Retrofitting District Heating Systems. Lessons learned from the Planning, Engineering and Data perspectives

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Roberto GARAY-MARTINEZ. Deusto

Brief introduction to a DH system

- Centralized heat generation and distribution systems.
- Public systems deliver 13% of heating energy in the EU.
- Multiple private systems provide to building and/or industrial complexes.
- Considered basic infrastructures for decarbonization.
- Evolution:
  - In origin, steam systems
  - Modern networks, systems in the order of 70-80ºC
  - Low temperature networks, on the order of ~55ºC (DHW)
  - Networks of very low temperature, on the order of ~35ºC

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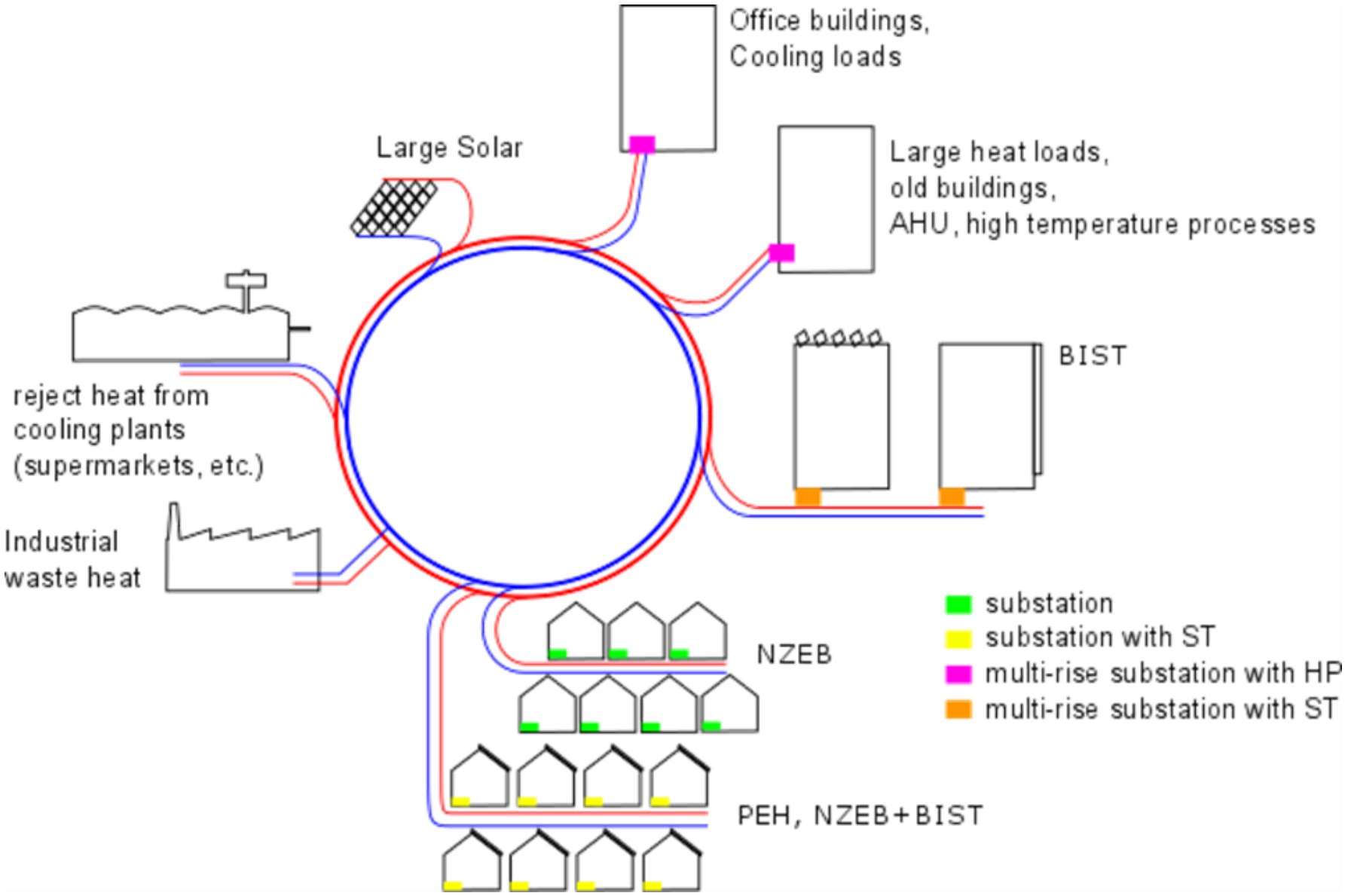

