ANALYTICS IN BUSINESS CAPSTONE PROJECT

FINAL REPORT

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Group H

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1.0 Project Brief

1.1 Project Title

Unlocking the Value of Curtailed Wind Energy in Orkney through Smart Demand Response

1.2 Client Partner

This project is delivered in collaboration with Kaluza, a smart energy platform that specializes in the orchestration of IoT-enabled residential energy devices. Kaluza's mission is to deliver grid flexibility and decarbonization at scale through intelligent control of domestic energy assets such as electric heaters, EV chargers, and hot water systems.

1.3 Context and Rationale

The Orkney Islands present a unique paradox: despite generating over 120% of their annual electricity demand from renewable sources—primarily wind—the local grid infrastructure cannot export all this clean energy. As a result, substantial volumes of wind generation are curtailed, representing both a technical inefficiency and a financially lost opportunity for local generators and the energy system.

The Heat Smart Orkney (HSO) initiative was launched as a response to this challenge. It seeks to utilize residential demand response (DR) to absorb surplus wind energy locally by dynamically activating heating systems in homes during curtailment events. This approach not only improves system efficiency but also offers the potential to reduce energy costs for residents and improve the economic case for local renewable generation.

1.4 Project Objective

The objective of this consultancy engagement is to evaluate and design a scalable, commercially viable demand response model using Kaluza's orchestration technology. The aim is to enable the absorption of curtailed wind energy by aligning residential demand with surplus generation, thereby creating value for three primary stakeholder groups:

Residents (through reduced electricity costs),
Wind generators (through retained output and increased revenue),
Kaluza (through monetization of flexibility services and platform scalability).

1.5 Key Deliverables

The project aims to produce the following outcomes:

- A quantitative assessment of wind curtailment patterns using real-world telemetry data.
- Scenario-based modelling of household energy usage and flexibility potential.

- A multi-channel business model outlining adoption pathways and monetization strategies.
- A marketing and distribution strategy targeting 39% household penetration over five years.
- A value-sharing framework aligning the interests of residents, generators, and platform provider.
- A replication roadmap for scaling the solution to other renewable-rich, grid-constrained geographies.

1.6 Intended Outcomes

The successful execution of this project is expected to deliver the following systemic and stakeholder-level benefits:

- **System Efficiency Gains:** By reducing curtailment, the solution enhances grid utilization and supports integration of variable renewable energy.
- **Consumer Cost Reductions:** Participating households can access lower-cost electricity by consuming during surplus periods, helping to mitigate fuel poverty.
- **Revenue Upside for Kaluza and Generators:** Monetizing avoided curtailment and enabling load orchestration creates new value streams.
- **Sustainability Impact:** Utilizing more locally generated renewable energy supports carbon reduction goals and national decarbonization strategies.
- **Scalability:** The solution offers a model that can be adapted and replicated in similar energy contexts across the UK and beyond.

1.7 Project Team Structure

The consultancy team was structured into three core workstreams, each with clearly defined responsibilities:

- **Market and Stakeholder Research**
  Led by Aditi and Senalka, this team conducted qualitative and quantitative research to identify adoption barriers, stakeholder interests, and regional demand characteristics.

- **Data Analysis and Technical Modelling**
  Led by Anushka, Harsh, and Saloni, this team undertook an exploratory data analysis (EDA) of wind turbine telemetry and residential demand to model flexibility potential and system impact.

- **Business Strategy and Commercial Planning**
  Led by Aarnav, Chinmay, and Ishan, this team was responsible for developing the business model, pricing strategy, incentive design, and the go-to-market plan to ensure financial viability and alignment across stakeholders.

2.0 Business Challenge and Objectives

2.1 Strategic Context

The Orkney Islands present a unique challenge within the energy transition landscape. Despite generating more than 120 percent of their annual electricity demand from renewable sources—primarily wind—constraints in grid export capacity have led to regular and significant curtailment of clean energy. This not only undermines national decarbonization targets but also represents a loss of economic value for energy producers and missed opportunities for local communities. Addressing this challenge requires an innovative, scalable, and commercially viable solution that maximizes the use of available renewable energy while delivering measurable benefits to all stakeholders involved.

Kaluza, a leading smart energy platform provider, offers a compelling technical solution through its ability to intelligently orchestrate residential electricity loads. By activating electric heating and storage systems during periods of surplus wind generation, Kaluza's platform has the potential to absorb curtailed energy locally, thereby enhancing grid flexibility, reducing curtailment, and unlocking latent economic and environmental value.

