Intel Data Center

INTRODUCTION: Intel, the semiconductor manufacturing powerhouse, is planning on building a new data center. Energy availability and usage are some of the key considerations in deciding on a location of the data center. For example, which regions produce a surplus of energy, and are therefore more likely to provide energy at cheaper prices? Which regions rely more on renewable energy sources?

In this project, co-designed with Intel's Sustainability Team, you'll write SQL queries that will power your analysis and create visualizations that will help the Intel team select the best location for the new data center.

HOW IT WORKS: Follow the prompts in the questions below to investigate your data. Post your answers in the provided boxes: the **yellow boxes** for the queries you write, **purple boxes** for visualizations and **blue boxes** for text-based answers. When you're done, export your document as a pdf file and submit it on the Milestone page – see instructions for creating a PDF at the end of the Milestone.

RESOURCES: If you need hints on the Milestone or are feeling stuck, there are multiple ways of getting help. Attend Drop-In Hours to work on these problems with your peers, or reach out to the HelpHub if you have questions. Good luck!

SQL App: Here's that link to our specialized SQL app, where you'll write your SQL queries and interact with the data.

— Data Set **Descriptions**

In this project you'll query 3 datasets as well as write a query to generate a new dataset that you will use in your tableau visualizations. The `intel.energy_data` dataset will be the main dataset you'll be working with. The `intel.energy_by_plant` and `intel.power_plants` datasets will be joined for an in-depth analysis of energy production at the power plant level.

Read below to learn more about the datasets and their features.

`intel.energy_data`: Contains information about daily energy production and consumption for different regions in the United States.

- `balancing_authority` - A Balancing Authority is responsible for maintaining the electricity balance within its region. This is a company that makes sure electricity is being exchanged between electric providers and regions so that no region runs out of electricity due to high demand.
- `date` - The date the energy was produced.
- `region` - The electric service area within a geographic area of the USA. e.g. California, Midwest, etc.
- `time_at_end_of_hour` - The time and date after energy was generated, .e.g., energy generated between 1pm-2pm will show up as 2pm in this field.
- `demand` - The energy demand in megawatts (MW) on the grid (what the houses/business are using).
- `net_generation` - The energy produced in MW in the region by all sources e.g., wind, coal, nuclear, etc.
- `all_petroleum_products` - The energy produced in MW by petroleum products.
- `coal` - The energy produced in MW by all coal products
- `hydropower_and_pumped_storage` - The energy produced in MW by water power and pumped heat sources.
- `natural_gas` - The energy produced in MW by natural gas sources
- `nuclear` - The energy produced in MW from nuclear fuel sources
- `solar` - The energy produced in MW by solar panels and other solar energy capturing methods.
- `wind` - The energy produced in MW from wind turbines and other wind sources.

`intel.power_plants`: Contains general information about power plants in the United States.

- `plant_name` - The name of the power plant.
- `plant_code` - The unique identifier of the plant.
- `region` - The region in the US where the power plant is located. Matches the regions in the intel.energy_data
- `state` - The state where the power plant is located.
- `primary_technology` - The primary technology used to generate electricity at the power plant.

`intel.energy_by_plant`: Contains total energy production information at the plant for the year 2022.

- `plant_name` - The name of the power plant.
- `plant_code` - The unique identifier of the plant.
- `energy_type` - The kind of energy generated by the power plant. Either renewable energy or fossil fuel.
- `energy_generated_mw` - The total energy generated, in MegaWatts, at the plant for the year 2022.

— **Task 1:** Energy Generation

Let's first identify regions that are net energy producers. Not all regions generate enough energy to meet the local demand. Some regions purchase power from other regions, while others sell their surplus to regions in need.

A. Write a query using the `intel.energy_data` table that calculates the sum total of energy produced, grouped by each region. Sort the output by highest total energy. Which region has the highest positive total energy?

```
SELECT
  region,
  SUM(net_generation) AS energy_generated,
  SUM(demand) AS energy_used,
  SUM(net_generation - demand) AS total_energy
```

```
FROM
  intel.energy_data
GROUP BY
  region
ORDER BY
  total_energy DESC
```

The region with the highest net energy is the Mid-Atlantic with 31693087 Megawatts.

