Velocity flow in the realistic setting (of a Russian or European city) is typically turbulent and incompressible but steady, i.e. it establishes fast (in seconds). However, changes in the heat, on either consumption or production sides, lead to slow transients which last for at least tens of minutes and often for hours. We classify relevant physical phenomena in a single pipe, e.g. thermal front, turbulent spread of the front, thermal waves following the front, and also discuss consequences of the phenomena for large networks of pipes connecting, consumers and producers of heat. We explain how to solve the direct problem [given consumer/producer temporal profile and steady flow distribution describe dynamics of the heat evolution in the system] and, then, motivate future research directions towards posing and solving of (1) inverse identification problem [given partial and uncertain measurements of flow and heat to reconstruct system-wide probabilistic profile of consumption/production] and (2) real time optimization/control problem for practical district heating system [given the observations find actions leading to feasible solutions striking a proper balance of cost and comfort]. This work is a part of Skoltech Energy Sysyems CREI collaboration with a group from Melentiev Energy systems institute (Irkutsk, SB RAS) lead by N.N. Novitsky.