CYCLE DE FORMATION ÉNERGIE – ENVIRONNEMENT

Geneve, 16 mai 2013

UNIVERSITÉ DE GENÈVE
INSTITUT DES SCIENCES DE L'ENVIRONNEMENT

District Heating and Cooling: an opportunity for profiting from local energy sources - 3 case studies

Dr. Aleksandar Ivancic – AIGUASOL

- Introduction
- Forum-22@ - Barcelona
- Marina/Zona Franca - Barcelona
- Chamartin – Madrid
- Conclusions

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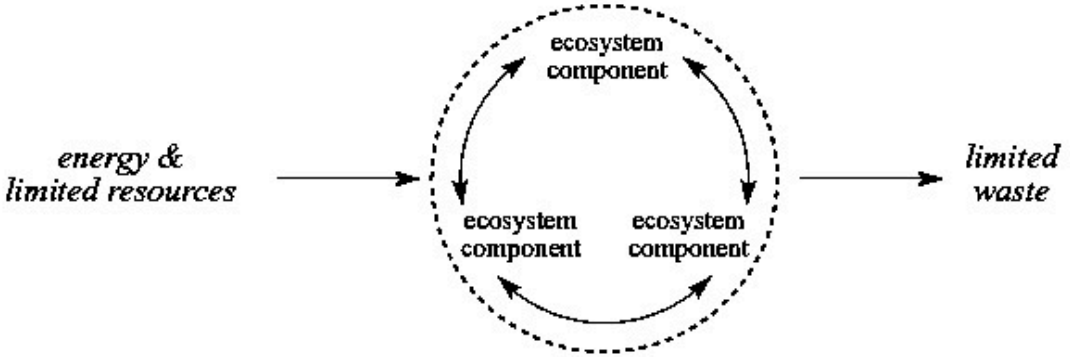
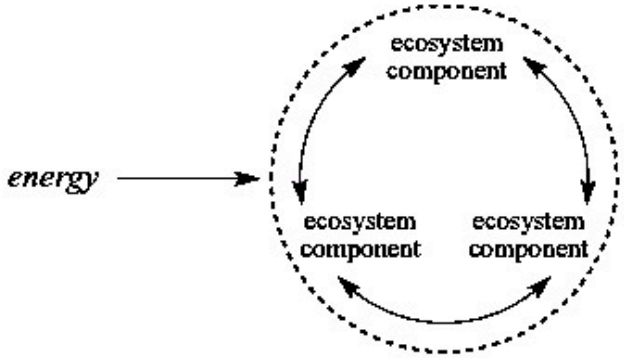
E (Piramide Keops) = 1 setmna BCN

Industrial ecology concepts

(a) QLinear materials flows in 'type I' ecology



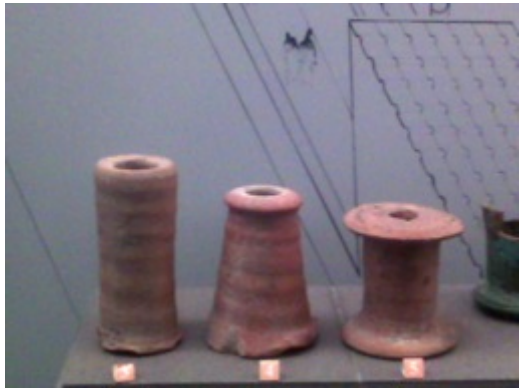
(b) Quasi-cyclic materials flows in 'type II' ecology



(c) Cyclic materials flows in 'type III' ecology

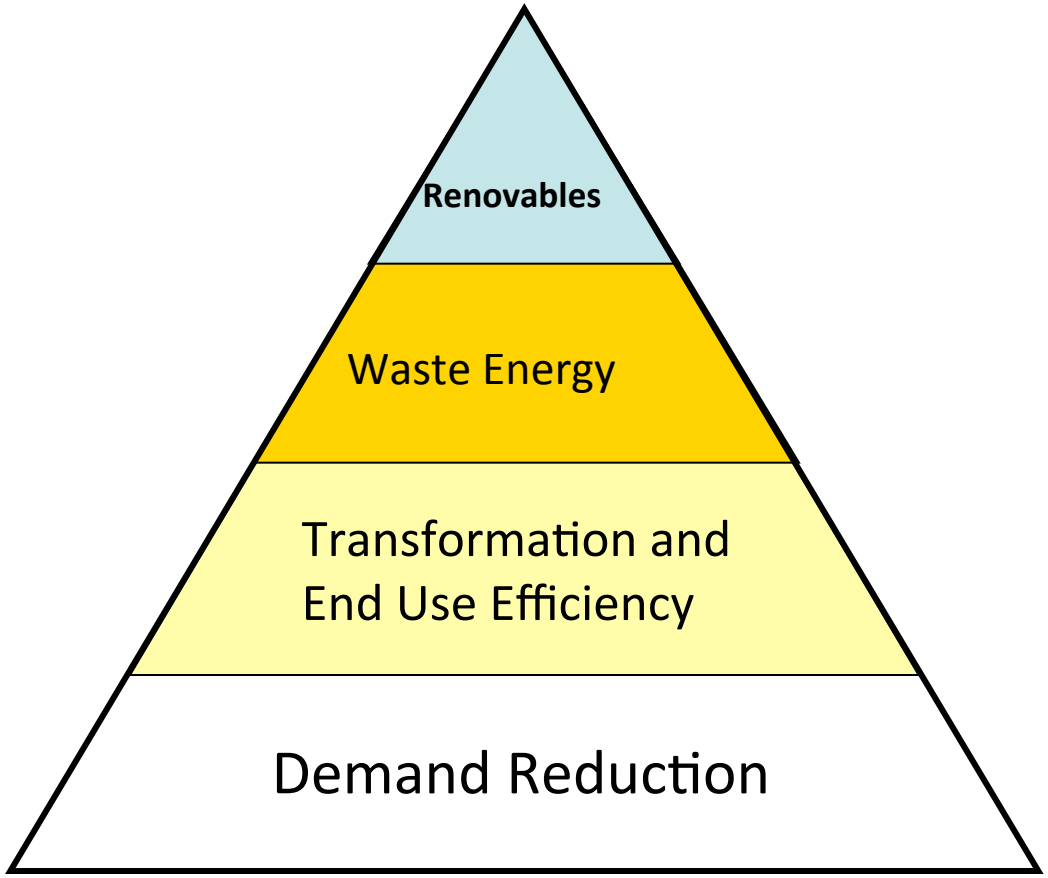
Source: Allenby

Is DHC a new system?



- In 1623 there was a proposal to install district energy in London
- Waste heat from factories was used to warm public baths by the 1830s
- •The Crystal Palace in London had district energy in 1851.
- 1877 Birdsill Holly first commercial DH syst Lockport, N.Y
- 1880s CHP + DH in USA
- 1890s waste incineration + DH

