

Formulierversie
2019.01

Aanvraaggegevens

Publiceerbare aanvraag/melding

Aanvraagnummer	4330987
Aanvraagnaam	Zonnepark Flevonice Duurzame Energie BV
Uw referentiecode	Zonnepark Flevonice Duurzame Energie BV

Ingediend op	05-04-2019
Soort procedure	Reguliere procedure

Projectomschrijving	Zonnepark Flevonice Duurzame Energie BV
Opmerking	nvt
Gefaseerd	Nee
Blokkerende onderdelen weglaten	Nee
Kosten openbaar maken	Nee
Bijlagen die later komen	nvt
Bijlagen n.v.t. of al bekend	nvt

Bevoegd gezag

Naam:	Gemeente Dronten
Bezoekadres:	De Rede 1 8251 ER DRONTEN
Postadres:	Postbus 100 8250 AC DRONTEN
Telefoonnummer:	0321 - 388 307
E-mailadres:	gemeente@dronten.nl
Website:	www.dronten.nl
Bereikbaar op:	Op werkdagen tussen 09.00 uur en 12.00 uur

Overzicht bijgevoegde modulebladen

Aanvraaggegevens

Locatie van de werkzaamheden

Werkzaamheden en onderdelen

 Zonnepaneel of -collector plaatsen

- Bouwen

Bijlagen

Formulierversie
2019.01

Locatie

1 Adres

Postcode	8256PZ
Huisnummer	20
Huisletter	-
Huisnummertoevoeging	-
Straatnaam	Strandgaperweg
Plaatsnaam	Biddinghuizen
Gelden de werkzaamheden in deze aanvraag/melding voor meerdere adressen of percelen?	☒ Ja ☐ Nee
Specificatie locatie	Mosselweg 7 te Biddinghuizen

3 Toelichting

Eventuele toelichting op locatie	nvt
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Bouwen

Zonnepaneel of -collector plaatsen

1 De bouwwerkzaamheden

Wat is er op het bouwwerk van toepassing?

- ☐ Het wordt geheel vervangen
☐ Het wordt gedeeltelijk vervangen
☒ Het wordt nieuw geplaatst

Eventuele toelichting

Het betreft het plaatsen van zonnepanelen in veldopstelling als uitbreiding op het reeds vergunde zonnepanelenpark met 11,8 hectare. Er kunnen maximaal 4900 panelen op een hectare worden geplaatst. Er kan gesteld worden dat er hierdoor totaal maximaal 58000 panelen extra nodig zijn. Naast de huidige trafohuisjes worden er 2 extra geplaatst.

Hebt u voor deze bouwwerkzaamheden al eerder een vergunning aangevraagd?

- ☐ Ja
☒ Nee

2 Plaats van het bouwwerk

Waar gaat u bouwen?

Terrein

3 Seizoensgebonden en tijdelijke bouwwerken

Gaat het om een seizoensgebonden bouwwerk?

- ☐ Ja
☒ Nee

Gaat het om een tijdelijk bouwwerk?

- ☒ Ja
☐ Nee

Hoeveel hele jaren blijft het bouwwerk op de locatie bestaan?

25

Hoeveel maanden?

0

4 Uiterlijk bouwwerk/welstand

5 Mondeling toelichten

Ik wil mijn bouwplan mondeling toelichten voor de welstandscommissie/stadsbouwmeester.

- ☐ Ja
☒ Nee

Bijlagen

Formele bijlagen

Naam bijlage	Bestandsnaam	Type	Datum ingediend	Status document
staande_situatie_luchtfoto_Flevonice_pdf	Bestaande situatie luchtfoto Flevonice.pdf	Anders	2019-04-05	In behandeling
Inmeting_Flevonice_pdf	Inmeting Flevonice.pdf	Anders	2019-04-05	In behandeling
htingsplan_nieuwe_situatie_Flevonice_pdf	Inrichtingsplan nieuwe situatie Flevonice.pdf	Anders	2019-04-05	In behandeling
Inrichtingsplan_profielen_Flevonice_pdf	Inrichtingsplan profielen Flevonice.pdf	Anders	2019-04-05	In behandeling
ofielen_bestaande_situatie_Flevonice_pdf	Profielen bestaande situatie Flevonice.pdf	Anders	2019-04-05	In behandeling
Zonnepark_Flevonice_pdf	Zonnepark Flevonice.pdf	Anders	2019-04-05	In behandeling
age_2_JA_Solar_JAM_72_PERC_Half_Cell_pdf	Bijlage 2 JA Solar JAM 72 PERC Half Cell.pdf	Anders	2019-04-05	In behandeling
Bijlage_3_SLD_V03_voorbeeld_pdf	Bijlage 3 SLD V03 voorbeeld.pdf	Anders	2019-04-05	In behandeling
Bijlage_4_SMA_Peak_3_SHP_150_pdf	Bijlage 4 SMA Peak 3 SHP 150.pdf	Anders	2019-04-05	In behandeling
Bijlage_5_SMA_central_MVPS_2200_3000_pdf	Bijlage 5 SMA central MVPS 2200 3000.pdf	Anders	2019-04-05	In behandeling
Bijlage_6_Diablo_40H_pdf	Bijlage 6 Diabolo 40H .pdf	Anders	2019-04-05	In behandeling
Bijlage_7_vd_Valk_montage_schuin_dak_pdf	Bijlage 7 vd Valk montage schuin dak.pdf	Anders	2019-04-05	In behandeling
Bijlage_8_Belectric_PEG_pdf	Bijlage 8 Belectric PEG.pdf	Anders	2019-04-05	In behandeling
ijlage_9_PEG_System_72Zeller_statics_pdf	Bijlage 9 PEG System 72Zeller statics.pdf	Anders	2019-04-05	In behandeling
lage_9a_Itemplan_PEG_WBL_Earth_screw_pdf	Bijlage 9a Itemplan PEG WBL Earth screw.pdf	Anders	2019-04-05	In behandeling
Bijlage_9b_Itemplan_helling_parallel_pdf	Bijlage 9b Itemplan helling parallel.pdf	Anders	2019-04-05	In behandeling



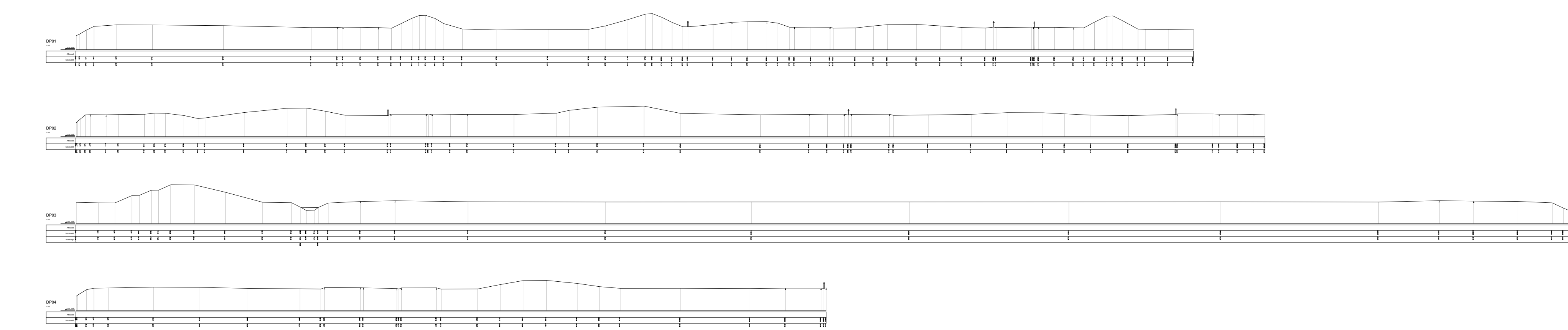
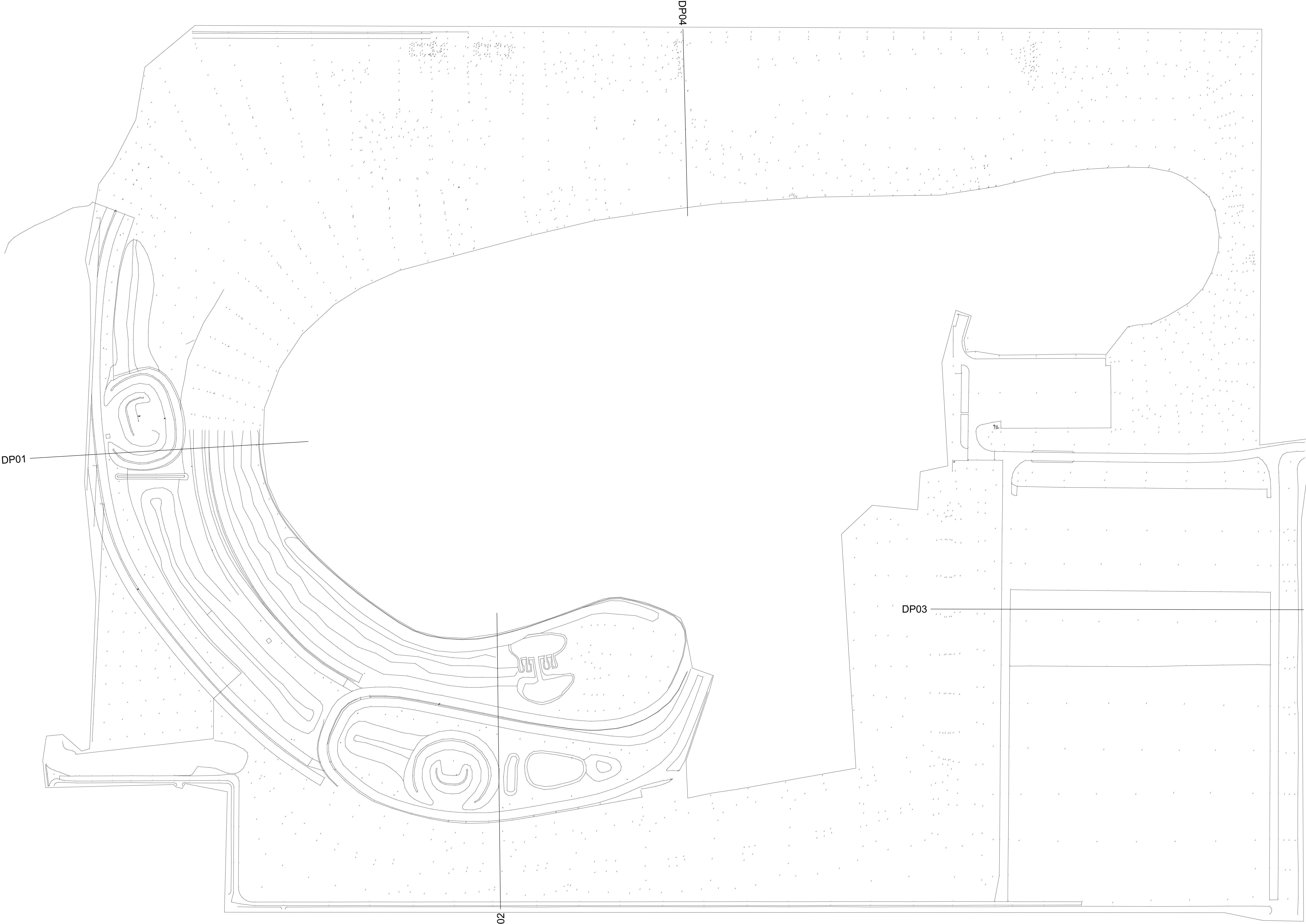
Opmerking:
Grondhevels en groen zijn schetsmatig aangegeven.

Projekt	Landschapsplan Flevonice	Get.	B. Poppe
Omschrijving	Ondergrond BGT, Kadaster en Luchtfoto	Datum	04-04-2019
Opdrachtgever	Flevonice B.V.	Sec.	M. Opgenoort
School	1:1000	Akt.	....
Status	Definitief	Besteekr.	....
	002	Projector.	....

COÖPERATIE
LANDSCHAPSPLANNING

Verporend 12
6901 BS Oosterveld
Tel. 0313 - 482 466
info@opdenoort.nl
www.opdenoort.nl

0 10 20 30 40m



Profielen

SCHAAL 1 : 500

Project		Landschapsplan Flevonice		Get.	Siegers
Omschrijving		Inmeting en profielen, bestaande situatie		Datum	04-04-2019
Opdrachtgever		Flevonice B.V.		Dec.	M. Opgenoort
Schaal		1:1000		Aks.	.....
Status		Definitief		Besteekr.	.....
Tekeningnummer		005		Projectnr.	.....
COÖPERATIE LANDSCHAPSPLANNING		Verantwoord 12 0901 001 Overstap Tel. 0313 - 402 406 info@opgarden.nl www.opgarden.nl			

Mono

380W PERC Half-Cell Module

JAM72S03 360-380/PR Series

Introduction

Assembled with high-efficiency PERC cells, the half-cell configuration of the modules offers the advantages of higher power output, better temperature-dependent performance, reduced shading effect on the energy generation, lower risk of hot spot, as well as enhanced tolerance for mechanical loading.



Higher output power



Lower temperature coefficient



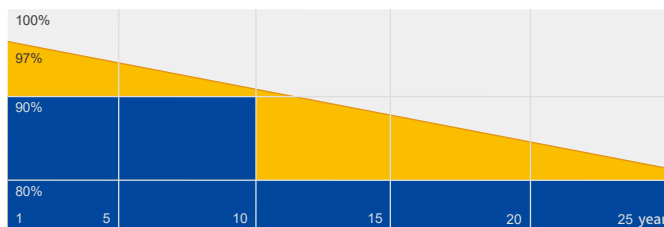
Less shading effect



Better mechanical loading tolerance

Superior Warranty

- 12-year product warranty
- 25-year linear power output warranty



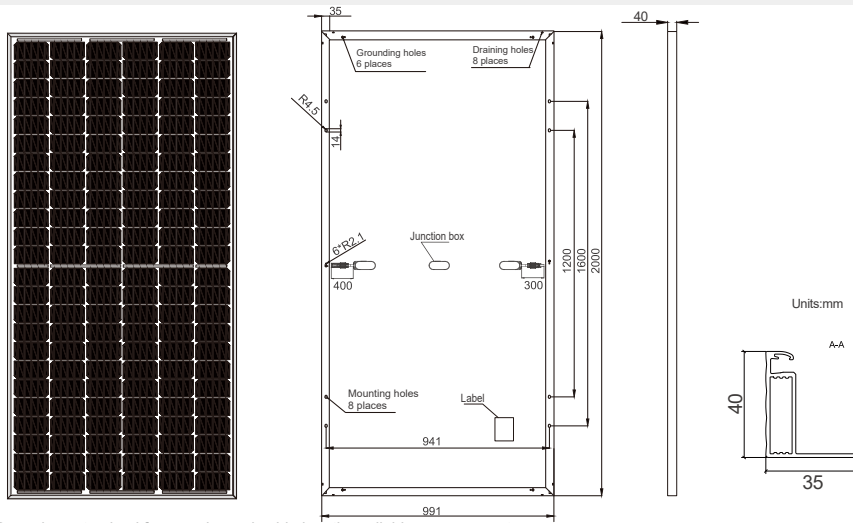
■ JA Linear Power Warranty ■ Industry Warranty

Comprehensive Certificates

- IEC 61215, IEC 61730, IEC TS 62804, IEC 61701, IEC 62716, IEC 60068-2-68
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- OHSAS 18001: 2007 Occupational health and safety management systems
- IEC TS 62941: 2016 Terrestrial photovoltaic (PV) modules – Guidelines for increased confidence in PV module design qualification and type approval



MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono
Weight	22.5kg±3%
Dimensions	2000mm×991mm×40mm
Cable Cross Section Size	4mm ²
No. of cells	144 (6×24)
Junction Box	IP68, 3 diodes
Connector	MC4 Compatible(1000V) QC 4.10-35(1500V)
Packaging Configuration	27 Per Pallet

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72S03 -360/PR	JAM72S03 -365/PR	JAM72S03 -370/PR	JAM72S03 -375/PR	JAM72S03 -380/PR
Rated Maximum Power(P _{max}) [W]	360	365	370	375	380
Open Circuit Voltage(V _{oc}) [V]	46.98	47.30	47.56	47.78	48.05
Maximum Power Voltage(V _{mp}) [V]	38.73	39.05	39.36	39.58	39.80
Short Circuit Current(I _{sc}) [A]	9.87	9.92	9.97	10.03	10.09
Maximum Power Current(I _{mp}) [A]	9.30	9.35	9.41	9.48	9.55
Module Efficiency [%]	18.2	18.4	18.7	18.9	19.2
Power Tolerance	0~+5W				
Temperature Coefficient of I _{sc} (α _{Isc})	+0.051%/°C				
Temperature Coefficient of V _{oc} (β _{Voc})	-0.289%/°C				
Temperature Coefficient of P _{max} (γ _{Pmp})	-0.360%/°C				
STC	Irradiance 1000W/m ² , cell temperature 25°C, AM1.5G				

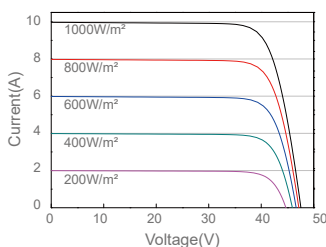
Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL PARAMETERS AT NOCT

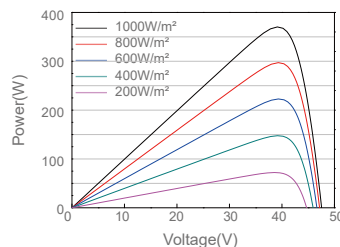
TYPE	JAM72S03 -360/PR	JAM72S03 -365/PR	JAM72S03 -370/PR	JAM72S03 -375/PR	JAM72S03 -380/PR	Maximum System Voltage	1000V/1500V DC(IEC)
Rated Max Power(P _{max}) [W]	266	270	274	278	281	Operating Temperature	-40°C~+85°C
Open Circuit Voltage(V _{oc}) [V]	43.48	43.80	44.06	44.28	44.51	Maximum Series Fuse	30A
Max Power Voltage(V _{mp}) [V]	35.81	36.11	36.37	36.59	36.81	Maximum Static Load, Front	5400Pa
Short Circuit Current(I _{sc}) [A]	7.90	7.94	7.98	8.02	8.08	Maximum Static Load, Back	2400Pa
Max Power Current(I _{mp}) [A]	7.44	7.48	7.53	7.58	7.64	NOCT	45±2°C
NOCT	Irradiance 800W/m ² , ambient temperature 20°C, wind speed 1m/s, AM1.5G					Application Class	Class A

CHARACTERISTICS

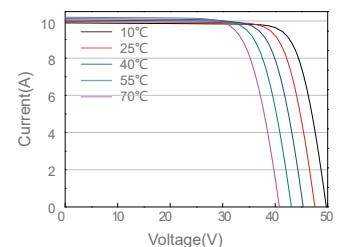
Current-Voltage Curve JAM72S03-370/PR

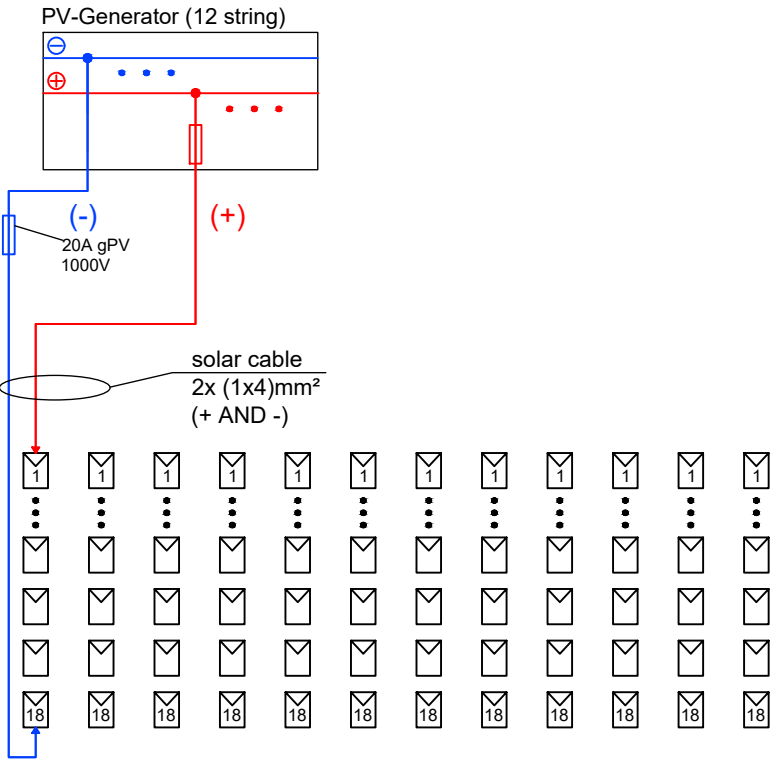
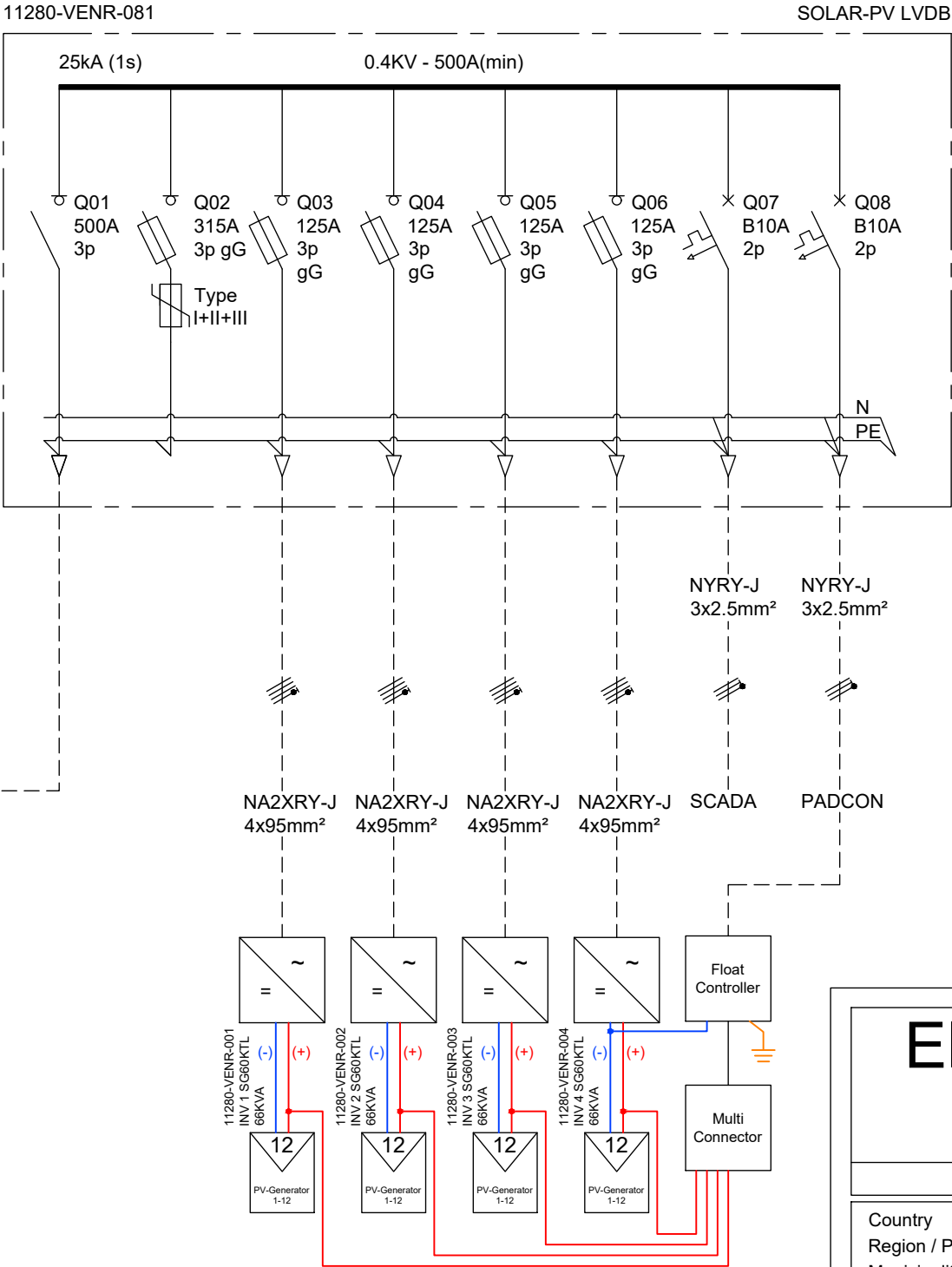
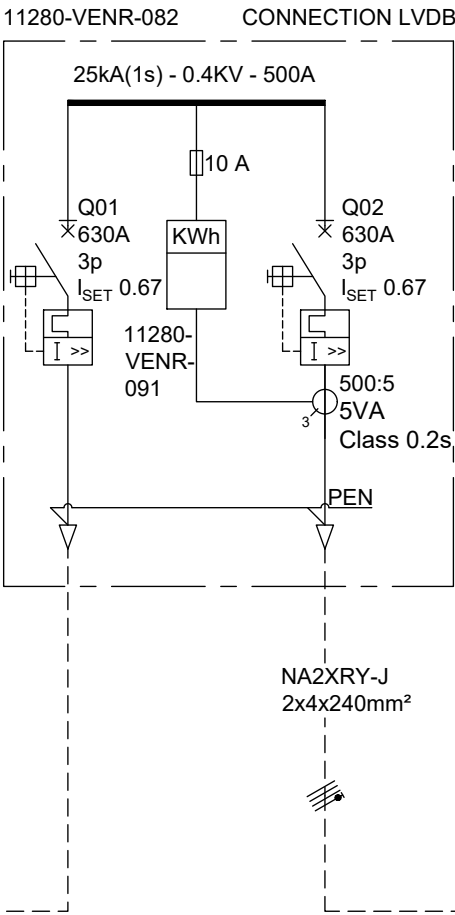
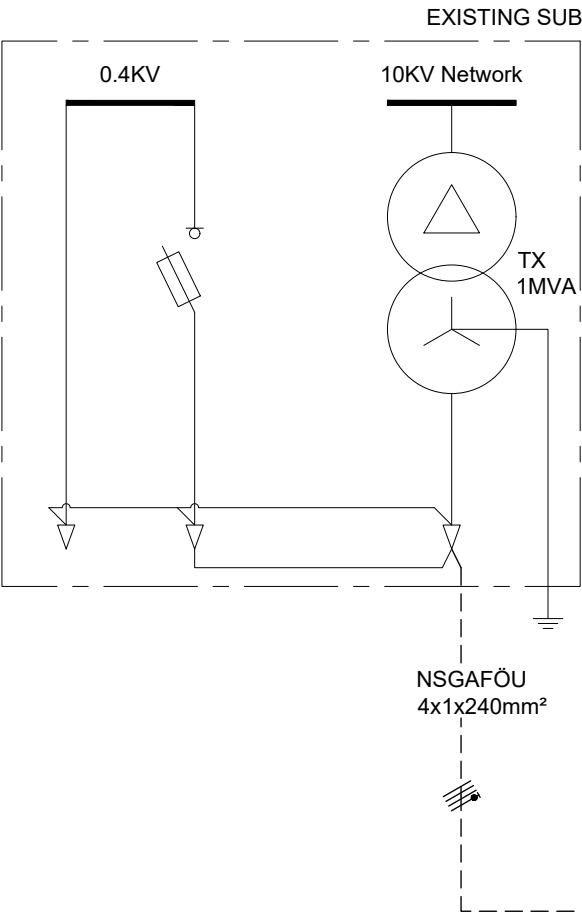


Power-Voltage Curve JAM72S03-370/PR



Current-Voltage Curve JAM72S03-370/PR





Electrical Design

SLD

Venray

Country - Netherlands
Region / Province - Limburg
Municipality - Venray

KEY

Existing installation

New installation

Information required

03	Q01,Q02 CBs, Q02 fuse	PR	18/10/18						
02	Adding DC SLD Float Controller + update Armoured cables	IG	22/08/18	ML	22/08/18	SW	22/08/18		
Rev	Changes in the Design	Name	Date	Checked	Date	Approved	Date		Sheet 1 of 1

☐ Preliminary ☐ Concept ☒ Execution ☐ as Built

overall single line diagram

Scale A 3

BELECTRIC

12-WBL_Venray_V03

BELECTRIC GmbH
Wadenbrunner Str. 10
97509 Kolitzheim
Tel. +49 (0)9385 9804-0
Fax. +49 (0)9385 9804-590

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SHP 150-20



Efficient

- High power density with 150 kW thanks to its compact structure
- Max. yield due to possible DC/AC ratio of up to 150%

Reliable

- Superior PV system availability with 150 kW units
- Innovative digital features aligned with the energy management platform ennexOS

Flexible

- For DC input voltages up to 1500 V
- Flexible DC solutions with customer-specific PV array junction boxes

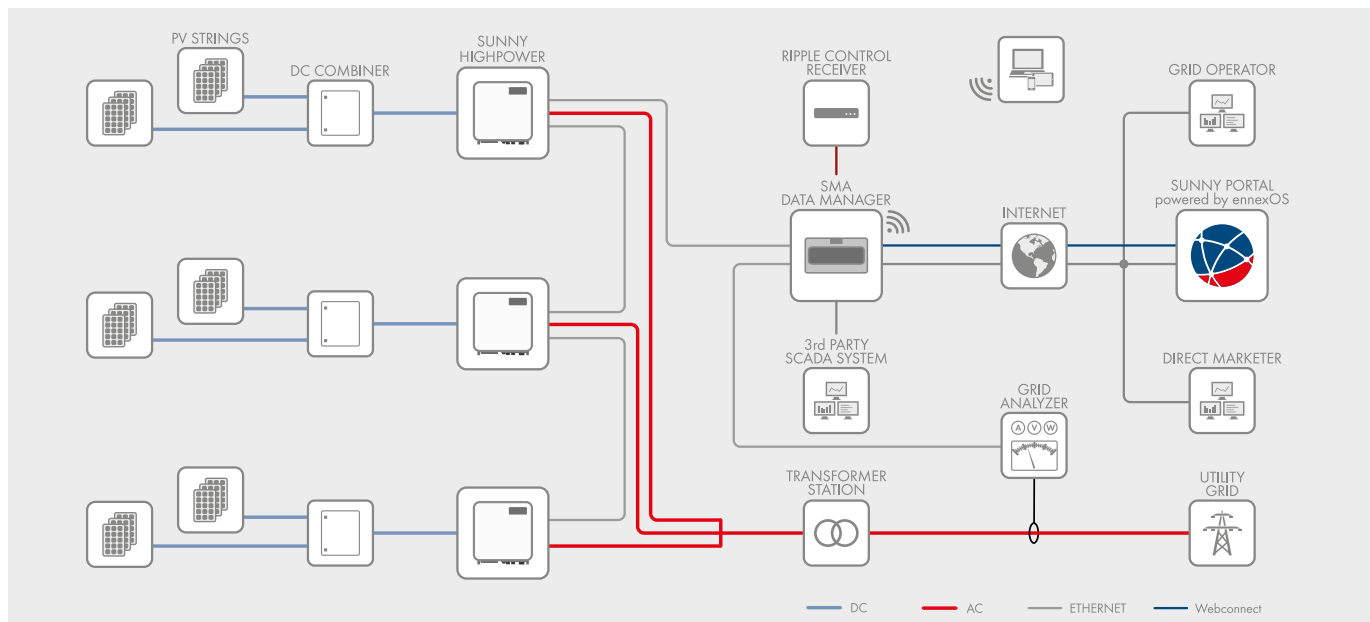
Easy to install

- Ergonomic handling and simple connection for quick installation
- Centralized commissioning and control of the PV power plant via SMA Data Manager

SUNNY HIGHPOWER PEAK3

Customized for tomorrow today

The Sunny Highpower PEAK3 is the central component of the SMA solution for PV power plants with a decentralized architecture and system voltages of 1500 V DC. This compact string inverter enables cost-optimized solutions for industrial PV applications thanks to its high power density. It also provides a simple way of transport and allows for quick installation and commissioning. This string inverter with 150 kW of power is equipped with the automatic SMA Smart Connected service for proactive servicing that facilitates operation and maintenance and reduces service costs throughout the entire project lifetime.



