[Kommentarer]

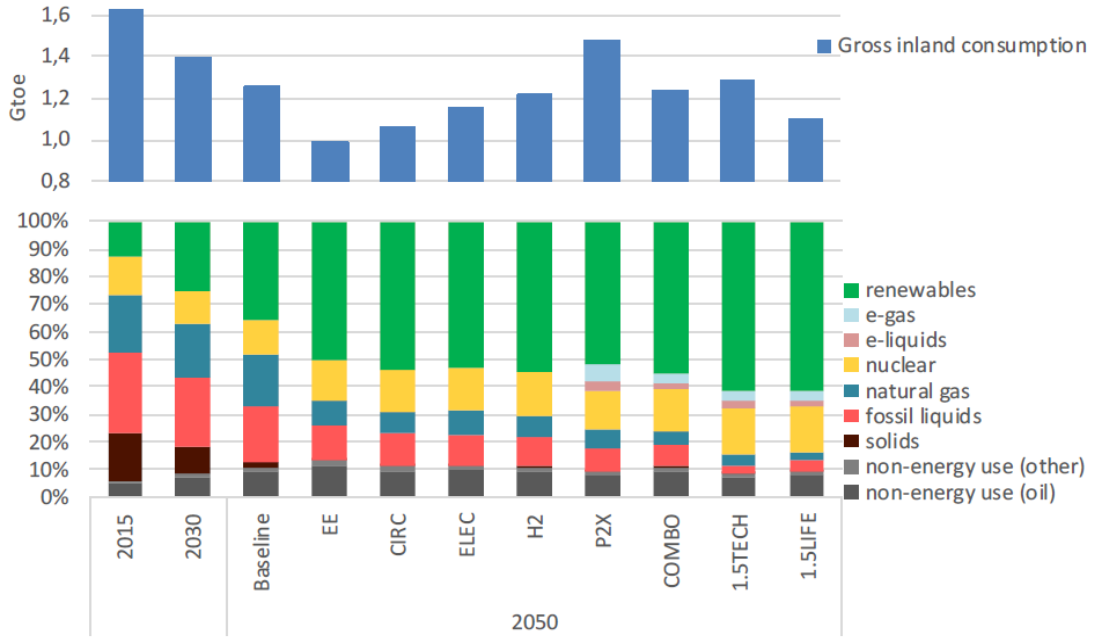
Document officer: HVE
Secretary:
Case no.: s2019-1276
Document no.: d2020-8307-3.0
14. maj 2020

EU strategy on Energy Sector Integration - Comments from Danish Energy

1. What would be the main features of a truly integrated energy system to enable a climate neutral future? Where do you see benefits or synergies?

As highlighted in the EU Commissions Communication IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773 A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy, any scenario which the EU pursues towards its carbon-neutral target in 2050 will imply significant electrification in all sectors - either directly or indirectly. Hence significant RE-expansion including increasing shares of wind and solar power is at the center of the green transition, re the graph below.

Figure 18: Gross inland consumption



Source: Eurostat (2015), PRIMES.

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Only by making sure that all sectors are electrified in a cost-effective way - using electricity directly in heat pumps for heating or for industrial processes and in batteries for EVs and storage in the grid etc. - or converting electricity into storable E-fuels and green gasses through Power-to-X (PtX)-processes - will enable the EU to achieve its climate change target and become carbon neutrality by 2050 in a cost-effective way.

In order to balance future power generation and consumption the electrification of all sectors needs to be implemented in a way that secures maximum demand response.

Digitalisation from generation to end-use and across all sectors is crucial to enable sector integration and ensure that demand response can be activated through price signals in the energy market. Digitalisation gives in-sight to each utility and business sector, enabling the development of effective price signals and value estimation. This makes it possible for energy producers as well as TSOs and DSOs to incentivize use of electricity across all sectors that are linked to the power demand and signal when it is abundant and therefore cheap as well as sending price signals to the grid-users that incentivizes moving consumption away from congested areas in time and space.

