Data Center Heat Reuse in the Food & Beverage Sector:

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**Business Case Analysis**

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# Summary

This report features the business case analysis of the DGA Heat Reuse Project for Microsoft Inc. The project in question focuses on heat reuse scenarios for Microsoft data centers, with Food and Beverage (F&B) facilities as recipients (“offtakers”) of the heat energy.

The report discusses a proposition for a **technical setup** for this heat energy reclamation, discussing piping, heat pumps, and heat exchangers for 30°C and 65°C scenarios. The design intent has been to create a closed-loop thermal system with piping, and (at the offtaker side) heat pumps and heat exchangers, where water circulates through each stage with strict temperature constraints and flow balance.

The report also introduces five real-world **use cases**, partly based on identified potential offtakers in the project’s Proximity Analysis sub-project. In this report, the use cases serve as templates rather than concrete recommendations, but unless they already employ heat reuse to handle their thermal demand, they can also be regarded potential candidates for Microsoft’s heat reuse projects.

Main takeaways from the report:

* The **thermal energy needs** of most large F&B industries seem to top out at 8-10 MW. Hence, this is the power range that Microsoft can hope to address and that the analysis focuses on. Though this figure is low in comparison to many of Microsoft’s data centers’ heat reuse capabilities, there are creative ways to increase heat reuse, as shown last in this report.
* **CAPEX** for the outlined system hovers around 9 million euros (not counting the heat exchange room of the data center). The main cost driver is the heat pumps. Where there is secondary use for warm water (washing etc.), and a second heat pump avoidable, CAPEX is considerably lower.
* In relative terms, **piping and trenching** seem surprisingly affordable, and the heat loss over distance manageable. As an illustration, the report includes one 15 km and one 30 km scenario.
* The **payback periods** for most of the template projects vary considerably, but with favorable pricing, they should range from 2-5 years. The actual payback period is dependent on the technical setup and the many possible uses for thermal energy at an F&B facility, but even more so on financial aspects such as local pricing for electricity, natural gas and avoided carbon tax, and the possibility of other subsidies. It is therefore important to understand that the calculations can only be viewed as indicators.
* The trend in Europe is a **move away from natural gas, and towards renewable or industrial thermal energy**. Of special interest to this analysis is the trend of increasing gas prices (see Appendix). This is in line with the intent of the EU ETS scheme, and with the EU’s climate ambitions overall.
* For the offtaker, **heat pumps win over gas boilers across all five use cases on OPEX alone**, despite higher electricity prices. The efficiency advantage (COP) of heat pumps is the game-changer: one gets three times the heat output per unit of electricity. Carbon pricing further heavily penalizes gas boilers, especially in the Nordics.
* As the **use cases** show, the possibility to heat an F&B facility is both real and substantial. It is impossible to know what of the facility’s existing infrastructure (such as heat pumps) can be used in these scenarios. Neither are the actual heat demands known, nor the facility’s financials today (energy pricing, exact subsidies in place, etc.). It is therefore not possible to definitely judge the business case performance for the cases. The only way to move forward would be to contact the companies in question. That being the case, the BCA shows that **there are clear possibilities for F&B industries to serve as partial offtakers of Microsoft’s heat offerings, across Europe.**

# The Technical System

To find the cost structure and the resulting cost for a closed-loop heat reuse (HR) system, there are three parts to consider:

* Heat exchange room of the data center (DC)
* Piping to and from offtaker (receiver of the heat energy)
* Offtaker’s heat pump (or similar arrangement)

Underpinning the estimates for these three parts are the energy offerings and demands. In this specific case, there is also the wish to remove heat from the system’s working fluid (water). The offerings and demands are as follows:

* Energy load available: 1-20 MW (depending on offtaker’s needs)
* Fluid type: Water
* Temperature at which the fluid leaves the data center: 30°C
* Temperature at which the fluid should return: 18°C or lower

The heat exchange room is part of the Microsoft premises, and will not really be affected by these calculations or use cases. For the European market, it is expected that heat reuse will be required. Hence, the data center heat exchange room is not the major point of the BCA, but it is included here for reference. The technical report emphasizes the remaining two parts – piping and offtaker system.

According to our observations, the offtakers’ thermal energy needs in the F&B sector top out at 8-10 MW. Hence, the cases in this report all use 8 MW (smaller facilities are not of interest to Microsoft, having substantially higher heat reuse ability). To obtain 8 MW thermal power with heat pumps, it is assumed that

* 2.4 MW electricity is added to
* 5.6 MW of supplied heat from the data center, to achieve a
* heat pump COP (Coefficient of Performance) of 3.3.

A COP of 3.3, in turn, is realistic for an industrial heat pump. With 24/7 production at the offtaker’s, the annual electricity consumption from the heat pump is 2.4 MW × 8,760 h = 21,024 MWh.

## The Heat Exchange Room

There are several reasons why a large-scale data center building should employ heat reuse.

For environmental reasons:

* Thermal pollution: Releasing large amounts of heat into the atmosphere raises local air temperatures, especially in urban or enclosed areas.
* Microclimate disruption: Can contribute to urban heat island effects, worsening air quality and increasing cooling demands nearby.
* No energy recovery: Throwing away a valuable resource that could be reused for many processes.

To adhere to regulatory and permitting challenges:

* Many municipalities (especially in Europe) restrict uncontrolled heat emissions, especially from fossil-fueled systems.
* Special permits may be needed for high-temperature exhaust stacks, noise levels, and emissions – even if it's “just heat”.

In addition, public perception and ESG point to heat reuse. In today’s climate-conscious world, emitting waste heat without reuse is seen as irresponsible, and undermines Microsoft’s sustainability goals.

With regards to the cooling system specifically, there are two more reasons:

* A gas engine typically has 40–45% electrical efficiency, meaning 55–60% becomes heat loss, on top of the heat lost through not employing heat reuse in the first place.
* Big cooling towers would be needed, consuming electricity, requiring space, needing maintenance and still carrying a substantial cost burden.

The estimates below may or may not be applicable to the client’s buildings. Still, it would be easy enough to alter the calculations to better reflect real-world scenarios.

The table below compares a heat rejection system with a system designed for heat reuse. The third column shows the difference, where a heat exchange room is built *instead of* a cooling system.

Table 1. CAPEX and OPEX heat exchange room comparison.

|  |  |  |  |
| --- | --- | --- | --- |
| Attribute | Heat Reuse Case | Heat Rejection Case | Savings |
| CAPEX | € 792.000 | € 10.450.000 | € 9.658.000 |
| OPEX | € 220.000/yr | € 3.170.000/yr | € 1.2-3.0M/yr |

Much more detail is found in the associated spreadsheet calculations.

Regarding the heat exchanger in the data center, there is the choice between using one or two units. For the financial analysis, what to choose does not matter much; it is rather a question of what serves the data center better. The table below compares the two setups.

Table 2. Heat exchanger setup comparison.

|  |  |  |
| --- | --- | --- |
| Feature | One Heat Exchanger | Two Heat Exchangers (Split Load) |
| Redundancy | None: full system down if unit fails | High: one unit can operate if the other fails |
| Maintenance | Requires full shutdown for servicing | Can service one while the other runs |
| Initial Cost | Lower due to fewer components | Slightly higher due to duplicate frames/piping |
| Operational Flexibility | Limited: always runs at full capacity | High: can run one or both depending on load |
| Space Requirements | Compact footprint | May need more space or clever layout |
| Pressure Drop | Higher due to full flow through one unit | Lower as flow is split between two units |
| Control Complexity | Simple because of single flow path | More complex: needs balancing and valves |
| Scalability | Harder to expand without full replacement | Easy: add/remove units as needed |
| Thermal Efficiency | Good if well-sized | Potentially better with optimized flow split |
| Startup Time | Faster: one system to bring online | Slightly longer: two systems to coordinate |

In the choice between a single and dual heat exchanger system, there are merits with both options:

* If designing for reliability, flexibility, or future expansion, the dual setup may be preferred.
* If simplicity and cost are top priorities, a single unit might be the better option.

Investigating promising CAPEX and OPEX financial incentives is complex, and needs further work. For this report, it is suggested that a 30% CAPEX cost reduction would be feasible. In either case, the cost for the heat exchange room is much smaller than the savings from a traditional heat rejection system, so any financial incentives will be smaller than savings from such investments (and power costs for chillers). Regarding OPEX, EU ETS should apply (for a large data center; thermal demand must be at least 20 MW.

The key takeaway regarding CAPEX and OPEX is:

* A heat exchange room is much less expensive than a setup for heat rejection (millions of euros).
* The heat reuse system slashes electricity use by eliminating chillers and cooling towers.
* Water savings are substantial – no evaporation, no municipal draw.
* Maintenance is simpler and cheaper, with fewer compressors, fans, and chemical cycles.
* Over 10 years, the OPEX savings would exceed €10 million, not including carbon credits or ESG benefits.
* Less strain on local electricity and water resources makes for easy approval from municipality.

## Piping

It is often said that in a heat reuse system, it is important to stay close to the offtaker; piping costs and heat losses during transportation of the fluid destroy the business case.

This may be true when air is used as fluid, but not so much when water is employed, due to its high heat capacity. The pipes themselves constitute a small part of the entire system CAPEX, and so do trenching (at least in rural areas with few obstacles) and installation.

In the scenarios in this report, 5.6 MW of water is transported. This is to respond to the F&B facilities’ needs for heat energy (see the Cases section). To carry this heat, 250 mm pipes were chosen, as they would provide reasonable pressure in the closed loop. With proper insulation, the temperature drop in water is insignificant over reasonable lengths (much less than 1°C over 1 km).

### Pipe Material

The choice of pipe material stands between HDPE and stainless steel. In Fifth Generation district heating – which uses water at the same temperatures as in the requirements laid out above – HDPE pipes are utilized, mainly as steel pipes are more expensive. HDPE pipes have an expected lifetime of at least 50 years – more than sufficient for the data center sector. Moreover, from the client’s perspective, steel pipes should be avoided as their carbon footprint would be higher than the carbon footprint of HDPE pipes. Conversations with manufacturers of district heating pipelines confirm this choice.

The table below compares HDPE and steel options.

Table 3. HDPE vs Stainless Steel for Long-Distance Water Transport

|  |  |  |
| --- | --- | --- |
| Attribute | HDPE Pipe | Stainless Steel Pipe |
| Cost | Low | High |
| Installation | Lightweight, flexible | Heavy, rigid |
| Maintenance | Minimal (no corrosion) | Requires monitoring for scaling/corrosion |
| Energy Efficiency | Low friction, less pumping power | Higher friction, more energy needed |
| Durability | Excellent chemical resistance | Excellent mechanical strength |
| Pressure Rating | Up to ~2.5 MPa (PN 25) | Much higher (can exceed 10 MPa) |
| Corrosion Resistance | Excellent (non-metallic) | Excellent, but scaling can occur |

The bottom line is that for up to 30 km of consistent flow, HDPE is more energy-efficient, easier to install, and significantly cheaper.

