Skoltech Center for Energy Systems

2nd International Conference of Skoltech Center for Energy Systems
organized jointly with International Institute for Energy Systems Integration

Shaping research in integrated gas-, heat- and electric- energy infrastructures

Hotel Hilton Leningradskaya, Moscow, May 30-31, 2016

COMBINED COOLING, HEAT AND POWER (CCHP) UNIT COMMITMENT PROBLEM: FROM ACCURATE CHARACTERIZATION TO YEARLY CONSTRAINTS

Aldo Bischi, Skoltech Center for Energy Systems, Russia

The presented work has been carried on by the author together with the Politecnico di Milano Groups of Energy Conversion Systems - GECOS and Operations Research.

Optimally scheduled Combined Cooling, Heat and Power (CCHP) makes rational use of primary energy generating simultaneously heat, electric/mechanical power and refrigeration effect. Several types of prime movers are suitable for CCHP applications, ranging from micro-turbines to gas-steam turbine combined cycles. They can have highly nonlinear performance curves describing their off-design behavior and they can have more than one independent operative variable, "degree-of-freedom"; their performance depends on ambient temperature as well. Prime movers may be integrated with auxiliary boilers, heat pumps and renewable energy sources. In addition, the on-off status, the thermal and/or electric storage and the national incentive policies come into play; this implies that each time step cannot be optimized separately and a larger period until a whole year should be considered at once.

Due to the large number of decision variables and the necessity of determining trade-off solutions, the operation planning of CCHP plants, with several units, requires the development of specific optimization tools. These challenges have been tackled developing a Mixed Integer Linear Programming (MILP) model by means of piecewise linearization of Non-Linear problems. This task has been accomplished in a comprehensive way, solutions to reduce the number of integer variables have been explored, e.g. superposition principle, and the proposed model has been extended via heuristic rolling-horizon algorithm to the whole year.

RECENT ADVANCES IN OPTIMAL DESIGN OF DISTRICUTED ENERGY SYSTEMS

Ryohei Yokoyama, Department of Mechanical Engineering, Osaka Prefecture University, Japan; Yuji Shinano, Department of Mathematical Optimization, Zuse Institute Berlin, Germany

To attain the highest performances of distributed energy systems, it is important to determine their design specifications rationally in consideration of their operational strategies corresponding to variations in energy demands. The first author has continued to develop mainly mixed-integer linear programming (MILP) approaches to the optimal design of distributed energy systems. However, such optimization problems become large scale with increases in the complexity of system configurations as well as the number of periods to consider variations in energy demands. Thus, the problems cannot necessarily be solved in reasonable computation times even by commercial MILP solvers available currently. Recently, the authors in different areas have tried to resolve such an issue and have obtained some fruitful results through their collaboration.

It is primarily important to solve the aforementioned optimization problems in reasonable computation times. First, the authors have developed a method of solving the optimization problems efficiently in consideration of the hierarchical relationship between design and operation variables. However, this method can produce only the optimal solution which minimizes the value of an objective function, in the same way as most of all the optimization methods. From the design viewpoint, it is important to produce not only the optimal solution but also suboptimal ones which follow the optimal one without any omissions, what are called *K*-best solutions. Second, the authors have extended the aforementioned method so that it can derive *K*-best solutions. However, these methods can be applied to the optimal design of distributed energy systems under certain conditions. Since some conditions, especially energy demands, are uncertain at the design stage, it is important to produce a robust solution against uncertain conditions. Third, the authors have applied the method to the robust optimal design under uncertain energy demands based on the minimax regret criterion. The authors will talk about these research activities for the optimal design of distributed energy systems.

INTEGRATED ENERGY SYSTEMS AND RENEWABLE SUPPLY SCENARIOS

Poul Alberg Østergaard, Department of Development and Planning, Aalborg University, Denmark

Future energy systems need to be based on renewable energy sources, they need to be integrated and thus exploiting synergies across traditionally distinct energy sub-sectors and they need to be flexible to accommodate variations in demand and availability of various fluctuating renewable energy sources. Analyses have demonstrated how such smart energy systems can cover the electricity needs as well as energy needs for transportation and thermal services (cooling/heating) of Denmark. Balancing the energy system with a high temporal resolution remains a challenge particularly when energy systems are designed under strong biomass availability constraints. Demand flexibility in the electricity sector is of limited avail for balancing the system, however integration with thermal needs and transportation enable the utilisation of low-cost storage and demand flexibility in these sectors.

