

# Feasibility of a Surface Water Source Heat Pump at Henley Business School

**Phil Jones**

*Building Energy Solutions*


*philjones100@virginmedia.com 07714 203045*

**Chris Dunham**

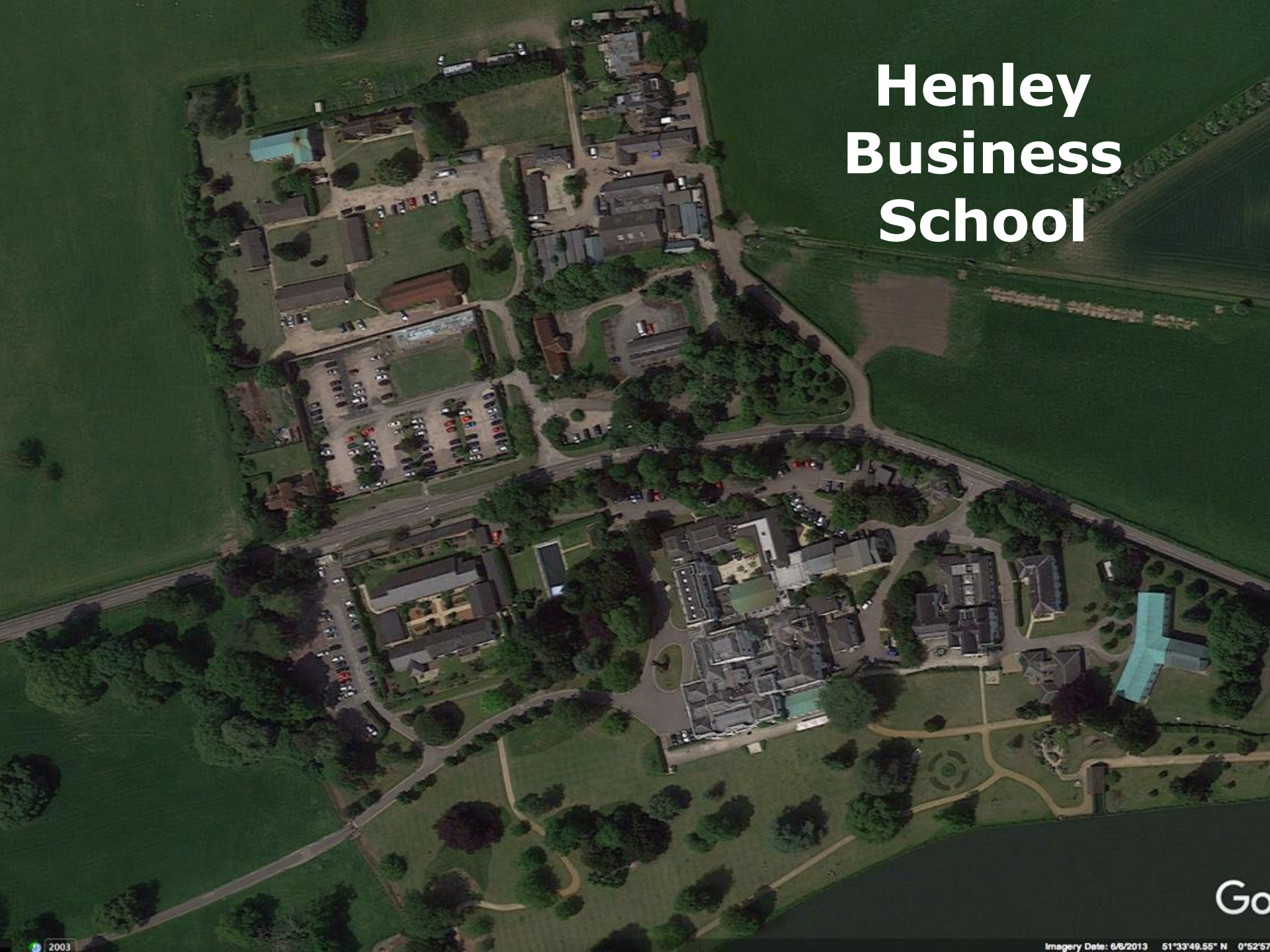
*Carbon Descent*

*ChrisD@carbondescent.org.uk 07904 267 306*

# THE OPPORTUNITY

- 
- A large, white, classical-style building with a prominent balcony and a flag flying on a tall pole. The building is set on a well-maintained green lawn. In the foreground, there is a body of water, likely a river. The sky is blue with some light clouds. The overall scene is bright and clear.
- Proximity to river
  - Large fast flowing river
  - Oil fired Heating & HWS
  - Renewable Heat Incentive

# Henley Business School



# Scope

## University of Reading

- Public areas (including leisure facilities)
- Conference and meeting rooms
- Offices / rooms / buildings
- Residential buildings
- Foot paths



- | Name                         |
|------------------------------|
| 1 Blue room                  |
| 2 John H Dunning Library     |
| 3 Garden Hall                |
| 4 Garden common Room         |
| 5 Bar common room (main bar) |
| 6 Chiltern room              |
| 7 Business centre            |
| 8 Luggage room               |
| 9 Vending machine            |
| A Giant chess set            |
| B Croquet lawn               |
| C Barbecue area              |

### Greenlands campus

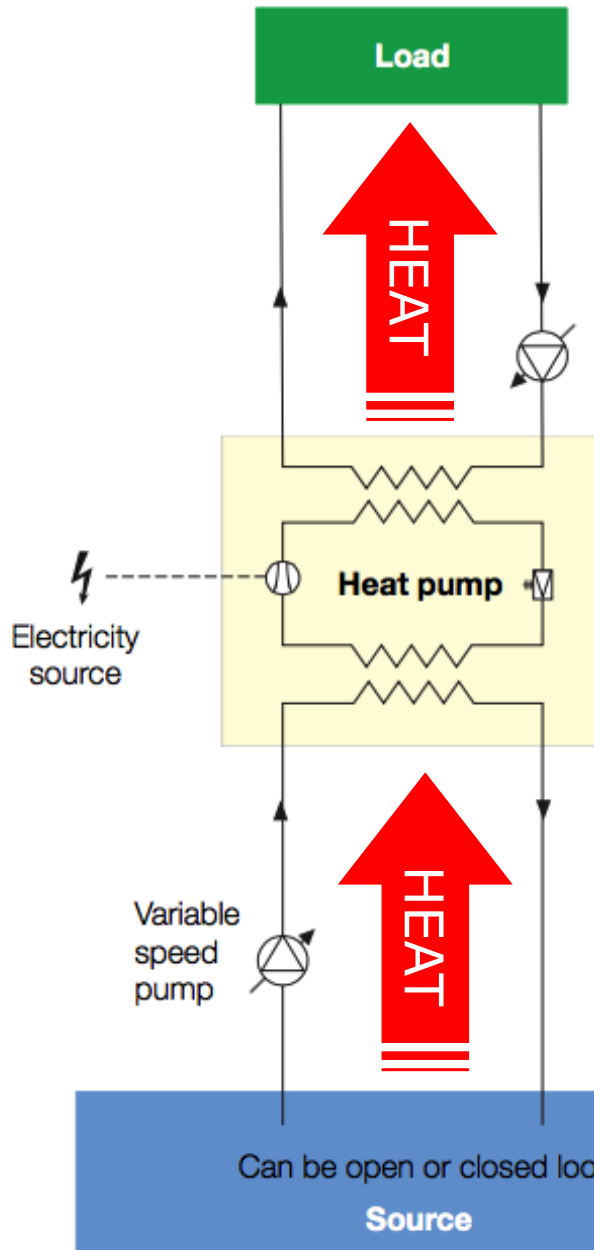
Updated June 2012. © Copyright The University of Reading



