DEVELOPMENT OF DISTRICT HEATING LINKED TO THE COGENERATION POWER PLANTS IN TURIN AREA

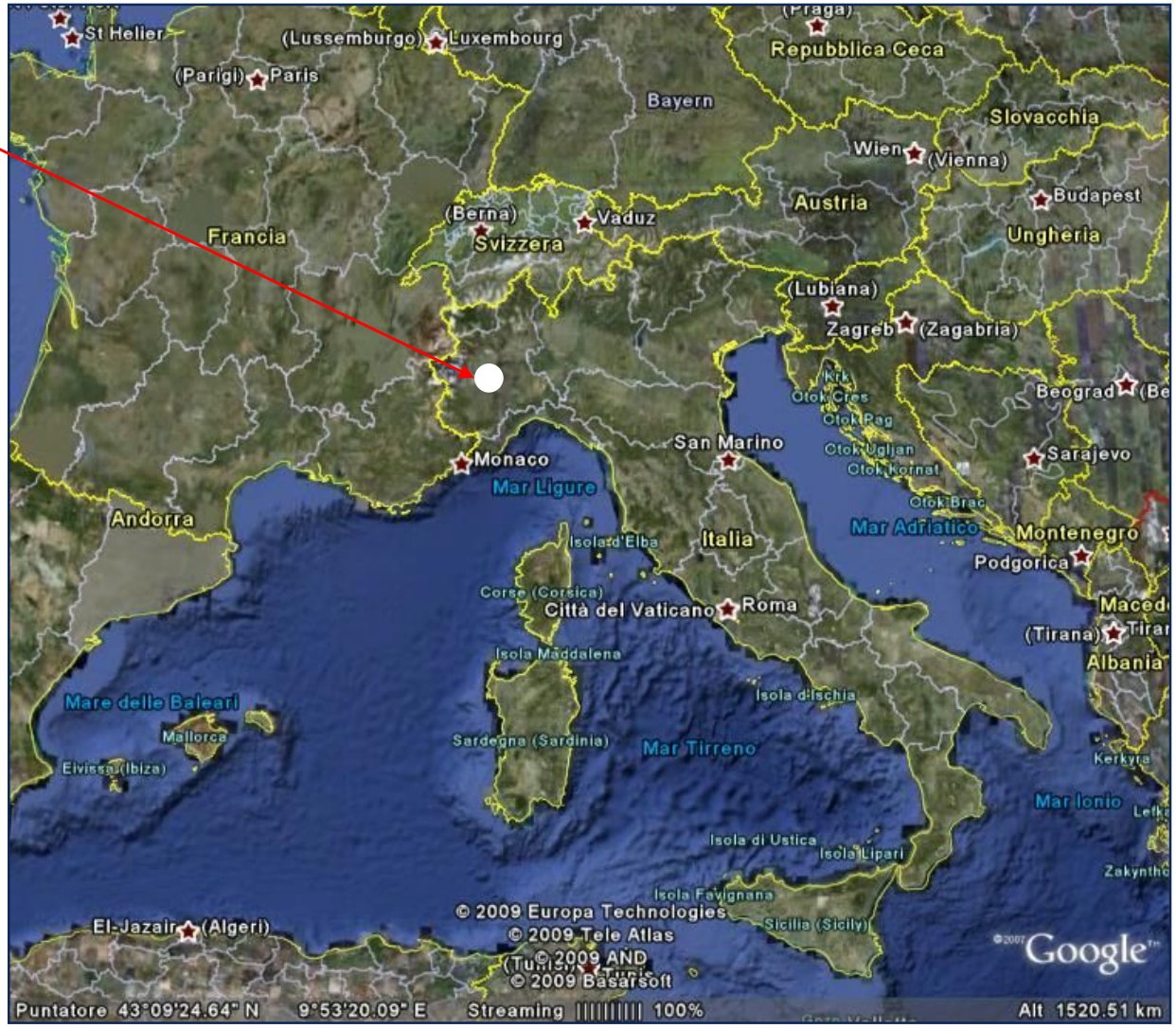
The 34th Congress of Euroheat & Power

Venice, 26/05/2009

Antonio ROSSI – Gianpaolo ROBUSTI

2 WHERE IS TURIN?

TURIN



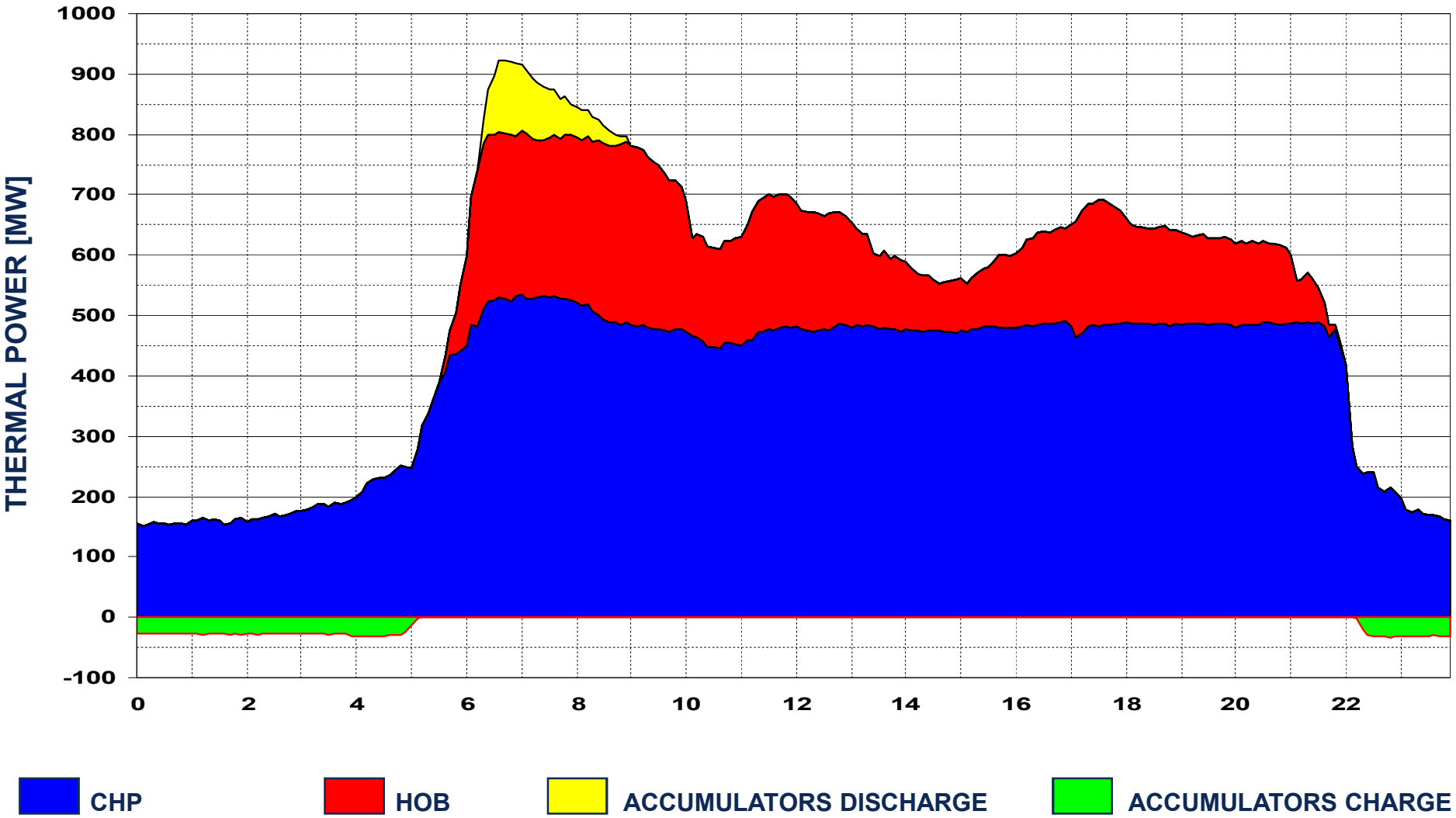
3 DISTRICT HEATING: EXISTING SITUATION

4 EXISTING SITUATION – GENERAL DATA

	SPACE HEATED	CITIZENS	NOMINAL THERMAL PEAK	THERMAL ENERGY	PIPELINES	HEAT EXCHANGER
	Mm^3	num	MW	GWh/y	km	num
SOUTH TURIN DH	27,0	250.000	675	1.140	230	2.050
CENTRE TURIN DH	9,0	100.000	225	390	85	700
LE VALLETTE DH	3,0	50.000	60	175	30	300
IRIDE DH SYSTEMS	39,0	400.000	960	1.705	345	3.050
NORTH-WEST AREA DH	3,6	20.000	85	100	55	400
NORTH-EAST AREA DH	1,4	10.000	35	45	30	290
OTHER DH SYSTEMS	5,0	30.000	120	145	85	690
TOTAL DH	44,0	430.000	1.080	1.850	430	3.740

