

#### NTU CHP works – Salix RGF4

January 2016

Scott Brooks

## Contents

- Project drivers
- Background
- Heat loads
- CHP operation / sizing
- Thermal store / sizing
- Proposed project
- Site plans
- Schematics
- Summary

|--|



## Project drivers

Nottingham Trent University Carbon Elephant Plan

Existing CHP at end of useful life

- Salix Finance/HEFCE Revolving Green Fund 4
  - Stream 1 Project value of £50k £750k
  - Stream 2 Project value of £750k £2m









# Background

#### Erasmus Darwin building

- 10000m<sup>2</sup> Science / research facility
- Essentially "8 pods"
- Each pod has own plant room (gas boiler plant)
- Additional heat provided by a 400kWe CHP (at end of useful life)
- Existing rooftop heat distribution
- Ongoing works to improve energy efficiency:
  - Upgraded ventilation (with heat recovery)
  - High frequency lighting
  - Variable speed drives/pumps/extract







# Building heat load/profile

Building Erasmus Darwin Z Block

- Building design criteria Performance analysis Depth (m) Height (m) Week Month Day 20 20 1 2 3 4 5 6 7 8 9 0 3 1 Monday Tuesday U Value 10 11 12 13 14 15 16 17 18 6 5 Walls 0.6 Winter temp (°C) 21 Floo 1.64 20 19 20 21 22 23 24 26 27 Thursday 10 11 Glazing (%) 25 9 Air pe Roof 0.45 20 28 31 32 33 34 35 36 13 14 15 29 30 12 n3/(m2.h) @ 50Pa Friday Saturday 37 43 44 45 17 19 38 39 40 41 42 16 18 Glazing 5.99 5.7 (ACH) Sunday 20 21 22 23 46 47 48 49 50 51 52 53 2198 Degree Day 100% 3.5 0% Hourly heat loss 250 Model outputs ak heat loss 207 kW Boiler size 227 kW 200 Gas use 79127 kWh £2,769 Fabric hea 15 Tonn Infiltration heating 20568 kWh 4 Tonnes £720 150 Ventilation heating 219819 kWh 41 Tonnes £7.694 Tota 319513 kWh 59 Tonne £11 183 Gas use 42010 kWh £1,470 38506 kWh £1,348 March 33316 kWh 31359 kWh £1,166 £1,098 6 Ton April May 23495 kWh £822 13040 kWh June 2 Tonne £456 July 8133 kWh £285 August 9811 kWh 2 Tonnes £343 16914 kWh £592 eptemb October November 29516 kWh 33715 kWh £1.033 £1,180 6 Tonnes Decembe 39699 kWh £1.389 Sum of Fabric heat loss (kW) Sum of Infiltration heat loss (kW) Sum of Ventilation heat loss (kW) Total heat loss Hourly external air temperature Monthly heat loss 45000 40000 30 35000 30000 25 £ 25000 20 15000 15 ŝ 10000 5000 224 Sum of Fabric heat loss (kW) Sum of Fabric heat loss (kW) Sum of Infiltration heat loss (kW) Sum of Infiltration heat loss (kW) Sum of Ventilation heat loss (kW) Sum of Ventilation heat loss (kW) -10
- Reviewed historic building energy use
- Carried out thermal simulation of each block

# Established heat load/profile

- Peak heat load  $\approx 2MW$
- Heat load varied by:
  - Block
  - Day/night
  - Season
- Limited options for efficient CHP installation
- Explored options to include thermal storage with the CHP



## **CHP** operation







CHP Heat supply > Demand





CHP Heat supply < Demand







## Benefit of thermal store – 100m<sup>3</sup>

- Run hours / carbon savings reviewed
- 3 CHP's considered
  - 250kWe
  - 307kWe
  - 400kWe



## Thermal store performance

• 307kWe, 356kWth CHP



#### CHP operation – Peak winter

1200 1000 800 Ş 600 400 200 0 8 12 6 20 8 16 20 8 16 20 8 12 16 20 0 8 12 16 20 Monday Tuesday Wednesday Thursday Friday Saturday Sunday 2 January Heat from CHP (kWh) Sum of 100m3 store Heat removed from store Sum of 100m3 store heat from boilers

Heat source (100m3 store)

## Store performance – Peak winter

Store performance (100m3)





#### Heat source

#### Given:

- 2MW heat load
- Mon Fri, 6am 8pm occupation
- 307kWe CHP
- 100m<sup>3</sup> thermal store

The CHP and stores will meet 77% of the annual heating requirement of the building.



# Proposed project

#### Works include:

- Fabrication of new central plant room
- $\approx$  300kWe Combined Heat and Power Unit (CHP)
- 50-100m<sup>3</sup>+ of thermal storage (water @ 85°C)
- Supplementary boiler plant
- Modifications to existing heat network
- Connections to existing infrastructure
- Demolition/relocation of exiting gas bottle store





## Existing site photos











NTU

## CHP + Stores proposed location



#### CHP + Stores proposed location



### Proposed plant room



NTU

## **Roof distribution**



18

## Site restrictions - Buried site services

 Restrictions on proposed CHP location given extensive buried services



19

## System schematic



# System schematic



21

NTU

# Costs / benefits summary

#### <u>Costs</u>

• Estimated cost £1.1m

#### **Funding**

- £1m secured from Salix RGF4
- £37k from existing NTU Salix revolving fund
- Remainder NTU internal

#### **Benefits**

- 360 tonnes CO2 annual saving (140 > than no store)
- 5300 CHP run hours (2000 > than no store)
- 8 year payback

#### <u>Timeline</u>

- Currently out to tender Jan 2016
- Proposed on site April 2016
- Completion August 2016



Thankyou

## Questions?

