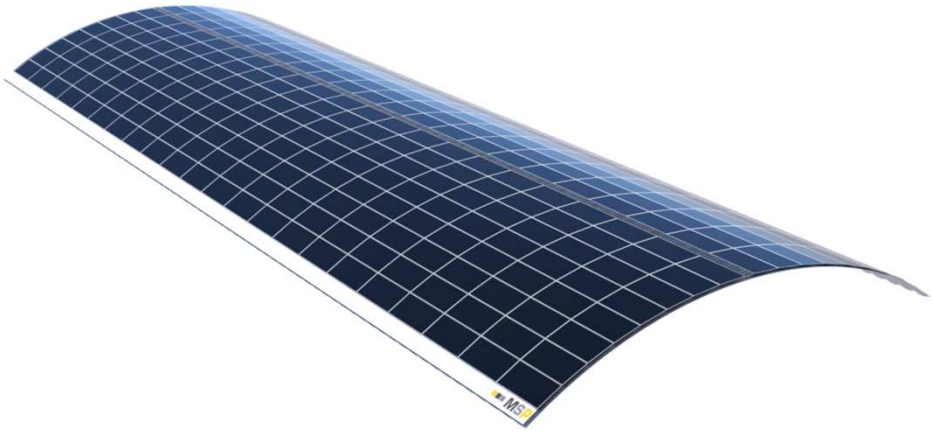
# PRODUCT BRIEF

## PRODUCT SUMMARY

| | |
|---|---|
| **Preliminary nominal DC power 252 kWp per cube (85m)** | |
| **System voltage** | **1000 V** |
| **Preliminary rated PV panel power** | **375 Wp bifacial** |
| **Mounting system** | **Fixed, GALVALUME AZ55 steel** |
| **Tilt angle of system** | **from 3 to 32° east/ west** |
| **Inverter type** | **String** |



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## 1. PREAMBLE

The contractor, on behalf of the customer, is intended to design and deliver a Plug an Play set of solar photovoltaic (PV) power and storage system .

As an full service provider with many years of experience in the construction of multi-megawatt photovoltaic power plants MSP can offer a broad spectrum of services ranging from pre-planning and detailed planning to project management and assembly of the whole power plant as well as maintenance after construction is finished.

The overall scope of work includes planning works, civil works, supply of components, mechanical and electrical installation, as well as testing and commissioning. Setup of project sites and provision of installation equipment are included. All works will be carried out in accordance with recognized standards of engineering as well as relevant German, international, and local standards. Our staff will only be adequately trained personnel. All components are tested prior to being used during the assembly of the power plant.

Planning works consist of preparation of optimised substructure layout and cable design, verification of the power plant capacity, projects layouts as well as electrical drawings. Technical documentation such as layouts and calculations for components will be provided in english language.

Civil works are minimal. Normal activities such as preparation of foundations required for equipment delivered, excavation of trenches for DC, AC, earthing, and data cables, and preparation of roadways and paths on site, are typically minimal using our system. Existing underground installations such as electric cables, water pipes, or drainage will not be affected, if the customer provides this information, such as appropriate layout plans. The contractor will perform GPS-aided measuring of positions for roadways, fence, and inverter / transformer stations.

Supply of technical components consists of works such as delivery as well as on-site management and distribution of substructure, PV modules, inverters, junctions boxes (if applicable), transformers and medium voltage switchgear, monitoring system, cable trays, solar PV cables, further DC cables (if applicable), and AC cables.

Mechanical installation works consist of GPS-aided measurement and installation of substructure as well as installation of the PV modules, and cable trays, if applicable.

Electrical installation works consist of installation of inverters, junction boxes (if applicable), monitoring equipment, electrical cables from PV modules up to the transfer station on site, and all other electrical equipment. The scope of work also covers installation of an earthing system for all electric components, substructures, and any foundations.

Test and commissioning works cover all electrical components of the power plant. Medium voltage cables will be provided at the transfer station. The grid connection of the solar power plant will be made in conjunction with the local grid operator. As part of the commissioning of the PV power plant operators will receive training for correct usage of electrical documentation and adequate operation of all control systems.

The contractor understands that the current grid connection agreements can accommodate the export capacity of the entire planned facility for each site. The projects shall be installed and connected in accordance with the network operator terms.

## 2. ABOUT US

Our company configures, plans, finances, builds, operates, and maintains large scale ground mounted photovoltaic systems around the world. Along with our 18-years' worth of experience in the solar industry, this places us among a very limited number of companies in the world with the ability to provide full project solutions for PV facilities and back it up with a strong track record in the market.

We offer a range of benefits to our clients. Over many years of operation, we have built strong relationships with leading manufacturers; hence we have access to the best equipment available at favourable prices. Due to our stringent construction standards, the "Made in Germany" quality is guaranteed. Therefore we believe all our dome based PV systems are long-lasting and highly profitable investments that cater to investors who think green.

We invite you to work with us on a new or an operating project. MSP highly specialised teams provide the highest quality throughout every phase of your photovoltaic investment.

### 2.1. BRIEF COMPANY HISTORY

The company was founded in Günzburg, Germany in 1994. The firm initially focused on building projects across the nation. After several profitable and successful years in construction, we recognised the growing potential of renewable energy sources. Therefore, since 2000 we have directed our focus towards the installation of photovoltaic power plants.

Over the following decade we built up a reputation as one of the world-leading solar energy EPC contractors. However we have gradually expanded our business scope and we now offer solutions for all stages of solar PV plant implementation worldwide. Overall, the company has developed a total capacity of above 7,500 MWp.

### 2.2. General Description and Layout

Each of the proposed PV power plants will be installed on a suitable plot of land with appropriate grid connection capacity. PV modules with a rated power of 375-380 Wp and up to 1000V system voltage have been selected for the purpose of technical design and of preparing this product brief. A preliminary layout for each plant has already been prepared.

## 3. OBJECTIVE

The contractor only uses components from reputable and bankable manufactures while the solution is designed and engineered in Germany by our personnel. The works include connection of inverters to transformer(s) which will be connected to the medium voltage substation. Electrical cables will run either via standard cable trenches in the ground or cable trays above the ground.

The power plant will be a OFF GRID solution or connected to the local medium voltage grid and the transfer station will be located within the construction site. It is the customer's responsibility to obtain all applicable licences, consents and building permits.

MSP proposes to use only the materials and components that comply with German, local and international standards as well as local regulatory specifications and authorisations. Any materials or components not covered by prevailing standards or regulations will be used only if explicitly requested by the customer. All materials will be protected from corrosion in accordance with their intended use. During construction all relevant guidelines and standards will be followed. Building materials which could damage any part of the facility or could be dangerous to the solar PV plant will not be used.

In addition to the above the following services are included in the scope of works:

- Setup of the project site.
- Provision of assembly equipment, if required.
- Operating instructions as well as care and maintenance instructions with information on the frequency and type of work required, specification of required spare parts and materials.
- Adjustment of system components wherever necessary, e.g. due to deviation variations caused by third parties.

Coordination of all tasks will be done thoroughly and according to a pre-agreed schedule. Our services will be undertaken so that any third party works can be accommodated as well. The construction will be done in a manner which simplifies future decommissioning of the plant.

Economic considerations will be given priority during the realisation of the project. All amendments will be submitted in writing. The contractor assures that machine operators and key personnel are appropriately trained so that safe and adequate operation of the plant is achieved. The documents will include all technical and functional specifications as well as the final configuration of the project.

The documentation could be provided in paper format in multiple copies as well as in digital form in DWG, DXF and PDF formats on a CD, whichever requested by the customer.

The plant will be a complete and ready-to-use electrical facility with all the following parts:

- Modules, inverters and transformers
- Power Dome based mounting solution
- Low voltage DC distribution system
- Wiring for the module strings
- AC circuit wiring
- Cable ducts
- Potential equalisation
- Surge protection
- Medium voltage cables in cable trays; installation with sockets and cable terminators, if applicable
- Wiring to an existing transmission station, if applicable

The safety measure against contact voltage will be protection by shutdown. All conductive parts will be included in the local or central potential equalization provisions.

## 3.1. GRID CONNECTION

The wiring will be done by us up to the medium voltage side of an existing transfer station, or one to be built by the grid operator. Therefore, the rest of the grid connection works to the local MV network via the transfer station connected to the power line, shall be arranged separately.

## 3.2. CIVIL WORKS

These will be minimal, due to the advantages of our system. Any civil works required for execution of tasks under the scope of work of the contractor will be undertaken by the contractor.

## 3.3. ROADWAYS AND PATHS

The access to the site shall be made suitable for heavy traffic. The availability of appropriate entry point(s) to the site will be the responsibility of the customer.

Roadways and paths on-site, if any, are also to be designed for heavy traffic. The preparation of such access routes will be the responsibility of the contractor.

The contractor assures compliance with safeguards and vehicle weight restrictions.

The customer will provide information on all requirements and obligations that are due to adverse soil conditions or local regulations.

### 3.4. COMMISSIONING

The power plant will be handed over to the customer with the following terms:

- The plant will be handed over in a ready to operate state.
- The plant will comply with fire regulations and noise protection requirements.
- The customer's representative and/or personnel will be trained on the system.
- The audit documents will be submitted.

### 3.5. Cables and Wires

Only UV-resistant solar cables will be used. The cross sections will be defined in accordance with the inverter manufacturer's specifications and according to cable length. The cable connecting module strings to junction boxes, if applicable, or inverters will be carried out using connectors and couplings as required by the manufacturer. These connectors are included within the scope of works. The necessary cable lengths will be determined from the module allocation plan. The scope of works will include wiring of all inverters including supply and installation of all cables and required auxiliary materials such ules on the mounting structure to junction boxes, inverters, and transformers. Within the transformer cube units the solar cables will be routed into cable ducts.

### 3.6 Installation EQUIPMENT

Connections in substation cube units will be done in accordance with the installation requirements provided by the manufacturer. These stations will also contain the medium-voltage switchgear.

### 3.7 Detailed Planning

Detailed planning will include, but not be limited to, preparation of comprehensive electrical and construction drawing as well as documents regarding electrical installations, dimensioning of cross sections for cables, plant layout and cable routes. The drawings and

- Single line drawings
- Distribution plans
- Power Dome views (from inside and outside)
- Installation plans

The coordination of cables routes with any third parties except subcontractors of the contractor will be the responsibility of customer. Required drawings and documentation will be made available to the site managers.

### 3.8. Documentation

Documentation will include all relevant drawings and documents for the power plant. The minimum documents to be provided after the installation of the power plant is finished are:

- Description of the power plant
- Overview of the project drawings and documents
- Maps of the project location
- Adaptation of drawings and documents related to construction implementation
- Electrical diagrams and drawings
- Cabinet / switch assignment schemes
- Wiring, terminal, and cable plans
- Measuring and test documentation
- Data sheets for all components of the power plant
- Operation manuals

### 3.9. Installation services

Installation services will include turnkey installation of solar modules including the substructure and all other system components. GPS measuring and marking of the locations of the plant, including the mounting positions, the container housings and transport routes according to a list of components and the installation plan will be included.

