Heat Smart Orkney (HSO) Demand-Response Valuation Analysis

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AGENDA

- Background & Purpose
- Hypotheses

- Curtail energy analysis

- Consumption pattern analysis
- Value analysis
- Sustainable solution

- Strengths & limitations
- Future opportunities

INTRODUCTION

Background

In Orkney, there are 500 wind turbines generating excess power than current island residential demand and export

Purpose

Feasibility of HSO programme based on amount of curtailed energy and number of residents involved

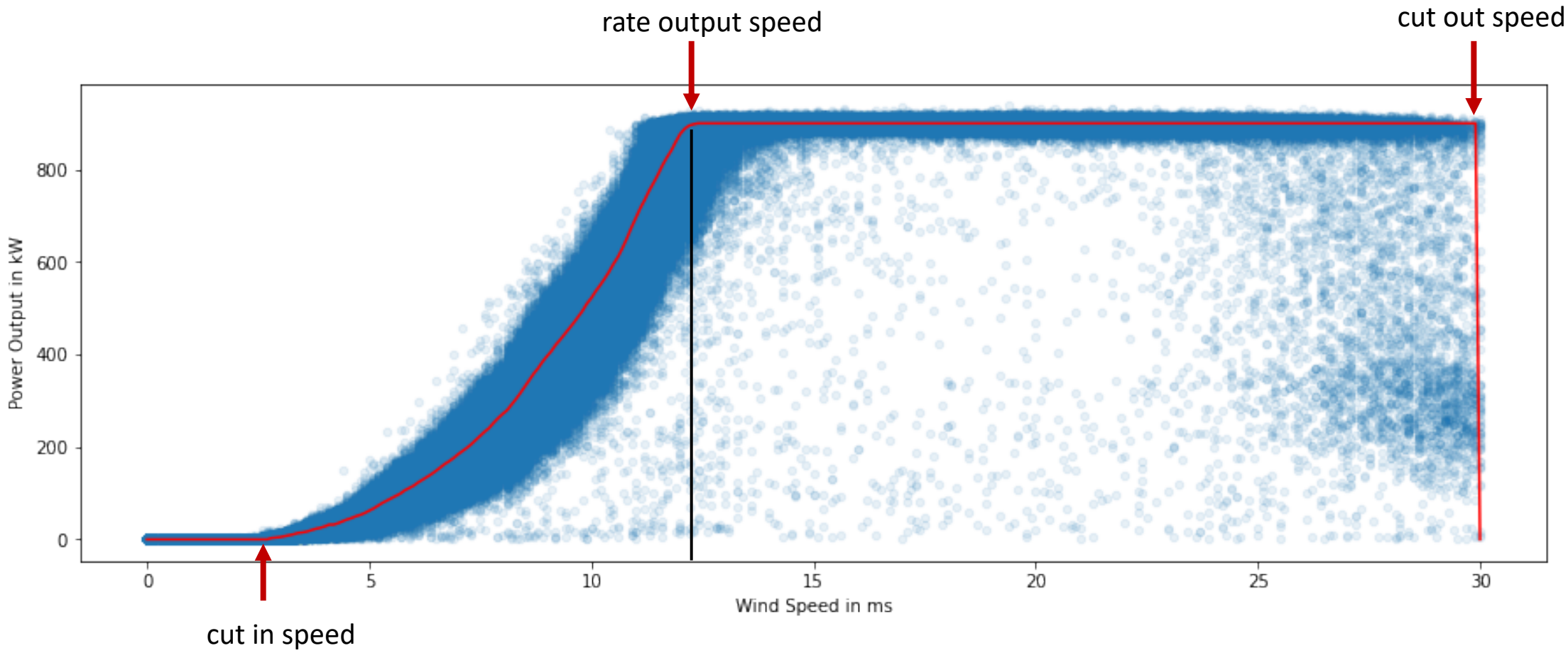
Hypotheses

- ❑ There is sufficient curtailed energy for feasibility
- ❑ The feasibility will also be determined by number of residents, costs, revenue, and environmental impact
- ❑ The project will deliver environmental values for residents

