UIUC Business School Solar Data Preparation

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Introduction

The data comes from the University of Illinois Gies College of Business solar panels above Deloitte Auditorium. Panel collection has been reported daily since the panels became operational in 2009. However, the solar panels became active in the later months of 2009, making the 2009 data mostly incomplete. The 2019 data extends to November 4. The default data collection performed by the panels creates very untidy data. This data must be prepared for analysis. This data was provided by Steve Hess, Director Classroom and Conferencing Technologies at the Gies College of Business at University of Illinois at Urbana-Champaign.

For the purposes of this analysis, we will only be cleaning the first twenty-six files.

Methods

The sum of the solar panel output is recorded every five minutes during sunlight hours, and stored in a csv. There are approximately 2400 csv files for the recorded data, one for each day. For the simplicity of this project, only 26 files were loaded in from January of 2019.

Because the data is only collected during sunlight hours, the number of records for each csv (each day) varies. The data has 17 variables for each of the six solar panels, and one variable for the timestamp for a total of 103 variables. Notable variables include:

- TimeStamp - The time the output was recorded in hh:mm format (24-hour clock)

- CO2 saved - The amount of CO2 saved by using the solar panels (lbs)
- E-total - The sum of the power the solar panel has produced in its lifetime (kWh)
- Temperature - The temperature of the solar panel (degC)

NOTE: With the exception of TimeStamp, these variables are repeated for each of the six solar panels.

The difficulty of this project was loading the data into SAS. A generic macro was written to read in every CSV file in a given directory. The code to do this can be found in the SAS file, but this cannot be run in SAS Studio due to lack of permissions regarding external command usage.

Each CSV file contained a header description in the first four lines, and variable units in the sixth line. Variable names were repeated across individual panels. After reading in each of the CSV files, all datasets were given another variable for day to differentiate repeated timestamps. The datasets were then merged. Formats and labels were created.

Variables analyzed include CO2 saved, E-total, and Temperature.

Results

Given the large size of the data, it is difficult/at least troublesome to combine multiple datasets without including unwanted features from the original data into our data preparation. Therefore, data combining is done on SAS macro, with a do loop which iterates through the data folder.

The following tables are results from various data-validating, data-cleaning, and subsetting processes. Since sunrise and sunset time varies from day to day, the length of solar panel's operating time varies as well. We noticed that if the time scope covers different seasons,

missing/unparalleled data becomes a significant issue as the sunshine duration in the summer is longer than in the winter.

The two main criteria of evaluating the solar panel capability are CO2 emission reduction, and energy generation. In this study, we managed to find the mean CO2 saved by each panel per day and the energy generation of each machine by points of time. Based on the result, solar panel 1 and 2 reduces the most Greenhouse Gas Emission among the six, and solar panel 4, however, performs far less efficiently. The reason, we think, might be that solar panel 4 receives less sunlight. In addition to this, the energy generation table suggests that, without surprise, energy generation reaches its peak at noon, when most direct sunlight is projected onto the ground.

Data Set Name	WORK.PROCESSED	**Observations**	2855
Member Type	DATA	**Variables**	104
Engine	V9	**Indexes**	0
Created	12/13/2019 20:32:18	**Observation Length**	832
Last Modified	12/13/2019 20:32:18	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Set Page Size	73728
Number of Data Set Pages	33
First Data Page	1
Max Obs per Page	88
Obs in First Data Page	68
Number of Data Set Repairs	0
Filename	/tmp/SAS_work691600000CC9_localhost.localdomain/SAS_workFCC100000CC9_localhost.localdomain/processed.sas7bdat
Release Created	9.0401M6
Host Created	Linux
Inode Number	673071

Engine/Host Dependent Information	
Access Permission	rw-rw-r--
Owner Name	sasdemo
File Size	2MB
File Size (bytes)	2506752

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
3	Backup_State_1	Num	8		
20	Backup_State_2	Num	8		
37	Backup_State_3	Num	8		
54	Backup_State_4	Num	8		
71	Backup_State_5	Num	8		
88	Backup_State_6	Num	8		
4	CO2_saved_1	Num	8		
21	CO2_saved_2	Num	8		
38	CO2_saved_3	Num	8		
55	CO2_saved_4	Num	8		
72	CO2_saved_5	Num	8		
89	CO2_saved_6	Num	8		
1	Date	Num	8	DATE9.	
6	E_Total_1	Num	8		Total Energy Generated
23	E_Total_2	Num	8		Total Energy Generated
40	E_Total_3	Num	8		Total Energy Generated
57	E_Total_4	Num	8		Total Energy Generated
74	E_Total_5	Num	8		Total Energy Generated
91	E_Total_6	Num	8		Total Energy Generated
5	Error_1	Num	8	ERROR.	
22	Error_2	Num	8	ERROR.	
39	Error_3	Num	8	ERROR.	
56	Error_4	Num	8	ERROR.	
73	Error_5	Num	8	ERROR.	
90	Error_6	Num	8	ERROR.	
7	Fac_1	Num	8		Frequency Between the Inverter and the Meter
24	Fac_2	Num	8		Frequency Between the Inverter and the Meter
41	Fac_3	Num	8		Frequency Between the Inverter and the Meter
58	Fac_4	Num	8		Frequency Between the Inverter and the Meter

