OPTIT
optimal solutions

Multi-energy systems design and operations in response of climate change policies

4th EURO Practitioners' Forum Conference
Berlin 21st April 2023

EURO
THE ASSOCIATION OF EUROPEAN OPERATIONAL RESEARCH SOCIETIES

EURO PRACTITIONERS' FORUM

Decision Support Systems & Services based on

Operations Research, Data Science, Advanced Analytics & Artificial Intelligence

45+ talents working to turn digital innovation into reality

OPTIT optimal solutions

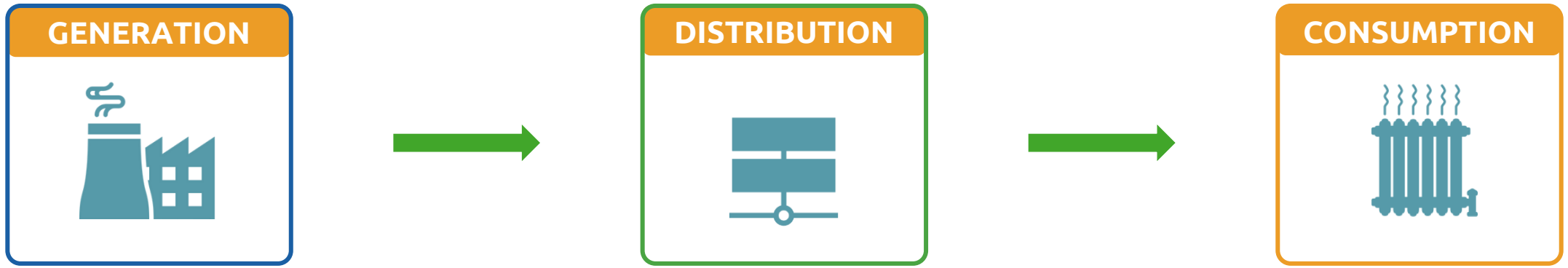
Bologna: Headquarters

Cesena: SW Factory

BUSINESS OBJECTIVES → DATA MANAGEMENT → MODELLING, ANALYTICS AND OPTIMIZATION → SOLUTIONS → CONSULTING & SERVICE MANAGEMENT

- ENERGY
- WASTE
- ANALYTICS & OPTIMIZATION
- LOGISTICS & SUPPLY CHAIN
- DIGITAL INDUSTRY

Impact of decarbonisation on (District) Energy Industry



DSS for Production Optimization

DSS for Network development

Advanced Analytics

Vice-Chair

Member

Co-founder

Digital Innovation Partner

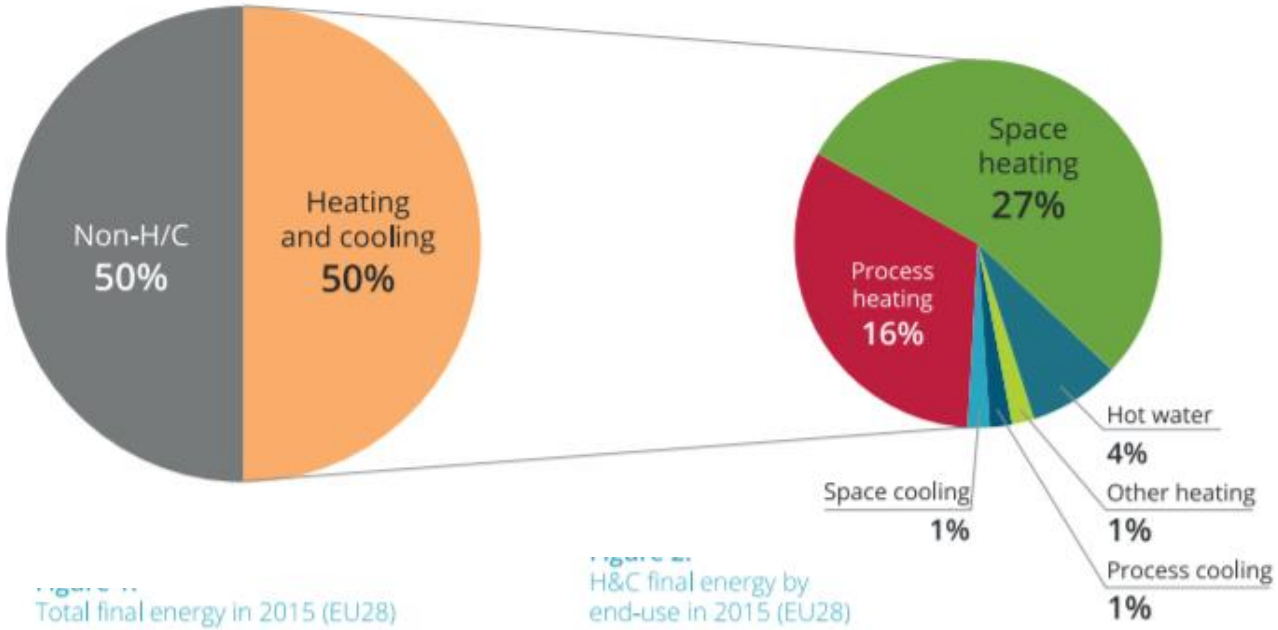
EU projects

Partner

- How is the sector is being shaped by the current legislation for decarbonization?
- What is the role of OR (and Advanced Analytics) as enablers of the industry's transition?

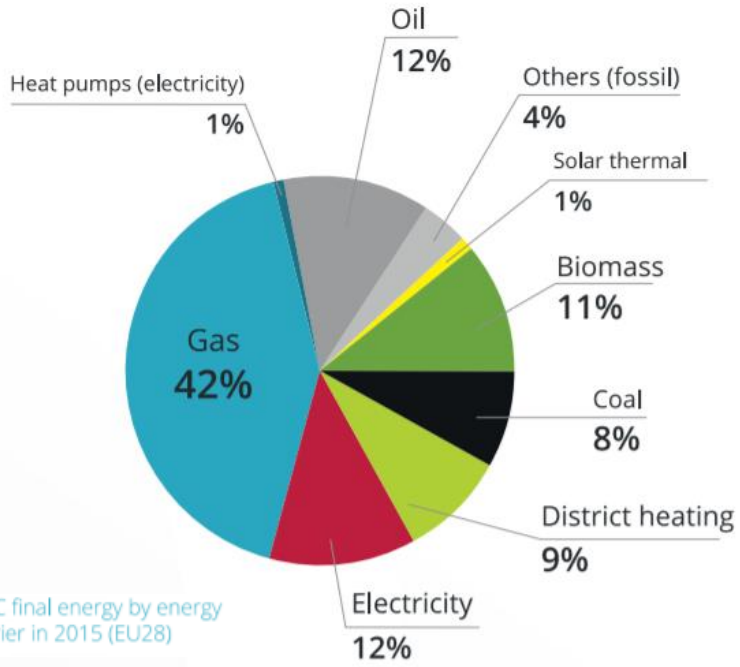
The role of Heating & Cooling in the general Energy System

Courtesy by Heat Roadmap Europe



Total final energy in 2015 (EU28)

