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PM - KME601 - HEAT BALANCE CALCULATIONS

Summary

KME is a consortium with material technology development as a base to make thermal energy processes more effective.

A sub programme to KME is called "More effective power production", which aim is to elaborate a reference power plant concept (RPP). A full scale pilot plant with increased power efficiency is planned to be demonstrated in year 2017-2018.

This PM summarizes various cases of process calculations as basis for further technical and economic evaluations as part of RPP.

Heat balance and performance analysis including integration between boiler and steam turbine system for defined process cases and with different biomass fuel sources have been calculated.

The Benchmark cases for each group of comparison are presented in the table below and have been used as reference for comparison with enhanced steam data processes with and without reheat. The results from the calculations are presented as relatives differences of net efficiencies from the selected and calculated benchmarks performances.

<i>~100 MWe CHP based on 170 MW District Heat</i>					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
LV0.1	140	540	No	45/90	227
LV11.4.2	175	600	45	45/90	265

~100 MWe Condensing Plant based on 292 MW fuel input					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	Condensing C	Feed Water
LV9.1	140	540	No	38	210
~75 MWe CHP based on 125 MW District Heat					
Wide range	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
IW0	90	500	No	45/90	210
~50 MWe CHP based on 85 MW District Heat					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
MV0	140	540	No	45/90	227
~50 MWe CHP based on 90 MW District Heat					
Wide range	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
MW0.2	90	500	No	45/90	210
~25 MWe CHP based on 45 MW District Heat					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
SV0	140	540	No	45/90	227
~25 MWe CHP based on 50 MW District Heat					
Wide range	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
SW0	90	500	No	45/90	211

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1. Background

KME is a consortium with material technology development as a base to make thermal energy processes more effective. The programme is divided into two main programme areas; Material technology, Base programme and Programme area "More effective power production". The main focus for the sub programme More effective power production is to elaborate a reference power plant concept (RPP) with increased power efficiency to be demonstrated in a full scale pilot plant in year 2017-2018.

This PM summarizes the part of RPP what regards process analysis and with activity steps, as follows:

1. Definition of base Benchmark references cases for each sizes and fuel mixes
2. Definition of process configurations and targeted steam data
3. Obtain preliminary solutions for steam turbine system and boiler system presented by the Supplier within the consortium to be input for heat balance analysis
4. Heat balance and performance analysis including integration between boiler and steam turbine system, for the defined process cases to be used for elaboration of the most technical economic RPP

2. Prerequisites for calculation input data assumptions

The input data for the steam turbine cycle, e.g. isentropic efficiency, gland steam flows are mainly based on data found in the Siemens Heat Balances, see appendix 1-6.

Boiler input data are mainly based on data received by Metso, see reference [3]

All heat balance calculations are performed with the process simulation tool Thermoflex. [1]

3. Reference plants

The reference Benchmark plants LV0.1, LV11.4.2, LV9.1, IW0, MV0, MW0.2, SV0 and SW0 are all steam cycles configured without reheat and FGC and with steam data and capacities as specified in Table 1.

The boiler is a CFB boiler of Metso Design. In these calculations so far, the boiler heat transfer input data and surfaces are just general and not adapted to a specific Metso boiler design. The turbine is based on Siemens design configured for the Benchmark cases LV0.1, LV9.1, see Appendix 1 and Appendix 2 with one casing with HP and LP part integrated. For the reheat cases the turbine is divided into two casings, one HP casing and one integrated IP and LP casing. The turbine is pressure controlled. These benchmark cases have extractions for two high-pressure preheaters, one feedwater tank and one low-pressure preheater. The final feedwater temperature is selected between 210-227 °C for the benchmark cases. The turbine exhausts steam are connected to two district heating exchangers, each producing half of the required temperature rise. For the condensing benchmark plant LV9.1 the condenser is of air cooled type.

Table 1 Reference Benchmark plants

~100 MWe CHP based on 170 MW District Heat					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
LV0.1	140	540	No	45/90	227
LV11.4.2	175	600	45	45/90	265
~100 MWe Condens Plant based on 292 Fuel LHV input					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	Condensing C	Feed Water
LV9.1	140	540	No	38	210
~75 MWe CHP based on 125 MW District Heat					
Wide range	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
IW0	90	500	No	45/90	210
~50 MWe CHP based on 85 MW District Heat					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
MV0	140	540	No	45/90	227
~50 MWe CHP based on 90 MW District Heat					
Wide range	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
MW0.2	90	500	No	45/90	210
~25 MWe CHP based on 45 MW District Heat					
Virgin biomass	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
SV0	140	540	No	45/90	227
~25 MWe CHP based on 50 MW District Heat					
Wide range	Process data RPP				
	Press (bar)	Temp C	RH press. (bar)	DH&Cooling C	Feed Water C
SW0	90	500	No	45/90	211

3.1Boiler

The boiler is assumed to be a circulating fluidised bed with natural circulation, for the Benchmark reference plants and for cases with live steam data up to 175 bar. Forced circulation is considered for live steam data of 190 bar. Once through boiler is considered for the over critical live steam data of 260 bar.

The economisers are placed after the superheaters, along with the air preheating system.

There is a steam pre- air preheating system for all cases which is fed by extraction steam from the turbine. The steam air preheater rises the air temperature to 60 C in order to prevent corrosion either in the tubular air preheater or for cases equal or above 100 MWe in the rotary air preheater placed in the convective final draft of the boiler.

The general condition for the boiler system and air and flue gas path for all the analysed cases are as stated in the below table.

Table 2 General outline of boiler and air and flue gas path

Boiler system	Data input
Air system	The primary air is 40 % of the total air
Air temperature inlet FD fan	35 C
Furnace	Furnace temperature 870 °C
	Excess air 24 %
Steam circuit	Boiler blowdown 0.25 %
Flue gas temperature inlet ID fan	150 C

Convective heating surfaces

The convective heating surfaces have been divided into three superheaters for all cases, with temperature control before the second and third superheater. Table 3 shows the basic assumptions for the convective heating surfaces. In addition, it is assumed that approximately 5 % of the heat release in the superheaters is transferred to the panel walls.

In addition to the convective superheaters there is an embedded final superheater placed in the cyclone leg

There is one economiser section placed in the final draft in front of the main air preheater.

Table 3 General outline for the convective heating surfaces

Minimum pinch	Configuration	Attenuation/Subcooling
SH 4	embedded	15°C Attenuation at inlet
SH 3 10 °C	Counter flow	1 % Attenuation at inlet
SH 2 10 °C	Counter flow	1 % Attenuation at inlet
SH 1 10 °C	Counter flow	
Eco 1 10 °C	Counter flow	>10 °C Subcooling at exit

Air preheater

It is considered that the air is preheated in a rotary air preheater, except for 190 bar live steam and cases below 100 MWe where a tubular convective air preheater has been considered.

The lowest acceptable metal temperature that can be tolerated to avoid low temperature corrosion is considered to be 100 C at a moisture content in flue gas between approximately 20-25%. At an exit flue gas temperature of about 150 C it is considered necessary to rise the air temperature in a steam fed air-preheater to above 60 C before it enter into the flue gas air preheater.

Dust cleaning

It is assumed that a bag filter is used to collect the fly ash.

All fans are assumed to have a design point isentropic efficiency of 80 % and a mechanical efficiency of 99 %

*Assumed pressure drop in air and flue gas path***Table 4 General Pressure drops in air and flue gas systems**

Air and Flue gas system	Path Pressure drop (kPa)
Primary air preheater and ducts	3.0
Secondary air preheater and ducts	3.0
Primary air to furnace top	15.0
Secondary air to furnace top	5.0
Boiler convective pass and ducts to filter	3.5
Filter	3.0
Ducts to stack	0.3

*Assumed pressure drop in steam pipes***Table 5 Pressure drop in steam lines accounted**

Steam pipe system	Pressure drop (%)
Live steam, boiler outlet to turbine valve inlet	2.0
Cold reheat exit turbine to Hot reheat turbine inlet	10
Extraction to HPPH1	5.1
Extraction to HPPH2	4.3
Extraction to LPPH1	2.3
Extraction to Deaerator	6.5
Extraction to District Heater 1	1.0
Extraction to District Heater 2	3.0

The pressure drop for the condensate and feedwater in the preheaters will be calculated by Thermoflex based on the estimated hardware. It has only a very limited influence on the efficiency.

3.2 Steam turbine island

Steam turbine

The efficiencies of the steam turbines are generally based on Siemens heat balance data in appendices 1-5.

The gland steam of the leakage flow at the turbine are based on Siemens data, see Appendix 6. In general, the Siemens gland steam flows is considered low, however, for comparison of different cycles it is just necessary to ensure that all cycles are based on the similar assumptions.

Feedwater heaters

The design of a preheater is often characterised by the TTD (Terminal Temperature Difference), DCA (Drain Cooler Approach) and residual superheat, at least for preheaters with both desuperheating, condensing and drain cooling sections.

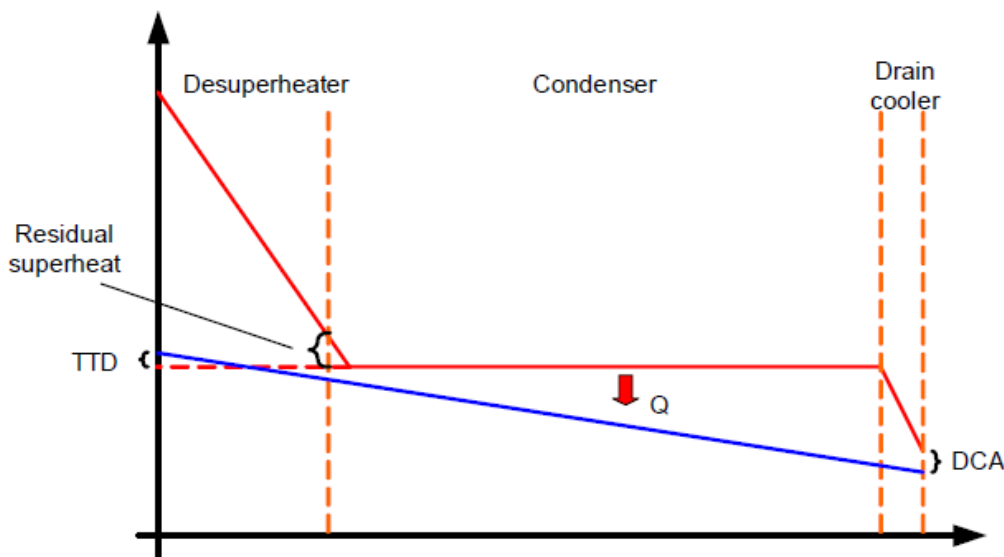


Figure 1 Definition of TTD, DCA and residual superheat [2]

The value of the TTD is quite dependent on the level of superheat in the steam. For example, for a highly superheated steam, the TTD might become negative, whereas for a limited superheating, the TTD will obviously be positive. The actual optimisation of the preheater design must be done by the turbine supplier. The overall TTD for all preheaters used in these calculations refer to Siemens heat balances and are stated in Table 6.

Table 6 Characteristics for preheaters

Heaters	TTD	DCA	Residual superheat inlet to condenser part C
	C	C	
LPPH	2.8	5,6	20
HPPH	2.8	5,6	20
District Heaters	2.0	5,6	

Pumps

All pumps are assumed to have an isentropic efficiency of 85 %.

Auxiliary power consumption, motors and generators

The auxiliary power consumption for the plant is based on the electrical consumption by all the components that are included in the model. This includes all the major power consuming components; for example, feedwater pump, FD and ID fan. In addition to the major components, it is assumed that there are miscellaneous consumptions as follows

- Fuel handling 0 kWh/ton fuel
- Miscellaneous minor uses 2 % of gross power output

The efficiency of the motors is estimated by Thermoflex, and will for this size typically be around 95 %.

The efficiency of the generator and gear is also estimated by Thermoflex to be around 98.4 %.

4. Process Calculations and Comparison with Benchmark (Thermoflex)

Table 7 Heat Balances results

100 MWe CHP based on 170 MW District Heat Virgin biomass

Process data RPP								Heat balance results									
No.	p (bar)	T C	RH p (bar)	RH T C	$DH\&Cooling$ T C	$Feed$ $Water$ T C	FGC	Net fuel input (LHV)	Gross power (MW)	Net power (MW)	Heat conden s. (MW)	Heat FGC (MW)	Total Heat (MW)	Therma l power (MW)	Gross Eff (LHV)	Net Eff. (LHV)	Net. Eff Diff.
Appendix 7 LV0.1	140	540	No		45/90	227	No	299	102	94	170	0	170	272	34,2%	31,5%	
Appendix 8 LV0.2	140	540	37	540	45/90	250	No	307	109	100	170	0	170	279	35,5%	32,7%	1,2%
Appendix 9 LV1	175	570	37	570	45/90	275	No	314	117	108	170	0	170	287	37,3%	34,3%	2,8%
Appendix 10 LV1.0	175	570	No		45/90	227	No	306	109	101	170	0	170	279	35,7%	32,9%	1,3%
Appendix 11 LV1.0.1	175	585	No		45/90	227	No	309	112	103	170	0	170	282	36,1%	33,3%	1,7%
Appendix 12 LV1.0.2	175	585	No		45/90	265	No	310	113	104	170	0	170	283	36,4%	33,4%	1,9%
Appendix 13 LV1.0.3	175	600	No		45/90	265	No	312	115	105	170	0	170	285	36,8%	33,8%	2,3%
Appendix 14 LV3.1	190	600	45	600	45/90	265	No	322	123	113	170	0	170	170	38,2%	35,1%	3,6%

100 MWe CHP based on 170 MW District Heat Virgin biomass																	
Process data RPP								Heat balance results									
No.	<i>p</i> (bar)	<i>T</i> C	<i>RH</i> <i>p</i> (bar)	<i>RH</i> <i>T</i> C	<i>DH&Cooling</i> <i>T</i> C	<i>Feed</i> <i>Water</i> <i>T</i> C	<i>FGC</i>	<i>Net</i> <i>fuel</i> <i>input</i> (LHV)	<i>Gross</i> <i>power</i> (MW)	<i>Net</i> <i>power</i> (MW)	<i>Heat</i> <i>conden</i> <i>s.</i> (MW)	<i>Heat</i> <i>FGC</i> (MW)	<i>Total</i> <i>Heat</i> (MW)	<i>Therma</i> <i>l power</i> (MW)	<i>Gross</i> <i>Eff</i> (LHV)	<i>Net</i> <i>Eff.</i> (LHV)	<i>Net.</i> <i>Eff</i> <i>Diff.</i>
Appendix 15 LV11.4.2	175	600	45	600	45/90C	265	No	320	122	112	170	0	170	170	37,9%	34,9%	
Appendix 16 LV11.4.3.1	175	585	45	600	45/90	265	No	319	120	111	170	0	170	170	37,7%	34,7%	-0,2%
Appendix 17 LV11.4.4.1	175	585	45	580	45/90	265	No	318	119	110	170	0	170	170	37,5%	34,5%	-0,4%
Appendix 18 LV11.4-5.1	175	585	45	585	45/90	265	No	318	120	110	170	0	170	170	37,6%	34,6%	-0,3%

100-150 MWe Condens based on 292-358 MW LHV Fuel input Virgin biomass																	
Process data RPP								Heat balance results									
No.	p (bar)	T C	RH p (bar)	RH T C	$DH\&Cooling$ T C	$Feed$ $Water$ T C	FGC	Net $Fuel$ $Input$ (LHV)	$Gross$ $Power$ (MW)	Net $Power$ (MW)	$Heat$ $Condens$ (MW)	$Heat$ FGC (MW)	$Total$ $Heat$ (MW)	$Thermal$ $Power$ (MW)	$Gross$ Eff (LHV)	Net Eff (LHV)	Net Eff $Diff$
Appendix 19 LV9.1	140	540	No		15/30 C (0,07 bar)	227	No	292	115	106	0	0	0	115	39,4%	36,2%	
Appendix 20 LV9.2	140	540	No		5/15 (0,03 bar)	227	No	292	119	111	0	0	0	119	40,9%	38,1%	1,9%
Appendix 21 LV9.3.1	140	540	No		5/15 (0,03 bar)	227	No	358	147	137	0	0	0	147	41,0%	38,3%	2,1%
Appendix 22 LV10	190	600	45	600	15/30 C (0,07 bar)	275	No	292	126	116	0	0	0	126	43,1%	39,6%	3,5%
Appendix 23 LV10.1.1	190	600	45	600	5/15 (0,03 bar)	275	No	292	130	121	0	0	0	130	44,6%	41,5%	5,3%
Appendix 24 LV12.4.2	260	600	45	600	5/15 (0,03 bar)	275	No	358	164	150	0	0	0	164	45,9%	41,9%	5,7%

~75 MWe CHP based on 125 MW District Heat Wide range Fuel																	
Process data RPP								Heat balance results									
No.	<i>p</i> <i>bar</i>	<i>T</i> <i>C</i>	<i>RH</i> <i>p. bar</i>	<i>RH</i> <i>T C</i>	<i>DH&Cooling</i> <i>T C</i>	<i>Feed Water</i> <i>T C</i>	<i>FGC</i>	<i>Net fuel input</i> <i>(LHV)</i>	<i>Gross power</i> <i>(MW)</i>	<i>Net power</i> <i>(MW)</i>	<i>Heat condens.</i> <i>(MW)</i>	<i>Heat FGC</i> <i>(MW)</i>	<i>Total Heat</i> <i>(MW)</i>	<i>Thermal power</i> <i>(MW)</i>	<i>Gross Eff</i> <i>(LHV)</i>	<i>Net Eff.</i> <i>(LHV)</i>	<i>Net. Eff. Diff.</i>
Appendix 25 IW0	90	500	No		45/90	210	No	211	67	61	125	0	125	192	31,6%	29,0%	
Appendix 26 IW0.1	90	500	No		45/90	210	No	210	67	62	126	0	126	193	31,9%	29,6%	0,6%
Appendix 27 IW1.2	160	560	No		45/90	230	No	219	77	70	126	0	126	203	34,9%	32,0%	3,0%
Appendix 28 IW6.2.1	160	560	33	560	45/90	230	No	226	83	76	126	0	126	209	36,6%	33,7%	4,7%

~50 MWe CHP based on 85 MW District Heat Virgin biomass																	
Process data RPP								Heat balance results									
No.	<i>p</i> <i>bar</i>	<i>T</i> <i>C</i>	<i>RH</i> <i>p. bar</i>	<i>RH</i> <i>T C</i>	<i>DH&Cooling</i> <i>T C</i>	<i>Feed Water</i> <i>T C</i>	<i>FGC</i>	<i>Net fuel input</i> <i>(LHV)</i>	<i>Gross power</i> <i>(MW)</i>	<i>Net power</i> <i>(MW)</i>	<i>Heat conden s.</i> <i>(MW)</i>	<i>Heat FGC</i> <i>(MW)</i>	<i>Total Heat</i> <i>(MW)</i>	<i>Thermal power</i> <i>(MW)</i>	<i>Gross eff</i> <i>(LHV)</i>	<i>Net eff.</i> <i>(LHV)</i>	<i>Net. Eff. Diff.</i>
Appendix 29 MV0	140	540	No		45/90	~227	No	149	50	45	85	0	85	135	33,3%	30,5%	
Appendix 30 MV3	175	600	45	600	45/90	265	No	159	59	54	86	0	86	145	37,0%	34,0%	3,5%
Appendix 31 MV4	175	585	45	585	45/90	265	No	158	58	53	86	0	86	144	36,7%	33,78%	3,3%
Appendix 32 MV5	175	600	No		45/90	265	No	155	55	51	85	0	85	140	35,7%	32,65%	2,2%
Appendix 33 MV6	175	585	No		45/90	265	No	154	55	50	85	0	85	140	35,4%	32,34%	1,9%
Appendix 34 MV7	175	585	No		45/90	230	No	153	54	49	85	0	85	139	35,0%	32,02%	1,5%

~50 MWe CHP based on MW District Heat Wide range Fuel																	
Process data RPP								Heat balance results									
No.	<i>p</i> <i>bar</i>	<i>T</i> <i>C</i>	<i>RH</i> <i>p. bar</i>	<i>RH</i> <i>T C</i>	<i>DH&Cooling</i> <i>T C</i>	<i>Feed Water</i> <i>T C</i>	<i>FGC</i>	<i>Net fuel input</i> <i>(LHV)</i>	<i>Gross power</i> <i>(MW)</i>	<i>Net power</i> <i>(MW)</i>	<i>Heat condens.</i> <i>(MW)</i>	<i>Heat FGC</i> <i>(MW)</i>	<i>Total Heat</i> <i>(MW)</i>	<i>Thermal power</i> <i>(MW)</i>	<i>Gross Eff</i> <i>(LHV)</i>	<i>Net Eff.</i> <i>(LHV)</i>	<i>Net. Eff. Diff.</i>
Appendix 35 MW0	90	500	No		45/90	210	No	150	50	43	90	0	90	140	31,2%	28,8%	
Appendix 36 MW1.2.2	160	560	No		45/90	230	No	158	55	50	90	0	90	145	34,6%	31,6%	2,8%
Appendix 37 MW6.2.3	160	560	46	560	45/90	230	No	166	59	54	90	0	90	149	35,6%	32,6%	3,8%

~25 MWe CHP based on 45 MW District Heat Virgin biomass																	
Process data RPP								Heat balance results									
No.	<i>p</i> <i>bar</i>	<i>T</i> <i>C</i>	<i>RH</i> <i>p.</i> <i>bar</i>	<i>RH</i> <i>T</i> <i>C</i>	<i>DH&Cooling</i> <i>T</i> <i>C</i>	<i>Feed Water</i> <i>T</i> <i>C</i>	<i>FGC</i>	<i>Net fuel input</i> <i>(LHV)</i>	<i>Gross power</i> <i>(MW)</i>	<i>Net power</i> <i>(MW)</i>	<i>Heat conden s.</i> <i>(MW)</i>	<i>Heat FGC</i> <i>(MW)</i>	<i>Total Heat</i> <i>(MW)</i>	<i>Thermal power</i> <i>(MW)</i>	<i>Gross eff</i> <i>(LHV)</i>	<i>Net eff.</i> <i>(LHV)</i>	<i>Net. Eff. Diff.</i>
Appendix 38 SV0	140	540	No		45/90	~227	No	79	26	24	45	0	45	71	32,9%	30,1%	
Appendix 39 SV1	175	570	No		45/90	250	No	81	28	54	45	0	46	73	34,5%	31,4%	1,3%

~25 MWe CHP based on 50 MW District Heat Wide range Fuel																	
Process data RPP								Heat balance results									
No.	<i>p</i> <i>bar</i>	<i>T</i> <i>C</i>	<i>RH</i> <i>p. bar</i>	<i>RH</i> <i>T C</i>	<i>DH&Cooling</i> <i>T C</i>	<i>Feed Water</i> <i>T C</i>	<i>FGC</i>	<i>Net fuel input</i> <i>(LHV)</i>	<i>Gross power</i> <i>(MW)</i>	<i>Net power</i> <i>(MW)</i>	<i>Heat condens.</i> <i>(MW)</i>	<i>Heat FGC</i> <i>(MW)</i>	<i>Total Heat</i> <i>(MW)</i>	<i>Thermal power</i> <i>(MW)</i>	<i>Gross Eff</i> <i>(LHV)</i>	<i>Net Eff.</i> <i>(LHV)</i>	<i>Net. Eff. Diff.</i>
Appendix 40 SW0	90	500	No		45/90	210	No	82	25	23	50	0	50	75	30,3%	27,8%	
Appendix 41 SW1	160	560	No		45/90	250	No	88	30	27	50	0	50	80	33,9%	30,6%	2,8%

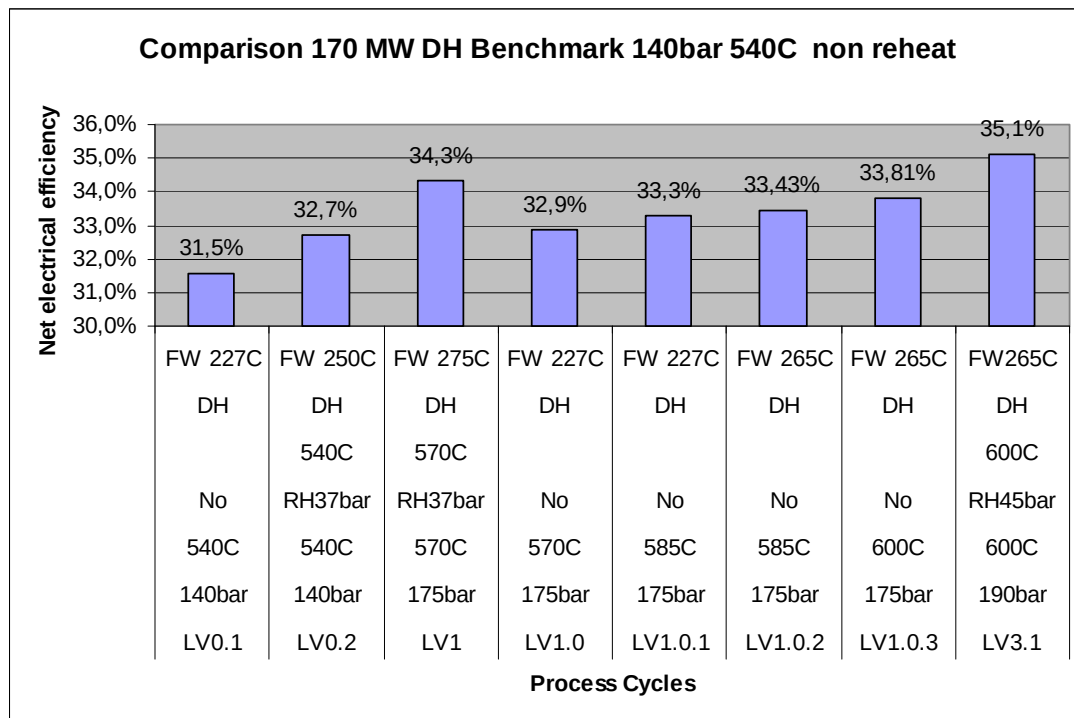


Figure 2 Benchmark Virgin fuel non reheat 140bar 540C as reference comparison (to be revised)

