INSTITUTE FOR CHEMICAL PROCESSING OF COAL

2018 International Pittsburgh Coal Conference
Xuzhou, Jiangsu Province, CHINA
October 15 - 18, 2018

# Future of coal - the case study from Poland

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# Scope of the presentation

1. Introduction
2. Coal in Polish energy mix
3. EU ETS and Winter Package
4. Future of coal regions
5. COP24 in Poland
6. Polish energy policy up to 2050
7. R&D actions
   - IChPW activity
   - $CO_2$ capture & utilization
   - Future Coal Technologies
8. Final remarks and conclusions

# Poland – key facts


Basic data:

- Population: 38 416 mln
- EC member from 2004
- GDP per capita (2017)

  12 000 Euro
- GDP 2017/2016 :

  104,8%

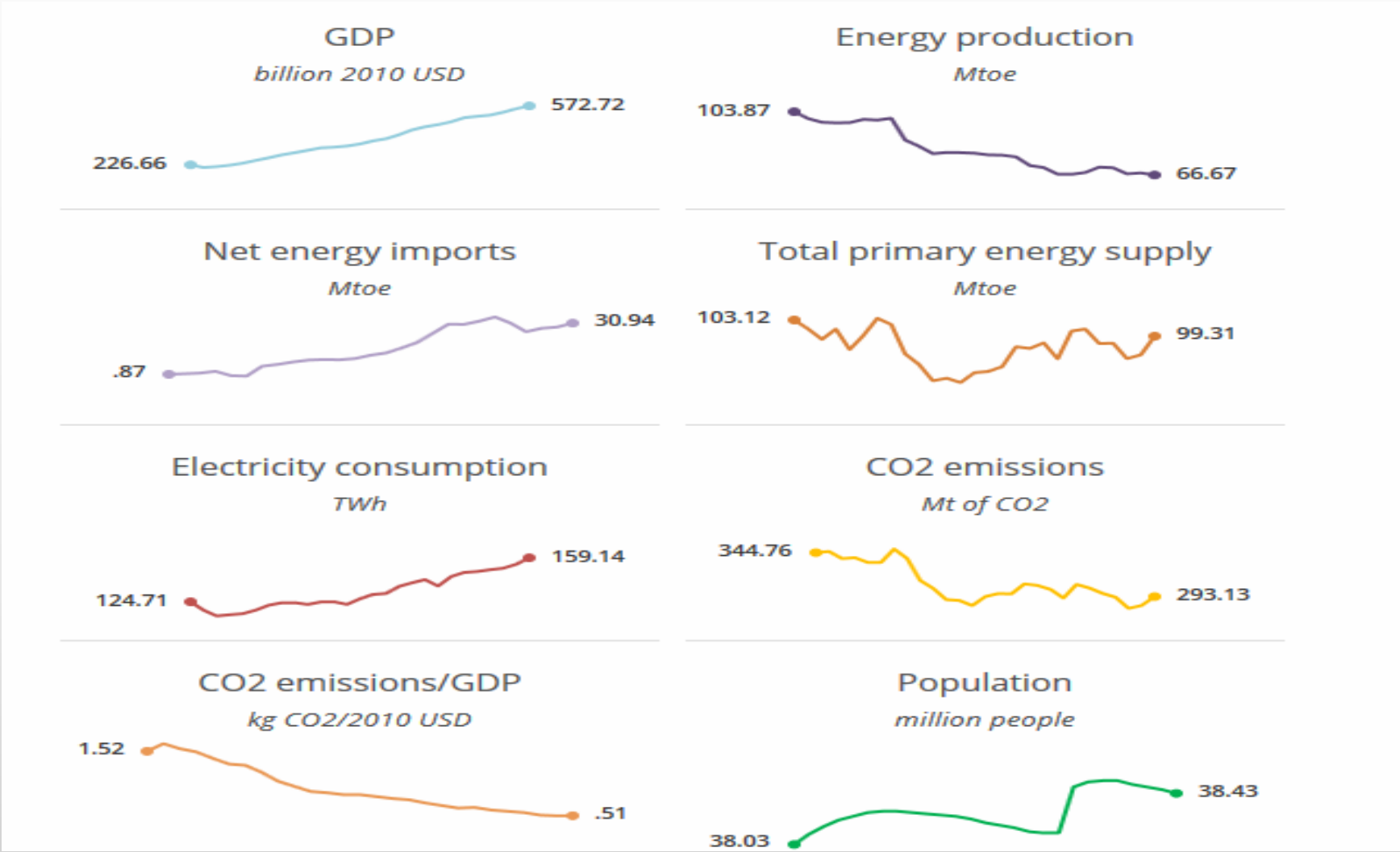
# Poland – key facts

wiedzieliśmy

POLAND
THE CENTENARY
OF REGAINING
INDEPENDENCE

In November 1918,
after 123 years of absence
on European political maps,
Poland regained its
independence.