Hence, with significant increase in the share of intermittent renewables (wind and solar power), the **main features** of a truly integrated energy system are based on maximum degree of sector integration between:

- *Power and Heating* (District heating may be the most patient flexible power consumer going forward. Likewise, individual heat pumps may provide flexibility by using the buildings ability to store heat or through power-gas-hybrid solutions for heating and industrial processes)
- *Power and Water and wastewater utilities* (2,3 % of DK-power consumption happens in the water sector, hence being a large power consumer with the ability to use power flexibly when pumping water / waste water. Danish studies demonstrate that the water sector can help the power system. Furthermore, wastewater sludge generates biogas which may be used for power generation or up-graded to be inserted into the natural gas-system. Finally, processes in the water sector generates heating. And sewage water in itself is warm and can be used for surplus heat production. (The sewage system is the largest under-ground heat storage in most cities)
- *Power and Transportation* (charging batteries for EVs when power is abundant and cheap and off-peak hours, and PtX for purposes where direct electricity is not possible (see below) and
- *Power and process industries* (Fuel switch from fossil fuels to power and applying heat pumps enables industries to provide flexibility by moving to off-peak hours or by using hybrid-solutions/ back-up biogas-installation. Furthermore, industrial processes develop heat which may be boosted with heat pumps and deliver surplus heating for the district heat system)

Sector and energy system integration walks hand-in-hand with energy flexibility on the demand-side in the applied heat pumps (heat and industries) as well as in the batteries (EVs

etc.). Only through efficient sector integration will EU countries be able to fully absorb the intermittent RE resources in a cost-effective way.

The main synergies appearing from sector integration is a cost-effective integration of intermittent RE-resources (wind and solar), which are the most cost-competitive elements of power production in the green transition to carbon neutrality.

Without sector integration RE-production will face numerous negative price hours, and production will be ordered to cease production to balance the energy system, while energy users are continuing to use fossil fuels or using more expensive RE energy sources.

Hence, provided demand side flexibility, sector integration will enable an ever-increasing amount of intermittent RE resources in the energy system, which is essential in areas with no natural hydro-resources.

Maximise RE-integration through inter-connectors and sector integration
A study which supports this statement is the so-called Flex-4-RES study. In this study, it is demonstrated how the Nordic countries and Baltics may develop into a flexibility hub for Europe providing RE-power to northern Europe. However, this will only happen if infrastructure is developed and interconnectors between and within EU countries are build and – in the Nordic case - if district heating in the Nordic and Baltics is used as storage facility when RE power is abundant, see graph from the study below.

In the policy scenario energy taxes and grid tariffs are developed to incentivize electrification and storage in the heat system. The combined *Policy scenario* and *Connect scenario* enables more RE than other scenarios. The *Connect scenario* is assuming interconnector-expansion beyond what is planed today.

