Reference

Maximum Ampacities for Wire

The table below shows allowable ampacities of conductors (wires) in conduit, raceway, and cable or directly buried, in an ambient temperature of 30°C (86°F). National Electrical Code (NEC) allows rounding up cable ampacity to next size standard fuse or breaker.

For ambient temperatures above 30°C (86°F), multiply the allowable ampacities shown at right by the correction factor listed under the insulation temperature rating below.

Maximum Ampacity of Copper and Aluminum Conductors at 30°C				
Wire size	Copper conductor temperature rating (A)		Aluminum conductor temperature rating (A)	
	75°C (167°F)	90°C (194°F)	75°C (167°F)	90°C (194°F)
[1]14	20 A	25 A	--	--
[1]12	25 A	30 A	20 A	25 A
[1]10	35 A	40 A	30 A	35 A
8	50 A	55 A	40 A	45 A
6	65 A	75 A	50 A	60 A
4	85 A	95 A	65 A	75 A
2	115 A	130 A	90 A	100 A
1	130 A	150 A	100 A	115 A
1/0	150 A	170 A	120 A	135 A
2/0	175 A	195 A	135 A	150 A
3/0	200 A	225 A	155 A	175 A
4/0	230 A	260 A	180 A	205 A

[1]NEC specifies that the overcurrent protection device not exceed 30 A for 10 AWG wire, 20 A for 12 AWG wire, and 15 A for 14 AWG wire.

Temperature Correction Factors for Ampacity			
Temperature range		75°F insulation	90°F insulation
31-35°C	87-95°F	0.94	0.96
36-40°C	96-104°F	0.88	0.91
41-45°C	105-113°F	0.82	0.87
46-50°C	114-122°F	0.75	0.82
51-55°C	123-131°F	0.67	0.76
56-60°C	132-140°F	0.58	0.71

Recommended Inverter Cable and Overcurrent Protection

Use this table to determine cable size and fuse or breaker size for common battery-based inverter models. Smaller cable sizes can be used if fuse or breaker size is reduced, but this can cause nuisance-tripping if the inverter is running near its maximum output. Larger cables may be necessary if the distance from the inverter to the battery is greater than 10'.

Use this table to choose the correct inverter breaker or fuse size required when choosing a pre-assembled power center that contains an over-current protection device (fuse or circuit breaker). Examples are MidNite Solar's E-Panels, Magnum Energy's MP and MMP panels, and OutBack Power's FLEXware power centers.

AEE stocks battery-to-inverter cables in #2, 2/0 and 4/0 AWG.

Cable and Overcurrent Protection Sizing					
Inverter voltage	Continuous watts	Max inverter input	Fuse size	Circuit breaker	Recommended wire size
12-volt	300 W	40 A	50 A	50 A	4 AWG
	600 W	80 A	110 A	100 A	2 AWG
	800 W	107 A	110 A	110 A	2 AWG
	1,000 W	135 A	200 A	175 A	2/0 AWG
	1,500 W	200 A	300 A	250 A	4/0 AWG
	2,000 W	265 A	300 A	250 A	4/0 AWG
	2,400 W	320 A	400 A	250* A	4/0 AWG
	2,500 W	334 A	400 A	250* A	4/0 AWG
	2,800 W	382 A	400 A	250* A	4/0 AWG
	3,000 W	400 A	400 A	250* A	4/0 AWG
24-volt	600 W	40 A	50 A	50 A	6 AWG
	800 W	54 A	70 A	75 A	4 AWG
	1,000 W	67 A	80 A	75 A	2 AWG
	1,500 W	100 A	110 A	110 A	2/0 AWG
	2,000 W	135 A	200 A	175 A	2/0 AWG
	2,400 W	160 A	200 A	175 A	2/0 AWG
	2,500 W	167 A	200 A	175 A	2/0 AWG
	3,000 W	200 A	300 A	250 A	4/0 AWG
	3,500 W	230 A	300 A	250 A	4/0 AWG
	4,000 W	265 A	300 A	250 A	4/0 AWG
48-volt	3,000 W	100 A	110 A	110 A	2/0 AWG
	3,600 W	120 A	200 A	125 A	2/0 AWG
	4,000 W	135 A	200 A	175 A	2/0 AWG
	4,500 W	155 A	200 A	175 A	2/0 AWG
	5,000 W	167 A	200 A	175 A	2/0 AWG
	6,000 W	200 A	400 A	250 A	4/0 AWG
	8,000 W	270 A	400 A	175 A (2 each)	2/0 AWG (2 each)

*These amperages exceed the capacity of a 250A breaker and 4/0 cable. Use two 2/0 cables with two 175A breakers if possible, or reduce loads to prevent tripping the breaker or blowing the fuse.

