No.

FINAL REPORT

ON

PREPARATORY SURVEY

ON

THE PHOTOVOLTAIC POWER PLANT PROJECT

IN

THE ARAB REPUBLIC OF EGYPT

APPENDIX 2/2

DECEMBER, 2012

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MEE
CR (10)
12-024

Appendix 2/2

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Appendix 2/2

Appendix 3-2-2: Method of Calculating monthly PV module temperature

Appendix 3-2-2 Method of Calculating monthly PV module temperature

Monthly PV module temperature is calculated as weighted average temperature of PV module which is weighted by Global solar radiation. Monthly PV module temperature is as shown in the following formula:

$$T_{CR} = \frac{\left(H_1 \times T_1 + H_2 \times T_2 + \cdots + H_n \times T_n\right)}{\left(H_1 + H_2 + \cdots + H_n\right)}$$

T_{CR} : Monthly PV module temperature [Deg./month]

H : Global solar radiation (measured data from JICA measurement system) [kW/m2/min.]

T : PV module temperature (measured data from JICA measurement system) [Deg./min.]

Appendix 3-3-1: Method of calculating solar radiation

Appendix 3-3-1 Method of Calculating solar radiation

(1) Basic Idea for Fundamental Approach

(a) The calculated amount of Total Solar Radiation at the lifted surface of the photovoltaic panels (the panels/modules) will be necessary for calculating the power energy output as the panels are usually installed in a lifted position.

(b) The amount of Total Solar Radiation at the lifted surface of the panels is total of the following radiation amounts (refer to (2) (b) of this Appendix).

- Amount of Direct Solar Radiation
- Amount of Scattered Solar Radiation at the lifted surface of the panels (radiations from air)
- Amount of Scattered Solar Radiation at the lifted surface of the panels (reflecting radiations from ground surface)

(c) Although the Solar Radiation data to be used for this study is average of 2007 – 2010 data of the Global Solar Radiation provided from Egyptian Methodological Authority and the measured Global Solar radiation data (2011-2012) from the installed measurement system by JICA as shown in Table 3-3-2-1, the Global Solar Radiation is necessary to separate to the 2 components, i.e., Direct Solar Radiation and Scattered Solar Radiation. The Formula of Page (Page, J.K. 1964, refer to the (2) (a) of this Appendix) has been adapted for the separation since it has been used from a long time ago with actual achievements.

(2) Calculation of daily average solar radiation at the lifted surface of the panels

(a) Separation of Direct Solar Radiation and Scattered Solar Radiation from Global Solar Radiation (by using Page Formula).

Calculate horizontal Scattered Solar Radiation (Hd) and horizontal Direct Solar Radiation (Hb) from Global Solar Radiation (H) in Table 3-3-2-1, by using the next formula of Page (Page, J.K. 1964).

Formula of separation: $(Hd / H) = 1.00 - 1.13 (H / Ho)$

Hd: Scattered Solar Radiation of horizontal surface

H: Global Solar Radiation

Ho: Solar Radiation of horizontal surface outside the atmosphere

Here, Ho is derived from the next formula.

$$Ho = (24/\pi) \cdot Isc \cdot \{1 + 0.033 \cdot \cos\{2\pi(n-2)/365\}\} \cdot (\cos\phi \cdot \cos\delta \cdot \sin\omega s + \omega s \cdot \sin\phi \cdot \sin\delta)$$

Isc : solar constants; 1.382kWm^{-2}

n : day serial number of setting January 1st as '1' ending in "365" which is December 31st.

ø : latitude of location (deg.)

δ : celestial declination (deg.)

ωs : solar sunset hour angle against the horizon line

$\omega s = \cos^{-1}(-\tan ø \tan\delta)$

As for the relational formula of H = Hb + Hd, direct solar radiation Hb is as follows.

Hb = H - Hd

(b) Based on the above, Daily Average Solar Radiation at the lifted surface of the panel (H_β) can be calculated by the following formula:

$$H_\beta = \underline{Rb \cdot Hb} + \underline{\mathrm{Fs} \cdot \mathrm{Hd}} + \underline{\mathrm{Fg} \cdot \rho \cdot \mathrm{H}}$$

→ *Scattered Solar Radiation (from ground surface)*
→ *Scattered Solar Radiation (from air)*
→ *Direct Solar Radiation*

Rb : lifted surface conversion coefficient

Hb : Direct Solar Radiation of horizontal surface

Fs : figuration coefficient for lifted surface against sky

$Fs = 0.5(1 + \cos\beta)$

β : lifted angle of the panel

Hd : scattered solar radiation of horizontal surface

Fg: figuration coefficient for lifted surface against ground

Fg = 1 - Fs

ρ : solar radiation reflection coefficient of ground surface

H: Daily Average Global Solar Radiation (Table 3-3-2-1)

(c) The Calculation of lifted surface conversion coefficient (Rb) with each angles are as shown in the following formula:

Rb = cosθ / sinh (θ: incidence angle of solar radiation incoming into lifted surface, h: height angle of sun)

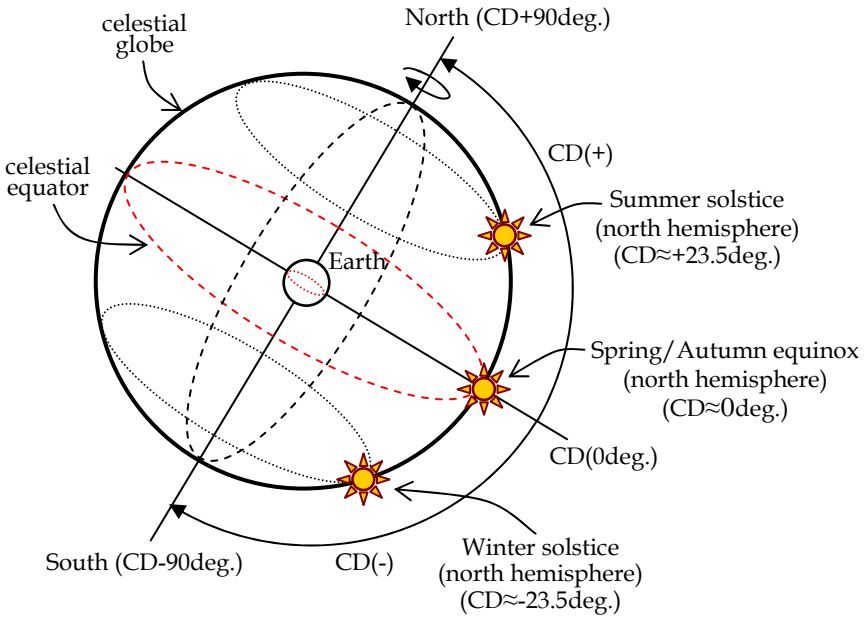
cosθ is derived from the next formula.

$$\cos\theta = (\sin\delta \sin\phi \cos\beta - \sin\delta \cos\phi \sin\beta \cos\gamma) + (\cos\delta \cos\phi \cos\beta \cos\varpi) + (\cos\delta \sin\phi \sin\beta \cos\gamma \cos\omega) + (\cos\delta \sin\beta \sin\gamma \sin\omega)$$

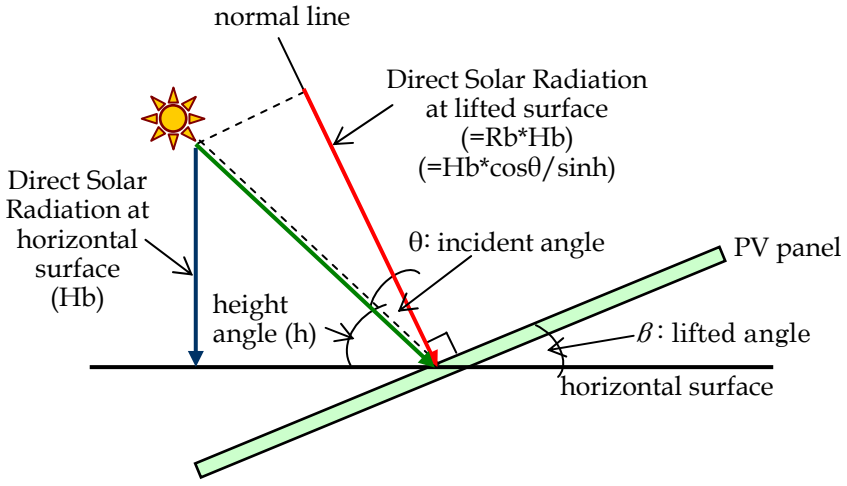
Here, δ is celestial declination (deg.), ø: latitude (deg.), ω: hour angle (deg.)

sinh is derived from the next formula.

$$\sinh = \sin\delta \sin\phi + \cos\delta \cos\phi \cos\omega$$



CD: celestial declination



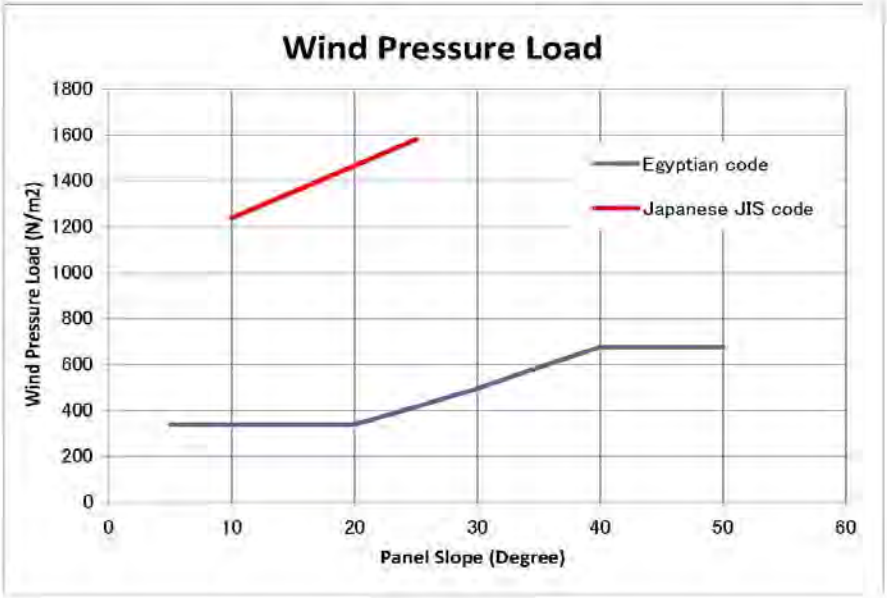
Appendix 3-3-2: Calculation of wind load and seismic load for PV foundation

Appendix 3-3-2 Calculation of wind load and seismic load for PV foundation

1. Wind load for PV foundation

Wind Speed (m/s) = 26 Air Density (kg/m^3) = 1.25

Angle(degrees)	Ce	Wind Pressure (N/m^2)	
		Egyptian code	Japanese JIS code
5	0.80	338	
10	0.80	338	1239
15	0.80	338	1352
20	0.80	338	1466
25	0.98	415	1581
30	1.17	495	
35	1.39	588	
40	1.60	676	
45	1.60	676	
50	1.60	676	



Wind Pressure Equation from Egyptian Code #201 (General code for loads and forces calculation in civil works and buildings construction)

$$Pe = C_e \times K_e \times q \qquad (1)$$

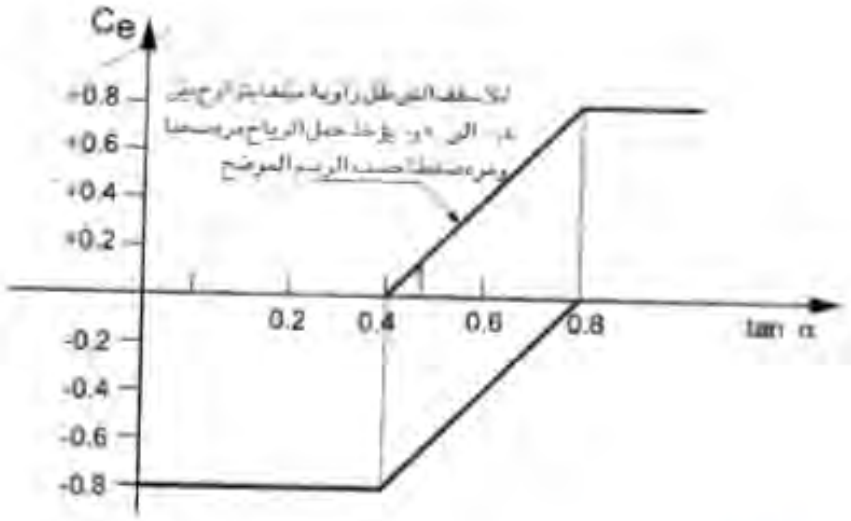
$$q = 0.5 \times \rho \times V^2 \times C_t \times C_s \qquad (2)$$

Where:

P_e = Wind external pressure acting statically on unit area of an external surface of a building
q = basic wind pressure, relevant to geographical location
k_e=Exposure Coefficient. Changes according to elevation
C_e = Wind pressure Coefficient, depends on building geometry
V = Wind Speed (36 for Hurghada)
ρ = Air Density (1.25 Kg/m^3)
C_t = Topography Coefficient
C_s = Construction Coefficient (=1 for buildings of height <60 m)

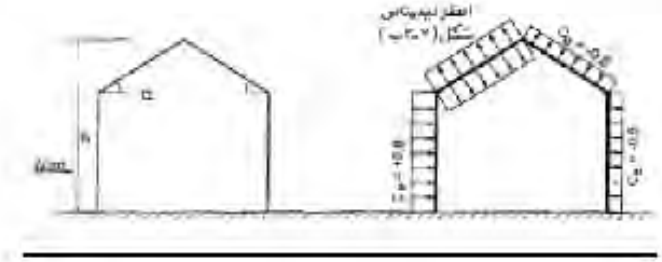
	Open Exposure	Suburban Exposure	City Centre Exposure
Elevation (m)		**K**	
0-10	1	1	1
10-20	1.15	1	1
20-30	1.4	1	1
30-50	1.6	1.05	1
50-80	1.85	1.3	1
80-120	2.1	1.5	1.15
120-160	2.3	1.7	1.36
160-240	2.5	1.85	1.55

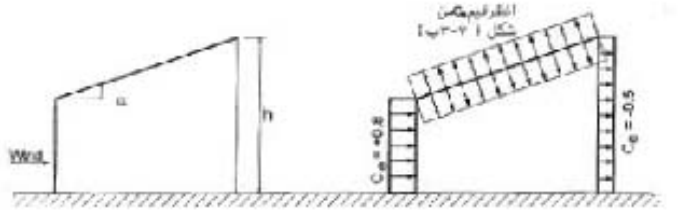
Surface condition of land surrounding the building	**C_t**
Slope rate less than 5% for an area with a minimum of 1 Km diameter	1
Surrounding land is relatively un-flat with a slope rate equals:	
5-10%	1.2
10-15%	1.4
15-20%	1.6
20-25%	1.8
>25%	1.8
Mountains, hills and similar types	1
Mountains' summits	1.8

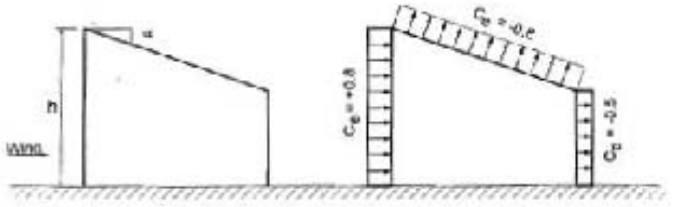


The Figure reads:

For roofs with slope angle tan between 0.4 & 0.8 and the wind load is taken once as suction and the once as pressure as shown in the figure







Wind Speed:

Wind speed's values can be found in the table below. For regions and areas not covered by this table, the value of the closest location from the locations below should be used. Wind speeds represent gust of 3 seconds at a height of 10 m above ground with a probability of occurrence that does not exceed 2% over a 50 year interval.

Location	Wind Speed (m/s)
Marsa Matrouh/ Dab'aa / Zaafarana	42
Saloom	39
Alexandria / Hurghada / Abu Soweir / and other coastal regions	36
Cairo / Assiut / Dakhla / Aswan / Siwa / Luxor	33
Menia / Fayoum / Tanta / Modeereyet El Tahrir / Mansoura	30

2. Seismic load for PV foundation in Egypt

Horizontal seismic load for foundation

K=k×G

where K :Seismic load(N)

k :Horizontal seismic coefficient

G :Total weight of mounting foundation (N)

The Hurghada is located along the Gulf of Suez seismic belt, which is known as one of the active seismic zones in Egypt. According to Seismic Activity Zones, Egypt is divided in terms of seismic impact into five zones. Hurghada is in zone 5a and value of k (Horizontal seismic coefficient) is 0.25g.

Egyptian Building Code Section 8 - Earthquake loads

8.4. Earthquake Actions

8.4.1. Earth Quake Zones

1- Egypt is divided in terms of seismic impact into five zones according to Design Basis Earthquake Ground Motion (DBEGM), or Peak Ground Acceleration (PGA) values are shown in table (8.2). Zones are shown in Figure 8.1

Table (8.2) Zones in Egypt in terms of seismic impact

Zone	DBEGM (a_g)
Zone 1	0.1 g
Zone 2	0.125 g
Zone 3	0.15 g
Zone 4	0.20 g
Zone 5a	0.25 g
Zone 5b	0.3 g

*Hurghada is in Zone 5a

2- Seismic impact is determined for most of the code applications according to the quantity of the coefficient (a_g) which represents the acceleration of the ground motion in a rock layer or hard soil, and is known as "design basis earthquake ground motion", or "Peak Ground Acceleration (PGA)". There are other important coefficients that affect the determination of earthquake load for example, the importance of the building.

3- Refer to the earthquake map in Figure (8.1) which is specified considering that the assumed return time for earth quakes is assumed to be 475 years. g=9.81 m/s^2.

4- Buildings should be designed taking into account the peak ground acceleration for each zone.

