April 15, 2025

Dear Customer,

We are pleased to release Version 33 of our software suite. This maintenance release includes updated cost estimates for all programs, new user interfaces for select programs, and other features/additions described below.

## PEACE

Gas power market activity has intensified since early last year. A combination of under-development of dispatchable power during the renewables push, replacement of old baseload plants, and intense interest in new power-hungry data centers conspired to cause a surge in project development activity. Major equipment suppliers and large EPCs now have full order books into 2029/2030. Consequently, budgetary costs for new plant have risen significantly faster than inflation. Cornerstone components, such as gas turbines, have long lead times resulting in very high costs for fast-track, short-term projects.

Relative to Version 32, PEACE estimates for gas turbines, steam turbines, HRSGs, condensers, large power equipment were revised substantially upwards. Costs for other equipment, labor, and commodities were all increased, to a lesser extent than the major equipment. Multi-unit discount schedule is now set to 'off' for GTs and STs by default. Default assumptions (which should be reviewed for each project) for both Contractor and Owner soft and miscellaneous costs were increased. Default prices for electricity, fuel, and heat (for which no universal assumptions are valid) were increased.

Estimated cost for a typical model built in Version 32, re-computed using Version 33 will be about 35% higher. However, changes to program-initialized inputs, many of which users regularly leave unchanged, mean building the same plant model in Version 33 that had been built in Version 32 will result in estimated owner costs being anywhere from 1.5 to 2.25 times higher, depending on specifics.

Estimated EPC cost for a typical 2x1 F-class reheat GTCC with ACC, located in the US gulf coast, increased by approximately 50% relative to Version 32 (early 2024). This plant is now estimated to have an EPC cost of 1425 $/kW. Estimated Owner cost for this plant is now just over 1800 $/kW.

Estimated EPC cost for a for a simple cycle peaking plant with 4 large aero-derivative gas turbines equipped with emissions abatement, located in the US gulf coast, is about twice what it was in Version 32 (early 2024) estimate. Estimated EPC cost is now about 2065 $/kW while estimated Owner cost is 2625 $/kW.

Cost estimate for wind farms was left at 2024 levels, while battery and inverter prices were revised modestly lower to track that market.

Solar PV plant cost estimates were held steady at 2024 levels. The cost model produces results somewhat higher than current expectations for utility-scale US projects. Estimates for other regions and smaller sizes may require user adjustment to the cost modifier to adequately represent costs in those market. Solar PV facilities are built using large quantities of relatively inexpensive commodities. Consequently, estimates vary widely due to effects of local commodity sourcing, local building codes and customs, bulk purchasing power from ordering trainloads of parts for multiple projects, government incentives, tariffs, and other externalities.

Tariffs affect estimated cost for 'imported' equipment. PEACE cannot automatically account for this effect. In situations where known tariffs are in effect, the user may wish to select the [Detailed] option on the [Plant Criteria] - [Regional Costs] topic to specify tariff levels for specific items. Alternatively, factors on the [Cost Modifiers] topics under the [Other PEACE] topic may be edited to account for tariffs.

PEACE cannot automatically capture pricing dynamics in extremely competitive markets where a large number of projects are bidding for a relatively scarce number of available key components. Users considering real projects with near-term schedules must be sure to inquire with OEMs to verify budgetary prices for critical equipment, and not rely solely on PEACE-produced estimates.

Reference currency exchange rates, relative to the USD, and regional cost multipliers were revised.

## Ongoing Maintenance

Our multi-year maintenance effort to re-structure our programs to ensure stability, longevity, and maintainability well into the future continues. This version includes new user interfaces for Plant Design Expert (PDE), RE-MASTER X, RE-MASTER N, RE-MASTER NX, and PROFUEL. These were entirely rewritten using a modern, well-supported programming language that is tightly integrated with current and foreseen versions of MS Windows. To ensure a seamless transition, we maintained the same look-and-feel we've used for over two decades, so all the model inputs you use and all the reports you rely on are in the same place and provide the same functionality.

