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1. Goal of this document

The goal of this document is to provide a *preliminary* version of a Joint strategy of PP's in D2Grids defining strategic goals, approach and key steps for the:

1) durability and scaling up of pilot investments in 5GDHC networks,
2) rolling out 5GDHC networks to new territories,
3) reaching out the 5GDHC concept to key target groups (industry, project developers, investors).

This deliverable should outline PP's *present* vision (at the start of the D2GRIDS-project) on the joint roll-out strategy after closure of the project. Therefore, the deliverable is called a 'preliminary version'. By the end of the project we will write a final version of the roll-out strategy based on the experiences and insight we gathered during the project.

2. Framework for a roll-out strategy for 5GDHC systems

2.1. General idea and objective of D2Grids

Project idea: The expansion of the 5GDHC-technology (as currently already applied in Heerlen at TRL7) to a scale of 5,000 to 10,000 dwellings (> 500,000 m^2) opens opportunities for product development, price reductions, win the trust of investors, training of professionals and interaction on the power grid.

Objective of D2Grids to increase the share of RES used for heating & cooling to 20 % in NWE 10 years after the project ends. Quantified:

1) By project ending:
    1) 5GDHC systems fed by 9,883 MWh/yr additional RES capacity and saving 1,753 tCO_2eq/yr will be operational at 5 pilot locations (WP Investments).
    2) share of RES used for heating & cooling in NWE will increase to 15% (present value 13%) by promoting DHC technologies that are adapted to the use of RES;
    3) the pilot sites will run 5GDHC systems with an overall thermal capacity of 60,000 MWh/yr, serving a surface area of 650,000 m^2;
    4) due to validation and test operation in different pilot contexts, TRL9 is reached;
2) 5 years after project ending:
    1) increase of share of RES used for H&C in NWE to 17 %;
    2) 1.5 Mm^2 floor area served by 5GDHC (1 Mm^2 by scaling-up of pilots + 0.5 Mm^2 by roll-out to follower regions) with 135,000 MWh/yr overall capacity incl. 100,000 MWh/a additional RES capacity;
    3) GHG emissions reduced by 18,000 tCO_2eq /yr.
3) 10 years after project ending:
    1) share of RES used for H&C in NWE rises to 20 %;
    2) a total of 5 Mm^2 floor area served by 5GDHC across NWE (up scaled pilot sites + roll-out) with 450,000 MWh/a overall capacity, incl. 340,000 MWh/yr additional RES capacity;
    3) GHG emissions reduced by 60,000 tCO_2eq /yr.

Within the timespan of the project only a start of scaling up can be realized (ca. 50,000 m^2). Due to the higher objectives a further expansion must be ensured. Follower regions are areas within NWE suitable for developing 5GDHC technology on a larger scale. The long-term objectives of D2Grids will be fulfilled by actively stimulating the development of 5GDHC in these follower regions.

Industries, large investors and educational institutes often operate on a transnational scale and have an interest to learn that the concept is applicable in various locations and under different (national/regional) circumstances. Through the experiences of the different pilots the technology of 5GDHC will develop to a broader and more robust concept. The pilots will generate a wider generic and easily replicable model of the 5GDHC technology that can be rolled out across NWE to regions with various geological, socio-economic and regulatory conditions. D2Grids is based on intense territorial cooperation, as it is vital to ensure that the system works in different environments under different conditions.

The method to accelerate the roll-out of 5GDHC systems during the D2Grids project period includes:

1) *industrialization* of the system (or typical components) through developing a generic technology model and product standards;
2) boosting *commercialization* potential of 5GDHC systems through presenting solid business plans and attracting investors;
3) *demonstrating* and augmenting the technology through five impactful pilot investments.