Installation services break down as follows:

- Site inspection and verification of cable routes
- Review of selected types of wires and cross sections, taking into account safety-related specifications and device-specific requirements
- Installation of cable ducts, protective tubes, conduits, etc
- Installation and full inspection of the electrical lines including marking of sending ends
- Installation of all wires and cables in the switchgear cabinet, as well computer and peripheral equipment and distributors including their verification
- Connection of all system components

### 3.10. Testing and Measurement

Measuring and testing will comprise the entire electrical system. Measured values will be documented and a test report will be included in the system documentation. The acceptance of the power plant will be made in the presence of the customer, with the participation of the contractor and a third party appraiser who will be designated by the customer. Acceptance of the power plant will include handover of an entire set of documents.

To ensure quality of the project the guidelines of the customer will be taken into account.

### 3.11. Briefing of Personnel

Eligible operators, appointed by the customer, will receive training for correct use of the electrical documentation and appropriate operation of all control systems. This one-off training session will take place on a date coordinated between the customer and the contractor. Protocols of the training will be included in the documentation.

# 4. Planning and Project Management

The scope of planning works covers preparation of optimised Power Dome units layout and cable design, verification of the power plant capacity, and construction layouts as well as electrical drawings.

The contractor will carry out planning and management for all tasks covered under his scope of work.

## 4.1. Preliminary planning

Preliminary planning forms the basis for all further planning phases. It includes preparation of preliminary optimisation of substructure layout, verification of the preliminary power plant capacity, and preliminary construction design drawings. The list of tasks includes:

- Agreement on the scope of works
- Advisory service on the optimal layout of the power plant
- Preliminary optimisation of substructure layout based on detailed analysis
- Preliminary positioning of the inverters and medium voltage units
- Preliminary DC and AC design
- Verification of the preliminary power plant capacity
- Estimation of the required civil works (including foundations, cable trays, and fences)
- Preliminary construction time planning
- Coordination of third parties regarding preparation of structural engineering calculations
- Compilation of pre-planning documents

## 4.2. Detailed Planning

Detailed planning includes preparation of optimised substructure layout and cable design, verification of PV power plant capacity, detailed electrical and construction drawing as well as full documents for the offered turnkey works. Detailed planning includes:

- Detailed electrical layout including optimised DC and AC cable design
- Detailed construction design including final mounting structure layout and positioning of components
- Detailed drawings showing required specifications, e.g. final implementation, execution, and construction plans as well as block diagrams, electrical distribution, cabinet view, and installation plans
- Detailed construction time planning for the offered turnkey works

- Coordination of involved third parties and implementation of third party input related to offered turnkey works
- Compilation of planning documents

### 4.3. Project Management

Preparation works include determination of quantities required and the specifications needed for DC and AC installations including medium voltage lines on site, if any, mechanical installation works, and civil works such as foundations, if needed. Contact with potential suppliers and subcontractors will be established early on.

During construction of the PV power plant, project management tasks include standard updates regarding the construction time planning, regular reports on the progress of installation works, project and site management including coordination of any third-parties involved in assembly of the power plant, and organisation of site meetings with all relevant parties.

The contractor will provide a health and safety manager, all necessary project documentation, and will provide support to the customer during commissioning of the PV system and acceptance tests required by local utility.

## 5. Civil Works

The scope of civil work covers preparation of any foundations required for components and equipment delivered and installed by the contractor, laying of DC, AC, earthing cables as well as data cables, and preparation of any roadways and paths on site. Our civil works are minimally invasive and can be carried out in many different kinds of soil. Existing underground installations such as electric cables, water pipes, or drainage will be particularly protected wherever the customer provides information such as appropriate layout plans.

Contractor will perform GPS-aided measuring of positions for roadways, fence, and standard / inverter / transformer cube units.

### 5.1. Access Roads

Access to the site has to be suitable for heavy traffic. The availability of a suitable access point to the site will be ensured by the customer.

Roadways and paths on site, if required, are to be prepared for heavy traffic. It shall be contractor's responsibility to ensure the delivery vehicles can enter and manoeuvre on the

Deconstruction of access roads, roadways, and paths and restoration of land to its former condition will, if required, be carried out by contracting party originally responsible for

# 6. Site Preparation

The scope of work for preparation of site covers supply and provision of equipment required for unobstructed installation process. The contractor will handle health and safety management and will, if necessary, install gates and access control system or provide a 24/7 security service.

If directly instructed, the contractor will be responsible for clearing of the project site from any trees or bushes. Otherwise, it will be responsibility of the customer to conduct clearing of the development site.

## 6.1. Clearing of Development Site

Before the start of construction the customer will clear the area used for construction of the PV power plant of all debris, vegetation, loose stones, and any harmful material.

If commissioned, the contractor will remove any trees and scrub. Trees with tree-trunk diameters exceeding 30 cm measured at a height of one meter will only be removed after written permission has been provided by the customer. Wood and scrub will either be stored in an area specified by the customer or will be shredded and distributed on site.

If the contractor is not commissioned for clearing the customer will conduct all clearing including removal of trees and bushes.

## 6.2. Site Setup and Equipment

The contractor will provide facilities and construction equipment that it deems necessary for on-site usage. This may include provision and delivery of containers for site office, common rooms, and storage for use during assembly period and their removal thereafter, provision and delivery of containers for accommodation facilities for use during construction period and their removal thereafter, and provision and erection of assembly areas for use during installation period and their removal thereafter. Storage areas may be prepared and maintained during assembly period.

During the site setup, the contractor will, if required, provide power connectors and power generators, allocate all other provisions necessary to set up the construction site, and supply operating sources of power.

## 6.3. Site Safety and Security

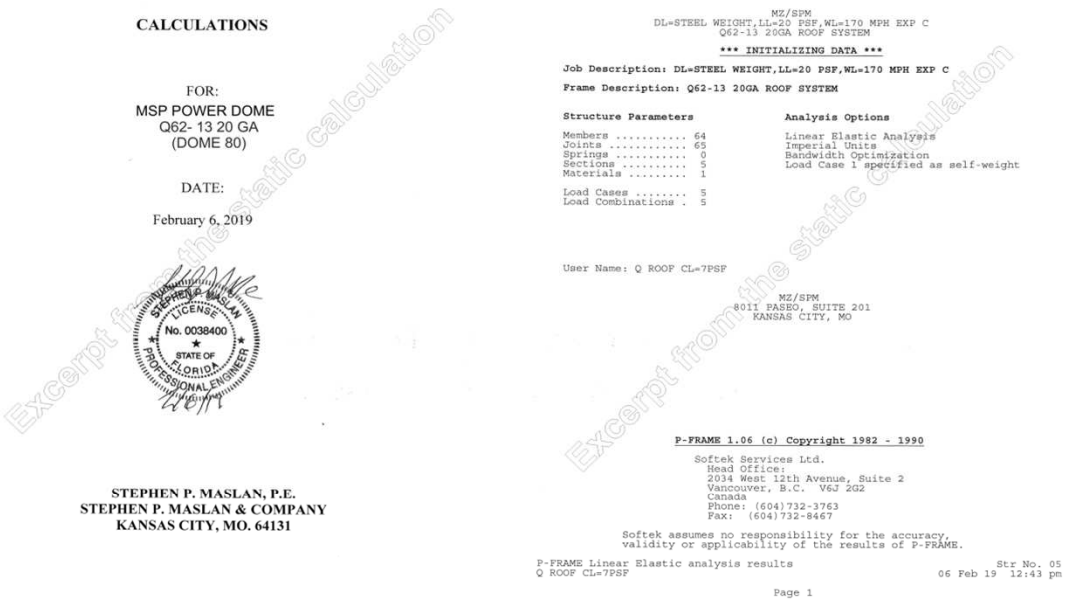
The contractor will, if necessary, install gates and access control system during the installation phase. Upon request, a 24/7 security service will be provided. A security officer will be appointed to instruct the staff and to supervise compliance with health and safety legislation.

Health and safety coordination will be conducted by the contractor during the installation phase, if necessary. It covers preparation of health and safety reports, plan, and site regulations as well as project specific training of any sub-contractors. Work will be checked in respect of compliance with health and safety regulations in regular intervals. If necessary, translators for the country's official language can be arranged during assembly phase.

## 6.4. Static Calculation

| Designation | Wind power | km/h | kn | m/s | mph |
|---|---|---|---|---|---|
| Wind load zone 1 | | 0- 81 | 0- 43.74 | 0- 22.5 | 0- 50.3 |
| Wind load zone 2 | | 82- 90 | 43.75- 48.60 | 22.6- 25.0 | 50.4- 55.9 |
| Wind load zone 3 | | 91- 99 | 48.61- 53.46 | 25.1- 27.5 | 56.0- 61.5 |
| Wind load zone 4 | | 100- 108 | 53.47- 58.32 | 27.6- 30.0 | 61.6- 67.1 |
| Hurricane Category 1 | weak | 118- 153 | 64- 82 | 33- 42 | 74- 95 |
| Hurricane Category 2 | moderate | 154- 177 | 83- 95 | 43- 49 | 96- 110 |
| Hurricane Category 3 | strong | 178- 210 | 96- 113 | 50- 58 | 111- 130 |
| Hurricane Category 4 | very strong | 211- 249 | 114- 135 | 59- 69 | 131- 155 |
| Hurricane Category 5 | devastating | > 251 | > 136 | >70 | > 156 |

According to static calculation from 06.02.2019, the MSP Power Dome can be used up to wind speeds of 170 mph. According to the table, this corresponds to wind speeds of more than hurricanes of category 5



CALCULATIONS

FOR:
MSP POWER DOME
Q62- 13 20 GA
(DOME 80)

DATE:

February 6, 2019

STEPHEN P. MASLAN
LICENSE
No. 0038400
STATE OF FLORIDA
PROFESSIONAL ENGINEER

STEPHEN P. MASLAN, P.E.
STEPHEN P. MASLAN & COMPANY
KANSAS CITY, MO. 64131

MZ/SPM
DL=STEEL WEIGHT,LL=20 PSF,WL=170 MPH EXP C
Q62-13 20GA ROOF SYSTEM

*** INITIALIZING DATA ***

Job Description: DL=STEEL WEIGHT,LL=20 PSF,WL=170 MPH EXP C

Frame Description: Q62-13 20GA ROOF SYSTEM

| Structure Parameters | | Analysis Options |
|---|---|---|
| Members | 64 | Linear Elastic Analysis |
| Joints | 65 | Imperial Units |
| Springs | 0 | Bandwidth Optimization |
| Sections | 5 | Load Case 1 specified as self-weight |
| Materials | 1 | |
| Load Cases | 5 | |
| Load Combinations | 5 | |

User Name: Q ROOF CL=7PSF

MZ/SPM
8011 PASEO, SUITE 201
KANSAS CITY, MO

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Softek assumes no responsibility for the accuracy, validity or applicability of the results of P-FRAME.

