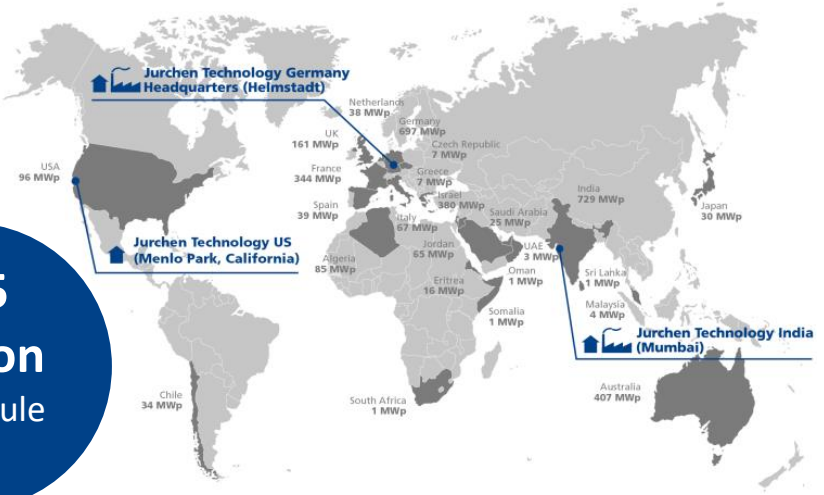
JURCHEN TECHNOLOGY

PEG EW System Overview

Jurchen Technology: Introduction

- **Established in 2008**
- **Supply of substructure / accessories and cabling harnesses:**

- **Extensive global presence:**



35 Countries **6** Continents

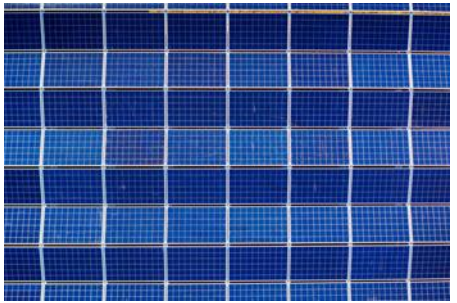
4.2 GW of wiring harness

3.6 GW of ground installation

145 million of module clips

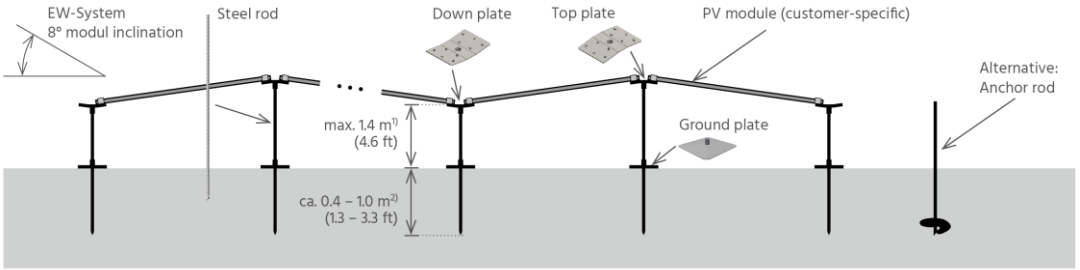
PEG: Main Benefits

- **Extremely high land use**. Comparison per acre:
  - **~3 times higher DC vs trackers**, **~ twice higher vs fixed-tilt**
  - **~225% higher yield** vs trackers & other fixed-tilt systems
- **Extremely cost-effective CAPEX** (supply and installations)
- **Low profile & shallow foundations, <1m** (**3.3ft**) above & below ground
- **Very light** system, **~9 kg (~20lb) per kWp** (540W modules)
- Proven globally, **over 500+ MWp installed**



PEG: Patented Design Characteristics

- **Only 3 items: Steel rod, Ground plate and Top plate**
- **Modules at 8 deg E-W tilt**, laid on the Top plates under the module's corners
- Optional **anchor rods** for soft soil or need for shallow foundations