INNOVATIVE POWER TO GAS SOLUTIONS FOR ENERGY STORAGE

Umberto Desideri, Department of Energy, Systems, Territory, and Construction Engineering Università di Pisa, Italy

There is a strong need of storing energy from intermittent renewable energy sources in systems that can deliver it at different times. There is no single solution for energy storage that fits the needs of short, medium and long time storage. Some off-the-shelf solutions include batteries, but they cannot provide daily and weekly energy storage, since the cost would be too high.

The presentation will focus on some electricity to gas technologies with a high roundtrip efficiency and allowing to store energy either for weekly duration or to produce fuels for mobility.

INTEGRATED MODELS FOR THE OPTIMAL DESIGN AND OPERATION OF DISTRICT HEATING SYSTEMS INVOLVING HEAT STORAGE SOLUTIONS

Vittorio Verda, Department of Energy, Politecnico di Torino, Italy

District heating networks constitute important infrastructures for the implementation of efficient heating and domestic hot water services to buildings located in urban areas. Modern district heating networks may involve the use of waste heat, renewable sources and heat from cogeneration thermal storage systems. In addition, management is operated through advanced ICT solutions able to minimize the global primary energy consumption and to increase end user awareness.

Detailed thermos-fluid dynamic simulation tools can be of extreme importance for the optimal management of modern district heating networks. Some of the issues that simulation tools are requested to face are: peak shaving, selection of the operating temperature, operation in the case of malfunctions, storage management. An important requirement consists in the possibility to perform fast simulations, even in the case of complex networks.

This presentation aims at presenting a detailed simulation approach that can be applied to large district heating networks, taking into account the various aspects of a district heating network: water distribution, plant management, storage design and management, building behavior. The entire network is represented as constituted by the main pipeline, which may be a tree shaped or a looped network, and the various subnetworks that distribute water from the main network to each single building. The main pipeline is fully modeled considering fluid flow and transient heat transfer. Subnetworks are simulated using a reduced model obtained from the full model. Storage units are modeled through reduced models obtained from detailed computational fluid dynamic models. Buildings are modeled through compact models which data are obtained from measurements at the thermal substations and validated through indoor measurements and detailed models.

The modeling approach is applied to the analysis of transient operation of the Turin district heating network. The thermal request of the users is obtained from temperature and mass flow rate measurements at the thermal substations, available with a frequency of six minutes. Thermo-fluid dynamic simulation allows one obtaining the corresponding thermal load profiles at the various thermal plants. Results show that a peak request is caused by the temperature reduction in the entire system caused by request reduction at night. Due to the advective transport of water in the network and the thermal losses, the shape and amplitude of the peak at the plant is completely different than that at the users.

A comparison between simulations and experimental results shows that the model is able to predict the network operation with good accuracy. Using this simulation approach it is therefore possible to examine the effects of variations, obtained through night attenuation or the installation local storage systems, on the thermal request profiles of some of the users on the global thermal load of the network during the start-up transient.

The proposed simulation approach is shown to represent a versatile and important tool for the implementation of advanced management to district heating systems.

FLEXIBILITY POTENTIALS IN COMBINED POWER AND THERMAL SYSTEMS

Henrik Madsen, Department of Applied Mathematics and Computer Science, Danmarks Tekniske Universitet, Denmark

This talk describes methods for harvesting the flexibility potentials which can be obtained by intelligently integrating power and thermal systems. Most of the examples are taken from the ongoing CITIES (Center for IT-Intelligent Energy Systems) research project in Denmark. In this project a concept called the Smart-Energy Operating-Systems (SE-OS) has been developed, and this concept is used for implementing many of the energy flexible solutions. The talk will describe this concept and illustrate how the flexibility can be described in the case of both direct and indirect (price-based) control of the power load. Examples related to cooling and heating will be provided.

MATHEMATICAL AND COMPUTER MODELS FOR IDENTIFICATION AND OPTIMAL CONTROL OF LARGE-SCALE GAS SUPPLY SYSTEMS

Sukharev Mikhail Grigorievich, Kosova K.O., Popov R.V., Gubkin Russian State University of Oil and Gas

This paper considers the optimal control problem of large gas supply systems. Solving this problem, we must take into account line packing in large-scale gas supply systems modeling.