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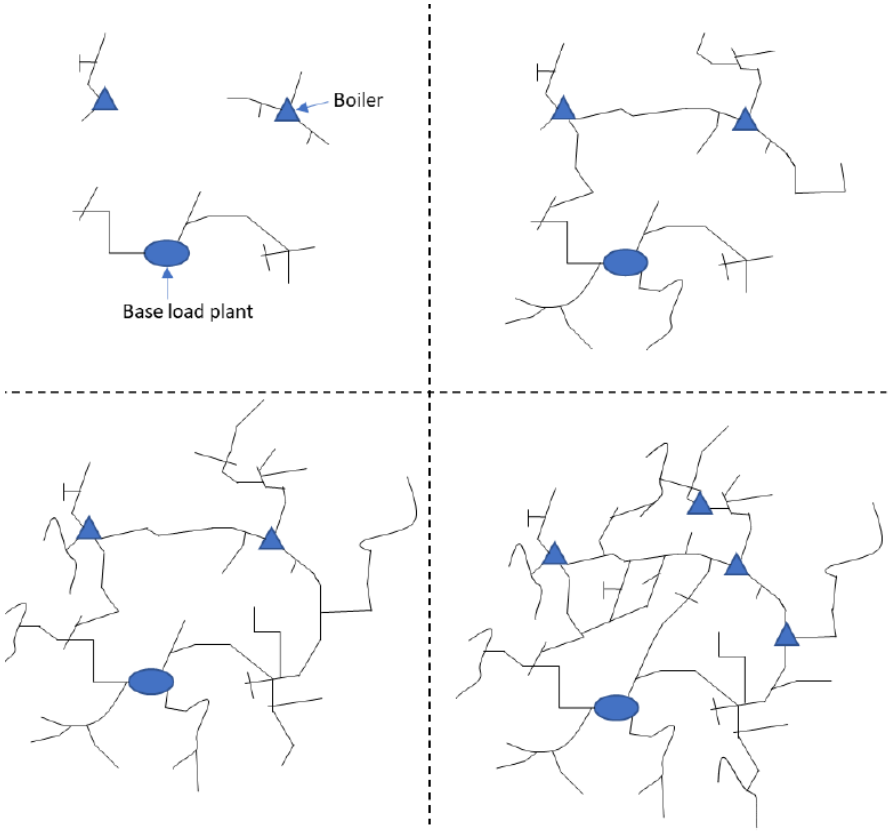
Multi-decade planning



Escalation of a DH, from individual and small scale centralised islands; further connection into tree structure (upper-right); ring structure (bottom-left); full systems (bottom-right).

- long-term vision
- progressive investment plan
- many years (probably decades) to reach full potential
- from
  - individual branches...
  - to subnetworks...
  - to full systems

