Why is my PV module rating larger than my inverter rating?

June 2023
TEB-00013-1.0

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Why is my PV module rating larger than my inverter rating?

PV module and inverter selection are two of the most important decisions in PV system design. Ensuring these components will work together is important from a technical, reliable, and economic perspective. Goals and design assumptions of different stakeholders can influence the decision-making process. The following considerations may ease the decision-making process:

- The DC:AC ratio is the relationship between PV module power rating and inverter power. Every PV system has a DC:AC ratio, regardless of the architecture. Many inverters have DC:AC ratio limitations for reliability and warranty purposes. Enphase microinverters have no DC:AC ratio input limit aside from DC input voltage and current compatibility.

- Higher DC:AC ratios always improve inverter utilization and the capacity factor. The measurement of inverter utilization is the capacity factor—the ratio between actual and maximum energy production. A significant portion of system cost is tied to the AC rating of the inverter (string or microinverter). Installing more DC on a given inverter will increase the capacity factor and may drive down the overall dollar-per-watt system cost.

- DC losses in string inverter systems (including those with optimizers) are typically higher than in microinverter systems. This means that string inverter system simulations may show lower clipping losses at a given DC:AC ratio. However, these additional DC losses also impact the nominal DC:AC ratio and result in better nominal DC:AC ratios for microinverter systems for a given pairing.

- Clipping losses in systems are typically very low compared to other sources of losses, such as orientation factors, soiling, shading, and thermal losses. Additionally, clipping losses over time decrease as module degradation takes place, while other loss factors, such as soiling and shading generally increase.

- Economic implications of various system performance metrics, including better inverter utilization and capacity factor by designing with higher DC:AC ratios, are ultimately dependent on the economics of the local energy market and system installation configuration. Economic simulation tools such as NREL System Advisor Model (SAM)[1] allow stakeholders to make their own evaluations.

Background

Why is my PV module rating larger than my inverter rating? — This common question has a simple answer. In real-world conditions, PV module output rarely produces power at the rated output due to thermal losses. PV module power is a product of DC current and DC voltage. In a PV module, the DC voltage is a function of the PV module cell temperature. That is, DC voltage goes down as cell temperature goes up. DC current is a function of the amount of available sunlight, called irradiance, which depends on the position of the sun relative to the module orientation and to environmental conditions.

1) System Advisor Model. National Research Energy Laboratory. Golden, CO. https://sam.nrel.gov/download

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Theory

Sizing starts by ensuring that PV modules are electrically compatible with the inverter. Enphase provides an online module compatibility calculator to determine electrical compatibility, purely based on the inverter DC input voltage and current ranges: https://enphase.com/en-us/support/module-compatibility.

The relationship between PV module power rating ($P_{DC\ STC}$) and inverter output power rating ($P_{AC\ MAX}$) is often referred to as the DC: AC ratio:

$$\text{DC:AC ratio} = P_{DC\ STC} / P_{AC\ MAX}$$

Enphase microinverters safely limit inverter power output electronically at the peak output power rating. Microinverters are tested for reliability in these conditions and have no DC:AC ratio limitations.

Important factors while deciding DC:AC ratio

There are a lot of factors that need to be considered while deciding the DC:AC ratio. Among these, two of the most important ones are discussed below.

1. Module degradation

The power of a module degrades every year. In this paper, the module degradation is taken as 2% for the first year and 0.4% each year after that. This degradation is in line with the top modules in the markets currently. The figure below illustrates module degradation over 25 years for various modules ranging from 300 W to 600 W.

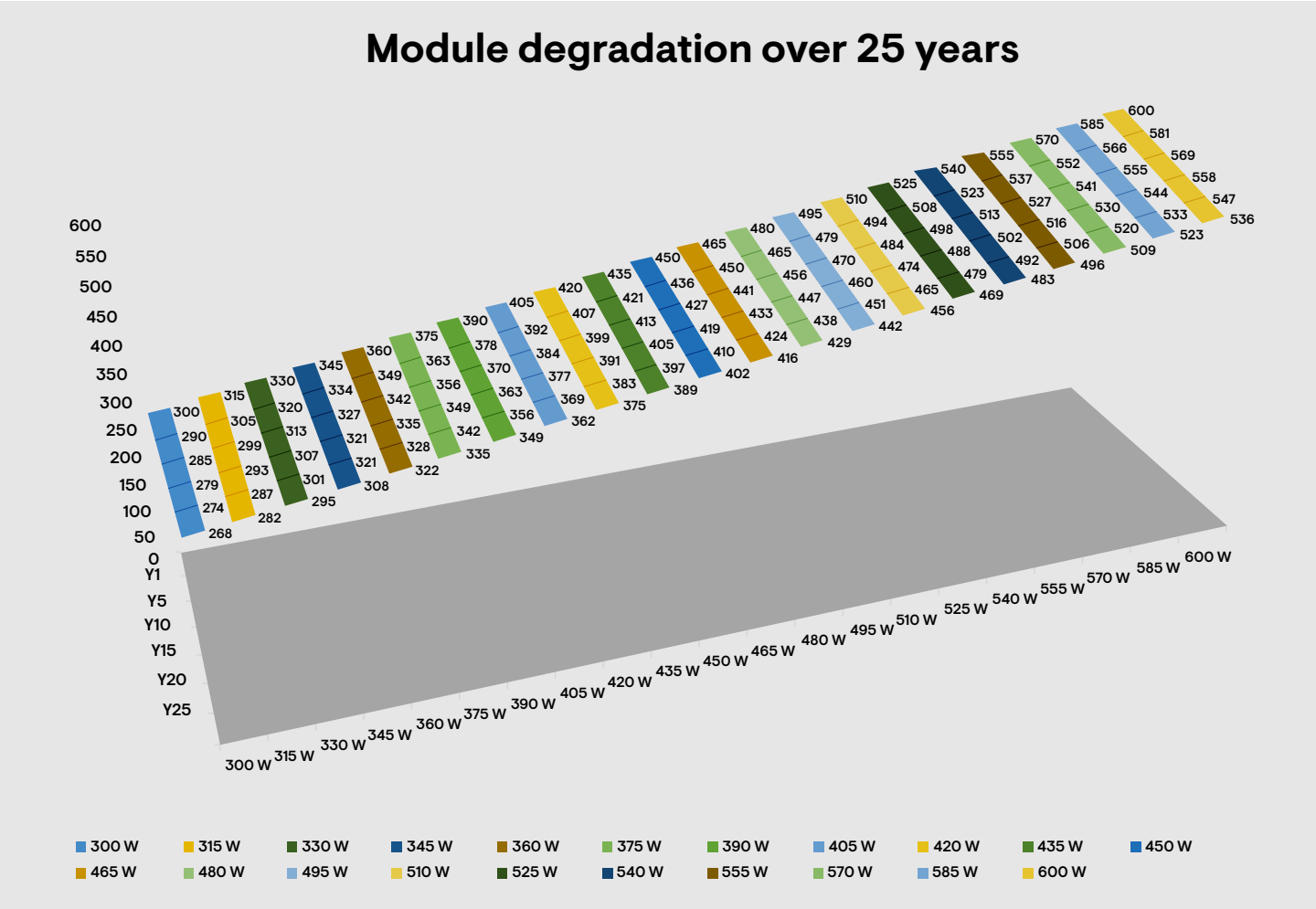

Chart 1 – Module degradation over 25 years

2. Module's deviation from STC

It is important to understand that the module power ratings on their data sheets are based on DC power at STC. However, modules do not operate at STC all the time because STC stands for Standard Test Conditions. In simpler terms, STC stands for laboratory conditions and is specified by irradiance at 1000 W/m^2, temperature at 75°F and pressure at 1 atmosphere. Any deviation from STC conditions means deviation from peak DC STC power. For example, if the temperature exceeds 75°F, module output will drop because that relationship is inversely correlated. Irradiance, on the other hand, directly correlates to power and any drop from 1000 W/m^2 will result in a proportional drop in module DC power output. For example, a 450 W DC STC module operating at 850 W/m^2, 95°F and XX atmospheres will not produce 450 W. This deviation from the datasheet value of the module is known as module deviation from STC. Module datasheets address this difference by including two different values – STC and NOCT.

The magnitude of the module's deviation from STC depends on the geographical location and how the system is installed. The simulations done (see below sections) ensure to capture all the geographical variations one can find in US.

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Which locations are considered for this study?

In order to capture all the climatic scenarios in the US, eight locations have been selected. These eight locations broadly encapsulate all the climate extremes that the US experiences. Among all the parameters that affect the Solar system energy harvest, irradiance and temperature are the most important ones.The following table lists those parameters for the selected regions.

LOCATION	STATE	IRRADIANCE (W/M²)		AMBIENT TEMPERATURE (°F)		
		AVG DAILY	MAX	MIN	AVG DAILY	MAX
Denver	Colorado	768	1073	-26.5	58.46	87.08
Los Angeles	California	559	1000	-2.02	55.94	89.06
New York City	New York	600	968	5	56.48	98.06
Dallas	Texas	702	1003	19.94	68	107.6
Miami	Florida	795	1034	50	78.8	87.8
Phoenix	Arizona	814	1149	35.96	86	111.92
Brainerd	Minnesota	578	982	-27.4	41.54	87.8
Newark	New Jersey	736	1058	12.2	53.24	102.2

Simulation tool and input parameters used

To provide some context on DC:AC ratios and assist in the decision-making process, energy performance was simulated with NREL System Advisor Model (SAM) using the Simple Efficiency Module Model (temperature coefficient: -0.35%/°C P_{MP}) with TMY3 weather data. The L_{total} was 2.5%, with 2% for the DC wiring loss and 0.5% for Diodes and connections losses. These DC loss assumptions are very conservative. Real-world losses, can be higher, which in turn would decrease resulting in clipping losses. There are many tools that perform similar calculations, though NREL SAM supports parametric simulations, which helps given the large number of system configurations and locations in this simulation.