For unsteady-state gas flow modeling, we propose the lumped-parameter model. On the base of this model, we present a system of ordinary differential equation for unsteady-state gas flow imitation in pipeline system of arbitrary configuration.

We propose a method to integrate this system. Example of the loop gas supply system illustrates proposed model adequate.

The paper includes the mathematical formulation of technical diagnostics problem of large pipeline system equipment in case of unsteady-steady gas flow. The estimation of technical state reduced to the conditional optimization problem. On the base of the lumped parameters model, we propose the algorithm of the solution of this problem and use it for identification of gas supply system of arbitrary topology. The numerical experiments demonstrate that the algorithm converges with good speed.

In this paper, we describe concept of large pipeline system control. Stated ideas can be applied for research of «black out» gas system process.

DYNAMIC MODELING OF NATURAL GAS QUALITY WITHIN TRANSPORT PIPELINES IN PRESENCE OF HYDROGEN INJECTIONS

Stefano Campanari, Energy Department, Politecnico di Milano, Italy

In the near future, the natural gas grid could face an increasing share of alternative fuels (biomethane, hydrogen) injected in addition to the traditional natural gas. Indeed, this pathway is particularly promising in order to reach environmental objectives of CO2 emissions reduction, in both thermal and electrical final uses. Biogas is already abundantly produced and could be easily upgraded to biomethane; hydrogen technologies are still under development, but they can help the exploitation of the increasing availability of renewable energy sources. A promising solution to problems due to unpredictable fluctuations of renewable energy production (in particular related to wind parks) or excess energy with respect to the load lies in hydrogen production by electrolysis and further injection in natural gas grid. In this scenario, the effects on design and management of the transport infrastructure should be investigated, and the compliance with composition limits and quality constraints has to be analyzed in both stationary and dynamic operation, tracking the gas quality downstream the injection point of the alternative fuels. A model was developed to simulate the unsteady operation of a portion of gas grid; with respect to traditional volume flow-based approaches, a novel energy-based approach is developed, including variable composition along the pipes and allowing to consider a constant energy delivery to customers as a constraint. After the validation against available operational data, a case study considering concentrated realistic domestic and industrial offtakes is simulated. The effects of hydrogen injection, usually not considered in NG grid design and operation analyses, are investigated in terms of composition, flow rate and pressure profiles with comparison to the reference natural gas case. The analysis shows how imposed quality thresholds can be respected, although the effects on calorific value, Wobbe index and density are not negligible; results indicate that the allowed hydrogen fractions are limited and highly sensitive to the profile and size of the offtakes connected to the pipeline. The discussion also evidence the potential impact of hydrogen injection on gas metering and measurements errors.

MULTI-LEVEL MODELING AND OPTIMIZATION OF LARGE-SCALE PIPELINE SYSTEMS OPERATION

<u>Alekseev Aleksandr Vladimirovich</u>, Novitsky N.N., Tokarev V.V., Shalaginova Z.I., Melentiev Energy Systems Institute of the Siberian Branch of the Russian Academy of Sciences (ESI), Russia

The report describes the problems and opportunities of power system integration (electricity, heat, gas, water, etc.). We present developed at Energy Systems Institute technique of piping systems (PS) multilevel modeling. The technique assumes the decomposition of PS and coordination subsystem solutions obtained for each of them. The effectiveness of a technique is illustrated by the example of the cities heat supply systems, and its universality by the example of operation modes calculations and their optimal planning. The possibility of such an approach for the analysis and optimization of integrated systems including different type and purpose is discussed.

OPTIMIZING, CONTROLLING AND OBSERVING PHYSICAL ENERGY FLOWS – CONNECTING PROBLEMS IN POWER, GAS AND DISTRICT HEATING

Mikhail Chertkov, Skoltech Center for Energy Systems, Russia

I start this talk briefly reviewing three seemingly unrelated subjects:

(a) topology reconstruction in power distribution systems (through physics informed machine learning);

(b) modeling propagation of a heat front in district heating pipes (with statistical hydrodynamics); and

(c) dynamical optimization of natural gas systems subject to uncertainty (taking advantage of the gas flow monotonicity).

Then, I speculate how these three (or at least two) aforementioned energy infrastructures, connect at the scale of a metropolitan city, like Moscow or Irkutsk, and can benefit from functioning in unison.