B. Intel is interested in regions that generate a large amount of energy from renewable sources. Renewable energy is defined as any energy generated from `hydropower_and_pumped_storage`, `wind`, and `solar` sources.

Write a query that calculates the sum total of renewable energy by region. Sort the output by the region with the highest renewable energy. What are the top two regions for total renewable energy production?

```
SELECT
  region,
  SUM(hydropower_and_pumped_storage + wind + solar) AS
renewable_generated
FROM
  intel.energy_data
GROUP BY
  region
ORDER BY
  renewable_generated DESC
```

The top two regions with the highest renewable energy output are the Northwest with 199266574 MW and Texas with 131367234 MW.

C. Modify your query slightly so that it calculates the **percentage** of renewable energy by region.

```
SELECT
  region,
  (SUM(hydropower_and_pumped_storage + wind + solar) /
SUM(net_generation)) * 100 AS percent_renewable
FROM
  intel.energy_data
GROUP BY
  region
ORDER BY
  percent_renewable DESC
```

D. Which regions change from the top 3 when looking at total renewable energy vs percentage of renewable energy?

When looking at the percent of energy that is renewable, Texas drops out of the top 3 and California jumps up, having 37.5%.

— **Task 2:** Generating New Data by Energy Type

Intel would like to know how renewable energy and fossil fuels trend over time. In order to do this, you will first need to generate a new table using your SQL knowledge and the `intel.energy_data` table before visualizing trends in Tableau Cloud.

A. Write a query that calculates the renewable energy generated for each row. Return only the `date`, `region`, and `energy_generated_mw` columns.

Note: `energy_generated_mw` is the alias for `hydropower_and_pumped_storage + wind + solar`.

```
SELECT
  date,
  region,
  SUM(hydropower_and_pumped_storage + wind + solar) AS
energy_generated_mw
FROM
  intel.energy_data
GROUP BY
  date,
  region
```

After showing the result of the query to your manager, she tells you that she wants it to be clear that the `energy_generated_mw` column is referring to renewable energy types. She asks you to create a new column called `energy_type` that has the value 'renewable energy' for each row.

A colleague teaches you a simple method to do this. When writing your query, add an additional column after your select statement. Here is an example:

```
SELECT
  *, -- any relevant fields to the query
  'renewable energy' AS energy_type
FROM intel.energy_data
```

B. Modify your query from Part **A.** to include the `energy_type` column.

```
SELECT
  date,
  region,
  SUM(hydropower_and_pumped_storage + wind + solar) AS
energy_generated_mw,
  'renewable energy' AS energy_type
FROM
  intel.energy_data
GROUP BY
  date,
  region
```

C. Next, write a **new** query that calculates the fossil fuel energy generated for each row. As in Part **A.**, return only the `date`, `region`, and `energy_generated_mw` columns, where `energy_generated_mw` is now the alias for `all_petroleum_products + coal + natural_gas + nuclear + other_fuel_sources`.

```
SELECT
  date,
  region,
  SUM(all_petroleum_products + coal + natural_gas + nuclear +
other_fuel_sources) AS energy_generated_mw
FROM
  intel.energy_data
GROUP BY
  date,
  region
```

D. Modify your query in Part **C.** to include the `energy_type` column. This column should have the value 'fossil fuel' for each row.

```
SELECT
  date,
  region,
  SUM(all_petroleum_products + coal + natural_gas + nuclear +
other_fuel_sources) AS energy_generated_mw,
  'fossil fuel' AS energy_type
FROM
  intel.energy_data
GROUP BY
  date,
  region
```

