The role of Sector Integration in Decarbonising Europe

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GEODE

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The following GEODE experts have contributed to the report:

Elisa Schenner – Wiener Stadtwerke, Austria

Rene Pollaschak – Wiener Netze, Austria

Randolph Brazier – Energy Networks Association, United Kingdom

Matthew Hindle – Energy Networks Association, United Kingdom

Petteri Haveri – Finnish Energy, Finland

Per Everhill – Tekniska Verken i Linköping, Sweden

Carmen Gimeno – GEODE Secretary General

Henning Eklund – GEODE Policy Adviser

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Introduction

By proclaiming the objective to make **Europe the first carbon-neutral continent by 2050**, the new European Commission President Ursula von der Leyen ushered in a new era of European Climate Policies. This objective was clearly stated in the Green Deal Communication in December 2019[1] and in the draft proposal for the first European Climate Law[2] in March 2020. Further, an increase of the GHG-emission abatement target for 2030 up to 50-55% - instead of 40% - was announced. All in all, this new approach clearly entails **the need to decarbonise the whole European economy faster** than foreseen.

GEODE supports the European Commission's climate ambitions and emission abatement targets and believes that the use of the right policy instruments is crucial now. Given the big challenge of decarbonising areas which are currently heavily reliant on fossil-fuels, such as the heating/cooling and transport sector, GEODE is convinced that a whole system approach benefiting all available low carbon energy carriers is needed. Although electricity consumption will undoubtedly increase and play an important role in decarbonising certain areas, GEODE believes that only a holistic approach that intelligently links the sectors together, thus, increases flexibility and efficiency, can deliver the desired outcomes.

The European Commission (EC) has already shown first signals to go in a similar direction. In its long-term strategy in November 2018, the EC stated that stronger connections must be made between the electricity sector and other sectors such as heating, transport, industry and gas. After working intensively on sector coupling, the European Commission is expected to publish its holistic strategy for sector integration in summer 2020.

In this paper GEODE presents its views on the important role of sector integration in decarbonising Europe. GEODE provides different best practice examples from Member States and makes recommendations for an enabling European regulatory framework that still respects local differences. GEODE is convinced that only a sector integration approach is capable of delivering high emission abatements in a cost-efficient manner and socially and economically beneficial. Distribution grids will play an important role in this transformation, enabling resources to be efficiently transferred between different sectors and market actors.

1 https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

2 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0080&qid=1588581905912&from=EN

Sector Integration

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The concepts and the meaning of « sector integration » and « sector coupling » have been widely discussed in Brussels and elsewhere. GEODE proposes the following definitions for the paper.

For **« sector coupling »** we use the definition employed by a study on sector coupling published by the EU-Commission in December 2019 which states: *"We understand sector coupling as linking the EU electricity and gas sectors, both in terms of their markets and infrastructure" (p4).*[3]

Sector integration goes beyond sector coupling and refers to an even more holistic energy system optimisation including more energy carriers and sectors. Sector integration characterises an efficient interplay between the energy production, use of heat and cooling and the transport sector and related industries due to their energy intensive nature. For instance, the district heating network together with its heat accumulators as well as the mobility sector - in the form of batteries or e-cars in households - can be used as storage, thereby, providing flexibility and increasing the efficiency of the system as a whole. Sector integration allows a more efficient economy by transferring energy resources to the markets actors that can make the most out of them; that is to say a whole system optimisation. Resources that are considered waste or left-overs in one sector such as excess heat in an industry, biomass residuals from the forest industry or excess wind power production, can be transferred to another sector where they can be put to use in other functions such as fuel.

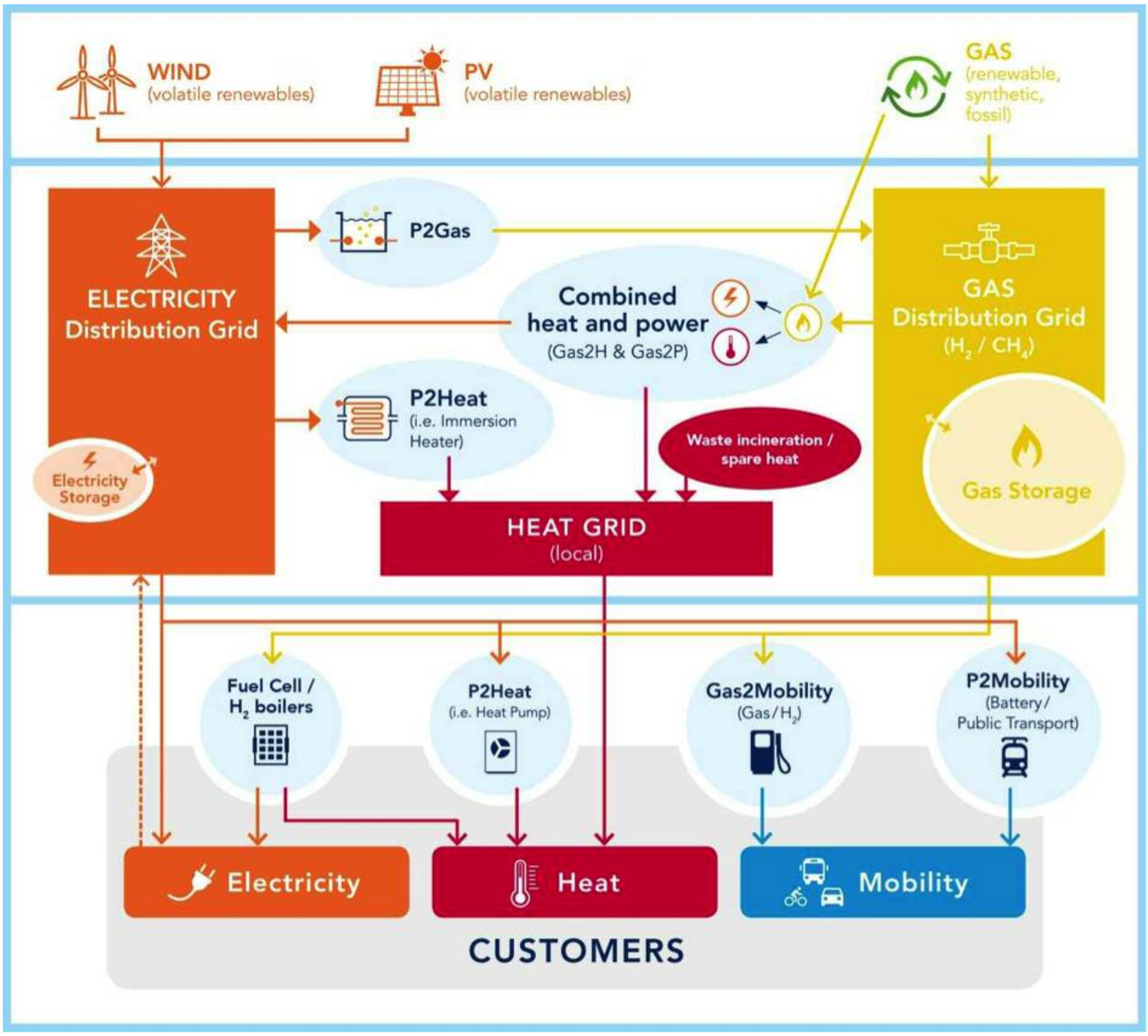
DEFINITIONS FOR THE PAPER:

Sector coupling describes the linking of the EU electricity and gas sectors, both in terms of their markets and infrastructure.

Sector integration goes beyond sector coupling and can broadly be described as energy system optimisation between and within the sectors of energy, transport heating/cooling and related industries such as waste management (P2X-solutions), with a customer focus.

Sector integration is not a solution by itself but an effective means to reach the climate and energy targets in a cost-efficient way by using existing infrastructure and cross-cutting interactions. The main objective lies in the decarbonisation of the energy system fostering the integration of renewables and improving efficiencies, thereby making the transition more cost-efficient and socially acceptable. One possible illustration of sector integration is depicted below.

[3] Study commissioned by the European Commission on *"Potentials of sector coupling for decarbonisation – Assessing regulatory barriers in linking the gas and electricity sectors in the EU", 19 December 2019* accessible via:
https://ec.europa.eu/energy/studies/potentials-sector-coupling-decarbonisation-assessing-regulatory-barriers_en?redir=1



Description of the illustration:

By using existing and updated infrastructure in combination with innovative P2X-solutions, available energy, such as surplus of renewable electricity can be integrated in the energy system in a cost-efficient and sustainable way. In countries with a gas grid, renewable and decarbonised gases and the existing valuable gas infrastructure will play a pivotal role in a cost-efficient and sustainable decarbonisation of all sectors. The use of renewable residual fuels such as biomass for heat and electricity production adds the same values in Member States with well-developed district heating networks. Thereby, sector integration enhances energy efficiency by the combined production of heat and power [CHP] and enables electricity to be stored as heat in the district-heating grid [P2H], as synthetic gas or H_2 in the gas grid [P2G] or as electricity in a battery for e.g. electric vehicles or public transport [P2M]. Smart grids and digital tools support the optimal combination of decentral (customers) and central (power plant, grid) assets will play a critical role in sector transition, and DSOs will need to create and utilise local flexibility markets from low carbon sources to ensure optimised operation of electricity networks.

SECTOR INTEGRATION – NO ONE SIZE FITS ALL SOLUTION

Sector integration is far from a new concept, but has been a living reality in many Member States and cities for decades. The respective characteristics and approaches differ, however, depending on the resources and conditions on the ground, i.e. there is no « one size fits all » solution.

Thus, it is of utmost importance that these diverse local, regional and national concepts of sector integration will continue to thrive in the future. They must not be constrained by too strict EU rules or provisions. The role of the European Union in sector integration is more to provide an enabling framework that leaves enough leeway for local initiatives and innovations to continue to thrive.

In order to show the diversity and variety of solutions in Europe, GEODE provides some best practice examples from its members in the **annex to the paper**.

Gaps and barriers 3

A number of key policy and regulatory barriers and gaps to sector integration have been identified by GEODE. Below we discuss these and make subsequent recommendations that should form the basis for a European Policy Framework for enabling sector integration, in turn optimising bills for customers and giving them choice, while ensuring secure energy supplies and decarbonising energy.

GEODE would like to address **the following barriers to sector integration:**

- No encouraging environment for sector integration solutions and the lack of a fair level-playing field between energy carriers.
- Carbon is not properly priced and flexibility not rewarded sufficiently.
- The focus on natural gas in infrastructure regulations and the neglect of renewable gases.
- An uncoordinated infrastructure planning between sectors (gas-electricity-heating) and levels (TSO-DSO).
- No recognition of the role of DSOs in sector integration and not enough incentives for them to facilitate this development.
- Regulatory barriers prevent decision-making cross-vector, e.g. for investment planning or operation.
- Innovation funding is siloed, therefore, less effective.
- The neglect of the benefits of district-heating and cooling networks for storage and flexibility.
- Unfair or unequal taxation.

In the following, GEODE defines key requirements for an enabling EU framework, which should complement the already existing regulatory requirements in the Clean Energy Package.

An Enabling EU Framework 4

Sector integration can take different forms and variations as outlined in chapter two and shown by the examples in the annex. It is, therefore, important that at the European level, the focus is on the establishment of **an enabling Framework, rather than rigid measures** that might jeopardize successful national, regional or local approaches. The subsequent chapters address the need for a general policy and regulatory Framework, the special role and needs of networks for electricity, gas and heating and cooling, the importance of a more coordinated approach towards infrastructure planning and the need for holistic non-siloed innovation funding.