HSO OPPORTUNITY: WIND MODEL

The model aims to estimate maximum power generated using wind turbines on Orkney island

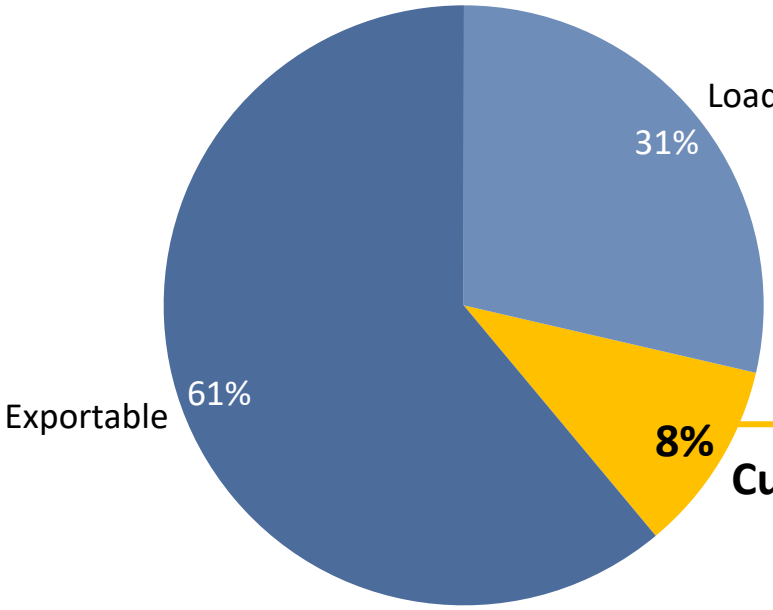
Data: Orkney wind turbine telemetry data