Figure(8.1) Seismic Active Zones

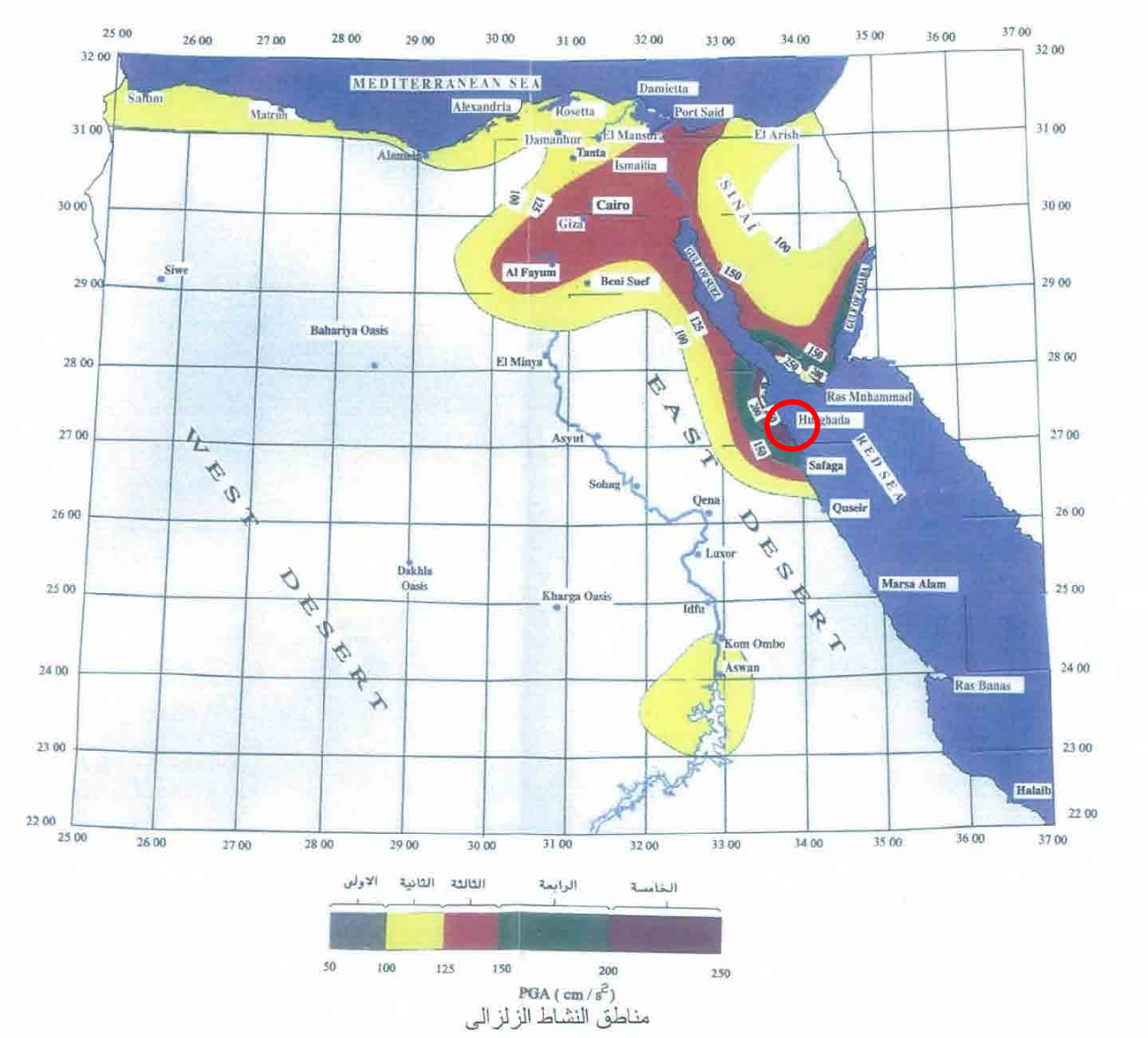


Table Calculation for Seismic Loads of PV foundation

Type of Module		Poly Crystallize	CIS	Tandem Thin Film
Tilted Angle 25°	Weight of PV Panel and Mounting Structure (kN)	2.466	3.103	3.531
	Seismic Coefficient (k)	0.25	0.25	0.25
	Seismic Load (kN)	**0.617**	**0.776**	**0.883**
20°	Weight of PV Panel and Mounting Structure (kN)	2.447	3.084	3.512
	Seismic Coefficient (k)	0.25	0.25	0.25
	Seismic Load (kN)	**0.612**	**0.771**	**0.878**
15°	Weight of PV Panel and Mounting Structure (kN)	2.426	3.063	3.491
	Seismic Coefficient (k)	0.25	0.25	0.25
	Seismic Load (kN)	**0.607**	**0.766**	**0.873**
10°	Weight of PV Panel and Mounting Structure (kN)	2.410	3.047	3.475
	Seismic Coefficient (k)	0.25	0.25	0.25
	Seismic Load (kN)	**0.607**	**0.766**	**0.873**

$K=k\times G$

where K :Seismic load(N)

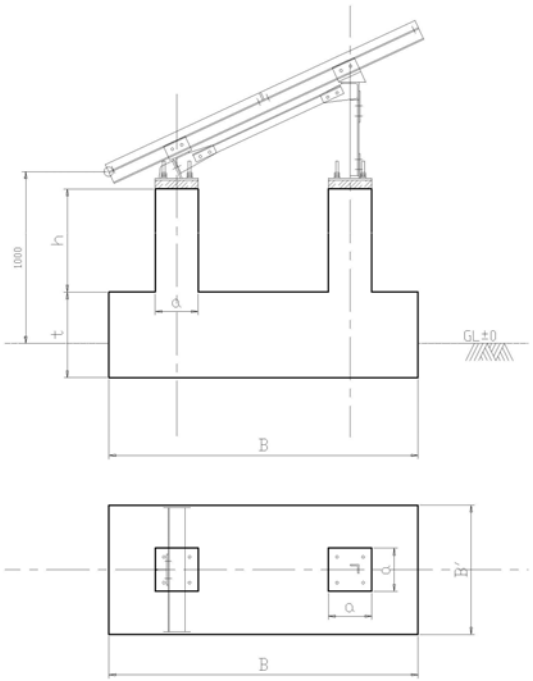
k :Horizontal seismic coefficient

G :Total weight of mounting foundation (N)

Appendix 3-3-3: Calculation of PV foundation

Appendix 3-3-3 Calculation of PV foundation

Calculation result of Foundation for Poly crystallize

Type of Module		Poly Crystallize			
Foundation Shape					
Tilted Angle (°)		25	20	15	10
Size (m)	a	0.25	0.25	0.25	0.25
	h	0.8	0.8	0.8	0.8
	B	1.5	1.5	1.5	1.5
	B′	0.4	0.4	0.4	0.4
	t	0.3	0.3	0.3	0.3
Result of Study	Uplift	Nil	Nil	Nil	Nil
	Compression	1.63 ≧ 1.20	1.94 ≧ 1.20	2.10 ≧ 1.20	2.27 ≧ 1.20
	Overturning	0.247 ≦ 0.500	0.146 ≦ 0.500	0.105 ≦ 0.500	0.066 ≦ 0.500
	Sliding	12.65 ≧ 1.20	19.21 ≧ 1.20	25.38 ≧ 1.20	37.78 ≧ 1.20
Concrete Volume of One Foundation (m^3)		0.280	0.280	0.280	0.280

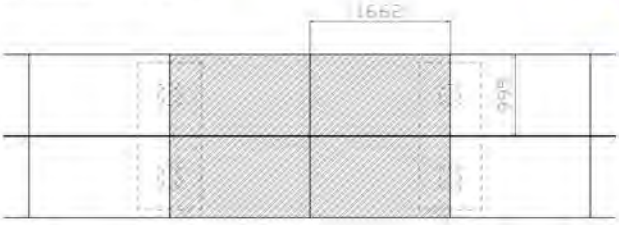
Design of the foundaiton for PV

1 Polly Crystallize type : Tilted angle 25°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.662 × 0.995 × 4 = 6.615 m^2

Weight for one foundation (WG) = = 2.466 kN



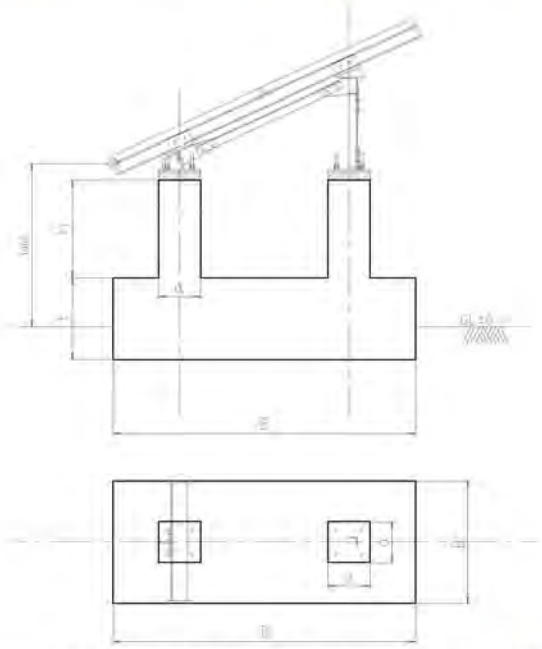
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

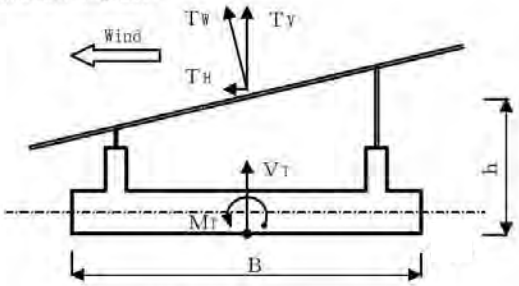
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

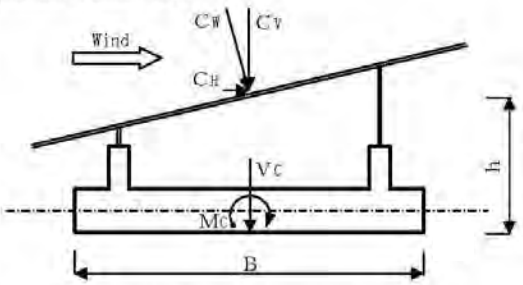


Supporting area (A =	1.662	×	0.995	×	4	=	6.615	m^2
Uplifting force (Tw.=						=	2.746	kN
Vertical (TV)	=	Tw	×	cos25°		=	2.489	kN
Horizontal (TH)	=	Tw	×	sin25°		=	1.161	kN
Overturning Moment (Mt)	=	TH	×	h		=	1.650	kN・m
		(h=	1.421	m)				

Tension load(Vt)	=	TV	−	WG	−	WC'	=	−6.697 kN

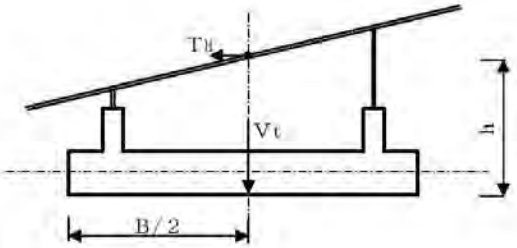
Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load



Supporting area (A =	1.662 × 0.995 × 4		=	6.615 m^2
Compression force (Tw)	=		=	2.746 kN
Vertical(CV)	= Cw × cos25°		=	2.489 kN
Horizontal(CH)	= Cw × sin25°		=	1.161 kN
Overturning Morment(Mc)	= CH × h		=	1.650 kN･m
	(h= 1.421 m)			
Vertical loads(Vc) =	CV + WC + WG		=	11.675 kN
Eccentric distance(e)	= Mc / Vc		=	0.142 m
α	= 1 + 6e / B		=	1.568
Ground reaction(σcmax)	= α × Vc / (B × B')		=	30.511 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand		=	50 kN/m^2
◎ Factor of safety(F) =	qa / σcmax	= 1.63	≧ 1.2	･･･【OK】

5) Overturning



Vertical loads (Vt) =		=	6.697 kN
Overturning moment(Mo)	= TH × h	=	1.650 kN・m
○ Eccentric distance(e)	= Mo / Vt	=	0.247 m

◎	e	= 0.247	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)		=	1.161 kN
Wind load(TH) = 1.161 kN Uplift	= 1.161 kN Compression		
○ Passive earth pressure(Pp)	= Kp × γ × h × B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	= tan^2 (45° + φ / 2)	=	2.882 kN
Unit weight(γ)	= loose sand	=	17.0 kN/m^3
Embedded length(h)	=	=	200 mm
Footing Width(B)	=	=	1500 mm
Internal friction angle(φ)	= 15 + √(20 × N)	=	29 °

◎ Factor of safety(F) =	Pp / Q	= 12.65	≧	1.2	・・・【OK】

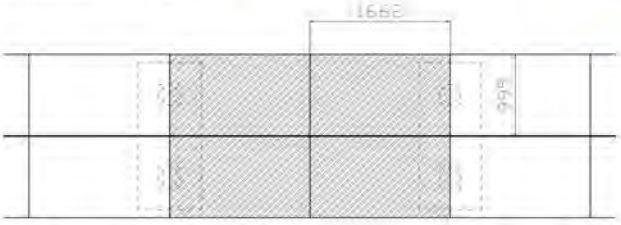
Design of the foundaiton for PV

1 Polly Crystallize type : Tilted angle 20°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.662 × 0.995 × 4 = 6.615 m^2

Weight for one foundation (WG) = = 2.447 kN



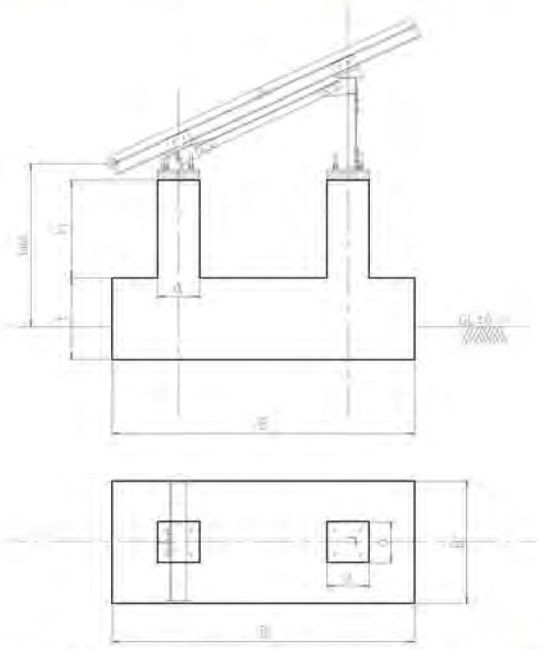
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

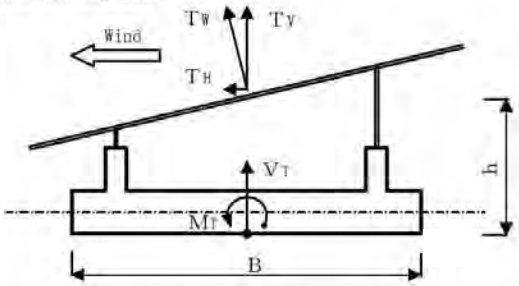
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load



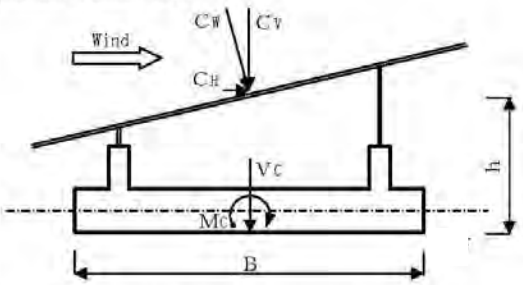
Supporting area (A =	1.662	×	0.995	×	4	=	6.615 m^2
Uplifting force (Tw) =						=	2.236 kN
Vertical (TV)	=	Tw	×	cos20°		=	2.102 kN
Horizontal (TH)	=	Tw	×	sin20°		=	0.765 kN
Overturning Moment (Mt)	=	TH	×	h		=	1.026 kN・m

(h= 1.34 m)

Tension load(Vt)	=	TV	−	WG	−	WG'	= −7.065 kN

Because weight is bigger than uplifting load, tension load is not occurred.

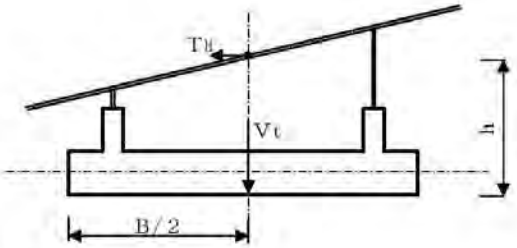
4) Stability against compression load



Supporting area (A =	1.662 × 0.995 × 4	=	6.615	m^2
Compression force (Tw)	=	=	2.236	kN
Vertical(CV)	= Cw × cos20°	=	2.102	kN
Horizontal(CH)	= Cw × sin20°	=	0.765	kN
Overturning Morment(Mc)	= CH × h	=	1.026	kN・m
	(h= 1.34 m)			
Vertical loads(Vc) =	CV + WC + WG	=	11.269	kN
Eccentric distance(e)	= Mc / Vc	=	0.092	m
α	= 1 + 6e / B	=	1.368	
Ground reaction(σcmax)	= α × Vc / (B × B')	=	25.694	kN/m^2
○ Allowable bearing capacity(pa)	: loose sand	=	50	kN/m^2

◎ Factor of safety(F) =	qa / σcmax	= 1.94	≧	1.2	・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.065 kN
Overturning moment(Mo)	=	TH	×	h		=	1.026 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.146 m

◎	e	=	0.146	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)						=	0.765 kN
Wind load(TH)	=	0.765 kN	Uplift	=	0.765 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	× γ ×	h	×	B	= 14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ	/ 2)	= 2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °

◎ Factor of safety(F) =	Pp	/	Q	=	19.21	≧	1.2 ・・・【OK】

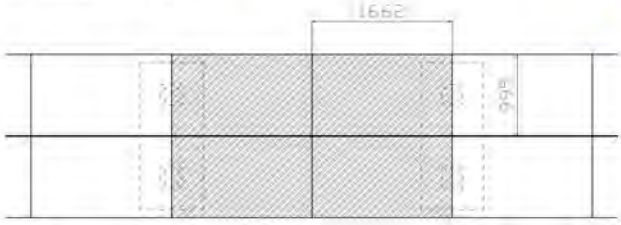
Design of the foundaiton for PV

1 Polly Crystallize type : Tilted angle 15°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.662 × 0.995 × 4 = 6.615 m^2

Weight for one foundation (WG) = = 2.426 kN



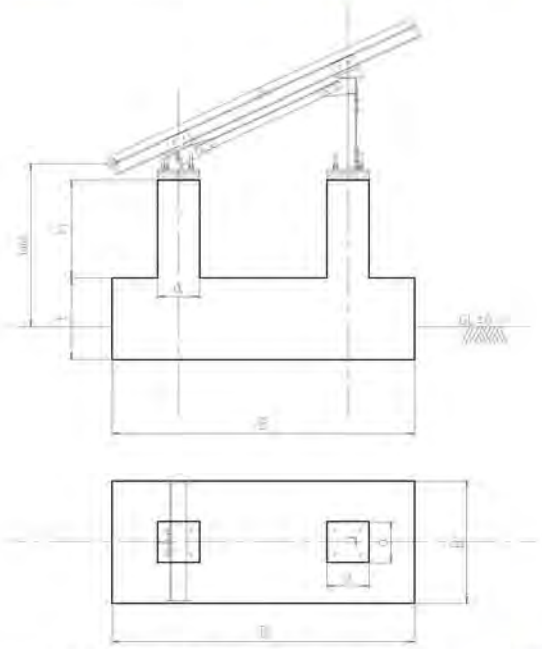
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

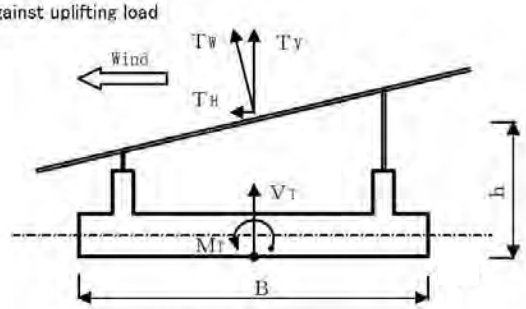
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

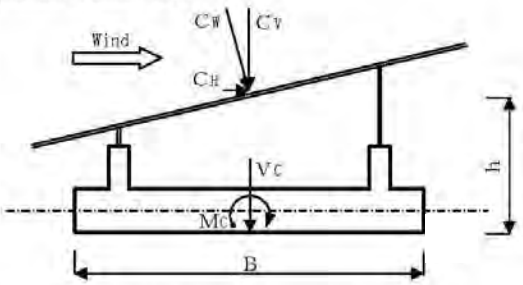


Supporting area (A =	1.662	×	0.995	×	4	=	6.615	m^2
Uplifting force (Tw.=						=	2.236	kN
Vertical (TV)	= Tw	×	cos15°			=	2.160	kN
Horizontal (TH)	= Tw	×	sin15°			=	0.579	kN
Overturning Moment (Mt)	= TH	×	h			=	0.729	kN・m
	(h=	1.258	m)					

Tension load(Vt)	= TV	−	WG	−	WC'	=	−6.986 kN

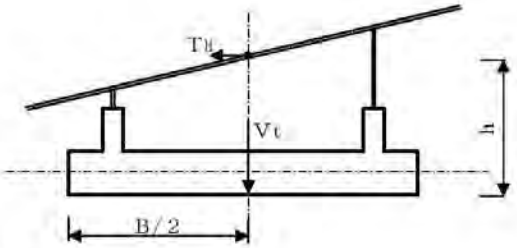
Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load



Supporting area (A =	1.662 × 0.995 × 4		=	6.615 m^2
Compression force (Tw)	=		=	2.236 kN
Vertical(CV)	= Cw × cos15°		=	2.160 kN
Horizontal(CH)	= Cw × sin15°		=	0.579 kN
Overturning Morment(Mc)	= CH × h		=	0.729 kN・m
	(h= 1.258 m)			
Vertical loads(Vc) =	CV + WC + WG		=	11.306 kN
Eccentric distance(e)	= Mc / Vc		=	0.065 m
α	= 1 + 6e / B		=	1.260
Ground reaction(σcmax)	= α × Vc / (B × B')		=	23.743 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand		=	50 kN/m^2
◎ Factor of safety(F) =	qa / σcmax	= 2.10	≧ 1.2	・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	6.986 kN
Overturning moment(Mo)	=	TH	×	h		=	0.729 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.105 m

◎	e	=	0.105	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)						=	0.579 kN
Wind load(TH)	=	0.579 kN	Uplift	=	0.579 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	×	γ	× h × B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ / 2)	=	2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °

