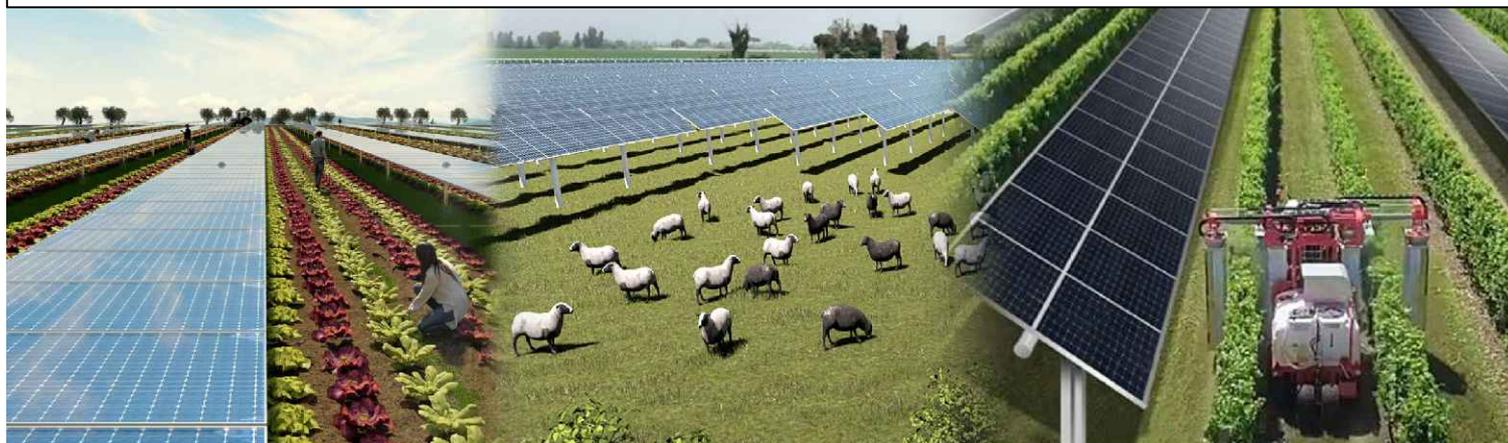


REGIONE CAMPANIA

PROVINCIA DI NAPOLI

COMUNE DI GIUGLIANO IN CAMPANIA

IMPIANTO AGRIVOLTAICO PER LA PRODUZIONE DI ENERGIA ELETTRICA E PRODUZIONE AGRICOLA UBICATO NEL COMUNE DI GIUGLIANO IN CAMPANIA (NA) IN LOCALITA' PROVVIDENZA, LA PIGNA, CINISTRELLI DELLA POTENZA NOMINALE DI 86.626,10 KW IN AGGIUNTA AD UN SISTEMA DI ACCUMULO DI 23.040 KWDC PER UNA POTENZA COMPLESSIVA AI FINI DELLA CONNESSIONE DI 109.666,10 KW COMPRESIVO DELLE OPERE DI RETE PER LA CONNESSIONE DELL'IMPIANTO ALLA RETE ELETTRICA NAZIONALE DI TERNA SPA



PROGETTO DEFINITIVO DELL'IMPIANTO DI PRODUZIONE COMPRESIVO DELLE OPERE DI RETE PER LA CONNESSIONE

ELABORATO

SCHEDE TECNICHE

DATA: Dicembre 2021

Scala:

Nome file:

PROPONENTE

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Agronomo Nicola Pierfranco Venti
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In collaborazione con :

Coldiretti Campania
PSR & Innovazione Campania Srl
Legambiente Campania

| revisione | descrizione | data | Elab. n. K1 |
|-----------|-------------|------|-----------------------|
| A | | | |
| B | | | |
| C | | | |

Tiger Neo N-type 78HL4-BDV 590-610 Watt

BIFACIAL MODULE WITH
DUAL GLASS

N-Type

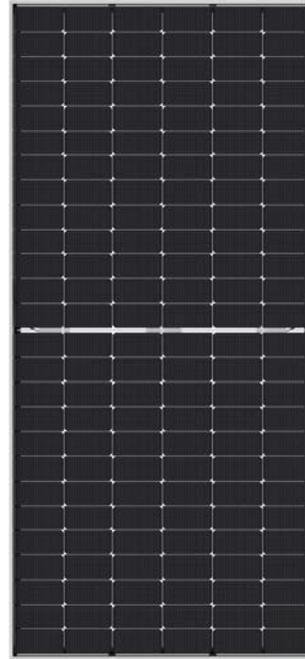
Positive power tolerance of 0~+3%

IEC61215(2016), IEC61730(2016)

ISO9001:2015: Quality Management System

ISO14001:2015: Environment Management System

ISO45001:2018
Occupational health and safety management systems



Key Features



SMBB Technology

Better light trapping and current collection to improve module power output and reliability.



PID Resistance

Excellent Anti-PID performance guarantee via optimized mass-production process and materials control.



Higher Power Output

Module power increases 5-25% generally, bringing significantly lower LCOE and higher IRR.



Hot 2.0 Technology

The N-type module with Hot 2.0 technology has better reliability and lower LID/LETID.

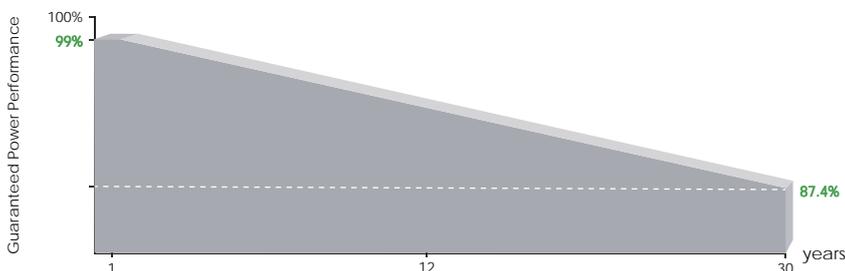


Enhanced Mechanical Load

Certified to withstand: wind load (2400 Pascal) and snow load (5400 Pascal).



LINEAR PERFORMANCE WARRANTY

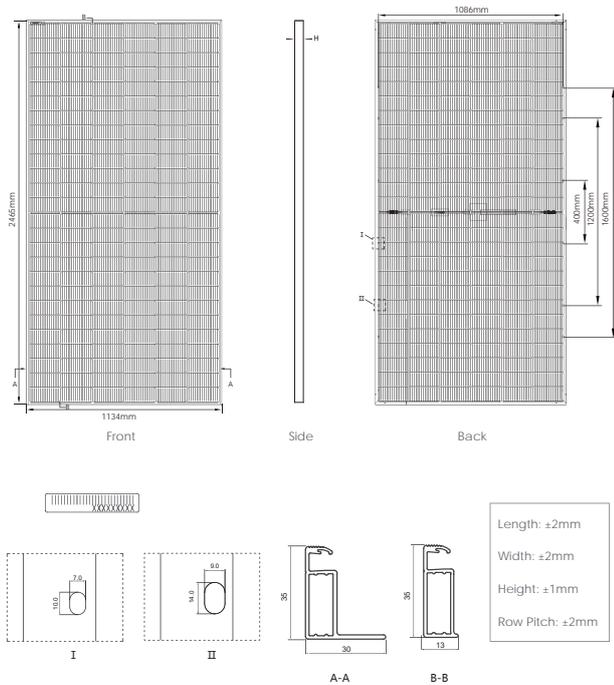


12 Year Product Warranty

30 Year Linear Power Warranty

0.40% Annual Degradation Over 30 years

Engineering Drawings

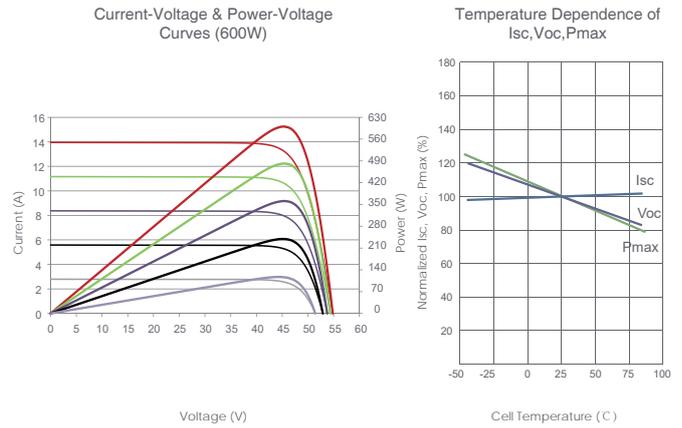


Packaging Configuration

(Two pallets = One stack)

31pcs/pallets, 62pcs/stack, 496pcs/ 40'HQ Container

Electrical Performance & Temperature Dependence



Mechanical Characteristics

| | |
|---------------|---|
| Cell Type | N type Mono-crystalline |
| No. of cells | 156 (2×78) |
| Dimensions | 2465×1134×35mm (97.05×44.65×1.38 inch) |
| Weight | 34.6kg (76.28 lbs) |
| Front Glass | 2.0mm, Anti-Reflection Coating |
| Back Glass | 2.0mm, Heat Strengthened Glass |
| Frame | Anodized Aluminium Alloy |
| Junction Box | IP68 Rated |
| Output Cables | TUV 1×4.0mm ² (+): 400mm, (-): 200mm or Customized Length |

SPECIFICATIONS

| Module Type | JKM590N-78HL4-BDV | | JKM595N-78HL4-BDV | | JKM600N-78HL4-BDV | | JKM605N-78HL4-BDV | | JKM610N-78HL4-BDV | |
|---|-------------------|--------|-------------------|--------|-------------------|--------|-------------------|--------|-------------------|--------|
| | STC | NOCT |
| Maximum Power (Pmax) | 590Wp | 444Wp | 595Wp | 447Wp | 600Wp | 451Wp | 605Wp | 455Wp | 610Wp | 459Wp |
| Maximum Power Voltage (Vmp) | 44.91V | 41.89V | 45.08V | 42.00V | 45.25V | 42.12V | 45.42V | 42.23V | 45.60V | 42.35V |
| Maximum Power Current (Imp) | 13.14A | 10.59A | 13.20A | 10.65A | 13.26A | 10.71A | 13.32A | 10.77A | 13.38A | 10.83A |
| Open-circuit Voltage (Voc) | 54.76V | 52.02V | 54.90V | 52.15V | 55.03V | 52.27V | 55.17V | 52.41V | 55.31V | 52.54V |
| Short-circuit Current (Isc) | 13.71A | 11.07A | 13.79A | 11.13A | 13.87A | 11.20A | 13.95A | 11.26A | 14.03A | 11.33A |
| Module Efficiency STC (%) | 21.11% | | 21.29% | | 21.46% | | 21.64% | | 21.82% | |
| Operating Temperature(°C) | -40°C~+85°C | | | | | | | | | |
| Maximum system voltage | 1500VDC (IEC) | | | | | | | | | |
| Maximum series fuse rating | 30A | | | | | | | | | |
| Power tolerance | 0~+3% | | | | | | | | | |
| Temperature coefficients of Pmax | -0.30%/°C | | | | | | | | | |
| Temperature coefficients of Voc | -0.25%/°C | | | | | | | | | |
| Temperature coefficients of Isc | 0.046%/°C | | | | | | | | | |
| Nominal operating cell temperature (NOCT) | 45±2°C | | | | | | | | | |
| Refer. Bifacial Factor | 80±5% | | | | | | | | | |

BIFACIAL OUTPUT-REAR SIDE POWER GAIN

| | | 5% | | 15% | | 25% | |
|--|--|----------------------|---------------------------|----------------------|---------------------------|----------------------|---------------------------|
| | | Maximum Power (Pmax) | Module Efficiency STC (%) | Maximum Power (Pmax) | Module Efficiency STC (%) | Maximum Power (Pmax) | Module Efficiency STC (%) |
| | | 620Wp | 22.16% | 679Wp | 24.27% | 738Wp | 26.38% |
| | | 625Wp | 22.35% | 684Wp | 24.48% | 744Wp | 26.61% |
| | | 630Wp | 22.54% | 690Wp | 24.68% | 750Wp | 26.83% |
| | | 635Wp | 22.73% | 696Wp | 24.89% | 756Wp | 27.05% |
| | | 641Wp | 22.91% | 702Wp | 25.10% | 763Wp | 27.28% |

*STC: Irradiance 1000W/m²

Cell Temperature 25°C

AM=1.5

NOCT: Irradiance 800W/m²

Ambient Temperature 20°C

AM=1.5

Wind Speed 1m/s

SUNNY CENTRAL

2200 / 2475 / 2500-EV / 2750-EV / 3000-EV



SC-2200-10 / SC-2475-10 / SC-2500-EV-10 / SC-2750-EV-10 / SC-3000-EV-10



Full power
up to 35 °C

Efficient

- Up to 4 inverters can be transported in one standard shipping container
- Overdimensioning up to 225% is possible
- Full power at ambient temperatures of up to 35 °C

Robust

- Intelligent air cooling system OptiCool for efficient cooling
- Suitable for outdoor use in all climatic ambient conditions worldwide

Flexible

- Conforms to all known grid requirements worldwide
- Q on demand
- Available as a single device or turnkey solution, including medium-voltage block

Easy to Use

- Improved DC connection area
- Connection area for customer equipment
- Integrated voltage support for internal and external loads

SUNNY CENTRAL 2200 / 2475 / 2500-EV / 2750-EV / 3000-EV

The new Sunny Central: more power per cubic meter

With an output of up to 3000 kVA and system voltages of 1100 V DC or 1500 V DC, the SMA central inverter allows for more efficient system design and a reduction in specific costs for PV power plants. A separate voltage supply and additional space are available for the installation of customer equipment. True 1500 V technology and the intelligent cooling system OptiCool ensure smooth operation even in extreme ambient temperature as well as a long service life of 25 years.

SUNNY CENTRAL 1000 V

| Technical Data | Sunny Central 2200 | Sunny Central 2475* |
|--|---|--------------------------------|
| Input (DC) | | |
| MPP voltage range V_{DC} (at 25 °C / at 35 °C / at 50 °C) | 570 to 950 V / 800 V / 800 V | 638 V to 950 V / 800 V / 800 V |
| Min. input voltage $V_{DC, min}$ / Start voltage $V_{DC, Start}$ | 545 V / 645 V | 614 V / 714 V |
| Max. input voltage $V_{DC, max}$ | 1100 V | 1100 V |
| Max. input current $I_{DC, max}$ (at 25 °C / at 50 °C) | 3960 A / 3600 A | 3960 A / 3600 A |
| Max. short-circuit current $I_{DC, sc}$ | 6400 A | 6400 A |
| Number of DC inputs | 24 double pole fused (32 single pole fused) | |
| Max. number of DC cables per DC input (for each polarity) | 2 x 800 kcmil, 2 x 400 mm ² | |
| Integrated zone monitoring | ○ | |
| Available DC fuse sizes (per input) | 200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A | |
| Output (AC) | | |
| Nominal AC power at $\cos \varphi = 1$ (at 35 °C / at 50 °C) | 2200 kVA / 2000 kVA | 2475 kVA / 2250 kVA |
| Nominal AC power at $\cos \varphi = 0.8$ (at 35 °C / at 50 °C) | 1760 kW / 1600 kW | 1980 kW / 1800 kW |
| Nominal AC current $I_{AC, nom}$ = Max. output current $I_{AC, max}$ | 3300 A | 3300 A |
| Max. total harmonic distortion | < 3% at nominal power | < 3% at nominal power |
| Nominal AC voltage / nominal AC voltage range ^{1) 8)} | 385 V / 308 V to 462 V | 434 V / 347 V bis 521 V |
| AC power frequency / range | 50 Hz / 47 Hz to 53 Hz 60 Hz / 57 Hz to 63 Hz | |
| Min. short-circuit ratio at the AC terminals ⁹⁾ | > 2 | |
| Power factor at rated power / displacement power factor adjustable ^{9) 10)} | ● 1 / 0.8 overexcited to 0.8 underexcited ○ 1 / 0.0 overexcited to 0.0 underexcited | |
| Efficiency | | |
| Max. efficiency ²⁾ / European efficiency ²⁾ / CEC efficiency ³⁾ | 98.6% / 98.4% / 98.0% | 98.6% / 98.4% / 98.0% |
| Protective Devices | | |
| Input-side disconnection point | DC load break switch | |
| Output-side disconnection point | AC circuit breaker | |
| DC overvoltage protection | Surge arrester, type I | |
| AC overvoltage protection (optional) | Surge arrester, class I | |
| Lightning protection (according to IEC 62305-1) | Lightning Protection Level III | |
| Ground-fault monitoring / remote ground-fault monitoring | ○ / ○ | |
| Insulation monitoring | ○ | |
| Degree of protection: electronics / air duct / connection area (as per IEC 60529) | IP65 / IP34 / IP34 | |
| General Data | | |
| Dimensions (W / H / D) | 2780 / 2318 / 1588 mm (109.4 / 91.3 / 62.5 inch) | |
| Weight | < 3400 kg / < 7496 lb | |
| Self-consumption (max. ⁴⁾ / partial load ⁵⁾ / average ⁶⁾ | < 8100 W / < 1800 W / < 2000 W | |
| Self-consumption (standby) | < 300 W | |
| Internal auxiliary power supply | Integrated 8.4 kVA transformer | |
| Operating temperature range ⁸⁾ | -25 °C to 60 °C / -13 °F to 140 °F | |
| Noise emission ⁷⁾ | 67.0 dB(A) | |
| Temperature range (standby) | -40 °C to 60 °C / -40 °F to 140 °F | |
| Temperature range (storage) | -40 °C to 70 °C / -40 °F to 158 °F | |
| Max. permissible value for relative humidity (condensing / non-condensing) | 95% to 100% (2 month/year) / 0% to 95% | |
| Maximum operating altitude above MSL ⁹⁾ 1000 m / 2000 m / 3000 m / 4000 m | ● / ○ / ○ / ○ (earlier temperature-dependent derating) | |
| Fresh air consumption | 6500 m ³ /h | |
| Features | | |
| DC connection | Terminal lug on each input (without fuse) | |
| AC connection | With busbar system (three busbars, one per line conductor) | |
| Communication | Ethernet, Modbus Master, Modbus Slave | |
| Communication with SMA string monitor (transmission medium) | Modbus TCP / Ethernet (FO MM, Cat-5) | |
| Enclosure / roof color | RAL 9016 / RAL 7004 | |
| Supply transformer for external loads | ○ (2.5 kVA) | |
| Standards and directives complied with | CE, IEC / EN 62109-1, IEC / EN 62109-2, BDEW-MSRL, IEEE1547, UL 840 Cat. IV, Arrêté du 23/04/08 | |
| EMC standards | IEC / EN 61000-6-4, IEC / EN 61000-6-2, EN 55022, IEC 62920, FCC Part 15 Class A, Cisp 11, DIN EN55011:2017 | |
| Quality standards and directives complied with | VDI/VDE 2862 page 2, DIN EN ISO 9001 | |
| ● Standard features ○ Optional * preliminary | | |
| Type designation | SC-2200-10 | SC-2475-10 |

1) At nominal AC voltage, nominal AC power decreases in the same proportion

2) Efficiency measured without internal power supply

3) Efficiency measured with internal power supply

4) Self-consumption at rated operation

5) Self-consumption at < 75% Pn at 25 °C

6) Self-consumption averaged out from 5% to 100% Pn at 25 °C

7) Sound pressure level at a distance of 10 m

8) Values apply only to inverters. Permissible values for SMA MV solutions from SMA can be found in the corresponding data sheets.

9) A short-circuit ratio of < 2 requires a special approval from SMA

10) Depending on the DC voltage

SUNNY CENTRAL 1500 V

| Technical Data | Sunny Central 2500-EV | Sunny Central 2750-EV | Sunny Central 3000-EV* |
|--|--|--|--|
| Input (DC) | | | |
| MPP voltage range V_{DC} (at 25 °C / at 35 °C / at 50 °C) | 850 V to 1425 V / 1200 V / 1200 V | 875 V to 1425 V / 1200 V / 1200 V | 956 V to 1425 V / 1200 V / 1200 V |
| Min. input voltage $V_{DC, min}$ / Start voltage $V_{DC, Start}$ | 778 V / 928 V | 849 V / 999 V | 927 V / 1077 V |
| Max. input voltage $V_{DC, max}$ | 1500 V | 1500 V | 1500 V |
| Max. input current $I_{DC, max}$ (at 25 °C / at 50 °C) | 3200 A / 2956 A | 3200 A / 2956 A | 3200 A / 2970 A |
| Max. short-circuit current rating | 6400 A | 6400 A | 6400 A |
| Number of DC inputs | 32 | 32 | 32 |
| Max. number of DC cables per DC input (for each polarity) | 2 x 800 kcmil, 2 x 400 mm ² | 2 x 800 kcmil, 2 x 400 mm ² | 2 x 800 kcmil, 2 x 400 mm ² |
| Integrated zone monitoring | ○ | ○ | ○ |
| Available DC fuse sizes (per input) | 200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A | | |
| Output (AC) | | | |
| Nominal AC power at $\cos \phi = 1$ (at 35 °C / at 50 °C) | 2500 kVA / 2250 kVA | 2750 kVA / 2500 kVA | 3000 kVA / 2700 kVA |
| Nominal AC power at $\cos \phi = 0.8$ (at 35 °C / at 50 °C) | 2000 kW / 1800 kW | 2200 kW / 2000 kW | 2400 kW / 2160 kW |
| Nominal AC current $I_{AC, nom} = \text{Max. output current } I_{AC, max}$ | 2624 A | 2646 A | 2624 A |
| Max. total harmonic distortion | < 3% at nominal power | < 3% at nominal power | < 3% at nominal power |
| Nominal AC voltage / nominal AC voltage range ^{1) 8)} | 550 V / 440 V to 660 V | 600 V / 480 V to 690 V | 655 V / 524 V to 721 V ⁹⁾ |
| AC power frequency | | 50 Hz / 47 Hz to 53 Hz 60 Hz / 57 Hz to 63 Hz | |
| Min. short-circuit ratio at the AC terminals ¹⁰⁾ | | > 2 | |
| Power factor at rated power / displacement power factor adjustable ^{8) 11)} | | ● 1 / 0.8 overexcited to 0.8 underexcited ○ 1 / 0.0 overexcited to 0.0 underexcited | |
| Efficiency | | | |
| Max. efficiency ²⁾ / European efficiency ²⁾ / CEC efficiency ³⁾ | 98.6% / 98.3% / 98.0% | 98.7% / 98.5% / 98.5% | 98.7% / 98.6% / 98.5% |
| Protective Devices | | | |
| Input-side disconnection point | | DC load-break switch | |
| Output-side disconnection point | | AC circuit breaker | |
| DC overvoltage protection | | Surge arrester, type I | |
| AC overvoltage protection (optional) | | Surge arrester, class I | |
| Lightning protection (according to IEC 62305-1) | | Lightning Protection Level III | |
| Ground-fault monitoring / remote ground-fault monitoring | | ○ / ○ | |
| Insulation monitoring | | ○ | |
| Degree of protection: electronics / air duct / connection area (as per IEC 60529) | | IP65 / IP34 / IP34 | |
| General Data | | | |
| Dimensions (W / H / D) | 2780 / 2318 / 1588 mm (109.4 / 91.3 / 62.5 inch) | | |
| Weight | < 3400 kg / < 7496 lb | | |
| Self-consumption (max. ⁴⁾ / partial load ⁵⁾ / average ⁶⁾ | < 8100 W / < 1800 W / < 2000 W | | |
| Self-consumption (standby) | < 370 W | | |
| Internal auxiliary power supply | Integrated 8.4 kVA transformer | | |
| Operating temperature range ⁸⁾ | -25 to 60 °C / -13 to 140 °F | | |
| Noise emission ⁷⁾ | 67.8 dB(A) | | |
| Temperature range (standby) | -40 to 60 °C / -40 to 140 °F | | |
| Temperature range (storage) | -40 to 70 °C / -40 to 158 °F | | |
| Max. permissible value for relative humidity (condensing / non-condensing) | 95% to 100% (2 month / year) / 0% to 95% | | |
| Maximum operating altitude above MSL ⁸⁾ 1000 m / 2000 m / 3000 m | ● / ○ / ○ (earlier temperature-dependent derating) | | |
| Fresh air consumption | 6500 m ³ /h | | |
| Features | | | |
| DC connection | Terminal lug on each input (without fuse) | | |
| AC connection | With busbar system (three busbars, one per line conductor) | | |
| Communication | Ethernet, Modbus Master, Modbus Slave | | |
| Communication with SMA string monitor (transmission medium) | Modbus TCP / Ethernet (FO MM, Cat-5) | | |
| Enclosure / roof color | RAL 9016 / RAL 7004 | | |
| Supply transformer for external loads | ○ (2.5 kVA) | | |
| Standards and directives complied with | CE, IEC / EN 62109-1, IEC / EN 62109-2, BDEW-MSRL, IEEE1547, Arrêté du 23/04/08 | | |
| EMC standards | CISPR 11, CISPR 22, EN55011:2017, EN 55022, IEC/EN 61000-6-4, IEC/EN 61000-6-2, IEC 62920, FCC Part 15 Class A | CISPR 11, CISPR 22, EN55011:2017, EN 55022, IEC 62920, FCC Part 15 Class A | |
| Quality standards and directives complied with | VDI/VDE 2862 page 2, DIN EN ISO 9001 | | |
| ● Standard features ○ Optional * preliminary | | | |
| Type designation | SC-2500-EV-10 | SC-2750-EV-10 | SC-3000-EV-10 |