2.2. Ensure long term effects of 5GDHC

During the D2Grids project period several activities will be done to ensure long term effects of the D2Grids pilot results, i.e. effects beyond the project period of 3 year. These activities are:

1) formulating strategies, feasibility assessments and plans to sustain, scale up and roll out 5GDHC systems;
   a. within the pilots to ensure the further expansion after projects end;
   b. to other regions (green fields) to adopt the 5GDHC concept for urban energy supply, starting at the designated follower regions;
2) developing tailor-made training packages developed for industry, professionals and policy makers;
3) building a transnational community by setting up a 5GDHC Platform that ensures knowledge exchange and interaction among key target groups;
4) drawing recommendations on EU and national policies, based on evaluations of the five pilots.

3. Transnational roll-out strategy

This document presents the transnational roll-out strategy for 5GDHC technologies. In this strategy five different aspects can be distinguished:

1) *Scaling up the pilots* demonstrated in the D2Grids project
2) Roll-out of the 5GDHC technology to 7 *follower regions*
3) *Industrialization* of the 5GDHC technology.
4) *Knowledge spreading* (e.g. education/training, community building, reach-out).
5) Attracting *investors*.

This section addresses each of these aspects in more detail.

3.1. Scaling up pilots

Within the D2Grids project the following five partners carry out pilot projects:

- Mijnwater, Brunssum, The Netherlands
- Clyde Gateway Developments Ltd, Glasgow, Scotland, United Kingdom
- Etablissement Public d'Aménagement Paris-Saclay, Paris, France
- FUW. Bochum, Germany
- Nottingham City Council, Nottingham, United Kingdom.

In the years following the end of the project each of the pilots is expected to grow and scale up from 650,000 m^2 of total floor area at the end of D2Grids to 1.5 Mm^2 five years later. In the following paragraphs scale-up strategies are outlined for each of the pilot projects individually. Detailed action plans for each of the regions will be reported in deliverable D.LT.1.2.

3.1.1. Mijnwater, Brunssum, The Netherlands

The pilot area in Brunssum, Brunssum-Noord, consists of around 850 dwellings, most of which are apartments located in 6 high rise apartment buildings. The pilot area contains 6,500 m^2 of public and utility buildings. This cluster will not get connected to the Mijnwater backbone at first. Rather, it will operate as an independent cluster, using natural aquifers for seasonal thermal energy storage. This local cluster will extend in the short run to include a group of buildings in the Brunssum city center area, where 214 buildings are being (re)built.

Further expansion of the pilot area is closely related to local transition vision on heat, in which all Dutch municipalities describe the preferred alternative to natural gas heating. These transition vision documents will be presented by the end of 2021. The current energy consumption in the built environment in Brunssum is about 500,000 MWh/yr. This needs to be generated by renewable sources by 2050. This means that on average 17,000 MWh/yr can be converted to renewable sources like 5GDHC. This would amount to 34,000 MWh/yr in 2022, 119,000 MWh/yr in 2027 and 204,000 MWh/yr in 2032. The actual figures will be lower, as not all buildings will be connected to 5GDHC and part of the energy demand will be reduced by improving efficiency.

3.1.2. Clyde Gateway Developments Ltd, Glasgow, Scotland, United Kingdom

No data on targets are yet available for this pilot.

3.1.3. Etablissement Public d'Aménagement Paris-Saclay, Paris, France

At Paris Saclay advanced demand side management will be tested on a limited number of buildings (three to five buildings) in the frame of the D2Grids project. In the five years following the end of the project, demand side management will be applied to most of the buildings connected to the existing DHC network (50 to 100 buildings).

Furthermore, at Paris Saclay thermal storage will be tested at one site and in a limited capacity in the frame of the D2Grids project. In the five years following the end of the project, the storage system will be implemented to other sites, in the case of decentralized storage, or capacity could be increased by at least 100%.

Future floor areas connected to 5GDCH are estimated to be 700,000 m^2 in 2022, 1,700,000m^2 in 2027 and 2,000,000 m^2 in 2032, corresponding to respectively 43,000, 104,000 and 123,000 MWh/y.