Technical Data	Sunny Highpower PEAK3
Input (DC)	
Max. PV array power	225000 Wp
Max. input voltage	1500 V
MPP voltage range / rated input voltage	855 V to 1425 V / 855 V
Max. input current / max. short-circuit current	180 A / 325 A
Number of independent MPP trackers	1
Number of inputs	1 or 2 (optional) for external PV array junction boxes
Output (AC)	
Rated power at nominal voltage	150000 W
Max. apparent power	150000 VA
Nominal AC voltage / AC voltage range	600 V / 480 V to 690 V
AC grid frequency / range	50 Hz / 44 Hz to 55 Hz 60 Hz / 54 Hz to 65 Hz
Rated grid frequency	50 Hz
Max. output current	151 A
Power factor at rated power / displacement power factor adjustable	1 / 0 overexcited to 0 underexcited
Harmonic (THD)	< 3%
Feed-in phases / AC connection	3 / 3-PE
Efficiency	
Max. efficiency / European efficiency	99.0% / 98.8%
Protective devices	
Ground fault monitoring / grid monitoring / DC reverse polarity protection	• / • / •
AC short-circuit current capability / galvanically isolated	• / —
All-pole-sensitive residual-current monitoring unit	•
Monitored surge arrester (type II) AC / DC	• / •
Protection class (according to IEC 62109-1) / overvoltage category (as per IEC 62109-1)	I / AC: III; DC: II
General Data	
Dimensions (W / H / D)	770 mm / 830 mm / 444 mm (30.3 in / 32.7 in / 17.5 in)
Weight	92 kg (202 lbs)
Operating temperature range	-25°C to +60°C (-13°F to +140°F)
Noise emission (typical)	< 65 dB(A)
Self-consumption (at night)	< 5 W
Topology	transformerless
Cooling method	OptiCool, active cooling, speed-controlled fan
Degree of protection (according to IEC 60529)	IP65
Max. permissible value for relative humidity (non-condensing)	100%
Features / function / accessories	
DC connection / AC connection	Terminal lug (up to 300 mm ²) / Screw terminal (up to 150 mm ²)
LED display (Status / Fault / Communication)	•
Ethernet interface	• (2 ports)
Data interface: SMA Modbus / SunSpec Modbus / Speedwire, Webconnect	• / • / •
Mounting type	Rack mounting
OptiTrac Global Peak / Integrated Plant Control / Q on Demand 24/7	• / • / •
Off-grid capable / SMA Fuel Save Controller compatible	• / •
Warranty: 5 / 10 / 15 / 20 years	• / ○ / ○ / ○
Certificates and approvals (planned)	IEC 62109-1/-2, AR N-4110, AR N-4120, CEI 0-16, C10/11:2012, EN 50549, PEA 2017, DEWA
• Standard features ○ Optional features — Not available Data at nominal conditions Status: August 2018	
Type designation)	SHP 150-20

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
- 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

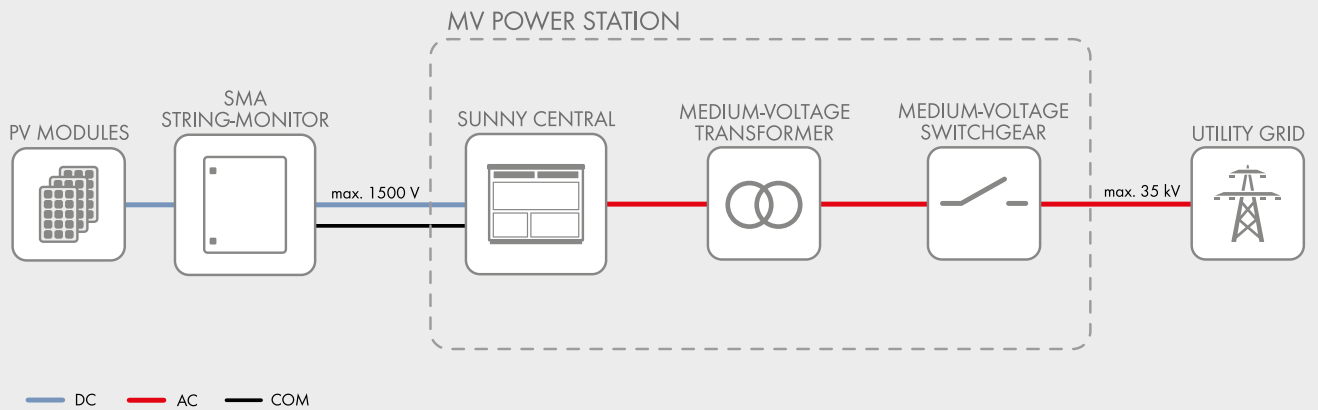
2200 / 2475 / 2500 / 2750 / 3000

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 at 33 kV	2.3 kW / 1.74 kW
Transformer short-circuit losses Standard / Ecodesign at 33 kV	21.0 kW / 20.7 kW
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 ³⁾	98.6%
European efficiency ³⁾	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 container without integrated oil containment (W / H / D) ⁵⁾	6058 mm / 2591 mm / 2438 mm
Dimensions of the 20-foot container with integrated oil containment (W / H / D) ⁵⁾	6058 mm / 2896 mm / 2438 mm
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 m³/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: without / with (integrated)	● / ○
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

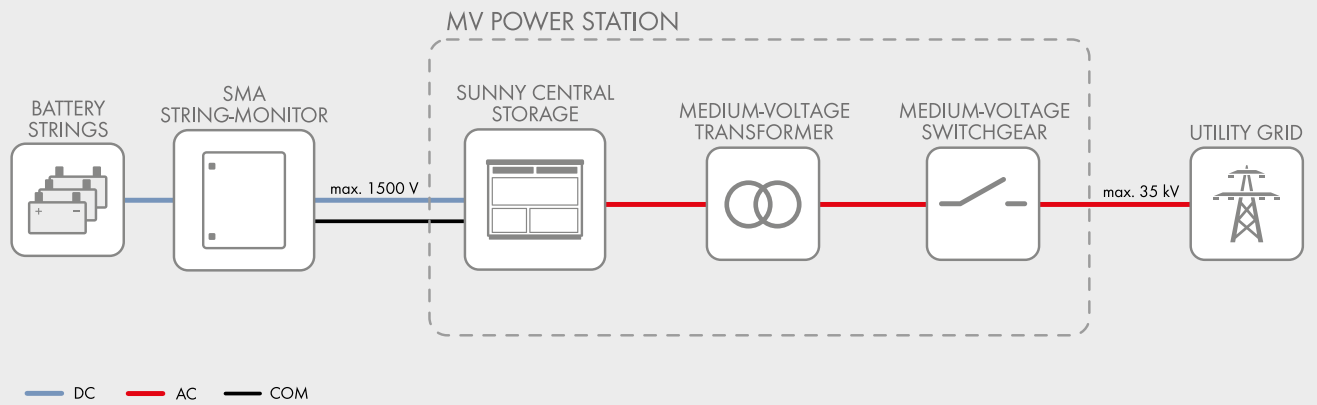
- 1) Data based on inverter
- 2) ONAN = Mineral oil with natural air cooling; KNAN = Organic oil with natural air cooling
- 3) Efficiency measured at inverter without internal power supply
- 4) Efficiency measured at inverter with internal power supply
- 5) Transport dimensions

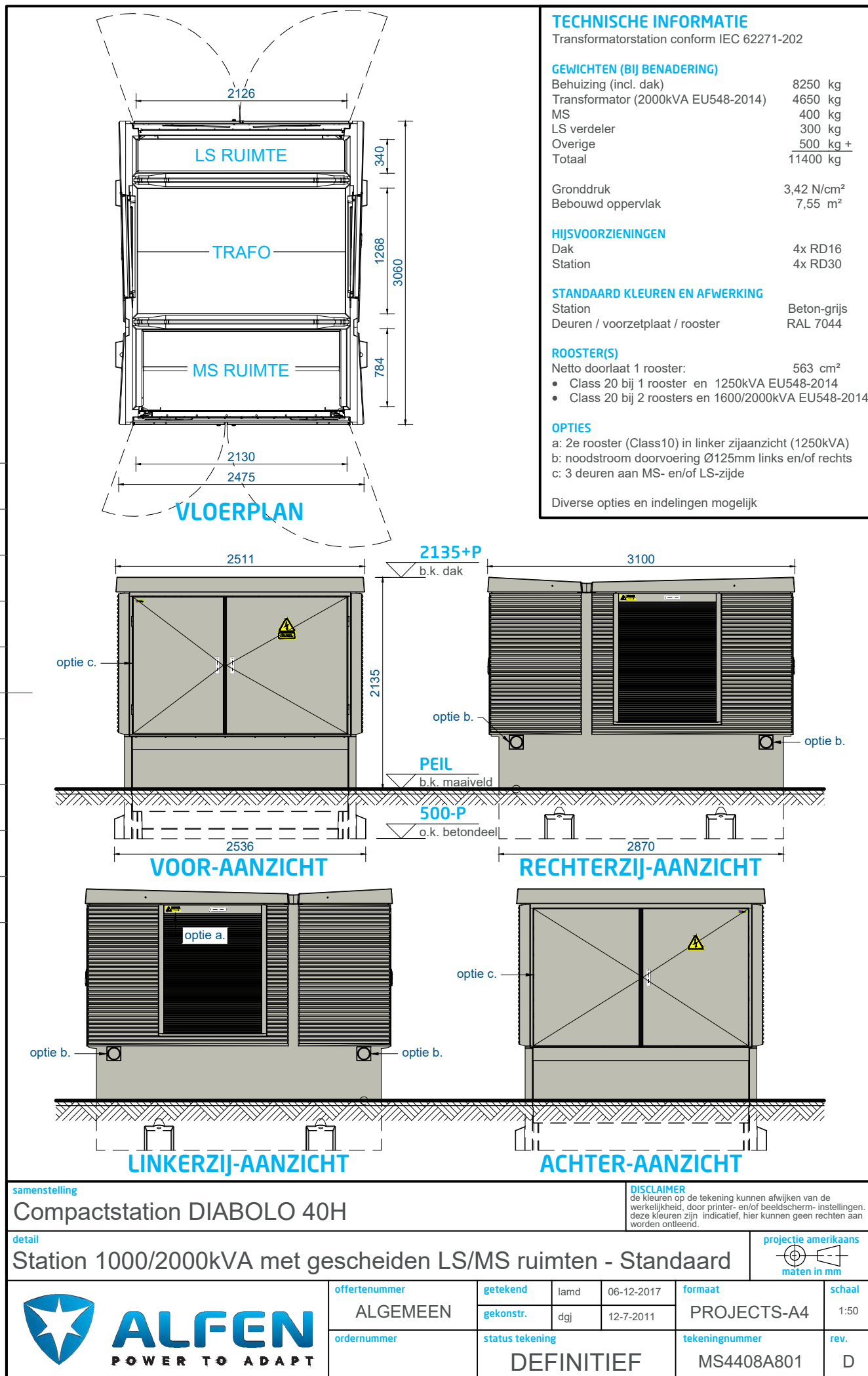
MV Power Station 2475	MV Power Station 2500	MV Power Station 2750	MV Power Station 3000
1 x SC 2475 or 1 x SCS 2475	1 x SC 2500-EV or 1 x SCS 2500-EV	1 x SC 2750-EV or 1 x SCS 2750-EV	1 x SC 3000-EV or 1 x SCS 3000-EV
1100 V	1500 V	1500 V	1500 V
3960 A	3200 A	3200 A	3200 A
24 double pole fused (32 single pole fused)			
○	○	○	○
200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A			
2475 kVA / 2250 kVA / 0 kVA	2500 kVA / 2250 kVA / 0 kVA	2750 kVA / 2500 kVA / 0 kVA	3000 kVA / 2700 kVA / 0 kVA
2475 kVA / 2250 kVA / 0 kVA	2500 kVA / 2250 kVA / 0 kVA	2750 kVA / 2500 kVA / 0 kVA	3000 kVA / 2700 kVA / 0 kVA
6.6 kV to 35 kV	6.6 kV to 35 kV	6.6 kV to 35 kV	6.6 kV to 35 kV
50 Hz / 60 Hz	50 Hz / 60 Hz	50 Hz / 60 Hz	50 Hz / 60 Hz
● / ○	● / ○	● / ○	● / ○
● / ○	● / ○	● / ○	● / ○
43 A	44 A	49 A	53 A
2.5 kW / 1.92 kW	2.5 kW / 1.92 kW	2.8 kW / 2.1 kW	3.0 kW / 2.3 kW
23.2 kW / 23.0 kW	23.2 kW / 23.0 kW	25.5 kW / 25.3 kW	27.4 kW / 27.3 kW
< 3%	< 3%	< 3%	< 3%
○ up to 60% of AC power	○ up to 60% of AC power	○ up to 60% of AC power	○ up to 60% of AC power
1 / 0.8 overexcited to 0.8 underexcited	1 / 0.8 overexcited to 0.8 underexcited	1 / 0.8 overexcited to 0.8 underexcited	1 / 0.8 overexcited to 0.8 underexcited
98.6%	98.6%	98.7%	98.8%
98.4%	98.3%	98.6%	98.6%
98.0%	98.0%	98.5%	98.5%
DC load-break switch	DC load-break switch	DC load-break switch	DC load-break switch
Medium-voltage vacuum circuit breaker	Medium-voltage vacuum circuit breaker	Medium-voltage vacuum circuit breaker	Medium-voltage vacuum circuit breaker
Surge arrester type I	Surge arrester type I	Surge arrester type I	Surge arrester type I
●	●	●	●
IAC A 20kA 1s	IAC A 20kA 1s	IAC A 20kA 1s	IAC A 20kA 1s
6058 mm / 2591 mm / 2438 mm	6058 mm / 2591 mm / 2438 mm	6058 mm / 2591 mm / 2438 mm	6058 mm / 2591 mm / 2438 mm
6058 mm / 2896 mm / 2438 mm	6058 mm / 2896 mm / 2438 mm	6058 mm / 2896 mm / 2438 mm	6058 mm / 2896 mm / 2438 mm
< 16 t	< 16 t	< 16 t	< 16 t
< 8.1 kW / < 1.8 kW / < 2.0 kW	< 8.1 kW / < 1.8 kW / < 2.0 kW	< 8.1 kW / < 1.8 kW / < 2.0 kW	< 8.1 kW / < 1.8 kW / < 2.0 kW
< 300 W	< 370 W	< 370 W	< 370 W
Control rooms IP23D, inverter electronics IP65			
● / ○ / ○	● / ○ / ○	● / ○ / ○	● / ○ / ○
● / ○ / ○	● / ○ / ○	● / ○ / ○	● / ○ / ○
15% to 95%	15% to 95%	15% to 95%	15% to 95%
● / ○ / ○ / ○	● / ○ / ○ / – (earlier temperature-dependent de-rating)		
(earlier temperature-dependent de-rating)			
6500 m³/h	6500 m³/h	6500 m³/h	6500 m³/h
Terminal lug	Terminal lug	Terminal lug	Terminal lug
Outer-cone angle plug	Outer-cone angle plug	Outer-cone angle plug	Outer-cone angle plug
● / ○	● / ○	● / ○	● / ○
● / ○	● / ○	● / ○	● / ○
○	○	○	○
RAL 7004	RAL 7004	RAL 7004	RAL 7004
● / ○ / ○	● / ○ / ○	● / ○ / ○	● / ○ / ○
● / ○ / ○	● / ○ / ○	● / ○ / ○	● / ○ / ○
● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
● / ○	● / ○	● / ○	● / ○
IEC 62271-202, IEC 62271-200, IEC 60076 , CSC certificate, EN 50588-1			
MVPS-2475-20	MVPS-2500-20	MVPS-2750-20	MVPS-3000-20

System diagram with Sunny Central



System diagram with Sunny Central Storage





VAN DER VALK



**OOK IN ZWART
VERKRIJGBAAR**

ValkPitched - Clamp

ValkPitched - Insert

ValkPitched - Trapezoidal

Bij de ontwikkeling van montagesystemen voor daken zijn montagegemak en snelheid belangrijke aandachtspunten. Als het gaat om schuine daken komt er echter nog een belangrijk aandachtspunt bij: flexibiliteit. Er zijn immers vele soorten schuine daken met elk hun vereisten voor een gedegen bevestiging. Ons assortiment voor schuine daken is zowel doordacht als compleet. Onderstaande drie basissystemen zijn toepasbaar op veel verschillende daktypen, zoals pannendaken, staaldaken, golfplaatdaken en felsnaaddaken. Met natuurlijk voor ieder schuin dak de juiste, veilige dakbevestiging.



ValkPitched - Clamp

Uniek aan dit systeem:

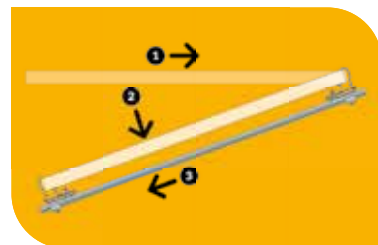
- ✓ Klemsysteem
- ✓ Universele tussen- en eindklemmen (H 28-50 mm)
- ✓ Minder dakbevestiging noodzakelijk door zeer sterk profiel
- ✓ Koppelstuk van gelijke sterkte als profiel, dus geen zwakke plekken
- ✓ Praktische en veilige zijmontage



ValkPitched - Insert

Uniek aan dit systeem:

- ✓ Inschuifstelsysteem
- ✓ Zeer snelle paneelmontage
- ✓ Automatisch een perfect uitgelijnd systeem
- ✓ Strak aanzicht
- ✓ Minimum aantal profielen nodig door optimale uitlijning



ValkPitched - Trapezoidal

Uniek aan dit systeem:

- ✓ Klemsysteem met universele tussen en- eindpaneelklemmen (H 28-50 mm)
- ✓ Logistiek voordeel door korte profiellengtes
- ✓ Indien gewenst ook lange lengtes verkrijgbaar
- ✓ Waterdichte bevestiging met speciale schroeven of popnagels
- ✓ Voorgeponste gaten in profielen voor snelle en eenvoudige montage
- ✓ Ook geschikt voor stalen golfplaatdaken

Toepassingen Schuin Dak Systemen

De **ValkPitched – Clamp**, de **ValkPitched – Insert** en de **ValkPitched – Trapezoidal** hebben verschillende bevestigingsmethoden. Hiermee is een snelle en bedrijfszekere bevestiging gewaarborgd bij zeer veel verschillende daktypen.

Zo maken we voor pannendaken gebruik van onze befaamde methode waarbij de **Smartline** dakhaak met een sterke schroefverbinding aan een geïmpregneerde houten plank wordt bevestigd. Dit maakt het systeem bestand tegen de zwaarste weersomstandigheden.

Als alternatief voor de **Smartline** dakhaak is er de **Slimline** dakhaak, waarbij de haak achter de panlat wordt geschoven en de **Strongline** dakhaak, waarbij de haak direct op de sparren wordt geschroefd.

	ValkPitched Clamp	ValkPitched Insert	ValkPitched Trapezoidal
Dakpannen Smartline	✓	✓	
Dakpannen Slimline	✓	✓	
Dakpannen Strongline	✓	✓	
Golfplaten	✓	✓	✓
Staal/ Trapezium	✓	✓	✓
Felsnaad (plat/ rond)	✓	✓	
Bitumen	✓	✓	
Lei/ Shingle	✓	✓	
Vlakke pan	✓	✓	

Bekijk hier welke systemen op welke dakbedekking kunnen worden toegepast.

Glaspanelen

Naast de gangbare zonnepanelen met frame kunnen ook zonnepanelen zonder frame middels glasklemmen worden bevestigd.

Gratis Software

Met onze gratis te gebruiken software, de ValkPVplanner, kan in eenvoudige stappen een complete projectcalculatie met artikellijst en projectspecifieke installatiehandleiding worden verkregen.

Van der Valk Solar Systems ontwikkelt en produceert solar montagesystemen voor:



Schuine daken



Platte daken



Open velden



Kassen



Waterpartijen

WAAROM VAN DER VALK SOLAR SYSTEMS?

- Innovatieve systemen ontwikkeld volgens wereldwijd geldende normeringen
- Snelle en betrouwbare leveringen dankzij modern machinepark en grote voorraden
- Systeemleverancier sinds 1963
- Gratis te gebruiken software voor projectontwerp en -calculatie
- Alle systemen toepasbaar op elk type dak of ondergrond
- Snelle montage dankzij voormontage van essentiële onderdelen
- Grote flexibiliteit in oplossingen
- Diverse systemen ook leverbaar als kant-en-klare kits



De montagesystemen van Van der Valk Solar Systems worden geleverd en geïnstalleerd via een uitgebreid netwerk van dealers en installateurs. Wij helpen u graag bij het zoeken naar het juiste contact bij u in de buurt.

Meer informatie (o.a. datasheets, prijslijsten en handleidingen) kunt u downloaden op onze website.

V02-2018

VOOR UITGEBREIDE PRODUCTINFORMATIE KUNT U TERECHT BIJ
VAN DER VALK SOLAR SYSTEMS OF UW DEALER / INSTALLATEUR.

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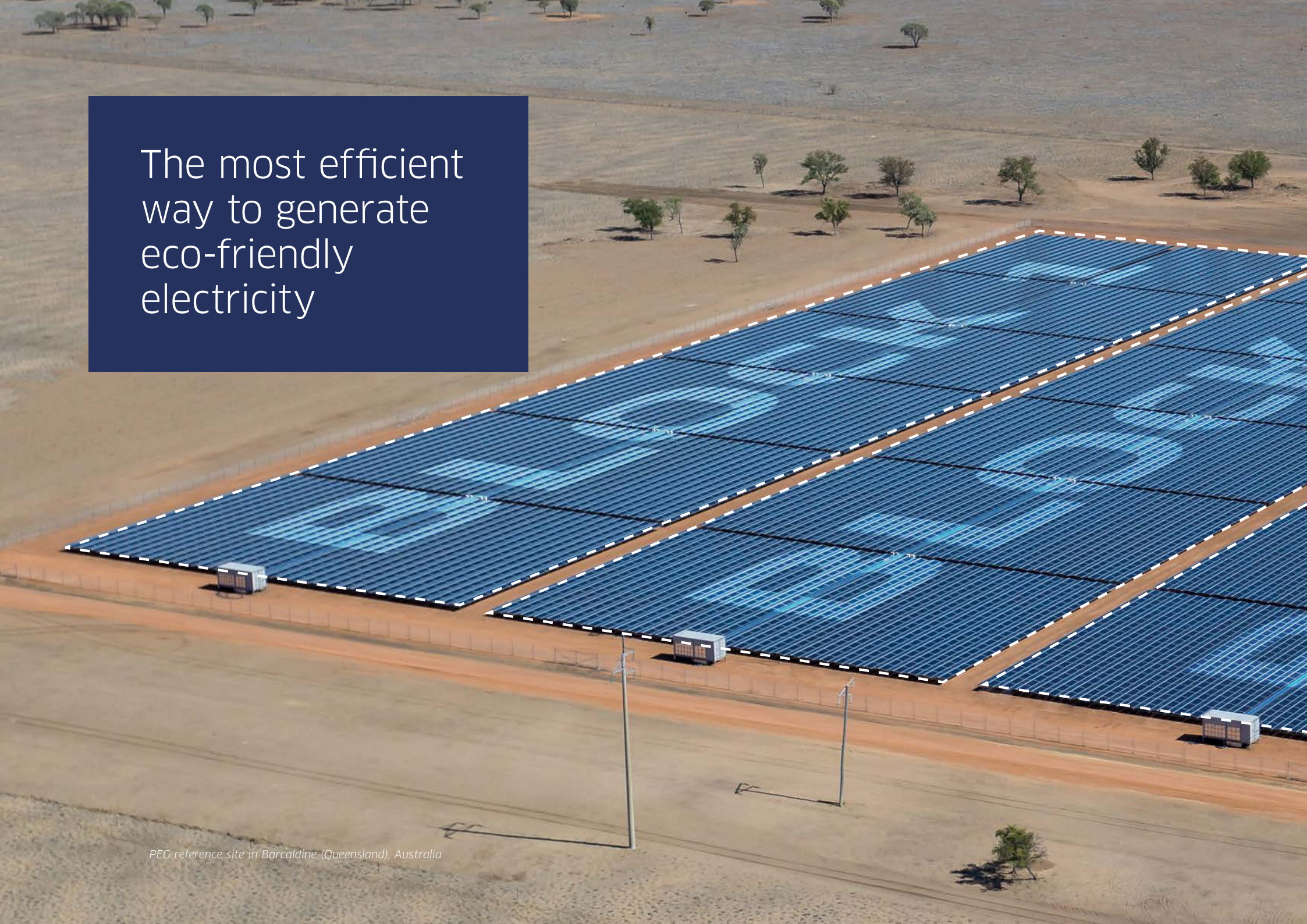


PEG[®] PV Plant

The Revolution in
Utility-scale PV Power

Reaching the lowest cost of electricity with a revolutionary new PV plant technology

The most efficient
way to generate
eco-friendly
electricity



PEG reference site in Barcaldine (Queensland), Australia



BELECTRIC's PEG power blocks energize your power grid with clean and affordable electricity

The Revolution of Renewable Energies

It's not only a historical milestone - in fact it was this great step in human electrification when Thomas Alva Edison invented the electrical light bulb and afterwards the power utilities - the basis of today's power grids. Now, over 130 years later we are in for the next revolution in electricity: The Transition to Renewable Energy.

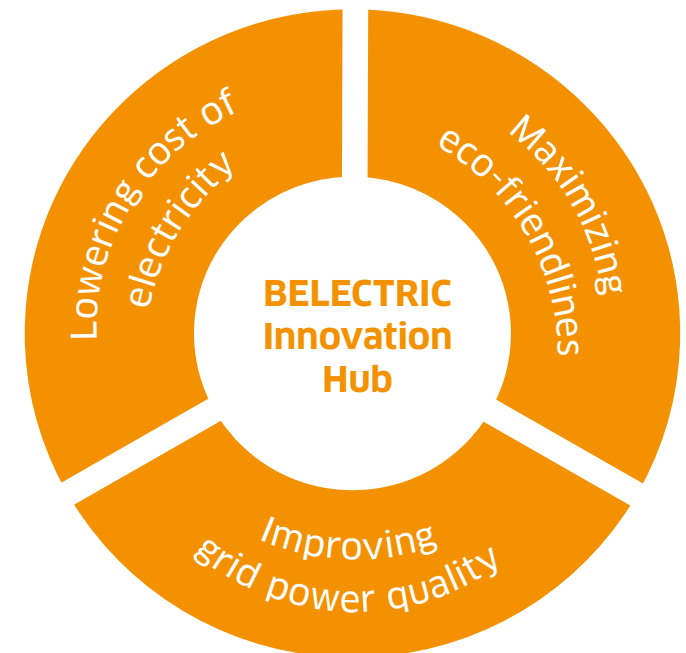
In the last decades our behavior in power consumption has changed. The demand for electricity in this "digital age" is highly individual. The growth of electric mobility claims more grid capacities. We should balance with this needs to generate that power in an eco-friendly manner.

Renewables are a global revolution.

Back to 2000 the only renewable energy source that was practically generating electricity was Hydro. The last decade renewable technologies have been enhanced - acting much more efficient.

Today, solar power generation through photovoltaics is the most valuable way for mankind to generate eco-friendly electricity.

Critical arguments based on the volatile power generation has been refuted with the power of decentralized battery energy storage systems and smart grid technologies.



Solar PV Industry Challenges

Levelized cost of electricity (LCOE)* is the main indicator to drive investment decisions. The key drivers are:

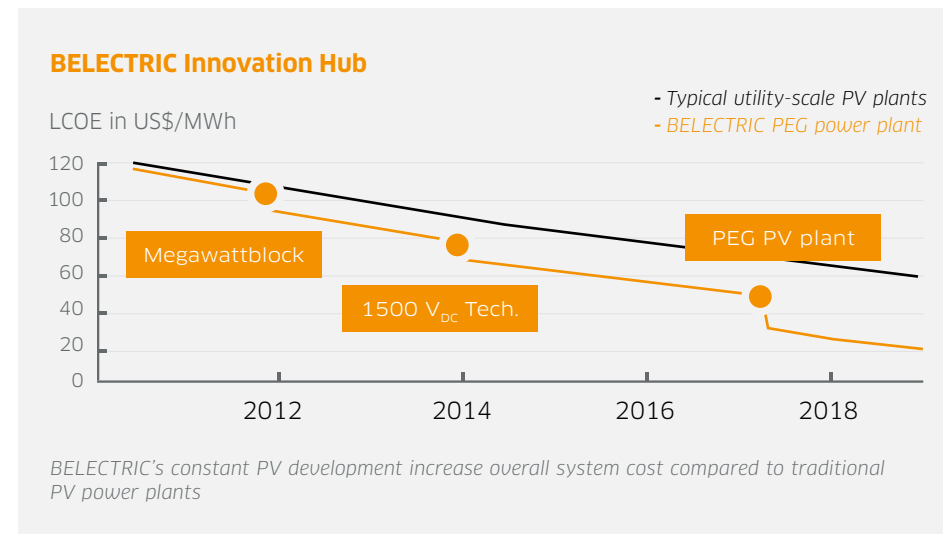
- **Investment cost for system installation (CAPEX)**
- **Operation and maintenance cost (OPEX)**
- **Average annual electricity yield (kWh per year)**

The market for solar PV (photovoltaics) is mainly driven by the continuous technology development which is improving the performance of the system and at the same time decreasing the cost. The PV cost of electricity has been decreasing over the last years. Higher system efficiencies, lower material usage and more innovative manufacturing processes are going to set a scene for the future market developments.

Recent reports show that LCOE for utility-scale PV power is cost-competitive with all of our general sources for electricity generation.