1) At nominal AC voltage, nominal AC power decreases in the same proportion

2) Efficiency measured without internal power supply

3) Efficiency measured with internal power supply

4) Self-consumption at rated operation

5) Self-consumption at < 75% Pn at 25 °C

6) Self-consumption averaged out from 5% to 100% Pn at 35 °C

7) Sound pressure level at a distance of 10 m

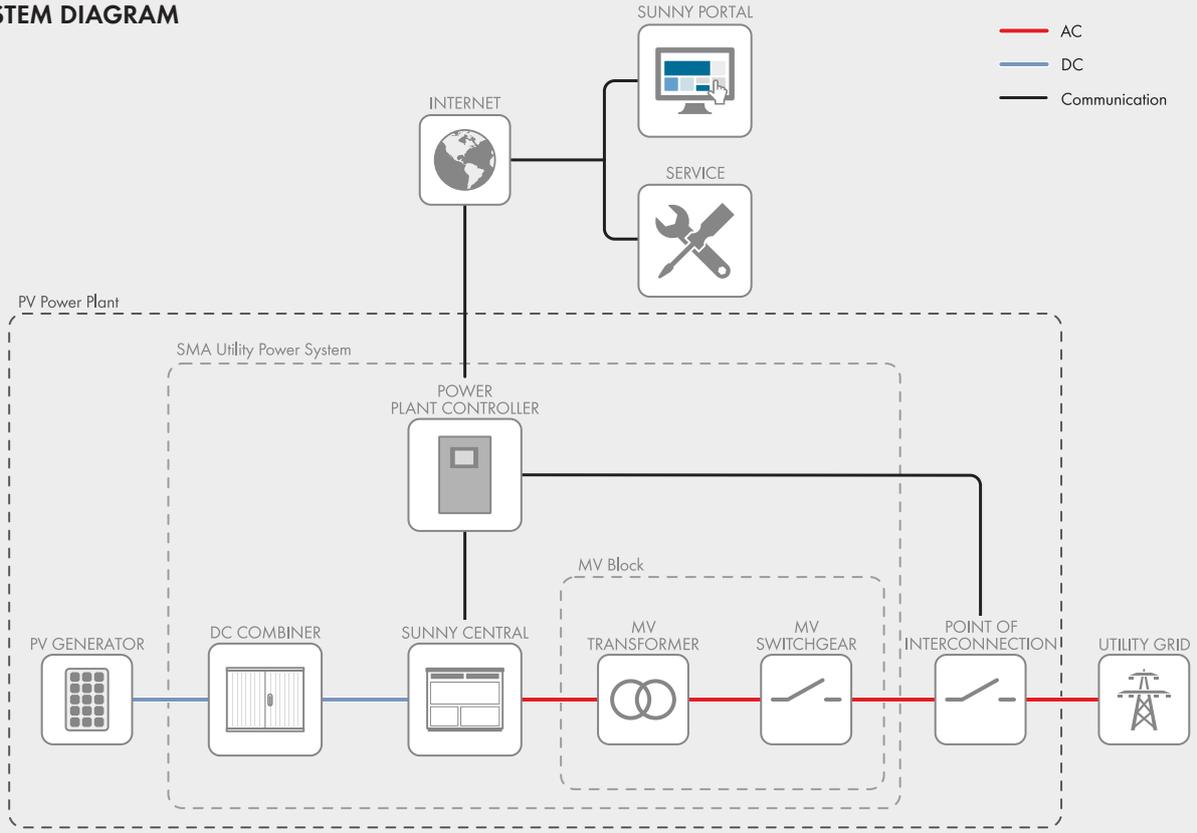
8) Values apply only to inverters. Permissible values for SMA MV solutions from SMA can be found in the corresponding data sheets.

9) AC voltage range can be extended to 753V for 50Hz grids only (option „Aux power supply: external“ must be selected, option “housekeeping” not combinable).

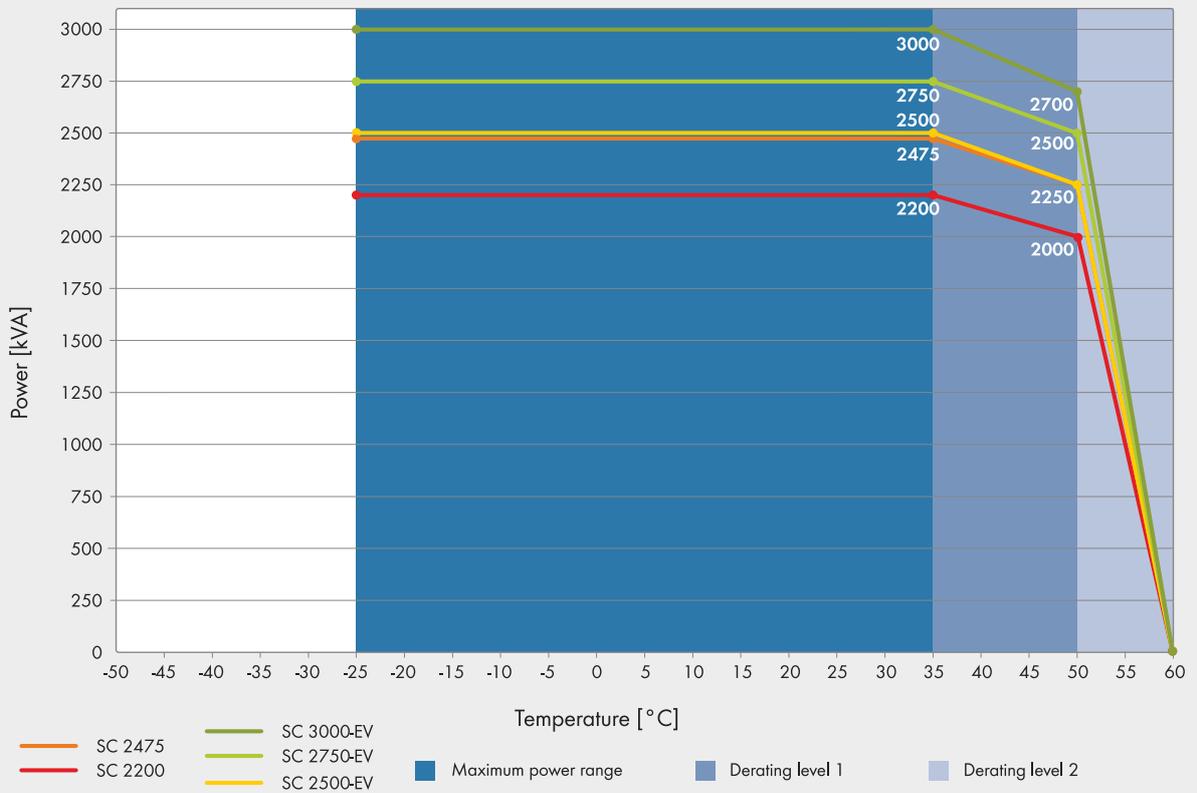
10) A short-circuit ratio of < 2 requires a special approval from SMA

11) Depending on the DC voltage

SYSTEM DIAGRAM



TEMPERATURE BEHAVIOR (at 1000 m)



MV POWER STATION

2200 / 2475 / 2500 / 2750 / 3000



MVPS 2200-20 / MVPS 2475-20 / MVPS 2500-20 / MVPS 2750-20 / MVPS 3000-20



Robust

- Station and all individual components type-tested
- Optimally suited to extreme ambient conditions

Easy to Use

- Plug and play concept
- Walk-in control rooms
- Completely pre-assembled for easy set-up and commissioning

Cost-Effective

- Easy planning and installation
- Low transport costs due to 20-foot container

Flexible

- Global solution for international markets
- Numerous options
- Compatible with MVPS 4400 – MVPS 6000

MV POWER STATION 2200 / 2475 / 2500 / 2750 / 3000

Turnkey Solution for PV Power Plants

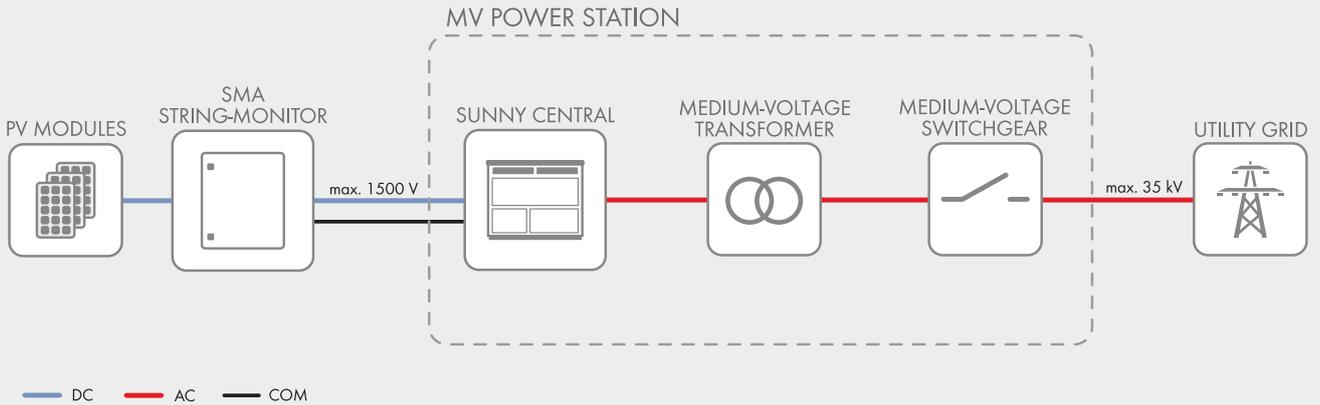
With the power of the new robust central inverters, the Sunny Central or Sunny Central Storage, and with perfectly adapted medium-voltage components, the new MV Power Station offers even more power density and is a turnkey solution available worldwide. The solution is the ideal choice for new generation PV power plants operating at 1500 V_{DC}. Delivered pre-configured in a 20-foot container, the solution is easy to transport and quick to assemble and commission. The MVPS and all components are type-tested. The MV Power Station combines rigorous plant safety with maximum energy yield and minimized deployment and operating risk.

MV POWER STATION

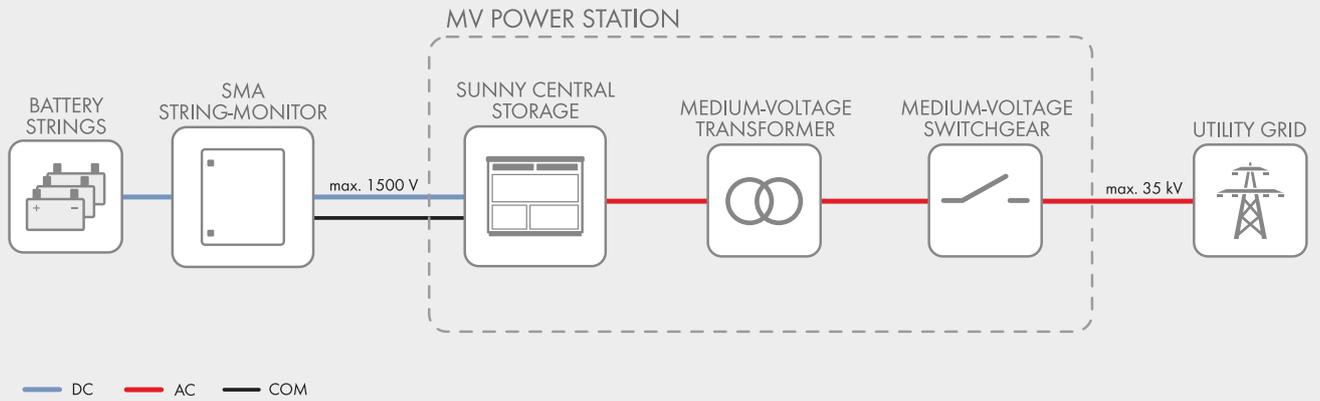
2200 / 2475 / 2500 / 2750 / 3000

| Technical Data | MV Power Station 2200 |
|---|--|
| Input (DC) | |
| Available inverters | 1 x SC 2200 or 1 x SCS 2200 |
| Max. input voltage | 1100 V |
| Max. input current | 3960 A |
| Number of DC inputs | 24 double pole fused (32 single pole fused) |
| Integrated zone monitoring | ○ |
| Available DC fuse sizes (per input) | 200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A |
| Output (AC) on the medium-voltage side | |
| Standard power at 1000 m and $\cos \varphi = 1$ (at 35°C / at 40°C / at 45°C) ¹⁾ | 2200 kVA / 2000 kVA / 0 kVA |
| Optionale power at 1000 m and $\cos \varphi = 1$ (at 35°C / at 50°C / at 55°C) ¹⁾ | 2200 kVA / 2000 kVA / 0 kVA |
| Typical nominal AC voltages | 6.6 kV to 35 kV |
| AC power frequency | 50 Hz / 60 Hz |
| Transformer vector group Dy11 / YNd11 | ● / ○ |
| Transformer cooling methods ONAN ²⁾ / KNAN ²⁾ | ● / ○ |
| Max. output current at 33 kV | 39 A |
| Transformer no-load losses Standard / Ecodesign ³⁾ | ● / ○ |
| Transformer short-circuit losses Standard / Ecodesign ³⁾ | ● / ○ |
| Max. total harmonic distortion | < 3% |
| Reactive power feed-in | ○ up to 60% of AC power |
| Power factor at rated power / displacement power factor adjustable | 1 / 0.8 overexcited to 0.8 underexcited |
| Inverter efficiency | |
| Max. efficiency | 98.6% |
| European efficiency | 98.4% |
| CEC weighted efficiency ⁴⁾ | 98.0% |
| Protective devices | |
| Input-side disconnection point | DC load-break switch |
| Output-side disconnection point | Medium-voltage vacuum circuit breaker |
| DC overvoltage protection | Surge arrester type I |
| Galvanic isolation | ● |
| Internal arc classification medium-voltage control room (according to IEC 62271-202) | IAC A 20 kA 1 s |
| General Data | |
| Dimensions of the 20-foot ISO container (W / H / D) ⁵⁾ | 6.058 m / 2.591 m / 2.438 m |
| Weight | < 16 t |
| Self-consumption (max. / partial load / average) ¹⁾ | < 8.1 kW / < 1.8 kW / < 2.0 kW |
| Self-consumption (stand-by) ¹⁾ | < 300 W |
| Degree of protection according to IEC 60529 | Control rooms IP23D, inverter electronics IP65 |
| Environment: standard / chemically active / dusty | ● / ○ / ○ |
| Degree of protection according to IEC 60721-3-4 (4C1, 4S2 / 4C2, 4S2 / 4C2, 4S4) | ● / ○ / ○ |
| Maximum permissible value for relative humidity | 15% to 95% |
| Max. operating altitude above mean sea level 1000 m / 2000 m / 3000 m / 4000 | ● / ○ / ○ / ○ (earlier temperature-dependent de-rating) |
| Fresh air consumption of inverter and transformer | 6500 m ³ /h |
| Features | |
| DC terminal | Terminal lug |
| AC connection | Outer-cone angle plug |
| Tap changer for MV-transformer: without / with | ● / ○ |
| Shield winding for MV-Transformer: without / with | ● / ○ |
| Communication package | ○ |
| Station enclosure color | RAL 7004 |
| Transformer for external loads: without / 20 kVA / 30 kVA | ● / ○ / ○ |
| Medium-voltage switchgear: without / 2 feeders / 3 feeders | ● / ○ / ○ |
| 1 or 2 cable feeders with load-break switch, 1 transformer feeder with circuit breaker, internal arc classification IAC A FL 20 kA 1 s according to IEC 62271-200 | |
| Accessories for medium-voltage switchgear: without / auxiliary contacts / motor for transformer feeder / cascade control / monitoring | ● / ○ / ○ / ○ / ○ |
| Oil containment | ○ |
| Industry standards (for other standards see the inverter datasheet) | IEC 62271-202, IEC 62271-200, IEC 60076 , CSC certificate, EN 50588-1 |
| ● Standard features ○ Optional features – Not available | |
| Type designation | MVPS-2200-20 |

System diagram with Sunny Central



System diagram with Sunny Central Storage





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To whom it may concern

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Date 28.01.2019

**Medium Voltage Grid Connection in Italy
MVPS Compliance according to CEI 0-16**

Hereby we confirm that our Medium Voltage Power Station (MVPS) is compliant to the Italian Standard CEI 0-16. According paragraph 8.5.13 of this standard there is a limit on 20 kV grid connection for Medium Voltage Transformers (MVT), defined with a transformer power of 2000 kVA and a short circuit voltage Vcc of 6 %. Higher power classes are allowed in case of using higher short circuit impedances, to reduce the short circuit power according to paragraph 8.5.13. SMA will deliver the following transformers for 20 kV grid connection:

| MVPS | DC Voltage | MVT power | AC Voltage | Vcc |
|------|------------|-----------|------------|----------|
| 2200 | 1000 V | 2000 kVA | 20 kV | > 6.00 % |
| 2475 | 1000 V | 2250 kVA | 20 kV | > 6.75 % |
| 2500 | 1500 V | 2250 kVA | 20 kV | > 6.75 % |
| 2750 | 1500 V | 2500 kVA | 20 kV | > 7.50 % |
| 3000 | 1500 V | 2700 kVA | 20 kV | > 8.10 % |

There is also a limit for the maximum power of 6000 kVA that can be energized at the same time according to paragraph 8.5.14 of the standard CEI 0-16. In this case SMA Solar Technology AG can offer the option Cascade Control for a delayed switching of the MV transformers, to reduce the inrush current

Yours sincerely,

SMA Solar Technology AG

i.A.

i. A. Thomas Weiss

Technical Product Manager
Business Unit Utility

i. A. Bernhard Voll

Platform Product Manager
Business Unit Utility

DC-CMB-U10-16 / DC-CMB-U10-24 / DC-CMB-U10-32 /
DC-CMB-U15-16 / DC-CMB-U15-24 / DC-CMB-U15-32



Robust

- Stable housing made of glass-fiber-reinforced polyester
- Indoor and outdoor installation possible thanks to IP54 degree of protection

- Can be operated at ambient temperatures of -25°C to 60°C and at altitudes of up to 4000 m above MSL

Easy to Use

- Easy to install thanks to its compact structure and low weight
- Integrated DC load-break switch for ultra-high safety

Versatile

- For PV array voltages of 1000 V and 1500 V
- Collection and safeguarding of 16, 24 or 32 strings for flexibility during the system design phase

SMA STRING-COMBINER

For safe collection of all strings in the PV field

The boxes can be installed quickly, safely and easily both indoors and outdoors thanks to their compact dimensions, while their robust enclosure guarantees durability and reliable safety in the PV field. The SMA String-Combiners with 24 and 32 string inlets are fitted with two cable outlets per pole as standard and cover – just like the Combiner with 16 string inlets – a sealing range of 17 to 38.5 millimeters. Cables with cross-sections of 70 to 400 mm² can be inserted.

