

PROCUREMENT FOR 5GDHC:

CONSIDERATIONS ON CHOOSING FOR 5GDHC, THE IMPLICATIONS
FOR PROCUREMENT, AND ENVISIONING PROCUREMENT'S ROLE IN
THE INDUSTRIALIZATION AND SCALING OF 5GDHC

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About D2Grids

This document has been updated starting from the Procurement Guide of the Interreg NWE project HeatNet NWE, to be also appropriate for the D2Grids project, which is funded by the Interreg NWE programme. The D2GRIDS project aims to develop 5th generation urban heating and cooling networks (5G DHC) in Europe. This document contributes to the goal of industrializing the 5GDHC approach by identifying the best procurement processes and development timelines for a 5GDHC system. As the D2Grids project is still underway, and final technical criteria are to be determined, some aspects of this guide may be updated by project's end.

For further information on D2Grids please visit www.nweurope.eu/d2grids

For further information on the original 4DHC procurement guide and on the HeatNet NWE project, please visit www.nweurope.eu/heatnet.

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Introduction

This procurement guide aims at assisting local authorities or local developers wanting to develop a 5th generation district heating and cooling system (5GDHC), more specifically on how to reach out and access carefully selected multiple expert service providers, qualified expertise and develop good projects. Additionally, it looks to ways in which procurement can be used innovatively to scale up 5GDHC development.

Differentiating from a 4th generation system, a 5GDHC system is based on the bidirectional exchange of thermal energy between buildings with different load profiles, maximizing the share of low-grade renewable and waste energy sources. Thermal storage at different times and scales is utilized to accommodate fluctuations in the grid. It takes an active and de-centralized approach to the construction and function of the grid, allowing it to start from small islands and scale up to a larger network. It is based on the following principles:



1/ Closing the energy loop

An optimized system allowing exchange of heat and cold between end users.



2/ Using low-grade sources for low-grade demand

In 5GDHC we match the supply with the requested quality level of the demand.



3/ Decentralized & demand-driven energy supply

Circulating energy within the system only when and where needed, as close as possible to the end user.



4/ An integrated approach of energy flows

Connecting heating and cooling to other energy flows (power grid, hydrogen conversion, solar plants, etc.) to avoid energy waste across sectors and reduce peak loads.



5/ Local sources as a priority

Avoiding big investments and energy loss during transport, while stimulating the local economy.

Figure 1: 5GDHC principles

Goals & structure

This document is an expansion of the document on 4th generation district heating & cooling procurement processes produced in the Interreg NWE project HeatNet. To read the original document from HeatNet, you may find it [here](#). This guide specifically focuses on points of attention in procuring for 5GDHC, and how procurement fits into the lens of industrializing technologies to accelerate the uptake and scale of 5GDHC systems. This guide does not attempt to be prescriptive,

as many organisations and countries have built in procurement processes for certain project aspects, and specific procurement regulations that must be followed.

Developments for 5GDHC are both revolutionary and complex, facing several organisational, technical, and financial challenges, and they are subject to meet European and national procurement standards. While there are some key factors and pre-requisites of an infrastructure procurement process, there are also many local specificities and diverse national legislations that make each area different.

Procuring consulting services as well as large-scale infrastructures that might be exploited by external companies (through a service/operation contract) needs serious skills and advanced knowledge. All key aspects must be thought of, measured, and analysed to secure high-quality planning, construction and future operations processes resulting in positive economic, environmental, and social impacts.

The first part of this document shall overview pre-procurement considerations, differentiating especially between 4DHC and 5GDHC. The second part looks at potential procurement strategies and procedures, as well as specific attention points for 5GDHC. Finally, the role of procurement in industrialization and scaling of 5GDHC is considered. In the appendix, case studies from D2Grids are shared, along with things to be considered regarding procurement.

Choosing a DHC system paradigm & impacts on the procurement process

A 4th generation DHC is innovative, with new priorities compared to older 3rd generation DHC, but the basic ideas and components are an evolution from a known paradigm. 5th generation DHC (5GDHC) is a new paradigm: the basic ideas are established¹, but the technological standards and performance requirements are still in development. This means that any organisation procuring works, services, or even consulting will also need to have relevant knowledge to make the right judgement calls. This section shortly describes this context.

Differences, similarities, & development capacity needs for 4DHC and 5GDHC

Even before the start of the procurement of the first consultants to help with the first basic design plans, you first need to understand 1) where you are in development; 2) what your role is in the DHC system set up, implementation, and operation; 3) your in-house abilities; and 4) your long-term goals and potential next steps with your DHC system.

You will also need basic knowledge of District Heating and Cooling (DHC) systems, such as understanding the differences between 5GDHC and previous generations (further information on that can be found [here](#)). And most importantly, you must consider why you are choosing for 5GDHC, in place of a traditional 3rd generation or even a 4th generation system. 5GDHC aims to be flexible and future-proof, to ensure no-regret investments for the energy transition. Ask yourself

¹ From the D2Grids project, see the Baseline document (D.T1.1.1), Ambition document (D.T1.1.3), and the preliminary Report on the 5GDHC technology model (D.T1.1.4)

these questions: do you want to focus on end users, and make use of a wide range of local sources? Do you want to prioritize circular reuse of energy before demanding additional renewable energy production from the grid, thus further reducing CO₂ emissions? Do you want a heating and cooling system that can be integrated to meet and balance multiple energy needs across sectors?

With every next step, you will build up experience and knowledge, and future steps will become easier. If initial development of your system is successful, all stakeholders will also become more comfortable with the chosen path of development, and the local community will have some basic idea of the procedures followed, the extent of disruption caused by construction, and the reliability of the system.

Possibilities for development:

So, why choose for 5GDHC at all? The answer to this question may depend on the situation in which you find yourself. If you are a town with an existing, old, 3rd generation district heating system, then you will need some transition strategy towards the future. On the one hand, you can make improvements to the current system, without changing the basic paradigm in which heat from central source(s) is distributed over a hierarchical grid (with a 'return line', i.e. as part of a 4th generation system). On the other hand, you can choose to completely redesign how your system delivers heat. 5GDHC has the advantage that it can work both at small and large scales and bring larger gains on efficiency and integration of more sources. This allows basic experience to be built up in a more gradual and controlled way, reducing risks.

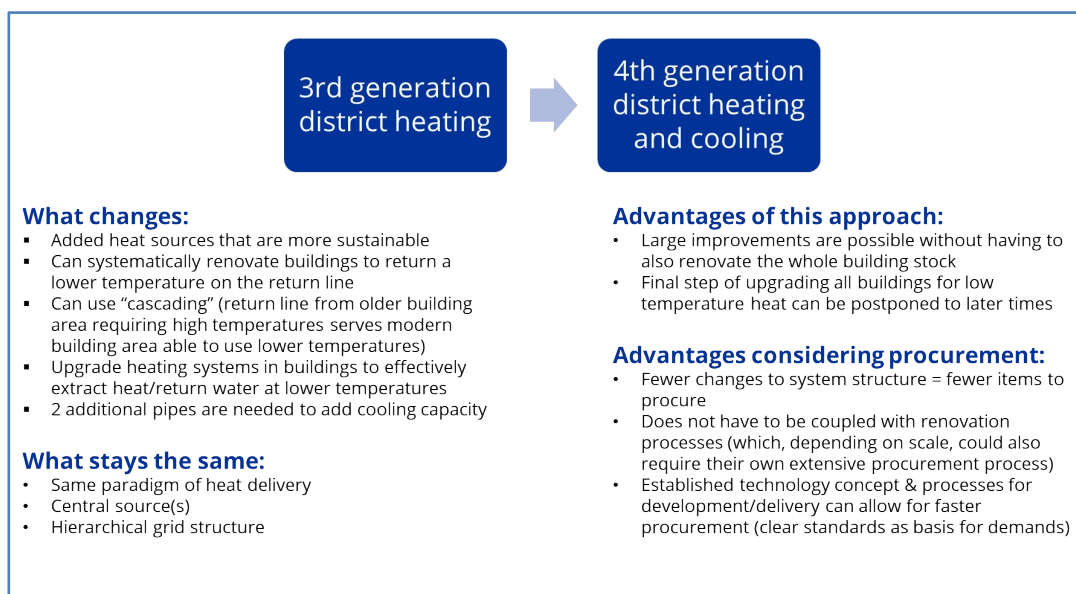


Figure 2: Comparing 3rd to 4th generation DH

Considering the conventional heat-delivery paradigm, the key advantage of the 4DHC approach is that if an existing system depended on old and CO₂-intensive source(s), large improvements are possible without having to also renovate the whole building stock. The final step of upgrading all

buildings for low temperature heat is still unavoidable but can be postponed to later times. This can of course also be considered a disadvantage, as renovation needs to happen at some point as we move forward in the energy transition.

