



**INSTITUTE FOR CHEMICAL
PROCESSING OF COAL**



1955-2016

5th International OMB Conference
Opposed Multi-Burner Coal Gasification
Technology, Promotion and Application

November 7-9, 2016 – Nanjing, China

**Coal gasification in
Poland -
perspectives and key
driving forces**

Aleksander Sobolewski and Tomasz Chmielniak



...beyond standards!

Scope of presentation

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

Energy policy in Poland



Krzysztof Tchórzewski

Minister of Energy



Grzegorz Tobiszowski

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

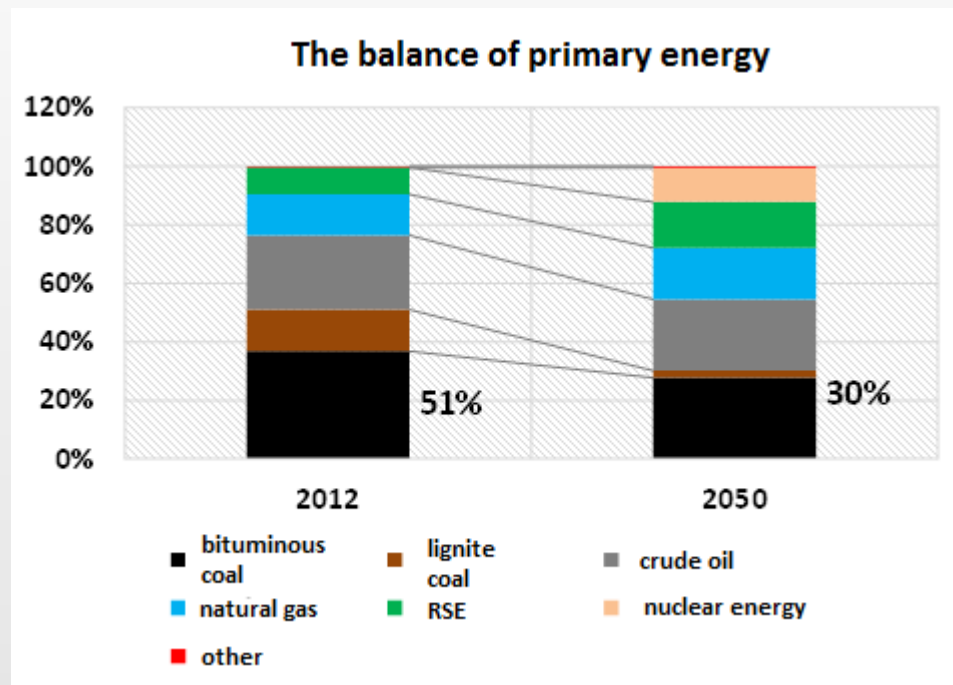
„The role of carbon energy sector in Poland must be seen as an opportunity for our country to be the European leader in the development of clean coal technologies.”

Krzysztof Tchórzewski, II Congress of Polish Electrical Engineering 11.04.2016

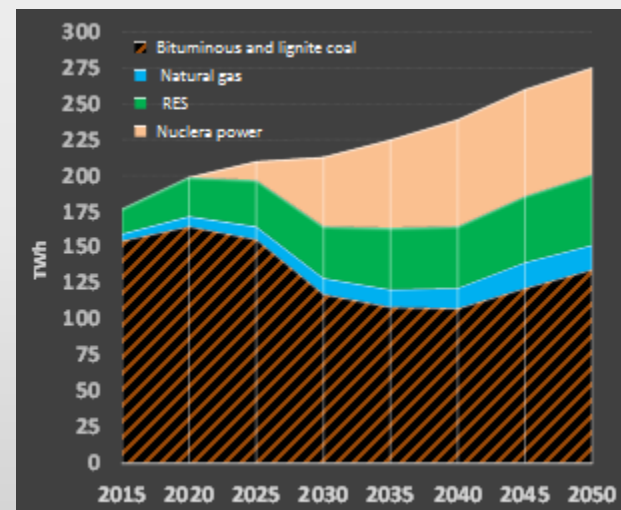
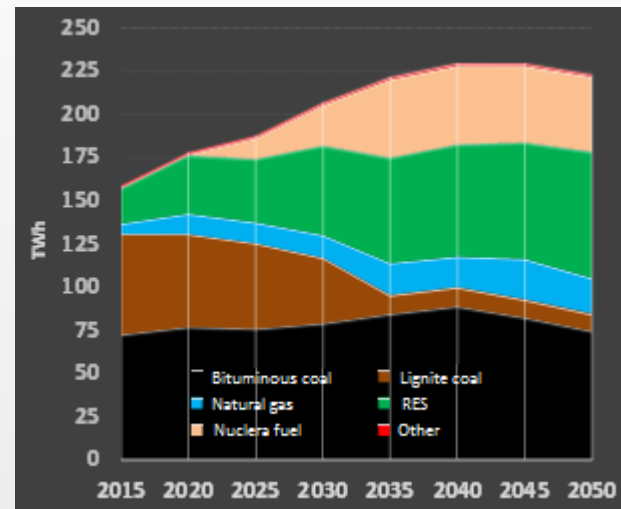
“(...) Coal gasification seems to be very promising type of clean coal technology.”