HSO OPPORTUNITY

Energy Curtailed = Potential Energy − Energy Consumed − Energy Exported

Data: Wind turbine telemetry data & household consumption data for 2017



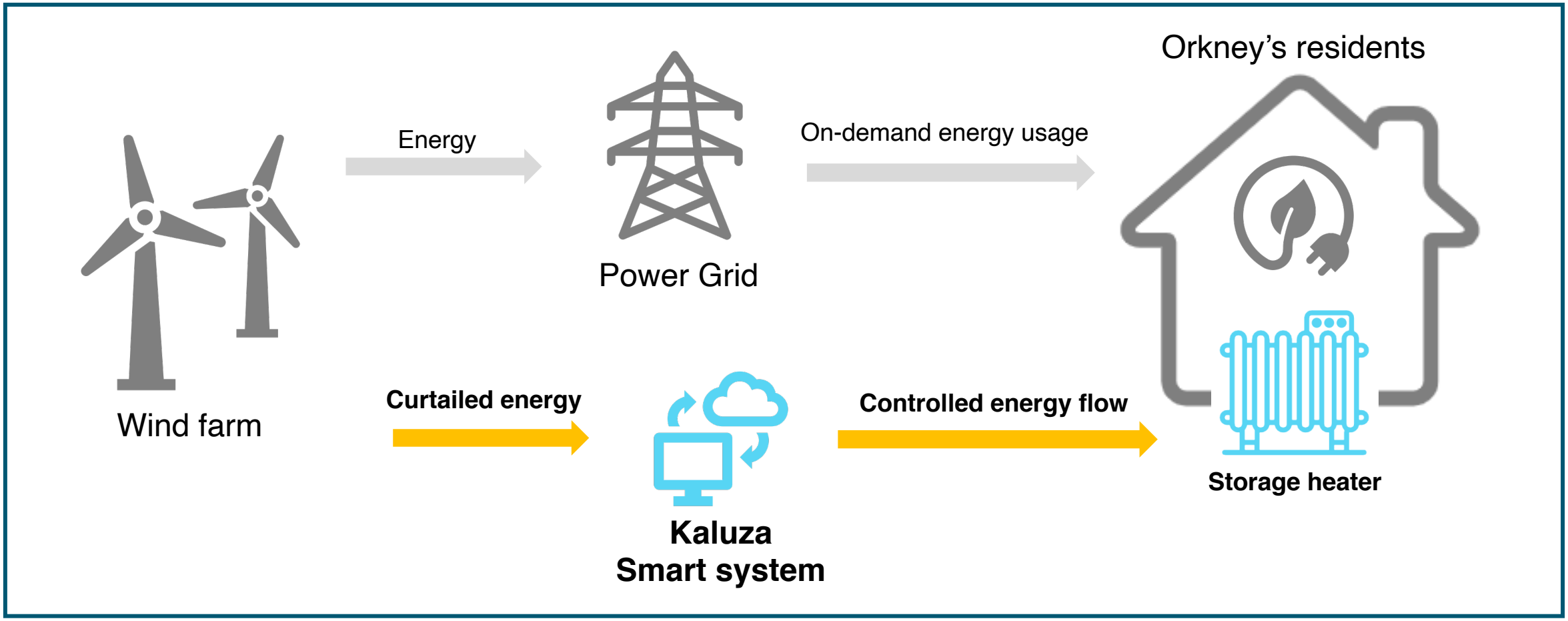
20,683MWh

2068 average households per year

☑ There is sufficient energy for feasibility of HSO programme

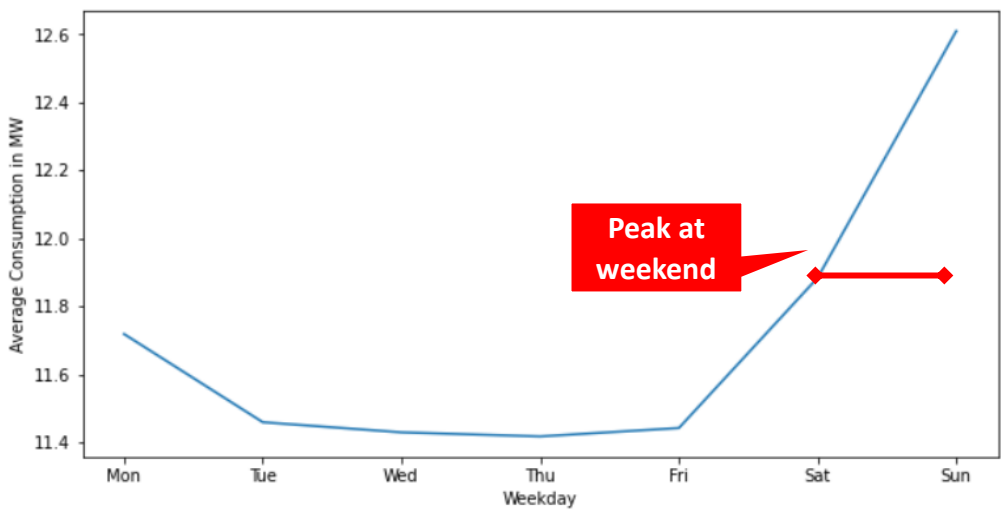
DIRECT RESPONSE SCHEME

Direct Response Scheme aims to control the heating of storage heaters to consume curtailed energy from wind turbines on Orkney islands.