Energy model



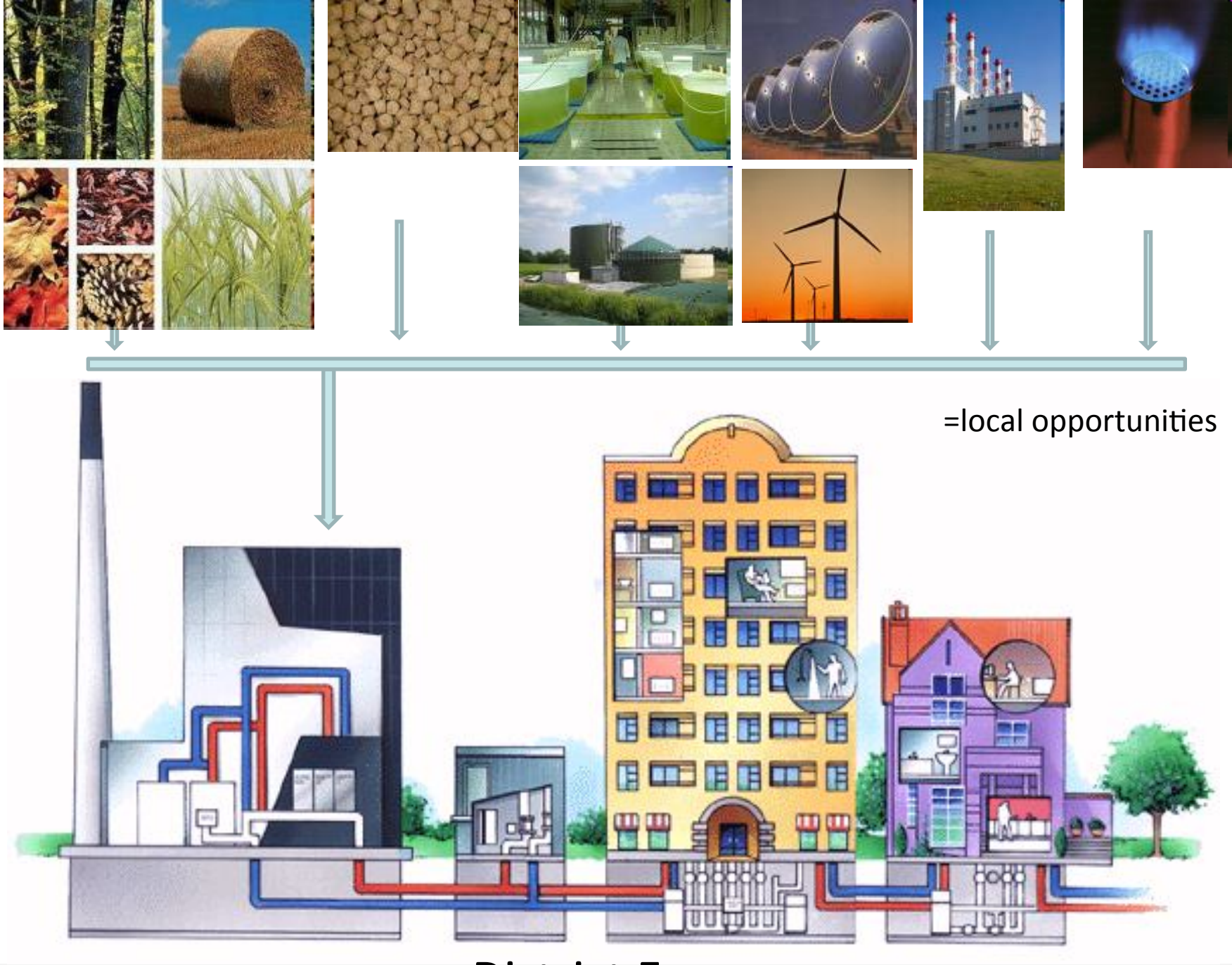
Urban integration

Infrastructure
optimization /Metabolic
concept

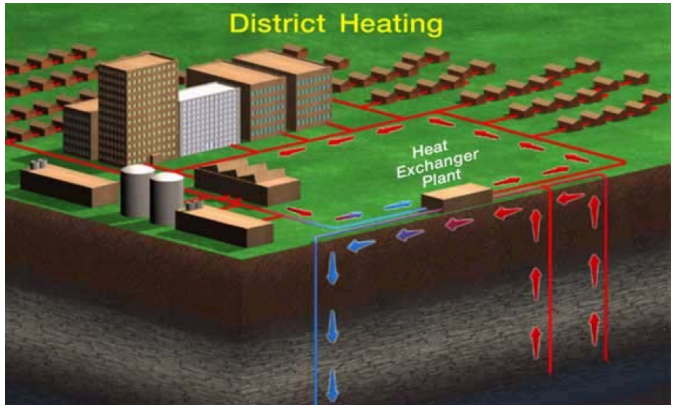
Optimization-
New needs fulfillment

Organization -
Systematization
Integration

DHC

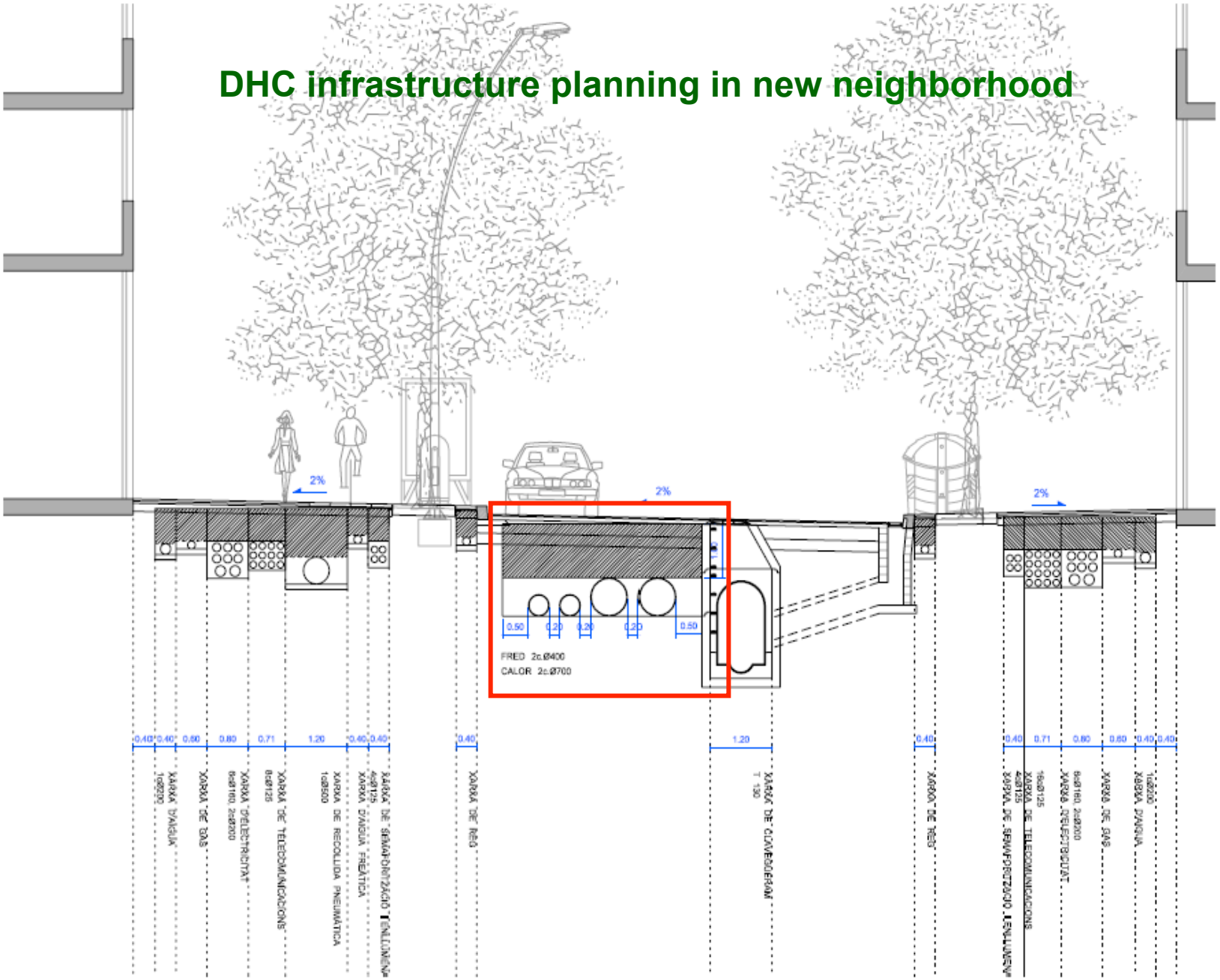


District Energy

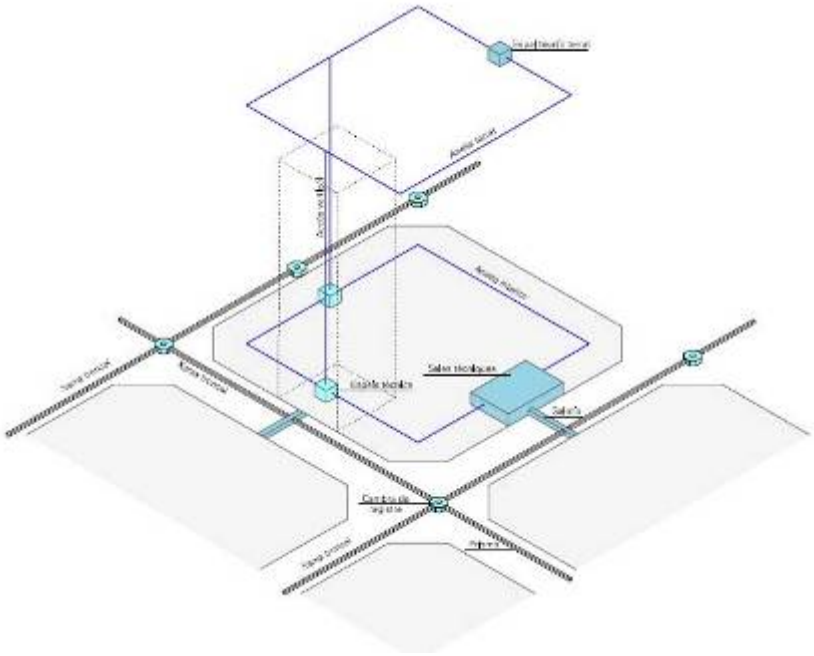

District Heating
Heat
Exchanger
Plant

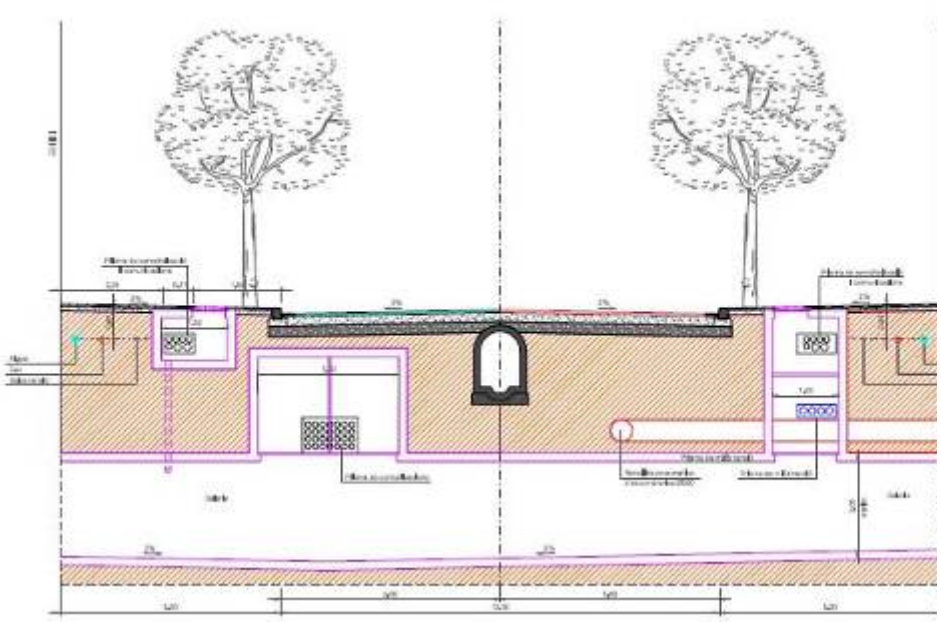

L N G

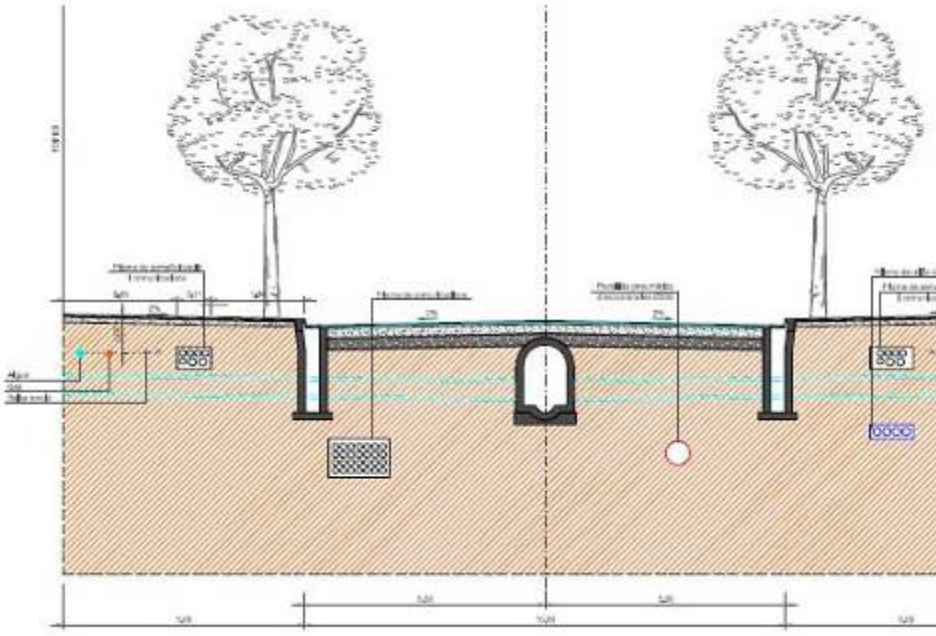
DHC infrastructure planning in new neighborhood



22@







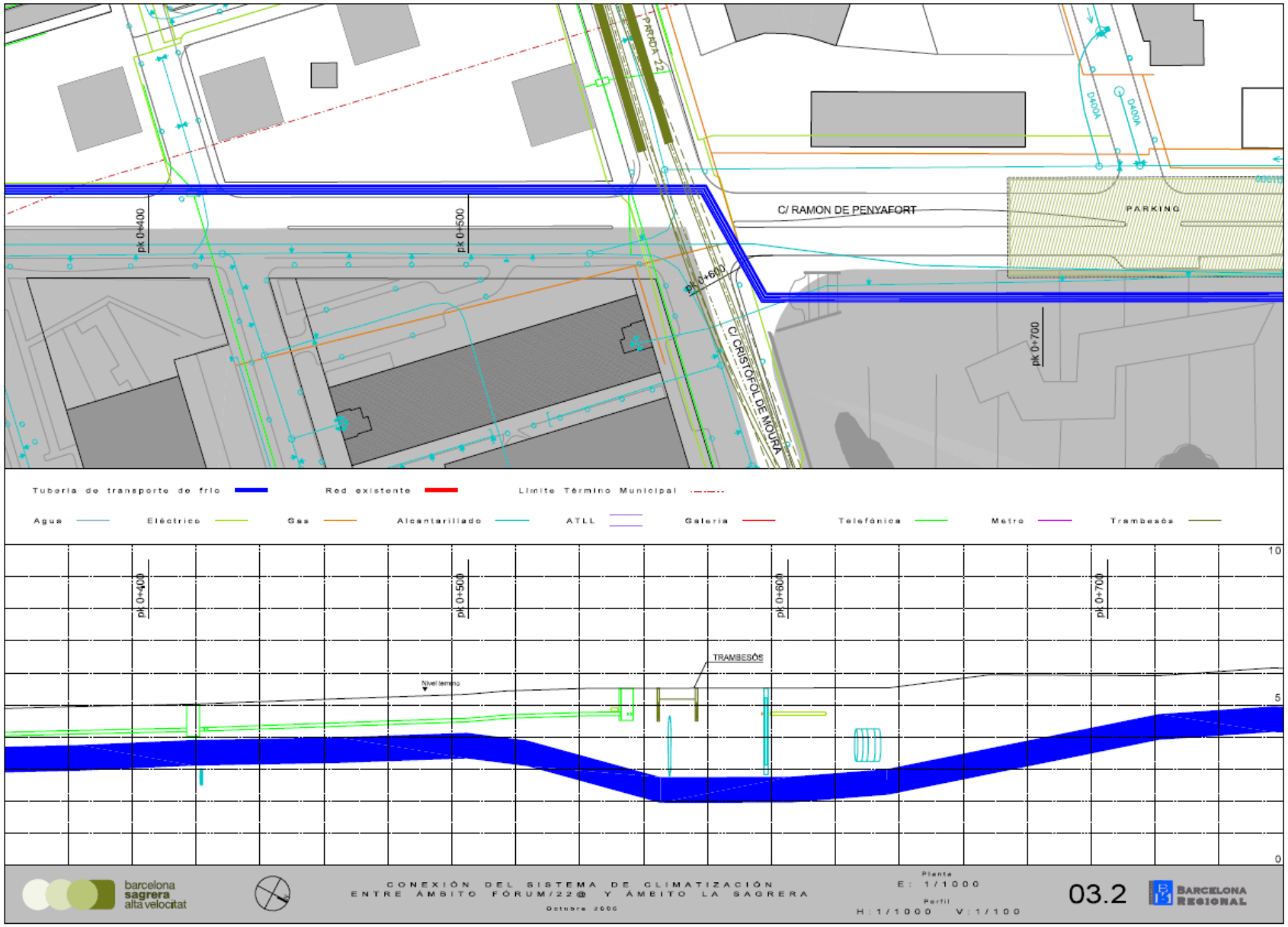
NOVES XARXES D'ENERGIA I TELECOMUNICACIONS

RECOLLIDA NEUMÀTICA SELECTIVA DE RESIDUS

CLIMATITZACIÓ CENTRALITZADA

GALERIES SUBTERRANIES REGISTRABLES

DHC infrastructure planning in existin city



DHC track record in bcn

- Before 1999, DHC almost **unknown** in Spain
- 1999 -22@ district infrastructure plan foreseen the possibility of DHC /Municipality initiative
- 2000 -Forum 2004 infrastructure plan foreseen the possibility of DHC /Municipality initiative
- 2003 -**Forum system in operation**
- 2004 - **Tub Verd (Mataro) in operation**
- 2006 - **22@ system in operation**
- 2004-06 -Port-Zona Franca system planning/Municipality iniciative
- 2005-06 – Parc de l'Alba (Cerdanyola de Valles) tender/Public iniciative
- 2006-07 -Sagrera system planning/Municipality iniciative
- 2009-2010 Tub Verd (Mataro) substantial expansion
- 2010-11 - Port-Zona Franca system in construction
- 2011 - **Parc de l'Alba system in operation**
- 2012 - 22@ new centrale in operation
- 2007-12 – Barcelona Metropolitan Area – several new candidates
- 2012 - **Port-Zona Franca system in operation**

