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Selection of the fuel type for syngas production by the high-temperature co-electrolysis CO_2 and H_2O

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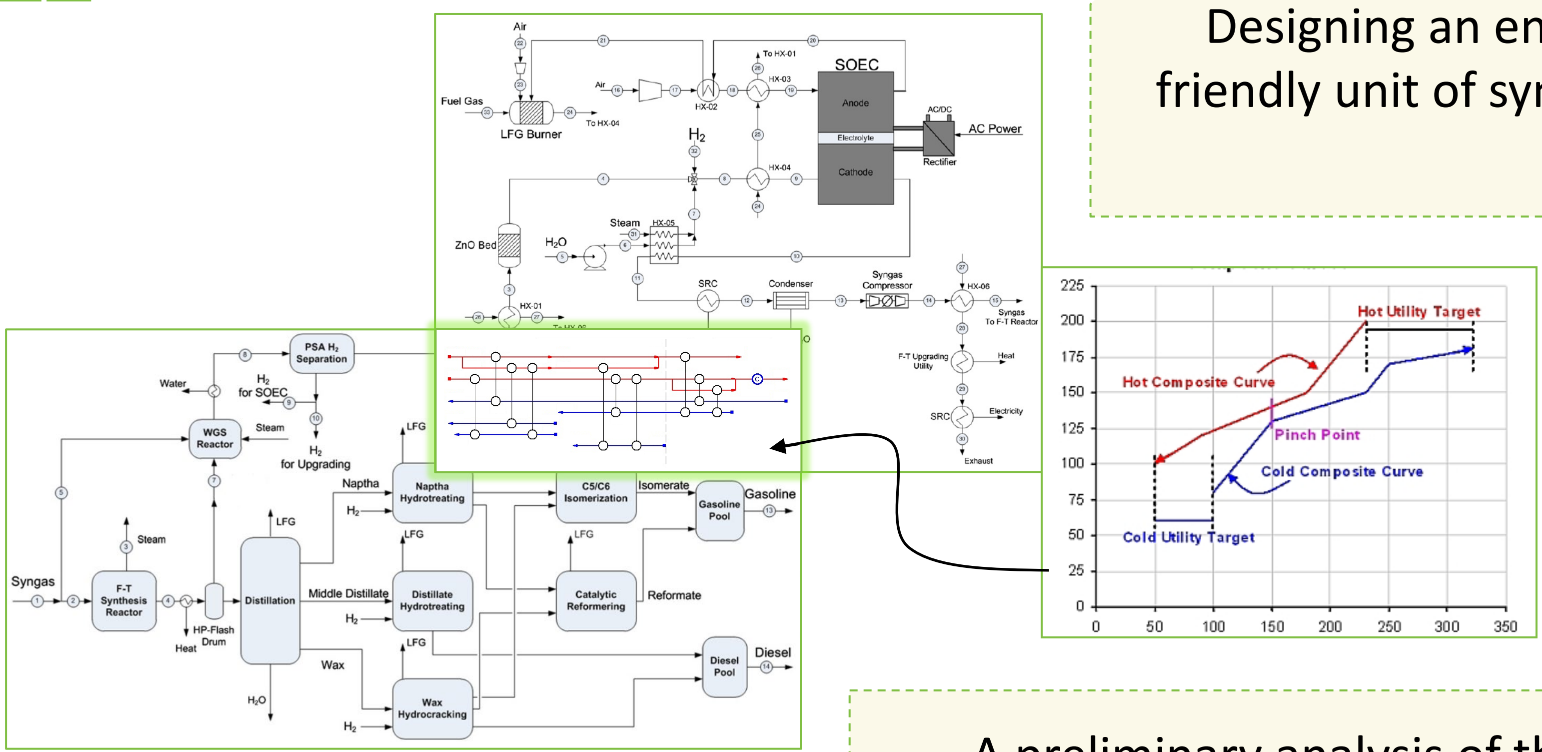
Boldyryev Stanislav

Tomsk Polytechnic University

The relevance of research



Designing an energy efficient and environmentally friendly unit of syngas production is the prerequisite in the modern world

A preliminary analysis of the heat exchange network and the selection of a source of hot utilities will speed up the development of the unit, as well as significantly reduce the cost of syngas

The relevance of research

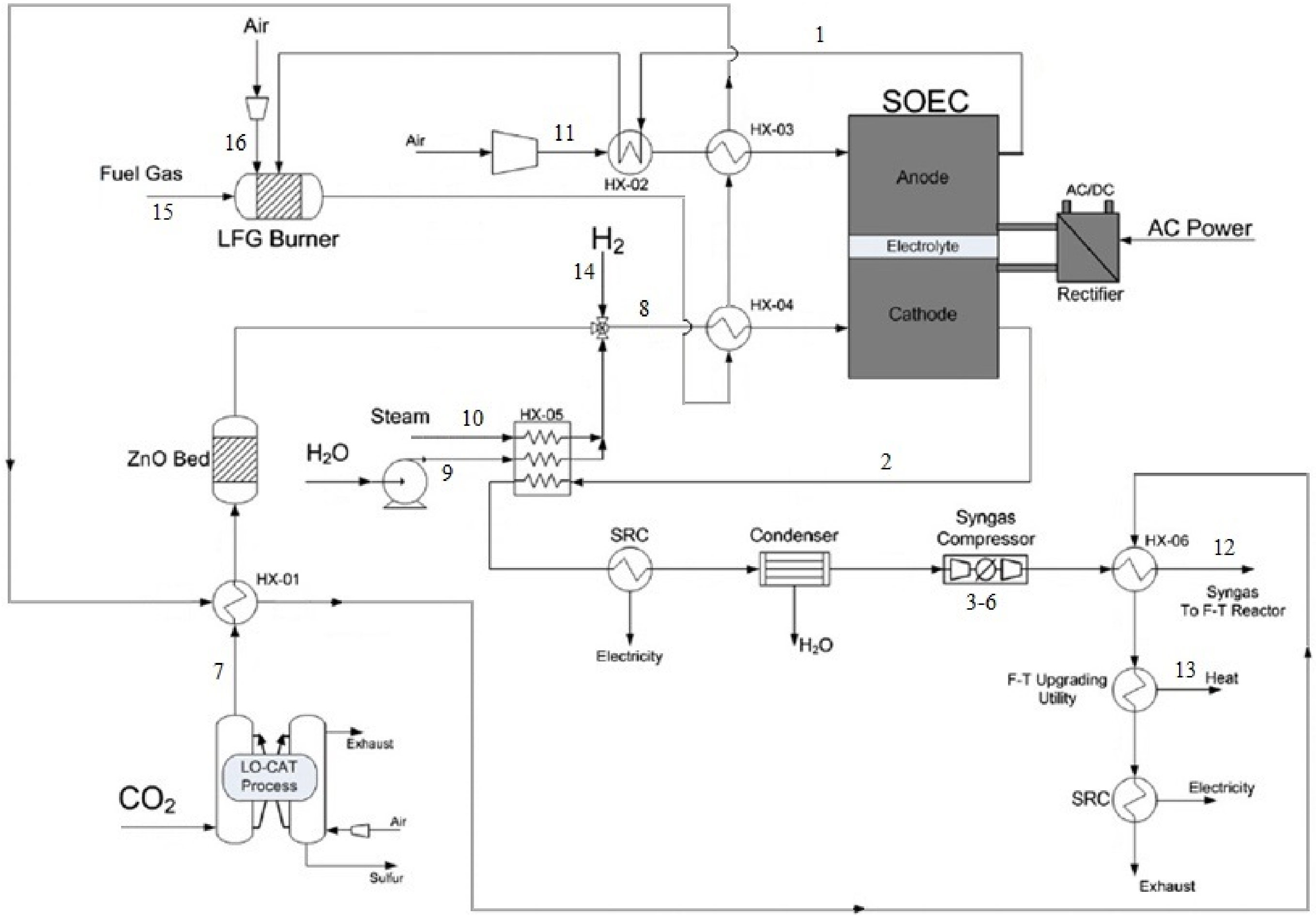
Scenario 1

- Utilization of by-products of the Fischer-Tropsch process as an energy source;
- Low cost of fuel source;
- Cogeneration of heat and power;
- Linkage to the Fischer-Tropsch low-capacity process

Scenario 2

- Sources of energy – natural gas, coal, fuel oil and LPG;
- Operating costs depend on the type of fuel;
- The possibility of using the obtained syngas for ammonia, methanol synthesis and the high-capacity Fischer-Tropsch process.

