Welcome!

Webinar #26: The Photovoltaic Field Feature in Thermoflex

25 04 2018

Agenda:

* Introduction
* The PV Field Component
* TD Mode / OD Mode: inputs, calculation and outputs
* Annual Output Estimate
* Examples
* 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**

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Feature Awareness Webinars

1- Assemblies in TFX, June 2017
2- Scripts in Thermoflow programs, GTP-GTM-TFX
3- Multi Point Design in GTP-GTM
4- Reciprocating Engines in TFX
5- TIME in GTM
6- Matching ST Perfromance 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 Thermoflex
12- Modelling GT's in Thermoflow programas-1
13- Thermoflex for on line and off line performance monitoring
14- Tflow 27, what's new
15- Modelling GT's in Thermoflow programas-2
16- Multi Point Design in GTP-GTM
17- Total Plant Cost in TFX
18- Steam Turbine Tunning
19- User Defined Components in TFX
20- Cooling System Optimization

……

26- The PV Field in THERMOFLEX

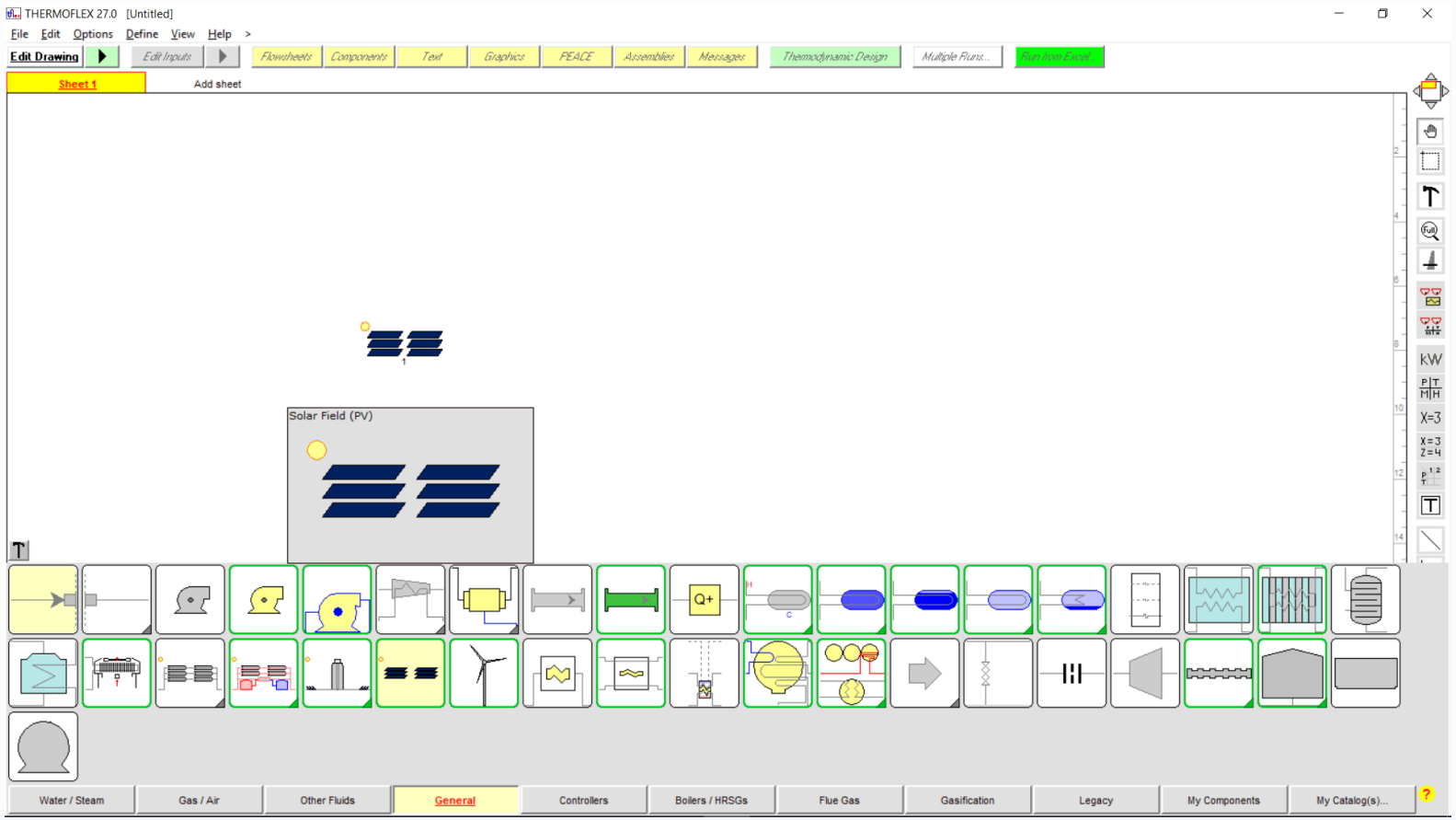
TF Renew - TFR

- New member of TF suite, scheduled for June 2018
- Focus: *to help the Developers to plan and design systems that contain any combination of renewable, storage and thermal power*
- Will integrate current thermal power capabilities, renewables (solar PV, Wind, Hydro, …) and storage systems (cold-hot tanks, batteries, pumped hydro, …)
- Intended to develop a logic to help the user pick reasonable / optimum capacity of renewable source, storage, thermal plant supplement
- Final results showing the whole year, 8.760 hours or defined periods, thermal and renewable production, fuel consumed, … in order to optimize the design for a given set of assumptions

➡ Wait for the announcement, Webinar on May 16

PV Field Component in TFX

- Available since Version 26 (2016)
- Can represent 1 Module or a PV Field



PV Field Component in TFX

- The Solar PV Field model is designed by the program to produce a field with a certain number of rows, each containing a particular number of modules feeding a computed number of DC to AC power inverters.

- The design is created using a snapshot set of irradiance data.

- The model produces a rectangular field that's assumed to be installed on a flat piece of property without any nearby shading from large buildings, trees, mountains, etc.

- Fields with non-rectangular shapes can be produced using multiple rectangular fields, each modeled by a single Solar PV Field icon.

PV Field Component in TFX

TD Mode, Inputs

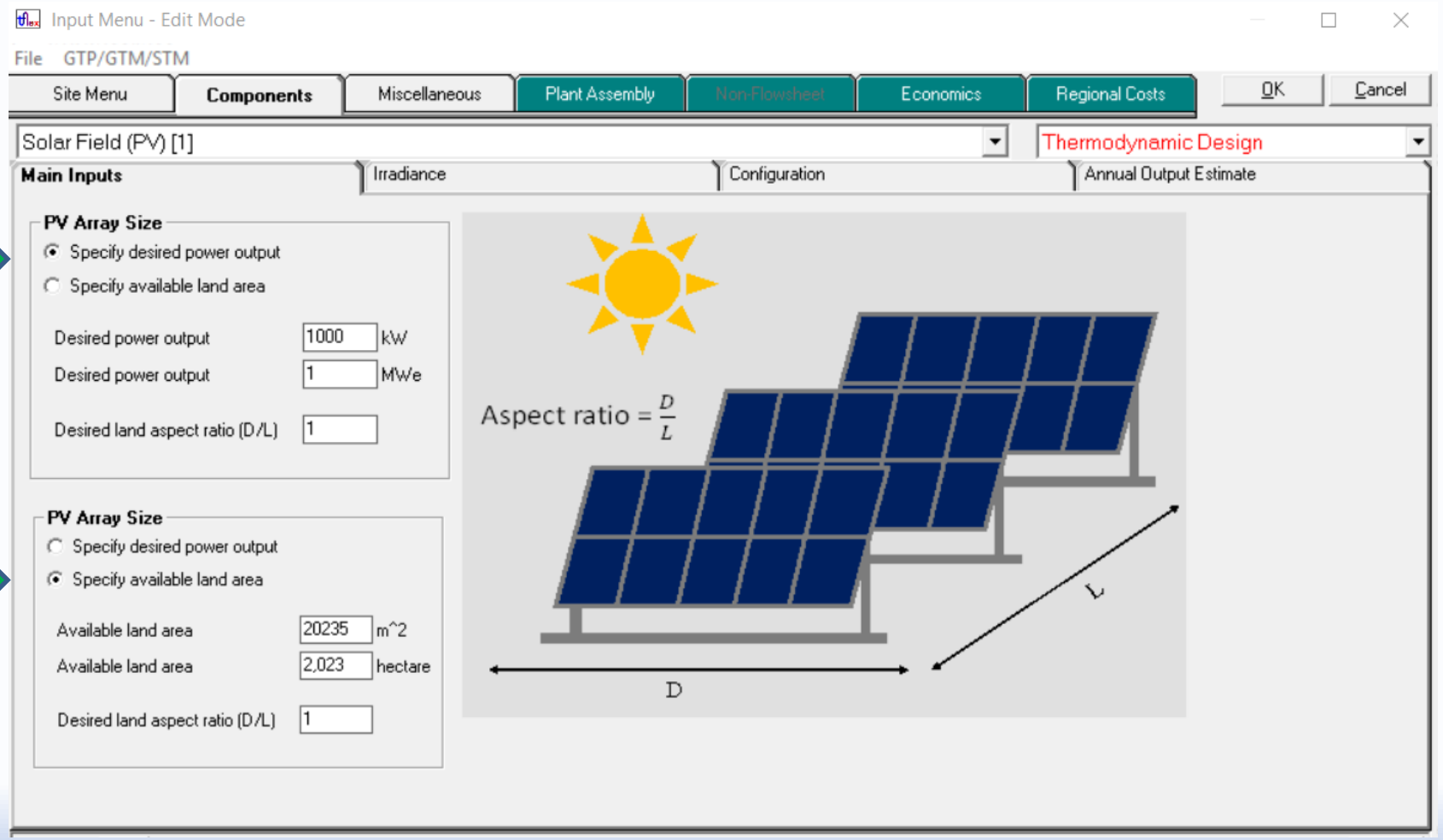
- Specification of the Size of the PV Field: Power or available land area
- Specification of the Irradiance at the design point
- Configuration: Module Definition, Derating, Row Configuration & Inverter
- Annual Output Estimate method