◎ Factor of safety(F) =	Pp	/	Q	=	25.38	≧	1.2 ・・・【OK】

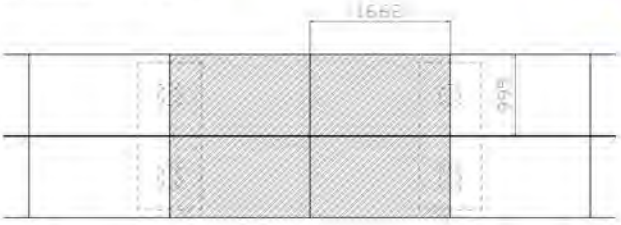
Design of the foundaiton for PV

1 Polly Crystallize type : Tilted angle 10°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.662 × 0.995 × 4 = 6.615 m^2

Weight for one foundation (WG) = = 2.410 kN



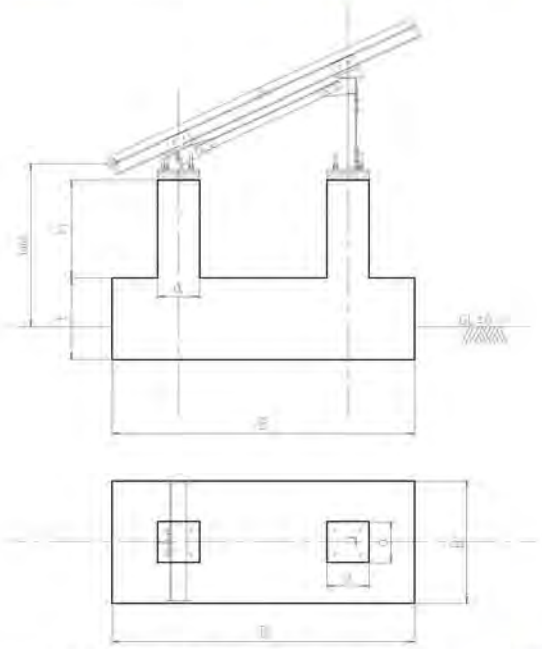
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

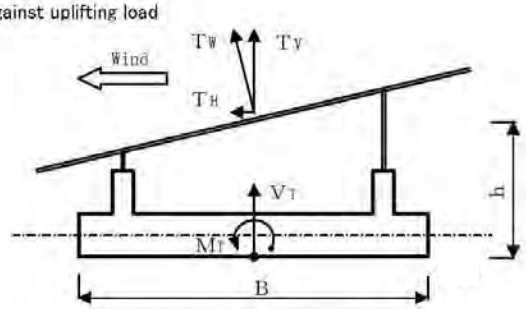
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

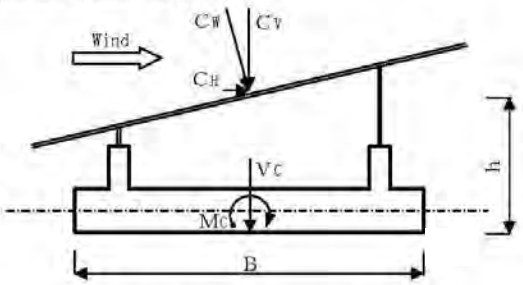


Supporting area (A =	1.662	×	0.995	×	4	=	6.615	m^2
Uplifting force (Tw) =						=	2.236	kN
Vertical (TV)	=	Tw	×	cos10°		=	2.203	kN
Horizontal (TH)	=	Tw	×	sin10°		=	0.389	kN
Overturning Moment (Mt)	=	TH	×	h		=	0.457	kN・m
		(h=	1.173	m)				

Tension load(Vt)	=	TV	−	WG	−	WC'	=	−6.927 kN

Because weight is bigger than uplifting load, tension load is not occurred.

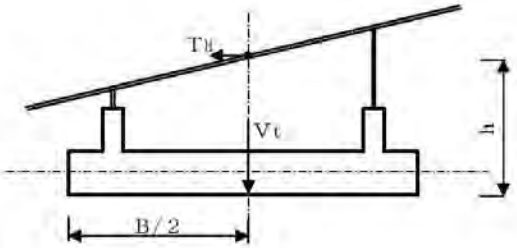
4) Stability against compression load



Supporting area (A =	1.662 × 0.995 × 4	=	6.615	m^2
Compression force (Tw)	=	=	2.236	kN
Vertical(CV)	= Cw × cos10°	=	2.203	kN
Horizontal(CH)	= Cw × sin10°	=	0.389	kN
Overturning Morment(Mc)	= CH × h	=	0.457	kN・m
	(h= 1.173 m)			
Vertical loads(Vc) =	CV + WC + WG	=	11.333	kN
Eccentric distance(e)	= Mc / Vc	=	0.041	m
α	= 1 + 6e / B	=	1.164	
Ground reaction(σcmax)	= α × Vc / (B × B')	=	21.987	kN/m^2
○ Allowable bearing capacity(pa)	: loose sand	=	50	kN/m^2

◎ Factor of safety(F) =	qa / σcmax	= 2.27	≧	1.2	・・・【OK】

5) Overturning



Vertical loads (Vt) =		=	6.927 kN
Overturning moment(Mo)	= TH × h	=	0.457 kN・m
○ Eccentric distance(e)	= Mo / Vt	=	0.066 m

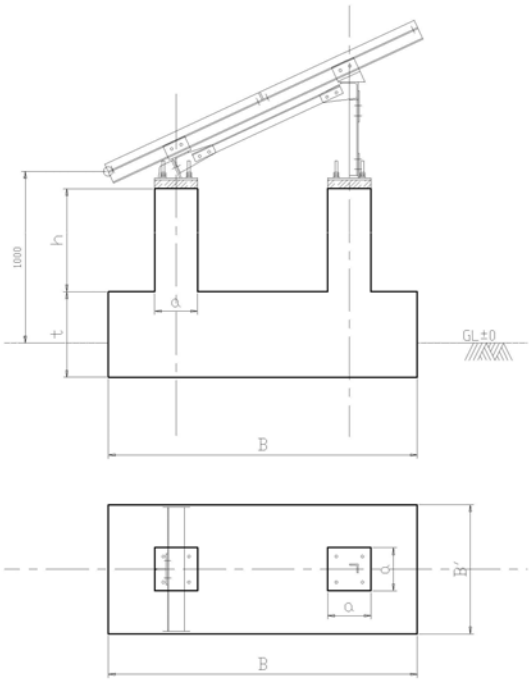
◎	e	= 0.066	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)		=	0.389 kN
Wind load(TH) = 0.389 kN Uplift	= 0.389 kN Compression		
○ Passive earth pressure(Pp)	= Kp × γ × h × B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	= tan^2 (45° + φ / 2)	=	2.882 kN
Unit weight(γ)	= loose sand	=	17.0 kN/m^3
Embedded length(h)	=	=	200 mm
Footing Width(B)	=	=	1500 mm
Internal friction angle(φ)	= 15 + √(20 × N)	=	29 °

◎ Factor of safety(F) =	Pp / Q	= 37.78	≧	1.2	・・・【OK】

Calculation result of Foundation for CIS

Type of Module		CIS			
Foundation Shape					
Tilted Angle (°)		25	20	15	10
Size (m)	a	0.25	0.25	0.25	0.25
	h	0.8	0.8	0.8	0.8
	B	1.5	1.5	1.5	1.5
	B′	0.4	0.4	0.4	0.4
	t	0.3	0.3	0.3	0.3
Result of Study	Uplift	Nil	Nil	Nil	Nil
	Compression	1.50 ≧ 1.20	1.78 ≧ 1.20	1.93 ≧ 1.20	2.09 ≧ 1.20
	Overturning	0.262 ≦ 0.500	0.154 ≦ 0.500	0.111 ≦ 0.500	0.070 ≦ 0.500
	Sliding	11.30 ≧ 1.20	17.15 ≧ 1.20	22.64 ≧ 1.20	33.78 ≧ 1.20
Concrete Volume of One Foundation (m^3)		0.280	0.280	0.280	0.280

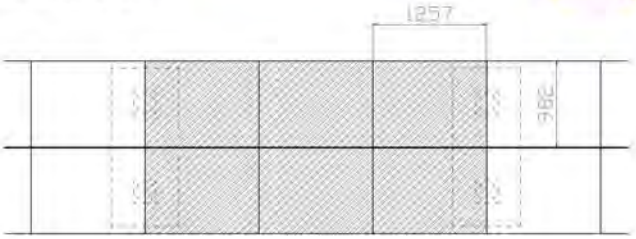
Design of the foundaiton for PV

1 CIS type : Tilted angle 25°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.257 × 0.982 × 6 = 7.406 m^2

Weight for one foundation (WG) = = 3.103 kN



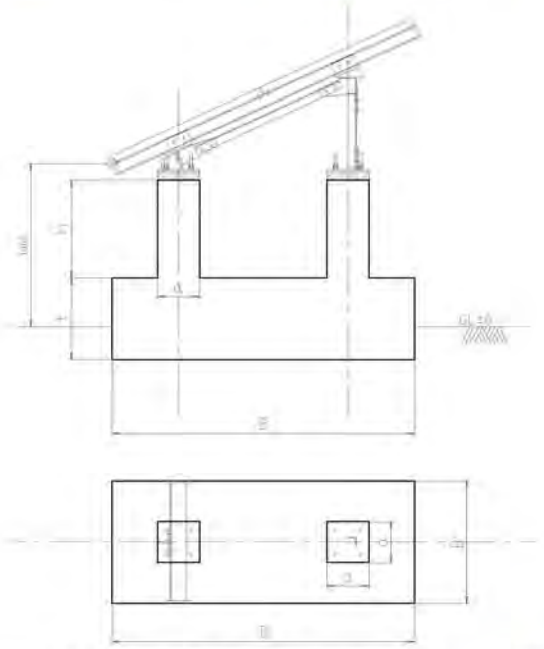
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

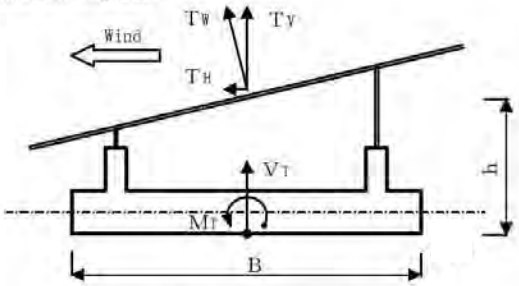
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

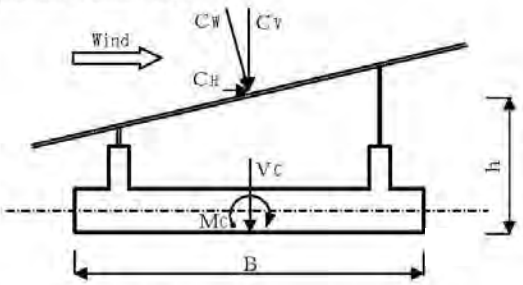


Supporting area (A =	1.257	×	0.982	×	6	=	7.406	m^2
Uplifting force (Tw.=						=	3.074	kN
Vertical (TV)	=	Tw	×	cos25°		=	2.786	kN
Horizontal (TH)	=	Tw	×	sin25°		=	1.300	kN
Overturning Moment (Mt)	=	TH	×	h		=	1.840	kN・m
		(h=	1.415	m)				

Tension load(Vt)	=	TV	−	WG	−	WC'	=	−7.037 kN

Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load

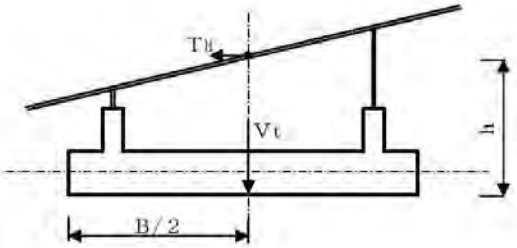


Supporting area (A =	1.257	×	0.982	×	6	= 7.406 m^2
Compression force (Tw)	=					= 3.074 kN
Vertical(CV)	=	Cw	×	cos25°		= 2.786 kN
Horizontal(CH)	=	Cw	×	sin25°		= 1.300 kN
Overturning Morment(Mc)	=	CH	×	h		= 1.840 kN・m
		(h=	1.415	m)		
Vertical loads(Vc) =	CV	+	WC	+	WG	= 12.609 kN
Eccentric distance(e)	=	Mc	/	Vc		= 0.146 m
α	= 1 +	6e	/	B		= 1.584
Ground reaction(σcmax)	=	α	×	Vc	/ (B × B')	= 33.288 kN/m^2

○ Allowable bearing capacity(pa) : loose sand = 50 kN/m^2

◎ Factor of safety(F) = qa / σcmax = 1.50 ≧ 1.2 ・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.037 kN
Overturning moment(Mo)	=	TH	×	h		=	1.840 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.262 m

◎	e	=	0.262	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)						=	1.300 kN
Wind load(TH)	=	1.300 kN	Uplift		= 1.300 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	×	γ	× h × B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ / 2)	=	2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °

◎ Factor of safety(F) =	Pp	/	Q	=	11.30	≧	1.2 ・・・【OK】

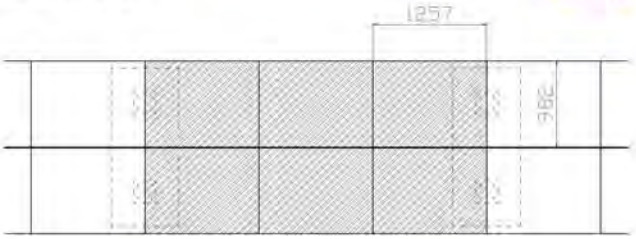
Design of the foundaiton for PV

1 CIS type : Tilted angle 20°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.257 × 0.982 × 6 = 7.406 m^2

Weight for one foundation (WG) = = 3.084 kN



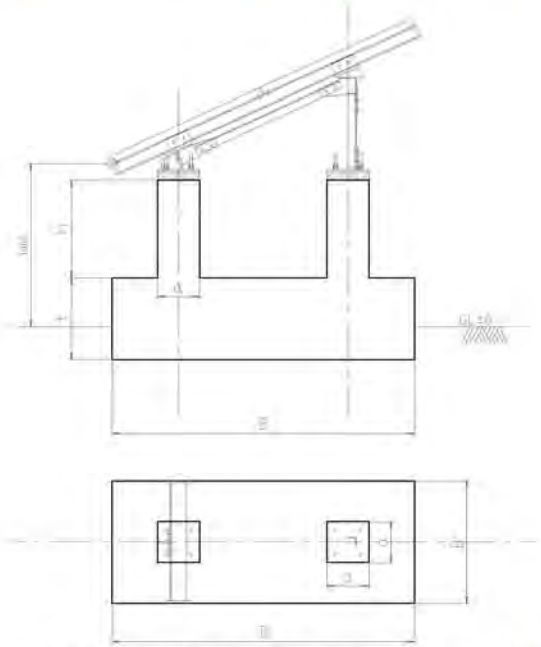
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

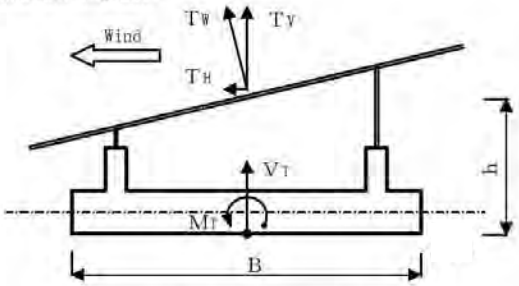
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

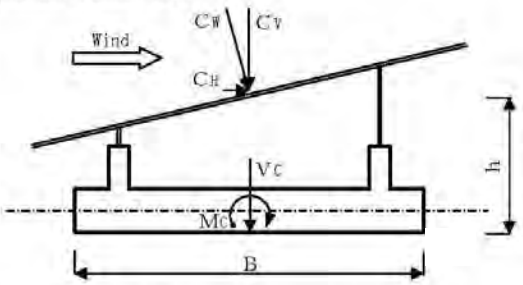


Supporting area (A =	1.257	×	0.982	×	6	=	7.406 m^2
Uplifting force (Tw.=						=	2.504 kN
Vertical (TV)	= Tw	×	cos20°			=	2.353 kN
Horizontal (TH)	= Tw	×	sin20°			=	0.857 kN
Overturning Moment (Mt)	= TH	×	h			=	1.145 kN・m
	(h=	1.336	m)				

Tension load(Vt)	= TV	−	WG	−	WC'	=	−7.451 kN

Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load

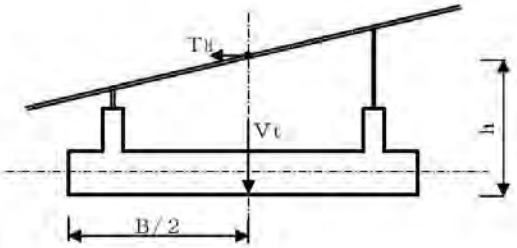


Supporting area (A =	1.257 ×	0.982 ×	6	=	7.406 m^2
Compression force (Tw)	=			=	2.504 kN
Vertical(CV)	= Cw ×	cos20°		=	2.353 kN
Horizontal(CH)	= Cw ×	sin20°		=	0.857 kN
Overturning Morment(Mc)	= CH ×	h		=	1.145 kN・m
	(h=	1.336 m)			
Vertical loads(Vc) =	CV +	WC +	WG	=	12.157 kN
Eccentric distance(e)	= Mc /	Vc		=	0.095 m
α	= 1 +	6e /	B	=	1.380
Ground reaction(σ cmax)	= α ×	Vc / (B ×	B')	=	27.962 kN/m^2

○ Allowable bearing capacity(pa) : loose sand = 50 kN/m^2

◎ Factor of safety(F) = qa / σcmax = 1.78 ≧ 1.2 ・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.451 kN
Overturning moment(Mo)	=	TH	×	h		=	1.145 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.154 m
◎	e	=	0.154	≦	0.500 (= B / 3)		・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)						=	0.857 kN
Wind load(TH)	=	0.857 kN	Uplift	=	0.857 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	×	γ	× h × B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ / 2)	=	2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °
◎ Factor of safety(F) =	Pp	/	Q	=	17.15	≧	1.2 ・・・【OK】

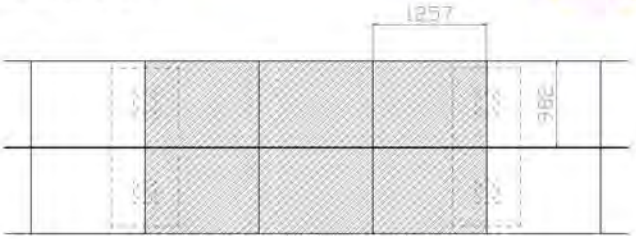
Design of the foundaiton for PV

1 CIS type : Tilted angle 15°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.257 × 0.982 × 6 = 7.406 m^2

Weight for one foundation (WG) = = 3.063 kN



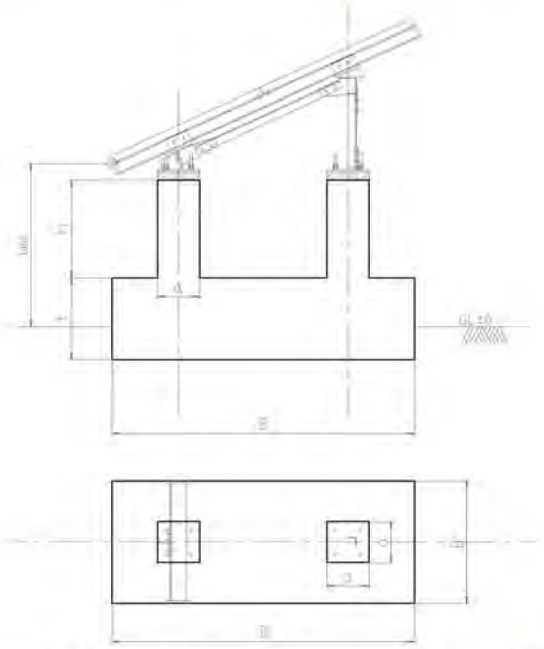
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

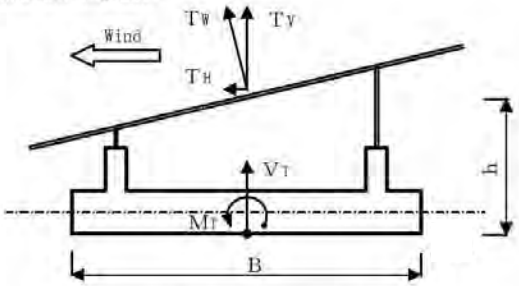
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