PV modules hold one of the main cost of a PV power plant. But over 60 % of system costs are generated by substructure, wiring, inverters and engineering and construction efforts. With its in-house capabilities BELECTRIC starts to think different and rework the traditional EPC process. As one of the leading PV technology

companies it develops something real new: The PEG PV plant. With the new system design the whole approach to build up solar PV power plants has changed. By this, BELECTRIC PEG is working at a price point, which is up to a third lower than the rest of PV industry. PEG is actually the most cost efficient way to produce electricity.



* Levelized costs of electricity (LCOE) is a industry primary metric for comparing overall electricity costs produced by a power generator



“I’d put my money
on the sun and
solar energy.”

Thomas Edison

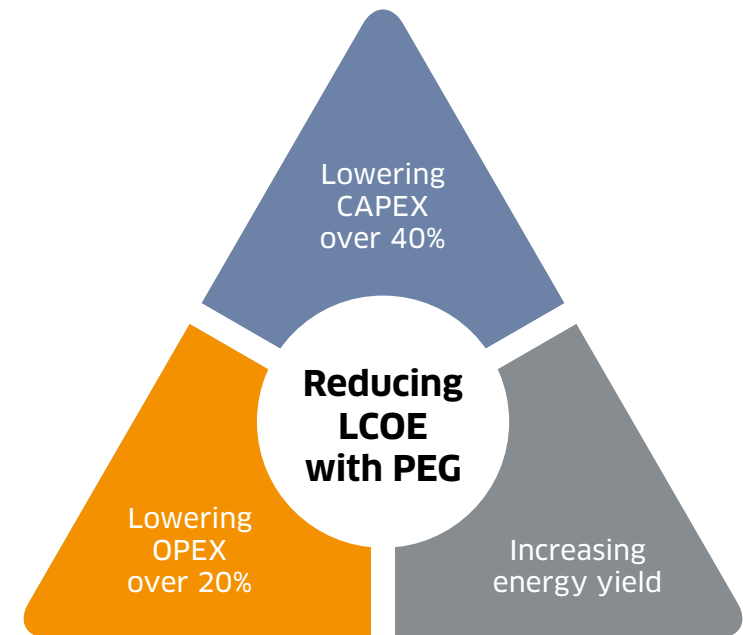


PEG[®] saving
CAPEX
over 40%
compared
to common
PV plants

The PEG Effect: Save CAPEX and OPEX

For many years solar photovoltaics has been defined by its typical **Engineering-Procurement-Construction (EPC)** process. Today, BELECTRIC is challenging this old-fashioned principle with **Engineering-Procurement-Installation (EPI)** - a new PV power realization process focused on quick and resource-saving installation.

PEG system was formed with a simple goal in mind: create a power unit to deliver electricity at lowest possible levelized costs of energy (LCOE), with best in class technologies, long-term reliability and large volume scalability. The PEG unit significantly reduces both substructure supply and delivery, as well as installation costs.



PEG CAPEX savings:

-90%
machine costs

-50%
logistic costs

-70%
labor costs



Lower CAPEX

With PEG's simplified system design there are no reasons for months of planning, a time consuming consulting and expensive construction tasks.

PEG works nearly without ground soiling foundations. No heavy construction machines are needed. Components are partly shipped pre-configured in container-based units.

Lower OPEX

BELECTRIC's decades long O&M experience has been run into the PEG development. Due to new working ergonomics and an above ground installed DC cabling maintenance costs can be reduced by a quarter.

PEG reference site in Haidt, Germany



A rod, which changes everything.

The new system design is based on a PV module mesh, which is borne by many rods. The whole logistic and realization process changes.



PEG[®] vs. common PV Plants

Comparison of:	Traditional Solar Power Plant	PEG Power Plant
Area utilization	Medium, cause system-related free space between straight PV module lines	PV module mesh with highest area utilization
Raw materials	High amount of steel, wood and concrete	No concrete, no wood; saving up to 65% steel
Project process	EPC: Engineering, Procurement, Construction over several months	EPI: Quick Engineering, Procurement and Installation over a few weeks
Engineering	Predominant individual process	3D scan-assisted planning with standardized PEG clusters; customer choice: Manufacturer of PV modules and inverter system
Procurement and logistics	Individual planning and components » complex transportation planning, customer duties and logistic efforts	Easy material flow, transport planning and logistic process by container-based units
Installation	Heavy machinery and many workmen with different skills with driving licenses needed; Construction works partly overhead (substructure, PV mounting)	Simplified process with small teams; nailing and mounting with hand tools; Besides AC/DC configuration no special skills needed; no heavy machines; no overhead working; no cable trenching
Operation & Maintenance	Overhead working, difficult tests with underground cabling	All component are installed over-ground with working height around one meter
Energy yield	Peak power generation at noon time	Balanced power generation with better energy yield at sunrise and sunset due to east/west exposition



No complex substructure



No heavy machines



It's not EPC, it is EPI

(Engineering-Planning-Installation)

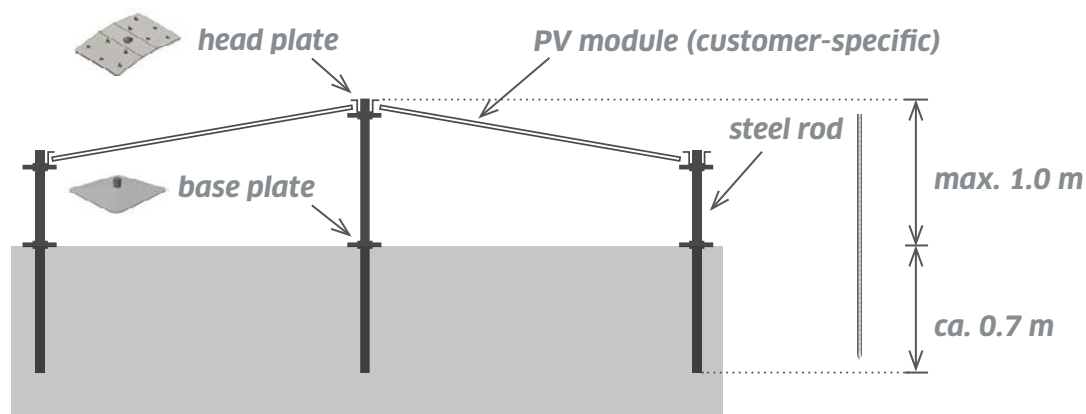
The PEG power plant will be installed rather than constructed. It is based on an innovative system design, which follows the ground surface - the PEG mesh. The ground-nailed substructure clamps the PV panels at about one meter elevation over-ground. The special engineered construction design with its flat 'zigzag' pattern is very durable against environmental

impacts. Furthermore at high wind loads the patented construction produces a down-lift, which increases the static characteristics.

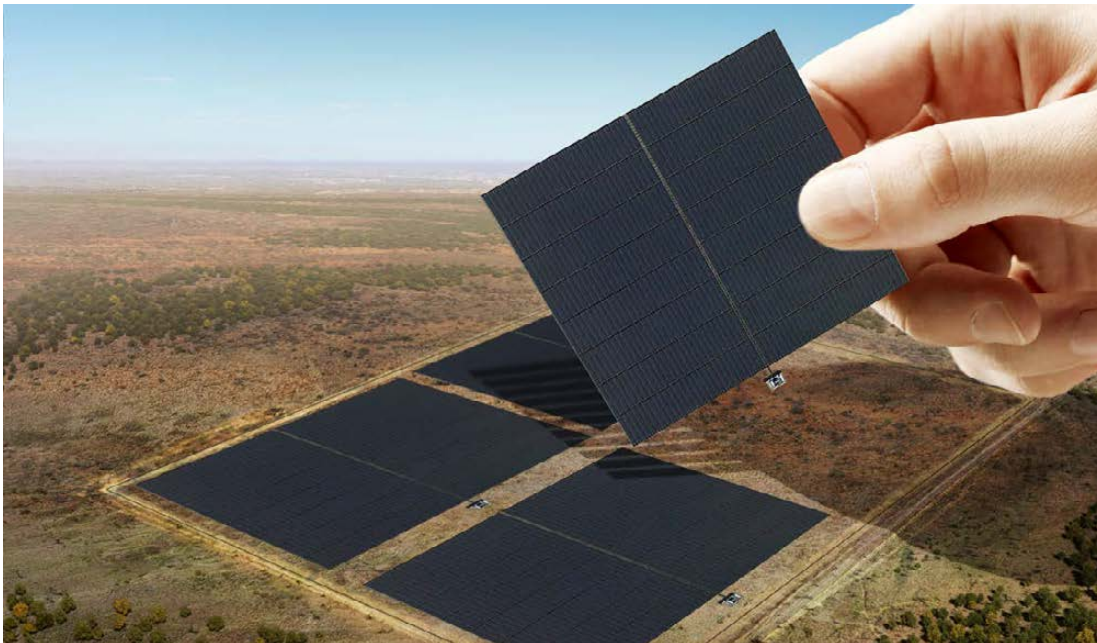
The PEG System is a revolution in the field of substructures for PV power plants with framed modules. It is a unique solution and especially designed for **east/west exposition**.

The PEG system significantly reduces both substructure supply and delivery as well as installation costs. Due to the lightweight construction no foundation is needed. Less material and a simple design lead to reduced labor costs and the phase between planning and commissioning is reduced significantly.

The PEG substructure is the lightest, most efficient and innovative system on the market. Substructures of our competitors are much heavier and more expensive. Most of them need concrete foundations and heavy machines. With PEG, the steel rods of the PEG substructure can also be installed with only a hammer drill.



Outstanding innovations behind PEG®



PEG reference site in Goondiwindi, Australia

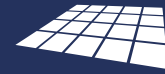




1.5 MWp =
One 40 ft. container



1.1 kWp
per man-hour



1.4 MWp
per hectare



PEG[®] Engineering

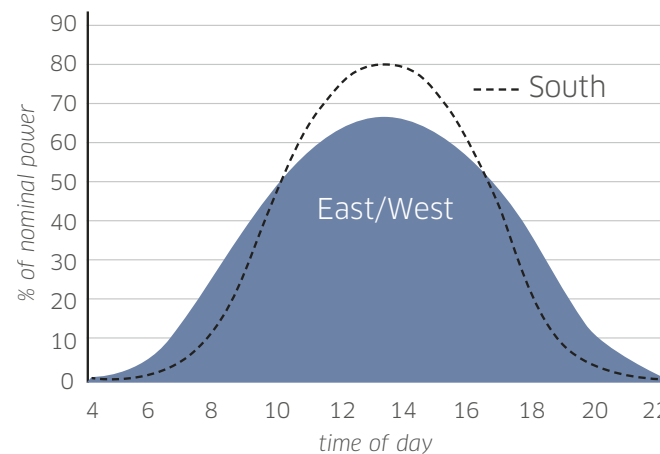
With PEG the engineering process has been enormously simplified. Cause substructure is based on a rod-mounted PV mesh, there is rather head space to plan a PV plant on a selected client surface. The ground leveling and the alignment of the PEG blocks is assisted by 3D scan and CAD engineering.

Clustering PEG power blocks

The whole engineering process has been simplified by a clear standardization with PEG system blocks. Related to PV panel type and the selected level of DC system voltage (1000 to 1,500 V_{DC}) PEG engineering process works with pre-defined power blocks.

In contrast to conventional PV module lines, the PEG mesh utilizes a greater power-generating photovoltaic area. The flat - typical east-west oriented - PV generator creates a smoother daily averaged electricity yield. Grid-connection points are less stressed and feed-in power peaks are more reduced.

Consistent energy generation across the day:



PEG engineering benefits:

- Full scalable system design
- High location variety: Like a millipede, numerous mounting poles will be adapted to the ground and establish a new freedom of site selection
- Suitable for many PV module types
- Freely adaptable for 1,000-1,500 V_{DC}
- Most effective land utilization for utility-scale photovoltaics
- Low visual and ecological impact
 - ▶ simplified approval procedures



Self stabilizing



Low visual impact



Wind-proofed *

* Designed for 2,400 Pa module pressure load; Max. wind speed is 135 mph (60.3 m/s)

Most effective land utilization.

Low visual impact.

Full scalable from 10 kWp to MWs.

The revolution in utility-scale PV power:
Best-in-class area utilization of 1.4 MWp per hectare



Reduced raw materials.
No concrete foundations.
Unit-based packaging.
No construction vehicles.



-50%

logistic
costs



PEG[®] Procurement

Nevermore dealing with heavy loads and on-site problems with impassable terrain; nevermore dealing with complex customs clearance. Besides its simplified engineering and installation workflow PEG system has one more ace up in sleeve: The consumption of raw materials and production resources is enormously lower compared to traditional solar PV projects.

All that even goes so far that you can install the whole DC-related PEG power plant with a small team equipped with some hand tools. Just for transportation purpose on-site BELECTRIC is using a compact track loader.

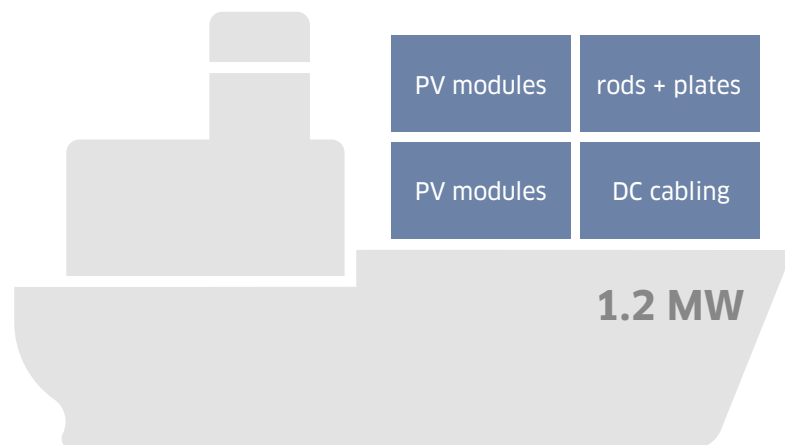
This elementary simplification opens up huge savings for PEG material procurement and project logistics. In short, four maritime containers are sufficing to transport a PEG power plant with one megawatt DC capacity.

PEG's revolutionary system design enables transportation to far reaches all over the world. Thus not only on-grid capacities but also off-grid systems can produce eco-friendly, decentralized electricity.



PEG procurement benefits:

- *Minimal material and transport cost*
- *Significantly reduced steel consumption*
- *Eliminates need for concrete foundations*



PEG[®] Installation

The PEG power plant installation based on a quick nailing process. Only four workmen are necessary to start-up a PEG power plant installation. Like an ink-based office printer is completing a print out, the PEG power plant will be installed line-by-line. In contrast to traditional PV power plant suppliers the working process does not depend on heavy working machines or vehicles. Most works can be run at waist level to ensure an ergonomic and HSE optimized working environment.

Despite the high-level of standardization the PEG system design is compatible to many PV panel manufacturers. For best individualism the customer can choose his favored panel type.



1.1 kWp
per man-hour

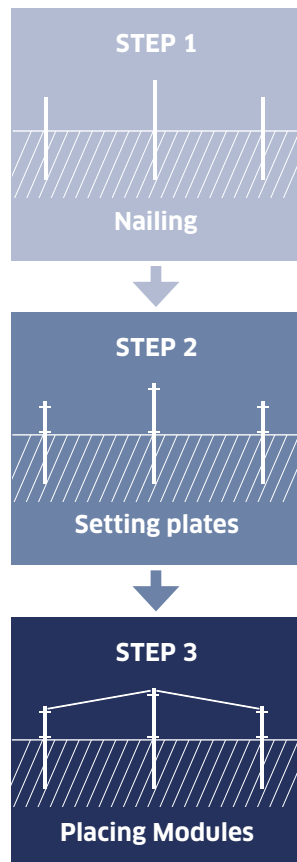


Easy and fast installation with PEG:

- *Installation speed: 1.1 kWp per man-hour*
- *Simple installation process:*
 - *no need for special construction requirements and heavy machinery*
 - *no concrete foundations*
 - *no cable trenches*
- *Reduced risks and cost in terms of HSE*
- *All components installed over-ground (no underground works necessary)*
- *Ergonomic working height: 0.6 m to 1.2 m*
- *PEG will be installed line by line with an easy nailing placement process*
- *Simple and residue-free dismantling after project life, in case of different land use designation*

No heavy machines.
No concrete foundations.
Simpler HSE procedures
on project site.

3 Steps to PEG:



Easy PV module maintenance.
Smart cleaning & mowing.
Constant energy across day.



Operation and Maintenance

BELECTRIC O&M services help to support continuous PV plant operation, giving higher energy yield and therefore high return on investment across life-cycle. From daily operation, routine and scheduled maintenance, to outage services our service team meets the demands of customers' individual operational and maintenance models comprising as risk sharing mechanisms.

- **Remote monitoring and diagnostics**
- **Maintenance**
- **Spare parts and obsolescence management**
- **Warranty extensions**
- **Response time guarantees**
- **Availability guarantees**

While developing the new PEG system our engineers considering BELECTRIC's know-how and long-time experience in the operation and maintenance of large-scale PV power plants. In result PEG's low substructure with overground DC cabling allows an simplified site inspection.

Besides, BELECTRIC introduces a new, smart O&M work-flow, especially a robot-assisted PV module cleaning process, an optional PEG mowing robot and an O&M service bench to access single PV modules on-site.

The PID reduction technology and long-term guarantees of all PEG integrated components safe a reliable operation.



Quick and easy site inspections:

- *Low substructure allows easy site inspections*
- *No parts installed under ground*
- *Quick and easy full-string check ups*
- *PV module servicing with PEG working bench*

PV site care

- *Automated PV module cleaning robot*
- *Robot-assisted turf mowing (in normal case not necessary with PEG)*

Improve Your ROI with real SCADA

The digitalization for Industry 4.0 applications is considered to be the next industrial revolution worldwide. By now, PEG PV plants are already equipped with all necessary components and sensor technology to collect and analyze important operating parameters in real-time. The SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION) system is powered by PADCON SCADA solutions. Besides data analysis and data warehousing the SCADA system enables energy forecasting, hybrid control and a warning and alert system for service engineers.

SCADA System

- Real-time data analyzing and visualization
- Remote inverter control
- Weather station and substation interface
- Historical data analysis

Plant Level Control System

- Controlling of Voltage (AVR), Frequency, Power factor, VAR
- Line drop compensation
- Power curtailment and ramp rate control
- Park shut-down/start-up

Data monitoring and Control Solutions

Cloud purpose-built for industrial data to analyze and pro-actively schedule maintenance or upgrades before failures occur

Energy Management System

EMS - Intelligent Energy Management System to control hybrid operation

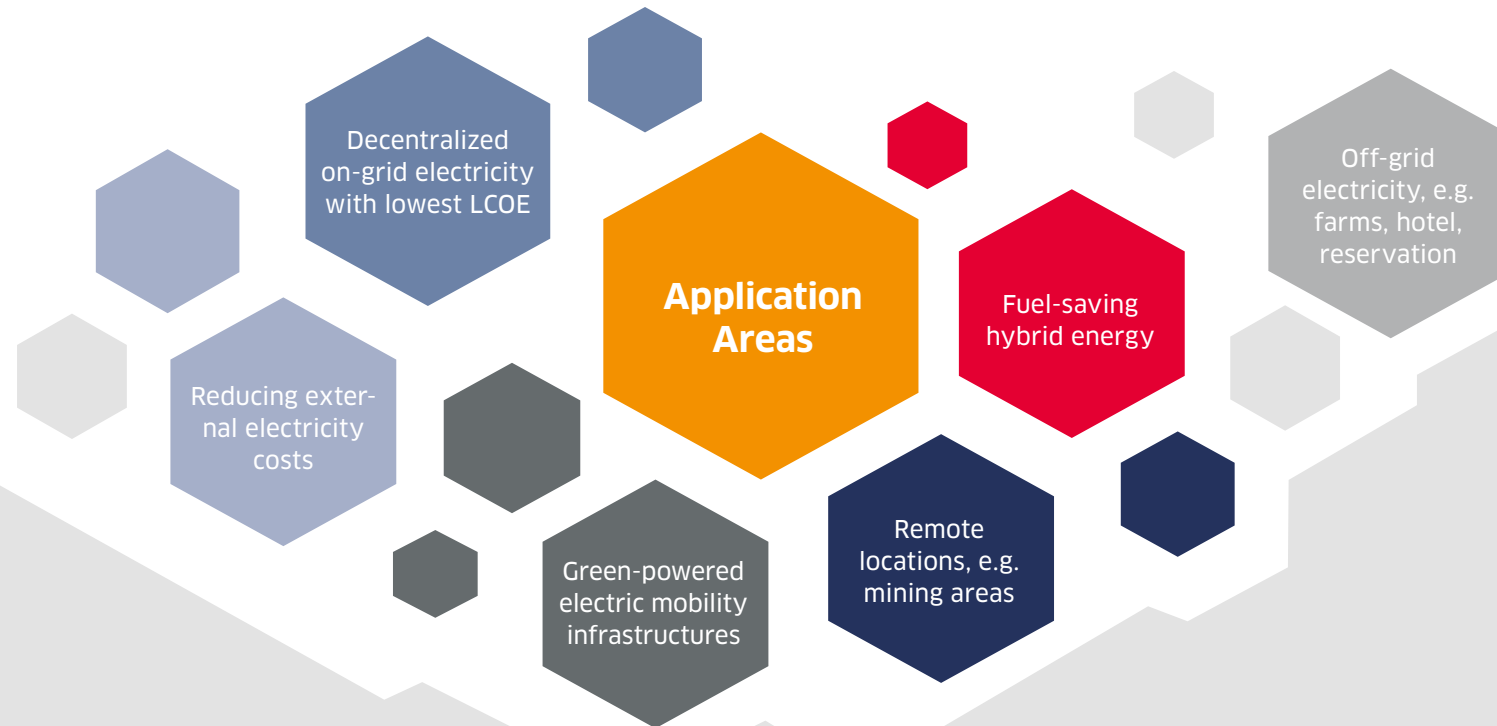




PEG[®] placement options

PEG PV plants are feasible in nearly every environment where affordable electricity is needed. Our engineers had tuned all components to operate under desert-proofed conditions as well as under Nordic climates. With its easy to transport units and weights PEG systems can be delivered to very remote locations. The high level of standardization make it possible to place a PEG power block to a variety of ground surfaces. This freedom in choice of location and PEG's optional battery and hybrid control extensions are enabling new business models for our customers.

How can PEG optimize your business?





Free scalable and
application-oriented
PEG placements



PEG[®] applicable: Battery Storage and Hybrid power

Besides its high solar PV expertise BELECTRIC develops industrial systems for battery storage and hybrid solutions. With these new technologies climate-friendly solar power will be combined with the benefits of fuel-based energy sources.

Lithium-Ion based battery storage and hybrid control units can be integrated into a PEG PV plant. The battery storage reacts on load and voltage variations in milliseconds. BELECTRIC's Energy Buffer Unit (abbr. EBU) enables ancillary grid stabilization services like black start, island operation and virtual inertia. It can provide grid stabilization through primary frequency response, enhanced frequency response, RoCoF

response, load shifting, peak shaving. As BELECTRIC PEG, the LION EBU is designed for maximal scalability and flexibility. It can be adapted for today's needs at local or national power grids, guaranteeing a stable grid, and even allowing more renewable energy in the near future.



Battery and hybrid benefits:

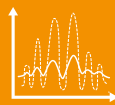
- *Highly standardized hybrid and battery power units compatible with PEG PV plant*
- *Improve power quality at regional grid*
- *Enables ancillary smart grid services*
- *Independent electricity 24/7 with maximized use of fuel-less solar PV*
- *Improve island and off-grid, micro-grid infrastructures*



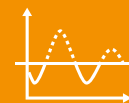
Hybrid



Island Power



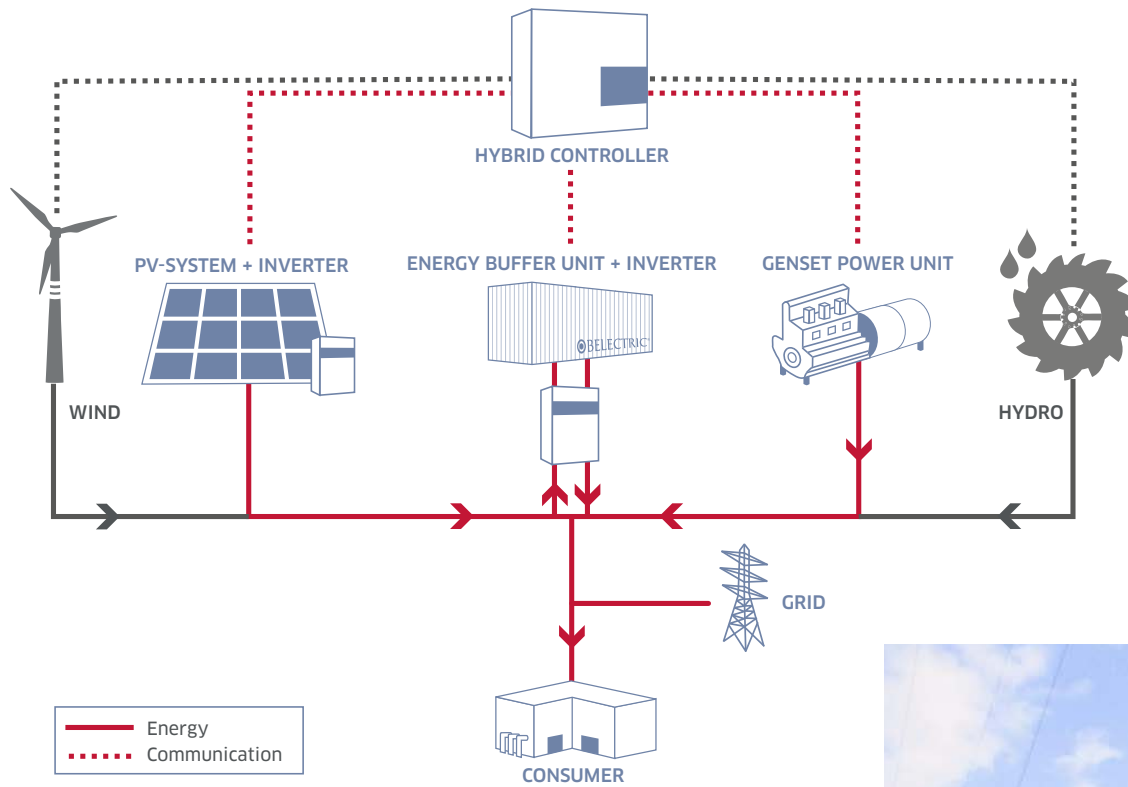
Fast response
Frequency Control



Peak Shaving



EV Charge



Optimize grid
quality and reduce
fuel consumption



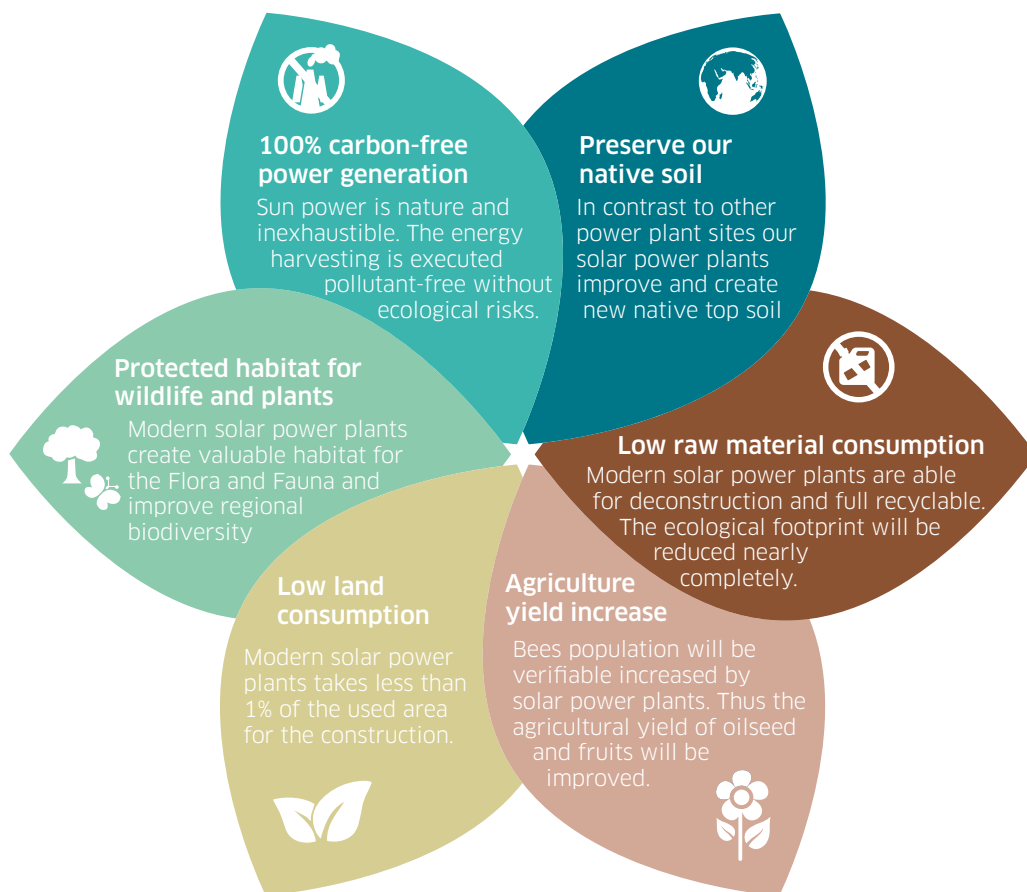
Low ecological footprint
in manufacturing, logistics
and installation.

Low land consumption.

Completely dismantlable
PV plant.

Solar energy
is a gift from
nature





Wildlife under threat

European farmland has changed greatly over the last decades. The old patchwork of mixed-use farms, with small fields surrounded by hedgerows and wild margins, provided abundant food and shelter for a wealth of wildlife. Today's farmland is dominated by industrial-scale mono-culture, often blanketing large expanses with crops such as cereals that provide little succor to wildlife – even to the pollinating insects on which other crops rely.

Solar farms put life back into countryside

Solar farms inject clean renewable energy directly into the power grid. We feel they should be enthusiastically embraced as not only a core part of the long-term solution to securing our national energy supply and meeting international climate change targets, but also as a boon for biodiversity. A little known fact about solar farms is that less than 5% of the land underneath has anything physical attached to it, meaning that more than 95% can be used throughout its lifetime to support wildlife.



Ecological benefits for PEG vs. traditional solar PV:

- Ecological footprint is much lower due to less raw materials and logistic efforts
- Protection of rare top soil cause no concrete works necessary and all DC cabling is fixed underground



PEG[®] – Harvesting the Power of the Sun

BELECTRIC Solar & Battery GmbH

Wadenbrunner Str. 10
97509 Kolitzheim, Germany

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info@belectric.com
www.belectric.com

BELECTRIC Solar & Battery GmbH is one of the most successful enterprises in the development and construction of utility-scale solar PV power plants and battery storage systems. The company was established in 2001 and has been expanded to an international group with activities on all continents since then.