P-FRAME Linear Elastic analysis results
Q ROOF CL=7PSF
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## 7. Supply of Power Plant Components

Quality of the components and equipment installed presents the key to durability of a photovoltaic system and to long-term consistent value creation. That is why our company cooperates with leading and reputable manufacturers of PV modules, inverters, cabling, monitoring, and energy storage solutions, among others.

Using our recommended equipment and components, we are able to guarantee high power plant performance. Because we have total faith in our products, we own a share in a variety of our projects worldwide and we only invest in facilities we developed.

MSP therefore has a long history of cooperation with the leading module manufacturers and these ties enable us to offer the highest quality items going forward. Similarly, we have used numerous different models of both central and string inverters from manufacturers. Working together with the best module manufacturers our company has also been able to offer latest technology such as bi-facial photovoltaic modules. Together with hand-selected inverters we are able to ensure better production and higher returns from the PV plant.

We are currently offering our latest Power Dome unit system. In cooperation with European partners, our systems are deployable at short notice, minimally-invasive and being designed to be readily compatible with different land configurations and climates worldwide, in order to ensure high utilisation, high availability, and short repayment period.

The scope of works for supply of technical components covers delivery as well as on-site management and distribution of cube units incl. PV modules, inverters, junctions boxes (if applicable), transformers and switchgear, cable trays, solar PV cables, further DC cables (if applicable), and AC cables. Technical documentation such as layouts and calculations for components will be submitted in English language.

### 7.1. Mounting System

Our product is a highly flexible and quick-to-install solar substructure. It effectively includes the entire set of required components in standard shipping containers 40ft , according to client requirements. The mounting system are completed on site using PV modules, cabling, mounting supports, and monitoring system. Specifications of each container are available upon request.

Therefore, a purchase of our system simply means the order of a desired number of Power Domes for quick installation and requires very little prior technical knowledge on behalf of our customers. The product and its constituent elements are up to the highest technical standards of global manufacturing and are designed to work together in an optimal manner.

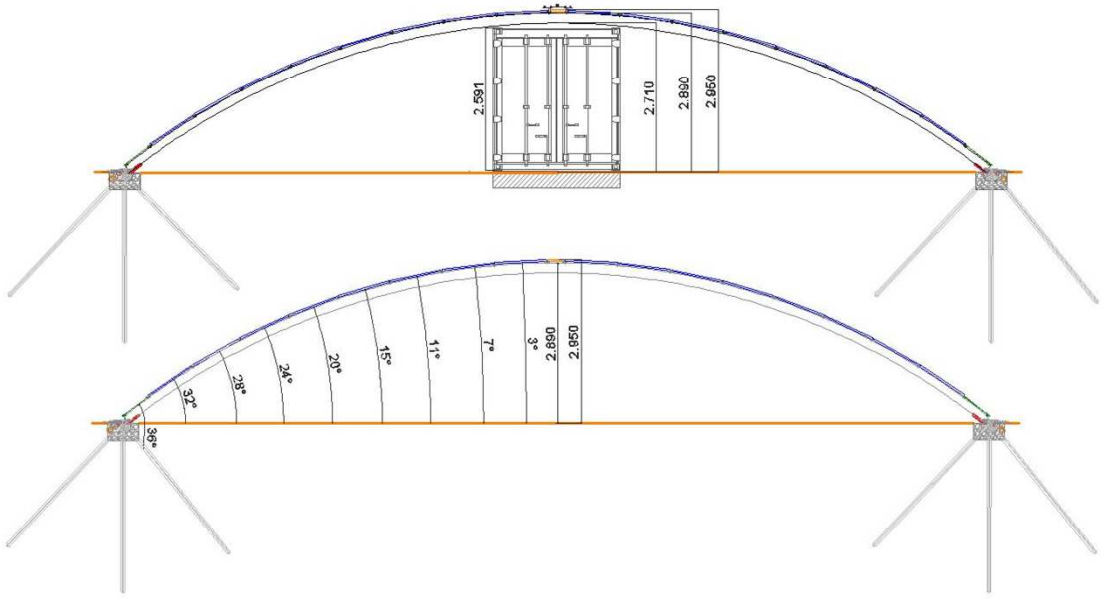



Figure 1: Power Dome front view and module angle

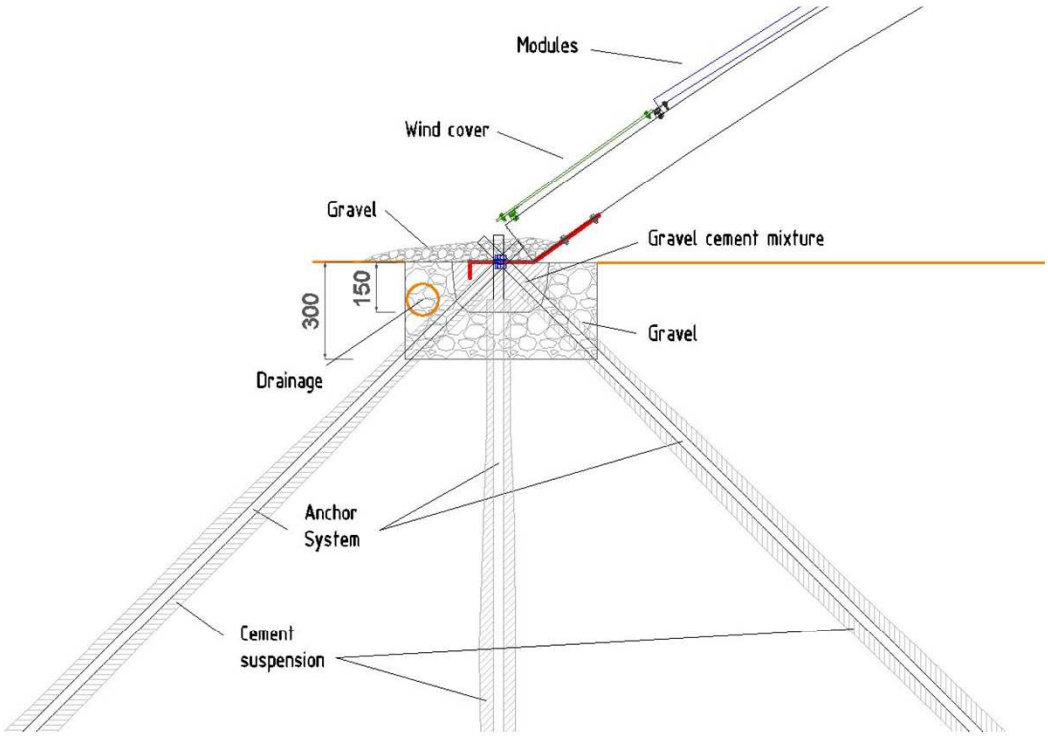
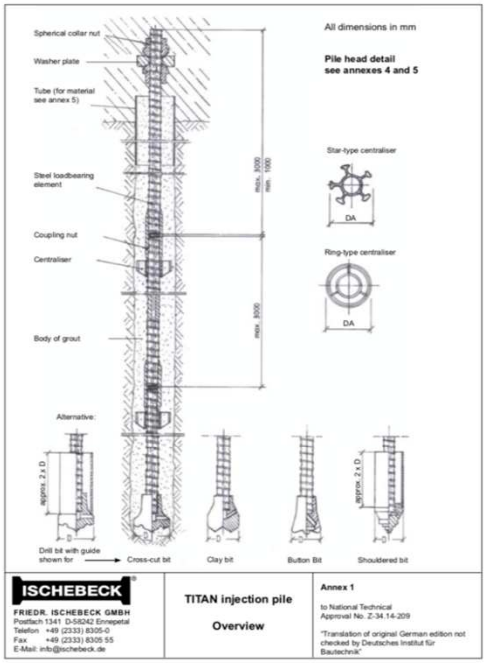
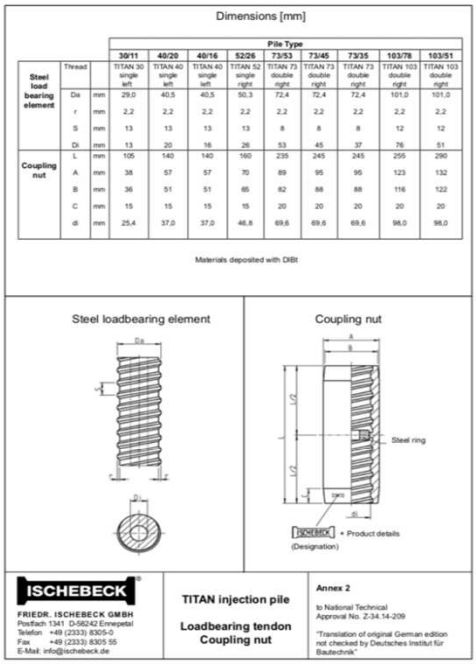



Figure 2: Concrete foundation Typ V (Detail)

### 7.1.1. Anchor System (Micro Piles)




| | | | 30/11 | 40/20 | 40/16 | 52/26 | 73/53 | 73/45 | 73/35 | 103/78 | 103/51 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TITAN 30 single left | TITAN 40 single left | TITAN 40 single left | TITAN 52 single right | TITAN 73 double right | TITAN 73 double right | TITAN 73 double right | TITAN 103 double right | TITAN 103 double right |
| Steel load bearing element | Da | mm | 29,0 | 40,5 | 40,5 | 50,3 | 72,4 | 72,4 | 72,4 | 101,0 | 101,0 |
| | r | mm | 2,2 | 2,2 | 2,2 | 2,2 | 2,2 | 2,2 | 2,2 | 2,2 | 2,2 |
| | S | mm | 13 | 13 | 13 | 13 | 8 | 8 | 8 | 12 | 12 |
| | Di | mm | 13 | 20 | 16 | 26 | 53 | 45 | 37 | 76 | 51 |
| Coupling nut | L | mm | 105 | 140 | 140 | 160 | 235 | 245 | 245 | 255 | 290 |
| | A | mm | 38 | 57 | 57 | 70 | 89 | 95 | 95 | 123 | 132 |
| | B | mm | 36 | 51 | 51 | 65 | 82 | 88 | 88 | 116 | 122 |
| | C | mm | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 20 |
| | di | mm | 25,4 | 37,0 | 37,0 | 46,8 | 69,6 | 69,6 | 69,6 | 98,0 | 98,0 |


