European Commission

OVERVIEW OF HEATING AND COOLING

PERCEPTIONS, MARKETS AND REGULATORY FRAMEWORKS FOR DECARBONISATION

Overview of Heating and Cooling: Perceptions, Markets and Regulatory Frameworks for Decarbonisation

Final report

N° ENER/C3/2019-487

Imprint

Project coordination

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European Commission, DG Ener, Brussels, Belgium

Published: August 2022

PDF ISBN 978-92-76-61540-8 doi:10.2833/962558 MJ-03-22-287-EN-N

Content

Abstract

The overall objectives of this study are to contribute to optimal pathways for decarbonisation of heating and cooling. The study depicts the perception or image of heat pumps and district heating and cooling among different consumers in the residential, industrial and public sectors, and analyses key elements and drivers that govern the decisions of key actors regarding H&C technologies. In a first step, a literature meta-analysis is carried out. Second, to fill the gaps identified in the literature with respect to perceptions and key drivers of decisions in heating and cooling, a survey among households and interviews with representatives of the industrial and public sectors are conducted. In a third step, a detailed literature and document analysis regarding the monetary and non-monetary incentives of renewable energy and energy efficiency technologies in heating and cooling is accomplished. The analysis includes also expert talks or interviews. Furthermore, the different cost components of DHC and HP are examined from perspectives of suppliers and final consumer. Finally, the potential of energy efficiency obligations schemes (EECSs) is analysed with respect to their tradable components to ensure an efficient and effective use of measures and policies, contributing to the decarbonisation of the H&C system.

Résumé

Les objectifs généraux de cette étude sont de contribuer aux trajectoires optimales pour décarboner le chauffage et le refroidissement. Elle décrit la perception ou l'image des pompes à chaleur ainsi que des réseaux de chaleur et de froid qu'ont les différents consommateurs dans les secteurs résidentiel, industriel et public et analyse les éléments clés et les facteurs qui déterminent les décisions des acteurs clés sur les technologies de chauffage et de refroidissement. Dans un pemier temps, une méta-analyse de la littérature est réalisée. Dans un deuxième temps et pour combler les lacunes identifiées dans la littérature en ce qui concerne les perceptions et les principaux facteurs de décision en matière de chauffage et de refroidissement, une enquête auprès des ménages et des interviews avec des représentants de l'industrie et du public sont réalisées. Dans un troisième temps, une analyse détaillée de la littérature et des documents concernant les incitations monétaires et non monétaires des énergies renouvelables et des technologies d'efficacité énergétique dans le domaine du chauffage et du refroidissement est effectuée. Elle comprend également des discussions ou des interviews avec des experts ainsi qu'un examen des différentes composantes du coût des pompes à chaleur et des réseaux de chaleur et de froid du point de vue du fournisseur et du consommateur final. Enfin, le potentiel des mécanismes d'obligations en matière d'efficacité énergétique est analysé par rapport à leurs composants échangeables pour assurer une utilisation efficace et effective des mesures et des politiques, contribuant à décarboner le système de chauffage et de refroidissement.

1 Executive Summary

Meta-study on factors governing decisions in Heating & Cooling

First, the objective was to provide a literature review of scientific publications examining decision and implementation factors of technologies that contribute to the decarbonisation of heating and cooling (H&C) in the residential, industrial and public sectors. The decision and implementation factors with respect to renewable or energy efficient H&C technologies differ among the various actors with respect to their significance as they are influenced by different drivers, such as regulatory, economic, environmental, social or cultural factors. For the purpose of this study, a meta-analysis was carried out. Publications were selected that deal with H&C technologies (renewable energies or energy efficiency) and have a focus on heat pumps (HP) and district heating and cooling (DHC). Further, respective key actors and their preferences and perceptions, as well as with drivers and decision-making factors regarding heat generation and consumption were selection criteria. Based on these criteria, 130 publications were identified and analysed. The findings are: Perceived challenges and concerns regarding the use of DHC are more complex than for HP. Regarding the use of DHC, key challenges are market power (and dependency), free market entry and switching of suppliers, competition issues as well as transparent pricing schemes and billing services for DHC services. In contrast, for the use HP, knowledge about the technologies seems to be a key issue. The HP technology is not as well-known as conventional heating technologies such as gas burners. Further, the majority of HP studies focuses on decision-making factors in the residential sector and less on companies or public authorities. Furthermore, the individual decision-making process for a H&C technology is not driven solely by profit orientation, but rather by the pursuit of well-being. This in turn, depends on an individual mix of self-centred (desires) and altruistic interests of monetary and non-monetary nature. Beyond individual interests, contextual factors referring to the individuals' environment influence energy generation and consumption behaviours. Individual and contextual factors belong to different levels: While the macro level comprises the overarching framework (social order, rules and economic system), the meso level relates to the energy system, the community or peers and their energy behaviour or culture. Together, both levels represent the contextual, external factors that impact individuals at the micro level. The micro level comprises various individual factors determining decisions: values, personal disposition and well-being as well as energy-related, socio-economic demographics of individuals as well as technical issues such as building features

Perceived features of DH and HP in the residential as well as in the industrial and public sectors

A second objective was to obtain a better understanding how actors in the residential, public and industrial sectors perceive heat pumps (HP) and district heating (DH). Surveys and interviews in the industry, the residential and public sectors of EU member states have been conducted on key characteristics such as climate protection, price risks, costs, dependency on supplier, reliability, and efforts to adopt selected H&C technologies. The analysis of the databases reveals the following findings.

In the residential sector, fossil fuels were perceived as the least climate-friendly and the costliest heating option, and were connected with a high risk of dependency on fossil fuel suppliers. In contrast, solar thermal was rated as the cheapest solution and was perceived as the heating option with the lowest price risk. Regarding DHC, in Lithuania, Spain, the Netherlands and the Czech Republic, perceived features are rated mostly below average, while in Sweden and Denmark the general perception is above average. Concerning HP, the effort to adopt HP is considered as high, since it is a less well-known technology. Overall, the lowest rating is given in the Netherlands and the highest in Poland. Attitudes and beliefs such as affinity to new technologies and environmental awareness positively correlate with a positive perception of heat pumps.

In the industrial and public sectors, we found that fossil fuels are perceived as the least climate-friendly heating option, however, they are seen as very reliable and easy to adopt by the industrial and public sectors. Regarding price risks, solar thermal shows the lowest price risks, and fossil fuels the highest. HP are perceived as a more climate-friendly heating option (than other options), while DH is connected with a higher dependency on an energy supplier. Drivers that impact adoption decisions differ between the industrial and public sectors compared to those in the residential sector. The primary focus of the industrial and public sectors is on economic issues or costs. However, energy-related regulations and norms (meso-level) as well as pressure of society (macro-level factor) on the company, e.g. public pressure for green products or green standards, can drive the use of sustainable energy.

Monetary and non-monetary incentives of HP and DH

A further objective of this study was to give an overview of incentives for the uptake of DHC and HP, which can make a significant contribution towards energy system flexibility and decarbonisation. In a first step, this involved a literature review to assess Framework Conditions (FC) for DHC and HP, in terms of their influence on the uptake of these technologies. The following FC were considered: a) Operational signalling refers to the need for technologies with flexibility potential, such as HP and newer DHC concepts to have market signals to respond to. This is very important in the light of sector coupling; b) The investment climate is critical to the uptake of DHC and HP technologies, as financial constraints are common barriers; c) The length and ease of the permitting process, including procedures in relation to consenting and licensing, can pose barriers to DHC and HP projects; d) Ownership and access rules can affect the uptake of DHC and HP; e) Certain technical factors can limit the deployment of technologies which provide flexibility; f) Electricity grid access addresses access to the physical electricity grid; g) Physical environment: flexible technologies depend on energy sources, whose economic potential may be limited by geography (e.g. distance from source to sink), demand characteristics (e.g. heat density) and policy/regulatory measures; h) Bounded rationality refers to a lack of awareness amongst relevant stakeholders, due to constraints in knowledge and experience; i) Acceptance refers to uncertainty about technologies, a perception that DHC and HP technologies and flexibility do not represent a core business activity and/or concerns about the extent of opportunity costs.

Second, we drew on the EC's database of State Aid cases, the National Energy and Climate Plans (NECPs) and MS' National Resilience and Recovery Plans (NRRPs) to assess the type of support mechanisms most used for DHC and HP, and whether the focus is on efficiency or decarbonisation. The EC investigates only a few cases of state aid for DHC infrastructure, of which a Lock-in effect or extension of fossil fuel-based power plants is expected. Further, the analysis showed that more countries target an increased share of renewable energy production (14 out of 16) than targeting energy efficiency (11 out of 16). The three most frequent support schemes are (i) public funding and tax mechanisms, (ii) tariffs and premiums, and (iii) grants. Where H&C technologies are considered in the National energy and climate plans (NECPs), the focus is primarily on DHC systems overall. Although HP are mentioned in all NECPs, assessments of the NECPs recommend that all MS show trajectories of how HP will develop in the future. The review of NRRPs highlighted that COVID-19 recovery initiatives and funds in the NRRP also support countries' NECP objectives, in particular, when these target H&C technology. All reviewed countries showed a degree of compatibility between their NRRPs and NECPs, however, the EC highlights that countries tended to focus either on efficiency or decarbonisation of H & C technologies.

Moreover, we provided an overview of strategic municipal heat planning and integrated spatial energy planning to support the uptake and acceptance of heating technologies. Heat planning, as a dedicated approach (as in Denmark) or as part of integrated energy spatial planning for heat (as in Austria) should be more widely implemented, because it has proven to be an effective tool to develop local measures to decarbonise the heating sector. To be effective, the municipal heat planning must be implemented by MS in a manner that horizontally aligns or integrates the usually separate regulatory frameworks for energy planning and spatial planning. However, it is also necessary to integrate vertical governance levels. We found that a polycentric energy governance approach to heat planning and integrated spatial energy planning is beneficial if it happens simultaneously to the design and transformation of heating systems. A polycentric governance approach is able to integrate multiple levels (from the local to the national and beyond), whilst involving a wider range of stakeholders in the policymaking process, including municipalities and citizens. To decide whether individual heat planning or spatial energy planning are appropriate, one needs to consider the differing constitutional and governance structures in each jurisdiction. In some MS heat planning is not yet implemented as a dedicated programme. But even in these MS, there are windows of opportunity for such implementation, for instance, via national legislation, energy and planning legislation and regulation (e.g. Poland).