Wire Loss Tables for 12 VDC and 24 VDC Systems

Use this table to determine the maximum distance from power source to load for 2% voltage drop. If a 4% loss is acceptable, the distance can be doubled, but do not exceed 2% drop for wire between PV modules and batteries. A 4% to 5% loss is acceptable between batteries and lighting circuits in most cases. Note that a 24 VDC array can be placed much further from the battery bank than a 12 VDC array of the same size due to the lower current.

12-volt System Maximum Wire Runs										
AMPS	#14	#12	#10	#8	#6	#4	#2	1/0	2/0	4/0
2% voltage drop										
1 A	45 ft	70 ft	115 ft	180 ft	290 ft	456 ft	720 ft	--	--	--
2 A	22.5 ft	35 ft	57.5 ft	90 ft	145 ft	228 ft	360 ft	580 ft	720 ft	1060 ft
4 A	10 ft	17.5 ft	27.5 ft	45 ft	72.5 ft	114 ft	180 ft	290 ft	360 ft	580 ft
6 A	7.5 ft	12 ft	17.5 ft	30 ft	47.5 ft	75 ft	120 ft	193 ft	243 ft	380 ft
8 A	5.5 ft	8.5 ft	15 ft	22.5 ft	35.5 ft	57 ft	90 ft	145 ft	180 ft	290 ft
10 A	4.5 ft	7 ft	12 ft	18 ft	28.5 ft	45.5 ft	72.5 ft	115 ft	145 ft	230 ft
15 A	3 ft	4.5 ft	7 ft	12 ft	19 ft	30 ft	48 ft	76.5 ft	96 ft	150 ft
20 A	2 ft	3.5 ft	5.5 ft	9 ft	14.5 ft	22.5 ft	36 ft	57.5 ft	72.5 ft	116 ft
25 A	1.8 ft	2.8 ft	4.5 ft	7 ft	11.5 ft	18 ft	29 ft	46 ft	58 ft	92 ft
30 A	1.5 ft	2.4 ft	3.5 ft	6 ft	9.5 ft	15 ft	24 ft	38.5 ft	48.5 ft	77 ft
40 A	--	--	2.8 ft	4.5 ft	7 ft	11.5 ft	18 ft	29 ft	36 ft	56 ft
50 A	--	--	2.3 ft	3.6 ft	5.5 ft	9 ft	14.5 ft	23 ft	29 ft	46 ft
100 A	--	--	--	--	2.9 ft	4.6 ft	7.2 ft	11.5 ft	14.5 ft	23 ft
150 A	--	--	--	--	--	--	4.8 ft	7.7 ft	9.7 ft	15 ft
200 A	--	--	--	--	--	--	3.6 ft	5.8 ft	7.3 ft	11 ft

24-volt System Maximum Wire Runs										
AMPS	#14	#12	#10	#8	#6	#4	#2	1/0	2/0	4/0
2% voltage drop										
1 A	90 ft	140 ft	230 ft	360 ft	580 ft	912 ft	1440 ft	--	--	--
2 A	45 ft	70 ft	115 ft	180 ft	290 ft	456 ft	720 ft	1160 ft	1440 ft	2120 ft
4 A	20 ft	35 ft	55 ft	90 ft	145 ft	228 ft	360 ft	580 ft	720 ft	1160 ft
6 A	15 ft	24 ft	35 ft	60 ft	95 ft	150 ft	240 ft	386 ft	486 ft	760 ft
8 A	11 ft	17 ft	30 ft	45 ft	71 ft	114 ft	180 ft	290 ft	360 ft	580 ft
10 A	9 ft	14 ft	24 ft	36 ft	57 ft	91 ft	145 ft	230 ft	290 ft	460 ft
15 A	6 ft	9 ft	14 ft	24 ft	38 ft	60 ft	96 ft	153 ft	192 ft	300 ft
20 A	4 ft	7 ft	11 ft	18 ft	29 ft	45 ft	72 ft	115 ft	145 ft	232 ft
25 A	3.6 ft	5.6 ft	9 ft	14 ft	23 ft	36 ft	58 ft	92 ft	116 ft	184 ft
30 A	3 ft	4.8 ft	7 ft	12 ft	19 ft	30 ft	48 ft	77 ft	97 ft	154 ft
40 A	--	--	5.6 ft	9 ft	14 ft	23 ft	36 ft	58 ft	72 ft	112 ft
50 A	--	--	4.6 ft	7.2 ft	11 ft	18 ft	29 ft	46 ft	58 ft	92 ft
100 A	--	--	--	--	5.8 ft	9.2 ft	14.4 ft	23 ft	29 ft	46 ft
150 A	--	--	--	--	--	--	9.6 ft	15.4 ft	19.4 ft	30 ft
200 A	--	--	--	--	--	--	7.2 ft	11.6 ft	14.6 ft	22 ft

Wire Loss Tables - 48V and 120V

Use these tables to determine the maximum distance one-way in feet of various gauge two-conductor copper wire from power source to load for 2% voltage drop in 48 VDC and 120 VDC system wiring. You can go twice the distance where a 4% loss is acceptable but do not exceed 2% drop for wire between PV modules and batteries. A 4 to 5% loss is acceptable between batteries and lighting circuits in most cases.

