



# Welcome!

## Webinar #17: Total Plant Cost in Thermoflex

21 Nov 2017

### **Agenda:**

- \* Introduction
  - PEACE Components in Thermoflex
  - Cost estimation in TFX, traditional approach
  - Plant Assembly and Total Plant Cost
  - Economic & Financial Assumptions
  - Non Flowsheet components
  - Results and Techno Economic Optimization
- \* Q & A Session

Presenter: IGNACIO MARTIN (SPAIN)

Support: Meritt Elmasri (U.S. HQ)

# Thermoflow Training and Support

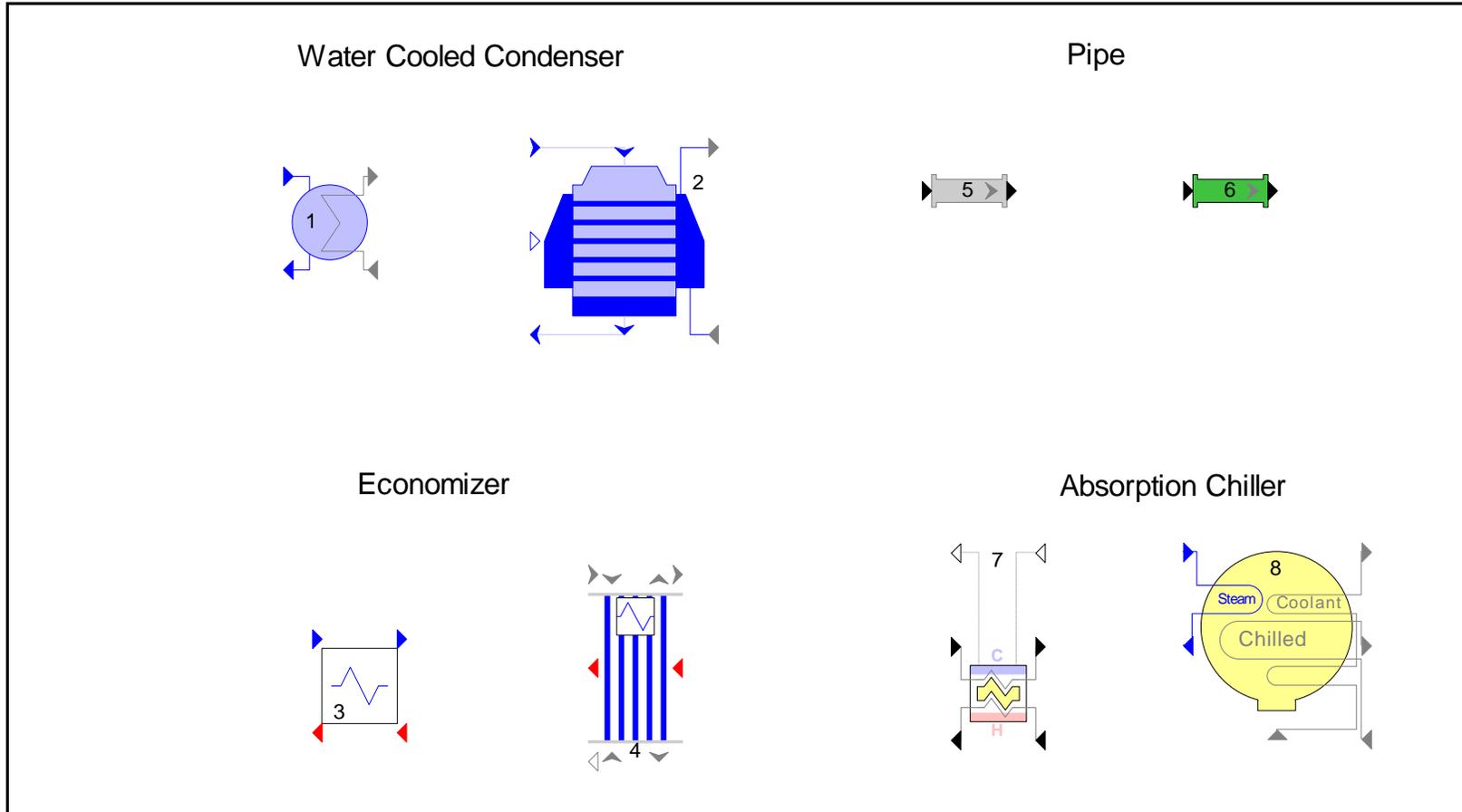
- Standard Training
- On site training course
- Advanced Workshop
- Webinars when new version is released
- Help, Tutorials, PPT, Videos
- Technical Support

**→ Feature Awareness Webinars**

# Feature Awareness Webinars

- 1- Assemblies in TFX
- 2- Scripts in Thermodflow programs, GTP-GTM-TFX
- 3- Multi Point Design in GTP-GTM
- 4- Reciprocating Engines in TFX
- 5- TIME in GTM
- 6- Matching ST Performance in STP
- 7- Modeling Solar Systems in TFX
- 8- Combining THERMOFLEX & Application-Specific Programs
- 9- Methods & Methodology in GT PRO & STEAM PRO
- 10- Supplementary Firing & Control Loops in GT PRO & GT MASTER
- 11- The Wind Turbine Feature in Thermodflex
- 12- Modelling GT's in Thermodflow programmas-1
- 13- Thermodflex for on line and off line performance monitoring
- 14- Tflow 27, what's new
- 15- Modelling GT's in Thermodflow programmas-2
- 16- Multi Point Design in GTP-GTM
-  **17- Total Plant Cost in Thermodflex**

