

Modeling and programming of a DH system

*Optimization and Analytics for your
business*

Stefano Morgione



Vilnius, March 7th 2019

Business Processes in Industry 4.0 / IoT (r-)evolution are



complex



data-driven



dynamic





Founded in **2007**

Spinoff of the
Operations Research
(OR) team of the
University of Bologna

We develop **solutions
and services** based on
**analytics &
optimization**



Young and highly skilled
team: everyone holds a
**STEM Master Degree
or PhD**

We are
**Data scientists,
Business consultants,
Operations Research
specialists,
SW application dev.
professionals**



We work for **medium
and large enterprises**
in **several industries:**
Energy, Waste,
Logistics, Retail, etc.

We participate in the
scientific community
and active in fostering
“OR in Practice”

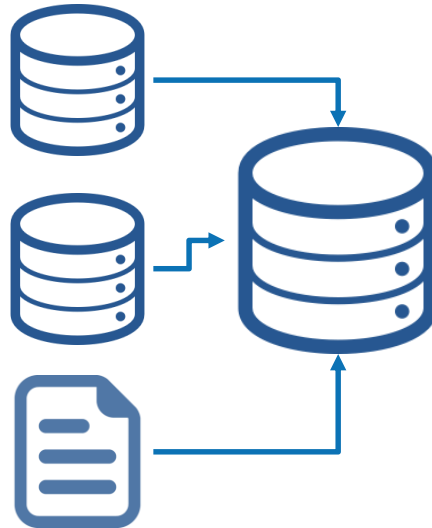


2 main Offices
Consultancy services
and Commercial HQ in
Bologna
SW Factory in **Cesena**

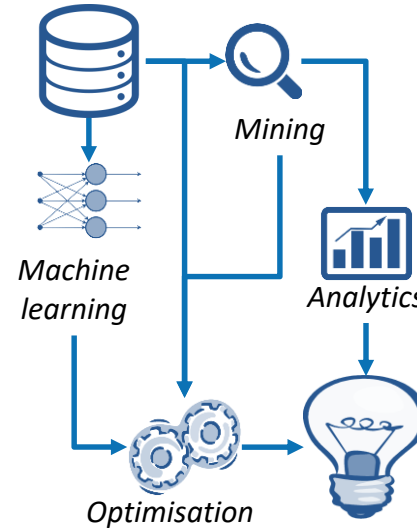
KNOW HOW TRANSFER



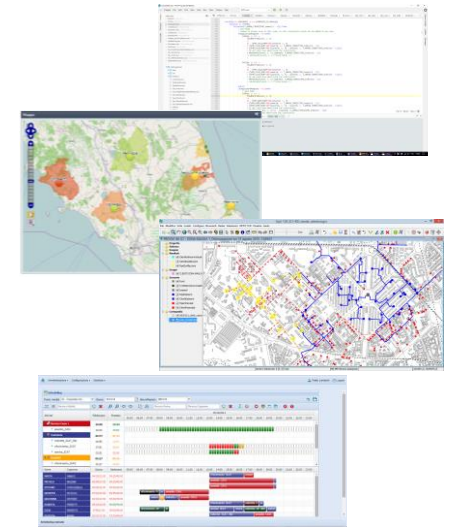
Starting from current processes and business objectives, our consultants help you **define the business issues to be addressed**



We are strongly focused on (even big) data, as our scientists «crunch» them to **extract insights**, answer questions (and – mostly – make new, better ones)

