PLOTTING OF SOLAR INCIDENT ENERGY INCLUDING EFFECT OF ATMOSPHERE WITH TILT AT DIFFERENT LOCATIONS.

The analysis and simulation for the Solar incident energy with and without atmospheric effect was carried out in Matlab software.

As per the procedure, Clearness index matrices and water vapour content was obtained for a particular location and was linked with the matlab software. After that the with the help of script Effect of solar incident energy outer the surface and including earth's atmospheric effect was analysed.

The script for the same is shown below,

```
%18BEE081
clear all;clc;

phi=23.02; %latitude of Ahmedabad
x=phi-35;

phi=phi*pi/180;

beta=phi;
Lsc=1.37;
rho=0.2;

G = [1.6204   -0.2291   -0.0068;
   1.6857   -0.0073   -0.0020;
  -1.2423   -0.0810   -0.0010;
   0.5626    0.0708    0.0019;
  -1.2140    0.0064    0.0014;
  -0.0990   -0.0133   -0.0004;
   0.4972    0.0605    0.0015];

AA =[0.5563    0.0089    0.0002    0.0743   -0.0089;
  -0.2350    0.0119    0.0004    0.1473   -0.0237;
  -0.1011   -0.0091   -0.0004    0.1029   -0.0201;
   0.0136    0.0041    0.0002   -0.0071    0.0010;
   0.1300   -0.0133   -0.0003   -0.0848    0.0098;
  -0.0600    0.0048    0.0002    0.0733   -0.0132;
   0.0970    0.0058    0.0002   -0.0282    0.0010];

kt= [0.7070;0.7164;0.7198;0.7073;0.6958;0.5998;0.4553;0.4393;0.6100;0.6952;0.7157;0.7051;  %Kt computed from computed Ho and measured Ha
   0.7231;0.7297;0.7242;0.7007;0.6991;0.5693;0.4330;0.4167;0.5969;0.7041;0.7239;0.7095;
   0.6694;0.6680;0.6766;0.6745;0.6811;0.5305;0.3836;0.3851;0.5229;0.6376;0.6730;0.6661;
   0.6012;0.6410;0.6441;0.6268;0.6366;0.4617;0.4270;0.4101;0.4740;0.5464;0.5924;0.6083;
   0.7394;0.7349;0.7289;0.7087;0.6887;0.6467;0.5592;0.5537;0.6660;0.7269;0.7501;0.7334;
   0.7707;0.7634;0.7009;0.6259;0.5755;0.5086;0.4208;0.4325;0.4565;0.4381;0.5251;0.6662;
   0.6427;0.6882;0.6955;0.6720;0.6467;0.5882;0.5385;0.5574;0.5953;0.5546;0.5453;0.5590;
   0.6906;0.6887;0.6716;0.6611;0.6493;0.5438;0.4021;0.3969;0.5470;0.6779;0.7087;0.6997;
   0.6792;0.6998;0.7108;0.6902;0.6751;0.5934;0.5044;0.5159;0.6504;0.7072;0.7244;0.7034;
   0.6904;0.7098;0.7034;0.6902;0.6972;0.5488;0.4216;0.4315;0.5434;0.6668;0.6888;0.6932;
   0.6809;0.6748;0.6679;0.6165;0.5771;0.5508;0.5108;0.5549;0.6043;0.5683;0.5719;0.6377;
   0.7068;0.6999;0.6770;0.6453;0.6375;0.5026;0.4483;0.4827;0.5643;0.6685;0.7029;0.7030];

for N=1:1:365

   delta=23.45*sin(2*pi*(N-80)/365);
   t=((2*pi)/365).*(N-80);
   delta=delta*pi/180;
   k=1+0.033*cos(2*pi*N/365);
   wsr=acos(-1*tan(delta)*tan(phi));
   wsrb=acos(-1*tan(delta)*tan(phi-beta));
   wsrt=min(wsr,wsrb);
   Ho(N)=(24*k*Lsc/pi)*((cos(delta)*cos(phi)*sin(wsr)) + (wsr*sin(delta)*sin(phi)));
   Hot(N)=(24*k*Lsc/pi)*((cos(delta)*cos(phi-beta)*sin(wsrt)) + (wsrt*sin(delta)*sin(phi-beta)));
   days(N)=N;

 %Introduction of atmospheric effects

 BB=[1;x;x.*x];

 G1=G(1,1:3)*BB;

 G2=G(2,1:3)*BB;


 G3=G(3,1:3)*BB;

G4=G(4,1:3)*BB;

 G5=G(5,1:3)*BB;

 G6=G(6,1:3)*BB;

 G7=G(7,1:3)*BB;


 W(N)=G1 + G2*(sin(t)) + G3*(sin(2*t)) + G4*(sin(3*t)) + G5*(cos(t)) + G6*(cos(2*t))+ G7*(cos(3*t));
 CC=[1;x;x.*x;W(N);W(N).*W(N)];
 A1=AA(1,1:5)*CC;

 A2=AA(2,1:5)*CC;


 A3=AA(3,1:5)*CC;

 A4=AA(4,1:5)*CC;
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A5=AA(5,1:5)*CC;

A6=AA(6,1:5)*CC;

A7=AA(7,1:5)*CC;

kte(N)=A1 + A2*(sin(t)) + A3*(sin(2*t)) + A4*(sin(3*t)) + A5*(cos(t)) + A6*(cos(2*t))+ A7*(cos(3*t));

Rd(N)= Hot(N)/Ho(N);

kd(N)= 1-1.13*kte(N);

rt(N)=((1-kd(N).*Rd(N)) + (kd(N).*(1+cos(beta)/2)) + (rho.*(1-(cos(beta))/2)));

Hat(N)=Ho(N)*rt(N)*kte(N);
%Ha(N)=Hat(N)/Rd(N);


end
plot(days,Hot,days,Hat);
hold on;
grid, xlabel('No. of days'),ylabel('Solar Incident Energy - Kwh/m^2/day'),
%title('(18BEE081)');
title('Solar Incident Energy with and without atmosphere effect including tilt angle at Ahmedabad.  (18BEE081)');
```