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Definition of output parameters used in the simulations

AC CAPACITY FACTOR

The capacity factor is the ratio of the system's predicted electrical output in the first year of operation to the nameplate output, which is equivalent to the quantity of energy the system would generate if it operated at its nameplate capacity for every hour of the year.

Capacity Factor = Net Annual Energy (kWhac/yr) / System Capacity (kWdc or kWac) / 8760 (h/yr)

Where Net Annual Energy is the total annual electric generation in the first year of operation, and System Capacity is the system's nameplate capacity.

TOTAL ENERGY CLIPPING IN 25 YEARS

It is the loss due to oversizing the system. Since the module degrades every year, the module power will degrade year after year, therefore the clipping loss will also decrease year after year. Module degradation in this paper has been considered as 2% for the first year and 0.4% from Year 2. This degradation is in alignment with how the top modules degrade in the market. This is an important parameter to understand that Year 1 clipping is not a constant and the overall 25 year clipping for the system will be much lesser than the first year clipping due to module degradation.

Example – AC energy increase with increasing DC:AC ratio and inverter clipping

Increasing DC:AC ratio increases AC energ;, however, there may be some loss of energy harvest due to Inverter clipping. The increased AC energy is always larger than the loss due to clipping, even at very high DC:AC ratios. Note that the inverter clipping shown below is simulated first-year clipping at Newark for IQ8. PV module power output degrades over time (as explained in the above section), so clipping losses will degrade proportionally.

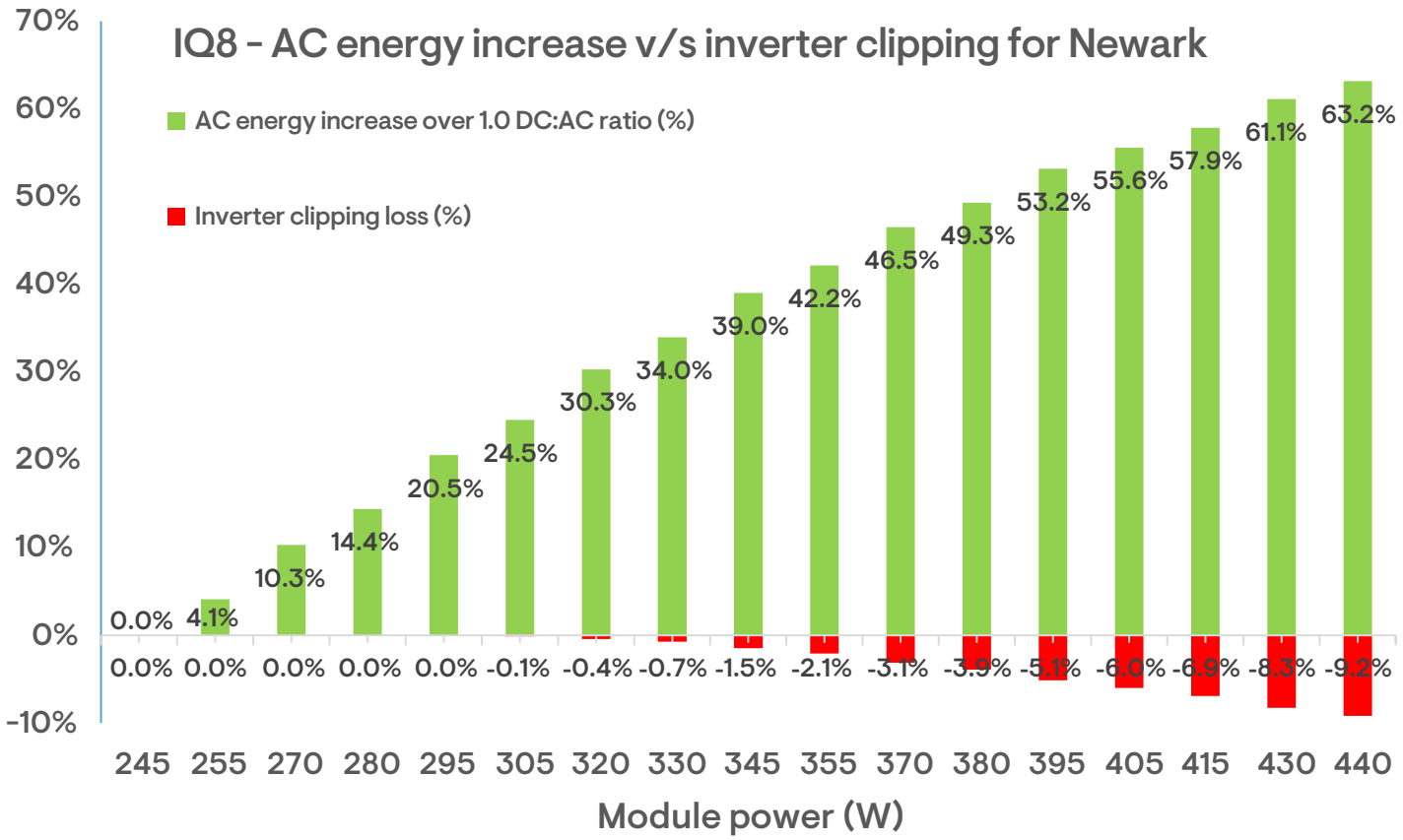

Chart 2 – First-year inverter clipping loss v/s energy increase over 1.0 DC:AC ratio for IQ8 at Newark

IQ8 simulation results

The following tables show the simulated single-module values for different DC:AC ratios on the IQ8 Microinverter in locations covering the United States, using a -0.35%/°C simple efficiency model. The IQ8 Microinverter has a peak output power rating of 245 VA. In this model, the module orientation is fixed at 180° azimuth, 20° tilt. Many real-world PV systems do not have ideal true south orientations of 180° azimuth and ideal tilt angles, so the impact of clipping will be less than shown in the tables below.

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Table 1: IQ8 - Denver, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	430.5	20.1	0.0	0.0	0.0
255	1.04	448.2	20.9	0.0	0.0	0.0
270	1.10	474.7	22.1	0.0	0.0	0.0
280	1.14	492.4	22.9	0.0	0.0	0.0
295	1.20	518.3	24.1	0.6	0.1	0.0
305	1.24	534.7	24.9	1.9	0.3	0.0
320	1.31	557.4	26.0	5.8	1.0	0.0
330	1.35	571.1	26.6	9.9	1.6	0.1
345	1.41	590.0	27.5	17.6	2.8	0.2
355	1.45	601.5	28.0	23.8	3.7	0.4
370	1.51	617.4	28.8	34.6	5.1	0.9
380	1.55	627.1	29.2	42.7	6.1	1.4
395	1.61	640.5	29.8	55.9	7.7	2.4
405	1.65	649.1	30.2	65.2	8.8	3.3
415	1.69	657.3	30.6	74.7	9.8	4.3
430	1.76	669.0	31.2	89.7	11.4	6.0
440	1.80	676.4	31.5	100.1	12.4	7.1

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Table 2: IQ8 – Los Angeles, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	446.8	20.8	0.0	0.0	0.0
255	1.04	465.2	21.7	0.0	0.0	0.0
270	1.10	492.7	23.0	0.0	0.0	0.0
280	1.14	511.1	23.8	0.0	0.0	0.0
295	1.20	538.4	25.1	0.2	0.0	0.0
305	1.24	555.7	25.9	1.3	0.2	0.0
320	1.31	579.4	27.0	5.2	0.9	0.0
330	1.35	593.2	27.6	9.8	1.6	0.1
345	1.41	611.9	28.5	18.7	2.8	0.2
355	1.45	623.2	29.0	25.8	3.8	0.4
370	1.51	638.5	29.7	38.3	5.4	1.0
380	1.55	647.4	30.2	47.8	6.6	1.7
395	1.61	659.6	30.7	63.3	8.4	3.0
405	1.65	667.1	31.1	74.2	9.6	4.1
415	1.69	674.3	31.4	85.5	10.8	5.4
430	1.76	684.8	31.9	102.8	12.5	7.3
440	1.80	691.4	32.2	114.7	13.7	8.5

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Table 3: IQ8 – New York City, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	344.3	16.0	0.0	0.0	0.0
255	1.04	358.5	16.7	0.0	0.0	0.0
270	1.10	379.8	17.7	0.0	0.0	0.0
280	1.14	393.9	18.4	0.0	0.0	0.0
295	1.20	415.0	19.3	0.2	0.0	0.0
305	1.24	428.9	20.0	0.6	0.1	0.0
320	1.31	449.0	20.9	1.7	0.4	0.0
330	1.35	461.7	21.5	3.2	0.7	0.0
345	1.41	479.7	22.4	6.5	1.3	0.1
355	1.45	490.9	22.9	9.5	1.8	0.1
370	1.51	506.7	23.6	15.0	2.8	0.2
380	1.55	516.7	24.1	19.3	3.4	0.3
395	1.61	530.7	24.7	26.6	4.6	0.7
405	1.65	539.4	25.1	32.1	5.4	1.0
415	1.69	547.7	25.5	38.1	6.2	1.5
430	1.76	559.5	26.1	47.6	7.5	2.3
440	1.80	567.0	26.4	54.4	8.4	3.0