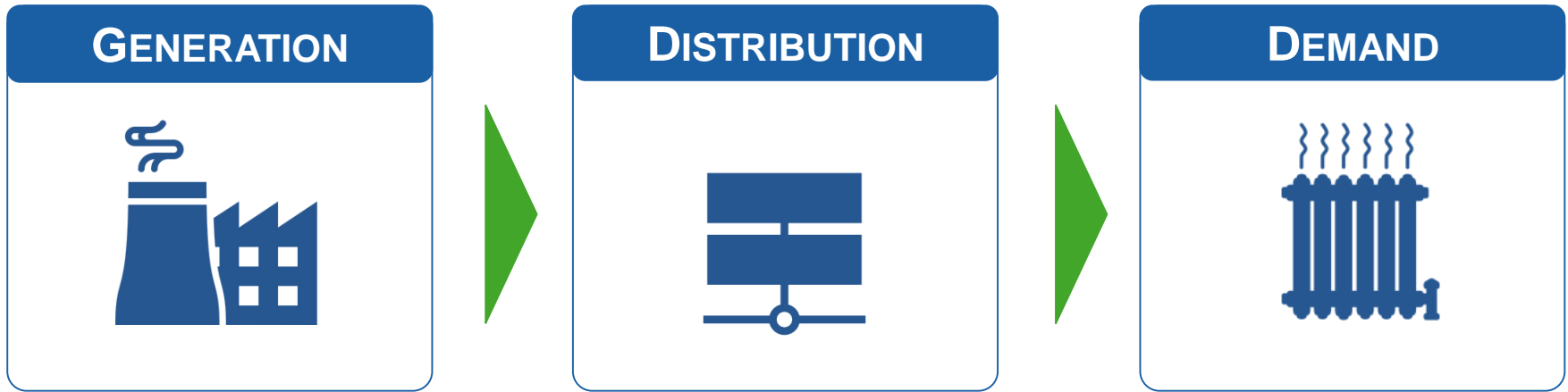


We **combine tools and techniques** of mining, machine & deep learning, optimisation in order to identify a full «resolution strategy» for the issue



We can develop and deploy **high level SW**, from «black-box» model to enterprise application, with guarantee of high level standards and high degree of **flexibility**

OUR VALUE PROPOSITION FOR THE DISTRICT ENERGY INDUSTRY



DSS for Energy production optimisation

- H/P/C demand **forecast**
- Operational **scheduling** of production assets to **optimise operating margin**
- **Budgeting** and what-if yearly analyses
- System integration for **automatized process**

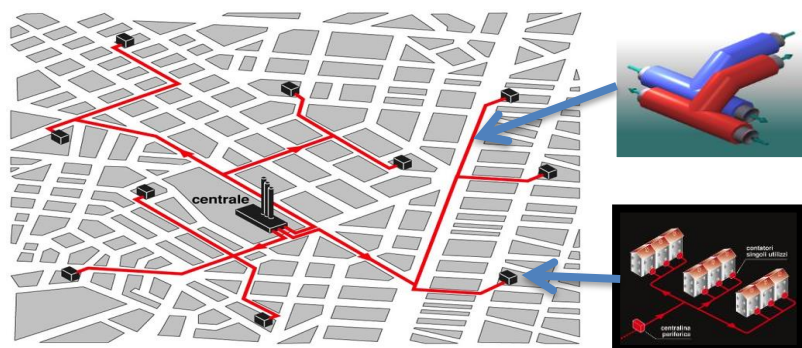
DSS for network development optimization

- **Investment (NPV)** optimisation analysis
- **Technical** and **economic** decision drivers integration
- Advanced built-in **thermal-hydraulic** model for feasibility check

Advanced analytics methodologies

- Heat consumption **patterns and profiling**
- Identification and qualification of **user clusters**

THE BUSINESS OBJECTIVE



How to plan District Heating (& Cooling) **Network Development** roadmaps that maximise the Return on Invested Capital (i.e. **Net Present Value**), amongst countless possible options?

CHALLENGES FOR DECISION MAKING



Geographic dimension of the business issue (overcome Excel)