Initial process flow diagram



Process flow diagram of high temperature co-electrolysis CO_2 and H_2O

* Becker W.L. et al. Production of Fischer–Tropsch liquid fuels from high temperature solid oxide co-electrolysis units // Energy. 2012. Vol. 47, № 1. P. 99–115.

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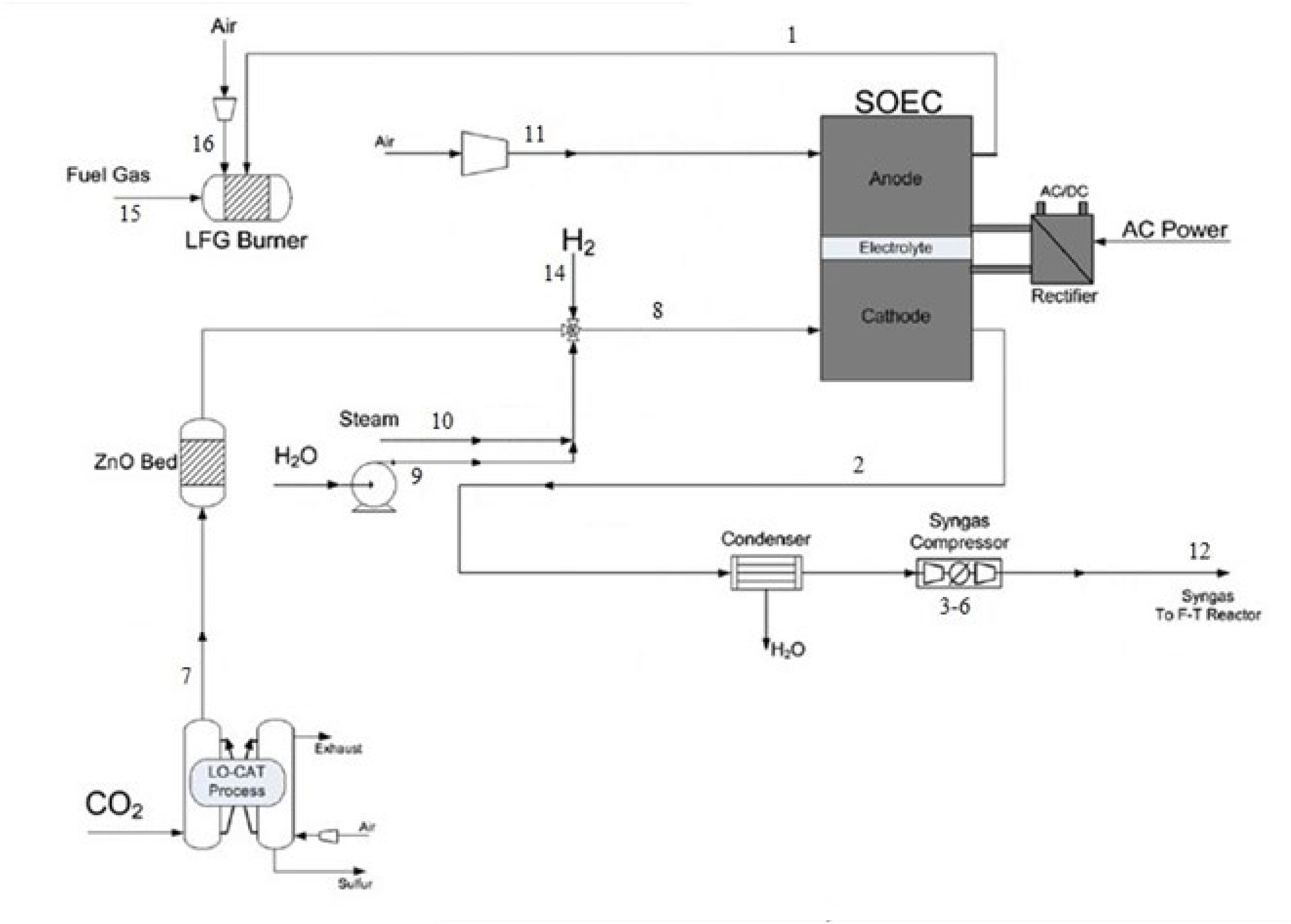

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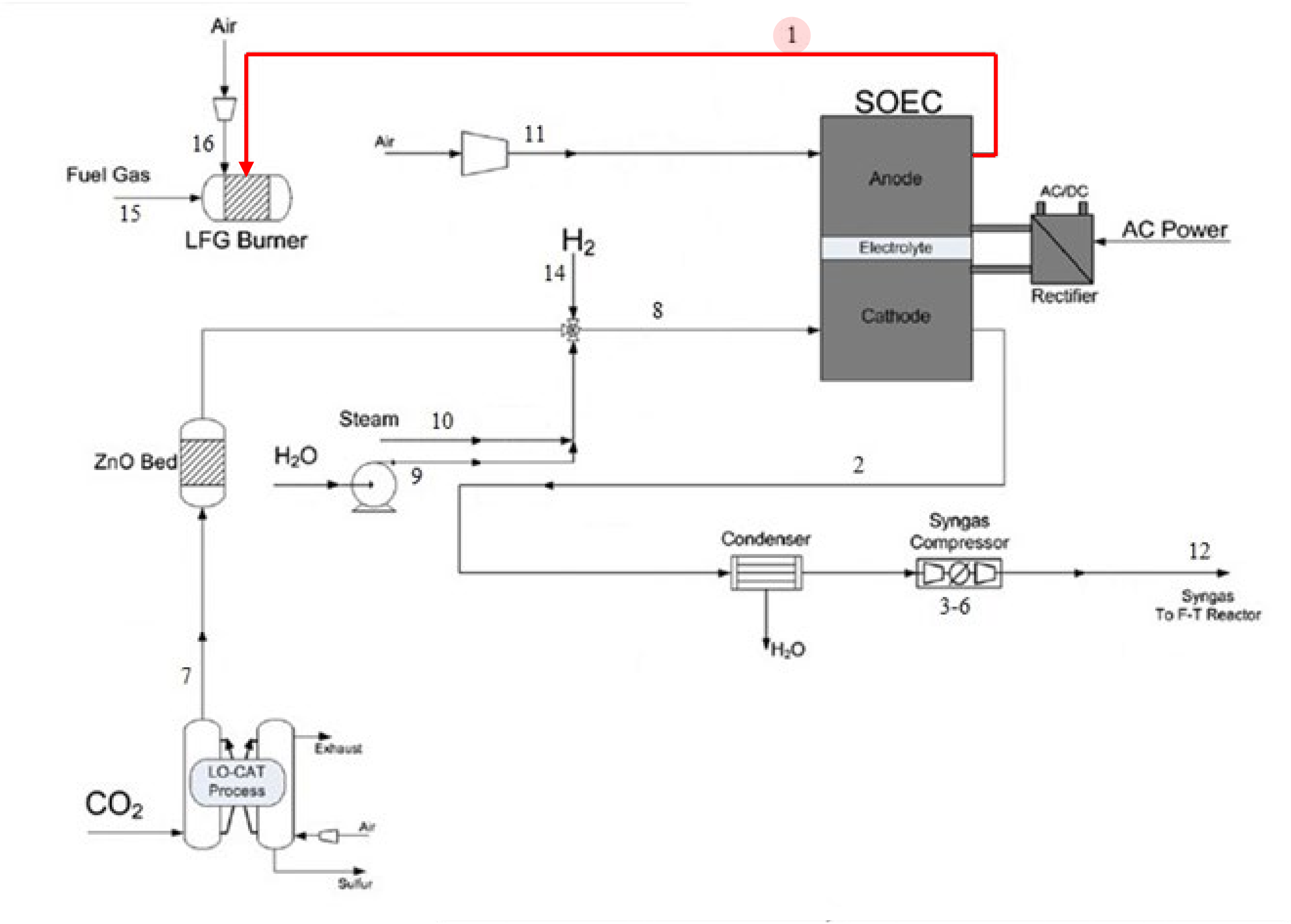

