



# **IREN experience in cogeneration and heat storages**

Torino Nord Power Plant - October 24, 2016



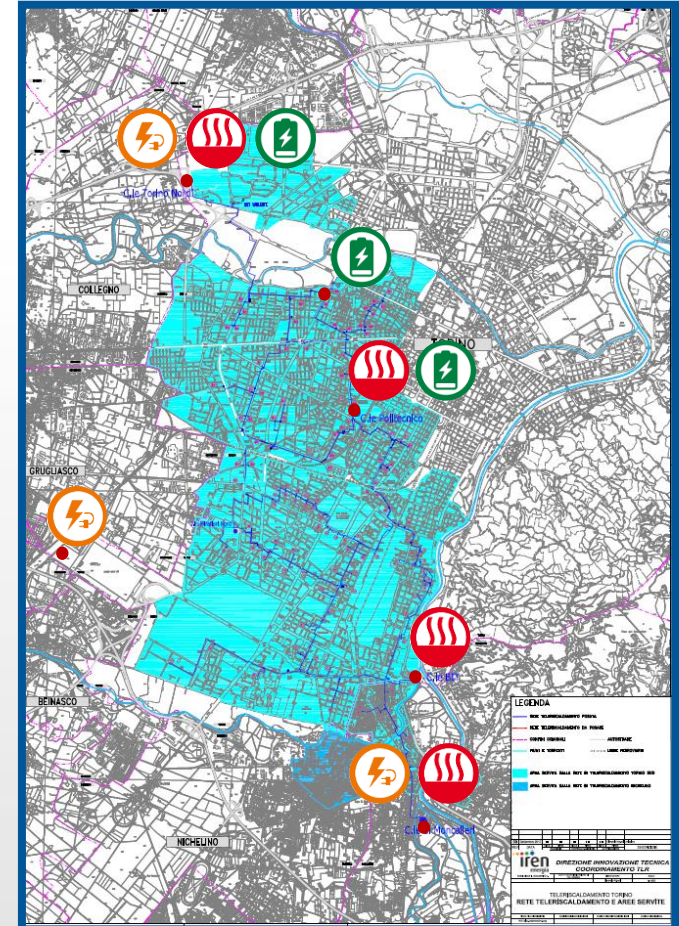
## District Heating and Cogeneration – the Turin case



# Torino District Heating system

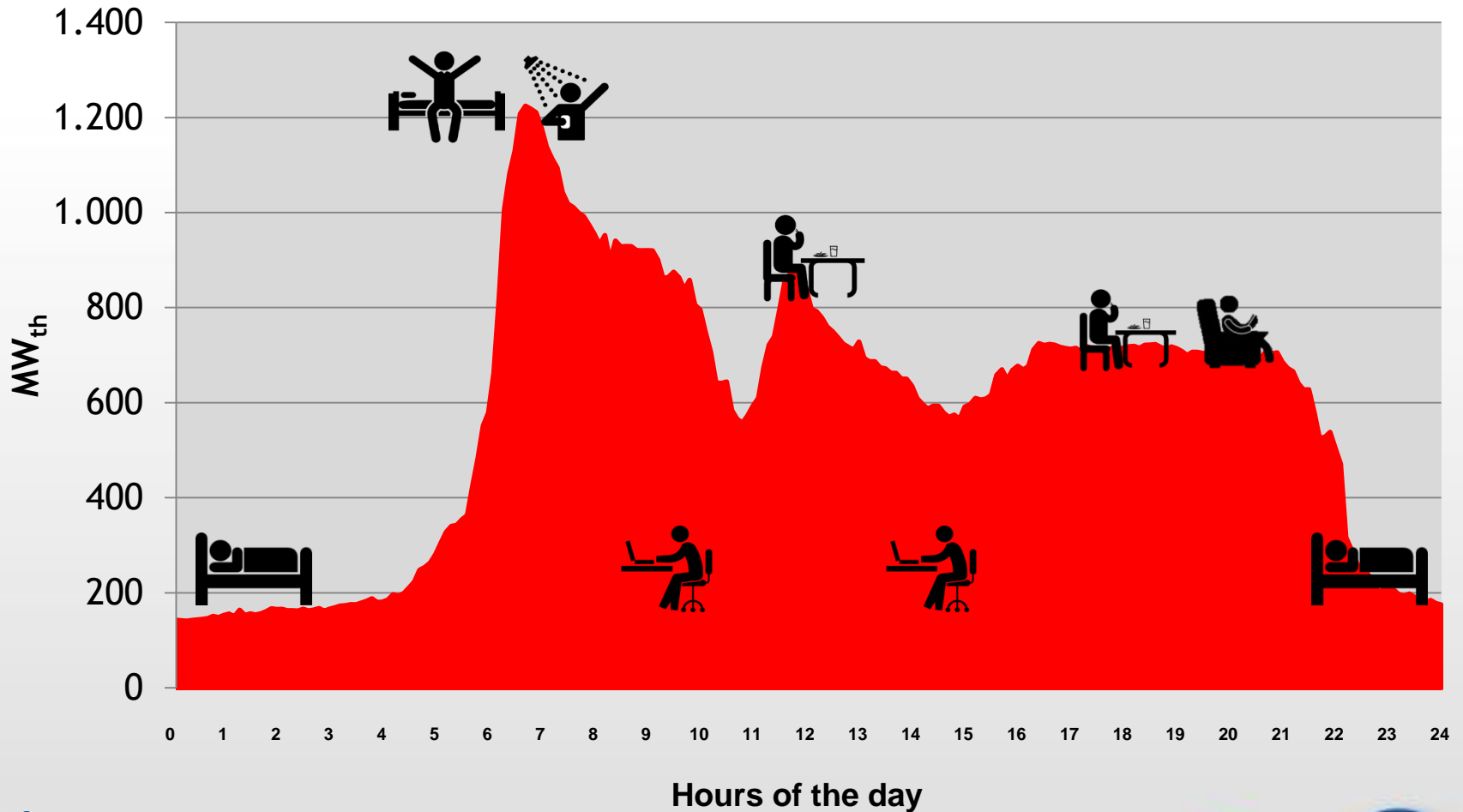
District Heating started in Torino in the 80s and operates with **superheated water** at a delivery temperature normally between 105°C and 120°C, based on a typical interconnected grid at the transport level and a radial grid at the distribution level.

- **528 km** of double pipeline
- **5.700** DH sub-stations
- **580.000** served inhabitants
- **1.300 MW** thermal peak demand
- **2.000 GWh** total thermal energy produced
- **over 98%** production from CHP