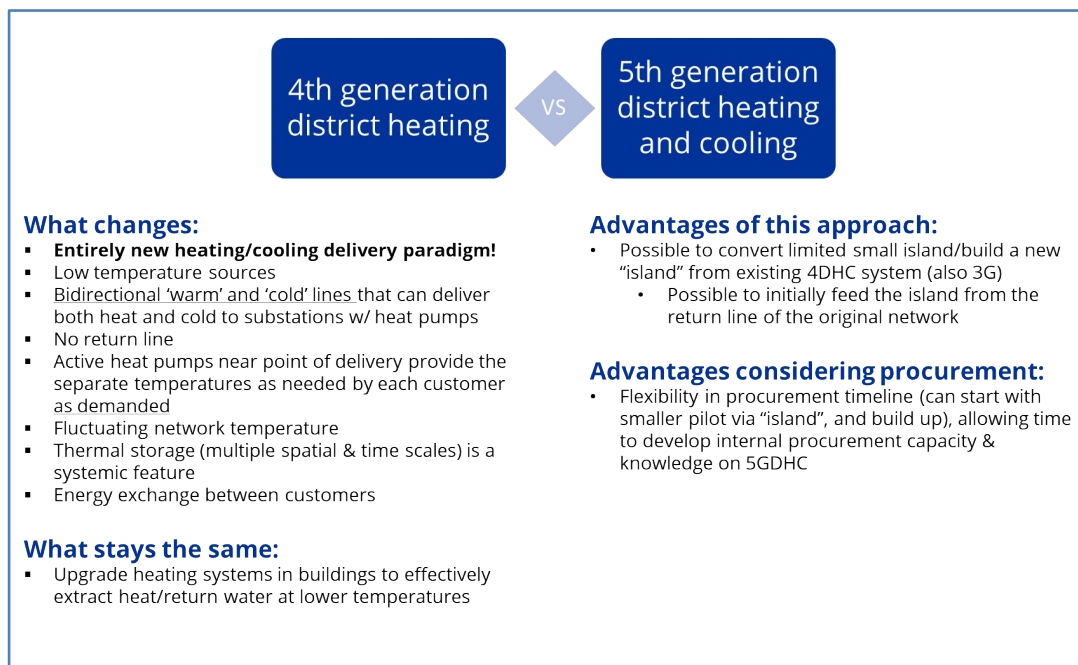


Figure 3: Comparing 4th to 5th generation DHC

The 5GDHC approach is to have a network that is configured differently, without a 'return line', and with bidirectional 'warm' and 'cold' lines that can deliver both heat and cold to substations with heat pumps that provide the separate temperatures as needed by each customer. It would be challenging to make such a transition rapidly for a complete 3rd or 4th generation system. However, it is possible to either convert a limited island, or build a small new island system. When converting, it would be possible to initially feed the island from the return line of the original network. However, the goal should now be to become independent from the higher temperature heat source. The concept of 'cascading' is superseded by the flexibility to deliver the right temperature to different connections in a more fine-grained fashion.

Although such a 5GDHC system presents a complete paradigm change as compared to the 4DHC system with its central sources, there is an important advantage to ease the change: 5GDHC is a paradigm that can work at both small and large scales. This provides a transition strategy starting with small independent island systems, that can then grow, and connect where it is useful.

What is the conclusion, and what does it mean for procurement?

If you want to start an entirely new system, it makes sense to go for the 5GDHC option. Why start with 4DHC now if you may later want to transition to 5GDHC? For an area with mixed building types and both demand for heat and cold, the 5GDHC option is very attractive. However, even for conventional residential areas with more homogeneous demands, it is more "future-proof" to

directly start with the 5GDHC system. The main reason for that is it can also provide cooling during hot summer periods, which is ever more relevant in Europe as we see further impacts from climate change. Also, if you start a new system, you will probably want to limit your initial investment and risk, start small to learn how it works, and prepare yourself and the local community for scaling more speedily at a later stage. 5GDHC provides this possibility for flexible development. If there is an existing DHC system with conventional centralized delivery, you can consider starting with converting or building a connecting 5GDHC “island” first.

Procurement is always a first definite step. How you do it will affect how you build it and balance the local capacity to continue making further steps. Ultimately, in the scope of procurement, choosing for 5GDHC depends on what risk level you are willing to take, your internal capacity for DHC development and for procurement, as well as your long-term strategy and future plans for expansion of the network.

How to procure?

Procurement

steps

For each service or good you would like to procure to develop a DHC network, you will have to follow the steps described in the Figure 2 (although they can vary depending on the type of procedures and on local conditions [1]). If you think you do not have sufficient knowledge of the market to define requirements for final outcomes, then you should first do a preliminary market consultation.

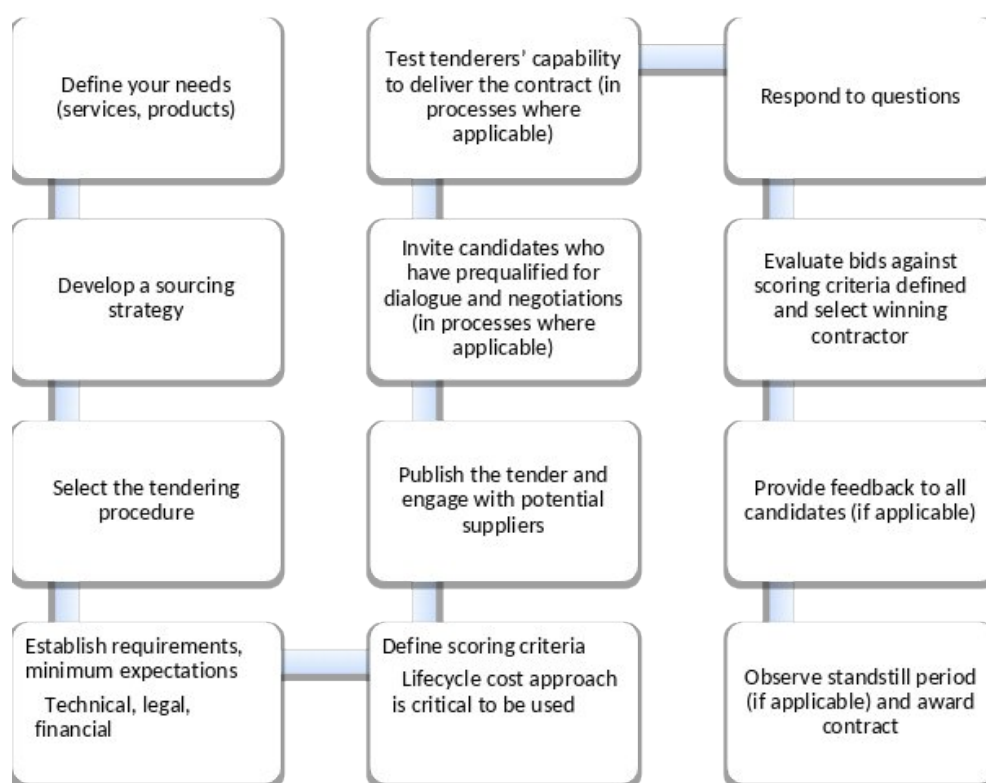


Figure 2: Steps of a procurement process (From HeatNet guide, 2019)

Procurement strategy

To give you the best possible hints, a procurement strategy must be set up [2]. It would allow anticipation and planning. This strategy should (at least) include the following points:

Project Team and Steering Committee: Who within your organisation is best placed to manage the procurement process and which departments should be involved? Is it relevant to include external experts or organisations in the group? For instance, departments for energy / infrastructure management / urban development should be considered to get involved in the process.

If working within a project with several demonstrator sites (either at EU or national scale), consider developing the above internal project team and or Steering Committee from the demonstrator site project managers and other relevant external experts early in the project phase.

Joint procurement: Are there other stakeholders/project members who have the same needs as you? Is it worthwhile to work with them (for example in joining a **procurement association**)? Does it make sense to set up a **framework agreement**? For example, in case of a DHC development on a campus or tech park, it is worthwhile to ally with universities, research centres and companies on site.

Joint procurement can be a valuable tool for engaging industry at a larger scale and achieving better prices for the design and components of your 5GDHC project. However, if you are considering joint procurement, especially across country borders, the possibility of joint procurement should be discussed as early as possible in the time frame of your project. By doing so, your project can better consider the commonalities that may be leveraged:

- Do the project sites require a similar overall grid design?
 - o i.e., Do they have similar connection types, demand profiles, geographical context, and scale?
- Do the project sites have differing design needs (due to scale, geographical context, etc.) but have at least one component in common?

Engaging Suppliers: Are you going to contact suppliers informally prior to starting a procedure? Is it better to meet with suppliers one-on-one or in groups? How will you share information and guarantee confidentiality at the same time?

Risk management: What are you going to do if there is only one or even no offer submitted at the end of the tendering process? What to do if the offers are beyond the calculated budget and make the business model not working? A form of mitigating risk can be done by downsizing / splitting the project into smaller parts. Another common solution is to set up a project company to manage the tendering and mitigate those risks.

With each tendering process, it should also be considered carefully by the contracting authority where most of the risk falls in terms of capacity and value. For example, in terms of the learning process, there are both benefits and downsides for a local municipality in procuring in multiple parts rather than to a larger contractor. Each contracting authority should thus consider carefully which procurement processes are suitable to their current capacity (especially regarding technical knowledge).

Types of procedures

The section below lists different approaches to tendering procedures and their basic functionalities. Depending on the stage of 5GDHC development, different procedures can be leveraged to:

- facilitate faster uptake of 5GDHC technologies
- better involve industry actors in the DHC network
- facilitate knowledge sharing between project developments and/or industry actors
- facilitate partnerships with industry leaders

The most common tendering procedures (see figures below) are typically as follows (illustrative list):

- Open Procedure (one stage, invitation to tender),
- Restricted Procedure (two stages, pre-qualification questionnaire and invitation to tender),
- Competitive Procedure with negotiation (3 stages)
- Competitive Dialogue (3 stages, dialogue can be iterative)

Tendering procedures can have a more specific target or purpose:

- Design contest: in this case the goal is to purchase one or more *designs*. These may not be executed in a specific project, or they may be for a generic class of cases
- Framework contracts: this is a formalisation of a long-term relationship in which different entities can work together, or repetitively collaborate on different projects
- Dynamic purchasing system (under Restricted): for the tendering of common goods/services/works over a longer timeframe, where all suppliers are pre-qualified before entering the system

Open Procedure (one step)



Restricted Procedure (two steps)



Competitive Procedure with negotiation



Competitive Dialogue



Design contest



Dynamic purchasing system (DPS)



Framework contract (1 supplier/contract)



Framework agreement (Multiple suppliers)



Figure 4: Summary of general and more targeted procurement options

The table (Table 1) below outlines different aspects per procedure listed on the prior page. For more detailed information per procedure, please see the original HeatNet document².