Finally, we analysed the cost structures for supply, transmission and distribution in the context of DHC systems and networks. A literature review on cost assessments methods of the network provides the necessary background on the H & C supply, transmission and distribution as well as on different approaches (bottom-up, top-down) of assessing costs. In general, DHC systems are only viable if the combined cost of centralised heat supply and the transmission and distribution network is less than the cost of individual heat supply. For this to be the case, the heat demand must be sufficiently concentrated, either due to population density or because of a concentration of energy-intense demands. However, future enhanced building energy efficiency might harm the viability of DH by reducing the heat demand. The viability of DH networks can be evaluated using top-down or bottom-up approaches. Bottom-up methods or tools such as Thermos provide a detailed spatial DHC planning for specific locations, while tools like Hotmaps or the Pan-European Thermal Atlas have increasingly been used to generate inputs for top-down assessments. The heat/cold supply is another critical component of DHC systems that is frequently neglected in bottom-up and top-down approaches, although it might represent an important cost component. To enable integrated spatial and heat planning at different levels, we need new methods that properly assess the costs. The development of such methods requires the provision of additional data that is currently of limited availability or completely unavailable. There have been vast improvements regarding data accessibility in recent years, but especially the following areas exhibit significant deficits: a) existing heat networks (e.g. German District Heating Atlas) require currently available heat sources, including waste heat and existing power plants, with location, capacity and temporal profiles (e.g. Pan-European Thermal Atlas); b) potentials of new heat/cold supply sources, particularly renewable ones such as geothermal, solar thermal or indirect heat pumps; c) building-level information relating to demand characteristics, and geospatial data, including topology, road networks and tuning parameters. Thus, policy needs to support the development, provision. access and regular updating of reliable data sources for DHC systems and technologies.

European end users' costs for heating and cooling with DH and HP

In this part, we assessed from an end user's perspective the final cost of owning and operating district heating connections and heat pumps for space heating and cooling as well as domestic hot water. Drivers of costs of final heat consumption are heating and cooling demand (e.g. driven by floor space, energy efficiency of the building, climate zone), electricity price for HP or boilers, labour costs, and eventually costs of capital. In Belgium, Denmark and Germany, the cost for Air/Air HP is significantly higher compared to the other technologies, which can be explained by the electricity costs. Croatia, Hungary and Spain are the cheapest countries for HP operation, due to low heating demand, low labour costs and low electricity prices. In general, countries located in a mild climate zone display a lower heat demand, and thus costs. A key challenge of calculating heating and cooling costs is to obtain appropriate and technology-, location- and country-specific data.

Overview of the existing EEOS, recommendations for improved design and analysis of the role of district heating and heat pumps in EEOS

The energy efficiency obligation schemes (EEOS) are market-based instruments and should be applied to generate the final energy savings as recommended and mandated in Article 7 of the Energy Efficiency Directive (EED). The EEOS are applied in the majority of EU Member States, either as sole policy measure or accompanied by alternative measures. An EEOS is designed for optimal exploitation of cost-effective energy efficiency potentials. However, these economic potentials are often not aligned with overall climate mitigation targets, in particular regarding heating and cooling. A reason for this is that the most climate-friendly technologies are often more expensive than their alternatives. As a result, EEOS need to be adapted to better incentivise the measures that support the necessary decarbonisation of the heating sector and to give the technologies required for this a competitive edge. Our main recommendations are: a) Reducing the savings obligation for district heating (DH) operators to stimulate the diffusion of this technology. b) Upholding the eligibility of connecting buildings to the DH network as a measure within EEOS. c) Adjusting the accounting of savings from technology replacements in the EED guidance (i.e. crediting difference between the mandatory minimum standard of the previous heating and the newly installed unit). d) Include an obligation for strategic heat planning in the EED recast and making EEOS compliant with centralised local heat planning, in order to use economies of scale (designation of areas where specific individual heating options, e.g. heat pumps are ineligible within EEOS). e) Funding and incentivising of DH measures outside the scope of EEOS.

Résumé analytique

Méta-étude sur les déterminants des décisions en matière de chauffage et de refroidissement

Le premier objectif était de fournir une revue de la littérature des publications scientifiques examinant les facteurs de décision et de mise en œuvre des technologies qui contribuent à la décarbonisation du chauffage et du refroidissement (angl. : heating and cooling ou H&C) dans les secteurs résidentiel, industriel et public. Les facteurs de décision et de mise en œuvre des technologies H&C renouvelables ou efficaces énergétiquement diffèrent selon les acteurs en ce qui concerne leur importance, car ils sont influencés par différents facteurs, tels que des facteurs réglementaires, économiques, environnementaux, sociaux ou culturels. Pour obtenir une vue d'ensemble, une méta-analyse a été réalisée. La sélection de publications couvre les technologies H&C (énergies renouvelables ou efficacité énergétique) et se concentrent sur les pompes à chaleur (PAC) et les réseaux de chaleur et de froid (angl. : district heating and cooling ou DHC). En outre, les acteurs clés respectifs, leurs préférences et leurs perceptions, ainsi que les moteurs et les facteurs de décision concernant la production et la consommation de chaleur ont été des critères de sélection. Sur la base de ces critères, 130 publications ont été identifiées et analysées. Les résultats sont les suivants : les défis et les préoccupations perçus relatifs à l'utilisation des DHC sont plus complexes que pour la HP. En ce qui concerne l'utilisation des DHC, les principaux défis sont le pouvoir du marché (et la dépendance), la libre entrée sur le marché et le changement de fournisseur, les questions de concurrence ainsi que la transparence des systèmes de tarification et des services de facturation pour les services DHC. Concernant l'utilisation des HP, la connaissance des technologies semble être un problème clé. La technologie HP n'est pas aussi connue que les technologies de chauffage conventionnelles telles que les brûleurs à gaz. De plus, la majorité des études sur les HP se concentrent sur les facteurs de décision dans le secteur résidentiel et moins dans l'industrie ou les autorités publiques. En outre, le processus de décision individuel concernant une technologie H&C n'est pas uniquement motivé par la recherche du profit, mais plutôt par la recherche du bien-être. Celui-ci dépend à son tour d'un mélange individuel d'intérêts égocentriques (désirs) et altruistes, et est de nature monétaire et non monétaire. Au-delà des intérêts individuels, des facteurs contextuels liés à l'environnement des individus influencent les comportements de production et de consommation d'énergie. Les facteurs individuels et contextuels appartiennent à des niveaux différents : alors que le niveau macro comprend le cadre global (ordre social, règles et système économique), le niveau méso se rapporte au système énergétique, à la communauté ou aux personnes proches et à leur comportement ou culture énergétique. Ensemble, ces deux niveaux représentent les facteurs contextuels et externes qui ont un impact sur les individus au niveau micro. Le niveau micro comprend divers facteurs individuels qui déterminent les décisions : les valeurs, les dispositions personnelles et le bien-être, ainsi que la situation socio-économique-démographique liée à l'énergie, et des questions techniques concernant les caractéristiques des bâtiments.

Caractéristiques perçues des DH et des HP dans le secteur résidentiel ainsi que dans les secteurs industriel et public.

Un deuxième objectif était de mieux comprendre comment les acteurs des secteurs résidentiel, public et industriel perçoivent les pompes à chaleur (HP) et le chauffage urbain (DH). Des enquêtes et des entretiens ont été menés dans ces trois secteurs des États membres de l'UE sur des caractéristiques clés telles que la protection du climat, les risques liés aux prix, les coûts, la dépendance à l'égard du fournisseur, la fiabilité et les efforts déployés pour adopter certaines technologies H&C. L'analyse des bases de données révèle les résultats suivants.

Dans le secteur résidentiel, les combustibles fossiles étaient perçus comme l'option de chauffage la moins respectueuse du climat et la plus coûteuse et étaient associés à un risque élevé de dépendance vis-à-vis des fournisseurs d'énergie. En revanche, le solaire thermique était considéré comme la solution la moins chère et était perçu comme l'option de chauffage présentant le risque de prix le plus faible. En ce qui concerne le DH, en Lituanie, en Espagne, aux Pays-Bas et en République Tchèque, les caractéristiques perçues sont pour la plupart jugées inférieures à la moyenne, tandis qu'en Suède et au Danemark, la perception des toutes les caractéristiques est supérieure à la moyenne. En ce qui concerne les HP, l'effort pour adopter cette technologie est considéré comme élevé, car il s'agit d'une technologie moins connue. La note la plus basse est donnée aux Pays-Bas et la plus haute en Pologne. Les attitudes et les croyances telles que l'affinité avec les nouvelles technologies et la conscience environnementale sont en corrélation positive avec une perception positive des pompes à chaleur.

Dans les secteurs industriel et public, il est constaté que les combustibles fossiles sont perçus comme l'option de chauffage la moins respectueuse du climat, cependant, ils sont considérés comme très fiables et faciles à adopter par les secteurs industriel et public. En ce qui concerne les risques de prix, le solaire thermique présente les risques de prix les plus faibles et les combustibles fossiles les plus élevés. Les HP sont perçues comme une option de chauffage plus respectueuse du climat que les autres options, tandis que les réseaux de chaleur sont associés à une plus grande dépendance vis-à-vis d'un fournisseur d'énergie. Les facteurs qui influencent les décisions d'adoption diffèrent entre les secteurs industriel et public et le secteur résidentiel. Les secteurs industriel et public se concentrent principalement sur les questions économiques ou les coûts. Toutefois, les réglementations et les normes liées à l'énergie (niveau méso) ainsi que la pression de la société (facteur de niveau macro) sur l'entreprise, par exemple la pression du public pour des produits ou des normes écologiques, peuvent inciter à utiliser l'énergie durable.

Incitations monétaires et non monétaires de HP et DH

Un autre objectif de cette étude est de donner une vue d'ensemble des incitations à l'adoption des DH et des HP, qui peuvent contribuer de manière significative à la flexibilité et à la décarbonisation du système énergétique.