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
75	Fac_5	Num	8		Frequency Between the Inverter and the Meter
92	Fac_6	Num	8		Frequency Between the Inverter and the Meter
8	Grid_Type_1	Num	8	GRIDTYPE.	
25	Grid_Type_2	Num	8	GRIDTYPE.	
42	Grid_Type_3	Num	8	GRIDTYPE.	
59	Grid_Type_4	Num	8	GRIDTYPE.	
76	Grid_Type_5	Num	8	GRIDTYPE.	
93	Grid_Type_6	Num	8	GRIDTYPE.	
11	Iac_1	Num	8		Intermediate Acceptance
28	Iac_2	Num	8		Intermediate Acceptance
45	Iac_3	Num	8		Intermediate Acceptance
62	Iac_4	Num	8		Intermediate Acceptance
79	Iac_5	Num	8		Intermediate Acceptance
96	Iac_6	Num	8		Intermediate Acceptance
12	Ipv_1	Num	8		Current Between Panel and the Inverter
29	Ipv_2	Num	8		Current Between Panel and the Inverter
46	Ipv_3	Num	8		Current Between Panel and the Inverter
63	Ipv_4	Num	8		Current Between Panel and the Inverter
80	Ipv_5	Num	8		Current Between Panel and the Inverter
97	Ipv_6	Num	8		Current Between Panel and the Inverter
13	Mode_1	Num	8		
30	Mode_2	Num	8		
47	Mode_3	Num	8		
64	Mode_4	Num	8		
81	Mode_5	Num	8		
98	Mode_6	Num	8		
14	Pac_1	Num	8		Energy Generated at Any Point of Time
31	Pac_2	Num	8		Energy Generated at Any Point of Time
48	Pac_3	Num	8		Energy Generated at Any Point of Time
65	Pac_4	Num	8		Energy Generated at Any Point of Time
82	Pac_5	Num	8		Energy Generated at Any Point of Time
99	Pac_6	Num	8		Energy Generated at Any Point of Time
15	Power_On_1	Num	8		
32	Power_On_2	Num	8		
49	Power_On_3	Num	8		

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
66	Power_On_4	Num	8		
83	Power_On_5	Num	8		
100	Power_On_6	Num	8		
16	Serial_Number_1	Num	8		
33	Serial_Number_2	Num	8		
50	Serial_Number_3	Num	8		
67	Serial_Number_4	Num	8		
84	Serial_Number_5	Num	8		
101	Serial_Number_6	Num	8		
17	Temperature_1	Num	8		
34	Temperature_2	Num	8		
51	Temperature_3	Num	8		
68	Temperature_4	Num	8		
85	Temperature_5	Num	8		
102	Temperature_6	Num	8		
2	TimeStamp	Char	8		
18	Vac_1	Num	8		Alternative Current Voltage
35	Vac_2	Num	8		Alternative Current Voltage
52	Vac_3	Num	8		Alternative Current Voltage
69	Vac_4	Num	8		Alternative Current Voltage
86	Vac_5	Num	8		Alternative Current Voltage
103	Vac_6	Num	8		Alternative Current Voltage
19	Vpv_1	Num	8		Voltage Between Panel and the Inverter
36	Vpv_2	Num	8		Voltage Between Panel and the Inverter
53	Vpv_3	Num	8		Voltage Between Panel and the Inverter
70	Vpv_4	Num	8		Voltage Between Panel and the Inverter
87	Vpv_5	Num	8		Voltage Between Panel and the Inverter
104	Vpv_6	Num	8		Voltage Between Panel and the Inverter
9	h_On_1	Num	8		Hours On
26	h_On_2	Num	8		Hours On
43	h_On_3	Num	8		Hours On
60	h_On_4	Num	8		Hours On
77	h_On_5	Num	8		Hours On
94	h_On_6	Num	8		Hours On
10	h_Total_1	Num	8		Total Hours

Alphabetic List of Variables and Attributes					
#	**Variable**	**Type**	**Len**	**Format**	**Label**
27	h_Total_2	Num	8		Total Hours
44	h_Total_3	Num	8		Total Hours
61	h_Total_4	Num	8		Total Hours
78	h_Total_5	Num	8		Total Hours
95	h_Total_6	Num	8		Total Hours

Obs	Date	TimeStamp	Backup_State_1	CO2_saved_1	Error_1	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_1	Hours On
1	01JAN2019	07:25	0	122407.70	None	72004.53	59.992	grid inter-tied	43897.46
2	01JAN2019	07:30	0	122407.70	None	72004.53	59.986	grid inter-tied	43897.54
3	01JAN2019	07:35	0	122407.70	None	72004.53	59.979	grid inter-tied	43897.63
4	01JAN2019	07:40	0	122407.70	None	72004.53	59.989	grid inter-tied	43897.71
5	01JAN2019	07:45	0	122407.70	None	72004.53	59.995	grid inter-tied	43897.79
6	01JAN2019	07:50	0	122407.70	None	72004.53	59.995	grid inter-tied	43897.87
7	01JAN2019	07:55	0	122407.70	None	72004.53	59.979	grid inter-tied	43897.96
8	01JAN2019	08:00	0	122407.70	None	72004.53	60.005	grid inter-tied	43898.04
9	01JAN2019	08:05	0	122407.70	None	72004.54	59.986	grid inter-tied	43898.12
10	01JAN2019	08:10	0	122407.71	None	72004.54	59.993	grid inter-tied	43898.21
11	01JAN2019	08:15	0	122407.71	None	72004.54	59.979	grid inter-tied	43898.29
12	01JAN2019	08:20	0	122407.73	None	72004.54	59.987	grid inter-tied	43898.38
13	01JAN2019	08:25	0	122407.73	None	72004.55	59.987	grid inter-tied	43898.46
14	01JAN2019	08:30	0	122407.74	None	72004.55	59.994	grid inter-tied	43898.54
15	01JAN2019	08:35	0	122407.75	None	72004.56	59.993	grid inter-tied	43898.62
16	01JAN2019	08:40	0	122407.77	None	72004.57	59.990	grid inter-tied	43898.71
17	01JAN2019	08:45	0	122407.78	None	72004.58	60.011	grid inter-tied	43898.79
18	01JAN2019	08:50	0	122407.80	None	72004.59	60.000	grid inter-tied	43898.88
19	01JAN2019	08:55	0	122407.81	None	72004.59	59.995	grid inter-tied	43898.96
20	01JAN2019	09:00	0	122407.82	None	72004.60	59.978	grid inter-tied	43899.04