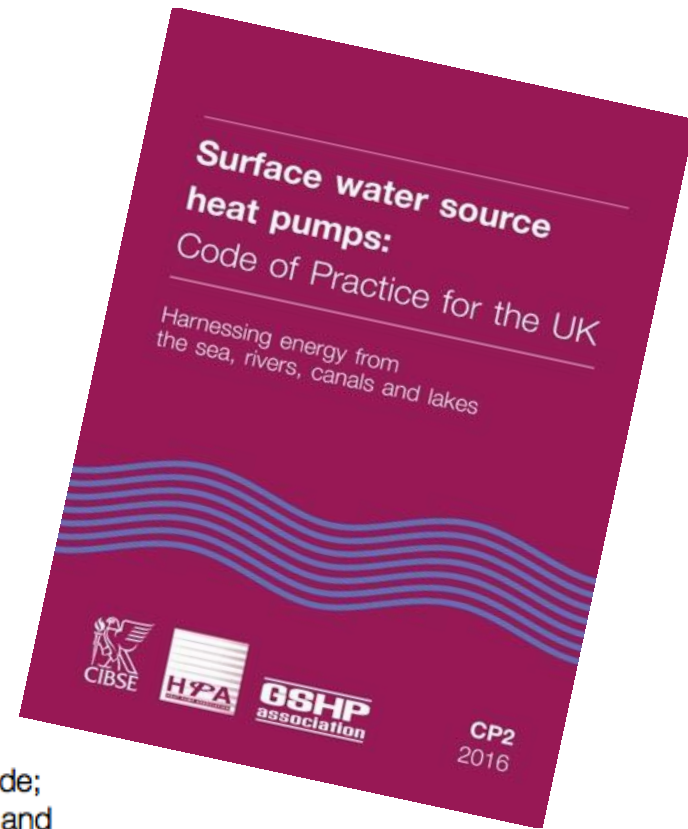
- SWSHP Study Scope
- New ASHP buildings excluded

# Surface Water Source Heat Pump

ELECTRICITY



Shown in heating mode; evaporator and condenser reverse roles when used in cooling mode



