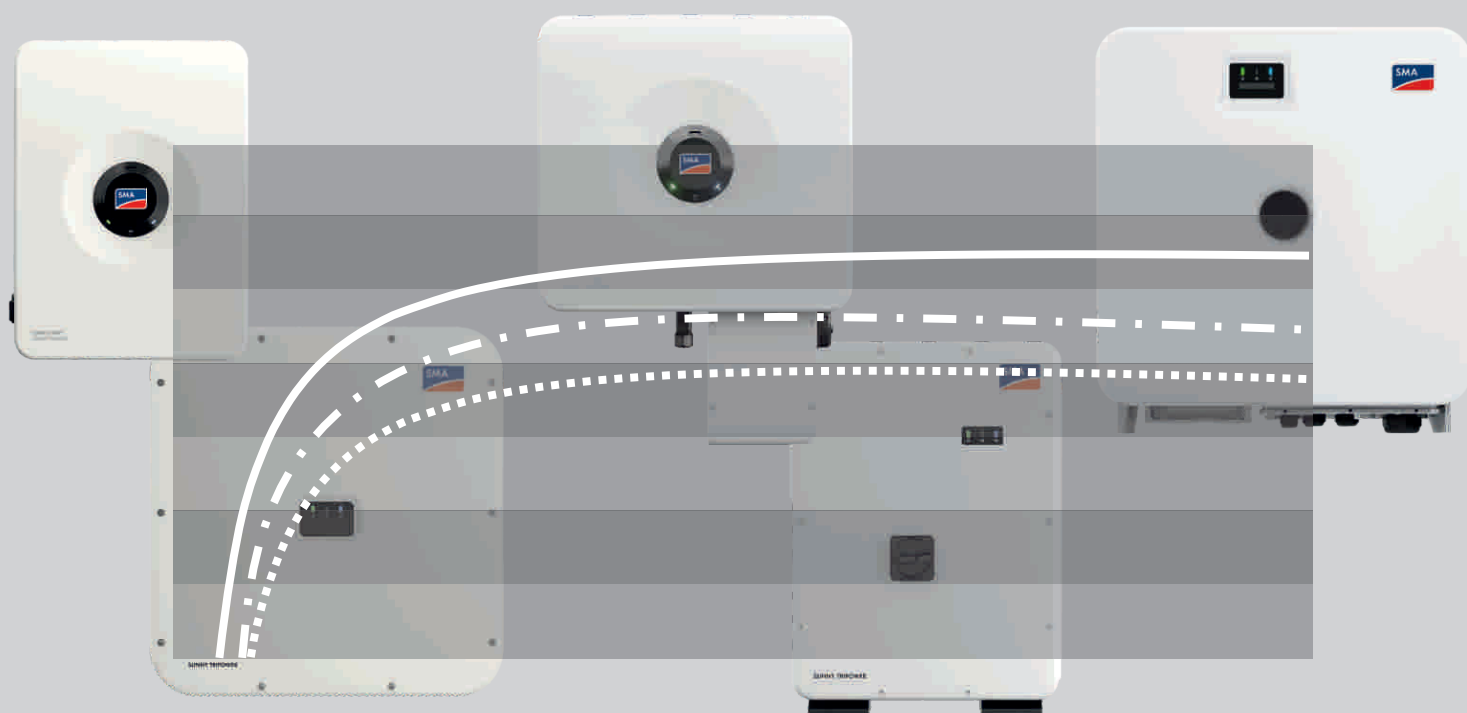




SUNNY BOY SMART ENERGY US / SUNNY TRIPOWER US / SUNNY HIGHPOWER US

Efficiency and Derating

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1 Information on this Document

1.1 Validity

This document describes in graphic and tabular form the efficiency profile and the derating behavior of the following SMA inverters (status: 10/2018, subject to technical changes):

Sunny Boy Smart Energy

- SBSE3.8-US-50 / SBSE4.8-US-50 / SBSE5.8-US-50 / SBSE7.7-US-50 / SBSE9.6-US-50 / SBSE11.5-US-50

Sunny Tripower

- STP 33-US-41 / STP 50-US-41 / STP 62-US-41
- STP 13-US-50 / STP 20-US-50 / STP 25-US-50 / STP 30-US-50
- STP 27-US-80 / STP 50-US-80 / STP 62-US-80 / STP 70-US-80

Sunny Highpower

- SHP 125-US-21 / SHP 150-US-21 / SHP 165-US-21 / SHP 172-US-21

1.2 Target Group

The information in this document is intended for installers and operators of PV systems with SMA inverters as well as for PV system planners.

2 Data Explanation

Efficiency Profile - Curve and Measured Values

The efficiency is the ratio of output power to input power and is given as a percentage value. This document describes the inverter efficiency in graphic and tabular form. The efficiency is given for the minimum MPP voltage, the rated input voltage and the maximum MPP voltage.

Maximum efficiency and Californian efficiency

The maximum efficiency is the highest inverter efficiency at rated input voltage. The Californian efficiency is calculated by weighing different partial load efficiencies and the full load efficiency at the rated input voltage according to the frequency in which they occur.

The calculation formula is: $\eta_{\text{CEC}} = (0.04 \times \eta_{10\%}) + (0.05 \times \eta_{20\%}) + (0.12 \times \eta_{30\%}) + (0.21 \times \eta_{50\%}) + (0.53 \times \eta_{75\%}) + (0.05 \times \eta_{100\%})$

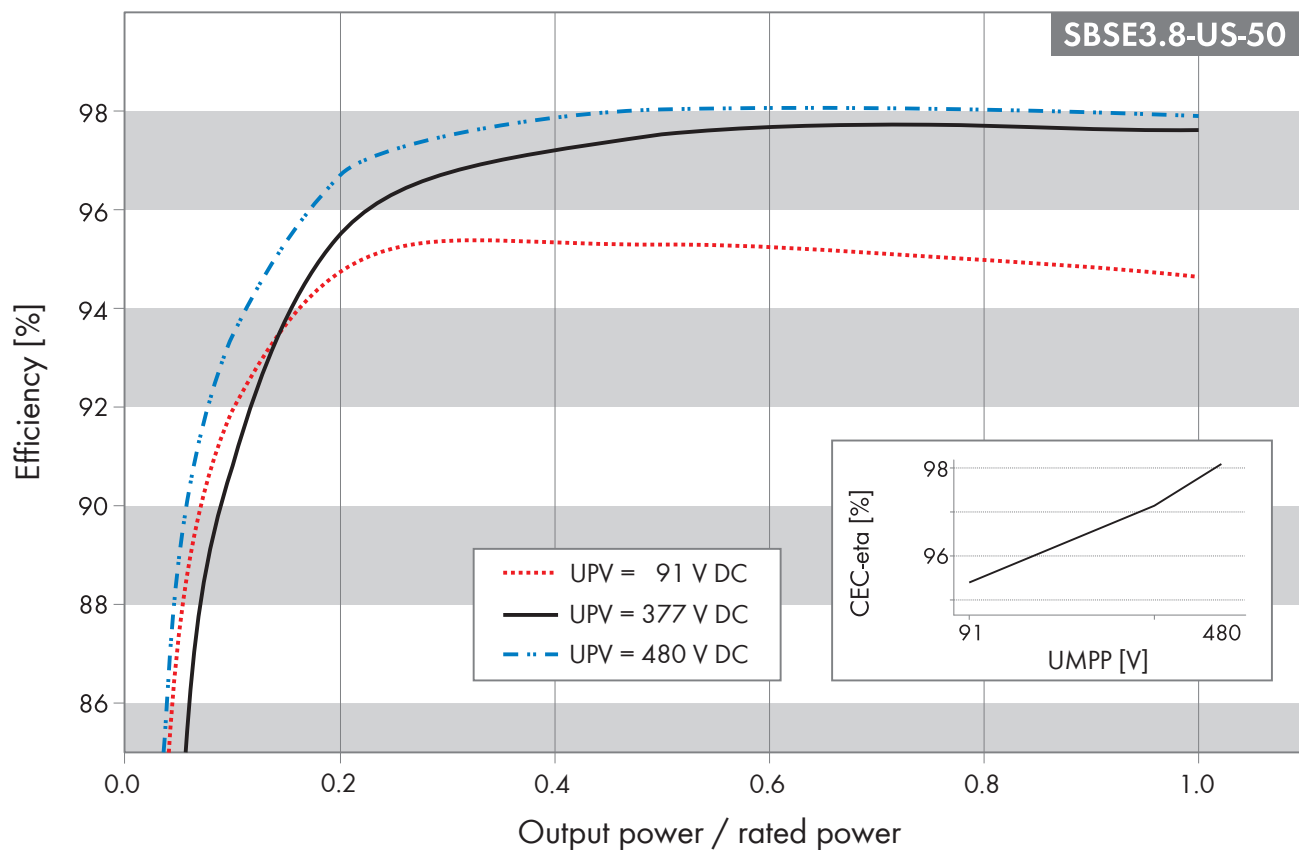
Derating Behavior

Safety mechanisms are implemented in the inverter protecting the inverter against damage due to too high ambient temperatures or too high output currents. This behavior reduces the inverter output power ("derating"). In this document, the derating behavior of the inverters is shown in graphic form. The derating behavior is given for the minimum MPP voltage, the rated input voltage and the maximum MPP voltage.

3 Sunny Boy Smart Energy

3.1 SBSE3.8-US-50

3.1.1 Efficiency at 208 V AC

Maximum efficiency, $\eta_{\max}$

98.1 %

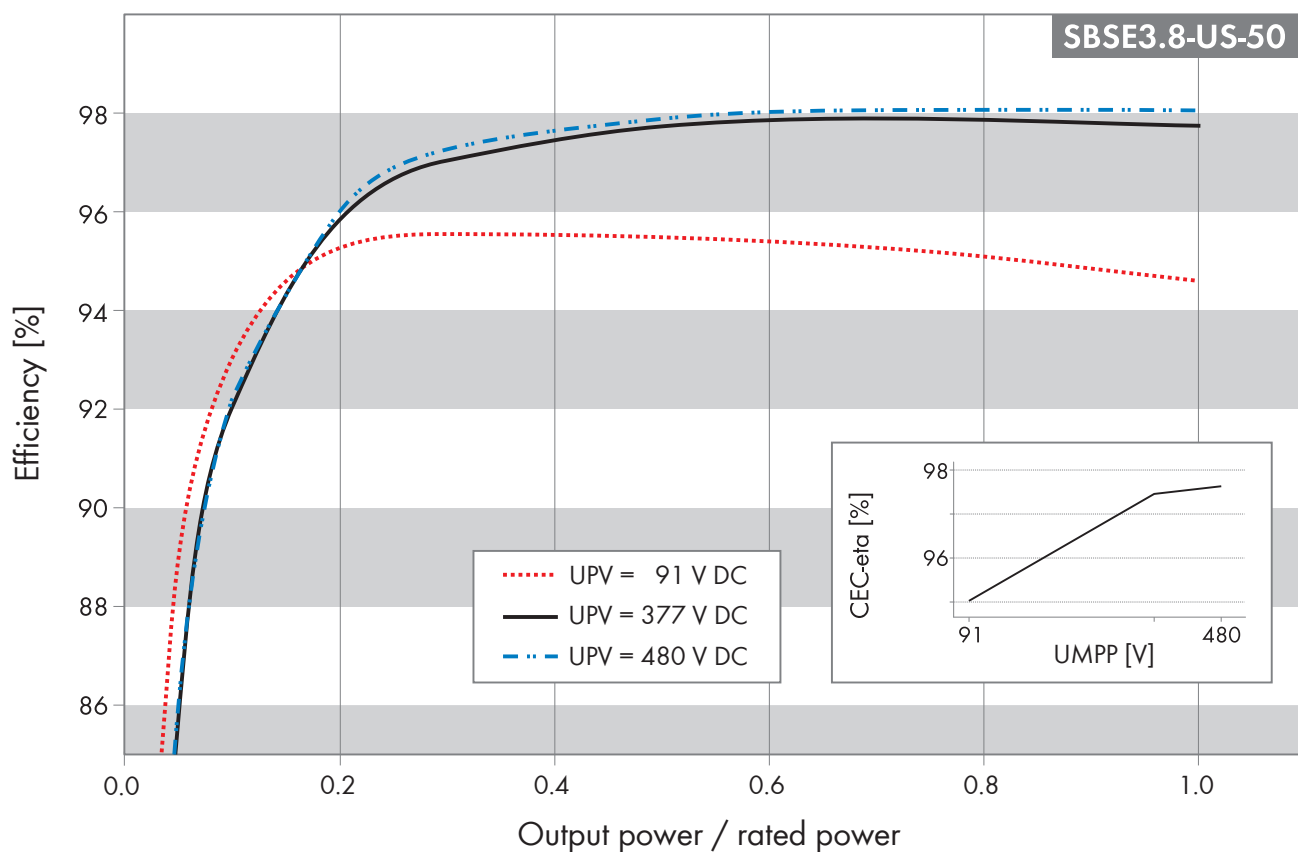
Californian efficiency, η_{CEC}

97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 91 V	Rated input voltage 377 V	Maximum MPP voltage 480 V
10 %	92.0 %	90.8 %	93.5 %
20 %	95.4 %	95.6 %	96.7 %
30 %	95.0 %	96.4 %	97.5 %
50 %	95.4 %	97.5 %	98.1 %
75 %	95.1 %	97.7 %	98.1 %
100 %	94.7 %	97.6 %	98.0 %

3.1.2 Efficiency at 240 V AC

Maximum efficiency, $\eta_{\max}$

98.1 %

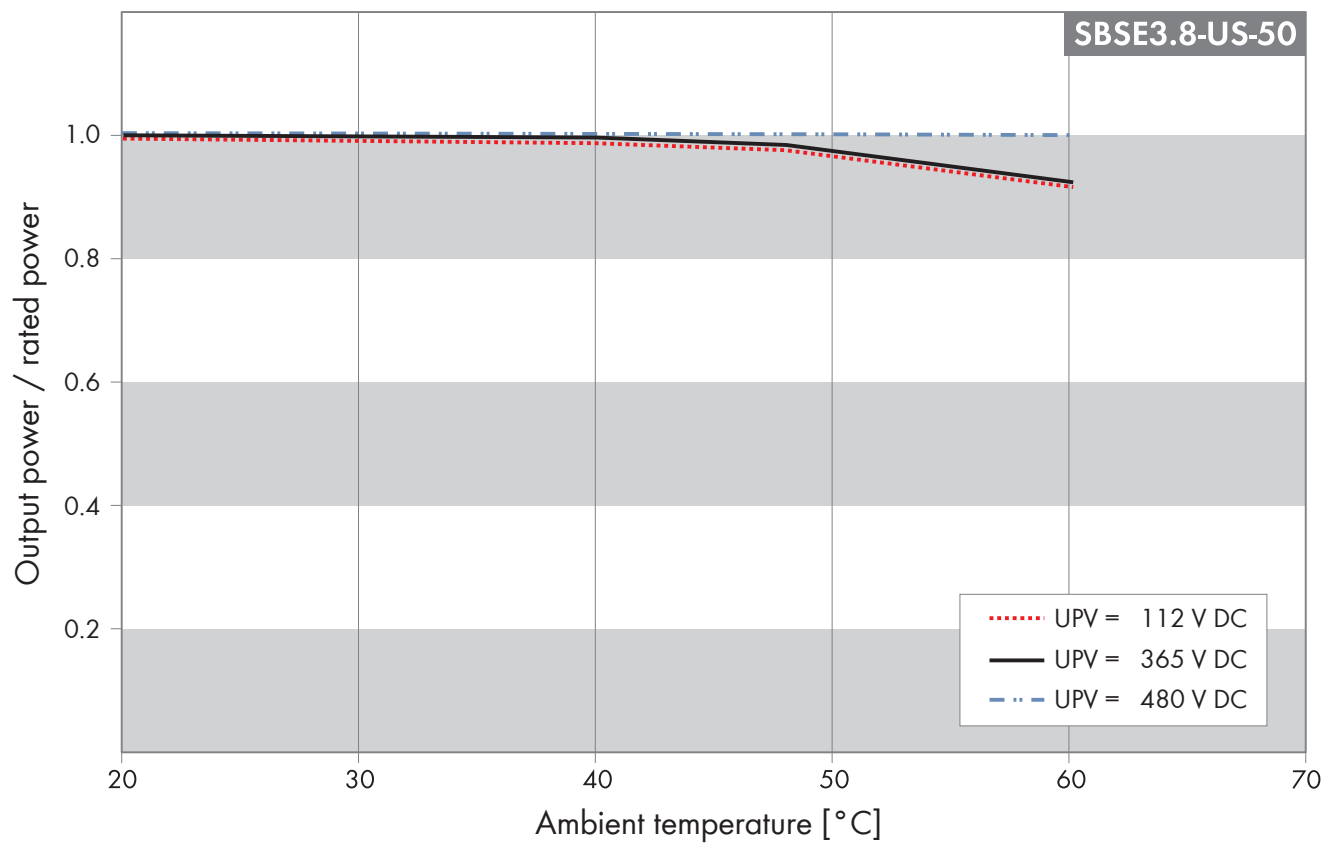
Californian efficiency, η_{CEC}

96.5 %

Efficiency Profile

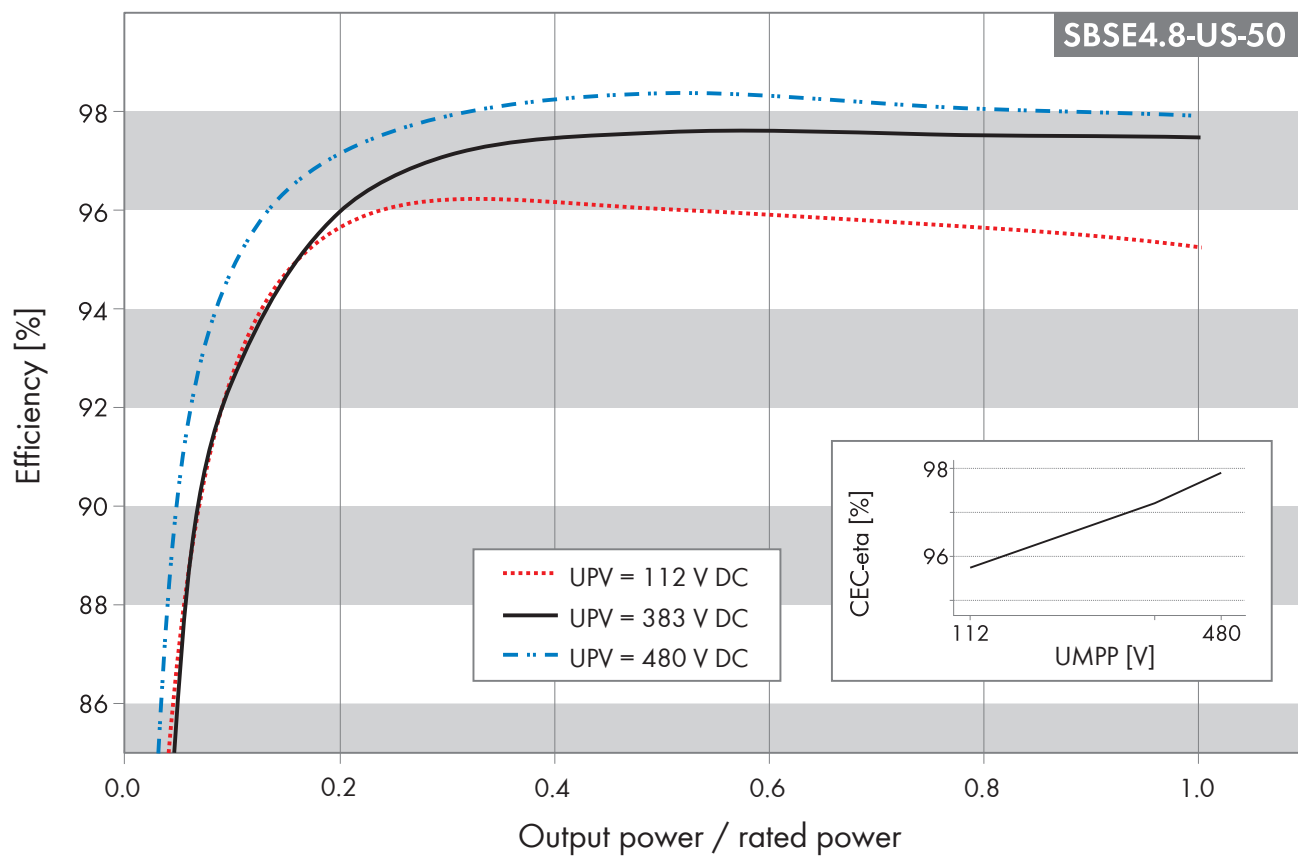
Standardized output power	Efficiency		
	Minimum MPP voltage 91 V	Rated input voltage 377 V	Maximum MPP voltage 480 V
10 %	93.1 %	92.1 %	92.2 %
20 %	95.7 %	96.0 %	96.1 %
30 %	95.3 %	97.0 %	97.3 %
50 %	95.4 %	97.7 %	97.9 %
75 %	95.2 %	98.0 %	98.1 %
100 %	94.7 %	97.8 %	98.1 %

3.1.3 Derating behavior at 240 V AC



3.2 SBSE4.8-US-50

3.2.1 Efficiency at 208 V AC

Maximum efficiency, $\eta_{\max}$

98.4 %

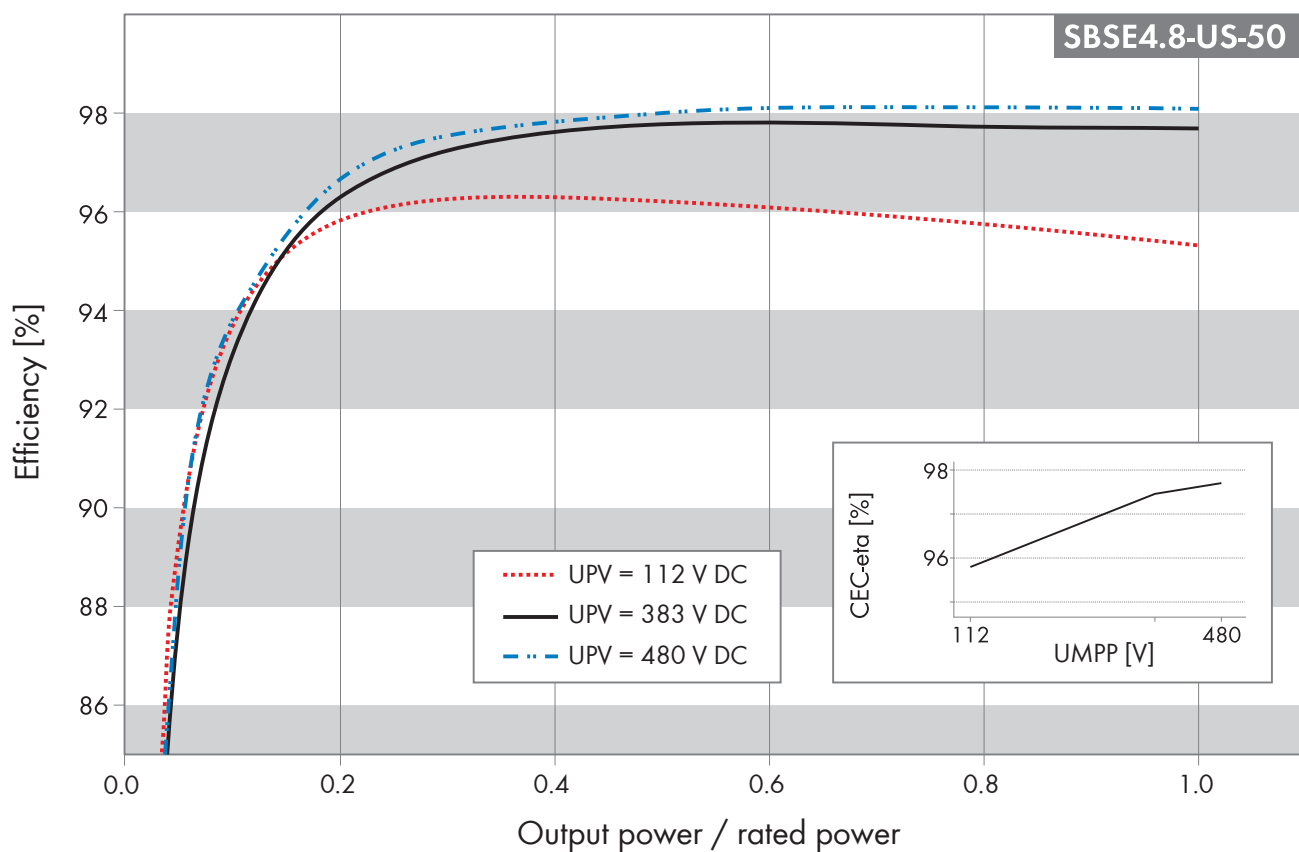
Californian efficiency, η_{CEC}

97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 112 V	Rated input voltage 383 V	Maximum MPP voltage 480 V
10 %	92.8 %	92.5 %	94.9 %
20 %	96.0 %	95.9 %	97.1 %
30 %	96.4 %	97.1 %	97.8 %
50 %	96.0 %	97.6 %	98.4 %
75 %	95.7 %	97.5 %	98.0 %
100 %	95.2 %	97.4 %	97.9 %