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Table 4: IQ8 – Dallas, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	387.2	18.0	0.0	0.0	0.0
255	1.04	403.1	18.8	0.0	0.0	0.0
270	1.10	427.0	19.9	0.0	0.0	0.0
280	1.14	442.9	20.6	0.0	0.0	0.0
295	1.20	466.6	21.7	0.2	0.0	0.0
305	1.24	482.0	22.5	0.7	0.1	0.0
320	1.31	504.3	23.5	2.3	0.4	0.0
330	1.35	518.4	24.2	4.2	0.8	0.0
345	1.41	538.0	25.1	8.6	1.5	0.1
355	1.45	549.9	25.6	12.6	2.1	0.1
370	1.51	566.1	26.4	20.4	3.3	0.3
380	1.55	576.1	26.8	26.4	4.2	0.5
395	1.61	589.9	27.5	36.6	5.6	1.1
405	1.65	598.4	27.9	44.0	6.6	1.7
415	1.69	606.6	28.3	51.9	7.6	2.3
430	1.76	618.1	28.8	64.4	9.1	3.6
440	1.80	625.3	29.1	73.2	10.1	4.6

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Table 5: IQ8 – Miami, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	412.3	19.2	0.0	0.0	0.0
255	1.04	429.2	20.0	0.0	0.0	0.0
270	1.10	454.6	21.2	0.0	0.0	0.0
280	1.14	471.6	22.0	0.0	0.0	0.0
295	1.20	496.9	23.2	0.1	0.0	0.0
305	1.24	513.5	23.9	0.5	0.1	0.0
320	1.31	537.3	25.0	2.1	0.4	0.0
330	1.35	552.1	25.7	4.3	0.7	0.0
345	1.41	572.3	26.7	9.6	1.6	0.1
355	1.45	584.5	27.2	14.4	2.3	0.1
370	1.51	601.4	28.0	23.0	3.5	0.3
380	1.55	611.8	28.5	29.6	4.4	0.6
395	1.61	626.4	29.2	40.5	5.8	1.2
405	1.65	635.5	29.6	48.5	6.8	1.8
415	1.69	644.2	30.0	56.8	7.8	2.5
430	1.76	656.2	30.6	70.4	9.3	3.8
440	1.80	663.6	30.9	80.0	10.3	4.8

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Table 6: IQ8 – Phoenix, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	458.3	21.4	0.0	0.0	0.0
255	1.04	477.2	22.2	0.0	0.0	0.0
270	1.10	505.4	23.5	0.0	0.0	0.0
280	1.14	524.2	24.4	0.0	0.0	0.0
295	1.20	552.3	25.7	0.2	0.0	0.0
305	1.24	570.7	26.6	0.7	0.1	0.0
320	1.31	596.6	27.8	3.1	0.5	0.0
330	1.35	612.2	28.5	6.3	1.0	0.0
345	1.41	633.0	29.5	13.8	2.0	0.1
355	1.45	645.5	30.1	20.3	2.9	0.2
370	1.51	662.1	30.9	32.0	4.4	0.6
380	1.55	672.1	31.3	40.9	5.5	1.1
395	1.61	686.3	32.0	55.2	7.1	2.0
405	1.65	695.0	32.4	65.4	8.2	2.9
415	1.69	703.3	32.8	76.1	9.4	3.9
430	1.76	714.4	33.3	93.3	11.1	5.7
440	1.80	721.1	33.6	105.6	12.3	7.0

Table 7: IQ8 – Minnesota, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	355.5	16.6	0.0	0.0	0.0
255	1.04	370.1	17.2	0.0	0.0	0.0
270	1.10	392.0	18.3	0.0	0.0	0.0
280	1.14	406.6	18.9	0.1	0.0	0.0
295	1.20	428.0	19.9	0.7	0.1	0.0
305	1.24	441.8	20.6	1.5	0.3	0.0
320	1.31	461.5	21.5	3.8	0.8	0.0
330	1.35	473.8	22.1	6.2	1.2	0.1
345	1.41	491.0	22.9	10.9	2.1	0.1
355	1.45	501.8	23.4	14.8	2.7	0.2
370	1.51	516.9	24.1	21.7	3.9	0.4
380	1.55	526.4	24.5	26.9	4.7	0.7
395	1.61	539.9	25.2	35.4	5.9	1.3
405	1.65	548.4	25.6	41.6	6.8	1.8
415	1.69	556.5	25.9	48.3	7.7	2.4
430	1.76	567.9	26.5	58.9	9.0	3.5
440	1.80	575.1	26.8	66.4	9.9	4.4

Table 8: IQ8 – Newark, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
245	1.00	354.4	16.5	0.0	0.0	0.0
255	1.04	369.0	17.2	0.0	0.0	0.0
270	1.10	390.8	18.2	0.0	0.0	0.0
280	1.14	405.4	18.9	0.0	0.0	0.0
295	1.20	427.1	19.9	0.2	0.0	0.0
305	1.24	441.3	20.6	0.6	0.1	0.0
320	1.31	461.8	21.5	2.0	0.4	0.0
330	1.35	474.8	22.1	3.6	0.7	0.0
345	1.41	492.7	23.0	7.6	1.5	0.1
355	1.45	503.8	23.5	11.2	2.1	0.1
370	1.51	519.3	24.2	17.6	3.1	0.2
380	1.55	529.1	24.7	22.4	3.9	0.4
395	1.61	542.8	25.3	30.7	5.1	0.9
405	1.65	551.3	25.7	36.8	6.0	1.3
415	1.69	559.4	26.1	43.4	6.9	1.9
430	1.76	570.9	26.6	53.8	8.3	2.9
440	1.80	578.3	26.9	61.2	9.2	3.7

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IQ8+ simulation results

The following tables show the simulated single-module values for different DC:AC ratios on the IQ8+ Microinverter in locations covering the United States, using a -0.35%/°C simple efficiency model. The IQ8+ Microinverter has a peak output power rating of 300 VA. In this model, the module orientation is fixed at 180° azimuth, 20° tilt. Many real-world PV systems do not have ideal true south orientations of 180° azimuth and ideal tilt angles, so the impact of clipping will be less than shown in the tables below.

Table 9: IQ8+ – Denver, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	527.5	20.1	0.0	0.0	0.0
315	1.05	554.0	21.1	0.0	0.0	0.0
330	1.10	580.6	22.1	0.0	0.0	0.0
345	1.15	607.0	23.1	0.1	0.0	0.0
360	1.20	632.9	24.1	0.7	0.1	0.0
375	1.25	657.6	25.0	2.6	0.4	0.0
390	1.30	680.3	25.9	6.5	0.9	0.0
405	1.35	700.9	26.7	12.5	1.7	0.1
420	1.40	719.8	27.4	20.2	2.6	0.2
435	1.45	737.2	28.1	29.4	3.7	0.4
450	1.50	753.2	28.7	40.0	4.8	0.8
465	1.55	767.8	29.2	52.0	6.1	1.4
480	1.60	781.4	29.7	65.1	7.4	2.2
495	1.65	794.3	30.2	78.9	8.7	3.2
510	1.70	806.6	30.7	93.3	10.0	4.4
525	1.75	818.3	31.1	108.2	11.2	5.8
540	1.80	829.4	31.6	123.8	12.5	7.2

Table 10: IQ8+ – Los Angeles, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	547.5	20.8	0.0	0.0	0.0
315	1.05	575.1	21.9	0.0	0.0	0.0
330	1.10	602.6	22.9	0.0	0.0	0.0
345	1.15	630.1	24.0	0.0	0.0	0.0
360	1.20	657.4	25.0	0.2	0.0	0.0
375	1.25	683.4	26.0	1.8	0.3	0.0
390	1.30	707.1	26.9	5.7	0.8	0.0
405	1.35	727.9	27.7	12.5	1.6	0.1
420	1.40	746.7	28.4	21.3	2.7	0.2
435	1.45	763.8	29.1	31.8	3.8	0.4
450	1.50	779.2	29.6	44.1	5.1	0.9
465	1.55	792.7	30.2	58.2	6.6	1.7
480	1.60	805.1	30.6	73.5	8.0	2.7
495	1.65	816.5	31.1	89.8	9.5	4.0
510	1.70	827.3	31.5	106.7	11.0	5.5
525	1.75	837.7	31.9	124.0	12.4	7.1
540	1.80	847.6	32.3	141.8	13.8	8.6

