Project | Sustainability Impact Analysis for Intel

— **Task 1:** Organizing and Understanding the Data

A. write a query that returns all of the columns from both tables, joining the two on the `device_id` column.

```
SELECT
  *
FROM
  intel.impact_data
  INNER JOIN intel.device_data ON
intel.impact_data.device_id =
intel.device_data.device_id;
```

B. To your joined dataset, add a new column called `device_age` calculated by subtracting the model_year from 2024.

```
SELECT
  *,
  (2024 - model_year) as device_age
FROM
  intel.impact_data
  INNER JOIN intel.device_data ON
intel.impact_data.device_id =
intel.device_data.device_id;

SANITY CHECK:

SELECT
  *,
  (2024 - model_year) as device_age
FROM
```

```
  intel.impact_data
  INNER JOIN intel.device_data ON
intel.impact_data.device_id =
intel.device_data.device_id
WHERE model_year = 2019;
```

C. Order your joined data by model_year (oldest to newest). Do you notice more older (5+ years) or newer (under 5 years) devices being repurposed? What might that indicate?

When the joined data is ordered by model_year from oldest to newest, it's clear that newer devices (under 5 years old) are being repurposed far more often than older ones. Devices from 2020 to 2023 account for over 436,000 repurposed units, while those from 2016 to 2019 make up only about 165,000. This suggests a trend where organizations are more likely to repurpose relatively modern hardware, possibly because it is still efficient, compatible with current technologies, and cost-effective to refurbish. It may also reflect faster upgrade cycles, where devices are replaced and reused more frequently.

D. Bucketing the `device_age` will allow us to analyze trends and patterns in energy savings and CO_2 reductions more effectively than using individual ages. Use a `CASE WHEN` clause to add one more column, called `device_age_bucket`, to your data, that is based on the device_age:

```
SELECT
  model_year,
  COUNT(intel.impact_data.device_id) AS n_devices,
  (2024 - model_year) AS device_age,
  CASE
```

```
    WHEN (2024 - model_year) <= 3 THEN 'newer'
    WHEN (
      (2024 - model_year) > 3
      AND (2024 - model_year) <= 6
    ) THEN 'mid-range'
    ELSE 'older'
  END AS device_age_bucket
FROM
  intel.impact_data
  INNER JOIN intel.device_data ON
intel.impact_data.device_id =
intel.device_data.device_id
GROUP BY
  model_year
ORDER BY
  n_devices DESC;
```

– **Task 2:** Key Insights

Now it's time to analyze the overall impact of Intel's repurposing program.

A. What is the total number of devices Intel repurposed in 2024?

Intel repurposed a total of 601,740 devices in 2024.

B. Write a query that returns the total number of devices repurposed, the average age of repurposed devices in 2024, the average estimated energy savings (kWh) from repurposed devices per year, and the total CO_2 emissions saved (in tons) from repurposed devices.

```
WITH intel_data AS (
  SELECT
```

```
    model_year,
    COUNT(i.device_id) AS n_devices,
    (2024 - model_year) AS device_age,
    AVG(i.energy_savings_yr) AS avg_energy_savings,
    SUM(i.co2_saved_kg_yr) AS total_co2_saved_kg,
    CASE
      WHEN (2024 - model_year) <= 3 THEN 'newer'
      WHEN (2024 - model_year) > 3
      AND (2024 - model_year) <= 6 THEN 'mid-range'
      ELSE 'older'
    END AS device_age_bucket
  FROM
    intel.impact_data AS i
    INNER JOIN intel.device_data AS d ON i.device_id =
d.device_id
  GROUP BY
    model_year
)
SELECT
  SUM(n_devices) AS total_devices_repurposed_2024,
  ROUND(AVG(device_age), 2) AS avg_age_repurposed,
  ROUND(AVG(avg_energy_savings), 2) AS
avg_estimated_energy_savings,
  ROUND(SUM(total_co2_saved_kg) / 1000.0, 2) AS
total_CO2_emissions_saved_tons
FROM
  intel_data;
```

C. Now with the calculated average estimated energy savings (kWh) and CO_2 emissions saved (tons), put these numbers into perspective.