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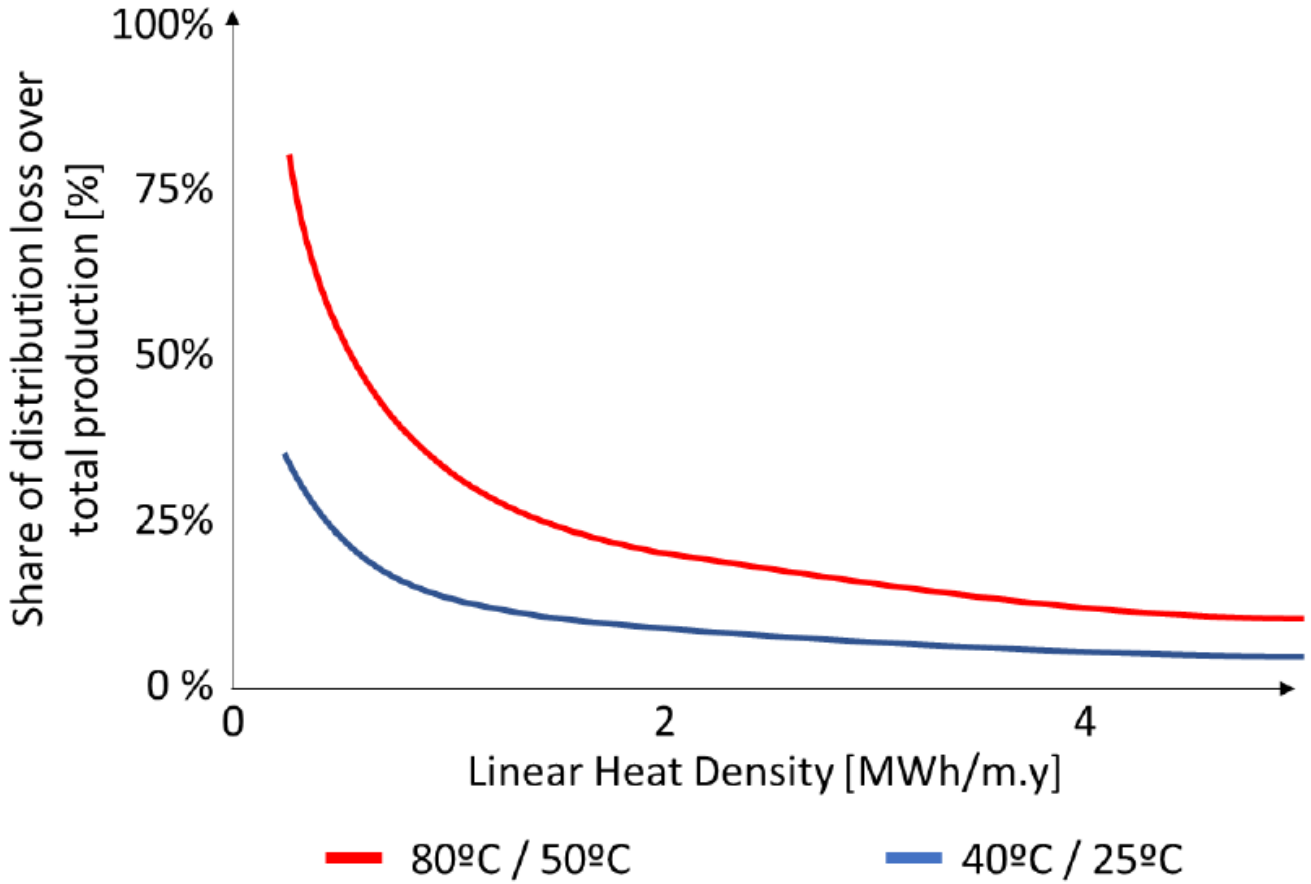

Annual heat distribution losses for various temperature levels over the linear heat demand density

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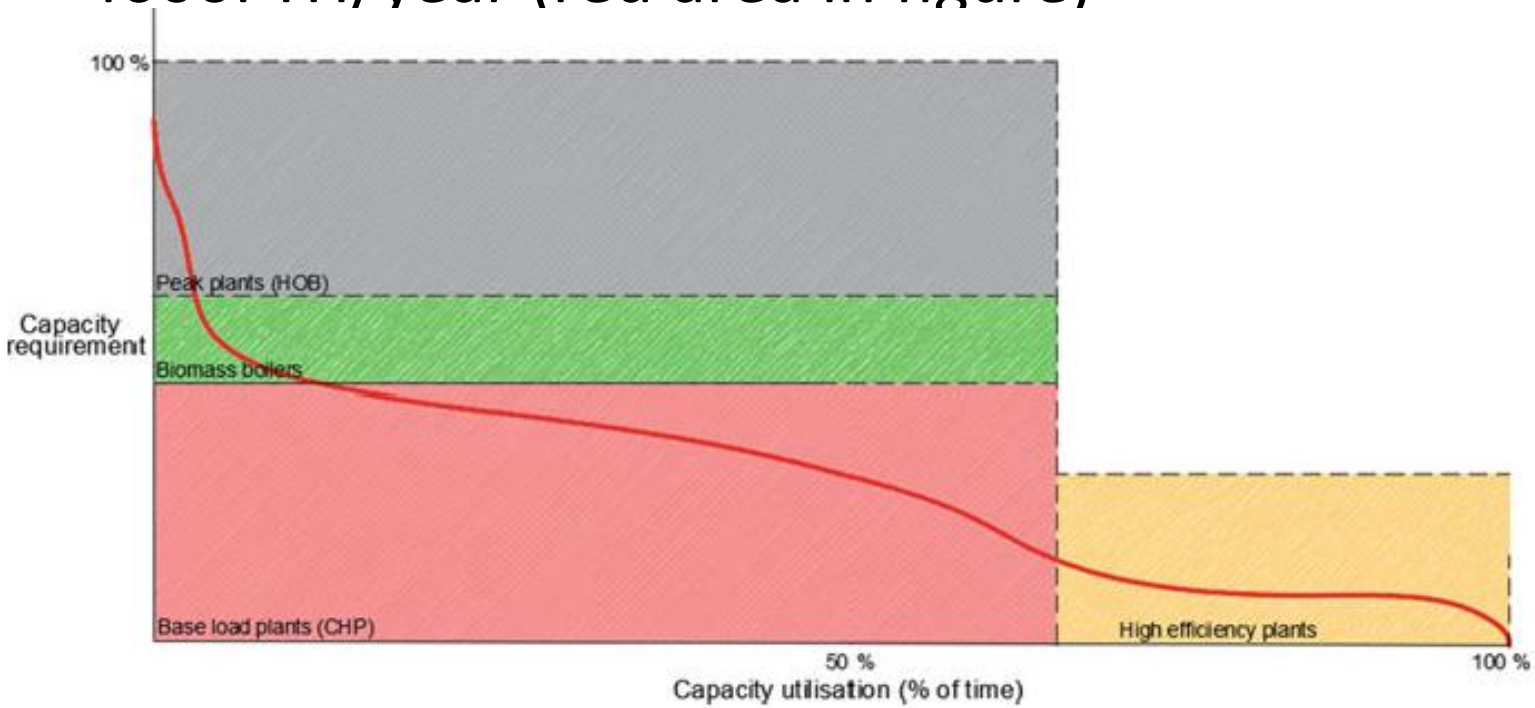
Upgrade of heat production