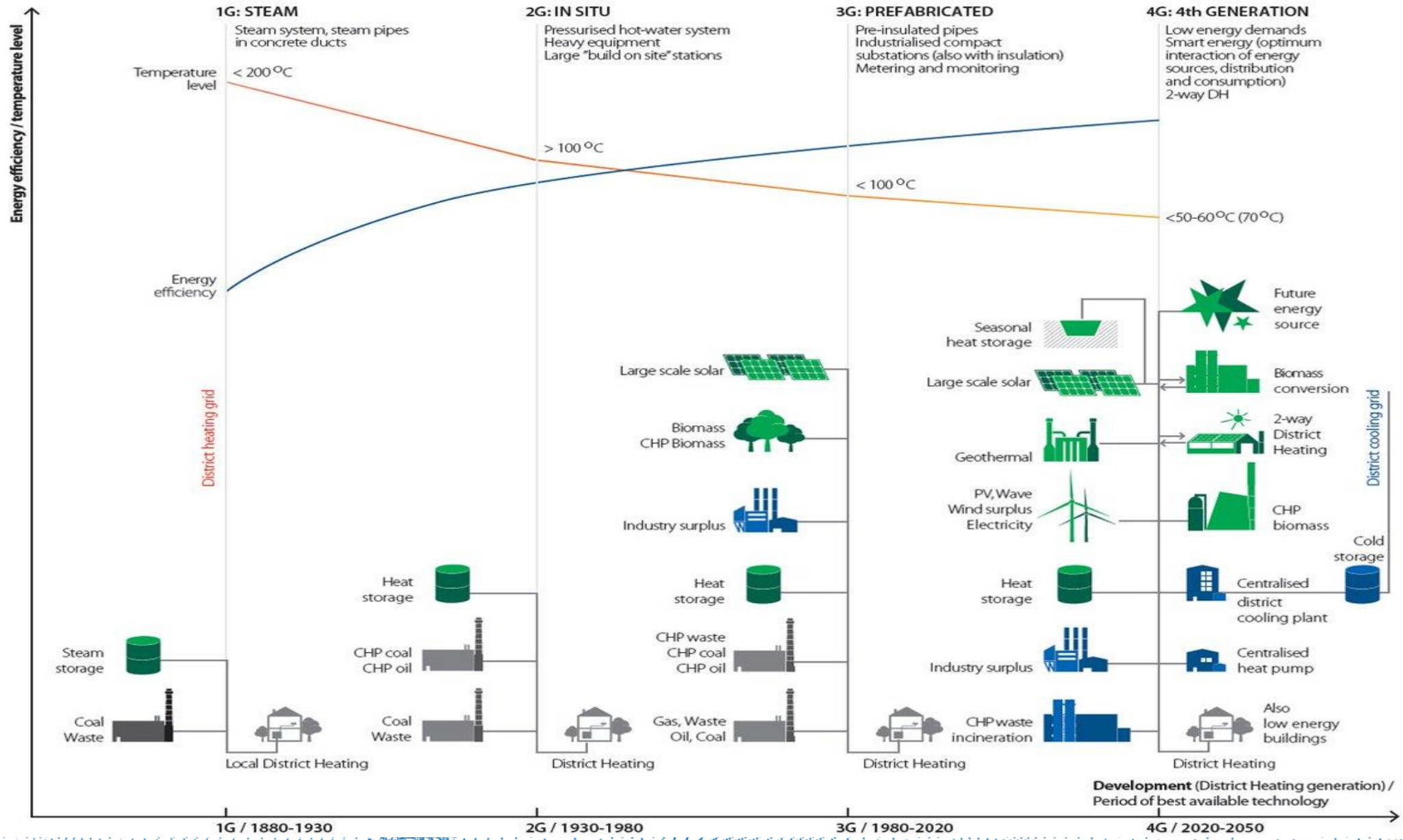
H&C final energy by end-use in 2015 (EU28)



H&C final energy by energy carrier in 2015 (EU28)

- Heating and cooling represent 50% of TOTAL energy consumption in the EU!
- Around 2/3 of thermal energy was produced (in 2015) using fossil fuels (mostly gas)
- Things are changing fast following the fuel crisis, yet the issue remains: decarbonising this sector is the key to achieving the European Targets

Evolution of the DHC (and Smart Energy Systems) industry



The role of Policy in this transition

In 2023, negotiations on the Green Deal “Fit for 55” package are expected to be finalised.
Overall and pending final political deals, there are significant provisions for the DHC sector.

COMPLETED

EU ETS

- The Emission Trading System (2) will be requested for all **fossil fuels used in buildings**, no distinction between commercial and private buildings (with cap to 45euro/ton until 2030).

Last trilogue on 29.03

RED

- **Waste heat** accountable towards RES targets
- **Sector integration**: accounting of green electricity towards H&C targets and DHC targets, **thermal storage** target
- Some limitation on use of woody biomass

Last trilogue on 09.03

EED

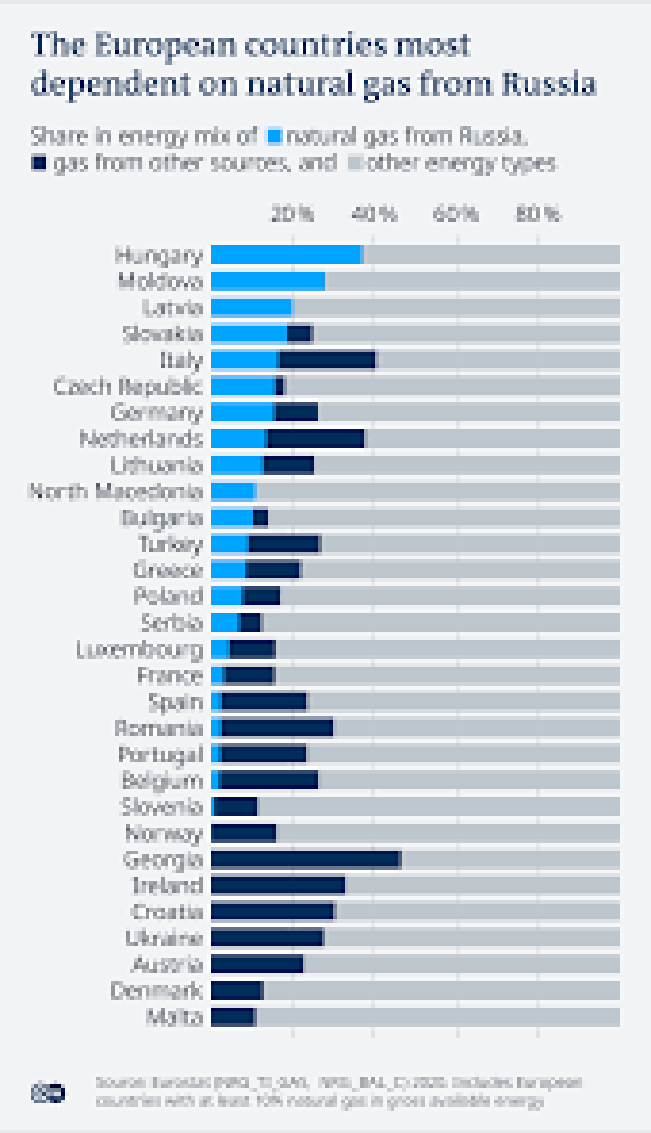
- Gradual **phase-in RES** and WH for efficient DHC
- Mandatory local heating & cooling **planning** (45k citizens)
- Mandatory waste heat recovery for **data centers** above 1MW

EPBD

- District approach to **building** decarbonization
- **Phase-out of fossil fuel boilers** in new & refurbished buildings
- Targets for Heat Pumps and Solar thermal