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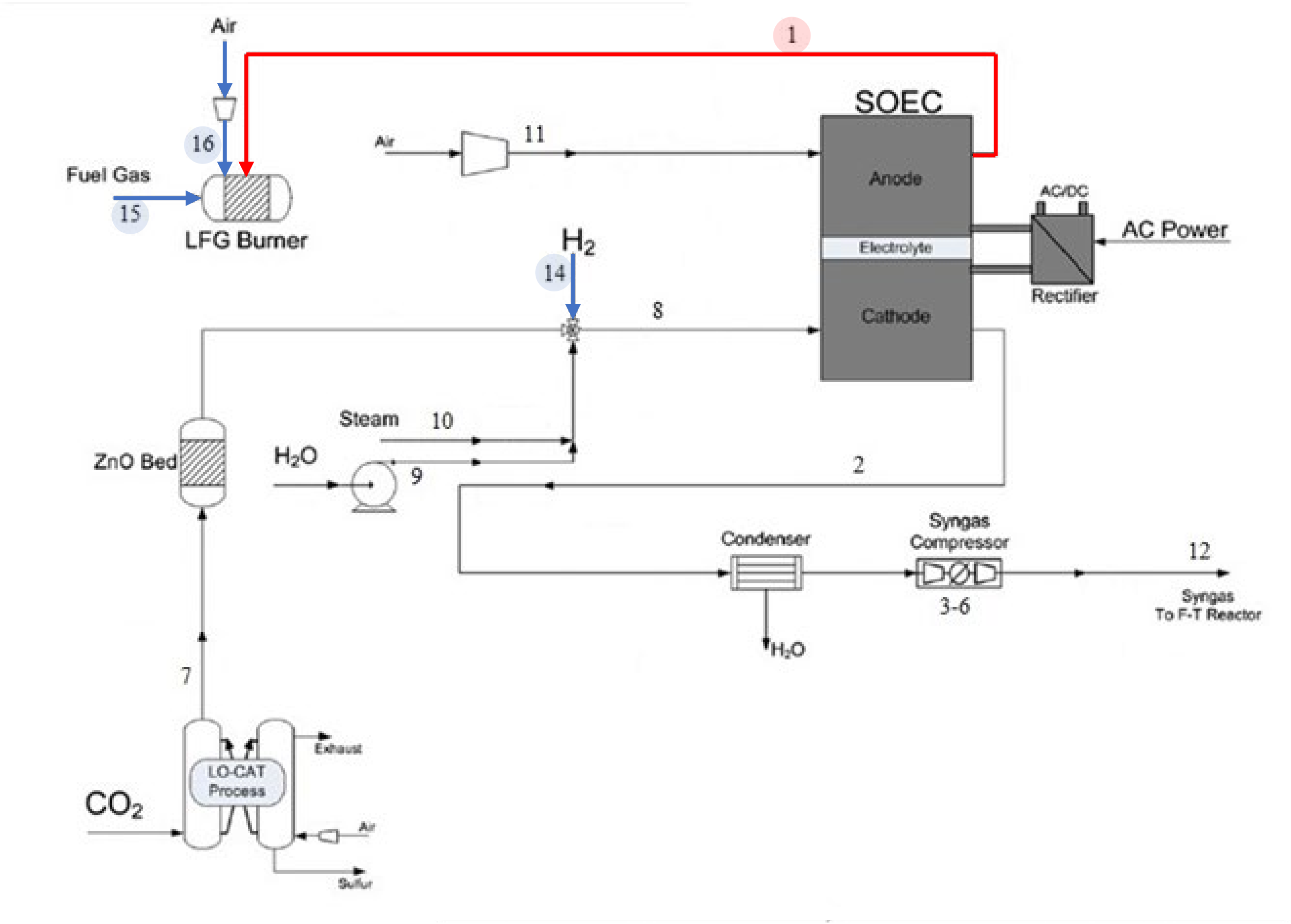

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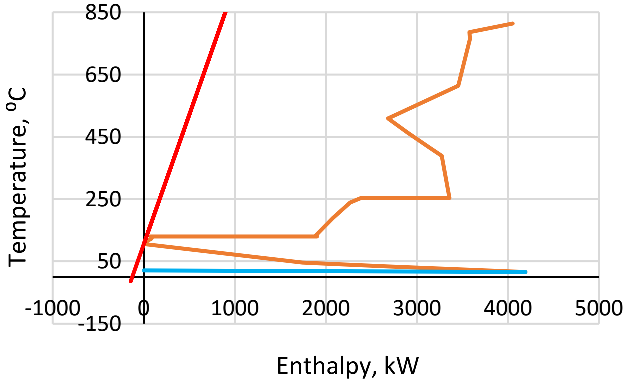
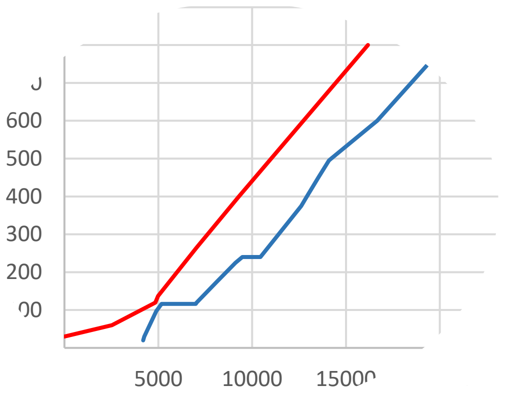
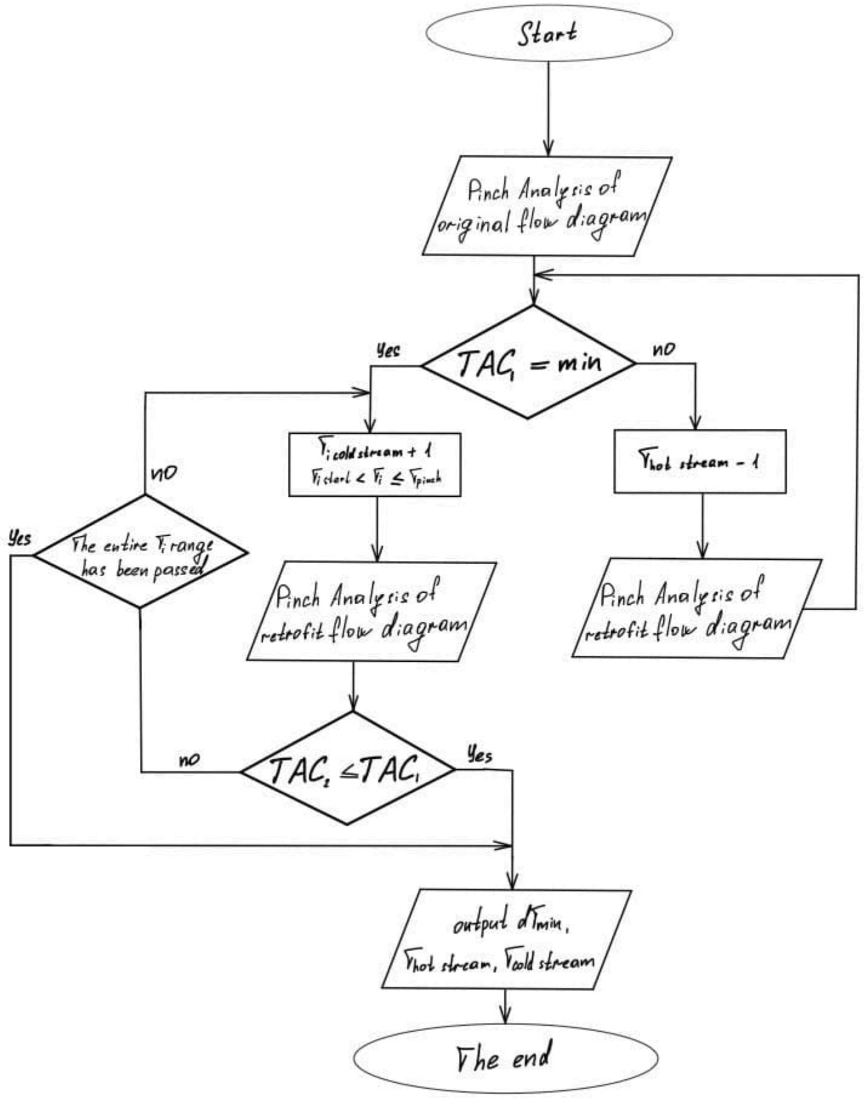
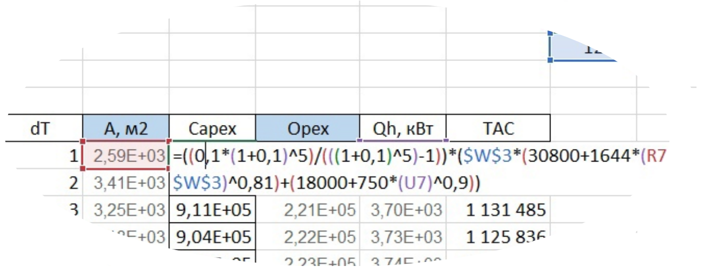
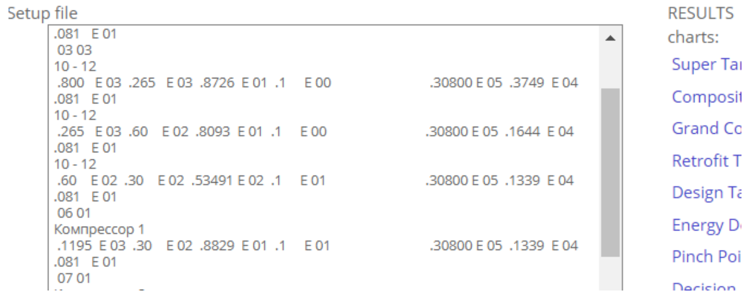
Blok diagram of workflow



