

Mounting systems for solar technology



K2 SYSTEMS GMBH
CALCULATION BASIS

PROJECT: Naylor Hall
AUTHOR: Hugo Silva
DATE: 19/07/2022

PROJECT DATA (ROOF 1)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36.38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10.80 m
Roof pitch	30 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN	
Failure consequence class (CC)	CC1	Design working life 25 years

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,25} = 0.596 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	34
Name	LR4-60HPH-375M	Total output power	12.750 kWp

Dimensions LxWxH	1755 x 1038 x 35.00 mm
Weight	19.5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 1)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity 4.40 m	Quantity 3.30 m	Part of Rail / m	Length / m	Rest / m
A	16.883	3		4.400	3.683	0.707
B	1.118			3.300	1.118	2.172
C	2.169			3.300	2.169	1.121
D	9.526		2	3.300	2.926	0.364

LEGEND

1.22



Distance to Roof Edge [m]

Fastener

Base rails

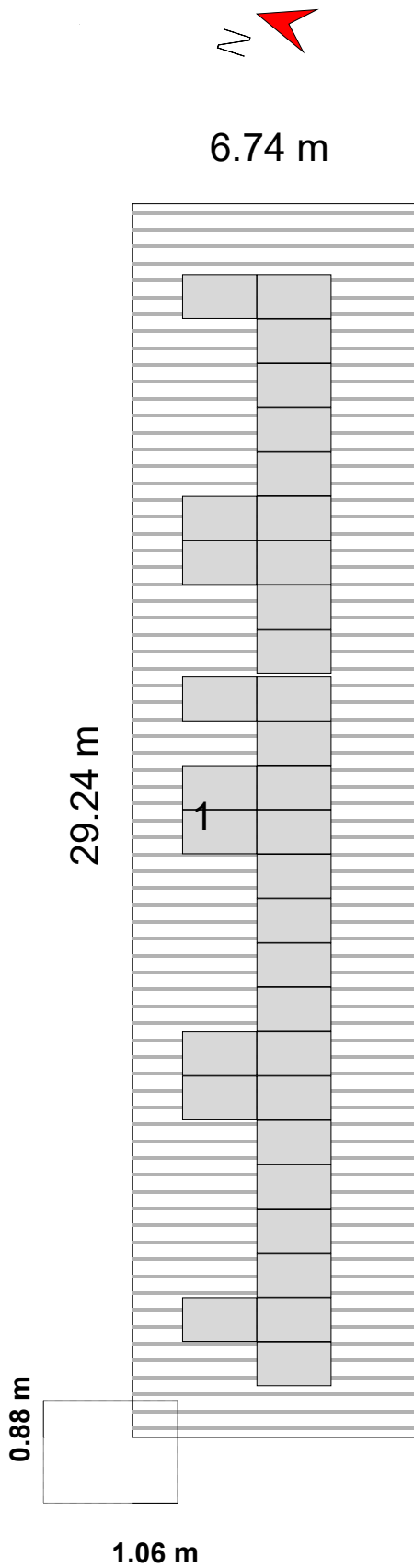
FASTENER SPACING

Module	Array	Distance
1	field area	0.80 m
1	ridge	0.80 m
1	corner region (eave)	0.40 m
1	eaves	0.40 m

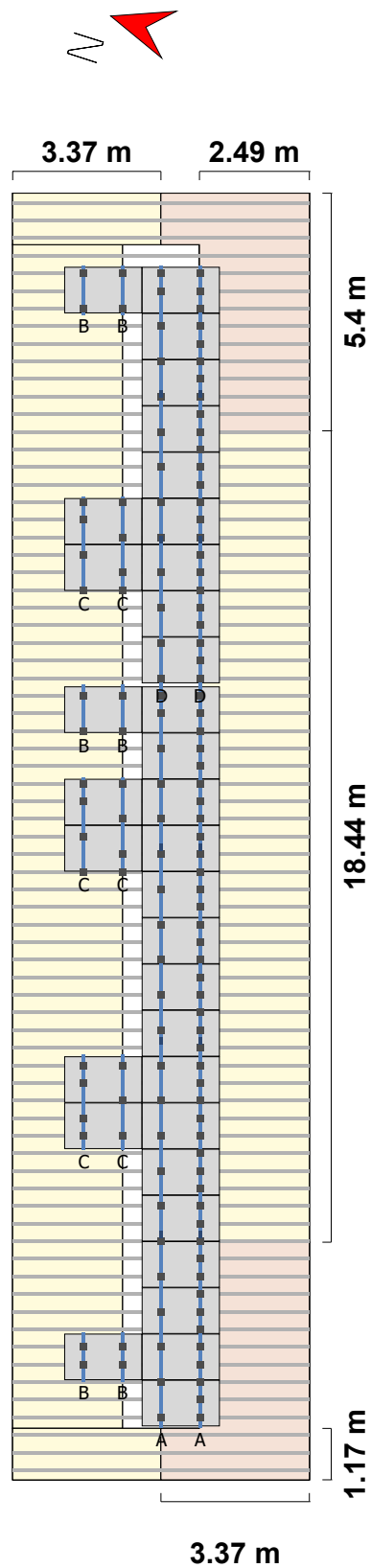
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	26.34	3.52	25	2

ASSEMBLY PLAN - OVERVIEW (ROOF 1)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 1)





RESULTS (ROOF 1)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1.82	840.1	379.7	-730.5	59.2	663.7	300.6	-550.8	59.2
ridge	1.82	840.1	379.7	-730.5	59.2	663.7	300.6	-550.8	59.2
corner region (eave)	1.82	976.9	379.7	-958.5	59.2	771.0	300.6	-729.7	59.2
eaves	1.82	976.9	379.7	-839.7	59.2	771.0	300.6	-636.5	59.2

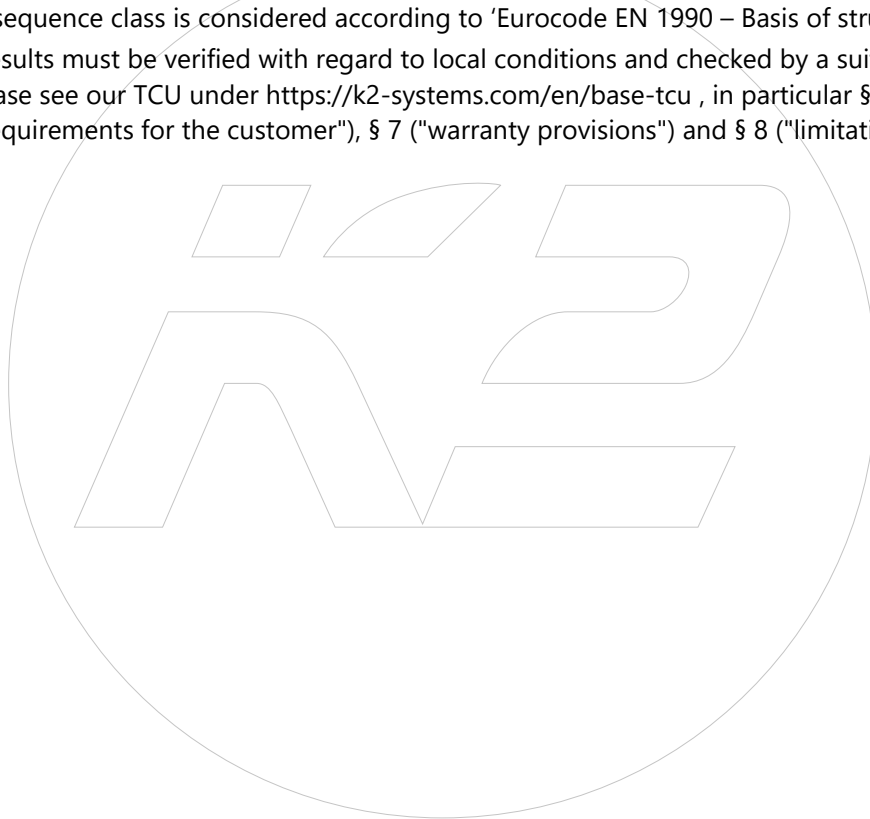
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	20.7	24.1	88.9	11.4	0.800	---	0.513	0.900
1	ridge	20.7	24.1	88.9	11.4	0.800	---	0.513	0.900
1	corner region (eave)	5.8	10.3	51.7	1.7	0.400	---	0.400	0.774
1	eaves	5.8	10.8	51.7	1.7	0.400	---	0.400	0.774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu> , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



STRUCTURAL ANALYSIS REPORT (ROOF 1)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
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Roof covering	Tile
Building height	10.80 m
Roof pitch	30 °
Min. roof edge distance	0.00 m
Rafter Spacing	0.400 m
Batten spacing	340.0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46.48 km
distance inside town terrain	10.50 km
Peak velocity pressure	$q_{p,50} = 0.647 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0.921$
Peak velocity pressure	$q_{p,25} = 0.596 \text{ kN/m}^2$

ROOF AREAS

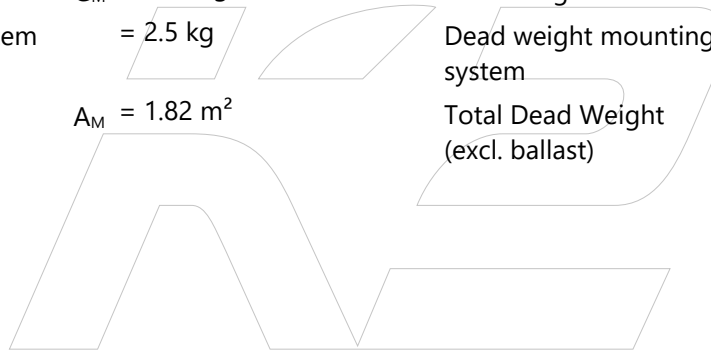
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10.00	0.400	-0.800	0.238	-0.477
ridge	10.00	0.400	-0.800	0.238	-0.477
corner region (eave)	10.00	0.700	-1.100	0.417	-0.656
eaves	10.00	0.700	-0.800	0.417	-0.477

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0.500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1.200$
Factor for roof pitch	$d_i = 0.000$
Snow load on roof	$s_{i,50} = 0.000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0.929$
Snow load on roof	$s_{i,25} = 0.483 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19.5 \text{ kg}$	Dead weight module	$= 10.70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2.5 \text{ kg}$	Dead weight mounting system	$= 1.37 \text{ kg/m}^2$
Module area	$A_M = 1.82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0.12 \text{ kN/m}^2$



LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1.35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1.00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1.10
Partial safety factor stabilising permanent load	$\gamma_{G,stb}$	0.90
Partial safety factor first variable load	γ_Q	1.50
Partial safety factor variable loads	γ_Q	1.50
Combination coefficient with regards to wind	$\psi_{0,W}$	0.60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0.20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0.50
Importance factor variable	$\kappa_{FI,Q}$	0.85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind	$\psi_{0,W}$	0.60
Combination coefficient with regards to Snow	$\psi_{0,S}$	0.50
Load case combination 00:		
Load case combination 01:	$E_d = G_k + S_{i,n}$	
Load case combination 02:	$E_d = G_k + W_{k,Pressure}$	
Load case combination 03:	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$	
Load case combination 04:	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$	
Load case combination 06:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10.00	0.840	0.380	-0.506	0.059	0.664	0.301	-0.374	0.059
ridge	10.00	0.840	0.380	-0.506	0.059	0.664	0.301	-0.374	0.059
corner region (eave)	10.00	0.977	0.380	-0.734	0.059	0.771	0.301	-0.553	0.059
eaves	10.00	0.977	0.380	-0.506	0.059	0.771	0.301	-0.374	0.059

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10.00	0.649	0.293	-0.390	0.046	0.513	0.232	-0.289	0.046
ridge	10.00	0.649	0.293	-0.390	0.046	0.513	0.232	-0.289	0.046
corner region (eave)	10.00	0.377	0.147	-0.283	0.023	0.298	0.116	-0.214	0.023
eaves	10.00	0.377	0.147	-0.195	0.023	0.298	0.116	-0.145	0.023

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1	K2 SolidRail UltraLight 32	2.610	2.59	5.54	1.57	2.84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1	SolidHook Flat Tile H33/119 75x4	0.81	0.73	2.00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		Cl Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	20.7	24.1	88.9	11.4	0.800	---	0.513	0.900
1	ridge	20.7	24.1	88.9	11.4	0.800	---	0.513	0.900
1	corner region (eave)	5.8	10.3	51.7	1.7	0.400	---	0.400	0.774
1	eaves	5.8	10.8	51.7	1.7	0.400	---	0.400	0.774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 1)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	136	135,6 kg
2	1000041	T-Bolt 28/15 M10x30	136	3,9 kg
3	1000042	Hexagon flange nut M10	136	1,5 kg
4	2004112	Heco-Topix Plus wood screw 8x100	272	7,3 kg
5	1005158	MiddleClamp XS Black Set 34-38	52	3,6 kg
6	1005268	EndClamp Black Set 34-36	32	2,4 kg
7	2002870	K2 Solar Cable Manager	34	0,1 kg
8	2003229	SolidRail UltraLight; 4.40 m	8	24,7 kg
9	2003228	SolidRail UltraLight; 3.30 m	18	41,6 kg
10	1004107	SolidRail UltraLight+Light RailConnector Set	10	2,3 kg
Total				222,9 kg



PROJECT DATA (ROOF 2)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	30 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	27
Name	LR4-60HPH-375M	Total output power	10,125 kWp

Dimensions LxWxH	1755 x 1038 x 35,00 mm
Weight	19,5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 2)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity 4,40 m	Quantity 3,30 m	Part of Rail / m	Length / m	Rest / m
A	16,883	3		4,400	3,683	0,707
B	2,169			3,300	2,169	1,121
C	1,118			3,300	1,118	2,172
D	4,271			4,400	4,271	0,119

LEGEND

0,88



Distance to Roof Edge [m]



Fastener

Rail connector base rail



Base rails

FASTENER SPACING

Module	Array	Distance
1	field area	0,80 m
1	ridge	0,80 m
1	gableboard	0,80 m
1	corner region (eave)	0,40 m
1	eaves	0,40 m

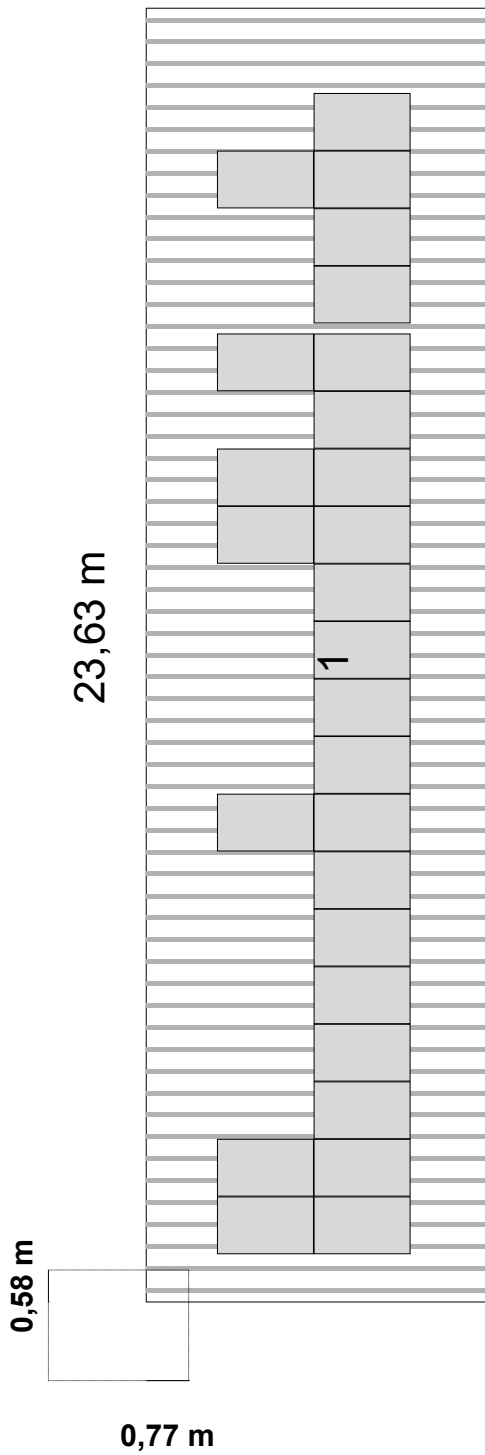
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	21,19	3,52	20	2

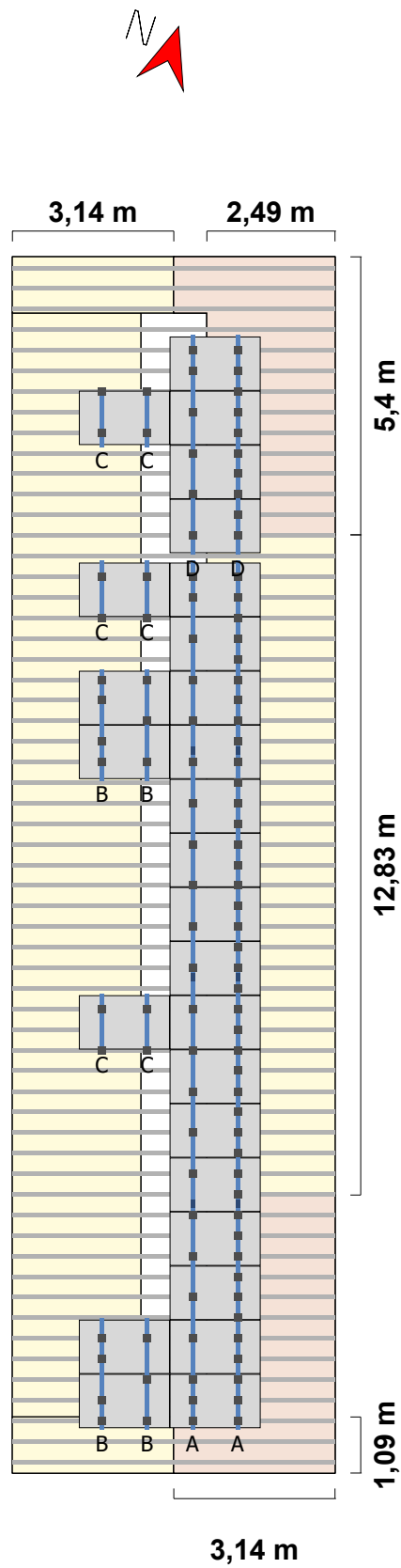
ASSEMBLY PLAN - OVERVIEW (ROOF 2)



6,28 m



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 2)





RESULTS (ROOF 2)