2.2 Project Objective

The core objective of this consultancy project is to assess and optimize the deployment of Kaluza's demand response (DR) technology in Orkney. The aim is to evaluate whether the orchestration of residential energy consumption can be transformed into a viable business model that generates value for the platform provider, wind energy producers, and local residents. This involves quantifying the flexibility potential of residential loads, designing an equitable revenue distribution framework, and proposing a scalable implementation strategy that ensures long-term financial and operational sustainability.

2.3 Specific Aims

The first aim is to establish a path to commercial viability for Kaluza by demonstrating how the intelligent control of IoT-enabled household devices can be monetized. This could include value streams such as service contracts with utilities, licensing fees for the orchestration platform, and shared savings agreements based on avoided curtailment.

The second aim is to enhance revenue retention for wind generators and energy providers. By reducing the volume of curtailed energy, generators will be able to sell a greater proportion of their output, thereby increasing their return on investment. Simultaneously, energy providers will benefit from improved grid stability and reduced need for capital-intensive infrastructure upgrades.

The third aim focuses on the consumer, specifically reducing the cost of energy for Orkney residents. By aligning household energy consumption with periods of excess supply, the project creates an opportunity for residents to access electricity at reduced rates. This is particularly important in Orkney, where fuel poverty remains a significant challenge due to a combination of low incomes, inefficient housing stock, and high reliance on electric heating.

The fourth aim is to support environmental sustainability. By maximizing the use of locally generated wind power and minimizing reliance on fossil-fuel-based imports, the project contributes directly to carbon reduction goals. It also provides a replicable model for other regions facing similar constraints, making it a relevant case study for broader policy and market replication.

The final aim is to develop a scalable and sustainable operating model. While the current Heat Smart Orkney trial relies on energy subsidies to support participant engagement, such a model is not viable at scale. This project seeks to define a market-driven approach that fairly allocates the value of avoided curtailment among consumers, technology providers, and generators—thereby ensuring long-term financial sustainability without the need for ongoing public funding.

2.4 Summary

In addressing these interconnected challenges, the project aims to produce a robust and data-driven set of recommendations that align commercial incentives with social and environmental outcomes. By doing so, it supports the emergence of a smarter, more inclusive, and more resilient energy system—one in which local communities play an active role in supporting the energy transition while also benefiting from it directly.

3.0 Market Research

3.1 Overview

To ensure that the strategic recommendations proposed in this report are grounded in the realities of local conditions, a detailed examination of the housing and energy landscape in Orkney was undertaken using data from 2017. This contextual analysis provides essential insights into residential structures, income distribution, heating systems, and energy-related vulnerabilities. These factors are critical in understanding the baseline conditions that influence both the feasibility and the impact of a residential demand response programme.

3.2 Household Characteristics

In 2017, Orkney had a total of 10,385 occupied households. The average household size was 2.1 individuals, and the median number of rooms per household fell between four and five. This indicates that, relative to other regions in the United Kingdom, residential properties in Orkney are relatively spacious. This spatial availability may present operational advantages for the deployment of household energy devices such as thermal storage units or smart heaters, which require both physical space and consistent usage patterns.

3.3 Income Distribution and Affordability Challenges

The average annual household income in Orkney was estimated at £24,619. This figure is significantly lower than the Scottish national average of £34,619. The income disparity has direct implications for energy affordability, as households in Orkney have less disposable income to invest in energy-efficient technologies or participate in market-based energy initiatives. It also increases the sensitivity of these households to energy price fluctuations, underscoring the importance of targeted, affordable solutions that reduce financial barriers to participation.

3.4 Prevalence of Fuel Poverty

Fuel poverty remains one of the most pressing socio-economic challenges in Orkney. As of 2017, approximately 63 percent of households were classified as being in fuel poverty. The median fuel poverty gap—the additional amount a household would need to spend to maintain an adequate heating standard—was £1,580. This was the highest recorded in Scotland at the time. These figures reflect not only income limitations but also structural inefficiencies in the housing stock and reliance on costly or inefficient heating systems. Any demand response solution must therefore be designed with affordability and accessibility at its core to ensure social equity and policy relevance.

3.5 Heating Systems and Energy Sources

An understanding of local heating technologies is essential for evaluating the technical potential of residential demand response. In 2017, approximately 3,150 homes in Orkney relied on electric central heating systems. A further 2,989 households used oil-fired heating. Smaller segments of the population depended on solid fuel systems (180 homes), wood or biomass (73 homes), or other forms of central heating (85 homes). Notably, around 470 homes were reported to have no central heating system at all. The prevalence of electric heating offers a strong starting point for smart load control interventions, given the compatibility of these systems with digital orchestration platforms such as that provided by Kaluza.