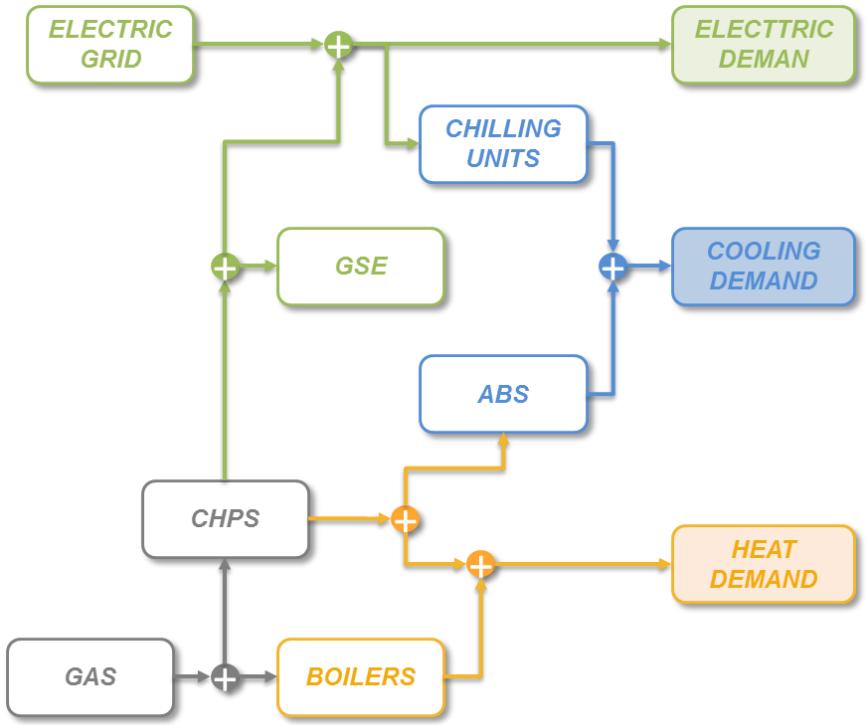
Building resiliency since the ban on Russian Gas

In fact, an even stronger push has been introduced by the ban on Russian fossil fuels, due to the Ukranian crisis

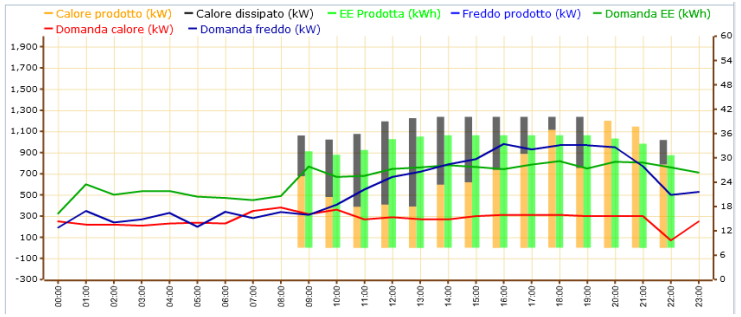


- Geo-political reasons are pushing the investment agenda even more towards increased diversification
- The district Heating community has a tremendous opportunity to serve the purpose of this transition

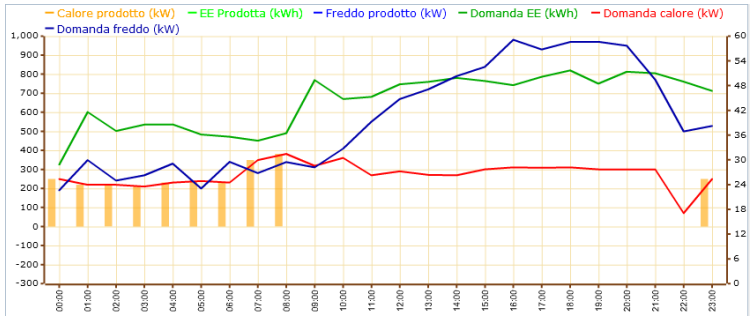
Where we started: CHCP production optimisation



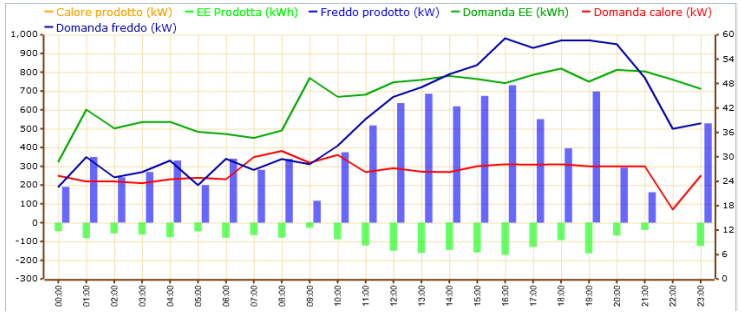
CHPs



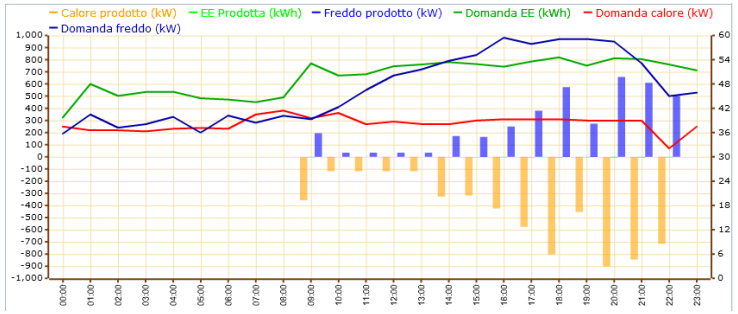
Boilers



Electrical Chillers



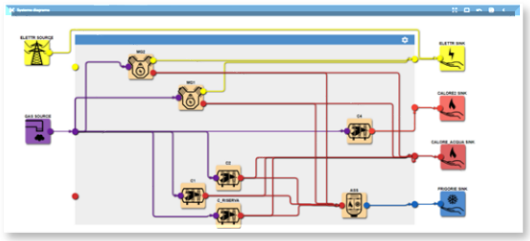
Absorption Chillers



- Resolving the **unit commitment** problem for a typical CHCP plant
- A rather well known problem, that uses (for the most part) MILP approaches

Optimizing production with increasing RES and sector integration

PLANT CONFIGURATION

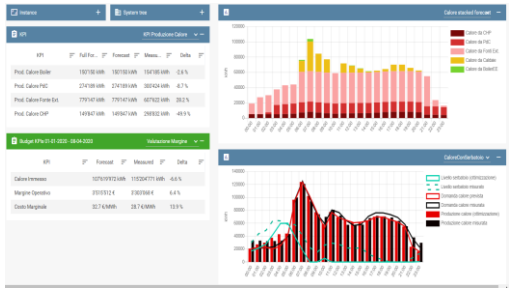


SYSTEM INTEGRATION

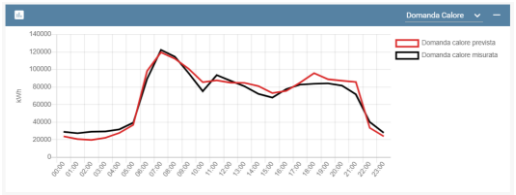
- Field data
- Market data
- Price estimates
- Economics
- Weather forecasts

LONG TERM (YEAR)

SHORT TERM (NEXT DAYS)



FORECASTING



TRADING (SAME DAY)