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_1	Energy Generated at Any Point of Time	Power_On_1	Serial_Number_1	Temperature_1
1	40796.66	0.000	0.000	3	0.000	33824	2000280197	19.343
2	40796.66	0.000	0.000	3	0.000	33824	2000280197	19.373
3	40796.66	0.000	0.000	3	0.000	33824	2000280197	19.400
4	40796.66	0.000	0.000	0	0.000	33824	2000280197	19.400
5	40796.66	0.000	0.000	3	0.000	33824	2000280197	19.400
6	40796.66	0.000	0.000	3	0.000	33824	2000280197	19.400
7	40796.72	0.046	0.168	7	12.818	33825	2000280197	19.877
8	40796.81	0.049	0.203	7	13.619	33825	2000280197	20.100
9	40796.89	0.062	0.215	7	17.150	33825	2000280197	20.370
10	40796.97	0.091	0.253	7	25.429	33825	2000280197	20.700
11	40797.06	0.146	0.302	7	40.955	33825	2000280197	20.973
12	40797.14	0.142	0.297	7	40.000	33825	2000280197	21.214
13	40797.22	0.153	0.299	7	43.095	33825	2000280197	21.271

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_1	Energy Generated at Any Point of Time	Power_On_1	Serial_Number_1	Temperature_1
14	40797.31	0.263	0.409	7	73.714	33825	2000280197	21.300
15	40797.39	0.257	0.399	7	72.333	33825	2000280197	21.500
16	40797.47	0.327	0.461	7	91.714	33825	2000280197	22.000
17	40797.56	0.409	0.517	7	115.000	33825	2000280197	22.171
18	40797.64	0.361	0.470	7	101.286	33825	2000280197	22.571
19	40797.72	0.314	0.430	7	88.095	33825	2000280197	22.600
20	40797.80	0.341	0.464	7	95.905	33825	2000280197	22.600

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_2	CO2_saved_2	Error_2	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_2	Hours On
1	281.238	289.714	0	121412.70	None	71419.23	59.991	grid inter-tied	43274.53
2	281.395	325.455	0	121412.70	None	71419.23	59.986	grid inter-tied	43274.61
3	281.267	362.476	0	121412.70	None	71419.23	59.975	grid inter-tied	43274.69
4	281.205	373.905	0	121412.70	None	71419.23	59.986	grid inter-tied	43274.78
5	281.091	380.955	0	121412.70	None	71419.23	59.992	grid inter-tied	43274.86
6	280.995	388.500	0	121412.70	None	71419.23	59.994	grid inter-tied	43274.94
7	281.595	313.000	0	121412.70	None	71419.23	59.978	grid inter-tied	43275.02
8	281.371	284.000	0	121412.70	None	71419.23	60.001	grid inter-tied	43275.11
9	281.380	296.450	0	121412.70	None	71419.24	59.982	grid inter-tied	43275.19
10	281.400	297.000	0	121412.70	None	71419.24	59.991	grid inter-tied	43275.28
11	281.464	309.682	0	121412.71	None	71419.24	59.979	grid inter-tied	43275.36
12	281.414	313.000	0	121412.71	None	71419.25	59.984	grid inter-tied	43275.44
13	281.119	318.333	0	121412.73	None	71419.25	59.984	grid inter-tied	43275.53
14	281.114	315.000	0	121412.74	None	71419.26	59.993	grid inter-tied	43275.61
15	281.276	322.429	0	121412.74	None	71419.26	59.991	grid inter-tied	43275.69
16	281.205	321.000	0	121412.75	None	71419.27	59.990	grid inter-tied	43275.78
17	281.143	335.095	0	121412.78	None	71419.28	60.010	grid inter-tied	43275.86
18	281.148	340.381	0	121412.79	None	71419.29	60.001	grid inter-tied	43275.94
19	281.200	340.143	0	121412.81	None	71419.30	59.994	grid inter-tied	43276.03
20	281.357	332.190	0	121412.82	None	71419.30	59.978	grid inter-tied	43276.11

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_2	Energy Generated at Any Point of Time	Power_On_2	Serial_Number_2	Temperature_2
1	40379.34	0.000	0.000	3	0.000	31172	2000573037	22.343
2	40379.34	0.000	0.000	3	0.000	31172	2000573037	22.573

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_2	Energy Generated at Any Point of Time	Power_On_2	Serial_Number_2	Temperature_2
3	40379.34	0.000	0.000	3	0.000	31172	2000573037	22.600
4	40379.34	0.000	0.000	3	0.000	31172	2000573037	22.600
5	40379.34	0.000	0.000	3	0.000	31172	2000573037	22.600
6	40379.36	0.010	0.049	7	2.667	31175	2000573037	22.600
7	40379.44	0.037	0.187	7	10.333	31175	2000573037	23.029
8	40379.53	0.040	0.187	7	11.273	31175	2000573037	23.200
9	40379.61	0.073	0.231	7	20.300	31175	2000573037	23.470
10	40379.69	0.094	0.256	6	26.286	31175	2000573037	23.800
11	40379.78	0.165	0.317	7	46.409	31175	2000573037	24.309
12	40379.86	0.155	0.308	7	43.400	31175	2000573037	24.465
13	40379.94	0.165	0.309	7	46.273	31175	2000573037	24.500
14	40380.03	0.280	0.423	7	78.571	31175	2000573037	25.014
15	40380.11	0.273	0.405	7	76.524	31175	2000573037	25.100
16	40380.19	0.342	0.470	7	95.857	31175	2000573037	25.100
17	40380.28	0.409	0.515	7	114.810	31175	2000573037	25.357
18	40380.36	0.371	0.493	7	104.100	31175	2000573037	25.700
19	40380.44	0.319	0.450	7	89.636	31175	2000573037	25.700
20	40380.52	0.374	0.489	7	105.095	31175	2000573037	25.700