SMA STRING-COMBINER

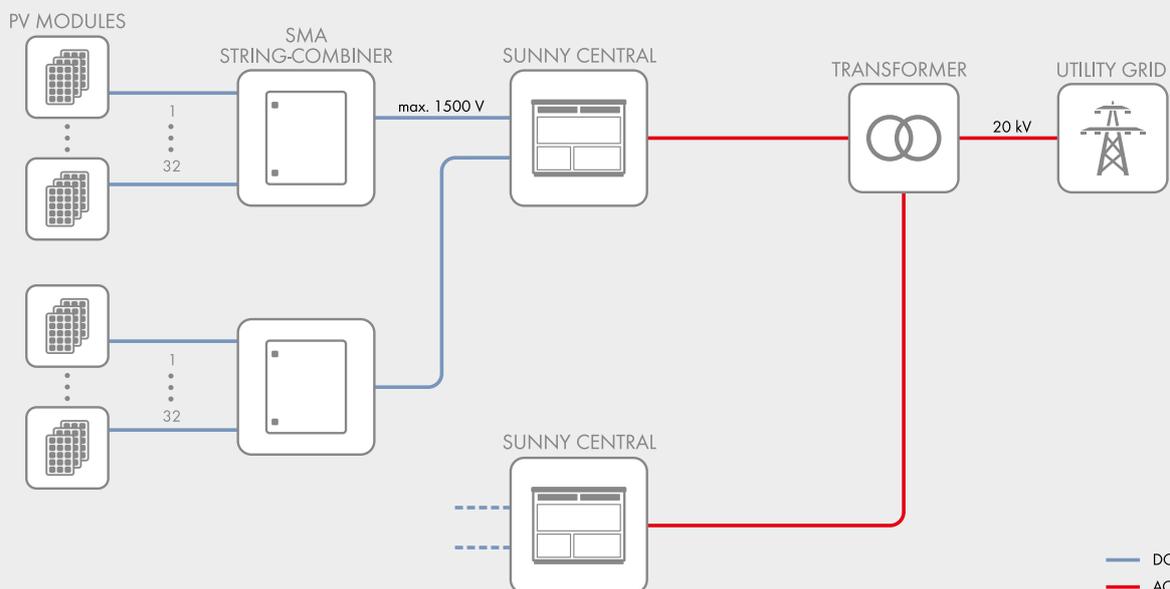
for 1000 V_{DC} systems

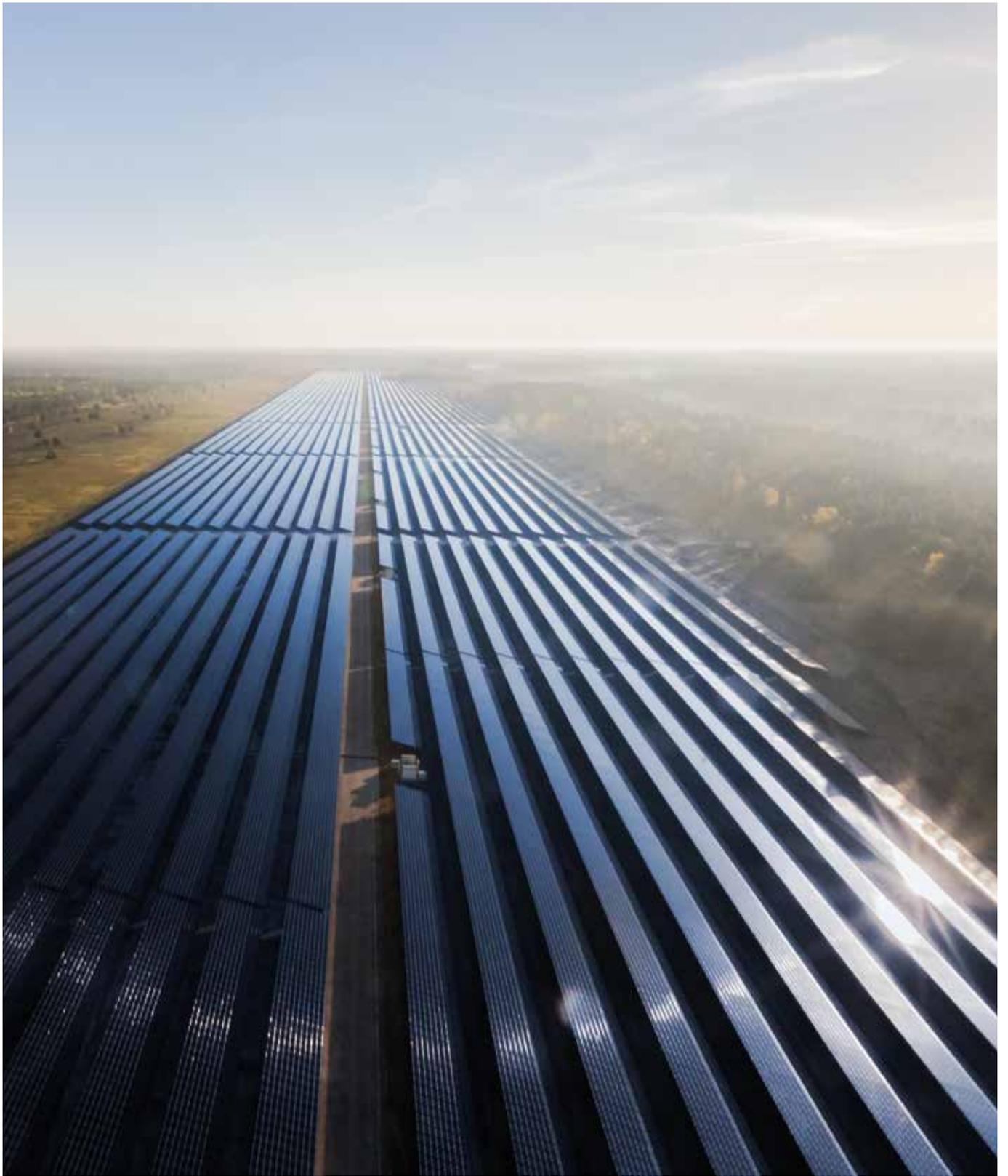
| Technical Data | DC-CMB-U10-16 | DC-CMB-U10-24 | DC-CMB-U10-32 |
|---|--|-------------------------|--|
| Input (DC) | | | |
| Rated voltage | 1000 V | 1000 V | 1000 V |
| Altitude derating (rated voltage) | 2001 m to 3000 m above MSL = reduction by 1.0% per 100 m 3001 m to 4000 m above MSL = reduction by 1.2% per 100 m | | |
| Number of string inputs / fuse holders per pole | 16 | 24 | 32 |
| Rated current | 13.75 A | 12.5 A | 12.5 A |
| Fuse type* | 10.3 x 38 - 1000 VDC - gPV | | |
| String connection | Connection to the fuse holder | | |
| Sealing range of cable gland | 5 mm to 8 mm | | |
| Output (DC) | | | |
| Rated current | 220 A | 300 A | 360 A |
| Temperature derating (rated current) | >50°C operating temperature = reduction by 1% per K | | |
| DC switch (load-break switch) | 250 A / 1000 V | 400 A / 1000 V | 400 A / 1000 V |
| Surge arrester | Type 2, I _n = 15 kA; I _{max} = 40 kA | | |
| DC output | Busbar (ring terminal lug M12) | | |
| Number of DC outputs | 1 | 1 / 2 | 1 / 2 |
| Conductor cross-section | Busbar 70 mm ² to 400 mm ² | | |
| Sealing range of cable glands | 17 mm to 38.5 mm | 17 mm to 38.5 mm | 17 mm to 38.5 mm |
| Enclosure / Ambient Parameters | | | |
| IP degree of protection according to IEC 60529 | IP 54 / self-ventilated | IP 54 / self-ventilated | IP 54 / self-ventilated |
| Enclosure material | Glass-fiber reinforced plastic / UV-resistant | | |
| Dimensions (W / H / D), wall mounting bracket and string cable harness included | 550 / 650 / 260 mm (21.65 / 25.59 / 10.24 inch) | | 590 / 790 / 285 mm (23.23 / 31.10 / 11.22 inch) |
| Max. weight | 24.2 kg (53.5 lb) | 27.4 kg (60.5 lb) | 34 kg (75 lb) |
| Protection class (according to IEC 61140) | II | II | II |
| Mounting type | Wall mounting | | |
| Ambient temperature in operation / during storage | -25°C to +60°C / -40°C to +70°C | | |
| Relative humidity | 0% to 95%, non-condensing | | |
| Max. altitude above MSL | 4000 m | 4000 m | 4000 m |
| Standards | | | |
| Compliance | CE, IEC 61439-1, IEC 61439-2 | | |
| * accessory required | | | |

SMA STRING-COMBINER for 1500 V_{DC} systems

| Technical Data | DC-CMB-U15-16 | DC-CMB-U15-24 | DC-CMB-U15-32 |
|---|--|-------------------------|--|
| Input (DC) | | | |
| Rated voltage | 1500 V | 1500 V | 1500 V |
| Altitude derating (rated voltage) | 2001 m to 3000 m above MSL = reduction by 1.0% per 100 m 3001 m to 4000 m above MSL = reduction by 1.2% per 100 m | | |
| Number of string inputs / fuse holders per pole | 16 | 24 | 32 |
| Rated current | 17.2 A | 13.75 A | 10.31 A |
| Fuse type* | 10.3 x 85 - 1500 VDC - gPV | | |
| String connection | Connection to the fuse holder | | |
| Sealing range of cable gland | 5 mm to 8 mm | | |
| Output (DC) | | | |
| Rated current | 275 A | 330 A | 330 A |
| Temperature derating (rated current) | >50°C operating temperature = reduction by 1% per K | | |
| DC switch (load-break switch) | 400 A / 1500 V | 400 A / 1500 V | 400 A / 1500 V |
| Surge arrester | Type 2, I _n = 15 kA; I _{max} = 40 kA | | |
| DC output | Busbar (ring terminal lug M12) | | |
| Number of DC outputs | 1 | 1 / 2 | 1 / 2 |
| Conductor cross-section | Busbar 70 mm ² to 400 mm ² | | |
| Sealing range of cable glands | 17 mm to 38.5 mm | 17 mm to 38.5 mm | 17 mm to 38.5 mm |
| Enclosure / Ambient Parameters | | | |
| IP degree of protection according to IEC 60529 | IP 54 / self-ventilated | IP 54 / self-ventilated | IP 54 / self-ventilated |
| Enclosure material | Glass-fiber reinforced plastic / UV-resistant | | |
| Dimensions (W / H / D), wall mounting bracket and string cable harness included | 550 / 650 / 260 mm (21.65 / 25.59 / 10.24 inch) | | 590 / 790 / 285 mm (23.23 / 31.10 / 11.22 inch) |
| Max. weight | 25 kg (55 lb) | 28 kg (62 lb) | 40 kg (88 lb) |
| Protection class (according to IEC 61140) | II | II | II |
| Mounting type | Wall mounting | | |
| Ambient temperature in operation / during storage | -25°C to +60°C / -40°C to +70°C | | |
| Relative humidity | 0% to 95%, non-condensing | | |
| Max. altitude above MSL | 4000 m | 4000 m | 4000 m |
| Standards | | | |
| Compliance | CE, IEC 61439-1, IEC 61439-2 | | |
| * accessory required | | | |

SYSTEM EXAMPLE



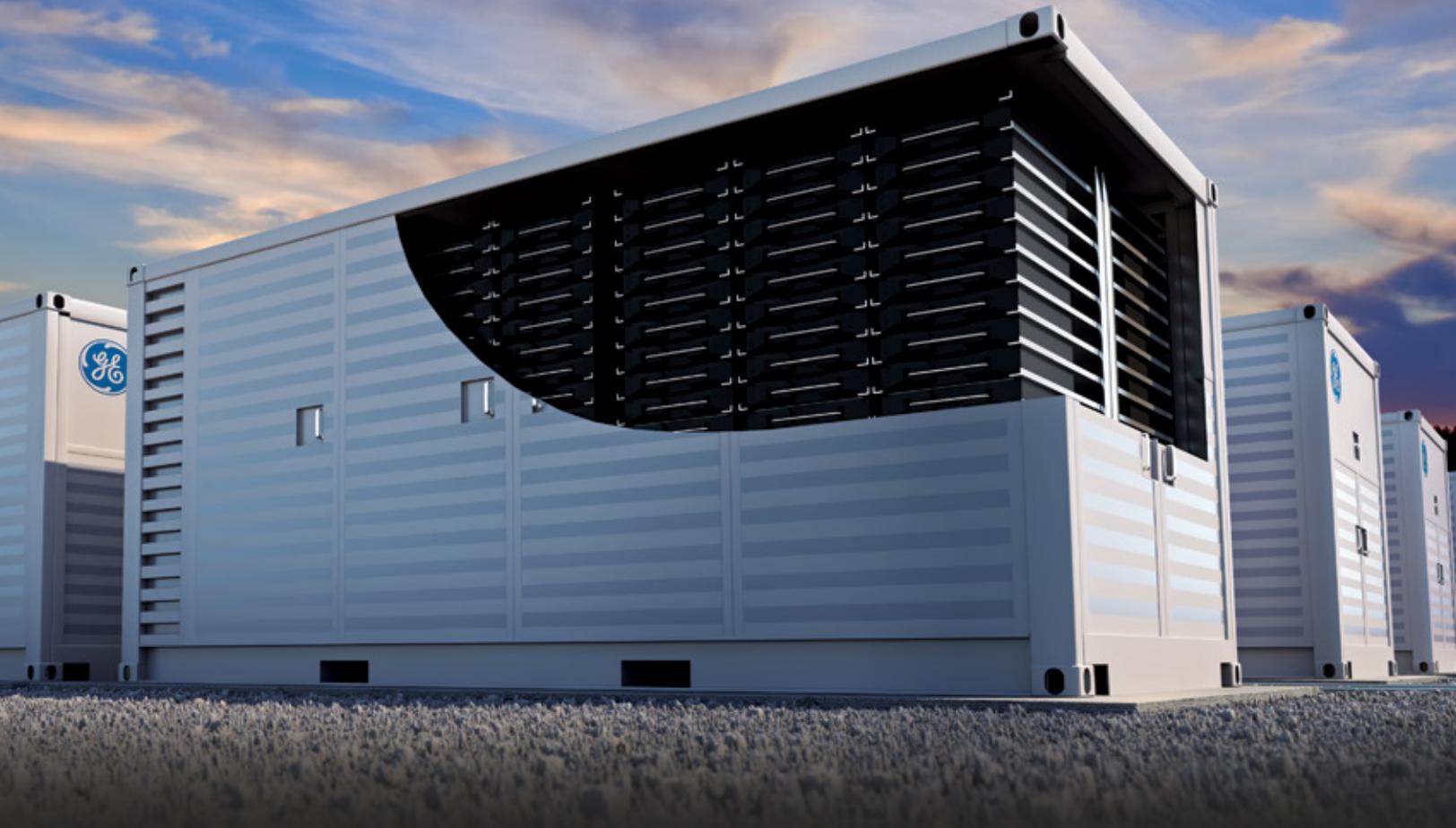


GE Power



RESERVOIR SOLUTIONS

Flexible, modular
Energy Storage Solutions
unlocking value across the
electricity network



TODAY'S ENVIRONMENT

The electricity industry is facing new challenges that have not been seen for the past 100 years. As consumers become active power producers who demand clean, reliable, and affordable power, the transforming grid needs innovative technical solutions that can unlock new business models and revenue streams.

**78% OF THE 9000GW+ OF NEW
GENERATION FORECAST TO BE BUILT BY 2040
WILL BE RENEWABLE**

**TOTAL ENERGY STORAGE SOFTWARE
REVENUE TO HIT \$3.3 BILLION BY 2025**

This change to energy generation and consumption is being driven by three powerful trends: the arrival of increasingly affordable distributed power technologies, decarbonization of the world's electricity network through the introduction of more renewable energy sources, and the emergence of digital technologies.



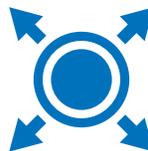
Decarbonization

The rapid deployment of low-carbon technologies such as wind and solar is making it increasingly difficult to forecast variable generation, creating challenges around grid stability, congestion and market volatility.



Digitization

A rise in the number of connected devices and smart sensors enables fast decision-making on dynamic and nodal prices, while intelligent control systems and internet-enabled software optimize power plants and the grid.



Decentralization

The growing penetration of distributed energy resources, including renewables and storage, is creating more “prosumers” (end users who are active in the power system), greatly increasing distribution grid complexity.

INTEGRATING INTERMITTENT RENEWABLES INTO AN AGING GRID REQUIRES **FLEXIBLE AND RESILIENT TECHNOLOGIES, ABLE TO RAMP QUICKLY AND DYNAMICALLY ADJUST TO REAL-TIME GRID SIGNALS**

ANNUAL INSTALLED CAPACITY OF DISTRIBUTED ENERGY RESOURCES IS EXPECTED TO REACH **530 GW** BY **2026**

WHY ENERGY STORAGE?

A battery energy storage solution offers new application flexibility and unlocks new business value across the energy value chain, from conventional power generation, transmission & distribution, and renewable power, to industrial and commercial sectors. Energy storage supports diverse applications including firming renewable production, stabilizing the electrical grid, controlling energy flow, optimizing asset operation and creating new revenue by delivering:



Active Power Services

- Frequency regulation
- Frequency response
- Peak shaving/firming
- Remote power commands
- Ramp rate control
- Curtailment avoidance
- Scheduled dispatch/shifting
- Scheduled power commands
- State of charge management
- Islanding
- Black start



Reactive Power Services

- Voltage control
- Voltage droop
- Power factor control
- VAR control

\$103B INVESTMENT IN ENERGY STORAGE PROJECTS BY 2030



Outcomes achieved with GE'S RESERVOIR SOLUTION

- **ENABLE UP TO 50% MORE SOLAR ENERGY SALES** WITH ENHANCED PV TO INVERTER LOADING RATIO
- **UP TO 50% REDUCED CONSTRUCTION TIME** WITH FACTORY BUILT & TESTED SOLUTION



Courtesy:
Convergent
Energy + Power

UNLOCKING NEW BUSINESS VALUE WITH GE'S RESERVOIR ENERGY STORAGE SOLUTION



Improve Financial Performance

Monetize assets through new revenue streams, increased asset utilization, improved yield, and reduced operating costs.



Increase Renewables Integration

Improve integration and maximize utilization of the energy generated from photovoltaics (PV) and wind turbines.



Optimize Electrical Grid

Defer upgrades, relieve congestion, control voltage, provide reserves and ancillary services, and improve reliability with backup power and black start functionality.



Reduce Energy Costs

Commercial and industrial end users can mitigate demand charges, optimize differential (Time of Day) energy prices, and benefit from additional onsite PV generation.



Develop Microgrids

Create a new and more flexible grid by locally integrating renewable generation and smart devices with energy storage and real-time communication.

- **UP TO 15% EXTENDED BATTERY LIFE** UTILIZING PROPRIETARY BLADE PROTECTION UNITS
- **IMPROVE SAFETY** BY REDUCING FAULT CURRENT BY **UP TO 5X**

GE'S RESERVOIR IS A FLEXIBLE ASSET THAT HELPS ENABLE GRID OPTIMIZATION

GE APPROACH

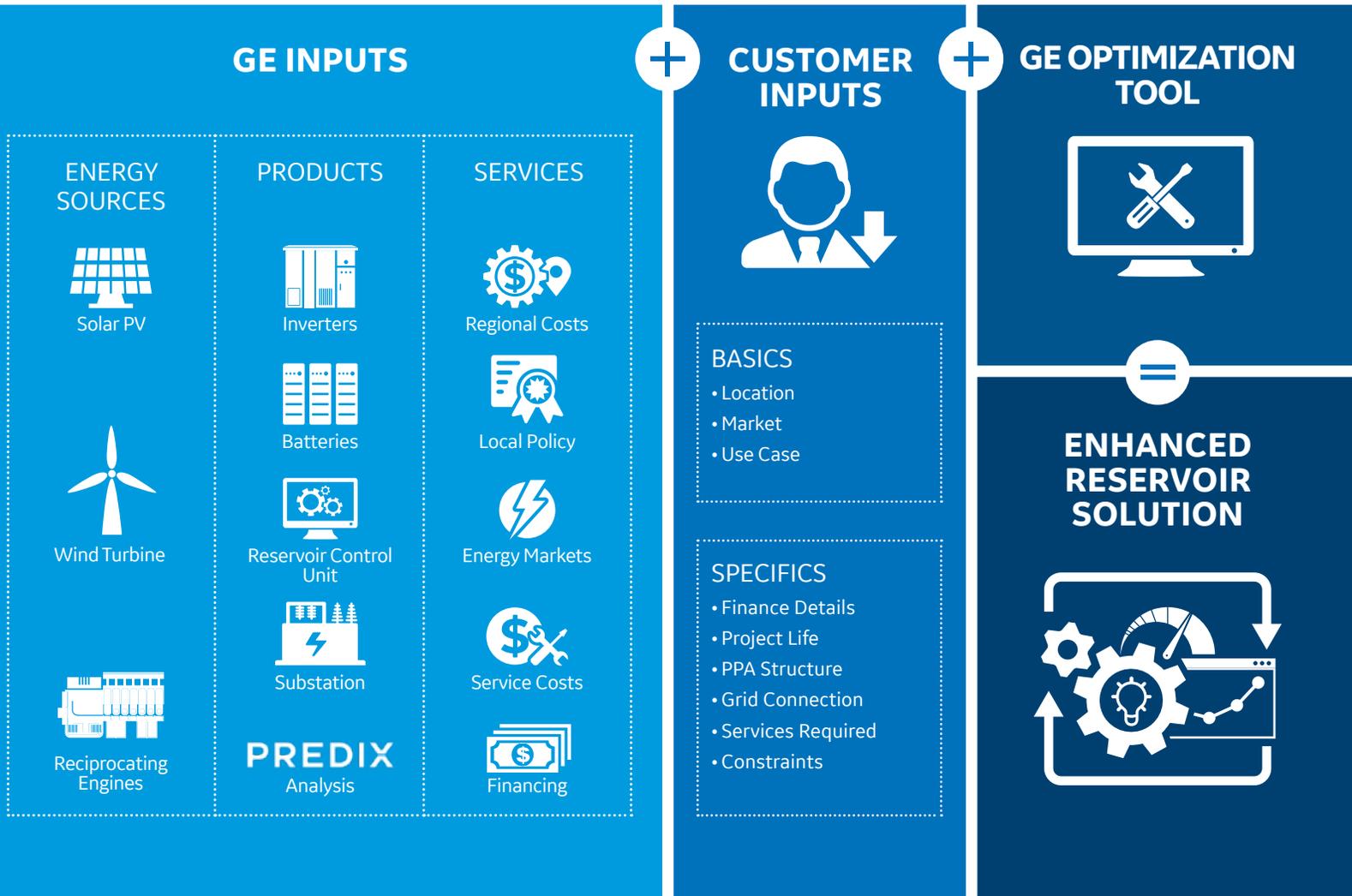
GE's broad portfolio of Reservoir Solutions can be tailored to your operational needs, enabling efficient, cost-effective storage distribution and utilization of energy where and when it's needed most. Our expert systems and applications teams utilize specialized techno-economic tools to help optimize the lifetime economics of a project. Our approach results in an investment grade business case that provides the basis of project planning and financing.

GE's System Approach



System Design Process & Optimization

Once the project scope, business objectives and services are established, GE's technical experts will define the energy sources, equipment and services required. Using advanced system planning and optimization tools, GE will deliver a tailored solution to meet the desired objectives.





GE SOLUTION

GE's Reservoir is a flexible, compact energy storage solution for AC or DC coupled systems. The Reservoir solution combines GE's advanced technologies and expertise in plant controls, power electronics, battery management systems and electrical balance of plant – all backed by GE's performance guarantees.

POWER CONVERSION

- Inverters are a bidirectional system converting AC to DC for battery charge and DC to AC for discharge
- 4 quadrant operation
- High efficiency

BATTERY MANAGEMENT

- Battery Protection Unit
- Long life Li-ion battery
- Integrated lockable disconnect
- Active string balancing
- Factory tested
- Field replacement

PURPOSE BUILT ENCLOSURES

- Ships with batteries installed
- Enhanced cooling and insulation
- Built in redundancy for 25 years of life
- Fast and flexible installation

RESERVOIR CONTROL UNIT

- Advanced functionalities to monitor batteries and help optimize asset operations
- Based on GE Mark™ Vle



FLEXIBLE SYSTEM DELIVERY

The solution can be delivered as Engineered Equipment Package (EEP), Engineering, Procurement, and Construction (EPC) turnkey solution or lease and financing arrangement.

MV TRANSFORMER

- Connects to any MV network up to 66kV through a step-up transformer
- Dry or oil-type transformer designed for both outdoor or e-house indoor environment

MV SWITCHGEAR

- MV switchgear and LV auxiliaries integrated into an ISO container for easy site installation

CONSULTING & SERVICES

- Technical and economic feasibility studies
- Network analysis
- Project management & design
- Real-time optimization services
- Long term service contracts
- Performance guarantees

SOFTWARE SUITE

- Asset performance management
- Fleet management
- Dispatch optimization

World's First Hybrid Electric Gas Turbine,
10 MW/4.3 MWh Energy Storage Solution

RESERVOIR STORAGE UNITS

The Reservoir Storage unit is a **modular** high density solution that is factory built and tested to reduce project risk, shorten timelines and cut installation costs. The Reservoir Storage unit is built with GE's Battery Blade design to achieve an industry leading energy density and minimized footprint. GE's proprietary Blade Protection Unit actively balances the safety, life and performance of each Battery Blade, extending battery life by up to 15% and reduce fault currents by up to 5X. The modular system has multiple installation and cabling options including pad or pier and is configured to minimize operation and maintenance (O&M) expenses over the life of the project with all weather capabilities and high efficiency cooling system.

