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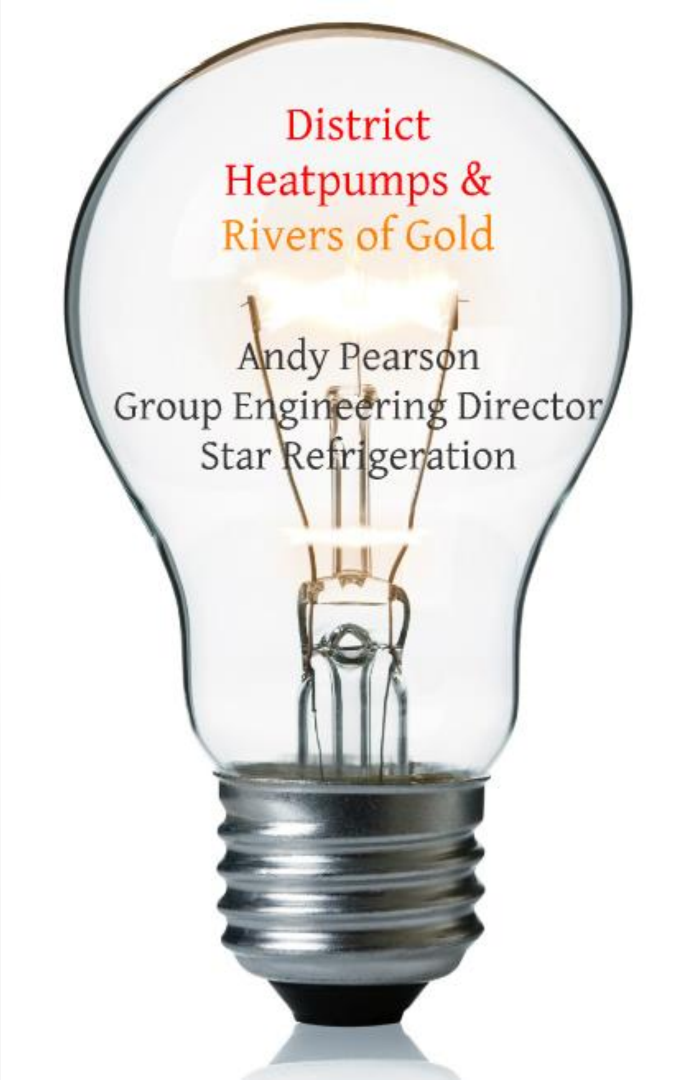
15-16 October 2013, Brussels



www.tinyurl.com/nh3-totalenergy

#1

Who are Star?

Founded 43 years ago

Who are Star?

Founded 1970

300+ team

Privately owned

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#2

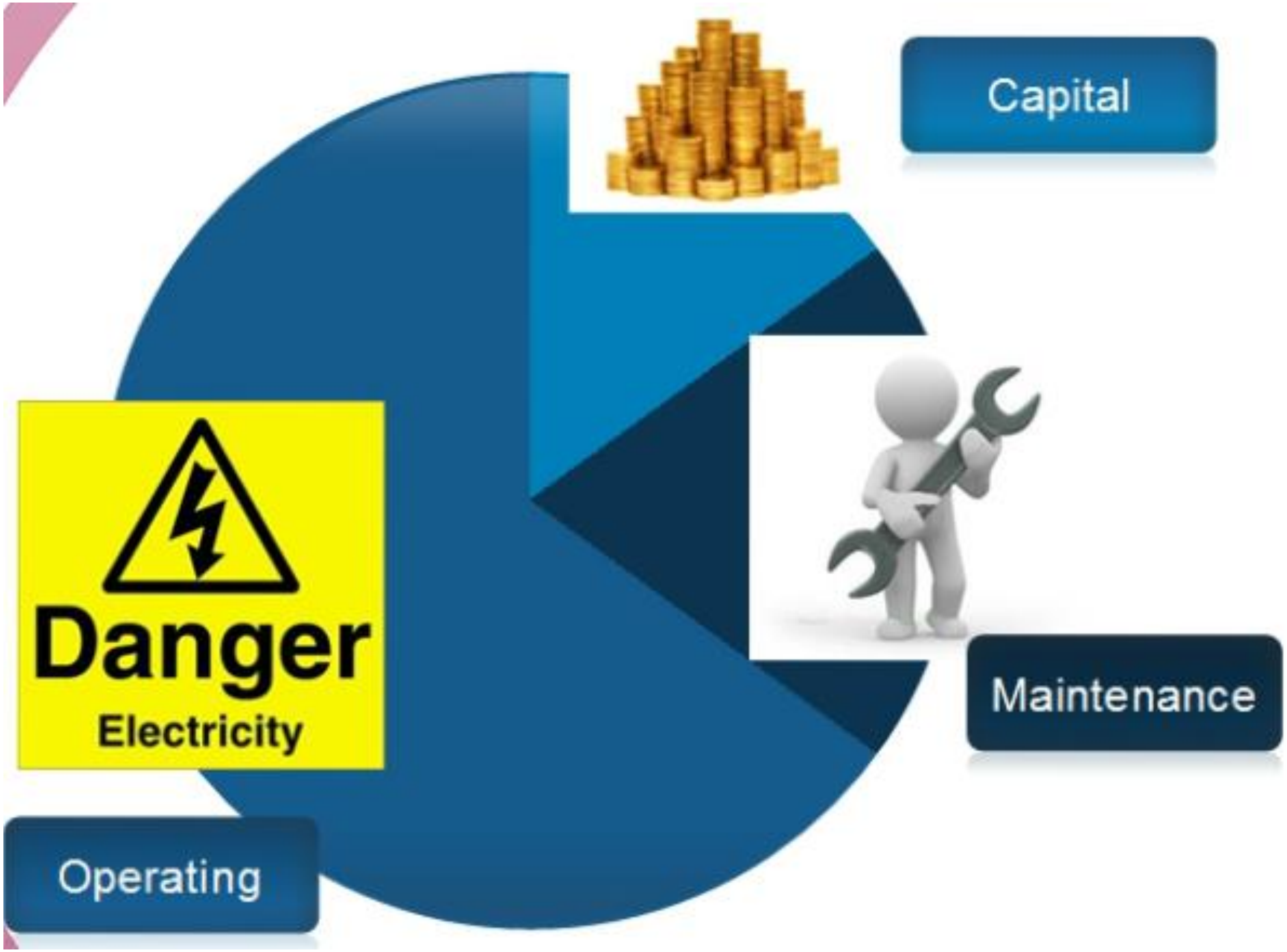
Who do we work with?