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_3	CO2_saved_3	Error_3	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_3	Hours On
1	280.857	307.000	0	52382.48	None	30813.22	59.992	grid inter-tied	19368.28
2	281.041	356.136	0	52382.48	None	30813.22	59.985	grid inter-tied	19368.36
3	280.850	366.800	0	52382.48	None	30813.22	59.975	grid inter-tied	19368.44
4	280.800	377.364	0	52382.48	None	30813.22	59.988	grid inter-tied	19368.53
5	280.695	384.381	0	52382.48	None	30813.22	59.992	grid inter-tied	19368.61
6	280.638	359.524	0	52382.48	None	30813.22	59.995	grid inter-tied	19368.69
7	281.186	269.000	0	52382.48	None	30813.22	59.979	grid inter-tied	19368.78
8	281.009	275.545	0	52382.48	None	30813.22	60.004	grid inter-tied	19368.86
9	280.975	295.000	0	52382.48	None	30813.23	59.985	grid inter-tied	19368.95
10	281.024	297.000	0	52382.49	None	30813.23	59.991	grid inter-tied	19369.03
11	281.168	315.773	0	52382.50	None	30813.23	59.978	grid inter-tied	19369.11
12	281.125	315.000	0	52382.50	None	30813.24	59.983	grid inter-tied	19369.20
13	280.818	320.727	0	52382.51	None	30813.24	59.983	grid inter-tied	19369.28
14	280.819	317.000	0	52382.52	None	30813.25	59.991	grid inter-tied	19369.36
15	280.886	328.476	0	52382.53	None	30813.25	59.992	grid inter-tied	19369.45

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_3	CO2_saved_3	Error_3	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_3	Hours On
16	280.838	325.000	0	52382.54	None	30813.26	59.989	grid inter-tied	19369.53
17	280.824	338.381	0	52382.56	None	30813.27	60.010	grid inter-tied	19369.61
18	280.845	327.350	0	52382.58	None	30813.28	60.000	grid inter-tied	19369.69
19	280.914	325.000	0	52382.59	None	30813.29	59.993	grid inter-tied	19369.78
20	281.038	333.429	0	52382.61	None	30813.30	59.977	grid inter-tied	19369.86

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_3	Energy Generated at Any Point of Time	Power_On_3	Serial_Number_3	Temperature_3
1	17959.67	0.000	0.000	2	0.000	18775	2001235000	18.829
2	17959.67	0.000	0.000	3	0.000	18775	2001235000	18.800
3	17959.67	0.000	0.000	3	0.000	18775	2001235000	18.800
4	17959.67	0.000	0.000	3	0.000	18775	2001235000	18.800
5	17959.67	0.000	0.000	3	0.000	18775	2001235000	18.800
6	17959.69	0.008	0.032	2	2.238	18779	2001235000	19.114
7	17959.77	0.052	0.210	7	14.636	18780	2001235000	19.400
8	17959.85	0.059	0.227	7	16.238	18780	2001235000	19.767
9	17959.94	0.079	0.232	7	21.800	18780	2001235000	20.100
10	17960.02	0.106	0.266	7	29.429	18780	2001235000	20.557
11	17960.10	0.169	0.319	7	47.091	18780	2001235000	20.700
12	17960.19	0.158	0.309	7	44.000	18780	2001235000	20.757
13	17960.27	0.180	0.324	7	49.952	18780	2001235000	21.214
14	17960.35	0.288	0.424	7	80.381	18780	2001235000	21.271
15	17960.44	0.291	0.416	7	81.000	18780	2001235000	21.333
16	17960.52	0.368	0.483	7	102.714	18780	2001235000	21.933
17	17960.60	0.459	0.545	7	127.905	18780	2001235000	21.933
18	17960.68	0.394	0.490	7	110.100	18780	2001235000	22.000
19	17960.77	0.343	0.451	7	95.864	18780	2001235000	22.055
20	17960.85	0.378	0.479	7	105.571	18780	2001235000	22.571

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_4	CO2_saved_4	Error_4	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_4	Hours On
1	279.310	296.238	0	9269.33	None	5452.55	59.991	grid inter-tied	3310.48
2	279.400	348.955	0	9269.33	None	5452.55	59.985	grid inter-tied	3310.57
3	279.365	361.200	0	9269.33	None	5452.55	59.977	grid inter-tied	3310.65

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_4	CO2_saved_4	Error_4	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_4	Hours On
4	279.305	373.909	0	9269.33	None	5452.55	59.988	grid inter-tied	3310.73
5	279.200	382.286	0	9269.33	None	5452.55	59.993	grid inter-tied	3310.82
6	279.143	359.571	0	9269.33	None	5452.55	59.994	grid inter-tied	3310.90
7	279.677	271.591	0	9269.33	None	5452.55	59.979	grid inter-tied	3310.98
8	279.448	263.000	0	9269.33	None	5452.55	60.005	grid inter-tied	3311.07
9	279.325	300.350	0	9269.33	None	5452.55	59.985	grid inter-tied	3311.15
10	279.348	299.000	0	9269.34	None	5452.55	59.991	grid inter-tied	3311.24
11	279.514	314.864	0	9269.34	None	5452.55	59.978	grid inter-tied	3311.32
12	279.462	314.000	0	9269.35	None	5452.56	59.985	grid inter-tied	3311.40
13	279.195	322.476	0	9269.35	None	5452.56	59.986	grid inter-tied	3311.48
14	279.200	321.000	0	9269.36	None	5452.57	59.992	grid inter-tied	3311.57
15	279.290	331.810	0	9269.37	None	5452.57	59.993	grid inter-tied	3311.65
16	279.281	331.048	0	9269.39	None	5452.58	59.991	grid inter-tied	3311.74
17	279.267	343.571	0	9269.40	None	5452.59	60.010	grid inter-tied	3311.82
18	279.230	344.600	0	9269.41	None	5452.60	59.999	grid inter-tied	3311.90
19	279.359	342.000	0	9269.42	None	5452.60	59.994	grid inter-tied	3311.98
20	279.395	344.190	0	9269.44	None	5452.61	59.978	grid inter-tied	3312.07