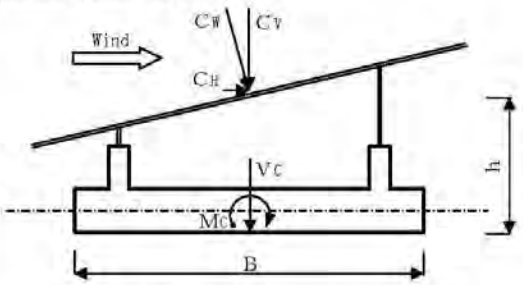


Supporting area (A =	1.257	×	0.982	×	6	=	7.406 m^2
Uplifting force (Tw.=						=	2.504 kN
Vertical (TV)	= Tw	×	cos15°			=	2.419 kN
Horizontal (TH)	= Tw	×	sin15°			=	0.649 kN
Overturning Moment (Mt)	= TH	×	h			=	0.814 kN・m
	(h=	1.254	m)				

Tension load(Vt)	= TV	−	WG	−	WC'	=	−7.364 kN

Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load

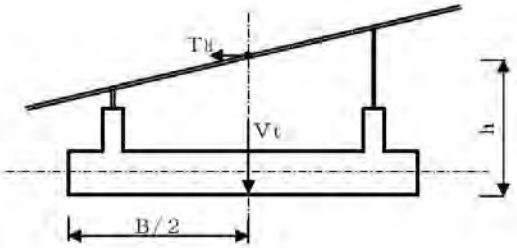


Supporting area (A =	1.257 ×	0.982 ×	6	= 7.406 m^2
Compression force (Tw)	=			= 2.504 kN
Vertical(CV)	= Cw ×	cos15°		= 2.419 kN
Horizontal(CH)	= Cw ×	sin15°		= 0.649 kN
Overturning Morment(Mc)	= CH ×	h		= 0.814 kN・m
	(h=	1.254 m)		
Vertical loads(Vc) =	CV +	WC +	WG	= 12.202 kN
Eccentric distance(e)	= Mc /	Vc		= 0.067 m
α	= 1 +	6e /	B	= 1.268
Ground reaction(σcmax)	= α ×	Vc / (B ×	B')	= 25.787 kN/m^2

○ Allowable bearing capacity(pa) : loose sand = 50 kN/m^2

◎ Factor of safety(F) = qa / σcmax = 1.93 ≧ 1.2 ・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.364 kN
Overturning moment(Mo)	=	TH	×	h		=	0.814 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.111 m

◎	e	=	0.111	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)						=	0.649 kN
Wind load(TH)	=	0.649 kN	Uplift	=	0.649 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	× γ ×	h	×	B	= 14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ	/ 2)	= 2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °

◎ Factor of safety(F) =	Pp	/	Q	=	22.64	≧	1.2 ・・・【OK】

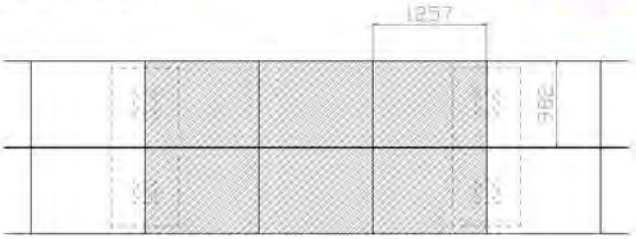
Design of the foundaiton for PV

1 CIS type : Tilted angle 10°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.257 × 0.982 × 6 = 7.406 m^2

Weight for one foundation (WG) = = 3.047 kN



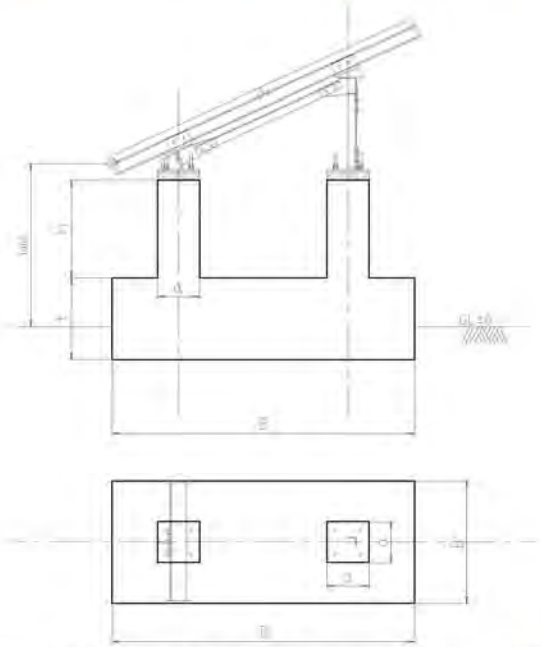
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

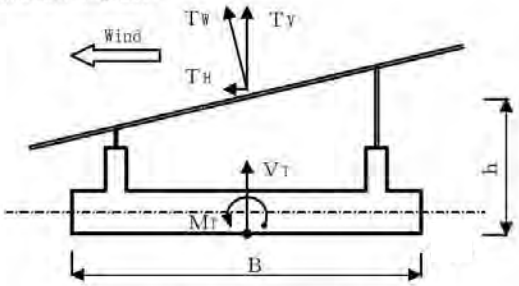
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

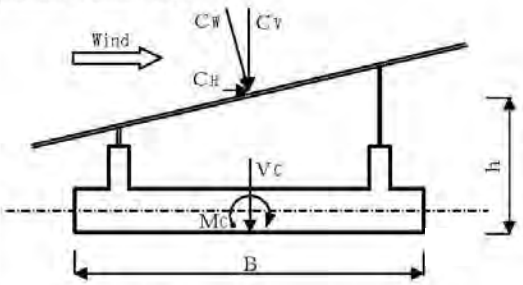


Supporting area (A =	1.257	×	0.982	×	6	=	7.406 m^2
Uplifting force (Tw) =						=	2.504 kN
Vertical (TV)	=	Tw	×	cos10°		=	2.466 kN
Horizontal (TH)	=	Tw	×	sin10°		=	0.435 kN
Overturning Moment (Mt)	=	TH	×	h		=	0.510 kN・m
		(h=	1.171	m)			

Tension load(Vt)	=	TV	−	WG	−	WC'	= −7.301 kN

Because weight is bigger than uplifting load, tension load is not occurred.

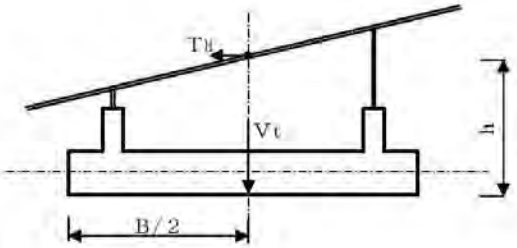
4) Stability against compression load



Supporting area (A =	1.257 × 0.982 × 6	=	7.406 m^2
Compression force (Tw)	=	=	2.504 kN
Vertical(CV)	= Cw × cos10°	=	2.466 kN
Horizontal(CH)	= Cw × sin10°	=	0.435 kN
Overturning Morment(Mc)	= CH × h	=	0.510 kN・m
	(h= 1.171 m)		
Vertical loads(Vc)	= CV + WC + WG	=	12.233 kN
Eccentric distance(e)	= Mc / Vc	=	0.042 m
α	= 1 + 6e / B	=	1.168
Ground reaction(σcmax)	= α × Vc / (B × B')	=	23.814 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand	=	50 kN/m^2

◎ Factor of safety(F) =	qa / σcmax	= 2.09	≧ 1.2	・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.301 kN
Overturning moment(Mo)	=	TH	×	h		=	0.510 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.070 m

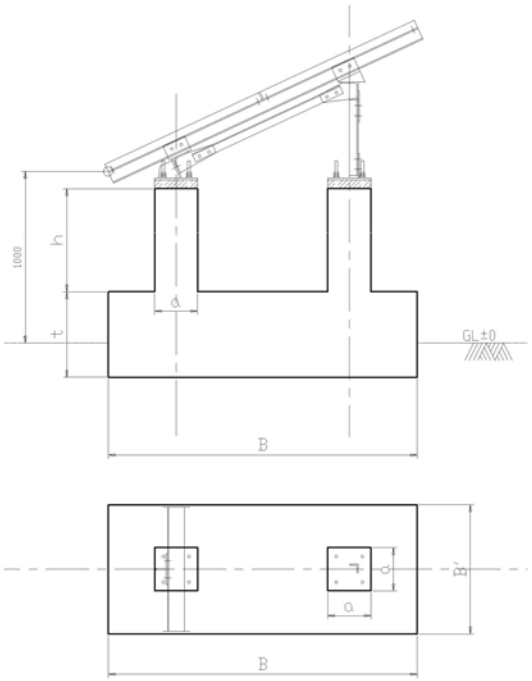
◎	e	=	0.070	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)							=	0.435 kN
Wind load(TH)	=	0.435 kN	Uplift		=	0.435 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	×	γ	×	h	× B	= 14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ	/	2)	= 2.882 kN
Unit weight(γ)	=	loose sand						= 17.0 kN/m^3
Embedded length(h)	=							= 200 mm
Footing Width(B)	=							= 1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)						= 29 °

◎ Factor of safety(F) =	Pp	/	Q	=	33.78	≧	1.2 ・・・【OK】

Calculation result of Foundation for Multi Layer Tandem Thin Film

Type of Module		Multi layer Tandem Thin Film			
Foundation Shape					
Tilted Angle (°)		25	20	15	10
Size (m)	a	0.25	0.25	0.25	0.25
	h	0.8	0.8	0.8	0.8
	B	1.5	1.5	1.5	1.5
	B′	0.4	0.4	0.4	0.4
	t	0.3	0.3	0.3	0.3
Result of Study	Uplift	Nil	Nil	Nil	Nil
	Compression	1.36 ≧ 1.20	1.64 ≧ 1.20	1.79 ≧ 1.20	1.95 ≧ 1.20
	Overturning	0.300 ≦ 0.500	0.175 ≦ 0.500	0.126 ≦ 0.500	0.080 ≦ 0.500
	Sliding	9.89 ≧ 1.20	15.01 ≧ 1.20	19.83 ≧ 1.20	29.57 ≧ 1.20
Concrete Volume of One Foundation (m^3)		0.280	0.280	0.280	0.280

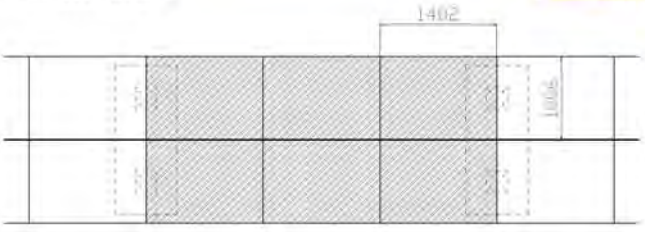
Design of the foundaiton for PV

1 Tandem thin film type : Tilted angle 25°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.402 × 1.006 × 6 = 8.462 m^2

Weight for one foundation (WG) = = 3.531 kN



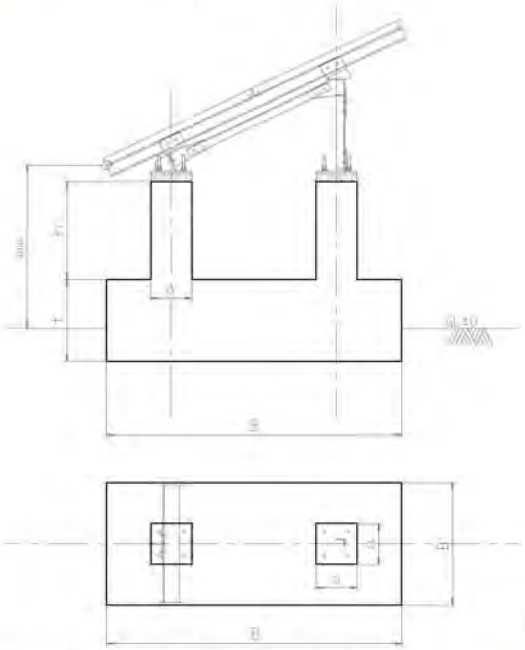
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

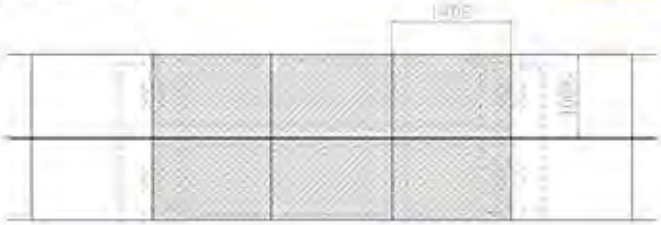
Design of the foundaiton for PV

1 Tandem thin film type : Tilted angle 25°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.402 × 1.006 × 6 = 8.462 m^2

Weight for one foundation (WG) = = 3.531 kN



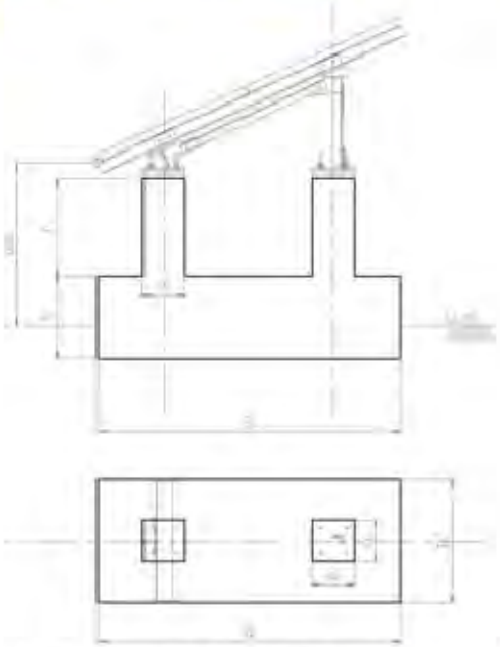
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

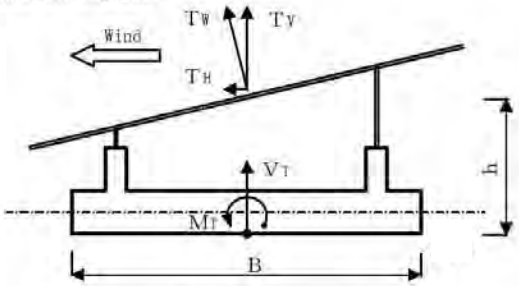
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

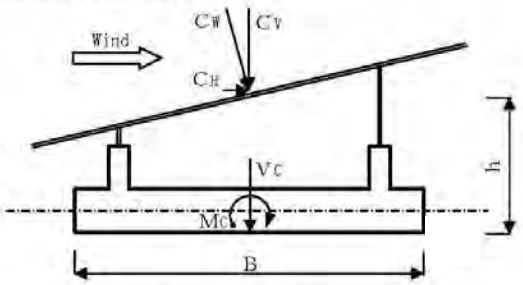


Supporting area (A =	1.402	×	1.006	×	6	=	8.462	m^2
Uplifting force (Tw.=						=	3.512	kN
Vertical (TV)	= Tw	×	cos25°			=	3.183	kN
Horizontal (TH)	= Tw	×	sin25°			=	1.485	kN
Overturning Moment (Mt)	= TH	×	h			=	2.117	kN・m
	(h=	1.425	m)					

Tension load(Vt)	= TV	−	WG	−	WC'	=	−7.068	kN

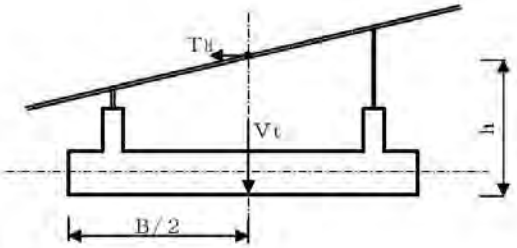
Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load



Supporting area (A =	1.402 × 1.006 ×	6	=	8.462 m^2
Compression force (Tw)	=		=	3.512 kN
Vertical(CV)	= Cw × cos25°		=	3.183 kN
Horizontal(CH)	= Cw × sin25°		=	1.485 kN
Overturning Morment(Mc)	= CH × h		=	2.117 kN･m
	(h= 1.425 m)			
Vertical loads(Vc) =	CV + WC + WG		=	13.434 kN
Eccentric distance(e)	= Mc / Vc		=	0.158 m
α	= 1 + 6e / B		=	1.632
Ground reaction(σcmax)	= α × Vc / (B × B')		=	36.541 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand		=	50 kN/m^2
◎ Factor of safety(F) =	qa / σcmax	= 1.36	≧ 1.2	･･･【OK】

5) Overturning



Vertical loads (Vt) =					=	7.068	kN
Overturning moment(Mo)	=	TH	×	h	=	2.117	kN・m
○ Eccentric distance(e)	=	Mo	/	Vt	=	0.300	m

◎	e	=	0.300	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)					=	1.485	kN
Wind load(TH)	=	1.485 kN	Uplift	=	1.485 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	× γ ×	h	× B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+ φ	/ 2)	=	2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °

◎ Factor of safety(F) =	Pp	/	Q	=	9.89	≧	1.2 ・・・【OK】

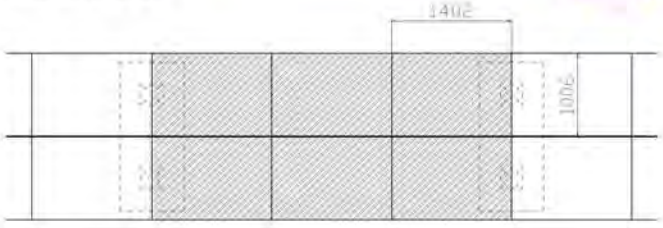
Design of the foundaiton for PV

1 Tandem thin film type : Tilted angle 20°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.402 × 1.006 × 6 = 8.462 m^2

Weight for one foundation (WG) = = 3.512 kN



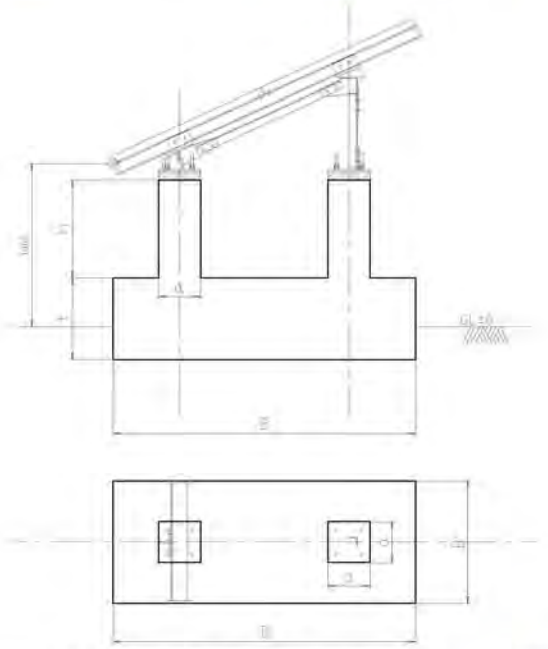
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

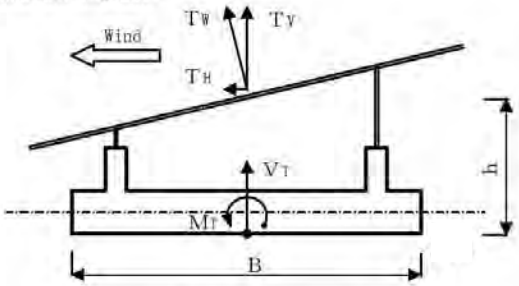
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

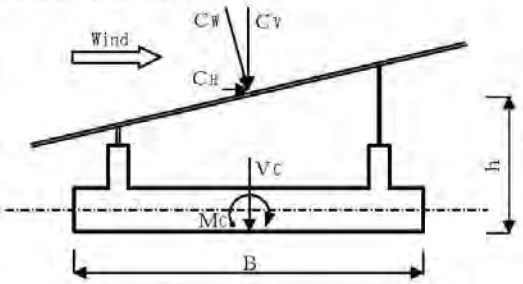


Supporting area (A =	1.402	×	1.006	×	6	=	8.462	m^2
Uplifting force (Tw) =						=	2.861	kN
Vertical (TV)	=	Tw	×	cos20°		=	2.689	kN
Horizontal (TH)	=	Tw	×	sin20°		=	0.979	kN
Overturning Moment (Mt)	=	TH	×	h		=	1.316	kN・m
		(h=	1.344	m)				

Tension load(Vt)	=	TV	−	WG	−	WC'	=	−7.543 kN

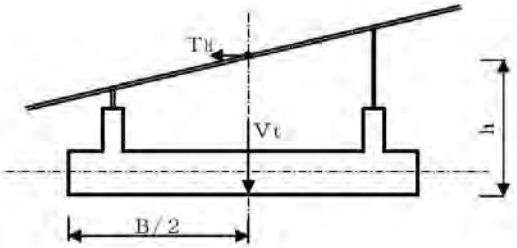
Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load