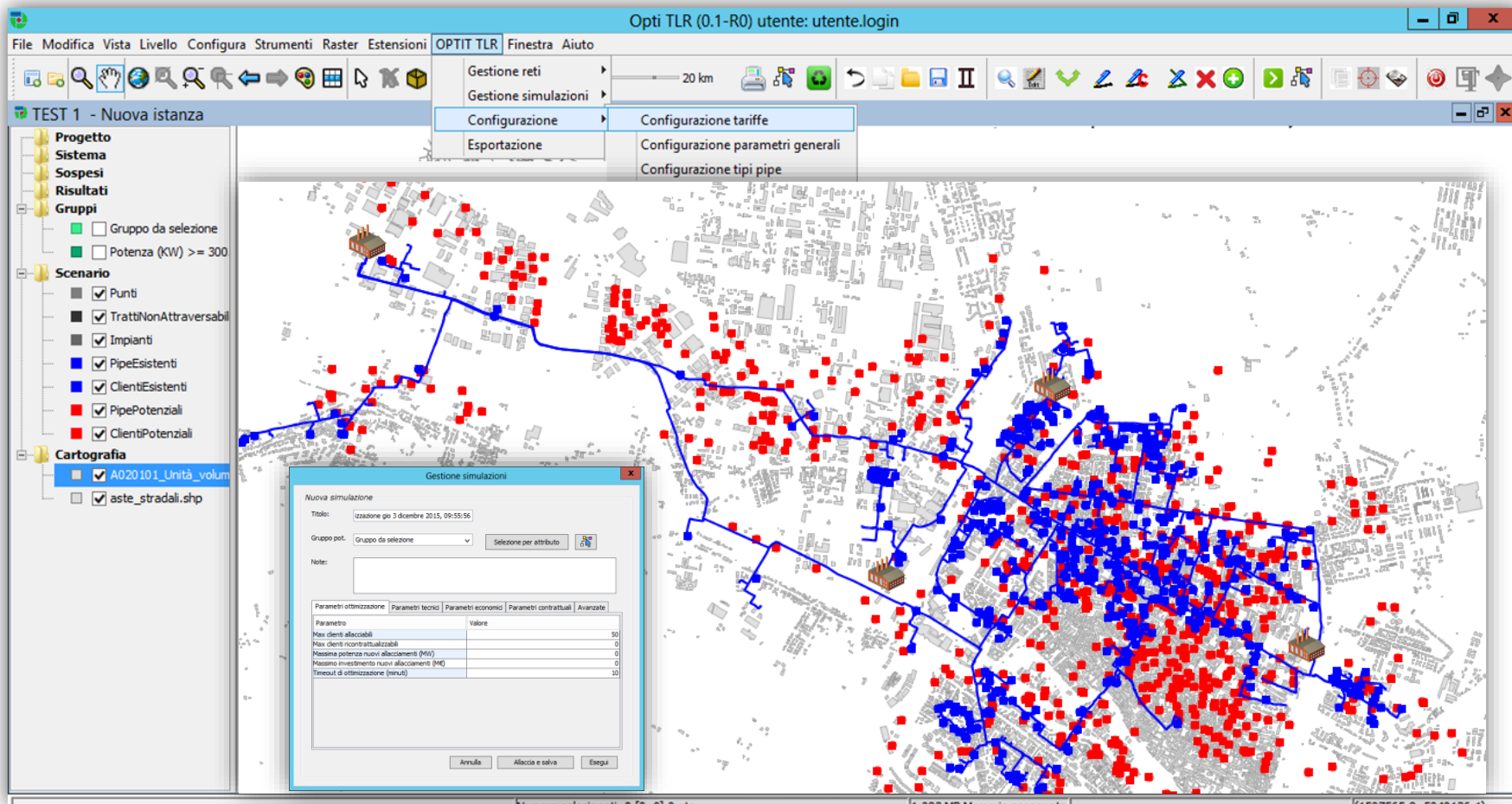
Economic value assignments on **costs and revenues** sides



Several possible potential **scenarios** (what-if)



Thermal-hydraulic feasibility analysis of proposed solutions



Advanced
Scenario Mgmt



Existing & potential
pipings & users



Existing &
potential plants



Import + Puntual
editing/drawing



Tariffs &
Capex/Opex



Technical
constraints



Financial
parameters

Development of new DHC networks

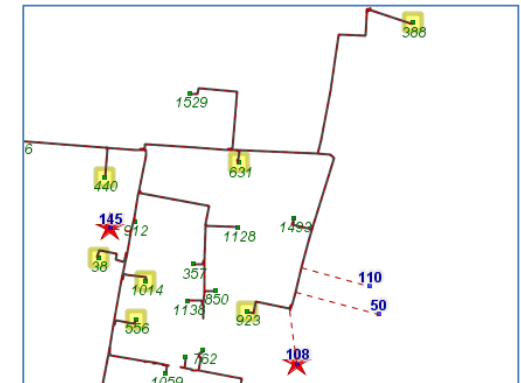
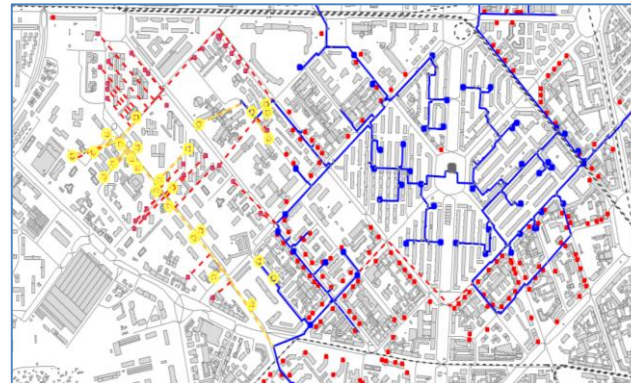
- Network extension to **optimise NPV / ROI**
- Optimal **dimensioning** of the potential piping to respect **thermal-hydraulic** constraints
- Economic **KPIs** of each scenario