Dans un premier temps, il s'agit de procéder à une analyse documentaire afin d'évaluer les conditions-cadres (angl. : Framework Conditions, FC) pour les DH et les HP, en termes d'influence sur l'adoption de ces technologies. Les conditions-cadres suivantes sont prises en compte : a) la signalisation opérationnelle, qui fait référence à la nécessité pour les technologies présentant un potentiel de flexibilité, telles que les HP et les nouveaux concepts de DHC, de disposer de signaux du marché auxquels répondre. Ceci est très important à la lumière du couplage sectoriel ; b) le climat d'investissement, qui est essentiel pour l'adoption des technologies car les contraintes financières sont des obstacles courants ; c) la longueur et la facilité du processus d'autorisation, y compris les procédures relatives à l'octroi d'autorisation et de licence, qui peuvent constituer des obstacles aux projets de chauffage et refroidissement urbains et des pompes à chaleur ; d) les règles de propriété et d'accès, qui peuvent affecter l'adoption des DH et HP ; e) certains facteurs techniques, qui peuvent limiter le déploiement des technologies offrant de la flexibilité ; f) l'accès au réseau électrique physique ; g) l'environnement physique, car les technologies flexibles dépendent des sources d'énergie, dont le potentiel économique peut être limité par la géographie (par exemple, la distance entre la source et le puits), les caractéristiques de la demande (par exemple, la densité thermique) et les mesures politiques/réglementaires ; h) la rationalité limitée, qui fait référence à un manque de sensibilisation parmi les parties prenantes concernées, en raison de contraintes en matière de connaissances et d'expérience ; i) l'acceptation, qui fait référence à l'incertitude concernant les technologies, à la perception que les technologies DH et HP et la flexibilité ne représentent pas une activité commerciale essentielle et/ou à une préoccupation concernant l'ampleur des coûts d'opportunité.

Deuxièmement, sur la base de données de la CE sur les cas d'aides d'État, les plans nationaux intégrés en matière d'énergie et de climat (PNEC) et les plans nationaux de résilience et de relance (PNRR) des États membres, e type de mécanismes de soutien les plus utilisés pour les DHC et les HP a été évalué, aussi l'analyse faite a permis de déterminer si l'accent est mis sur l'efficacité ou la décarbonisation. La CE n'enquête que sur quelques cas d'aides d'État en faveur des infrastructures DHC, dont un effet de verrouillage ou une extension de centrales électriques à combustibles fossiles est attendu. En outre, l'analyse montre que davantage de pays (14 sur 16) visent l'augmentation de la part de la production d'énergie renouvelable plutôt que l'efficacité énergétique (11 sur 16). Les trois dispositifs de soutien les plus fréquents sont (i) le financement public et les mécanismes fiscaux, (ii) les tarifs et les primes, et (iii) les subventions. Lorsque les technologies de chauffage et de refroidissement sont prises en compte dans les PECN, l'accent est principalement mis sur les systèmes DH dans leur ensemble. Bien que les HP soient mentionnées dans tous les PECN, les évaluations de ces plans recommandent à tous les États membres d'indiquer les trajectoires montrant leur développement à l'avenir. L'examen des PNRR met en évidence la mesure dans laquelle les initiatives et les fonds de relance de COVID dans les PNRR soutiennent également les objectifs des PECN des pays, en particulier lorsque ceux-ci ciblent les technologies de chauffage et de refroidissement. Tous les pays examinés ont montré un certain degré de compatibilité entre leurs PNRR et leurs PECN, cependant la CE souligne que les pays ont eu tendance à se concentrer soit sur l'efficacité soit sur la décarbonisation.

Suit un aperçu de la planification stratégique municipale en matière de chaleur et de la planification spatiale intégrée de l'énergie en tant que moyen de soutenir l'adoption et l'acceptation des technologies thermiques. La planification de la chaleur, qu'il s'agisse d'une approche spécifique (comme au Danemark) ou d'une partie de la planification énergétique spatiale intégrée pour la chaleur (comme en Autriche), devrait être plus largement mise en œuvre, car elle s'est avérée être un outil efficace pour élaborer des mesures locales visant à décarboner le secteur de la chaleur. Pour être efficace, la planification municipale de la chaleur doit être mise en œuvre par les États membres d'une manière qui aligne ou intègre horizontalement les cadres réglementaires habituellement distincts pour la planification énergétique et l'aménagement du territoire. Cependant, il est également nécessaire d'intégrer les niveaux de gouvernance verticaux. L'incitation à la planification municipale de la chaleur dans la proposition de refonte du DEE est une occasion de soutenir une approche plus intégrée entre les cadres (par exemple, l'énergie, l'efficacité énergétique, le cadre d'aménagement du territoire), afin d'éviter l'inefficacité de la gouvernance de la chaleur dans des cadres réglementaires distincts et de ne pas s'aligner sur l'important aspect spatial ou d'aménagement du territoire de l'infrastructure thermique. Nous constatons que l'approche de gouvernance énergétique polycentrique de la planification de la chaleur et de la planification énergétique spatiale intégrée est bénéfique en parallèle avec la conception et la transformation des systèmes de chauffage. Une approche de gouvernance polycentrique est capable d'intégrer plusieurs niveaux, du local au national (et au-delà), tout en impliquant un plus grand nombre de parties prenantes dans le processus d'élaboration des politiques, y compris les municipalités et les citoyens. Les différentes structures constitutionnelles et de gouvernance de chaque juridiction doivent être prises en compte lors de l'examen de la manière de mettre en œuvre efficacement la planification de la chaleur, que ce soit individuellement ou dans le cadre de la planification énergétique spatiale. Même dans les États membres où la planification de la chaleur n'est pas encore mise en œuvre en tant que programme spécifique, la législation nationale offre des possibilités de mise en œuvre, par le biais de la législation et de la réglementation en matière d'énergie et de planification (par exemple, en Pologne).

Enfin, l'étude analyse les structures de coûts pour la fourniture, la transmission et la distribution dans le contexte des systèmes et réseaux DHC. Nous passons en revue la littérature sur les méthodes d'évaluation des coûts pour la distribution et la transmission DHC. À cette fin, nous présentons le contexte nécessaire à la fourniture, la transmission et la distribution de chaleur ou de froid ainsi que les différentes méthodes pour déterminer les caractéristiques techniques du système et ses coûts. Les approches descendantes et ascendantes sont discutées. En général, la viabilité des systèmes DHC n'est assurée que si le coût combiné de la fourniture centralisée de chaleur et des réseaux de transmission et de distribution est inférieur au coût de la fourniture individuelle de chaleur. Pour que cela soit le cas, la demande de chaleur doit être suffisamment concentrée, soit en raison de la densité de population, soit en raison d'une concentration de demandes à forte intensité énergétique. Cependant, les améliorations prévues de l'efficacité énergétique des bâtiments pourraient nuire à la viabilité du chauffage urbain en réduisant la demande de chaleur. La viabilité des réseaux de chauffage urbain peut être évaluée à l'aide d'approches descendantes ou ascendantes. Les méthodes ou outils ascendants, telles que Thermos, fournissent une planification spatiale détaillée du DH pour des lieux spécifiques, tandis que des outils tels que Hotmaps ou l'Atlas thermique paneuropéen sont de plus en plus utilisés pour générer des données pour les évaluations descendantes. La fourniture de chaleur est un autre composant critique des systèmes DHC qui est souvent négligé dans les approches ascendantes et descendantes, bien qu'il puisse représenter un élément de coût important. Pour permettre une planification intégrée de l'espace et de la chaleur à des niveaux différents, il faut établir des méthodes permettant d'évaluer correctement les coûts. Le développement de telles méthodes exige la fourniture de données supplémentaires qui sont actuellement d'une disponibilité limitée voire complètement indisponibles. L'accessibilité aux données a été considérablement améliorée ces dernières années, mais les domaines suivants présentent des lacunes importantes : a) les réseaux de chaleur existants (par exemple, l'Atlas allemand du chauffage urbain) nécessitent les sources de chaleur actuellement disponibles, y compris la chaleur résiduelle et les centrales électriques existantes, avec leur emplacement, leur capacité et leur profil temporel (par exemple, l'Atlas thermique paneuropéen) ; b) les potentiels des nouvelles sources de fourniture de chaleur et de froid, en particulier les sources renouvelables telles que la géothermie, le solaire thermique ou les pompes à chaleur indirectes, c) des informations sur les caractéristiques de la demande au niveau des bâtiments et des données géospatiales, notamment la topologie, les réseaux routiers et les paramètres de réglage.. Afin de permettre la mise en œuvre des recommandations, la politique doit soutenir le développement, la fourniture et la mise à jour régulière de sources de données fiables pour les systèmes et technologies DH.

Coûts des utilisateurs finaux européens pour le chauffage et le refroidissement avec DH et HP

Dans cette partie, l'étude évalue, du point de vue de l'utilisateur final, le coût final de possession et d'exploitation des connexions de chauffage urbain et des pompes à chaleur pour le chauffage et le refroidissement des locaux ainsi que pour l'eau chaude sanitaire. Les facteurs qui déterminent les coûts de la consommation finale de chaleur sont la demande de chauffage et de refroidissement (par exemple, en fonction de la surface au sol, de l'efficacité énergétique du bâtiment, de la zone climatique), le prix de l'électricité pour les pompes à chaleur ou les chaudières, les coûts de la main-d'œuvre et, éventuellement, les coûts du capital. En Belgique, au Danemark et en Allemagne, le coût des HP Air/Air est significativement plus élevé par rapport aux autres technologies, ce qui peut s'expliquer par le prix de l'électricité. La Croatie, la Hongrie et l'Espagne sont les pays les moins chers, en raison d'une faible demande de chauffage, de faibles coûts de main-d'œuvre et de faibles prix de l'électricité. En général, les pays situés dans une zone climatique douce affichent une demande de chaleur, et donc des coûts, plus faibles. L'un des principaux défis du calcul des coûts de chauffage et de refroidissement consiste à obtenir des données appropriées et spécifiques à la technologie, au lieu et au pays.

Aperçu des EEOS existants, recommandations pour améliorer la conception et analyse du rôle du chauffage urbain et des pompes à chaleur dans les EEOS.

Les systèmes d'obligation en matière d'efficacité énergétique (angl. : Energy Efficiency Obligation Schemes ou EEOS) sont des instruments basés sur le marché et devraient être appliqués pour générer les économies d'énergie finales comme recommandé et mandaté dans l'article 7 de la directive relative à l'efficacité énergétique (angl. : Energy Efficiency Directive ou EED). Les EEOS sont appliqués dans la majorité des États membres de l'UE, soit en tant que mesure politique unique, soit accompagnés de mesures alternatives. Un EEOS est conçu pour une exploitation optimale des potentiels rentables d'efficacité énergétique. Cependant, ces potentiels économiques ne sont souvent pas alignés sur les objectifs généraux d'atténuation du climat, en particulier en ce qui concerne le chauffage et le refroidissement. Cela s'explique notamment par le fait que les technologies les plus respectueuses du climat sont souvent plus coûteuses que leurs alternatives. Par conséquent, les EEOS doivent être adaptées pour mieux encourager les mesures qui soutiennent la décarbonisation nécessaire du secteur du chauffage et pour donner aux technologies requises un avantage concurrentiel. Les principales recommandations ressortant de l'étude sont les suivantes : a) réduire l'obligation d'économies pour les opérateurs de chauffage urbain (DH) afin de stimuler la diffusion de cette technologie. b) maintenir l'éligibilité du raccordement des bâtiments au réseau DH en tant que mesure dans le cadre des EEOS. c) ajuster la comptabilisation des économies résultant des remplacements de technologie dans le EED (c'est-à-dire créditer la différence entre la norme minimale obligatoire du chauffage précédent et l'unité nouvellement installée). d) inclure une obligation de planification stratégique de la chaleur dans la refonte de la EED et rendre l'EEOS conforme à la planification locale centralisée de la chaleur, afin d'utiliser les économies d'échelle (désignation des zones où les options de chauffage individuel spécifiques, par exemple les pompes à chaleur, ne sont pas éligibles dans l'EEOS). e) financement et incitation des mesures de DH en dehors du champ d'application de l'EEOS.

