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ENVIRONMENTAL SUSTAINABILITY

Heat Network Efficiency Controls - Storage - ORC Lessons Learnt

Joel Cardinal
Head of Energy and Sustainability
University of Warwick
j.cardinal@warwick.ac.uk

sirach
www.sirach.org.uk

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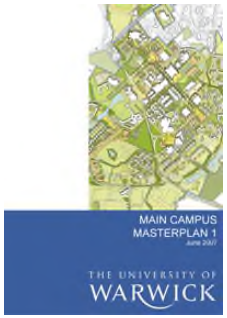
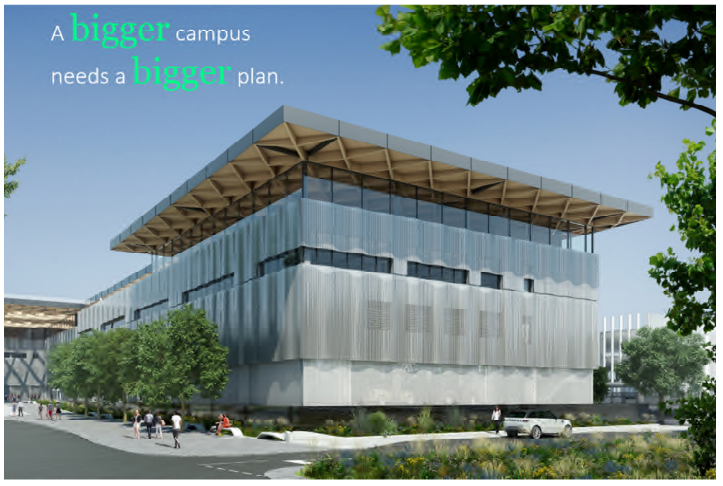
Agenda

- ✓ Unique heat Network Asset
- ✓ Sustainability Policy to 2020-30
- ✓ Efficiency and Innovation
- ✓ Organic Rankine Cycle Engine – Lessons Learnt





University of Warwick Vision

- Globally connected leader
- High Quality teaching and research
- Sustainability at the core of everything
- Pioneer in knowledge transfer

"a living demonstration of the principles of environmental sustainability"

An international university

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Warwick is a globally connected University

"To make a real impact on global issues and deliver the **best research and teaching experience** for its staff and students it has chosen to form **close partnerships** with a select group of **research-heavy institutions** that exist in many locations, do research in many locations, and which produce students who see themselves as global citizens.

Such close and select partnerships can share research resources enhances the student experience and help serve a much wider community both nationally and Internationally. Warwick has also chosen to form partnerships, such as with **Monash University in Australia** and **CUSP in New York**, that are not based on geographical proximity or focused on a search for economies but has instead in each case sought partnerships between autonomous institutions that are academically excellent, share Warwick's organisational and academic ethos between and which help create a truly global network."

