Forum Energie

Position Paper

Turning the power transition into an energy transition
Sector coupling

VDMA statement

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The demands of the VDMA:

- Define sector coupling in a multidirectional manner. Consider the potential of innovative technologies and remain open to all technological approaches.

- In the electricity segment, take requirements from other sectors into account at an early stage when expanding renewable energies and plan for the effects on the grid infrastructure in good time.

- Make the existing power plants future-proof by increasing flexibility and using greenhouse-gas-neutral fuels in order to guarantee reliable energy provision.

- Develop an economically sustainable and coherent framework for sector coupling. In the future, a comprehensive energy transition should not be financed solely by the electricity segment.

- Fundamentally reform the emissions trading system (ETS): Although this was successful as a volume control instrument, for various reasons the resulting price was unable to have a sufficient steering effect.

- CO_2 emission fees through a trading system or additional, compatible instruments with the aim of creating a long-term economic incentive for climate protection – but not at a solely national level.

- Take the heterogeneity of processes in industry into account. Competitive solutions are therefore necessary, but the technical requirements of the existing machines and systems must also be noted.

- Regard CO_2 as a reusable material (carbon capture and use) and take the first steps toward a climate-neutral carbon cycle.

- Treat buildings as communicating elements of a networked energy system. In order to meet the challenges associated with the growing proportion of renewable energies and the increasing variable load resulting from these, not only are highly efficient and smart buildings required, but also the possibilities offered by storage, energy supply and the use of demand response technologies. It must be possible to refinance this flexibility in a market.

- Implement the energy transition in the transport sector through alternative drives and fuels.

- On an EU-wide level, incorporate the expansion and facilitation of all sector coupling technologies in a regulatory framework in the “Clean Energy for All Europeans” package.

Turning the power transition into an energy transition

Sector coupling

Just a few years ago, the energy transition was seen as a purely German phenomenon – even by sections of business. Today, however, a significant realignment of many energy systems is taking place worldwide. This is evident in view of the fact that more money is being invested in renewable energy technologies than in their fossil fuel counterparts worldwide. The Paris Agreement has given this development further political impetus and has bestowed a a greater obligation in the long term. In summer 2017, 19 members of the G20 declared that the agreement was irreversible.

Mechanical and plant engineering has long been a provider of solutions for new, sustainable energy systems. However, it is also a user of such solutions and bears part of the system costs. We have made great progress in recent years: The necessity of increasing energy efficiency has sunk into the public consciousness and thermal power plants can now react highly flexibly to the generation of electricity using renewable energies. Technological innovations made it possible to reduce costs for renewable energy systems. Many of these developments originate from Germany.

But more is required in order to achieve the ambitious, long-term goals set in the political arena – in particular a more efficient energy transition. After all, the transformation of energy supply must not be limited to a power transition. Industry, buildings and transport comprise decisive segments of the energy system whose sustainability will determine the success of the transformation. This can only succeed if the three markets of the energy industry – electricity, heating and transport – are linked together in the future.

Within politics, business and society, a far-reaching transformation is imminent, with systematic changes in all sectors. Very long-term legal provisions reaching beyond a single legislative term and that offer investors continual planning security far into the future are an essential prerequisite for success.

Defining sector coupling in a multidirectional manner

Sector coupling is the key challenge when it comes to a coordinated and comprehensive energy transition. The aim is to achieve the politically defined energy and climate goals in all areas of business and society while also ensuring security of supply and affordability as a triad of energy policy objectives.

The networking of the energy, industry, buildings and transport sectors (i.e. the three markets of electricity, heating and transport) through sector coupling is multidirectional and has four distinguishing features.

- Physical: The availability of the technologies and the required amounts of energy
- Market-based: The energy markets must be linked in an open and equitable way
- Data-related: Only the availability of information on supply and demand in all sectors enables the energy systems to be linked in a sensible way
- Regulatory: Regulatory instruments must take reciprocal effects and permeability as well as economic aspects into account

The Green Paper on Energy Efficiency and the assessment report define sector coupling very narrowly – that is, as the consumers of electricity from renewable energies. It is undisputed that the role of the electricity sector will continue to grow over the coming decades through direct and indirect electrification (power-to-X). However, this view is too one-dimensional.