What do they have in common?

#3

They get it!

Opex is the key



#4

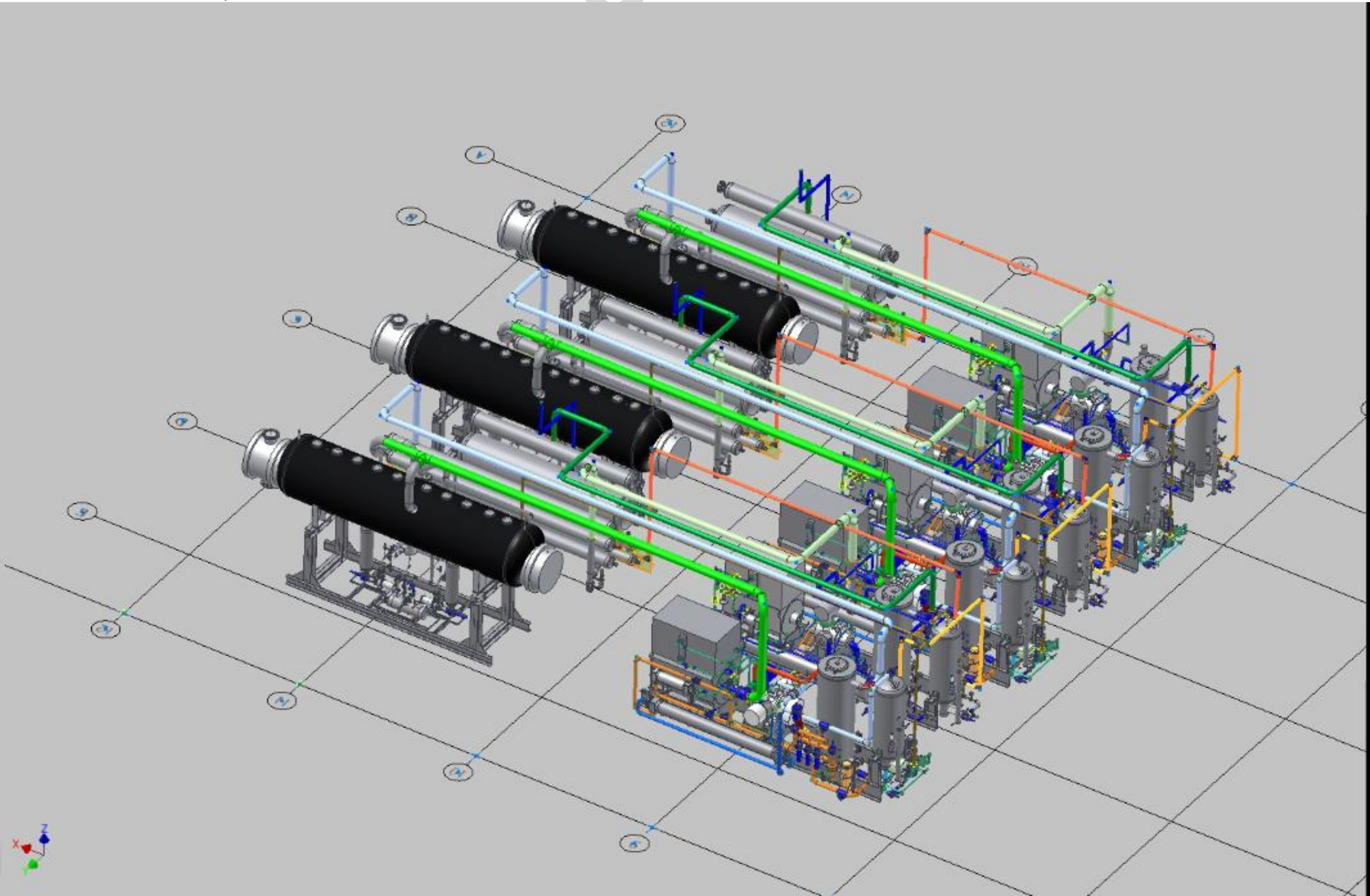
District heating

Throwing away cooling!