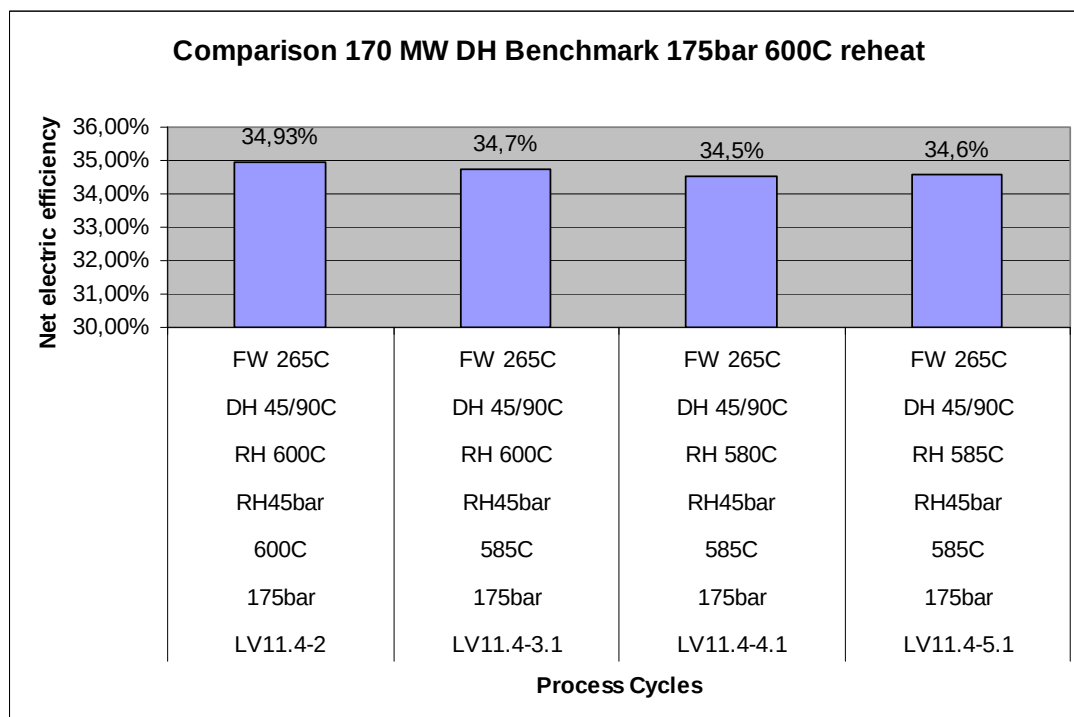


Figure 3 Benchmark Virgin fuel reheat 175bar 600/600 C as reference comparison (to be revised)

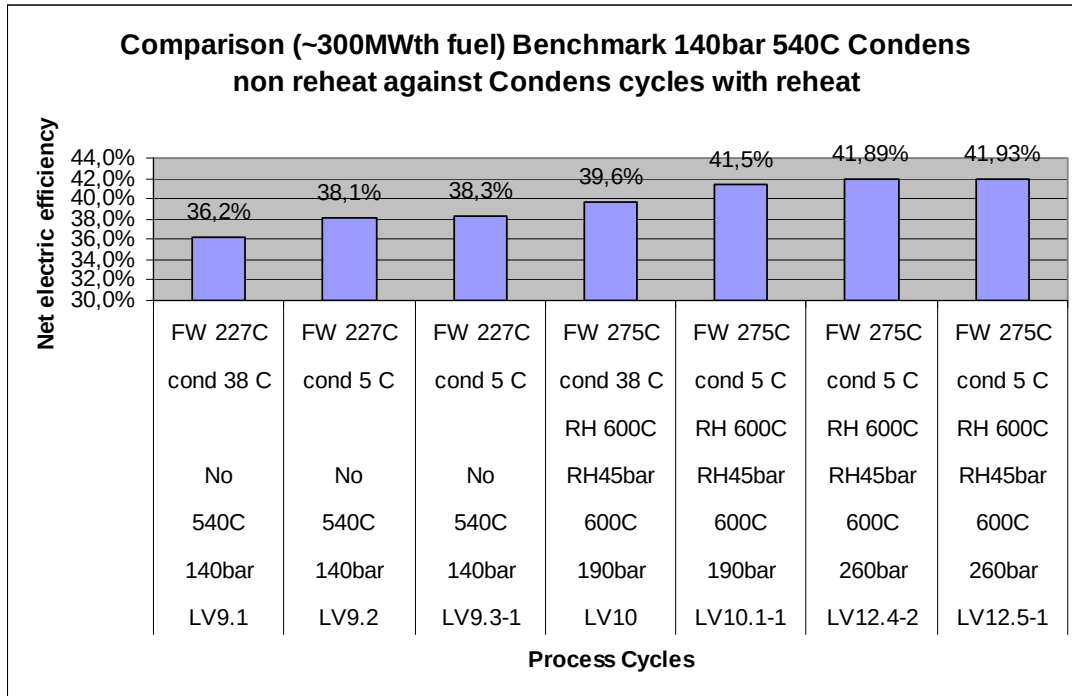


Figure 4 Benchmark Virgin fuel non reheat ACC as reference comparison

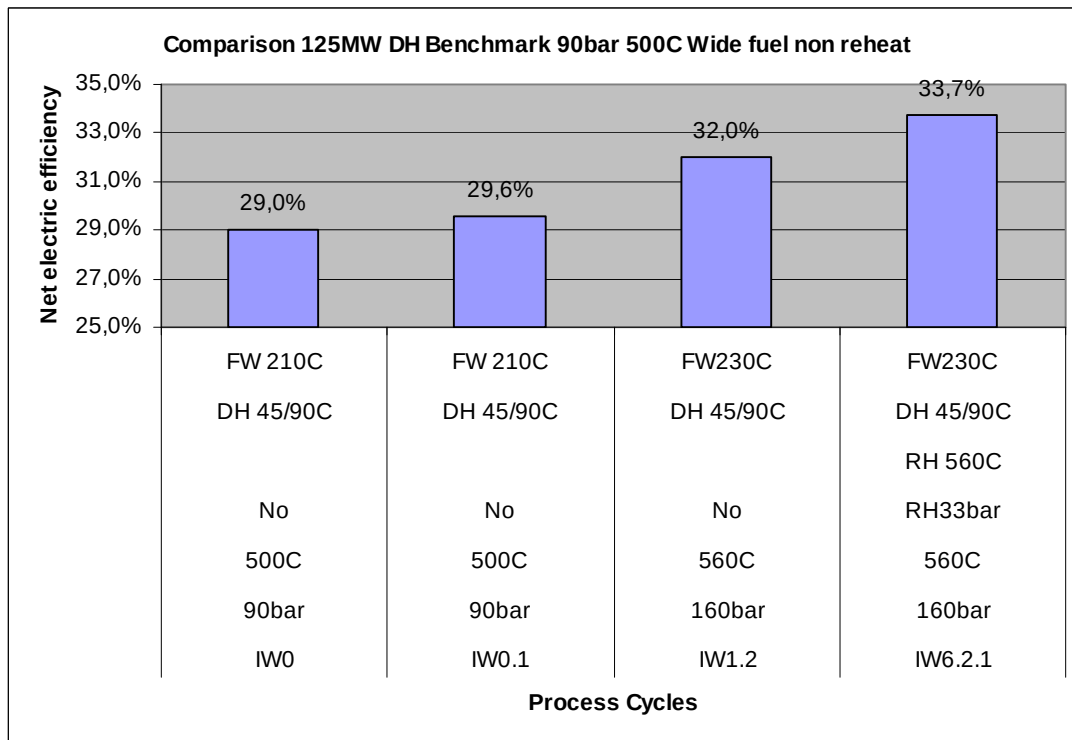


Figure 5 Benchmark Wide fuel non reheat as reference comparison

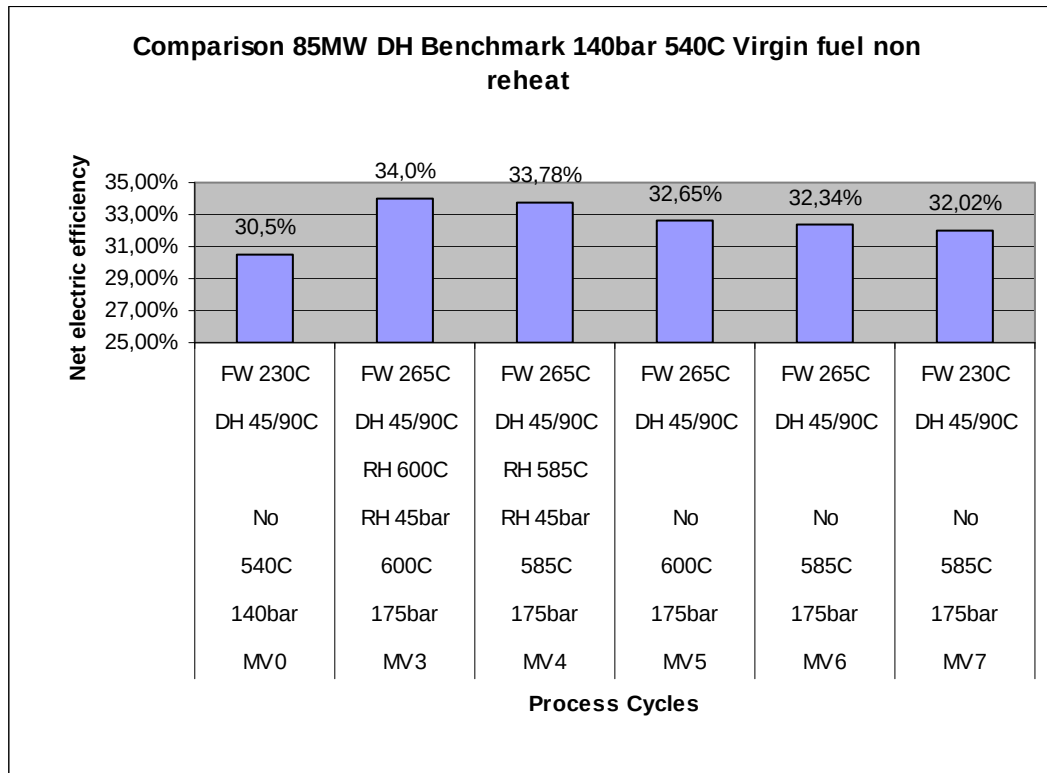
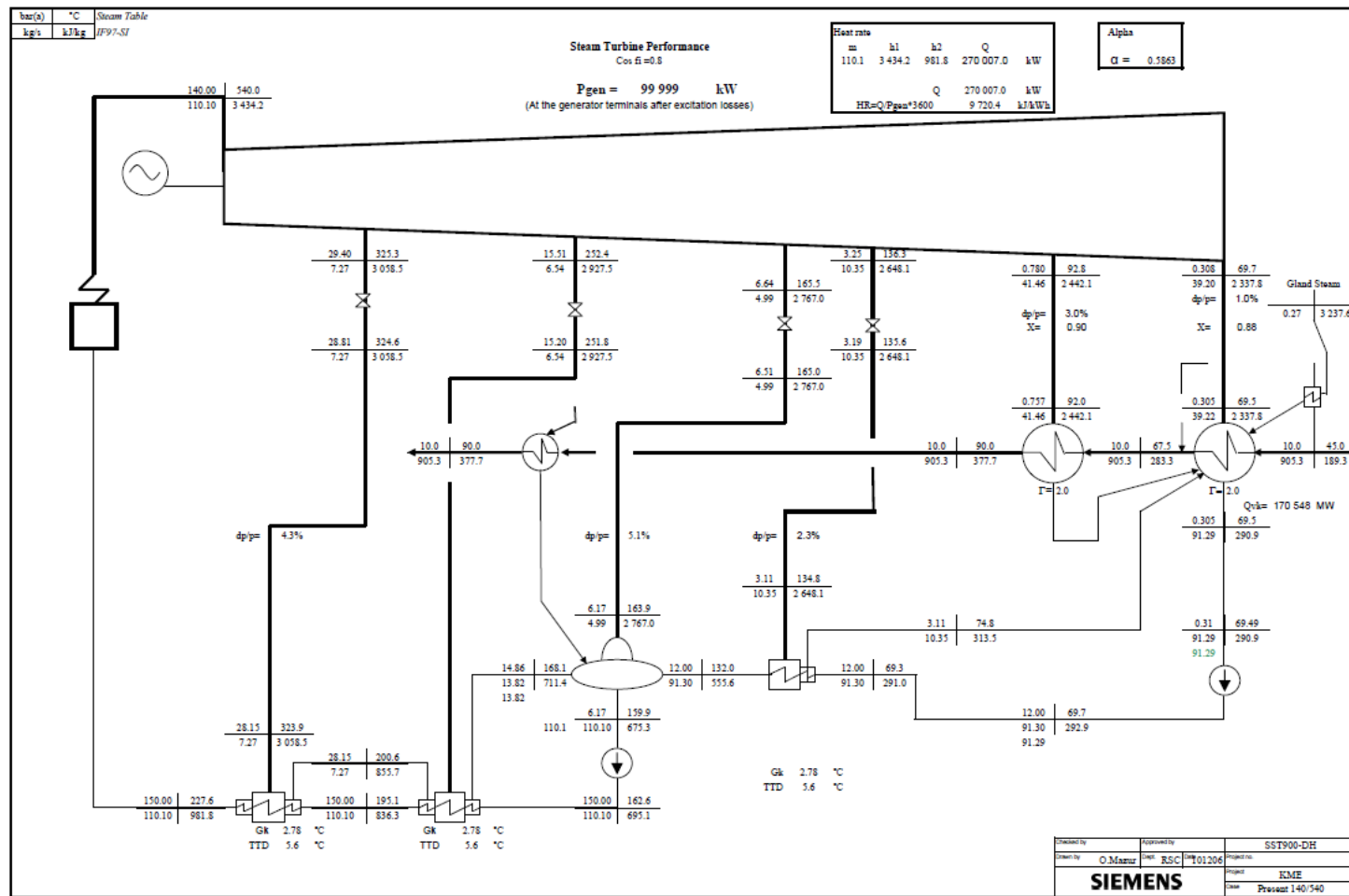


Figure 6 Benchmark 50 MW Virgin fuel non reheat as reference comparison (to be revised)

5. Referenser

- [1] Thermoflow Inc
- [2] BIO DEMO UPPSALA ,Concepts for high-efficiency biomass CHP ,Report Number U
11:63
- [3] Metso list of inputs 2010-11-30

6. Appendices

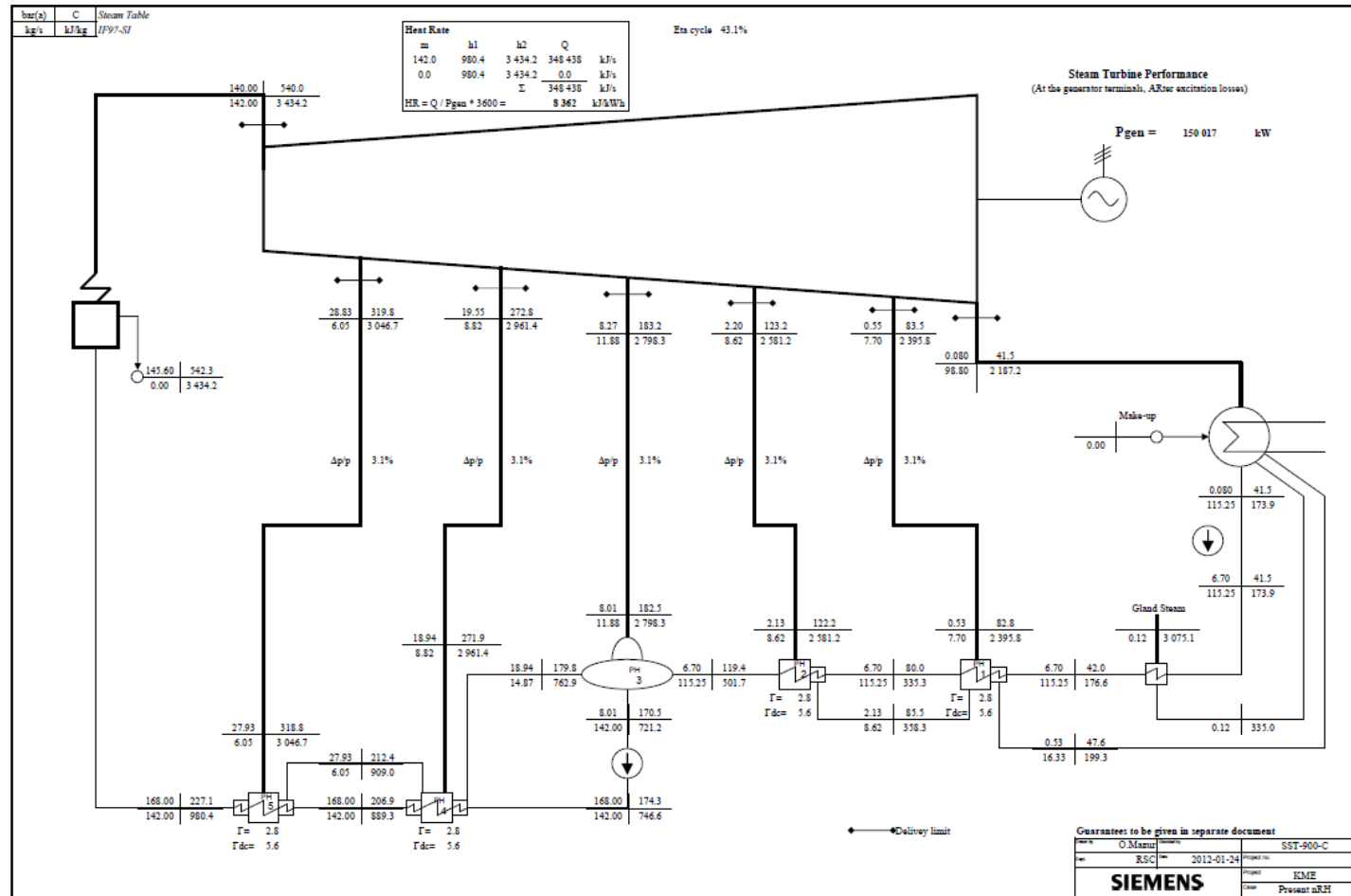


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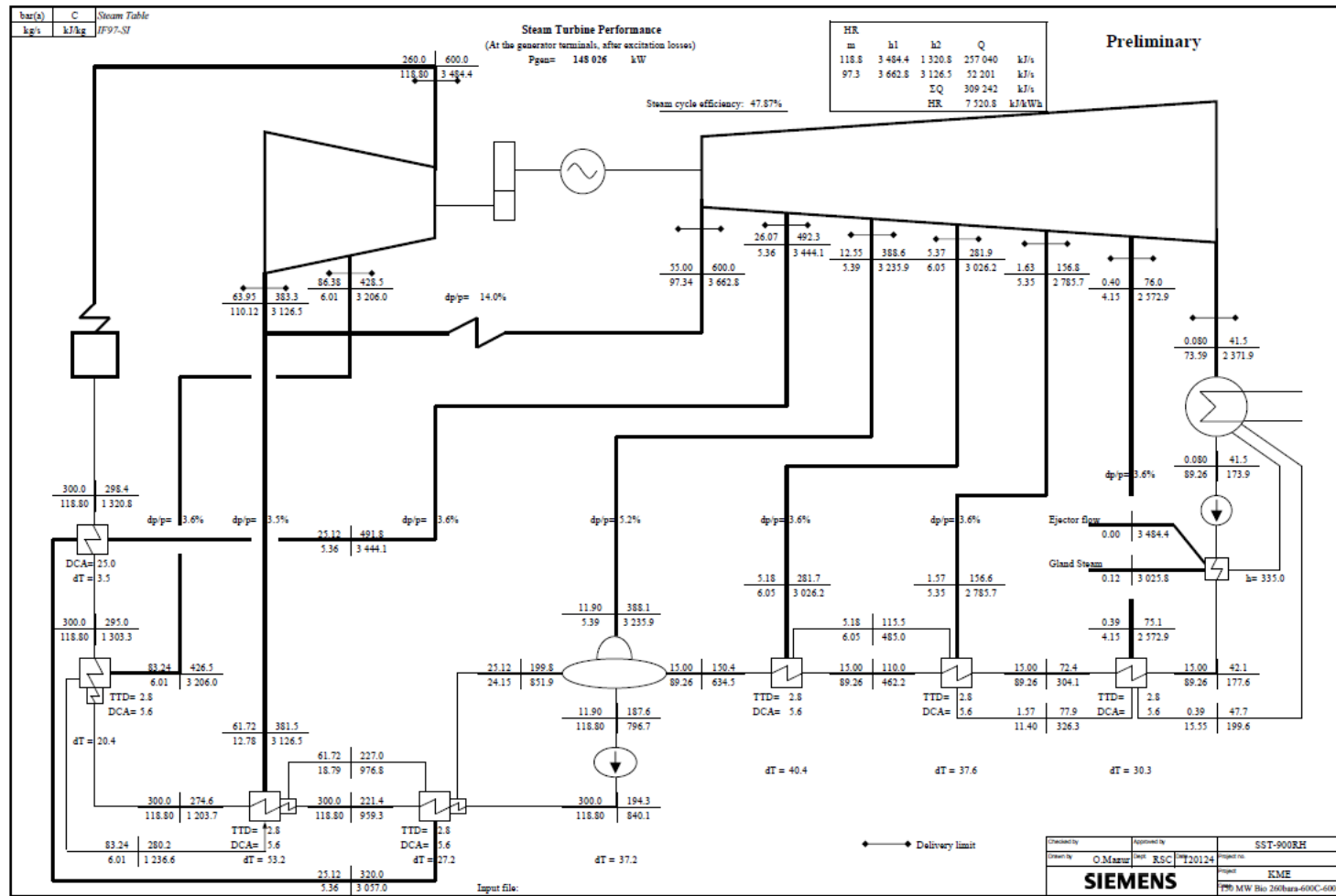
140_540

SST900DH

Appendix 1 Siemens Heat Balance diagram Benchmark 140bar 540 C

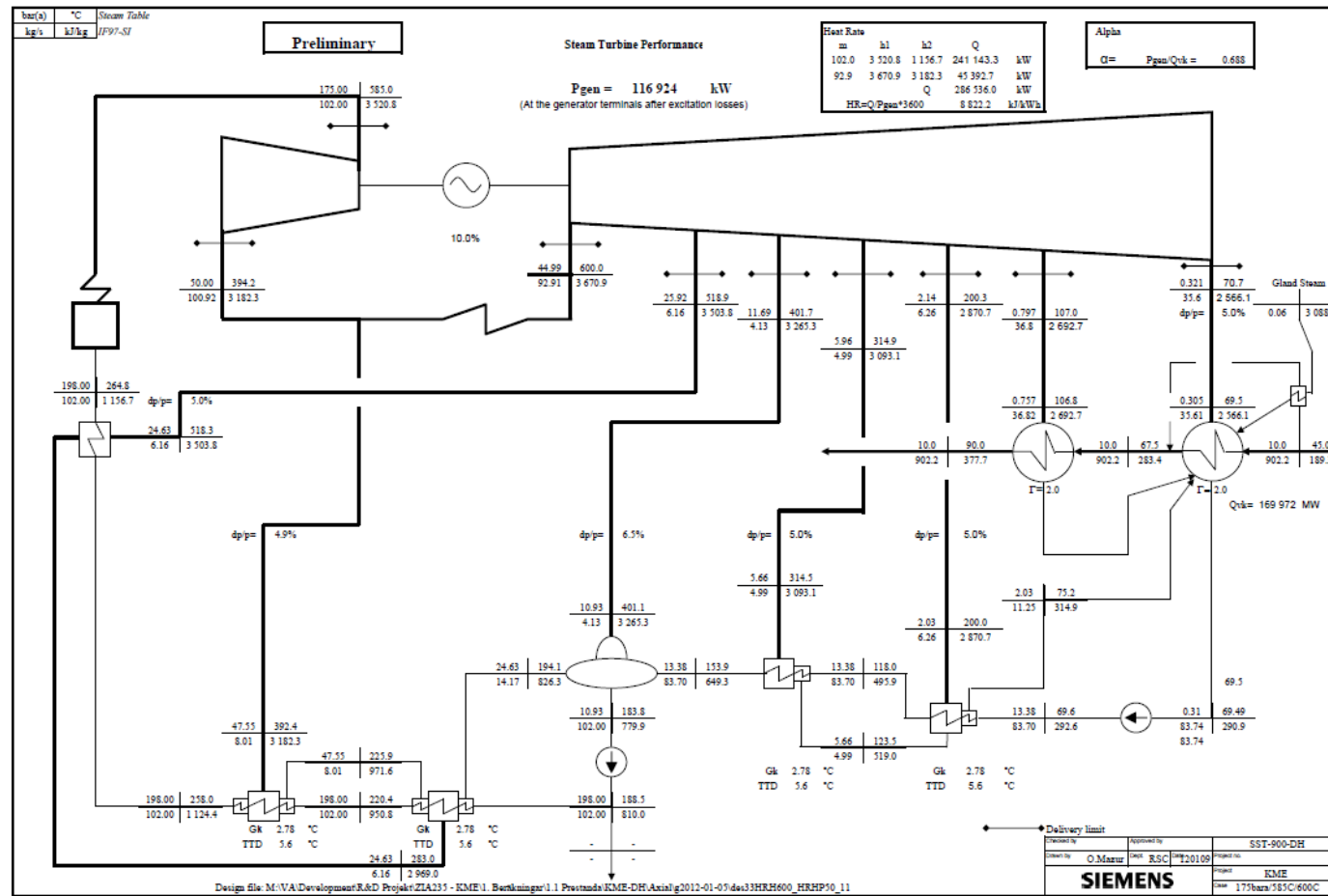


Appendix 2 Siemens Heat Balance diagram 140bar 540 C Condensing



M:\VA\Development\R&D Projekt\ZIA235 - KME\1. Berikningar\1.1 Prestanda\Biomass-UK\120124\Future_260_600\20103 Performance 260bara.xls