BELECTRIC has constructed 300 solar PV power plants with around 2 GWp PV capacity. In addition, the company realized battery energy storage systems and hybrid power solutions, which combines different technologies to autarkic systems. As one of the largest O&M providers globally, BELECTRIC's full-integrated services provide continuous operation.

System static

(Input values see building specifications)

Netherlands

Manufacturer: BELECTRIC GmbH
Wadenbrunner Str. 10
97509 Kolitzheim

Construction project: Solar power station PEG-System
Open space station (PlanTec, east-west, modules „72-Cells“; 8°)

Scale:	Contents, Preliminary notes	page: 2 - 3
	Plans, Static Analysis	page: 4 - 38
	Annex: Calculation of c_{pe} -values	page: 1 - 4

Thomas Siedler
Graduate engineer (FH)



Compiled: Kolitzheim 11.09.2018

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1 Preliminary notes:

1.1 Assumed load (input value)

Load according Eurocode:

Wind: Wind region I - II, high of the building $\leq 1\text{m}$; terrain category 0,
Wind region I - III, high of the building $\leq 1\text{m}$; terrain category 2,
wind speed corresponds to acting over a time of 10 minutes and return period of 50 years
(NEN EN 1991-1-4)

Snow: $s_k = 0,70 \text{ kN/m}^2$ (Characteristic ground snow load, NEN EN 1991-1-3)

All calculations are done with the maximum load (Wind region I and terrain category 0).

Minimum pull load in tests see page 38

Maximum load on module see page 37

At higher impact, the manufacturer should be contacted.

1.2 Building specification:

In the present construction project is a ground mounted solar power plant with Peg-system.
This framework modules mounted in gable roof form (orientation east-west) with an angle of 8 degrees,
without further substructure, directly on threaded rods. The reinforcing rods are each placed at the vertices
of modules up to a defined depth in the subsoil. Four modules are connected with metal sheets on a
reinforcing rod and thus firmly connected together.

The maximum admissible distance from top ground surface to the beginning of the lowermost module is
0,70m.

At the ground level the reinforcing rods are connected to base plates to derive the pressure force.

Two variations are possible for the foundation:

V1: Reinforcing rods are rammed directly in the ground.

V2: Earth screws are drilled in the ground.

1.3 General:

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permission.

Before the construction work begins, the building ground is to be tested for the required values.

The structural engineer is to be notified of open questions immediately.

1.4 Materials:

Steel B 500 S (A)

Steel S 235 JR+AR – hot-dip-galvanised

1.5 Basic calculation principles:

1.5.1 Literature:

- 1) Eurocode
- 2) relevant provisions
- 3) wind report of I.F.I. institute
- 4) The used materials are to be taken from the items
- 5) Literature: Schneider building tables
- 6) Calculation carried out with RSTAB software from Dlubal

1.5.2 Wind load approach:

Especially for the Peg-system is a wind report available.

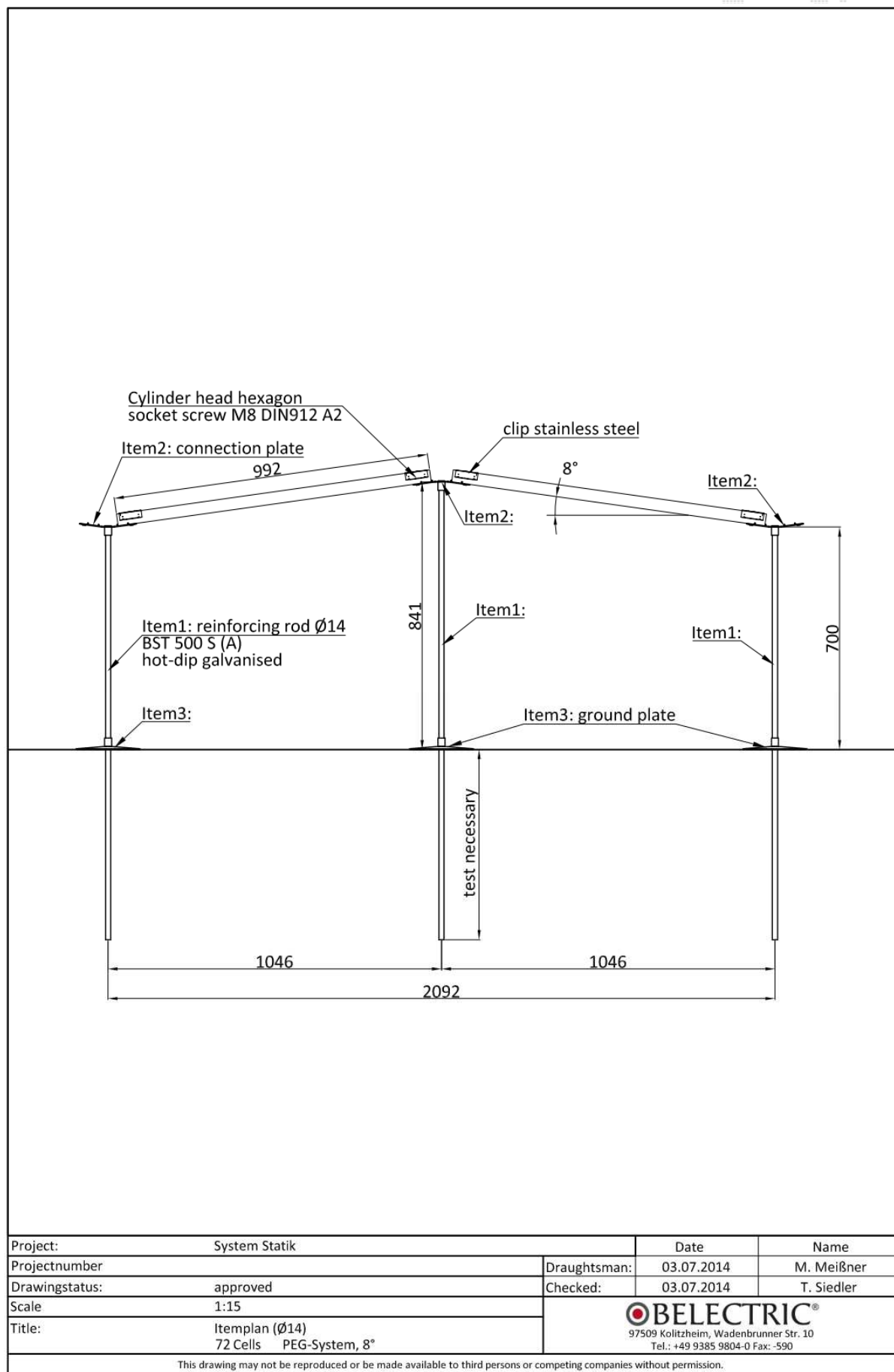
In this wind report both $c_{p,10}$ -values and $c_{p,1}$ -values are given.

In the present design is the impact surface, the surface of a module ($1,0\text{m} \times 2,0\text{m} \times 4 = 8\text{m}^2$).

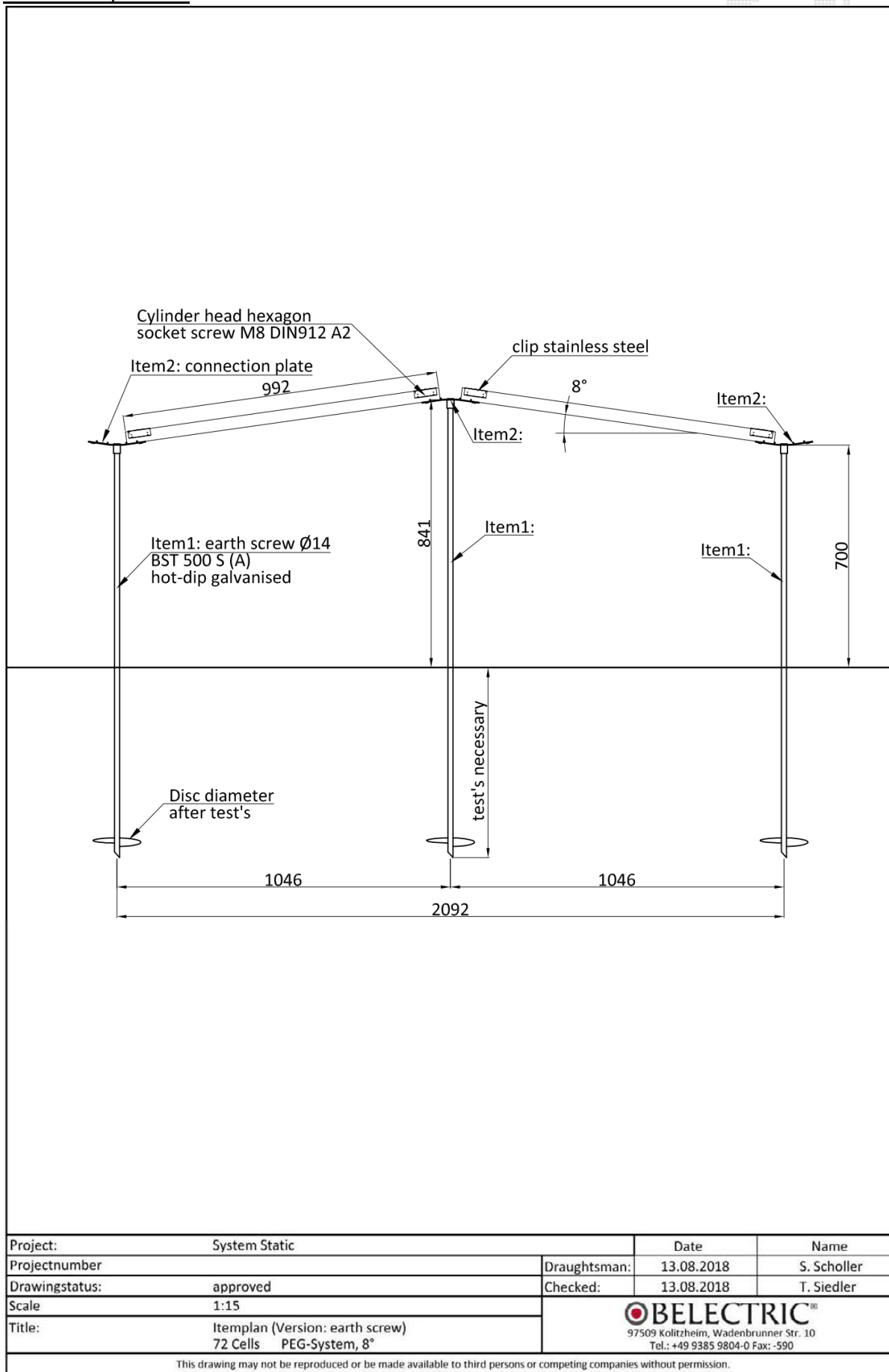
The static Analysis is performed with the $c_{p,8}$ -values.

The maximum load on module is performed with the $c_{p,2}$ -values.

2.1 Item plan V1:



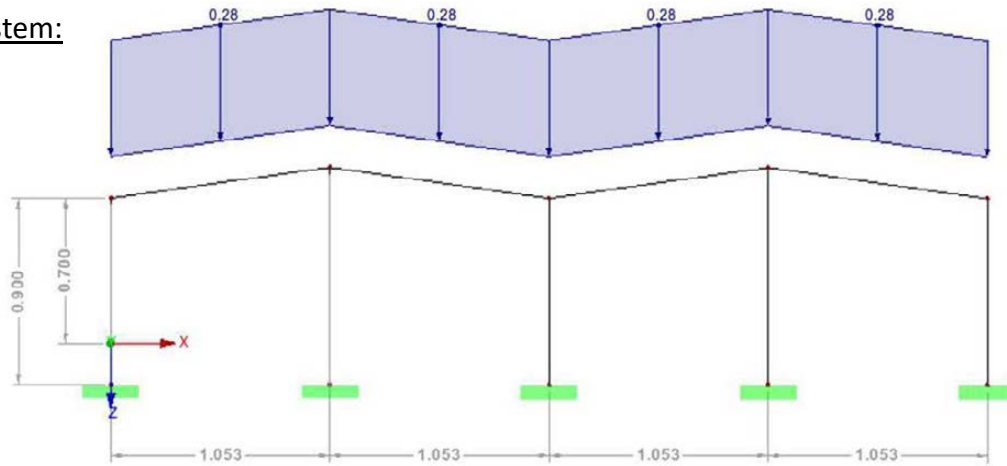
2.2 Item plan V2:



Item: 1a) BT: PlanTec east-west, reinforcing rod D=14; B 500 S (A); zone A to wind report

The max. admissible distance from top ground surface to the beginning of the lowermost module is 70 cm. For the analysis, the first 20 cm of the embedment depth are determined as not supporting.

Static System:



The frame module is simulated be an aluminum support bar 60x60x2 mm

Load (load per frame) (a ≈ 2,0 m):

Load case 1): g = dead load:

- Support rod is automatically detected.
- Solarmodul (crystalline module 1000 x 2000 mm = 28 kg):

$$= g_{\text{module}} = \frac{g}{b \cdot l} \cdot a = \frac{0,28 \text{ kN}}{1,0 \text{ m} \cdot 2,0 \text{ m}} \cdot 2,0 \text{ m} = 0,28 \text{ kN/lfd.m}$$

Load case 2 - 3): wind (NEN EN 1991-1-4):

Height of the building ≤ 1,0 m, terrain category 0, coast

wind zone I → $v_{b, \text{map}} = 29,5 \text{ m/s}$; $c_e(z) = 1,7$ Tab. D.1 return period 20 years = 0,95

$$q_p(z) = q_p \cdot c_e(z) = 0,49 \frac{\text{kN}}{\text{m}^2} \cdot 1,7 = 0,83 \frac{\text{kN}}{\text{m}^2}$$

$$q_b = \frac{1}{2} \cdot \rho \cdot v_m^2 = \frac{1}{2} \cdot 1,25 \cdot (0,95 \cdot 29,5)^2 = 490,9 \frac{\text{N}}{\text{m}^2} = 0,49 \frac{\text{kN}}{\text{m}^2}$$

Load case 2): wind transverse the rows (wind direction east-west)

c_p -value, s. annex, wind report, load case a

$$1 \text{ m}^2 < A = 8 \text{ m}^2 \leq 10 \text{ m}^2 \rightarrow c_{p,x} = c_{p,1} + (c_{p,10} - c_{p,1}) \cdot \frac{A}{10}$$

1. row at field edge: $c_{p,8, \text{pressure}} = 0,3 + (0,1 - 0,3) \cdot \frac{8}{10} = 0,12$; $c_{p,8, \text{suction}} = -0,7 + (-0,4 - (-0,7)) \cdot \frac{8}{10} = -0,43$

further rows: $c_{p,8, \text{pressure}} = 0,2 + (0,1 - 0,2) \cdot \frac{8}{10} = 0,11$; $c_{p,8, \text{suction}} = -0,5 + (-0,3 - (-0,5)) \cdot \frac{8}{10} = -0,32$

$$w_{\text{pressure, 1.row}} = 0,12 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = 0,20\text{kN/m}$$

$$w_{\text{suction, 1.row}} = -0,43 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,71\text{kN/m}$$

$$w_{\text{pressure, further row}} = 0,11 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = 0,18\text{kN/m}$$

$$w_{\text{suction, further row}} = -0,32 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,53\text{kN/m}$$

Load case 3): wind longitudinal to the row (wind direction north-south):

c_p -value, s. annex, wind report, load case b

$$1 \text{ m}^2 < A = 8 \text{ m}^2 \leq 10 \text{ m}^2 \rightarrow c_{p,x} = c_{p,1} + (c_{p,10} - c_{p,1}) \sqrt[4]{\frac{A}{10}}$$

$$1. \text{ row at field edge: } c_{p,8,\text{suction}} = -0,4 + (-0,3 - (-0,4)) \sqrt[4]{8} = -0,31$$

$$\text{further rows: } c_{p,8,\text{suction}} = -0,3 + (-0,2 - (-0,3)) \sqrt[4]{8} = -0,21$$

$$w_{\text{suction, 1.row}} = -0,31 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,51\text{kN/m}$$

$$w_{\text{suction, further row}} = -0,21 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,35\text{kN/m}$$

wind because of friction $c_r = 0,02$ (s. annex)

$$w_{\text{friction}} = 0,02 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = 0,03\text{kN/m} \quad \text{negligible}$$

Load case 4): Snow load (see page 3):

Multiplication factor K_{FI} for actions: 0,9 (EN 1990 Annex B)

$$s_k = 0,70\text{kN/m}^2 \quad s_i = 0,70 \frac{\text{kN}}{\text{m}^2} \cdot 0,9 \cdot 0,8 \cdot 2,0\text{m} = 1,01\text{kN/lf.d.m}$$

Load case combinations:

	combination	DL (1)	Wp (2)	Ws (3)	S (4)
Assumed load	C1	1,35	0,9		1,5
	C2	1,35	1,5		0,9
	C3	1	1,5		
	C4	1		1,5	

Calculation of internal force variable and analysis see pages 9 – 20:

Project: Model: 1a) Frame (Zone A)

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Graphic	STEEL EC3 CA1 - Model, Against Y-direction	

1.1 NODES

Node No.	Reference Node	Coordinate System	Node Coordinates		Comment
			X [m]	Z [m]	
1	-	Cartesian	0.000	-0.700	
2	-	Cartesian	1.053	-0.848	Gelagert
3	-	Cartesian	2.106	-0.699	
4	-	Cartesian	3.159	-0.846	Gelagert
5	-	Cartesian	4.212	-0.697	
6	-	Cartesian	0.000	0.200	
7	-	Cartesian	1.053	0.200	
8	-	Cartesian	2.106	0.201	
9	-	Cartesian	3.159	0.201	
10	-	Cartesian	4.212	0.202	

1.2 MATERIALS

Matl. No.	Modulus E [kN/cm²]	Modulus G [kN/cm²]	Spec. Weight γ [kN/m³]	Coeff. of Th. Exp. α [1/K]	Partial Factor γ_M [-]	Material Model
1	Aluminium EN AW-6060 (ET,EP,ER/B) T6 | ENV 1999-1-1:1998 7000.00	2700.00	27.00	2.30E-05	1.10	Isotropic Linear Elastic
2	steel B 500 S (A) SF1,1 | EN 1992-1-1:2004/AC:2010 20000.00	7691.31	78.50	1.00E-05	1.10	Isotropic Linear Elastic
Benutzerdefiniertes Material						

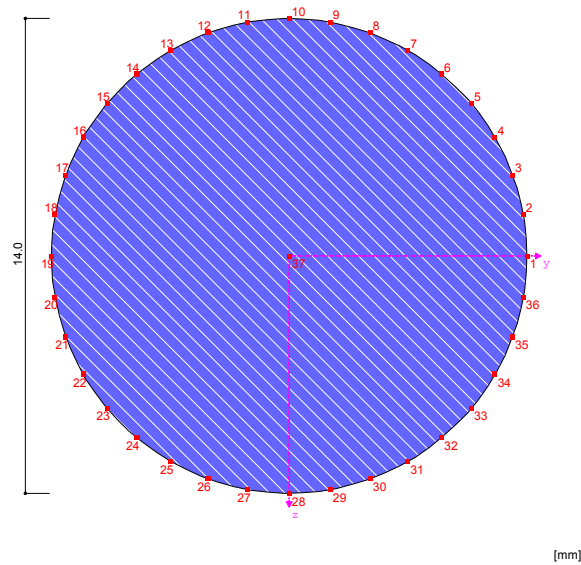
1.3 CROSS-SECTIONS

Section No.	Matl. No.	J [cm⁴]	I _y [cm⁴]	I _z [cm⁴]	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [mm]	
		A [cm²]	A _y [cm²]	A _z [cm²]			Width b	Height h
1	TO 60/60/2/2/2/2 1	4.64	26.05	1.94	0.00	0.00	60.0	60.0
2	RD 14 | DIN 1013-1 2	1.54	0.19	1.29	0.00	0.00	14.0	14.0

Project: Model: 1a) Frame (Zone A)

RD 14

DIN 1013-1



CROSS-SECTION PROPERTIES

RD 14

Cross-Section Property	Symbol	Value	Unit
Diameter	T	14.0	mm
Cross-sectional area	A	1.54	cm ²
Shear area	A _y	1.29	cm ²
Moment of inertia	I _y	0.19	cm ⁴
Governing radius of gyration	r _y	3.5	mm
Polar radius of gyration	r _o	4.9	mm
Volume	V	154.00	cm ³ /m
Weight	wt	1.2	kg/m
Surface	A _{surf}	0.044	m ² /m
Section factor	A _{tm} /V	285.599	1/m
Torsional constant	J	0.38	cm ⁴
Elastic section modulus	S _y	0.27	cm ³
Plastic section modulus	Z _y	0.46	cm ³
Buckling curve (DIN 18800-2:2008-11)	BC _{y,DIN}	c	
Buckling curve for steel with f _y >= 460 N/mm ² (DIN 18800-2:2008-11)	BC _{y,DIN,S460}	c	
Buckling curve acc. to EN	BC _{y,EN}	c	
Buckling curve acc. to EN for steel S 460	BC _{y,EN,S460}	c	
Statlcal moment of area	Q _{y,max}	0.23	cm ³

1.7 MEMBERS

Mbr. No.	Member	Node		Rotation		Cross-Section		Hinge No.		Ecc. No.	Div. No.	Length L [m]	
		Start	End	Type	β [°]	Start	End	Start	End				
1	Beam	1	2	Angle	0.00	1	1	-	-	-	-	1.064	XZ
2	Beam	3	2	Angle	0.00	1	1	-	-	-	-	1.063	XZ
3	Beam	3	4	Angle	0.00	1	1	-	-	-	-	1.063	XZ
4	Beam	5	4	Angle	0.00	1	1	-	-	-	-	1.064	XZ
5	Beam	1	6	Angle	0.00	2	2	-	-	-	-	0.900	Z
6	Beam	2	7	Angle	0.00	2	2	-	-	-	-	1.048	Z
7	Beam	3	8	Angle	0.00	2	2	-	-	-	-	0.900	Z
8	Beam	4	9	Angle	0.00	2	2	-	-	-	-	1.048	Z
9	Beam	5	10	Angle	0.00	2	2	-	-	-	-	0.900	Z

1.8 NODAL SUPPORTS

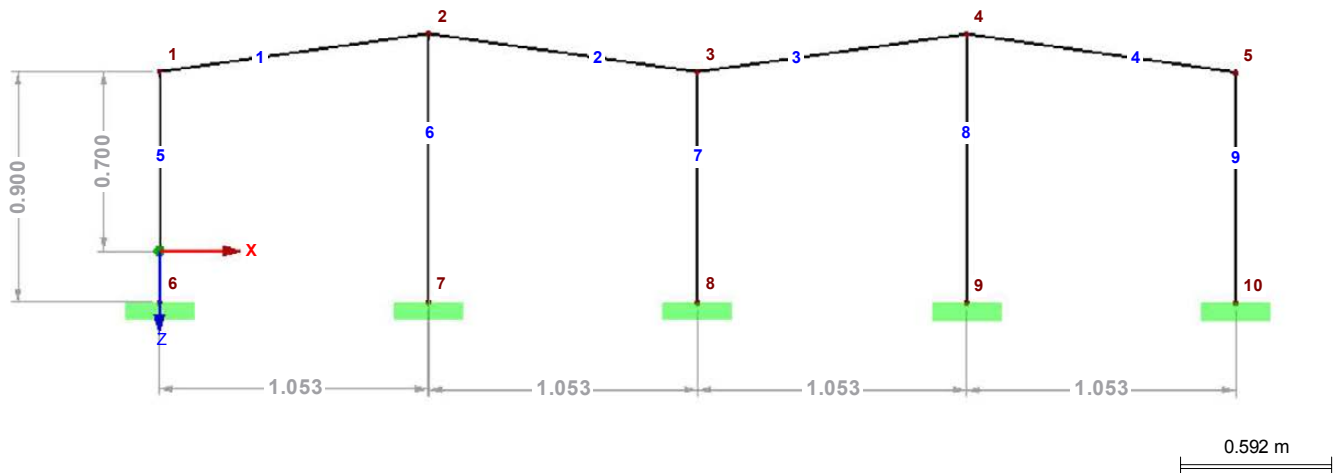
Support No.	Nodes No.	Rotation [°] about Y	Support or Spring [kN/m] [kNm/rad]			Comment
			u _x	u _z	φ _y	
1	6-10	0.00	☒	☒	☒	

Project: Model: 1a) Frame (Zone A)

■ STRUCTURE

Node Numbering
Member Numbering

Against Y-direction



■ 2.1 LOAD CASES

Load Case	Load Case Description	No Standard Action Category	Self-Weight - Factor in Direction			
			Active	X	Y	Z
LC1	dead load	Permanent	☐			
LC2	wind lateral	Wind	☐			
LC3	wind longitudinal	Wind	☐			
LC4	snow load	Snow / ice	☐			

■ 2.6 RESULT COMBINATIONS

Result Combin.	DS	Result Combination		Loading			Criterion	Alternate Group
		Description	No.	Factor				
RC1		Assumed load (C1)	1	1.35	LC1	dead load	Permanent	-
			2	0.90	LC2	wind lateral	Permanent	-
			3	1.50	LC4	snow load	Permanent	-
RC2		Assumed load (C2)	1	1.35	LC1	dead load	Permanent	-
			2	1.50	LC2	wind lateral	Permanent	-
			3	0.75	LC4	snow load	Permanent	-
RC3		Assumed load (C3)	1	1.00	LC1	dead load	Permanent	-
			2	1.50	LC2	wind lateral	Permanent	-
RC4		Assumed load (C4)	1	1.00	LC1	dead load	Permanent	-
			2	1.50	LC3	wind longitudinal	Permanent	-

Project: Model: 1a) Frame (Zone A)

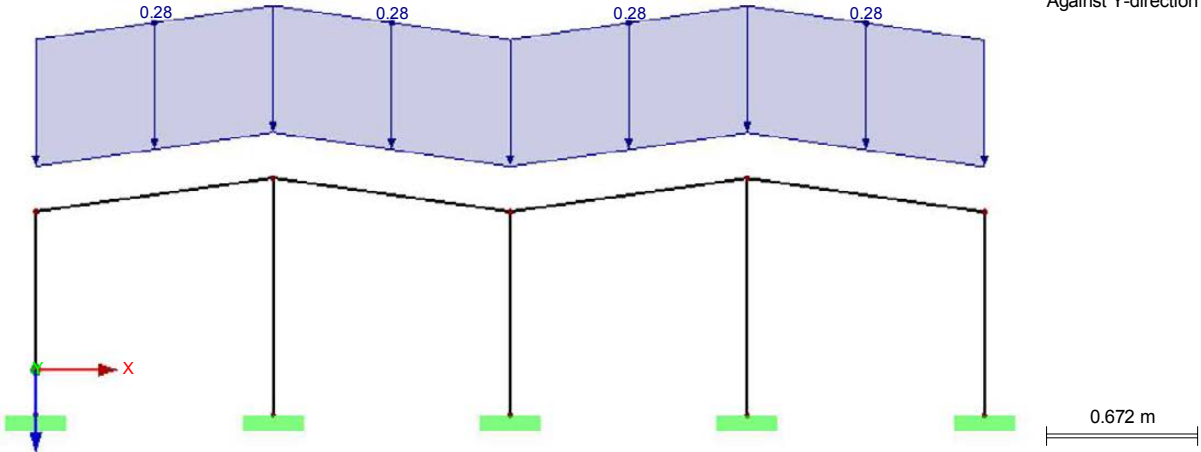
3.2 MEMBER LOADS

LC1: dead load

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1-4	Force	Uniform	Z	True Length	p	0.28	kN/m

LC1: DEAD LOAD

Against Y-direction



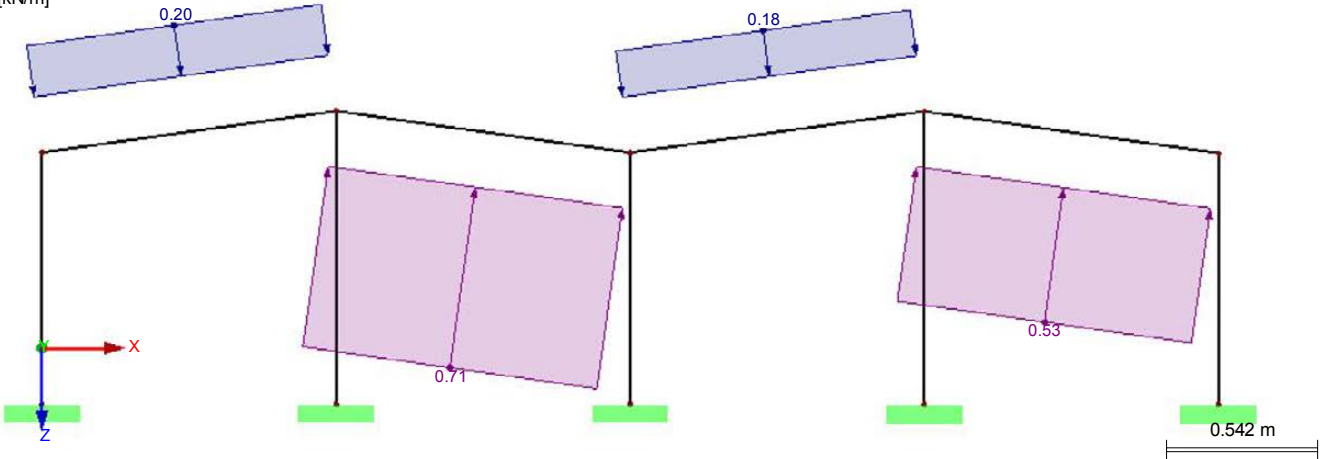
3.2 MEMBER LOADS

LC2: wind lateral

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1	Force	Uniform	z	True Length	p	0.20	kN/m
2	Members	2	Force	Uniform	z	True Length	p	-0.71	kN/m
3	Members	3	Force	Uniform	z	True Length	p	0.18	kN/m
4	Members	4	Force	Uniform	z	True Length	p	-0.53	kN/m

LC2: WIND LATERAL

Against Y-direction



LOADS

Project: Model: 1a) Frame (Zone A)