3.1.4. FUW-Stadtwerke Bochum, Bochum, Germany

The Bochum pilot will take place at of the former Opel plant in Bochum, called "Mark 51°7" at which a broad mixture of businesses and office buildings are developed. Based on the energy supply concept developed, about 40% of heating and cooling needs shall be supplied by using the thermal source of mine water from the former mine Dannenbaum (that lies below the area) with the support of a heat pump system. The overall investment consists of three elements: 1) creation of low-temperature heating & cooling network (low-ex), 2) geothermal development of the mine building via two directional boreholes and 3) construction of the heating & cooling centre with reversible heat pump system. Within D2Grids, the underground development of the Mark 51°7 site will be implemented. The mine building is to be developed hydraulically via two directional wells. Due to the high complexity of the geothermal development the project focusses on a network connection to one pilot customer and the corresponding heat pump during the investment phase. Within a five year timespan the connection of most of the Mark 51°7 site seems reasonable with the support of further funding.

It is estimated that in future floor area connected to 5GDHC will be 8,000 m^2 in 2022, 180,000 m^2 in 2027 and about 270,000 m^2 in 2032.This corresponds to respectively 570, 1,850 and 21,200 MWh/yr.

3.1.5. Nottingham City Council, Nottingham, United Kingdom

The pilot in Nottingham (NCC) focusses on the Crabtree farm estate. It is anticipated that the D2Grids project will connect circa 60 homes, with infrastructure installed to allow many more to be connected. NCC owns 512 homes on the estate that could be connected through a second phase of the project within five years. NCC would also seek to analyse other areas of the city that may have suitable geological conditions to install this technology. To provide context; NCC owns 25,500 homes across Nottingham.

Additionally, there is a private development planned in close proximity to the Crabtree estate. NCC would seek to work with the developer to support them in utilizing the 5GDHC technology at this development. Stanton Tip is a 40-acre development site which could house about 500 new homes.

3.2. Roll-out to follower regions

Besides scaling up the pilot projects, rolling out 5GDHC technologies to predetermined follower regions in NWE should lead to 500,000 m^2 of floor area getting supplied using renewable energy sources. The roll-out of 5GDHC technology is planned for these seven follower regions:

- Parkstad Limburg, The Netherlands
- Genk region, Belgium
- North-East France
- Luxemburg
- Scotland, United Kingdom
- Ruhr area, Germany
- East Midlands, United Kingdom

The following paragraphs give a short description of the activities in the follower regions. A more detailed vision for development and preliminary feasibility assessment will be reported in D.LT.1.3. Local action plans will be made, based on these feasibility assessments (D.LT.1.4), and stakeholders of follower regions will be mentored and coached in applying 5GDHC technology (D.LT.1.5).

3.2.1. Parkstad Limburg, The Netherlands

Mijnwater has an existing network in Parkstad. The Brunssum pilot will be a stand-alone cluster in the region, to be connected to the regional network at a later stage. The pilot will show the viability of these kinds of stand-alone clusters. Within the Parkstad Limburg region Mijnwater BV opts to scale up from 10,000 dwellings to 100,000 dwellings (including utility buildings); when possible also look outside Parkstad Limburg area, e.g. using Limburg Energy Fund (provincial).

Currently, the regional energy strategy (RES) and the heat transition visions are under development by all local and regional governments in Netherlands. The RES will show the availability of renewable energy sources, the heat transition visions will indicate alternatives to fossil-based heating for each Dutch neighbourhood. These two documents will indicate more clearly the potential development path of 5GDHC in the Parkstad region and beyond. The documents have to be finalized by the local municipalities by the end of 2021. The regional ambition for generation sustainable heat from shallow geothermal energy was formulated to be 1,000,000 MWh/yr in 2040.

3.2.2. Flanders/Genk, Belgium

For the Genk region the floor area of buildings is planned to grow from 37,000 m^2 in 2022 to 58,000 m^2 in 2027 up to 79,000m^2 finally in 2032, corresponding with respectively 2,300 MWh/yr, 3,200 MWh/yr and 4,100 MWh/yr.