## Updates Affecting Multiple Programs

**Gas Turbine Database** – The gas turbine database was updated with the following additions.

787: GE 9HA.02 performance updated
869: Doosan DGT6-300H S1 added to library
870: Doosan DGT6-300H S2 added to library

**Solar PV Panel Database** – PV panel database used by THERMOFLEX and NOVO PRO was updated with the inclusion of 356 new panels, as follows.

| OEM | Number Panels Added |
|---|---|
| Adani Solar (new OEM to database) | 7 |
| Aiko (new OEM to database) | 36 |
| Astronergy | 5 |
| CanadianSolar | 46 |
| First Solar | 16 |
| GCL | 2 |
| JA Solar | 9 |
| Jinko Solar | 30 |
| Longi | 5 |
| REC | 7 |

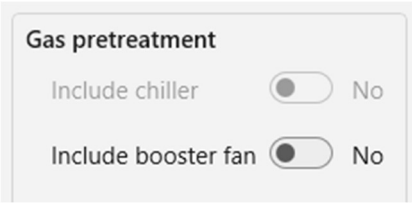
| | |
|---|---|
| RenewSys (new OEM to database) | 27 |
| Suntech Power | 31 |
| Talesun | 24 |
| Tongwei Solar (new OEM to database) | 10 |
| Trina Solar | 42 |
| Vikram Solar (new OEM to database) | 41 |
| Yingli Solar | 18 |

**Wind Turbine Database** – Wind Turbine database used by THERMOFLEX and NOVO PRO was updated with the inclusion of the following models/

| **OEM** | **Turbine** |
|---|---|
| Enercon | E-175EP5E2/7000 |
| Hanjin | HJWT1500/77 |
| Hanjin | HJWT2000/87 |
| Hanjin | HJWT2000/93 |
| Vensys | VENSYS82-1.85MW |
| Vensys | VENSYS175-7.8MW |
| Vestas | V172-7.2MW |
| Vestas | V236-15MW |
| Vestas | V236-15MW |

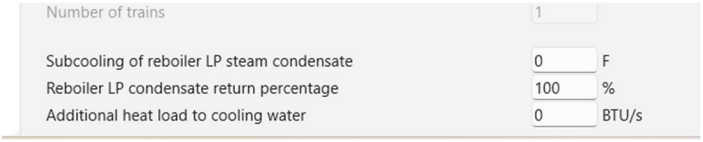
## GT PRO & GT MASTER

1. CO2 Capture System model improvements:
    a. Defaults for newly created designs were revised to be more consistent with current practice. Default capture efficiency was raised from 85% to 95%. Default heat input was raised from 1100 to 1500 BTU/lb (2558 to 3489 kJ/kg) consistent with the 95% desired capture efficiency. Assumed flue gas pressure loss was reduced from 50 in H2O / 124.5 mbar to 32 in H2O / 80 bar.
    b. GT PRO now includes an option to specify if a dedicated forced draft fan is included or not. The default remains to include this fan. When excluded, the gas turbine exhaust pressure increases to overcome this loss. This leads to back pressures that are considerably higher than for typical HRSG applications. The range of back pressures supported by some engine models in the library may be too limited to support this calculation. Users are advised to consult GT OEMs to ensure the resulting back pressure is suitable for a given engine.

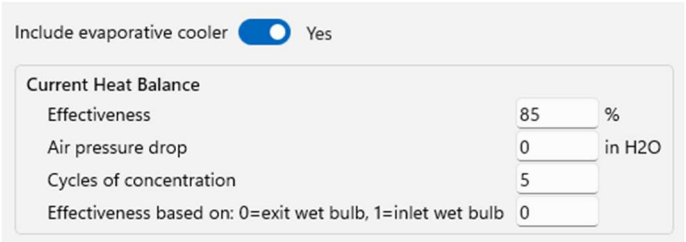



    c. The reboiler heat (steam) source now includes an ‘External’ option in addition to the complete list of internal sources. This allows sourcing steam at user-defined conditions from outside the plant model.

d. Three new inputs were added to the [Miscellaneous] tab of the [CO2 Capture - Other] topic. The first allows the reboiler heating stream to return subcooled condensate. The second allows specifying loss (blowdown) of reboiler heating steam. The third allows specifying additional heat to be carried away by the CO2 capture system cooling water stream. The defaults for these inputs reflect the previous assumptions that were built into the model before these inputs were added.