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

The energy balance of Poland



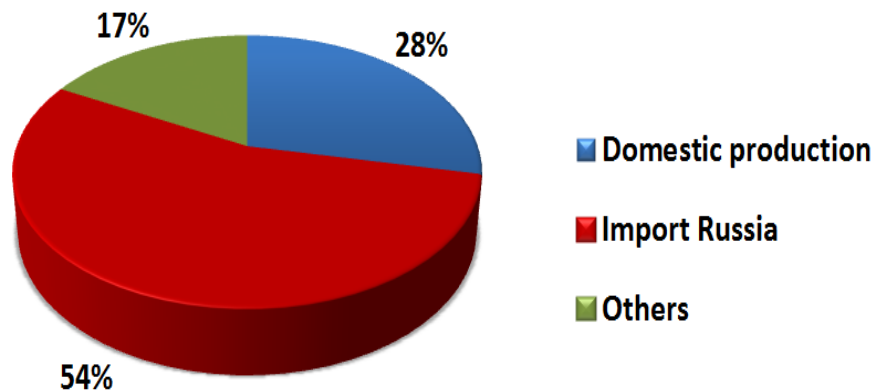
Power generation



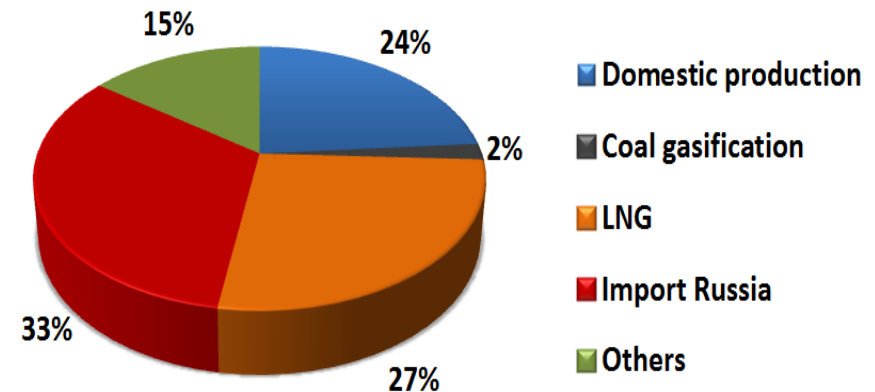
Conclusions from the analysis for Polish Energy Policy until 2050; Annex 2.: the Polish Energy Policy until 2050; The project version 02.

Natural gas sources for Polish economy

2014



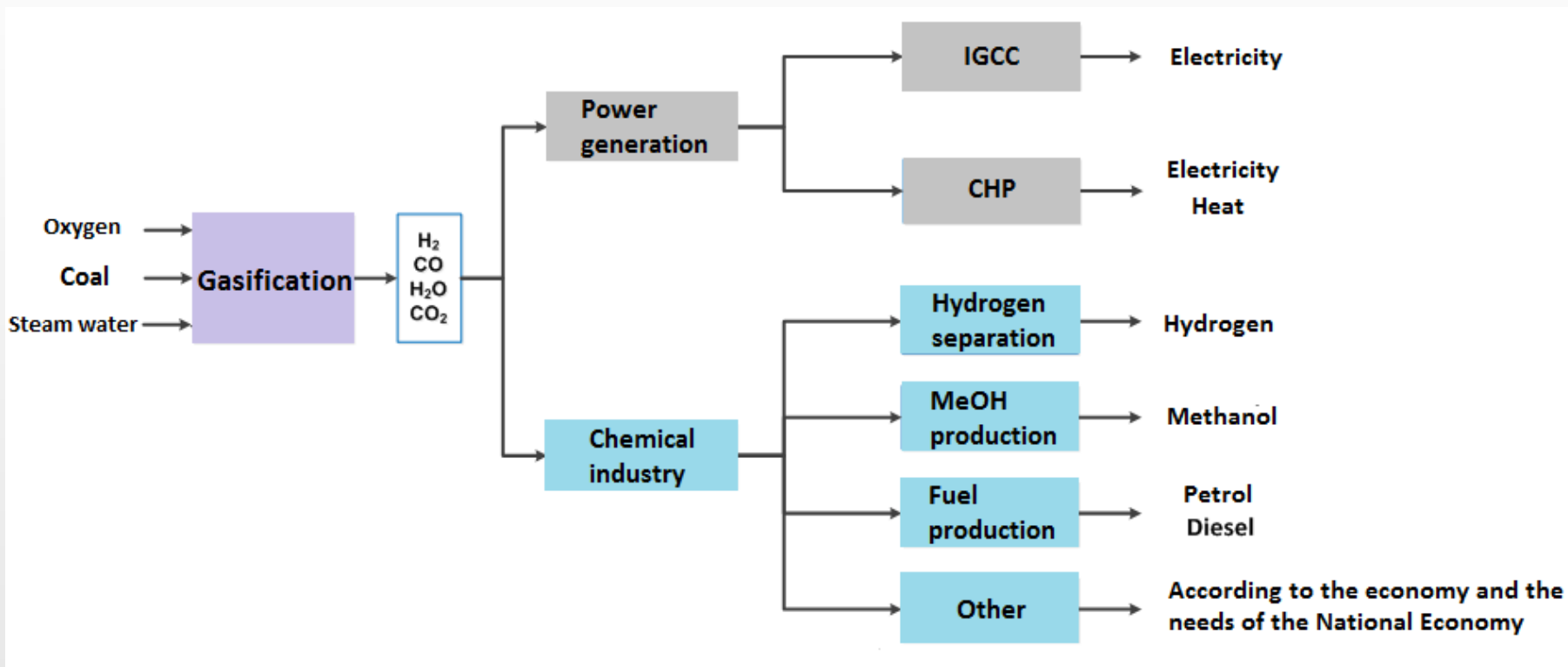
2025 - prognosis



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.

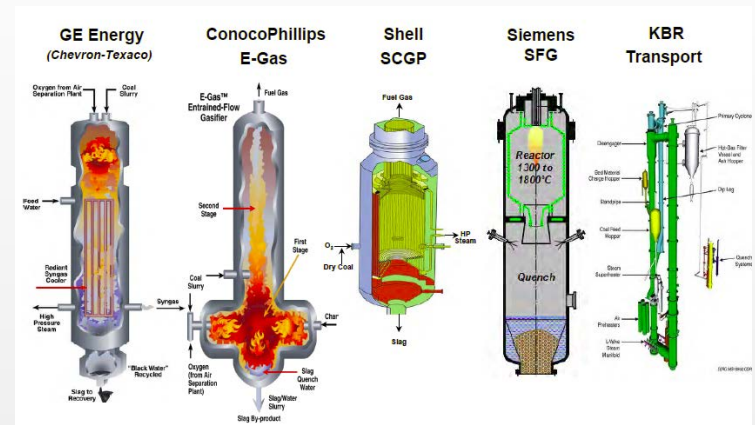
Coal gasification technology: Advantages



