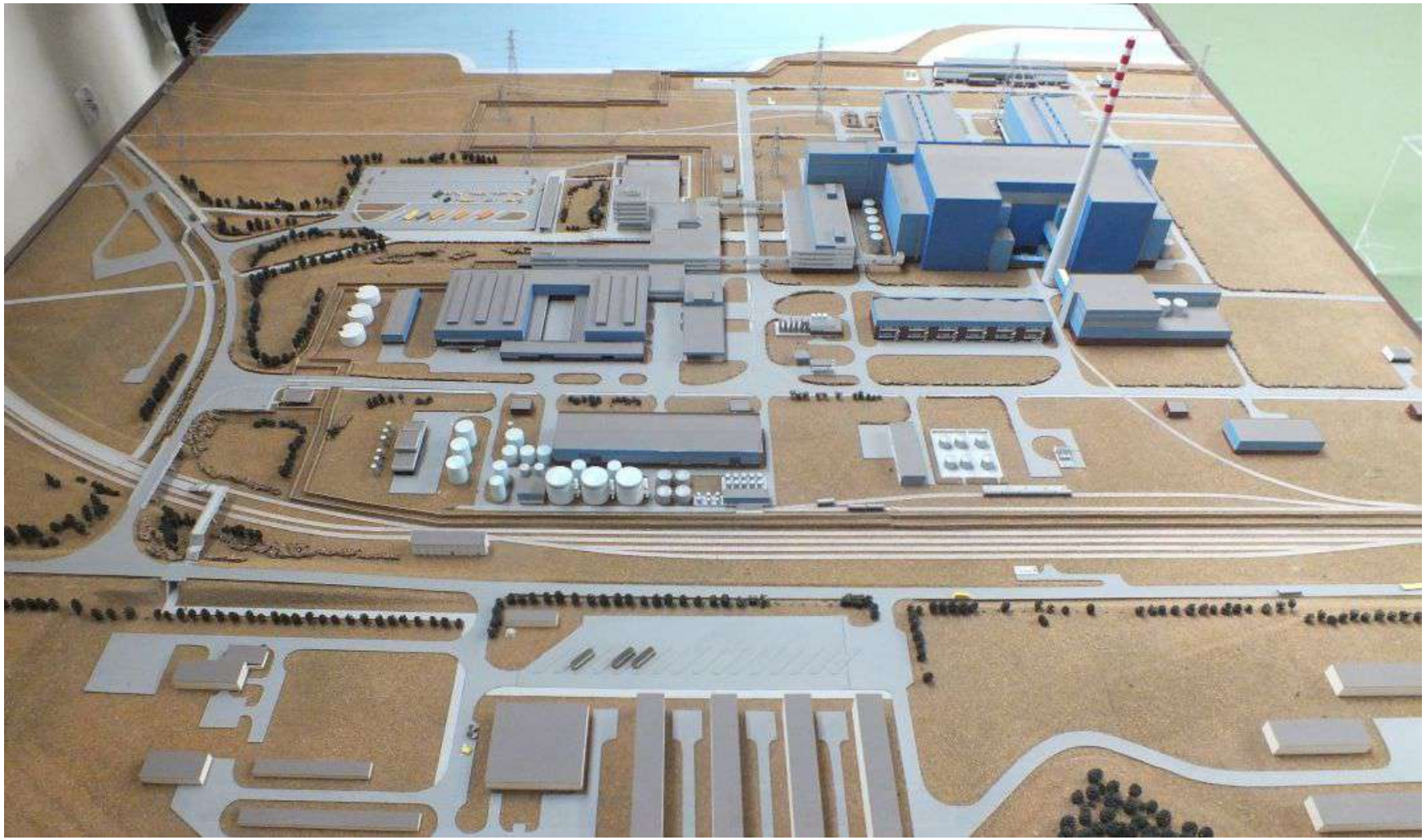
# Second nuclear programme

## Żarnowiec NPP

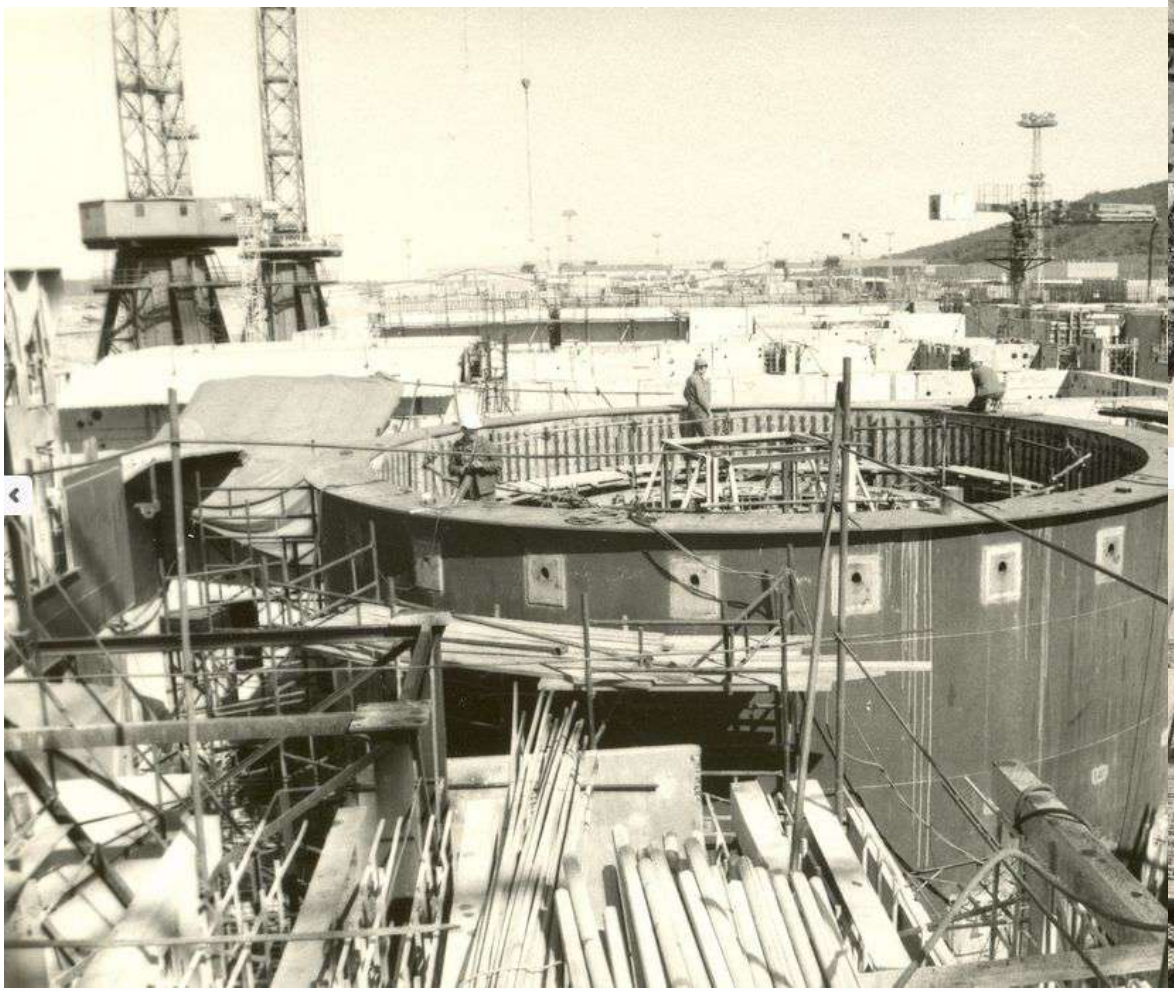
| Unit | Reactor type | Net power (MWe) | Construction start | Scheduled startup |
|---|---|---|---|---|
| 1 | WWER-440/213 | 427 | 10.12.1985 | 31.12.1991 |
| 2 | WWER-440/213 | 427 | 10.12.1985 | 31.12.1992 |
| 3 | WWER-440/213 | 427 | Earthworks only | 31.12.1994 |
| 4 | WWER-440/213 | 427 | Earthworks only | 31.12.1995 |