5 SOUTH AND CENTRE TURIN DH - DAILY THERMAL LOAD

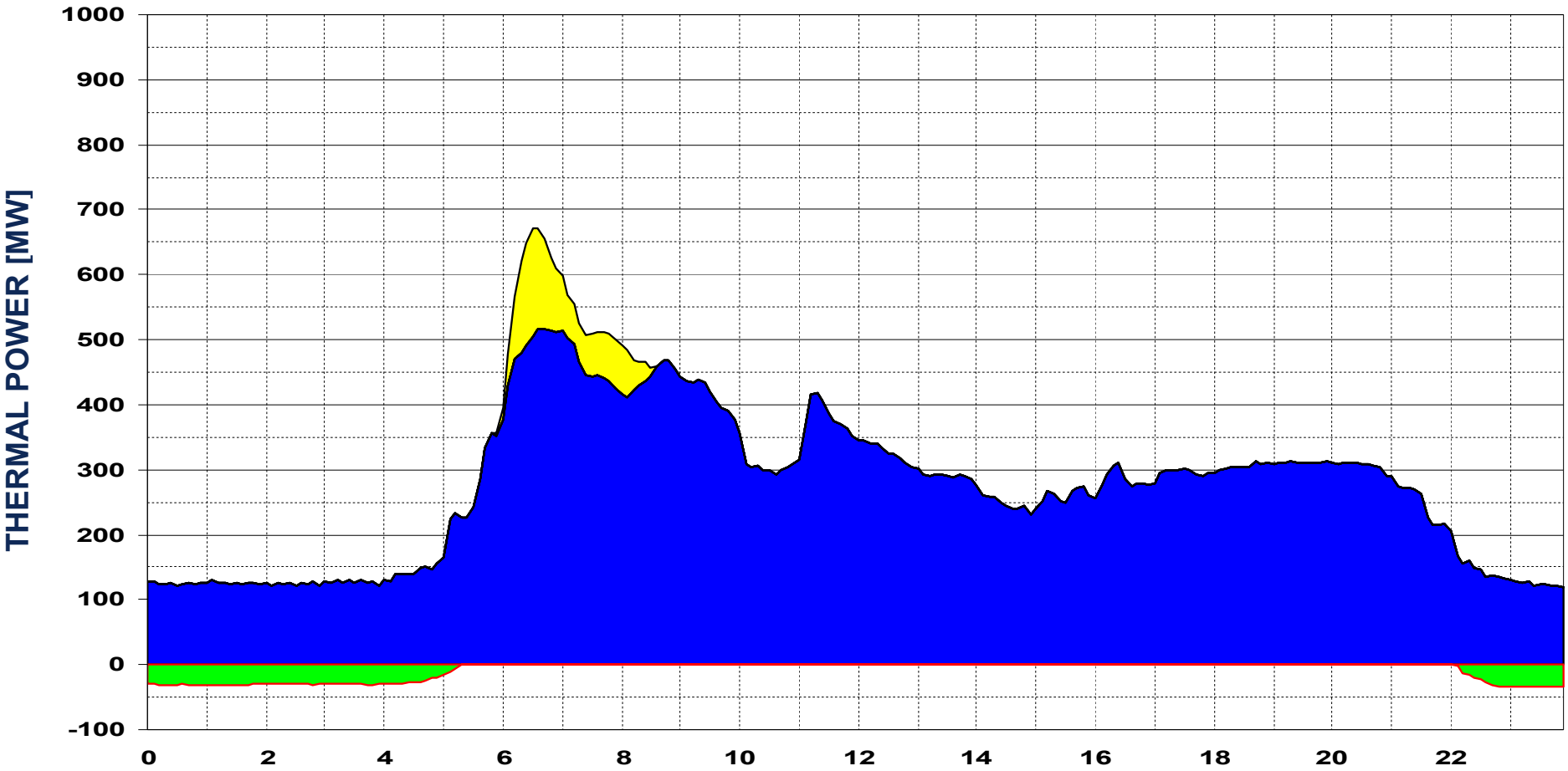
13th JENUARY 2009 – THERMAL SEASON PEAK



IRIDE ENERGIA

6 SOUTH AND CENTRE TURIN DH - DAILY THERMAL LOAD

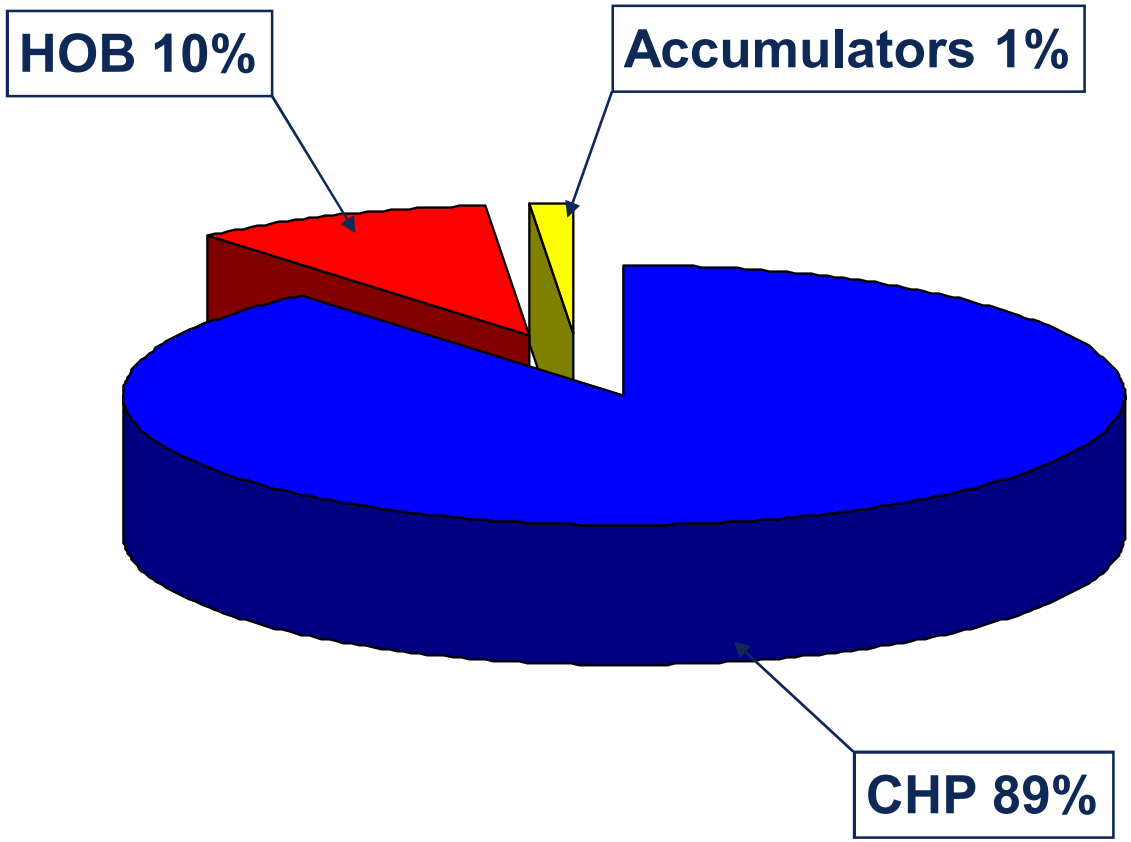
8th MARCH 2009



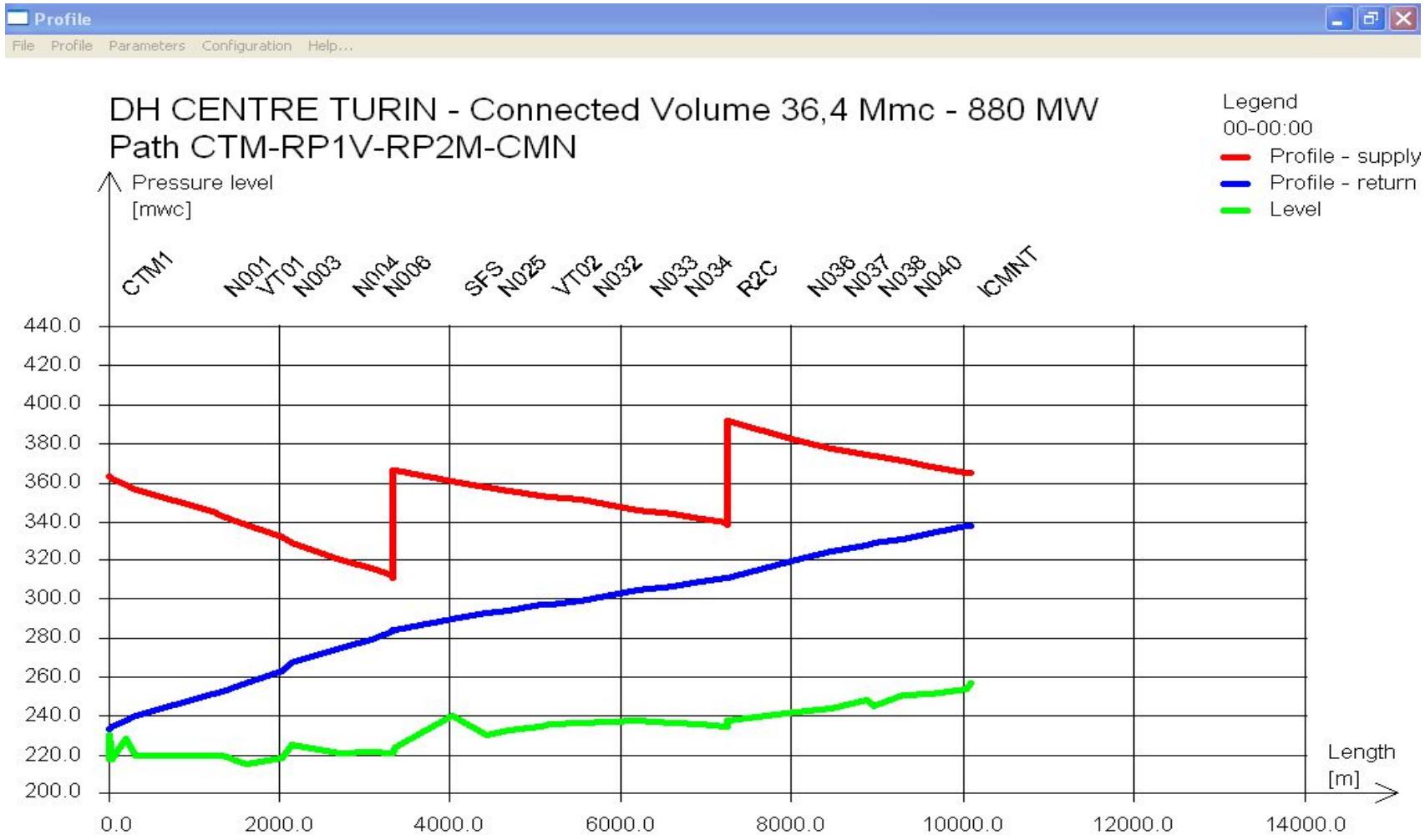
CHP HOB ACCUMULATORS DISCHARGE ACCUMULATORS CHARGE

IRIDE ENERGIA

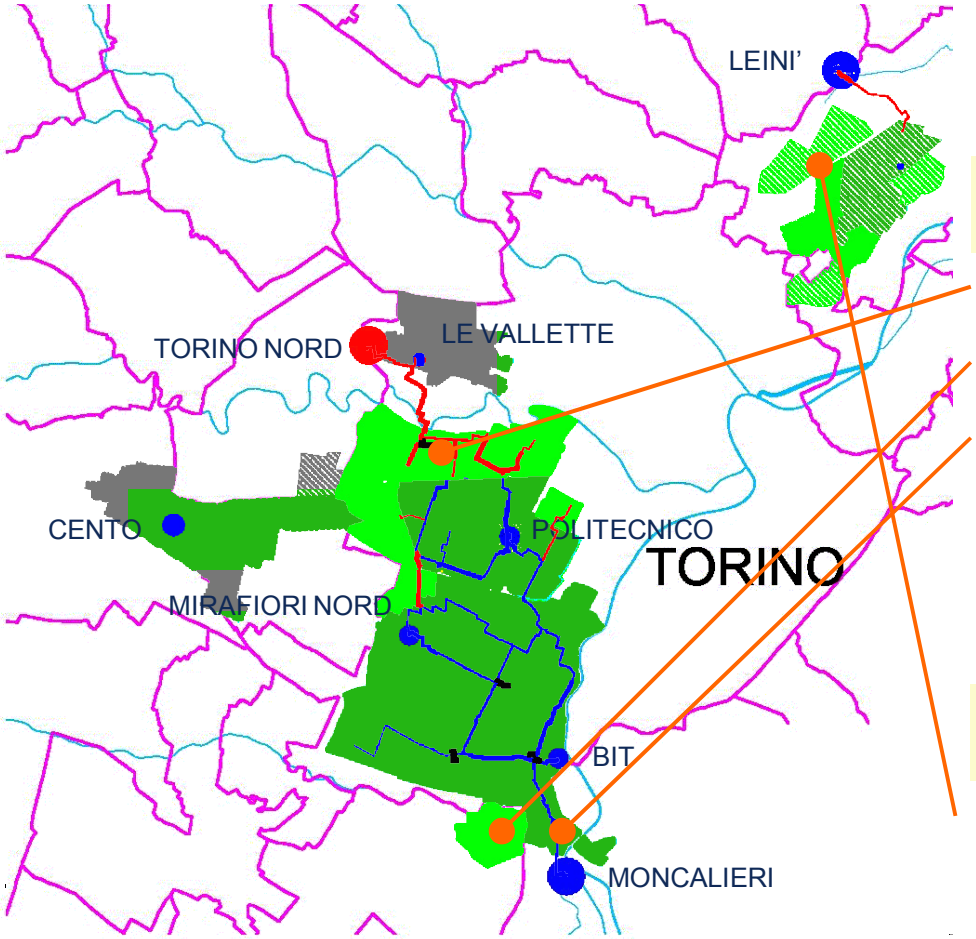
SOUTH AND CENTRE TURIN DH - THERMAL ENERGY



SOUTH AND CENTRE TURIN DH – PRESSURE LEVEL



DISTRICT HEATING PLANNING: STEP 0



SPACE HEATED

EXISTING IRIDE DH:	39,0 Mm^3
NORTH TURIN:	15,0 Mm^3
NICHELINO DH:	2,0 Mm^3
MONCALIERI DH:	0,5 Mm^3
IRIDE DH STEP 0:	**56,5 Mm^3**