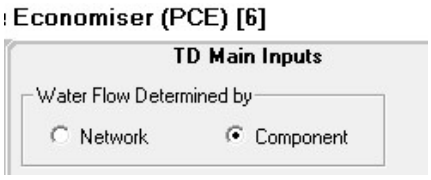

2. Evaporative cooler effectiveness basis: historically, the effectiveness calculation in Thermoflow models was based on wet bulb temperature at the compressor inlet, after pressure losses in the filter and cooling media. However, some wish to specify this parameter based on the ambient wet bulb, particularly for acceptance testing purposes. The new 'Effectiveness based on:' flag, shown here, allows you to specify the basis on which the wet bulb is computed. This input is available on the [Evaporative Cooler] topic under the [Inlet Heating & Cooling] topic on the [GT Inputs] topic.



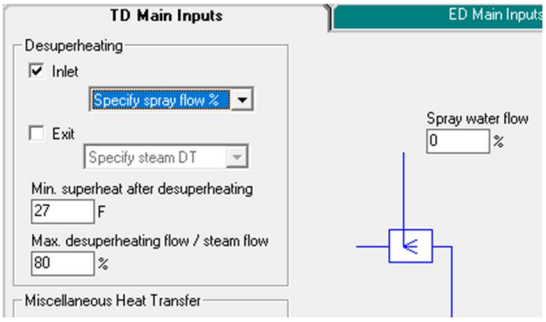

3. A new option to limit desuperheating water flow was added to GT PRO and GT MASTER to augment the existing minimum superheat limit. The new additional limit allows specifying the maximum desuperheating flow as a percentage of the steam flowrate entering the desuperheater. These inputs are available on the [Design Point Desuperheating] topic under the [HRSG Layout] topic in GT PRO. They're available [Temperature Set Points] topic under the [HRSG Inputs] topic in GT MASTER.

## THERMOFLEX

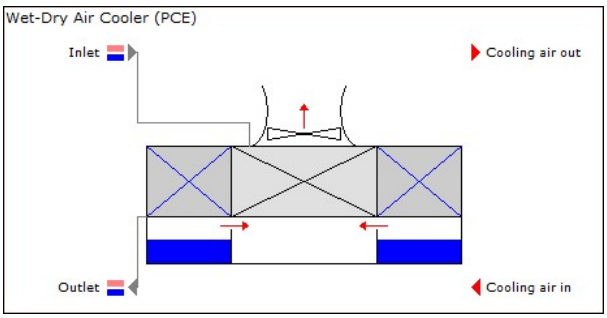
1. PEACE Economiser: a new option was introduced that allows the economiser to determine water flowrate. This is useful when the economizer is used for district heating in HRSGs and other circumstances where water flowrate is not naturally established by an evaporator in the circuit.




2. PEACE Superheater: A new option to limit desuperheating water flow was added to augment the existing minimum superheat limit. The limit allows specifying the maximum desuperheating flow as a percentage of the steam flowrate entering the desuperheater. It is available on the superheater's [Main Inputs] topic.

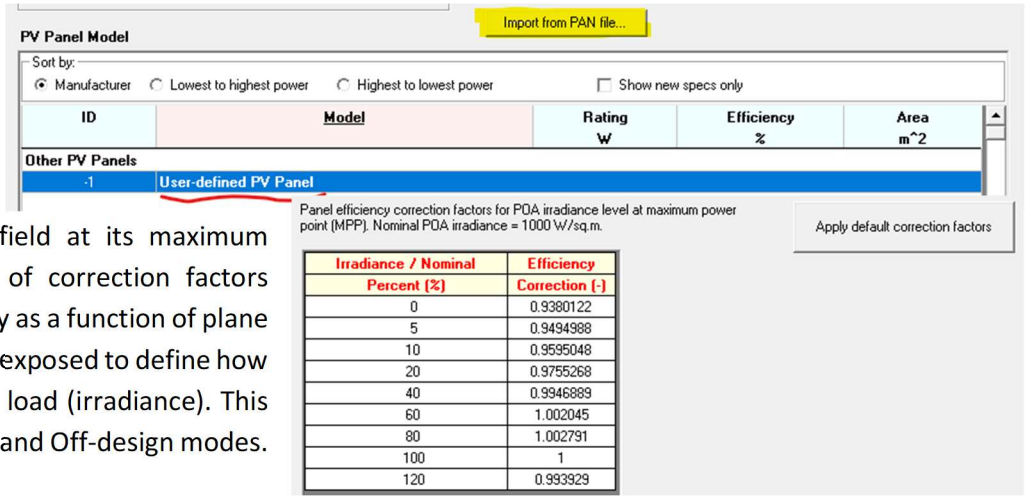


3. Wet/Dry Air Cooler: This new component was added to the [General] tab of the icon selector. It allows the cooling duty for either water or HTF streams to be accomplished partly by dry cooling and partly by wet cooling to allow for plume abatement. This PEACE component reports heat balance, specification, and estimated cost report on output.




