WP3 –Technical and economical analysis of systems

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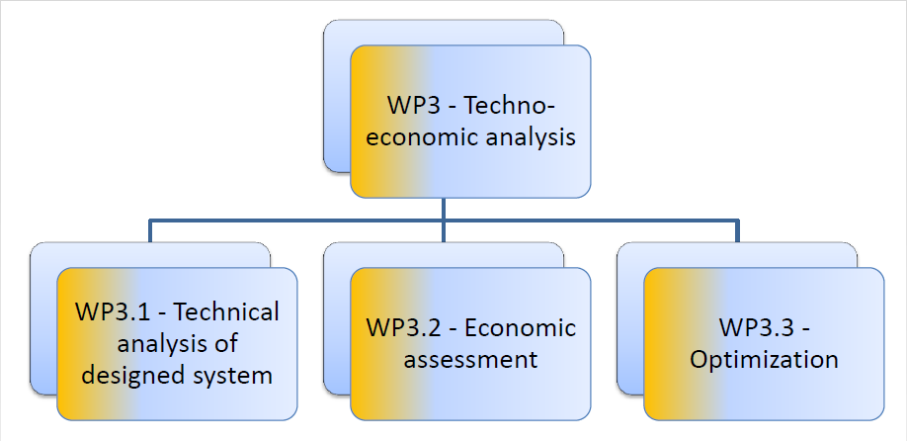
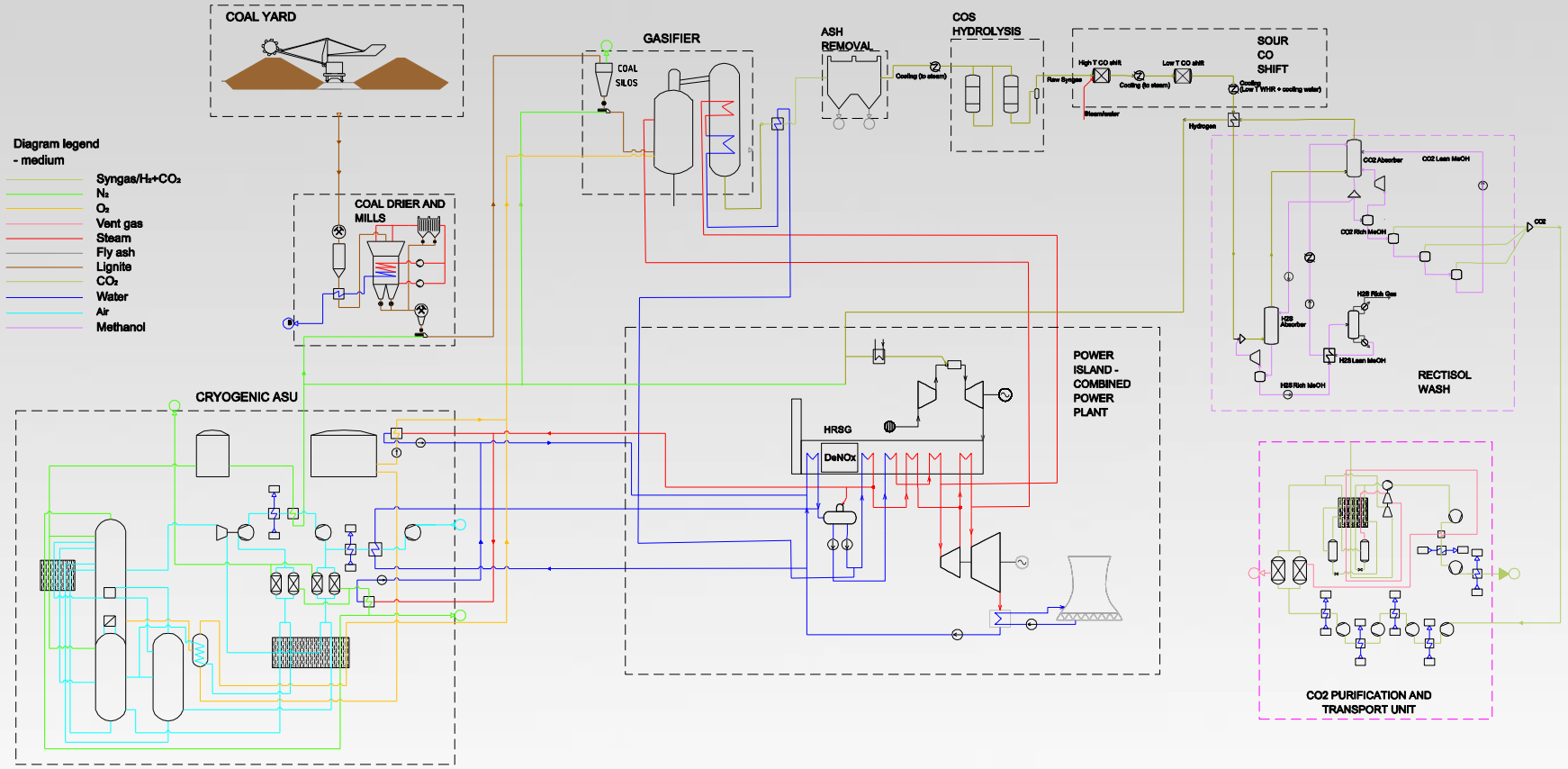
Structure and time harmonogram