# ENERGY COSTS

THAMES COURT  
£18,030

MAIN  
£52,260

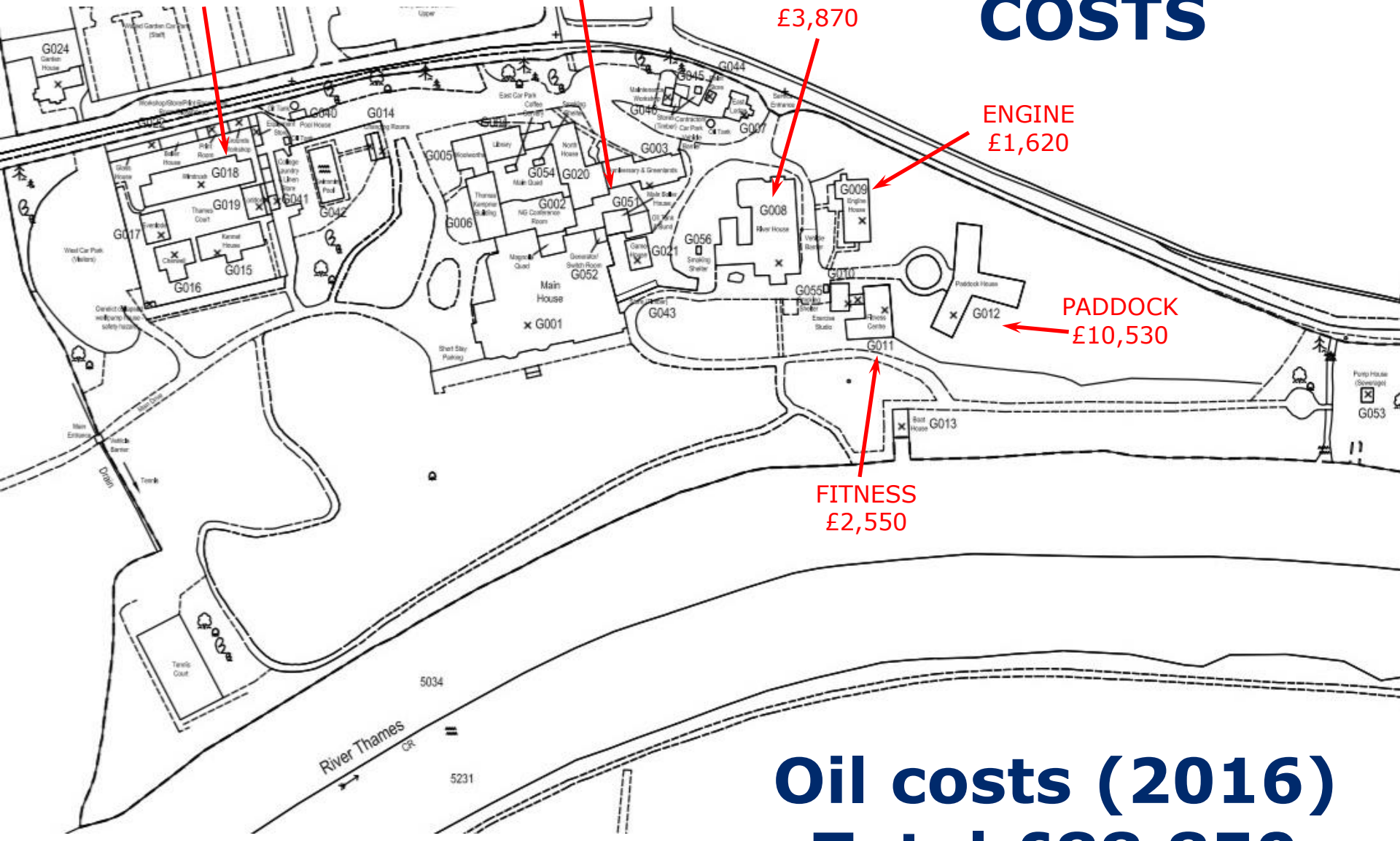
RIVER  
£3,870

ENGINE  
£1,620

PADDOCK  
£10,530

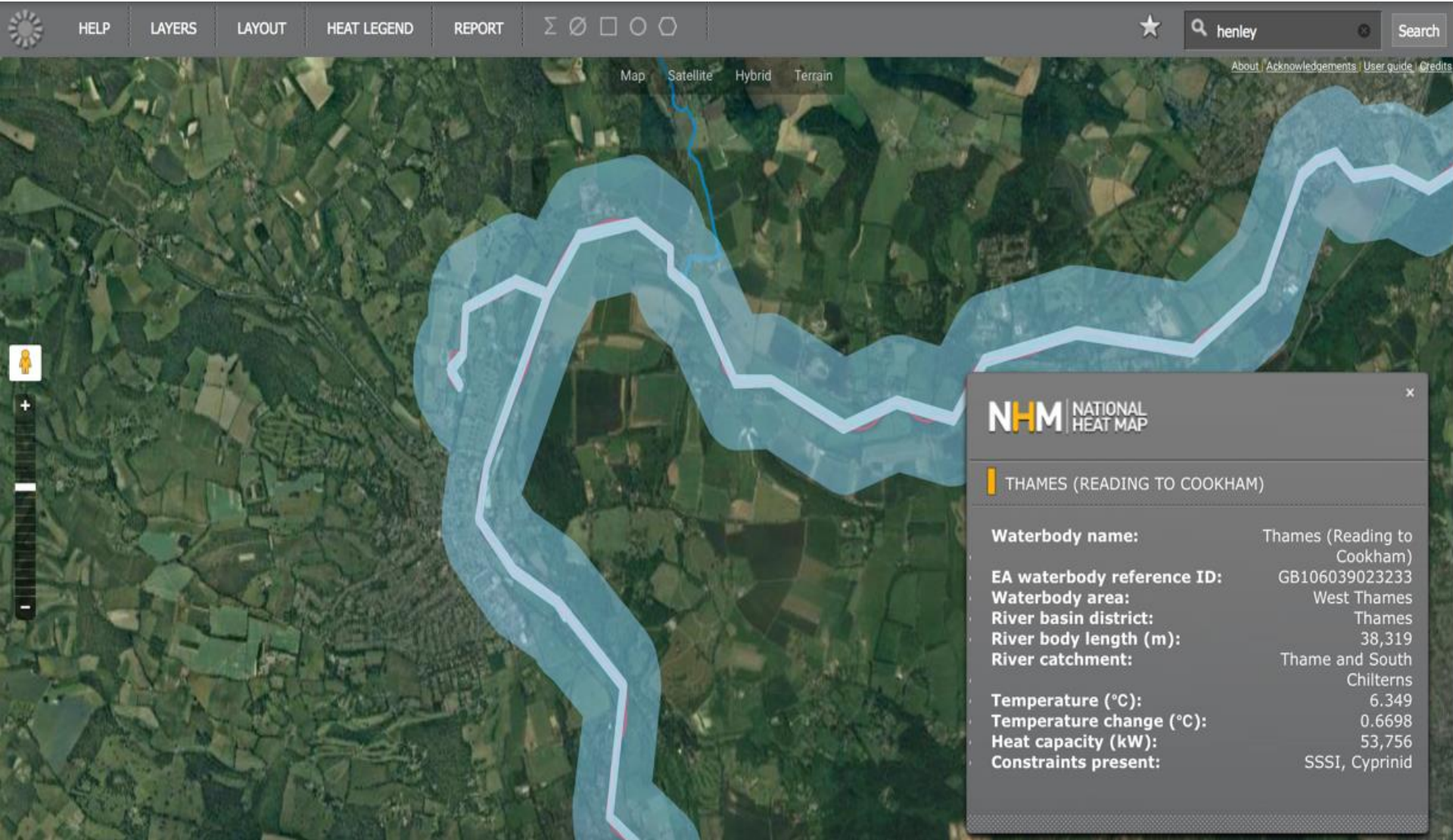
FITNESS  
£2,550

**Oil costs (2016)**  
**Total £88,850**



100m

# National Heat Map



River capacity 53MW

## 39130 - Thames at Reading

# 65MW for 95% of the year

[Station Info](#)[Daily Flow Data](#)[Catchment Info](#)Data Series: 

Period of Record: 1992 - 2015

Graph Type:  Year:

2015

[Refresh](#)

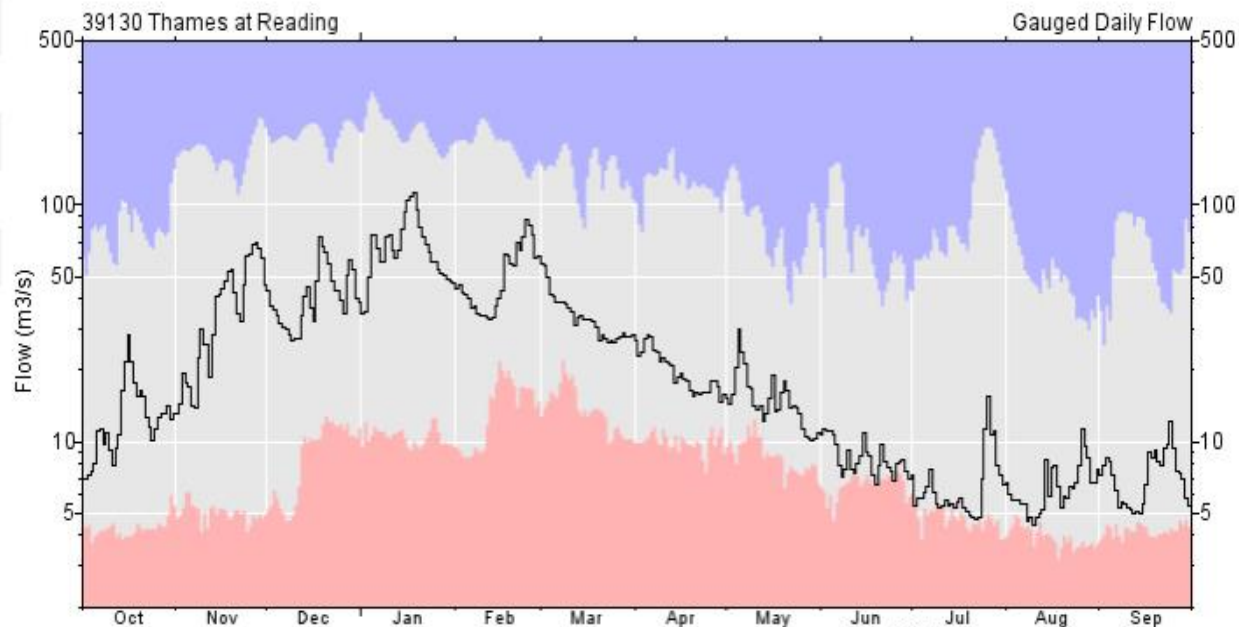
Percent Complete: &gt;99 %

Base Flow Index: 0.65

Mean Flow: 38.491 m<sup>3</sup>/s**95% Exceedance (Q95): 5.2 m<sup>3</sup>/s**70% Exceedance (Q70): 12.8 m<sup>3</sup>/s50% Exceedance (Q50): 23.3 m<sup>3</sup>/s10% Exceedance (Q10): 96.1 m<sup>3</sup>/s

### Download Data

River flow time series data are available for this station for download.

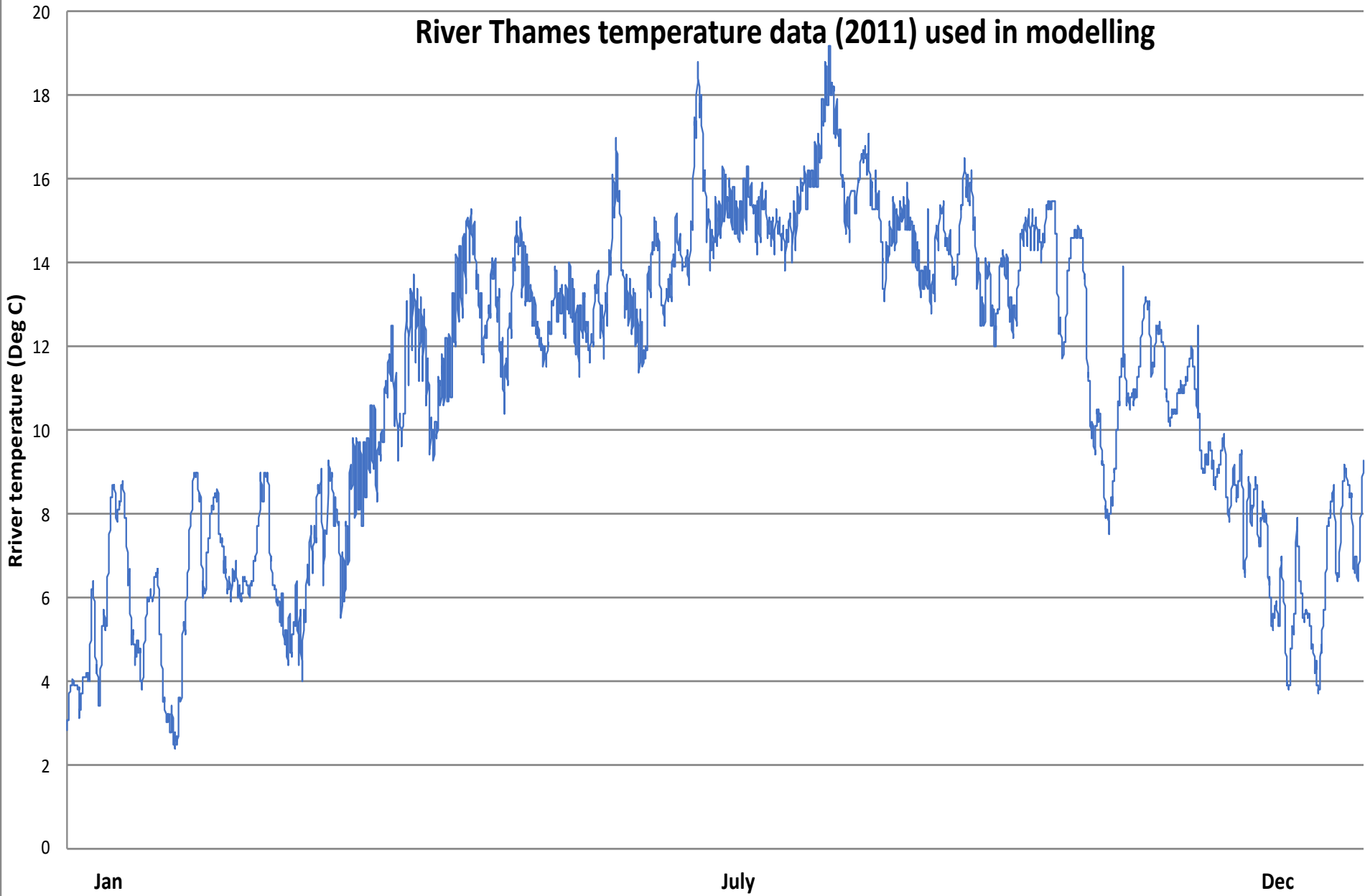
[Download flow data](#)