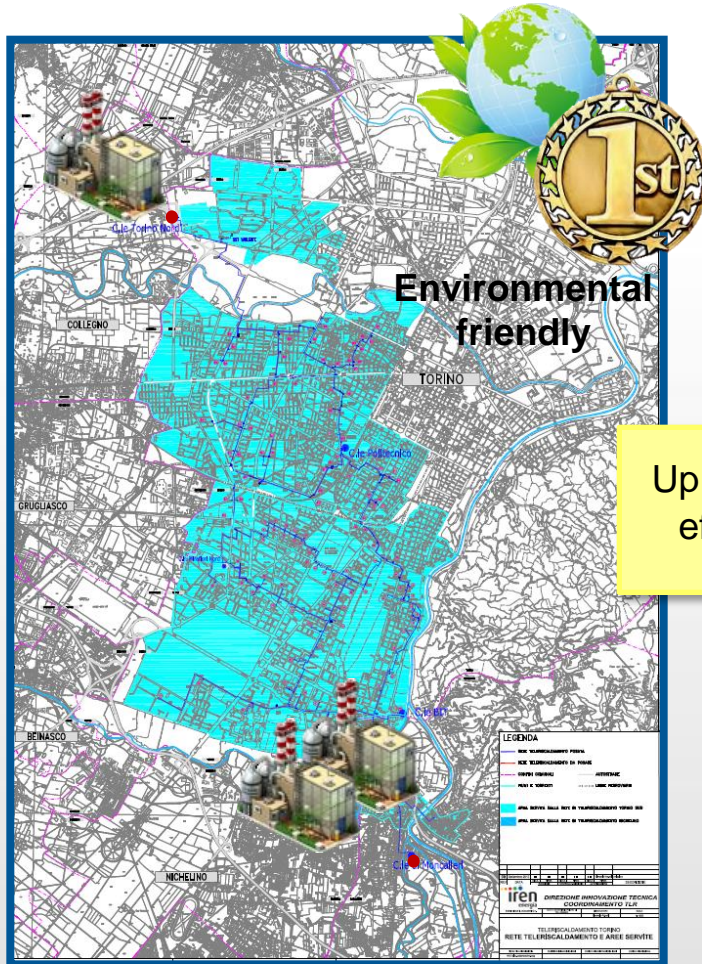


With **58 mln m<sup>3</sup>** heated, Torino is the most district heated city in Italy nowadays.

# The behavior of the heat demand



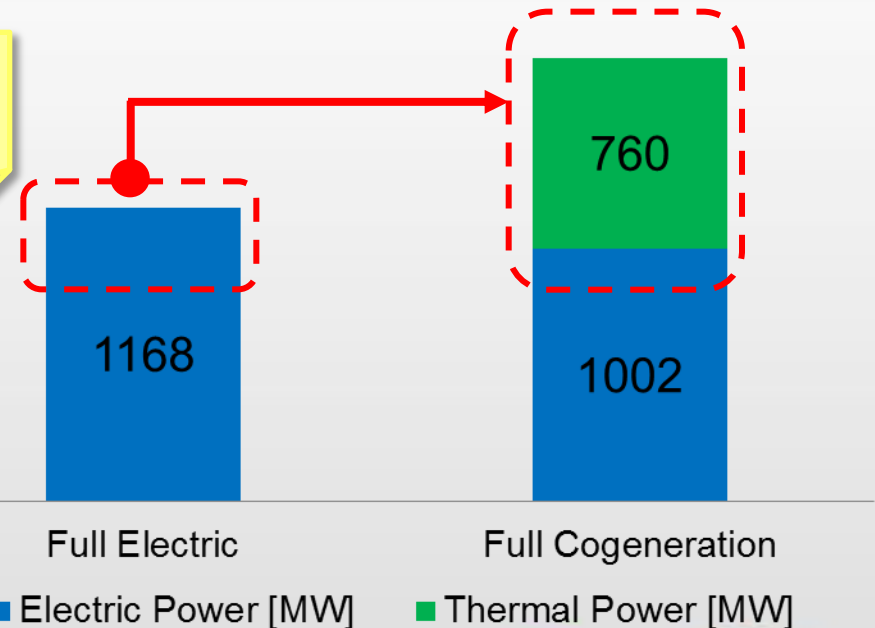
# Cogeneration Combined Cycle Gas Turbine Plants



- Moncalieri 3°GT (2005)
- Moncalieri RPW2°GT (2008)
- Torino Nord (2012)

All equipped with **DeNO<sub>x</sub>** a **CO** catalyst systems

Up to **90 %** efficiency



# Why cogeneration?

**Cogeneration:** the process whereby a single fuel source, such as natural gas, is used to produce simultaneously **both electrical** and **thermal** energy.



$\eta = 45\%$   
Conventional plants

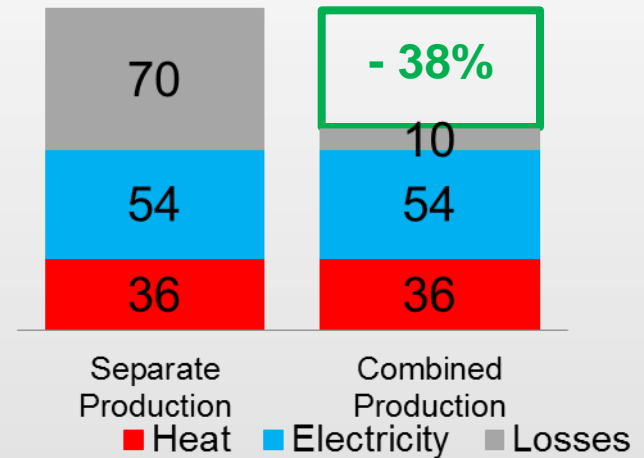
$\eta = 90\%$   
Heat Only Boilers

Separate production  
 $\eta = 56\%$   
Overall efficiency

**+34%**  
efficiency

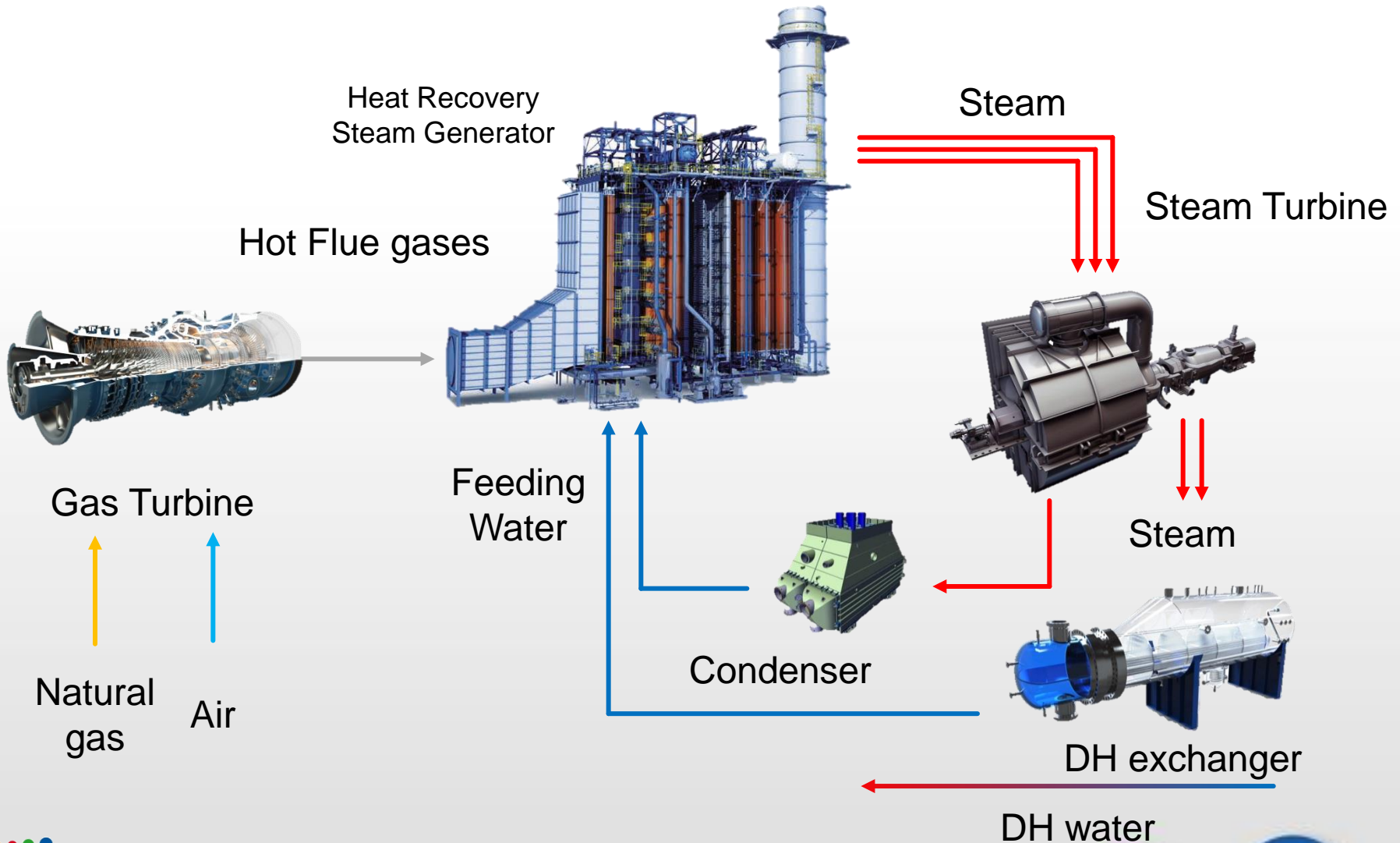
$\eta = 56 - 58\%$   
Full Electric  
 $\eta = 85 - 90\%$   
Full Cogeneration