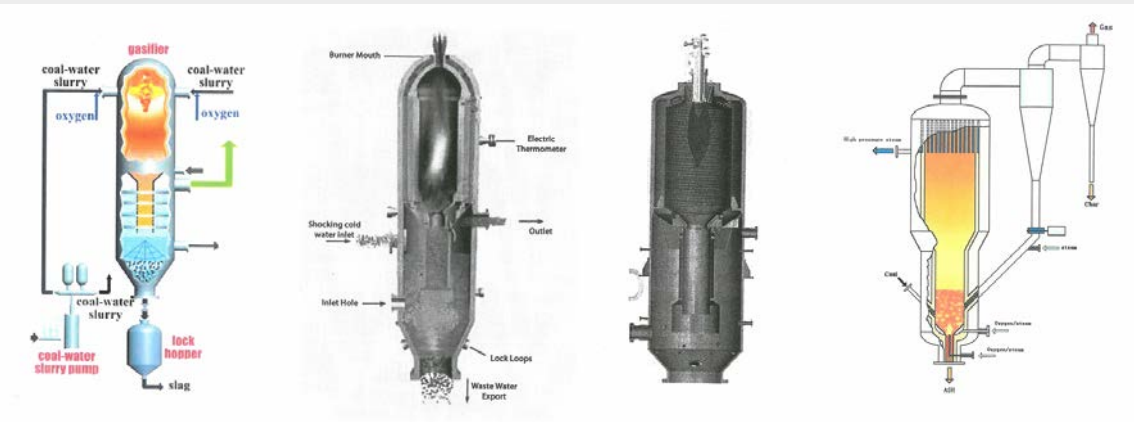
- ↳ Zero emission power generation – CCS/current CCU model
- ↳ Substitution liquid and gaseous fuel – chemical synthesis
- ↳ Polygeneration systems (chemical and energy)

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**)

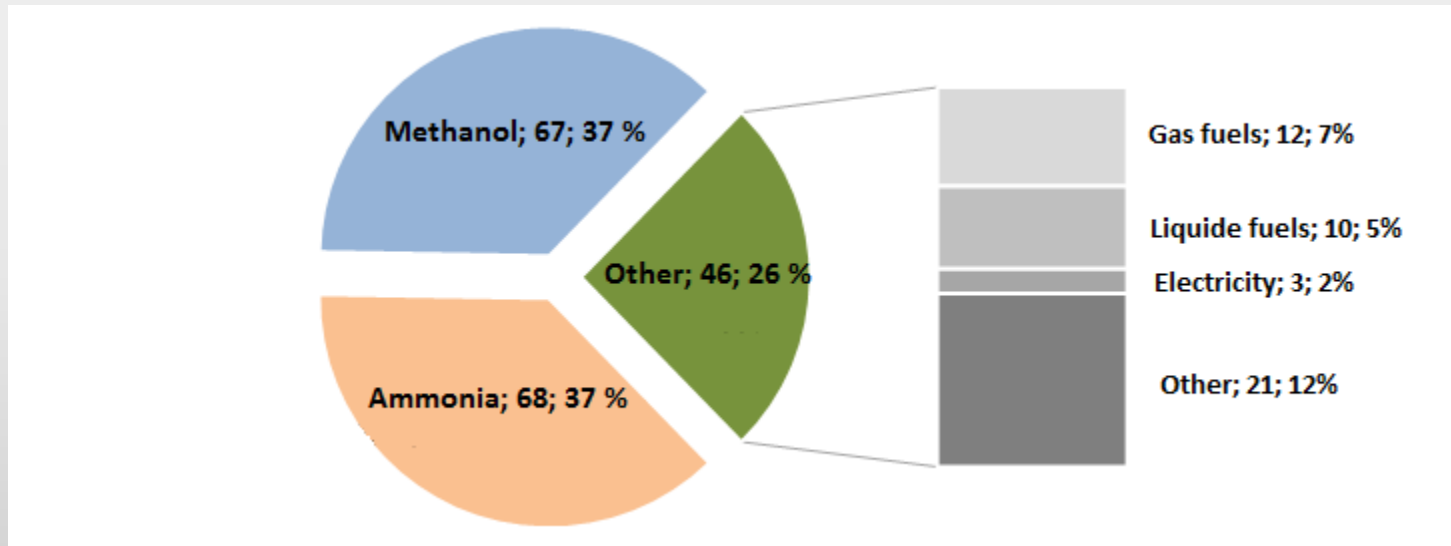


Coal gasification technology: State of business

Coal gasification:

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

Production directions – example of China





1955-2016

Institute for Chemical Processing of Coal

- Establishment: 1955
- Supervision: Polish Ministry of Energy
- Employment: 180 people



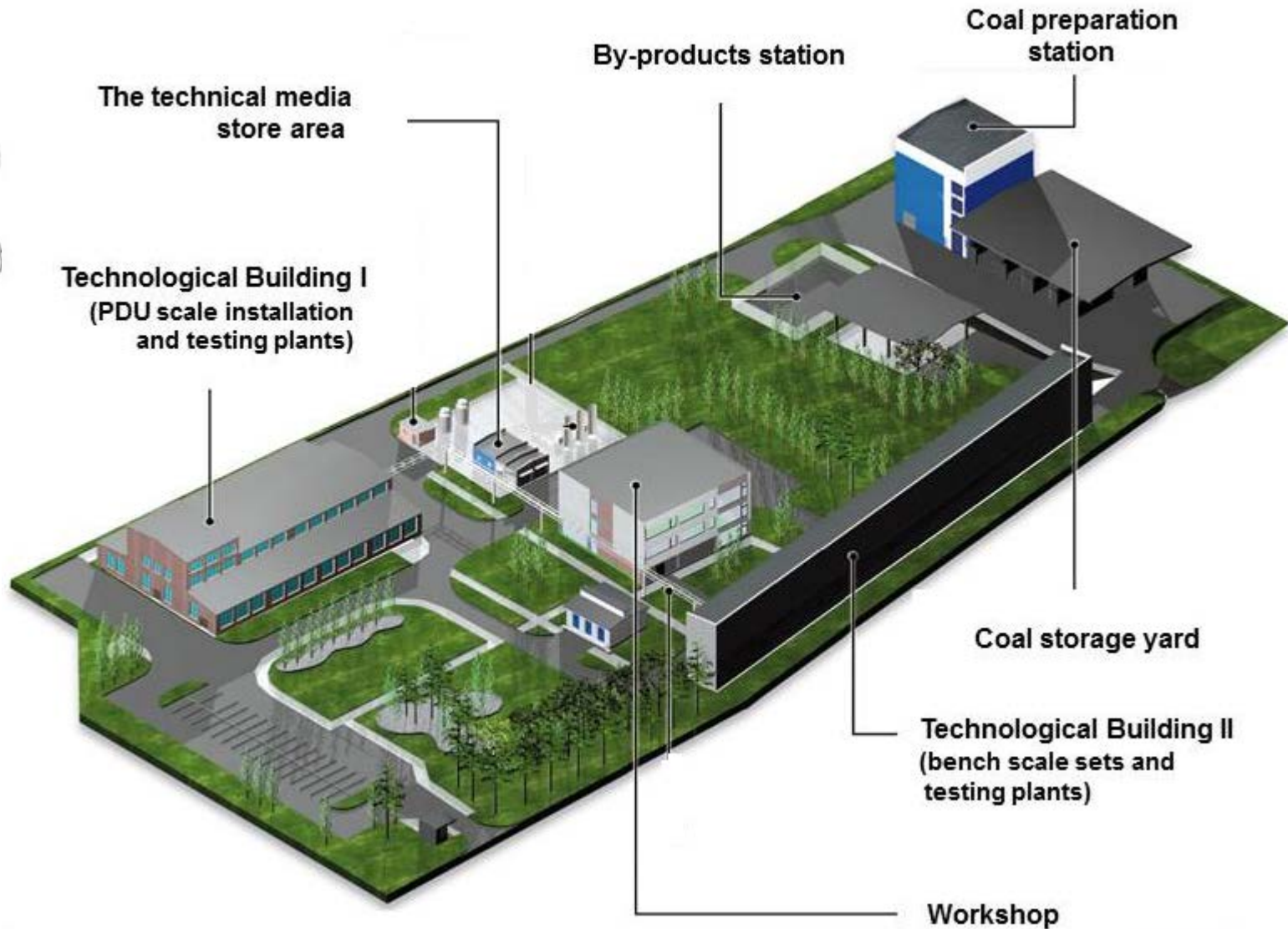
Zabrze (Poland)