Expansion of existing networks

- Optimal strategy for **new customer connections**
- Dimensioning of **new connection piping**
- **Technical analysis** of the new network set-up

Saturation of existing networks

- Strategic evaluation of **recontractualization** of existing customers after demand reduction
- **Maximization** of heat production capacity for further development



Investment Analysis

- Validation and refinement of pre-set **network expansion** scenarios
- **Evaluation of Integration** of new sources
- Impact assessment of new **economic frameworks**

Parametro	Valore
GRUPPO DI RIFERIMENTO	Potenza (kW) >= 50.0 Distanza (m) <= ...
Costo fisso contratto nuovo allaccio (€)	0
Costo fisso contratto ricontrattualizzazione...	100
Pressione min cliente (bar)	0,4
Fattore contemporaneità	0,6
Tasso di interesse VAN	0,065
Max clienti allacciabili	50
Max clienti ricontrattualizzabili	100
Profilo min ricontrattualizzabilità (h)	400

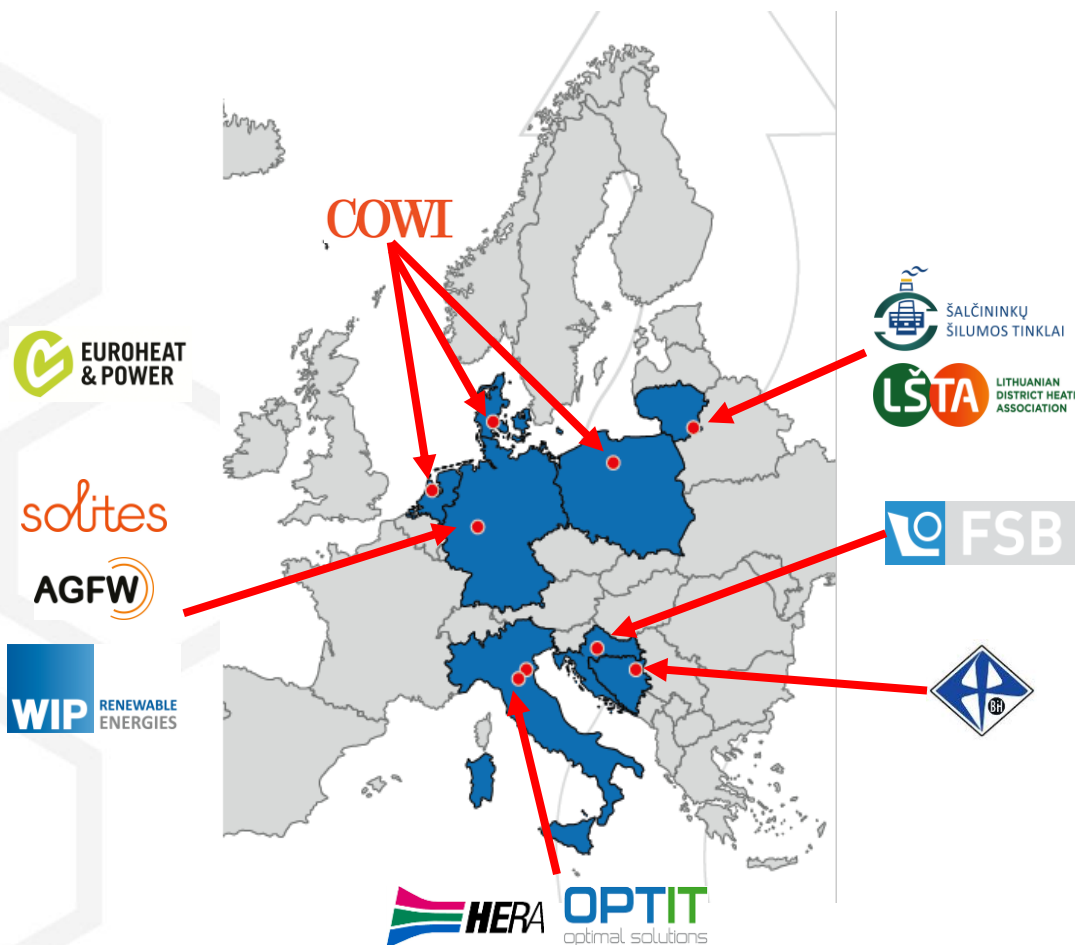
K	L	M
	INDICE	VALORE
	VAN	€ 399.739
	TIR	12,1%
	BPT	14