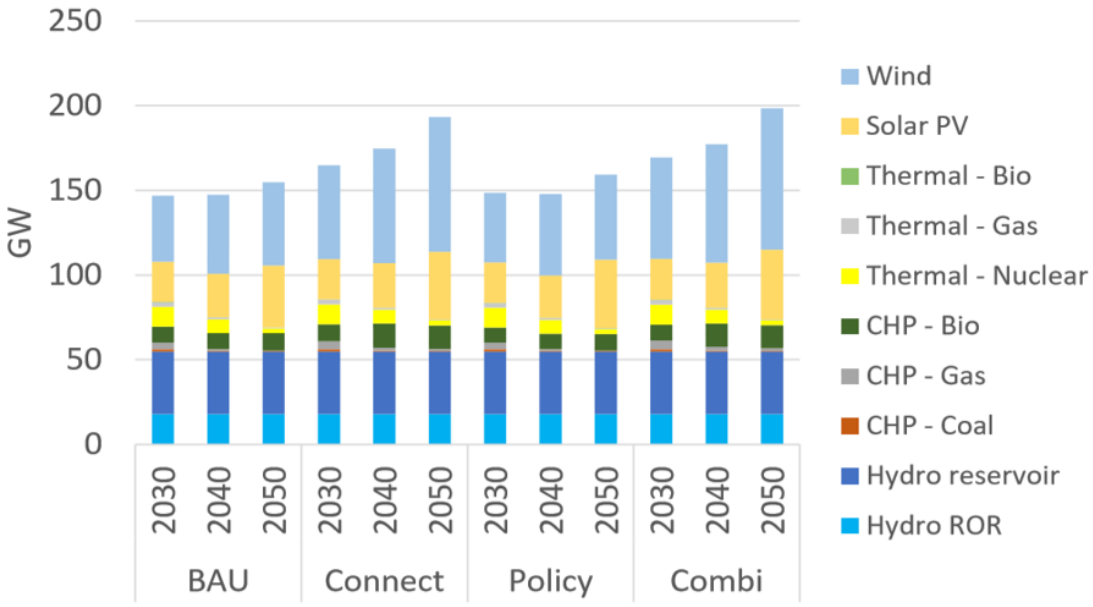

Figure 5: Installed electricity capacity by technology in the Nordics and Baltics

To a large extend, the direct use of power in all sectors and hence direct energy system and sector integration builds on existing, known technologies, which are very close to being commercially viable compared to fossil fueled technologies. Besides existing technologies high-temperature heat-pumps are assumed to take another 3-5 years in order to reach 160degreesC, hence covering a multitude of industrial purposes. However, this will probably only take us part of the way.

Reaching carbon-neutrality by 2050
However, becoming carbon neutral by 2050, will require further development of less known technologies and completely new technologies will appear that we are not yet aware of.

In a Danish context, facing a 70% reduction target by 2030, all parts of the industry have over the winter been involved in so-called Climate Partnerships (13 business driven partnerships in total). All of these delivered their contribution to a pathway for 2030 mid-March and what they as utilities, industry, transport, etc. would be able to do in order to reach the 2030 70% reduction target. Especially, heavy industry and transportation found it impossible to reach this target by use of direct electricity.

Hence, a strategy for biogas, PtX and Carbon capture and storage was demanded.

Especially to avoid carbon leakage in the sectors exposed to global competition, a comprehensive European strategy for green gasses, incl. PtX and CCS is required, not only to deliver on an effective sector and energy system integration strategy, but simply to deliver commercially viable solutions for heavy transport and industry as we approach 2030 and beyond.

High-temperature heat pump development needed
Reaching the EUs 40% or elevated 50-55% CO2-reduction target by 2030 can be done with technologies we have within reach. Especially, developing high-temperature heat pumps (160 degrees) is likely within 3-5 years. But it is important to speed up this development, to avoid industrial investment and lock-in of fossil fueled technologies.

Combining heat-pumps and biogas in hybrid solutions within heat and industrial processing must also be an element of the power-heat/industry sector integration.

However even with biogas and high temperature heat pumps, as highlighted in the above-mentioned Commission Communication, further development and up-scale of the conversion of power into E-fuels (PtX) that can be stored, is necessary in most of the outlined scenarios towards 2050 and full carbon neutrality.

PtX is able to deliver abundant volumes of green E-fuel to meet requirements in

- Heavy transportation (land, air and maritime)
- Energy intensive industries (where even high temperature heat pumps cannot meet the requirements)

Common EU strategy to avoid higher development costs and national competition that removes potential synergies from co-operation
It is important – as an element in the sector integration strategy - to put a common EU-strategy in place for PtX. The technology development costs are significant, and national and in-coherent PtX strategies are likely to make the costs even higher. A common EU strategy must ensure that benefits from the synergies across member states are harvested, and that national strategies don't compete against each other but work to enhance each other.

Sector integration between power and industry and transportation, perhaps including integration with gas-systems, depending on type of e-fuel, is important to meet the 2050 ambitions.

Bringing costs down on PtX will determine the ability for fuel switch away from fossil fuels in processes where direct electrification is not possible and where the only alternative is biogas which is a scarce resource, especially on an EU scale. If the EU doesn't succeed with a common PtX strategy it is unlikely to meet its 2050-targets because EU industry and heavy transport will be inclined to stick to fossil fuels for competitive reasons. For industry CCS may be a better option, providing that costs are brought down on this technology too. Hence a CCS strategy – while not being a sector integration strategy will be an important contribution to the overall decisions on PtX.