**Key:** Red and blue envelopes represent lowest and highest flows on each day over the period of record.

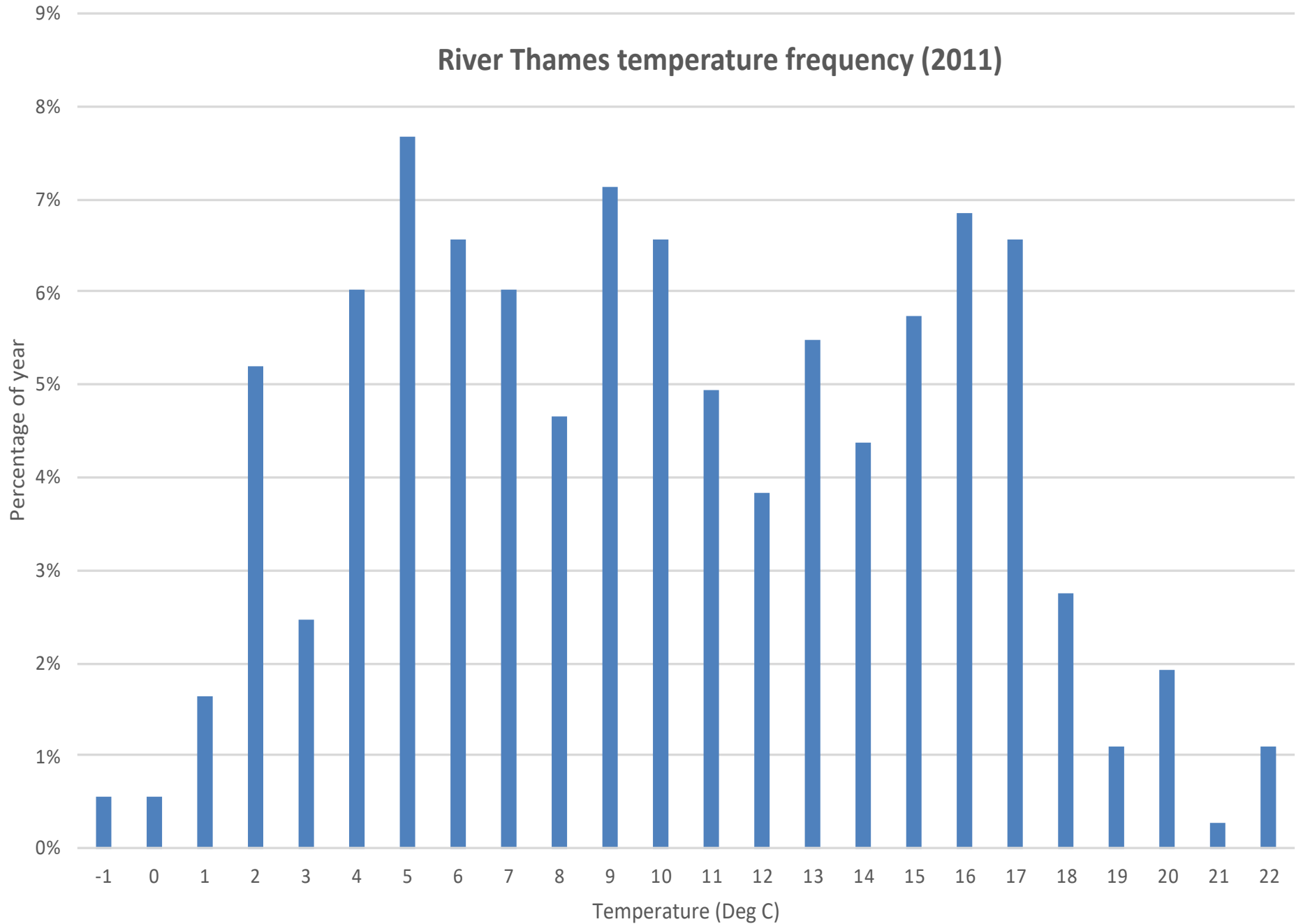
Underlying data supplied by the Environment Agency