PV Field Component in TFX

Size Specification

Power

Land

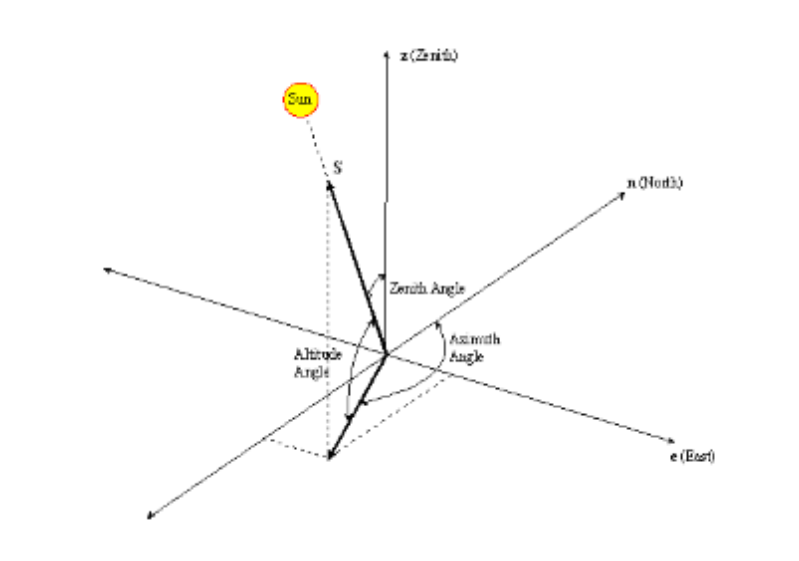


PV Field Component in TFX

Irradiance Specification

Irradiance Specification

- (•) Estimated from site data
- ( ) User-defined POA irradiance
- ( ) User-defined GHI + DNI + Sun position
- ( ) Use database



Estimated Irradiance

Site latitude	35	degrees
Site altitude (for info - edit on TFX Site Menu)	0	m
Day of the year	82	
Hour of the day (solar time)	12	
Cloud cover factor	0	

Day 82 ~ Vernal equinox
Day 173 ~ Summer solstice
Day 264 ~ Autumnal equinox
Day 356 ~ Winter solstice

User-defined Irradiance at Array

Plane of array (POA) irradiance	1000	W/m^2

User-defined Irradiation

Global Horizontal Irradiance (GHI)	800	W/m^2
Direct Normal Irradiance (DNI)	800	W/m^2
Solar zenith angle	11,5	degrees
Solar azimuth angle	180	degrees
Albedo	0,2	

PV Field Component in TFX

Irradiance Specification, Database

Solar Irradiance Database

Day of the year: 82

Hour of the day (local time): 12

Change Location

Chosen Location: DAGGETT BARSTOW-DAGGETT AP, CA
Lat: 34,9 deg, Long: -116,8 deg, Elev: 586 m

Day 82 ~ Vernal equinox
Day 173 ~ Summer solstice
Day 264 ~ Autumnal equinox
Day 356 ~ Winter solstice

Locations in TMY Database

US NREL TMY3 Locations | Environment Canada CWEC Locations

OK

Cancel

Station ID	State	Site Name	Elevation, m	Latitude, °	Longitude, °
723418	AR	TEXARKANA WEBB FIELD	0110	33,45	-94
723406	AR	WALNUT RIDGE (AWOS)	0083	36,133	-90,917
722748	AZ	CASA GRANDA (AWOS)	0446	32,95	-111,767
722745	AZ	DAVIS MONTHAN AFB	0809	32,167	-110,883
722784	AZ	DEER VALLEY/PHOENIX	0450	33,683	-112,083
722735	AZ	DOUGLAS BISBEE-DOUGLAS INTL A	1249	31,467	-109,6
723755	AZ	FLAGSTAFF PULLIAM ARPT	2132	35,133	-111,667
723783	AZ	GRAND CANYON NATL P	2065	35,95	-112,15
723700	AZ	KINGMAN (AMOS)	1033	35,267	-113,95
722785	AZ	LUKE AFB	0331	33,55	-112,367
723710	AZ	PAGE MUNI (AMOS)	1304	36,933	-111,45
722780	AZ	PHOENIX SKY HARBOR INTL AP	0337	33,45	-111,983
723723	AZ	PRESCOTT LOVE FIELD	1537	34,65	-112,417
722747	AZ	SAFFORD (AMOS)	0950	32,817	-109,683
722789	AZ	SCOTTSDALE MUNI	0460	33,617	-111,917
723747	AZ	SHOW LOW MUNICIPAL	1954	34,267	-110
722740	AZ	TUCSON INTERNATIONAL AP	0777	32,133	-110,95
723740	AZ	WINSLOW MUNICIPAL AP	1490	35,033	-110,717
722800	AZ	YUMA INTL ARPT	0063	32,667	-114,6
699604	AZ	YUMA MCAS	0065	32,65	-114,617
725958	CA	ALTURAS	1341	41,5	-120,533
725945	CA	ARCATA AIRPORT	0062	40,983	-124,1
723840	CA	BAKERSFIELD MEADOWS FIELD	0149	35,433	-119,05
724837	CA	BEALE AFB	0038	39,133	-121,433
724800	CA	BISHOP AIRPORT	1250	37,367	-118,35
725845	CA	BLUE CANYON AP	1609	39,3	-120,717
747188	CA	BLYTHE RIVERSIDE CO ARPT	0119	33,617	-114,717
722880	CA	BURBANK-GLENDALE-PASSADENA AP	0226	34,2	-118,35
723926	CA	CAMARILLO (AWOS)	0023	34,217	-119,083
722926	CA	CAMP PENDLETON MCAS	0023	33,3	-117,35
722927	CA	CARLSBAD/PALOMAR	0100	33,133	-117,283
746120	CA	CHINA LAKE NAF	0677	35,683	-117,683
722899	CA	CHINO AIRPORT	0198	33,967	-117,633
722904	CA	CHULA VISTA BROWN FIELD NAAS	0159	32,583	-116,983
724936	CA	CONCORD CONCORD-BUCHANAN FIEL	0007	38	-122,05
725946	CA	CRESCENT CITY FAA AI	0017	41,783	-124,233
723815	CA	DAGGETT BARSTOW-DAGGETT AP	0586	34,85	-116,8

Underlying data source is US NREL TMY3 datafiles.

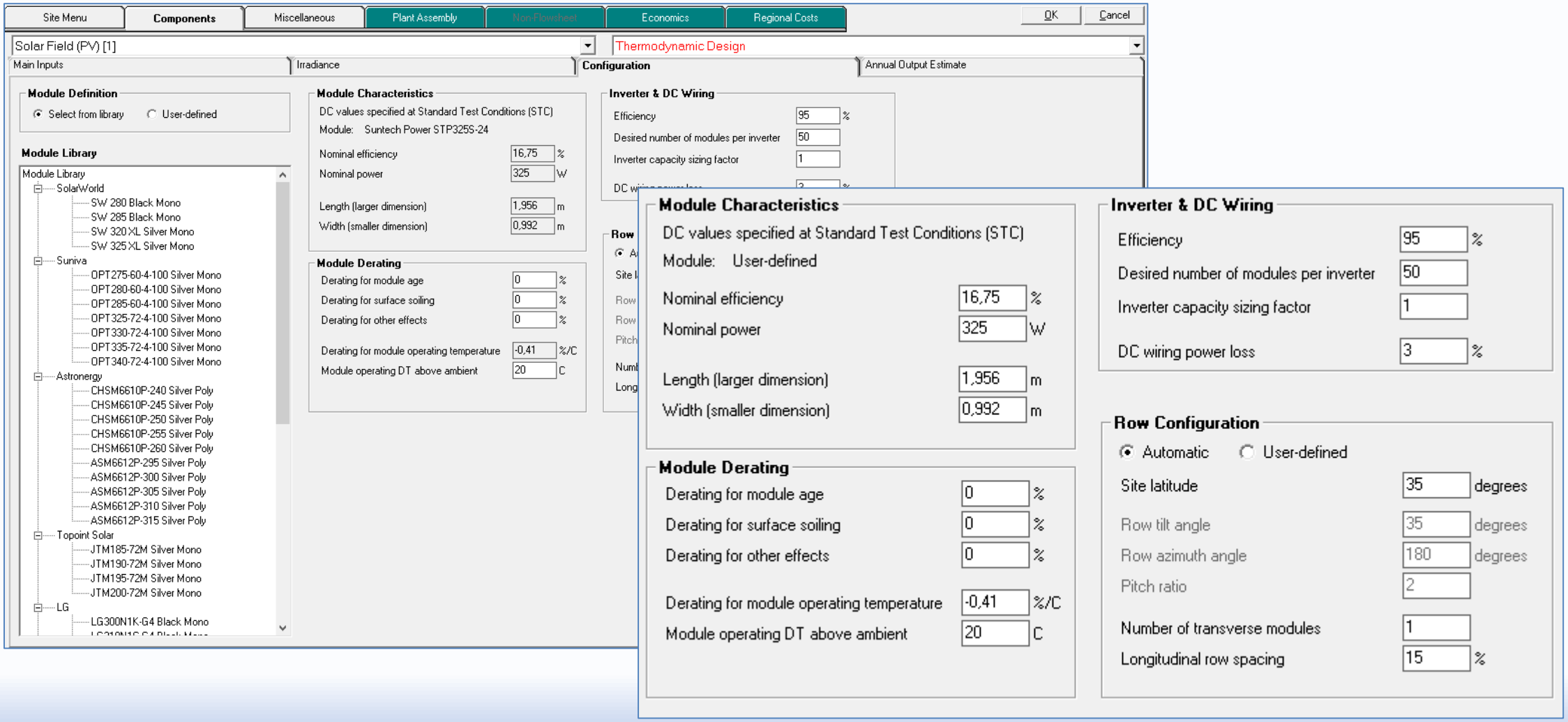
PV Field Component in TFX

Configuration

- Module definition: from Library or User Defined
- Module Derating: age, soil, others, T
- Inverter & DC Wiring
- Row configuration