Supporting area (A =	1.402 × 1.006 ×	6	=	8.462 m^2
Compression force (Tw)	=		=	2.861 kN
Vertical(CV)	= Cw × cos20°		=	2.689 kN
Horizontal(CH)	= Cw × sin20°		=	0.979 kN
Overturning Morment(Mc)	= CH × h		=	1.316 kN･m
	(h= 1.344 m)			
Vertical loads(Vc) =	CV + WC + WG		=	12.921 kN
Eccentric distance(e)	= Mc / Vc		=	0.102 m
α	= 1 + 6e / B		=	1.408
Ground reaction(σcmax)	= α × Vc / (B × B')		=	30.322 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand		=	50 kN/m^2
◎ Factor of safety(F) =	qa / σcmax	= 1.64	≧ 1.2	･･･【OK】

5) Overturning



Vertical loads (Vt) =						=	7.543 kN
Overturning moment(Mo)	=	TH	×	h		=	1.316 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.175 m
◎	e	=	0.175	≦	0.500 (= B / 3)		・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)							=	0.979 kN
Wind load(TH)	=	0.979 kN	Uplift	=	0.979 kN	Compression		
○ Passive earth pressure(Pp)	=	Kp	×	γ	×	h × B	=	14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ	/ 2)	=	2.882 kN
Unit weight(γ)	=	loose sand					=	17.0 kN/m^3
Embedded length(h)	=						=	200 mm
Footing Width(B)	=						=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)					=	29 °
◎ Factor of safety(F) =	Pp	/	Q	=	15.01	≧	1.2	・・・【OK】

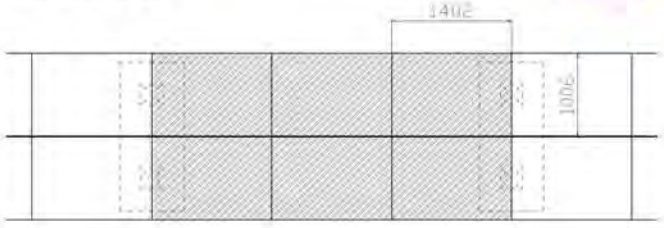
Design of the foundaiton for PV

1 Tandem thin film type : Tilted angle 15°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.402 × 1.006 × 6 = 8.462 m^2

Weight for one foundation (WG) = = 3.491 kN



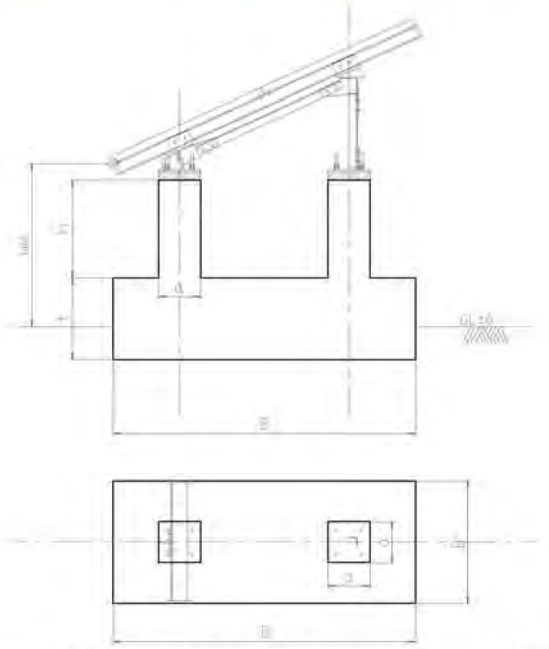
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

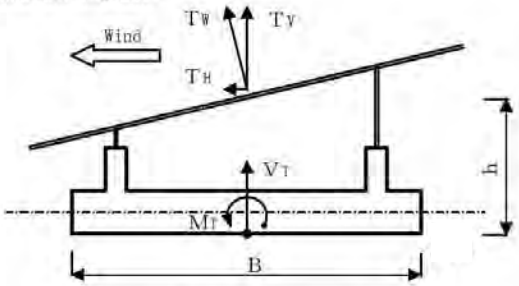
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load

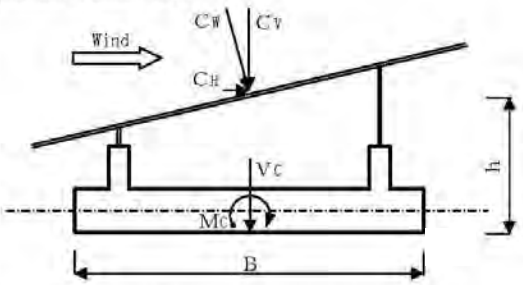


Supporting area (A =	1.402	×	1.006	×	6	=	8.462 m^2
Uplifting force (Tw.=						=	2.861 kN
Vertical (TV)	= Tw	×	cos15°			=	2.764 kN
Horizontal (TH)	= Tw	×	sin15°			=	0.741 kN
Overturning Moment (Mt)	= TH	×	h			=	0.934 kN・m
	(h=	1.26	m)				

Tension load(Vt)	= TV	−	WG	−	WC'	=	−7.447 kN

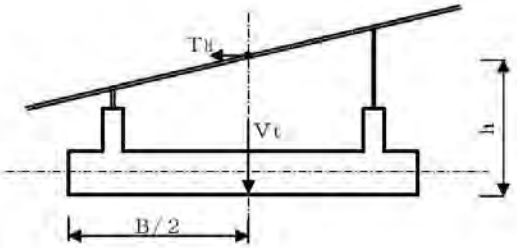
Because weight is bigger than uplifting load, tension load is not occurred.

4) Stability against compression load



Supporting area (A =	1.402 × 1.006 ×	6	=	8.462 m^2
Compression force (Tw)	=		=	2.861 kN
Vertical(CV)	= Cw × cos15°		=	2.764 kN
Horizontal(CH)	= Cw × sin15°		=	0.741 kN
Overturning Morment(Mc)	= CH × h		=	0.934 kN・m
	(h= 1.26 m)			
Vertical loads(Vc) =	CV + WC + WG		=	12.975 kN
Eccentric distance(e)	= Mc / Vc		=	0.072 m
α	= 1 + 6e / B		=	1.288
Ground reaction(σcmax)	= α × Vc / (B × B')		=	27.853 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand		=	50 kN/m^2
◎ Factor of safety(F) =	qa / σcmax	= 1.79	≧ 1.2	・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.447 kN
Overturning moment(Mo)	=	TH	×	h		=	0.934 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.126 m

◎	e	=	0.126	≦	0.500 (= B / 3)	・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)						=	0.741 kN
Wind load(TH)	=	0.741 kN	Uplift	=	0.741 kN	Compression	
○ Passive earth pressure(Pp)	=	Kp	× γ ×	h	×	B	= 14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ / 2)	=	2.882 kN
Unit weight(γ)	=	loose sand				=	17.0 kN/m^3
Embedded length(h)	=					=	200 mm
Footing Width(B)	=					=	1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)				=	29 °

◎ Factor of safety(F) =	Pp	/	Q	=	19.83	≧	1.2 ・・・【OK】

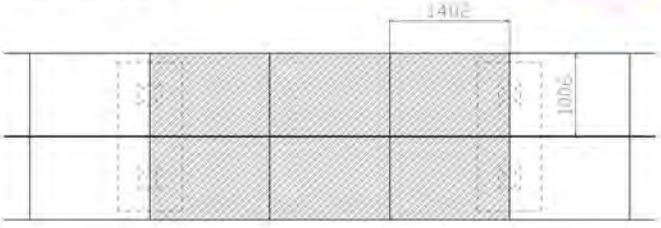
Design of the foundaiton for PV

1 Tandem thin film type : Tilted angle 10°

1) Dead load (PV panels & mounting steel structures)

Supporting area (A) = 1.402 × 1.006 × 6 = 8.462 m^2

Weight for one foundation (WG) = = 3.475 kN



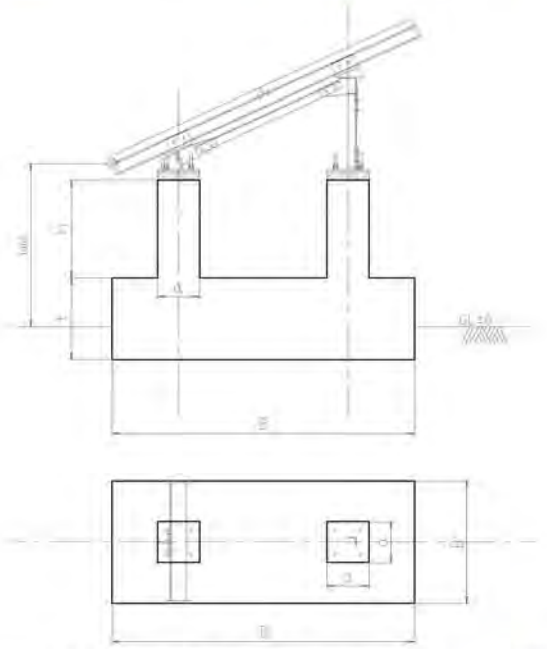
2) Foundation weight

Size of post part

Width (a) = 250 mm Height(h) = 800 mm

Size of footing part

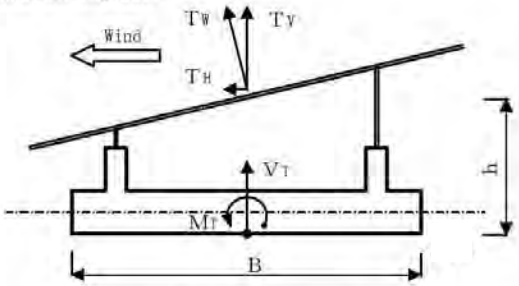
Long side (B) = 1500 mm Short side(B') = 400 mm Height(t) = 300 mm



Foundation weight(WC) = (a^2 × H × 2 + B × B' × t) × γ = 6.720 kN

Unit weight of reinforced concrete (γ) = 24.0 kN/m^3

3) Stability against uplifting load



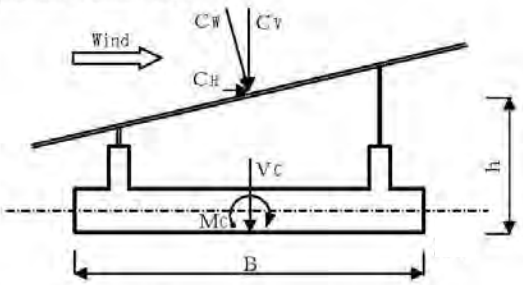
Supporting area (A =	1.402	×	1.006	×	6	=	8.462	m^2
Uplifting force (Tw) =						=	2.861	kN
Vertical (TV)	=	Tw	×	cos10°		=	2.818	kN
Horizontal (TH)	=	Tw	×	sin10°		=	0.497	kN
Overturning Moment (Mt)	=	TH	×	h		=	0.584	kN・m

(h= 1.175 m)

Tension load(Vt)	=	TV	−	WG	−	WC'	=	−7.377 kN

Because weight is bigger than uplifting load, tension load is not occurred.

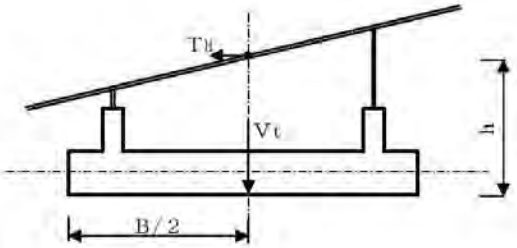
4) Stability against compression load



Supporting area (A =	1.402 × 1.006 × 6	=	8.462 m^2
Compression force (Tw)	=	=	2.861 kN
Vertical(CV)	= Cw × cos10°	=	2.818 kN
Horizontal(CH)	= Cw × sin10°	=	0.497 kN
Overturning Morment(Mc)	= CH × h	=	0.584 kN・m
	(h= 1.175 m)		
Vertical loads(Vc) =	CV + WC + WG	=	13.013 kN
Eccentric distance(e)	= Mc / Vc	=	0.045 m
α	= 1 + 6e / B	=	1.180
Ground reaction(σcmax)	= α × Vc / (B × B')	=	25.593 kN/m^2
○ Allowable bearing capacity(pa)	: loose sand	=	50 kN/m^2

◎ Factor of safety(F) =	qa / σcmax	=	1.95	≧	1.2 ・・・【OK】

5) Overturning



Vertical loads (Vt) =						=	7.377 kN
Overturning moment(Mo)	=	TH	×	h		=	0.584 kN・m
○ Eccentric distance(e)	=	Mo	/	Vt		=	0.080 m
◎	e	=	0.080	≦	0.500 (= B / 3)		・・・【OK】

6) Sliding

○ Horizontal load(Q) = (Uplift or Compression, whichever is greater)							=	0.497 kN
Wind load(TH)	=	0.497 kN	Uplift	=	0.497 kN	Compression		
○ Passive earth pressure(Pp)	=	Kp	×	γ	×	h	× B	= 14.698 kN
Coefficient of passive earth pressure(Kp)	=	tan^2 (	45°	+	φ	/	2)	= 2.882 kN
Unit weight(γ)	=	loose sand						= 17.0 kN/m³
Embedded length(h)	=							= 200 mm
Footing Width(B)	=							= 1500 mm
Internal friction angle(φ)	=	15 + √(20 × N)						= 29 °
◎ Factor of safety(F) =	Pp	/	Q	=	29.57	≧	1.2	・・・【OK】

Appendix 3-4-1: Cost breakdowns for Poly Crystalline, MLTF and CIS

Appendix 3-4-1 Cost breakdowns for Poly Crystalline, MLTF and CIS

The following cost breakdown is attached here for reference.

- ✓ Poly Crystalline
- ✓ MLTF
- ✓ CIS

*For MLTF, refer to Appendix 3-5-1 "Cost Breakdown for the Project".

Cost breakdown for the Project (Poly Crystalline)

No.	Items to be requested	Nos. of Required	Cost (Thousand dollar)					Notes
			CIF to Port Saied		Inland Transportation	Site Works (Installation replacement etc.)	Total	
			unit	amount				
			(Foreign Currency)		(Local Currency)			
1 Construction of 20MW PV Power Plant including necessary equipment				**44,751.9**	**451.9**	**16,896.1**	**62,100.0**	62,100.0
1) PV module								
1-1	PV Module (Poly-Crystalline)	LS		32,648.0	84.5	3,487.1	36,219.6	
1-2	Terminal Box	LS		728.0	2.0	105.3	835.3	
1-3	DC cable	LS		1,564.8	35.8	397.7	1,998.3	
1-4	Frame for PV	LS		896.0	37.0	8,840.4	9,773.4	
Sub-Total				35,836.8	159.3	12,830.5	48,826.6	
2) Inverter								
2-1	Inverter	LS		3,600.0	3.4	363.6	3,967.0	
2-2	Step-up Transformer	LS		260.0	1.7	3.7	265.4	
2-3	LV, MV switchgear	LS		300.0	6.7	17.9	324.6	
2-4	LV,MV cable for inverter	LS		87.0	0.0	37.6	124.6	
2-5	Monitoring System terminal unit	0		5.0	0.0	17.1	22.1	
Sub-Total				4,252.0	11.8	439.9	4,703.7	
3) MV switchgear								
3-1	Switchgear Box	LS		320.0	0.8	36.3	357.1	
3-2	Monitoring System terminal unit	LS		4.5	0.0	8.9	13.4	
Sub-Total				324.5	0.8	45.2	370.5	
4) Distribution line connection								
4-1	Feeder Box	LS		80.0	0.8	1.2	82.0	
4-2	Monitoring System terminal unit	LS		1.0	0.0	0.9	1.9	
Sub-Total				81.0	0.8	2.1	83.9	
5) Monitoring System								
5-1	Monitoring System	LS		281.5	0.0	10.1	291.6	
Sub-Total				281.5	0.0	10.1	291.6	
6) Internal cable connection								
6-1	MV Cable Connection	LS		1,320.0	5.5	278.1	1,603.6	
6-2	LV Cable Connection	LS		600.0	0.5	105.3	705.8	
6-3	Optic fiber cable connection	LS		176.0	0.5	48.7	225.2	
Sub-Total				2,096.0	6.6	432.1	2,534.7	
7) Grounding system								
7-1	Grounding conductor	LS		200.0	0.5	37.3	237.8	
Sub-Total				200.0	0.5	37.3	237.8	
8) Civil works								
8-1	PV and transformer foundation	LS		0.0	262.1	2,071.1	2,333.2	
8-2	land leveling	LS		0.0	0.0	111.8	111.8	
8-3	road and drain work	LS		0.0	0.0	152.2	152.2	
Sub-Total				0.0	262.1	2,335.1	2,597.2	
9) House construction								
9-1	Inverter house construction	LS		0.0	2.5	252.0	254.5	
9-2	MV Switchgear house construction	LS		0.0	2.5	248.0	250.5	
Sub-Total				0.0	5.0	500.0	505.0	
10) Guard Fence								
10-1	Guard Fence	LS		0.0	1.9	190.8	192.7	
Sub-Total				0.0	1.9	190.8	192.7	
11) Information Center								
11-1	Exhibition System	LS		300.0	3.0	0.0	303.0	
11-2	Construction of house	LS		0.0	0.0	70.0	70.0	
Sub-Total				300.0	3.0	70.0	373.0	
12) Central Hurghada Substation Modifications								
12-1	Central Hurghada S/S modifications	LS		20.0	0.2	3.0	23.2	
Sub-Total				20.0	0.2	3.0	23.2	
13) Training to Owner's engineers								
13-1	Training	LS		70.0			70.0	
Sub-Total				70.0			70.0	
14) Maintenance contract for PV power plant								
14-1	Maintenance Contract Cost for 2 years	LS		861.4			861.4	1% of the above 1) -7)per year * 2 years
Sub-Total				861.4			861.4	
15) Spare parts								
15-1	Spare parts for PV, Inverter, etc.	LS		428.7			428.7	1% of above 1)-6)
Sub-Total				428.7			428.7	
2 Installation of 2MW High Performance Battery including necessary equipment				**11,220.8**	**29.3**	**645.6**	**11,895.7**	11,895.7
1) High Performance Battery								
1-1	High Performance Battery	LS		9,086.0	24.7	162.6	9,273.3	
1-2	Power conditioning system for battery	LS		1,600.0	0.7	91.3	1,692.0	
1-3	MV Switchgear for Battery	LS		80.0	0.2	4.0	84.2	
1-4	MV Cable Connection	LS		60.0	0.2	23.7	83.9	
1-5	Room for Battery and PCS	LS		0.0	3.6	364.0	367.6	
Sub-Total				10,826.0	29.3	645.6	11,500.9	
2) Training to Owner's engineers								
2-1	Training	LS		70.0			70.0	
Sub-Total				70.0			70.0	
3) Maintenance contract for Battery System								
3-1	Maintenance Contract Cost for 2 years	LS		216.5			216.5	1% of the above 1) per year * 2 years
Sub-Total				216.5			216.5	
4) Spare parts								
13-1	Spare parts for Battery,PCS, etc.	LS		108.3			108.3	1% of above 1)
Sub-Total				108.3			108.3	
3 Dispute Board for 3 persons				**963.0**	**0.0**	**0.0**	**963.0**	
Total				**56,935.7**	**481.2**	**17,541.7**	**74,958.6**	74,958.6

Detailed Cost breakdown for the Project (Poly Crystalline)