4.1. Policy and regulatory requirements

Sector integration has not been properly addressed in European or National policy, and energy systems in most European countries are still somewhat siloed. It is, therefore, important that **a European level Policy Framework is created to further facilitate sector integration**. This enabling Framework should build on, and would be complimentary to, the Clean Energy Package, which has created a strong focus on the role of markets and networks working together to enable decarbonisation.

The Policy Framework described here will **specifically focus on enhancing sector integration, which includes removing barriers, creating a level playing field, ensuring fair and equal data access, and facilitating innovation**. Given the differences in the energy mix across European countries, this enabling Framework should be written such that it still allows for successful national or regional approaches, which are critical to meeting European decarbonisation targets. This initial section discusses some high-level recommendations – more detailed policy requirements for the framework and associated energy regulation recommendations will be discussed in the following sections. **Regulation will be mainly set at an NRA level, but high-level regulations such as those discussed below will be required at a European level**.

LEVEL PLAYING FIELD

The lack of a fair level playing field between different energy types and technologies severely hampers sector integration. **A true level playing field needs to encompass a range of different areas: taxation, market access, regulatory treatment, carbon impact, etc**. A key aspect of creating a level playing field is ensuring that an energy vector and technology neutral approach is taken; treating technologies fairly and accounting for their impacts on an unbiased basis.

- **Taxation** is a critical aspect that needs to be evened out across energy vectors and technologies. Double taxation needs to be avoided or removed where it exists. For example, in many energy systems, technologies such as Power-2-Gas (P2G) or Power-2-Heat (P2H) will be disincentivised, as these plants are treated as end-users, i.e. they incur electricity end-user costs (which include a suite of end-user taxes) as well as any associated with generation. Similarly, there should not be double taxation when shifting energy between gas and electricity vectors – being able to move energy between vectors will enable a range of zero carbon solutions, especially hydrogen.

- For a net zero future and promotion of renewable energy, as well as the promotion of sector integration, **carbon costs should be calculated in all vectors and levied according to the principle of a level playing field**. For example, green taxes and levies are often placed on electricity usage only – a level playing field would ensure all energy vectors are taxed in a consistent manner. A range of mechanisms exist to ensure the carbon impact of technologies is calculated and accounted for appropriately (e.g.: carbon taxes, carbon trading, etc.). It is not the intention of this paper to investigate these, but it must be done fairly across energy vectors to ensure a level playing field. Equally, the beneficiaries of the incentive mechanisms created and funded by the carbon/green taxes should be evenly spread among energy vectors and technologies as much as possible.

- A level playing field for **market access** is also critical to enabling sector integration and **lowering costs to customers**. Whether it is wholesale, retail, balancing or flexibility markets, all energy vectors and technologies should be able to compete on an equal footing. This includes not discriminating against size.

DATA ACCESS & SHARING

Where possible, the Policy Framework should ensure open data access and sharing of data between different energy vectors on an equal footing. Sharing of data between energy vectors can enable and possibly expedite, sector integration. In the future smart, flexible energy system, having access to data from all energy vectors will allow networks, NRAs and Governments to make better informed decisions as to the most economically efficient and lowest carbon solutions for the planning and operation of the energy system. Data sharing and data access must, however, respect the protection of personal and security sensitive data. Not all data can be completely shared in a "carte blanche" manner with third parties and/or be disclosed openly, especially not when it comes to certain data of critical infrastructure providers such as DSOs. Markets will also operate more efficiently and transparently, ultimately increasing liquidity and driving down costs compared to a business as usual scenario. A fair and equal approach to sharing of data that respects the principles above can support sector integration in all of the other sections described in this paper; regulation, planning, operation and innovation.

REGULATION

- Removing regulatory barriers is critical to enabling sector integration. Regulatory barriers vary from country to country, but are often a result of individual sectors (such as gas and electricity) being regulated separately, i.e. they are siloed. When new regulatory price controls or frameworks are designed for regulated DSOs, the DSOs, regulators and stakeholders should work together to decide for framework that enable DSOs to apply economically efficient tariff-structures from a whole system perspective.

- Siloed regulation prevents cross vector solutions and inhibits the most efficient "whole energy system" solution from being selected. For example, in a siloed system often the most optimal investment decisions cannot be made – if the best whole system solution is one energy vector instead of another, there is no way to shift the allowance (cost) of the investment between vectors. Investment planning is discussed further in section 4.3. below. Barriers can happen in all timescales as well – for example in some countries, due to unbundling legislation, gas and electricity control centres are not allowed to speak to each other, even though their peaks are often interdependent. More generally, where there are benefits that optimise the whole energy system, either financial or carbon related, regulation must enable to shifting of funds, benefits and resources between energy vectors.

- Energy Efficiency Regulation should not undermine wider network decarbonisation. Energy Efficiency and network regulation should be complimentary, and ensure optimal whole system solutions prevail. When considering decarbonisation regulation, local/on-site solutions must be able to be compared on a level playing field with larger grid connected solutions. Customers must be able to equally weigh up on-site local low carbon generation (i.e. local renewables) vs. accessing large scale generation via the grid (i.e. national renewables), and have the choice as to which they prefer.

The following sections describe further aspects of the Policy Framework, as well as associated regulatory changes, that will be required to successfully enable sector integration at a European level.

4.2. Future role of energy networks as enablers

Networks for electricity, gas and heating/cooling play a pivotal role in facilitating sector integration. The gas grid can actively support the electricity grid in keeping the network stable, for instance, when the storage of fluctuating, renewable energies is facilitated through P2G solutions or through the use of the gas grid as a storage facility. Similar to that, Power to Heat solutions are capable of storing electricity as heat in the district heating system, thereby increasing its flexibility. In light of the steadily growing relevance of DSOs in the energy system, it is important to give them a greater voice and active involvement in European decision-making processes.