PV Field Component in TFX

Configuration



PV Field Component in TFX

Derating

The Module Derating panel includes inputs used to characterize module performance under current operating conditions, which are often different from laboratory test conditions. The following four derating inputs are available for your use.

Derating for module age (also referred to as light-induced derating) is an input that accounts for module degradation that occurs as it ages in the field. The default is 0% since it's assumed the field design initially uses newly produced modules. Values greater than or equal to zero may be entered.

Derating for surface soiling is an input that accounts for site-related fouling due to dirt and grime. This input has a default value of 0% since the modules are assumed to be initially new and clean. Note this input is highly site dependent. In dry desert conditions, where little or no cleaning is done this can be a significant source of module derating.

Derating for other effects is a general purpose derating input you can use to derate the module for any sort of reason.

Derating for module operating temperature is an input that works in conjunction with the Module operating DT above ambient input parameter. Module capacity decreases with increasing cell temperature. Typical values in the range -0.3 to -0.5 % per degree C are often listed on spec sheets. While there are complicated models to estimate module operating temperature, these require the user to assume a number of other values as input. To reduce complexity without loss of capability, this model allows the user to specify the module operating temperature as a difference above ambient. In colder windier situations this input will tend to be smaller, and in hot still climates this input will likely be higher. This input may be positive, or negative as appropriate.

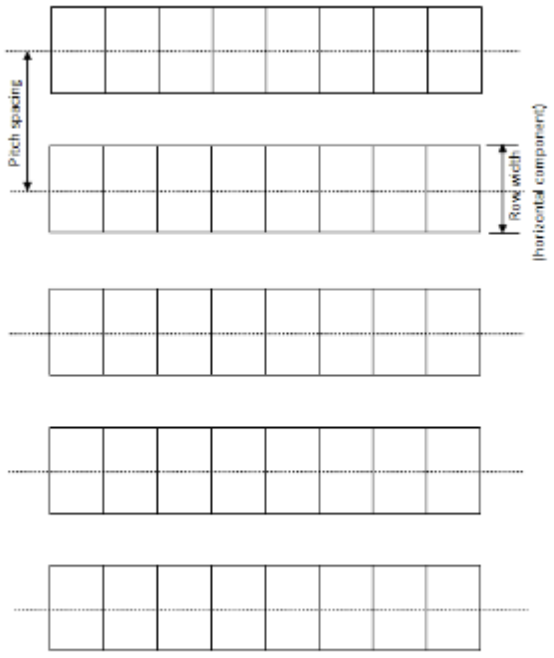
These four derating inputs are used to reduce module efficiency for current operating conditions according to the following equation:

$$\textbf{Current Module Efficiency} = \textbf{Nominal Module Efficiency} * (1-D_1/100) * (1-D_2/100) * (1-D_3/100) * (1-(T_{module}[C] - 25[C]) * D_4/100)$$

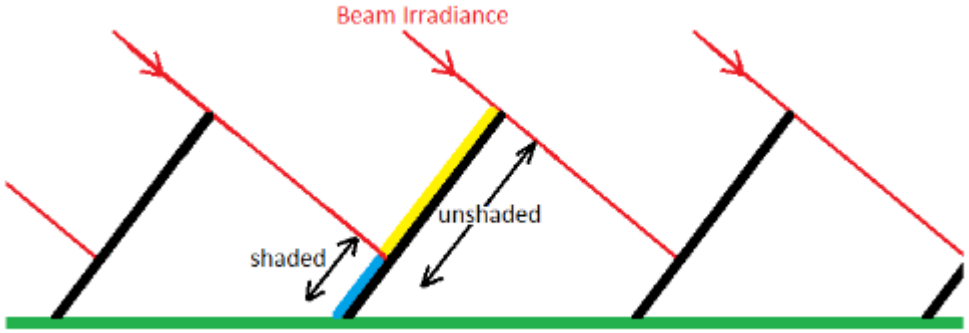
Where D_1 is derating for module age, D_2 is derating for surface soiling, D_3 is derating for other effects, and D_4 is the derating for module operating temperature. T_{module} is computed by adding the Module operating DT above ambient input to THERMOFLEX's current ambient temperature as specified on the Site Menu