Clean Coal Technology Center



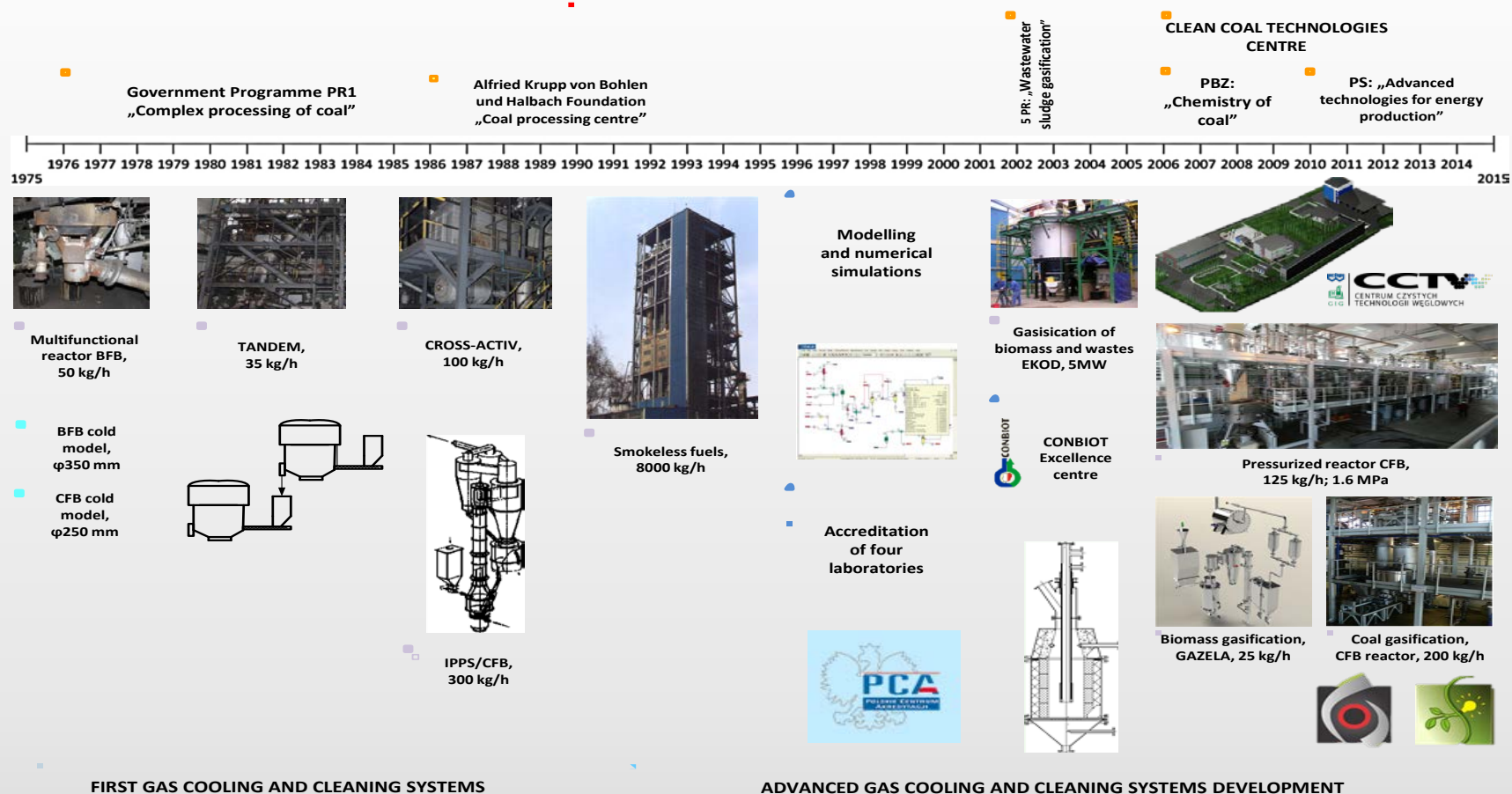
Zabrze



Clean Coal Technology Center (technological building no 1)



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



RESEARCHES

- Gaining of knowledge and experience
- No attention to process economy

MARKET

- Cooperation with industrial partners
- Feasibility studies and novel technologies implementation

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.