2 Introduction

The overarching goal of this study is to contribute to the decarbonisation of heating and cooling (H&C) through fostering the expansion of renewable energy (RET) and energy efficient (EET) heating and cooling technologies such as heat pumps (HP) and district heating and cooling (DHC) at the system level.

Figure 1 illustrates the context and links between the overarching objective of the project, the task objectives and the tasks: the tasks are represented by the outer grey boxes in Figure 1, the objectives of the tasks are depicted as text next to the grey boxes, and the overall objectives of this study are in the center of Figure 1. In a first step, we analyse critical elements and drivers that govern decisions of key actors on H&C technologies, including the perception or image of HP and DHC that different consumers in the residential, industrial and public sectors have. This is done by a meta-analysis. Second, to fill the gaps identified in the literature with respect to perceptions, we conduct a survey among households and interviews with representatives of the industrial and public sector. In a third step, a detailed analysis regarding the monetary and non-monetary incentives of EET and RET H&C technologies is conducted which includes also expert talks or interviews. Furthermore, we have a closer look at different cost components of DHC and HP. Finally, the potential of energy efficiency obligations schemes (EECSs) is analysed with respect to their tradable components to ensure an efficient and effective use of measures and policies, contributing to the decarbonisation of the H&C system.

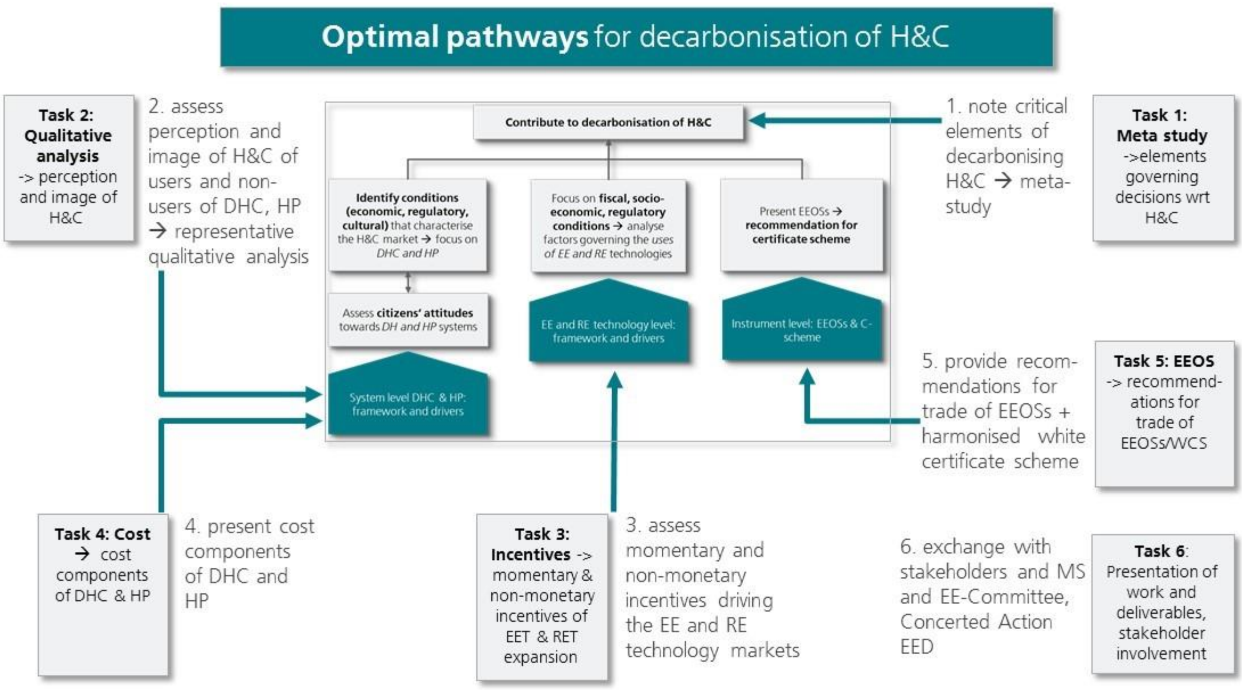

Figure 1: Objectives and tasks

This final report provides an outline of the results of each task. Detailed descriptions about the methodology or approaches and results are available for each task in the "Task Reports. These Task Reports encompasses all deliverables of task (1-5) and are attached to this document. The tasks are:

- Task 1: Deliverable 1: Meta-study on factors governing decisions in H&C
- Task 2: Deliverable 2: Perceived features of DH and HP in the residential as well as in the industrial and public sector
- Task 3: Deliverable 3: Monetary and non-monetary incentives of HP and DH

- Task 4: Deliverable 4: European end users' costs for heating and cooling with DH and HP
- Task 5: Deliverable 5: Overview of the existing EEOS, recommendations for improved design and analysis of the role of district heating and heat pumps in EEOS
- Task 6: Dissemination of findings

The following chapter presents for each of the tasks the main findings and results. Detailed information on each task is give by the Annex Deliverables

3 Results

3.1 Meta-study on factors governing decisions in H&C

The objective of Task 1 is to provide an overview of the elements that govern the decision-making and implementation of the decarbonisation of H&C in the residential, industrial and public sector. Decisions regarding renewable energy or energy efficiency H&C technologies are made by actors, who have different attitudes, perceptions and preferences, and are influenced by different drivers, such as regulatory, economic, environmental, social or cultural factors. Therefore, the aim is to collect all these aspects that govern the decisions on decarbonisation of H&C. To gain an overview, a meta-study was conducted. We primarily selected studies that discuss questions surrounding actors and their behaviour (perceptions, preferences), drivers and decision factors regarding energy behaviour (consumption and generation) and energy technologies with a focus on DHC and HP. We identified 130 studies.

According to the literature reviewed, perceived challenges and concerns regarding the further deployment of DHC are more complex than for HP. This is reflected by the issues discussed in the literature such as market power, free market entry and switching of suppliers, competition issues as well as appropriate and transparent pricing schemes and billing services for DHC services. In contrast, no study linked the use of HP to helplessness and dependency on energy suppliers. Concerning HP, understanding the technologies seems to be more of an issue. The majority of studies focuses on individuals' (residential sector) decision-making factors and less on companies or public authorities. Main findings are:

- Long-term commitment and planning security is key when deciding to implement DHC, but less crucial for the adoption of HP systems.
- Institutional frameworks ensuring clarity of and compliance with pricing rules, access to information, restriction of market power and transparency of markets are preconditions for DHC and are less important for HP adoption.
- Social and ecological (energy) values, attitudes, trust in institutions, culture and practices of peers, citizens, community members and customers are major and undisputed factors affecting ES decisions in all sectors and across all technologies.
- Local environment and conditions such as availability of local natural resources, building stock, financial capacities and socio-demographic aspects are preconditions for using certain H&C technologies.
- Energy literacy and technical and managerial expertise, are considered important drivers, especially for HP and RES-H&C technologies.
- In the industrial sector the increasing awareness and preferences of consumers for socially fair and environmentally clean production has added new product characteristics,
- The decision process of individuals is not triggered by profit orientation alone but by striving for well-being that is contingent on self-centred interests (desires) and altruistic aspects, on both monetary and non-monetary effects. The factors are grouped into contextual factors at the macro and meso level, and individual factors at the micro level. While the macro level comprises the overarching framework (social order, rules and economic system) under which actions take place, the meso level relates to the energy system and the community or peers with respect to their energy behaviour or culture. Both levels together represent the contextual, external factors that have an influence on individuals at the micro level. The micro level comprises different factors governing decisions: values, personal disposition and well-being as well as the energy-related, socio-economic-demographic situation of individuals, and building features.

3.2 Perceived features of DH and HP in the residential as well as in the industrial and public sector

Task 2 assesses the perception of renewable and energy efficient heating and cooling (H&C) technologies, with a focus on district heating (DH) and heat pumps (HP). The task, thereby, covers the residential sector on the one hand and on the other hand the industrial and public sectors. Moreover, the study outlines differences and similarities in perceptions between the sectors.

For the **residential sector** (Task 2.1), an online survey was conducted. The survey was open from June to August 2022, i.e., during the Russian-Ukrainian war. In total 7.857 respondents from 11 different countries participated, which is a representative sample. Key results for the residential sector are:

- Fossil fuels are perceived as the least climate friendly heating option, the most costly option, and connected with a high risk of dependency on fossil fuel suppliers. This assessment reflects the impacts of the Russian-Ukrainian war on the global energy market. In contrast, solar thermal is rated as the cheapest solution and connected with the lowest price risk.
- Regarding the two focus technologies, DH and HP, the perceived features and characteristics across countries differ, but the overall perception of DH and HP in the surveyed countries is positive. In Lithuania, Spain, the Netherlands and the Czech Republic, some perceived features of DH are below average, while in Sweden and Denmark the general perception is above average. Concerning HP, the overall image is in the lower range in the Netherlands and in the upper range in Poland.
- Regarding drivers of the perception of DH and HP, attitudes and beliefs such as affinity to technologies and environmental awareness predict the perception of heat pumps (better than socio-demographic variables). In addition, features like the perceived climate-friendliness of the technology, its cost and reliability present essential drivers of the image of DH and HP.
- Our results highlight that information and financial regulations can help to enhance the diffusion and improve the perception of DH and HP in the residential sector.

