Trinomics

Outcome of the FINNISH ENERGY WORKSHOP ON SECTOR COUPLING

BRUSSELS, 10 OCTOBER 2019

INTRODUCTION

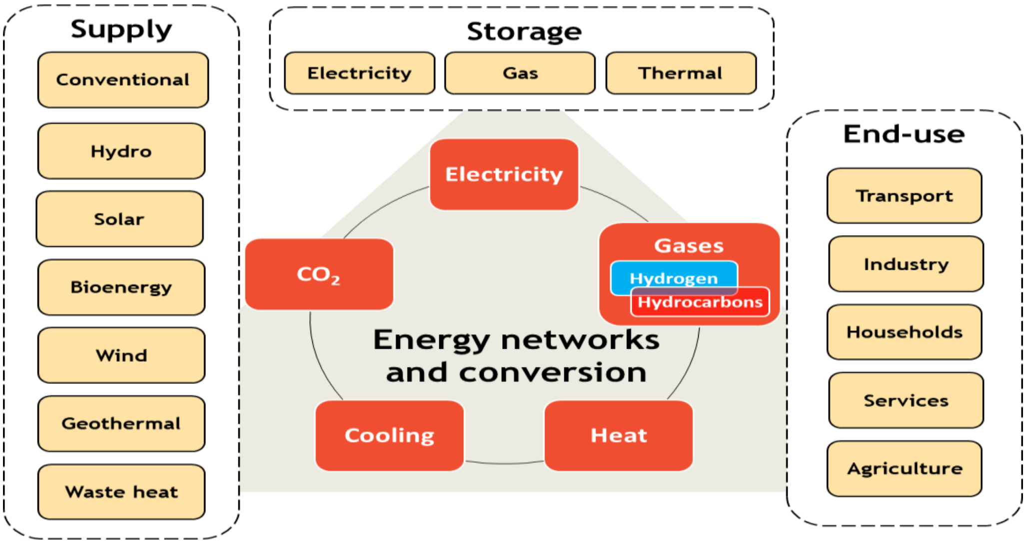
The new Commission President, Ursula von der Leyen has emphasised the importance of sector coupling in the energy transition towards climate-neutrality by 2050. In her mission letter to the Commissioner-designate for energy, Kadri Simson, she requested to investigate how to facilitate the smart integration of the electricity, heating, transport and industry sectors. At the same time, Finland is currently presiding over the Council of the EU and has listed climate leadership as one of its key priorities. Based on this, Finnish Energy (the industry organisation of Finnish electricity, district heating and cooling, as well as gas companies) in cooperation with Trinomics B.V. organized a roundtable workshop on sector coupling on October 10th, 2019. The purpose of the workshop was to discuss the role of sector coupling in the decarbonization of the European energy system and the upcoming Commission's agenda related to the topic. The workshop was moderated by Koen Rademaekers, Luc Van Nuffel and Frank Gerard. What follows is a short analysis of the three topics discussed during the workshop (sector coupling, heating and cooling, governance), followed by the moderators' recommendations.

1. SECTOR COUPLING

Sector Coupling is considered as a cost-efficient strategy to decarbonize the energy system, by valuing synergy potentials and interlinkages between different parts of the energy sector.

Electrification is an appropriate decarbonization option for large parts of the energy demand (renewable electricity sources are abundantly available and are meanwhile competitive compared to conventional sources) but it has some limits: certain end-uses are hard to electrify (e.g. feedstock for industry, high-temperature processes, old building stock) – seasonal energy storage needs cannot be efficiently covered by electricity storage – long distance transport of high energy volumes is more efficient and cheaper via gas pipelines than via electricity transmission infrastructure – investment costs in electricity grid extension or reinforcement can be reduced if existing gas infrastructure can be used instead.

Fig. 1: The elements of sector coupling (Trinomics, 2018)



Sector coupling was initially understood as integration between electricity supply and end use (e.g. self-production of electricity by consumers). Meanwhile, the definition has been broadened to energy systems' integration, which is the interaction between energy vectors and sectors, e.g. conversion between electricity, gas, liquid or solid energy vectors and heat by using "new" technologies, such as power-to-x, gas-to-x, etc.

The increasing share of intermittent renewable electricity (mainly wind and solar power) leads to higher system and price volatility and specific challenges to balance electricity demand and supply at any moment as well as to ensure the system reliability and security of supply. This 'new' situation creates multiple opportunities for sector coupling in different sub-sectors, e.g. x-to-power can be used at moments of low electricity supply (high prices), while power-to-x can be used at moments of high supply (low prices).