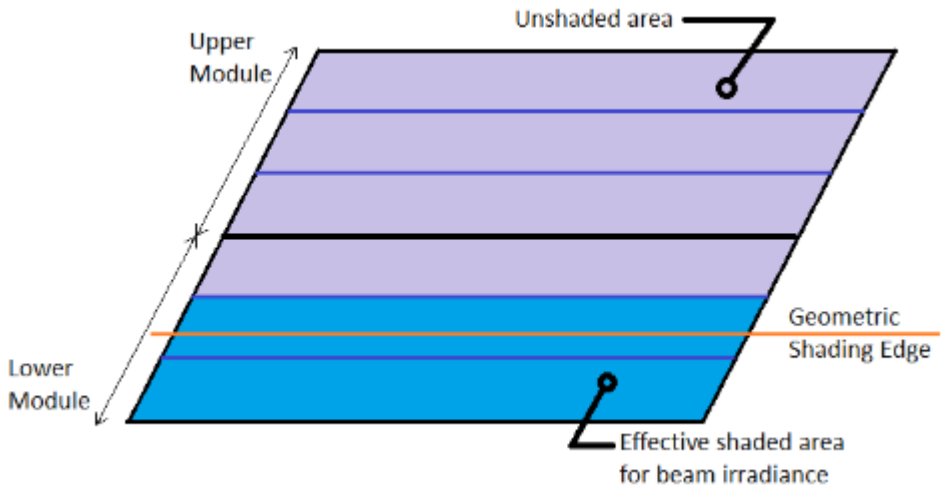
PV Field Component in TFX

Row Configuration



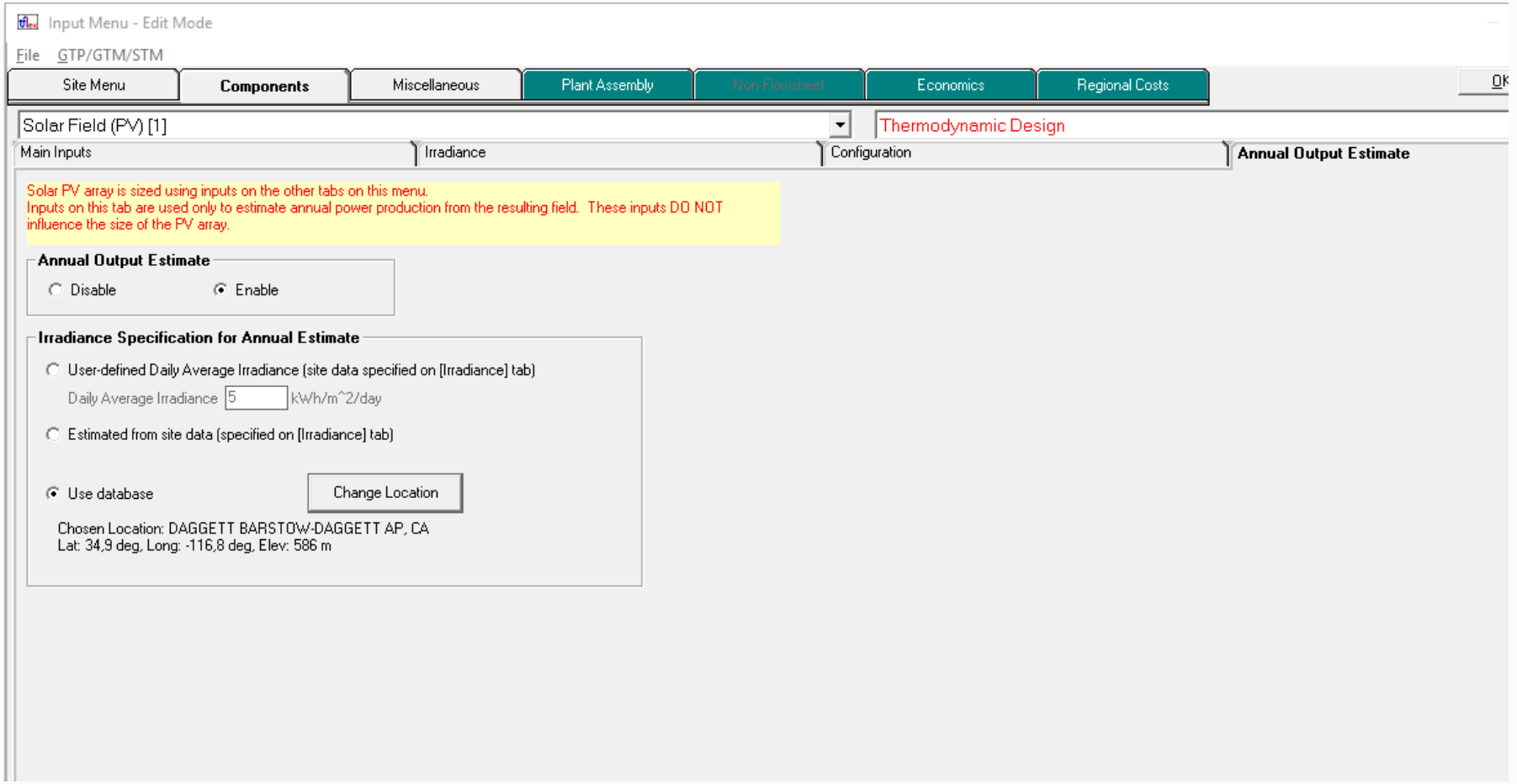
Shading Model





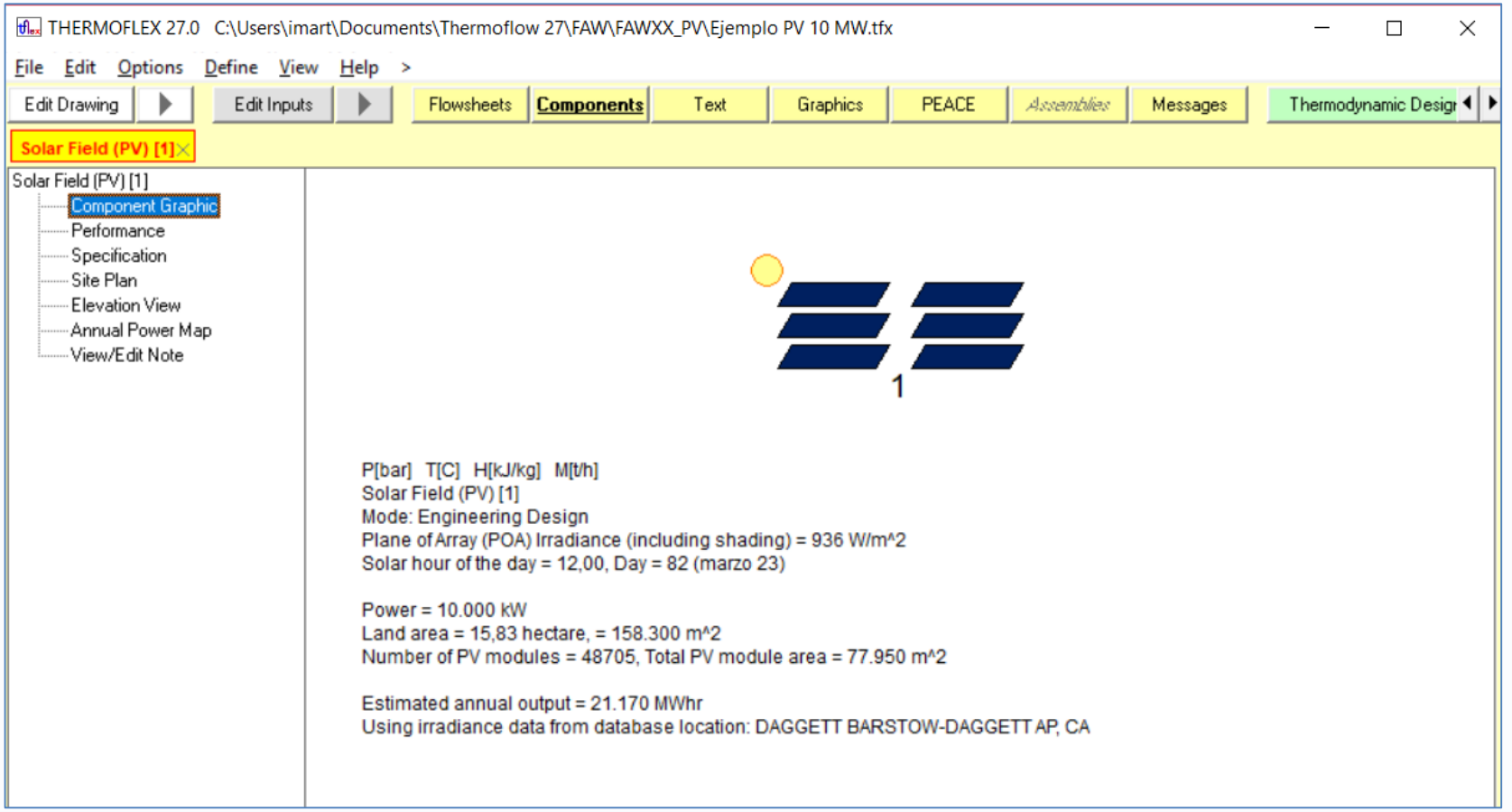
PV Field Component in TFX

Annual Output Estimate



PV Field Component in TFX

TD Mode, Outputs



PV Field Component in TFX

Solar Field (PV)

- Solar Field (PV) [1]
  - Component Graphic
  - Performance
  - Specification
  - Site Plan
  - Elevation View
  - Annual Power Map
  - View/Edit Note

Solar Field (PV) [1]		
1. Performance Summary		
Power output	10	MWe
Power output	10000	kW
Solar irradiance at plane of array	72983	kW
Estimated annual production	21.170	MWhr
2. Operating Conditions		
Irradiance method: Estimated from site data		
Site latitude	35	degrees
Elevation	0	m
Day of the year	82	
Solar hour of the day	12	
Cloud cover factor	0	
Global Horizontal Irradiance	783,5	W/m^2
Direct Normal Irradiance	825	W/m^2
Diffuse Horizontal Irradiance	106,7	W/m^2
Earth's declination angle	0,1224	degrees
Solar zenith angle	34,88	degrees
Solar azimuth angle	180	degrees
Solar altitude angle	55,12	degrees
Angle of incidence	0,1219	degrees
Plane of Array (POA) Irradiance (including shading)	936,2	W/m^2
Plane of Array (POA) beam irradiance	825	W/m^2
Plane of Array (POA) ground-reflected irradiance	14,17	W/m^2
Plane of Array (POA) sky-diffuse irradiance	97,01	W/m^2
IAM correction factor	1	
Geometric row shading percentage (row-to-row shadow)	0	%
Effective row shading percentage for beam irradiance	0	%
Module operating temperature	35	C
Module operating temperature difference above standard test conditions (77F/25C)	10	C
3. Performance (per PV module)		
Current module efficiency	14,87	%
Current module DC capacity	222,8	W
DC wiring loss	6,684	W
Inverter loss	10,81	W
Inverter output power (AC)	205,3	W

PV Field Component in TFX

Estimated Solar Field Data		
Solar Field (PV) [1]		
1. Summary		
Total number of PV modules	48705	
Total PV module area	77.950	m^2
Field DC ('peak') rating	12.180	kW
Field AC rating	10.000	kW
Total land area occupied by the PV field	15,83	hectare
Total land area occupied by the PV field	158.300	m^2
Land aspect ratio	0,9968	
2. Field Details		
PV field length (parallel to the rows)	397,2	m
PV field length (perpendicular to the rows)	398,5	m
Number of rows	231	
Row length (full row)	395,5	m
Row pitch	1,722	m
Row tilt angle	35	degrees
Row azimuth angle	180	degrees
Number of modules in each full row	211	
Percentage occupancy of the last row	82,94	%
3. Module Details		
Module Name	Samsung LPC250SM	
Nominal efficiency	15,62	%
Nominal DC capacity	250	W
Area	1,601	m^2
Length (larger dimension)	1,63	m
Width (smaller dimension)	0,982	m
4. Inverter Details		
Number of inverters	974	
Inverter capacity (each)	10,27	kW
Number of modules per inverter	50,01	

5. Reference Material, Equipment and Installation cost		
Equipment		
Total PV module and racking structure reference cost	10.319.000	USD
Total Inverter and wiring reference cost	3.145.000	USD
Electrical		
Electrical material cost	134.000	USD
Electrical labor	63.800	hours
Electrical labor cost	2.680.000	USD
Mechanical		
Mechanical material cost	46.480	USD
Mechanical labor	22.670	hours
Mechanical labor cost	929.600	USD
Civil		
Excavation/backfill material and equipment cost	76.100	USD
Civil labor	42.280	hours
Civil labor cost	1.522.000	USD
6. Cost Summary		
Total reference installed cost	**18.853.000**	**USD**
Total reference installed cost per unit PV module area	**241,8**	**USD/m^2**
Total reference installed cost per kW 'peak' capacity	**1548,4**	**USD/kW**
Total installed cost adjustment factor	**1**	
Total estimated installed cost	**20.822.000**	**USD**

