

Conclusions of the Catalan Task Force of the SmartReFlex Project

The Catalan Land Institute (INCASÒL) and the Catalonia Institute for Energy Research (IREC) have taken part in the European project SmartReFlex within the framework of the *IEE - Intelligent Energy_Europe* programme, with the aim of increasing the dissemination of intelligent and flexible systems of district heating and cooling (DHC), through the use of 100 % renewable energy sources (RES), for European cities.

SmartReFlex is a European project integrated in the Intelligent Energy Europe (IEE) programme where a total of 14 partners from 5 countries (Germany, Ireland, Spain and Denmark) have participated, involving 6 study regions.

The participation in SmartReFlex is oriented to the fulfilment of the goals of Horizon 2020 programme (H2020) such as scientific excellence, technical improvement of DHC networks, business growth, enhancement of the competitiveness of industries in the field of DHC and use of renewable energies for an increased sustainable business growth, among others.

As part of the project's development, each of the participating regions has worked with a taskforce commission or group, with key players at a regional level and, where appropriate, at a national level.

In Catalonia this task force has been led by INCASÒL and is made up of representatives of public and private sectors: ministries of the regional government (Generalitat de Catalunya), associations of heating and cooling systems, municipalities with experience in this kind of systems, urban projects, entities linked to DHC networks, law firms and county councils, among others.

The goal of this task force has been to remove current barriers by putting in place legislative and organizational measures to foster and facilitate the use of renewable energies in DHC systems and stimulate local and municipal authorities for the development of real projects in this field, as well as to develop a regional strategy. For this purpose, several meetings and seminars have been held throughout the 3 years of the project, which have concluded with a summary document of all the work carried out, which is presented below:

LEGAL FRAMEWORK

Setting legal conditions for RES DHC

Proposals for adaptation of national, regional and local regulations: proposal for adaptation of the Spanish Low Voltage Regulation (REBT) in the case of districts/buildings with DHC systems

The REBT and its Complementary Technical Instructions do not foresee the situation of a building connected to an urban DHC system, which results in an oversized power grid of both the building and the urban area where it is located.

The REBT determines two basic design powers for buildings that depend on the planned installations. Thus, any residential building equipped with an air conditioning system must be designed with a high degree of electrification, that is to say 9,2 kW per dwelling unit, above the 5,75 kW of a basic degree. Even so, with 5,75kW of electric power and considering the target scenario set in Horizon 2020, with the limited energy demands of nearly zero energy buildings (nZEB), these minimum electric powers seem excessive. It has been shown that electric powers of around 3 kW per dwelling, combined with a global energy management, are more than enough to guarantee energy efficiency and the quality of supply to homes.

The interest in limiting the installed electric power is due to the high costs (economic, environmental and social) of the electricity network, especially in the external connections to the urban area on which it operates and the transformation costs in the electric substations (300 €/kW and above). Therefore it is necessary to design and size electrical installations with a lower real power, which would optimize the electrical resources to be considered in the feasibility analysis of the new networks. Given the scenario of Horizon 2020, the powers currently foreseen in the external connections of a predominantly residential area, exceed by more than 200% the real needs - considering the European standards for 2020 -.

It is therefore imperative that a modification of the REBT be made, including the possibility of reducing the degree of electrification considering energy efficiency measures or even the use of renewable or alternative energy production systems, such as RES DHC.

Until such modification is made, a justified regulatory exemption should be requested from the competent authority, which should include the analysis of the energy demand taking into account the reduction of consumption thanks to the connection to an external thermal network.

Proposal of modification of urban planning regulations (acts, ordinances...) to foster the deployment of DHC at a regional/local scale. Modification of the Catalan Urban Planning Act. Roadmap to 2020 goals. Proposal of regional regulation for energy self-production for its immediate consumption, to avoid inconsistencies with national acts.

Horizon2020 and its demands in terms of reduction of consumption, greenhouse gas emissions and the increase of RES shares, implies an energy update of the regulations linked to urban planning. This, together with the appearance of the nZEB buildings, leads us to a unique paradigm, where distributed generation assumes the prominence as the only solution to achieve this challenge.

New regulations are beginning to be drawn up in which both thermal and electrical distributed generation is encouraged. With regard to the thermal energy, two very recent examples such as the Special Infrastructure Plan in Poblenou (Barcelona) and the Director Urban Plan for the

development of the Centre Direccional in the municipality of Cerdanyola del Vallès, are good examples of this policy.

In both cases, these are new urban plans that have foreseen a DHC from the very beginning, so the determination of the involved authorities was clear. Usually the municipalities are the most interested in implementing these systems to their urban fabric. On the other hand these regulations are passed only when there are prospects of a future DHC system or even when the decision has already been made.

However the scope should be much wider. It is crucial to consider these systems at higher levels of legislation (national/regional) and to promote through regulation the simplicity for the execution and operation of such systems. Therefore, decrees to promote energy efficiency or environmental measures (emissions), acts that deal with issues related to climate change or state or regional regulations that imply requirements in buildings where there is thermal consumption, must undoubtedly integrate prescriptions to facilitate the implantation and the development of the urban networks of thermal generation and distribution.

The new Catalan Territory Act, that will replace the Catalan Urban Planning Act and is currently being drafted and debated, should be the fundamental document in Catalonia for the promotion of DHC systems, both for the benefit of the environment and for the generation of a beneficial energy business for operators and users, as well as for the noticeable reduction of the country's energy bill, with the inclusion of RES at the level of distributed generation.

The Catalan Territory Act should include the energy as one of its key articles and within it, distributed thermal generation as the major opportunity to achieve the great challenge in renewable energy in 2050 set in the National Pact for Energy Transition proposed by the Government of Catalonia.

The simplest and more straightest route would be the requirement for all new urban planning to include a study justifying the feasibility of a DHC in the new urban development, and if not feasible, that the energy requirements (efficiency, performance and RES share) as well as the environmental ones (emission control) provided by any other proposed system would improve or at least equal those of a RES DHC.