ELECTRICAL INTEGRATION

- DC disconnect, service rated
- Auxiliary power equipment
- Optional combiner package for DC coupled PV
- Bottom and front entry cable option

ENCLOSURE

- High density configuration with reduced footprint
- All weather capabilities
- High efficiency cooling
- Long service life

BATTERY BLADE UNIT

- Integrated protection unit
- Serviceable with integrated lockable disconnect device
- Digital twin technology for lifecycle management
- 1500V class with less cable, fuses and switches
- Tier 1 Li-Ion cells for highest cycle life

BLADE PROTECTION UNIT (BPU)

- Active string regulation to extend life by up to 15%
- Reduce fault currents by up to 5X to improve safety
- Intelligent DC bus enables direct PV integration
- Enables safe replacement of individual battery modules
- Reduces NFPA PPE levels from HRC4 to HRC2

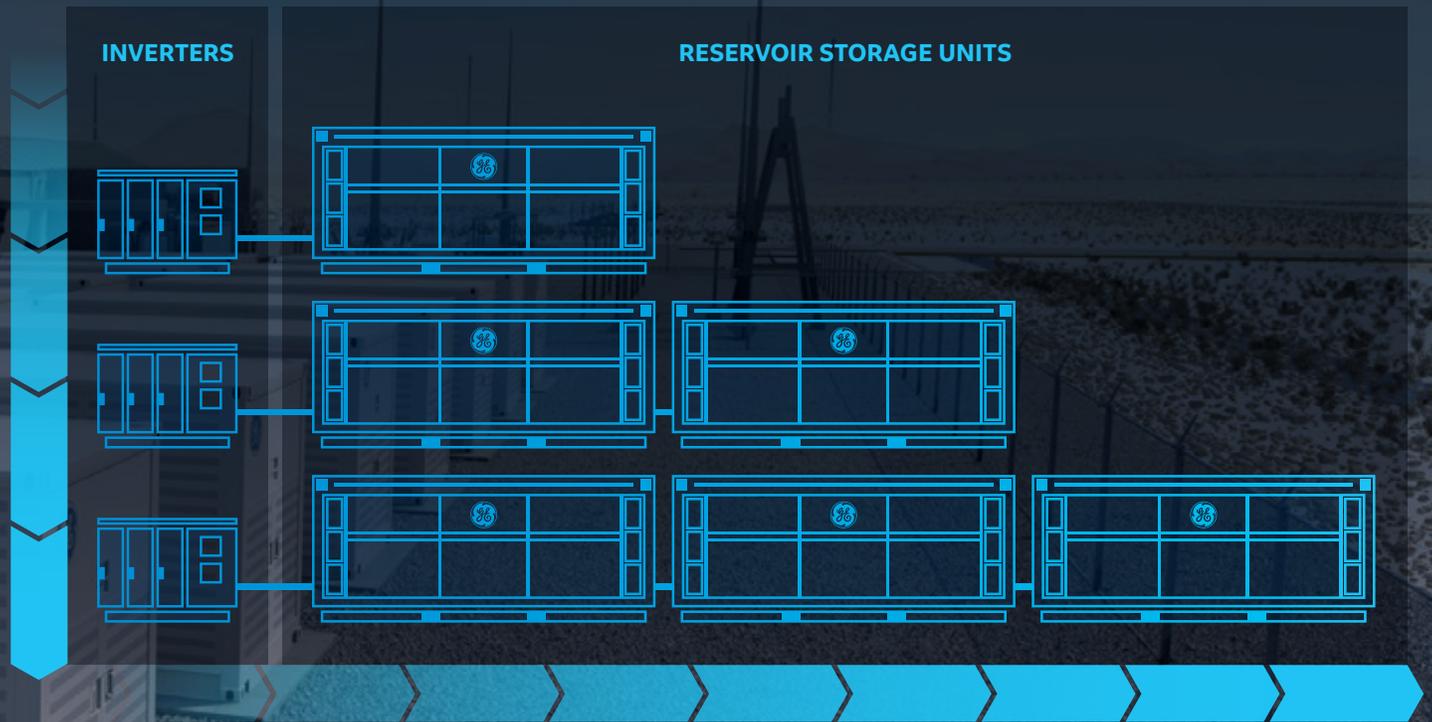
Large Energy Reservoir, 20' Package, 1.2 MW / 4 MWh*

* Final Specifications subject to change

SYSTEM CONFIGURATIONS

The Reservoir Solution can be designed in a power or energy configuration depending on the required application. In an energy configuration, the batteries are used to inject a steady amount of power into the grid for an extended period of time. In a power configuration, the batteries are used to inject a large amount of power into the grid over a short period of time. The configuration of power or energy is determined by the ratio of inverters to batteries.

Modular and Scalable Solution



MORE POWER

Additional inverters are added to achieve desired power level.

MORE ENERGY

Additional reservoir storage units are added to achieve desired energy output.

GE'S DC COUPLED RESERVOIR SOLUTION ENABLES ENHANCED PV TO INVERTER LOADING RATIO RESULTING IN UP TO **50%** INCREASE IN ANNUAL SOLAR ENERGY SALES PER SITE

TYPICAL RESERVOIR APPLICATIONS

Standalone Applications

Generation Transmission Distribution



POWER



ENERGY

| | Generation | Transmission | Distribution |
|--|------------|--------------|--------------|
| Voltage Regulation Compensate anomalies or disturbances (e.g., voltage magnitude, harmonics, etc.) by sending reactive energy into system. | | | ✓ |
| Frequency Response Provide fast regulation of grid frequency to balance supply and demand. | | ✓ | |
| Frequency Regulation Provide regulation of grid frequency to balance supply and demand based on signals sent by the grid operator. | ✓ | | |
| Renewable Integration Balance the local excesses or deficits of renewable generation caused by rapid weather fluctuations. | | | ✓ |
| Black Start Energize part of the generation asset without outside assistance after a blackout. | ✓ | ✓ | |
| Back-Up Store energy to maintain service continuity and grid resilience in the event of an outage. | | | ✓ |
| Peak Management Reduce grid capacity needs during peak periods with local storage. | | ✓ | ✓ |
| Shifting Buy or produce electricity at low price (off-peak) to store and sell at peak price. | ✓ | | |
| Capacity Store renewable energy production for peak and base load consumption. | ✓ | ✓ | |



Integrated Hybrid Solution Applications

Solar



Wind



Thermal



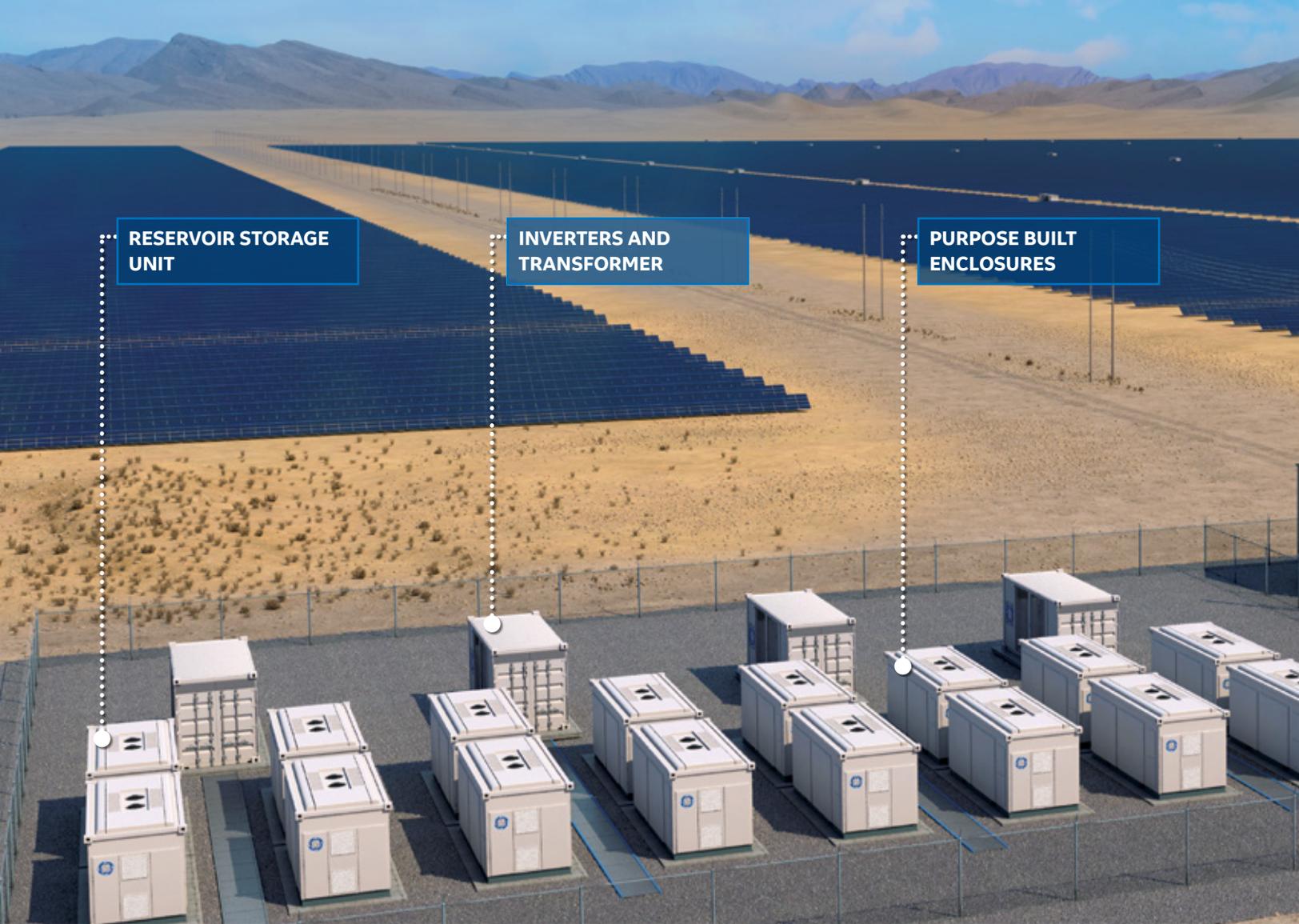
POWER



ENERGY

| | Solar | Wind | Thermal |
|---|-------|------|---------|
| Synthetic Inertia Compensate losses of grid inertia caused by high renewable penetration. | | | ✓ |
| Frequency Regulation Provide fast regulation of grid frequency to balance supply and demand. | ✓ | ✓ | ✓ |
| Firming Prevent undesirable short-duration effects from rapid fluctuations in solar generation due to intermittency and weather conditions. | ✓ | ✓ | |
| Improved Operations Help optimize generation fleet operations and costs. | | | ✓ |
| Contingency Reserve Provide fast ramp-rate to meet grid requirement for online dispatch within a short delay of operating reserve. | | | ✓ |
| Curtailement Avoidance Avoid output curtailment at certain times, preventing loss of energy production. | ✓ | ✓ | |
| Dispatchable Control solar generation at request of power grid operators or according to market needs. | ✓ | ✓ | |





RESERVOIR STORAGE UNIT

INVERTERS AND TRANSFORMER

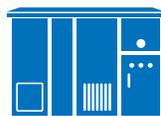
PURPOSE BUILT ENCLOSURES

KEY COMPONENTS



Reservoir Control Unit (RCU)
 GE's integrated Reservoir Control Unit is a supervisory control and data acquisition system for energy storage plants.

At the heart of the system is GE's field proven Mark™ V1e control system used to monitor and control gas turbines, wind and solar energy fleets.

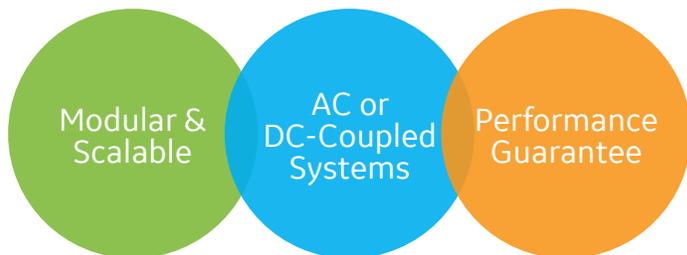


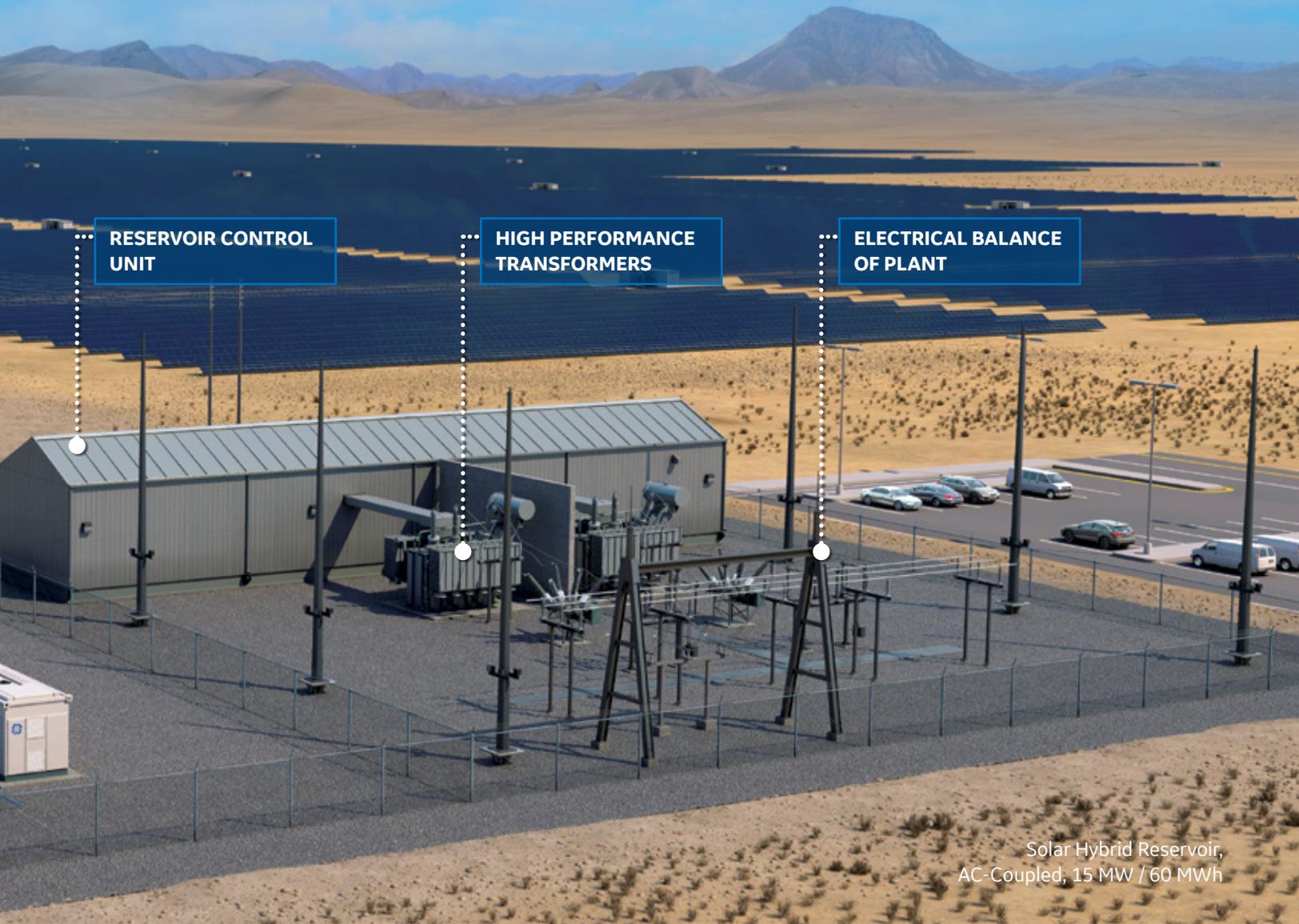
Inverters
 GE's inverters are designed specifically for dynamic operation and high performance lithium ion batteries.

Built with enhanced technology including integral ground fault detector/interrupter low voltage, zero voltage and high voltage ride through capability (LVRT, ZVRT, HVRT).



Reservoir Storage Unit
 GE utilizes proven Li-Ion technology for battery storage solutions; each solution is tailored based on the customer's application. GE's battery solution exceeds industry standards for protecting against common industrial battery failure and reduces environmental impact with restricted use of substances controlled by US EPA, Global REACH and RoHS regulations.





Solar Hybrid Reservoir,
AC-Coupled, 15 MW / 60 MWh



High Performance Transformers

GE provides comprehensive portfolio of HV and MV transformers. Each transformer is made for performance, efficiency and immunity to withstand electronic noise.



Electrical Balance of Plant

GE offers a comprehensive portfolio of high voltage and medium voltage substation equipment and technical expertise to ensure efficient and reliable interconnection of power generation.



Purpose Built Enclosures

GE's enclosures are prefabricated with redundant HVAC and optional fire suppression systems, and provide the following benefits:

- Low maintenance, configured with enhanced cooling and insulation with built-in redundancy for 25 years of life.
- Easy transportation, minimal installation effort on site and better battery insulation

FROM ADVANCED TECHNOLOGIES
AND PLANT CONTROLS TO BATTERY
MANAGEMENT SYSTEMS, **GE**
DELIVERS COMPREHENSIVE
STORAGE SOLUTIONS

RESERVOIR SOFTWARE SUITE

The reservoir software suite includes edge to cloud infrastructure that's scalable, adaptable and easy to use. The software suite includes:



FLEET MANAGEMENT

Fleet aggregation software designed for asset monitoring, alerts, trends and forecasting.



COMPONENT LIFE ANALYTICS

Manages battery life based on history and expected future use profiles to minimize downtime and unplanned outages.



DISPATCH OPTIMIZATION

Charges and discharges batteries based on equipment status and market conditions to maximize customer outcomes.





Reservoir Services

GE's service agreements are customized based on the customers' requirements and can lower operating costs and mitigate operational and financial risks. GE's services include:

Planned Maintenance

Routinely service equipment and keep the energy storage system online, resulting in superior fleet performance.

Unplanned Maintenance

Monitor, troubleshoot and inspect equipment, boosting uptime and lifecycle production.

Parts Plans

Provide full range of offerings to support preferred levels of service. Our forecasting capability, driven by fleet-wide parts consumption data configuration and management knowledge, can even help to predict what you may need.

Remote Operations Center

Provides continuous monitoring and diagnostics services 24 hours a day, 365 days a year. An on-site SCADA system enables continuous tracking of key operating parameters and detects abnormal conditions. GE technicians can then troubleshoot or reset the equipment remotely, in real-time.

Performance Guarantee

The specific performance criteria and duration of the performance guarantee will vary depending on your application, economic incentives, and requirements. Performance guarantees are only available to customers who maintain a contractual services agreement with GE and include:



Availability Guarantee

This guarantees that the battery energy storage solution will be available to charge or discharge electric energy at the nameplate power output and at the agreed-upon percentage of time.

Capacity Guarantee

The amount of energy that the battery is able to extract from and discharge to the grid can be guaranteed.

Custom Metric Guarantee

Some owners have unique measurements or metrics, such as the PJM fast response frequency regulation score. In such cases, GE works with you to assess the risks involved and define a guarantee structure that aligns the interests of both parties throughout the life of the asset.

SERVING GLOBAL CUSTOMERS WITH LOCAL EXPERTISE

GE is globally recognized for designing and delivering customized energy storage solutions for diverse applications. With regionally located technical experts, our teams work directly with customers during the lifetime of the project. To date GE has more than **207 MWh of energy storage** in operation or in construction globally.



126 MWh
in North America

Services

52+ SERVICE AND REPAIR CENTERS

17 TECHNICAL INSTITUTES

INDUSTRY EXCELLENCE



10 years
of storage experience

20 year
performance guarantee

PIONEERING



1st Hybrid EGT
storage + gas turbine peaker
in operation

Black Start
first proven emergency start
of CCGT

LOCAL EXPERTISE



40+ Countries
providing comprehensive
consulting & services

53 MWh
in Europe

7 MWh
in Africa

21 MWh
in Asia

CUSTOMER APPLICATIONS



CUSTOMER ENERGY STORAGE DEVELOPER

CHALLENGE

Local grid support

GE SOLUTION

41MW / 41MWh BESS

APPLICATION

Standalone - Generation

Capacity; demand charge management

LOCATION

United Kingdom

STATUS

Under construction

This project will relieve pressure on the host country's energy system and provide flexibility when it is most needed to deliver a more balanced, secure energy system and help reduce consumer energy cost. The focus is on building long term commercially sustainable battery storage systems that are not reliant on subsidies and incentives.



CUSTOMER INVESTOR-OWNED ENERGY COMPANY

CHALLENGE

Meeting resource adequacy requirement

GE SOLUTION

2MW / 8MWH BESS

APPLICATION

Hybrid - Solar

Solar integration

LOCATION

Southern California (US)

STATUS

In operation

"We have a history of working with GE in thermal and wind, and we are pleased to continue our long-standing collaboration into the evolving world of energy storage. GE brings a strong technical solution, along with performance guarantees."





CUSTOMER PUBLIC POWER UTILITY

CHALLENGE

Addressing local grid reliability concerns

APPLICATION

Hybrid - Thermal (EGT)
Spinning reserve

LOCATION

Southern California (US)

STATUS

In operation

GE SOLUTION

10MW / 4.3MWh BESS,
integrated controls

This project consists of two 10 MW of battery energy storage systems, each paired with GE's proven 50 MW LM6000 aeroderivative gas turbines, capable of providing instantaneous response during a spinning reserve event.



CUSTOMER DISTRIBUTION NETWORK OPERATOR

CHALLENGE

Local grid reliability

APPLICATION

Standalone - Distribution
Load shifting, frequency &
voltage regulation

LOCATION

Nice, France

STATUS

In operation

GE SOLUTION

1MW / 560 kWh BESS, EMS

Smart-solar energy demonstration project. First application of large storage integrated at microgrid level, combined with a solar PV farm.

CUSTOMER APPLICATIONS



CUSTOMER ENERGY STORAGE ASSET DEVELOPER

CHALLENGE

Balance long duration voltage and frequency irregularities

GE SOLUTION

7MW / 7MWh BESS

APPLICATION

Standalone - Transmission

Voltage control, reactive power support, frequency regulation, ramp rate control, peak shaving, load shifting

LOCATION

Ontario, Canada

STATUS

In operation

“GE worked with us to create a fully integrated energy storage solution that helps meet the growing needs of the local transmission system. The project utilizes reliable GE equipment and products ranging from enclosures through the point of utility interconnection — a strategy that is cost-efficient, simplifies system warranties and guarantees, and provides a financeable solution to our customers.”



CUSTOMER LARGE INDUSTRIAL COMPANY

CHALLENGE

Grid support; pilot program

GE SOLUTION

2MW / 2MWh BESS

APPLICATION

Standalone - Transmission

Frequency regulation

LOCATION

Belgium

STATUS

Under construction

This project will repurpose their facility in order to develop a large scale storage park. The goal of the storage park is to further develop know-how on large scale storage. In the first stage, 6 MW of li-ion battery energy storage systems will be installed to deliver primary frequency regulation for the Transmission System Operator as a first application.





CUSTOMER PUBLIC POWER UTILITY

CHALLENGE

Providing grid stability & smoothing renewable output

GE SOLUTION

33MW / 20MWh BESS

APPLICATION

Standalone - Transmission

Emergency power / black start capability, distribution management system integration, ramp rate control, frequency response, spinning reserve

LOCATION

Southern California (US)

STATUS

In operation

Located in California, which has some of the most aggressive renewable portfolio requirements in the US, this 33MW / 20MWh battery system complements the integration of renewable resources, such as solar and wind, by adding stability and improving power quality.