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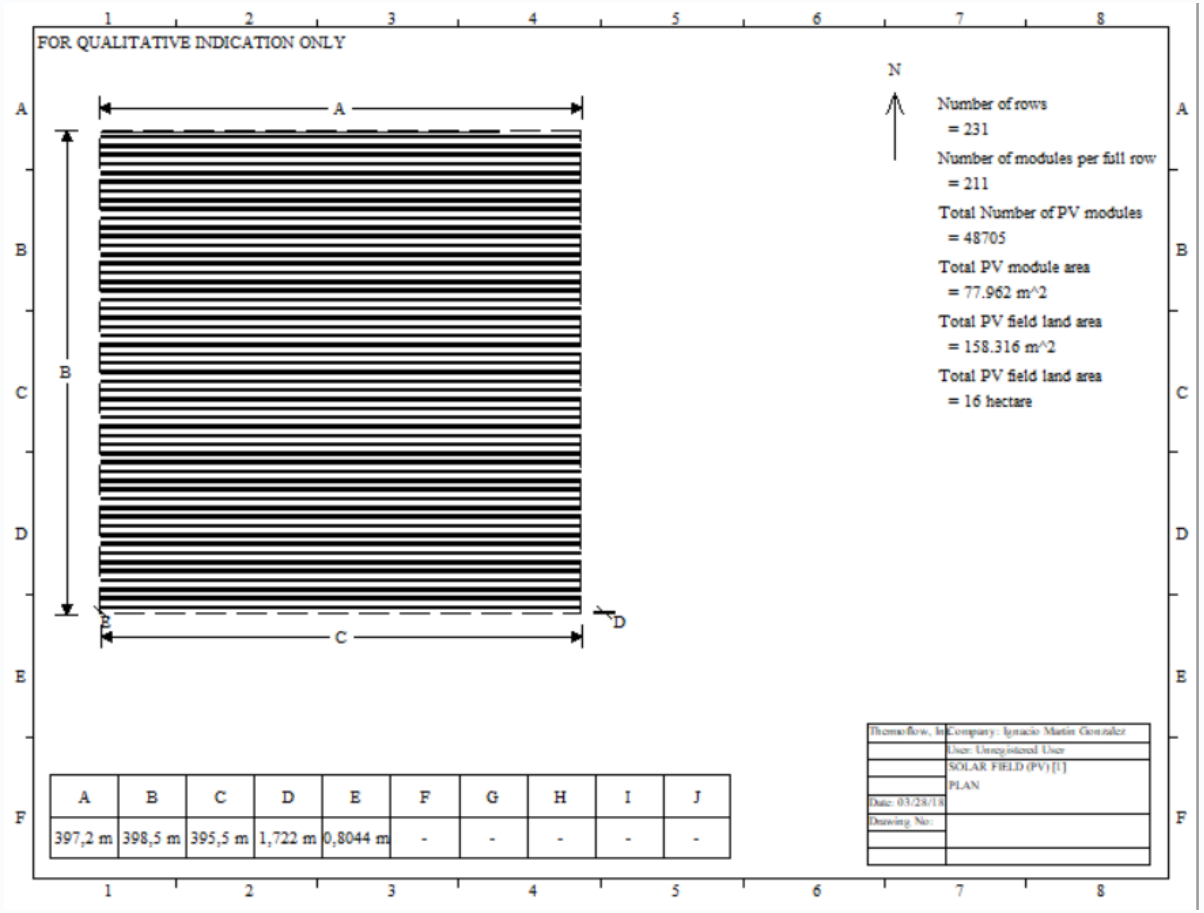
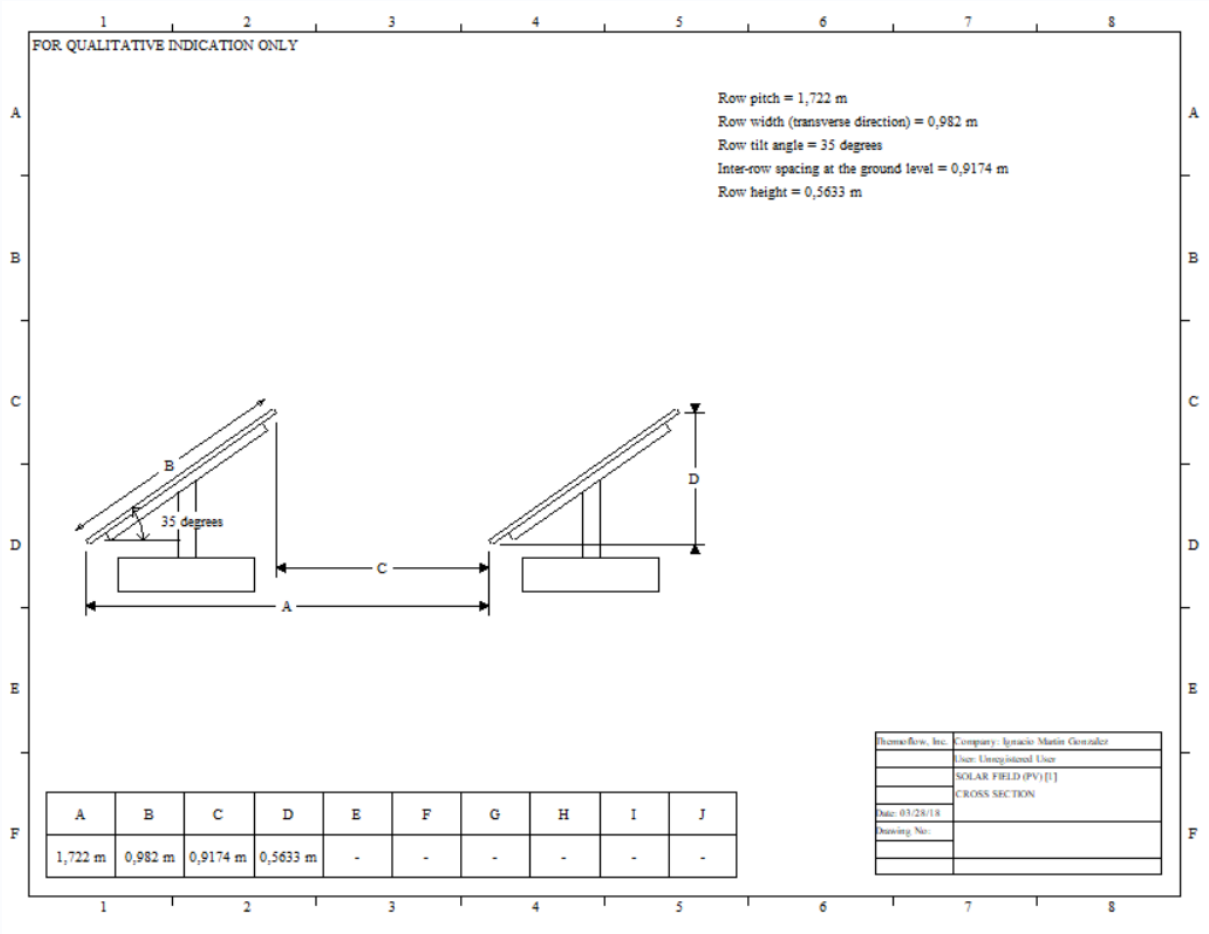
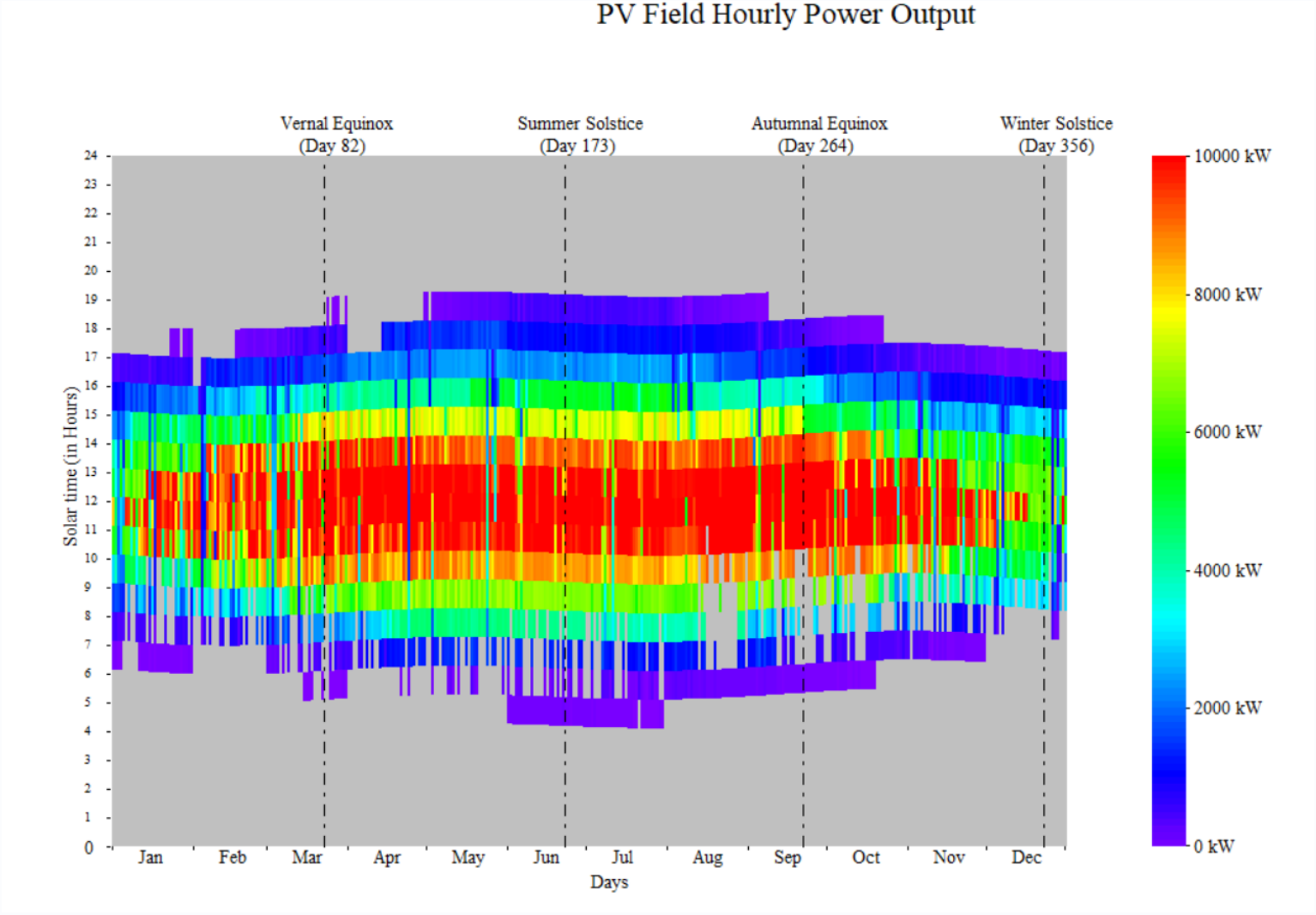
PV Field Component in TFX