3.6 Summary

This market research highlights that while Orkney offers a technically viable landscape for demand response innovation—particularly due to the high prevalence of electric heating—it also presents critical socio-economic challenges. The widespread incidence of fuel poverty, combined with lower average incomes and diverse heating technologies, necessitates a tailored solution that balances technological feasibility with affordability and inclusivity. Understanding these baseline conditions ensures that the proposed strategy for demand response deployment is not only technically effective but also socially responsive and economically realistic.

4.0 Exploratory Data Analysis (EDA)

The complete eda file is in .ipynb format attached along with this file

4.1 Methodological Approach

This analysis was grounded in a multi-source dataset that included wind turbine telemetry, residential electricity demand data, and heating system profiles for households in Orkney. The methodology followed a systematic structure combining time-series analysis, statistical modeling, and scenario simulation. The core objective was to assess the feasibility of using smart demand response (DR) systems to absorb curtailed wind energy and reduce energy costs for residents while supporting generator revenue and grid stability.

The methodology proceeded in the following stages:

- **Data Cleaning and Preprocessing:**
  Turbine telemetry data from 2015 to 2018 was cleaned to remove missing and non-

representative entries. Given significant data gaps in 2015, only data from 2016 to 2017 was used for analysis. Hourly resampling was performed to align turbine generation data with demand-side profiles.

- **Curtailment Identification:**
  Curtailment was calculated by comparing the actual power output against the maximum allowable setpoint. The difference was aggregated to determine both hourly and seasonal curtailment volumes.

- **Wind-to-Power Correlation Modeling:**
  The relationship between wind speed and turbine power output was visualized and modeled using empirical power curves to predict theoretical maximum generation and to validate curtailment estimations.

- **Residential Demand Profiling:**
  Demand data was segmented into monthly averages and household usage tiers (low, medium, high). A flexibility factor of 50 percent was applied to simulate controllable load, following industry norms for thermal storage and smart electric heating systems.

- **Scenario Simulations:**
  Penetration rates of 10 to 50 percent were applied to determine the number of households required to meet DR targets. The effect of these interventions was modeled on monthly system demand curves to simulate reductions in peak loads and energy waste.

- **Value Distribution Modeling:**
  The economic value of avoided curtailment was simulated and distributed across stakeholders (farmers, residents, Kaluza) under several revenue-sharing scenarios. Seasonal adjustment was later introduced to reflect higher curtailment risk in winter.

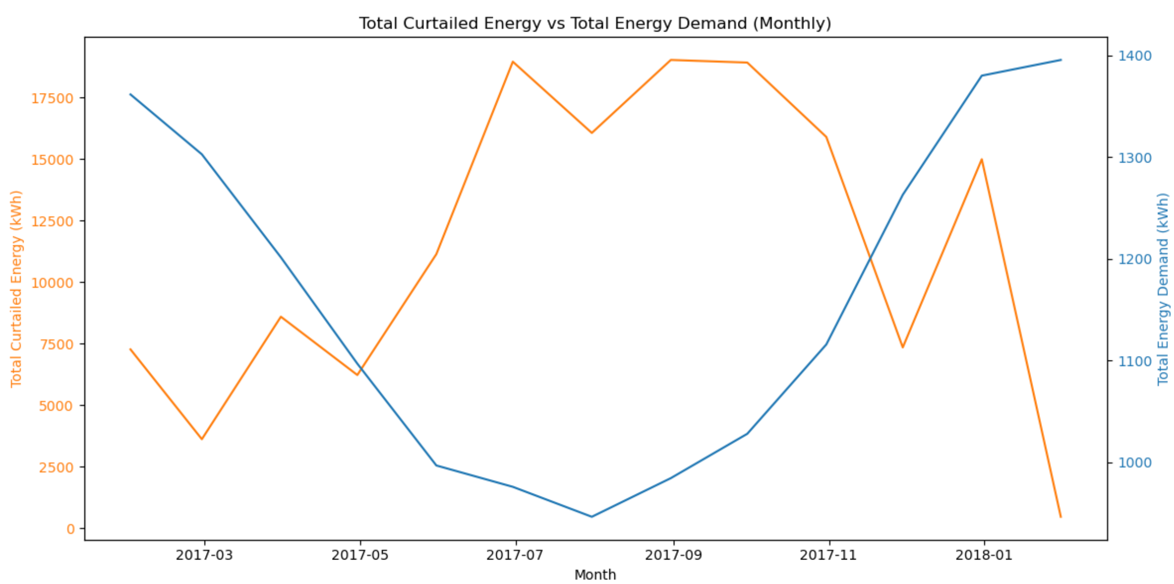
4.2 Analytical Approach

The primary analytical objective of this project was to quantify the volume and value of curtailed wind energy in Orkney, assess the conditions under which curtailment occurs, and estimate the potential economic recovery through targeted interventions. This required a detailed reconstruction of turbine performance, identification of energy loss patterns, and monetization of curtailed output using realistic market pricing. These insights directly informed the pricing model, revenue distribution scenarios, and system design recommendations.