E. Your queries from Parts **B.** and **D.** should both have the columns `date`, `region`, `energy_generated`, and `energy_type`. Write one final query that `UNION`s these two together.

```
(SELECT
  date,
  region,
  SUM(hydropower_and_pumped_storage + wind + solar) AS
energy_generated_mw,
  'renewable energy' AS energy_type
FROM
  intel.energy_data
GROUP BY
  date,
  region)
UNION
(SELECT
  date,
  region,
```

```
  SUM(all_petroleum_products + coal + natural_gas + nuclear +
other_fuel_sources) AS energy_generated_mw,
  'fossil fuel' AS energy_type
FROM
  intel.energy_data
GROUP BY
  date,
  region)
```

Task 3: Aggregating Power Plant Data

Intel has provided you with additional data in order to reach the best conclusion about the location of its next data center. In this task you will be working with two tables `intel.power_plants` and `intel.energy_by_power_plant`. You will need to join these tables before you can aggregate them to help the Intel team with their analysis.

A. Join the `intel.power_plants` and `intel.energy_by_power_plant` data on the `plant_code`. This joined table will form the basis for the rest of the task.

```
SELECT
  *
FROM
  intel.power_plants AS p
  INNER JOIN intel.energy_by_plant AS e
  ON p.plant_code = e.plant_code
```

B. Write a query that returns the total number of **renewable energy** power plants for each region. Which region has the most renewable power plants?

```
WITH ppe AS (
  SELECT
```

```
    *
  FROM
    intel.power_plants AS p
    INNER JOIN intel.energy_by_plant AS e ON p.plant_code =
e.plant_code
)
SELECT
  region,
  COUNT(*) AS renewable_energy_plants
FROM
  ppe
WHERE
  energy_type LIKE 'renewable_energy'
GROUP BY
  region
ORDER BY
  renewable_energy_plants DESC
```

The region containing the most renewable energy power plants is the Midwest with 234.

C. Next, write a query that returns both the total number of power plants and the total energy generated, specifically from plants that use "Solar Photovoltaic" technology, grouped by each region.

```
WITH ppe AS (
  SELECT
    *
  FROM
    intel.power_plants AS p
    INNER JOIN intel.energy_by_plant AS e ON p.plant_code =
e.plant_code
)
```

```
SELECT
  region,
  SUM(energy_generated_mw) AS total_energy_generated,
  COUNT(*) AS energy_plants
FROM
  ppe
WHERE
  primary_technology ILIKE 'Solar_Photovoltaic'
GROUP BY
  region
ORDER BY
  energy_plants DESC
```

D. Modify your query in part **C** to only show regions having at least 50 power plants that use “Solar Photovoltaic” technology. What can you infer about the efficiency (or size) of the power plants in the Midwest region relative to the other regions in your output?

```
WITH ppe AS (
  SELECT
    *
  FROM
    intel.power_plants AS p
    INNER JOIN intel.energy_by_plant AS e ON p.plant_code =
e.plant_code
)
SELECT
  region,
  SUM(energy_generated_mw) AS total_energy_generated,
  COUNT(*) AS energy_plants
FROM
  ppe
WHERE
  primary_technology ILIKE 'Solar_Photovoltaic'
GROUP BY
  region
```

```
ORDER BY
  energy_plants DESC
```

The Midwest plants appear to be much smaller or much less efficient as regions with similar Solar-Photovoltaic plants produce significantly more total energy. California, having 10 less plants, produces 3 times the amount of total energy.

Note: There is more Tableau work up ahead! If you want to skip the LevelUp jump straight to **Task 4** below!

— **LevelUp:** Hourly Trends in Renewable Energy

Before moving on to your Tableau Visualizations, let's investigate how renewable energy generation fluctuates with the time of day.