48-volt System Maximum Wire Runs										
AMPS	#14	#12	#10	#8	#6	#4	#2	1/0	2/0	4/0
2% voltage drop										
1 A	180 ft	280 ft	460 ft	720 ft	1160 ft	1824 ft	2880 ft	--	--	--
2 A	90 ft	140 ft	230 ft	360 ft	580 ft	912 ft	1440 ft	2320 ft	2880 ft	4240 ft
4 A	40 ft	70 ft	110 ft	180 ft	290 ft	456 ft	720 ft	1160 ft	1440 ft	2320 ft
6 A	30 ft	48 ft	70 ft	120 ft	190 ft	300 ft	480 ft	772 ft	972 ft	1520 ft
8 A	22 ft	34 ft	60 ft	90 ft	142 ft	228 ft	360 ft	580 ft	720 ft	1160 ft
10 A	18 ft	28 ft	48 ft	72 ft	114 ft	182 ft	290 ft	460 ft	580 ft	920 ft
15 A	12 ft	18 ft	28 ft	48 ft	76 ft	120 ft	192 ft	306 ft	384 ft	600 ft
20 A	8 ft	14 ft	22 ft	36 ft	58 ft	90 ft	144 ft	230 ft	290 ft	464 ft
25 A	7.2 ft	11.2 ft	18 ft	28 ft	46 ft	72 ft	116 ft	184 ft	232 ft	368 ft
30 A	6 ft	9.6 ft	14 ft	24 ft	38 ft	60 ft	96 ft	154 ft	194 ft	308 ft
40 A	--	--	11.2 ft	18 ft	28 ft	46 ft	72 ft	116 ft	144 ft	224 ft
50 A	--	--	9.2 ft	14.4 ft	22 ft	36 ft	58 ft	92 ft	116 ft	184 ft
100 A	--	--	--	--	11.6 ft	18.4 ft	28.8 ft	46 ft	58 ft	92 ft
150 A	--	--	--	--	--	--	19.2 ft	30.8 ft	38.8 ft	60 ft
200 A	--	--	--	--	--	--	14.4 ft	23.2 ft	29.2 ft	44 ft

120-volt System Maximum Wire Runs										
AMPS	#14	#12	#10	#8	#6	#4	#2	1/0	2/0	4/0
2% voltage drop										
1 A	450 ft	700 ft	1150 ft	1800 ft	2900 ft	4560 ft	7200 ft	--	--	--
2 A	225 ft	350 ft	575 ft	900 ft	1450 ft	2280 ft	3600 ft	5800 ft	7200 ft	10600 ft
4 A	100 ft	175 ft	275 ft	450 ft	725 ft	1140 ft	1800 ft	2900 ft	3600 ft	5800 ft
6 A	75 ft	120 ft	175 ft	300 ft	475 ft	750 ft	1200 ft	1930 ft	2430 ft	3800 ft
8 A	55 ft	85 ft	150 ft	225 ft	355 ft	570 ft	900 ft	1450 ft	1800 ft	2900 ft
10 A	45 ft	70 ft	120 ft	180 ft	285 ft	455 ft	725 ft	1150 ft	1450 ft	2300 ft
15 A	30 ft	45 ft	70 ft	120 ft	190 ft	300 ft	480 ft	765 ft	960 ft	1500 ft
20 A	20 ft	35 ft	55 ft	90 ft	145 ft	225 ft	360 ft	575 ft	725 ft	1160 ft
25 A	18 ft	28 ft	45 ft	70 ft	115 ft	180 ft	290 ft	460 ft	580 ft	920 ft
30 A	15 ft	24 ft	35 ft	60 ft	95 ft	150 ft	240 ft	385 ft	485 ft	770 ft
40 A	--	--	28 ft	45 ft	70 ft	115 ft	180 ft	290 ft	360 ft	560 ft
50 A	--	--	23 ft	36 ft	55 ft	90 ft	145 ft	230 ft	290 ft	460 ft
100 A	--	--	--	18 ft	29 ft	46 ft	72 ft	115 ft	145 ft	230 ft
150 A	--	--	--	--	--	--	48 ft	77 ft	97 ft	150 ft
200 A	--	--	--	--	--	--	36 ft	58 ft	73 ft	110 ft