Profilo n°	A	B	C	D	E	F	G	H	I	J	K
Pressioni	ANNO	RICAVO	COSTO	AMMORTAMENTO	IMPONIBILE	TASSE	FLUSSO_NETTO	COEFF	VALORE ATTUALIZZATO	VALORE_ATT_CUMULATO	
Orizzonti	0	€ 221.612	€ 1.093.214	€ 23.296	€ 65.348	€ 20.519	-€ 892.122	1,000	-€ 892.122	-€ 892.122	
Sconto	1	€ 354.579	€ 357.999	€ 28.656	€ 113.175	€ 35.537	-€ 38.957	0,926	-€ 36.071	-€ 928.193	
Tariffa	2	€ 443.223	€ 362.768	€ 32.229	€ 145.060	€ 45.549	€ 34.906	0,857	€ 29.926	-€ 898.267	
Fattore	3	€ 487.546	€ 340.945	€ 34.016	€ 161.002	€ 50.555	€ 96.046	0,794	€ 76.245	-€ 822.022	
Soglia p	4	€ 531.868	€ 367.538	€ 35.802	€ 176.945	€ 55.561	€ 108.769	0,735	€ 79.949	-€ 742.074	
Rapport	5	€ 576.190	€ 394.131	€ 37.589	€ 192.887	€ 60.567	€ 121.492	0,681	€ 82.686	-€ 659.388	
Rapport	6										
Rapport	7										

Technical Analysis

- Thermal-hydraulic **network physical model** (pressure, velocity, heat balances)
- **Resizing** of existing piping to be revamped
- Analyses of **fault & maintenance**





Improving existing DH networks in Europe:

- ➔ Initiate the DH **upgrading process** for 8 systems up to the investment stage (Generation, Distribution, Use)
- ➔ Produce **Best Practices and Tools** Handbooks
- ➔ Develop regional / national action plans for DHN **retrofitting**
- ➔ **Replicate** the proposed solutions across Europe



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KEY FIGURES

- Salcininkai is 45 km from Vilnius and has around 7,000 inhabitants in an area of 2.98 km²
- Installed heat capacity: 54.04 MW
- Heat supplied in 2016: 38.88 GWh
- About 2,200 consumers connected to DH network

MAIN ISSUES

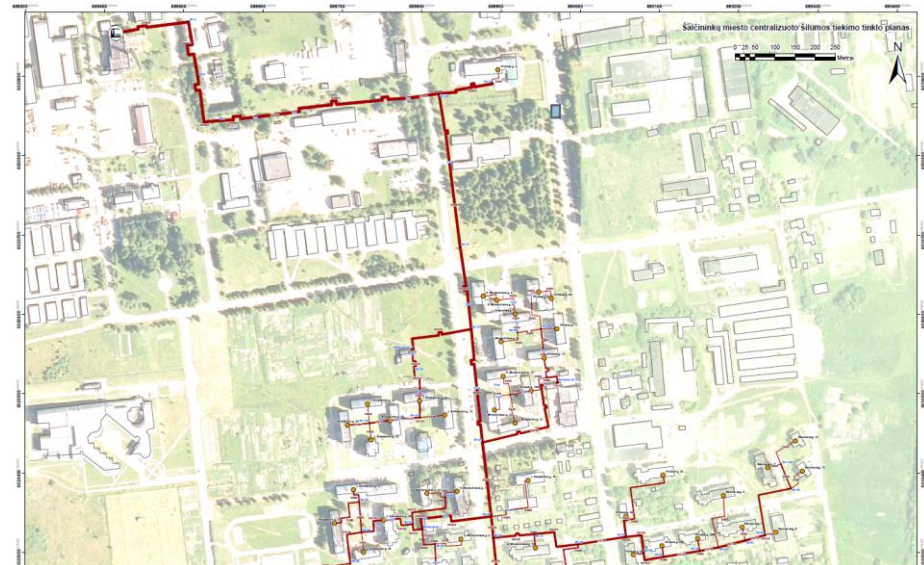
- High heat losses (24.5% in 2016)
- Piping maintenance status (external corrosion and defects in installation)
- Overall aging of the assets



