

The following is a transcript of an email conversation between Ty Neises of NREL and Franck Golanec of TotalEnergies about the Physical Trough model for parabolic troughs in NREL's [System Advisor Model \(SAM\)](#) in May 2025.

This document is from the SAM forum: <https://sam.nrel.gov/forum/forum-general/3841-differences-field-fraction-of-focused-sca-and-field-optical-focus-fraction.html#11050>

The most recent conversation is at the top of this document. The conversation begins at the end of this document

Hi Franck,

Your explanation of the cause of defocusing is correct.

The classical way to avoid this defocus problem is to add thermal energy storage. Without storage, defocus is required to resolve instantaneous mismatches between solar field output and heat sink demand

The model differentiates "startup" from "on" by checking the trough outlet temperature against a minimum value required for on. You can change this value in the UI. If you make that minimum value colder, the plant will turn on sooner, but 1) you will be sending relatively cold heat to your process, which may not be practical and 2) you still have to heat up the receiver material, so you're not really going to get "extra" heat out of system over time, it's just going to change the temperature-heat-time profile a bit in the morning.

Ty

Hi Ty,

Thank you for your detailed explanation.

From the updated table you sent below, my understanding is that the solar field defocuses because at Time step 6 it produces 56.48 MWt while the demand is only 25.2 MWt. Is that correct?

If yes, do you know if there is a way to avoid this defocusing? By stopping the start-up earlier, for example?

Because it seems a shame to waste energy when demand isn't being met. Moreover, on the next row 179 it can be observed that the demand is not met: Heat sink thermal power = 92 MWt while Target thermal power = 157 MWt.

Thanks
Franck

Hi Franck,

Thank you for the thoughtful questions. My explanation in the previous email about how to calculate the 'Field thermal power leaving in HTF' during timesteps with both 'startup' and 'on' modes was incorrect for two reasons. First, this value represents the thermal power delivered to the HTF and transferred to the cycle or TES, so it represents the thermal power *after defocus is applied*. In your case without TES, this value necessarily needs to equal the thermal power to the heat sink. Second, the 'Field fraction of focused SCAs' and 'Field thermal power leaving in HTF' outputs don't align, because there is a problem with how the code reports 'Field thermal power leaving in HTF' during startup. This value should always be 0.0 during 'startup' because the HTF is recirculating, but the code is mistakenly reporting a value from the trough startup energy balance. It is purely coincidental in row 178 that this incorrectly reported value during startup is around the same magnitude as the target heat sink power.

We will fix this reporting issue for the next release. Meanwhile, you can use your approach to calculate 10-min-timestep 'Field fraction of focused SCAs' to back-calculate the Field Thermal Power:

- N_{su} = number of 10-min-timesteps in startup mode
- N_{on} = number of 10-min-timesteps in on mode
- $Defocus_{reported} = (N_{su}/6) + (N_{on}/6) * Defocus_{on}$
- Solving for $Defocus_{on} = (6/N_{on}) * (Defocus_{reported} - (N_{su}/6))$

For row 178 $N_{su} = 5$ and $N_{on} = 1$, so $Defocus_{on} = 0.446$, as you show in your table. Then the estimated thermal power *before defocus* is $25.2 / 0.446 = 56.48$.

I've annotated the table below with these values.

I'm sorry for these issues. Please let me know if you have any other questions.

Thanks,
Ty

Average	0.9077		Incorrect reported value 26.300 Should = Heat sink thermal power for case with no TES = 4.2	25.2056	4.20133
Time Step	Field fraction of focused SCAs	Estimated field thermal power before defocus	Field thermal power leaving in HTF (MWt)	Target thermal power to PC (MWt)	Heat sink thermal power (MWt)
1	1.00	0	0	25.2	0.0
2	1.00	0	0	25.2	0.0
3	1.00	0	0	25.2	0.0
4	1.00	0	0	25.2	0.0
5	1.00	0	0	25.2	0.0
6	0.446	56.48	25.2	25.2	25.2

Hi Ty,

Thank you for your answer.