Procedure name	Short description	When is it applicable?	Potential drawbacks	Advantage(s) for local authorities	Advantage(s) for suppliers
Open procedure	Open to all businesses No restriction of number of tenderers Structured to be faster	When the service, good, and/or works are readily available on the market When you have clearly defined performance indicators and specifications, but want a variety of suppliers to choose from	Can take longer if many suppliers submit, or if performance indicators/specifications not clearly defined	Variety of suppliers to choose from Simplified procedure	Provides greater opportunities for SMEs who may be trying to break into the market
Restricted procedure	Contractors send request to authority Authority can restrain nr. of candidates via initial selection stage Selection via pre-qualification questionnaire	Same applicability as open procedure	Less choice available via this procedure Can miss out on suitable suppliers if pre-qualification questionnaire is not well-	Can ensure that suppliers are of high quality & meet all key requirements and expectations early on Can be a shorter process due to limited suppliers formally invited to	Depending on how the selection is done and whether the authority gives feedback, the suppliers can better structure future tender

² G, S, W= goods, services, and works

	(mandatory requirements, minimum expectations, capability, and capacity)		constructed for 5GDHC development considerations	tender Useful if ideal suppliers have already been identified in market research & dialogue	proposals to meet 5GDHC requirements
Competitive Procedure with negotiation	Like the restricted procedure but allows the authority additional step of negotiation before assessing bids authority must define the required characteristics before competition used to procure G, S, W which include an element of adaptation, design, innovation or other features which make the award of a contract without prior negotiations unsuitable	If you have precise performance standards in mind, & design and technical components for your system, but market research and dialogue has shown that there are still some gaps between what is available on the market and what would suit the “ideal” goals of your project	Negotiation period can go on longer than expected and cause potential delays	Allows for flexibility in coming to a final ‘Most Economically Advantageous Tender’ (MEAT), but in potentially less time as invited suppliers can be limited (in the same way as a restricted tender process)	Depending on how the negotiation process is structured, suppliers can have the opportunity to gain additional knowledge from their competitors
Competitive Dialogue	For complex tenders like large infrastructures, for which the authority cannot define in advance all technical specifications and/or financial and legal specifications After a dialogue step, each contractor submits offer based on their own solutions to the needs expressed, instead of answering to the same specification	For contracting authorities with limited capacity to adequately initiate and/or carry out the development of a district energy system	Can be time-consuming depending on how many dialogue rounds and selection stages are used Can require significant internal capacity to carry out	For authorities with limited internal capacity, this process can help to establish the grounds for a good working partnership throughout the DHC system development Can allow authorities to determine what level of involvement in DHC development is suitable/possible for them, and best determine what should be done externally	Depending on how dialogue process is structured, suppliers can have the opportunity to gain additional knowledge from their competitors Opportunity to innovate & expand expertise into new areas and/or contexts
Design Contest	Challenge a group of contestants to produce a <i>design</i>	Specify that the design is generic, and replicable in large numbers. This makes it worthwhile to organize such a contest, & attracts strong competitors who see it as a chance to get into a		Acquiring designs gives flexibility to use design for more than one project development, eliminating need to tender for design later Leaves a lot of room for the creative process	Depending on how the contest is organized, can learn from competitors Greater opportunity for SMEs

		<p>potential new market</p> <p>could be relevant (if produced at early stages) for those without the capacity to facilitate system design themselves</p>		<p>Forming an idea and awarding the contract remain separate, but can also be combined</p>	
Dynamic Purchasing System	<p>two phases: 1) the admission phase (suppliers request to participate)</p> <p>2) the tender phase (where the contracting authority then invites members of the DPS to tender)</p>	<p>intended for “commonly used purchases,” applies to the categories of services, works, and goods.</p> <p>Commonly used goods not strictly defined but indicate a high-level of market and technical readiness and availability.</p>	<p>Extensive administrative work to set up and maintain</p>	<p>Longer period of validity than framework contract</p> <p>Maximum flexibility</p> <p>Reduces admin. burden for repeated tendering exercises</p> <p>Potentially reduce tender timeframes</p> <p>can enable greater cost savings and innovation</p>	<p>Beneficial to SMEs, suppliers join at any time as long as they meet the requirements of the DPS</p> <p>Supports innovative developments</p> <p>longer period of the validity than a framework contract</p>
Framework contracts & agreements	<p>Contain aggregated requirements of various municipalities and/or project developers</p> <p>Tenders can be invited for part, or all of the requirements in different areas (lots)</p>	<p>useful to have a dedicated organisation taking care of the procurement process for several authorities</p>	<p>Extensive administrative work to set up</p>	<p>procurement processes are shorter</p> <p>buying power of authority increases, enables lower prices and better conditions</p> <p>access to expertise reduces risk of poor tech. implementation and/or fines re: procurement</p> <p>projects bundling attracts more suppliers & enables the implementation of high standards</p>	<p>single entry-point to market, reduces barriers to market entry for new suppliers</p> <p>can negotiate w/ competent experts, decreases transaction costs & fasten the process</p> <p>higher selling volumes & potential for standardisation</p> <p>sales forecasts more easily assessed, decreasing uncertainty</p>

What needs to be procured? Starting up and developing a project

The following figure from the D2Grids website 5GDHC.eu shows the interplay of various parties and stakeholders, starting from the initiation phase, through various stages, until realization and finally the operation. One of the ways that these parties are activated and brought together is through procurement processes, that also evolve roughly in parallel.

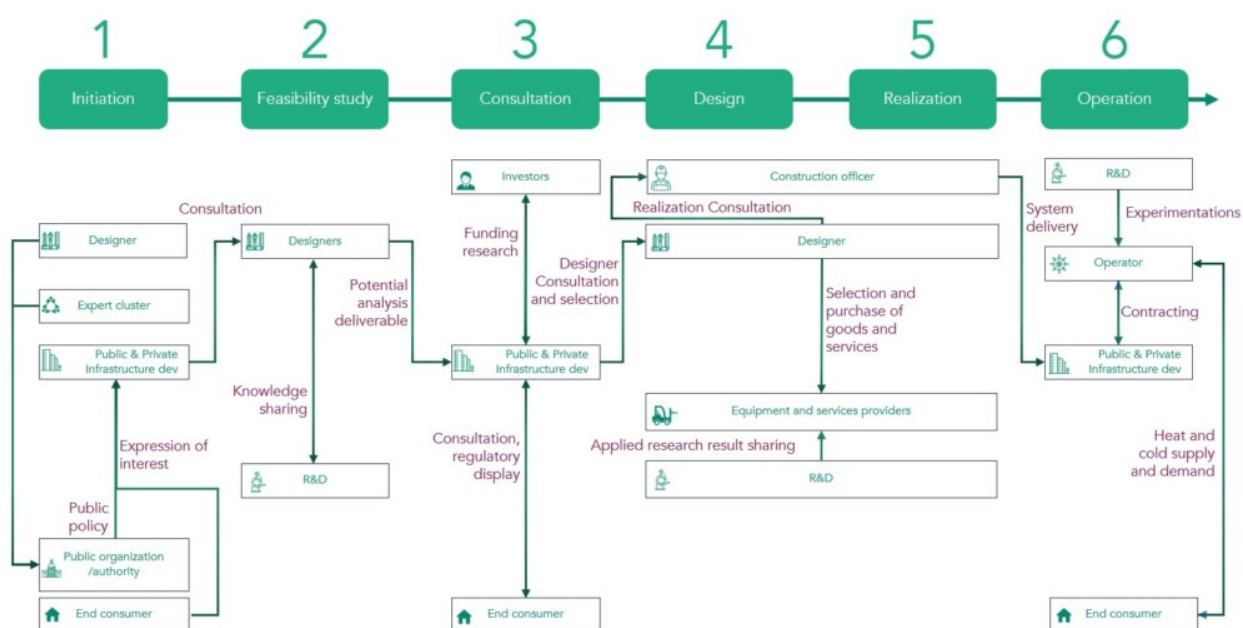


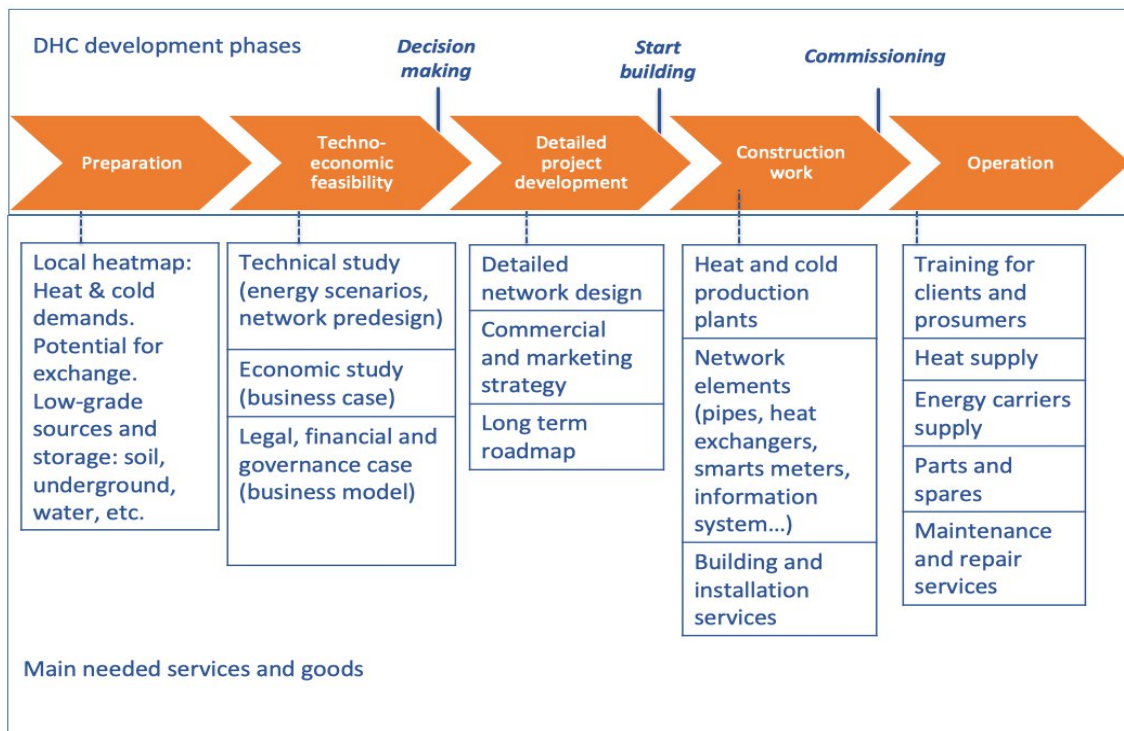
Figure 5: from 5GDHC.eu, produced by GreenFlex. Not that the division in stages differs from that in figure 6.