4.3 Seasonal and Temporal Trends
Visual analysis of curtailment by month and hour revealed distinct patterns:

- **Seasonal Concentration:**
  Approximately 70 percent of total curtailment occurred between October and April, aligning with Orkney's windiest months. This supports the design of a pricing and operational model that prioritizes high-season flexibility and incentive schemes.

- **Time-of-Day Impact:**
  Curtailment peaks were consistently observed between 13:00 and 16:00, indicating that mid-afternoon is the critical window for intervention. This was attributed to low residential load and high wind output during these hours, underscoring the need to target this window for any recovery or absorption strategies.



This plot illustrates the monthly total curtailed energy (orange line, left y-axis) in relation to the total energy demand (blue line, right y-axis) throughout 2017. Several key observations emerge:

Inverse Relationship: There is a clear inverse relationship between curtailed energy and energy demand. During the summer months (around June to September), curtailed energy reaches its peak, while energy demand is at its lowest. Conversely, in winter months (January to March and November to December), curtailed energy drops and demand increases.

Curtailment Opportunity: This dynamic highlights a significant mismatch between supply and demand—a core insight that supports the business opportunity for curtailment optimization.

Especially in summer, substantial amounts of potential energy are curtailed while demand is low, indicating excess generation capacity that could be better utilized.

Systemic Imbalance: These patterns underscore the importance of demand-side flexibility and intelligent energy distribution

4.4 Pricing and Value Estimation

To convert technical curtailment into financial terms, a market-based approach was adopted:

- **Wholesale Electricity Price:**
  A flat rate of £0.10 per kWh was applied to all curtailed energy, aligning with conservative UK wholesale electricity estimates during off-peak hours.

- **Total Curtailment Value:**
  Based on the annual curtailment estimate of 607,520 kWh, the recoverable market value of curtailed energy is £60,752 per turbine per year. When extrapolated to multiple turbines across Orkney, the total recoverable value approaches £220,000 annually, forming the economic basis for business model projections.

- **Avoided Curtailment as Revenue Stream:**
  This figure was then used to model a hypothetical revenue stream in which Kaluza, wind farmers, and households could share the avoided curtailment value through software licensing, hardware installation, or energy credit redistribution.

4.5 Implications for System Design and Strategy

- The quantification of curtailment, its consistent seasonal pattern, and its concentrated value provide a strong technical justification for targeted interventions.
- Afternoon recovery windows and winter-heavy curtailment suggest that operational strategies and pricing incentives should be weighted accordingly.
- The translation of technical curtailment into recoverable value creates a financial anchor that supports stakeholder participation and business model sustainability.
- These insights also establish a framework for cost-benefit analysis when evaluating investment in orchestration platforms, storage systems, or load control infrastructure.

5.0 Business Plan

5.1 Core Proposition

The central proposition of this business model is to harness curtailed wind energy in Orkney by deploying Kaluza's internet-connected control technology. These smart devices integrate with residential heat storage systems to store electricity during periods of low demand and high curtailment—typically in the afternoon—and then release heat during peak evening hours. This strategy provides tangible benefits to all key stakeholder groups. Local households gain access to more affordable heating powered by renewable energy. Kaluza establishes a scalable commercial platform capable of delivering real-time grid flexibility. Simultaneously, the broader energy system benefits from a reduction in wind curtailment and a decrease in reliance on fossil fuel-based imports.

5.2 Revenue Model

The revenue strategy is structured around a hybrid model that combines upfront hardware sales with ongoing software subscription services. Kaluza will offer flexible market access through three complementary distribution channels, each targeting a different segment of the consumer and commercial landscape.

5.2.1 Direct-to-Consumer Channel

Under the direct-to-consumer model, Kaluza will sell its devices directly to environmentally conscious households, early adopters of smart technologies, and cost-sensitive consumers seeking to lower their energy bills. The retail pricing strategy includes a device cost of one hundred pounds and a recurring subscription fee of five pounds and ninety-nine pence per month. Households installing three or more devices will qualify for a discounted subscription rate of four pounds and ninety-nine pence per device per month. Sales will be facilitated through Kaluza's official website, as well as through partnerships with energy retailers and online smart home product marketplaces. This channel offers high per-unit margins, provides Kaluza with full control over branding and customer experience, and is highly scalable through targeted digital marketing efforts.

5.2.2 Integration with Original Equipment Manufacturers

A second sales pathway involves integration with manufacturers of heat storage systems and other residential heating solutions. In this model, devices will be sold in bulk at a unit price of eighty pounds. Manufacturers will embed Kaluza's technology into their heating appliances as a value-added feature. The software subscription model remains consistent, with the same monthly fee structure and bundled pricing available to customers.