# Thermoflex PEACE & no PEACE Components

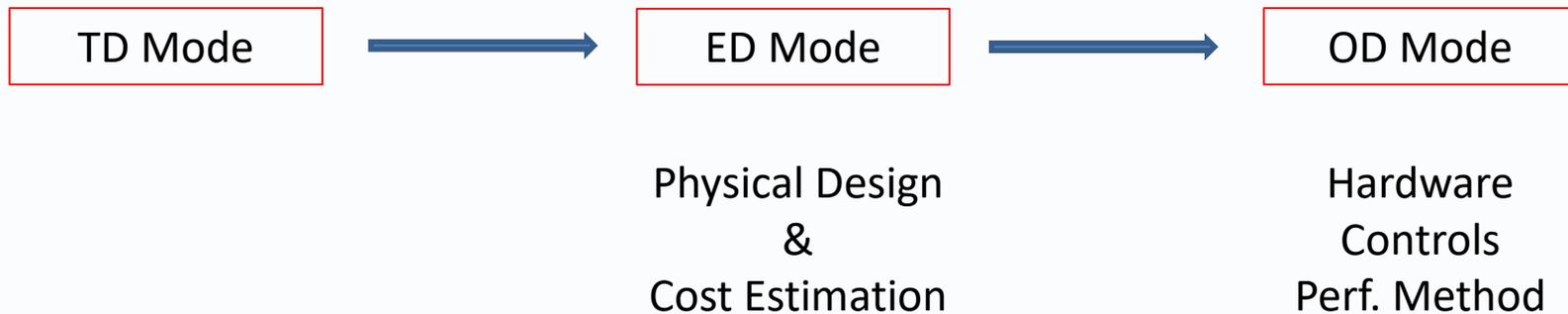


# Thermoflex PEACE & no PEACE Components

*No PEACE*  
Components



*PEACE*  
Components



# Thermoflex PEACE & no PEACE Components

No PEACE

Input Menu - Edit Mode  
File GTP/GTM/STM

Site Menu	Components	Miscellaneous	Gen/Motors	Plant Assembly	No/Flow/Heat	Economics
Water-cooled Condenser [35] 0 - Design						
1. Mode				0 - Design		
2. Design point condenser pressure	bar	0,065				
3. Design point cooling water temperature rise	C	10				
4. Design point minimum pinch	C	2				
5. Condensate subcooling	C	0				
6. Water head to condensate outlet	m	3,6576				
7. Design point cooling water head loss	m	9,144				
8. Internal pump overcomes cooling water head loss		0 - No				
9. Pump efficiency	%	NA				
10. Off-design status		NA				
11. Off-design cooling water as % of nominal	%	NA				
12. Design point steam-side thermal resistance/total resistance		NA				
13. Design point water-side thermal resistance/total resistance		NA				
14. Design point tube wall & fouling resistance/total resistance		NA				
15. Nominal steam massflow	t/h	NA				
16. Nominal water massflow	t/h	NA				
17. Nominal UA	kW/C	NA				
18. Correction factor for overall h.t.c.		NA				
19. Water-side flow resistance coefficient	$10^{-3}m^{-4}$	NA				
20. Scaling exponent for steam-side h.t.c w/ steam flow		NA				
21. Scaling exponent for water-side h.t.c w/ water flow		NA				

er (PCE) [13] Thermodynamic Design

Water head to condensate outlet: 3.658 m

Condensate subcooling at condensing pressure: 0 C

Condenser pressure: 0.065 bar  
Condenser pressure: 4.875 cm Hg  
Condenser saturation temperature = 37.63C

Assumed water-side pressure drop for TD mode: 0.3447 bar

Cooling water temperature rise: 10 C

Water-cooled Condenser (PCE) [20] Engineering Design

TD Main Inputs

Hardware Design Method:  Automatic  User-defined

Tube Material: Stainless Steel(304)

Tube Type: Seam welded

Apply fouling factor: 0,0002  $m^2 \cdot C/W$

Apply cleanliness factor: 90 %

Tube outer diameter: 15,88 mm

Tube thickness: 0,7112 mm

Tube pitch/outside diameter: 1,6

Tube metal conductivity: 14,88  $W/m \cdot C$

Tube water velocity: 1,829 m/s

Number of condenser passes: 2

Condenser external h.t.c. (0=auto): 0  $W/m^2 \cdot C$

CW pressure drop correction factor: 1

Tube bundle h.t.c. / Single tube h.t.c.: 0,875

ED Main Inputs

Non-condensible Removal:  Mechanical vacuum pump  External mech. vacuum pump  Steam jet air ejector

Aspect ratio of uniformly-spaced tube bundle (Height/Width): 1

Condenser cross section / Uniformly-spaced tube bundle cross section: 1,56

Hotwell condensate storage requirement: 5 min

Cooling water pipe water velocity: 2,591 m/s

Mole percent (y) of non-condensibles gases: 0 %

C in h.t.c. correction factor (H=1/(1+Cy)): 0,51

Condenser Heat Transfer Calculation:  Hardware model  HEI method

No PEACE

THERMOFLEX 27.0 C:\Users\imart\Documents\Thermoflow 27\FAW\FAW17\_Plant Cost TFX\Eejmlo 1P TFX\_ED\_Plant Ass\_no FlowS\_no PEACE WCC.tfx

File Edit Options Define View Help

Flowsheets Components Text Graphics PEACE Assemblies Messages Engineering Design

Water-cooled Condenser [20]

- Component Graphic
- Heat Balance
- Specification
- Elevation View
- Plan View
- TQ Diagram
- View/Edit Note

(27) P = 0,0589  
T = 35,82  
x = 0,908  
H = 2344,80  
H\* = -202,69  
M = 61,66

(25) P = 1,743  
T = 32,85  
Sub = 83,1  
H = 137,73  
H\* = -2409,76  
M = 2310,4

(31) P = 0,4178  
T = 35,83  
Sub = 41,1  
H = 150,09  
H\* = -2397,40  
M = 61,66

(23) P = 2,406  
T = 18,83  
Sub = 107,3  
H = 79,15  
H\* = -2468,34  
M = 2311,3

P[bar] T[C] H[kJ/kg] H\*[kJ/kg] M[Mh]  
Water-cooled Condenser [20]  
Mode: Engineering Design  
Condenser pressure = 0,0589 bar, Saturation temperature = 35,82 C  
Condenser heat rejection (per unit) = 37593 kW  
Steam mass flow (per unit) = 61,66 th  
Cooling water flow (per unit) = 2310,4 th, Inlet = 18,83 C, Exit = 32,83 C  
Cooling water pressure drop = 0,8637 bar  
Water head to condensate outlet = 3,658 m

PEACE

THERMOFLEX 27.0 C:\Users\imart\Documents\Thermoflow 27\FAW\FAW17\_Plant Cost TFX\Eejmlo 1P TFX\_ED\_Plant Ass\_no FlowS.tfx

File Edit Options Define View Help

Flowsheets Components Text Graphics PEACE Assemblies Messages Engineering Design

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Cooling water pressure drop = 0,8637 bar  
Water head to condensate outlet = 3,658 m

Water-cooled Condenser [PCE] [20]

- Component Graphic
- Heat Balance
- Specification
- Elevation View
- Plan View
- TQ Diagram
- View/Edit Note

**Estimated Condenser Data (per unit)**

2. Condenser Shell Description	
Shell material	
Nominal shell thickness	
Number tube support plates	
Tube support plate spacing	
Hotwell depth	
Total dry weight	
Overall footprint area	
Overall length	
Overall width	
Overall height	