Solar Insolation

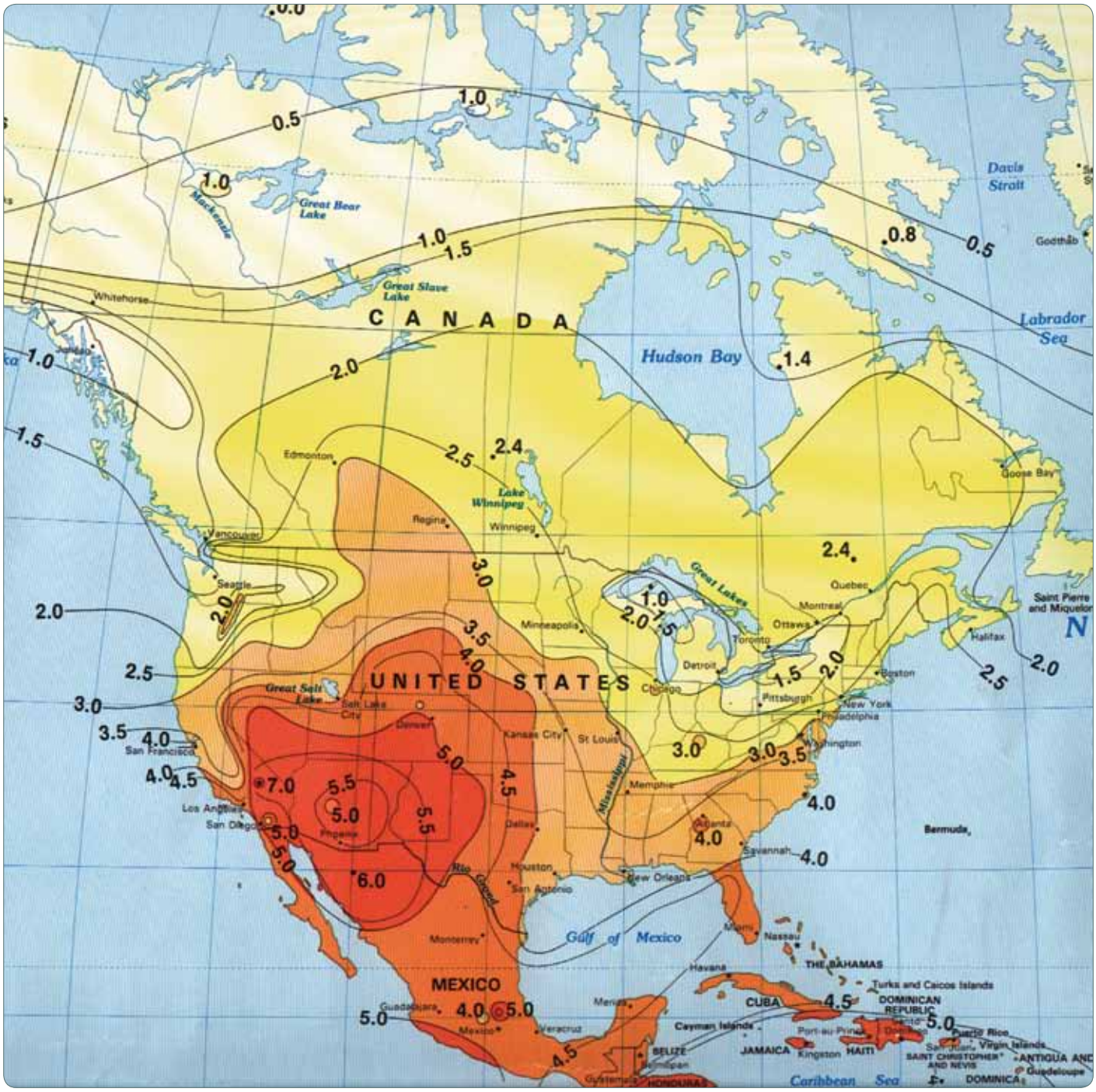
This table shows solar insolation in kilowatt hours per square meter per day in many U.S. locations, known as "sun-hours per day." To find average sun-hours per day in your area, check local weather data, look at the maps on the following pages, or find a city in the table below that has similar weather to your location.

For year-round autonomy, use the low figure. For autonomy in summer only, use the high number. For a utility grid-tie system with net metering, use the average figures.