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_4	Energy Generated at Any Point of Time	Power_On_4	Serial_Number_4	Temperature_4
1	3099.58	0.000	0.000	3	0.000	2077	2001434798	18.833
2	3099.58	0.000	0.000	0	0.000	2077	2001434798	19.182
3	3099.58	0.000	0.000	3	0.000	2077	2001434798	19.314
4	3099.58	0.000	0.000	3	0.000	2077	2001434798	19.371
5	3099.58	0.000	0.000	3	0.000	2077	2001434798	19.400
6	3099.58	0.000	0.000	3	0.000	2077	2001434798	19.400
7	3099.62	0.035	0.123	7	9.476	2078	2001434798	19.400
8	3099.71	0.050	0.204	7	14.095	2078	2001434798	19.967
9	3099.79	0.065	0.219	7	18.150	2078	2001434798	20.100
10	3099.88	0.094	0.254	7	26.136	2078	2001434798	20.564
11	3099.96	0.145	0.300	7	40.619	2078	2001434798	20.700
12	3100.04	0.148	0.301	7	41.571	2078	2001434798	20.729
13	3100.12	0.157	0.307	7	43.714	2078	2001434798	21.186
14	3100.21	0.254	0.399	7	70.909	2078	2001434798	21.332
15	3100.29	0.237	0.378	7	66.100	2078	2001434798	21.755
16	3100.38	0.300	0.433	7	83.591	2078	2001434798	22.000

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_4	Energy Generated at Any Point of Time	Power_On_4	Serial_Number_4	Temperature_4
17	3100.46	0.354	0.477	7	98.952	2078	2001434798	22.171
18	3100.54	0.321	0.443	7	89.800	2078	2001434798	22.570
19	3100.62	0.270	0.396	7	75.476	2078	2001434798	22.600
20	3100.71	0.323	0.450	7	90.364	2078	2001434798	22.600

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_5	CO2_saved_5	Error_5	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_5	Hours On
1	279.783	295.611	0	34512.90	None	20301.71	59.990	grid inter-tied	12522.16
2	279.977	303.909	0	34512.90	None	20301.71	59.983	grid inter-tied	12522.24
3	279.862	359.762	0	34512.90	None	20301.71	59.974	grid inter-tied	12522.33
4	279.829	372.619	0	34512.90	None	20301.71	59.985	grid inter-tied	12522.41
5	279.764	379.091	0	34512.90	None	20301.71	59.990	grid inter-tied	12522.50
6	279.695	388.381	0	34512.90	None	20301.71	59.991	grid inter-tied	12522.58
7	280.171	338.619	0	34512.90	None	20301.71	59.977	grid inter-tied	12522.66
8	280.029	289.000	0	34512.90	None	20301.71	60.000	grid inter-tied	12522.74
9	279.975	297.050	0	34512.91	None	20301.71	59.983	grid inter-tied	12522.83
10	280.009	298.045	0	34512.91	None	20301.71	59.988	grid inter-tied	12522.91
11	280.086	309.381	0	34512.92	None	20301.72	59.975	grid inter-tied	12522.99
12	280.057	315.000	0	34512.92	None	20301.72	59.983	grid inter-tied	12523.08
13	279.767	318.857	0	34512.93	None	20301.72	59.984	grid inter-tied	12523.16
14	279.759	315.000	0	34512.94	None	20301.73	59.989	grid inter-tied	12523.25
15	279.750	321.050	0	34512.95	None	20301.74	59.990	grid inter-tied	12523.33
16	279.695	322.045	0	34512.96	None	20301.75	59.990	grid inter-tied	12523.41
17	279.705	328.190	0	34512.98	None	20301.76	60.009	grid inter-tied	12523.50
18	279.675	332.000	0	34513.00	None	20301.76	59.998	grid inter-tied	12523.58
19	279.781	336.000	0	34513.01	None	20301.77	59.990	grid inter-tied	12523.66
20	279.882	327.000	0	34513.03	None	20301.78	59.975	grid inter-tied	12523.75

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_5	Energy Generated at Any Point of Time	Power_On_5	Serial_Number_5	Temperature_5
1	11614.84	0.000	0.000	3	0.000	4578	2001922410	21.400
2	11614.84	0.000	0.000	3	0.000	4578	2001922410	21.586
3	11614.84	0.000	0.000	3	0.000	4578	2001922410	21.767
4	11614.84	0.000	0.000	3	0.000	4578	2001922410	21.833
5	11614.84	0.000	0.000	3	0.000	4578	2001922410	21.968

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_5	Energy Generated at Any Point of Time	Power_On_5	Serial_Number_5	Temperature_5
6	11614.84	0.000	0.000	3	0.000	4578	2001922410	22.000
7	11614.90	0.056	0.186	7	15.619	4579	2001922410	21.967
8	11614.98	0.058	0.214	7	16.000	4579	2001922410	22.571
9	11615.07	0.070	0.222	7	19.400	4579	2001922410	22.600
10	11615.15	0.099	0.260	7	27.409	4579	2001922410	23.118
11	11615.23	0.158	0.306	7	44.190	4579	2001922410	23.200
12	11615.32	0.152	0.302	7	42.381	4579	2001922410	23.429
13	11615.40	0.167	0.310	7	46.810	4579	2001922410	23.771
14	11615.49	0.278	0.413	7	77.636	4579	2001922410	23.864
15	11615.57	0.266	0.396	7	74.400	4579	2001922410	24.290
16	11615.65	0.354	0.473	7	98.773	4579	2001922410	24.468
17	11615.74	0.440	0.545	7	123.000	4579	2001922410	24.500
18	11615.82	0.380	0.487	7	106.050	4579	2001922410	24.620
19	11615.90	0.330	0.448	7	92.095	4579	2001922410	24.986
20	11615.99	0.379	0.487	7	106.000	4579	2001922410	25.100