Drammen
14MW@90C
from Seawater

#5

3 x 4.6MW systems



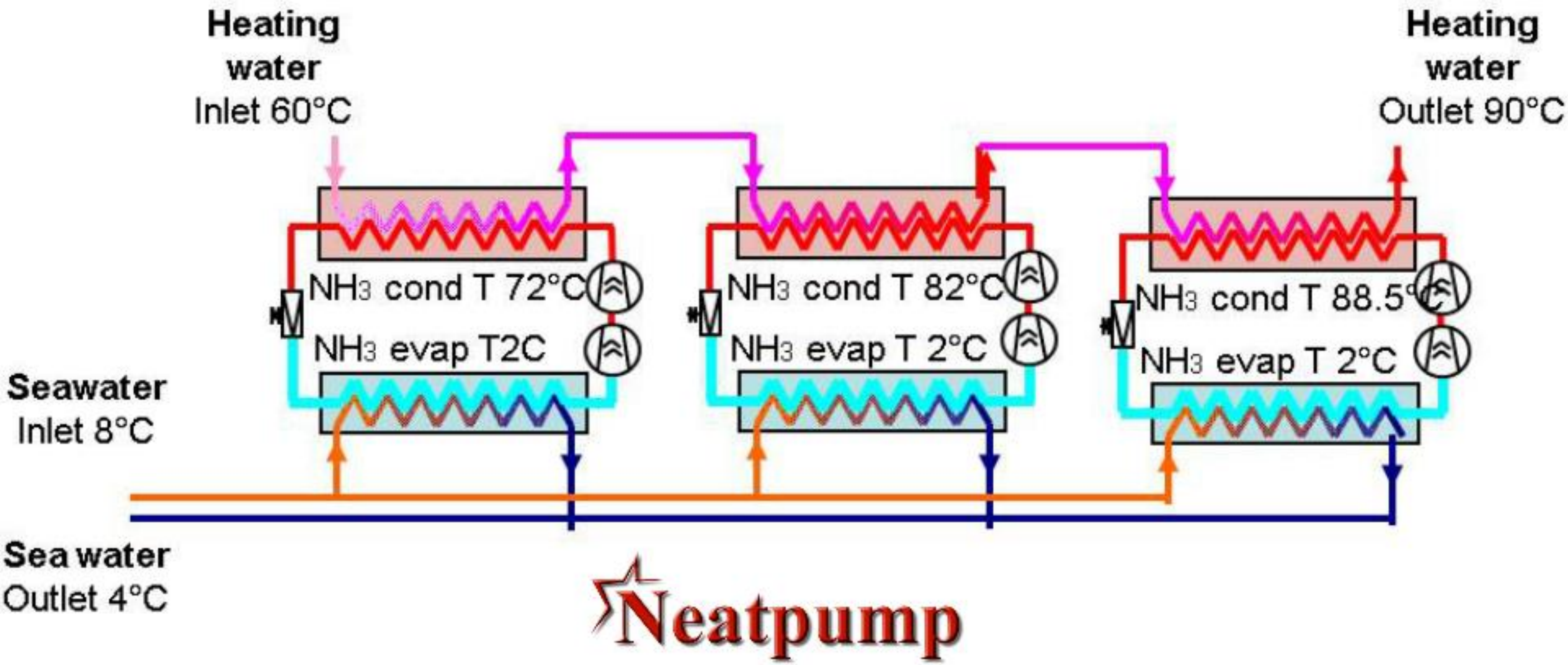
#7

COP > 3.0 at 90ºC

#8

Clever configuration

Plus as much extra as possible!



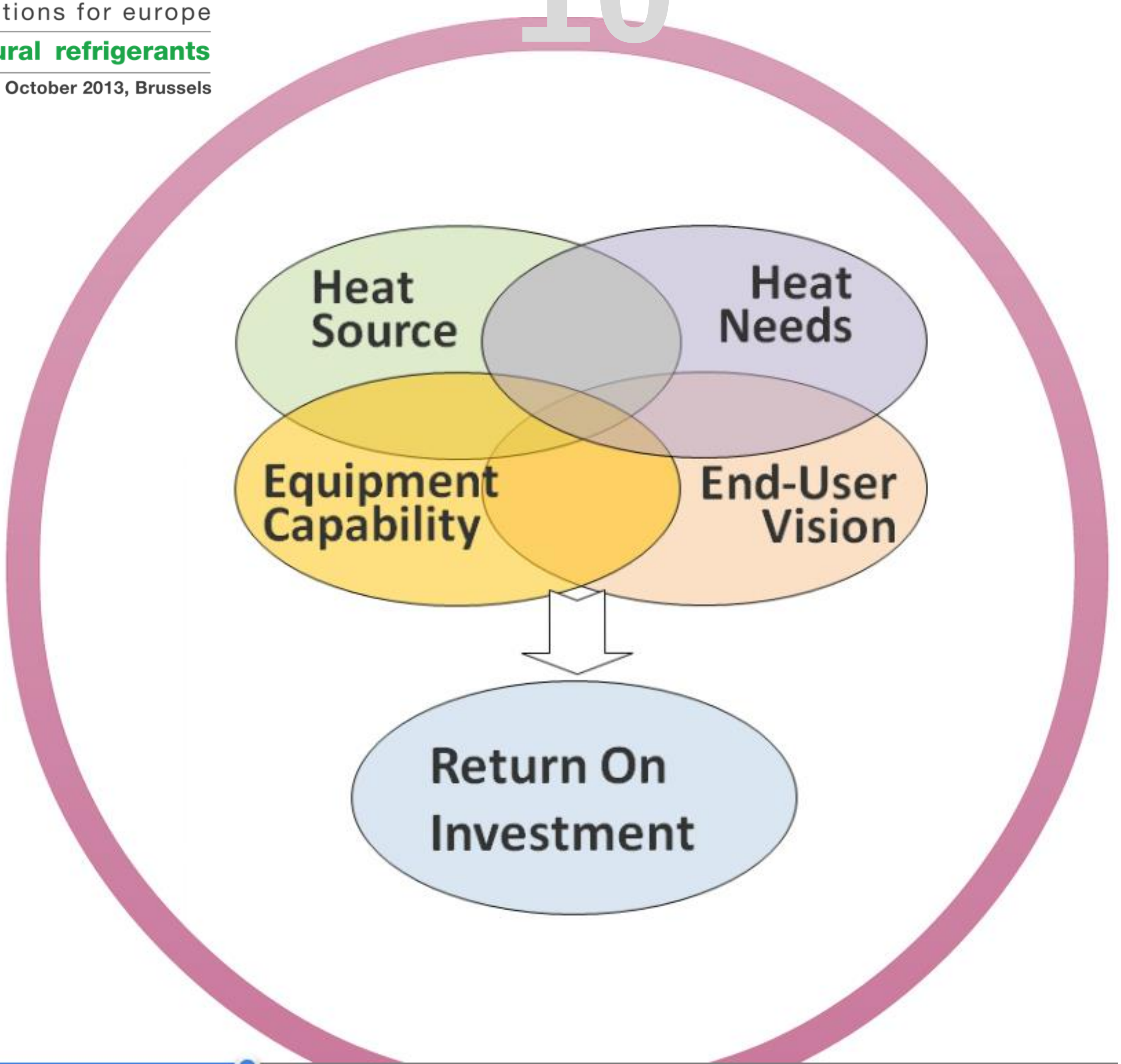
#9

NH_3

Delivering District Heating

#10

But why ammonia?