3. Condenser Operating Parameters	
Non-condensible removal system	Vacuum Pump
Water depth in hotwell	0,37 m
Volume water stored in hotwell	5,170 l
Total operating (wet) weight (excluding vacuum forces)	37.860 kg

**4. Reference Material, Equipment, and Installation Costs**

Equipment	
Condenser cost	579.095 EUR

Mechanical	
Mechanical material cost	9.574 EUR
Mechanical labor	1.310 hours
Mechanical labor cost	53.579 EUR

Electrical	
Electrical material cost	2.164 EUR

FOR QUALITATIVE INDICATION ONLY

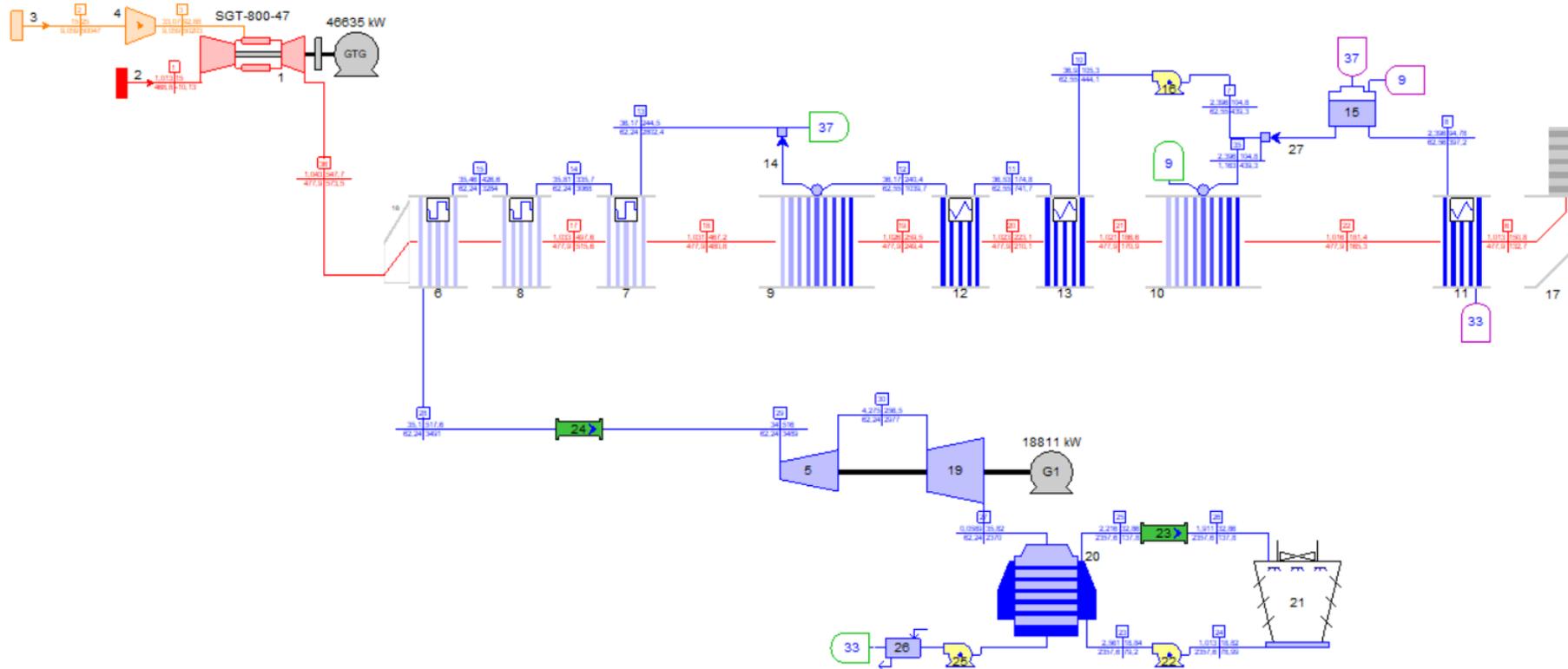
A	B	C	D	E	F	G	H	I	J
8,47 m	0,8382 m	7,212 m	0,4191 m	0,96 m	2,305 m	1,548 m	0,3707 m	-	-

Company	Quantity	Material	Quantity
		Line ID	
		WATER-COOLED CONDENSER (PCE) [20]	
		NEW ELEVATION	
		Date: 11/20/17	
		Drawing No:	

# Cost Estimation in Thermoflex

## Example 1P CC

bar | C  
t/h | kJ/kg



# Cost Estimation in Thermoflex

## Example 1P CC

(Reference: File imported from GT Pro)

1. TD Mode → No Cost
2. ED Mode, no Assemblies
3. ED Mode, ST and HRSG Assemblies
4. ED Mode, Plant Assembly, no Non-Flowsheets components
5. ED Mode, Plant Assembly & Non-Flowsheet components from GTP
6. ED Mode, Plant Assembly & Non-Flowsheet components from GTP, Economics from GTP

# Cost Estimation in Thermoflex

## Pipe

<b>2. Reference Material, Equipment, and Installation Costs</b>		
<b>Mechanical</b>		
Pipe cost	27.000	EUR
Fitting cost	2.840	EUR
Miscellaneous field material and equipment cost	14.920	EUR
Mechanical labor	1453,9	hours
Mechanical labor cost	59.600	EUR
<b>3. Cost Summary</b>		
<b>Total reference installed cost</b>	<b>104.350</b>	<b>EUR</b>
<b>Total installed cost adjustment factor</b>	<b>1</b>	
<b>Total estimated installed cost</b>	<b>121.500</b>	<b>EUR</b>

# Cost Estimation in Thermoflex

## WC Condenser

Estimated Condenser Data (per unit)		
<b>4. Reference Material, Equipment, and Installation Costs</b>		
<b>Equipment</b>		
Condenser cost	480.515	EUR
<b>Mechanical</b>		
Mechanical material cost	7.727	EUR
Mechanical labor	1.050	hours
Mechanical labor cost	43.238	EUR
<b>Electrical</b>		
Electrical material cost	1.746	EUR
Electrical labor	186	hours
Electrical labor cost	7.816	EUR
<b>Civil</b>		
Foundation concrete volume	41,12	m <sup>3</sup>
Foundation material & equipment cost	33.929	EUR
Excavation/backfill volume	129	m <sup>3</sup>
Excavation/backfill material and equipment cost	5.817	EUR
Civil labor	1.290	hours
Civil labor cost	41.786	EUR
<b>5. Cost Summary</b>		
<b>Total reference installed cost</b>	<b>622.573</b>	<b>EUR</b>
<b>Total installed cost adjustment factor</b>	<b>1</b>	
<b>Total estimated installed cost</b>	<b>672.269</b>	<b>EUR</b>