COMPONENTS

Fastener SolidHook Flat Tile H33/119 75x4

Base Rails K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1,82	840,1	379,7	-730,5	59,2	663,7	300,6	-550,8	59,2
ridge	1,82	840,1	379,7	-730,5	59,2	663,7	300,6	-550,8	59,2
gableboard	1,82	840,1	379,7	-1299,0	59,2	663,7	300,6	-996,7	59,2
corner region (eave)	1,82	976,9	379,7	-958,5	59,2	771,0	300,6	-729,7	59,2
eaves	1,82	976,9	379,7	-839,7	59,2	771,0	300,6	-636,5	59,2

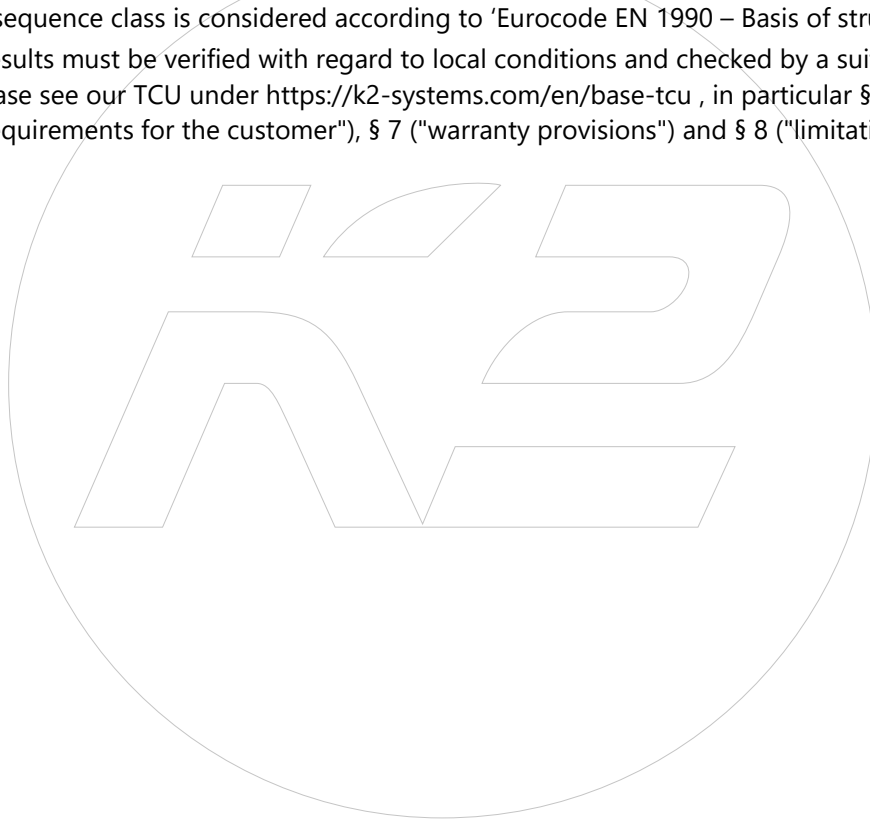
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No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	20,7	25,0	88,9	11,4	0,800	---	0,513	0,900
1	ridge	20,7	25,0	88,9	11,4	0,800	---	0,513	0,900
1	gableboard	20,7	4,9	91,7	12,3	0,800	---	0,503	0,873
1	corner region (eave)	5,8	16,1	51,7	1,7	0,400	---	0,400	0,774
1	eaves	5,8	25,5	51,7	1,7	0,400	---	0,400	0,774

Pr Profile
 Fst Fastener
 σ Tension
 f Deflection
 F Force
 CL/Lmax [m] maximum cantilever length
 Fst Dmax [m] maximum fastener spacing
 BR Base Rail
 UR Upper rail
 Usab. serviceability limit state
 Cl Cantilever

NOTES

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Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

ROOF AREAS

Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10,00	0,400	-0,800	0,238	-0,477
ridge	10,00	0,400	-0,800	0,238	-0,477
gableboard	10,00	0,400	-1,400	0,238	-0,835
corner region (eave)	10,00	0,700	-1,100	0,417	-0,656
eaves	10,00	0,700	-0,800	0,417	-0,477

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1,200$
Factor for roof pitch	$d_i = 0,000$
Snow load on roof	$s_{i,50} = 0,000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0,929$
Snow load on roof	$s_{i,25} = 0,483 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2,5 \text{ kg}$	Dead weight mounting system	$= 1,37 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,12 \text{ kN/m}^2$

LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stb}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Load case combination 00:		
Load case combination 01:	$E_d = G_k + S_{i,n}$	
Load case combination 02:	$E_d = G_k + W_{k,Pressure}$	
Load case combination 03:	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$	
Load case combination 04:	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$	
Load case combination 06:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,840	0,380	-0,506	0,059	0,664	0,301	-0,374	0,059
ridge	10,00	0,840	0,380	-0,506	0,059	0,664	0,301	-0,374	0,059
gableboard	10,00	0,840	0,380	-0,962	0,059	0,664	0,301	-0,732	0,059
corner region (eave)	10,00	0,977	0,380	-0,734	0,059	0,771	0,301	-0,553	0,059
eaves	10,00	0,977	0,380	-0,506	0,059	0,771	0,301	-0,374	0,059

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,649	0,293	-0,390	0,046	0,513	0,232	-0,289	0,046
ridge	10,00	0,649	0,293	-0,390	0,046	0,513	0,232	-0,289	0,046
gableboard	10,00	0,649	0,293	-0,743	0,046	0,513	0,232	-0,565	0,046
corner region (eave)	10,00	0,377	0,147	-0,283	0,023	0,298	0,116	-0,214	0,023
eaves	10,00	0,377	0,147	-0,195	0,023	0,298	0,116	-0,145	0,023

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1	K2 SolidRail UltraLight 32	2,610	2,59	5,54	1,57	2,84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1	SolidHook Flat Tile H33/119 75x4	0,81	0,73	2,00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	20,7	25,0	88,9	11,4	0,800	---	0,513	0,900
1	ridge	20,7	25,0	88,9	11,4	0,800	---	0,513	0,900
1	gableboard	20,7	4,9	91,7	12,3	0,800	---	0,503	0,873
1	corner region (eave)	5,8	16,1	51,7	1,7	0,400	---	0,400	0,774
1	eaves	5,8	25,5	51,7	1,7	0,400	---	0,400	0,774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 2)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	107	106,7 kg
2	1000041	T-Bolt 28/15 M10x30	107	3,1 kg
3	1000042	Hexagon flange nut M10	107	1,2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	214	5,8 kg
5	1005158	MiddleClamp XS Black Set 34-38	40	2,8 kg
6	1005268	EndClamp Black Set 34-36	28	2,1 kg
7	2002870	K2 Solar Cable Manager	27	0,1 kg
8	2003229	SolidRail UltraLight; 4.40 m	10	30,8 kg
9	2003228	SolidRail UltraLight; 3.30 m	10	23,1 kg
10	1004107	SolidRail UltraLight+Light RailConnector Set	6	1,4 kg

Total

177,1 kg



PROJECT DATA (ROOF 3)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	30 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	34
Name	LR4-60HPH-375M	Total output power	12,750 kWp

Dimensions LxWxH	1755 x 1038 x 35,00 mm
Weight	19,5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 3)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity 4,40 m	Quantity 3,30 m	Part of Rail / m	Length / m	Rest / m
A	16,883	3		4,400	3,683	0,707
B	2,169			3,300	2,169	1,121
C	1,118			3,300	1,118	2,172
D	4,271			4,400	4,271	0,119
E	3,220			3,300	3,220	0,070

LEGEND

1,56



Distance to Roof Edge [m]

Fastener

Rail connector base rail

Base rails

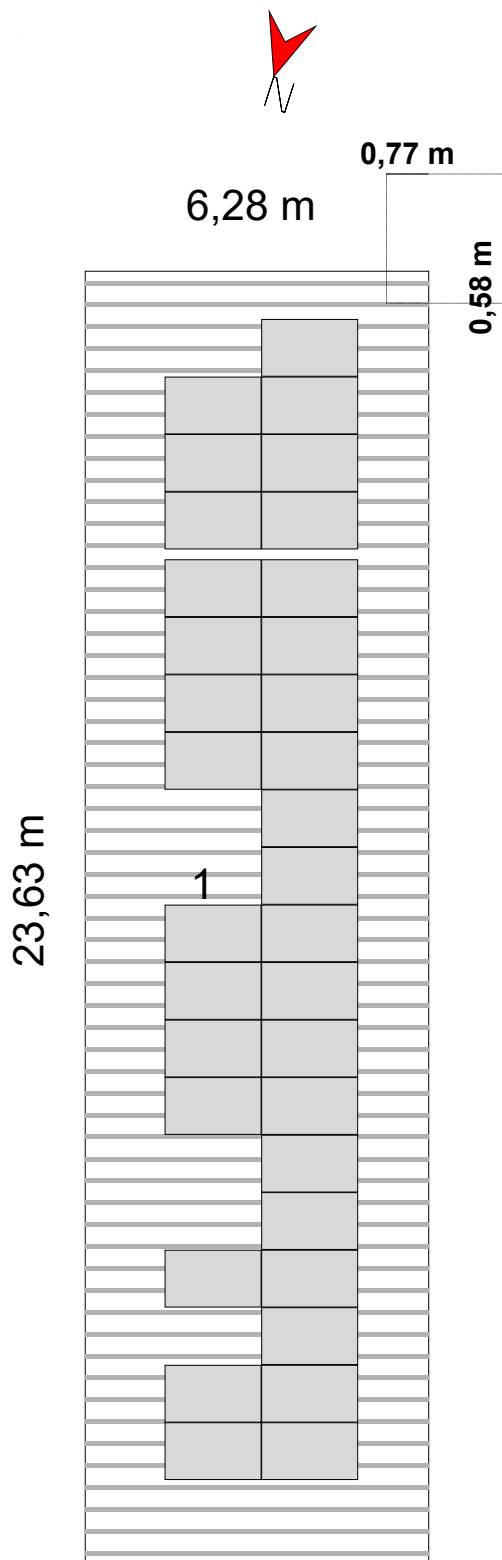
FASTENER SPACING

Module	Array	Distance
1	field area	0,80 m
1	ridge	0,80 m
1	corner region (eave)	0,40 m
1	eaves	0,40 m

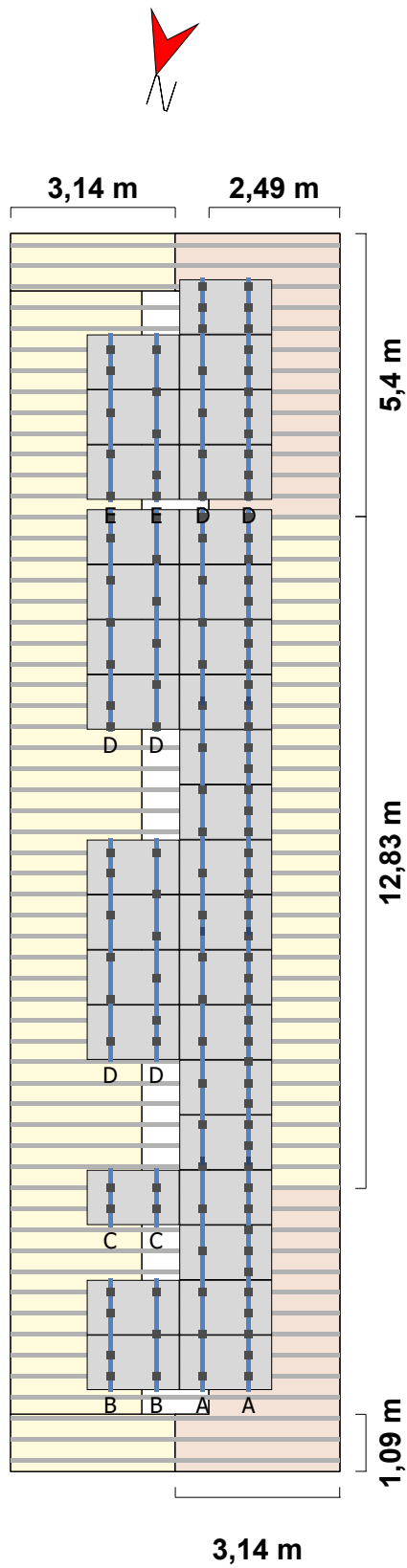
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	21,19	3,52	20	2

ASSEMBLY PLAN - OVERVIEW (ROOF 3)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 3)





RESULTS (ROOF 3)

COMPONENTS

Fastener	SolidHook Flat Tile H33/119 75x4
Base Rails	K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1,82	840,1	379,7	-730,5	59,2	663,7	300,6	-550,8	59,2
ridge	1,82	840,1	379,7	-730,5	59,2	663,7	300,6	-550,8	59,2
corner region (eave)	1,82	976,9	379,7	-958,5	59,2	771,0	300,6	-729,7	59,2
eaves	1,82	976,9	379,7	-839,7	59,2	771,0	300,6	-636,5	59,2

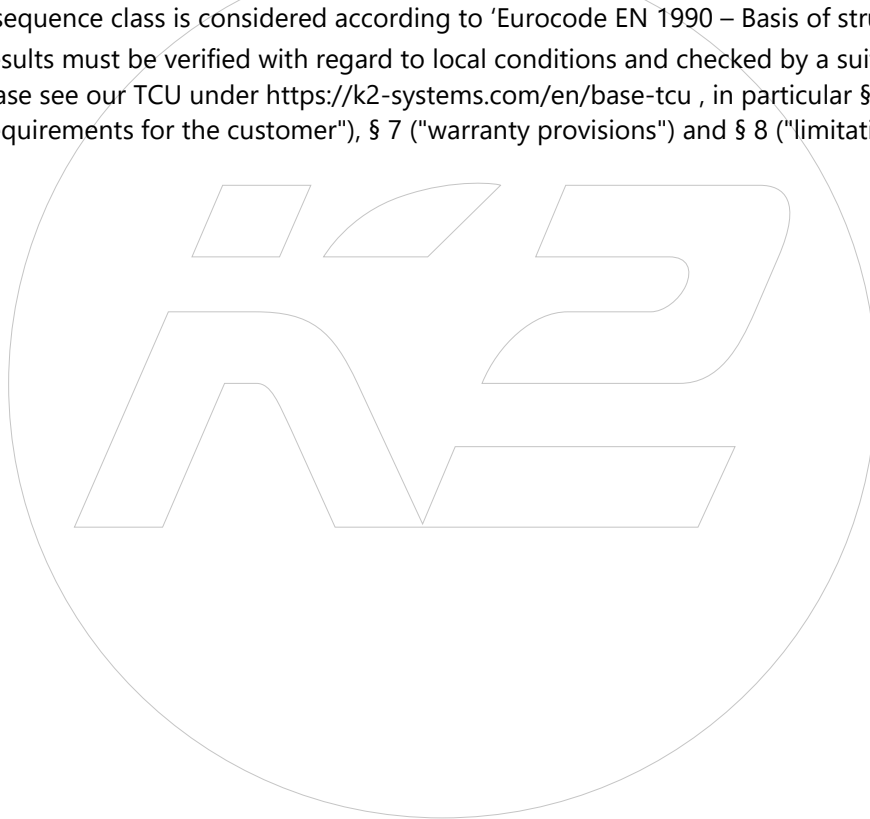
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	20,7	24,8	88,9	11,4	0,800	---	0,513	0,900
1	ridge	20,7	24,8	88,9	11,4	0,800	---	0,513	0,900
1	corner region (eave)	5,8	16,1	51,7	1,7	0,400	---	0,400	0,774
1	eaves	5,8	0,0	51,7	1,7	0,400	---	0,400	0,774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu> , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



STRUCTURAL ANALYSIS REPORT (ROOF 3)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	30 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,50} = 0,647 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0,921$
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

ROOF AREAS

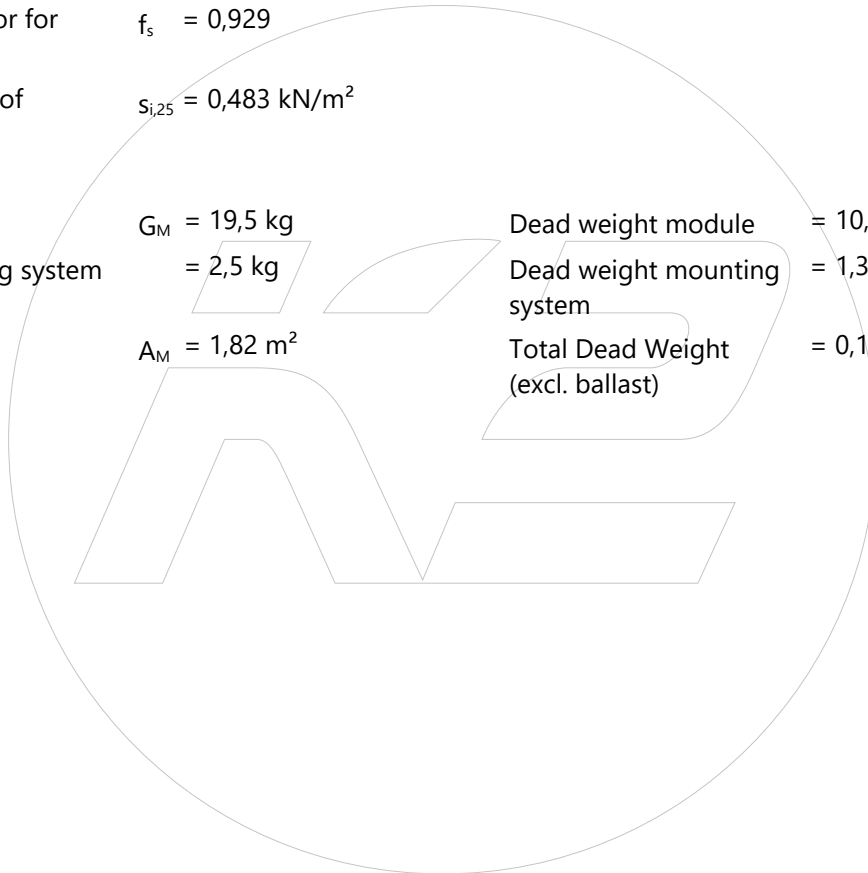
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10,00	0,400	-0,800	0,238	-0,477
ridge	10,00	0,400	-0,800	0,238	-0,477
corner region (eave)	10,00	0,700	-1,100	0,417	-0,656
eaves	10,00	0,700	-0,800	0,417	-0,477