### Chosen Pipe Types

The pipe (from PipeLife) used in these calculations have the following characteristics:

Table 4. Characteristics of chosen pipe.

|  |  |
| --- | --- |
| Parameter | Value |
| Type | HDPE Pipe (250 mm outer diameter) |
| SDR Rating | SDR 11 or SDR 17 (depending on pressure needs) |
| Pipe type | Pre-insulated HDPE, buried |

For the return pipe, no insulation is needed. In fact, **omitting insulation lowers the temperature of the return water, in turn decreasing cooling costs at the data center**. The cost per meter is low: circa €120 for an insulated pipe (forward), and €45 for an uninsulated pipe (return).

Installation, trenching and auxiliary parts are highly variable (trenching especially). In the scenarios, these have been set to €100 per meter. Project management and other costs have been added to the calculations, without affecting the overall CAPEX much.

### Trenching

Trenching (burying of pipes) costs vary over Europe, due to differences in soil conditions as well as labor costs.

Another factor to consider is existing infrastructure in densely populated areas: It can be assumed that trenching close to major cities (i.e. FLAP-D) is much more difficult and costlier than in rural areas.

With fewer obstacles between the data center and the offtaker in rural areas, it is also reasonable to assume that building permission is easier to obtain there than within city limits.

### Piping Conclusion

Estimating piping costs is difficult, in large part due to trenching and installation costs. To illustrate, the Swedish organization for district heating argues the total cost for their piping (which is about twice as high as for this case, due to larger water volumes) can differ from 200 and 1200 euros per meter[[1]](#footnote-1).

Again, working in a rural position is much less expensive and much more feasible than doing groundwork within a city.

## Offtaker Heating Scenario

The proposed system is designed to recover heat from the industrial process and reuse it via heat pumps. Coupled with use of residual heat at different temperatures, this is a relatively straightforward way to make use of nearly all available heat energy from the data center.

### System Architecture

Two heat pumps lift water temperature to 80°C, and repeated uses of the water cools it down. Below is an overview of the system.



Figure 1. Heat Reuse flow diagram.

The temperature streams, and the volumes moved in the system, are also depicted in the following table.

Table 5. Temperatures and volumes of streams in system.

|  |  |  |
| --- | --- | --- |
| Stream | Temp (°C) | Notes |
| DC → Heat pump A | 29 | Cool water from data center |
| Heat pump A → Heat pump B | 51.5 | Heated water goes to cascaded heat pump |
| Heat pump B → Storage tank | 80 | Heated stream stored in buffer |
| Storage tank → HX Ind. process | 80 | Delivered to industrial process |
| HX Ind. process → HX 2 | 62 | Residual heat after process |
| HX 2 → HX 3 | 44 | Residual heat after process |
| HX 3 → HX/Chiller | 26 | Residual heat after second process |
| HX/Chiller → DC | 18 | Cooled stream returned to data center |

The overarching idea behind the configuration is this:

1. To reach 80°C from 29°C, two (cascading) heat pumps are required. The average temperature lift of approximately 25 degrees per heat pump is ideal.
2. Taking away residual heat cools the remaining water. However, only so much energy can be transferred through one process via heat exchangers. Through several consecutive processes, as much heat energy as possible is reclaimed.

The table below shows one example of how this could work in practice. In this case, the processes would be for a dairy.

Table 6. Thermal cascade breakdown for a dairy.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stage | Temp (°C) | ΔT | MW used | Notes | Stage |
| Pasteurization | 80 → 62 | 18 | 2.29 | High-grade heat | Pasteurization |
| Washing | 62 → 45 | 17 | 2.16 | Mid-grade heat | Washing |
| Cleaning | 45 → 25 | 20 | 2.54 | Low-grade heat | Cleaning |
| Final rinse | 25 → ~20 | ~5 | 1.01 | Pre-chiller cooling | Final rinse |
| Total | **80 → ~20** | **60** | **8** | **Matches thermal input** | **Total** |

### System Components

Here is a brief overview of the system components for the F&B facility.

#### Heat Pump A

This heat pump lifts the water temperature to 51.5°C, a sweet spot for optimization of COPs of the heat pumps (see chart below).

#### Heat Pump B

The second heat pump lifts the water temperature to the desired goal of 80°C. At the higher temperature and with a modest delta-T, it is efficient at lifting the temperature coming from the data center to the industrial process. As a total, the cascaded heat pumps deliver heat at a COP of approximately 3.

Table 7. Heat pump data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Heat Pump | Temp Lift (°C) | Heat Output (MW) | Electrical Input (MW) | Source Heat Input (MW) | COP |
| HP A | 29 → 51.5 | ~6.55 | ~1.21 | ~5.34 | ~5.4 |
| HP B | 51.5 → 80 | 8 | ~1.49 | (~6.51) | ~5.4 |
| Total | **51** | **8** | **2.7** | **~5.34** | **2.95** |

#### Storage Tank

A thermal storage tank is added, between the Heat Pump and the first heat exchanger, to store water at 80°C, the highest temperature in the system. The tank allows uninterrupted supply to the industrial process if the heat pump pauses. It further decouples the heat pump operation from immediate demand, enabling smarter control. As a result, the storage tank improves system resilience and smooths out temperature fluctuations – at a relatively low cost.

#### Heat Exchangers

The system features several heat exchangers, to deliver heat to the various industrial processes. Exactly how many heat exchangers will be needed, and at what temperature ranges they operate, will depend on the use case. In the schematics, it is assumed that every heat exchanger lowers the residual heat by 18°C. While that number is realistic, it will ultimately be case-specific as well.

#### Chiller

The system might need a chiller to obtain the desired 18°C. It is a low-cost add-on, and OPEX for the chiller is negligible compared to the electrical input needed for the heat pumps.

### Remarks

In practice, the offtaker would like to see variations in this configuration, depending on their exact needs:

* Perhaps 80°C is not required, but only 75, which would lower energy costs.
* Perhaps the return temperature from the industrial process is higher (pasteurization via heat exchangers would lower the temperature by approximately 18°C -20°C).

In truth, there are many possible uses and configurations for this setup.

Moreover, one may want to consider the use of two 4 MW heat pumps instead of one 8 MW heat pump. This increases heat pump costs by 10-20%, but has several advantages:

* Staged deployment: It is possible to install one unit, then add the second as demand grows – or rather, when it has been determined the system operates as planned.
* Load matching: If not 24/7 operation, one unit can be run during shoulder seasons, and both during peak demand.
* Maintenance resilience and overall redundancy: One unit can stay online while the other is serviced.

It should be noted that the two 8 MW heat pumps in the proposed system offer some redundancy in themselves already (especially with an added storage tank). Moving to four 4 MW heat pumps offers even greater redundancy and stabilization to the system.

## 65 Degree Scenario

With the advent of high-performance compute follows increasingly higher chip and rack densities. This, in turn, leads to much higher temperatures in the server room. Hence, the analysis also uses a 65°C (150 degrees Fahrenheit) scenario. This scenario, in turn, can be varied as well.

### Reuse at 80°C

In this scenario, changes are seen in terms of piping and the offtaker architecture.

Regarding piping, stainless steel may be preferred over HDPE pipes, for endurance. Stainless steel is, however, costlier than HDPE. As shown in a previous table, there are also other factors to consider in the choice between HDPE and steel.

For the Heat Reuse system, several changes are made:

* There is no more a need for a second heat pump, as the temperature from the data center is high.
* Consequently, the whole system becomes leaner and less expensive.
* However, a heat exchanger is added to help regulate and stabilize return temperatures, especially when the direct output from a process fluctuates. Doing so ensures that the return temperature to the data center (or any other system) does not exceed a set limit, even if the industrial process sometimes outputs water at a higher temperature.
* One difference from the 30°C system is the lower temperature lift of the heat pump, only 16°C. The fact that the heat pump operates at higher temperatures makes the system a bit expensive in terms of CAPEX, but also increases COP, resulting in lower OPEX.
* The outgoing temperature is set at 53°C, to comply with the data center’s expected 12°C delta-T. Exactly what that temperature will be depends on how the heat energy is used in the industrial process.

The rest of the system stays the same. The figure below shows the updated flow diagram.

Figure 2. Heat Reuse flow diagram at 65°C.

### Reuse at 64°C

As the temperature is already high enough for many activities in the F&B sector, one possibility is to use the heat as-is, at 65°C (or perhaps at one degree lower, due to temperature losses in piping).

This configuration should be highly profitable as it needs no heat pump whatsoever. Also here, a second heat exchanger and an external cooling loop are needed to avoid fluctuations to the return temperature.

