4th Generation District Energy Network Development
Kinlochleven Case Study

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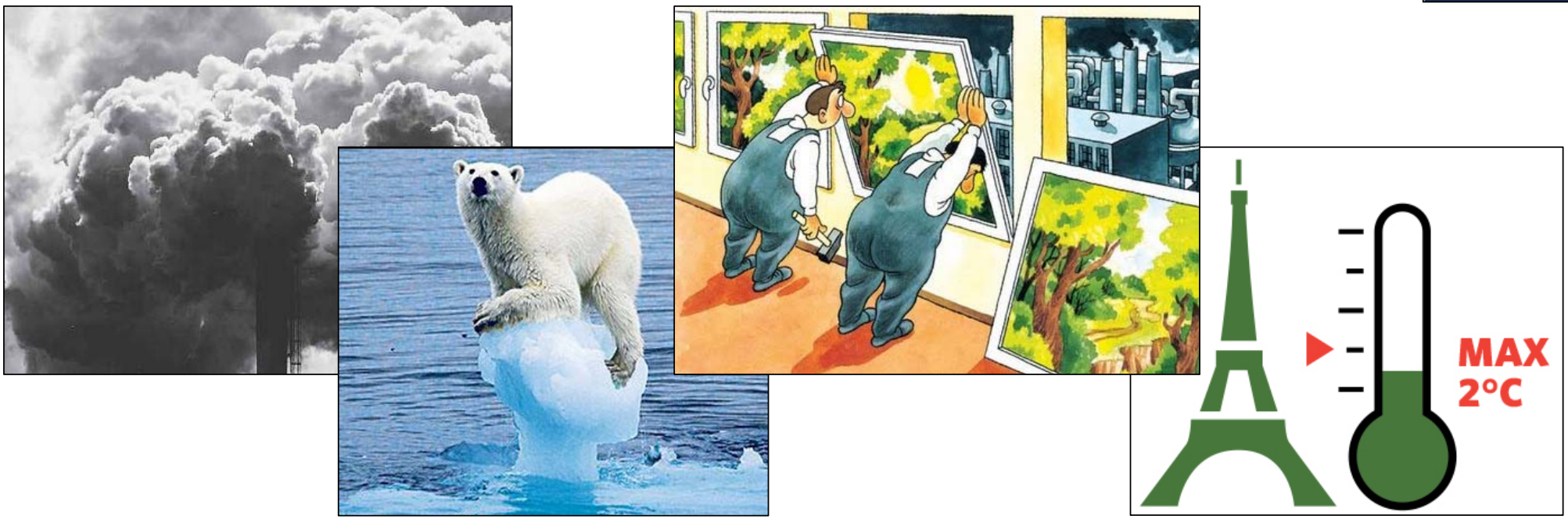
Motivation

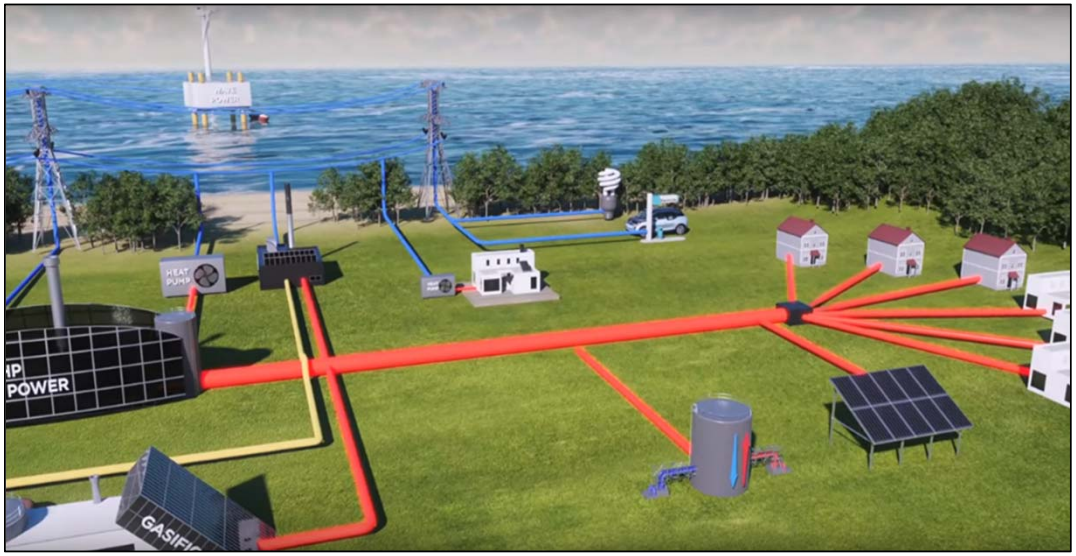


"We do not inherit the Earth from our Ancestors, we borrow it from our Children"

- Ancient proverb

Our Aim

To investigate the potential to deliver sustainable heat to communities through a 4th generation district energy network based on water source heat pumps powered by local renewable sources.



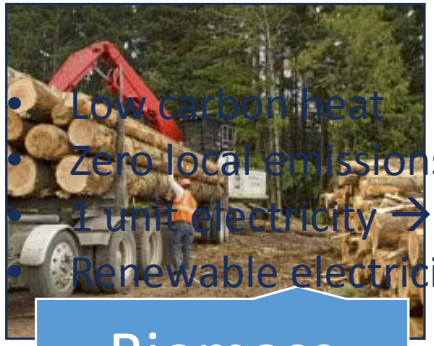
Thanks to Smart Heating Europe

Why Kinlochleven?