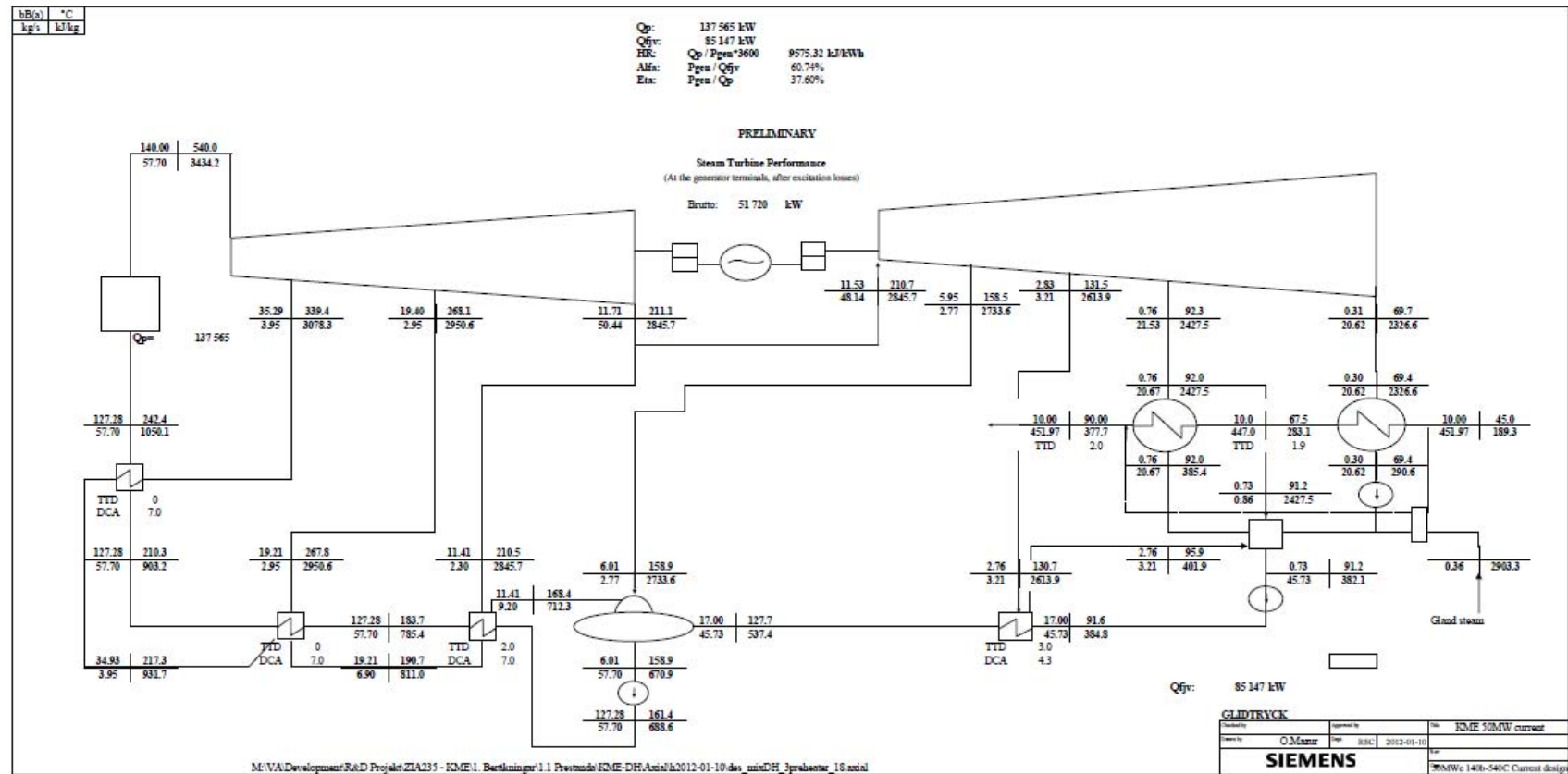
Appendix 3 Siemens Heat Balance diagram 260bar 600C RH600 Condensing



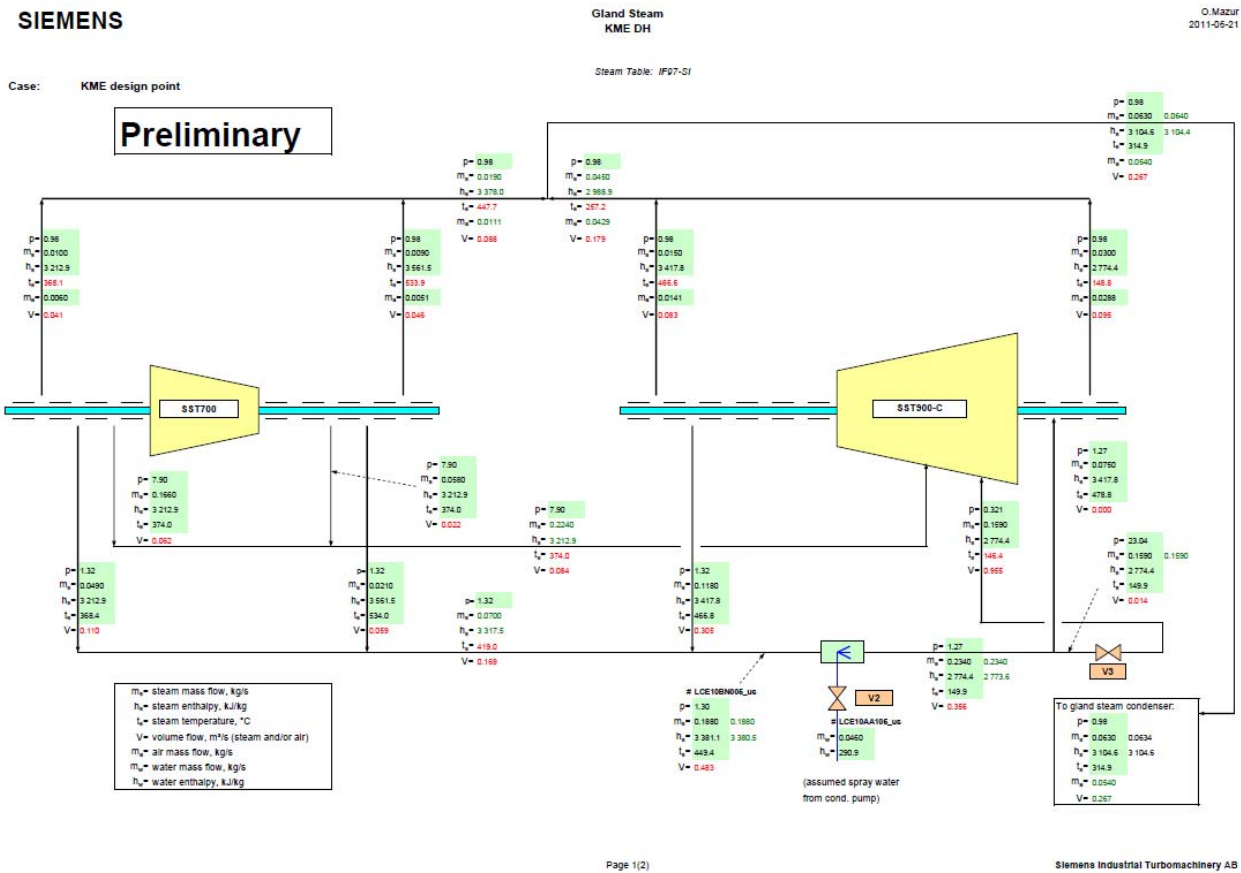
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SST900DH

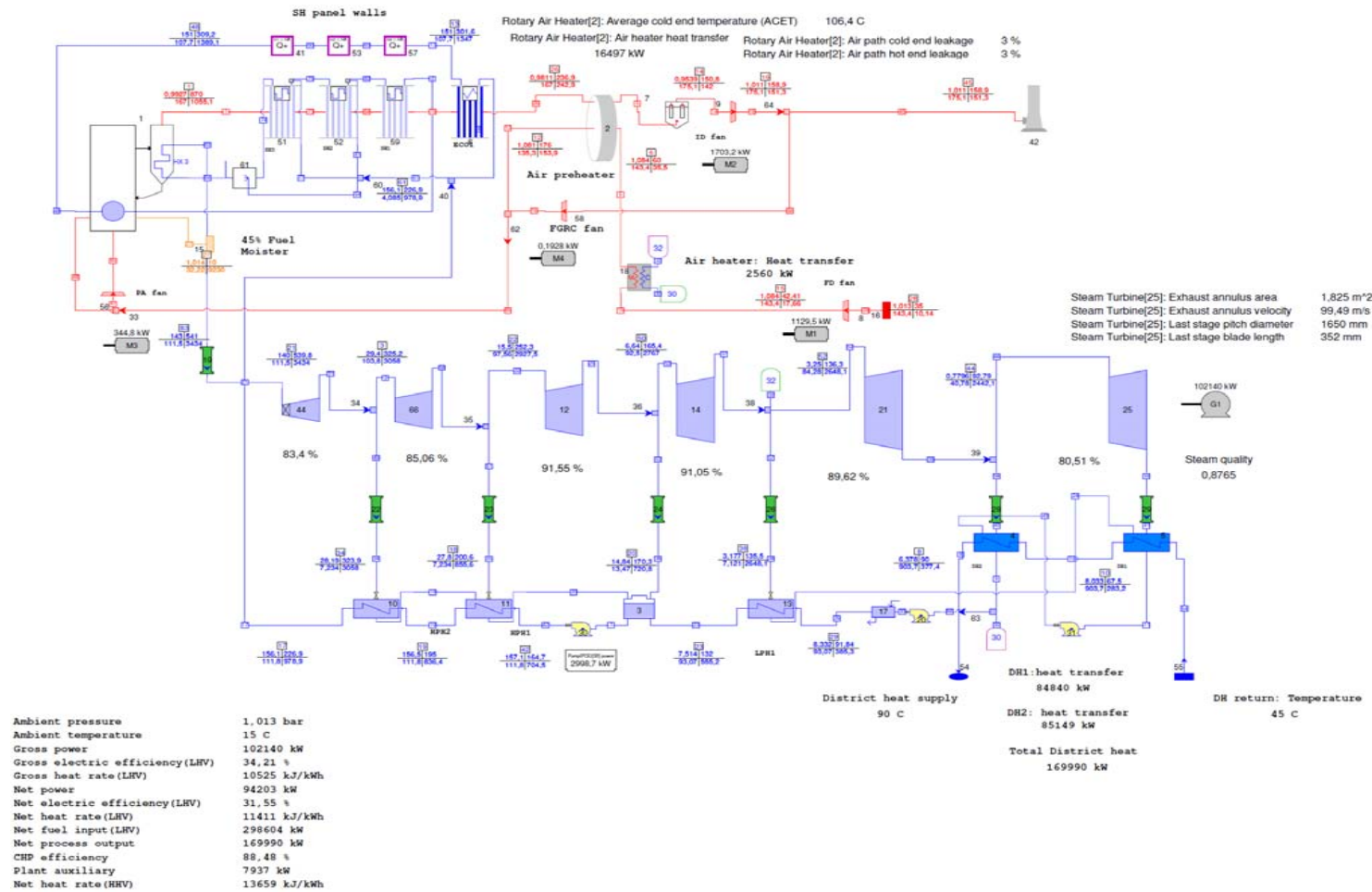
Appendix 4Siemens HB 175bar 585C RH600



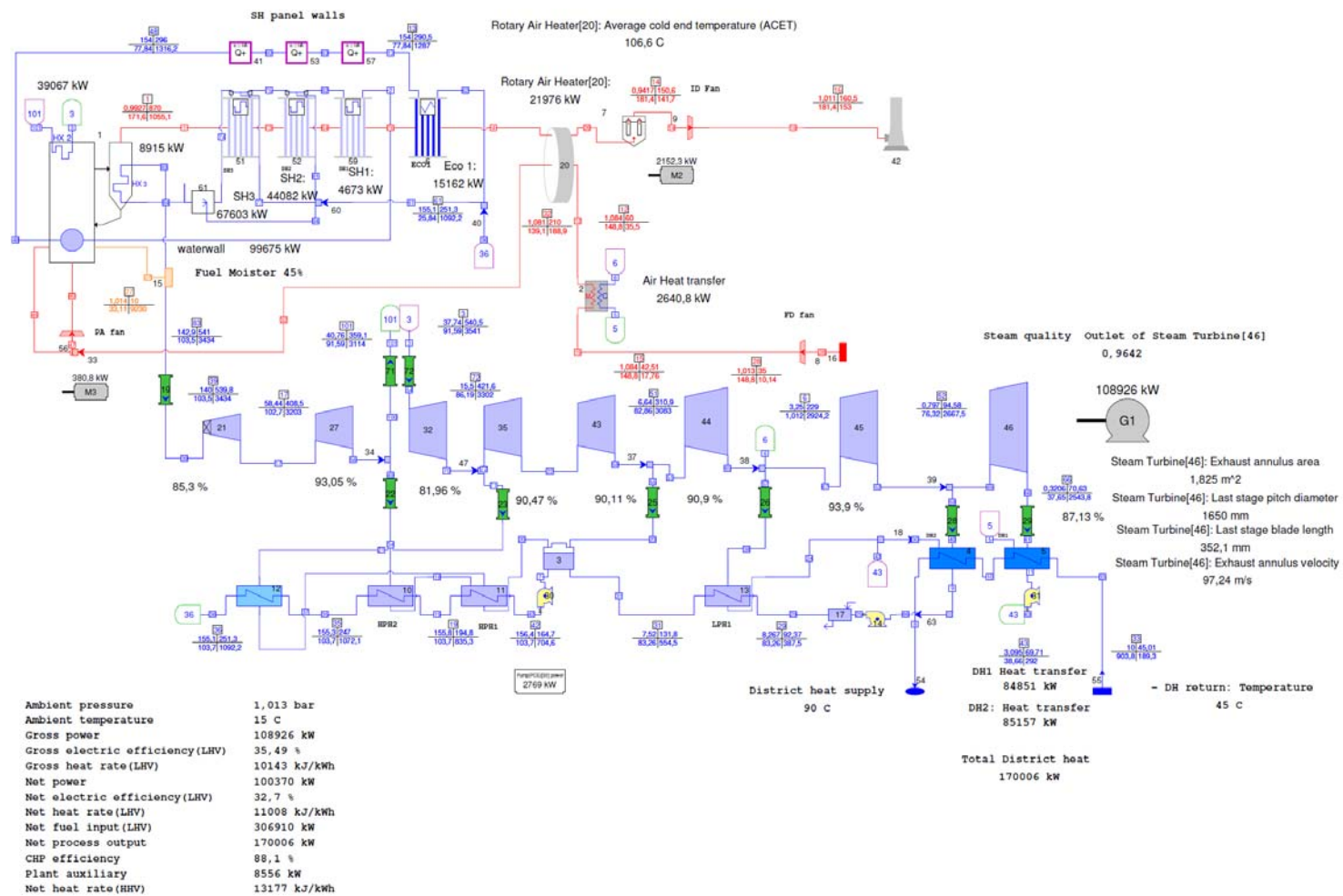
Appendix 5 Siemens Heat Balance diagram 50MWe 140bar 540C



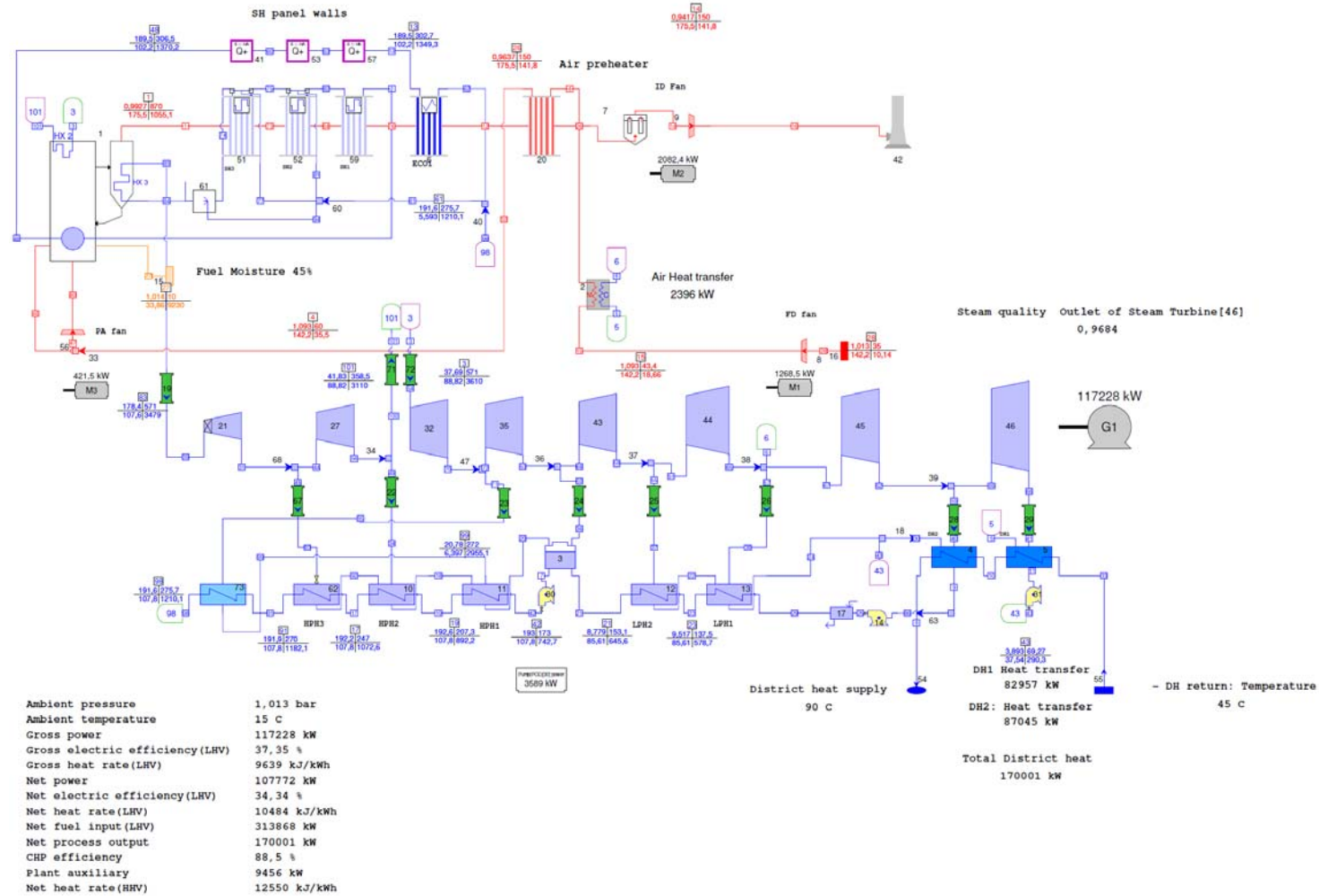
Appendix 6 Siemens Gland Steam diagram



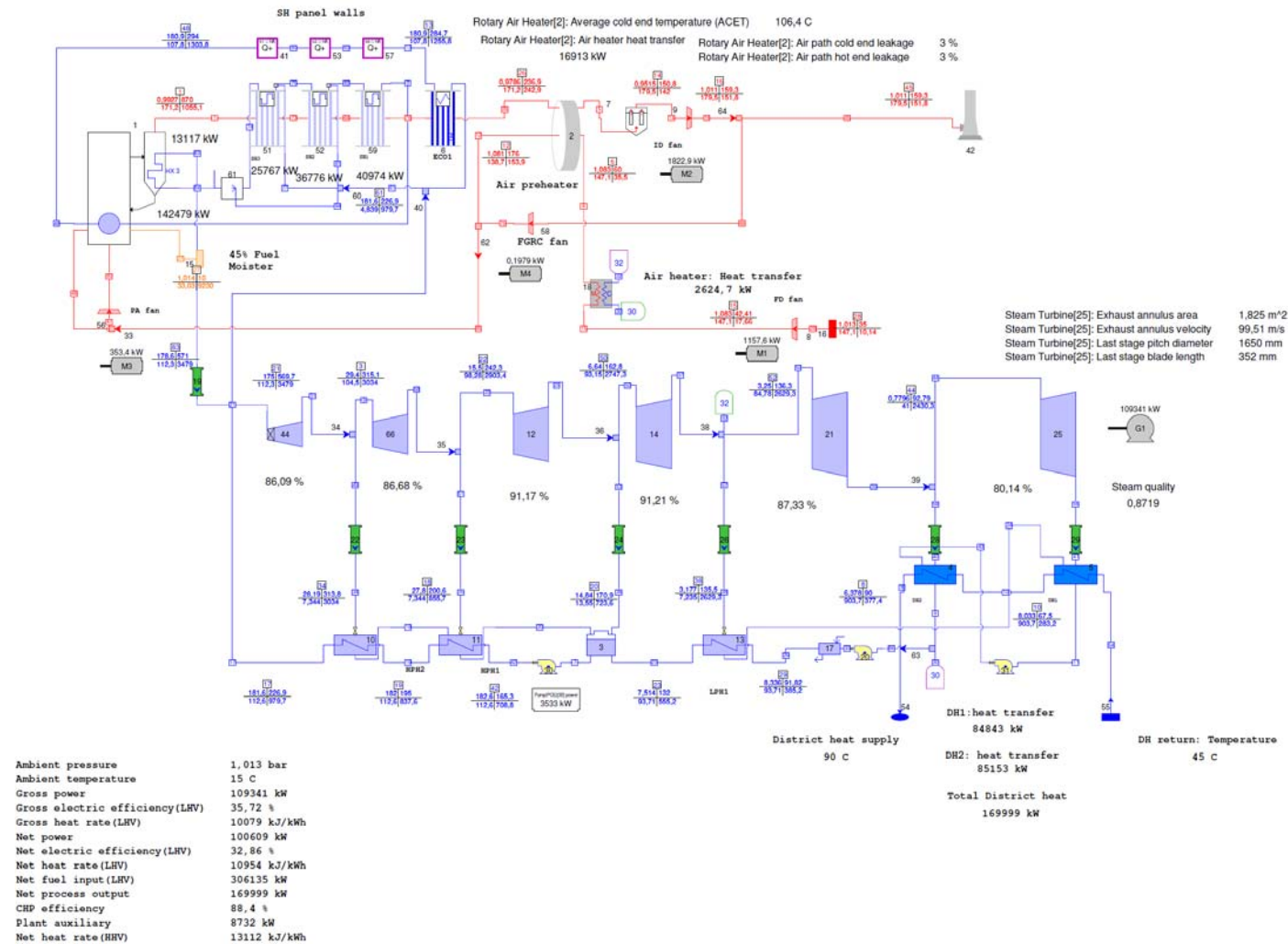
Appendix 7LV0.1 i Benchmark 100MWe Virgin Biomass 140 bar



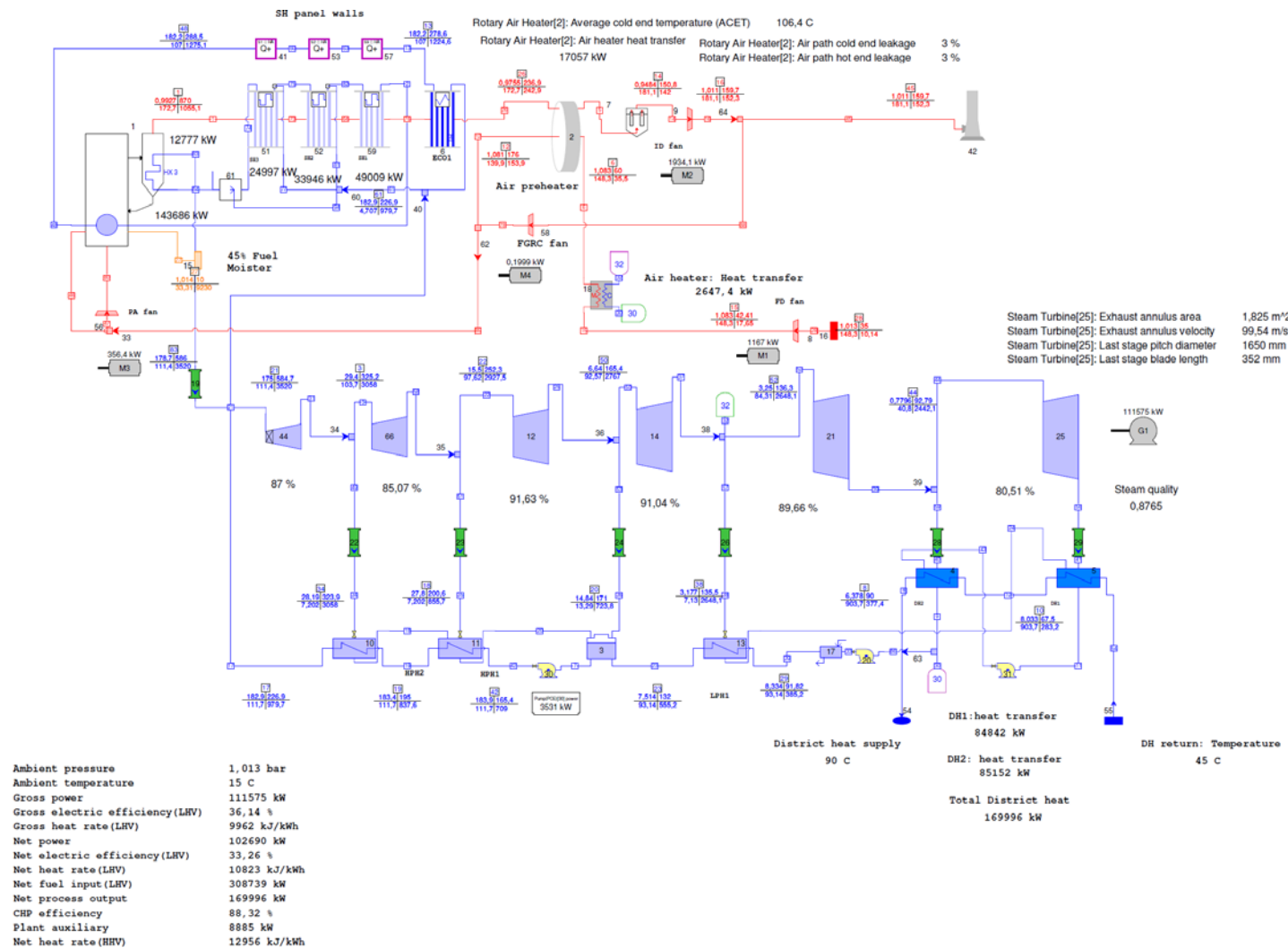
Appendix 8LV0.2 ii 100MWe Virgin Biomass 140 bar 540/540C reheat