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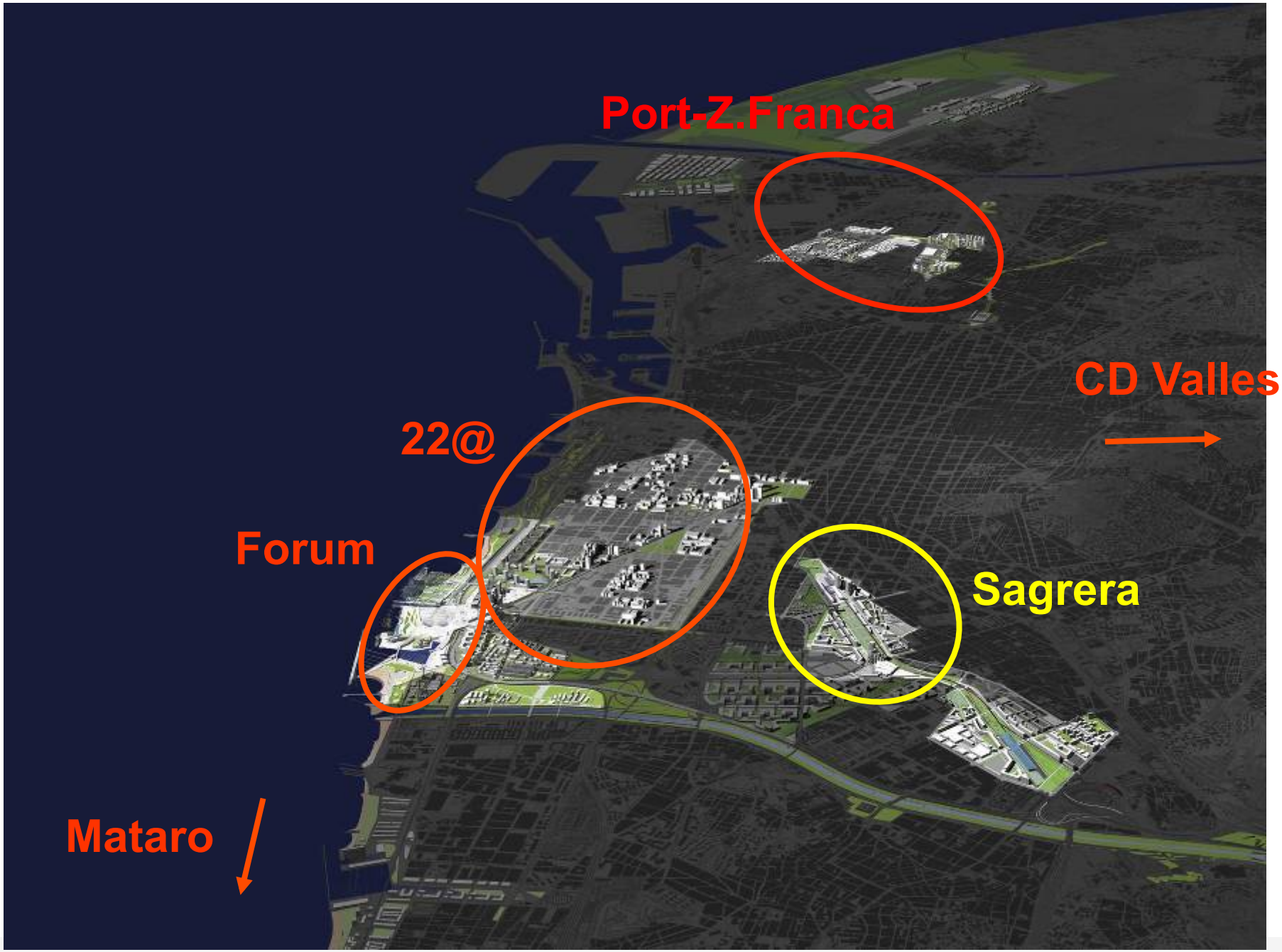
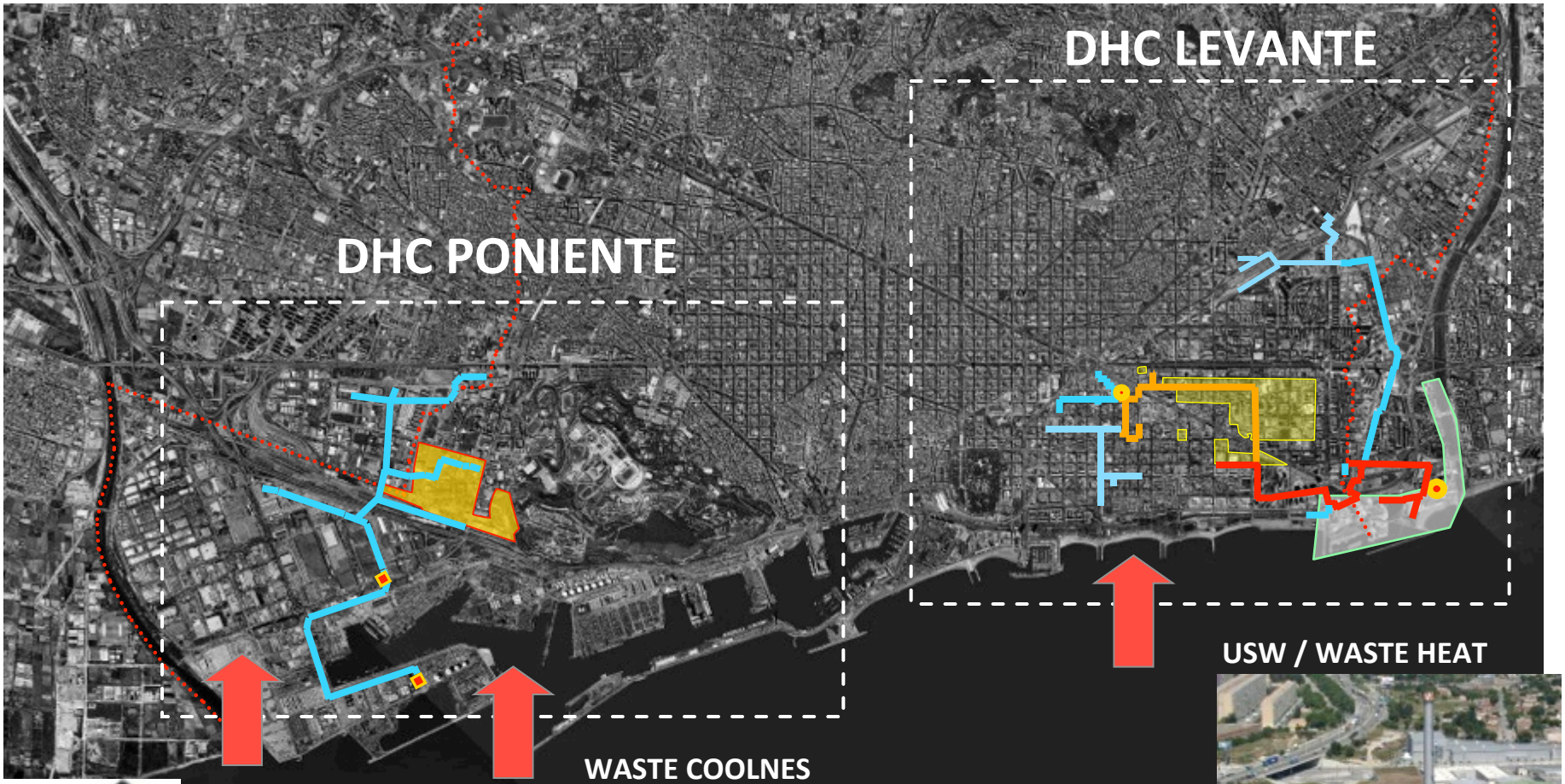