Another way to go and that would undoubtedly promote the development of networks would be the declaration of these as a public service or - as in other European countries - as a network of general economic interest. In Spanish legislation DHC are not considered neither a public service nor an activity reserved to public authorities. Certainly introducing these concepts in the corresponding section of the new Catalan Territory Act or in the regulations linked to it, would raise the interest of investors and concessionaires for the development of DHC.

It is also essential to foresee from the first phases of planning the use of the surplus energies produced mainly in industrial activities and that in many cases end up being dissipated. This energy should be quantified and its commercialization should be fostered through district networks, taking advantage of basically industrial synergies, but also of other origins, for use in their immediate surroundings. Cases of success are the Districlima generation plant in the 22@ area of Barcelona, with the use of the residual energy from urban waste incineration in the TERSA plant or the use of the cold, also residual, of the regasification plant located Barcelona harbour and recovered for its commercialization and use by Ecoenergies in the La Marina de Barcelona.

We are certainly talking about energy surpluses of high value, both environmentally and economically, which must be taken into account from the very beginning of the production

activity. The legal framework that regulates these activities must take it into account to foster the energy utilization.

The Catalan Territory Act must consider this major source of energy, that together with a good recovery and distribution will bring the countries and in this case Catalonia towards energy independence.

In January 2017, an official written request was sent from the SmartReFlex group to the drafters of the Catalan Territory Act suggesting to introduce in the draft document the need to consider the assessment of energy aspects in new urban development or urban regeneration.

At a somewhat more local level, it is very important to take into account the needs in terms of civil works infrastructure and land reserves, to allow the possibility of locating centralized air conditioning systems, both in the case of generation within the own urban development - for direct consumption - and in the case of generation or use of nearby surplus energy - not directly located in the new development -. In the case of the new urban plan of L'Estrella, in Badalona (one of the pilot tests in the SmartReFlex project), the requirements have already been considered both at the feasibility study level and the reservation of land and easements for future possible actions in energy management in general and thermal distributed generation in particular.

The urban planning regulations of L'Estrella in Badalona emphasize the unification of energy management and its production, both thermal and electrical, as well as the public and private services that stem from them. This energy management, in many ways on the frontier of energy regulation in force, is the factor guaranteeing success in order to meet the demands and objectives set by the European Union with Horizon 2020.

It must be stressed that the requirements of Horizon 2020, with nZEB buildings, consider not only energy savings and efficiency, but also the generation of compensatory energies. This generation as well as the guarantee of the fulfilment of the nZEB requirements, make crucial the role of the energy manager, who should probably be unique to give flexibility and globality to the urban development. It is difficult to imagine a successful energy management of a residential development with different energy agents, since the requirement of the net balance of an urban area cannot be imagined without taking advantage of the signals that could be given by a single energy manager as guarantor of the nZEB.

However, this unification of energy management should integrate different concurring technologies from different distributed generation networks, which must be controlled with great diligence. Therefore, it is of great importance that inefficiencies in one of the services are not masked at the expense of the good results of another. Therefore, and as a general criterion, the Public Sector Contracts Act goes in the line of not 'mixing' things, although currently awarding contracts in lots is common practice.

The Consortium of L'Estrella in Badalona formed by INCASÒL and the City Council of Badalona is preparing a contract for energy services to allow the largest number of tenderers, paying special attention to the non-exclusion of SMEs and compliance of nearly zero consumption requirements, not only at a building scale but also at the global level of the urban development. Thus, it should be possible to unify the management of the DHC for private and public users, the management of public lighting, the electrical supply of buildings, etc., without losing sight of the criteria and dangers mentioned in the previous sections.

However, it must be taken into account that the instability and legal uncertainty of the electric sector in Spain can be an obstacle both at the level of production and self-consumption and for the DHC networks with renewable sources when they foresee combined heat and power

generation, and when this CHP represents a key aspect for the economic feasibility of the project.

Unlike the case of other networks - such as hydrocarbons, electricity, telecommunications and railways - there is a lack of systematic and understandable legal framework for the development of urban heating and cooling networks. The safety of water distribution facilities is not regulated either.

Study of the obligation to connect through regulatory requirements

The requirements for the compulsory connection to DHC systems are very complicated. There is no doubt that the right to free competition and the consumers' choice of the type of energy supply is a fundamental right.

However, it must also be borne in mind that free competition must be raised between products or services of identical characteristics, that is, it should serve to protect the users, not to penalize them by favouring products or services of poor quality or offering lower values, not only at an individual scale but also of general or social interest.

The case of a new DHC network in an existing urban area is undoubtedly the most complicated scenario, since the change or sign-up of a new user must be absolutely voluntary, either by economic or environmental criteria. That is why this case deserves a separate study.

In the case of new urban developments the promotion of networks is much more straightforward. There is no doubt that both economically and above all at the environmental level, DHC have many final advantages over the traditional systems in our country.

The level of emissions produced by a DHC, and especially those powered by renewable energies, is much lower than traditional (non-renewable) individual or even centralized thermal systems. Therefore, in the new urban plan, which should already be oriented to the 2020 horizon, criteria to achieve reductions in both consumption and emissions and to increase global contributions by energy production through renewable sources should be included.

Achieving compliance with the implementation of *nearly zero energy buildings* (nZEB) cannot be treated individually, since the required RES shares are too large to be charged to a single building. Hence the importance of global energy management. The management of both electrical and thermal energy production needs tools to organize all this array of environmental requirements of Horizon 2020.

There is no doubt that a DHC is a guarantee for a reduction of GHG emissions and for a good management both in the penetration of renewable energies to the system and in an optimization of the energy resources, fully fulfilling the requirements of the mentioned horizon.

The new urban planning will require the inclusion of nZEB and a key resource to be able to meet this requirement is the connection to DHC system. Therefore, in the case of an existing or planned DHC in the urban area the regulations should foresee that, in case of not connecting to that network, the promoter will have to deploy a system that guarantees or improves the characteristics regarding reductions in emissions and primary energy consumption and the use of renewable energies, in equivalence to the planned or existing district network.

This guarantee of 'equivalence' must be maintained over time, so energy management is also essential at the individual level.

This would be for example the model proposed by Barcelona City Council in the Special Infrastructure Plan in Poblenou.

