GROUND SOURCE VERY LOW TEMPERATURE 5GDHC IN ZORROTZAURRE. BILBAO

FINAL CONFERENCE

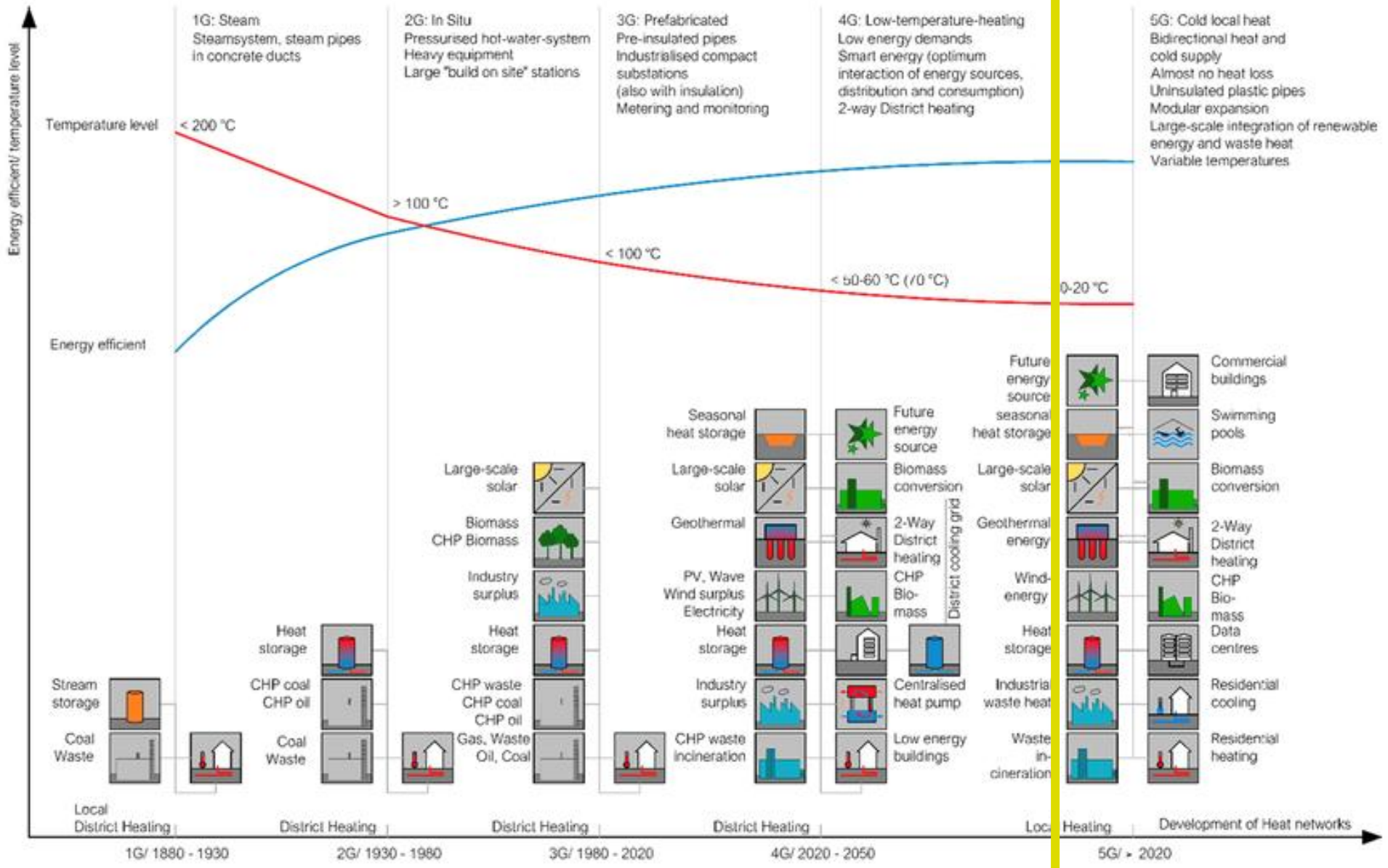
12th March 2026

AmsTErdam BiLbao cItizen drivEn smaRt cities

atelier
Positive Energy Districts

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.864374

INTRODUCTION



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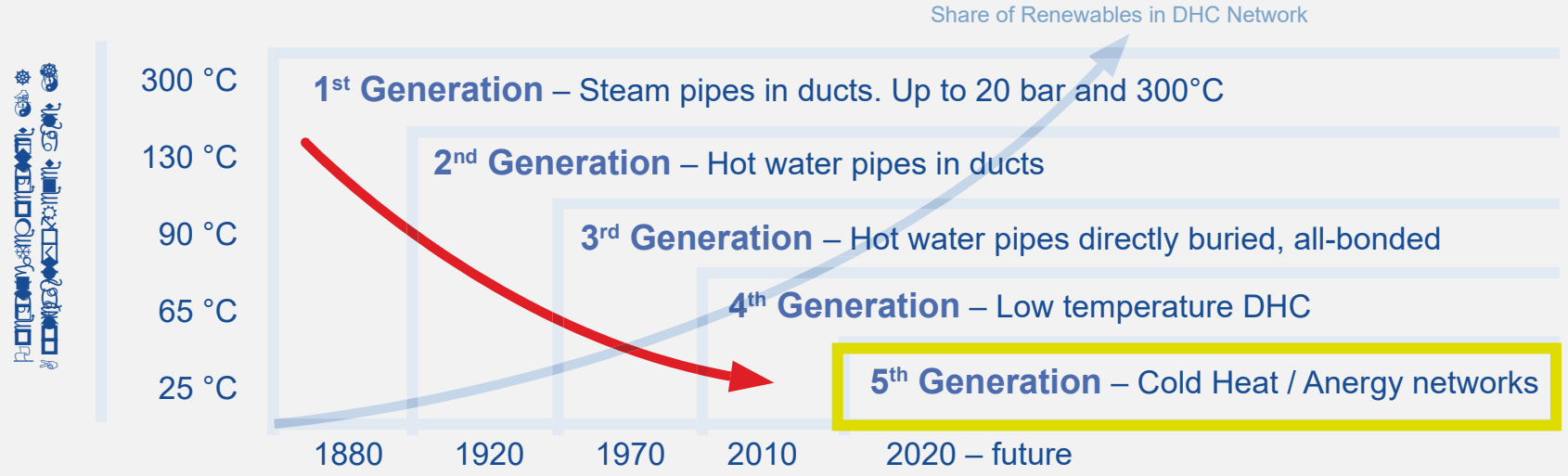
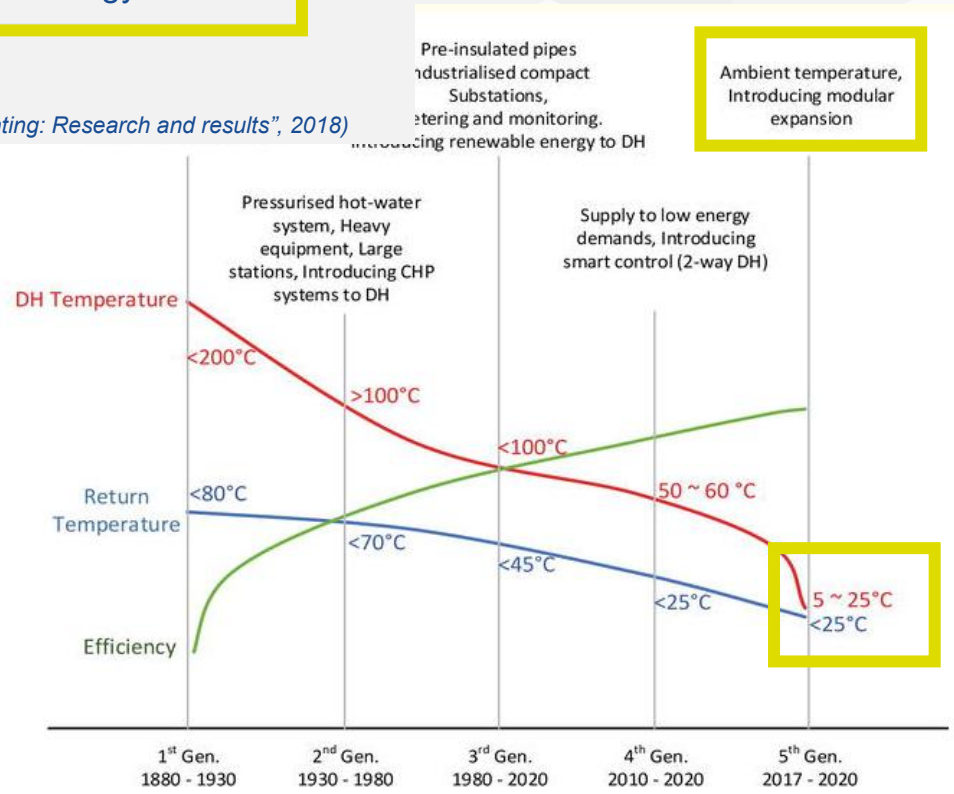
5G DHC (very low temperature networks)



Development of district heating systems. (in accordance with: Lund, H. et.al.: "The status of 4th generation district heating: Research and results", 2018)

5G DHC

- Anergy networks
- Supply heat / cold
- Heat flow bidirectional, sources and sinks.
- Large scale integration of renewable energy (GSHP, solar thermal) and waste heat.
- Not heat losses (even heat gain)
- Reduced investment: plastic piping vs steel. 2 pipes to provide cold and heat (not 4). Uninsulated HDPE pipes
- Temperatures 10 ºC (winter) – 30 ºC (summer)
- Ideal for mixes-use areas: residential, services and industrial



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ZORROTZAURRE DISTRICT

AREA HEATED	457.00 m^2
NEW DWELLINGS	3.650 (62 BLOCKS)
EXISTING DWELLINGS	400 (46 BLOCKS)
NEW BUILDINGS	17
REFURBISHED BUILDINGS	23
HEATING CAPACITY	21 MW
HEATING DEMAND	12.7 GWh/y
COOLING CAPACITY	13 MW
COOLING DEMAND	8.5 GWh/y

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ENERGY/CAPACITY KPI Zorrotzaurre District

