Sistem Fotovoltaic

Putere instalată: 300 kWp
Denumire proiect:
S.A.”RED-Nord” mun. Balti

Localizare proiect

Mun.Balti
str. Stefan cel Mare 180 "A"

Beneficiar

S.A.”RED-Nord"
str. Stefan cel Mare 180 "A"
mun. Balti

Memoriu tehnic

Designer

COMPASS SRL
str.Petricani 5/1
MD2059 - Chisinau

Data:
Chisinau, 31.01.2023

SCOPUL ACESTUI DOCUMENT

Documentul reprezinta un memoriul tehnic al sistemului fotovoltaic. In document va fi identificata instalatia, vor fi furnizate datele proiectului, caracteristicile materialelor utilizate (module[panouri] fotovoltaice, invertoare), criteriile de alegere a solutiilor de sistem si criteriile de proiectare a componentelor majore. In plus, acestea vor fi raportate la calculele preliminare, necesare pentru dimensionarea sistemului fotovoltaic, vor fi estimate cantitatile si vor fi elaborate desene tehnice - diagramele de circuit si amplasamentul sistemului.

1 - MEMORIU TEHNIC

Sistemul fotovoltaic cu putere instalata[1] nominala 300 kW va fi amplasat pe adresa mun.Balti str.Stefan cel Mare 180 "A", si va fi conectat la reteaua electrica de distributie de tip Low voltage Three-phase, de curent alternativ 0.4 kV, in baza conditiilor tehnice eliberate de operatorul de retea.

1.1 Datele proiectului

Datele proiectului sunt raportate mai jos si se refera la client, la adresa de instalare, la datele privind alimentarea cu energie electrica, prezenta/absenta umbririi obiectelor.

Beneficiar	
Denumire	S.A."RED-Nord"
Adresa	str. Stefan cel Mare 180 "A"
Localitate	Mun. Balti

Adresa de instalare	
Localitate	Mun.Balti
Adresa	Str.Stefan cel Mare 180 "A"
Latitudine	47,74°
Longitudine	27,88°
Temperatura maxima	26,40 °C
Temperatura minima	-6,24 °C
Iradiatie globala pe suprafata orizontala	1 178,95 kWh/m^2
Date iradiatie	NASA-SSE
Albedo	20%

Sistemul fotovoltaic va fi conectat la reteaua beneficiarului, deservita de un operator de retea si care are urmatoarele caracteristici:

Reteaua electrica de distributie	
Operator de retea	S.A."RED-Nord"
Tipul de bransament	Trifazic
Tensiune nominala	400 V
Putere racordata	300 kW
Consumul anual mediu	700 000 kWh
Cod consumator	
Numar contract	

[1] The nominal power of a photovoltaic system is intended as the sum of the nominal power of each module measured at standard test conditions (STC).

1.2 Descrierea sistemului fotovoltaic

Sistemul fotovoltaic cu putere instalata nominala 300 kWp va fi racordat la reteaua electrica de distributie de Low voltage Three-phase de curent alternativ de tip Trifazic 400 V, aflat in gestiunea S.A.”RED-Nord".

Caracteristicile sistemului sunt rezumate mai jos, in special in Figura 1a, 1b care prezinta schema electrica monofilara a doua sisteme a cate 150 kWp fiecare, unde sunt aratate distinct componentele sistemului fotovoltaic, respectiv, pentru fiecare dintre cele doua sisteme de 150 kW:

- 15 siruri din 20 module conectate in serie
- Grupul de conversie format din invertor/invertoare tip Three-phase in numar de 3 un.
- Grupul de interfata
- Sistemele de masurare a energiei

1.2.1 Sistemul fotovoltaic

Acesta contine:
- Module PV conectate in serii care formeaza siruri
- Cabluri electrice atat pentru interconectarea modulelor PV, cat si pentru conectarea modulelor PV cu tablourile electrice de distributie

Mai jos sunt date caracteristicile sistemului fotovoltaic si ale componentelor sale principale, si anume, siruri si module.

Caracteristicile electrice ale sistemului fotovoltaic	
Putere instalata nominala	300 kWp
Numarul de module PV	600
Suprafata ocupata	1422 m^2
Numarul de siruri	30
Tensiunea maxima @STC (Voc)	911 V
Tensiunea la capacitate maxima @STC (Vmpp)	767,6 V
Curentul de scurtcircuit @STC (Isc)	69,5 A
Curentul la capacitate maxima @STC (Impp)	65,15 A

Pentru instalatia in cauza, generatorul fotovoltaic are o singura expunere (unghi de inclinare si unghi de azimut egal pentru toate modulele fotovoltaice) si anume:
Expunerea generatorului fotovoltaic:

Azimut : 150°
Unghi de inclinare : 30°

Sistemul fotovoltaic cu puterea instalata nominala de 300 kW are configuratia serie-paralel si va fi impartit in 30 siruri de module conectate in serie. Lista de mai jos prezinta componenta sirurilor in sistem.

Caracteristicile electrice ale sirurilor	
Numarul de module PV in serie	20
Putere nominala	10 kW
Tensiunea circuit deschis (Voc)	911 V
Curentul de scurtcircuit (Isc)	13,9 A
Curentul la capacitate maxima (Impp)	13,03 A

Datele de productie a modulelor:

Datele de productie a modulelor	
Producator	LONGi Solar
Model	LR5-66HIH-500M
Tehnologie	Si-Mono
Putere nominala	500 W
Toleranta	3,00%
Tensiune circuit deschis (Voc)	45,55 V
Tensiune la capacitate maxima (Vmpp)	38,38 V
Curentul de scurtcircuit (Isc)	13,90 A
Curentul la capacitate maxima (Impp)	13,03 A
Suprafata	2,37 m^2
Eficienta	21,1%

1.2.2 Grupul de conversiune DC/AC

Grupul de conversiune DC/AC al sistemului fotovoltaic va contine invertor/invertoare tip Three-phase in numar de 6 un., cu putere totala de iesire 300 kW.

Specificatiile tehnice a invertoarelor sunt reprezentate in tabel.