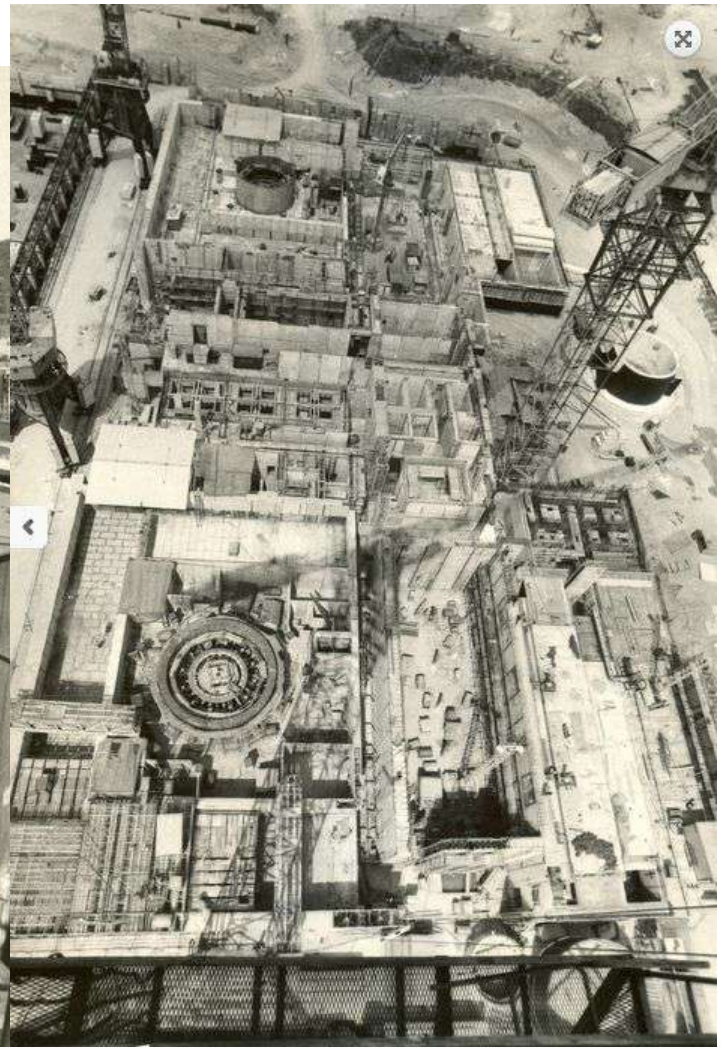
**Cancelled 07.12.1991**

# Second nuclear programme



# Second nuclear programme





# Second nuclear programme

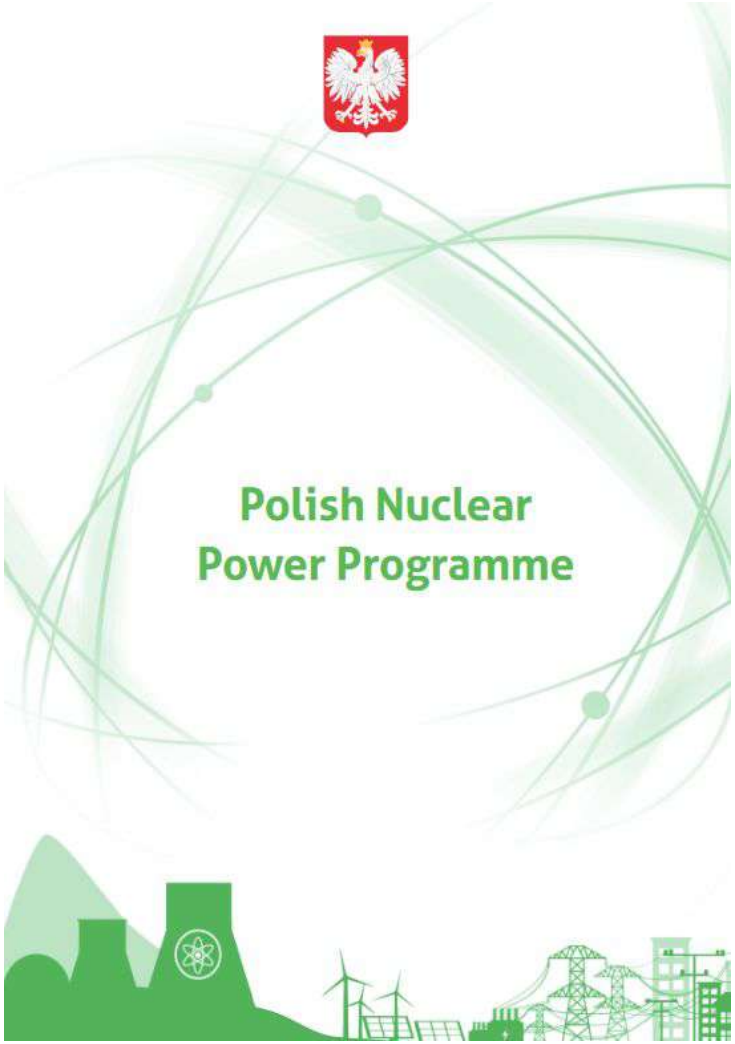

# Third nuclear programme

**Third time's a charm**

**Omne trinum perfectum**

# Polish nuclear power programme

# Polish nuclear power programme



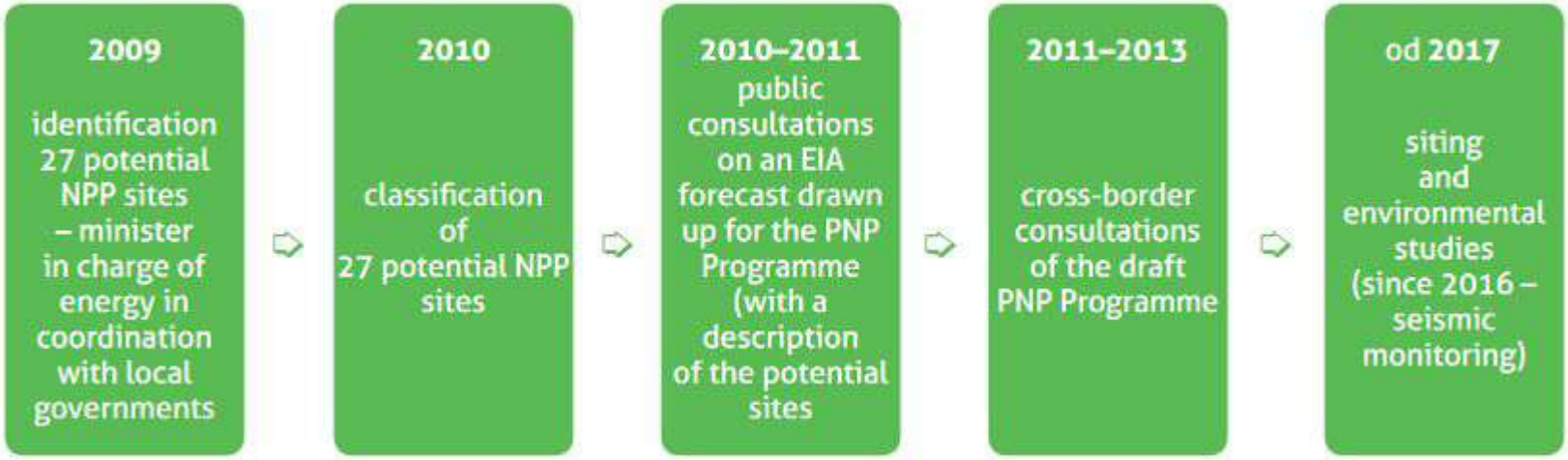

**Adopted in October 2020**

**First unit operational in 2033**

**6 units (6-9 Gwe) operational in 2033**

**Proven designs, large (>1 Gwe), PWR**

# History


2009
identification 27 potential NPP sites – minister in charge of energy in coordination with local governments
2010
classification of 27 potential NPP sites
2010–2011
public consultations on an EIA forecast drawn up for the PNP Programme (with a description of the potential sites
2011–2013
cross-border consultations of the draft PNP Programme
od 2017
siting and environmental studies (since 2016 – seismic monitoring)

# Potential sites

# Schedule

| | |
|---|---|
| **2021** | – selection of technology for NPP1 and NPP2 |
| **2022** | – obtaining the environmental and location decisions for NPP1 (approval of NPP1 location site choice) |
| | – signing the contract with the technology provider and the main EPC contractor |
| **2023** | – commencement of preliminary and preparatory work at NPP1 site |
| | – signing the connection agreement with the TSO for NPP1 |
| | – commencement of work on the selection of site location for NPP2 |
| **2025** | – issuance of the building permit for NPP1 by PAA President |
| **2026** | – obtaining the building permit and commencement of NPP1 construction |
| **2028** | – obtaining the environmental and location decisions for NPP2 (approval of NPP2 location site choice) |