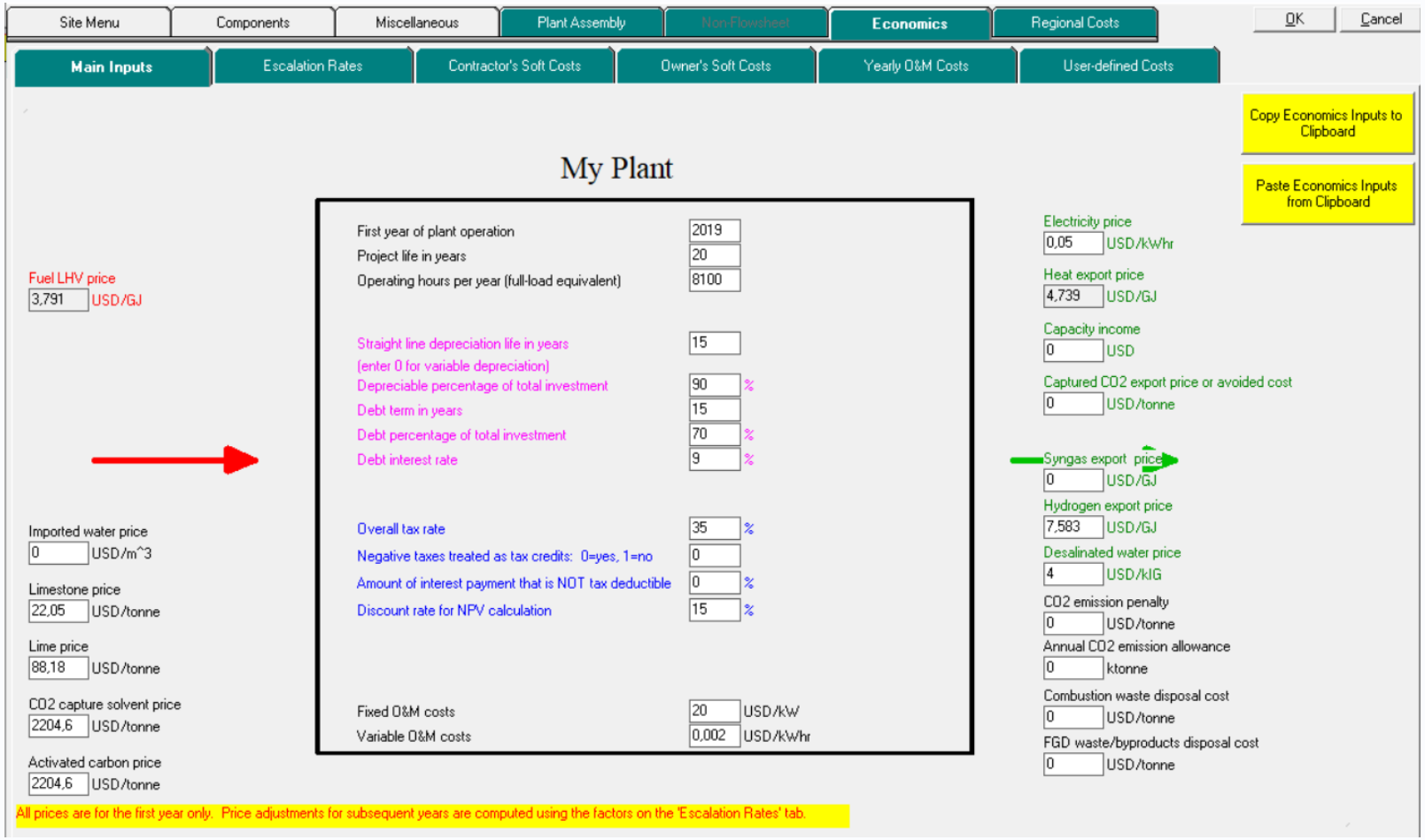


PV Field Component in TFX



PV Field Component in TFX

PEACE, Economic Inputs



PV Field Component in TFX

PEACE, Outputs

PEACE Output - Simplified

File Edit

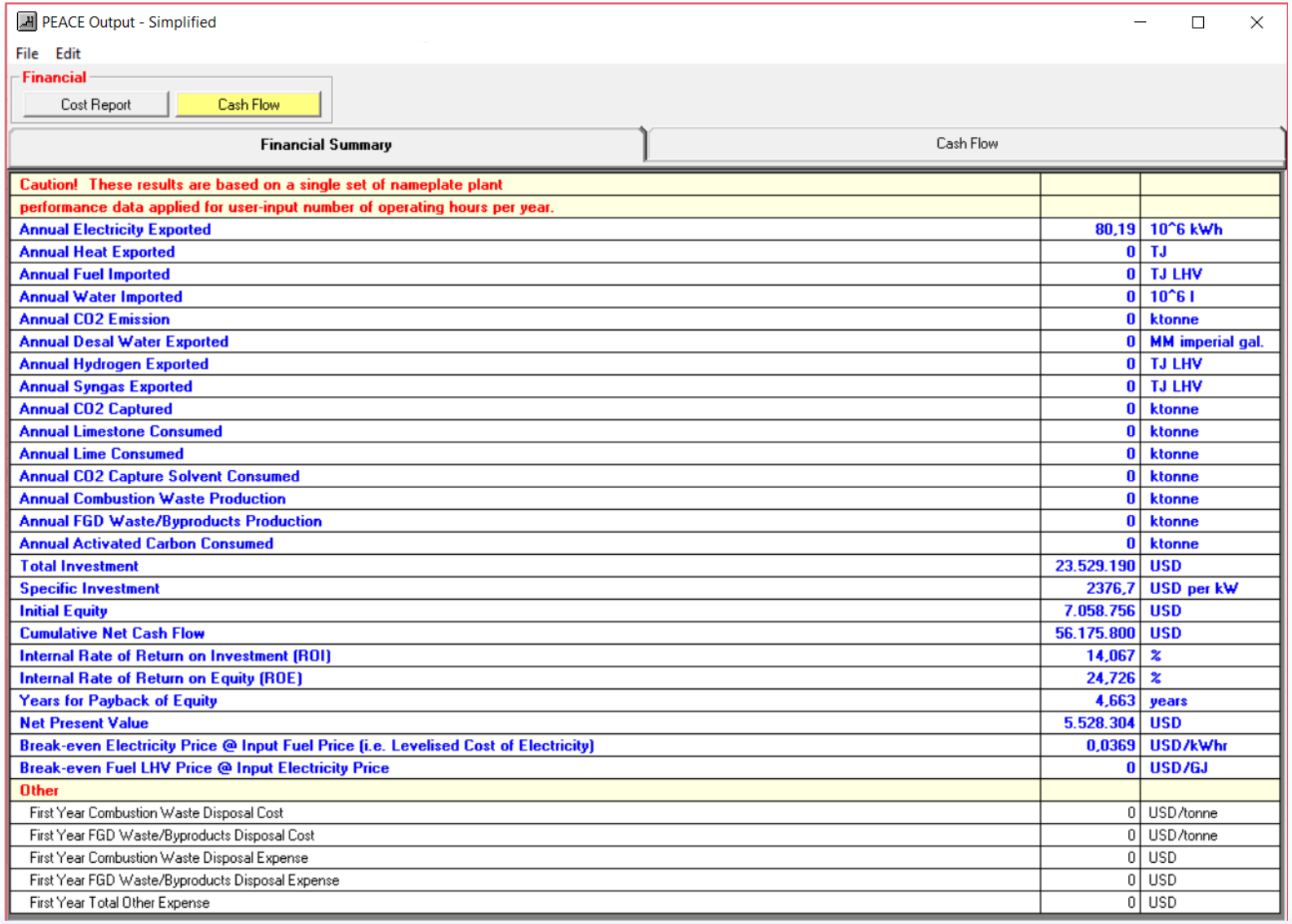
Financial

Cost Report | Cash Flow

Cost Summary | Cost Breakdown

Cost Summary	Estimated Cost	
1. Sum of Costs for Equipment and PEACE Components	20.822.290	USD
2. Sum of User-defined Costs	0	USD
3. Sum of PEACE Components, Linked Files, and User-defined Costs (Contractor's Internal Cost)	20.822.290	USD
Contractor's Soft & Miscellaneous Costs	832.892	USD
4. Contractor's Price	21.655.180	USD
Owner's Soft & Miscellaneous Costs	1.874.006	USD
5. Total - Owner's Cost - See Cautionary Note Below	23.529.190	USD
6. Plant Net Electric Output	9,9	MWe
Cautionary Note:		
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.		