National agencies/networks that could be useful in building 5GDHC networks are: Warmtenetwerk Vlaanderen, Organisatie Duurzame Energie (Ode), Vlaamse Regulator van de Elektriciteits- en Gasmarkt (VREG), Local DSO: Fluvius.

3.2.3. North-East France

BRGM will support the Paris Saclay pilot site scale-up in the 5 years following the end of the project by proposing a feasibility study for interseasonal storage by reversing flows of geothermal wells. This will include environmental impact assessment (bio-geochemical, water/rock interactions, etc.) due to warmer or colder water reinjection and also authorization issues.

BRGM in collaboration with the National Federation of French Local Authorities (FNCCR) will propose to do preliminary assessment studies in selected cities (2 to 3) located in the project area of the Interreg North-West in France (e.g. Grand-Est, Hauts-de-France, Ile-de-France, Centre Val-de-Loire, Bourgogne-Franche-Comté) and presenting potential interest in developing 5GDHC system. Figure 1 shows the existing or on going low temperature DHC grids in the national territory that where granted by ADEME (French Agency of Environment and Energy Management).

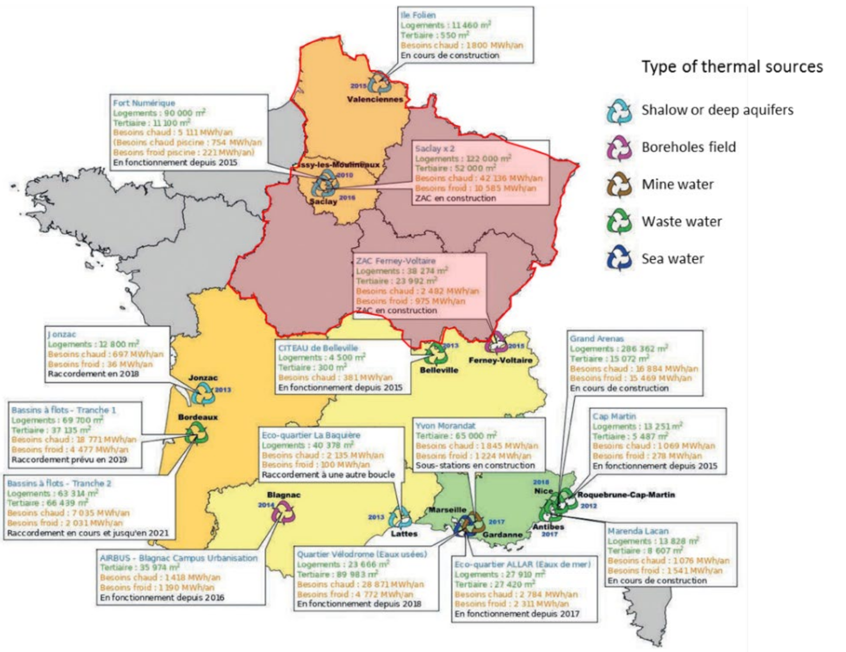

Figure 1. Existing low temperature DHC grids on the national territory and targeted regions for roll-out strategy in red (adapted from AFPG, 2019).

The assessment will consist in the evaluation of the current and forthcoming heating and cooling demand (level of temperature needed), the typology of buildings (residential, tertiary sector), connection to a DHC network if any, the subsurface conditions (presence of shallow aquifers, mine workings, etc.) and potentially other sustainable thermal sources. BRGM will propose conceptual models of the surface and subsurface conditions for those selected areas to evaluate and quantify the potential development of 5GDHC in the targeted location. Based on this first evaluation in specific locations, BRGM, with the support of FNCCR, will provide actions plans and guidelines for the deployment of 5GDHC in North-East France.

3.2.4. Luxembourg

The project D2Grids supports the Luxembourgish strategy to reduce CO_2 production on the field of heating houses. The D2Grids concept will be developed on the big quarter project “fond Kirchberg” or “fond du logement” program. In addition, it is intended to develop the 5GDHC concept in a small project of about 10 private houses and use the “ecovat” system. The ministry of energy is are very interested in the result. D2Grids approach will be a baseline of new legislation.