For the **industrial and public sectors** (Task 2.2) a mixed method approach, including a short online survey, interviews and a case study analysis was applied. The analysis was done between January 2021 to February 2022, i.e. before the Russian-Ukrainian war. The resulting sample includes about 140 respondents and is, thus, not representative. Key findings for the industrial and public sectors are:

- Fossil fuels are perceived as the least climate friendly heating option, however, they are seen as very reliable and easy to adopt by the industrial and public sectors. Further, the industrial and public sectors consider the costs of the different heating options as rather similarly high. Regarding price risks, solar thermal shows the lowest price risks, and fossil fuels the highest.
- The perception of the two focus technologies is overall positive. HP are perceived as more climate friendly, while DH is connected with a higher dependency on one energy supplier.
- Drivers of decisions in the industrial and public sectors are different from those in the residential sector. The primary focus of the industrial and public sectors is economic issues or costs. However, energy-related regulations and norms as well as factors on the company level can drive the use of sustainable energy supply and usage (e.g. public pressure for green products or green standards)

Finally, for both sectors, regulations and financial support can promote the use of renewables and energy efficiency in the H&C sector. The analysis shows that information is a key element that could push sustainable energy use at different levels and in different sectors (e.g. information campaigns on environmental awareness, advice of energy experts).

3.3 Monetary and non-monetary incentives of HP and DH

The objective of Task 3 is to provide an overview of incentives for the uptake of District Heating and Cooling / District Heating (DHC/DH) and Heat Pumps (HP), which can make a significant contribution towards energy system flexibility and decarbonisation. The geographic scope of the analysis is the former EU28 members (EU27 + UK), Norway, Switzerland and Iceland.

Task 3.1 involves a literature review to assess Framework Conditions (FC) for DHC and HP, in terms of their influence on the uptake of these technologies. These FC are based on work by Sneum (2021). The FC are mapped across a literature set and a selection of EU and non-EU countries. **Task 3.2** draws on the ECs database of State Aid cases, the National Energy and Climate Plans (NECPs) and MS National Resilience and Recovery Plans (NRRPs) to assess the type of support mechanisms most used for DHC and HP and whether the focus is on efficiency or decarbonisation. **Task 3.3** involves an overview of strategic municipal heat planning and integrated spatial energy planning as a means of supporting the uptake and acceptance of heat technologies. **Task 3.4** has the objective of analyzing the cost structures for supply, transmission and distribution in the context of DHC systems and networks.

Task 3.1: Framework conditions (FC) for DHC and HP

Operational signalling (FC1) refers to the need for technologies with flexibility potential, such as HP and newer DHC concepts (particularly 4th and 5th generation) to have market signals to respond to. Certain barriers can weaken or remove DHC and electricity market signals for flexible technologies:

- Operational taxes should be used in a manner which does not affect the competitiveness of flexible technologies, such as DHC and HP.
- Flexible tariffs, such as time of use tariff schemes can provide greater flexibility, as the operation of technologies such as Power to Heat (PtH) can be managed around peak prices.
- Operational standards and procedures should avoid adding transaction costs for market access to smaller participants in the DHC and HP sector, for example through the removal of overly restrictive technical conditions for certain technologies.
- The natural monopoly of DHC systems presents particular challenges but flexible pricing is seen as a way of managing the tension between the aim of minimizing costs for consumers, without negatively affecting the income of DHC companies.

The investment climate (FC2) is critical to the uptake of DHC and HP technologies as financial constraints are common barriers:

- As investment subsidy might reduce the competitiveness of some technologies if they either support competing technologies or are not market-based, access to capital can present a better way to address investment issues.
- Lack of capital availability can be a barrier to implementing efficiency measures, including in relation to DHC and HP. Recommendations include lower interest rates and long-term loans. The characteristics of the building stock are also relevant to capital availability, both for renovation and/or new building stock.
- The rate of return can affect investors' choice of technology and discount rates can vary between countries depending on: (i) normative and positive considerations of discounting (ii) maturity of the project, and (iii) risk aversion.
- One way to consider investment policy is to break down related policy recommendations according to the existing share of renewable heat within a country to determine the level and nature of policy intervention required. This allows for a more context-specific approach to investment policy.

The length and ease of the **permitting process (FC3),** including procedures in relation to consenting and licensing, can pose barriers to DHC and HP projects:

- Permitting processes should be streamlined. Planning procedure should allow energy supply to be aligned with energy efficiency measures (demand). Enabling providers of DHC and HP technologies through smart meters, for example, can provide the information required for such alignment.

Ownership and access rules (FC4) can affect the uptake of DHC and HP:

- Some vertical integration is considered necessary for all but the largest DHC businesses, because the separation of different DHC business functions (e.g. sales, production) can entail ongoing transactional costs between those functions. Solutions include reforming regulation to enable deployment of special categories of generators and bespoke conditions aimed at certain types/sizes of organisations.
- The natural monopoly characteristics of DHC networks mean that third party access (TPA) regulation can be a means of maintaining competition in DHC networks. However, it is necessary to consider the networks' specific characteristics in terms of technical characteristics and economic viability. TPA may offer good options for smaller waste heat production and renewable energy sources to gain access to the network. An important factor can be the type of ownership structure in place for DHC companies in different markets, in terms of public/municipal or private ownership for example. A variety of TPA models should therefore be considered.

Certain **technical factors (FC5)** can limit the deployment of technologies which provide flexibility:

- Investments can be large, especially for renewable DHC, flexible thermal power plants, HPs and waste heat extraction. Support is therefore required for increased innovation, for example in the form of subsidies or tax rebates.
- The availability of skilled staff can inhibit supply chain maturity in terms of growth and recruitment. Policies to support supply chain growth should therefore be considered, such as enabling recruitment in relevant industries and support for enhancing staff competencies.
- In relation to high temperature systems, policies for the modernisation of networks, particularly where older systems of DHC are due to be decommissioned, should focus on the conversion to lower temperature systems.

Electricity grid access (FC6) addresses access to the physical electricity grid:

- High grid connection costs can be managed by improving non-discriminatory interconnections, either by socialising the cost of electricity lines, or interruptible grid connection agreements. In the case of a flexible system-serving operation, the connection cost of HP could be reduced to acknowledge its potential contribution to local peak demand reduction and therefore reduced grid costs.
- Standardised interconnection agreements can incentivize expedient connection and clarify applicable regulation and codes relating to bi-directional flows of electricity. Grid codes could alternatively mandate minimum criteria for connected technologies.

Physical environment (FC7): flexible technologies depend on energy sources, whose economic potential may be limited by geography (e.g. distance from source to sink), demand characteristics (e.g. heat density) and policy/regulatory measures:

- Region-specific constraints on the availability of heat sources must be considered, as they determine the available heating options, which can increase costs.
- Efficient technologies should be integrated into renovation projects and new infrastructure developments. Spatial planning and zoning to integrate DHC priority zones can strongly support the economic effectiveness of DHC grids.

Bounded rationality (FC8) refers to a lack of awareness amongst relevant stakeholders, due to constraints in knowledge and experience. **Acceptance (FC9)** refers to uncertainty about technologies, a perception that DHC and HP technologies and flexibility do not represent a core business activity and/or a concern about the extent of opportunity costs:

- Future policies should reduce consumer uncertainty by targeting information asymmetry and imperfect information, and improving access to metering technology. Communication programmes, including normative lifestyle campaigns, should focus on comfort and indoor climate as key elements in a household's valuation of benefits of investments in heating and cooling technology.
- Barriers to uptake also derive from the knowledge and acceptance of different levels of authority, governance bodies, plant staff who may have limited authority to implement new technologies and/or incumbent utilities who can be resistant to new entrants to the DHC sector and also to HP. Solutions include disseminating information on national and local heat systems and pilot projects for information and training.

Links between FCs and proposed further research: **Sector coupling** is a particularly strong thread between the FCs, which is a key means of improving the uptake and deployment of DHC and HP. Countries with rapid growth in renewables should place great priority on sector coupling, including the use of HP for demand response. Sector coupling can make market signals more effective but market prices must be consistent across the relevant sectors. **Little consideration is given to gender aspects** in heating and cooling policy in the reviewed literature. Gender as a factor can impact consumer willingness to adopt and pay for heating and cooling technologies. Policy indicators should address the extent of gendered participation in energy transition in addition to energy poverty, as a result of the gendered nature of decision-making on energy infrastructure.

Task 3.2: Overview of State Aid

The vast majority of cases relating to 'district' and 'heat' in the ECs database of state aid cases were not investigated further by the Commission. The cases in which further investigation was initiated suggest that the EC will object to state aid for renewal or upgrade of DHC infrastructure, where such activities would lead to a lock-in or extended lease of life for existing fossil fuel-based power plants.

The review of NECPs shows that more countries (14 out of 16) target the increase in share of renewable energy production than energy efficiency (11 out of 16). The three most frequent support schemes are (i) public funding and tax mechanisms, (ii) tariffs and premiums, and (iii) grants. Soft loans and guarantees were least frequent. Where heating and cooling technologies are considered in the NECP, the focus is primarily on DHC systems overall. Although HP are mentioned in all NECPs, assessments of the heating and cooling chapters of the NECP recommend that all MS show trajectories of how HP will develop in future and provide more detailed analysis of how to increase the use of HP.

The Commission's analyses of a set of NRRPs have been examined to show where the EC has commented on not only the compatibility between the NECP and NRRP but also to highlight specific references to energy efficiency in buildings and/or heating. The review highlights the extent that COVID recovery initiatives and funds in the NRRP also support countries' NECP objectives in particular where these target heating and cooling technology. All reviewed countries showed a degree of compatibility between their NRRPs and NECPs, however the EC highlights that countries tended to focus either on efficiency or decarbonisation. Where both decarbonisation and efficiency measures were prioritised, this leads in certain instances to issues with the extent of funding required to fulfil those targets.

Task 3.3: Heat and Spatial Energy Planning with and overview of MS NECP provisions on heat

Step 1 of Task 3.3 involves an overview of heat planning and integrated spatial energy planning as a means of supporting the uptake and acceptance of heat technologies. It examines the background and relevance of the concept of heat planning and integrated energy spatial planning as governance tools for the uptake and acceptance of heat infrastructure. Step 1 also provides the legislative context to the Member State (MS) requirement to report on heating and cooling plans. As this is a requirement within each MS's National Energy and Climate Plans (NECP) Step 1 therefore examines the treatment of heat planning and energy spatial planning in the 27 MS NECPs. In order to show the role of heat planning and spatial energy planning in heat infrastructure uptake, the task involved examining the link between the concept of heat planning, which has proven successful for the uptake and integration of DH in countries such as Denmark over the past four decades. With the proposals for a recast Energy Efficiency Directive (the proposed recast EED), the concept of municipal heat planning is now also embedded within the draft legislation. This provided the impetus for examining the status of heat planning and spatial energy planning for heat in selected EU MS in addition to Scotland (UK) and Switzerland. The case studies are preceded by a general overview of MS approaches to heat in the National Energy and Climate Plans (NECP). Step 2 provides detailed case studies from 6 jurisdictions in relation to the status of heat planning and spatial energy planning for heat in those countries. Four of the countries are MSs (Denmark, Germany, Austria and Poland), and two are non-EU countries (Scotland UK and Switzerland), which have been examined for comparison and due to their constitutional governance structures that can helpfully inform EU policy. The case studies in Step 2 serve to illustrate where heat planning and spacial energy planning for heat have been successful (e.g. Denmark), are increasingly implemented at different regional and national levels (Austra, Germany, Scotland and Switzerland) and where there is no formal heat planning but there is some potential in the regulatory framework (Poland).

