



**INSTITUTE FOR CHEMICAL
PROCESSING OF COAL**



1955-2016

**33rd International Pittsburgh Coal
Conference**
August 8-12, 2016 - Cape Town, South Africa

Coal gasification in Poland - perspectives and key driving forces

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Scope of presentation

1. Energy balance of Poland : coal vs. natural gas
2. Coal gasification
 - Technology overview
 - Gasification R&D in Poland
3. Strategy for coal gasification development in Poland
4. Economy and profitability
5. Actions taken in Poland 2015/2016
6. Conclusions

Background : Poland 2016

1. population: 38 million
2. history : coal-based economy
3. 85% of electricity from coal
4. a lot of old coal-fired power plants
5. excellent R&D coal processing
6. European environmental protection regulations

7. coal overproduction : 8 MTPY
 - ▶ export ?
 - ▶ shut down of some coal mines ?
 - ▶ alternative usage !

Energy policy in Poland



Krzysztof Tchórzewski

Minister of Energy



Grzegorz Tobiszowski

Deputy Minister of Energy,
Government Plenipotentiary.
Restructuring of coal mining

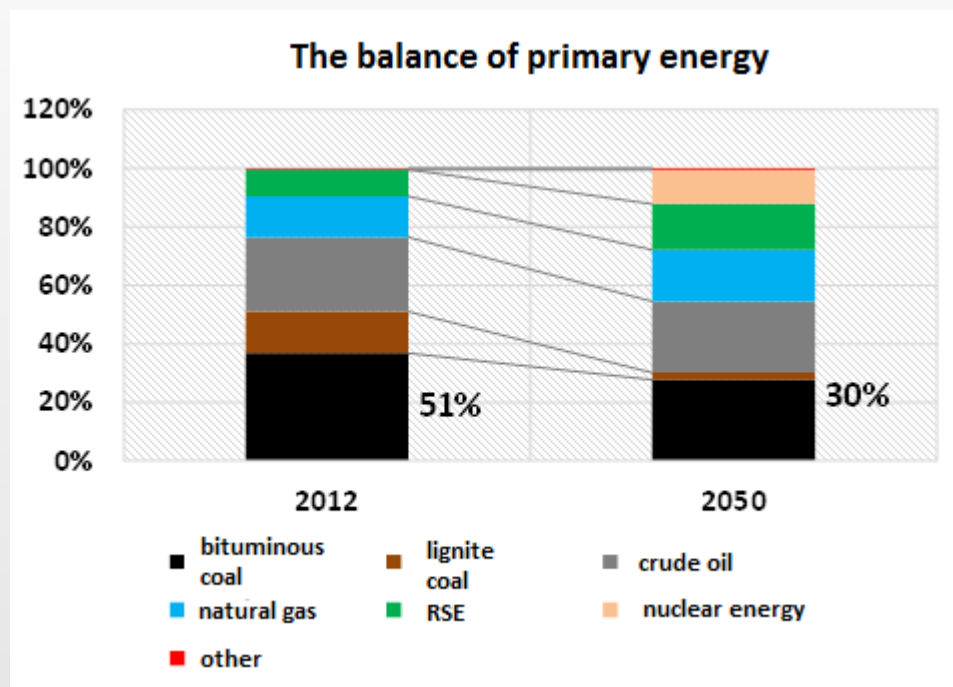
„The basis for covering the demand for electricity will be the use of energy generated in domestic sources, primarily based on energy resources, mainly coal.”

Krzysztof Tchórzewski, IV National Energy and Economic Summit, 20.04.2016

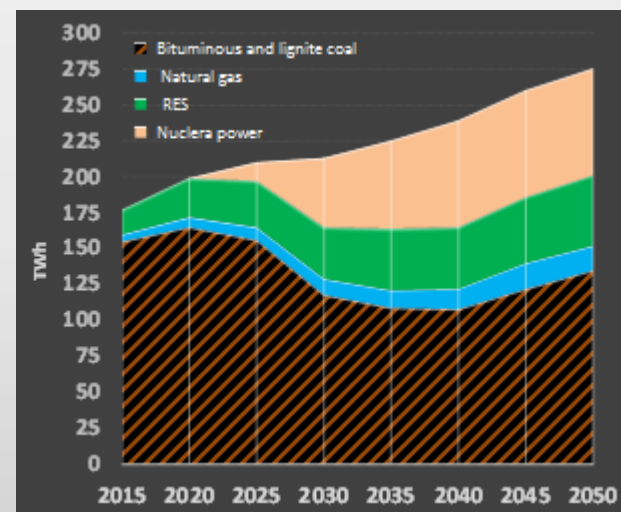
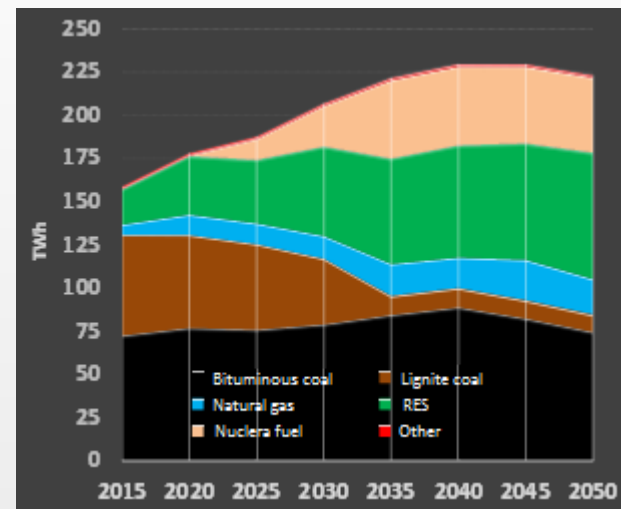
„The role of carbon energy sector in Poland must be seen as an opportunity for our country to be the European leader in the development of clean coal technologies.”