ISCHEBECK TITAN

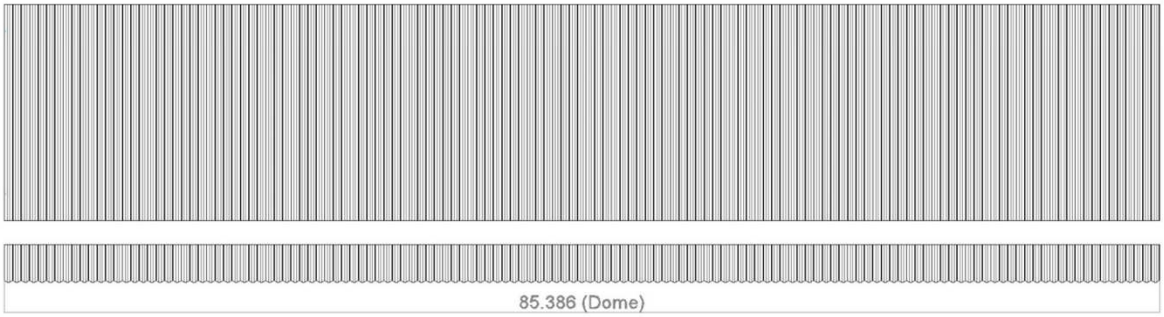
DEUTSCHES INSTITUT FÜR BAUTECHNIK
Anstalt des öffentlichen Rechts

Allgemeine bauaufsichtliche Zulassung

Zulassungsnummer: Z-34.14-209

Antragsteller: Friedr. Ischebeck GmbH, Lohe Str. 31-79, 58256 Ennepetal

Zulassungsgegenstand: Verpresspfähle TITAN



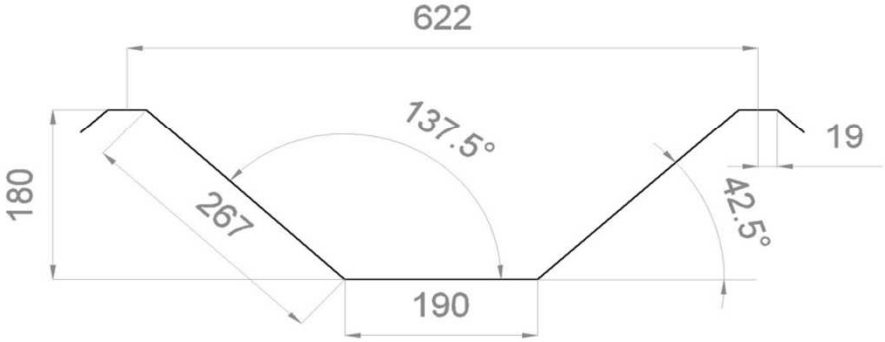




Figure 3: Roof profile

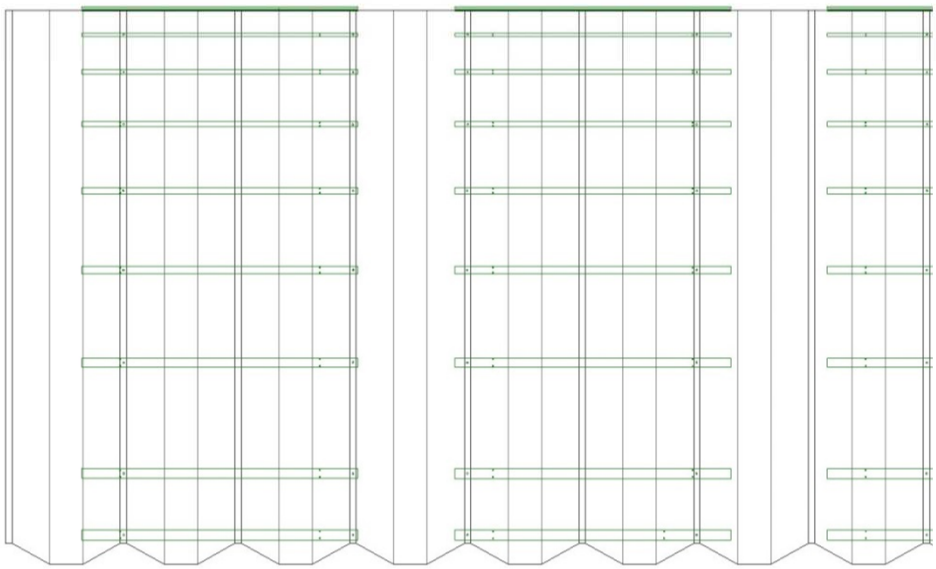


Figure 4: Modul substructure on high rib

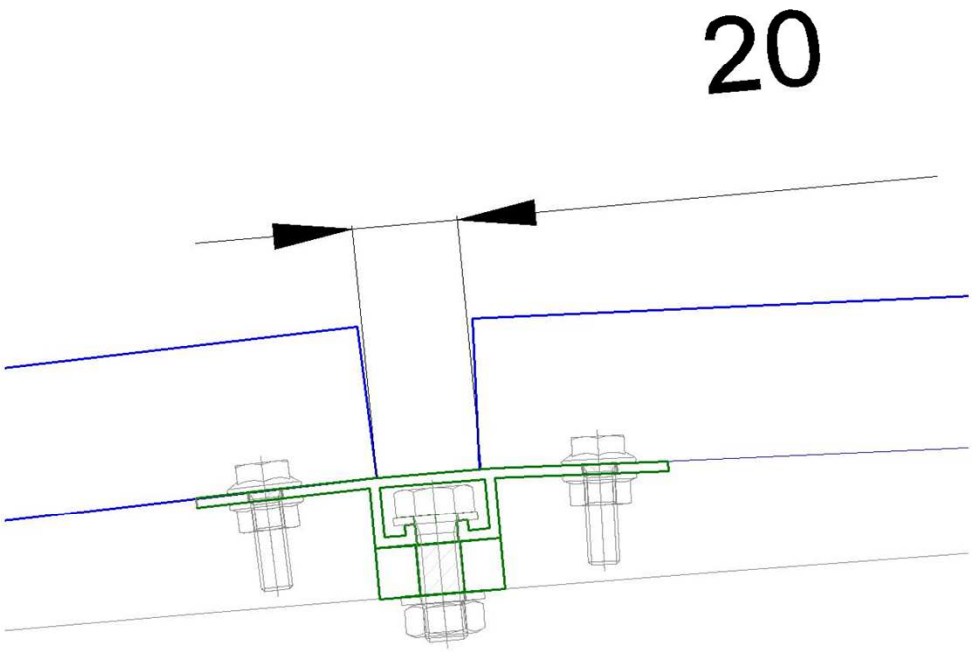



Figure 4.1: Modul substructure system (Detail)

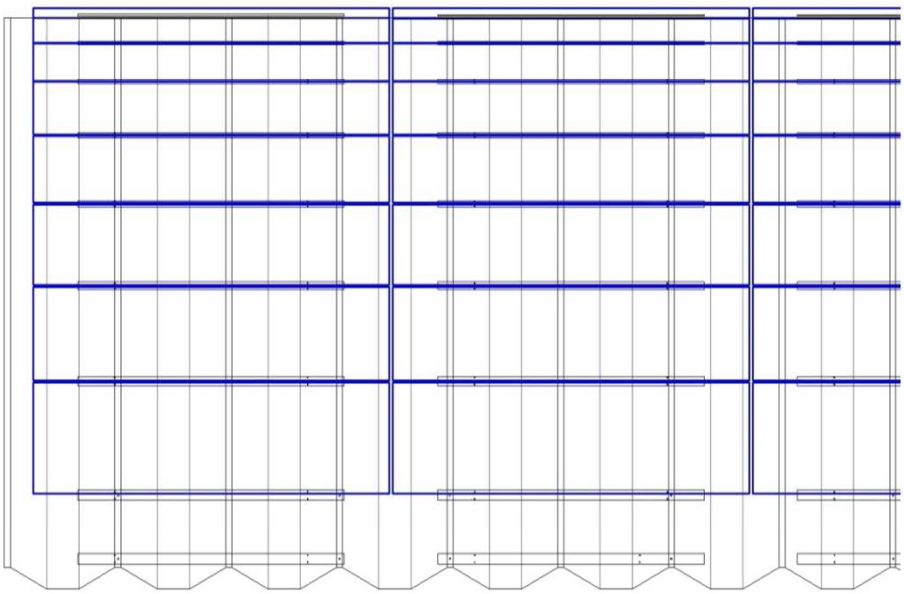


Figure 5: Modul mounting system

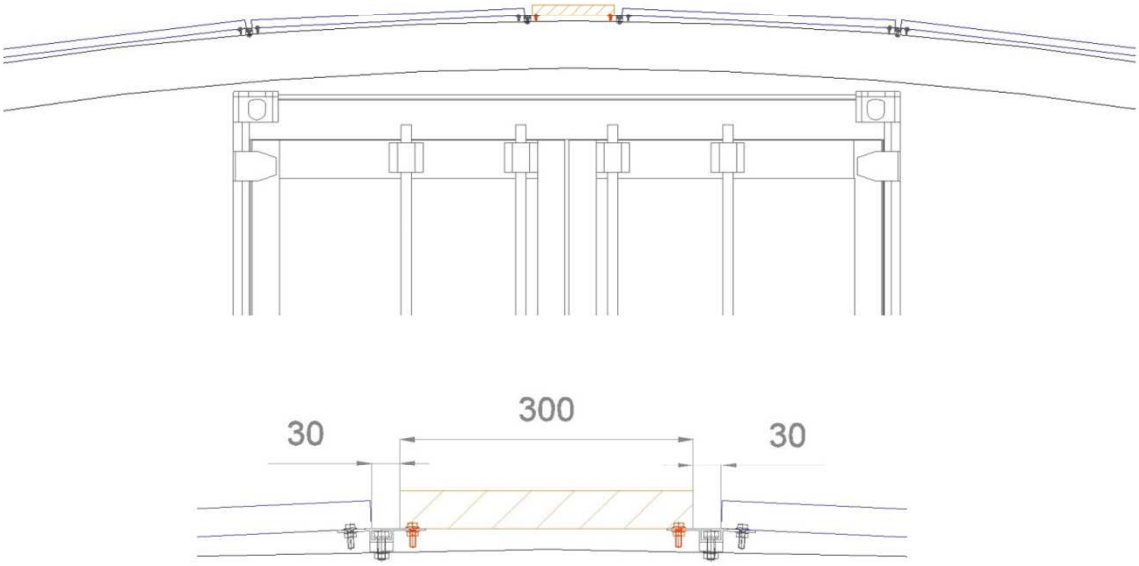



Figure 6: Maintenance bridge (Detail)

The solar PV market has shown growing popularity and wide-spread deployment of bi-facial panels, which generate electricity from light that hits the front as well as the back of the PV cells. This flexible solution has been designed to make the best use of not only the conventional modules but also the bi-facial technology.

Our plug & play product is a unique and highly flexible Power Dome. It effectively includes the entire set of required components, according to client requirements. This includes PV modules, inverters, cabling, mounting supports, as well as optional monitoring system and battery storage. Specifications of each solar Power Dome are available upon request.