Where do you see the biggest energy efficiency and cost-efficiency potential through system integration?
Cost-efficiency in meeting the climate goals implies using the cheapest power producing resources – wind and solar power. And only if measures are made to make sure that power is used in all sectors cost-efficiency will be ensured. Hence, electrification is the foundation for a system and sector integration strategy, electrifying heating, cooling, transportation and industrial processing. And because the heat pump technologies ensure higher energy-efficiency, sector integration is also the way to ensure the biggest energy efficiency gains.

Meeting the double target of cost-efficiency and energy-efficiency can only happen through energy system integration, This is because the key technology in sector integration with heat and industry appears from the utilization of heat pumps which triples the energy-efficiency and is a cost effective solution. Hence, it is crucial that the further development of high temperature heat pumps is supported to expand the sector integration potential for industry. And – based on Danish experience – due to taxation and up-front investment costs the economy of heat pumps within district heating and individual heating is still at a stage where economic support and regulation is required.

Within industry and water utilities the ability to generate surplus heating from their processes is estimated to be able to cover a significant share of the total heating demand, at the same time it also enhances the energy-efficiency gains in combination with ensuring sector integration between power-&industry / industry/water sector &heating.

2. What are the main barriers to energy system integration that would require to be addressed in your view?

As demonstrated in the Flex4RES analysis (re the connect scenario) investments in interconnectors that facilitate the EUs internal energy market is fundamental for the transmission of power, from where abundant RE resources are located to where power utilization takes place.

Utilities within power, heat, water and gas are tightly regulated in many member states, because they are monopolies. It is important that this regulation supports the green transition of utilities. Investments in non-fossil fuels in general and in particular innovative investments in green solutions must be enabled. As an example, massive increase in EVs will not happen if the infrastructure isn't ready to service EVs need for charging, likewise with heat pumps when converting from oil stoves and natural gas-fired stoves.

Regulation needs to support the cost-effective choice between infrastructure investments and demand for flexibility. And local and regional/national markets for flexibility need to be developed to meet the need in the energy market as well as in the grid.

The CEP should deliver on flexibility and infrastructure development
The implementation of the Clean Energy Package needs to be monitored and evaluated to see if it meets the requirement of the future energy system in terms of effective framework conditions for activating end-users flexibility and for timely and effective planning of infrastructure development, especially cross border.

In terms of implementing the Clean Energy Package and further developing the EUs internal energy market attention needs to be given to the implementation of Article 32 of the Electricity Directive stating that:

Member States shall provide the necessary regulatory framework to allow and provide incentives to distribution system operators to procure flexibility services, including congestion management in their areas, in order to improve efficiencies in the operation and development of the distribution system.

With the Clean Energy Package in place by 1. January 2021, DSOs have a framework at European level to use flexibility and optimise network investment decisions, as well as to handle more efficiently the challenge of facilitating the integration of renewables on the electricity networks. DSOs act as neutral market facilitators, with the goal of decreasing costs for the network users, while ensuring secure and stable electricity supply. In this context, a proper implementation of Article 32 of the Electricity Directive will help reap all potential benefits flexibility can provide.

Thus, in addition to traditional grid reinforcements, National Regulators should acknowledge that there are alternative solutions to efficient provision of network services for which more tailored economic incentives are needed. At present, flexibility procurement might not provide the same systemic benefits in the long term as grid reinforcements do. Any particular risks of opting for flexibility services should be therefore taken into account in the contracting and remuneration scheme to make these alternative solutions viable. Ideally, all stakeholders should strive towards flexibility procurement mechanisms that provide comparable systemic and societal benefits as grid reinforcement.

Attention needs to be directed to the national incentive schemes for the procurement of flexibility by DSOs to ensure that flexibility is activated efficiently as an alternative to traditional grid reinforcement throughout the EU.

At the same time, it is important to acknowledge that significant tradition grid investments are needed in the distribution network to support massive electrification and further penetration of RES-E throughout the EU. Yet, active utilization of flexibility through effective incentives for DSOs carries the potential to reduce the investment need markedly. Our calculations show that DSO investments towards 2030 – where a 70 pct. CO2 reduction target is set by parliament – may be reduced by up to 30-40 pct. compared to a situation without utilization of flexibility provided that proper incentives are in place for DSOs and that commercial actors succeed in taking up the flexibility potential for end users.