## NOVO PRO

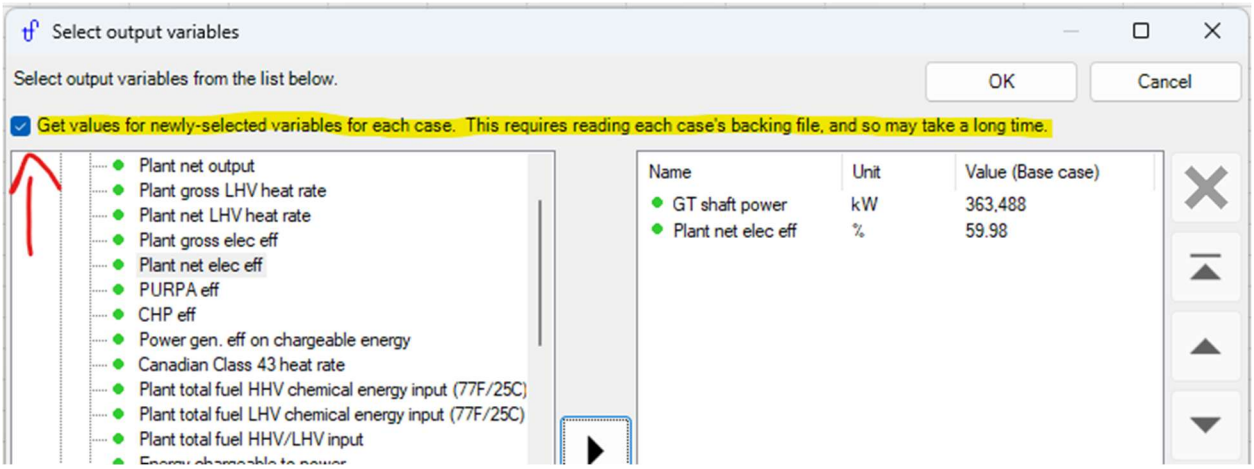
**Solar PV Model**: User-defined solar PV panel model allows the user to import data from a PAN file to define the panel characteristics. PAN files are provided by some panel OEMs to characterize the panels they offer. Only reasonably current PAN files can be read, particularly those stored as plain text files. The data imported from the PAN file includes nominal panel efficiency and DC output along with panel length and width. No other data is imported.




**Solar PV Model**: The solar PV inverter model operates the field at its maximum power point (MPPT). A table of correction factors applied to the nominal efficiency as a function of plane of array (POA) irradiance is now exposed to define how the panel efficiency varies with load (irradiance). This table is available in both Design and Off-design modes.

## ELINK

An option was added to harvest current values when the selected output list is modified. When checked, ELINK reads each computed case model to gather up-to-date values whenever additional outputs are added to the list. Since reading all the case files can take considerable time, this box is unchecked by default. When unchecked, all newly selected outputs are initially displayed using the 'Base Case' value. Regardless the state of this option, all selected output parameters are always updated after ELINK computes the case(s).


Select output variables
Select output variables from the list below.
OK
Cancel
Get values for newly-selected variables for each case. This requires reading each case's backing file, and so may take a long time.
Plant net output
Plant gross LHV heat rate
Plant net LHV heat rate
Plant gross elec eff
Plant net elec eff
PURPA eff
CHP eff
Power gen. eff on chargeable energy
Canadian Class 43 heat rate
Plant total fuel HHV chemical energy input (77F/25C)
Plant total fuel LHV chemical energy input (77F/25C)
Plant total fuel HHV/LHV input
Name
Unit
Value (Base case)
GT shaft power
kW
363,488
Plant net elec eff
%
59.98