Specificatiile invertorului	
Producator	Sofar Solar
Model	SOFAR 50KTLX-G3
Puterea nominala	50 kW
Puterea maxima	75 kW
Eficienta maxima	98,80%
Tensiunea maxima PV	1 100 V
Tensiunea minima pe MPPT	200 V
Curentul maxim de intrare	200 A
Numarul de MPPT / intrari	4 / 8

Tensiunea AC	400 V
Tip retea	Three-phase
Frecventa retea	50 Hz

2. Scheme, schite

2.1 - Schema electrica monofilara

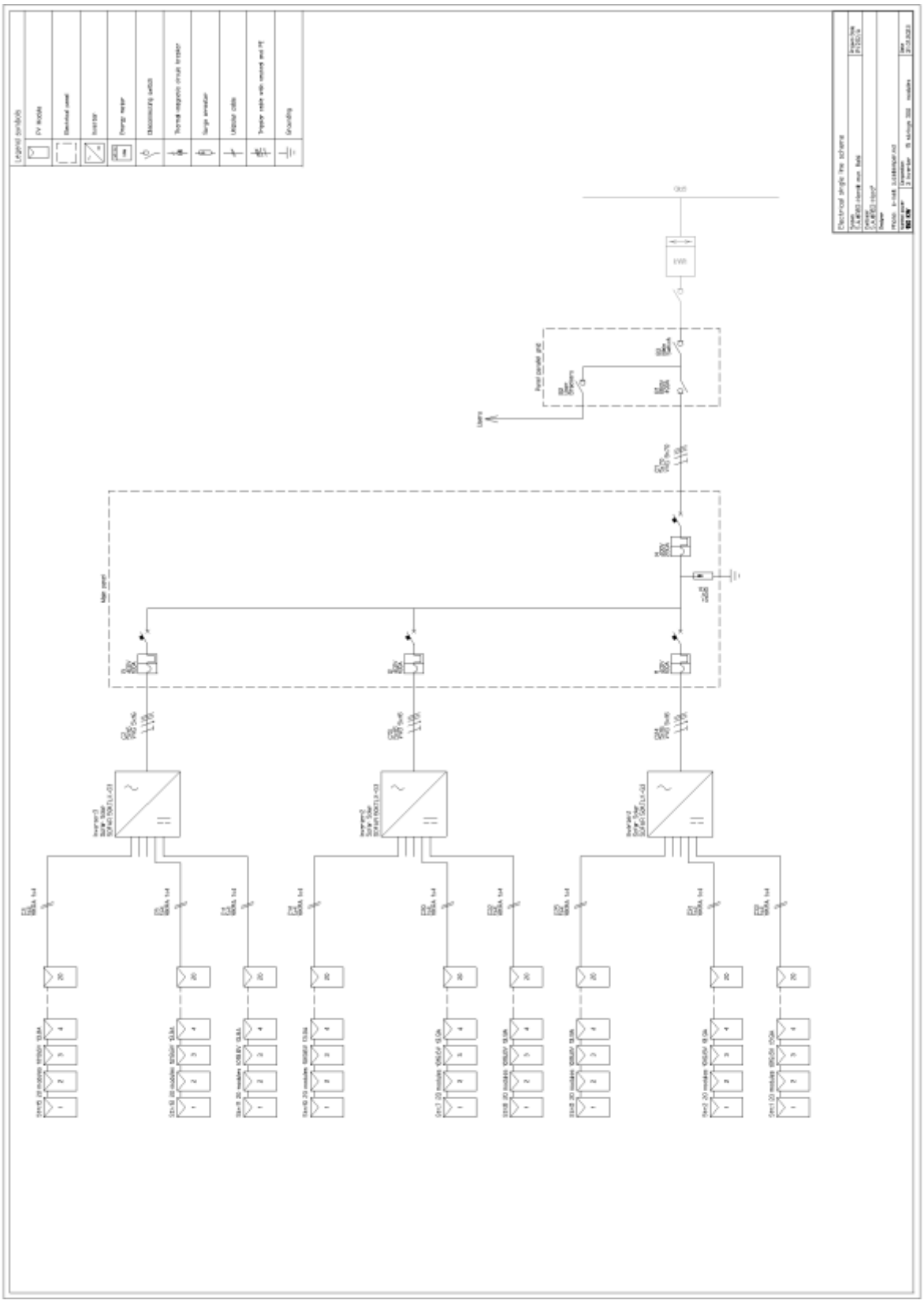


Figura 1a: Schema electrica monofilara
Sistem PV1 - 150 kWp

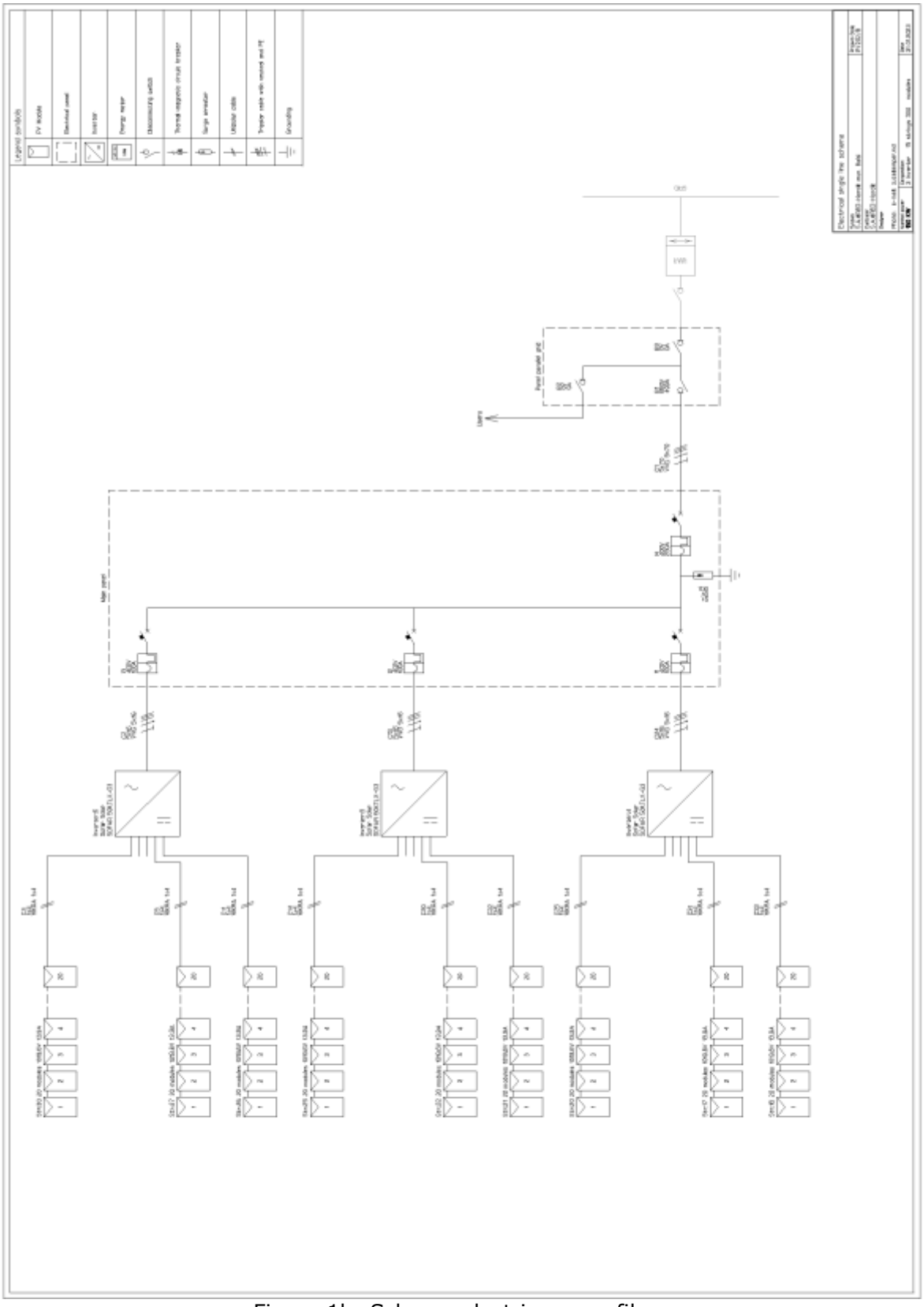


Figura 1b: Schema electrica monofilara
Sistem PV2 - 150 kWp

2.2 - Schita de amplasament al sistemului fotovoltaic

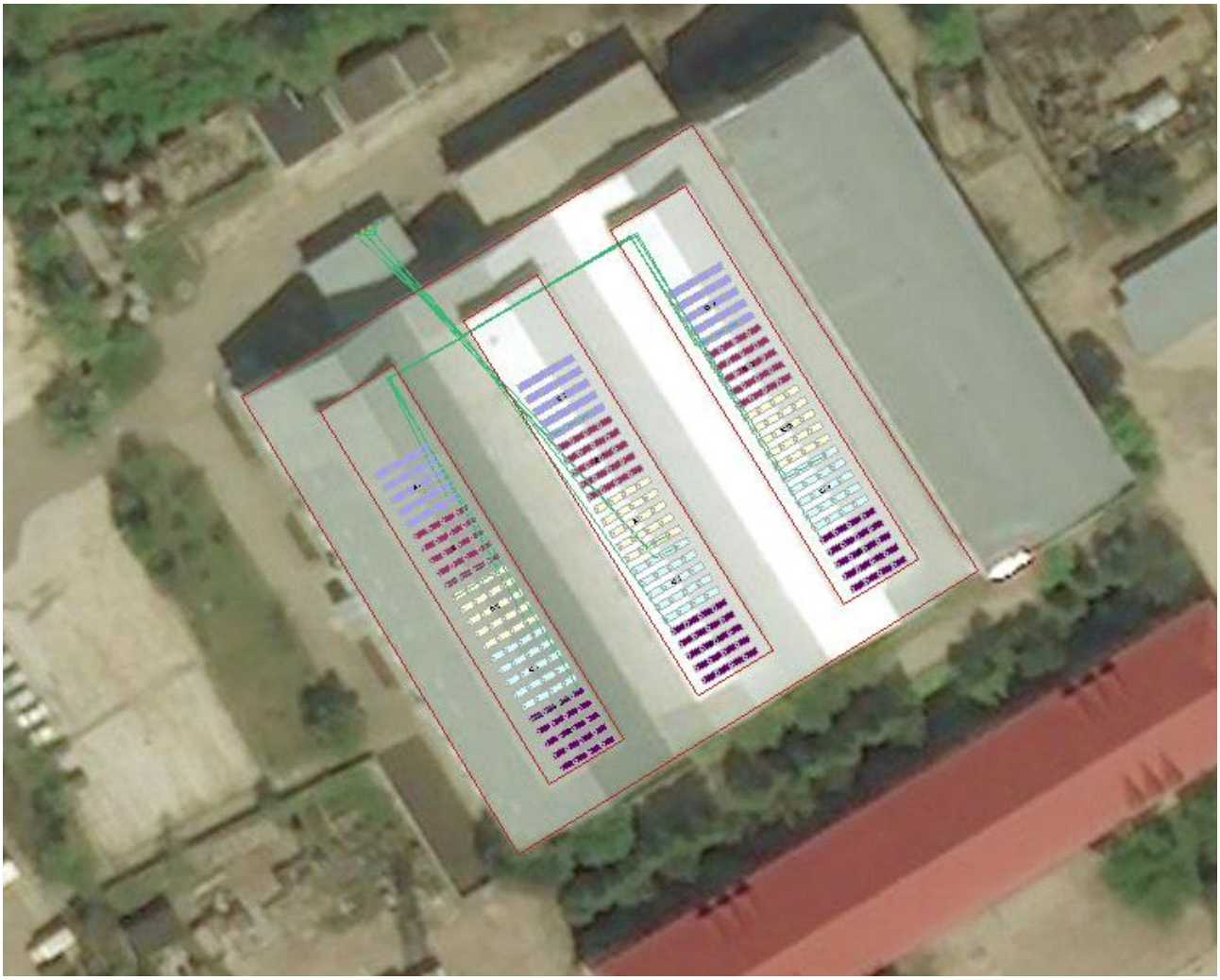


Figura 2a: Schita de amplasament al panourilor fotovoltaice si grupului de conversiune
Sistem PV1 - 150 kWp

