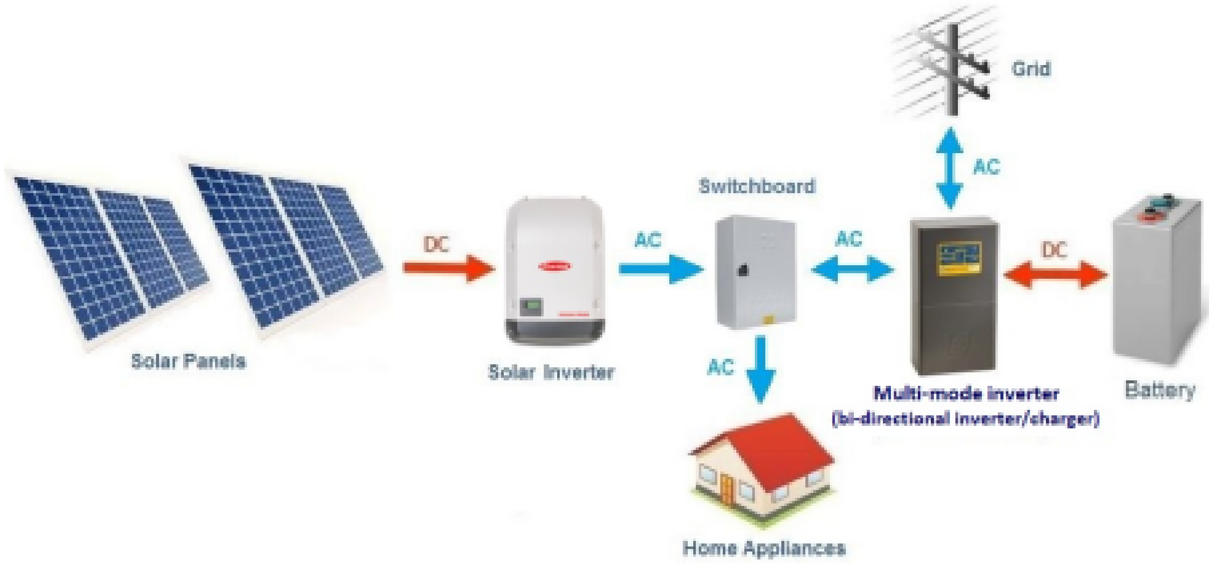
Solar_Power_Dataset_2

You should have a SolarPower dataset containing two tables:

- SolarPower.Generation_Data
- SolarPower.Weather_Sensor_Data

Roughly speaking, when the sunlight hits a solar panel, a flow of charge is created, resulting in the generation of DC Power (Direct Current). The DC Power is then transferred to an inverter, which converts it into AC Power (Alternating Current), which eventually reaches our homes.



Given this data, answer the following questions:

1. Write a query that shows the average AC and DC Power generated, grouped by each power plant.

```
SELECT plant_id,
 avg(DC_POWER) as avg_dc_power,
 avg(AC_POWER) as avg_ac_power
FROM `sql-sandbox-347110.SolarPower.Generation_Data`
GROUP BY plant_id
```

2. In the process of DC-to-AC conversion, no inverter can achieve 100% efficiency. This means that the output (AC) energy is not as high as the input (DC) energy. The efficiency of the inverter, calculated as AC Power/DC Power, generally ranges from 95 to 98%. Adding to the last query, what is the overall average inverter efficiency for each Plant?

```
SELECT plant_id,
 avg(DC_POWER) as avg_dc_power,
 avg(AC_POWER) as avg_ac_power,
 round(avg(AC_POWER) / avg(DC_POWER) * 100, 2) as
pct_inverter_efficiency FROM
`sql-sandbox-347110.SolarPower.Generation_Data`
GROUP BY plant_id
```

3. According to this data, which Plant is the most efficient? Do you notice anything strange? If so, what could the reason be?

One of the two plants (plant_id 4135001) has a DC Power that is 10x higher than the other. The most reasonable explanation is some kind of error in the recording or reporting of the data.