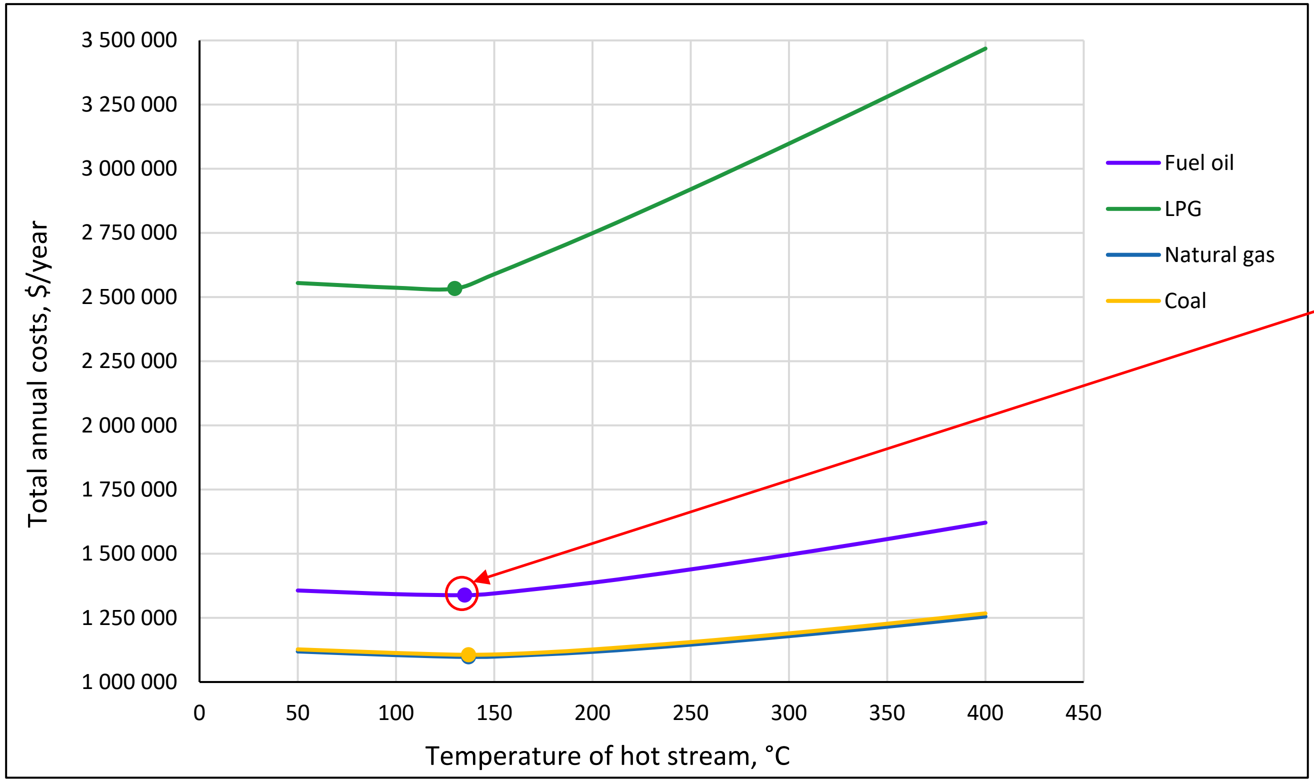




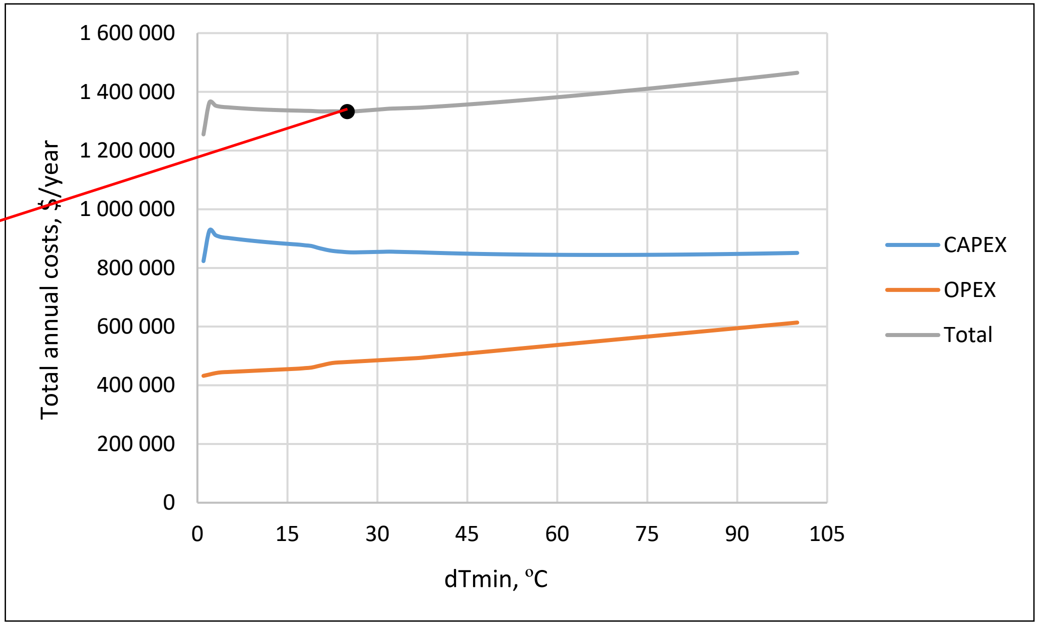




Pinch Analysis

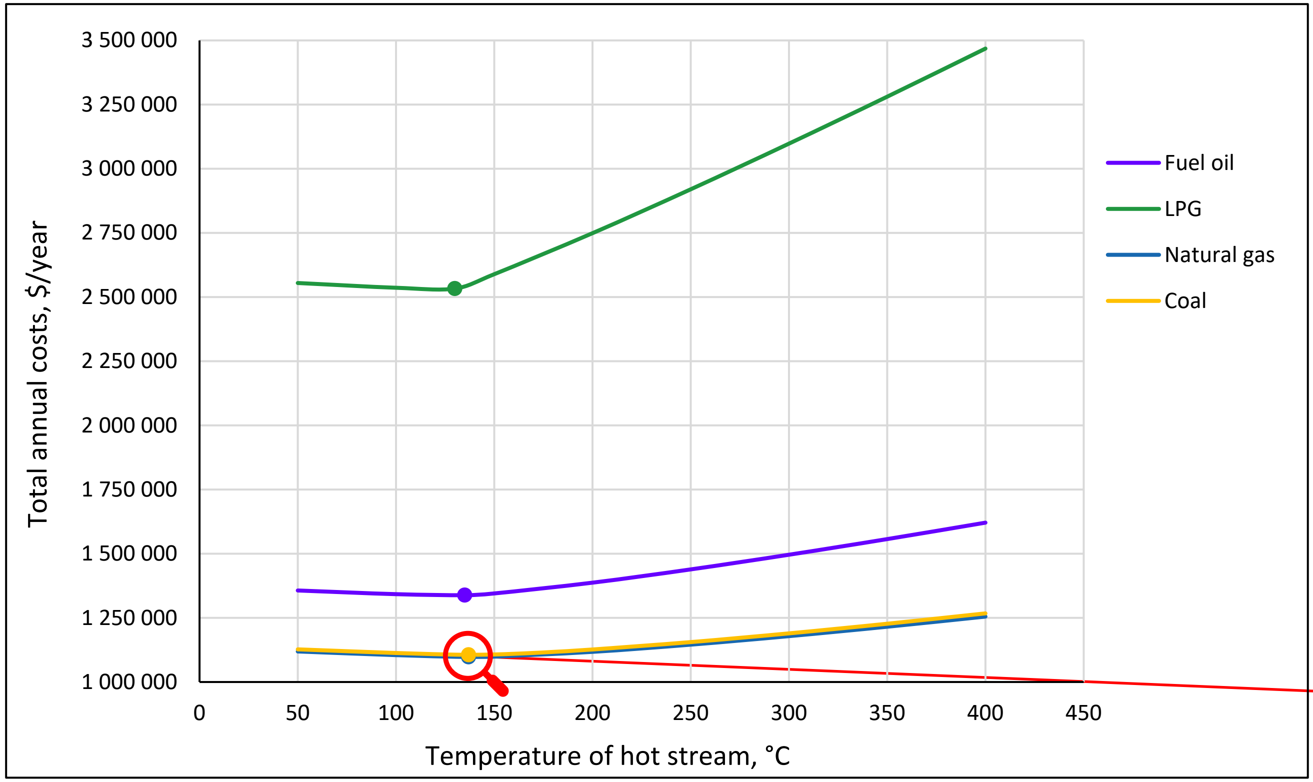


Correlation of TAC by hot stream temperature



Super targets

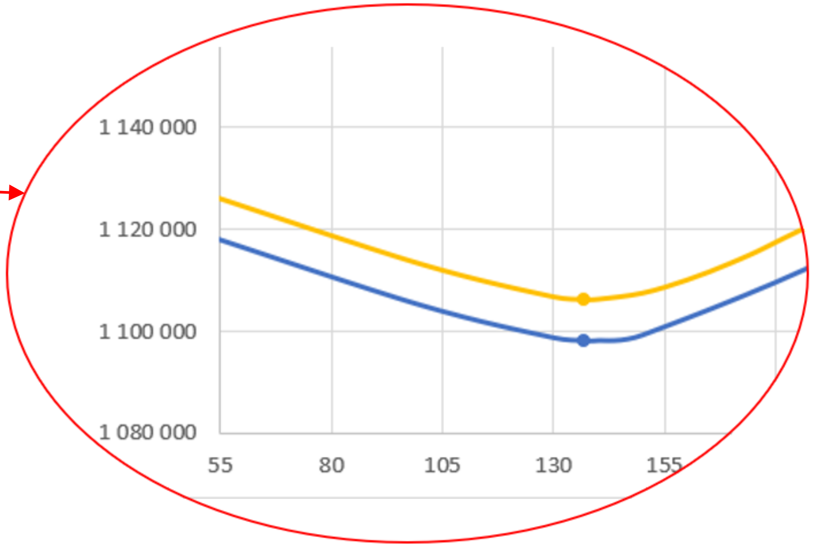
Pinch Analysis



Correlation of TAC by hot stream temperature

Results of Pinch Analysis