**RISK OF UNSATISFIED CUSTOMERS
ABANDONING THE SERVICE**

KEY FEATURES

- Fuel mix: Woodchips (69%), fossil fuels (18.2%) and other wood fuels (12.8%)
- Transmission line is 18.7 km long (built mostly in 1980-1990)
- Poor piping insulation



POTENTIAL UPGRADING MEASURES

Digitalization process



Integrating in the Mgmt & Ops processes **innovative technological approaches**

Integration of new energy sources



Solar thermal has been identified as best suited RES implementation:

- How to analyze the impact of the new generation mix on the overall **thermal-hydraulic balance** in various operating conditions?
- How to evaluate the investment scenario, in terms of **CAPEX & OPEX, NPV, ROI?**

What-if analyses at a design level



Defining potential key refurbishing opportunities of existing piping:

- What would be the theoretical **optimal piping dimensioning?**

OPTIT'S APPROACH AND DELIVERABLES

Data collection

- Technical and economic framework of the existing network
- Reconstruction of georeferenced network graph shape file from a «non-informatized» drawing
- Design features of perspective solar thermal plant

Set up & Early Analyses

- Set up and configuration of the system in Optit's tool
- First simulation runs of existing network to calibrate thermal-hydraulic model
- Preliminary analyses on impacts of solar thermal integration
- Preliminary what-if optimization for piping sizing in «blank canvas» scenario