STRATEGIC DECISIONS

- Investments
- Sensitivity (what-if)
- Budgeting

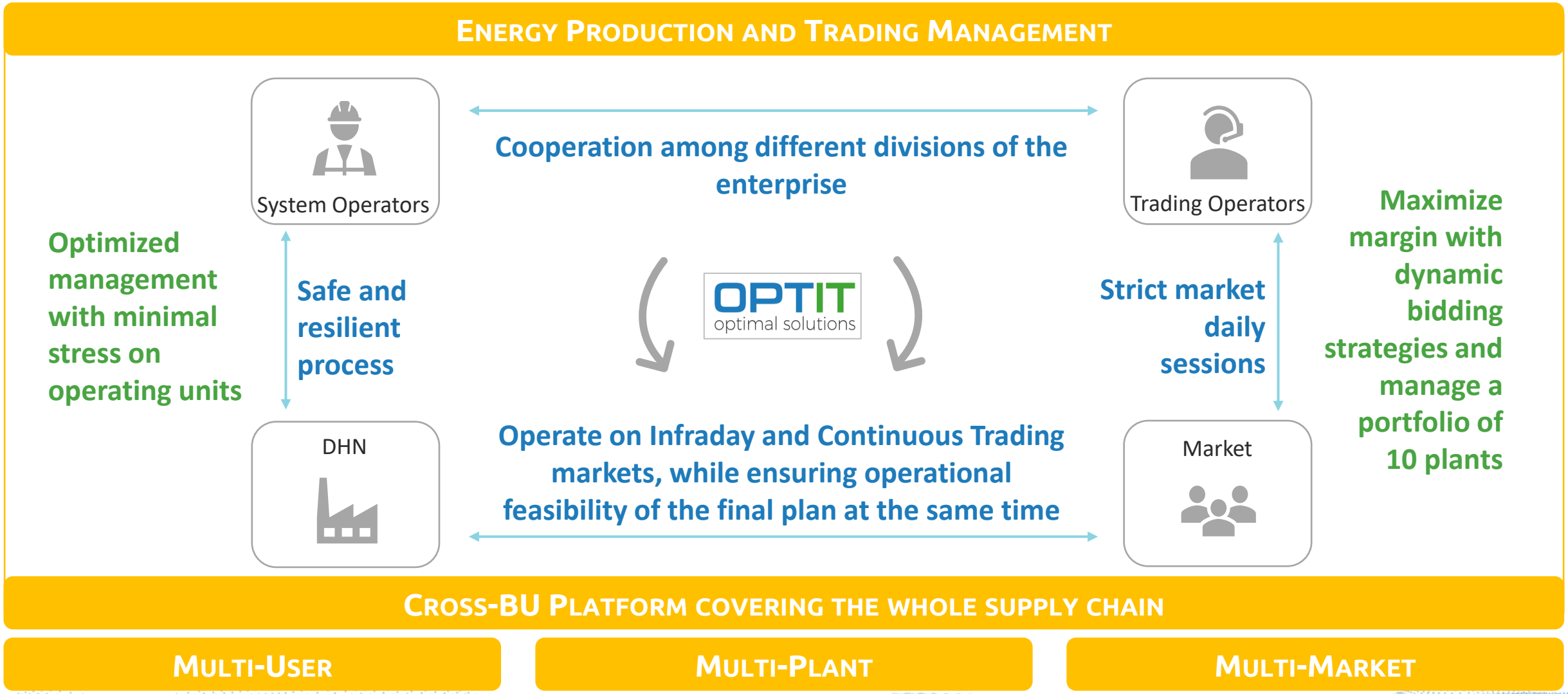
OPS DECISIONS

- Unit commitment
- Margin optimisation
- Automatisation

TRADING DECISIONS

- DA/SD adj. Trading
- Capacity markets
- XBID

Trading Optimization: Business Integration with conflicting objectives



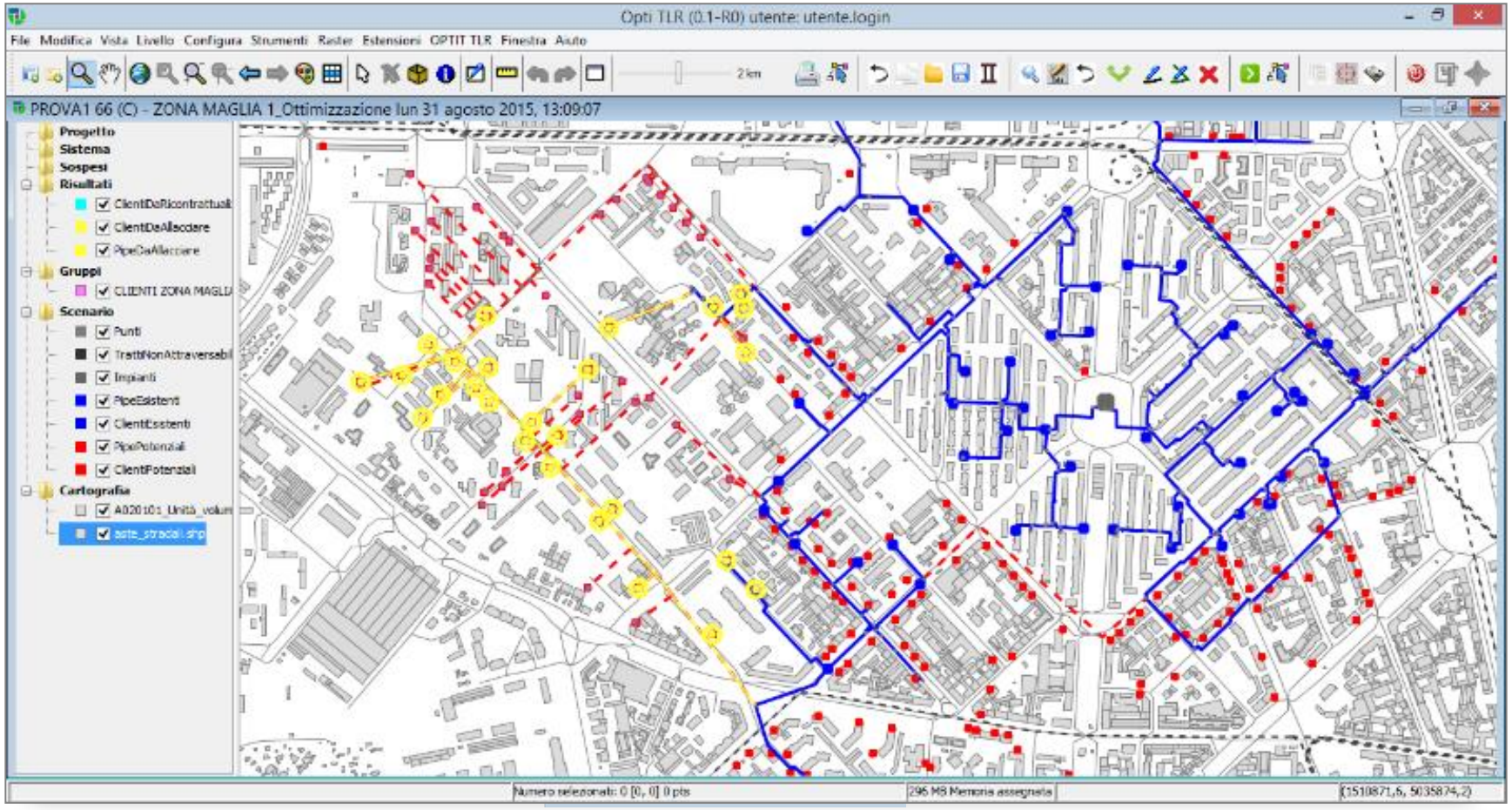
Optimal development of DHC network (maximization of NPV)

Existing & potential **pipings**

Existing & potential **users**

Existing & potential **plants**

Import + Puntual **editing** /drawing



Advanced **Scenario** Mgmt

Tariffs & **Capex/Opex**

Technical constraints

Financial parameters

Integrating Engineering & Economic Analysis

Investment Evaluation

- **Investment Validation** for network expansion
- Evaluation of **new equipment** integration
- Evaluation of Policy or Contractual Framework **Impacts**