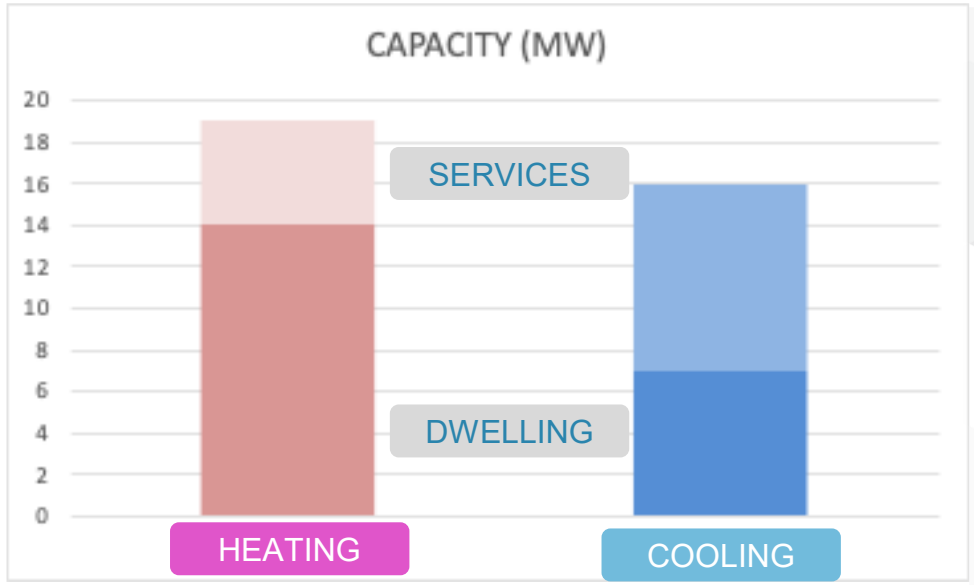
PEAK LOAD

HEATING 21 MW

DWELLING	SERVICES
14 MW	7 MW

COOLING 13 MW

DWELLING	SERVICES
5 MW	9 MW



THERMAL ENERGY DEMAND

HEATING 12.7 GWh/y

DWELLING	SERVICES
8.6 GWh/y	4.1 GWh/y

COOLING 8.5 GWh/y

DWELLING	SERVICES
4.3 GWh/y	4.2 GWh/y

SHW 3.7 GWh/y

DWELLING
3.7 GWh/y

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Zorrotzaurre District Thermal Energy Proposals

1	DH with CHP natural gas plant on site (3G DH)
2	DH with Biomas placed in the neighbourhood of the island (3G DH)
3	DH with Waste Heat of Waste incineration Plant of Zabalgarbi (distance 10 km) (3G DH)
4	**5 th generation DHC -> geothermal source: closed and open loop and surface water for peak loads**

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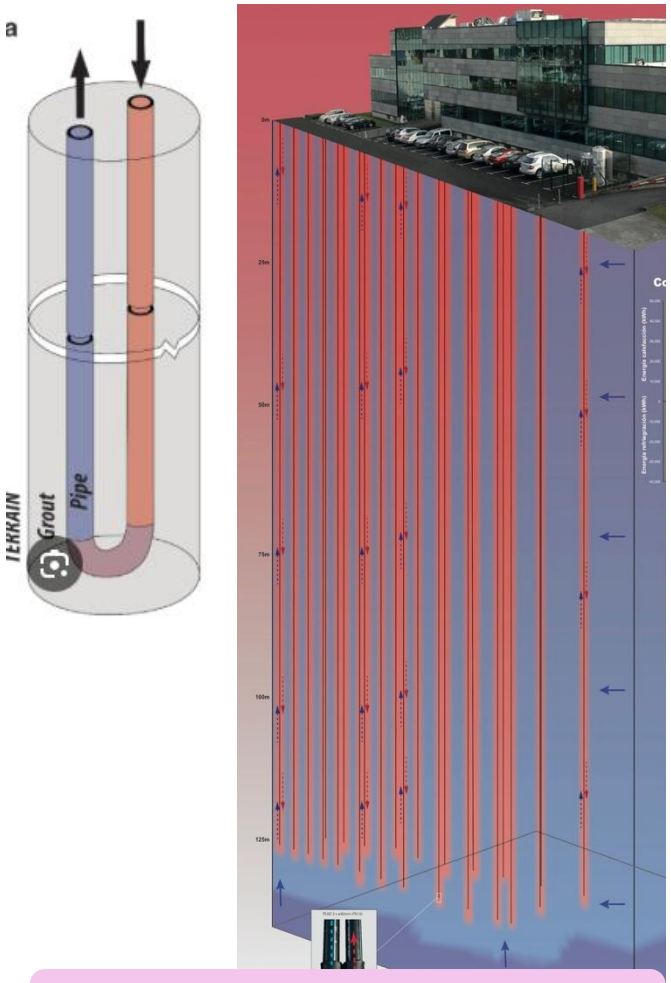
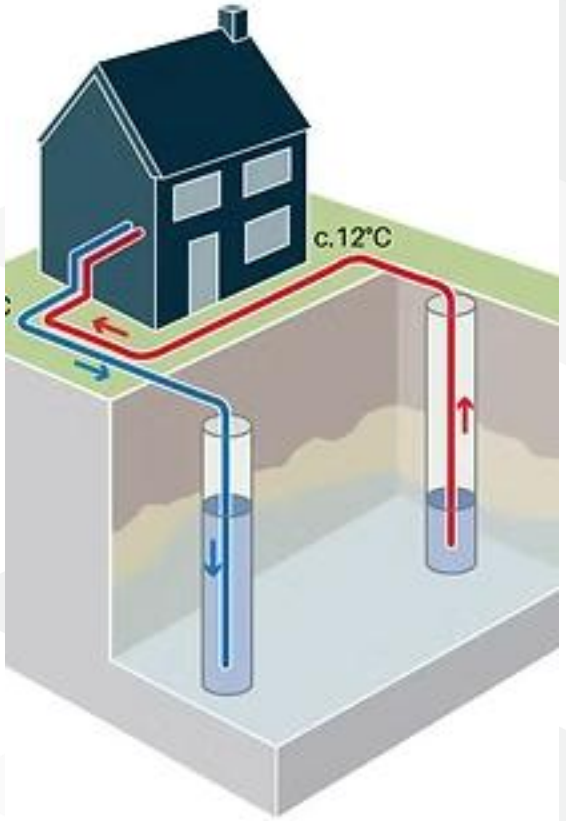
Zorrotzaurre 5GDHC WITH WATER-WATER HEAT PUMPS

CLOSE LOOP
(BOREHOLES)



4 MW

OPEN LOOP
(GOUND WATER WELLS)



8 MW

SURFACE WATER
(HYDROTHERMAL)

3 MW

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Zorrotzaurre 5GDHC EVOLUTION

2015	5GDHC first proposal: boreholes, groundwater wells and hydrothermal energy support. First configuration of the network. 19 rings
2019 November	EU Atelier project started. Possitive energy district. 3 demo areas: North, South, Centre
2020 October	Execution of opportunity works. Construction of the intakes to the river (Deusto channel)
2021 December	Boreholes field in the centre of the island to connect with Mondragon University, Digipen and dwellings
2022 December	5G DHC North Area. Completion of the network
2023 December	5G DHC South Area. Completion of the network
2025 March	Subfluvial crossing the river to the left bank

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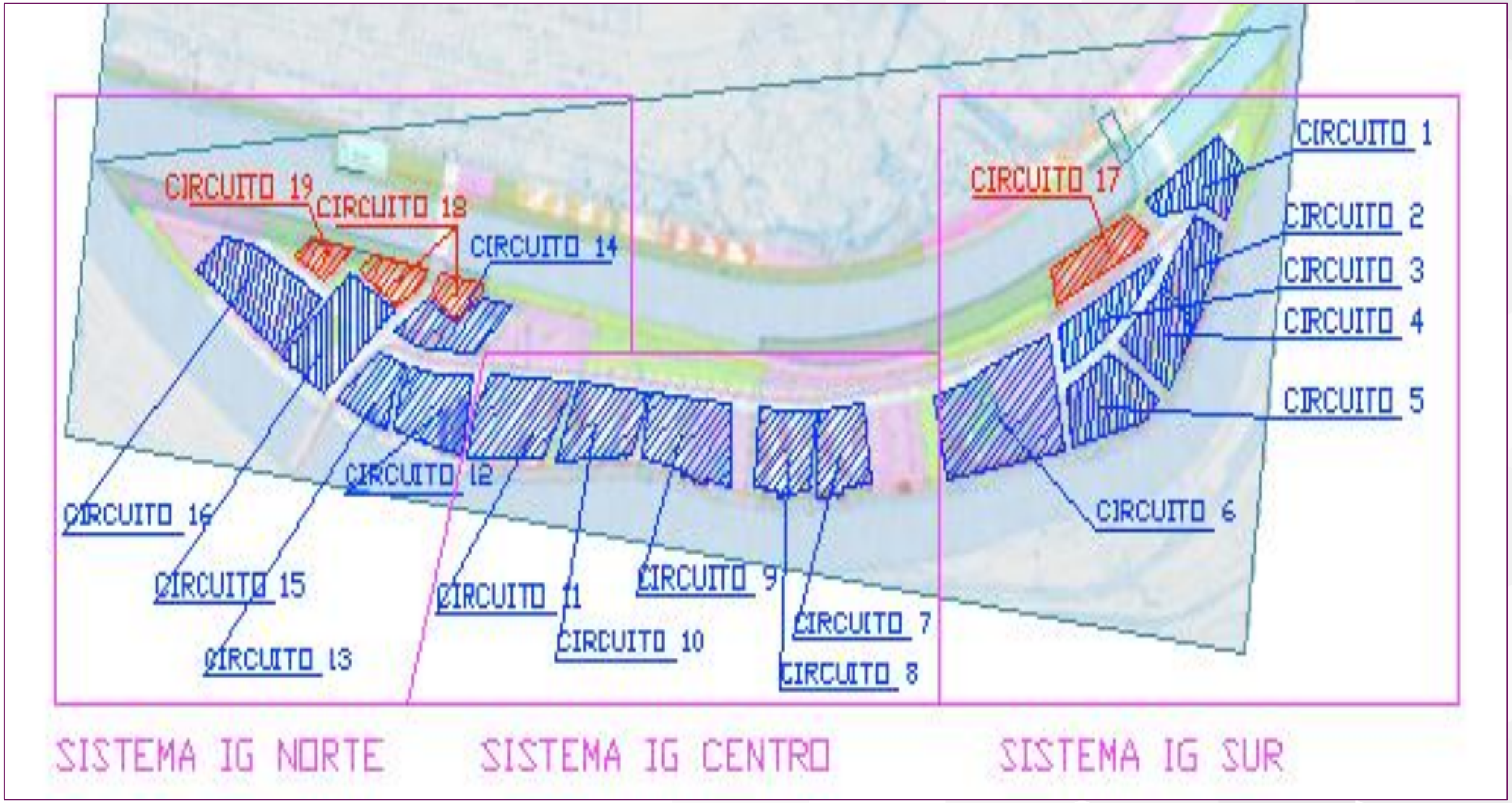
5GDHC ZORROTZAURRE 2015