LC3
wind longitudinal

■ 3.2 MEMBER LOADS

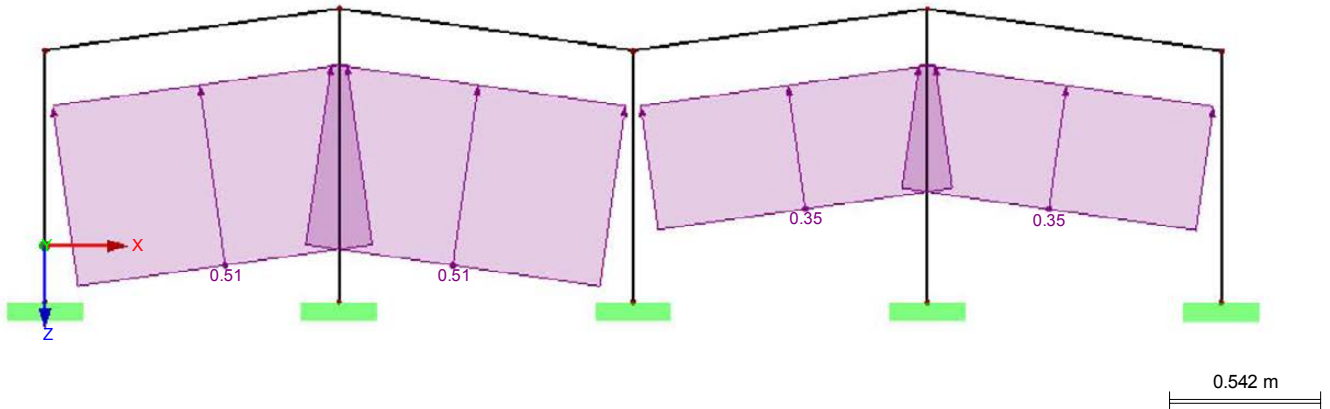
LC3: wind longitudinal

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	2	Force	Uniform	z	True Length	p	-0.51	kN/m
2	Members	4	Force	Uniform	z	True Length	p	-0.35	kN/m
3	Members	1	Force	Uniform	z	True Length	p	-0.51	kN/m
4	Members	3	Force	Uniform	z	True Length	p	-0.35	kN/m

■ LC3: WIND LONGITUDINAL

LC3: wind longitudinal
Loads [kN/m]

Against Y-direction



LC4
snow load

■ 3.2 MEMBER LOADS

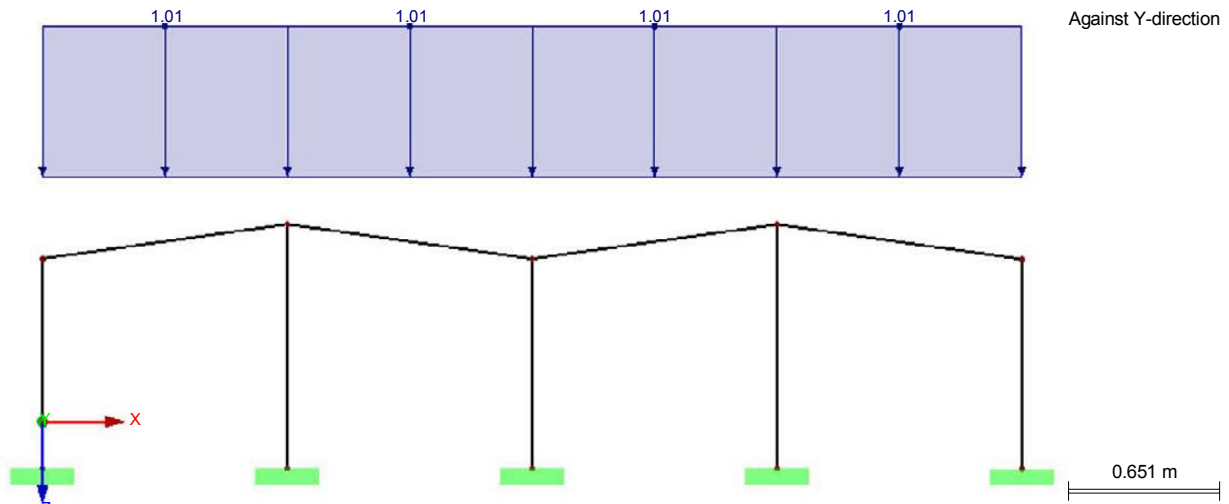
LC4: snow load

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1-4	Force	Uniform	Z	Projection Z	p	1.01	kN/m

■ LC4: SNOW LOAD

LC4: snow load
Loads [kN/m]

Against Y-direction



RESULTS

Project: Model: 1a) Frame (Zone A)

■ 4.4 NODES - SUPPORT FORCES

Node No.	LC/CO	Support Forces [kN]		Support Moments	Comment
		P _x	P _z	M _y [kNm]	
6	LC1	0.00	0.12	0.00	dead load
	LC2	0.05	0.09	-0.03	wind lateral
	LC3	0.00	-0.22	0.00	wind longitudinal
	LC4	0.00	0.42	0.00	snow load
7	LC1	0.00	0.34	0.00	dead load
	LC2	0.04	-0.28	-0.02	wind lateral
	LC3	0.00	-0.61	0.00	wind longitudinal
	LC4	0.00	1.21	0.00	snow load
8	LC1	0.00	0.28	0.00	dead load
	LC2	0.05	-0.28	-0.03	wind lateral
	LC3	0.00	-0.43	0.00	wind longitudinal
	LC4	0.00	1.00	0.00	snow load
9	LC1	0.00	0.34	0.00	dead load
	LC2	0.04	-0.21	-0.02	wind lateral
	LC3	0.00	-0.40	0.00	wind longitudinal
	LC4	0.00	1.21	0.00	snow load
10	LC1	0.00	0.12	0.00	dead load
	LC2	0.05	-0.22	-0.02	wind lateral
	LC3	0.00	-0.15	0.00	wind longitudinal
	LC4	0.00	0.42	0.00	snow load
Σ Supp.	LC1	0.00	1.19		
Σ Loads	LC1	0.00	1.19		
Σ Supp.	LC2	0.24	-0.91		
Σ Loads	LC2	0.24	-0.91		
Σ Supp.	LC3	0.00	-1.81		
Σ Loads	LC3	0.00	-1.81		
Σ Supp.	LC4	0.00	4.25		
Σ Loads	LC4	0.00	4.25		

RESULTS

Project: Model: 1a) Frame (Zone A)

4.3 CROSS-SECTIONS - INTERNAL FORCES

Result Combinations

Member No.	RC	Node No.	Location x [m]		Forces [kN]		Moments M _y [kNm]	Corresponding Load Cases
					N	V _z		
Section No. 1: TO 60/60/2/2/2								
1	RC1		1.064	MAX N	0.20	-1.30	-0.21	LC 1,2,4
4	RC1		0.000	MIN N	-0.14	0.58	-0.03	LC 1,2,4
3	RC1		0.000	MAX V _z	-0.13	0.99	-0.12	LC 1,2,4
1	RC1		1.064	MIN V _z	0.20	-1.30	-0.21	LC 1,2,4
1	RC1		0.425	MAX M _y	0.03	0.01	0.20	LC 1,2,4
3	RC1		1.063	MIN M _y	0.14	-1.16	-0.21	LC 1,2,4
Section No. 2: RD 14 | DIN 1013-1								
6	RC4		0.000	MAX N	0.58	0.00	0.00	LC 1,3
8	RC1		0.000	MIN N	-2.07	0.03	-0.02	LC 1,2,4
9	RC2		0.000	MAX V _z	-0.14	0.09	-0.04	LC 1,2,4
9	RC4		0.000	MIN V _z	0.11	0.00	0.00	LC 1,3
9	RC2		0.900	MAX M _y	-0.14	0.09	0.04	LC 1,2,4
9	RC2		0.000	MIN M _y	-0.14	0.09	-0.04	LC 1,2,4

4.4 NODES - SUPPORT FORCES

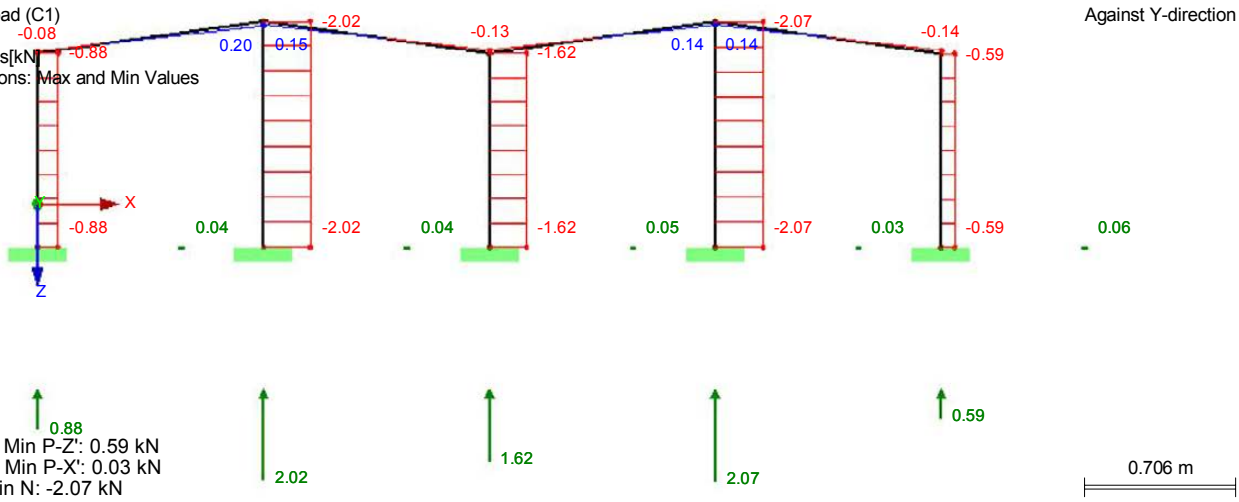
Result Combinations

Node No.	RC		Support Forces [kN]		Support Moments M _y [kNm]	Corresponding Load Cases
			P _x	P _z		
6	RC1	Max P _x	0.04	0.88	-0.02	LC 1,2,4
		Min P _x	0.04	0.88	-0.02	LC 1,2,4
	RC2	Max P _x	0.08	0.61	-0.04	LC 1,2,4
		Min P _x	0.08	0.61	-0.04	LC 1,2,4
	RC3	Max P _x	0.08	0.26	-0.04	LC 1,2
		Min P _x	0.08	0.26	-0.04	LC 1,2
	RC4	Max P _x	0.00	-0.21	0.00	LC 1,3
		Min P _x	0.00	-0.21	0.00	LC 1,3
7	RC1	Max P _x	0.04	2.02	-0.02	LC 1,2,4
		Min P _x	0.04	2.02	-0.02	LC 1,2,4
	RC2	Max P _x	0.06	0.95	-0.03	LC 1,2,4
		Min P _x	0.06	0.95	-0.03	LC 1,2,4
	RC3	Max P _x	0.06	-0.07	-0.03	LC 1,2
		Min P _x	0.06	-0.07	-0.03	LC 1,2
	RC4	Max P _x	0.00	-0.58	0.00	LC 1,3
		Min P _x	0.00	-0.58	0.00	LC 1,3
8	RC1	Max P _x	0.05	1.62	-0.02	LC 1,2,4
		Min P _x	0.05	1.62	-0.02	LC 1,2,4
	RC2	Max P _x	0.08	0.70	-0.04	LC 1,2,4
		Min P _x	0.08	0.70	-0.04	LC 1,2,4
	RC3	Max P _x	0.08	-0.15	-0.04	LC 1,2
		Min P _x	0.08	-0.15	-0.04	LC 1,2
	RC4	Max P _x	0.00	-0.37	0.00	LC 1,3
		Min P _x	0.00	-0.37	0.00	LC 1,3
9	RC1	Max P _x	0.03	2.07	-0.02	LC 1,2,4
		Min P _x	0.03	2.07	-0.02	LC 1,2,4
	RC2	Max P _x	0.06	1.04	-0.03	LC 1,2,4
		Min P _x	0.06	1.04	-0.03	LC 1,2,4
	RC3	Max P _x	0.06	0.02	-0.03	LC 1,2
		Min P _x	0.06	0.02	-0.03	LC 1,2
	RC4	Max P _x	0.00	-0.27	0.00	LC 1,3
		Min P _x	0.00	-0.27	0.00	LC 1,3
10	RC1	Max P _x	0.06	0.59	-0.02	LC 1,2,4
		Min P _x	0.06	0.59	-0.02	LC 1,2,4
	RC2	Max P _x	0.09	0.14	-0.04	LC 1,2,4
		Min P _x	0.09	0.14	-0.04	LC 1,2,4
	RC3	Max P _x	0.08	-0.22	-0.04	LC 1,2
		Min P _x	0.08	-0.22	-0.04	LC 1,2
	RC4	Max P _x	0.00	-0.11	0.00	LC 1,3
		Min P _x	0.00	-0.11	0.00	LC 1,3

Project: Model: 1a) Frame (Zone A)

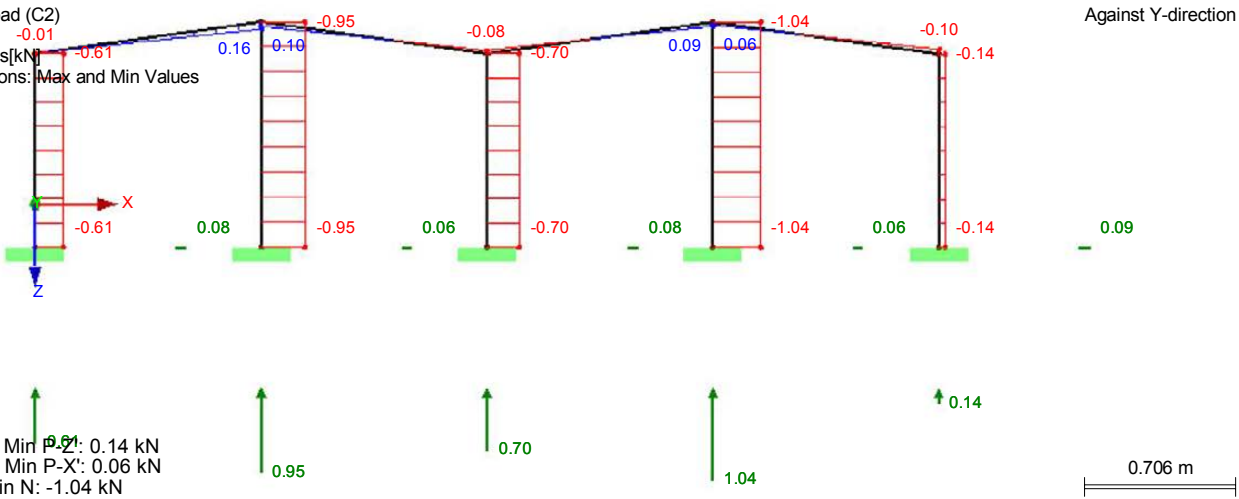
■ NODES N, LK1: ASSUMED LOAD (C1)

RC1: Assumed load (C1)
Internal Forces N -0.08
Support Reactions[kN]
Result Combinations: Max and Min Values



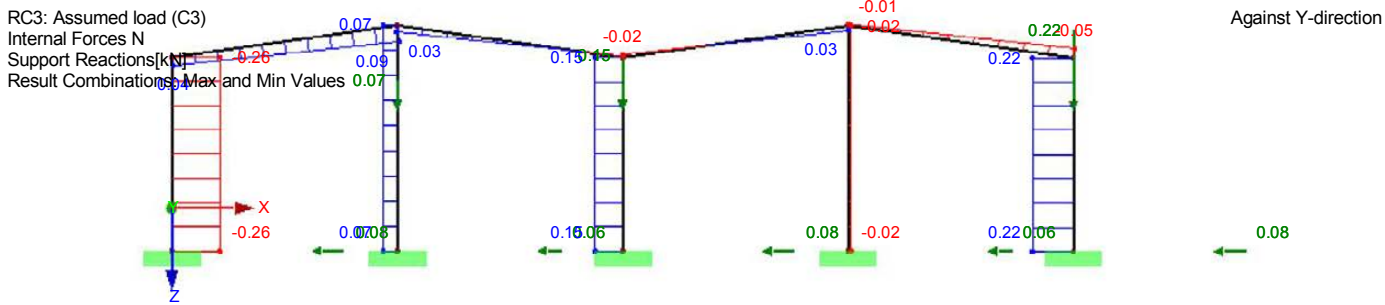
■ NODE N, LK2: ASSUMED LOAD (C2)

RC2: Assumed load (C2)
Internal Forces N -0.01
Support Reactions[kN]
Result Combinations: Max and Min Values



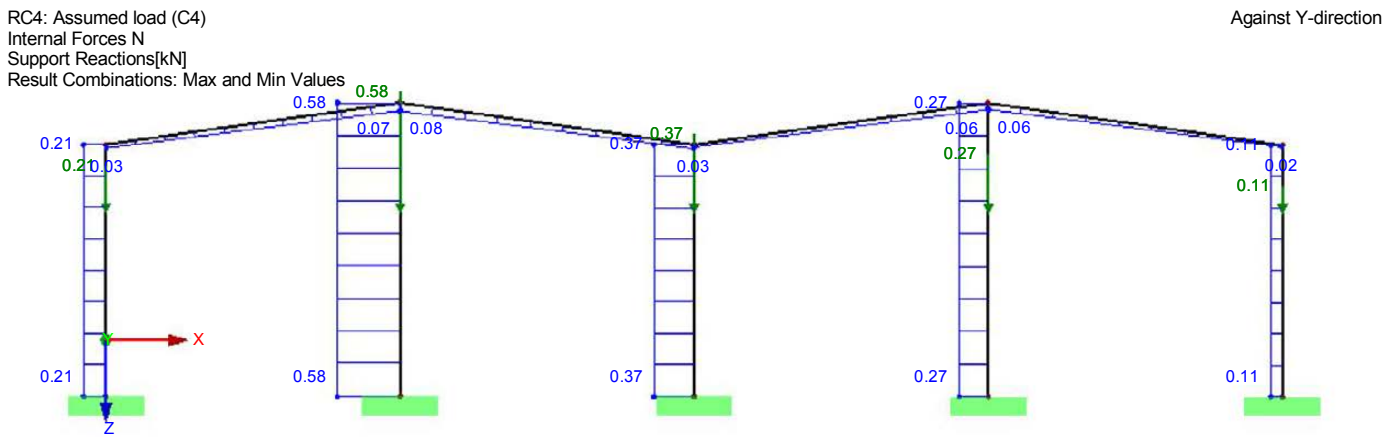
Project: Model: 1a) Frame (Zone A)

■ NODE N, LK3: ASSUMED LOAD (C3)



Max P-Z': 0.26, Min P-Z': -0.22 kN
Max P-X': 0.08, Min P-X': 0.06 kN
Max N: 0.22, Min N: -0.26 kN

■ NODE N, LK4: ASSUMED LOAD (C4)



Max P-Z': -0.11, Min P-Z': -0.58 kN
Max P-X': 0.00, Min P-X': 0.00 kN
Max N: 0.58, Min N: 0.02 kN

STEEL EC3

CA1

Design of steel members
according to Eurocode 3

Project: Model: 1a) Frame (Zone A)

1.1 GENERAL DATA

Members to design:	5-9
Sets of members to design:	
Ultimate Limit State Design	
Result combinations to design:	RC1 RC2 RC3 RC4
	Assumed load (C1) Assumed load (C2) Assumed load (C3) Assumed load (C4)

1.1.1 DETAILS

Stability Analysis	☒
Stability Check	☒
Bending About the Major y-Axis	
Equivalent Member Method acc. to 6.3	☒
Include second-order effects acc. to 5.2.2(4) by increasing bending moment	☐
Bending About the Minor z-Axis	
Equivalent Member Method acc. to 6.3	☒
Include second-order effects acc. to 5.2.2(4) by increasing bending moment	☐
Determination of elastic critical moment for lateral-torsional buckling	
For members:	Automatically by Eigenvalue Method
Load application of positive transverse loads:	On cross-section edge directed to shear center (e.g. top flange, destabilizing effect)
Model type acc. to Table B.3	
Sway y - y ($C_{my} = 0.9$)	☐
Sway z - z ($C_{mz} = 0.9$)	☐
Limit Load for Special Cases	
Unsymmetric cross-sections with compression and bending	
$M_{y,Ed} / M_{pl,y,Rd} \leq$	0.01
$M_{z,Ed} / M_{pl,z,Rd} \leq$	0.01
$N_{c,Ed} / N_{pl} \leq$	0.01
Non-Symmetrical Cross-Sections, Tapered Members or Sets of Members	
$M_{z,Ed} / M_{pl,z,Rd} \leq$	0.05
Cross-Sections with Torsion	
$\tau_{t,Ed} / \tau_{t,Rd} \leq$	0.05
Stability analysis method for sets of members acc. to	6.3.4 General Method
Classification of Cross-Sections	
Type of determination of ψ and α acc. to Table 5.2:	
For limit c/t of Class 3, increase material factor ϵ acc. to 5.5.2(9)	Increase N_{Ed} and M_{Ed} uniformly
Use SHAPE-THIN for classification of all supported cross-section types (only Classes 3 and 4 possible)	☒
Ignore classification of curved parts	☐
if $c/t \leq$	5.00
Options	
Elastic Design (also for cross-sections of Class 1 or 2)	☐
Stability Analyses with Second-Order Internal Forces	☐
Use γ_{M1} for determination of the cross-section resistance	☐
Cross-section check for M+N	
Use linear interaction acc. to 6.2.1(7)	☐
Cross-sections with Class 4 and torsion	
$\tau_{t,Ed} / \tau_{t,Rd} \leq$	0.05
Member Slendernesses	
Members with	λ_{limit}
Tension only:	300
Compression / flexure:	200
Design of Welds	
Allow design of welds	☐

1.1.2 NATIONAL ANNEX

Partial Factors acc. to 6.1, Note 2B	
For resistance of cross-sections γ_{M0} :	1.00
For resistance of members to buckling (assessed for checks in Clause 6.3) γ_{M1} :	1.00
For resistance of cross-sections in tension to fracture γ_{M2} :	1.25
Fire Properties	
$\gamma_{M,fi}$	1.00
Shear acc. to 6.2.6(3) and shear buckling acc. to EN 1993-1-5	
Factor η :	1.00

Project: Model: 1a) Frame (Zone A)

1.1.2 NATIONAL ANNEX

Parameters for Lateral-Torsional Buckling	
Imperfection coefficients of lateral-torsional buckling curves acc. to Table 6.3	
Buckling Curve a:	0.21
Buckling Curve b:	0.34
Buckling Curve c:	0.49
Buckling Curve d:	0.76
Use factor f for modification of χ_{LT} according to 6.3.2.3(2)	☒
Parameters for Φ_{LT} acc. to 6.3.2.3(1):	
Rolled I-Sections	
$\lambda_{LT,0}$:	0.40
β :	0.75
Welded I-Sections	
$\lambda_{LT,0}$:	0.40
β :	0.75
Determine lateral-torsional buckling curves:	If possible, acc. to 6.3.2.3, Eq. (6.57), otherwise acc. to 6.3.2.2, Eq. (6.56)
Determine interaction factors for 6.3.3(4) according to Method:	2 according to Annex B
Serviceability Limits (Deflections) acc. to 7.2	
Combination of actions (Table A1.4 of EN 1990):	
SC:	Characteristic
SF:	Frequent
SQ:	Quasi-permanent
	L / 250
	L / 333
	L / 200
	Cantilevers
	L_c / 125
	L_c / 166
	L_c / 100
General Method according to 6.3.4	
Use General Method also for non-I-sections	☒
Always use General Method for stability design according to 6.3.4	☐
Use European lateral-torsional buckling curve according to [5]	☐
Use the method of Johannes Caspar Naumes for assessing the out-of-plane stability	☐
Use interpolation acc. to Eq. (6.66)	☐
Stainless Steel (EN 1993-1-4) Parameters	
Partial Factors acc. to 5.1	
For resistance of cross-sections	
γ_{M0}	1.10
For resistance of members to buckling (assessed for checks in Clause 6.3)	
γ_{M1}	1.10
For resistance of cross-sections to fracture due to tension	
γ_{M2}	1.25
Shear according to 5.6(2) and shear buckling	
η	1.00
Parameters for Stability Design	
Imperfection Coefficient	
Buckling	
Cold formed open sections	
Hollow sections (welded or seamless)	
Welded open sections (about the major axis)	
Welded open sections (about the minor axis)	
Torsional and Lateral-Torsional Buckling	
All structural members	
	0.49
	0.49
	0.49
	0.76
	0.34
Parameter for Φ	
Buckling	
Cold formed open sections	
Hollow sections (welded or seamless)	
Welded open sections (about the major axis)	
Welded open sections (about the minor axis)	
Torsional and Lateral-Torsional Buckling	
All structural members	
	λ_0
	0.40
	0.40
	0.20
	0.20
	0.20
Imperfection Coefficient	
Cold formed sections and hollow sections (welded and seamless)	
Welded open sections and other sections	
	α_{LT}
	0.34
	0.76

1.2 MATERIALS

Matl. No.	Material Description	E- Modulus E [kN/cm ²]	Shear Modulus G [kN/cm ²]	Poisson's Ratio ν [-]	Yield Stress f_{yk} [kN/cm ²]	Max. Thickness t [mm]
2	steel B 500 S (A) SF1.1 | EN 1992-1-1:2004/AC:2010 Benutzerdefiniertes Material	20000.00	7691.31	0.300	50.00	1000.0

Project: Model: 1a) Frame (Zone A)

1.3 CROSS-SECTIONS

Sect. No.	Matl. No.	Cross-Section Description	Cross-Section Type for Classification	Max Design Ratio	Comment
2	2	RD 14 | DIN 1013-1 Type General - Only Class 3 possible	General	0.40	

1.5 EFFECTIVE LENGTHS - MEMBERS

Member No.	Buckling Possible	Buckling About Axis y			Buckling About Axis z			Lateral-Torsional Buckling				
		Possible	$k_{cr,y}$	$L_{cr,y}$ [m]	Possible	$k_{cr,z}$	$L_{cr,z}$ [m]	Possible	k_z	k_w	L_w [m]	L_T [m]
5	☑	☑	0.70	0.630	☑	0.70	0.630	☑	1.0	1.0	0.900	0.900
6	☑	☑	0.70	0.733	☑	0.70	0.733	☑	1.0	1.0	1.048	1.048
7	☑	☑	0.70	0.630	☑	0.70	0.630	☑	1.0	1.0	0.900	0.900
8	☑	☑	0.70	0.733	☑	0.70	0.733	☑	1.0	1.0	1.048	1.048
9	☑	☑	0.70	0.630	☑	0.70	0.630	☑	1.0	1.0	0.900	0.900

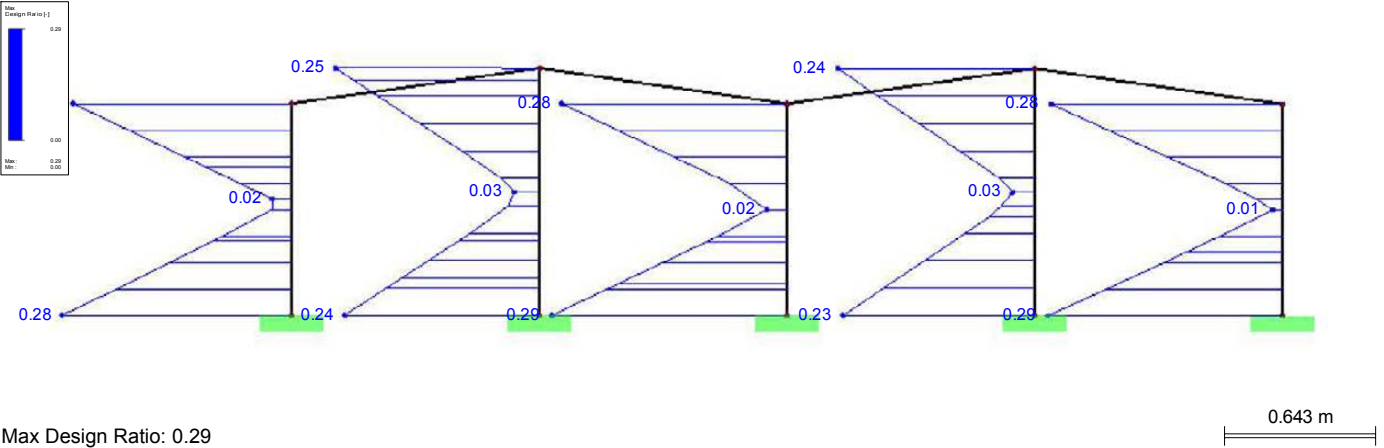
2.1 DESIGN BY LOAD CASE

LC/CO/RC	Load Case or CO/RC Description	Member No.	Location x [m]	Design	Acc. to Formula	
Ultimate Limit State Design						
RC1	Assumed load (C1)	6	0.052	0.40	≤ 1	354) PT
RC2	Assumed load (C2)	8	0.000	0.29	≤ 1	354) PT
RC3	Assumed load (C3)	9	0.900	0.28	≤ 1	183) PT
RC4	Assumed load (C4)	5	0.000	0.01	≤ 1	183) PT

MODEL

STEEL EC3 CA1
Ultimate Limit State: Cross-Section Design

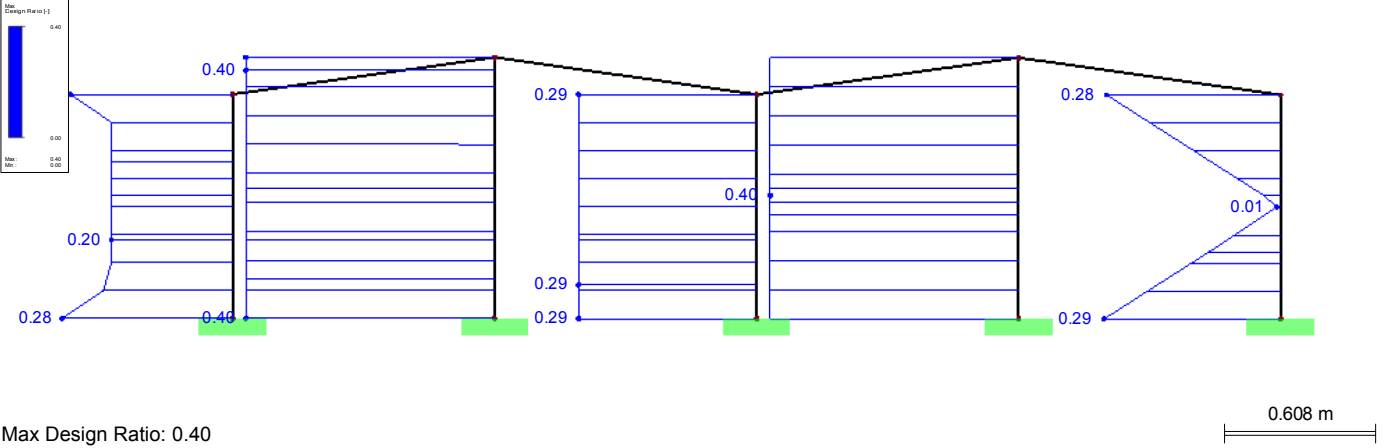
Against Y-direction



MODEL

STEEL EC3 CA1
Ultimate Limit State: Stability Design

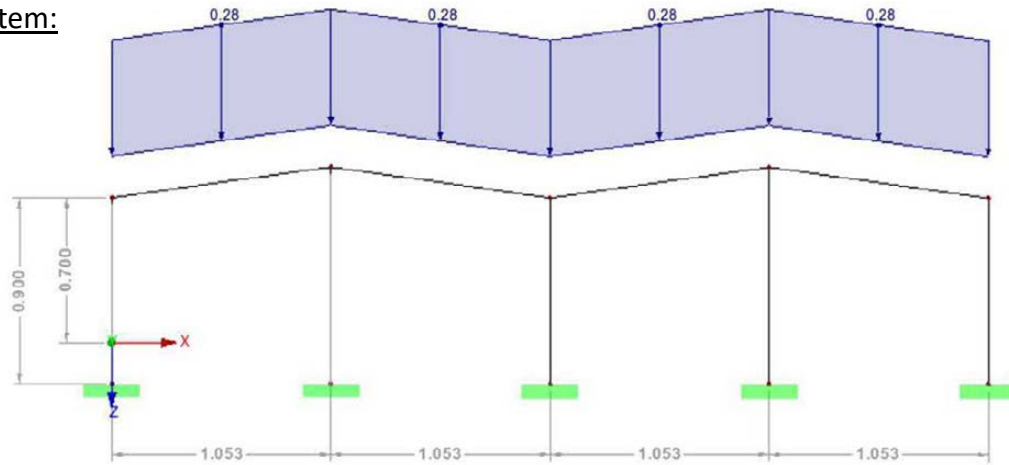
Against Y-direction



Item: 1b) BT: PlanTec east-west, reinforcing rod D=14; B 500 S (A); zone B to wind report

The max. admissible distance from top ground surface to the beginning of the lowermost module is 70 cm.
For the analysis, the first 20 cm of the embedment depth are determined as not supporting.