Furthermore, it is intended to include the habitants of the quarter with local ESCO to develop and manage the local 5GDHC grid.

Luxembourg is one of the biggest places of green bounds; we manage and offer opportunity of the bounds to invest on the grids based on the 5GDHC technology a new model.

In Luxembourg rough estimates of the growth of 5GDHC floor area are 50,000 m^2 in 2020 to 200,000 in 2027 m^2 to 500,000 m^2 in 2032, corresponding to respectively 5,500, 21000 and 55,000 MWh/yr.

3.2.5. Scotland, United Kingdom

No concrete plans and targets are yet available for this region.

3.2.6. Ruhr area, Germany

As the whole of the Ruhr area is a huge former mining region, there seems to be a huge potential for similar geothermal 5GDHC grids in the area as such. As a result of a successful implementation of the 5GDHC principle at the Mark 51°7 site other former mining sites could make use of the demonstrated principles. At the Mark 51°7 site the development of such a big site in one go highly benefits the implementation of the low-ex grid. As the Ruhr area already is a highly developed urban area further site developments of this scale are limited. Therefore, an implementation of further four projects of similar dimensions can be estimated until 2032. In total a floor area of about 720,000 m^2 corresponding to 74,000 MWh/yr energy seems to be attainable in 2032.

3.2.7. East Midlands, United Kingdom

The results of the D2Grids pilot project will be communicated by the Nottingham City Council (NCC) through the Midlands Energy Hub. This hub is managed by NCC and provides support to local authorities from nine local enterprise partnerships (LEP) areas across the East and West Midlands, with an officer based in each area to support the development of energy projects. In 2019 15 heat network projects which could be suited to 5GDHC technology have already been identified across the LEP areas.

NCC’s experience predominantly lies in the public sector and social housing, although it operates the largest district heating network in the UK. This includes commercial properties through its wholly owned energy service company (ESCo), Enviroenergy. In this capacity, NCC will work alongside social housing providers to introduce low carbon and affordable energy to their housing stocks and new build projects, through communal heating schemes (utilizing 5GDHC technology where viable). Additionally, they will work with planning authorities to introduce supplementary planning guidance which requires more stringent carbon standards, such as requiring developers to connect to low-carbon DH networks.

Nordic Heat is developing a programme to reduce the cost of connecting individual homes to 5GDHC networks. This includes technical and commercial modelling to assist public and private sector developers in managing the challenge of adopting this relatively new technology. Also included in this programme is a ‘bundling’ strategy designed to provide a simplified implementation solution.

4. Roll-out in North-West Europe

Ten years after the closure of D2Grids, 5 Mm^2 of floor area should be supplied using 5GDHC technologies. This will be done by disseminating knowledge about 5GDHC through an industry partner network and a 5GDHC community. Knowledge and information about the 5GDHC business model will be spread among potential investors, as well as public authorities and infrastructure service providers.

At the end of D2Grids the generic business planning for commercialisation of 5GDHC has been formulated (WP.T2.1). The specific business cases of the pilot sites will also be clear (WP.T2.2). The next step is to share this knowledge with neighbouring cities, district heat suppliers, and other relevant partners. The outreach to and beyond the follower regions is supported by training and education packages developed as part of WP.LT.3 and the interactive online platform hosting key projects developed in WP.LT.4.

Cities and regions in NWE that were not defined as follower regions in D2Grids can use the training packages and the 5GDHC platform to find out where 5GDHC can be viably applied within their boundaries. This includes an overview of flooded mines that can be used as heat storage, but also different types of business models of 5GDHC.

Boundary conditions for successful implementation at these scales are:

1) widespread knowledge of the 5GDHC concepts: a clear description on 5GDHC is needed pointing out the advantages of implementing 5GDHC systems to overcome the restrictions investors have nowadays (low level of knowledge, high ROI time),
2) wide availability of 5GDHC technology,
3) presence of political support for 5GDHC in the follower regions,
4) availability of financial incentives to make heat from alternative sources as attractive as heat from fossil fuels,
5) creation of clear regulations regarding 5GDHC.