Port-Z.Franca
CD Valles
22@
Forum
Sagrera
Mataro

Barcelona: LNG residual coolness / Heat from USW treatment



BESOS LLEVANT - Previous situation

Forum: Besos – Sea waterfront

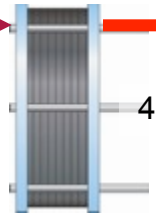
Forum: Besos – Sea waterfront

Ecoparc – Solid Waste Treatment

Incineradora del Besòs

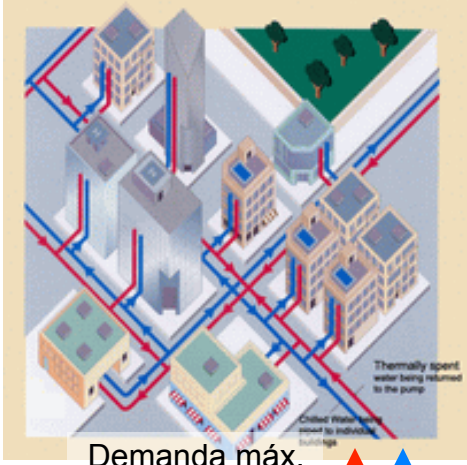
30 tn/h vapor 8 barg

90/60ºC



4 x 5000 kWt

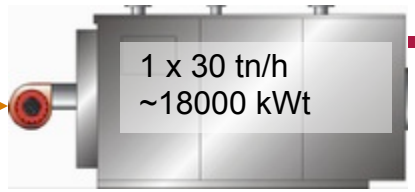
500 m³



Demanda máx.
29 MWt calor
41 MWf frío

90/60ºC

Red de Gas Natural



1 x 30 tn/h
~18000 kWt

5/14ºC

5/14ºC

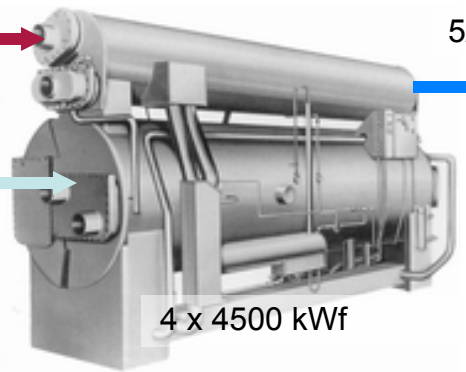
Darsena Puerto Sant Adrià

5300 m³/h max

ΔT=5ºC

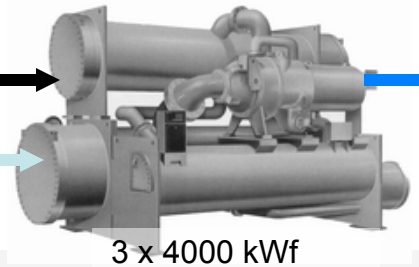
ΔT5º C

Colector Clabsa



4 x 4500 kWf

Red eléctrica conexión en alta tensión



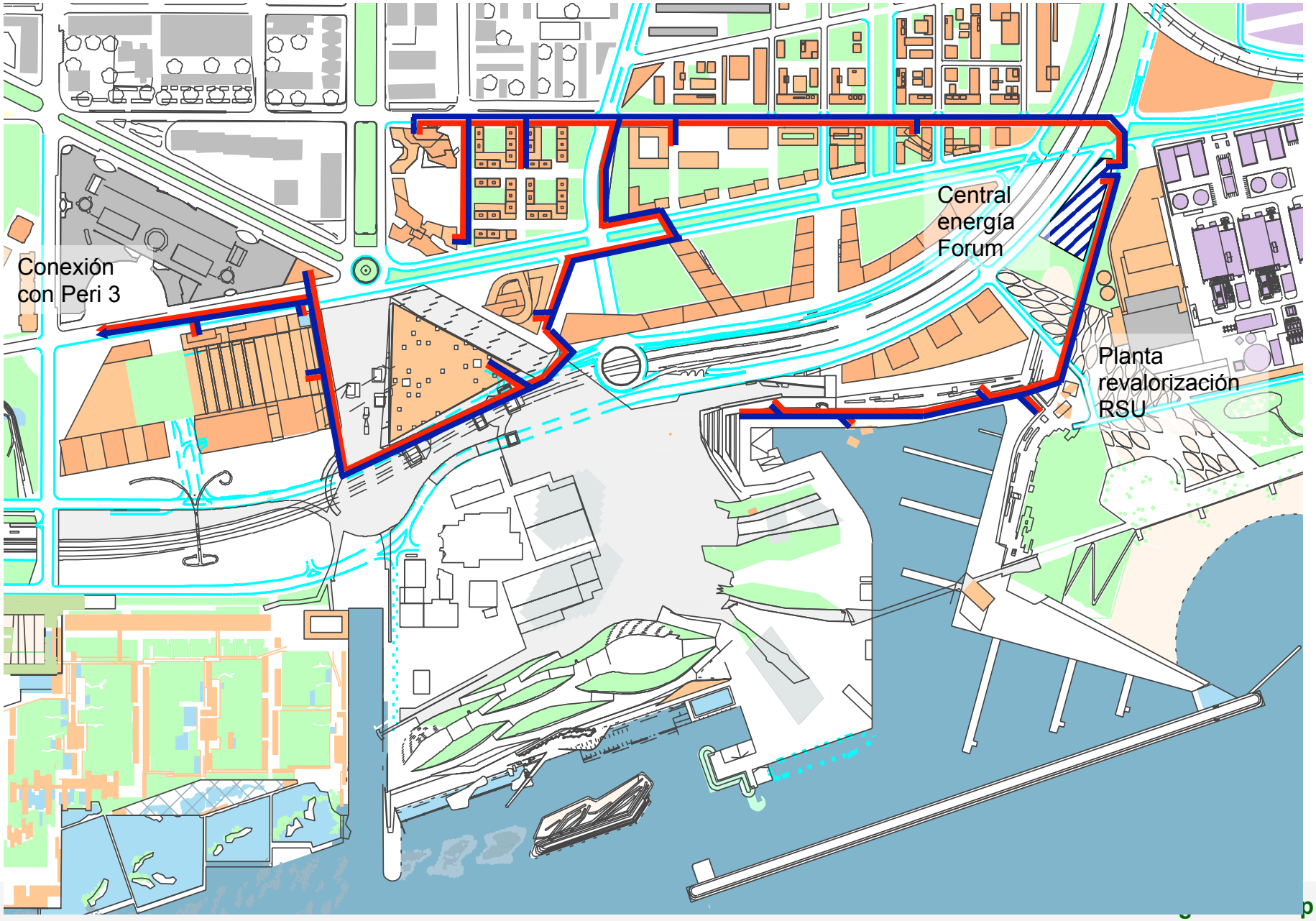
3 x 4000 kWf

5000 m³

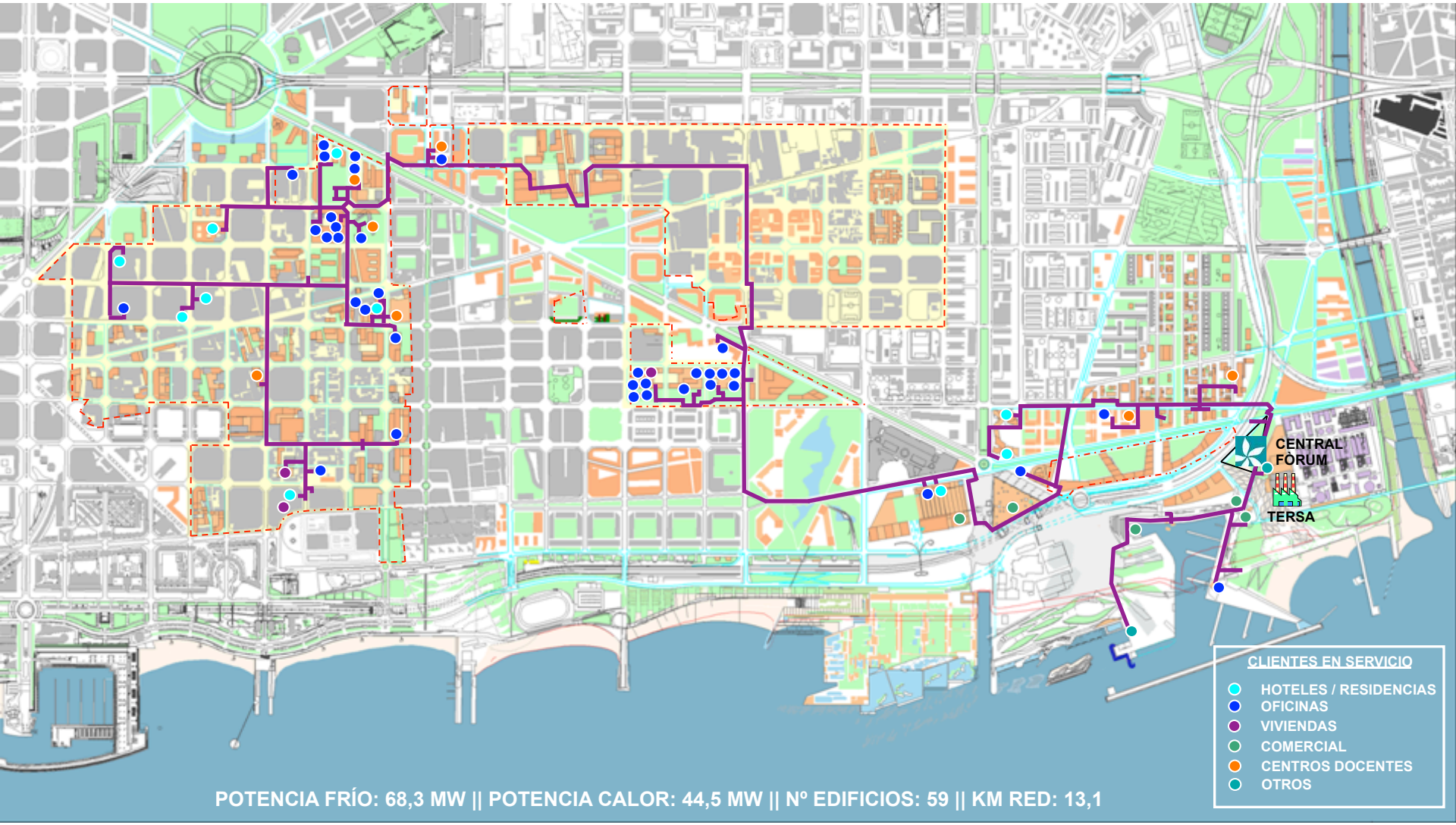
Initial Objetives

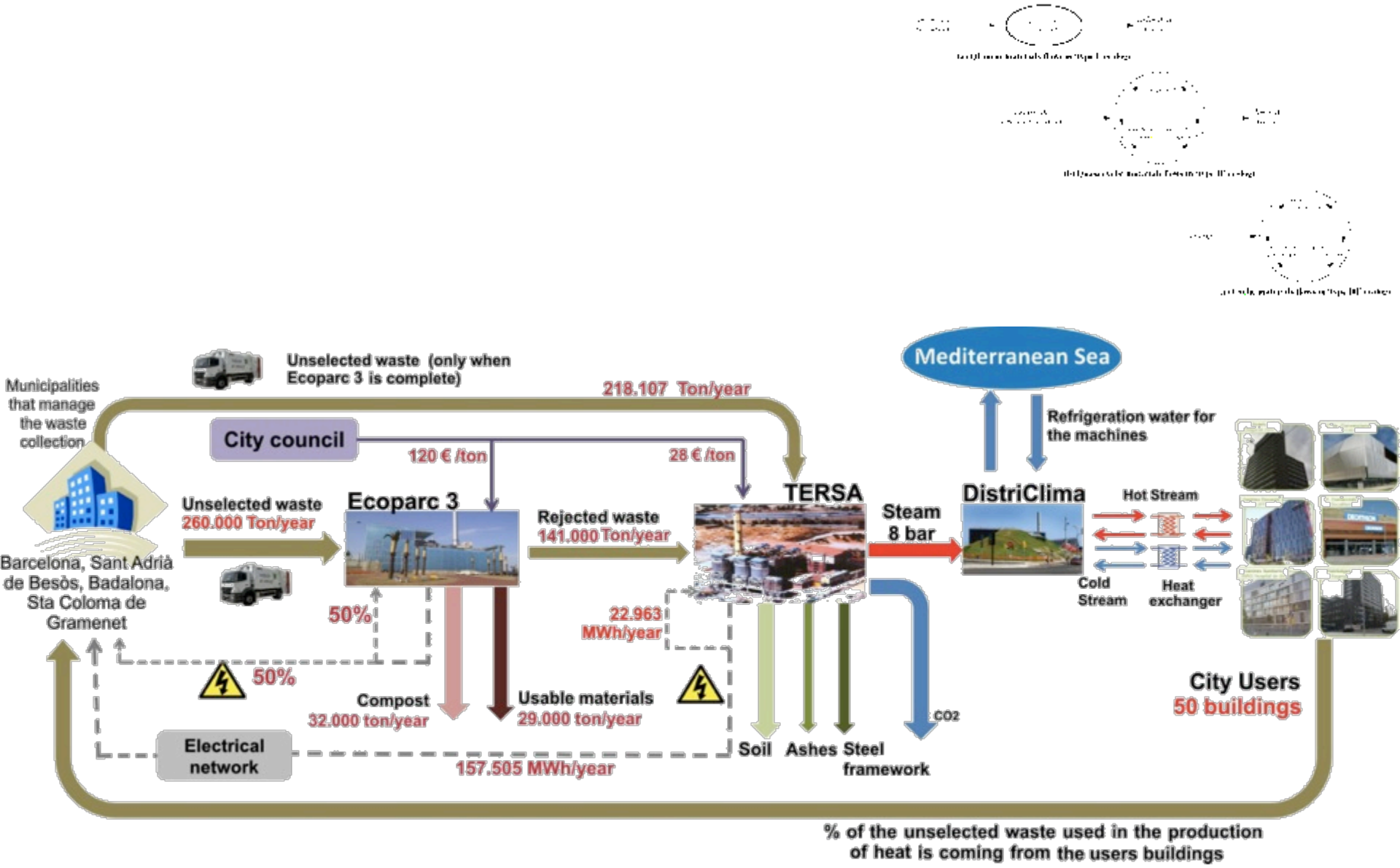
- Max Demand heating 29 MWt
- Max Demand cooling - 41 MWc

- Fossile primary energy reduction 35%
- Power consumption reduction 50%
- GHG emission reduction 52%


Conexión
con Peri 3
Central
energía
Forum
Planta
revalorización
RSU

Forum - 22@


CENTRAL FÒRUM
TERSA
CLIENTES EN SERVICIO
HOTELES / RESIDENCIAS
OFICINAS
VIVIENDAS
COMERCIAL
CENTROS DOCENTES
OTROS
POTENCIA FRÍO: 68,3 MW || POTENCIA CALOR: 44,5 MW || Nº EDIFICIOS: 59 || KM RED: 13,1

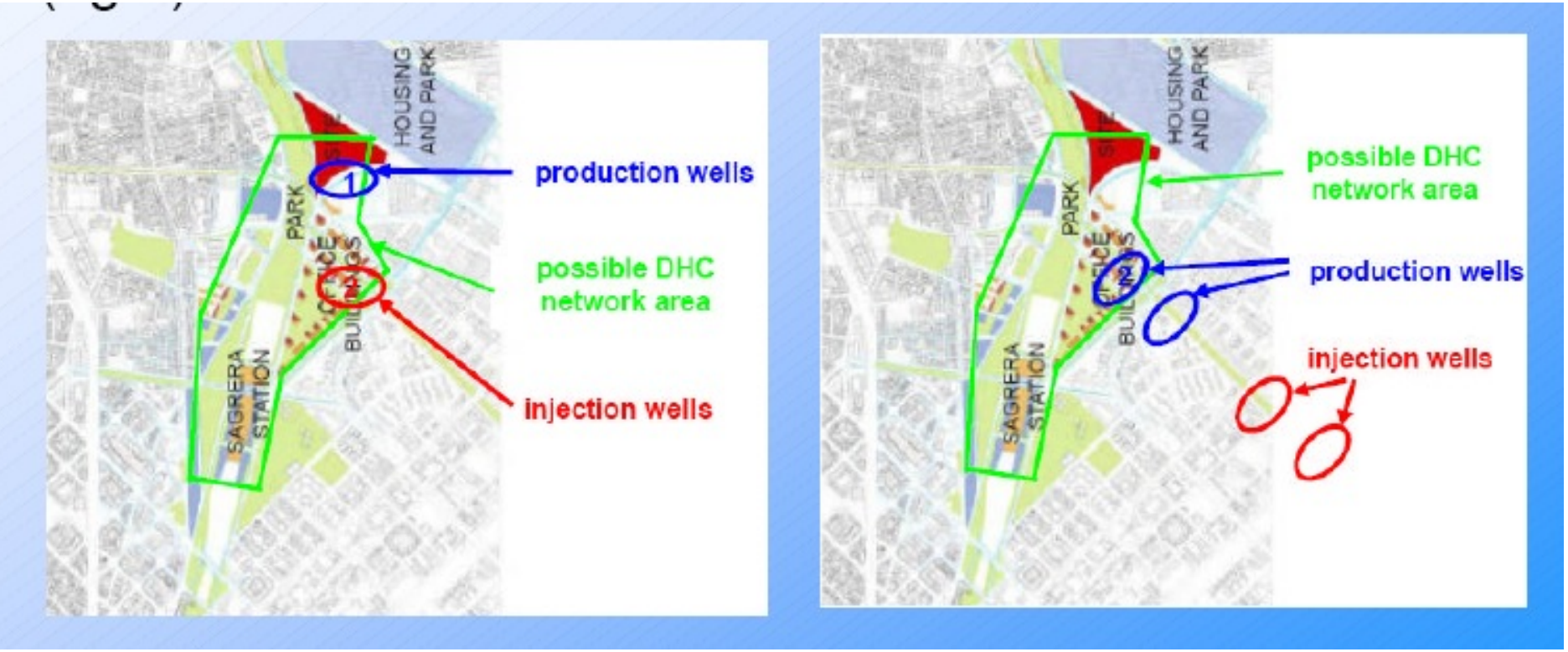

Unselected waste (only when Ecoparc 3 is complete)
218.107 Ton/year
Municipalities that manage the waste collection
City council
120 € /ton
28 € /ton
Mediterranean Sea
Refrigeration water for the machines
Unselected waste
260.000 Ton/year
Ecoparc 3
Rejected waste
141.000 Ton/year
TERSA
Steam
8 bar
DistriClima
Hot Stream
Cold Stream
Heat exchanger
Barcelona, Sant Adrià de Besòs, Badalona, Sta Coloma de Gramenet
50%
22.963 MWh/year
50%
Compost
32.000 ton/year
Usable materials
29.000 ton/year
CO2
City Users
50 buildings
Electrical network
157.505 MWh/year
Soil
Ashes
Steel framework
% of the unselected waste used in the production of heat is coming from the users buildings


CENTRAL FORUM
PLANTA VALORIZACIÓN RESIDUOS

22@ Peak central

Sagrera

Cooling demand
> 40 MW
71.000 MWh/year


HOUSING AND PARK
PARK
SAGRERA STATION
1
2
production wells
possible DHC network area
injection wells
HOUSING AND PARK
PARK
SAGRERA STATION
possible DHC network area
production wells
injection wells

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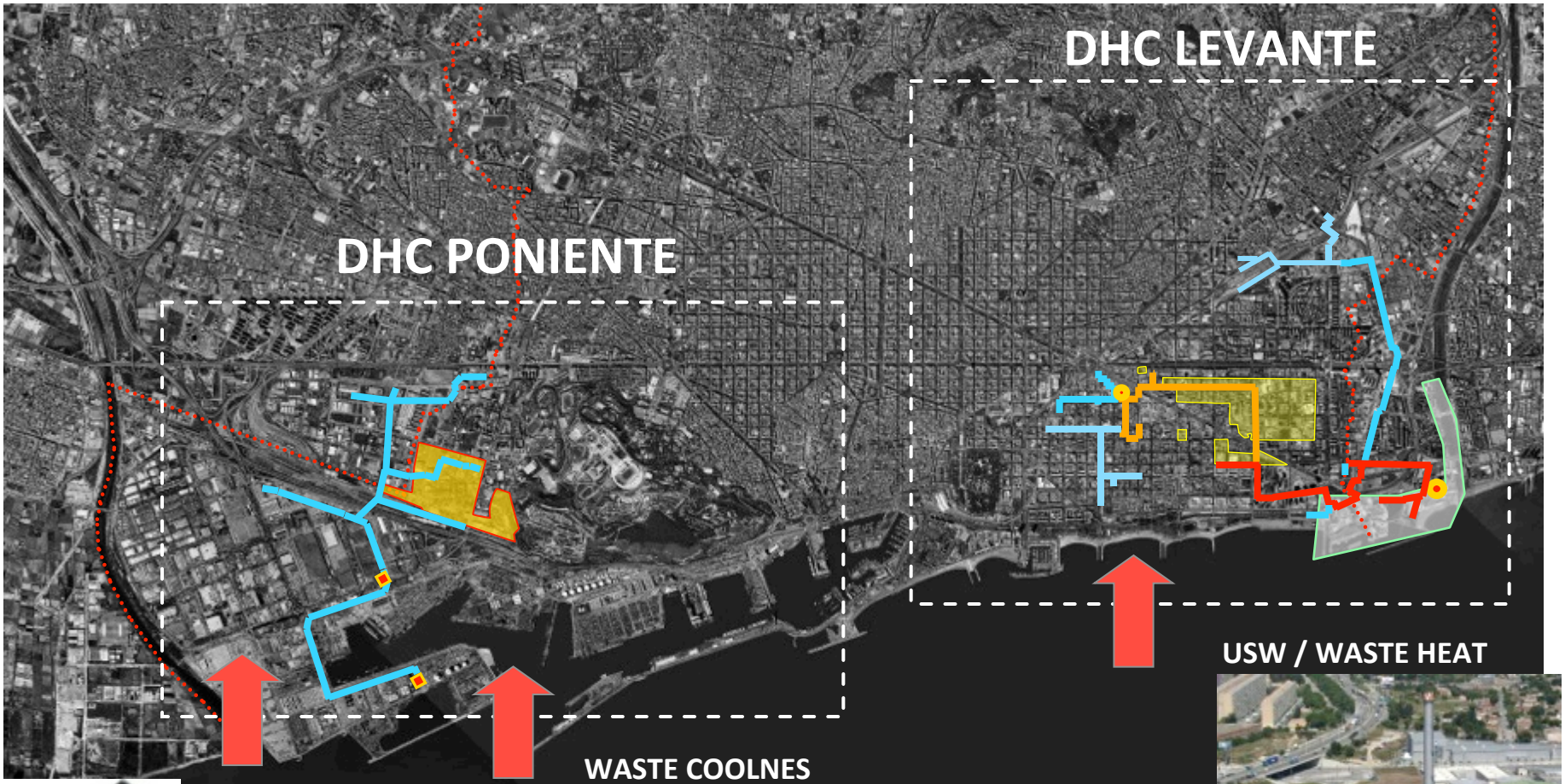
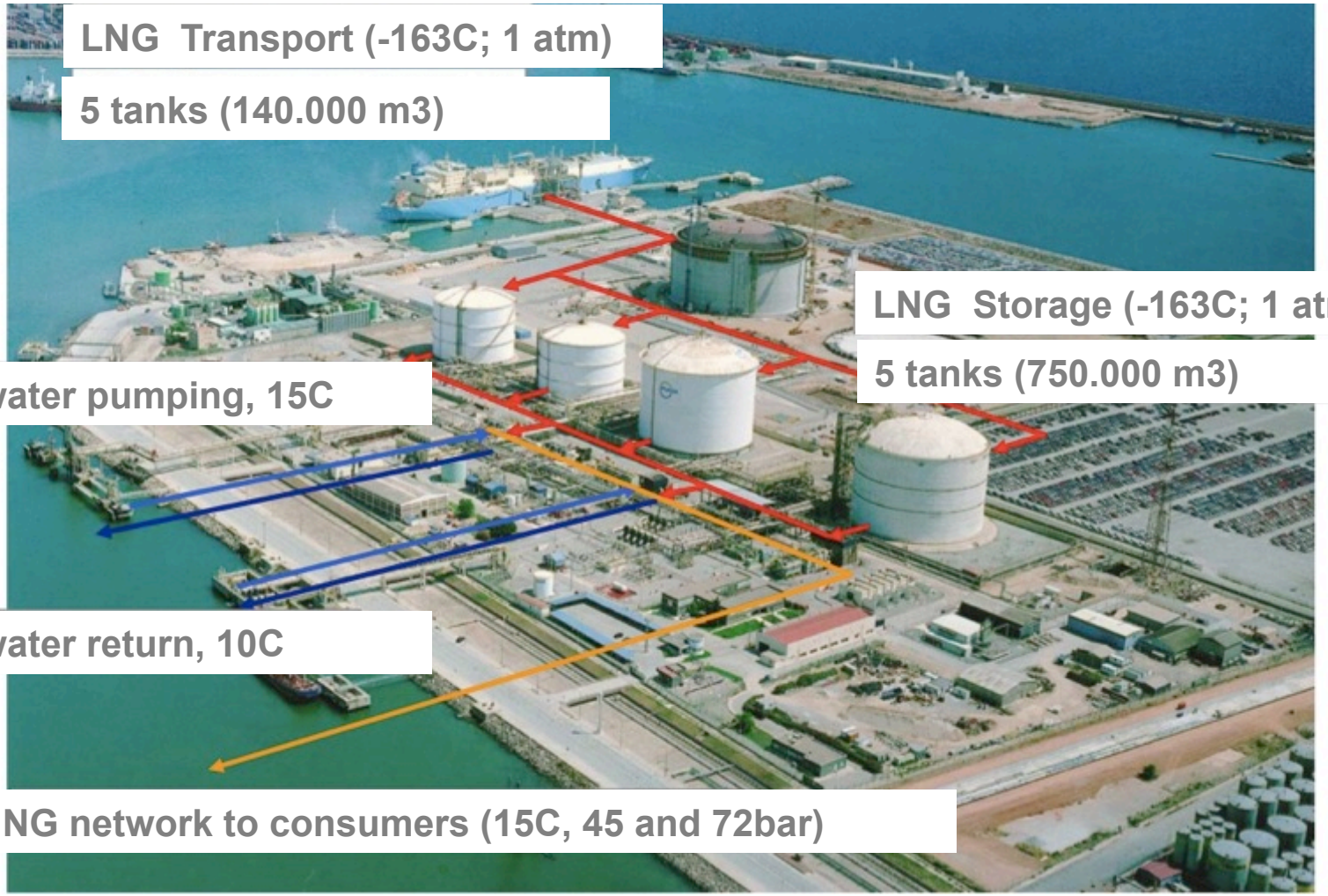
Barcelona: LNG residual coolness / Heat from USW treatment