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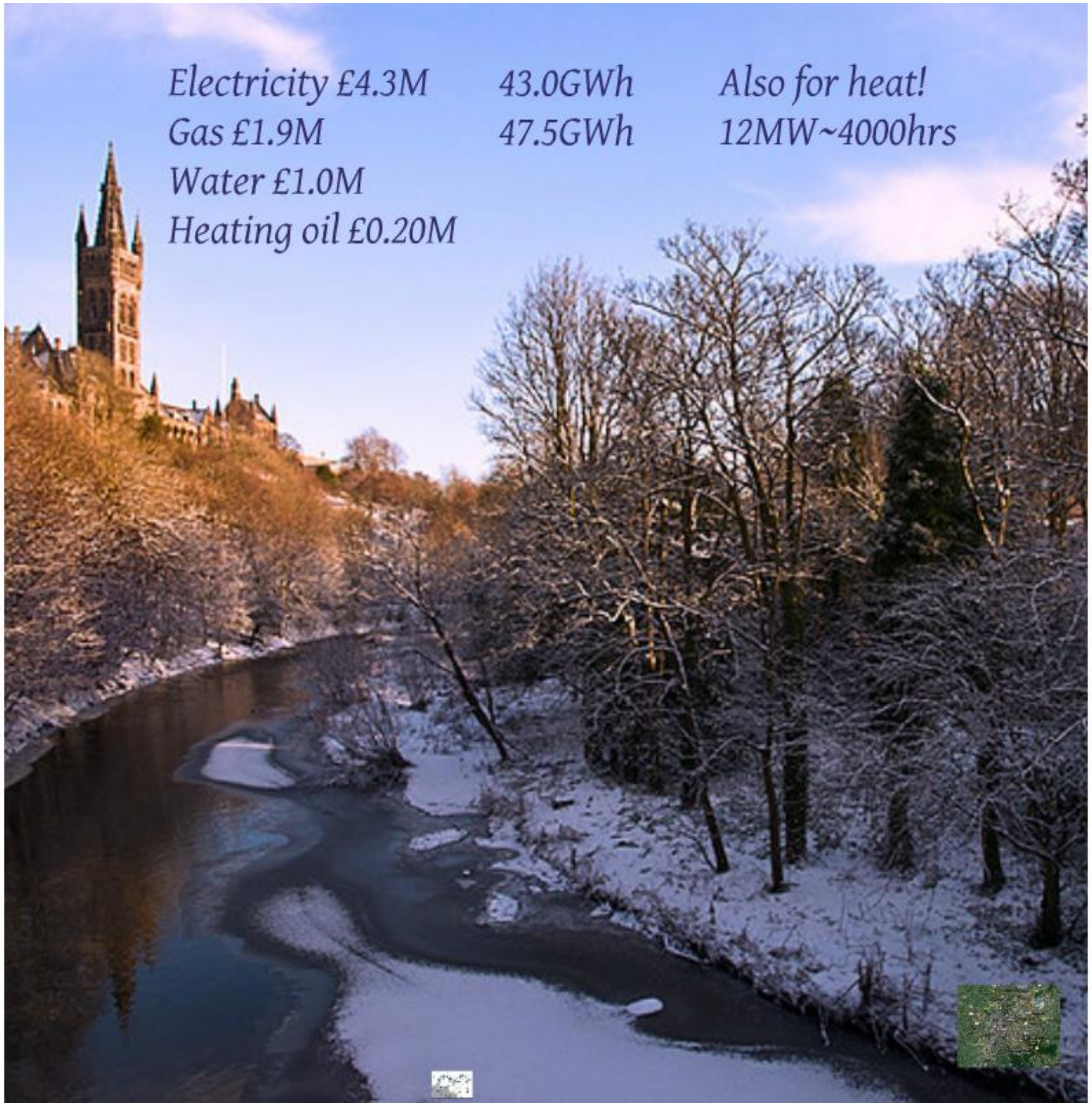
#11