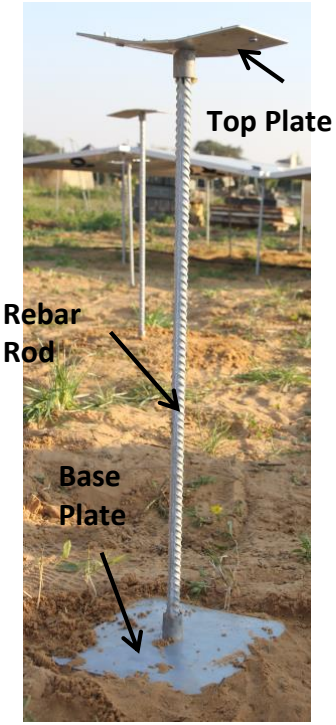


1) subject to the site conditions and system design

2) For exceptional permafrost conditions, the ramming depth could be up to 2m, done by the use of two rods crimped together onsite through a sleeve, subject to project-specific approval.

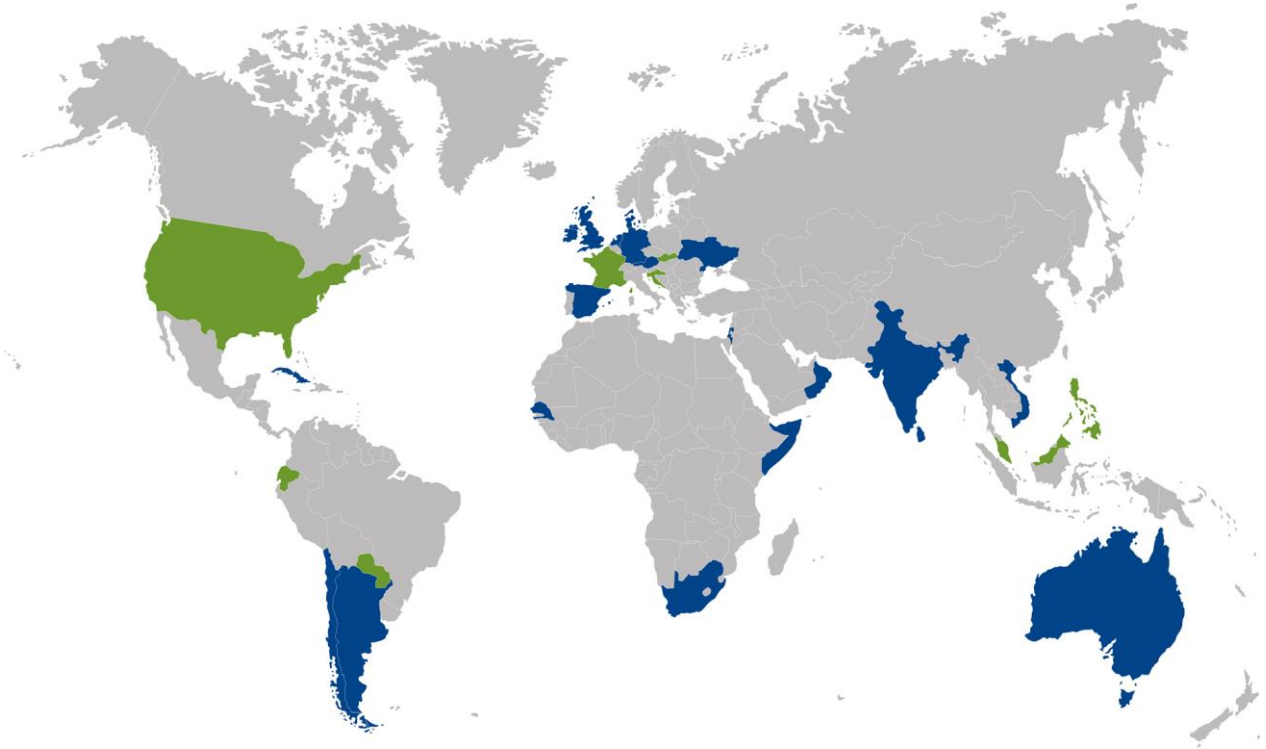
Auger diameter either
80, 150 or 250 mm

Optional helical screw anchor rod



PEG: Worldwide Installations

PEG systems worldwide: >500MWp, in 30 **countries** in all **6 continents**



In green, new countries during 2022: Croatia, Ecuador, France, Malaysia, Paraguay, Philippines, Slovakia, USA, Vietnam