Parametri input

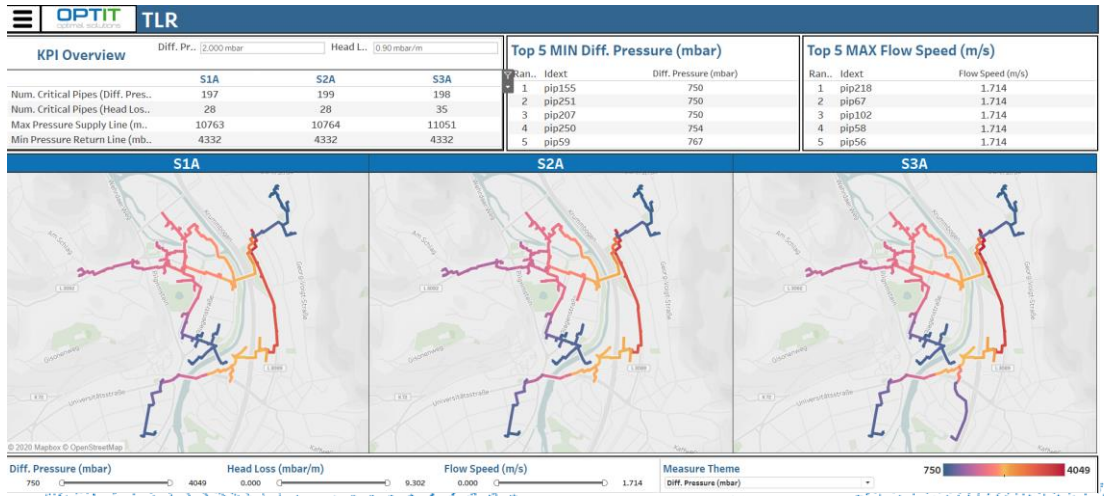
Parametro	Valore
GRUPPO DI RIFERIMENTO	Potenza (KW) >= 50.0 Distanza (m) <= ...
Costo fisso contratto nuovo allaccio (€)	0
Costo fisso contratto ricontrattualizzazion...	100
Pressione min cliente (bar)	0,4
Fattore contemporaneità	0,6
Tasso di interesse VAN	0,065
Max clienti allacciabili	50
Max clienti ricontrattualizzabili	100
Profilo min ricontrattualizzabilità (h)	400
Profilo max ricontrattualizzabilità (h)	1.100
Pressione max impianto	
Pressione ritorno cliente	
Orizzonte temporale (an	
Sconto allacciamento (%	
Tariffa assegnata ai clie	
Fattore consumo equiva	
Soglia potenza per prev	
Rapporto minimo ricontr	
Rapporto massimo ricon	

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

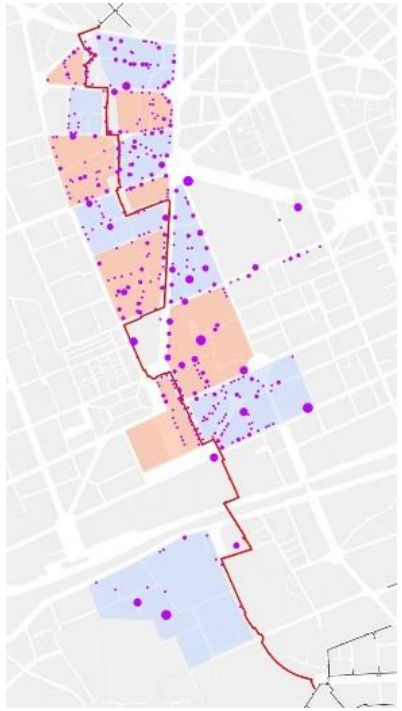
	ANNO	RICAVO	COSTO	AMMORTAMENTO	IMPONIBILE	TASSE	FLUSSO_NETTO	COEFF	VALORE ATTUALIZZATO	VALORE_ATT_CUMULATO
1	0	€ 221.612	€ 1.093.214	€ 23.296	€ 65.348	€ 20.519	-€ 892.122	1,000	-€ 892.122	-€ 892.122
2	1	€ 354.579	€ 357.999	€ 28.656	€ 113.175	€ 35.537	-€ 38.957	0,926	-€ 36.071	-€ 928.193
3	2	€ 443.223	€ 362.768	€ 32.229	€ 145.060	€ 45.549	€ 34.906	0,857	€ 29.926	-€ 898.267
4	3	€ 487.546	€ 340.945	€ 34.016	€ 161.002	€ 50.555	€ 96.046	0,794	€ 76.245	-€ 822.022
5	4	€ 531.868	€ 367.538	€ 35.802	€ 176.945	€ 55.561	€ 108.769	0,735	€ 79.949	-€ 742.074
6	5	€ 576.190	€ 394.131	€ 37.589	€ 192.887	€ 60.567	€ 121.492	0,681	€ 82.686	-€ 659.388

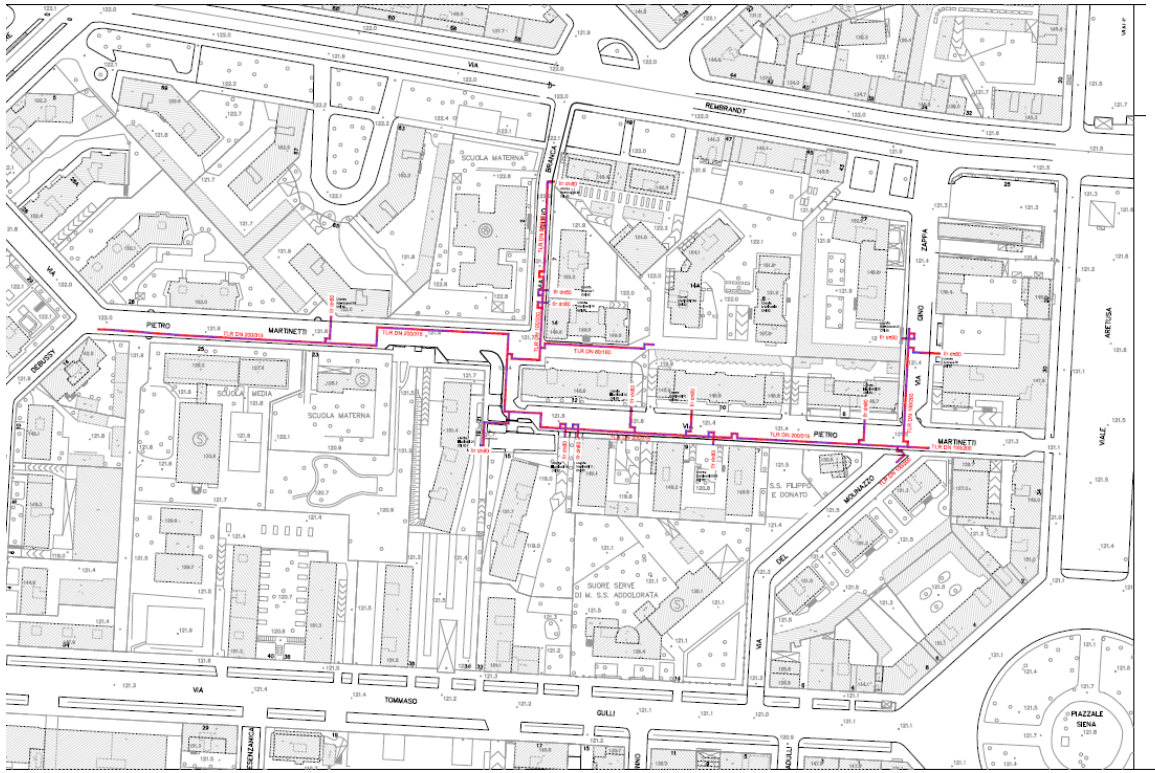
Technical Analysis

- **Thermal-Hydraulic** Simulation (flow and pressure profiles)
- Network Design Analysis and Optimization
- Risk and Maintenance Assessment