4.1. Industry partners

To ensure the 5GDHC concept reaches out to industry it will be important to establish an industrial alliance, bringing together technology suppliers to jointly represent sectoral interests for optimization and the roll-out of 5GDHC. Furthermore, it is important to quantify the market for the industry in terms of sales as well as promoting incentives for R&D (such as Crédit Impôt Recherche in France). The role of the industry is two-fold: 1) supplying the technology for 5GDHC at an attractive cost and with innovative services (such as performance engagement) and 2) potential supplier of heat or cold for DHC networks.

By the end of the D2Grids project the potential of using mines or other low temperature reservoirs for heat storage, like aquifer thermal energy storage or borehole thermal energy storage, has been demonstrated, and there are still challenges with temperature balancing in existing projects. From this point the 5GDHC model can be standardized and tailored to more situations, as will be described in WP.T1.1. The first step of the strategy is to focus on boosting the production of 5GDHC technologies. This will generate a price drop of 5GDHC components, which will make it easier to expand to a wider variety of applications, like urban agriculture. A market exploration should determine which products and components of 5GDHC require a rapid scale up in production in order to create economies of scale. Once 5GDHC is a proven technology for a large range of urban applications, focus should be put on incorporating heating and cooling balance issues in urban development. This means that heating and cooling loads should considered in the planning stage of developing or redeveloping urban areas.

To create incentives for industries to participate in DHC networks as supplier of heat the Internal Rate of Return of industrial heat recovery and distribution should become sufficiently high. The final situation is a highly competitive marketplace for components and technologies. Effective recovery and reuse will lead to less wasted heating and cooling for the industry.

4.2. Knowledge spreading

During the D2Grids project training packages will be developed (WP.LT.2) and an online 5GDHC Platform will be established (WP.LT.3) to ensure knowledge sharing, exchange and interaction among key target groups. The platform will collect descriptions, demands, and designs to be taken up by industrial partners for production of systems and component. The advantages of 5GDHC systems using low temperature level (5°C - 30°C) should be clearly explained to future operators/stakeholders, e.g. in the lead of designing the energy supply of new eco-neighbourhoods and ZACs (Concerted Development Zone). A cost-benefit analysis of 5GDHC compared to other conventional DHC should be a key element to get interest in the technology from future operators. Advantages that should be highlighted are:

- energetic, economic and environmental performance;
- adaptability to all types of needs (hot and/or cold, DHW);
- seasonal and short-term energy storage;

- possibility of having several sources of energy on the same loop (geothermal energy on groundwater or boreholes, mine water, heat recovery from waste water, seawater, water treatment plants, lake, river, etc.) likely to be linked in several phases according to the evolution of the demands to be met;
- Intelligent energy recovery between different consumers with their specific needs.

Sharing the in-depth technology in an open access tool (open platform) will lead to better design and reduction of costs. The idea of sharing knowledge (inventions) between competitors is that it will accelerate the process of product development and save (design) costs for the different manufacturers. This should not be a threat considering the huge potential of the market to be served. During the project ideas might be generated on admission conditions for applicants to the platform or some kind of privileges for high contributors (awarding the effort to successfully develop the platform).

Important partners that should be taken into consideration in France are:

- Agence de l'Environnement et de la Maîtrise de l'Énergie (ADEME)
- Association des collectivités territoriales et des professionnels (AMORCE)
- Syndicat National du Chauffage Urbain et de la Climatisation Urbaine (SNCU)
- L'association Via Sèva
- La Fédération nationale des collectivités concédantes et régies (FNCCR)
- Association Française des Professionnels de la Géothermie (AFPG)
- Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (CEREMA)

The Midlands Energy Hub is one of five Local Energy Hubs across the UK. These Local Energy Hubs could be used to disseminate knowledge more widely and identify further applications for the technology. In addition, there are other networks which could be utilised: the central government's Heat Network Delivery Unit, Mine Energy Taskforce and Smart City Alliance. Nordic Heat (delivery partner for the Nottingham pilot project) is involved in the development of a number of other mine heat projects in the UK. The learnings from D2Grids will enhance the deliverability of these projects. Nordic Heat is also promoting 5GDHC in other regions of the UK, particularly in former mining areas.