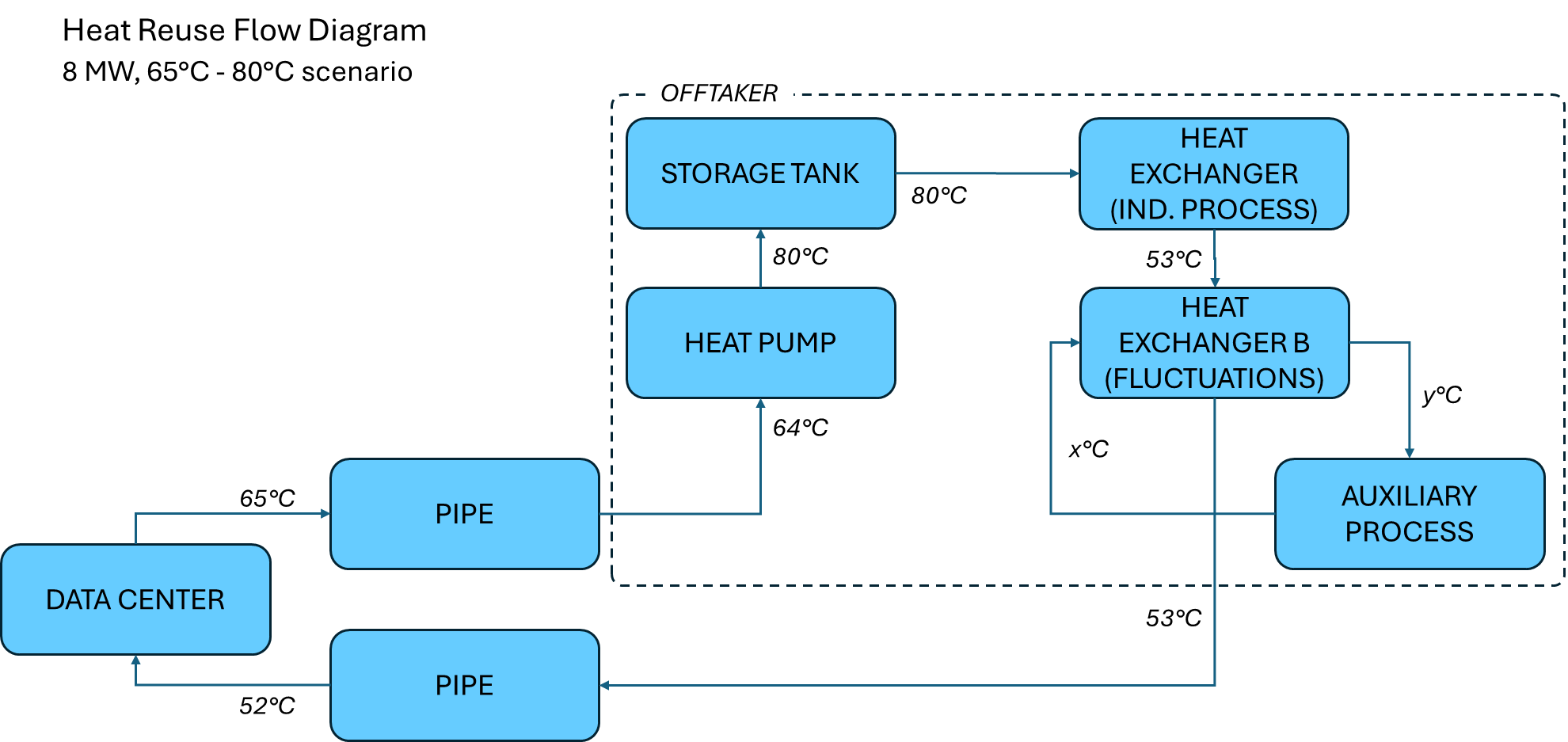


Figure 3. Heat Reuse flow diagram at 64/65°C, without temperature lift.

# Identifying Offtaker Energy Needs

The Proximity Analysis has defined a large number of potential offtakers within 3 kms of the client’s existing DCs. The question remains how to rank these in terms of good matches for the client. This section presents an attempt to do so.

The offtaker table does not contain energy needs per se, as that information is typically not disclosed. Instead, employed personnel are used (this figure is found in the data sets used for the Proximity Analysis). However, personnel intensity is not equally divided between industry categories. Hence, these industry segments required some initial grouping to identify suitable potential offtakers.

Below is a list of the industry segments and their needs for thermal energy, ranked according to heat energy use.

Table 8. Industry segments and their needs for thermal energy.

|  |  |  |  |
| --- | --- | --- | --- |
| Industry | Heat Energy Use Level | Personnel Intensity Level | Observations |
| Manufacture of sugar | Very High | High to Very High | Steam-heavy processes; seasonal labor spikes |
| Production of meat and poultry meat products | Very High | Very High | Cooking and sterilization require both heat and manual handling |
| Distilling, rectifying and blending of spirits | Very High | High | Continuous boiling; skilled labor for safety and quality |
| Operation of dairies and cheese making | High | Very High | Pasteurization and fermentation need heat and skilled oversight |
| Manufacture of starches and starch products | High | Moderate | Steam-intensive but largely automated |
| Manufacture of oils and fats | High | Moderate | Heating for extraction; moderate staffing |
| Manufacture of cocoa, chocolate and sugar confectionery | High | High | Thermal precision and manual decoration |
| Manufacture of beer | High | Moderate to High | Boiling and fermentation; skilled brewing staff |
| Manufacture of bread | Moderate to High | Moderate to High | Baking ovens and manual shaping |
| Manufacture of fresh pastry goods and cakes | Moderate to High | Very High | Baking and decoration are labor-intensive |
| Manufacture of prepared meals and dishes | Moderate to High | High | Diverse cooking and packaging tasks |
| Manufacture of macaroni, noodles, couscous, etc. | Moderate | Moderate | Drying and boiling; packaging may be manual |
| Manufacture of grain mill products | Moderate | Moderate | Drying uses heat; milling is mechanical |
| Manufacture of prepared feeds for farm animals | Moderate | Moderate | Pelleting and drying; less labor than human food |
| Manufacture of food products (general) | Variable | Variable | Depends entirely on product type |
| Manufacture of soft drinks | Low | Low | Mixing and carbonation; highly automated |
| Production of mineral waters and other bottled waters | Very Low | Very Low | Filtration and bottling; minimal heat or labor |

The quadrant below shows the relationship between industry segment and personnel intensity. (For this project, the main segments to investigate would be the ones in the right quadrants, as they have a large use for thermal energy.)

A diagram of food items

AI-generated content may be incorrect.

Figure 4. Quadrant showing the relationship between thermal energy and personnel

When consulting the Proximity Analysis, these were taken into account. Below is a list of the top industries in the Analysis, ordered after Thermal energy needs and then #Employees.

A screenshot of a computer

AI-generated content may be incorrect.

Figure 5. Some industries identified in the Proximity Analysis, ordered by thermal energy needs.

Should any of these industries be considered relevant, a next step would be to contact the individual industry and ask them about their energy use and heat supply. However, that is beyond the scope of this pre-feasibility analysis.

It should be said that also the table above has its limitations, in that it is not concerned with the temperatures of the processes in the sectors. For example, the sugar industry – a huge user of thermal energy – needs heat far hotter than what can be made available with data centers heat and one or two heat pumps.

# Cases

The European Food and Beverage (F&B) sector is quite large. It ranks among the top three employers in many European countries, and has major impact on European revenue. France, Germany, Italy and Spain are the largest EU F&B producers by turnover.[[2]](#footnote-2) The UK, in turn, is the largest producer of processed food.

Due to the abundance of F&B production sites across Europe, it is not surprising that many of them are in the vicinity of large and small data centers. There are, however, fewer facilities that can match the power availability from largescale or hyperscale data centers.

Microsoft wants assurance that the return fluid has indeed been cooled sufficiently. The only way to make such an assurance is to work with large industries, which are more likely to use around-the-clock processes and have more flexibility in their heat loads due to their substantial operations.

We have found that it is rare to find any F&B facility with thermal energy needs above 8-10 MW, even when industrial cooling is accounted for. Heat demand typically constitutes two thirds of the total need. Of these heat needs, some industries need quite high temperatures (for baking, for example), indicating that the heat energy offered from data centers is not a good match. Still, many industries are dependent on temperatures less than 100°C, such as dairy and meat producers, who need heat for pasteurization, sterilization, and more purposes in the 70-80°C temperature range. These industries also need heat at lower temperatures, for washing, cleaning, and so on. The analysis focuses on these industries and their heat needs in that temperature region.

This report contains five use cases, Frankfurt am Main (Germany), Newport (UK), [[3]](#footnote-3) “Agroport A7” in Middenmeer (The Netherlands), Zaragoza (Spain),[[4]](#footnote-4) and Staffanstorp (Sweden).

The cases were carefully chosen, with the intent of being as diverse as possible, in terms of location as well as in heat reuse options, thus maximizing the value of the analysis. They are summarized in the following tables, which concern country-specific and case-specific information:

* The first table below gives a high-level picture of the demographic and legal landscape of the use cases.
* Second table provides an overview of each offtaker’s type, size, and temperature needs, as well as key financial data. More financial details are provided in the case descriptions, in the appendix, and in the enclosed Excel workbook.

Table 9. Use case demographic and legal settings.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Location | Nationwide: Population | Nationwide: Population Density | Site:  Population | Site:  DC Density | Relevant Considerations |
| Germany (Frankfurt) | 85 M (Germany) | 241 | High | Very high | German Energy Efficiency Act |
| UK (Newport) | 67.5 M | 277 | High | Rather high | Not EU |
| The Netherlands (Amsterdam) | 17.4 M | 520 | High | Very high | EU EED |
| Spain  (Madrid) | 46.6 M | 92 | High | Rather high | EU EED |
| Sweden (Staffanstorp) | 10.6 M | 24 | Very low | Low | EU EED |

Table 10. Offtaker type, size, and temperature needs, as well as key financial data.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Location | F&B Facility Type | Distance (m) | DC Temp  (°C) | Offtaker Temp (°C) | Heat need  Total/DC (MW) | CAPEX + subsidy Offtaker (€) | Net savings per year (€) | Payback period (years) |
| Germany (Frankfurt) | Meat processing | 1,560 | 30 | 80 | 8.0/5.6 | 8.5M | 3.0M | 2.8 |
| UK (Newport) | Processed food | 15,000 | 65 | 80 | 8.0/5.6 | 5.2M | 5.0M | 1.1 |
| The Netherlands (Agriport A7) | Horticulture | 1000 | 55 | 55 | 8.0/5.6 | - | - | - |
| Spain  (Zaragoza) | Beer | 3,000 | 30 | 80 | 8.0/5.6 | 4.4M | 1.0M | 4.3 |
| Sweden (Staffanstorp) | Oat milk production | 30,000 | 30 | 75 | 8.0/5.6 | - | - | - |

The financial figures above should be treated with some care. Still, the reasoning behind them, and the cases themselves, should have merit, thereby be able to spur further discussions, investigations, and ideas.

Prices for electricity and natural gas fluctuate, and carbon tax and energy transition financial incentives are often complex to measure. Carbon tax varies greatly between countries, as shown by a Worldbank tool.[[5]](#footnote-5) However, most industrial emissions in the EU are regulated under the EU Emissions Trading System (EU ETS), which is available to large-scale projects and is explained in the following.

## The EU Emissions Trading System (EU ETS)

The EU ETS is a cap-and-trade system that sets a limit (cap) on total greenhouse gas emissions from certain sectors, including large industrial facilities. Companies receive or buy emission allowances, each permitting the release of 1 ton of CO₂. If a company emits more than its allowances, it must buy extra allowances or reduce emissions.

The cap shrinks annually, making emissions more expensive over time and encouraging decarbonization.

### Financial effect

The financial effect of the EU Emissions Trading System (EU ETS) is functionally similar to a carbon tax, but with some key differences in how it works:

* Carbon Tax: One pays a fixed price per ton of CO₂ emitted.
* EU ETS: One pays a market-based price per ton of CO₂ via allowances.

In both cases:

* The more one emits, the more you pay.
* Cleaner technologies (like heat pumps) help avoid these costs.