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1,200$
Factor for roof pitch	$d_i = 0,000$
Snow load on roof	$s_{i,50} = 0,000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0,929$
Snow load on roof	$s_{i,25} = 0,483 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2,5 \text{ kg}$	Dead weight mounting system	$= 1,37 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,12 \text{ kN/m}^2$



LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stb}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Load case combination 00:		
Load case combination 01:	$E_d = G_k + S_{i,n}$	
Load case combination 02:	$E_d = G_k + W_{k,Pressure}$	
Load case combination 03:	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$	
Load case combination 04:	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$	
Load case combination 06:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,840	0,380	-0,506	0,059	0,664	0,301	-0,374	0,059
ridge	10,00	0,840	0,380	-0,506	0,059	0,664	0,301	-0,374	0,059
corner region (eave)	10,00	0,977	0,380	-0,734	0,059	0,771	0,301	-0,553	0,059
eaves	10,00	0,977	0,380	-0,506	0,059	0,771	0,301	-0,374	0,059

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,649	0,293	-0,390	0,046	0,513	0,232	-0,289	0,046
ridge	10,00	0,649	0,293	-0,390	0,046	0,513	0,232	-0,289	0,046
corner region (eave)	10,00	0,377	0,147	-0,283	0,023	0,298	0,116	-0,214	0,023
eaves	10,00	0,377	0,147	-0,195	0,023	0,298	0,116	-0,145	0,023

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1	K2 SolidRail UltraLight 32	2,610	2,59	5,54	1,57	2,84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1	SolidHook Flat Tile H33/119 75x4	0,81	0,73	2,00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	20,7	24,8	88,9	11,4	0,800	---	0,513	0,900
1	ridge	20,7	24,8	88,9	11,4	0,800	---	0,513	0,900
1	corner region (eave)	5,8	16,1	51,7	1,7	0,400	---	0,400	0,774
1	eaves	5,8	0,0	51,7	1,7	0,400	---	0,400	0,774

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 3)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	128	127,6 kg
2	1000041	T-Bolt 28/15 M10x30	128	3,7 kg
3	1000042	Hexagon flange nut M10	128	1,4 kg
4	2004112	Heco-Topix Plus wood screw 8x100	256	6,9 kg
5	1005158	MiddleClamp XS Black Set 34-38	54	3,8 kg
6	1005268	EndClamp Black Set 34-36	28	2,1 kg
7	2002870	K2 Solar Cable Manager	34	0,1 kg
8	2003229	SolidRail UltraLight; 4.40 m	14	43,1 kg
9	2003228	SolidRail UltraLight; 3.30 m	6	13,9 kg
10	1004107	SolidRail UltraLight+Light RailConnector Set	6	1,4 kg

Total

204,0 kg



PROJECT DATA (ROOF 4)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	35 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2,250 kWp

Dimensions LxWxH	1755 x 1038 x 35,00 mm
Weight	19,5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 4)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity 4,40 m	Quantity 3,30 m	Part of Rail / m	Length / m	Rest / m
A	2,169			3,300	2,169	1,121
B	4,271			4,400	4,271	0,119

LEGEND

1,45	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

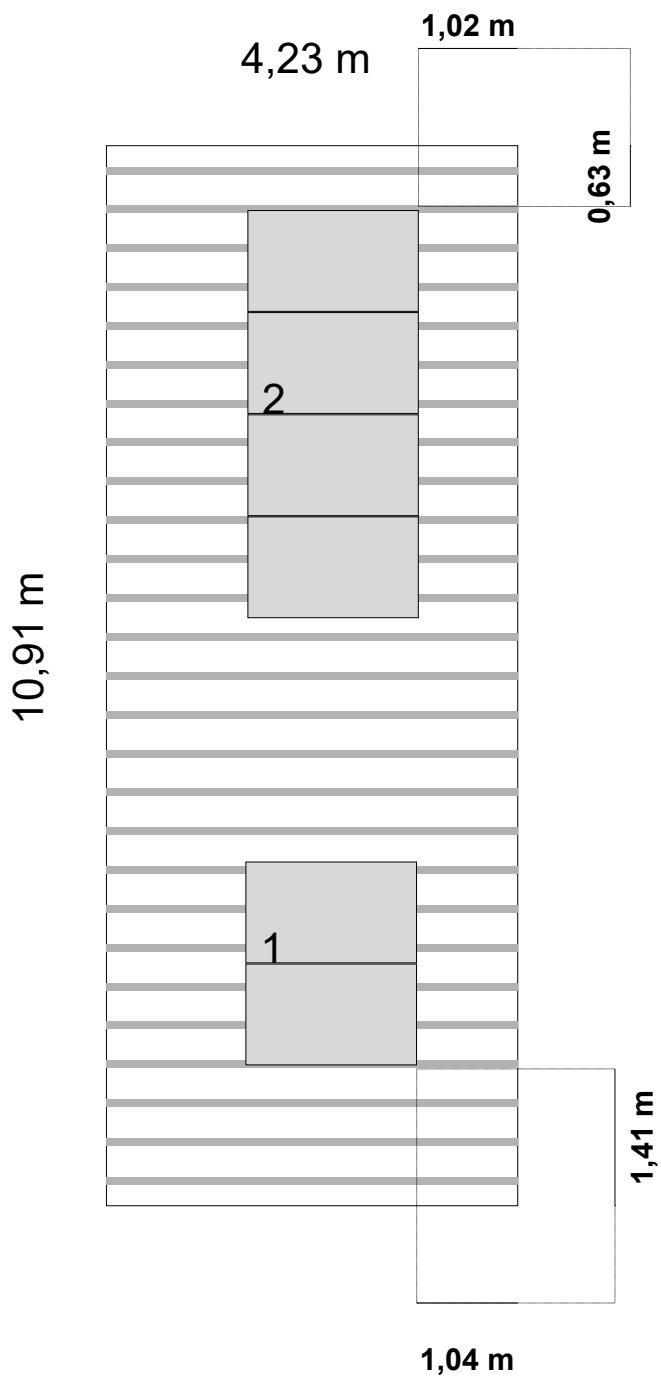
FASTENER SPACING

Module	Array	Distance
1	field area	0,80 m
1	corner region (eave)	0,80 m
1	eaves	0,80 m
2	field area	0,80 m
2	gableboard	0,80 m
2	corner region (eave)	0,80 m
2	eaves	0,80 m

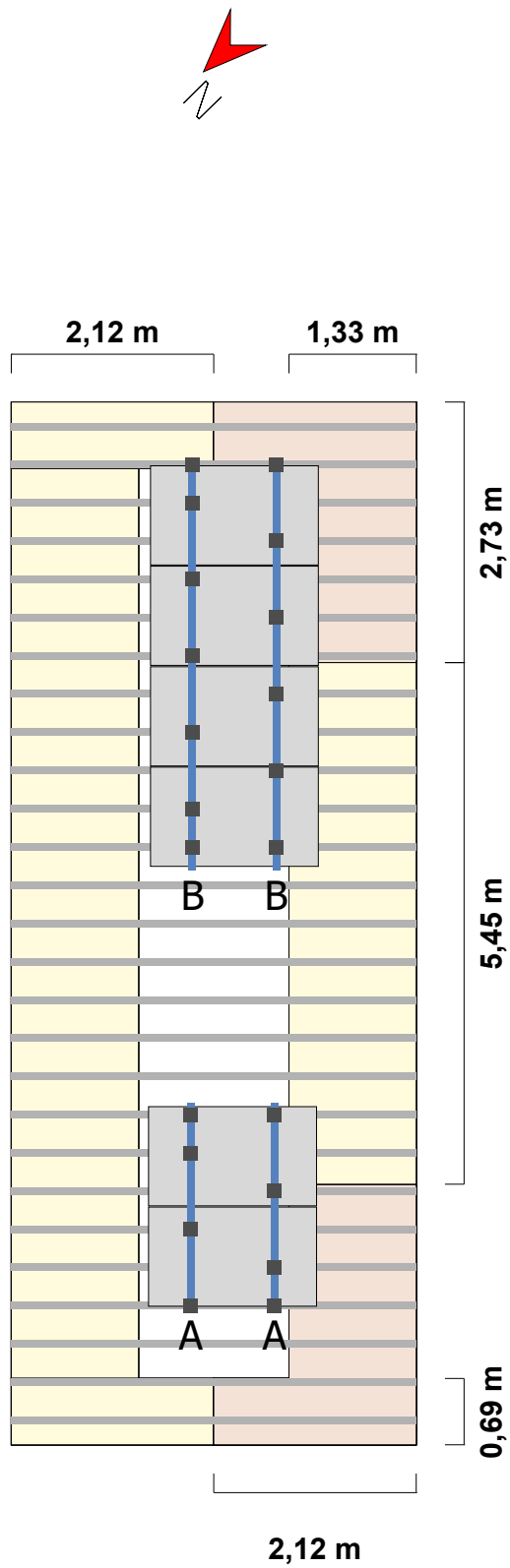
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	2,09	1,76	2	1
2	4,19	1,76	4	1

ASSEMBLY PLAN - OVERVIEW (ROOF 4)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 4)





RESULTS (ROOF 4)

COMPONENTS

Fastener SolidHook Flat Tile H33/119 75x4

Base Rails K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1,82	728,1	360,8	-742,6	67,9	575,6	286,2	-561,5	67,9
corner region (eave)	1,82	848,7	360,8	-964,1	67,9	670,2	286,2	-735,2	67,9
eaves	1,82	848,7	360,8	-742,6	67,9	670,2	286,2	-561,5	67,9
gableboard	1,82	728,1	360,8	-1304,6	67,9	575,6	286,2	-1002,3	67,9

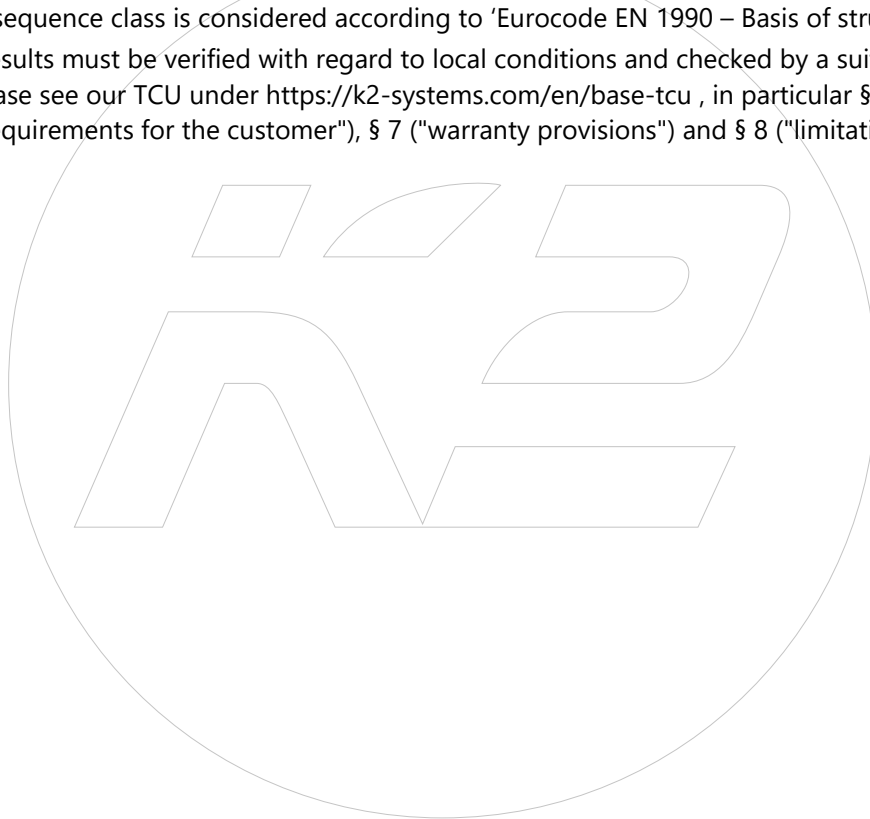
UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	18,2	2,2	77,0	10,0	0,800	---	0,533	1,039
1	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
1	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	field area	18,2	8,5	77,0	10,0	0,800	---	0,533	1,039
2	gableboard	19,8	0,0	92,2	12,4	0,800	---	0,502	0,868
2	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891

Pr Profile
 Fst Fastener
 σ Tension
 f Deflection
 F Force
 CL/Lmax [m] maximum cantilever length
 Fst Dmax [m] maximum fastener spacing
 BR Base Rail
 UR Upper rail
 Usab. serviceability limit state
 Cl Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu> , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



STRUCTURAL ANALYSIS REPORT (ROOF 4)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	35 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

WIND LOAD

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,50} = 0,647 \text{ kN/m}^2$
Adjustment factor for service life	$f_w = 0,921$
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

ROOF AREAS

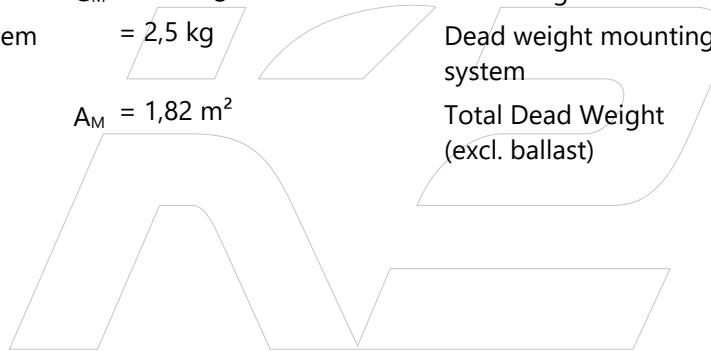
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10,00	0,467	-0,833	0,278	-0,497
corner region (eave)	10,00	0,700	-1,100	0,417	-0,656
eaves	10,00	0,700	-0,833	0,417	-0,497
gableboard	10,00	0,467	-1,400	0,278	-0,835

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1,000$
Factor for roof pitch	$d_i = 0,000$
Snow load on roof	$s_{i,50} = 0,000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0,929$
Snow load on roof	$s_{i,25} = 0,380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2,5 \text{ kg}$	Dead weight mounting system	$= 1,37 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,12 \text{ kN/m}^2$



LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stb}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Load case combination 00:		
Load case combination 01:	$E_d = G_k + S_{i,n}$	
Load case combination 02:	$E_d = G_k + W_{k,Pressure}$	
Load case combination 03:	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$	
Load case combination 04:	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$	
Load case combination 06:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,728	0,361	-0,536	0,068	0,576	0,286	-0,400	0,068
corner region (eave)	10,00	0,849	0,361	-0,739	0,068	0,670	0,286	-0,559	0,068
eaves	10,00	0,849	0,361	-0,536	0,068	0,670	0,286	-0,400	0,068
gableboard	10,00	0,728	0,361	-0,967	0,068	0,576	0,286	-0,738	0,068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,562	0,279	-0,414	0,052	0,445	0,221	-0,309	0,052
corner region (eave)	10,00	0,655	0,279	-0,571	0,052	0,518	0,221	-0,432	0,052
eaves	10,00	0,655	0,279	-0,414	0,052	0,518	0,221	-0,309	0,052
gableboard	10,00	0,562	0,279	-0,747	0,052	0,445	0,221	-0,570	0,052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2,610	2,59	5,54	1,57	2,84

FASTENER

No. Module Array	Fastener	R _{D,Suction, Perpendicular} [kN]	R _{D,Pressure, Perpendicular} [kN]	R _{D,Pressure, Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0,81	0,73	2,00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances			Fst Fst Dmax[m]
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	
1	field area	18,2	2,2	77,0	10,0	0,800	---	0,533	1,039
1	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
1	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	field area	18,2	8,5	77,0	10,0	0,800	---	0,533	1,039
2	gableboard	19,8	0,0	92,2	12,4	0,800	---	0,502	0,868
2	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
Cl	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 4)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	21	20,9 kg
2	1000041	T-Bolt 28/15 M10x30	21	0,6 kg
3	1000042	Hexagon flange nut M10	21	0,2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	42	1,1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0,6 kg
6	1005268	EndClamp Black Set 34-36	8	0,6 kg
7	2002870	K2 Solar Cable Manager	6	0,0 kg
8	2003229	SolidRail UltraLight; 4.40 m	2	6,2 kg
9	2003228	SolidRail UltraLight; 3.30 m	2	4,6 kg
Total				34,8 kg



PROJECT DATA (ROOF 5)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	35 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2,250 kWp

Dimensions LxWxH	1755 x 1038 x 35,00 mm
Weight	19,5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 5)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity	Quantity	Part of Rail / m	Length / m	Rest / m
A	3,220	4,40 m	3,30 m	3,300	3,220	0,070

LEGEND

0,95	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

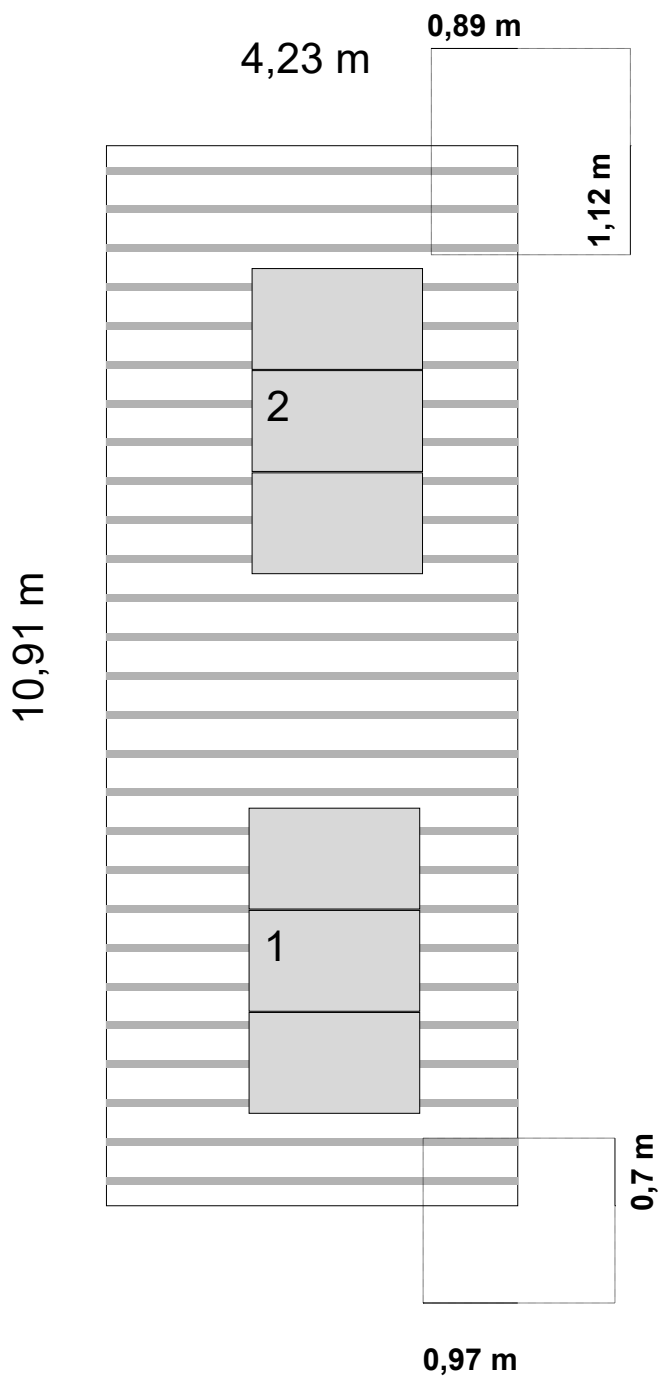
FASTENER SPACING

Module	Array	Distance
1	field area	0,80 m
1	corner region (eave)	0,80 m
1	eaves	0,80 m
2	field area	0,80 m
2	corner region (eave)	0,80 m
2	eaves	0,80 m