Digitalisation the foundation of energy system integration
As already mentioned, digitalisation and data application (asset management) is the foundation of energy system integration and sector coupling. Hence EUs Digitalisation strategy should pave the way for stronger utilization of data in managing utilities and identifying where sector integration could enhance flexibility and enable more cost-effective solutions developed by digital-driven business, often SMVs. More clarity on next step in the implementation of EUs Digital strategy from Feb. 2020 is required to see if it meets the need.

PtX-strategy
An EU PtX-strategy could address how to establish a market driven demand for PtX-products, and which support tools and/or demand requirements should be in place at EU level. A special focus should be on cross boarder services such as trucks, ships and airplanes. Also, cross boarder infrastructure regarding power and hydrogen should play a key role in the strategy.

Regulation supporting the use of surplus heat from PtX processes in industries or district heating systems would improve the economic performance of PtX-products and increase the sector coupling significantly.

Further, EU-definition of green renewable hydrogen is important for further development of Power-to-X.

Activating the private consumer
However, the real barrier is activating the end-user, many of the system-decisions have been made and implemented, but for electrification to take place in private heating and transportation, the individual consumer need to be activated. Otherwise, there is nothing to integrate. The CEPs aim at improving conditions for the independent aggregator may enable activation. But being green isn't enough to activate the end-user. Energy taxes must be compliant with the Climate targets, hence giving the consumer the economic benefit of electrification, and a hub of digital entrepreneurs must be nourished to see new products being developed.

In general, the public consumer should lead the way, in terms of green public procurements and looking at the total economy – and not just up-front investment - when investing in new facilities, renovating etc.

Emissions trading as primary tool in decarbonizing ETS-sectors
Carbon emissions trading within the EU Emissions Trading System (ETS) is the most effective way to reach climate neutrality and should remain Europe's primary tool in decarbonising. A market-based system will guarantee the achievement of green affordable and reliable energy to all European citizens.

To maintain an efficient EU ETS that incentivizes sectors to swift towards a greener energy consumption, strengthening the EU ETS is necessary.

The current Linear Reduction Factor (LRF) is based on the 40 % reduction target in 2030. In order to reach 50-55 % reduction by 2030 and climate neutrality by 2050, the LRF should be adjusted upwards accordingly, supporting EU Climate targets. Likewise, to avoid the risk of oversupply of allowances, we strongly advocate maintaining the 24 % intake rate after 2023 instead of reducing it to 12 %. To protect the ETS from sudden significant decreases in demand for allowances and to protect investors against sudden plummeting carbon prices, the introduction of an ETS carbon price floor should be considered.

Non-ETS sectors should be addressed through other carbon pricing measures, using the most efficient tool for each sector.

Energy taxation should incentivize the use of renewable-based electricity
The revision of the Energy Taxation Directive should reflect the important role of direct and indirect electrification and ensure a favorable treatment for renewable based electricity.

Energy taxation should facilitate that Member States can price externalities of energy production and energy consumption correctly, whilst alleviating the inherent pressures of cross-European competition. The current directive lacks a common framework causing each Member States to apply its own minimum tax rates on energy product and its own rules for exemptions. Energy tax rates currently applied by Member States differ significantly which leads to market fragmentation and situations where renewable energy can be taxed more heavily than fossil fuel-based energy.

Double taxation for flexibility tools such as storage, batteries or power-to-gas facilities should be removed as these technologies will play a key role in integrating the growing shares of renewables.

An efficient taxation directive would ease the possibilities of exposing more sectors to a meaningful carbon price signal. The introduction of a climate component must be an effective complement to the ETS, which should remain Europe's primary tool in decarbonising.

3. More specifically:

How could electricity drive increased decarbonisation in other sectors? In which other sectors do you see a key role for electricity use? What role should electrification play in the integrated energy system?

Indirect electrification (notably via green hydrogen) should complement renewable-based direct electrification. Direct electrification needs to be prioritised as it is the most cost- and energy-efficient option.