Krzysztof Tchórzewski, II Congress of Polish Electrical Engineering 11.04.2016

The energy balance of Poland



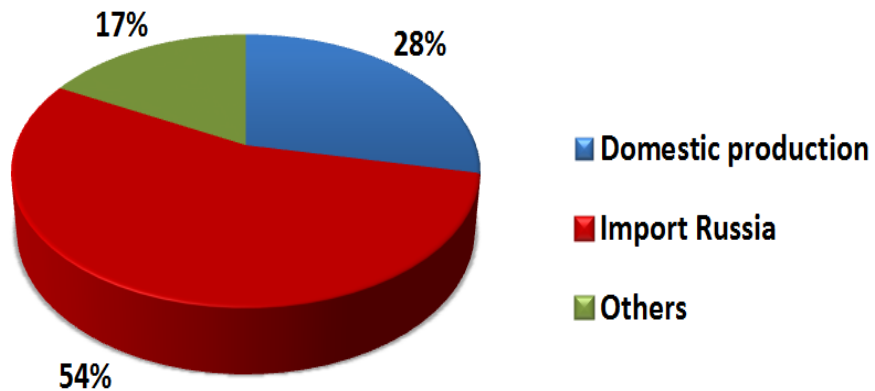
Power generation



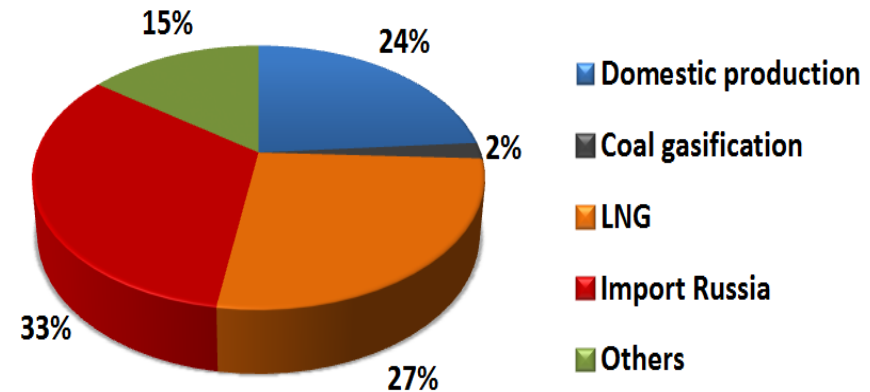
Conclusions from the analysis for Polish Energy Policy until 2050; Annex 2.: the Polish Energy Policy until 2050; The project version 02.

Natural gas sources for Polish economy

2014



2025 - prognosis



REPORT ON THE RESULTS OF MONITORING GAS FUEL SUPPLY SECURITY from the period from 1 January 2014 till 31 December 2014 The Ministry of Economy 2015

The forecast on the basis of the Polish Energy Policy until 2050 and taking into account LNG terminal (amount of gas production and import from Germany and the Czech Republic as in 2014), Coal gasification: 1 million t/year.