Again, the cost will increase over time, as the number of credits shrinks each year. Thus, for every year, the transition to heat pumps will be more and more financially rewarding. The price of a carbon credit is currently 73 euros per ton CO2 (which equals 14.7 euro per MWh from natural gas).

### Applicability

The EU ETS scheme is only applicable to facilities with a **combined rated thermal input ≥ 20 MW**. This is to say that if cooling makes up for a third of the total energy use, the data center in total would need to be at approximately 60 MW. If the data center’s total burners (absorption chillers, emergency generators, boilers) stay below 20 MWₜₕ, it is exempt from EU ETS obligations – and as a consequence, it cannot take advantage of these allowance-avoidance savings.

If it exceeds 20 MW on-site, every ton of CO₂ avoided by exporting heat instead of firing gas-driven chillers translates into €60–80 per ton CO₂ saved. This analysis presupposes a 5.6 MW heat load (as part of a larger system). In monetary terms, this means 7,000–14,000 tCO₂/yr, or €0.5M–1.1M/yr on top of fuel-cost avoidance.

Although the data center’s heat reuse outlook is positive thanks to the EU ETS trading scheme, the 20 MW capacity constraint precludes the analysis’s identified F&B offtakers. It is true that some of them are parts of larger corporations or cooperatives. Even so, EU ETS does not apply to them (only to the large data center); as stated above, the scheme works at the facility level.

Germany

### A map of germany with cities AI-generated content may be incorrect.Introduction

Germany is Europe's largest food producer, with the food and drink industry as its fourth largest sector. It is also both the third-largest exporter and importer of agricultural and food products worldwide.[[6]](#footnote-6) More than 6,000 companies generate an annual turnover of close to 200 billion euros and employ over 600,000 people,[[7]](#footnote-7) making it the leading F&B industry in Europe.[[8]](#footnote-8) One third of all processed foods manufactured in Germany are exported, mainly to other EU countries.[[9]](#footnote-9)

The German F&B sector is particularly strong in bread, dairy, and beer. Figure 7 shows an overview of the sector.

Figure 6. Germany and its many surrounding countries.

A green and white graph with text

AI-generated content may be incorrect.

Figure 7. The German F&B sector.[[10]](#footnote-10)

With 85 million people, the domestic market is substantial for the German F&B sector. In fact, the German retail market is Europe’s biggest.[[11]](#footnote-11) Moreover, Germany is Europe’s largest market for soft drinks and alcoholic beverages.[[12]](#footnote-12) Wellbeing and eating healthy is a strong trend among these consumers, and these traits are connected to sustainability. Hence, there is currently a focus on organic food, health/wellness, and sustainability.

For the German, going grocery shopping is traditionally an act not to take lightly, almost like a ritual, where product quality is critical. Still, busy lifestyles have started to lead to an increase in ready-made meals – cfr the UK market.

From the perspective of this project, these consumer trends point to a market option, with a “…growing focus on environmentally-friendly and socially responsible products”, which in turn creates “a demand for products that are locally sourced, reduce waste, and use eco-friendly packaging”.[[13]](#footnote-13)

Based on the above,there seems to be a market opportunity in producing energy-conservative operations for processing, storage, and packaging in Germany. This matter could be at the core of locating a market space for the waste heat. It is easy to view waste heat usage from an operations carbon-saving perspective, but with consumer trends driving the F&B market forces, it should also be regarded as a business opportunity for the offtaker.

Further, the ready-made market would provide challenges for cold storage (due to shortened shelf-life). Hence, **F&B cooling** may potentially become an even more important aspect of the German market.

### Case Selection

Due to Germany’s sizeable area, population, economy, and F&B sector, there should be plenty type cases for industrial waste heat for F&B industries. Some notable areas include Bread & Rolls, Dairy, Edible oil, Sugar processing, and Breweries.

Being a member of FLAP-D, Frankfurt am Main was selected as the city for the German case. The data center map for Frankfurt is shown below.

A screenshot of a map

AI-generated content may be incorrect.

Figure 8. Data center map for Frankfurt. From the Proximity Analysis.

Equinix FR7 (west) is not likely suitable for DC HR, as it is so centrally located that piping would be difficult. Further, no F&B facilities have been located in its vicinity. Digital Realty FRA11 (also called Interxion; east) is more suitable, as it would be possible to lay pipes to the nearby offtakers.

Among the F&B facilities discovered in the Proximity Analysis for Frankfurt are several breweries, but they were not appropriate for the use case. Instead, the meat producer **Wilhelm Brandenburg GmbH & Co** seems to be the most suitable offtaker, and is presented in the following.

### Chosen Offtaker

**Wilhelm Brandenburg GmbH & Co**[[14]](#footnote-14) is located 1500 meters from FR11. Brandenburg is owned by REWE Group.[[15]](#footnote-15)

The Proximity analysis states an employee figure of 750, which seems correct: It is the largest branch of six REWE meat producers and there are 3000 employees in total in these facilities.

The annual meat production at the Frankfurt site is 70,000 tons.

### Energy and Financials

With 70,000 tons per year, and a total thermal energy use of ~1,500 kWh/ton, Wilhelm Brandenburg is a large energy user (105,000 MWh/year). The thermal demands include heating and chilling. A rough estimate gives 2/3 for heating and 1/3 for chilling, as shown below.

Table 11. Estimated thermal energy distribution of Wilhelm Brandenburg.

|  |  |  |  |
| --- | --- | --- | --- |
| Process | % of Thermal Energy | Annual Energy (MWh) | Average Power (MW) |
| Heating | 65% | 68,250 | 7.79 |
| Chilling | 35% | 36,750 | 4.2 |
| Total | 100% | 105,000 | 11.99 |

For this scenario, only heating is accounted for, though it should be said that there could be merit investigating data center waste heat uses for chilling as well.

For an 8 MW scenario, with carbon subsidies, the payback period can be acceptable. The price is rather volatile, depending on pricing and policy (see Appendix), so further discussion with a potential offtaker in Frankfurt is certainly needed.

For the time being (until 2029 or 2030), the otherwise high electricity prices in Germany are capped at the EU allowed minimum, 50 cents[[16]](#footnote-16). This is to compensate industries for financial problems relating to the war in Ukraine, and to, at the same time, incentivize a transition from gas to electricity. Indeed, this is very good news for the German heat reuse prospect.

Especially considering Germany’s strict energy implementation, the German Energy Efficiency Act, where heat recovery is mandatory, the case at hand should be an appealing solution.

United Kingdom

### A map of the united kingdom AI-generated content may be incorrect.Introduction

Figure 9. The United Kingdom with its neighboring countries.

Excluding Russia, the United Kingdom is the largest non-EU European nation. Brexit has made massive changes to the country, not least in terms of trade. Food security is one of the issues Britain must face: in the aftermath of the COVID closures, it became impossible to acquire fruit and vegetables from abroad, leading to the “Tomato crisis”. Another trend is the rise of the food processing industry, where the UK is the leading nation in Europe. With those facts in mind and with a market of close to 70,000,000 people, there should be plenty of opportunities for the F&B sector.

These opportunities align well with Microsoft’s expansion plans. Microsoft is currently investing several billion pounds to rapidly double its UK data center capacity, with a strong focus on high-performance infrastructure, renewable energy, and community integration.

### Case Selection

The Proximity Analysis points to locations in London, Cardiff, and Slough (just west of London). Of these, the most promising plant is the Mars chocolate factory. The Mars facility in Slough is a cornerstone of the company's UK operations and a hub of chocolate innovation. Originally opened in 1932, it is now a production site for Mars, Snickers, Galaxy, Maltesers, and other brands. More than 2.5 million Mars bars are produced daily, and these and other candy bars are shipped across Europe, China, and Australia. For reference, below is a table of the world’s largest chocolate producers.

Table 12. The world’s largest producers of chocolate. Estimates.

|  |  |  |
| --- | --- | --- |
| Company | Production/year | Notable Brands |
| Ferrero | 1.5 million tons | Nutella, Ferrero Rocher, Kinder |
| Hershey | 450,000 tons | Hershey’s, Reese’s, Kisses |
| Mars | 400,000+ tons | M&M’s, Snickers, Twix, Dove |
| Nestlé | 100,000 tons | KitKat, Smarties, Cailler |
| Lindt & Sprüngli | 140,000 tons | Lindt, Ghirardelli |

However, being such a large production site, the Mars facility is already supplied with a district heating system, biomass (waste wood) and waste-derived fuels to generate electricity, steam, and heat. Hence, the analysis focused elsewhere.

Moving beyond the Proximity Analysis to feature also planned British Microsoft data center sites, some stand out, because of their size, readiness, and focus on high-density compute (which provides the analysis with a 65-degree scenario):

* Park Royal, London
* Skelton Grange, Leeds
* Newport, Wales
* Eggborough, North Yorkshire
* Cardiff, Wales

A building with cars parked in front of it

AI-generated content may be incorrect.Of these, the **Newport** site (the “Imperial Park” campus) was chosen (see figure). The facility has been approved but not yet built. Its two large data halls will support AI model hosting and cloud services, and serve as a major component of the company’s UK AI infrastructure plan.[[17]](#footnote-17)

Figure 10. A computer image of the coming Newport data center.

This particular data center was selected as it has a large Unilever facility nearby. The facility is described below.

### Chosen Offtaker

The Unilever Foods plant is situated in Crumlin, just north of Newport. Its operations should include pasteurization, cooking, CIP (clean-in-place), and packaging – all heat-intensive processes.

A plant of this size needs between 6 and 10 MW of power, and though Unilever works towards a green transition,[[18]](#footnote-18) the current energy source of the plant is likely still natural gas.

The distance between the two entities is long, 15 kilometers. This makes the use case interesting as a challenge. As long as HDPE pipes can be utilized, there are no true physical or financial problems in overcoming this distance. With high projected rack densities at the site, the case would gain from being at 65 instead of 30 degrees. For durability, stainless steel is slightly better at this temperature, which would increase costs for piping over such a distance, but not to the extent that it would threaten the business case.

Indeed, heat transfer at these temperatures is commonplace in other locations, such as in the Nordics. Hence, the 65°C degree scenario is utilized here, as an illustration if nothing else.

At 65°C, this table describes heat rangers, power needs and the suitability for different heating procedures at the plant.