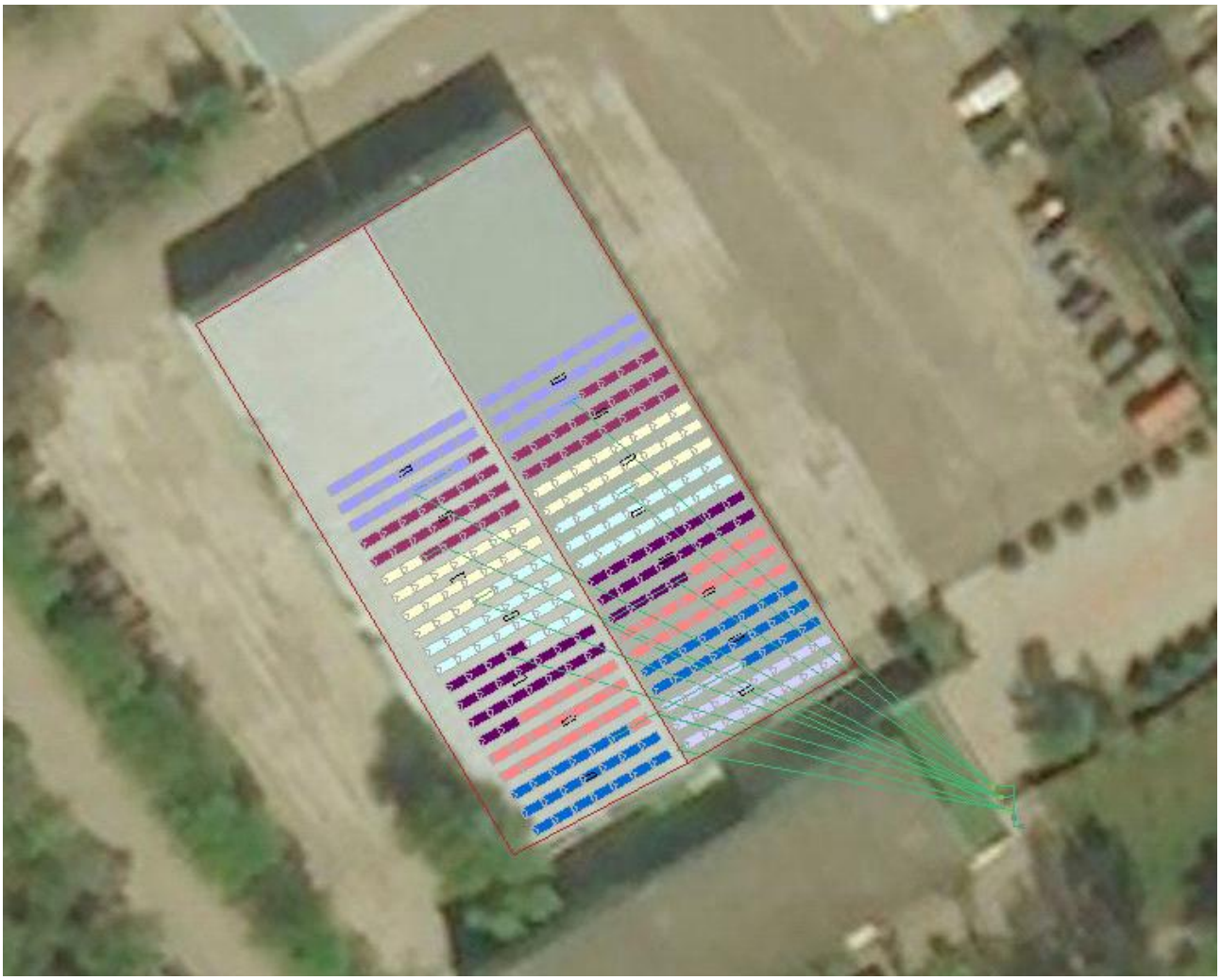


Figura 2b: Schita de amplasament al panourilor fotovoltaice si grupului de conversiune Sistem PV2 - 150 kWp