One positive step in this direction was taken in the Clean Energy Package which established an EU DSO Entity for electricity. The task of the EU DSO Entity is to collaborate with the Transmission System Operators (ENTSO-E) and the EU Commission on the development of future legislation, especially network codes. This Entity will be operational in the first quarter of 2021. GEODE appreciates this acknowledgement of DSOs for the energy system and demands further involvement of DSOs in relevant decision-making processes at European level. The following paragraphs sketch the role and importance of electricity, gas and heating/cooling networks in sector integration.

ELECTRICITY NETWORKS

The electricity grids are key enablers of sector integration. They are connecting different types of distributed resources with different energy characteristics, many of which are renewable. Many of the new decarbonised energy sources – renewables – are variable in nature, e.g. solar and wind energy, and are connected to a large extent to the power distribution network. Similarly, there are new ways in which customers are using and generating electricity; new low carbon technologies such as electric vehicles and heat pumps are creating new demand on the system, and customers are producing and storing energy via solar PV, batteries and vehicle-2-grid systems. This is not how the power distribution networks were traditionally designed to operate, and hence they now need to be managed in a more active manner. With increasing levels of renewables, generation is becoming distributed and more variable and electricity DSOs will need more flexibility into their systems as well as more flexible DER penetration, ensuring distribution grids are efficiently operated.

Besides technical grid solutions, flexibility is needed both on the generation and on the demand side to help manage distribution grids and to relieve constraints in an efficient manner. Electricity DSOs can procure and activate flexibility services from 3rd parties to locally manage the network capacity and voltages.

There are a wide range of technologies that are available to provide the flexibility required, which will need a whole system approach and major integration among sectors. Smart Grids will contribute to make sector integration a reality and data is key to the smart grid. Data can facilitate a better understanding of generation, network and consumption, so that smart grid technologies and new markets can be used to optimise the operation and planning of the electricity networks. The smart grid will also enable smart aggregation of residential and highly local technologies such as heat pumps, batteries, heat storage, EVs and renewables to provide flexible, low carbon electricity to support DSOs (and national TSOs) in an efficient and secure manner. In the future, this flexibility could also be produced by local hydrogen generation and storage.

The use of energy storage for network purposes has vast potential. This will include third parties providing services to the electricity networks such as seasonal storage, congestion management (capacity support), frequency response for grid balancing, voltage and reactive power control, demand side response, fault response, phase balancing, harmonic response, etc. Electric Vehicles (EVs) can also be considered as mobile energy storage that can consume or produce electricity (Vehicle 2 grid) and therefore the closest integration of electricity and transport sector is essential.

Cogeneration, as the simultaneous production of electricity and useful heat ("CHP" systems) is another important technology to provide flexibility to electricity grids, integrating electricity, gas and heating sectors. CHP systems are currently powered by natural gas, biogas, bio-methane, biofuels or gas and power consumption depending on technical or price signals. Small scale CHP may provide demand side flexibility especially at the local level as they lessen the load at the electricity grids (by shifting demand to gas networks), avoid transmission losses and provide storage capacity at local level. Small scale CHP requires regulatory clarity and incentives for investments.

Large gas-fired cogeneration plants, which can reach energy efficiency levels around 90%, are already today playing a vital role to supply cities with district heating and electricity and contributing significantly to the security of supply (of the electricity and heating system) of urban living spaces. This is the case in the city of Vienna (Austria).

Large gas-fired cogeneration may become a primary supply source for district heating and may help electricity DSOs to manage and facilitate integration of the fluctuating renewable energies, when powered by green gases. These technologies have the potential to make a large contribution towards net zero and security of supply of the whole system.

GAS NETWORKS

In countries with an existing gas infrastructure the interactions between the electricity, gas and district-heating grids can be used to improve the functioning of the whole system.

Through the gradual increase of renewable and decarbonised gases, gas grids play an important role in accomplishing carbon neutrality by 2050. Several recent studies have demonstrated that the active inclusion of the gas infrastructure can reduce overall system costs in the energy transition. The Ecofys "*Gas for Climate*" Study from 2018 compares an *all-electric solution* with a *gas-electricity integrated solution* and arrives at the conclusion that an integrated scenario saves up to 138 billion Euros per year. The Eurogas PRIMES Study from the same year arrives at similar conclusions.[4] Similar studies are available for the UK and Germany on a country basis.[5]

[4] https://gasforclimate2050.eu/wp-content/uploads/2020/03/Ecofys-Gas-for-Climate-Report-Study-March18.pdf
https://eurogas.org/website/wp-content/uploads/2018/05/Press-Release_scenario-study-with-PRIMES.pdf

[5] Navigant's "Pathways to Net Zero" sets out a detailed plan to deliver a zero carbon gas grid for the UK, with clear technical, operational and regulatory actions that need to take place to achieve it. By following a Pathway as set out in the report where we use more low carbon and renewable gases along with further electrification, the approach could save around £13bn a year compared to a Pathway that relies on electricity alone. https://www.energynetworks.org/gas/futures/gas-decarbonisation-pathways/pathways-to-net-zero-report.html.

INTERACTIONS BETWEEN THE GAS AND ELECTRICITY GRID

The steadily increasing amount of intermittent renewable electricity in the energy system leads to large fluctuations since renewable generation is not always produced when demand exists. The lack of electricity transmission lines can lead to curtailing of valuable renewable electricity production. In these cases, the gas grid acts as valuable partner by enabling the use of excess electricity as hydrogen or synthetic methane via the power to gas technology (P2G). Synthetic methane and blends of hydrogen can be feed into the existing gas grid without additional investments. For the infusion of larger quantities of hydrogen, the gas grids have to be retrofitted. A gradual increase of the amount of H_2 in the gas grid in close cooperation with (local) gas DSOs is necessary. In addition, manufacturers of end-products must also be obliged to produce devices that are capable of enduring a higher percentage of H_2.