- Potential for District Heating Network
- Replicable solution
- Air Pollution

Selection of heat source

Heat pumps

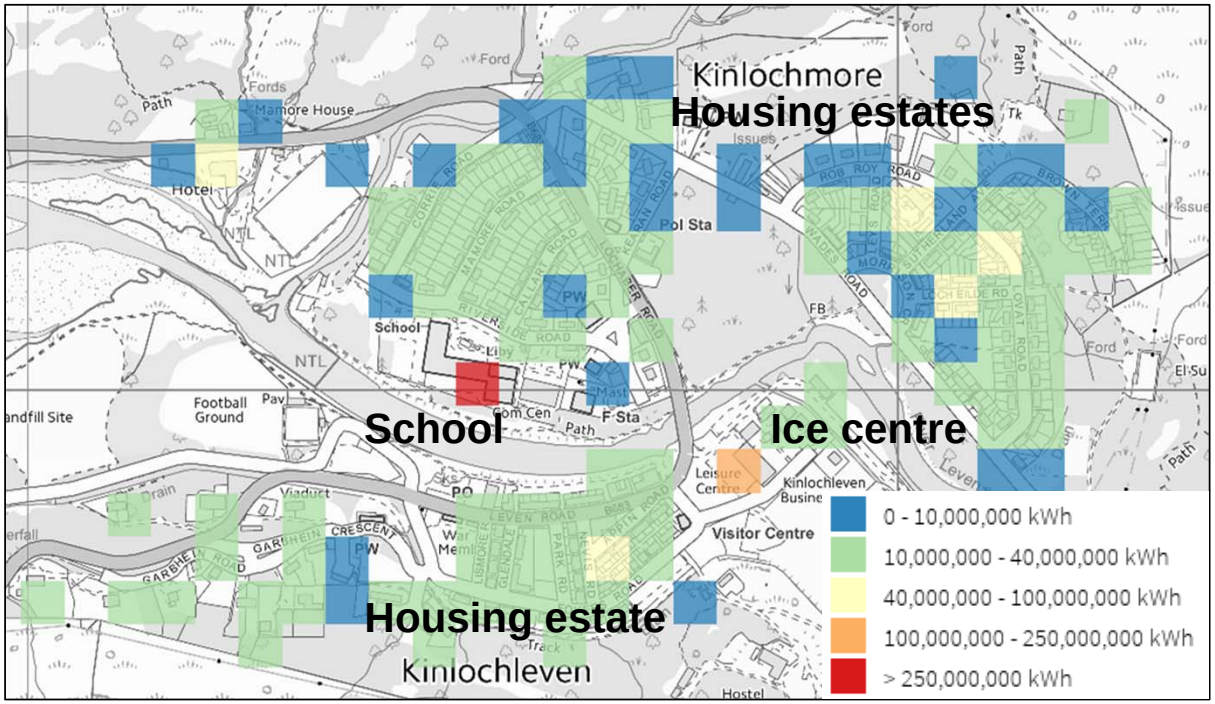


- Low carbon heat
- Zero local emissions
- 1 unit electricity → 3 units heat
- Renewable electricity integration

Biomass

Thanks to GEA, Shutterstock

Heat Demand Assessment



Domestic validation:

- ✓ HEM
- ✓ Carbon Trust Sizing Tool

Non-domestic validation:

- ✓ TM46 Energy Benchmarks - CIBSE

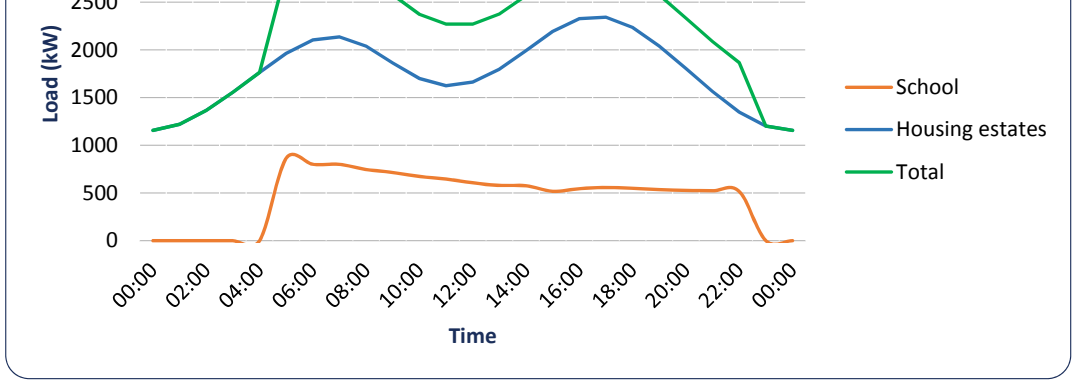
Total annual energy demand:

- ✓ 7.7 GWh

Heat Demand Modelling

Data input:

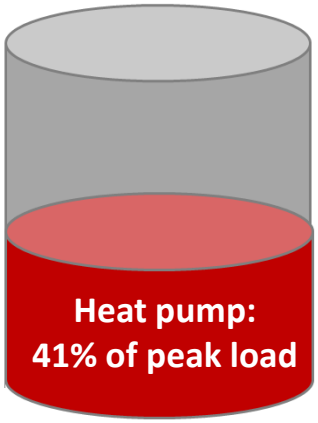
- **Heat demand**
- Climate
- Building characteristics
- Occupancy
- Ventilation

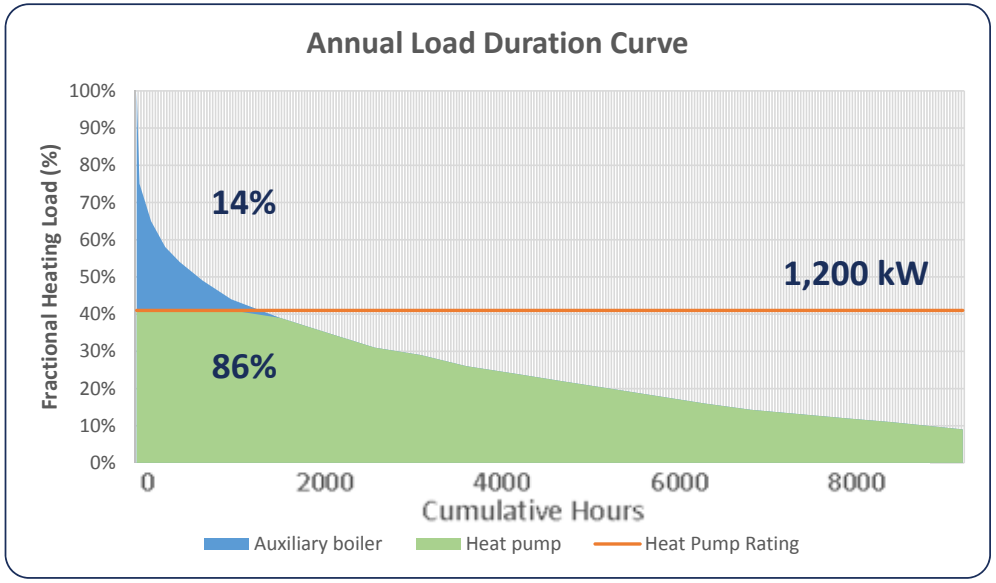


Peak load on system:

✓ 2,900 kW

Sizing and optimisation





Size of heating system:

- ✓ 1,200 kW heat pump
- ✓ 1,700 kW auxiliary boiler
- ✓ 125,000 l thermal store

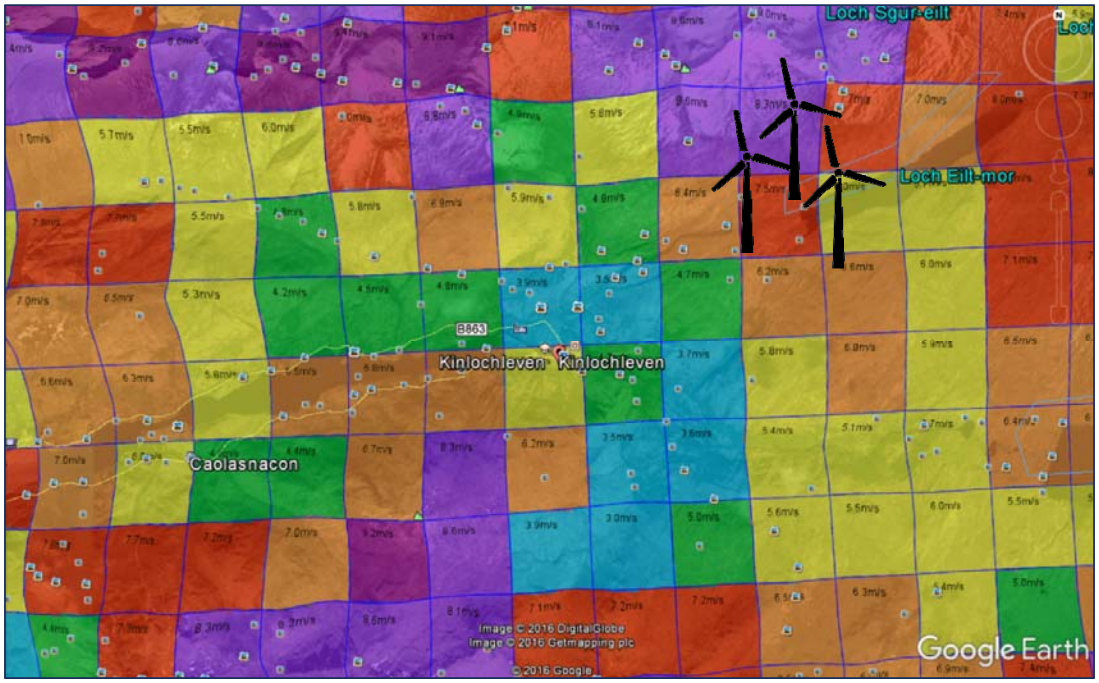
Renewable Energy Resources

Annual heat pump output: 7.2 GWh_{th}
Average COP: 3

→

Annual electricity consumption: 2.4 GWh_{e}

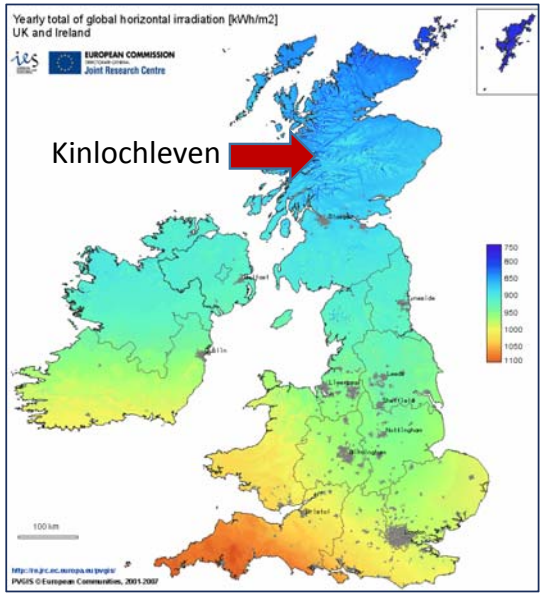
Renewable Energy Resources: Wind

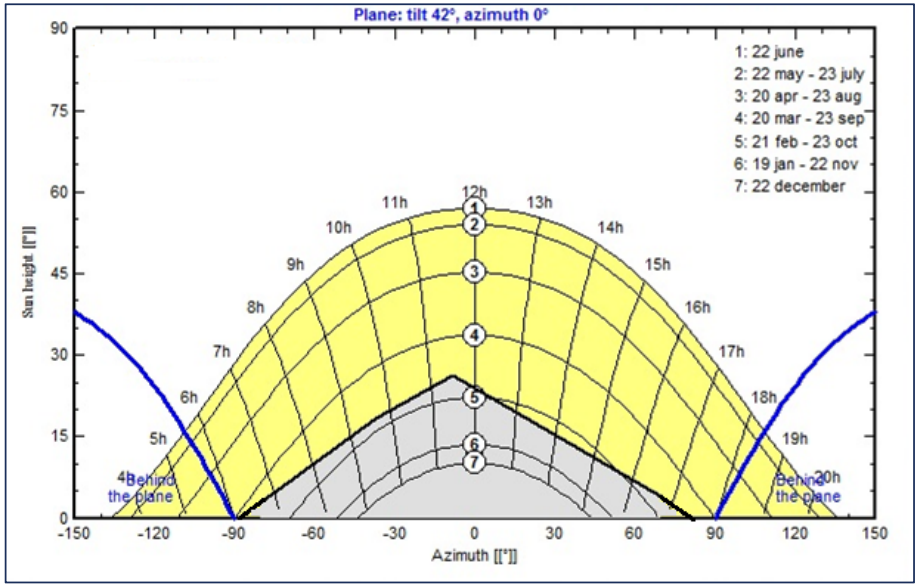


- ✓ High wind resource
- ✓ Appropriate terrain
- ✓ Access by road

Outstanding Potential

Renewable Energy Resources: Solar





- Low solar irradiation
- Mountain shading

Limited potential

Renewable Energy Resources: Hydro

New Small Hydro

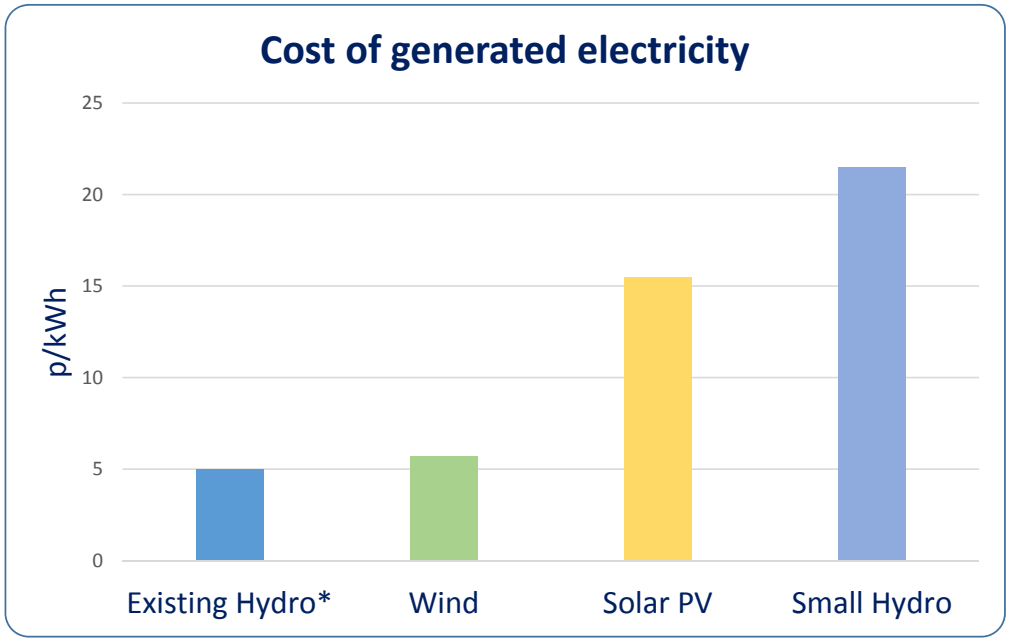
- High capital cost
- Limited power availability

Existing Hydro

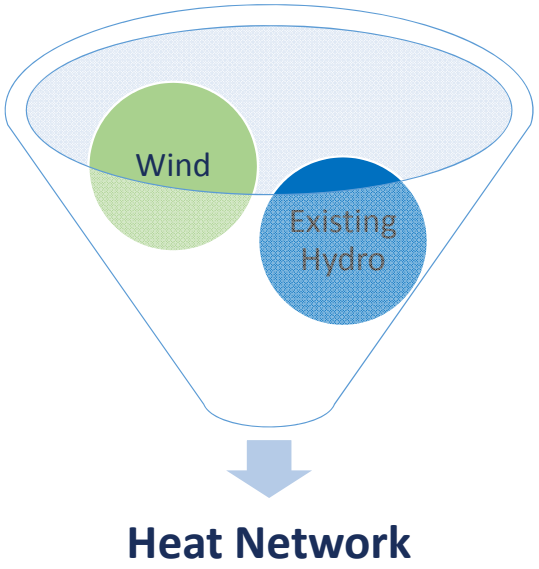
Possibility of price support for local electricity?