CUSTOMER UTILITY

CHALLENGE

Local grid reliability

GE SOLUTION

1MW / 560 kWh BESS

APPLICATION

Standalone - Transmission

Frequency regulation

LOCATION

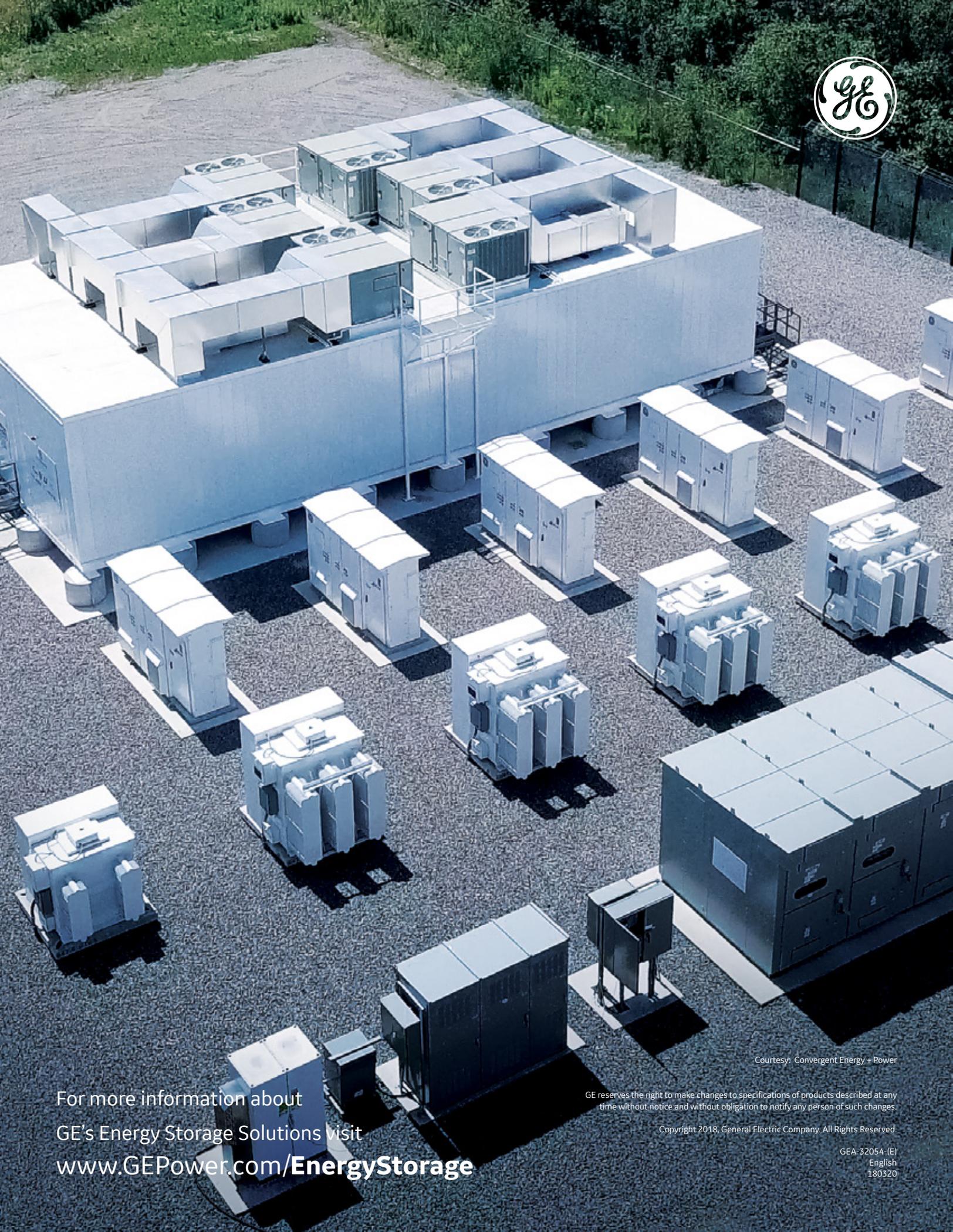
France

STATUS

In operation

The project is part of a larger initiative to test battery storage in real conditions for the purpose of frequency regulation, stabilizing the grid and preventing blackouts.





Courtesy: Convergent Energy + Power

For more information about
GE's Energy Storage Solutions visit
www.GEPower.com/EnergyStorage

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GEA-32054-(E)
English
180320



Reservoir Storage Unit

Modular, Scalable Solutions For Utility Scale Applications

RSU-4000 Series

| Overview | RSU-4000/20 | RSU-4000/16 | RSU-4000/12 |
|---|-------------|---|-------------|
| | RSU-4000/20 | RSU-4000/16 | RSU-4000/12 |
| Overview | | | |
| Nameplate Energy Capacity (KWh.dc, usable) | 4184 | 3347.2 | 2510.4 |
| Individual Battery Blades - Factory Installed | 20 of 20 | 16 of 20 | 12 of 20 |
| Maximum Power - Factory Installed (KW.dc) | 1200 | 960 | 720 |
| Maximum DC Current - Factory Installed (A) | 1600 | 1280 | 960 |
| Available Augmentation Capacity (% BOL) | 0% | 25% | 67% |
| Available Augmentation Capacity (kWh.dc) | N/A | 836.8 | 1673.6 |
| Key Features | | | |
| Battery Management System | | GE Blade Protection Unit (BPU) | |
| Compatible Inverters | | GE RIU-2750MV | |
| Remote Management | | Reservoir Suite | |
| Solar DC Coupling | | Yes (DC:AC Ratio <2.8) | |
| Integrated PV Combiner | | Yes | |
| Integrated Lockable Disconnect | | Module & Rack Level | |
| Augmentation Options for Lifecycle Management | | Yes | |
| DC Bus Control | | DC-IQ Intelligent Bus | |
| Battery LifeCycle Management | | Digital Twin Life Optimization - Optional | |
| Unit Validation | | Factory Built & Tested | |
| Design life (years) | | 25 | |
| Battery Information | | | |
| Battery Chemistry | | Lithium-Ion, NCM | |
| Battery Module Design | | Energy | |
| Continuous C-Rate | | <C/3 | |
| Pulse C-Rate | | <C/3 | |
| Voltage Class | | 1500V | |
| Nominal DC Voltage (V) | | 1300 | |
| Minimum DC Voltage (V) | | 770 | |
| Mechanical Information | | | |
| Package Format | | 20' ISO w/Exterior Acces | |
| Dimensions (mm) (L X W X H) | | 6058 x 2438 x 2890 mm | |
| Weight (kg) | 37k | 31k | 25k |
| Fully Integrated HVAC | | Dual Self-Contained 3 Ton Units (High Efficiency 10. EER) | |
| - Hot Climate Upgrade | | +33% Cooling Capacity | |
| - Cold Climate Upgrade | | + Electric Heating Package | |
| Fire Suppression - Aerosol | | Optional | |
| Installation | | Pad/Pier | |
| Cable Entry | | Bottom | |
| Weatherization | | NEMA 3R, IP54 | |
| Design Conditions | | | |
| Min Operating Temperature (C) | | -40°C | |
| Max operating Temperature (C) | | 50°C (55°C w/ hot climate upgrade) | |
| Maximum Altitude (m) | | 2000 | |
| Maximum Relative Humidity (%) | | 95%, non-condensing | |
| Seismic Zone | | UBC Zone-4 | |
| Audible Noise | | <60 dB at 3M | |
| Certifications & Compliance | | | |
| Certifications | | UN38.3, UL 1973, UL 508C, CE | |
| Compliance | | UL1642, UNDOT 38.3, IEC 62477-1, NFPA 70E, IEC 50110, ASTM4169, IEEE 605, IEEE C37.32 | |

GE reserves the right to make changes to specifications of products described at any time without notice and without obligation to notify any person of such changes.



Technical specifications

Tracker version: ST

Summary

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1. Overview

With iTracker™, the intelligent solar tracker, Soltigua bring to the PV market their many years of sun tracking experience in the highly demanding concentrating solar thermal industry.

iTracker™ has many innovative features:

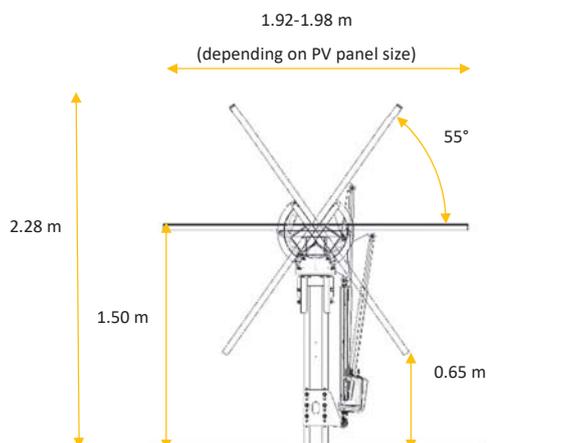
- **Single-row tracking:** no mechanical components in the corridors between tables;
- **Long tracker structure:** up to 100 pv panels per tracker (e.g. 5 strings of 20 modules, 5 strings of 18 modules, etc.) to optimize drive costs;
- **User friendly size:** 1-module-portrait/2-module-landscape configuration to simplify installation and O&M vs. larger tables such as 2-module in portrait;
- **Maintenance free components:** minimized O&M costs;
- **Balanced design:** improved mechanical accuracy and reduced stress on the drive.

2. Tracking features

iTracker is a horizontal single axis, single row tracker.

It can accommodate 1 PV module in portrait or 2 modules in landscape configuration.

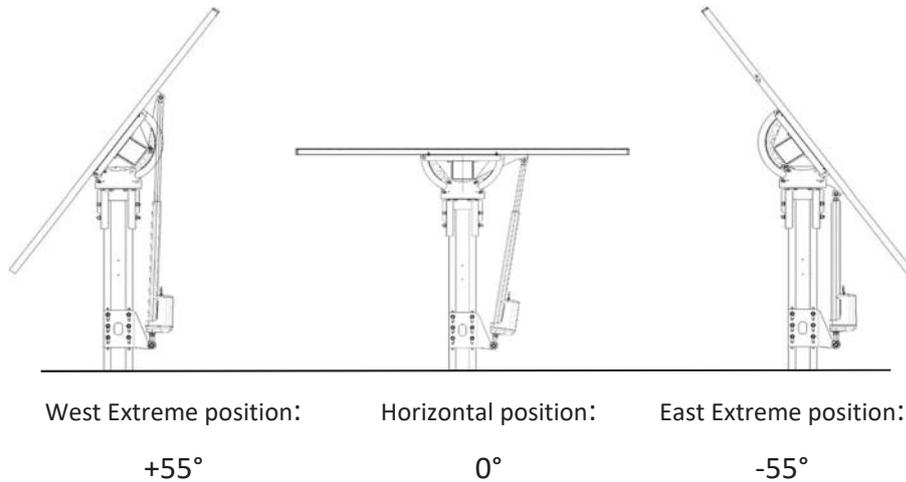
The following drawing shows iTracker's dimensions.



iTracker's main dimensions

In single row tracking each tracker moves independently from the others, guided by its own drive system.

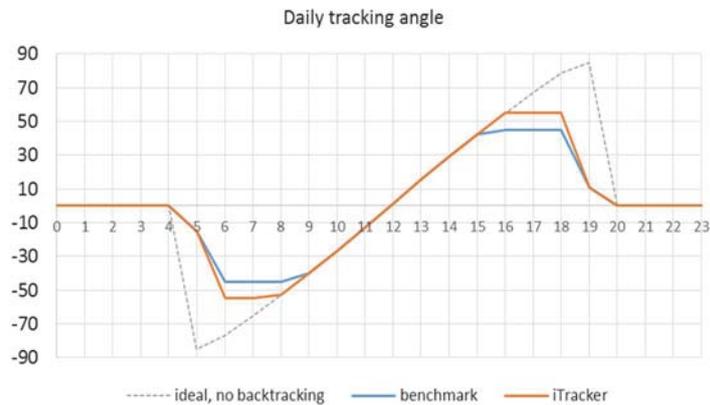
The following drawings show the extreme positions and the position assumed at solar noon.



iTracker rotation range

iTracker's **extended rotation range** is 110° (-55° ; $+55^\circ$) and it allows for higher energy yields than industry benchmark of (-45° ; $+45^\circ$).

As shown in the following graph, the broader rotation allows iTracker to follow the ideal tracking pattern for a longer period of time.



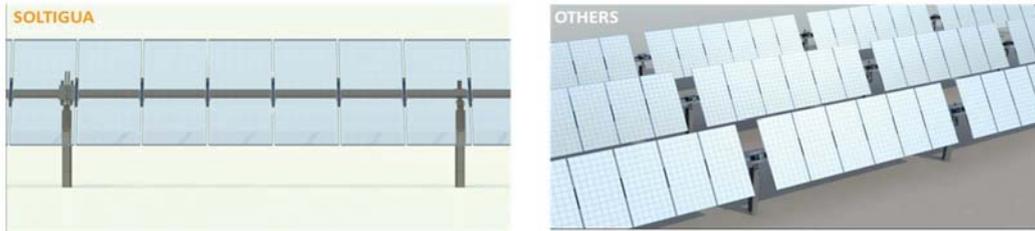
iTracker tracking angle compared to a benchmark solution

When Ground Cover Ratio is lower than 0.5, iTracker's broader rotation translates into an increase in annual yield which can be up to 1%.

Thanks to the **"continuous beam" concept** and a virtual rotation axis, iTrackerTM maximizes the power density on the available ground area, increasing the installable peak capacity by up to 14% compared to other trackers. The continuous beam concept generates the following benefits:

- Land savings;
- Capex reduction;
- Higher peak power in limited size plots;

- No shadows from the structure.



Soltigua's continuous beam (left), compared to a benchmark solution which interrupts the structure every 6 modules

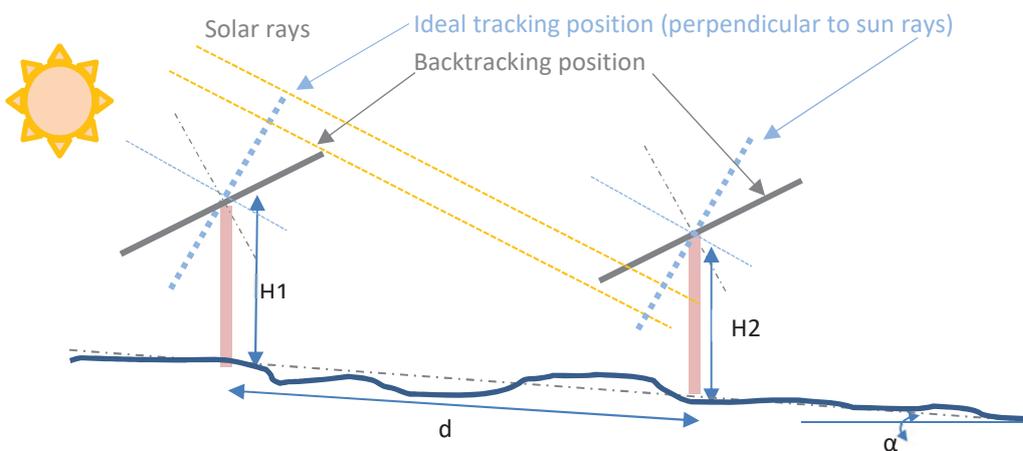
Soltigua's **bearing solution**, with a center-of-mass virtual rotation axis, has the following advantages:

- The structure is balanced, avoiding large tracking errors at the ends of long trackers and also reduces internal mechanical stress in the structure;
- The connection with the piles is stiff, greatly reducing trampoline associated vibrations;
- Torsional vibrations are reduced, avoiding need for dampers and reducing risk of galloping.

2.1 Backtracking

iTracker™ control software includes a **backtracking algorithm** to prevent mutual shadows between adjacent rows. When sun elevation is low, the PV panels rotate off their ideal tracking position to avoid the mutual shadowing, which would reduce the electrical output of the strings. The less-than-ideal inclination reduces the solar radiation available to the PV panels, but increases the overall array output, as PV cells and strings are more evenly exposed to sun irradiance over the entire PV array.

Thanks to individual tracking, Soltigua's backtracking algorithm can optimize the tracking angles of each single tracker, which is particularly helpful in case of uneven or undulated terrains where adjacent trackers are not at the same height.



Individual backtracking concept

Based on the interaxis between trackers, sun inclination and ground slope (typically along East-West), the algorithm evaluates if the adjacent tracker generates shadows (the one on the East side in the morning; the tracker on the West in the afternoon). If this is the case, the tracking angle is reduced by the minimum amount that avoids such shadows.

3. Structural characteristics

iTracker™ **support structure** is made of construction steel, and designed according to **Eurocodes standards**. Most tracker metallic components (torque tube, piles, ...) are hot dip galvanized according to ISO 1461 (batch bath) or ISO 3575 (continuous bath) standards. Module rails can be either hot dip galvanized according to ISO 1461, or made in Magnelis, a Zinc-Aluminum-Magnesium coating, applied as well via hot dip bath, which has an even superior resistance in harsh outdoor environments.

Standard module rails are 440 mm long. Different lengths can be priced as an option.

As a standard, all iTracker™ structures are guaranteed 30 years in ISO 14713-1 atmospheric corrosion category up to C2. Different guarantee durations can be agreed as an option.

Mechanical components have been designed with FEM simulations and 3D CAD software, and extensively tested for more than 50 years equivalent service life.

Thermal expansion of the structure is included in the design.

Different tracker lengths are available, accounting for a different number of strings.

3.1 Wind resistance and safety position

iTracker™ design is also the result of **wind tunnel test studies**.

The trackers start the safety procedure when the gust wind speed is higher than 50 km/h, and resist up to 55 km/h during operations.

Based on wind tunnel studies, the safety position assumed in case of excessive wind is not horizontal, but at 35°, so that **wind galloping is avoided**, which otherwise could damage both the PV modules and the tracker structure.



Illustrative stow position of the various rows within the PV array

In safety position, iTracker™ can withstand a gust wind speed of 120 km/h. Higher values are available as an option for dedicated tracker versions.

Gust wind speed is the 3 sec mean. Wind speeds are defined as wind velocity at 10 m above ground level in open country terrain, as per Eurocodes definition.

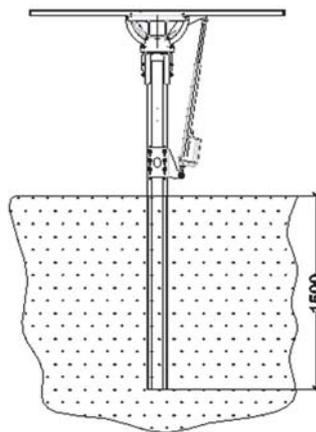


Wind tunnel test studies of PV array allow optimizing the tracker structure

During stowing procedures, trackers are managed in a sequence of 2 groups, in order to optimize the electrical architecture and power consumption. The total stowing time for the array is on average 3 minutes.

3.2 Foundations

iTrackerTM can be installed on **different foundations**: concrete blocks, driven piles, screw piles. Piles are C-shaped, and in case of driven piles, they are rammed directly inside the ground. Standard pile embedment length is 1.500 mm \pm 150 mm tolerance. Different lengths are available as an option. A practical pull-test in the field is recommended to verify the actual required pile embedment.



Tracker pile rammed in the ground

4. Ease of use

4.1 Installation

Building on its experience, Soltigua developed iTracker™ to optimize **ease of installation** and minimize installation errors, also when personnel lacks previous experience with trackers and/or specific skills.

Maximum ground slope along the longitudinal axis of rotation of each tracker: 15% (i.e. 8°).

Maximum ground slope along perpendicular to the longitudinal axis of rotation: 100% (i.e. 45°).

The ground level at the basis of each intermediate pile of a given tracker should be within 150 mm from the height of the ideal line connecting the basis of the first pile and of the last pile of that tracker.

No welding nor drilling is required during erection and installation tolerances allowed by iTracker™ rank the highest in the market.

| Feature | iTracker | Benchmark |
|----------------------------|----------|-----------|
| Vertical tolerance (Z) | ±45 mm | ±20 mm |
| Transversal tolerance (X) | ±25 mm | ±20 mm |
| Longitudinal tolerance (Y) | ±50 mm | ±35 mm |
| Tilt | 8° | 2° |
| Twist | 15° | 5° |

iTracker installation tolerances compared to a benchmark solution

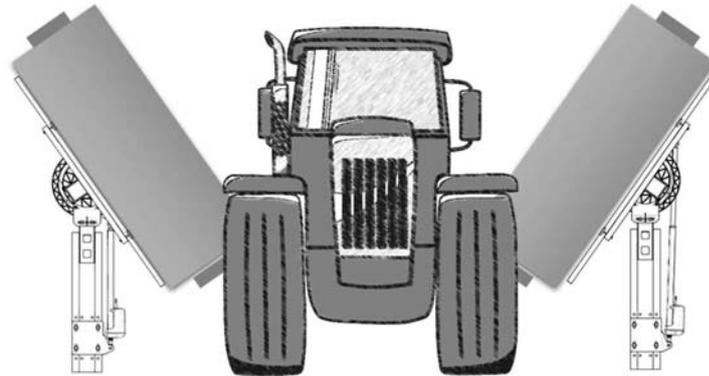
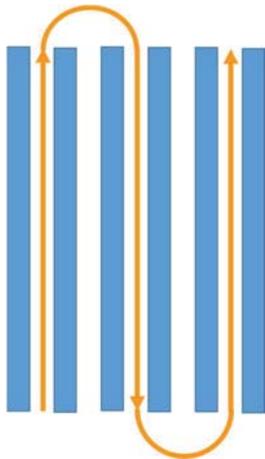
These large installation tolerances help at minimizing site repairs/modifications and ground works and at achieving:

- lower installation costs;
- no delays in project timeline;
- easier project management.

4.2 Maintenance

All components are **maintenance free**, including the linear actuator and its motor, which has an IP66 dynamic rating. The rotation bearings are made of stainless steel rollers with self-lubricating washers.

Single row tracking **simplifies cleaning and vegetation management** because there are no obstacles between rows. Adjacent trackers can be rotated to face each other in order to enable their simultaneous cleaning.



Single row trackers allow cleaning 2 tables at once

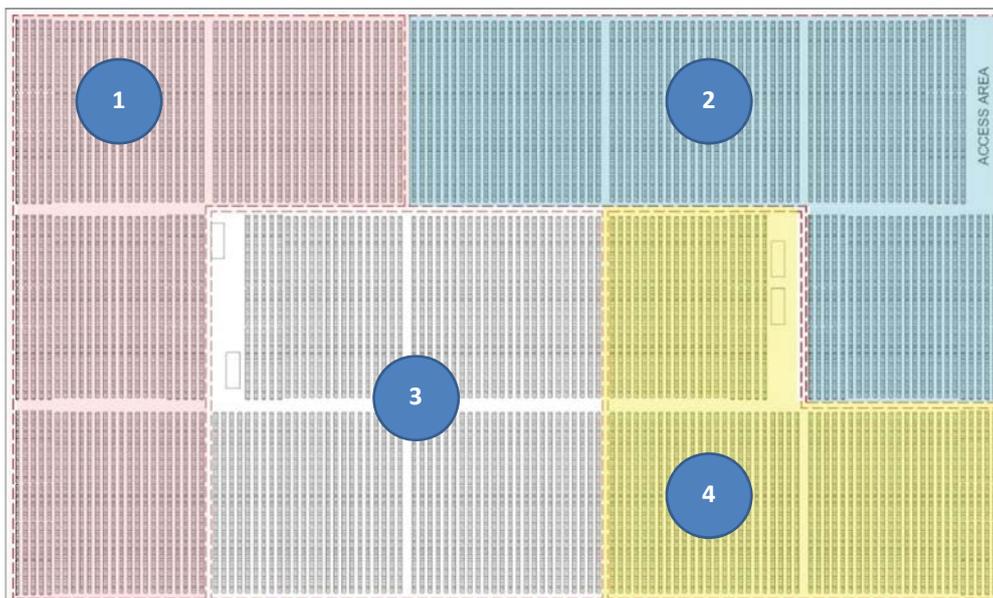
Continuous tables are already optimized for autonomous robot cleaning.

SolControl intelligent **monitoring system** enables the operators to evaluate the tracking system status at a glance, even remotely, in an intuitive manner.

If necessary, details down to single tracker level can be checked.

5. Tracking system architecture

The whole tracking system of a PV power plant is usually divided into some sub arrays, each of which coincides with the part of the plant related to a transformer station or to a centralized inverter.