From your explanation, my understanding is that the row 178 (corresponding to one complete hour) is divided into 6 time steps (10 minutes each). The potential values of the different variables for each 10 minutes time step are in the table below.

Average	0.9077	26.300	25.2056	4.20133
Time Step	Field fraction of focused SCAs	Field thermal power leaving in HTF (MWt)	Target thermal power to PC (MWt)	Heat sink thermal power (MWt)
1	1.00	0	25.2	0.0
2	1.00	0	25.2	0.0
3	1.00	0	25.2	0.0
4	1.00	0	25.2	0.0
5	1.00	0	25.2	0.0
6	0.45	157.8	25.2	25.2

Is that table correct?

If yes, it means that the solar field defocuses because it produces 157.8 MWt while the demand is only 25.2 MWt.

Thank you for your help.

Regards,
Franck

Hi Franck,

You are correct about the defocus variable in your version of SAM.

Your observation about morning start-up is related to how SAM handles hourly reporting during timesteps that experience two operating modes. In row 178, the solar field begins in "startup" mode where the outlet fluid is recirculated to the inlet. The solar field model solves every 10 minutes during startup mode to minimize energy balance errors. After every 10 minutes, the code checks if the outlet temperature exceeds the "startup" threshold. When this condition is met, the solar field reports the total startup duration to the plant controller, which then solves the full system model for that duration of time (e.g. 50 minutes). Then, assuming there is time remaining in the hourly timestep, the plant controller solves the remaining timestep assuming that the field output goes to the heat sink (or TES as applicable). Because SAM's framework

restricts outputs to evenly spaced intervals (typically hourly), we have to report a single output for timesteps where there are multiple operating modes. For power outputs, we typically report a time-weighted average.

We know that is difficult to see this behavior in the results. In your case, you can divide K178 by L178 and get a result of 6. Because the outputs show that the field is defocusing, we should expect that when the solar field is “on” (rather than starting up), it meets the target thermal power. As such, the ratio of these values means that the plant was in “startup” for 50 minutes and “on” for 10 minutes. Similarly, you can multiply E178 by 6 to get the field output thermal power during the 10 “on” minutes of the timestep.

Thanks,
Ty

Hi Ty,

Thank you for your investigation and for your answer.

My understanding is that the variable called “Field fraction of focused SCAs” must be considered in my version of SAM, as it gives the correct information about the defocusing state of the solar field. Is it that correct?

Another thing I have noticed is that during morning start-up SAM seems systematically defocusing lthough the heat demand is not supplied.

For example on the screenshot below (coming from the attached Excel file of SAM output), the “Field fraction of focused SCAs” is 0.90 (meaning 10% of SCAs of the solar field are defocused) although the Solar field produces 26.3 MWt (Field thermal power leaving in HTF), the Heat delivered to the heat sink is 4.2 MWt and Target thermal power is 25.2 MWt.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Time stamp	Resource Dry bulb temperature (C)	Resource Beam normal irradiance (W/m2)	Field thermal power incident (MWt)	Field thermal power leaving in HTF (MWt)	Loop timestep-averaged inlet temperature (C)	Loop timestep-averaged outlet temperature (C)	Receiver mass flow rate (kg/s)	Field pressure drop (bar)	Field fraction of focused SCAs	Target thermal power to PC (MWt)	Heat sink thermal power (MWt)
173	01/01/2008 03:00	0	0	0	-0.152825	267.352	247.578	1	0.138981	1	0	0
174	01/01/2008 04:00	1	0	0	-0.146439	262.867	243.696	1	0.138802	1	0	0
175	01/01/2008 05:00	1	0	0	-0.140053	258.539	239.987	1	0.138645	1	0	0
176	01/01/2008 06:00	1	0	0	-0.134142	254.366	236.409	1	0.138508	1	0	0
177	01/01/2008 07:00	2	366	229.789	0.828066	249.641	256.454	2.60419	0.841234	1	0	0
178	01/01/2008 08:00	4	674	423.164	26.3102	275.812	342.803	5.68328	4.55352	0.907739	25.2056	4.20133
179	01/01/2008 09:00	6	526	330.244	92.1286	301.501	389.459	3.07638	1.28938	1	157.535	92.1286
180	01/01/2008 10:00	9	902	566.312	176.379	300.238	389.818	4.3936	2.57083	1	198.494	176.379
181	01/01/2008 11:00	10	17	10.6733	33.3071	300.048	308.049	1	0.142006	1	201.645	33.3071
182	01/01/2008 12:00	11	175	109.872	23.664	300.029	330.475	1	0.143291	1	201.645	23.664
183	01/01/2008 13:00	10	529	332.127	70.1104	300.013	387.255	2.39471	0.787554	1	207.946	70.1104
184	01/01/2008 14:00	9	239	150.054	42.9513	300.005	389.845	1.17383	0.199451	1	217.398	42.9513