The **main barriers** for the implementation of sector coupling technologies are technical and economic, but there are also some hurdles related to market and/or regulatory practices:

- Some 'new' technologies such as power-to-x are not yet cost competitive and the energy efficiency level of certain processes is still rather low; further applied research and innovation, including pilot projects, is needed to lower the cost and increase efficiency.
- The current lack of market-based end-user electricity prices in most EU Member States does not properly stimulate sector coupling technologies, such as local energy storage and demand response. Dynamic market-based retail prices are needed to minimize the overall system costs and to drive investments and operations in flexibility.
- Energy policies are not fully consistent and do not provide long term signals and certainty that trigger market parties to invest in low-carbon technologies, also because adequate carbon pricing in non-ETS sectors is still not implemented in several EU Member States.
- Network tariff methodologies and energy tax legislation represent in some Member States a hurdle for energy storage and conversion, e.g. electricity taken off from the grid for storage or for conversion purposes is considered as consumption and hence subject to the same levies/taxes/grid charges as end-users, which negatively affects the competitiveness of these technologies.
- Adequate transport and storage infrastructure for renewable or low-carbon hydrogen is not yet available: low hydrogen volumes could be injected into existing methane infrastructure, but an enabling regulatory framework is missing. For larger volumes, the preferred option would be to use dedicated hydrogen networks. Storage of hydrogen can be considered in salt caverns that are currently used for methane storage, or in suitable geological formations.

Energy efficiency allowing to reduce primary energy needs is of course the first option before considering sector coupling or conversion processes that anyhow involve energy losses. Different proven technologies and options can in this context be considered: insulation in buildings, high-efficient end-user appliances, such as heat pumps and combined heat and power (CHP) (possibly coupled with thermal storage to optimally value the price volatility on the electricity market), recovery of waste heat, etc. The overall system efficiency should be maximised, by choosing the optimal combination of technologies.

Natural gas will continue to play a major role in the transition period and will allow to lower the GHG emissions in specific market segments, e.g. by replacing coal or heavy fuel. In the medium term, fossil fuels can gradually be replaced with locally produced or imported **biogas/biomethane**, renewable **hydrogen** (produced with electrolysers using renewable electricity) and low-carbon hydrogen (produced by steam methane reforming using CCUS). The advantage of this option is that existing methane transport and end-use infrastructure can continue to be used; when the hydrogen concentration in a methane grid will exceed a certain threshold (e.g. 5 to 20%, currently under review and different depending on grid characteristics and end-user appliances), adaptation of the infrastructure will be necessary. Public acceptance of carbon storage is a critical issue in most Member States, which can however be addressed by properly informing the public.

Energy storage and power-to-gas are expected to play a key role to enable sector coupling. While the legal framework and possible involvement of network operators in storage has recently been clarified in new EU regulation, this is not yet the case for power-to-gas. Although this development should a priori be considered as a competitive activity that should be taken up by the market, grid operators are at present participating in pilot projects. A legal framework like that for storage could be considered. More clarity would also be appropriate regarding the role of regulated network operators in **transport and distribution of hydrogen** via existing methane networks or refurbished/new dedicated pipelines.

Taking into account important **regional and national differences** in availability of resources, existing infrastructure and energy mix (e.g. Nordic countries versus Central Western Europe or Eastern Europe), different approaches and technologies will be needed depending on the specificities of Member States, in particular their RES potential, future flexibility needs versus available flexibility resources (including demand response and storage) and end-user needs and appliances.

Sector coupling is already effectively taking place as market parties and end users are increasingly investing in RES, CHP and storage of heat and electricity (batteries). Business cases for RES- and CHP-installations are being improved by coupling them to storage installations, which also enable prosumers to actively participate in the electricity markets.

2. HEATING & COOLING

Electricity is expected to play a key role in the decarbonization strategy. However, electrification has its limitations. Some end-use sectors are hard to electrify, for instance older building stock, heavy-duty road transport, aviation, shipping and industry (processes in the steel, cement, and chemical sectors requiring high-temperature heat). In addition, many renewable electricity sources are intermittent (wind, solar) while seasonal electricity storage still remains problematic. **The heating and cooling (H&C) sector is rather complex to decarbonise** and the process of decarbonization has not yet started at a large scale. Barriers to decarbonizing this sector include an incomplete assessment of available resources and demand patterns, lack of information and familiarity, inadequate urban spatial planning and difficulty for end-users to access relevant information.