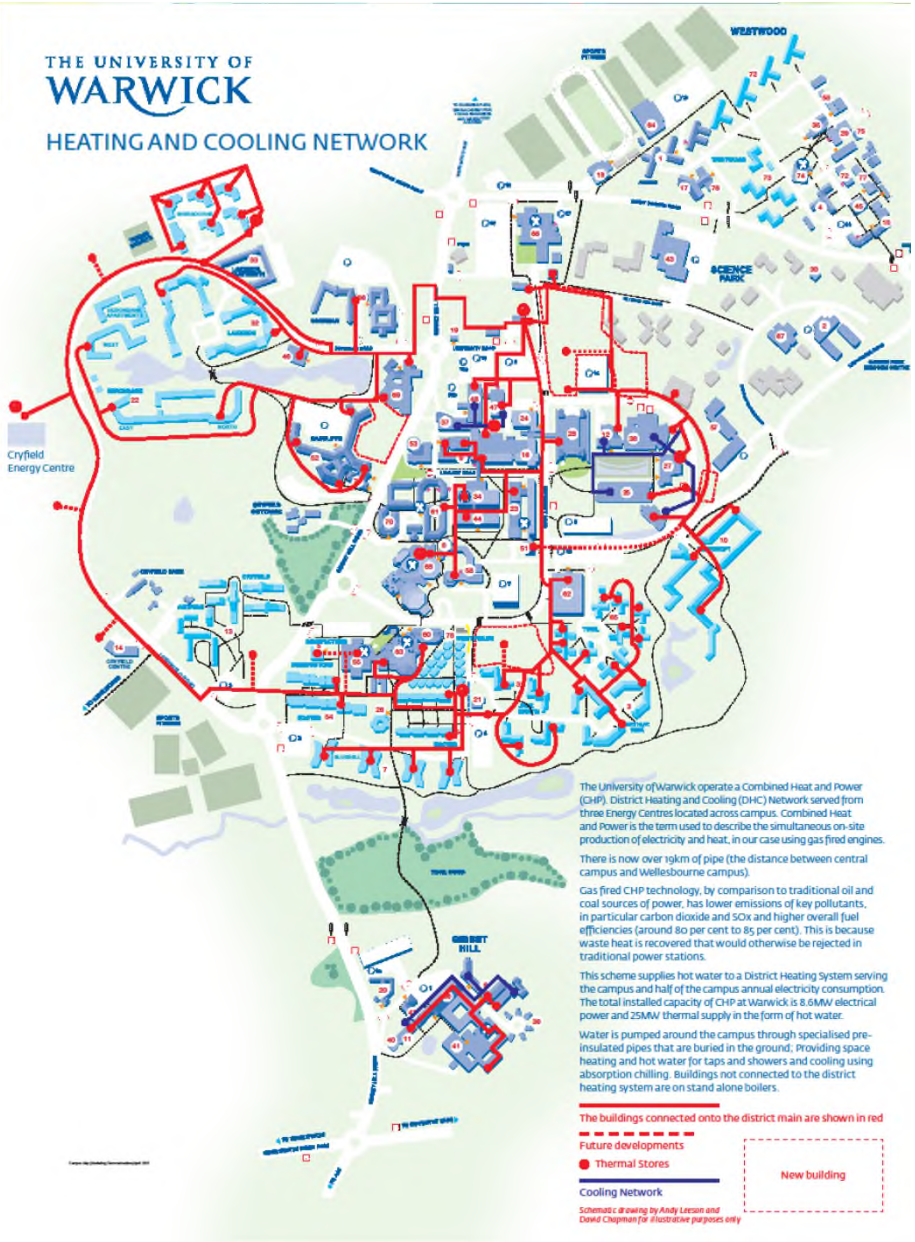
Our Campus

A 24/7 town of 30,000

- 23,000 students
- 5,500 staff
- 1.5 mile long
- 7,000 students rooms
- More than 150 buildings
- 3 conference centres
- 2 Sport centres
- Retail / cafes / restaurants
- Arts Centre
- Offices & teaching buildings
- Industrial & Research buildings

Generate 50% of heat & power
2nd E. Centre open June 2014
Saving compared to grid supply to increase from 5,000 to 8.000 tCO2