# River Thames temperature data (2011) used in modelling



## River Thames temperature frequency (2011)



Heat Pump

41m

25m

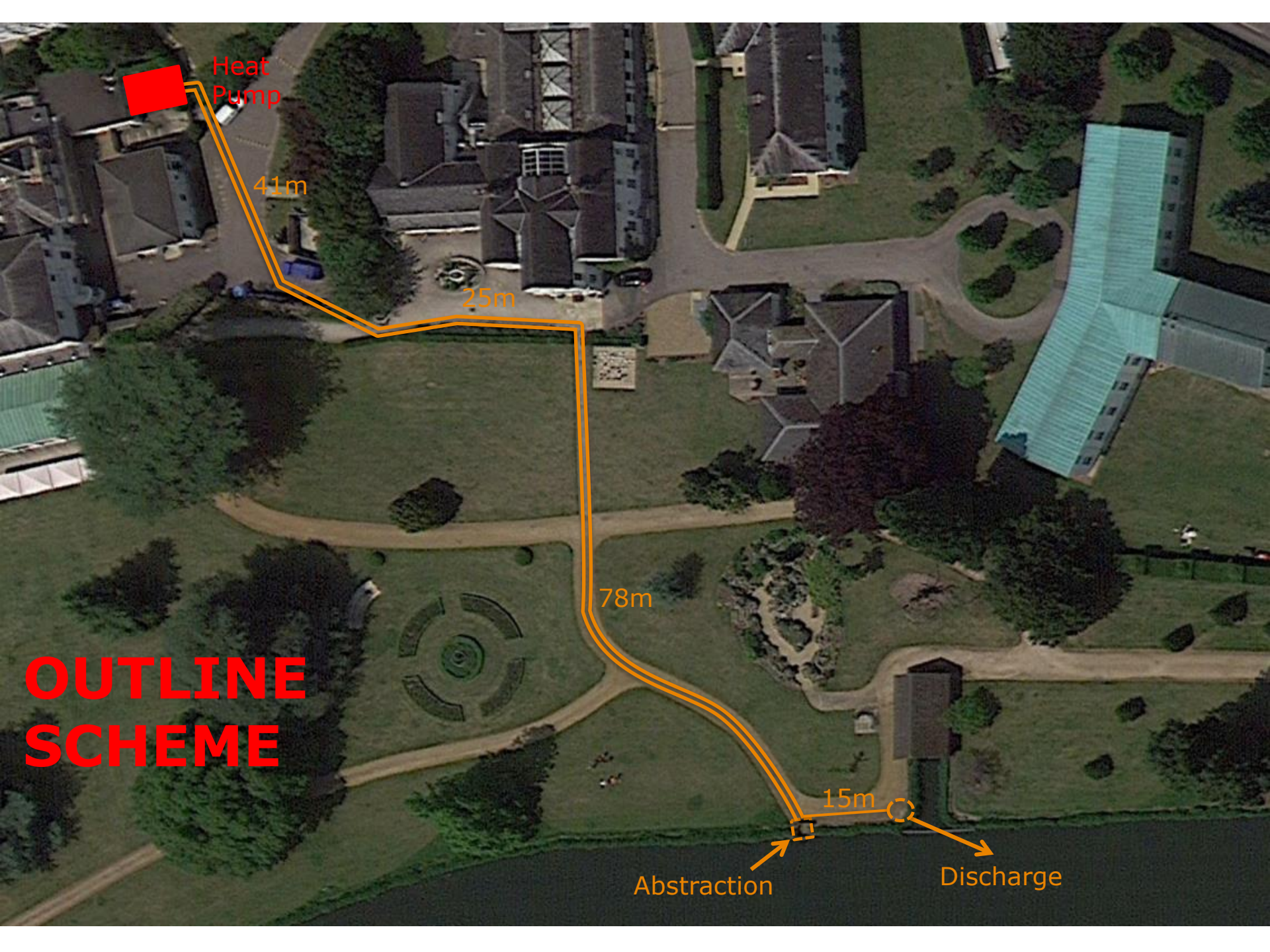
78m

15m

Abstraction

Discharge

**OUTLINE  
SCHEME**









Abstraction  
Point





Discharge  
outlet



The Boat House



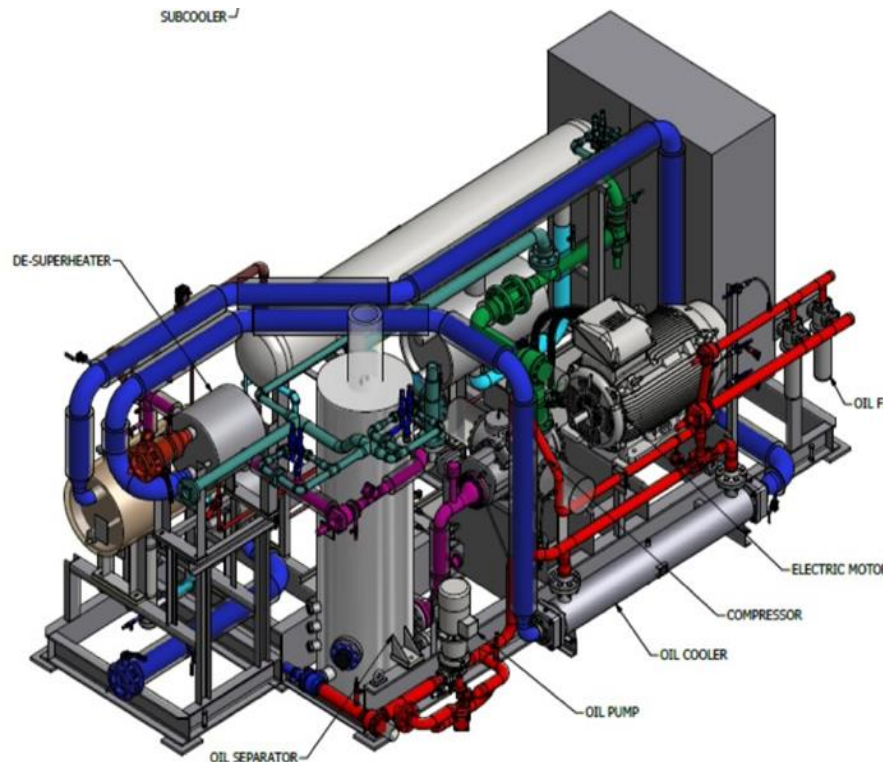


Discharge design

**GSK**  
**(Brentford)**

# The heat pump

- Modelling indicates 580kWth heat pump
- 230kWe electrical supply at 415V
- CoP  $\sim 2.7$  to  $\sim 2.9$



- Supplying 72°C Flow to the 70/60°C heating system
- Ammonia based heat pump

# Abstraction/discharge

- Abstraction/discharge  $\Delta T$  of 3°C and ~40 litres/sec
- Submersible pumps/screens at abstraction point
- Pipework run in pathways to avoid disruption to lawns/trees
- Soft-dig and easy to re-instate
- Discharge pipework returns on same route as abstraction
- Automatic self cleaning screen under existing jetty
- Backwash system to auto flush screens
- Around 400mm abstraction/discharge pipes
- Plastic uninsulated abstraction/discharge pipework



THAMES COURT

Total West  
253m

Heat Pump

RIVER

ENGINE

PADDOCK

FITNESS

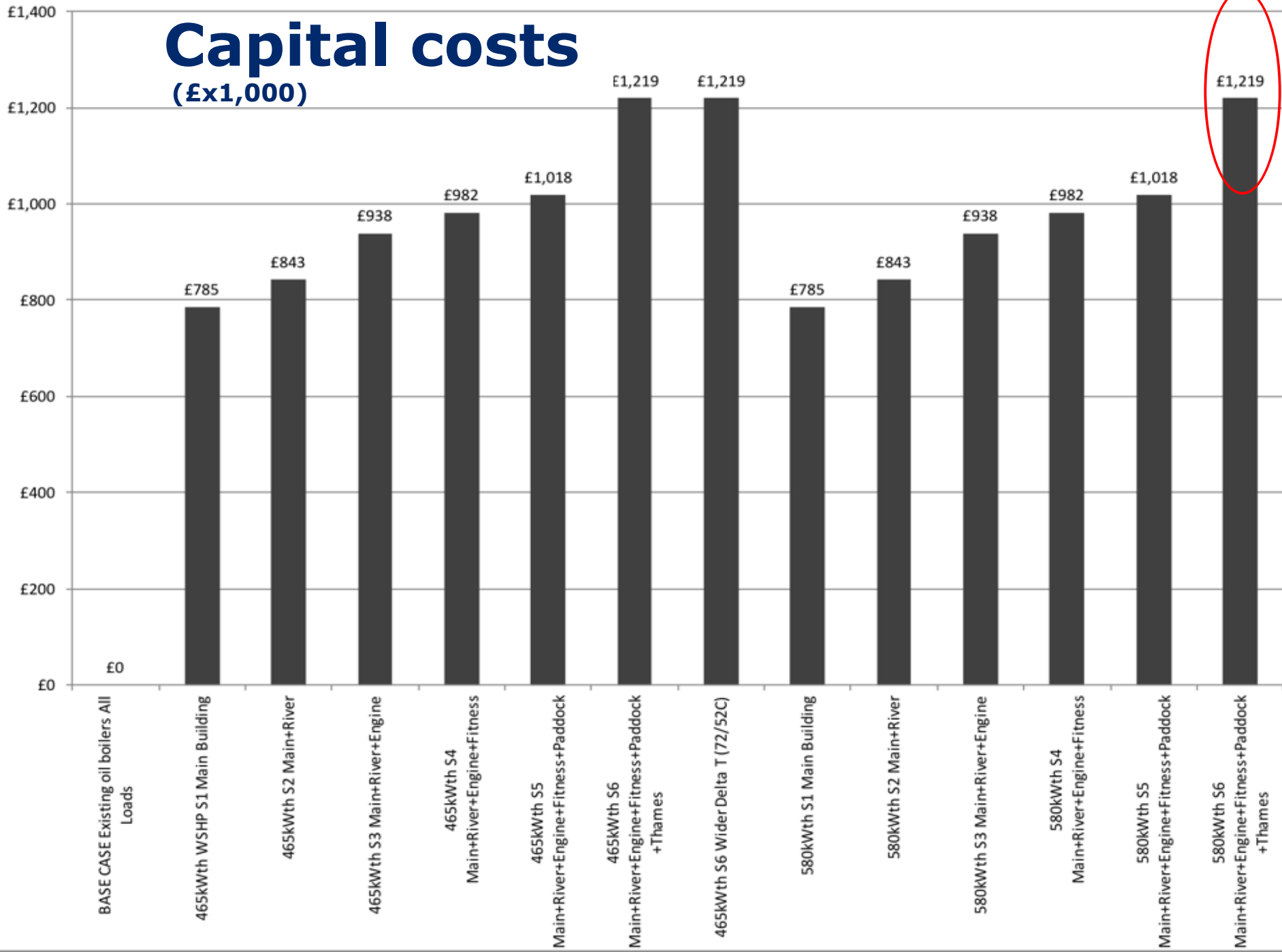
Total (East)  
168m

**FAVOURED  
OUTLINE  
SCHEME**

- 1. RIVER 48m
- 2. ENGINE +110m (inc 60m common dig)
- 3. FITNESS +33m
- 4. PADDOCK +25m
- 5. THAMES +205m