3.2.2 Efficiency at 240 V AC

Maximum efficiency, $\eta_{\max}$

98.0 %

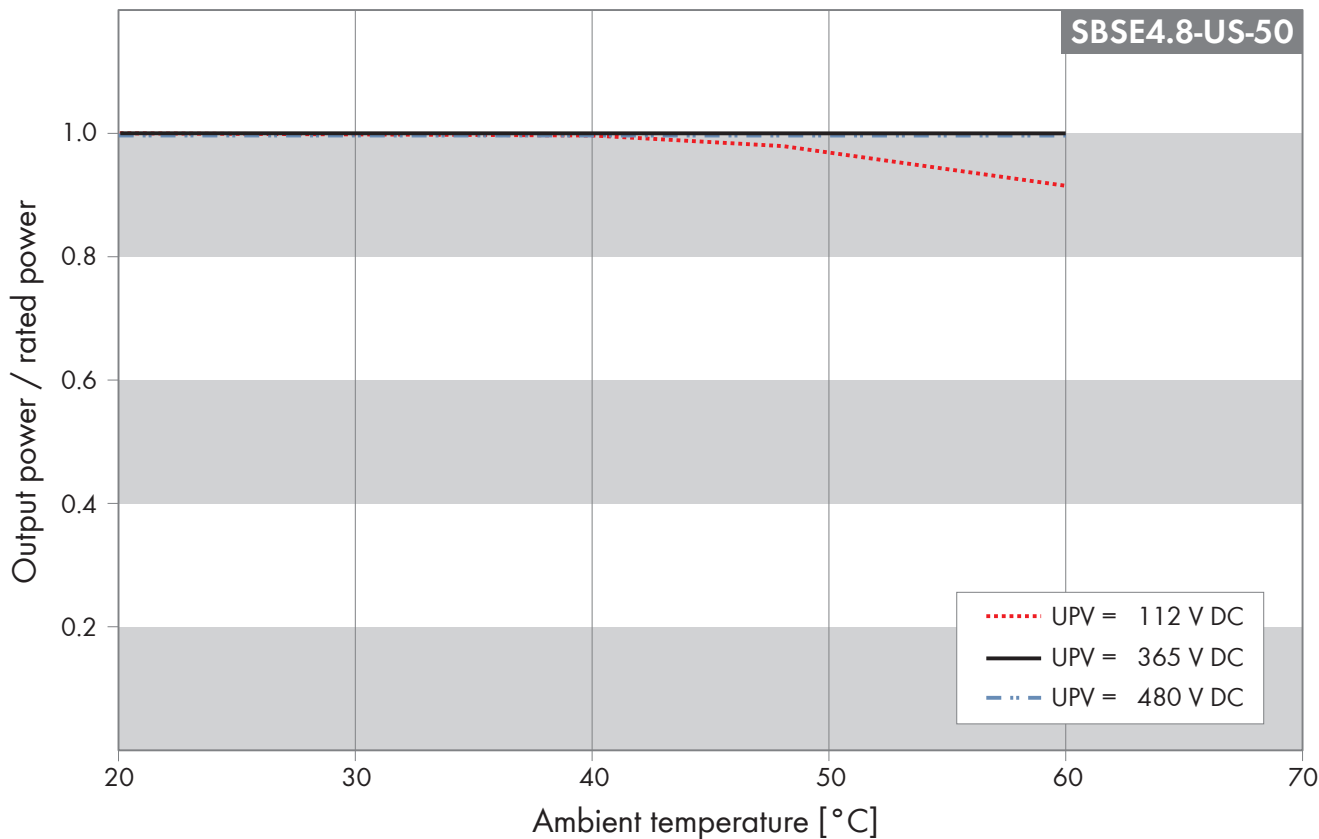
Californian efficiency, η_{CEC}

97.0 %

Efficiency Profile

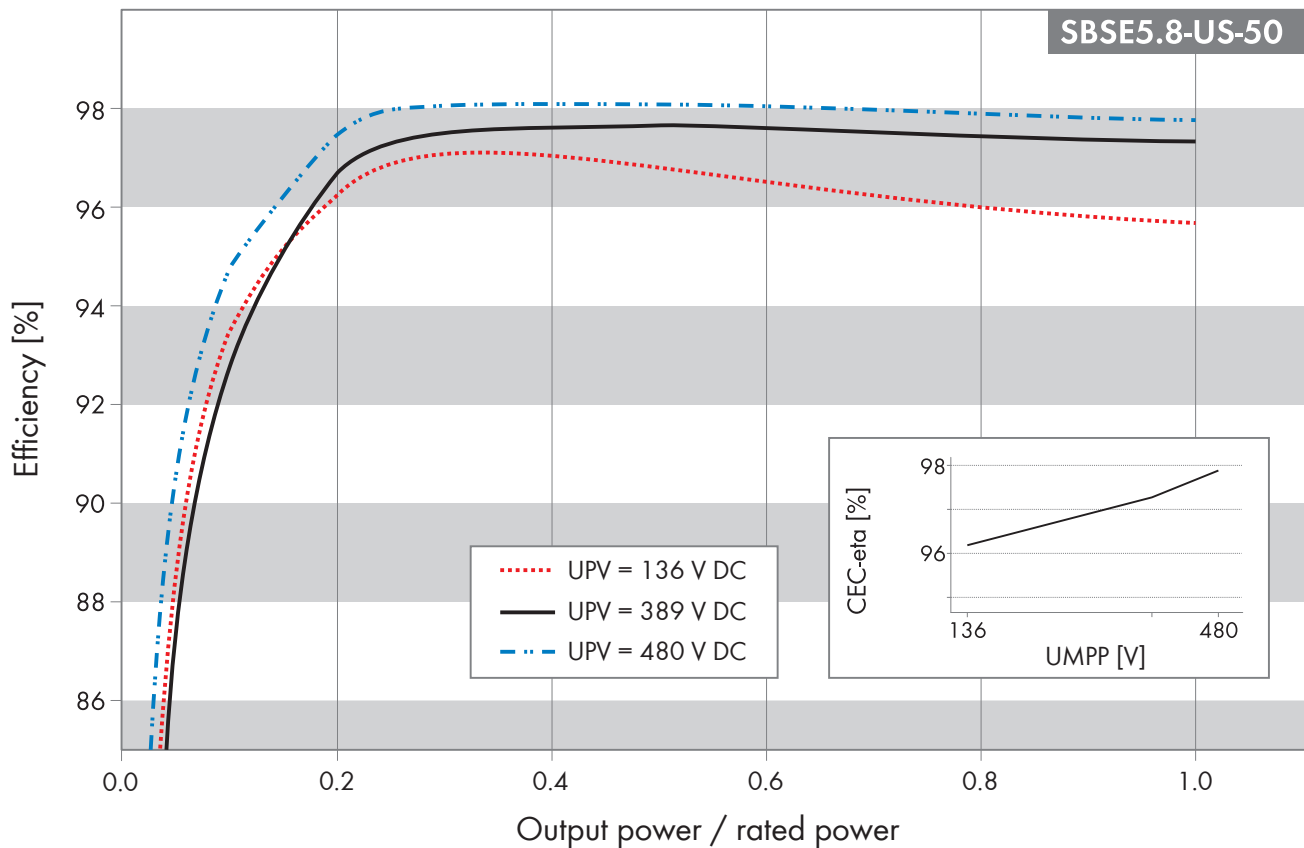
Standardized output power	Efficiency		
	Minimum MPP voltage 112 V	Rated input voltage 383 V	Maximum MPP voltage 480 V
10 %	93.6 %	93.2 %	93.8 %
20 %	96.3 %	96.5 %	96.7 %
30 %	96.1 %	97.2 %	97.5 %
50 %	96.1 %	97.9 %	97.9 %
75 %	95.8 %	97.7 %	98.0 %
100 %	95.3 %	97.7 %	98.0 %

3.2.3 Derating behavior at 240 V AC



3.3 SBSE5.8-US-50

3.3.1 Efficiency at 208 V AC



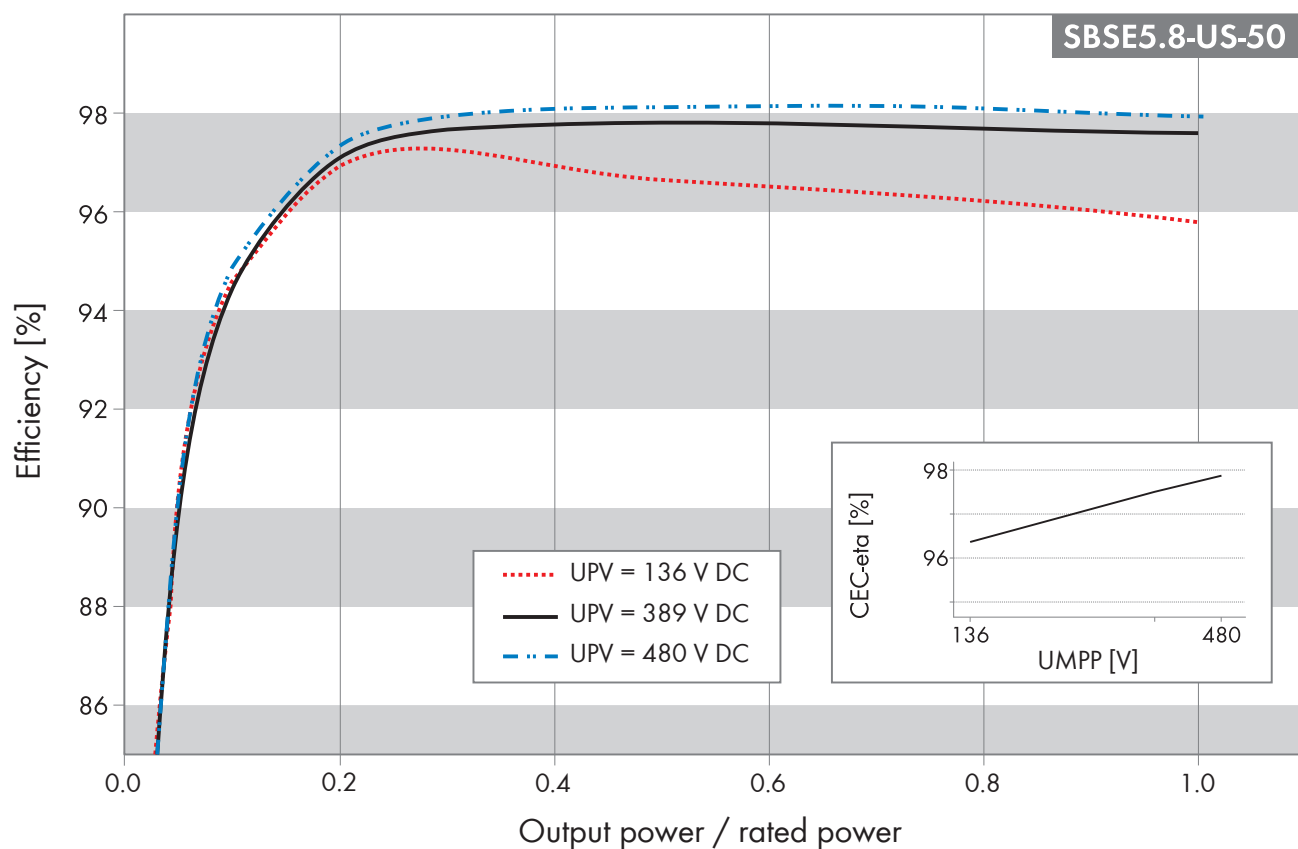
Maximum efficiency, $\eta_{\max}$ 98.1 %

Californian efficiency, η_{CEC} 97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 136 V	Rated input voltage 389 V	Maximum MPP voltage 480 V
10 %	93.5 %	92.8 %	94.9 %
20 %	96.3 %	96.6 %	97.5 %
30 %	97.1 %	97.4 %	98.1 %
50 %	96.4 %	97.7 %	98.1 %
75 %	96.1 %	97.5 %	98.0 %
100 %	95.7 %	97.3 %	97.8 %

3.3.2 Efficiency at 240 V AC

Maximum efficiency, $\eta_{\max}$

98.1 %

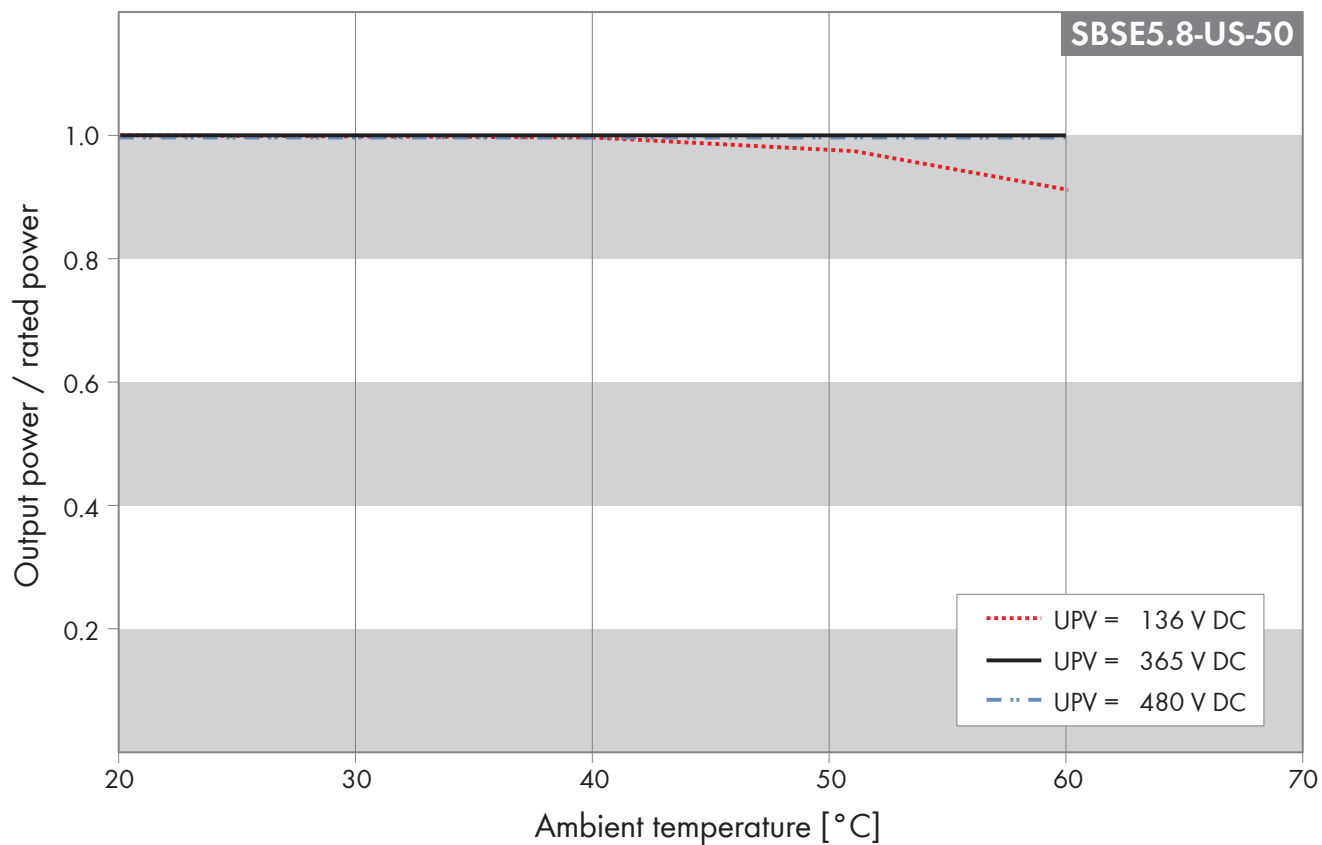
Californian efficiency, η_{CEC}

97.5 %

Efficiency Profile

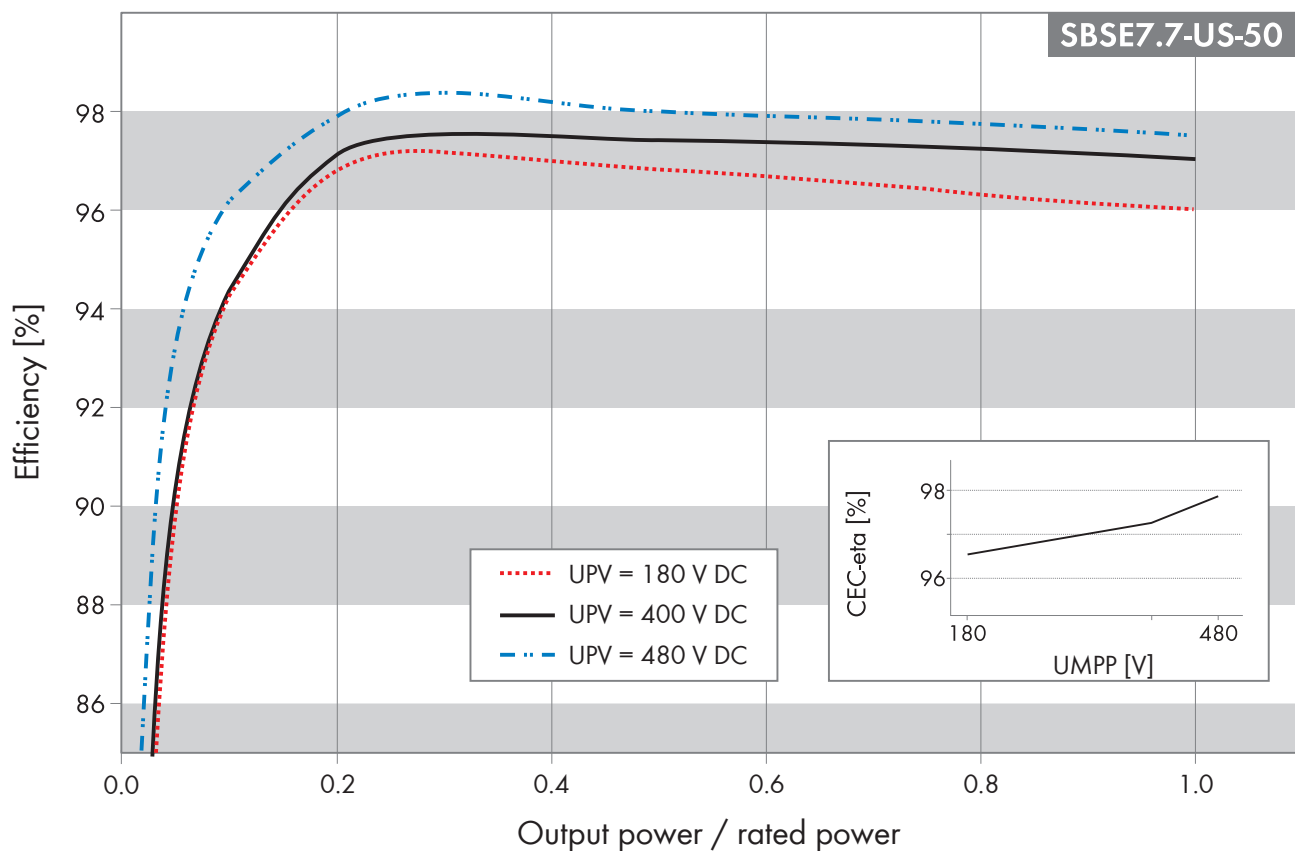
Standardized output power	Efficiency		
	Minimum MPP voltage 136 V	Rated input voltage 389 V	Maximum MPP voltage 480 V
10 %	94.6 %	94.4 %	94.8 %
20 %	96.8 %	97.0 %	97.3 %
30 %	97.2 %	97.6 %	97.9 %
50 %	96.6 %	97.7 %	98.1 %
75 %	96.3 %	97.7 %	98.1 %
100 %	95.8 %	97.6 %	97.9 %

3.3.3 Derating behavior at 240 V AC



3.4 SBSE7.7-US-50

3.4.1 Efficiency at 208 V AC



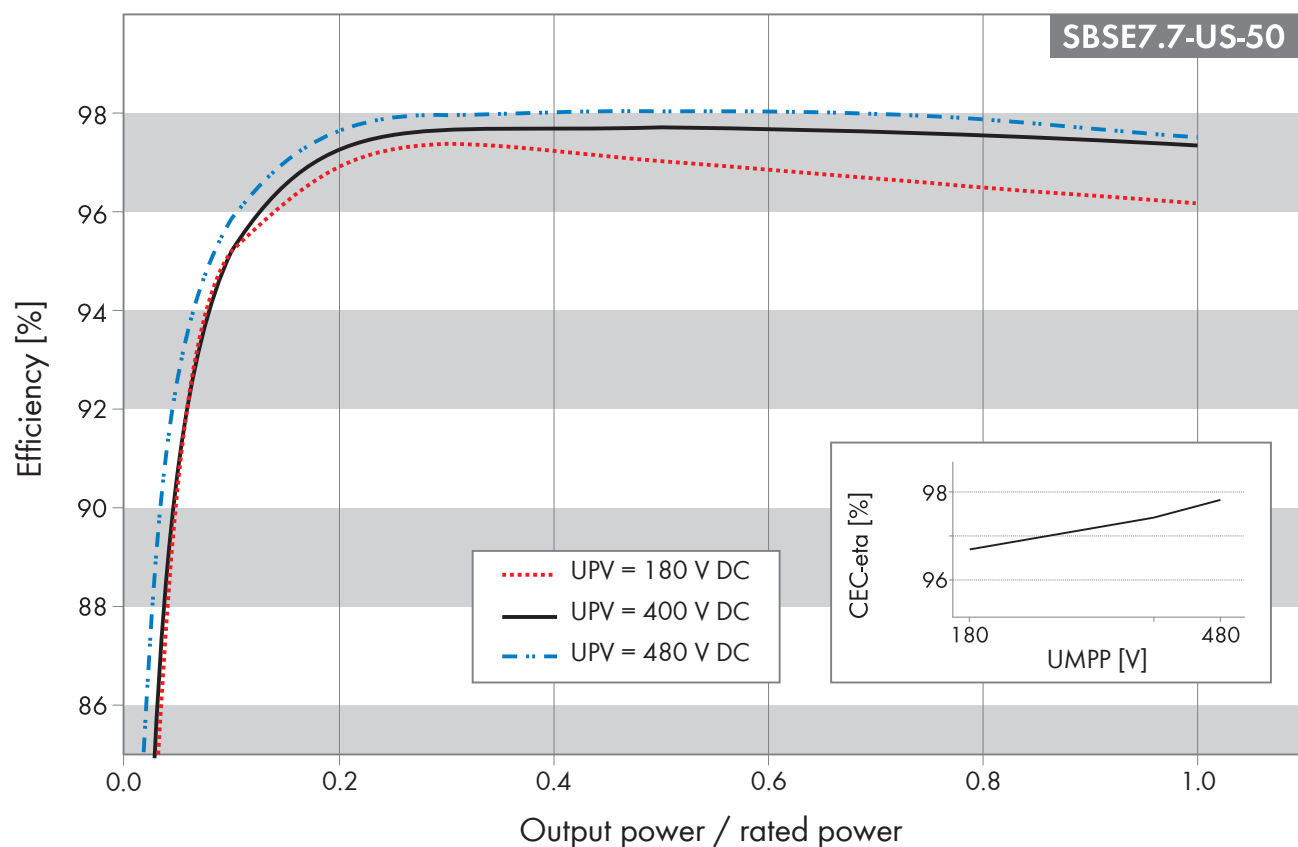
Maximum efficiency, $\eta_{\max}$ 98.4 %