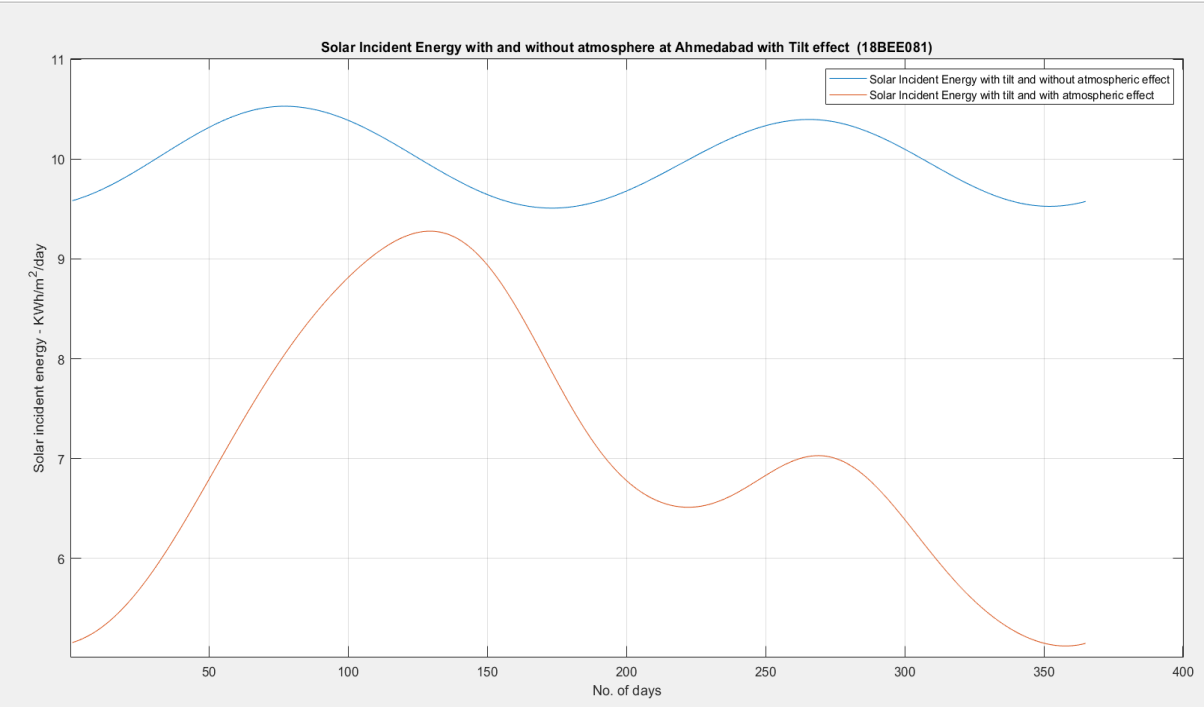

Fig. **Solar Incident energy of PV panel without and with atmosphere and including tilt at Ahmedabad.**