PV Field Component in TFX


PEACE Output - Simplified

File Edit

Financial

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	80,19	10^6 kWh
Annual Heat Exported	0	TJ
Annual Fuel Imported	0	TJ LHV
Annual Water Imported	0	10^6 l
Annual CO2 Emission	0	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	23.529.190	USD
Specific Investment	2376,7	USD per kW
Initial Equity	7.058.756	USD
Cumulative Net Cash Flow	56.175.800	USD
Internal Rate of Return on Investment (ROI)	14,067	%
Internal Rate of Return on Equity (ROE)	24,726	%
Years for Payback of Equity	4,663	years
Net Present Value	5.528.304	USD
Break-even Electricity Price @ Input Fuel Price (i.e. Levelised Cost of Electricity)	0,0369	USD/kWhr
Break-even Fuel LHV Price @ Input Electricity Price	0	USD/GJ
Other		
First Year Combustion Waste Disposal Cost	0	USD/tonne
First Year FGD Waste/Byproducts Disposal Cost	0	USD/tonne
First Year Combustion Waste Disposal Expense	0	USD
First Year FGD Waste/Byproducts Disposal Expense	0	USD
First Year Total Other Expense	0	USD

PV Field Component in TFX

Cash Flow USD	2019 (1)	2020 (2)	2021 (3)	2022 (4)	2023 (5)	2024 (6)	2025 (7)	2026 (8)	2027 (9)	2028 (10)	2029 (11)	2030 (12)	2031 (13)	2032 (14)	2033 (15)	2034 (16)	2035 (17)	2036 (18)	2037 (19)	2038 (20)
Escalators																				
Inflation	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
Fuel	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
Steam	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
Electricity	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
kW degrade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat Rate increase	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imported Water	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
CO2 Emission Penalty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desal water	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
H2 from syngas	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
Reagent	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
Activated carbon	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
Prices																				
Electricity, USD per kWh	0,05	0,0523	0,0546	0,0571	0,0596	0,0623	0,0651	0,068	0,0711	0,0743	0,0776	0,0811	0,0848	0,0886	0,0926	0,0968	0,1011	0,1057	0,1104	0,1154
Fuel, USD/GJ	3,791	3,962	4,14	4,327	4,521	4,725	4,937	5,16	5,392	5,634	5,888	6,153	6,43	6,719	7,022	7,338	7,668	8,013	8,373	8,75
Steam, USD/GJ	4,739	4,953	5,175	5,408	5,652	5,906	6,172	6,45	6,74	7,043	7,36	7,691	8,037	8,399	8,777	9,172	9,585	10,02	10,47	10,94
Imported Water, USD/m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2 Emission Penalty, USD/tonne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desal water, USD per 1000 imperial gallon	4	4,18	4,368	4,565	4,77	4,985	5,209	5,443	5,688	5,944	6,212	6,491	6,784	7,089	7,408	7,741	8,089	8,454	8,834	9,231
H2 from syngas, USD/GJ	7,583	7,924	8,281	8,653	9,043	9,45	9,875	10,32	10,78	11,27	11,78	12,31	12,86	13,44	14,04	14,68	15,34	16,03	16,75	17,5
Syngas, USD/GJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limestone, USD/tonne	22,05	23,04	24,08	25,16	26,29	27,47	28,71	30	31,35	32,76	34,24	35,78	37,39	39,07	40,83	42,67	44,59	46,59	48,69	50,88
Lime, USD/tonne	88,18	92,15	96,3	100,6	105,2	109,9	114,8	120	125,4	131,1	136,9	143,1	149,6	156,3	163,3	170,7	178,3	186,4	194,8	203,5
Captured CO2, USD/tonne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2 capture solvent, USD/tonne	2204,6	2303,8	2407,5	2515,8	2629,1	2747,4	2871	3000	3135	3276	3424	3578	3739	3907	4083	4267	4459	4659	4869	5088
Activated carbon, USD/tonne	2204,6	2303,8	2407,5	2515,8	2629,1	2747,4	2871	3000	3135	3276	3424	3578	3739	3907	4083	4267	4459	4659	4869	5088
Plant Data																				
Electricity Exported, 10^6 kWh	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19	80,19
Fuel Imported, TJ LHV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenues																				
Electricity	4.009.469	4.189.895	4.378.440	4.575.470	4.781.366	4.996.528	5.221.371	5.456.333	5.701.868	5.958.452	6.226.583	6.506.775	6.799.584	7.105.566	7.425.316	7.759.455	8.108.631	8.473.519	8.854.827	9.253.294
Capacity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desal water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2 from syngas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syngas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Captured CO2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4.009.469	4.189.895	4.378.440	4.575.470	4.781.366	4.996.528	5.221.371	5.456.333	5.701.868	5.958.452	6.226.583	6.506.775	6.799.584	7.105.566	7.425.316	7.759.455	8.108.631	8.473.519	8.854.827	9.253.294
Operating Expenses																				
Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limestone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lime	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2 capture solvent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imported Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2 Emission Penalty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activated carbon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inflating O&M	358.377	374.504	391.357	408.968	427.372	446.603	466.700	487.702	509.648	532.583	556.549	581.594	607.765	635.115	663.695	693.561	724.771	757.386	791.468	827.085
Book Value O&M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Constant O&M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	358.377	374.504	391.357	408.968	427.372	446.603	466.700	487.702	509.648	532.583	556.549	581.594	607.765	635.115	663.695	693.561	724.771	757.386	791.468	827.085
Operating Income	**3.651.091**	**3.815.391**	**3.987.083**	**4.166.502**	**4.353.994**	**4.549.925**	**4.754.671**	**4.968.632**	**5.192.220**	**5.425.870**	**5.670.034**	**5.925.185**	**6.191.819**	**6.470.451**	**6.761.621**	**7.065.894**	**7.383.859**	**7.716.133**	**8.063.359**	**8.426.209**
-Depreciation	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	1.411.751	0	0	0	0	0
-Deductible Interest Exp	1.482.339	1.431.852	1.376.821	1.316.838	1.251.456	1.180.190	1.102.509	1.017.838	925.546	824.948	715.296	595.775	465.436	323.495	168.713	0	0	0	0	0
Pre-Tax Income	**757.001**	**971.787**	**1.198.511**	**1.437.913**	**1.690.787**	**1.957.984**	**2.240.410**	**2.539.042**	**2.854.922**	**3.189.171**	**3.542.986**	**3.917.659**	**4.314.570**	**4.735.204**	**5.181.157**	**7.065.894**	**7.383.859**	**7.716.133**	**8.063.359**	**8.426.209**
-Tax	264.951	340.126	419.479	503.270	591.775	685.294	784.144	888.665	999.223	1.116.210	1.240.045	1.371.180	1.510.100	1.657.321	1.813.405	2.473.063	2.584.351	2.700.646	2.822.176	2.949.173
-Non-Deductible Interest Exp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income	**492.051**	**631.662**	**779.032**	**934.643**	**1.099.012**	**1.272.689**	**1.456.267**	**1.650.378**	**1.855.700**	**2.072.961**	**2.302.941**	**2.546.478**	**2.804.470**	**3.077.883**	**3.367.752**	**4.592.831**	**4.799.509**	**5.015.487**	**5.241.184**	**5.477.036**
Debt Principal Payment	560.965	611.451	666.482	726.465	791.847	863.114	940.794	1.025.465	1.117.757	1.218.355	1.328.007	1.447.528	1.577.805	1.719.808	1.874.591	0	0	0	0	0
Debt Coverage	1,79	1,87	1,95	2,04	2,13	2,23	2,33	2,43	2,54	2,66	2,77	2,9	3,03	3,17	3,31	0	0	0	0	0
Net Cash Flow	1.342.838	1.431.962	1.524.301	1.619.929	1.718.915	1.821.327	1.927.224	2.036.663	2.149.694	2.266.357	2.386.685	2.510.702	2.638.416	2.769.826	2.904.913	4.592.831	4.799.509	5.015.487	5.241.184	5.477.036
Cumulative Net Cash Flow	**1.342.838**	**2.774.799**	**4.299.101**	**5.919.030**	**7.637.946**	**9.459.272**	**11.386.500**	**13.423.160**	**15.572.850**	**17.839.210**	**20.225.890**	**22.736.600**	**25.375.010**	**28.144.840**	**31.049.750**	**35.642.580**	**40.442.090**	**45.457.580**	**50.698.760**	**56.175.800**