Thanks to Scottish Hills

Renewable Energy Resources: Comparison



* Potential subsidized energy

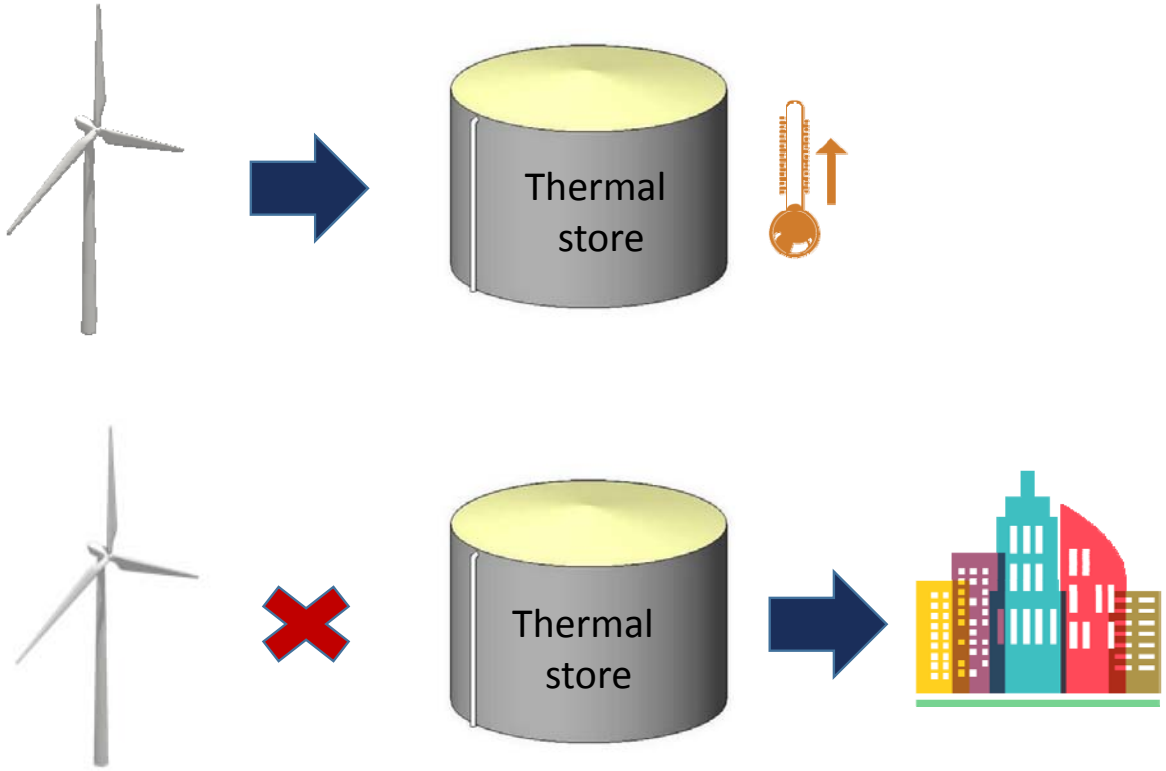


Renewable Energy Integration

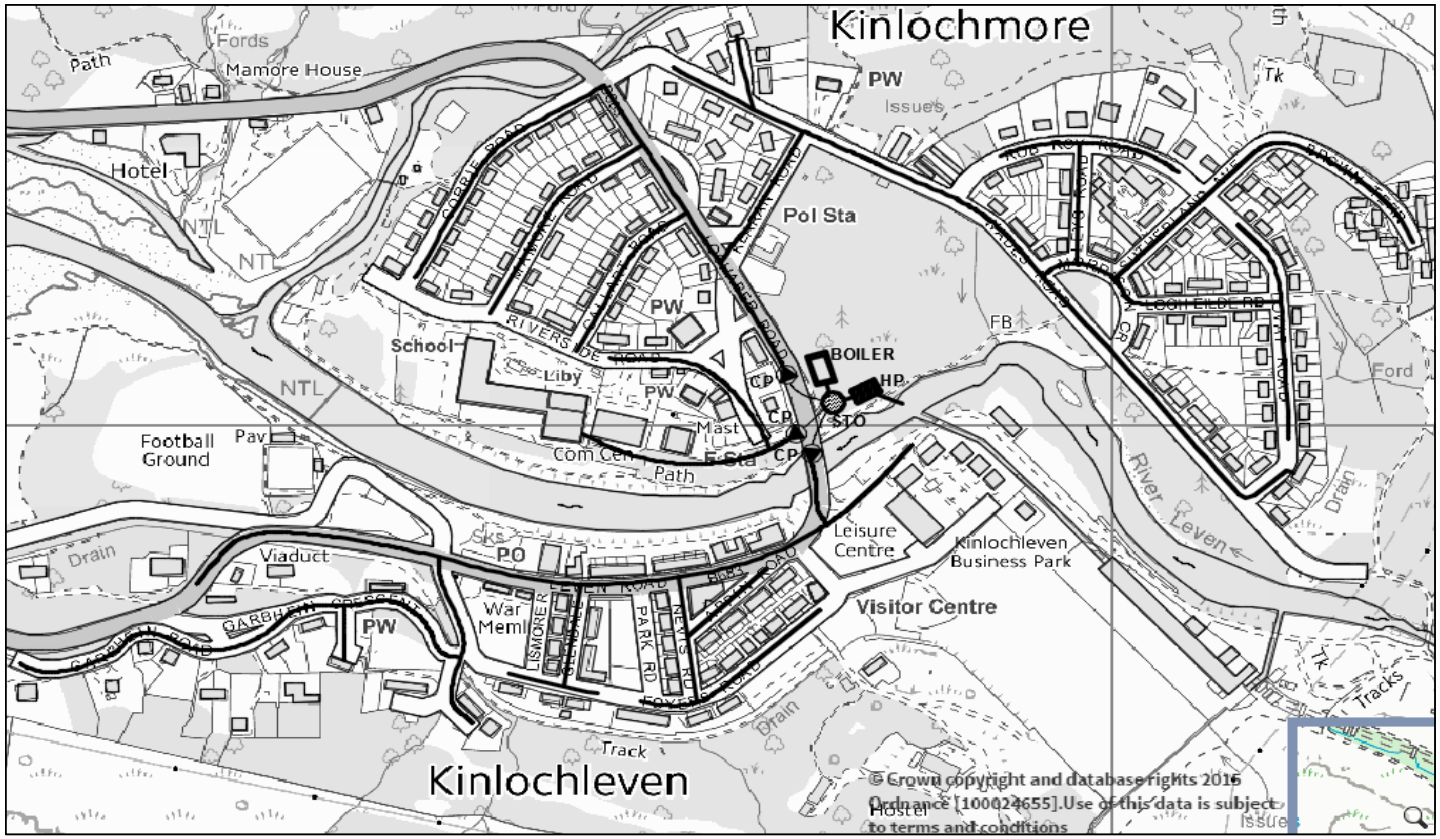
Problem: Resource is variable