Another possibility is the one implemented in the Director Urban Plan for the development of the Centre Direccional of Cerdanyola del Vallès, where the promoters of the land have to foresee and pay for all those elements, spaces and easements, in favour of the City Council and/or the utilities and service companies necessary for the implementation of the DHC.

All purchasers of plots that were initially publicly owned must connect all of their thermal demand (cold and heat) to the district network, and must sign a supply contract with the company that operates the service. For this purpose, the Consortium of the Centre Direccional specified the conditions of this service in the phase of urban management.

In the event that the central heating and cooling system is not used, the building design must include or foresee the installation of air conditioning. The solution given to the installation must prevent acoustic, heat or other discomfort from agents outside the building involved. It must also be aesthetically satisfactory and place the outdoor equipment preferably on the roof of the buildings. This air conditioning installation will require the appropriate municipal license. These requirements will also apply to redundant air conditioning equipment.

In any case, the greatest interest in the connection in a district network by the user is based on the conditions of the service offered, namely the guarantees of supply and quality of service (rather, a matter of promotion and information to the customer) and a good economic offer that is competitive in such a complicated market as the energy.

There is no doubt that there is a great social lack of knowledge of the great contributions in energy and environment of the DHC in residential, industrial or economic activities. For this reason, both local authorities involved in this type of network and companies generating and distributing heat and cold must undertake information actions in the groups included in the area where this DHC could be developed.

Once the implementation of this network has been decided, the first agent to be convinced will be the promoter of residential, service, industrial or logistics buildings, activities with different requirements and needs. This building may be for the promoter's own use or to sell, but its initial approach is that the heating and/or cooling solution adopted has a lower economic cost. Therefore, the economic offer of the DHC system must be more affordable than the cost of the system of production of cold and heat considered initially by the developer of the building. This cost clearly includes all the connection rights, the substations required, and also the costs of a new indoor installation of the building and the possible individual or collective equipment necessary for the proper functioning of the system.

It is crucial that the promoter of the building subject to connection is offered a good, flawless study, which specifies not only the own cost of the general distribution system but the actual comparison with respect to its initial cost and its saving alternatives. From this point on other very important factors, such as the environmental ones, appear, but in many cases they unfortunately fall into the background for most promoters, who usually have to justify their operations only on an economic basis.

The case of the end user is certainly different since the offer must be, as indicated, mainly economic (price of energy) and also with guarantees in the supply. Commercially the companies that supply this type of thermal energy have these offers perfectly bounded, so this factor is a good asset in their favour.

However, there are certain groups that still doubt about the guarantees in the supply of this energy. There have been cases of distrust of large Data Processing Centres (DPC) or even

shopping centres that have expressed such doubts. In the case of obligation to connect to the DHC, this fact may represent a problem for plot sales.

It is important to campaign against those mistaken opinions.

PROCUREMENT, FINANCING AND PUBLIC AIDS

Procurement models and financial tools for RES DHC. How to provide favourable financial conditions for RES DHC. Identify the basic financial indicative return on investments (NPV, IRR and Payback), for different typologies and cases of DHC (fed with RES, non RES, with waste heat, etc.)

As indicated in the ICAEN (Catalan Energy Institute) DHC Project and Development Guide, the fact that a public authority promotes the network by making a part of the investment (e.g. extension and civil works) substantially contributes to the success of the DHC. In addition, it must be kept in mind that the network will become the property of the public administration. This investment can be recovered as the operating period advances and the demand for heat and cold for which the project has been designed is progressively achieved.

Despite this, if the financial indicators of the investments are attractive enough, thus assuring the solvency of the project and a foreseeable demand, with the consequent reduction of risks, the private operator could assume the investments perfectly on its own.

Any model can be valid, be it a total or partial initial investment by the administration (with or without return of said investment), a public-private investment or the total investment by the operator thus assuming the entire risk. Obviously the model is linked to the business model and its profitability.

When asked about the most suitable procurement model, some members of the SmartReFlex working group show a preference for the mixed contract of supply and services.

The European Directives on public procurement (2014) foresee two types of procurement procedures where contracting entities are seeking private operators to respond to specific needs not determined prior to the request for tenders (such as the search for innovative solutions by the Public Administrations), which are:

1. Competitive dialogue, where the contracting authority invites specific economic operators and
2. The negotiated procedure, where every economic operator may submit an application for admission.

These award procedures are preferable to innovation partnerships.

Within the EU the two procedures are regarded as very valuable to improve the quality of the work or service sought. However, in Catalonia it seems they are not widespread procedures among private operators.

In any case, the municipality involved in the DHC must ensure the budgetary stability of the project, assuming a part of the risk, either by adding additional extensions over the initial duration, expanding in the case of buildings or municipal facilities with new supplies not initially foreseen (it must be taken into account in the tender document or else it won't be possible to exceed what is provided in the contract by more than 20 %) or the possibility of including, in the case of a planned municipal network, private clients that have not been foreseen in the initial network.

Usually the information requested by the financial institution is the business plan, the contract and/or contract award conditions, project profitability, risk definition and guarantees (solvency of the company and especially the final customer). Mainly technical terms usually play a subordinate role.

There are limitations, depending on the kind of financial institution, regarding the minimum amount of investment. For example, some large-format financiers working with venture capital funds discard investments below 500,000 €.

As for the profitability, this varies according to the interest rate (recently it has dropped from 12 % to the 7-10 % range). Some international investors are already interested in returns of 6 % or even 3-4 % for medium-term investments (3 or 4 years). On the other hand, it is also possible to consider the 'country risk', which can increase the expected profitability up to 3 points, or demand guarantees from the parent firm to be able to grant the financing.

In one of the most recent cases, the projected IRR was 4 % with a projection to the future, annually reshaping the business plan and the new projection. In this case, this minimum IRR was proposed, taking as a reference the profitability that Endesa Distribución [NT: the main Distribution System Operator, DSO, in the area] has guaranteed over all the investments made by the company, in its case, 6.5 %. If the resulting IRR is lower, it must be negotiated to compensate the losses, whereas if it is higher than 16 %, the distribution of the benefits is agreed.

