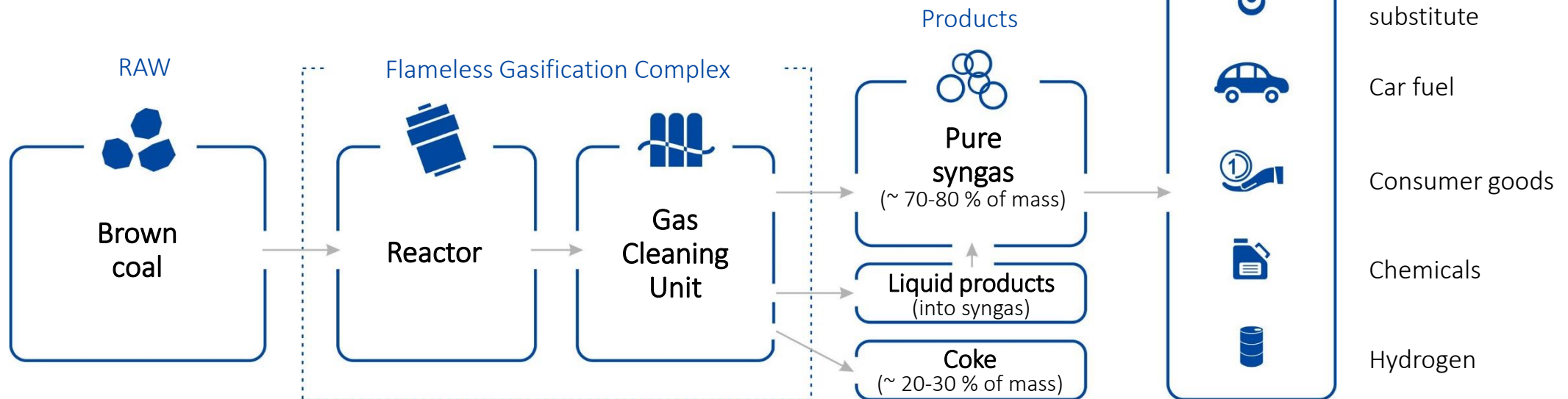




Technology
of flameless gasification of coal:
an effective way to improve
the economic, energy
and environmental safety
of the enterprise

Advantages of Flameless Gasification Technology

- Flameless processing occurs without direct combustion of brown coal and without blowing air with oxygen;
- Continuity and stability of obtaining the required final product for a potential customer, as well as transferring about 99.00 percent of the entire organic part of brown coal into the gas phase;
- With flameless coal gasification, there is no carbon dioxide emissions, while during the coal combustion in thermal power plant it is formed in significant amounts;
- Production of a large volume of synthesis gas, both for the generation of energy resources and for production of hydrogen and chemical products;
- Operates in atmospheric pressure mode;
- It is a continuous gasification process.