Type of fuel	Price, $/kW year	Temperature of hot stream, °C	dT_{min}, °C	TAC, $/year
Natural gas	54	137	28	1 097 998
Coal	56	137	27	1 106 094
Fuel oil	114	135	25	1 338 692
LPG	417	130	23	2 532 928



Pinch Analysis

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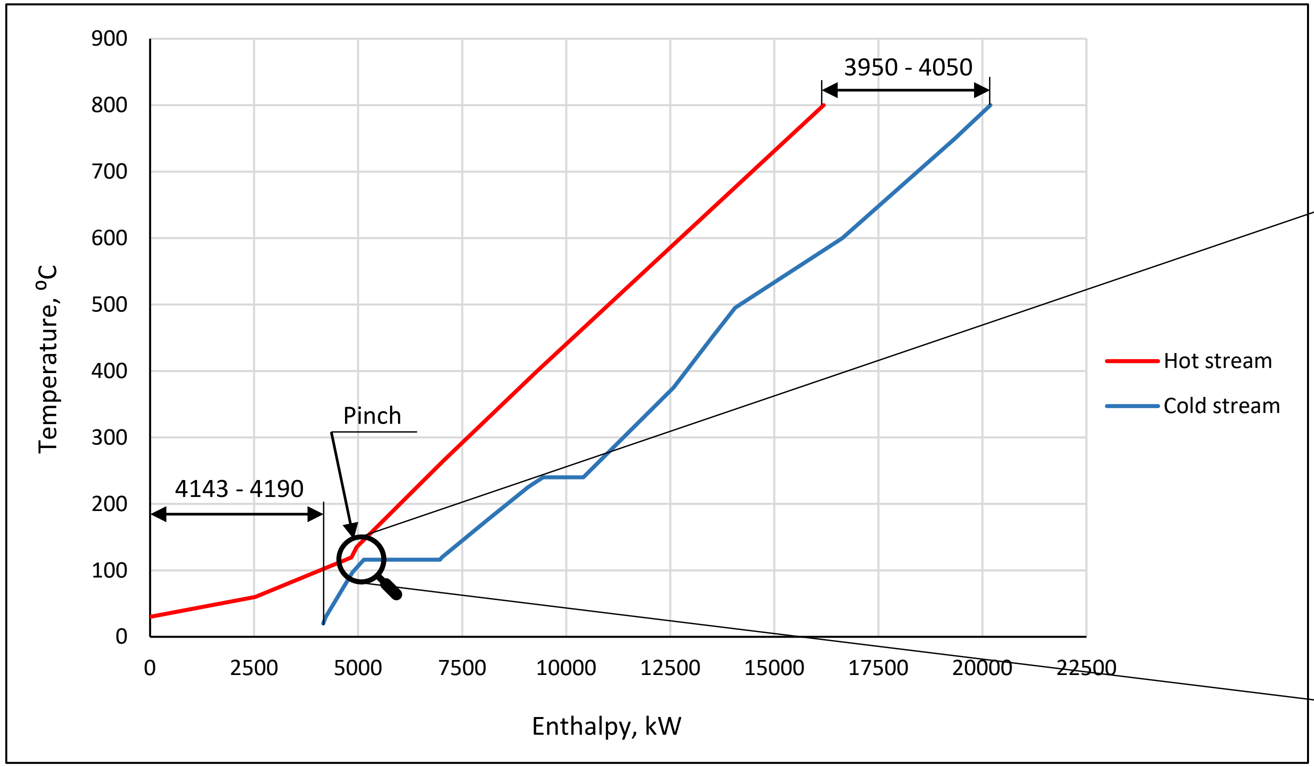
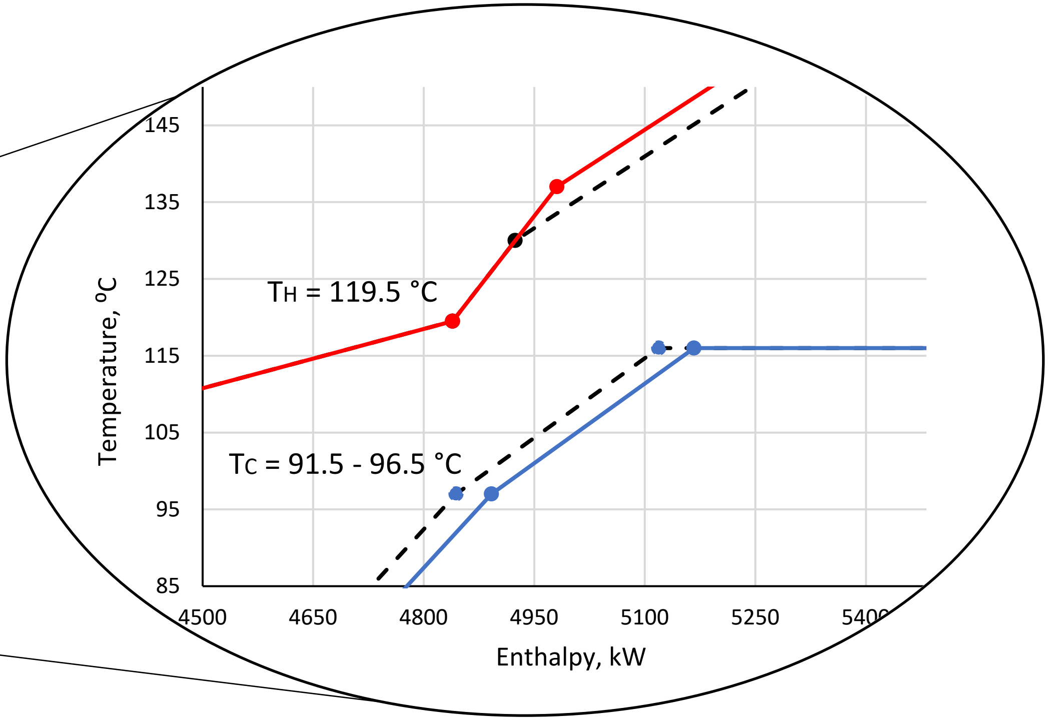