In this case, the Barcelona City Council as regulator of the service requires thorough economic controls, so that effective supervision can be carried out and rescue the service if necessary at any time.

Although they cannot be considered as actual financial conditions, the so-called Imbalance Clauses are of crucial importance to obtain guarantees in the investment. When the awarded tenderer suffers from an imbalance and has to be assisted by the Administration it is essential to know the moment from which the clause should come into force (starting from the first year of losses, after 20 years of the investment...). In fact, it is more relevant to define when to notify the Administration than to set an upper limit. In a recent case, the concessionaire has agreed a minimum IRR for the rescue of 2 %, with a projection of 5 years.

It is therefore crucial to warn at an early stage of imbalance in order to find a solution as quickly as possible, through negotiation and new financing. In order to evaluate the status of the concession, it is critical for the administration to be aware of the state of the network.

There are other cases in which the concessionaire does not have the right to economic rebalancing, but the Administration may come to the rescue of the concession in two ways: extending the period of the concession or else increasing the period of return of the investment made by the Administration in the network. Regarding the physical limits of the concession, it is an issue that has to be very well defined in the contract for any extension would require a new tender. In this particular case, the scope of the contract was fixed in the urban area that includes the network, with a forecast of possible extensions up to 200m away from the limit of the concession.

In the case where a public administration wanted to provide the service directly, it would be protected by the figure of 'public initiative in economic activity' (art. 128 of the Spanish Constitution) for activities of general interest. It would also be under the legal framework of the European Procurement Directives 2014/24/EU and 2014/25/EU. This activity would have to be self-financed, since it is not considered a basic service, based on the Law of Rationalization and Sustainability of Local Administration. The requirement of self-financing

does not imply that third-party financing is not possible, but no public budget could be injected.

Given the question of whether aspects such as the influence of renewables on the new DHC, environmental or social aspects or even public-private collaboration have a specific weight to finance, most experts agree that in cases of conventional banking –although tending to have specific products for projects with an environmental concerns – there are no more favourable conditions than for the rest of products and that marketing aspects prevail.

These aspects on the other hand tend to be relevant in cases of ethical banking or crowdfunding. In other cases, such as the actions funded by the European Investment Bank, environmental aspects may even become a requirement for access to funding. There are also investment companies that include this type of investment into their venture capital funds, thus achieving a unique product with a clear environmental interest.

At the moment the classic financial institutions value almost exclusively the solvency of the City Council promoting a project, and not the return of the same (IRR). Moreover, the Resolution of 16 September 2016 of the General Secretariat of the Treasury and Financial Policy of the Spanish government, which defines the principle of financial prudence applicable to borrowing operations and derivatives of the regional and local entities, entails that the maximum financial cost that can be charged is in the order of 0.83%.

Some members of the taskforce presented their financial entity as a supplier via renting, which could be equated to a large mixed contract, which in this case would focus on facilities that improve energy efficiency. The estimated duration would be about 7-8 years, which in exceptional cases could reach 12 years. It is clear that in terms of DHC these deadlines are shorter than the lifespan of the facilities.

In the case of alternative funding, like crowdfunding, limitations may vary. A common case could be the participation of up to 3,000 € per investor with a return of 5.5 % in 5 years. Therefore, for small projects or low returns, crowdfunding may be an option, since large investors often look for high volumes of investment with returns approaching 10 %.

There are basically four modalities of crowdfunding: capital investment for companies, funding of projects (*crowdlending*), donations or contributions to projects in exchange for small compensations (rewards).

The *crowdlending* is about collecting contributions to finance an operation in the form of a collective loan through the internet. Products of energy efficiency projects are usually accepted, with certain guarantees, so they are usually advised by law firms specialized in the energy field. Examples of platforms are Ecrowd!, Comunitae, Loanbook, Arboribus and Growly.

The Spanish law regulating this type of investment, *Law 5/2015, of April 27, to promote business financing*, only allows a maximum participation of 3,000 € per investor and project and a maximum of 10,000 € per year per investor in all platforms. Projects funded through crowdfunding cannot exceed a budget of 2,000,000 €.

In accordance with Law 5/2015 it is necessary to create a Participatory Financing Platform (PFP). Participative Financing Platforms are companies that put in contact a plurality of investors with promoters of participatory financing projects through web pages. For its establishment, it requires the authorization of the National Stock Market Commission. In the case of Catalonia it can be managed through the public company ACCIÓ.

The expenses for the financed project will normally be 3-4% of the revenue collected as a 'success commission', and a commission of 1.5% per year, by the entity that manages the process of collection and payment (e.g. Paypal) on accrued interest.

Crowdfunding is a very widespread system in other European Union countries, to a much greater extent than it is in Spain. One of the important points that are pending adjustment is the regulation at the level of tender specifications in case of actions of the Public Administrations. At the moment, bodies such as Diputació Barcelona [Barcelona County Council] are drafting specific specifications.

Crowdfunding is an interesting model for projects promoted by municipalities because of their great share of citizen engagement. The City Council opens a part of the financing (for example, 20%) to the citizen participation (participation accounts). This percentage - without the need to be covered by collective financing - is without doubt a good tool to engage the citizens in the project and make it their own.

Of course, in such cases, a good dissemination campaign is crucial. Vilanova i la Geltrú is a municipality that used this tool of citizen engagement, where 15% of a municipal project was financed by the popular investment initiative.

While not commonly used financial products applicable to DHC, there is no doubt that initiatives to obtain funding for social, sustainable or solidary purposes are multiplying. In some cases renewable energy can be a good claim when it comes to obtaining financing. An example was presented in the working group called *Living off the Air of the Sky*. *'The main objective of the Living off the Air of the Sky project is to install a shared-ownership wind turbine to generate clean and green electricity, making it possible to create solidarity between people living in urban areas and those living in rural areas.'*

Another clearly social product, also presented in the working group is *Teaming*. *'Teaming is an online tool to raise funds for social causes through micro donations of 1 € a month. The philosophy of Teaming is based on the idea that with 1 €, we alone cannot do much but if we join we can achieve great things.'*

Although these are 2 initiatives that have little connection with DHC, they do give an idea of the amount of products, initiatives and solutions available today for financing any business.