- This acitivity start in April 2015



Harmonogram - plan	Deadline	2015												2016			
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04
Design of IGCC power plant model	31.9.2015																
Creation of complex model of IGCC power plant	31.10.2015																
Technical Optimization processes	31.1.2016																
Economic analysis	28.2.2016																
Techno-economic optimization processes	31.3.2016																

IGCC power plant model



WP3.1 – Technical analysis - Aspen model

- Model of subsystems prepared
- Complexity model in preparation

Unit name	Aspen model	Responsible project partner
WTA dryer + fuel treatment	OK	CTU in Prague
ASU unit	OK	CTU in Prague/UJV Rez
Gasification unit including cleaning sys	(OK) - optimization and control of preliminary results	CTU in Prague/UJV Rez
COS shift unit	OK	CTU in Prague
sour W-G shift unit	OK	CTU in Prague
Desulphurisation unit (Rectisol)	(OK) - optimization and control of preliminary results	CTU in Prague
CO2 separation units		
Rectisol dual unit	(OK) - optimization and control of preliminary results	CTU in Prague
Cryogenic unit	OK	SINTEF ER
Membranes unit	OK	SINTEF ER
GT	OK	CTU in Prague
3 pressure steam cycle	(OK) - but not suitable for this application	CTU in Prague/UJV Rez
2 pressure steam cycle	in preparation	CTU in Prague/UJV Rez

WP3.1 – Technical analysis - Aspen model – preliminary results and comparison

Parameters	IGCC w/o CCS	IGCC w CCS (rectisol unit)
Fuel consumption	30,05 kg/s	33,97 kg/s
Net power	236,2 MWe	216,5 MWe
Efficiency (LHV)	47,64%	38,64%
Efficiency (HHV)	43,50%	35,30%
Potentially useful waste heat	77,5 MWt (~20-25%)	138 MWt (~25-41%)

Parameters	Reference plant I.	Post combustion Ammonia scrubbing	Oxyfuel
Net efficiency [%]	38.9%	28.2%	31.2%
COE [USD/MWh]	50	75	70
Investment cost [USD]	600 mil.	900 mil.	950 mil.
Removal cost [USD/t]	-	29	26

ALTERNATIVE UTILIZATION OF WASTE HEAT

- **Air Separation Unit**
  - Compressor intercooling and aftercooling
  - Waste heat as hot water 100-200°C
- **Coal Dryer**
  - Fluid bed dryer (WTA type)
  - Exiting mixture of air and vapours ~100°C
- **Syngas cooling**
  - Cooling down syngas from ~ 160°C
  - High content of condensing vapours
  - Clean H2 rich gas much smaller heat capacity
- **CO2 compression**
  - Compressor intercooling and aftercooling
  - Water at temperature > 80°C
- **Flue gas from HRSG**
  - Flue gas leaving HRSG at ~ 100°C
  - After Rectisol CO2 capture very clean (minimum of S)
  - Even with 3 pressure system hard to recover heat below 100°C
  - Therefore proposed “Superbottoming“ unit after steam cycle

ALTERNATIVE UTILIZATION OF WASTE HEAT

W/o CCS

System	Stream	Net output [kW]	WHR unit type	Output of steam integration [kW]
ASU	Air Compressors	359	APC	
	Oxygen compressors	2 428	ORC (Isopentane)	1 863
Coal dryer	Waste vapours stream	450	APC	
Syngas cooling	N.A. - Used for regenerative fuel preheating			
CO2 compression	N.A. -Capture not implemented			
"Super-bottoming" unit	Flue gas	1 685	APC	
Total change in plant net output		**3 059**		

With CCS

System	Stream	Net output [kW]	WHR unit type	Output of steam integration [kW]
ASU	Air Compressors	500	APC	
	Oxygen compressors	3 381	ORC (Isopentane)	2 316
Coal dryer	Waste vapours stream	627	APC	
Syngas cooling	Hot syngas	10 044	ORC (Isobutane)	8 467
CO2 compression	Stage 2-7	771	APC	
"Super-bottoming" unit	Flue gas	1 324	APC	
Total change in plant net output		**5 864**		

Results of WHR units application

- Additional power output – increase in plant efficiency
- Higher impact on CCS plant

	IGCC - CCS	IGCC
Original power output [MW]	250	250
Power output with WHR [MW]	255.9	253.1
Original efficiency [%]	32.1	44.7
Efficiency with WHR [%]	34.2	45.2
Efficiency increase [p.p.]	**2.1**	**0.5**