Strategy for coal gasification development in Poland



Short term activities beyond 2020

- Development of industrial scale plant based on selected commercial available technology



Medium and long term activities beyond 2030

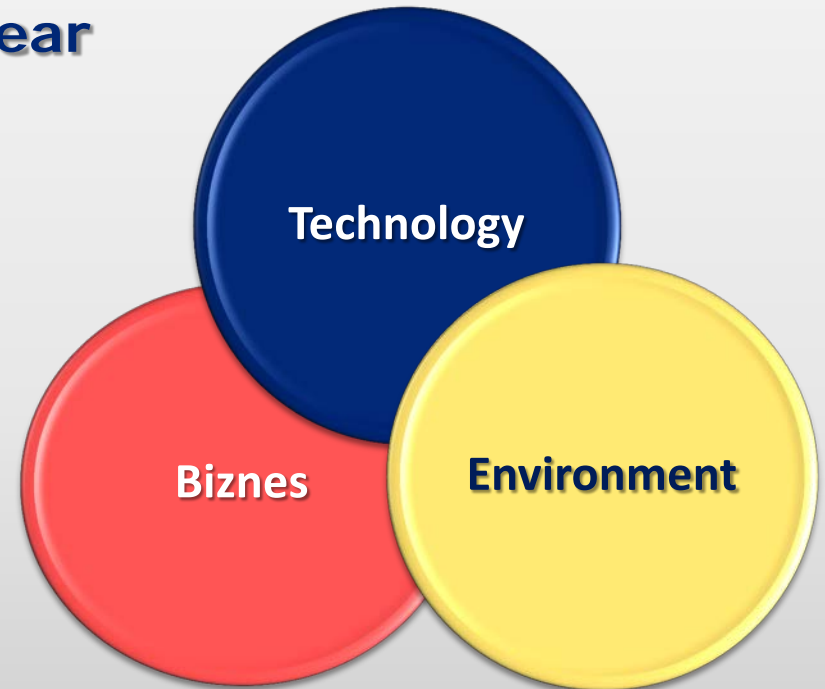
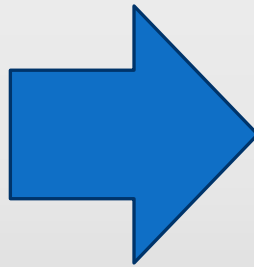
- Development of industrial scale plant based on Polish national gasification technology in CFB reactor
(Demo stage necessary !!)

Strategy for coal gasification development in Poland

**The first in EC full commercial scale
coal gasification plant
oriented for chemicals**

Scale : 1 Mt of coal/year

**What is
necessary ?**



Actions taken in Poland 2015/2016

Consortium:

Grupa Azoty SA, TAURON SA, KGHM SA



Feasibility Study of Polygeneration 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**

Economic analysis – assumptions (Poland 2015/16)

➔ Coal:

- 2 bituminous coal from Poland
- LHV : 20 – 24 MJ/kg

➔ Entrained flow reactor

- One reactor (1000 K t/y)

➔ Brown field investment

- in existing chemical plant

➔ Products: ammonia /methanol

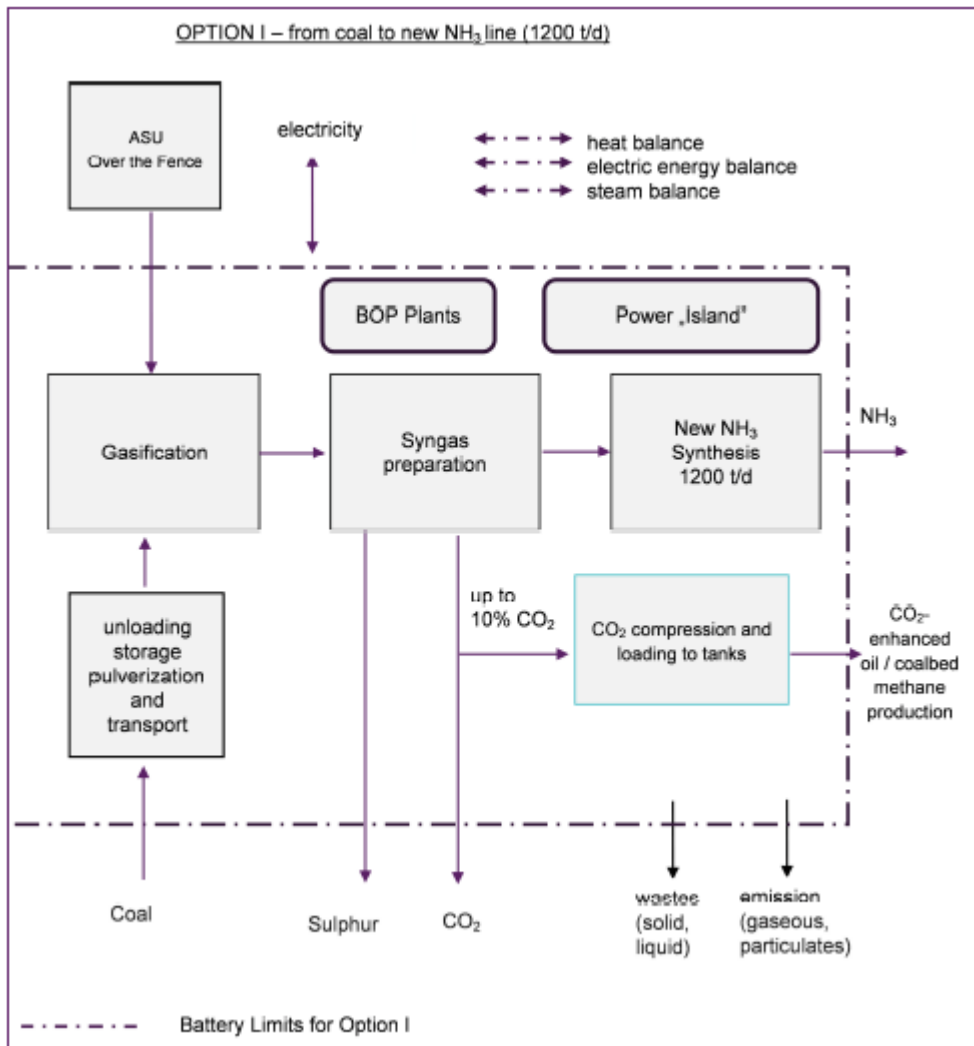
➔ 4 technological options:

- 1) ammonia - new line
- 2) ammonia - extended line
- 3) ammonia - extended line 2
- 4) methanol