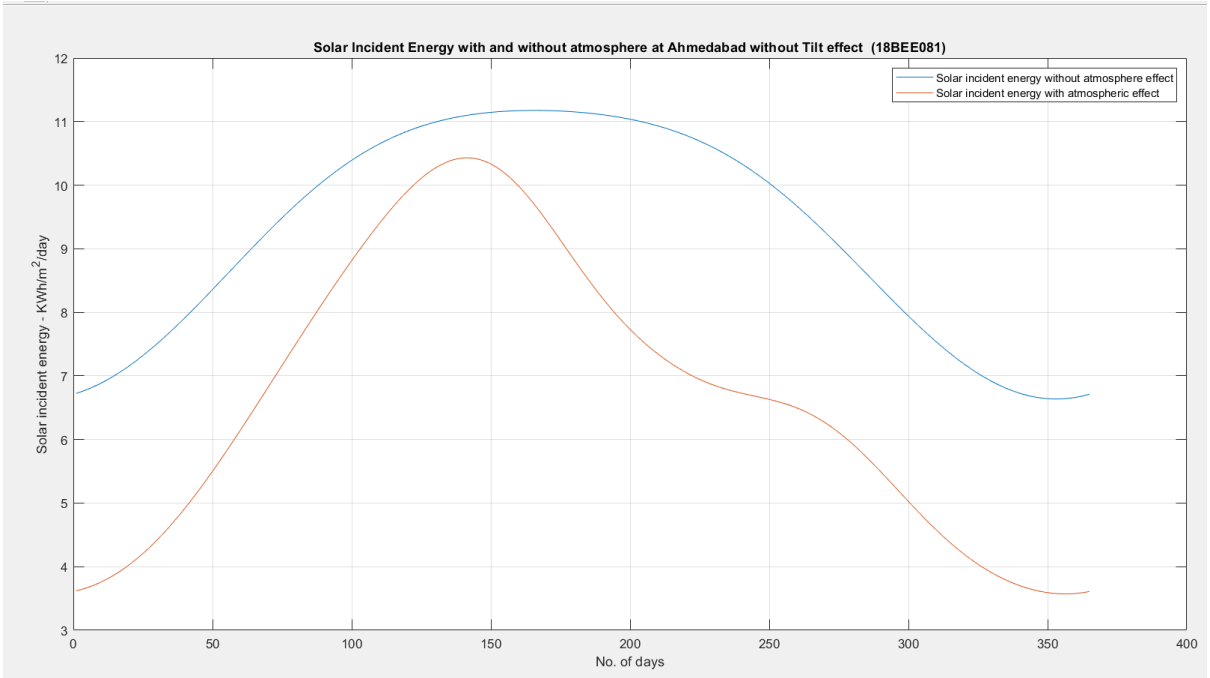

Fig. **Solar Incident energy of PV panel without and with atmosphere and without tilt at Ahmedabad.**