Given the above constraints in the decarbonization of the H&C sector, and the electrification of many end-use sectors, potential **synergies between H&C and electricity could be better exploited**. The coupling of electricity, gas and the H&C sectors can facilitate decarbonization at least cost. Thus, the **idea behind sector coupling is to leverage synergies and reduce system costs**. Importantly**, energy efficiency needs to be the priority** and should be a no regret option.

Many technology options for **sector coupling between H&C and electricity** are already available. These include CHP, heat pumps and in the (near) future hydrogen. Among different solutions, CHP technologies can be used even more to store heat (which is cheaper than storing electricity) in order to provide flexibility to the electricity market. Heat pumps can be deployed for storing heat from building inertia and hydrogen offers possibilities for injection into the gas grid and long-term storage. These technologies and their use increase the complexity of the system but offer more alternative solutions and flexibility options for energy operators and end-users. With regards to infrastructure,

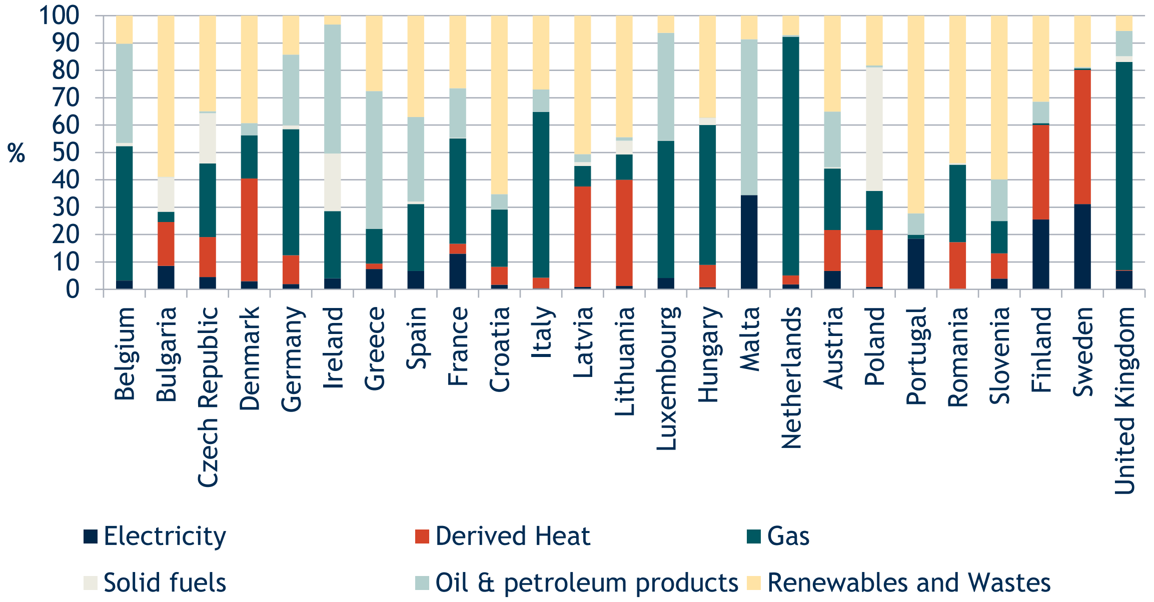
district heating is a key technology to address sector coupling, to leverage economies of scale (individual solutions might be more expensive), provide sustainable H&C to end users and flexibility to the system. As illustrated by **the Helen case** (Finland), district heating provides flexibility to the whole energy system as it allows storing heat when producing electricity; moreover, thanks to the connection of users with different heating profiles, the global demand profile is smoothened. District heating also provides energy efficiency to the system and allows to use waste/excess heat more efficiently. Therefore, infrastructure planning in concertation with all relevant energy actors and public authorities is key. A specific example that illustrates the importance of an holistic planning is that of peak demand shaving, with e.g. heat storage. These potential benefits could be reached through a more holistic and integrated approach. However, such potential savings need to be addressed in the process of infrastructure planning.