From Analysis to Construction in Milano (Italy)



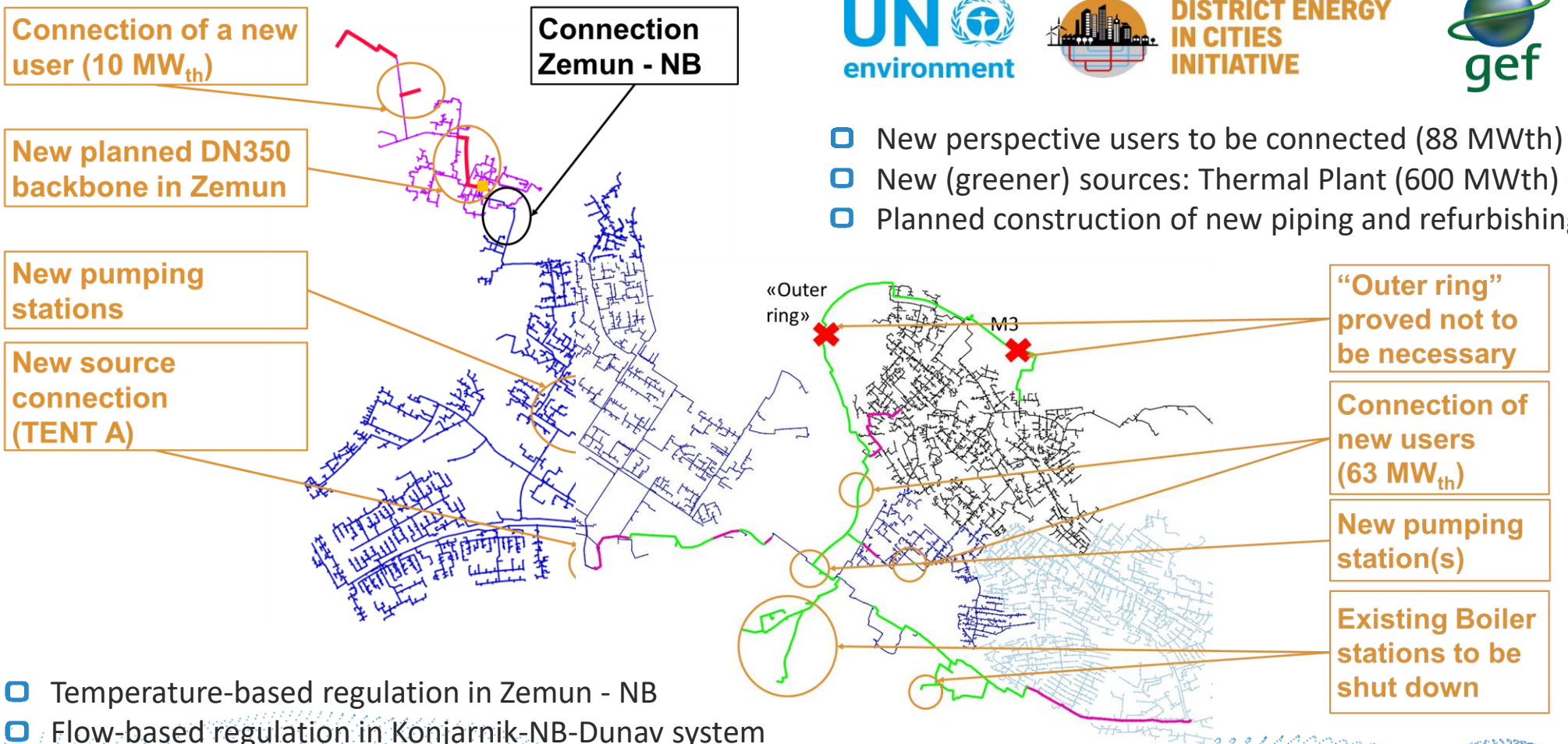


- Optimal allocation of 100 MWth in densely populated area
- Quick transition from plan to construction

DECISION DRIVERS INTEGRATION

The Tool supported the transition from the commercial to the engineering departments, speeding up the project execution.

Analysis of Waste Heat exploitation in Belgrade



- New perspective users to be connected (88 MWth)
- New (greener) sources: Thermal Plant (600 MWth) + WTE (56 MWth)
- Planned construction of new piping and refurbishing of existing piping

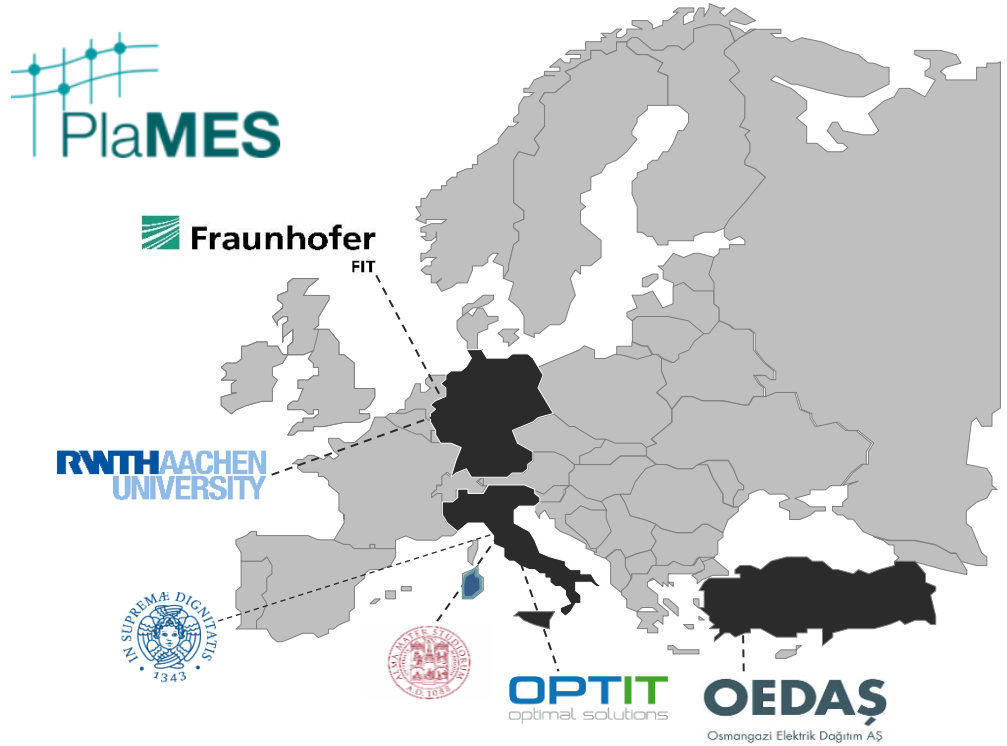
- Temperature-based regulation in Zemun - NB
- Flow-based regulation in Konjarnik-NB-Dunav system