Challenge: Maximise renewable electricity usage

Solution: Heat storage

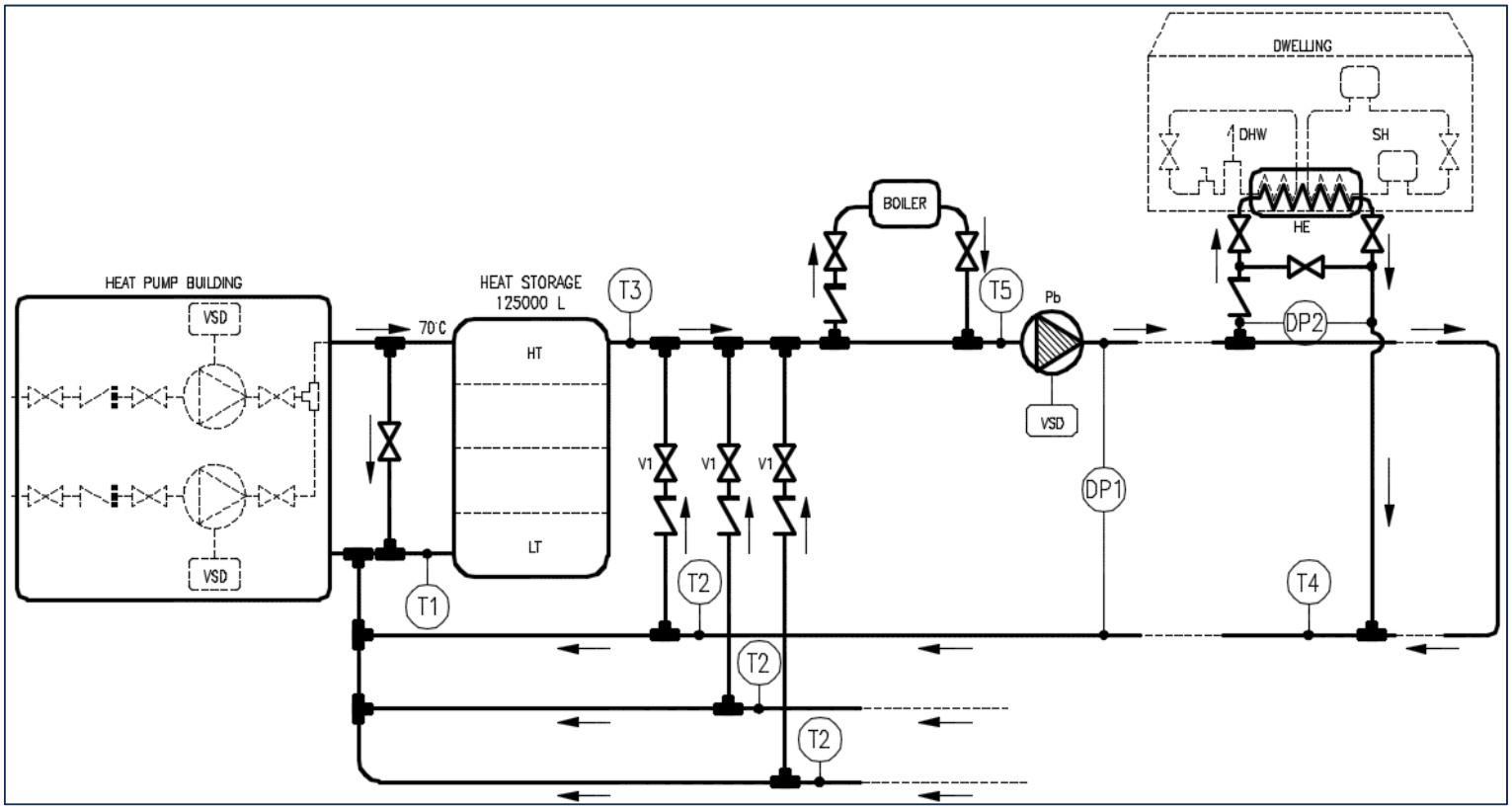


Network Layout

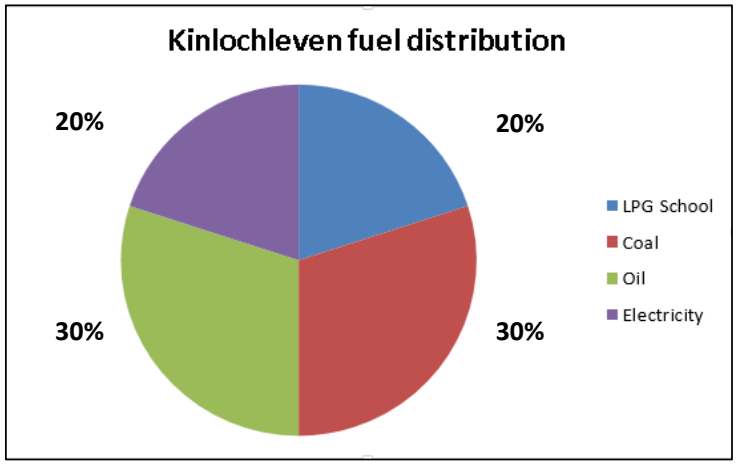


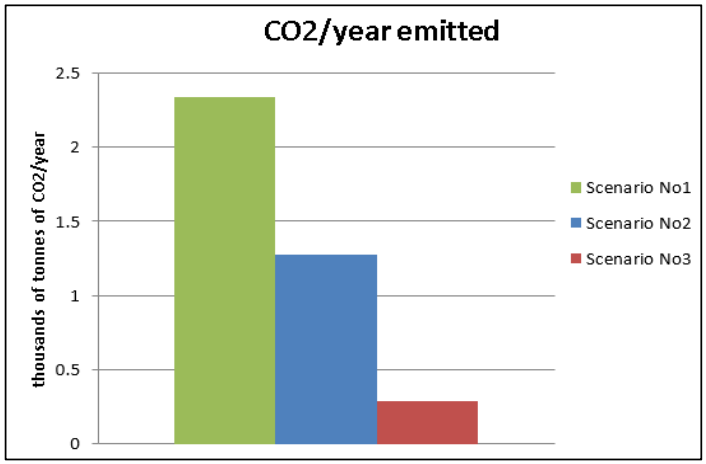
HP	→	1.2 MW
STO	→	125,000 L
AUX	→	1.7 MW
CP	→	7.5 HP