Californian efficiency, η_{CEC} 97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 180 V	Rated input voltage 400 V	Maximum MPP voltage 480 V
10 %	94.3 %	94.4 %	96.3 %
20 %	96.9 %	97.2 %	97.9 %
30 %	97.2 %	97.5 %	98.4 %
50 %	96.9 %	97.5 %	98.0 %
75 %	96.5 %	97.3 %	97.8 %
100 %	96.0 %	97.1 %	97.5 %

3.4.2 Efficiency at 240 V AC

Maximum efficiency, $\eta_{\max}$

98.0 %

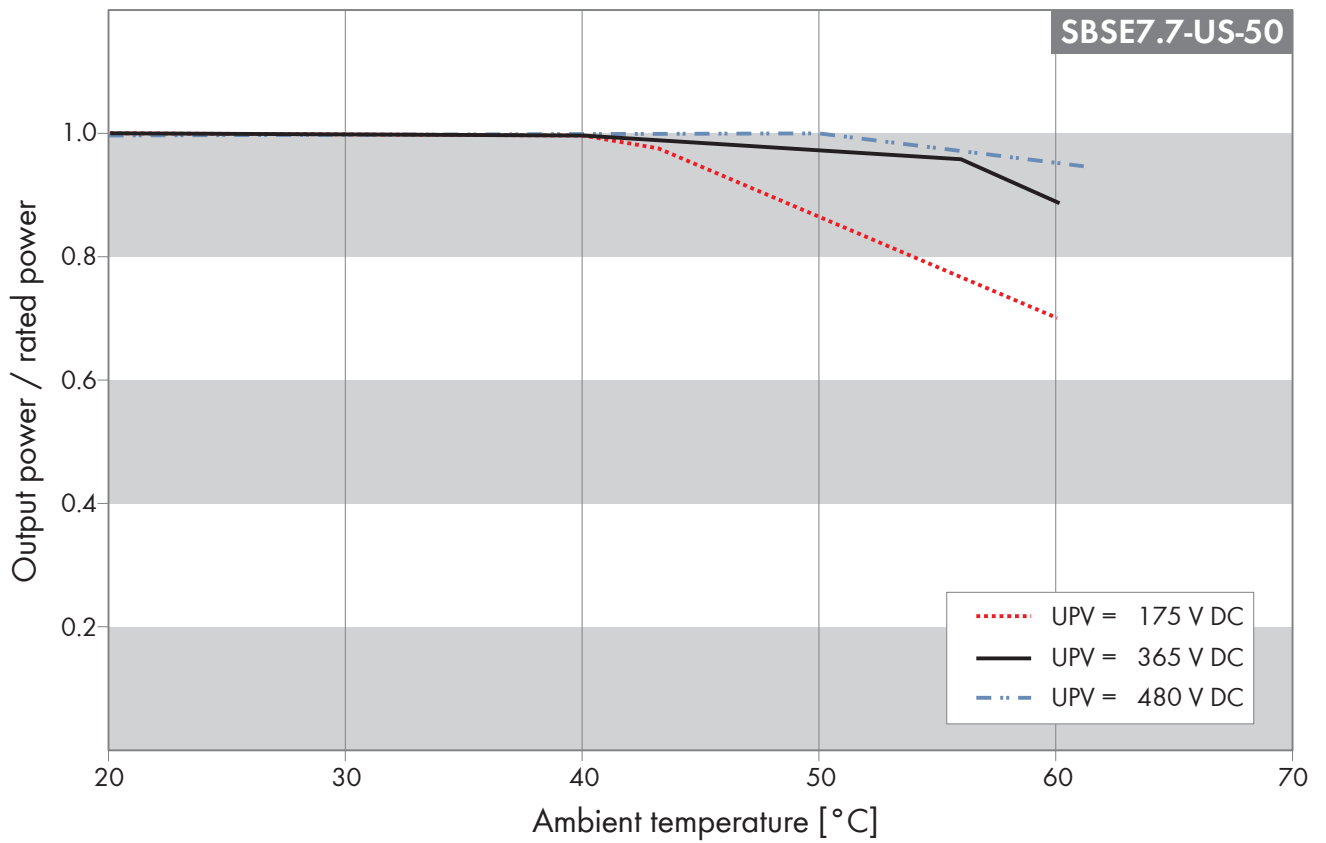
Californian efficiency, η_{CEC}

97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 180 V	Rated input voltage 400 V	Maximum MPP voltage 480 V
10 %	95.4 %	95.1 %	95.9 %
20 %	96.9 %	97.2 %	97.6 %
30 %	97.4 %	97.5 %	97.9 %
50 %	97.0 %	97.6 %	98.0 %
75 %	96.6 %	97.5 %	97.9 %
100 %	96.1 %	97.3 %	97.5 %

3.4.3 Derating behavior at 240 V AC



3.5 SBSE9.6-US-50

3.5.1 Efficiency at 208 V AC

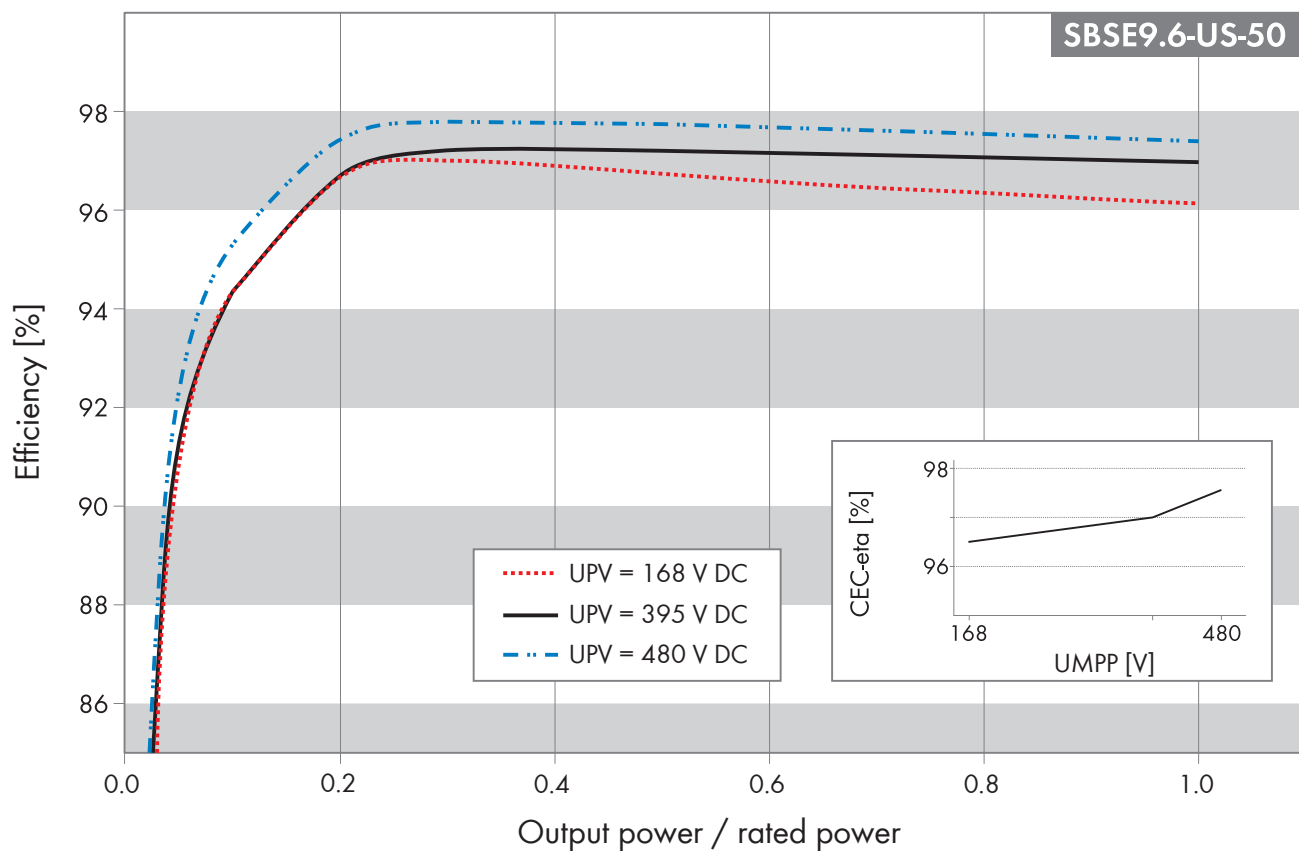


Figure 1:

Maximum efficiency, $\eta_{\max}$ 97.8 %

Californian efficiency, η_{CEC} 97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 168 V	Rated input voltage 395 V	Maximum MPP voltage 480 V
10 %	94.4 %	94.4 %	95.4 %
20 %	96.8 %	96.6 %	97.5 %
30 %	97.1 %	97.2 %	97.8 %
50 %	96.8 %	97.2 %	97.8 %
75 %	96.4 %	97.1 %	97.6 %
100 %	96.1 %	97.0 %	97.4 %

3.5.2 Efficiency at 240 V AC

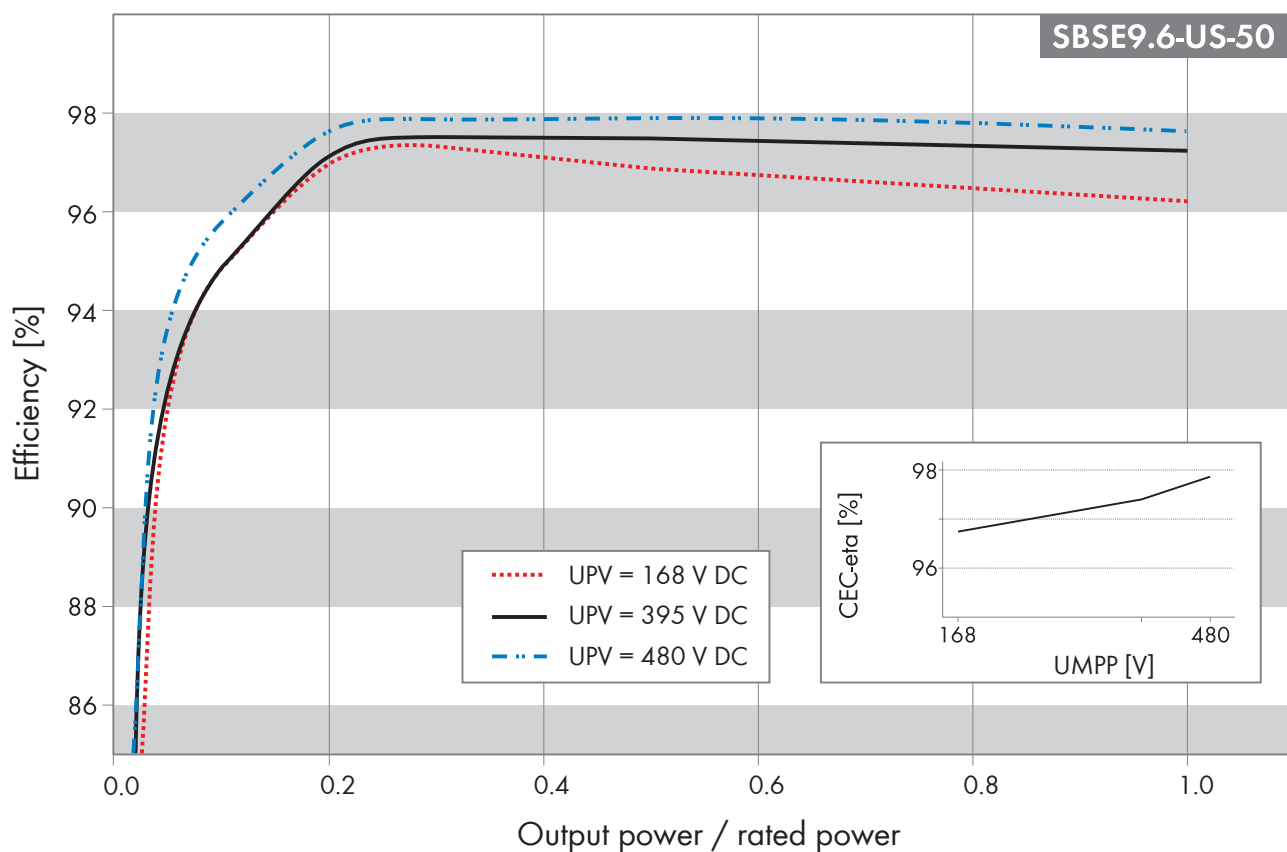


Figure 2:

Maximum efficiency, $\eta_{\max}$	98.0 %
Californian efficiency, η_{CEC}	97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 168 V	Rated input voltage 395 V	Maximum MPP voltage 480 V
10 %	95.0 %	94.9 %	95.9 %
20 %	97.1 %	97.3 %	97.7 %
30 %	97.5 %	97.6 %	98.0 %
50 %	97.0 %	97.6 %	98.0 %
75 %	96.7 %	97.5 %	98.0 %
100 %	96.3 %	97.3 %	97.7 %

3.5.3 Derating behavior

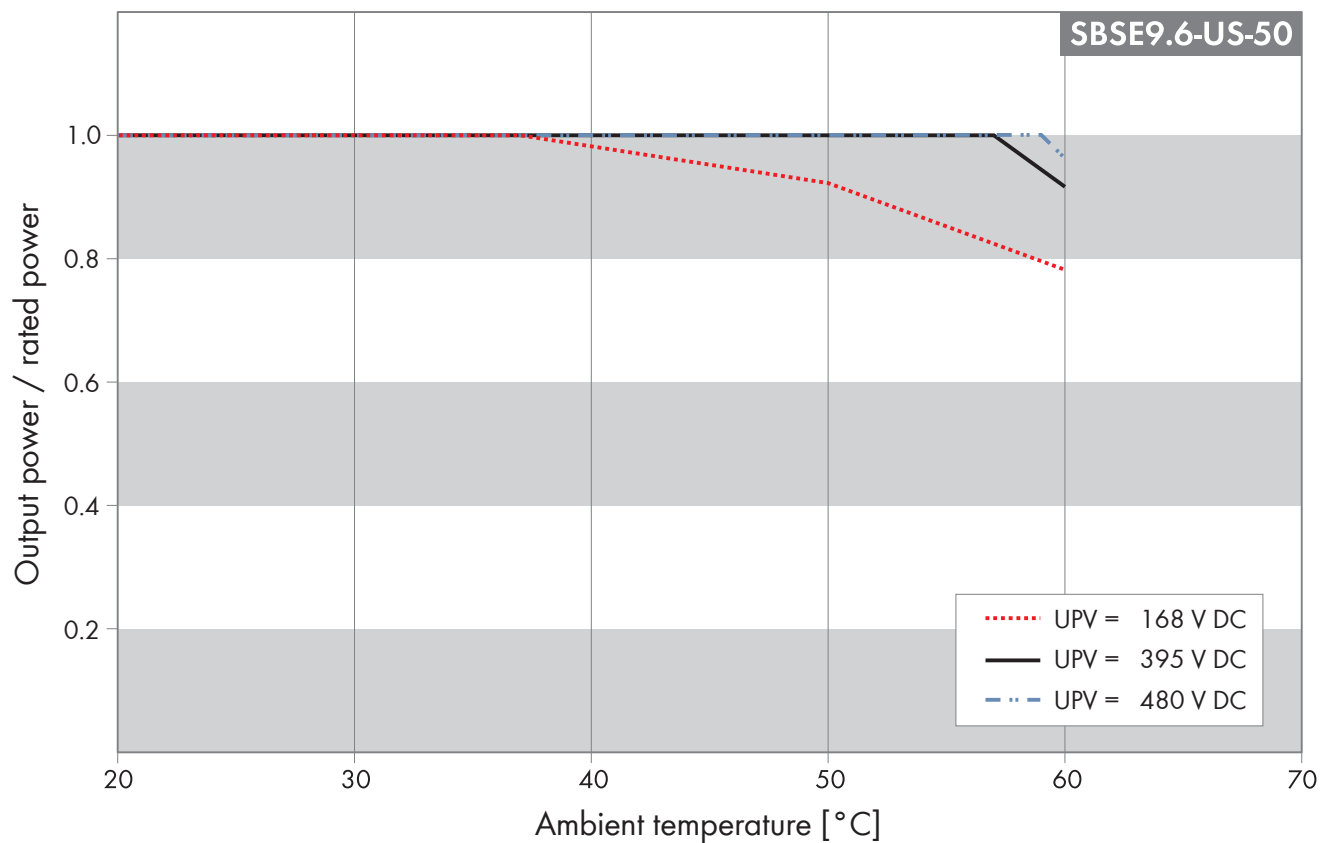


Figure 3:

3.6 SBSE11.5-US-50

3.6.1 Efficiency at 208 V AC

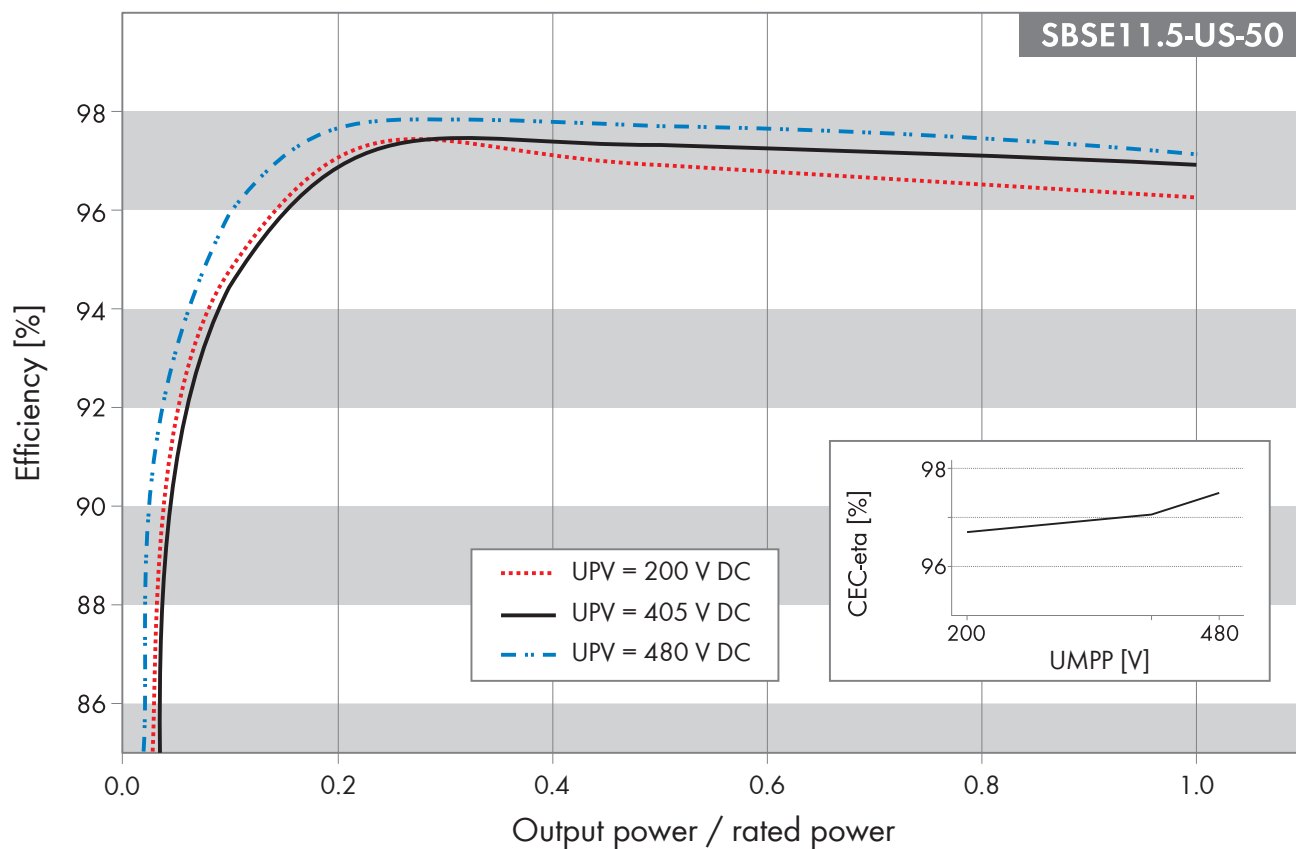


Figure 4:

Maximum efficiency, $\eta_{\max}$ 97.8 %

Californian efficiency, η_{CEC} 97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 200 V	Rated input voltage 405 V	Maximum MPP voltage 480 V
10 %	94.8 %	94.4 %	96.0 %
20 %	97.1 %	97.1 %	97.7 %
30 %	97.4 %	97.2 %	97.8 %
50 %	96.9 %	97.3 %	97.7 %
75 %	96.6 %	97.1 %	97.5 %
100 %	96.3 %	96.9 %	97.2 %

3.6.2 Efficiency at 240 V AC

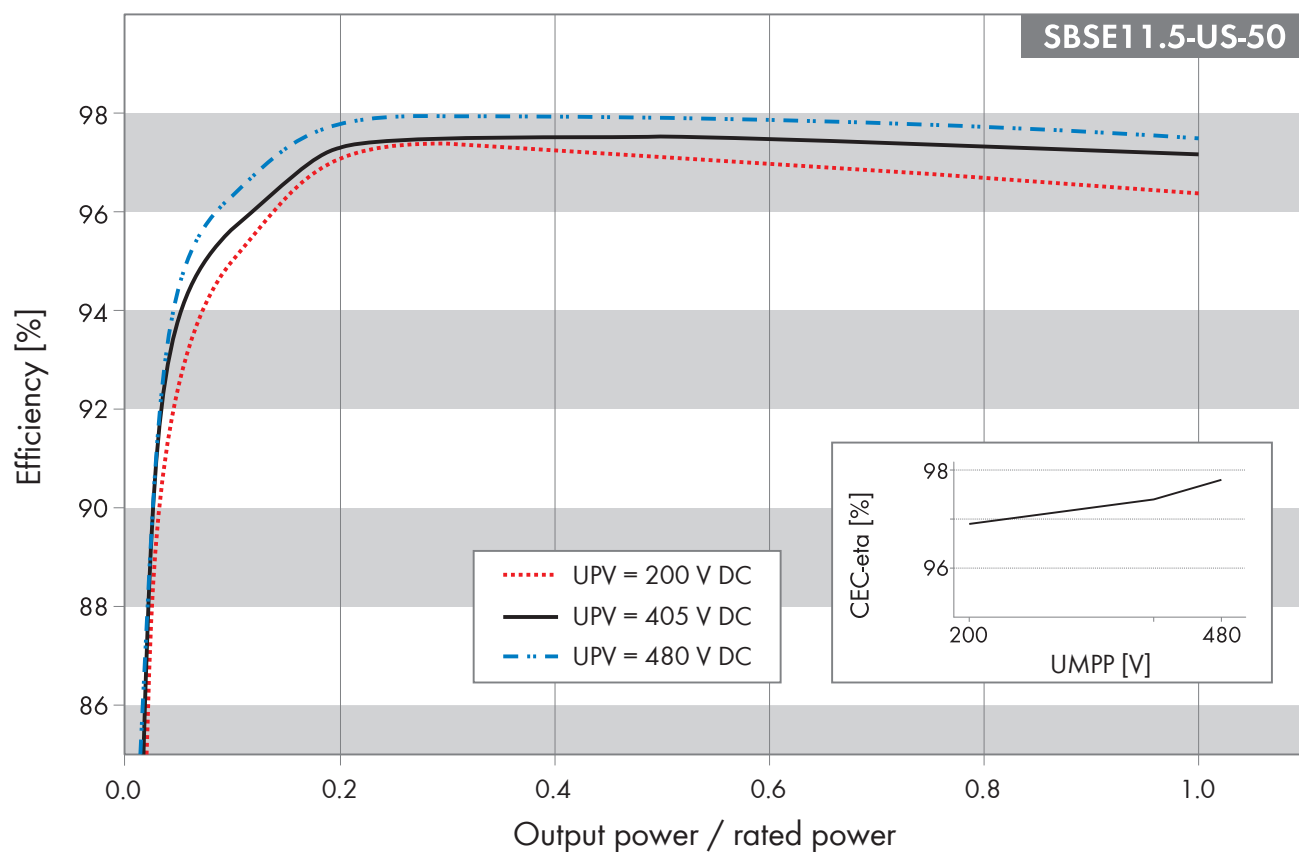


Figure 5:

Maximum efficiency, $\eta_{\max}$ 98.0 %

Californian efficiency, η_{CEC} 97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 200 V	Rated input voltage 405 V	Maximum MPP voltage 480 V
10 %	95.1 %	95.8 %	96.4 %
20 %	97.2 %	97.4 %	97.9 %
30 %	97.5 %	97.5 %	98.0 %
50 %	97.2 %	97.6 %	98.0 %
75 %	96.8 %	97.4 %	97.8 %
100 %	96.5 %	97.3 %	97.6 %

3.6.3 Derating behavior

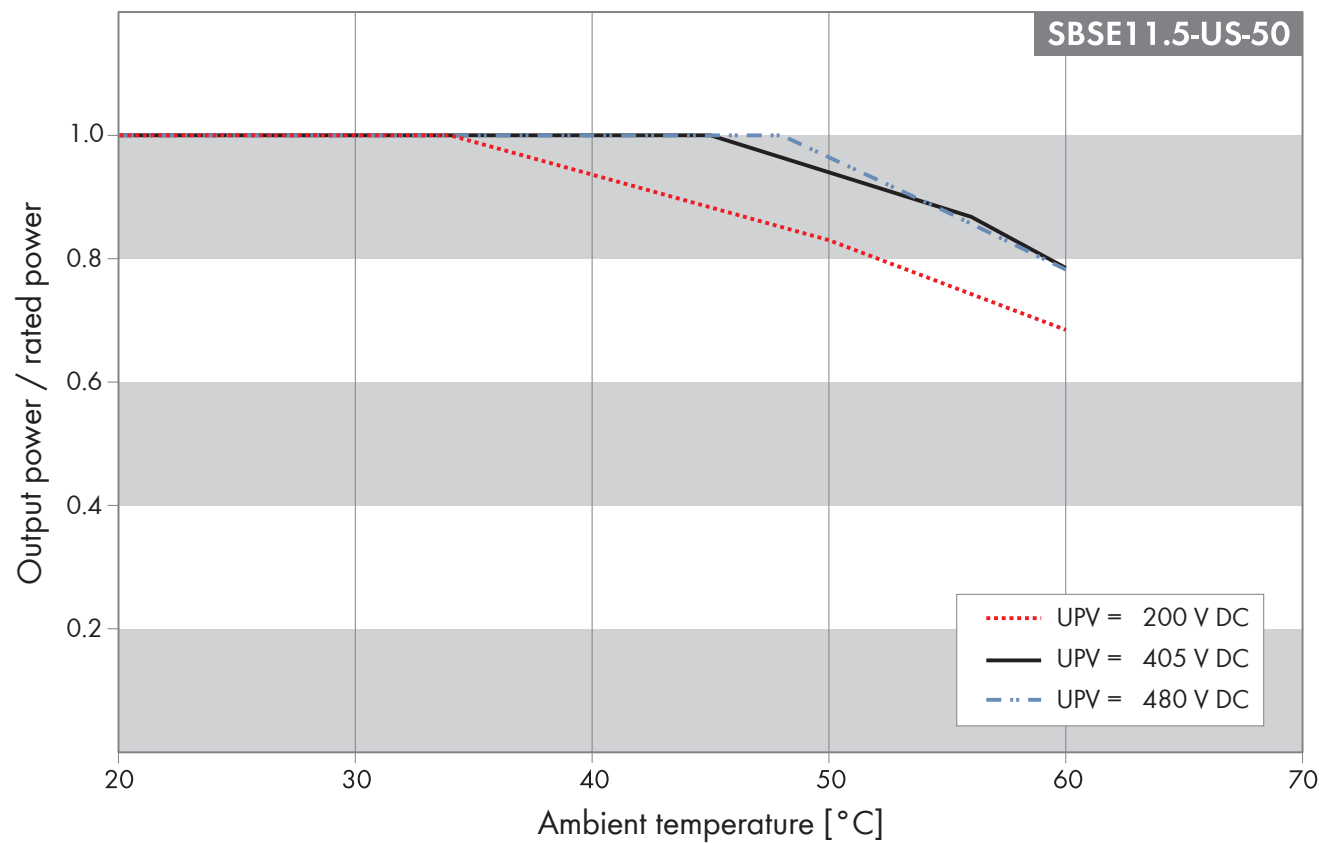


Figure 6:

4 Sunny Tripower

4.1 STP 13-US-50

4.1.1 Efficiency at 120 V AC

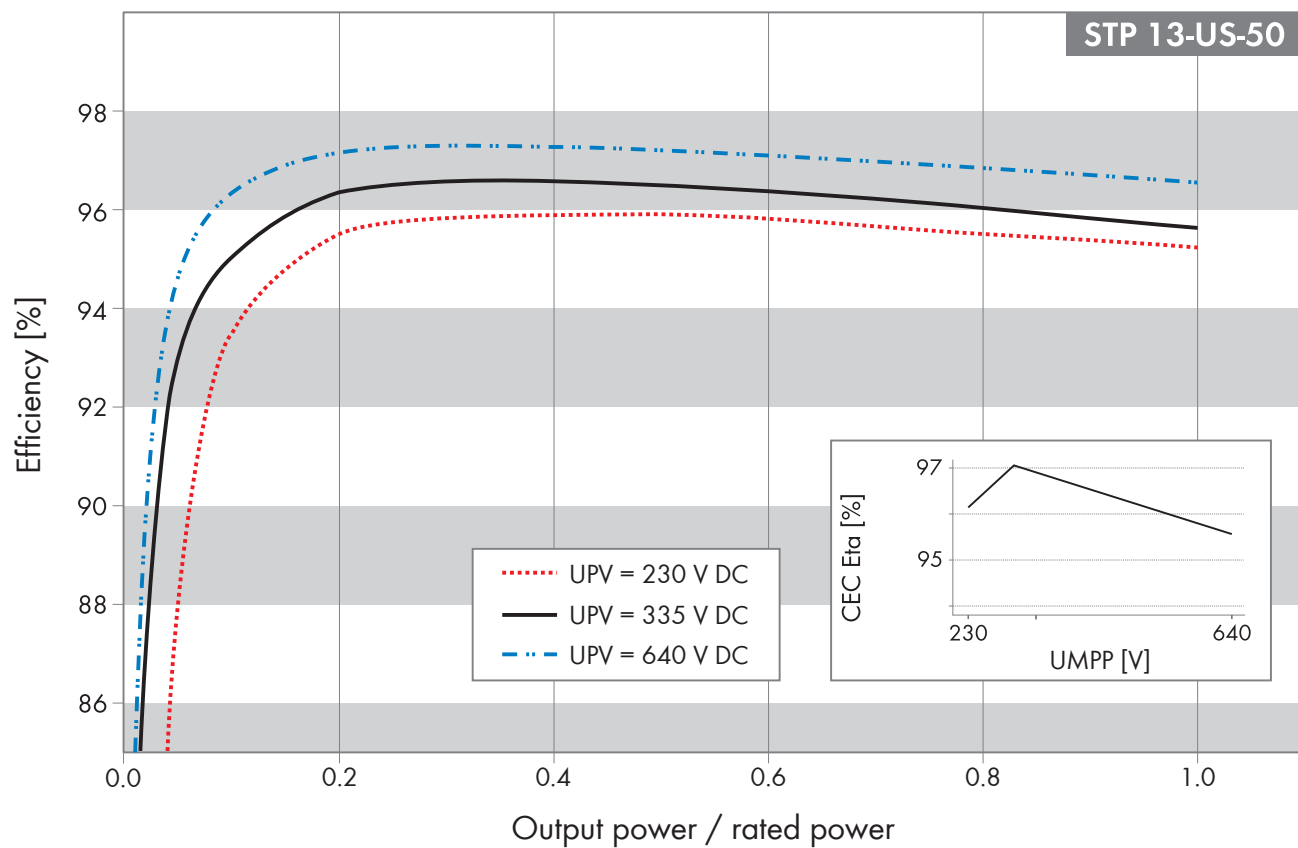


Figure 7:

Maximum efficiency, $\eta_{\max}$ 97.3 %

Californian efficiency, η_{CEC} 97.0%

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 230 V	Rated input voltage 335 V	Maximum MPP voltage 640 V
10 %	95.0 %	96.5 %	93.5 %
20 %	96.3 %	97.2 %	95.5 %
30 %	96.4 %	97.3 %	95.7 %
50 %	96.4 %	97.3 %	95.9 %
75 %	96.1 %	97.0 %	95.6 %
100 %	95.6 %	96.6 %	95.3 %

4.1.2 Derating behavior at 120 V AC

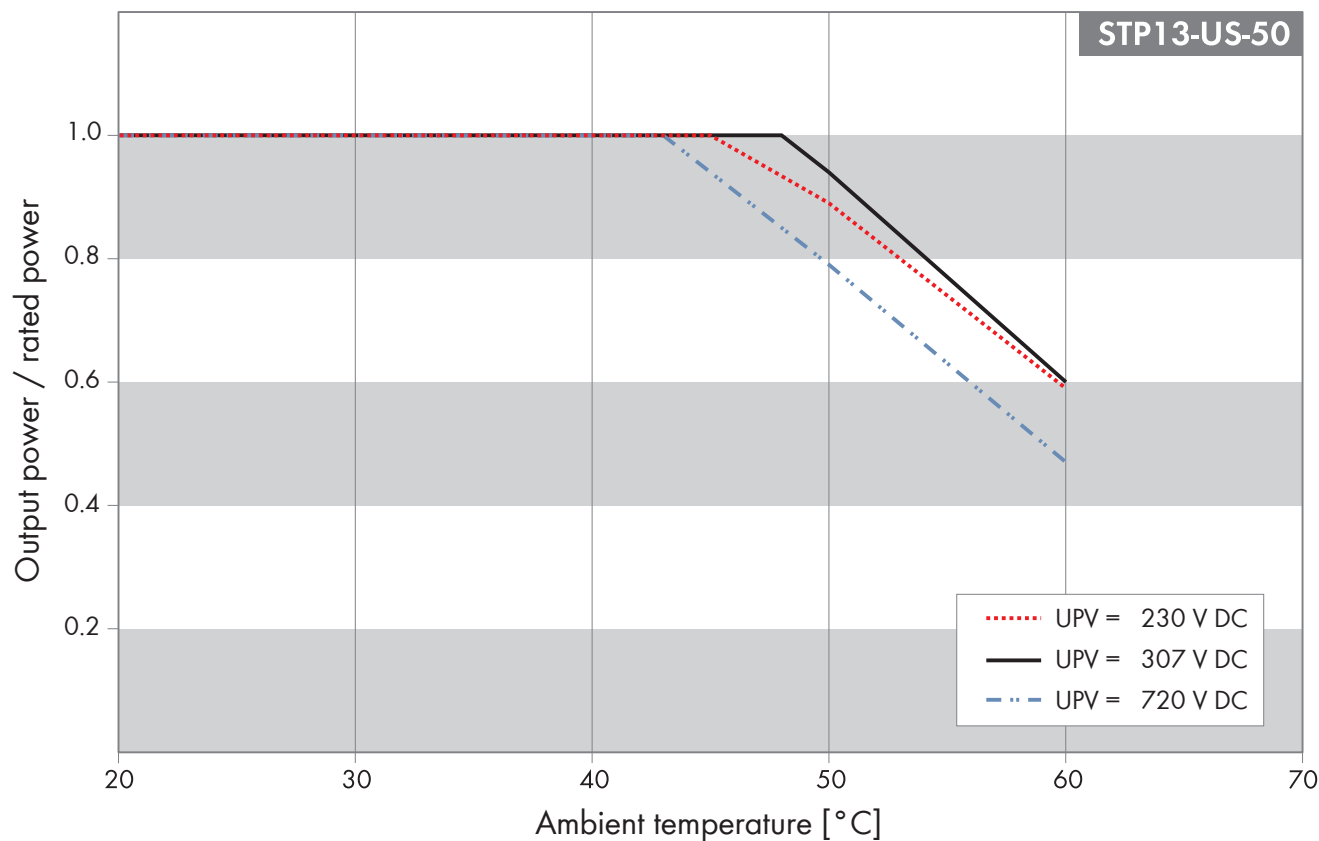
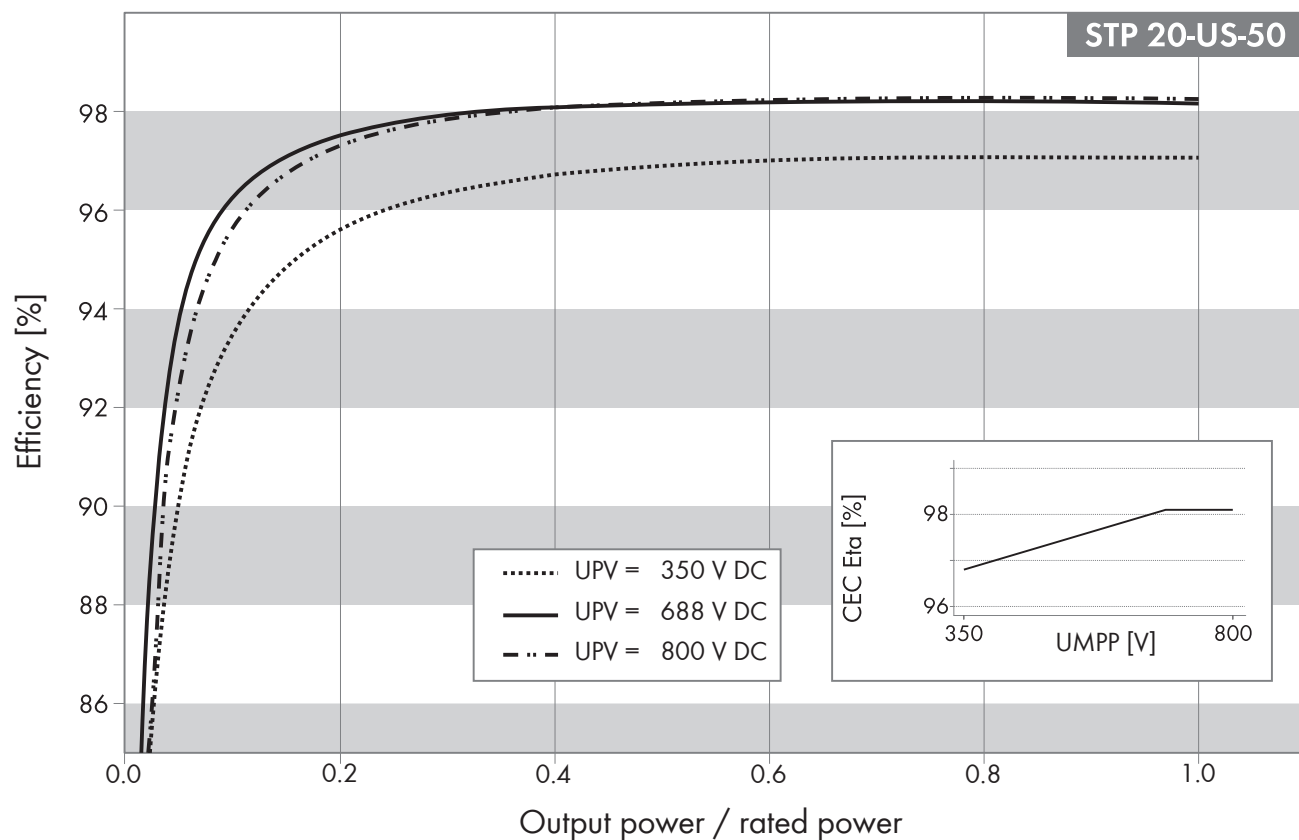


Figure 8:

4.2 STP 20-US-50

4.2.1 Efficiency at 277 V AC

Maximum efficiency, $\eta_{\max}$

98.2%

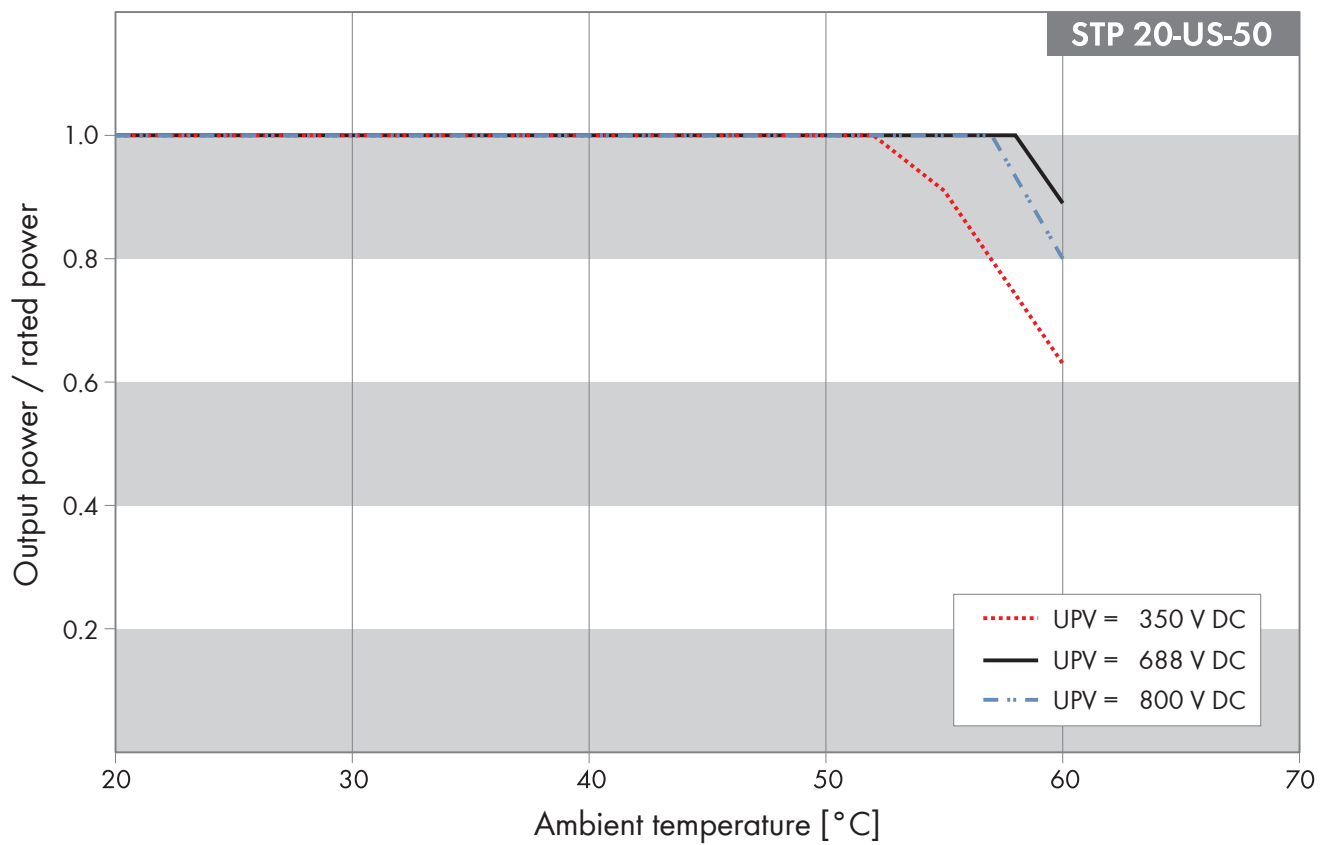
Californian efficiency, η_{CEC}

97.5%

Efficiency Profile

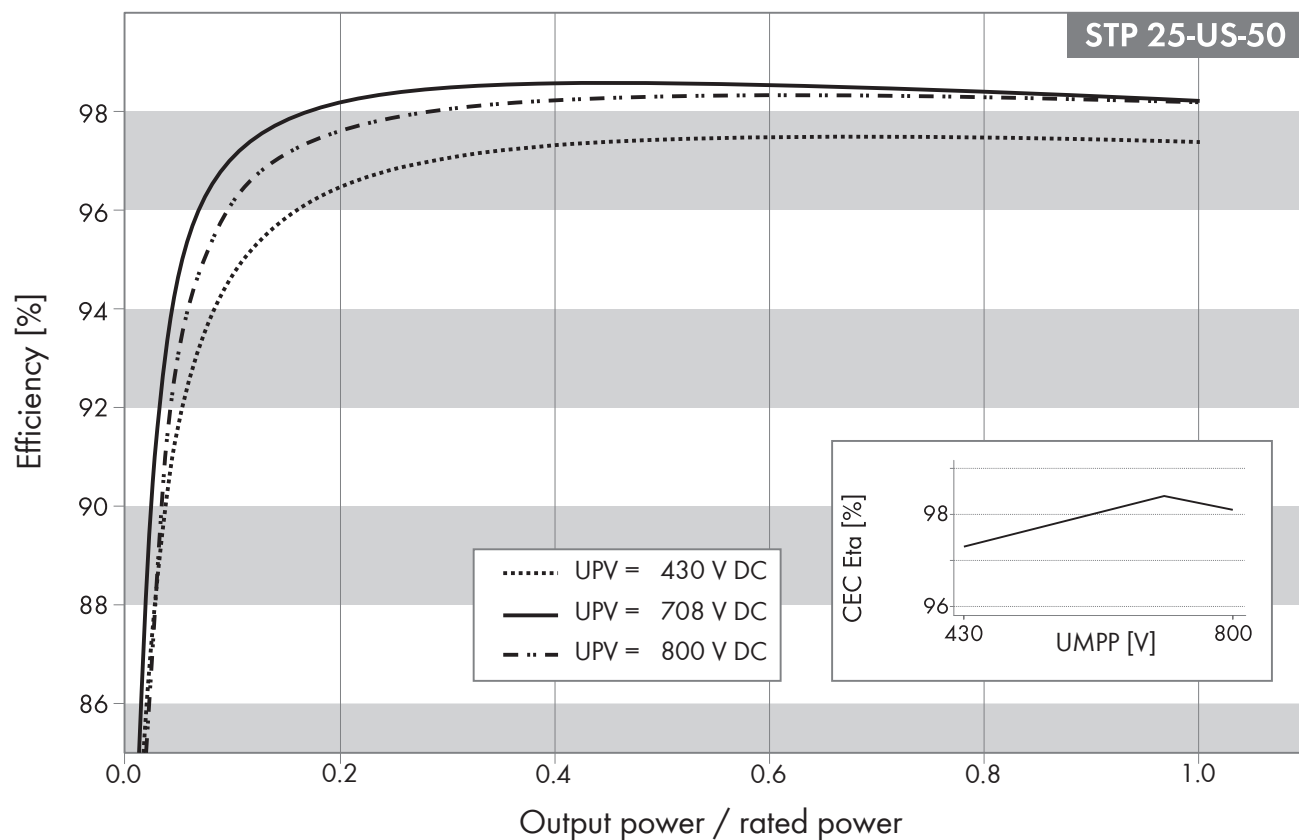
Standardized output power	Efficiency		
	Minimum MPP voltage 350 V	Rated input voltage 688 V	Maximum MPP voltage 800 V
10%	93.5%	96.3%	95.6%
20%	95.6%	97.5%	97.3%
30%	96.4%	97.9%	97.9%
50%	96.9%	98.2%	98.2%
75%	97.1%	98.2%	98.3%
100%	97.1%	98.2%	98.3%