4.3. Community building

The partners in D2Grids are a natural existing group to start off a much broader 5GDHC community after the project's official closure date. The will to enhance the existing pilot sites and spread 5GDHC should be central for this.

Key characteristics of a community platform should be to share general information upon the technology and the different pilots under development, its benefits and potential barriers (regulatory, technical or environmental). Indeed, it is important to describe the different phases of a 5GDHC project to future developers and give them all the information needed to get interest in the technology and build a successful project. An online platform should be part of the community; it should feature a forum for sharing problems and solutions – an "ask the expert" section, and case descriptions and best practices.

The business models of 5GDHC should become attached to the spreading of the community. This could for example be the case by economies of scale benefits. This way there are financial benefits to maintaining and enlarging the 5GDHC community. There should also be money dedicated directly to maintaining the community, which will have costs for communication infrastructure, meetings, etc.

In France, we should make a strong connection to associations as FNCCR and AFPG. FNCCR (National Federation of French Local Authorities, associated partner to the D2Grids project) represents local authorities and drives their development in the energy field. As such, FNCCR organizes several committees, trainings, working groups, and publications dealing with renewables energy and energy networks. AFPG (French Association of Geothermal energy Professionals) regroups professionals such as industrial partners, operators, engineering offices, research offices that work on geothermal energy project development. These associations could touch a large panel of stakeholders through their channels by creating bridges between the project and their members.

The final situation is a self-sustaining 5GDHC community, which works from benefits created within the sector and no longer requires external support. An important issue with the community platform is that it should remain managed on the long term.

4.4. Training & education

Although training packages will be available after closure of the D2Grids project, widespread coherent offer of professional training and education on 5GDHC techniques and concepts will not be available by then. By project ending the inclusion of 5GDHC subjects in training courses (workshops, written materials, online introduction to the technology, rolling program of site visits) or curricula just still depends on individual teachers and/or programs; no coordination is in place. In a first step relevant educational bodies should be informed and involved. The 5GDHC concepts and techniques should become fixed elements of a broad variety of programs: architecture, urban planning, engineers, etc. In a next step a centre of expertise for 5GDHC should be established that provides knowledge on 5GDHC and educational approaches to teach these subjects.

Focus should be on homogenizing education of potential stakeholders (equity investors, lenders, contractors, the general public, etc.) so that uptake of the technology is consistent and keeps the pace of development across NWE. For investors, education can come through conferences and newsletters, but also by seeing and understanding pilot projects.

The industry sector can be reached with articles in industry blogs, periodicals and LinkedIn, presentations at industry exhibitions and shows, publishing technical papers – online and in written form. Policy makers could be reached by brief project summaries with links to articles and pilot project websites, meetings with key stakeholders at national and local levels, use expertise and networks of existing project partners to progress these dialogues. Local communities should get involved through site visits, online site descriptions and project progress updates, articles in local newspapers and magazines

In the final situation 5GDHC is a standard part of a wide variety of curricula: 1) for engineers who design, build and maintain these grids; 2) for anybody involved in the built environment (planners, architects, city mayors, engineering consultancies, network operators etc.). Basic knowledge on 5GDHC is widely available through the web for teachers and public. An international centre of expertise coordinates the knowledge build up and the support of educational training programs on 5GHDC

4.5. Finance & investments

At the end of the D2Grids project the business case of 5GDHC is formulated, based on the lessons learned from pilot sites (WP.T2). In the next step this knowledge should be used to improve the business case by increasing the scale of the project, enhancing the supply chain of technology, modularize and standardize the technology. After this 5GDHC can be presented to customers as a single proposition, with a clear set of benefits. Especially for existing buildings 5GDHC might prove a viable technology, as other energy renovations are very expensive. Once the business case is clear, awareness of the existence of 5GDHC needs to spread in the investors' community (see 4.5 Knowledge spreading).