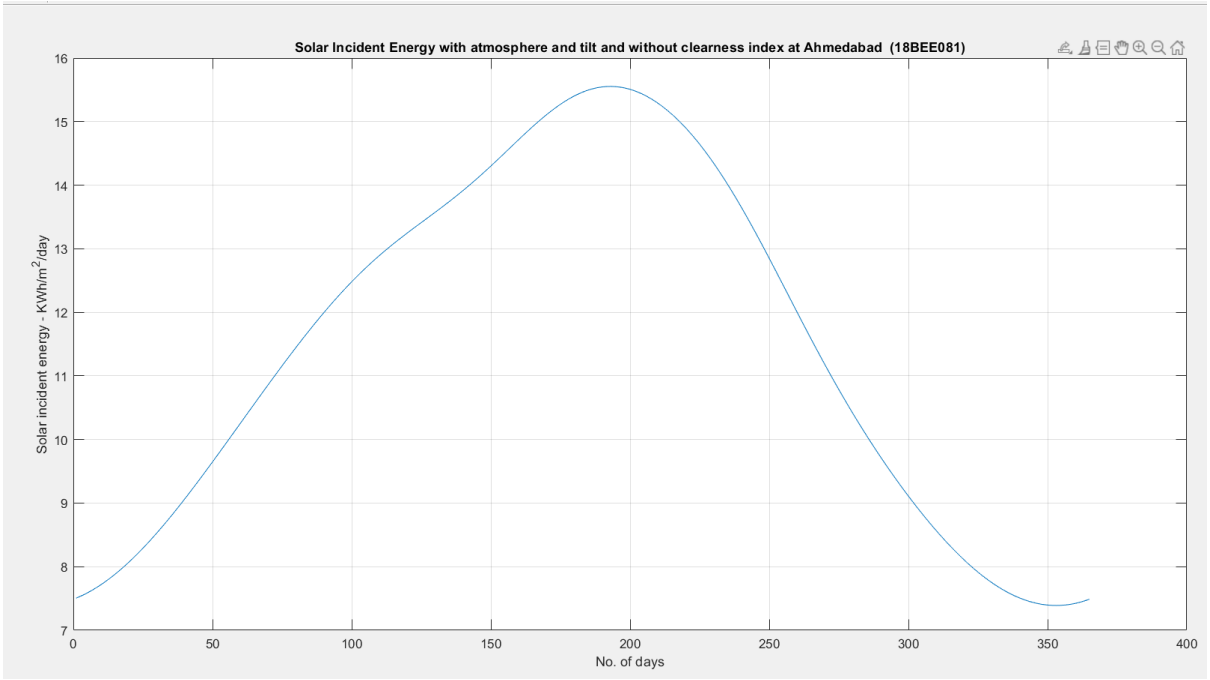

Fig. **Solar Incident energy of PV panel with atmosphere and tilt but without Clearness Index at Ahmedabad.**

