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Discussion Paper

»Flexibility first, Efficiency second«

Why System Efficiency is the new Paradigm

Berlin, May 2020. The nature of the electricity system is changing dramatically due to the adjusted European Union's goals with respect to climate neutrality. That is why our policy thinking needs to change in profound ways, too. If we seriously aim at achieving greenhouse gas (GHG) emission reductions, a simple energy conservation focus doesn't do justice anymore to the complexity of the situation in an increasingly decentralized, digitized and decarbonized energy world. We need to assess the GHG emissions associated with various ways to power end uses, as opposed to simply count the number of kilowatt-hours consumed. To that end, "system efficiency" will be as important or even more important than "energy efficiency". Of course, energy efficiency cannot be neglected and will continue to play an important role. In some cases, however, it may make sense to accept energy losses or place cost efficiency at the side if the provision of energy or its use is in line with the concept of system efficiency.

Introduction

The traditional premise of simply saving energy without taking system efficiency into account made sense in an energy world that relied on a purely fossil fuel-based system. However, mounting research suggests that aggressive electrification of energy end uses – such as space heating, water heating, and transportation – is needed if the EU and the world are to achieve ambitious emission reduction goals for carbon dioxide. In the United States (U.S.), this concept, the electrification of energy end uses that previously have been powered by fossil fuels (natural gas, propane, gasoline, diesel, or fuel oil) in order to reduce GHG emissions, has been coined "**environmentally beneficial electrification**".[1] This term is hardly known in European energy policy debates. Nonetheless, conceptually suggested revisions of current policy framework conditions apply on both sides of the Atlantic Ocean.

Achieving the GHG emission reductions possible through environmentally beneficial electrification will require regularly revisiting and updating prevailing energy

[1] K. Dennis, K. Colburn, J. Lazar (2016): Environmentally beneficial electrification: The dawn of 'emissions efficiency', in: The Electricity Journal 29 (2016) 52-58.

efficiency metrics and accounting methodologies in order to maximize gains. More specifically, it is appropriate to consider whether reduced electricity consumption (i.e., kWh) is the best compass with which to navigate the path to a zero-carbon future, when, in fact, substitution of electricity for fossil fuels will in some cases increase electricity consumption.

In times in which the energy system is developing fundamentally differently with the expansion of renewable energies, flexibility and system efficiency should prevail. The necessary **sector coupling** requires a predominant electrification of the heating and transport sectors. This will result in a higher electricity demand in the long-run. **System efficiency** means, **every generated kWh and every investment therefore should be used optimally in the interests of the overall system**. This new model should include the power, heating, and transport sectors. Linking these sectors intelligently, while unlocking flexibility and at the same time, enabling investment decisions and energy use under realistic conditions should be the model's primary goal. The model should also take local differences and regional location factors into account and, in addition to saving energy, create space and impetus for the expansion of renewable energies and further decarbonization options.

Growing consensus for environmentally beneficial electrification

Consensus is growing that meeting ambitious GHG reduction goals will require electrification of end uses such as space heating, water heating, and transportation. Meeting the objectives of the Paris Agreement will require a deep decarbonization of the EU economy. The European Commission's Long Term Decarbonization strategy "A Clean Planet for All" highlights that renewable (and decarbonized) electricity should increase significantly, replacing fossil fuels in Europe's energy mix and across all sectors of the economy, as a pre-condition to meeting our climate objectives. The German Ministry for Economic Affairs and Energy (BMWi) finds that "*electricity from the wind and sun reduces the CO2 emissions of vehicles, buildings and industry*".[2]

Trends behind environmentally beneficial electrification

- **GHG emission reduction goals**
  The European Council, in June 2017, strongly reaffirmed the commitment of the EU and its Member States to swiftly and fully implement the Paris Agreement. With a new institutional cycle that has begun on December 1st, 2019, Commission President Ursula von der Leyen is aiming to putting climate neutrality by 2050 into law and increasing the climate ambition level for 2030. The Commission is expected to present a comprehensive plan on how to increase the EU's GHG reduction target for 2030 to at least 50% and towards 55% in a responsible way by October 2020.