- Renewables should be sized to operate a large number of FTE hours.
- ~>4000FTH/year (red area in figure)



Henahan, R.K., Garrido-Marijuan, A., Garay-Martinez, R., Lumbreras-Mugaguren, M. (2022). System Level Planning of Heat Production Technologies. In: Garay-Martinez, R., Garrido-Marijuan, A. (eds) Handbook of Low Temperature District Heating. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-031-10410-7_4

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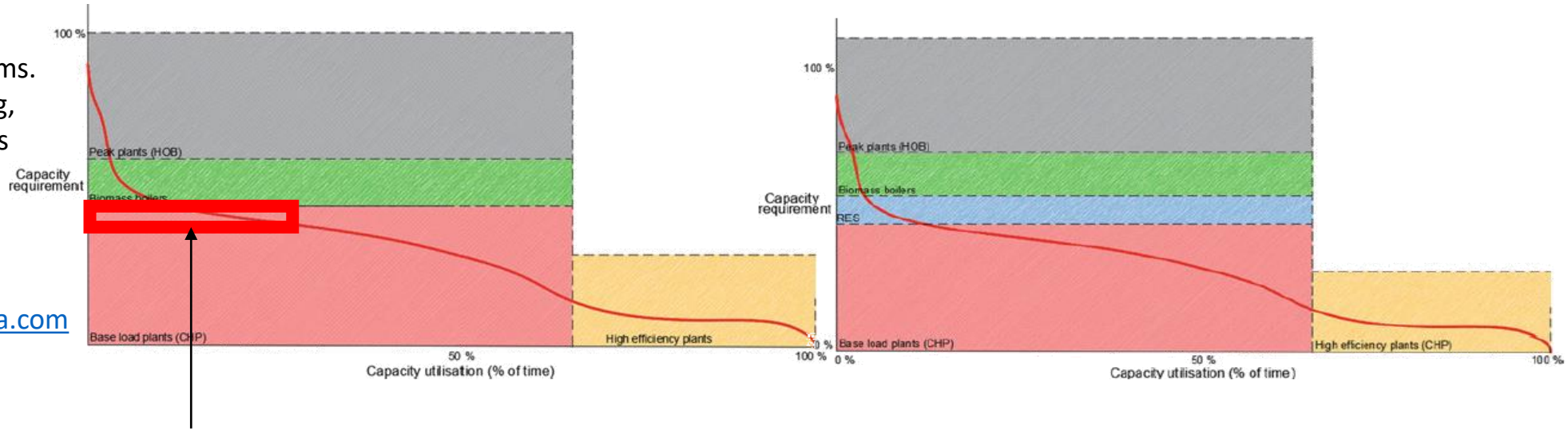
Upgrade of heat production

- When large RES energy is incorporated, pre-existing baseload capacity can be displaced.
- This has potentially relevant economic impacts in investments yet to be deprecated