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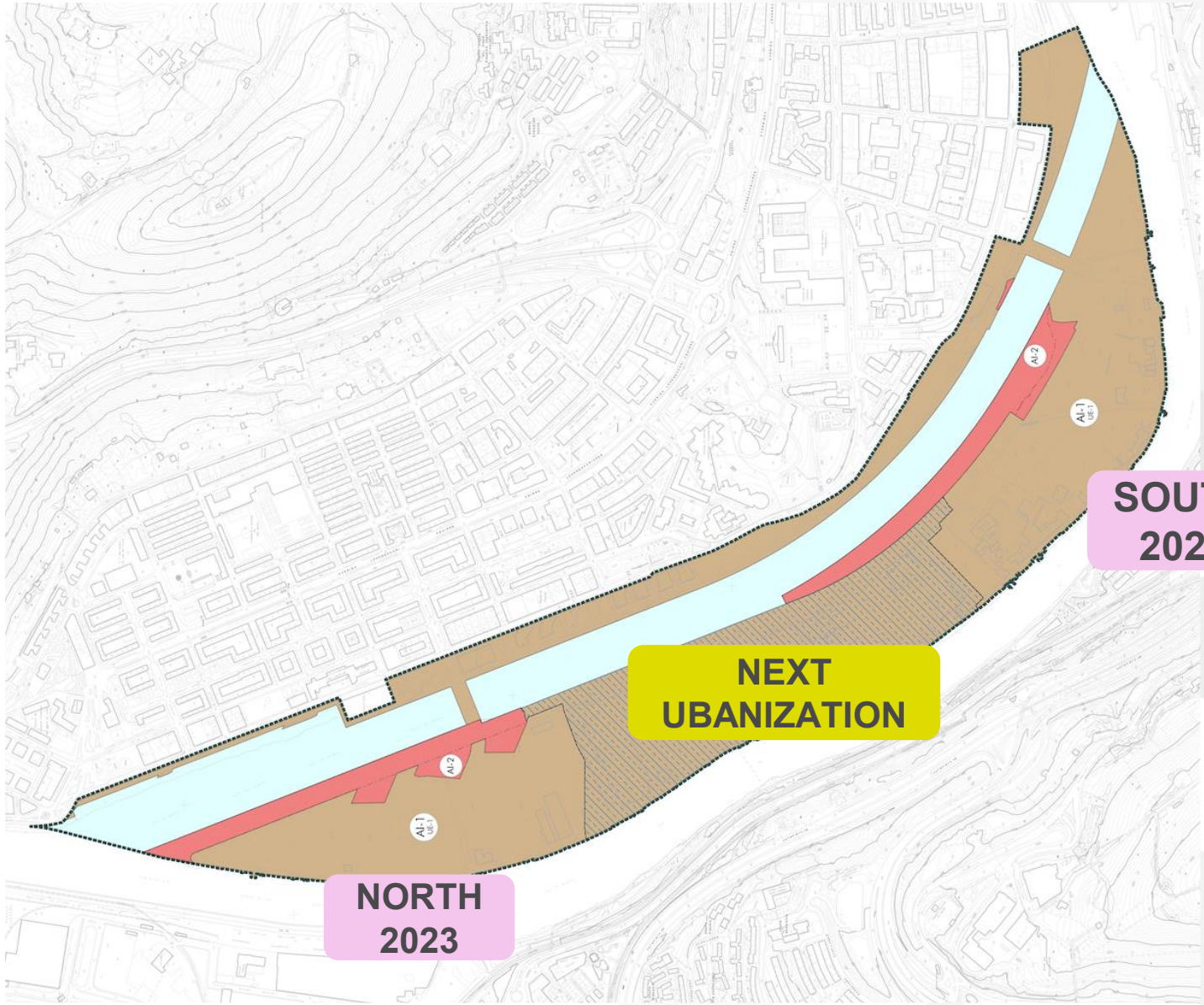
ZORROTZAURRE URBANISATION PHASES



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5GDHC ZORROTZAURRE 2026

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5G DHC NORTH AREA

Lenth
3.000 m

Capacity
9 MW

Heated/cooled
174.000 m²

37 buildings
24 new dwellings blocks
8 new service buildings
5 reburbished service buildings

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5GDHC ZORROTZAURRE 2026

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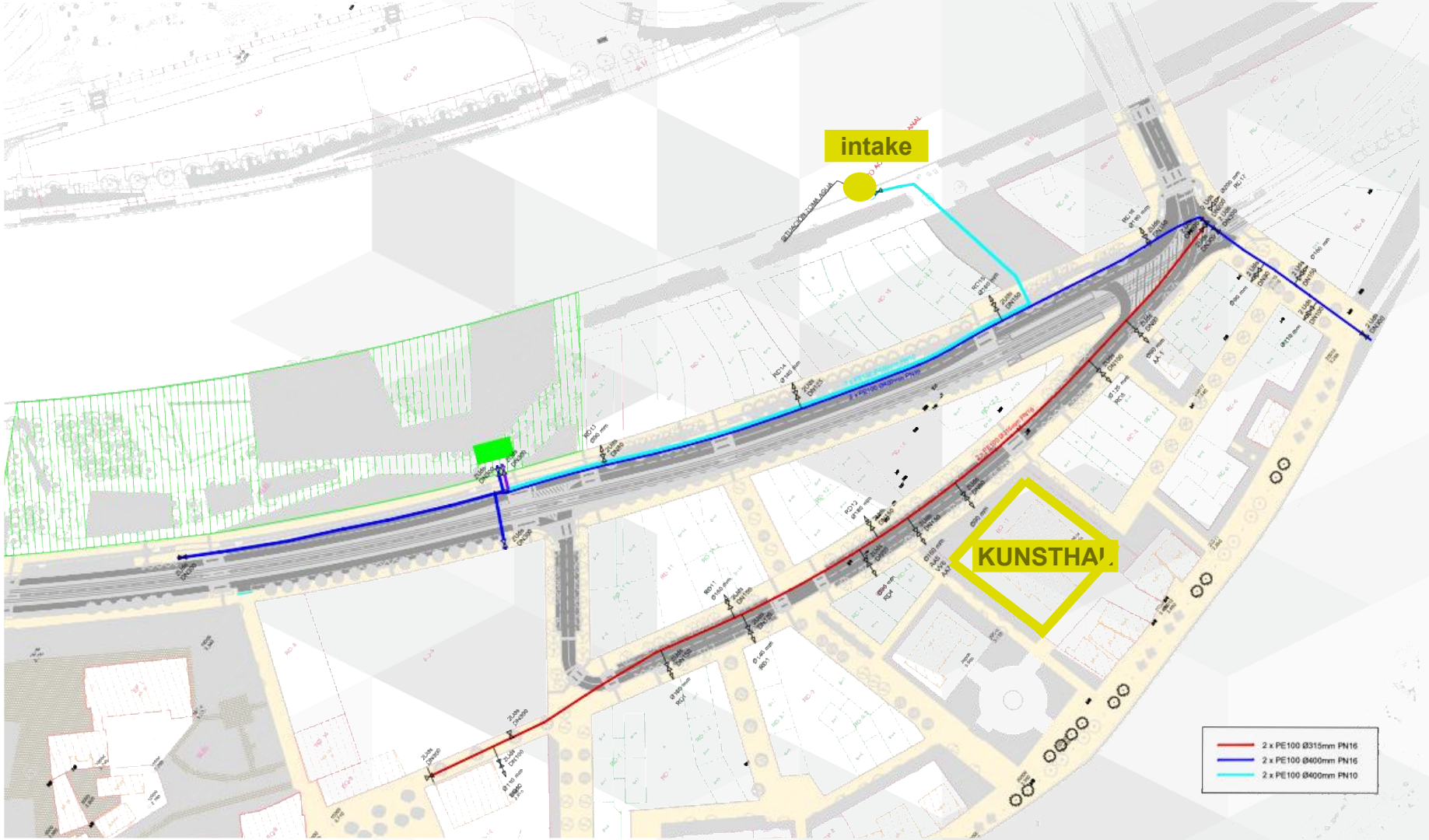
5G DHC SOUTH AREA

Lenth
3.200 m

Capacity
8,2 MW

Heated/cooled
156.000 m²

73 buildings
16 new dwellings blocks
34 existing dwellings blocks
9 new service buildings
14 refurbished service buildings



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North Edge 5G DHC Piping Works

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Surface Water Intake (Peak load)

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South Edge 5G DHC Piping Works

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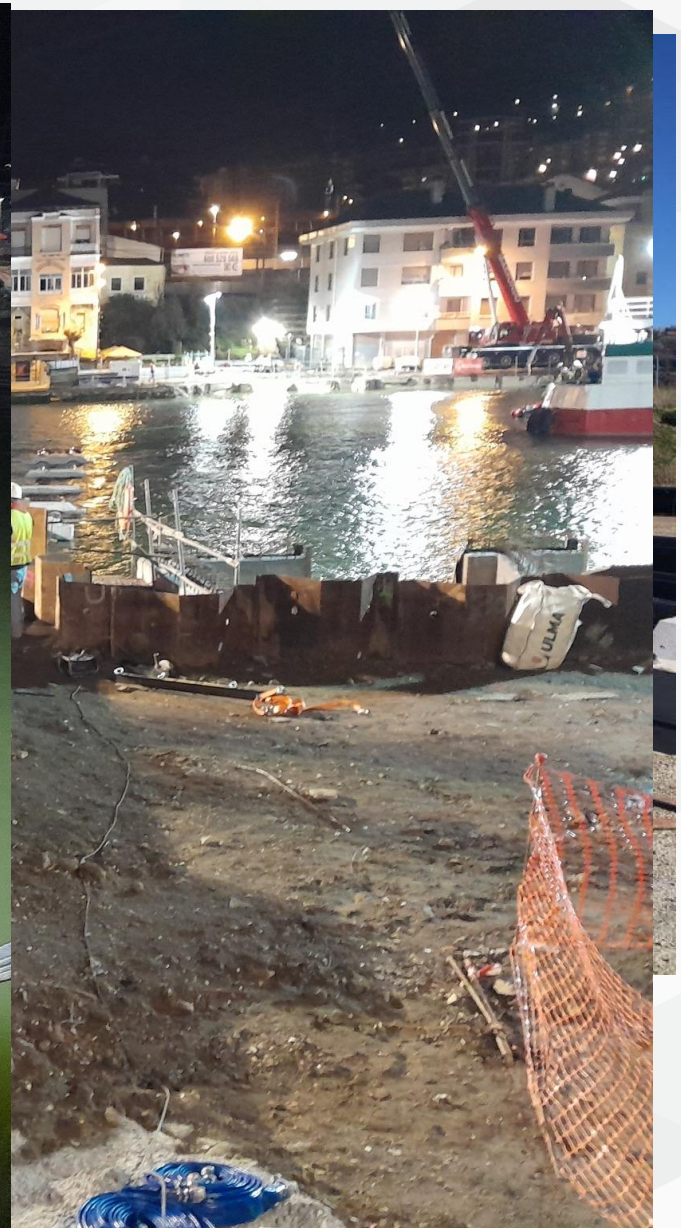
Sub-Fluvial Crossing



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KPI Zorrotzaurre District

ENVIRONMENTAL KPI	CONVENTIONAL BEST TECHNOLOGY CTE [1] NG Boiler (Condensation) + Solar Thermal + AWHP (High Efficiency)	%G DHC (5th Generation) GSHP	Improvement of 5G DHC vs Conventional Best Technology
Primary Energy Consumption (GWh/y)	30	13	- 17 (- 57 %)
Green House Gas Emissions GGE ($t\ CO_2/y$)[2]	6.000	2.000	- 4.000 (- 68 %)
Renewable Energy Generation in the Downtown (GWh/y)	1	15	+ 14 (x 14)
Renewable Thermal Power in the Downtown (MW)[3][4]	2	21	+19 (x 9.5)

[1] CTE Código Técnico de la Edificación (Building construction regulation of Spain).
[2] MINETUR: According Factores de emisión de CO_2 y coeficientes de paso a energía primaria of Spain Penisular electricity mix and NG.
[3] EU Directive 2018/2001 related to the use of energy from renewable sources.
[4] IDAE: Prestaciones medias estacionales de bombas de calor para producción de calor en edificios (Average seasonal performance of heat pumps for heat production in buildings).