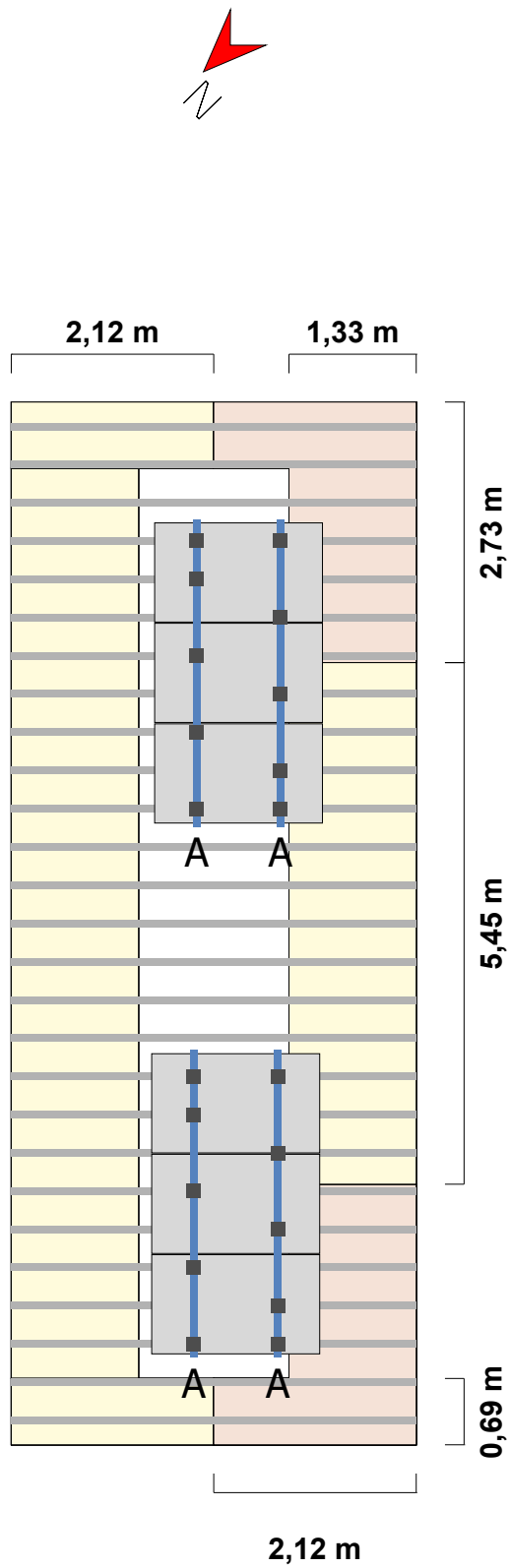
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	3,14	1,76	3	1
2	3,14	1,76	3	1

ASSEMBLY PLAN - OVERVIEW (ROOF 5)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 5)





RESULTS (ROOF 5)

COMPONENTS

Fastener SolidHook Flat Tile H33/119 75x4

Base Rails K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1,82	728,1	360,8	-742,6	67,9	575,6	286,2	-561,5	67,9
corner region (eave)	1,82	848,7	360,8	-964,1	67,9	670,2	286,2	-735,2	67,9
eaves	1,82	848,7	360,8	-742,6	67,9	670,2	286,2	-561,5	67,9

UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	18,2	10,9	77,0	10,0	0,800	---	0,533	1,039
1	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
1	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	field area	18,2	7,6	77,0	10,0	0,800	---	0,533	1,039
2	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891

Pr

Fst

σ

f

F

CL/Lmax [m]

Fst Dmax [m]

BR

UR

Usab.

Cl

Profile

Fastener

Tension

Deflection

Force

maximum cantilever length

maximum fastener spacing

Base Rail

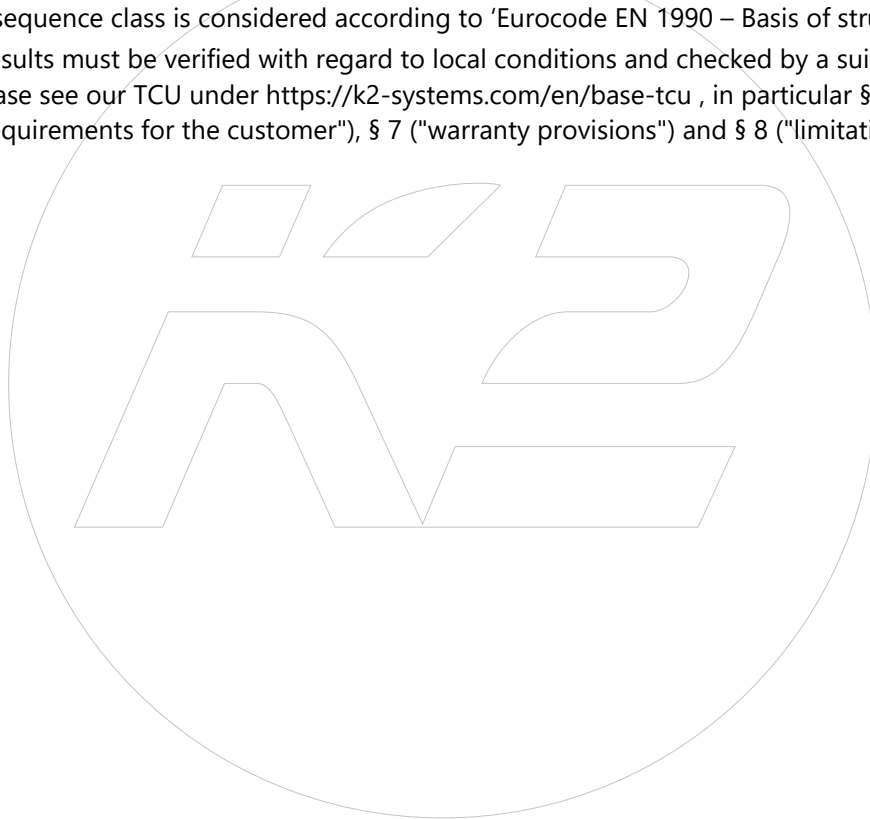
Upper rail

serviceability limit state

Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu> , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



STRUCTURAL ANALYSIS REPORT (ROOF 5)

GENERAL INFORMATION

Name Naylor Hall
 Mounting System SolidRail
 Customer Cor Energy
 Author Hugo Silva

LOCATION

Address 6 Old Birley St, Hulme,
 Manchester M15 5RG, UK
 Ground elevation 36,38 m
 Roof type Gable roof
 Fastening method Roof construction
 Roof covering Tile
 Building height 10,80 m
 Roof pitch 35 °
 Min. roof edge distance 0,00 m
 Rafter Spacing 0,400 m
 Batten spacing 340,0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

Terrain category Town Terrain
 distance to shoreline 46,48 km
 distance inside town terrain 10,50 km
 Peak velocity pressure $q_{p,50} = 0,647 \text{ kN/m}^2$
 Adjustment factor for service life $f_w = 0,921$
 Peak velocity pressure $q_{p,25} = 0,596 \text{ kN/m}^2$

ROOF AREAS

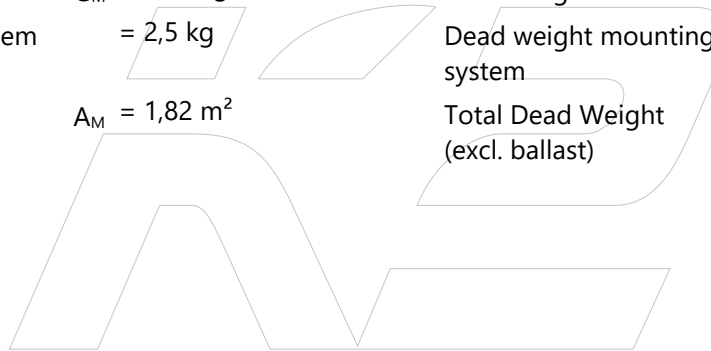
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10,00	0,467	-0,833	0,278	-0,497
corner region (eave)	10,00	0,700	-1,100	0,417	-0,656
eaves	10,00	0,700	-0,833	0,417	-0,497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1,000$
Factor for roof pitch	$d_i = 0,000$
Snow load on roof	$s_{i,50} = 0,000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0,929$
Snow load on roof	$s_{i,25} = 0,380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2,5 \text{ kg}$	Dead weight mounting system	$= 1,37 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,12 \text{ kN/m}^2$



LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stb}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Load case combination 00:		
Load case combination 01:	$E_d = G_k + S_{i,n}$	
Load case combination 02:	$E_d = G_k + W_{k,Pressure}$	
Load case combination 03:	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$	
Load case combination 04:	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$	
Load case combination 06:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,728	0,361	-0,536	0,068	0,576	0,286	-0,400	0,068
corner region (eave)	10,00	0,849	0,361	-0,739	0,068	0,670	0,286	-0,559	0,068
eaves	10,00	0,849	0,361	-0,536	0,068	0,670	0,286	-0,400	0,068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,562	0,279	-0,414	0,052	0,445	0,221	-0,309	0,052
corner region (eave)	10,00	0,655	0,279	-0,571	0,052	0,518	0,221	-0,432	0,052
eaves	10,00	0,655	0,279	-0,414	0,052	0,518	0,221	-0,309	0,052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2,610	2,59	5,54	1,57	2,84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0,81	0,73	2,00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	18,2	10,9	77,0	10,0	0,800	---	0,533	1,039
1	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
1	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	field area	18,2	7,6	77,0	10,0	0,800	---	0,533	1,039
2	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 5)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19,9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0,6 kg
3	1000042	Hexagon flange nut M10	20	0,2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1,1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0,6 kg
6	1005268	EndClamp Black Set 34-36	8	0,6 kg
7	2002870	K2 Solar Cable Manager	6	0,0 kg
8	2003228	SolidRail UltraLight; 3.30 m	4	9,2 kg

Total

32,2 kg



PROJECT DATA (ROOF 6)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	SolidRail
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Gable roof
Fastening method	Roof construction
Roof covering	Tile
Building height	10,80 m
Roof pitch	35 °
Min. roof edge distance	0,00 m
Rafter Spacing	0,400 m
Batten spacing	340,0 mm
Terrain category	Town Terrain

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category	Town Terrain
distance to shoreline	46,48 km
distance inside town terrain	10,50 km
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$

MODULES

Manufacturer	Longi Solar	Quantity	6
Name	LR4-60HPH-375M	Total output power	2,250 kWp

Mounting systems for solar technology



Dimensions LxWxH	1755 x 1038 x 35,00 mm
Weight	19,5 kg
Output power	375 W



ASSEMBLY PLAN (ROOF 6)

Type	Whole Rails			Rail cutting		
	Total Rail Length / m	Quantity	Quantity	Part of Rail / m	Length / m	Rest / m
A	3,220	4,40 m	3,30 m	3,300	3,220	0,070

LEGEND

0,95	Distance to Roof Edge [m]
■	Fastener
■	Rail connector base rail
■	Base rails

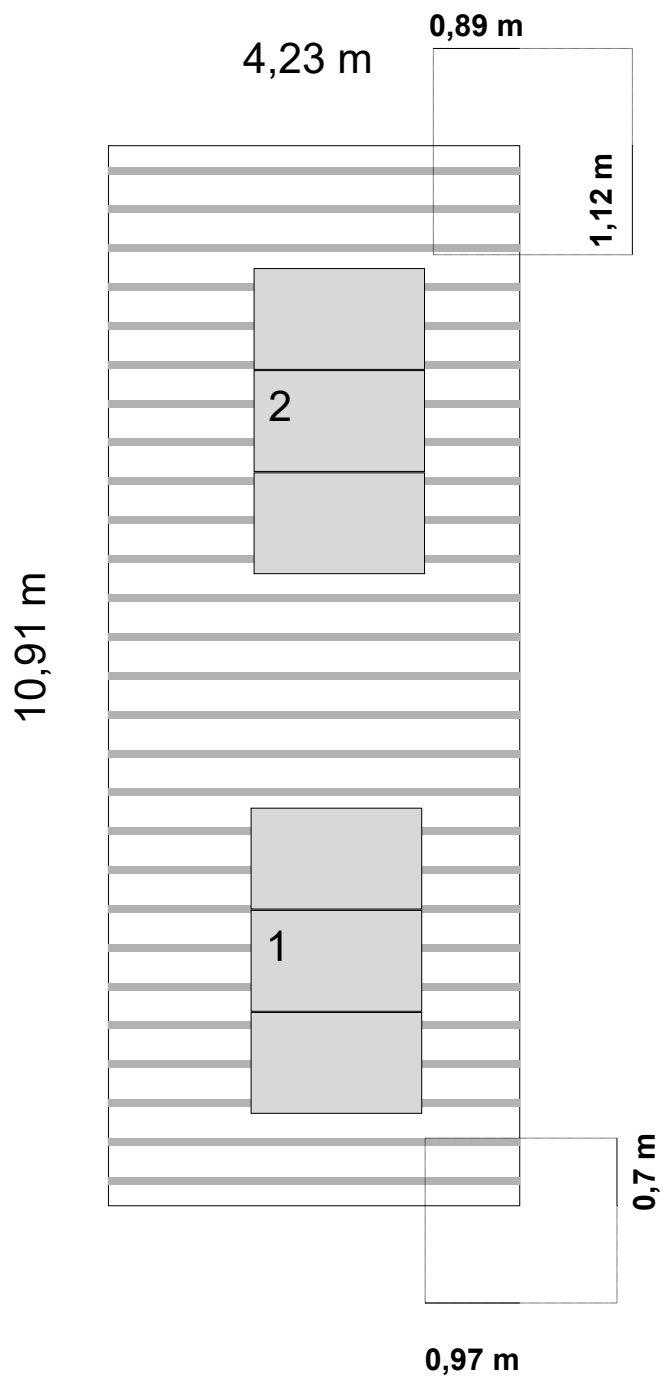
FASTENER SPACING

Module	Array	Distance
1	field area	0,80 m
1	corner region (eave)	0,80 m
1	eaves	0,80 m
2	field area	0,80 m
2	corner region (eave)	0,80 m
2	eaves	0,80 m

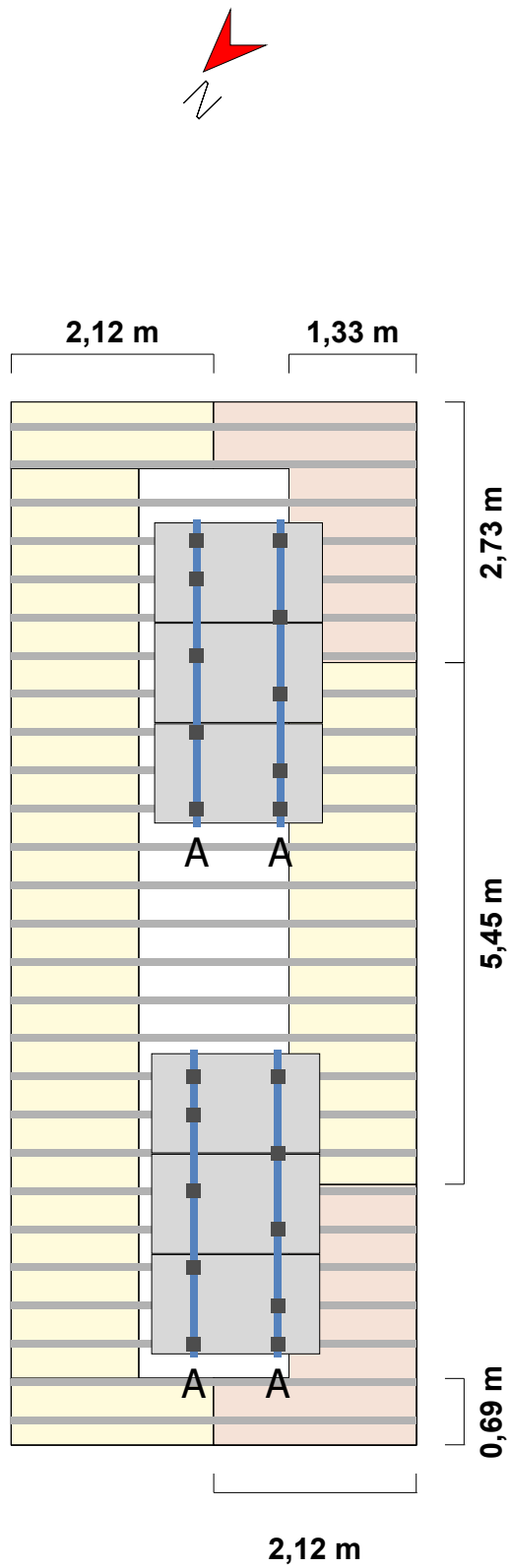
MODULE ARRAYS

Module array	Width [m]	Length [m]	Width in modules	Length in modules
1	3,14	1,76	3	1
2	3,14	1,76	3	1

ASSEMBLY PLAN - OVERVIEW (ROOF 6)



ASSEMBLY PLAN - BASE RAIL LAYER (ROOF 6)





RESULTS (ROOF 6)

COMPONENTS

Fastener SolidHook Flat Tile H33/119 75x4

Base Rails K2 SolidRail UltraLight 32

LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [Pa]				Serviceability [Pa]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	1,82	728,1	360,8	-742,6	67,9	575,6	286,2	-561,5	67,9
corner region (eave)	1,82	848,7	360,8	-964,1	67,9	670,2	286,2	-735,2	67,9
eaves	1,82	848,7	360,8	-742,6	67,9	670,2	286,2	-561,5	67,9

UTILISATION RESULT

No. Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		maximum values	
		Pr σ [%]	Cl σ [%]	Fst F [%]		Fst [m]	BR [m]	Cl Lmax[m]	Fst Dmax[m]
1	field area	18,2	10,9	77,0	10,0	0,800	---	0,533	1,039
1	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
1	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	field area	18,2	7,6	77,0	10,0	0,800	---	0,533	1,039
2	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891

Pr

Fst

σ

f

F

CL/Lmax [m]

Fst Dmax [m]

BR

UR

Usab.