Another of the major issues is the interest of the incorporation of Energy Services Companies in the DHC space. Although the purpose of an ESCO is to obtain its income through energy savings, sharing with the customer the economic savings, we raise the possibility of this possible interest by both parties to take part in the savings business with the implementation of a DHC system.

No doubt the volume of savings can be as large as the volume of consumption. For this reason, industrial areas with high consumption of heat or business areas with great density of tertiary buildings and demand for thermal energy would have a great potential for new systems. In addition, this intervention could be extended to electric saving, making the business more complete.

The general perception has been that the ESCO contract model in the administrations where the idea of a DHC, mainly local, is planned is limited to the investment and management of public lighting networks. In fact it might seem that they have some formal similarity with the networks of thermal production and distribution.

However the examples we have known consist mostly in the improvement of existing equipment, rather than in the new implementation of non-existent systems. In addition there is the difficulty that although the ESCO could be incorporated, the City Council promoting the project should take action where the ESCO could not act, thus becoming the service company an energy manager rather than a direct catalyst of savings.

Another factor that discourages the ESCO model is the improvement of the investment capacity of the municipalities. Based on *Organic Law 2/2010, of April 27, on budgetary stability and financial sustainability*, City Councils are having positive annual results (reduction of expenses, staff reductions...). For this reason, in the new systems, municipalities prefer own or external management, but with their own control of the savings. The ESCO model grew during the crisis when there was no municipal investment capacity; at present it exists, and that is the reason why the interest of the municipalities in the management and control is encouraged.

In conclusion, funding should not be a problem if the project is viable and feasible.

Public aids for RES DHC

Analysis of possible public measures to support financing, either to DHC promoters, building promoters or users. Proposals for tax benefits: rebate of local taxes, reduction of the cost of building permits, tax credits for ESCO/energy cooperatives

Clearly any public aid, be it subsidies or reductions/rebates of general and municipal taxes, represents a good incentive both economic and in image for investment in a DHC. On the one hand, it shows a particular interest on the part of the municipality or of the administration that offers these measures; and on the other it directly favours the investor, manager or user.

To simplify, 3 types of aid can be considered: state, regional and local. The taxes are distributed according to the competences and unfortunately the simplest and more clearly identified by the concepts they integrate - local taxes - are the ones that have lower amounts and are focused in the end user.

The moment we consider who should be the beneficiary of this aid, a deep debate is created. On the one hand it seems clear that in order to obtain the success of a DHC the number of users and final consumers has to be the greater the better, but on the other hand, considering the good performance of a DHC system, the end user is already receiving the benefit of cheaper energy and better quality than those who are not included in the system.

On the other hand, the promoters of the buildings could also be beneficiary of these incentives, to favour their interest in the connection of their building - that would imply the final contracting by the users of the dwellings marketed by the promoter -. In this regard, some opinions consider that the best incentive for a promoter is that the cost of the final installation is at least equal to that of a traditional system.

As for the investor in the network, there is no doubt that a reduction in the taxes related to the execution of the system would facilitate their initial effort, although it must also be taken into account that in many cases the investment in the execution has a certain municipal colour, thus there being a contradiction in that bonus.

At the local level, and for legal reasons, it is easier to establish a line of subsidies for certain activities than to grant exemptions or reduce municipal taxes. This is due to the fact that subsidies are discretionary contributions by the Administration, while taxes are highly regulated and may even depend on several administrations. This is the case for example of the Tax on Mechanical Traction Vehicles, in which the municipal part is 75% and the state part of 25%. Thus the local administrations can only act on the municipal part of the tax.

In fact, the Property Tax is a state tax transferred to municipalities and has quantitative and qualitative reduction limits. In any case, there are examples in that sense.

We have collected examples of tax rebates for facilities and works for the adoption of energy efficiency measures where the additional investment is only symbolically charged with the

Property Tax in case of geothermal energy or to the Trade Income Tax of the operator. These cases occur in municipalities such as Sant Cugat del Vallès, Vilanova i la Geltrú or Terrassa.

The Barcelona City Council does not offer any subsidy, although a proposal for a reduction of 70% of the Property Tax or the Tax on Constructions, Installations and Works (ICIO) is being drafted in the light of the reduction in demand. Above all from the point of view of the initial investor a reduction in the ICIO for the initial execution - not in the improvement or reduction of demand - would be interesting.

The City Council of Sant Cugat del Vallès has planned rebates in both the Trade Income Tax for the companies holding the execution and in the ICIO, although in this case they generally affect in the following terms: *‘Works of expansion or installation in existing buildings to include elements of sustainable construction based on active systems of solar energy, biomass, geothermal, and/or water saving systems. 95% based on the cost of additional installation’.*

We must bear in mind that both Property Tax and ICIO are limited by the Local Finance Act and only temporality can be reduced. In addition, the Property Tax is implicit to the estate (dwelling or building), so it is applied at an individual level.

As a reference at national or regional level, no aid or rebates are known regarding the new DHC systems. To meet the requirements of Horizon 2020 it is crucial to propose incentives for the development of systems that guarantee the reduction of emissions, through renewable energies and, of course, the promotion of DHC is no doubt the best solution. These aids must be set at the national level, since the fulfilment of the European requirements have that competence scope.

Regarding tax policy at a national level a prime example is France, where reduced VAT is paid whenever a consumer is connected to a network with a contribution of renewables of at least 50%. With this criterion, the cost of the final thermal energy would represent a reduction of the energy bill to the user of more than 15% only in taxes, apart from the possible better price for making use of energies surely cheaper than fossil fuels.

Proposal of possible formalisations of public-private partnership that allow the feasible implementation of RES DHC

Public-private partnership is understood as the collaboration between a public entity and a private entity in which one or more contracting authorities carry out a contract with one or more economic operators for the provision of services, for the supply of products or for the execution of works.

As public-private partnerships, associations, co-operations and business combinations are also considered, especially when we refer to water, energy, transport and postal services contracts, as envisaged in Directive 2014/25/EU.

The last three European Procurement Directives of 2014 also envisage innovation partnerships as collaboration between public and private entities to obtain innovative solutions.