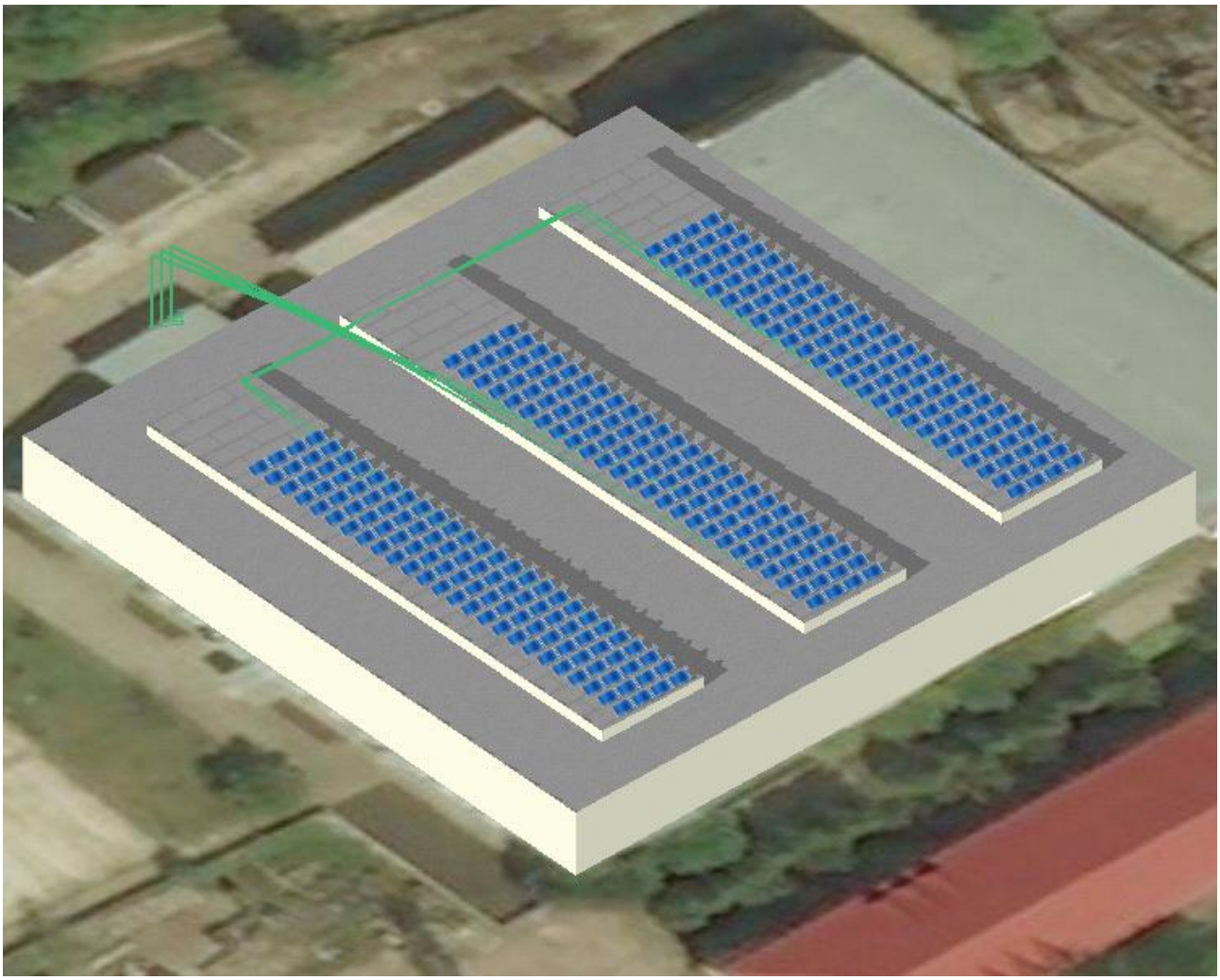


Figura 3a: Vizualizare 3D

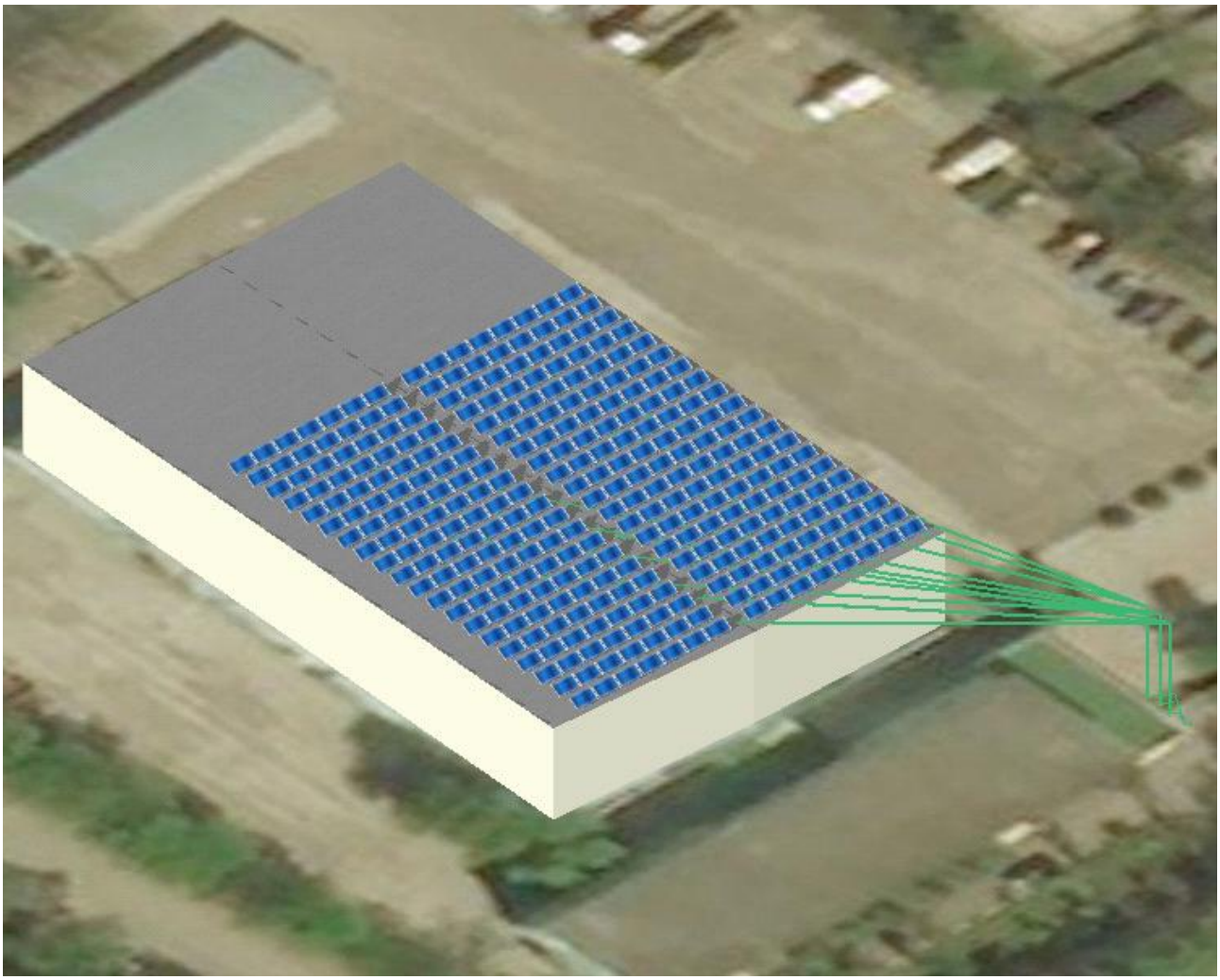


Figura 3b: Vizualizare 3D

3. Calcule prealabile

3.1 - Productivitatea anuala

Sistemul fotovoltaic va fi instalat in localitatea mun.Balti str.Stefan cel Mare 180 "A". Tabelul de mai jos indica datele geografice ale instalatiei.

Date geografice ale instalatiei fotovoltaice	
Locatie	Mun.Balti
Latitudine	47,74°
Longitudine	27,88°
Temperatura maxima	26,40 °C
Temperatura minima	-6,24 °C
Iradiatie	NASA-SSE

Iradiatia zilnica pentru locatia mentionata (pe suprafata orizontala conform NASA-SSE).

Lunile anului	Difusa, zilnic [kWh/m^2]	Directa, zilnic [kWh/m^2]	Globala, zilnic [kWh/m^2]
Ianuarie	0,77	0,51	1,28
Februarie	1,11	0,99	2,10
Martie	1,64	1,43	3,07
Aprilie	2,13	1,79	3,92
Mai	2,48	2,59	5,07
Iunie	2,66	2,58	5,24
Iulie	2,56	2,69	5,25
August	2,24	2,50	4,74
Septembrie	1,71	1,71	3,42
Octombrie	1,17	1,09	2,26
Noiembrie	0,81	0,55	1,36
Decembrie	0,65	0,39	1,04
Anual	**605,90**	**573,05**	**1 178,95**

Valorile medii lunare se calculeaza in baza iradiatiilor zilnice pentru luna respectiva. Tot asa, se calculeaza si valoarea iradiatiei anuale globale pe suprafata orizontala pentru locatia data mun.Balti (MD). Aceasta valoare este egala cu 1 178,95 [kWh/m^2].

Estimarea productibilitatii
Productibilitatea sistemului a fost calculata in baza datelor, derivate din sursa datelor climatice NASA-SSE, pentru locul concret de instalare si in raport cu media globala lunara a radiatiei solare incidente pe suprafata orizontala.