PEG: Installation of Rods and Modules

Extremely **simple, safe and fast installation:**

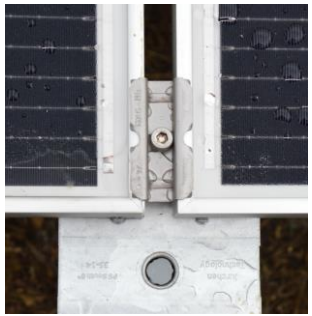
Hammer drill for rod installation

Crimping of top plate

Crimping of bottom plate*

Installation of modules

Installation of module clips



Edge clip and center clip for bonding path

EPC Estimate Overview with man hour breakdown available upon request

* Base plate is required for rebar only. Helical screw anchor rods do not require

PEG: Under Array Design and Cable Management

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View under array

View under array

Cable Management

Combiner Box

Cable routing (No DC trenching)

Inverter station

PEG: Installation Process

- **Simple, safe and fast installation** process
- Labor: **~450-520 man-hours / MWp** (subject to project size ~1-5 MW) for all DC plant (assuming 550W modules and including surveying, substructure, modules, cabling & logistics until inverters) Crews of 8-10 people per MW per week
- Tools: **Drill hammer** (with chisel function, 1200W min power, Impact Energy: 8-11 Joules) or **Auger Drilling tool**, Hydraulic **Crimping tool** (Milwaukee or Burndy) * Optional Rotary Laser for leveling top plates in undulating terrain

* Pre-qualified crimping tools for PEG

PEG installation manual is available upon request, where labor man-hour breakdown is included

PEG: Bankable System

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- **Debt finance was provided** for PEG projects, both pre and post construction
- **DNV-GL bankability report**

Examples of banks provided debt finance for PEG projects

Australian banks

nab

Commonwealth Bank

Dutch banks

ING

a.s.r.

Rabobank

DNV·GL

TECHNOLOGY ASSESSMENT

PEG Solar Racking

Jurchen Technology GmbH

Document No.: 10188745-OAL-R-01

Mounting type	GCR (Ground Cover Ratio)
PEG	≈1.0
Fixed-tilt, ground-mount	US locations: 0.40 Tropical locations: 0.87-0.93
Single-axis tracker	0.33

Energy land-use efficiency (MWh/acre/yr)	
Location	Gain PEG vs. FT/SAT
St. Cloud, Minnesota	+217% FT +224% SAT
Las Vegas, Nevada	+227% FT +222% SAT
Raleigh, North Carolina	+231% FT +241% SAT

- PEG's main advantage is in the efficiency of land use (the energy output per acre) and CAPEX reduction.
- the area-related energy harvest per acre is almost the same for either the fixed-tilt or single-axis tracker systems, while the PEG system exhibits a comparative 227% advantage over either of these types.
- The PEG product has been installed in the field since 2014 and Jurchen has not received any warranty claims to date.
- Jurchen has performed geotechnical and structural engineering which is typical for a product of this type,

PEG: Mechanical BOM – Material Spec

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Item	Material (India / Germany supply)	Corrosion protection ** (India / Germany supply)	Weight
Rod *	Ripped Steel rebar: Fe 500D / B500B	Zinc coating ~80 µm	16mm rod: ~1.75 Kg/m (~1.18lbs/ft)
Ground plate	Steel: S275MPa / S280GD	Zinc coating ~50 µm HDG / Z275 MA Pre-galvanized	~0.8 kg (1.76lbs)
Top plate	Steel: S275MPa / S280GD	Zinc coating ~50 µm HDG / Z275 MA Pre-galvanized	~0.46 kg (1.0lbs)
Corner Bracing	Steel: E250 or E350 / DX51D	Zinc coating ~80 µm HDG / Z275 MA Pre-galvanized	~3.5-4.0kg (~7.7-8.8lb)
Middle clamp	Stainless steel: SS304 / 1.4301	(None)	~0.05 kg (0.11lbs)
Edge clamp	Aluminium Alloy: 6063-T6 / EN AW 6060	(None)	~0.04 kg (0.09lbs)
Bolts	Stainless steel: SS304 / A2-70	(None)	~0.02 kg (0.045lbs)