# Cost Estimation in Thermoflex

## ST Assembly

<b>STAssembly [1]</b>		
<b>Estimated Steam Turbine Data</b>		
<b>3. Reference Material, Equipment, and Installation Costs</b>		
<b>Equipment</b>		
Steam Turbine Package Cost	5.568.000	EUR
Including:		
- Turbine		
- Generator		
- Exhaust System		
- Electrical/Control/Instrumentation Package		
- Lube Oil Package w/ main, auxiliary & emergency pump		
- Transportation to Site		
<b>Mechanical</b>		
Mechanical material cost	37.160	EUR
Mechanical labor	5.640	hours
Mechanical labor cost	207.950	EUR
<b>Electrical</b>		
Electrical material cost	20.390	EUR
Electrical labor	2.420	hours
Electrical labor cost	91.300	EUR
<b>Transportation &amp; Rigging</b>		
On-site Transportation & Rigging	70.650	EUR
<b>Civil (ST and Laydown Pads)</b>		
Foundation concrete volume	133	m <sup>3</sup>
Foundation material & equipment cost	146.350	EUR
Excavation/backfill volume	196	m <sup>3</sup>
Excavation/backfill material and equipment cost	7.300	EUR
Civil labor	4.420	hours
Civil labor cost	143.200	EUR
<b>5. Cost Summary</b>		
<b>Total Reference Installed Cost</b>	<b>6.292.000</b>	<b>EUR</b>
<b>Total Installed Cost Adjustment Factor</b>	<b>1</b>	
<b>Total Adjusted Reference Installed Cost</b>	<b>6.292.000</b>	<b>EUR</b>
<b>Total Estimated Installed Cost</b>	<b>6.695.000</b>	<b>EUR</b>

# Cost Estimation in Thermoflex

## HRSG Assembly

HRSGAssembly [1]		
Estimated HRSG Data		
<b>Equipment</b>		
Overall HRSG Unit Cost - including:	3.043.000	EUR
Main Stack	471.250	EUR
<b>Mechanical</b>		
Mechanical Labor	10.710	hours
Mechanical Labor Cost	395.050	EUR
<b>Transportation &amp; Rigging</b>		
On-site Transportation & Rigging	198.450	EUR
<b>Civil</b>		
Foundation Concrete Volume	217	m <sup>3</sup>
Civil Labor	4.230	hours
Civil Labor Cost	137.000	EUR
Total Civil Cost	292.200	EUR
<b>Total Cost</b>		
Total Reference Installed Cost	3.928.000	EUR
Total Installed Cost Adjustment Factor	1	
Total Adjusted Reference Installed Cost	3.928.000	EUR
Total Estimated Installed Cost	4.231.000	EUR

# Cost Estimation in Thermoflex

## Traditional Approach → Sum of Cost of Components

Cost Breakdown	Unit Cost	Cost Adj. Facto	Ref. Cost	Est. Cost	
<b>Sum of Costs for Equipment and PEACE Components</b>			<b>132.248.800</b>	<b>139.140.900</b>	<b>EUR</b>
<b>HRSG Assembly [1]</b>		<b>1</b>	<b>30.794.840</b>	<b>32.474.380</b>	<b>EUR</b>
Duct - GT to Horizontal HRSG [19]					
Economiser (PCE) [28]					
Economiser (PCE) [31]					
Economiser (PCE) [33]					
Economiser (PCE) [37]					
Evaporator (PCE) [25]					
Evaporator (PCE) [32]					
Evaporator (PCE) [35]					
Steel Stack [38]					
Superheater (PCE) [20]					
Superheater (PCE) [21]					
Superheater (PCE) [22]					
Superheater (PCE) [23]					
Superheater (PCE) [24]					
Superheater (PCE) [27]					
Superheater (PCE) [29]					
Superheater (PCE) [30]					
<b>ST Assembly [1]</b>		<b>1</b>	<b>31.969.250</b>	<b>33.609.320</b>	<b>EUR</b>
ST Group [6]					
ST Group [7]					
ST Group [8]					

<b>Deaerator</b>			<b>533.892</b>	<b>560.587</b>	<b>EUR</b>
Deaerator [42]	533.892	1			
<b>Fuel Compressor</b>			<b>2.645.182</b>	<b>2.782.417</b>	<b>EUR</b>
Fuel Compressor [3]	2.645.182	1			
<b>Gas Turbine (GT PRO)</b>			<b>54.082.080</b>	<b>56.786.180</b>	<b>EUR</b>
Gas Turbine (GT PRO) [2]	54.082.080	1			
<b>Pump (PCE)</b>			<b>2.441.266</b>	<b>2.569.944</b>	<b>EUR</b>
Pump (PCE) [15] - Condenser C.W. Pump	623.870	1			
Pump (PCE) [18] - Condensate Forwarding Pump	182.264	1			
Pump (PCE) [39] - HP Feedwater Pump	1.057.000	1			
Pump (PCE) [40] - IP Feedwater Pump	578.133	1			
<b>Water-cooled Condenser (PCE)</b>			<b>2.444.783</b>	<b>2.580.655</b>	<b>EUR</b>
Water-cooled Condenser (PCE) [13]	2.444.783	1			
<b>Pipe (PCE)</b>			<b>7.337.467</b>	<b>7.777.418</b>	<b>EUR</b>
Pipe (PCE) [5] - HPB to HPT	1.171.253	1			
Pipe (PCE) [9] - Cold Reheat	316.745	1			
Pipe (PCE) [10] - Hot Reheat	1.150.284	1			
Pipe (PCE) [12] - LPB to LPT	387.891	1			
Pipe (PCE) [14] - Main Circulating Water	4.311.293	1			