Cl

Profile

Fastener

Tension

Deflection

Force

maximum cantilever length

maximum fastener spacing

Base Rail

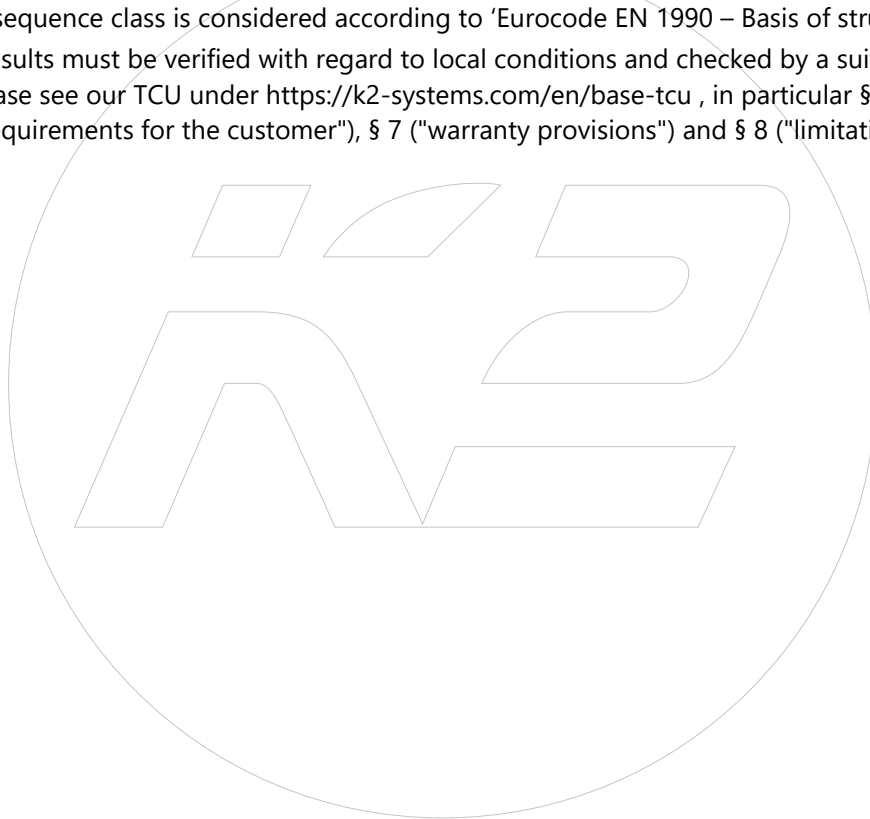
Upper rail

serviceability limit state

Cantilever

NOTES

- The dimensioning of the timber construction screws is not part of this structural analysis. The dimensioning and positioning of the timber construction screws to be used must be carried out in accordance with the respective applicable codes of practice.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu> , in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").



STRUCTURAL ANALYSIS REPORT (ROOF 6)

GENERAL INFORMATION

Name Naylor Hall
 Mounting System SolidRail
 Customer Cor Energy
 Author Hugo Silva

LOCATION

Address 6 Old Birley St, Hulme,
 Manchester M15 5RG, UK
 Ground elevation 36,38 m
 Roof type Gable roof
 Fastening method Roof construction
 Roof covering Tile
 Building height 10,80 m
 Roof pitch 35 °
 Min. roof edge distance 0,00 m
 Rafter Spacing 0,400 m
 Batten spacing 340,0 mm
 Terrain category Town Terrain

LOADS

Design method BS EN
 Failure consequence class CC1
 Design working life 25 years
 (CC)

WIND LOAD

Terrain category Town Terrain
 distance to shoreline 46,48 km
 distance inside town terrain 10,50 km
 Peak velocity pressure $q_{p,50} = 0,647 \text{ kN/m}^2$
 Adjustment factor for service life $f_w = 0,921$
 Peak velocity pressure $q_{p,25} = 0,596 \text{ kN/m}^2$

ROOF AREAS

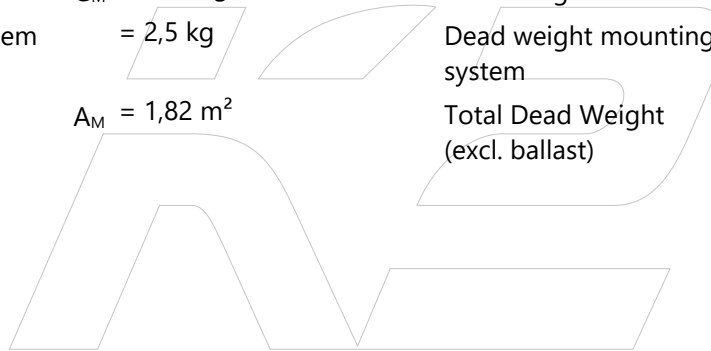
Array	load impact area [m ²]	maxCpe	minCpe	wind pressure [kN/m ²]	wind suction [kN/m ²]
field area	10,00	0,467	-0,833	0,278	-0,497
corner region (eave)	10,00	0,700	-1,100	0,417	-0,656
eaves	10,00	0,700	-0,833	0,417	-0,497

SNOW LOAD

Snow load zone	3
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$
Snow guard	No
Shape Coefficient for Snow	$\mu_i = 1,000$
Factor for roof pitch	$d_i = 0,000$
Snow load on roof	$s_{i,50} = 0,000 \text{ kN/m}^2$
Adjustment factor for service life	$f_s = 0,929$
Snow load on roof	$s_{i,25} = 0,380 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 2,5 \text{ kg}$	Dead weight mounting system	$= 1,37 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,12 \text{ kN/m}^2$



LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stb}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	
Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$	
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$	
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$	
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$	
Load case combination 05:		
Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$	

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Load case combination 00:		
Load case combination 01:	$E_d = G_k + S_{i,n}$	
Load case combination 02:	$E_d = G_k + W_{k,Pressure}$	
Load case combination 03:	$E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$	
Load case combination 04:	$E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$	
Load case combination 06:	$E_d = G_k + W_{k,Suction}$	

MAXIMUM LOADS ON MODULES

Array	A-TrA [m ²]	ultimate state [kN/m ²]				Serviceability [kN/m ²]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,728	0,361	-0,536	0,068	0,576	0,286	-0,400	0,068
corner region (eave)	10,00	0,849	0,361	-0,739	0,068	0,670	0,286	-0,559	0,068
eaves	10,00	0,849	0,361	-0,536	0,068	0,670	0,286	-0,400	0,068

MAX. LOAD ON FASTENER

Array	A-TrA [m ²]	ultimate state [kN]				Serviceability [kN]			
		Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel	Pressure Perpendicular	Pressure Parallel	Suction Perpendicular	Suction Parallel
field area	10,00	0,562	0,279	-0,414	0,052	0,445	0,221	-0,309	0,052
corner region (eave)	10,00	0,655	0,279	-0,571	0,052	0,518	0,221	-0,432	0,052
eaves	10,00	0,655	0,279	-0,414	0,052	0,518	0,221	-0,309	0,052

RESISTANCE VALUES OF COMPONENTS

BASE RAILS

No. Module Array	Base Rails	A [cm ²]	I _y [cm ⁴]	I _z [cm ⁴]	W _y [cm ³]	W _z [cm ³]
1 - 2	K2 SolidRail UltraLight 32	2,610	2,59	5,54	1,57	2,84

FASTENER

No. Module Array	Fastener	R _{D,Suction,Perpendicular} [kN]	R _{D,Pressure,Perpendicular} [kN]	R _{D,Pressure,Parallel} [kN]
1 - 2	SolidHook Flat Tile H33/119 75x4	0,81	0,73	2,00

UTILISATION RESULT

Module Array	roof areas	ultimate limit state			Usab. Pr f [%]	Distances		CL Lmax[m]	Fst Fst Dmax[m]
		Pr σ [%]	CL σ [%]	Fst F [%]		Fst [m]	BR [m]		
1	field area	18,2	10,9	77,0	10,0	0,800	---	0,533	1,039
1	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
1	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	field area	18,2	7,6	77,0	10,0	0,800	---	0,533	1,039
2	corner region (eave)	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891
2	eaves	20,6	0,0	89,8	11,5	0,800	---	0,512	0,891

Pr	Profile
Fst	Fastener
σ	Tension
f	Deflection
F	Force
CL/Lmax [m]	maximum cantilever length
Fst Dmax [m]	maximum fastener spacing
BR	Base Rail
UR	Upper rail
Usab.	serviceability limit state
CL	Cantilever

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 6)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	20	19,9 kg
2	1000041	T-Bolt 28/15 M10x30	20	0,6 kg
3	1000042	Hexagon flange nut M10	20	0,2 kg
4	2004112	Heco-Topix Plus wood screw 8x100	40	1,1 kg
5	1005158	MiddleClamp XS Black Set 34-38	8	0,6 kg
6	1005268	EndClamp Black Set 34-36	8	0,6 kg
7	2002870	K2 Solar Cable Manager	6	0,0 kg
8	2003228	SolidRail UltraLight; 3.30 m	4	9,2 kg

Total

32,2 kg



PROJECT DATA (ROOF 7)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	S-Dome 6.10 Classic
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10,80 m
Parapet wall height	0,10 m
Roof pitch	1 °
Min. roof edge distance	0,60 m
Material	Single ply membrane
Friction coefficient	0,50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46,48 km		
distance inside town terrain	10,50 km		
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$		

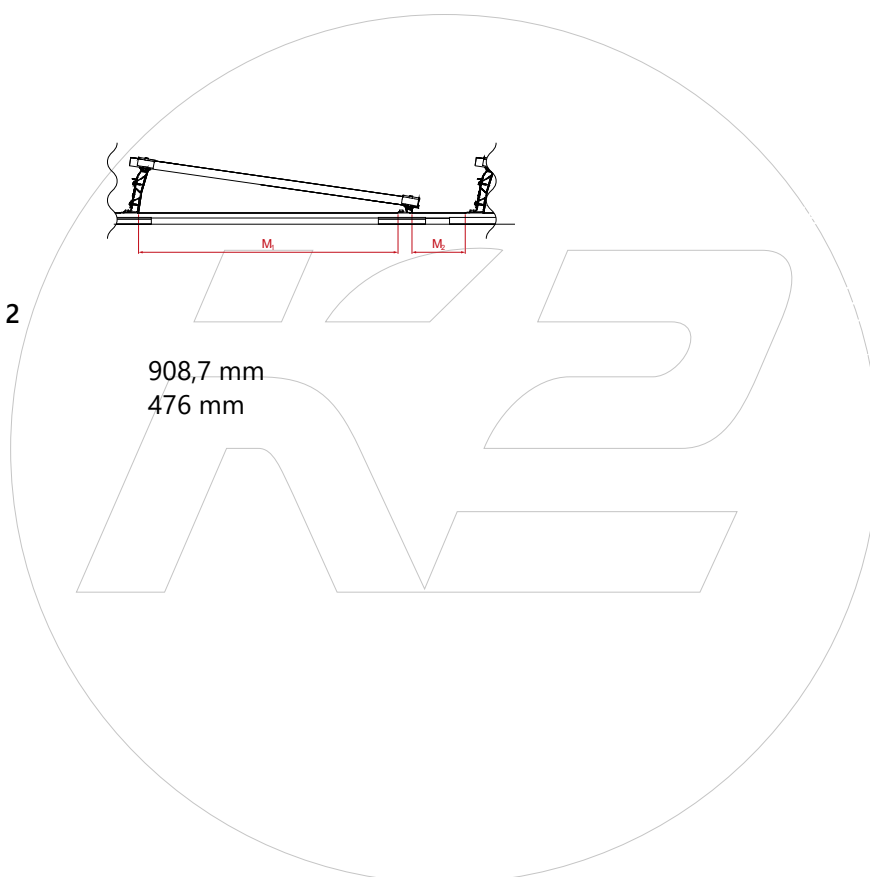
MODULES

Manufacturer	Longi Solar	Quantity	21
Name	LR4-60HPH-375M	Total output power	7,875 kWp
Dimensions LxWxH	1755 x 1038 x 35,00 mm	Panel Tilt	9,5 °
Weight	19,5 kg		
Output power	375 W		

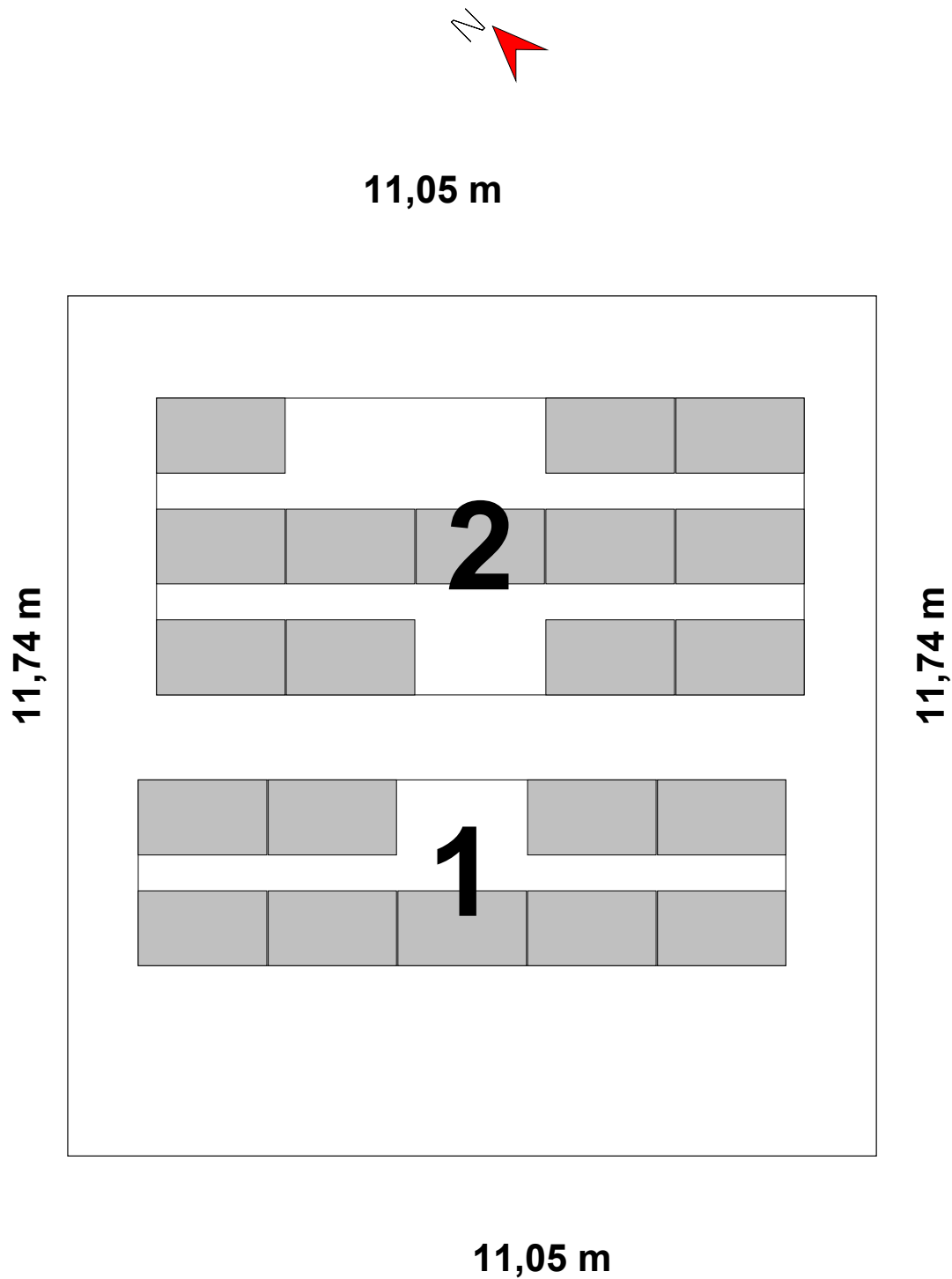
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 7)

Module Array 1, 2

M1
M2



ASSEMBLY PLAN (ROOF 7)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 3,30 m	Quantity 4,40 m	Part of / m	Length / m	Rest / m
A	3,015			3,300	3,015	0,275
B	4,530	1		3,300	1,230	2,060



LEGEND

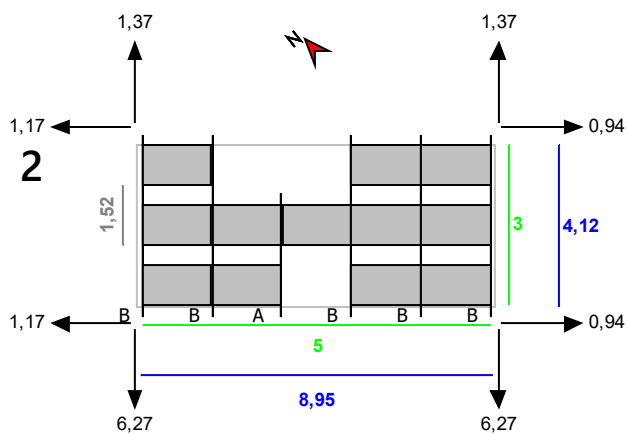
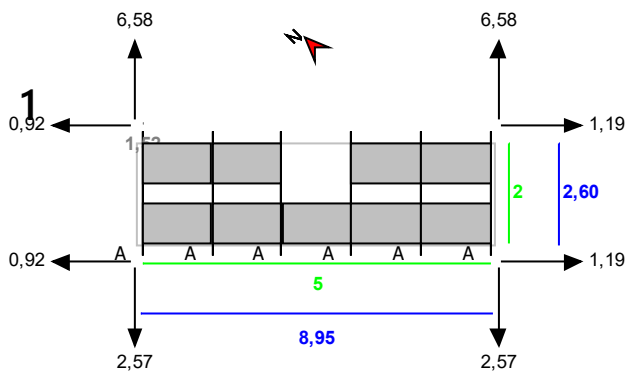
Distance to neighbouring module array [m]

Distance to roof edge [m]

Number of modules

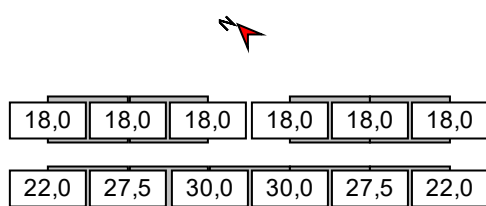
Length/width of module array [m]

Row distance [m]

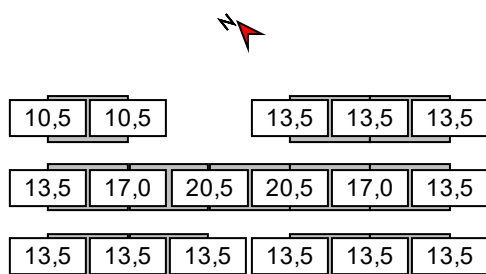


BALLAST PLAN (ROOF 7)

1



2



RESULTS (ROOF 7)

BALLAST CAPACITY

Speed Porter	40,0 kg
Porter	108,0 kg
module clamp	MiniClamp Black MC Set 30-50
end clamp	MiniClamp Black EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	23,44
	suction	32,35
Loads on modules (ultimate state) [Pa]	pressure	1320
	suction	-841
Loads on modules (Serviceability) [Pa]	pressure	988
	suction	-588

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	9	---	---	267,0	479,4	0,23	---	---
module array 2	12	---	---	244,5	527,7	0,18	---	---
all Blocks	21	---	---	511,5	1007,1	---	0,08	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu>, in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").