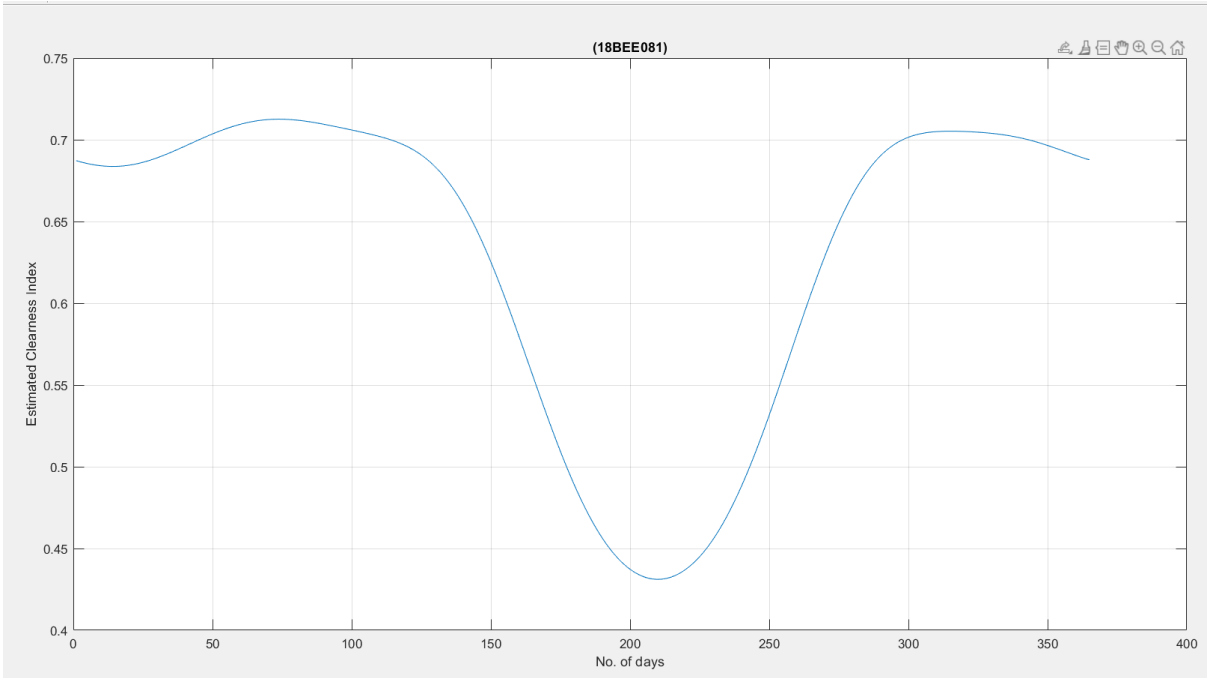

Fig. **Days V/S Clearness Index at Ahmedabad.**

Q1. A) Calculate the values of Solar Incident Energy using the Experiment matrix.

Ans.

Here, the Latitude of Goa is chosen (15.29 degrees) and the same script is followed to analyse the Solar Incident Energy at Goa.

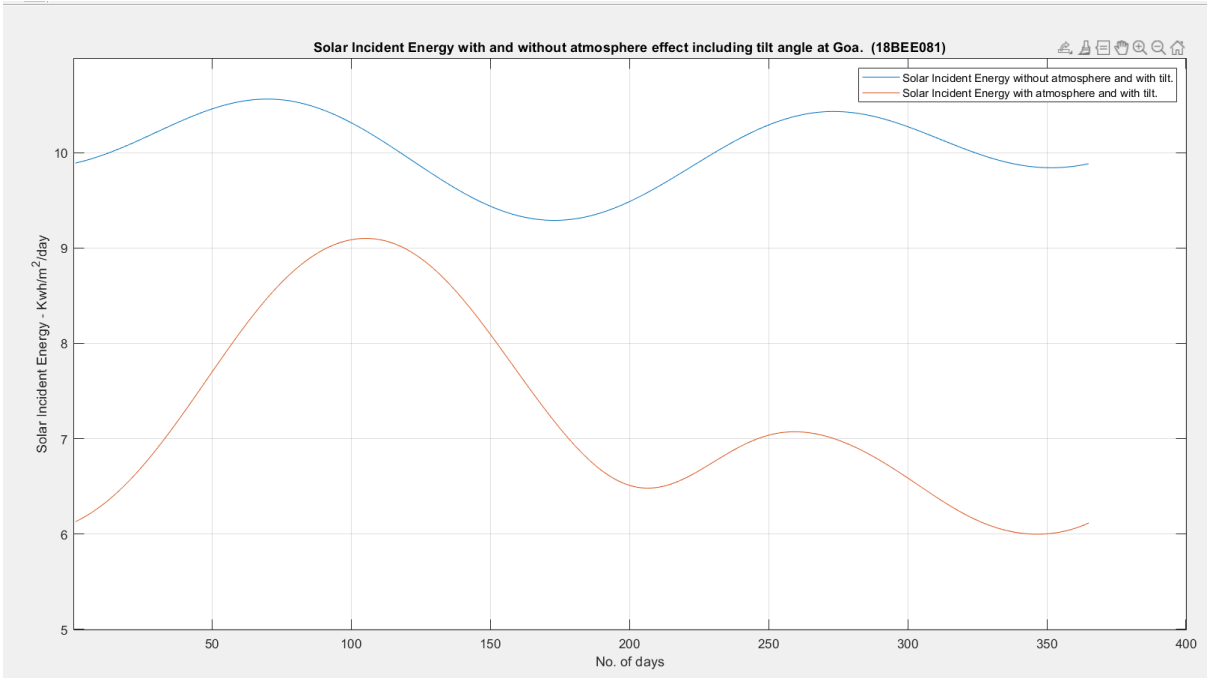

Fig. **Solar Incident energy of PV panel without and with atmosphere and including tilt at Goa.**

Q1. B) Plot the error between measured value of Solar incident energy and calculated value of solar energy. Measured values of Goa is already given in the table.

Ans.