| **2029** | – commencement of preliminary and preparatory work at NPP2 site |
| | – signing the connection agreement with the TSO for NPP2 |
| **2031** | – issuance of the building permit for NPP2 by PAA President |
| **2032** | – issuance of the start-up permit by PAA President, nuclear start-up and synchronisation of the first reactor at NPP1 |
| | – obtaining the building permit and commencement of NPP1 construction |
| **2033** | – issuance of the operation permit by PAA President and commissioning of the first reactor at NPP1 |

# Schedule

| | |
|---|---|
| 2034 | – issuance of the start-up permit by PAA President, nuclear start-up and synchronisation of the second reactor at NPP2 |
| 2035 | – issuance of the operation permit by PAA President and commissioning of the second reactor at NPP1 |
| 2036 | – issuance of the start-up permit by PAA President, nuclear start-up and synchronisation of the third reactor at NPP2 |
| 2037 | – issuance of the operation permit by PAA President and commissioning of the third reactor at NPP1 |
| 2038 | – issuance of the start-up permit by PAA President, nuclear start-up and synchronisation of the first reactor at NPP2 |
| 2039 | – issuance of the operation permit by PAA President and commissioning of the first reactor at NPP2 |
| 2040 | – issuance of the start-up permit by PAA President, nuclear start-up and synchronisation of the second reactor at NPP2 |
| 2041 | – issuance of the operation permit by PAA President and commissioning of the second reactor at NPP2 |
| 2042 | – issuance of the start-up permit by PAA President, uclear start-up and synchronisation of the third reactor at NPP2 |
| 2043 | – issuance of the operation permit by PAA President and commissioning of the third reactor at NPP2 |