Illustrative PV plant divided into sub-arrays

Each sub-array is provided with a distribution panel (DP) and a back-up UPS (available as an option), which is used to perform the safety procedure in case of lack of electricity.

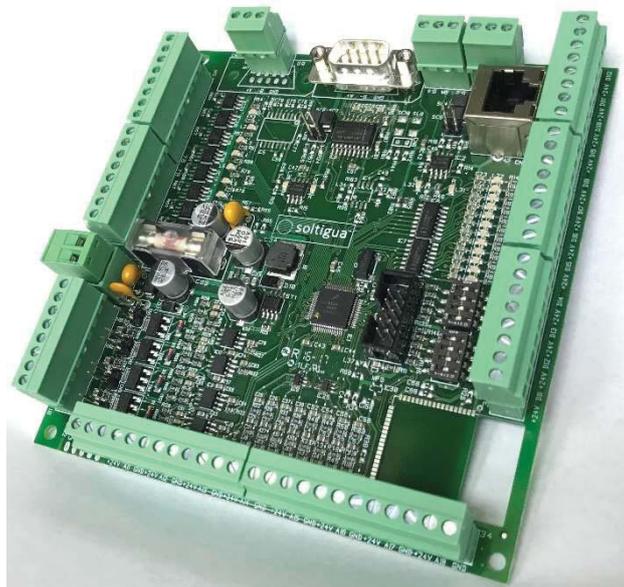
The DP distributes the power to the tracker field panels (FP) of the sub-array, each of which in turns supplies up to 4 tracker motors.

A central Tracker Control Panel (TCP) contains the industrial controller, which manages all the trackers in the PV array. The TCP communicates with the DP and with the FPs, where Soltigua's proprietary printed control boards (PCB) acquire trackers data.

The codification is the following:

| CODE | DESCRIPTION |
|----------|--|
| TCP | Tracking system control panel. There is one per PV power plant |
| xx | Sub-array. there can be several, typically one every 3-5 MWp |
| xx.DP | Sub- array distribution panel. There is one per sub-array |
| xx.FPyy | Tracker field panel; yy= 01 ... 40 |
| xx.TRzzz | Tracker in the sub-array xx; zzz = 001 ... 160 |

Each PCB acquires data of up to 4 trackers, and communicates them to the central controller via Modbus RTU protocol over an RS-485 network.

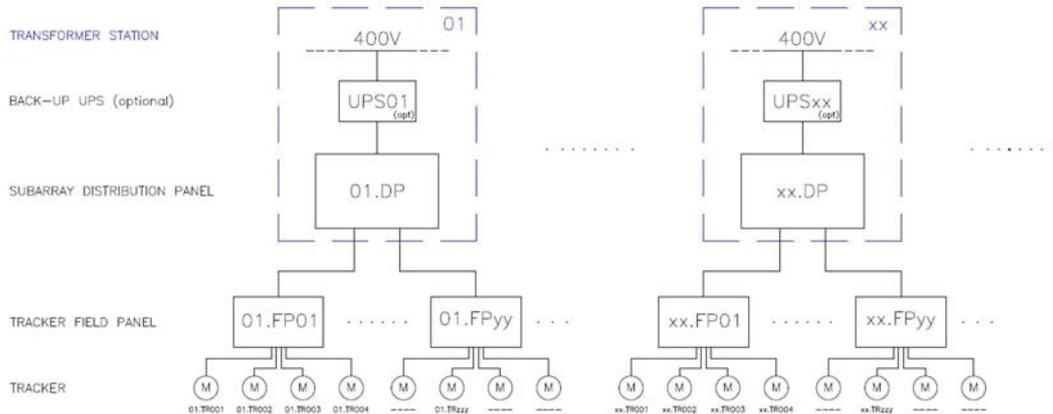


Soltigua's custom Printed Control Board (PCB)

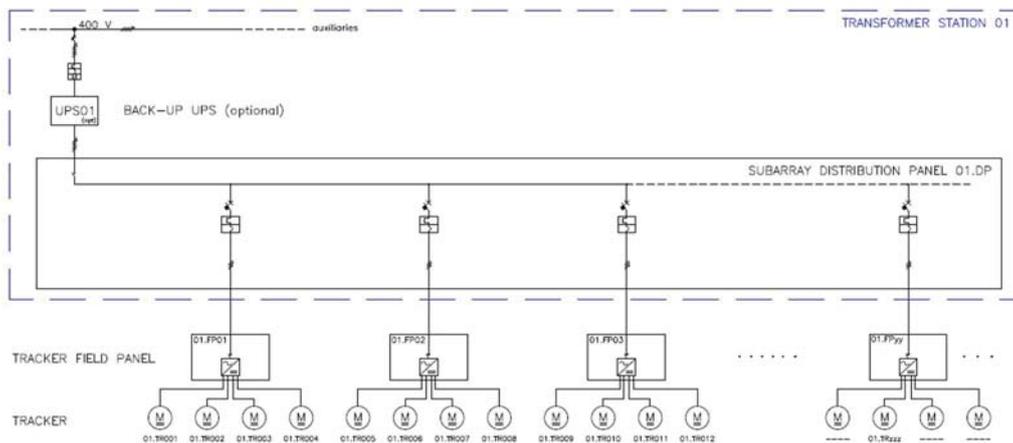
5.1 Power supply

The UPS and distribution panel DP are fed with electricity by the grid/PV plant (400 V AC 50/60 Hz), and supply the field panels FP at 230 V. Each FP supplies the tracker motors at 24V DC.

The following diagrams illustrate the typical power supply architecture, which is highly modular, flexible and scalable.



Example of general power supply architecture



Example of sub-array detailed power supply

Working conditions are as follows:

- distribution panels (DP) and optional UPS: indoor installation, 5°C ÷ 35°C;
- Field panels (FP): outdoor installation; IP 66; -10° ÷ 50°C, with max 90% humidity.

Each tracker has the following power requirements:

- Standby (between one tracking step and the following): 5 W;
- Tracking (with a wind speed of 15 km/h): 77 W.

The average tracking time is less than 1.0% of daylight hours, therefore iTracker™ control software dynamically manages the assembly of trackers in the field by operating them in a sequence of 2 groups, in order to limit peak power consumption and optimize the UPS battery usage. Moreover, at night, all

trackers can be switched off, so that power consumption is further reduced, unless it is advisable to keep them on when ambient temperature falls below 5°C.

Each sub array can include a maximum of 160 iTrackers for an equivalent power capacity of 5 MWp, for a maximum total power consumption of 22 kVA and a maximum inrush current of 45 A @400V. Typically a sub-array will include less trackers, hence will require lower values.

The maximum power consumption is only obtained if the wind blows at the maximum operational wind speed and the trackers are at their maximum working angle.

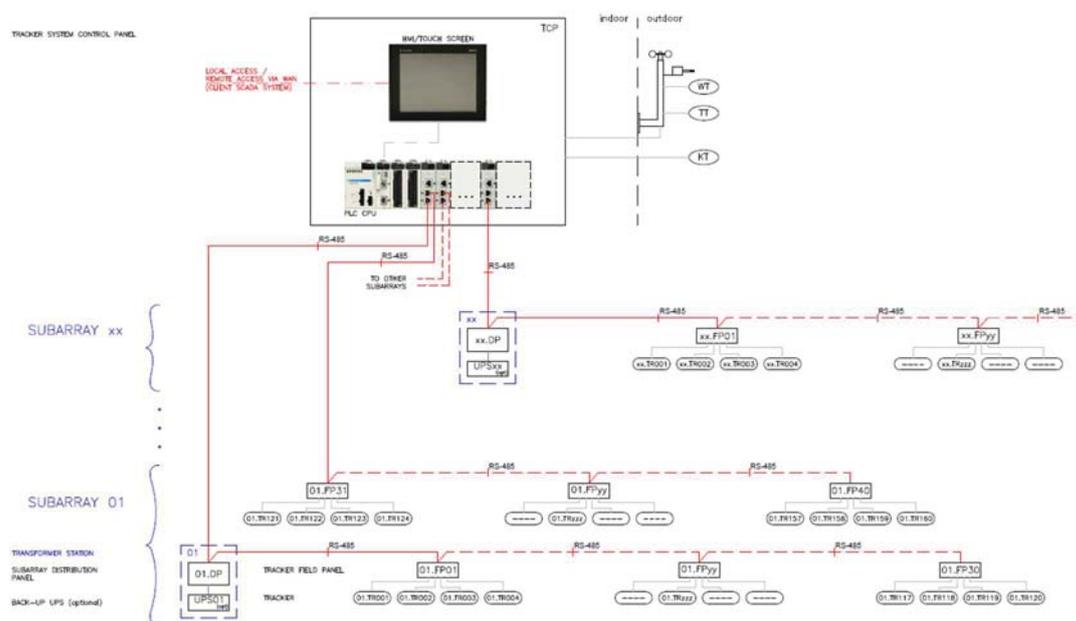
Average power consumption is 0.13 kW/MWp during daytime and 0.01 kW/MWp during nighttime.

5.2 Control and Monitoring

The central controller takes care of the automatic tracking cycle, including the backtracking function and the safety procedure in case of warnings such as high wind. The controller reads the following sensors:

- Wind speed sensor: to check the working conditions;
- Ambient temperature probe: to check for extreme operating temperatures;
- GPS receiver: to communicate with satellites for time update;
- Back-up UPS (optional): to verify its operational functionality.

The following diagram shows the typical I&C architecture.



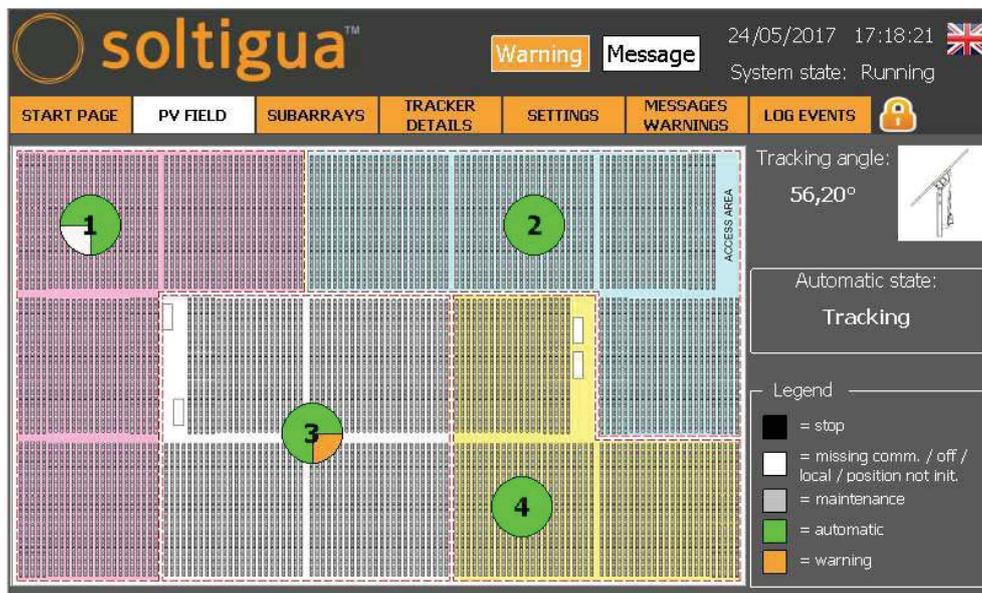
Example of typical communication architecture

Thanks to **Soltigua's SolControl supervision software**, three different interfaces can be used for checking operating data in real time and setting specific functions:

- Local touchscreen monitor on the tracker control panel;
- Locally connected pc (to customer's care);
- Remotely connected pc, via GSM or WAN, thanks to the integrated router.

SolControl specific functions include:

- Rotation to maintenance position of a sub array (for cleaning or other purposes);
- Individual rotation of single trackers to a desired position (special activities on given strings);
- Datalogging;
- Alarms log.



Soltigua's SolControl supervision software

The controller monitors and makes available operational data via Modbus TCP/IP protocol to any other monitoring system. Data are updated every second for continuous communication, whereas a given amount of historical data are stored locally for non-continuous extraction.

In addition, Soltigua can provide remote assistance and monitoring via the integrated WAN/GSM router.

For data extraction possibilities, the following parameters are available in the log file:

- For the whole PV array:
 - Date and time;
 - Sun elevation and sun azimuth;
 - Wind speed;
 - Power plant state;
 - Ideal tracking angle;
- For each sub-array:

- Global working state;
- Active warnings (e.g.: high wind);
- N° of trackers in automatic mode;
- N° of trackers in manual mode;
- N° of trackers in maintenance mode;
- N° of trackers in local alarm;
- For each tracker:
 - Tracking angle;
 - Active alarms.

6. Earthing

iTrackerTM rotating structure is connected to earth through its drive pile. In cases where the earthing requirements are not satisfied because of the ground features or because of local code requirements, more piles can be connected to the structure to reduce the resistance to earth by means of optional additional grounding braids.

Modules earthing is not included as a standard, but it can be provided, as an option, via the iTrackerTM metallic structure by means of earthing washers or similar items.



iTracker: catching all the sun

iTracker – the intelligent tracker – maximizes the output of your PV power plant, thanks to its all-around performance and Soltigua's customer-tailored solutions



soltiguaTM

Track and field: iTracker's decathlon

"The decathlon includes ten separate events and they all matter. You can't work on just one of them."

Dan O'Brien
Olympic gold medal

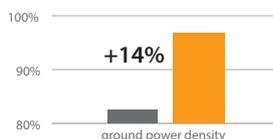
Track Horizontal single-axis trackers increase the performance of PV power plants by up to 30% with a limited increase of the investment. By following the sun throughout the day PV trackers maximise power generation. They also better match the grid demand profile, which peaks in the afternoon, and contribute to a smarter and more sustainable energy system.

Field To maximize the actual PV output in the field, trackers must deliver on several dimensions during the different phases of the PV project life: design, installation, operation and maintenance. Challenges are numerous and diversified, ranging from field configuration to need for local content, from local labour skills to weather conditions, from budgetary constraints all the way down to asset management for a long lifespan.

iTracker's decathlon Effective tracker performance requires all-around achievements and attention to detail, like a decathlete, who prepares for multiple challenges at the same time. This is iTracker's intelligence: delivering everywhere it matters!

01 Power Density

Smallest footprint for each installed PV module



- Up to 14% additional capacity for a given area
- Continuous table with no interruptions thanks to virtual axis of rotation
- Length up to 96 meters
- Single row 3D backtracking maximises annual output

02 Site Adaptability

The most flexible tracker on the market



- Optional universal joint for undulating sites avoids ground works
- North South slopes up to 15% - no East West slope limitation
- Independent row tracking enables more flexible layouts
- Alignment is possible in any direction to adapt to site constraints



03 Wind Management **Holistic approach to wind loads**



- Wind tunnel tested, including dynamic analysis
- Intelligent stowing position along the array avoids wind galloping
- Soltigua's patented bearing concept includes a torsional limiter
- An embedded damping factor avoids the addition of external dampers

04 Outdoor Resistance **Ready for the harshest environment**



- Linear actuator with IP 66 dynamic rating and IP69K static rating
- IP 65 electric box against moisture, dust and sand
- Broad range of working temperatures from -10°C to +50°C
- HDG metal structure and components with advanced coatings (Zn-Al-Mg)

05 Endurance & Reliability **Designed and field tested for 50-year service**



- Patented balanced design reduces mechanical stress on structure and actuator
- Proprietary rugged printed control board can resist temperatures from -20° to +80°C
- Drive and bearing components tested on the field for an equivalent 50-year service
- Technical due diligence available on request

06 Advanced Design **Integrated mechanical engineering**



- Tracking precision, balanced design and broad rotation range increase yield by up to 1,5%
- Engineering platform leverages Soltigua's experience in complex CSP collectors
- 3D CAD modelling enables rapid virtual prototyping and in depth analysis
- FEM (Finite Elements) analysis performed for various load cases on critical components



07 Intelligent Monitoring **Monitoring tailored to specific customer needs**



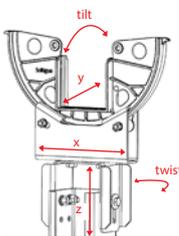
- Individual monitoring and control of each tracker
- Soltigua's cloud-based SCADA shows solar array status at a glance, in an intuitive manner
- Single tracker status can also be detected, including warnings and alerts
- Real time and historical data available

08 Minimized O&M **Minimized operating cost for the pv array**



- Simplified cleaning and vegetation management: no obstacles between rows
- Adjacent rows can face each other to allow their simultaneous cleaning
- Continuous table is already optimized for autonomous robot cleaning
- All moving parts are maintenance free, as they are sealed and self lubricated

09 Ease of installation **Fast, simple and user friendly installation**



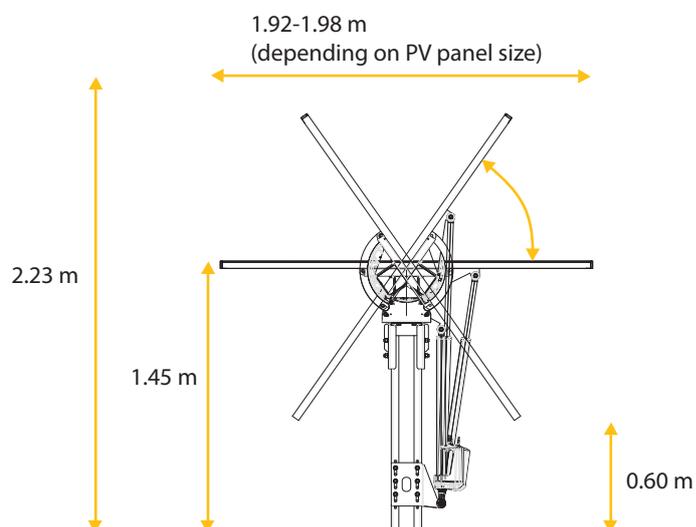
- Highest installation tolerances on the market avoid repair work at construction site
- No specialized tool is required during installation: no welding, no drilling
- Installation manual available to partners and clients
- Installation courses in Soltigua's headquarters and on project sites

10 Certified Quality **100% compliant to state-of-the-art standards**

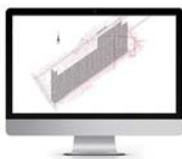


- CE marked according to the Machinery Directive 2006/42/UE
- Structural design compliant with Eurocodes EN 1991-1-1, EN 1991-1-3, EN 1991-1-4
- Electrical design as per EU Directives 2014/35/UE (LV) and 2014/30/UE (EMC)
- Quality system certified by TUV Sud according to ISO 9001:2015

| | |
|-----------------------------|--|
| Tracking type | Independent single axis horizontal tracker; Any tracker alignment possible (ideally along North-South direction); Individual 3D backtracking |
| Tracking algorithm | Accurate astronomical formulas; tracking precision = 0.5° |
| Rotation range | ±55° |
| Ground cover ratio | Freely configurable by customer (between 34% and 50%) |
| PV Module compatibility | Framed modules; All major brands |
| Module mount | 1 module portrait; 2 modules landscape |
| Drive system | 1 Independent linear actuator per tracker |
| Peak power per tracker | Up to 32.64 kWp per tracker (with 340Wp panels) |
| N° of Module per tracker | Up to 100 72-cell modules (1000 V) or 90 72-cell modules (1500 V) |
| PV array voltage | 1000 V or 1500 V |
| Power supply | 400 V AC (50/60 Hz) / Self powered |
| Communication | Private wired network / wireless with star topology |
| Monitoring | Local control via SCADA; Remote control available |
| Power consumption | ≈ 600 kWh/MWp/year |
| Foundation type | standard: driven pile; compatible also with: cement block; ground screw |
| Wind resistance (Eurocodes) | In operation: up to 80 km/h in any position, depending on tracker version; Stow position: up to 200+ km/h in stow position, depending on tracker version. |
| Snow resistance | Up to 1'050 N/m ² ; depending on tracker version |
| Tracker stowing time | ≤ 3 min |
| Installation tolerances | North South: ±45 mm; East-West: ±25 mm; Height tolerance: ±40 mm; Tilt: 8°; Twist: 15° |
| Ground slope | Max 15% slope in longitudinal direction (North- South); Any slope in transversal direction (East-West) [max 70% local slope for rotation clearance] |
| Installation method | Engineered for fast and easy assembly; no welding nor drilling required on site |
| Materials | HDG construction steel; Maintenance free drive components (actuator and bearings) |
| Certifications/Compliance | CE 2006/42/UE; Eurocodes EN1991-1-1/3/4; LV 2014/35/UE; EMC 2014/30/UE; ISO 9001-2015 |
| Warranty | Structure: 10 years; Drive and electronics: 5 years; Warranty extension available |



Dedicated global service



Project engineering - Tailored to the needs of each individual plant

- Choice of optimal trackers based on project features (PV modules, land, wind etc.)
- Detailed layout development already during proposal
- Optimization during basic engineering



Scope of supply - Flexible battery limits for goods and services

- On-site presence adapted to customer preference: from simple supervision to full turn-key
- If wished, selected structural components can be sourced locally by the client



Project management - Reliable network across 4 continents

- 100+ year of cumulative experience in project management
- Extensive network of local partners for seamless client service
- Projects successfully delivered and commissioned across 4 continents



Post sale assistance - Guaranteed support - online and onsite

- 99% availability guarantee included as sales contract standard
- Suitable stock of spare parts supplied and maintained available on site
- Remote monitoring service available upon request



Training - Supporting continuous learning during the entire life of the plant

- Dedicated courses at Soltigua's headquarters for construction partners
- On-site sessions during erection and commissioning phase
- Comprehensive manuals for detailed reference during O&M

A unique product portfolio



Soltigua is the only PV tracker supplier with a 10-year experience in engineering and manufacturing concentrating collectors for solar heat up to 320°C. By manufacturing both parabolic troughs and Fresnel collectors, Soltigua can offer the most suitable solution to any solar thermal installation.

For more information and quotes write to sales@soltigua.com



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CPR (UE) n° 305/11
E_{ca}

Regolamento Prodotti da Costruzione/ *Construction Products Regulation*
Classe conforme norme EN 50575:2014 + A1:2016 e EN 13501-6:2014
Class according to standards EN 50575:2014 + A1:2016 and EN 13501-6:2014

DoP n° 1036/17

EN 50618
CEI EN 60332-1-2
CEI EN 50525
CEI EN 50289-4-17 A
CEI EN 50396
2014/35/UE
2011/65/CE
CA01.00546

Costruzione e requisiti/ *Construction and specifications*
Propagazione fiamma/ *Flame propagation*
Emissione gas/ *Gas emission*
Resistenza raggi UV/ *UV resistance test*
Resistenza ozono/ *Ozone resistance*
Direttiva Bassa Tensione/ *Low Voltage Directive*
Direttiva RoHS/ *RoHS Directive*
Certificato IMQ/ *IMQ Certificate*



<HAR>



DESCRIZIONE

Cavo unipolare flessibile stagnato per collegamenti di impianti fotovoltaici. Isolamento e guaina realizzati con mescola elastomerica senza alogeni non propagante la fiamma.

Conduttore

Corde flessibile di rame stagnato, classe 5

Isolante

Mescola LSOH di gomma reticolata speciale di qualità conforme alla norma EN 50618
LSOH = Low Smoke Zero Halogen

Guaina esterna

Mescola LSOH di gomma reticolata speciale di qualità conforme alla norma EN 50618

Colore anime

Nero

Colore guaina

Blu, rosso, nero

Marcatura a inchiostro

BALDASSARI CAVI IEMMEQU <HAR> H1Z2Z2-K 1/1 kV
(sez) (anno) (m) (tracciabilità)

CARATTERISTICHE TECNICHE

Tensione massima: 1800 V c.c. - 1200 V c.a.