State	City	High	Low	Avg
AK	Fairbanks	5.87	2.12	3.99
	Matanuska	5.24	1.74	3.55
AL	Montgomery	4.69	3.37	4.23
AR	Bethel	6.29	2.37	3.81
	Little Rock	5.29	3.88	4.69
AZ	Tucson	7.42	6.01	6.57
	Page	7.30	5.65	6.36
	Phoenix	7.13	5.78	6.58
CA	Santa Maria	6.52	5.42	5.94
	Riverside	6.35	5.35	5.87
	Davis	6.09	3.31	5.10
	Fresno	6.19	3.42	5.38
	Los Angeles	6.14	5.03	5.62
	Soda Springs	6.47	4.40	5.60
	La Jolla	5.24	4.29	4.77
	Inyokern	8.70	6.87	7.66
CO	Granby	7.47	5.15	5.69
	Grand Lake	5.86	3.56	5.08
	Grand Junction	6.34	5.23	5.85
	Boulder	5.72	4.44	4.87
DC	Washington	4.69	3.37	4.23
FL	Apalachicola	5.98	4.92	5.49
	Belie Is.	5.31	4.58	4.99
	Miami	6.26	5.05	5.62
	Gainesville	5.81	4.71	5.27
	Tampa	6.16	5.26	5.67
GA	Atlanta	5.16	4.09	4.74
	Griffin	5.41	4.26	4.99
HI	Honolulu	6.71	5.59	6.02
IA	Ames	4.80	3.73	4.40
ID	Boise	5.83	3.33	4.92
	Twin Falls	5.42	3.42	4.70
IL	Chicago	4.08	1.47	3.14
IN	Indianapolis	5.02	2.55	4.21
KS	Manhattan	5.08	3.62	4.57
	Dodge City	6.50	4.20	5.60
KY	Lexington	5.97	3.60	4.94
LA	Lake Charles	5.73	4.29	4.93
	New Orleans	5.71	3.63	4.92
	Shreveport	4.99	3.87	4.63
MA	E. Wareham	4.48	3.06	3.99
	Boston	4.27	2.99	3.84
	Blue Hill	4.38	3.33	4.05
	Natick	4.62	3.09	4.10
	Lynn	4.60	2.33	3.79
MD	Silver Hill	4.71	3.84	4.47
ME	Caribou	5.62	2.57	4.19
	Portland	5.23	3.56	4.51
MI	Sault Ste. Marie	4.83	2.33	4.20
	E. Lansing	4.71	2.70	4
MN	St. Cloud	5.43	3.53	4.53
MO	Columbia	5.50	3.97	4.73
	St. Louis	4.87	3.24	4.38
MS	Meridian	4.86	3.64	4.43
MT	Glasgow	5.97	4.09	5.15
	Great Falls	5.70	3.66	4.93
	Summit	5.17	2.36	3.99
NM	Albuquerque	7.16	6.21	6.77
NB	Lincoln	5.40	4.38	4.79
	N. Omaha	5.28	4.26	4.90
NC	Cape Hatteras	5.81	4.69	5.31
	Greensboro	5.05	4	4.71
ND	Bismarck	5.48	3.97	5.01
NJ	Sea Brook	4.76	3.20	4.21
NV	Las Vegas	7.13	5.84	6.41
	Ely	6.48	5.49	5.98
NY	Binghamton	3.93	1.62	3.16
	Ithaca	4.57	2.29	3.79
NY	Schenectady	3.92	2.53	3.55
	Rochester	4.22	1.58	3.31
	New York City	4.97	3.03	4.08
OH	Columbus	5.26	2.66	4.15
	Cleveland	4.79	1.99	3.94
OK	Stillwater	5.52	4.22	4.99
	Oklahoma City	6.26	4.98	5.59
OR	Astoria	4.67	1.99	3.72
	Corvallis	5.71	1.90	4.03
	Medford	5.84	2.02	4.51
PA	Pittsburgh	4.19	1.45	3.28
	State College	4.44	2.79	3.91
RI	Newport	4.69	3.58	4.23
SC	Charleston	5.72	4.23	5.06
SD	Rapid City	5.91	4.56	5.23
TN	Nashville	5.20	3.14	4.45
	Oak Ridge	5.06	3.22	4.37
TX	San Antonio	5.88	4.65	5.30
	Brownsville	5.49	4.42	4.92
	El Paso	7.42	5.87	6.72
	Midland	6.33	5.23	5.83
	Fort Worth	6.00	4.80	5.43
UT	Salt Lake City	6.09	3.78	5.26
	Flaming Gorge	6.63	5.48	5.83
VA	Richmond	4.50	3.37	4.13
WA	Seattle	4.83	1.60	3.57
	Richland	6.13	2.01	4.44
	Pullman	6.07	2.90	4.73
	Spokane	5.53	1.16	4.48
	Prosser	6.21	3.06	5.03
WI	Madison	4.85	3.28	4.29
WV	Charleston	4.12	2.47	3.65
WY	Lander	6.81	5.50	6.06

These maps show the average value of total solar energy received in peak sun hours per day on an optimally tilted surface during the month with the lowest solar radiation (not the yearly average). This is the best number to use in off-grid system design where the electrical demand is continuous or is not expected to vary seasonally and the system must be designed to operate year around. (Use this number for line 3 in the Off-Grid Solar Array Sizing Worksheet in the System Design section.)