THE GAS GRID AND RELATED INDUSTRIES

Ties between the gas infrastructure and other sectors such as waste management and the agriculture industry will increase in the future. Biomethane plays an important role in greening the gas grid. The availability of renewable and decarbonised gases at affordable prices will be important for a successful decarbonisation. The lack of a coherent European regulatory framework regarding the production and feed-in of renewable and decarbonised gases hampers the development of a broader European market. Additionally, existing funding systems are not sufficient to boost production.

The current regulations should be changed to reduce uncertainties for producers of renewable and decarbonised gas and provide incentives for them such as rebates on system usage charges for the injection in comparison to natural gas. If the accruing costs are covered by the network tariffs, some DSOs could undertake the task of upgrading biogas to the required quality standard to give producers more security.

HEATING AND COOLING NETWORKS

The local distribution of heating and cooling has great potential for sector integration due to the versatile nature of heat as a source of energy. Heating networks bring a cost-efficient alternative for purchasing heat and enable the combination of various different heat sources cost-, energy and resource-efficiently. In addition to this, the heating network acts as a storage for heat. In many district heating systems, there already exists a heat storage (water accumulator) connected to the heat production plant which grows the ability to utilise the surplus of renewable electricity. Where electricity taxation and network tariffs are reasonable, heat can also be produced with heat pumps and other electricity-based technologies and the heating network can hence also provide flexibility to the electricity system.

The presence of a district heating grid enables local industry and tertiary sector to efficiently share excess heat within its community neighbours. As technology develops, the ability to utilise heat even with rather low temperatures is now an option. This increases the number of potential sources of energy to the district heating grid. Also, the district heating grid and the already existing heat storages itself can be used as a battery for heat in order to optimize production and usage.

Today, in the Nordic countries mainly recycled fuels and excess heat are utilised in district heat production. By utilising society's leftovers such as sorted municipal waste, recycled wood from the building industry and residues from the forest industry, for example wood shavings, the district heating is a textbook example of resource efficiency. The heat network together with its operator enable this resource sharing. The phase out of the last fossil district heating is going fast and within a decade (in Sweden already this year), most of the fossil fuelled production units are used as reserve components and are gradually being replaced with renewable alternatives such as bio-oil.

In contrast with most other energy grids, district heating is usually not regulated and operated on market basis in competition with other heating solutions. The heating network is an integral part of the heating system, consisting of end-user appliances, the network itself, management of the network (temperature etc.) and purchasing the heat from various sources being available. Competition with other heating alternatives creates incentives for cost efficiency, technology development and high environmental performance. The heating networks and systems are of different sizes. Varying from large systems providing heat for entire metropolitan areas to smaller offering services for a residential or industrial area. In order to promote sector integration, it is critical that district heating remains unregulated for maintaining an overall system management of the heating system.

While common in the Nordic countries and in Eastern Europe, there is a huge potential for the development of district heating in other parts of Europe. A driver for such development could be sector integration. One example is the challenge with waste in many parts of Europe, which could be reduced by using waste that cannot be recycled as fuel for heat and electricity production. More use of district heating also allows for electricity to be freed for other more qualified purposes such as vehicle charging & data centres.

4.3. Infrastructure planning, collaboration and operation

COORDINATED, CROSS-SECTORAL INFRASTRUCTURE PLANNING

A range of benefits can be unlocked through better coordinated, cross-sectoral infrastructure planning. Our energy systems are not only more integrated between vectors, they are also interlinked with other sectors in increasingly complex ways. This includes examples such as:

- Transport, with increasing demands for gas and electricity from distribution networks.
- Waste and Resources, as a source of feedstock for generating energy.
- Agriculture and land use, as energy generators or feedstock sources.
- Housing development, where energy efficiency measures adopted will have significant impact on demands for energy networks.
- Water, as both users and generators of energy.
- Industrial plants and parks, with their relatively high energy consumption profiles.

Co-ordinated planning across networks is particularly important to optimise the generation, transmission, distribution and supply of energy. For example, in certain EU countries, wind power is curtailed due to grid constraints. Electricity distribution networks, via local flexibility markets, or Gas networks, via production and injection of green gases like hydrogen, could significantly help reduce these constraints and/or be used to soak up the free wind power. Hence a whole system approach to local and national network planning needs to be undertaken. Accordingly, networks need to be incentivised to take this approach to planning in regulation.

Connections between sectors across our economies mean that efficiency and decarbonisation rely on coordinated planning. Much of this activity needs to happen at national, regional or sub-regional level, in order to maximise benefits in different locations. However, the implications need to be considered across the system: policy makers, regulators and planning authorities (local and national) should consider how such benefits can be maximised, and what impacts national or regional decision making will have on the system as a whole.

For example, use of bioenergy resources in one part of the system may mean they are not available in another, and national or regional decisions on housing insulation standards can have impact on demand across distribution and transmission systems. Similarly, national decisions on policy support for low carbon transport could impact technology development, with implications for the systems and capacity required in other areas in the future. Delivering carbon neutrality will depend on understanding these interdependencies.

A SECTOR INTEGRATION APPROACH FOR THE TEN YEAR NETWORK DEVELOPMENT PLANNING

When it comes to infrastructure planning at the European level the coordination and cooperation between sectors (electricity/gas) and levels (TSO/DSO) has to be improved. At the 2019 Copenhagen forum the EC has already acknowledged the need for a greater involvement of DSOs in ENTSOs' Ten-Year Network Development Planning (TYNDP) by inviting electricity and gas ENTSOs and DSO associations to develop a common roadmap towards scenario building and coordination principles. In addition, according to the Electricity Directive (EU) 2019/944 and Electricity Regulation (EU) 2019/943), electricity DSOs have to develop network development plans every two years. It is important that DSOs are not only obliged to deliver data but that their right to take part of the process is formally enshrined in EU legislation.