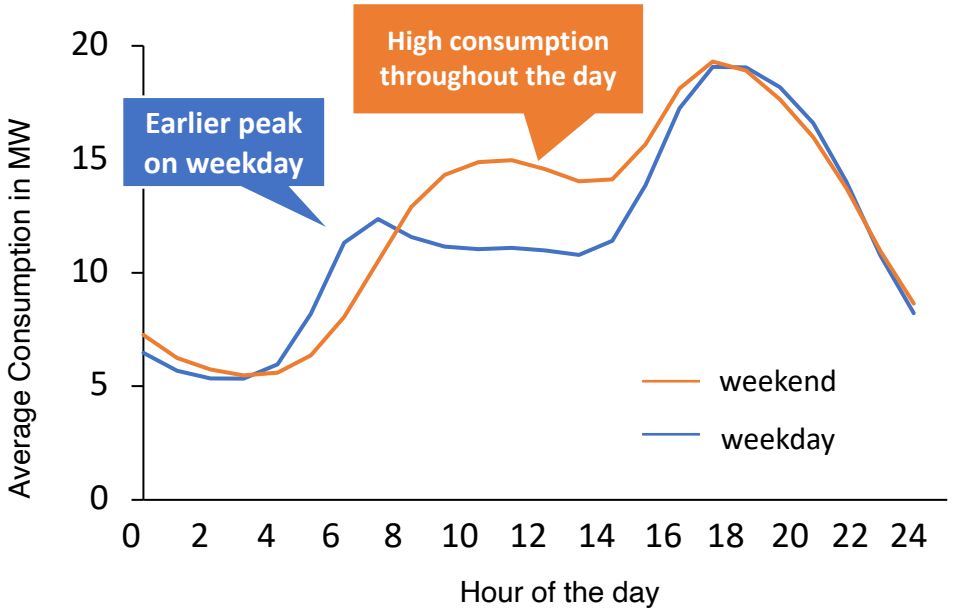
CONSUMPTION PATTERNS

Day of the Week



Consumption pattern varies during the week. Peak consumption rate over the weekend

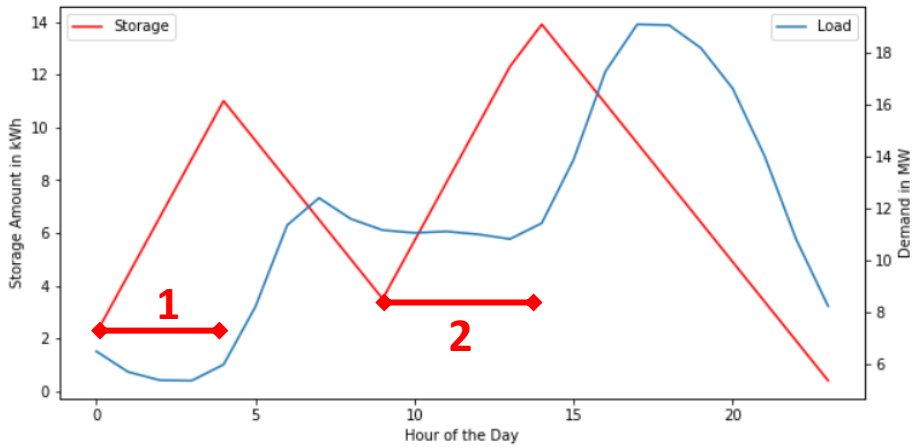
Hour of the Day



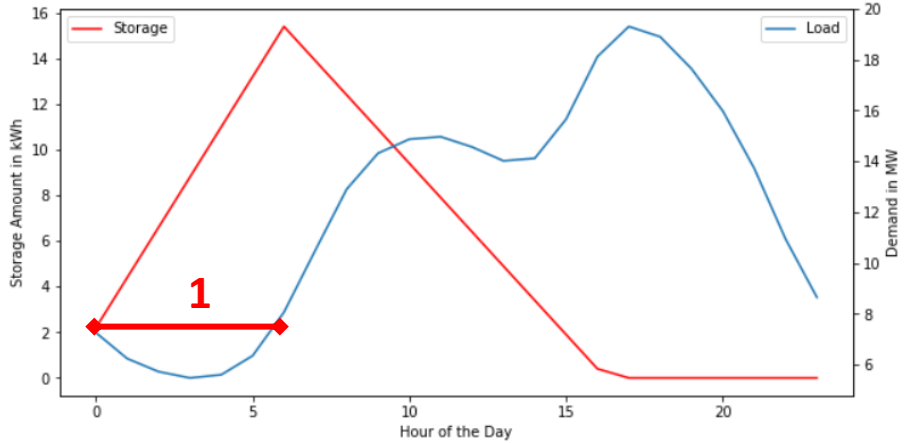
Consumption pattern during the day matches with normal workday schedule.