Temperatura massima di esercizio: 90°C

Temperatura minima di esercizio: -40°C

Temperatura minima di posa: -40°C

Temperatura massima di corto circuito: 250°C

Sforzo massimo di trazione: 15 N/mm²

Raggio minimo di curvatura: 4 volte il diametro esterno massimo

Condizioni di impiego

Per l'interconnessione di elementi di impianti fotovoltaici. Adatti per l'installazione fissa all'esterno e all'interno, entro tubazioni in vista o incassate o in sistemi chiusi similari.

Adatti per la posa direttamente interrata o entro tubo interrato e per essere utilizzati con apparecchiature di classe II.

DESCRIPTION

Flexible single-core cable for connection in photovoltaic installations. Insulation and sheath made of elastomeric compound, halogen free and flame retardant.

Conductor

Tinned copper flexible wire, class 5

Insulation

Special LSOH cross-linked rubber compound according to EN 50618 quality
LSOH = Low Smoke Zero Halogen

Outer sheath

Special LSOH cross-linked rubber compound according to EN 50618 quality

Cores colour

Black

Sheath colour

Blue, red or black

Inkjet marking

BALDASSARI CAVI IEMMEQU <HAR> H1Z2Z2-K 1/1 kV
(section) (year) (m) (traceability)

TECHNICAL CHARACTERISTICS

Maximum voltage U_o/U: 1800 V d.c. - 1200 V a.c.

Maximum operating temperature: 90°C

Minimum operating temperature: -40°C

Minimum installation temperature: -40°C

Maximum short circuit temperature: 250°C

Maximum tensile stress: 15 N/mm²

Minimum bending radius: 4 x maximum external diameter

Use and installation

For interconnection of photovoltaic elements. Suitable for fixed installation indoor and outdoor, in pipes exposed or embedded or in similar closed systems.

Suitable for laying directly underground or in pipe underground and to be used for class II equipment.



| Formazione <i>Formation</i> | Ø indicativo conduttore <i>Approx. conductor Ø</i> | Spessore medio isolante <i>Average insulation thickness</i> | Spessore medio guaina <i>Average sheath thickness</i> | Ø indicativo produzione <i>Approx. production Ø</i> | Peso indicativo cavo <i>Approx. cable weight</i> | Resistenza elettrica max a 20°C <i>Max. electrical resistance at 20°C</i> | Portata di corrente in aria libera <i>Current rating free in air</i> | |
|--------------------------------|---|--|--|--|---|--|---|--|
| | | | | | | | Singolo cavo <i>Single cable</i> 60°C | 2 cavi adiacenti <i>2 adjacent cables</i> 60°C |
| n° x mm ² | mm | mm | mm | mm | kg/km | ohm/ km | A | A |
| 1 x 1,5 | 1,5 | 0,7 | 0,8 | 4,7 | 34 | 13,7 | 30 | 24 |
| 1 x 2,5 | 2,1 | 0,7 | 0,8 | 5,2 | 47 | 8,21 | 40 | 33 |
| 1 x 4 | 2,5 | 0,7 | 0,8 | 5,8 | 58 | 5,09 | 55 | 44 |
| 1 x 6 | 3,0 | 0,7 | 0,8 | 6,5 | 80 | 3,39 | 70 | 70 |
| 1 x 10 | 4,0 | 0,7 | 0,8 | 7,9 | 127 | 1,95 | 95 | 95 |
| 1 x 16 | 5,0 | 0,7 | 0,9 | 8,8 | 180 | 1,24 | 130 | 107 |
| 1 x 25 | 6,2 | 0,9 | 1,0 | 10,6 | 270 | 0,795 | 180 | 142 |
| 1 x 35 | 7,6 | 0,9 | 1,1 | 12,0 | 360 | 0,565 | 220 | 176 |
| 1 x 50 | 8,9 | 1,0 | 1,2 | 14,1 | 515 | 0,393 | 280 | 221 |
| 1 x 70 | 10,5 | 1,1 | 1,2 | 15,9 | 720 | 0,277 | 350 | 278 |
| 1 x 95 | 12,5 | 1,1 | 1,3 | 17,7 | 915 | 0,210 | 410 | 333 |
| 1 x 120 | 13,7 | 1,2 | 1,3 | 19,8 | 1160 | 0,164 | 480 | 390 |
| 1 x 150 | 16,1 | 1,4 | 1,4 | 21,7 | 1460 | 0,132 | 566 | 453 |
| 1 x 185 | 17,7 | 1,6 | 1,6 | 24,1 | 1780 | 0,108 | 644 | 515 |
| 1 x 240 | 19,9 | 1,7 | 1,7 | 26,7 | 2310 | 0,082 | 775 | 620 |



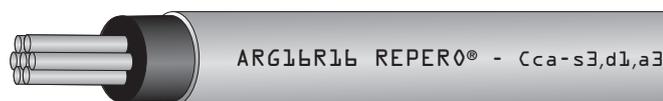
CPR (UE) n°305/11
C_{ca} - s3, d1, a3

Regolamento Prodotti da Costruzione/Construction Products Regulation
Classe conforme norme EN 50575:2014 + A1:2016 e EN 13501-6:2014
Class according to standards EN 50575:2014 + A1:2016 and EN 13501-6:2014

DoP n°1043/17

CEI 20-13
CEI EN 60332-1-2
2014/35/UE
2011/65/CE

Costruzione e requisiti/Construction and specifications
Propagazione fiamma/Flame propagation
Direttiva Bassa Tensione/Low Voltage Directive
Direttiva RoHS/RoHS Directive



DESCRIZIONE

Cavo unipolare per energia con conduttore in alluminio, isolato in gomma etilenpropilenica ad alto modulo di qualità G16, sotto guaina di PVC, con particolari caratteristiche di reazione al fuoco e rispondente al Regolamento Prodotti da Costruzione (CPR).

Conduttore

Corda di alluminio rigida, classe 2

Isolante

Mescola di gomma etilpropilenica ad alto modulo di qualità G16

Guaina esterna

Mescola di PVC di qualità R16

Colore anime

Normativa HD 308

Colore guaina

Grigio

Marcatura a inchiostro

BALDASSARI CAVI REPERO® ARG16R16 0,6/1 kV (sez)
Cca-s3,d1,a3 IEMMEQU EFP (anno) (m) (tracciabilità)

CARATTERISTICHE TECNICHE

Tensione nominale U_o/U: 0,6/1 kV

Temperatura massima di esercizio: 90°C

Temperatura minima di esercizio: -15°C
(in assenza di sollecitazioni meccaniche)

Temperatura minima di posa: 0°C

Temperatura massima di corto circuito:
250°C fino alla sezione 240 mm², oltre 220°C

Sforzo massimo di trazione: 50 N/mm²

Raggio minimo di curvatura: 6 volte il diametro esterno massimo

Condizioni di impiego

Per trasporto energia nell'edilizia industriale e/o residenziale. Adatto per impiego all'interno in locali anche bagnati o all'esterno; posa fissa su murature e strutture metalliche. Ammessa anche la posa interrata.

DESCRIPTION

Single-core power cable with aluminum conductor, HEPR insulated (G16 quality), PVC sheathed, with special fire reaction characteristics according to Construction Products Regulation (CPR).

Conductor

Aluminium stranded wire, class 2

Insulation

Rubber HEPR compound G16 quality

Outer sheath

PVC compound, R16 quality

Cores colour

HD 308 Standard

Sheath colour

Grey

Inkjet marking

BALDASSARI CAVI REPERO® ARG16R16 0,6/1 kV (section)
Cca-s3,d1,a3 IEMMEQU EFP (year) (m) (traceability)

TECHNICAL CHARACTERISTICS

Nominal voltage U_o/U: 0,6/1 kV

Maximum operating temperature: 90°C

Minimum operating temperature: -15°C
(without mechanical stress)

Minimum installation temperature: 0°C

Maximum short circuit temperature:
250°C up to 240 mm² section, over 220°C

Maximum tensile stress: 50 N/mm²

Minimum bending radius: 6 x maximum external diameter

Use and installation

Power cable for industrial and/or residential uses. Suitable to be used indoor and outdoor, even in wet environments; it can be fixed on walls and/or metal structures. Suitable also for laying underground.



| Formazione <i>Formation</i> | Ø indicativo conduttore <i>Approx. conductor Ø</i> | Spessore medio isolante <i>Average insulation thickness</i> | Spessore medio guaina <i>Average sheath thickness</i> | Ø indicativo produzione <i>Approx. production Ø</i> | Peso indicativo cavo <i>Approx. cable weight</i> | Resistenza elettrica max a 20°C <i>Max. electrical resistance at 20°C</i> | Portata di corrente <i>Current rating</i> | | | |
|--------------------------------|---|--|--|--|---|--|---|---|--|--|
| | | | | | | | In aria libera <i>Free in air 30°C</i> | In tubo in aria <i>In pipe in air 30°C</i> | Interrato <i>Underground 20°C</i> | In tubo interrato <i>Underground in pipe 20°C</i> |
| n° x mm ² | mm | mm | mm | mm | kg/km | ohm/km | A | A | A | A |
| 1 x 16 | 4,9 | 0,7 | 1,4 | 9,1 | 109 | 1,91 | 70 | 64 | 98 | 75 |
| 1 x 25 | 6,1 | 0,9 | 1,4 | 10,7 | 151 | 1,20 | 102 | 88 | 119 | 95 |
| 1 x 35 | 7,1 | 0,9 | 1,4 | 11,7 | 185 | 0,868 | 136 | 110 | 141 | 115 |
| 1 x 50 | 8,2 | 1,0 | 1,4 | 13,0 | 230 | 0,641 | 164 | 131 | 167 | 134 |
| 1 x 70 | 9,9 | 1,1 | 1,4 | 14,9 | 315 | 0,443 | 218 | 175 | 204 | 173 |
| 1 x 95 | 11,4 | 1,1 | 1,5 | 16,6 | 405 | 0,320 | 261 | 209 | 245 | 196 |
| 1 x 120 | 13,1 | 1,2 | 1,5 | 18,5 | 510 | 0,253 | 310 | 250 | 277 | 238 |
| 1 x 150 | 14,4 | 1,4 | 1,6 | 20,4 | 620 | 0,206 | 350 | 280 | 313 | 250 |
| 1 x 185 | 16,2 | 1,6 | 1,6 | 22,6 | 750 | 0,164 | 415 | 334 | 350 | 300 |
| 1 x 240 | 18,4 | 1,7 | 1,7 | 25,2 | 955 | 0,125 | 490 | 392 | 413 | 331 |
| 1 x 300 | 20,7 | 1,8 | 1,8 | 27,9 | 1150 | 0,100 | 567 | - | 454 | 400 |
| 1 x 400 | 23,6 | 2,0 | 1,9 | 31,4 | 1520 | 0,0778 | 665 | - | 512 | 450 |
| 1 x 500 | 26,5 | 2,2 | 2,0 | 34,9 | 1850 | 0,0605 | 765 | - | 578 | 505 |
| 1 x 630 | 30,2 | 2,4 | 2,2 | 39,8 | 2415 | 0,0469 | 880 | - | 646 | 580 |

N.B. Il coefficiente di resistività termica del terreno preso a riferimento per il calcolo della portata dei cavi interrati è di 1° C.m/W, profondità di posa 0,8 m. Calcolo della portata di corrente eseguito considerando quattro cavi a contatto con temperatura dei conduttori di 90°C.

N.B. The thermal resistivity coefficient used as a reference for the calculation of the underground cables current rating is 1° C.m/W, 0,8 m installation depth. Calculation of current rating performed considering four cables in contact with conductor temperature of 90°C.

CAVI MEDIA TENSIONE - PER IMPIANTI EOLICI
MEDIUM VOLTAGE CABLES - WIND POWER PLANTS

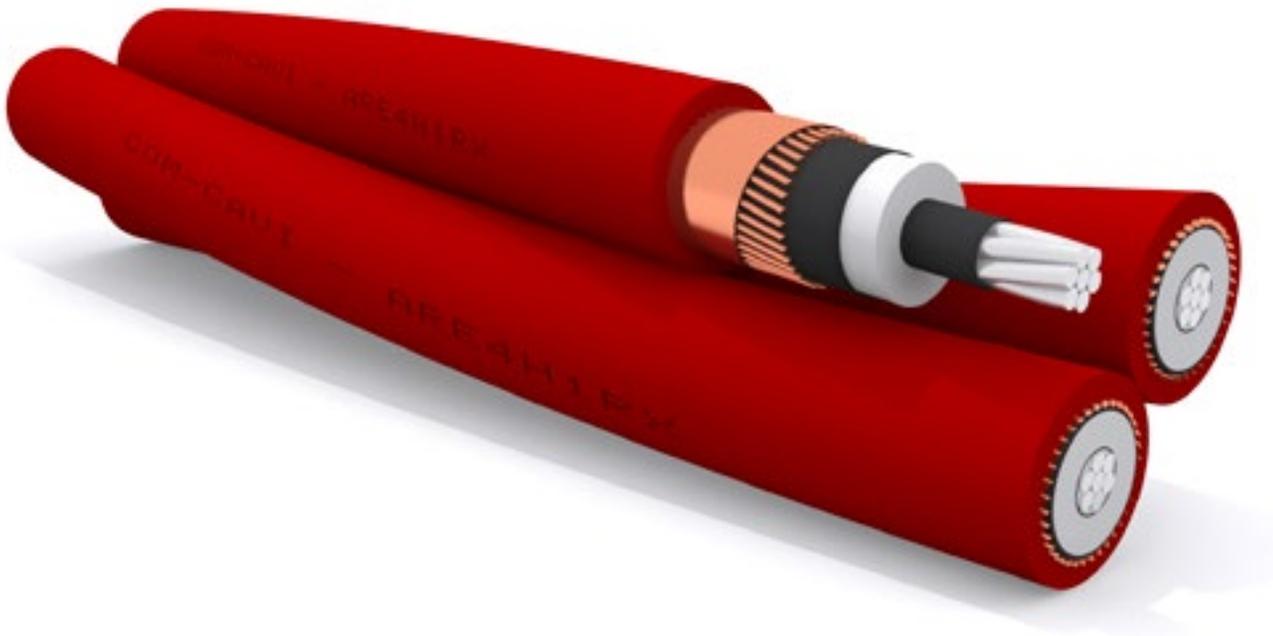
ARE4H1RX - Elica visibile 12/20 kV - 18/30 kV

MEDIA TENSIONE - ENERGIA
MEDIUM VOLTAGE - ENERGY



RIFERIMENTO NORMATIVO/STANDARD REFERENCE

| | |
|---|------------|
| Costruzione e requisiti/Construction and specifications | EC 60502-2 |
| Propagazione fiamma/Flame propagation | CEI 20-35 |
| Direttiva RoHS/RoHS Directive | 2011/65/CE |



CARATTERISTICHE FUNZIONALI:

- Tensione nominale U_0/U : : 12/20 kV - 18/30 kV
- Temperatura massima di esercizio: 90°C
- Temperatura minima di posa: 0°C
- Temperatura massima di corto circuito: 250°C

CARATTERISTICHE PARTICOLARI:

Cavi media tensione non propaganti la fiamma. Adatti per impianti eolici.

CONDIZIONI DI IMPIEGO:

Adatti per installazioni in canale interrato; tubo interrato; interro diretto; aria libera; interrato con protezione.

FUNCTIONAL CHARACTERISTICS

- Nominal voltage U_0/U : 12/20 kV - 18/30 kV
- Maximum operating temperature: 90°C
- Minimum installation temperature: 0°C
- Maximum short circuit temperature: 250°C

SPECIAL FEATURES

Medium voltage cable, not propagating flame. Suitable for wind power plants.

USE AND INSTALLATION

Suitable for installations in buried trough; buried duct; directly buried; open air; buried with protection.

ARE4H1RX - Elica visibile 12/20 kV - 18/30 kV

COSTRUZIONE DEL CAVO / CABLE CONSTRUCTION

| | | |
|---|---|---|
|  | CONDUTTORE Materiale: Conduttore a corda rotonda compatta di alluminio | CONDUCTOR Material: stranded wire aluminium |
|  | SEMICONDUTTIVO INTERNO Materiale: Mescola estrusa Colore: Nero | INNER SEMICONDUCTIVE Material: extruded compound Colour: Black |
|  | ISOLANTE Materiale: Mescola di polietene reticolato Colore: Naturale | INSULATION Material: polyethylene compound Colour: Natural |
|  | SEMICONDUTTIVO ESTERNO Materiale: Mescola estrusa Colore: Nero | OUTER SEMICONDUCTIVE Material: extruded compound Colour: Black |
|  | SCHERMO Tipo: Fili di rame rosso e contospirale Materiale: Rame rosso (R max 3 Ω/km) | SCREEN Type: Copper wire Colour: Copper (R max 3 Ω/km) |
|  | GUAINA ESTERNA Materiale: PVC di qualità Rz/ST2 Colore: Rosso | OUTER SHEATH Material: PVC compound, Rz quality Colour: grey |

MARCATURE:

- COM-CAVI - ARE4H1RX 12/20 kV - <N° COND. X SEZIONE> <ANNO> <MARCATURA METRICA>

MARKINGS

- CCOM-CAVI - ARE4H1RX 12/20 kV - <N° CONDUCT. S SECTION> <YEAR> <METRIC MARKING>

ARE4H1RX - Elica visibile 12/20 kV

12/20 kV Dati dimensionali - size characteristics

| Formazione | Ø nominale conduttore | Spessore isolante | Spessore guaina | Ø nominale cavo | Peso nominale cavo | Raggio minimo di curvatura |
|----------------------|--------------------------|----------------------|------------------|--------------------|----------------------|----------------------------|
| Size | Nominal conduct. Ø | Insulation thickness | Sheath thickness | Nominal cable Ø | Nominal cable weight | Minimum bending radius |
| n° x mm ² | mm | mm | mm | mm | kg/km | mm |
| 25 | 6,0 | 5,5 | 1,8 | 29,6 | 610 | 350 |
| 35 | 7,0 | 5,5 | 1,8 | 30,7 | 670 | 360 |
| 50 | 8,1 | 5,5 | 1,8 | 31,7 | 720 | 380 |
| 70 | 9,9 | 5,5 | 1,8 | 33,3 | 840 | 400 |
| 95 | 11,5 | 5,5 | 1,9 | 35,4 | 955 | 430 |
| 120 | 12,9 | 5,5 | 1,9 | 37,0 | 1060 | 450 |
| 150 | 14,2 | 5,5 | 2,0 | 38,5 | 1210 | 470 |
| 185 | 15,9 | 5,5 | 2,0 | 40,0 | 1345 | 490 |
| 240 | 18,3 | 5,5 | 2,1 | 43,2 | 1590 | 530 |
| 300 | 20,7 | 5,5 | 2,2 | 45,8 | 1845 | 570 |
| 400 | 23,5 | 5,5 | 2,3 | 49,0 | 2175 | 610 |
| 500 | 26,5 | 5,5 | 2,4 | 52,0 | 2620 | 650 |
| 630 | 30,1 | 5,5 | 2,5 | 56,2 | 3110 | 710 |
| 3x1x25 | 6,0 | 5,5 | 1,8 | 63,9 | 1834 | 350 |
| 3x1x35 | 7,0 | 5,5 | 1,8 | 66,3 | 2014 | 360 |
| 3x1x50 | 8,1 | 5,5 | 1,8 | 68,5 | 2164 | 380 |
| 3x1x70 | 9,9 | 5,5 | 1,8 | 71,9 | 2525 | 400 |
| 3x1x95 | 11,5 | 5,5 | 1,9 | 76,5 | 2871 | 430 |
| 3x1x120 | 12,9 | 5,5 | 1,9 | 79,9 | 3186 | 450 |
| 3x1x150 | 14,2 | 5,5 | 2,0 | 83,2 | 3637 | 470 |
| 3x1x185 | 15,9 | 5,5 | 2,9 | 86,4 | 4043 | 490 |
| 3x1x240 | 18,3 | 5,5 | 2,1 | 93,3 | 4780 | 530 |
| 3x1x300 | 20,7 | 5,5 | 2,2 | 98,9 | 5546 | 570 |
| 3x1x400 | 23,5 | 5,5 | 2,3 | 105,8 | 6538 | 610 |
| 3x1x500 | 26,5 | 5,5 | 2,4 | 112,3 | 7876 | 650 |

Per i cavi con isolamento in G7 i dati dimensionali sono da ritenersi identici.
 For cables with insulation G7 dimensional data are to be considered identical.

ARE4H1RX - Elica visibile 12/20 kV

12/20 kV Caratteristiche elettriche - electrical characteristics

| Formazione Size | Capacità nominale Nominal capacity | Corrente capacitiva nominale a tensione U_0 Nominal capacitive current at voltage U_0 | Reattanza di fase a 50 HZ Reactance phase 50HZ | Resistenza massima in CC del conduttore a 20°C Conductor max electrical resist. CC at 20°C | Resistenza massima in CC dello schermo a 20°C Screen max electrical resist. CC at 20°C | Resistenza massima in CA del conduttore a 90°C Conductor max electrical resist. CA at 90°C | Portata di corrente Current rating A | | Corrente di corto circuito del conduttore Short circuit current conductor (1s) |
|----------------------|---------------------------------------|--|---|---|---|---|--|--|---|
| n° x mm ² | mm | A/Km | Ω/Km | Ω/Km | Ω/Km | Ω/Km | in aria a 30° C in air at 30° C | interrato a 20° C Underground at 20° C Rt=1m°C/W | kA |
| 25 | 0,15 | 0,56 | 0,155 | 1,200 | 3,0 | 1,540 | 136 | 133 | 2,3 |
| 35 | 0,16 | 0,65 | 0,147 | 0,868 | 3,0 | 1,115 | 160 | 156 | 3,2 |
| 50 | 0,17 | 0,71 | 0,141 | 0,641 | 3,0 | 0,852 | 198 | 181 | 4,6 |
| 70 | 0,20 | 0,80 | 0,132 | 0,443 | 3,0 | 0,570 | 243 | 222 | 6,5 |
| 95 | 0,22 | 0,89 | 0,125 | 0,320 | 3,0 | 0,412 | 296 | 263 | 8,8 |
| 120 | 0,24 | 0,96 | 0,120 | 0,253 | 3,0 | 0,328 | 338 | 296 | 11,1 |
| 150 | 0,25 | 1,03 | 0,117 | 0,206 | 3,0 | 0,268 | 387 | 337 | 13,8 |
| 185 | 0,28 | 1,12 | 0,112 | 0,164 | 3,0 | 0,213 | 441 | 378 | 17,0 |
| 240 | 0,30 | 1,23 | 0,108 | 0,125 | 3,0 | 0,163 | 517 | 436 | 22,1 |
| 300 | 0,33 | 1,34 | 0,105 | 0,100 | 3,0 | 0,132 | 586 | 493 | 27,6 |
| 400 | 0,37 | 1,48 | 0,101 | 0,0778 | 3,0 | 0,103 | 677 | 567 | 36,8 |
| 500 | 0,40 | 1,62 | 0,098 | 0,0605 | 3,0 | 0,081 | 775 | 626 | 46,0 |
| 630 | 0,44 | 1,80 | 0,095 | 0,0469 | 3,0 | 0,064 | 882 | 700 | 58,0 |
| 3x1x25 | 0,15 | 0,56 | 0,155 | 1,200 | 3,0 | 1,540 | 136 | 133 | 2,3 |
| 3x1x35 | 0,16 | 0,65 | 0,147 | 0,868 | 3,0 | 1,115 | 160 | 156 | 3,2 |
| 3x1x50 | 0,17 | 0,71 | 0,141 | 0,641 | 3,0 | 0,825 | 198 | 181 | 4,6 |
| 3x1x70 | 0,20 | 0,80 | 0,132 | 0,443 | 3,0 | 0,570 | 243 | 222 | 6,5 |
| 3x1x95 | 0,22 | 0,89 | 0,125 | 0,320 | 3,0 | 0,412 | 296 | 263 | 8,8 |
| 3x1x120 | 0,24 | 0,96 | 0,120 | 0,253 | 3,0 | 0,328 | 338 | 296 | 11,1 |
| 3x1x150 | 0,25 | 1,03 | 0,117 | 0,206 | 3,0 | 0,268 | 387 | 337 | 13,8 |
| 3x1x185 | 0,28 | 1,12 | 0,112 | 0,164 | 3,0 | 0,213 | 441 | 378 | 17,0 |
| 3x1x240 | 0,30 | 1,23 | 0,108 | 0,125 | 3,0 | 0,163 | 517 | 436 | 22,1 |
| 3x1x300 | 0,33 | 1,34 | 0,105 | 0,100 | 3,0 | 0,132 | 586 | 493 | 27,6 |
| 3x1x400 | 0,37 | 1,48 | 0,101 | 0,0778 | 3,0 | 0,103 | 677 | 567 | 36,8 |
| 3x1x500 | 0,40 | 1,62 | 0,098 | 0,0605 | 3,0 | 0,081 | 775 | 626 | 46,0 |

Per i cavi con isolamento in G7 le portate di corrente sono da ritenersi più basse di 4-6 A.
For cables with insulation G7 current rating are to be considered more low 4-6 A.