		No.	Item	Specification	Unit Price (US$)	Unit Price (EGP)	Total Quantity	units	Total Price (US$)	Total Price (EGP)	Remarks
1.PV	PV module	1	PV module (Poly-Crystalline)	240W							
			1MW	(1.6$/W)	385	2,330	84,800		32,648,000	197,584,000	
		2	Terminal Box								
					1,300	7,840	560		728,000	4,390,400	
		3	DC cable connection								
			From PV module to Terminal box		2	20	782,400	m	1,564,800	15,648,000	
		4	DC cable connection								
			From Terminal box to Inverter		8	50	112,000	m	896,000	5,600,000	
		5	Frame for PV								
					2,000.0	12,060	2,786	t	5,572,000	33,599,160	
		6	Sub Total (1+2+3+4+5)						**41,408,800**	**256,821,560**	
	Inverter	7	Inverter	500kVA							
					90,000	542,700	40		3,600,000	21,708,000	
		8	Step-up Transformer	400V/22kV							
				2000kVA	26,000	156,780	10		260,000	1,567,800	
		9	LV Switchboard	400V							
					10,000	60,300	10		100,000	603,000	
		10	MV Switchgear	22kV							
					20,000	120,600	10		200,000	1,206,000	
		11	LV cable Connection								
			From Inverter to LV Switchboard		50	310	1,200	m	60,000	372,000	
		12	LV cable Connection								
			From LV Switchboard to Step-up transformer		50	310	180	m	9,000	55,800	
		13	MV Cable Connection								
			From Step-up transformer to MV Switchgear		100	610	180	m	18,000	109,800	
		14	Monitoring system terminal unit								
					500	3,020	10		5,000	30,200	
		15	Sub Total (7+8+9+10+11+12+13+14)						**4,252,000**	**25,652,600**	
	MV Switchgear	16	Feeder box								
					40,000	241,200	6		240,000	1,447,200	
		17	VT Box								
					20,000	120,600	2		40,000	241,200	
		18	Bus coupler Box								
					40,000	241,200	1		40,000	241,200	
		19	Monitoring system terminal unit								
					500	3,020	9		4,500	27,180	
		20	Sub Total (16+17+18+19)						**324,500**	**1,956,780**	
	Distribution line connection	21	Feeder Box (Extension)								
					40,000	241,200	2		80,000	482,400	
		22	Monitoring system terminal unit								
					500	3,020	2		1,000	6,040	
		23	Sub Total (21+22)						**81,000**	**488,440**	
	Monitoring System	24	M/M computer system								
					80,000	482,400	1		80,000	482,400	
		25	server system								
					200,000	1,206,000	1		200,000	1,206,000	
		26	Communication interface								
					1,000	6,030	1		1,000	6,030	
		27	UPS								
					500	3,020	1		500	3,020	
		28	Sub Total (24+25+26+27)						**281,500**	**1,697,450**	
	Internal cable connection	28	MV Cable Connection								
			from unit substation to 22kV bus unit		100	610	13,200	m	1,320,000	8,052,000	
		29	MV cable Connection from 22kV bus unit								
			to Hurghada Wind Distribution Point		100	610	6,000	m	600,000	3,660,000	
		30	Optical fiber cable Connection								
					20	130	8,800	m	176,000	1,144,000	
		31	Sub Total (28+29+30)						**2,096,000**	**12,856,000**	
	Grounding system	32	Grounding conductor								
					20	130	10,000	m	200,000	1,300,000	
		33	Sub Total (32)						**200,000**	**1,300,000**	
	Civil works	34	PV foundation								
					335	2,030	6,182		2,071,104	12,550,272	27730 x 0.28m3
		35	Ground leveling								
					3	20	33,880	m3	111,804	677,600	
		36	road construction								
					2	20	63,420	m	152,208	1,268,400	
		37	Sub Total (34+35+36)						**2,335,116**	**14,496,272**	
	Inverter house construction	38	Inverter house								
					350	2,120	360	m2	126,000	763,200	36m2 / 1room x 10 rooms
		39	Interior work								
					350	2,120	360	m2	126,000	763,200	
		40	Sub Total (38+39)						**252,000**	**1,526,400**	
	MV switch gear house	41	MV switch gear house								
					400	2,420	310		124,000	750,200	
		42	Interior work								
					400	2,420	310		124,000	750,200	
		43	Sub Total (41+42)						**248,000**	**1,500,400**	
	Guard Fence work	44	Guard Fence								
					58	350	3,290	m	190,820	1,151,500	
		45	Sub Total (44)						**190,820**	**1,151,500**	
	Information Center	46	Exhibition System								
					300,000	1,809,000	1	LS	300,000	1,809,000	
		47	Construction of house								
					350	2,120	100	m2	35,000	212,000	
		48	Interior work								
					350	2,120	100	m2	35,000	212,000	
		49	Sub Total (46+47+48)						**370,000**	**2,233,000**	
	Central Hurghada S/S modifications	50	S/S modifications								
					20,000	120,600	1	LS	20,000	120,600	
		51	Sub Total						**20,000**	**120,600**	
2.Battery	High Performance Battery	1	High Performance Battery	1,000kW							
					4,543,000	27,394,290	2	**unit**	9,086,000	54,788,580	
		2	Power conditioning system(PCS) for Battery	500kW							
					400,000	2,412,000	4	unit	1,600,000	9,648,000	
		3	MV Switchgear								
					40,000	241,200	2	unit	80,000	482,400	
		4	MV Cable connection								
					100	610	600	m	60,000	366,000	
		5	Room for battery and PCS								
					350	2,120	520	m2	182,000	1,102,400	
		6	Room Interior work including air conditioner								
					350	2,120	520	m2	182,000	1,102,400	
		7	Sub Total (1+2+3+4+5+6)						**11,190,000**	**67,489,780**	
3. DB	Dispute Board	1	Dispute Board								
					963,000	5,806,890	1	LS	963,000	5,806,890	
		2	Sub Total						**963,000**	**5,806,890**	

Cost breakdown for the Project (CIS)

No.	Items to be requested	Nos. of Required	Cost (Thousand dollar)					Notes
			CIF to Port Saied		Inland Transportation	Site Works (Installation replacement etc.)	Total	
			unit	amount				
			(Foreign Currency)		(Local Currency)			
1 Construction of 20MW PV Power Plant including necessary equipment				**35,434.3**	**452.1**	**17,206.8**	**53,093.1**	53,093.1
1) PV module								
1-1	PV Module (CIS)	LS		23,601.6	84.5	3,487.1	27,173.2	
1-2	Terminal Box	LS		728.0	2.0	105.3	835.3	
1-3	DC cable	LS		1,564.8	35.8	397.7	1,998.3	
1-4	Frame for PV	LS		896.0	37.0	8,840.4	9,773.4	
Sub-Total				26,790.4	159.3	12,830.5	39,780.2	
2) Inverter								
2-1	Inverter	LS		3,600.0	3.4	363.6	3,967.0	
2-2	Step-up Transformer	LS		260.0	1.7	3.7	265.4	
2-3	LV, MV switchgear	LS		300.0	6.7	17.9	324.6	
2-4	LV,MV cable for inverter	LS		87.0	0.0	37.6	124.6	
2-5	Monitoring System terminal unit	0		5.0	0.0	17.1	22.1	
Sub-Total				4,252.0	11.8	439.9	4,703.7	
3) MV switchgear								
3-1	Switchgear Box	LS		320.0	0.8	36.3	357.1	
3-2	Monitoring System terminal unit	LS		4.5	0.0	8.9	13.4	
Sub-Total				324.5	0.8	45.2	370.5	
4) Distribution line connection								
4-1	Feeder Box	LS		80.0	0.8	1.2	82.0	
4-2	Monitoring System terminal unit	LS		1.0	0.0	0.9	1.9	
Sub-Total				81.0	0.8	2.1	83.9	
5) Monitoring System								
5-1	Monitoring System	LS		281.5	0.0	10.1	291.6	
Sub-Total				281.5	0.0	10.1	291.6	
6) Internal cable connection								
6-1	MV Cable Connection	LS		1,320.0	5.5	278.1	1,603.6	
6-2	LV Cable Connection	LS		600.0	0.5	105.3	705.8	
6-3	Optic fiber cable connection	LS		176.0	0.5	48.7	225.2	
Sub-Total				2,096.0	6.6	432.1	2,534.7	
7) Grounding system								
7-1	Grounding conductor	LS		200.0	0.5	37.3	237.8	
Sub-Total				200.0	0.5	37.3	237.8	
8) Civil works								
8-1	PV and transformer foundation	LS		0.0	262.1	2,363.8	2,625.8	
8-2	land leveling	LS		0.0	0.0	111.8	111.8	
8-3	road and drain work	LS		0.0	0.0	152.2	152.2	
Sub-Total				0.0	262.1	2,627.8	2,889.9	
9) House construction								
9-1	Inverter house construction	LS		0.0	2.5	252.0	254.5	
9-2	MV Switchgear house construction	LS		0.0	2.5	248.0	250.5	
Sub-Total				0.0	5.0	500.0	505.0	
10) Guard Fence								
10-1	Guard Fence	LS		0.0	2.1	208.8	210.9	
Sub-Total				0.0	2.1	208.8	210.9	
11) Information Center								
11-1	Exhibition System	LS		300.0	3.0	0.0	303.0	
11-2	Construction of house	LS		0.0	0.0	70.0	70.0	
Sub-Total				300.0	3.0	70.0	373.0	
12) Central Hurghada Substation Modifications								
12-1	Central Hurghada S/S modifications	LS		20.0	0.2	3.0	23.2	
Sub-Total				20.0	0.2	3.0	23.2	
13) Training to Owner's engineers								
13-1	Training	LS		70.0			70.0	
Sub-Total				70.0			70.0	
14) Maintenance contract for PV power plant								
14-1	Maintenance Contract Cost for 2 years	LS		680.6			680.6	1% of the above 1) -7)per year * 2 years
Sub-Total				680.6			680.6	
15) Spare parts								
15-1	Spare parts for PV, Inverter, etc.	LS		338.3			338.3	1% of above 1)-6)
Sub-Total				338.3			338.3	
2 Installation of 2MW High Performance Battery including necessary equipment				**11,220.8**	**29.3**	**645.6**	**11,895.7**	11,895.7
1) High Performance Battery								
1-1	High Performance Battery	LS		9,086.0	24.7	162.6	9,273.3	
1-2	Power conditioning system for battery	LS		1,600.0	0.7	91.3	1,692.0	
1-3	MV Switchgear for Battery	LS		80.0	0.2	4.0	84.2	
1-4	MV Cable Connection	LS		60.0	0.2	23.7	83.9	
1-5	Room for Battery and PCS	LS		0.0	3.6	364.0	367.6	
Sub-Total				10,826.0	29.3	645.6	11,500.9	
2) Training to Owner's engineers								
2-1	Training	LS		70.0			70.0	
Sub-Total				70.0			70.0	
3) Maintenance contract for Battery System								
3-1	Maintenance Contract Cost for 2 years	LS		216.5			216.5	1% of the above 1) per year * 2 years
Sub-Total				216.5			216.5	
4) Spare parts								
13-1	Spare parts for Battery,PCS, etc.	LS		108.3			108.3	1% of above 1)
Sub-Total				108.3			108.3	
3 Dispute Board for 3 persons				**963.0**	**0.0**	**0.0**	**963.0**	
Total				**47,618.0**	**481.4**	**17,852.4**	**65,951.8**	65,951.8

Detailed Cost breakdown for the Project (CIS)

		No.	Item	Specification	Unit Price (US$)	Unit Price (EGP)	Total Quantity	units	Total Price (US$)	Total Price (EGP)	Remarks
1.PV	PV module	1	PV module (CIS)	140W							
			1MW	(1.18$/W)	165	1,000	143,040		23,601,600	143,040,000	
		2	Terminal Box								
					1,300	7,840	560		728,000	4,390,400	
		3	DC cable connection								
			From PV module to Terminal box		2	20	782,400	m	1,564,800	15,648,000	
		4	DC cable connection								
			From Terminal box to Inverter		8	50	112,000	m	896,000	5,600,000	
		5	Frame for PV								
					2,000.0	12,060	3,854	t	7,708,000	46,479,240	
		6	Sub Total (1+2+3+4+5)						**34,498,400**	**215,157,640**	
	Inverter	7	Inverter	500kVA							
					90,000	542,700	40		3,600,000	21,708,000	
		8	Step-up Transformer	400V/22kV							
				2000kVA	26,000	156,780	10		260,000	1,567,800	
		9	LV Switchboard	400V							
					10,000	60,300	10		100,000	603,000	
		10	MV Switchgear	22kV							
					20,000	120,600	10		200,000	1,206,000	
		11	LV cable Connection								
			From Inverter to LV Switchboard		50	310	1,200	m	60,000	372,000	
		12	LV cable Connection								
			From LV Switchboard to Step-up transformer		50	310	180	m	9,000	55,800	
		13	MV Cable Connection								
			From Step-up transformer to MV Switchgear		100	610	180	m	18,000	109,800	
		14	Monitoring system terminal unit								
					500	3,020	10		5,000	30,200	
		15	Sub Total (7+8+9+10+11+12+13+14)						**4,252,000**	**25,652,600**	
	MV Switchgear	16	Feeder box								
					40,000	241,200	6		240,000	1,447,200	
		17	VT Box								
					20,000	120,600	2		40,000	241,200	
		18	Bus coupler Box								
					40,000	241,200	1		40,000	241,200	
		19	Monitoring system terminal unit								
					500	3,020	9		4,500	27,180	
		20	Sub Total (16+17+18+19)						**324,500**	**1,956,780**	
	Distribution line connection	21	Feeder Box (Extension)								
					40,000	241,200	2		80,000	482,400	
		22	Monitoring system terminal unit								
					500	3,020	2		1,000	6,040	
		23	Sub Total (21+22)						**81,000**	**488,440**	
	Monitoring System	24	M/M computer system								
					80,000	482,400	1		80,000	482,400	
		25	server system								
					200,000	1,206,000	1		200,000	1,206,000	
		26	Communication interface								
					1,000	6,030	1		1,000	6,030	
		27	UPS								
					500	3,020	1		500	3,020	
		28	Sub Total (24+25+26+27)						**281,500**	**1,697,450**	
	Internal cable connection	28	MV Cable Connection								
			from unit substation to 22kV bus unit		100	610	13,200	m	1,320,000	8,052,000	
		29	MV cable Connection from 22kV bus unit								
			to Hurghada Wind Distribution Point		100	610	6,000	m	600,000	3,660,000	
		30	Optical fiber cable Connection								
					20	130	8,800	m	176,000	1,144,000	
		31	Sub Total (28+29+30)						**2,096,000**	**12,856,000**	
	Grounding system	32	Grounding conductor								
					20	130	10,000	m	200,000	1,300,000	
		33	Sub Total (32)						**200,000**	**1,300,000**	
	Civil works	34	PV foundation								
					335	2,030	7,056		2,363,760	14,323,680	27730 x 0.28m3
		35	Ground leveling								
					3	20	33,880	m3	111,804	677,600	
		36	road construction								
					2	20	63,420	m	152,208	1,268,400	
		37	Sub Total (34+35+36)						**2,627,772**	**16,269,680**	
	Inverter house construction	38	Inverter house								
					350	2,120	360	m2	126,000	763,200	36m2 / 1room x 10 rooms
		39	Interior work								
					350	2,120	360	m2	126,000	763,200	
		40	Sub Total (38+39)						**252,000**	**1,526,400**	
	MV switch gear house	41	MV switch gear house								
					400	2,420	310		124,000	750,200	
		42	Interior work								
					400	2,420	310		124,000	750,200	
		43	Sub Total (41+42)						**248,000**	**1,500,400**	
	Guard Fence work	44	Guard Fence								
					58	350	3,600	m	208,800	1,260,000	
		45	Sub Total (44)						**208,800**	**1,260,000**	
	Information Center	46	Exhibition System								
					300,000	1,809,000	1	LS	300,000	1,809,000	
		47	Construction of house								
					350	2,120	100	m2	35,000	212,000	
		48	Interior work								
					350	2,120	100	m2	35,000	212,000	
		49	Sub Total (46+47+48)						**370,000**	**2,233,000**	
	Central Hurghada S/S modifications	50	S/S modifications								
					20,000	120,600	1	LS	20,000	120,600	
		51	Sub Total						**20,000**	**120,600**	
2.Battery	High Performance Battery	1	High Performance Battery	1,000kW							
					4,543,000	27,394,290	2	**unit**	9,086,000	54,788,580	
		2	Power conditioning system(PCS) for Battery	500kW							
					400,000	2,412,000	4	unit	1,600,000	9,648,000	
		3	MV Switchgear								
					40,000	241,200	2	unit	80,000	482,400	
		4	MV Cable connection								
					100	610	600	m	60,000	366,000	
		5	Room for battery and PCS								
					350	2,120	520	m2	182,000	1,102,400	
		6	Room Interior work including air conditioner								
					350	2,120	520	m2	182,000	1,102,400	
		7	Sub Total (1+2+3+4+5+6)						**11,190,000**	**67,489,780**	
3. DB	Dispute Board	1	Dispute Board								
					963,000	5,806,890	1	LS	963,000	5,806,890	
		2	Sub Total						**963,000**	**5,806,890**	

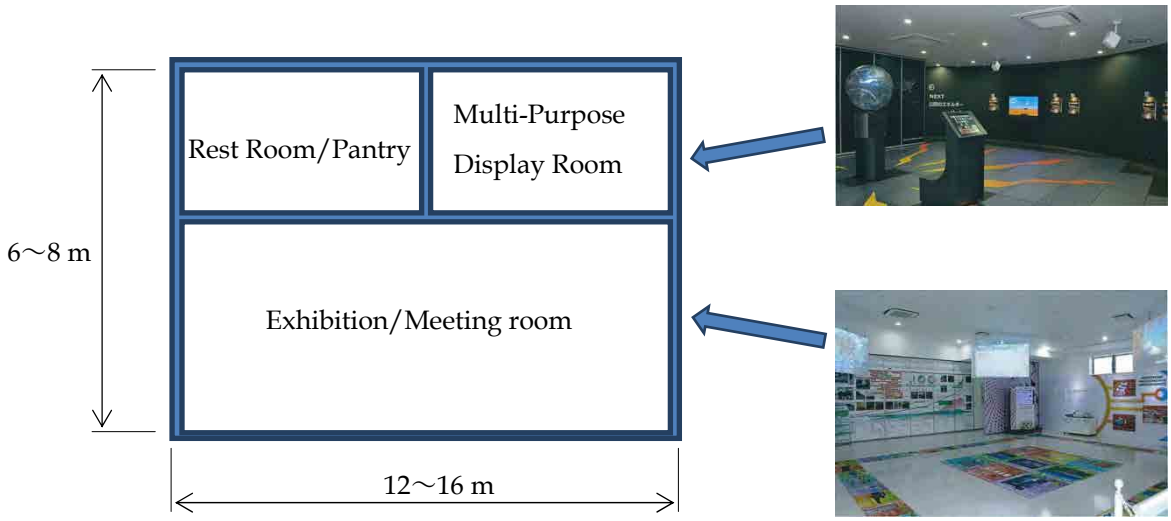
Appendix 3-4-2: Image of information center (layout and interior)

Appendix 3-4-2 Image of Information Center (layout and interior)

Since the detailed requirements and conditions are not decided yet, details shall be decided during the detailed design stage.

This Appendix is describing only image of the information center.

The following schematic diagram is just reference for layout of the information center based on visitor center of Komekura-yama PV power plant in Japan where NREA . Photos are exhibitions of the PV power plant for reference where NREA engineers visited during training in Japan.



You may refer to the followings web site as reference (but this is Japanese only).

http://www.pref.yamanashi.jp/kg-denki/komekurayama_prshisetsu.html

According to NREA, this information center will be used for mainly person related to energy sector with following purposes:

- Learning solar energy in general
- Learning PV technology including how to generate
- Exhibition for solar conditions in Egypt
- Background of this information center (why created and who support), etc.

Appendix 3-4-3: Terms of Reference for Consulting Services (Draft)

Appendix 3-4-3 Terms of Reference for Consulting Services (Draft)

Photovoltaic Power Plant Project in Hurghada
Terms Of Reference For Consulting Services (Draft)

1- General

(1) Power demand in Egypt has been growing rapidly, e.g., 7% in last fifteen years.

(2) Power generation needs to be developed in line with the demand. According to 6th five year development plan (2007/8-2011/12), the generation will be increased by 9.1% p.a.

(3) In consideration to the above, GoE (Government of Egypt) established "Supreme Council of Energy" in 2006 and has adopted a resolution to cover 12% of the generation capacity development plan of up to 2011, and by 2020 to cover 20% of the total generation capacity with renewable energy.

(4) Climate in Egypt has an excellent condition of strong solar radiation for solar power generation. GoE intends to request to GoJ (Government of Japan) to provide Japanese ODA (Official Development Assistance) Yen Loan for photovoltaic power plant in Egypt.

2- Scope of the Project

(1) Objectives

To develop 20MW photovoltaic power plant in Hurghada with 2MW battery at NREA's wind power plant.

(2) Scope of the Project

Engineering, procurement & construction of the photovoltaic power plant facilities on turn key basis including the following:

- 20MW Photovoltaic modules with related equipment
- 2MW battery with related equipment
- Remote monitoring and control system
- Electrical works including renovation/expansion of Hurghada wind farm distribution point
- Civil works including access roads, gate, fence, drainage, houses, etc.
- Social and environmental considerations (mitigation measures & monitoring)

3- Objectives of the Consulting Service

The services to be rendered by the Consultant will cover preparation of draft pre-qualification (P/Q) and draft bid documents, the assistance for P/Q and bid evaluation, contract negotiation, construction supervision and contract management of the

project as well as warranty verification including data measuring. Expected consulting services period is approximately 68 months.