Final Analyses & Delivery

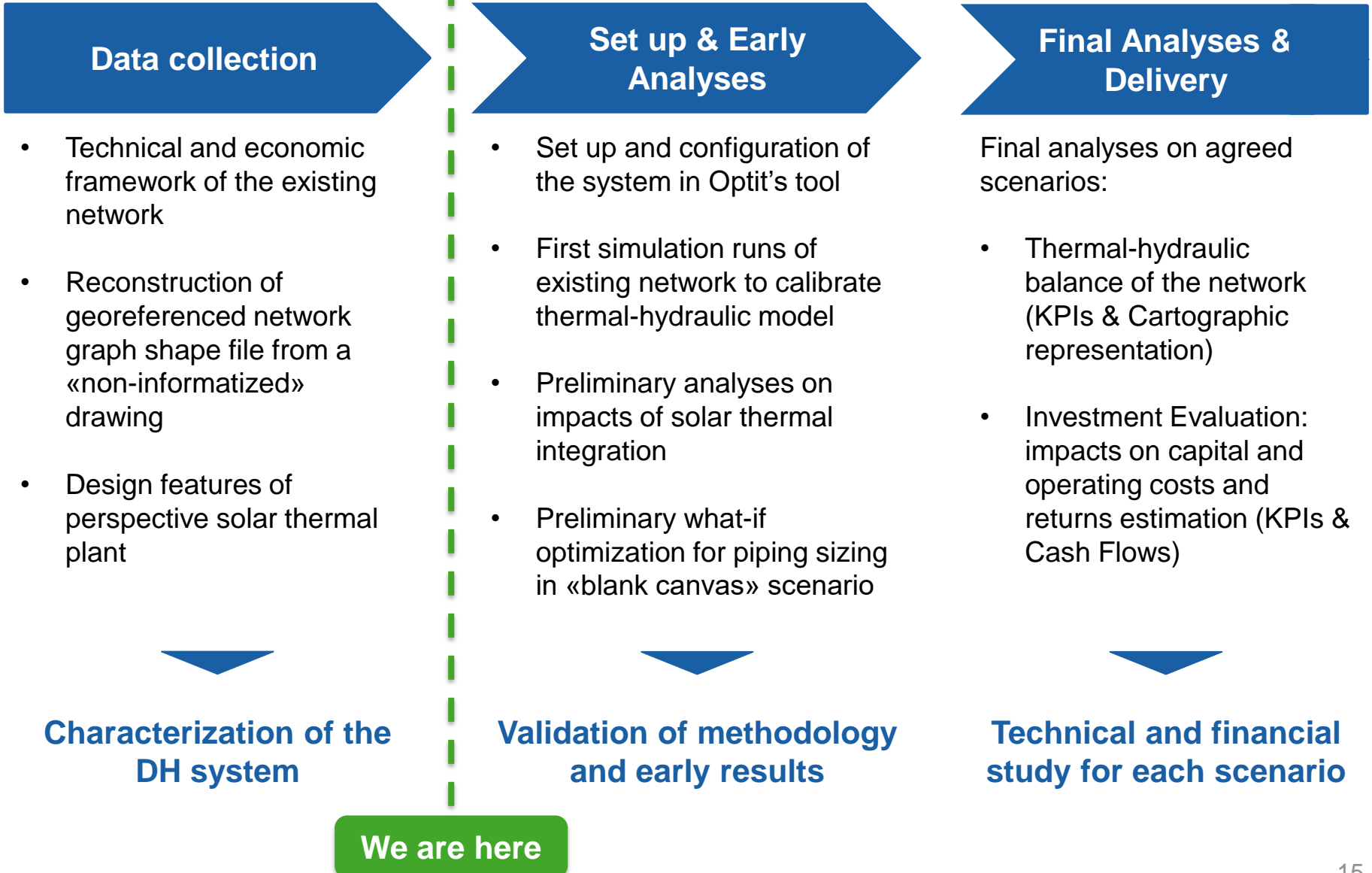
- Final analyses on agreed scenarios:
- Thermal-hydraulic balance of the network (KPIs & Cartographic representation)
 - Investment Evaluation: impacts on capital and operating costs and returns estimation (KPIs & Cash Flows)

**Characterization of the
DH system**

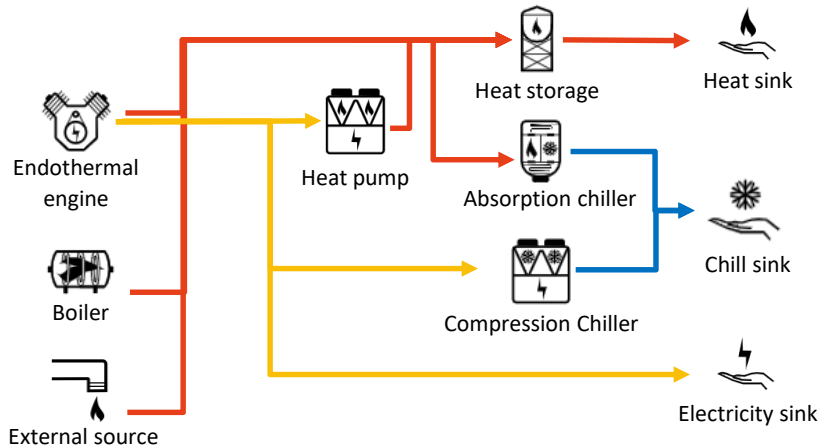
**Validation of methodology
and early results**

**Technical and financial
study for each scenario**

OPTIT'S APPROACH AND DELIVERABLES



THE BUSINESS OBJECTIVE



How to maximise **Operating Margins** of complex **Energy CHCP Production Systems** in view of variation of demand, prices and operating conditions?

CHALLENGES FOR DECISION MAKING



Complex plant **configuration**



Technical and operative **constraints**



Fine granularity (60'-15'- ...)