Heat planning and spatial energy planning to strengthen infrastructure uptake

Spatial energy planning and heat planning are considered important tools for the energy transition. However, heat planning is still at the very beginning of broader implementation in Europe, with only some countries, notably Denmark, leading the way. Heat planning is a means of enabling municipalities to plan and decarbonise their heat supply within a defined geographic area. It takes into account the local characteristics and potential of heat supply. In order to develop heating and cooling infrastructure at a local level, heat planning has been recognised as an effective way to implement decarbonisation in a cost-effective way that is also appropriate to the local area. Heat planning is therefore a key tool for implementing heat transition whilst fostering local solutions by incorporating local participation of municipalities and permitted local citizens. The engagement of relevant stakeholders is considered an essential way of ensuring the long-term success of heat planning and a spatial approach has a key role in infrastructure transition, which is particularly relevant in the context of heat system transition and uptake or acceptance of heat technologies. Heat planning is a form of spatial planning approached at a very localised level with local participation. Municipal heat planning could go towards addressing that spatial dimension for the uptake of heat infrastructure. However, a stronger link needs to exist between goals set out in the NECPs and regional spatial planning laws or regulations due to the importance of land use for renewable energy and heat infrastructure integration. This entails a streamlining of provincial and municipal spatial planning regulations, especially in terms of mandatory goals to support the NECP and national climate neutrality targets. This approach should be extended to heat planning and energy spatial planning for heat and place them between the various regional approaches and goals of the NECP. As spatial energy planning for heat involves municipalities and can affect citizens, the acceptance of infrastructure investments for the energy transition is likely to be more acceptable through the use of spatial planning approaches. The impact of public acceptance of additional energy infrastructure has a spatial dimension. Spatial planning tools should support municipalities and local stakeholders with implementing national renewable energy and efficiency goals in a way that is suitable for the local scale.

Overview of NECPs

In light of the provisions for heat planning at municipal level under Article 23 of the proposed recast EED, the extent to which MS have integrated municipal heat planning as a form of energy spatial planning in the NECPs was reviewed. MS must continue, as part of their integrated NECPs, to notify the Commission of their comprehensive heating and cooling plans. The NECPs of the 27 MSs were reviewed for their coverage of or reference to (i) (municipal) heat planning, (ii) spatial planning in relation to energy, (iii) spatial energy planning in relation to heat, (iv) a national strategy or programme for heat (planned or implemented, including as part of a national energy strategy, and (v) reference to the requirements of Article 14 the EED 2012 currently in force. The NECP review revealed that none of the MS referred expressly to municipal heat planning as a term. Several countries do specifically link spatial energy planning to heat. Spatial energy planning is a broader term that can include not just heat but all spatial planning aspects of the energy value chain. These countries are Austria, Denmark, France, Luxembourg, Netherlands, Poland and Slovenia. Several countries indicated that they have implemented or are planning a national strategy or programme for heat. These countries are Cyprus, the Czech Republic, Germany, Hungary, Ireland, Lithuania and Slovenia. Finally, most MSs refer to some aspect of the comprehensive assessment required under Article 14 EED 2012, such as heat mapping or assessing the potential of heat demand or more general heat studies. However, there is not much focus on the local/municipal level as now contained in the proposed recast EED. The review of the NECP revealed that in most NECPs, apart from Austria, Denmark, France, Luxembourg, the Netherlands, Poland and Slovenia, spatial planning is mainly referred to in the context of maritime spatial planning and transport infrastructure but not in relation to heat or energy more broadly. This represents an opportunity to highlight and encourage the use of spatial energy planning more specifically in relation to heat, due to its use of many of the tools of a heat planning approach, including heat mapping and zoning and a spatial planning approach from a regulatory perspective.

Step 2 of Task 3.3 provides case studies of 6 European jurisdictions (4 EU + 2 Non-EU). The countries examined were Austria, Denmark, Germany, Switzerland, Poland and Scotland (UK).

To be effective, spatial planning requires governance powers across sectors and levels. Those countries which have sought to align their energy planning and spatial planning approaches through integrated spatial energy planning in addition to alignment between different governance levels are showing more progress with heat planning. This is particularly the case for Denmark, a leader in heat planning approach and Austria, which has integrated heat planning into its spatial energy planning. The case studies show that spatial energy planning initiatives relating to heat and heat planning benefit most from a combined top-down and bottom-up governance framework (as shown in the sections on Denmark but also seen more recently in Austria). Further discussion is then set out in Section 2.5. A combined top-down and bottom-up approach has contributed to broad acceptance and uptake of heat technologies, especially DH systems in Denmark. However, it is important to understand that where integrated spatial energy planning for heat or heat planning are being implemented, these can originate from different governance levels, depending on the governance framework of the jurisdiction. In Germany and Austria, the powers for spatial energy planning and heat planning reside with the regions or states. In Denmark, although national legislation and policy has empowered municipalities to take on responsibility and autonomy in relation to heat planning activities, these powers originate from the national level. The key to the success of heat planning in Denmark is the local autonomy coupled with the strong support from top-down policies and government decisions issued over decades and regularly strengthened through legislation and policies.

The other jurisdictions examined here, such as Germany, Austria and Switzerland have implemented heat planning and spatial energy planning for heat more recently. Although Austria and Germany have initiated heat planning and spatial energy planning at a regional level due to the framework of competencies for planning activities relating to heat in those jurisdictions, Austria has made more progress in aligning national heat strategy with regional integrated spatial energy planning approaches by creating a joint mandate between the national level and the regions in relation to transitioning towards sustainable heat provision. In both Austria and Germany, although the regional approaches are very promising, they can lead to an uneven implementation across the country and continued difficulty with aligning planning approaches for heat between regional and national levels. As in Germany and Austria, energy planning, in relation to heat, is conducted at the level of the Swiss regions using regional laws. Similarly to Austria and

Germany, there has therefore not been a uniform approach to energy and heat planning across Switzerland. Unlike Germany, although some Swiss regions take a lead on a spatial approach to heat as part of their energy spatial planning, it is not a dedicated heat planning approach. Apart from the obligation to align with national energy policy and strategy there is also not a top-down governance structure aligning with the bottom-up approach and responsibility of some of the regions as there is in Denmark and to some extent in Austria. In Switzerland as in Denmark and to some extent in Austria, a broad variety of stakeholders participate in this energy planning exercise, which includes spatial planning consultants, municipal council departments, such as urban planning and energy providers. Similar to Denmark, these actors are obliged to participate in energy planning, which can achieve broader acceptance of the proposed plans.

Scotland has similarities with Denmark in that strong national legislative and policy signals are being provided in relation to heat infrastructure. The approach in Scotland to national planning, especially relating to energy including heat, is considered to be distinctive and pioneering in the UK context, as it links national infrastructure priorities with the spatial energy planning system from the very beginning of a project through National Planning Frameworks. Scotland shows a particular strength in seeking to align its energy and spatial energy planning both at national (Scottish) level and at local level through the Scottish Planning Policy. As in Denmark, this combines a top-down and bottom-up approach in enabling cities or municipalities to take ownership of their spatial energy planning in relation to heat. It should be noted though that unlike Denmark, Scotland is a nation within the overall constitutional framework of the United Kingdom with certain devolved powers relating to energy infrastructure planning. Heat planning is not yet more developed in Poland, however there are some promising initiatives, for example Heat Roadmaps Europe has conducted a study for Poland primarily in relation to heat mapping, which can be a useful tool for initiating wider heat planning measures. Poland has also identified local authorities and local energy planning as a key role in the implementation of national policy for DH. There are some promising legislative tools in place, which might be used to support the wider implementation of heat planning.

Task 3.3 makes the following recommendations:

- Heat planning, whether as a dedicated approach (as in Denmark) or as part of integrated energy spatial planning for heat (as in Austria) should be more widely implemented, because it has proven to be an effective tool to develop measures locally to decarbonise the heat sector. Further importance is added to a municipal heat planning approach in light of the new proposed provisions for municipal level heat planning in the recast EED. This provides a framework for improving the uptake of heat infrastructure in a way that is appropriate to each local context. This is particularly facilitated by a simultaneous top-down and bottom-up approach to heat governance.
- To be effective, the municipal level heat planning must be implemented by MS in a manner that horizontally aligns or integrates the usually separate regulatory frameworks for energy planning and spatial planning, as has been demonstrated in Austria. However, it is also necessary to integrate vertical governance levels as demonstrated in Denmark. Heat planning as part of a spatial planning approach can link the local, regional and national levels but requires to be made effective via the appropriate cross sectoral governance mechanisms. A key issue is that heat can be governed in separate regulatory frameworks, either energy or energy efficiency frameworks and not in planning frameworks. The push for municipal heat planning in the proposed recast of the EED is an opportunity to support a more integrated approach between these frameworks, thereby providing a better overall system perspective to avoid the inefficiency of governing heat in separate regulatory frameworks and not aligning with the important spatial or land use aspect of heat infrastructure.
- This report supports the position that polycentric energy governance approach to heat planning and integrated spatial energy planning is beneficial in parallel with the design and transformation of heating systems. A polycentric governance approach is able to integrate multiple levels from the local to the national (and beyond), whilst involving a wider range of stakeholders in the policymaking process,

including municipalities and citizens. This is why Denmark can be considered to provide a best practice example for successful heat planning for heat transition. However, that conclusion is caveated by the observation in other case studies, that the governance or constitutional structure of a state matters for the efficacy of implementing a polycentric approach to heat planning and integrated spatial energy planning, as it will not always originate from a national scale (as in Denmark). The enabling framework may emanate from a more regional level (as in Austria or Germany).