* The rods diameter is 14mm (non UL), 16mm or 20mm. The length of the short & long rods is determined per site based on the required ramming depth (determined by Geotech report and pullout tests) and the required above-ground height.
** Indian plates supply are HDG (Hot-Dip Galvanized). German plates supply are pre-galvanize.

PEG: Design Robustness – Track Record

- **Hurricane Ian passed through PEG EW site in Cuba** on 27-Sep-2022 with intense winds, Category 3, **~120mph (~190kmh) speed**, **without causing any damage** to the PEG
- **Three severe storms** (Zeynep, Ylenia, and Antonia) **on the Waalwijk Landfill site in the Netherlands** during early 2022, with **extreme winds up to 100 mph (160 km/hr)**, **without any damage to the PEG** substructure, the modules and the cables.

27-Sep-2022, Hurricane Ian ~500km wide with its center only ~100km from a PEG EW site in Cuba

Bert van Woudenberg
Director, ProfiNRG

ProfiNRG
Professioneel in zonne-energie

» At first glance the PEG might look a vulnerable and weak substructure, however the engineering work done by Jurchen Technology and the 3 extreme storm events only few months after the completion of the PEG installations had proven completely otherwise, clearly showing the PEG unique design is very robust and can withstand for extreme weather events. This is even more impressive due to the system's shallow foundation which was required for this old landfill site where the substructure could not be deeper than 0.5m below ground. «

PEG: Soil Requirements – Type

Soil type:

- Can be **either non-cohesive** (e.g. sand or sand-gravel) **or cohesive** (e.g. sandy-clay, clayey silt)
- **Ramming through soft soil is possible** by using anchor rods
- **Ramming through limestone rock might be possible** (experience in AUS)
- **Predrill and concrete** required **for harder rock** (e.g. basalt, asphalt, coral limestone)