Composite curves



Pinch point location

New process flow diagram

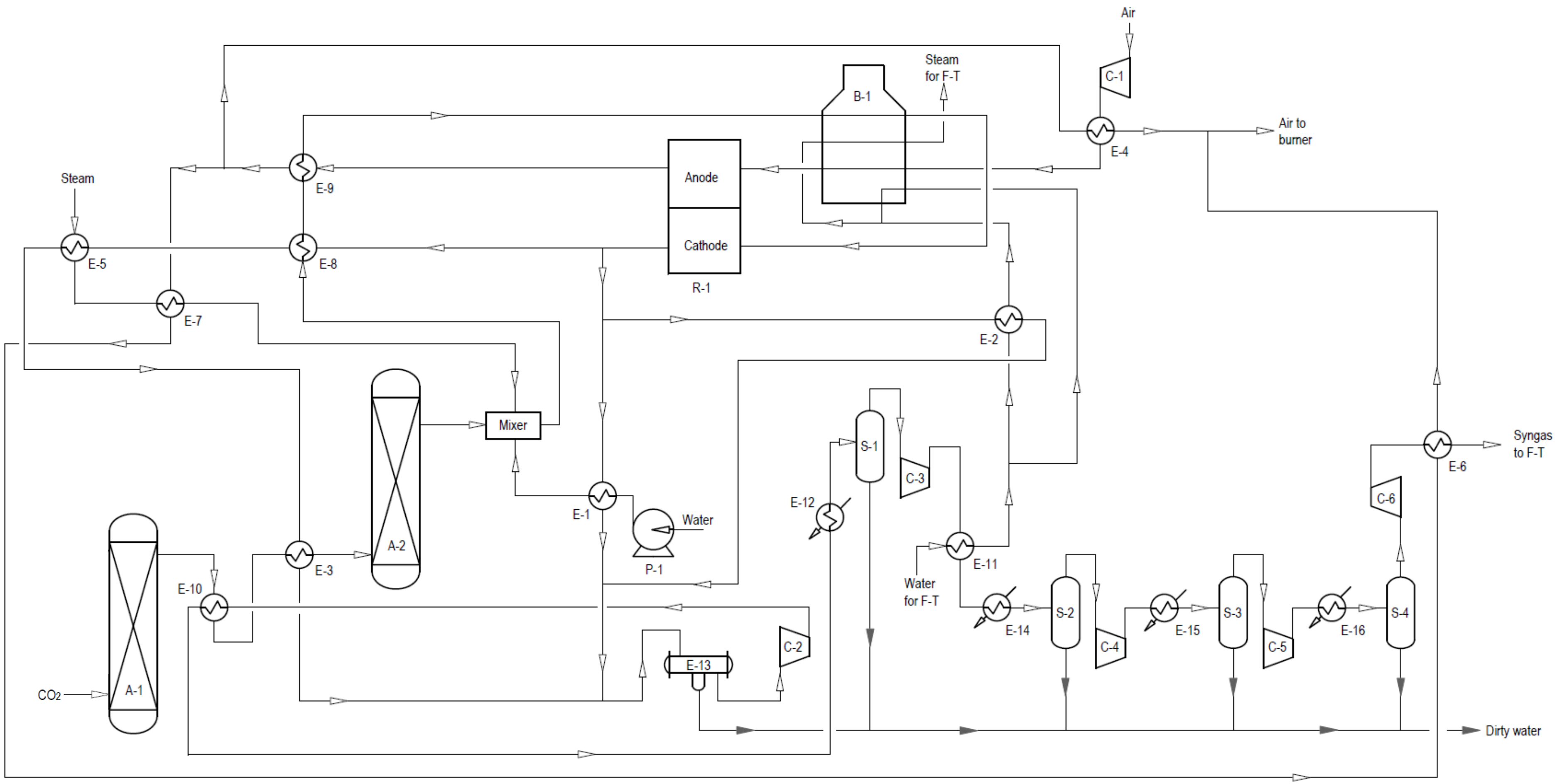
- Fuel – **Natural gas**
- Hot utility – **4050** kW
- Cold utility – **4190** kW
- Number of HE:

Recovery – **11**

Utility – **5**

Total – **16**

- Total heat transfer area – **3447** m^2



High-temperature co-electrolysis

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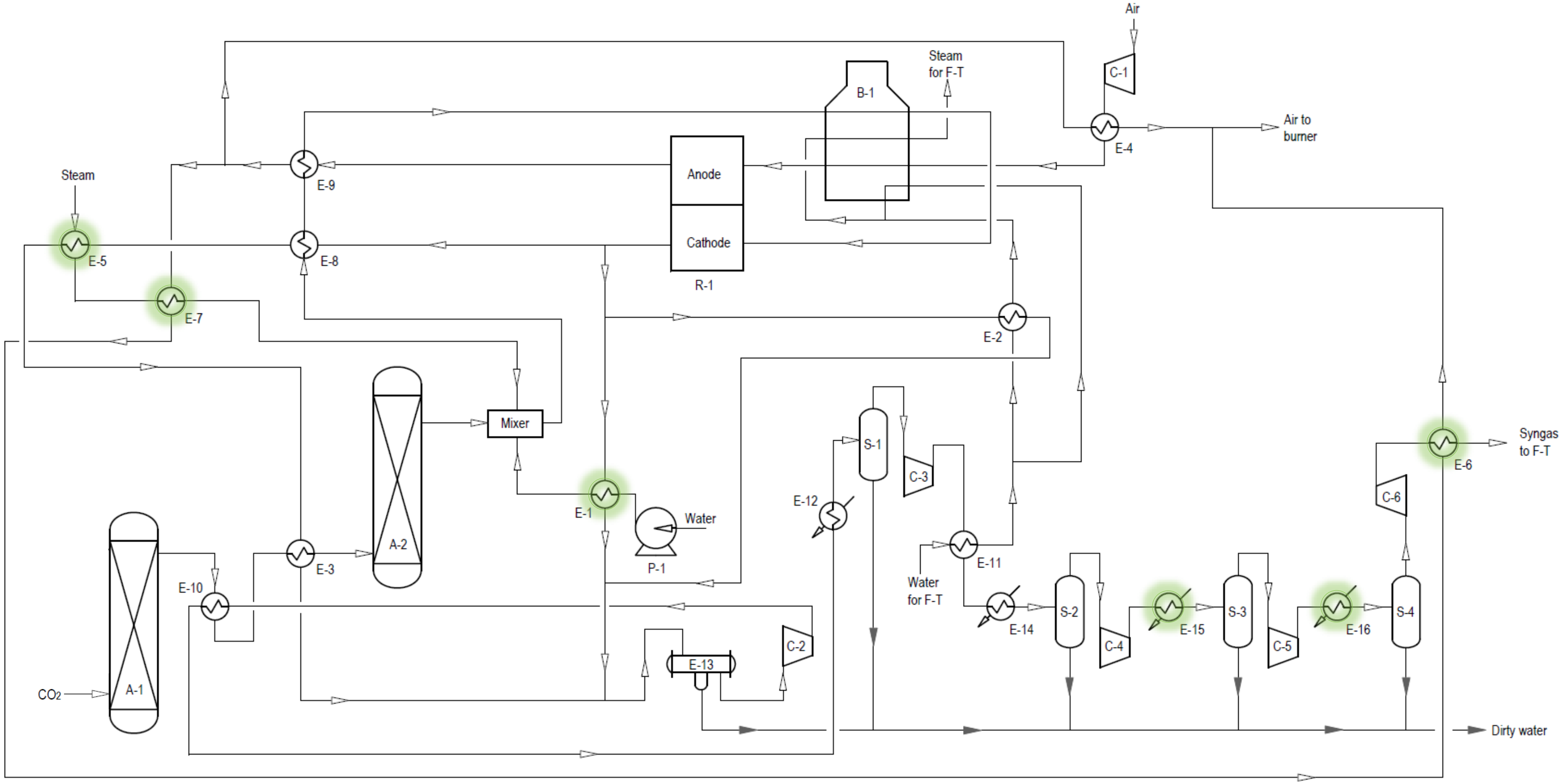