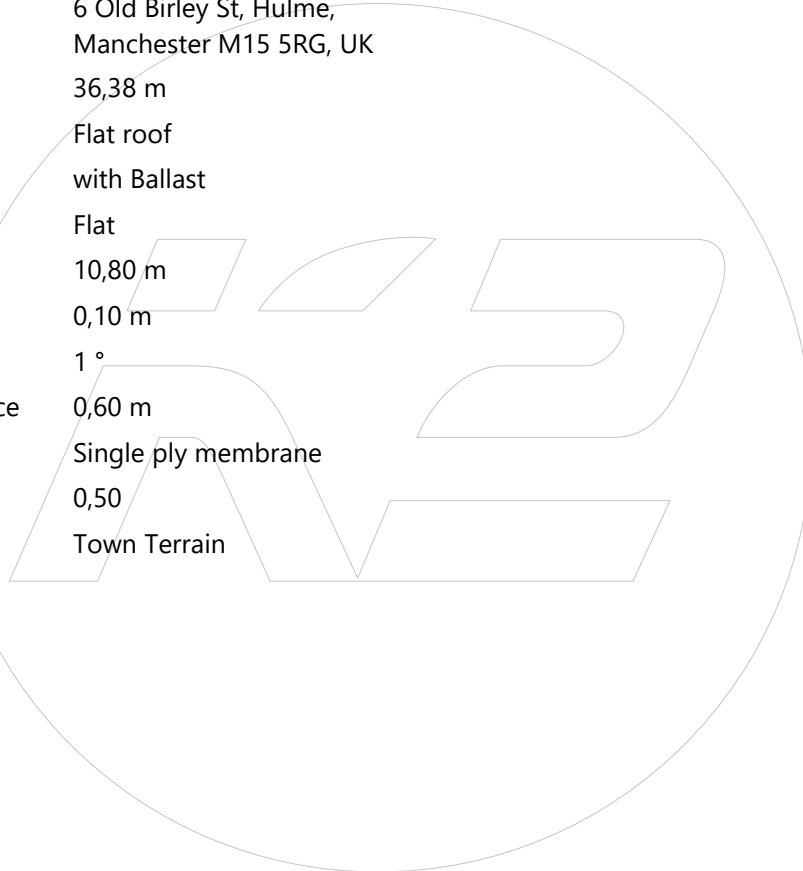
STRUCTURAL ANALYSIS REPORT (ROOF 7)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	S-Dome 6.10 Classic
Customer	Cor Energy
Author	Hugo Silva

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10,80 m
Parapet wall height	0,10 m
Roof pitch	1 °
Min. roof edge distance	0,60 m
Material	Single ply membrane
Friction coefficient	0,50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46,48 km

distance inside town terrain 10,50 km

Peak velocity pressure $q_{p,50} = 0,647 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0,921$

Peak velocity pressure $q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone 3

Snow load on ground level $s_k = 0,500 \text{ kN/m}^2$

Shape Coefficient for Snow $\mu_i = 0,800$

Factor for roof pitch $d_i = 1,000$

Snow load on roof $s_{i,50} = 0,400 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0,929$

Snow load on roof $s_{i,25} = 0,372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4,1 \text{ kg}$	Dead weight mounting system	$= 2,25 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,13 \text{ kN/m}^2$

LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stab}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
---------------------------	---

Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind $\psi_{0,W}$ 0,60

Combination coefficient with regards to Snow $\psi_{0,S}$ 0,50

Load case combination 00: $E_d = G_k$

Load case combination 01: $E_d = G_k + S_{i,n}$

Load case combination 02: $E_d = G_k + W_{k,Pressure}$

Load case combination 03: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

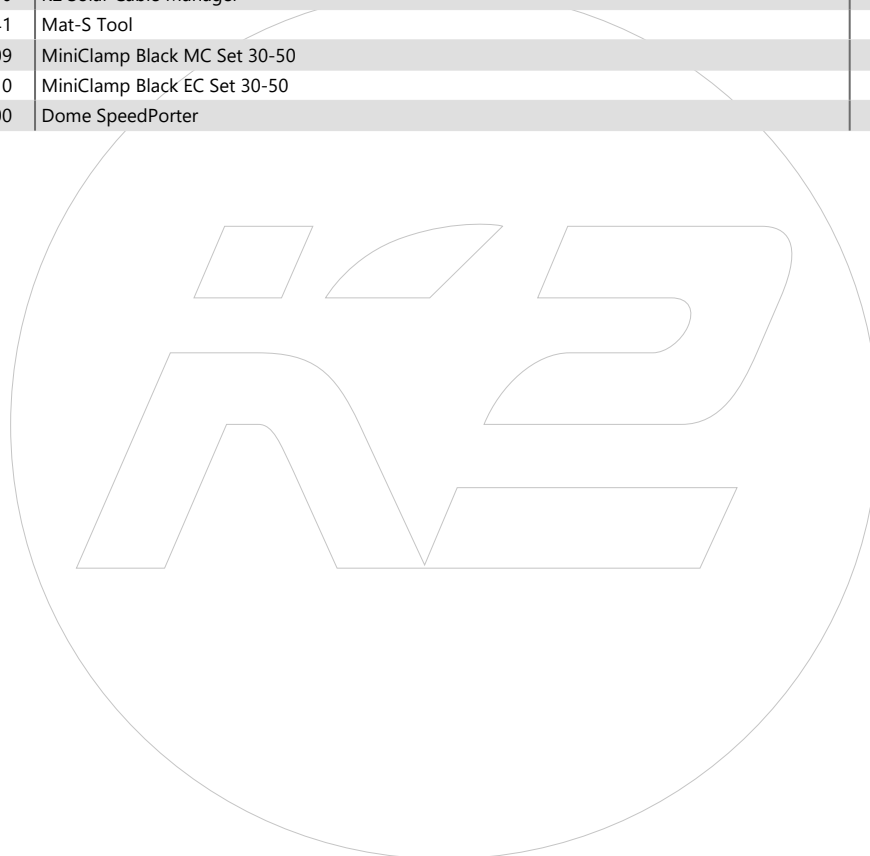


BILL OF MATERIALS (ROOF 7)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	29	8,7 kg
2	1001643	MK2	58	1,0 kg
3	2001729	Socket Head Bolt serrated M8x20	58	0,8 kg
4	2003243	Dome 6.10 SD	29	8,8 kg
5	2003126	Dome Mat S 380	58	21,3 kg
6	2003249	S-Dome 6.10 Windbreaker short	21	37,8 kg
7	1005207	Thread-forming metal screw 6.0x25	58	0,3 kg
8	2003239	SpeedRail 22; 3.30 m	17	36,1 kg
9	1006039	Dome FlatConnector Set	5	1,0 kg
10	2002870	K2 Solar Cable Manager	21	0,1 kg
11	2004141	Mat-S Tool	1	0,0 kg
12	2002609	MiniClamp Black MC Set 30-50	26	1,5 kg
13	2002610	MiniClamp Black EC Set 30-50	32	2,1 kg
14	2002300	Dome SpeedPorter	58	4,4 kg

Total

123,9 kg



PROJECT DATA (ROOF 8)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	S-Dome 6.10 Classic
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10,80 m
Parapet wall height	0,10 m
Roof pitch	1 °
Min. roof edge distance	0,60 m
Material	Single ply membrane
Friction coefficient	0,50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46,48 km		
distance inside town terrain	10,50 km		
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$		

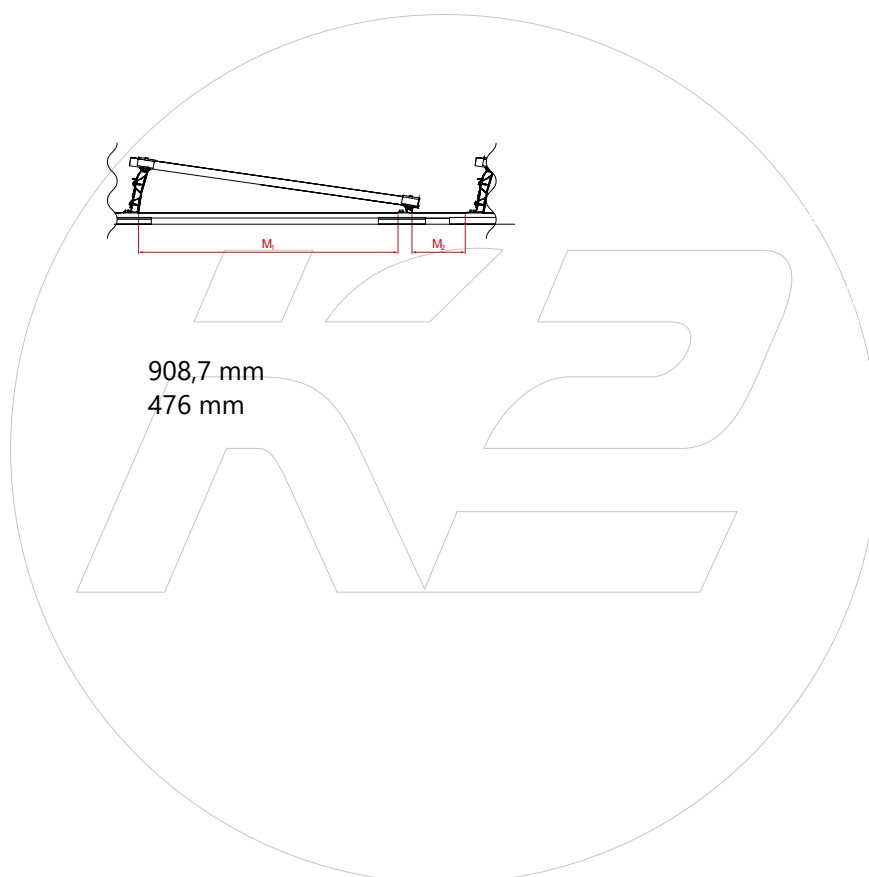
MODULES

Manufacturer	Longi Solar	Quantity	11
Name	LR4-60HPH-375M	Total output power	4,125 kWp
Dimensions LxWxH	1755 x 1038 x 35,00 mm	Panel Tilt	9,5 °
Weight	19,5 kg		
Output power	375 W		

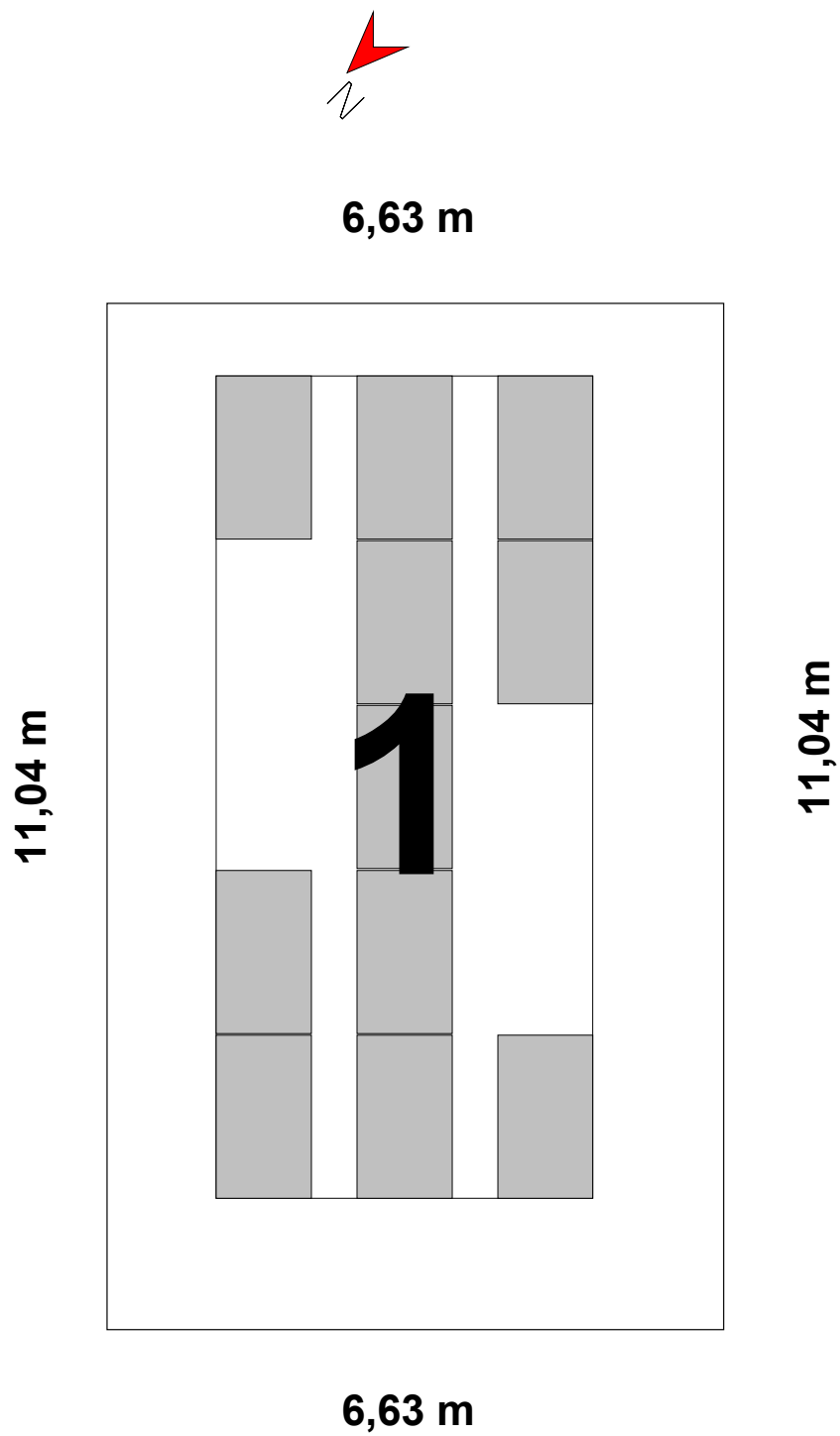
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 8)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 8)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 4,40 m	Quantity 3,30 m	Part of / m	Length / m	Rest / m
A	4,530		1	3,300	1,230	2,060
B	3,015			3,300	3,015	0,275



LEGEND

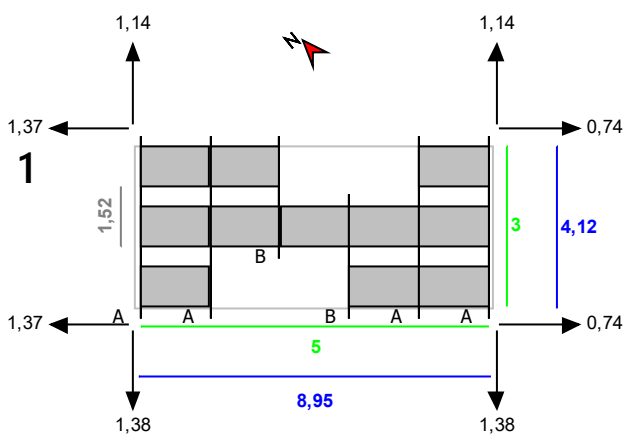
Distance to neighbouring module array [m]

Distance to roof edge [m]

Number of modules

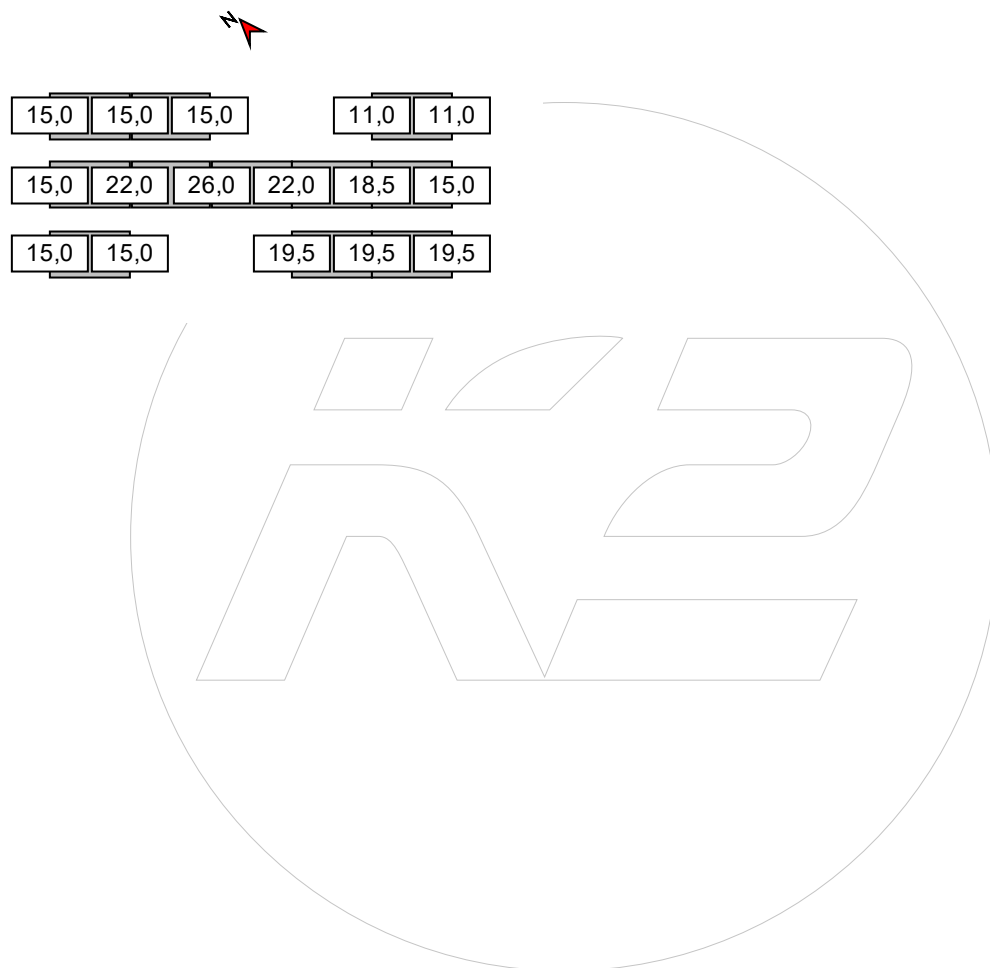
Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 8)

1



RESULTS (ROOF 8)

BALLAST CAPACITY

Speed Porter	40,0 kg
Porter	108,0 kg
module clamp	MiniClamp Black MC Set 30-50
end clamp	MiniClamp Black EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22,19
	suction	32,35
Loads on modules (ultimate state) [Pa]	pressure	1320
	suction	-841
Loads on modules (Serviceability) [Pa]	pressure	988
	suction	-588

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	11	---	---	274,0	533,6	0,20	---	---
all Blocks	11	---	---	274,0	533,6	---	0,07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu>, in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").