Total Investment Cost

Option	(TPC) [kEuro]
ammonia 1)	490 600
ammonia 2)	486 400
ammonia 3)	480 500
methanol 4)	593 300

Economic analysis – assumptions (Poland 2015/16)



➔ Ammonia new line:

➔ Coal consumption:

- coal A – 81,0 t/h
- coal B – 66,3 t/h

➔ Ammonia production:

- 1200 t/day
- 394 200 t/y

Economic analysis – assumptions (Poland 2015/16)

Coal „A”
(20 MJ/kg)

Coal ultimate and proximate analysis – As Received			
Symbol	Unit	Value	Min/Max
C	%wt	52.6	
H	%wt	3.3	
N	%wt	0.9	
S	%wt	1.1	0.8 – 1.7
O	%wt	10.1	
Cl	%wt	0.2	0.13 – 0.45
Water	%wt	20.1	
Ash	%wt	12.2	
LHV (calculated)	kJ/kg	19,861	
HHV (calculated)	kJ/kg	21,098	

Coal „B”
(24 MJ/kg)

Coal ultimate and proximate analysis – As Received			
Symbol	Unit	Value	Min/Max
C	%wt	62.4	
H	%wt	3.6	
N	%wt	1.0	
S	%wt	0.7	0.5 – 1.1
O	%wt	7.2	
Cl	%wt	0.173	0.11 – 0.32
Water	%wt	13.6	
Ash	%wt	11.7	
LHV (calculated)	kJ/kg	24,242	
HHV (calculated)	kJ/kg	25,402	

Economic analysis– assumptions (Poland 2015/16)

⇒ Coal cost (2016-2026) :

- Variant 1 : Expensive bituminous Polish coal “B” 2,71 – 3,73 € /GJ
- Variant 2 : Cheap bituminous Polish coal “A” 2,24 – 2,80 € /GJ

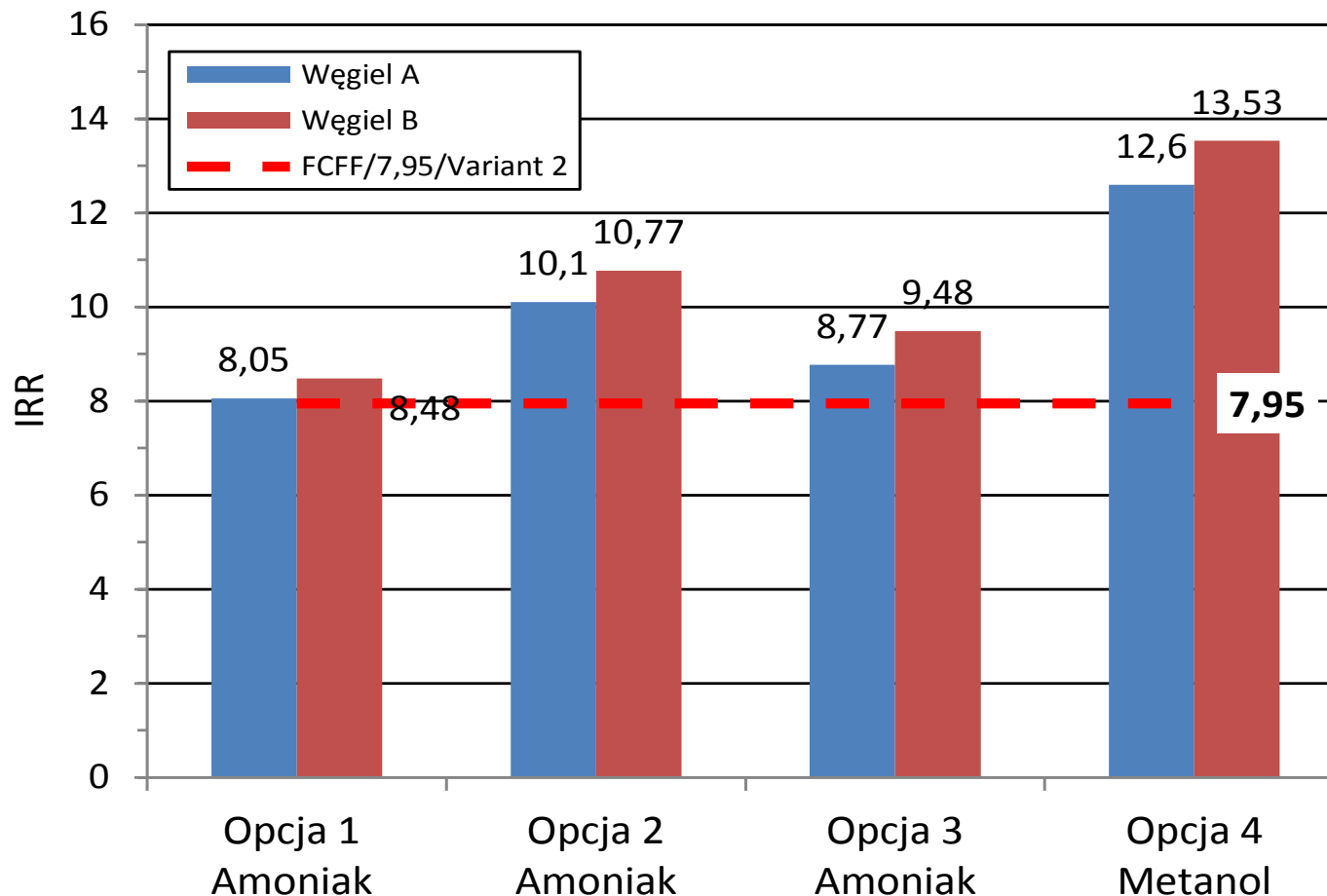
⇒ Sales prices of the products:

- Ammonia: Variant 2 : 366 – 440 € /t
- Methanol: Variant 2 : 410 – 469 € /t

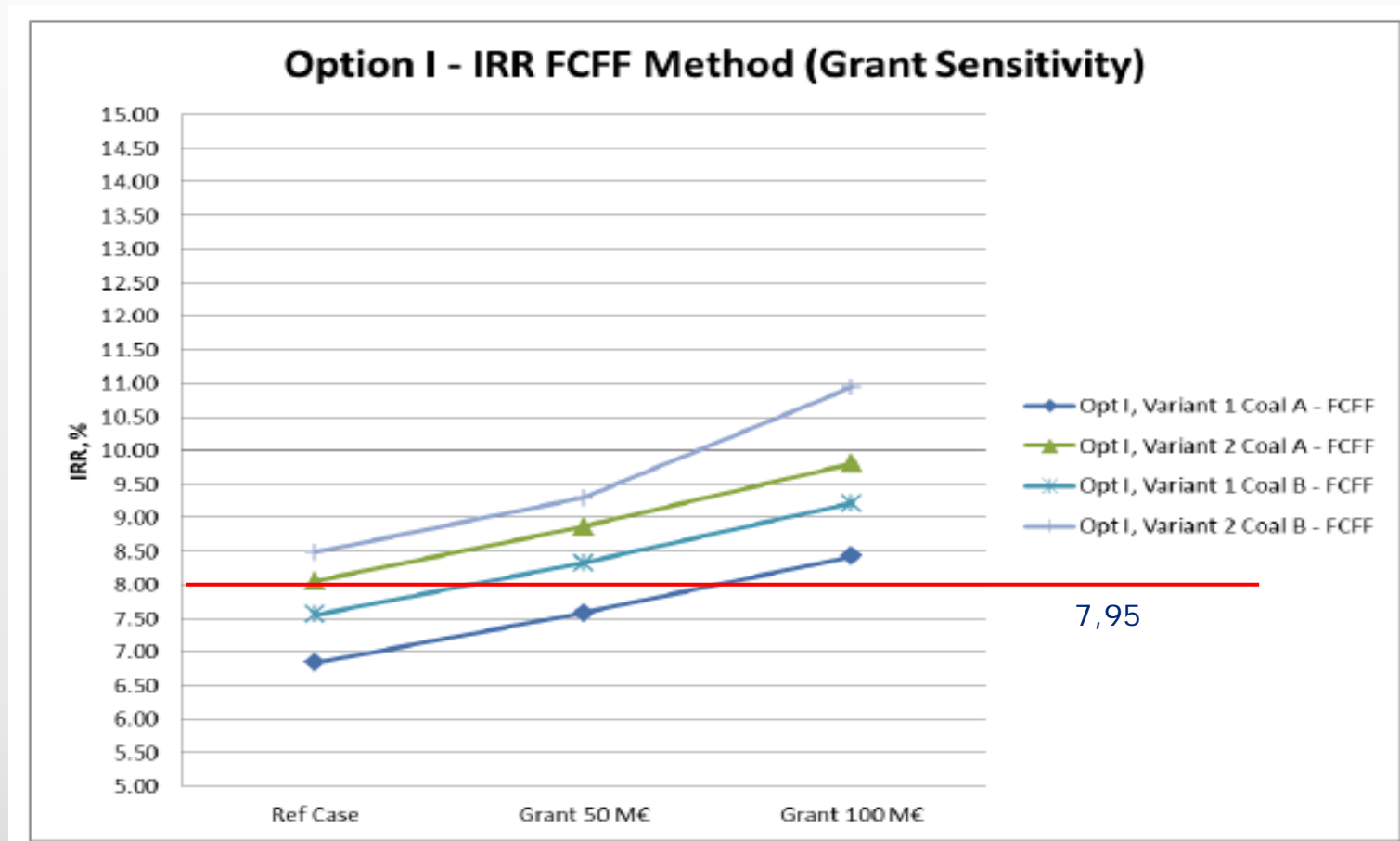
(average methanol market price

2014-2015: 363 € /t; max: 450 € /t)

Economic analysis– results (1)