Mixed coral with boulders and sand and shallow water table

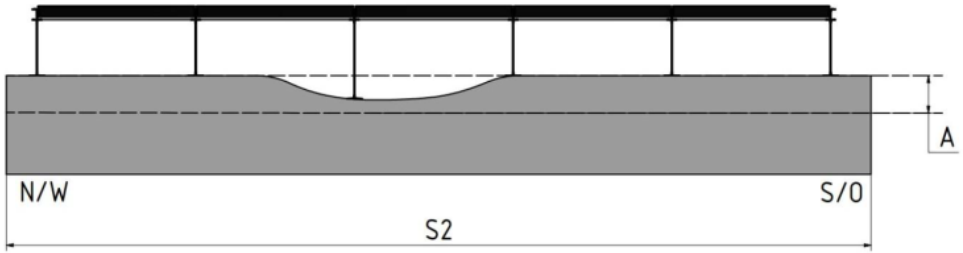
Shallow basalt example

Mixed limestone, 8 MW Cuba site

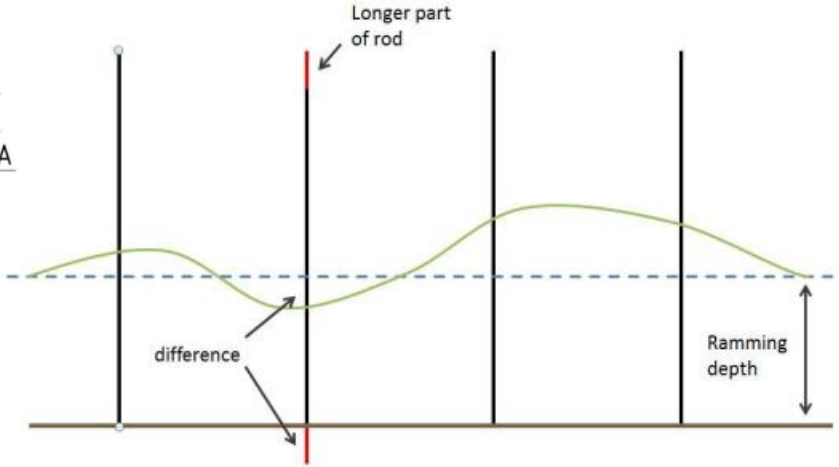
Further information is available in the **Jurchen Technology PEG slopes guidance**

PEG: Soil Requirements – Flatness

- Ground flatness: **Up to 500mm (19.68 Inch) over 9-40m (29- 130ft)** is recommended *
- Higher value is possible as long as the required ramming depth and the max above-ground height are achieved
  → The rods should be sufficiently long for the ground flatness onsite



A = Up to 0.7m (~27.5 Inch), S2 = 9-40m (29- 130ft)
* The above is implemented through customized block size to address the ground flatness



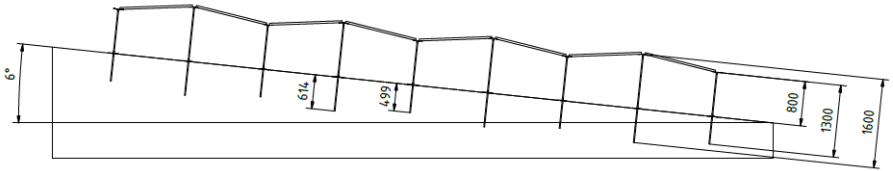
Further information is available in the **Jurchen Technology PEG slopes guidance**

Design: Ground/Soil Requirements – Type & Slopes

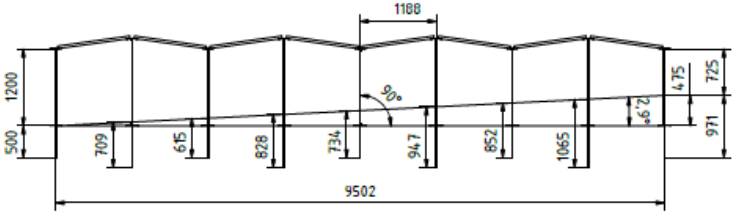
Site slopes:

The PEG can be installed on the following slopes (in any direction):

- **For sites without snow: Up to ~10 degree (~16.5%)**. slopes at 11% or higher may require additional module washing
- **For sites with snow: Up to 2 degree (3.5%)**. **Higher slope of up to ~3.5 degree (~6%)** possible– evaluated per project



Example installation for 11% slope
(no snow)



Example installation for 5% slope
(snow present)

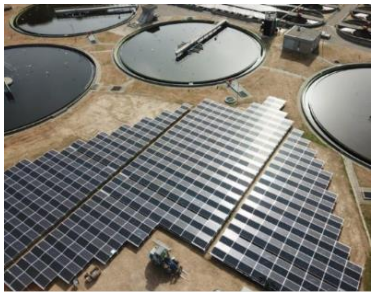
Further information available in the **Jurchen Technology PEG slopes guidance**

PEG: Land Use

- Extremely high land use: **~0.8MWp/Acre (1.9MWp/Hectare)** with ~550W modules
- **Flexible system design** allowing very high land use, also on sites with irregular shape (e.g. narrow and long or not-rectangle)
- The system's **orientation can be alighted to the site boundaries** (NOT to the East-West direction) **to maximize the land use**, with **NO impact on the system's yield**, due to the low modules' tilt