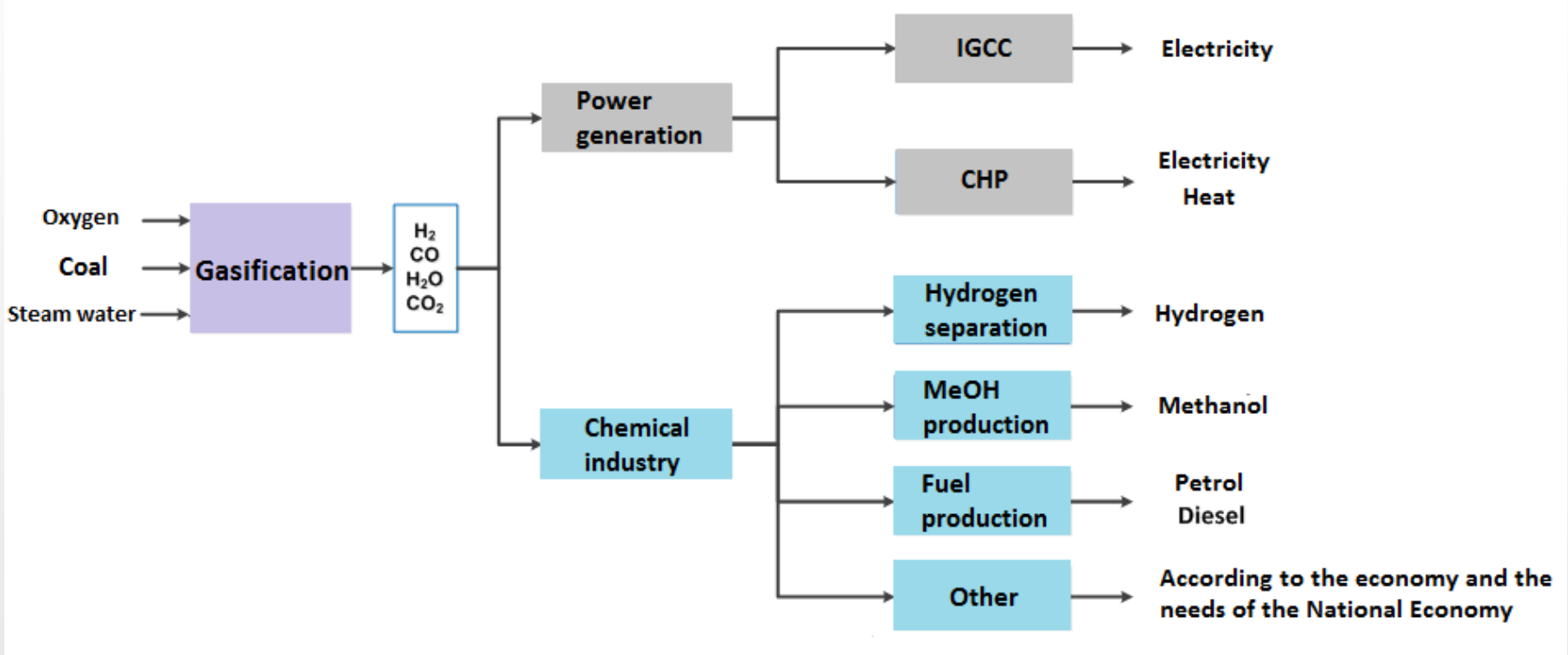
Diversification of natural gas supply

*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.*

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

**Despite that, the need of NG source diversification is indicated repeatedly in the new Energy Policy of Poland (2050), one can not find in document that:
exist the possibility of its efficient substitution by
gasification of domestic coal.**

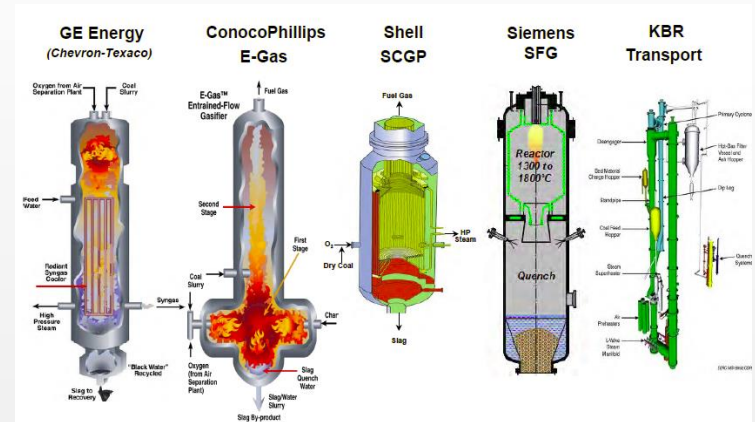
Coal gasification technology: Advantages



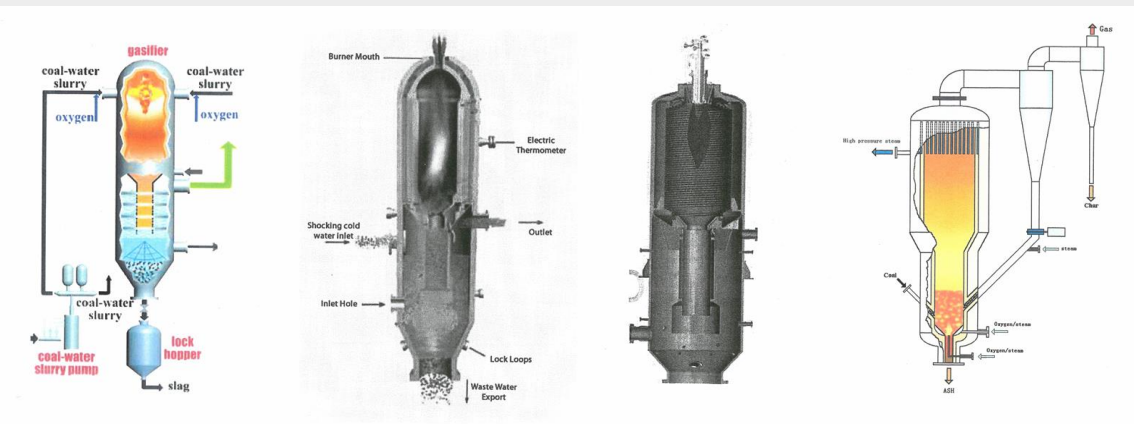
- ↳ Zero emission power generation – CCS/current CCU model
- ↳ Substitution liquid and gaseous fuel – chemical synthesis
- ↳ Polygeneration systems (chemical and energy)