This was already highly efficient / cheap heat production

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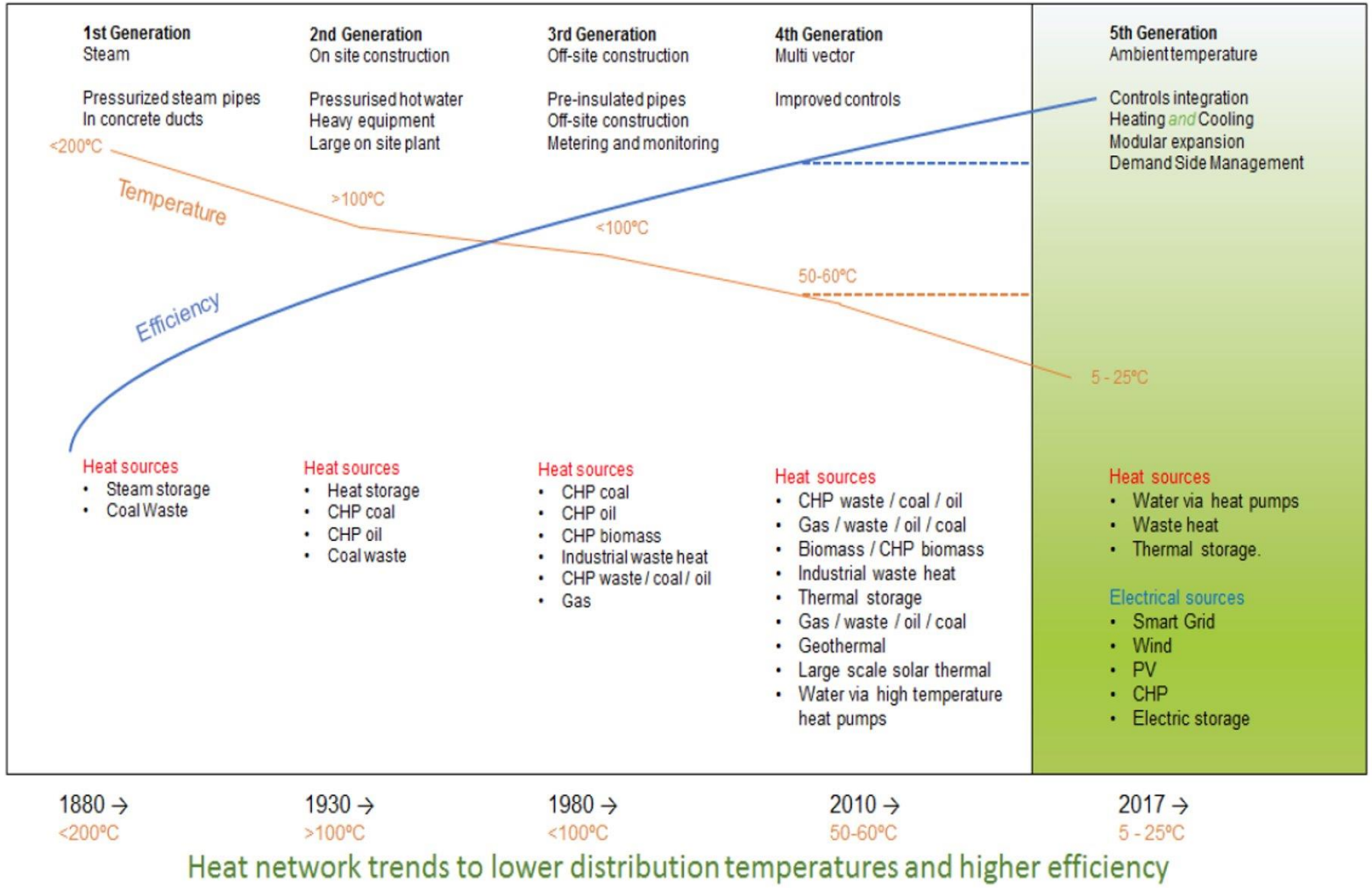
Downgrade of temperature levels



Heat network trends to lower distribution temperatures and higher efficiency

https://www.icax.co.uk/image_Fifth_Generation_Heat_Networks.html

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Downgrade of temperature levels

- Increase distribution efficiency
- Allow services in more dispersed areas
- Decentralized network, buildings as energy nodes
- Bidirectional heat pumps
  - Cooling
- New energy sources
  - Residual Heat (industrial)
  - Solar systems

	Energy distribution (MWh)	Energy delivered (MWh)	Losses (MWh)	Losses (%)
2019	8505	6991	1514	17.8%
2020	8267	7193	1074	13.0%
2021	7713	6595	1119	14.5%