LNG Regasing plant in Barcelona (ENAGAS)



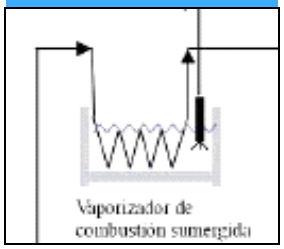
Current process description

1 atm
-163ºC

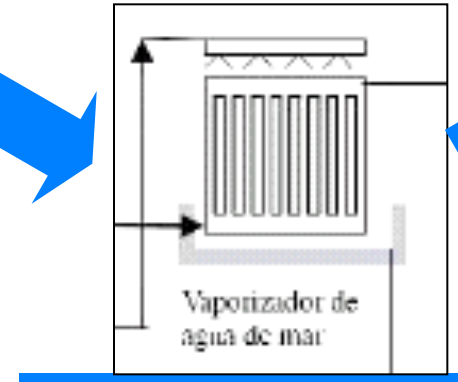
9.300.000 m^3/year of LNG

1 atm
-163ºC

Submerged Combustion



Natural gas consumption



Seawater regassing

45-72 bar
15ºC

5.600.000.000 m^3(n)/year of natural gas

950 GWh/year of residual cooling energy

Cooling seawater

Uses:

Cryogenic Generation

Liquid air separation

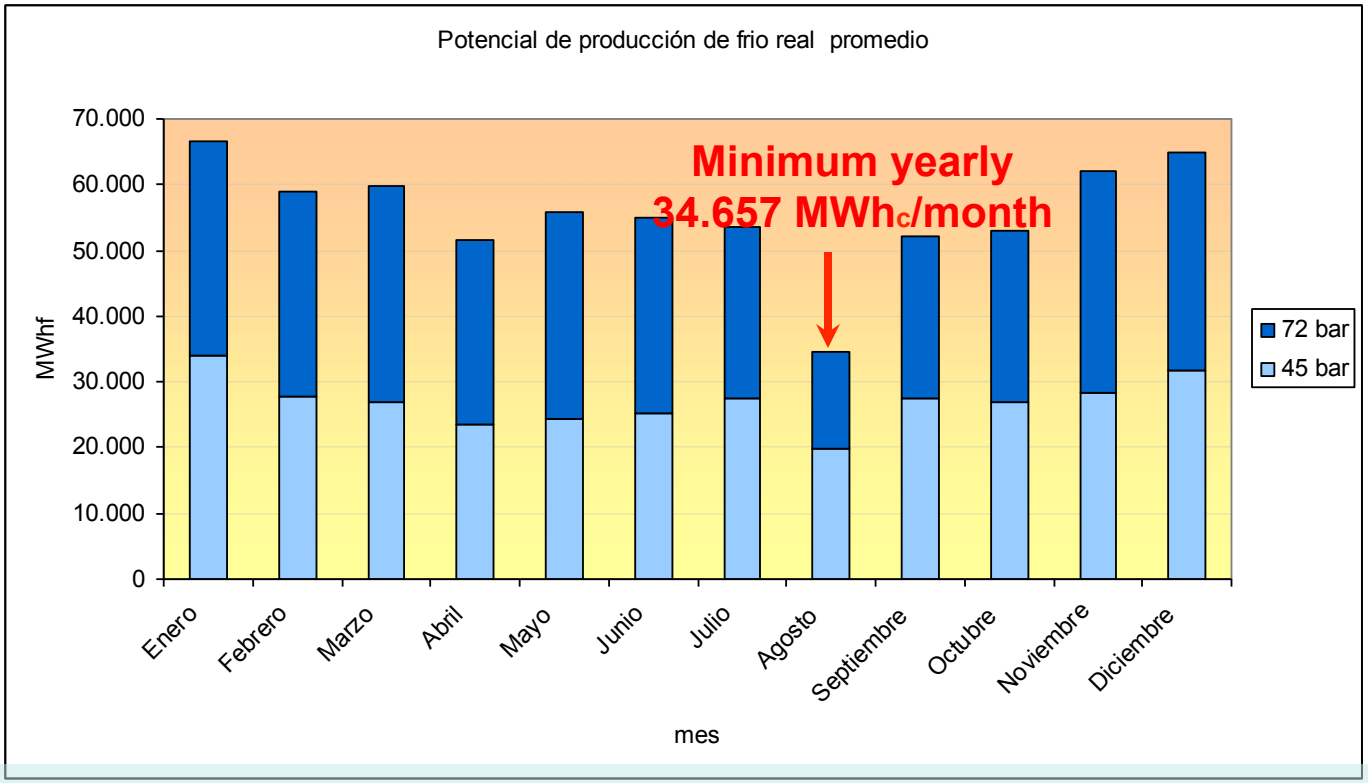
Liquefaction of Boil-Off Gas (BOG)

Freezing and conservation storage

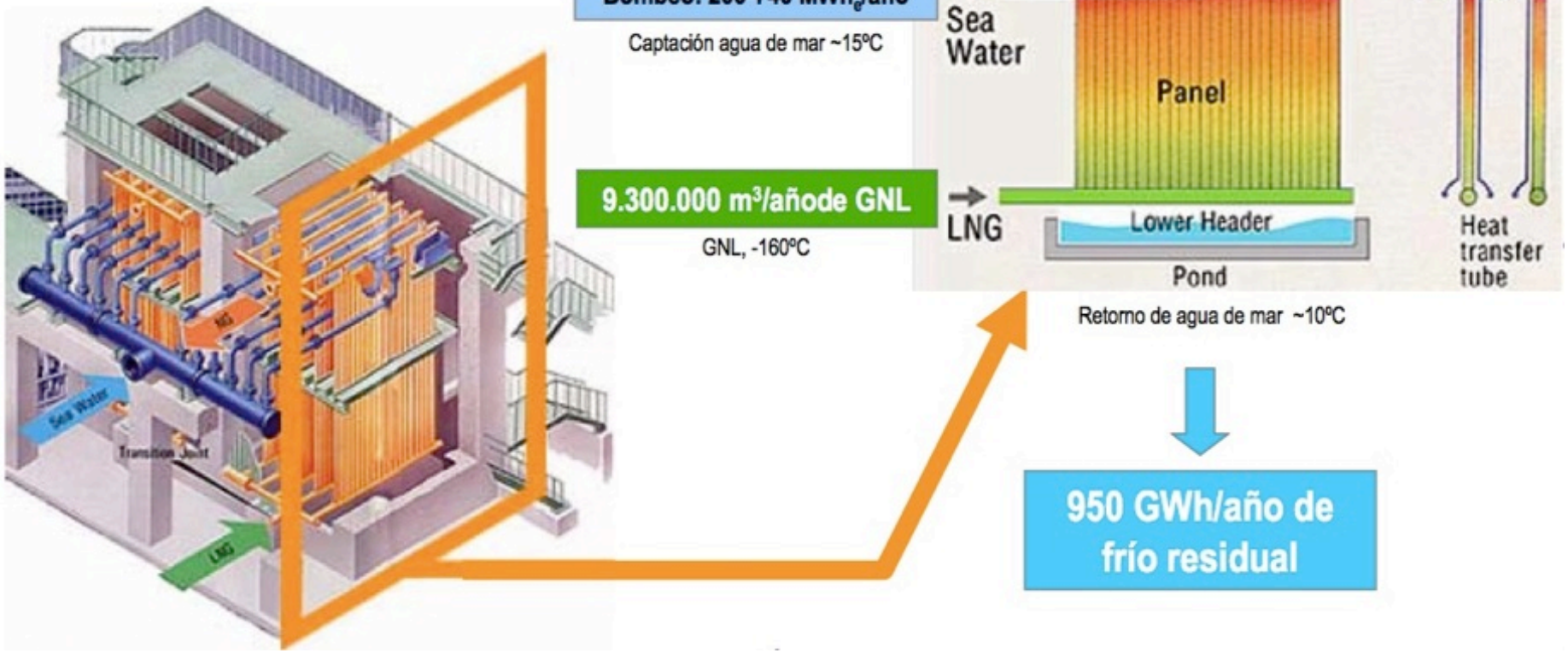
REGASSING & COOLING PRODUCTION

Cooling production capacity

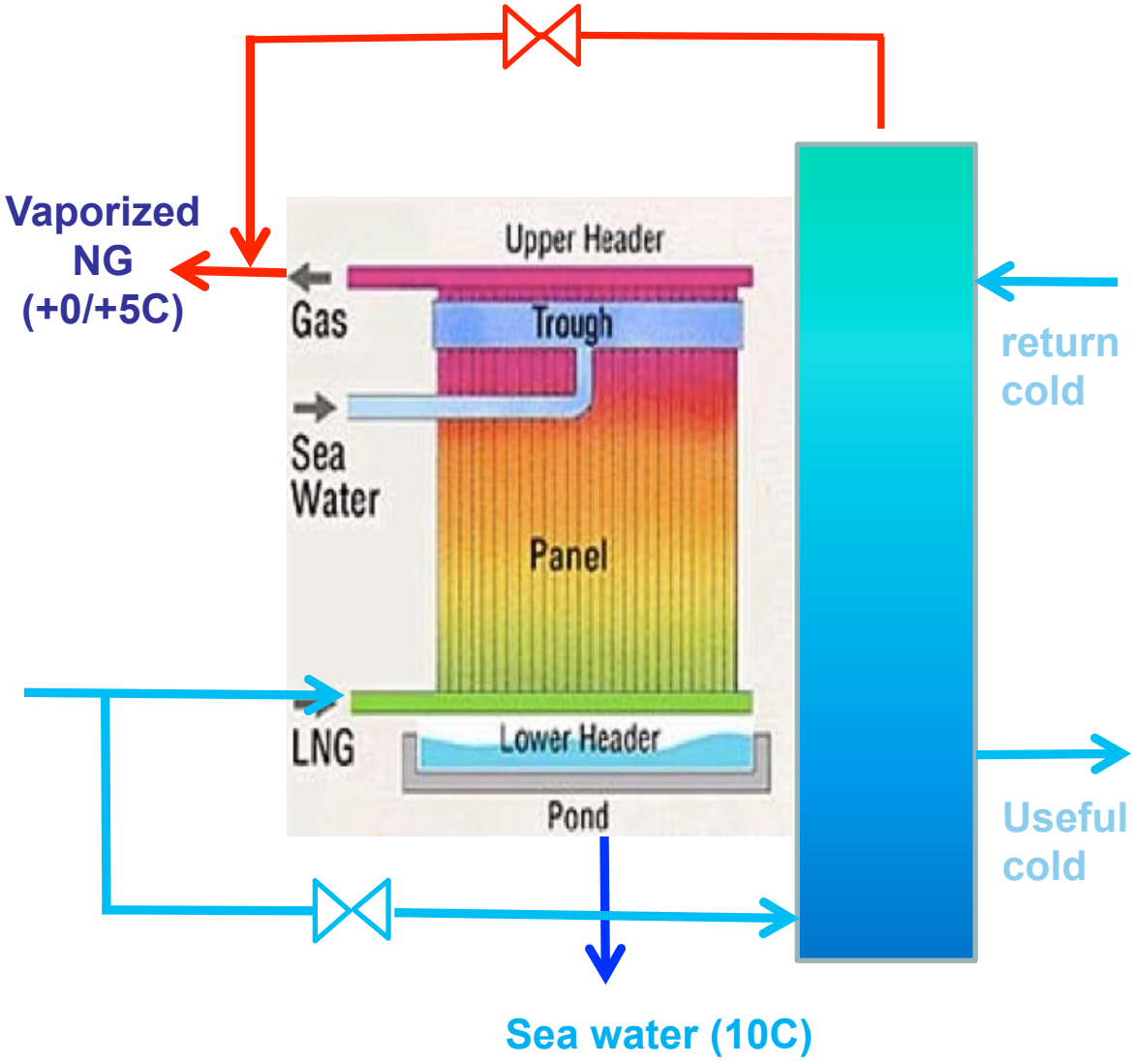
The REAL cooling potential of the Regassing Plant is: **664.753 MWh_c/year**



The hourly analysis has allow determinate the average of the cooling power during August, **47 MWc** (76 MWc during the year),and the daily average in august has been valuated in **1.120 MWhc/day**


Gas Natural, +10ºC
5.000.000.000 Nm³/año
Gas
Bombeo: 200-740 MWhe/año
Sea Water
Captación agua de mar ~15ºC
9.300.000 m³/añode GNL
LNG
GNL, -160ºC
Upper Header
Trough
Panel
Lower Header
Pond
Heat transfer tube
Retorno de agua de mar ~10ºC
950 GWh/año de frío residual
Sea Water
Transition Joint
LNG

Technical approach to coolness recovery



- No interference with Regasification process
- No partial loads allowed: “use it or lose it”
- Temperature levels that allow a feasible technical solution

Urban planning

In this area many new and future urban projects have been under planning

85 buildings in the area, that exist or are foreseen.