Coal gasification technology: Commercial technology suppliers

- ↳ Entrained flow technologies
 - Water slurry and dry feeding
- ↳ Fluidized bed technologies
- ↳ Fixed bed technologies



- ↳ East China University of Science and Technology (**OMB: Opposed Multi-Burner Gasifier**)
- ↳ Northwest Research Institute (**MCSG: The Multi-Component Slurry Reactor**)
- ↳ Aerospace Science and Technology Corporation (**HT-L: Pressurized, Down-Flow, Entrained Reactor**)
- ↳ Institute of Coal Chemistry (**AFB: Ash Agglomerated, Fluidized-Bed Reactor**)

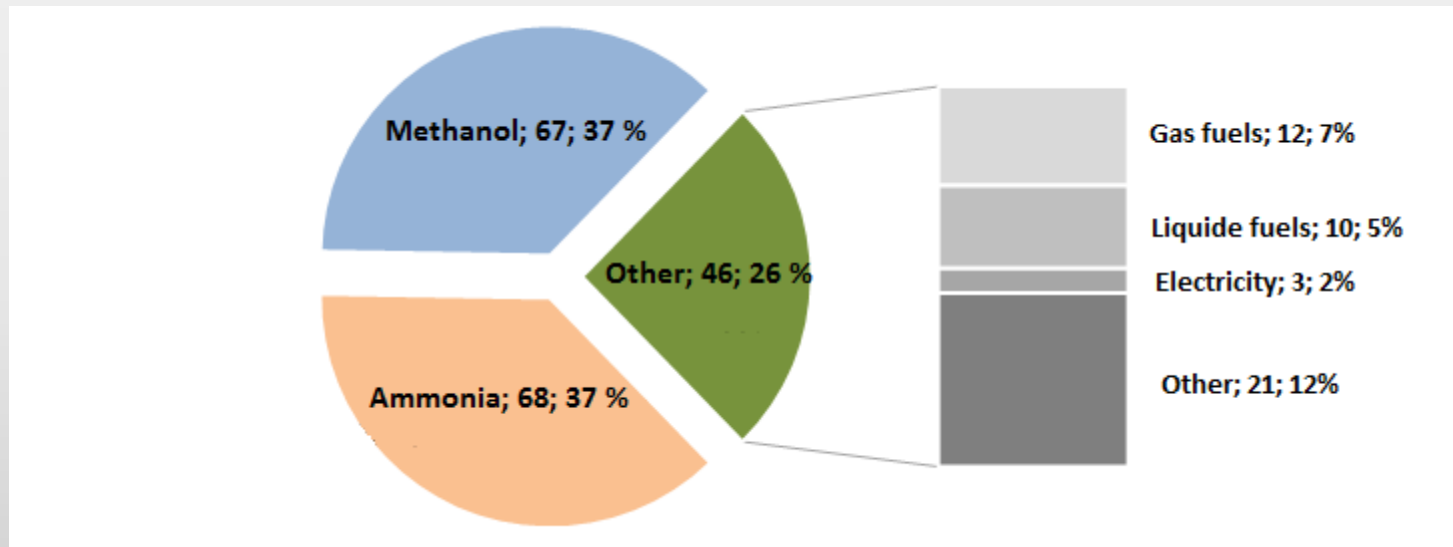


Coal gasification technology: State of development

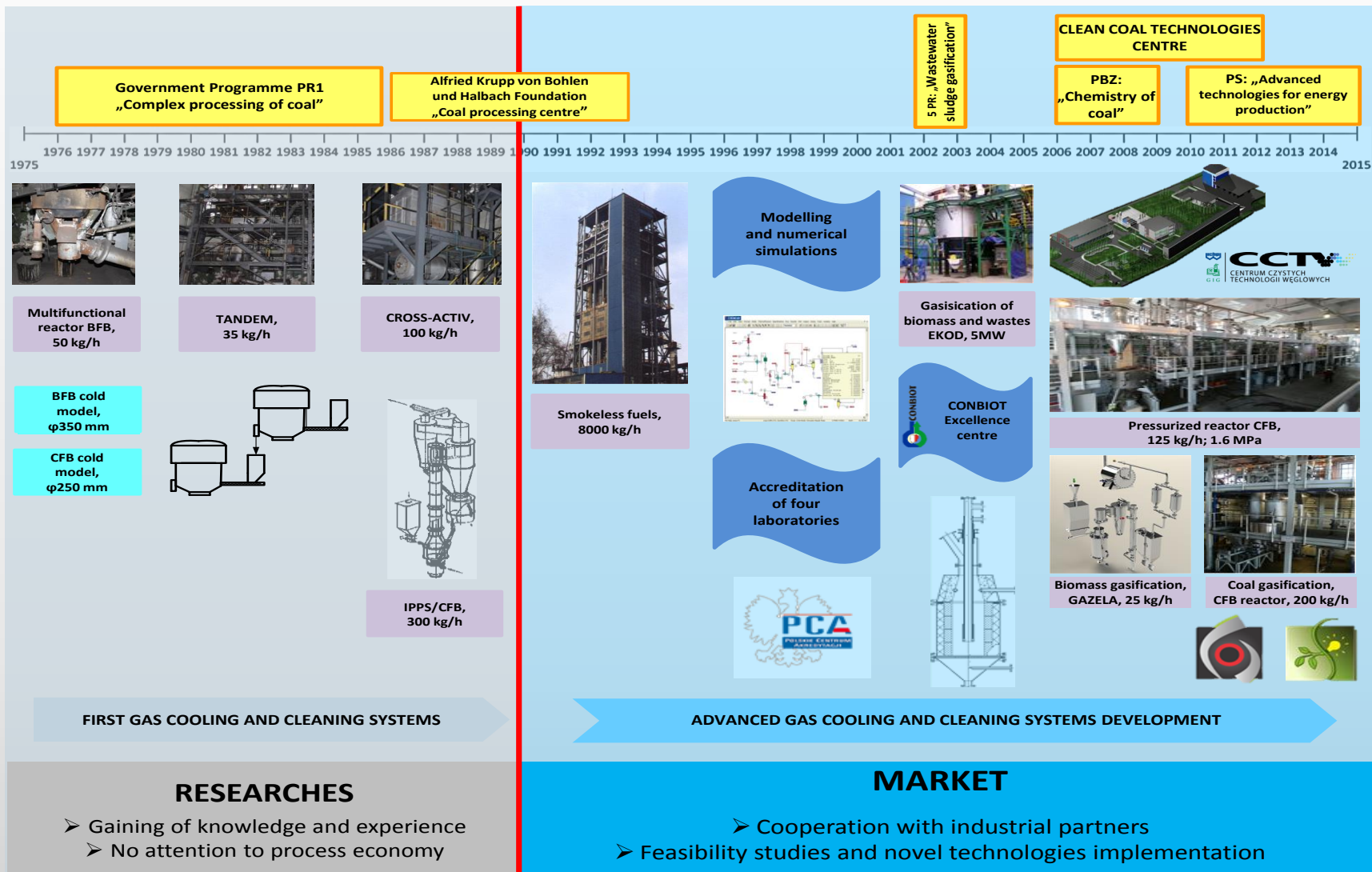