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_6	CO2_saved_6	Error_6	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_6	Hours On
1	279.957	285.381	0	34590.47	None	20347.33	59.991	grid inter-tied	12518.21
2	280.118	319.000	0	34590.47	None	20347.33	59.985	grid inter-tied	12518.30
3	280.029	357.952	0	34590.47	None	20347.33	59.977	grid inter-tied	12518.38
4	279.948	371.000	0	34590.47	None	20347.33	59.988	grid inter-tied	12518.46
5	279.886	379.545	0	34590.47	None	20347.33	59.992	grid inter-tied	12518.55
6	279.786	388.238	0	34590.47	None	20347.33	59.993	grid inter-tied	12518.63
7	280.248	310.095	0	34590.47	None	20347.33	59.979	grid inter-tied	12518.72
8	280.095	286.000	0	34590.47	None	20347.34	60.002	grid inter-tied	12518.80
9	280.015	297.800	0	34590.47	None	20347.34	59.985	grid inter-tied	12518.88
10	280.045	297.000	0	34590.48	None	20347.34	59.991	grid inter-tied	12518.96
11	280.214	314.571	0	34590.48	None	20347.34	59.977	grid inter-tied	12519.05
12	280.129	318.095	0	34590.48	None	20347.34	59.984	grid inter-tied	12519.13
13	279.867	324.333	0	34590.49	None	20347.35	59.985	grid inter-tied	12519.22
14	279.850	323.000	0	34590.50	None	20347.35	59.992	grid inter-tied	12519.30
15	279.880	330.250	0	34590.51	None	20347.36	59.992	grid inter-tied	12519.38
16	279.832	330.000	0	34590.52	None	20347.37	59.990	grid inter-tied	12519.46
17	279.848	332.190	0	34590.53	None	20347.37	60.010	grid inter-tied	12519.55
18	279.780	337.000	0	34590.55	None	20347.38	59.999	grid inter-tied	12519.63

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter	Backup_State_6	CO2_saved_6	Error_6	Total Energy Generated	Frequency Between the Inverter and the Meter	Grid_Type_6	Hours On
19	279.848	334.000	0	34590.56	None	20347.39	59.994	grid inter-tied	12519.72
20	279.941	338.727	0	34590.58	None	20347.40	59.977	grid inter-tied	12519.80

Obs	Total Hours	Intermediate Acceptance	Current Between Panel and the Inverter	Mode_6	Energy Generated at Any Point of Time	Power_On_6	Serial_Number_6	Temperature_6
1	11602.51	0.000	0.000	2	0.000	8658	2002124152	17.657
2	11602.51	0.000	0.000	2	0.000	8658	2002124152	17.873
3	11602.51	0.000	0.000	3	0.000	8658	2002124152	18.143
4	11602.51	0.000	0.000	1	0.000	8665	2002124152	18.200
5	11602.51	0.000	0.000	3	0.000	8665	2002124152	18.200
6	11602.51	0.000	0.000	3	0.000	8665	2002124152	18.200
7	11602.57	0.044	0.168	7	12.238	8666	2002124152	18.200
8	11602.66	0.041	0.193	7	11.286	8666	2002124152	18.714
9	11602.74	0.045	0.189	7	12.450	8666	2002124152	18.800
10	11602.82	0.077	0.239	7	21.238	8666	2002124152	19.229
11	11602.91	0.126	0.283	7	35.091	8666	2002124152	19.400
12	11602.99	0.130	0.286	7	36.286	8666	2002124152	19.433
13	11603.07	0.141	0.294	7	39.333	8666	2002124152	19.900
14	11603.16	0.239	0.389	7	66.619	8666	2002124152	20.100
15	11603.24	0.224	0.370	7	62.571	8666	2002124152	20.271
16	11603.32	0.283	0.422	7	78.857	8666	2002124152	20.671
17	11603.41	0.350	0.470	7	97.429	8666	2002124152	20.700
18	11603.49	0.342	0.454	7	95.429	8666	2002124152	20.700
19	11603.57	0.297	0.414	7	82.857	8666	2002124152	20.986
20	11603.66	0.353	0.476	7	98.545	8666	2002124152	21.300

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter
1	279.586	288.952
2	279.709	296.955
3	279.648	305.429
4	279.610	326.048
5	279.500	375.273
6	279.481	384.333
7	279.900	300.095

Obs	Alternative Current Voltage	Voltage Between Panel and the Inverter
8	279.705	269.048
9	279.615	285.650
10	279.610	287.000
11	279.809	303.955
12	279.776	309.048
13	279.476	313.381
14	279.490	310.000
15	279.514	317.571
16	279.505	318.000
17	279.495	329.476
18	279.486	338.000
19	279.633	340.714
20	279.705	326.000

Mean CO2 Emission Saved by Each Panel Per Day

Date	MeasureCount	MeanMachine1	MeanMachine2	MeanMachine3	MeanMachine4	MeanMachine5
						MeanMachine6
01JAN2019	110	122408.6	121413.6	52383.41	9270.158	34513.81
						34591.31
02JAN2019	107	122410.3	121415.4	52385.17	9271.824	34515.55
						34592.98
03JAN2019	117	122430	121435.3	52404.33	9291.713	34534.77
						34613.58
04JAN2019	117	122453.8	121459.7	52427.24	9315.887	34557.61
						34638.35
05JAN2019	119	122475.4	121481.7	52448.11	9337.333	34578.6
						34660.7
06JAN2019	114	122504.9	121511.8	52476.51	9367.556	34606.99
						34691.47
07JAN2019	116	122514.9	121521.9	52486.37	9377.61	34616.74
						34701.59
08JAN2019	119	122533.7	121541.2	52504.46	9395.963	34634.46
						34720.88
09JAN2019	119	122568.3	121576.5	52537.5	9430.693	34667.68
						34756.81
10JAN2019	120	122599.6	121608.2	52567.5	9462.974	34697.53
						34789.47
11JAN2019	117	122626.2	121635.2	52592.95	9490.133	34723.09
						34816.98
12JAN2019	43	122630.8	121639.8	52597.52	9494.592	34727.65
						34821.5
13JAN2019	81	122630.8	121639.8	52597.52	9494.594	34727.65
						34821.5
14JAN2019	105	122631.2	121641.3	52597.65	9497.618	34727.74
						34824.98
15JAN2019	112	122633.4	121645.8	52597.92	9504.445	34727.9
						34833.48