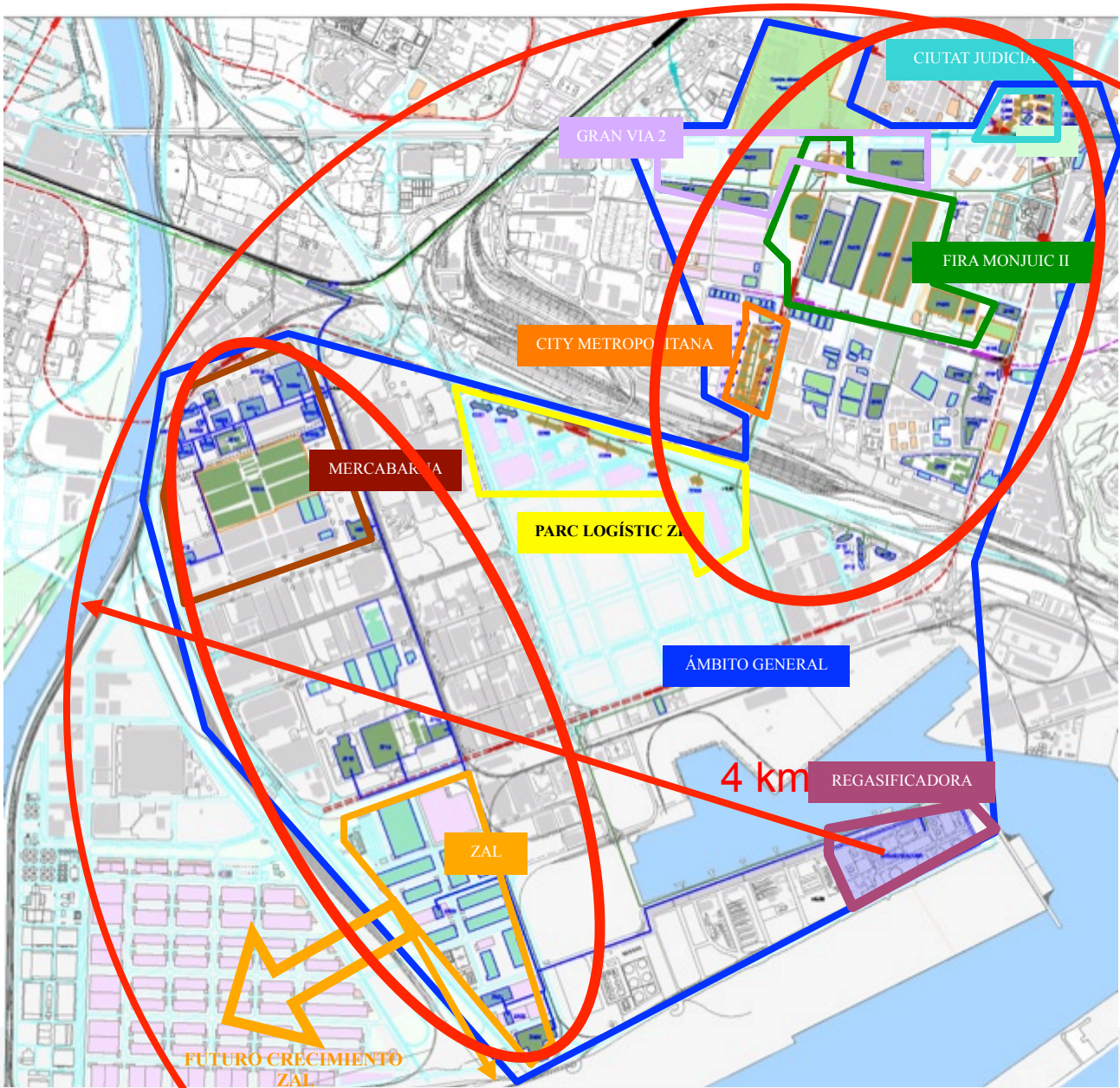
The total surface of tertiary sector are sector **1.136.167 m^2.**
The freezing volume are **364.346 m^3**.

DHC Poniente: ZF, Marina District, Pl. Europa

The Regassing plant is located in the Barcelona's Harbor.

Within a radius of 4 km there is an industrial area and tertiary sector.

Within this area there are potential consumers of both industrial cooling and of air conditioning, in two differentiated areas.



Potential uses of the cooling energy

In the immediately environment of the Regassing Plant:

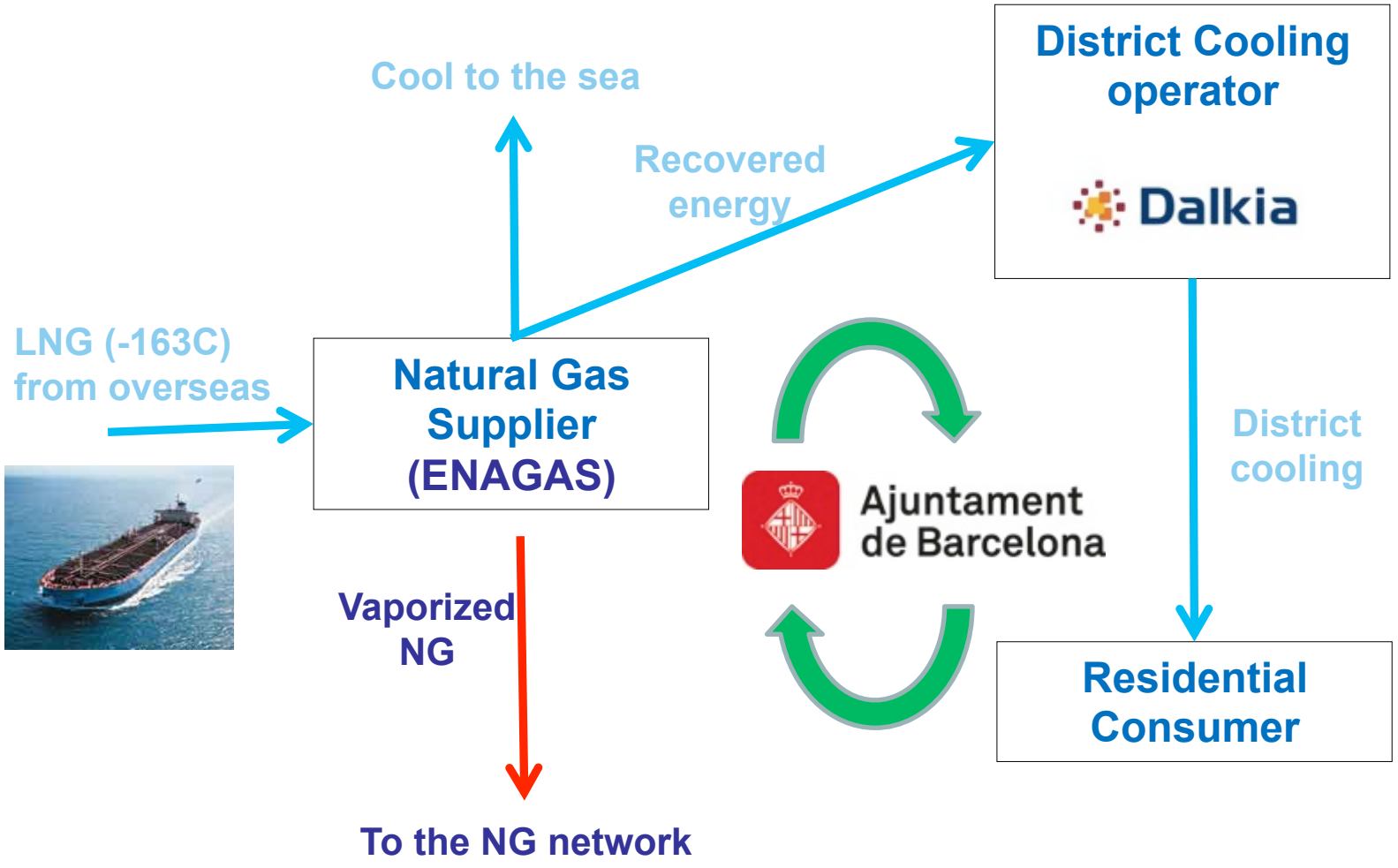
- Industrial
- Tertiary

(a huge potential in front of future urban development)

Depending on the temperature of use they are been classified like:

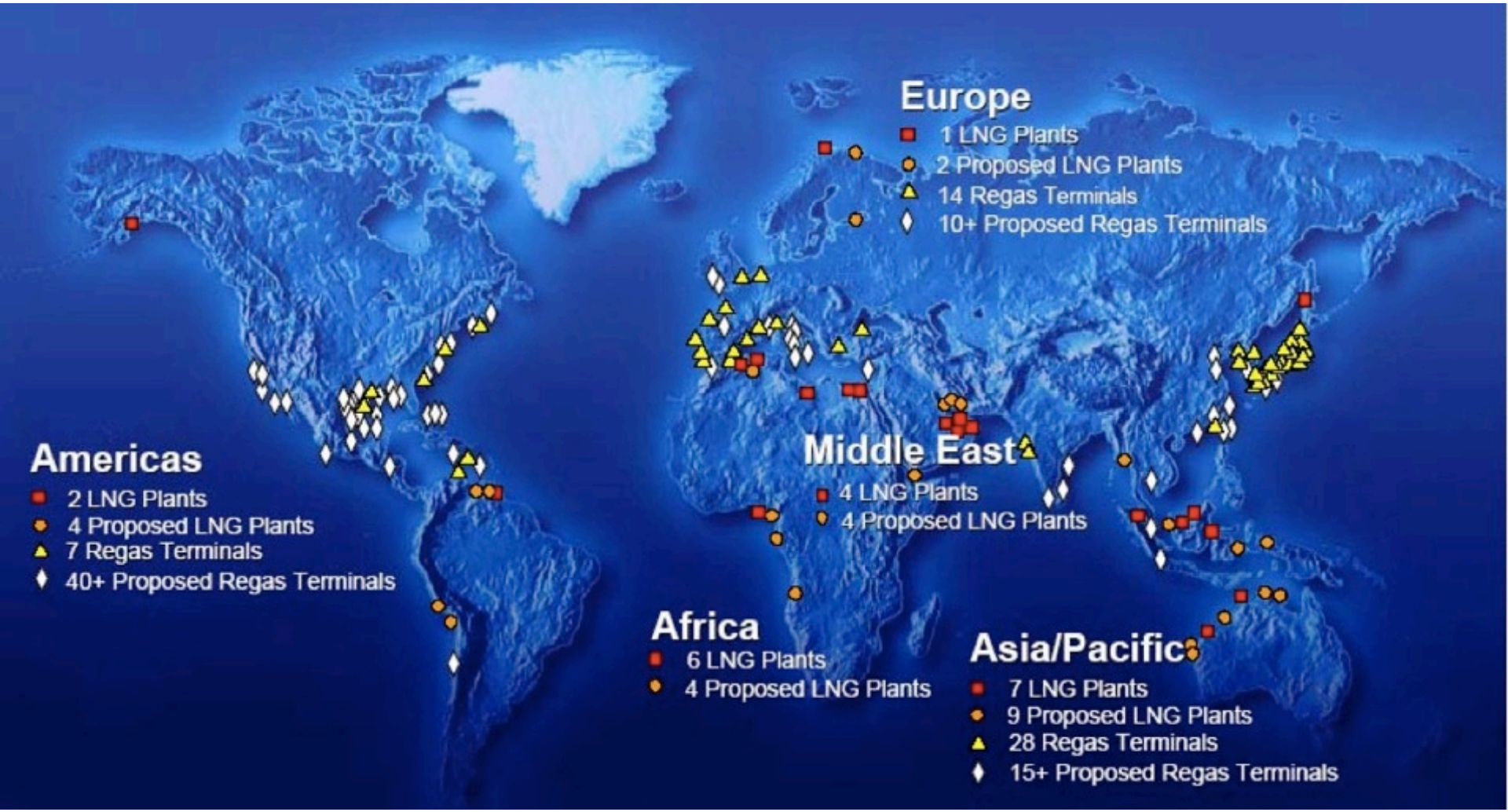
- Refrigeration (+15ºC)
- Air conditioning (+5ºC)
- Conservation (-5ºC)
- Freezing (-30ºC)

Stakeholders in cool recovery




2
1
3

Replicability



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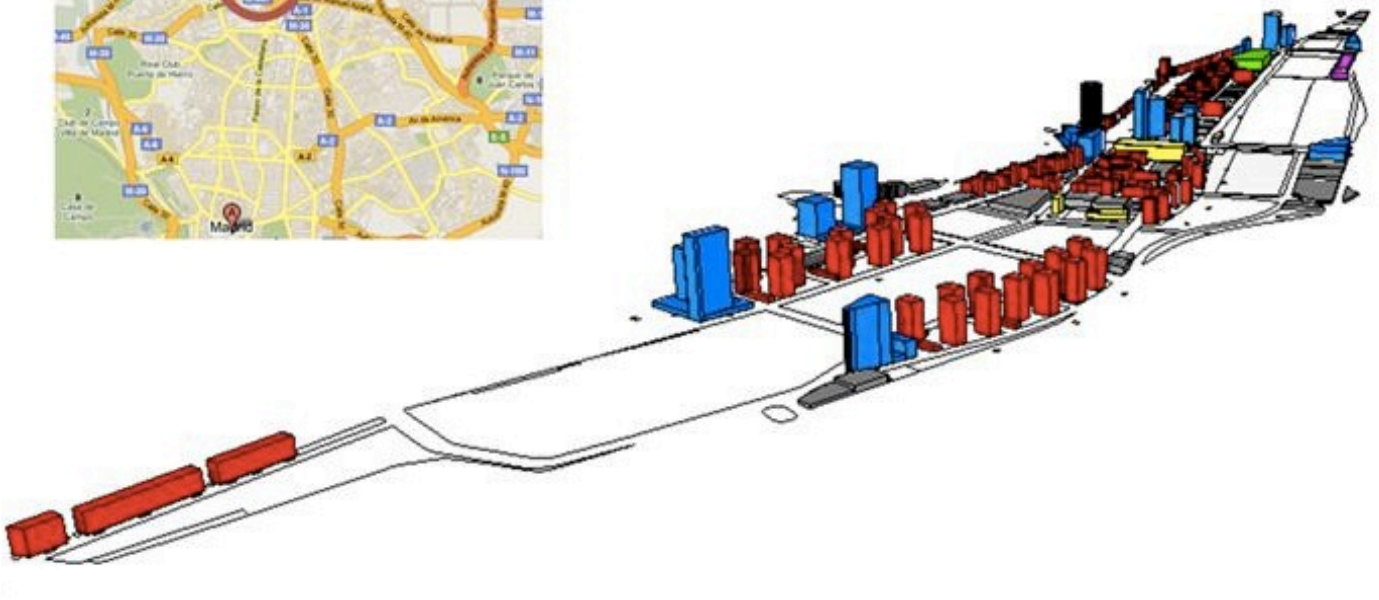
Chamartin - Madrid