OPTIMIZATION BETWEEN REGULATION AND PHYSICS

Thorsten Koch, Department of Scientific Information and Mathematical Optimization, Zuse Institute Berlin; Institute of Mathematics, Technische Universität Berlin, Germany

About 25% of the Energy demand of Europe is supplied by natural gas.

To foster competition, the European Union has implemented a sophisticated regulatory system for the gas market. In this setting Germany decided to end nuclear power and conduct an energy turnaround.

While renewables shall account for the majority of the electricity, the plan calls for gas power stations to absorb peak demands from the electrical grid.

Due to the unbundling of gas transport and gas trading by the EU, the transport system operators are now required to reliably provide large amounts of gas to the newly build power stations on very short notice. Extending the network costs about 1 Mio Euro per km. By utilize existing capacities for dynamically a new type of contract allows coping with this situation much more efficiently on a pure legal basis.

But it also means you need a robust solution to a large-scale stochastic mixed-integer non-linear optimization problem every day. In the talk we will describe some of the physical and technical fundamentals of gas networks and bring them together with legal requirements and the business demands to describe possible solutions.

METAMODELING OF COMPRESSOR STATIONS IN TRANSMISSION PIPELINE OPTIMIZATION

Richard Carter, DNV GL, USA

Design and operation of oil and gas pipeline networks lead to a myriad of simulation and optimization problems, many of which remain intractable.

A broad variety of simplifications are used by different authors to reduce particular problems to forms that can be solved with current methodologies and hardware. Such simplifications are sometimes useful and even necessary, but in other instances can shift the solution of the optimization problem unacceptably. For example, common theoretical models of compressor stations often bear little resemblance to models that respect actual device performance. If compressor station limits are binding constraints in an optimization problem, large errors in representing those constraints will directly induce large errors in computing the attainable limits of pipeline operation.

Detailed modeling of station operation is computationally expensive and is often structured in ways that are awkward for inclusion in optimization problems. We consider ways of metamodeling compressor stations by replacing the computational model over the full operational domain with a reduced representation solely of the *boundaries* of station operation. Using only a boundary manifold model within the operational domain eliminates some of the issues with general modeling. Moreover it is computationally quite tractable, particularly in a parallel setting. However it can also introduce new problems. The pros and cons of this approach are discussed.

INTEGRATED MODELING OF ACTIVE DEMAND RESPONSE WITH ELECTRIC HEATING SYSTEMS COUPLED TO THERMAL ENERGY STORAGE SYSTEMS

Dieter Patteeuw*; Kenneth Bruninx*; Alessia Arteconi+; Erik Delarue*; William D'haeseleer*; Lieve Helsen*

*** KU Leuven Energy Institute, Belgium**

+ Università degli Studi eCampus, Italy

Active Demand Response (ADR) can contribute to a more cost-efficient operation of, and investment in, the electric power system as it may provide the needed flexibility to cope with the intermittent character of some forms of renewables, such as wind. One possibly promising group of demand side technologies in terms of ADR are electric heating systems. These systems could modify their electrical load pattern without affecting the final, thermal energy service they deliver, thanks to the thermal inertia in the system. One of the major remaining obstacles for a large scale roll-out of ADR schemes is the lack of a thorough understanding of interactions between the demand and supply side of the electric power system and the related possible benefits for consumers and producers. Therefore, in this presentation, an integrated system model of the electric power system, including electric heating systems (heat pumps and auxiliary resistance heaters) subjected to an ADR scheme, is explained, taking into account the dynamics and constraints on both the supply and demand side of the electric power system. This presentation will show that only these integrated system models are able to simultaneously consider all technical and comfort constraints present in the overall system. This allows to accurately assess the benefits for, and interactions of, demand and supply under ADR schemes. Furthermore, we illustrate the effects not captured by traditional, simplified approaches used to represent the demand side (e.g., price elasticity models and virtual generator models) and the supply side (e.g., electricity price profiles and merit order models). Based on these results, we formulate some conclusions which may help modelers in selecting the approach most suited for the problem they would like to study, weighing the complexity and detail of the model.

VARIABLE RENEWABLE ENERGY INTEGRATION: INFRASTRUCTURE ASPECTS

Mark O'Malley, School of Electrical and Electronic Engineering, University College Dublin, Ireland

Increasing penetrations of variable renewable energy into electricity grids is leading to additional infrastructure needs. The primary requirement is for electric transmission and distribution infrastructure. However other infrastructures are also being impacted e.g. the need for more flexible generation and other flexible resources such more coupling to other energy infrastructures such as heat.