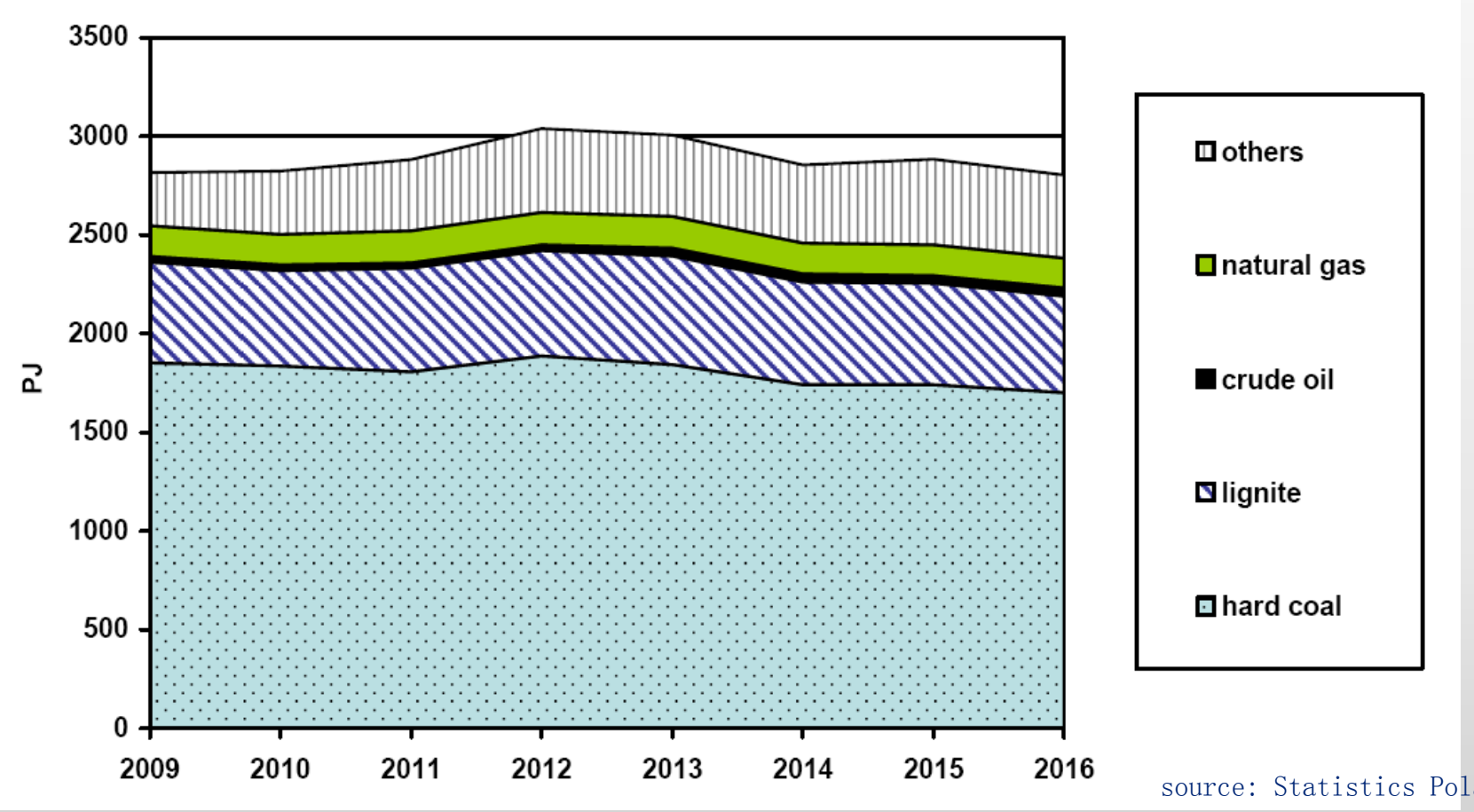
# Key stats for Poland, 1990-2016



# Coal in Polish energy mix

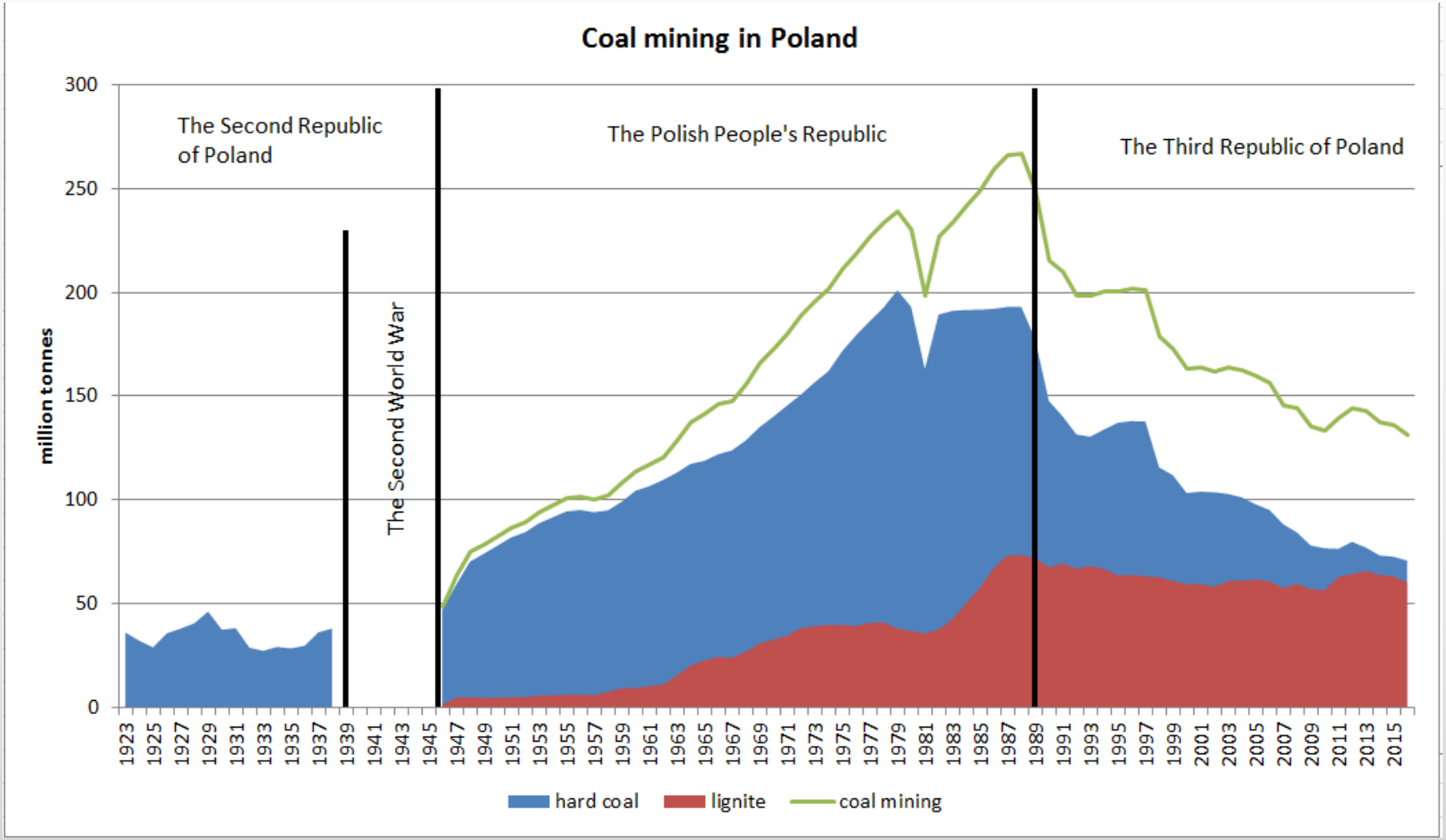
# Primary energy production

Poland – an example of coal based economy



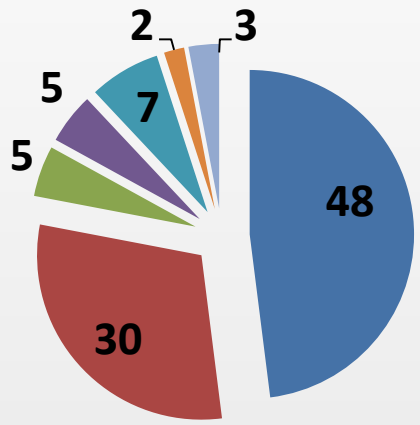

source: Statistics Poland

# Hard coal and lignite mining in Poland

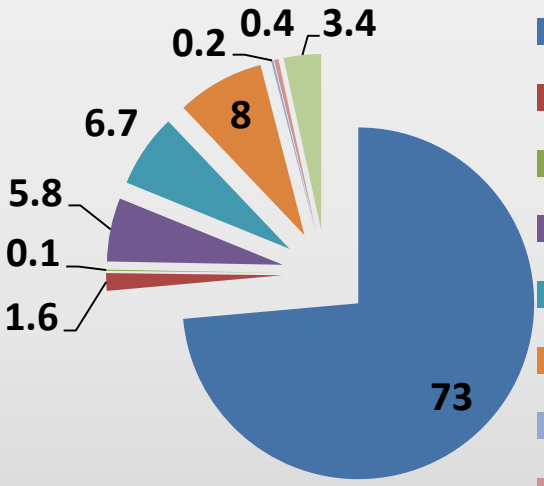



Sources: Central Statistical Office of Poland; J. Lazar, *Import i eksport węgla w okresie międzywojennym*, SGH, Warszawa 2016.

# Electricity and heat production (2016)




- hard coal
- lignite
- natural gas
- biofuels
- wind
- water
- other

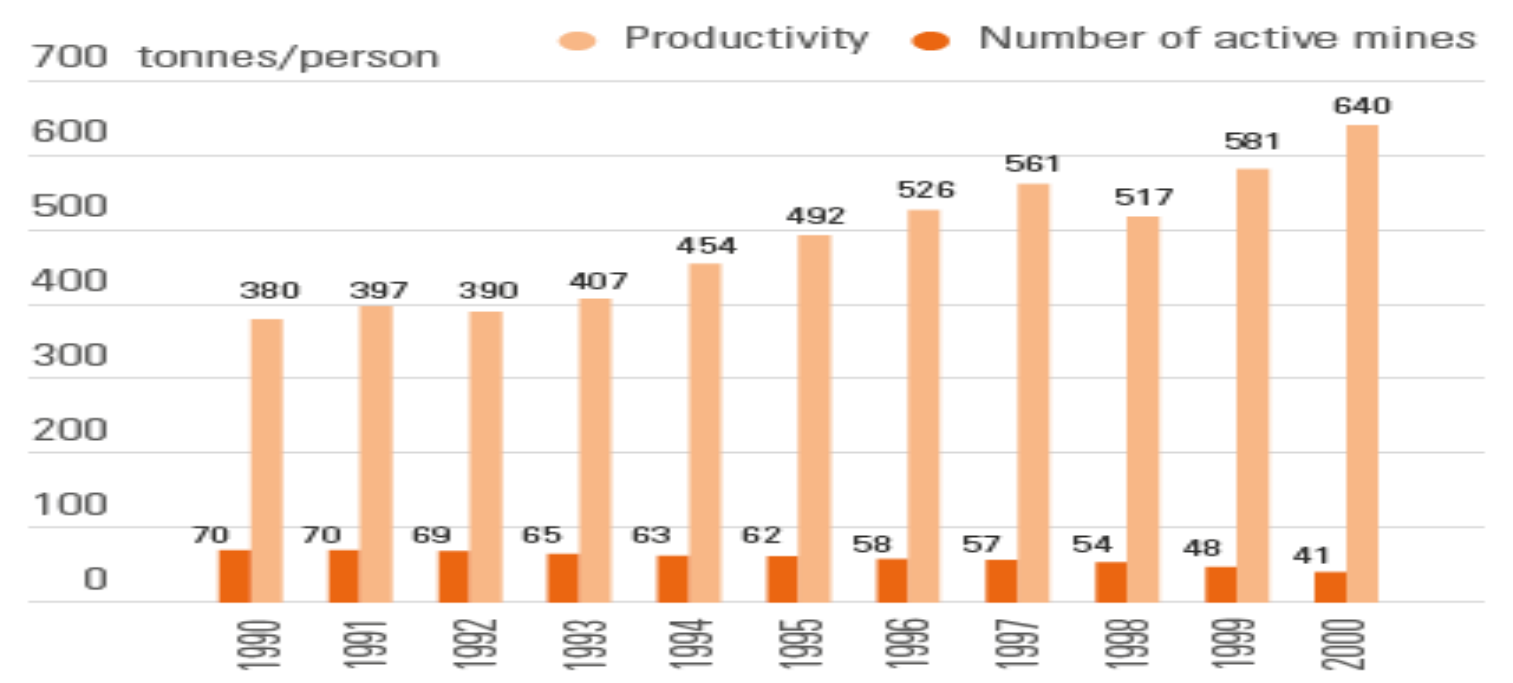



- hard coal
- lignite
- light oil
- heavy oil
- natural gas
- biomass
- renewables
- waste non-renewable
- other

source: Program dla sektora górnictwa węgla kamiennego w Polsce

# Coal mining sector :

Number of active coal mines and productivity per year:




2013 - 704 t/person

2016 - 823 t/person **23 coal mines**

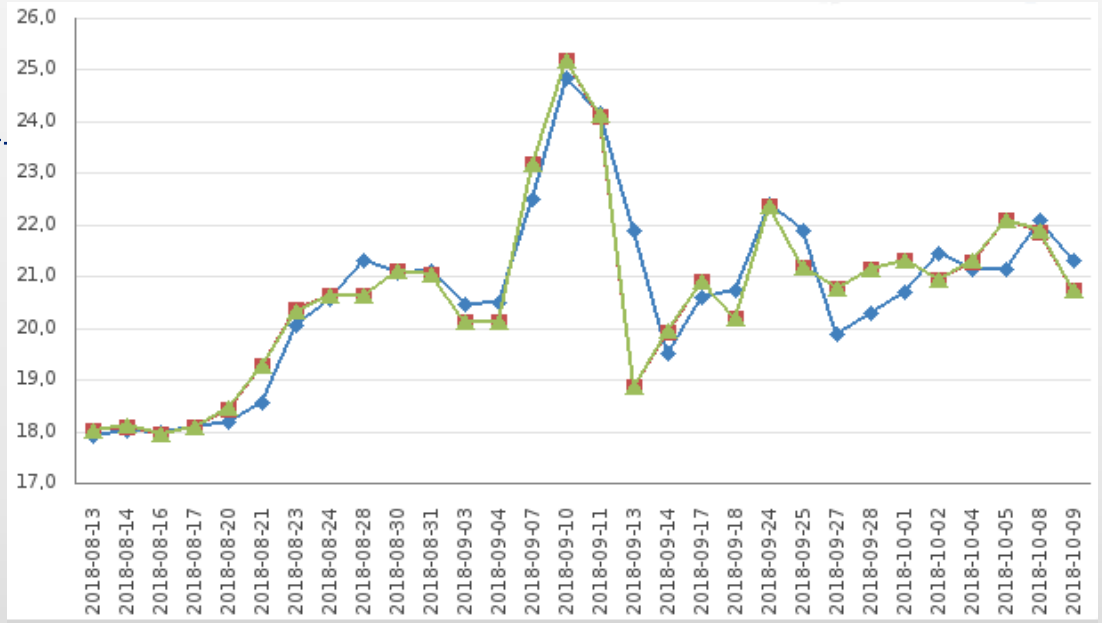
# EU ETS and “Winter Package”

# Emissions trading system (ETS)

Set up in 2005, the EU emissions trading system (EU ETS) is a cornerstone of the EU's policy to combat climate change and its key tool for reducing greenhouse gas emissions cost-effectively. It is the world's first major carbon market and remains the biggest one.

The EU ETS:

- operates in **31 countries**
- more than **11,000 heavy energy-using installations** and **airlines**
- covers around **45%** of the EU's greenhouse gas emissions.




In **2020**, emissions from sectors covered by the system will be **21% lower than in 2005**. In **2030**, under the revised system they will be **43% lower**.

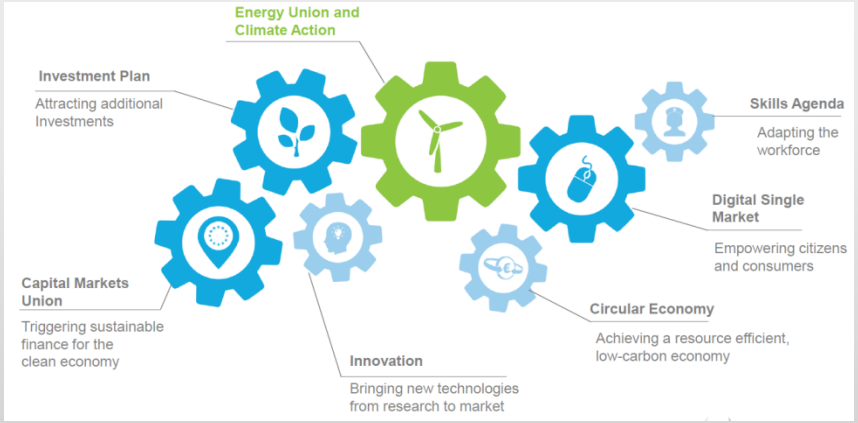
# Clean Energy for All Europeans – „Winter Package”

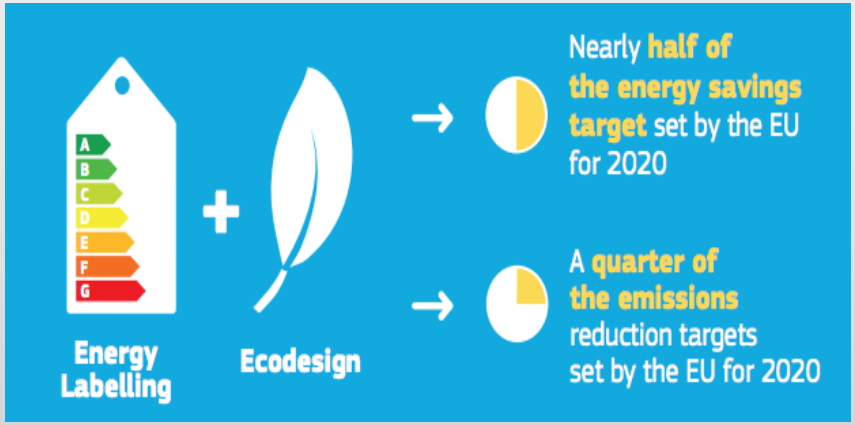
On 30 November 2016 the European Commission presented a „Winter package” to keep the EU competitive as the clean energy transition changes global energy markets.

The Clean Energy for All Europeans legislative proposals cover energy efficiency, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union.

Main goals:

- Putting energy efficiency first
- Achieving global leadership in renewable energies
- Providing a fair deal for consumers



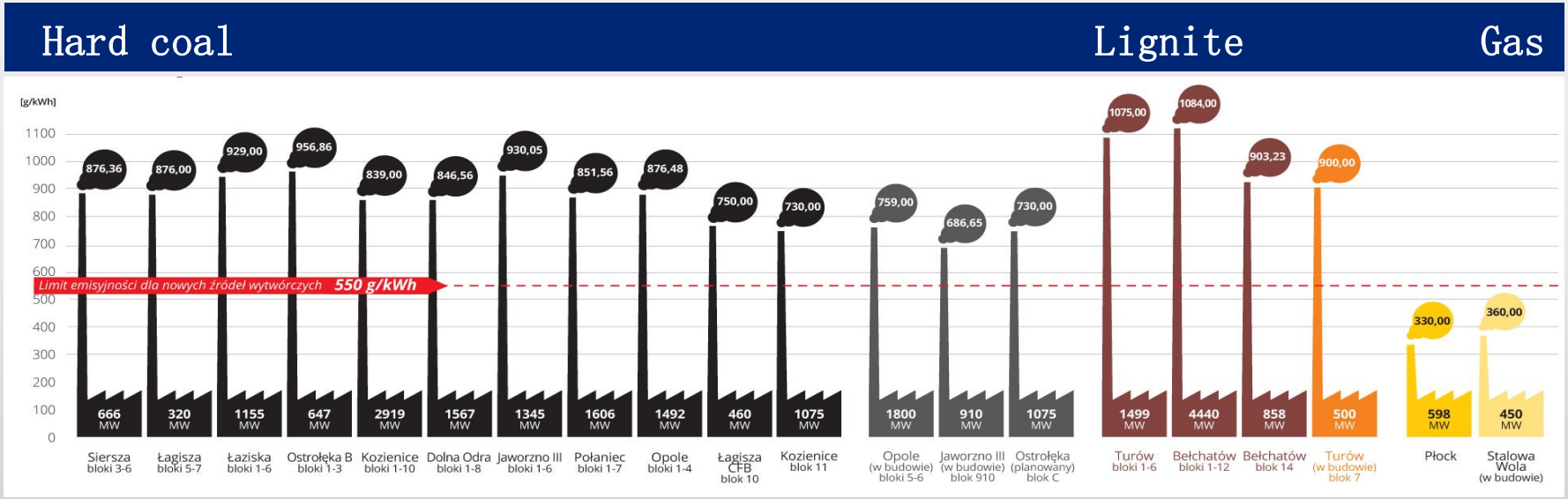




Source: https://ec.europa.eu/energy

# $CO_2$ emissions of Polish power plants and 550 kg/MWh requirement

Proposal for a
REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
on the internal market for electricity