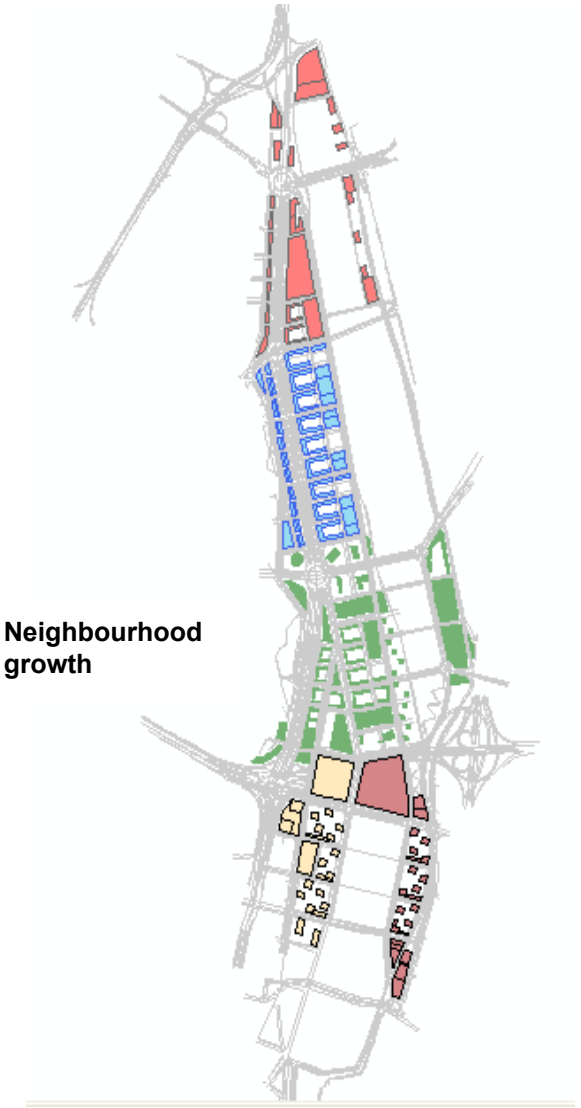


Phasing

	Período de ejecución	Superfície edificable	Número de edificios
Fase 1A	**2013-2015**	415,848.00	25
Fase 1B	**2015-2018**	791,136.00	23
Fase 2	**2017-2020**	1,185,906.00	54
Fase 3	**2019-2022**	512,064.00	44
Fase 4	**2025-2030**	398,434.00	27
TOTAL		**3,303,388.00**	**173**

Fase 1A
Fase 1B
Fase 2
Fase 3
Fase 4

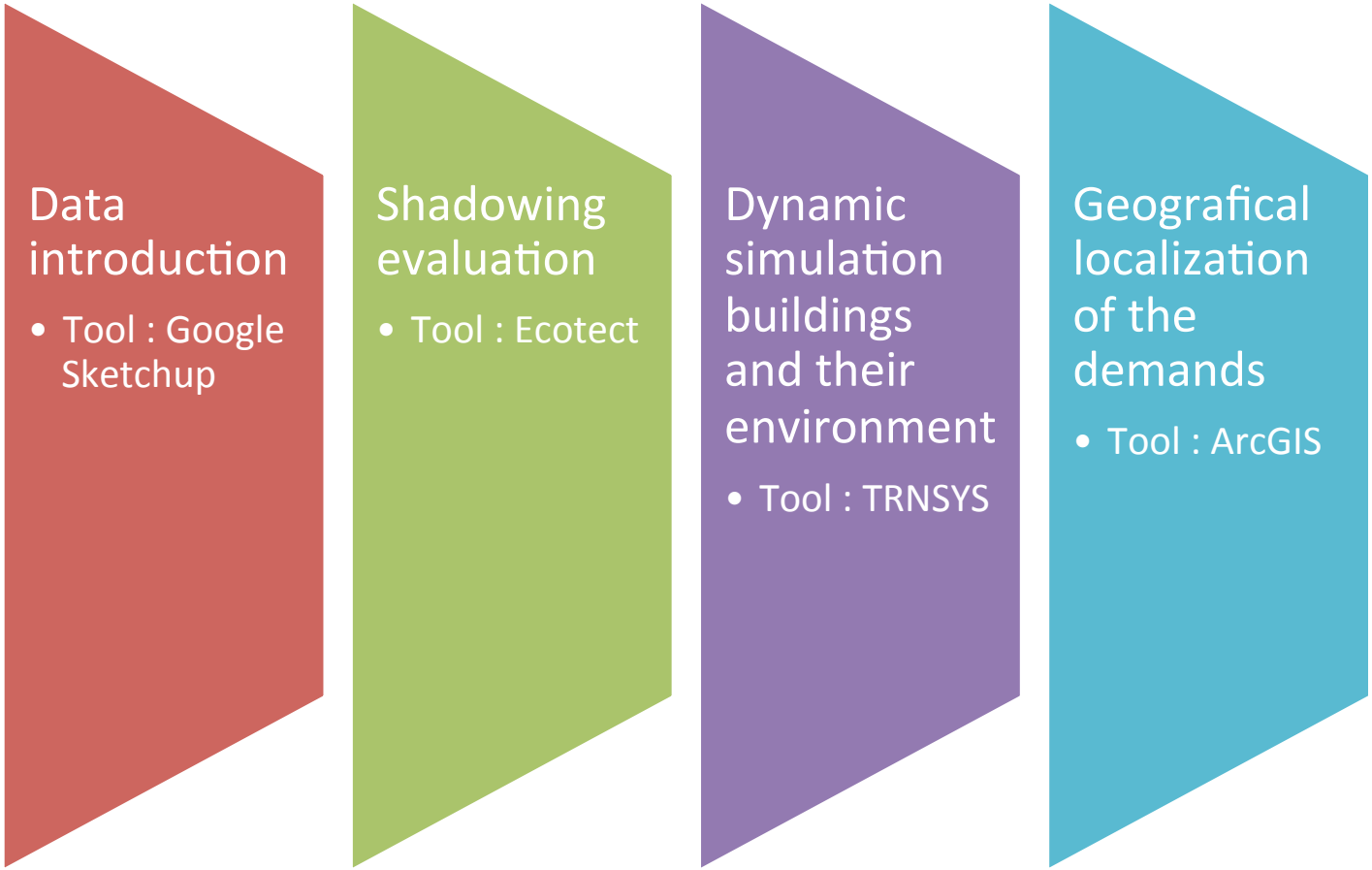
Neighbourhood growth



METODOLOGY

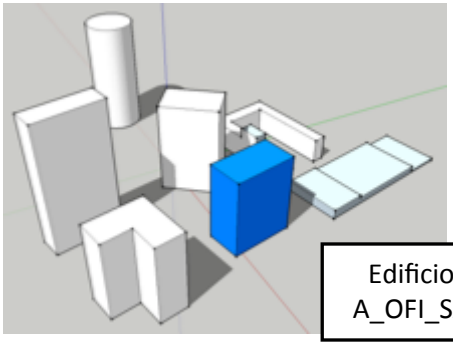
- ESTABLISHMENT OF THE TECHNO_ECONOMIC HYPOTHESIS
- DEMAND ANALYSIS UNDER DIFFERENT CRITERIA: PRESENT AND FORTHCOMING BUILDING CODES
- MAPPING OF THE ENERGY DEMANDS WITHIN THE NEIGHBOURHOOD
- AGREGATION OF THE DEMANDS WITHIN DIFFERENT NETWORKS, AFTER THE GROWTH SCENARIOU
- EVALUATION OF THE ENERGY SUPLY ALTERNATIVES
- FINANCE ANALYSIS OF DIFEERENT SCENARIOUS