Procurement scope and timeline

To develop a 5th generation DHC network, a large range of services and goods are needed (figures 5 and 6). What is needed depends on the type of the intended project which can be:

- creating a new district heating and cooling system;
- [partially] transforming and upgrading an existing 3rd or 4th generation system into a 5th generation district energy system;
- extending an existing district energy system.

The way these items are procured may also vary. While the local heat map is usually procured alone, the studies (technical, economic as well as legal and financial) necessary to decide upon



should be procured together. It will add consistency to the scenarios proposed: contractors answering the tender could gather in a consortium of consulting companies from different fields (technical, financial, and legal services) [6]. Once the construction decision is made, the related services can be procured in different ways, depending on the chosen business model.

Figure 6: Goods and services which could be procured along a 5th generation DHC project. The 5th generation focus on low-grade thermal sources, and the opportunities for exchanging energy between demands for heat and cooling need to receive attention right from the start. It also needs to be considered at the high-level design of the district, as the right combination of a diversity of building types becomes important. Otherwise, this same scheme also applies to the 4th generation paradigm. Figure modified from HeatNet.

A project developer willing to build and own a network, can opt for diverse business models, depending on whether you aim to (illustrative list):

- build, operate, and maintain a district energy network via a municipal company;
- build, operate, and maintain a district energy network via a concession (public-private partnership);
- build a network and procure operation and maintenance services

Based on the business model chosen, and which party is initiating project development, it will have impacts on what items may need to be procured by the involved local authority, the company receiving the concession, or the contractor for operation and maintenance services.

	Municipal company builds, operates and maintains the system	Construction, operation and maintenance services procured via a concession	Contractor operates and maintains municipal system assets
Consultancy services to generate the complex datasets required for quality analysis and planning	•	•	•
Consultancy services to generate the pre-feasibility and feasibility studies, certain draft tender documents	•	•	•
Asset purchase (district energy generation or distribution assets)	•		•
Construction works	•	•	•
Operation and maintenance services		•	•
Heat purchase agreements	when third party heat sources are utilised too		possibly, when third party heat sources are utilised too
Building (social housing, public buildings) renovation, automation	when part of the municipal project		

Table 2: Types of goods and services directly procured by a local authority in various (illustrative) business models. From HeatNet guide (2019).

The question of the suppliers is also crucial. Before looking for an external company, local authorities can see whether the competencies are available internally or in a public company owned by them. Sourcing the services and goods internally can speed up the process and guarantee results which better consider the local context and specificities.

In any case the first step before launching a 5GDHC project is to establish a local heat map. Indeed, the key objectives of 5GDHC systems are increased system efficiency, energy reuse, and the integration of sustainable heat and cold production sources (renewables and waste sources). Comprehensive quality information regarding local heat and cold sources as well as energy demand are thus a must. For a 5GDHC project, with its focus on low-grade thermal sources, the mapping of cooling demand becomes more essential, as there are possible locations for thermal storage and any potential for (shallow) geothermal sources.

Summarized details of what needs to be procured

This document does not cover detailed specifics of everything needed to procure for 5GDHC but provides a summary table of key aspects to consider based on Figure 6 and the original HeatNet procurement guidelines. For further detailed information, reference the [existing HeatNet procurement guidelines](#).

Procurement aspect	Development stage	Key success factors	Stakeholder engagement	Suitable procurement procedure	Providers
Local heatmap (heat & cold demands, potential for exchange, low-grade sources and storage, etc.)	Preparation	<p>Strong political commitment from municipal departments & partners to acquire necessary data re: heating & cooling sources & usage data for buildings</p> <p>Open & well-structured communication & information flows</p>	<p>Large group & early dialogue process needed with (indicative):</p> <ul style="list-style-type: none"> -Municipal departments -Utility companies -Local energy agency -Social housing -Industrial companies - Educational institutions/large offices -Shops, data centres, any places with cooling -Landowners for underground thermal sources/storage 	<p>Open</p> <p>Restricted</p>	<p>Engineering consulting companies for energy management & energy planning (specialized with GIS)</p> <p>Local & regional energy agencies</p>
Technical study	Techno-economic feasibility	<p><u>Focus on:</u></p> <ul style="list-style-type: none"> -matching sources & needs based on temperatures - matching supply & demand on short-term (peak), medium-term (seasonal), and long-term to determine applicable storage options -comparison of baseline & proposed 5GDHC development scenario, also beyond energy impacts <p>Highlight in tender the need to consider scenarios for low-temperature sources and combinations that maximize opportunities for energy exchange, but don't request too many scenarios for consideration (aim 2 to 3)</p> <p>Consider needs of digitalization and smart control appliances for use in your system & your local context</p>	<p>Engage potential customers of DHC system in process, eg. as part of steering committee or consulting on different scenarios proposed</p> <p>Important to build trust since 5GDHC is an innovative approach</p>	<p>Open</p> <p>Restricted</p> <p>Competitive procedure with negotiation</p>	<p>Engineering consultancies specialized in renewable energy and low temperature technologies</p>
Economic model	Techno-economic feasibility	<p>1st phase: Have a clear picture of investment costs and operational costs to determine prices of heat sold. Conduct sensitivity tests to analyse impact of different parameters</p> <p>2nd phase: Examine business model (including legal analysis & financial impacts), considering key objectives, risk attitudes, level control desired, regulatory compliance, financing access, & desired ROI</p> <p>Complete in same timeframe as</p>	<p>Same as for the technical study, but particularly engage political level</p>		<p>Engineering consulting firms with project financing competency</p> <p>Consulting companies specialized in market analysis and technical projects</p>

		technical study			
Training for clients & prosumers	Operation	<p>Ensure all clients & prosumers understand specificities of technology to ensure maximum advantages of system</p> <p>Ensure understanding of digitalisation, data usage, and specificities linked to contractual clauses</p> <p>Cover sustainable behavior, system operations, and smart controllers as soon as people connect to DHC network (or in advance)</p>	<p>Dependent on chosen business model</p> <p>Municipal departments: regulatory elements, city's involvement</p> <p>District operator: explaining DHC operations & impact of behaviour on DHC system</p> <p>Manufacturers/distributors smart controllers</p> <p>Heat producers</p>	<p>Seems not necessary to have a procurement procedure for this service but to add it as a requirement in the procurement procedures set up for the other goods and services</p>	<p>Relevant partners of the DHC system development with necessary expertise for different aspects of training</p>
Heat & cold supply	Operation	<p>Heat supply agreements (HSAs) should be secured before construction starts</p> <p>Clear minimum standards of service and mechanisms of enforcement should be defined</p> <p>Define monitoring & enforcement of these standards</p>	<p>In case a new heat provider is sought:</p> <p>Customers who are located in the district that can become heat/cold providers;</p> <p>city representatives and officers;</p> <p>financial partners; neighbours if they are affected by the "new installation".</p>	<p>If no technology preferred, competitive dialogue</p> <p>If technical solution provided, competitive procedure with negotiation suitable for complex infra</p>	<p>Project developers</p> <p>Utility companies</p> <p>Waste heat from industry, commercial, and tertiary buildings</p>

Additional notes for 5GDHC:

Local Heat Map: For a 5GDHC system, the cooling demand is very important, as this can indicate locations around which development can start. More conventional larger sources of waste heat may also be attractive but may also be more difficult to properly integrate into a paradigm that aims to fully exploit local low-grade thermal sources. It is also important to search possible locations for thermal storage, or shallow geothermal. A 5GDHC also explicitly demands an integrated view of the underground, below both private and public properties. In a dense town, coordination of the thermal storage/sources in the underground can make a very large difference.

As part of D2Grids, it is being examined for the Long-Term work package how existing generic heat map data and online tools (like Hot Maps or the PlanHeat tool from DHC+) can be adapted for mapping the needs and opportunities for 5GDHC in the follower regions of the project (Parkstad Limburg in the Netherlands, Luxembourg, Flanders in Belgium, North-East France, Ruhr-area of Germany, Scotland, and the East Midlands of the UK). Further updates regarding mapping of 5GDHC will come towards the end of the D2Grids project.

Technical study: When developing a 5GDHC system, it helps to aim high, and if this is your start with the paradigm, prefer to make a small and more pure system, rather than a larger one with

significant compromises to the paradigm. If it is your first step in 5th generation, try to build up local experience and capacity. That will also help you build trust among future stakeholders.

For 5GDHC, many of the components in the system are the same in a 4DHC. As part of D2Grids, an online catalogue of best available technologies (BATs) is being developed. This will be made available on the 5GDHC platform (5ghdc.eu) which will be available to project developers looking to develop a 5GDHC project & utilize relevant and recommended system technologies and components.