PEG aligned to the site boundaries

Non-rectangle PEG block



PEG on a very narrow land, ~10m wide

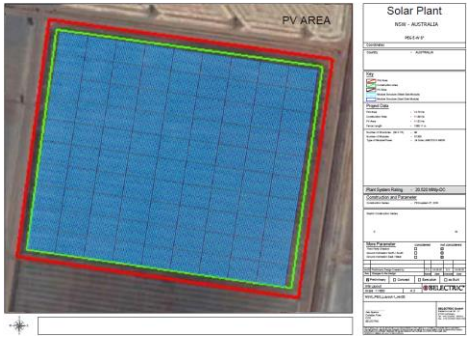
PEG: Land Use – Example

Layout example PEG vs Tracker on the same land with the same modules:

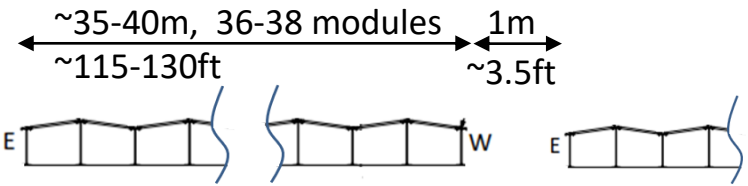
The DC with PEG EW is ~3 times higher vs with Tracker

PEG

~20.5MWp



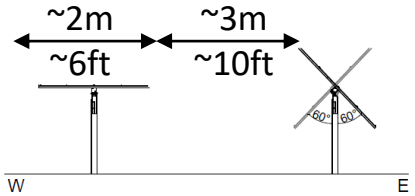
Fewer gaps, ~1m (~3.3ft) each



Tracker

~7.0MWp

Many large gaps, ~3m (~10ft) each



PEG: Approved Modules

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- **Modules suitable for PEG must have frames**
- **Approved modules list regularly updated at** https://www.jurchen-technology.com/products/pv-substructures/peg
- Some approved module manufacturers:

ASTRONERGY, BYD *, CanadianSolar *, GCL *, EGING PV ®, URECO *, First Solar, YINGLI SOLAR *, JA SOLAR *, JinKO Solar *, ZNSHINESOLAR *, LONGi *, REC *, risen solar technology *, SERAPHIM SOLAR-SYSTEM *, SOLAR FRONTIER, SUNTECH *, TALESUN, Trinasolar

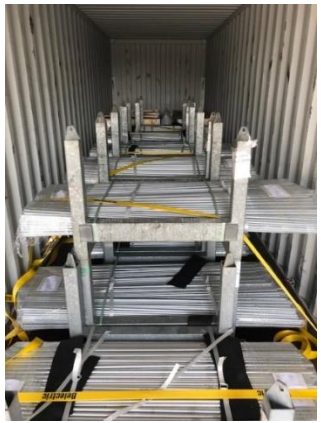
Module's compatibility with PEG MUST be confirmed before ordering

*** Approved for UL2703**

PEG: Packing & Delivery

- Substructure weight (16mm rods): **~9kg (~20lb) per kWp** for MWp scale system (with 550W modules)
- **~2.25MWp** (16mm rods) packed **in a 40ft HC container** (with 550W modules)

Examples of PEG item packing for shipment

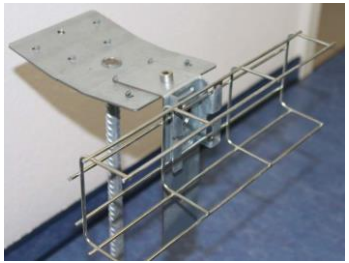
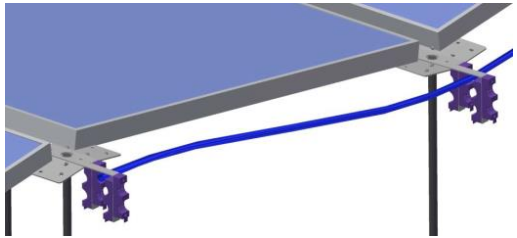



The **PEG packing specification** is available upon request

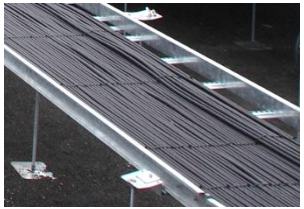
PEG: Cable Management System

- All **DC cables are above ground without trenches** in the DC plant
- Jurchen Technology offers cables management solutions for the PEG *