HE	→	0.5 m²

Network Layout



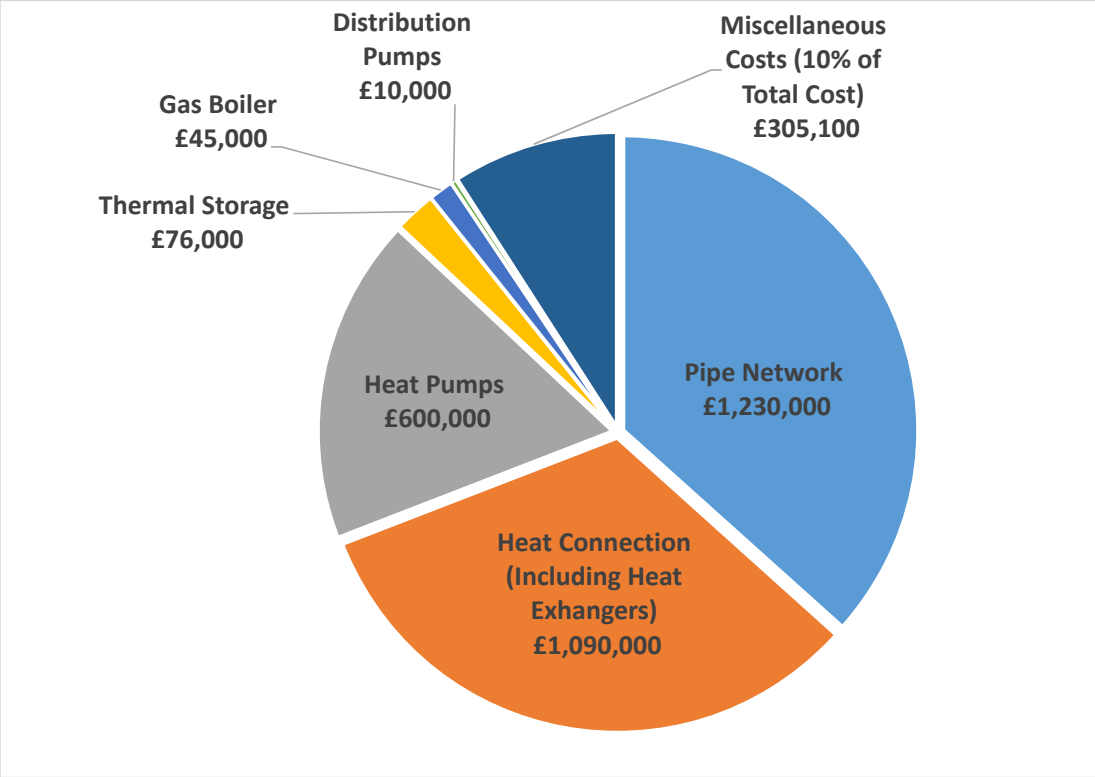
Environmental Analysis





- **Scenario 1:** Current Situation
- **Scenario 2:** District Energy Scheme
- **Scenario 3:** District Energy Scheme after the implementation of Renewables