EXISTING OTHER DH:	5,0 Mm^3
NEW NORTH-EAST DH:	3,5 Mm^3
OTHER DH STEP 0:	**8,5 Mm^3**

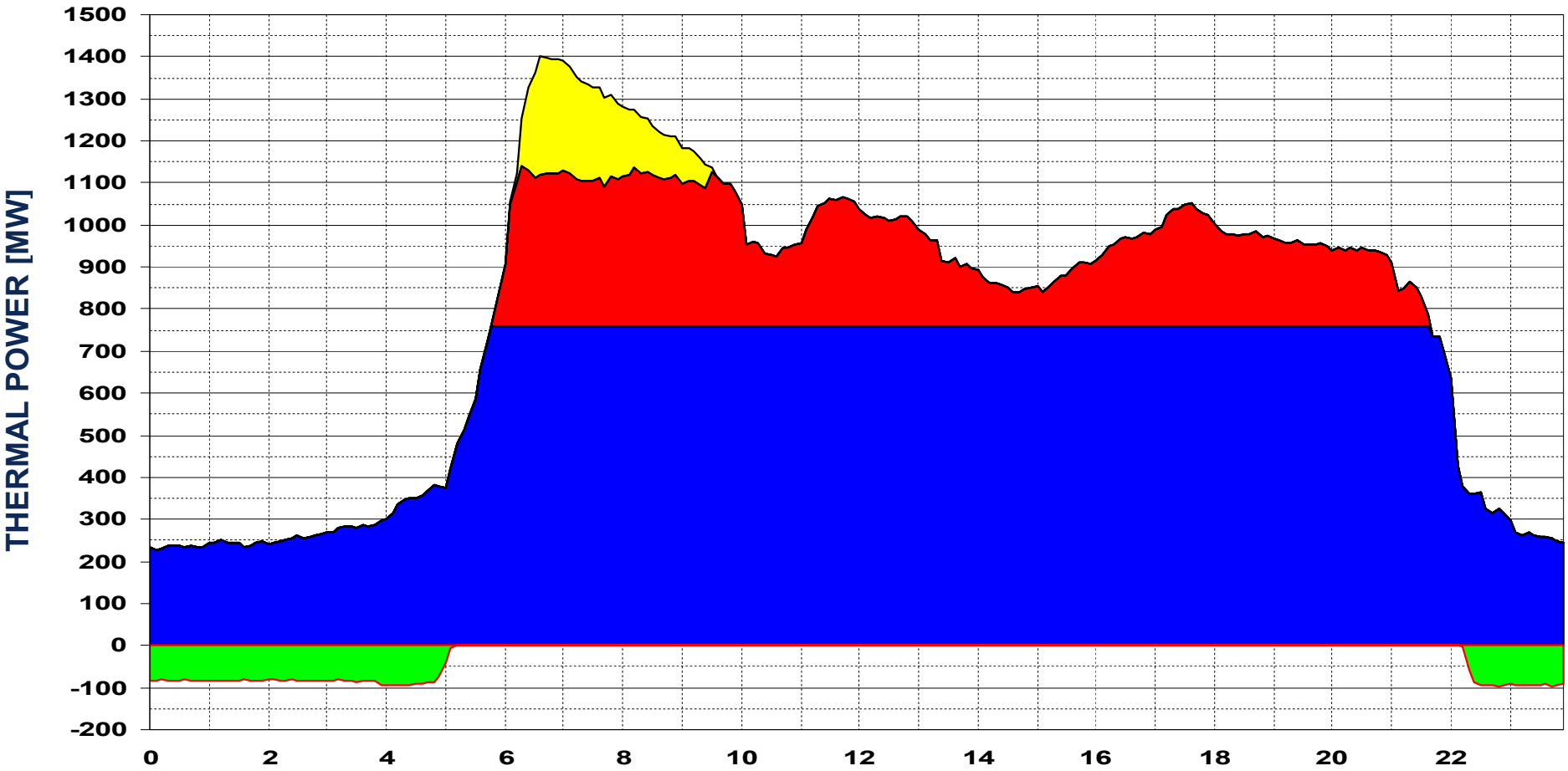
TOTAL DH SYSTEMS STEP 0: 65,0 Mm^3

STEP 0 – GENERAL DATA

	SPACE HEATED	CITIZENS	NOMINAL THERMAL PEAK	THERMAL ENERGY	PIPELINES	HEAT EXCHANGER
	Mm³	num	MW	GWh/y	km	num
EXISTING IRIDE DH	39,0	400.000	960	1.705	345	3.050
NORTH TURIN DH	15,0	150.000	375	620	150	1.550
NICHELINO DH	2,0	20.000	50	80	20	400
MONCALIERI DH	0,5	5.000	13	20	5	100
IRIDE DH STEP 0	56,5	575.000	1.398	2.425	520	5.100
EXISTING OTHER DH	5,0	30.000	120	145	85	690
NEW NORTH-EAST AREA DH	3,5	20.000	87	105	40	500
OTHER DH STEP 0	8,5	50.000	207	250	125	1.190
TOTAL DH STEP 0	65,0	625.000	1.605	2.675	645	6.290

IRIDE DH SYSTEM STEP 0 - DAILY THERMAL LOAD

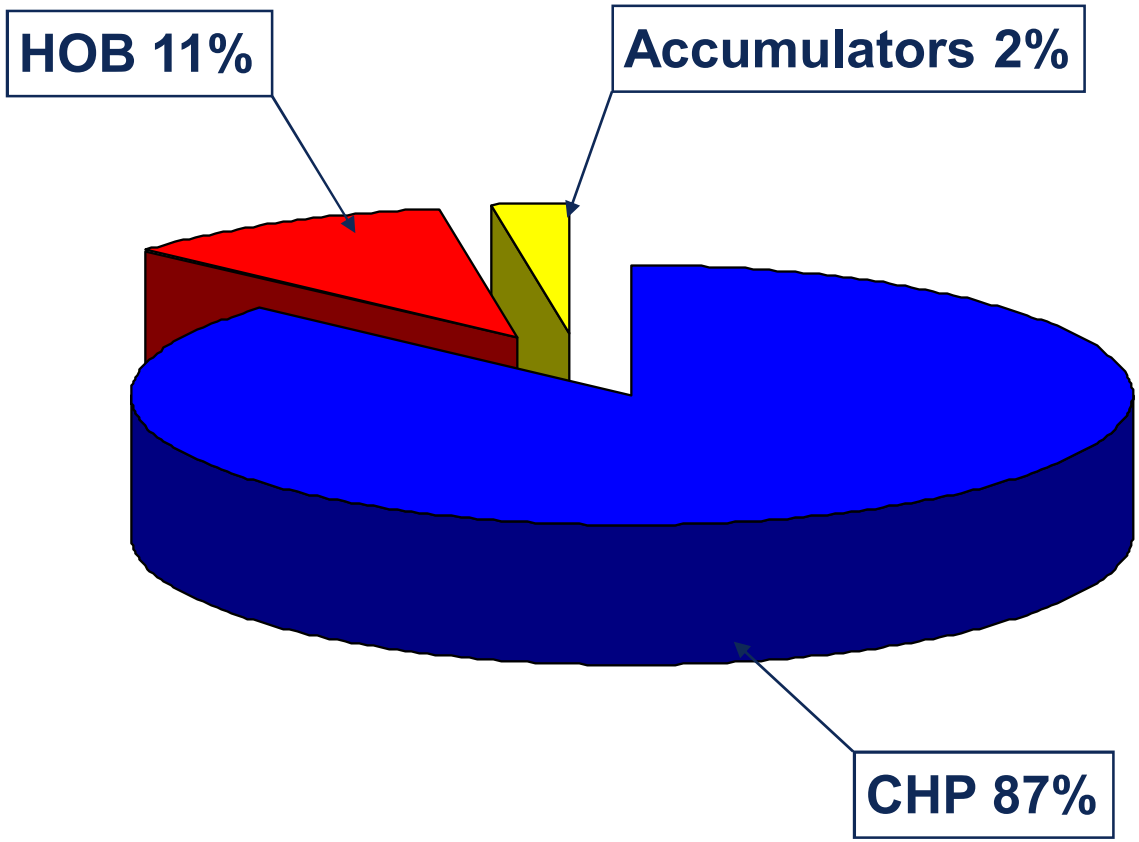
THERMAL SEASON PEAK



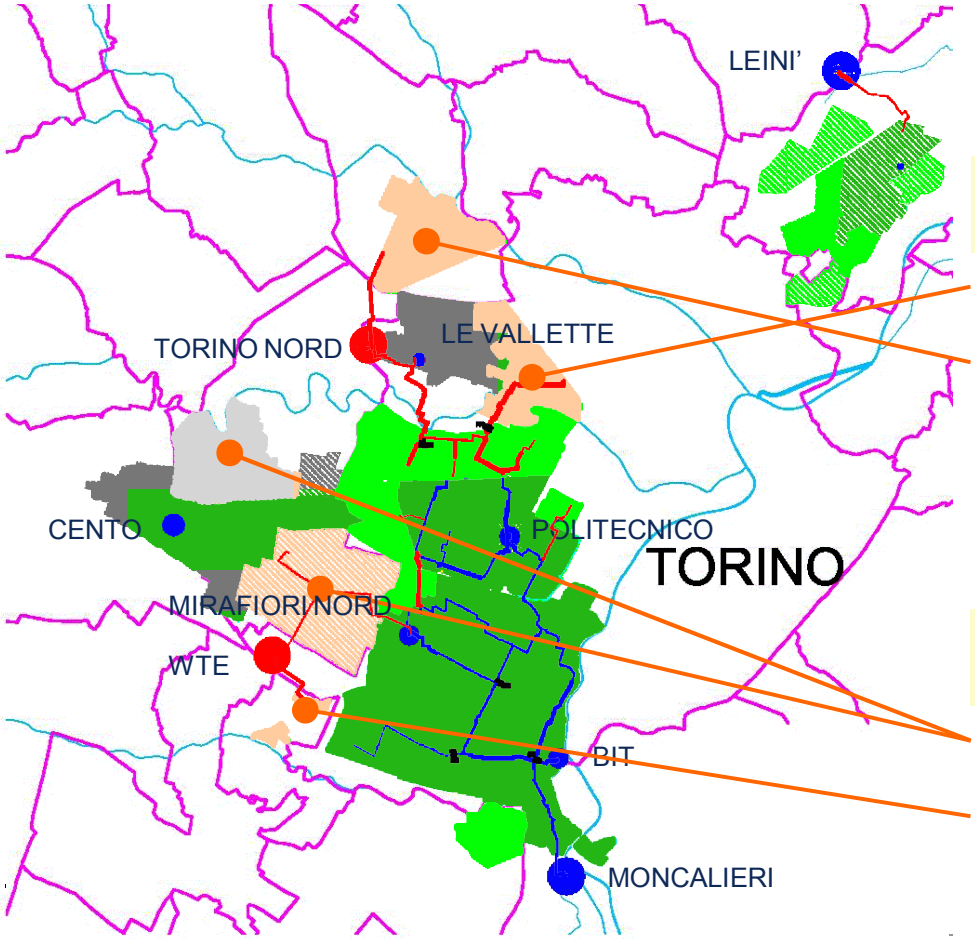
CHP | HOB | ACCUMULATORS DISCHARGE | ACCUMULATORS CHARGE

IRIDE ENERGIA

IRIDE DH STEP 0 - THERMAL ENERGY



DISTRICT HEATING PLANNING: STEP 1



SPACE HEATED

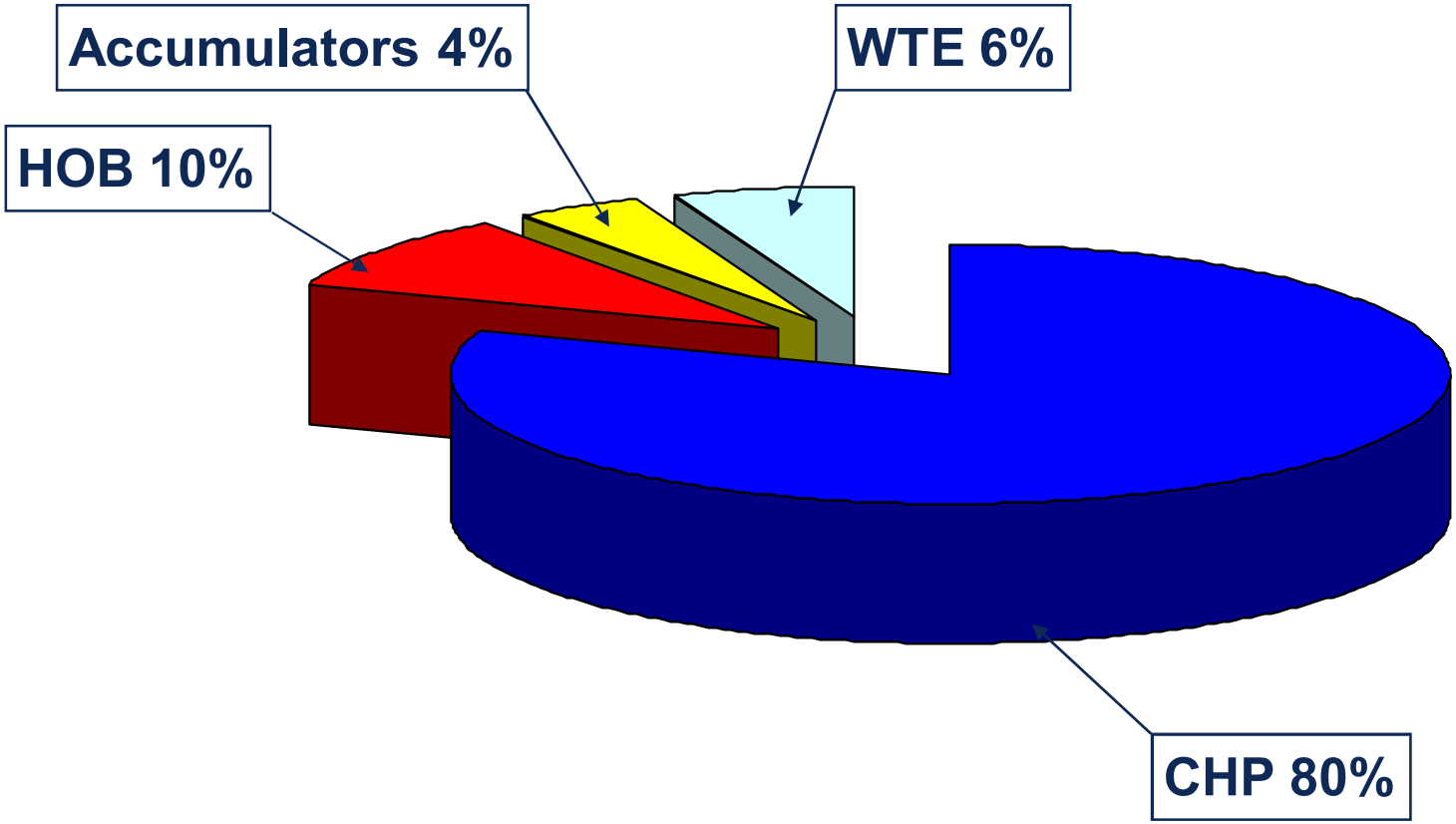
IRIDE DH STEP 0:	**56,5 Mm³**
BORGO VITTORIA DH:	**3,0 Mm³**
VENARIA REALE DH:	**1,2 Mm³**
IRIDE DH STEP 1:	**60,7 Mm³**
OTHER DH STEP 0:	**8,5 Mm³**
NEW NORTH-WEST AREA:	**4,3 Mm³**
BEINASCO DH:	**0,5 Mm³**
OTHER DH STEP 1:	**13,3 Mm³**