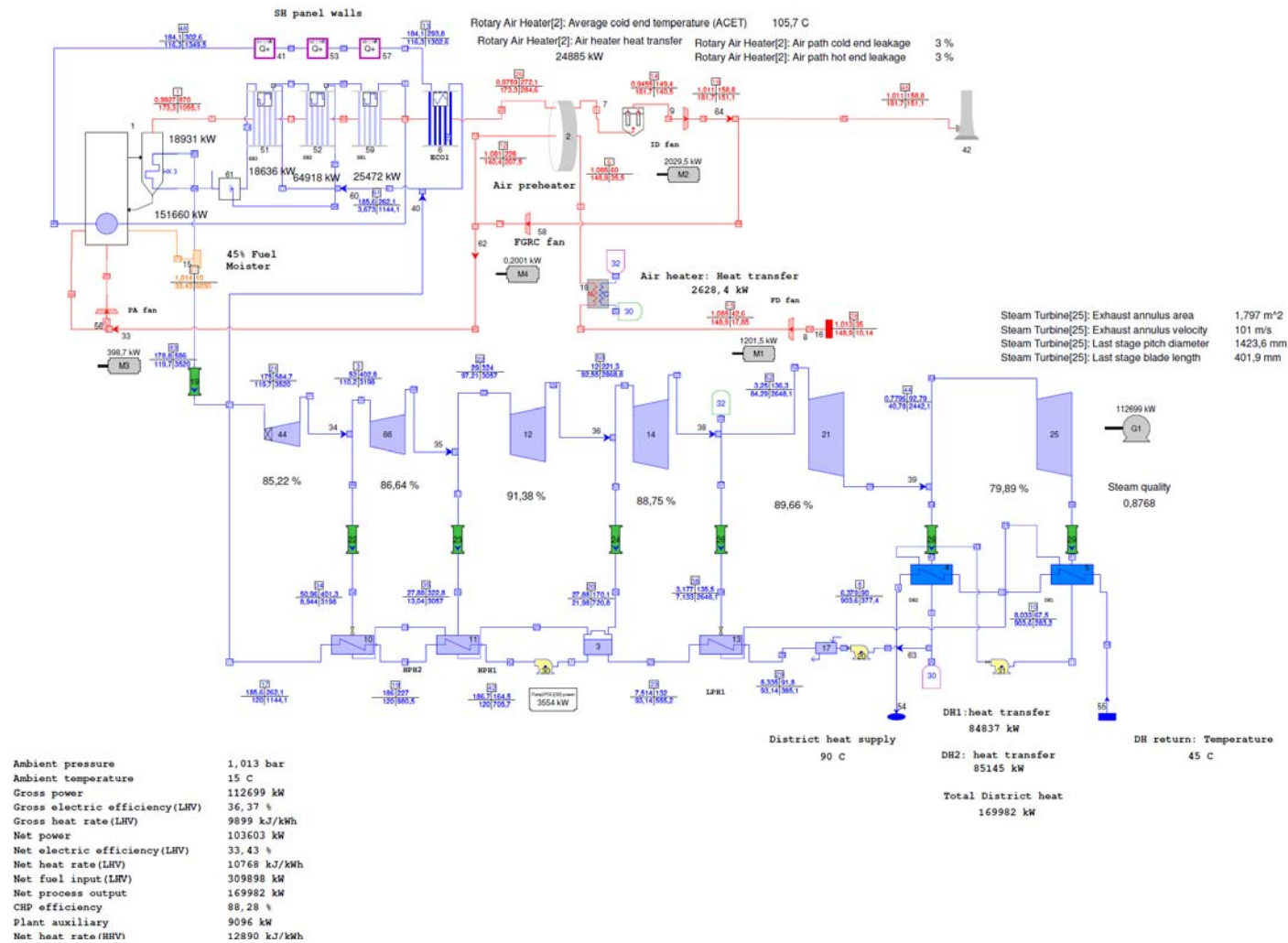
Appendix 9 LV1 100MWe Virgin Biomass 175 bar 570/570C reheater



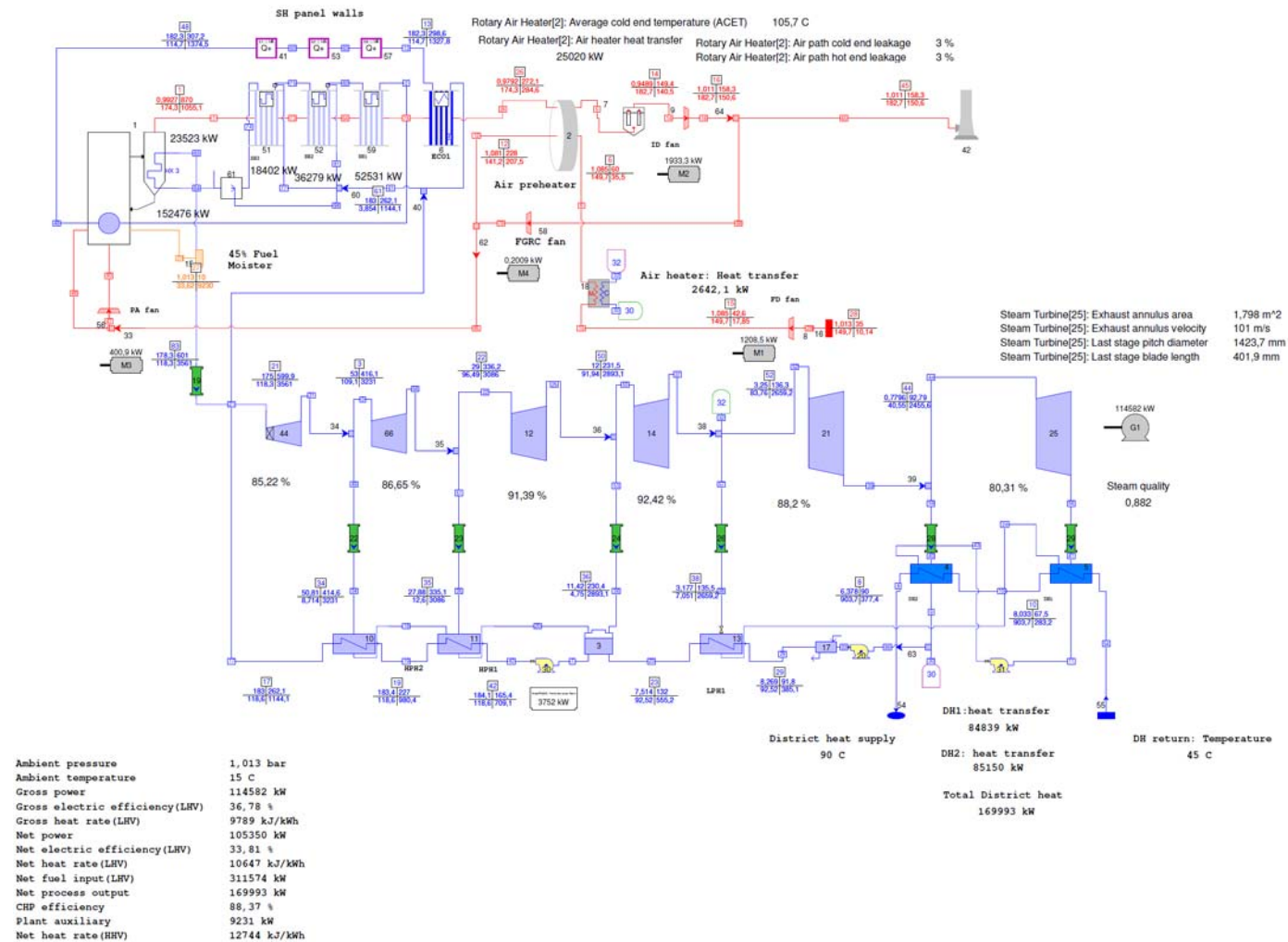
Appendix 10 LV1.0 100MWe Virgin Biomass 175 bar 570C



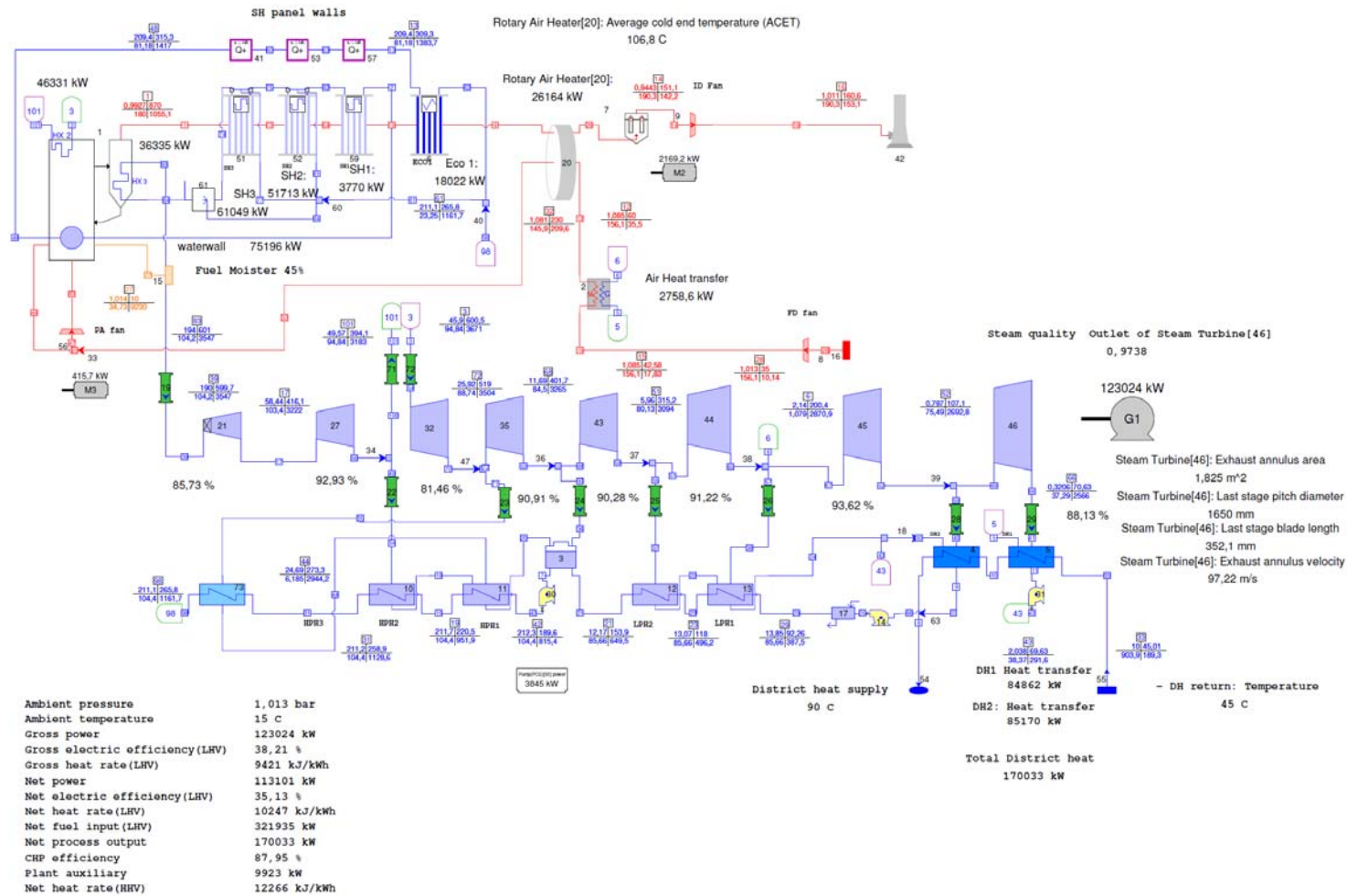
Appendix 11 LV1.0.1 100MWe Virgin Biomass 175 bar 585C FW 227 C



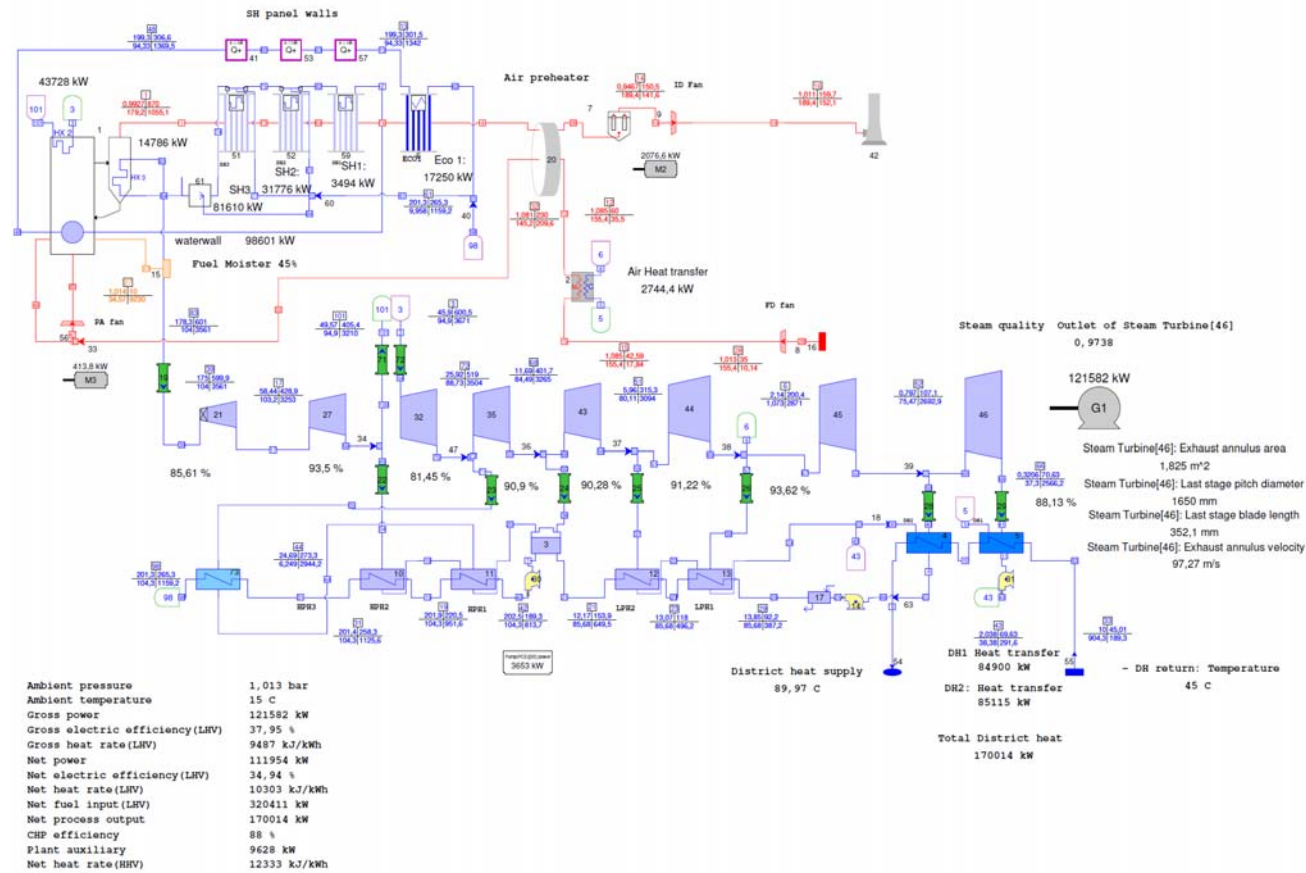
Appendix 12 LV1.0.2 100MWe Virgin Biomass 175 bar 585C FW 265C

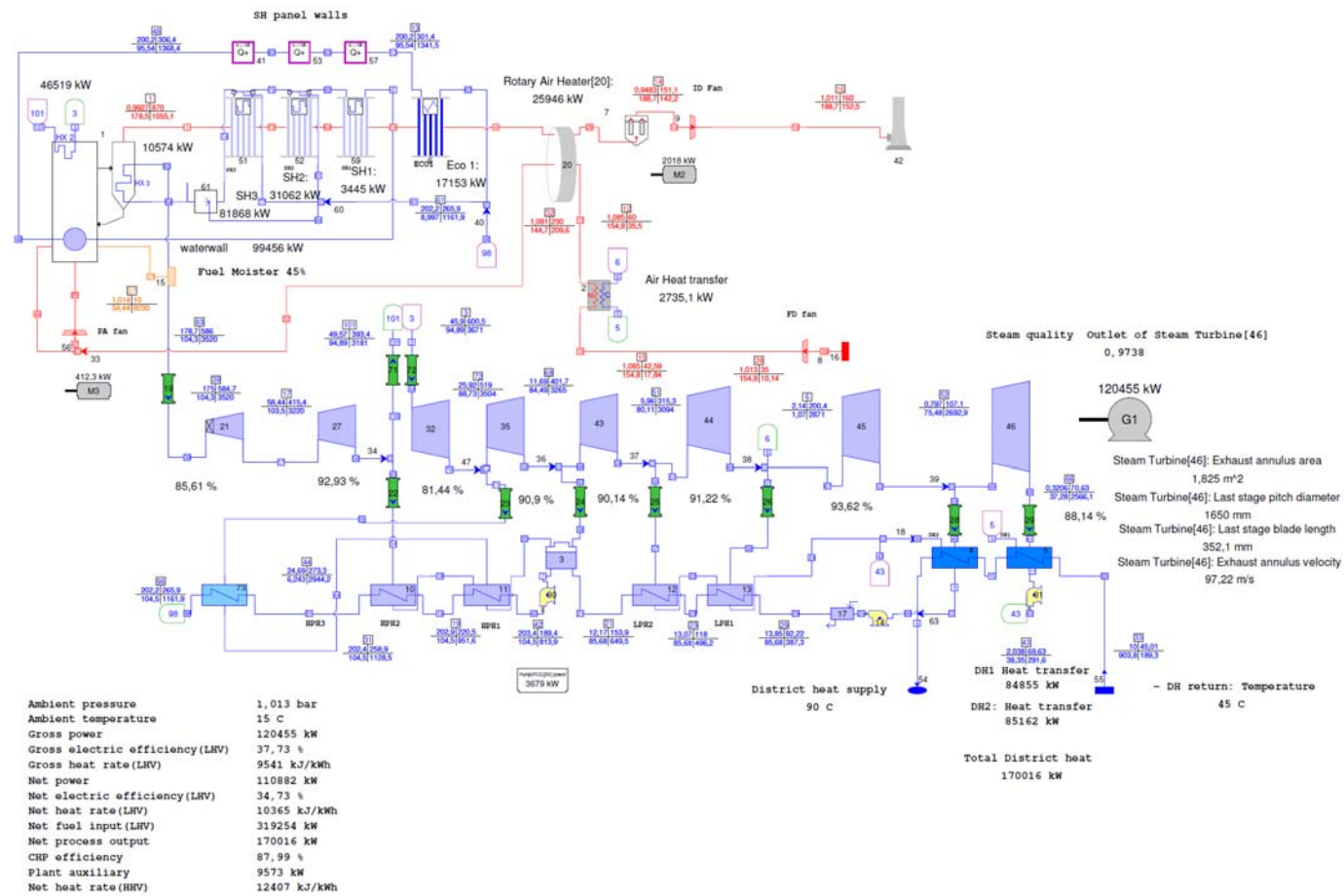


Appendix 13 LV1.0.3 100MWe Virgin Biomass 175 bar 600C FW 265C.rev.