Static System:



The frame module is simulated be an aluminum support bar 60x60x2 mm

Load (load per frame) (a ≈ 2,0 m):

Load case 1): g = dead load:

- Support rod is automatically detected.
- Solarmodul (crystalline module 1000 x 2000 mm = 28 kg):

$$= g_{\text{module}} = \frac{g}{b \cdot l} \cdot a = \frac{0,28 \text{ kN}}{1,0 \text{ m} \cdot 2,0 \text{ m}} \cdot 2,0 \text{ m} = 0,28 \text{ kN/lfd.m}$$

Load case 2 - 3): wind (NEN EN 1991-1-4):

Height of the building ≤ 1,0 m, terrain category 0, coast

wind zone I → $v_{b,\text{map}} = 29,5 \text{ m/s}$; $c_e(z) = 1,7$ Tab. D.1 return period 20 years = 0,95

$$q_p(z) = q_p \cdot c_e(z) = 0,49 \frac{\text{kN}}{\text{m}^2} \cdot 1,7 = 0,83 \frac{\text{kN}}{\text{m}^2}$$

$$q_b = \frac{1}{2} \cdot \rho \cdot v_m^2 = \frac{1}{2} \cdot 1,25 \cdot (0,95 \cdot 29,5)^2 = 490,9 \frac{\text{N}}{\text{m}^2} = 0,49 \frac{\text{kN}}{\text{m}^2}$$

Load case 2): wind transverse the rows (wind direction east-west)

c_p -value, s. annex, wind report, load case a

$$1 \text{ m}^2 < A = 8 \text{ m}^2 \leq 10 \text{ m}^2 \rightarrow c_{p,x} = c_{p,1} + (c_{p,10} - c_{p,1}) \cdot \sqrt{A}$$

$$1. \text{ row at field edge: } c_{p,8,\text{pressure}} = 1,3 + (0,4 - 1,3) \cdot \sqrt{8} = 0,49; c_{p,8,\text{suction}} = -1,2 + (-0,5 - (-1,2)) \cdot \sqrt{8} = -0,57$$

$$\text{further rows: } c_{p,8,\text{pressure}} = 1,0 + (0,3 - 1,0) \cdot \sqrt{8} = 0,37; c_{p,8,\text{suction}} = -1,1 + (-0,5 - (-1,1)) \cdot \sqrt{8} = -0,56$$

$$w_{\text{pressure, 1.row}} = 0,49 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = 0,81\text{kN/m}$$

$$w_{\text{suction, 1.row}} = -0,57 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,95\text{kN/m}$$

$$w_{\text{pressure, further row}} = 0,37 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = 0,61\text{kN/m}$$

$$w_{\text{suction, further row}} = -0,56 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,93\text{kN/m}$$

Load case 3): wind longitudinal to the row (wind direction north-south):

c_p -value, s. annex, wind report, load case b

$$1 \text{ m}^2 < A = 6 \text{ m}^2 \leq 10 \text{ m}^2 \rightarrow c_{p,x} = c_{p,1} + (c_{p,10} - c_{p,1}) \times \lg A$$

$$1. \text{ row at field edge} = \text{further rows: } c_{p,8,\text{suction}} = -0,8 + (-0,4 - (-0,8)) \times \lg 8 = -0,44$$

$$w_{\text{suction}} = -0,44 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = -0,73\text{kN/m}$$

wind because of friction $c_r = 0,02$ (s. annex)

$$w_{\text{friction}} = 0,02 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} \cdot 2,0\text{m} = 0,03\text{kN/m} \quad \text{negligible}$$

Load case 4): Snow load (see page 3):

Multiplication factor K_{FI} for actions: 0,9 (EN 1990 Annex B)

$$s_k = 0,70\text{kN/m}^2 \quad s_i = 0,70 \frac{\text{kN}}{\text{m}^2} \times 0,9 \times 0,8 \times 2,0\text{m} = 1,01\text{kN/lfd.m}$$

Load case combinations:

	combination	DL (1)	Wp (2)	Ws (3)	S (4)
Assumed load	C1	1,35	0,9		1,5
	C2	1,35	1,5		0,9
	C3	1	1,5		
	C4	1		1,5	

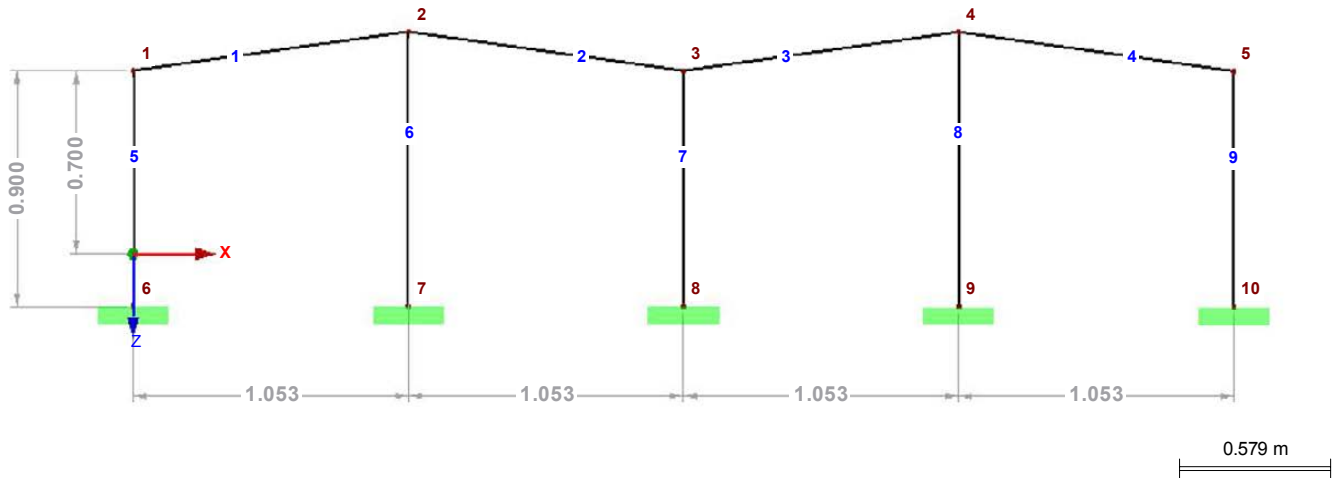
Calculation of internal force variable and analysis see pages 23 – 33:

Project: Model: 1b) Frame (Zone B)

■ STRUCTURE

Node Numbering
Member Numbering

Against Y-direction



■ 2.1 LOAD CASES

Load Case	Load Case Description	No Standard Action Category	Self-Weight - Factor in Direction			
			Active	X	Y	Z
LC1	dead load	Permanent	☐			
LC2	wind lateral	Wind	☐			
LC3	wind longitudinal	Wind	☐			
LC4	snow load	Snow / ice	☐			

■ 2.6 RESULT COMBINATIONS

Result Combin.	DS	Result Combination Description	No.	Factor	Loading		Criterion	Alternate Group
RC1		Assumed load (C1)	1	1.35	LC1	dead load	Permanent	-
			2	0.90	LC2	wind lateral	Permanent	-
			3	1.50	LC4	snow load	Permanent	-
RC2		Assumed load (C2)	1	1.35	LC1	dead load	Permanent	-
			2	1.50	LC2	wind lateral	Permanent	-
			3	0.75	LC4	snow load	Permanent	-
RC3		Assumed load (C3)	1	1.00	LC1	dead load	Permanent	-
			2	1.50	LC2	wind lateral	Permanent	-
RC4		Assumed load (C4)	1	1.00	LC1	dead load	Permanent	-
			2	1.50	LC3	wind longitudinal	Permanent	-

LOADS

Project: Model: 1b) Frame (Zone B)

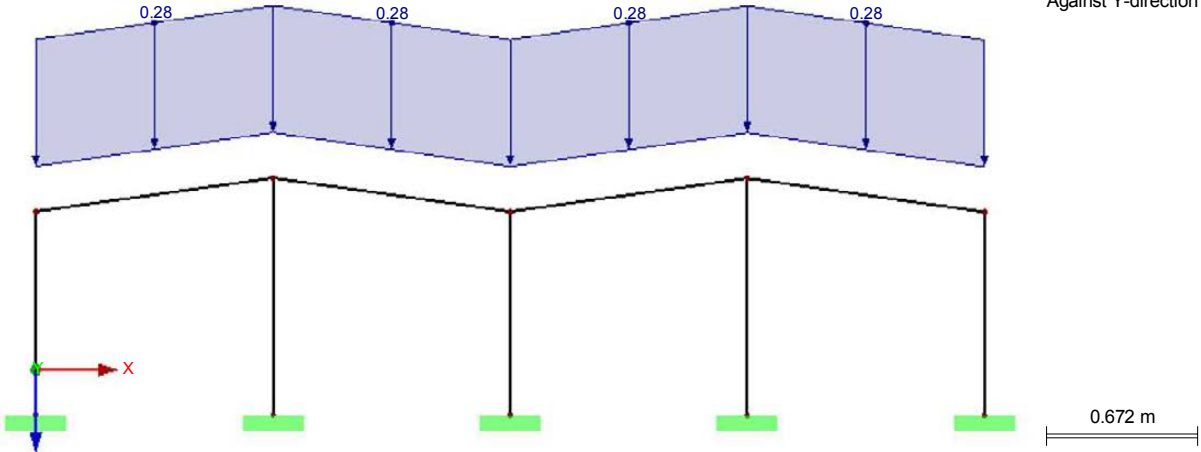
3.2 MEMBER LOADS

LC1: dead load

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1-4	Force	Uniform	Z	True Length	p	0.28	kN/m

LC1: DEAD LOAD

Against Y-direction



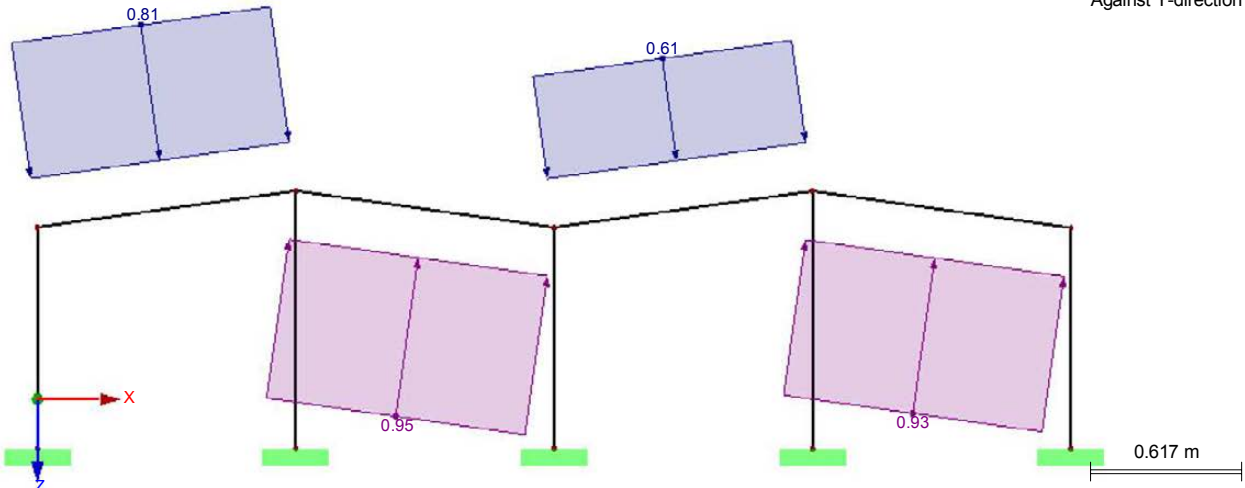
3.2 MEMBER LOADS

LC2: wind lateral

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1	Force	Uniform	z	True Length	p	0.81	kN/m
2	Members	2	Force	Uniform	z	True Length	p	-0.95	kN/m
3	Members	3	Force	Uniform	z	True Length	p	0.61	kN/m
4	Members	4	Force	Uniform	z	True Length	p	-0.93	kN/m

LC2: WIND LATERAL

Against Y-direction



LOADS

Project: Model: 1b) Frame (Zone B)

3.2 MEMBER LOADS

LC3: wind longitudinal

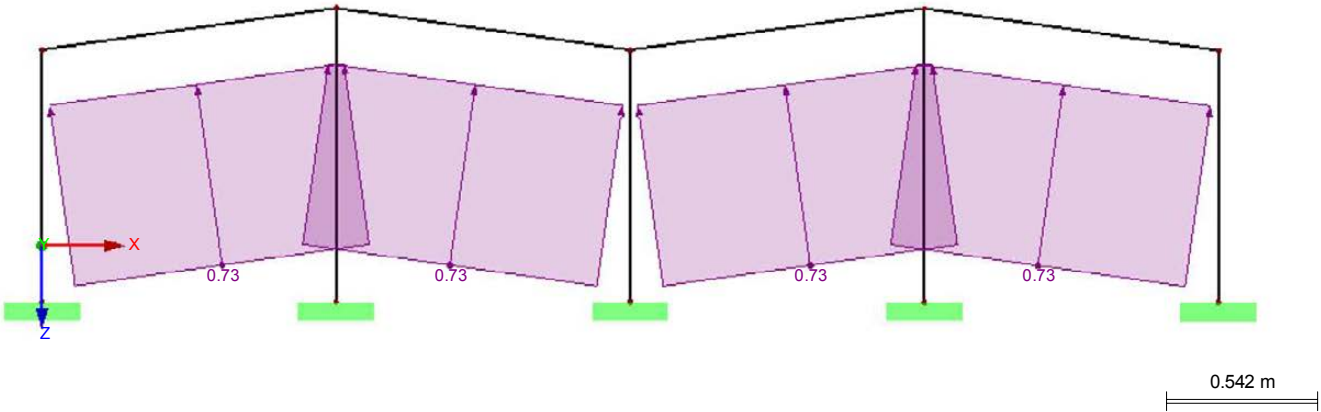
LC3
wind longitudinal

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1-4	Force	Uniform	z	True Length	p	-0.73	kN/m

LC3: WIND LONGITUDINAL

LC3: wind longitudinal
Loads [kN/m]

Against Y-direction



3.2 MEMBER LOADS

LC4: snow load

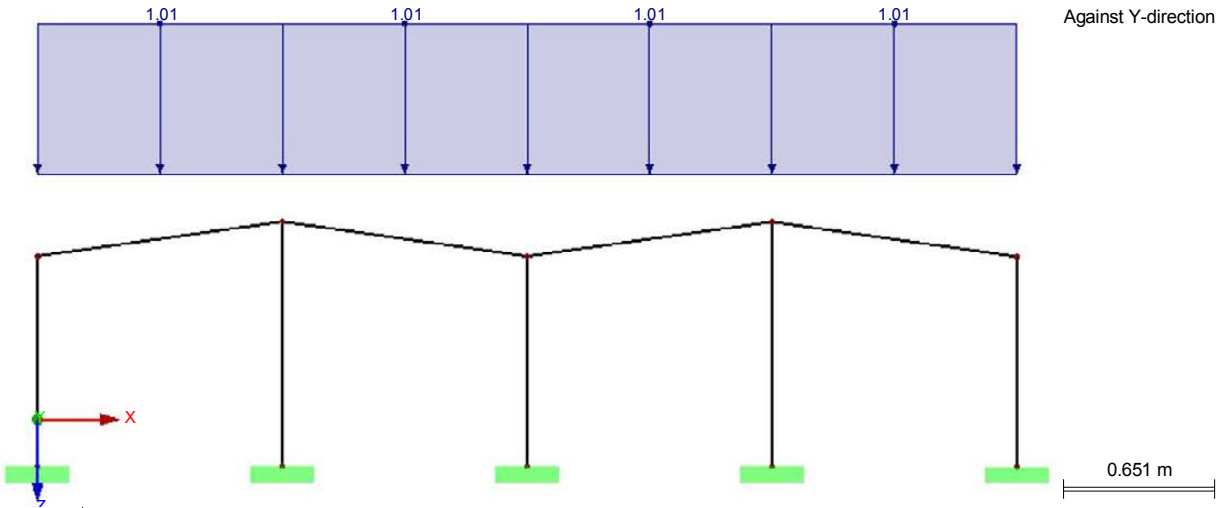
LC4
snow load

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters		
							Symbol	Value	Unit
1	Members	1-4	Force	Uniform	Z	Projection Z	p	1.01	kN/m

LC4: SNOW LOAD

LC4: snow load
Loads [kN/m]

Against Y-direction



Project:

Model: 1b) Frame (Zone B)

■ 4.4 NODES - SUPPORT FORCES

Node No.	LC/CO	Support Forces [kN]		Support Moments	Comment
		P _x	P _z	M _y [kNm]	
6	LC1	0.00	0.12	0.00	dead load
	LC2	0.11	0.35	-0.05	wind lateral
	LC3	0.00	-0.31	0.00	wind longitudinal
	LC4	0.00	0.42	0.00	snow load
7	LC1	0.00	0.34	0.00	dead load
	LC2	0.08	-0.03	-0.04	wind lateral
	LC3	0.00	-0.86	0.00	wind longitudinal
	LC4	0.00	1.21	0.00	snow load
8	LC1	0.00	0.28	0.00	dead load
	LC2	0.11	-0.19	-0.05	wind lateral
	LC3	0.00	-0.73	0.00	wind longitudinal
	LC4	0.00	1.00	0.00	snow load
9	LC1	0.00	0.34	0.00	dead load
	LC2	0.08	-0.23	-0.04	wind lateral
	LC3	0.00	-0.86	0.00	wind longitudinal
	LC4	0.00	1.21	0.00	snow load
10	LC1	0.00	0.12	0.00	dead load
	LC2	0.11	-0.40	-0.05	wind lateral
	LC3	0.00	-0.31	0.00	wind longitudinal
	LC4	0.00	0.42	0.00	snow load
Σ Supp.	LC1	0.00	1.19		
Σ Loads	LC1	0.00	1.19		
Σ Supp.	LC2	0.49	-0.48		
Σ Loads	LC2	0.49	-0.48		
Σ Supp.	LC3	0.00	-3.07		
Σ Loads	LC3	0.00	-3.07		
Σ Supp.	LC4	0.00	4.25		
Σ Loads	LC4	0.00	4.25		

RESULTS

Project: Model: 1b) Frame (Zone B)

4.3 CROSS-SECTIONS - INTERNAL FORCES

Result Combinations

Member No.	RC	Node No.	Location x [m]		Forces [kN]		Moments M _y [kNm]	Corresponding Load Cases
					N	V _z		
Section No. 1: TO 60/60/2/2/2								
1	RC1		1.064	MAX N	0.21	-1.64	-0.24	LC 1,2,4
4	RC1		0.000	MIN N	-0.17	0.42	-0.05	LC 1,2,4
3	RC1		0.000	MAX V _z	-0.14	1.18	-0.12	LC 1,2,4
1	RC1		1.064	MIN V _z	0.21	-1.64	-0.24	LC 1,2,4
1	RC2		0.425	MAX M _y	0.09	0.03	0.29	LC 1,2,4
1	RC1		1.064	MIN M _y	0.21	-1.64	-0.24	LC 1,2,4
Section No. 2: RD 14 | DIN 1013-1								
8	RC4		0.000	MAX N	0.95	0.00	0.00	LC 1,3
6	RC1		0.000	MIN N	-2.24	0.07	-0.04	LC 1,2,4
9	RC2		0.000	MAX V _z	0.12	0.17	-0.08	LC 1,2,4
9	RC4		0.000	MIN V _z	0.35	0.00	0.00	LC 1,3
9	RC2		0.900	MAX M _y	0.12	0.17	0.08	LC 1,2,4
9	RC2		0.000	MIN M _y	0.12	0.17	-0.08	LC 1,2,4

4.4 NODES - SUPPORT FORCES

Result Combinations

Node No.	RC		Support Forces [kN]		Support Moments M _y [kNm]	Corresponding Load Cases
			P _x	P _z		
6	RC1	Max P _x	0.09	1.11	-0.04	LC 1,2,4
		Min P _x	0.09	1.11	-0.04	LC 1,2,4
	RC2	Max P _x	0.16	1.01	-0.07	LC 1,2,4
		Min P _x	0.16	1.01	-0.07	LC 1,2,4
	RC3	Max P _x	0.16	0.65	-0.08	LC 1,2
		Min P _x	0.16	0.65	-0.08	LC 1,2
	RC4	Max P _x	0.00	-0.35	0.00	LC 1,3
		Min P _x	0.00	-0.35	0.00	LC 1,3
	RC1	Max P _x	0.07	2.24	-0.04	LC 1,2,4
		Min P _x	0.07	2.24	-0.04	LC 1,2,4
7	RC2	Max P _x	0.12	1.32	-0.06	LC 1,2,4
		Min P _x	0.12	1.32	-0.06	LC 1,2,4
	RC3	Max P _x	0.12	0.30	-0.06	LC 1,2
		Min P _x	0.12	0.30	-0.06	LC 1,2
	RC4	Max P _x	0.00	-0.95	0.00	LC 1,3
		Min P _x	0.00	-0.95	0.00	LC 1,3
	RC1	Max P _x	0.10	1.70	-0.05	LC 1,2,4
		Min P _x	0.10	1.70	-0.05	LC 1,2,4
	RC2	Max P _x	0.17	0.84	-0.08	LC 1,2,4
		Min P _x	0.17	0.84	-0.08	LC 1,2,4
8	RC3	Max P _x	0.17	-0.01	-0.08	LC 1,2
		Min P _x	0.17	-0.01	-0.08	LC 1,2
	RC4	Max P _x	0.00	-0.82	0.00	LC 1,3
		Min P _x	0.00	-0.82	0.00	LC 1,3
	RC1	Max P _x	0.07	2.06	-0.04	LC 1,2,4
		Min P _x	0.07	2.06	-0.04	LC 1,2,4
	RC2	Max P _x	0.12	1.02	-0.06	LC 1,2,4
		Min P _x	0.12	1.02	-0.06	LC 1,2,4
	RC3	Max P _x	0.12	0.00	-0.06	LC 1,2
		Min P _x	0.12	0.00	-0.06	LC 1,2
9	RC4	Max P _x	0.00	-0.95	0.00	LC 1,3
		Min P _x	0.00	-0.95	0.00	LC 1,3
	RC1	Max P _x	0.11	0.44	-0.05	LC 1,2,4
		Min P _x	0.11	0.44	-0.05	LC 1,2,4
	RC2	Max P _x	0.17	-0.12	-0.08	LC 1,2,4
		Min P _x	0.17	-0.12	-0.08	LC 1,2,4
	RC3	Max P _x	0.17	-0.47	-0.08	LC 1,2
		Min P _x	0.17	-0.47	-0.08	LC 1,2
	RC4	Max P _x	0.00	-0.35	0.00	LC 1,3
		Min P _x	0.00	-0.35	0.00	LC 1,3

Project: Model: 1b) Frame (Zone B)

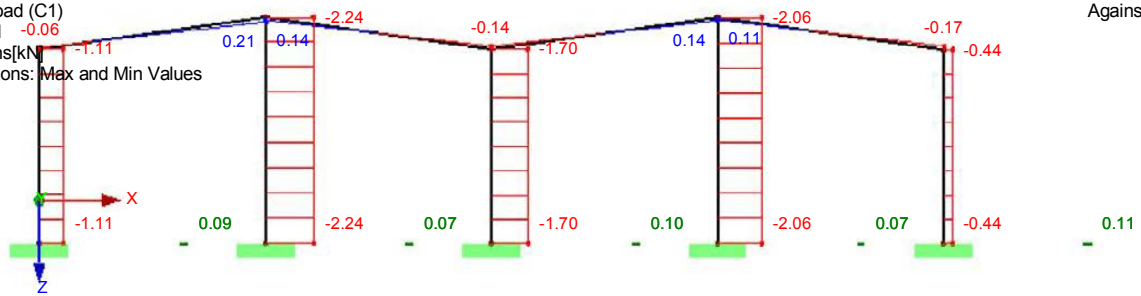
■ NODE N, LK1: ASSUMED LOAD (C1)

RC1: Assumed load (C1)

Internal Forces N

Support Reactions[kN]

Result Combinations: Max and Min Values



Against Y-direction

Max P-Z': 2.24, Min P-Z': 0.44 kN
Max P-X': 0.11, Min P-X': 0.07 kN
Max N: 0.21, Min N: -2.24 kN

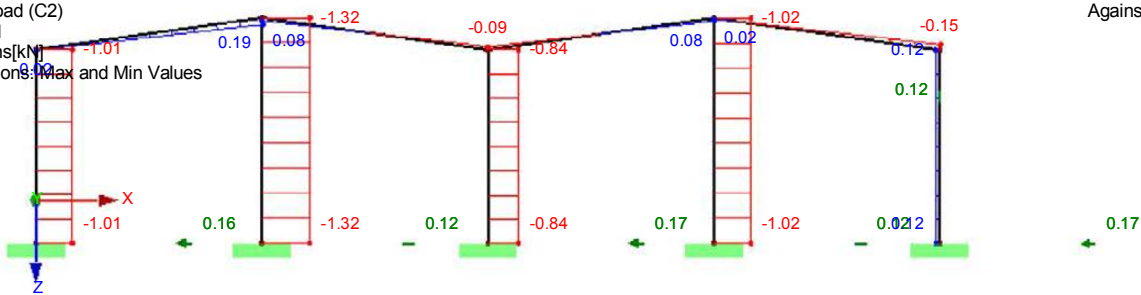
■ NODE N, LK2: ASSUMED LOAD (C2)

RC2: Assumed load (C2)

Internal Forces N

Support Reactions[kN]

Result Combinations: Max and Min Values



Against Y-direction

Max P-Z': 1.32, Min P-Z': -0.12 kN
Max P-X': 0.17, Min P-X': 0.12 kN
Max N: 0.19, Min N: -1.32 kN

Project:

Model: 1b) Frame (Zone B)

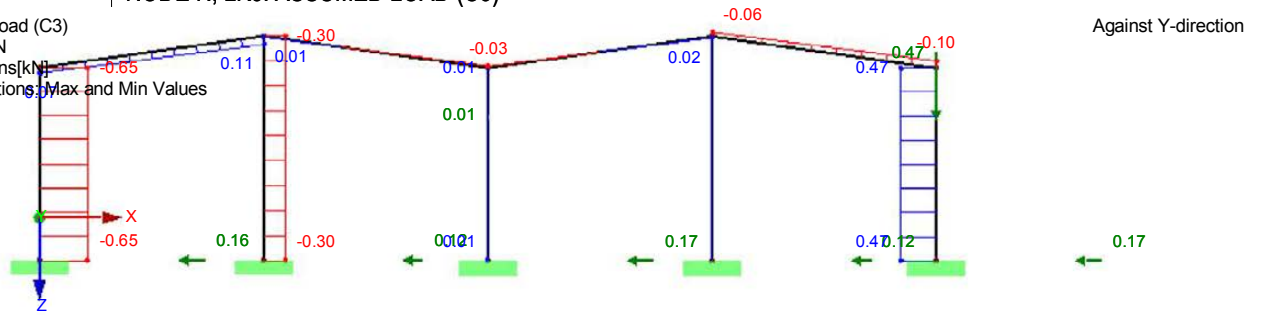
■ NODE N, LK3: ASSUMED LOAD (C3)

RC3: Assumed load (C3)

Internal Forces N

Support Reactions[kN]

Result Combinations: Max and Min Values



Max P-Z': 0.65, Min P-Z': -0.47 kN
Max P-X': 0.17, Min P-X': 0.12 kN
Max N: 0.47, Min N: -0.65 kN

0.711 m

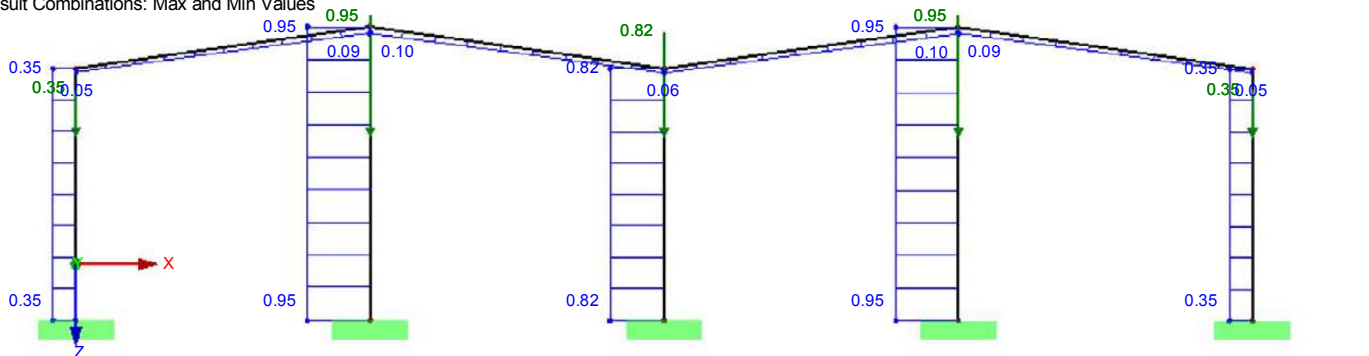
■ NODE N, LK4: ASSUMED LOAD (C4)

RC4: Assumed load (C4)

Internal Forces N

Support Reactions[kN]

Result Combinations: Max and Min Values



Max P-Z': -0.35, Min P-Z': -0.95 kN
Max P-X': 0.00, Min P-X': 0.00 kN
Max N: 0.95, Min N: 0.05 kN