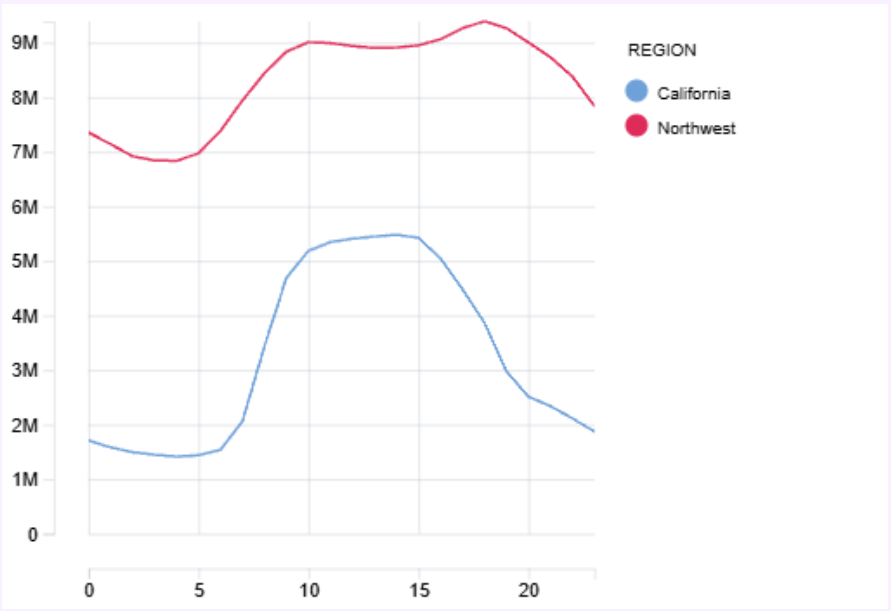
A. Write a query that calculates the total **renewable** energy generated in each region for each hour of the day.

```
SELECT
  region,
  DATE_PART('hour', time_at_end_of_hour) AS hour_of_day,
  SUM(hydropower_and_pumped_storage + wind + solar) AS
total_renewable_energy
FROM
  intel.energy_data
GROUP BY
  region,
  DATE_PART('hour', time_at_end_of_hour)
ORDER BY
  region,
  hour_of_day
```

B. Modify your query to filter to the ‘California’ and ‘Northwest’ regions only.

```
SELECT
  region,
  DATE_PART('hour', time_at_end_of_hour) AS hour_of_day,
  SUM(hydropower_and_pumped_storage + wind + solar) AS
total_renewable_energy
FROM
  intel.energy_data
WHERE
  region IN ('California', 'Northwest')
GROUP BY
  region,
  DATE_PART('hour', time_at_end_of_hour)
ORDER BY
  region,
  hour_of_day
```

C. Use the built-in visualizer in the SQL app to plot a line graph of the energy generated for each hour of the day and colored by the region. If done correctly you should have two lines in your visualization.



D. What can you say about the renewable energy generation between California (CAL) and the Pacific Northwest (NW)?

> Not only is the Northwest region more consistently generating renewable energy throughout the day, it also is usually doubling California's generation.

— **Task 4:** Visualizing and Analyzing Using Tableau

Click this link to navigate to the workbook you'll use to complete the remainder of this Project.

Once you've published your Tableau Workbook, paste the Share Link in the box below.

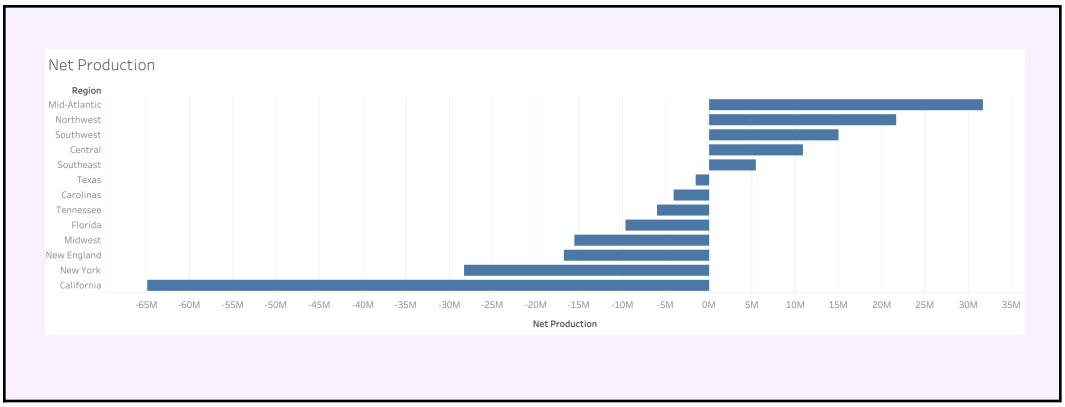
Note: Your share link must begin with:
`https://prod-useast-b.online.tableau.com/#/site/globaltech/workbooks/...`

> https://prod-useast-b.online.tableau.com/#/site/globaltech/workbooks/1770503?:origin=card_share_link

Continue to post your answers in the provided boxes: purple boxes for your visualizations, and blue boxes for text-based answers.

