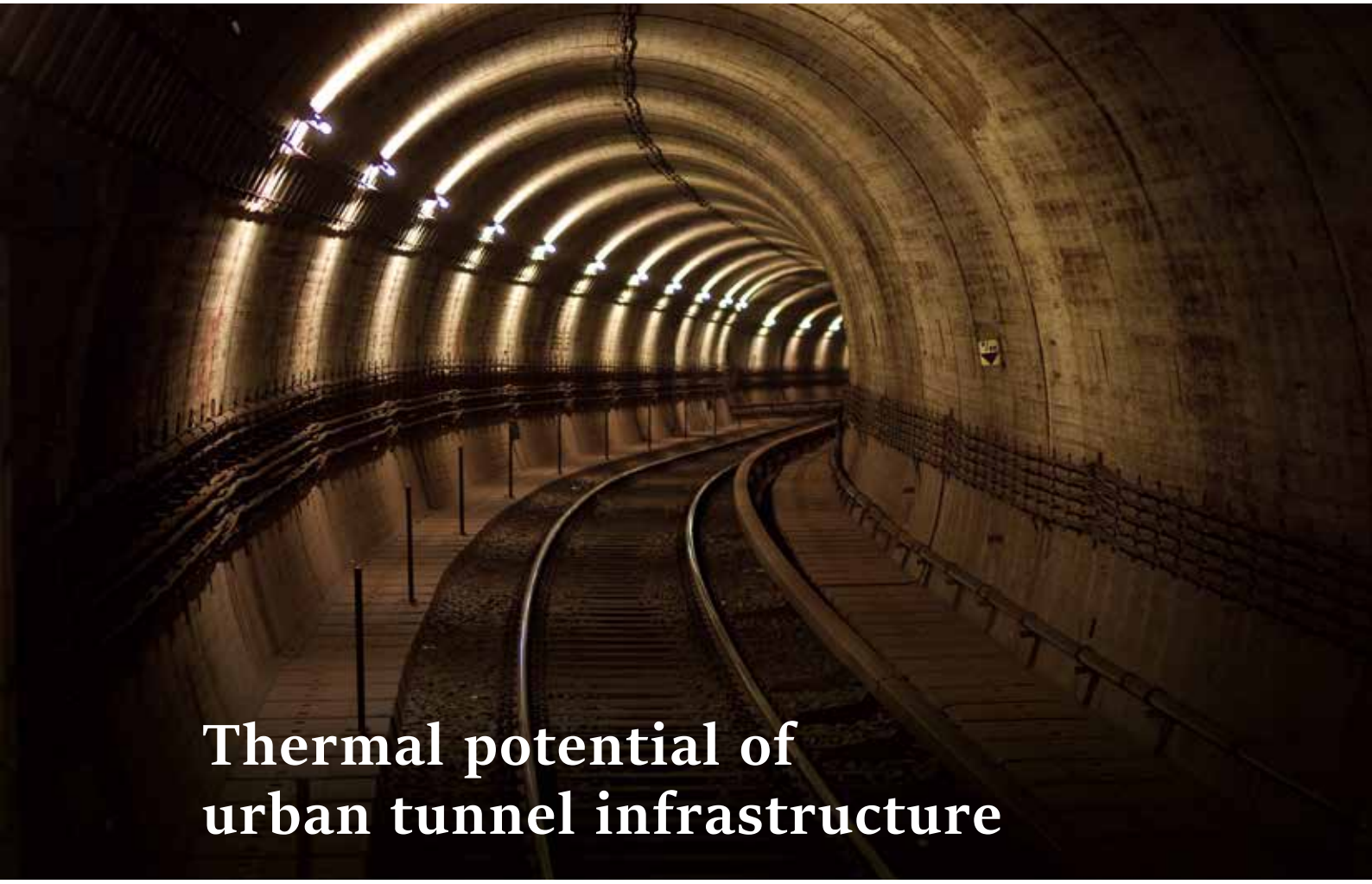


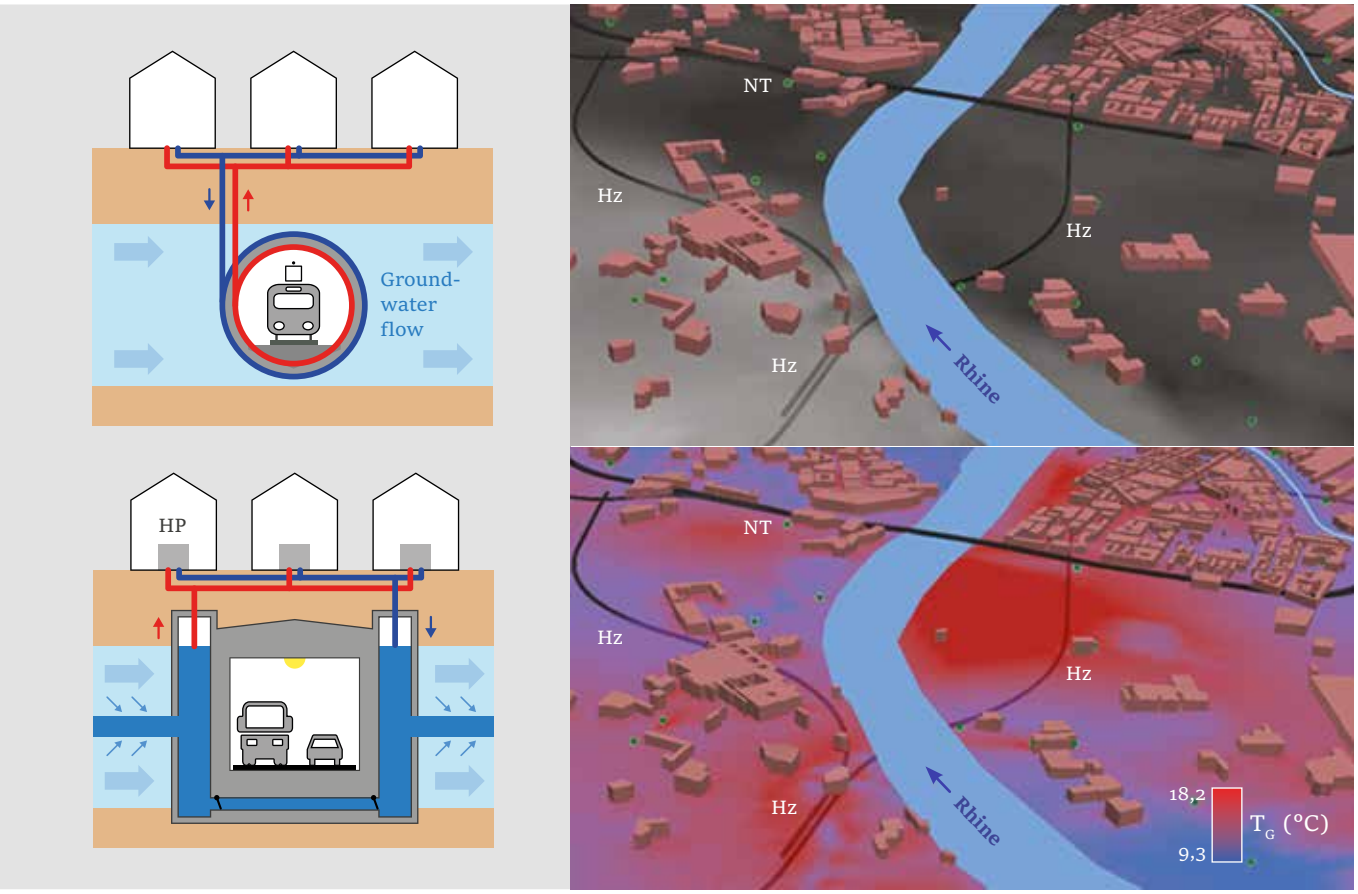
Thermal potential of urban tunnel infrastructure

Tunnel tube of the subway in Munich (Source: Wikipedia, author: OhWeh).

In many urban areas, groundwater temperatures are often high and this means there is potential for the energy to be utilised when constructing underground transport routes. The feasibility of this utilisation of tunnel infrastructures is currently being studied in the agglomeration of Basel.

In the city of Basel, the use of ground heat in the context of the cooling of buildings and the heat generated by using subsurface constructions (buildings, tunnels, etc.) results in higher groundwater temperatures of up to 18° C. This poses the question whether the heat can be reused so that groundwater temperatures can be stabilised. Initial studies have shown that the enormous quantity of excess heat below the surface could cover 20 up to 100 percent of the demand for heating energy.

Researchers at the University of Basel are currently developing tools for studying thermal influences on groundwater resources and assessing the potential use of tunnel infrastructures for energy purposes. Here the focus is on the transport of heat through groundwater channels in highly porous unconsolidated rock formations. Large contact areas between tunnel structures and the underground enable the utilization of subsurface heat, especially in districts where major restructuring is planned and associated energy requirements can be met through the use of “active” heat pump systems that utilise groundwater,



Use of tunnel infrastructure for thermal purposes with absorber elements in the cladding. Bottom: Utilisation of groundwater with the aid of heat pump (HP) systems.