This strategy enables cost-efficient customer acquisition, accelerates the rate of market penetration, and ensures immediate compatibility with a wide range of heating infrastructure already in place across Orkney. It also supports expansion into new housing developments and appliance replacement cycles.

5.2.3 Broadband and Internet Service Provider Partnerships

The third distribution model is structured around partnerships with broadband and internet service providers. In this arrangement, consumers will pay an additional seven pounds per month on their broadband bill, which will include a free internet-connected device, full access to the orchestration platform, enhanced connectivity features, and a subscription to Kaluza's services. Internet service providers will receive a one-pound per month revenue share per customer.

This approach aligns with the increasing digital connectivity observed in rural Scotland and presents an attractive bundled proposition to households. It eliminates the need for an upfront hardware payment, thereby lowering barriers to entry and simplifying onboarding for new customers.

5.3 Strategic Fit and Scalability

The proposed multi-channel strategy has been designed to ensure comprehensive market reach, operational flexibility, and sustained scalability. The direct-to-consumer model targets early adopters and digitally engaged households who are more likely to embrace new energy technologies. The original equipment manufacturer model facilitates integration with existing heating infrastructure and captures value from appliance upgrade cycles and new residential developments. The internet service provider model enables rapid deployment in rural areas, leveraging existing broadband relationships to introduce Kaluza's technology at scale.

Together, these three pathways support the overarching goal of scaling residential demand response across Orkney. Moreover, the structure is designed to be replicable in other regions across the United Kingdom that face similar challenges in integrating renewable energy into constrained local grids. This business model lays the foundation for long-term commercial growth while contributing to the decarbonization and digital transformation of the residential energy sector.

6.0 Marketing Strategy

6.1 Strategic Objective

The primary marketing objective is to support the adoption of Kaluza's connected thermal storage solution in Orkney by activating demand across a diverse customer base. The marketing strategy is designed to enable meaningful utilisation of curtailed wind energy while positioning Kaluza as a trusted technology partner in the transition to smarter, cleaner home energy. The commercial target is to reach 39 percent household penetration over five years, representing an estimated revenue opportunity of approximately four point eight million pounds.

6.2 Customer Segmentation

The residential market has been segmented into three core groups, each defined by their current heating systems and their readiness to adopt new technologies. Each segment is approached with differentiated messaging and acquisition strategies.

- The group A includes homes already equipped with electric storage heaters. These customers represent the most accessible early adopters due to the existing technical compatibility of their systems. This segment is expected to contribute approximately sixteen percent of total adoption.

- The group B consists of households with electric heating systems that are not designed for energy storage. These customers will be targeted through upgrade incentives and messaging that focuses on long-term savings and climate benefits. This segment is projected to account for seven percent of total adoption.

- The group C comprises homes that currently rely on fossil fuels or lack central heating altogether. These households will be engaged through partnerships and bundled offers, especially where there is a need for equipment replacement. This segment is expected to drive another sixteen percent of adoption.

6.3 Channel Strategy

To deliver scale and flexibility, Kaluza's go to market approach is structured around three primary sales and marketing channels. Each channel is aligned with specific customer behaviours and acquisition pathways.

6.3.1 Direct to Consumer

Kaluza will engage directly with households through its official website and a curated network of local hardware retailers. A digital campaign strategy will focus on geo targeted advertising using

platforms such as Facebook, Google, and YouTube. These efforts will be supported by local offline activities including printed mailers, utility bill inserts, and branded displays in community centres. To incentivise early adoption, new customers will be eligible for a free one year subscription when the product is bundled with select internet service provider packages.
This channel is designed to maximise brand visibility, customer control, and margin retention. It is especially suited to digitally engaged households and environmentally conscious consumers

6.3.2 Manufacturer Integration

Kaluza will form strategic partnerships with heat storage equipment manufacturers to embed its orchestration technology directly into new appliances. These original equipment manufacturer partnerships will include co branded promotions, retrofit campaigns, and sales enablement materials that position Kaluza as a premium value add feature. This route to market supports efficient scaling and ensures compatibility with a wide range of heating systems at the point of manufacture.

6.3.3 Broadband Partnerships

The third channel focuses on collaboration with broadband and internet service providers. In this model, the Kaluza device is bundled with a household's internet package for an additional seven pounds per month. This price includes the device, cloud access, and smart control capabilities. A portion of the monthly fee, typically one pound, is shared with the provider to create a mutually beneficial revenue model.