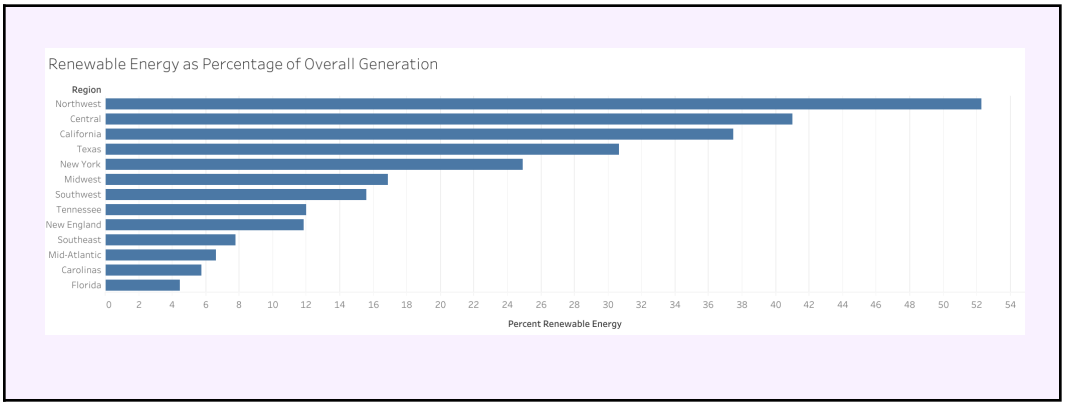
A. On the "Net Production" sheet, create a bar chart of net production , by region. Sort the chart in *descending* order, from tallest to smallest.

   The net energy produced is calculated by subtracting the total energy demand from the total energy generation. This is already created in the field called `Net Production`.



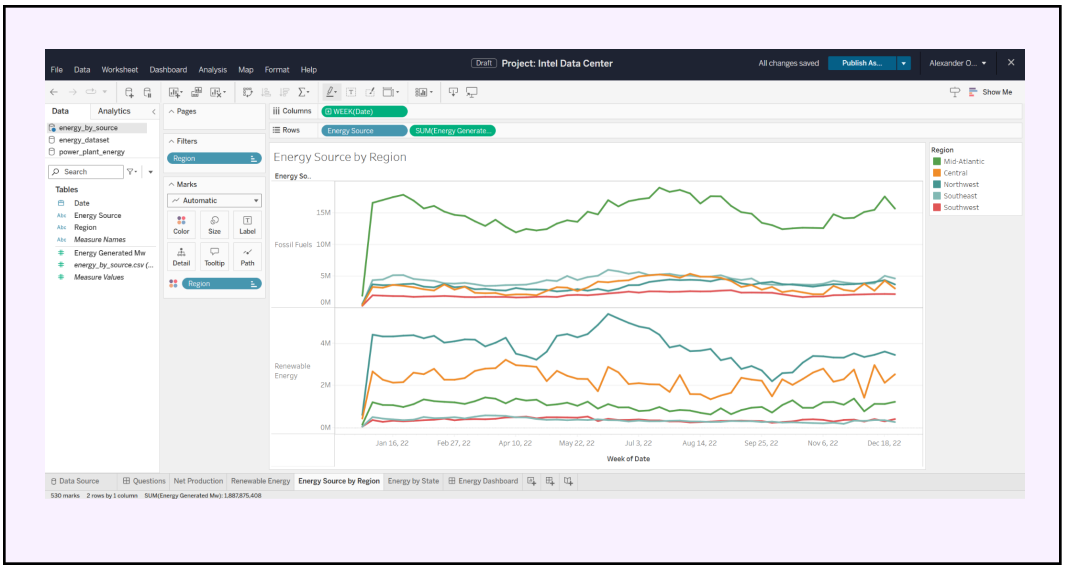
B. Next, on the "Renewable Energy" sheet, create a bar chart illustrating which regions generate the greatest percentage of renewable energy.