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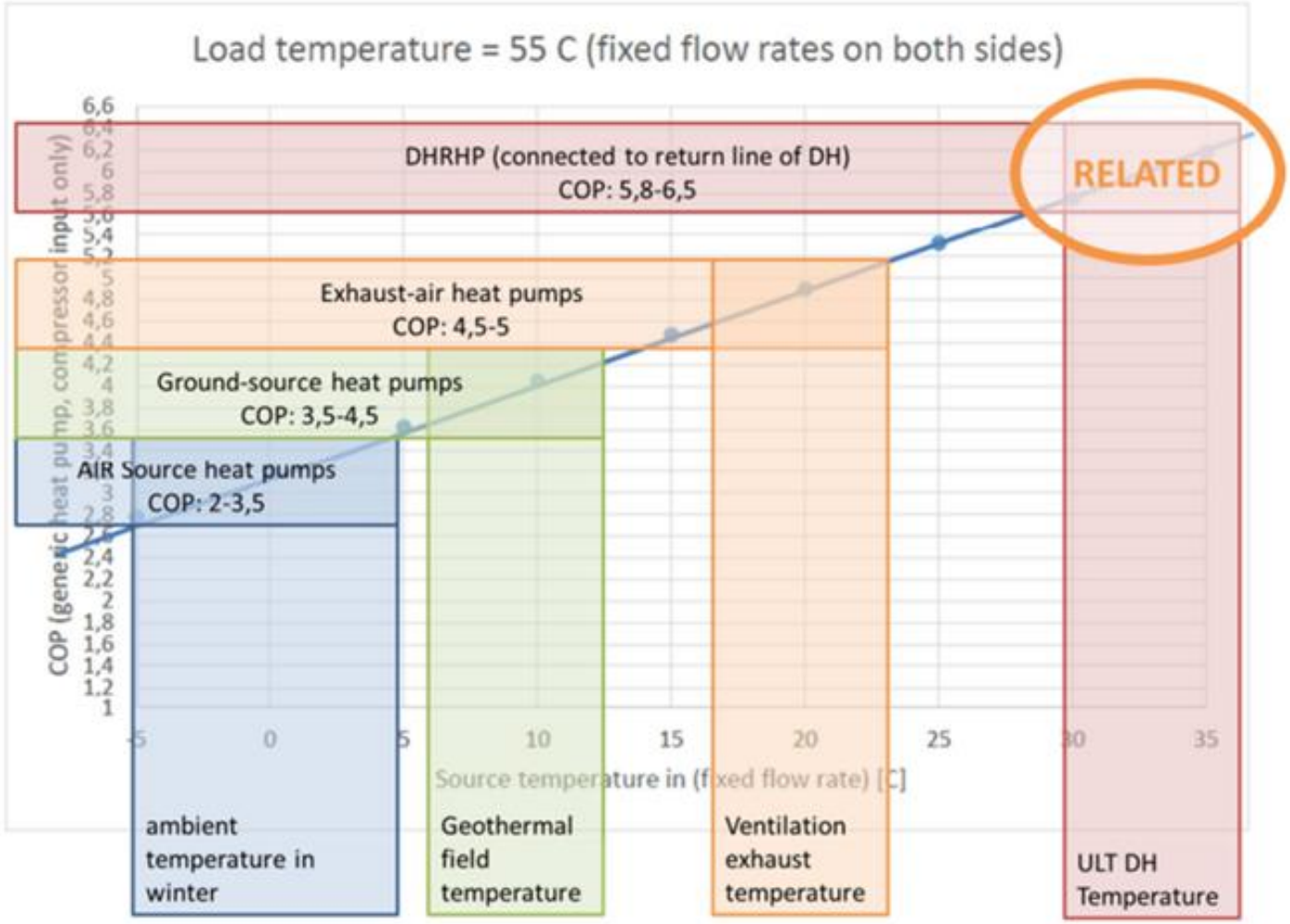

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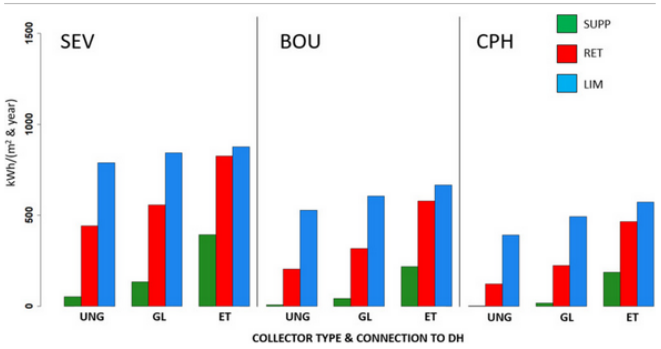
Local RES

- Building-Integrated Solar Thermal Systems, connected to DH.
  - Increased delivery of heat (no limitation to sinking capacity)
  - Better performance (can be connected to return line, at least with solar fractions <~30%)
  - Lower investment cost than with isolated ST systems