TOTAL DH SYSTEMS STEP 1: 74,0 Mm³

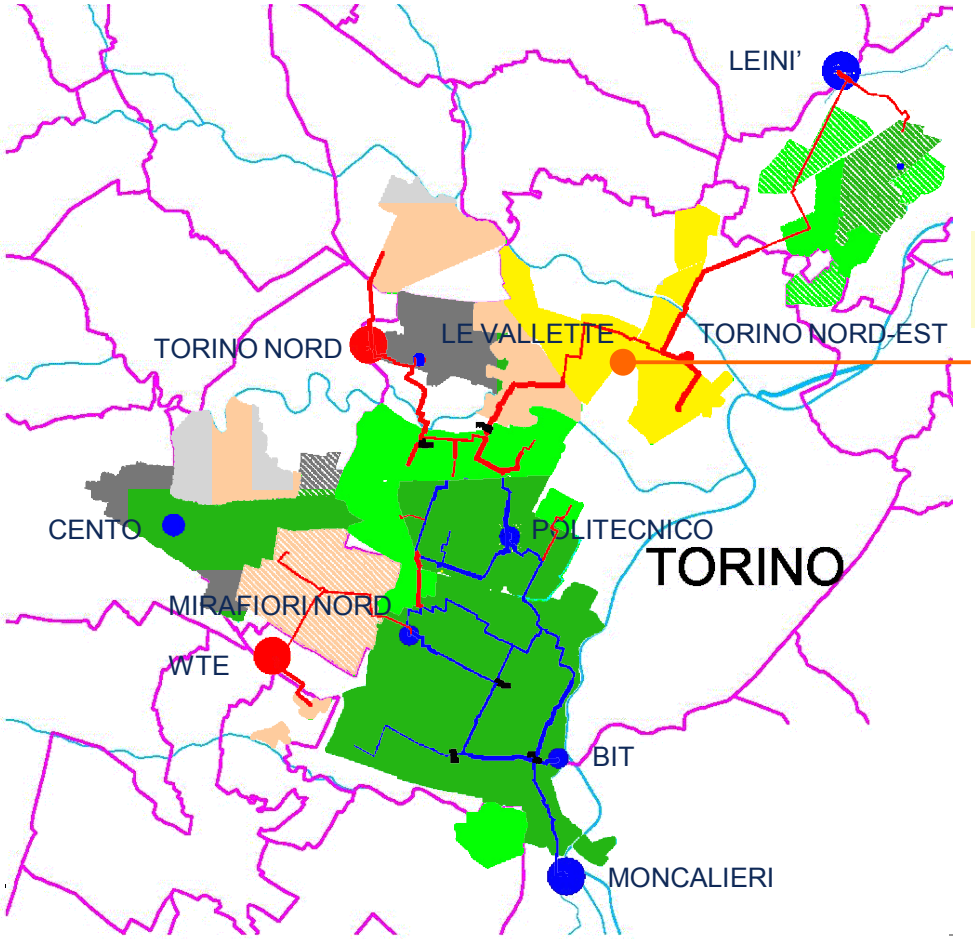
STEP 1 – GENERAL DATA

	SPACE HEATED	CITIZENS	NOMINAL THERMAL PEAK	THERMAL ENERGY	PIPELINES	HEAT EXCHANGER
	Mm³	num	MW	GWh/y	km	num
IRIDE DH STEP 0	56,5	575.000	1.398	2.425	520	5.100
BORGO VITTORIA DH	3,0	30.000	72	120	35	600
VENARIA REALE DH	1,2	10.000	30	50	15	250
IRIDE DH STEP 1	60,7	615.000	1.500	2.595	570	5.950
OTHER DH STEP 0	8,5	50.000	207	250	125	1.190
NEW NORTH-WEST AREA DH	4,3	30.000	107	132	47	700
BEINASCO DH	0,5	5.000	11	18	8	100
OTHER DH STEP 1	13,3	85.000	325	400	180	1.990
TOTAL DH STEP 1	74,0	700.000	1.825	2.995	750	7.940

IRIDE DH STEP 1 - THERMAL ENERGY



DISTRICT HEATING PLANNING: STEP 2



SPACE HEATED

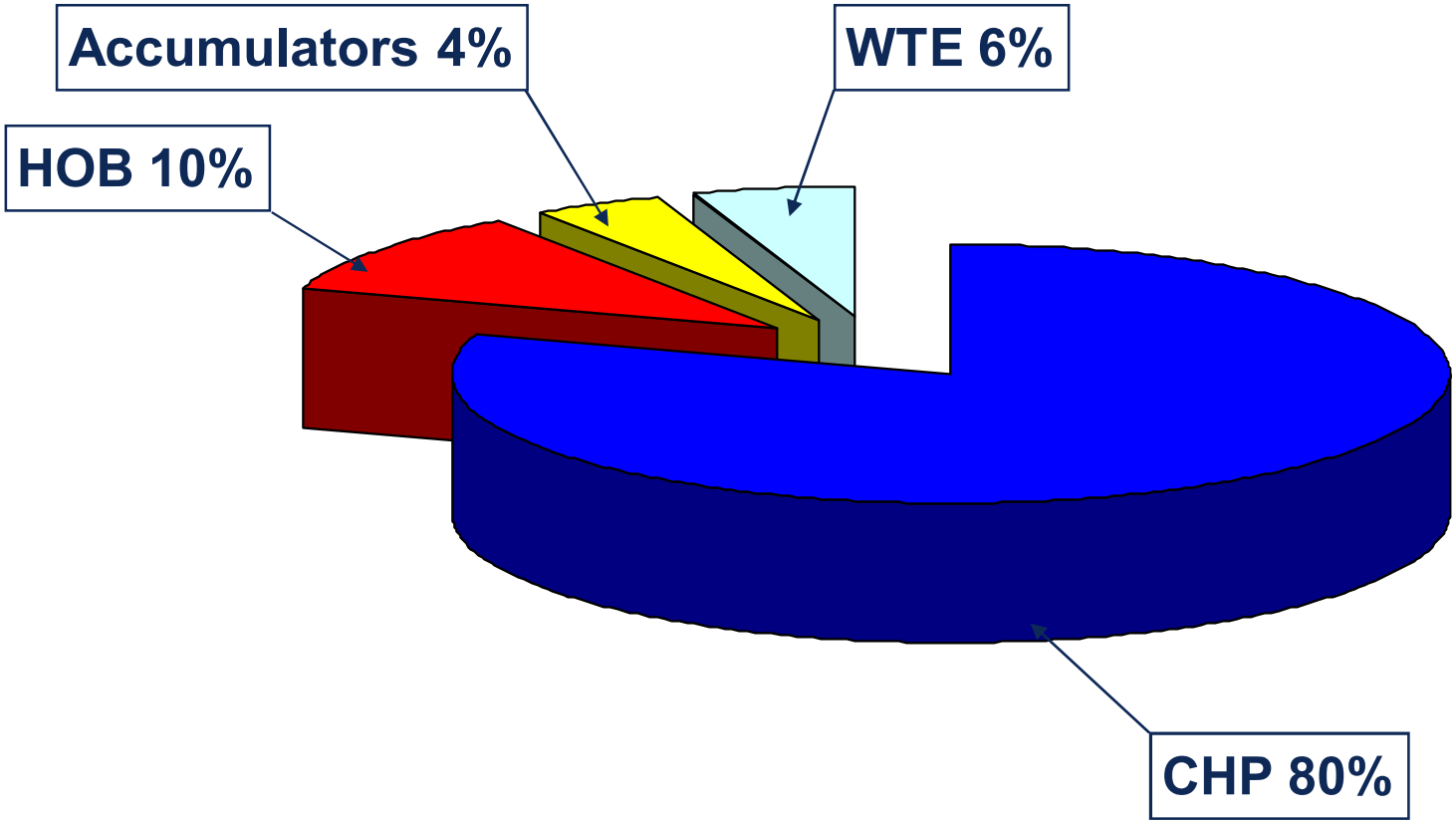
IRIDE DH STEP 1:	**60,7 Mm³**
NORTH-EAST TURIN DH:	**10,0 Mm³**
IRIDE DH STEP 2:	**70,7 Mm³**
OTHER DH STEP 1:	**13,3 Mm³**
TOTAL DH SYSTEMS STEP 2:	**84,0 Mm³**

