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 AS d
INNER JOIN intel.impact_data AS 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 AS d
LEFT JOIN intel.impact_data AS 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 👇)

The majority of repurposed devices in 2024 were newer than 5 years old, with 437,017 devices under 5 years old compared to 164,723 devices aged 5 years or older.

This suggests that Intel's repurposing program is focusing more on recent devices, maybe because these are still in good working

condition and offer better performance for secondary use. However, the significantly lower number of older devices being repurposed may indicate that many older machines are either too outdated for reuse or are being recycled instead (which could represent a missed opportunity to extend their life where possible).

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 AS d
LEFT JOIN intel.impact_data AS 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 👇)

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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 👇)

```
SELECT
  COUNT(*) AS total_devices,
  AVG(2024 - d.model_year) AS avg_device_age,
  AVG(i.energy_savings_yr) AS avg_energy_savings_kwh,
  SUM(i.co2_saved_kg_yr) / 1000 AS total_co2_saved_tons
FROM intel.device_data AS d
```

```
LEFT JOIN intel.impact_data AS i
  ON d.device_id = i.device_id
```

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 repurposing program saved an estimated 15.49 million kilowatt-hours (kWh) of electricity in 2024. Since each repurposed device saved about 25.74 kWh per year, and Intel repurposed 601,740 devices (25.74 × 601,740). This is enough to power around 1,447 average U.S. homes for a full year (because one home uses about 10,700 kWh per year).
On the emissions side, Intel avoided approximately 6,768 tons of CO_2. That means the program's environmental impact is similar to removing nearly 1,500 cars from the road for a year (6,768 ÷ 4.6)
These outcomes show the the great environmental impact of extending device lifecycles through repurposing, especially in reducing both electricity consumption and greenhouse gas emissions

— **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,
  AVG(i.energy_savings_yr) AS avg_energy_savings_kwh,
  AVG(i.co2_saved_kg_yr) / 1000 AS avg_co2_saved_tons
FROM intel.device_data AS d
LEFT JOIN intel.impact_data AS 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 more to both energy savings and CO_2 reductions overall, due to the significantly higher number of devices repurposed (408,064 laptops versus 193,676 desktops). While the average energy and emissions savings per device are quite similar between desktops

and laptops, the volume of laptops in the program nearly doubles that of desktops. This results in a much greater total environmental impact from laptops.

This could be because laptops are more widely used in both corporate and consumer environments, have shorter upgrade cycles, and are more portable, which makes them more likely to be collected and reused efficiently.

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,
  AVG(i.energy_savings_yr) AS avg_energy_savings_kwh,
  AVG(i.co2_saved_kg_yr) / 1000 AS avg_co2_saved_tons
FROM intel.device_data AS d
LEFT JOIN intel.impact_data AS 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 👇)

Older devices offer the highest energy and CO_2 savings per unit, averaging 48.02 kilowatt-hours and 0.021 tons of CO_2. However, they represent a small portion of the total devices repurposed. Most repurposed devices are newer, but they save less energy per unit (only 19.07 kilowatt hours on average). Mid-age devices provide a good balance between quantity and environmental impact.

This suggests that while older devices are more impactful individually, Intel's repurposing strategy currently favors newer devices, likely due to better usability or longer remaining lifespan.

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,
  AVG(i.energy_savings_yr) AS avg_energy_savings_kwh,
  AVG(i.co2_saved_kg_yr) / 1000 AS avg_co2_saved_tons
FROM intel.device_data AS d
LEFT JOIN intel.impact_data AS 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 👇)

Although energy savings per device are similar across all regions, the average CO_2 savings differ significantly. Devices repurposed in Asia show the highest CO_2 reduction per unit at 0.01547 tons, followed by

North America at 0.01028 tons. Europe shows the lowest at 0.00644 tons. This difference reflects the carbon intensity of electricity generation in each region. Countries with more fossil fuel based power grids, like parts of Asia, produce more CO_2 per kilowatt hour. As a result, repurposing a device in those regions offsets more emissions compared to regions like Europe, where electricity tends to be cleaner.