I found that each repurposed device saves approximately 31.6 kWh of energy per year, and Intel's repurposing program saved about 6,768 tons of CO_2 emissions in one year. To put this into perspective, the energy saved by repurposing these devices is roughly equivalent to the annual electricity consumption of over 2,700 average U.S. households (considering the average household uses about 10,600 kWh per year). In terms of carbon emissions, saving 6,768 tons of CO_2 is comparable to taking approximately 1,470 passenger cars off the road for a year (since an average car emits about 4.6 tons of CO_2 annually).

These comparisons highlight the significant environmental impact of Intel's repurposing program. By extending the life of devices, the program not only conserves energy but also substantially reduces greenhouse gas emissions, contributing meaningfully to climate change mitigation and resource conservation efforts. This scale of savings demonstrates how corporate sustainability initiatives can drive real-world environmental benefits comparable to major community-wide efforts.

– **Task 3:** Identifying Trends & Maximizing Sustainability

A. Write a query that returns the total number of devices, the average energy savings, and the average CO_2 emissions saved (in tons), grouped by device_type.

```
SELECT
  d.device_type,
  COUNT(i.device_id) AS total_devices,
  ROUND(AVG(i.energy_savings_yr), 2) AS
avg_energy_savings,
  AVG(i.co2_saved_kg_yr) / 1000 AS
avg_CO2_emissions_saved_tons
FROM
  intel.impact_data AS i
  INNER JOIN intel.device_data AS d ON i.device_id =
d.device_id
GROUP BY
  d.device_type
ORDER BY AVG(i.co2_saved_kg_yr) / 1000 DESC;
```

B. Which device type contributes the most to energy savings and CO_2 reduction? Why might that be the case?

Based on the results, laptops contribute the most to total energy savings and CO_2 reduction because there are more than twice as many repurposed laptops (408,064) compared to desktops (193,676). Although the average energy savings and CO_2 emissions saved per device are very similar between laptops and desktops, the higher volume of repurposed laptops leads to a greater overall environmental impact. This could be because laptops are more widely used, replaced, and repurposed due to their portability and shorter upgrade cycles compared to desktops.

C. Write a query that returns the total number of devices, the average energy savings, and the average CO_2 emissions saved (in tons), now grouped by `device_age_bucket`.

```
WITH intel_data AS (
  SELECT
    model_year,
    d.device_type,
    COUNT(i.device_id) AS n_devices,
    (2024 - model_year) AS device_age,
    AVG(i.energy_savings_yr) AS avg_energy_savings,
    AVG(i.co2_saved_kg_yr) AS avg_co2_saved_kg,
    CASE
      WHEN (2024 - model_year) <= 3 THEN 'newer'
      WHEN (2024 - model_year) > 3
      AND (2024 - model_year) <= 6 THEN 'mid-range'
      ELSE 'older'
    END AS device_age_bucket
```

```
  FROM
    intel.impact_data AS i
    INNER JOIN intel.device_data AS d ON i.device_id =
d.device_id
  GROUP BY
    model_year,
    d.device_type
)
SELECT
  device_age_bucket,
  device_type,
  SUM(n_devices) AS total_devices,
  ROUND(AVG(avg_energy_savings), 2) AS
avg_energy_savings,
  ROUND(AVG(avg_co2_saved_kg) / 1000, 4) AS
avg_CO2_emissions_saved_tons
FROM
  intel_data
GROUP BY
  device_age_bucket,
  device_type
ORDER BY
  avg_CO2_emissions_saved_tons DESC;
```

D. What do you notice about the relationship between device age and the number of devices repurposed versus the average energy saved?

The data shows that older devices, although fewer in number, have the lowest average energy savings per device when repurposed.
Mid-range devices, which represent a moderate share of repurposed units, achieve the highest average energy savings, indicating they remain efficient enough to generate significant energy benefits. Newer devices, while repurposed in the greatest numbers (especially laptops) tend to save less energy on average because they are already more

energy-efficient. Overall, this suggests that mid-range devices strike the best balance between quantity repurposed and energy savings, whereas newer devices are more numerous but offer smaller per-device energy savings.