# Cost Estimation in Thermoflex

## Traditional Approach → Sum of Cost of Components

Cost Summary	Estimated Cost	
<b>1. Sum of Costs for Equipment and PEACE Components</b>	<b>139.140.900</b>	<b>EUR</b>
<b>2. Sum of User-defined Costs</b>	<b>0</b>	<b>EUR</b>
<b>3. Sum of PEACE Components, Linked Files, and User-defined Costs (Contractor's Internal Cost)</b>	<b>139.140.900</b>	<b>EUR</b>
Contractor's Soft & Miscellaneous Costs	34.798.670	EUR
<b>4. Contractor's Price</b>	<b>173.939.600</b>	<b>EUR</b>
Owner's Soft & Miscellaneous Costs	12.522.680	EUR
<b>5. Total - Owner's Cost (0,899999976158142 EUR per USD) - See Cautionary Note Below</b>	<b>186.462.200</b>	<b>EUR</b>
<b>6. Plant Net Electric Output</b>	<b>444,7</b>	<b>MWe</b>
<b>Cautionary Note:</b>		
In Simplified PEACE mode, THERMOFLEX does not provide complete plant cost estimates as is done in the Comprehensive PEACE mode or in GT PRO and STEAM PRO.		
In Simplified PEACE mode, THERMOFLEX only includes capital cost estimates for PEACE components and for linked GT PRO, GT MASTER, and STEAM MASTER files. Complete plant cost estimates often contain features not included in the THERMOFLEX model. It is the user's responsibility to carefully review the cost estimate and its scope to ensure suitability to the project at hand.		
Costs for features not included in the model should be included via the user-defined cost inputs available from: 'Edit Inputs' -> 'Economics & Regional Costs' menu -> 'User-Defined Costs' tab.		
* Cost estimates as of August 2017.		

# Plant Assembly in Thermoflex

1. PEACE Method = Simplified → Sum of Costs, traditional method  
= **Comprehensive** → **Total Plant Cost**
2. Select “Site Plant Groups”: GT+HRSG, ST+Condenser, GT+HRSG+ST (Single Shaft), ...
3. Add main components to Site Plant Groups
4. Add other components / Include all
5. Include Generators
6. Include Non-Flowsheets components (pipes, pumps, tanks, ...) and other PEACE inputs
7. Regional Costs and Economic Assumptions

# Plant Assembly in Thermoflex

Site Menu
Components
Miscellaneous
Plant Assembly
Non-Flowsheet
Economics
Regional Costs
OK
Cancel

**PEACE Method**

Simplified
  Comprehensive
 Plant cost estimate includes costs from PEACE components and other ancillary equipment typically included in a complete power plant, and defined on the [Non-Flowsheet] tab.

Included Components

Included Generators

Drag components from list on left (Available), to list on right (Included) to define what's included in the PEACE Plant Assembly. Drag onto main category to create new Site Plan Group of that type. Drag onto existing Site Plan Group to add the model component to an existing group.

Automatically Include Remaining Available Components

**Available Flowsheet Components**

- Gas Turbines (driving an intrinsic generator)
  - Gas Turbine (GT PRO) [2]
- Stacks
- HRSGs
  - HRSG Assembly [1]
- Steam Turbines (driving an intrinsic generator)
  - ST Assembly [1]
- Condensers
  - Water-cooled Condenser (PCE) [13]
- Cooling Towers
- Pumps
  - Pump (PCE) [39] - HP Feedwater Pump
  - Pump (PCE) [15] - Condenser C.W. Pump
  - Pump (PCE) [18] - Condensate Forwarding Pump
  - Pump (PCE) [40] - IP Feedwater Pump
- Pipes
  - Pipe (PCE) [5] - HPB to HPT
  - Pipe (PCE) [9] - Cold Reheat
  - Pipe (PCE) [10] - Hot Reheat
  - Pipe (PCE) [12] - LPB to LPT
  - Pipe (PCE) [14] - Main Circulating Water
- Fuel Compressors
  - Fuel Compressor [3]
- Package Boilers
- Electric Chillers
- Absorption Chillers
- Fin Fan Coolers
- Coils
- Evap Coolers / Foggers
- Feedwater Heaters

**Flowsheet Components Included in PEACE Plant Assembly**

**SITE PLAN GROUPS**

- GT (Simple Cycle)
- HRSG Only
- GT + HRSG
- ST + CONDENSER
- ST + CONDENSER + COOLING TOWER
- ST Only
- MAIN COOLING TOWER
- GT+HRSG+ST+CND (Single Shaft)
- GT+HRSG+ST+CND+CT (Single Shaft)
- GT+HRSG+ST (Single Shaft)
- PACKAGE BOILERS

**OTHERS**

- PUMPS
- PIPES
- FUEL COMPRESSORS
- CHILLERS
- AUX COOLING TOWERS
- FIN FAN COOLERS
- COILS
- EVAP COOLERS / FOGGERS
- FEEDWATER HEATERS
- DISTRICT HEATERS
- DESALINATION-MSF
- DESALINATION-RO
- DESALINATION-MED
- SOLAR PV FIELDS
- WIND FARMS
- FANS

# Plant Assembly in Thermoflex, Non-Flowsheet

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu Components Miscellaneous **Plant Assembly** **Non-Flowsheet** Economics Regional Costs OK Cancel

**Site Characteristics** Buildings Electrical Tanks Other Piping Other Pumps Cooling Others

Site

Site climate  
 Temperate ▼ Nominal plant makeup flowrate 94.63 lpm

Site soil classification  
 Packed - Somewhat Rocky ▼

Main Cooling Tower Arrangement

These inputs are used when the model includes multiple cooling towers shown on the site plan.

Organize towers collectively  Organize towers individually

Maximum number of CT cells per bank 10 (plantwise)

Copy Non-Flowsheet Settings to Clipboard

Paste Non-Flowsheet Settings from Clipboard...

# Plant Assembly in Thermoflex, Economics

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu Components Miscellaneous **Plant Assembly** Non-Flowsheet **Economics** Regional Costs OK Cancel

Main Inputs Escalation Rates Contractor's Soft Costs Owner's Soft Costs Yearly O&M Costs User-defined Costs

**My Plant**

Fuel LHV price  
5,118 EUR/GJ

Imported water price  
0 EUR/m<sup>3</sup>

Limestone price  
19,84 EUR/tonne

Lime price  
79,37 EUR/tonne

CO2 capture solvent price  
1984,2 EUR/tonne

Activated carbon price  
1984,2 EUR/tonne

First year of plant operation 2018

Project life in years 20

Operating hours per year (full-load equivalent) 8100

Straight line depreciation life in years 15  
(enter 0 for variable depreciation)

Depreciable percentage of total investment 90 %

Debt term in years 15

Debt percentage of total investment 70 %

Debt interest rate 9 %

Overall tax rate 35 %

Negative taxes treated as tax credits: 0=yes, 1=no 0

Amount of interest payment that is NOT tax deductible 0 %

Discount rate for NPV calculation 15 %

Fixed O&M costs 18 EUR/kw

Variable O&M costs 0,0018 EUR/kWhr

Electricity price 0,045 EUR/kWhr

Heat export price 4,265 EUR/GJ

Capacity income 0 EUR

Captured CO2 export price or avoided cost 0 EUR/tonne

Syngas export price 0 EUR/GJ

Hydrogen export price 6,825 EUR/GJ

Desalinated water price 3,6 EUR/kG

CO2 emission penalty 0 EUR/tonne

Annual CO2 emission allowance 0 ktonne

Combustion waste disposal cost 0 EUR/tonne

FGD waste/byproducts disposal cost 0 EUR/tonne

Copy Economics Inputs to Clipboard

Paste Economics Inputs from Clipboard

All prices are for the first year only. Price adjustments for subsequent years are computed using the factors on the 'Escalation Rates' tab.