Coal gasification:

- ↳ 25% of global ammonia production
- ↳ 30% of global methanol production

Production directions – example of China



Coal gasification: R&D in Poland: 40 years of IChPW experience



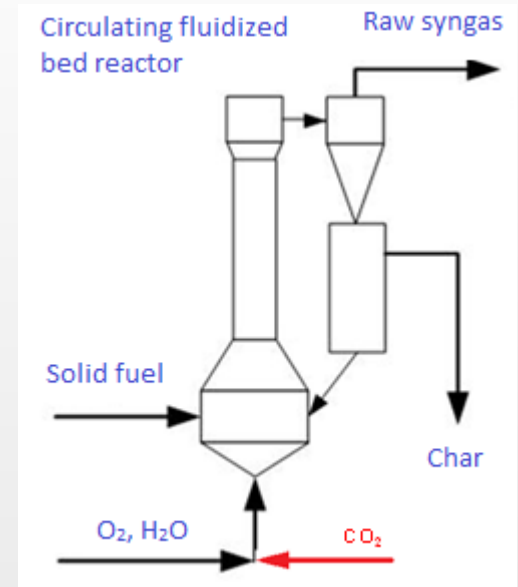
CO₂ enhanced coal gasification in CFB reactor

Technology developed by IChPW

Results:

- ➔ Increasing the efficiency of the process and the improvement of economic factors of production of syngas.
- ➔ Reducing the consumption of fossil fuel with a constant production of syngas.
- ➔ Reduction of oxygen consumption (use of CO₂ as a carrier of oxygen).
- ➔ Utilization of CO₂, which is produced during the conversion of fossil fuels.