With decentralisation and an increase in renewable production, DSOs are now more important for the system as a whole. However, to date, only four DSO smart grid projects have been selected as Projects of Common Interest (PCI) to be implemented under the TEN-E Framework, out of 170+.

It is therefore essential to pay more attention to DSOs and regional sector integration projects instead of siloed cross-country transmission infrastructure projects only. Local, decentralised projects could indeed bring positive effects not only to regional and national systems but also throughout multiple Members States, e.g. in integrating renewables, solving congestions and avoiding negative externalities. Thus, single country projects with a sector integration approach should also be eligible to receive the status of a Project of Common Interest (PCI).

4.4. Innovation and R&D

As described in section 4.1., regulation must not be siloed, and a whole energy systems approach must be taken. One key aspect of regulation of energy networks is innovation: It is well established that incentivizing innovation in networks can deliver a wide range of benefits to customers and supporting innovation is key to removing some of the barriers that are particularly relevant to renewable and low-carbon gas technologies in the transition phase.

However, in many European countries, innovation funding is siloed between energy vectors and gas and electricity networks cannot innovate together, and benefits cannot be shared across customers. Part of the Sector Integration Policy Framework and associated NRA regulation, must include ensuring whole energy system innovation and allow sharing of innovation costs and benefits across the different energy vector customers. The nature of such an approach enables co-ordination and collaboration with a range of other parties including generation, demand, customers, market parties, local and regional authorities, suppliers, etc.

Innovation funding is required for DSOs for research and development, pilot projects or demonstration projects. The resulting knowledge and learning from innovations will not only benefit the stakeholders who make and finance the investment, but will also have a positive external impact. Given the nature of whole energy system solutions, **innovation funding must also be significantly increased**. This will allow end-to-end solutions to be trialed at scale, enabling learning of how the different aspects of the future energy system, both gas and electricity, interact and interface with each other.

Policy Recommendations

5

GEODE recommends the following policy measures to promote sector integration in the EU and its Member States. The proposals are separated in one set of recommendations on the general policy and regulatory framework and cross-cutting issues such as coordinated infrastructure planning and innovation and one set of more sector-specific network recommendations.

General Policy and Regulatory Recommendations

A European level Policy Framework is required to further facilitate sector integration. The Policy Framework must remove barriers, create a level playing field, ensure fair and equal data access, facilitate innovation and ensure security of supply of the whole energy system.

- A level playing field for taxation is required. This includes avoiding double taxation where it exists, and calculating carbon costs in all vectors and applying green taxes/levies fairly across vectors. Incentives should be evenly spread among energy vectors and technologies.
- Wholesale, retail, balancing or flexibility markets must be accessible by all energy vectors and technologies on an equal footing.
- Where possible, the Policy Framework should ensure fair and equal open data access taking into account exemptions for critical infrastructure and sharing of data between different energy vectors on an equal footing.
- Removing regulatory barriers is critical to enabling sector integration. For regulated networks, when new regulatory price controls or frameworks are designed, they must enable DSOs to consider a whole system perspective.
- Where there are benefits that optimise the whole energy system, either financial or carbon, regulation must enable transfer of funds, benefits and resources between energy vectors.
- Energy Efficiency regulation should not undermine wider Network decarbonisation. Energy Efficiency and Network regulation should be complimentary, and ensure optimal whole system solutions prevail.

Improved infrastructure planning and coordination

- Improved infrastructure planning between sectors (gas/electricity/heating) and levels (TSO/DSO) and the compulsory inclusion of electricity and gas DSOs in the preparation of the Ten Year Network Development Plan (TYNDP).
- The establishment of a DSO-Entity for gas analogous to the electricity sector and its inclusion in the preparation of the TYNDP.
- A broader definition of Projects of Common Interests (PCIs) that encompasses projects of sector integration on a more regional DSO level.
- Incentives for network operators to achieve cost savings at system level.
- A whole systems approach to local and national network planning needs to be undertaken. Accordingly, networks need to be incentivised to take this approach to planning in regulation.

Cross-vector focus in Innovation & Research and Development

- Enabling whole energy system innovation. Siloed funding must be removed and sharing of innovation costs and benefits across the different energy vector customers enabled.
- Given the nature of whole energy system solutions, innovation funding must be significantly increased.

Network Specific Recommendations

- A dynamic regulatory framework that ensures that the DSO can operate the distribution grid and enables and incentivises a variety of network solutions, including both traditional network build and new (non-build) flexibility services procurement from 3rd parties, to deliver optimal customer outcomes.
- Where useful electrification should be facilitated and smart grids should incorporate storage and power to X technologies through sector integration.
- Combined heat and power plants are sector integration technologies linking the electricity, gas and heating system, thereby, providing flexibility and security of supply. They require regulatory clarity and incentives for investments.
- A European Framework for renewable gases is required which includes a European target for renewable gases and support mechanisms for the expansion of generation capacities.
- Incentives for producers of renewable gases and policy and regulatory frameworks which facilitate the blending and conversion of networks to carry them are needed.
- Initiation of an EU-wide minimum percentage target for the blending of H_2 into the network, including EU-wide requirements for device manufacturers.
- Acknowledge district heating and cooling systems as self-contained local systems with a demand-lead heating production. Recognise district heating in building regulations and local energy plans as a way to encourage local sector integration and to provide low carbon heating for homes and businesses.
- Promote utilisation of society's non-recyclable waste as fuel for heating (leftovers from the forest industry, municipal waste that can´t be recycled, spare heat). This can be done through environmental regulations, such as restrictions for landfills while ensuring that the waste is treated responsibly (such as utilised as energy).
- Recognise the importance of heating networks as energy storage and a way to integrate various sources of heat for heating and open European funding for local district heating and cooling solutions (e.g. EU green finance programs, CEF, TEN-E, PCI).