IRIDE ENERGIA

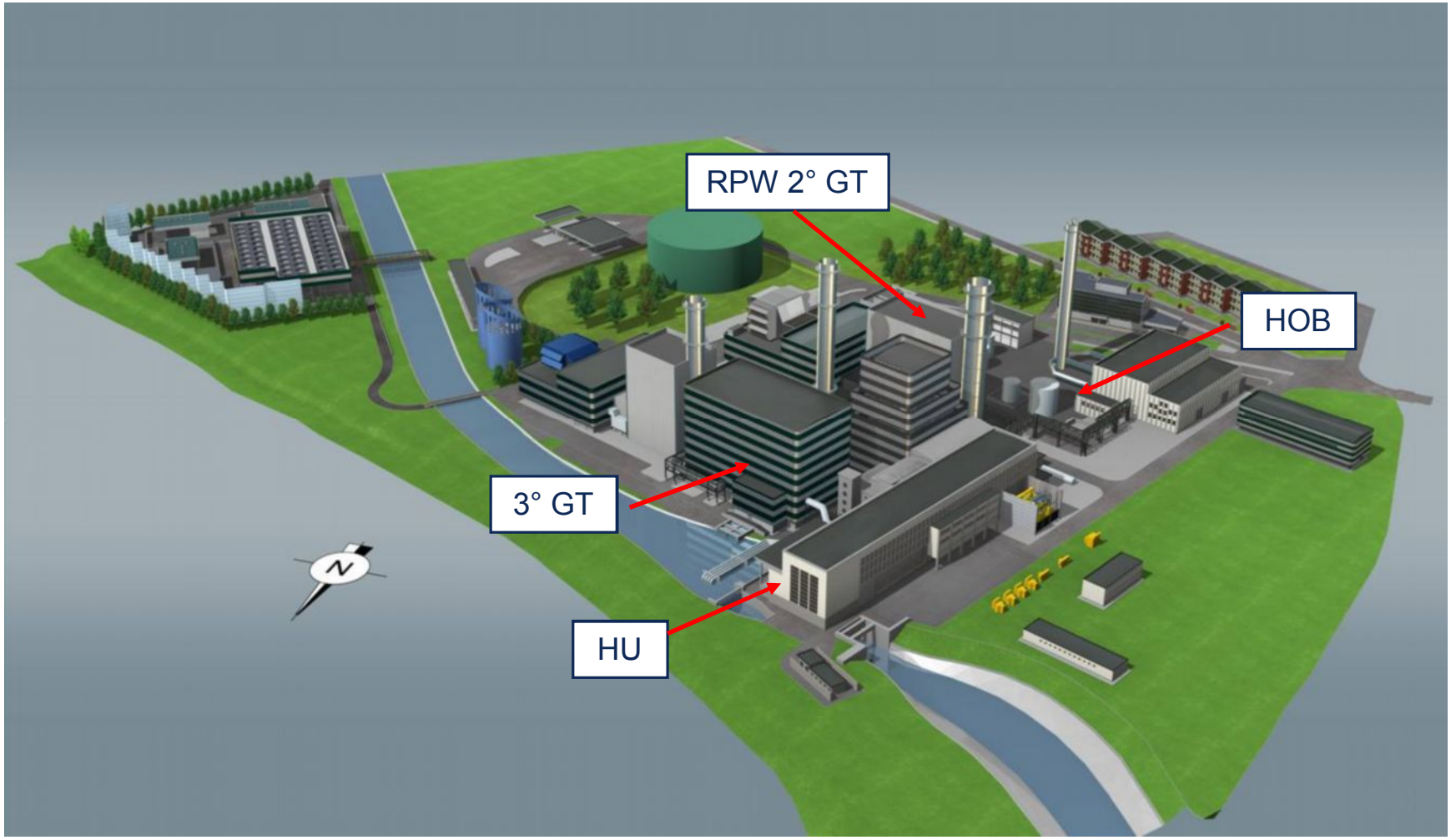
STEP 2 – GENERAL DATA

	SPACE HEATED	CITIZENS	NOMINAL THERMAL PEAK	THERMAL ENERGY	PIPELINES	HEAT EXCHANGER
	Mm³	num	MW	GWh/y	km	num
IRIDE DH STEP 1	60,7	615.000	1.500	2.595	570	5.950
NORTH-EAST TURIN DH	10,0	85.000	250	420	120	2.000
IRIDE DH STEP 2	70,7	700.000	1.750	3.015	690	7.950
OTHER DH STEP 1	13,3	85.000	325	400	180	1.990
TOTAL DH STEP 2	84,0	785.000	2.075	3.415	870	9.940

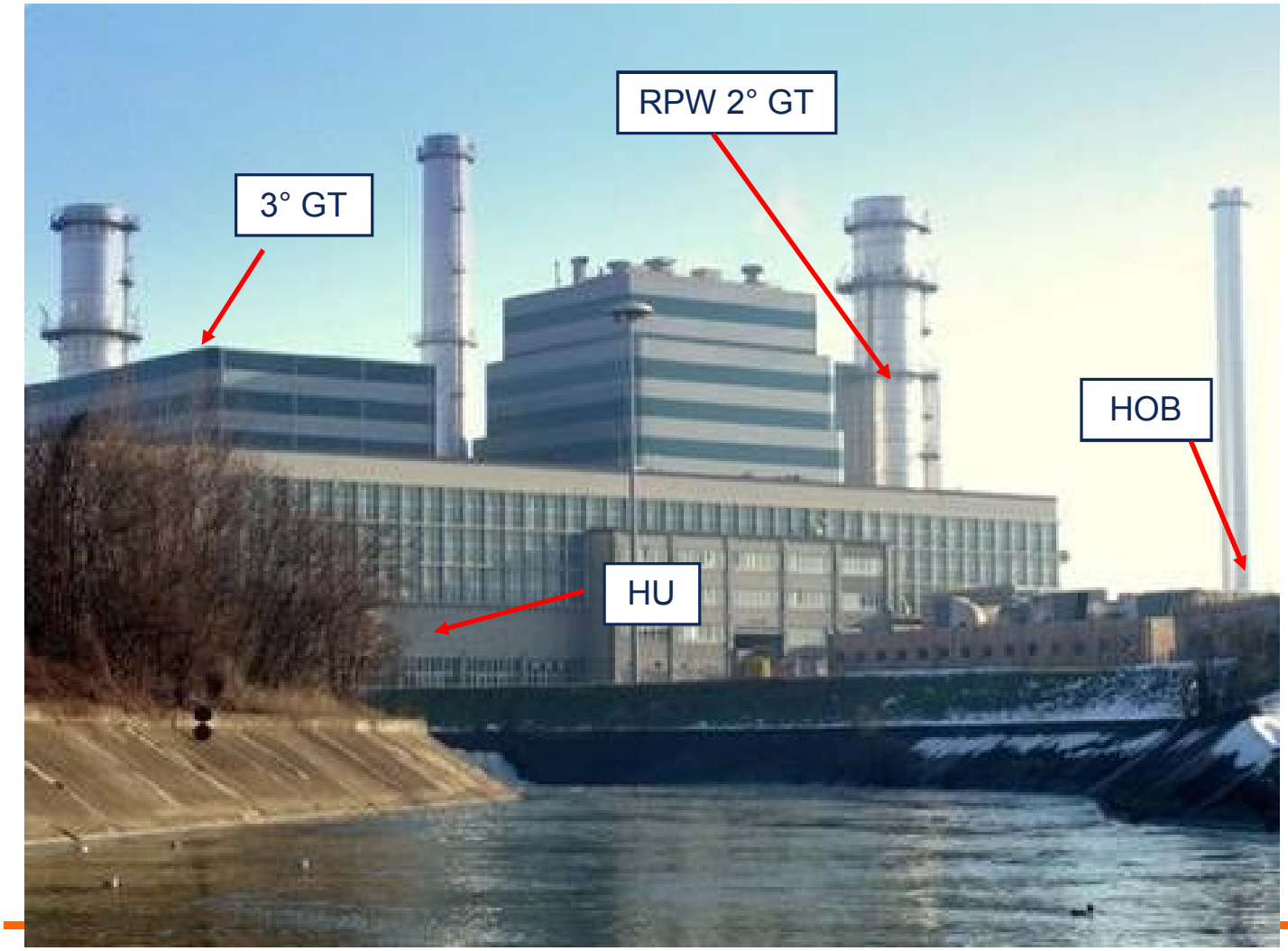
IRIDE DH SYSTEM STEP 2 - THERMAL ENERGY



THE NEW FACE OF MONCALIERI CHP PLANT FOR TURIN DH



THE NEW FACE OF MONCALIERI CHP PLANT FOR TURIN DH



IRIDE ENERGIA

MONCALIERI CHP PLANT BEFORE REPOWERING

- an Hydraulic Unit (“HU”) of 4,5 MWe;
- a traditional steam Thermoelectric Unit (“1° GT”) of 35 MWe;
- a traditional steam CHP Unit (“2° GT”) of 141 MWe (100 MWe + 200 MWt);
- a GT Unit (“TG”) of 35 MWe + 70 MWt;
- a HOB Plant, as Integration and Reserve (“HOB”) of 141 MWt;
- the DH system: pumps station, pressurization, expansion, demi water feeder system, filtration and conditioning system;
- auxiliary systems.

~ 215 MWe ~ 410 MWt

MONCALIERI CHP PLANT AFTER REPOWERING

- an Hydraulic Unit (“HU”) of 4,5 MWe;
- ~~a traditional steam Thermoelectric Unit (“1° GT”) of 35 MWe;~~ ELIMINATED
- a CHP GTCC Unit (“RPW2° GT”) of 395 MWe (345 MWe + 260 MWt); REPOWERED
- ~~a GT Unit (“TG”) of 35 MWe + 70 MWt;~~ ELIMINATED
- a HOB Plant, as Integration and Reserve (“HOB”) of 141 MWt;
- the DH system: pumps station, pressurization, expansion, demi water feeder system, filtration and conditioning system;
- auxiliary systems;
- a CHP GTCC Unit (“3° GT”) of 383 MWe (322 MWe + 260 MWt). NEW

~ 780 MWe ~ 660 MWt

GOALS

+ POWER

ELECTRIC

HEAT (combined)

BETTER EFFICIENCY

Competitiveness

&

BETTER USE OF PRIMARY SOURCES

- POLLUTION

Environment

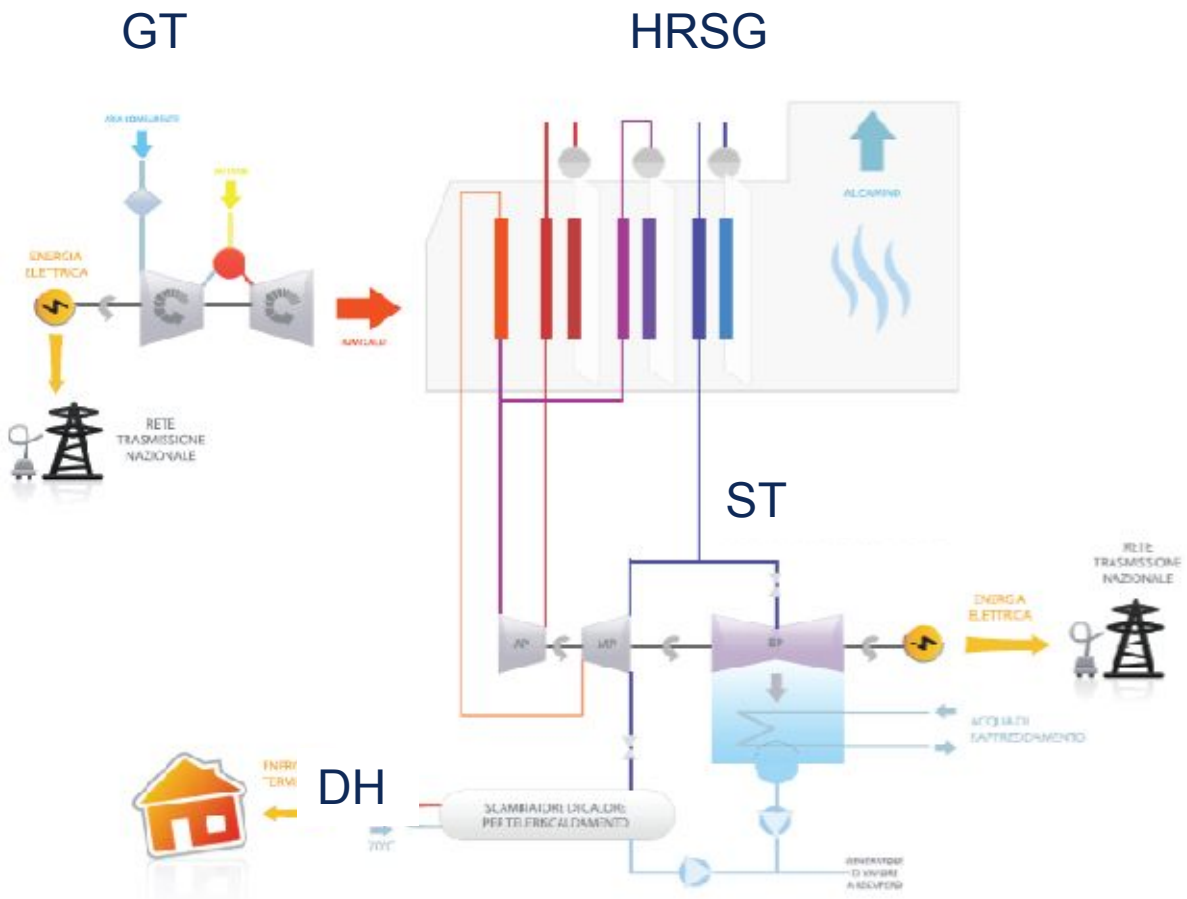
Carefull

DEVELOPMENT

PARTICULAR CARE OF ARCHITECTURAL AND ACUSTIC IMPACT

COMBINED PRODUTION = ELECTRIC POWER + HEAT

CHP GT COMBINED CYCLE (with 3 levels of pressure and REHEATER)



EFFICIENCY

TRADITIONAL STEAM CYCLE
(with REHEATER and FEEDER WATER STEAM PREHETER) η = 38 - 40 %

GT UNIT (OPEN CYCLE) η = 33 - 39 %

GTCC (with 3 levels of pressure and REHEATER) η = 57 - 58 %

CHP GTCC (with 3 levels of pressure and REHEATER) U.F.F. = 87 - 90 %

better use of primary sources

Less pollution and greenhouse gas emission

MONCALIERI POWER PLANT REPOWERING PROJECT

1st PHASE FINISHED (MAY 2005)

New CHP GTCC ("3° GT")

383 MWe (322 MWe + 260 MWt)

2nd PHASE FINISHED (OCTOBER 2008)

Repowering of the CHP 2° GT as a CHP GTCC ("RPW 2° GT")

395 MWe (345 MWe + 260 MWt)

THE NEW CHP GTCC „3° GT“

1st PHASE

The NEW CHP GTCC, installed in the Moncalieri CHP Power Plant, is made by the following main equipment:

1. **a SIEMENS GT**, feeded only by natural gas;
2. **an Ansaldo Caldaie HRSG,** feeded by the GT exhaust;
3. **a SIEMENS ST,** with a river condenser and a steam extraction for the district heating.