A**ddressing sector coupling between H&C and electricity can become a very complex issue** when integrating all variables of the whole energy system (production, regulation, performance of building evolving in time, behaviour of consumer, etc.). Key aspects requiring further efforts to allow for further coupling between H&C and electricity include internalizing all benefits and costs, including external costs, and finding ways in which the benefits can be better captured by society and maximize the social welfare (system benefit). Currently the value of system coupling is hard to capture in, for example, modelling exercises. These complexities often impair Member States from adopting comprehensive plans to decarbonize the H&C system.

Based on the complexity associated with sector coupling**, energy should be addressed as a service** (rather than as a commodity, not buying kWh but buying services such as heating, cooling,), through ESCOs or suppliers. This approach would address more efficiently the issue of minimizing the (primary) energy losses (energy recovery is one option that should be emphasised). Metering is essential, to be put towards the customer. Transport of electricity should also be seen as a service (pays the capacity).

A good understanding of the current energy related resources is very important to plan the decarbonisation of the H&C sector. An assessment of the current infrastructure and buildings is important. There are **no "one size fits all" solutions**. Renovation and insulation of buildings will be key considering the cost of the solutions (EE or low carbon energy production). Hybrid technologies (fossil and RES), lock in effects and infrastructure (expand, maintain or dismantle) should be addressed together. A stepwise approach, having in mind the transition dimension (e.g. more efficient fossil fuel appliances) and the conversion dimension (e.g. from natural gas to biomethane and/or renewable or low-carbon hydrogen) is recommended.

Fig. 2: Share of different vectors in final residential space heating energy consumption, 2016 (Trinomics & OEKO)



In addition to achieving positive climate outcomes, the other energy policy objectives such as **security of energy supply** at local and national level and access to competitive and affordable energy need to be addressed. **Energy poverty** is central when addressing the H&C sector (social acceptance). However, poverty should be ideally addressed from a larger perspective than only from the energetic one. A crucial element when addressing the transition of the energy system is the question **of public acceptance**. In order to address the issue of public acceptance, **access to information** is key.

3. GOVERNANCE

The **new regulation on governance of energy union and climate action** (24/12/2018) puts emphasis on increased cooperation between Member States to reach the 2030 targets, promoting certainty, making reporting more consistent and reducing administrative burden. Increased cooperation between Member States is needed but will this be enough? The lack of integrated planning, adequate energy market designs and network tariff methodologies as well as too low prices of carbon under the ETS are some of the key impediments to further integration of energy sectors. Adequate carbon pricing has been a recurring debate but has now come again at the forefront of the agenda of the Commission's Presidency. To address these issues, a **strong EU-led governance** structure will be necessary. One way forward is to help the Member States with the implementation of the NECPs.

The final National Energy and Climate Plans (NECPs), which should be submitted before 1 January 2020, will provide important information on the national long-term strategies to decarbonize the energy sector and advance sector coupling. Having an integrated reporting, monitoring and data publication structure will allow for transparency and better assessment of gaps. As such, the **NECPs are an important achievement** and right step in the process of achieving carbon neutrality by 2050. However, several key barriers remain to be tackled including the financing and implementation of these Plans. In this context energy taxation is gaining increased attention. Taxation is of course a shared competence with limited involvement of the EU. Subsidiarity in the governance structure still plays an important role and in this context the question of state sovereignty is a delicate one. However, a more efficient and democratic decision making in the EU energy and climate policy should be sought after. For example, the Energy Taxation Directive (2003) is outdated (also indicated in the recent evaluation of this directive). In the context of sector coupling, problems of internal market fragmentation and distortion are observed. Moreover, Member States are not obliged to consider carbon intensity and sustainability of technologies (biofuels, heat pumps, renewable energy, EVs, power-to-X).