Mean CO2 Emission Saved by Each Panel Per Day

16JAN2019	110	122634.3	121647.6	52598.31	9506.615	34727.9
						34835.77
17JAN2019	107	122635.8	121650	52600.12	9509.403	34729.27
						34838.61
18JAN2019	115	122641	121656.7	52605.53	9515.715	34734.41
						34844.94
19JAN2019	102	122643.9	121660.4	52608.82	9519.265	34737.67
						34848.49
20JAN2019	114	122646	121662.8	52610.71	9521.929	34739.63
						34851.13
21JAN2019	115	122649.6	121667	52613.87	9526.87	34742.93
						34856.07
22JAN2019	103	122651.8	121669.4	52615.64	9529.855	34744.79
						34859.1
23JAN2019	117	122654.1	121671.7	52617.96	9532.093	34747.09
						34861.41
24JAN2019	123	122660	121677.9	52624.03	9537.805	34753.19
						34867.23
25JAN2019	121	122679.9	121698	52643.43	9557.718	34772.71
						34887.38
26JAN2019	112	122693.2	121711.5	52656.56	9571.603	34785.92
						34901.24

Mean Energy Generated by Each Panel Across Points of Time

TimeStamp	TimeCount	EnergyPeak1	EnergyPeak2	EnergyPeak3	EnergyPeak4	EnergyPeak5	EnergyPeak6
07:05	4	0	0	0	0	0	0
07:10	7	0	0	0	0	0	0
07:15	8	0.071375	0	0	0.056875	0	0
07:20	11	1.477273	1.428545	1.181818	1.245455	1.207818	1.504545
07:25	15	3.7608	4.9832	2.972467	3.6238	3.1238	3.326267
07:30	17	11.98106	14.80524	8.246529	11.95706	10.13065	11.53482
07:35	19	27.32647	33.89789	19.02142	24.84458	27.78737	25.12842
07:40	20	48.1523	55.81175	41.40555	37.2892	54.2884	39.2228
07:45	20	73.1527	79.6314	67.59915	54.51955	82.9658	61.48005
07:50	20	96.0526	107.242	99.77065	70.8857	118.8332	80.6458
07:55	21	111.5863	122.4838	115.9097	76.18124	143.1993	92.64414
08:00	21	138.9765	145.839	138.8989	88.34657	191.3087	117.6265
08:05	23	156.7052	174.8825	159.7306	100.7336	222.4132	133.367
08:10	24	186.9532	203.5791	200.983	113.2158	249.8121	154.7455
08:15	24	243.3145	254.336	266.8764	141.5517	294.4018	199.6432
08:20	24	331.0217	337.0499	337.1529	182.3849	354.5407	254.794
08:25	24	356.3807	377.6087	354.2096	226.2542	367.1171	285.632
08:30	24	413.4767	446.4964	421.8994	260.8853	423.9188	355.4568
08:35	24	493.3632	517.4424	491.8905	316.4848	489.3495	446.7165
08:40	25	542.1785	557.0529	529.293	342.9609	525.3485	545.096
08:45	25	526.7324	539.8584	514.1952	351.2468	506.4844	558.9938
08:50	25	530.3183	543.6994	516.1191	362.4116	511.4694	565.7401
08:55	25	549.7316	564.2714	535.3212	421.8206	532.573	587.2144
09:00	25	568.2467	584.9048	555.6706	486.7556	553.1779	607.0982
09:05	25	599.7677	617.7506	587.696	564.45	585.2203	639.9635
09:10	25	627.5524	646.7473	613.683	647.4418	611.4383	671.9336
09:15	25	673.1425	690.038	657.8674	722.6004	654.7848	715.6448
09:20	25	693.7072	712.2689	678.4131	750.148	674.1101	738.9474
09:25	25	727.2314	743.6738	711.211	782.2933	708.0891	769.5316
09:30	25	773.7605	792.0094	756.368	831.1222	753.5543	820.5244
09:35	25	794.5207	812.0395	776.1079	851.9461	772.6003	841.0696
09:40	25	825.2963	840.053	803.6118	882.9756	801.9218	871.3524
09:45	25	885.5204	904.6974	864.5558	947.2115	860.3246	937.8372
09:50	25	926.7216	948.3972	904.4266	994.7918	899.3591	984.4864
09:55	25	983.7717	1006.296	961.1488	1059.047	954.9579	1040.796
10:00	25	997.9578	1022.686	973.7254	1074.986	968.6379	1063.627
10:05	25	994.4436	1019.636	970.4732	1074.348	964.2638	1066.187
10:10	25	1081.947	1112.744	1055.537	1167.929	1057.339	1157.192
10:15	25	1125.981	1157.019	1100.772	1213.445	1095.271	1200.741
10:20	25	1003.129	1038.556	983.4769	1084.238	973.3704	1073.129
10:25	25	1055.878	1076.978	1018.485	1142.649	1027.644	1131.929