Own & maintain all services networks
Including 2,200 utilities meters



Our Energy and Carbon Strategy

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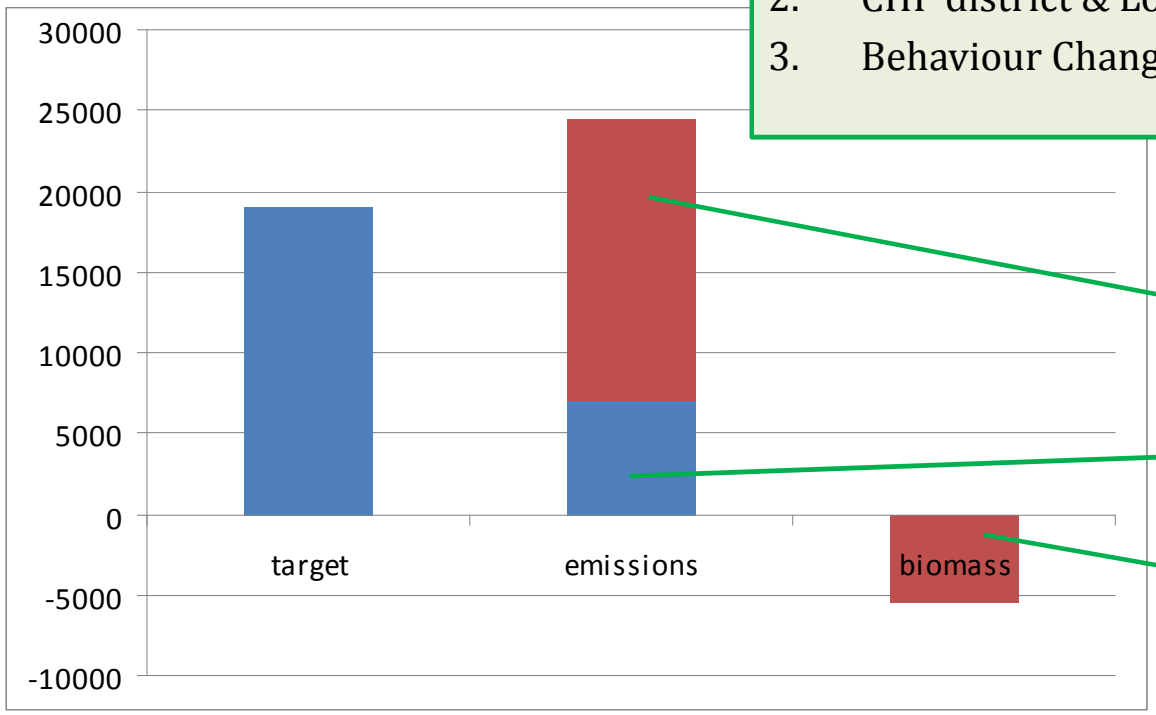
1. Energy conservation & efficiency
2. CHP district & Low carbon generation
3. Behaviour Change



Emissions from "improved" current Estates

Emissions from new Estates

"Low Carbon" fuelled CHP

Predicted 2020 CO2e emissions for Planned campus expansion as per Master Plan & Strategy 2007

Heat Network Innovation Project

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Department of Energy & Climate Change

- ✓ Warwick drive for efficiency is applied to heating-cooling network design and operation.
- ✓ DECC Heat Network Innovation was opportunity to explore new options
  - ? Can 2010 BEMS controls be improved
  - ? Can we improve thermal energy storage
  - ? Can we make more electricity from waste heat

EBRI European Bioenergy Research Institute
Aston University Birmingham
couchperrywilkes engineering change
imagination at work

Warwick Heat network with thermal storage

Heat network without thermal storage

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Artificial Neural network

ORC

Steam Expander

Current controls =
- Limited to 4 hour prediction
- limited modulation
- No weather prediction
- No account of differences between normal use/weekend use/out of term use
- Limitation of BMS integration
- Limitation in ability to use full volume of the thermal stores

- Cooling cycle 35°C for small thermal inputs
- Cooling cycle 90°C for large thermal input (6MWth)
- Electrical efficiency
- Complexity and costs

- Cooling cycle 100°C for small thermal inputs
- Limited electrical efficiency
- Complexity and costs

- Carbon savings ?
- Financial savings ?
- Return on investment ?