Regarding stakeholders, especially for a 5GDHC, it is important to build trust that this innovative new approach can work and is the best way forward in the longer term. There should also be reasonable trust that the system will be able to provide services that are both better and at a lower price than sustainable alternatives like individual air-source heat pumps.

Regarding procurement, when considering components for the design as part of the technical study, it can already be considered:

- Which items could potentially best benefit from joint procurement (e.g., heat pumps) and why? [Relevant when working in a project partnership]
- Which items are best individually procured, or can be ideally arranged via frameworks (e.g., pipes)
- What things can be procured to meet your system requirements using available market & customizing to suit needs? (i.e., Mijnwater example 4-pipe system)

Also as part of D2Grids, detailed technological standards and key performance indicators are being developed. These additional criteria (to be delivered by December 2022) can be used in creating a program of demands for 5GDHC procurement.

Economic study: For larger customers it can be mutually attractive to also have a more substantive one-time contribution to the initial investment for constructing the connection.

For 5GDHC, the business model of such systems is currently in development as well as business plans for each of the D2Grids pilot sites, with input from the pilot sites factoring into both deliverables. And for procurement of the study, for 5GDHC, you need to ascertain that the company has sufficient knowledge, understanding and experience of working in what is still a new paradigm.

Training for clients and prosumers: Within the Work Package Long-term for D2Grids, training materials are being developed for industry, policy-makers, and vocational education. These materials can help to establish informed local authorities, industry actors, and a specialized workforce on how to plan, develop, and implement 5GDHC systems, allowing for a further industrialized and accelerated 5GDHC system uptake.

For local authorities, having training for 5GDHC will enable capacity development for setting up efficient procurement processes & ensuring the best possible contractors and suppliers are chosen to meet the needs of their region. Implementation of training materials at the local level also adds to the workforce capacity able to carry out the development, construction, operation, and

maintenance of the 5GDHC system, potentially enabling local authorities to procure more local companies & further boost 5GDHC development in their region.

As written above, adding this training (once developed) to the tendering process also provides incentives for industry. Winners of the tendering process who receive the training will be better prepared to successfully submit tender proposals for later 5GDHC development processes.

Role of Procurement in Innovation & Industrialization for DHC

A key goal of D2Grids is to initiate pathways for industrialization of technologies that fit with the concept of 5GDHC and the required system components. The 5GDHC paradigm can build on the technology developed for earlier systems, but there are not yet established standard components, leading to a need for innovative designs, designs that allow production of components in (semi)industrial fashion, modularisation to ease installation and allow a certain freedom to combine modules in the future. Designs need to be replicable but are still undergoing continuous innovation and improvement.

Considering measures in policy or governance that can be utilized to activate industry to either 1) innovate for specific needs of a 5GDHC system and/or 2) optimize on existing technologies for DHC to be better suited for 5GDHC, procurement falls on the demand-side of possible measures.

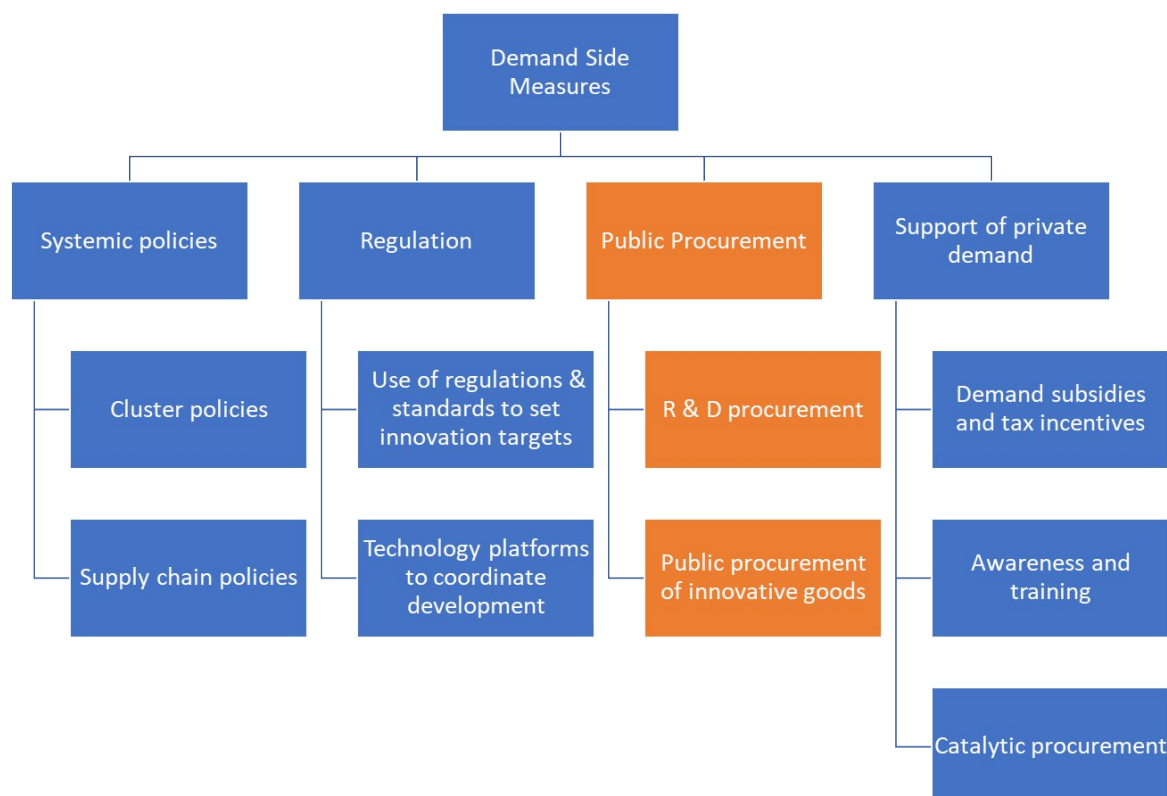


Figure 7: Public procurement as a demand side measure. Figure adapted from Edler and Georghiou, 2007.

Specifically, within the EU, public procurement constitutes a significant portion of GDP and is an important motivator for further innovation and industrialization of technologies, to move beyond niches and into the mainstream regime. Authorities procuring for a 5GDHC system could help fine-tune existing market technologies and have them adapt/innovate for broader contexts, while ensuring that these technologies and services (particularly for 5GDHC) can better establish themselves in the energy market as a viable competitor for long-established technologies.

The following sections detail challenges to realizing industrialisation for DHC and potential solutions via procurement.

Challenges to DHC transitions, procurement, industrialisation

Making the transition to a new paradigm for heating and cooling creates uncertainties and new risks. A key aspect of 5GDHC is to make the district heating system integrated as a holistic part of the larger system of all energy carriers. This means that the value propositions must change, as district heating will perform certain functions beyond serving heat to its direct customers. It can help stabilise the electrical grid and provide flexibility services that allow renewable electricity to grow, ultimately to 100%. But how can this value be created, optimised, and who pays for that service, in which way?

The other large looming uncertainty of transition is one that affects all district heating systems: buildings are being upgraded, they will need less energy for heating and cooling, and they will be able to deal with low temperature heat, and high temperature cooling. This will eventually put all business models under pressure that depend on distributing a certain amount of thermal energy. It is a long-term risk, if the value and size of a district heating network is purely measured in the amount of GJ of heat distributed. Even more if it is optimised for high temperature delivery.

5GDHC is a district heating and cooling system, but without the imperative of a centralised network linking energy source(s) to all customers. The system may consist of smaller sub-grids, which do not necessarily connect. The challenge for a 5GDHC system is to make sure that the costs of this infrastructure are compensated by the additional value it provides.

The consequences are that a 5GDHC system needs to be designed, built, rolled out, optimised, operated, governed in ways that differ from what we have been used to. The new technical paradigm must be complemented by new ways to segment the business into parts that can be optimised separately. It needs to be determined which parts can be treated as a market, which should be under democratic local governance, and which are more appropriately seen as a common, owned and valued by the local community. This opens exciting new chances for local government and the local community to take back some of the control from the market. This transitional and innovative situation also represents uncertainty and risk.

It is important to realise that the procurement phase of designing and rolling out a 5GDHC is the start of a long period of transition, that brings with it opportunities and risks. During the procurement phase and thereafter, local governance structures can build capacity and experience needed at later phases. It is important to find the right balance between outsourcing to external parties and building local capacity for later growth. This capacity can be in the local government, but also the local community, and in local business.

Potential solutions for DHC transition & industrialisation via procurement

Synergy between projects

In EU projects like D2Grids, the goal is that there are synergies where different pilots can together be more innovative than they would be on their own. Likewise, it is possible to think about joint procedures, or ways to work together, to also make procurement processes more effective or powerful. Where and when can such opportunities be found?

Scaling via “copy-paste” designs

Many towns may have opportunities that promise rapid scale-up from first a single small island seed-system, to many ‘follower’ small seed-systems. Afterwards, each has the potential to grow and connect with their immediate neighbourhoods.

For example, in the town of Utrecht in the Netherlands, the idea has been discussed to build small systems based on thermal storage in an aquifer doublet to provide heating and cooling for schools. Since schools have significant needs for cooling, it is then attractive to subsequently connect each such school to the residential buildings nearby. After making this work for one well-chosen school, it can become a copy-paste process to scale it up for many schools.

Such scaling provides great opportunity for standardisation, industrialised production, and a series of projects that can be constructed by one or more construction companies from the local region. It is also clear that procuring the first demonstrator-school could be done in the form of a competition, explicitly awarding innovative solutions, and designs for industrialised construction. The scale-up phase would be procured from the initial contestants, to allow more construction companies to join, all learning from the first winning project. It is imaginable that a few winners are asked to combine their ideas for the initiator-school. This example shows that a structure with a start-up project, followed by many copies, it can be worthwhile to structure the procurement process to enhance innovation and industrialisation.