INTEGRATED ENERGY SYSTEMS: HEAT, POWER & TRANSPORT

Philip Taylor, School of Electrical and Electronic Engineering, Newcastle University, UK

Phil will discuss some UK projects and will look at interactions and interdependencies between heat, power and transport and the need for a whole systems approach. Energy systems are vitally important to the future of UK industry and society. However the energy trilemma presents many complex interconnected challenges. Current integrated energy systems modelling and simulation techniques suffer from a series of shortcomings that undermine their ability to develop and inform improved policy and planning decisions therefore preventing the UK realising huge potential benefits. The current approach is characterised by high level static models which produce answers or predictions that are highly subject to a set of critical simplifying assumptions and therefore cannot be relied upon with a high degree of confidence. They are unable to provide sufficiently accurate or detailed, integrated representations of the physics, engineering, social, spatial temporal or stochastic aspects of real energy systems. They also struggle to generate robust long term plans in the face of uncertainties in commercial and technological developments and the effects of climate change, behavioural dynamics and technological interdependencies.

The presentation will discuss the following full scale multi vector energy systems projects:

Science Central – Geothermal borehole, CHP, heating and cooling network, EV Filling station and Grid scale energy storage test bed

Multi-Storey Communities – Investigating the use of gas and electricity in multi storey communities

Cockle Park Farm – Anaerobic Digestion with CHP, back to back converters and second life EV batteries.

ASSESSMENT OF GAS SHORTAGES IN COUPLED GAS-ELECTRICITY INFRASTRUCTURES

Konstantin Turitsyn, Department of Mechanical Engineering, MIT, USA

Many power systems around the world are experiencing simultaneous increases of the gas-fired and renewable portions in the generation profile. The resulting strong coupling of power systems and gas transmission networks through gas-fired generators imposes additional risks on the system. In particular, excessive fuel usage by gas-fired power plants may lead to violation of gas pressure limits and result in gas supply shortages. We develop a computational framework that characterizes regions of generator dispatch solutions that maintain gas system feasibility. The proposed algorithmic framework is modular - built through a coordinated execution of multiple generation scenarios within power and gas simulation modules. Monotone dependence of the gas pipeline pressure on the rates of gas withdrawals allows to establish and certify regions of feasibility/infeasibility in the space of the gas injections.

HYBRID ENERGY SYSTEMS: IMPACT ON THE INTEGRITY OF ENERGY DELIVERY SYSTEMS

James McCalley, Department of Electrical and Computer Engineering, Iowa State University, USA

Conventional thermal electric generating power plants have served well for many decades to produce electricity reliably, and at low costs, but the presence of some types, particularly coal-fired, are being replaced by non-thermal renewables (wind, solar PV, and hydro). Although electric energy production via non-thermal renewables will continue to increase, there remains significant potential for thermal power plants utilizing natural gas, bio-renewables, geothermal, and concentrated solar thermal, a potential made even more attractive within hybrid energy systems (HES). We are interested in the design of HES as multi-input/flex-fuel technologies, coupled with thermal storage, that poly-generate heat, electricity, and transportation fuels. In this talk, we describe these technologies in terms of their components, their potential topologies, and various ways they may deployed. We also illustrate how wide-scale deployment of HES will benefit the four system integrity measures: flexibility, reliability, resilience, and adaptability.

SPECIFIC FEATURES OF INTERCONNECTED OPERATION OF GAS AND ELECTRIC POWER SYSTEMS UNDER EMERGENCIES IN RUSSIAN GAS TRANSMISSION NETWORK

Sergey Senderov, Melentiev Energy Systems Institute of the Siberian Branch of Russian Academy of Sciences (ESI), Russia

The presentation discusses the features of the interconnected operation of the system of gas supply and electricity system of Russia in emergency situations (ES) in the gas transport network. A mathematical model of the functioning of the gas sector formulated from the standpoint of the requirements of minimizing resource deficit by consumers in various operating conditions of the sys-tem. The studies were conducted using the software "Oil and Gas of Russia" developed at ESI SB RAS.