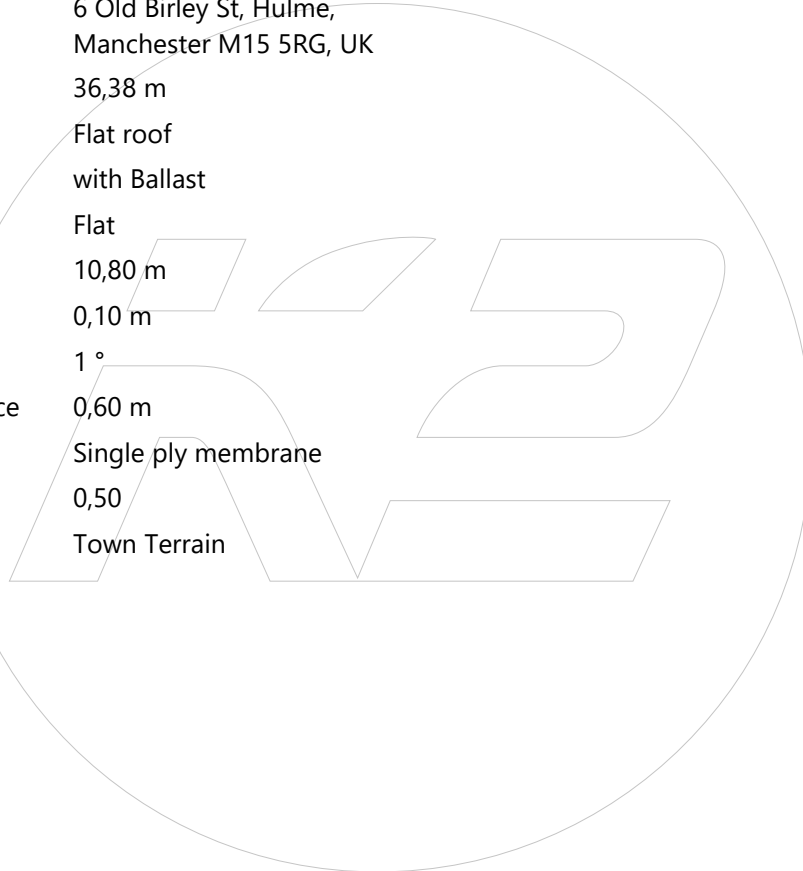
STRUCTURAL ANALYSIS REPORT (ROOF 8)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	S-Dome 6.10 Classic
Customer	Cor Energy
Author	Hugo Silva

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10,80 m
Parapet wall height	0,10 m
Roof pitch	1 °
Min. roof edge distance	0,60 m
Material	Single ply membrane
Friction coefficient	0,50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46,48 km

distance inside town terrain 10,50 km

Peak velocity pressure $q_{p,50} = 0,647 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0,921$

Peak velocity pressure $q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone 3

Snow load on ground level $s_k = 0,500 \text{ kN/m}^2$

Shape Coefficient for Snow $\mu_i = 0,800$

Factor for roof pitch $d_i = 1,000$

Snow load on roof $s_{i,50} = 0,400 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0,929$

Snow load on roof $s_{i,25} = 0,372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4,1 \text{ kg}$	Dead weight mounting system	$= 2,25 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,13 \text{ kN/m}^2$

LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stab}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
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Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
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Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind $\psi_{0,W}$ 0,60

Combination coefficient with regards to Snow $\psi_{0,S}$ 0,50

Load case combination 00: $E_d = G_k$

Load case combination 01: $E_d = G_k + S_{i,n}$

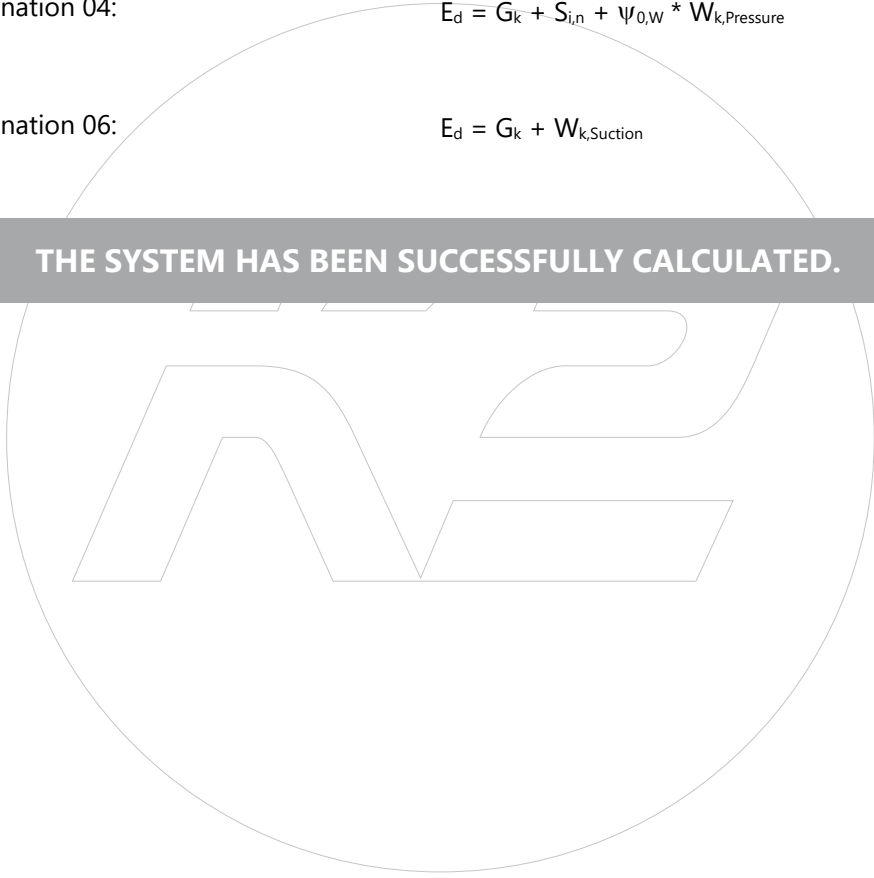
Load case combination 02: $E_d = G_k + W_{k,Pressure}$

Load case combination 03: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

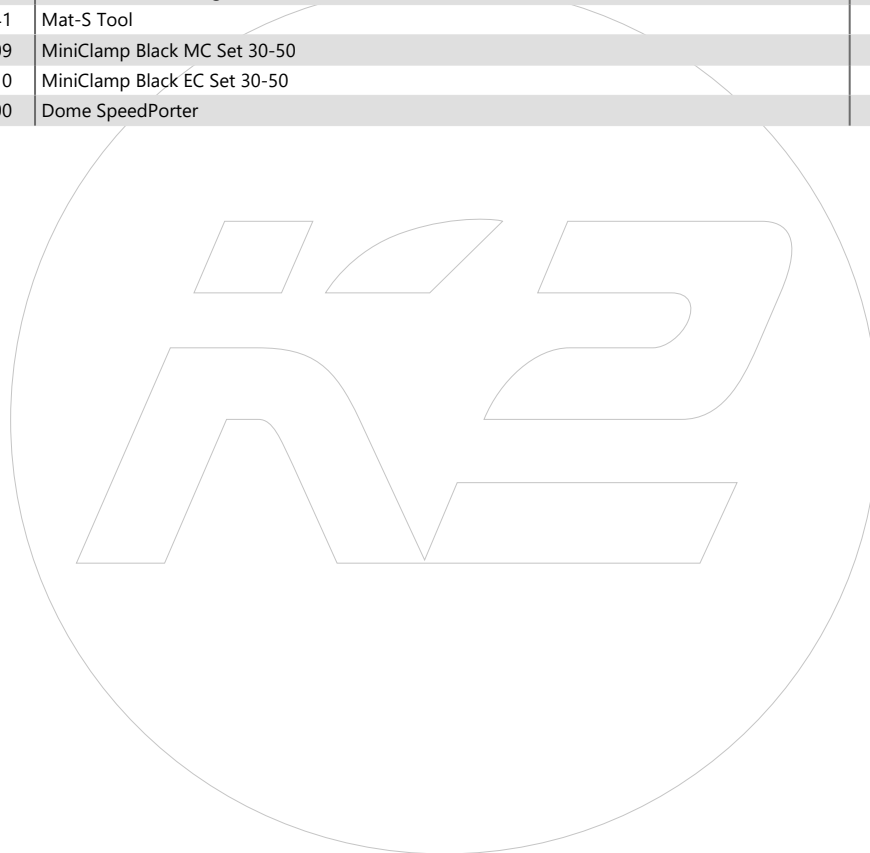
Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.



BILL OF MATERIALS (ROOF 8)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	16	4,8 kg
2	1001643	MK2	32	0,6 kg
3	2001729	Socket Head Bolt serrated M8x20	32	0,4 kg
4	2003243	Dome 6.10 SD	16	4,8 kg
5	2003126	Dome Mat S 380	32	11,8 kg
6	2003249	S-Dome 6.10 Windbreaker short	11	19,8 kg
7	1005207	Thread-forming metal screw 6.0x25	32	0,2 kg
8	2003239	SpeedRail 22; 3.30 m	10	21,2 kg
9	1006039	Dome FlatConnector Set	4	0,8 kg
10	2002870	K2 Solar Cable Manager	11	0,0 kg
11	2004141	Mat-S Tool	1	0,0 kg
12	2002609	MiniClamp Black MC Set 30-50	12	0,7 kg
13	2002610	MiniClamp Black EC Set 30-50	20	1,3 kg
14	2002300	Dome SpeedPorter	32	2,4 kg
Total				68,8 kg



PROJECT DATA (ROOF 9)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	S-Dome 6.10 Classic
Customer	Cor Energy
Author	Hugo Silva

REMARKS

Best assumptions made for any missing information

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10,80 m
Parapet wall height	0,10 m
Roof pitch	1 °
Min. roof edge distance	0,60 m
Material	Single ply membrane
Friction coefficient	0,50
Terrain category	Town Terrain

The friction coefficients given here must be checked onsite. If a lower value is found, this must be specified here for the ballast calculation!

LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years
Terrain category	Town Terrain		
distance to shoreline	46,48 km		
distance inside town terrain	10,50 km		
Peak velocity pressure	$q_{p,25} = 0,596 \text{ kN/m}^2$		
Snow load zone	3		
Snow load on ground level	$s_k = 0,500 \text{ kN/m}^2$		

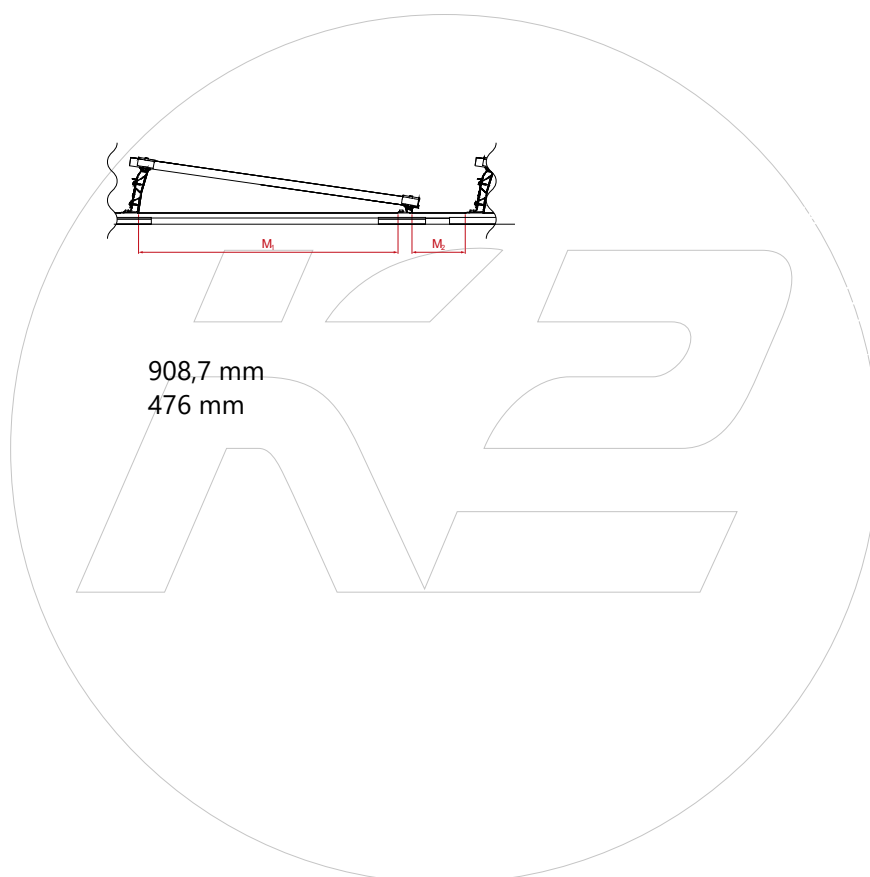
MODULES

Manufacturer	Longi Solar	Quantity	11
Name	LR4-60HPH-375M	Total output power	4,125 kWp
Dimensions LxWxH	1755 x 1038 x 35,00 mm	Panel Tilt	9,5 °
Weight	19,5 kg		
Output power	375 W		

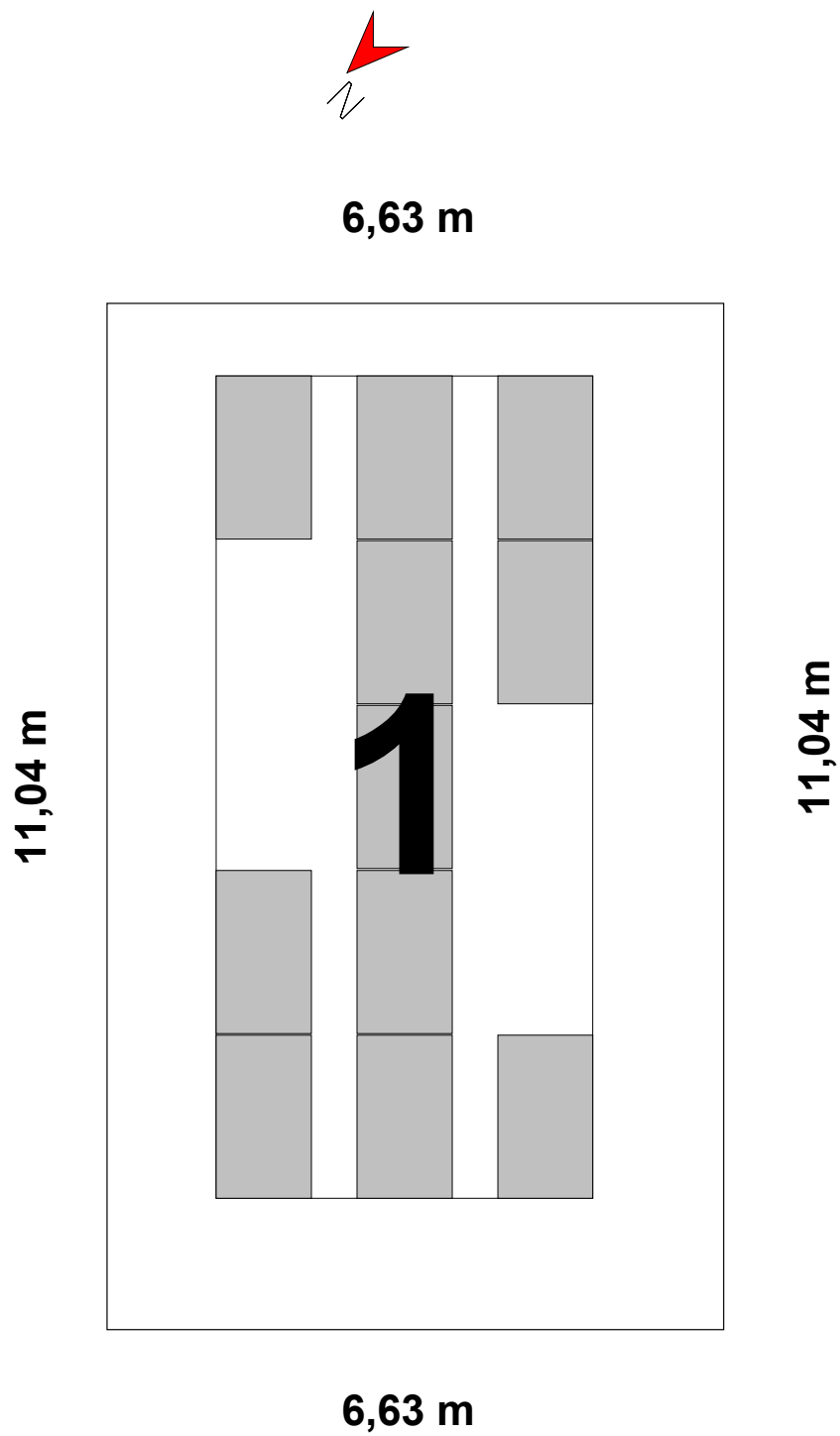
PRE-ASSEMBLY / ASSEMBLY INSTRUCTIONS (ROOF 9)