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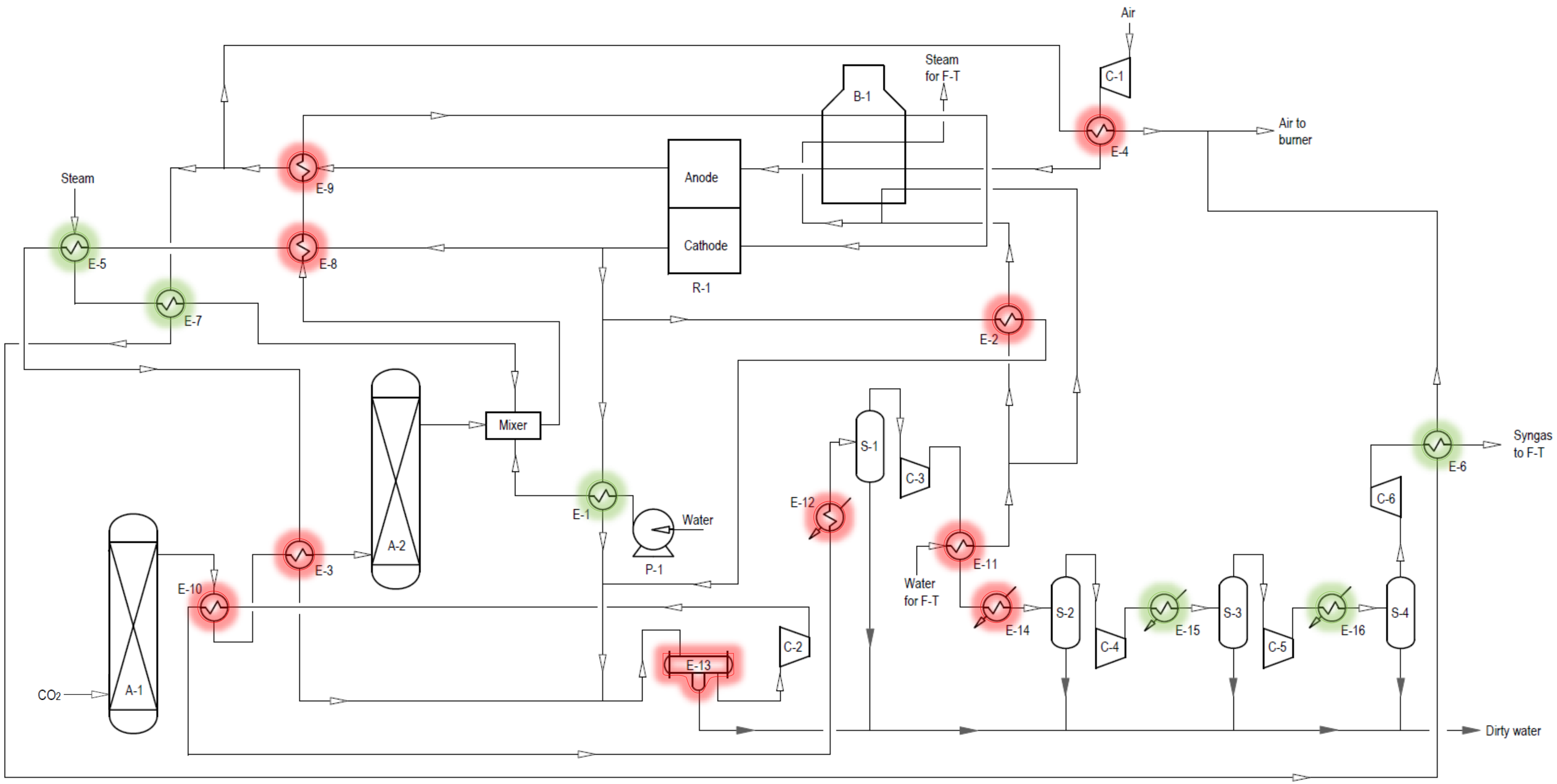

High-temperature co-electrolysis

Results

Type of fuel	Price, \$/kW year	$Q_{overall}$, kW	OPEX, \$/year	CAPEX, \$/year	TAC, \$/year	M_{CO2}, t/year	M_{SO2}, t/year
Coal	56	4383,81	245 493	1 078 676	1 324 169	12860	217
Fuel oil	114	4209,02	479 828	1 034 054	1 513 882	10309	16
Natural gas	54	4103,97	221 614	1 075 181	1 296 796	6831	-
LPG	417	4154,89	1 732 589	1 134 341	2 866 930	8454	0,28

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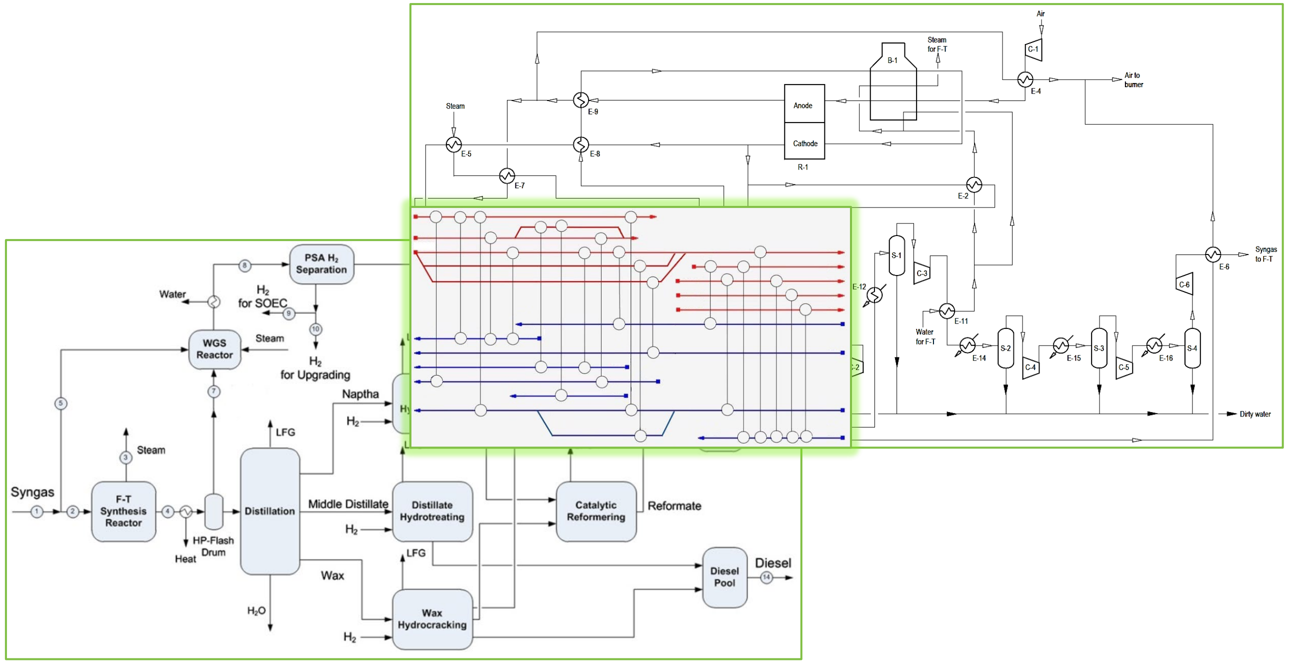
Gas fields