Therefore, a purchase of the MSP system simply means the order of a desired number of Power Domes ready for quick installation and requires no significant prior technical knowledge on behalf of our customers. The product and its constituent elements are up to the highest technical standards of European manufacturing and are designed to work together in an optimal manner.

We provide the owners of our mounting frameworks peace of mind during the operation of the facility in several ways. The package includes constant remote monitoring of plant performance via satellite connection and cutting-edge software, therefore enabling quick identification of any technical issues. Secondly, the system features security cameras which operate 24/7 and an intelligent alarm system which alerts the user instantly to any break-ins and potential damage or theft. Also, the cabling is protected by being laid in a duct inside the Power Dome.

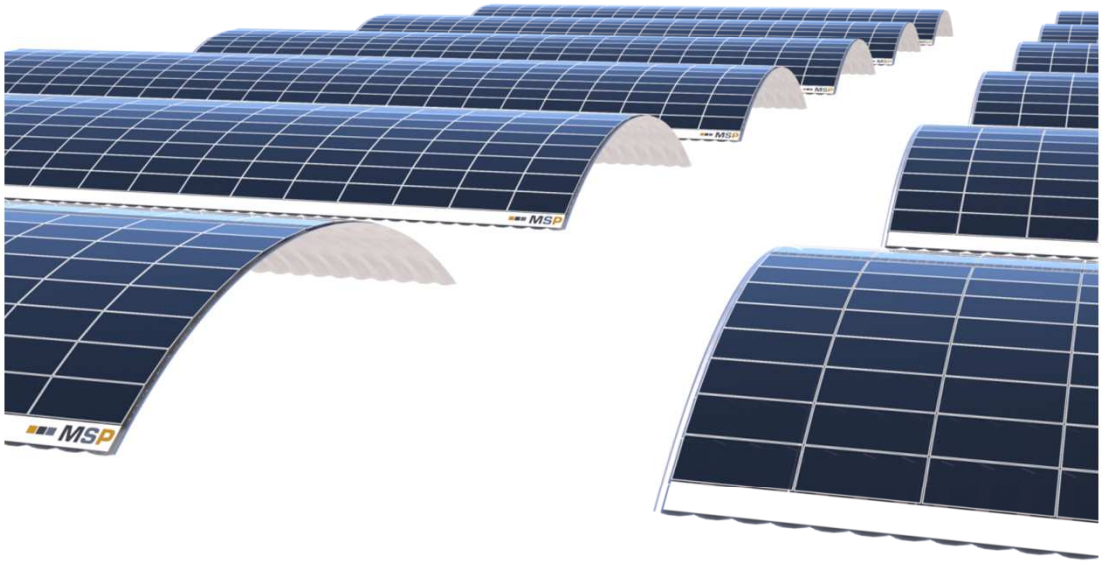



Figure 7: Illustrative side view of the Power Domes

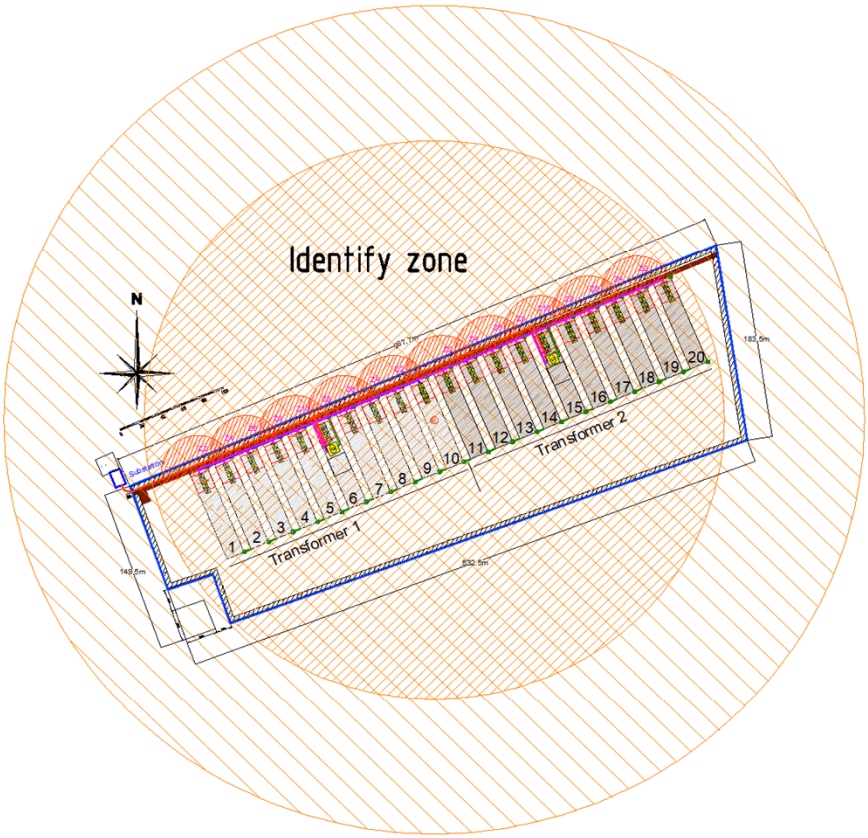



Figure 7.1: Example Project planning

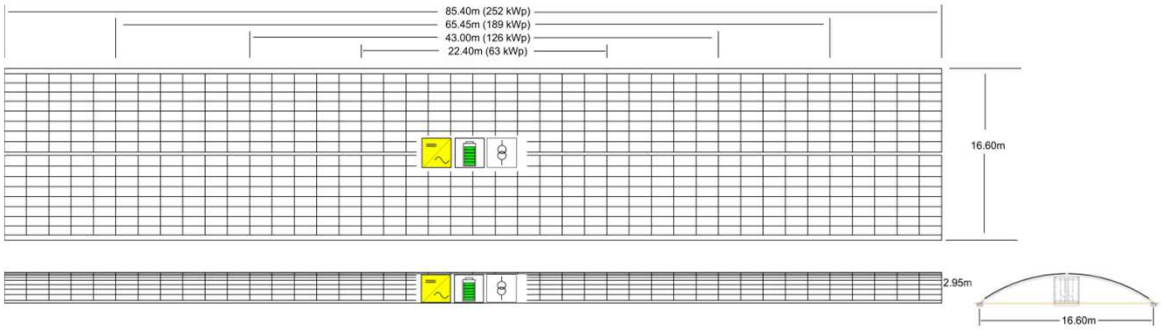



Figure 7.2: Power Dome Expansions Stages

| Transport logistics | 20 Feet Container | 40 Feet Container | | |
|---|---|---|---|---|

| Type | | | Dome 20 | | | Dome 40 | | | Dome 60 | | | Dome 80 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length [m] | | | 22.40 | | [kwh] | 43.00 | | [kwh] | 65.45 | | [kwh] | 85.40 | | [kwh] |
| PV kWp | | | 63 | | | 126 | | | 189 | | | 252 | | |
| max AC Power [kW] | | | 50 | | | 100 | | | 150 | | | 200 | | |
| | | | per day | per year | Storage 1 | per day | per year | Storage 1 | per day | per year | Storage 1 | per day | per year | Storage 1 |
| Yield [kWh/kWp] per Year | 1000 | Average Yield [kWh] | 173 | 63.000 | 133 | 345 | 126.000 | 200 | 518 | 189.000 | 333 | 690 | 252.000 | 570 |
| | 1100 | | 190 | 69.300 | 133 | 380 | 138.600 | 200 | 570 | 207.900 | 333 | 759 | 277.200 | 570 |
| | 1200 | | 207 | 75.600 | 133 | 414 | 151.200 | 200 | 621 | 226.800 | 333 | 828 | 302.400 | 570 |
| | 1300 | | 224 | 81.900 | 133 | 449 | 163.800 | 200 | 673 | 245.700 | 333 | 898 | 327.600 | 570 |
| | 1400 | | 242 | 88.200 | 133 | 483 | 176.400 | 200 | 725 | 264.600 | 333 | 967 | 352.800 | 570 |
| | 1500 | | 259 | 94.500 | 133 | 518 | 189.000 | 200 | 777 | 283.500 | 333 | 1.036 | 378.000 | 570 |
| | 1600 | | 276 | 100.800 | 133 | 552 | 201.600 | 200 | 828 | 302.400 | 333 | 1.105 | 403.200 | 570 |
| | 1700 | | 293 | 107.100 | 133 | 587 | 214.200 | 200 | 880 | 321.300 | 333 | 1.174 | 428.400 | 570 |
| | 1800 | | 311 | 113.400 | 133 | 621 | 226.800 | 200 | 932 | 340.200 | 333 | 1.243 | 453.600 | 570 |

1. Storage capacity can be flexibly costomized according to customer specifications

The support structure is a Power Dome unit. No drilling or ramming is needed. Additional civil works ar avoided. The orientation of modules is from 3° to 32° to each site of the Dome, which blends elegant design with considerable load-carrying capacity and the strength of the entire framework

## 7.2. Solar PV Modules

Our firm has connections to the most bankable manufacturers of both PV panels and inverters. In combination with finely-tuned transformers and optimal cabling length and dimension MSP is able to guarantee an above-average power plant performance.

Solar PV modules are one of the key components of a photovoltaic power plant. For commercial scale installations there are two main cell technologies available on the market; thin film and crystalline-silicon. Crystalline cells are further separated into polycrystalline and monocrystalline cells with main differences in output power as well as electrical characteristics.

For technical and economic reasons we favour utilisation of crystalline modules. For these projects specifically, we recommend 72-cell modules, compatible with a system voltage of up to 1500V. The high rated power and voltage compatibility enable us to create a more efficient and cost-effective plant layout, particularly with respect to cabling and mounting materials. The following section shows the selected solar PV module.