*Article 23*
*Design principles for capacity mechanisms*
*1. ….. ……..*
4. Generation capacity for which a final investment decision has been made after ……shall only be eligible to participate in a capacity mechanism if its emissions are below 550 g CO2/kWh. Generation capacity emitting 550 g CO2/kWh or more shall not be committed in capacity mechanisms 5 years after the entry into force of this Regulation.




Source: Mapa drogowa polskiej elektroenergetyki 2030+, red. Dr C. Schnell, 2017

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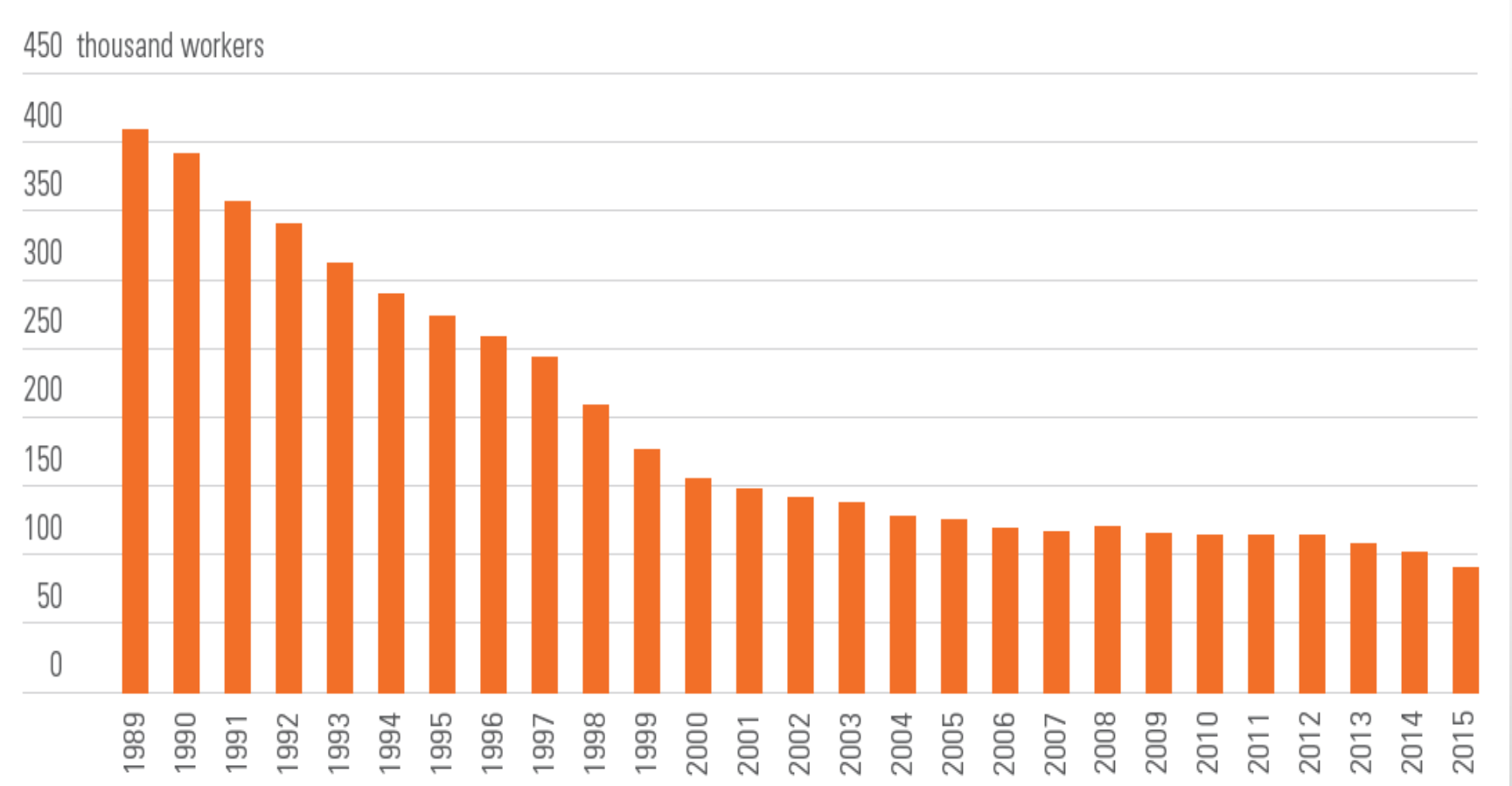
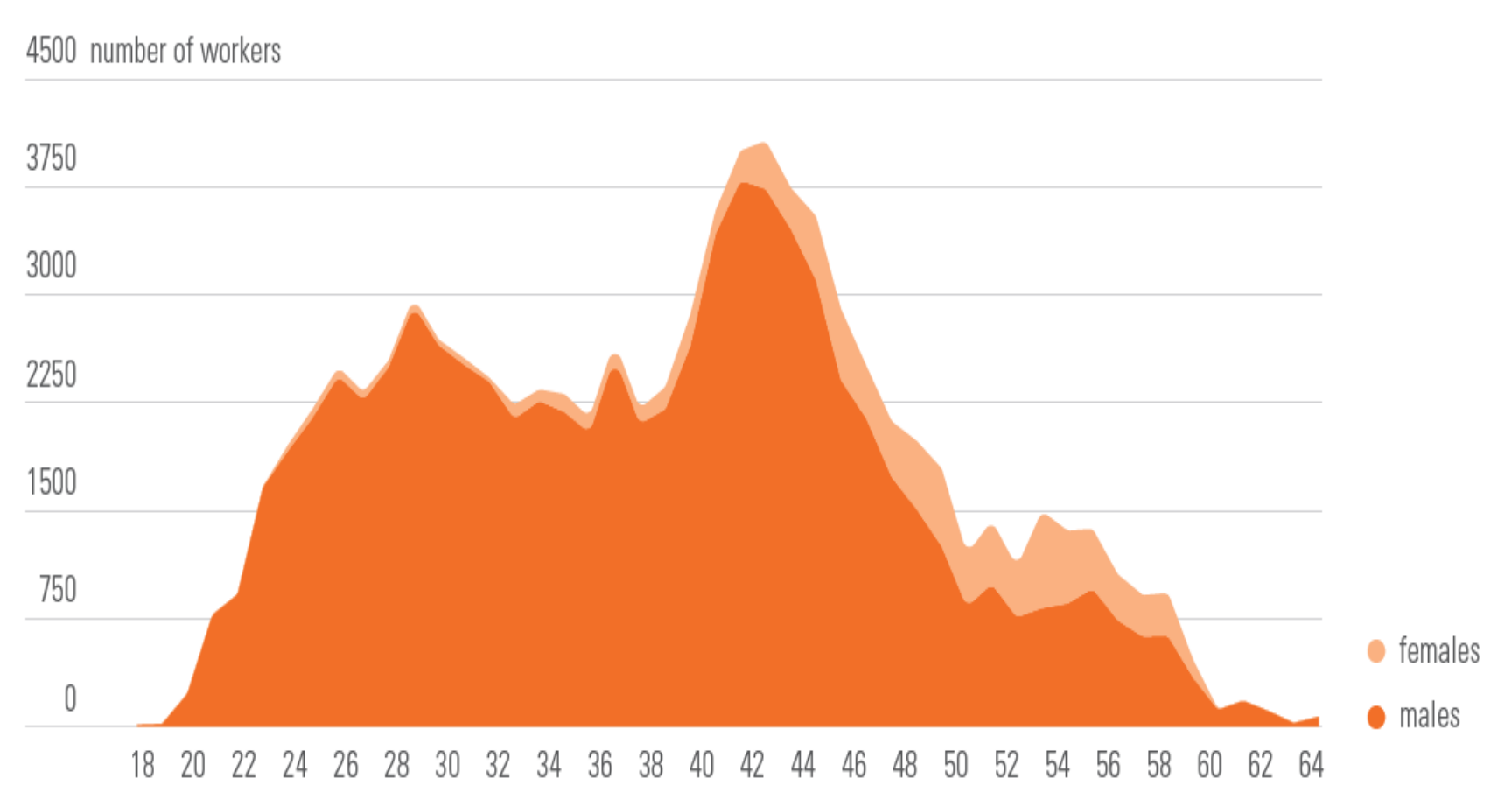
# Future of coal regions