4. Let's now focus on plant_id = 4136001. Write a query that shows the average DA and AC Power as well as the average inverter efficiency for each hour of the day. *Hint: careful about the "division by zero" error*

```
SELECT extract(hour from DATE_TIME) as hour_of_day,
 avg(DC_POWER) as avg_dc_power,
 avg(AC_POWER) as avg_ac_power,
 round(avg(case when AC_POWER <> 0 then AC_POWER end)/avg(case when DC_POWER
<> 0 then DC_POWER end)*100, 2) as pct_inverter_efficiency
FROM `sql-sandbox-347110.SolarPower.Generation_Data`
WHERE plant_id = 4136001
GROUP BY hour_of_day
ORDER BY hour_of_day
```

5. What can you say about the hourly distribution of power generated? Why are there zeros in the resulting table?

Interestingly, although the highest power generation happens in the warmest hours of the day, the highest levels of inverter efficiency is obtained at lower levels of energy production. Those are the night hours, where there is no sunlight and therefore no power is generated by the power plant.

6. How many inverters (source_key) are there in the Generation_Data table? And in the Weather_Sensor_Data table?

There are 44 unique source keys in the first table and only 2 in the second.

7. Are there any source keys in the Weather_Sensor_Data table that are also present in the Generation_Data table? Can you think of a way of using a SUBQUERY (in the WHERE clause of a query) to check for this?

```
 SELECT distinct source_key
FROM `sql-sandbox-347110.SolarPower.Generation_Data`
WHERE source_key in (select distinct source_key FROM
`sql-sandbox-347110.SolarPower.Weather_Sensor_Data`)
```

8. Let's say that the anomaly in the data you observed at question 3 is due to a measurement error. Write a query that will modify only the DC Power data relative to plant_id 4135001 by moving the decimal point one step to the left (eg: divide by 10). *Note: you won't be able to execute the update statement due to BigQuery's Sandbox limitations, just write down the code that would make the appropriate changes.*

```
UPDATE `sql-sandbox-347110.SolarPower.Generation_Data`
SET DC_POWER = DC_POWER/10
WHERE PLANT_ID = 4135001
```

Advanced Exercise:

1. Since we can’t update the existing table, let’s re-create the Generation_Data table via a UNION statement and call it Generation_Data_Clean. Make sure you:

   a. Fix the DC Power problem in the Plant1 table

   b. Add a new string column in the final table called Plant_nr where you manually specify whether that data is relative to “plant_1” or “plant_2”

```
CREATE TABLE `sql-sandbox-347110.SolarPower.Generation_Data_Clean` AS
SELECT "plant_1" AS PLANT_NR, DATE_TIME, PLANT_ID, SOURCE_KEY, DC_POWER/10 as
DC_POWER, AC_POWER, DAILY_YIELD, TOTAL_YIELD
FROM `sql-sandbox-347110.SolarPower.Plant_1_Generation_Data`
UNION ALL
SELECT "plant_2" AS PLANT_NR, DATE_TIME, PLANT_ID, SOURCE_KEY, DC_POWER,
AC_POWER, DAILY_YIELD, TOTAL_YIELD
FROM `sql-sandbox-347110.SolarPower.Plant_2_Generation_Data`
```

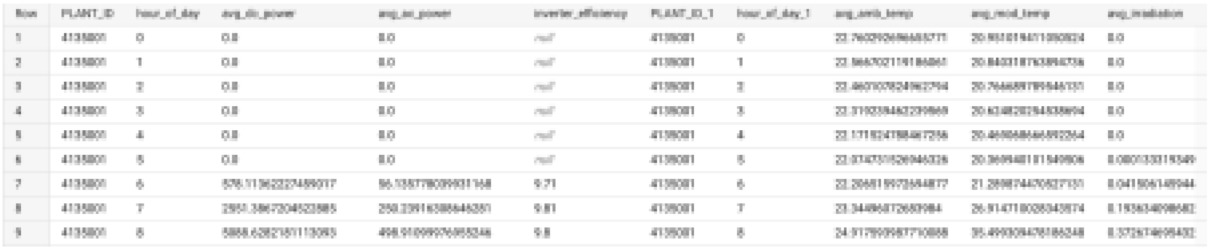
2. The Weather_Sensor_Data table stores records of the average *ambient* (outdoor temp) and *module* (photovoltaic panel temp) temperatures as well as *irradiation* levels (the amount of the sun's power detected by a sensor). What are the average ambienttemperature, module temperature and irradiation by hour of day?

```
SELECT extract(hour from DATE_TIME) as hour_of_day,
 avg(AMBIENT_TEMPERATURE) as avg_amb_temp,
 avg(MODULE_TEMPERATURE) as avg_mod_temp,
 avg(MODULE_TEMPERATURE) - avg(AMBIENT_TEMPERATURE) as
 avg_temp_diff, avg(IRRADIATION) as avg_irradiation
FROM `sql-sandbox-347110.SolarPower.Weather_Sensor_Data`
GROUP BY hour_of_day
ORDER BY hour_of_day
```

3. What can you say about the data you just generated?

   As one would expect, irradiation is higher during the daytime and near zero at nighttime. Also, it is interesting to note that the module temperature is greater than the ambient at daytime and viceversa at nighttime.