E. Finally, write a query that returns the total number of devices, the average energy savings, and the average CO_2 emissions saved (in tons), now grouped by region.

```
SELECT
  i.region,
  d.device_type,
  COUNT(i.device_id) AS total_devices,
  ROUND(AVG(i.energy_savings_yr), 2) AS
avg_energy_savings,
  ROUND(AVG(i.co2_saved_kg_yr) / 1000,4) AS
avg_CO2_emissions_saved_tons
FROM
  intel.impact_data AS i
  INNER JOIN intel.device_data AS d ON i.device_id =
d.device_id
GROUP BY
  i.region, d.device_type;
```

F. How does the carbon intensity of electricity in each region impact the total CO_2 savings from repurposed devices? Are there regions where repurposing leads to significantly higher environmental benefits? Why might that be?

The carbon intensity of electricity in each region significantly affects the total CO_2 savings from repurposed devices. From the data, devices repurposed in Asia show the highest average CO_2 emissions saved per device, nearly double that of devices in Europe and about 50% higher than those in North America. This suggests that repurposing in Asia leads to greater environmental benefits, likely because the region's electricity generation relies more heavily on carbon-intensive sources like coal, resulting in higher emissions per unit of energy consumed. In contrast, Europe and North America tend to have cleaner energy mixes with more renewables and natural gas, so the CO_2 savings per device are lower. Therefore, repurposing devices in regions with higher carbon intensity yields significantly larger reductions in CO_2 emissions, emphasizing the greater environmental impact of such efforts in places where electricity is more carbon-heavy.

– **Task 4:** Data-Driven Recommendations

Using the findings from this analysis, summarize key takeaways and develop actionable recommendations for Intel. The goal is to refine Intel's repurposing strategy to maximize energy savings and CO_2 reductions while ensuring the most effective use of resources.

A. Based on your analysis of the repurposed devices (including energy savings, CO_2 emissions, and device age), write **four** key takeaways in succinct sentences/bullets that summarize the most important patterns and insights from the data.

- Intel repurposes significantly more newer devices (under 5 years old), which are more energy-efficient but yield lower average energy savings per device compared to mid-range devices.

- Mid-range devices (4–6 years old) offer the highest average energy savings and CO_2 reductions, representing a strategic opportunity for maximizing environmental impact.

- Older devices (7+ years) have the lowest energy savings and CO_2 benefits, suggesting limited returns on investment for repurposing very old hardware.

- Targeting repurposing efforts in regions with higher carbon-intensive electricity (e.g., Asia) can amplify CO_2

emissions reductions, making location an important factor in strategy optimization.

B. Based on your four key takeaways and ChatGPT as your teammate, write a recommendation for Intel on how to improve the repurposing program. Your recommendation should include a clear action or strategy for Intel based on the data and a data-driven justification for why this approach would maximize energy savings and CO_2 reductions.

To maximize energy savings and CO_2 reductions, Intel should prioritize repurposing mid-range devices (4–6 years old), as they deliver the greatest environmental benefits per unit. While newer devices are repurposed in higher volumes, focusing more on mid-range hardware will enhance overall energy efficiency and carbon savings. Additionally, Intel should tailor its repurposing efforts by region, concentrating on areas with higher carbon intensity in electricity generation (such as Asia) to achieve greater CO_2 emissions reductions. This targeted strategy will ensure resources are used most effectively, balancing device age and geographic impact to drive the largest possible sustainability gains.

C. Briefly reflect on how ChatGPT's suggestions influenced your recommendation. Did it help you see something you hadn't considered? What parts of your recommendation were improved based on its response?

ChatGPT's suggestions helped me better understand the importance of focusing on mid-range devices rather than just newer ones, highlighting their higher energy savings and CO_2 reductions per device. It also emphasized the regional impact of electricity carbon intensity, which I hadn't fully considered before. This insight improved my recommendation by adding a geographic dimension to the strategy, making it more targeted and data-driven. Overall, ChatGPT helped me create a more nuanced and effective plan for Intel's repurposing program.