**Cogeneration**  
Combined Cycle  
Gas Turbine Units

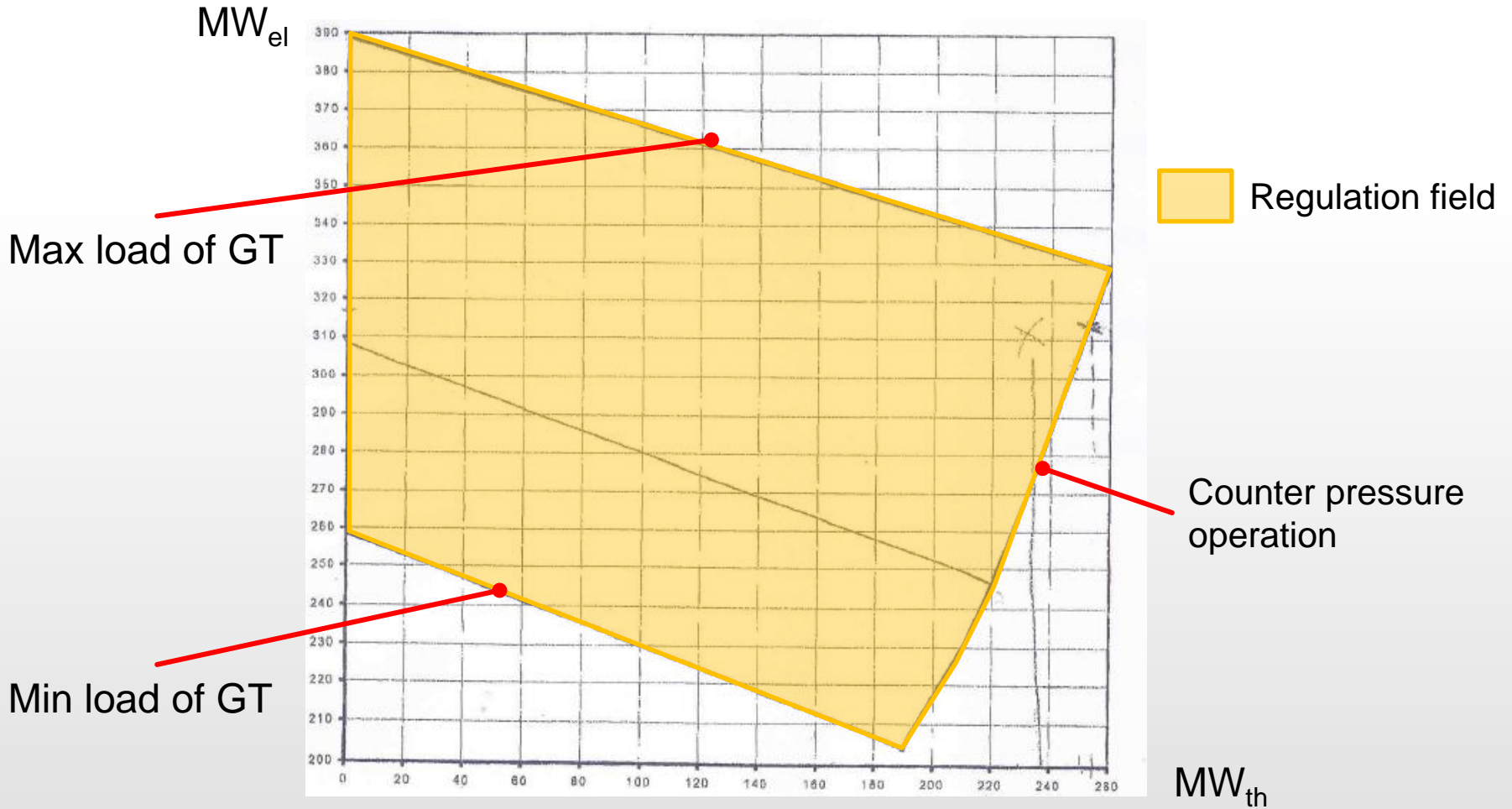




# How a CCGT CHP unit works



# How a CCGT CHP unit works





# Environmental benefits

- Optimization of fuel consumption
- Reduction of emissions
- Higher total efficiency than building (90%) or individual (80-85%) localized boilers
- Economical benefits and subsidies

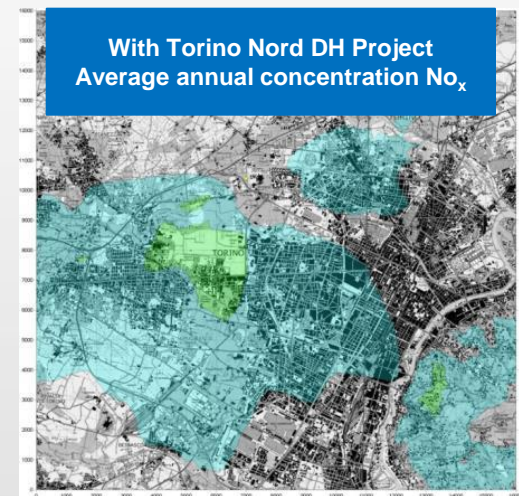
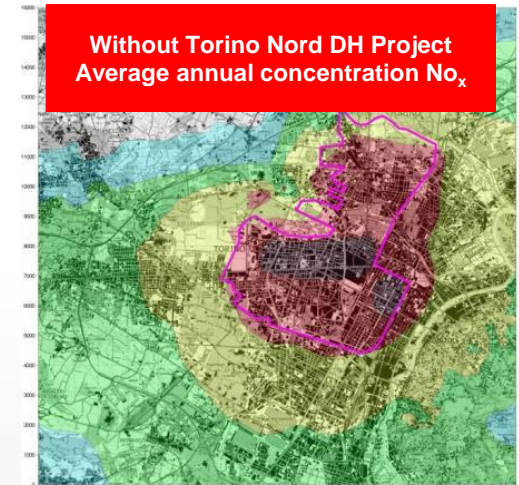
## Savings

- **220.000** TOE

- **1.000.000** tons of CO<sub>2</sub>

- **1.830** tons of NO<sub>x</sub>

Equivalent to – **780.000** cars



# Environmental friendly

Plant type	Emission level associated with BAT (mg/Nm <sup>3</sup> )		O <sub>2</sub> level (%)	BAT options to reach these levels
	NO <sub>x</sub>	CO		
<b>Gas turbines</b>				
New gas turbines	20 – 50	5 – 100	5	Dry low NO <sub>x</sub> premix burners or SCR
DLN for existing gas turbines	20 – 75	5 – 100	15	Dry low NO <sub>x</sub> premix burners as retrofitting packages if available
Existing gas turbines	50 – 90*	30 – 100	15	Water and steam injection or SCR

European Reference Document on Best Available Techniques for  
**Large Combustion Plants**

	NO <sub>x</sub>	CO
Combustion plants other than gas turbines and gas engines	100	100
Gas turbines (including CCGT)	50 <sup>(1)</sup>	100
Gas engines	75	100

Note:

<sup>(1)</sup> For single cycle gas turbines having an efficiency greater than 35 % – determined at ISO base load conditions – the emission limit value for NO<sub>x</sub> shall be  $50x\eta/35$  where  $\eta$  is the gas turbine efficiency at ISO base load conditions expressed as a percentage.