Module Array 1

M1
M2



ASSEMBLY PLAN (ROOF 9)



Dimensions in [m]

Type	Whole Rails			Rail cutting		
	Total Rail / m	Quantity 4,40 m	Quantity 3,30 m	Part of / m	Length / m	Rest / m
A	4,530		1	3,300	1,230	2,060
B	3,015			3,300	3,015	0,275



LEGEND

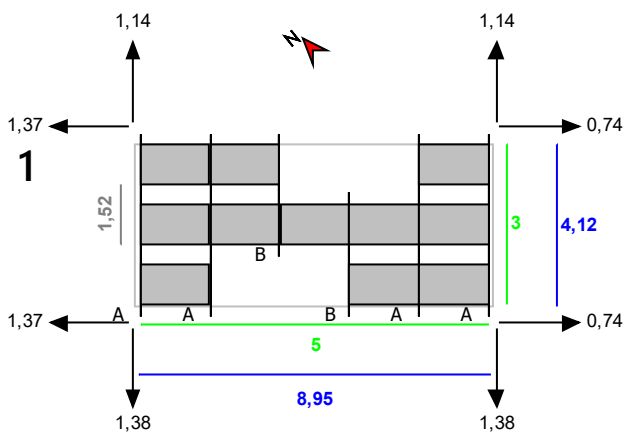
Distance to neighbouring module array [m]

Distance to roof edge [m]

Number of modules

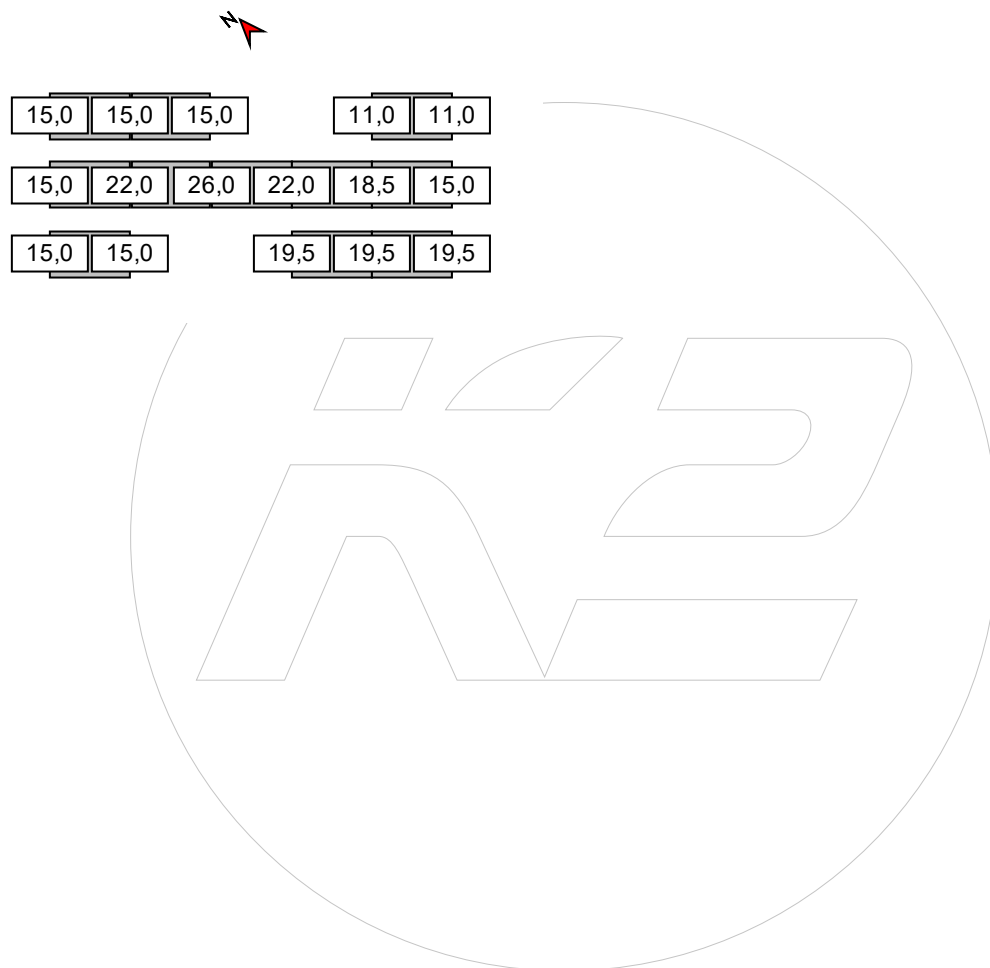
Length/width of module array [m]

Row distance [m]



BALLAST PLAN (ROOF 9)

1



RESULTS (ROOF 9)

BALLAST CAPACITY

Speed Porter	40,0 kg
Porter	108,0 kg
module clamp	MiniClamp Black MC Set 30-50
end clamp	MiniClamp Black EC Set 30-50

VERIFICATION SYSTEM UTILISATION

Verification system utilisation [%]	pressure	22,19
	suction	32,35
Loads on modules (ultimate state) [Pa]	pressure	1320
	suction	-841
Loads on modules (Serviceability) [Pa]	pressure	988
	suction	-588

SPECIFIC LOADS

Index (module block)	No. of modules (module block)	---	---	Ballast [kg] (module block)	Dead weight [kg] (module block)	Dead Load [kN/m ²] (module block)	Dead Load [kN/m ²] (roof surface area)	Own weight [kN/m ²]
module array 1	11	---	---	274,0	533,6	0,20	---	---
all Blocks	11	---	---	274,0	533,6	---	0,07	---

NOTES

- The proof of position safety and load capacity of the system are carried out by checking the load cases lifting and shifting by wind and by further static calculations. You will find a short version of the wind tunnel report and a certificate for the further static calculations on our homepage.
- The structural design complies with BS EN 1990 - Basics of Structural Design.
- Snow loads are determined in accordance with National Annex BS NA EN 1991-1-3 (2018) - UK National Annex to EC1 - Action on structures - general actions - snow loads.
- Wind loads are determined in accordance with National Annex BS NA EN 1991-1-4 - UK National Annex to EC1 - Action on structures, general actions - wind actions.
- Service life is recognised according to 'Eurocode EN 1991 – Action on structures, Snow loads' and 'Eurocode EN 1991 – Actions on structures, Wind actions'. Subject to the Building Regulations and for security-relevant reasons the installation has to be dismantled at the end of its service life.
- Failure consequence class is considered according to 'Eurocode EN 1990 – Basis of structural design'.
- Data and results must be verified with regard to local conditions and checked by a suitably qualified person. Please see our TCU under <https://k2-systems.com/en/base-tcu>, in particular § 2 ("technical and specialist requirements for the customer"), § 7 ("warranty provisions") and § 8 ("limitation of liability").

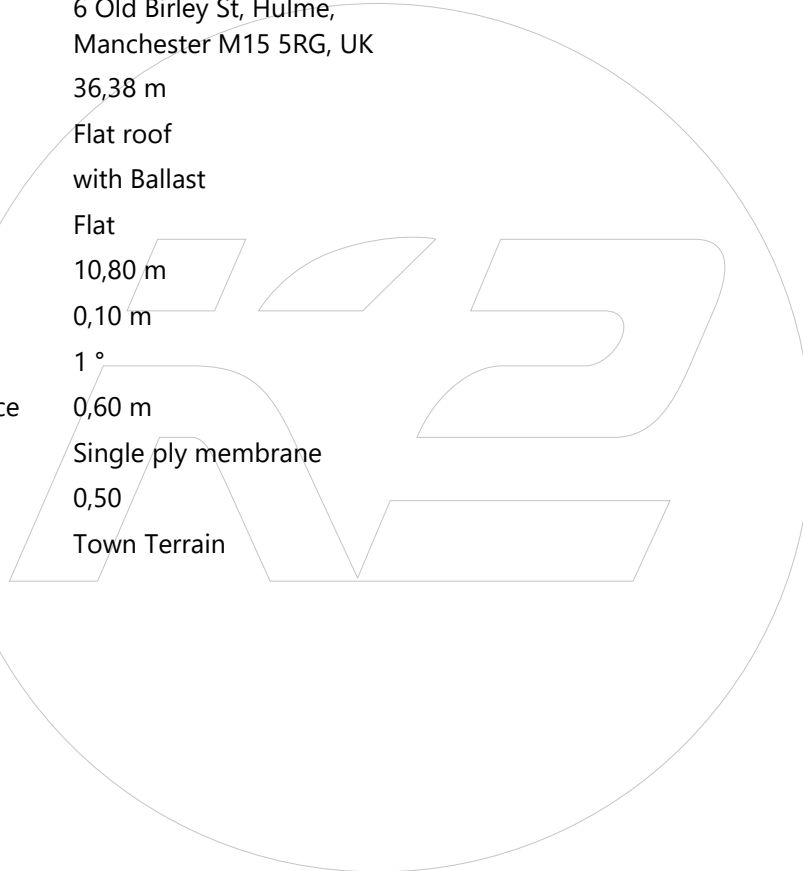
STRUCTURAL ANALYSIS REPORT (ROOF 9)

GENERAL INFORMATION

Name	Naylor Hall
Mounting System	S-Dome 6.10 Classic
Customer	Cor Energy
Author	Hugo Silva

LOCATION

Address	6 Old Birley St, Hulme, Manchester M15 5RG, UK
Ground elevation	36,38 m
Roof type	Flat roof
Fastening method	with Ballast
Roof covering	Flat
Building height	10,80 m
Parapet wall height	0,10 m
Roof pitch	1 °
Min. roof edge distance	0,60 m
Material	Single ply membrane
Friction coefficient	0,50
Terrain category	Town Terrain



LOADS

Design method	BS EN		
Failure consequence class (CC)	CC1	Design working life	25 years

Terrain category Town Terrain

distance to shoreline 46,48 km

distance inside town terrain 10,50 km

Peak velocity pressure $q_{p,50} = 0,647 \text{ kN/m}^2$

Adjustment factor for service life $f_w = 0,921$

Peak velocity pressure $q_{p,25} = 0,596 \text{ kN/m}^2$

Snow load zone 3

Snow load on ground level $s_k = 0,500 \text{ kN/m}^2$

Shape Coefficient for Snow $\mu_i = 0,800$

Factor for roof pitch $d_i = 1,000$

Snow load on roof $s_{i,50} = 0,400 \text{ kN/m}^2$

Adjustment factor for service life $f_s = 0,929$

Snow load on roof $s_{i,25} = 0,372 \text{ kN/m}^2$

DEAD LOAD

Weight module	$G_M = 19,5 \text{ kg}$	Dead weight module	$= 10,70 \text{ kg/m}^2$
Weight mounting system per module area	$= 4,1 \text{ kg}$	Dead weight mounting system	$= 2,25 \text{ kg/m}^2$
Module area	$A_M = 1,82 \text{ m}^2$	Total Dead Weight (excl. ballast)	$= 0,13 \text{ kN/m}^2$

LOAD COMBINATIONS

ULTIMATE LIMIT STATE

Partial safety factor unfavourable permanent load	$\gamma_{G,sup}$	1,35
Partial safety factor favourable permanent load	$\gamma_{G,inf}$	1,00
Partial safety factor destabilising permanent load	$\gamma_{G,dst}$	1,10
Partial safety factor stabilising permanent load	$\gamma_{G,stab}$	0,90
Partial safety factor first variable load	γ_Q	1,50
Partial safety factor variable loads	γ_Q	1,50
Combination coefficient with regards to wind	$\psi_{0,W}$	0,60
Combination coefficient with regards to wind (additional varying influences)	$\psi_{1,W}$	0,20
Combination coefficient with regards to Snow	$\psi_{0,S}$	0,50
Importance factor variable	$\kappa_{FI,Q}$	0,85
Characteristic dead weight	G_k	
Characteristic snow load on the roof	$S_{i,n}$	
Characteristic wind load	W_k	

Load case combination 00:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * S_{i,n}$
Load case combination 02:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Pressure}$
Load case combination 03:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (W_{k,Pressure} + \psi_{0,S} * S_{i,n})$
Load case combination 04:	$E_d = \gamma_{G,sup} * \kappa_{FI,G} * G_k + \gamma_Q * \kappa_{FI,Q} * (S_{i,n} + \psi_{0,W} * W_{k,Pressure})$

Load case combination 06:	$E_d = \gamma_{G,inf} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,Suction}$
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Uplift Verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Uplift}$
----------------------	---

Displacement verification:	$E_d = \gamma_{G,stab} * G_k + \gamma_Q * \kappa_{FI,Q} * W_{k,n,Displacement}$
----------------------------	---

SERVICEABILITY LIMIT STATE

Combination coefficient with regards to wind $\psi_{0,W}$ 0,60

Combination coefficient with regards to Snow $\psi_{0,S}$ 0,50

Load case combination 00: $E_d = G_k$

Load case combination 01: $E_d = G_k + S_{i,n}$

Load case combination 02: $E_d = G_k + W_{k,Pressure}$

Load case combination 03: $E_d = G_k + W_{k,Pressure} + \psi_{0,S} * S_{i,n}$

Load case combination 04: $E_d = G_k + S_{i,n} + \psi_{0,W} * W_{k,Pressure}$

Load case combination 06: $E_d = G_k + W_{k,Suction}$

THE SYSTEM HAS BEEN SUCCESSFULLY CALCULATED.

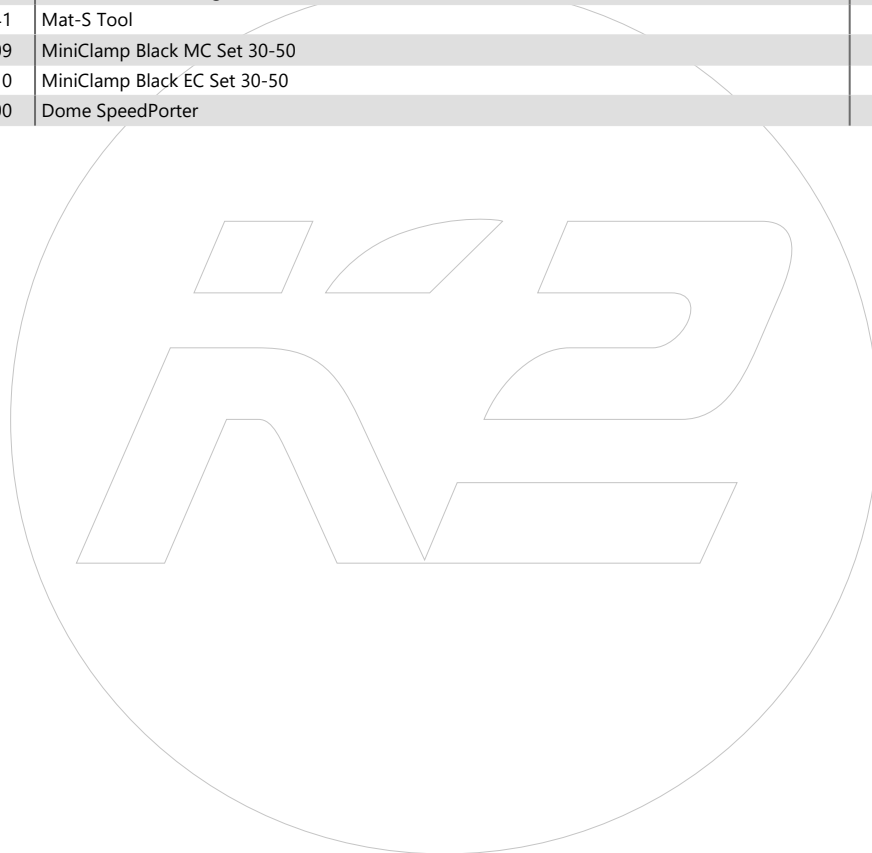


BILL OF MATERIALS (ROOF 9)

Position	Item no.	Item description	Quantity	Weight
1	2004125	Dome 6.10 Peak	16	4,8 kg
2	1001643	MK2	32	0,6 kg
3	2001729	Socket Head Bolt serrated M8x20	32	0,4 kg
4	2003243	Dome 6.10 SD	16	4,8 kg
5	2003126	Dome Mat S 380	32	11,8 kg
6	2003249	S-Dome 6.10 Windbreaker short	11	19,8 kg
7	1005207	Thread-forming metal screw 6.0x25	32	0,2 kg
8	2003239	SpeedRail 22; 3.30 m	10	21,2 kg
9	1006039	Dome FlatConnector Set	4	0,8 kg
10	2002870	K2 Solar Cable Manager	11	0,0 kg
11	2004141	Mat-S Tool	1	0,0 kg
12	2002609	MiniClamp Black MC Set 30-50	12	0,7 kg
13	2002610	MiniClamp Black EC Set 30-50	20	1,3 kg
14	2002300	Dome SpeedPorter	32	2,4 kg

Total

68,8 kg



TOTAL BILL OF MATERIALS (ALL ROOFS)

Position	Item no.	Item description	Quantity	Weight
1	2003073	SolidHook Flat Tile H33/119 75x4	432	430,7 kg
2	1000041	T-Bolt 28/15 M10x30	432	12,5 kg
3	1000042	Hexagon flange nut M10	432	4,8 kg
4	2004112	Heco-Topix Plus wood screw 8x100	864	23,3 kg
5	1005158	MiddleClamp XS Black Set 34-38	170	11,9 kg
6	1005268	EndClamp Black Set 34-36	112	8,4 kg
7	2002870	K2 Solar Cable Manager	156	0,4 kg
8	2003229	SolidRail UltraLight; 4.40 m	34	104,8 kg
9	2003228	SolidRail UltraLight; 3.30 m	44	101,7 kg
10	1004107	SolidRail UltraLight+Light RailConnector Set	22	5,0 kg
11	2004125	Dome 6.10 Peak	61	18,3 kg
12	1001643	MK2	122	2,1 kg
13	2001729	Socket Head Bolt serrated M8x20	122	1,6 kg
14	2003243	Dome 6.10 SD	61	18,5 kg
15	2003126	Dome Mat S 380	122	44,9 kg
16	2003249	S-Dome 6.10 Windbreaker short	43	77,4 kg
17	1005207	Thread-forming metal screw 6.0x25	122	0,7 kg
18	2003239	SpeedRail 22; 3.30 m	37	78,5 kg
19	1006039	Dome FlatConnector Set	13	2,5 kg
20	2004141	Mat-S Tool	3	0,1 kg
21	2002609	MiniClamp Black MC Set 30-50	50	2,9 kg
22	2002610	MiniClamp Black EC Set 30-50	72	4,8 kg
23	2002300	Dome SpeedPorter	122	9,3 kg
Total				965,1 kg