Cabling management products (East-West and North-South)



* Jurchen Technology cables management document is available upon request

PEG: CAPEX Costs Saving vs other systems

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Cost Factor	Saving
Material	**Substructure: 50-65% less, DC cables: ~20-30% less**
Logistics	**~50% less** due to far lower substructure quantities and weight
Labor	**~50% less** due to less labour time (hr/MW) & skilled labour (avg. hr cost)
Construction material	**No concrete & sand is required** for foundations or DC trenching
Machinery & tools	**No heavy machinery is required** (e.g. ramming, trenching, concreting). Only small forklift for site logistics and hand tools required.
Site operation	**~30-50% less installation time**, leading to saving of site operation costs, e.g. management, safety & security labor & equipment, consumables, Etc.
Safety	**Far simpler installation process**, e.g. without working on heights and without heavy substructure items, leading to significant less OHS effort and injury risks
Land	**DC area ~50-65% smaller** → Lower land acquisition / rent costs, lower installation costs, shorter perimeter fence

PEG: O&M – Access to DC plant

- **Walking paths** between the blocks allow access to the DC plant
- **Access from underneath** the PEG, **Trolley** in use by few customers
- **Walking platform** for access on top of the modules *

Walking paths, 10.8MWp PEG in Barcaldine, Qld, AUS

O&M personnel
under the PEG

Drones for inspection

Trolley for access
under the PEG

PEG: O&M – Modules Cleaning

- **Robotic machines:**
  - **GEVA BOT**, first productive use since August 2022, **~220 modules/hours with 1m wide brush** (for Landscape modules' orientation), or **~470 modules/hours 2m wide brush** (for Portrait modules' orientation)
  - **Serbot**, successfully tested during 2022 for commercial use)
- **Manual cleaning:** Gal-In, a **lightweight**, **18 kg (40lb)**, pulled with a rope and operated by two workers. **430 modules cleaned per man-hour.**

GEVA BOT robot on the PEG

Serbot pvClean Robot on the PEG

Gal-In manual cleaning system

[Additional information is available online]

PEG: O&M – Vegetation Control

Mowing solutions:

- **Fabric sheet** placed on the ground, prevents vegetation growth. Commercially available product, not flammable, allows water to penetrate
- **Raymo robotic mower** under the structure, operated by a remote control
- **Clover grass**, ~150mm (~0.5ft) tall, drought-resistant, prevents other plants growth
- **French Ouessant sheep**, less than 50cm high, successful trial in Europe during H2 ‘22

Fabric sheet under the PEG

Raymo robotic mower under the PEG

French Ouessant sheep under the PEG

Additional information is available online

PEG vegetation control spec is available upon request

PEG: LCOE Optimized with high DC/AC

For **PV to BESS Storage projects** consider modeling PEG with 2.1+ DC/AC ratio

For **Pure PV projects** consider overloading SMA Central Inverters with Ratios at 1.8+ DC/AC

Reverse DC-Coupled PV+S

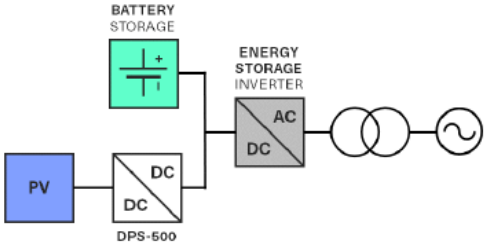
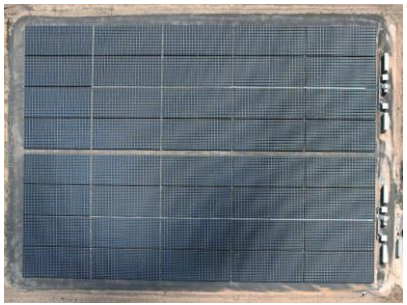


Figure 2: Reverse DC-coupled PV+S system configuration

A second configuration — Reverse DC-Coupled PV+S — currently being deployed by Dynapower ties a grid-tied bi-directional energy storage inverter with energy storage directly to the DC bus. PV is coupled to the DC bus through a DC-DC converter (Dynapower's DPS-500). Reverse DC-coupled PV+S is most often well suited for microgrid applications because of its inherent ability to efficiently provide safe and reliable power to an islanded microgrid.