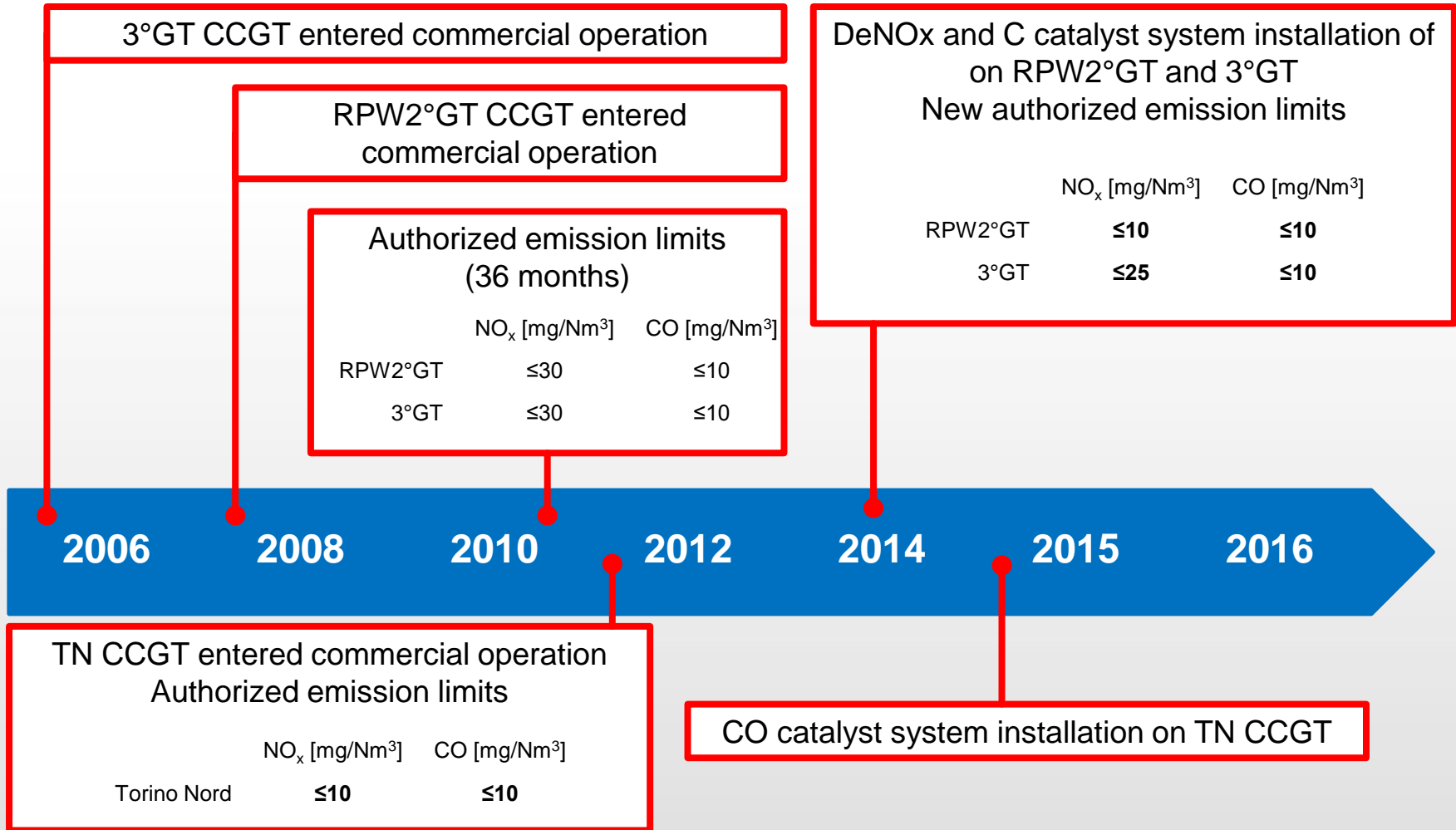
**Directive 2010/75/EU**

	NO <sub>x</sub>	CO
Gas Turbines (included CCGT) installed before 2013	50	100
Gas Turbines (included CCGT) installed after 2013	30	100

**Italian D.Lgs. 152/2006**  
amended with D.Lgs 46/2014



# IREN virtuosity

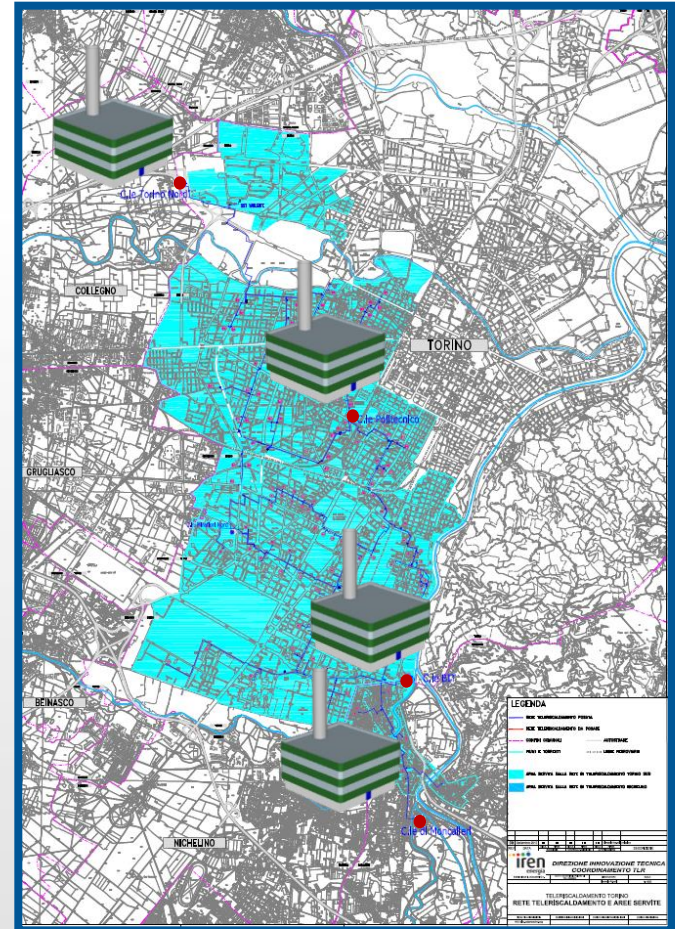
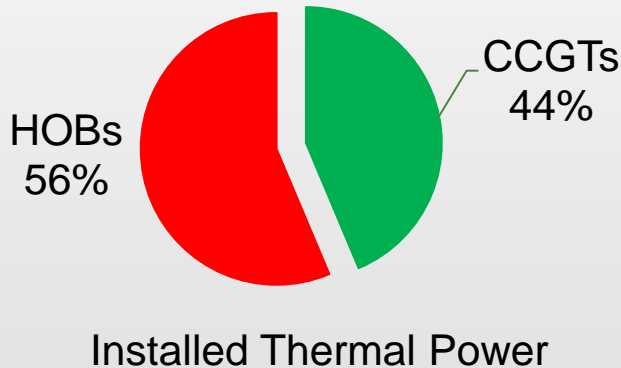


# Heat Only Boilers

Heat Only Boilers (HOB) are used for **integration** and are a **redundancy** of CCGTs.