ANNEX

Best practice examples for sector integration

In order to show the diversity and variety of solutions in Europe, GEODE provides some best practice examples from its members.

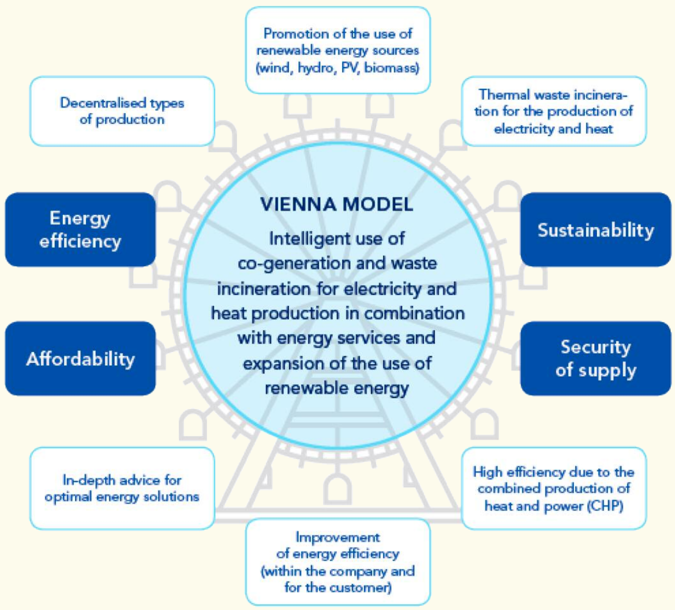
The Vienna Model AUSTRIA

The Vienna Model combines the use of waste heat from power generation (known as cogeneration), the generation of energy from 800,000 tonnes of municipal waste, 200,000 tonnes of sewage sludge and 100,000 tonnes of industrial and commercial waste per year, the use of industrial waste heat and the use of renewable energy sources, thereby guaranteeing the supply of electricity, heating and natural gas to around 1.4 million customers and **saving up to three million tonnes of CO_2 annually by maximising efficiency**.

The Vienna Model is built on **six cornerstones** developed by Wiener Stadtwerke back in the 1960s which can be seen in the graph below.

In recent years this «traditional Vienna Model» has been extended and complemented by different *Heat2Power* solutions which additionally increase the flexibility of the system. Large heat pumps (1 GWth installed capacity) use the heat of CHP-plants as source which would otherwise be disposed of in the Danube. Two giant electric kettles à 10 MW capacity each are powered with excess electricity. Rapid availability of system (within 10 minutes 20 MW are at disposal). Mainly used for the participation in the balancing market and as back up for the district heating system.

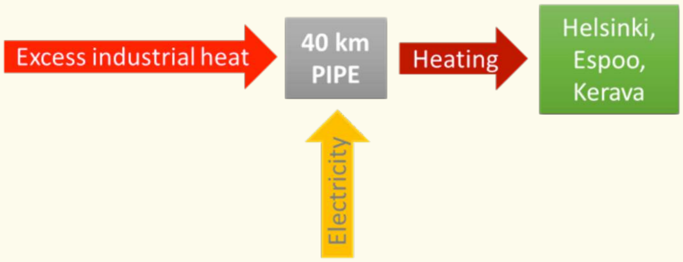
The Vienna Model is additionally supported by three energy networks – gas, electricity and district heating. These networks guarantee an optimal interaction between the various forms of energy. All technologies are connected to the energy networks and also to each other, so that energy can be converted, stored or fed directly into the network in a flexible way and when required.



Source: Wiener Netze and Wiener Stadtwerke

Kilpilahti Project FINLAND

Examining the possibilities of using waste heat from a refinery for heating the homes in Helsinki region



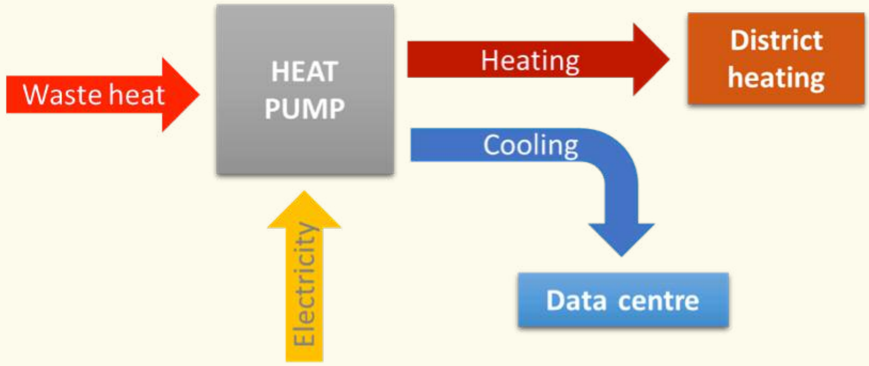
Source: Finnish Energy

Helsinki and Finland are moving fast towards carbon neutrality, which requires new solutions and ever more intelligent use existing energy sources. Kilpilahti refinery is located 40 km from Helsinki. Today the heat generated in the process is not utilized, but it could provide as much as 1 GW of heat with the help of new heat pipe and heat pumps.

Data centres as a part of the energy system FINLAND

Data centre of TietoEvry and Elisa in Espoo

Data centres are needed more than ever. They need a lot cooling. Typically, the cooling is done with electricity and the heat is released in the air. In Espoo the heating network is utilized, and the cooling is done by heat pumps, pumping the excess heat from data centre into the heating network. In Espoo the cooling of data centre and the exchange of energy is done with two heat pumps and the total energy provided from data centre cooling into the heating network is 20 GWh/a.



Source: Finnish Energy

Hydropower and flood management FINLAND

The Finnish hydropower is mainly from run of river power plants which have been amended with reservoirs. Especially in Northern Finland the floods have earlier been challenging but with the reservoirs combined with hydropower system they are now manageable. The Kemijoki river system provides 4,5 TWh of renewable flexible electricity, while enabling manageable changes in river flows for the residents living by the river.