# Plant Assembly in Thermoflex, Equipment Data

PEACE Output

File Edit Cost Modifiers

**Preliminary Engineering** **Financial**

Equipment Data Cost Report Cash Flow

Site Piping Pumps **Motors** Electrical Tanks Water Treatment Miscellaneous

Estimated Electric Loads	Count	Nominal Operating kWe	Nominal Standby kWe	Voltage volts
	<b>85</b>	<b>1.570</b>	<b>904</b>	
<b>1. Pump Motors</b>	<b>15</b>	<b>334</b>	<b>16,5</b>	
Pump (PCE) [16]	1	140	0	480
Pump (PCE) [22]	1	140	0	480
Pump (PCE) [25]	1	20	0	480
Condenser Vacuum Pump	2	14	0	480
Aux Cooling Water Pump (closed loop)	2	8	8	480
Treated Water Pump	1	0,5	0	480
Jockey Fire Pump	1	1,5	0	480
Demin Water Pump	2	0,5	0,5	480
Raw Water Pump 1	1	0,5	0	480
Raw Water Pump 2	1	0,5	0	480
Aux Cooling Water Pump (open loop)	2	8	8	480
<b>2. Cooling Tower Fans</b>	<b>4</b>	<b>160</b>		
Wet Cooling Tower (PCE) [21] - Cooling Tower Fan	4	160	0	480
<b>3. Fuel Compressor Motors</b>	<b>2</b>	<b>700</b>	<b>700</b>	
Fuel Compressor [4] - Motor	2	700	700	4.160
<b>4. Air Compressor Motors</b>	<b>2</b>	<b>12</b>	<b>12</b>	
Station Air Compressor	2	12	12	480
<b>5. Water Treatment System Motors</b>	<b>18</b>	<b>9</b>	<b>18</b>	
Misc. Makeup Water Auxiliary Loads	18	9	18	480
<b>6. Bridge Crane</b>	<b>10</b>		<b>70</b>	
GT Bridge Crane hoist motor	1	0	28	480
GT Bridge Crane bridge motor	2	0	5	480
GT Bridge Crane trolley motor	2	0	4,5	480
ST Bridge Crane hoist motor	1	0	24	480
ST Bridge Crane bridge motor	2	0	4,5	480
ST Bridge Crane trolley motor	2	0	4	480

# Plant Assembly in Thermoflex, Cost Report

PEACE Output

File Edit Cost Modifiers

**Preliminary Engineering** | **Financial**

Equipment Data | **Cost Report** | Cash Flow

Soft & Miscellaneous Costs

Buildings | Engineering & Plant Startup | Linked Files & Other Systems

Civil | Mechanical | Electrical Assembly & Wiring

**Project Cost Summary** | Specialized Equipment | Other Equipment

<b>Project Cost Summary (EUR)</b>	<b>Ref Cost</b>	<b>Est Cost</b>	
<b>Power Plant</b>			
I. Specialized Equipment	27.737.000	29.124.000	EUR
II. Other Equipment	2.228.000	2.339.000	EUR
III. Civil	3.702.000	3.933.000	EUR
IV. Mechanical	4.026.000	4.307.000	EUR
V. Electrical Assembly & Wiring	1.487.000	1.589.000	EUR
VI. Buildings & Structures	2.583.000	2.751.000	EUR
VII. Engineering & Startup	5.107.000	5.114.000	EUR
VIII. Linked Files & Other Systems	0	0	EUR
<b>Subtotal - Contractor's Internal Cost</b>	<b>46.870.000</b>	<b>49.157.000</b>	<b>EUR</b>
IX. Contractor's Soft & Miscellaneous Costs	12.272.000	13.044.000	EUR
<b>Contractor's Price</b>	<b>59.142.000</b>	<b>62.201.000</b>	<b>EUR</b>
X. Owner's Soft & Miscellaneous Costs	5.323.000	5.598.000	EUR
<b>Total - Owner's Cost</b>	<b>64.465.000</b>	<b>67.799.000</b>	<b>EUR</b>
<b>Nameplate Net Plant Output</b>	<b>64,13</b>	<b>64,13</b>	<b>MWe</b>
<b>Price per kW - Contractor's</b>	<b>922,2</b>	<b>969,9</b>	<b>EUR/kW</b>
<b>Cost per kW - Owner's</b>	<b>1005,2</b>	<b>1057,2</b>	<b>EUR/kW</b>
<b>* Cost estimates as of August 2017.</b>			