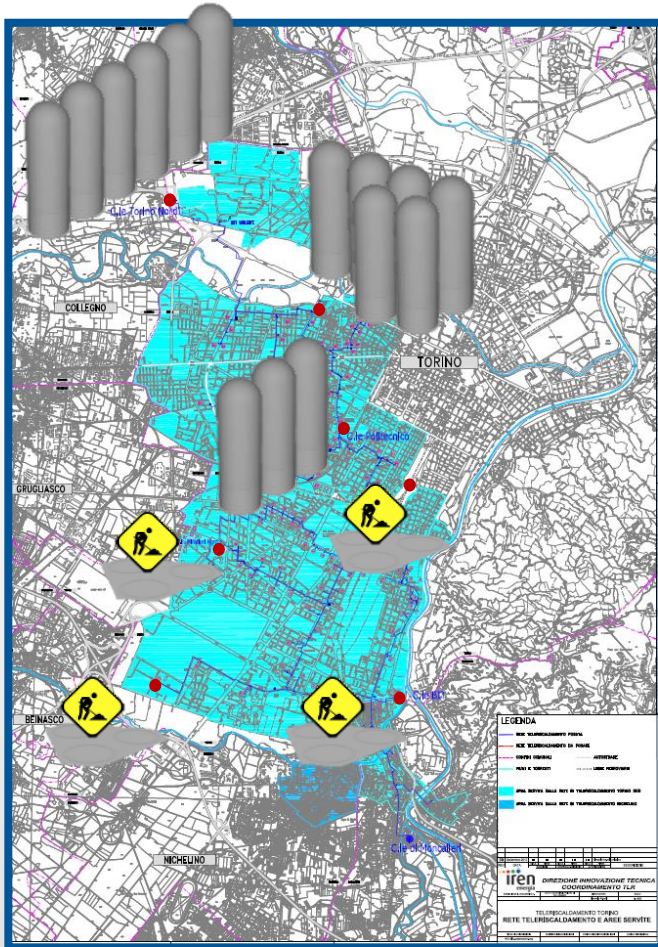
4 Plants with HOBs are distributed all around the city in **strategic places**.

**1.000 MW** overall HOBs power





# Heat storage systems



**3** Heat storage systems in Turin

**12.500 m<sup>3</sup>** Overall capacity

**178 GWh** energy stored in thermal season 2013/14, the **10 %** of the entire energy produced



## Ongoing Heat Storage Systems

BIT	Oct. 2016	+ 2.500 m <sup>3</sup>
Mirafiori Nord	Oct. 2018	+ 2.500 m <sup>3</sup>
San Salvario	Oct. 2018	+ 2.500 m <sup>3</sup>
Mirafiori Sud	Oct. 2018	+ 2.500 m <sup>3</sup>



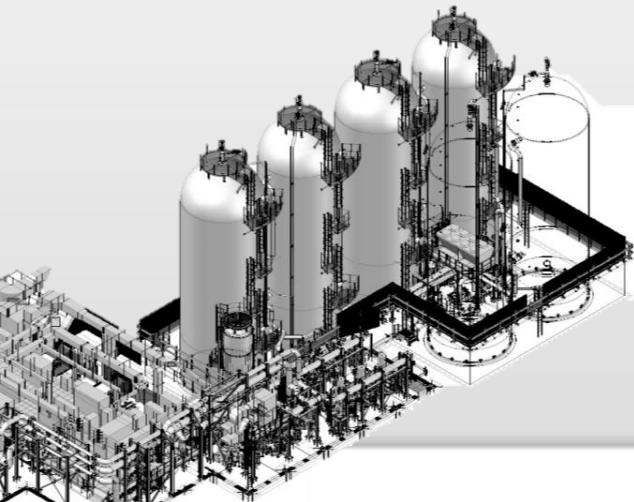


# Heat storage systems

**Store** thermal energy produced by CCGT plants and use it during the hours of maximum load of the district heating system, **reducing** the use of **HOBs**



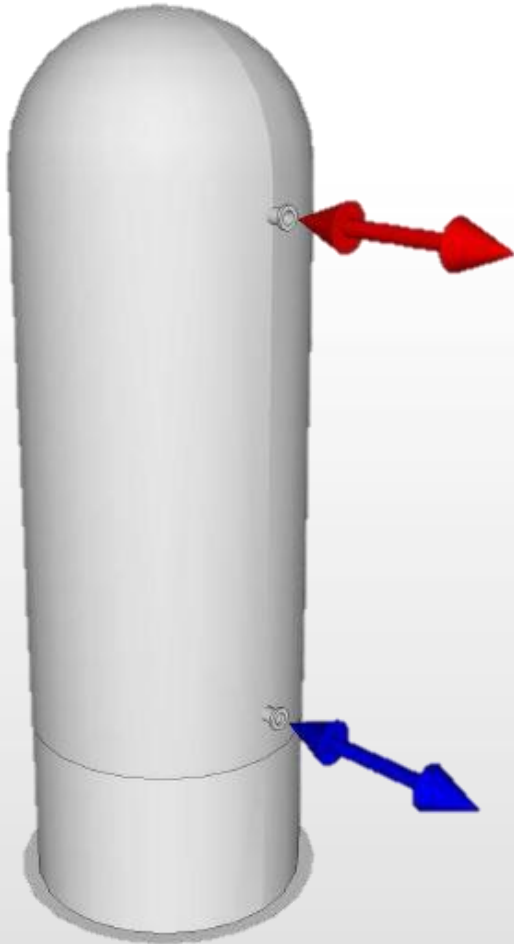
Operated from  
**remote control rooms**



Based on the service needs, the storage tanks may be filled and emptied **several times a day**