North America

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Port-au-Prince
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EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
San José
Puerto Rico
Virgin Islands
SAINT CHRISTOPHER AND NEVIS
ANTIGUA AND BARBUDA
Guadeloupe
DOMINICA
Martinique
SAINT LUCIA
BARBADOS
SAINT VINCENT AND THE GRENADINES
GRENADA
Neth. Antilles
TRINIDAD AND TOBAGO
Port-of-Spain
Caracas
VENEZUELA
Georgetown
GUYANA
Paramaribo
French Guiana
Cayenne
COLOMBIA
Medellín
Bogotá
Cali
SURINAME
Equator
Galapagos Islands
ECUADOR
Quito
Guayaquil
Manaus
Amazon
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Fortaleza
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Salvador
Brasília
Lake Titicaca
La Paz
BOLIVIA
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Rio de Janeiro
São Paulo
Asunción
San Miguel de Tucumán
Pampas
Porto Alegre
Córdoba
Rosario
URUGUAY
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Valparaíso
Santiago
Buenos Aires
Concepción
ARGENTINA
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Bahía Blanca
CHILE
Stanley
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South Georgia
Scotia Sea
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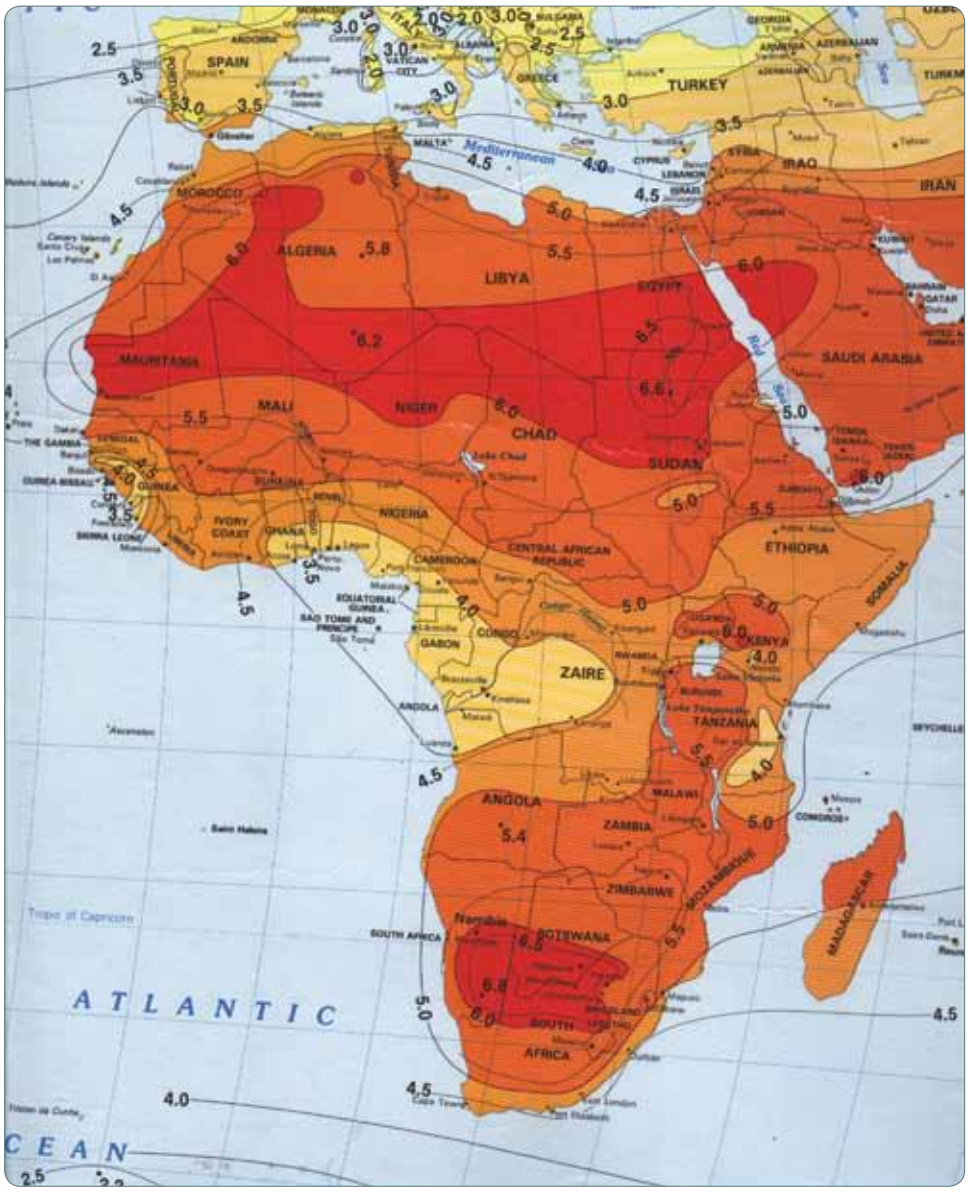
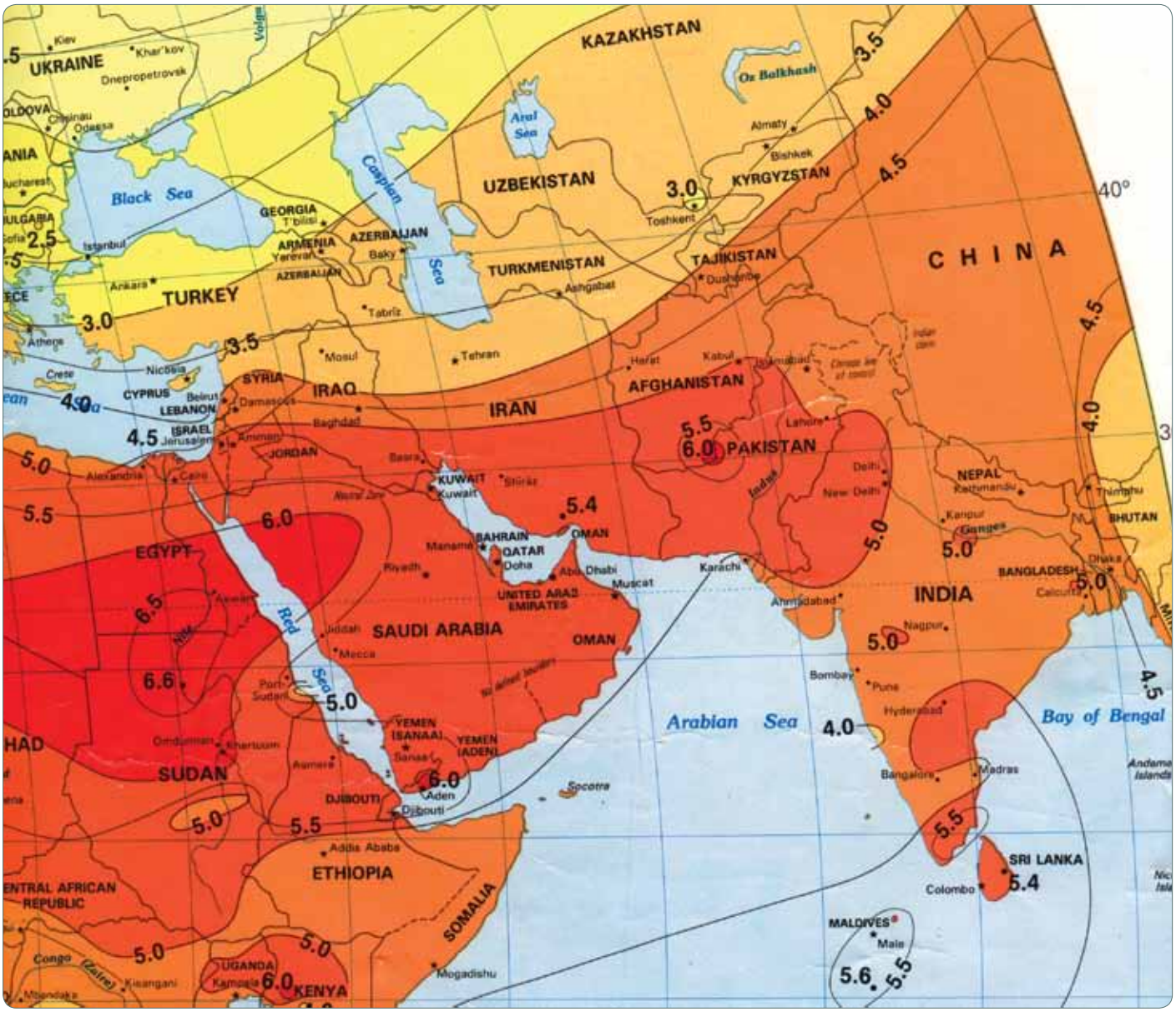
Europe