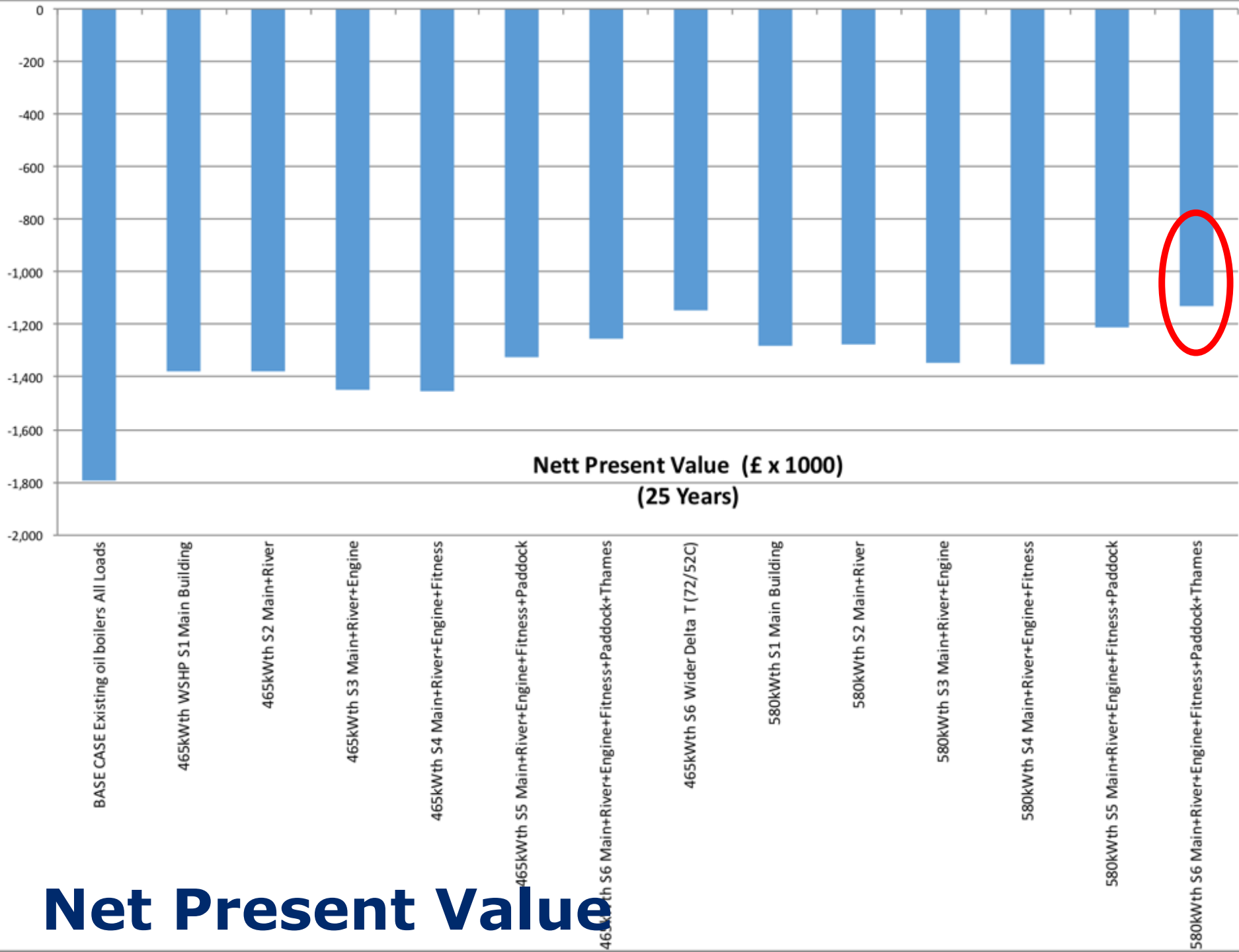
# Capital costs

(£x1,000)



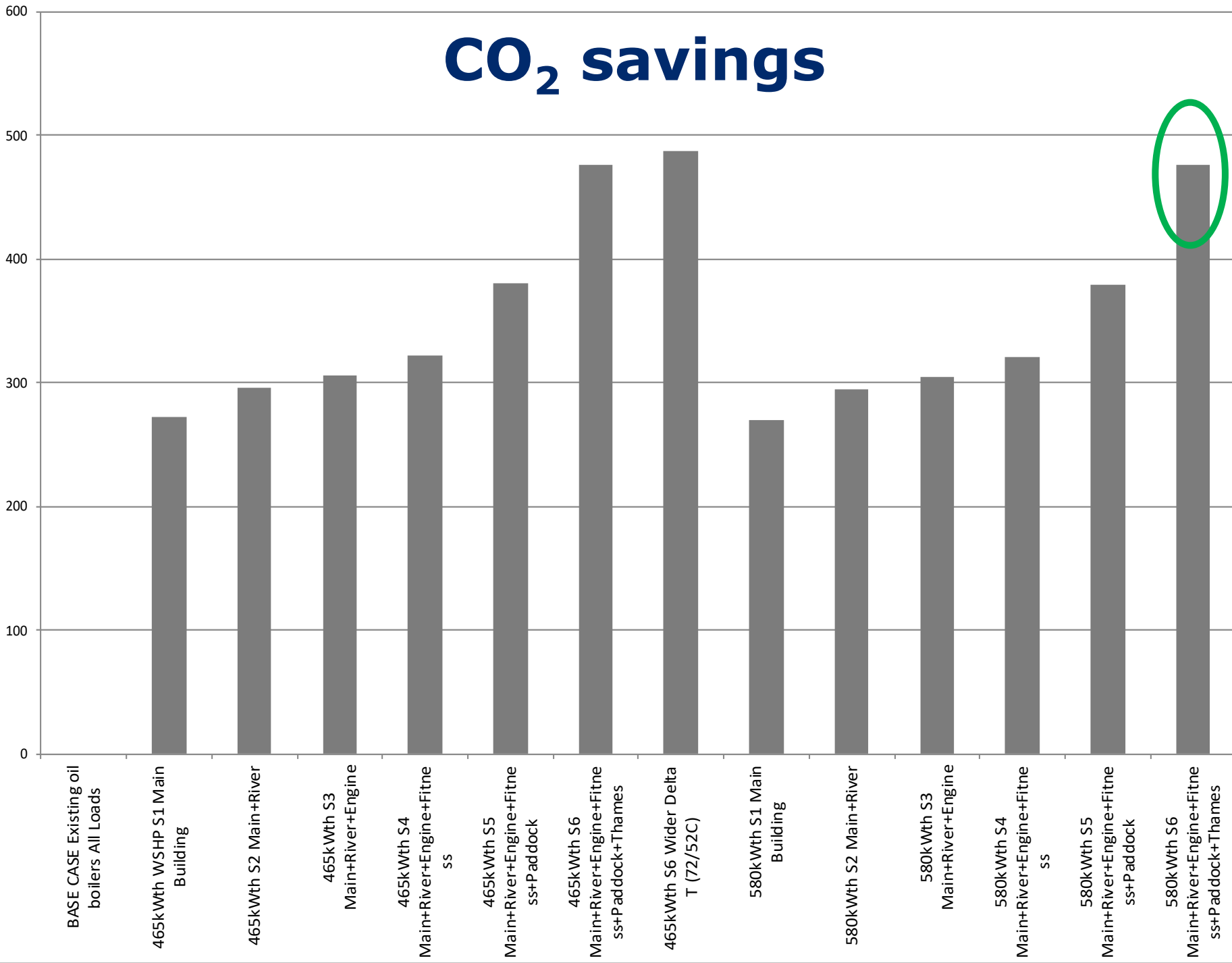
HENLEY BUSINESS SCHOOL	Simple payback (Years)	IRR (25 years)	NPV (£ x 1000) (25 years)	Operating Surplus 2016 (£ x 1000)	CO2 Saving (Tonnes/yr)	INITIAL CAPEX (£ x 1000)
BASE CASE Existing oil boilers All Loads	0.0	0.0%	-1,795	-110	0	£0
465kWth WSHP S1 Main Building	10.0	8.1%	-1,380	-31	273	£785
465kWth S2 Main+River	10.2	7.8%	-1,379	-28	296	£843
465kWth S3 Main+River+Engine	11.1	6.7%	-1,450	-26	306	£938
465kWth S4 Main+River+Engine+Fitness	11.3	6.5%	-1,456	-23	322	£982
465kWth S5 Main+River+Engine+Fitness+Paddock	10.5	7.5%	-1,323	-13	380	£1,018
465kWth S6 Main+River+Engine+Fitness+Paddock+Thames	10.7	7.4%	-1,257	4	476	£1,219
465kWth S6 Wider Delta T (72/52C)	10.1	8.1%	-1,149	11	487	£1,219
580kWth S1 Main Building	9.2	9.2%	-1,281	-24	270	£785
580kWth S2 Main+River	9.4	8.9%	-1,275	-20	294	£843
580kWth S3 Main+River+Engine	10.2	7.7%	-1,345	-18	304	£938
580kWth S4 Main+River+Engine+Fitness	10.4	7.5%	-1,350	-16	320	£982
580kWth S5 Main+River+Engine+Fitness+Paddock	9.7	8.5%	-1,212	-5	379	£1,018
580kWth S6 Main+River+Engine+Fitness+Paddock+Thames	10.0	8.2%	-1,133	12	476	£1,219