This approach offers immediate access to large customer bases and simplifies onboarding by integrating energy services into a familiar billing structure. It is particularly well suited for deployment in rural areas, where broadband adoption is accelerating and where upfront equipment costs can be a barrier.

6.4 Strategic Fit

The multi-channel strategy enables Kaluza to reach a broad and diverse market while balancing customer engagement, operational cost, and sales velocity. The direct-to-consumer path captures early adopters and offers high control over the user journey. Manufacturer integration allows for deep alignment with product life cycles and simplifies scaling. Internet provider partnerships expand access in rural and hard to reach communities, offering a frictionless entry point for customers new to smart energy technology.

Together, these strategies form a coherent and commercially focused approach to marketing Kaluza's residential demand response solution. They support not only the immediate goal of adoption in Orkney, but also provide a replicable framework for national expansion across other renewable intensive but grid constrained regions.

Campaign Name	Target Segment	Offer Description
Smart Start Upgrade	Segment A	Free install + 1st year cloud access
Scrappage Scheme	Segments B, C	£150–£750 rebate for replacing old heaters
Warm Neighbours Referral	Segment A	£25 referral bonus for both parties
Try Smart Heat (60-Day)	Segment B	No-commitment trial to encourage conversion
Cold Home Makeover	Segment C	Full system giveaway via story-based application
Fuel Bill Challenge	All Segments	Savings forecast based on current bill uploads

Budget & KPIs

- Marketing Budget: £848,000 (17.5% of revenue ceiling)
- Estimated CAC: ~£70
- Primary KPIs:
- Monthly installations (by segment)
- Subscription conversions
- Website traffic and lead form completions
- Engagement and click-through rates (ads, emails)

Adoption Timeline (5-Year Horizon)

Segment	Phase 1 (Years 1–2)	Phase 2 (Years 3–5)
A	Fast capture (TV/radio)	Plateau, upsell and retain
B	Awareness, trials	Peer-led scaling via testimonials
C	Education, incentives	Trust-led adoption via community

This multi-channel strategy ensures Kaluza's solution reaches the diverse Orkney market with tailored value propositions supporting revenue growth, sustainability outcomes, and customer affordability.

7.0 Pricing Model

7.1 Marketing Strategy

Addressable households on Orkney: 10385 (grid-connected dwellings that could host controllable devices).

7.2 Proposed price architecture

Component	Kaluza device	OEM device	ISP-bundled
Up-front device price (per unit)	£100	£80	£0
Subscription fee (per device per month)	£4.90	£4.90	£5.90
Average devices per home	3	3	1
Installation cost (borne by Kaluza)	£60	£0*	£40
Manufacturing cost (per unit)	£50	£50	£50

* OEM assumes installations are self-fit or funded separately; no cost booked in the model.
Devices per home: 3 for Kaluza and OEM customers; 1 for ISP customers (bundled with plan).
Assumption for 3 device bundled purchase, installation cost is £60, while single device installation bundled with ISP costs £40.

7.3 Volume outlook & market penetration assumptions

Year	Penetration rate (new-build)	Cumulative penetration	New homes equipped	Cumulative homes
1	8 %	8 %	831	831
2	10 %	18 %	1039	1869
3	8 %	26 %	831	2700
4	7 %	33 %	727	3427
5	6 %	39 %	623	4050

- (Totals = rate × 10 385; rounded to nearest whole home.)
- Overall Channel split: Kaluza 38%, OEM 40%, ISP 22%. of devices.
- Resulting hardware / device volumes: ~ 10000 devices shipped over five years

7.4 Financial outcomes (5th year view, undiscounted cashflows)

NPV= £3.86 m *	Cumulative Revenue (Hardware + Subscription)	Cumulative Cost *	**Cumulative Profit**
Kaluza + Retail	**£2.69 m**	£0.82 m	£1.87 m
OEM	**£4.25 m**	£0.76 m	£3.49 m
ISP	**£1.08 m**	£0.60 m	£0.47 m
Combined	**£8.03 m**	£2.20 m	£5.83 m

* **Cumulative Cost = Operation & Maintenance Cost + Installation Cost + Manufacturing cost.**
* **For NPV, WACC is considered as 9.5%.**

- Subscription cash-flow dominates: ~ 90% of lifetime value comes from the £4.90 device fee once homes are online.
- Incorporated Cost of inflation: Operation and Maintenance cost grows 2% p.a.; manufacturing and install costs scale linearly with device count.
- 5-year NPV of the project comes around £3.86 m, while calculating IRR come to 235%.

7.5 Sensitivity Analysis of the Pricing Plan

This section stress-tests the commercial model on two axes:
Break-even & economies-of-scale thresholds for each route-to-market.
Subscription-price elasticity – the effect on value if we lift or cut the monthly fee.