PV Field Component in TFX

OD Mode

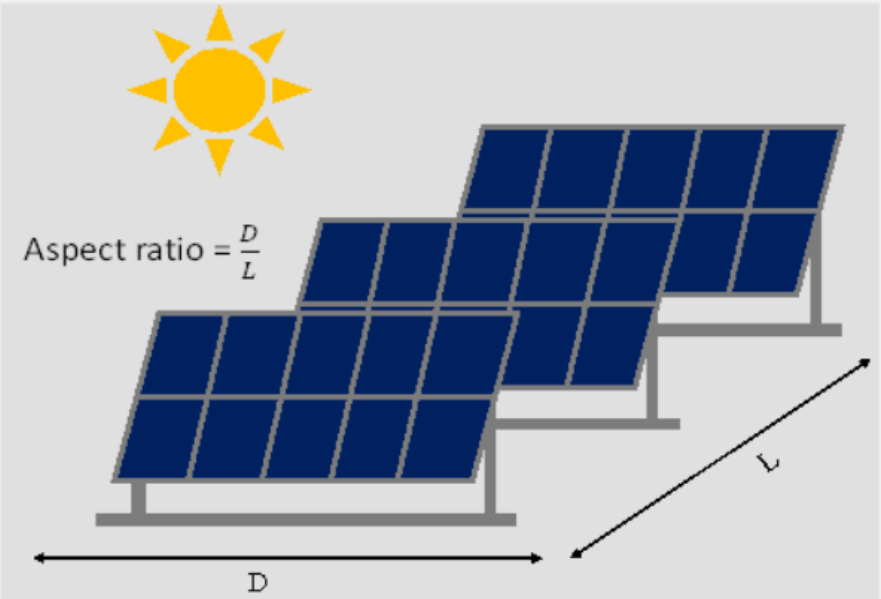
- Working / Out of service
- Irradiance = TD
- Configuration: Hardware inputs, Derating
- Annual Output Estimate = TD

PV Field Component in TFX

OD Main Inputs | Irradiance

Component Status

(•) Working ( ) Out-of-service



Module Characteristics

DC values specified at Standard Test Conditions (STC)

Module: User-defined

Nominal efficiency	15,62	%
Nominal power	250	W
Length (larger dimension)	1,63	m
Width (smaller dimension)	0,982	m

Module Derating

Derating for module age	0	%
Derating for surface soiling	0	%
Derating for other effects	0	%
Derating for module operating temperature	-0,48	%/C
Module operating DT above ambient	20	C

Inverter & DC Wiring

Inverter efficiency	95	%
Total number of inverters in field	974	
Inverter AC capacity (each)	10,27	kW
DC wiring power loss	3	%

Row Configuration

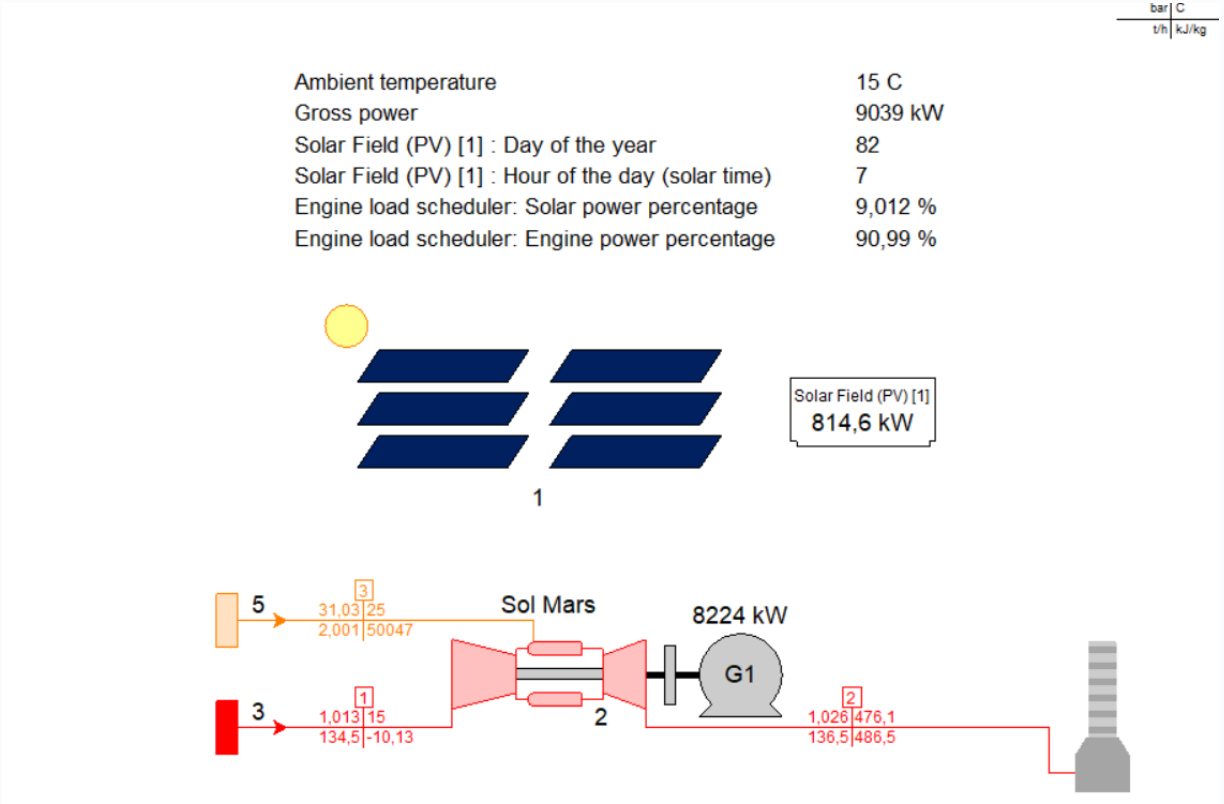
Row tilt angle	35	degrees
Row azimuth angle	180	degrees
Row pitch	1,722	m
Number of traverse modules	1	
Longitudinal row spacing	15	%
Desired row length	395,5	m
Number of rows	231	

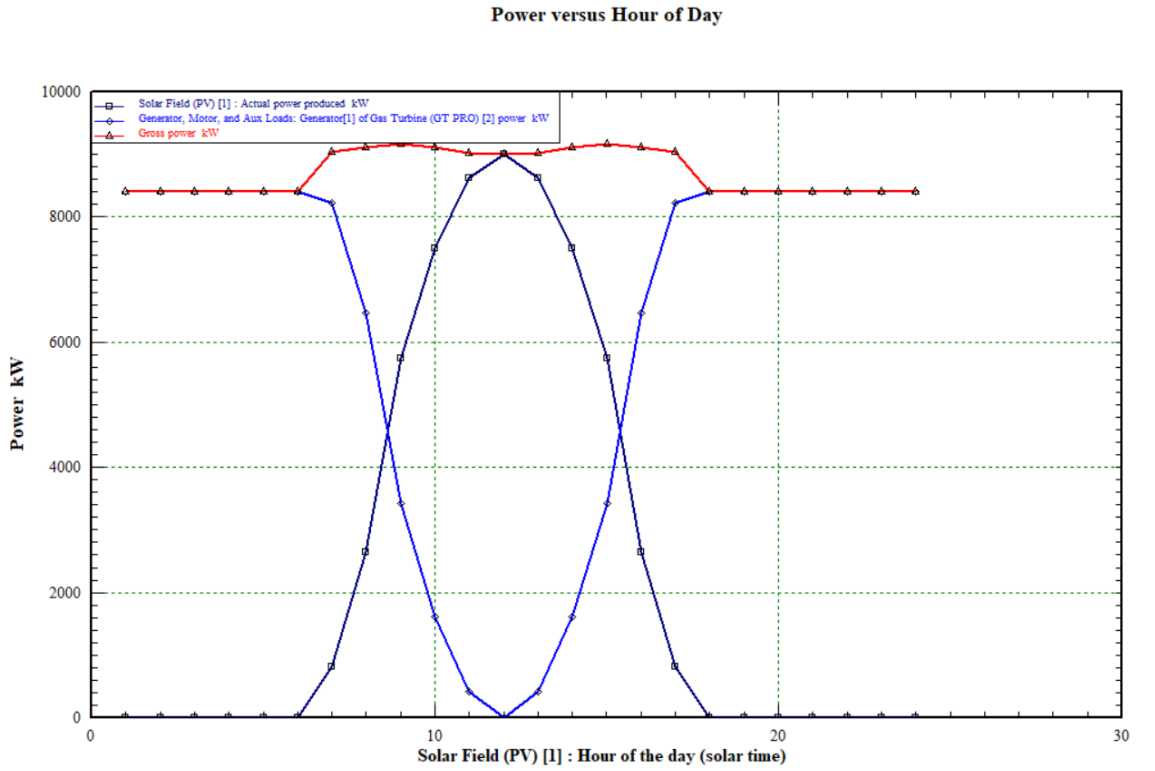
Final Row

( ) Full (•) Partial Desired occupancy 82,94 %

PV Field Component in TFX

Sample: (S5-22) Solar PV with Gas Turbine Backup using Scripting





Conclusions

TD Mode:

- Size the field based on a desired kW or available land
- Select a commercial PV module or enter your user defined data
- Choose from several methods of Irradiance specification, including database for USA and Canada
- Initial Estimation of Land required, Annual Output and Cost
- Initial Comparison of Performance of a PV Field at different sites
- Initial Comparison of Performance and Cost of different PV Fields at one site

OD Mode:

- Specify final configuration and hardware, include derating
- Annual Output Estimation from a Solar Database, 8760 hours data

Hybrid Plants

- Conventional (GT, Recip. Engine, …) + PV
- Renewal (Wind, Solar Thermal, …) + PV

Q & A Session

- Please forward your questions on the WebEx Chat
- Further questions by email to: **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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