Key indicators of coal gasification technological processes

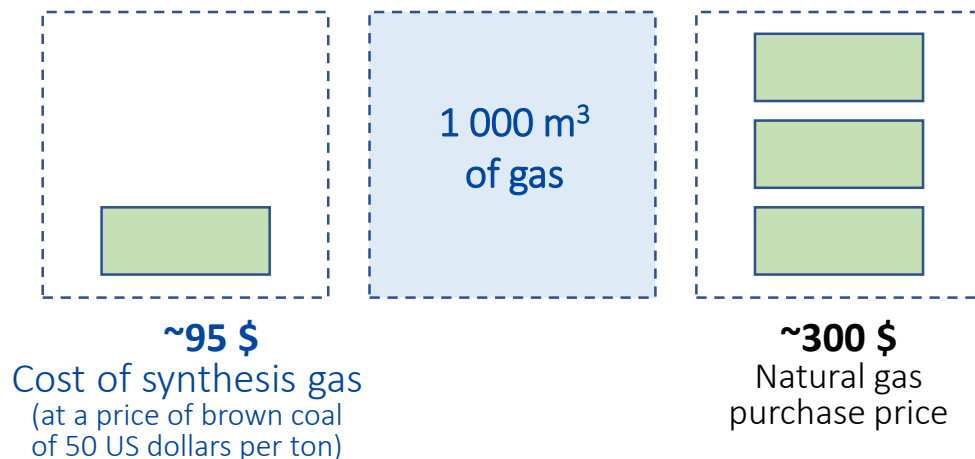
INDICATOR	LURGI	WINKLER	KOPPERS-TOTZEK	Flameless Gasification
Type of coal	Brown, non-coking	Brown	All types	All types
Capacity of coal, t / h	40-75	20-35	Up to 40	Any (power ascension by blocks)
Coal particle size	Large pieces 6-50 mm	<10 mm	Pulverized, <0,1 mm	Large pieces 50 mm – 100 mm
Gasification efficiency, %	75-85	65-85	65-85	99.99
Temperature in the reaction zone, °C	750-1100	820-1100	1300-1700	750 - 950
Consumption:				
Coal, kg /1000 m ³ of dry gas	800-650	750-610	660-560	500 - 600
Oxygen, m ³ / 1000 m ³ (CO + H ₂)	210-250	300-350	400-500	None
Heat of gas combustion, MJ/m ³	11,9-16,3	7,5-9,4	10,3-11,7	10 - 13 to get H ₂ (aggregate mode 1) or 35-45 – to generate energy (aggregate mode 2)
Composition of dry gas, % CO ₂ + H ₂ S	25-31	17-22	10-13	3 - 10 (CO ₂) (no formation of H ₂ S)
CH ₄				5 - 30
CO	17-25	31-35	50-60	15 - 35
H ₂	40-42	32-43	29-34	35 - 60

Opportunities from flameless gasification of brown coal

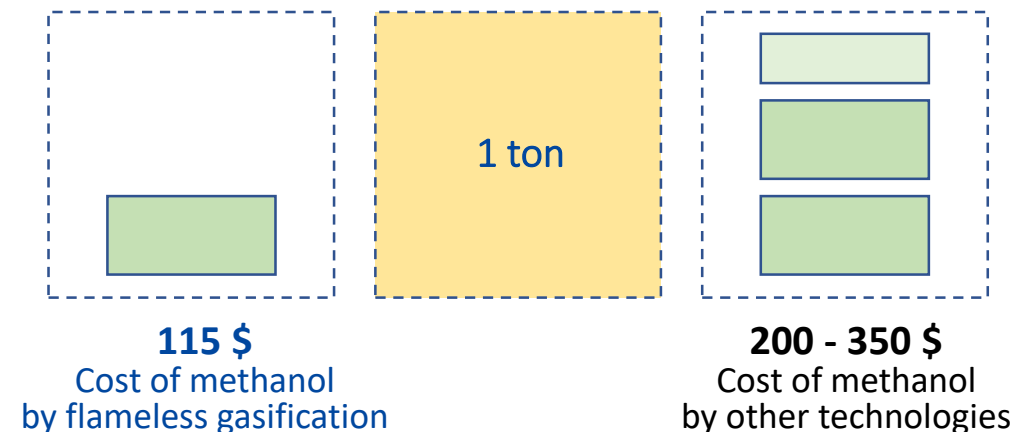
Flameless gasification of brown coal will allow:

- To transfer the ecologically “dirty” coal-burning Thermal Power Plants to the category of “Gas Thermal Power Stations” which will use syngas obtained from brown coal, providing a sharp reduction of harmful emissions;
- To reduce the cost of generating energy resources by saving on coal transportation;
- To develop production of hydrogen and the most important chemical products, which will increase the profitability of coal production, giving significant revenues to the budget and increase the country's export potential;
- To use reserves of cheap and poor-quality brown coal, with a simultaneous significant increase in coal production and creation of new jobs.