Mean Energy Generated by Each Panel Across Points of Time

TimeStamp	TimeCount	EnergyPeak1	EnergyPeak2	EnergyPeak3	EnergyPeak4	EnergyPeak5	EnergyPeak6
10:30	25	1165.967	1197.058	1135.54	1251.849	1129.789	1247.253
10:35	25	1159.983	1192.856	1130.11	1244.181	1124.204	1242.338
10:40	25	1074.651	1104.468	1042.977	1157.494	1038.657	1155.274
10:45	25	1119.964	1158.614	1094.076	1205.934	1089.472	1202.616
10:50	25	1110.398	1141.585	1082.217	1193.576	1073.776	1187.857
10:55	25	1105.63	1141.417	1076.171	1192.44	1074.852	1189.826
11:00	25	1117.254	1150.719	1086.969	1200.983	1081.762	1197.379
11:05	25	1137.833	1174.237	1112.308	1223.674	1103.562	1217.585
11:10	26	1084.859	1118.694	1060.053	1163.191	1054.247	1159.637
11:15	26	1079.29	1113.38	1055.7	1157.069	1049.3	1153.759
11:20	26	1095.712	1129.71	1069.519	1178.816	1059.272	1171.955
11:25	26	1143.779	1173.037	1113.205	1226.613	1112.225	1220.329
11:30	26	1071.798	1110.614	1046.382	1166.566	1041.2	1148.976
11:35	26	1027.159	1051.886	986.7317	1124.444	996.7432	1098.035
11:40	26	1076.409	1111.761	1043.894	1171.471	1039.177	1150.647
11:45	26	1145.278	1181.377	1108.252	1254.335	1110.469	1232.797
11:50	26	1207.439	1247.196	1168.201	1321.55	1178.191	1302.25
11:55	26	1220.134	1258.399	1181.748	1334.526	1182.477	1309.416
12:00	26	1164.803	1204.285	1127.395	1277.163	1127.005	1253.08
12:05	26	1174.434	1213.691	1138.587	1297.201	1142.981	1263.508
12:10	26	1170.451	1216.685	1138.146	1292.265	1139.35	1265.337
12:15	26	1197.024	1247.154	1167.439	1321.556	1166.233	1288.236
12:20	26	1102.371	1150.496	1070.797	1215.601	1071.546	1188.865
12:25	26	1141.66	1199.713	1105.073	1259.762	1104.842	1242.303
12:30	26	1039.798	1103.405	1013.408	1152.356	1005.305	1137.438
12:35	26	1081.021	1136.779	1046.814	1195.354	1051.034	1185.052
12:40	26	1070.715	1136.277	1049.777	1184.676	1041.574	1202.085
12:45	26	1088.758	1140.511	1059.584	1201.826	1056.445	1217.892
12:50	26	1073.584	1131.017	1047.919	1184.353	1039.049	1207.537
12:55	26	981.9996	1037.823	957.1793	1088.083	950.4	1112.825
13:00	26	986.635	1042.772	958.2877	1098.048	955.8368	1124.249
13:05	26	1041.744	1093.284	1009.349	1155.314	1003.308	1178.442
13:10	26	938.7138	988.5208	911.9782	1048.625	905.307	1072.488
13:15	26	984.4277	1032.016	953.4997	1098.258	952.1929	1123.44
13:20	26	1004.614	1053.978	970.9032	1121.649	968.19	1148.939
13:25	25	1011.718	1065.165	976.883	1138.821	973.9289	1169.901
13:30	25	903.8103	955.9532	875.189	1024.137	870.3276	1055.714
13:35	25	879.8722	928.853	851.7638	997.0299	848.0848	1030.827
13:40	25	871.8863	919.1792	843.0986	988.4704	840.7559	1021.35
13:45	26	828.3417	871.2574	801.2516	940.6022	796.0186	973.4178
13:50	26	855.7578	901.5445	824.2077	970.1543	823.5101	1009.901

Mean Energy Generated by Each Panel Across Points of Time

TimeStamp	TimeCount	EnergyPeak1	EnergyPeak2	EnergyPeak3	EnergyPeak4	EnergyPeak5	EnergyPeak6
13:55	26	808.4911	852.2683	778.1662	922.265	775.994	958.4495
14:00	26	793.1089	837.3771	763.6341	906.3188	762.0845	940.026
14:05	26	750.8283	798.2896	720.5417	861.7328	720.8955	895.405
14:10	26	734.7952	782.1673	702.5971	845.5551	704.9763	879.9189
14:15	26	742.596	788.7006	709.8213	852.5081	712.8473	885.1334
14:20	26	715.714	764.2918	678.0683	825.1017	682.0826	856.5331
14:25	26	673.7922	728.6817	639.5664	782.0398	641.9297	814.1373
14:30	26	666.5307	718.7237	632.2131	775.177	634.2286	807.7068
14:35	26	721.5836	772.156	672.3192	830.1262	674.7185	861.37
14:40	26	633.421	664.8021	573.7028	713.9996	573.5432	744.8255
14:45	26	691.641	730.488	620.6974	783.4135	622.851	806.0731
14:50	26	677.9684	712.8958	606.8953	764.5603	604.3406	784.753
14:55	26	650.9236	687.7577	582.2385	740.0307	582.6445	757.6143
15:00	26	649.8173	686.809	580.2638	735.5326	580.4861	756.3152
15:05	25	598.4441	640.9415	532.7227	676.8305	528.0041	693.3888
15:10	25	594.2086	633.4634	525.4751	665.6401	524.9864	674.535
15:15	25	578.2505	612.4505	512.1845	620.2272	512.284	632.6962
15:20	25	549.4773	582.1768	465.4758	555.2388	461.4376	584.8895
15:25	24	482.4565	517.9958	392.854	472.9143	377.2829	499.722
15:30	24	452.5608	478.8948	360.2252	410.3135	339.263	452.9088
15:35	24	429.2896	451.1908	340.877	332.537	331.0721	405.8187
15:40	24	389.8023	415.5402	325.172	281.7088	295.4878	338.2905
15:45	24	351.461	392.2932	287.5656	247.4421	236.0882	296.3545
15:50	24	306.737	350.525	253.5706	210.2186	183.4155	256.7208
15:55	24	268.7462	335.9746	209.9515	177.7594	182.3149	239.7169
16:00	24	229.8075	348.3035	213.183	153.9061	160.5134	214.0721
16:05	24	159.6123	258.938	160.7245	127.3768	106.6516	166.7415
16:10	24	124.5056	175.0535	110.1736	105.1154	78.087	133.0091
16:15	24	93.68096	105.6976	70.26033	89.67838	65.45054	105.808
16:20	24	64.40358	73.52529	37.76188	70.81675	38.58063	75.79313
16:25	23	44.50022	48.41061	24.09413	47.94261	24.28452	50.82017
16:30	22	28.93673	30.14655	18.80595	31.28655	18.36468	30.10818
16:35	21	14.18457	14.576	13.235	16.33029	12.42205	15.40586
16:40	20	6.92105	7.2834	7.46065	6.92445	6.8181	6.7854
16:45	19	3.092579	3.372421	3.329789	2.682789	2.987421	2.546053
16:50	15	1.769	1.4048	1.826933	1.5254	1.197867	1.510067
16:55	13	0	0	0	0	0	0
17:00	9	0	0	0	0	0	0
17:05	3	0	0	0	0	0	0
17:10	2	0	0	0	0	0	0
17:15	2	0	0	0	0	0	0