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City	Payback period	1–5 years	5–10 years	10–15 years	15–20 years
SEV	Net amount of cases	287	1582	871	266
	Percentage	9.5%	52.6%	29.0%	8.9%
BOU	Net amount of cases	0	624	737	177
	Percentage	0%	40.6%	47..9%	11.5%
CPH	Net amount of cases	0	88	320	264
	Percentage	0%	13.1%	47.6%	39.3%

Mikel Lumbreras, Roberto Garay, Energy & economic assessment of façade-integrated solar thermal systems combined with ultra-low temperature district-heating, Renewable Energy, Volume 159, 2020, ISSN 0960-1481, https://doi.org/10.1016/j.renene.2020.06.019

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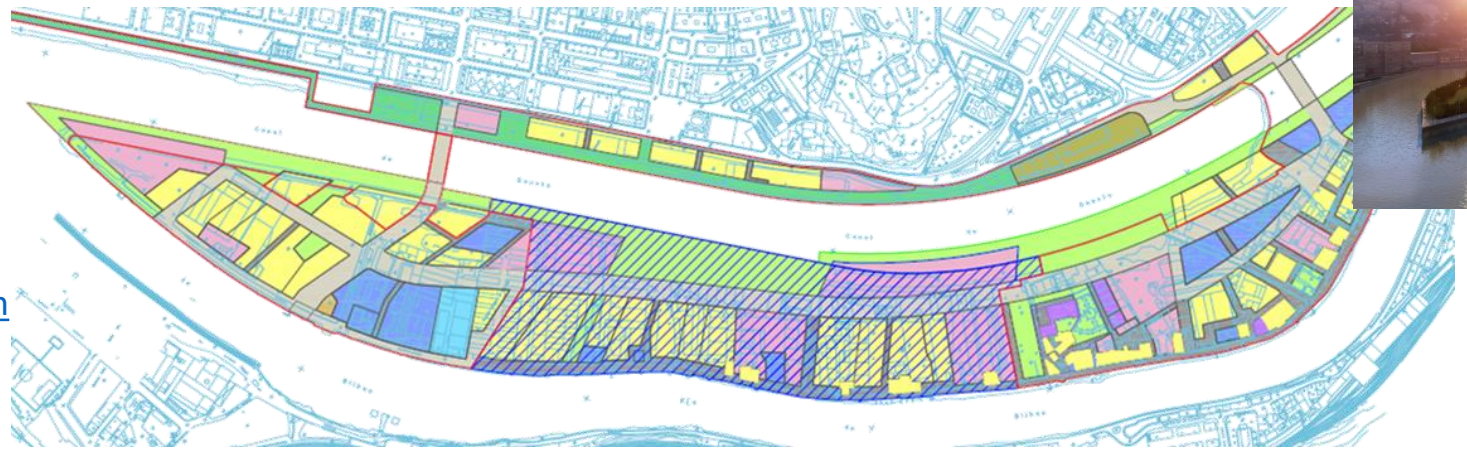
Development

- Urban development is performed in phases
- System should be modulated and capacity escalated along the urban plan development
- Link to an existing system makes life easier
- DH utility / developer roles should be allocated at the early stages. Particularly in areas without DH tradition.



https://www.zorrotzaurre.com/

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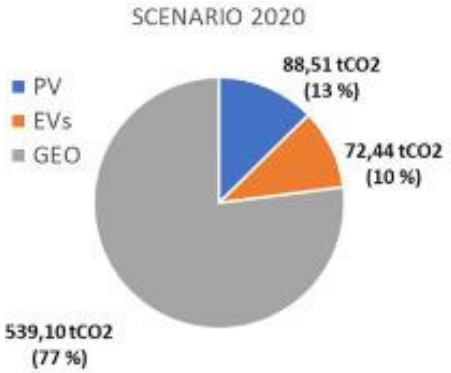
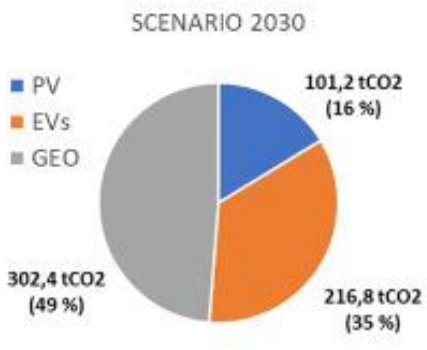
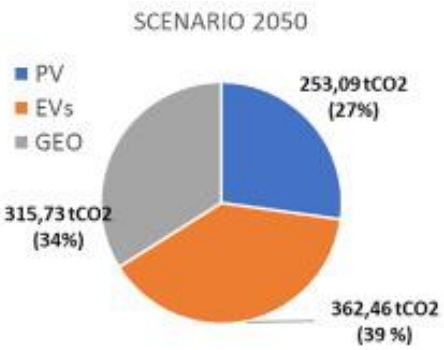
Development