Cost of synthesis gas production vs natural gas acquisition cost (per 1,000 m³)



Cost of methanol production



Estimates of the cost of centralized hydrogen production

Estimates of the cost of centralized production
of liquefied hydrogen according to its production options US dollars / kg
* I - optimistic estimates, II - moderate estimates, III – pessimistic estimates

Production technology	Production cost *			Emissions CO2, kg CO2/kg H2
	I	II	III	
Liquefied H2				
Vapor conversion of methane (natural gas conversion)	2,9	3,7	4,4	17,4
Coal gasification by pyrolysis	3,8	3,9	4,1	30,0
Flameless Gasification of coal	0,75	1,25	1,75	--
Thermochemical decomposition of water in high-temperature gas cooled reactor	5,7	7,9	10,2	9,2
Electrolysis using electricity:				
from power system	5,7	8,6	11,6	48,6
from wind power	6,07	12,3	31,2	--
from solar installation	9,1	21,8	59,1	--

Efficiency of implementation of flameless gasification technology for a project of processing of 180 000 tons of brown coal per annum

Operation mode I



Possibility to obtain from the given volume of brown coal per annum (at price of 50.00 USD per ton), at the technological mode for the production of chemical products, of about

120 000 tons of methanol per year

(simple payback of about 2.7 years)

OR

57 500 tons of ethylene per year

+ 40 000 tons of propylene per year

+ 12 500 tons of butylene per year

(simple payback of about 2.0 years)