Only by making sure that all sectors are electrified in a cost-effective way - using electricity directly in heat pumps for heating or for industrial processes and in batteries for EVs and storage in the grid etc. - or converting electricity into storable E-fuels and green gasses through Power-to-X (PtX)-processes - will enable the EU to achieve its climate change target and become carbon neutrality by 2050 in a cost-effective way.

Electrification is the foundation for a energy sector integration strategy, electrifying heating, cooling, transportation and industrial processing

Meeting the double target of cost-efficiency and energy-efficiency can only happen through energy system integration. Heat pump technologies are three times more energy-efficient and is a cost-effective solution. Hence, the further development of high temperature heat pumps is crucial to expand the sector integration potential for industry.

Another sector in which electrification is key in meeting climate and energy efficiency targets is road transport. Instalment of charging stations and thus improving EV infrastructure is the number one determining factor in the electrification of European road transport, and the revision of the Alternative Fuels Infrastructure Directive should address this.

What role should renewable gases play in the integrated energy system?

The shift from fossil gas to renewable gases is a prerequisite to succeed with the transition to a carbon-neutral energy system.

The production of renewable gases is increasing, however, renewable gas is a scarce resource which is relatively expensive compared to other renewable energy. Renewable gases should be used in sectors where electrification and the use of renewable power is not possible or economically viable, e.g. industrial activity using high temperatures and heavy-duty transport.

The increase of variable renewable electricity in the energy system will require flexibility solutions. Electricity system balancing and flexibility can be provided by multiple competing sources within and outside the electricity sector, such as conventional firm generation capacity (incl. gas-fired power), demand side response, energy storage solutions and flexible production of power-to-gas products (renewable hydrogen, synthetic methane) or power-to-liquids.

The role of renewable gas as a flexibility provider to the energy system will vary within the EU depending on the available flexibility solution, however, it is vital for an efficient transition of the energy system that this is determined by market forces.

What measures should be taken to promote decarbonised gases?

Decarbonised gases can be understood as fossil gases with carbon capture, or electrolysis using low-carbon electricity that is not renewable (e.g. nuclear). It is important to establish classifications of both renewable gases and decarbonised gases which are clear and consistent. The classifications will provide a common terminology and enable the introduction and development of the technologies that contribute to the green transition of the energy system.

Decarbonised gasses only have a role to play where carbon-neutral, renewable options are not feasible. Therefore, promotion of these gases should be strictly limited to situations where cleaner alternatives are not available.

What role should hydrogen play and how its development and deployment could be supported by the EU?

In cases where direct electrification is not possible, such as aviation and energy intensive industries where even high temperature heat pumps cannot meet the requirements, indirect electrification via green hydrogen is going to play a vital role.

A common EU-strategy for PtX should be an element in EU's strategy for energy sector integration. The technology development costs are significant, and national and in-coherent PtX strategies are likely to make the costs even higher. A common EU strategy must ensure that benefits from the synergies across member states are harvested, and that national strategies don't compete against each other but work to enhance each other. A PtX strategy must also ensure infrastructure development, including dedicated hydrogen pipelines in the gas transmission development.

Bringing costs down on PtX will determine the ability for fuel switch away from fossil fuels in processes where direct electrification is not possible and where the only alternative is biogas, which is a scarce resource, especially on an EU scale. To meet the EUs 2050-targets, having a PtX strategy is a must – otherwise EU industry and heavy transport will be inclined to stick to fossil fuels for competitive reasons.

How could circular economy and the use of waste heat and other waste resources play a greater role in the integrated energy system? What concrete actions would you suggest to achieve this?

Waste in the circular economy approach is required, but it is regarded as a longer-term effort in terms of behavioral and system change. Compared to the green transition circular economy is a fundamental change of how we see waste, turning it into a resource. In the Danish

context the vision is to re-use 90 pct. of all waste by 2030. This will form the basis of a truly circular economy, where waste is a resource in high demand.

Waste incineration plants forms the basis of fuel in the Danish heating system, hence a 2030 target of 90% recycling of waste will reduce the share of waste heat in the system and other RE-sources will be demanded.

At the same time the higher share of re-cycling will mean more fraction will probably go into biogas-production and hence increase this RE source.

Better sorting of plastic waste and recycling of plastic will reduce emissions and may create new industries for recycled plastic.

