Smart sector coupling and increasingly smart plant operations in modern District Energy Systems

Matteo Pozzi, CEO Optit srl
• We are a spin-off of the Operations Research (OR) team of the University of Bologna, founded in 2007, with offices in Bologna and Cesena
• We develop solutions and services based on advanced analytics, machine learning & mathematical optimization in several industries (Energy, Waste, Logistics, …)
• We are a young and highly skilled team (30+ constantly growing) integrating Data & Operations Research scientist, Business consultants and a full SW application factory
• We participate in the scientific community of “Operations Research in Practice” and are members of DHC+ and the District Energy in Cities Initiative
• We work with all the major DHC Utilities in Italy (and some industrial players with CHP plants) and we run projects in various EU countries (incl. H2020 Upgrade DH)
• Our key offering includes solutions for DH Network Development Optimisation and Energy Production Optimisation (focus of this presentation)
THE UNIT COMMITMENT PROBLEM IN PRACTICE: HOW TO MANAGE A COMPLEX ENERGY SYSTEM TO OPTIMISE ITS MARGINS?
INCREASINGLY COMPLEX PLANT & ENERGY MIX CONFIGURATIONS

Technical parameters & constraints

Operative policies & constraints

Multiple cost/price & contractual factors

Data integration & management
AN END TO END PROCESS TO INTEGRATE LONG TO SHORT TERM DECISION DRIVERS LEVERAGING ON UP TO DATE INFORMATION

KEY PROCESS PHASES

FORECASTING
- Demand profiles prediction

LONG TERM
- Budget
- What if analysis
- Long term constraints

SHORT TERM
- Detailed unit commitment
- Storage optimisation

INTRA-DAY & ADV. TRADING
- Production plan fine tuning
- Advanced trading

OPTIMAL PLANNING & MONITORING
ADVANCED MACHINE LEARNING METHODOLOGIES TO PREDICT ENERGY LOADS TO BE DELIVERED

**INPUT DATA**
- Historical data
- Operating data
- Meteo data
- Specific drivers

**DEMAND PROFILE**
- Electric
- Thermal
- Chill

**INERTIAL MODELS**

**MULTI-LINEAR REGRESSION**

**NEURAL NETWORKS**
A FULLY INTEGRATED PROCESS TO CONSISTENTLY PLAN ENERGY PRODUCTION & DISPATCHING

Plant management system

Meteo data

Electricity & fuels prices

Standard reports

Data to BI tools

Electric markets trading data
ENABLING INCREASINGLY CHALLENGING BUSINESS PROCESS INTEGRATION AND EFFICIENCY

- Decisions taken (often on Excel analysis) by experienced staff
- Actuation is “manual”
- Rough modulation capability

- Decisions Support Models employed
- Basic system integration
- Actuation still involves human intervention
- Advanced what-if analysis off line

- Decision Support System integration
- Automatic dataflows management
- Operator involved mostly for exceptions or anomalies

- Decision Support System integration at Enterprise level
- System to support multiple key users
- Advanced governance
THE NEXT BIG THING (IN ITALY): PARTICIPATION TO BALANCING MARKETS TO TRADE FLEXIBILITY AS WELL AS ELECTRICITY

**BALANCING MARKET**

- A Balancing Service Provider can qualify *Virtual Aggregate Units* to bid flexibility on the Dispatching Services Market
  - **Fixed** remuneration on power committed
  - **Variable** remuneration on energy sold
  - Must demonstrate capacity to ramp up/down in 15’

**OPTIMIZATION CHALLENGES**

- Provide *flexibility* margins on *electricity* markets while respecting *thermal* demand (and self-consumption)
- Indication on *marginal operating costs*
- Optimal plant *activation order*
- Plant operations becomes subject to *multiple* stakeholder’s (conflicting) *objectives!*

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**Relevant Plants**
- Power > 10 MVA

**Aggregated plants**
- Power > 5 MVA
CONCLUSIONS AND NEXT CHALLENGES

KEY LESSONS LEARNT

- A coherent **DH Digitalisation Strategy**, powered by **Advanced Analytics DSS**, is key to capture the challenges to operate efficiently modern Energy Systems
- Management of **complexity** becomes the key challenge to DH plant operators
- Increasing **sector coupling** interaction is shifting operating decisions from plant managers to trading department and TSOs, creating increased need for structured enterprise approaches enabling **new business & operating models**

CURRENT INVESTMENTS TO MEET FUTURE CHALLENGES

- Bring **Plant/Trading integration** to the market
- Focus on business process **automation**
- Introduce explicit **Non Linearity** in the models
- Explore the opportunity to introduce **stochasticity** and **robustness** in practice
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