

Proper modelling approaches for operational simulation and optimization of large district heating networks *Elisa Guelpa, <u>Vittorio Verda</u>*

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IDENTIFY THE EFFECTS OF IMPROVEMENTS ON THE NETWORK BEFORE THEIR IMPLEMENTATION



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WHY NETWORK MODELLING ?







NETWORK MODELLING





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The **largest** district heating network in Italy:

- 55% of the buildings are connected (700.000 inhabitants)
- 800 km of double pipes
- 182 distribution networks

Turin district heating network



NETWORK MODELS



MASS CONSERVATION EQUATION

N nodes of the network

MOMENTUM EQUATION

M branches of the network

ENERGY EQUATION N nodes of the network N equations in the matrix form $\mathbf{A} \cdot \mathbf{G} + \mathbf{G}_{_{\mathrm{ext}}} = \mathbf{O}$ M equations in the matrix form

$$\mathbf{G} = \mathbf{Y} \cdot \mathbf{A}^{\mathrm{T}} \cdot \mathbf{P} + \mathbf{Y} \cdot \Delta \mathbf{p}_{\mathrm{pumps}}$$

N equations in the matrix form

$$\mathbf{M} \cdot \dot{\mathbf{T}} + \mathbf{K} \cdot \mathbf{T} = \mathbf{g}$$

GUESS AND CORRECT METHOD





1. FLUID DYNAMIC MODEL





1. COMPACT FLUID DYNAMIC MODEL





MASS FLOW RATES



- MASS CONSERVATION EQUATION
- MOMENTUM EQUATION

MASS CONSERVATION EQUATION

1. COMPACT FLUID DYNAMIC MODEL





LOOPED NETWORK

TREE-SHAPED NETWORK

1. COMPACT FLUID DYNAMIC MODEL





1. RESULTS



EVALUATION OF MASS FLOW IN THE ENTIRE NETWORK DEVIATIONS (TOTAL FLOW RATE ABOUT 2000 KG/S @ 100% LOAD) LOAD:30% LOAD:60% LOAD:90% y coordinate [km] ب 8 y coordinate [km] y coordinate [km] x coordinate [km] x coordinate [km] x coordinate [km]

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2. COMPACT THERMAL MODEL





2. RESULTS











t (daily evolution)

Optimal installation of 12 MW heat pump on the return network.

Analysis of the possible locations and the various operating conditions along the year. Evaluation of the thermal losses and effects on the thermal plants.





CONCLUSIONS



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Planning and operational tools for optimising energy flows & synergies between energy networks



https://www.h2020-planet.eu/



THANK YOU FOR THE ATTENTION

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