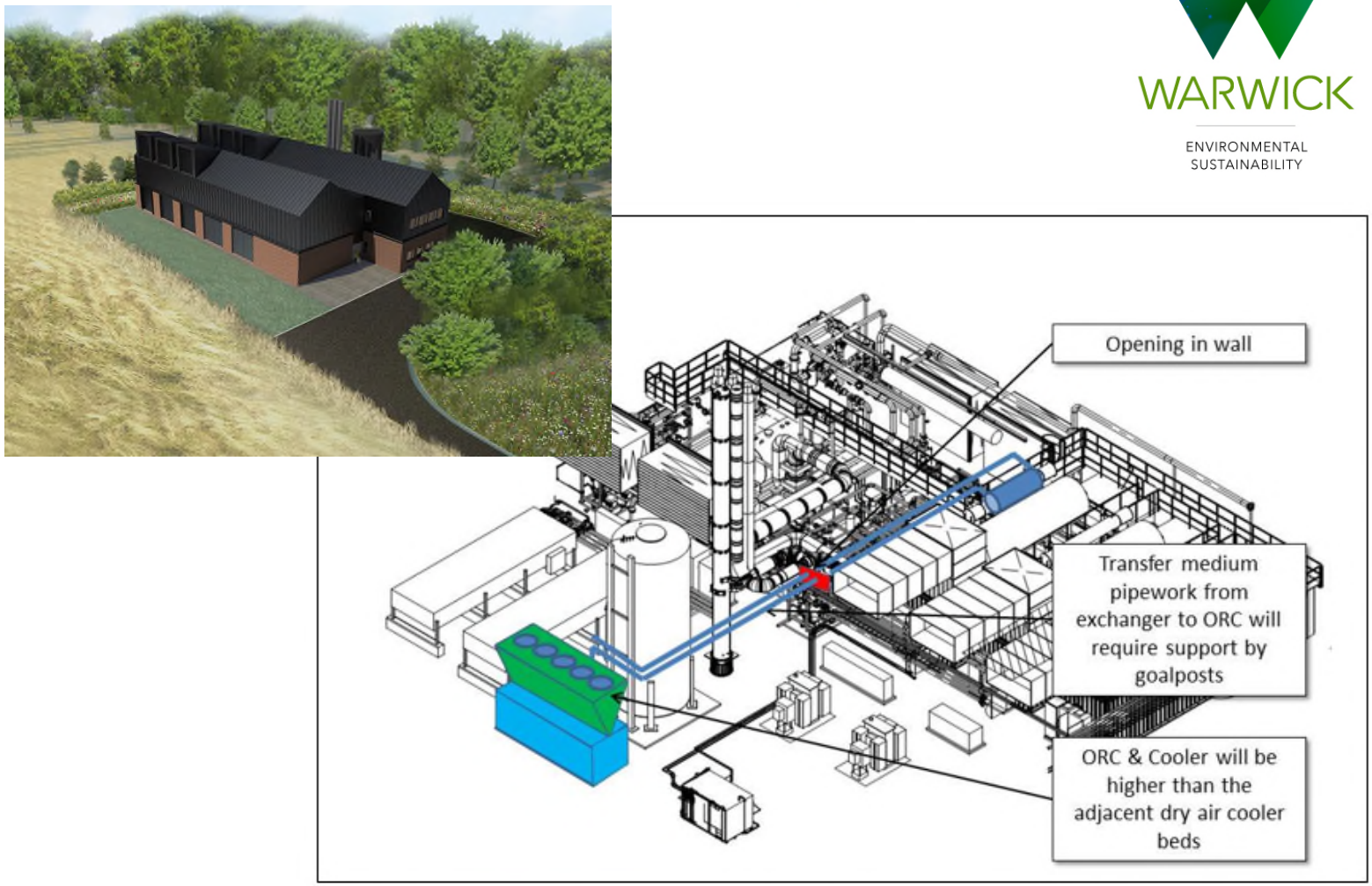

Figure 5. Schematic Isometric View of ORC Location and Integration with Existing CHP Plant

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Results - Lessons Learnt

Artificial Neural network + storage

- 4-5 years pay back for development; perhaps less as commercial product?
- Innovation is applicable to majority of large of heat networks
- Innovation is able to unlock financial viability of heat network projects that struggle to reach financial closure.
- Innovation is likely to be more accessible than a proprietary software where such companies may require retrofitting the entire controls system

ORC

- Only few ORC available in UK of smaller size 500KW – 3MW
- ORC is more effective at electrical generation than steam expander
- ORC - viable as a standalone where heat is dumped as opposed to situations where the heat used is maximised as at Warwick.
- Increased carbon emissions because heat cannot be recovered in heat network (35°C cooling)

Steam Expander

- The low electrical generation yield of the Steam Generator introduce inefficiency making steam a less viable option than simply reusing the flue heat directly into the district network
- Steam - may offer more viability if there is existing steam production on site again not the case at Warwick.

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Conclusion

Controls are always viable:

- Perfect match to enhance thermal storage
- Can make heat network projects achieve financial closure

When ORC and steam generation can be viable:

- District CHP system is electrically led rather than heat led
- CHP operates in an island mode with no grid electricity available on the site
- CHP or other equipment does not already make use of reclaimed flue heat

What could change the market:

- Further technology development to increase versatility (90°C cooling) for smaller thermal input ORC
- Better technical and maintenance integration for ORC and steam technologies (reduced complexity).