Procedura pentru calcularea energiei produse de sistem ia in considerare puterea nominala (300 kW), unghiul de inclinare si azimut (30° , 150°) al panourilor fotovoltaice, pierderile din sistemul fotovoltaic (pierderi resistive, pierderi datorate diferentelor de temperaturi pe module, pierderi din cauza reflectiei si nepotrivirilor intre siruri), eficienta invertorului, precum si coeficientul de reflectanta a solului si suprafetelor din fata panourilor fotovoltaice (20%) (albedo).

Prin urmare, energia produsa de sistem, estimat pe o baza anuala (Ep, y) se calculeaza dupa cum urmeaza:

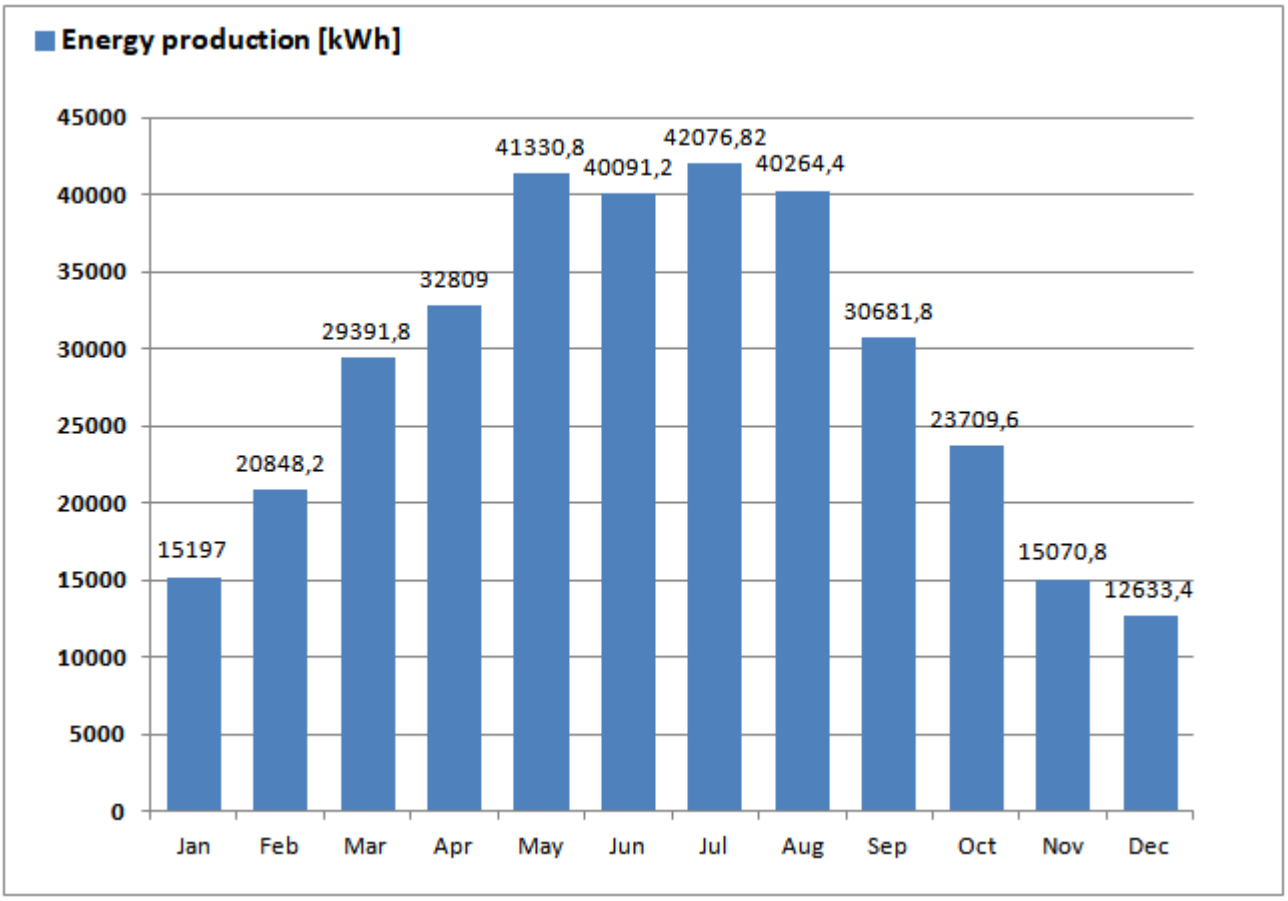
$$Ep,y = Pnom * Irr * (1-Losses) = 344\ 104,82\ kWh$$

Unde:
- Pnom = Puterea nominala a systemului: 300 kW
- Irr = Iradiatia anuala pe suprafata modulelor: 1306,06 kWh/m^2
- Losses = Pierderi de putere: 12,18 %

Pierderile in sistem depind de un sir de factori. Mai jos sunt indicati unii dintre acestia, respectiv, valorile procentuale raportate la capacitatea sistemului.

Pierderi in sistem	
Pierderi din cauza factorilor de temperatura	3,00 %
Pierderi in utilaje	2,00 %
Pierderi resistive	4,00 %
Pierderi conversiune DC/AC	1,80 %
Alte pierderi	2,00 %
Total pierderi	**12,18 %**

Diagrama trendului prognozat de productie lunara de energie electrica pe durata anului



3.2 – Verificarea potrivirii conexiunilor electrice intre modulele fotovoltaice si grupul de conversie DC / AC.

Pentru a alege corect invertorul este necesar de verificat compatibilitatea dintre invertoarele utilizate si campurile fotovoltaice proiectate.
Verificarile la invertoare se refera la segmentul DC a sistemului fotovoltaic, in speta:

- Verificarea tensiunii DC
- Verificarea curentului DC
- Verificarea puterii

Verificarea tensiunii DC
Verificarea tensiunii DC consta in a verifica, daca pe toate circuitele DC, tensiunile furnizate de campul fotovoltaic catre invertor, sunt compatibile cu parametrii tensiunii de intrare a invertorului.

Verificarea curentului DC
Verificarea curentului DC consta in a verifica, ca curentul de scurtcircuit al campului fotovoltaic, pentru conditii @ STC, sa fie mai mic, decat curentul maxim admis de intrare al invertorului.

Verificarea puterii
In acest sens, se verifica ca puterea nominala a grupului de conversie DC / AC (suma puterii nominale a invertorului) sa fie mai mare decat 80% si mai mica decat 120% din puterea nominala a sistemului fotovoltaic.

Rezultatul acestor verificari sunt aratate mai jos.