Many sector coupling applications are long-established developments. When viewed from this perspective, sector coupling has been taking place for a long time through combined heat and power plants (CHP), which produce electricity and heating at the same time. Power generation from waste heat is also a proven technology for coupling industrial processes and the generation of electricity. The direct electrification of further fields of application, from the electrical heating of highly efficient buildings to electromobility, is the key priority of sector coupling. However, this alone will not guarantee the comprehensive penetration of renewable energies. Therefore, more technological developments must be taken into account when determining the regulatory framework for sector coupling. For applications in which comprehensive direct electrification is not foreseen or particularly advantageous, the conversion of electricity into thermal or chemical energy or base chemicals offers a solution. Reconversion, i.e. power-to-gas-to-power, can be a further solution. Synthetic gas produced from renewable energy is currently the only known means of long-term or seasonal storage which is feasible for large-scale technical use. As every conversion process is accompanied by efficiency losses, further research is needed in this field.

Remaining open to all technological approaches

For a long-term task like sector coupling, all technological solutions must be given an equal footing. The goal must remain economically efficient sector coupling. It will mainly be decided on the market which technologies ultimately prevail. However, this needs to be done in such a way that the price reflects system effects. Efficiency is an important criterion in the assessment of technologies, but is by no means the only one. It is also important to consider the following aspects:

1. Enable a variety of solutions
Many politically preferred technologies for direct electrification also have the potential to prevail on the market. However, this does not necessarily have to be the case for all conceivable fields of application. For example, the heat pump can play a major role in the building sector, but is possibly not suited for the high-temperature range (>150°C) in the industrial sector. The battery electric drive will become important for passenger cars. However, in other areas, such as shipping or aviation (passenger and freight transportation) and in the construction and agricultural sectors, direct electric drives will not be available for all performance ranges, even in the medium term. As such, there is no “one size fits all” solution for the energy transition. The players involved should be able to implement the most suitable and economical solutions for their specific application. In this context, conceivable options would include the expansion of local hydrogen networks in local industry clusters, electrical hybrid trolley trucks and trolley buses or hydrogen buses on selected public transport lines, or the alternative LNG or hydrogen trains for non-electrified regional train lines.

2. Do not ignore system costs
The reduction of the energy transition to a power transition has highlighted the infrastructural limits of the project. Grid expansion is currently lagging behind the demand for renewable energies. The existing gas and heating network infrastructures, on the other hand, can also absorb large amounts of energy and facilitate an efficient and greenhouse-gas-neutral energy supply. Lower infrastructure costs can even make less effective technologies useful for the overall system. A cost-efficient energy transition optimizes both system costs and the costs for expanding renewable energies if, for example, international energy markets are involved.

3. Customer preferences and acceptance
Policymakers cannot decree customer preferences for certain technologies. Therefore, only those technologies that are accepted by the customers will prevail on the market. The market must be able to respond to this without having to adhere to political demands.

Large-scale projects, including grid expansion, are increasingly encountering problems gaining acceptance from the people. Grid expansion is essential for the success of the energy transition and must be driven forward. However, with regard to the existing acceptance problems, it can be advantageous to continue using the existing gas and heating infrastructure for the energy transition.

4. Use international energy markets
It is not adequate enough to simply optimize the German energy system. The objective of the energy transition is to achieve politically defined energy and climate goals, and is not energy self-sufficiency. Thanks to the possibility of storage and transport, power-to-X processes in particular allow the security of supply to be guaranteed across Europe and also throughout world markets. Where the power-to-X energy sources are ultimately produced is a matter of economic efficiency.

5. Enable innovations
The perception of what an optimal technology mix looks like changes over the course of time and is influenced by innovations. Although some innovations are foreseeable in the medium term, there are constant disruptive technological developments. Technologies that are not currently ready for the market or do not appear to be a cost-effective solution can emerge as key technologies in the long term. In order to avoid any lock-in effects, the world of politics should not specify any directions for technological developments. Necessary decisions on infrastructure made in the political arena must be reached carefully and with an eye on the technological options.

6. Strengthen the role of Germany as a leading market
A successful energy policy in Germany and Europe cannot be judged solely on the basis of the specific implementation of energy and climate goals in Germany and the technologies preferred here. Around two thirds of goods manufactured by the mechanical and plant engineering sector are exported to Europe and across the world. The mechanical and plant engineering sector must therefore be able to serve a global market and cannot develop technologies which are tailored to German political requirements. Even today, Germany and Europe are competing with North America and Asia for the role of leading market and leading provider. German and European manufacturers can remain competitive in the long term through innovative technological solutions which can assert themselves on the global market. Framework conditions conducive to different technologies as well as research funding can play an important role here.