# Technology

framatome

**EPR – European Pressurised Reactor**

**Electric power: 1650 MW**

**Thermal power: 4500 MW**

**Number of loops: 4**

# Technology

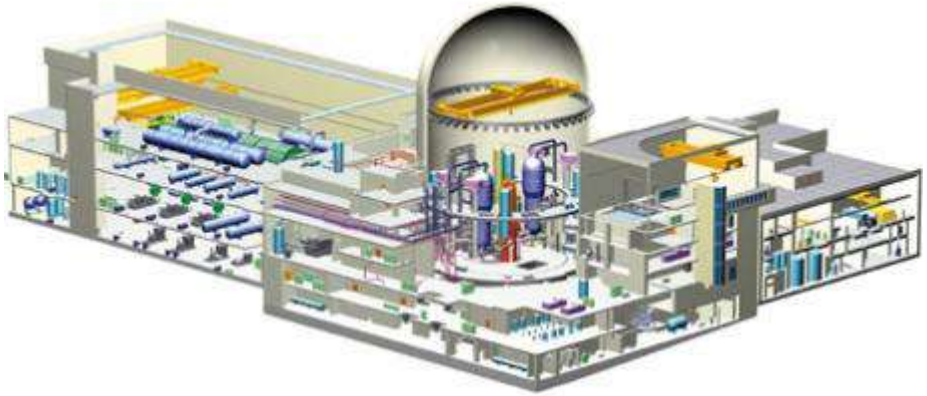
한국전력공사
KOREA ELECTRIC POWER CORPORATION

**APR-1400 – Advanced Pressurised Reactor**

**Electric power: 1400 MW**

**Thermal power: 4000 MW**

**Number of loops: 2**



# Technology

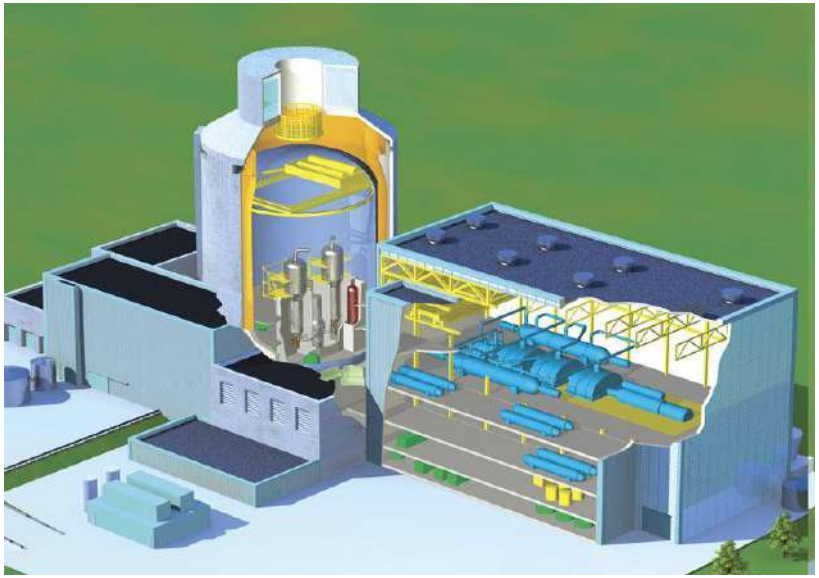
Westinghouse

**AP1000 – Advanced Passive**

**Electric power: 1110 MW**

**Thermal power: 3415 MW**

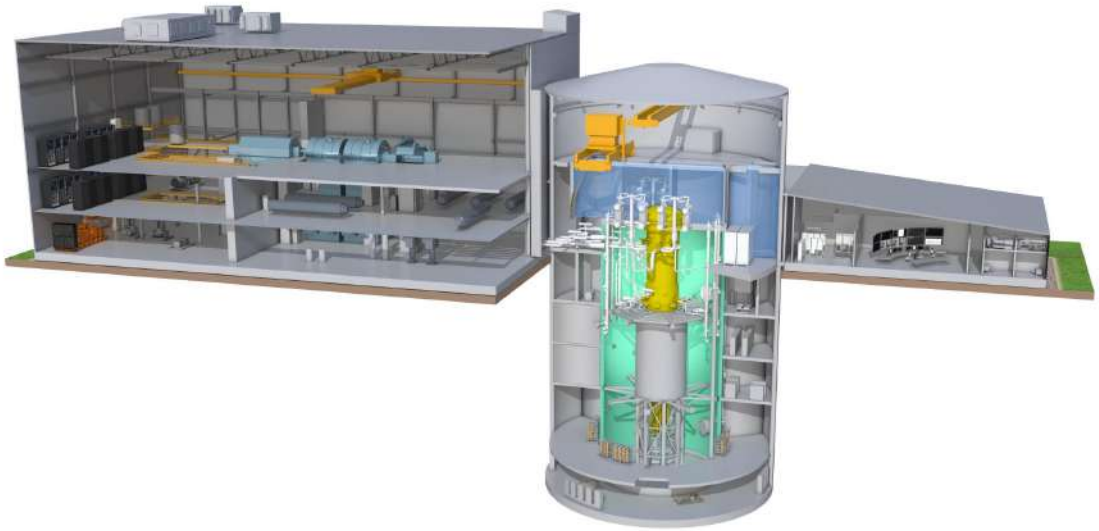
**Number of loops: 2**



# Other nuclear programmes

**BWRX-300**

**Electric power: 300 MW**



# Other nuclear programmes

KGHM POLSKA MIEDŹ

NUSCALE

**Nuscale Power VOYGR**

**Electric power: 77 MW**

**Thermal power: 250 MW**

# Research, education and training

**Research institutes:**
**National Centre of Nuclear Research**
**Institute of Nuclear Chemistry and Technology**
**Institute of Nuclear Physics**
**Institute of Plasma Physics and Laser Microfusion**