Glasgow University

A case study



#12

The River Kelvin

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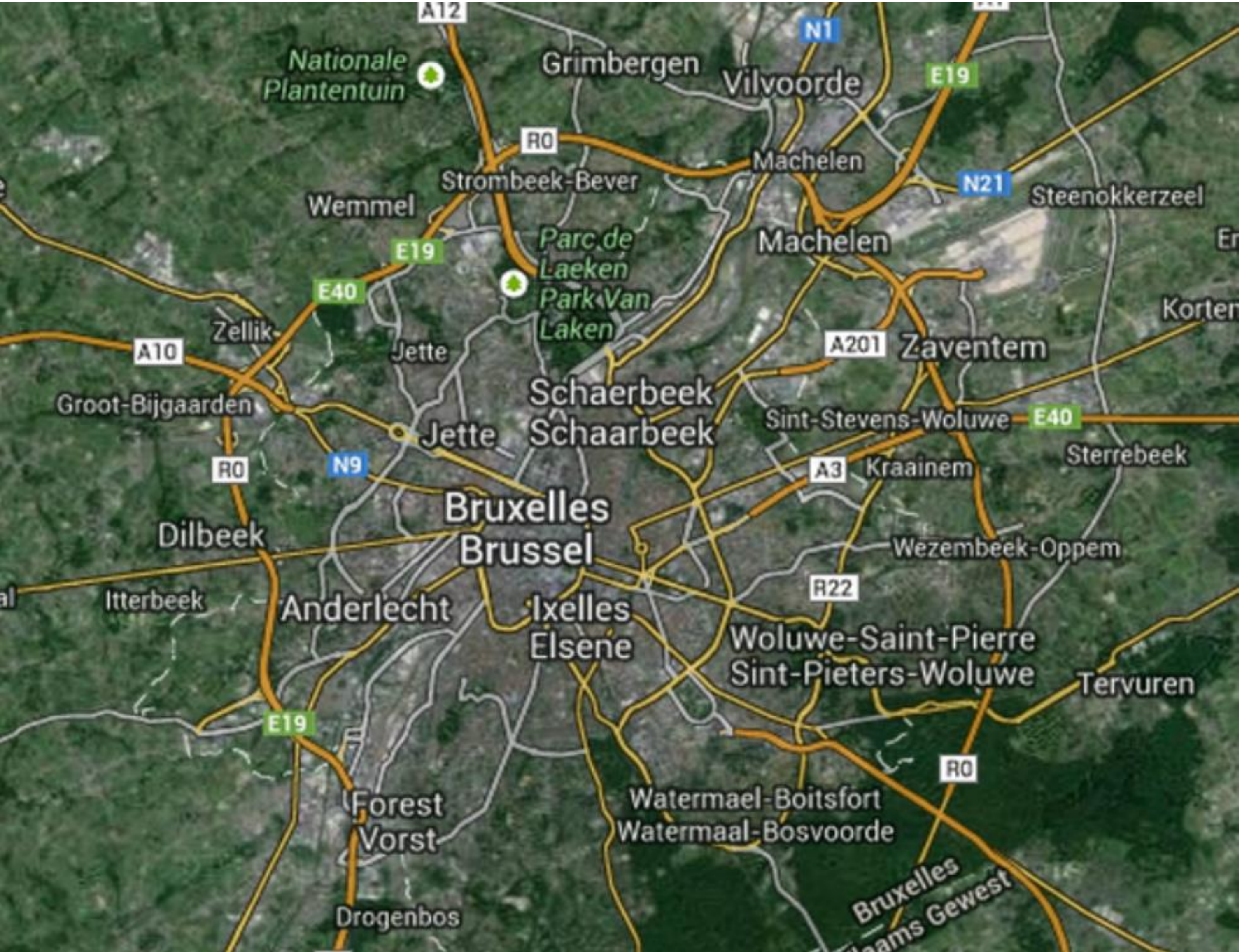
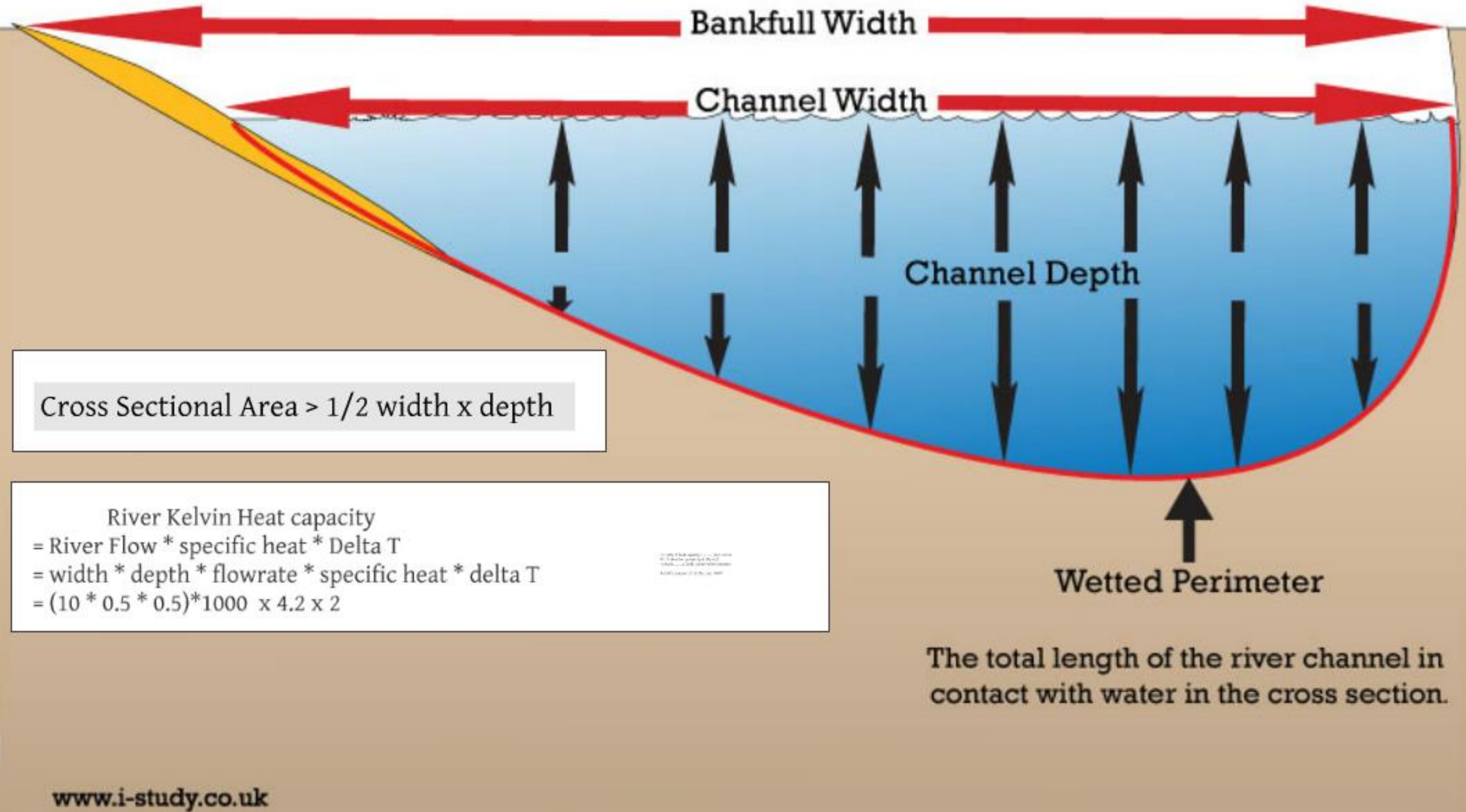
#14 What about Brussels?