7.6 Break-even & economies of scale

Channel	Market Penetration for Breakeven	# Households	# Devices	Breakeven Year
Kaluza + Retail	**7.15 %**	**≈ 742**	**≈ 2227**	**Year 3**
OEM Partner	**3.78 %**	**≈ 393**	**≈ 1178**	**Year 1**

The ISP line itself breaks even in Year 5, but when aggregated with the other years considering the cumulative effect the strategy is cash-positive from **Year 4**.

7.7 Subscription-price sensitivity (five-year window)

Scenario	Monthly device fee (K / O / I) *	Five-year NPV (£ m, 9.5 % WACC)	Cum. profit Yr 5 (£ m)
Base case	**4.9 / 4.9 / 5.9**	**3.86**	**5.84**
+ £1	**5.9 / 5.9 / 6.9**	**4.84**	**7.27**
– £1	**3.9 / 3.9 / 4.9**	**2.89**	**4.40**

* K = Kaluza; O = OEM; I = ISP

Key Takeaway:

- More than 90 % of income comes from the monthly per-device fee (subscription), the model is highly sensitive to its price movements.
- Base case: Generates a five-year NPV of £3.9 m, cumulative profit of £5.8 m, and a pay-back in Year 3.
- Increase fee by £1: Adds roughly £1 m to NPV and £1.4 m to five-year profit, while pulling cash pay-back forward to Year 2 and trimming household break-even to ~725.
- Cut fees by £1: Erodes NPV by a similar £1 m and suppresses cumulative profit by £1.4 m. The project still breaks even overall in Year 3, but Kaluza now needs about 760 homes to benefit from economies of scale.
- A swing of just ±£1 in the monthly fee can shift five-year value by roughly 25 %.

8.0 Deliverables

Consumers (People of Orkney)

Benefit from lower energy bills and improved heating comfort by utilizing cheaper wind power stored during off-peak hours in advanced smart heat storage devices, particularly for off-gas households.

OEMs (Original Equipment Manufacturers)

Drive the adoption of smart appliances and storage heaters, opening new revenue opportunities while accelerating the growth of the smart home ecosystem in rural energy markets.

ISPs (Internet Service Providers)

Enhance customer acquisition and retention by offering bundled energy and internet deals, increasing monthly revenue and fostering long-term loyalty through added incentives.

Wind Farmers

Create new revenue from previously curtailed energy, ensuring more stable income and reducing financial losses without the need for new infrastructure or subsidies.

Energy Providers

Enhance grid stability and customer loyalty through dynamic tariffs and by harnessing affordable local wind energy to reduce peak demand and improve load balancing.

Government

Advance net-zero and fuel poverty goals by supporting local renewable energy, cutting carbon emissions, and promoting energy equity in rural and island communities.

9.0 Future Plans

1. Expand to commercial buildings

Deploy demand response-enabled heat storage in high-consumption sites such as supermarkets, offices, and public buildings to maximize the impact of demand shifting.

2. Export the Orkney model

Replicate the demand response and curtailed wind energy integration strategy in other constrained renewable regions across the UK and internationally.

3. Target farms and rural households

Extend this solution to remote and agricultural communities with high energy costs and limited grid access, ensuring equitable access to benefits.

4. Engage government for subsidy-backed rollout

Partner with local and national governments to secure funding for deployment in low-income homes through energy poverty grants and rural innovation programs.

5. Add hybrid storage capability

Incorporate small battery storage to capture curtailed energy not used for heating, broadening use cases to include EV charging and powering appliances.

10.0 Limitations

1. Grid dependency

The approach remains limited by local grid infrastructure, which can cap the amount of curtailed energy that can be redirected without grid upgrades.

2. Capital cost barrier

High upfront costs for heat storage devices may hinder adoption, particularly for low-income households lacking financial support or subsidies.

3. Behavioral inertia

Some users may be hesitant to adopt or may override automated heating controls due to comfort needs or lack of familiarity.

4. Forecasting accuracy

Success depends on accurate wind and demand forecasting; poor predictions can reduce overall efficiency and impact.

5. Limited storage flexibility

Heat storage capacity is finite and may not perfectly align with peak curtailment periods or diverse energy needs.