Multiple **cost/revenue** factors



Energy demand **forecasting**



Operating and **managing** reports

INPUT DATA ACQUISITION



Configuration



Field data integration



Meteo data



Prices & costs

KEY PROCESS MODULES

FORECASTING



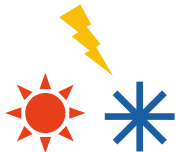
LONG TERM



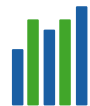
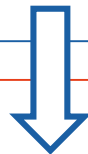
SHORT TERM



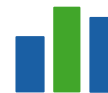
INFRA-DAY & TRADING



Demand profiles



Budget & Constraints



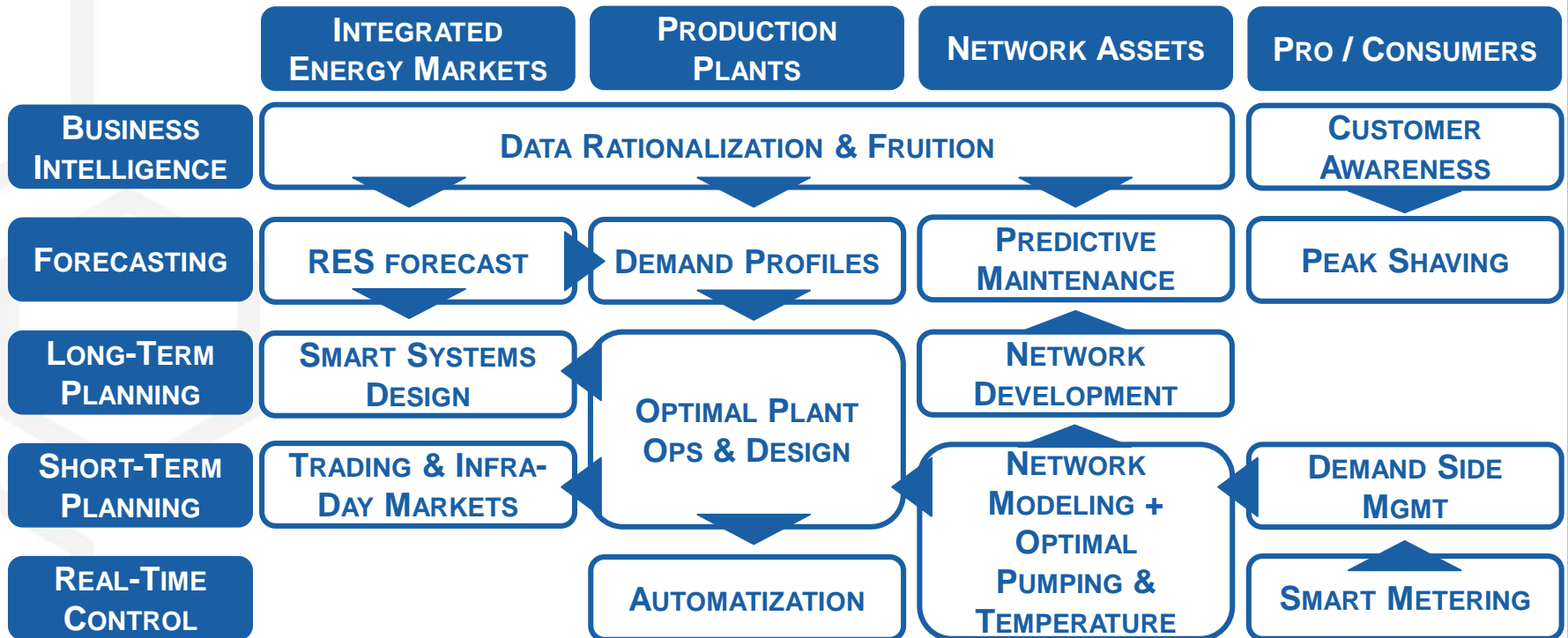
Unit commitment



Market management

OPTIMAL PLANNING & MONITORING

PARADIGM OF DECISION-MAKING 4.0: INTEGRATION



- **Analytics** allows to extract practical insights from raw data and ensures optimal decision-making (leveraging upon existing expertise)
- **Digitalization & ICT** allow to automatize the *Analytics Intelligence* and integrate it into the companies' internal processes
- These approaches may be applied also in **not-yet fully digitalized contexts**



OPTIT
optimal solutions

Optit srl

Legal Office: Viale Amendola, 56/d 40026 Imola (BO)

Office in Cesena: Via Ravennate 959
47521 Cesena (FC) Tel: 0547 385703 fax 0547 072802

Office in Bologna: Via Mazzini 82
40138 Bologna (BO) Tel: 051 4381574 Fax: 0514381575

P.I. 02756991200 - www.optit.net

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