Inverter:1	
Voltage limits	Mppt1 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt2 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt3 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt4 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt1 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt2 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt3 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt4 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt1 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt2 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt3 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt4 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Limits on current	Mppt1 - Short circuit current (27,8 A) < Maximum inverter current (50 A)
Limits on current	Mppt2 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt3 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt4 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Power limits	Sizing factor on power (80 %) < (100%) < (120 %)

Inverter:2	
Voltage limits	Mppt1 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt2 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt3 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt4 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt1 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
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Voltage limits	Mppt3 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt4 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
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Voltage limits	Mppt2 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt3 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt4 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Limits on current	Mppt1 - Short circuit current (27,8 A) < Maximum inverter current (50 A)
Limits on current	Mppt2 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt3 - Short circuit current (13,9 A) < Maximum inverter current (50 A)

Limits on current	Mppt4 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Power limits	Sizing factor on power (80 %) < (100%) < (120 %)

Inverter:3	
Voltage limits	Mppt1 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt2 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt3 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt4 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt1 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt2 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt3 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt4 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt1 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt2 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt3 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt4 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Limits on current	Mppt1 - Short circuit current (27,8 A) < Maximum inverter current (50 A)
Limits on current	Mppt2 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt3 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt4 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Power limits	Sizing factor on power (80 %) < (100%) < (120 %)

Inverter:4	
Voltage limits	Mppt1 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt2 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt3 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt4 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt1 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt2 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt3 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt4 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt1 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt2 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt3 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt4 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Limits on current	Mppt1 - Short circuit current (27,8 A) < Maximum inverter current (50 A)
Limits on current	Mppt2 - Short circuit current (13,9 A) < Maximum inverter current (50 A)

Limits on current	Mppt3 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt4 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Power limits	Sizing factor on power (80 %) < (100%) < (120 %)

Inverter:5	
Voltage limits	Mppt1 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt2 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt3 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt4 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt1 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt2 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt3 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt4 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt1 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt2 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt3 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt4 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Limits on current	Mppt1 - Short circuit current (27,8 A) < Maximum inverter current (50 A)
Limits on current	Mppt2 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt3 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt4 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Power limits	Sizing factor on power (80 %) < (100%) < (120 %)

Inverter:6	
Voltage limits	Mppt1 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt2 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt3 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt4 - Minimum voltage at module temperature of 70°C (658,96 V) > Minimum voltage of MPPT (200 V)
Voltage limits	Mppt1 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt2 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt3 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt4 - Maximum voltage at module temperature of -20°C (876,24 V) < Maximum voltage of MPPT (1000 V)
Voltage limits	Mppt1 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt2 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt3 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Voltage limits	Mppt4 - Open circuit voltage at module temperature of -20°C (1019,64 V) < Maximum inverter voltage (1100 V)
Limits on current	Mppt1 - Short circuit current (27,8 A) < Maximum inverter current (50 A)

Limits on current	Mppt2 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt3 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Limits on current	Mppt4 - Short circuit current (13,9 A) < Maximum inverter current (50 A)
Power limits	Sizing factor on power (80 %) < (100%) < (120 %)

3.3 – Conductorii electrici

Dimensionarea cablurilor electrice implica urmatoarele calcule:

- Calcularea caderii de tensiune

Calcularea caderii de tensiune
Pentru a cunoaste lungimea conductorilor, tipul de cablu si curentul maxim pe acesta, se va calcula caderea procentuala de tensiune pentru cablul din circuitul DC :

$$\Delta V_{\%} = 2 \cdot \frac{R}{V_{nom}} \cdot I_{nom} \cdot \frac{L}{1000}$$

unde:
L lungimea conductorului, m
I_{nom} curentul in cablu, pentru conditii @STC
V_{nom} tensiunea in cablu, pentru conditii @STC
R rezistenta cablului, per km de cablu, temperatura t=80 °C

De retinut, ca lungimea cablului, tipul de cablu si curentul maxim, calculul caderii procentuale de tensiune pentru linia de curent alternativ, se va efectua in baza relatiei :

Pentru linia monofazata:

$$\Delta V_{\%} = 2 \cdot \frac{\sqrt{R^2 + X^2}}{V_{AC}} \cdot I_{nom} \cdot \frac{L}{1000}$$

Pentru linia trifazata:

$$\Delta V_{\%} = 1{,}73 \cdot \frac{\sqrt{R^2 + X^2}}{V_{AC}} \cdot I_{nom} \cdot \frac{L}{1000}$$

unde:
L lungimea conductorului, m
I_{nom} curentul in cablu, pentru conditii @STC
V_{AC} tensiunea in reteaua de distributie
R, X rezistenta si reactanta in linie (per km, temperatura t=80 °C)

Tabele de referinta pentru cablurile utilizate

Cabluri Sistem 1, 150 kWp					
Model	**Cod**	**Descriere**	**Format**	**Cadere de tensiune**	**Lungime**
C1	VVG 5x70	From: Main panel To: Utility grid	5x70	0,05%	5,37 m
C2	VVG 5x16	From: Inverter:3 To: Main panel	5x16	0,12%	2,35 m
C3	HIKRA SOL 1x4	From: Str:15 To: Inverter:3	1x4	1,91%	100,98 m