# Results



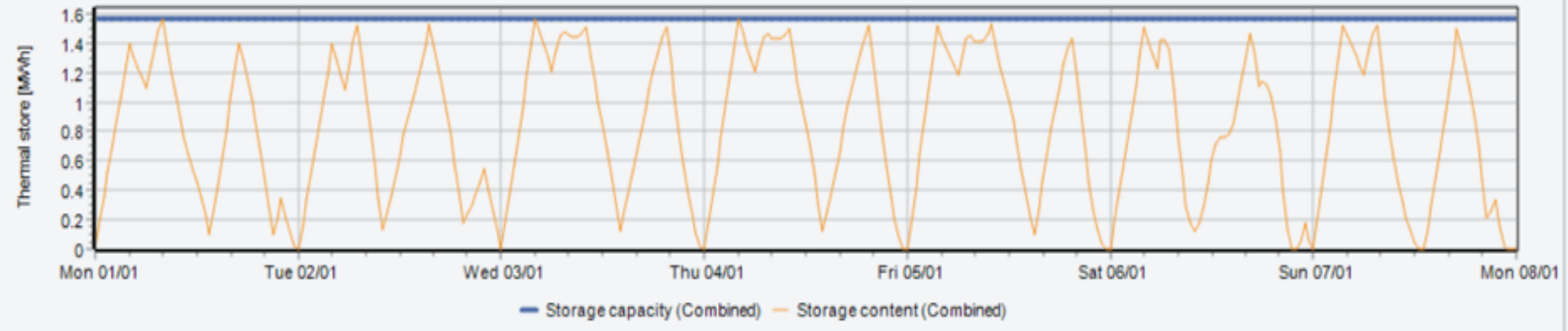
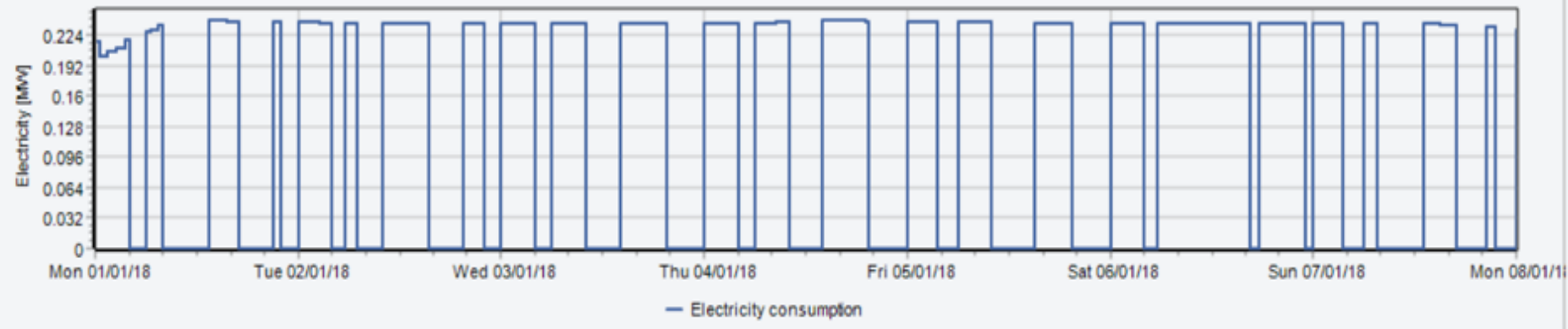
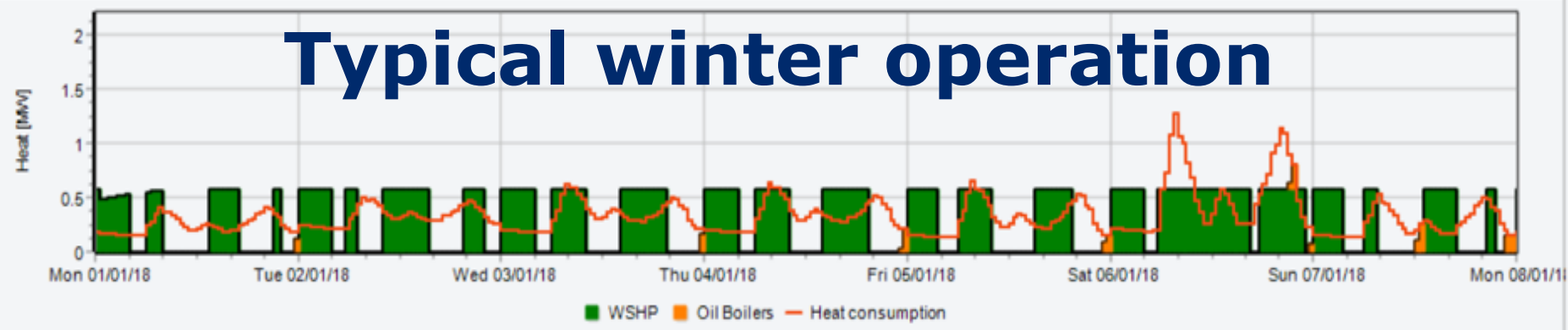
# Net Present Value