7. Sector coupling that includes all types of technology increases security of supply
In a comprehensive energy transition, sector coupling does not just neutralize greenhouse gases in the fields of energy, industry, buildings and transport. Technologically diverse sector coupling also creates flexibility, thereby contributing to the security of supply.

Taking the additional demand from other sectors into account when expanding renewable energies and power grids

The coupling of sectors will cause the demand for electrical power to increase considerably in the coming decades. The first priority here is not to expand business models on the basis of the use of excess electricity, as this is purely a phenomenon of the transitional period.

In view of the existing power plants, it will not suffice to gradually replace these plants with renewable and – with the exception of biomass – non-fuel-burning capacity by the end of their service lives, i.e. to make the obligatory reinvestments in renewable energies. Rather, due to sector coupling, today's nominal generation capacity will need to be increased many times over. Indeed, most studies examining the development of electricity demand anticipate an increase from 550 TWh to 800 TWh and more. Furthermore, as a result of the energy transition, the load will be physically separated from generation for the first time, which would alone necessitate modification of the grid infrastructure. In addition, decentralized and fragmented generation, such as prosumers, charging infrastructure for electromobility and changes brought about by flexible loads and storage, will require a fundamentally new grid infrastructure on all grid levels.

Therefore, the expansion strategies for renewable energies must be pursued and developed and oriented toward the growing demand brought about by sector coupling. The enormous reductions in the cost of onshore and offshore wind power and photovoltaics in recent years show that, instead of narrowing down the choice of technologies at an early stage, it is worth creating a flexible framework which can utilize the sharp cost reductions in existing technologies in an economic sense, while at the same time not ruling out the use of new technologies for the future. Here too, we are still in the early stages of the development of innovative technologies, the potential of which would remain partially untapped as a result of excessively fragmented political control. Of course, the requirements of the electricity grid infrastructure must be seen in context and are increasing considerably. The expansion of the grid must therefore be coordinated with the expansion of renewable energies.

At the same time, the existing thermal power plants must be made sustainable by increasing flexibility and using greenhouse-gas-neutral fuels. This will then enable a reliable supply of electricity to be ensured in a greenhouse-gas-neutral energy system.

“Efficiency first” versus “energy efficiency first”

In the Green Paper on Energy Efficiency, the German Federal Ministry for Economic Affairs and Energy has set out the three main principles of the energy transition: efficiency first (permanent reduction of energy demand), the direct use of renewable energies and efficient sector coupling. VDMA has always stressed the great importance of energy efficiency as a central pillar of the energy transition. There is still great potential for savings in the fields of energy, industry, buildings and transport. This must be leveraged with market-oriented instruments based on the voluntary nature of business decisions.

Moreover, VDMA supports the principle of “efficiency first” as a political guiding principle for the implementation of the energy transition. However, the principle of an efficient energy system must be used in a holistic way as part of a fully integrated energy system. As such, an efficient energy system is not about saving electricity in all sectors, at all time, no matter the cost. For example, an efficient energy system saves energy where it is economically prudent to do so and offers flexibility when it is necessary and profitable. In a fully integrated energy system, it is therefore not the consumption of a single energy source that is relevant, but final energy consumption as a whole.

Developing an economically sustainable framework for sector coupling

A comprehensive energy transition must be financed by the entire energy system and not solely by the electricity segment. It is therefore important to develop a sustainable and coherent concept in which the tax, contribution and levy systems do not present an additional burden during the transition between energy forms. As a rule, energy costs must be financed through the energy system in a way that is fair to both consumers and producers. The main objective must be the development of a market-based system that does not discriminate against providers or consumers and internalizes external costs, such as environmental damage.

The emissions trading system (ETS) is successful as a volume control instrument in the energy and industrial fields. However, the resulting price was unable to have a sufficient steering effect for various reasons. There is therefore urgent need for reform. VDMA sees no reason for the isolated expansion of emission trading to the non-ETS sectors on a European level. Before further European-wide measures are implemented for the building, agricultural and transport sectors, these must be justified on the basis of a sectoral cost-benefit analysis. Germany must throw its weight behind general CO_2 emission fees on a European and international level in addition to and compatible with the ETS. This allows the greatest steering effect to be achieved. If Germany was to go down this path alone, this would merely harm the German industrial sector. However, an international approach would be advantageous for mechanical and plant engineering as the efficient technologies required are already available here.