Table 11: IQ8+ – New York City, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	422.1	16.1	0.0	0.0	0.0
315	1.05	443.4	16.9	0.0	0.0	0.0
330	1.10	464.6	17.7	0.0	0.0	0.0
345	1.15	485.9	18.5	0.0	0.0	0.0
360	1.20	506.9	19.3	0.2	0.0	0.0
375	1.25	527.6	20.1	0.8	0.1	0.0
390	1.30	547.8	20.8	1.9	0.3	0.0
405	1.35	566.9	21.6	4.1	0.7	0.0
420	1.40	585.0	22.3	7.3	1.2	0.1
435	1.45	601.8	22.9	11.7	1.8	0.1
450	1.50	617.7	23.5	17.1	2.6	0.2
465	1.55	632.7	24.1	23.5	3.4	0.3
480	1.60	646.9	24.6	30.7	4.3	0.6
495	1.65	660.1	25.1	38.8	5.3	1.0
510	1.70	672.5	25.6	47.7	6.4	1.5
525	1.75	684.3	26.0	57.3	7.4	2.2
540	1.80	695.6	26.5	67.4	8.5	3.0

Table 12: IQ8+ – Dallas, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	474.5	18.1	0.0	0.0	0.0
315	1.05	498.4	19.0	0.0	0.0	0.0
330	1.10	522.3	19.9	0.0	0.0	0.0
345	1.15	546.2	20.8	0.0	0.0	0.0
360	1.20	569.8	21.7	0.2	0.0	0.0
375	1.25	593.0	22.6	1.0	0.2	0.0
390	1.30	615.3	23.4	2.6	0.4	0.0
405	1.35	636.4	24.2	5.4	0.8	0.0
420	1.40	656.1	25.0	9.6	1.4	0.1
435	1.45	674.1	25.7	15.6	2.2	0.1
450	1.50	690.4	26.3	23.2	3.1	0.2
465	1.55	705.4	26.8	32.2	4.2	0.5
480	1.60	719.4	27.4	42.2	5.3	1.0
495	1.65	732.3	27.9	53.2	6.5	1.6
510	1.70	744.6	28.3	65.0	7.7	2.4
525	1.75	756.0	28.8	77.5	8.9	3.4
540	1.80	766.8	29.2	90.8	10.2	4.7

Table 13: IQ8+ – Miami, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	505.2	19.2	0.0	0.0	0.0
315	1.05	530.6	20.2	0.0	0.0	0.0
330	1.10	556.1	21.2	0.0	0.0	0.0
345	1.15	581.4	22.1	0.0	0.0	0.0
360	1.20	606.8	23.1	0.1	0.0	0.0
375	1.25	631.6	24.0	0.7	0.1	0.0
390	1.30	655.4	24.9	2.3	0.3	0.0
405	1.35	677.6	25.8	5.6	0.8	0.0
420	1.40	698.0	26.6	10.7	1.4	0.1
435	1.45	716.4	27.3	17.8	2.3	0.1
450	1.50	733.4	27.9	26.3	3.3	0.3
465	1.55	749.2	28.5	36.0	4.4	0.6
480	1.60	763.9	29.1	46.8	5.5	1.1
495	1.65	777.6	29.6	58.6	6.7	1.7
510	1.70	790.6	30.1	71.2	7.9	2.6
525	1.75	802.6	30.5	84.7	9.2	3.7
540	1.80	813.7	31.0	99.1	10.4	4.9

Table 14: IQ8+ – Phoenix, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	561.6	21.4	0.0	0.0	0.0
315	1.05	589.9	22.4	0.0	0.0	0.0
330	1.10	618.1	23.5	0.0	0.0	0.0
345	1.15	646.4	24.6	0.0	0.0	0.0
360	1.20	674.4	25.7	0.2	0.0	0.0
375	1.25	701.9	26.7	1.0	0.1	0.0
390	1.30	727.8	27.7	3.3	0.4	0.0
405	1.35	751.3	28.6	8.1	1.0	0.0
420	1.40	772.2	29.4	15.5	1.9	0.1
435	1.45	791.0	30.1	25.0	2.9	0.2
450	1.50	807.9	30.7	36.6	4.2	0.5
465	1.55	823.0	31.3	49.8	5.5	1.1
480	1.60	837.3	31.9	63.9	6.8	1.8
495	1.65	850.6	32.4	79.0	8.2	2.8
510	1.70	862.9	32.8	95.1	9.5	4.0
525	1.75	874.0	33.3	112.4	10.9	5.5
540	1.80	884.1	33.6	130.7	12.4	7.1

Table 15: IQ8+ – Minnesota, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	435.7	16.6	0.0	0.0	0.0
315	1.05	457.7	17.4	0.0	0.0	0.0
330	1.10	479.6	18.2	0.0	0.0	0.0
345	1.15	501.4	19.1	0.2	0.0	0.0
360	1.20	522.8	19.9	0.7	0.1	0.0
375	1.25	543.4	20.7	2.0	0.4	0.0
390	1.30	563.1	21.4	4.3	0.7	0.0
405	1.35	581.6	22.1	7.8	1.3	0.1
420	1.40	598.9	22.8	12.4	2.0	0.1
435	1.45	615.2	23.4	18.2	2.8	0.2
450	1.50	630.3	24.0	25.1	3.7	0.4
465	1.55	644.6	24.5	32.8	4.6	0.7
480	1.60	658.2	25.0	41.2	5.6	1.1
495	1.65	671.1	25.5	50.4	6.7	1.7
510	1.70	683.2	26.0	60.3	7.8	2.5
525	1.75	694.6	26.4	70.9	8.9	3.4
540	1.80	705.4	26.8	82.2	10.0	4.5

Table 16: IQ8+ – Newark, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
300	1.00	434.4	16.5	0.0	0.0	0.0
315	1.05	456.2	17.4	0.0	0.0	0.0
330	1.10	478.1	18.2	0.0	0.0	0.0
345	1.15	500.0	19.0	0.0	0.0	0.0
360	1.20	521.7	19.9	0.2	0.0	0.0
375	1.25	542.9	20.7	0.8	0.1	0.0
390	1.30	563.4	21.4	2.2	0.4	0.0
405	1.35	582.9	22.2	4.6	0.8	0.0
420	1.40	600.8	22.9	8.6	1.3	0.1
435	1.45	617.5	23.5	13.8	2.1	0.1
450	1.50	633.2	24.1	20.1	3.0	0.2
465	1.55	647.9	24.7	27.3	3.9	0.4
480	1.60	661.8	25.2	35.4	4.9	0.8
495	1.65	674.7	25.7	44.5	5.9	1.3
510	1.70	686.7	26.1	54.4	7.0	2.0
525	1.75	698.3	26.6	64.8	8.1	2.8
540	1.80	709.3	27.0	75.8	9.3	3.8

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IQ8M & IQ8MC simulation results

The following tables show the simulated single-module values for different DC:AC ratios on the IQ8M & IQ8MC Microinverters in locations covering the United States, using a -0.35%/°C simple efficiency model. The IQ8M & IQ8MC Microinverters has a peak output power rating of 330 VA. In this model, the module orientation is fixed at 180° azimuth, 20° tilt. Many real-world PV systems do not have ideal true south orientations of 180° azimuth and ideal tilt angles, so the impact of clipping will be less than shown in the tables below.

Table 17: IQ8M & IQ8MC – Denver, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	580.5	20.1	0.0	0.0	0.0
345	1.05	607.0	21.0	0.0	0.0	0.0
365	1.11	642.3	22.2	0.0	0.0	0.0
380	1.15	668.8	23.1	0.1	0.0	0.0
395	1.20	694.7	24.0	0.7	0.1	0.0
415	1.26	727.4	25.2	3.4	0.4	0.0
430	1.30	749.9	25.9	7.5	0.9	0.0
445	1.35	770.4	26.7	13.5	1.6	0.1
460	1.39	789.5	27.3	21.0	2.5	0.1
480	1.45	812.7	28.1	33.3	3.8	0.4
495	1.50	828.6	28.7	44.0	4.8	0.8
510	1.55	843.3	29.2	56.0	6.0	1.3
530	1.61	861.4	29.8	73.4	7.5	2.3
545	1.65	874.2	30.2	87.2	8.7	3.3
560	1.70	886.6	30.7	101.6	9.9	4.4
580	1.76	902.1	31.2	121.6	11.4	6.0
595	1.80	913.2	31.6	137.2	12.6	7.3

Table 18: IQ8M & IQ8MC – Los Angeles, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	602.5	20.8	0.0	0.0	0.0
345	1.05	630.0	21.8	0.0	0.0	0.0
365	1.11	666.7	23.1	0.0	0.0	0.0
380	1.15	694.2	24.0	0.0	0.0	0.0
395	1.20	721.5	25.0	0.2	0.0	0.0
415	1.26	755.9	26.2	2.5	0.3	0.0
430	1.30	779.4	27.0	6.6	0.8	0.0
445	1.35	800.1	27.7	13.5	1.6	0.1
460	1.39	819.1	28.3	22.2	2.5	0.1
480	1.45	841.9	29.1	36.2	3.9	0.5
495	1.50	857.2	29.7	48.5	5.1	0.9
510	1.55	870.8	30.1	62.5	6.4	1.6
530	1.61	887.3	30.7	83.0	8.2	2.8
545	1.65	898.6	31.1	99.4	9.6	4.0
560	1.70	909.4	31.5	116.3	10.9	5.4
580	1.76	923.3	31.9	139.3	12.6	7.3
595	1.80	933.1	32.3	157.2	13.9	8.7