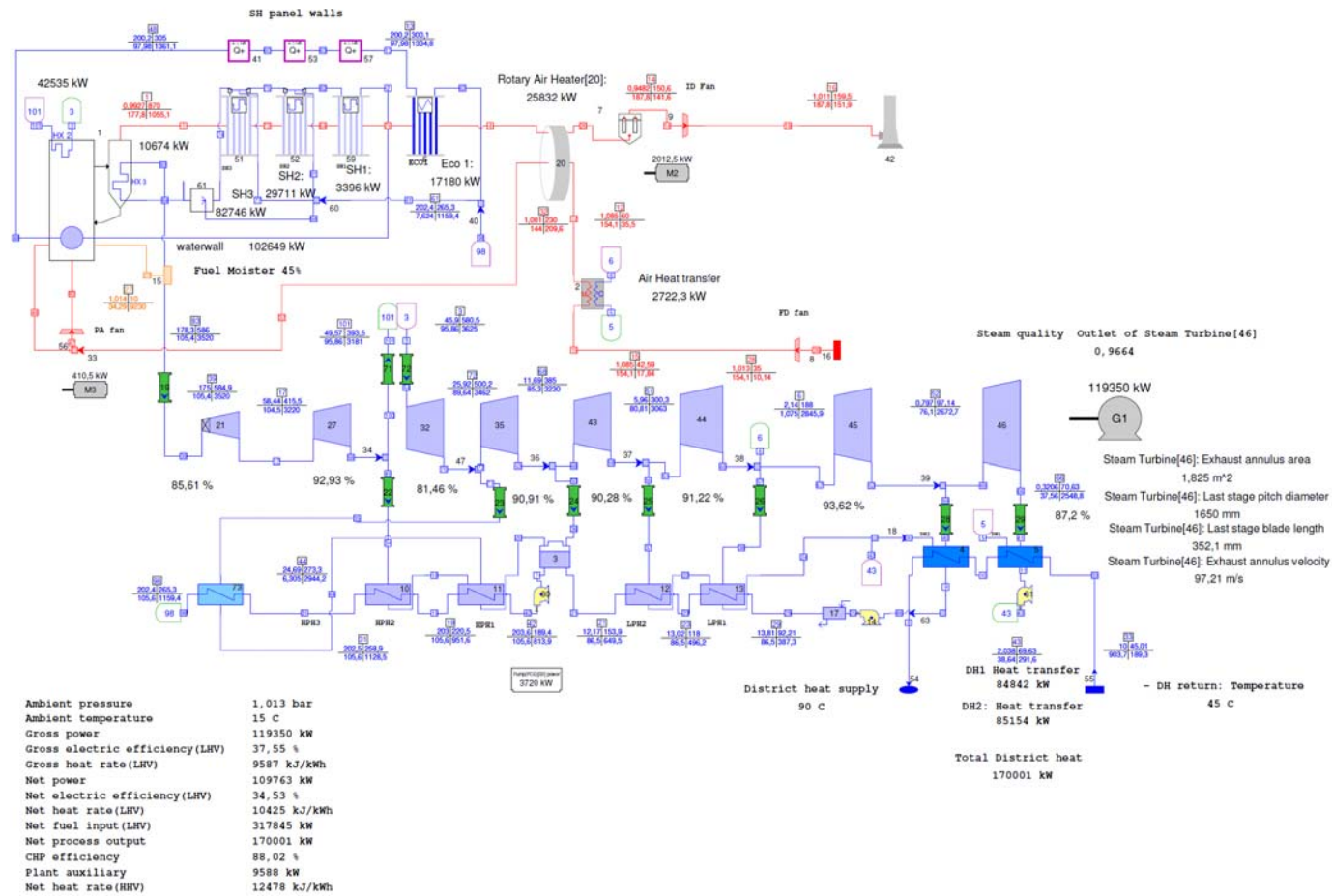


Appendix 14 LV3.1 100MWe Virgin Biomass 190 bar 600/600C reheat

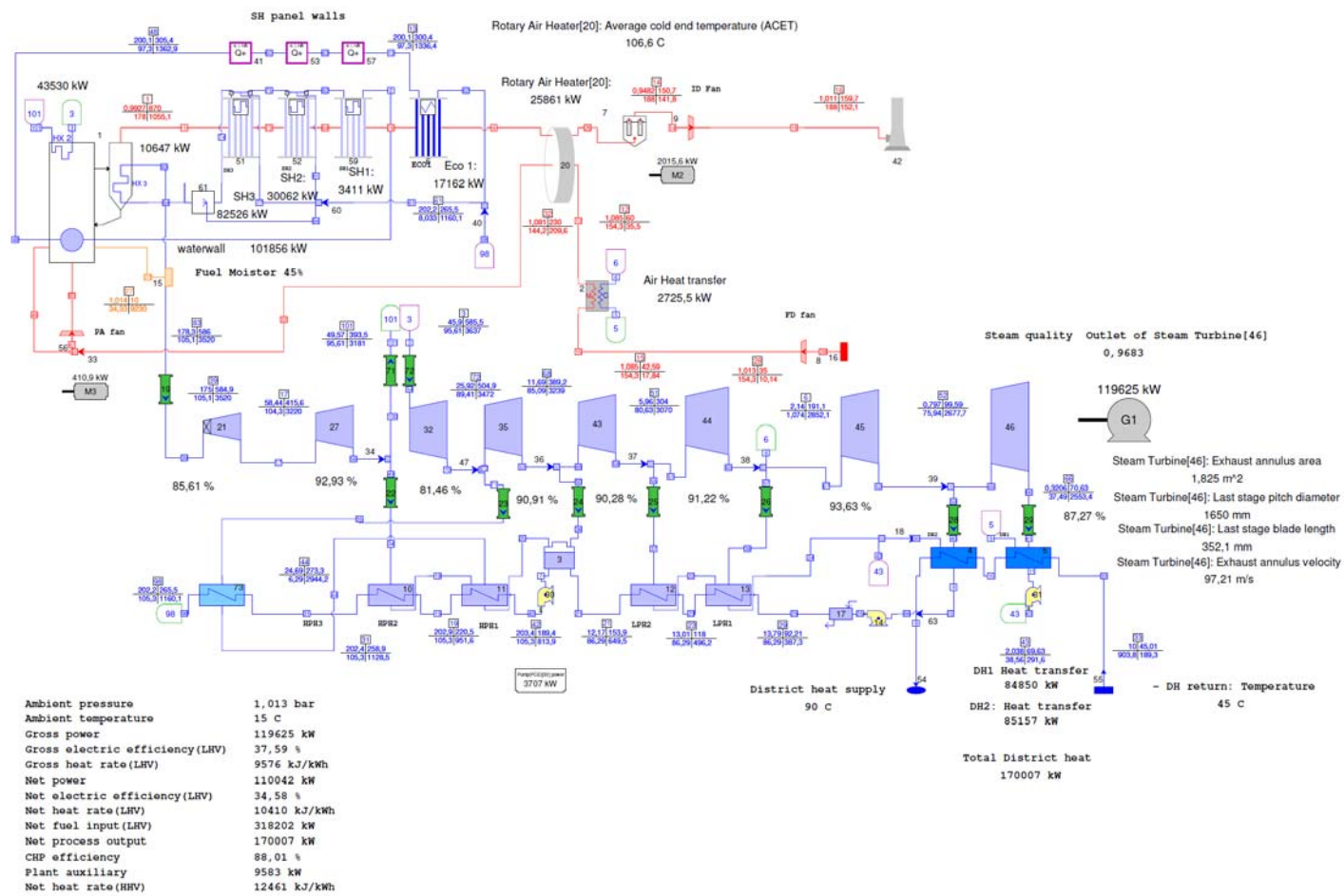




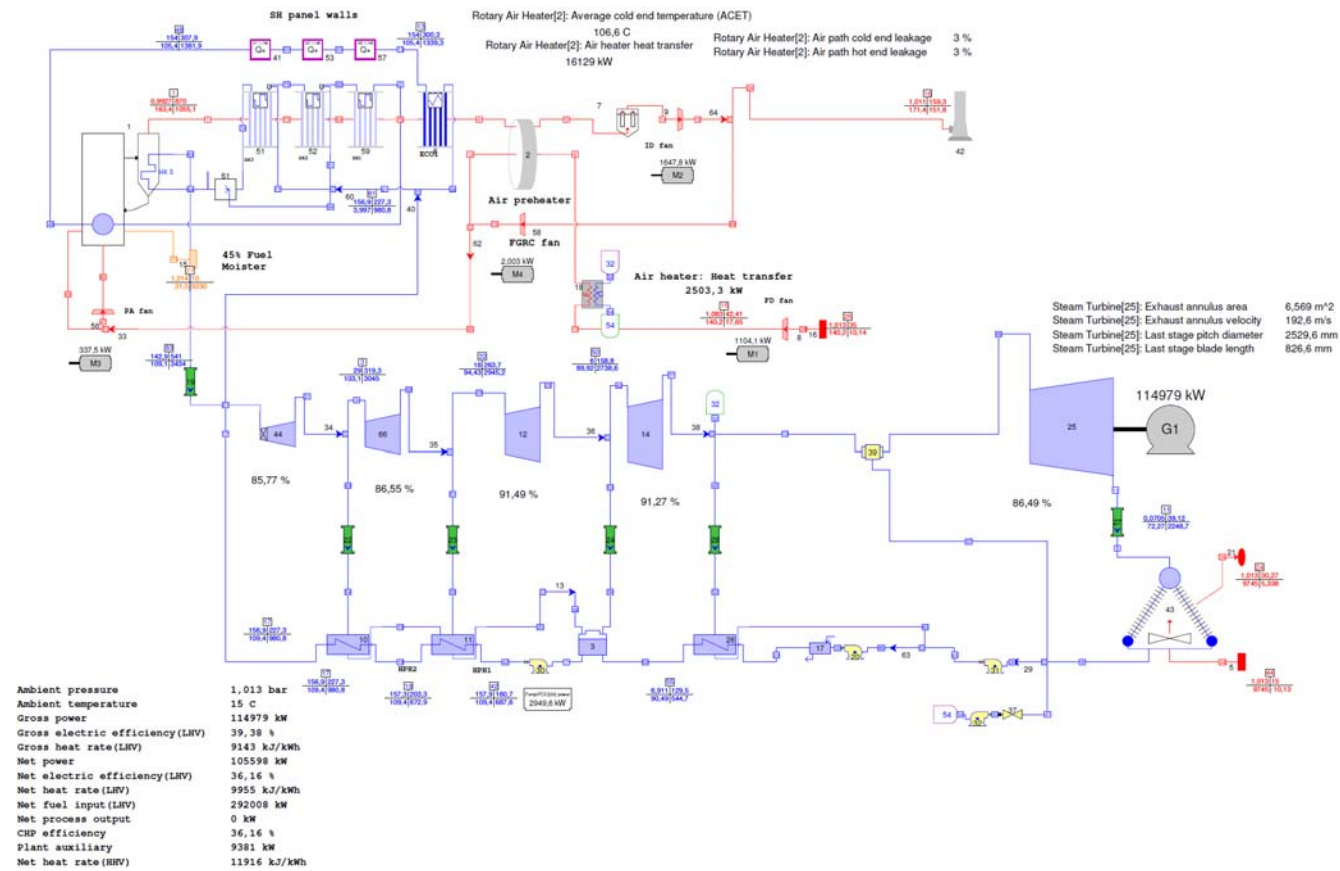
Appendix 16LV11.4.3.1 i 100MWe Virgin Biomass 175 bar 585 C Reheat 45 bar 600 C



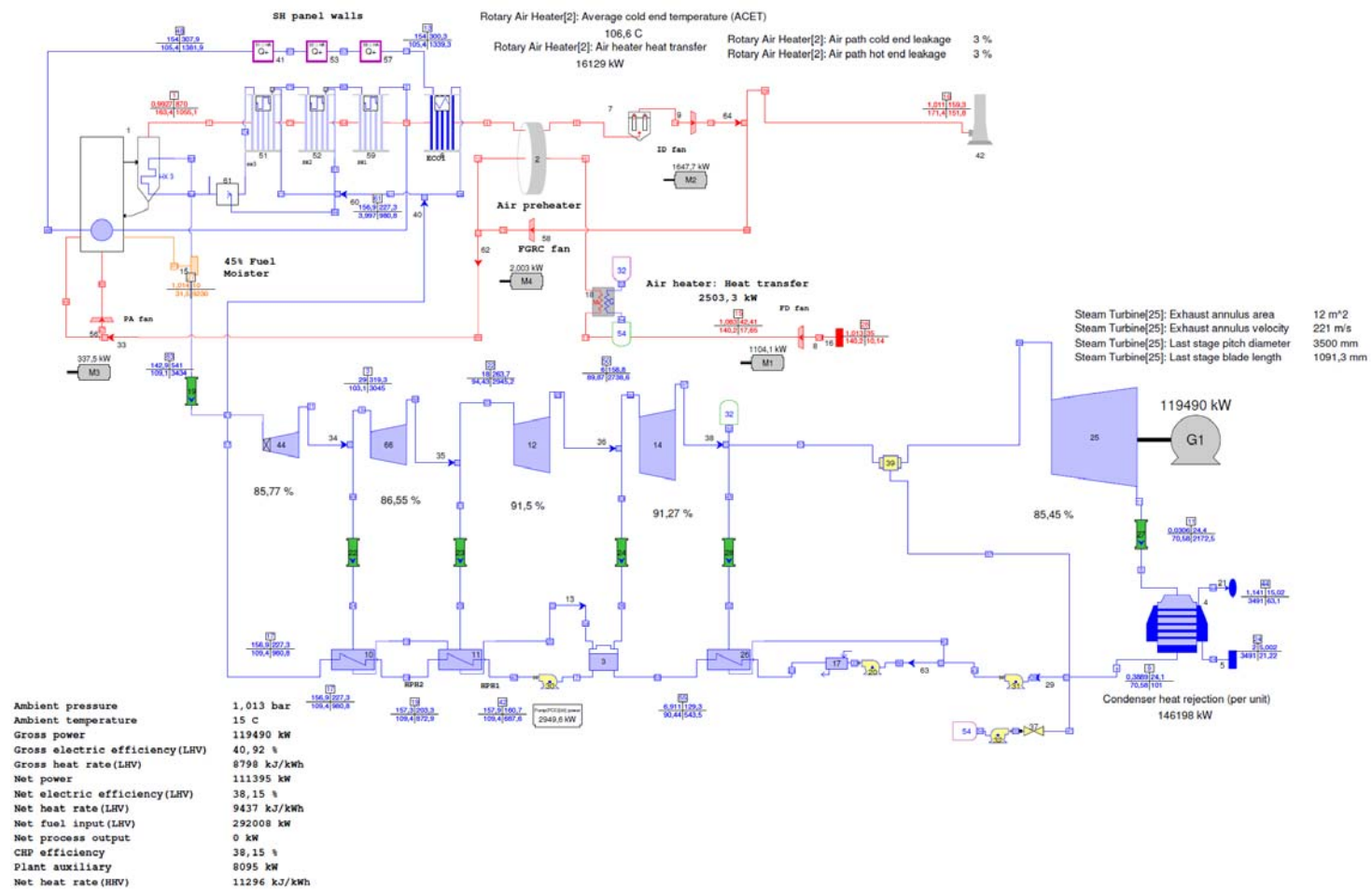
Appendix 17LV11.4.4.1 i 100MWe Virgin Biomass 175 bar 585 C Reheat 45 bar 580 C



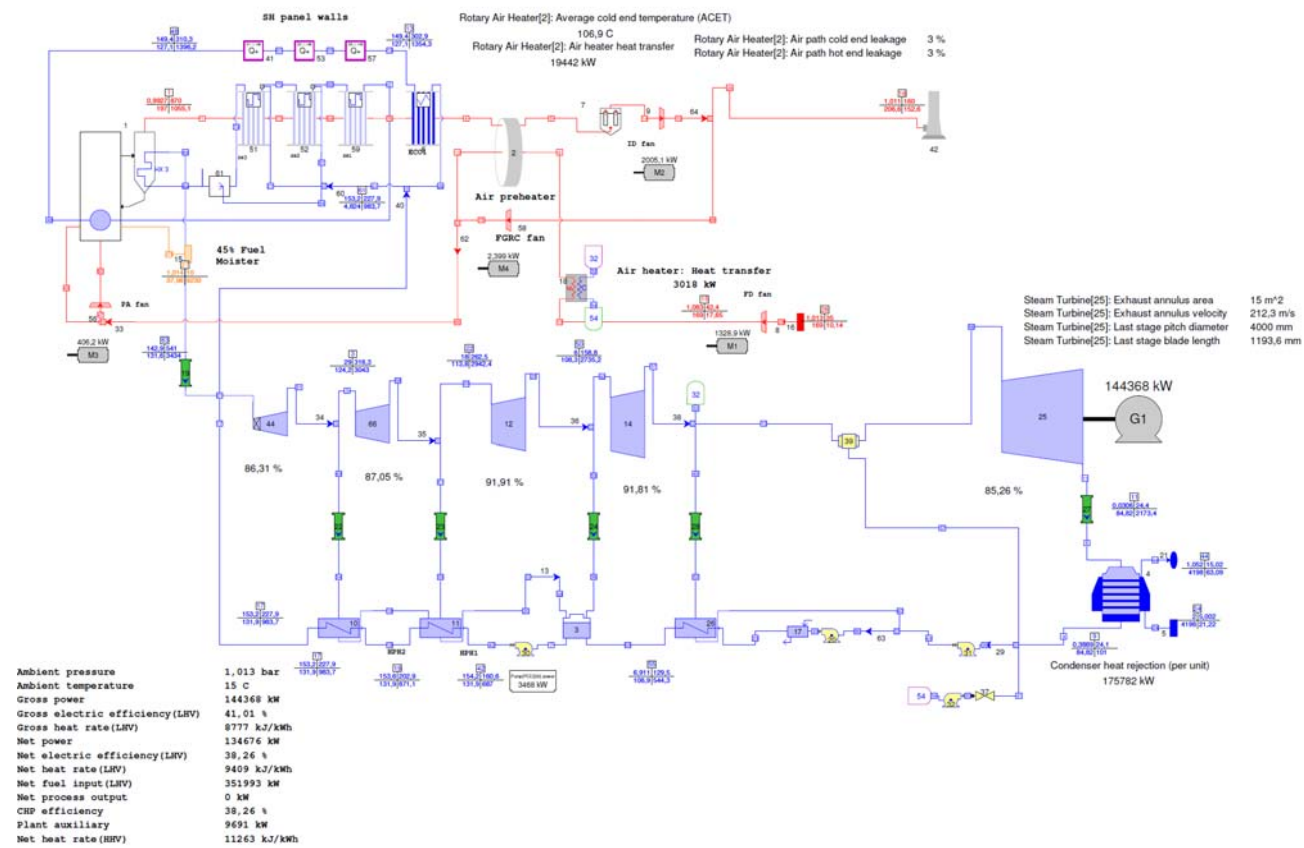
Appendix 18 LV4.5.1 100MWe Virgin Biomass 175 bar 585 C Reheat 45 bar 585 C



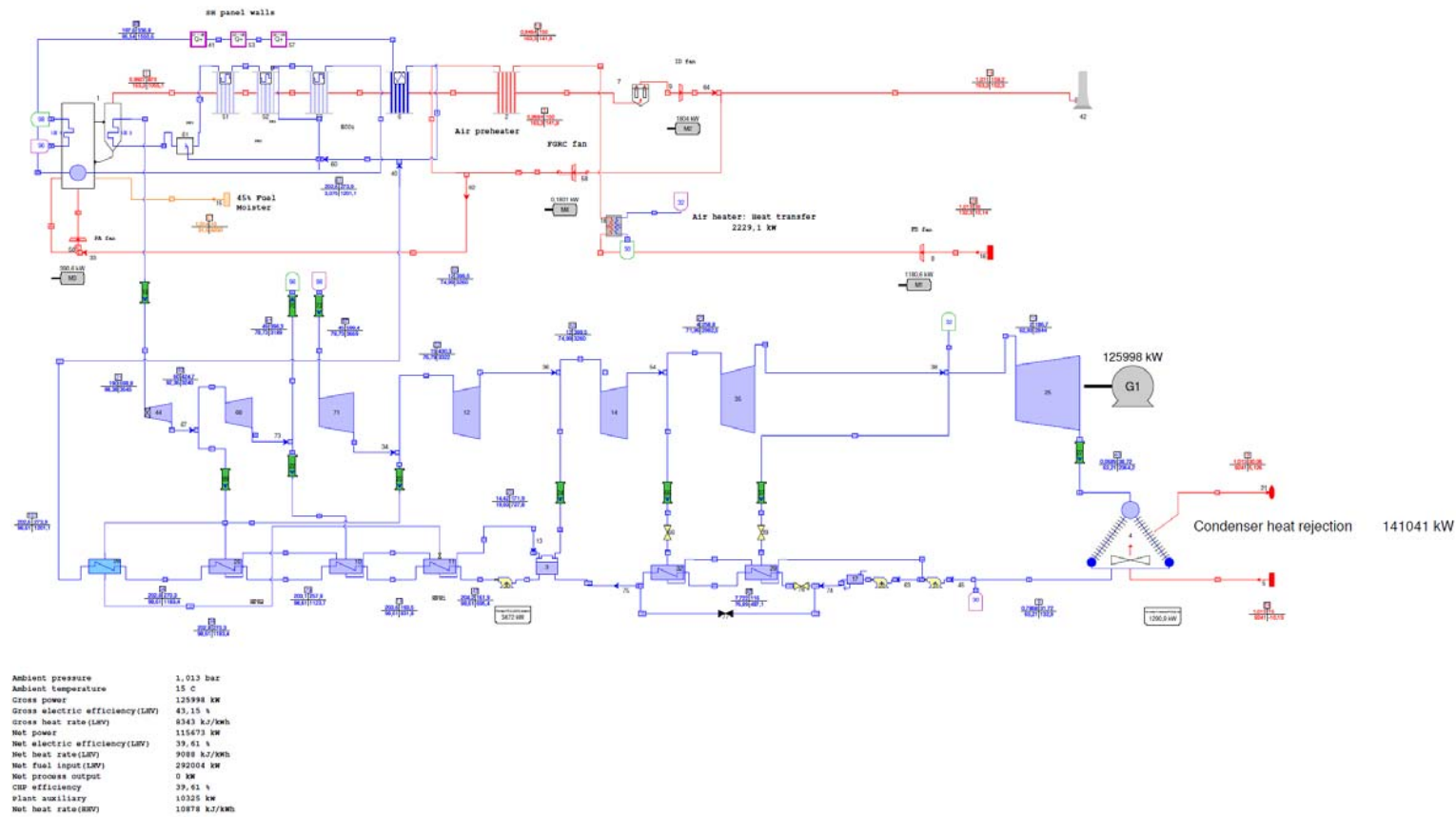
Appendix 19 LV9 1i Benchmark 100MWe Virgin Biomass 140 bar 540 C Air Cooled Condenser



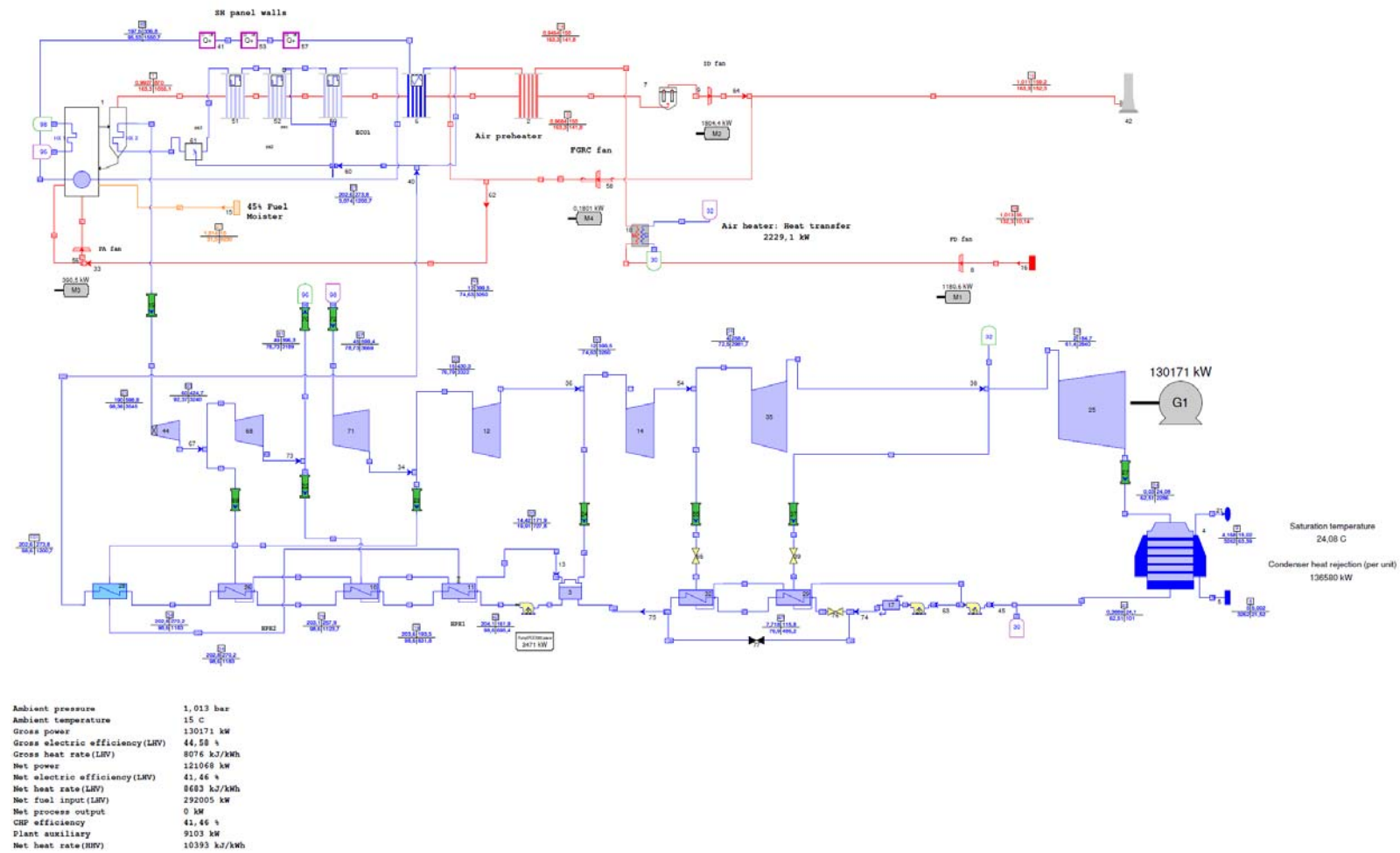
Appendix 20 LV9.2 100MWe Virgin Biomass 140 bar 540 C Water Cooled Condenser OTC



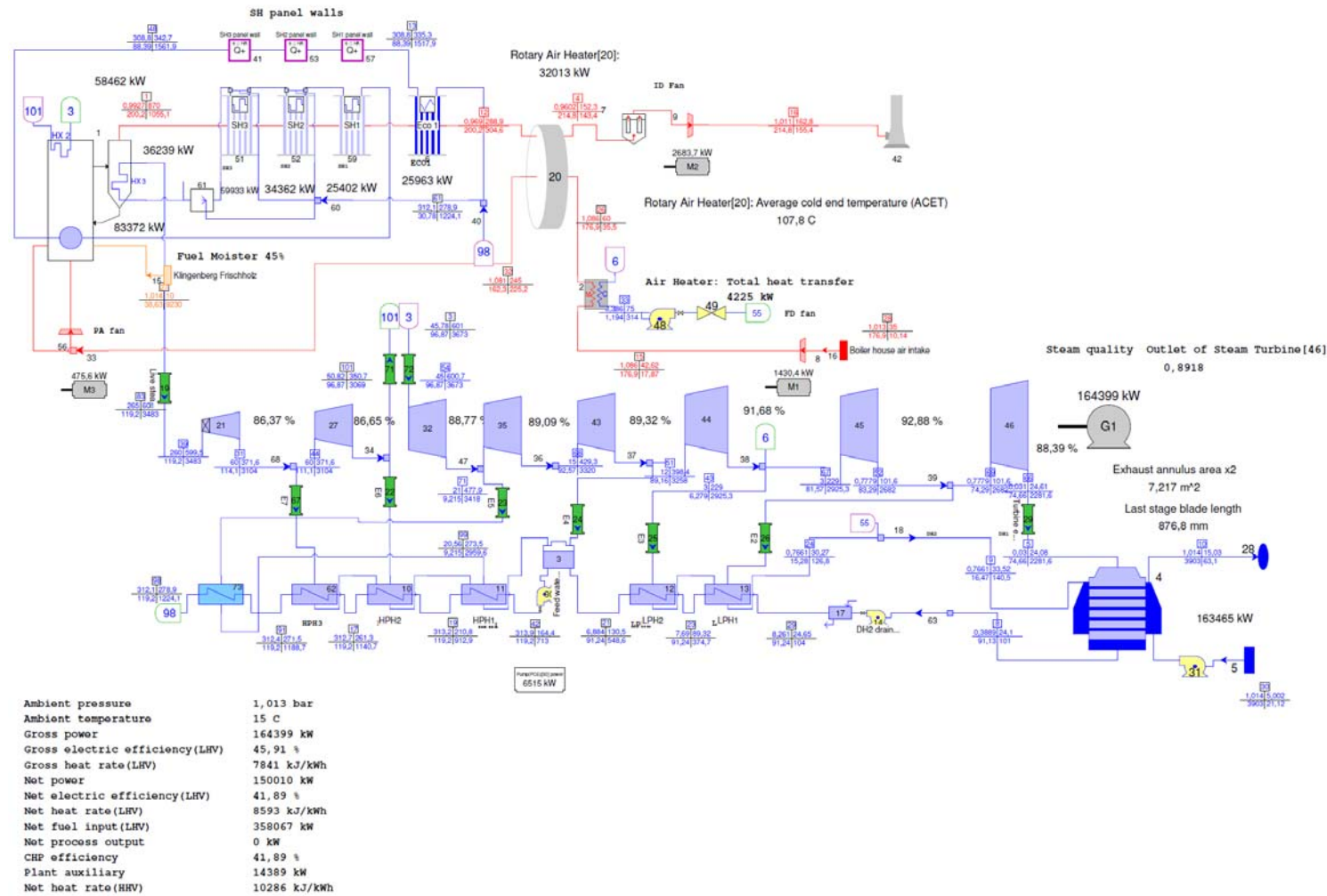
Appendix 21LV9.3.1 i 150MWe Virgin Biomass 140 bar 540C Water Cooled Condenser