During the project implementation stage, the Consultant is requested to be "Engineer" which will be defined in the contract conditions to be developed later. JICA recommends using FIDIC (Federation International Des Ingenieurs Conseils) as contract condition under Japanese ODA Loan project.

4- Scope of Services to be performed by Consultant

4.1 Pre Award Stage

a) Design Stage

The Consultant shall carry out the followings:

- To review previous study reports conducted by NREA or other agencies, with respect to the requirements of the photovoltaic power plant
- To carry out site reconnaissance to grasp situation of the site and existing distribution point, especially space availability, situation of existing facilities, topography, soil condition and environmental circumstances, etc.
- To carry out basic and detailed design in consideration of site conditions, design criteria, applicable photovoltaic power plant specifications, practice, etc. in order to prepare technical specifications
- To estimate bill of quantities and costs
- To develop integrated implementation schedule

b) Pre-Qualification Stage

The Consultant shall carry out the followings:

- To prepare draft Pre-Qualification (P/Q) documents including evaluation criteria in accordance with JICA's rule, guidelines and sample documents for the project.
- To make draft reply to questions from applicants.
- To make draft evaluation report of P/Q for the projects in consultation with NREA.

c) Tendering Stage

The Consultant shall carry out the followings:

- To prepare draft tender documents for the project including evaluation criteria in accordance with JICA's rule, guidelines and sample documents as well as considering NREA's practices.
- To make draft reply to questions from tenderers.
- To attend pre-tender meeting.
- To carry out evaluations and make draft technical and financial evaluation report

for the projects in consultation with NREA.

- To attend contract negotiation with a successful tenderer and prepare the draft contract documents.

4.2 Project Implementation Stage

The Consultant is request to be (behave) "Engineer" under FIDIC contract condition or equivalent.

In addition to roles of "Engineer" above, the Consultant shall also carry out the followings:

- To assist in kick-off meeting for the project.
- To assist in progress meetings.
- To assist in review of the detailed overall work schedule prepared by the contractor.
- To assist in carrying out construction supervision in view of quality control, scheduling control and disbursement control.
- To assist in monitoring and evaluating of the work progress.
- To assist in inspection of manufacturing and fabrications at the site.
- To assist in witnessing of manufacturing and fabrications at factories.
- To assist in review and approval for testing procedure prepared by contractor.
- To witness the testing and commissioning at site as well as factory acceptance tests.
- To check the as-built drawings and operation & maintenance manual prepared by the Contractor.
- To assist in the evaluation of potential contractual claims.
- To assist in punch list preparation and preparation of Taking Over and Acceptance Certificate

4.3 Warranty Stage

The Consultant shall carry out the followings:

- To assist in the photovoltaic power plant performance verification.
- To assist the verification of deterioration ratio of the installed PV modules.
- Carry out end of warranty inspection.
- To assist in preparation of Final Acceptance Certificate

4.4 Environmental aspects

The Consultant shall carry out the followings:

- To assist setting up environmental monitoring system during construction.
- To monitor environmental measures and resettlement situations, if any, under the Project.

4.5 Co-ordination

The Consultant will assist NREA to maintain proper co-ordination and communication between NREA/JICA and NREA/Contractor.

4.6 Training

The Consultant will carry out/coordinate trainings to NREA's staffs based on description in Chapter 4 of this report.

- This should be defined later

4.7 Measuring

The Consultant shall measure and record of measured data such as solar radiation, output current of modules, temperature of modules, air temperature which can be obtained from measuring system provided by JICA. The Consultant shall maintain the measuring system provided by JICA properly during the services period.

The Consultant shall also measure and record of measured data of newly installed measuring system by the Contractor.

Then the Consultant will analyze such measuring data.

5- Duties of the Owner

The followings are assumed to be provided from the Owner for the consulting services:

- To provide to the Consultants in an expeditious manner access to and copies of studies, plans, specifications, maps, drawings, criteria, and other information related to the Project, if available to the Owner and necessary for the Consultants to perform the Services, at no expense to the Consultants.
- To assist the Consultants in obtaining customs clearance for materials or equipment brought into Egypt for performance of the Services by the Consultants. The Owner shall directly pay the customs duties associated with materials or equipment reimbursable hereunder brought for the jobsite office only, which at completion of the Project will be delivered to the Owner as Owner's property.
- To assist the Consultants, if required, in obtaining clearances, visas, and extensions; resident work permits; and any other documents relating to Expatriates of the Consultant, their accompanying dependents, and their personal effects assigned to perform the Services and shall use its best efforts to assist the Consultant, its Sub-consultants, and employees to obtain the benefit of all privileges, exemptions, and other favorable treatment, which are or may become lawfully available under any decisions, laws, regulations, or rules of Egypt.

- To provide overall management, direction, and control of the Project. In addition, the Owner intends to provide a dedicated Owner's team for the Project to coordinate with the Consultants' project team.
- To facilitate and expedite the Services, the Owner shall approve or object to the Consultants' replies and/or recommendations within two weeks after receipt of such replies/recommendations made during the Project's implementation period and in accordance with the Project's milestone schedule. For the purposes of assuring continuity in the performance of the Consultants' Services, in the event approval or objection is not made within such two weeks period, the replies/recommendations shall be deemed approved unless otherwise agreed for a longer period.

6- Reports to be prepared by the Consultant

The Consultant shall prepare and submit to the Owner for the following reports:

- Quarterly Progress Report including Project Status Report which JICA request Executing Agency
- Draft PQ Evaluation report
- Draft Technical Evaluation Report
- Draft Financial Evaluation Report
- Project Completion Report
- Warranty Inspection Report
- Final Report

Appendix 3-5-1: Cost Breakdown for the Project

Appendix 3-5-2: Detailed Cost breakdown for the Project

Appendix 3-5-3: Annual Fund Requirements (JP Yen basis)

Appendix 3-5-4: Cost Breakdown for Consulting Services

Appendix 3-5-5: Man-Months allocation for consultant

Appendix 3-5-1 Cost breakdown for the Project

The cost breakdown is attached as follows.

Cost for PV project (Reference only)

No.	Items to be requested	Nos. of Required	Cost (Thousand dollar)					Notes
			CIF to Port Saied		Inland Transportation	Site Works (Installation replacement etc.)	Total	
			unit	amount				
			(Foreign Currency)		(Local Currency)			
1 Construction of 20MW PV Power Plant including necessary equipment				**34,494.7**	**452.5**	**17,485.7**	**52,432.9**	52,432.9
1) PV module								
1-1	PV Module (MLTF)	LS		22,689.6	84.5	3,487.1	26,261.2	
1-2	Terminal Box	LS		728.0	2.0	105.3	835.3	
1-3	DC cable	LS		1,564.8	35.8	397.7	1,998.3	
1-4	Frame for PV	LS		896.0	37.0	8,840.4	9,773.4	
Sub-Total				25,878.4	159.3	12,830.5	38,868.2	
2) Inverter								
2-1	Inverter	LS		3,600.0	3.4	363.6	3,967.0	
2-2	Step-up Transformer	LS		260.0	1.7	3.7	265.4	
2-3	LV, MV switchgear	LS		300.0	6.7	17.9	324.6	
2-4	LV,MV cable for inverter	LS		87.0	0.0	37.6	124.6	
2-5	Monitoring System terminal unit	0		5.0	0.0	17.1	22.1	
Sub-Total				4,252.0	11.8	439.9	4,703.7	
3) MV switchgear								
3-1	Switchgear Box	LS		320.0	0.8	36.3	357.1	
3-2	Monitoring System terminal unit	LS		4.5	0.0	8.9	13.4	
Sub-Total				324.5	0.8	45.2	370.5	
4) Distribution line connection								
4-1	Feeder Box	LS		80.0	0.8	1.2	82.0	
4-2	Monitoring System terminal unit	LS		1.0	0.0	0.9	1.9	
Sub-Total				81.0	0.8	2.1	83.9	
5) Monitoring System								
5-1	Monitoring System	LS		281.5	0.0	10.1	291.6	
Sub-Total				281.5	0.0	10.1	291.6	
6) Internal cable connection								
6-1	MV Cable Connection	LS		1,320.0	5.5	278.1	1,603.6	
6-2	LV Cable Connection	LS		600.0	0.5	105.3	705.8	
6-3	Optic fiber cable connection	LS		176.0	0.5	48.7	225.2	
Sub-Total				2,096.0	6.6	432.1	2,534.7	
7) Grounding system								
7-1	Grounding conductor	LS		200.0	0.5	37.3	237.8	
Sub-Total				200.0	0.5	37.3	237.8	
8) Civil works								
8-1	PV and transformer foundation	LS		0.0	262.1	2,600.9	2,863.0	
8-2	land leveling	LS		0.0	0.0	111.8	111.8	
8-3	road and drain work	LS		0.0	0.0	152.2	152.2	
Sub-Total				0.0	262.1	2,865.0	3,127.0	
9) House construction								
9-1	Inverter house construction	LS		0.0	2.5	252.0	254.5	
9-2	MV Switchgear house construction	LS		0.0	2.5	248.0	250.5	
Sub-Total				0.0	5.0	500.0	505.0	
10) Guard Fence								
10-1	Guard Fence	LS		0.0	2.5	250.6	253.1	
Sub-Total				0.0	2.5	250.6	253.1	
11) Information Center								
11-1	Exhibition System	LS		300.0	3.0	0.0	303.0	
11-2	Construction of house	LS		0.0	0.0	70.0	70.0	
Sub-Total				300.0	3.0	70.0	373.0	
12) Central Hurghada Substation Modifications								
12-1	Central Hurghada S/S modifications	LS		20.0	0.2	3.0	23.2	
Sub-Total				20.0	0.2	3.0	23.2	
13) Training to Owner's engineers								
13-1	Training	LS		70.0			70.0	
Sub-Total				70.0			70.0	
14) Maintenance contract for PV power plant								
14-1	Maintenance Contract Cost for 2 years	LS		662.2			662.2	1% of the above 1) -7)per year * 2 years
Sub-Total				662.2			662.2	
15) Spare parts								
15-1	Spare parts for PV, Inverter, etc.	LS		329.1			329.1	1% of above 1)-6)
Sub-Total				329.1			329.1	
2 Installation of 2MW High Performance Battery including necessary equipment				**11,220.8**	**29.3**	**645.6**	**11,895.7**	11,895.7
1) High Performance Battery								
1-1	High Performance Battery	LS		9,086.0	24.7	162.6	9,273.3	
1-2	Power conditioning system for battery	LS		1,600.0	0.7	91.3	1,692.0	
1-3	MV Switchgear for Battery	LS		80.0	0.2	4.0	84.2	
1-4	MV Cable Connection	LS		60.0	0.2	23.7	83.9	
1-5	Room for Battery and PCS	LS		0.0	3.6	364.0	367.6	
Sub-Total				10,826.0	29.3	645.6	11,500.9	
2) Training to Owner's engineers								
2-1	Training	LS		70.0			70.0	
Sub-Total				70.0			70.0	
3) Maintenance contract for Battery System								
3-1	Maintenance Contract Cost for 2 years	LS		216.5			216.5	1% of the above 1) per year * 2 years
Sub-Total				216.5			216.5	
4) Spare parts								
13-1	Spare parts for Battery,PCS, etc.	LS		108.3			108.3	1% of above 1)
Sub-Total				108.3			108.3	
3 Dispute Board for 3 persons				**963.0**	**0.0**	**0.0**	**963.0**	
Total				**46,678.5**	**481.8**	**18,131.3**	**65,291.6**	65,291.6

Appendix 3-5-2 Detailed Cost breakdown for the Project

		No.	Item	Specification	Unit Price (US$)	Unit Price (EGP)	Total Quantity	units	Total Price (US$)	Total Price (EGP)	Remarks
1.PV	PV module	1	PV module (MLTF)	128W							
			1MW	(1.1$/W)	145	880	156,480		22,689,600	137,702,400	
		2	Terminal Box								
					1,300	7,840	560		728,000	4,390,400	
		3	DC cable connection								
			From PV module to Terminal box		2	20	782,400	m	1,564,800	15,648,000	
		4	DC cable connection								
			From Terminal box to Inverter		8	50	112,000	m	896,000	5,600,000	
		5	Frame for PV								
					2,000.0	12,060	4,420	t	8,840,000	53,305,200	
		6	Sub Total (1+2+3+4+5)						**34,718,400**	**216,646,000**	
	Inverter	7	Inverter	500kVA							
					90,000	542,700	40		3,600,000	21,708,000	
		8	Step-up Transformer	400V/22kV							
				2000kVA	26,000	156,780	10		260,000	1,567,800	
		9	LV Switchboard	400V							
					10,000	60,300	10		100,000	603,000	
		10	MV Switchgear	22kV							
					20,000	120,600	10		200,000	1,206,000	
		11	LV cable Connection								
			From Inverter to LV Switchboard		50	310	1,200	m	60,000	372,000	
		12	LV cable Connection								
			From LV Switchboard to Step-up transformer		50	310	180	m	9,000	55,800	
		13	MV Cable Connection								
			From Step-up transformer to MV Switchgear		100	610	180	m	18,000	109,800	
		14	Monitoring system terminal unit								
					500	3,020	10		5,000	30,200	
		15	Sub Total (7+8+9+10+11+12+13+14)						**4,252,000**	**25,652,600**	
	MV Switchgear	16	Feeder box								
					40,000	241,200	6		240,000	1,447,200	
		17	VT Box								
					20,000	120,600	2		40,000	241,200	
		18	Bus coupler Box								
					40,000	241,200	1		40,000	241,200	
		19	Monitoring system terminal unit								
					500	3,020	9		4,500	27,180	
		20	Sub Total (16+17+18+19)						**324,500**	**1,956,780**	
	Distribution line connection	21	Feeder Box (Extension)								
					40,000	241,200	2		80,000	482,400	
		22	Monitoring system terminal unit								
					500	3,020	2		1,000	6,040	
		23	Sub Total (21+22)						**81,000**	**488,440**	
	Monitoring System	24	M/M computer system								
					80,000	482,400	1		80,000	482,400	
		25	server system								
					200,000	1,206,000	1		200,000	1,206,000	
		26	Communication interface								
					1,000	6,030	1		1,000	6,030	
		27	UPS								
					500	3,020	1		500	3,020	
		28	Sub Total (24+25+26+27)						**281,500**	**1,697,450**	
	Internal cable connection	28	MV Cable Connection								
			from unit substation to 22kV bus unit		100	610	13,200	m	1,320,000	8,052,000	
		29	MV cable Connection from 22kV bus unit								
			to Hurghada Wind Distribution Point		100	610	6,000	m	600,000	3,660,000	
		30	Optical fiber cable Connection								
					20	130	8,800	m	176,000	1,144,000	
		31	Sub Total (28+29+30)						**2,096,000**	**12,856,000**	
	Grounding system	32	Grounding conductor								
					20	130	10,000	m	200,000	1,300,000	
		33	Sub Total (32)						**200,000**	**1,300,000**	
	Civil works	34	PV foundation								
					335	2,030	7,764		2,600,940	15,760,920	27730 x 0.28m3
		35	Ground leveling								
					3	20	33,880	m3	111,804	677,600	
		36	road construction								
					2	20	63,420	m	152,208	1,268,400	
		37	Sub Total (34+35+36)						**2,864,952**	**17,706,920**	
	Inverter house construction	38	Inverter house								
					350	2,120	360	m2	126,000	763,200	36m2 / 1room x 10 rooms
		39	Interior work								
					350	2,120	360	m2	126,000	763,200	
		40	Sub Total (38+39)						**252,000**	**1,526,400**	
	MV switch gear house	41	MV switch gear house								
					400	2,420	310		124,000	750,200	
		42	Interior work								
					400	2,420	310		124,000	750,200	
		43	Sub Total (41+42)						**248,000**	**1,500,400**	
	Guard Fence work	44	Guard Fence								
					58	350	4,320	m	250,560	1,512,000	
		45	Sub Total (44)						**250,560**	**1,512,000**	
	Information Center	46	Exhibition System								
					300,000	1,809,000	1	LS	300,000	1,809,000	
		47	Construction of house								
					350	2,120	100	m2	35,000	212,000	
		48	Interior work								
					350	2,120	100	m2	35,000	212,000	
		49	Sub Total (46+47+48)						**370,000**	**2,233,000**	
	Central Hurghada S/S modifications	50	S/S modifications								
					20,000	120,600	1	LS	20,000	120,600	
		51	Sub Total						**20,000**	**120,600**	
2.Battery	High Performance Battery	1	High Performance Battery	1,000kW							
					4,543,000	27,394,290	2	**unit**	9,086,000	54,788,580	
		2	Power conditioning system(PCS) for Battery	500kW							
					400,000	2,412,000	4	unit	1,600,000	9,648,000	
		3	MV Switchgear								
					40,000	241,200	2	unit	80,000	482,400	
		4	MV Cable connection								
					100	610	600	m	60,000	366,000	
		5	Room for battery and PCS								
					350	2,120	520	m2	182,000	1,102,400	
		6	Room Interior work including air conditioner								
					350	2,120	520	m2	182,000	1,102,400	
		7	Sub Total (1+2+3+4+5+6)						**11,190,000**	**67,489,780**	
3. DB	Dispute Board	1	Dispute Board								
					963,000	5,806,890	1	LS	963,000	5,806,890	
		2	Sub Total						**963,000**	**5,806,890**	

Appendix 3-5-3 Annual Fund Requirements (JP Yen basis)

(Million JP Yen)

No.	Item	Total			2013			2014			2015			2016			2017			2018		
		F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. ELIGIBLE PORTION																						
1	Construction of 20MW PV Power Plant including necessary equipment incl. 2MW battery	3,847	1,535	5,382							1,539	614	2,153	1,924	767	2,691	192	77	269	192	77	269
2																						
3																						
4																						
5	Total (1-4)	3,847	1,535	5,382							1,539	614	2,153	1,924	767	2,691	192	77	269	192	77	269
6	Price Escalation	312	576	888							100	177	277	166	308	474	21	40	61	25	51	76
7	Physical Contingency	209	106	315							82	40	122	105	54	159	11	6	17	11	6	17
8	Total (5+6+7)	4,368	2,217	6,585							1,721	831	2,552	2,195	1,129	3,324	224	123	347	228	134	362
9	Consulting Service	964	244	1,208	193	49	242	241	61	302	241	61	302	241	61	302	29	7	36	19	5	24
10	Price Escalation	57	64	121	4	4	8	10	11	21	16	18	34	21	24	45	3	4	7	3	3	6
11	Physical Contingency	52	16	68	10	3	13	13	4	17	13	4	17	13	4	17	2	1	3	1		1
12	Total (9+10+11)	1,073	324	1,397	207	56	263	264	76	340	270	83	353	275	89	364	34	12	46	23	8	31
13	**A. Total (8+12)**	5,441	2,541	7,982	207	56	263	264	76	340	1,991	914	2,905	2,470	1,218	3,688	258	135	393	251	142	393
B. NON ELIGIBLE PORTION																						
14	Land acquisition & Compensation																					
15	Price Escalation																					
16	Physical Contingency																					
17	Total (14+15+16)																					
18	Administration cost		329	329								128	128		166	166		17	17		18	18
19	Price Escalation		125	125								37	37		67	67		9	9		12	12
20	Physical Contingency		23	23								8	8		12	12		1	1		2	2
21	Total (18+19+20)		477	477								173	173		245	245		27	27		32	32
22	VAT		221	221								83	83		113	113		12	12		13	13
23	CD		437	437								172	172		220	220		22	22		23	23
24	**B. Total (21+22+23)**		1,135	1,135								428	428		578	578		61	61		68	68
25	**TOTAL (A+B)**	5,441	3,676	9,117	207	56	263	264	76	340	1,991	1,342	3,333	2,470	1,796	4,266	258	196	454	251	210	461
26	IDC	115		115				1		1	14		14	30		30	34		34	36		36
27	Commitment Charge	33		33	6		6	6		6	6		6	6		6	6		6	6		6
	Grand Total (25+26+27)	5,589	3,676	9,265	213	56	269	271	76	347	2,011	1,342	3,353	2,506	1,796	4,302	298	196	494	293	210	503
		5,592	3,676	9,268																		