Table 13. Thermal energy breakdown for the Unilever plant.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Process | Temp Range (°C) | Description | % Thermal Demand | Power Need (MW) | 64°C Heat Match | Opportunity |
| Pasteurization | 70–90 | Heating sauces/spreads to kill pathogens; batch or continuous | ~25% | 2.0–2.5 | Yes | Ideal match—can use 64°C supply directly for continuous pasteurization |
| Cooking & Blending | 80–100 | Thermal processing of ingredients; includes emulsification and mixing | ~20% | 1.5–2.0 | Partial | May require heat pump boost; good for pre-heating or low-temp cooking |
| CIP (Cleaning-in-Place) | 60–85 | Hot water and steam for cleaning tanks, pipes, and fillers | ~15% | 1.0–1.5 | Partial | 64°C supply usable with minor upgrading; heat pump could close the gap |
| Hot Water Supply | 50–70 | General sanitation, handwashing, and facility hygiene | ~10% | 0.5–1.0 | Yes | Perfect match—direct use for facility hot water |
| Steam for Packaging | 100–120 | Sterilization of packaging materials and sealing processes | ~15% | 1.5–2.0 | No | Requires high-grade heat; not feasible with 64°C supply |
| Space Heating & HVAC | 20–40 | Ambient heating for production areas and offices | ~10% | 0.5–1.0 | Yes | Easily covered by 64°C supply; ideal for HVAC and comfort heating |
| Other (e.g. drying) | Varies | Minor processes like drying or pre-heating ingredients | ~5% | <0.5 | Partial | Some drying steps may be supported; depends on product and process |

The 64°C supply temperature is perfectly suited for low-temperature pasteurization (72°C is needed for commercial milk pasteurization) and hot water systems.

CIP and drying are within reach with modest heat pump support. Sterilization remains out of range without high-temperature solutions, but only accounts for a small proportion of the total thermal heat needs.

### Energy and Financials

Electricity prices in the UK are exceptionally high. Several factors contribute:

* Grid and network charges in the UK are among the highest in Europe.
* Environmental levies (like Contracts for Difference and Capacity Market charges) are bundled into industrial bills.
* The UK’s energy mix still relies heavily on gas, which has been volatile.
* Unlike countries like Sweden or Spain, the UK doesn’t benefit from large sources of cheap hydro or solar.

Natural gas remains cheaper than electricity per MWh, but carbon pricing and volatility make it less attractive long-term.

For political reasons, the UK energy market suffers from universal electricity pricing. In other words, under current legislation, there is no point in being close to a power plant or far away from heavy power users (such as London). This is a very unfortunate situation, which we project will be resolved – especially as that puts unnecessary strain on the national power grid (cfr the four energy tax zones in Sweden, which steer large-scale facilities to the large rivers in the north). When that happens, the financial situation of Britain will become brighter.

Carbon tax applies mainly to electricity generators; industrial users may face indirect costs via energy pricing. Some CAPEX funding is in place, but OPEX funding is not set. However, there is lowered electricity costs for industries (similar to Germany), considerably driving down cost for power[[19]](#footnote-19). There are also more incentives to explore, such as Climate Change Agreements (CCA) and the Energy Intensive Industries Exemption Scheme.

The financial analysis (see Appendix) shows that the setup could indeed be profitable within reasonable time, especially given the high temperatures from the data center, and the lack of a second heat pump.

The Netherlands

### Introduction

A map of the country

AI-generated content may be incorrect.The Netherlands has a strong tradition of commerce, shipping, and generally of working internationally, a heritage from its days as a prominent seafarer nation. This heritage means the Dutch commercial landscape is easy to work with for international enterprises.

A prolific FLAP-D member, Amsterdam has long been at the center of attention to the data center industry. However, the Amsterdam power grid is exceptionally strained. As a consequence, moratoria have been put in place for Amsterdam sites, and data center owners have turned elsewhere to expand their businesses. This is also true for Microsoft.

Figure 11. The Netherlands with its neighboring countries.

### Case Selection

The **Agriport A7** industrial park[[20]](#footnote-20) in Middenmeer, 40 km north of Amsterdam, is Microsoft's main data center campus in the Netherlands. Here, the company has the ability to take active part in heat reuse projects, delivering waste heat to nearby greenhouses.[[21]](#footnote-21) Alas, there are no reports on that this has ever happened. From our previous conversations, we have learned that tax subsidies for natural gas among Dutch greenhouse owners have made this apparently straightforward business case unappealing.

There does not seem to be any other F&B production site near Agriport A7 (that is, except for the greenhouses).

An option to Agriport A7 would be the town of **Alkmaar**, north of Amsterdam as well and not that far from Agriport A7. This is the second site of Microsoft’s Dutch data centers. Unfortunately, the closest F&B plant, a cheese factory, is 12 kms away and tops out at about 3 MW.

Another option entirely would be the chocolate factory in **Veghel**, in the southern part of the country. It is the largest production site owned by Mars, Inc, and among the largest chocolate factories in the world.

Closer to the current data center hubs, the Edam and Gouda cheese clusters would be excellent fits. However, Microsoft has no official plans to build data centers outside of Agriport A7 and Alkmaar.

### Chosen Offtaker

Of the investigated locations, the choice fell on Agriport A7. The reason why is the vastness of the data center – and the many greenhouses in need of thermal energy. It is true that heat would be needed primarily in the winter season, but Agriport A7 is actively investing in heat reuse options, and more generally, how to create an industrial symbiosis connecting agriculture and data centers. Hence, there is both a need and a willingness to try these concepts.

As explained earlier in this report, there are two options for the water stream: 30°C (from traditional compute) and 65°C (from more extreme computation). Neither temperature is entirely appropriate for the greenhouses:

* A 30°C water supply is readily available and easy to handle. It is also ideal for low-temperature radiant heating or pre-heating irrigation water. Still, it is too low for direct air heating in winter, and therefore, it needs heat pumps to boost temperature.
* A 65°C water supply on the other hand, is suitable for direct greenhouse heating, without any need for additional heat pumps. However, using 65°C water to heat greenhouses is wasteful and therewith unfavorable for both financial and environmental reasons.

Indeed, it seems the optimal temperature lies somewhere in between. Since the Agriport A7 site features both systems, it would be easy enough to mix their waste streams ad libitum.

Thus, with the goal of maximizing the usability and efficiency of the heat energy, Microsoft would want a temperature that:

1. matches greenhouse heating needs,
2. minimizes infrastructure complexity,
3. avoids the need for heat pumps, and
4. works well with a 12°C delta-T in a closed-loop system.

The optimal temperature would be 55°C, as to balance usefulness and efficiency. The table below shows why.

Table 14. Usefulness and efficiency of three temperature scenarios.

|  |  |  |  |
| --- | --- | --- | --- |
| Criteria | 30°C | 55°C | 65°C |
| Usable for radiant heating | Limited | Yes | Yes |
| Usable for air heating | No | Yes | Yes |
| Need for heat pumps | Likely | No | No |
| Pipe insulation requirements | Low | Moderate | Higher |
| Safety & control complexity | Simple | Manageable | More complex |
| Integration with existing systems | Limited | Compatible | Compatible |

### Energy And Financial Aspects

As concluded in the Appendix, it is difficult to estimate the heat needs of the nearby greenhouses. In itself, it is relatively easy to find average costs per hectare, but the question is what sort of horticulture is carried out at the site in question. Still, with an abundance of available heat energy and with a forward-looking industrial park, the setup is well worth exploring.

For large Dutch industries, the electricity price is lower than Eurostat’s figures, bringing them down to an approximate €100 euros/MWh from €117[[22]](#footnote-22).

Under the current Dutch taxation system, the heat would probably be given away rather than sold in this instance. Microsoft would still benefit from this highly affordable solution, getting lower temperature in return, closing in on its sustainability targets, being a good neighbor, and obtaining building permission easier for future expansion.

*A note: There are government-funded subsidies to apply for. Of interest is the SDE++ subsidy, which is explicitly geared towards waste heat projects.[[23]](#footnote-23) In 2025, the largest subsidy intensity for which SDE++ technologies can apply is €400 per ton CO2.[[24]](#footnote-24) Note that the current SDE++ application period runs between 7 October and 6 November 2025.*

Spain

### A map of spain with cities AI-generated content may be incorrect.Introduction

Figure 12. Spain (and Portugal).

In terms of population (47 million) and land area, Spain is one of Europe’s largest countries. Spain also surrounds Portugal, adding another 10 million people and more land (and water) area. This southern nation has ample sunshine the year around. As a consequence, Spain is a major fruits and vegetables exporter. In other words, its F&B sector is quite large.

The Spanish climate is challenging for data centers. The mild winters do not help with cooling (as winters do in the Nordics), nor are there many district heating systems that can act as offtakers for data center waste heat.[[25]](#footnote-25) Indeed, the hot summer months pose greater challenges. Still, due to the population size, Spain remains an important data center market, and so, waste heat concerns must be addressed. The sizable F&B sector might be the answer to these concerns.

### Case Selection

Microsoft’s Spanish data centers are located in Madrid, which is also the primary Spanish data center hub. The Proximity Analysis identified three potential offtakers in close vicinity of these data centers, but did not turn out to be good fits.

Despite widening the search, there were no suitable potential offtakers to be found in the area. In truth, Madrid seems like a challenging area for largescale waste heat reclamation.

However, there is another Spanish data center hub currently emerging in **Zaragoza**. Microsoft’s coming facilities here are part of the company’s broader European high-performance strategy and cloud expansion, aimed at supporting digital transformation across industries. Investments for over €10 billion are planned across multiple campuses. Zaragoza is also home to several major F&B companies, active in the meat production sector, but also in others.

The map below shows two of the Microsoft sites in Zaragoza. Puerto Venecia is a 59-hectare industrial complex just south of the city. The Microsoft site here is now under construction. Villamayor de Gállego is a planned site – more on its significance below.

A map of a city

AI-generated content may be incorrect.

Figure 13. Two of Microsoft's coming data centers in Zaragoza, and two potential offtakers, La Zaragozana and Costa Group.

### Chosen Offtaker

The chosen offtaker here is La Zaragozana[[26]](#footnote-26) (commercially known as Ambar Beers), Founded in 1900, it is one of Spain’s most iconic breweries. As a brewery, it is further a major heat consumer in the 60–100 °C range, as seen in the table below.

Table 15. Thermal energy breakdown for La Zaragozana.

|  |  |  |  |
| --- | --- | --- | --- |
| Process | Temp Range | Thermal Load (MW) | Notes |
| Mashing | 62–72 °C | 1–2 MW | Converts starches to sugars; most energy-intensive step |
| Lautering | ~75 °C | Included in mashing | Separation of wort from grain |
| Boiling | 100 °C | 1–2 MW | Sterilization and hop addition |
| Fermentation | 10–20 °C | ~1 MW (cooling) | Depends on beer type (lager vs. ale); cooling required |
| Cleaning (CIP) | 70–85 °C | 0.5–1 MW | Hot water and caustic solutions used for sanitation |
| Malting (if on-site) | 50–65 °C | 1–2 MW | Germination and drying phases |

The product range includes a dozen varieties of beer, bottled water, and soft drinks. The production plant of La Zaragozana is in the city centre, 3 kms from the Microsoft site in Puerto Venecia.