In terms of concrete actions, the Climate partnership for Waste and water points to:

- The need for new roles in the waste market (In Denmark this would imply, moving it away from the municipalities to private market operators)
- Centralization of waste sorting (today we sort many fractions in the household, the partnership points to a more efficient way of sorting waste if this is centralized and professionalized)

(Above is mentioned that business has been involved in 13 Climate partnerships and over the winter developed analysis and recommendations as to how the 70% Climate target should be met)

How can energy markets contribute to a more integrated energy system?

Sector and energy system integration walks hand-in-hand with energy flexibility on the demand-side in the applied heat pumps (heat and industries) as well as in the batteries (EVs etc.). Only through efficient sector integration will EU countries be able to fully absorb the intermittent RE resources in a cost-effective way.

Without sector integration's ability to ensure demand-side flexibility RE-production will face numerous negative price hours, and production will be ordered to cease in order to balance the energy system, while energy users are continuing to use fossil fuels or using more expensive RE energy sources.

Hence, energy markets product design and product terms for e.g. balancing services, as well as the infrastructures congestion-driven demand are crucial demand-side elements that must be further developed in order to reward and put the right value on the electrified assets in heating, cooling, transportation, water and industry. Only provided demand side flexibility, sector integration will enable an ever-increasing amount of intermittent RE resources in the energy system, which is essential in areas with no natural hydro-resources.

How can cost-efficient use and development of energy infrastructure and digitalisation enable an integration of the energy system?

Reference made to the above, emphasizing that digitalisation and data application (asset management) is the foundation of energy system integration and sector coupling. Hence EUs

Digitalisation strategy should pave the way for stronger utilization of data in managing utilities and identifying where sector integration could enhance flexibility and enable more cost-effective solutions developed by digital-driven business, often SMVs. More clarity on next step in the implementation of EUs Digital strategy from February 2020 is required to see if it meets the need.

4. Are there any best practices or concrete projects for an integrated energy system you would like to highlight?

Historically, Denmark has been at the forefront with district heating and combined power-and-heat generation. This has increased the energy efficiency from the EU-average of 30% to around 90%. By 2030 most, if not all, combined power-and-heat generation in Denmark will be non-fossil based.

The Danish district heating areas are currently deploying a lot of large electric heat pumps (based on many different heat sources) and electric boilers for peak load. This allows for a very flexible heating system that can transform electricity into heat, when RE-electricity is abundant, and produce power on CHP plants when RE-electricity production is low.

CHP plants in combination with large electric heat pumps and boilers is a best practice for areas with district heating or high heat density where district heating can be applied. It is both energy efficient and flexible so it can integrate large amount of RE-electricity in the heating sector.

5. What policy actions and legislative measures could the Commission take to foster an integration of the energy system

A comprehensive European strategy for green gasses, incl. PtX and CCS is required, not only to deliver on an effective sector and energy system integration strategy, but simply to deliver commercially viable solutions for heavy transport and industry as we approach 2030 and beyond.

An EU PtX-strategy could address how to establish a market driven demand for PtX-products, and which support tools and/or demand requirements should be in place at EU level. A special focus should be on cross boarder services such as trucks, ships and air-planes. Also, trans-European infrastructure including infrastructure for hydrogen should play a key role in the strategy. Further, EU-definition of green renewable hydrogen is important for further development of Power-to-X.

Improve national and trans-European energy infrastructure to facilitate the transportation of clean energy across Europe and locally. Investments in inter-connectors are important as they facilitate cross-border trade in the EUs internal energy market.

A swift implementation of the Clean Energy Package developing the EUs internal energy market is important, and attention should be given to the implementation of Article 32 of the Electricity Directive, ensuring national DSOs to use flexibility and optimise network investment decisions, as well as to handle more efficiently the challenge of facilitating the integration of renewables on the electricity networks.

The revision of the Energy Taxation Directive should reflect the important role of direct and indirect electrification and ensure a favourable treatment for renewable based electricity. Parallel to this, the Commission should encourage Member States to use energy taxation as an energy policy tool to promote renewable electricity and price externalities of energy production and energy consumption correctly.

Yours sincerely
Danish Energy

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