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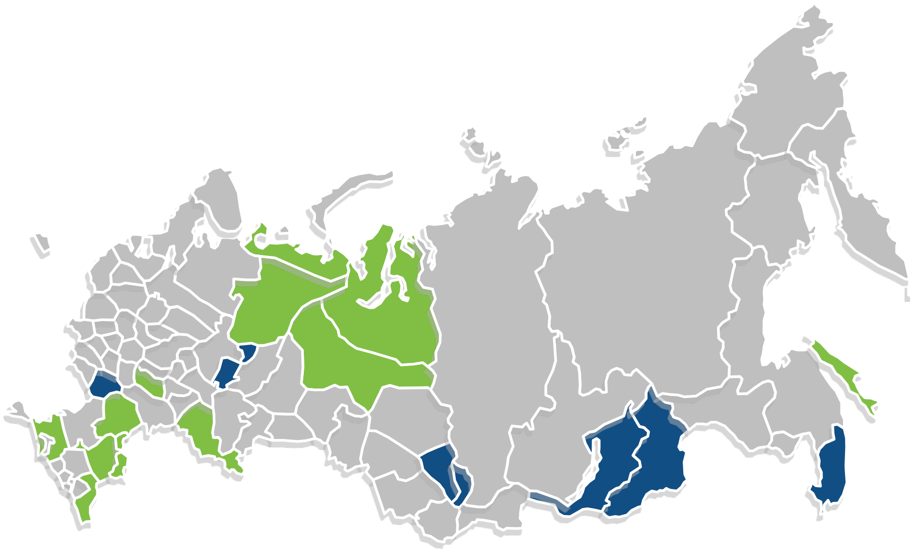
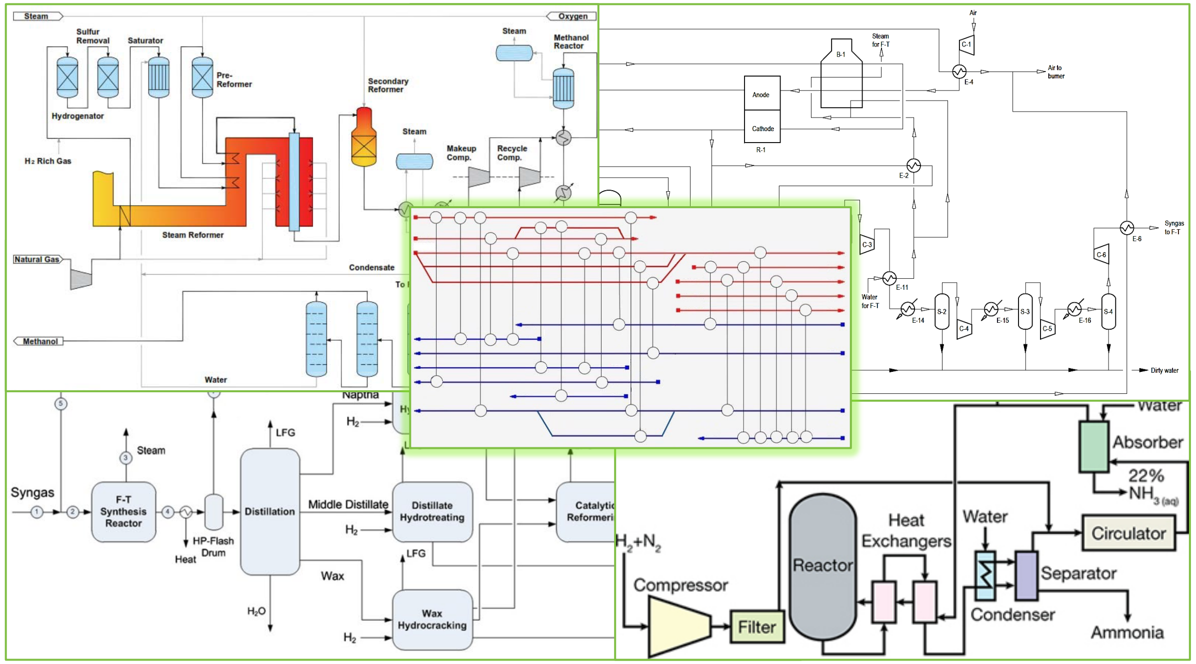


Gas and coal fields



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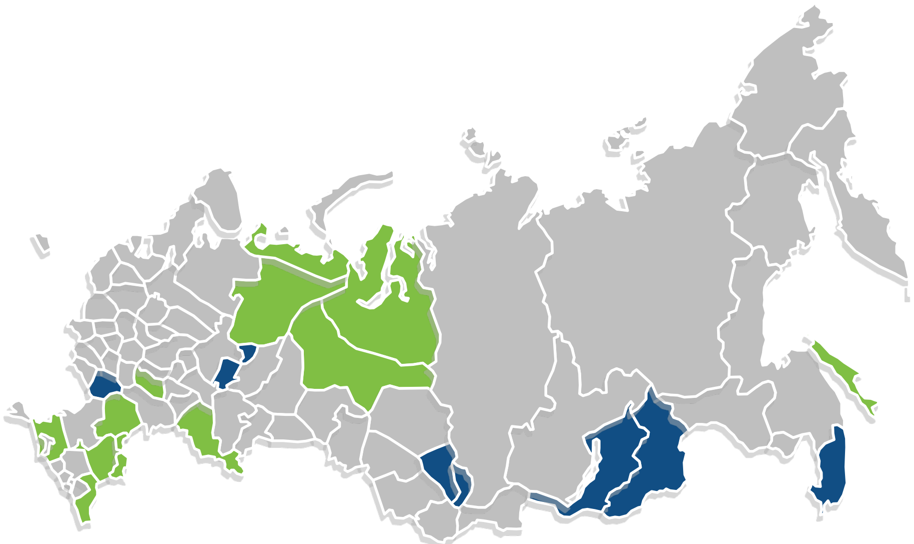

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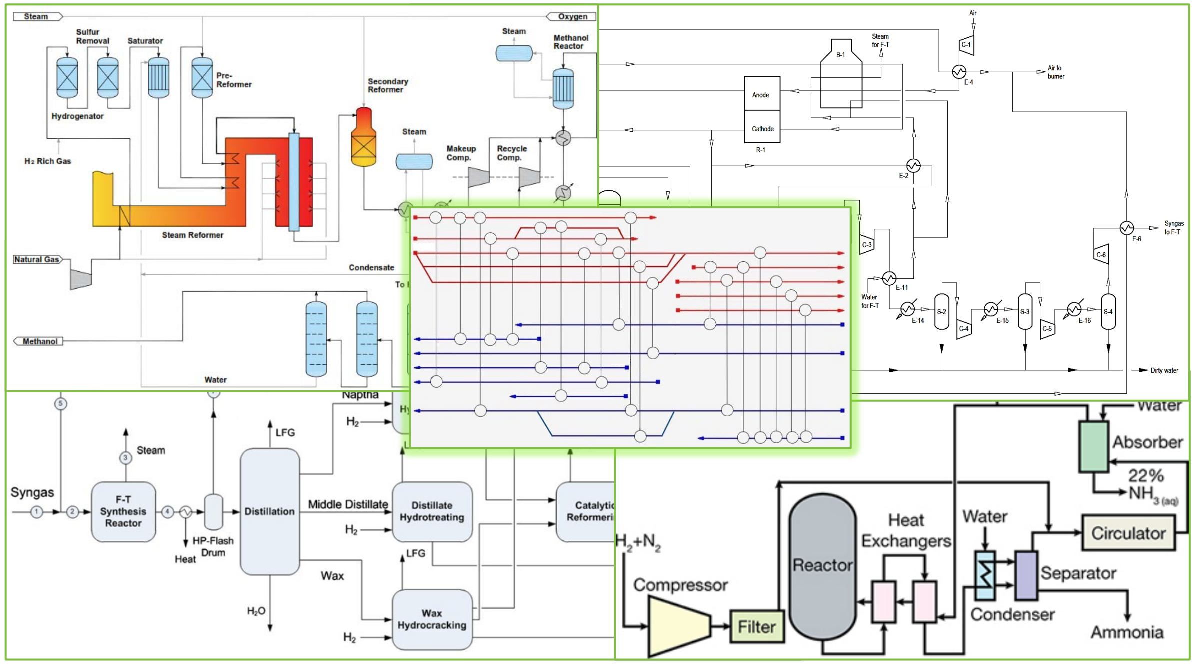

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