Public bodies can provide the service directly or through externalisation. However, since thermal energy is not considered a basic supply, it is not possible to use the public budget and DHC must be a self-financing business.

In case of public contracts there are three possibilities: concession of public works, concession of public services or mixed concession of works and services. This last option seems to be the most interesting, because it offers greater flexibility in contracting and because it is not limited to 4 years of operation (as in the public service concession modality), since this period is

insufficient taking into account the economic indicators of the investments of a DHC (Payback, IRR and NPV).

This is the typical case of the ESCO model. In this case, certain criteria must be met so that it does not compute as a municipal deficit. It is usually requested that the update/improvement/remodelling is more than 50 % of the current power, and that service is given to clients other than public facilities. ADHAC [Spanish Association of DHC companies] provides a note from Eurostat of 7 August 2015 (*'The impact of energy performance contracts on government accounts'*) on this subject.

According to *Royal Decree-Law 6/2010, of 9 April, on measures to boost economic recovery and employment*:

'For the purposes of this Royal Decree-Law, an energy services company [ESCO] is understood as a natural or legal persons who provide energy services at a user's premises or premises and face some degree of economic risk in doing so. All of this, provided that the payment for the services provided is based, either partially or totally, on the achievement of energy savings by introducing improvements in energy efficiency and compliance with other agreed performance requirements.

The energy service provided by ESCO will consist of a set of benefits including the realization of intangible investments, works or supplies necessary to optimize the quality and the reduction of energy costs. This action may include the construction, assembly or transformation of energy-consuming installations, equipment and systems, their maintenance, updating or renewal, their exploitation or suggestion derived from the incorporation of efficient technologies. The energy service thus defined shall be provided on the basis of a contract which shall be accompanied by verifiable, measurable or estimable energy savings.'

Whatever solution is chosen, it is recommended that the public body keeps the ownership of the network. On the other hand, if the cost of the network is assumed by the public entity, either as a sunk cost or foreseeing its compensation once the operation has started, it seems that the financial feasibility of the DHC for private operators would increase.

The Districlima and Ecoenergies systems in Barcelona are examples of mixed concession of works and public services, whereas Cerdanyola (Parc de l'Alba) and Olot (Xarxa Espavilada) are examples of concessions of public works.

Contracts usually include penalties for non-compliance with service conditions and the rate (and subsequent review possibilities) is regulated. These can be extended to environmental issues, as there have been cases of exceeding by an established share in the contribution of fossil fuels.

Not only these limitations but also the requirement of a percentage of biomass is set in areas with local production, such as parks and gardens in Barcelona, which mandates the incorporation in one of the urban DHC system of their biomass production estimated at 8,000 Tn/year. It must be taken into account that the global needs of DH is of 30,000 Tn/year.

Since reliability in the continuous supply of biomass can be a condition for the feasibility of a DHC supplied with this fuel, biomass supply contracts are already sign for up to 5 years. In the case of small boilers (1-2 MW of power) with a price of 70-80 €/Tn the installation is cost-effective thanks to the fact that the boilers are amortized quickly (about 5-6 years).

The project has provided knowledge and examples of contract types and clauses. In the case of biomass, a standard contract has been obtained and disseminated to ensure the reliability of the supplies of this energy source.

Energy poverty is undoubtedly a serious problem in progressive spread. It is important to include in the tender documents of the service concession a clause that includes protection to groups vulnerable to energy poverty. Although most of the DHC are in areas of new development and that therefore the index of people affected by this problem should not be high, the passage of time and unfortunately the social panorama does not predict a future too flattering in that sense. Therefore we should think of systems such as economic buffers to partially cover this problem, special rates for groups at risk of social exclusion, prepaid systems for specific groups, etc. This section is addressed to the end user, so even though it would be included in the concession conditions, it would be applicable by the energy manager in charge of individual billing in case the concessionaire does not conduct it.

Technical and economic feasibility and best available technologies. Establish DHC in new areas and introduction of renewable energy into existing DHC

Considering the implementation of RES DHC in new urban developments, where there is waste heat available or availability of renewable energy, through the development of feasibility studies in the framework of the case studies of the SmartReFlex project, has been the most primary objective developed by the work team.

The residential area L'Estrella in Badalona has been studied for the feasibility of a DHC with fundamental support of biomass as primary energy. The study of IREC determined the initial profitability of the network and the need to make a definitive study for its implementation in the area. Currently the Consortium ARE L'Estrella (Badalona City Council and INCASOL, basically) has undertaken a theoretical business plan and the development of the urbanization project of the area is being prepared, with the implementation of the DHC system, with both the possibilities of biomass or else geothermal exchange. The documents for the tender of the service concession are also in preparation. All these documents and studies are based on the contributions made by the members of the SmartReFlex project taskforce.

The possibility of introducing renewable energies to existing DHC in Catalonia, analysing their costs and their viability through the development of feasibility studies in the case studies of SmartReFlex project, is certainly one of the key objectives developed by the taskforce.

The goal should be to encourage the use of local energy sources. These energies can be obtained from renewable sources or residual energy, as already mentioned above. At present there are several DHC in Catalonia that use industrial waste heat and others in study where there is a very important requirement of thermal energy in some industries and heat dissipation in others, so the synergy is direct. Examples such as 22 @, La Marina, Parc de l'Alba or Adobers (in Igualada), are good examples of the use of waste energies or waste transformation, be it physical or dissipated.

For this purpose, collecting information on the types of local energy sources that can be supplied by RES DHC (industrial waste heat, biomass, solar thermal, geothermal, biogas...) is crucial. The SmartReFlex project has developed a map viewer incorporating the entire known census of renewable energy production in Catalonia using the data recorded by ICAEN, in which both the origins of these energies and the expected generation power can be known. There is still an important inventory work of waste energies of industrial origin that are dissipating throughout the territory and certainly it would have great potential from the point of view of proximity.

Currently the waste energy used in DHC is originated from large production facilities, such as the TERSA incinerator or the gasifier of the Barcelona harbour, but others of a smaller size or use, such as the biogas of the Parc de l'Alba or the 'Adobers' area in Igualada (under study),

would serve as an example of that use of initially dissipated energies, already transformed and that only need to be piped and stored for their use.