- The differing constitutional and governance structures in each jurisdiction must be taken into account when considering how to effectively implement heat planning, whether individually or as part of spatial energy planning. It is necessary to align the approach to heat planning with governmental structure of the jurisdiction in question with particular focus on where the powers to develop and implement heat planning and energy strategy emanate from, i.e. at national or regional level. The constitutional structure is therefore important, whether as a federal structure (Germany, Austria, Switzerland) as opposed to powers emanating from the national government (Denmark) or even as part of a devolved system as in Scotland.
- Conceptualising heat planning as part of an energy spatial planning framework (e.g. Austria, Scotland and Switzerland) can support a whole systems approach that integrates the local level with decarbonisation and emissions targets at national and international levels.
- Even in MS where heat planning is not yet implemented as a dedicated programme, there are windows of opportunity via national legislation for such implementation, via energy and planning legislation and regulation (e.g. Poland), however these must be effectively and consistently enforced. They should also be aligned with each other to avoid gaps in competencies for implementation.

Task 3.4: Cost Structures for supply, transmission and distribution of DHC

Task 3.4 has the objective of analyzing the cost structures for supply, transmission and distribution in the context of District Heating and Cooling (DHC) systems and networks. This section therefore reviews the literature on cost assessment methods for DHC distribution and transmission. To this end, it presents the necessary background on the supply, transmission and distribution of heat or cold as well as different methods to determine the technical characteristics of the system and its costs. Top-down and bottom-up approaches are discussed and the development of a meta-level approach that combines the strengths of both is proposed. Furthermore, the available data on a European level is reported and a case study applying such an assessment method to the whole of Germany is presented.

Task 3.4 has the following high-level conclusions:

- For district cooling, the supply can come either from heat or from electricity whereas district heating has a much larger array of options. While CHP based on fossil fuels or bioenergy dominates the current fuel mix, alternatives such as geothermal, solar thermal or heat pumps allow for a cleaner heat supply. The generated heat is then carried to the site of demand, first through large transmission pipes that use higher pressures/temperatures to reduce losses and then through distribution grids to the destination, which have lower costs at the expense of higher losses.
- The viability of DHC systems is only ensured if the combined cost of centralized heat supply and the transmission and distribution networks together is less than the cost of individual heat supply. For this to be the case, the heat demand must be sufficiently concentrated, either due to population density or because of a concentration of energy-intense demands. Indeed, dense urban areas in Europe, which constitute less than 1% of the total land areas but nearly half of all heat demand, are ideal locations for the development of DH. However, predicted improvements in the building energy efficiency might harm the viability of DH by reducing the heat demand.
- The viability of DH networks can be evaluated using top-down or bottom-up approaches. Bottom-up methods such as Thermos provide a detailed spatial planning of DHC for specific locations while tools like Hotmaps or the Pan-European Thermal Atlas have increasingly been used to generate inputs for

top-down assessments. The state-of-the-art top-down approaches estimate the distribution capital costs using the method developed by Persson & Werner (2011). This approach re-quires information on the heat density, i.e. the heat demand per unit area, and on the plot ratio, i.e. the ratio of building area to land area, as well as the tuning of input parameters to the local con-text. The distribution capital cost only reflects a part of the total network cost which in turn does not constitute the total cost of the DH system.
- The heat/cold supply is another critical component of DHC systems that is frequently neglected from bottom-up and top-down approaches. This can be justified if excess heat is exploited but DHC systems might even be viable with a completely new source of supply, in which case this represents an important cost component. Supply technologies can be characterized according to their investment and operational costs as well as the operational hours into baseloads and peaks. These cost components can be combined to cost functions, which in turn dictate the areas of operation of these plants in terms of capacity and full load hours for a given application.

Task 3.4 makes the following recommendations:

- To enable integrated spatial and heat planning at national, but also regional and local levels, the development of tools and methods at the so-called meta-level is recommended. Such approaches combine the strengths of top-down methods, which have a broad coverage and are easily transferable but not spatially explicit, and bottom-up methods, which are highly accurate but require detailed and frequently difficult-to-obtain data. Furthermore, they consider not only the DHC network but also the generation of heat or cold, either excess from existing plants or new supply. Thus, such methods can achieve much higher accuracy with moderate data requirements.
- The development of such methods requires the provision additional data that is currently of limited availability or completely unavailable. There have been vast improvements in recent years but the following areas in particular exhibit significant deficits:
  - Existing heat networks (e.g. German District Heating Atlas)
  - Currently available heat sources, including waste heat and existing power plants, with location, capacity and temporal profiles (e.g. Pan-European Thermal Atlas)
  - The potential of new heat/cold supply sources, particularly renewable ones such as geothermal, solar thermal or indirectly heat pumps, according to their economic viability and technical characteristics
  - Building-level information relating to demand characteristics
  - Geospatial data, including topology, road networks and tuning parameters
- In order to enable the above two recommendations, policy needs to support the development, provision and regular updating of reliable data sources for DHC systems and technologies. Some innovative and useful sources have been highlighted in this report, but there is still a need to invest resources into ensuring widely available, open data is available for DHC systems, especially but not only in the above areas. Whilst the focus has been on heating systems in this report, DHC systems are likely to increase in importance in the future in the context of energy system integration, increased urbanisation and climate change resulting in greater cooling demands.

3.4 European end users' costs for H&C with DH and HP

The focus of Task 4 is on the evaluation of the final cost for owning and operating district heating (DH) connections and heat pumps (HPs) for preparing space heating and space cooling as well as domestic hot water (DHW) from an end user's perspective. This analysis was conducted for different typical residential consumers in the individual Member States of EU27, UK, Norway, Switzerland, and Iceland.

Due to the fact, that not all the necessary data is available for all countries, clusters of similar countries were selected to fill in missing data (North, West, South, Central and East). Further on, since the cost for heating and cooling is influenced by the characteristics of the building and the behaviour of the consumer (end user), "typical customers" have been developed for each cluster as well as an "European typical customer". Each typical customer is described by seven properties (building density, dwelling type, construction period, renovation status, household size and tenure status). The methodology in principle considers following technologies and technology combinations for providing space heating, domestic hot water (DHW) and space cooling:

Main heat supply technology: **Heat pump (HP)**			Main heat supply technology: **District heating (DH)**		
Heating	Domestic hot water (DHW)	Cooling	Heating	Domestic hot water (DHW)	Cooling
Air/Air **Air/Water** **Ground/ Water**			**Direct substation** **Indirect substation**		**Air/Air Heat pump**

Here,

- Air/Air HPs can be used for heating and cooling, but they cannot be used to supply DHW. In turn, an electric boiler for the supply with DHW is considered.
- Ground/Water HPs can be used for free cooling by circulating the fluid through the collectors.
- For DH, cooling is always produced using Air/Air HPs, since district cooling is normally not available to end users. Also, in some cities, DH is turned off during summer times. In turn, an optional electric boiler for the supply with DHW can be considered.

Within this task, the **annualised total cost of ownership** is considered as the main indicator for estimating the end users' costs for H&C services (excluding recycling and subsidies), since it allows the fairest comparison between the different technologies. It considers the total annualised capex and the total opex together with the value added tax. Possible subsidies are not included in the investigation, since a country-specific investigation was beyond the resources of the underlying project.

For HPs, DH substations and electric boilers, the **total annualised capex** is based on the cost of the equipment and the installation costs. For DH, the costs for connecting the building to the DH network are included. Those costs depend on the installed capacity, that is calculated based on the heating and/or cooling load of the individual buildings. In all cases, the lifetime of the device, the country-specific interest rate as well as a labour factor is considered.

The **total opex** consist of the fixed operation and maintenance expenses and the opex of the HP, DH substation, or electric boiler. The latter depends mainly on the heating and / or cooling demand as well as the demand for domestic hot water. Further on, the HP efficiency is taken into account as well as the country-specific electricity and DH tariff.

The required data for the calculations is gathered from various literature sources, including Eurostat, the TABULA/ Episcope building data, the Hotmaps Building Stock Analysis; the Database Energinet, EHPA statistics and data, Sven Werner's European district heating price series, District heating and cooling – country-by-country survey and others. Regarding data availability, countries that are not part of the EU (Norway, Iceland, Switzerland and the UK) have the least data availability, whereby the UK has the best availability out of the four because of their recent exit from the EU. For a validation of the methodology and data, the results and assumptions of the calculations are compared with those of established online heating cost calculators. As one of the key results, an *Excel sheet for calculating typical cost* is attached to this report and is referenced since important data and references are included.

The following results can be summarised:

Comparison of the main influencing factors

- The heating and cooling demand is one of the main influencing factors on the yearly energy costs. Overall, the heating demand decreases the later the building was constructed. In some countries, the demand of the construction years 1945-1969 are lower than the demand of buildings built before 1945. The northern countries have the highest heating demands in general. Even considering the low insulation standards, the southern countries still have the lowest heating demand, due to the warmer climate. On the contrary, the south has the highest cooling demand, followed by the eastern countries due to the wide spectrum of countries included in the cluster.
- The demand for domestic hot water not only depends on the number of people living in the building but also on the country of the consumers. There are large differences in the different European countries. With 1.95 MWh/a Denmark has the highest DHW demand per person, and Lithuania has the lowest with 0.55 MWh/a.
- The electricity price has an influence on the energy cost of the HP or boiler. The highest electricity prices are in Germany with 0.30 €/kWh followed by Denmark and Belgium. In general, the central and southern countries have the highest prices, while the electricity cost in the east and north are the lowest. The prices in Bulgaria are only one third of the ones in Germany.
- The labour cost has also a wider variation. As well as the electricity price, the labour cost is lower in the eastern countries. The highest costs are in the centre and the north of Europe, with Switzerland having over eight times higher costs than Bulgaria.
- The floor space per person influences the heating and cooling demand of a building as well as the size of the installed H&C equipment. Generally, the floor space per person in a single-family house (SFH) is higher than in an apartment building (AB). In both, SFH and AB, the least floor space is used in the eastern countries. In the central and northern countries, the floor space is equal for each building type. The southern countries need the most space per person in SFH, while the central and northern countries use the most floor space in AB.
- The interest rate has an impact on the annualised capex. The data considered in the tool is only for the countries of the eurozone, which leads to the assignment of cluster values for over one third of the countries.

Cost comparison by country

For comparing the annual costs for DH, Air/Air HPs, Air/Water HPs and Ground/Water HPs, the calculations are based on an average EU consumer. This customer lives in a multifamily house, built between 1990 and 1999, with a usual refurbishment, in a suburban area. The average EU consumer owns his flat, lives in a household of three persons and is not of low social status.