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11.0 Appendix

1) Revenue Model from Different Strategies:

Kaluza + Retail											
Year	Cumulative Homes (Installed)	New Homes	Hardware Margin (£)	Subscription Revenue (£)	Cumulative Revenue (£)	O&M Cost (£)	Installation Cost (£)	Manufacturing Cost (£)	Cumulative Revenue (£)	Profit (£)	Cumulative Profit (£)
1	166	166	49,848.00	29,310.62	79,158.62	100,000.00	9,969.60	24,924.00	134,893.60	-55,734.98	-55,734.98
2	426	260	77,887.50	104,419.10	261,465.22	102,000.00	15,577.50	38,943.75	291,414.85	25,785.35	-29,949.63
3	758	332	99,696.00	267,459.44	628,620.67	104,040.00	19,939.20	49,848.00	465,242.05	193,328.24	163,378.62
4	1,122	363	109,042.50	599,035.88	1,336,699.04	106,120.80	21,808.50	54,521.25	647,692.60	525,627.83	689,006.44
5	1,464	343	102,811.50	1,258,524.92	2,698,035.46	108,243.22	20,562.30	51,405.75	827,903.87	1,181,125.15	1,870,131.60
				2,258,749.96							

OEM											
Year	Cumulative Homes (Installed)	New Homes	Hardware Margin (£)	Subscription Revenue (£)	Cumulative Revenue (£)	O&M Cost (£)	Installation Cost (£)	Manufacturing Cost (£)	Cumulative Revenue (£)	Profit (£)	Cumulative Profit (£)
1	374	374	89,726.40	65,948.90	155,675.30	100,000.00	0.00	56,079.00	156,079.00	-403.70	-403.70
2	841	467	112,158.00	214,333.94	482,167.24	102,000.00	0.00	70,098.75	328,177.75	154,393.19	153,989.49
3	1,174	332	79,756.80	487,289.12	1,049,213.17	104,040.00	0.00	49,848.00	482,065.75	413,157.92	567,147.42
4	1,428	254	61,063.80	1,019,460.14	2,129,737.11	106,120.80	0.00	38,164.88	626,351.43	936,238.27	1,503,385.68
5	1,646	218	52,340.40	2,077,390.48	4,259,467.98	108,243.22	0.00	32,712.75	767,307.39	1,988,774.91	3,492,160.59
		1,646		3864422.583							

ISP											
Year	Cumulative Homes (Installed)	New Homes	Hardware Margin (£)	Subscription Revenue (£)	Cumulative Revenue (£)	O&M Cost (£)	Installation Cost (£)	Manufacturing Cost (£)	Cumulative Revenue (£)	Profit (£)	Cumulative Profit (£)
1	291	291	0.00	20,587.22	20,587.22	100,000.00	11,631.20	14,539.00	126,170.20	-105,582.98	-105,582.98
2	602	312	0.00	63,232.19	83,819.41	102,000.00	12,462.00	15,577.50	256,209.70	-66,807.31	-172,390.29
3	768	166	0.00	138,228.50	222,047.92	104,040.00	6,646.40	8,308.00	375,204.10	19,234.10	-153,156.18
4	878	109	0.00	284,177.22	506,225.13	106,120.80	4,361.70	5,452.13	491,138.73	168,242.59	15,086.41
5	940	62	0.00	572,765.98	1,078,991.12	108,243.22	2,492.40	3,115.50	604,989.84	458,914.87	474,001.27

2) 3 Test Cases showcasing Revenue Generation based on Different Prices:

A. Increasing the price by £1

Change Price +1 (5.9,5.9,6.9)		
Year	Profits Combined	Cumulative Profit
Year 1	-138,791.57	-138,791.57
Year 2	189,140.18	50,348.62
Year 3	803,179.15	853,527.77
Year 4	2,008,579.63	2,862,107.39
Year 5	4,406,692.97	7,268,800.36
	NPV	**4,839,108.83**
	Kaluza	OEM
Breakeven Percentage	6.99%	3.74%
Breakeven Household	726.22	388.05
Breakeven Devices	2,178.67	1,164.14

B. Recommended Price

Normal Test-case (4.9,4.9,5.9)		
Year	Profits Combined	Cumulative Profit
Year 1	-161,721.65	-161,721.65
Year 2	113,371.22	-48,350.42
Year 3	625,720.27	577,369.85
Year 4	1,630,108.69	2,207,478.53
Year 5	3,628,814.93	5,836,293.46
	NPV	**3,862,429.43**
	Kaluza	OEM
Breakeven Percentage	7.15%	3.78%
Breakeven Household	742.39	392.62
Breakeven Devices	2,227.18	1,177.85

C. Decreasing the price by £1

Change Price -1 (3.9,3.9,4.9)		
Year	Profits Combined	Cumulative Profit
Year 1	-184,651.73	-184,651.73
Year 2	37,602.26	-147,049.46
Year 3	448,261.39	301,211.93
Year 4	1,251,637.75	1,552,849.67
Year 5	2,850,936.89	4,403,786.56
	NPV	**2,885,750.03**
	Kaluza	OEM
Breakeven Percentage	7.31%	3.83%
Breakeven Household	759.30	397.23
Breakeven Devices	2,277.90	1,191.68