Sector coupling in industry: enabling climate-neutral heating and carbon cycles

Around two thirds of the energy requirements for heat generation are covered by the direct use of fossil fuels in the industrial sector today. Given the energy and climate goals, this sector is faced with the challenge of almost completely reducing greenhouse gas emissions. Direct electrification can make a contribution here. However, industrial processes are highly heterogeneous. Very high temperatures are needed to generate heat. In the future, heat in the low-temperature range can be generated directly using electricity from renewable energies. For high-temperature processes (>150°C) it will be predominantly energy source substitution, i.e. the switch to greenhouse-gas-neutral power-to-X fuels, that plays the major role. As such, existing infrastructure for gas and heating can continue to be used. In order to raise efficiency, the waste heat generated should be used as a heat and cooling source far more than has been the case so far. Alongside the generation of renewable fuels for heating, power-to-X technologies also create products for material use in industry (power-to-chemicals). CO2 is deployed as a reusable material in many of the conversion processes (carbon capture and use, or CCU). VDMA also believes the process holds great potential for reducing CO2 emissions in industrial processes (e.g. the steel, cement or chemical industry) in the future. For this to be realized, intrinsic CO2 sources should be used multiple times where possible in order to take the first steps toward a climate-neutral carbon cycle. When diversifying gaseous, greenhouse-gas-neutral fuels, the technical requirements of the machines and plants must be taken into consideration. Even today a compatibility of up to around ten percent hydrogen is often assumed in the natural gas distribution grid without natural gas filling stations and complex industry. However, the energy sources used must be determined by the consumers. A significant example and even a potential hazard is the suitability of fuels with different specifications in various applications, such as a fluctuating hydrogen content in natural gas. Further development of the technology will enable new plants to meet these challenges. In many existing plants, fluctuating gas quality has considerable effects in terms of exhaust gas behavior, efficiency and service life.

Sector coupling in buildings

Sector coupling in the building sector will make an important contribution to meeting the energy and climate goals in the future and represents a key opportunity for a comprehensive energy transition. Building technology can play an essential and, above all, sustainable role in achieving the political objectives. Sector coupling for the building sector is of key importance for realizing the heating transition. To the same extent, the building sector is also an elementary component for sector coupling.

In line with the “efficiency first” principle, the initial aim is to raise energy efficiency, cover as much of the remaining energy requirement as possible from renewable sources and then to couple the sectors in an intelligent manner. In order to meet the challenges associated with the growing proportion of renewable energies and the increasing variable load resulting from these, not only highly efficient and smart buildings are required, but also the possibilities offered by energy monitoring and management, storage, energy delivery and the use of demand response technologies. Even today, some buildings generate more electricity and heat than they consume themselves. Buildings are becoming communicating elements. A prerequisite for this is digitalization, which in turn is based on building automation. It is important to retrofit and operate the residential and non-residential buildings that are not yet digitalized with intelligent components, systems and building automation systems in order to make them “smarter” and more efficient.

Customer preferences, behavior and acceptance of the technologies play a major role in existing buildings. For this reason, additional benefits for the building users, such as increased comfort and convenience for residents, improved indoor air quality and optimized energy management, are important drivers of the energy transition and support the penetration of a technology mix consisting of the direct and indirect use of electricity. If people are not open to technology, the goal of a greenhouse-gas-neutral building sector will not be achieved. The political framework conditions must therefore create a level playing field for purely electrical and power-to-X applications as well as hybrid systems.

The advantages resulting from the continued use of existing or further developed structures – such as the existing gas and heating grid infrastructure – should be incorporated in political planning. The same applies for other storage technologies and the utilization of waste heat, which has so far been neglected in the political discussions relating to sector coupling. Waste heat from processes can be used as a source of heat and cooling, couples the industrial and building sectors and increases the efficiency of the energy supply.

New energy in transport: alternative fuels and drives

In order to achieve the energy and climate goals, the transport sector must also make a considerably greater contribution toward reducing greenhouse gas emissions than was previously the case. VDMA welcomes the measures taken by the federal government so far within the scope of the Climate Action Programme 2020 and the National Energy Efficiency Action Plan (NAPE) which are aimed at reducing final energy consumption in transport.