### 7.2.1. Suntech STP 380

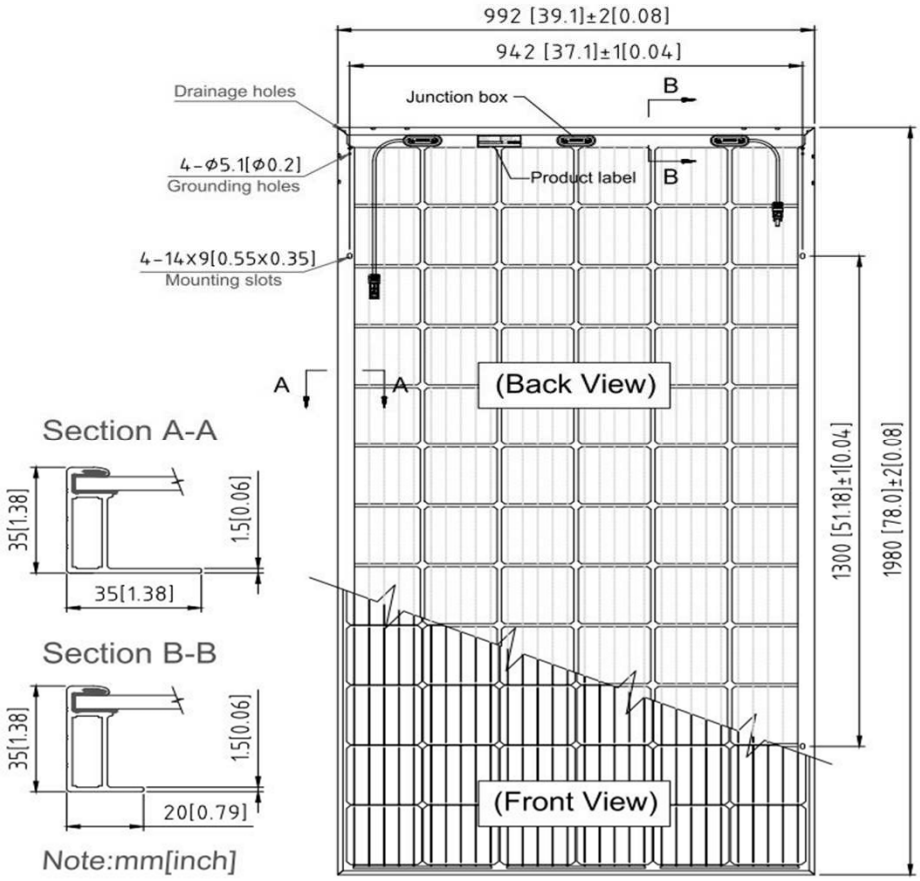



Figure 8: Suntech STP 380S-72/ Pfd+

| | |
|---|---|
| ▪ Manufacturer | Suntech |
| ▪ Country of origin | Vietnam |
| ▪ Dimensions (L x W) | 1,980 x 992 x 35 mm |
| ▪ Weight | 26.1 kg |
| ▪ Solar Cells | 72 monocrystalline, bifacial technology |
| ▪ Power tolerance | 0/+5 Wp |
| ▪ Frame | Anodized aluminium |
| ▪ Junction box | IP 68 rated, 4mm$^2$ solar cable, 0,35m + 0,16m |
| ▪ Connectors | MC4 compatible |
| ▪ Product Warranty | 12 years |
| ▪ Performance guarantee | 30 years linear power output warranty; at least 97.5% for first year; decline of no more than 0.5% per year as of the second year; at least 83% after 30 years |

## 7.3. Inverters & Battery Storage

Other than modules, we also have good relationships with leading manufacturers of inverters. Implementing finely-tuned inverters and optimal cabling our company is able to guarantee an above-average power plant performance.

Inverters are one of the key components of a photovoltaic power plant. For commercial scale installations there are two main inverter technologies available on the market; central and decentral inverters with main differences in rated power as well as electrical characteristics. Another distinct feature of central and decentral inverters is that, as the name suggests, central inverters serve a section of the PV power plant from a central location, while alternatively multiple decentral inverters can also be installed inside of our cube units, as is the case with our solution.

For technical and economic reasons we would recommend utilisation of decentral inverters for this project. The following section presents an example inverter which we intend to use, or an inverter equivalent to it.

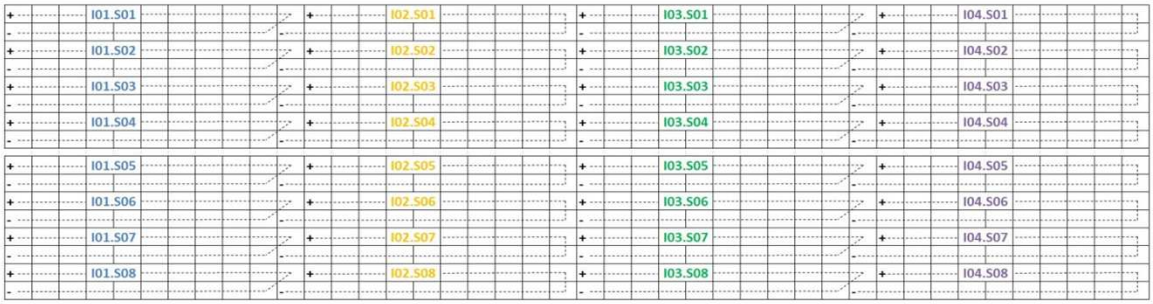



Figure 9: String Layout

### 7.3.1. Kaco Blueplanet 50 TL3


Figure 10: String Inverter

- Inverter type — Decentral (string)
- Nominal power — 50 kVA
- Max. efficiency — 98.5%
- MPP voltage (Pnom) — 580- 900 V
- Nr. of MPP inputs — 1
- Operating grid voltage — 400 V, 3-phase
- Protection class — IP65
- Dimensions (W x D x H) — 760 x 500 x 425mm
- Weight — 70 kg


The blueplanet Mini-Argus 50.0 is an external generator junction box (GAK) for string inverters blueplanet 50.0 TL3. The device combines string fuse, DC overvoltage protection and DC disconnect in a separate housing

Optionally, this junction box is also available with string monitoring

Figure 11: Combiner Box KACO Mini Argus 50.0

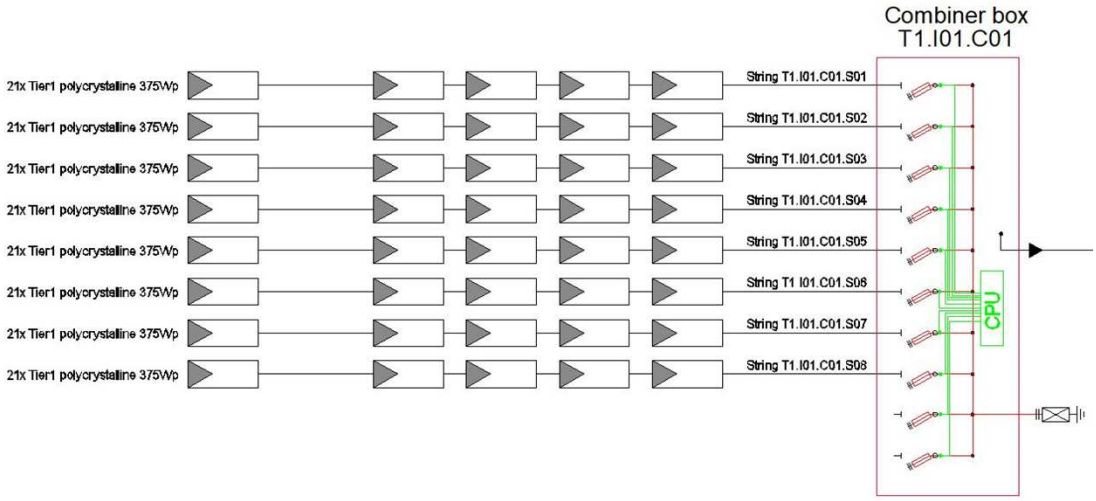
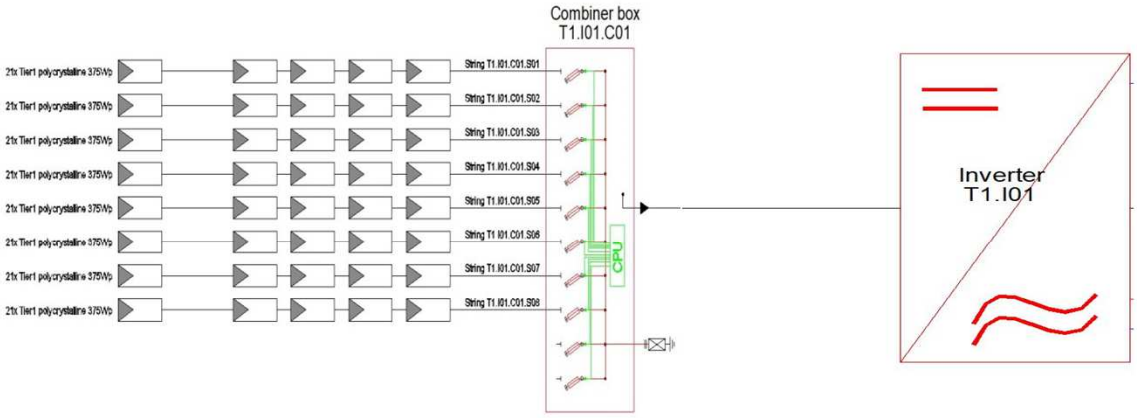



Figure 12: Connection diagram with optional string monitoring



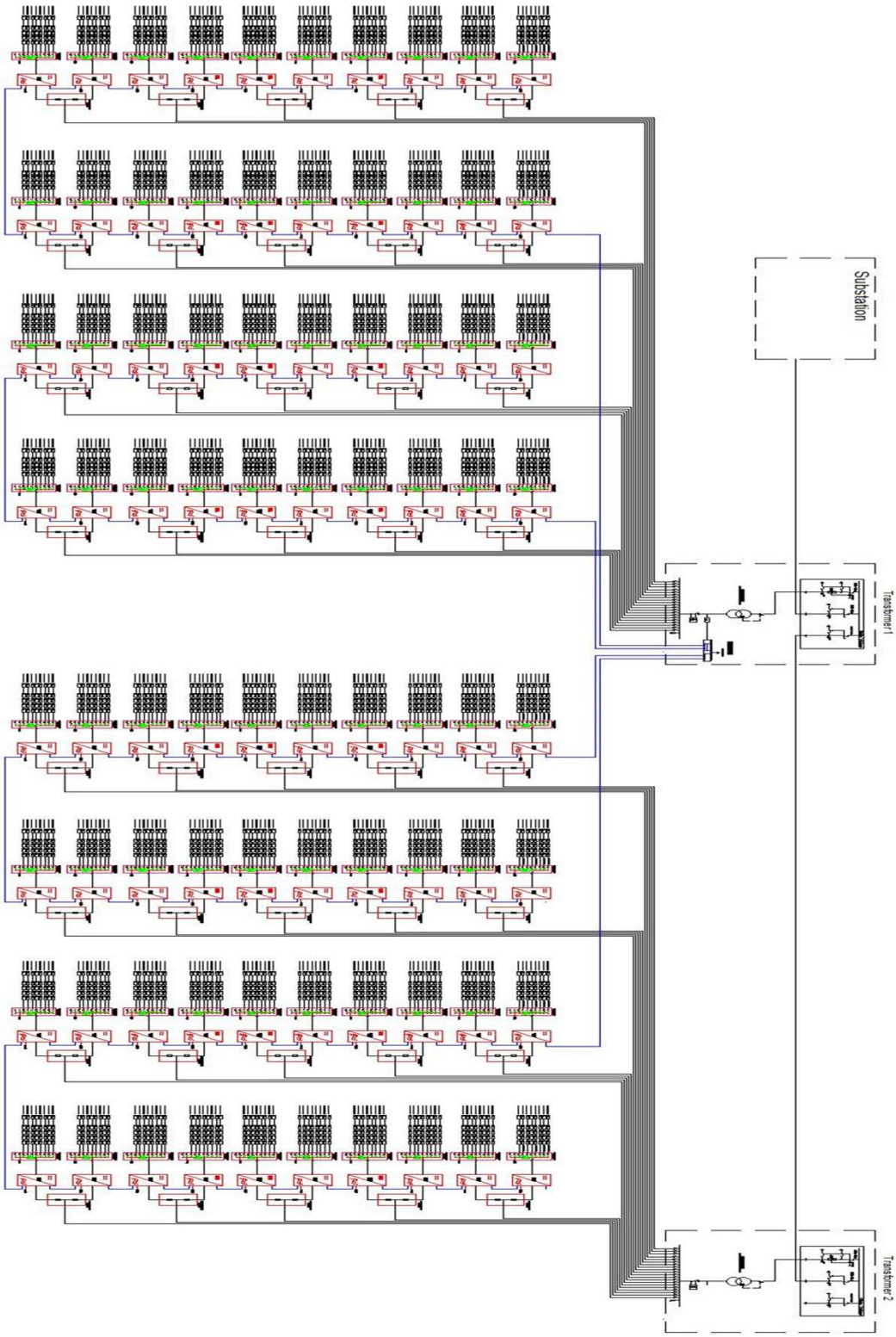



Figure 12.1: Single Line Diagram, Example 5 MWp PV- Park

### 7.3.2. STORAGE SYSTEM

The Battery Storage System is a lithium iron phosphate (LiFePO4) battery unit with battery management system (BMS) for usage with an internal biderectional inverter.