# Plant Assembly in Thermoflex, Financial

PEACE Output

File Edit Cost Modifiers

Preliminary Engineering Financial

Equipment Data Cost Report Cash Flow

Financial Summary Cash Flow

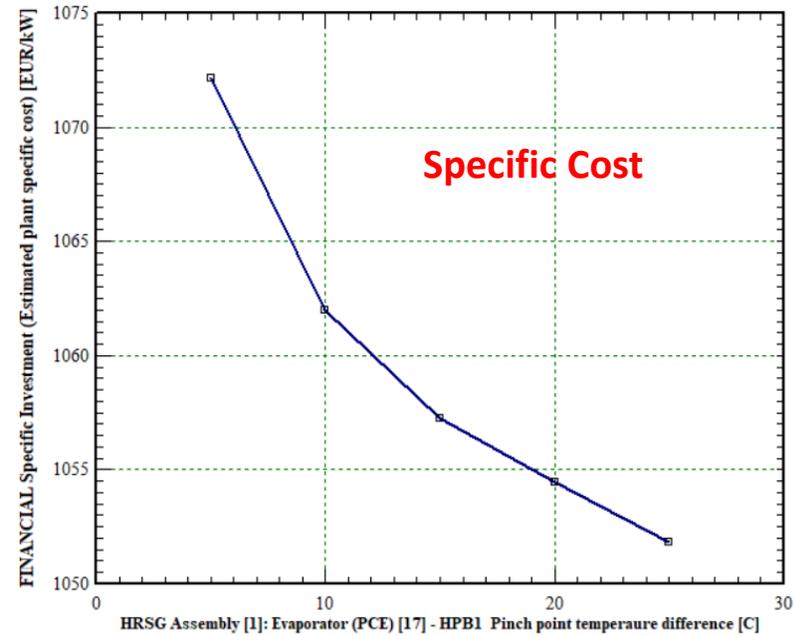
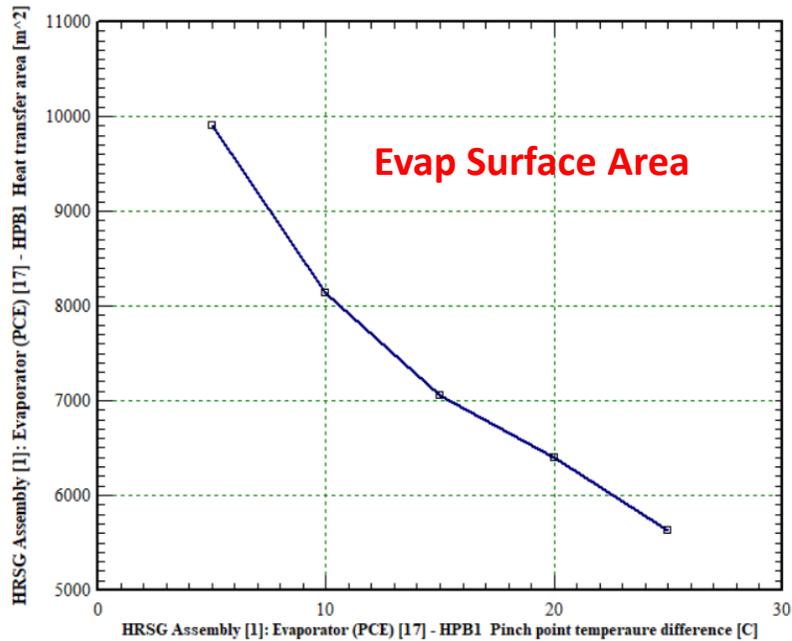
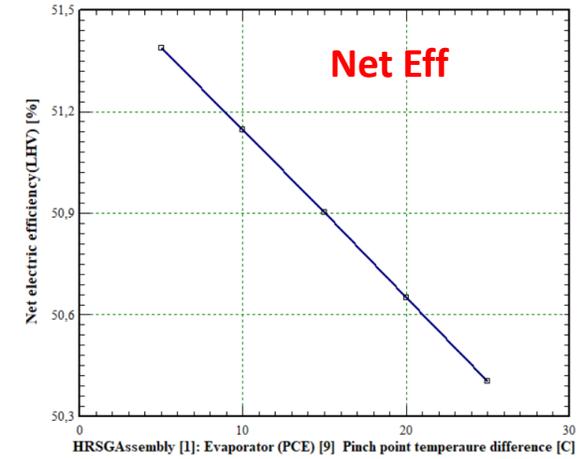
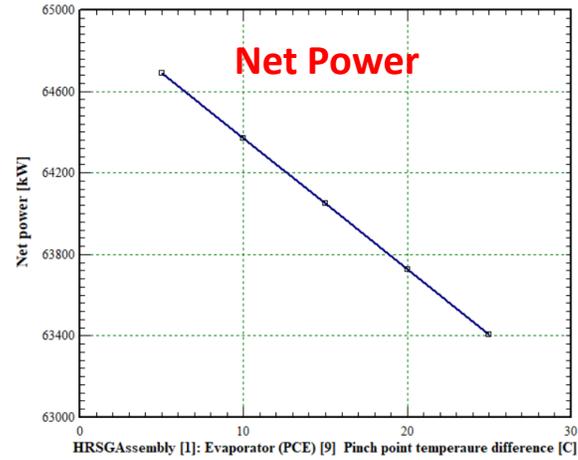
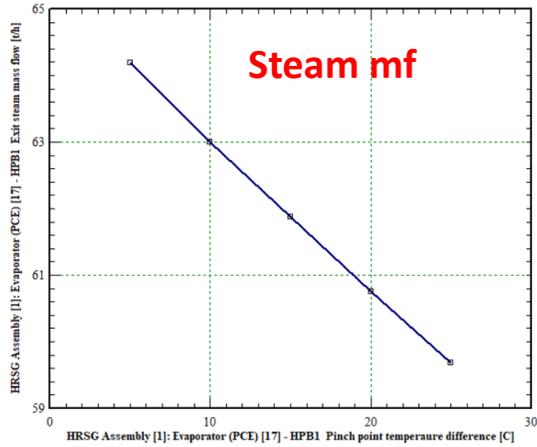
**Caution! These results are based on a single set of nameplate plant performance data applied for user-input number of operating hours per year.**

Annual Electricity Exported	420,8	10 <sup>6</sup> kWh
Annual Heat Exported	0	TJ
Annual Fuel Imported	2.976	TJ LHV
Annual Water Imported	356,1	10 <sup>6</sup> l
Annual CO2 Emission	163,1	ktonne
Annual Desal Water Exported	0	MM imperial gal.
Annual Hydrogen Exported	0	TJ LHV
Annual Syngas Exported	0	TJ LHV
Annual CO2 Captured	0	ktonne
Annual Limestone Consumed	0	ktonne
Annual Lime Consumed	0	ktonne
Annual CO2 Capture Solvent Consumed	0	ktonne
Annual Combustion Waste Production	0	ktonne
Annual FGD Waste/Byproducts Production	0	ktonne
Annual Activated Carbon Consumed	0	ktonne
Total Investment	67.740.050	EUR
Specific Investment	1057,6	EUR per kW
Initial Equity	20.322.010	EUR
Cumulative Net Cash Flow	143.602.400	EUR
Internal Rate of Return on Investment (ROI)	12,493	%
Internal Rate of Return on Equity (ROE)	22,366	%
Years for Payback of Equity	5,185	years
Net Present Value	27.785.550	EUR
Break-even Electricity Price @ Input Fuel Price (i.e. Levelised Cost of Electricity)	0,0498	EUR/kWhr
Break-even Fuel LHV Price @ Input Electricity Price	6,35	EUR/GJ