Table 19: IQ8M & IQ8MC – New York City, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	464.5	16.1	0.0	0.0	0.0
345	1.05	485.8	16.8	0.0	0.0	0.0
365	1.11	514.1	17.8	0.0	0.0	0.0
380	1.15	535.3	18.5	0.0	0.0	0.0
395	1.20	556.4	19.2	0.2	0.0	0.0
415	1.26	584.0	20.2	1.0	0.2	0.0
430	1.30	604.0	20.9	2.2	0.4	0.0
445	1.35	623.1	21.6	4.4	0.7	0.0
460	1.39	641.3	22.2	7.5	1.1	0.0
480	1.45	663.8	23.0	13.4	1.9	0.1
495	1.50	679.7	23.5	18.9	2.6	0.2
510	1.55	694.7	24.0	25.1	3.3	0.3
530	1.61	713.6	24.7	34.7	4.5	0.6
545	1.65	726.7	25.1	42.9	5.3	1.0
560	1.70	739.1	25.6	51.9	6.3	1.5
580	1.76	754.8	26.1	64.6	7.6	2.3
595	1.80	766.0	26.5	74.8	8.5	3.1

Table 20: IQ8M & IQ8MC – Dallas, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	522.2	18.1	0.0	0.0	0.0
345	1.05	546.1	18.9	0.0	0.0	0.0
365	1.11	577.9	20.0	0.0	0.0	0.0
380	1.15	601.8	20.8	0.0	0.0	0.0
395	1.20	625.4	21.6	0.2	0.0	0.0
415	1.26	656.3	22.7	1.3	0.2	0.0
430	1.30	678.4	23.5	3.0	0.4	0.0
445	1.35	699.5	24.2	5.8	0.8	0.0
460	1.39	719.3	24.9	9.9	1.3	0.1
480	1.45	743.4	25.7	17.8	2.2	0.1
495	1.50	759.6	26.3	25.5	3.1	0.2
510	1.55	774.7	26.8	34.4	4.1	0.5
530	1.61	793.2	27.4	47.8	5.5	1.0
545	1.65	806.2	27.9	58.9	6.5	1.6
560	1.70	818.4	28.3	70.7	7.6	2.4
580	1.76	833.6	28.8	87.4	9.1	3.6
595	1.80	844.3	29.2	100.7	10.2	4.7

Table 21: IQ8M & IQ8MC – Miami, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	555.9	19.2	0.0	0.0	0.0
345	1.05	581.4	20.1	0.0	0.0	0.0
365	1.11	615.2	21.3	0.0	0.0	0.0
380	1.15	640.6	22.2	0.0	0.0	0.0
395	1.20	665.9	23.0	0.1	0.0	0.0
415	1.26	699.0	24.2	0.9	0.1	0.0
430	1.30	722.7	25.0	2.7	0.4	0.0
445	1.35	744.8	25.8	6.0	0.8	0.0
460	1.39	765.3	26.5	10.9	1.4	0.1
480	1.45	789.9	27.3	20.3	2.4	0.1
495	1.50	806.9	27.9	28.9	3.3	0.3
510	1.55	822.7	28.5	38.5	4.3	0.6
530	1.61	842.3	29.1	53.0	5.7	1.2
545	1.65	856.0	29.6	64.8	6.8	1.8
560	1.70	868.9	30.1	77.4	7.9	2.5
580	1.76	884.9	30.6	95.5	9.4	3.8
595	1.80	896.0	31.0	110.0	10.5	5.0

Table 22: IQ8M & IQ8MC – Phoenix, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	618.0	21.4	0.0	0.0	0.0
345	1.05	646.2	22.4	0.0	0.0	0.0
365	1.11	683.9	23.7	0.0	0.0	0.0
380	1.15	712.1	24.6	0.0	0.0	0.0
395	1.20	740.2	25.6	0.2	0.0	0.0
415	1.26	776.7	26.9	1.4	0.2	0.0
430	1.30	802.4	27.8	3.9	0.5	0.0
445	1.35	825.8	28.6	8.7	1.0	0.0
460	1.39	846.9	29.3	16.0	1.8	0.1
480	1.45	872.1	30.2	28.6	3.0	0.2
495	1.50	888.8	30.7	40.2	4.2	0.5
510	1.55	904.0	31.3	53.4	5.4	1.0
530	1.61	922.9	31.9	72.3	7.0	1.9
545	1.65	936.2	32.4	87.4	8.2	2.8
560	1.70	948.5	32.8	103.5	9.4	3.9
580	1.76	963.3	33.3	126.6	11.2	5.7
595	1.80	973.3	33.7	145.0	12.5	7.2

Table 23: IQ8M & IQ8MC – Minnesota, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	479.5	16.6	0.0	0.0	0.0
345	1.05	501.5	17.3	0.0	0.0	0.0
365	1.11	530.7	18.4	0.0	0.0	0.0
380	1.15	552.4	19.1	0.2	0.0	0.0
395	1.20	573.8	19.9	0.7	0.1	0.0
415	1.26	601.3	20.8	2.5	0.4	0.0
430	1.30	620.9	21.5	4.9	0.7	0.0
445	1.35	639.3	22.1	8.4	1.2	0.1
460	1.39	656.7	22.7	13.0	1.9	0.1
480	1.45	678.4	23.5	20.7	2.8	0.2
495	1.50	693.5	24.0	27.6	3.7	0.4
510	1.55	707.8	24.5	35.3	4.6	0.7
530	1.61	726.0	25.1	46.5	5.8	1.2
545	1.65	738.7	25.6	55.7	6.7	1.8
560	1.70	750.9	26.0	65.6	7.7	2.4
580	1.76	766.0	26.5	79.9	9.1	3.6
595	1.80	776.7	26.9	91.2	10.1	4.6

Table 24: IQ8M & IQ8MC – Newark, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
330	1.00	478.0	16.5	0.0	0.0	0.0
345	1.05	499.9	17.3	0.0	0.0	0.0
365	1.11	529.0	18.3	0.0	0.0	0.0
380	1.15	550.9	19.1	0.0	0.0	0.0
395	1.20	572.6	19.8	0.2	0.0	0.0
415	1.26	600.9	20.8	1.0	0.2	0.0
430	1.30	621.3	21.5	2.5	0.4	0.0
445	1.35	640.7	22.2	5.0	0.7	0.0
460	1.39	658.8	22.8	8.8	1.3	0.1
480	1.45	681.0	23.6	15.8	2.2	0.1
495	1.50	696.6	24.1	22.1	3.0	0.2
510	1.55	711.4	24.6	29.2	3.8	0.4
530	1.61	729.9	25.2	40.1	5.0	0.8
545	1.65	742.7	25.7	49.2	6.0	1.3
560	1.70	754.8	26.1	59.1	7.0	1.9
580	1.76	770.1	26.6	73.1	8.3	2.9
595	1.80	781.1	27.0	84.1	9.3	3.8

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IQ8A & IQ8AC simulation results

The following tables show the simulated single-module values for different DC:AC ratios on the IQ8A & IQ8AC Microinverters in locations covering the United States, using a -0.35%/°C simple efficiency model. The IQ8A & IQ8AC Microinverters has a peak output power rating of 366 VA. In this model, the module orientation is fixed at 180° azimuth, 20° tilt. Many real-world PV systems do not have ideal true south orientations of 180° azimuth and ideal tilt angles, so the impact of clipping will be less than shown in the tables below.

Table 25: IQ8A & IQ8AC – Denver, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	645.9	20.1	0.0	0.0	0.0
385	1.05	681.4	21.3	0.0	0.0	0.0
405	1.11	717.0	22.4	0.0	0.0	0.0
420	1.15	743.5	23.2	0.1	0.0	0.0
440	1.20	778.1	24.3	1.1	0.1	0.0
460	1.26	810.5	25.3	4.2	0.5	0.0
475	1.30	832.9	26.0	8.4	1.0	0.0
495	1.35	860.2	26.8	16.8	1.8	0.1
510	1.39	879.0	27.4	24.7	2.6	0.2
530	1.45	902.2	28.1	37.2	3.8	0.4
550	1.50	923.3	28.8	51.7	5.1	0.9
565	1.54	937.9	29.3	63.9	6.2	1.4
585	1.60	956.0	29.8	81.5	7.6	2.3
605	1.65	973.1	30.4	100.2	9.0	3.5
620	1.69	985.4	30.7	114.7	10.1	4.5
640	1.75	1001.0	31.2	134.8	11.5	6.0
660	1.80	1015.7	31.7	155.9	12.9	7.5

Table 26: IQ8A & IQ8AC – Los Angeles, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	670.4	20.9	0.0	0.0	0.0
385	1.05	707.3	22.1	0.0	0.0	0.0
405	1.11	744.1	23.2	0.0	0.0	0.0
420	1.15	771.8	24.1	0.0	0.0	0.0
440	1.20	808.2	25.2	0.4	0.0	0.0
460	1.26	842.3	26.3	3.2	0.4	0.0
475	1.30	865.7	27.0	7.5	0.8	0.0
495	1.35	893.1	27.9	17.1	1.8	0.1
510	1.39	911.8	28.4	26.2	2.7	0.2
530	1.45	934.6	29.2	40.4	4.0	0.5
550	1.50	954.8	29.8	57.2	5.5	1.0
565	1.54	968.2	30.2	71.6	6.6	1.7
585	1.60	984.7	30.7	92.2	8.3	2.8
605	1.65	999.7	31.2	114.2	9.9	4.3
620	1.69	1010.5	31.5	131.3	11.1	5.6
640	1.75	1024.4	32.0	154.5	12.7	7.3
660	1.80	1037.6	32.4	178.5	14.2	9.0