4. Using a JOIN and SUBQUERIES, merge the output table from question 4 (using the new "Clean" table and without the filter on the power plant) to the table produced in question 8. Add the PLANT_ID to both outputs so that you can use that in the JOIN as well. In the end you should have an output table that looks like this (I also used plant_nr instead of plant_id):



Row	PLANT_ID	hour_of_day	avg_dc_power	avg_ac_power	inverter_efficiency	PLANT_ID_1	hour_of_day_1	avg_amb_temp	avg_mod_temp	avg_irradiation
1	4135001	0	0.0	0.0	null	4135001	0	22.760292696665771	20.931019471090824	0.0
2	4135001	1	0.0	0.0	null	4135001	1	22.566702119186061	20.840318763896736	0.0
3	4135001	2	0.0	0.0	null	4135001	2	22.460107824962794	20.766689789546131	0.0
4	4135001	3	0.0	0.0	null	4135001	3	22.310339462239869	20.634820284538694	0.0
5	4135001	4	0.0	0.0	null	4135001	4	22.171924788467256	20.465048646692264	0.0
6	4135001	5	0.0	0.0	null	4135001	5	22.074731526946326	20.360940181549806	0.080133319349
7	4135001	6	576.11362227489017	56.135778039931168	9.71	4135001	6	22.206815972684877	21.289874470527131	0.041506148944
8	4135001	7	2951.3867204522885	290.23916388644281	9.81	4135001	7	23.34486872659984	26.914718028343874	0.193634098682
9	4135001	8	5888.6282181113093	498.91099976955246	9.8	4135001	8	24.917893987710858	35.499309478185248	0.372674695432

```
SELECT *
FROM
 (SELECT PLANT_ID, extract(hour from DATE_TIME) as hour_of_day,
  avg(DC_POWER) as avg_dc_power,
  avg(AC_POWER) as avg_ac_power,
  round(avg(case when AC_POWER <> 0 then AC_POWER end)/avg(case when DC_POWER
<> 0 then DC_POWER end)*100, 2) as inverter_efficiency
 FROM `sql-sandbox-347110.SolarPower.Generation_Data`
 GROUP BY PLANT_ID,hour_of_day) a
LEFT JOIN
 (SELECT PLANT_ID, extract(hour from DATE_TIME) as hour_of_day,
  avg(AMBIENT_TEMPERATURE) as avg_amb_temp,
  avg(MODULE_TEMPERATURE) as avg_mod_temp,
  avg(IRRADIATION) as avg_irradiation
 FROM `sql-sandbox-347110.SolarPower.Weather_Sensor_Data`
 GROUP BY PLANT_ID, hour_of_day) b
 on a.PLANT_ID = b.PLANT_ID
 and a.hour_of_day = b.hour_of_day
ORDER BY a.PLANT_ID, a.hour_of_day
```

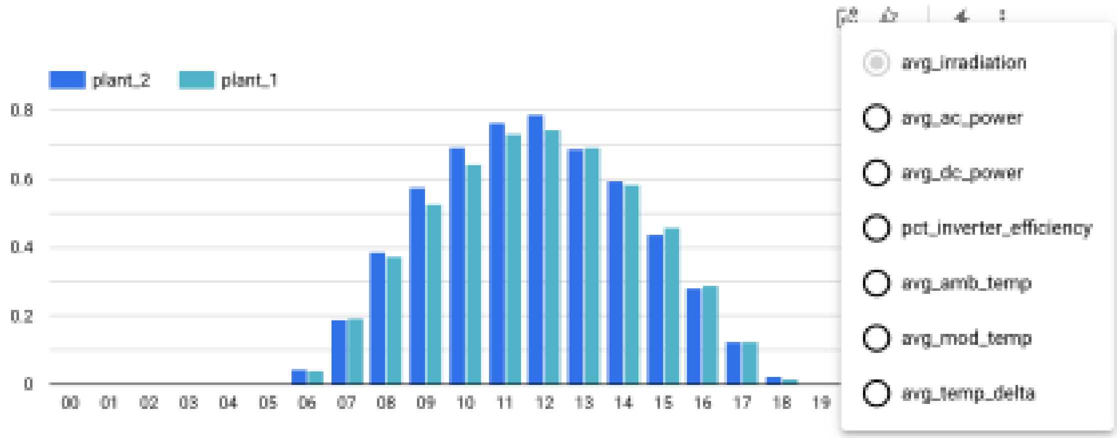
5. Using the previous query as the base, create a new table and call it

Hourly_Generation_Weather_Plant.