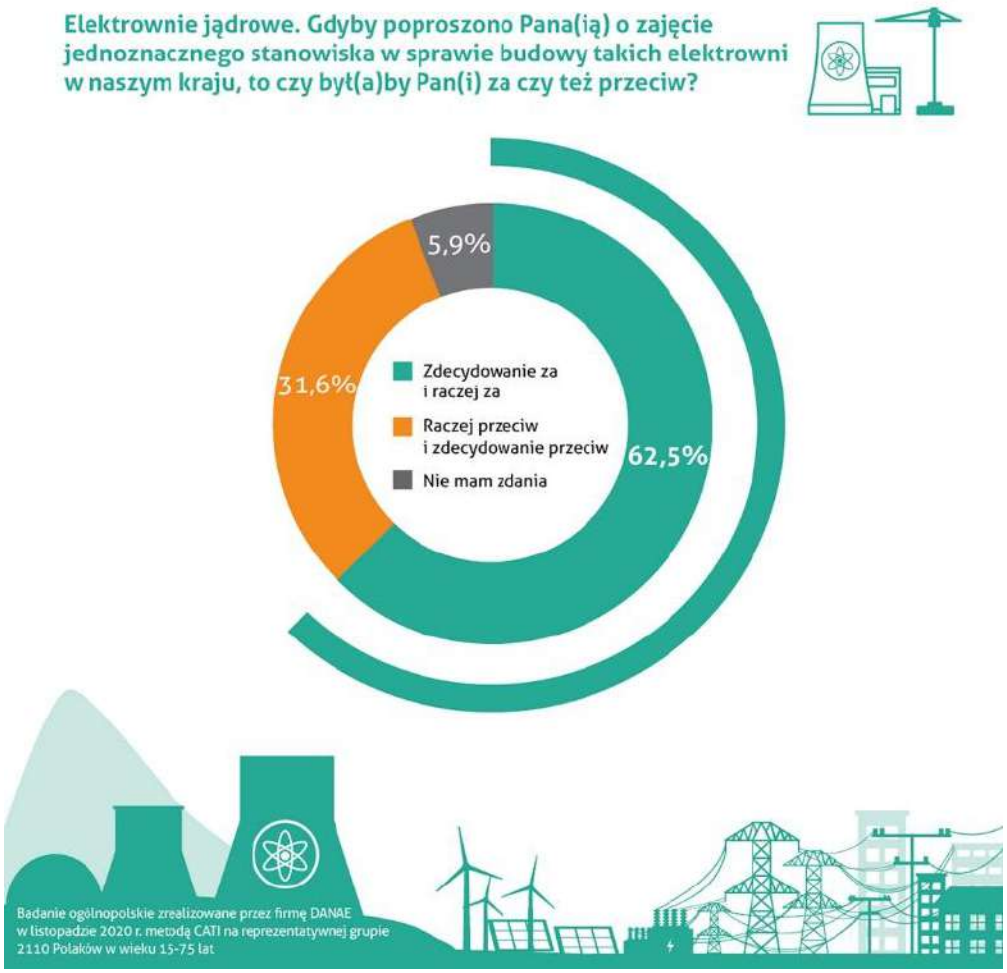
**Supporting institutions:**
**National Atomic Energy Agency (regulator)**
**Central Laboratory of Radiological Protection**
**Radioactive Waste Management Plant**
**National Nuclear Waste Repository**

**Universities:**
**Nuclear power programmes: AGH-UST, WUT**
**Power engineering programmes with nuclear elements: PUT, SUT, WUST, GUT**
**+ supporting specializations**