Learning from complementarity: Examples from D2Grids

How is this for a project like D2Grids? As an Interreg NWE project, D2Grids brought together five pilot projects, from different countries, different local situations, with different organisations, each

with its special advantages, and each ready to make a ‘first next step’. The diversity of pilot sites guarantees that the lessons learned will complement each other. Unlike the example of the project in the previous section, they cannot have the same common focus and the tight common strategy, the coherently phased timing with a plan for rapid scale-up. But still, the pilots can inspire and help each other, and one may hope for some cooperation in procurement processes.

Mijnwater in Heerlen has an existing 5GDHC system in the town of Heerlen, but it was ready to make a first step in the neighbouring town of Brunssum, starting with a small independent island. At Paris-Saclay, an existing network is being converted to 5GDHC. As it serves an area with university buildings, science experiments, companies, and residential buildings for students, this could become the new largest 5GDHC system in the world. In Bochum, a large old industrial area is being cleaned up and re-purposed for new companies, with a new district heating system that is to make use of the mine water system in the underground. A small subsystem will demonstrate 5GDHC, and hopefully grow to serve more. Likewise, in Nottingham and Glasgow, the plans are to start a small 5GDHC system, with the option to connect it to old mine water systems in the underground, possibly at a later stage.

The D2Grids Long Term work package foresees that each pilot project recruits ‘followers’, or next stage projects to which the demonstrated technologies can be replicated in the coming years. That will be a second chance for a well-chosen procurement process to award or stimulate quick replication and industrialised construction.

Innovative procurement options for industrializing 5GDHC

There are several procurement processes currently allowed and implemented under EU and national procurement rules, but that are not standard/used less frequently in procuring for 5GDHC. The sections below discuss the benefits and potential scaling/industrialization that could be achieved via three distinct procurement processes: design contests, dynamic purchasing systems, and framework contracts.

Design Contest

The goal of a design contest is to challenge a group of contestants to produce a design. For DHC development, the challenge could be to get designs for a more generic purpose, with the explicit goal to drive innovation, and exploit the opportunities for industrialised production. In that case, the contest could be structured in a way that several top designs get awarded with a certain amount, and a possible winner is selected to be the basis of a first implementation. It is even possible that the ‘final’ design to be used for a first implementation combines winning features of more than one competitor. Since the designs are procured and paid for, they can be made public and open for use by others, with the idea that they help drive innovation and industrialisation.

The Dutch ‘Energiesprong’ project designed such a type of contest, where the goal was to find new standards for renovating standard types of buildings, like terraced dwellings, or flat blocks, to a high level of sustainability, at a reasonable price. For this contest, they developed what they called

the 'Soft Selection Method'. This method works well for projects oriented towards the following features:

- Defined in terms of performance
- Innovation is needed, and the point is to get new ideas, which could be implemented for a large application, with industrial design and leveraged with mass production technologies.
- Transparency is important, as all competitors would have to see this contest as a learning opportunity.

It is important for this type of contest that the design is generic, and replicable in large numbers. This makes it worthwhile to organize such a contest, and to attract strong competitors who see it as a chance to get into this potential new market. The purpose of this kind of contest is not to procure the labour to build a specific project, but to procure several designs that are generic, replicable, and need to deliver on performance requirements. The performance requirements were defined at three levels:

- Must have performance requirements, precisely formulated.
- Nice to have performance goals, freely formulated as 'soft requirement'
- Any "pleasant surprises" that the contestant might add

The kind of contest organised by Energiesprong utilised a diverse jury to score the designs based on the 'must have' requirements, then decide which design was best at the 'nice to have', and possible surprising additions. The final choice was made at a meeting of the jury where all competitors were present, each project could present itself, and the jury could motivate their choice, which was based on these 'soft selection' criteria.

The winning design could then be built. At this phase, the winner went into the next step of the procurement, with the owners of the buildings. The plan was worked out in detail, and the builder had to give a guarantee for the designed performance levels. There was a subsidy to make this first prototype affordable, but part of the subsidy was only awarded after the renovation was finished, and the promised performance levels were achieved. The idea of this was that it puts the risk of failure with the party that can be responsible to prevent failure.

This specific contest resulted in the 'net zero energy building' paradigm (NOM: 'null op de meter'), with a combination of insulation, heat pumps, and solar panels that could generate the amount of electricity needed on average over a year. This was not fixed in the 'must have' requirements but was the result of creative design to deliver on the 'soft' requirements.

Dynamic purchasing system

A dynamic purchasing system can be widely valuable in the scaling of 5GDHC, particularly with respect to buying components in bulk and encouraging competition among suppliers at varying

scales (local SMEs, larger national enterprises, etc.). A DPS is also attractive for ongoing innovation within a given market (see Figure 8 for additional market characteristics).

The challenge for a DPS lies in its set-up and administration. Currently, the use of DPS for energy in general is limited, with most prominent procurement bodies focusing on this being within the UK. DPS's exist in most European countries, but their scope typically focuses on education, office supplies, and staffing. The administrative tasks of a DPS can also be extensive, as there must be a dedicated evaluator to assess ongoing supplier applications to the DPS, and then they must also manage the actual online DPS system itself. For this reason, scaling via DPS is likely best done by project developers by either coordinating to establish a public procurement body dedicated to this task, or approaching an existing public procurement body to add a DPS to their existing portfolio.

Particularly considering 5GDHC development, many components and/or technologies used for the system design have a high level of market and technical readiness (see the D2Grids preliminary 5GDHC product and process standards for further detail). For technologies with high market and technical readiness, a DPS could be set up, with the performance requirements for 5GDHC specified, so that a ready directory of 5GDHC-tailored components could be compiled for project developers.

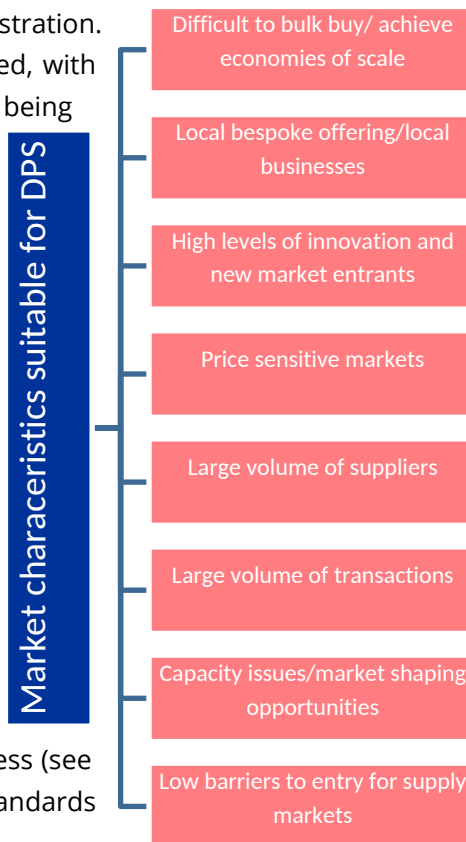


Figure 8: Market characteristics suitable for DPS. Figure adapted from Sigma, 2018.

Framework contracts & agreements

A framework agreement is a longer-term contract between parties (one supplier or more) with the intent of working together on similar projects in the future, without needing to go through a full procurement process for each of these projects. This could be to formalise a longer-term relationship with a consultant or contractor. But it could also be a way to formalise a Procurement Association.

A framework contract is a longer-term contract between a developer and one supplier for up to 4 years at the EU-level offering. This also eliminates the need for additional procurement processes, as the developer simply awards the contract from the start with the necessary parameters for goods, works, and/or services to be fulfilled by the supplier. The amount does not have to be defined.

In the context of DHC development, particularly for 5GDHC, framework agreements are valuable because they can be time and cost saving, but also give room for negotiation and flexibility for

what you require from your supplier(s). In a framework agreement, you are also not obligated to make purchases, so if the larger context of your project changes, you can adjust planning and the contract you want to offer to your supplier(s).

Conclusion on role of procurement for 5GDHC development & industrialisation

Each of the above specialized procedures for procurement can be used in an innovative way to spur further development and industrialization of DHC. Depending on how you structure your procurement strategy, some of these procedures could even be used in combination.

As the figure from MITA below shows, these specialized procedures can vary with respect to time to prepare and execute the tendering process, risk level associated with the procedure, and potential attractiveness to suppliers.