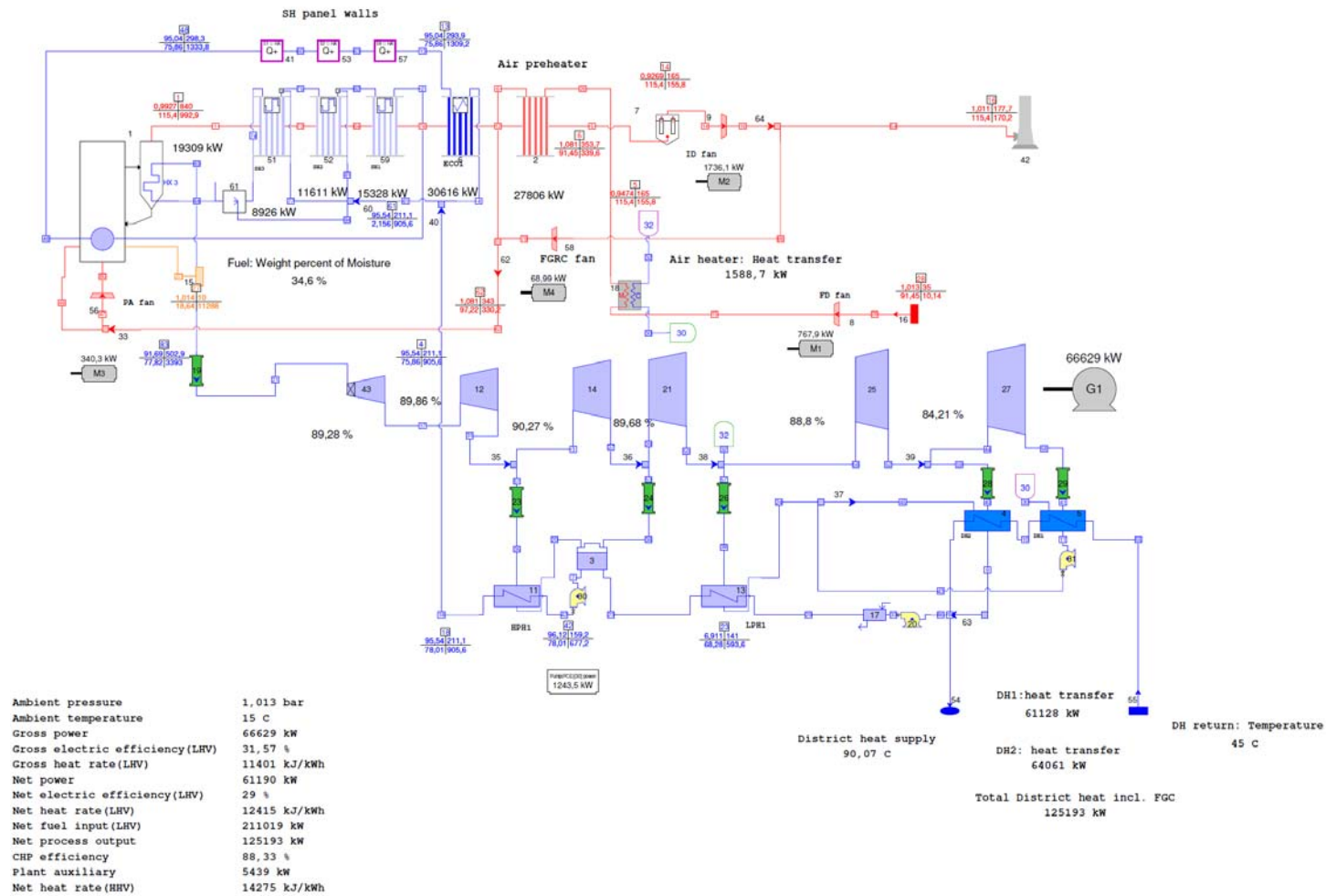
Appendix 22LV10 Net fuel input 292 MW 190 bar 600 C RH 45bar 600C Air Cooled Condenser



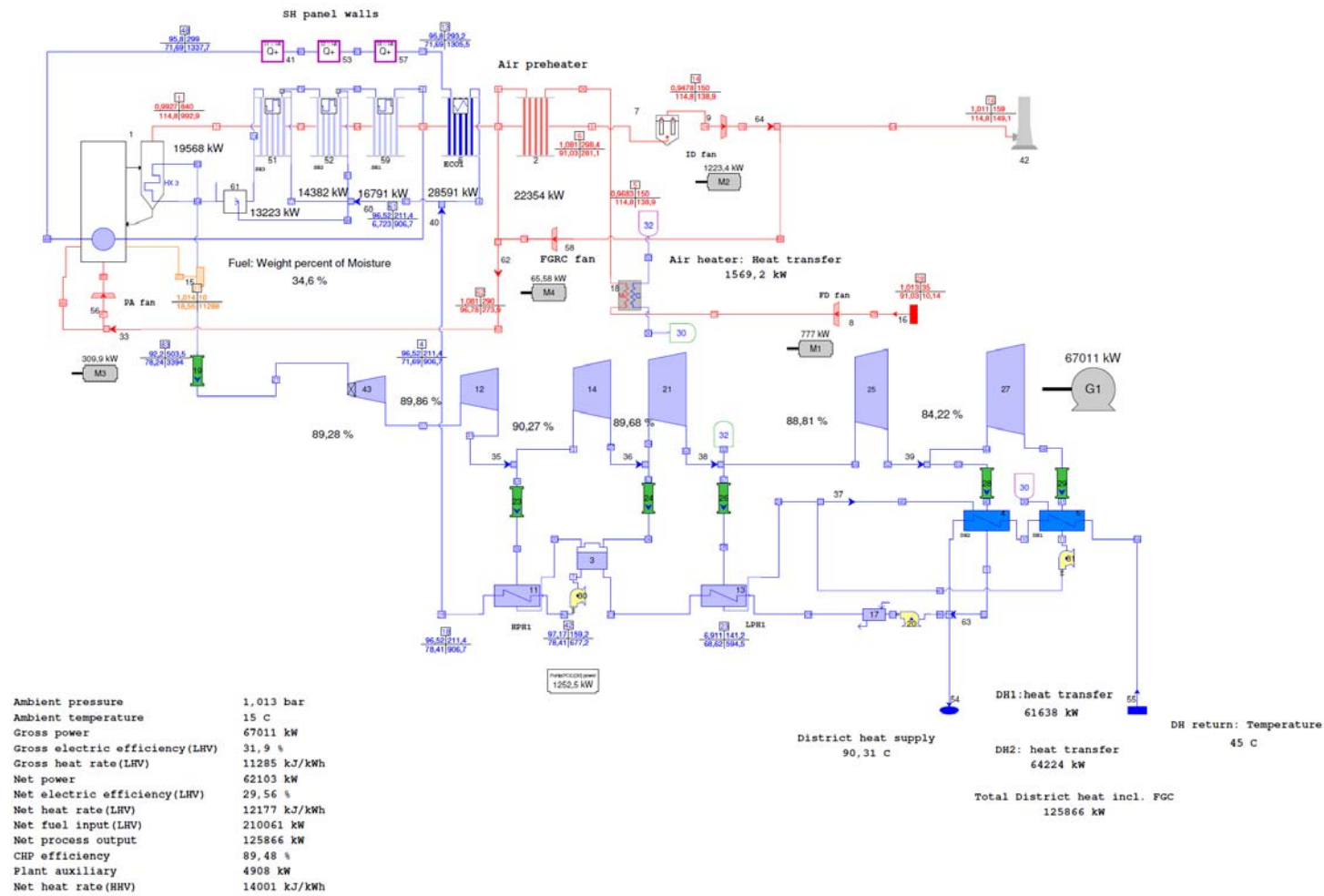
Appendix 23LV10.1.1 i Net fuel input 292 MW 190 bar 600 C RH 45bar 600C Water Cooled Condenser



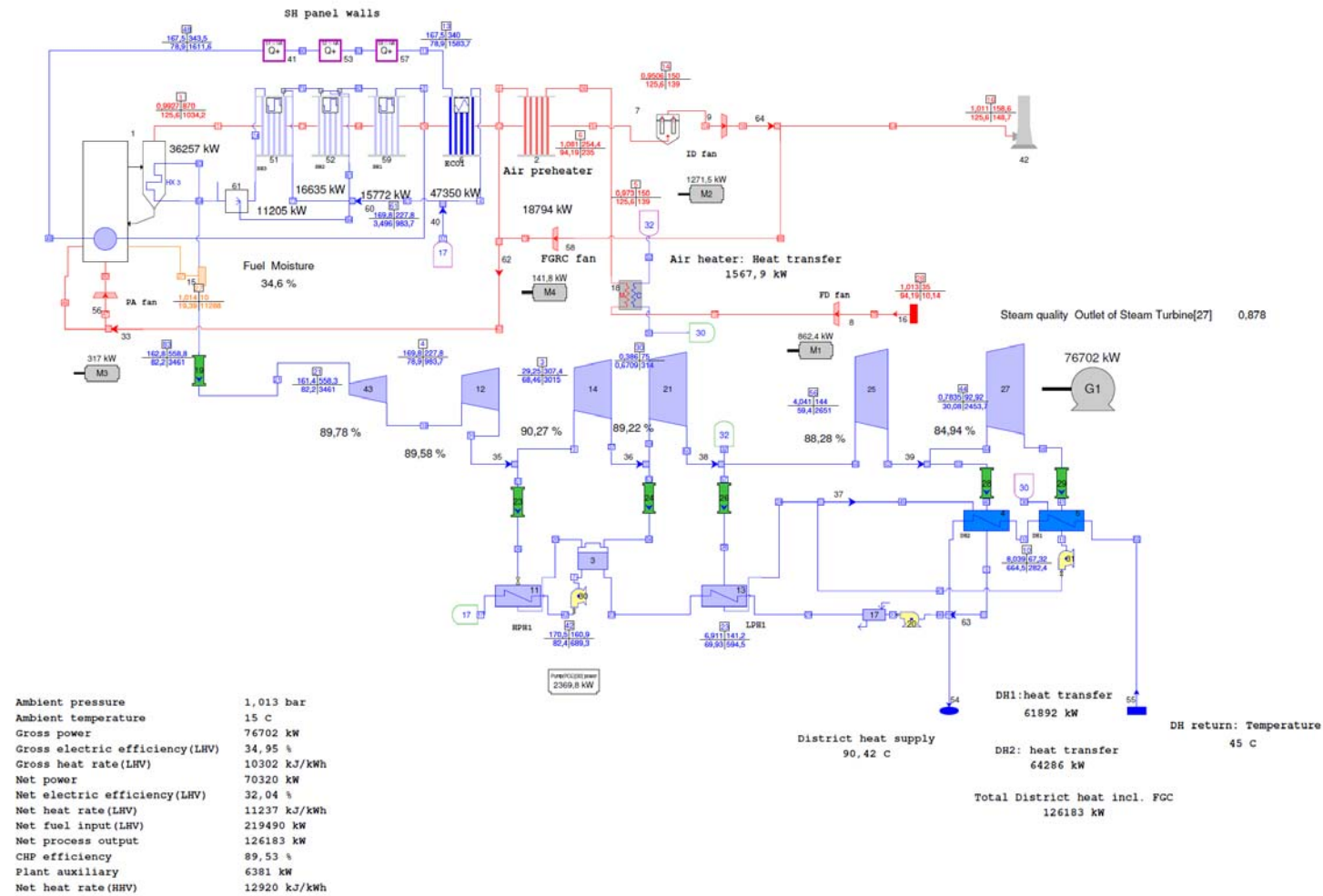
Appendix 24LV12.4.2 i 150 MWe 260 bar 600 C RH 45bar 600C Water Cooled Condenser



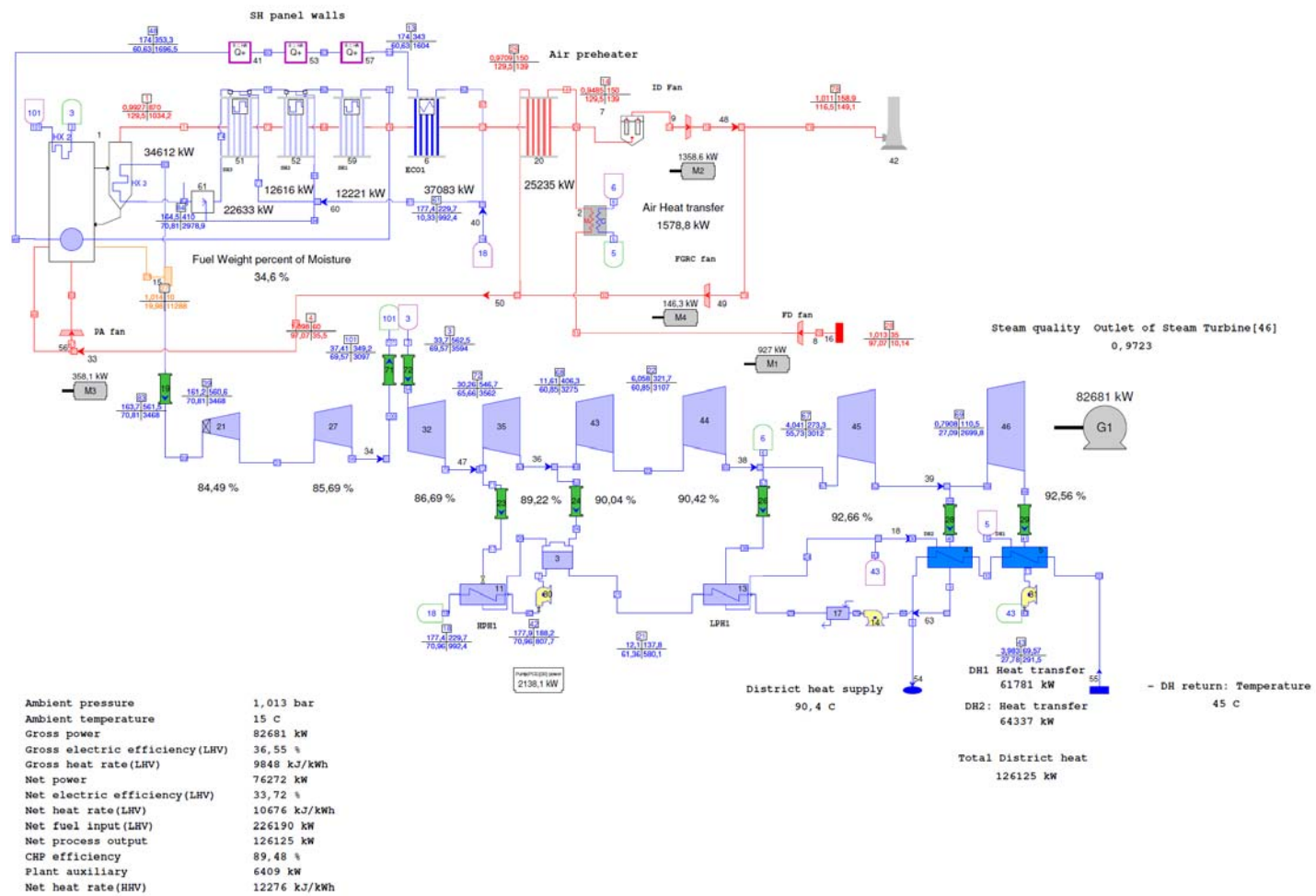
Appendix 25 IW0 Benchmark 125 MW DH Wide range fuel 90bar 500CFGT 165C (420C convective steam temperature)



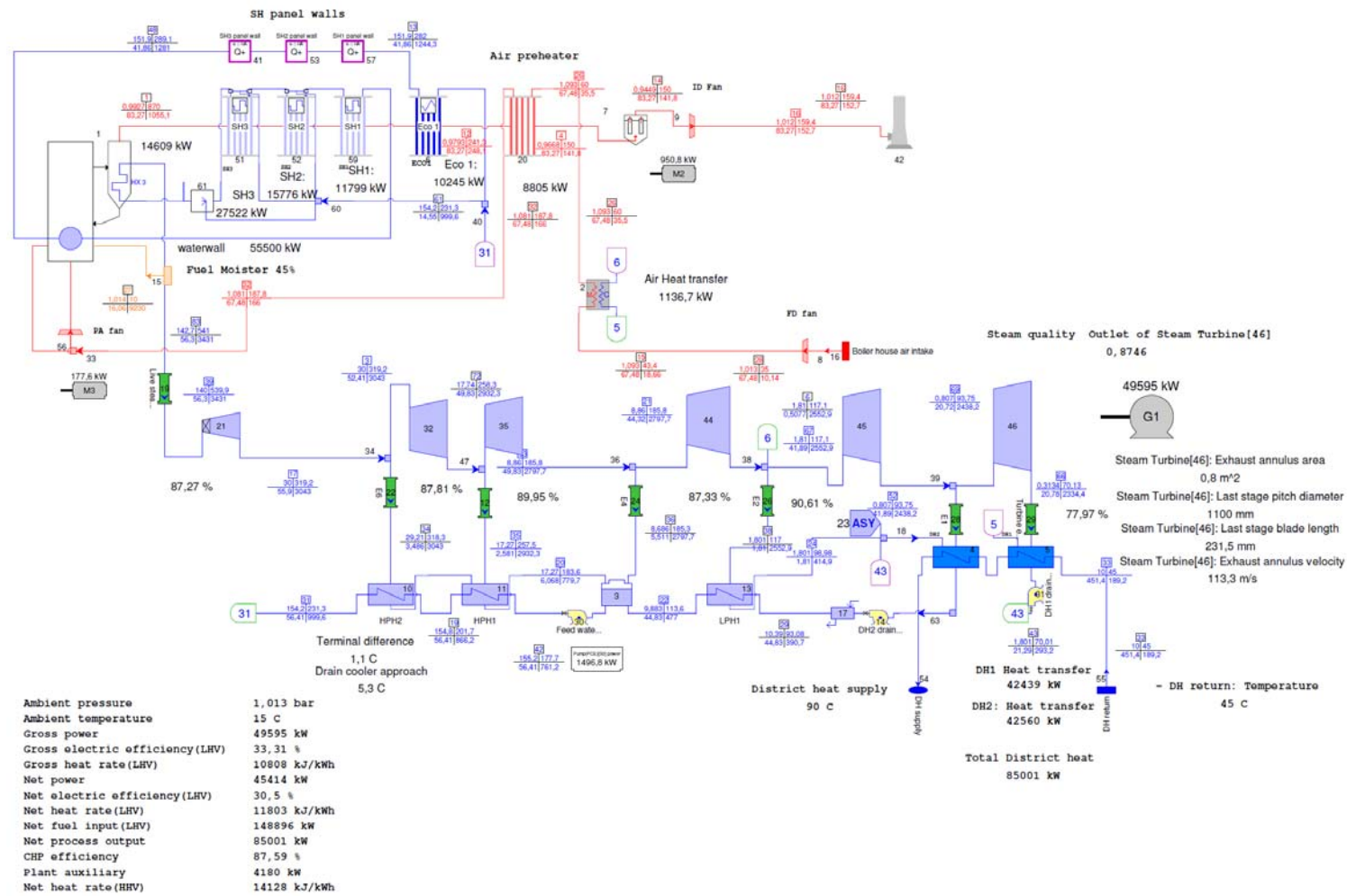
Appendix 26 IW0.1 Benchmark 125 MW DH Wide range fuel 90bar 500C FGT 150C (480C convective steam temperature)



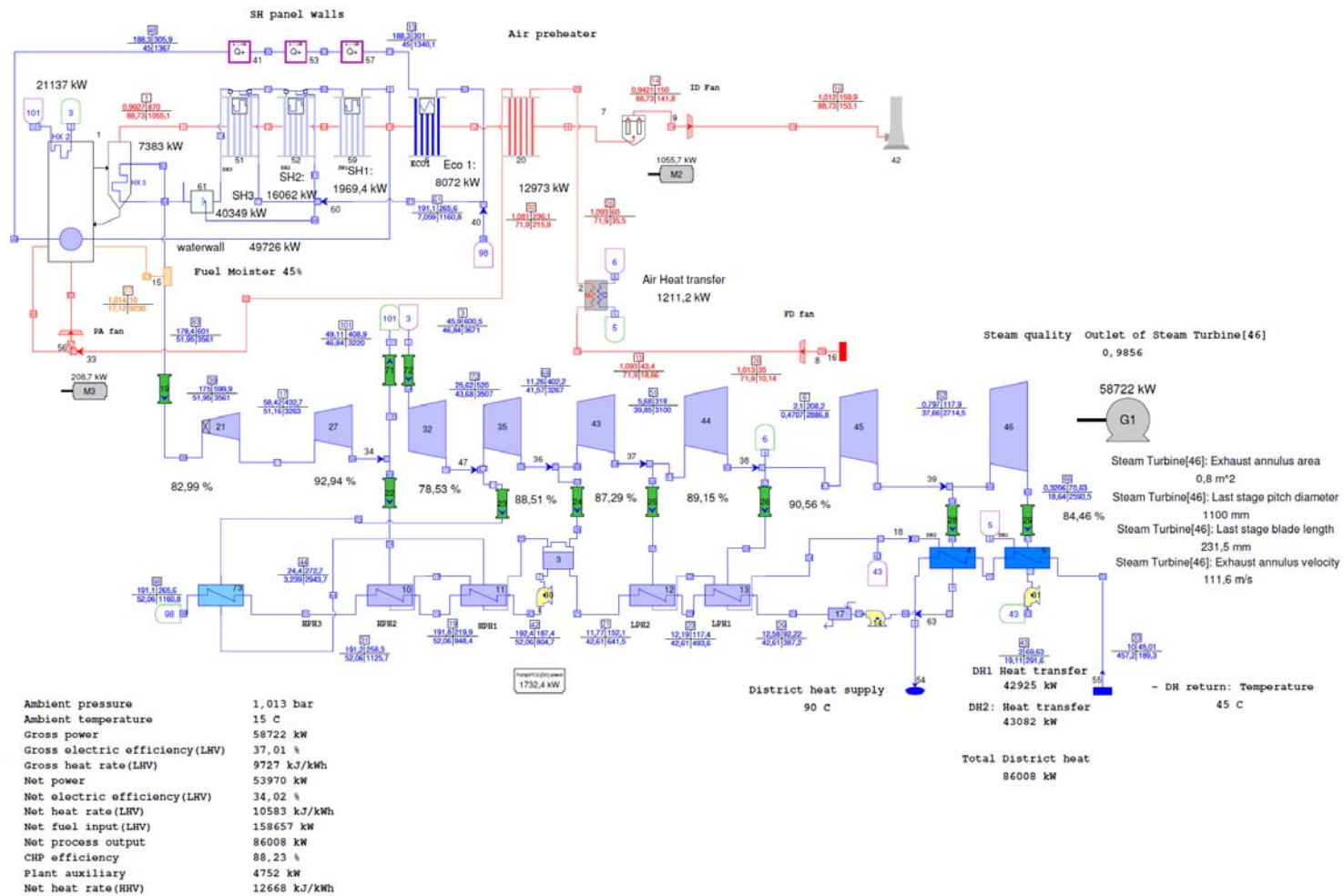
Appendix 27 IW1.2 i 125 MW DH Wide fuel 160bar 560C



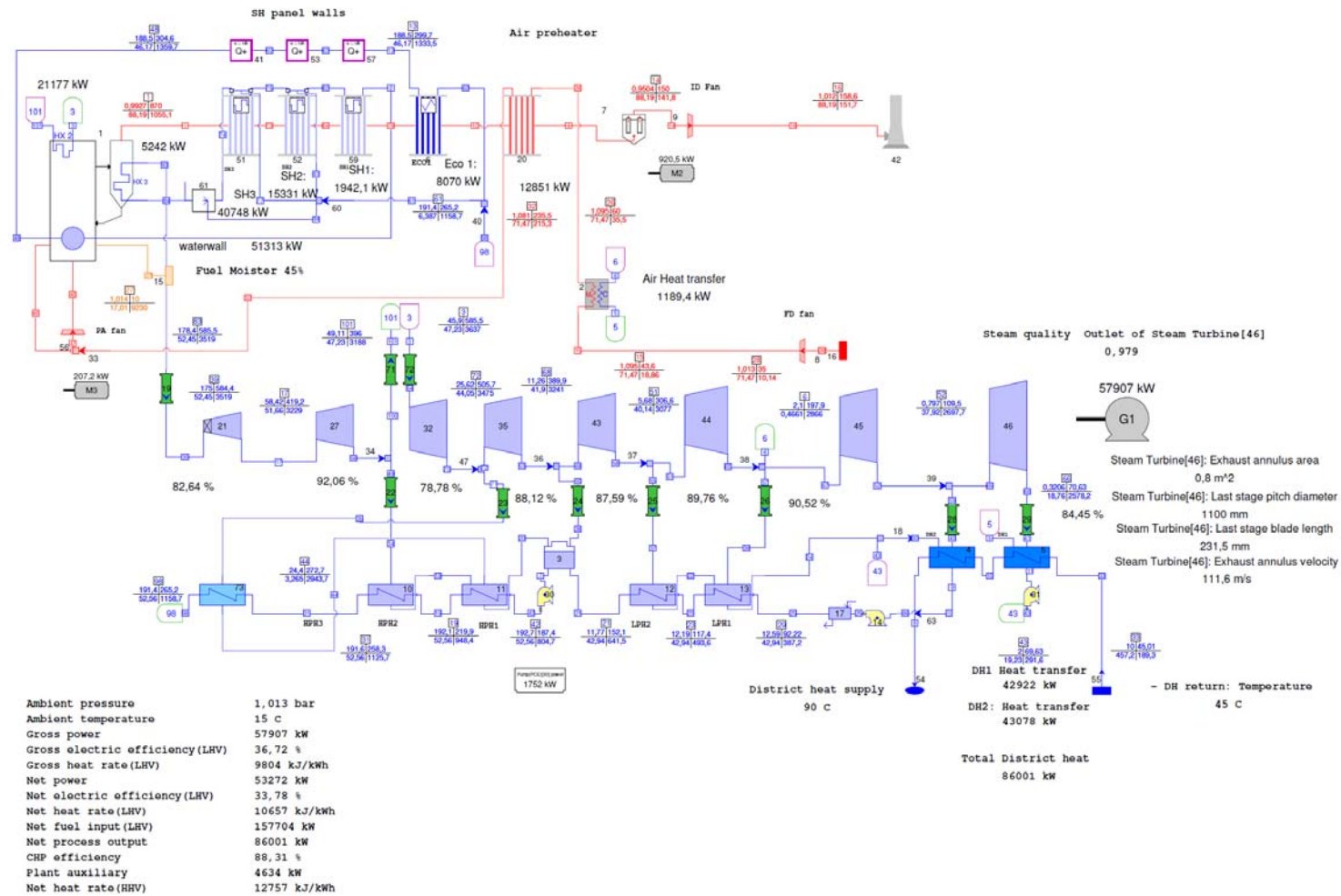
Appendix 28 IW6.2.1 125 MW DH Wide fuel 160bar 560C Reheat 33 bar 560C