DEMAND ANALYSIS FOR THE NEIGBOURHOOD

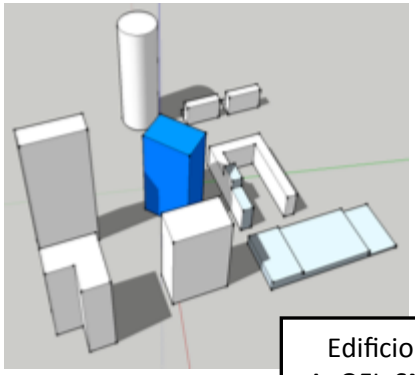


DEMAND CALCULATION FOR THE NEIGBOURHOOD

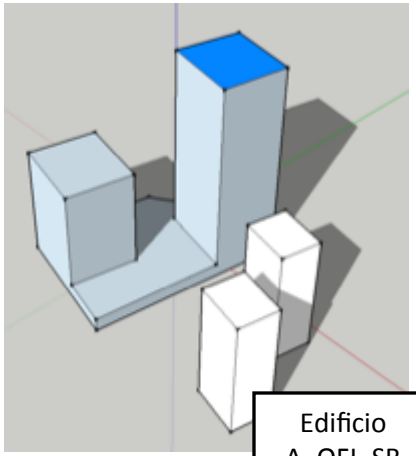
- Offices



Edificio
A_OFI_SA



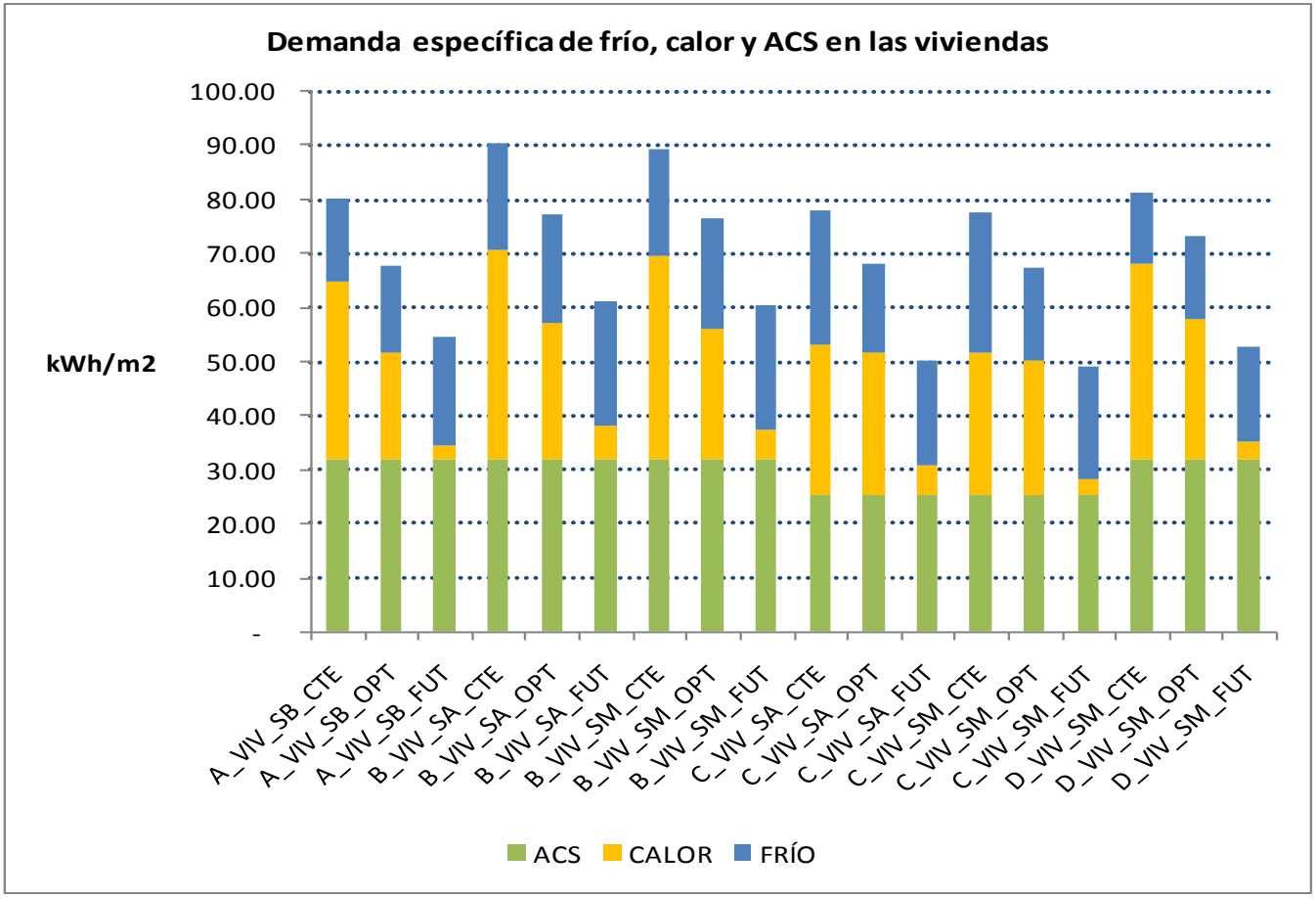
Edificio
A_OFI_SM



Edificio
A_OFI_SB

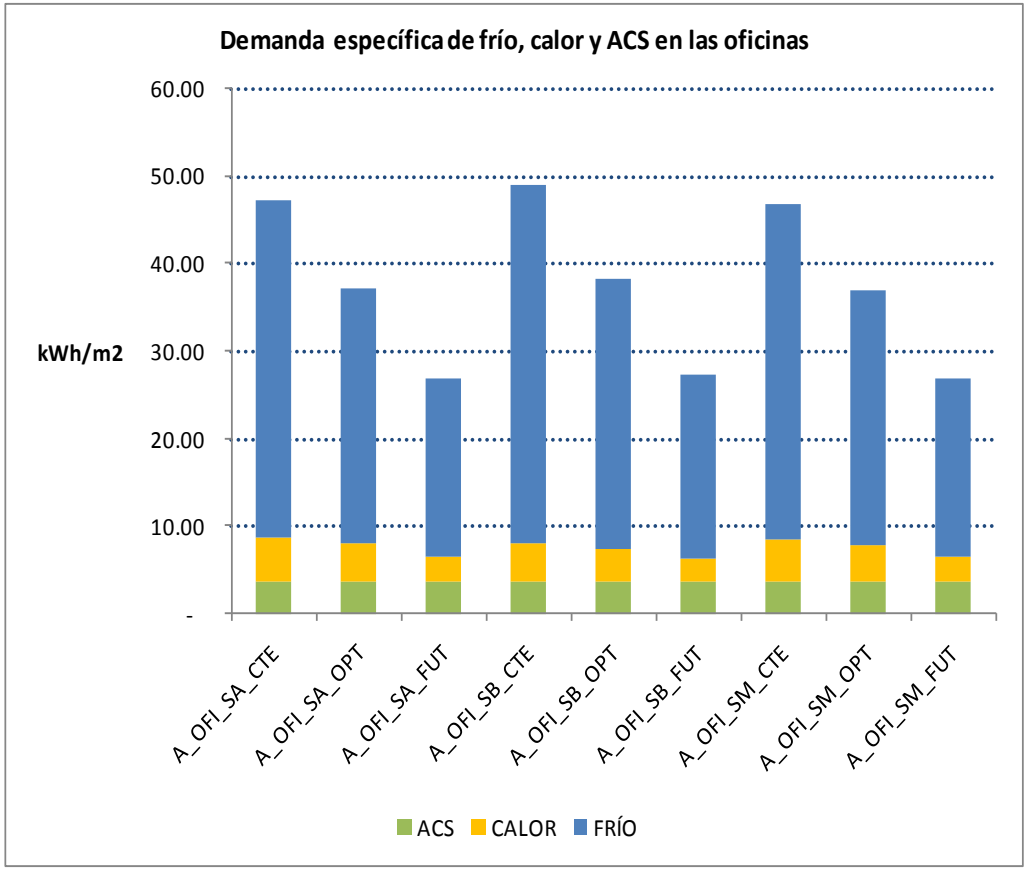
Demand Calculation For The Neigbourhood

- Residential



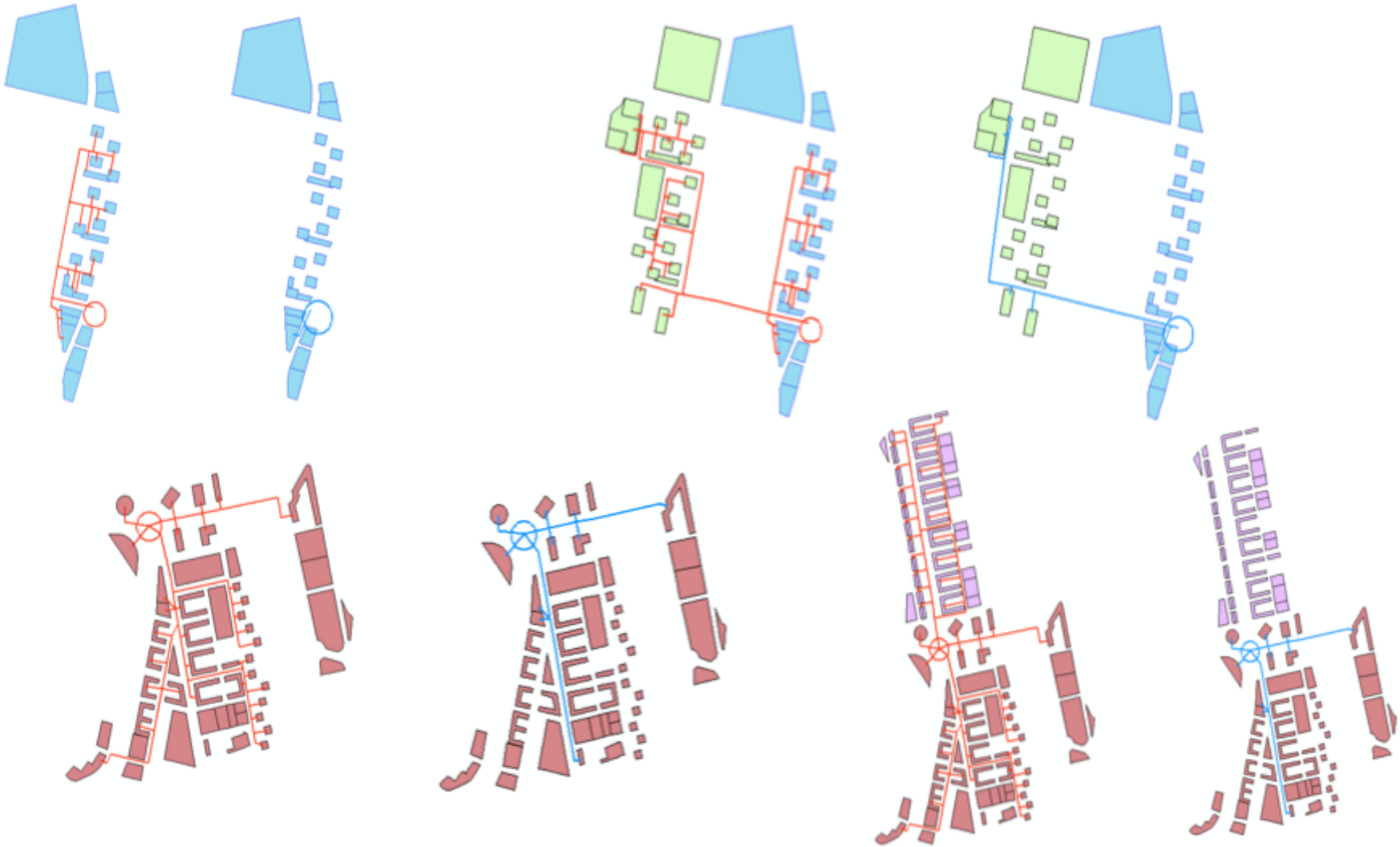
Demand Calculation For The Neigbourhood

- Offices



MAPPING OF THE ENERGY DEMANDS WITHIN THE NEIGHBOURHOOD

Demand Agregation

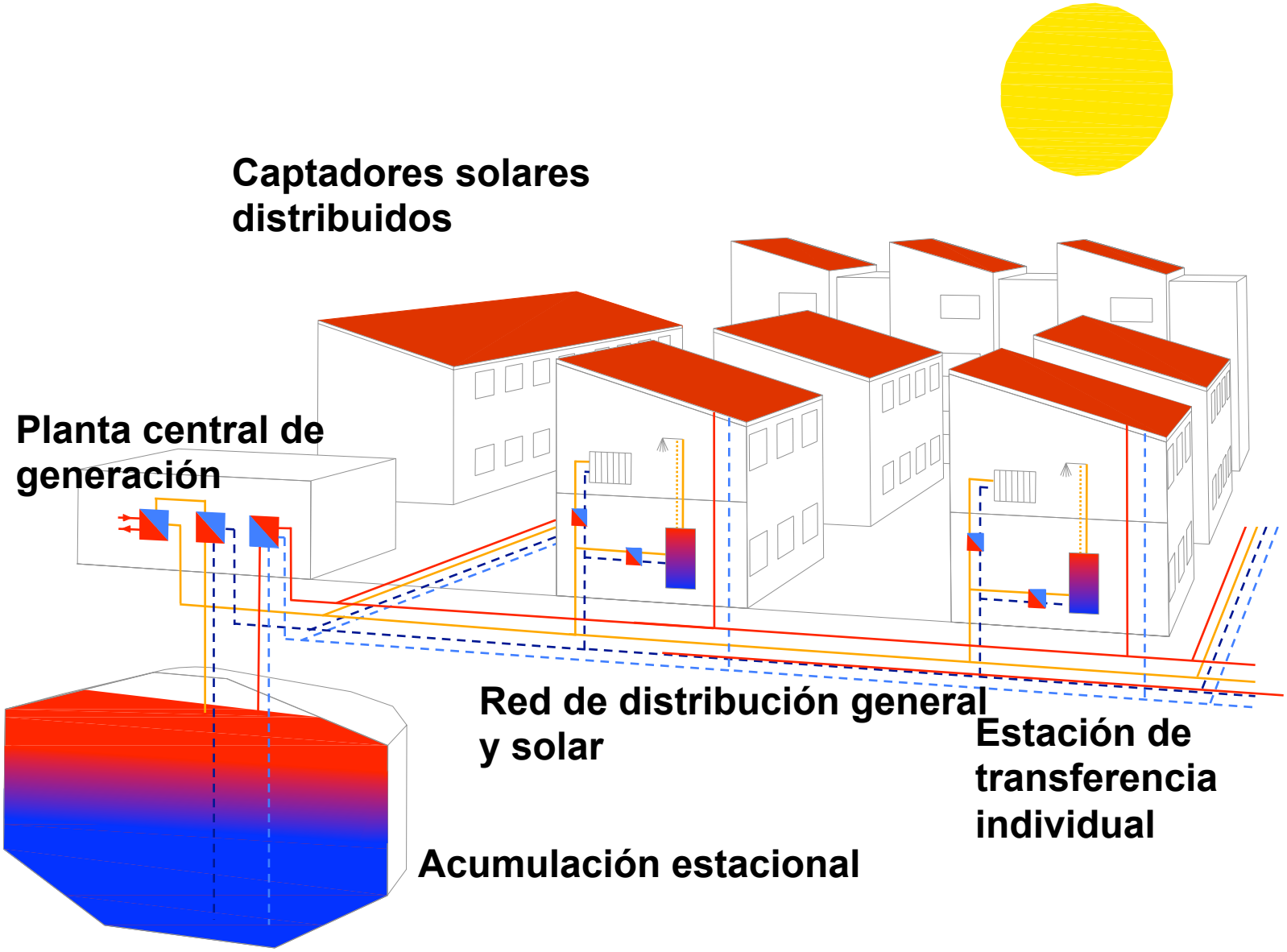


ENERGY SUPLY ALTERNATIVES

- Co/tri generation

- Biogas
- Solar integration

SOLAR INTEGRATION



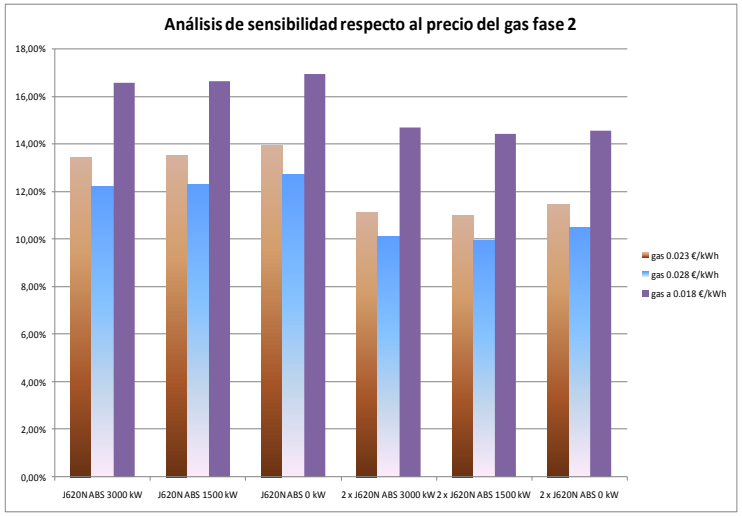
SOLAR INTEGRATION

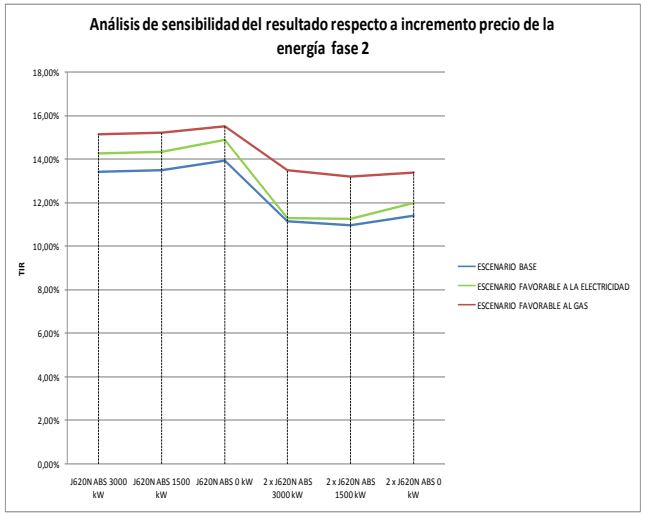
1) Connection to the return, without storage

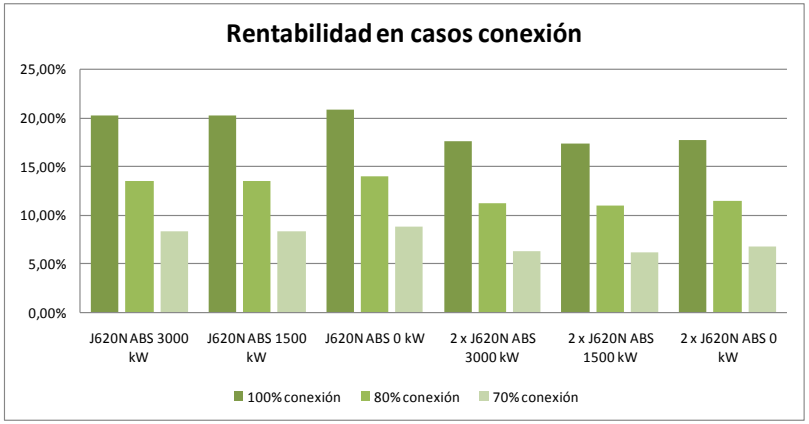
2) Connection via segregated circuit; with seasonal storage

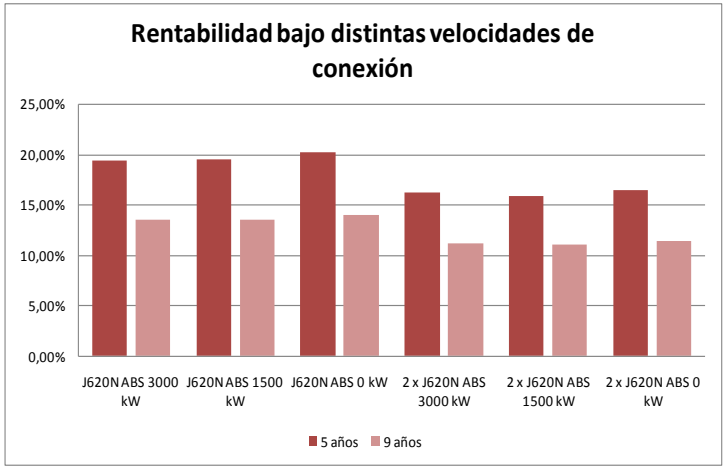
3) Network 2.0: low temp distribution (45º C). Excess heat from office air conditioning with distributed HP. Solar connected before oa after HP

FINANCE ANALYSIS









- Introduction
- Forum-22@ - Barcelona
- Marina/Zona Franca - Barcelona
- Chamartin – Madrid
- Conclusions

Several areas for innovation:

- Technological
  - In core technology
  - In system management (by source using, by demand management)
  - In system implementation

- Non technological
  - In COMMUNICATION
  - In pricing system
  - In finance
  - In client capturing

Core technology

- Production
  - Efficiency of the conventional equipment (including growth / volume – to industrial machines); Magnetic levitation beerings
  - Natural sources (free cooling: see, lakes, rivers, aquifers, snow; solar; geothermal)
  - Residual energy (waste treatment, regasing LNG)
  - CO2 reuse

- Distribution
  - Network capacity increase (DT)
  - Materials+ insulation (nanotech, High Performance Thermal Insulation)
  - Fluids
  - Storage (phase change – ice slurries)
  - System implementation (synergy with other infrastructures)
  - DHC 2.0

- Delivery
  - Communication with client system (<=> non tech. - Dynamic pricing)
  - Foster alternative solutions on client side (in planning)
  - Admit lower in temperature on primary


THANK YOU !
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