### Energy And Financial Aspects

Brewing beer is a delicate process, where several temperature levels must be precisely upheld. The table above shows these levels and needs, as well as estimated needs for the Zaragozana brewery. All these processes (with the exception of fermentation) would be suitable for waste heat use. Boiling would require a supplementary heat pump; in practice, the final temperature lift would probably be carried out with existing heaters.

With these many potential uses, there would be a multitude of alternatives to the proposed offtaker configuration. For example, it is evident that not all of the water volume needs to be lifted to 80°C. Based on the complexity displayed in the table above, it seems clear that an exact setup for a brewery is impossible to sketch. Direct contacts must be taken with the specific brewery – be it La Zaragozana or some other – to provide an accurate financial analysis.

In any case, the many options for heat reuse available, the fact that Zaragoza is virgin territory for data center heat reuse, and the PR value from working with an iconic, highly recognizable brand, are all promising. And even more so in this country, where ambient heat is too high to enable efficient district heating.

A few notes on the financial situation for the use case:

* Electricity prices in Zaragoza are moderate compared to other EU regions, making heat pumps economically viable. Natural gas is currently cheaper per MWh, but also subject to price volatility and carbon costs under the EU ETS. Carbon tax in Spain is minimal for CO₂; most industrial emissions are regulated under the EU Emissions Trading System.
* The CAPEX support is generous, reaching 35% for large-scale industrial heat pumps.[[27]](#footnote-27) However, they need to meet certain efficiency criteria. Planning and installation costs are also eligible for funding. These subsidies, administered by the Spanish Institute for Energy Diversification and Saving (IDAE), are part of Spain’s broader push to decarbonize heating and cooling under EU climate targets.
* OPEX support is not formalized, but operational savings and EU decarbonization incentives make heat pumps attractive.

In total – and as shown in the Appendix – this seems as a promising case for today’s operational Microsoft facility.

### An Option Pointing Towards the Future

La Zaragozana was partly chosen because both it and the Microsoft facility are operational today. Another, very exciting, option is planned east of Zaragoza, in **Villanueva de Gállego** (see the map above). This is to become an agri-food and tech development zone, Centro Logístico Agroalimentario del Valle del Ebro (CLAVE). It will also be the home of a future Costa Group meat complex, an envisioned large-scale pork processing and distribution hub.

The Costa Group already handles over 200 million kg of pork per year, works with over 800 farms and exports meat to nearly 60 countries. The Zaragoza expansion is expected to be one of the most advanced in Europe, and employ up to 3,000 people.

Costa has a circular production model, spanning feed production, farming, slaughter, and distribution. Taking advantage of waste heat for its industrial processes would be a logical step. Working together with Microsoft, signaling a convergence of agri-food and tech infrastructure, would be attractive in this regard, for Costa and for the region as a whole.

Sweden

### Introduction

A map of europe with blue points

AI-generated content may be incorrect.The practice of Microsoft is to build new data centers in the same location as existing ones. Microsoft has data centers on several locations in Sweden: in Stockholm and elsewhere. The trend of the company is to build facilities in semi-rural areas, in towns with 20,000-100,000 people. The current ones are *Gävle, Sandviken, and Staffanstorp*. Therefore, combined with the fact there is no offtaker of suitable size near the Stockholm plant, these are the locations for the search for a suitable offtaker within the F&B industry.

Figure 14. Sweden and its Microsoft data centers.

### Site Selection

**Sandviken**, 300 kilometers north of Stockholm, is home to the global special steel company Sandvik. However, there are no large F&B industries close to the town.

**Gävle**, not far from Sandviken, hosts one of Sweden's major coffee roasteries (Gevalia, now part of Mondelez), but its temperature needs are not a good match to Microsoft's offer. Gävle also had a major dairy firm, but unfortunately, the operations moved away last year. Microsoft has started an application to build another datacenter in Gävle, next to the existing facility.

Though rather far north, both Gävle and Sandviken are – unfairly – just within the same power grid section as Stockholm (SE3), making it expensive to lift temperatures using heat pumps in the area.

**Staffanstorp** is located in the Skåne (Scania) region, very near Malmö and Denmark. Skåne's fertile soils has made the region an important F&B actor, not only in Sweden but also abroad. Microsoft has announced plans for more datacenters in southern Sweden, so one may assume that Staffanstorp is a top candidate for a new facility.

Because of the many F&B facilities nearby and the prospects of additional datacenters in the area, Staffanstorp was chosen for this analysis.

### Chosen Offtaker

There are indeed several options for choosing an appropriate offtaker in the Staffanstorp region, as it is situated in the agricultural area very close to Malmö and Denmark. Some potential offtakers are listed below.

Table 16. Large F&B industries in the vicinity of Staffanstorp.

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Location | Sector | Estimated Thermal Demand |
| Orkla Foods Sverige AB | Eslöv | Packaged foods | High — cooking, sterilization |
| Skånemejerier AB | Malmö | Dairy products | High — milk pasteurization, CIP |
| Carlsberg Sverige AB | Falkenberg (just outside 50 km) | Brewing | Very High — wort boiling, cleaning |
| Findus Sverige AB | Bjuv | Frozen foods | High — blanching, freezing, steam |
| Lantmännen Cerealia AB | Malmö | Grain & cereal processing | Medium — drying, milling |
| Paulig Group (Santa Maria) | Mölndal (slightly beyond) | Spices & sauces | Medium — cooking, packaging |
| Frigoscandia AB | Staffanstorp | Cold chain logistics | Medium — refrigeration, defrosting |
| First Class Brands of Sweden | Staffanstorp | Beverages | Medium — bottling, cleaning |
| Vilomix Sweden AB | Staffanstorp | Animal feed | Medium — drying, mixing |

Despite the presence of these industrial actors, **Oatly** (the inventor of oat milk) was chosen. Oatly has its main production plant 30 kilometers from the Staffanstorp facility. Not only does Oatly have a use for the heat energy; it is also a highly sustainability-focused company,[[28]](#footnote-28) so it would be a good partner for Microsoft’s CSR efforts. As with Mars, the true gain would be from global cooperation.

As an enterprise, Oatly leads the way in terms of oat-based drinks. It is now a global company operating from its own factories as well as with partners. Below is a list of its current factories (partner factories excluded), with a very crude estimate of the facilities’ thermal energy needs.

Table 17. Main Oatly factories.

|  |  |  |
| --- | --- | --- |
| Factory Location | Estimated Thermal Energy Need (MW) | Notes |
| Landskrona, Sweden | 5.7 | Flagship facility; oat base + packaging |
| Millville, New Jersey, USA | 3.5 | Supplies other US sites |
| Ogden, Utah, USA | 4.0 | Transitioned from end-to-end to hybrid model |
| Vlissingen, Netherlands | 4.0 | Co-manufacturing with local partner |
| Ma’anshan, China | 6.0 | Built to reduce transport emissions to Asia-Pacific |
| Singapore (Senoko) | 5.0 | Regional hub for Southeast Asia |

### Energy And Financial Aspects

Sweden’s energy mix makes the energy and financial analysis different from the other cases. Here, it is not fossil fuel that is offset. Instead, for their thermal energy needs, Swedish industries rely on waste heat (often in the form of district heating or exhaust gases), biofuels (such as pellets and other leftovers from the forestry industry), and electricity. It is therefore unlikely that a large Swedish offtaker seeks to transition from natural gas to waste heat; they already employ the latter. That being said, for an extension to an existing industry, or where there is not enough heat today, a waste heat scenario would certainly be welcome – and well-understood.

Some notes:

* Electricity prices in Sweden are relatively low for industrial users, especially in SE4 (which includes Staffanstorp). So in contrast to the UK case, where to put a data center does have implications on power cost.
* Natural gas remains significantly more expensive per MWh than electricity, reinforcing the economic case for electrification.
* Carbon tax is substantial and incentivizes switching from fossil fuels to renewable or electric alternatives.
* Heat pump subsidies are primarily focused on capital investment (CAPEX), with support from the Swedish Energy Agency and EU programs. Staffanstorp offers free energy and climate advisory services to help navigate these options.
* No formal OPEX subsidies were identified, but operational savings from switching to heat pumps (due to lower electricity costs and avoided carbon tax) are often substantial.

Further, 30 kms is truly a stretch for heat reuse options (and as a previous table showed, there are indeed other industries closer to Staffanstorp). The length makes the piping estimate difficult, and must be more closely examined, on a case basis. Still, if OPEX savings are high enough, even such lengths are acceptable.

In short, the financial analysis is a special case, as there is no natural gas to replace. Further investigation would be needed to judge its feasibility. Still, it should be said that Sweden is a leader in heat reuse projects. The nation wouldn’t be, unless it made financial sense to reclaim waste heat.

# Use case reflections

This report presents piping, offtaker configuration scenarios and a variety of use case options for the selected countries.

The financial data must be verified with each site of interest, due to volatile energy pricing and constantly changing policy on local and national levels. That being said, the conclusion for every use case points to a possible financial gain from the implementation.

Financial gain, in turn, should be viewed as just one component in the gain from employing heat reuse: the environmental gain is substantial and also in line with Microsoft’s sustainability policy. Further, the PR value of, say, heating the local brewery or producing oat milk with data center waste heat, should not be underestimated.

A matter of concern is the – relatively speaking – small energy needs of F&B offtakers. The following section outlines measures to resolve this concern.

# Beyond 8 MW

Both the envisioned technical system and the cases presented in this report are for 8 MW offtaker use, as that seems to be a realistic limit to large offtakers’ needs. For existing and planned hyperscalers, this figure may be undesirably small. While this problem cannot be entirely solved, it can be alleviated.

There are – at least – four ways to counter this issue, whilst keeping the F&B industry focus. These are examined in the following.

## Supplying Heat to Industrial Parks

Often today, the presence of data centers attracts more data centers, with competition over resources (power, land, water) as a result. But not only data centers conglomerate – this is true for other business segments too. In industrial parks with one dominant data center and several potential offtakers, it is therefore possible to scale up heat reuse through acting as a heat energy source with many outlets: in principle, to act as a district heating provider.