- District heating: Generally northern countries like Denmark, Norway and Sweden as well as Germany are the most expensive when it comes to DH Systems. This can be related to the fact of generally lower temperatures and higher heating demand. In high income countries, maintenance influences the total costs more due to higher labour costs. For the annualised capex, the interest rate is a major factor. Therefore, Estonia, which has the highest interest rate, has a high annualised capex, while labour costs are quite low. Croatia has the lowest costs, due to generally warmer climate and low labour costs. While in western and northern Europe DH prices are high, they are lower in eastern Europe. Denmark is the most expensive country with an annual cost of 2117.95 € per year and Croatia has the lowest cost with 578.78 per year. In most cases Croatia has the lowest overall costs due to low labour costs and warm temperatures, while Denmark is among the highest labour costs with generally colder temperatures.
- Air/Air heat pump: As the Air/Air HP cannot produce hot water, an electric boiler was considered in the calculation. This added cost of the boiler makes the Air/Air HP one of the most expensive systems. Denmark and Germany are the most expensive countries and Croatia has the lowest overall

costs. Due to low electricity prices and low warm water demands Malta and Croatia are among the lowest costs. Especially, central Europe ranges among the most expensive areas for Air/Air HPs and eastern and southern Europe is less expensive. Air/Air HPs also have the greatest difference between highest and lowest price. Countries with lower electricity prices have lower overall costs for the Air/Air HP because of assumed electric boiler.

- Air/Water heat pump: High energy costs for heating play a major role in the cost structure. Denmark, Germany and Belgium are the most expensive countries, while Croatia again is the cheapest. This can be related to low demands in Croatia, while the capex in Belgium is high compared to other countries. Germany and the surrounding countries show the highest costs for the Air/Water HP, while mainly southern and south-eastern countries show lower costs, due to low demands and lower labour costs.
- Ground/Water heat pump: Germany and its surrounding countries rank also among the most expensive countries, with Croatia as the cheapest due to low costs and low demands. On average, the Ground/Water HP ranges as the cheapest system compared to the three other systems above. A great cost factor is once again the high energy costs for heating, while also the capex in Belgium is quite high. Germany and the surrounding countries show the highest costs for the Ground/Water HP, while mainly southern and south-eastern countries show lower costs, due to low demands and lower labour costs. In Belgium, the high capex cost plays a major role.

Summary: In Belgium, Denmark and Germany, the cost for Air/Air HPs is significantly higher compared to the other technologies, which can be related to the highest electricity costs in Europe. Croatia, Hungary and Spain are the cheapest countries, due to low heating demand, low labour costs and low electricity prices. In general, central Europe with moderate temperatures, higher labour costs and higher electricity costs is the most expensive cluster, followed by the North, with colder, darker winters and generally higher labour costs. The western European countries resemble the north and the central cluster. The fact that all systems are slightly cheaper could be related to the milder temperatures. The southern cluster is among the cheapest, due to low labour costs and generally milder temperatures. For the eastern cluster, the lower labour and energy costs play a more significant role, while also milder temperatures for more southern countries of the eastern cluster come into play. While for DH mainly the central European countries and the Scandinavian countries are among the most expensive ones, for HPs Germany and its surrounding countries face the highest costs.

The **overall conclusions and data gaps** can be summarised as follows:

- One of the key challenges for calculating the end-user costs was to identify and collect the required data for all countries considered
- For calculating realistic and fair costs, a set of complex technical combinations and conditions had to be considered
- There is very little data on cooling and especially district cooling

3.5 Overview of the existing EEOS, recommendations for improved design and analysis of the role of district heating and heat pumps in EEOS

The objective of Task 5 is to analyse the role of heating and cooling in the context of energy efficiency obligation schemes (EEOS). These market-based instruments are the recommended way to generate the final energy savings mandated in Article 7 of the Energy Efficiency Directive (EED). In order to do so, the majority of EU Member States makes use of them, either as sole policy measure or accompanied by alternative measures (see Task 5.1).

Regarding the overall design of EEOS, a proposal to harmonise the Member States' schemes along best practice cases and experiences for the different characteristics is developed in this study (Task 5.3). However, this does not mean by default that these recommendations should be applied uniformly across the European Union. The EEOS are often adapted to national circumstances and used to tackle other national policy objectives. Therefore, these recommendations should not be seen as a fixed blueprint that every member state must comply with, but rather as guidelines to alleviate some of the problems encountered in the past and to profit from best-practice examples.

An EEOS is designed for optimal exploitation of cost-effective energy efficiency potentials. However, these economic potentials are often not aligned with overall climate mitigation targets, in particular with regard to heating and cooling, since the technologies most expedient for the fight against climate change are often more expensive than their legacy alternatives. As a result, EEOS need to be adapted to better incentivise the measures that support the necessary heat decarbonisation and to give the technologies required for this a competitive edge. Main recommendations are:

- Reducing the savings obligation for district heating (DH) operators, in order to stimulate the diffusion of the technology.
- Upholding the eligibility of connecting buildings to the DH network as a measure within EEOS.
- Adjusting the accounting of savings from heating replacements in the EED guidance. Instead of crediting the difference between the mandatory minimum standard of the newly installed heater and the installed unit, crediting should count the difference between the mandatory minimum standard of the previous heating and the newly installed unit. This is pivotal for the incentivising of heat pumps.
- Making EEOS compliant with centralised local heat planning, in order to use economies of scale. In particular, heat planning should allow for the designation of areas where specific heating technologies (e.g. heat pumps in designated DH areas) are ineligible within EEOS. This would also need more specific provisions in Article 23 EED, which encourages municipalities of more than 50 000 inhabitants to create heat plans.
- Funding and incentivising of DH measures outside the scope of EEOS. While it can be fruitful to address DH measures with a more centralistic approach, it is paramount to further invest in this key technology to further decarbonise the heat supply and prevent lock-in effects.

3.6 Dissemination of findings

Objectives

The results of the work carried out, i.e., the other tasks were presented in four meetings, lasting between one to two hours. The meetings were organized with the European Commission (DG Ener), Member States' representatives and relevant stakeholders. The meetings were recorded – for minute purposes – minutes were taken, including the input of the stakeholders, and shared alongside with all the presentations.

Approach

EHPA used its extensive experience from H2020/Interreg projects and planned and executed this task. This included gathering data and results from the tasks, liaising with partners and the Commission on planning and scheduling of meetings, approaching and involving other relevant stakeholders and using and presenting the results in other events of EHPA i.e., exploitation measures (building upon it for other initiatives and projects).

Results

Four online meetings were organized by the European Commission with Member States representatives and relevant stakeholders following the timeline below:

Month 14 (23 September 2021): first meeting

During the first meeting, Dr. Barbara Breitschopf gave an overview of the tasks, the factors that drive pathways for heating and cooling and the geographical coverage. Anna Billerbeck and Katherina Wohlfahrt provided a general outlook on Task 1 and Task 2 respectively.

25 people participated in the meeting.

Minutes are available here.

Month 16 (23 November 2021): second meeting

On the second meeting, Dr. Barbara Breitschopft and Anna Billerbeck presented Task 2.2. Mary Gilmore did a presentation on Task 3.1 and Task 3.2.

14 people participated in the meeting.

Minutes are available here.

Month 19 (22 February 2022): third meeting

Anna Billerbeck provided a brief overview of the project. Prof. Russell McKenna gave a presentation on Task 3.4 and Dr-Ing. Ralf-Roman Schmidt provided the first results of Task 4.

22 people participated in the meeting.

Minutes are available here.

Month 24 (July 07 2022): fourth meeting

On the fourth meeting Veronika Jirickova (DG Ener) provided an introduction to the project. Dr. Barbara Breitschopf, Anna Billerbeck and Sabine Preuss presented the results of Task 2, Frederic Berger introduced those of Task 5 and Dr-Ing. Ralf-Roman Schmidt presented the ones of Task 4.

19 people participated in the meeting.

Minutes are available here.

Each session represented an opportunity not only for presentations but also for feedback from stakeholders. Notes were taken (and minutes provided) for each one of the meetings. The topics of each meeting were based on the work done, for example, in month 14 on perceptions, overview of framework conditions for DHC, in month 16 on the role of DHC in EEOS and cost structures of DHC and HP, in month 19/20 and 24 on acceptability of DHC including costs of expanding DHC, costs by different types of end-users, tradable elements in EEOS.

EHPA, as task leader and using its experience in planning and executing online events, proposed to integrate some contributions of the project into sessions organized by EHPA for other projects or in a different context. Two additional online sessions took place:

First online session organized end of month 8 (09 March 2021)

The "Digitalisation in the Heating and Cooling industry: combining Policy and Project perspectives" online event, was held under the umbrella of the EU Industry Week, being coupled with this initiative as well as several EU funded projects. It had 134 registrations and 113 attendees, with the recording being made available here with a link to the event agenda here and the structure merging policy, project, start-up, NGO and consultancy points of view.

Underlining that, as end users become aware of the efficiency, economic, environmental and health benefits of HPs, steps are being taken into making the installation, maintenance and upgrading as standardised and efficient as possible. Innovations such as: Heating and Cooling as a Service (H&CS), Pre-emptive maintenance, One Stop Shops (OSSs), ensure ease of purchase, servicing, and monitoring.

Second online session organized end of month 12 (28 July 2021)

“Matchmaking Heat Pumps and Stakeholders: Research, Innovation and Projects”, on the 28th of July 2021. In this occasion Dr. Barbara Breitschopf gave a presentation of the project’s goals and results of Task 1 and Task 2. Other EU funded projects were presented (agenda here), and there was the opportunity to have a Q&A and an online networking after the online event; thus, to enhance further discussions with stake-holders and audience. More than 80 people participated in the event. The recording of the session is available here.

4 Annex

4.1 Annex of Task 1:

4.1.1 Deliverable 1: Meta-study on factors governing decisions in H&C

4.1.2 Annex 1.1: Literature database (Excel data file)

4.2 Annex Task 2: Deliverable 2: Perceived features of DH and HP in the residential as well as in the industrial and public sector

4.3 Annex Task 3: Deliverable 3: Monetary and non-monetary incentives of HP and DH

4.4 Annex of Task 4:

4.4.1 Deliverable 4: European end users' costs for heating and cooling with DH and HP

4.4.2 Annex 4.1: D4.4 Calculation Tool (Excel based tool)

4.5 Annex Task 5: Deliverable 5: Overview of the existing EEOS, recommendations for improved design and analysis of the role of district heating and heat pumps in EEOS

MJ-03-22-287-EN-N

ISBN 978-92-76-61540-8

Publications Office
of the European Union