Operation mode II

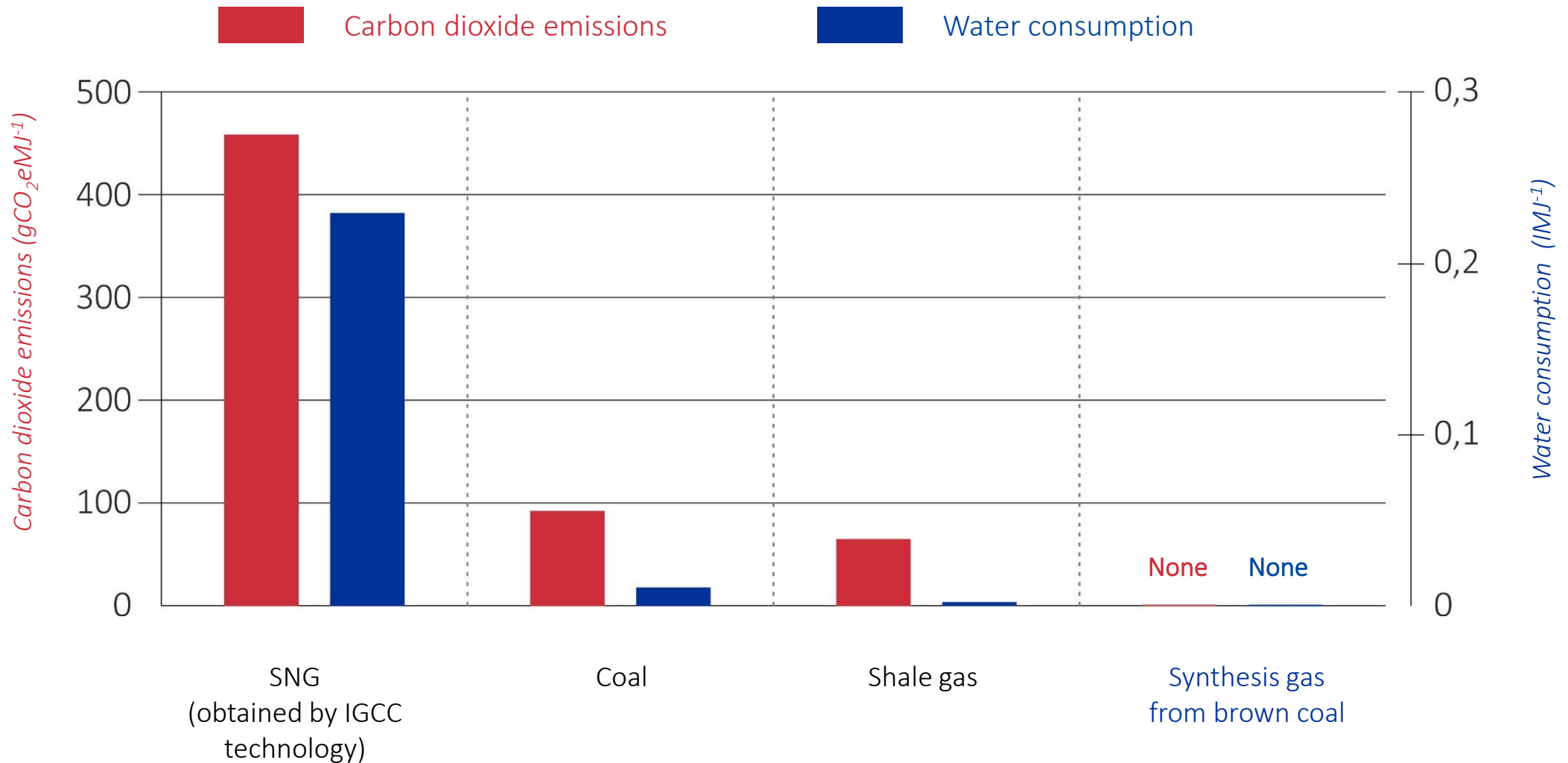


Possibility to obtain from the given volume of brown coal per annum, at the technological mode for generation of energy from syngas (a power plant with an efficiency of 0.40), of about

100,0 MW/h of energy

(simple payback of about 3.50 – 4.00 years)

Water consumption and carbon dioxide emissions in the production of SNG, coal, shale gas and syngas



The average indicators of air pollution during fuel combustion, g / kW-hour

Matter	Fuel				
	Syngas from brown coal	Natural gas	Coal	Brown coal	Mazut
SO ₂	None	0,002	6	7,7	7,4
NO _x	0,3	1,9	21	3,45	2,45
Fluoride compounds	None	None	0,05	0,11	0,004
Particulates	None	None	1,4	2,7	0,7

Indicators for Power Stations using 12 000 000 tons of coal

Indicators	TPP obtaining syngas from brown coal	Nuclear Power Plant	Coal Power Plant (in average, based on world experience)
Fuel consumption	12 000 000 tons of brown coal (for gasification)	286 tons UO ₂	12 000 000 tons of coal
Emissions to the environment:			
Nitrogen oxides	0,8 thousand tons	None	34,2 thousand tons
Sulfur oxides	None	None	124,4 thousand tons
Hydrocarbonate	None	None	7,3 tons
Ash and soot not trapped by filters	None	None	3,36 thousand tons
Benzopyrene	None	None	12 tons
Vanadium pentoxide	None	None	37 tons
Heavy metals (Cu, Co, Pb, Sn, Zn and other)	None	None	5 tons
Long-lived radionuclides (40K, 212Pb, 210Po and other.)	None	2 Ci	40 Ci
Solid waste	None	30 tons	830 thousand tons
Used area	32,3 Ha	15,4 Ha	130 Ha

Synthesis gas using flameless gasification technology in comparison with other fuel gases

Gas composition, %	Low calorie			High calorie	
	Blast furnace gas	Gasification of raw with oxygen	Synthesis gas (operating mode I – for the production of chemical products)	Natural gas	Synthesis gas (operating mode II – for energy production)
CH ₄	-	-	7.0	97.0	30.0
C ₁ -C ₄	0.1	-	2.5	1.0	3.0
H ₂	3.2	29.6	50.0	1.0	30.0
CO	23.3	58.7	25.0	-	25.0
CO ₂	11.5	10.4	15.0	-	12.0
N ₂	53.7	1.3	0.5	1.0	-
H ₂ O	8.2	-	-	-	-
Kcal/m ³	756	2 428	3 000	9 465	11 000

Thank you for your attention!