Table 27: IQ8A & IQ8AC – New York City, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	517.1	16.1	0.0	0.0	0.0
385	1.05	545.6	17.0	0.0	0.0	0.0
405	1.11	574.0	17.9	0.0	0.0	0.0
420	1.15	595.4	18.6	0.0	0.0	0.0
440	1.20	623.5	19.4	0.3	0.1	0.0
460	1.26	651.1	20.3	1.2	0.2	0.0
475	1.30	671.2	20.9	2.5	0.4	0.0
495	1.35	696.6	21.7	5.6	0.8	0.0
510	1.39	714.7	22.3	9.0	1.2	0.1
530	1.45	737.2	23.0	15.0	1.9	0.1
550	1.50	758.3	23.7	22.4	2.8	0.2
565	1.54	773.2	24.1	28.9	3.5	0.3
585	1.60	792.1	24.7	38.6	4.5	0.6
605	1.65	809.6	25.3	49.7	5.6	1.1
620	1.69	821.9	25.6	58.8	6.4	1.6
640	1.75	837.7	26.1	71.7	7.6	2.3
660	1.80	852.6	26.6	85.4	8.8	3.3

Table 28: IQ8A & IQ8AC – Dallas, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	581.2	18.1	0.0	0.0	0.0
385	1.05	613.2	19.1	0.0	0.0	0.0
405	1.11	645.2	20.1	0.0	0.0	0.0
420	1.15	669.1	20.9	0.0	0.0	0.0
440	1.20	700.7	21.9	0.4	0.1	0.0
460	1.26	731.6	22.8	1.6	0.2	0.0
475	1.30	753.8	23.5	3.4	0.4	0.0
495	1.35	781.8	24.4	7.4	0.9	0.0
510	1.39	801.4	25.0	11.8	1.4	0.1
530	1.45	825.4	25.7	19.9	2.3	0.1
550	1.50	846.9	26.4	30.5	3.3	0.3
565	1.54	861.9	26.9	39.6	4.2	0.5
585	1.60	880.4	27.5	53.2	5.5	1.0
605	1.65	897.6	28.0	68.1	6.8	1.8
620	1.69	909.8	28.4	80.0	7.8	2.5
640	1.75	925.0	28.9	96.9	9.2	3.6
660	1.80	939.3	29.3	114.9	10.5	5.0

Table 29: IQ8A & IQ8AC – Miami, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	618.7	19.3	0.0	0.0	0.0
385	1.05	652.7	20.4	0.0	0.0	0.0
405	1.11	686.7	21.4	0.0	0.0	0.0
420	1.15	712.2	22.2	0.0	0.0	0.0
440	1.20	746.1	23.3	0.2	0.0	0.0
460	1.26	779.2	24.3	1.2	0.1	0.0
475	1.30	802.8	25.0	3.1	0.4	0.0
495	1.35	832.2	26.0	7.8	0.9	0.0
510	1.39	852.4	26.6	13.1	1.5	0.1
530	1.45	877.0	27.4	22.7	2.4	0.1
550	1.50	899.5	28.1	34.4	3.5	0.3
565	1.54	915.2	28.5	44.3	4.5	0.6
585	1.60	934.8	29.2	58.9	5.7	1.2
605	1.65	953.0	29.7	74.9	7.0	1.9
620	1.69	965.9	30.1	87.6	8.0	2.6
640	1.75	981.8	30.6	105.9	9.4	3.8
660	1.80	996.6	31.1	125.4	10.8	5.3

Table 30: IQ8A & IQ8AC – Phoenix, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	687.7	21.4	0.0	0.0	0.0
385	1.05	725.5	22.6	0.0	0.0	0.0
405	1.11	763.3	23.8	0.0	0.0	0.0
420	1.15	791.7	24.7	0.0	0.0	0.0
440	1.20	829.2	25.9	0.3	0.0	0.0
460	1.26	865.6	27.0	1.7	0.2	0.0
475	1.30	891.3	27.8	4.4	0.5	0.0
495	1.35	922.3	28.8	11.4	1.2	0.1
510	1.39	943.1	29.4	19.0	1.9	0.1
530	1.45	968.1	30.2	32.0	3.1	0.2
550	1.50	990.2	30.9	47.8	4.4	0.6
565	1.54	1005.3	31.4	61.3	5.5	1.1
585	1.60	1024.2	31.9	80.3	7.0	1.9
605	1.65	1041.8	32.5	100.8	8.5	3.0
620	1.69	1054.0	32.9	117.1	9.7	4.1
640	1.75	1068.8	33.3	140.4	11.2	5.7
660	1.80	1082.1	33.8	165.2	12.8	7.5

Table 31: IQ8A & IQ8AC – Minnesota, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	533.7	16.6	0.0	0.0	0.0
385	1.05	563.1	17.6	0.0	0.0	0.0
405	1.11	592.5	18.5	0.0	0.0	0.0
420	1.15	614.3	19.2	0.2	0.0	0.0
440	1.20	642.8	20.1	1.1	0.2	0.0
460	1.26	670.3	20.9	3.1	0.4	0.0
475	1.30	689.9	21.5	5.5	0.8	0.0
495	1.35	714.3	22.3	10.5	1.4	0.1
510	1.39	731.7	22.8	15.3	2.0	0.1
530	1.45	753.3	23.5	23.1	2.9	0.2
550	1.50	773.4	24.1	32.5	3.9	0.4
565	1.54	787.6	24.6	40.3	4.7	0.7
585	1.60	805.8	25.1	51.6	5.8	1.2
605	1.65	822.8	25.7	64.1	7.0	1.9
620	1.69	834.9	26.0	74.2	7.9	2.5
640	1.75	850.1	26.5	88.5	9.1	3.6
660	1.80	864.4	27.0	103.8	10.3	4.8

Table 32: IQ8A & IQ8AC – Newark, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	532.1	16.6	0.0	0.0	0.0
385	1.05	561.4	17.5	0.0	0.0	0.0
405	1.11	590.7	18.4	0.0	0.0	0.0
420	1.15	612.6	19.1	0.0	0.0	0.0
440	1.20	641.6	20.0	0.3	0.0	0.0
460	1.26	669.9	20.9	1.3	0.2	0.0
475	1.30	690.3	21.5	2.9	0.4	0.0
495	1.35	716.1	22.3	6.5	0.9	0.0
510	1.39	734.0	22.9	10.5	1.4	0.1
530	1.45	756.3	23.6	17.6	2.2	0.1
550	1.50	777.0	24.2	26.3	3.2	0.2
565	1.54	791.7	24.7	33.6	3.9	0.4
585	1.60	810.2	25.3	44.5	5.0	0.8
605	1.65	827.2	25.8	56.9	6.2	1.4
620	1.69	839.2	26.2	67.0	7.1	2.0
640	1.75	854.6	26.7	81.0	8.4	2.9
660	1.80	869.2	27.1	95.8	9.6	4.0

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IQ8H-240 & IQ8HC simulation results

The following tables show the simulated single-module values for different DC:AC ratios on the IQ8H-240 & IQ8HC Microinverters in locations covering the United States, using a -0.35%/°C simple efficiency model. The IQ8H-240 & IQ8HC Microinverters has a peak output power rating of 384 VA. In this model, the module orientation is fixed at 180° azimuth, 20° tilt. Many real-world PV systems do not have ideal true south orientations of 180° azimuth and ideal tilt angles, so the impact of clipping will be less than shown in the tables below.

Table 33: IQ8H-240 & IQ8HC – Denver, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	677.9	20.2	0.0	0.0	0.0
405	1.05	713.2	21.2	0.0	0.0	0.0
420	1.09	739.7	22.0	0.0	0.0	0.0
440	1.15	775.0	23.0	0.1	0.0	0.0
460	1.20	809.6	24.1	0.8	0.1	0.0
480	1.25	842.4	25.0	3.3	0.4	0.0
500	1.30	842.4	25.0	3.3	0.4	0.0
520	1.35	899.9	26.8	16.7	1.7	0.1
540	1.41	924.9	27.5	27.1	2.7	0.2
560	1.46	947.8	28.2	39.7	3.9	0.4
575	1.50	963.7	28.6	50.4	4.8	0.7
590	1.54	983.3	29.2	66.4	6.1	1.4
615	1.60	1001.4	29.8	83.8	7.4	2.2
635	1.65	1018.5	30.3	102.2	8.8	3.3
655	1.71	1034.8	30.8	121.4	10.1	4.6
670	1.74	1046.5	31.1	136.4	11.1	5.7
690	1.80	1061.4	31.6	157.1	12.4	7.1