# Employment in hard coal mining, 1989-2015




source: Coal transition in Poland, Options for a fair and feasible transition for the Polish coal sector, 2018

# Age structure of employment in hard coal mining, 2014




source: Coal transition in Poland, Options for a fair and feasible transition for the Polish coal sector, 2018

# Future of coal regions

As part of the **Clean Energy for All Europeans Package**, a number of actions were announced to boost the clean energy transition by **bringing more focus on social fairness, new skills and financing for the real economy.**

The European Commission has launched a **Platform on Coal Regions in Transition** to help regions with coal mining activities identify, develop and implement projects with the potential to kick-start a viable economic and technological transformation, and to enable multi-stakeholder dialogue on policy framework and regulations.

- Coal Regions designated into the Pilot Program:
  - Slovakia – Trencin,
  - Germany – North Rhine Westphalia
  - Poland – Upper Silesia,
  - Greece – Western Macedonia,
  - Romania – Jiu Valley


- Estimated budget around 1 bln Euro

# Past Coal regions transition (1)

Silesia City Centre (previously: Kleofas Coal Mine), Katowice, 2004


Źródło: http://www.pastsilesia.pl/

# Past Coal regions transition (2)

Strefa Kultury (previously: Katowice Coal Mine), Katowice, 2014

Źródło:https://pl.wikipedia.org/wiki/Strefa_Kultury_(Katowice)

# COP24 in Poland

# COP24 - Katowice (Poland), 3–14 December 2018

## 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)

- The UNFCCC is a "Rio Convention", one of three adopted at the "Rio Earth Summit" in 1992. The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The countries that have ratified the Convention are called Parties to the Convention.

- The COP is the supreme decision-making body of the Convention. All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.


# More background on the COP

- Kyoto Protocol
  - ✓ Before 2020, the world's only legally binding instrument for cutting greenhouse gas ($CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, $SF_6$) emissions is the 1997 Kyoto Protocol;
  - ✓ 1st period (2008-2012) - industralised countries committed to reduce emissions by an average of 5% below 1990 levels;
  - ✓ 2nd period (2013-2020) - Parties who joined this period committed to reduce emissions by at least 18% below 1990 levels.
- Paris Agreement
  - ✓ A long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels;
  - ✓ To aim to limit the increase to 1,5°C, since this would significantly reduce risks and the impacts of climate change.
- The Polish presidency plans to focus its message on three key themes:
  - ✓ Technology - development of climate-friendly modern solutions, such as electromobility;
  - ✓ Man - solidary and just transition of industrial regions;
  - ✓ Nature - supporting achieving climate neutrality by absorbing $CO_2$ by forests and land, or by water management.

| Year | Session | Location |
|---|---|---|
| 2018 | COP24 | Katowice, Poland |
| 2017 | COP23 | Bonn, Germany |
| 2016 | COP22 | Marrakech, Morocco |
| 2015 | COP21 | Paris, France |
| 2014 | COP20 | Lima, Peru |
| 2013 | COP19 | Warsaw, Poland |
| 2012 | COP18 | Doha, Qatar |
| 2011 | COP17 | Durban, South Africa |
| 2010 | COP16 | Cancun, Mexico |
| 2009 | COP15 | Copenhagen, Denmark |
| 2008 | COP14 | Poznan, Poland |
| 2007 | COP13 | Bali, indonesia |
| 2006 | COP12 | Nairobi, Kenya |
| 2005 | COP11 | Montreal, Canada |
| 2004 | COP10 | Buenos Aires, Argentina |
| 2003 | COP9 | Milan,Italy |
| 2002 | COP8 | New Delhi, India |
| 2001 | COP7 | Marrakech, Morocco |
| 2000 | COP6 | The Hague, Neherlands |
| 1999 | COP5 | Bonn, Germany |
| 1998 | COP4 | Buenos Aires, Argentina |
| 1997 | COP3 | Kyoto, Japan |
| 1996 | COP2 | Geneva, Switzerland |
| 1995 | COP1 | Berlin, Germany |

# Polish energy policy up to 2050

# Polish Energy Policy

The Energy Policy until 2030 specifies six basic directions for the development of Polish energy sector:

1. Improvement of **energy efficiency**;
2. Enhancement of fuel and energy **supply security**;
3. **Diversification of electricity generation mix** by introducing nuclear energy;
4. **Development of the use of renewable energy sources, including biofuels**;
5. Development of competitive fuel and Energy markets;
6. **Reduction of the environmental impact** of the power industry.

"In 2050 we want to have only 50 percent of coal-based energy. This requires investment of up to EUR 70 billion,"

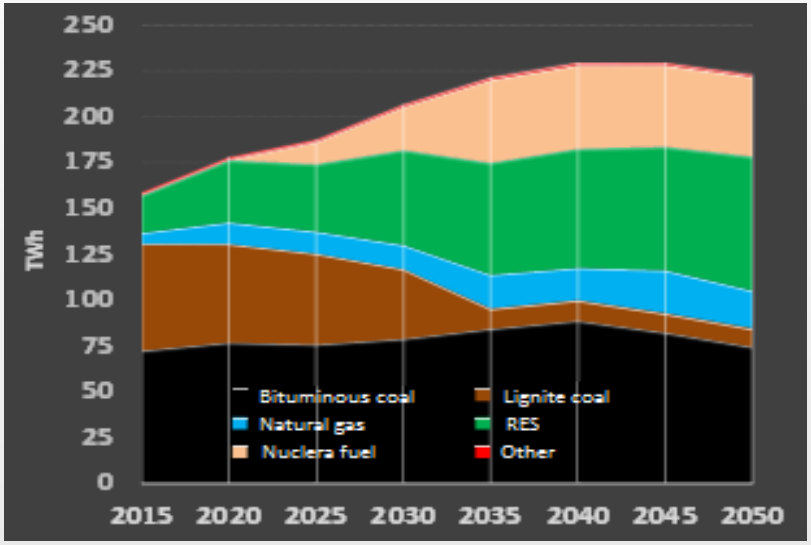
Krzysztof Tchórzewski, Minister of Energy (2018)

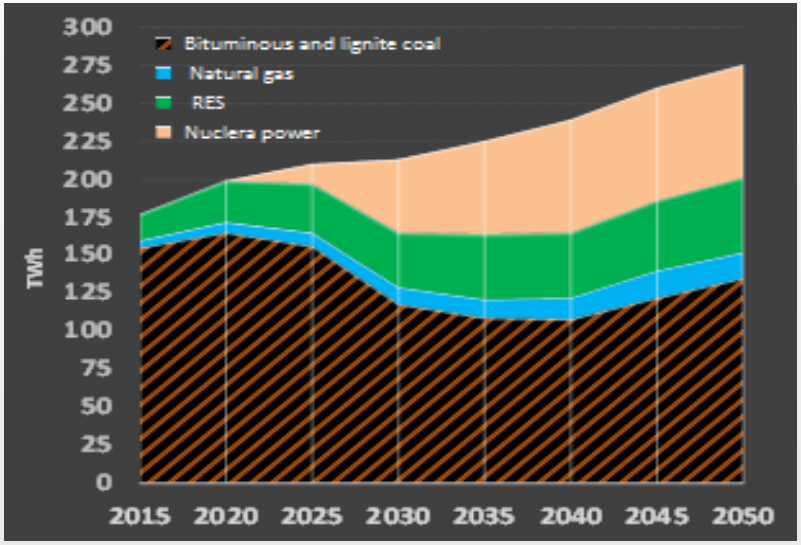
source: PAP/Reuters 11.09.2018

MINISTERSTWO ENERGII

# Energy mix of Poland

**Different scenarios of power generation in Poland until 2050**




Conclusions from the analysis for Polish Energy Policy until 2050; Annex 2 .: the Polish Energy Policy until 2050; The project version 02.