A major gap to cross is the trust of investors in low temperature DHC networks. Therefore, it should be made clear how the 5GDHC solution can become self-financing, so understanding the business case in detail is vital and this must consider country specific requirements/conditions. By the end of the project, these specific business cases have become clear (WP.T2). This includes the variety of income streams (e.g. government incentives, heat as a service contracts with users), an overview of existing funds (e.g. maintenance plans for retrofit projects), and proposals for finance packages for those that do not have capital or do not want to manage the schemes themselves.

Commercial modelling, such as the programme that Nordic Heat is working on to improve the viability of connecting individual homes to heat networks, is an example of the kind of strategy that will be necessary to provide confidence to the investment market that 5GDHC is the most cost effective and sustainable way of developing future networks. These models will need to be continually updated as political, technical and commercial conditions change.
From a UK governmental perspective, subsidies and grants would be under the Department for Business, Energy and Industrial Strategy and so important for early projects looking to scale up.

There are several ways that projects like this (high upfront cost) can be funded; most would likely receive a combination of grants and private investment, and some may also raise debt to fund capital costs. Other forms of financing (e.g. crowdfunding, community projects, green bonds) make up a small portion of overall investment but may grow in future.

In further development of the finance strategy the question of the public subsidies should be raised. The low temperature DHC grids using geothermal energy or other RES assimilated are among the high-performance energy that produce hot and cold while reducing greenhouse gas emissions (GHGs). As such, they can already benefit in France from several financing mechanisms such as the Renewable Heat Fund from ADEME, European ERDF aid, Energy Savings Certificate scheme (CEE), specific regional funds, reduced VAT on the selling price of heat and cold.
The Renewable Heat Fund is a financial aid for geothermal installations producing renewable heat or cold in the collective housing, the tertiary sector, the industry and the agriculture. Initially dedicated only to renewable heat, the fund was enlarged to renewable cold in 2018 and recently to low temperature DHC system (5-30 °C). The fund enables geothermal facilities to be economically competitive compared to conventional energy-using facilities. In the case of low temperature DHC grids (like 5GDHC), are eligible the resource recovery (geothermal wells, borehole thermal exchanger…), the heating and cooling grid and the decentralized heat pumps. Aid from the Heat Fund allocated to geothermal energy DHC projects (creation or extension) is conditioned by the fact that the buildings should be supplied at least by 50% of RES. In addition, some technical criteria of the DHC must be met as the length of the network (minimum of 200 m), the energy supply from RES (minimum of 200 MWh/y) and the global COP of the installation (COP>3).
In order to optimize the overall energy efficiency of the installations, it is also recommended to study:

- possibilities for pooling needs between buildings (possible implementation of bypass of the resource, hot and cold water storage, ...),
- the use of variable flow regulation to optimize the electrical consumption of the pumps,
- the control of the auxiliaries to the heat pumps and the configuration of the heat pumps to adapt their temperature according to the needs of the emitters and the outside temperature.

Funding possibilities in Belgium are: National: FWO (fonds voor wetenschappelijk onderzoek) for research topics, Flanders: VLAIO: Vlaams agentschap voor innovatie en ondernemen; Regional: POM Limburg, SALK.

The final roll-out strategy should indicate which financing tools relevant for 5GDHC should be further aligned on a European level to avoid different levels of development of the technology in the next ten years. A comparison of the different financing tools in France, Netherlands, Germany, United Kind and Belgium will enable to propose some guidelines for national funding agencies.

The boundary conditions are that the technical solution works for a large portion of buildings. 5GDHC should also be applicable in different regulatory contexts. In the final situation 5GDHC has a viable business model that investors want to finance. This model is viable in both a financial, environmental, and social manner.