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Table 34: IQ8H-240 & IQ8HC – Los Angeles, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	703.6	20.9	0.0	0.0	0.0
405	1.05	740.2	22.0	0.0	0.0	0.0
420	1.09	767.8	22.8	0.0	0.0	0.0
440	1.15	804.4	23.9	0.0	0.0	0.0
460	1.20	840.8	25.0	0.3	0.0	0.0
480	1.25	875.5	26.0	2.4	0.3	0.0
500	1.30	875.5	26.0	2.4	0.3	0.0
520	1.35	934.5	27.8	16.9	1.7	0.1
540	1.41	959.3	28.5	28.8	2.8	0.2
560	1.46	981.8	29.2	43.2	4.0	0.5
575	1.50	997.0	29.6	55.5	5.1	0.9
590	1.54	1015.2	30.2	74.3	6.5	1.6
615	1.60	1031.6	30.7	94.7	8.1	2.7
635	1.65	1046.7	31.1	116.5	9.6	4.1
655	1.71	1061.1	31.5	139.0	11.1	5.7
670	1.74	1071.5	31.9	156.3	12.2	6.9
690	1.80	1084.8	32.2	180.0	13.7	8.5

Table 35: IQ8H-240 & IQ8HC – New York City, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	542.7	16.1	0.0	0.0	0.0
405	1.05	571.1	17.0	0.0	0.0	0.0
420	1.09	592.3	17.6	0.0	0.0	0.0
440	1.15	620.6	18.4	0.0	0.0	0.0
460	1.20	648.7	19.3	0.3	0.0	0.0
480	1.25	676.3	20.1	1.0	0.1	0.0
500	1.30	676.3	20.1	1.0	0.1	0.0
520	1.35	728.5	21.7	5.5	0.7	0.0
540	1.41	752.4	22.4	10.0	1.3	0.1
560	1.46	774.6	23.0	16.1	2.0	0.1
575	1.50	790.5	23.5	21.5	2.5	0.1
590	1.54	810.5	24.1	29.9	3.4	0.3
615	1.60	829.4	24.7	39.5	4.4	0.6
635	1.65	846.9	25.2	50.4	5.4	1.0
655	1.71	863.4	25.7	62.4	6.5	1.6
670	1.74	875.1	26.0	72.0	7.3	2.1
690	1.80	890.2	26.5	85.4	8.4	3.0

Table 36: IQ8H-240 & IQ8HC – Dallas, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	610.0	18.1	0.0	0.0	0.0
405	1.05	641.8	19.1	0.0	0.0	0.0
420	1.09	665.7	19.8	0.0	0.0	0.0
440	1.15	697.5	20.7	0.0	0.0	0.0
460	1.20	729.0	21.7	0.3	0.0	0.0
480	1.25	759.9	22.6	1.2	0.2	0.0
500	1.30	759.9	22.6	1.2	0.2	0.0
520	1.35	817.6	24.3	7.3	0.8	0.0
540	1.41	843.6	25.1	13.1	1.5	0.1
560	1.46	867.2	25.8	21.4	2.3	0.1
575	1.50	883.4	26.3	29.1	3.1	0.2
590	1.54	903.5	26.9	41.0	4.2	0.5
615	1.60	922.1	27.4	54.4	5.3	1.0
635	1.65	939.3	27.9	69.1	6.6	1.7
655	1.71	955.5	28.4	84.9	7.8	2.5
670	1.74	967.0	28.7	97.4	8.8	3.3
690	1.80	981.4	29.2	115.0	10.1	4.6

Table 37:IQ8H-240 & IQ8HC – Miami, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	649.3	19.3	0.0	0.0	0.0
405	1.05	683.2	20.3	0.0	0.0	0.0
420	1.09	708.6	21.1	0.0	0.0	0.0
440	1.15	742.4	22.1	0.0	0.0	0.0
460	1.20	776.1	23.1	0.2	0.0	0.0
480	1.25	809.3	24.1	0.9	0.1	0.0
500	1.30	809.3	24.1	0.9	0.1	0.0
520	1.35	870.4	25.9	7.6	0.8	0.0
540	1.41	897.2	26.7	14.7	1.5	0.1
560	1.46	921.4	27.4	24.4	2.5	0.1
575	1.50	938.3	27.9	33.0	3.3	0.3
590	1.54	959.4	28.5	45.9	4.4	0.6
615	1.60	979.0	29.1	60.3	5.6	1.1
635	1.65	997.3	29.6	76.1	6.8	1.8
655	1.71	1014.4	30.2	92.9	8.1	2.7
670	1.74	1026.4	30.5	106.5	9.0	3.5
690	1.80	1041.3	31.0	125.6	10.3	4.8

Table 38: IQ8H-240 & IQ8HC – Phoenix, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	721.7	21.5	0.0	0.0	0.0
405	1.05	759.3	22.6	0.0	0.0	0.0
420	1.09	787.6	23.4	0.0	0.0	0.0
440	1.15	825.2	24.5	0.0	0.0	0.0
460	1.20	862.6	25.6	0.2	0.0	0.0
480	1.25	899.2	26.7	1.3	0.1	0.0
500	1.30	899.2	26.7	1.3	0.1	0.0
520	1.35	964.8	28.7	11.1	1.1	0.0
540	1.41	992.3	29.5	21.2	2.0	0.1
560	1.46	1017.0	30.2	34.3	3.1	0.2
575	1.50	1033.7	30.7	45.9	4.1	0.5
590	1.54	1054.0	31.3	63.5	5.5	1.0
615	1.60	1072.9	31.9	82.4	6.8	1.8
635	1.65	1090.6	32.4	102.5	8.3	2.9
655	1.71	1106.8	32.9	124.1	9.7	4.2
670	1.74	1118.0	33.2	141.4	10.8	5.3
690	1.80	1131.5	33.6	165.7	12.3	7.0

Table 39:IQ8H-240 & IQ8HC – Minnesota, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	560.2	16.7	0.0	0.0	0.0
405	1.05	589.4	17.5	0.0	0.0	0.0
420	1.09	611.3	18.2	0.0	0.0	0.0
440	1.15	640.4	19.0	0.2	0.0	0.0
460	1.20	668.9	19.9	0.9	0.1	0.0
480	1.25	696.5	20.7	2.6	0.4	0.0
500	1.30	696.5	20.7	2.6	0.4	0.0
520	1.35	747.2	22.2	10.4	1.3	0.1
540	1.41	770.1	22.9	16.8	2.0	0.1
560	1.46	791.5	23.5	24.7	2.9	0.2
575	1.50	806.6	24.0	31.6	3.6	0.4
590	1.54	825.7	24.5	41.9	4.6	0.7
615	1.60	843.8	25.1	53.0	5.7	1.2
635	1.65	860.9	25.6	65.3	6.8	1.8
655	1.71	876.9	26.1	78.7	7.9	2.6
670	1.74	888.3	26.4	89.3	8.8	3.3
690	1.80	902.8	26.8	104.2	9.9	4.4

Table 40: IQ8H-240 & IQ8HC – Newark, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
385	1.00	558.4	16.6	0.0	0.0	0.0
405	1.05	587.6	17.5	0.0	0.0	0.0
420	1.09	609.4	18.1	0.0	0.0	0.0
440	1.15	638.6	19.0	0.0	0.0	0.0
460	1.20	667.5	19.8	0.2	0.0	0.0
480	1.25	695.8	20.7	1.0	0.1	0.0
500	1.30	695.8	20.7	1.0	0.1	0.0
520	1.35	748.9	22.3	6.3	0.8	0.0
540	1.41	772.7	23.0	11.7	1.4	0.1
560	1.46	794.6	23.6	18.9	2.2	0.1
575	1.50	810.2	24.1	25.3	2.9	0.2
590	1.54	829.9	24.7	34.8	3.9	0.4
615	1.60	848.4	25.2	45.6	4.9	0.8
635	1.65	865.5	25.7	57.8	6.0	1.3
655	1.71	881.5	26.2	71.0	7.2	2.0
670	1.74	893.0	26.5	81.5	8.0	2.7
690	1.80	907.7	27.0	96.0	9.2	3.7

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IQ8H-208 & IQ8HC simulation results

The following tables show the simulated single-module values for different DC:AC ratios on the IQ8H-208 & IQ8HC Microinverters in locations covering the United States, using a -0.35%/°C simple efficiency model. The IQ8H-208 & IQ8HC Microinverters has a peak output power rating of 366 VA. In this model, the module orientation is fixed at 180° azimuth, 20° tilt. Many real-world PV systems do not have ideal true south orientations of 180° azimuth and ideal tilt angles, so the impact of clipping will be less than shown in the tables below.