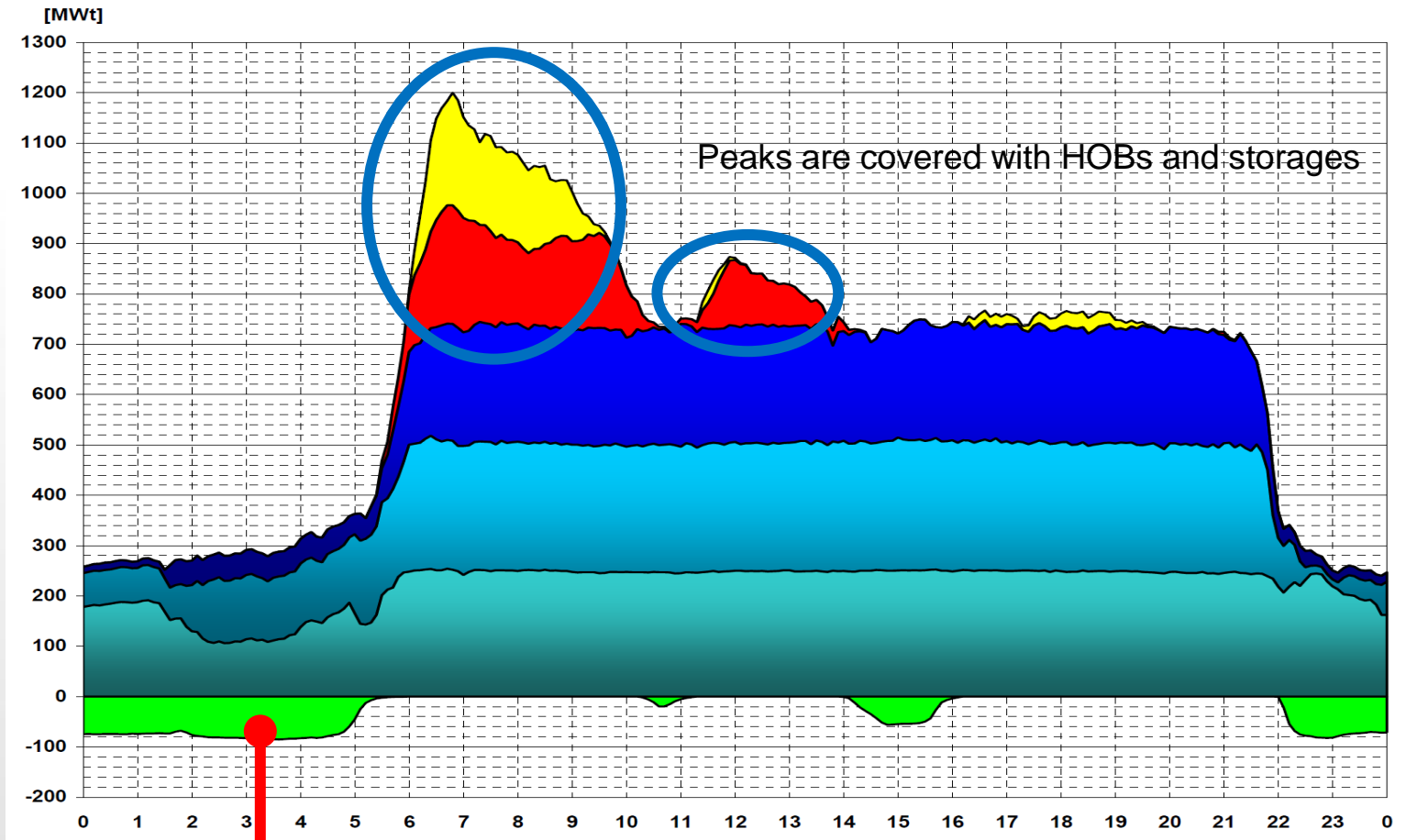
# Heat storage systems



- **Reliability** of thermal energy supply
  - **Flexibility** of CHP plant for electricity dispatching
  - **Efficiency** of the system and of CCGTs
  - Heated volumes
- 
- **Fast charge** of the storage
  - **Rapid start up** in terms of available power for DH
  - Highly **flexible** control of the heat flow
- 
- Heated generation installed capacity
  - **Emissions** (– 1 TOE/m<sup>3</sup> per year)
  - Operation and maintenance **costs**