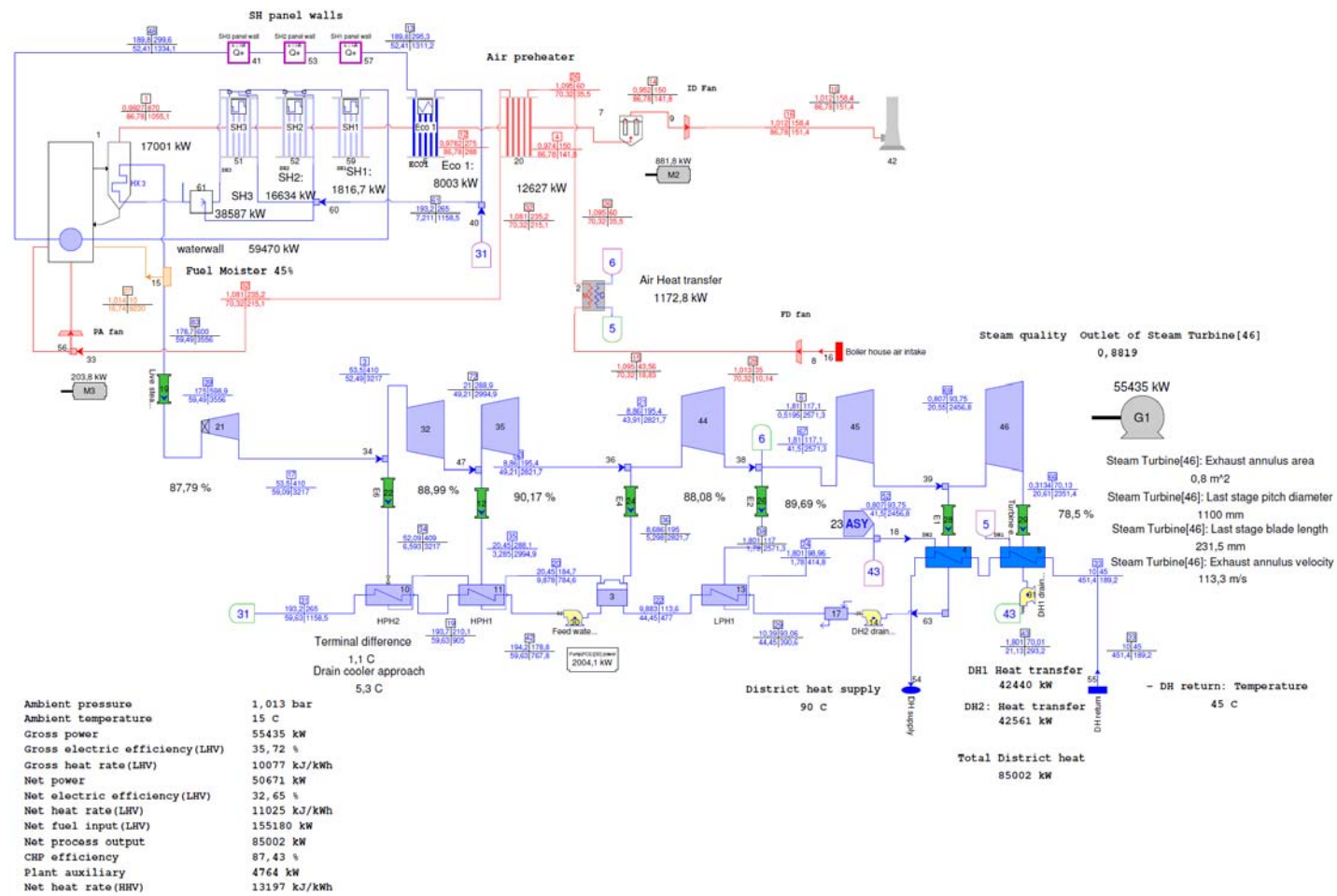
Appendix 29MV0 i Benchmark 50MWe Virgin Biomass 140bar 540C FW 230C



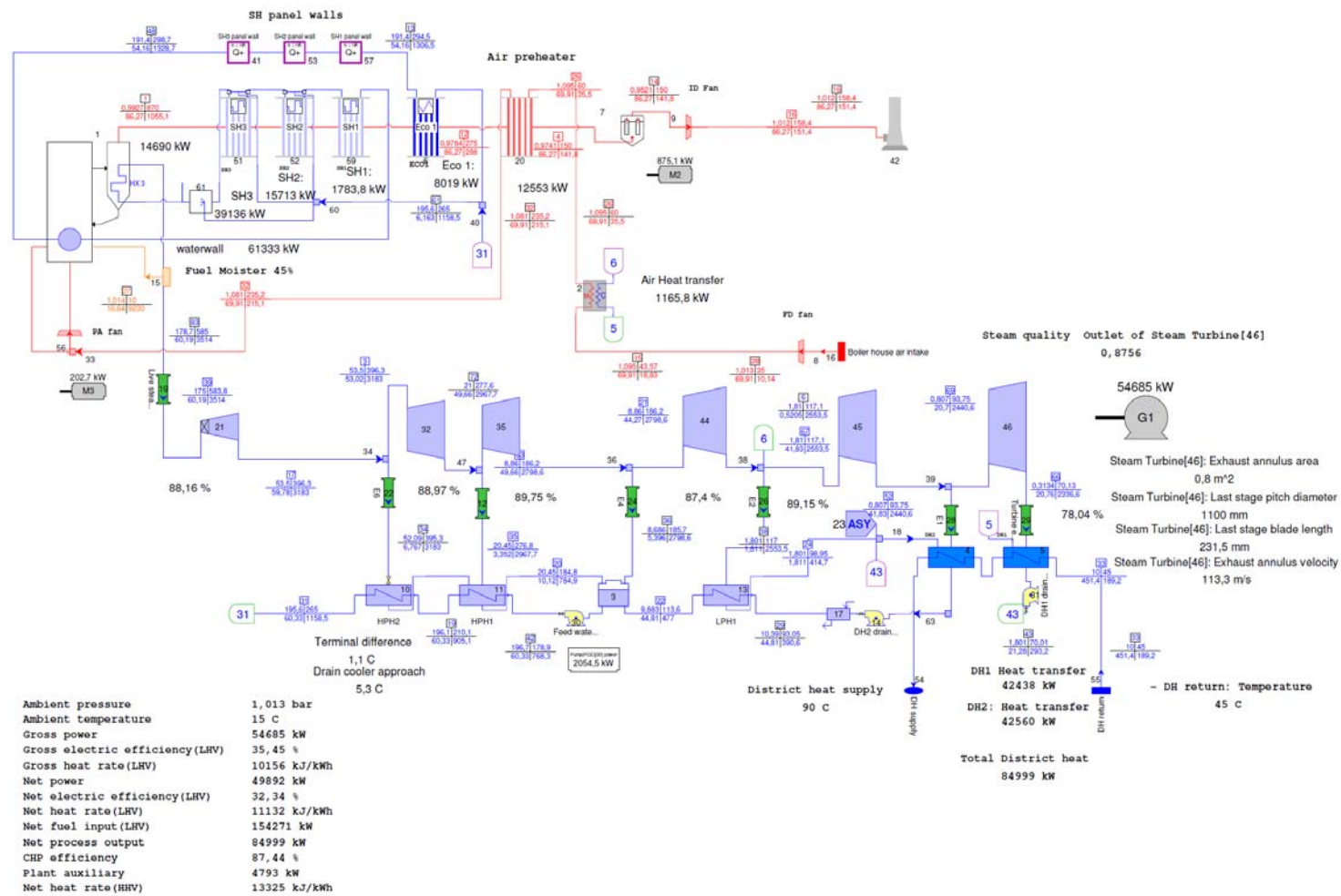
Appendix 30MV3 i 50MWe Virgin Biomass 175bar 600C RH 45bar 600C FW 265C



Appendix 31 MV4 50MWe Virgin Biomass 175bar 585C RH 45bar 585C FW 265C

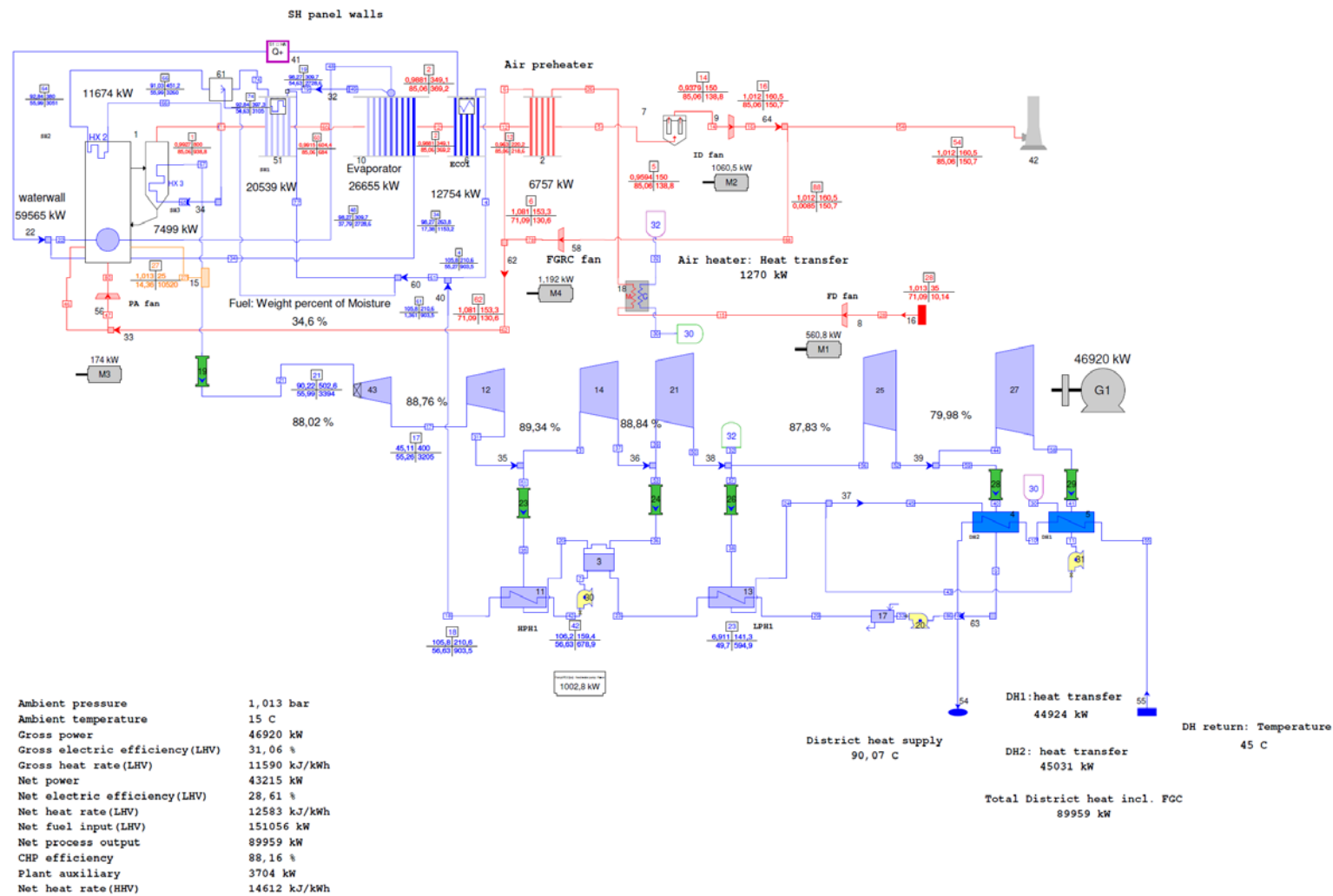


Appendix 32 MV5 50MWe Virgin Biomass 175bar 600C FW 265C



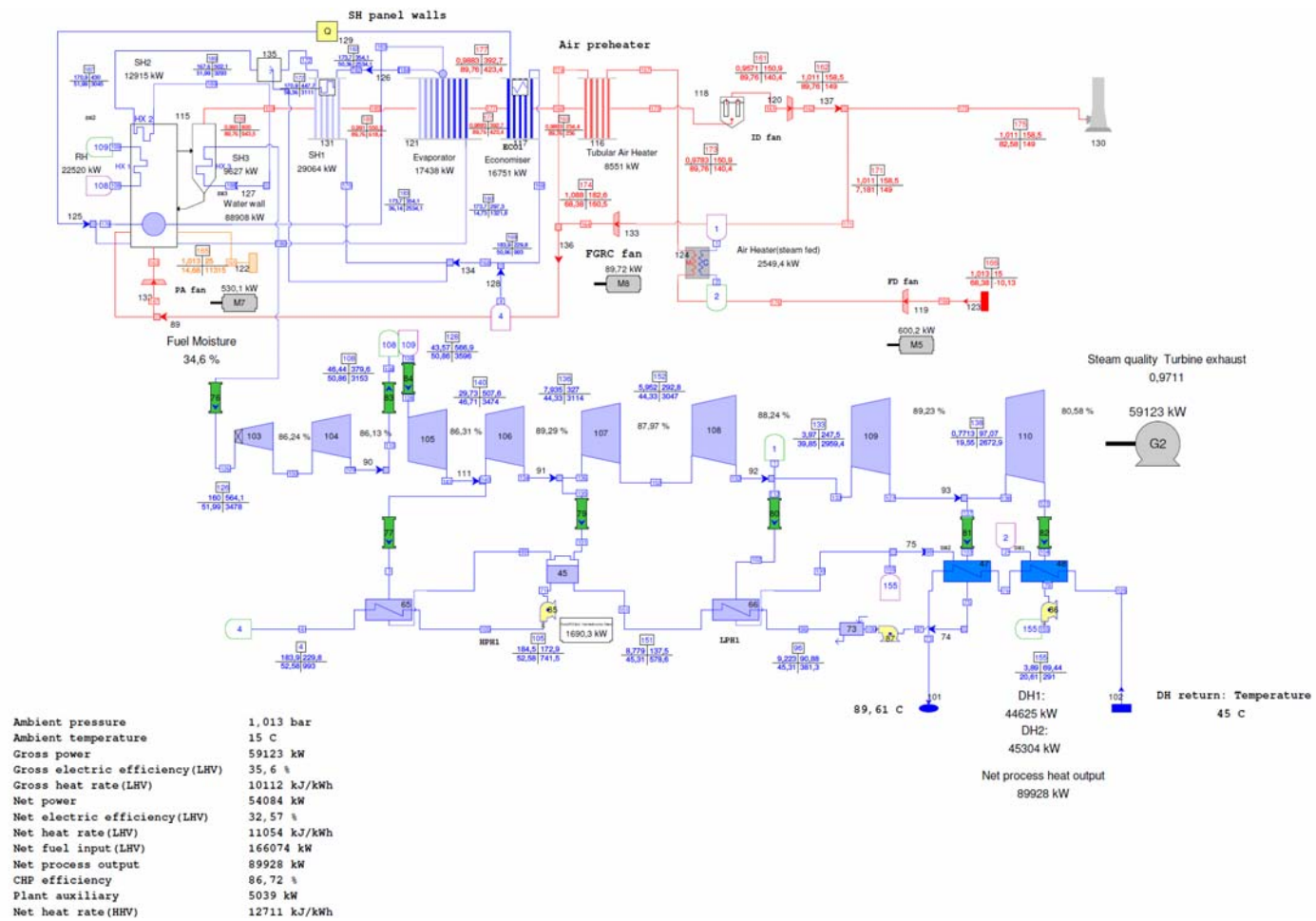
Appendix 33 MV6 50MWe Virgin Biomass 175bar 585C FW 265C



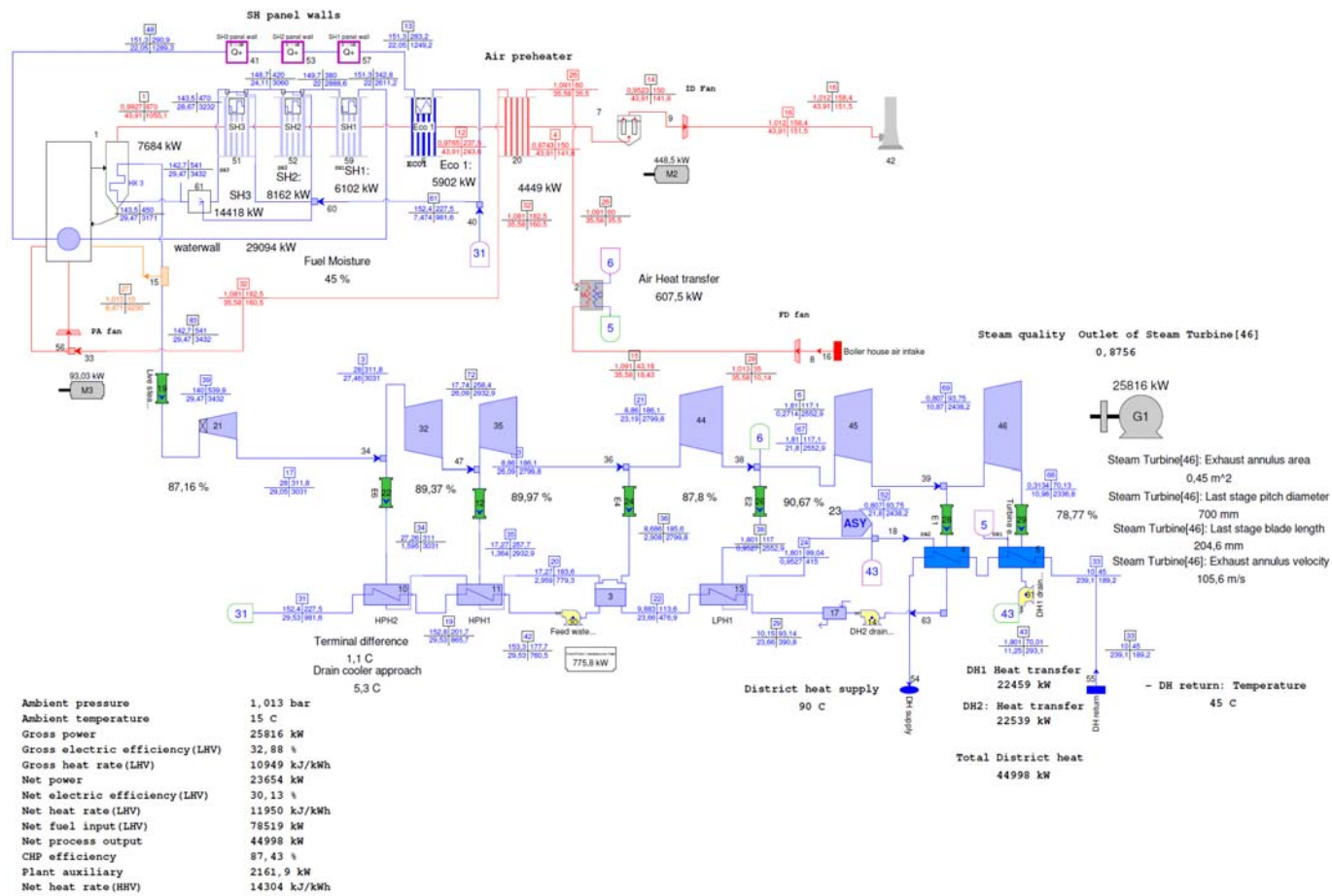


Appendix 35 MW0.2 50MWe Wide fuel range 90bar 500C FW 230C

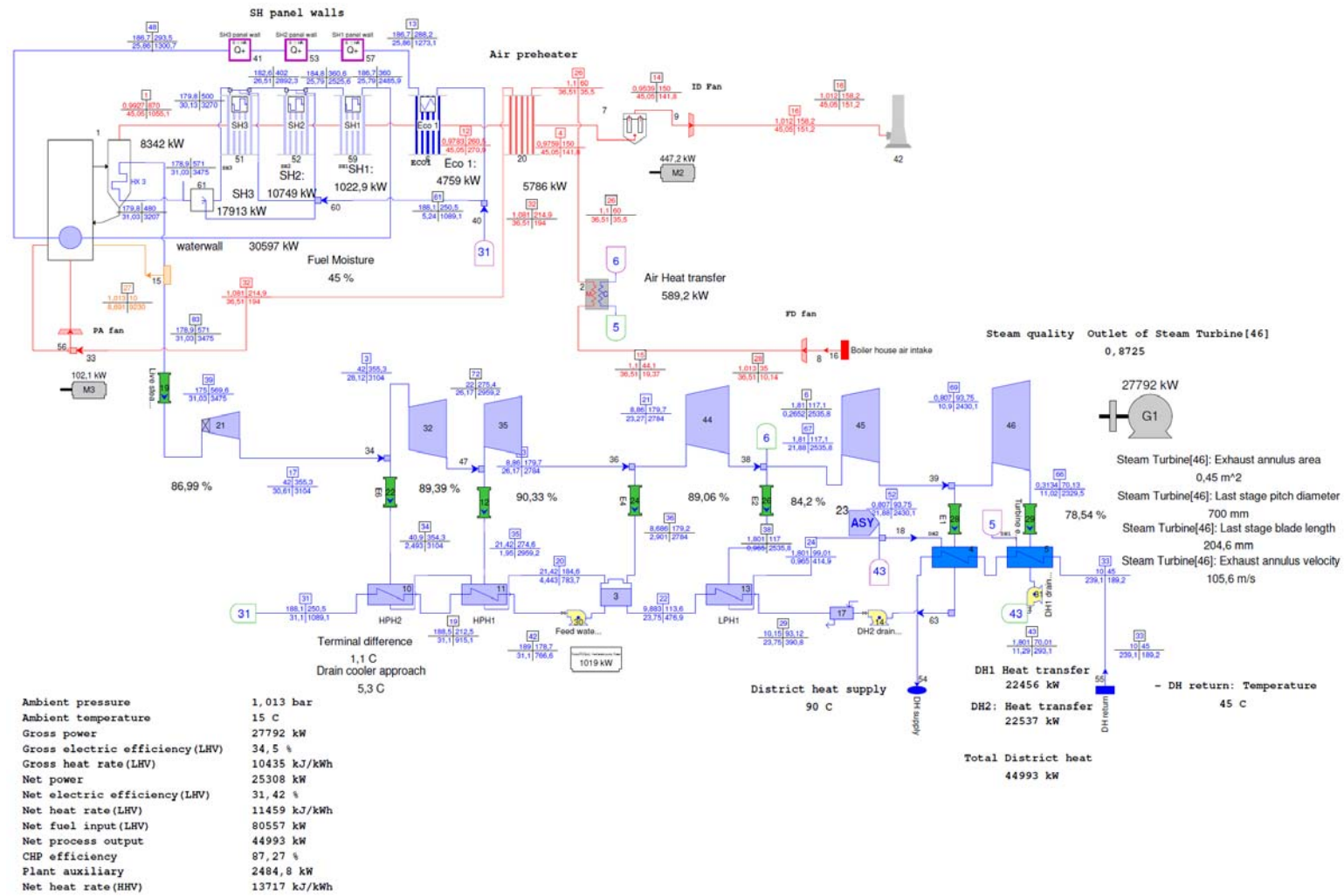




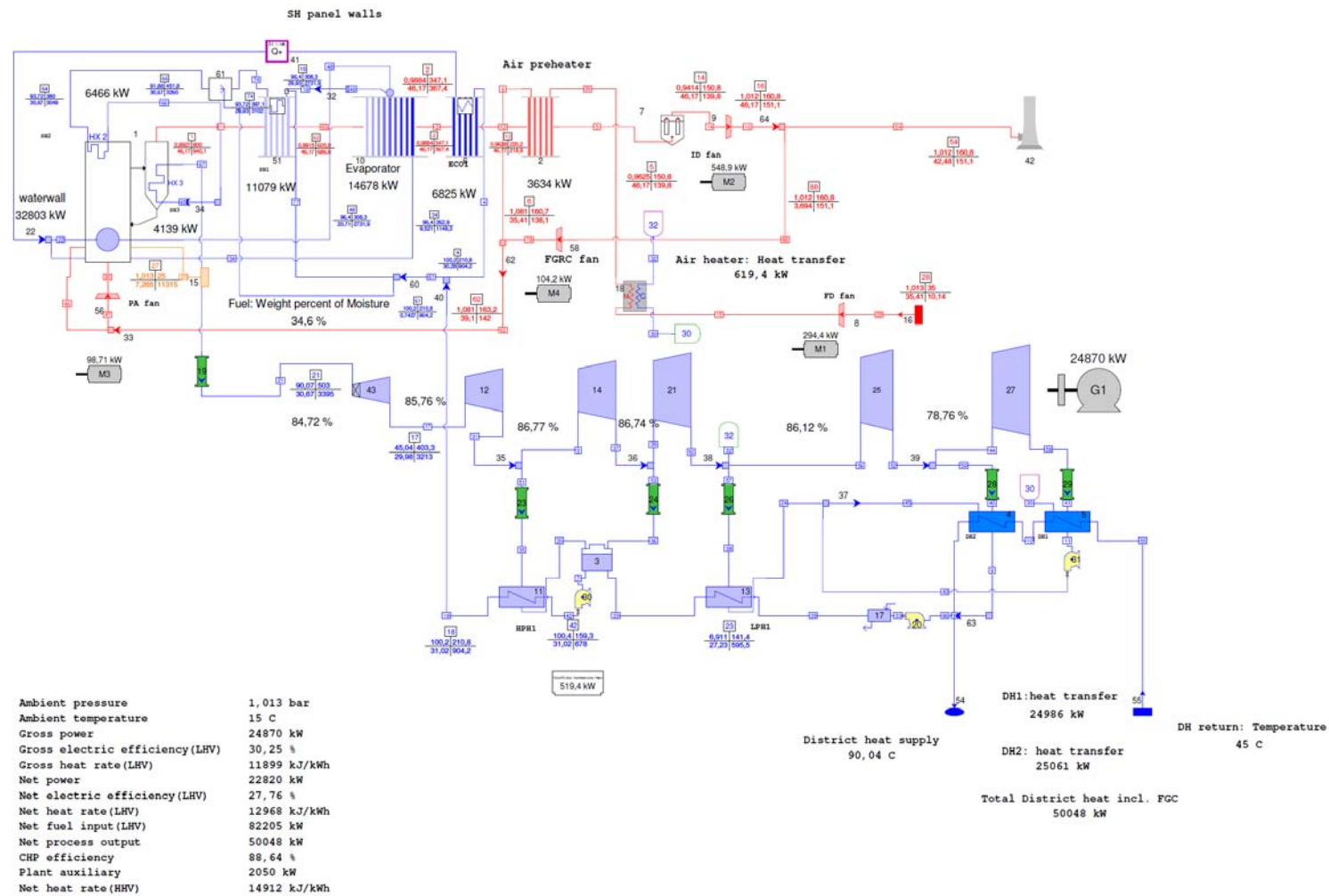
Appendix 37 MW6.2.3 50MWe Wide fuel range 160bar 560C RH 46bar FW 230C