All big cities are built on rivers!



#15

The Maths



Cross Sectional Area > 1/2 width x depth

River Kelvin Heat capacity
= River Flow * specific heat * Delta T
= width * depth * flowrate * specific heat * delta T
= (10 * 0.5 * 0.5)*1000 x 4.2 x 2

Cross Sectional Area > 1/2 width x depth

River Kelvin Heat capacity

= River Flow * specific heat * Delta T

= width * depth * flowrate * specific heat * delta T

= (10 * 0.5 * 0.5)*1000 x 4.2 x 2

The Maths

=21 MW of heat capacity…………..heat source
PLUS absorbed power typically +1/3
=28 MW……….a fairly conservative estimate

but let's assume 1/3 of this, say 10MW

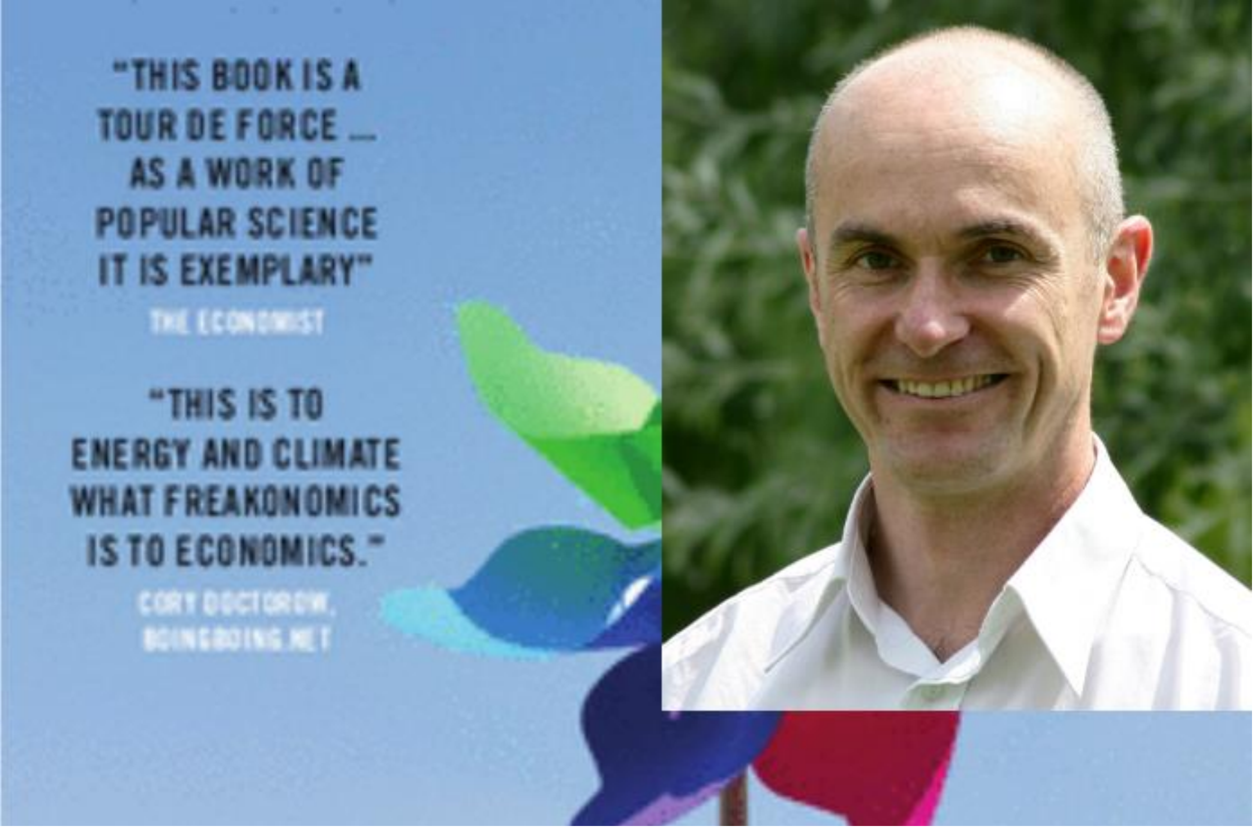
The Maths

A 10MW district heating example

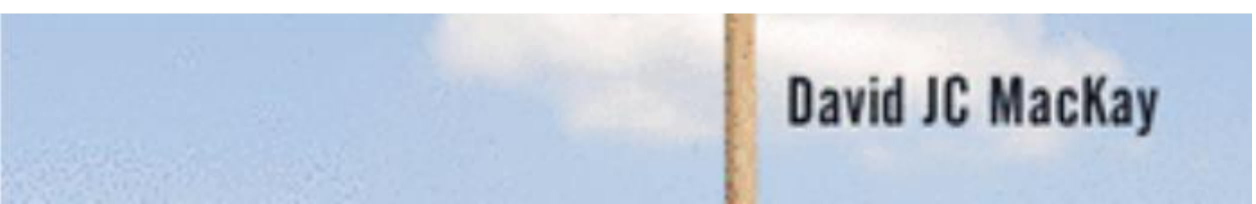
Worked example: 10MW district heating in UK

	Centralised heat pump	Gas District Heating	Gas CHP
Capital	~£4.0M	~£0.5M	~£7.0M
Usage/pa	4000 hrs	4000 hrs	4000 hrs
Gas/kWh		4p/kWh	4p/kWh
Elec/kWh	9p/kWh		
Efficiency	4.0	0.85	0.37e/0.43th
OPEX/pa	£0.90M (-44%/+45%)	£1.6M	£0.62M (£3.72Mth -£3.1Me)
CO2/pa	4,498 T (-39.3%)	7,400 T	17,120 T -16650 T 470 T
ROI	17.5% (+25%)		14.0%
	RHI £0.035/kWh * 10,000 *4,000 = £1.4M/a for 20 years		Nil

As the grid cleans this facility is "clean". .... this facility is "dirty".