– **LevelUp:** Optimizing Repurposing Strategy for Maximum Impact

Now that you've gained insights into the energy savings and CO_2 reductions across different device types and regions, let's use this data to optimize Intel's repurposing strategy for maximum environmental benefit.

A. Add to your final query of Task 3 that returns the total number of devices, the average energy savings, and the average CO_2 emissions saved (in tons), grouped by region, **the percentage** of the total energy savings and CO_2 reductions contributed by each device type within each region.

```
WITH region_totals AS (
  SELECT
    id.region,
    SUM(id.energy_savings_yr) AS
total_energy_savings_region,
    SUM(id.co2_saved_kg_yr) AS total_co2_saved_region
  FROM
    intel.impact_data AS id
    INNER JOIN intel.device_data AS dd ON id.device_id
= dd.device_id
  GROUP BY
    id.region
),
device_type_totals AS (
  SELECT
    id.region,
    dd.device_type,
    COUNT(id.device_id) AS total_devices,
```

```
    SUM(id.energy_savings_yr) AS total_energy_savings,
    SUM(id.co2_saved_kg_yr) AS total_co2_saved_kg
  FROM
    intel.impact_data AS id
    INNER JOIN intel.device_data AS dd ON id.device_id
= dd.device_id
  GROUP BY
    id.region,
    dd.device_type
)
SELECT
  dt.region,
  dt.device_type,
  dt.total_devices,
  ROUND(dt.total_energy_savings / dt.total_devices, 2)
AS avg_energy_savings,
  ROUND(
    (dt.total_co2_saved_kg / dt.total_devices) / 1000,
    4
  ) AS avg_CO2_emissions_saved_tons,
  ROUND(
    100.0 * dt.total_energy_savings /
rt.total_energy_savings_region,
    2
  ) AS pct_energy_savings,
  ROUND(
    100.0 * dt.total_co2_saved_kg /
rt.total_co2_saved_region,
    2
  ) AS pct_CO2_reductions
FROM
  device_type_totals dt
  JOIN region_totals rt ON dt.region = rt.region
ORDER BY
  dt.region,
  pct_CO2_reductions DESC;
```

B. Based on the results of your query, analyze the data to answer:

- Which device types in which regions contribute the most energy savings and CO_2 reductions relative to their numbers?
- How can this analysis help Intel prioritize specific device types in certain regions to maximize environmental benefits?

The data reveals that laptops consistently contribute the highest share of energy savings and CO_2 reductions across all regions, even though desktops are also repurposed in significant numbers. In Asia, laptops account for 68.05 percent of total savings, with similar trends observed in Europe at 68.03 percent and North America at 67.90 percent. This indicates that laptops, relative to their numbers, deliver greater environmental benefits per device than desktops. Additionally, regions such as Asia, where electricity generation is more carbon intensive, further increase the CO_2 reduction impact of each repurposed device. Based on this analysis, Intel should focus on repurposing laptops, especially in regions with higher carbon intensity, to maximize energy savings and emissions reductions while using resources most effectively.

C. In addition to focusing on sustainability, imagine Intel needs to optimize for cost-effectiveness in their repurposing program. How might you adjust your query to incorporate cost data (e.g., cost per repurposed device)? What strategies could Intel use to balance sustainability goals with cost constraints?

To incorporate cost data into the analysis, the query could include a cost per device column to calculate the total repurposing cost by device type and region. By also computing metrics such as cost per ton of CO_2 saved or cost per kilowatt-hour of energy saved, Intel could identify which device types and regions offer the most environmental benefit for the lowest investment. To balance sustainability goals with cost constraints, Intel could prioritize repurposing mid-range laptops in regions with higher carbon intensity, as these devices tend to deliver strong environmental returns while likely being more affordable to refurbish than older hardware. Using cost-effectiveness ratios alongside environmental metrics would help Intel make more informed and efficient decisions.