# Coverage of DH load with CCGT CHP units and storages in early 2013

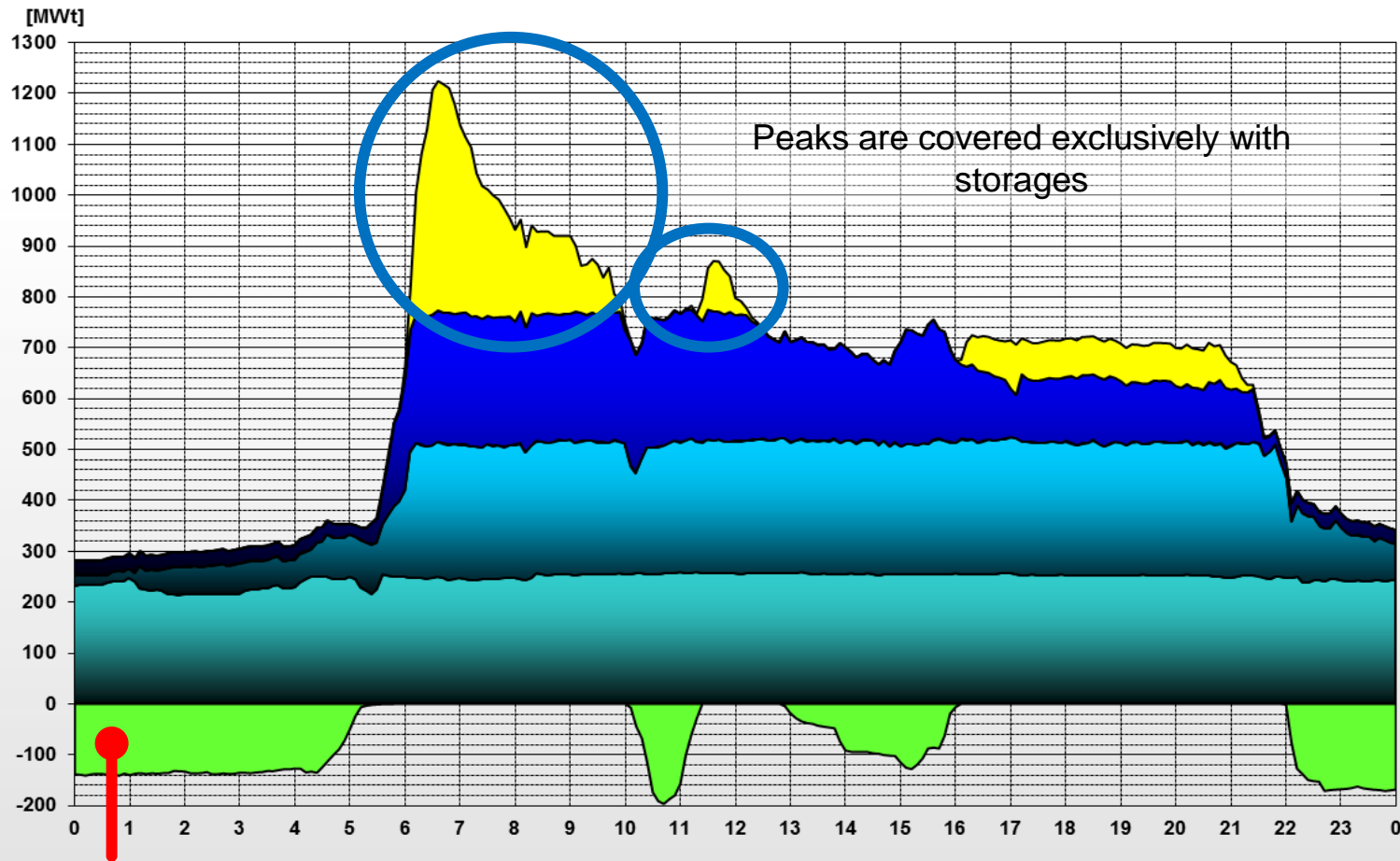


Peaks are covered with HOBs and storages

Storages are charged during the night

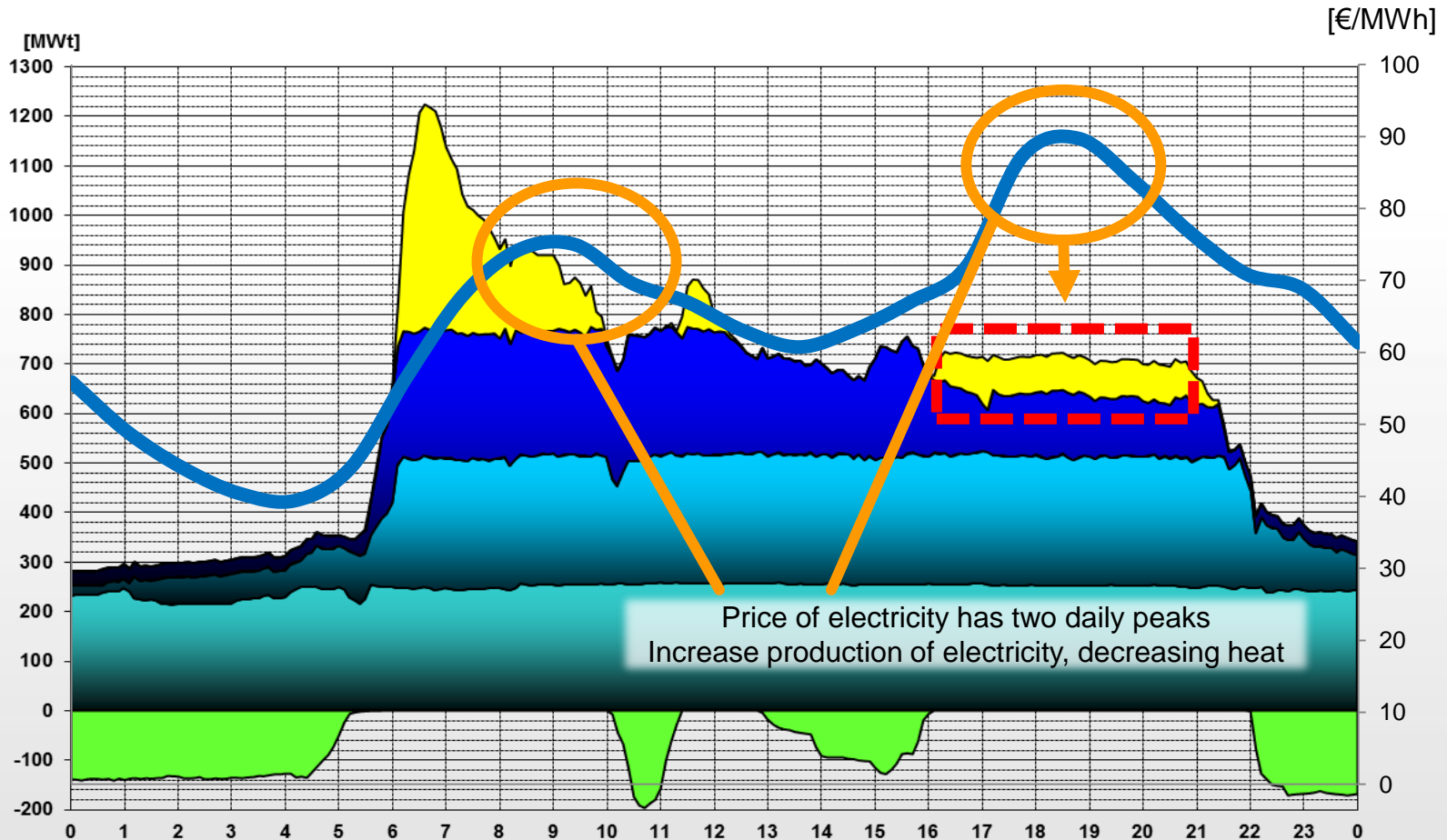


# Coverage of DH load with CCGT CHP units and storages in late 2013



Maximization of CCGTs efficiency during the night thanks to the heat storage system

# Flexible use of cogeneration plant





# Torino Nord Power Plant





Torino Nord Power Plant

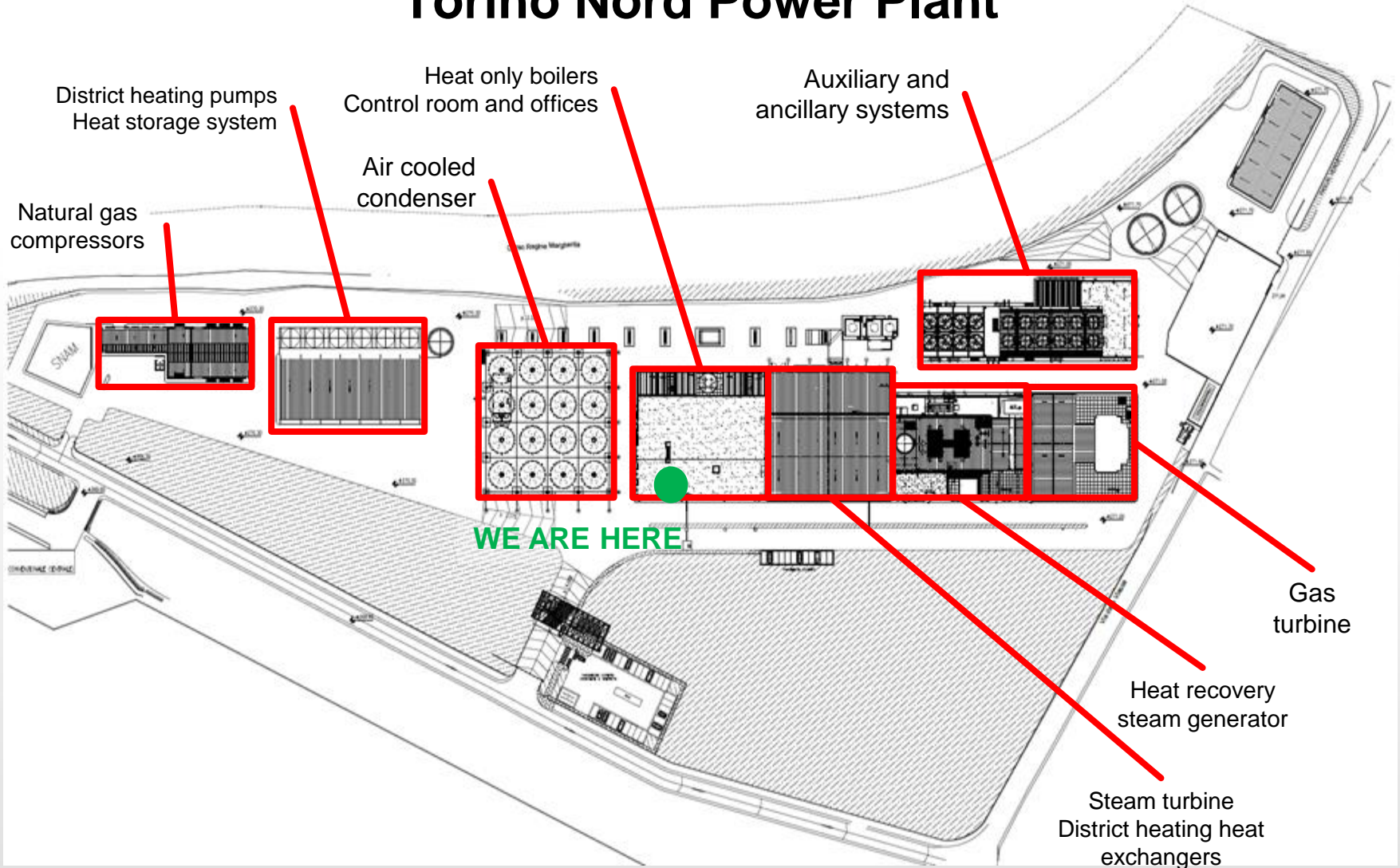


## Torino Nord Power Plant – Some numbers

<b>CCGT CHP unit</b>	<b>Full electric mode</b>	<b>Full cogeneration mode</b>
Electrical power	395 MW	357 MW
Thermal power	0 MW	230 MW
Efficiency	56 %	87 %
Fuel	Natural gas	
<b>Integration and backup boilers</b>		
Thermal power	3 x 113 MW	
Efficiency	92%	
Fuel	Natural gas	
<b>Heat storage system</b>		
Number of tanks	6	
Overall volume	5.000 m <sup>3</sup>	
Stored energy	280 MWh	



# Torino Nord Power Plant





# Enjoy the visit!





IREN Group



# IREN Group



**IREN** is one of the **biggest multiutility** company playing on the Italian scene. It is listed on the Italian Stock Exchange.