4. POLICY RECOMMENDATIONS

- **Sector coupling** still needs to be coherently addressed in relevant related EU initiatives. There is a need to clearly **define sector coupling** and precise market interactions to identify potential barriers and inconsistencies (e.g. would a change in electricity tariffs have an impact on the coupling with H&C?).
- **Closer cooperation between gas, electricity and heat network operators should be encouraged**, both cross vector and between TSOs and DSOs, in view of coordinating their investment plans and operations considering interlinkages between the different vectors and ensure that new investments in network infrastructure are futureproof and allow to minimise overall system costs.
- **Policies for electricity, gas and heating/cooling should be consistent and provide adequate long-term investment signals and a level playing field** to all relevant renewable and low-carbon technologies, allowing to reach the energy and climate targets at least cost while ensuring competitiveness/affordability of energy and security of supply. Adequate **carbon price signals**, including for the non-ETS sectors is one of the key instruments in this context. The fact that similar renewable energy sources may have very different impacts should be addressed, regardless of a technology-neutral approach or not.
- The implementation of **smart technologies** (especially smart meters) should be accelerated allowing energy suppliers to offer **dynamic market-based prices to end-users**. This deployment will stimulate demand response and local production/storage and hence facilitate sector coupling.
- Large scale implementation of variable **grid tariffs** would also be useful, in order to incentivize end-users to adapt their load profile, not only based on market signals but also considering grid constraints, allowing to reduce grid congestion and postpone investments in grid reinforcements. Grid tariff methodologies should in general be technology neutral (which implies that it is up to the market to select the most efficient technologies provided that external costs are internalised). The methodologies should also reflect the specific positive impacts of local injection and storage on grid investments and operations. Off-take of electricity from the grid for storage or conversion to gas purposes, should in the tariff methodology not be assimilated to end-use.
- **Energy and ancillary services markets** should be accessible to all relevant market parties, including active household consumers and prosumers via aggregators. Product characteristics (e.g. minimum bid size, verification rules) should be properly determined in order to ensure that all resources that can contribute to flexibility, system reliability and/or supply security are enabled to effectively participate.
- **Taxonomy**: there seems to be a lack of an integrated approach, with each energy carrier addressed individually. A more comprehensive methodology, where all technologies including renewable energies are equally considered considering their specific impacts, would be appropriate.
- **Energy taxation**: the current legal EU framework does not ensure a level playing field and does not consider new technologies nor the carbon intensity and sustainability of the different energy vectors. A revision would be appropriate but is very challenging considering the diverging existing national taxation initiatives (including carbon taxes) and the strong Member

States' competence in this domain. Nevertheless, an EU initiative would be useful to address crucial issues such as tax exemptions to fossil fuels, border tax, outdated tax rates and the current exclusion of 'new' energy vectors.

- **Just transition and public participation**: fair cost distribution, end-user's involvement and public acceptance will be key given the need to develop distributed energy resources, energy efficiency measures and to enable energy transmission and storage
  - EU regulation needs to allow room for Member States to take appropriate measures considering the national context e.g. regarding the impact of the energy transition on vulnerable consumers (which shouldn't be used to justify anti-market measures);
  - Adequate cost allocation mechanisms are needed for electricity, heat and gas to leverage economies of scale and to enhance cost-reflectiveness by considering the security of supply and flexibility benefits brought by methane/hydrogen/heat networks;
  - EU just transition mechanisms need a strong connection to other regional development policies.
- The potential role of **renewable and low-carbon hydrogen** should be further assessed and specific applied research and pilot projects are needed to make these technologies more competitive and efficient. Further experimentation of admixture of hydrogen into natural gas grids and setting up dedicated hydrogen infrastructure is also needed, with competent authorities providing legal clarity, including regarding the potential role of network operators. Considering the characteristics of hydrogen networks, a similar approach as to methane networks would be adequate.
- Considering the recent and further expected developments in the energy sector, an **update of the scope and eligibility criteria of the TEN-E and CEF regulations** would be appropriate, to include for instance investments related to power-to-X and hydrogen, while also updating the sustainability criteria.
- Member States need **clear objectives** (addressing the "what" and "where") and relevant policies and measures (addressing the "how") **to plan the decarbonisation of the H&C sector**. An EU plan would not help, considering the diversity of H&C profiles, but easy to apply EU guidance would be helpful in order to guide Member States to start from a complex topic and plan in an easy way. The revised annex of the energy efficiency directive did not receive much attention. Member States should take up their responsibility to push this forward. One cross-cutting policy and measure has to be addressed at EU level: carbon taxation in the non-ETS sector, having in mind energy poverty and fair distribution of the costs and benefits.
- **Regulation**: the NECPs 2030 will play an important role to guide future national legislation. National choices must be clearly indicated and serve as a guide to also develop cross-sectoral measures in view of facilitating sector coupling. The European Commission (DG ENER-DG CLIMA) should guide the Member States not only by organising technical working groups but on a bilateral and regular basis (min. 4 times a year).
- **An EU energy industrial policy:** there is a need for more collaboration between the different DGs of the European Commission (led by Sec. Gen.), putting a clear EU energy industrial policy high on the agenda (taking into account the whole value chain of the most important energy technologies to reach our 2030-2050 energy and climate targets).