Top: Urban underground structures at the elbow of the Rhine in Basel: route of the planned suburban railway tunnel (core section) and the existing motorway tunnel infrastructure (northern bypass) in relation to the underground rock surface (grey zone). Bottom: Current groundwater temperatures at the elbow of the Rhine in Basel (Source: University of Basel).

and the use of "passive" energy absorbers. Heat exchangers installed in tunnel segments form "passive" systems (see illustration above). "Active" systems are used in aquifers beneath tunnels. They secure the flow of the groundwater and help prevent backwater effects and stagnation zones in the vicinity of tunnel structures.

There are various solutions for the use of heat from tunnel structures, depending on the type of tunnel and the local geological circumstances. In railway tunnels, excess heat from trains causing temperatures of around 30° C in the tunnel can be "passively" utilised, and at the same time heat extraction cools the tunnel infrastructure. Large-diameter motorway tunnels tend to be suitable for "active" utilisation, especially if the tunnel crosses a groundwater flow in an unconsolidated rock formation.

An ongoing study in Basel suggests that, in two sections with lengths of 740 and 280 metres respectively, near the entrance to a planned suburban railway tunnel one may utilise thermal output levels of around 4.8 and 1.8 MW. This would make it possible to provide 10, respectively 3.7 GWh of heat during the heating season. In the planned motorway tunnel crossing the Rhine, only those sections that cross the relatively warm groundwater flow are suitable for heat utilisation. In a section with a length of 320 metres, one may harness a thermal output of around half a megawatt. The results of the Basel study serve for developing strategies for the sustainable management of underground resources in urban regions.

Jannis Epting and Peter Huggenberger,
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