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NEXT STEPS

INSIDE THE ISLAND	OUTSIDE THE ISLAND EXTENSION 5G DHC
Public buildings: connected to the grid	EXTEND TO THE OTHER SIDE OF THE RIVER
Private buildings: keep on with the engagement	**BUILDINGS INVOLVED** Hospital Public University of the Basque Country Basque television headquarters Stadium Congress Centre …
New Dwellings: keep on with the engagement	

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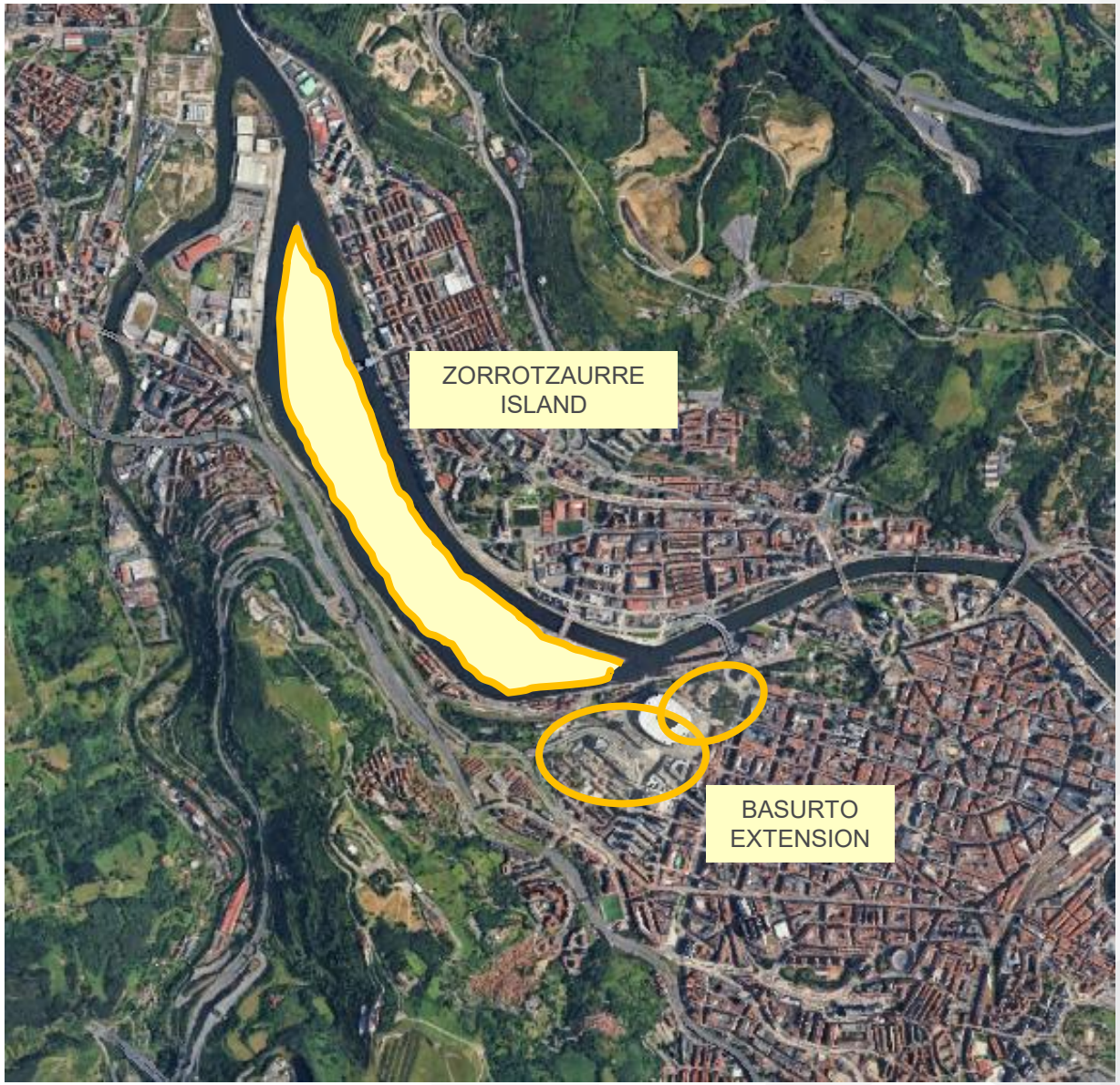
5GDHC EXTENSION



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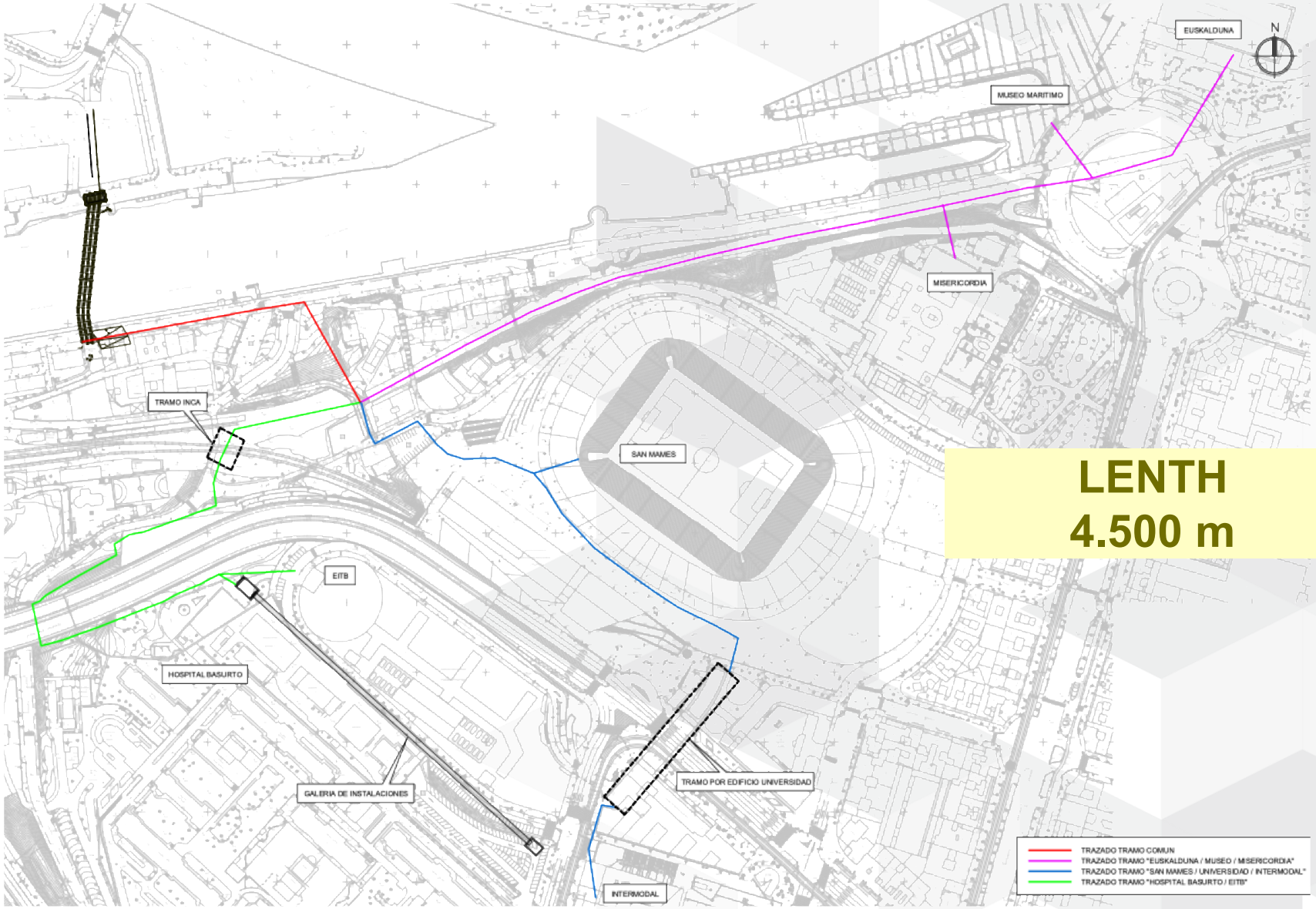
5GDHC EXTENSION



LENTH
4.500 m

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5GDHC LEFT BANK BASURTO

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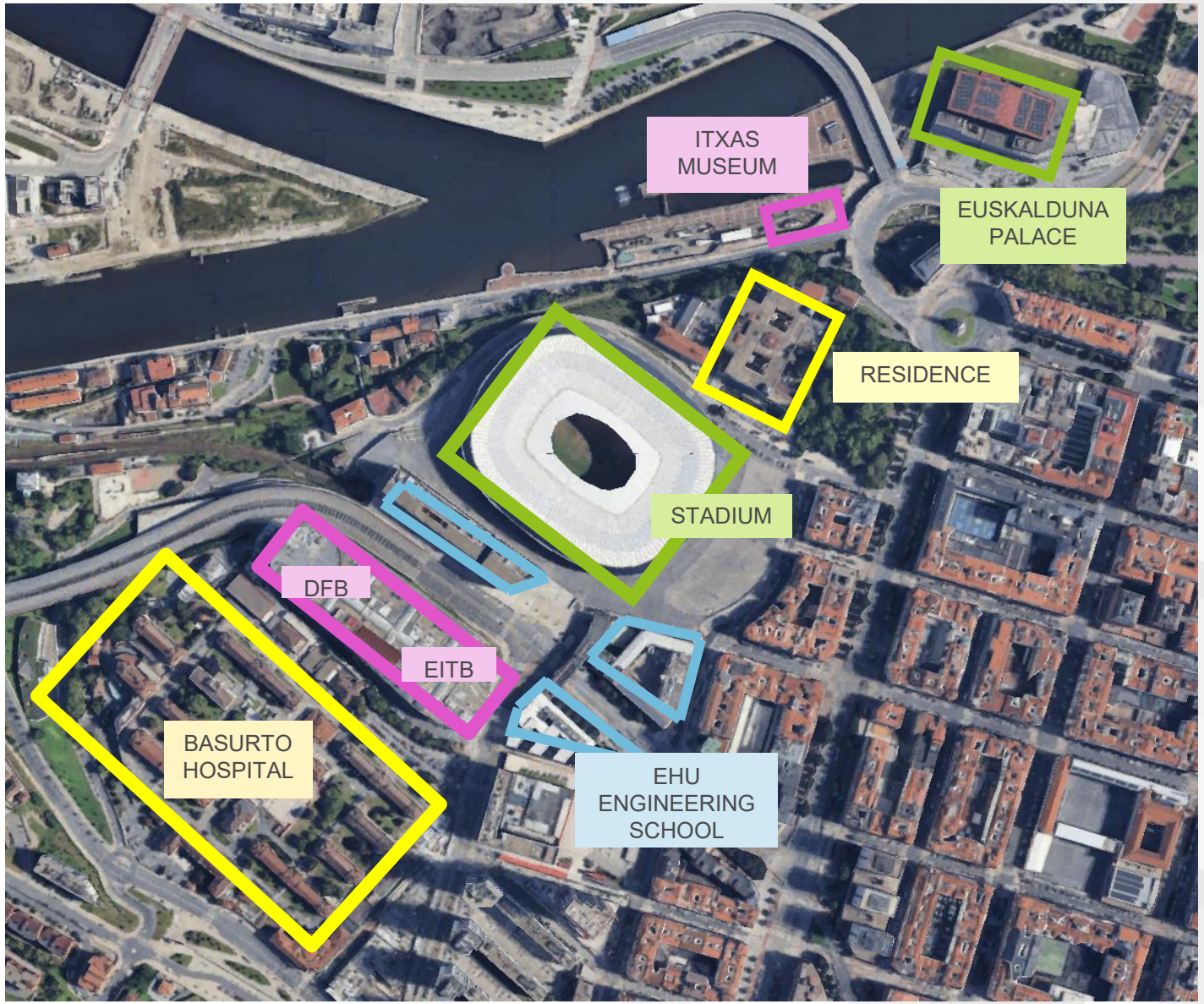
HEATING
20 GWh/y