The performances of the new Unit are the following:

MAX Net Electric Power: 383 MW (without DH), 322 MW (with DH)

MAX HEAT available for DH: 260 MWt;

Efficiency in electric operation: 57 %;
Efficiency in combined operation: 88 %;

<u>EMISSIONS</u>: CO < 30 mg/Nm^3 NOx < 50 mg/Nm^3

(Ref. 15% of O_2 dry, between minimun load and 100%)

GAS TURBINE

MAIN FEATURES:

MODEL: **SIEMENS V94 3A2**, **260 MW** (ISO conditions), singleshaft;

Axial turbine with 4 STAGES (ceramic coating);

Axial compressor with 15 STAGES;

Double air filtration STAGES;

Hollow rotor made by disks interlocked via Hirth serrations fixed via one central tie bolt;

2 radial bearings at the ends (axial beering at compressor side);

Generator coupling at cold end drive;

Axial flow exhaust.

Annular combustion chamber, with **24 Dry-Low-Nox,** feeded only by natural gas and protected by ceramic and metallic heat shields (ISO inlet turbine temperature **1.230 °C**);

Turbine blades internally cooled by air and externally protected by colling air films and ceramic coatings.

GAS TURBINE

MAIN FEATURES:

Variable Inlet compressor Vanes (IGV) to control the air flow;

3 Combustione MODES:

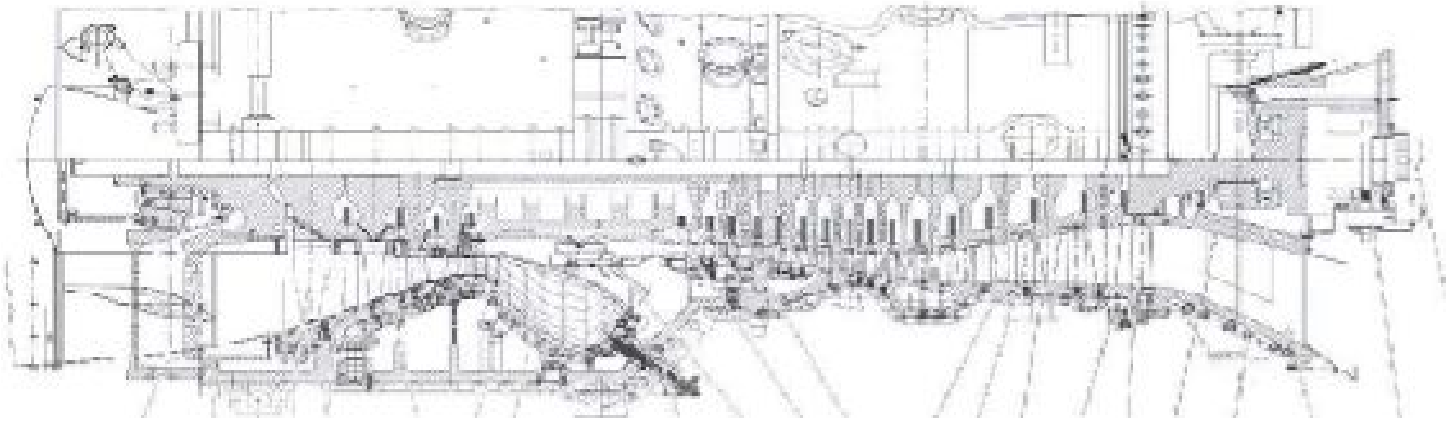
- **DIFFUSION**, from 0 to 50 Hz;
- **PREMIX**, from 0% to 100% LOAD; → **LOW NOx**
- **PYLOT**, from 0 Hz to 100% LOAD to stabilize the flame

Size of the GT building: **43 m x 38 m x H20/14 m**.

The building is provided with a 130 ton crane.

The **SIEMENS** GT generator **TLRI 115/52**, air cooled, has a nominal power of **280 MVA.**

ON SITE



GAS TURBINE

V94.3A Econopac

Speed	3000 rpm
Frequency	50 Hz
Net Power Output	**260** MW
Net Efficiency	39.0 %
Net Heat Rate	9,231 kJ/kWh
Exhaust Temperature	585 °C
Exhaust Flow	665 kg/s

Conditions for Performance Data
- ISO Ambient Temperature: 15 °C/59 °F
- ISO Barometric Pressure: 1.013 bar/14.7 psia
- ISO Relative Humidity: 60%
- Fuel: Natural Gas
- Inlet/Exhaust Pressure Losses: 9/10 mbar
- Injection of Water: No

HRSG

Start-Up Times

to full speed	~ 6 min.
to full load	~ 26 min.

NOx Emissions

Natural Gas (dry)	25 ppm / 15 ppm at lower turbine inlet temperature
~~Fuel Oil (dry)~~	73 ppm / 58 ppm lower turbine inlet temperature
~~Fuel Oil (water)~~	42 ppm

HEAT RECOVERY STEAM GENERATOR

MAIN FEATURES:

Manufacturer: **ANSALDO CALDAIE**

Type: **HORIZONTAL** with 3 levels of pressure, LP integrated deaerator and REHEATER

NATURAL CIRCULATION evaporators

HP (105 bar), IP (30 bar), LP (7,5 bar)

2 feedwater pumps (2 x 100%)

STEAM BY- PASS FOR District Heating in case of ST trip.

NO GT EXHAUST BY- PASS

Size of the HRSG building: **25 m x 21 m x H37 m**. The chimney is 60 mt high.

STEAM TURBINE

MAIN FEATURES:

MODEL: **SIEMENS HMN**, nominal power **138 MW**, river condenser with extractions for DH

3 SECTIONSI: HP (104 bar / 550 °C), IP (28 bar / 560 °C), LP (3 bar / 250 °C)

TURBINE BLADES designed via **3-dimensional lfow optimization**

OPPOSED HP/IP FLOWs, 2 LP OPPOSED FLOWS

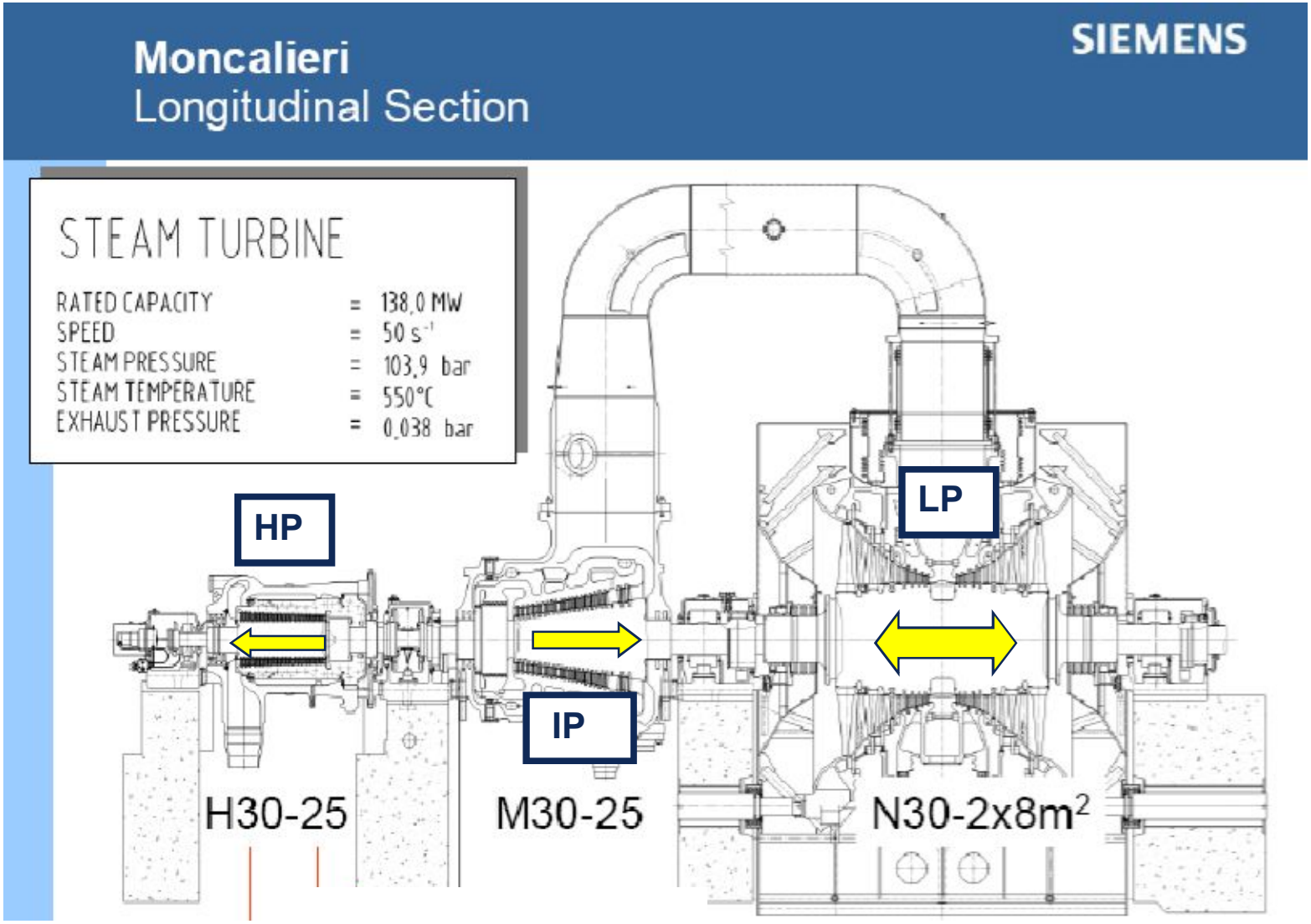
2 STEAM EXTRACTIONS in IP section for DH (**260 MWt**)

Size of the ST building: **48 m x 25 m x H35,7 m**.

The building is provided with a 150 ton crane.

The **SIEMENS** ST generator **TLRI 100/36**, air cooled, has a nominal power of **155 MVA**.

STEAM TURBINE



THE REPOWERED CHP GTCC „2° GT“

2nd PHASE

The traditional steam cycle CHP 2°GT of the Moncalieri CHP Power Plant has been repowerd as a CHP GTCC NEW CHP GTCC. This Unit is made by the following main equipment:

1. **an Ansaldo Energia GT**, feeded only by natural gas;
2. **an Ansaldo Caldaie HRSG,** feeded by the GT exhaust;
3. **a ALSTOM ST,** with a river condenser and a steam extraction for the district heating.

