Project | Sustainability Impact Analysis for Intel

INTRODUCTION: As you learned listening in on the strategy meeting with Dr. Alvarez and Intel's Sustainability Team, Intel is committed to reducing its carbon footprint and improving the sustainability of its devices – not just during manufacturing, but throughout the entire lifecycle.

A key part of this effort is their repurposing programs, which play a central role in achieving these sustainability goals. Repurposing and recycling programs aim to reduce e-waste, energy consumption, and CO_2 emissions by extending the life of existing devices, and thus reducing the need for new device manufacturing. Like Michael Campbell said: the average household in the US has anywhere from 3–5 PCs devices, tablets, notebooks, desktops that are perfectly functional, but not being used!

One challenge Intel faces is determining which devices in its repurposing program should be prioritized for the maximum environmental benefit. That's where data analysis comes in! To help with this, Intel gathered data on each device repurposed or recycled in 2024.

Your task is to evaluate the effectiveness of Intel's current repurposing strategy and provide a data-driven recommendation to help guide the program's direction and optimize sustainability efforts.

HOW IT WORKS: Follow the prompts in the questions below to investigate the data. Post your answers in the provided boxes: the **yellow boxes** for the queries you write and **blue boxes** for your text-based analysis. Once you're done, you'll submit your ***completed*** .pdf file to HQ for feedback from The Accelerator Team.

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

NOTE: The dataset you are working with is designed for The Global Career Accelerator to reflect the key characteristics and structure of Intel's real data, while protecting their confidentiality and proprietary information. Be aware that any conclusions or results derived from this dataset should be viewed as hypothetical and for illustrative purposes only.

— Data Set **Descriptions**

In this project you'll query 2 different datasets, `intel.device_data` and `intel.impact_data`, that you will join together for your analysis. Here you'll find the data dictionary for each dataset.

`intel.device_data`

- `device_id`: Unique identifier for each repurposed device
- `device_type`: Type of device, values are either "Laptop" or "Desktop"
- `model_year`: The year the device was manufactured (e.g., 2018, 2019, etc.)

`intel.impact_data`

- `impact_id`: Unique identifier for the repurposed device's impact record (e.g., "LP20NA141592")
- `device_id`: Unique identifier linking the impact record to a specific device in the `intel.device_data` table
- `usage_purpose`: The specific purpose for which the device is being repurposed, values are Education & Digital Literacy, Corporate & Enterprise, Government & Public Sector, Environmental Sustainability Programs, and Social Impact & Non-Profit
- `power_consumption`: Power consumption of the device in watts (W) when in use (e.g., 50W, 75W)
- `energy_savings_yr`: Estimated energy savings per device per year when repurposed compared to a new device, measured in kilowatt-hours (kWh)
- `co2_saved_kg_yr`: Estimated CO2 emissions saved per device per year from manufacturing a new device, measured in kilograms (kg).
- `recycling_rate`: The percentage of the device that is recyclable (e.g., 80%, 90%).
- `region`: The geographical region where the device was repurposed, values are "North America", "Europe", and "Asia"

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

We'll start by **joining** the device data with the impact data, allowing for a comprehensive analysis of device types, model years, repurpose regions, and energy savings in one dataset.

A. Simply write a query that returns all of the columns from both tables, joining the two on the `device_id` column. Be sure to choose the appropriate join so that all relevant data is included in your result. **Note:** your query will have more than 150,000 rows (the max display for SQLPad!)

(paste your query below 👇)

```
SELECT
  *
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
```

B. To your joined dataset, add a new column called `device_age` calculated by subtracting the model_year from 2024. Paste your query below and double check that the values in your new column make sense. For example, a 2019 device should be 5 years old.

(paste your query below 👇)

```
SELECT
  *,
  2024 - d.model_year AS device_age
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
```

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?

(write your **answer** below 👇)

There are more older devices (5+ years) being repurposed compared to newer ones. This indicates that Intel's repurposing strategy focuses on extending the life of devices that are reaching or have surpassed their typical corporate lifecycle. Repurposing older devices likely offers higher environmental impact by avoiding the need to manufacture a replacement while still ensuring the devices are functional for less intensive tasks.

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:

- `WHEN` the `device_age` is less than or equal to 3, `device_age_bucket` should be "newer"
- `WHEN` the `device_age` is greater than 3 but less than or equal to 6, `device_age_bucket` should be "mid-age"
- `WHEN` the `device_age` is greater than 6, `device_age_bucket` should be "older"

HINT: Instead of using e.g. `device_age <= 3`, you need to reference the calculation directly: `2024 - d.model_year <= 3`.