# Cost estimation in TFX. Comparison

		1	2	3	4	5	6
Mode		TD	ED	ED	ED	ED	ED
ST-HRSG Ass		no	no	yes	yes	yes	yes
Plant Ass		no	no	no	yes	yes	yes
Non Flowsheets		no	no	no	no	yes	yes
Economics		TFX	TFX	TFX	TFX	TFX	=GTP
Gross Power	MW	65,5	65,4	65,8	65,8	65,8	65,8
Net Power	MW	64,1	64,0	64,3	64,1	64,0	64,0
Net Elect. Eff	%	50,86	50,86	51,12	50,93	50,9	50,9
Auxiliary Power	MW	1,4	1,4	1,5	1,7	1,8	1,8
Contractor's Internal Cost	M€	No Cost	19,7	31,3	46,3	49,1	49,1
Contractor's Price	M€		22,8	37,0	55,2	59,3	62,1
Total Owner's Cost	M€		24,6	39,8	60,1	64,6	67,7
	€/kW		384	619	938	1.009	1.058
	%		36%	59%	89%	95%	100%
ROI	%						12,5
NPV	M€						27,8
LCOE	€/MWh						49,8

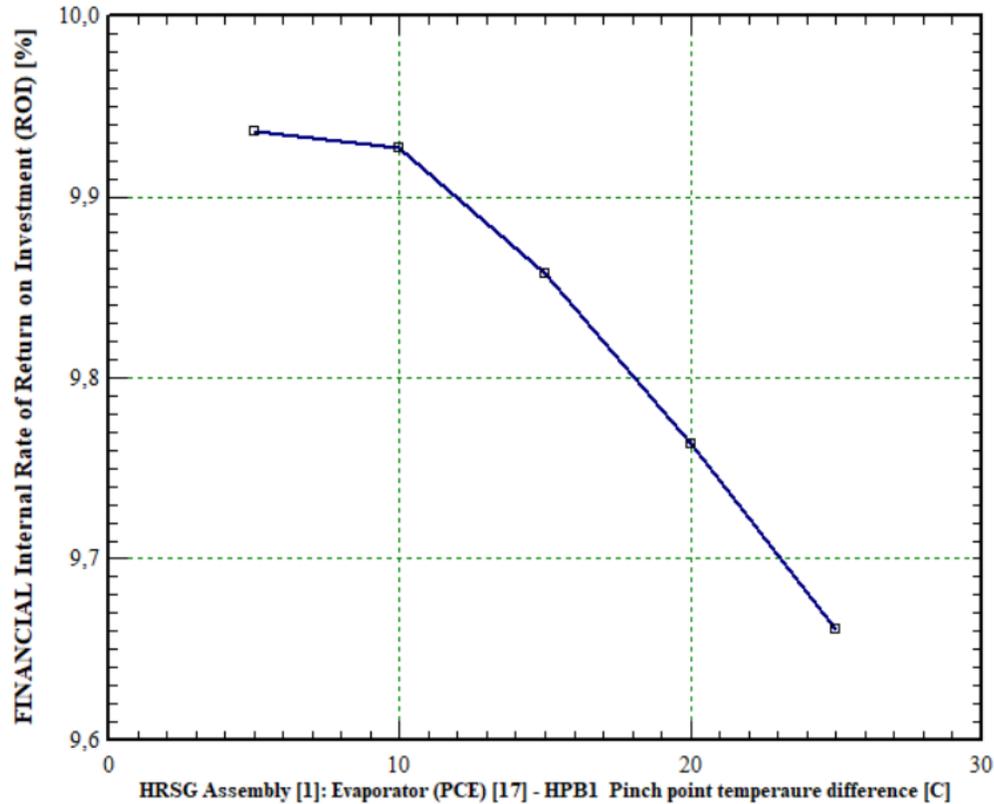
# Techno Economic Optimization



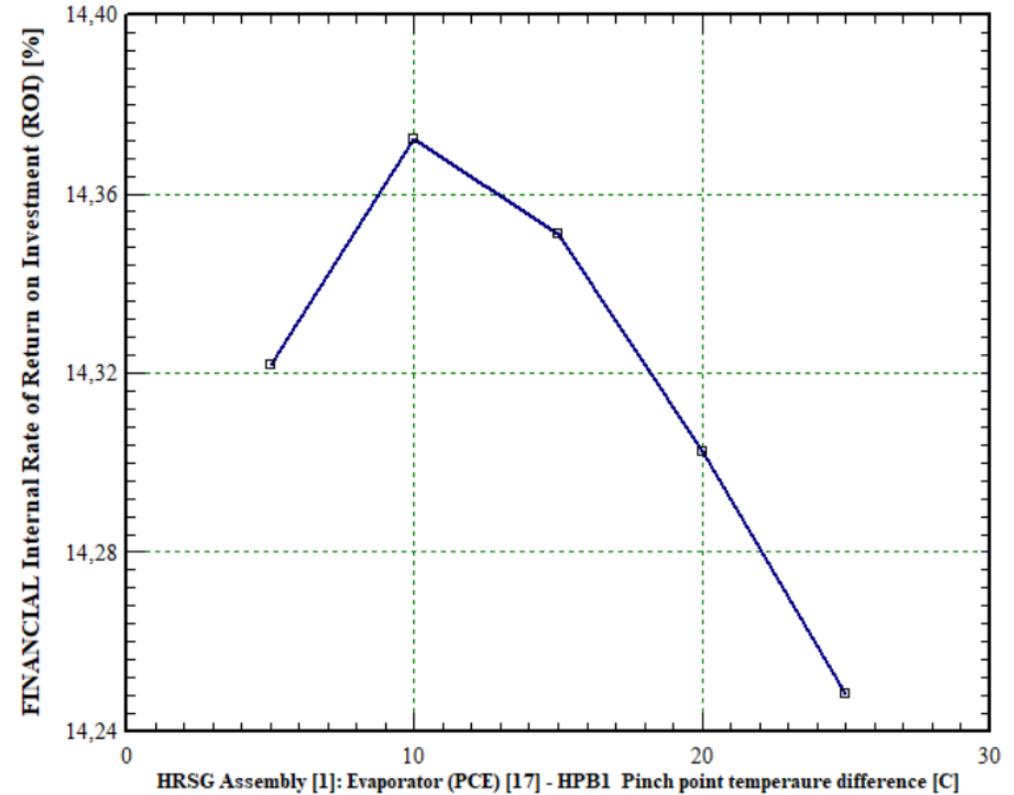
# Techno Economic Optimization

## ROI Calculation

Fuel = 5,1 €/GJ



Fuel = 4,0 €/GJ



## Q & A Session

- Please forward your questions on the WebEx Chat
- Further questions by email to: [info@thermoflow.com](mailto:info@thermoflow.com)
  
- PP Presentation will be available on the Website / Tutorials
- Video will be available on the Service Center

# Thank you!

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