— **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 👇)

The repurposed devices are mostly less than 5 years old, but older devices conserve an amount of energy and emissions per unit much more.

Newer products are preferred in large numbers, and have the lowest environmental impact per unit.

Asia demonstrates the greatest amount of CO2 etalon per-device savings since it has a more carbon-intensive electrical grid.

Laptops contribute the most overall savings because they make up the majority of repurposed devices.

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 👇)

> Intel should expand efforts to repurpose more mid age and older devices, especially in high-carbon regions like Asia, where the environmental payoff per unit is highest. While newer devices dominate in quantity, older ones deliver far greater energy and CO_2 savings per device.
> By targeting devices aged 5 years and older for repurposing (especially Asia), Intel could significantly increase total emissions avoided without needing to scale up the overall program size. A targeted approach combining age and location would optimize environmental impact while making better use of existing resources.

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 allowed me to bridge the gap between the data trends and viable strategies that I had not thought of in the first place. As an example, it highlighted the fact that carbon intensity varies across regions and that refurbishment in Asia may be more environmentally friendly. Plus, it allowed me to find the tradeoff between age of devices and number of devices, explaining that prioritising on older devices would be more valuable on a per basis. All these facts assisted me in crafting a more specific and statistics based recommendation.

— **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 region_totals AS (
  SELECT
    i.region,
    SUM(i.energy_savings_yr) AS region_total_energy,
    SUM(i.co2_saved_kg_yr) AS region_total_co2
  FROM intel.device_data AS d
  LEFT JOIN intel.impact_data AS i
    ON d.device_id = i.device_id
  GROUP BY i.region
)

SELECT
  i.region,
  d.device_type,
```

```
  COUNT(*) AS total_devices,
  SUM(i.energy_savings_yr) AS total_energy_kwh,
  SUM(i.co2_saved_kg_yr) / 1000 AS total_co2_tons,
  ROUND((SUM(i.energy_savings_yr) /
rt.region_total_energy) * 100, 2) AS pct_region_energy,
  ROUND((SUM(i.co2_saved_kg_yr) / rt.region_total_co2)
* 100, 2) AS pct_region_co2
FROM intel.device_data AS d
LEFT JOIN intel.impact_data AS i
  ON d.device_id = i.device_id
JOIN region_totals AS rt
  ON i.region = rt.region
GROUP BY i.region, d.device_type,
rt.region_total_energy, rt.region_total_co2
```

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 majority of energy and CO_2 savings in every region, accounting for about 68 percent of each region's total impact. This reflects both their higher volume and strong efficiency.

This suggests that Intel should prioritize repurposing laptops, especially in regions with more carbon intensive electricity like Asia. By focusing on high impact device types in high impact regions, Intel can maximize sustainability outcomes more efficiently.

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 add cost-effectiveness, I would add additional column of cost_per_device into the query and compute such metrics as number of CO_2 saved per dollar & number of energy saved per dollar. This would enable Intel to make comparisons of which device or region as to which gives the most impact in relation to the cost per unit.

Intel would then be able to focus on priority devices and places that give greater environmental returns on investment. (ex: assume that laptops in Asia come at good emissions reductions relatively at low costs of repurposing => then laptops in Asia will be prioritized). Intel can also spell minimal effects levels per dollar to make the use of its resources efficient while noting the objectives of its sustainability targets.

— Evaluation Rubric

Unlike your Milestones that were evaluated largely based on your effort, the evaluation of your Portfolio Project will follow traditional evaluation methods, with tasks assessed for correctness and assigned point values accordingly.

Partial credit will be given where parts of this task are correct, even if other parts are incorrect or incomplete.

Task title	Max points
Task 1: Organizing and Understanding the Data	40
Task 2: Key Insights	25
Task 3: Identifying Trends & Maximizing Sustainability	60
Task 4: Data-Driven Recommendations	75

TOTAL POINTS:	200
LevelUp	
Optimizing Repurposing Strategy for Maximum Impact	20