Accessori Consigliati/Recommended accessories

Accessori per cavi con tensione di esercizio/Cables accessories with voltage 12/20 kV

| Sezione nominale conduttore Nominal section conductor | Terminazione termorestringente da interno unipolare Xxxxxxx | Terminazione termorestringente da esterno unipolare Xxxxxxx | Giunto termorestringente unipolare Xxxxxxx |
|--|--|--|---|
| 35 | 24TTMI1-50C12 | 24TTME1-50C12 | 24GTS1-50C |
| 50 | 24TTMI1-50C12 | 24TTME1-50C12 | 24GTS1-50C |
| 70 | 24TTMI1-185C12 | 24TTME1-185C12 | 24GTS1-185E2AC |
| 95 | 24TTMI1-185C12 | 24TTME1-185C12 | 24GTS1-185E2AC |
| 120 | 24TTMI1-185C12 | 24TTME1-185C12 | 24GTS1-185E2AC |
| 150 | 24TTMI1-185C12 | 24TTME1-185C12 | 24GTS1-185E2AC |
| 185 | 24TTMI1-185C12 | 24TTME1-185C12 | 24GTS1-185E2AC |
| 240 | 24TTMI1-300C16 | 24TTME1-300C16 | 24GTS1-185E2AC |
| 300 | 24TTMI1-300C16 | 24TTME1-300C16 | 24GTS1-300C |
| 400 | 24TTMI1-630C16 | 24TTME1-630C16 | 24GTS1-630C |
| 500 | 24TTMI1-630C16 | 24TTME1-630C16 | 24GTS1-630C |
| 630 | 24TTMI1-630C16 | 24TTME1-630C16 | 24GTS1-630C |

N.B. Per i cavi tripolari utilizzare tre confezioni unipolari della sezione corrispondente.

ARE4H1RX - Elica visibile - 18/30 kV

18/30 kV Dati dimensionali - size characteristics

| Formazione | Ø nominale conduttore | Spessore isolante | Spessore guaina | Ø nominale cavo | Peso nominale cavo | Raggio minimo di curvatura |
|----------------------|--------------------------|----------------------|------------------|--------------------|----------------------|----------------------------|
| Size | Nominal conduct. Ø | Insulation thickness | Sheath thickness | Nominal cable Ø | Nominal cable weight | Minimum bending radius |
| n° x mm ² | mm | mm | mm | mm | kg/km | mm |
| 35 | 7,0 | 8,0 | 1,9 | 36,0 | 920 | 430 |
| 50 | 8,1 | 8,0 | 2,0 | 37,5 | 990 | 460 |
| 70 | 9,9 | 8,0 | 2,0 | 39,5 | 1140 | 480 |
| 95 | 11,5 | 8,0 | 2,1 | 41,1 | 1265 | 500 |
| 120 | 12,9 | 8,0 | 2,1 | 42,5 | 1380 | 530 |
| 150 | 14,2 | 8,0 | 2,2 | 44,2 | 1510 | 550 |
| 185 | 15,9 | 8,0 | 2,2 | 45,8 | 1665 | 570 |
| 240 | 18,3 | 8,0 | 2,3 | 49,0 | 1940 | 610 |
| 300 | 20,7 | 8,0 | 2,4 | 51,5 | 2245 | 640 |
| 400 | 23,5 | 8,0 | 2,5 | 57,6 | 2625 | 690 |
| 500 | 26,5 | 8,0 | 2,6 | 57,7 | 3065 | 730 |
| 630 | 30,1 | 8,0 | 2,7 | 63,4 | 3860 | 810 |
| 3x1x35 | 7,0 | 8,0 | 1,9 | 77,8 | 2766 | 430 |
| 3x1x50 | 8,1 | 8,0 | 2,0 | 81,0 | 2976 | 560 |
| 3x1x70 | 9,9 | 8,0 | 2,0 | 85,3 | 3427 | 480 |
| 3x1x95 | 11,5 | 8,0 | 2,1 | 88,8 | 3803 | 500 |
| 3x1x120 | 12,9 | 8,0 | 2,1 | 91,8 | 4148 | 530 |
| 3x1x150 | 14,2 | 8,0 | 2,2 | 95,5 | 4539 | 550 |
| 3x1x185 | 15,9 | 8,0 | 2,2 | 98,9 | 5005 | 570 |
| 3x1x240 | 18,3 | 8,0 | 2,3 | 105,8 | 5832 | 610 |
| 3x1x300 | 20,7 | 8,0 | 2,4 | 111,2 | 6748 | 640 |

Per i cavi con isolamento in G7 i dati dimensionali sono da ritenersi identici.
 For cables with insulation G7 dimensional data are to be considered identical.

ARE4H1RX - Elica visibile - 18/30 kV

18/30 kV Caratteristiche elettriche - electrical characteristics

| Formazione Size | Capacità nominale Nominal capacity | Corrente capacitiva nominale a tensione U_0 Nominal capacitive current at voltage U_0 | Reattanza di fase a 50 HZ Reactance phase 50HZ | Resistenza massima in CC del conduttore a 20°C Conductor max electrical resist. CC at 20°C | Resistenza massima in CC dello schermo a 20°C Screen max electrical resist. CC at 20°C | Resistenza massima in CA del conduttore a 90°C Conductor max electrical resist. CA at 20°C | Portata di corrente Current rating A | | Corrente di corto circuito del conduttore Short circuit current conductor (1s) |
|----------------------|---------------------------------------|--|---|---|---|---|--|--|---|
| n° x mm ² | mm | A/Km | Ω/Km | Ω/Km | Ω/Km | Ω/Km | in aria a 30° C in air at 30° C | interrato a 20° C Underground at 20° C Rt=1m°C/W | kA |
| 35 | 0,13 | 0,74 | 0,153 | 0,868 | 3,0 | 1,115 | 160 | 156 | 3,2 |
| 50 | 0,13 | 0,83 | 0,149 | 0,641 | 3,0 | 0,825 | 198 | 181 | 4,6 |
| 70 | 0,15 | 0,92 | 0,140 | 0,443 | 3,0 | 0,570 | 243 | 222 | 6,5 |
| 95 | 0,16 | 1,01 | 0,132 | 0,320 | 3,0 | 0,412 | 289 | 263 | 8,8 |
| 120 | 0,18 | 1,10 | 0,127 | 0,253 | 3,0 | 0,328 | 334 | 296 | 11,1 |
| 150 | 0,19 | 1,16 | 0,123 | 0,206 | 3,0 | 0,268 | 373 | 337 | 13,8 |
| 185 | 0,21 | 1,22 | 0,119 | 0,164 | 3,0 | 0,213 | 426 | 371 | 17,0 |
| 240 | 0,22 | 1,37 | 0,115 | 0,125 | 3,0 | 0,163 | 494 | 419 | 22,1 |
| 300 | 0,24 | 1,49 | 0,111 | 0,100 | 3,0 | 0,132 | 555 | 469 | 27,6 |
| 400 | 0,27 | 1,64 | 0,107 | 0,0778 | 3,0 | 0,103 | 630 | 526 | 36,8 |
| 500 | 0,29 | 1,79 | 0,103 | 0,0605 | 3,0 | 0,081 | 714 | 581 | 46,0 |
| 630 | 0,32 | 1,96 | 0,100 | 0,0469 | 3,0 | 0,064 | 793 | 625 | 58,0 |
| 3x1x35 | 0,13 | 0,74 | 0,153 | 0,868 | 3,0 | 1,115 | 160 | 156 | 3,2 |
| 3x1x50 | 0,13 | 0,83 | 0,149 | 0,641 | 3,0 | 0,825 | 198 | 181 | 4,6 |
| 3x1x70 | 0,15 | 0,92 | 0,140 | 0,443 | 3,0 | 0,570 | 243 | 222 | 6,5 |
| 3x1x95 | 0,16 | 1,01 | 0,132 | 0,320 | 3,0 | 0,412 | 289 | 263 | 8,8 |
| 3x1x120 | 0,18 | 1,10 | 0,127 | 0,253 | 3,0 | 0,328 | 334 | 296 | 11,1 |
| 3x1x150 | 0,19 | 1,16 | 0,123 | 0,206 | 3,0 | 0,268 | 373 | 337 | 13,8 |
| 3x1x185 | 0,21 | 1,22 | 0,119 | 0,164 | 3,0 | 0,213 | 426 | 371 | 17,0 |
| 3x1x240 | 0,22 | 1,37 | 0,115 | 0,125 | 3,0 | 0,163 | 494 | 419 | 22,1 |
| 3x1x300 | 0,24 | 1,49 | 0,111 | 0,100 | 3,0 | 0,132 | 555 | 469 | 27,6 |

Per i cavi con isolamento in G7 le portate di corrente sono da ritenersi più basse di 4-6 A.
For cables with insulation G7 current rating are to be considered more low 4-6 A.

Accessori Consigliati/Recommended accessories

Accessori per cavi con tensione di esercizio/Cables accessories with voltage 18/30 kV

| Sezione nominale conduttore Nominal section conductor | Terminazione termorestringente da interno unipolare Xxxxxx | Terminazione termorestringente da esterno unipolare Xxxxxx | Giunto termorestringente unipolare Xxxxxx |
|--|---|---|--|
| 35 | 36TTMI1-70C12 | 36TTME1-70C12 | 36GTS1-95C |
| 50 | 36TTMI1-70C12 | 36TTME1-70C12 | 36GTS1-95C |
| 70 | 36TTMI1-70C12 | 36TTME1-70C12 | 36GTS1-95C |
| 95 | 36TTMI1-240C12 | 36TTME1-240C12 | 36GTS1-95C |
| 120 | 36TTMI1-240C12 | 36TTME1-240C12 | 36GTS1-240C |
| 150 | 36TTMI1-240C12 | 36TTME1-240C12 | 36GTS1-240C |
| 185 | 36TTMI1-240C12 | 36TTME1-240C12 | 36GTS1-240C |
| 240 | 36TTMI1-240C16 | 36TTME1-240C12 | 36GTS1-240C |
| 300 | 36TTMI1-300C16 | 36TTME1-300C16 | 36GTS1-300C |
| 400 | 36TTMI1-630C16 | 36TTME1-630C16 | 36GTS1-630C |
| 500 | 36TTMI1-630C16 | 36TTME1-630C16 | 36GTS1-630C |
| 630 | 36TTMI1-630C16 | 36TTME1-630C16 | 36GTS1-630C |

N.B. Per i cavi tripolari utilizzare tre confezioni unipolari della sezione corrispondente.

| Technical characteristics | | ITEM 1 | |
|-----------------------------------|-----|---------------------|------------|
| Applicable standard | | IEC 60076 | |
| Rated frequency | Hz | 50 | |
| Rated voltage ratio (no-load) | kV | 150 ± 12x1,25% / 30 | |
| Vector group | | YNd11 | |
| Cooling system | | ONAN/ONAF | |
| Rated power | MVA | 63/77 | |
| No-load losses | kW | 26,3 | (IEC tol.) |
| Load losses | kW | 329 | (IEC tol.) |
| Short-circuit impedance | % | 13,5 | (IEC tol.) |
| Max ambient temperature | °C | 40 | |
| Top oil temperature rise | K | 60 | |
| Average winding temperature rise | K | 65 | |
| Hot-spot winding temperature rise | K | 78 | |

| Insulation levels | | HV | HV-N | LV | LV-N |
|--------------------------------|----|-----|------|-----|------|
| Full wave lightning impulse LI | kV | 650 | 650 | 125 | N/A |
| Applied voltage AV | kV | 275 | 275 | 50 | N/A |

| Bushing | | HV | HV-N | LV | LV-N |
|---------------------------------------|----|----------------|----------------|---------|------|
| Type | | O.I.P. ceramic | O.I.P. ceramic | Ceramic | N/A |
| Nominal Voltage (U _m) | | 170 | 170 | 24 | N/A |
| Full wave lightning impulse LI | kV | 750 | 750 | 125 | N/A |
| Current | A | 800 | 800 | 3150 | N/A |
| Air Insulated Cable Boxe ¹ | | - | - | - | - |
| Bushing for IPB | | - | - | - | - |

| Weights and Dimensions (approximate values) | | |
|---|----|-----------------|
| Oil weight | kg | 23 000 |
| Total weight | kg | 87 000 |
| Total dimensions (L x W x H) | m | 7,5 x 5,1 x 6,7 |

Notes

- The indicated guaranteed values are referred to the maximum rated power
- Sound pressure level (Lpa) at No load + Cooling: <75 dBA
- Total losses (Load losses + no load losses) according to TIER 2 @80MVA

Technical Description

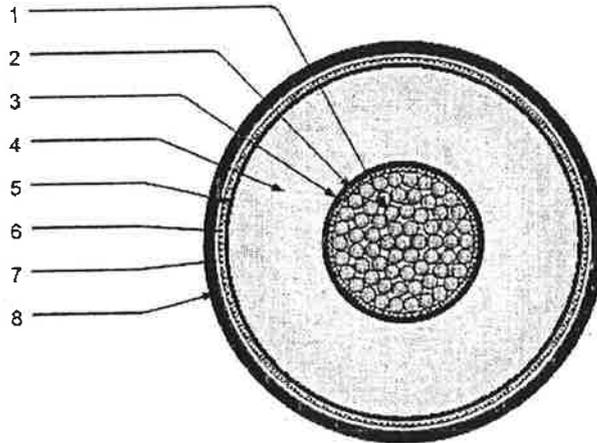
| | |
|------------------------|---|
| Applicable standard | IEC 60076, IEC 60296, IEC 60137, IEC 60214 |
| Installation | Outdoor |
| Transformer type | Power Oil Transformer Three-phase |
| Cooling system | ONAN/ONAF |
| Means of cooling | Radiators on the tank side + fans |
| Tap changer on HV side | On- load, filled with oil |
| Tap changer on LV side | N.A. |
| Magnetic core | Three limbs core type, made by cold rolled grain oriented sheet steel |
| Windings | Circular concentric construction, made by electrolytic copper conductors insulated with KRAFT paper or paperless/netting tape |
| Tank | Welded tank with bolted cover |
| Insulation class | A |
| Insulating oil | Mineral non-inhibited |
| Painting | Internal: Hot-oil-resistant paint External: See the enclosed Painting Specification. |

Standard accessories

- Oil conservator
- No.2 oil level indicator, magnetic type, with minimum oil level alarm contact (NO type)
- Pressure relief valve on the transformer tank, fitted with trip contact;
- Buchholz relay for transformer oil equipped with: No.1 alarm contact and No.1 trip contacts
- Oil thermometer fitted with No.1 alarm contact and NO. 1 trip contact
- Thermometer pockets on tank cover
- Upper + lower filter press valves
- Oil sampling valve
- No. 2 stainless steel earthing clamps installed diagonally at the transformer tank
- No. 4 lifting lugs for lifting the core and winding assembly
- No. 4 lifting lugs for lifting the complete transformer
- No. 4 pulling hooks for towing the transformer in both direction (90°)
- No. 4 jacking plates
- Stainless steel name plates with characteristics according to IEC Standards
- Auxiliary terminal box mounted on a tank side IP54
- Sensformer (see "Pager-Sensformer_FINAL.pdf)
- Auxiliary supplier is 400VAC 50Hz, 3ph, for fans and OLTC motor drive

$S = \pi r^2$
 $r = \sqrt{\frac{S}{\pi}}$

| | | | | |
|---------------|--|-----------------|--|---------------------------------------|
| Type of Cable | Water Blocked Single Core Conductor 220kV XLPE Cable with Welded Al Sheath | | | |
| Voltage 220kV | Conductor Size 500 mm ² | Insulation XLPE | Single-phase short circuit: 42kA/1sec. | Three-phase short circuit: 40kA/3sec. |



Diagrammatic Only - Not To Scale

| Item | Description | Thickness (mm) | Details | Nominal Diameter |
|------|-------------------|----------------|-----------------------------------|------------------|
| 1 | Conductor | - | Filled Compacted Copper | 27.2 |
| 2 | Binder | - | Semi-Conducting tape | - |
| 3 | Conductor Screen | - | Semi-Conducting Polymer | 31.1 |
| 4 | Insulation | 25.5 min ave | XLPE | 83.1 |
| 5 | Insulation Screen | - | Semi-Conducting Polymer | 86.0 |
| 6 | Binder | - | Hygroscopic Semi- conducting tape | 88.0 |
| 7 | Metallic Sheath | 1.4 nominal | Welded Al | 90.8 |
| | Glue | - | Glue | - |
| 8 | Finish | 4.5 nominal | Polyethylene + Graphite | 100.7 |

$S = 1000 \text{ mm}^2$
39 ?

| | | | |
|----------------|----------------|--------------------------------|-----------------------------|
| Drawn by: MA | Date: 05/10/05 | Approximate Weight : 12.0 kg/m | Drg No: HVSYS05/124_CD(1).0 |
| Checked by: MM | | | |

prof
1.5m 1000 A

$S = 1600 \text{ mm}^2 \rightarrow \phi \approx 45 \text{ mm}$ 51.3 mm
 $S = 1000 \text{ mm}^2 \rightarrow \phi \approx 39 \text{ mm}$ do CONFIRM

XLPE High Voltage Cables

| | | |
|--|---|---|
| Single-core Cable for 220/127 (245) kV with Copper wire screen and Lead sheath | | XDRCU-PBT |
| Cable layout <ul style="list-style-type: none"> Copper conductor, round stranded or segmented optionally with longitudinal water barrier Inner semiconductive layer firmly bonded to the XLPE insulation XLPE main insulation, cross-linked Outer semiconductive layer firmly bonded to the XLPE insulation Copper wire screen as short-circuit current carrying component with semi-conductive swelling tapes above and below as longitudinal water barrier Extruded Lead sheath as radial diffusion barrier Thermoplastic oversheath as mechanical protection optionally with semi-conductive and/or flame-retardant layer | Features of metallic sheath <ul style="list-style-type: none"> Robust seamless construction 100% impervious to moisture Long-term proven design Production process The inner semiconductive layer, the XLPE main insulation and the outer semiconductive layer are extruded in a single operation applying a dry curing and a water or nitrogen cooling method. |  |
| Applicable standards IEC 62067 AEIC CS9 ANSI / ICEA S-108-720 | | |

Technical data

| Copper conductor cross-section | | Outer diameter (approx.) | Cable weight (approx.) | Capacitance | Impedance (90°C, 50 Hz) | Impedance (90°C, 50 Hz) | Surge impedance | Min. bending radius | Max. pulling force |
|--------------------------------|-------|--------------------------|------------------------|-------------|-------------------------|-------------------------|-----------------|---------------------|--------------------|
| mm ² | kcmil | mm | kg/m | µF/km | Ω/km | Ω/km | Ω | mm | kN |
| 300 | 600 | 100 | 19 | 0.12 | 0.25 | 0.17 | 65 | 2000 | 18 |
| 400 | 800 | 100 | 20 | 0.13 | 0.24 | 0.16 | 60 | 2000 | 24 |
| 500 | 1000 | 100 | 22 | 0.14 | 0.23 | 0.15 | 56 | 2000 | 30 |
| 630 | 1250 | 101 | 23 | 0.16 | 0.22 | 0.14 | 51 | 2000 | 38 |
| 800 | 1600 | 105 | 25 | 0.19 | 0.21 | 0.13 | 46 | 2100 | 48 |
| 1000 | 2000 | 111 | 29 | 0.21 | 0.20 | 0.12 | 42 | 2200 | 60 |
| 1200 | 2400 | 112 | 32 | 0.24 | 0.19 | 0.12 | 39 | 2200 | 72 |
| 1400 | 2750 | 112 | 33 | 0.25 | 0.19 | 0.11 | 37 | 2200 | 84 |
| 1600 | 3200 | 116 | 36 | 0.27 | 0.18 | 0.11 | 36 | 2300 | 96 |
| 2000 | 4000 | 120 | 40 | 0.29 | 0.18 | 0.10 | 34 | 2400 | 120 |
| 2500 | 5000 | 130 | 48 | 0.31 | 0.17 | 0.10 | 32 | 2600 | 150 |

Ampacity

| | | Directly buried | Directly buried | In ducts | In ducts | In free air | In free air | In ductbank | Directly buried |
|-----------------|-------|-----------------|-----------------|----------|----------|-------------|-------------|--------------|-----------------|
| | | 20°C | 20°C | 20°C | 20°C | 35°C | 35°C | 15°C | 40°C |
| | | 1.0 Km/W | 1.0 Km/W | 1.0 Km/W | 1.0 Km/W | - | - | 0.8/1.0 Km/W | 1.4 Km/W |
| mm ² | kcmil | A | A | A | A | A | A | A | A |
| 300 | 600 | 597 | 650 | 589 | 615 | 716 | 778 | 654 | 445 |
| 400 | 800 | 686 | 750 | 678 | 709 | 838 | 917 | 755 | 509 |
| 500 | 1000 | 774 | 850 | 766 | 803 | 960 | 1056 | 855 | 573 |
| 630 | 1250 | 879 | 974 | 875 | 920 | 1122 | 1246 | 982 | 650 |
| 800 | 1600 | 990 | 1101 | 983 | 1037 | 1283 | 1435 | 1109 | 727 |
| 1000 | 2000 | 1168 | 1293 | 1152 | 1219 | 1542 | 1725 | 1304 | 852 |
| 1200 | 2400 | 1261 | 1404 | 1246 | 1320 | 1693 | 1909 | 1416 | 917 |
| 1400 | 2750 | 1351 | 1512 | 1368 | 1432 | 1850 | 2086 | 1536 | 983 |
| 1600 | 3200 | 1441 | 1620 | 1490 | 1544 | 1978 | 2257 | 1654 | 1043 |
| 2000 | 4000 | 1595 | 1805 | 1654 | 1720 | 2229 | 2574 | 1843 | 1147 |
| 2500 | 5000 | 1749 | 1990 | 1817 | 1896 | 2496 | 2908 | 2035 | 1260 |

Calculation basis:

Conductor temperature 90°C, 50 Hz, load factor 1.0, laying depth 1200 mm, phase distance at flat formation 30 cm
 Earthing method: Single-Point Bonding or Cross-bonding

Note:

Values apply for cables with rated voltages from 220 kV to 230 kV acc. to IEC 62067

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