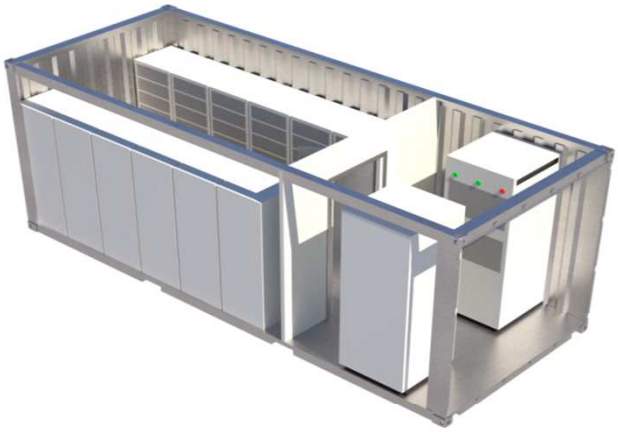


Figure 13: Expansion 20 Foot Container with 570 kWh Storage (Example)

**General Properties**

| **Model** | 20ft Container System |
|---|---|
| AC voltage | 400V |
| Dimension(W*H*D) | 6058mm×2591mm×2438mm |
| Enclosure | IP54 |
| Weight | Up to 9.6 ton |
| Battery capacity | 573.44KWh nominal |
| Max discharge power | 50kW/100kW/200kW( two 100kW units in parallel) |
| Max charge power | 50kW/100 kW /200 kW |
| Battery chemistry | Li-ion(LFP) |
| Discharge depth | 90% |
| Full cycles | 6.000 |
| Operating temp | -20 ℃ to 50℃ |

**PCS parameters**

| **Model** | PWG2-50K-EX | PWG2-100K-EX |
|---|---|---|
| | **Utility-interactive Mode** | |
| Battery voltage range | 400V(250~520V) | |
| Batter DC Max Current | 130A | 260A |
| PV Voltage Range | 520~900V | |
| PV DC. Max Current (in case of completely consumption) | 220A | 440A |
| MPPT tracking voltage range | 520~860V | 520~860V |
| MPPT tracking accurancy | >99%, 550~800V | >99%, 550~800V |
| AC voltage | 400V(340V~460V) | |
| AC current | 72A | 144A |
| Nominal power | 50kW | 100kW |
| AC frequency | 50/60Hz(±2.5Hz) | |
| Output THDI | ≤3% | ≤3% |

Figure 13.1: Datasheet

## 7.4. Transformers and Medium Voltage Switchgear

For technical and economic reasons we would favour utilisation of string inverters over central inverters. With our system, the transformer units would arrive to site in pre-installed shipping containers, which minimises site works.

All necessary ancillary components such as transformers and medium voltage switchgear are supplied in the power ratings and quantities required enabling the target AC capacity to be reached. A detailed product description of ancillary components will be arranged by mutual agreement between customer and contractor before the assembly begins.

Please refer to the following sections for more details on transformer stations.

### 7.4.1. Transformer Station

Transformers and medium voltage switchgear would be delivered in suitable shipping containers, which would remain on site. Container housing would be appropriate for local environmental conditions and would include air-conditioning, fire protection and communication equipment. The transformer station would be accessible from the outside.

The recommended transformer for this project is the below solar station up to 2.5MVA.

The transformer will be installed in inverter/transformer cube units

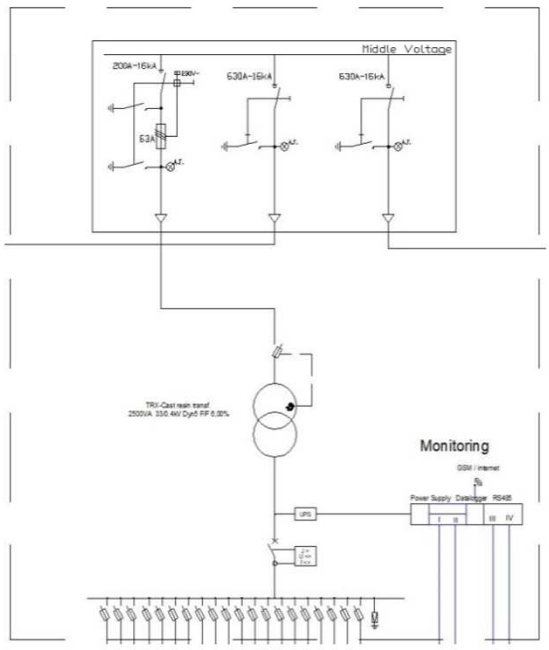



Figure 14: Transformer Station with Middle Voltage Switchgear

## 7.5. Monitoring and Control System

The monitoring and control system consists of a weather station, data logger, and a control unit suitable for proper supervision and operation of the PV power plant. All inverters with a pre-defined number of strings will be monitored separately.

Details on monitoring and control system are to be proposed and provided by the contractor at a later stage. Typical monitoring and control system interface is shown in Figure 15

Figure 15: Typical monitoring and control system interface

## 7.6. Cables

Only UV-resistant solar cables will be used. Cable cross sections (diameter) will be defined to achieve an overall power loss of not more than 2% at standard testing conditions (STC) for all cable of the PV power plant. The aforementioned power loss at STC equals a power loss of < 1% and < 1.2% per year for irradiation values used for
calculation of European efficiency and Californian efficiency, respectively. Cross sections will be defined in accordance with inverter manufacturer's specifications. Cable connections of module strings with string boxes, if any, and inverters will be carried out using connectors and couplings or screw fitting as required by the manufacturers. All required connectors, couplings, or fittings are included within the scope of works. Any bare wire at terminals will be sealed using shrinkable tubing.

Necessary cable lengths will be determined using the module allocation plan. The scope of works includes wiring of all inverters including supply and installation of all cables and required auxiliary materials such as clips, fasteners, fittings, seals, cable ties, etc.

DC cables are placed on the mounting system below the modules or in cable trays/ducts wherever cables run between multiple rows of cube unit rows. Cables on the mounting system will be fixed using cable ties or in cable trays, as applicable. Cables from string boxes to inverters, if required, or inverters to transformers as well as any medium voltage cable will be laid in cable trays on the ground. Within the transformer station all cables will be routed in cable ducts.

All cables will be insulated. If required, armoured cables will be used. Any above ground cable installation will be performed in such a way, that mechanical damage is avoided. All sharp edges of metal parts of the mounting system which could cause damage to electrical installations will be covered before cables are installed. Cables will be laid with minimum bending radii according to the manufacturer's specifications.

Low voltage and high voltage cables will comply with IEC standards. Cable installation will be done using rollers in order to avoid damage to the cable jacket.

Typical specifications for solar PV cables are:

| | |
|---|---|
| ▪ Operational temperature | -40° to +120 °C |
| ▪ Tension | Not less than 0.6/1 kV |
| ▪ Health and safety | Halogen free, low smoke emission, and low toxicity |
| ▪ Safety and durability | Flame retardant, high UV resistance |

## 7.7. Distributors

Distributors will have an all-round metal cladding or consist of ejection resistant, flame-retardant insulating material according to DIN VDE 0304 part 3, BH1 level. The distribution assembly will be carried out in accordance with the electrical installation. The contractor will check whether the provided fittings are satisfactory, or whether they need to be extended or reduced. All given dimensions are approximate and have to be checked. Any necessary substructures for distributors will be included.

Installation of all parts in the distributors will be made in order to enable access in such a way, that removal of security installations is not required.

The wiring will be carried out using the appropriate ducts. Heat losses from equipment will be diverted safely. Installation of all components will be conducted with ready-to-use wiring and terminals. Balanced load has to be assured. Inlets and outlets of performance and control units will be connected to terminal blocks in such a way that testing is feasible.

Identification marking of circuits will be made using engraved designation labels. Exposed bus bars will be fitted with safety covers. Circuit breakers and screw type fuses will be installed in such a way that contact with the terminals is not possible during operation. Equipment with open terminal blocks will be placed so that accidental contact is precluded.

Terminals still under voltage after the main switch has been turned off will be marked clearly. Lengthening of wires using clips of any kind is not permitted within the distribution. Wiring ducts up to terminal blocks in installation and small distribution boards, meter boards, switchgear and distribution boxes, as well as the laying of cables and wires will be included in the scope of works. All materials used have to be flame-retardant, self-extinguishing and halogen free.

All switching devices (contactors, fuses, circuit breaker, and power switches) will be measured regarding actual electric flows and checked for allowable loads according to VDE regulations prior to the commissioning of the power plant.

Distributions will be equipped with schematic circuit diagram and legends in a tarpaulin bag according to VDE 0105. A uniform design will be used during installation of equipment in distribution boards and switchgears, respectively.

## 7.8 Fencing and Construction Road

A fence and gates will be installed surrounding the development site. The indicative standard fence has a height of 2,000 mm with a mesh size of 50 x 50 mm and will be equipped with an anti-climb guard. The fence finish will be zinc plated steel with a minimum standard according to DIN 1548.

The standard gates will be installed at access roads and have dimensions of 4,000 mm x 2,030 mm. They are made of galvanized steel. Typical fence design is shown in figure 16. Please note, the actual fence and gate may be different and in line with specific customer requirements.