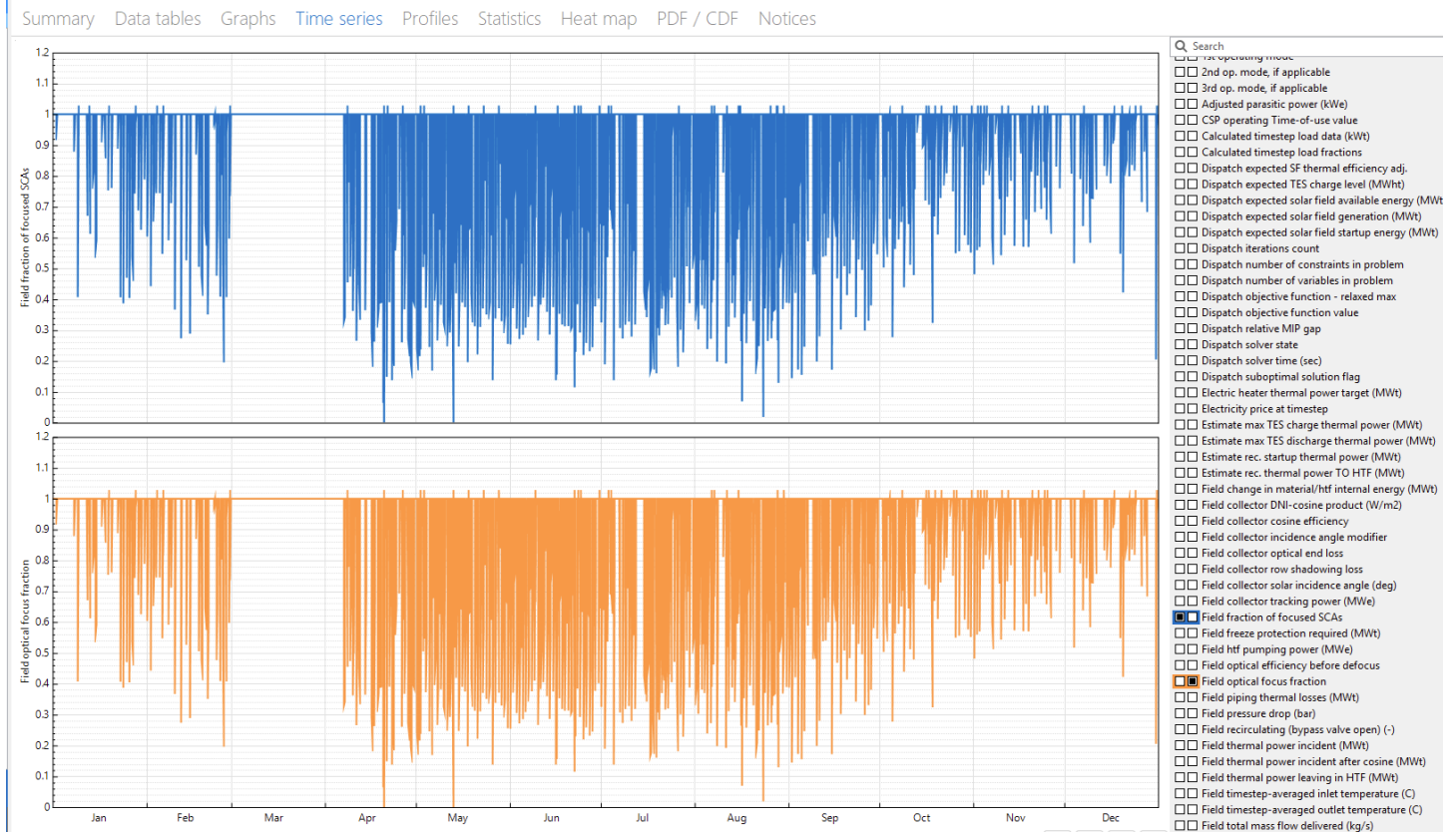
Would you have an explanation about this phenomenon?

