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Decision support system for district heating network development optimization

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4th Generation District Heating Technologies and Systems
Summary

- Company info
- Business problem

- Company info
- OptiDH: Decision Support System to optimise DH networks

- Case study: analysis and results
- Conclusions
A2A Calore & Servizi: DH key numbers

Is the main player in the DH sector in Italy

<table>
<thead>
<tr>
<th>Network extension (pair of pipes)</th>
<th>Customers</th>
<th>Heated volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(km)</td>
<td>(n.)</td>
<td>(Mm$^3$)</td>
</tr>
<tr>
<td>Bergamo</td>
<td>69</td>
<td>545</td>
</tr>
<tr>
<td>Brescia area</td>
<td>665</td>
<td>20,726</td>
</tr>
<tr>
<td>Milan area</td>
<td>281</td>
<td>3,109</td>
</tr>
<tr>
<td>Varese area</td>
<td>16</td>
<td>146</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,031</strong></td>
<td><strong>24,526</strong></td>
</tr>
</tbody>
</table>

(last update 31/12/2015)

<table>
<thead>
<tr>
<th>OPERATING DATA$^{(1)}$</th>
<th>2015</th>
<th>2016</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat production</td>
<td>GWh</td>
<td>984</td>
<td>1,186</td>
</tr>
<tr>
<td>Purchases from other business units</td>
<td>GWh</td>
<td>1,026</td>
<td>1,181</td>
</tr>
<tr>
<td>Purchases from third parties</td>
<td>GWh</td>
<td>287</td>
<td>334</td>
</tr>
<tr>
<td>Heat volumes sales</td>
<td>GWh</td>
<td>2,297</td>
<td>2,702</td>
</tr>
<tr>
<td>Electricity production from cogeneration plants</td>
<td>GWh</td>
<td>235</td>
<td>214</td>
</tr>
</tbody>
</table>

($^{(1)}$ Net of distribution losses)

A2A Calore & Servizi: DH networks

Main DH systems

- **Milan area**
  - **West System (2015)**

- **Lombardia**
  - Operating pressure: up to 14 bar
  - Operating temperature:
    - winter: 90°C ÷ 120°C supply, 60°C return
    - summer: 80°C ÷ 90°C supply, 60°C return

- **Bergamo**

- **Brescia area**

The business problem (1)

- Potential customers:
  - $P \leq 0.2\ MW$
  - $0.2\ MW < P \leq 0.5\ MW$
  - $0.5\ MW < P \leq 1\ MW$
  - $1\ MW < P \leq 5\ MW$
  - $P > 5\ MW$

- Development areas:
  - New pipeline

- Heat demand potential $> 100\ MW$
  - (130\ GWh)
The business problem (2)

Summarizing

- Huge heat demand potential
- Limiting conditions both for the production side and for transport capacity of the system
- Need to analyse and compare a lot of small areas to decide on DH development plan

As a result

- Market survey for DSS tool (network development optimization)
- Development of an existing tool based on A2A requirements
Optit srl is a spinoff of the Operations Research team of the University of Bologna with the mission to develop innovative Decision Support Systems based on state-of-the-art Operations Research.

WHAT WE DO

- IT solutions development & deployment
- Operations Research and Mathematical Modelling
- Business analysis & management consulting

MAIN BUSINESS AREAS

- WASTE
- ENERGY
- LOGISTICS & TRANSPORTS
- RESOURCE MANAGEMENT
- ADVANCED AD HOC MODELS
Challenges in DH networks development

Urban and industrial district heating networks require significant investments, which imply a challenging planning process:

- Where should the new pipes be built ...
- Which potential new customers should be acquired first ...
- Should current ones be re-contractualised?

... in order to achieve max Net Present Value?
Optimizing DH network development

Decisions require dealing with:

• **large numbers** of existing and potential new customers and pipings leading to a huge number of possible combinations
• Capability to assign **cost/revenue** values to every single element of the network
• The network must respect complex **thermohydraulic constraints**

Optit’s solution is an innovative decision support system, based on GIS technology, to generate and analyse strategic and commercial development scenarios of district heating networks

Network setup and configuration

- Import of existing network and customers (*)
- Import of potential customers
- Editing of imported items

(*): Multiple networks can be managed as separate instances
Configuration of scenario and parameters

Configuration of heating plants (max / min pressure & power)

Selection of set of potential customers

Set up of optimization parameter: technical constraint (pressure, falling,...), economic (rate, amortization, allowance,...) and strategic (max investment, max pressure)

Set up of revenues and costs (tariff, cost of pipe,...)
Scenario optimization: what if analysis of a new development area

- Drawing of potential backbone
- Creation and configuration of virtual plant
Scenario optimization: what if analysis of a new development area

**Optimal Solution**
- customers to be connected and pressure settings
- backbone and service pipes to be realised with optimal diameter;
- investment value: costs, revenues, cash flows, NPV
Examples of optimization results

KEY PERFORMANCE INDICATORIS

CARTOGRAPHIC VISUALISATION

LIST OF PROSPECTS
Case study (1)

Import data and set input parameters + create new virtual system

Potential customers
Hypothetical network layout

Virtual power plant
Existing network
Case study (2)

System without any limitation

Results
Case study (3)

System with investment limitation

Results

Case study (4)

System with new customers total power limitation

Results

A2A Calore & Servizi : DH planning

Milan underground services
DH general urban plan

DSS tool planned analysis
Conclusions

Key benefits of OptiDH

- Support for development / investment decisions (long term) enabling effective multiple scenario generation and analysis
- Commercial campaigns: choice of next best customers (medium to short term) that maximise return
- Solution provides scenarios to maximise Net Present Value, i.e. balance between CAPEX, OPEX and Turnover
- Solutions incorporate both commercial and tactical rationales, leading to more effective internal processes
Questions or comments?

Thank you for your attention

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