   Create a bar chart in descending order of regions with the most renewable energy percentage.



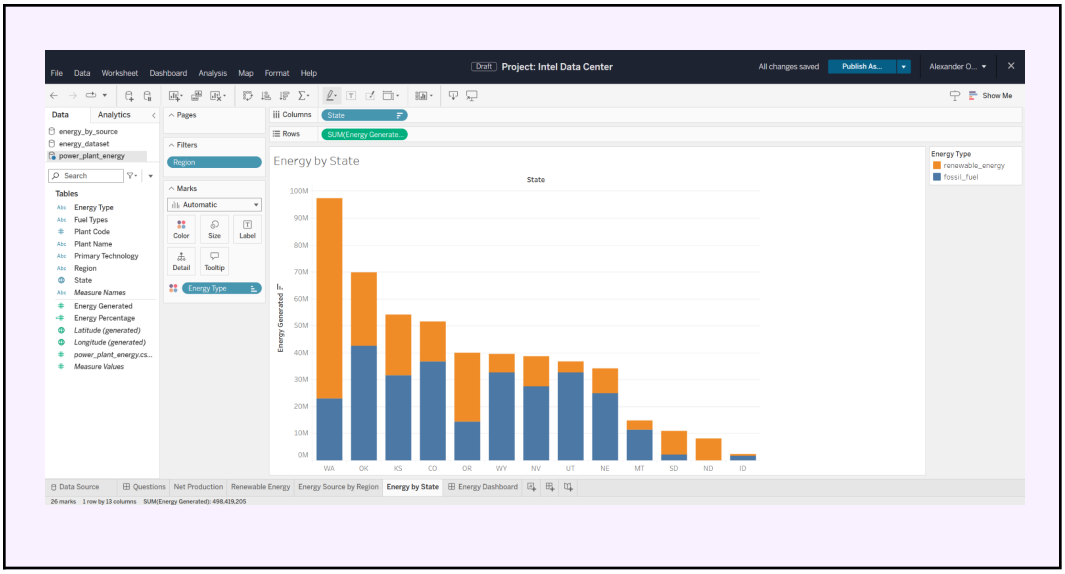
C. On the "Energy Source by Region" sheet, create a line chart of the energy generated for each energy source (fossil fuels & renewable energy) at the weekly date level. Add a filter for the region to your chart.

   For this chart, you will use the `energy_by_source` dataset loaded into your Tableau workbook.



D. On the “Energy by State” sheet create a bar chart of the total energy generated by each state and energy type. Color the bars by energy type. Include a region filter in your chart to reduce the amount of bars shown.

For this chart you will use the `power_plant_energy` dataset that you created. You can select the data source in the upper left hand column in Tableau.



— **Task 5:** Communicating Results

Your manager wants you to share the visualizations you created in Task 3 with the Sustainability team for visibility. She has created a dashboard with your visualizations (see the "Dashboard" sheet in Tableau) and has asked you to write a short paragraph explaining which region you recommend that the next data center be built.

A. In 1–2 paragraphs, summarize what can be gleaned from your visualizations. What **region** and **state** do you think is best and why?

There was a clear path to follow in this analysis and it started with the Net Production and % Renewable Energy visualizations. Two main regions really stuck out at the beginning, Northwest and Central, as they both had net positive generation and high renewable %. However, it still felt too early to count out the other net positive regions so I included them in the Energy Source by Region filter. My suspicions were confirmed though when the dominant renewable energy generators were shown to be the Northwest and Central regions. This left only the states in those regions to be considered for the site of the new data center. Washington is by far the most promising location and Oklahoma is a good second option. This decision takes into account the power draw of the surrounding region as well as the renewable energy output of the state.