A NEW EXPERIMENTAL PLATFORM TO FACE SOLAR DISTRICT HEATING & 4TH GENERATION DISTRICT HEATING CHALLENGES
INTRODUCTION TO 4TH GENERATION DISTRICT HEATING

SOURCE: 4TH GENERATION DISTRICT HEATING (4GDH): INTEGRATING SMART THERMAL GRIDS INTO FUTURE SUSTAINABLE ENERGY SYSTEMS, LUND & AL (2014)
EVOLUTION OF DISTRICT HEATING

Source: 4 DH research center
CHALLENGES OF 4TH GENERATION DISTRICT HEATING

- Supply low-temperature district heating for space heating and domestic hot water (DHW) to existing buildings, energy-renovated existing buildings and new low-energy buildings.

- Distribute heat in networks with low grid losses

- Recycle heat from low-temperature sources and integrate renewable heat sources such as solar and geothermal heat

- Integration in a smart energy systems (i.e. integrated smart electricity, gas, fluid and thermal grids)

- Ensure suitable planning, cost and motivation structures in relation to the operation as well as to strategic investments related to the transformation into future sustainable energy systems

DESCRIPTION OF CEA INES EXPERIMENTAL PLATFORM
An experimental platform allowing to implement, test and validate:

- **Innovative components or systems** in real environment
- **Advanced management** algorithms
- **Our dynamic modeling** and simulations

A **scalable** platform:

- connecting the **3 energy vectors** (heat, gas, electricity)
- And connected with the **other INES platforms** (thermal system test bench, smart electrical grid, ...)

CEA INES EXPERIMENTAL PLATFORM
μ-DISTRICT HEATING AND COOLING:
OPERATION PRINCIPLE

Central plant:
- Gas condensing boiler - 280 kW
- Solar collectors - 300m²
- Power to heat - 50 kW
- CHP – 80 kWt / 50 kWe
- Absorption chiller - 100kWf

Thermal storage:
- Heat - 40 m³
- Cold - 5 m³

Distribution:
- Heat - 2 pipes (70 – 50°C)
- Cold - 2 pipes (7-12°C)

Consumers:
- Industrial and office building
- Thermal needs emulation

Control / monitoring:
- Advanced control algorithm
μ-DISTRICT HEATING AND COOLING:
A SCALABLE PLATFORM

- Absorption chiller – 100 kWf (planned)
- Solar collectors 300 m²
- Gas condensing boiler – 280 kW
- CHP (planned)
- Heat and cold thermal storage
- Smart substation (planned)
- Heat pump 50 kW (planned)

Smart Thermal network
Advanced control
GAS NETWORK
ELECTRICAL MICROGRID
HOW DOES IT WORK?

EXEMPLE OF THE DEVELOPMENT OF A TWO WAYS SUBSTATION
**SYSTEM TESTING**

**Issues:**
- A thermal system is an assembly of many components that compose a system including the control
- Global performance need to be determined
- System are working in dynamic
- And:

\[ \sum \text{efficient \_ components} \neq \text{efficient \_ system} \]

**Methodology:**
- Test of the system in real time in a semi-virtual environment

**Advantages of semi-virtual test:**
- Real time test
- Sequence that can reproduce in a limited time the operation of the system over different periods of the year
- Reproductible sequence: possibility to replicate operations having generated malfunctioning installation
TESTING A 2 WAYS SUBSTATION

- Principle of semi-virtual test
  - Application to a bi-directionnal DH substation
TESTING A 2 WAYS SUBSTATION

- Principle of semi-virtual test
  - Application to a bi-directionnal DH substation
TESTING A 2 WAYS SUBSTATION

• Principle of semi-virtual test
  ▪ Application to a bi-directional DH substation

INES µ-District Heating Network

Sub-Station

INORG

DHW loop

Solar collector

INES µ-District Heating Network
TESTING A 2 WAYS SUBSTATION

- Principle of semi-virtual test
  - Application to a DH substation
CONCLUSION & PERSPECTIVES
CONCLUSION & PERSPECTIVES

• An experimental platform ready for 4thGDH:
  • A real approach in a controlled laboratory environment with a significant scale of installation
  • A scalable platform for integrating new component technologies
  • Complementary to simulation-based theoretical approaches

• Perspectives for using the platform
  • Solar thermal integration (innovative solar thermal collector fields, centralised & decentralised feed in, return-return, return to flow connection,…)
  • Advanced control of district heating
  • Innovative substation
  • Integration of storage in district heating*
  • Integration into smart energy network (power to heat, CHP,…)
  • …
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