Double check that the values in your new column make sense! For example, a 2019 device should be characterized as "mid-age".

(paste your query below 👇)

```
SELECT
  *,
  2024 - d.model_year AS device_age,
  CASE
    WHEN 2024 - d.model_year <= 3 THEN 'newer'
    WHEN 2024 - d.model_year <= 6 THEN 'mid-age'
    ELSE 'older'
  END AS device_age_bucket
FROM
```

```
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
```

— **Task 2:** Key Insights

Now it's time to analyze the overall impact of Intel's repurposing program. You will use your final query from **Task 1** together with the `WITH` keyword for the remainder of this Project as you aggregate and analyze the data you've organized and prepped. For a refresher, rewatch " 🍿 The `WITH` Keyword" in SkillBuilder 6.

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

HINT: The dataset **is** representing all devices repurposed in 2024! You just need to COUNT all the rows in your joined data from Task 1!

(write your **answer** below 👇)

There were 601740 devices that were repurposed in 2024 by Intel.

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.

Note: CO_2 emissions are typically measured in tons. Since `CO₂_saved_kg_yr` is measured in kg, divide the `SUM(CO₂_saved_kg_yr)` by 1000 to report the total CO_2 emissions saved in tons.

(paste your query below 👇)

```
WITH joined_data AS (
  SELECT
    d.device_id,
    d.device_type,
    d.model_year,
```

```
    2024 - d.model_year AS device_age,
    i.energy_savings_yr,
    i.co2_saved_kg_yr
  FROM
    intel.device_data d
    JOIN intel.impact_data i ON d.device_id =
i.device_id
)
SELECT
  COUNT(*) AS total_devices,
  ROUND(AVG(device_age), 2) AS avg_device_age,
  ROUND(AVG(energy_savings_yr), 2) AS
avg_energy_savings_kwh,
  ROUND(SUM(co2_saved_kg_yr) / 1000, 2) AS
total_co2_saved_tons
FROM
  joined_data
```

C. Now that you have calculated the average estimated energy savings (kWh) and CO_2 emissions saved (tons), use ChatGPT to help put these numbers into perspective.

> **Try this prompt:** I found that each repurposed device saves approximately of XXX kWh of energy per year and Intel's repurposing program saved XXX tons of CO_2 emissions in one year. Help me understand the significance of these numbers. How would this compare to the energy consumption of a small city or the amount of CO_2 produced by cars? What is the environmental impact of these savings?

What comparisons did you find most impactful in terms of scale? Summarize how much energy and CO_2 emissions were saved and how it compares to something familiar, like powering households or reducing car emissions.

(write your **answer** below 👇)

Intel's device repurposing program in 2024 resulted in significant environmental benefits. With over 601,000 devices repurposed, the program saved an estimated 15.5 million kilowatt-hours (kWh) of energy—enough to power more than 1,400 U.S. households for an entire year. Additionally, it prevented approximately 6,768 tons of CO_2 emissions, which is comparable to removing nearly 1,500 gasoline-powered cars from the road. These figures underscore the powerful environmental impact of extending device lifecycles, reinforcing the value of Intel's sustainability efforts through thoughtful repurposing.

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

By grouping our data in different ways, we can uncover patterns in energy savings and CO_2 reductions. These insights will help us determine which categories of devices contribute the most to sustainability efforts and where Intel should focus its repurposing strategy for maximum impact.

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.

Note (again): You'll need to divide `AVG(CO₂_saved_kg_yr)` by 1000 to report the average CO_2 emissions saved in tons.

(paste your query below 👇)

```
SELECT
  d.device_type,
  COUNT(*) 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_saved_tons
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
```

```
GROUP BY
  d.device_type
```

B. Based on the results, which device type contributes the most to energy savings and CO_2 reduction? Why might that be the case?

Hint: Don't forget you can use ChatGPT as your Teammate to help think through your response!

(write your **answer** below 👇)

Laptops contribute the most to both total energy savings and CO_2 reduction. This is primarily due to their significantly higher volume in the repurposing program with 408,064 laptops compared to 193,676 desktops. While the per-device differences are small with laptops averaging around 25.80 kWh of energy savings and 0.0113 tons of CO_2 reduction vs. 25.62 kWh and 0.0112 tons for desktops, the cumulative effect is much greater for laptops. This likely reflects their greater portability, higher demand for reuse, and inherently lower energy consumption, making them more suitable for energy-efficient repurposing at scale.

