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The thermoroad - full-scale demonstration of geothermal 5th generation district heating and cooling combined with sustainable urban drainage

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The thermoroad combines a 5th generation district heating and cooling (5GDHC) grid with a sustainable urban drainage system (SUDS) by utilizing the roadbed for surface water retardation and as a geothermal energy source. The porous roadbed is hydraulically separated from the surrounding soil by a bentonite membrane and is able to retain approximately 150 mm of infiltrating surface water when fully drained. Water is drained to the roadbed through drain grates and the roadbed is then drained to the sewer by embedded drainage pipes. The drainage pipes connect to a water brake that restricts maximum water flow to the sewer to 0.78 l/s. Therefore, water is prevented from overloading the sewer in case of extreme precipitation. Instead, the water accumulates in the roadbed and is safely drained to the sewer later. 1200 m of geothermal piping is embedded in the roadbed, separated in two groups on the manifold. A further 3 borehole heat exchangers have been established serving as backup and heat sink for cooling in the summer. A single 100 m long 40 mm 1U pipe has been placed below the central wastewater pipe at a depth of roughly 2.5 m, to harness the waste heat. Once commissioned, 12 single family houses are supplied with surface water management in addition to heating and cooling by ground source heat pumps connected to the 5GDHC grid. The system is fully monitored, with energy meters on the brine side of the heat pumps and on the geothermal sources in addition to compiled weather station data from the field site. Model analysis of operational data from the first prototype of the thermoroad, shows that the energy extraction from the geothermal pipes in the roadbed is increased by 56% from the drainage of surface water. The thermoroad is an example of integration of the energy and water sectors where synergies are created. The project consortium has built the second prototype of the thermoroad in full scale and for real consumers near Horsens in central Jutland, Denmark. The thermoroad is commissioned in February 2024. We present the engineering approach behind the thermoroad and the first experience with commissioning of the system.