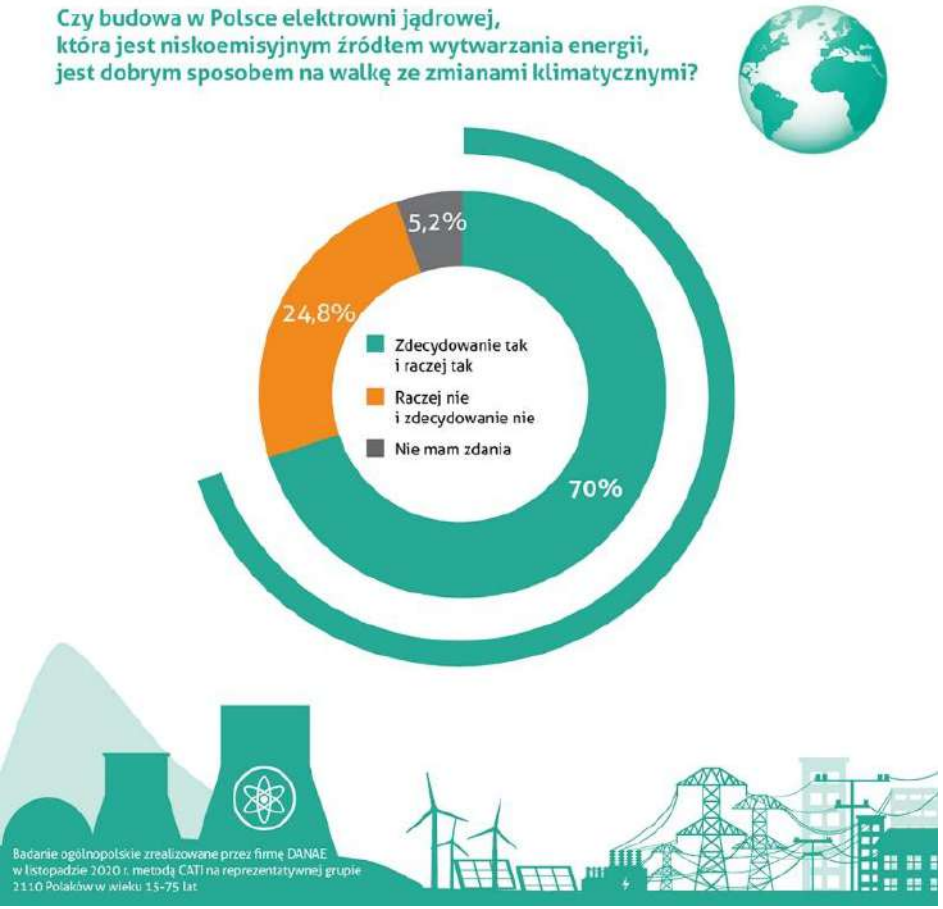
**Key issues:**
**Generation gap**
**Lack of candidates**