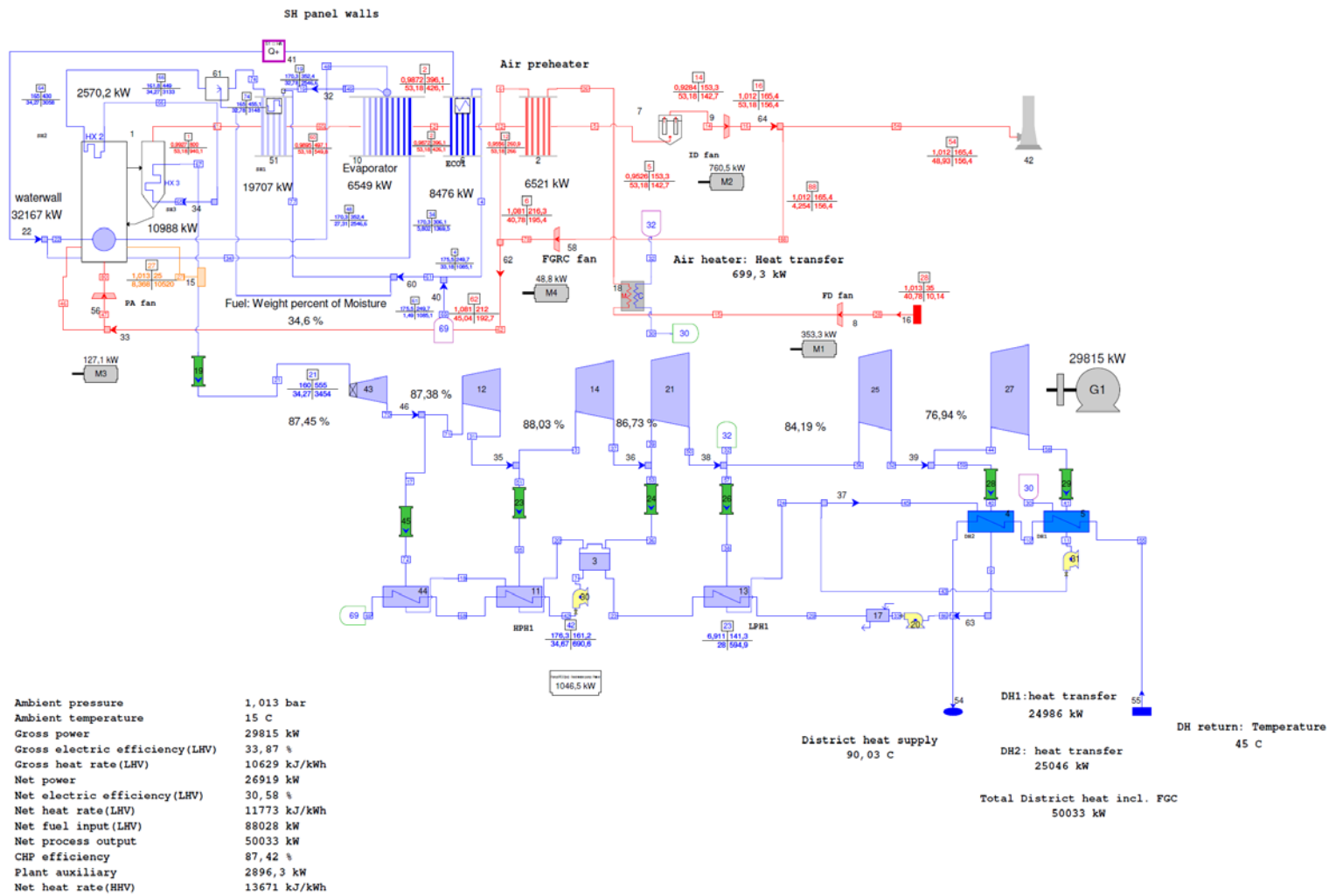
Appendix 38 SV0 25MWe Virgin fuels 140bar 540 FW 227C



Appendix 39 SV1 25MWe Virgin fuels 175bar 570 FW 250C



Appendix 40 SW0 25MWe Wide range fuels 90bar 500 FW 210C



Appendix 41 SW1 25MWe Wide range fuels 160bar 560 FW 250C

02 Delivery Limits and Scope of Supply, Boiler plant

1/16

Revision **1**Project name **KME RPP-0 Base Case**

Doc. ID

Project ID **100 MWe Virgin fuel**

Mikko Lehtiniemi

14.10.2011

Preliminary for pricing

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1 DELIVERY LIMITS AND SCOPE OF SUPPLY

1.1 Delivery limits

1.1.1 Mechanical and process

For the in- and outgoing pipes and ducts the general delivery limit at the boiler house wall is one (1) meter outside of the boiler house wall column line at the pipe bridge elevation of four (4) meters.

For the pipes and ducts ending to the roof the delivery limit is three (3) meters above the roof.

For drains to sewers/effluent canals etc. the delivery limit is ground floor + 0.000 m in the boiler house.

The piping connections on the delivery limits are not included in the scope.

1.1.1.1 Inlets

	Value
Feedwater	One (1) meter outside the boiler house wall column line
Demineralised water	One (1) meter outside the boiler house wall column line
Condensate	One (1) meter outside the boiler house wall column line
Biofuel	Fuel silo inlet above the silo
Combustion air	Inlets of suction duct(s) in the boiler building
Make-up sand	inlet of silo pneumatic filling pipe
Ammonia solution	Inlet of storage tank filling pipe
Light fuel oil	Inlet of day tank
Ignition gas	Gas bottle outlets at the boiler house wall. Bottles are not included
Medium pressure steam	One (1) meter outside the boiler house wall column line MP steam to HP preheaters not in Metso's scope
Low pressure steam	One (1) meter outside the boiler house wall column line
Cooling water	One (1) meter outside the boiler house wall column line
Fire water	One (1) meter outside the boiler house wall column line
Chemical dosing	The filling connection of the chemical tanks
Potable water	One (1) meter outside the boiler house wall column line
Sealing water	One (1) meter outside the boiler house wall column line
Instrument air	One (1) meter outside the boiler house wall column line
Pressurized air	One (1) meter outside the boiler house wall column line
Glycol-water mixture in	One (1) meter outside the boiler house wall column line

02 Delivery Limits and Scope of Supply, Boiler plant

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Project name **KME RPP-0 Base Case**
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14.10.2011
Preliminary for pricing

1.1.1.2 Outlets

	Value
Main steam	Main steam stop valve
Sampling	at the inlet of sewer connection
Boiler vents	Outlet of vent steam pipe on the roof
Boiler drains	Blowdown tank drain pipe, at the inlet of sewer connection
Start-up valves	Silencer outlet
Main steam safety valves	Silencer outlet
Sootblowing steam safety valve	Silencer outlet
Cooling water	Return piping at 1 m outside boiler house wall column line
Steam condensates	One (1) meter outside the boiler house wall column line Condensate from HP preheaters: at feedwater tank
Flue gas	Stack outlet
Fly ash	Discharging equipment of fly ash silo
Bottom ash	Bottom ash containers
Light fuel oil return	One (1) meter outside the boiler house wall column line
Glycol-water mixture out	One (1) meter outside the boiler house wall column line

1.2 Scope of supply

1.2.1 CYMIC boiler

Explanation for the abbreviations used in the following table:

M = Metso, C = Customer, O = Option (Metso), NA= Not applicable

Scope of Supply	Process design	Basic eng.	Detail eng.	Supply	Erection	Note:
BOILER						
Furnace	M	M	M	M	M	
Cyclones and loopseals	M	M	M	M	M	2 pcs
Primary Superheater	M	M	M	M	M	
Secondary Superheater	M	M	M	M	M	
Tertiary Superheater	M	M	M	M	M	
Reheater	NA	NA	NA	NA	NA	
Boiler bank	NA	NA	NA	NA	NA	
Empty pass	NA	NA	NA	NA	NA	
Steam drum with internals	M	M	M	M	M	

02 Delivery Limits and Scope of Supply, Boiler plant

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Revision **1**

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Scope of Supply	Process design	Basic eng.	Detail eng.	Supply	Erection	Note:
Circulation and connection pipes	M	M	M	M	M	
Spray water attemperators	M	M	M	M	M	2 phases
Spray water piping, valves	M	M	M	M	M	
Economizers	M	M	M	M	M	
Maintenance roof openings	M	M	M	M	M	
Beams and aluminum planks for maintenance roof	C	C	C	C	C	
MAIN STEAM						
Steam pipe to boiler house wall line	M	M	M	M	M	
Steam pipe outside boiler house wall line	C	C	C	C	C	
BOILER ACCESSORIES						
Mains steam stop valve	M	M	M	M	M	
Main steam safety valves	M	M	M	M	M	
Safety valve control unit with impulse connection from drum	M	M	M	M	M	
Start-up valves	M	M	M	M	M	
Sootblowing steam safety valve						
Exhaust piping and silencer for main steam safety valve, start up valve and sootblowing safety valve	M	M	M	M	M	
Main steam reduction valve station	C	C	C	C	C	
Continuous blow down tank	M	M	M	M	M	
Continuous blow down piping	M	M	M	M	M	
Continuous blow down heat exchanger	M	M	M	M	M	
Blow down tank	M	M	M	M	M	
Boiler drain and vent piping	M	M	M	M	M	
FEED WATER SYSTEM						
Feed water tank	M	M	M	M	M	
Deaerator	M	M	M	M	M	
Vent steam condenser	M	M	M	M	M	
Feed water pumps, electric motor driven	M	M	M	M	M	3*50%
Feed water pumps, diesel for emergency cooling	M	M	M	M	M	
Feed water piping and valves	M	M	M	M	M	
HP preheater with valves	C	C	C	C	C	
HP preheater with piping inside boiler house	C	M	M	M	M	
FUEL FEEDING SYSTEM						

02 Delivery Limits and Scope of Supply, Boiler plant

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Doc. ID

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14.10.2011

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Scope of Supply	Process design	Basic eng.	Detail eng.	Supply	Erection	Note:
Fuel storage and handling system (including receiving, conveying, sieving, crushing) up to the boiler fuel silo(s)	C	C	C	C	C	
Fuel feeding system, biofuel						
Silo	M	M	M	M	M	
Silo reclaimer	M	M	M	M	M	
Mixing screw	M	M	M	M	M	
Drag chain conveyor	M	M	M	M	M	
Balancing pocket(s)	M	M	M	M	M	
Metering screws	M	M	M	M	M	
Rotary valve feeders	M	M	M	M	M	
Fuel feeding wall screws to furnace	NA	NA	NA	NA	NA	
Fuel feeding system, RDF/REF						
Silo	NA	NA	NA	NA	NA	
Silo reclaimer	NA	NA	NA	NA	NA	
Dosing feeders	NA	NA	NA	NA	NA	
Rotary valve feeders	NA	NA	NA	NA	NA	
Fuel feeding chutes to furnace	NA	NA	NA	NA	NA	
Underpressure system for RDF/REF	NA	NA	NA	NA	NA	
MAKE-UP SAND SYSTEM						
Sand silo	M	M	M	M	M	
Sand silo filling pipe	M	M	M	M	M	
Sand feeding screw	M	M	M	M	M	
Sand feeding pipe	M	M	M	M	M	
LIMESTONE FEEDING SYSTEM						
Limestone silo	NA	NA	NA	NA	NA	
Limestone feeder	NA	NA	NA	NA	NA	
Limestone feeding blower	NA	NA	NA	NA	NA	
Limestone feeding pipes	NA	NA	NA	NA	NA	
AUXILIARY FIRING						
Start-up burners						
Start-up burners	M	M	M	M	M	2 pcs
Burner valve groups	M	M	M	M	M	
Aux. fuel piping	M	M	M	M	M	

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Atomizing steam/air piping	M	M	M	M	M	
Load burners						
Load burners	NA	NA	NA	NA	NA	
Burner valve groups	NA	NA	NA	NA	NA	
Aux. fuel piping	NA	NA	NA	NA	NA	
Atomizing steam/air piping	NA	NA	NA	NA	NA	
Heavy fuel oil system						
Heavy oil tank	NA	NA	NA	NA	NA	
Heavy oil pumping and heating	NA	NA	NA	NA	NA	
Suction filters	NA	NA	NA	NA	NA	
Heavy oil pumps	NA	NA	NA	NA	NA	
Steam oil heater	NA	NA	NA	NA	NA	
Electric oil heater	NA	NA	NA	NA	NA	
Heavy fuel oil piping	NA	NA	NA	NA	NA	
Light fuel oil system						
Light oil tank	M	M	M	M	M	
Light oil pump	M	M	M	M	M	
Light oil suction filters	M	M	M	M	M	
Light oil piping	M	M	M	M	M	
Natural gas system						
Natural gas reduction station	NA	NA	NA	NA	NA	
Natural gas piping inside the delivery limits	NA	NA	NA	NA	NA	
Ignition gas						
Ignition gas bottle rack / storage	C	C	C	C	C	
Ignition gas piping	M	M	M	M	M	
COMBUSTION AIR						
Suction duct with silencers and control dampers	M	M	M	M	M	Inside the boiler house
Primary air						
Primary air fan	M	M	M	M	M	
Primary air SCAH (Steam coil air preheater)	M	M	M	M	M	
Primary air FGAH (Flue gas air preheater)	M	M	M	M	M	
Primary air ducting	M	M	M	M	M	
Primary air nozzles	M	M	M	M	M	

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Secondary air/Overfire air						
Secondary air fan	M	M	M	M	M	
Secondary air SCAH	M	M	M	M	M	
Secondary air FGAH	M	M	M	M	M	
Secondary air ducting	M	M	M	M	M	
Secondary air nozzles	M	M	M	M	M	
Loopseal air						
Loop seal fan	M	M	M	M	M	
Sound attenuation hoods for loopseal air blowers	M	M	M	M	M	
Loopseal air ducting	M	M	M	M	M	
Loopseal air nozzles	M	M	M	M	M	
FLUE GAS						
Flue gas ducting	M	M	M	M	M	
Fly ash pre-separator	NA	NA	NA	NA	NA	
Bag house filter	M	M	M	M	M	
ID fan(s)	M	M	M	M	M	2 pcs
Recirculation gas fan	NA	NA	NA	NA	NA	
Recirculation gas duct, dampers and accessories	NA	NA	NA	NA	NA	
Recirculation gas nozzles	NA	NA	NA	NA	NA	
Flue gas dampers	M	M	M	M	M	
Flue gas duct silencer	M	M	M	M	M	
Stack	M	M	M	M	M	
FLUE GAS TREATMENT SYSTEM						
Ammonia injection system						
Ammonia storage tank	M	M	M	M	M	
Ammonia unloading pump to tank	M	M	M	M	M	
Ammonia feeding pump	M	M	M	M	M	
Ammonia piping with valves	M	M	M	M	M	
Ammonia nozzles	M	M	M	M	M	
Emergency showers	M	M	M	M	M	
Ca(OH) ₂ /NaCO ₃ injection system including storage tank and injection system into flue gas duct before bag house filter	NA	NA	NA	NA	NA	
Activated carbon injection system including storage tank and injection system into flue gas duct before	NA	NA	NA	NA	NA	

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bag house filter						
Flue gas scrubber including heat recovery system	NA	NA	NA	NA	NA	
SOOTBLOWING						
Sootblowers	M	M	M	M	M	
Sootblower supports	M	M	M	M	M	
Steam and condensate piping	M	M	M	M	M	
ASH HANDLING SYSTEM						
Coarse material removal system						
Bottom ash chutes	M	M	M	M	M	
Shut off gates	M	M	M	M	M	
Water cooled screw conveyors	M	M	M	M	M	
Bottom ash conveyor	M	M	M	M	M	
Bottom ash containers	M	M	M	M	M	
Bottom ash recycling system						
Bottom ash magnet separator	NA	NA	NA	NA	NA	
Bottom ash screen	M	M	M	M	M	
Recirculated sand pneumatic transmitter	M	M	M	M	M	
Buffer silo and rotary feeder for recirculated sand	NA	NA	NA	NA	NA	
Recirculated sand pneumatic conveying pipe to furnace	M	M	M	M	M	
Boiler ash handling system						
Empty pass ash handling system	NA	NA	NA	NA	NA	
Loopseal ash handling system	M	M	M	M	M	
Fly ash pre-separator (multicyclone/ESP) ash handling system	NA	NA	NA	NA	NA	
Boiler ash silo	NA	NA	NA	NA	NA	To fly ash silo
Dry unloading system	NA	NA	NA	NA	NA	
Wet unloading system	NA	NA	NA	NA	NA	
Fly ash handling system						
Drag chain conveyor for 2 nd pass ash	M	M	M	M	M	
Fly ash pneumatic transmitters	M	M	M	M	M	
Fly ash silo	M	M	M	M	M	
Dry unloading system	M	M	M	M	M	
Wet unloading system	M	M	M	M	M	

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AUXILIARY SYSTEMS						
Sampling						
Sample station with coolers	M	M	M	M	M	
Chemical dosing system						
Chemical dosing system with pumps and tanks	C	C	C	C	C	
Chemical dosing piping	M	M	M	M	M	
Cooling water system						
Plant cooling water piping	M	M	M	M	M	Inside boiler house
Closed cooling water tank	M	M	M	M	M	
Closed cooling water pump	M	M	M	M	M	
Closed cooling water heat exchanger	M	M	M	M	M	
Closed cooling water piping	M	M	M	M	M	
Auxiliary steam and condensate system						
Medium pressure steam piping (to HP preheaters)	M	M	M	M	M	Inside boiler house
Low pressure steam piping (to SCAHs and feedwater tank)	M	M	M	M	M	Inside boiler house
SCAH condensate tanks	M	M	M	M	M	
SCAH condensate pumps	M	M	M	M	M	
SCAH condensate piping	M	M	M	M	M	Inside boiler house
Instrument and pressurized air system						
Compressor unit for instrument air	C	C	C	C	C	
Compressor unit for pressurized air	C	C	C	C	C	
Pressurized air tank	C	C	C	C	C	
Instrument air tank	C	C	C	C	C	
Pressurized air piping with risers	M	M	M	M	M	Inside boiler house
Instrument air piping with risers	M	M	M	M	M	Inside boiler house
Water piping						
Fire water piping	M	M	M	M	M	Inside boiler house
Service water piping	M	M	M	M	M	Inside boiler house
Potable water piping	M	M	M	M	M	Inside boiler house (if any)

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CASING, REFRACTORY, INSULATION & LAGGING						
Boiler refractory	M	M	M	M	M	
Boiler insulation	M	M	M	M	M	
Boiler lagging	M	M	M	M	M	
Insulation of equipment, tanks, ducts and piping	M	M	M	M	M	
Lagging of equipment, tanks, ducts and piping	M	M	M	M	M	
SPARE PARTS						
Spare parts for two years operation	-	M	M	M		
Consumable parts for commissioning	-	M	M	M		
Electrical spare parts	-	C	C	C		
Instrument spare parts	-	C	C	C		
Consumable spare parts	-	C	C	C		

1.2.2 Electrification

Explanation for the abbreviations used in the following table:

M=Metso, C=Customer, O=Option(Metso), NA= Not applicable

Scope of Supply	Process design	Basic eng.	Detail eng.	Supply	Erection	Note:
Integral motors	-	M	M	M	M	
Standard low voltage (LV) motors	-	M	M	M	M	
Standard medium voltage (MV) motors	-	M	M	M	M	
Variable frequency drives	-	M	M	M	M	
LV distribution switchgears	-	M	M	M	M	
LV motor control centers	-	M	M	M	M	
LV busducts or cable systems from transformers to LV switchgears or MCCs	-	M	M	M	M	
MV to LV power distribution transformers (11 kV to 690 V)	-	M	M	M	M	
MV to LV power distribution transformers (11 kV to 400 V)	-	M	M	M	M	
MV distribution switchgears (11 kV)	-	M	M	M	M	Power distribution to the transformers needed for the boiler plant
MV motor control centers	-	NA	NA	NA	NA	
MV busducts or cable systems from transformers to MV switchgears or MCCs	-	C	C	C	C	
MV power distribution transformers (xx kV / 11 kV)	-	C	C	C	C	
Power factor compensation capacitors	-	M	M	M	M	
Harmonic filters	-	M	M	M	M	for the supplied frequency converters
UPS with batteries	-	M	M	M	M	
UPS distribution panels	-	M	M	M	M	
Emergency diesel generator		C	C	C	C	
Power and control cables	-	M	M	M	M	
Cable trays and conduits	-	M	M	M	M	
Electrical installation		M	M	M	M	
Electrical installation supervision		M	M	M	M	
Local safety isolation switches for motors		M	M	M	M	
Local control switches for motors		M	M	M	M	

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Scope of Supply	Process design	Basic eng.	Detail eng.	Supply	Erection	Note:
Lighting and maintenance power system in boiler building	-	M	M	M	M	
Lighting and maintenance power system in flue gas cleaning area	-	M	M	M	M	
Lighting in electrical rooms		M	M	M	M	
Electrification for ventilation in boiler building	-	M	M	M	M	
Electrification for HVAC in electrical rooms	-	M	M	M	M	
Grounding of electrical equipment	-	M	M	M	M	
Separate PLC for sootblowing system	-	NA	NA	NA	NA	
Separate PLC for flue gas cleaning system	-	M	M	M	M	For bag cleaning
Building communication system		C	C	C	C	
Fire alarm system	-	C	C	C	C	

1.2.3 Instrumentation and automation

Explanation for the abbreviations used in the following table:

M=Metso, C=Customer, O=Option(Metso), NA= Not applicable

Scope of Supply	Basic eng.	Detail eng.	Supply	Erection	Note:
Pneumatic Control Valves	M	M	M	M	
Pneumatic ON/OFF -Valves	M	M	M	M	
Flow elements, water and steam lines	M	M	M	M	(orifice and nozzle type)
DCS (SW, HW and Configuration)	M	M	M	M	
Control room equipment	M	M	M	M	
SIS&BMS FAT	M	M	M	M	Client to participate
DCS FAT	M	M	M	M	Client to participate
Burner management system (BMS)	M	M	M	M	
Safety Instrumented System (SIS)	M	M	M	M	
Flue gas analyzers	M	M	M	M	O ₂ , CO, SO ₂ , NO _x , DUST
Flue gas analyzer reporting system	M	M	M	M	
Furnace O ₂ measurement	M	M	M	M	O ₂ (CO)
Temperature elements	M	M	M	M	

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Scope of Supply	Basic eng.	Detail eng.	Supply	Erection	Note:
Standard Transmitters	M	M	M	M	PT, PDT, TT
Mass and Magnetic flow	M	M	M	M	
Radar, Ultrasonic and Radiometric levels	M	M	M	M	
Analyzers for sample station	M	M	M	M	
Local gauges	M	M	M	M	
Other Field instruments	M	M	M	M	LS, WI, FI
Instruments included in machines which are in Metso delivery	M	M	M	M	
Instrument installation materials	M	M	M	M	
Instrumentation erection	M	M	M	M	
Instrumentation erection supervision	M	M	M	M	

1.2.4 Civil and structural

Explanation for the abbreviations used in the following table:

M=Metso, C=Customer, O=Option(Metso), NA= Not applicable

Scope of Supply	Basic eng.	Detail eng.	Supply	Erection	Note:
Boiler support beams	M	M	M	M	
Boiler support columns	M	M	M	M	
Boiler building columns	M	M	M	M	
Anchor bolts for boiler building	M	M	M	M	
Anchor bolts for equipment	M	M	M	M	
Steel grating platforms	M	M	M	M	
Checkered plate platforms	M	M	M	M	
Form sheets for elevated slabs	M	M	M	M	
Stairs in boiler building	M	M	M	M	
Railings in boiler building	M	M	M	M	
Boiler building roof	M	M	M	M	
Wall siding	M	M	M	M	
Building insulation	M	M	M	M	
Windows	M	M	M	M	

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Scope of Supply	Basic eng.	Detail eng.	Supply	Erection	Note:
Doors	M	M	M	M	
Architectural design	C	C	C	C	
Company logo on building	C	C	C	C	
Duct support steel inside building	M	M	M	M	
Flue gas duct supports from boiler to stack	M	M	M	M	
Support steel for pipe hangers	M	M	M	M	
Auxiliary pipe bridges from boiler house to main pipe bridge	C	C	C	C	
Freight elevator	M	M	M	M	
Staff elevator	NA				
Hoist in boiler building	M	M	M	M	
Boiler building ventilation	M	M	M	M	
Glycol system for ventilation	M	M	M	M	
El. building HVAC	M	M	M	M	
Roof drain piping	M	M	M	M	
Drain piping from elevated slabs	M	M	M	M	
Fire water risers	M	C	C	C	
Sprinklers in boiler building	M	C	C	C	
Safety showers	M	M	M	M	
Potable water piping	M	M	M	M	
Fire fighting for el. building	C	C	C	C	
Vacuum cleaning piping	M	M	M	M	
Vacuum cleaner	M	M	M	M	
Demolition works	C	C	C	C	
Earthwork	C	C	C	C	
Excavation	C	C	C	C	
Earth moving	C	C	C	C	
Backfilling	C	C	C	C	
Dewatering	C	C	C	C	
Foundations	C	C	C	C	
Piling	C	C	C	C	
Pile caps	C	C	C	C	
Slab on grade	C	C	C	C	
Surface treatment of grade slab	C	C	C	C	

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Scope of Supply	Basic eng.	Detail eng.	Supply	Erection	Note:
Column foundations	C	C	C	C	
Equipment foundations on grade	C	C	C	C	
Grounding grid underground	C	C	C	C	
Concrete works above grade	C	C	C	C	
Concrete shell for dissolving tank	C	C	C	C	
Elevated concrete slabs	C	C	C	C	
Surface treatment of elevated slabs	C	C	C	C	
Metal inserts in concrete	C	C	C	C	
Elevator and stair shaft	C	C	C	C	
ESP support structure	C	C	C	C	
Electrical building below ESP	C	C	C	C	
Electrical building adj. to boiler house	C	C	C	C	
Underground piping	C	C	C	C	

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1.2.5 Project services

	Included	Excluded	Notes
PROJECT SERVICES			
Project management and reporting	X		
Delivery and shipping schedule	X		
Erection schedule	X		
QA/QC of supplied equipment	X		
QA/QC of erection	X		
HSE plan	X		
Sea freight / transportation to site	X		
Erection supervision	X		
Erection	X		
Commissioning and start up supervision	X		
Chemical cleaning	X		
Steam blows	X		
Operator and maintenance training & manuals	X		
Performance test		X	Metso assists
Performance test report	X		Metso assists