The old FRANCO TOSI boiler (420 ton/h) has been kept as reserve.
The performances of the repowerd Unit are the following:

MAX Net Electric Power: 395 MW (without DH), 345 MW (with DH)
MAX HEAT available for DH: 260 MWt;

Efficiency in electric operation: 58 %;
Efficiency in combined operation: 90 %;

EMISSIONS: **CO < 30 mg/Nm^3** **NOx < 30 mg/Nm^3**
(Ref. 15% of O_2 dry, between minimun load and 100%)

MAIN DIFFERENCES RPW2°GT - 3° GT

GT MODEL V94.3A4 instead V94.3A2:

- **+ 8% ELECTRIC POWER** with the same efficiency
- **AXIAL CLEARENCES** hydraulic recovery AT COMPRESSOR SIDE BEARING
- HYDRAULIC IGV rather than electric

DE-ICEING SYSTEM with DH water / air heat exchanger

LOW NOx EMISSIONS: 30 mg/Nm^3 rather than 50 mg/Nm^3

HRSG designed for SCR (NOx)

CHANGES TO THE exinsting ALSTOM STEAM TURBINE:

NEW **AIR cooled generator** rather than HYDROGEN cooled old generator

NEW PIPES for the **CONDENSER**

NEW ST ACUSTIC ENCLOSURE

1 **NEW 3-phases TRANSFORMER** rather than 3 single-phase TRASFORMERS

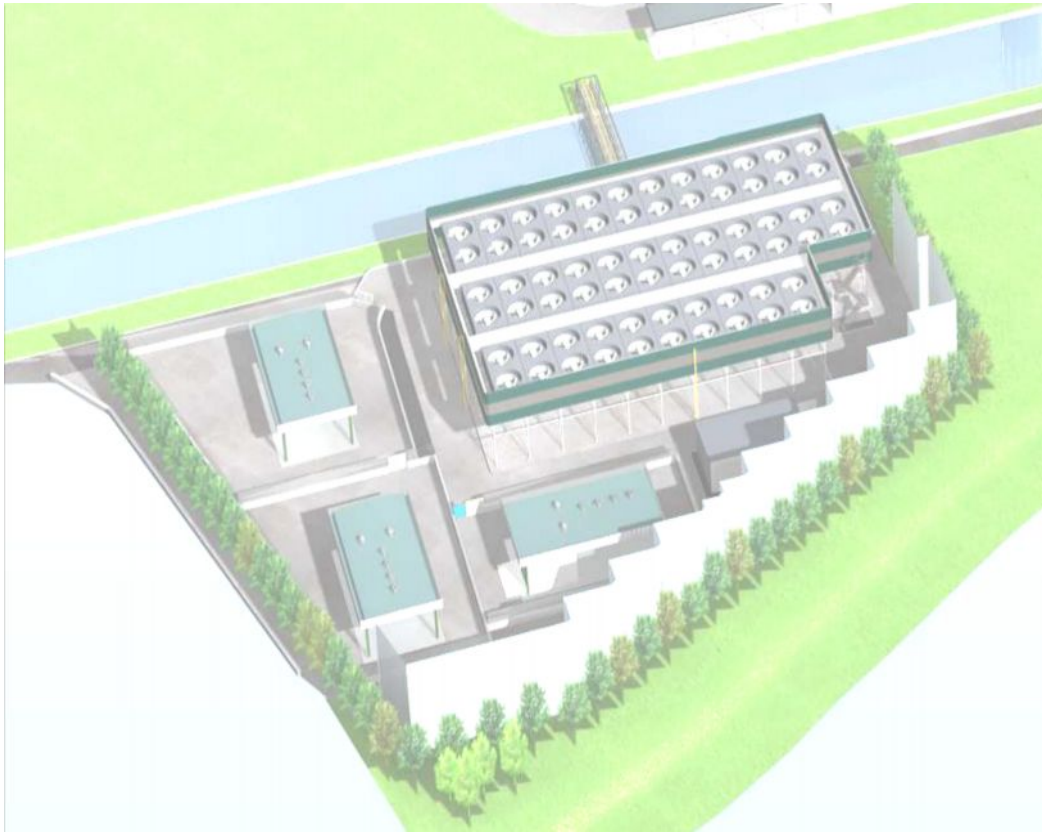
NEW 15,75 kV DUCT without UNIT BREAKER

NEW DH HEAT EXCHANGER (260 MWt rather than 200 MWt)

NEW MONCALIERI AIR COOLER

binding: MAX ΔT 3 °C of the river water

goal = INCREASE the availability of the 2 GTCC Units in **SUMMER**



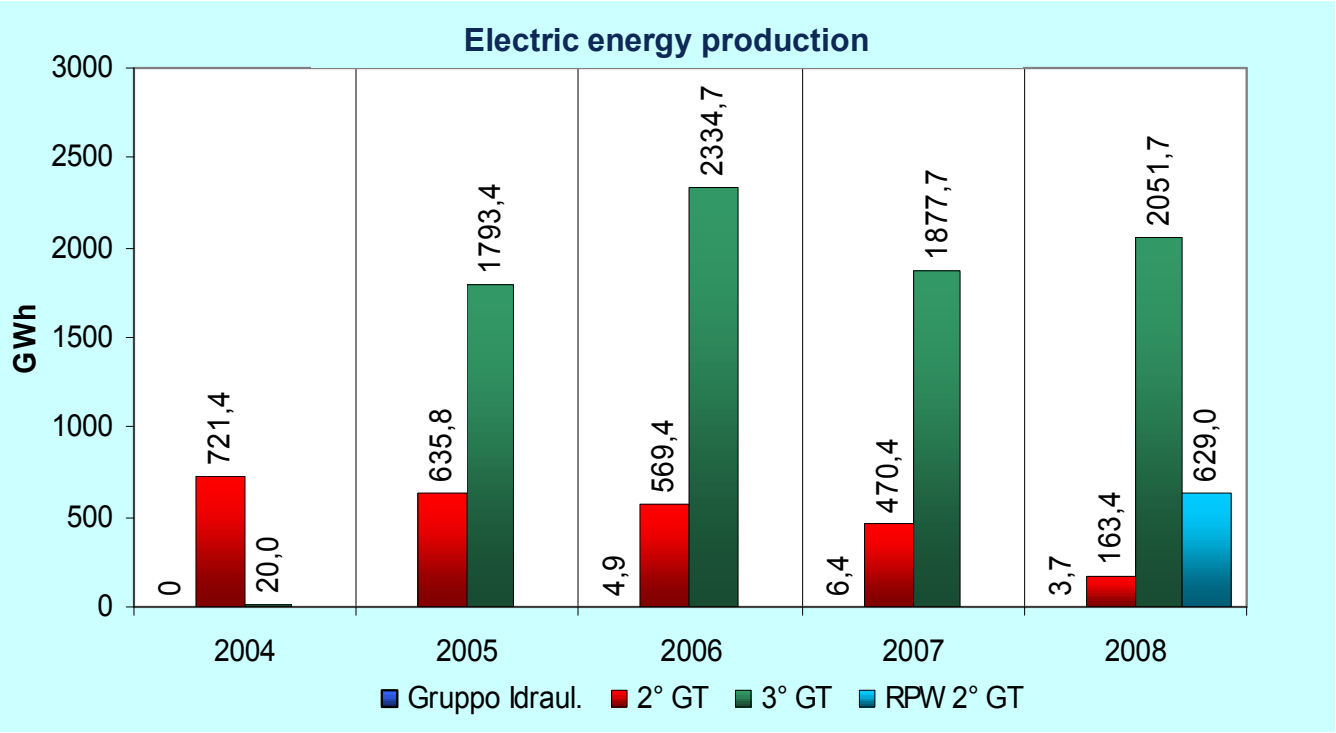
MAX thermal power exchanged	**340 MWt**
DH water inlet temperature	110 °C
DH water outlet temperature	70 °C
Ambient temperature	30 °C