"Setting fire to chemicals like gas should be made a thermodynamic crime," he said. "If people want heat they should be forced to get it from heat pumps. That would be a sensible piece of legislation."




Gas
Heat

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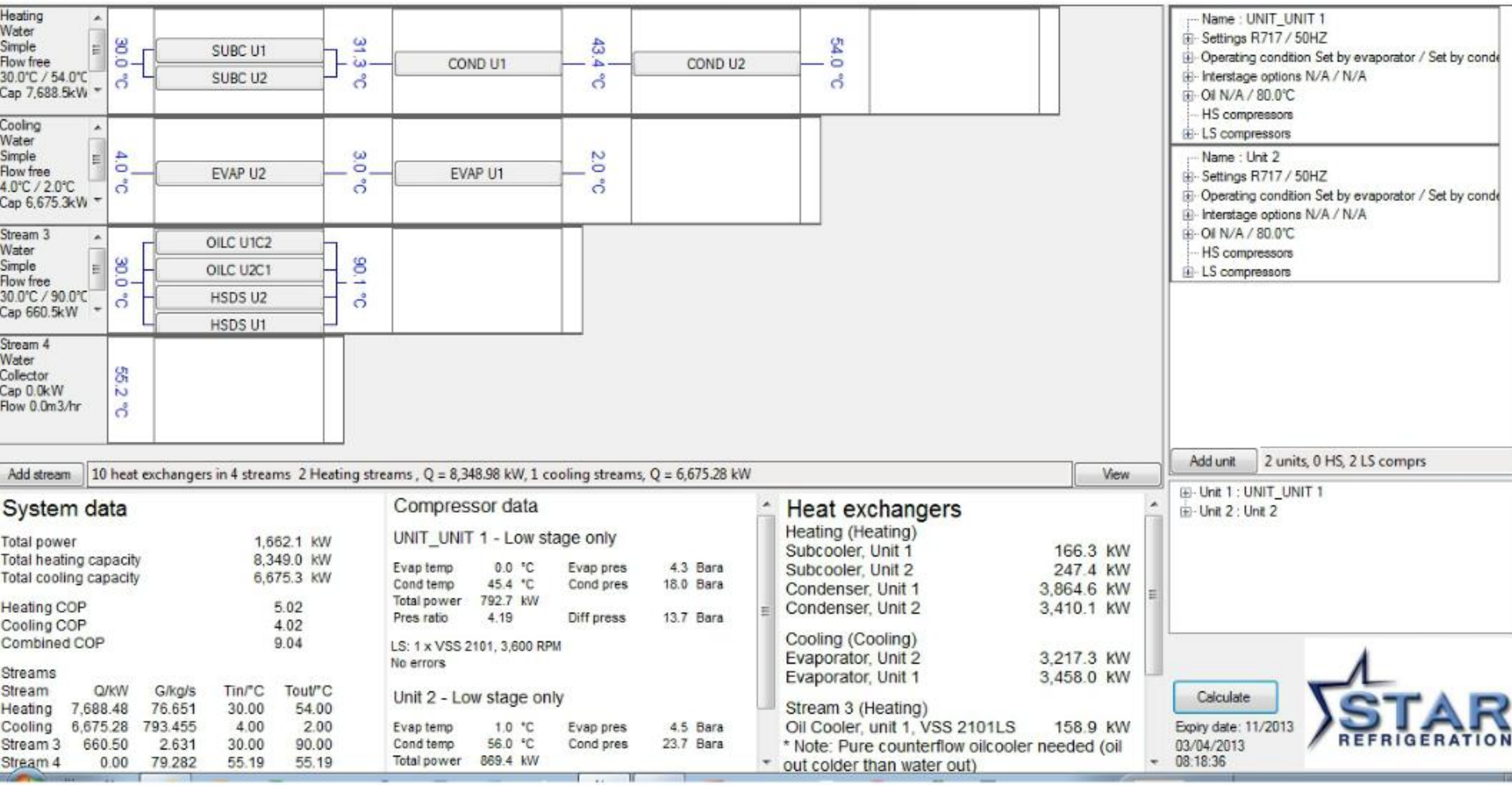
#21

Heat from the river

Performance Assessment



#22

Heat from the river

COP > 5.0

System data

Total power	1,662.1	kW
Total heating capacity	8,349.0	kW
Total cooling capacity	6,675.3	kW
Heating COP	5.02	
Cooling COP	4.02	
Combined COP	9.04	