The Münster Model GERMANY

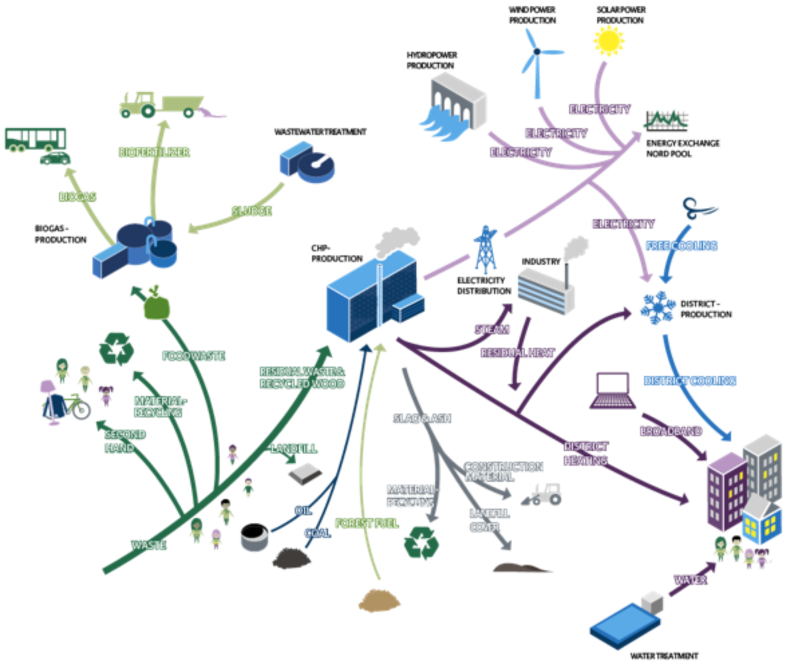
Integrating Renewable Energy into the local public transport system

Stadtwerke Münster GmbH (DSO), located in western Germany and fully integrated in the city of Münster, operates as a German distribution system operator the production of electricity, the supply of gas, district heating and water as well as the public bus transportation. Since 2018, Stadtwerke Münster is **integrating the sector of renewable energy production into the public transport** by electrifying the local bus system and helps to decarbonise both sectors of the energy system and public transport in the municipality. Self-produced renewable wind and solar energy "refuels" E-busses at charging points at the each end of the electrified bus routes. A **smart load management** helps to charge buses when the proportion of renewable energy is high in the grid and this helps to balance the load profile of the local distribution network as well. Each battery-charged bus in Münster helps to save 85 tonnes of CO_2 every year. In the summer of 2020, two bus routes will be electrified running with 16 buses in total and on green energy only. By 2030, all bus routes in Münster and around 200 buses will be fully electrified, contributing to **save 13.250 tonnes CO_2 annually**. The next step for 2021 is an additional integration of green hydrogen buses upon a way to a zero carbon public bus transport of the city of Münster.

Source: Stadtwerke Münster

The Linköping model SWEDEN

In the municipality of Linköping in Sweden, there is a long tradition of sector integration between energy, waste and agriculture sector. Useful resources from waste from both Sweden and abroad are being separated for various purposes such as biogas & fertilizer production and material recovery while what is left is used for production of electricity and heat in five local CHP plants. This is complemented by renewable electricity production from hydro, wind and solar. The combination of heat and electricity production is essential for balancing the energy needs during cold winter days. The foundation for this sharing economy is the local electricity and district heating grid. Increased efficiency has led to the abandonment of coal and oil as a reserve fuel in 2019. **The whole system is estimated to save 860 400 tons of CO_2 annually**.



Source: Tekniska Verken i Linköping

The COOL DH project SWEDEN

Excess heat from research facilities provides district heating

The COOL DH project is an EU funded project with the objectives to support cities in their endeavour to plan and deploy new, efficient district heating and cooling systems, and extend and refurbish existing ones to higher standards.

The new district Brunnshög, in the city of Lund (Sweden), is one area involved in the project. Here the world's largest low temperature district heating (LTDH) network is under construction, with the first customer connected in 2019. Scandinavia's two largest research facilities are also located in the area. The MAX IV and ESS facilities will generate huge amounts of, not only research data, but also excess heat from their operations. Connecting these facilities to the local energy company's (Kraftringen) LTDH and 3rd generation DH network enables a sustainable cooling solution while also using the excess heat to provide district heating and warm tap water for the entire district of Brunnshög. In fact, the overall energy solution was one of the key factors behind the decision to locate the international research facility ESS, European Spallation Source, in Lund.

Visualisation: ESS

Case Study UNITED KINGDOM

Developing Green Gas Heating Technology

While existing natural gas boilers can use biomethane and blends of hydrogen, full decarbonisation will require new technology to make the most of limited biomethane potential and use 100% hydrogen. In the UK, Hybrid Heating systems have been trialled in the Freedom Project, a joint initiative from Wales & West Utilities and Western Power Grid, which showcased how smart technology which combines the gas boiler with a small heat pump can reduce gas demand and avoid costly reinforcement across the energy system. Alongside this, the Hy4Heat project funded by the UK government has funded the development of hydrogen boilers and other appliances.

InTEGReL UNITED KINGDOM

A test bed for future energy solutions

Led by Northern Gas Networks, and in partnership with Northern Powergrid and Newcastle University, InTEGReL is a new integrated energy facility based in Gateshead in the North East of England. The facility is helping to tackle the UK's energy challenges with teams of academics and engineers working to deliver breakthroughs in the decarbonisation of heat, energy storage and transport, to identify the most affordable and practical solution to moving customers onto low carbon, low cost energy.

Avenue Marnix 28 • 1000 Brussels
+32 2 204 44 60

info@geode-eu.org
www.geode-eu.org

@GEODE_EU