FIRST RESULTS

MORE ELECTRIC PRODUCTION

3° GT

RPW2°GT

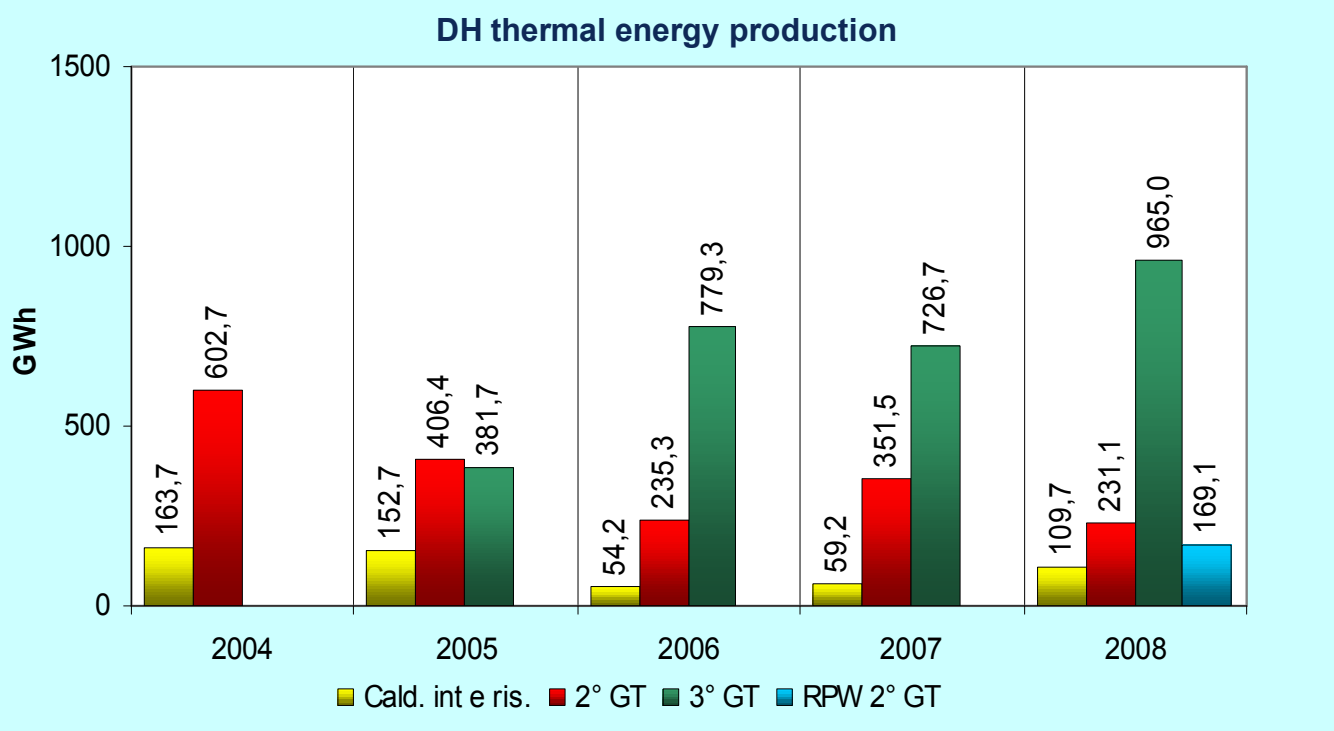


FIRST RESULTS

MORE HEAT

3° GT

RPW2°GT

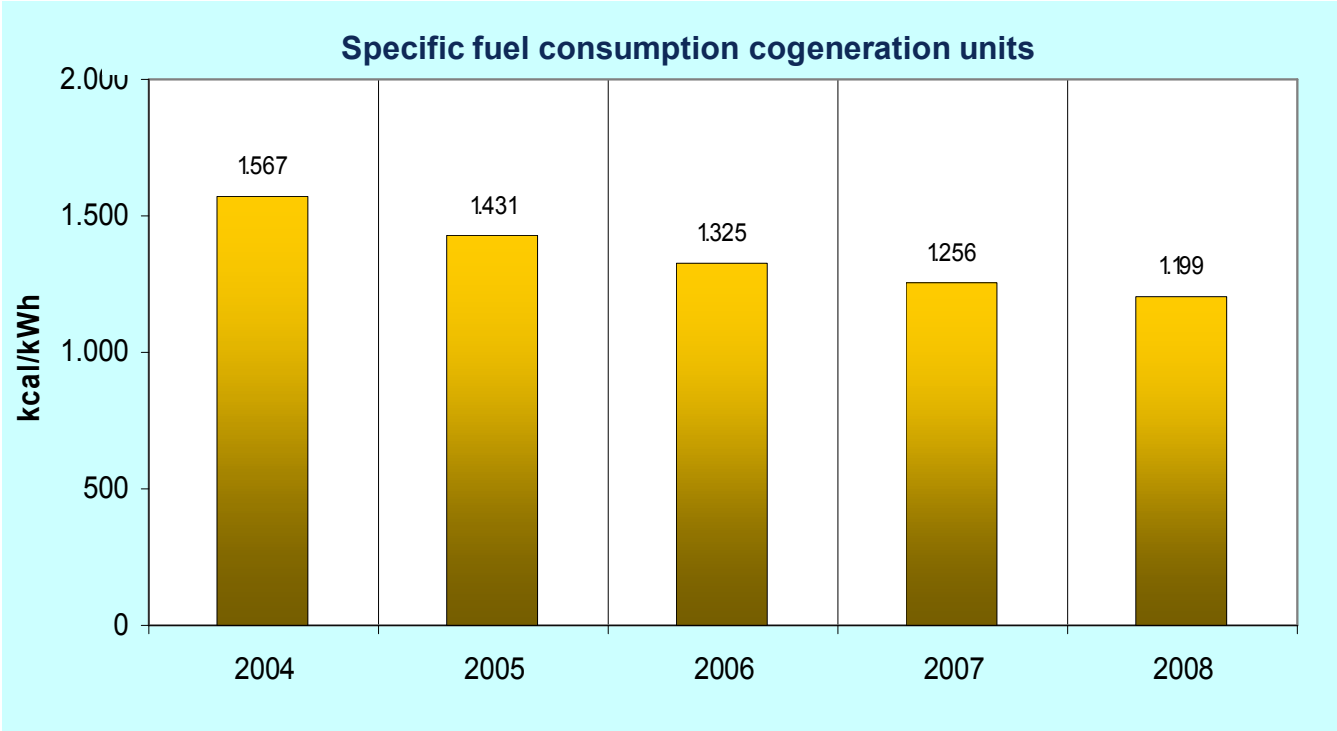


FIRST RESULTS

BETTER EFFICIENCY

3° GT

RPW2°GT

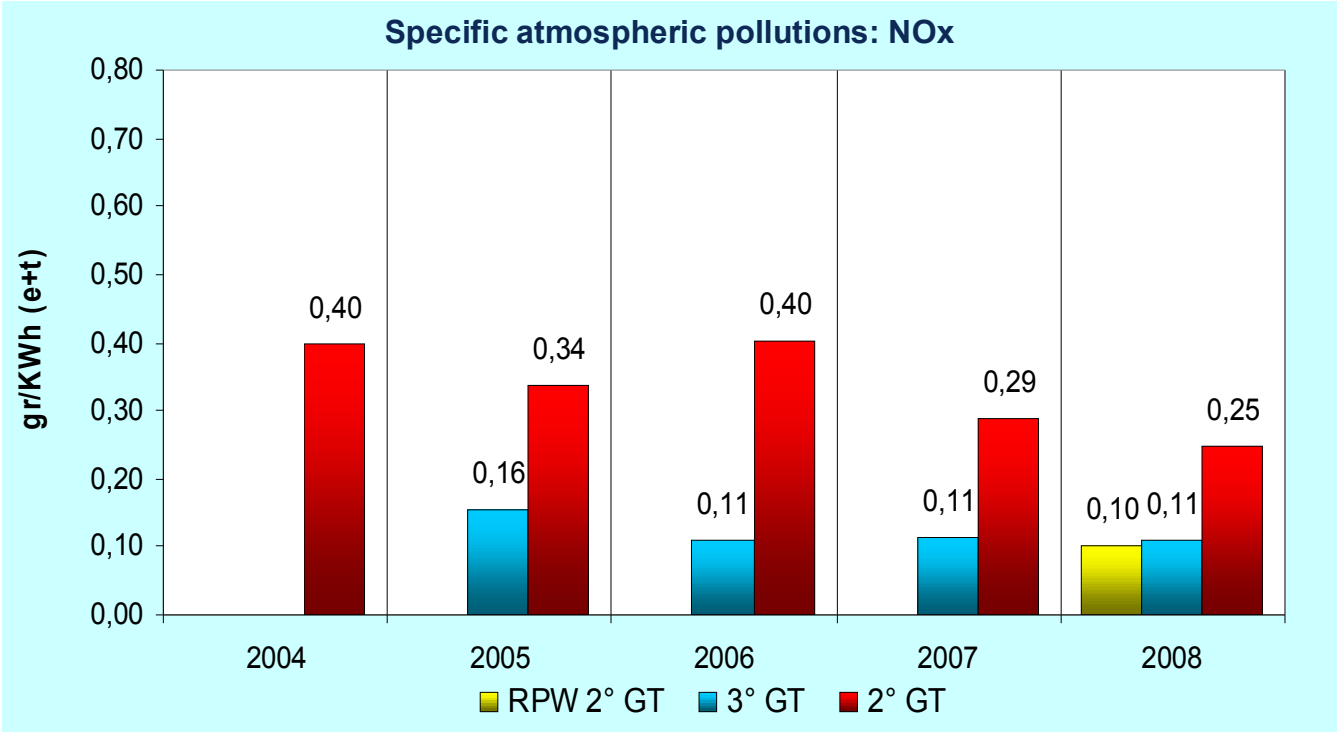


FIRST RESULTS

LESS POLLUTION

3° GT

RPW2°GT

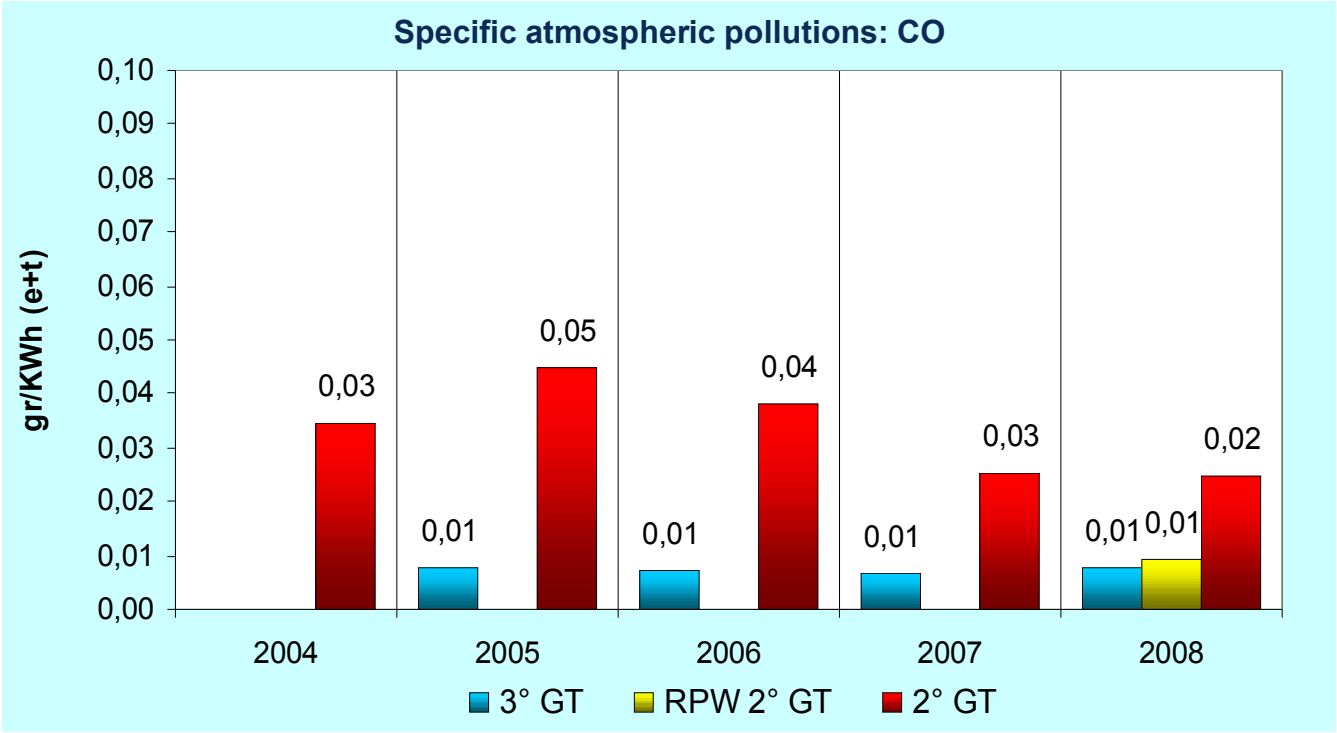


FIRST RESULTS

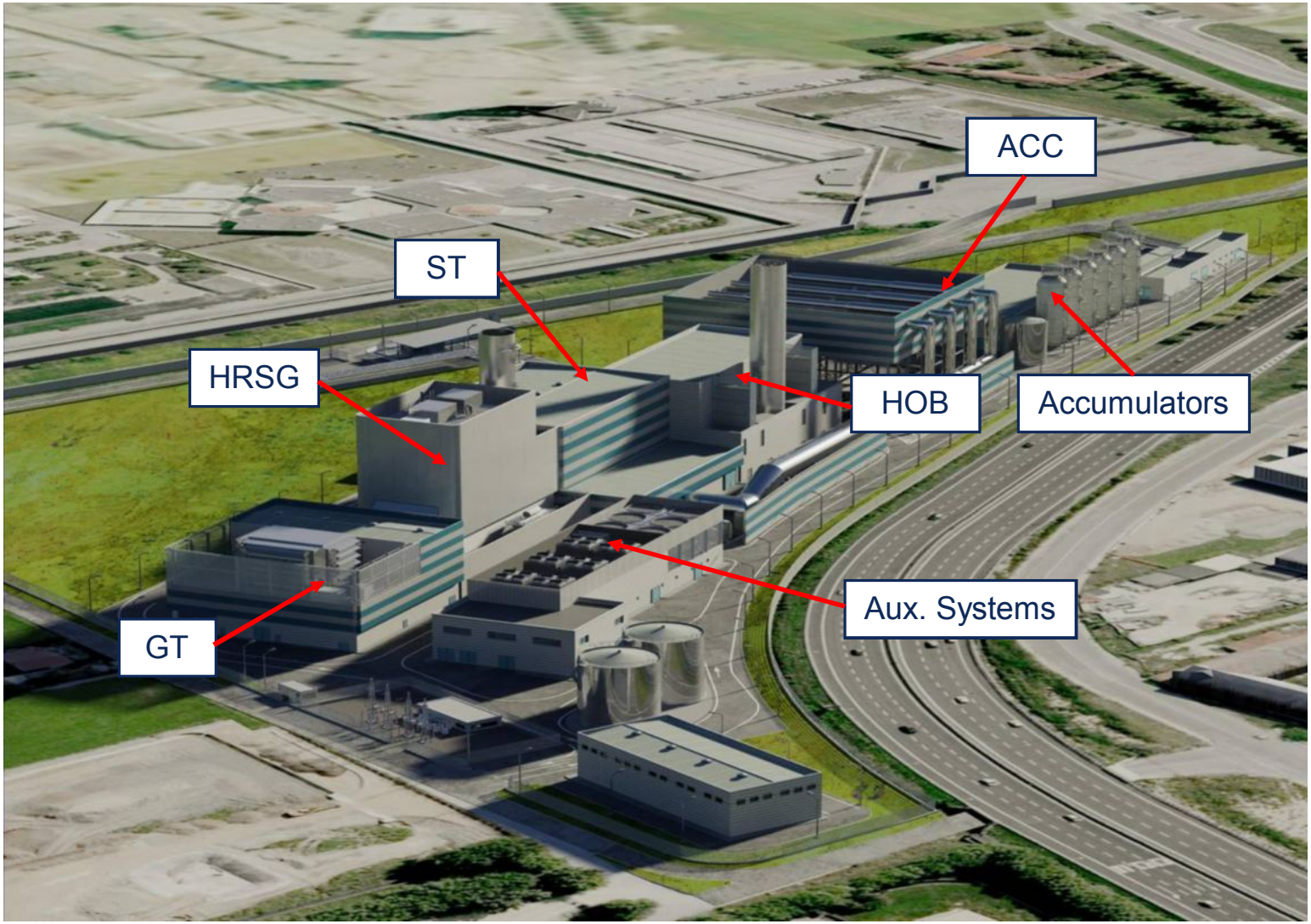
LESS POLLUTION

3° GT

RPW2°GT



TORINO NORD POWER PLANT



TORINO NORD POWER PLANT – TECHNICAL DATA

CCGT	Electric mode	Combined mode
ELECTRIC POWER	390 MW	340 MW
HEAT	0 MW	220 MW
EFFICIENCY	56 %	87 %
FUEL	NATURAL GAS	

HEAT ONLY BOILERS		Thermal mode
HEAT		340 MW
EFFICIENCY		92 %
FUEL	NATURAL GAS	

HEAT STORAGE SYSTEM		Thermal mode
WATER SPACE		5.000 m^3
HEAT AT PEAK		150 MW

TORINO NORD POWER PLANT ENVIRONMENTAL BENEFITS

- **Energy saving** **100.000 tep/year**
- **Emissions avoided of CO_2** **300.000 t/year**
- **Emissions avoided of NO_X** **134 t/year**
- **Emissions avoided of SO_2** **400 t/year**
- ***Decommissioning "Le Vallette" Power Plant***

Thank you for your attention!