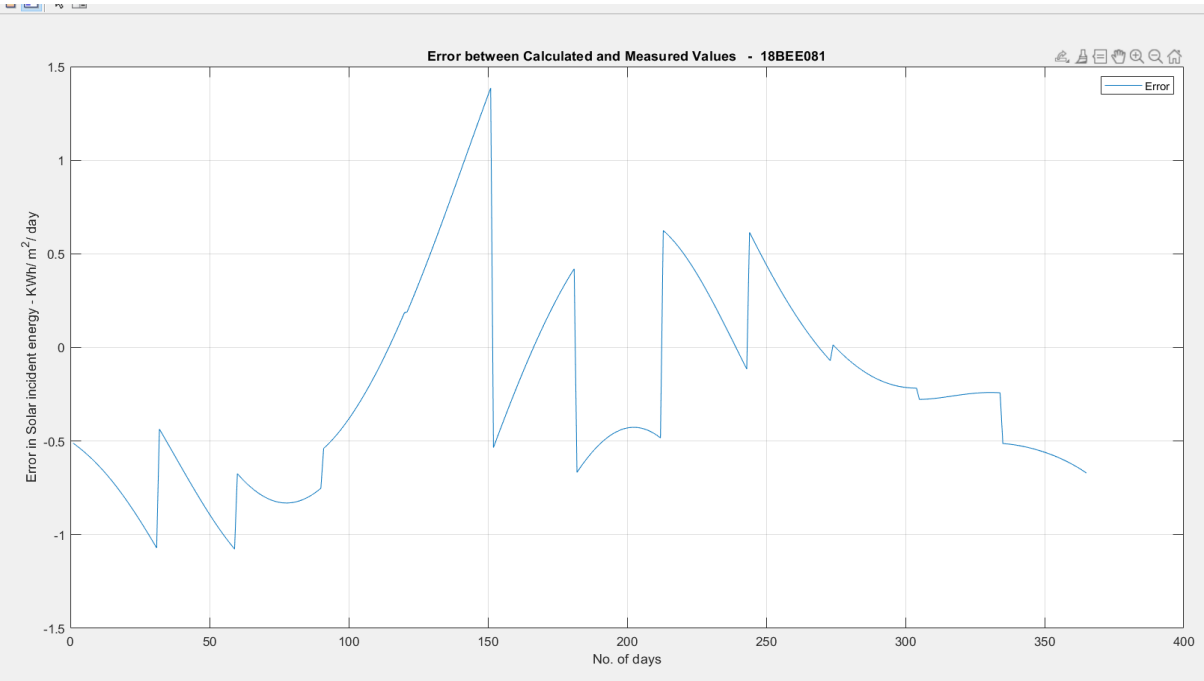

Fig. **Error between Calculated and measured value at Goa.**

Q2. Try to obtain such data for the place other than Goa and Repeat the procedure.

Ans.

Here, other than Goa, Jaipur is chosen. Latitude of Jaipur is 26.912 degrees and the same script is followed to analyse the Solar Incident Energy at Jaipur. But here for the error analysis we need the real or calculated value for Jaipur. It is shown below,

Loc	Ins	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jaipur	Htm	4.19	5.00	6.09	7.08	7.23	6.64	5.15	4.81	5.42	5.00	4.27	3.68