Hence, on some locations, one Microsoft data center could well supply several F&B actors with heat energy. Doing so would also lower the risk for uneven heat energy offtake from the data center: for example, it is unlikely that all connected offtakers will provide maintenance for their industries at the same time.

The planned industrial park east of Zaragoza, Spain, would be ideal in this regard, as it pinpoints the food industry specifically. In other words, there will likely be more potential offtakers in Zaragoza than the one used for the case.

## Supplying Heat to Several Facilities Within a Corporation

A dream scenario relating to the F&B sector would be if Microsoft could be the single supplier of thermal heat to one of the world's largest F&B corporations (Nestlé, Unilever, Tyson Foods, Mars, Mondelez, Danone etc.). That would not bring more heat reuse possibilities for the specific site, but exciting opportunities for growth could emerge: Facility engineers would learn from earlier installs, and common work procedures and legal practices would be established.

Consequently, it would become easier to deploy heat reuse on a global scale, even though every offtaker facility would only need limited heat energy.

## Offer Cooling

It has been estimated that the energy use of the Food and Beverage (F&B) sector reaches approximately 25 % of European energy, and that of this consumption, around 30 % stems from cooling[[29]](#footnote-29). Cooling is essential both for food safety and for reducing waste throughout the food supply chain.

In Europe, the cold supply chain – which includes refrigeration during transport, processing, and storage – is considered one of the most energy-demanding systems in the F&B sector. In the dairy industry specifically, cooling and refrigeration are among the top energy-consuming processes.

For example, the dairy industry needs cooling during several stages. The figure below shows the sequence of the dairy supply chain, focusing on its energy uses.

A diagram of a dairy plant

AI-generated content may be incorrect.

Figure 15. The dairy supply chain[[30]](#footnote-30).

In light of the above, the cold supply chain could gain significantly from large volumes of low-cost, reliable cooling. The data center industry can supply just that, enabling circularity and achieving massive carbon reductions in the process.

For maximum flexibility and performance, a hybrid system may combine heating and cooling through smart use of absorption chillers, boosters, and heat pumps. However such a system is configured, the hybrid strategy has several benefits:

* The hybrid system delivers high value per kWh of data center waste heat.
* It can maximize CO₂ savings by displacing both electric chillers and gas boilers.
* It provides great flexibility: cooling and heating can be scaled independently as demand shifts.
* This strategy also allows for seasonal changes, for example emphasizing cooling during summers, when temperatures rise and industrial work may decrease.

## Noting the Difference Between Boilerplate and True Use

Hyperscale data centers are typically provisioned for 100 MW or more. However, actual average IT load tends to be much lower – often 40–60% of provisioned capacity depending on the facility’s age, design, and workload patterns. Even in highly optimized hyperscale environments, idle capacity is common. For example, a 100 MW data center might only be drawing 50–60 MW on average, with the rest reserved for peak demand, redundancy, and future expansion.

With that in mind, what may seem like a 25% reuse scenario (for a 20 MW data center) is, in reality, a 50% reuse scenario.

Note that this is not a play on numbers. On the contrary, these numbers will be used in carbon accounting of the organization. Thus, accurately interpreting these figures carries significant implications for Microsoft's ESG reporting and broader sustainability initiatives, and ultimately carries weight for global climate action.

# Appendix

The table below shows F&B data for EU members. Thus, this table is useful when investigating options for F&B facility heat reuse in other EU countries.

Table 18. Food and drink industry data by Member State 2022[[31]](#footnote-31).

A table of numbers and text

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## Gas prices for non-domestic consumers in the EU, autumn 2024

The prices for natural gas are based on average prices from Eurostat.

Energy prices make up a substantial part of the financial aspects of the business case. It must therefore be emphasized that gas prices are quite volatile and that it is strongly recommended to confirm prices with a potential offtaker before negotiations take place.

The figure below shows prices for the EU countries, autumn 2024. More details can be found on trading sites[[32]](#footnote-32).

A graph of the price of non-household consumers

AI-generated content may be incorrect.

Figure 16. Electricity prices for non-household consumers, second half 2024 (€ per kWh). Source: Eurostat[[33]](#footnote-33).

Of interest to this analysis is the trend of increasing gas prices. This is in line with the intent of the EU ETS scheme, and with the EU’s climate ambitions overall. The figure below, taken from the IEA, displays this trend quite clearly. It shows price changes for the last year, as according to European pricing (TTF) as well as Asian pricing (Platts JKM).

A graph with blue lines

AI-generated content may be incorrect.

Figure 17. The sizable fluctuation of gas prices[[34]](#footnote-34).

## Electricity prices for non-domestic consumers in the EU, autumn 2024

The values in the document partially reflect these values, but not entirely, as they aim to echo actual prices paid by industries.

Notes:

* Germany offers partial exemptions for energy-intensive industries, but still has significant grid and tax costs.
* UK industrial users face volatile pricing and no price cap, but some relief via contract negotiation.
* The Netherlands has no indirect cost compensation and high offshore grid fees, making it the most expensive.
* Spain’s prices are moderate and stable, with increasing renewables helping to contain costs.
* Sweden’s industrial users benefit from low grid costs and a fossil-free energy mix.

A graph showing the number of people in the us

AI-generated content may be incorrect.

Figure 18. Electricity prices for non-household consumers, second half 2024 (€ per kWh). Source: Eurostat.[[35]](#footnote-35)

## Financial situation: Germany (Frankfurt) case

**Electricity Price (avg annual):** €180 per MWh (for now, €50 per MWh)

**Natural Gas Price (avg annual):** €58 per MWh

**Carbon Tax per MWh CO₂:** €13.

**CAPEX Subsidy for Heat Pumps:** Up to 50% of installation cost for large-scale systems

**OPEX Subsidy:** 0.

A screenshot of a computer screen

AI-generated content may be incorrect.

## Financial situation: UK (Newport) case

**Electricity Price (avg annual):** €140 per MWh after incentive (€215 normal)

**Natural Gas Price (avg annual):** €78 per MWh

**Carbon Tax per MWh CO₂:** 0.

**CAPEX Subsidy for Heat Pumps:** Limited. There is a £7,500 guaranteed grant per heat pump.

**OPEX Subsidy:** 0 in this example.

A screenshot of a computer screen

AI-generated content may be incorrect.

## Financial situation: The Netherlands (Agriport) case

**Electricity Price (avg annual):** €100 per MWh (instead of €117)

**Natural Gas Price (avg annual):** €42 per MWh

**Carbon Tax per MWh CO₂:** 20.

**CAPEX Subsidy for Heat Pumps:** 30%. ISDE subsidy.

**OPEX Subsidy:** 0.

The case has quite limited CAPEX and OPEX costs, are there is no investment for heat pumps and no cost for power to drive them.

Moreover, there is likely no carbon tax avoidance in this scenario.

However, the price for large industrial users is lower than the typical ratio.

## Financial situation: Spain (Zaragoza) case

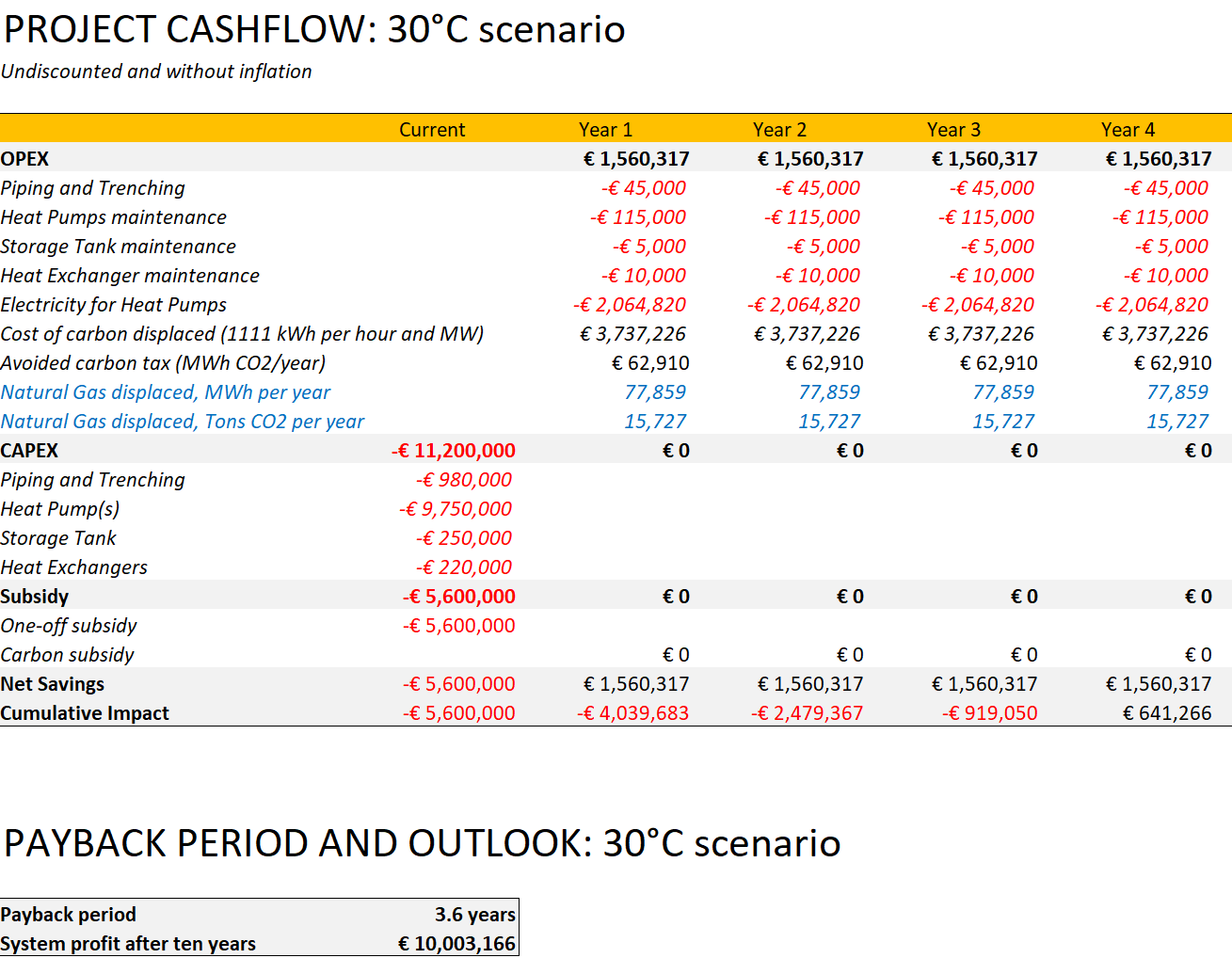
**Electricity Price (avg annual):** €90 per MWh (as opposed to normal €98)