**… 3) Coal will remain the basis for energy security of Poland in the foreseeable period (ie. 2050), but its share will decrease …**

*Conclusions from the analysis for the purpose of the Energy Policy of Poland until 2050; Annex 2 .: the Energy Policy of Poland until 2050; The project version 02.*

# New coal fired power plants in Poland (1)

Supercritical and ultrasupercritical units

Kozienice

Opole

Fuel: steam coal
Total gross output: 1075 MW
Steam parameters: 25MPa/610°C/610°C
Net efficiency: 45.6%
Advancement: 100%
Commissioned: 2017

Fuel: steam coal
Total gross output: 2 x 900 MW
Steam parameters: 28.5MPa/610°C/610 °C
Net efficiency: 45.5%
Advancement: 93%
Expected grid connection: 2018/2019

$CO_2$ emission still much over 550 g/kWh !

# New coal fired power plants in Poland (2)

Supercritical and ultrasupercritical units

Jaworzno

Fuel: steam coal
Total gross output: 910 MW
Steam parameters: 27.5MPa/600°C/600 °C
Net efficiency: 45.9%
Advancement: 80 % (cold start-up)
Expected grid connection: 2019

Turów

Fuel: lignite
Total gross output: 450 MW
Steam parameters: 28.5MPa/610°C/610 °C
Net efficiency: 43.4%
Advancement: 62 %
Expected grid connection: 2020

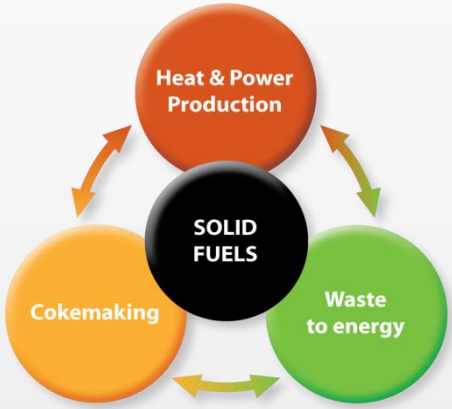
$CO_2$ emission still much over 550 g/kWh !

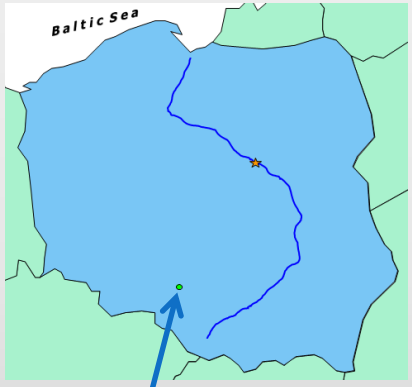
# R&D actions

# Institute for Chemical Processing of Coal

- Establishment:1955
- Supervision:  Ministry of Energy
- Employment:  160

Ministerstwo Energii

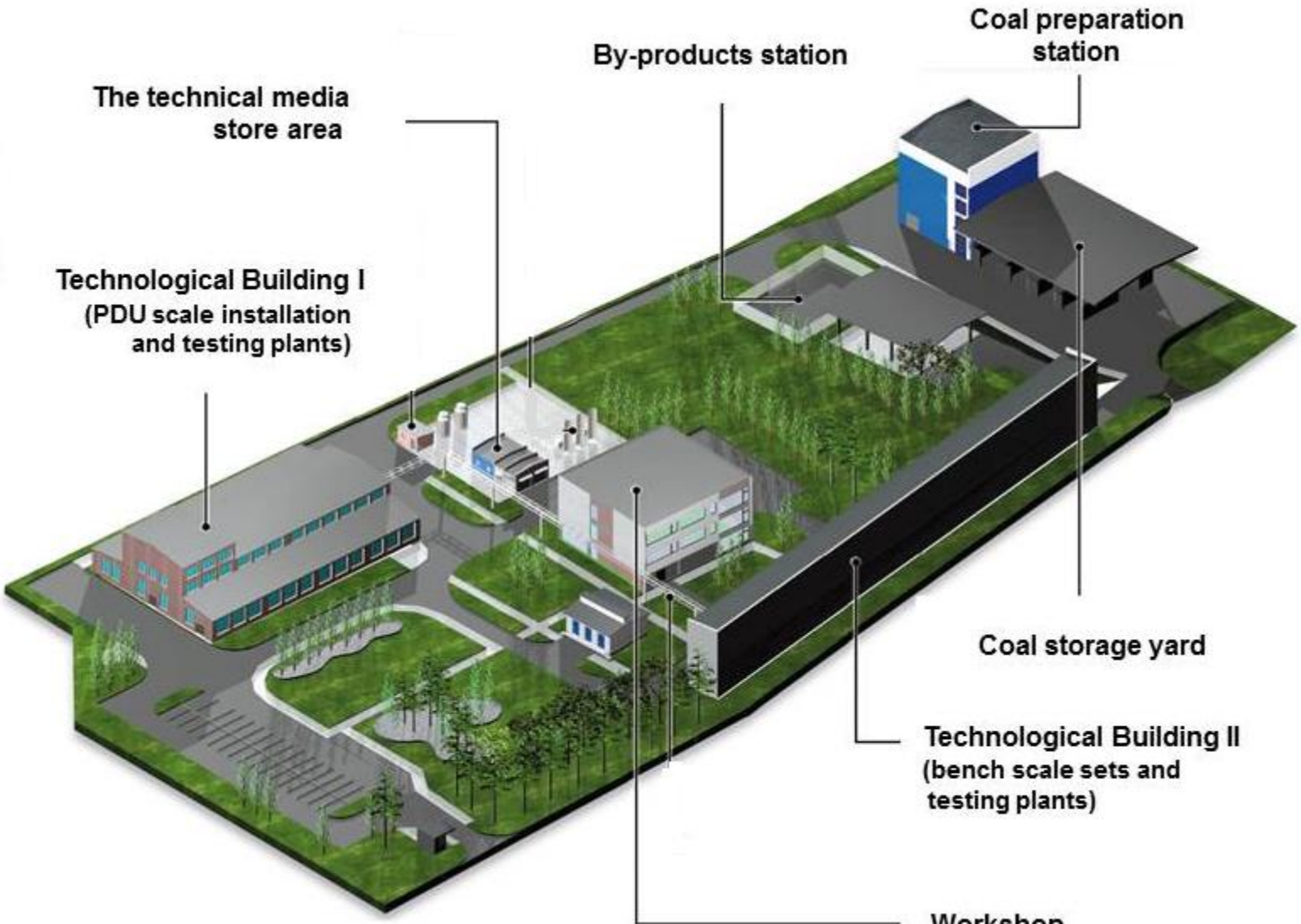



Zabrze (Poland)

# Clean Coal Technology Center

***Zabrze***



# Clean Coal Technology Center

(technological building no 1)

# CLEAN COAL TECHNOLOGIES CENTRE

The implementation of the IChPW-based technological part is aimed at creation in Zabrze of an EU-leading centre for technological research in the field of coal processing. The unique research infrastructure of the Centre allows performing technological tests and creating development of clean coal technologies. The results obtained and the equipment modification result in creation of new know-how.

**The key research areas are referred to as:**

- coal, biomass and waste gasification,
- $CO_2$ capture and utilization,
- process gases cleaning and combustion,
- oxy-combustion and chemical looping,
- energy storage by chemical way.