Tony Castillo-Calzadilla, Roberto Garay-Martinez, Cristina Martin Andonegui, Holistic Fuzzy Logic methodology to assess Positive Energy District (PathPED), Sustainable Cities and Society, 2022, 104375, ISSN 2210-6707, https://doi.org/10.1016/j.scs.2022.104375

Increased RES &
Efficiency
New phases
Relevance change of
energy vectors







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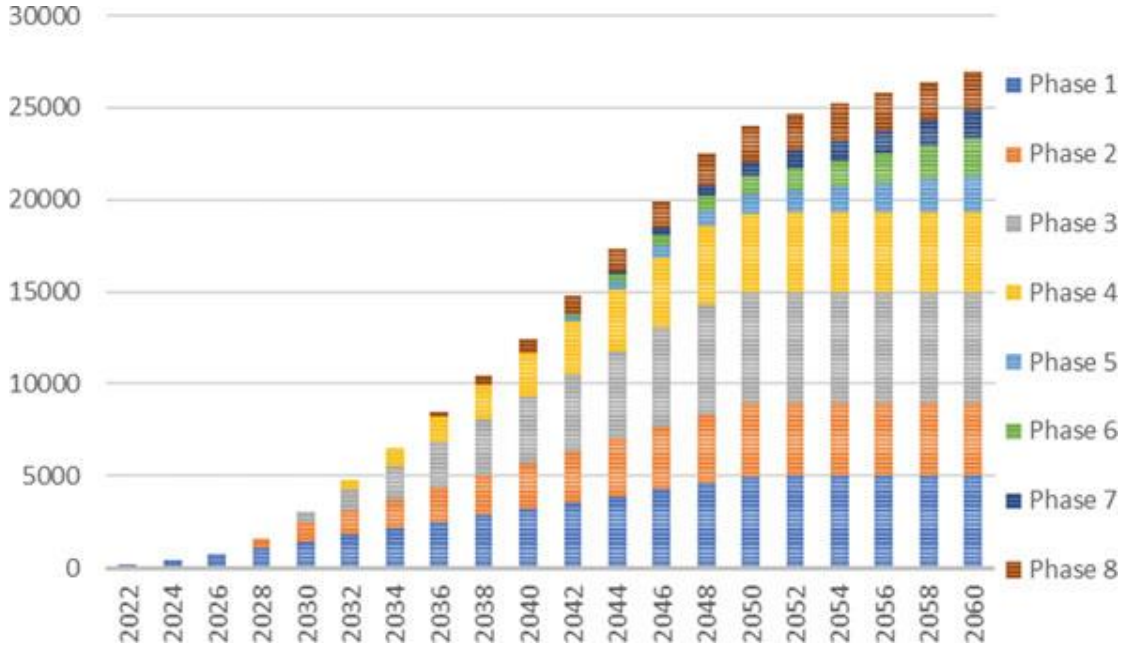
New phases
Increasing loads
New plants



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Regulations & Public Relations

(Particularly for areas without DH tradition)

- Long-term regulations on the pricing of heat and DH services should be in place.
- At planning stage, provisions should be made to avoid competition aganist natural gas
- The role of DH developer should be defined
  - Construction of network
  - Operation & maintenance
  - Engagement of custommers (tariffs & bilateral contracts)
  - Financial risks & long-term engagement
  - …

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Closure

- District Energy Systems are planned in multi-decade time horizons
- Enabling technology to integrate local RES (heat)
- Systemic approach is needed to the heat production mix
- Low temperature pays-off
- Some areas in EU do not have a DH tradition. Leading roles and market regulations are required

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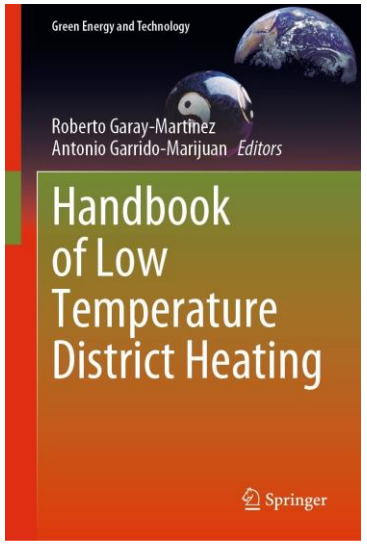

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