4.2.2 Derating behavior at 277 V AC



4.3 STP 25-US-50

4.3.1 Efficiency at 277 V AC

Maximum efficiency, $\eta_{\max}$

98.6%

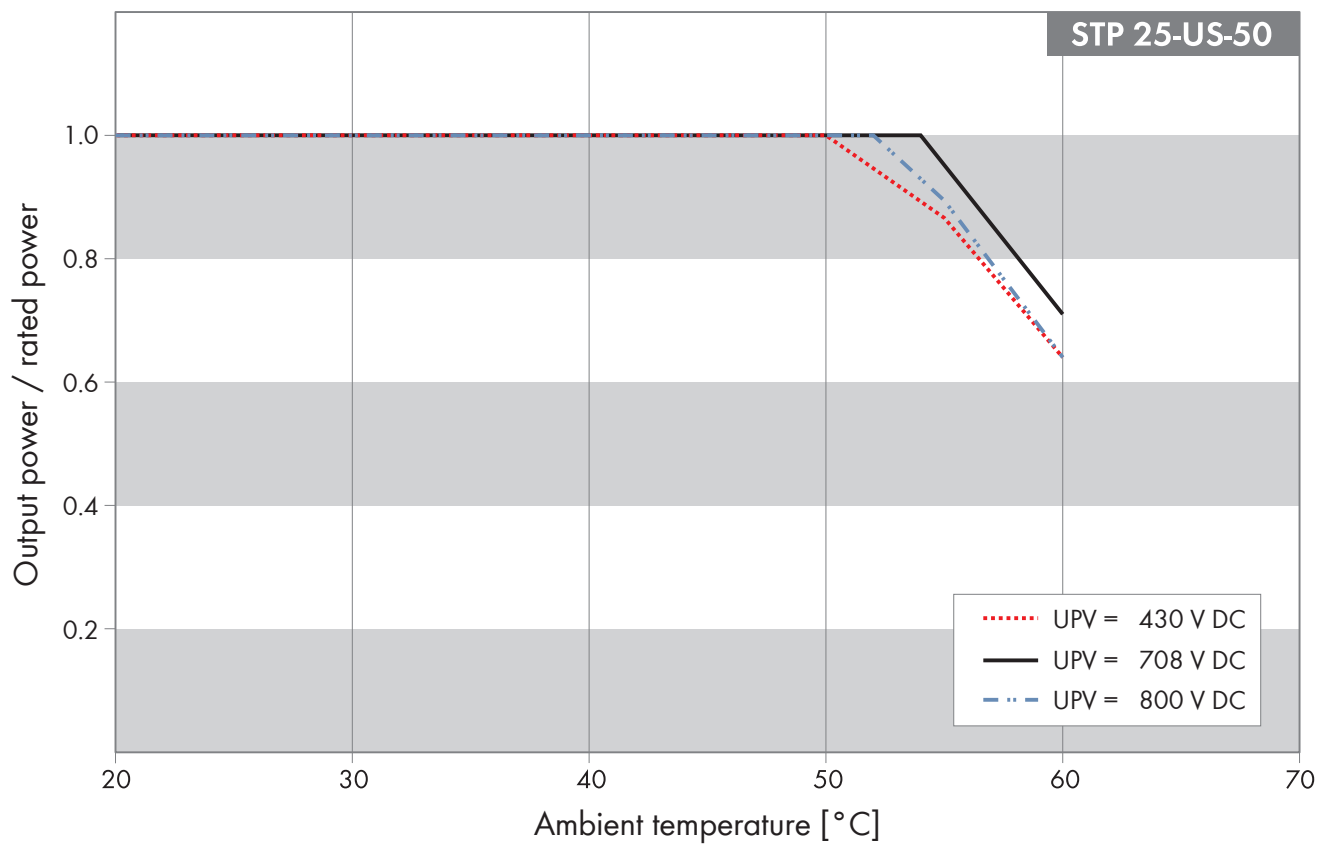
Californian efficiency, η_{CEC}

98%

Efficiency Profile

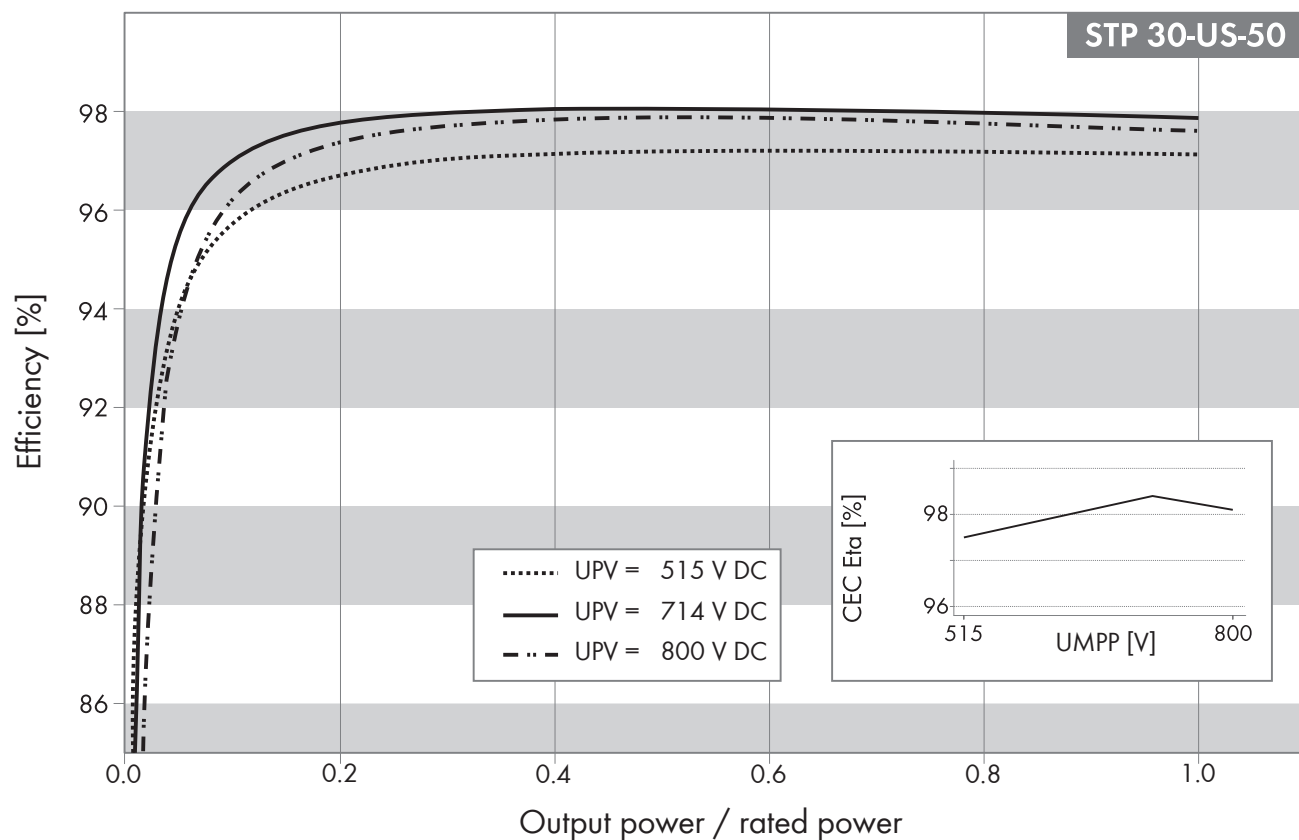
Standardized output power	Efficiency		
	Minimum MPP voltage 430 V	Rated input voltage 708 V	Maximum MPP voltage 800 V
10%	94.7%	97.1%	96.1%
20%	96.5%	98.2%	97.6%
30%	97.1%	98.5%	98.1%
50%	97.4%	98.6%	98.3%
75%	97.5%	98.4%	98.3%
100%	97.4%	98.2%	98.2%

4.3.2 Derating behavior at 277 V AC



4.4 STP 30-US-50

4.4.1 Efficiency at 277 V AC

Maximum efficiency, $\eta_{\max}$

98.5%

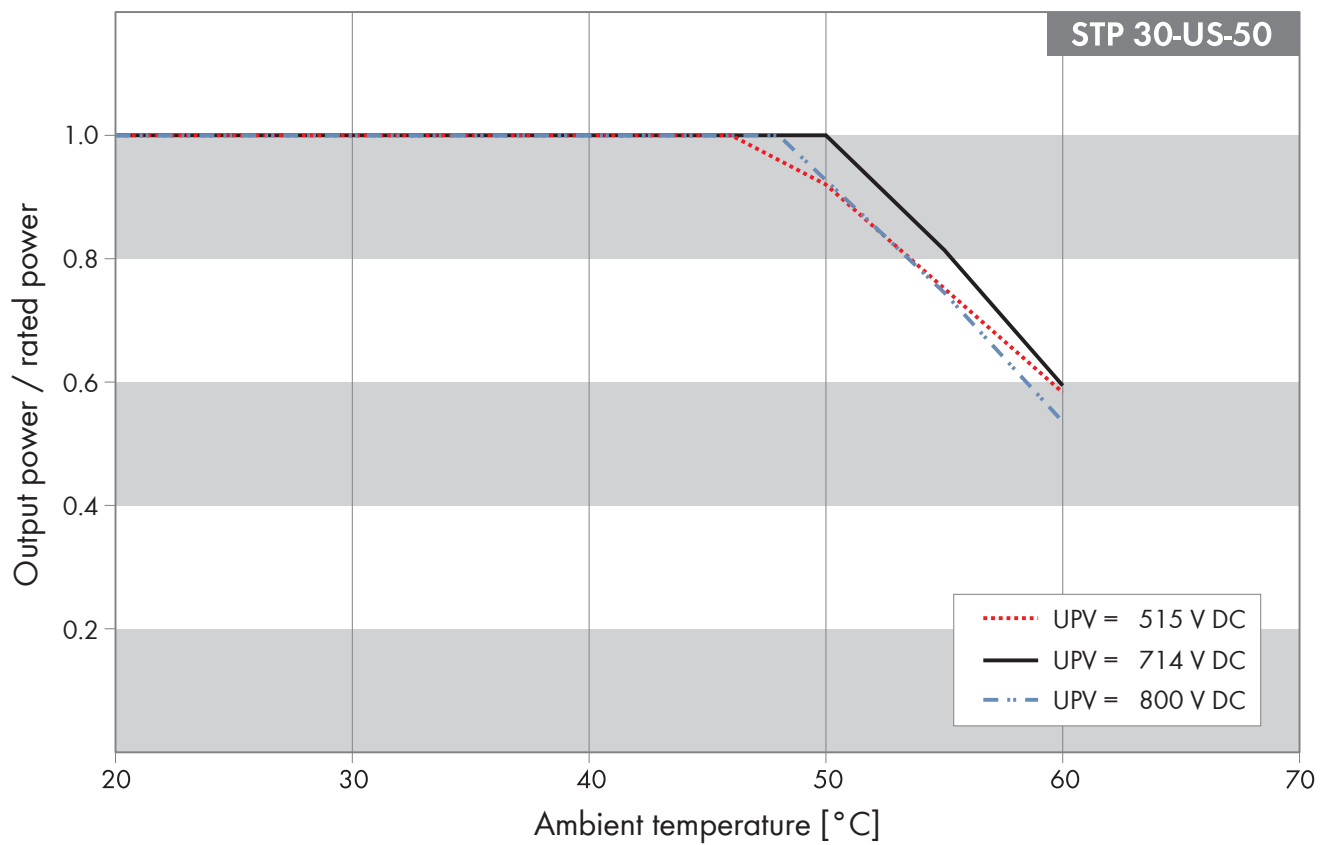
Californian efficiency, η_{CEC}

98%

Efficiency Profile

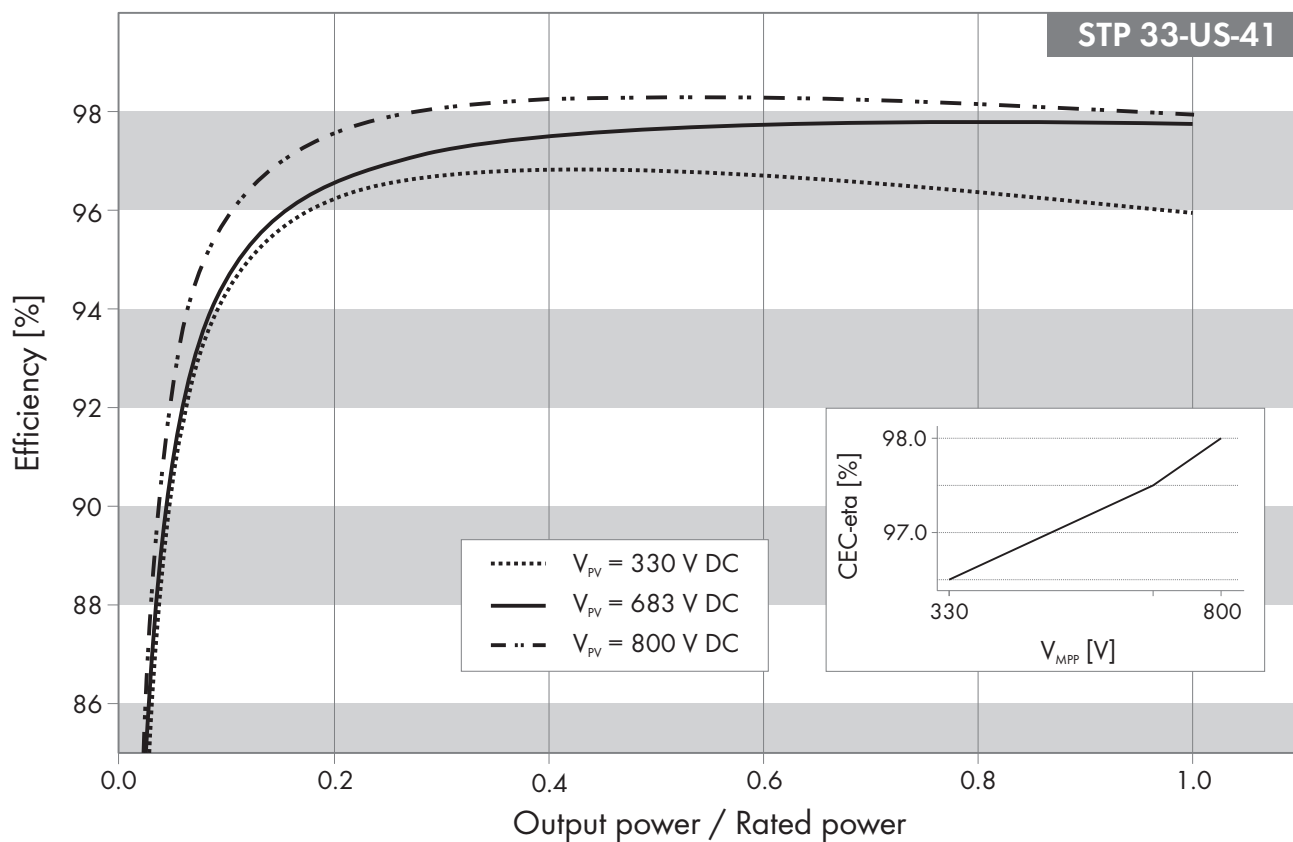
Standardized output power	Efficiency		
	Minimum MPP voltage 515 V	Rated input voltage 714 V	Maximum MPP voltage 800 V
10%	96.1%	97.4%	96.6%
20%	97.1%	98.2%	97.8%
30%	97.4%	98.4%	98.2%
50%	97.6%	98.6%	98.3%
75%	97.6%	98.4%	98.2%
100%	97.5%	98.3%	98.1%

4.4.2 Derating behavior at 277 V AC



4.5 STP 33-US-41

4.5.1 Efficiency at 277 V AC

Maximum efficiency, $\eta_{\max}$

98.2 %

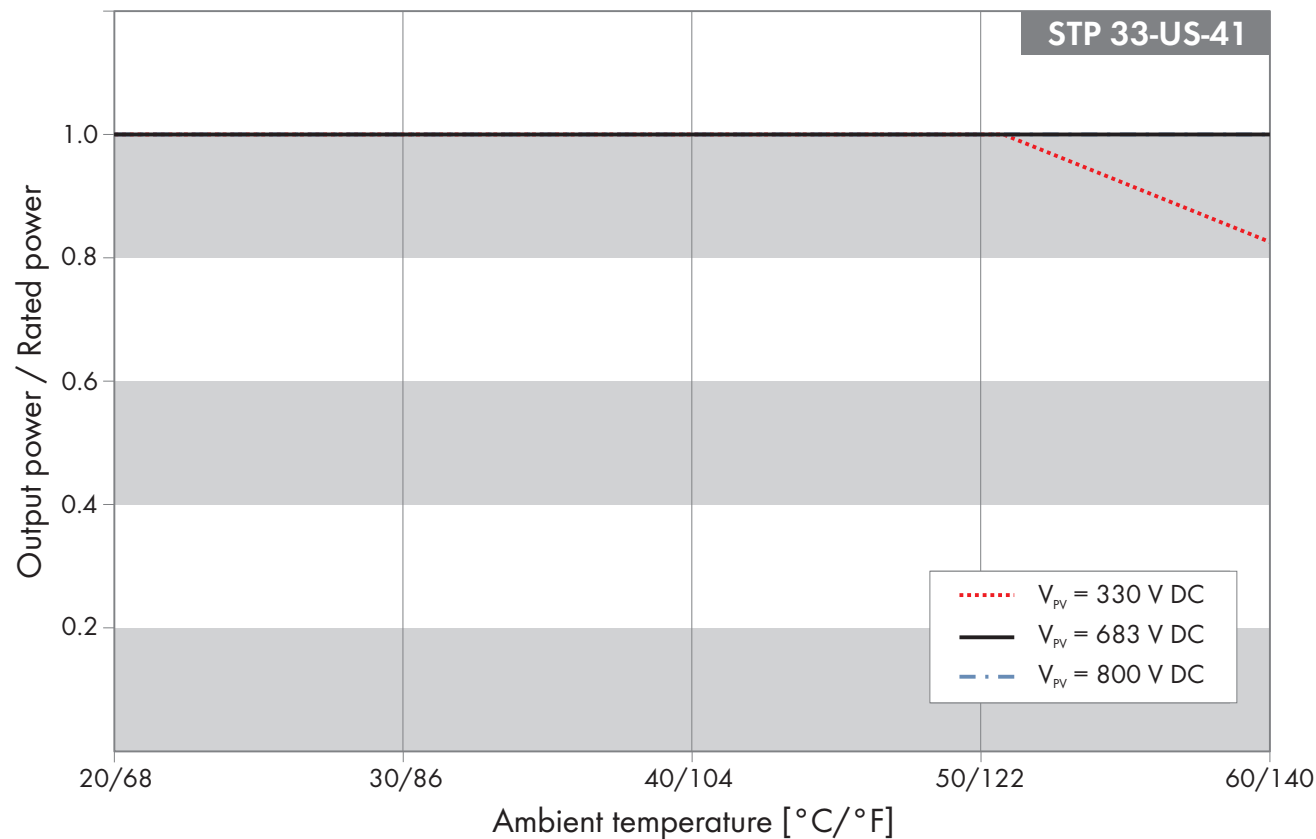
Californian efficiency, η_{CEC}

97.5 %

Efficiency Profile

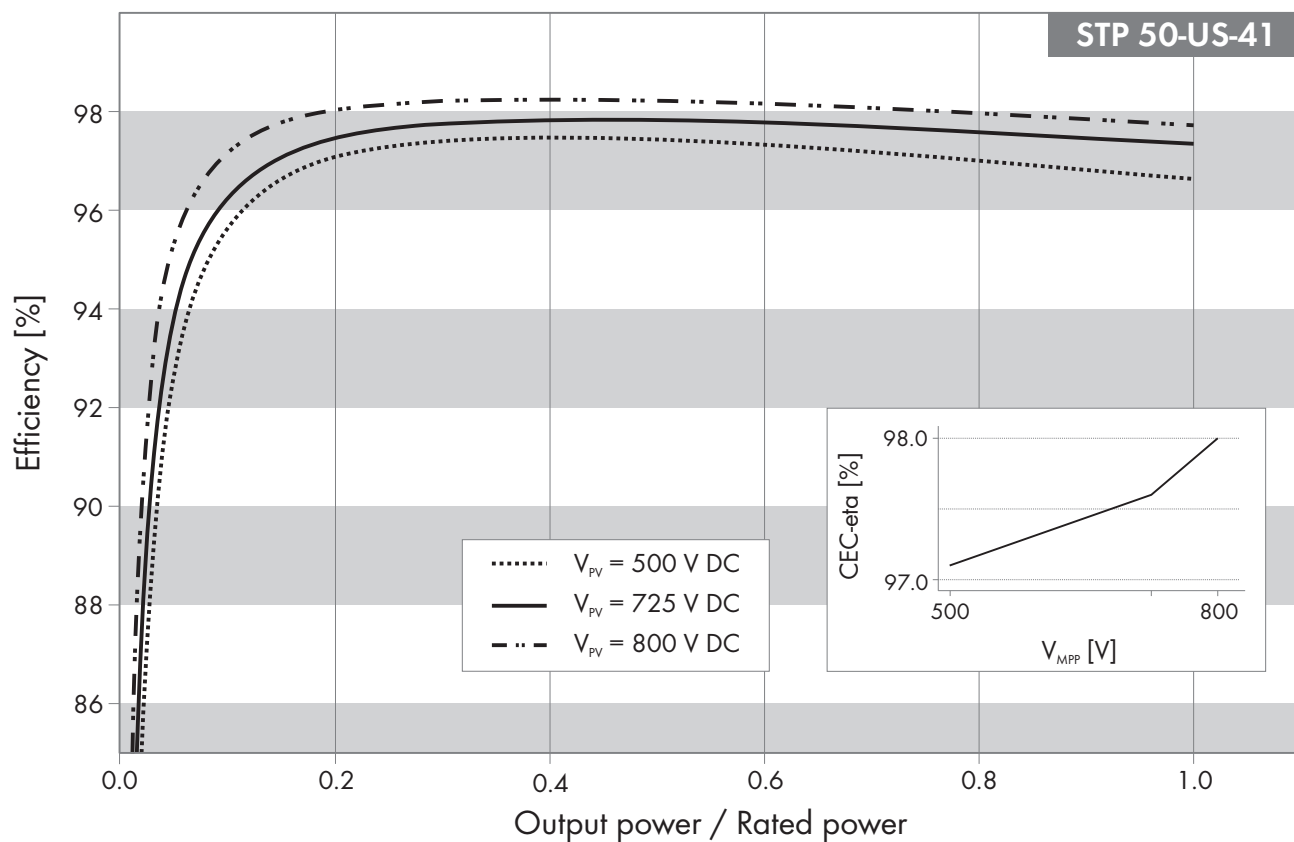
Standardized output power	Efficiency		
	Minimum MPP voltage 330 V	Rated input voltage 683 V	Maximum MPP voltage 800 V
10 %	94.2 %	94.7 %	95.7 %
20 %	96.3 %	96.8 %	97.6 %
30 %	96.7 %	97.3 %	98.0 %
50 %	96.6 %	97.7 %	98.2 %
75 %	96.5 %	97.7 %	98.1 %
100 %	96.0 %	97.7 %	97.9 %