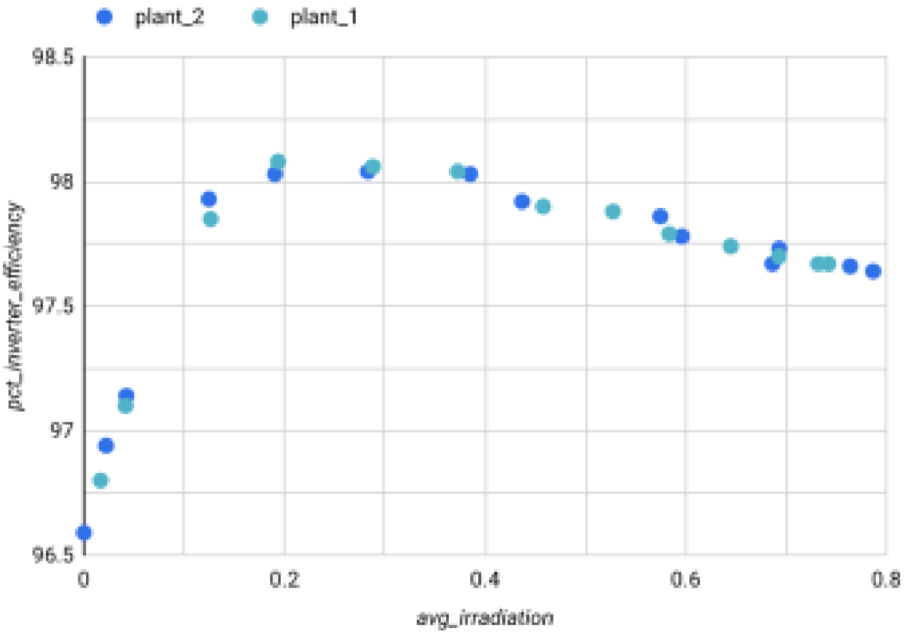
```
CREATE TABLE SolarPower.Hourly_Generation_Weather_Plant AS
SELECT a.plant_nr, a.hour_of_day, a.avg_dc_power, a.avg_ac_power,
a.pct_inverter_efficiency, b.avg_amb_temp, b.avg_mod_temp, b.avg_irradiation
FROM
 (SELECT plant_nr, PLANT_ID, extract(hour from DATE_TIME) as hour_of_day,
  avg(DC_POWER) as avg_dc_power,
  avg(AC_POWER) as avg_ac_power,
  round(avg(case when AC_POWER <> 0 then AC_POWER end)/avg(case when DC_POWER
<> 0 then DC_POWER end)*100, 2) as pct_inverter_efficiency
 FROM `sql-sandbox-347110.SolarPower.Generation_Data_Clean`
 GROUP BY plant_nr, PLANT_ID,hour_of_day) a
LEFT JOIN
 (SELECT PLANT_ID, extract(hour from DATE_TIME) as hour_of_day,
  avg(AMBIENT_TEMPERATURE) as avg_amb_temp,
  avg(MODULE_TEMPERATURE) as avg_mod_temp,
  avg(IRRADIATION) as avg_irradiation
 FROM `sql-sandbox-347110.SolarPower.Weather_Sensor_Data`
 GROUP BY PLANT_ID, hour_of_day) b
 on a.PLANT_ID = b.PLANT_ID
 and a.hour_of_day = b.hour_of_day
ORDER BY a.PLANT_ID, a.hour_of_day
```

6. Go to Google Data Studio, connect to the last table you created (Hourly_Generation_Weather_Plant) and explore the data in it.

7. Create a chart, like the one below, that shows the relationship between the hour of the day and a variety of metrics (of your choice) and highlights (with colour) the differences between plant_1 and plant2:



8. Create a chart, like the one below, that shows the relationship between irradiation and the inverter's efficiency among the two power plants. What is the chart telling us? What can you say about this relationship?



There is a non-linear relationship between the two metrics: initially, efficiency rises as irradiation increases, but after a peak point, efficiency

starts to decrease as irradiation keeps increasing, thus determining a point of optimal maximum (around avg_irradiation = 0.2), where the efficiency of the inverter is maximised.