Thank you for your help.

Regards,
Franck

Hi Franck,

Thank you for finding this issue. The code was incorrectly reporting the “field optical focus fraction” as 1.0 in some of the defocus modes. I fixed the reporting issue, and the new results show that the defocus is all driven by the system controller. This problem was isolated to reporting and does not change your system performance.



We will fix this in the next patch or release.

Ty

Hi Ty,

Thank you for answer. Please find attached the following files :

1. **SAM simulation - Rev 4.2.4.sam** à The SAM file
2. **SAM Simulation output.xlsx** à The hourly output results considering in input the meteo file for Dagett in California that can be found in the default Solar Resource Library in SAM. In the second sheet, a screenshot of the results can be found for the period from February 10 to February 15.

Than you very much for your help.

Best regards,
Franck

Hi Franck,

I'm sorry for my long delay responding to your question. You have the right understanding of those outputs. I don't expect the results you show, and I don't see this behavior in the default Trough case. Can you share a SAM file that reproduces the results?

Thanks,
Ty

Hello,

I am contacting you regarding the following question: What is the difference between "Field fraction of focused SCAs" and "Field optical focus fraction" in the Parabolic Trough model?

I saw that there is this answer in the forum :

https://sam.nrel.gov/index.php?option=com_kunena&view=topic&catid=5&id=3841&Itemid=487#11050

Where it is described that :

- Field optical focus fraction = a signal from the plant controller that causes the field to defocus when the TES/cycle cannot accept all of its heat output

- Field fraction of focused SCAs = the field optical focus fraction + local receiver defocus required to maintain receiver HTF mass flow rate at the “Max single loop flow rate” on the Solar Field page.

Nevertheless, I run a simulation where I put a Max single loop flowrate of 12 kg/s (see Input data below) and it can be seen that the SCAs are defocusing even if the flowrate in the loop does not reach the maximum threshold of 12 kg/s above which the SCAs should defocus.

In other words, my understanding is that the “Field fraction of focused SCAs” curve (in blue) and the “Field optical focus fraction” curve (in orange) should be the same while the Single loop flowrate curve (in red) stays below 12 kg/s.