**Natural Gas Price (avg annual):** €48 per MWh

**Carbon Tax per MWh CO₂:** 4.

**CAPEX Subsidy for Heat Pumps:** 50%. Funded via IDAE. Here: 35% for heat pump and another 15% for installation.

**OPEX Subsidy:** 0.



## Financial situation: Sweden (Staffanstorp) case

**Electricity Price (avg annual):** €100 per MWh

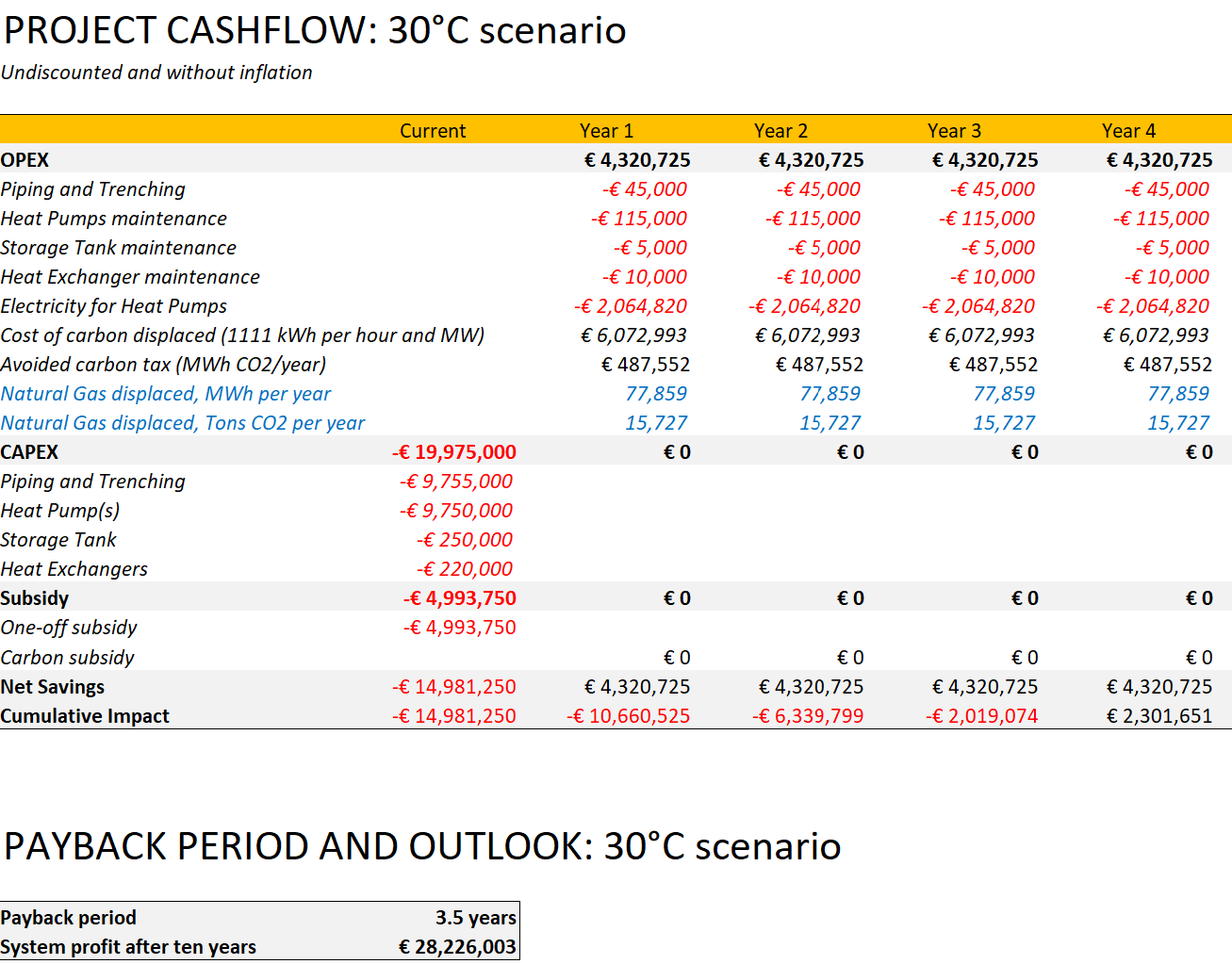
**Natural Gas Price (avg annual):** €78 per MWh

**Carbon Tax per MWh CO₂:** 31.

**CAPEX Subsidy for Heat Pumps:** 50%. Funded via IDAE. Here: 35% for heat pump and another 15% for installation.

**OPEX Subsidy:** 0.

The case is promising, but there are in reality no carbon savings involved, as Sweden is not using fossil fuel for its industries. The cashflow scenario is included here to facilitate comparisons to the other cases.



1. <https://www.energiforetagen.se/energifakta/fjarrvarme/fjarrvarmenaten-distribution/> [↑](#footnote-ref-1)
2. Food Drink Europe (2024). Data and Trends. EU Food and Drink Industry 2024 Edition. [↑](#footnote-ref-2)
3. For the business case analysis, there was a choice between Ireland and the United Kingdom. Microsoft has recently announced that it would cease to look for opportunities in Ireland, due to power grid restraints. Instead, the company will now turn to European growth markets, and also increase its presence in the Nordics. [↑](#footnote-ref-3)
4. Likewise, there was a choice between Spain and Italy – two populous nations where ambient heat poses challenges for data center operations as well as for heat reuse. Italy neighbors Switzerland, which has a more favorable climate that Italy. However, for most of Spain and Portugal, there is no truly good alternative for data center placement abroad. Hence, to push the limits for what heat reuse can meaningfully achieve, Spain was the chosen candidate. [↑](#footnote-ref-4)
5. <https://carbonpricingdashboard.worldbank.org/compliance/price> [↑](#footnote-ref-5)
6. Industry Overview: The Food & Beverage Industry, Germany Trade & Invest (GTAI), 2022-2023. [↑](#footnote-ref-6)
7. List of the 400 largest food producers Germany [2024 Update], ResearchGermany, 2024. <https://www.researchgermany.com/product/food-producers-germany/> [↑](#footnote-ref-7)
8. <https://www.business.gov.uk/export-from-uk/markets/germany/food-and-drink-in-germany/#germany-foodanddrink-trade-associations> [↑](#footnote-ref-8)
9. Industry Overview: The Food & Beverage Industry, Germany Trade & Invest (GTAI), 2022-2023. [↑](#footnote-ref-9)
10. BVE Report 2020/21. Bundesvereinigung der Deutschen Ernährungsindustrie e.V. 2021. [↑](#footnote-ref-10)
11. Industry Overview: The Food & Beverage Industry, Germany Trade & Invest (GTAI), 2022-2023. [↑](#footnote-ref-11)
12. Industry Overview: The Food & Beverage Industry, Germany Trade & Invest (GTAI), 2022-2023. [↑](#footnote-ref-12)
13. <https://www.business.gov.uk/export-from-uk/markets/germany/food-and-drink-in-germany/#germany-foodanddrink-trade-associations> [↑](#footnote-ref-13)
14. <https://wilhelmbrandenburg.de/frankfurt-am-main/> [↑](#footnote-ref-14)
15. See this link for REWE’s Sustainability report 2022: <https://rewe-group-nachhaltigkeitsbericht.de/2022/en/energy-climate-and-the-environment/energy/index.html> [↑](#footnote-ref-15)
16. [BMWK Newsletter Energiewende - Relief for manufacturing and energy-intensive companies](https://energiewende.bundeswirtschaftsministerium.de/EWD/Redaktion/EN/Newsletter/2024/01/Meldung/news5.html) [↑](#footnote-ref-16)
17. <https://local.microsoft.com/blog/newport-imperial-park-datacentre-construction-overview/> [↑](#footnote-ref-17)
18. <https://www.unilever.com/sustainability/climate/#cleaner-smarter-energy-in-our-operations> [↑](#footnote-ref-18)
19. <https://www.gov.uk/government/collections/industrial-energy-prices> [↑](#footnote-ref-19)
20. <https://www.agriporta7.nl/> [↑](#footnote-ref-20)
21. Whether or not that has actually transpired or if it was just a hope, can not be verified. Source: <https://www.datacenterdynamics.com/en/news/microsofts-2bn-netherlands-data-center-revealed/> [↑](#footnote-ref-21)
22. <https://www.metaalnederland.com/wp-content/uploads/2024/04/Electricity-cost-assessment-for-large-industry-in-the-Netherlands-Belgium-Germany-and-France.pdf> [↑](#footnote-ref-22)
23. <https://business.gov.nl/subsidy/sustainable-energy-production/> [↑](#footnote-ref-23)
24. <https://english.rvo.nl/subsidies-financing/sde/features#subsidy-intensity> [↑](#footnote-ref-24)
25. Spain does have around 1,500 MW of district heating capacity, with about 70% powered by renewables like biomass and waste heat. Major systems exist in cities like Barcelona (Districlima), Pamplona, Soria, and Valladolid, though overall coverage remains limited compared to other EU countries. [↑](#footnote-ref-25)
26. <https://ambar.com/fabrica-cerveza/> [↑](#footnote-ref-26)
27. <https://solarthermalworld.org/news/more-than-eur-1-billion-of-incentives-available-in-spain/> [↑](#footnote-ref-27)
28. For reference, here is Oatly’s sustainability report for 2024: <https://a.storyblok.com/f/107921/x/cbdb92c917/oatly-sustainability-update-2024.pdf> [↑](#footnote-ref-28)
29. JRC Science and Policy report. Energy use in the EU food sector: State of play and opportunities for improvement (2015). <https://publications.jrc.ec.europa.eu/repository/bitstream/JRC96121/ldna27247enn.pdf> [↑](#footnote-ref-29)
30. Gomes, R. L., Modelling energy consumption in the dairy supply chain. Single and Multi-product Manufacturing and Distribution. EU Commission 2020. [↑](#footnote-ref-30)
31. Source: Food Drink Europe (2024). Data and Trends. EU Food and Drink Industry 2024 Edition. [↑](#footnote-ref-31)
32. This is one example: <https://tradingeconomics.com/commodity/eu-natural-gas> [↑](#footnote-ref-32)
33. <https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=685641> [↑](#footnote-ref-33)
34. <https://www.iea.org/reports/gas-market-report-q3-2025/executive-summary> [↑](#footnote-ref-34)
35. <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_price_statistics#Electricity_prices_for_non-household_consumers> [↑](#footnote-ref-35)