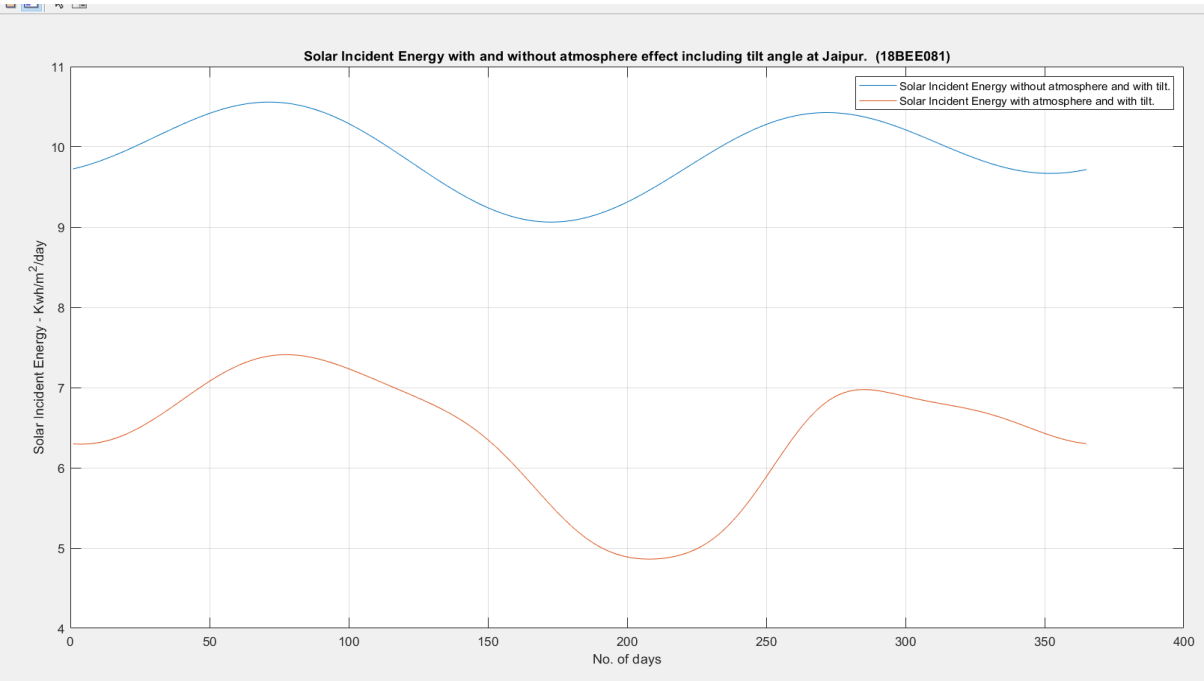

Fig. **Solar Incident energy of PV panel without and with atmosphere and including tilt at Jaipur.**

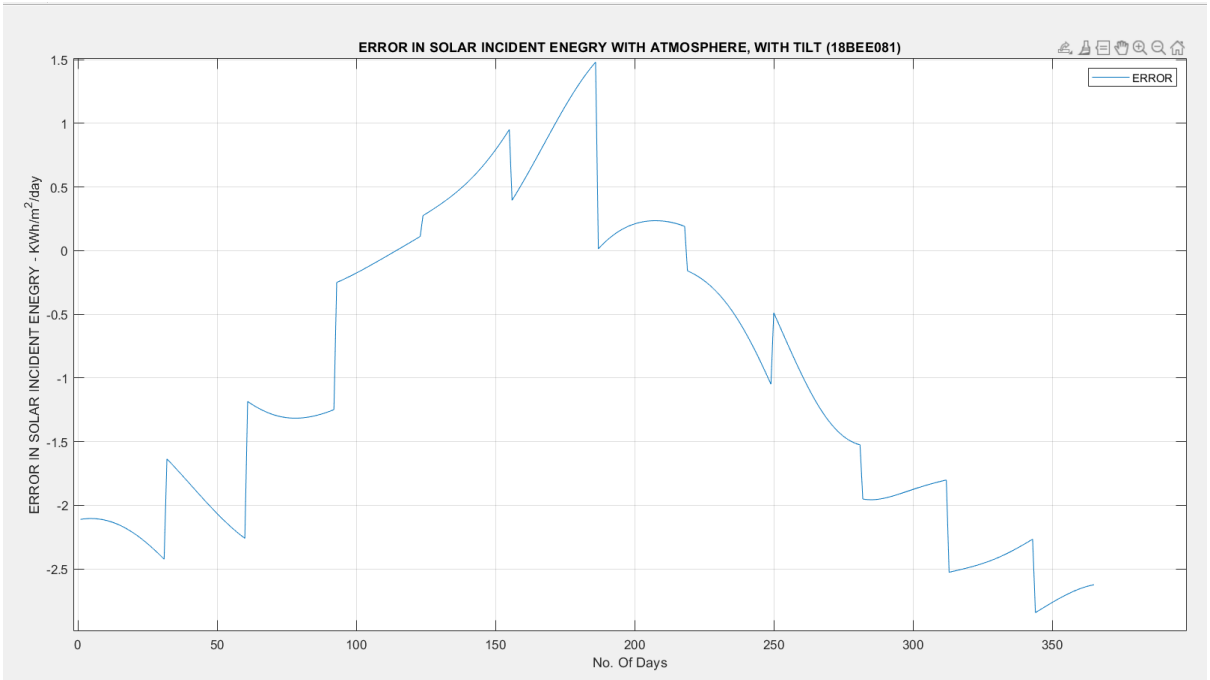

Fig. **Error between Calculated and measured value at Jaipur.**