# CO<sub>2</sub> savings

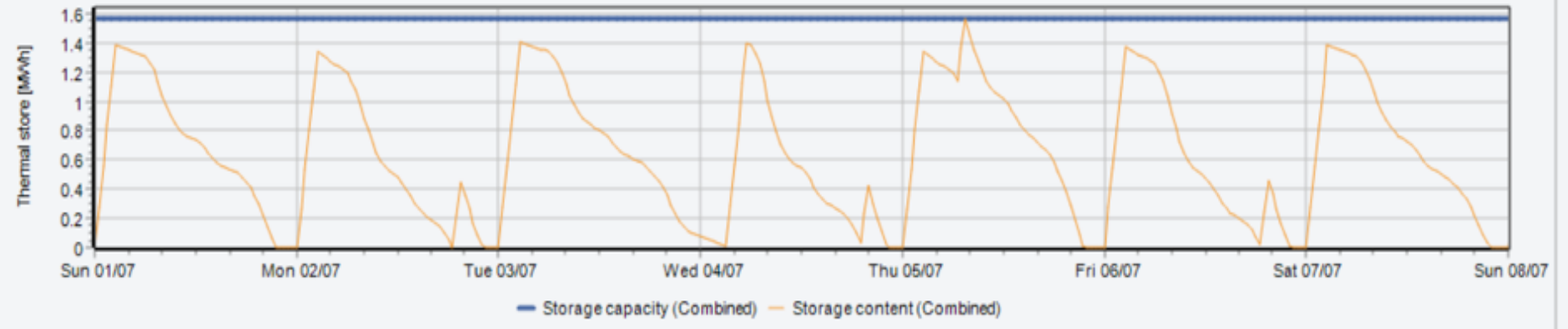
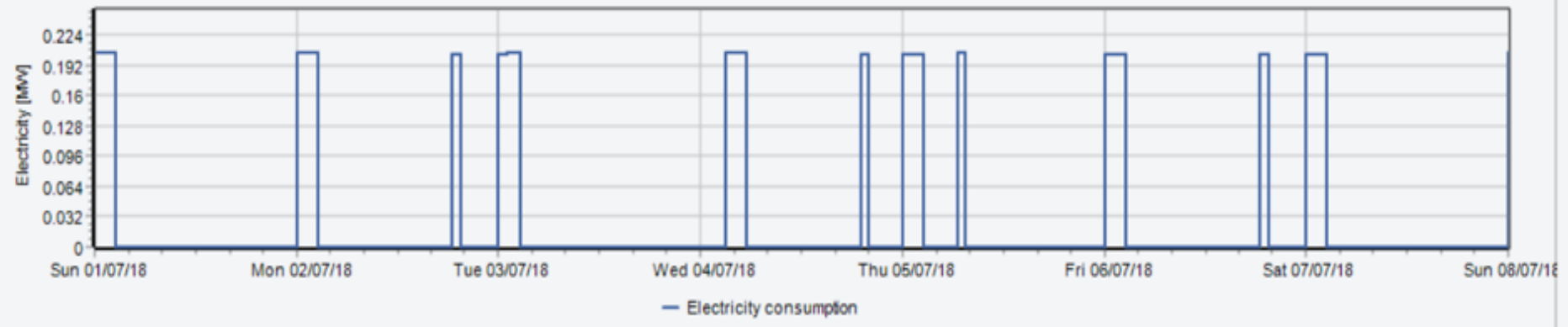
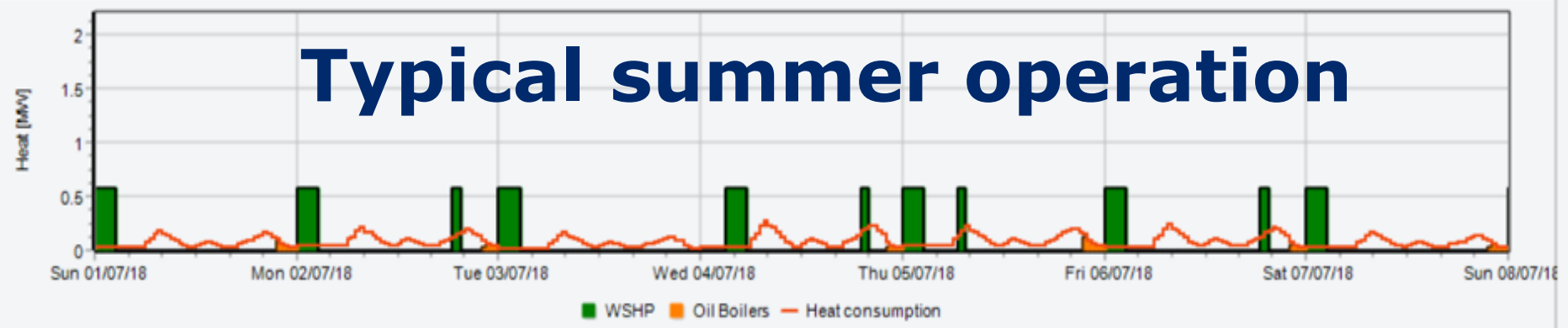




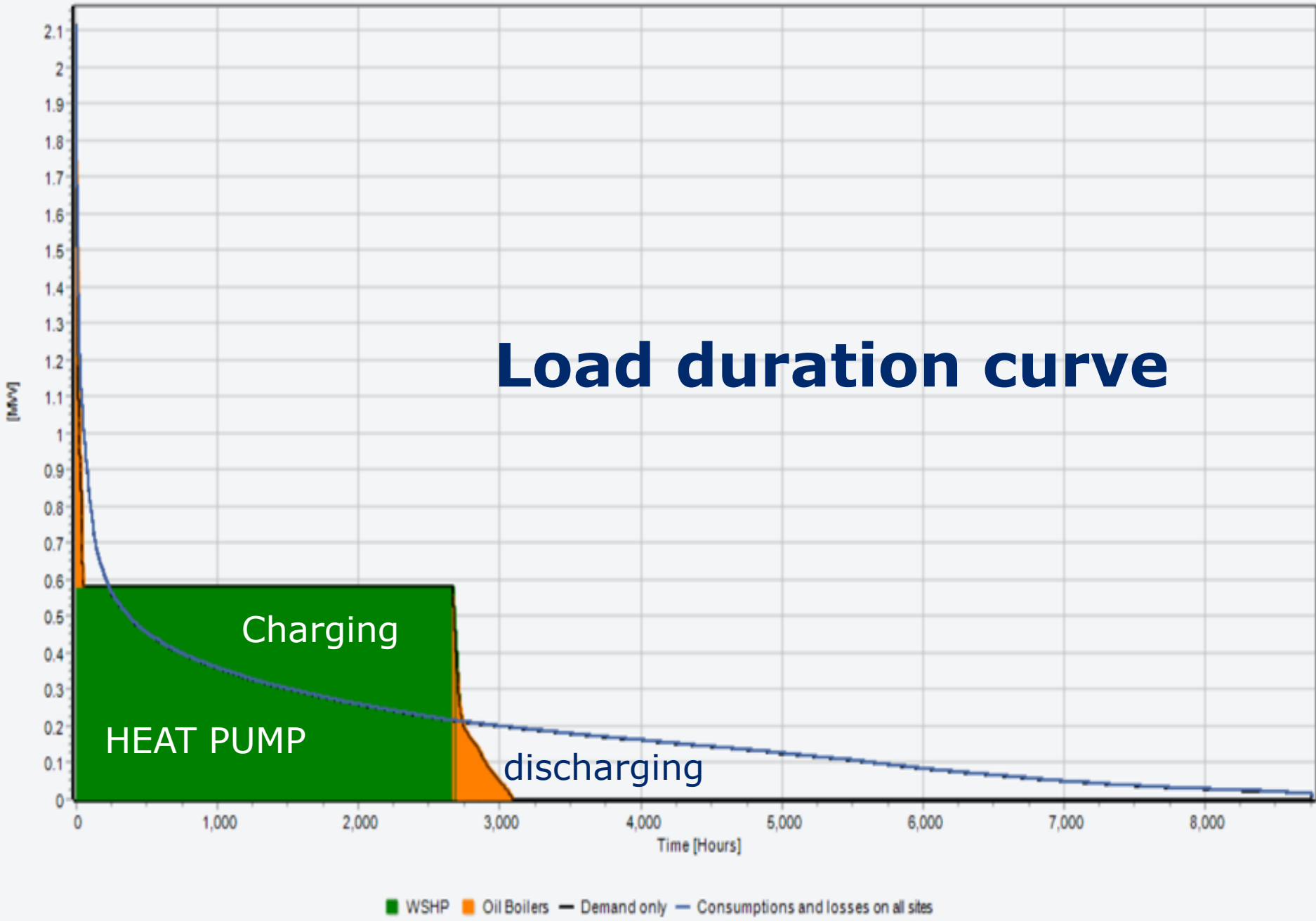
# Typical winter operation



# Typical summer operation



Duration curve for heat demand  
(01 January 2018 to 01 January 2019)



# Summary

- River energy capacity is capable of supporting 580kWth heat pump
- High temperature ammonia heat pump to supply at 70/60°C
- Outline design to extract heat from the river
- Outline design for new heat network to connect the satellite buildings
- Existing central oil boilers retained to provide supplementary back-up
- Study shows scheme is practical, feasible, buildable

# Summary

- Capital cost around £1.2M
- Techno-economic modelling ~10yr payback
- £660k Improvement in NPV (25 years)
- IRR of ~8.2% including RHI
- Carbon savings of 476 Tonnes/yr
- A pre-application gained approval from the environment agency

- A real practical study detailing engineering/economics of SWSHP to supply low carbon District Heating
- The University of Reading is currently taking this scheme to detailed design stage

# Feasibility of a Surface Water Source Heat Pump at Henley Business School

**Phil Jones**

*Building Energy Solutions*

*philjones100@virginmedia.com 07714 203045*

**Chris Dunham**

*Carbon Descent*

*ChrisD@carbondescent.org.uk 07904 267 306*