From the platform of SmartReFlex and the capacity of the members of the Public Administrations that are part of the taskforce, our aim is to include in the regulations all kind of strategies that support the industrial energy symbiosis with prescriptive effects of 'soft law'.

Regarding the promotion of biomass, it has been absolutely demonstrated that there is enough availability in Catalonia but that a contract is vital to guarantee the supply, both quantitatively and qualitatively. On the other hand the insecurity in the variability of the price creates a great concern and uncertainty in the regular user of this energy. In order to remedy these weaknesses we have identified biomass labels for proximity supplies (km 0) and/or labels that guarantee the quality of the fuel, which can certainly provide security and guarantees in the biomass trade. Likewise, the work of the Cluster of Biomass of Catalonia promotes, simplifies and gives guarantee to the user of our great energy good.

Thus, thanks to the participation in the *Catalan Strategy to promote the energy use of forest and agricultural biomass*, we have collected and disseminated a standard contract for the supply of biomass.

The limitations in the Metropolitan Area of Barcelona for those municipalities considered areas of special protection against atmospheric pollution - that can be linked to the combustion of biomass - have also been highlighted. There is no doubt that it is fundamentally the incidence of emissions of vehicles that makes the Metropolitan Area of Barcelona a much penalized area for the use of biomass as a source of energy. To solve this problem there are solutions such as the one adopted by the Olot system where, in case the PM10 emission limit is exceeded, the biomass boiler is shut down and the gas boiler start to operate. Other solutions consist in requiring certain technical specifications to be met by biomass boilers and certain qualitative characteristics of the fuel, which guarantee PM10 emissions below the levels permitted by air pollution legislation.

The SmartReFlex taskforce has drafted an emission compliance ordinance to include in urban planning regulations in areas of vulnerability to air pollution, thanks to the support of the Biomass Cluster of Catalonia. In the application of the case study of Badalona L'Estrella the new emissions have been linked to the reduction resulting from the promotion of the electric vehicle and the increase of public transport and its intermodality. In addition, urban planning regulations and atmospheric protection include the obligation for boilers to comply with certain technical conditions related to emissions, as well as other qualitative requirements applicable to biomass fuel.

What measures could be envisaged to reduce the impact on air pollution in these cases? The *Commission Regulation (EU) 2015/1189 of ecodesign requirements for solid fuel space boilers* sets the maximum values for particulate matter and NOx emissions in combustion. For the reduction or the control of the compounds of NOx, SOx and PM10/2,5 two aspects should preferably be considered:

1. The quality of the fuel, credited with quality labels, either for chip (Biomasud and Dbosq) or for pellet (Dinplus and Enplus)
2. The technologies used, either in the boilers themselves or in the filtration systems available to them.

The two aspects may be required in the procurement plans of the public authorities that promote DHC, in order to ensure control of emissions.

One should be cautious if the environment is sensitive to PM_{2,5} or PM₁₀, as boilers could produce an overload of pollutants if they do not have adequate filtration systems or are fed with low quality biomass. This would be the case of the around 40 municipalities of the Metropolitan Area of Barcelona declared zones of special protection against the atmospheric pollution. Of these, the municipalities with more than 100,000 inhabitants need to have PAMQA (Action Plan for improvement of the air quality).

We should not mistake the combustion of individual biomass chimneys, which have no regulation, for collective biomass boilers. These have a much lower emission level per kW, and they can also have efficient technologies to further reduce PM₁₀ emissions.

It would be very important to have a comparison on the emission of particles of the most common equipment (vehicles, individual boilers, fireplaces...) in cities at risk of limiting particulate emissions and compare them with biomass boilers indexed by kWh produced or number of beneficiaries.

PRIVATE FACILITIES AND CONSUMERS

Creation of a specific office to provide support and advice to the DHC and all agents engaged in its creation (energy promoters, developers/municipalities, financial/investment entities, users, etc.). Promote the social acceptance of DHC systems.

At the end-user level, DHCs are a huge unknown. Distrust towards the centralized systems is very great in Catalonia and if we consider a system in which a new energy services company appears – different from the traditional ones –, the problem of confidence increases.

On the other hand, there are unfortunately examples of bad practices in former times where the resolution of the problems arising from the supply lasted for years, with the consequent discrediting of the system. There is no doubt that these bad practices do much more harm than the benefit of the success examples, which are a majority.

So it is crucial to provide maximum information to all those interested or even curious, who want to know what constitutes a DHC system. The user of the network goes from the land promoter, through the one promoter of the buildings, to the end user, who will use that facility.

These components are vital for the development of the project, since they will be the ones who will finally say if it is useful or not to implement the installation, either from an economic, technical or environmental point of view.

Being conscious as we are of the goodness of the system, the path should be the dissemination at a citizen level of the DHC, with a major pedagogic work. A thermal network must be a plus of quality given to an urban area and when a building is connected to that system, it must differentiate it qualitatively from another not connected.

For all that, it is vital to create an information and advisory office for the DHC in all steps for planning, contracting, execution, management and marketing and ranging from urban planning to consumer care and advocacy. This Office does not necessarily have to be physical, but it should allow the careful referral of the interested party to the competent authority that will solve the doubts or problems that arise.

Thus, the Departments of Territori i Sostenibilitat, General Directorates such as *Industry, Energy and Mines* or *Medi Ambient*, Agencies or Institutes of Energy, promoters of land and housing, developers and managers of the system, associations or consumer agencies, Energy, engineering of the DHC sector, etc., must be interconnected and coordinated by that 'Office', who will be the one who receives the question, complaint or interest from citizens interested in a DHC.

To achieve interest or at least public curiosity, an information campaign on DHC must be carried out, revealing all the benefits of a DHC system and focusing all efforts on such simple issues as prices and guarantee. Those are two points that currently create great mistrust between users, both the end user and the promoters.

The lack of interest or knowledge on the part of the Consumer Agencies, the Associations and unions of Consumers of the subject of the DHC is noteworthy. This can be given a positive reading, since the lack of information in these agencies and institutions indicates that there have been no relevant conflicts, but there is no doubt that in case of conflict that ignorance observed could bring serious consequences.