4.5.2 Derating behavior at 277 V AC



4.6 STP 50-US-41

4.6.1 Efficiency at 277 V AC

Maximum efficiency, η_{max}

98.2 %

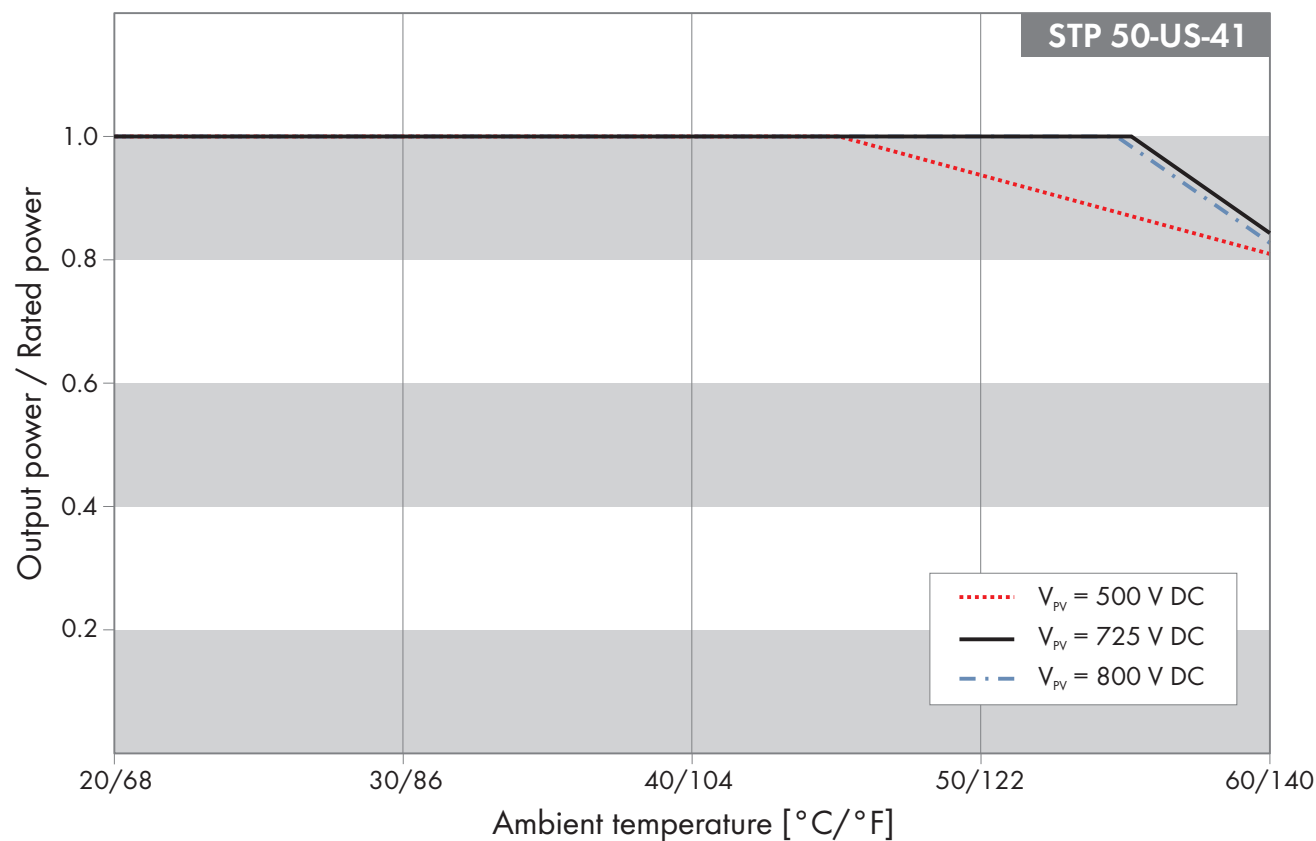
Californian efficiency, η_{CEC}

97.5 %

Efficiency Profile

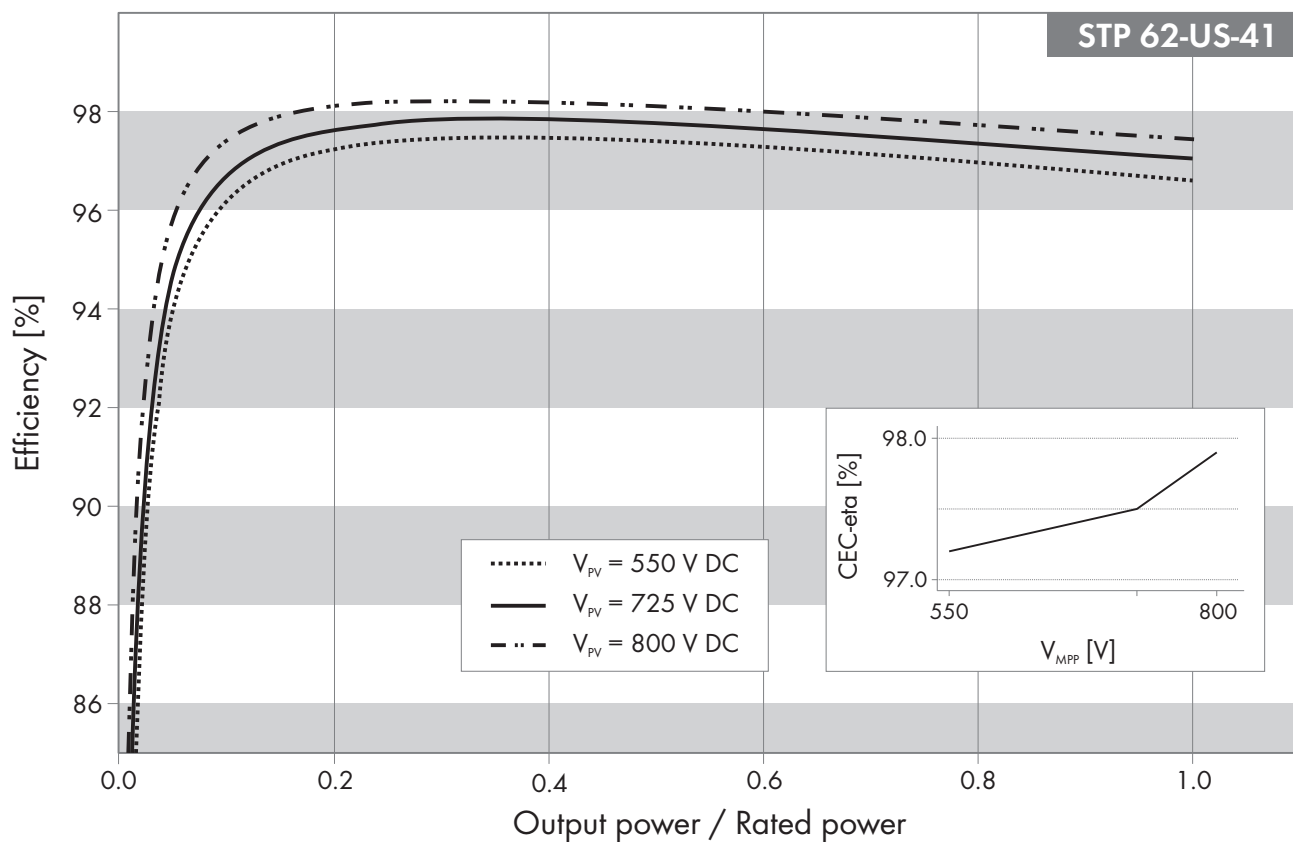
Standardized output power	Efficiency		
	Minimum MPP voltage 500 V	Rated input voltage 725 V	Maximum MPP voltage 800 V
10 %	95.6 %	96.2 %	97.1 %
20 %	97.1 %	97.5 %	98.1 %
30 %	97.4 %	97.7 %	98.2 %
50 %	97.4 %	97.8 %	98.1 %
75 %	97.0 %	97.6 %	98.0 %
100 %	96.7 %	97.4 %	97.8 %

4.6.2 Derating behavior at 277 V AC



4.7 STP 62-US-41

4.7.1 Efficiency at 277 V AC

Maximum efficiency, η_{max}

98.2 %

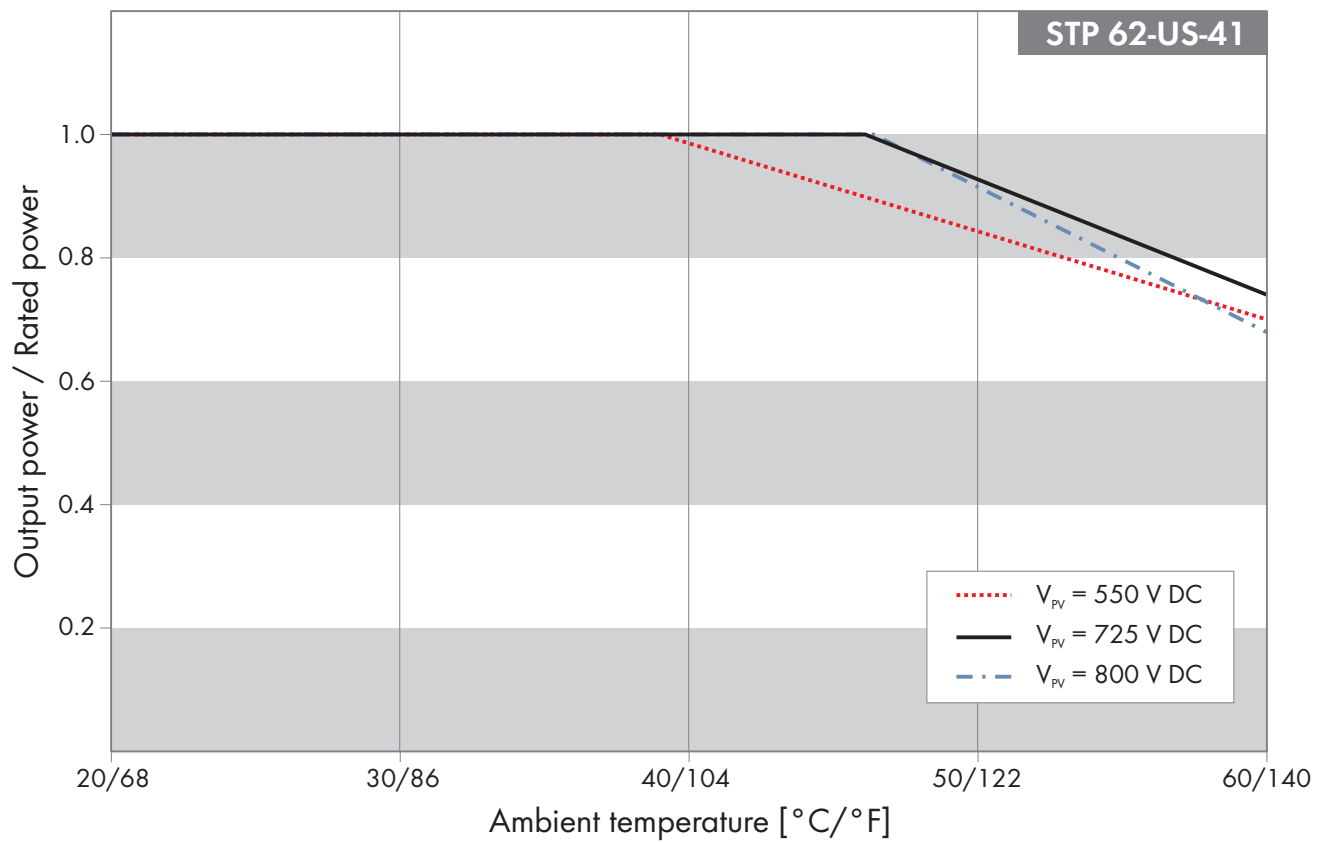
Californian efficiency, η_{CEC}

97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 550 V	Rated input voltage 725 V	Maximum MPP voltage 800 V
10 %	96.2 %	96.7 %	97.4 %
20 %	97.3 %	97.7 %	98.2 %
30 %	97.4 %	97.8 %	98.2 %
50 %	97.4 %	97.8 %	98.1 %
75 %	97.2 %	97.4 %	97.8 %
100 %	96.5 %	97.1 %	97.5 %

4.7.2 Derating behavior at 277 V AC



4.8 STP 27-US-80

4.8.1 Efficiency at 120 V AC

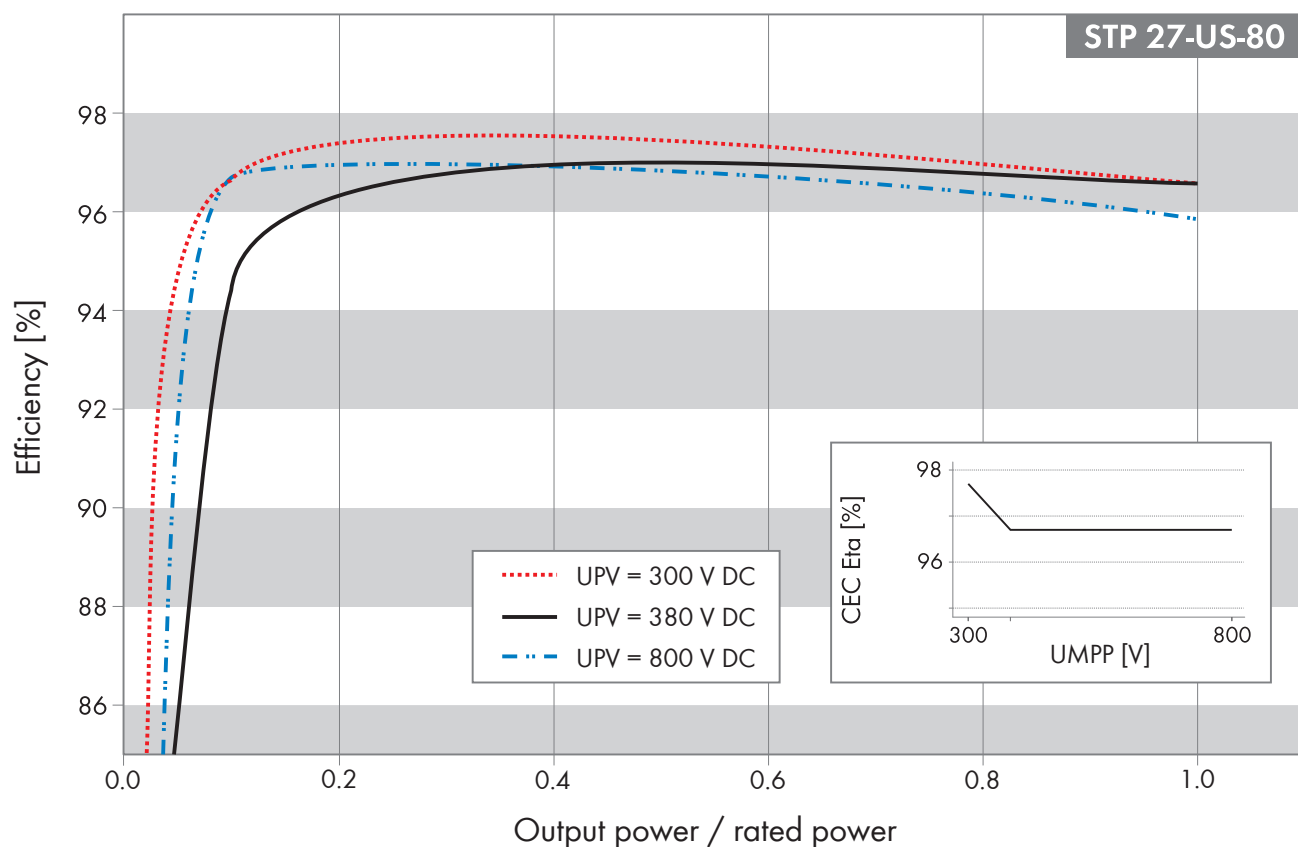


Figure 9:

Maximum efficiency, $\eta_{\max}$	97.6 %
Californian efficiency, η_{CEC}	97.0 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 300 V	Rated input voltage 380 V	Maximum MPP voltage 800 V
10 %	96.8 %	94.5 %	97.0 %
20 %	96.7 %	96.9 %	97.0 %
30 %	97.2 %	96.7 %	96.8 %
50 %	97.6 %	96.6 %	96.7 %
75 %	96.9 %	96.9 %	96.7 %
100 %	96.6 %	96.7 %	96.0 %

4.8.2 Derating behavior at 120 V AC

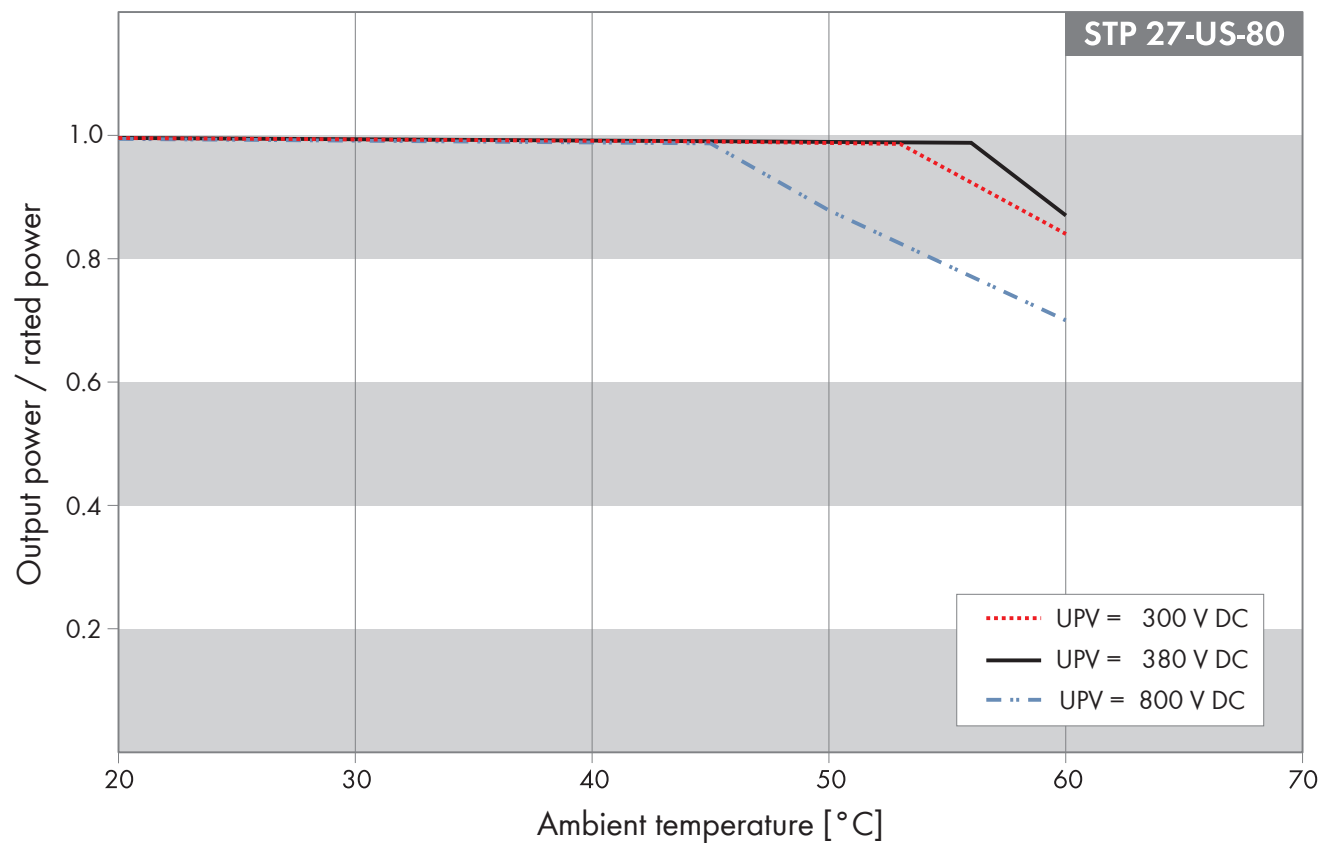


Figure 10:

4.9 STP 50-US-80

4.9.1 Efficiency at 277 V AC

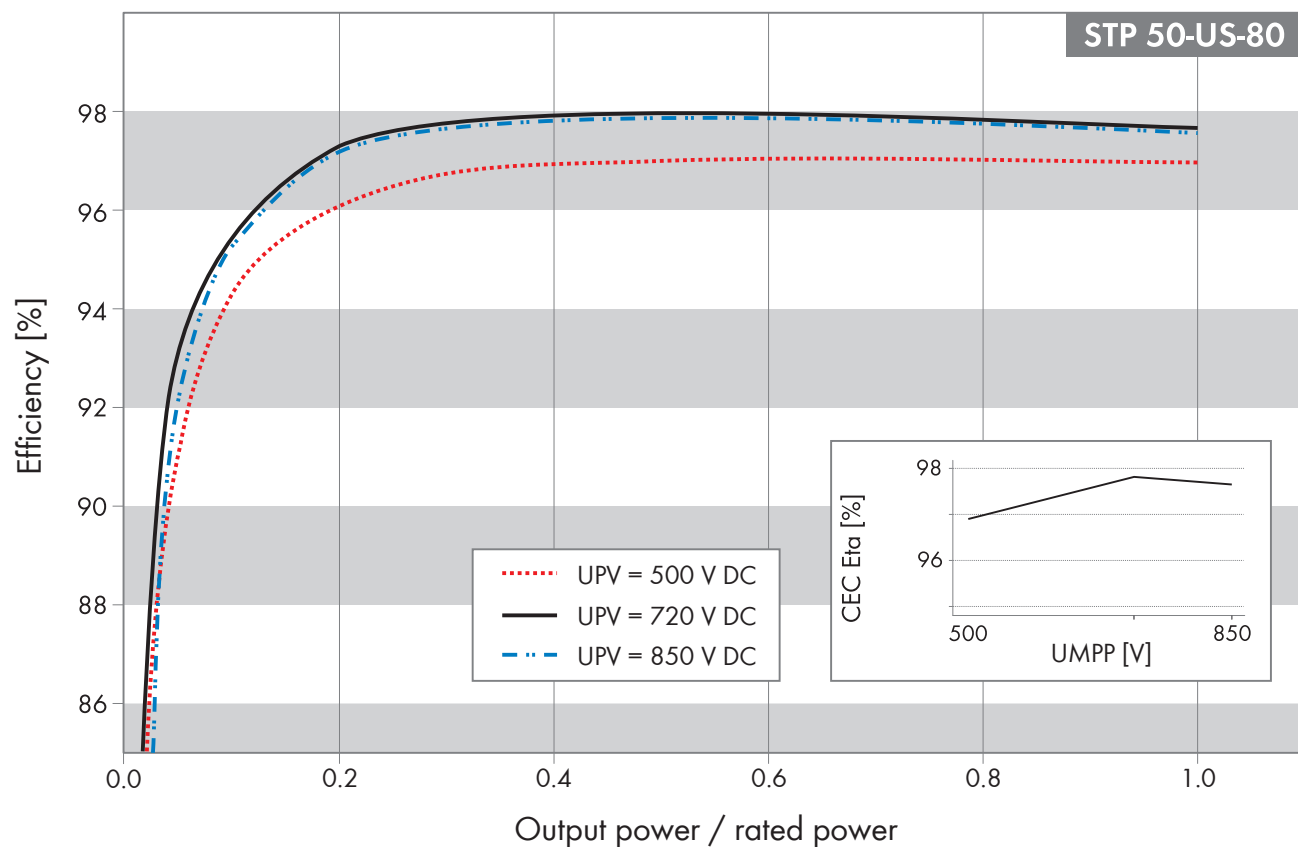


Figure 11:

Maximum efficiency, $\eta_{\max}$ 98.0 %

Californian efficiency, η_{CEC} 97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 500 V	Rated input voltage 720 V	Maximum MPP voltage 850 V
10 %	94.3 %	95.7 %	95.5 %
20 %	96.1 %	97.3 %	97.3 %
30 %	96.8 %	97.8 %	97.6 %
50 %	97.1 %	98.0 %	97.8 %
75 %	97.1 %	98.0 %	97.8 %
100 %	97.0 %	97.7 %	97.7 %

4.9.2 Derating behavior at 277 V AC

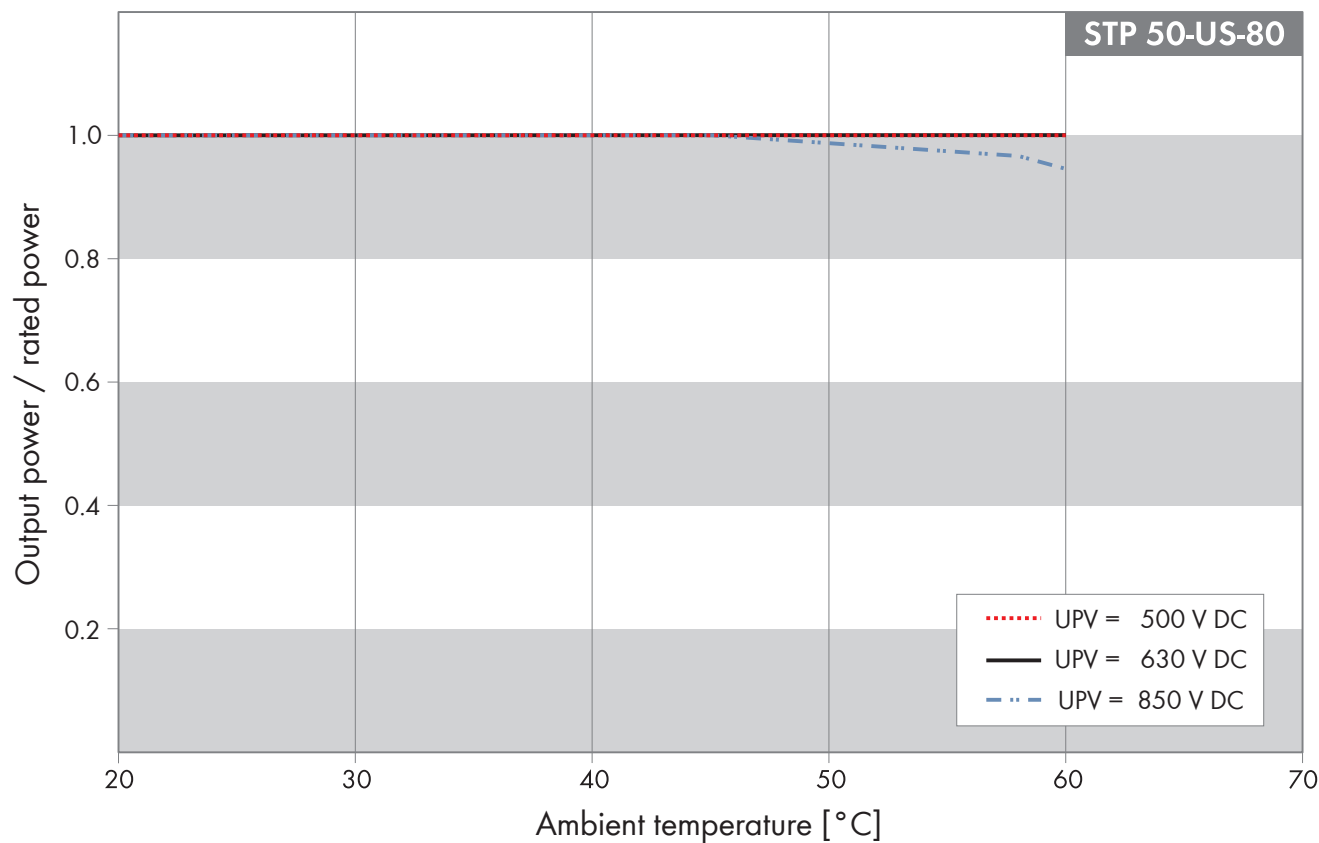


Figure 12:

4.10 STP 62-US-80

4.10.1 Efficiency at 277 V AC

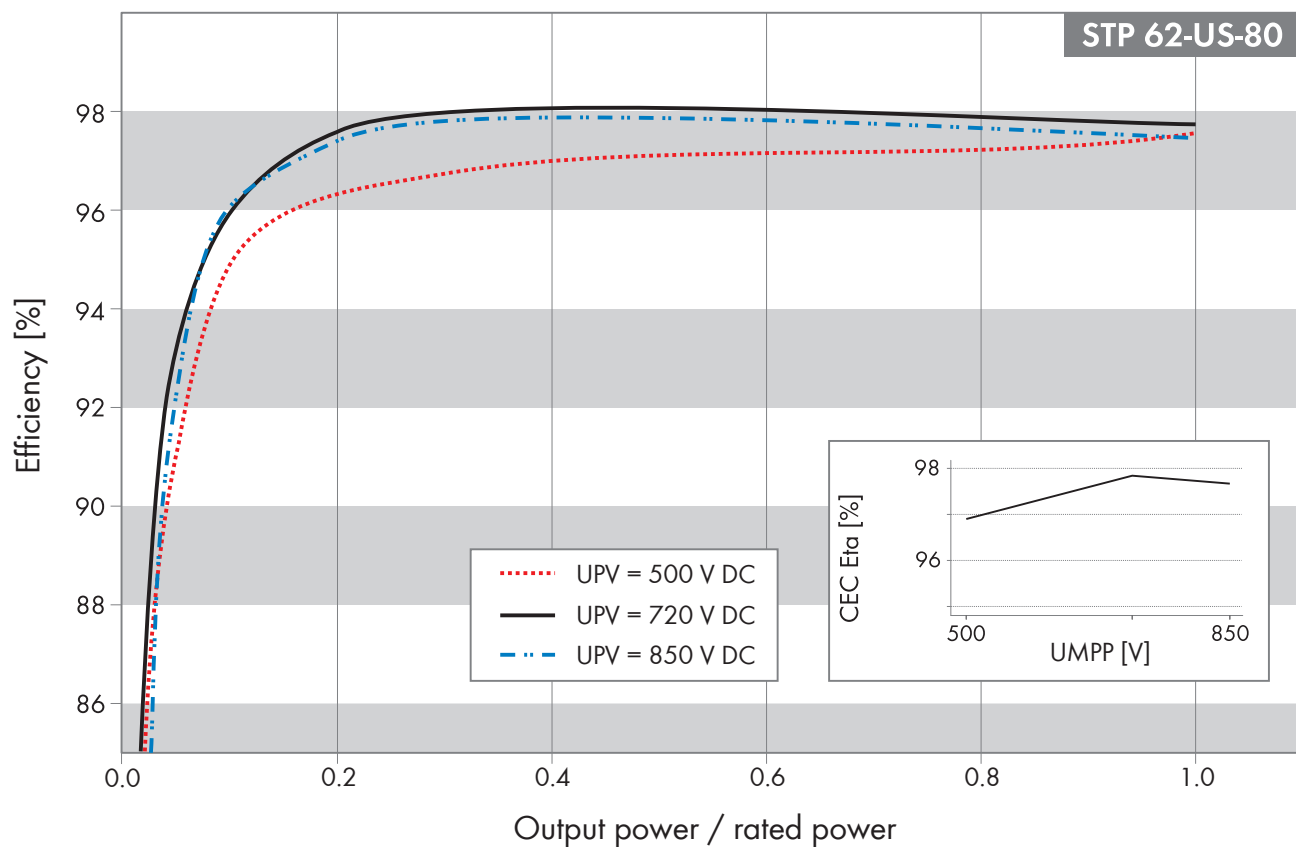


Figure 13:

Maximum efficiency, $\eta_{\max}$ 98.0 %

Californian efficiency, η_{CEC} 97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 500 V	Rated input voltage 720 V	Maximum MPP voltage 850 V
10 %	95.0 %	96.1 %	96.2 %
20 %	96.3 %	97.6 %	97.5 %
30 %	96.8 %	97.9 %	97.8 %
50 %	97.0 %	98.0 %	97.9 %
75 %	97.0 %	97.9 %	97.7 %
100 %	97.7 %	97.8 %	97.5 %

4.10.2 Derating behavior at 277 V AC

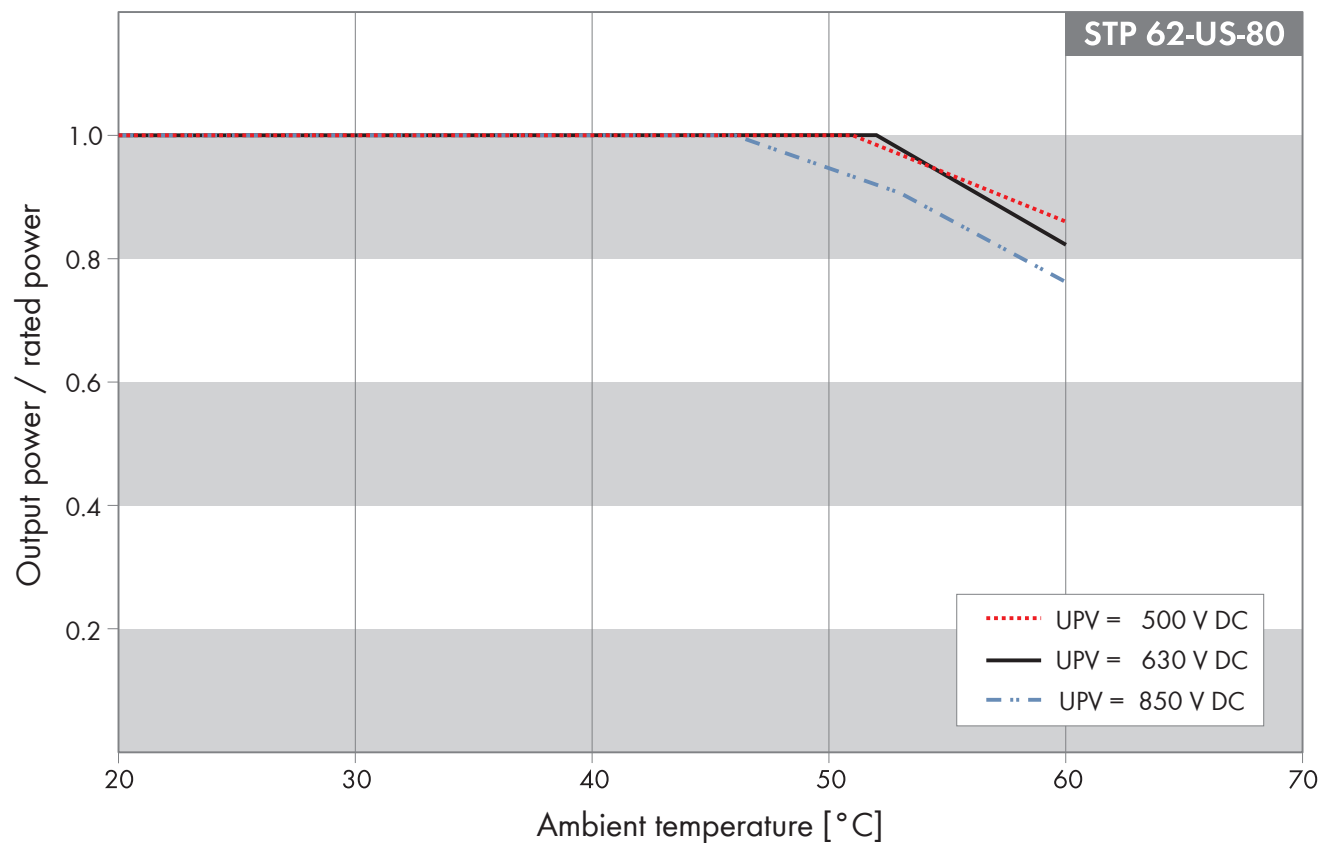


Figure 14:

4.11 STP 70-US-80

4.11.1 Efficiency at 277 V AC

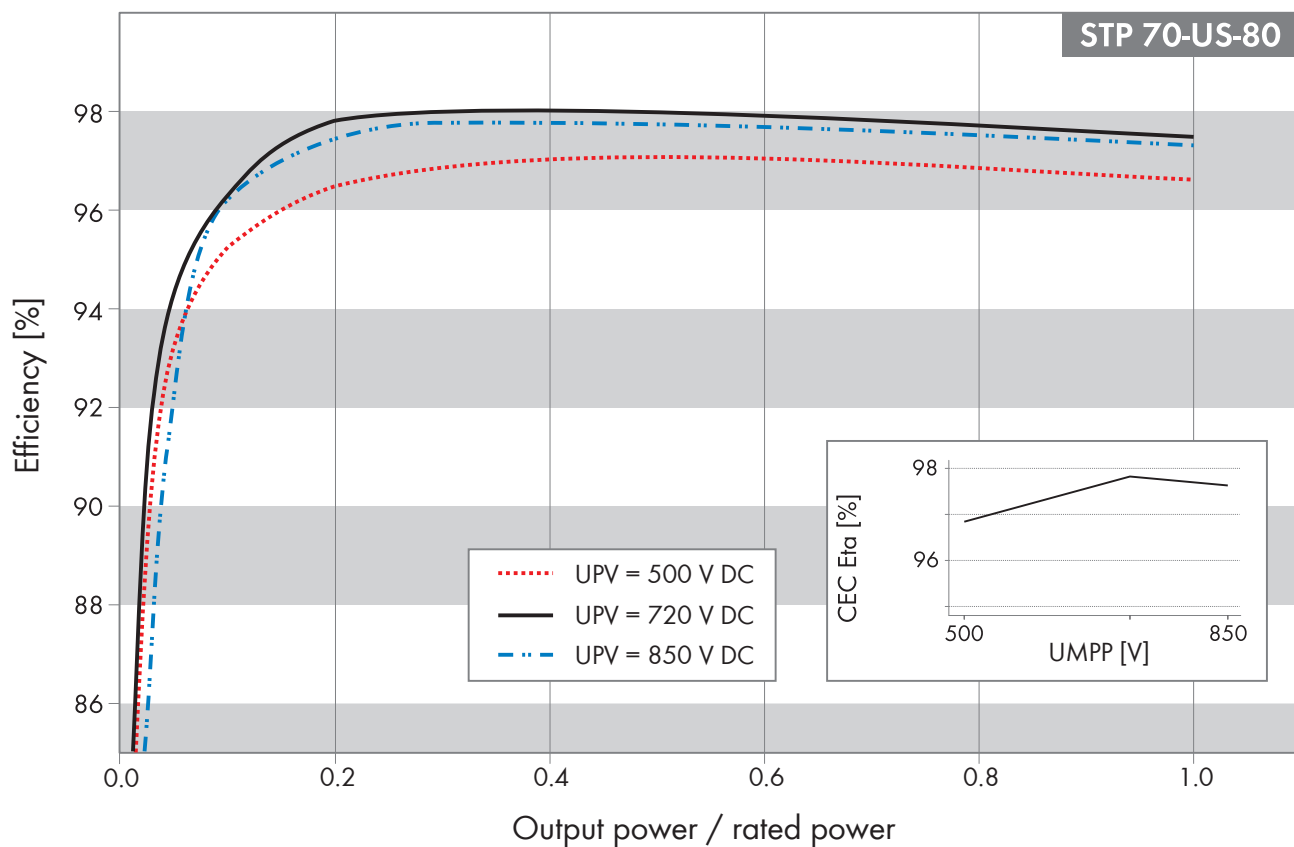


Figure 15:

Maximum efficiency, $\eta_{\max}$	98.0 %
Californian efficiency, η_{CEC}	97.5 %

Efficiency Profile

Standardized output power	Efficiency		
	Minimum MPP voltage 500 V	Rated input voltage 720 V	Maximum MPP voltage 850 V
10 %	95.3 %	96.2 %	96.4 %
20 %	96.6 %	97.9 %	97.6 %
30 %	96.8 %	97.9 %	97.9 %
50 %	97.1 %	98.0 %	97.8 %
75 %	96.9 %	97.9 %	97.6 %
100 %	96.7 %	97.6 %	97.4 %

4.11.2 Derating behavior at 277 V AC

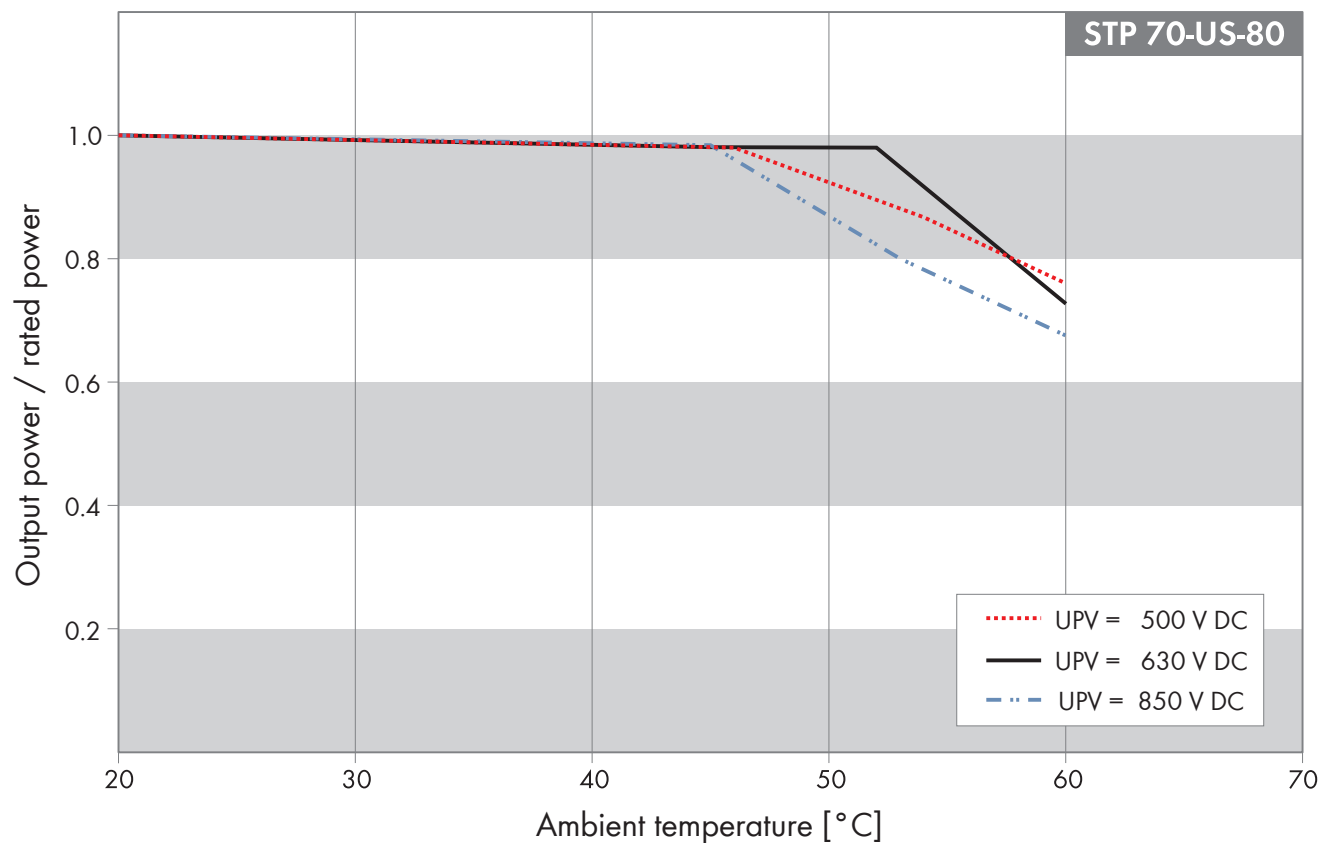
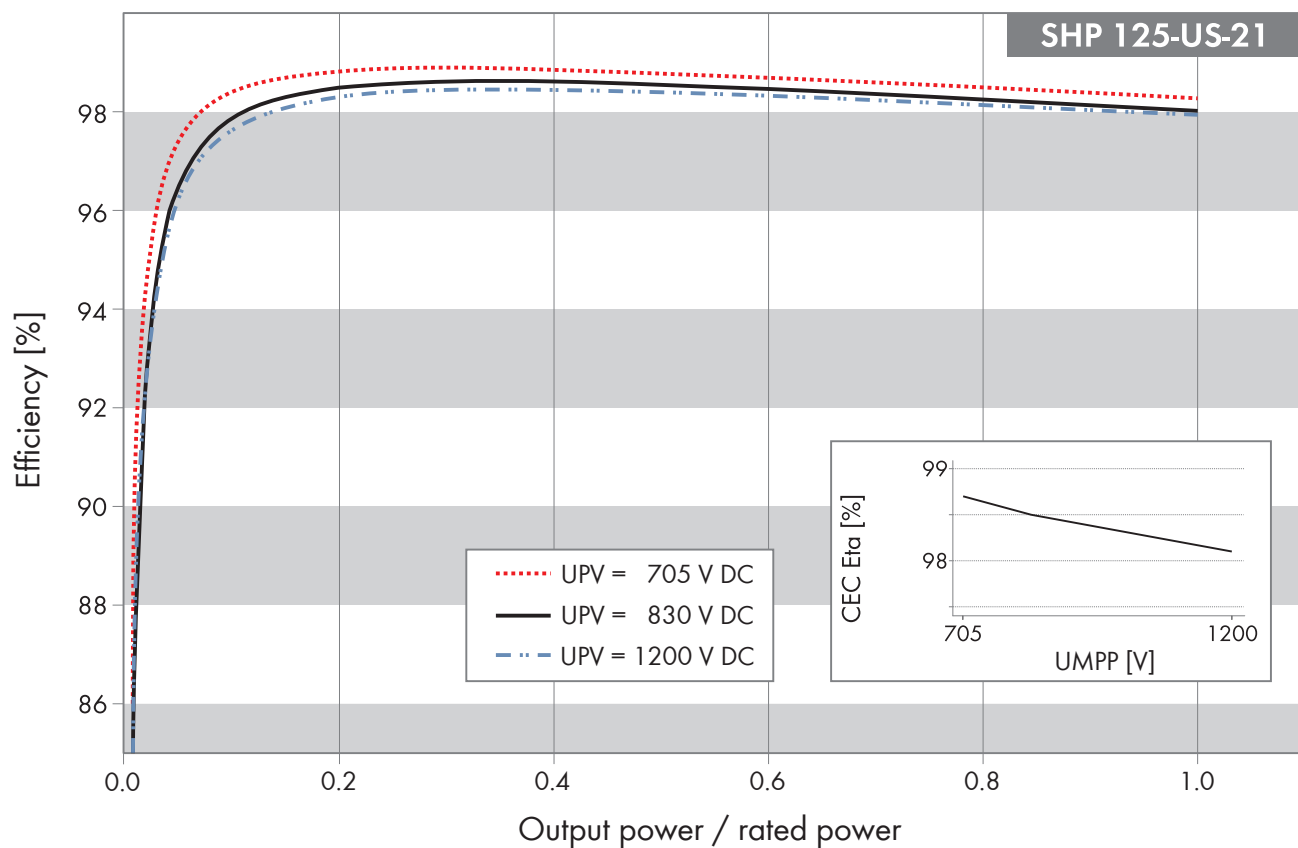


Figure 16:

5 Sunny Highpower

5.1 SHP 125-US-21

5.1.1 Efficiency at 480 V AC

Maximum efficiency, $\eta_{\max}$

99.0%

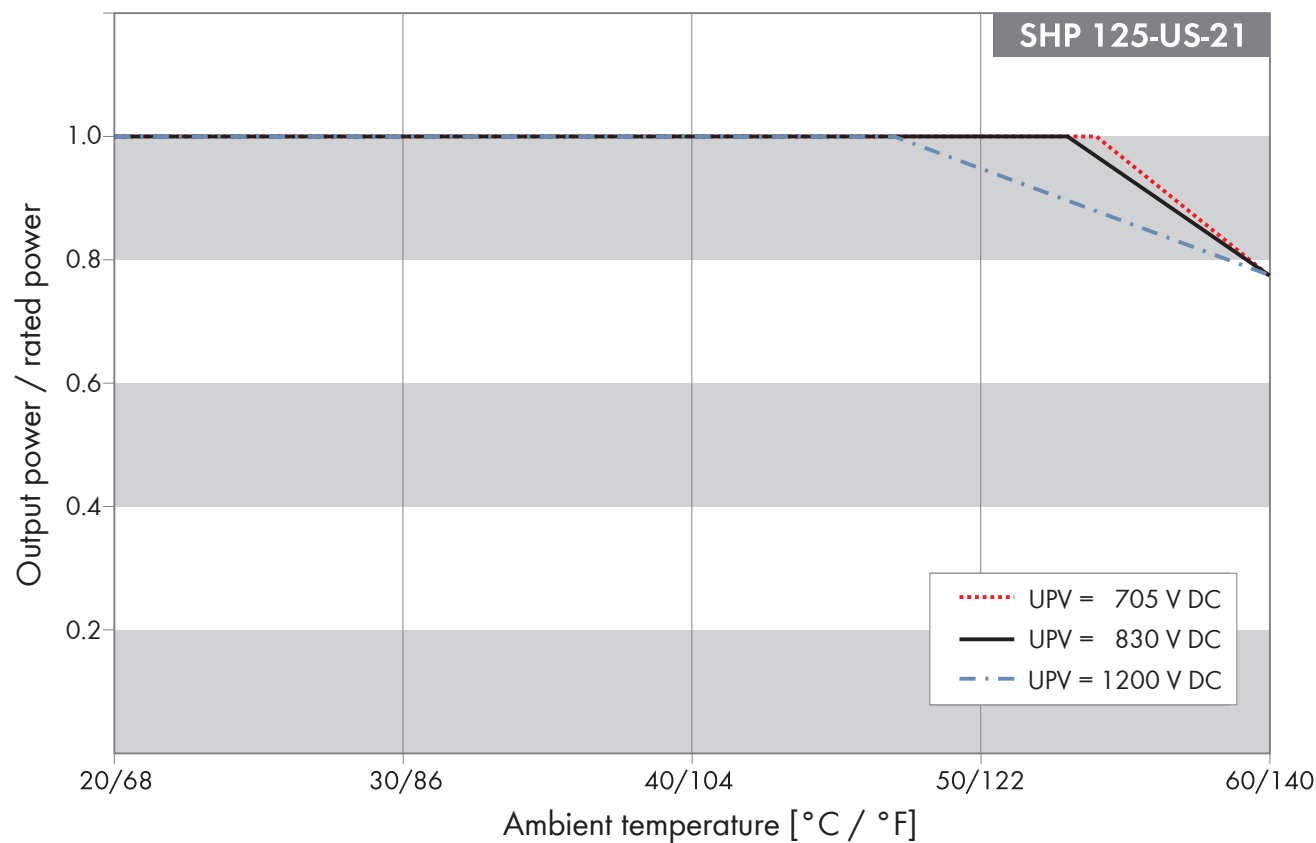
Californian efficiency, η_{CEC}

98.5%

Efficiency Profile

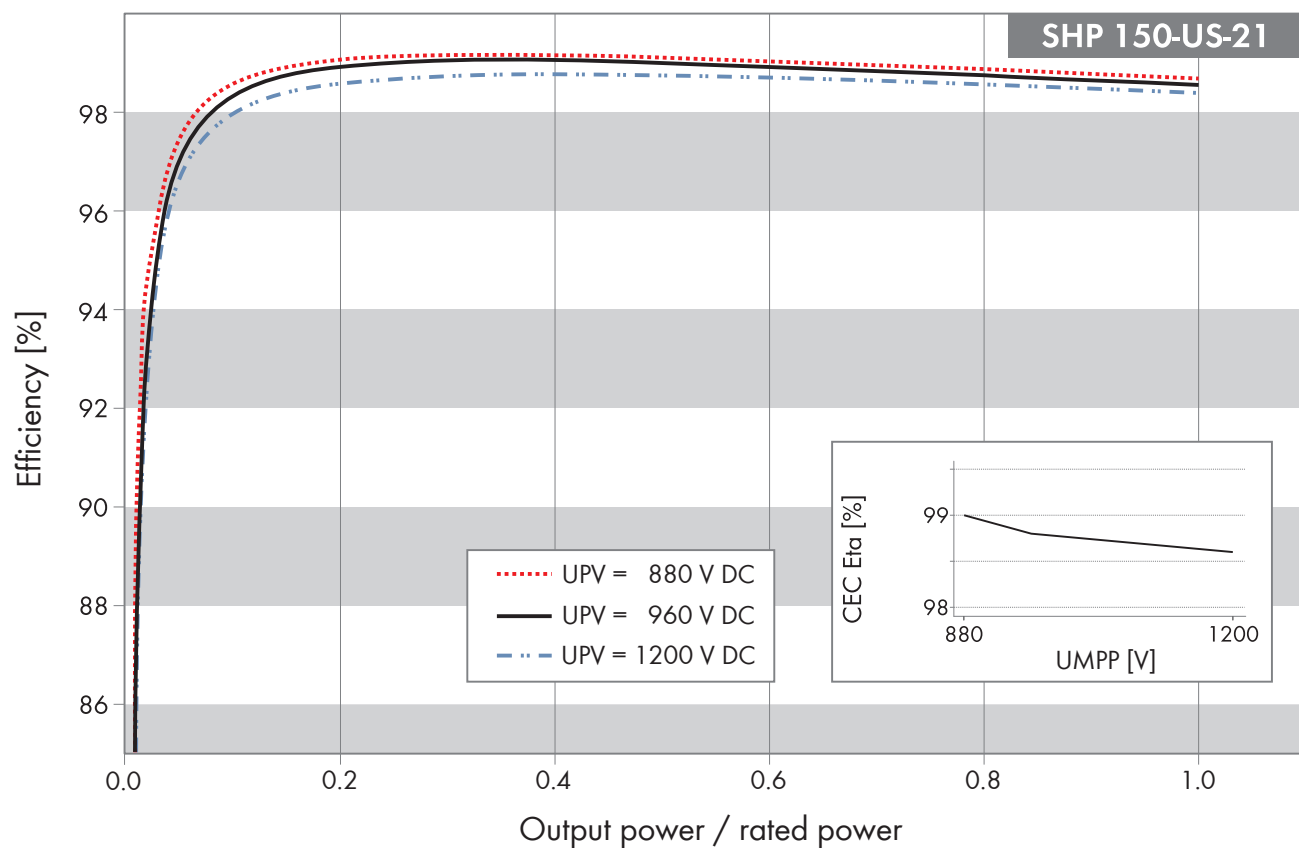
Standardized output power	Efficiency		
	MPP voltage 705 V	MPP voltage 830 V	MPP voltage 1200 V
10%	98.8%	98.4%	97.5%
20%	99.0%	98.8%	98.0%
30%	98.9%	98.7%	98.2%
50%	98.8%	98.6%	98.3%
75%	98.6%	98.4%	98.2%
100%	98.3%	98.1%	97.8%

5.1.2 Derating behavior at 480 V AC



5.2 SHP 150-US-21

5.2.1 Efficiency at 600 V AC

Maximum efficiency, $\eta_{\max}$

99.1%

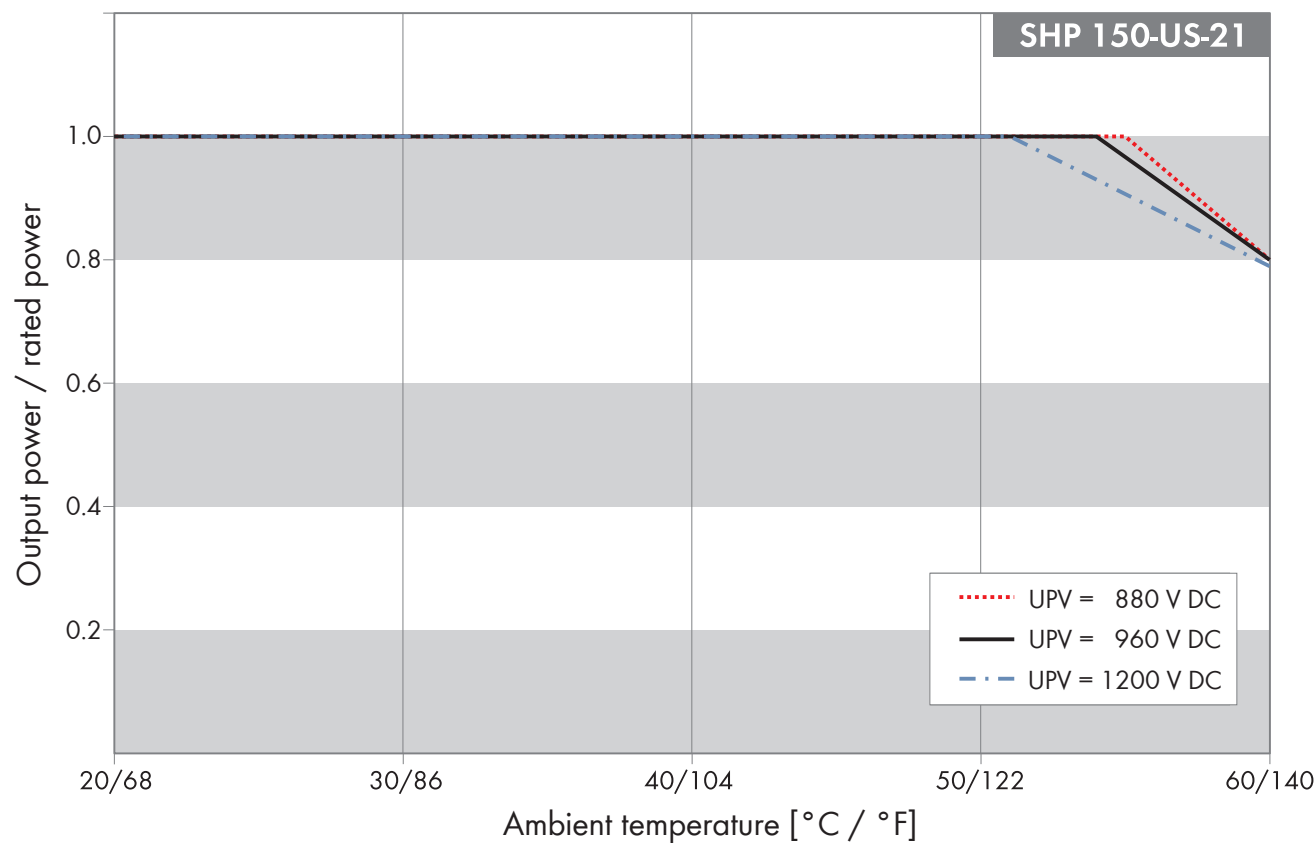
Californian efficiency, η_{CEC}

99.0%

Efficiency Profile

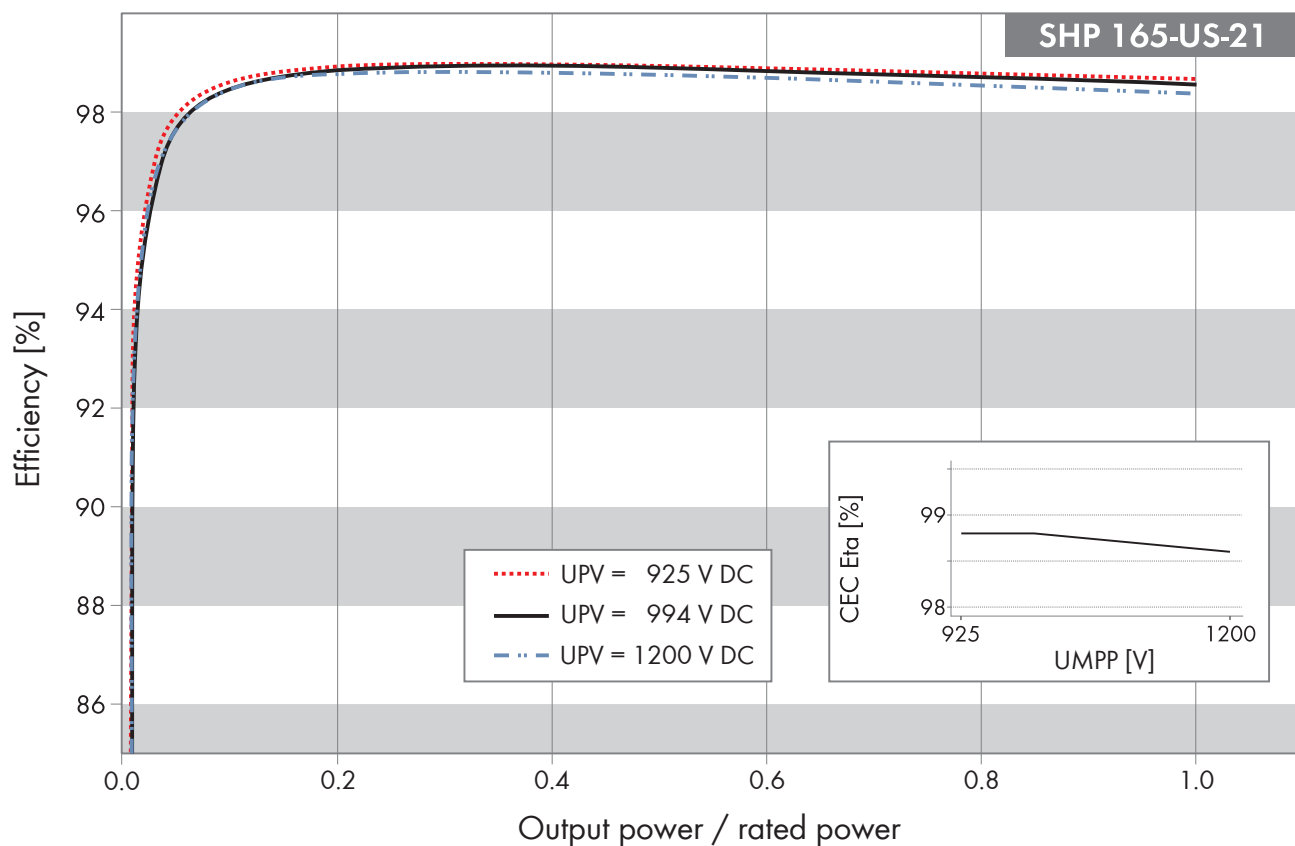
Standardized output power	Efficiency		
	MPP voltage 880 V	MPP voltage 960 V	MPP voltage 1200 V
10%	98.7%	98.7%	98.1%
20%	99.1%	99.0%	98.6%
30%	99.0%	99.0%	98.7%
50%	99.0%	99.0%	98.7%
75%	98.8%	98.8%	98.6%
100%	98.6%	98.5%	98.3%

5.2.2 Derating behavior at 600 V AC



5.3 SHP 165-US-21

5.3.1 Efficiency at 630 V AC

Maximum efficiency, $\eta_{\max}$

99.0%

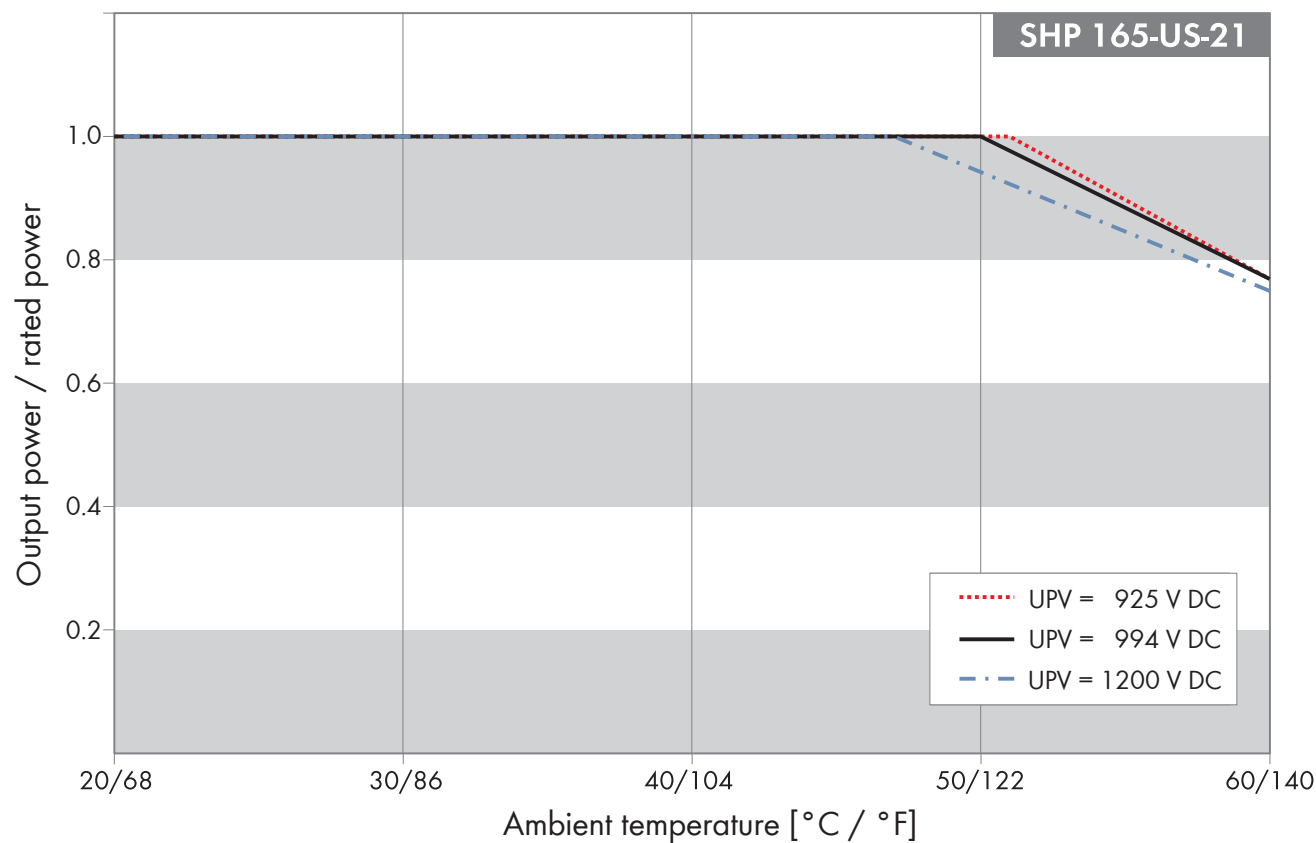
Californian efficiency, η_{CEC}

99.0%

Efficiency Profile

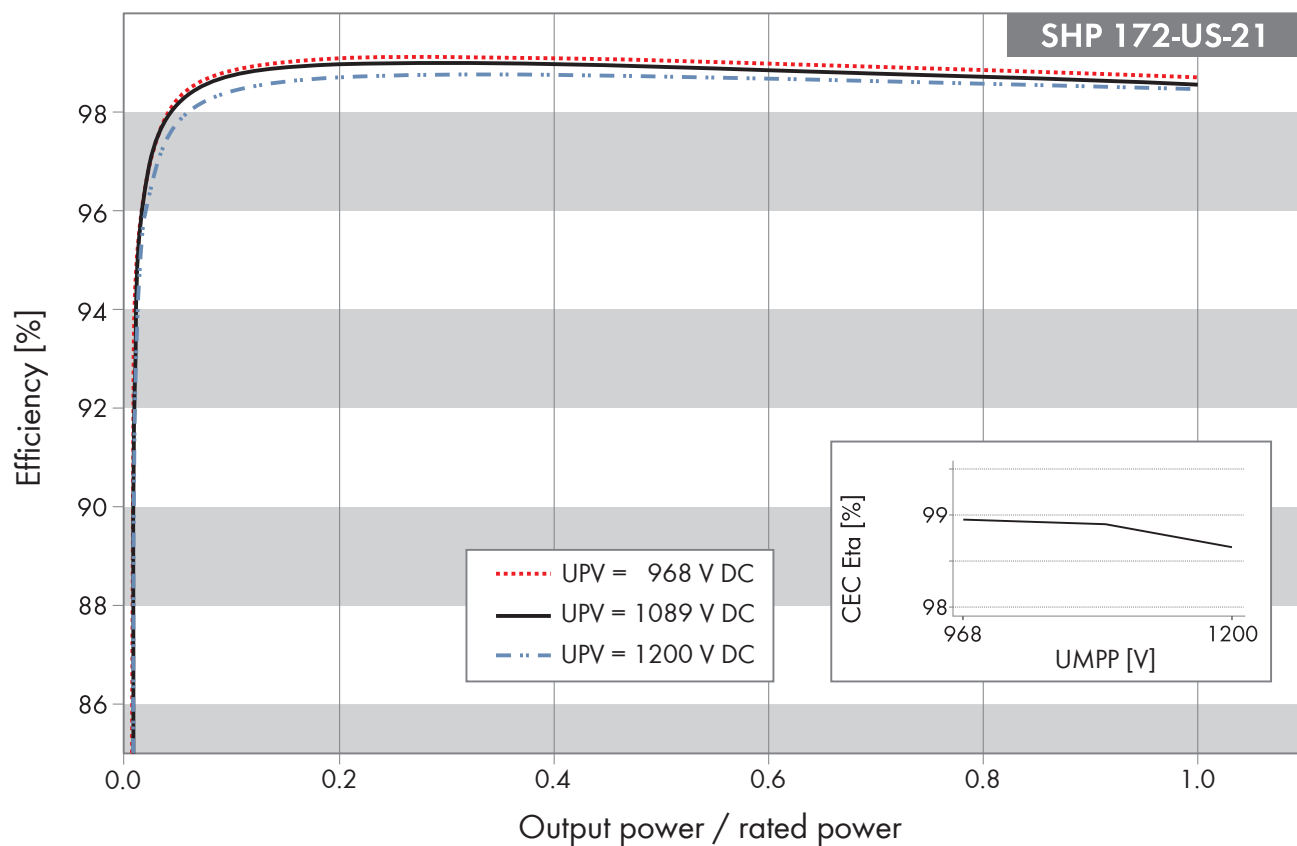
Standardized output power	Efficiency		
	MPP voltage 925 V	MPP voltage 994 V	MPP voltage 1200 V
10%	98.6%	98.5%	98.4%
20%	98.9%	98.9%	98.8%
30%	99.0%	99.0%	98.8%
50%	98.9%	99.0%	98.7%
75%	98.8%	98.8%	98.6%
100%	98.6%	98.6%	98.4%

5.3.2 Derating behavior at 630 V AC



5.4 SHP 172-US-21

5.4.1 Efficiency at 660 V AC



Maximum efficiency, $\eta_{\max}$

99.1%

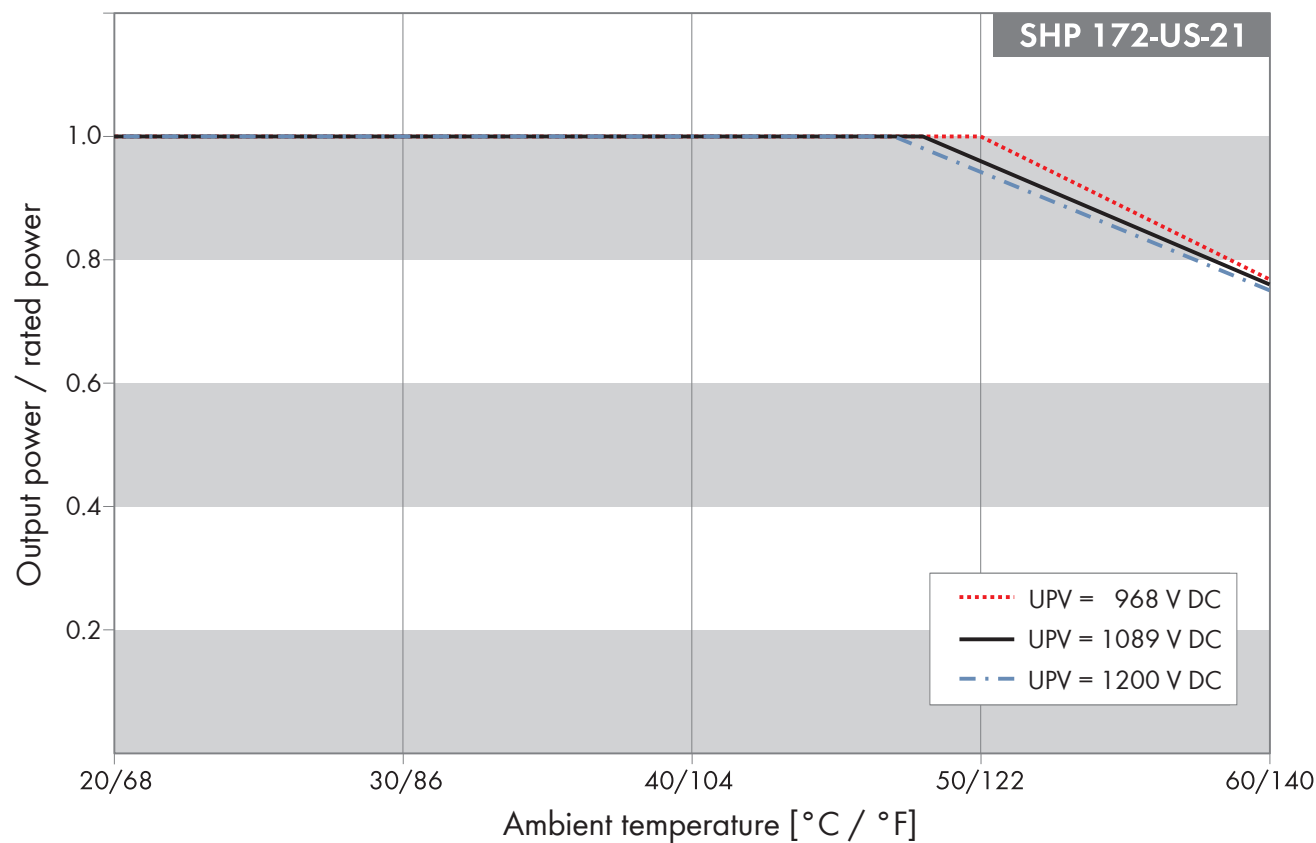
Californian efficiency, η_{CEC}

99.0%

Efficiency Profile

Standardized output power	Efficiency		
	MPP voltage 968 V	MPP voltage 1089 V	MPP voltage 1200 V
10%	98.8%	98.7%	98.4%
20%	99.1%	99.0%	98.7%
30%	99.1%	99.0%	98.8%
50%	99.1%	99.0%	98.7%
75%	98.9%	98.7%	98.6%
100%	98.7%	98.6%	98.5%

5.4.2 Derating behavior at 660 V AC



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