Heat recovery from the London Underground

Temperatures on the London Underground have been steadily rising since it began operation in the 19th century; the ambient temperature of the London Clay around the tunnels was originally 14°C, and in the 1920s the Underground was advertised as somewhere to go to keep cool in hot summers.[1] However, by 1940 the temperature in the clay had risen to 21ºC, and it is now around 30ºC in the summer – it is no longer an effective heat sink. The heat in the tunnel comes largely from the trains, as detailed in the table to the right.[1] Although this can be reduced by measures such as regenerative braking, several factors will result in further increases in temperature:

Heat source	%
Braking losses	38%
Mechanical losses	22%
Drive losses	16%
Train auxiliaries	13%
Tunnel systems	4%
Station systems and passengers	4%
Train passengers	3%

- Rising ambient temperatures in London
- Plans to add air conditioning to the deep line tube trains will result in more hot air being dumped into the tunnels.
- Line upgrades will mean more frequent trains

The network is currently cooled using vents in the tunnels and at stations. Large fan systems are used to extract air, and in some cases these can operate in reverse and push fresh air into the system. Although there are 110 vents on the network, the majority are on the modern section of the Jubilee line; some lines (such as the Central Line) have very few vents, and the land use above the lines prevents new ones being built.[1] Currently, most of the heat is absorbed in the tunnelwalls and approximately 10% of the heat is removed by mechanical ventilation.[2]

The systems are less effective in summer, when ambient temperatures outside mean that pumping air into the tunnels does not result in cooling. Some vents used for pumping air into the network have had cooling systems installed, with the air cooled to 4–6ºC below the ambient temperature; however, these systems have high electricity consumption and are difficult to install due to the amount of space required.[1]

Case studies

See CELSIUS demonstrator: Capture of heat and extension of the seed network in Islington

Best available technology

The technological solution for recovering heat from the London Underground is to install a heat exchanger in the vents used to extract hot air from the network. With the use of a heat pump, this can create water hot enough to be used in a district heating network.

The heat pump is being integrated with existing building stock and heating systems. One of the biggest challenges is to operate the heat pump at a temperature which optimises efficiency of the heat pump yet is fully compatible with the existing, and potentially quite old, secondary heating system. In order to achieve this we are specifying an ammonia refrigerant heat pump which maintains efficiency at a higher than normal temperature for heat pumps. We are also reducing the network temperature to have a greater delta T and lower return temperatures.

This system has the advantage of being able to be used in reverse in the summer; the fan is put into reverse, and heat is extracted from the warm summer air before being pushed into the tunnels at a lower temperature. This creates both heat for the district heating network and cooler air for the London Underground.

Best practice

The level of innovation within this project means that there are is no real best practice template in place to replicate. There are however construction, health & safety and technical standards in place for the project.

To ensure that best practice is achieved then all contractors have been appointed using a full OJEU public procurement process where they were evaluated for both quality and best value. Both project teams work closely together to ensure that relevant engineering and building standards are adhered to. The design process involves a series of stages of sign-off by each stakeholder to ensure best practice and suitability for both London Underground and London Borough of Islington.

Read more

Introduction to District Energy

- Waste energy recovery
- Waste heat from urban infrastructure

Technical Toolbox

- Waste heat recovery from electrical substations

CELSIUS Network

- ReUseHeat

References

1. ↑ Jump up to:1.0 1.1 1.2 1.3 Jamie Burn (2014) *Cooling the Tube & Bunhill*, Presentation given at the Celsius Conference, 11 November 2015
2. Jump up↑ Handbook - 25 cases of urban waste heat recovery

CELSIUS contacts

CELSIUS partners contributing to this article: LBOI

For further engagement on this subject you are welcome to turn to your CELSIUS city contact person or use the contact form for guidance to relevant workshops, site visits or the expert team.