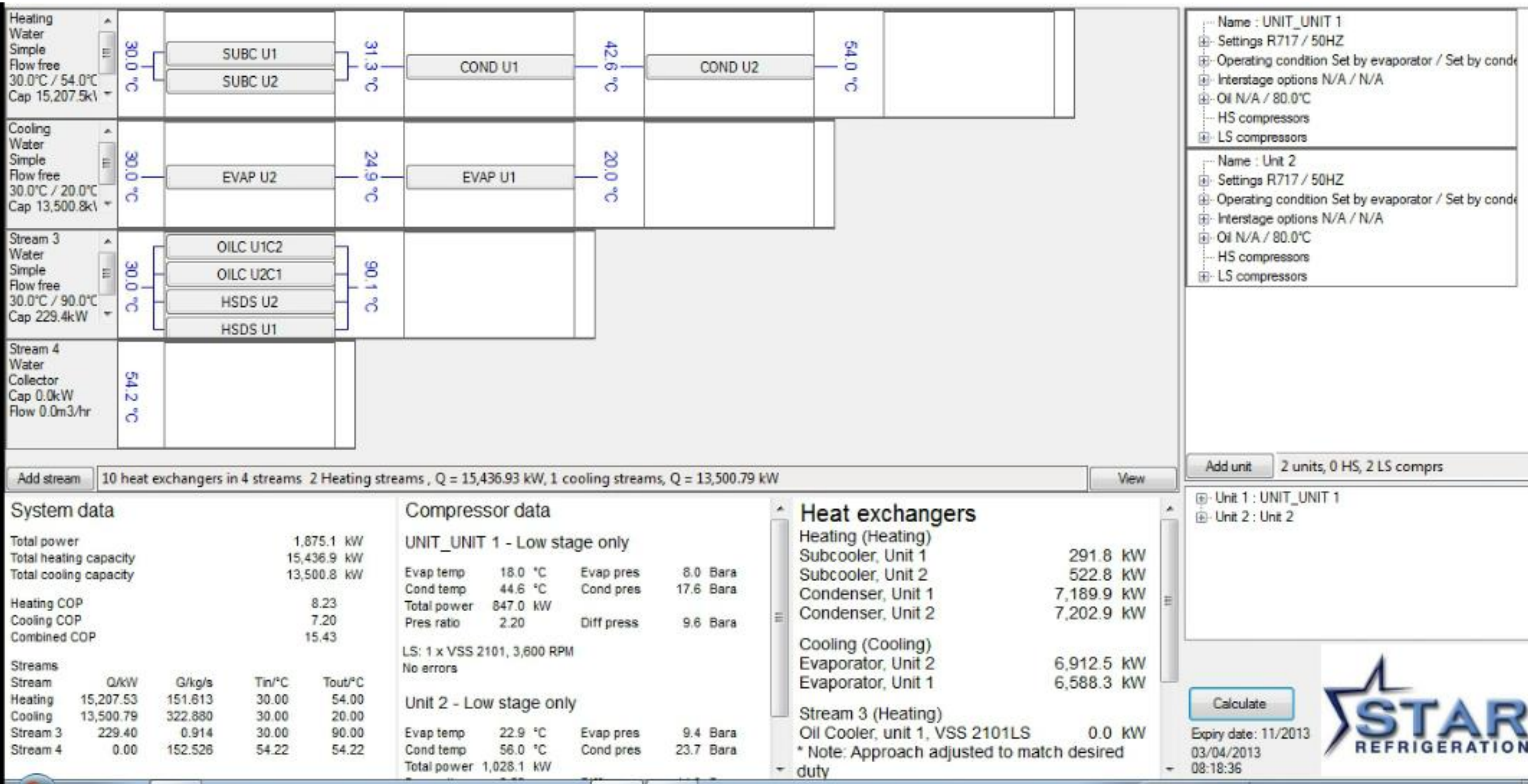
Streams

Stream	Q/kW	G/kg/s	Tin/°C	Tout/°C
Heating	7,688.48	76.651	30.00	54.00
Cooling	6,675.28	793.455	4.00	2.00
Stream 3	660.50	2.631	30.00	90.00
Stream 4	0.00	79.282	55.19	55.19

#23

Heat from processes

Performance Assessment



#24

Heat from processes

COP > 8.0

System data

Total power	1,875.1 kW
Total heating capacity	15,436.9 kW
Total cooling capacity	13,500.8 kW
Heating COP	8.23
Cooling COP	7.20
Combined COP	15.43

Streams

Stream	Q/kW	G/kg/s	Tin/°C	Tout/°C
Heating	15,207.53	151.613	30.00	54.00
Cooling	13,500.79	322.880	30.00	20.00
Stream 3	229.40	0.914	30.00	90.00
Stream 4	0.00	152.526	54.22	54.22

Student Project #1

Evaluating the demand

project 1- evaluating the demand for a networked heating system across the campus.

The campus has a huge energy bill. Not only is this a drain on the finances of the University, with ever increasing pressure to reduce carbon footprint, the real cost is only set to rise.

Campus or district heating systems offer a way of reducing this cost and even reduce the carbon footprint to zero.

The aim of this project is initially to determine the loads of each of the main buildings and then the existing infrastructure in each building. In addition the heat load needs to be determined across as long a period as possible, logged versus ambient temperature.

This will be presented as a 4D map of location, quantity and time of use.

The second part of the project will take this data and the preliminary output from project2 (heat sources) and propose a campus wide system meeting the bulk of the load with large heat pumps sourcing the heat from the river Kelvin. (if driven by renewable energy this will be deemed zero carbon). As this scheme would be eligible for the renewable heat incentive, the support available is adequate to finance such a project over a short period.

The project should conclude with an estimate of capital, and operational cost and therefore present an ROI (return on investment) to be considered by the Estates Director and Finance Director.

#26

Buildings on campus

Student Project #2

Evaluating the sources

Project 2 - evaluating the sources of heat available on campus. The principal source being the river Kelvin.

The campus has a huge energy bill. Not only is this a drain on the finances of the University, with ever increasing pressure to reduce carbon footprint, the real cost is only set to rise.

Campus or district heating systems offer a way of reducing this cost and even reduce the carbon footprint to zero.

The aim of this project initially to determine the quantity of heat that could be extracted from the Kelvin. Principally this means measuring flow rate and temperature. Once this data capture is established to record across 3 months, the focus of the project will shift to an assessment of the operation criteria for the heat pump. Dialogue with project will provide preliminary data.

The project will then begin to assess feasibility of distributing heat around the campus. There are several techniques to be considered from high temperature networks at 90C to ambient loops at 15C (each local then drawing heat via a local heat pump.)

The second part of the project will take this data and the preliminary output from project1 (heat sources) and propose a campus wide system meeting the bulk of the load with large heat pumps sourcing the heat from the river Kelvin. (if driven by renewable energy this will be deemed zero carbon). As this scheme would be eligible for the renewable heat incentive, the support available is adequate to finance such a project over a short period.

The project should conclude with an estimate of capital, and operational cost and therefore present an ROI (return on investment) to be considered by the Estates Director and Finance Director.

Conclusions:

- *strong evidence that heatpumps work*
- *strong evidence they are lowest carbon*
- *strong evidence they are economical*
- *reasonable evidence the Kelvin flow is considerable*
- *reasonable evidence the University heat demand is significant*
- *Ammonia is the key to the economics*

It is likely that there is enough useable heat in the Kelvin for bulk of demand.........even if it is high temperature demand at ~80/90C

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Thank you.

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Thank you very much!