0.542 m

STEEL EC3

CA1

Design of steel members
according to Eurocode 3

Project: Model: 1b) Frame (Zone B)

1.1 GENERAL DATA

Members to design:	5-9
Sets of members to design:	
Ultimate Limit State Design	
Result combinations to design:	RC1 RC2 RC3 RC4
	Assumed load (C1) Assumed load (C2) Assumed load (C3) Assumed load (C4)

1.1.1 DETAILS

Stability Analysis	☒
Stability Check	☒
Bending About the Major y-Axis	
Equivalent Member Method acc. to 6.3	☒
Include second-order effects acc. to 5.2.2(4) by increasing bending moment	☐
Bending About the Minor z-Axis	
Equivalent Member Method acc. to 6.3	☒
Include second-order effects acc. to 5.2.2(4) by increasing bending moment	☐
Determination of elastic critical moment for lateral-torsional buckling	
For members:	Automatically by Eigenvalue Method
Load application of positive transverse loads:	On cross-section edge directed to shear center (e.g. top flange, destabilizing effect)
Model type acc. to Table B.3	
Sway y - y ($C_{my} = 0.9$)	☐
Sway z - z ($C_{mz} = 0.9$)	☐
Limit Load for Special Cases	
Unsymmetric cross-sections with compression and bending	
$M_{y,Ed} / M_{pl,y,Rd} \leq$	0.01
$M_{z,Ed} / M_{pl,z,Rd} \leq$	0.01
$N_{c,Ed} / N_{pl} \leq$	0.01
Non-Symmetrical Cross-Sections, Tapered Members or Sets of Members	
$M_{z,Ed} / M_{pl,z,Rd} \leq$	0.05
Cross-Sections with Torsion	
$\tau_{t,Ed} / \tau_{t,Rd} \leq$	0.05
Stability analysis method for sets of members acc. to	6.3.4 General Method
Classification of Cross-Sections	
Type of determination of ψ and α acc. to Table 5.2:	
For limit c/t of Class 3, increase material factor ϵ acc. to 5.5.2(9)	Increase N_{Ed} and M_{Ed} uniformly
Use SHAPE-THIN for classification of all supported cross-section types (only Classes 3 and 4 possible)	☒
Ignore classification of curved parts	☐
if $c/t \leq$	☒
	5.00
Options	
Elastic Design (also for cross-sections of Class 1 or 2)	☐
Stability Analyses with Second-Order Internal Forces	☐
Use γ_{M1} for determination of the cross-section resistance	☐
Cross-section check for M+N	
Use linear interaction acc. to 6.2.1(7)	☐
Cross-sections with Class 4 and torsion	
$\tau_{t,Ed} / \tau_{t,Rd} \leq$	0.05
Member Slendernesses	
Members with	λ_{limit}
Tension only:	300
Compression / flexure:	200
Design of Welds	
Allow design of welds	☐

1.1.2 NATIONAL ANNEX

Partial Factors acc. to 6.1, Note 2B	
For resistance of cross-sections γ_{M0} :	1.00
For resistance of members to buckling (assessed for checks in Clause 6.3) γ_{M1} :	1.00
For resistance of cross-sections in tension to fracture γ_{M2} :	1.25
Fire Properties	
$\gamma_{M,fi}$	1.00
Shear acc. to 6.2.6(3) and shear buckling acc. to EN 1993-1-5	
Factor η :	1.00

Project: Model: 1b) Frame (Zone B)

1.1.2 NATIONAL ANNEX

Parameters for Lateral-Torsional Buckling	
Imperfection coefficients of lateral-torsional buckling curves acc. to Table 6.3	
Buckling Curve a:	0.21
Buckling Curve b:	0.34
Buckling Curve c:	0.49
Buckling Curve d:	0.76
Use factor f for modification of χ_{LT} according to 6.3.2.3(2)	☒
Parameters for Φ_{LT} acc. to 6.3.2.3(1):	
Rolled I-Sections	
$\lambda_{LT,0}$:	0.40
β :	0.75
Welded I-Sections	
$\lambda_{LT,0}$:	0.40
β :	0.75
Determine lateral-torsional buckling curves:	If possible, acc. to 6.3.2.3, Eq. (6.57), otherwise acc. to 6.3.2.2, Eq. (6.56)
Determine interaction factors for 6.3.3(4) according to Method:	2 according to Annex B
Serviceability Limits (Deflections) acc. to 7.2	
Combination of actions (Table A1.4 of EN 1990):	
SC:	Characteristic
SF:	Frequent
SQ:	Quasi-permanent
	L / 250
	L / 333
	L / 200
	Cantilevers
	L_c / 125
	L_c / 166
	L_c / 100
General Method according to 6.3.4	
Use General Method also for non-I-sections	☒
Always use General Method for stability design according to 6.3.4	☐
Use European lateral-torsional buckling curve according to [5]	☐
Use the method of Johannes Caspar Naumes for assessing the out-of-plane stability	☐
Use interpolation acc. to Eq. (6.66)	☐
Stainless Steel (EN 1993-1-4) Parameters	
Partial Factors acc. to 5.1	
For resistance of cross-sections	
γ_{M0}	1.10
For resistance of members to buckling (assessed for checks in Clause 6.3)	
γ_{M1}	1.10
For resistance of cross-sections to fracture due to tension	
γ_{M2}	1.25
Shear according to 5.6(2) and shear buckling	
η	1.00
Parameters for Stability Design	
Imperfection Coefficient	
Buckling	
α	
Cold formed open sections	0.49
Hollow sections (welded or seamless)	0.49
Welded open sections (about the major axis)	0.49
Welded open sections (about the minor axis)	0.76
Torsional and Lateral-Torsional Buckling	
All structural members	0.34
Parameter for Φ	
Buckling	
λ_0	
Cold formed open sections	0.40
Hollow sections (welded or seamless)	0.40
Welded open sections (about the major axis)	0.20
Welded open sections (about the minor axis)	0.20
Torsional and Lateral-Torsional Buckling	
All structural members	0.20
Imperfection Coefficient	
α_{LT}	
Cold formed sections and hollow sections (welded and seamless)	0.34
Welded open sections and other sections	0.76

1.2 MATERIALS

Matl. No.	Material Description	E- Modulus E [kN/cm ²]	Shear Modulus G [kN/cm ²]	Poisson's Ratio ν [-]	Yield Stress f_{yk} [kN/cm ²]	Max. Thickness t [mm]
2	steel B 500 S (A) SF1.1 | EN 1992-1-1:2004/AC:2010 Benutzerdefiniertes Material	20000.00	7691.31	0.300	50.00	1000.0

Project: Model: 1b) Frame (Zone B)

1.3 CROSS-SECTIONS

Sect. No.	Matl. No.	Cross-Section Description	Cross-Section Type for Classification	Max Design Ratio	Comment
2	2	RD 14 | DIN 1013-1 Type General - Only Class 3 possible	General	0.58	

1.5 EFFECTIVE LENGTHS - MEMBERS

Member No.	Buckling Possible	Buckling About Axis y			Buckling About Axis z			Lateral-Torsional Buckling				
		Possible	$k_{cr,y}$	$L_{cr,y}$ [m]	Possible	$k_{cr,z}$	$L_{cr,z}$ [m]	Possible	k_z	k_w	L_w [m]	L_T [m]
5	☒	☒	0.70	0.630	☒	0.70	0.630	☒	1.0	1.0	0.900	0.900
6	☒	☒	0.70	0.733	☒	0.70	0.733	☒	1.0	1.0	1.048	1.048
7	☒	☒	0.70	0.630	☒	0.70	0.630	☒	1.0	1.0	0.900	0.900
8	☒	☒	0.70	0.733	☒	0.70	0.733	☒	1.0	1.0	1.048	1.048
9	☒	☒	0.70	0.630	☒	0.70	0.630	☒	1.0	1.0	0.900	0.900

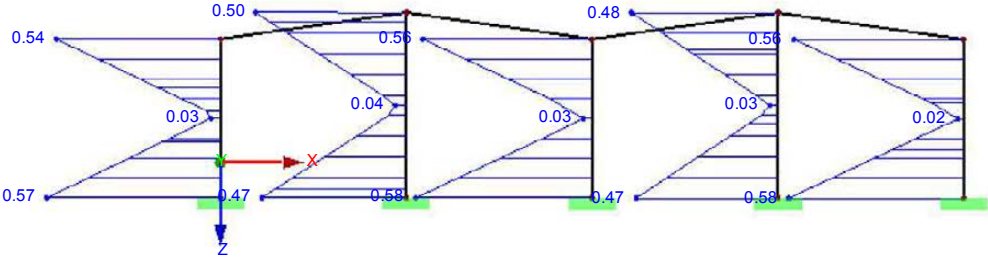
2.1 DESIGN BY LOAD CASE

LC/CO/ RC	Load Case or CO/RC Description	Member No.	Location x [m]	Design	Acc. to Formula	
Ultimate Limit State Design						
RC1	Assumed load (C1)	6	0.000	0.50	≤ 1	354) PT
RC2	Assumed load (C2)	7	0.900	0.58	≤ 1	183) PT
RC3	Assumed load (C3)	9	0.900	0.57	≤ 1	183) PT
RC4	Assumed load (C4)	5	0.000	0.02	≤ 1	183) PT

DESIGN: ULTIMATE LIMIT STATE - CROSS-SECTION DESIGN

STEEL EC3 CA1
Ultimate Limit State: Cross-Section Design

Against Y-direction



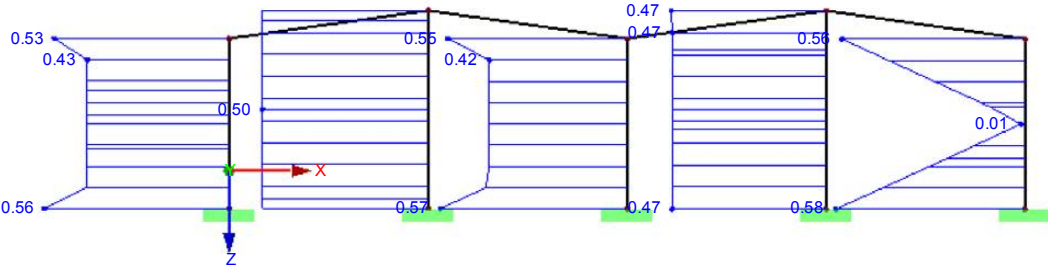
Max Design Ratio: 0.58

0.857 m

DESIGN: ULTIMATE LIMIT STATE - STABILITY DESIGN

STEEL EC3 CA1
Ultimate Limit State: Stability Design

Against Y-direction



Max Design Ratio: 0.58

0.801 m

Item: 2) BT: Connection module – reinforcing rod

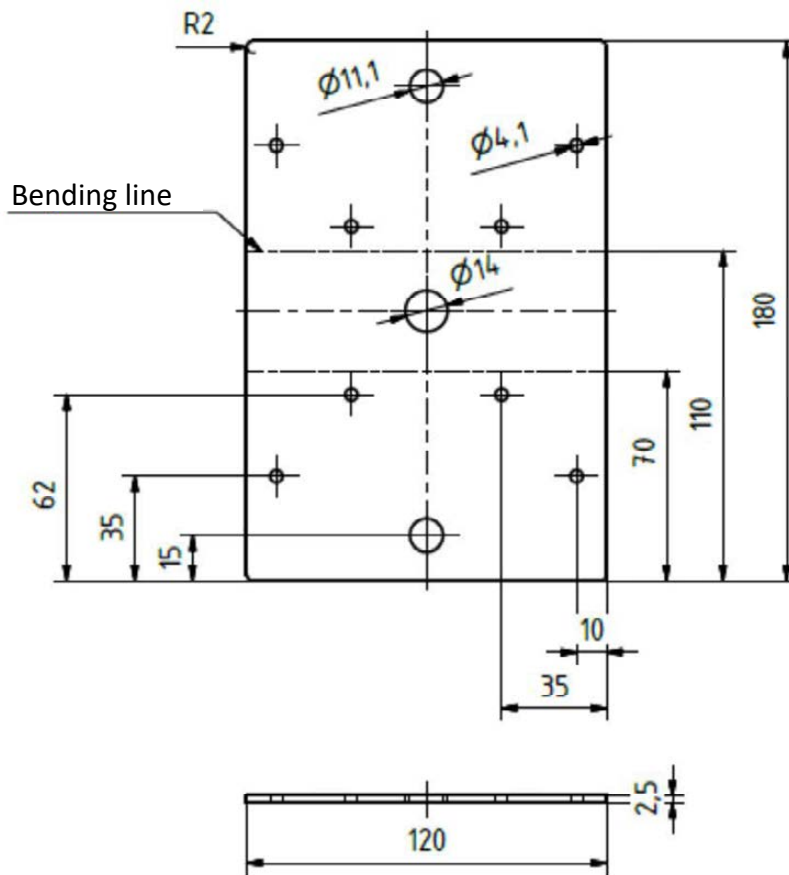
Connection plate:

chosen: edged plate, S280 GD, b/t = 120/2,5 mm

$$W_{y,plate} = 0,125\text{cm}^3; \quad A_{plate} = 3,0\text{cm}^2$$

$$\sigma_{Rd} = 28\text{ kN/cm}^2$$

Developed view:



Folded model:



Analysis max. suction:

from Item: 1b)

max. $P_{z,d,suction} = -0,95 \text{ kN}$ (see page: 30, RSTAB-printout, RC 4, node-no. 7)

Load per module connector:

max. $P_{z,d,suction} = -0,95 \text{ kN} / 2 = -0,48 \text{ kN}$

$$M_d = 0,48 \text{ kN} \cdot 7 \text{ cm} \cdot \frac{1}{2} = 1,66 \text{ kNcm}$$

$$\sigma_{Ed} = \frac{1,66 \text{ kNcm}}{0,125 \text{ cm}^3} + \frac{0,48 \text{ kN}}{3,0 \text{ cm}^2} = 13,46 \frac{\text{kN}}{\text{cm}^2} \leq 28,0 \frac{\text{kN}}{\text{cm}^2}$$

Analysis max. pressure:

from Item: 1b)

max. $P_{z,d,pressure} = 2,24 \text{ kN}$ (see page: 29, RSTAB-printout, RC1, node-no. 7)

Load per module connector:

max. $P_{z,d,pressure} = 2,24 \text{ kN} / 2 = 1,12 \text{ kN}$

$$M_d = 1,12 \text{ kN} \cdot 2 \text{ cm} \cdot \frac{1}{2} = 1,12 \text{ kNcm}$$

$$\sigma_{Ed} = \frac{1,12 \text{ kNcm}}{0,125 \text{ cm}^3} + \frac{1,12 \text{ kN}}{3,0 \text{ cm}^2} = 9,33 \frac{\text{kN}}{\text{cm}^2} \leq 28,0 \frac{\text{kN}}{\text{cm}^2}$$

Element of connection:

max. $P_{z,d,suction} = -0,48 \text{ kN}$ (see above)

chosen: rivetting nut M8
cylinder head hexagon socket screw M8, A2
frame module clip, stainless steel

allowed extraction force (screw M8) $F_{t,Rd} = k_2 \times f_{ub} \times A_s / \gamma_{M2} = 0,9 \times 70 \frac{\text{kN}}{\text{cm}^2} \times 0,366 \text{ cm}^2 / 1,25 = 18,45 \text{ kN}$

allowed shearing force (screw M8) $F_{v,Rd} = \alpha_v \times f_{ub} \times A_s / \gamma_{M2} = 0,6 \times 70 \frac{\text{kN}}{\text{cm}^2} \times 0,366 \text{ cm}^2 / 1,25 = 12,30 \text{ kN}$

no further verification needed

Element of connection: connecting plate – rod:

max. $P_{z,d,pressure} = 2,24 \text{ kN}$ (see above)

minimum value of test: 400kg $\rightarrow F_{z,k} = 4,0 \text{ kN}$

$$F_{z,d} = F_{z,k} / \gamma_M = 4,0 \text{ kN} / 1,3 = 3,08 \text{ kN}$$

Analysis: $\frac{F_{z,Ed}}{F_{z,Rd}} = \frac{2,24 \text{ kN}}{3,08 \text{ kN}} = 0,73 \leq 1$

Load on module

Here, for example, the calculation with wind zone I and terrain category 0.

Wind load:

a) Zone A to wind report (max. Wind-load):

Load case 2): wind transverse the rows (wind direction east-west)

c_p -value, s. annex, wind report, load case a

$$1 \text{ m}^2 < A = 2 \text{ m}^2 \leq 10 \text{ m}^2 \rightarrow c_{p,x} = c_{p,1} + (c_{p,10} - c_{p,1}) \cdot \lg A$$

$$\begin{aligned} \text{1. row at field edge: } c_{p,2,\text{pressure}} &= 0,3 + (0,1 - 0,3) \cdot \lg 2 = \underline{0,24}; \\ c_{p,2,\text{suction}} &= -0,7 + (-0,4 - (-0,7)) \cdot \lg 2 = \underline{-0,61} \end{aligned}$$

$$\begin{aligned} \text{further rows: } c_{p,2,\text{pressure}} &= 0,2 + (0,1 - 0,2) \cdot \lg 2 = \underline{0,17}; \\ c_{p,2,\text{suction}} &= -0,5 + (-0,3 - (-0,5)) \cdot \lg 2 = \underline{-0,44} \end{aligned}$$

$$W_{\text{pressure, 1.row}} = 0,24 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = 0,20 \frac{\text{kN}}{\text{m}^2} = 200 \text{ Pa}$$

$$W_{\text{suction, 1.row}} = -0,61 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = -0,51 \frac{\text{kN}}{\text{m}^2} = -510 \text{ Pa}$$

$$W_{\text{pressure, further row}} = 0,17 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = 0,14 \frac{\text{kN}}{\text{m}^2} = 140 \text{ Pa}$$

$$W_{\text{suction, further row}} = -0,44 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = -0,37 \frac{\text{kN}}{\text{m}^2} = -370 \text{ Pa}$$

b) Zone B to wind report (max. Wind-load):

Load case 2): wind transverse the rows (wind direction east-west)

c_p -value, s. annex, wind report, load case a

$$1 \text{ m}^2 < A = 2 \text{ m}^2 \leq 10 \text{ m}^2 \rightarrow c_{p,x} = c_{p,1} + (c_{p,10} - c_{p,1}) \cdot \lg A$$

$$\begin{aligned} \text{1. row at field edge: } c_{p,2,\text{pressure}} &= 1,3 + (0,4 - 1,3) \cdot \lg 2 = \underline{1,03}; \\ c_{p,2,\text{suction}} &= -1,2 + (-0,5 - (-1,2)) \cdot \lg 2 = \underline{-0,99} \end{aligned}$$

$$\begin{aligned} \text{further rows: } c_{p,2,\text{pressure}} &= 1,0 + (0,3 - 1,0) \cdot \lg 2 = \underline{0,79}; \\ c_{p,2,\text{suction}} &= -1,1 + (-0,5 - (-1,1)) \cdot \lg 2 = \underline{-0,92} \end{aligned}$$

$$W_{\text{pressure, 1.row}} = 1,03 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = 0,85 \frac{\text{kN}}{\text{m}^2} = 850 \text{ Pa}$$

$$W_{\text{suction, 1.row}} = -0,99 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = -0,82 \frac{\text{kN}}{\text{m}^2} = -820 \text{ Pa}$$

$$W_{\text{pressure, further row}} = 0,79 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = 0,66 \frac{\text{kN}}{\text{m}^2} = 660 \text{ Pa}$$

$$W_{\text{suction, further row}} = -0,92 \cdot 0,83 \frac{\text{kN}}{\text{m}^2} = -0,76 \frac{\text{kN}}{\text{m}^2} = -760 \text{ Pa}$$

Snow load: $s_i = 0,70 \frac{\text{kN}}{\text{m}^2} \cdot 0,9 \cdot 0,8 = 0,50 \frac{\text{kN}}{\text{m}^2} = 500\text{Pa}$

Calculation maximum load on module:

Pressure: $850\text{Pa} \times 0,9 + 500\text{Pa} \times 1,5 = 1515\text{Pa}$
 $850\text{Pa} \times 1,5 + 500\text{Pa} \times 0,9 = 1725\text{Pa}$

Suction: $-820\text{Pa} \times 1,5 = -1230\text{Pa}$

Summary:

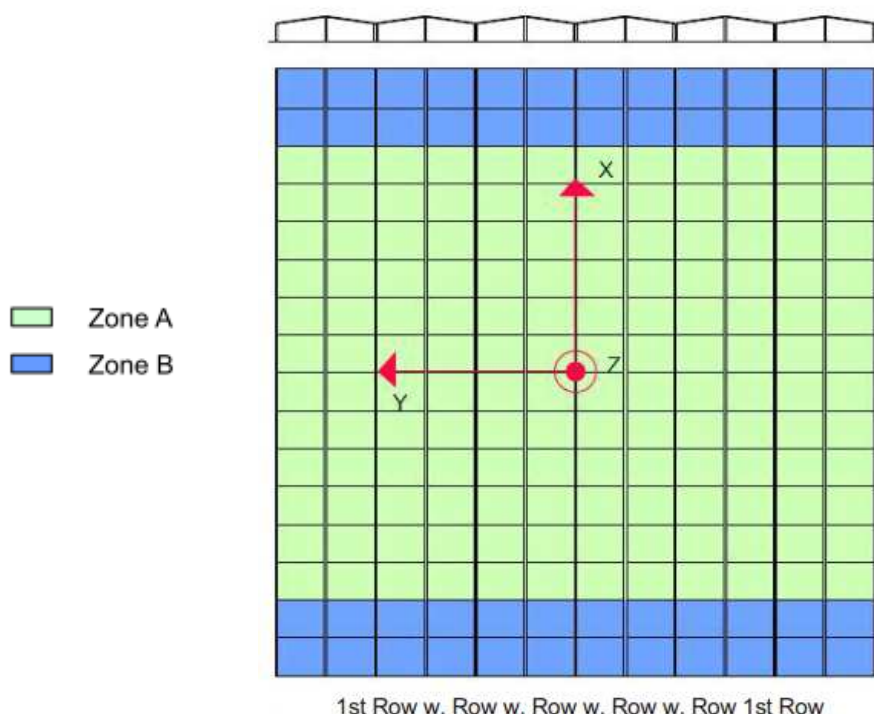
Max. load on module [Pa]		PRESSURE	SUCTION
Wind zone 1	Terrain category 0	1725	1230
	Terrain category 2	1590	1095
Wind zone 2	Terrain category 0	1530	1035
	Terrain category 2	1410	915
Wind zone 3	Terrain category 2	1245	750

Summary of the suction load:

Zone A: load combination RC4, page 17

Zone B: load combination RC4, page 30

Suction load [kN]		Zone A		Zone B	
		Short rod	Long rod	Short rod	Long rod
Wind zone 1	Terrain category 0	0,37	0,58	0,82	0,95
	Terrain category 2	0,30	0,49	0,70	0,81
Wind zone 2	Terrain category 0	0,26	0,43	0,66	0,76
	Terrain category 2	0,20	0,34	0,55	0,63
Wind zone 3	Terrain category 2	0,12	0,24	0,40	0,46



Minimum pull load in tests: $F_{\text{Test}} = \gamma_M \times F_{\text{suction}}$ (with $\gamma_M = 1,25$)

Minimum Load [kg]		Zone A		Zone B	
		Short rod	Long rod	Short rod	Long rod
Wind zone 1	Terrain category 0	46,25	72,5	102,5	118,75
	Terrain category 2	37,5	61,25	87,5	101,25
Wind zone 2	Terrain category 0	32,5	53,75	82,5	95,0
	Terrain category 2	25,0	42,5	68,75	78,75
Wind zone 3	Terrain category 2	15,0	30,0	50,0	57,5

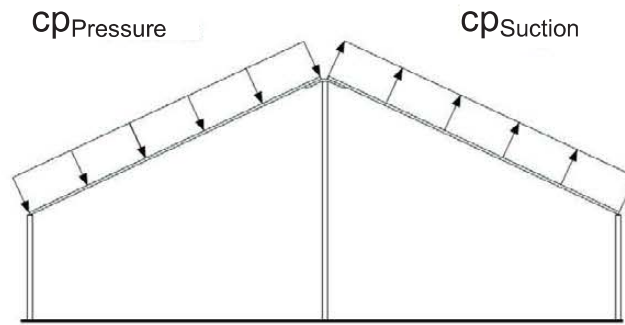


Figure 4.1: Definition of the positive and negative assigns for pressure coefficients c_{p^+} and c_{p10}

Figure 4.2 shows the wind directions, the designation of the rows and the sub-areas in accordance with the evaluation. The $0^\circ - 90^\circ$ wind sector was measured. Owing to the double symmetry of the “Plan Tec” open land system, these measurement values can be transcribed for all wind sectors from $0^\circ - 360^\circ$.

Load zone A applies for the inner modules in a row and zone B applies for the outer two double modules in a row.

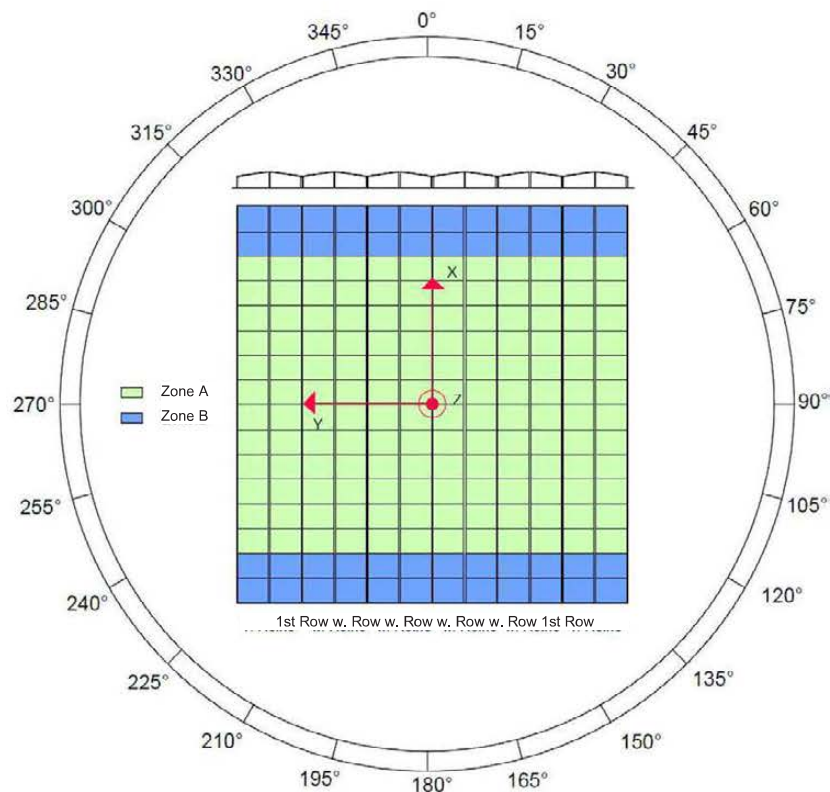


Figure 4.2: Definition of the wind direction θ and designation of the rows and sub-areas

4.1 Panel loads

Only wind loads vertical to the plane of the panel are taken into account. In order to obtain the assessment wind loads w_1 [kN/m²] for the respective installation locations for the “Plan Tec” open land system, the pressure coefficient $c_{p,1}$ [-] for a load area of 1 m² must be multiplied by the peak velocity pressure q_p in accordance with EN 1991-1-4 for the actual location conditions:

$$w_1 = c_{p,1} \cdot q_p \quad (1)$$

Rising wind loads have a negative sign, so point away from the module surface. Pressing wind loads are positive and affect the module surface.

4.2 Global loads

In order to obtain the assessment wind loads w_{10} [kN/m²] for the respective installation locations for the “Plan Tec” open land system, the pressure coefficient $c_{p,10}$ [-] for a load area of 10 m² must be multiplied by the peak velocity pressure q_p in accordance with EN 1991-1-4 for the actual location conditions:

$$w_{10} = c_{p,10} \cdot q_p \quad (2)$$

The resulting assessment wind loads are vertical to the plane of the panel. As a result, the rising wind loads are likewise negative and the pressing wind loads are positive.

4.3 Wind loads through friction

The flow along the module surfaces causes a frictional force F_R , which acts in direction x . This frictional force can be determined mathematically using the equation (3) and is applicable for flows from all wind sectors.

$$F_{R,x} = -c_r \cdot \cos(\theta) \cdot A_r \cdot q_p \quad (3)$$

where

$$c_r = \text{Friction coefficient} = 0.02$$

5 Results

During the course of the testing carried out, it was possible to determine the pressure coefficients which are required for the installation of the PV system in the wind tunnel which can also be used in accordance with EN 1991-1-4 in combination with the applicable national Annexes.

The aerodynamic forces acting on the modules result from the local deflection of the wind on the modules. Here, the wind presses, with frontal and cross flows, on the surfaces (positive resulting pressure coefficients) which are aligned to the windward side. At the ridge, the flow disperses so that a suction effect (negative resulting pressure coefficient) arrives on the lee side of a row. As soon as the wind flows proportionally from wind directions parallel to the rows, there is a suction effect across all modules in a row. Both load cases are outlined in Figure 5.1.