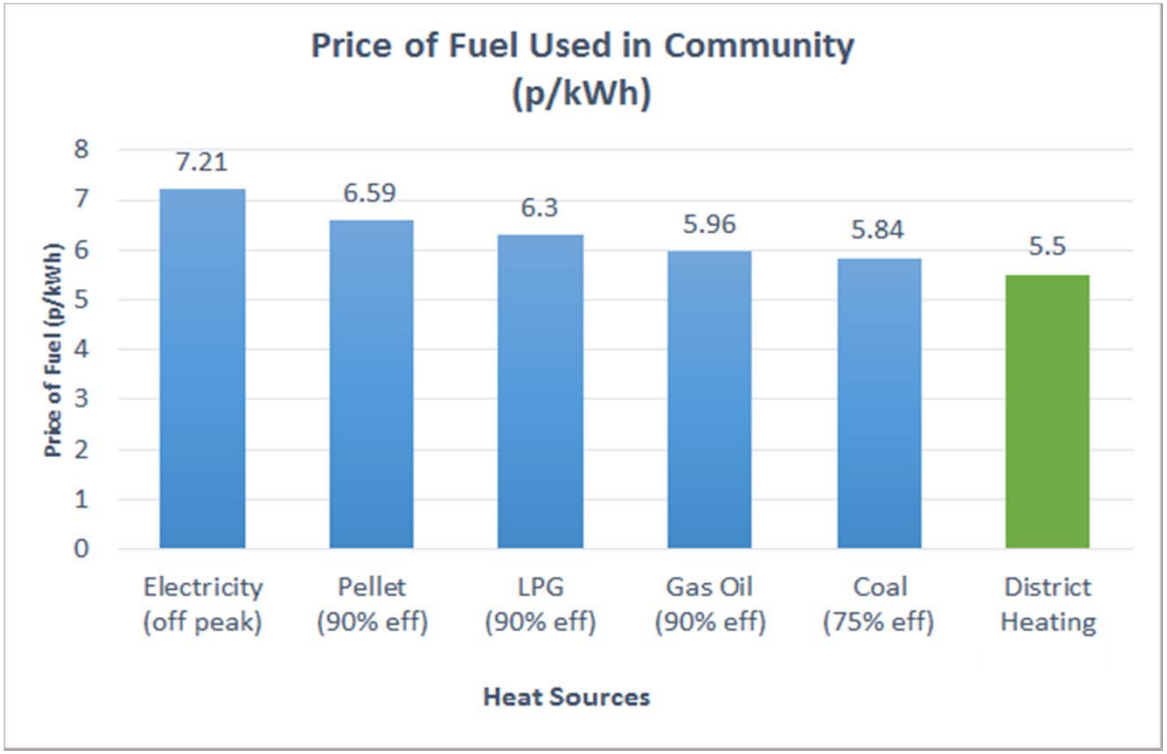
Financial Analysis



Total Capital Cost Estimation

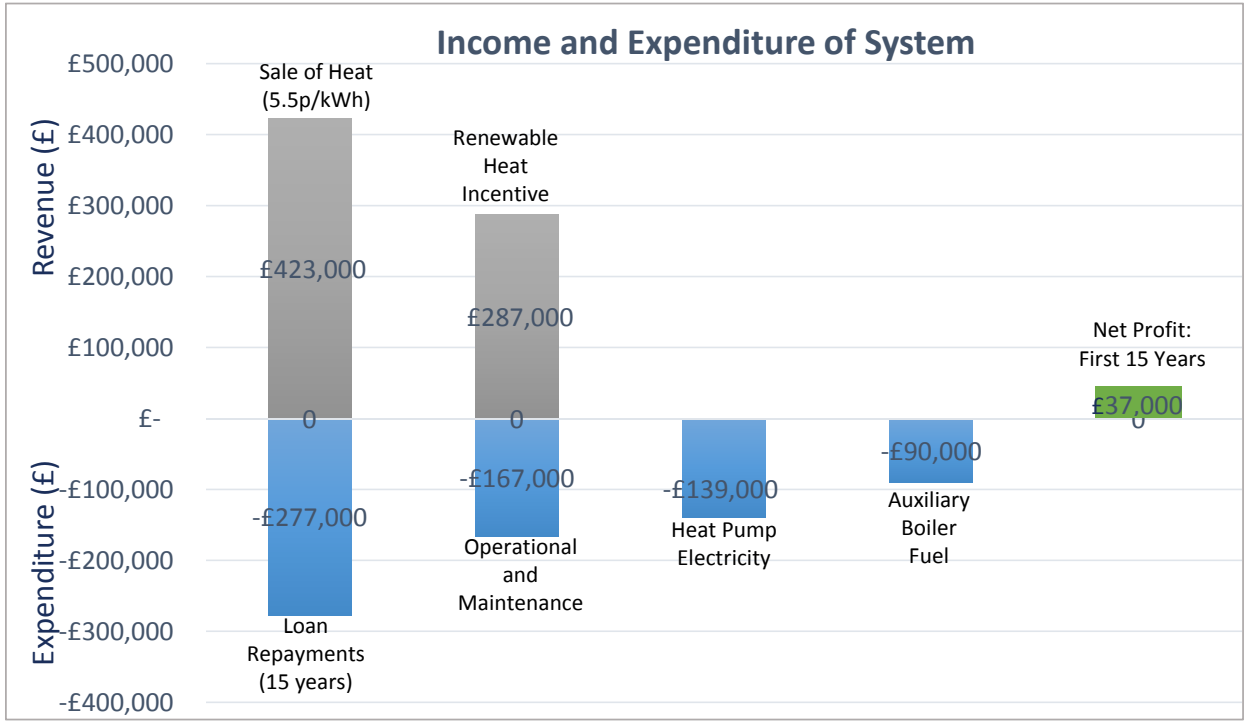
£3,350,000

Financial Analysis



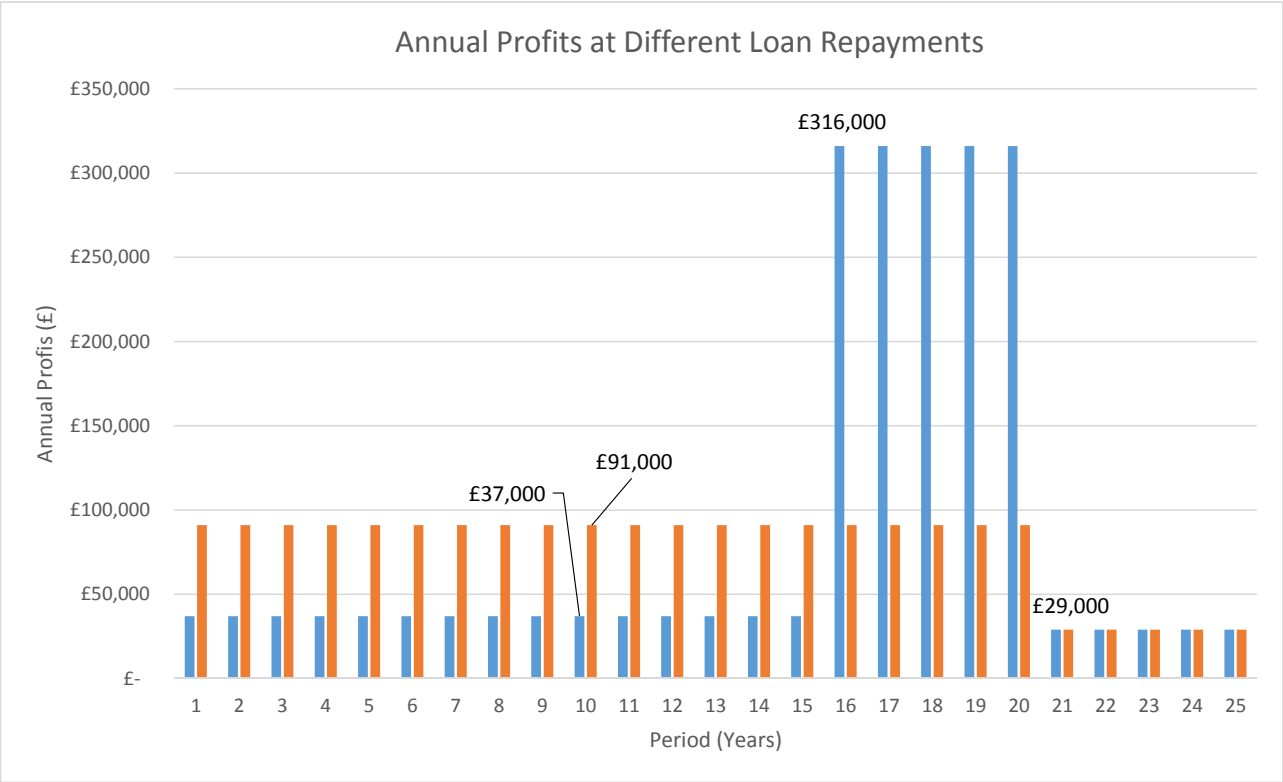
*http://www.nottenergy.com/energy_cost_comparison/

Financial Analysis



- Renewable Heat Incentive will be paid over 20 years
- Capital Cost repayments for 15 years at an interest of 3 %
- Profits will be used to retrofit homes and rejuvenate the community

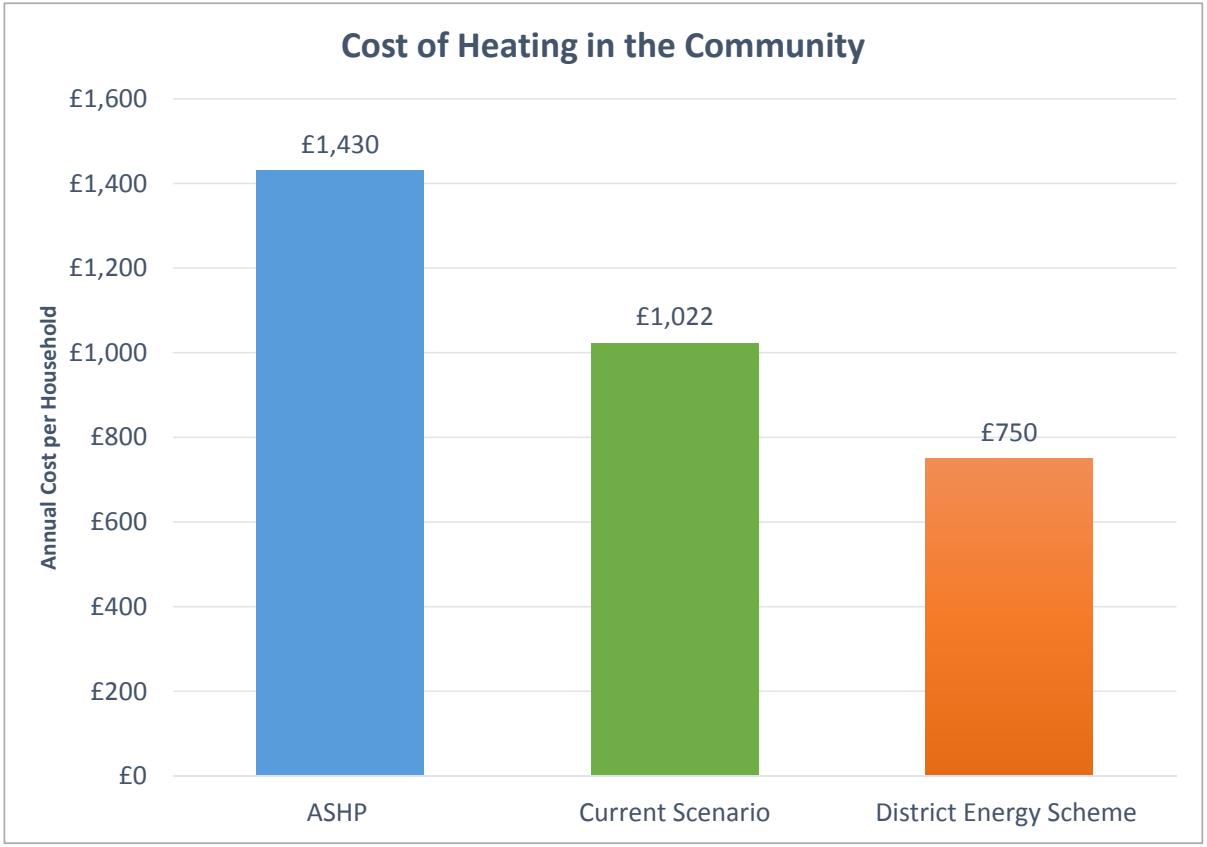
Financial Analysis



20 years Loan Repayment

15 years Loan Repayment

Financial Analysis



- Renewable Heat Incentive for Domestic properties is paid for 7 years

Financial Analysis

Potential Government Incentives: Grants and Loans

HEAT NETWORKS INVESTMENT PROJECT

SALIX

SALIX
£320m funding being provided to cover capital costs of developing Heat Network

Keep Scotland Beautiful

Climate Challenge Funding (CCF)
Annual grant of £150k available for community-led projects.

Currently combined expenditure £9.97million for 113 projects

energy saving trust

District Heating Loan
£500k, 3.14% interest rate 15 year payback

Conclusions

- 4th Generation District Energy Networks can deliver sustainable, low-carbon heat to communities.
- They are a viable option for addressing fuel poverty and meeting Scotland energy targets.
- They can be adapted to future energy systems supply
- The developed methodology can be replicable to other communities in the UK.
- Require a minimum demand density to be viable - may not be suitable for disperse communities

Further recommendations

- Government support needed to finance the capital costs, regulate and safeguard the emerging market.
- Local authorities to produce strategic plans for district heating.
- Increasing awareness of the technology's potential benefits.

Acknowledgements:

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SEPA Scottish Environment Protection Agency

REHAU

STAR RENEWABLE ENERGY

CARBON TRUST

CIBSE