COOLING
12 GWh/y



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IMPACT IN BILBAO

BILBAO 150.000 dwellings

BILBAO 350.000 INHABITATS

BILBAO DWELLINGS
GAS NATURAL CONSUMPTION
600 GWh hcv

5th DHC
HEATING DEMAND

ZORROZAURRE
LEFT BANK

40 GWh/año

5th DHC
AVOIDED GAS NATURAL
53 GWh hcv

EQUIVALENT
DECARBONIZATION
9% of the housing sector
BILBAO

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Remarks

5th Generation VLT DHC, with ground storage, could be considered as a BAT for renewable thermal energy supply in the cities, at least, in these conditions:

WHAT	WHY
Heating demand bellow 2,500 h/y. DHW service 8,760 h/y, of course.	Minimal thermal loss; minimal investment, operating and maintenance cost.
Cooling demand over 500 h/y, with a raising trend	Heating and cooling with 2 not isolated HDPE pipes. Lower investment and better performance as H&C demands are getting more equalized.
Consolidated urban plot. Historic or Architecture Protected Buildings	No external equipment or noises. As bigger the DHC is as greater synergies achieved it.
Low prices of thermal energy market	Implemented with an utility perspective could be even below 60 €/MWh.
Urban heat island troubles	It can put on value, digest, any type of excess heat over 10ºC. Would we arrive to see taxes to waste heat?
Finite electrical generation, storage, distribution and back-up capacity	Peak load shaving and energy storage
Renewable, scalable, replicable, distributed energy in the downtown.	Will we able to implement a regulatory framework and the business models on time?

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Thank you for your attention

GP/Aliendalde Auzunea, 6
48200 Durango · Bizkaia
T: 94 6818916
www.telur.es

asainztrapaga@telur.es

iarrizabalaga@telur.es

www.smartcity-atelier.eu

@AtelierH2020

AtelierH2020

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GOBIERNO DE ESPAÑA

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

District heating & cooling: Implementation of EED & RED

Subdirectorate-General for Energy Efficiency and Access to Energy

Secretary of State for Energy

Ministry for Ecological Transition and Demographic Challenge

March 2026

SPANISH BOUNDARY CONDITIONS FOR DHC

Begoña (Bilbao)

- 66,000 inhabitants
- 35,000 People/ km^2
- HDD-15-26: 702; CDD-26: 64

Eixample (Barcelona)

- 263,000 inhabitants
- 36,000 People/ km^2
- HDD-15: 1215; CDD-26: 94

Chamberí (Madrid)

- 140,000 inhabitants
- 30,000 People/ km^2
- HDD-15: 1290; CDD-26: 281

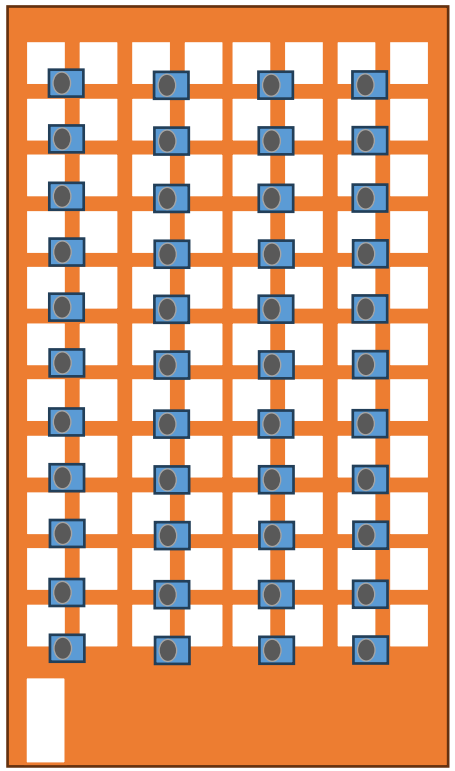
Other References:

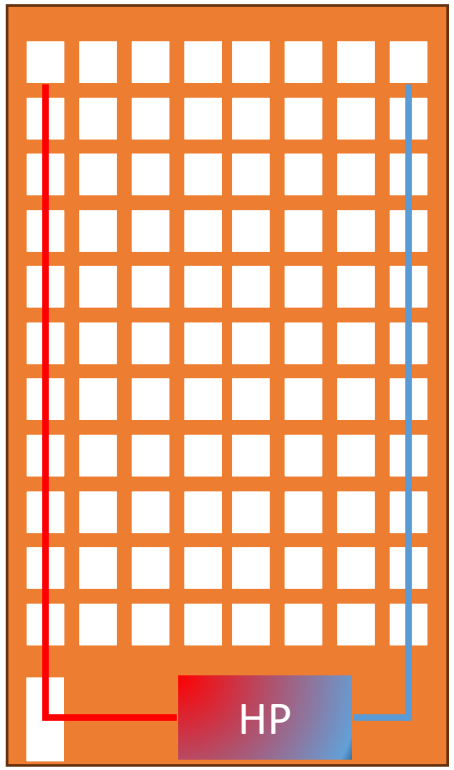
- Berlin, Brussels, Amsterdam: <5000 People/ km^2
- Strasbourg: HDD-15: 1887; CDD-26: 63
- Athens: HDD-15: 383; CDD-26; 319

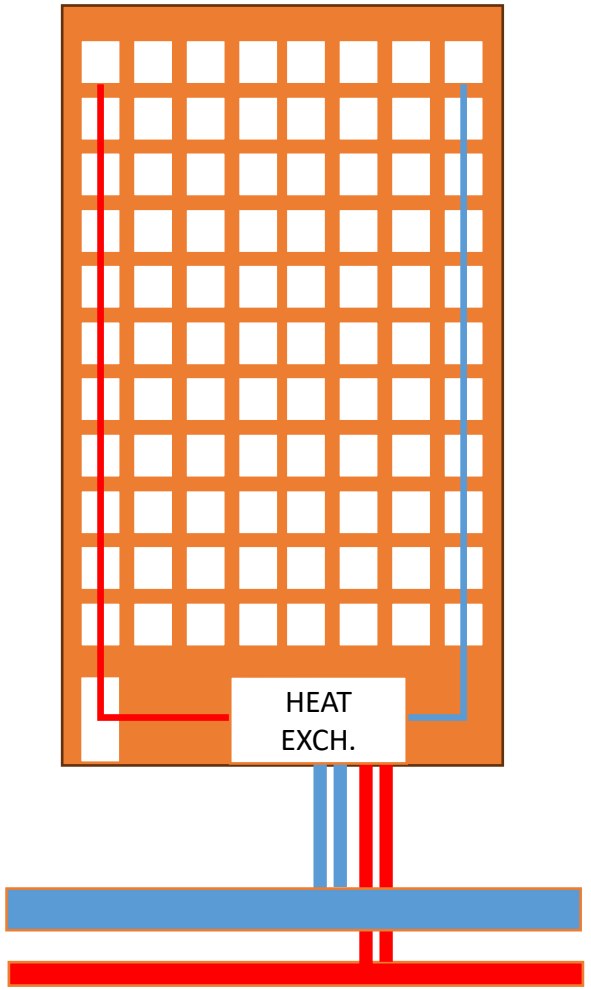
ENERGY APPROACH – district systems?

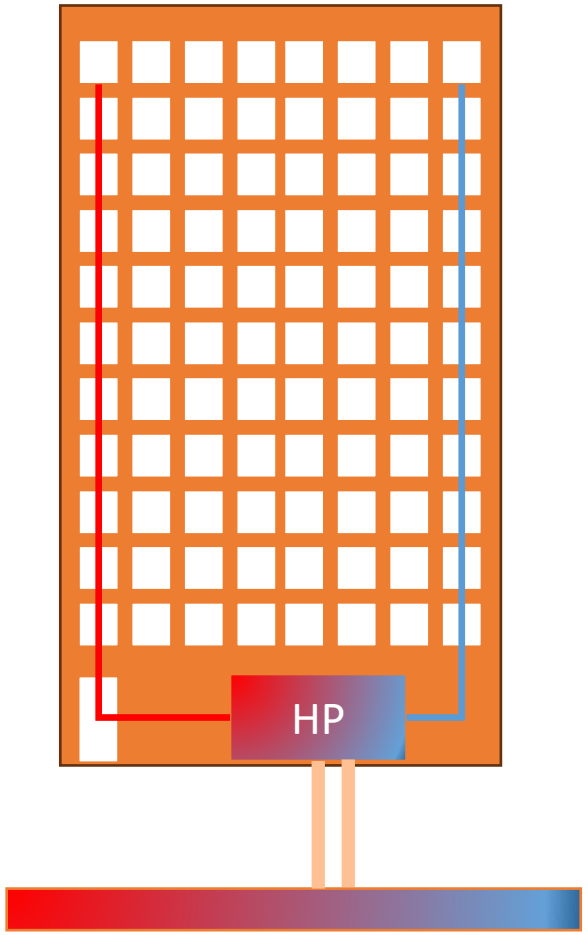
Advantages	Disadvantages	Challenges
High density of population (3/4 blocks)		Regulation
Flexibility Heating & Cooling	Short Winters	Private initiative
Less equipment/m^2 at home	Need for planning	Public awareness
Less Heat Island effect	Lack of technical know-how / tradition	Building refurbishment
Technical flexibility (H/C - inputs)		Different owners in the same building

ENERGY APPROACH – alternatives









ENERGY APPROACH - alternatives

	Individual systems	Building-level systems	District Heating & Cooling
Scale	Dwelling	Building / block	District / city
Main equipment	Heat pumps Electric heaters Non-fossil boilers	Central heat pumps Electric heaters Non-fossil boilers	(***) CHP Large heat pumps Boilers Solar thermal Electric heaters Storage
Energy Sources	Electricity Non-fossil gases (*)	Electricity Solar thermal Non-fossil gases (*) Bioliquids (*) Biomass (**)	Waste heat & cold Solar thermal Electricity Non-fossil gases Bioliquids Biomass
Energy integration potential	Low	Medium	High
Ability to use waste heat	No	Limited	High

IMPLEMENTATION OF DHC REQUIREMENTS (EED, RED)

Urban & Industry Planning & Information

- >45,000 inhabitants → obligation of H&C planning: technologically neutral but DHC must me seriously analysed (layers, long-term economic analysis)
- Facilities exceeding specific power levels (*) must perform a CBA on the use of waste heat when they are designed or substantially renovated

(*) industrial	*8 MW*
(*) thermoelectric	*10 MW*
(*) service	*7 MW*
(*) data centres	*1 MW*

- Promotion of the interconnections
- DHC must provide information → official census:

Power
Energy sources
Energy mix, among other things
…

IMPLEMENTATION OF DHC REQUIREMENTS (EED, RED)

Efficient urban heating and cooling system

- Minimum thresholds for renewable energy, waste heat, or high-efficiency cogeneration in their energy mix. Thresholds are updated by increasing the weight of renewables and waste heat until 2050
- New inefficient SUCYRS will not be permitted

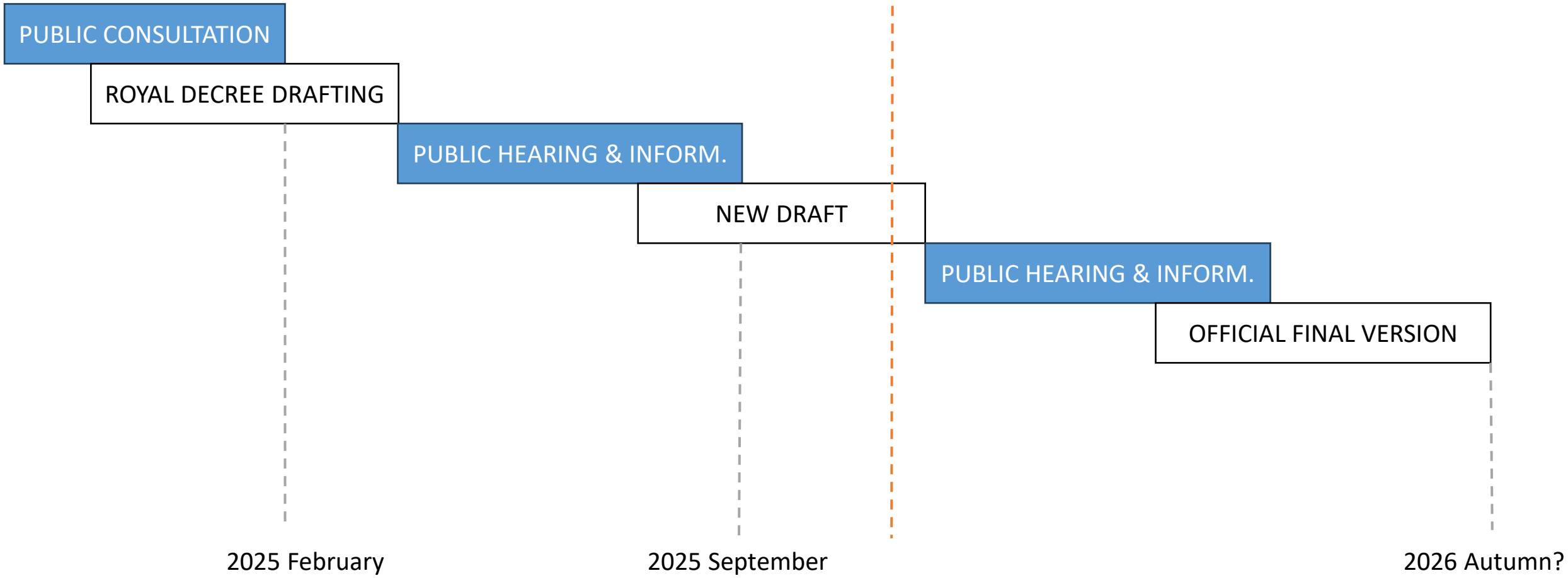
Administrative simplification

- Promotion of one-stop shops to speed up authorizations and permits

Third-party access

- Operators > 25 $MW_{thermal}$ $\rightarrow$ allow connection of third parties (may refuse connection for technical reasons)

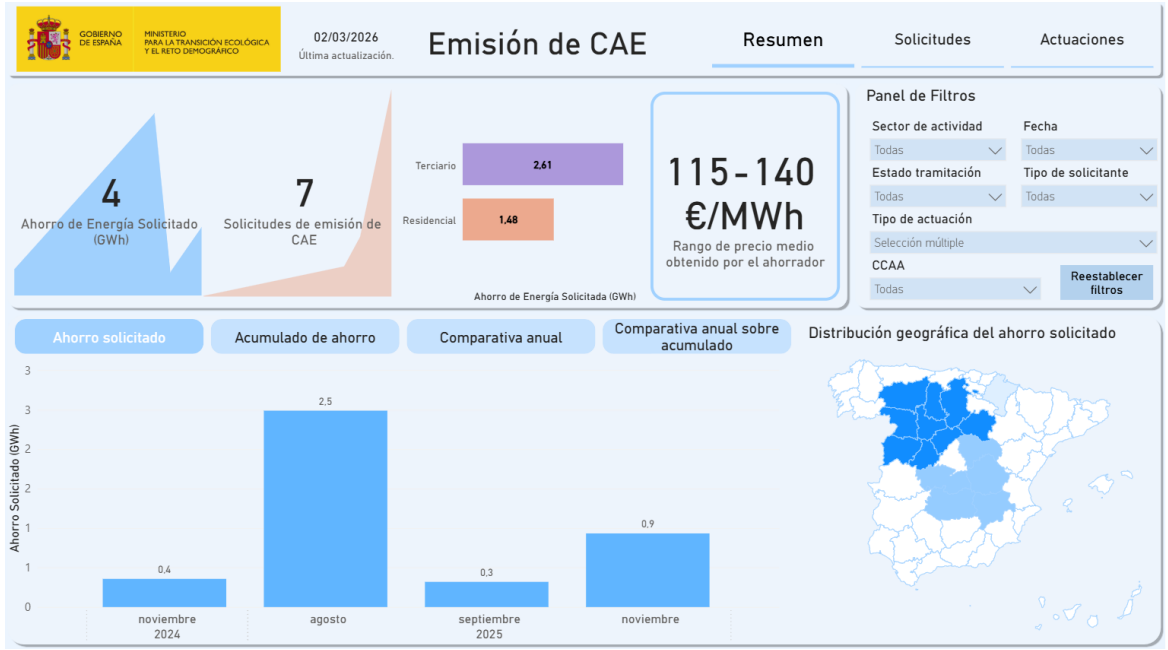
IMPLEMENTATION TIMETABLE



CURRENT DHC REGULATORY SUPPORT

WHITE CERTIFICATES (Sistema de CAE)

- Standard sheets (RES210, TER210): 7 projects – 4000 MWh/year
- More standard sheets in the pipeline



CAE system links:

- General: https://www.miteco.gob.es/es/energia/eficiencia/cae.html
- Power BI: https://www.miteco.gob.es/es/energia/eficiencia/cae/seguimiento-del-sistema-de-cae.html

- Singular projects
- Subsidies (outside CAE system)

CONCLUSIONS

- Spain needs to incorporate District Heating and Cooling as a serious option for supplying heat and cold

  - Advantages: urban density, growing cooling demand

  - Challenges: shorter heating seasons

- Implementation of the Energy Efficiency Directive (EED) and Renewable Energy Directive (RED) is in progress. Main issues include:

  - Urban and industrial planning & information

  - Administrative simplification

- White certificates are becoming an important supporting tool.

Thank you for your attention

Mila esker zure atxikimenduagatik

bzn-CAE@miteco.es

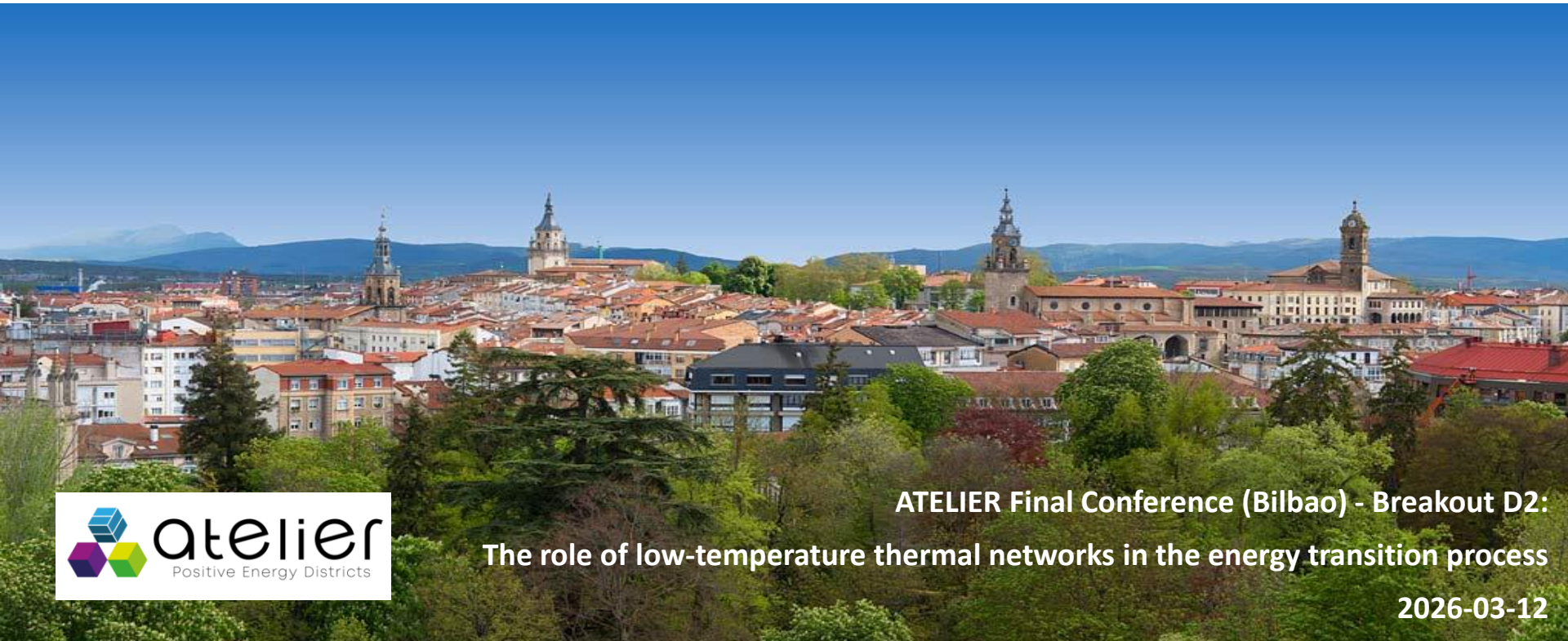
Subdirectorate-General for Energy Efficiency and Access to Energy

Secretary of State for Energy

Ministry for Ecological Transition and Demographic Challenge

Ayuntamiento
de Vitoria-Gasteiz
Vitoria-Gasteizko
Udala

MUNICIPAL DECARBONISED DISTRICT ENERGY NETWORK IN VITORIA-GASTEIZ



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ATELIER Final Conference (Bilbao) - Breakout D2:

The role of low-temperature thermal networks in the energy transition process

2026-03-12

BACKGROUND. EXISTING DISTRICT HEATINGS IN THE CITY

Private district heating. Txagorritxu (1.974)

- **Initially Diesel / Currently natural gas**
- **770 homes connected**

Coronación district heating (2.021)

- **1 MW biomass (2 x 500 kW) and gas boiler for peak loads and backup.**
- **450 homes and a church (equivalent to 11 homes) connected.**
- **Public-private partnership.**

Mendizorroza municipal district heating (2.023)

- **1MW (3 x 330 kW biomass boilers)**
- **Swimming pools, pelota courts, sports centre and social centre.**