C4	HIKRA SOL 1x4	String cable: Str:15	1x4	0,77%	40,96 m
C5	HIKRA SOL 1x4	From: Str:14 To: Inverter:3	1x4	1,75%	92,78 m
C6	HIKRA SOL 1x4	String cable: Str:14	1x4	0,77%	40,93 m
C7	HIKRA SOL 1x4	From: Str:13 To: Inverter:3	1x4	1,59%	83,99 m
C8	HIKRA SOL 1x4	String cable: Str:13	1x4	0,77%	40,74 m
C9	HIKRA SOL 1x4	From: Str:12 To: Inverter:3	1x4	1,56%	82,32 m
C10	HIKRA SOL 1x4	String cable: Str:12	1x4	0,77%	40,6 m
C11	HIKRA SOL 1x4	From: Str:11 To: Inverter:3	1x4	1,38%	73,17 m
C12	HIKRA SOL 1x4	String cable: Str:11	1x4	0,77%	40,65 m
C13	VVG 5x16	From: Inverter:2 To: Main panel	5x16	0,20%	3,96 m
C14	HIKRA SOL 1x4	From: Str:10 To: Inverter:2	1x4	1,80%	95,17 m
C15	HIKRA SOL 1x4	String cable: Str:10	1x4	0,77%	40,8 m
C16	HIKRA SOL 1x4	From: Str:9 To: Inverter:2	1x4	1,63%	86,21 m
C17	HIKRA SOL 1x4	String cable: Str:9	1x4	0,77%	40,8 m
C18	HIKRA SOL 1x4	From: Str:8 To: Inverter:2	1x4	1,59%	84,18 m
C19	HIKRA SOL 1x4	String cable: Str:8	1x4	0,77%	40,86 m
C20	HIKRA SOL 1x4	From: Str:7 To: Inverter:2	1x4	1,41%	74,57 m
C21	HIKRA SOL 1x4	String cable: Str:7	1x4	0,77%	40,92 m
C22	HIKRA SOL 1x4	From: Str:6 To: Inverter:2	1x4	1,21%	64,11 m
C23	HIKRA SOL 1x4	String cable: Str:6	1x4	0,77%	40,96 m
C24	VVG 5x16	From: Inverter:1 To: Main panel	5x16	0,28%	5,51 m
C25	HIKRA SOL 1x4	From: Str:5 To: Inverter:1	1x4	1,80%	95,27 m
C26	HIKRA SOL 1x4	String cable: Str:5	1x4	0,77%	40,93 m
C27	HIKRA SOL 1x4	From: Str:4 To: Inverter:1	1x4	1,63%	86,27 m
C28	HIKRA SOL 1x4	String cable: Str:4	1x4	0,77%	40,96 m
C29	HIKRA SOL 1x4	From: Str:3 To: Inverter:1	1x4	1,45%	76,44 m
C30	HIKRA SOL 1x4	String cable: Str:3	1x4	0,77%	40,83 m
C31	HIKRA SOL 1x4	From: Str:2 To: Inverter:1	1x4	1,41%	74,53 m
C32	HIKRA SOL 1x4	String cable: Str:2	1x4	0,77%	40,93 m
C33	HIKRA SOL 1x4	From: Str:1 To: Inverter:1	1x4	1,21%	63,91 m
C34	HIKRA SOL 1x4	String cable: Str:1	1x4	0,77%	40,95 m

Cabluri Sistem 2, 150 kWp					
Model	**Cod**	**Descriere**	**Format**	**Cadere de tensiune**	**Lungime**
C1	VVG 5x70	From: Main panel To: Utility grid	5x70	0,05%	4,46 m

C2	VVG 5x16	From: Inverter:6 To: Main panel	5x16	0,17%	3,26 m
C3	HIKRA SOL 1x4	From: Str:30 To: Inverter:6	1x4	1,09%	57,54 m
C4	HIKRA SOL 1x4	String cable: Str:30	1x4	0,76%	40,38 m
C5	HIKRA SOL 1x4	From: Str:29 To: Inverter:6	1x4	1,21%	63,94 m
C6	HIKRA SOL 1x4	String cable: Str:29	1x4	0,76%	40,15 m
C7	HIKRA SOL 1x4	From: Str:28 To: Inverter:6	1x4	1,17%	61,79 m
C8	HIKRA SOL 1x4	String cable: Str:28	1x4	0,76%	40,3 m
C9	HIKRA SOL 1x4	From: Str:27 To: Inverter:6	1x4	1,30%	68,51 m
C10	HIKRA SOL 1x4	String cable: Str:27	1x4	0,76%	40,2 m
C11	HIKRA SOL 1x4	From: Str:26 To: Inverter:6	1x4	1,43%	75,55 m
C12	HIKRA SOL 1x4	String cable: Str:26	1x4	0,76%	40,37 m
C13	VVG 5x16	From: Inverter:5 To: Main panel	5x16	0,07%	1,36 m
C14	HIKRA SOL 1x4	From: Str:25 To: Inverter:5	1x4	0,90%	47,77 m
C15	HIKRA SOL 1x4	String cable: Str:25	1x4	0,76%	40,42 m
C16	HIKRA SOL 1x4	From: Str:24 To: Inverter:5	1x4	0,86%	45,61 m
C17	HIKRA SOL 1x4	String cable: Str:24	1x4	0,76%	40,25 m
C18	HIKRA SOL 1x4	From: Str:23 To: Inverter:5	1x4	0,78%	41,35 m
C19	HIKRA SOL 1x4	String cable: Str:23	1x4	0,76%	40,42 m
C20	HIKRA SOL 1x4	From: Str:22 To: Inverter:5	1x4	0,99%	52,55 m
C21	HIKRA SOL 1x4	String cable: Str:22	1x4	0,76%	40,42 m
C22	HIKRA SOL 1x4	From: Str:21 To: Inverter:5	1x4	1,13%	60 m
C23	HIKRA SOL 1x4	String cable: Str:21	1x4	0,76%	40,23 m
C24	VVG 5x16	From: Inverter:4 To: Main panel	5x16	0,26%	5,06 m
C25	HIKRA SOL 1x4	From: Str:20 To: Inverter:4	1x4	0,85%	44,86 m
C26	HIKRA SOL 1x4	String cable: Str:20	1x4	0,77%	40,52 m
C27	HIKRA SOL 1x4	From: Str:19 To: Inverter:4	1x4	1,02%	54,08 m
C28	HIKRA SOL 1x4	String cable: Str:19	1x4	0,77%	40,52 m
C29	HIKRA SOL 1x4	From: Str:18 To: Inverter:4	1x4	1,03%	54,49 m
C30	HIKRA SOL 1x4	String cable: Str:18	1x4	0,76%	40,42 m
C31	HIKRA SOL 1x4	From: Str:17 To: Inverter:4	1x4	1,20%	63,65 m
C32	HIKRA SOL 1x4	String cable: Str:17	1x4	0,76%	40,33 m
C33	HIKRA SOL 1x4	From: Str:16 To: Inverter:4	1x4	1,20%	63,59 m
C34	HIKRA SOL 1x4	String cable: Str:16	1x4	0,77%	40,51 m

Centralizator pentru cablurile folosite in sistem, 300 kWp					
Cod	**Producator**	**Descriere**	**Format**	**Sectiune**	**Lungime**
VVG 5x70	VVG 5x70	VVG 5x70	5x70	70,00 mm^2	9,83 m
VVG 5x16	VVG 5x16	VVG 5x16	5x16	16,00 mm^2	21,50 m
HIKRA SOL 1x4	HIS Renewables GmbH	Nominal voltage 1.5kV DC/1.0kV AC	1x4	4,00 mm^2	5396,62 m