The level of technological readiness: 6



Strategy for coal gasification development in Poland

➔ Commercial technologies:
short term perspective 2020

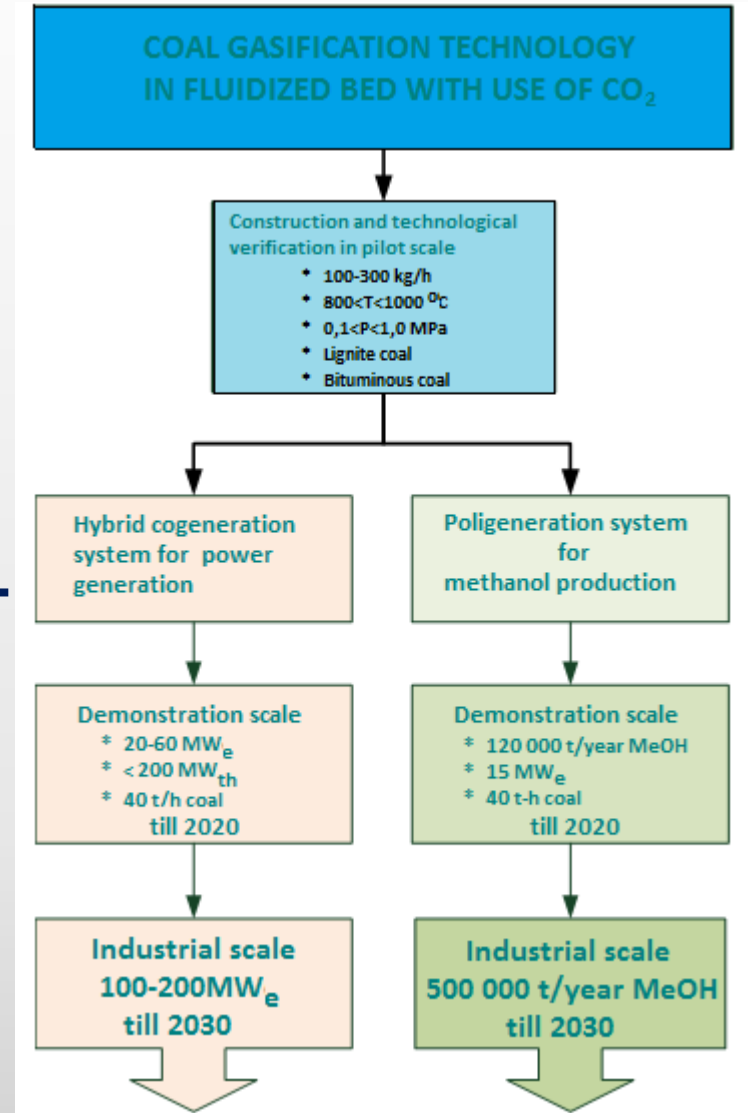
➔ Developing technologies:
medium term perspective 2030

(Results of Task No.3: „ Development of coal gasification technology for highly efficient production of fuel and electricity”)

➔ Polygeneration systems integrated with coal gasification

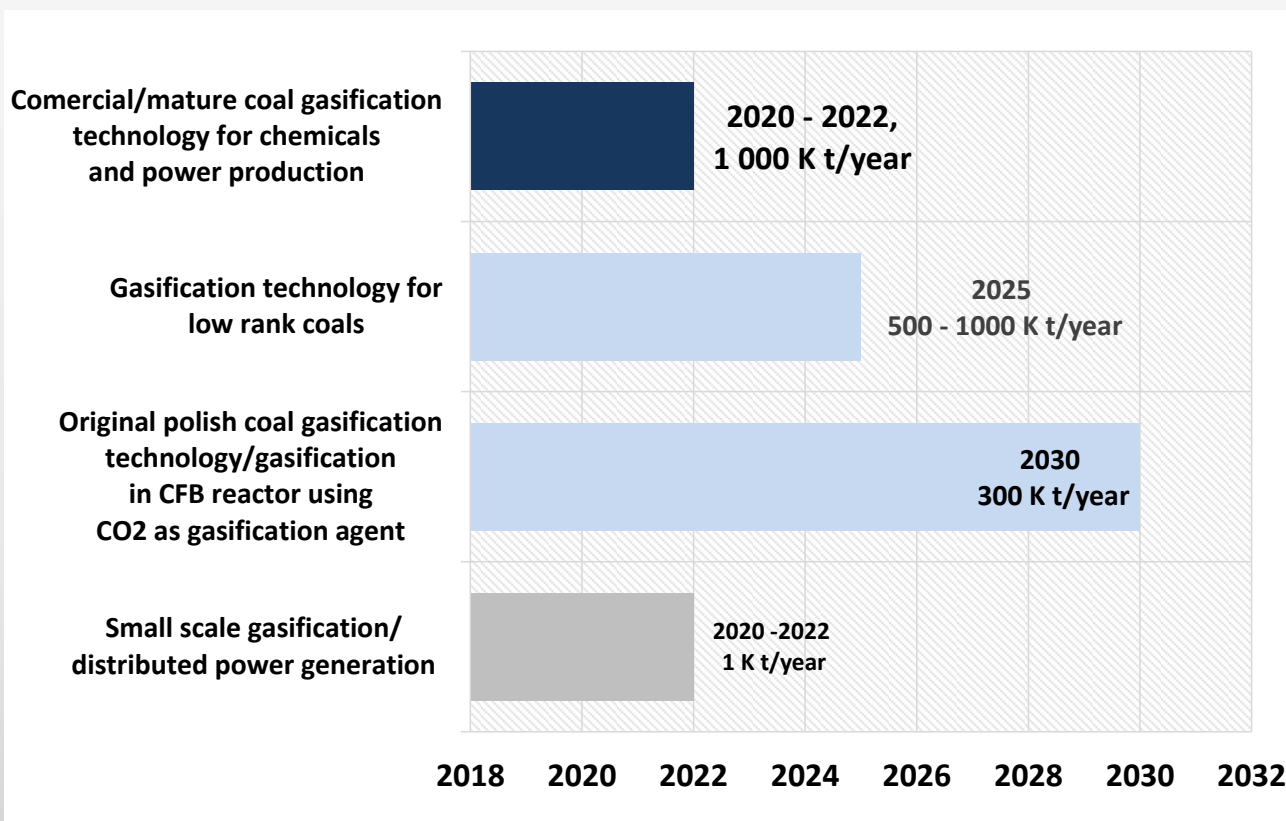
➔ Substitution of natural gas to produce hydrogen for ammonia synthesis