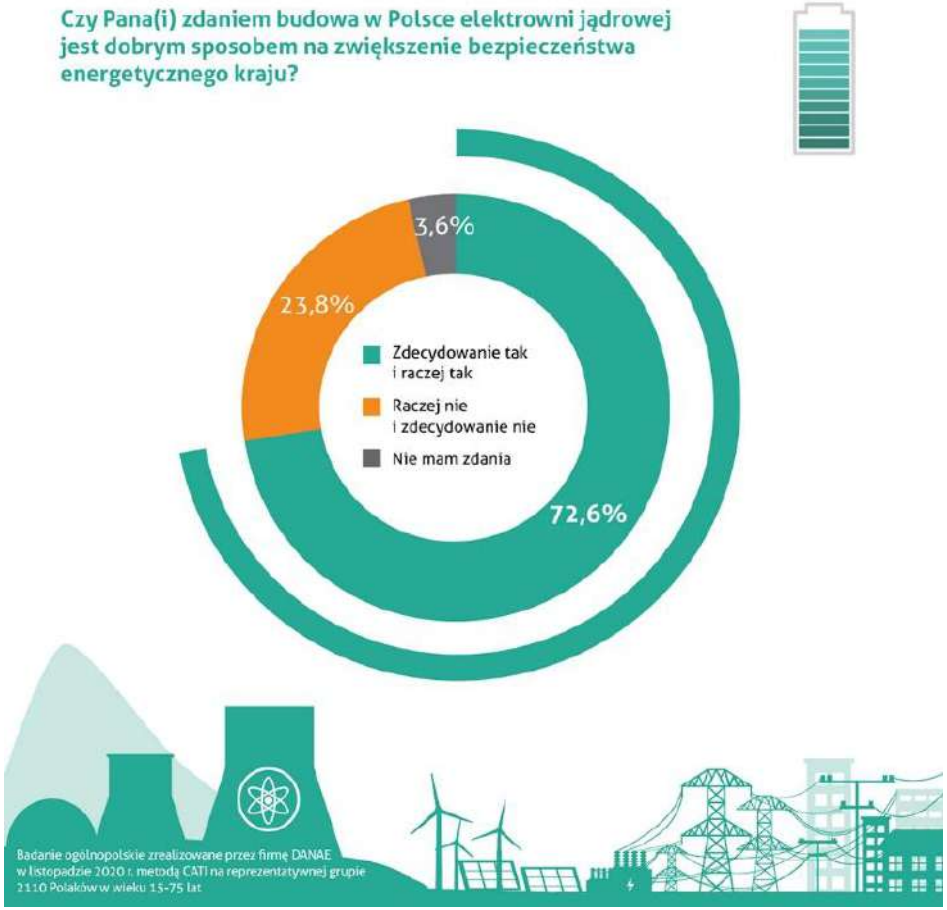
# Public debate

# Public debate

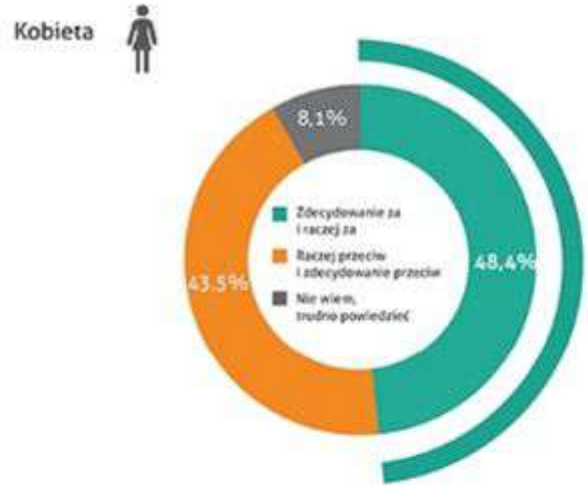


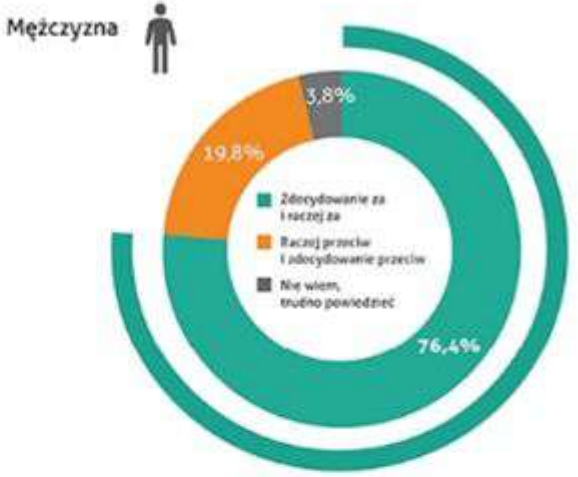
# Public debate

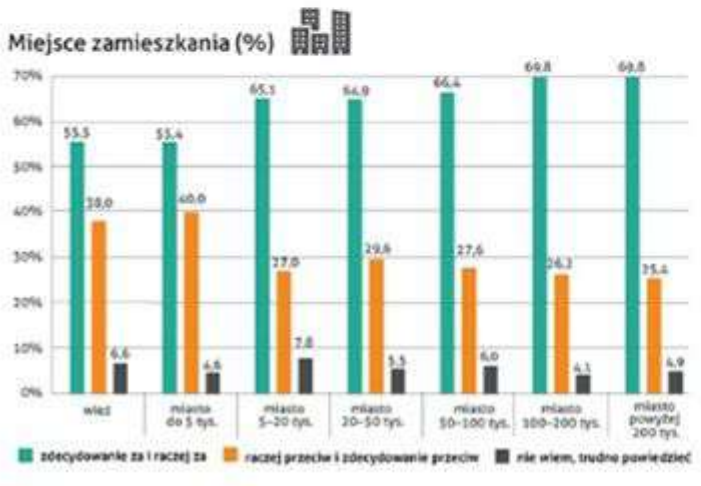


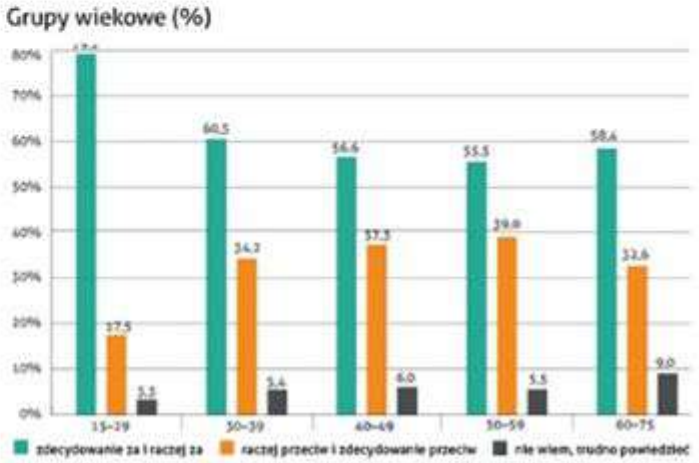



# Public debate



# Conclusions

- **Nuclear power is expected to play important part in Poland's Energy transition;**
- **Public support is rather high;**
- **Nuclear programme suffered significant delays in the past;**
- **Technology is still to be chosen;**
- **Financial model is still to be finalized;**
- **Preparatory works are ongoing;**
- **Private business shows interest in nuclear technology;**


Thank you for attention!