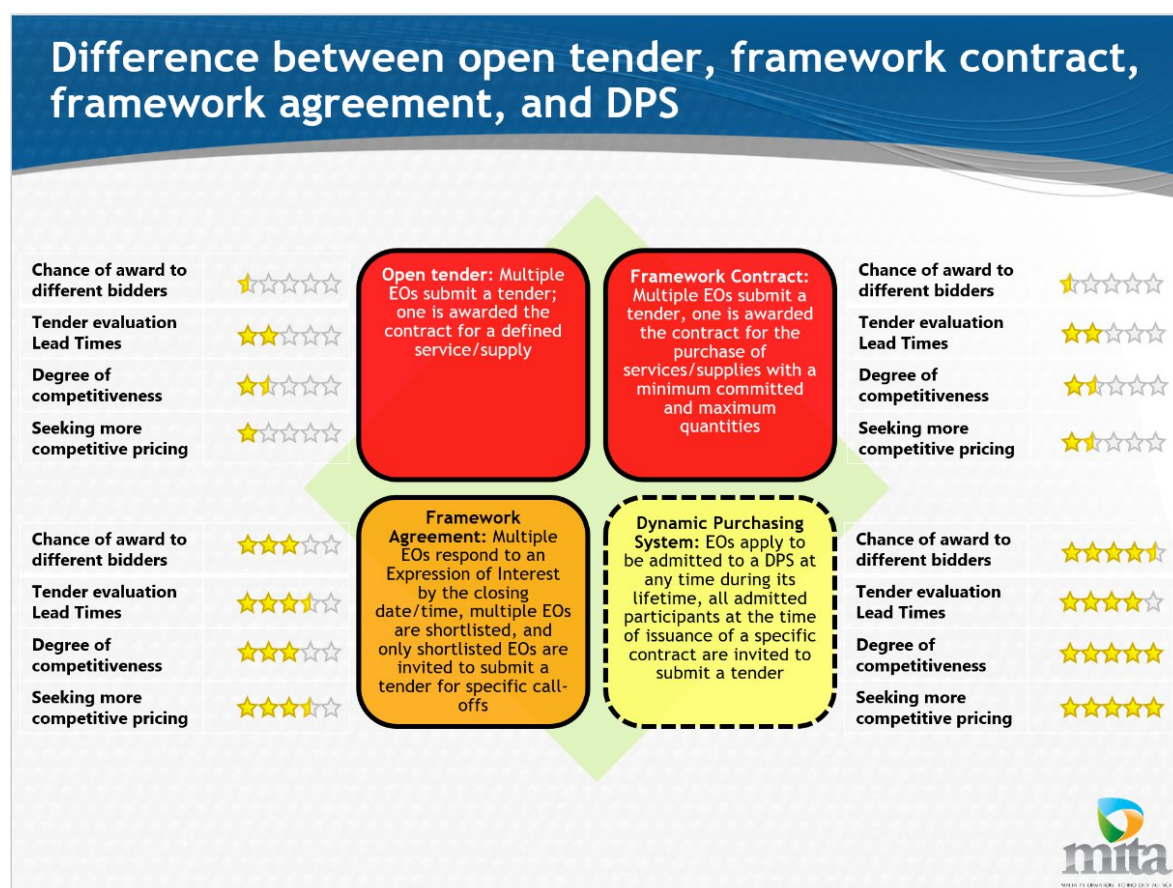


Figure 9: Figure from MITA comparing the open tender process, framework contracts, framework agreements, and dynamic purchasing system. The abbreviation "EO" stands for Economic Operators, which we refer to as suppliers in this document.

Therefore, project developers must carefully balance what is most attractive for suppliers, and what their own needs and risk-acceptance levels are. This loops back to what procurement strategy you choose, and what is most prudent for your development of a 5GDHC network.

Bibliography

How to procure?

- [1] International Bank for reconstruction and development - the World Bank Group, *Benchmarking Public Procurement*, pdf, 2017. Available [here](#).
- [2] Semple Abby, *Guidance for public authorities on Public Procurement of Innovation*. Procurement of Innovation Platform and ICLEI – Local Governments for Sustainability, pdf. Available [here](#).
- [3] CMS Legal Service, *Guide to EU procurement rules*, pdf, 2017. Available [here](#).
- [4] European Commission, *Your Europe website*. Available [here](#).
- [5] King Michael, *Presentation of District Energy Procurement Agency*. Available [here](#).
- [6] Smart SPP, *Driving energy efficient innovation through procurement: A practical guide for public authorities*, pdf, 2020. Available [here](#).
- [7] European Commission, *Public Procurement Guidance for Practitioners*, pdf, 2015. Available [here](#).
- [8] Paul Smith, *Dynamic Purchasing Systems*, presentation at the Sigma Public Procurement workshop organized in Ankara in April 2018. Available [here](#).
- [9] HeatNet, *4DHC Procurement Guidelines*, pdf, 2019. Available [here](#).

What needs to be procured?

- [10] Robinson George, *Preparing an HMT business case for heat networks and procuring advisers*, presentation at the workshop “Developing your business case” of the District Energy Vanguard Network organised in January 2018. Available [here](#).
- [11] Cornelis E., Baastrup Holm A., Lauersen B., Lygnerud K., *Insights from drafting local heating and cooling action plans*, Stratego Project, pdf, 2016. Available [here](#).
- [12] Roy R., *Guide de création d'un réseau de chaleur*, pdf, 2017 (French). Available [here](#).
- [13] DHC+ Technology Platform c/o Euroheat & Power, *Digital roadmap for district heating & cooling*, STORM project, pdf, 2018. Available [here](#).
- [14] Hedda Gunnarson H., Melin Hamber E., *The future of blockchain in district heating*, pdf, 2018. Available [here](#).
- [15] Andrews Tipper H., Ashcroft E., Salmeri M., *Stakeholder Engagement in Heat Networks*, pdf, 2018. Available [here](#).

Role of Procurement in Innovation & Industrialization for DHC

- [16] Edler, J., & Georgiou, L. (2007). Public procurement and innovation—resurrecting the demand side. *Research Policy*, 36(7), 949–963. Available [here](#).
- [17] Paul Smith, *Dynamic Purchasing Systems*, presentation at the Sigma Public Procurement workshop organized in Ankara in April 2018. Available [here](#).
- [18] MITA, *Dynamic Purchasing System Information Session* [Video]. Available [here](#).

Appendix 1: Case studies D2Grids Pilot Partners (5GDHC)

	Brunssum	Glasgow	Paris-Saclay	Bochum	Nottingham
New installation	X	X		X	X
Extension of existing network			X		
5 th generation DH principles applied	Island system, low-grade sources, decentralised energy centres & smart demand management	Use of low-grade waste heat, smart demand management	Advanced demand-side management, thermal storage, low-graded renewable sources	low-grade renewable sources, decentralised energy centre	Low-grade renewable sources, decentralised energy centre, smart demand management

Brunssum	Glasgow	Nottingham	Bochum	Paris-Saclay
<ul style="list-style-type: none"> ✓ greenfield DHC investment to residential areas ✓ no access to mine water – aquifers + subsoil vessel ✓ pilot owner is an energy service company 	<ul style="list-style-type: none"> ✓ connection between industrial and commercial districts through a „smart bridge“ ✓ exploitation of heat from waste water treatment works ✓ pilot owner is an urban regeneration company 	<ul style="list-style-type: none"> ✓ new connection to residential areas subject to energy refurbishments ✓ access to former mining works ✓ pilot owner is the local municipality 	<ul style="list-style-type: none"> ✓ commercial development site exploitation ✓ thermal energy from former mine galleries ✓ pilot owner is a traditional DHC provider 	<ul style="list-style-type: none"> ✓ connection to an area including industrial, commercial and residential buildings ✓ exploitation of geothermal energy ✓ pilot owner is a public authority

Brunssum – Restricted Procedure & Framework Agreements

Kind of services procured	<p>Detailed design, 3D design, coordination of construction process. Consultancy for the social housing association doing the renovations and building, to help them make their buildings ready for Mijwater connections.</p> <p>Aquifer test drilling, drilling for the doublet.</p> <p>Construction of a concrete basement and a skid with technical installation with pumps to extract/inject heat/cold from/into the doublet aquifer source and serve it to the basement with the energy plant. Installation and commissioning in place.</p> <p>Construction of a concrete basement and a skid with technical installation of pumps, pipes, heat pumps to upgrade the thermal energy from the aquifer for a local area heating/cooling network serving three small areas.</p>
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	<p>Civil works to lay 4-pipe local area network connecting the energy plant to the three areas served with heating and cooling.</p> <p>Construction work to connect the buildings to the 4-pipe network.</p>
Procedure chosen	<p>Framework contract with an engineering consultancy to do the detailed designs and coordination of construction.</p> <p>A significant number of separate procurements of works, construction, and installation. These followed the restricted procedure with minimally 3 companies invited to bid.</p>
Standards considered relevant	<p>Procurement standards in the Netherlands, Heerlen, and Brunssum, as well as those for the D2Grids project and the EU.</p>
How was expertise found to prepare a proper feasibility study	<p>Mijnwater has about 15 years of expertise in Heerlen, which was supplemented by intensive contact with stakeholders in Brunssum, coordinated with the social housing association, and the municipality. A report was produced with a plan for Brunssum to gain a subsidy from the Dutch programme to transition neighbourhoods away from natural gas ('Proeftuin Gasvrije Wijken'). This work was done in-house by Mijnwater to build capacity and expertise. Students were involved in this work, and some are now employed to continue it.</p>
Kind of data sources used	<p>Building energy consumption, heat and cold loads, potential of waste heat recovery of industries, data centres, shopping centres, longer term potential of the underlying coal mines.</p>
Local low cost & environmentally friendly sources of heat studied	<p>Waste heat and cooling from shopping centres, industries, tertiary buildings, houses, defunct coal mines under the town of Brunssum.</p> <p>Geothermal energy, Aquifer Thermal Energy Storage</p>
Specific focus on 5GDHC	<p>Brunssum is a first attempt for Mijnwater to construct an independent local area network serving a few hundred homes with heat and cooling over a 4-pipe network, fed from a local energy plant connected to an aquifer thermal energy storage and source. Energy exchange happens at the energy plant. The plan is to later connect this local network to a 2-pipe network that will gather and exchange energy from and to customers around the town.</p>
Suggestions for others	<p>There were problems in the coordination of so many separate procurements, and the points where these projects connect. Permitting by the municipality of Brunssum caused delays. After working for many years with the Heerlen municipality, it was underestimated that new working relations needed to be established with another municipality. COVID19 complicated communications.</p>

Glasgow – Restricted procedure & competitive negotiation

Kind of services procured	Full project design
Procedure chosen	Restricted, competitive negotiation
Standards considered relevant	Procurement standards in the UK and Glasgow, as well as those for the D2Grids project and the EU.
How was expertise found to prepare a proper feasibility study	Clyde Gateway has extensive experience in preparing for other projects in the region and engaged in extensive market dialogue.
Kind of data sources used	Building energy consumption, heat and cold loads,
Local low cost & environmentally friendly sources of heat studied	Heat from wastewater treatment works
Specific focus on 5GDHC	Connection between industrial and commercial districts through a smart bridge Exploitation of heat from wastewater treatment works