**Main objectives of the Centre's research activities are: increasing efficiencies of the processes, reduction of negative environmental impact of these processes and improvement of their economy.**

# $CO_2$ capture & utilization

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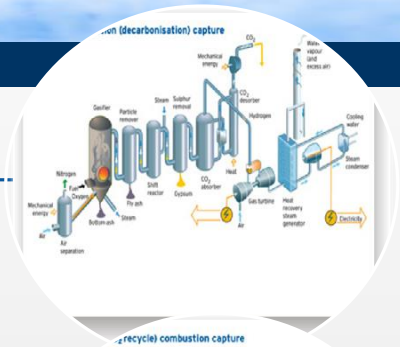
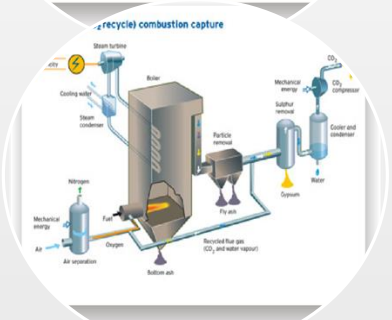
# $CO_2$ capture for zero emission power plants

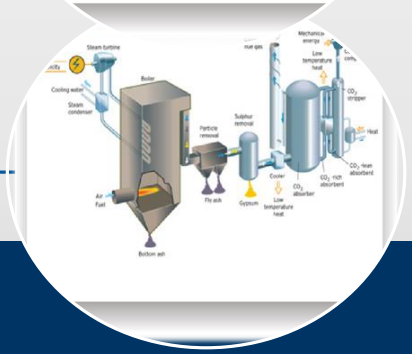
Pre combustion



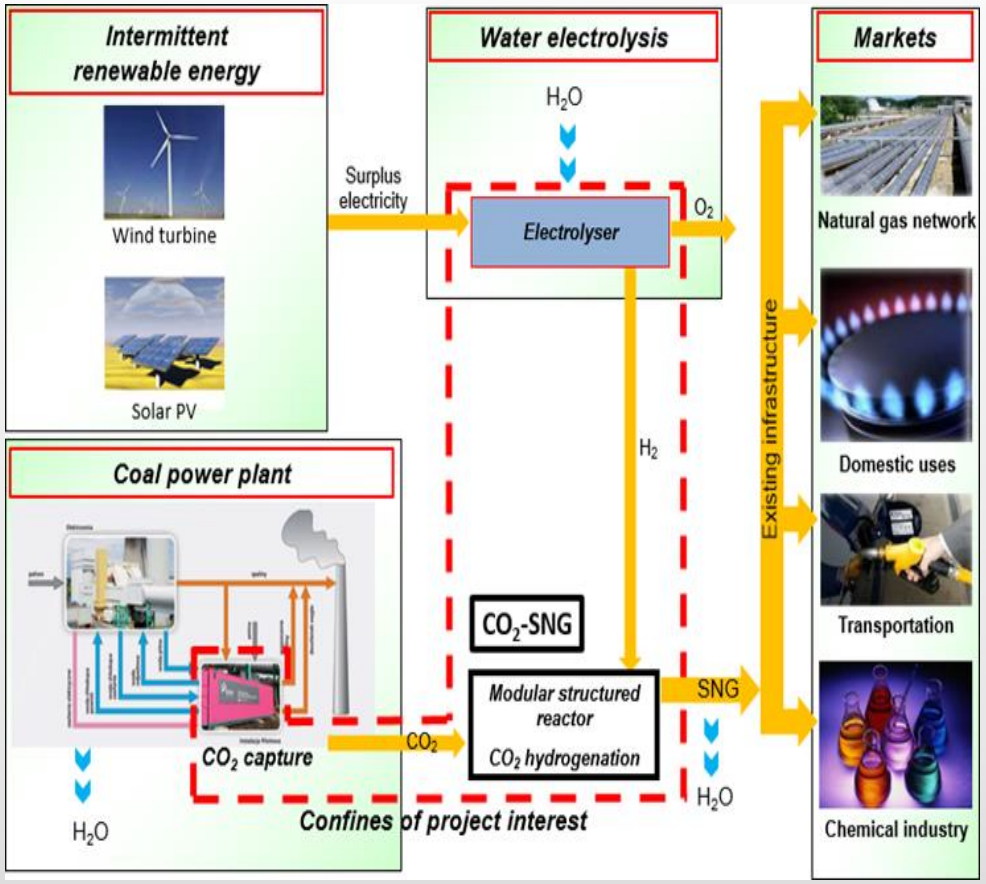
Oxy combustion



Post combustion



# New project of POWER to GAS type – „CO2SNG”
# $CO_2$ methanation system for electricity storage through SNG production




Problem:

- electricity producers are forced to reduce $CO_2$ emission
- renewable energy sources are promoted in the EU - there is a big challenge in building renewable electricity storage potential
- the EU is strongly dependent on external natural gas supply

Solution:

- utilization of captured $CO_2$ for synthesis gas production
- utilization of hydrogen generated with the use of renewable energy
- chemical energy storage.

TAURON WYTWARZANIE · RAFAKO GRUPA PBG · ichp · cea · ATMOSTAT ALCEN · wt&t · EXERGON

# Future Coal Technologies – R&D project

Idea:

Road Map for coal utilization in Europe until 2050

Project:

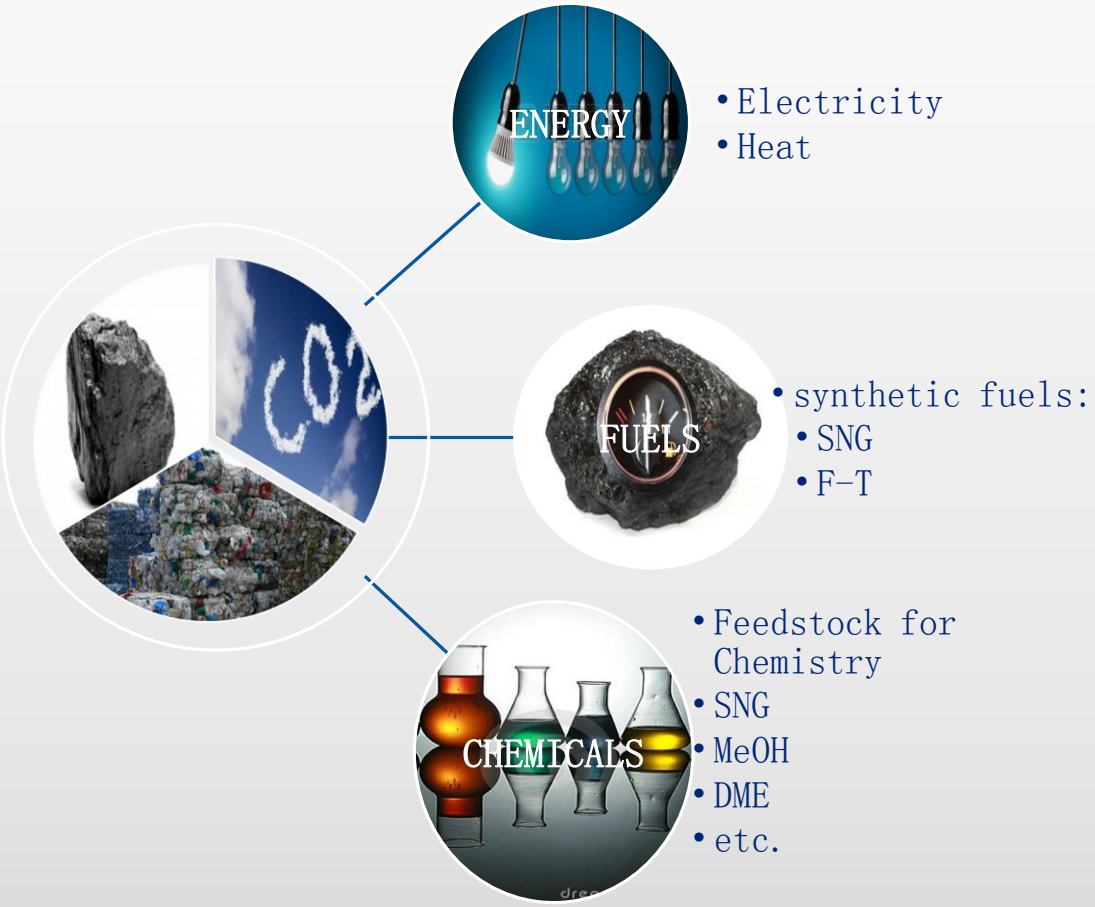
*Feasibility Study Concerning the Sustainable Usage of Lignite / Coal*

*„Options and Prospects of Closed Carbon Cycles”*

Main goals:

- mid- and long-term solution for effective and zero-emission usage of domestic coal reserves,
- increase of national energy and resource security,
- change in European Comission’s approach for using coal in energy and chemical sectors in the 2050 perspective,
- ensuring the sustained perspective of economic development for regions strongly connected with mining industry.