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`.

(paste your query below 👇)

```
SELECT
  CASE
    WHEN 2024 - d.model_year <= 3 THEN 'newer'
    WHEN 2024 - d.model_year <= 6 THEN 'mid-age'
    ELSE 'older'
```

```
  END AS device_age_bucket,
  COUNT(*) 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_saved_tons
FROM intel.device_data d
JOIN intel.impact_data i ON d.device_id = i.device_id
GROUP BY device_age_bucket
```

D. Based on the result of your query, what do you notice about the relationship between device age and the number of devices repurposed versus the average energy saved?

(write your **answer** below 👇)

The data reveals a clear trend: older devices save significantly more energy and CO_2 per device, but fewer of them are being repurposed. Older devices (7+ years old) have the highest average energy savings at 48.02 kWh and 0.0210 tons of CO_2, but only 20,239 of them were repurposed. Mid-age devices (4–6 years old) offer a moderate balance, with 32.04 kWh energy savings and 0.0140 tons of CO_2 per device, and a larger count of 264,310 units repurposed. Newer devices (0–3 years old) were repurposed the most (317,191 units), but they yield the lowest energy savings at 19.07 kWh and 0.0083 tons of CO_2 per device. This suggests a tradeoff between volume and impact — Intel is repurposing more newer devices, but repurposing older devices results in greater environmental benefit per unit.

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.

(paste your query below 👇)

```
SELECT
    i.region,
    COUNT(*) 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_saved_tons
FROM
     intel.device_data d
    JOIN intel.impact_data i ON d.device_id = i.device_id
GROUP BY
     i.region
```

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?

(write your **answer** below 👇)

The carbon intensity of electricity has a noticeable impact on the CO_2 savings from repurposed devices across regions.Based on the data, Asia shows the highest average CO_2 savings per device at 0.0155 tons, despite having a similar average energy savings (~25.79 kWh) compared to other regions. North America comes next with 0.0103 tons of CO_2 saved per device.Europe, despite similar energy savings (~25.75 kWh), has the lowest average CO_2 savings at just 0.0064 tons. This shows that repurposing in regions with more carbon-intensive electricity grids yields higher environmental benefits in terms of CO_2 reduction. Europe likely benefits from cleaner energy sources, such as renewables and nuclear, resulting in lower CO_2 emissions to begin with — and therefore less CO_2 saved per device when repurposed. Repurposing devices in regions with dirtier energy grids can lead to greater CO_2 reductions per device. Intel can leverage this insight by prioritizing repurposing programs in higher carbon-intensity regions to maximize environmental impact.

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

Using the findings from this analysis, we need to summarize key takeaways and develop actionable recommendations for Intel. Remember: 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. These should be specific, concise, and focused on the implications of repurposing newer versus older devices.

(write your **answer** below 👇)

Four Key Takeaways:

- Mid-age devices (those between 4 and 6 years old) are the most commonly repurposed and strike an effective balance between volume and environmental benefit, with solid average energy savings of 32.04 kWh and CO_2 reductions of 0.0140 tons per device.

- Older devices, those over 6 years old, produce the highest average energy savings (48.02 kWh) and CO_2 reductions (0.0210 tons) per device, yet they make up the smallest portion of repurposed devices.

- Newer devices, which are less than 3 years old, are repurposed most frequently but contribute the least environmental benefit, with the lowest average energy savings (19.07 kWh) and CO_2 reduction (0.0083 tons) per device.

- Devices repurposed in Asia lead to significantly higher CO_2 savings compared to Europe and North America, due to the region's higher carbon intensity in electricity generation, despite similar energy savings across all regions.

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.

(write your **answer** below 👇)

To maximize environmental benefits, Intel should prioritize repurposing mid-age and older devices, as these provide the greatest average energy savings and CO_2 reductions per unit. Although newer devices are repurposed more frequently, the data shows they yield lower sustainability impact per device. Additionally, Intel should focus repurposing efforts in regions like Asia, where the carbon intensity of electricity is higher, thereby amplifying the CO_2 reduction benefits of each repurposed device. By strategically targeting both device age and geographic location, Intel can enhance the effectiveness of its repurposing program and achieve greater overall energy and emissions savings.

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?

(write your **answer** below 👇)

ChatGPT helped me identify the importance of carbon intensity differences across regions, which deepened my understanding of how location affects environmental impact. It also encouraged me to focus on average energy and emissions savings per device, rather than just total volume, which shifted my recommendation toward maximizing impact instead of quantity. These insights made my recommendation more strategic and data-driven, highlighting the importance of both what devices are repurposed and where the repurposing takes place.