The results for the configuration tested are compiled for two load cases and have been reduced to two areas, edge and middle area. Lower resulting pressure coefficients can thus be estimated in the middle of the rows, since the flow dispersed at the edge of the row is generated again and there is thus lower turbulence in the middle of the row. In addition, the wind loads in the middle of the field are reduced by shadowing from the upstream rows. The compiled results are presented in Table 5.1 and Table 5.2 and the zone allocation is shown in Figure 4.2. Edge zone B should always be set for the two outermost modules and zone A should be set for the rest of the modules in a row. All of the resulting pressure coefficients $c_{p,1}$ and $c_{p,10}$ in Table 5.1 **do not include a safety coefficient**. The usual securities in the building industry should be observed.

		cp_{10}		cp_1	
		Zone A	Zone B	Zone A	Zone B
1st Row at the edge of the field	Pressure	0.1	0.4	0.3	1.3
	Suction	-0.4	-0.5	-0.7	-1.2
Other rows	Pressure	0.1	0.3	0.2	1.0
	Suction	-0.3	-0.5	-0.5	-1.1

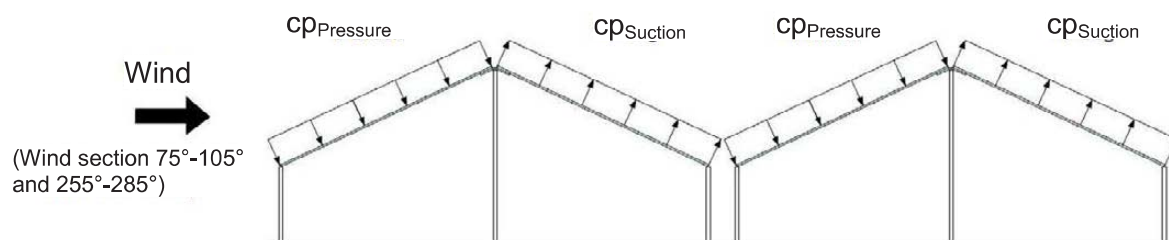
Table 5.1: Resulting pressure coefficients $cp_{,1}$ and $cp_{,10}$ for the row edge and row middle area; load case a)

		cp_{10}		cp_1	
		Zone A	Zone B	Zone A	Zone B
1st Row at the edge of the field	Suction	-0.3	-0.4	-0.4	-0.8
	Suction	-0.3	-0.4	-0.4	-0.8
Other rows	Suction	-0.2	-0.4	-0.3	-0.8
	Suction	-0.2	-0.4	-0.3	-0.8

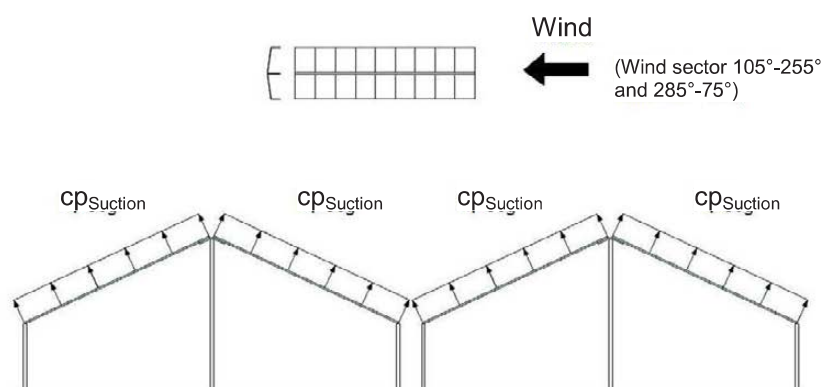
Table 5.2: Resulting pressure coefficients cp_1 and cp_{10} for the row edge and row middle area; load case b)

Two load cases can be defined from the wind tunnel results:

- Pressure on the windward, angled surfaces and suction on the leeward side (applied for the wind sectors 75°-105° and 255°-285°)
- Simultaneous suction on both angled sides of a row (applied for the wind sectors 105°-255° and 285°-75°)

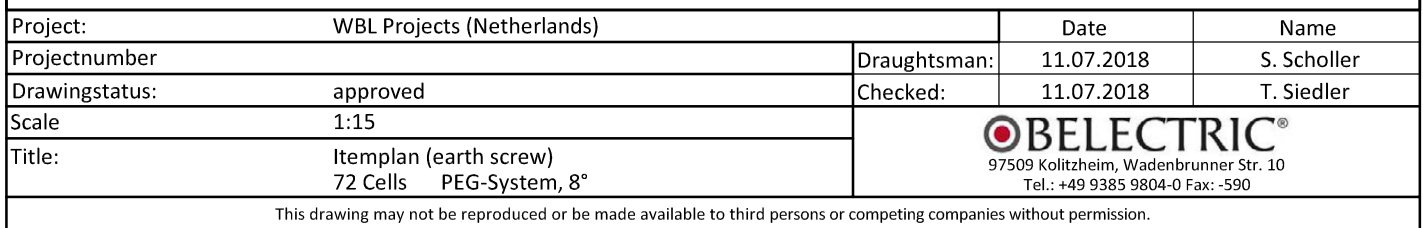


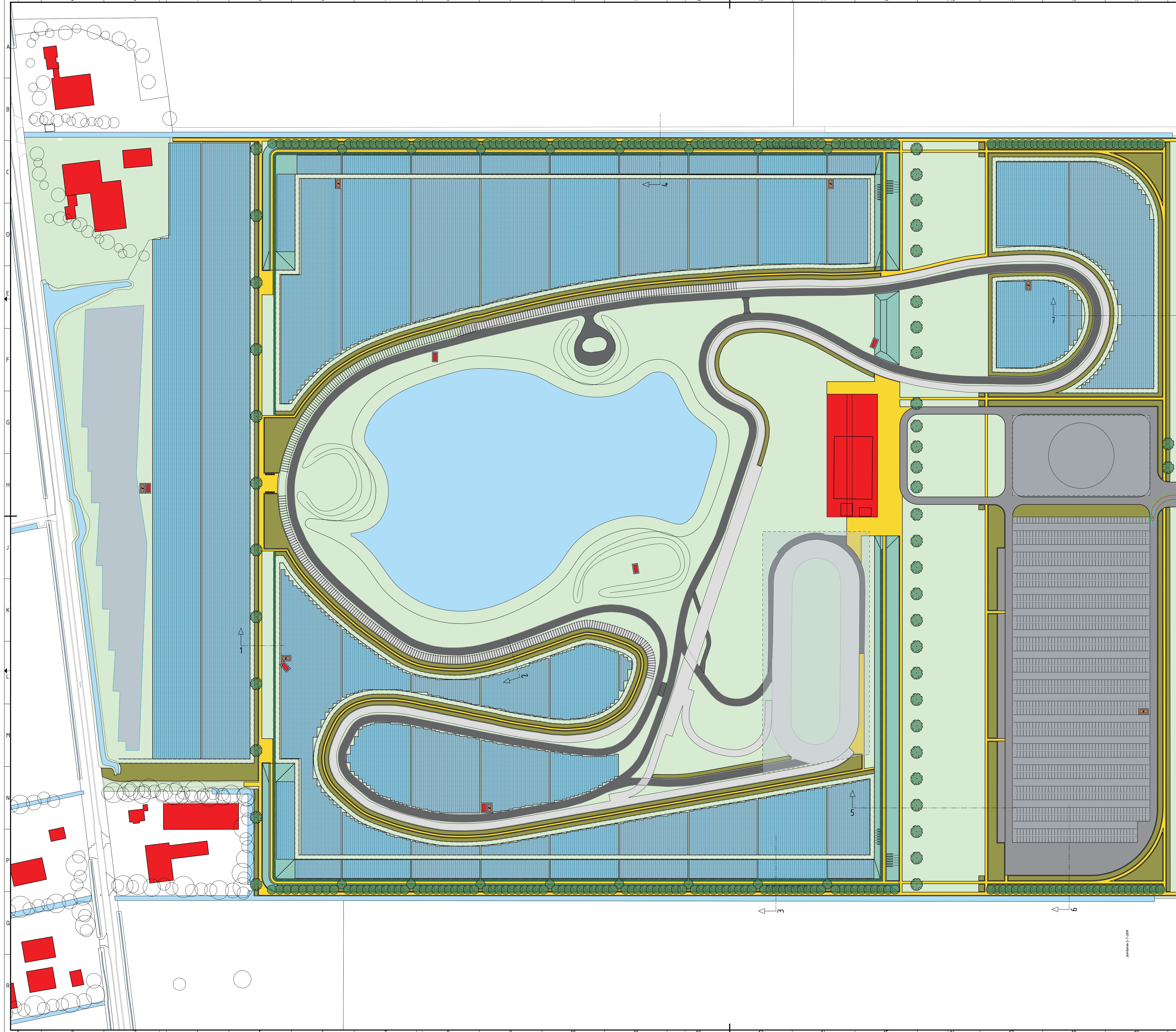
Load case a)



Load case b)

Figure 5.1: Representation of the two load cases on the “Plan Tec” open land system





- Legenda algemeen**
- locatie doorbrede, zie blad 003
 - bestaande bebouwing
 - bestaand oppervlakt water
 - nieuw te maken grondvlak
 - zonnepanelen
 - bestaande trafocover
 - nieuw te plaatsen trafocover

- verharding**
- bestaande baan
 - bestaand asfalt verharding
 - rijbaan
 - parkeervak
 - pad

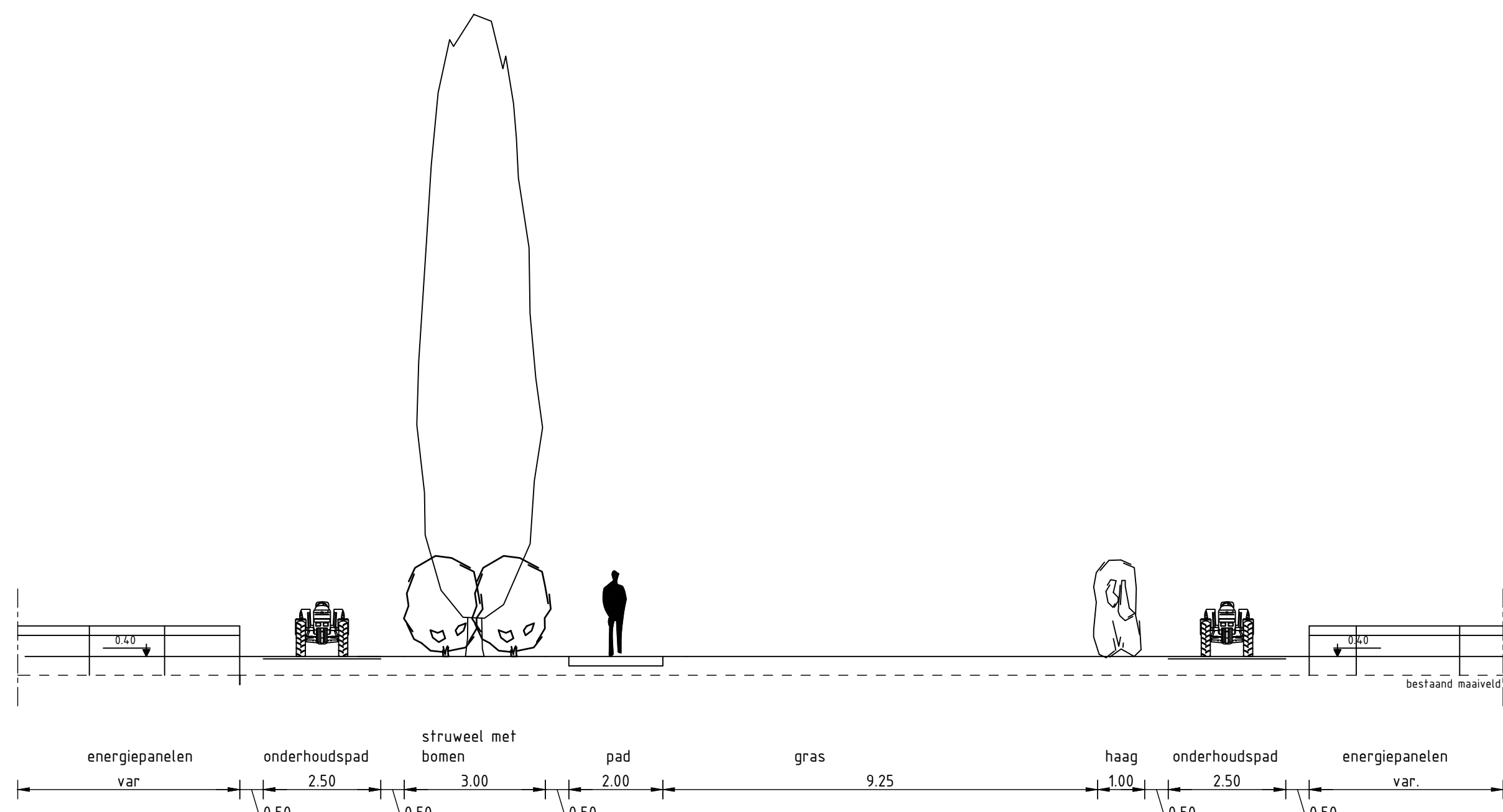
- groen**
- te planten boom Lente
 - te planten boom Herfst/Naaldbomen
 - te planten struik
 - haag
 - onderhoudspad in gras
 - gras

Opmerking:
Grondhevels en groen zijn schetsmatig aangegeven.

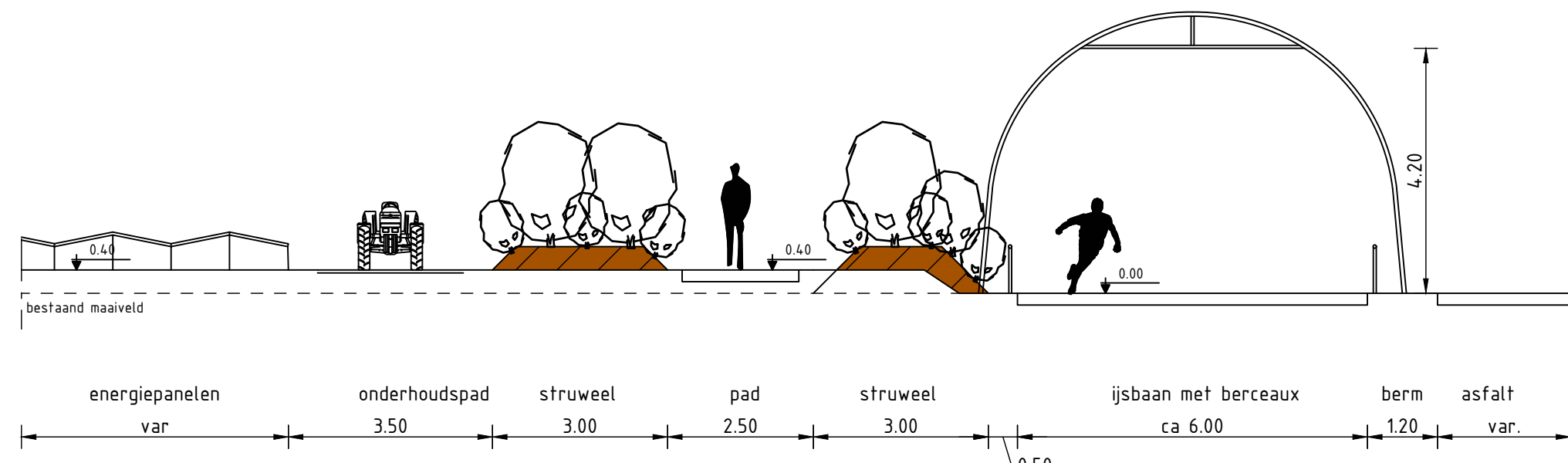
Project	Landschapsplan Flevonice	Get.	B. Poppe
Omschrijving	Nieuwe situatie	Datum	02-07-2019
Opdrachtgever	Flevonice B.V.	Sec.	M. Ogenoot
School	1:1000	Akt.	.....
Status	CONCEPT	Besteekr.	.....
	001	Projector.	.....

COÖPERATIE LANDSCHAPSPLANING

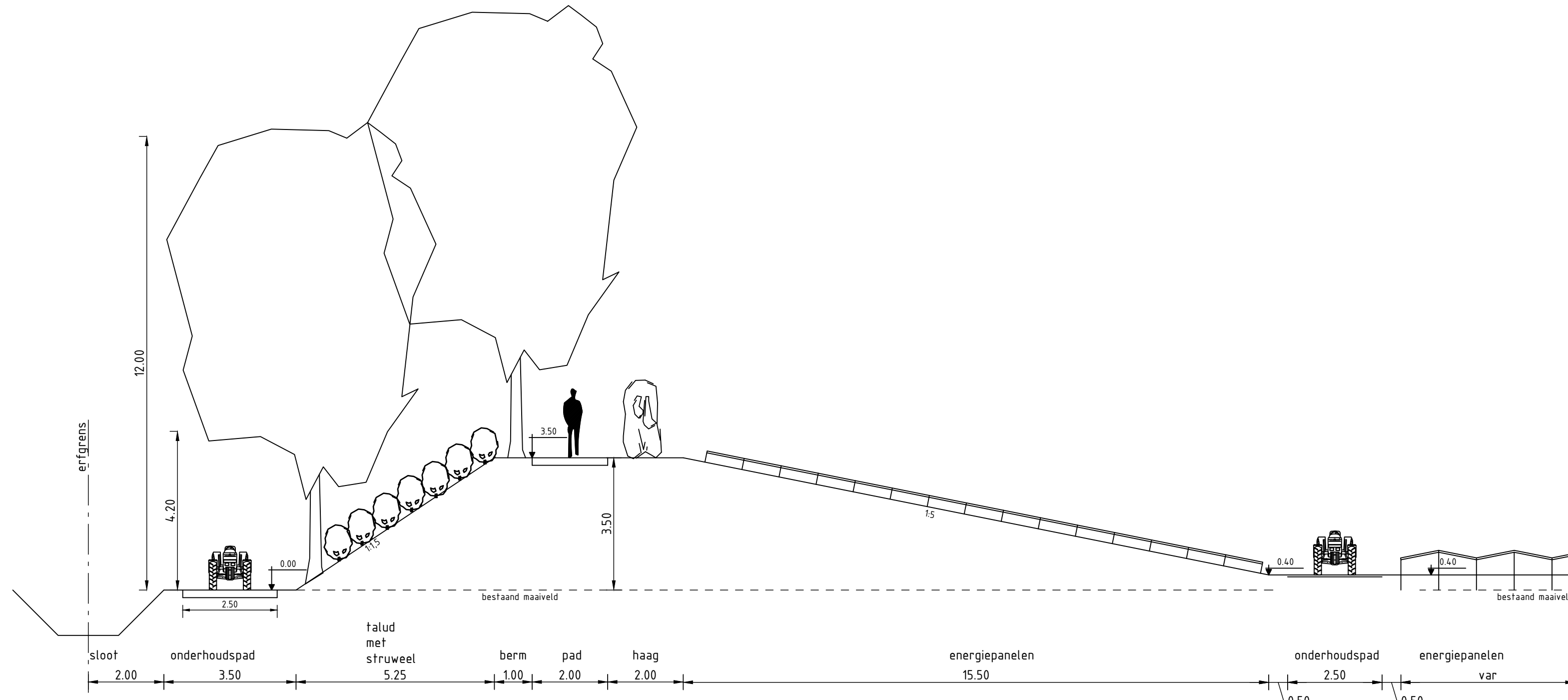
Vereniging 12
4001 BS Oosterveld
Tel. 0313 - 402 406
info@opdrachtgever.nl
www.opdrachtgever.nl



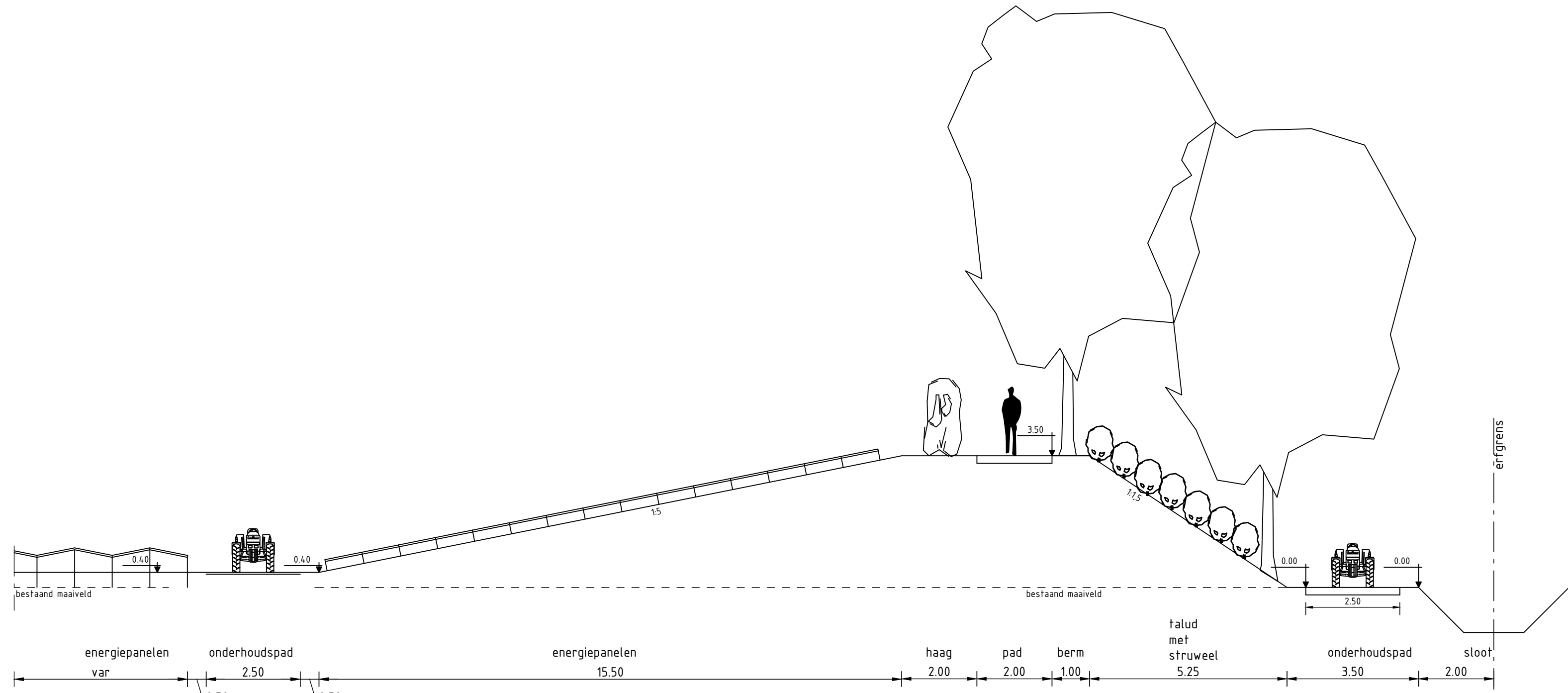
Profiel 1
SCHAAL 1 : 100



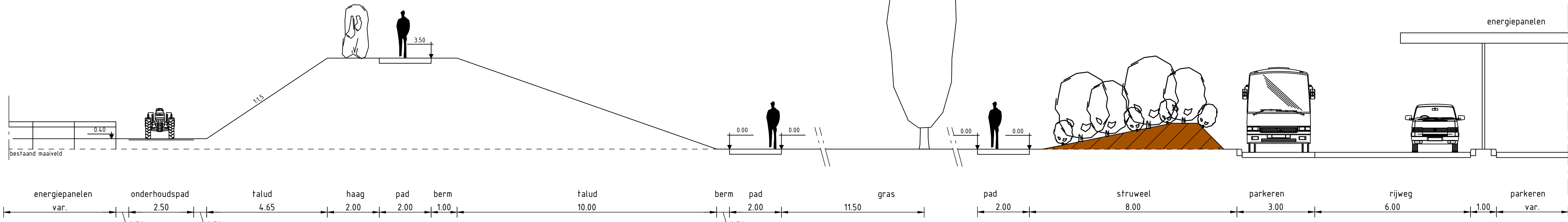
Profiel 2
SCHAAL 1 : 100



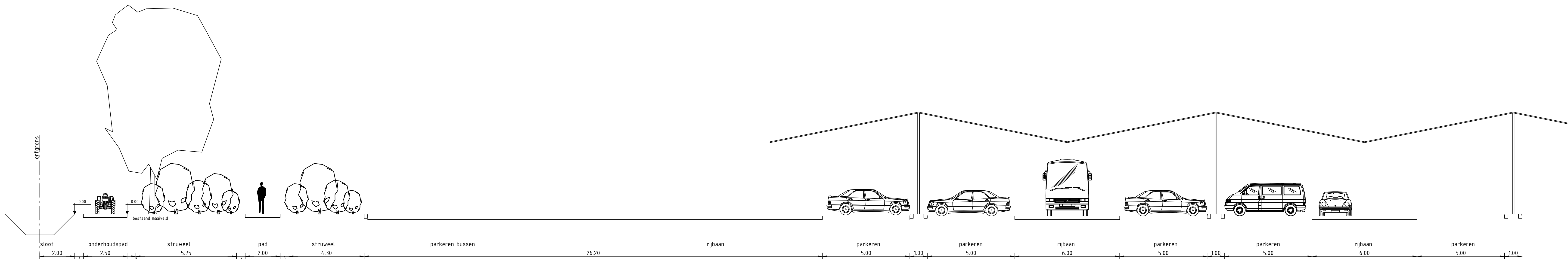
Profiel 3
SCHAAL 1 : 100



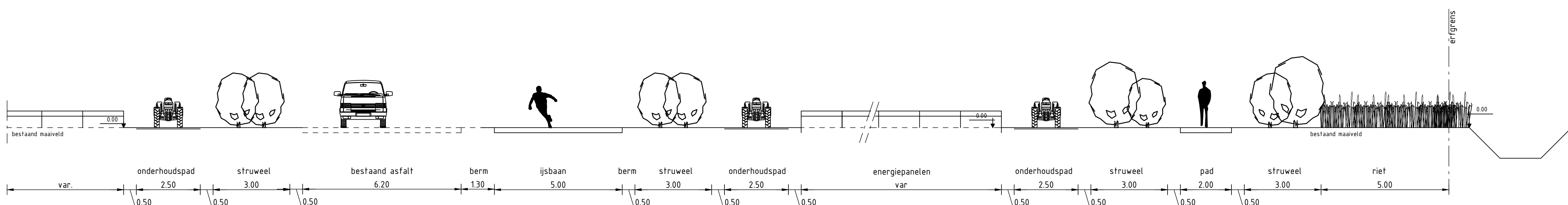
Profiel 4
SCHAAL 1 : 100



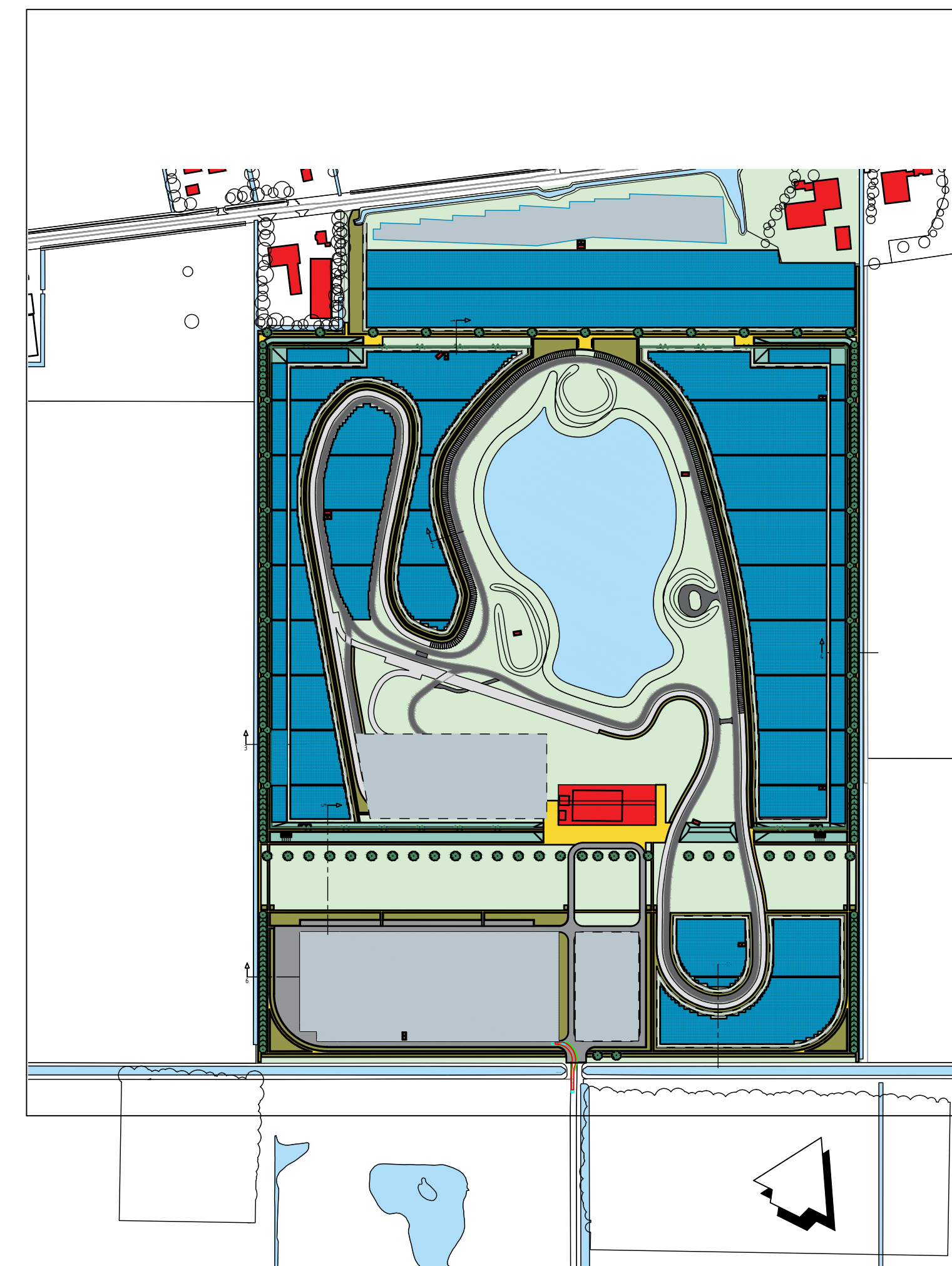
Profiel 5
SCHAAL 1 : 100



Profiel 6
SCHAAL 1 : 100



Profiel 7
SCHAAL 1 : 100



Project	Landschapsplan Flevonice	Get.	B. Poppe
Omschrijving	Profielen	Datum	02-07-2019
Opdrachtgever	Flevonice B.V.	Dec.	M. Ogenoor
School	1:100	Awk.	.....
Status	CONCEPT	Besteknr.	.....
Tekeningnummer	003	Projectnr.	.....
COÖPERATIE LANDSCHAPSPLANNING		Verporreid 12 4001 BS Oosterveld Tel. 0311-482 486 info@opland.nl www.opland.nl	

Gemeente Dronten
De heer R. Wiebers
Postbus 100
8250 AC DRONTEN

Verzenddatum	Bijlagen	Kenmerk
1-05-2019	-	Z2019-001845/D2019-113227

Onderwerp:
Advies milieu, Strandgaperweg 20 in Biddinghuizen

Geachte heer Wiebers,

Op 25 april 2019 heeft u om een advies gevraagd over de activiteit milieu van de aanvraag omgevingsvergunning met olo-nummer 4330987. De aanvraag gaat over het plaatsen van zonnepanelen. De activiteit vindt plaats aan de Strandgaperweg 20 in Biddinghuizen.

Conclusie

De omgevingsvergunning voor het aspect bouwen kan, voor wat betreft de activiteit milieu, verleend worden.

Toelichting

Zonnepanelen zijn elementen die op zich niet onder de milieuregelgeving vallen. Nu worden ze geplaatst bij een inrichting die wel onder de milieuregelgeving valt; Flevonice valt onder de vergunningplicht wat betreft het onderdeel milieu. Er is voor het bouwen van de zonnepanelen geen indieningsvereiste nodig middels een melding voor het Activiteitenbesluit, maar Flevonice zou dat wel vrijblijvend mogen doen middels een veranderingsmelding.

Vragen

Heeft u vragen dan kunt u contact opnemen met de heer Raggars via telefoonnummer: 06-22509275 of e-mail: f.raggars@ofgv.nl.

Hoogachtend,

A handwritten signature in blue ink, consisting of a stylized 'P' followed by a long horizontal stroke.

mr. drs. P.M.R. Schuurmans
Directeur Omgevingsdienst Flevoland en Gooi & Vechtstreek