BACKGROUND. DECARBONISED DISTRICT ENERGY AS A BASIC LEVER FOR NEUTRALITY

Directive 2023/1791 on energy efficiency

New Renewable Energy Directive (RED III)

Directive 2024/1275 Energy Performance of Buildings (EPBD)

EU Heating and Cooling Strategy (expected in 2Q 2026)

Law 1/2024 Energy Transition and Climate Change

Law 4/2019 Energy sustainability

DECARBONISED DISTRICT ENERGY AS A BASIC LEVER ON THE ENERGY AXIS TO ACHIEVE ENERGY NEUTRALITY

BACKGROUND. NEED TO START CONSIDERING COOLING AS A NECESSITY

The Basque Government publishes the first study on the evolution of the climate in the Basque Country over the last 50 years

https://www.irekia.euskadi.eus/es/news/102706-gobierno-vasco-publica-primer-estudio-sobre-evolucion-del-clima-euskadi-los-ultimos-anos

June 19, 2025

- **The report notes an increase in the frequency and duration of heat waves, a rise in sea level of more than 20 cm in the last two centuries, and an increase in the average temperature of the Basque Country of 0.3°C per decade since 1970.**

Euskalmet describes the meteorological summer as very warm and highlights, as its main characteristic, the incidence of three heat waves

https://www.euskadi.eus/gobierno-vasco/-/noticia/2025/euskalmet-califica-verano-meteorologico-muy-calido-y-destaca-como-principal-caracteristica-del-mismo-incidencia-tres-olas-calor/

Publication date: 09/19/2025

The Basque Meteorological Agency, Euskalmet, has classified the meteorological summer (June, July, and August) as very warm (with an anomaly of 1.6 °C above the average for the normal period 1991-2020), making it the third hottest summer since 1970, surpassed only by those of 2023 and 2022.

Individual air conditioning is energy intensive, causes noise and vibrations, affects the aesthetics of buildings, generates residual heat in its surroundings (heat island effect), leads to peaks in demand on the electricity grid, etc.

A VERY LOW TEMPERATURE (5G) NETWORK AS A SOLUTION

DISTRIBUTION RING

2 pipes with water at 15-25°C instead of standard 70-90°C district heating

HEAT PUMPS

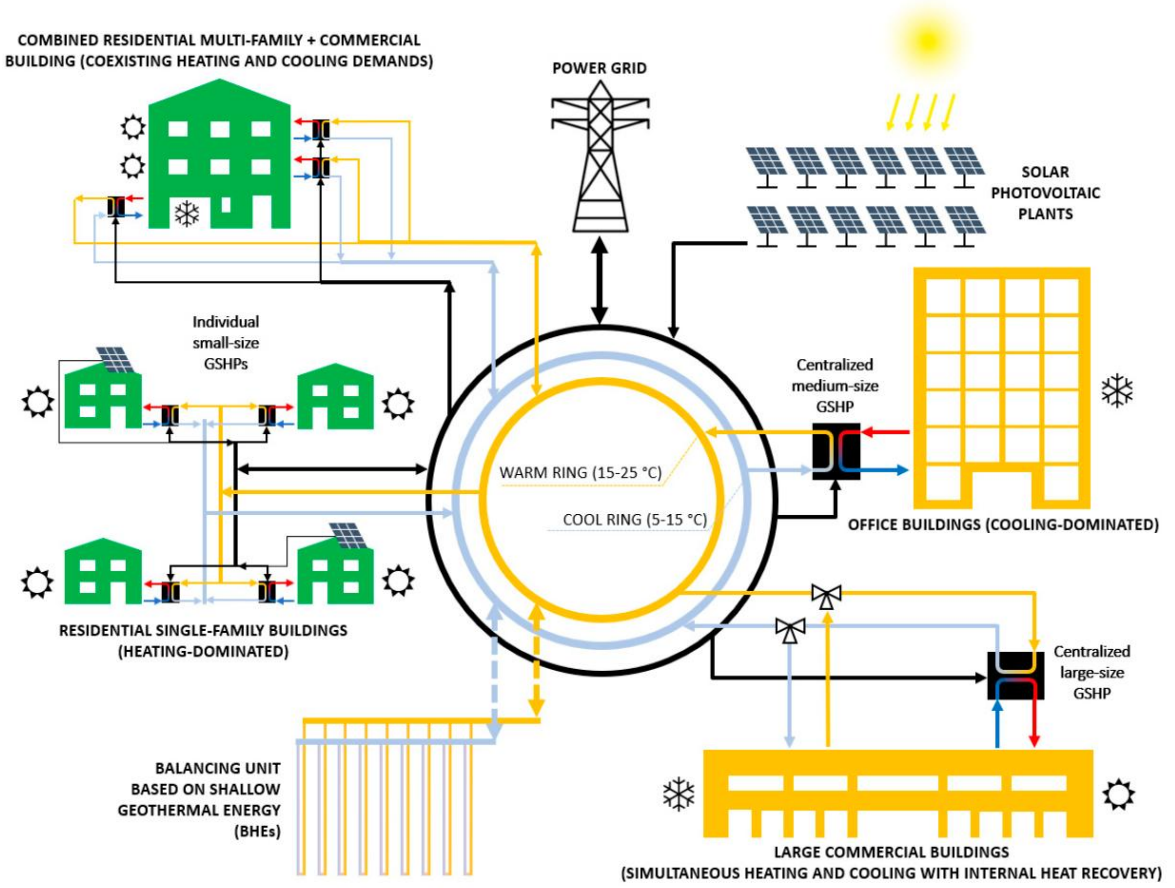
Heat pumps at each building take heat or cold from the network and supply the remaining energy required.

ENERGY CIRCULARITY

Residual heat/cold from one building is used by another

HEATING AND COOLING IN A SINGLE NETWORK

Two district networks are not required to provide heating and cooling simultaneously



https://www.mdpi.com/1996-1073/16/1/147

OTHER BENEFITS BEYOND ECONOMIC FEASIBILITY

Inherent to any type of decarbonised district energy network

+

Linked to a decarbonised very low temperature (5G) network

Improves air quality by eliminating combustion systems.

Efficiency Directive: helps the development of local cold and heat plans for municipalities with more than 45,000 inhabitants.

Simultaneous cooling and heating without the need of two networks or future re-works on the same streets.

Electrification of demand, distributed generation and prosumer buildings.

Eases and accelerates just and inclusive energy transition to citizens and public administrations.

Avoid heat pumps on façades/roofs: less noise, vibrations, reduced heat island effect, aesthetics, etc.

Energy circularity: residual heat/cold from one building can be used by another.

Part of the investment can be phased and aligned with the connection of buildings.

Work completed to date

Promoter

Ayuntamiento de Vitoria-Gasteiz
Vitoria-Gasteizko Udala

Consultant

tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Contributor

ENERGIAREN EUSKAL ERAKUNDEA
ENTE VASCO DE LA ENERGÍA

DISTRICT ENERGY NETWORK OBJECTIVE

Decarbonise heating and eventually cooling (refrigeration) in the residential, tertiary and institutional sectors of Vitoria-Gasteiz.

ALREADY CONDUCTED STUDIES. STEPS:

1. City energy/socio-economic diagnosis using GIS.
2. Search for the most viable area for a Phase-1.
3. Renewable resources and waste heat analysis.
4. Network type (high or low temperature).
5. Analyse the economic viability of the solution in that area.

Key elements for district energy network deployment

Generation sources

Selection to be done based on foreseen operating conditions and available resources.

Heat and/or cooling

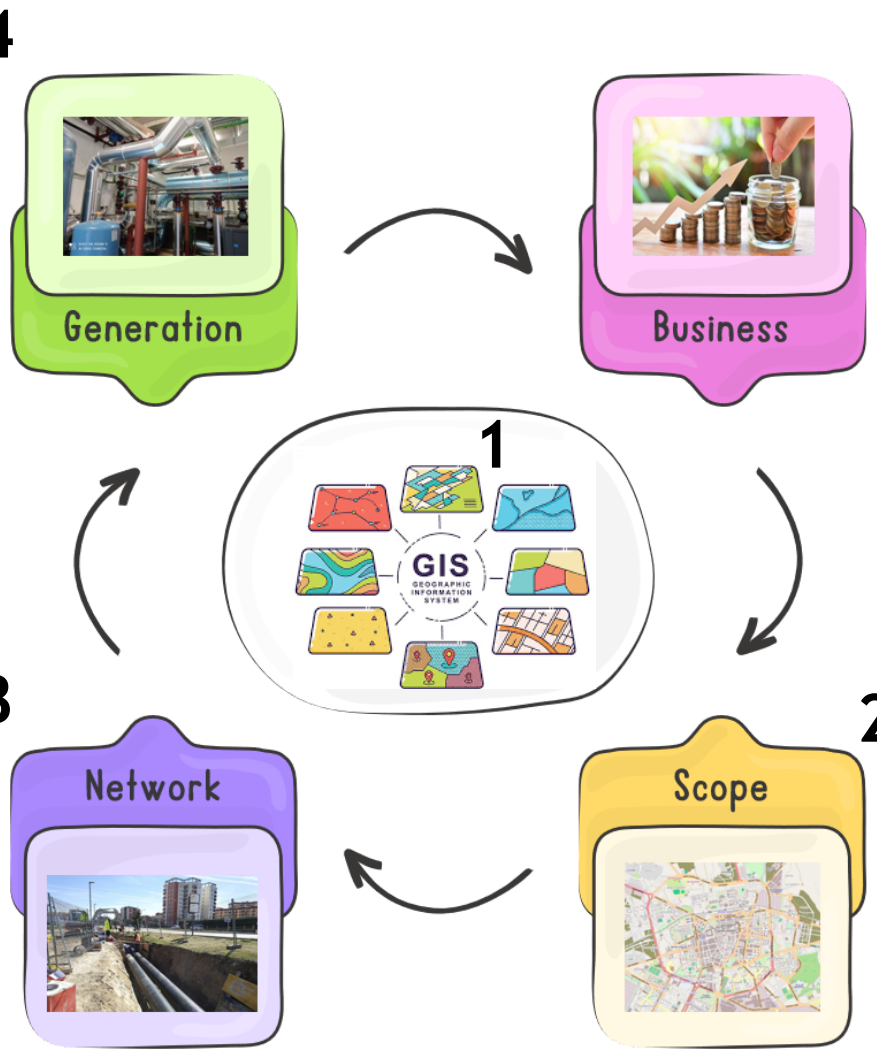
Distribution network characteristics selection: high temperature (3G), low temperature (4G) or ultra-low temperature (5G).