PLAMES: Integrated Planning of Multi-Energy Systems

Objectives

- Develop a **decision support tool** to design the optimal (cost-effective) decarbonized energy systems of the future, balancing investments between **supply & transmission/distribution networks**
- Electricity, heat, gas, EV-load and hydrogen **integration** exploiting **synergies & flexibility**
- Dedicated **models** to manage:
  - Large scale / National / Transmission system (HV) - use case: Germany
  - Local case / Regional / Distribution system (MV) Use case: Bilecik region, Turkey

Partners



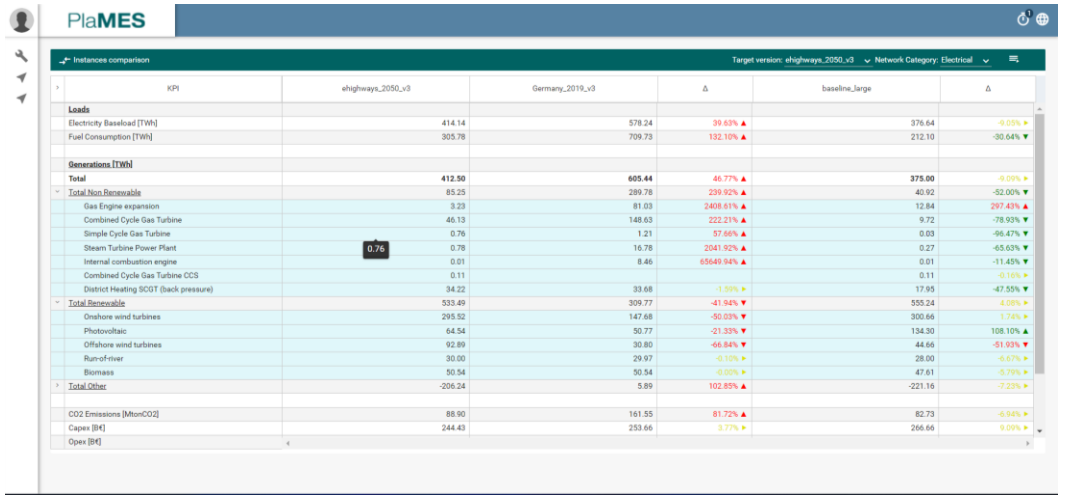
Advisory board

amprion SIEMENS EUROHEAT & POWER FSR

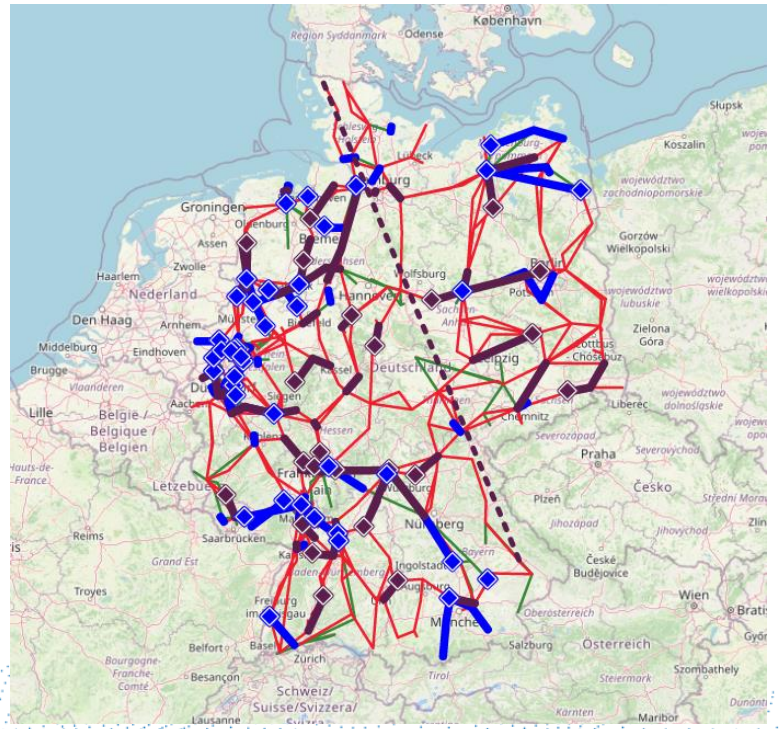
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863922.

PLAMES: Integrated Planning of Multi-Energy Systems

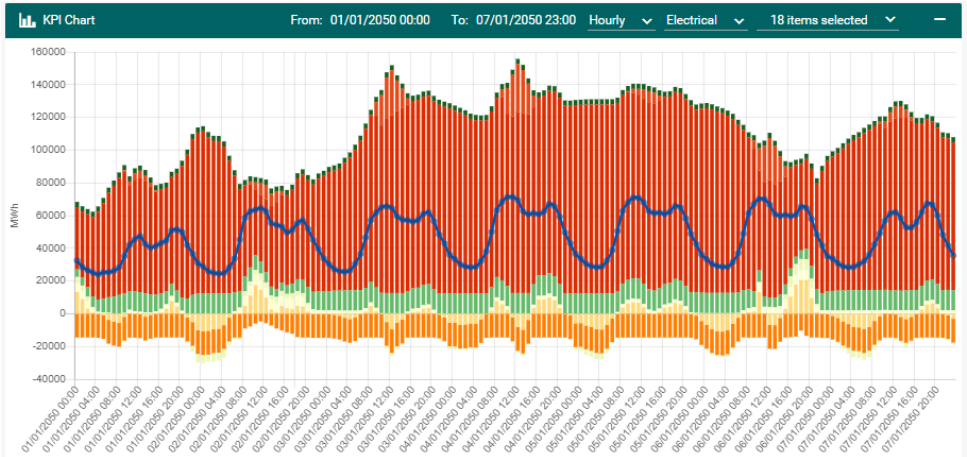
Generation of long-term and Large-scale scenarios of future multi-energy (electricity, heat, gas, EV-load and H_2) systems designed to meet **decarbonization** targets with minimum costs



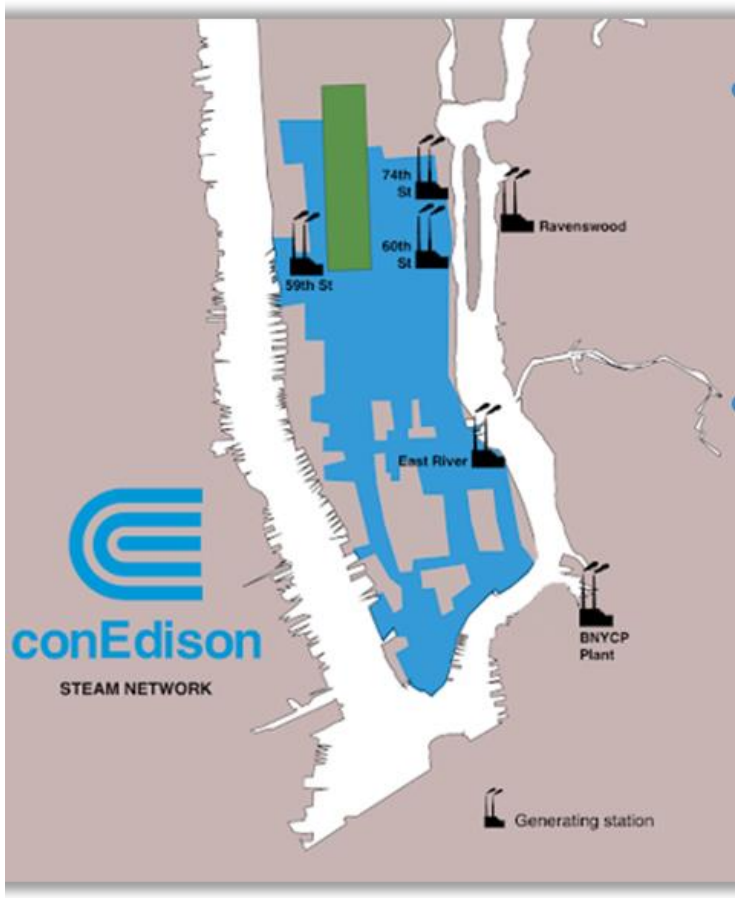
Detailed (year, with hourly granularity) optimized **energy production mix** for each scenario