Table 41: IQ8H-208 & IQ8HC – Denver, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	642.6	20.0	0.0	0.0	0.0
385	1.05	677.9	21.1	0.0	0.0	0.0
405	1.11	713.3	22.2	0.0	0.0	0.0
420	1.15	739.7	23.1	0.1	0.0	0.0
440	1.20	774.2	24.1	0.9	0.1	0.0
460	1.26	806.8	25.2	3.7	0.4	0.0
475	1.30	829.4	25.9	7.6	0.9	0.0
495	1.35	856.9	26.7	15.6	1.7	0.1
510	1.39	875.9	27.3	23.2	2.5	0.1
530	1.45	899.2	28.0	35.3	3.6	0.4
550	1.50	920.5	28.7	49.6	4.9	0.8
565	1.54	935.2	29.2	61.5	5.9	1.3
585	1.60	953.4	29.7	78.8	7.3	2.2
605	1.65	970.5	30.3	97.2	8.7	3.3
620	1.69	982.8	30.7	111.6	9.8	4.3
640	1.75	998.5	31.1	131.4	11.2	5.8
660	1.80	1013.2	31.6	152.2	12.6	7.3

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Table 42: IQ8H-208 & IQ8HC – Los Angeles, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	666.9	20.8	0.0	0.0	0.0
385	1.05	703.6	21.9	0.0	0.0	0.0
405	1.11	740.3	23.1	0.0	0.0	0.0
420	1.15	767.8	23.9	0.0	0.0	0.0
440	1.20	804.2	25.1	0.3	0.0	0.0
460	1.26	838.5	26.2	2.7	0.3	0.0
475	1.30	862.1	26.9	6.7	0.7	0.0
495	1.35	889.8	27.8	15.7	1.7	0.1
510	1.39	908.7	28.3	24.5	2.5	0.1
530	1.45	931.7	29.1	38.3	3.8	0.4
550	1.50	952.1	29.7	54.7	5.2	0.9
565	1.54	965.7	30.1	68.7	6.4	1.5
585	1.60	982.3	30.6	89.0	8.0	2.6
605	1.65	997.5	31.1	110.8	9.6	4.1
620	1.69	1008.3	31.4	127.6	10.8	5.3
640	1.75	1022.2	31.9	150.6	12.3	7.0
660	1.80	1035.4	32.3	174.3	13.9	8.7

Table 43: IQ8H-208 & IQ8HC – New York City, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	514.4	16.0	0.0	0.0	0.0
385	1.05	542.8	16.9	0.0	0.0	0.0
405	1.11	571.1	17.8	0.0	0.0	0.0
420	1.15	592.3	18.5	0.0	0.0	0.0
440	1.20	620.4	19.4	0.3	0.0	0.0
460	1.26	647.9	20.2	1.1	0.2	0.0
475	1.30	668.0	20.8	2.3	0.3	0.0
495	1.35	693.5	21.6	5.1	0.7	0.0
510	1.39	711.6	22.2	8.3	1.1	0.0
530	1.45	734.2	22.9	14.1	1.8	0.1
550	1.50	755.4	23.6	21.3	2.6	0.2
565	1.54	770.4	24.0	27.6	3.3	0.3
585	1.60	789.4	24.6	37.1	4.3	0.6
605	1.65	807.0	25.2	47.9	5.4	1.0
620	1.69	819.4	25.6	56.8	6.2	1.4
640	1.75	835.1	26.0	69.5	7.4	2.2
660	1.80	850.1	26.5	83.0	8.5	3.1

Table 44: IQ8H-208 & IQ8HC – Dallas, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	578.2	18.0	0.0	0.0	0.0
385	1.05	610.0	19.0	0.0	0.0	0.0
405	1.11	641.8	20.0	0.0	0.0	0.0
420	1.15	665.7	20.8	0.0	0.0	0.0
440	1.20	697.2	21.7	0.3	0.0	0.0
460	1.26	728.0	22.7	1.4	0.2	0.0
475	1.30	750.2	23.4	3.0	0.4	0.0
495	1.35	778.3	24.3	6.8	0.8	0.0
510	1.39	798.1	24.9	11.0	1.3	0.1
530	1.45	822.3	25.6	18.6	2.1	0.1
550	1.50	844.0	26.3	28.8	3.2	0.3
565	1.54	859.0	26.8	37.8	4.0	0.5
585	1.60	877.7	27.4	51.0	5.3	1.0
605	1.65	895.0	27.9	65.7	6.6	1.6
620	1.69	907.3	28.3	77.5	7.6	2.3
640	1.75	922.6	28.8	94.1	8.9	3.4
660	1.80	937.0	29.2	111.7	10.2	4.7

Table 45: IQ8H-208 & IQ8HC – Miami, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	615.5	19.2	0.0	0.0	0.0
385	1.05	649.4	20.3	0.0	0.0	0.0
405	1.11	683.2	21.3	0.0	0.0	0.0
420	1.15	708.6	22.1	0.0	0.0	0.0
440	1.20	742.3	23.2	0.2	0.0	0.0
460	1.26	775.3	24.2	1.0	0.1	0.0
475	1.30	799.1	24.9	2.7	0.3	0.0
495	1.35	828.6	25.8	7.0	0.8	0.0
510	1.39	849.1	26.5	12.1	1.3	0.1
530	1.45	873.8	27.3	21.3	2.3	0.1
550	1.50	896.4	28.0	32.6	3.4	0.3
565	1.54	912.2	28.5	42.3	4.3	0.6
585	1.60	931.9	29.1	56.6	5.5	1.1
605	1.65	950.3	29.6	72.3	6.8	1.8
620	1.69	963.2	30.0	84.8	7.8	2.5
640	1.75	979.3	30.5	102.8	9.1	3.6
660	1.80	994.2	31.0	122.0	10.5	5.0

Table 46: IQ8H-208 & IQ8HC – Phoenix, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	684.1	21.3	0.0	0.0	0.0
385	1.05	721.8	22.5	0.0	0.0	0.0
405	1.11	759.4	23.7	0.0	0.0	0.0
420	1.15	787.6	24.6	0.0	0.0	0.0
440	1.20	825.0	25.7	0.2	0.0	0.0
460	1.26	861.4	26.9	1.5	0.2	0.0
475	1.30	887.3	27.7	3.8	0.4	0.0
495	1.35	918.6	28.7	10.3	1.1	0.0
510	1.39	939.6	29.3	17.6	1.8	0.1
530	1.45	964.9	30.1	30.0	2.9	0.2
550	1.50	987.3	30.8	45.4	4.2	0.5
565	1.54	1002.4	31.3	58.6	5.3	1.0
585	1.60	1021.5	31.9	77.4	6.8	1.8
605	1.65	1039.2	32.4	97.5	8.2	2.8
620	1.69	1051.5	32.8	113.5	9.4	3.8
640	1.75	1066.5	33.3	136.4	10.9	5.4
660	1.80	1079.9	33.7	160.9	12.5	7.2

Table 47: IQ8H-208 & IQ8HC – Minnesota, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	531.0	16.6	0.0	0.0	0.0
385	1.05	560.2	17.5	0.0	0.0	0.0
405	1.11	589.4	18.4	0.0	0.0	0.0
420	1.15	611.2	19.1	0.2	0.0	0.0
440	1.20	639.7	20.0	0.9	0.1	0.0
460	1.26	667.1	20.8	2.8	0.4	0.0
475	1.30	686.8	21.4	5.1	0.7	0.0
495	1.35	711.3	22.2	9.8	1.3	0.1
510	1.39	728.7	22.7	14.4	1.9	0.1
530	1.45	750.5	23.4	21.9	2.7	0.2
550	1.50	770.6	24.0	31.1	3.7	0.4
565	1.54	784.9	24.5	38.8	4.5	0.6
585	1.60	803.2	25.1	49.9	5.6	1.1
605	1.65	820.3	25.6	62.1	6.8	1.8
620	1.69	832.4	26.0	72.0	7.6	2.4
640	1.75	847.7	26.4	86.1	8.9	3.4
660	1.80	862.0	26.9	101.2	10.1	4.6

Table 48: IQ8H-208 & IQ8HC – Newark, -0.35%/°C simple efficiency model, 180° azimuth, 20° tilt.

MODULE POWER (W)	DC:AC RATIO	ANNUAL ENERGY (kWh)	AC CAPACITY FACTOR (%)	YEAR 1 INVERTER CLIPPING LOSS (kWh)	YEAR 1 INVERTER CLIPPING LOSS (%)	TOTAL INVERTER CLIPPING IN 25 YEARS (%)
365	1.00	529.3	16.5	0.0	0.0	0.0
385	1.05	558.5	17.4	0.0	0.0	0.0
405	1.11	587.6	18.3	0.0	0.0	0.0
420	1.15	609.5	19.0	0.0	0.0	0.0
440	1.20	638.4	19.9	0.3	0.0	0.0
460	1.26	666.6	20.8	1.1	0.2	0.0
475	1.30	687.1	21.4	2.6	0.4	0.0
495	1.35	712.9	22.2	5.9	0.8	0.0
510	1.39	731.0	22.8	9.7	1.3	0.1
530	1.45	753.3	23.5	16.6	2.1	0.1
550	1.50	774.1	24.1	25.0	3.0	0.2
565	1.54	789.0	24.6	32.1	3.8	0.4
585	1.60	807.5	25.2	42.8	4.8	0.8
605	1.65	824.6	25.7	54.9	6.0	1.3
620	1.69	836.7	26.1	64.8	6.9	1.9
640	1.75	852.1	26.6	78.7	8.1	2.7
660	1.80	866.8	27.0	93.3	9.3	3.8

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Conclusion

The primary purpose of this paper is to provide a technical framework for discussion. Some common configurations of Enphase inverters were simulated in NREL SAM to illustrate how various performance metrics change by varying DC:AC ratios. PV modules seldom produce power at their test condition power rating. This leads installers to pair PV modules with power ratings higher than the inverter power rating. In many locations, high DC:AC ratios may not result in significant clipping losses. However, further increasing the DC:AC ratio will increase the inverter capacity factor which may increase the value of the system. Also, in tandem if one considers 25 years value of a system, the DC:AC ratio can be pushed even higher given the module degradation over these years which leads to lesser overall clipping.

Revision history

REVISION	DATE	DESCRIPTION
TEB-00013-1.0	June 2023	Updated document for product names
Previous releases		