Business model

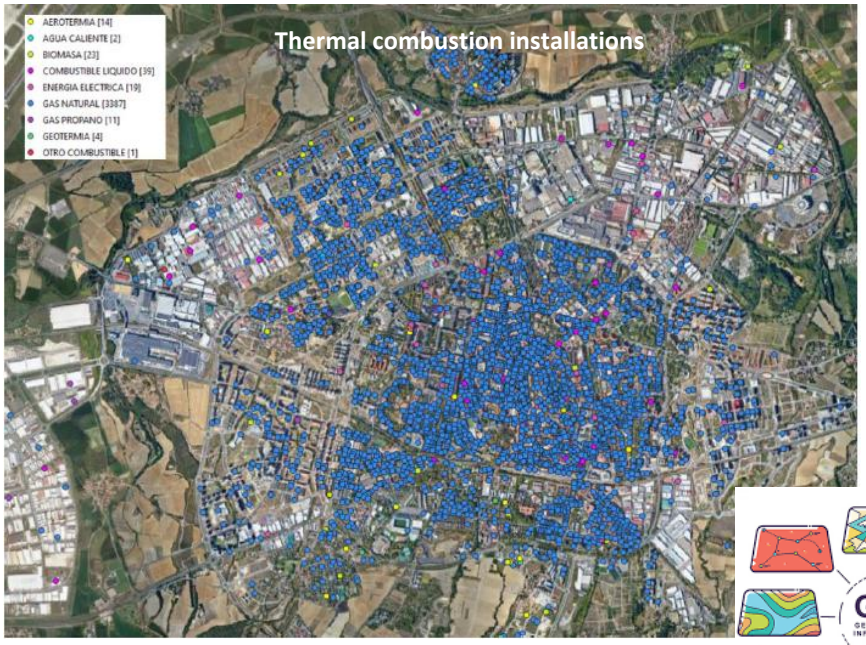
Public participation in the Project and business model.

Project scope and development

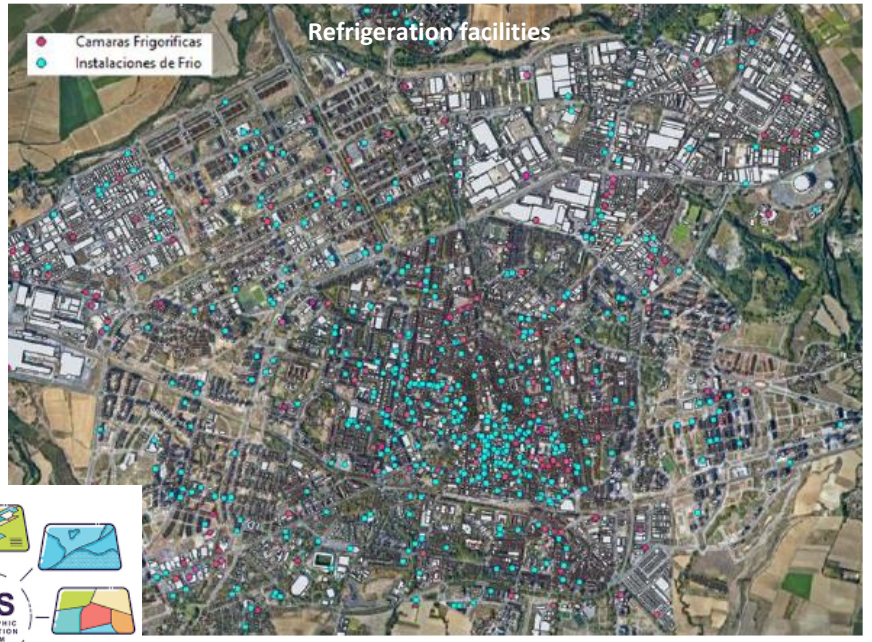
Determine whether to focus on a specific area of the city, a larger one or even the entire city, establishing development phases.



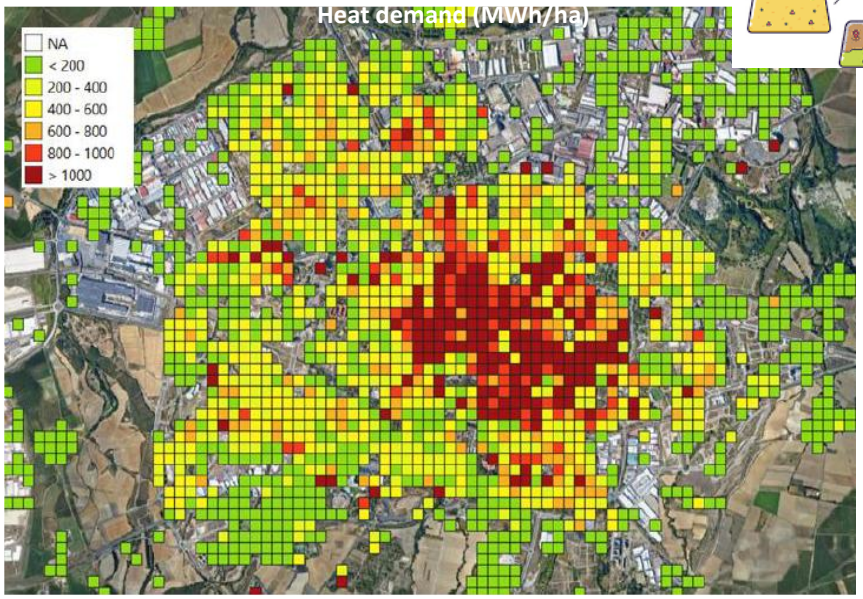
1. GIS diagnostics. Examples of layers obtained at city level



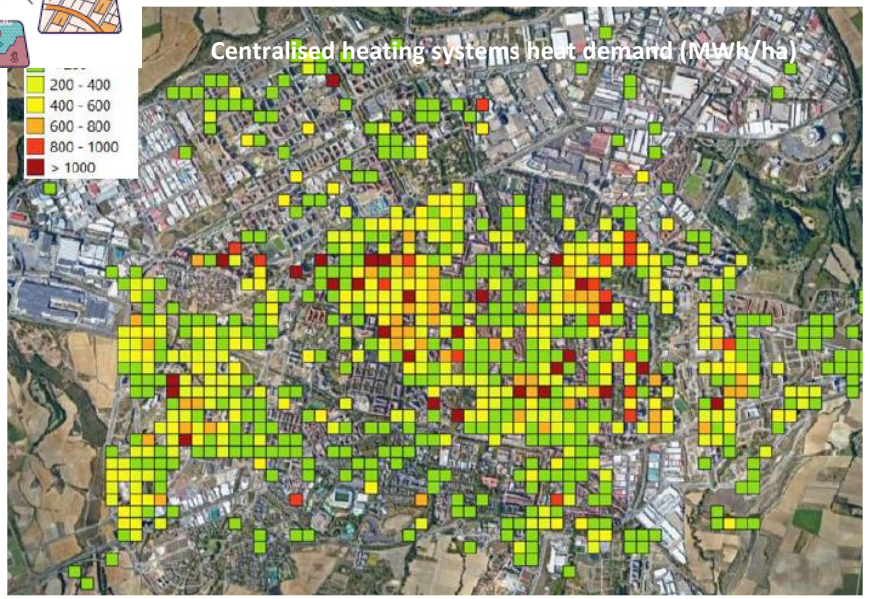
Thermal combustion installations



Refrigeration facilities



Heat demand (MWh/ha)



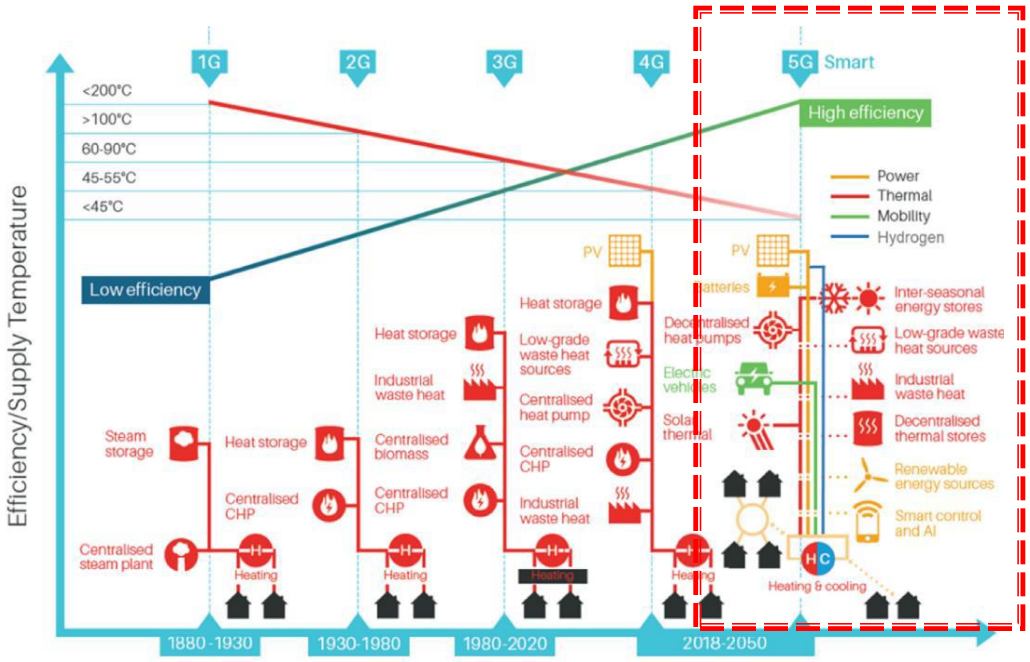
Centralised heating systems heat demand (MWh/ha)

2. Scope. Highest expected viability area for Phase 1

MAIN SELECTION CRITERIA

1. **High public consumption (Town Council, Provincial Council and Basque Government).**
2. **Significant residential consumption through centralised heating systems.**
3. **Highly consuming private tertiary sector: residences, educational centres, etc.**
4. **Renewable resources and waste heat available.**
5. **Existence of vacant plots in the vicinity.**

3-4. Network typology and decarbonised generation options in the area



Evolution of thermal networks

- **Biomass**
- **Aerothermal energy**
- **Geothermal energy**
- **Hydrothermal energy (sewage, river, WWTP, aquifer)**
- **Waste heat (data centres, cooling towers, supermarkets, etc.)**

5. Business model: Technical and economic feasibility. Possible scenarios analysis

504 posible techno-economic scenarios in priority area

- **4 possible locations for the power plant**
- **6 types of heat sources considered**
- **Energy demand (public/private tertiary, residential)**
- **Pricing scenarios.**

<u>Sensitivity analysis</u> → 504 scenario simulation carried out

OBJECTIVE: affection analysis of varying generation technologies, the location of generation plants and the amount of energy demanded.

5. Business model: Sensitivity analysis of possible scenarios. Conclusions

SIMULATED DEMAND, POWER AND INVESTMENT RANGES

Demand: between 7 and 28 GWh/year
(from a total of 54GWh/year in priority area)

Required generation power:
between 4 and 12 MW

Investment for medium-sized scenario: 15 M€ approx.
(Generation power 8 MW / Demand 17 GWh/year)

SENSITIVITY ANALYSIS MAIN CONCLUSION

Technically and environmentally feasible project, aligned with EU guidelines and Directives.

Economically, to compete with current heat and cooling systems, it is essential to maximize:

- **Waste heat percentage in the district energy network.**
- **Financial incentives.**

Next steps to take for the decarbonised district energy network deployment

Next steps

- **Assess other public institutions interest.**
- **Deeper evaluate real waste heat potential in the area.**
- **Identify public buildings for base demand.**
- **Define final target scenario: target consumption, associated generation and plot(s).**
- **Preliminary design of thermal network and feasibility study.**
- **Fundraise.**
- **Business model. Possible public-private collaboration with the participation of several Public Administrations.**

Ayuntamiento
de Vitoria-Gasteiz
Vitoria-Gasteizko
Udala

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THANK YOU
ESKERRIK ASKO
MUCHAS GRACIAS

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