- **Significantly increased efficiency of end-use equipment itself**
  The second trend creating plentiful opportunity for environmentally beneficial electrification is the notably increased efficiency of end-use equipment

[2] BMWi (2017): Electricity 2030. Long-term trends – tasks for the coming years.

itself. For instance, the availability and performance of heat pump technology, which is often 200% to 300% efficient at converting electricity into heat and hot water for homes and businesses,[3] offers significant opportunity for electrified loads to reduce emissions compared to fossil powered alternatives.[4]

- **Growing need for flexibility to enable greater integration of renewable energy into the electric grid**
  The third electrification trend is the growing need for flexibility to enable greater integration of variable and intermittent renewable energy into the electric grid. While the electricity system was historically designed under the principle that generation follows demand, the uptake of variable renewable energy sources has changed this. Networks increasingly rely on flexibility in energy production and/or consumption in order to integrate the increasing share of solar and wind in the energy mix. Because electricity can only be stored to a limited extent, the variability of supply must be balanced with the ability to vary demand. It thus becomes far more important – and far more valuable – to control the load side of the equation by managing the operation of electric loads that possess energy storage capabilities (e.g. industrial loads, electric water boilers, electric vehicles). These "flexible" loads can be called upon to "absorb" the power generated by renewable electricity when the sun is shining, or the wind is blowing, and can be quickly shed when they are not. Optimization of demand-side resources will be key to keeping electricity reliable and affordable as large amounts of renewable generation are added to the generation mix. Thermal loads, such as industry processes, space conditioning, water heating and (heat or ice) storage tanks are excellent candidates for storage (in the form of ice, chilled water, and hot water), allowing loads to operate when power is available, and still deliver end-use energy services when heating or cooling are desired.

Policy framework conditions which hamper environmentally beneficial electrification

The increase in the flexibility potential of decentralized producers, storage facilities and consumers are closely linked to the **system of network charges**, which today, however, has an inhibiting effect on flexibility in many EU Member States, such as Germany for example. Therefore, a correction is required by a corresponding **revision of the network charging system**.

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[3] Heat pumps use electricity to move heat from one place to another instead of generating heat directly. To move the heat, heat pumps work like a refrigerator in reverse. By using electricity to move heat out of surrounding air, it can deliver two to three times more heating energy than the electricity it uses, thus the technology is 200–300% efficient at heating space and water.

[4] However, from a system-wide perspective, the increased annual performance factor of heat pumps as a result of stricter energy efficiency requirements bears the risk that the flexible operation of heat pumps becomes increasingly difficult. This contradiction needs to be addressed in system efficiency thinking.

Likewise, efficiency potentials are not raised by the **high burden on electricity with taxes, charges and levies**, as this puts electricity at a massive disadvantage compared to fossil fuels. In both the transport and heating sectors, the different burdens on energy sources play a crucial role. Here it is fundamentally necessary to create a level playing field between the different energy sources.

While the goal of greenhouse gas neutrality by 2050 is undisputed, views differ widely on the individual sub-objectives for how to reach this goal and the path towards them. However, the assumption that (renewable) electricity consumption will increase strongly in the medium and long term is largely acknowledged. Increasing energy efficiency will be able to cushion this development, but most likely will not be able to reverse the expected growth trends[5]. Therefore, we explicitly point towards the problem that – considering current tendencies and figures – **overambitious expectations of future energy savings** lead to wrong conclusions that would weaken the expansion of renewable energies. For example, the proposed Building Energy Act in Germany continues the concept of compensating for renewable energies through efficiency measures and thus plays them off against each other. However, this doesn't serve the purpose of achieving carbon neutrality. Measures should complement each other – thereby, system efficiency would be massively enhanced.

Using subsidies wisely to foster environmentally beneficial electrification while exiting heat supply with fossil fuels

The building sector is still a long way from achieving its carbon reduction goals. In order to achieve progress in reducing final energy consumption and GHG emissions at the necessary speed, especially by 2030, a few clear and transparent measures are needed to increase energy efficiency and use renewable energies in buildings. These must address both, the new construction of energy-optimized buildings as well as the energy-efficient refurbishment of existing buildings. Therefore, a realistic view of the effectiveness of the measures is needed, which should be evaluated under the premise that "*every public euro used contributes to saving as much CO2 as possible*"[6]. Or in other words, the measures should contribute to system efficiency which basically means fewer emissions created per unit of useful output of an energy-consuming service. For example, fewer grams of CO2 emitted per kilometer traveled by a car or fewer grams of CO2 emitted per liter of hot water provided by a water heater.