# Carbon as a feedstock




**1 mln tones of coal = 0.4 bln m³ of natural gas**

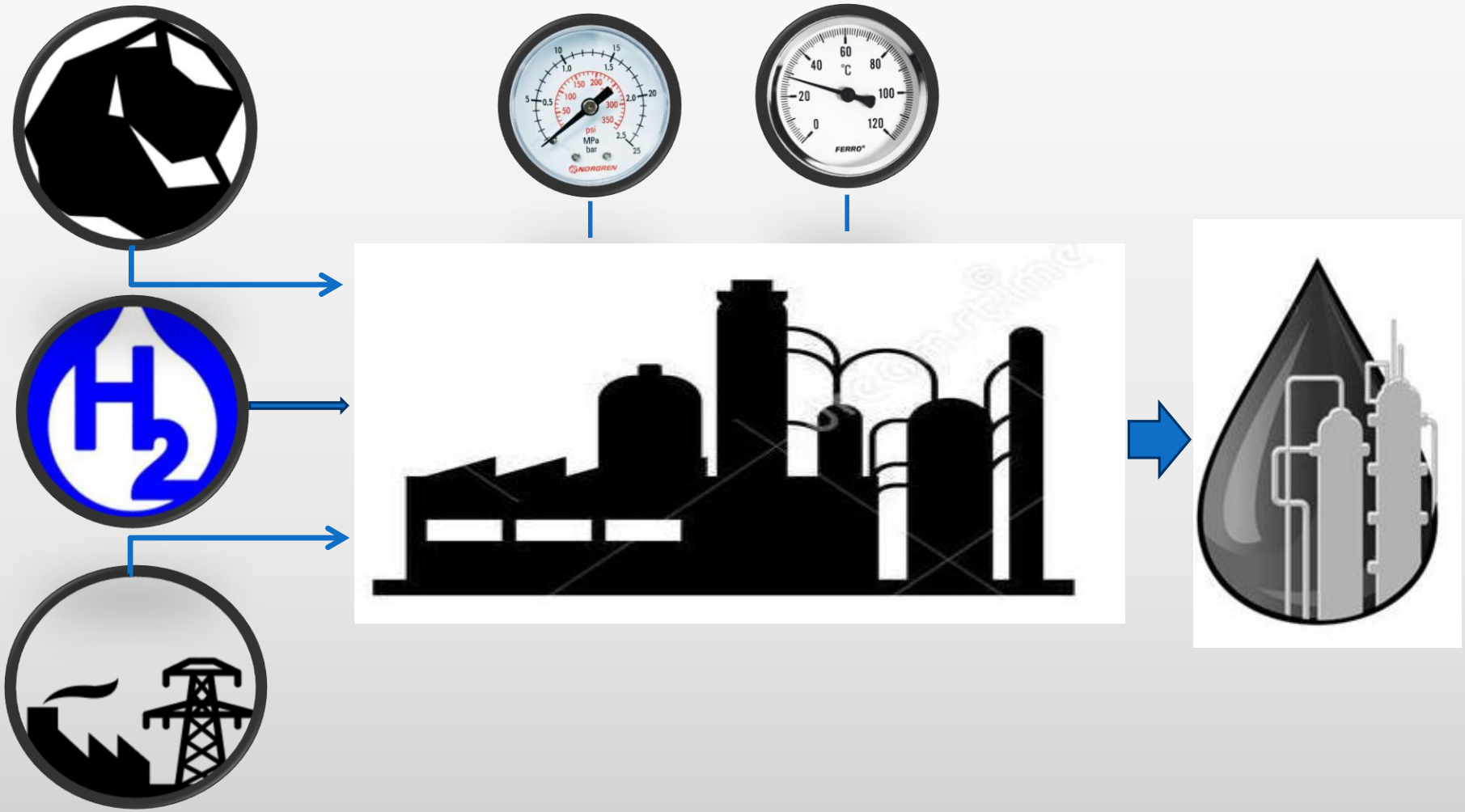
# Carbon as a feedstock


- Electricity
- Heat

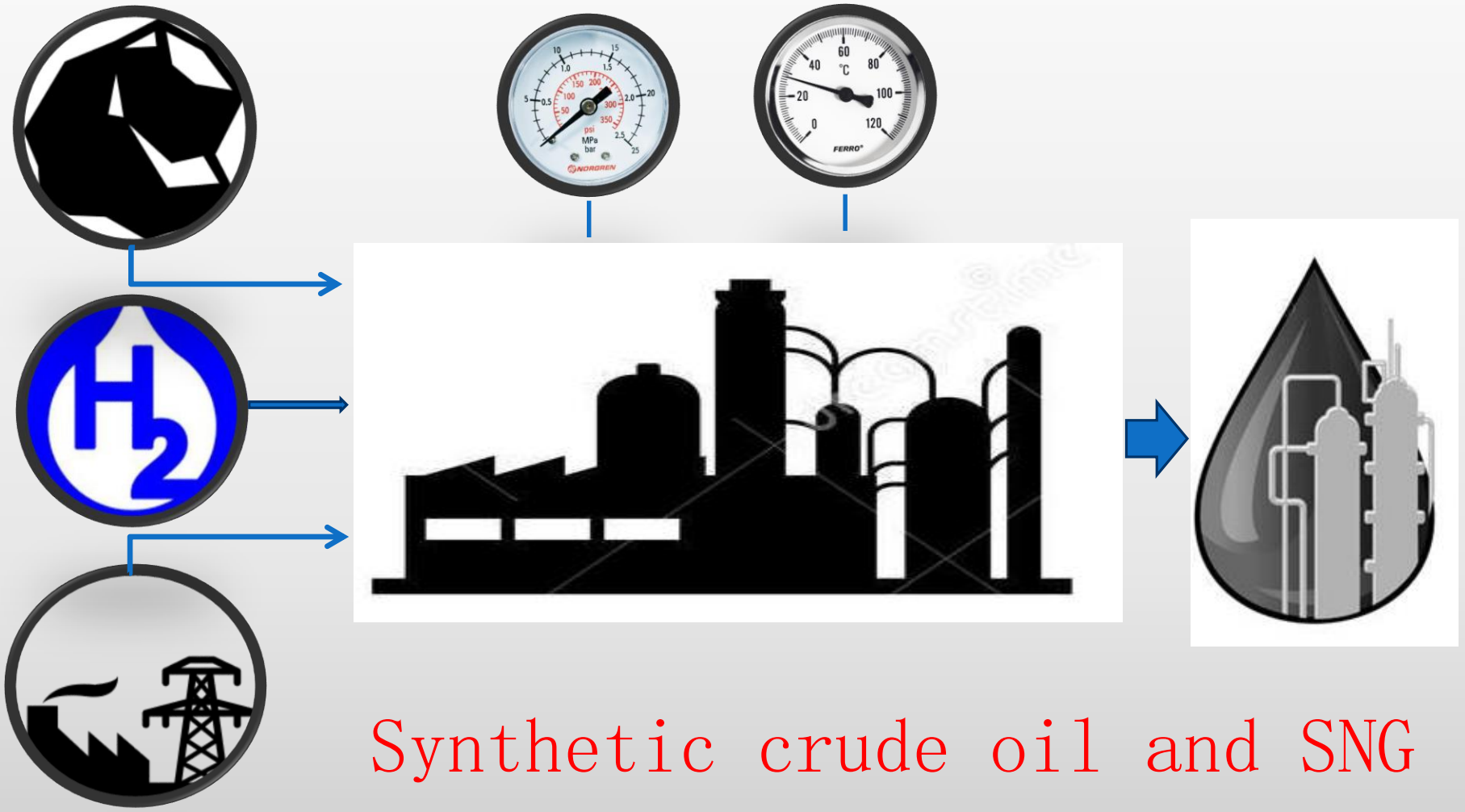
- synthetic fuels:
  - SNG
  - F-T

- Feedstock for Chemistry
- SNG
- MeOH
- DME
- etc.

# Basic technological idea



# Basic technological idea



# Different country – different feedstock

**Feedstock:**

- **Lignite/coal**
- **Biomass**
- **CO2**
- **Wastes**

**Products:**

- **SNG**
- **Crude synthetic oil**
- **Chemicals**

# Final remarks

# and

# conclusions

# Conclusions


"Decarbonization Policy"

vs

Future of coal

# Conclusions

- Clean Coal Technologies are and will be necessary in Europe as a part of new energy strategy and our security.
- EU environmental regulations (eg. “winter package” and ETS) are barriers for clean coal technologies development – especially for start up of new demo plants.
- Future Coal Technologies R&D program is an interesting idea of international collaboration for new CCT development (liquefaction, gasification).
- **We must find in EU a balance between economy and environmental requirements. Thinking about future should be realistic at present**.

# Thank you for your attention!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