CONSUMPTION PATTERNS: APPLICATION

Weekday



Weekend

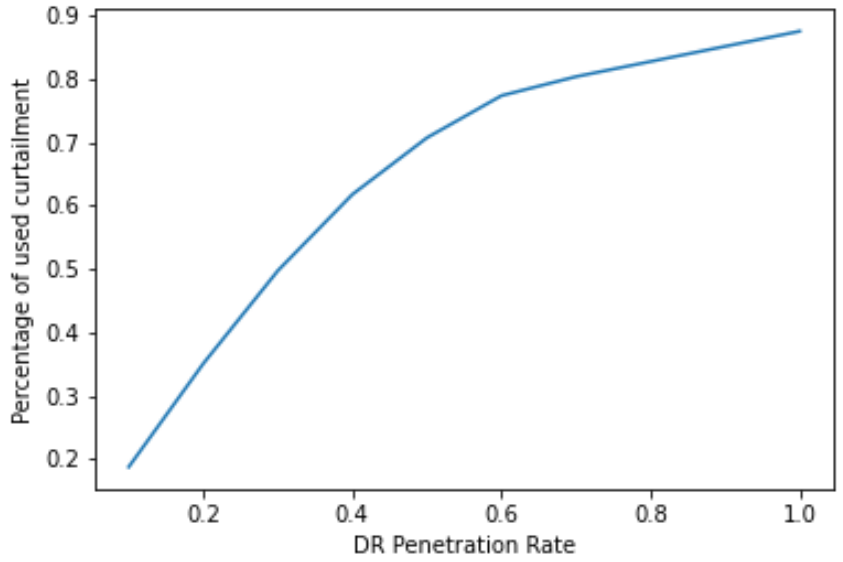


Store curtailed energy in storage heaters once before weekday morning heating at 6:00 (1) and once before evening heating at 15:00 (2)

Store curtailed energy in storage heaters once before weekend morning heating at 8:00 (1)

VALUE ANALYSIS

Project feasibility



Higher residents participation results in higher reduction in curtailed energy
Non-linear increase in curtailed energy usage

All households can join the DR scheme

Commercial viability

DR Penetration Rate

Participation rate on 10,500 households varied to determine optimal business model

Revenue / Benefits Generated

Curtailed energy sold to households at maximum Economy 7 rate with varying discounts

Cost Incurred

- Storage heaters & installation
- Operating & Management
- Energy purchase

Environmental Impact

Reduction of emissions by introducing storage heaters.
60% of households with oil heaters currently

☑ The feasibility will also be determined by number of residents, costs, revenue, and environmental impact

VALUE ANALYSIS: SCENARIO I

	Kaluza		Orkney residents
Cost Incurred	£500/storage heater/household + 10% installation fee	+	£750/storage heater (same price for all users)
Revenue / Benefits Generated	Sales margin: 2.7p/kwh Payback period: 5 years Max NPV of £739,126/10 years	+	Economy 7 rate - 20% discount 3 years payback period (electricity heater users) No additional benefit (oil heater users)
DR Penetration Rate	40% DR penetration	=	4,200 households
Environmental Impact	53,516 tons carbon emission reduced £2.6M saved due to displaced Carbon		

Positive environmental impact from the project will help in getting Scottish government involved to increase attractiveness to oil customers