For this reason, the training and dissemination of knowledge about DHC to consumer protection organizations is a great challenge acknowledged in SmartReFlex project and that

should be undertaken in a specialized way. Each of the experts will provide their knowledge and experiences in a way choral way, for they must be perfectly coordinated to meet the demands of the users.

Likewise, it is crucial to develop a proposal for an End User Protection Code to ensure the supply of heating and cooling under pre-established conditions and where the support of the local administration appears. That protection code should correspond to the contract signed between operators and users and should be unique whatever the company providing the service.

This Office should also report on topics such as contracting, possible aids, or even simplified specifications for the implementation of RES DHC Energy Cooperatives, which should be applied in future tenders.

For purposes of end user and promotion, it is essential to have all that information to resolve any doubts concerning the connection the building or to have the security that the system will give all the guarantees of both service and bills.

The development of the 'soft law' framework to ensure the supply of HC to the housing developer and the communication of the technical conditions necessary to ensure a correct connection to the DHC is a vital objective to facilitate the development of DHC systems. For this reason, during the development of the SmartReflex project the knowledge, suggestions and demands necessary to draw this 'soft law' have been collected to help all the stakeholders related to DHC to incorporate the networks with ease in the new urban areas and even in existing ones.

Based on the experience of a residential building connected to the largest DHC system in Catalonia, the operator's best pricing system and the distribution of participation among the neighbours within the building has been analysed. The project has allowed to find examples of billing in buildings connected to DHC, business models with the conditions between property administrators and operators, regulation of the price of heat or cold, distribution of the cost of losses within the building or the possibility of integrating other services - electricity generation, lighting management... - within the management contract of DHC.

As fundamental consumer rights, subjects such as the consumer's possibility to compare their energy cost in a DHC with other traditional systems - such as a mixed individual gas boiler - have been analysed. It is also critical to distinguish the expenses corresponding to the global consumption and the impact of the energy expenses derived from the internal distribution of the building, both the losses of the system and the consumption of the indoor installation - pumps, heat recovery systems, heat exchangers... -. Therefore, it is essential to determine a fair distribution system for losses due to the internal distribution of the building, alien to the DHC source of energy.

The volume of the energy losses of the system in the indoor distribution of the building in moments of low consumption is in certain cases - low occupation, little or no heat demand, reduced consumption to a minimum requirement of domestic hot water - clearly altering the criteria of energy efficiency. Therefore solutions such as the temporary limitation of supply and above all the accumulations both at building level and individual consumption point would optimize energy resources by clearly reducing energy losses in the indoor distribution. We must bear in mind that the start/stop of the internal circuit pumps is undoubtedly an action that directly affects the 'marginal losses/consumption' of the global installation.

For this reason the management of the system is crucial to guarantee the energy success and for this reason it must be undertaken by a company fully familiarised with the concept distributed generation and with a careful maintenance conceived for the energy savings.

In the case of buildings with existing solar thermal installations, the coexistence of the two systems is perfectly possible. It involves the distribution of hot water with four pipe installations to segregate the heating from the domestic hot water instead of the systems of two pipes which have shown inefficiencies since there are many months without heating demand. Combining this with a proper accumulation, especially in the consumption units, we will achieve great energy savings thanks to the possibility of not having to pump the entire energy mass through the building's pipework at any moment of demand, thus concentrating in fewer boots with higher demands.

Losses in most cases are distributed - as in the case of the lift - by coefficients, based on the surface of each dwelling unit or premise. Therefore, a possible option would be that the fixed cost is divided by building coefficients and variable cost depending on consumption.

In the case of buildings connected to DHC systems, it is essential to set in the deed of constitution of the building the distribution coefficients for the participation in the costs deriving from the connection to the network.

A great success in the diffusion and promotion of the DHC would be the individual billing. It is a very complex issue that most network operators reject. It is always more comfortable to bill at a building scale, and it simplifies both billing and payment for the operator, reducing the rate of unpaid bills. However from the point of view of the individual user, direct billing of the dealer is much more straightforward and more real. The best scenario would be the complete billing to the user, with the incorporation of the total consumption including the so-called 'losses' of the indoor installation. There are already large networks in which the operator/utility of the network bills individually, where the mentioned 'losses' are already included in the bill, with a fixed price for residential use.

As for the regulation of tariffs, there are two usual ways: to set prices based on costs and to do it based on the complementary energy tariff.

In the first case there is an imperfect relationship between what is regulated and its regulation. The variable costs can be calculated, but it is very difficult to do it with fixed costs, so the Administration would also have to regulate what costs and margin would be reasonable - staff expenses, management, profit, etc. -.

The second case is much simpler to apply, but it is probably more unreal, since it only fits the non-renewable energy market, indexing costs to the price of gas or electricity, which are in fact regulated. In most cases studies in the SmartReFlex Project this is the used review system.

DISSEMINATION

The dissemination of the SmartReFlex project in public and private financial sector and investment entities has been a key element in the development of our work, with the inclusion of representatives of entities related to the financing and economic development of investments to the task force of the project. Thus public financing institutions, private entities, alternative financing groups, etc. have been active members of the working group, with direct exchange of needs and problems raised by the different stakeholders of the development of DHC system.

To carry out a pilot project. To promote the development of a RES DHC that considers and evaluates the application or the result of all the necessary action lines to reach each of the goals that configure the strategy.

Studies have been carried out on several pilot cases, most of them already implemented, - such as Olot or Cerdanyola del Vallès - which have served as experience and knowledge of success. From these, IREC has studied the implementation and management of a DHC in the residential area of L'Estrella de Badalona, formulating several proposals for a thermal network mainly fed with renewable sources.

At the moment this urban area is in the phase of rafting of the urbanization project and the implementations of the DHC system is under discussion. There is no doubt that through this European Programme, it has been possible to incorporate the requirement of studying the feasibility of a DHC in new urban plans, to justify or discard the development of such thermal installations.

SmartReFlex team of the Catalan Land Institute and IREC, with the collaboration of the Catalan task force.

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