Paris-Saclay – Restricted procedure

Kind of services procured	External expertise (feasibility studies), Advanced demand-side management (web application for monitoring and thermostatic valves), thermal storage
Procedure chosen	Restricted
Standards considered relevant	Procurement standards in France, as well as those for the D2Grids project and the EU.
How was expertise found to prepare a proper feasibility study	EPAPS already has extensive experience with district heating, and the D2Grids pilot site is an extension of the existing DHC system in the region. EPAPS is also helped by an external expert.
Kind of data sources used	Building energy consumption, heat and cold loads, modelling
Local low cost & environmentally friendly sources of heat studied	Geothermal energy, waste heat from cold production
Specific focus on 5GDHC	Advanced demand-side management, integration of thermal storage, use of low-graded sources

Bochum – Restricted procedure

Kind of services procured	<p>Procurements already carried out:</p> <ol style="list-style-type: none"> (1) Consulting services for the planning of geothermal drillings (2) Planning services for geothermal drillings (3) Planning services for the drilling site (4) drilling contractor (EU-wide) (call for tenders is currently underway) <p>Further planned procurements:</p> <ol style="list-style-type: none"> (1) Construction of the drilling site (2) various trades regarding geothermal drillings (3) Construction of the heat/cold centre for pilot customer
Procedure chosen	<p>Restricted Procedure</p> <p>The procurements already made (1-3) were made using the 80/20 rule (if the scope of the project obliges you to call for EU-wide tenders, it is possible to make use of the 80/20-rule. This means that procurements up to a cumulative value of 20% of the total investment amount do not have to be awarded in an EU-wide tender but just in a national restricted procedure. However, it is important that the individual trades/orders within the 80/20-rule do not exceed a threshold of € 1 million for construction work or € 80.000 for planning services). According to procurement instructions of the Stadtwerke Bochum Group, at least three companies were asked to submit an offer (four companies were asked for the consulting services, six companies were asked for the planning services and seven companies were asked for the planning of the drilling site).</p>
Standards considered relevant	<p>The hierarchy of procurement standards is as follows: 1. standards relevant due to regulations of the D2Grids project, 2. procurement standards of Stadtwerke Bochum Group (they refer to the further application of EU or national procurement standards).</p>
How was expertise found to prepare a proper feasibility study	<p>FUW/StwBo worked with the Fraunhofer IEG (former: The International Geothermal Centre" (GZB)) in Bochum to determine the feasibility of using the Dannenbaum mines for heating & cooling supply of the system. FUW/StwBo also consulted with Mijwater regarding design components.</p>
Kind of data sources used	<p>Building energy consumption, heat and cold loads, regional geological and hydrogeological maps, regional underground temperature data, data of the drainage measures of RAG, map and layout data of the mining area of the abandoned Colliery Dannenbaum (underground infrastructures, levels, shafts, galleries etc.) provided by the mine authority and the mine owner (E.ON SE), various thermophysical data for subsurface modelling.</p>
Local low cost & environmentally friendly sources of heat studied	<p>Geothermal energy from mine water (through the development of flooded galleries of an abandoned colliery).</p>
Specific focus on 5GDHC	<p>Using low-grade geothermal energy & closing the energy loop:</p> <p>It is planned to use the geothermal heat and cold stored in the mine water of the former</p>

	<p>Dannenbaum coal mine. The heat and cold is uncoupled directly next to the two geothermal drillings via heat exchangers to an intermediate circuit. Within D2Grids one fully decentralized heat pump should be implemented to connect one pilot customer to the geothermal heat and cold supply. Furthermore, through the intermediate circuit, the heat and cold is mainly transported to the Energy Center East which contains other centrally clustered heat pumps for the connections with the other part of the project falling underneath a national subsidy. In the Energy Center East, the temperature levels of the mine water for the downstream low-temperature heat network are raised by a heat pump system and lowered for the downstream cooling network.</p>
Suggestions for others	<p>The procurements regarding the geothermal drillings were/are made as several single lots/trades. The coordination effort of this procedure is significantly higher than the procurement by means of a general contractor. However, the chosen method should lead to more economic bids. It is always a trade-off between higher internal effort and better prices.</p> <p>In addition, planning should consider the fact that EU-wide tenders/procurement are significantly more time-consuming compared to national tenders/procurements.</p>

Nottingham – Restricted procedure

Kind of services procured	Feasibility study [inclusive technoeconomic and environmental aspects], full project design
Procedure chosen	Restricted
Standards considered relevant	Procurement standards in the UK and Nottingham, as well as those for the D2Grids project and the EU.
How was expertise found to prepare a proper feasibility study	Nottingham City Council worked with their sub partner Nordic Heat and the Coal Authority to carry out the feasibility study.
Kind of data sources used	Building energy consumption, heat and cold loads, longer term potential of the underlying coal mines
Local low cost & environmentally friendly sources of heat studied	Geothermal energy from former mineshafts, potential waste heat recovery from other buildings in area for future development
Specific focus on 5GDHC	Low-grade renewable sources (making use of former coal mine workings in the region), decentralized energy centres, smart demand management
Suggestions for others	Geothermal energy from former coal mine workings, waste heat recovery from buildings in the area (short and long-term development)

Appendix 2: Things to keep in mind for DHC development & procurement (From HeatNet)

- **Analyze energy consumption of buildings** (to be supplied) – not only historic consumption but also potential future consumption – especially in the case of buildings with excessive consumption, where building automation and control, billing linked to the actual energy consumption of individual flats, other relatively low cost measures can achieve significant savings. These and changes in the building envelope (e.g. external insulation) can result in more than 50% decrease in consumption, as experience shows.
- **Appropriate Heat (&Cold) map** – make sure that you have a proper analysis of local renewable and waste heat and cooling sources and potentials (e.g. rooftop solar, industrial, sewage or data centre waste heat) to optimise planning, create synergies.
- **Focus on measures to identify and seize network and buildings efficiency potentials** rather than installing more renewable heat sources as a first priority. Energy efficiency should be the first fuel, renewable energy sources should not be installed to feed wasteful systems.
- **Start with an unbiased comprehensive factual analysis of the actual local problem**, rather than a specific solution in mind.
- **Select open protocols for digital solutions** (e.g. smart meters, software) that can communicate with other systems without 'lock-in' effect. This is a key technical feature that can cause great harm to municipalities. "Open" protocols solutions should be utilised to enable a free selection among potential suppliers when upgrading the system in the future.
- **Design and implement supporting new internal working processes, procedures** that support the creation and operation of an integrated municipal database, essential for the implementation of 4th generation district energy solutions.
- **Ensure proper internal communications among municipal departments** and establish willingness to share data to create an integrated database. Releasing information may be seen by certain managers, bureaucrats as releasing power or a risk that mistakes made, inappropriate quality solutions may become known within the municipality. Therefore without a strong political will and project management, relevant (infrastructure, building, social, energy, etc.) data may stay in silos and not utilised for project planning and monitoring.

About procurement process:

- **Establish proper communications with all key stakeholders** (utilities, authorities, building owners, tenants, etc.) to mitigate risks and ensure stakeholder buy-in. Without timely engagement of relevant stakeholders, project risks increase significantly, citizens and local businesses are much less likely to be satisfied with the results [11].
- **Define a clear enough project scope** for running successful tenders. One of the barriers can be to find adequate expertise for developing the project.
- **Consider quality indicators when awarding tenders** – the awarded proposal of the tender procedure should not be the cheapest one. The chosen company should be also select on its ability of integral working and its solution-oriented thinking. Typically the weighting of scoring criteria could 25% cost (fixed price, budget and hourly rates) and 75% quality (split down into resourcing, skills, approach etc). To be transparent and fair to all tenderers, the scoring criteria should be attached with the Request for Quotations.

- **Take time to do a proper market research** before launching a procurement procedure, it will help you to better defined your needs and requirements and will save time in the following steps
- **Look for local companies** and engage them in your projects. It could lead to develop local competencies and increase local employment opportunities.
- **Specify the rules you apply in terms of subcontracting in the Request for Quotations** (allowed, forbidden, how many levels of subcontracting allowed, requirements set for subcontractors, etc.).

Countries	List of interesting resources
Several countries	EuroHeat&Power , network of district energy organisations and professionals CEDEC , the European Federation of Local Energy Companies Celsius City , network promoting sustainable heating and cooling Danish Energy Agency
Belgium	Brussels Environment , Environment and Energy Agency of Brussels Government Wallonie Energie SPW , Energy Department of Wallonia Government Vlaams Energieagentschap , Flemish Energy Agency TWEED Cluster , association of sustainable energy companies in Wallonia
Ireland	Sustainable Energy Authority of Ireland Association of Irish Energy Agencies Irish District Energy Association
France	CEREMA , centre of studies and expertise on risks, environment, mobility and urban planning ADEME , French Environment and Energy Management Agency Regional Energy Agencies' Network Federation of local energy agencies Fedene , trade Federation for Environment and Energy Services Technical Association Energy Environment , federation of stakeholders (including consulting companies) AMORCE , association of local authorities and companies FNCCR , association of local authorities for public services
Netherlands	PBL Netherlands Environmental Assessment Agency Energie-Nederland , association of electricity producers, electricity and gas traders and electricity, gas and heat retail companies PIANOo , Procurement Expertise Center of the Ministry of Economic Affairs and Climate Warmtenetwerk.nl , website with lots of information about District Heating, partly for members
United-Kingdom	Heat Networks Delivery Unit of the Department for Business, Energy and Industrial Strategy, United Kingdom government Re:fit programme of Local Partnerships LPP (a joint venture between HM Treasury, the Local Government Association and Welsh Government) Chartered Institution of Building Services Engineers , association of consulting firms Energy UK , association of energy companies Association of Decentralised Energy , trade association YPO , public procurement body in the UK

Table 2: Resources to procure services and goods related to 4DHC and 5GDHC projects