Africa

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Almaty
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Black Sea
Caspian Sea
UZBEKISTAN
KYRGYZSTAN
Toshkent
GEORGIA
T'bilisi
ARMENIA
Yerevan
AZERBAIJAN
Baky
TURKMENISTAN
Ashgabat
TAJIKISTAN
Dushanbe
CHINA
Istanbul
Ankara
TURKEY
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Nicosia
CYPRUS
SYRIA
IRAQ
IRAN
Beirut
Damascus
LEBANON
Baghdad
ISRAEL
Jerusalem
Amman
JORDAN
Basra
Lahore
PAKISTAN
Alexandria
Cairo
KUWAIT
Kuwait
Shiraz
Delhi
New Delhi
NEPAL
Kathmandu
Thimphu
BHUTAN
Kanpur
Ganges
Indus
EGYPT
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Doha
OMAN
Muscat
Riyadh
Abu Dhabi
UNITED ARAB EMIRATES
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INDIA
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Aswan
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Jiddah
SAUDI ARABIA
Mecca
Nagpur
Bombay
Pune
Hyderabad
Port Sudan
Arabian Sea
Bay of Bengal
YEMEN (SANAA)
YEMEN (ADEN)
Omdurman
Khartoum
Asmera
Socotra
Bangalore
Madras
SUDAN
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Aden
Djibouti
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ETHIOPIA
SRI LANKA
Colombo
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Male
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Kisangani
UGANDA
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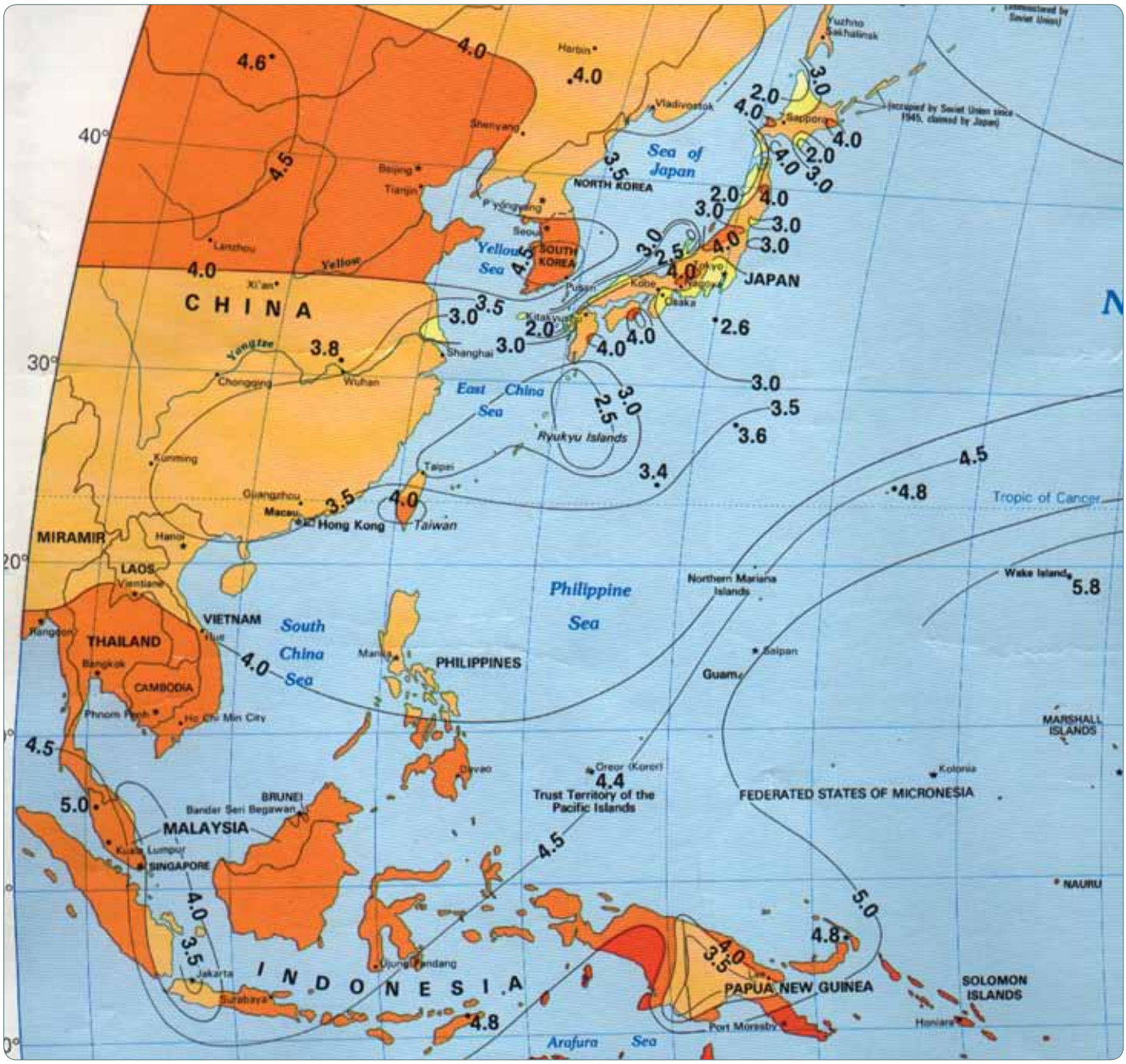
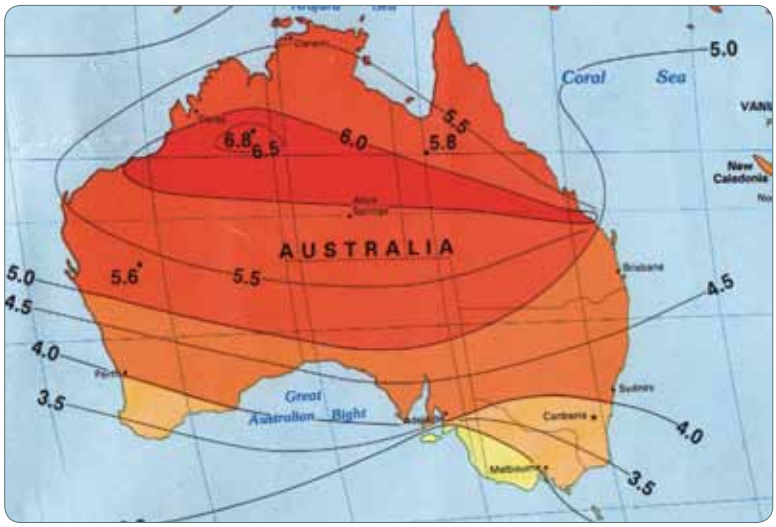
Asia



Australia



New Zealand