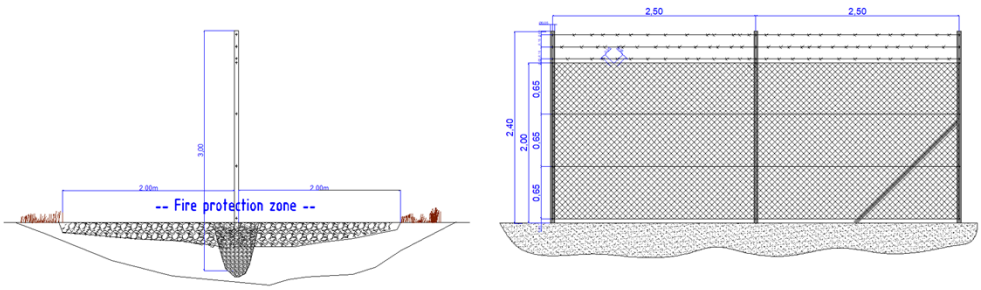



Figure 16: Typical fence design

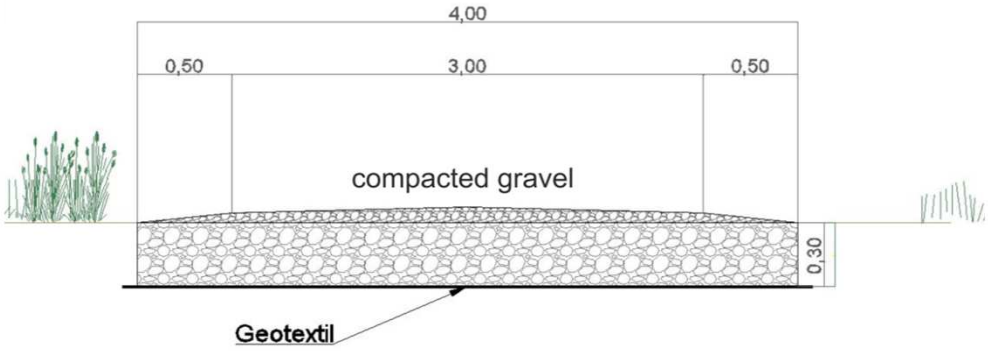



Figure 16.1: Typical Construction road design

## 8. Mechanical and Electrical Installation Works

The scope of mechanical installation work covers GPS-aided measurement and installation of inverter/transformer Cubes, substructures as well as installation of PV modules, and cable trays.

The scope of electrical installation work covers installation of inverters, string boxes (if applicable), monitoring equipment, electrical cables from PV modules up to the transfer station on site, and all further electrical equipment. The scope of work also covers installation of earthing system for all electric components, substructures, and foundations as well as testing and commissioning of all electric components.

### 8.1. Installation of mounting system

Our Power Dome unit solution minimizes the need for conventional EPC (Engineering, Procurement and Construction) services on site. With this multi-orientation systems there is no significant heavy machinery required and the only activities that take place on site are assembly procedures rather than full construction.

The setup of our system mainly involves placing units at satellite-confirmed points in line with the technical design. For each block of pv unists, there is a corresponding inverter unit and a pre-assembled inverter/transformer unit, which features security, cabling, monitoring and others. DC cabling is connected on site. There is no need for highly-skilled labour and the amount of manpower required is far lower. Erection of multi-megawatt projects can be completed much faster than average.

## 8.2. Installation of Solar PV Modules

Solar PV modules are mounted on the appropriate pv unit structure. Fixing of modules is done from the lower side of substructure. This prevents damages to solar PV modules during assembly and allows for simplified maintenance. Just as for installation of the mounting system, the installation of solar PV modules is carried out in sections, as soon as installation of the mounting system is finished.

## 8.3 Electrical Installation

Civil works required as preparation for the electrical installation works run in parallel to installation of the mounting structure and solar PV modules. PV cables within one row of tables are installed in the substructure of the mounting system and are fixed using cable ties or adequate fastening material. Solar PV cables will be placed in cable ducts or trays wherever cables run between multiple rows of pv unit installations. Cables from junction boxes to inverters, if required, or inverters to transformers as well as any medium voltage and data cables will be laid in cable trays. Within the transformer station all cables will be routed in cable ducts.

All DC and AC cables will have flexible copper or aluminium conductors. The cables will be suitable for outdoor use, UV resistant, and properly labelled. All cables will meet local utility requirements.

Wherever cables and terminals are made of different materials bimetal connectors will be used. Bare terminals will be protected using shrinkable tube. All connections will be made according to specifications of cable and terminal manufacturers. High voltage cables typically consist of four or five copper or aluminium conductors, metallic shield, PVC cover, as well as insulation layers and waterproofing.

An energy meter suitable for rated PV power plant size, as well as local requirements will be provided and installed in the transfer station. The transfer station will be located on the construction site and is not covered under scope of work by the contractor but will be organised with the local grid connection provider.

Earthing wires are laid between multiple rows of Power Domes. They are then connected to structures elements using screw connections. Earthing bridges are used to connect mounting structures within one row. Inherent to the design of the mounting structure electrical connection between substructure elements of one mounting structure is made by screw connection. All installations will be performed according to recognised standards of good practice.

The following components will be included in the earthing system of the PV power plant:

- Solar PV modules and Cube
- Inverters
- Transformer stations, and medium voltage switchgear
- Monitoring and control system
- Security system and fencing

A monitoring system and sensors will be installed in a ready-to-use state. For the purpose of monitoring, an internet connection via landline, mobile/GSM, or any other suitable service shall be enabled. Internet connection will be provided prior to testing and commissioning of the PV power plant. The contractor has to be notified of the choice of connection as early as possible to allow for selection and ordering of required compatible components.

## 8.4. Test and Commissioning

The scope of test and commissioning stage covers all components of the power plant as well as provision of medium voltage cables at the transformer station. The grid connection of the solar power plant will be made in conjunction with the local grid operator. As part of commissioning of the PV power plant operators will receive training to the electrical documentation and proper operation of all control systems. Documentation will be provided in English language.

Grid connection is not a part of the contractor's default scope of work. However, support during discussions with the local utility or grid operator regarding the location and dimensioning of the required grid connection can be provided.

All tests will be made in compliance with international standards and national regulations. Documentation according to EN 62446 will be provided.

## 9. Engineering Standards

All components and equipment will comply with national and international engineering standards and regulations.

Table 1: IEC/EN standards

| Standard | Description |
|---|---|
| EN 50132-7 | Alarm systems- CCTV surveillance systems for use in security applications. Part 7: application guidelines |
| EN 62271-100 | AC high voltage circuit breakers |
| EN 62271-102 | AC high voltage disconnector switches and earth switches |
| IEC 60044-1 | Instrument transformers: Part 1 – Current transformers |
| IEC 60044-2 | Instrument transformers: Part 2: Inductive voltage |
| IEC 60076 | Power transformers |
| IEC 60287 | Electric cables - Calculation of the current rating |
| IEC 60364 | Low-voltage electrical installations |
| IEC 60502 | Power cables with extruded insulation and their accessories |
| IEC 60529 | Degrees of protection provided by enclosures (IP Code) |
| IEC 60853 | Cyclic rating factor for cables up to and including 18/30 (36) |
| IEC 60947 | Low-voltage switchgear and control gear |
| IEC 61378-1 | Part 1:Transformers for industrial applications |
| IEC 61439 and | Low-voltage switchgear and control gear assemblies |
| IEC/TS 61836 | Solar photovoltaic energy systems - Terms, definitions and |
| IEC 61936 | Power installations exceeding 1 kV a.c. IEC 62305 series, |
| IEC 62053 | Electricity metering equipment (AC) |
| IEC 62055 | Electricity metering – Payment systems |
| IEC 62262 | Degrees of protection provided by enclosures for electrical |
| IEC 62271-200 | AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV |
| IEC 62271-202 | High voltage/low voltage prefabricated substations |
| IEC/TS 61836 | Solar photovoltaic energy systems - Terms, definitions and symbols |

Table 2: Eurocode standards

| Standard | Description |
|---|---|
| Eurocode 0, BS EN 1990 | Basis of structural design |
| Eurocode 1, BS EN 1991-X-Y | Actions |
| Eurocode 3, BS EN 1992-X-Y | Design of Steel Structures |
| Eurocode 7, BS EN 1997-X | Geotechnical |
| Eurocode 8, BS EN 1998-X | Earthquake |
| Eurocode 9, BS EN 1999-X | Aluminium |

Table 3: Further standards

| Standard | Description |
|---|---|
| CDM 2007 | Construction, Design and Management Regulations 2007 |
| CE marking directive 93/68/EEC | CE marking directive |
| CEN/TS 54-14 | Fire detection and fire alarm systems - Part 14: Guidelines for planning, design, installation, commissioning, use and maintenance |
| Dire Restruct ctive uring | Restructuring the community framework for the taxation of energy products and electricity |
| EMC Directive 89/336/EEC | Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility |
| Low voltage directive 2006/95/EC | Directive of the European Parliament and of the Council of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits |
| Machinery Directive 98/37/EC | Directive of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery |

Table 4: South America standards

| Standard | Description |
|---|---|
| Código Eléctrico NC 800-1:2011 (Ed 1.0) | Baja Tensión |
| NC Norma 365:2011 | Tensiones Normalizadas |
| NC 96-50/86 | Protección Contra Incendios, Instalaciones Eléctricas, Requisitos Generales |
| NC 212/02 | Protección contra incendios. Requisitos generales. (de carácter obligatorio) |
| NC (IEC 62305-2:2006) | Protección Contra Descargas Eléctricas Atmosféricas. Evaluación de riesgos |
| NC (ISO 11602-1:2000, IDT) | Extintores de incendio portátiles y móviles—parte 1: selección e Instalación |
| NC 27/2012 | Vertimiento de Aguas Residuales de las aguas terrestres y su alcantarillado |
| Normas UNE y Recomendaciones UNESA que sean de aplicación | |
| Condiciones impuestas por las entidades públicas afectadas | |
| Condiciones impuestas por los Organismos Públicos afectados y Ordenanzas Municipales | |
| NC 18001:2005 | Sistema de Gestión de Seguridad y Salud del Trabajo. |
| NC 667-1 | Áreas verdes |
| NC 96-02-01.1987 | Protección contra incendios. Resistencia al fuego de las Construcciones. (Obligatoria) |
| NC 39/99 | Calidad del aire y requisitos sanitarios |
| NC-220-1, 2, 3, 4,5:05 | Requisitos de diseño para la eficiencia energética |
| NC 1005 | Requisitos para el cálculo de la iluminación natural |
| NC 1072 | Climatización Industrial; indicadores para el desempeño energético |
| ISO 50001:2011 | Sistemas de Gestión de la Energía; requisitos con orientación para su uso |
| NC-217-02-3 | Climatización Especificaciones de diseño temperaturas en Locales Climatizados |
| NC 31/99 | Calidad del suelo Requisitos para la protección de la capa fértil del suelo al realizar los trabajos de movimiento de tierra |