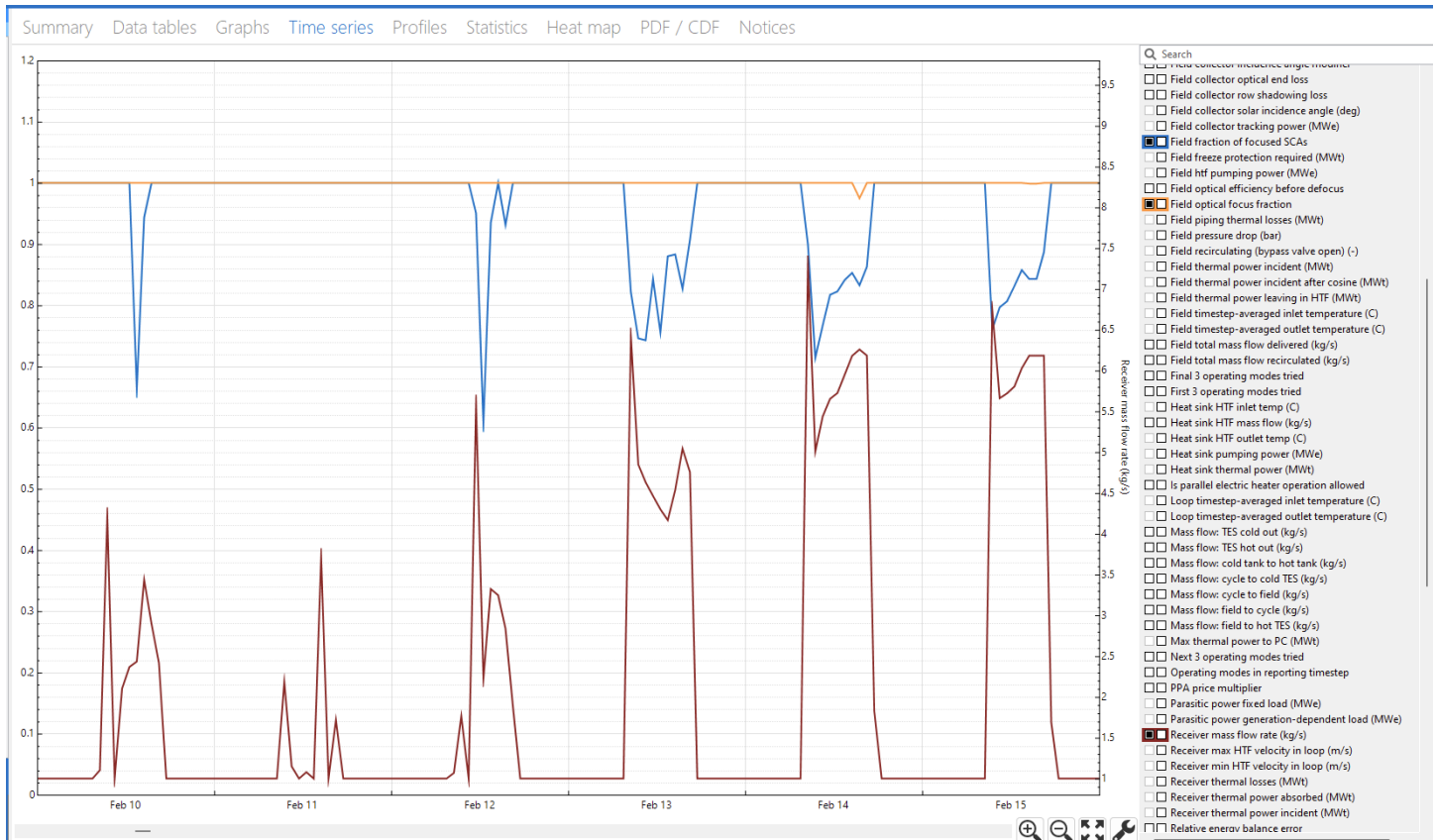
Is my understanding correct?

Do you have any explanation about the difference between the blue and orange curve?

Input data:

HTF Flow Limits			
Loop mass flow limit:	Min mass flow	<input type="text" value="1"/>	<input type="text" value="1.000"/> kg/s
<input checked="" type="radio"/> Absolute limit	Max mass flow	<input type="text" value="12"/>	<input type="text" value="12.000"/> kg/s
<input type="radio"/> Relative limit	Min fraction	<input type="text" value="0.25"/>	<input type="text" value="0.073"/>
	Max fraction	<input type="text" value="1.2"/>	<input type="text" value="0.875"/>
	Min field flow velocity	<input type="text" value="0.6"/>	<input type="text" value="0.6"/> m/s
	Max field flow velocity	<input type="text" value="8.8"/>	<input type="text" value="8.8"/> m/s
		Cold Headers	Hot Headers
	Header design min flow velocity	<input type="text" value="2"/> m/s	<input type="text" value="2"/> m/s
	Header design max flow velocity	<input type="text" value="3"/> m/s	<input type="text" value="3"/> m/s

Graph of results:



Thank you very much for your help.

Best regards,
Franck Gloanec