Incentives must be designed in such a way that they motivate consumers not only in theory but also in practice. The annual renovation rate for existing buildings is only one percent. However, in order to achieve the goal of an almost climate-neutral building stock by 2050, the promotion strategy needs to be adapted. The introduction of **tax incentives** for energy-efficient building refurbishment is an important component for advancing energy efficiency in buildings. The concept of **tax savings** is very well suited to motivate building owners to carry out renovation measures.

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[5] For example, the German Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) forecasted an increase in electricity consumption of 200-250 TWH by 2050.

[6] Like stated in the coalition contract of the German government (2018): Ein neuer Aufbruch für Europa – Eine neue Dynamik für Deutschland – Ein neuer Zusammenhalt für unser Land.

The impact of proposed measures needs to be reviewed from different perspectives. Buildings consume energy, but they can also produce and store energy in ways that make the entire energy system more flexible and efficient.
A practical example in this respect are heat pumps, which due to the high energy efficiency requirements have been unilaterally optimized by manufacturers to save energy, but which restrict their control and use as flexible electricity consumers in the energy market. For the integration of renewable energies, flexibly controlled heat pumps are indispensable and much more effective than models designed solely for energy savings.

Any **financial incentive** (e.g. premiums, rebates, or other subsidy schemes) for the replacement of oil-based heating systems can in principle result in the right decision, namely the conversion of the heating system to renewable energies. This measure will have far-reaching consequences, as the newly installed heating system will remain in place for up to 30 years. Nonetheless, false lock-in effects by installing heating technologies that appear cheap in the short-term should be avoided. The simple replacement of one fossil energy source (oil) by another fossil energy source (natural gas) may result in (only limited) CO2 savings in the short-term. In the long run, however, just another fossil-fuel based system will be installed. In order to avoid such fossil lock-ins, the market rules should already now be adjusted in such a way that heating systems are converted as soon as possible to a system of renewable energies (e.g. renewable electricity or clean gas), storage tanks and/or heat pumps.

Other needed policy framework adaptations to support environmentally beneficial electrification

The energy revolution and the associated transformation process to a carbon-neutral industrial society provide great economic opportunities. However, this requires consistent proposals for measures and reliable framework conditions.
In that vein, in Germany we call for the introduction of an **effective carbon price** of 35 - 45 Euros per ton of carbon-dioxide-equivalent from 2020 onwards, including for the heating and transport sectors, combined with an **ambitious price path**. A draft amendment to raise the fixed price in the German fuel emissions trading act to 25 €/t CO2 from 2021 with an increase to 55 €/t in 2025 was only approved by the German Government in May. However, this important adjustment still must pass the legislative process successfully.

Another central lever in the building sector is the **consistent reassessment of primary energy factors** (PEF). These are of key importance in the evaluation of the heat supply of new buildings, but also in the refurbishment of existing buildings. However, the methodology currently implemented in Germany for determining the PEFs is not suitable for providing answers to the questions of the climate impact of the buildings' energy requirements. Thus, there is no decisive steering effect with regard to climate protection. This applies in particular to the almost equalization of heating oil, natural gas, hard coal and lignite with a PEF of 1.1 and 1.2, respectively, which in reality show different CO2 emission levels. Accordingly, significantly higher PEFs must be set for coal and heating oil in particular. Primary energy factors of the energy sources should be designed according to their CO2 emissions.

Thus, allowing consumers to immediately see the different impact of the chosen energy source toward the goal of climate neutrality.

Conclusion

Metrics matter greatly. If policies are measured in an undifferentiated way based on consumption metrics (such as kWh), we will miss many cost-effective GHG emission reduction opportunities from fuel conversions. Numerous opportunities for environmentally friendly electrification are within reach. Recognizing and taking advantage of these opportunities will not be possible simply by focusing on reducing the kilowatt hours (kWh) consumed.

The electric system is dynamic and evaluating the impacts and benefits of electricity use is not a simple task. It is important that metrics are effective and accurate. But no single metric can be pursued in isolation. It is necessary to look at the system broadly, develop priorities (including security of supply, affordability, flexibility, compliance with environmental regulations, and economic development), and optimize the integrated system accordingly.

Who we are: Bundesverband Neue Energiewirtschaft e.V. (bne) / Association of Energy Market Innovators – a strong voice for independent energy companies

bne represents the interests of grid-independent energy suppliers and energy service companies in Germany. By combining competition, renewables and innovation members create a new energy industry and unleash the forces of energy system transformation.

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