– **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.

HINT: To calculate the percentage of the total energy savings, use this formula:
Total energy savings for the device type / Total energy savings for the region) * 100
You'll use a similar one for the percentage of the total CO_2 reductions.

Try this prompt: What's the best way to calculate the percentage of CO_2 reductions contributed by each device type in each region?

(paste your query below 👇)

```
WITH regional_totals AS (
  SELECT
    i.region,
    SUM(i.energy_savings_yr) AS
total_energy_savings_region,
    SUM(i.co2_saved_kg_yr) AS total_co2_saved_region
  FROM
    intel.device_data d
    JOIN intel.impact_data i ON d.device_id =
i.device_id
  GROUP BY i.region
)
```

```
SELECT
  i.region,
  d.device_type,
  COUNT(*) 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_saved_tons,
  ROUND(SUM(i.energy_savings_yr) /
r.total_energy_savings_region * 100, 2) AS
pct_of_region_energy_savings,
  ROUND(SUM(i.co2_saved_kg_yr) /
r.total_co2_saved_region * 100, 2) AS
pct_of_region_co2_savings
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
  JOIN regional_totals r ON i.region = r.region
GROUP BY
  i.region, d.device_type,
r.total_energy_savings_region, r.total_co2_saved_region
ORDER BY
  i.region, pct_of_region_co2_savings 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?

(write your **answer** below 👇)

Laptops contribute the most energy savings and CO_2 reductions across all regions. In Asia, Europe, and North America, laptops consistently account for approximately 68% of both the total energy savings and CO_2 reductions in their respective regions, even though they are not the only device type being repurposed. Desktops, while fewer in number, still provide a substantial share of impact. Desktops contribute roughly 32% of the energy and CO_2 savings in each region, indicating that although they are repurposed in lower quantities, their environmental impact per device is still significant and fairly close to that of laptops. Asia shows the highest per-device CO_2 savings.
Both laptops and desktops in Asia yield significantly higher CO_2 savings per device (0.0155 and 0.0154 tons respectively) compared to the same device types in Europe (0.0065 and 0.0064 tons) and North America (0.0103 and 0.0102 tons). This is likely due to the higher carbon intensity of electricity in Asia, which makes energy savings more impactful in terms of CO_2 reduction. Relative contributions are consistent, but regional carbon intensity makes a difference. While the percentage contributions by device type are similar across all regions (approx. 68% laptops, 32% desktops), the actual environmental benefits vary. Repurposing devices in high-carbon-intensity regions like Asia results in greater CO_2 reductions per unit energy saved. This analysis can help Intel strategically focus its repurposing efforts by prioritizing repurposing laptops in all regions, since they consistently deliver the majority of the environmental benefits, focusing even more on Asia for both laptops and desktops, as devices there yield the highest CO_2 reductions per unit due to the region's more carbon-intensive electricity, and in regions with cleaner energy, emphasize repurposing larger volumes of devices to maximize energy savings, even if CO_2 reductions are less dramatic. By targeting device types with high impact in regions where energy savings translate to greater CO_2 reductions, Intel can maximize its sustainability outcomes more 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?

(write your **answer** below 👇)

To optimize its repurposing program for both sustainability and cost-effectiveness, Intel can enhance its analysis by incorporating the repurposing_cost_usd column from the intel.device_data table to calculate key efficiency metrics such as energy savings per dollar and CO_2 reductions per dollar. This allows Intel to identify high-impact, low-cost combinations by pinpointing the device types and regions that deliver the most environmental benefit per dollar spent. Based on these metrics, Intel can create a tiered repurposing priority system—Tier 1 for high impact and low cost, Tier 2 for moderate impact or cost, and Tier 3 for low impact or high cost—to guide strategic decisions and resource allocation. Additionally, economies of scale should be considered by focusing on regions and device types where bulk repurposing is logistically feasible, even if individual returns are slightly lower, since overall cost-effectiveness may improve through volume. Factoring in the expected lifespan and usability of devices is also critical, particularly for older devices that may offer high environmental benefits but reduced longevity; integrating this into ROI metrics like CO_2 saved per dollar per year of use would support more sustainable planning. Finally, Intel could enhance the cost-efficiency and societal impact of its program by pursuing donation or resale strategies, especially in educational or underserved markets, which could generate tax benefits and improve brand reputation while still advancing environmental goals.