Balanced development requirements based on future demand between **transmission / distribution** and optimized **RES supply and coupling infrastructure**, leveraging on the **flexibility** of a multi-energy approach



Decarbonisation is becoming key alo on the other side of the ocean

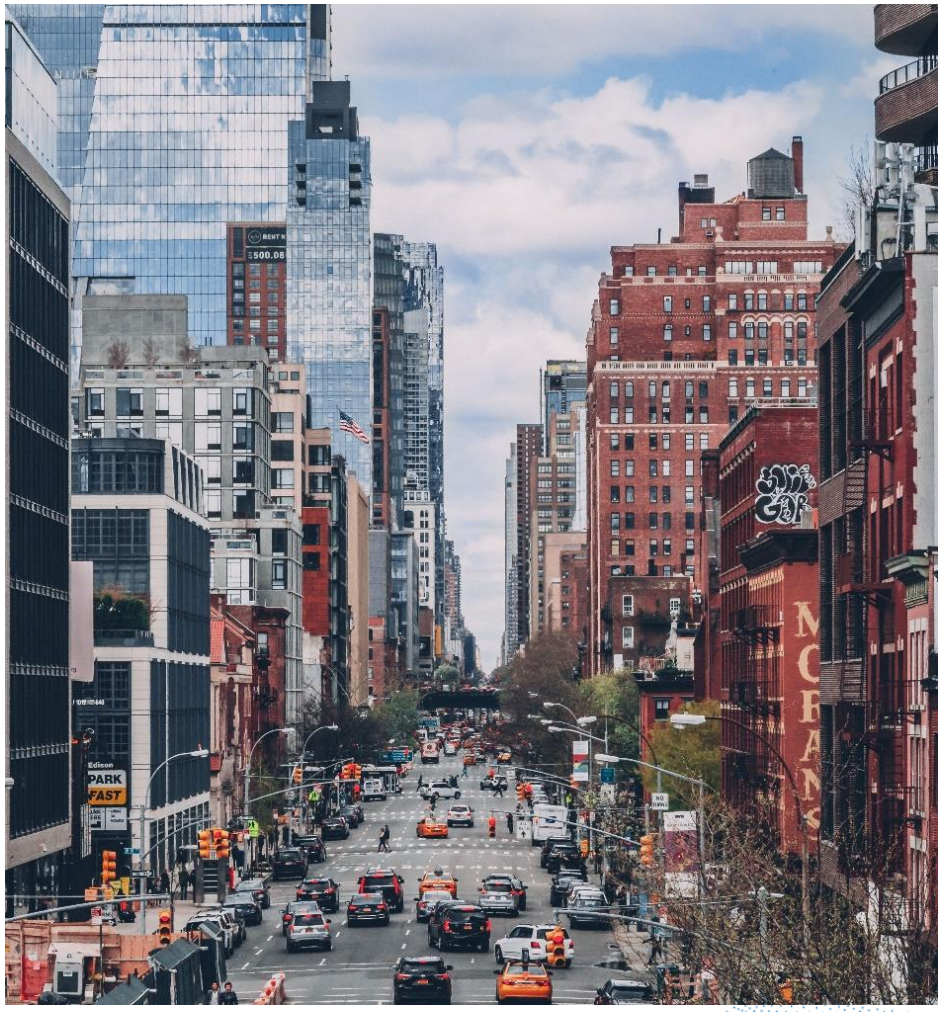


- New York State **Climate Leadership and Community Protection Act** is amongst the most ambitious climate laws in the USA and requires NYC to **reduce economy-wide greenhouse gas** emissions 40% by 2030 and no less than 85% by 2050 (wrt 1990 levels)
- **Local Law 97** requires most medium to large size **buildings** (that produce the majority of the emissions) meet new energy efficiency and GHG emissions limits by 2024, with stricter limits coming into effect in 2030 and beyond
- Local Law 154 dictates the **phase out of fossil fuels** for all new constructions starting in 2024

The local utility, that manages the steam system for the city of NY (USA), has the imperative to become the key decarbonization enabler for the whole city (vs. costs of electrification)

Digital and analytics strategy design (and implementation)

- Review of regulatory and strategic objectives
- Analysis of current processes and systems
- Evaluate the impacts of new technologies, like the integration of Renewable energy sources (Wind + Solar) and lower temperature (hot water) networks
- Enable fuel source diversification, sector coupling and integration, crucial to manage the upcoming system
- Qualification of the **digital and analytics tools to manage and integrate the whole value** chain, from production to carbon accounting for the individual customer
- Definition of the development roadmap and its progressive implementation



Looking ahead: resorting to (Trustworthy) AI to explore novel approaches

Tuples
TRUSTWORTHY AI

TRUSTWORTHY PLANNING AND SCHEDULING WITH LEARNING AND EXPLANATIONS

TUPLES is a 3 year project aiming to obtain scalable, yet **transparent, robust and safe algorithmic solutions for planning and scheduling, combining symbolic P&S methods with data-driven methods**

We will demonstrate and evaluate our methods in a laboratory environment, on a range of use cases, including an energy management case posed by Optit.

We expect to explore novel **hybrid modelling** techniques to describe and resolve large, complex problems

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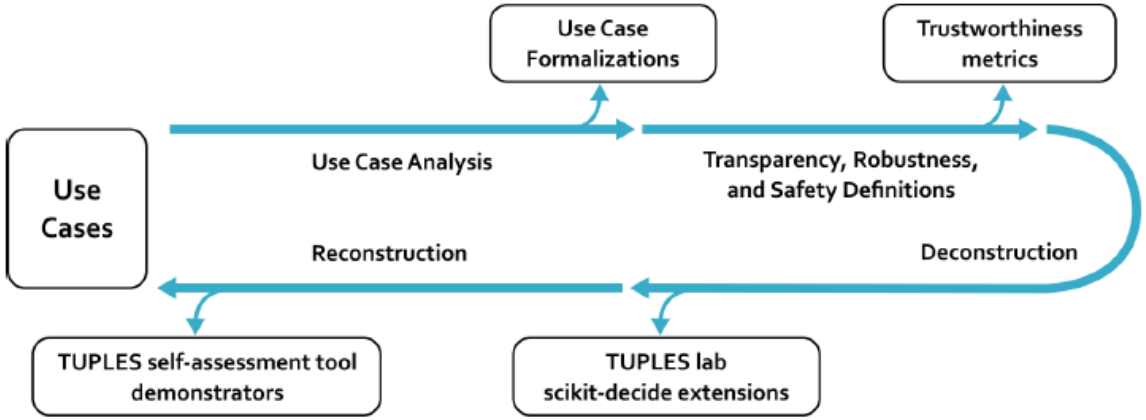

Figure 1: use-case driven development process

Via Mazzini, 82 - 40138 Bologna (BO) Tel: +39 051 4381574
Via Ravennate, 959 - 47522 Cesena (FC) Tel: +39 0547 385703
www.optit.net
info@optit.net
@optitsrl_en
@optit-s.r.l.