➔ Methanol synthesis and olefin production



Strategy for coal gasification development in Poland

Development variant/direction	Possible date of implementation (the first commercial property) Scale of single system/ yearly coal consumption	Technology source and development stage
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License purchase
Mature Technology

Technological partnership
Requires demo scale operation
Common technology

The level of technological readiness: 6
Requires demo scale operation
Original Polish technology

Different technology.
The level of technological readiness: 3-6

Economic analysis – assumptions (IChPW, Poland 2015)

⇒ 2 coals:

- Bituminous coal – ZW Janina
- Lignite coal – KWB Bełchatów

⇒ Entrained flow reactor - dry feeding

- One reactor (1000 K t/y)
- Shell, Siemens

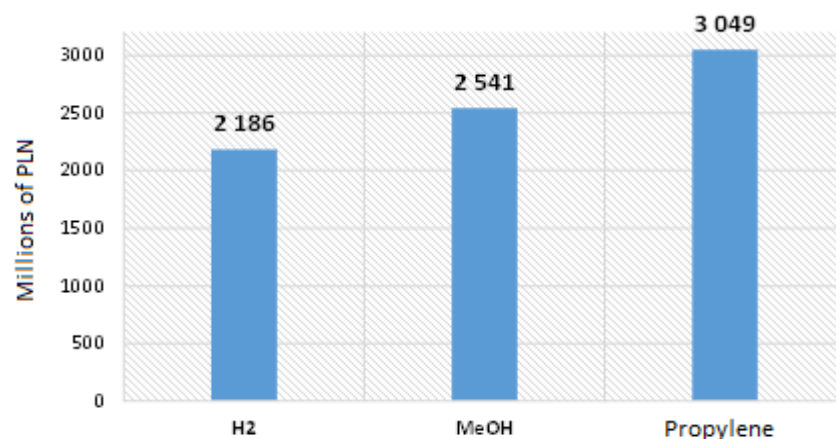
⇒ CCS ready system (CO₂ capture and compression)

⇒ Products: H₂ /MeOH/ Propylene

⇒ The scale of production can meet the needs of the polish industry in:

- 17% in the case of propylene
- 100 % in the case of methanol

Total Investment Cost



Economic analysis– results (IChPW, Poland 2015)

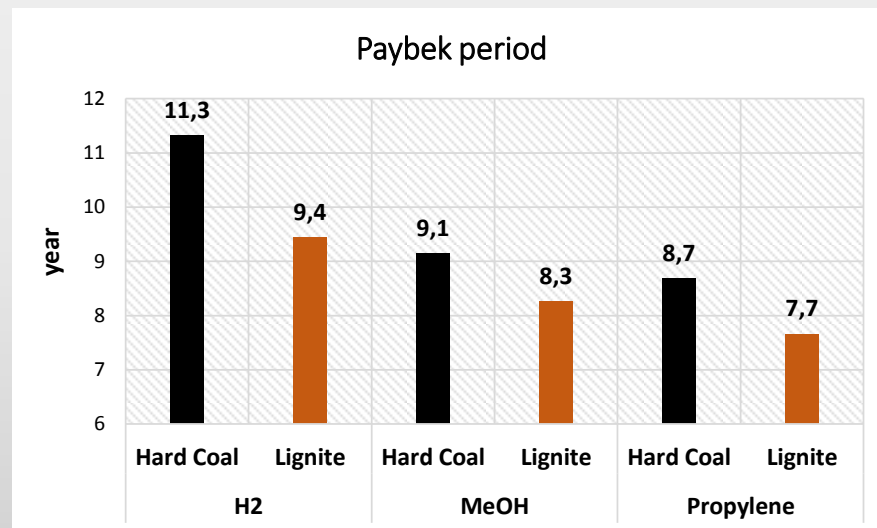
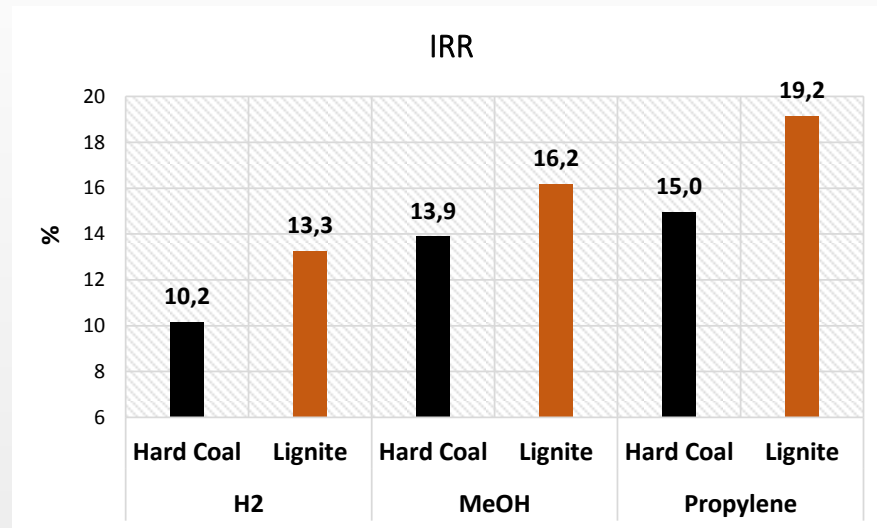
➔ Coal cost:

- Bituminous coal: 2,4 €/GJ
- Lignite coal: 1,7 €/GJ

➔ Sales prices of the products:

- Hydrogen: 1,55 € /kg (260 € /K m³)
- Methanol: 354 €/t (average market price 2014-2015: 363 €/t; max: 450 €/t)
- Propylene: 1330 €/t

1 € = 4,2 PLN



Possible substitution of natural gas

- ☑ **To meet the needs of domestic nitrogen plants (2,5 billions m³ of natural gas) 7 – 8 millions tons of coal must be gasified (depending on the fuel quality and gasification technology)**
- ☑ **To produce 500 000 t/year of methanol about 1 million tons of coal is needed, what is equivalent of approx. 400 million m³ of natural gas consumption.**

Actions taken in Poland 2015/2016

Consortium:

Grupa Azoty SA, TAURON SA, KGHM SA



➔ „Verification of Assumptions for the Feasibility Study polygeneration power plant”

- Development of pre-feasibility study for different configuration of chemical and power production systems integrated with coal gasification.
- Contractor: **ICHPW, Zabrze**
- **The results of this work were the basis for next actions**



➔ Feasibility Study of Polygeneration Power Plant

- **Complete Feasibility Study** for different chemical production systems integrated with coal gasification.
- **Location: Grupa Azoty, Zakłady Azotowe Kędzierzyn S.A.**
- Contractor: **Amec Foster Wheeler Italiana**



Actions taken in Poland 2015/2016

Polska Grupa Energetyczna SA

(the biggest power producer in Poland)



➔ **Formation of the Working Group for the coal gasification technology**

➔ **The report – the review of coal gasification technology**

- **Objective:** To analyze the possibility of developing gasification technology in Poland with the use of bituminous and lignite coal deposits
- Analysis of the available and world leading commercial gasification technologies
- Study visits, expert meetings - including direct meetings with gasification technology suppliers.



Summary

Results of works done in 2010 – 2015 :

- ✓ Detailed analysis of the potential for coal gasification in Poland, well-established team of experts and researchers to promote the industrial implementation
- ✓ Qualitative and quantitative analysis of usefulness the polish coals for gasification
- ✓ Knowledge of the existing coal gasification technology (commercial and being under development)
- ✓ Collected and analyzed detailed information on the investment and operating costs, economic efficiency of different production directions and internal and external markets for products.

**Poland is ready to take the
strategic decision
about construction and start-up
the first industrial
coal gasification plant**

Poland – future for coal gasification



Krzysztof Tchórzewski

Minister of Energy



Grzegorz Tobiszowski

Deputy Minister of Energy,
Government Plenipotentiary.
Restructuring of coal mining

(...) Coal gasification seems to be very promising type of clean coal technology. I see the potential in the development of CO₂ processing technology, in management of this gas in carbochemistry and production of fuels, including biofuels „

Grzegorz Tobiszowski, Conference: "Clean coal technologies in the context of achieving the objectives of the National Energy Policy", 07.04. 2016, Warsaw.

„We need to combine high efficiency, flexibility and environmental parameters with the real economic effect (...). It will also be important alternative possibilities of coal use, like gasification.”

Michał Kurtyka, Undersecretary of State,
"EU Energy Policy - pillars and the prospect of development" Conference, 25.04. 2016

Summary

Key driving forces :

- ✓ availability and quality of coal
- ✓ lack of natural gas
- ✓ well-known technology
- ✓ educated staff and R&D
- ✓ negative trade balance for chemicals

....and

We are still waiting!

**Thank you for
your attention !**