Fiscal Year: From April to March

Price Escalation (F/C) :	2.1 %	Administration Cost=	5%	of the Eligible portion
Price Escalation (L/C) :	8.8 %	VAT=	10%	of expenditure in local currency of the Eligible portion
Physical Contingency :(construction)	5.0 %	CD=	10%	of expenditure in foreign currency of the Eligible portion (incl. VAT)
Physical Contingency (others) :	5.0 %			
Exchange Rate : 1.0 =	1.0 Yen/LE	Commitment Charge ratio=	0.1%	
	82.43 US$/Yen	Duration of Disbursement=	6	year
Eligible ratio	87.4%			
Financing rate (Foreign/Total)	60.3 %			
Interest rate	0.650 %	Interest rate for Consul=	0.01%	

Actual Disbursement/Temporally allocation				207.0			264.0			1,991.0			2,470.0			258.0			251.0		
Debt at the end of term				207.0			471.0			2,463.0			4,947.0			5,235.0			5,520.0		
Interest during const							1.0			14.0			30.0			34.0			36.0		

Financing rate =Grand Total F/C / Grand Total
Actual Disbursement = Total cost except for Interest during construction * Financing rate
Debt at the end of term = Actual Disbursement of same year + Debt at the end of last year + Interest during const of last year
Interest during const = Debt at the end of term * Interest rate

Appendix 3-5-4 Cost Breakdown for Consulting Services

<Monthly/Daily Unit Rate>

1. ENGINEERING FEE							
1.1 Outside of Egypt	**MM**	**RATE**		**Paid in LE**		**Paid in JP Yen**	
Foreign Consultant (FC)	6.0	2,562,000	Yen/MM			15,372,000	Yen
Foreign Consultant for Training	20.0	2,562,000	Yen/MM			51,240,000	Yen
1.2 In Egypt (incl. Factory Test)							
Foreign Consultant (FC)	201.0	2,712,000	Yen/MM			545,112,000	Yen
Local Consultant (LC)	303.0	55,000	LE/MM	16,665,000	LE		
1.3 Subtotal for Engineering Fee				16,665,000	LE	611,724,000	Yen
2. Direct Cost							
2.1 Airfare	**Trips**						
Air Fare from Japan to Egypt	61	450,000	Yen/trip			27,450,000	Yen
Air Fare for FC for factory test	3	450,000	Yen/trip			1,350,000	Yen
2.2 Accommodation	**person-night**						
Accommodation for FC in Egypt	6,030	18,000	Yen/Person-Night			108,540,000	Yen
Accommodation for FC for factory test	75	23,000	Yen/Person-Night			1,725,000	Yen
2.3Local Transportation	**car-months/days**						
for FC in Egypt	101	230,000	Yen/Car-Months			23,230,000	Yen
for LC in Egypt	152	5,000	LE/Car-Months	760,000	LE		
for factory test for FC	38	8,000	Yen/days			300,000	Yen
for factory test for LC	0	400	LE/days	0	LE		
2.4 Offices and Equipment/Facilities	**months**						
Rental fee for Egypt Office for FC	64	300,000	Yen/Months			19,200,000	Yen
Office equipment/furniture for Egypt FC office	LS	-	Yen/Months			30,000,000	Yen
PC, printers, faxes, copiers for Egypt FC office	LS	-	Yen/Months			20,000,000	Yen
Office staff for Egypt FC office	64	300,000	Yen/Months			19,200,000	Yen
Office equipment/furniture etc. for site office	20.0	20,000	LE/Months	400,000	LE	0	Yen
2.5 Communication and Document Delivery							
Any communication and document delivery for FC	64	500,000	Yen/Months			32,000,000	Yen
2.6 Any Direct Costs related Training to NREA							
Air Fare to Japan from Egypt	40	320,000	Yen/trip			12,800,000	Yen
Accommodation for NREA in Japan	1,200	23,000	Yen/Person-Night			27,600,000	Yen
Transportation in Japan	40	100,000	Yen/Person-Trip			4,000,000	Yen
Allowances for NREA staffs	1,200	4,000	Yen/Person-Night			4,800,000	Yen
Any facilities and documents required for Training	LS					20,000,000	Yen
2.6 Subtotal for Direct Cost				1,160,000	LE	352,195,000	Yen
3. Total Amount (1+2)				17,825,000	LE	963,919,000	Yen

Appendix 3-5-5 Man-Months allocation for consultant

Man-Months allocation table for Consulting Services for 20MW PV power plant project in Hurghada

year		1												2												3												4												5												6												Total
month		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	
Pre-Construction stage																																																																										
Basic Design, Preparation of PQ and Tender Docs	8	1	1	1	1	1	1	1	1																																																																	
Tendering stage (incl. prep. for tender docs, evaluations upto contract sign)	12									1	1	1	1	1	1	1	1	1	1	1	1																																																					
Construction Stage	20																					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																																	
Detailed Design incl. site investigations	4																					1	1	1	1																																																	
Manufacturing and transportation	13																								1	1	1	1	1	1	1	1	1	1	1	1	1																																					
Factory test of PV	0																									★																																																
Factory test of Inverter	0																										★																																														
Factory test of MV equipment	0																											★																																													
Civil Works	14																							1	1	1	1	1	1	1	1	1	1	1	1	1	1																																					
Site installation works	13																										1	1	1	1	1	1	1	1	1	1	1	1	1																																		
Commissioning test	2																																							1	1																																	
Training	5																										1	1														1	1	1																														
Warranty period	24																																									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
Verification and acceptance test	0																																																			★	★													★	★									

Consultant MM allocation

year		1												2												3												4												5												6												Total	Nos. of Trip
month		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72		
International Consultant																																																																											
Inside Egypt																																																																											
Project Manager		1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	0.5	1.0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0								1.0	1.0											1.0	1.0									44.0	6
PV Specialist		1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	0.5	1.0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0								1.0	1.0											1.0	1.0									44.0	6
Civil Engineer		1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0		1.0			1.0	1.0		1.0			1.0	1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0	1.0																																					22.0	9
Eclectic Engineer for LV		1.0	1.0	1.0	1.0	1.0							1.0			1.0							1.0				1.0	1.0	1.0				1.0	1.0					1.0	1.0	1.0																																	16.0	7
Eclectic Engineer for MV		1.0	1.0	1.0	1.0	1.0	1.0		1.0				1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																														34.0	8
Control System Engineer		1.0	1.0	1.0	1.0	1.0	1.0																1.0														1.0				1.0																																	9.0	4
Environmental Specialist		1.0	1.0	1.0	1.0																		1.0										1.0				1.0				1.0																																	8.0	5
Commercial Expert				1.0	1.0	1.0	1.0					1.0		1.0		1.0				1.0			1.0										1.0				1.0				1.0																																	12.0	9
Legal Expert				1.0	1.0	1.0	1.0													1.0													1.0								1.0																																	7.0	4
Safety Expert		1.0	1.0	1.0																			1.0										1.0																																									5.0	3
Sub-Total																																																																										201.0	61
Outside Egypt																																																																										
PV Specialist																																																																										0.0	1
Eclectic Engineer																																																																										0.0	2
Engineers for Training																												4.0	4.0													4.0	4.0	4.0																														20.0	
Home Office Support													1.0												1.0												1.0												1.0												1.0				1.0									6.0	
Sub-Total																																																																										26.0	
Total for International Consultant																																																																											
Local Consultant																																																																										
Leader of Local Consultant		1.0	1.0	1.0	1.0	1.0	1.0				1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0												1.0	1.0																	41.0	
Civil Engineer		1.0	1.0	1.0	1.0	1.0	1.0				1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																																				33.0	
Eclectic Engineer for LV		1.0	1.0	1.0	1.0	1.0	1.0				1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0												1.0	1.0																	41.0	
Eclectic Engineer for MV		1.0	1.0	1.0	1.0	1.0	1.0				1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0												1.0	1.0																	41.0	
Control System Engineer		1.0	1.0	1.0	1.0	1.0	1.0						1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0															1.0	1.0																	37.0	
Measuring device maintenance and data acquisition		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5									32.0	
Environmental Specialist		1.0				1.0	1.0															1.0					1.0				1.0						1.0																																					7.0	
Legal and Contractual Expert		1.0				1.0	1.0							1.0			1.0	1.0	1.0	1.0		1.0	1.0	1.0			1.0				1.0						1.0				1.0																																	15.0	
Procurement Materials Control Experts																			1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																																	22.0	
Document Control and Administration											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																														34.0	
Supervisors																																																																										0.0	
Total																																																																										303.0	

Appendix 6-1: Screening Format of JICA's Guidelines for Environmental and Social Considerations and JICA's Environmental Checklist for Other Electric Generation

Appendix 6-1 Screening Format of JICA's Guidelines for Environmental and Social Considerations and JICA's Environmental Checklist for Other Electric Generation

JICA's Environmental Checklist for Other Electric Generation (1 of 2)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) ESIA and Environmental Permits	(a) Have ESIA reports been already prepared in official process? (b) Have ESIA reports been approved by authorities of the host country's government? (c) Have ESIA reports been unconditionally approved? If conditions are imposed on the approval of ESIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)Y (b)N (c)- (d)-	(a) ESIA (Environmental and Social Impact Assessment) report will be finalized in December 2012. It will be submitted to EEAA (Egyptian Environmental Affairs Agency) soon. (b) It has not been approved yet. (c) Not Applicable (N/A) (d) N/A
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)Y	(a) Public hearings were held two times. Outline of the project and possible impacts were explained to the local stakeholders. (b) Impact of flood and impact on water resources were anticipated by the local people at the scoping meeting. Then additional topographical survey and detail impact assessments were made. Based on the impact assessment, suitable mitigation measures were taken in cooperated to the project design.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) Alternatives of module types, cleaning methods, and alternative locations were considered. Environmental and social issues were considered in the alternative comparison.
2 Pollution Control	(1) Air Quality	(a) In the case that electric power is generated by combustion, such as biomass energy projects, do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by power plant operations comply with the country's emission standards and ambient air quality standards? Are any mitigating measures taken? (b) Do air pollutants emitted from other facilities comply with the country's emission standards?	(a) - (b) Y	(a) This project is not thermal power system. (b)Gas emission from construction vehicles during construction and gas emission from water pump during operation. But the amount of the gas is expected to be very limited and it will be minimized by periodical check and maintenance plan described in the EMP (Environmental Management Plan, a part of ESIA).
	(2) Water Quality	(a) Do effluents (including thermal effluent) from various facilities, such as power generation facilities comply with the country's effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country's ambient water quality standards? (b) Do leachates from the waste disposal sites comply with the country's effluent standards and ambient water quality standards? Are adequate measures taken to prevent contamination of soil, groundwater, and seawater by leachates?	(a) Y (b) -	(a) The waste water will only be domestic water by workers. The high polluted waste water will not be discharged. (b) Inverters and batteries might contain hazardous substances. Then adequate check will be done for the effluence to prevent soil contamination. EMP suggests suitable treatment, if unusual conditions are confirmed.
	(3) Wastes	(a) Are wastes generated by the plant operations properly treated and disposed of in accordance with the country's regulations (especially biomass energy projects)?	(a) Y	(a) Possible industrial waste is expected to be used PV modules and used batteries. The adequate treatment policies are written in the EMP.
	(4) Soil Contamination	(a) Has the soil in the project site been contaminated in the past? Are adequate measures taken to prevent soil contamination?	(a) Y	(a) No soil contaminations are recorded in the past. The monitoring and inspections are planned in the EMP to prevent soil pollution.
	(5) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards? (b) In case of Wind Power Station, does low frequency noise comply with the environmental standard?	(a) Y (b) -	(a) The assessed impact noise level fulfill the Environmental standard in Egypt. (b)It is not a wind farm project.
	(6) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Water pumping from underground is not planned.
	(7) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) N	(a) There is no source of odor in the project.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country' s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) The project site is outside of the protected area. Although migration birds are moving above the project site, no adverse impact are anticipated because no high facilities are planned.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that localized micro-meteorological changes due to wind power generation will affect valuable vegetation in the surrounding areas (Is there valuable vegetation in the vicinity of the wind power generation facilities)? If impacts on vegetation are anticipated, are adequate measures considered? (e) Are the wind power generation facilities (wind turbines) sited by considering the habitat and migration routes of sensitive or potentially affected bird species?	(a) N (b) N (c) N (d) - (e) -	(a) No (b) No (c) No serious ecological impact are anticipated. (d) This project is not a wind farm project. (e)This project is not a wind farm project.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to installation of the structures, such as weirs will adversely affect the water flows, waves and tides?	(a) N	(a) The project facilities will not block the water flow might be considered by potential flood from wadies. Then the water system will not be changed.
	(4) Topography and Geology	(a) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas?	(a) N	(a) No

JICA's Environmental Checklist for Other Electric Generation (2 of 2)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plan developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) - (c) - (d) - (e) - (f) - (g) - (h) - (i) - (j) -	(a) No resettlement is required under this project. (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) N/A (j) N/A
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water (e.g., surface water, groundwater) used and discharge of effluents by the project will adversely affect the existing water uses and water area uses?	(a) N (b) N	(a) Dust pollution will temporally be happened during construction stage because of the construction vehicles. But some mitigation measures such as speed limitations are suggested in the ESIA. (b) Impact on water resources are assessed because the fresh water will be used for module cleaning during operation. But the amount of the water is not so much. Then no serious impacts are anticipated.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) No
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There is no special view and/or landscape around the project site.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) - (b) -	(a) There is no impact on the lifestyle of the ethnic minorities and indigenous people. (b) There is no impact on the natural resources of the ethnic minorities and indigenous people.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Minimizing impact on workers are proposed in the ESIA. (b) Electrical facilities are designed based on Japanese safety standard. Then precautions for industrial accidents are fully considered. (c) Training for the workers are planned in the EMP. (d) Security guards are currently working on the site and there is no confliction between surrounding area.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) - (c) -	(a) Mitigation measures for noise, dust, exhaust gases during construction are suggested in the ESIA. (b) There is no serious adverse impact on ecology during construction. (c) There is no serious adverse impact on social aspects during construction.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) - (c) Y (d) N	(a) Monitoring plan is mentioned in the EMP. (b) Monitoring items, methods, and frequencies are adequately defined in the EMP. (c) Monitoring cost is estimated in the EMP. (d)Not yet developed. Reporting frequencies are not mentioned in the EMP.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) -	(a) Transmission and Distribution lines are not included in the project.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) -	(a) N/A

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

Screening Format of JICA's GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

Name of Proposed Project:

THE PHOTOVOLTAIC POWER PLANT PROJECT IN THE ARAB REPUBLIC OF EGYPT

Project Executing Organization, Project Proponent or Investment Company:

New & Renewable Energy Authority (NREA)

Name, Address, Organization, and Contact Point of a Responsible Officer:

Name: Eng. Afaf Meakhail Tawfic
Address: Dr. Ibrahim Abu El-Naga St., Ext. Abbass El-Akkas St., Nasr City, Cairo, Egypt.
Organization: New & Renewable Energy Authority (NREA)
Tel: (202) 22710081
Fax: (02) 227 122 67
E-Mail: afaftawfic@hotmail.com

Date: 2/10/2012

Signature:

Check Items

Please write "to be advised (TBA)" when the details of a project are yet to be determined.

Question 1: Address of project site

The project is planned to be located in the northern part of Hurghada city, along Hurghada -Ras_Garib road, on the site of Hurghada wind farm owned by NREA.

Question 2: Scale and contents of the project (approximate area, facilities area, production, electricity generated, etc.)

2-1. Project profile (scale and contents)

This is a 20MW Photovoltaic (PV) power plant. The materials and equipment are as follows.

- 20 MW PV modules (as temporary solution the following mixture arrangement is anticipated; 18 MW to be selected from Polycrystalline type, 1MW to be selected from Multi-Layer Thin Film type and 1 MW to be selected from CIS type) with accessories such as terminal boxes, DC power cables, optic fiber cables, supporting structures for PV modules, etc.
- Electrical equipment for PV power plant including Inverters (500kVA * 40 units), step-up transformers (400V/22kV, 2MVA, 10 units), switchgears, cables, etc.
- Electrical equipment for existing Distribution Point including MV switchgears, buscouplers, terminal units, etc.
- High performance battery (Sodium Sulfur or Lead battery, 2MW, 12MWh)
- Monitoring systems including server, communication interface, UPS, etc.
- Exhibition system including sophisticated 3 D and/or 2D screens, etc.

2-2. How was the necessity of the project confirmed?

Is the project consistent with the higher program/policy?

☑YES: Please describe the higher program/policy.

(The strategy for the electricity generation (February 2008))

☐NO

2-3. Did the proponent consider alternatives before this request?

☑YES: Please describe outline of the alternatives (No Development Alternative, Alternative Site Location, Alternative Electricity Generating Renewable Energy Technologies, Alternative PV Types, Alternative panel cleaning, and Energy Storage batteries are considered.)

☐NO

2-4. Did the proponent implement meetings with the related stakeholders before this request?

☑Implemented ☐Not implemented

If implemented, please mark the following stakeholders.

☑Administrative body

☑Local residents

☑NGO

☐Others ( )

2-5 Does the project include any of the following items?

☐Yes ☑ No

If yes, please mark the items included in the project.

☐Involuntary resettlement (scale: households persons)

☐Groundwater pumping (scale: m3/year)

☐Land reclamation, land development, and/or land-clearing (scale: hectors)

☐Logging (scale: hectors)

Question 3:

Is the project a new one or an ongoing one? In the case of an ongoing project, have you received strong complaints or other comments from local residents?

☑New

☐Ongoing (with complaints)

☐Ongoing (without complaints)

☐Other

Question 4:

Is an Environmental Impact Assessment (EIA), including an Initial Environmental Examination (IEE) Is, required for the project according to a law or guidelines of a host country? If yes, is EIA implemented or planned? If necessary, please fill in the reason why EIA is required.

☑Necessity (☐Implemented ☑Ongoing/planning)

(Reason why EIA is required: Egyptian Environmental Affairs Agency (EEAA) requirments.

☐Not necessary

☐Other (please explain)

Question 5:
In the case that steps were taken for an EIA, was the EIA approved by the relevant laws of the host country? If yes, please note the date of approval and the competent authority.

☐Approved without a supplementary condition
☐Approved with a supplementary condition
☐Under appraisal
(Date of approval: Competent authority:)
☑Under implementation
☐Appraisal process not yet started
☐Other ( )

Question 6:
If the project requires a certificate regarding the environment and society other than an EIA, please indicate the title of said certificate. Was it approved?

☐Already certified
Title of the certificate: ( )
☐Requires a certificate but not yet approved
☑Not required
☐Other

Question 7:
Are any of the following areas present either inside or surrounding the project site?

☐Yes ☑No
If yes, please mark the corresponding items.

☐National parks, protection areas designated by the government (coastline, wetlands, reserved area for ethnic or indigenous people, cultural heritage)
☐Primeval forests, tropical natural forests
☐Ecologically important habitats (coral reefs, mangrove wetlands, tidal flats, etc.)
☐Habitats of endangered species for which protection is required under local laws and/or international treaties
☐Areas that run the risk of a large scale increase in soil salinity or soil erosion
☐Remarkable desertification areas
☐Areas with special values from an archaeological, historical, and/or cultural points of view
☐Habitats of minorities, indigenous people, or nomadic people with a traditional lifestyle, or areas with special social value

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Question 8:

Does the project include any of the following items?

☐Yes ☑No

If yes, please mark the appropriate items.

☐Involuntary resettlement (scale: households persons)

☐Groundwater pumping (scale: m3/year)

☐Land reclamation, land development, and/or land-clearing (scale: hectors)

☐Logging (scale: hectors)

Question 9:

Please mark related environmental and social impacts, and describe their outlines.

☐Involuntary resettlement

☐Air pollution

☑Local economies, such as employment, livelihood, etc.

☐Water pollution

☐Soil pollution

☐Land use and utilization of local resources

☑Waste

☐Noise and vibrations

☐Social institutions such as social infrastructure and local decision-making institutions

☐Ground subsidence

☐Offensive odors

☐Geographical features

☐Existing social infrastructures and services

☐Bottom sediment

☐Biota and ecosystems

☐Poor, indigenous, or ethnic people

☑Water usage

☐Misdistribution of benefits and damages

☑Accidents

☐Local conflicts of interest

☐Global warming

☐Limitation of accessibility to information, meetings, etc. on a specific person or group

☐Gender

☐Children's rights
☐Cultural heritage
☐Infectious diseases such as HIV/AIDS
☐Other ( )
Outline of related impact:

Question 10:

In the case of a loan project such as a two-step loan or a sector loan, can sub-projects be specified at the present time?

☐Yes ☑No

Question 11:

Regarding information disclosure and meetings with stakeholders, if JICA's environmental and social considerations are required, does the proponent agree to information disclosure and meetings with stakeholders through these guidelines?

☑Yes ☐No