The project will deliver environmental values for residents

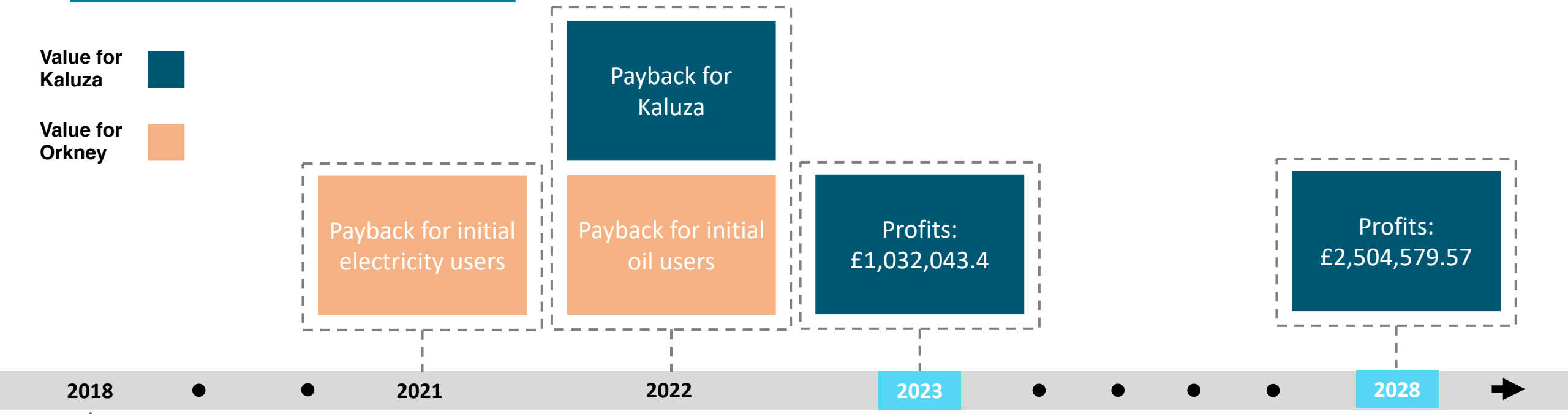
VALUE ANALYSIS: SCENARIO II

Support needed from Scottish government:

- For Orkney residents:
  - 90% cost of the stored electricity for oil heater users
  - 50% of cost for oil users' storage heaters
- For Kaluza:
  - 50% of cost for replacing the oil heaters

	Kaluza		Orkney residents
Cost Incurred	£250/storage heater/household + 10% installation fee	+	£375/storage heater (oil heater users) £750/storage heater (electricity users)
Revenue / Benefits Generated	Sales margin: 2.7p/kwh Payback period: 3 years Max NPV of £1,452,090/10 years	+	90% rebate (oil heater users) & 20% (electric heater users) 4 years payback period (oil heater users) 3 years (electric heater users)
DR Penetration Rate	50% DR penetration	=	5,250 households
Environmental Impact	53,446 tons carbon emission reduced £2.6M saved per year due to displaced Carbon		

SUSTAINABLE SOLUTION



- **No. of residents:** 5,250 residents
- **Initial investment:** £1,244,250
- **Discount Rate:** 20% for electricity users
- **Price:** Economy 7 rate with 20% discount for electric heater users
- **Government support:** 50% cost investment reduction for Kaluza & 90% cost reduction for residents
- **Curtailed plan:** energy stored twice in weekdays and once in weekend

STRENGTHS & LIMITATIONS

Strengths

- Design of DR scheme considered customer consumption behavior
- Performed value analysis based on reasonable assumption to evaluate the viability of HSO project

Limitations

- The NPV calculation takes equal supply of curtailed wind energy
- Assumed all households partaking in this initiative have one storage heater instead of multiple
- No increase in DR with time

How We Plan to Address the Limitations

- Perform NPV evaluation with data for multiple years
- Conduct dynamic analysis with respect to the number of heaters in each households

FUTURE OPPORTUNITIES

New Products

- Apply model to products similar to space heating

Heating for water cylinders

Electric Charging stations

New Locations

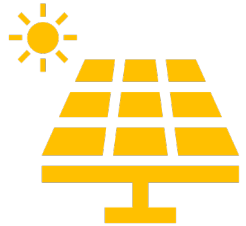
- Apply model to windy islands similar to Orkney

Maderia, Portugal

Samsø, Denmark

New Opportunities

- Apply model to other types of renewable energy



Solar energy opportunity

Hydro energy opportunity

THANK YOU FOR YOUR ATTENTION