Russian gas transportation system is characterized by a significant number of the major intersections of main gas pipelines. In a possible embodiment of the emergency elected possible disruption of the largest major intersections of main gas pipelines. As a result of the model of iterative studies it was calculated the value of the natural gas shortage in some regions of the country under the largest average accident at the intersections of main gas pipelines. By means of economic and mathematical model of fuel energy complex of federal districts of Russia (developed by ESI SB RAS) were evaluated possible volumes of electricity generation by region and analyzes the distribution of possible shortages of electricity. It is shown that electricity shortages may occur in areas with a significant share of electrically driven compressors at the compressor stations (CS) gas mains. Failure to supply electricity to the electrically driven CS entails a reduction in the capacity of the relevant gas mains. This additional negative impact on the gas transport system can increase gas short-ages in some regions. The paper concluded that the need to reduce the dependence of the work of the Russian gas transmission network of electric power systems and the need to reduce the number of electrically driven compressor stations.

TECHNO-ECONOMIC MODELLING AND OPTIMIZATION OF DISTRIBUTED MULTI-ENERGY SYSTEMS

Pierluigi Mancarella, School of Electrical and Electronic Engineering, University of Manchester, UK

While the Smart Grid is a key concept to move towards a sustainable power system, decarbonisation of the whole energy sector requires rethinking the role of electricity in a wider context. This refers in particular to the interaction with the heating, cooling and transport sectors (which contribute substantially to greenhouse gas emissions) on the end-use side, and with various types of fuels (and natural gas in particular) on the supply-side. In this outlook, the recently emerging concept of multi-energy systems (MES), which also entail Smart Buildings, Smart Communities and Smart Cities, has the potential to unlock value somehow hidden when considering only electricity and to access new forms of flexibility that may be essential in future networks. On the other hand, significant challenges also arise in terms of the complexity of modelling and then operating and planning such an integrated system.

The aim of this talk is to present some of the research activities that are going on for a few years at the University of Manchester on this topic, in particular considering distributed multi-energy systems. The presentation will touch on: multi-energy residential load modelling; integrated load flow and optimal power flow analysis for electricity, heat and gas networks; multi-service co-optimization of distributed multi-energy systems (cogeneration, trigeneration, storage, heat pumps, etc.); and flexible expansion planning of distributed multi-energy systems in the presence of uncertainty. The geographical scope will mostly be at the level of districts and towns, with openings to city level modelling.

TECHNOLOGICAL ARCHITECTURE OF INTEGRATED ENERGY SUPPLY SYSTEMS

N.I. Voropai, V.A. Stennikov, Evgeny Alekseevich Barakhtenko, O.N. Voitov, Melentiev Energy Systems Institute of Siberian Branch of the Russian Academy of Sciences (ESI), Russia

Modern cities and industrial centers are characterized by a developed energy infrastructure including electricity, heat/cool and gas supply systems. The goal of their operation is to ensure efficient energy supply to consumers with a required level of reliability and admissible quality. The integration of the isolated systems of different levels into a unified technological complex will contribute to the implementation of new functional capabilities, application of more advanced technologies in operation, and establishment of integrated centralized distributed systems with coordinated control of their operation and active participation of consumers in the energy supply process. The paper will present a technological architecture of the integrated energy supply systems. The study revealed the problems of and conditions for the integration of energy systems. The results of the research into the integrated energy supply systems are presented. The weakest points for the development of the integrated energy supply systems are determined and recommendations for their elimination are generated.

SMART PROCUREMANT OF NATURALLY GENERATED ENERGY (SPONGE) FOR PHEV'S

Robert Shorten, School of Electrical and Electronic Engineering, University College Dublin, Ireland

We discuss a recently introduced ECO-driving concept known as SPONGE in the context of Plug-in Cars and Hybrid Electric Buses (PHEB)'s. Examples are given to illustrate the benefits of this approach to ECO-driving. This includes, financial, environmental, as well as demand side management benefits. Finally, distributed algorithms to realize SPONGE are discussed, paying attention to the privacy implications of the underlying optimization problems.

HIGH EFFICIENCY GOGENERATION PLANTS AND LARGE SCALE HEAT STORAGES – IREN EXPERIENCE

Enrico Pochettino, Gruppo IREN, Italy

IREN will illustrate its experience in complex and flexible district heating network in the North of Italy. The Turin district heating network, the biggest of Italy, couple 3 CHP CCGT plants with an electrical capacity of 1.200 MW with a set of high pressure heat storages. The system avoids the utilization of heat-only-boilers and enhance the flexibility of power plants for electricity dispatching.