Latitude Solar Project, 9 MW DC PEG EW racking with 11 MWh BESS using reverse DC coupled architecture 1.78 DC/AC

TREND TOWARD HIGHER OVERSIZING

Currently, PV power plants worldwide are already oversized on average between 120% and 140%. One of the main reasons to oversize the DC generator is that the theroretical peak power of the modules is often not achieved in reality. Thus, a certain minimum of oversizing is necessary to compensate for losses.

Reasons for this include:

- Irradiation values are not achieved (e.g., in the winter months)
- Ambient temperatures are too high
- Pollution of the modules
- Suboptimal orientation of the modules throughout the day (the factor decreases significantly with tracking systems)
- Module degradation: module performance drops annually by approx. 0.5%; after 25 years approx. 80% of the original nominal power still remains
- Mismatching losses caused, for example, by cable losses

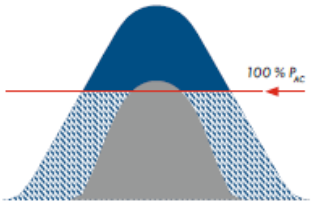


Fig. 1: Exemplary daily curve
DC/AC ratio 80%
Surplus through 180% oversizing
DC/AC ratio 130%

Dyna Power Reverse DC coupled White Paper and SMA Inverter oversizing white paper available upon request

PEG: Worldwide Installations

PEG systems worldwide:

Maastricht Landfill, Netherlands, 12MWp (2020)

Ecuador KFC Phase 1, 1.5 MWp (2023)

Konowa, AUS, 9.18 MWp (2019)

Cuba, 8MWp (2022)

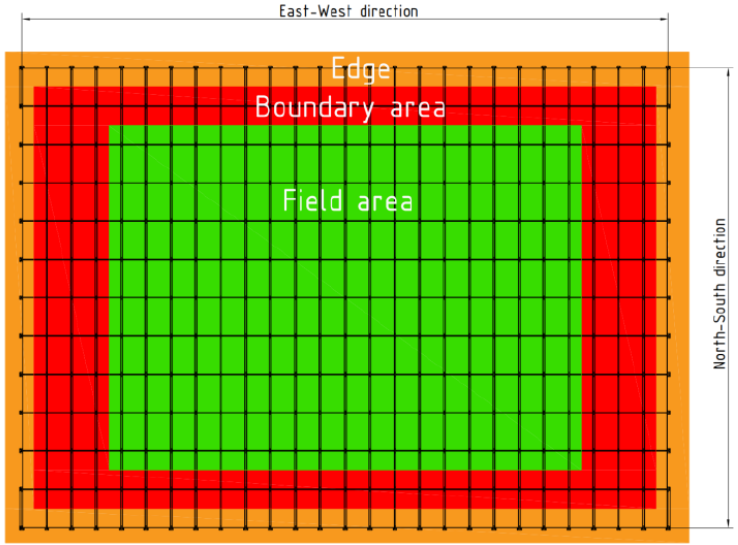
Florida, USA 248 kWp (2022)

Dareton, Australia, 3.8 MWp (2019)

PEG: High Load Wind Design

- PEG Design is determined by wind speed, wind exposure and module size
- 475 watt module max wind speed standard design 180 mph wind exposure C, ASCE
  - 185+ mph for HL design
- 550 watt module max wind speed standard design 160 mph wind exposure C, ASCE
  - 200+ mph for HL design

Above shows HL clip design with additional rod, to the right shows wind impact on PEG block and shows hybrid block design



THANK YOU FOR YOUR ATTENTION

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