IREN is structured as an industrial parent company with its main corporate offices in **Reggio Emilia** and its operating units in **Genoa, Parma, Piacenza** and **Turin**.

The Group actively contributes to the growth of the territory in which it operates, tangibly promoting economic development and innovation.



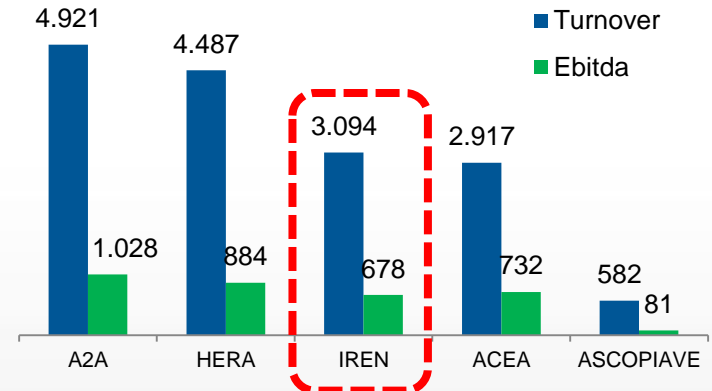
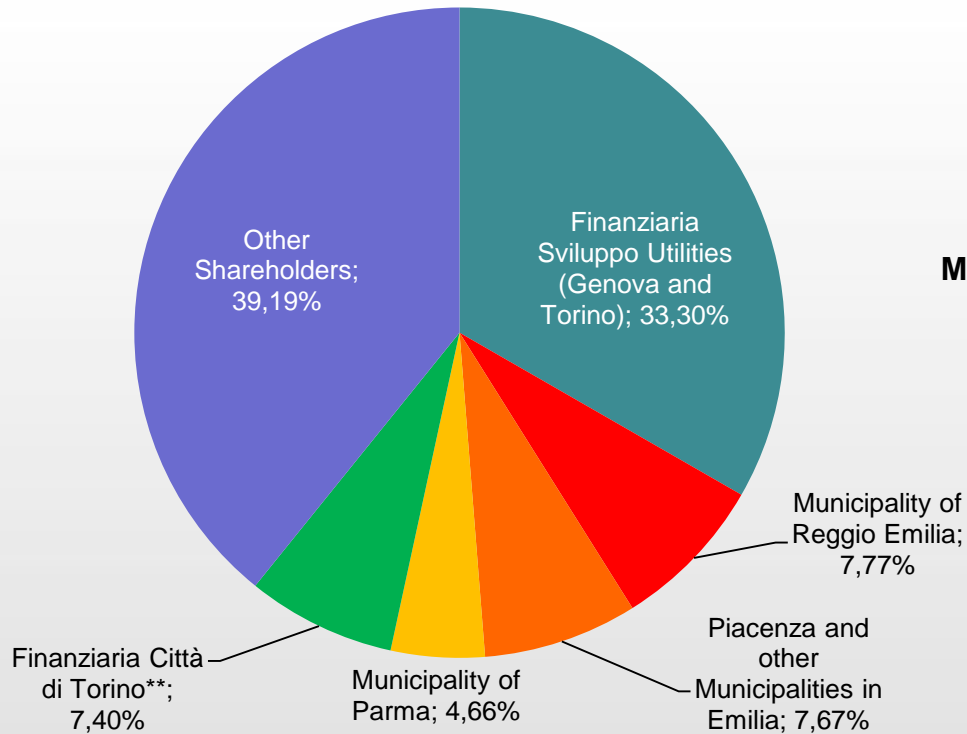
We are more than **6.200** employees on 8 provinces



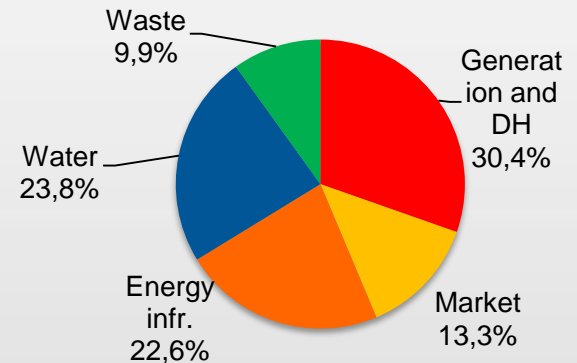
# Shareholding structure and ranking in Italy's utility market

Current market capitalization\*

**1,85 €bIn (2,08 \$bIn)**



Major local listed utility ranking in 2015 (€mIn)



EBITDA breakdown in 2015

(\*) Sept 16, 2016  
 (\*\*) Pref. stocks - No voting rights



# IREN Key Drivers



## ELECTRICAL ENERGY

2.7 GW of installed capacity  
8.1 TWh produced in 2015  
12.4 TWh sold in 2015  
4.0 TWh distributed



## WATER SERVICES

Integrated water cycle management to 2.4 mln inhabitants  
162 mcm distributed in 2015  
24,500 km of pipelines



## DISTRICT HEATING

6 co-generation plants  
825 km of DH pipelines  
2,9 TWh heat produced in 2015  
1st operator in Italy with 760,000 served inhabitants



## NATURAL GAS

1.2 mln final users  
9,000 km network  
1 regasification LNG terminal,  
3.75 bln m<sup>3</sup>/y of authorized capacity  
(41,7% IREN stake)



## ENVIRONMENT

3 WTE managed  
1,7 mln tons treated in 2015  
Waste collection in more than 100 towns



## OTHER SERVICES

133,000 street lighting point  
19,000 traffic lights  
Facility management and global service

# Cogeneration, thermal and thermoelectric production

**1<sup>st</sup>** operator in Italy in District Heating

Over **82** mln m<sup>3</sup> of DH heated volume

Up to **90%** Efficiency in CHP

Over **2.100 MW<sub>el</sub>**  
and **2.300 MW<sub>th</sub>**

**14.000 m<sup>3</sup>** heat storage capacity

**1.000.000 tons** of CO<sub>2</sub> emissions avoided through CHP/DH



Politecnico HOB Plant

Torino Nord 400 MW CCGT Plant



Moncalieri 2x400 MW CCGT Plant

Martinetto heat storage system





# Emilia Romagna and Genova District Heating systems



**Reggio Emilia**

- Heated volume: **13,3 mln m<sup>3</sup>**
- Network length: **219 km**
- N° of DH sub-stations: **1.954**
- Served inhabitants: **130.000**
- Total thermal capacity: **310 MW<sub>t</sub>**



**Parma**

- Heated volume: **5,6 mln m<sup>3</sup>**
- Network length: **98 km**
- N° of DH sub-stations: **710**
- Served inhabitants: **50.000**
- Total thermal capacity: **175 MW<sub>t</sub>**



**Piacenza**

- Heated volume: **1,4 mln m<sup>3</sup>**
- Network length: **22 km**
- N° of DH sub-stations: **121**
- Served inhabitants: **10.000**
- Total thermal capacity: **39 MW<sub>t</sub>**



**Genova**

- Heated volume: **3,6 mln m<sup>3</sup>**
- Network length: **10 km**
- N° of DH sub-stations: **39**
- Served inhabitants: **20.000**
- Total thermal capacity: **71 MW<sub>t</sub>**

In 2015, almost the entire production (over 80%) of heat was granted by high efficiency CHP plants allowing important environmental benefits.