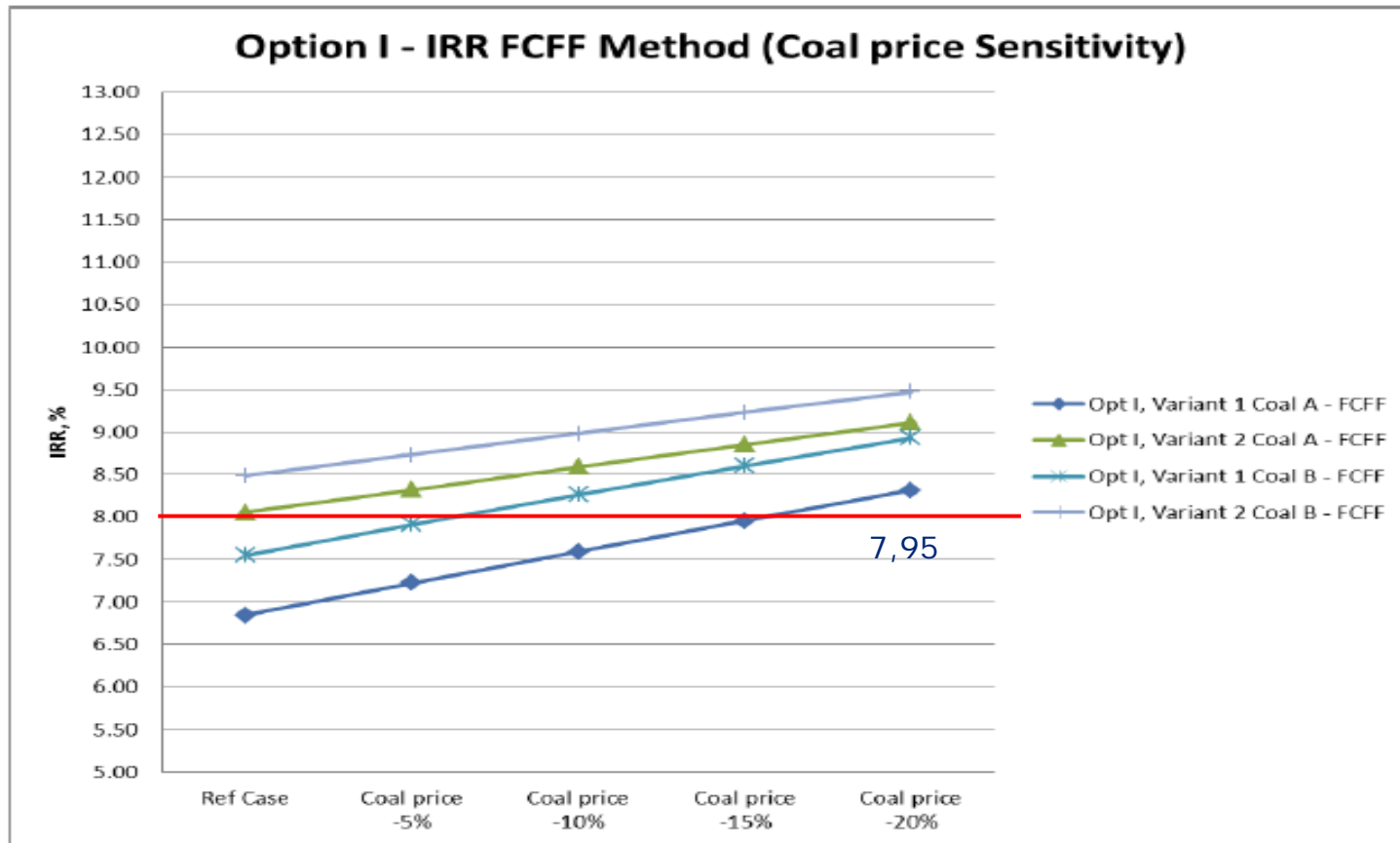


Economic analysis– results (2)



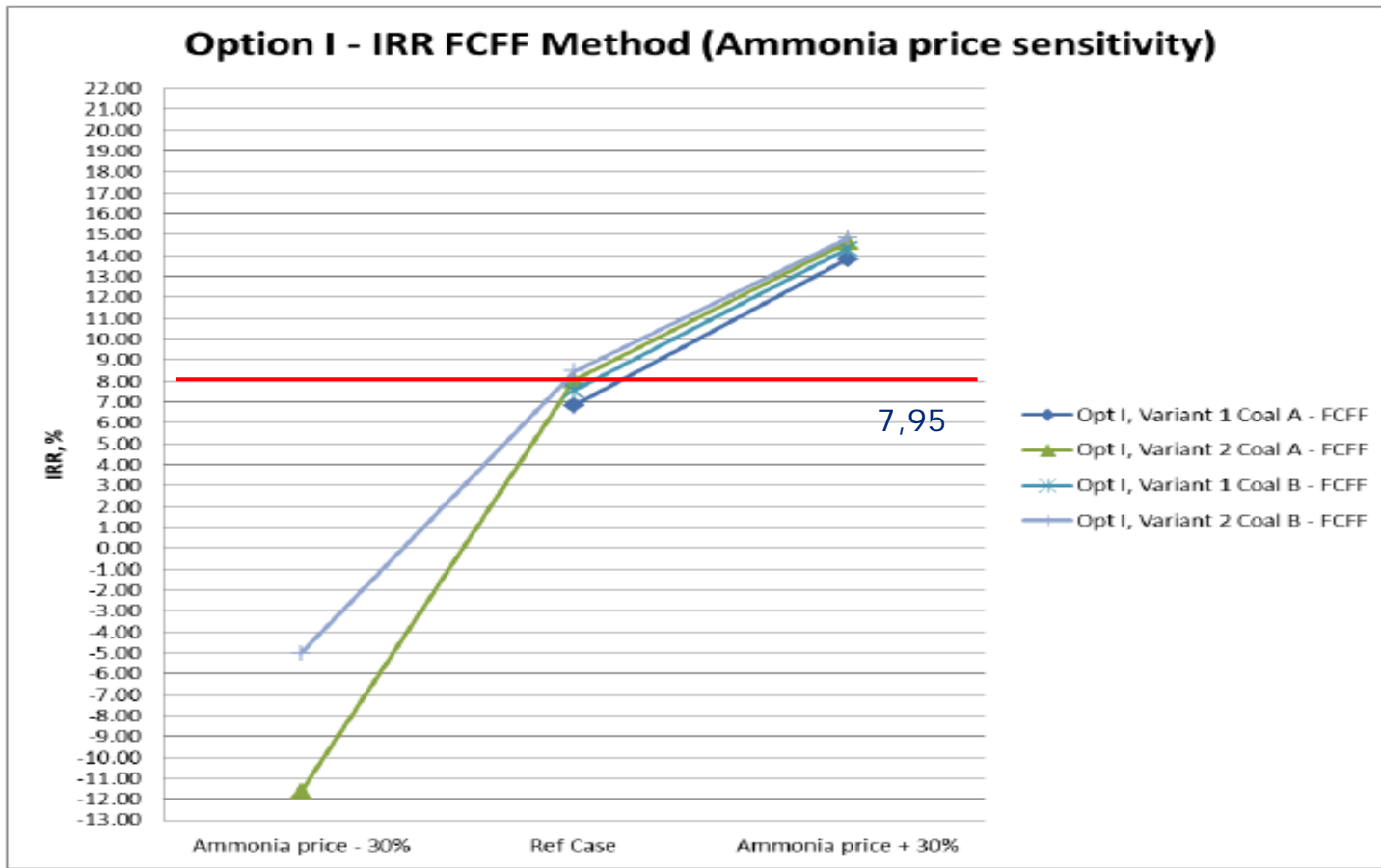
- Option 1 – new ammonia line 1200 t/d
- Investment Grant – up to 100 MEuro

Economic analysis– results (3)



- Option 1 – new ammonia line 1200 t/d
- Coal price – reduction up to 20%

Economic analysis– results (4)



- Option 1 – new ammonia line 1200 t/d
- Ammonia price : -30% to +30%

Economic analysis– conclusions :

It looks good

– for the first moment only.

- The price of coal is critical. Coal in Europe is too expensive. Expectation : 1Euro/GJ vs real market price : 2.5 Euro/GJ
- Gasification business is very sensitive for final products prices
- High CAPEX – cheaper technology is needed !

Why not ECUST ??

Key question :

Why is so difficult to start up coal gasification in EU ?

- ❑ Not stable market prices for coal, natural gas and chemicals
- ❑ Not enough profitable business & high risk. Expected banks payback rate (official) IRR=10—15%, businessman expectation (unofficial) IRR>20% !!
- ❑ Decarbonisation Policy of European Commission
- ❑ Restrictive environmental protection regulations

EU "Sustainable Development" concept :



➔ **Nice idea :**
especially during
election campaign

➔ **Real problem:**
especially for heavy
industry

EU "Sustainable Development" concept :



European Union in XXI century ?

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

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 !**