Nevertheless, these measures alone will not be sufficient to achieve the set reduction objectives in the transport sector in Germany as they do not adequately consider several of the major emission sources in the transport segments. In segments that continue to enjoy strong growth such as heavy-duty transport, shipping and aviation (passenger and freight transportation) and in the construction and agricultural sectors, a mix of direct electric drives, fuels low in greenhouse gases (e.g. CNG, LNG, biodiesel, bioethanol), synthetic, greenhouse-gas-neutral fuels (e.g. hydrogen, methane or liquid hydrocarbons based on renewable energies) as well as hybrid systems (e.g. synthetic fuel and alternative drives) must make an important contribution to reducing CO_2. The expansion of biofuels alongside the existing fuel mix as a contribution toward reducing CO_2 should also not be neglected. Together with battery-based electromobility for urban areas and hydrogen-powered fuel cell vehicles as well as electrical road systems for use nationwide, competition is currently developing worldwide between all alternative fuels and the corresponding drive systems, depending on profitability and their use in the respective transport situation. The German mechanical and plant engineering sector is playing a key role here and provides mature technologies for generating sources of energy and building up and expanding the necessary storage and distribution infrastructure as well as components for the broad range of drive systems.

Given the emerging variety of alternative fuels and drive technologies dependent on the mode and purpose of transport, it is necessary to keep all alternative technological approaches on the table and to develop them further, as a final assessment of their long-term market viability is not yet possible.

At the same time, new infrastructures are also required to convert the transport systems, including infrastructure for charging battery-driven vehicles, overhead lines for electrical street systems and the expansion of infrastructure for alternative gas fuels (CNG, LNG, hydrogen) and connections to neighboring EU countries. This expansion should be privately financed to the greatest possible extent. However, state framework conditions and incentives are needed for this.
VDMA also sees great savings potential in an optimization of logistics chains through intelligent networking. Industrie 4.0 approaches can also contribute toward a significant increase in efficiency in the transport sector as well as in construction and agriculture.
The investment costs for building the infrastructure needed for alternative fuel and drive systems on the supply side and for the purchase of alternative means of transport on the customer side are considerable and are planned for a timescale of ten to 15 years (or sometimes longer for systems). A current impediment to investment in more efficient or alternative drive technologies, however, is the low cost of fossil fuels. It is therefore necessary to consider internationally coordinated CO2 emission fees, particularly in international transport segments such as maritime shipping, in which immense competitive pressure discourages investment without tangible cost advantages.

EU-wide sector coupling – integrated energy

The European Union is to implement an integrated common energy market across Europe. Alongside the basic principle of supply security, the objective of this is to achieve the climate and energy goals of the EU. The Energy Union can already point to some initial successes through the funding of renewable energies, increasing energy efficiency and intensified grid expansion. However, the potential of the energy system is far from exhausted. The Energy Union can only succeed as a European energy transition if all players and sectors work together.

This is also the assessment of the “State of the Energy Union” report. According to current estimates, the EU will meet its energy and climate goals for 2020, but efforts toward reaching the goals for 2030 need to be intensified. Among other things, at least 27 percent of gross final energy consumption is to originate from renewable sources by 2030. This means that the proportion of renewables in the electricity sector must increase significantly.
Sector coupling can and should be a central element here. The task of the EU is to provide the regulatory framework conditions which the member states then implement as specific measures on a national level. The coupling of sectors should also be used to forge new dialog-based approaches between member states here, in which national experiences and best practice examples are exchanged.

The “Clean Energy for All Europeans” package proposed by the Commission in November 2016 is part of this. A balanced approach when revising the legislative package is of crucial importance for the further development of the Energy Union. The inclusion of low-CO2 technologies in the regulatory framework at an EU-wide and national level is synonymous with the expansion and funding of all sector coupling technologies through European institutions.

In the case of the EU guidelines on renewable energies, it should be noted that the increase of the binding 27 percent share of renewables across the EU can be used both for power-to-X solutions and other technologies, for instance direct electrification. It is vital for the future development of the technologies on the market that these guidelines are specific and non-discriminatory. Furthermore, they must be implemented in such a way that they are consistent with the electricity market regulation.

The EU buildings directive stipulates the introduction of charging stations (at least every tenth parking space)[1] for the expansion of infrastructure for alternative fuels in non-residential buildings which are subjected to extensive renovation. It should be noted that synthetic fuels can also be used here.

As a central element of the legislative package, the governance directive prescribes the creation of national plans for achieving the energy and climate objectives for 2030. In accordance with the current schedule, the member states were to submit their plans for reaching these goals as early as January 2018. Sector coupling should be a key element when defining the measures for the German plan. The correct incentivizing and steering effects will unlock the potential to make an essential contribution to implementing the energy transition.

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[1] Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings (Article 8, Paragraph 2, Subparagraph 1; p. 19); November 30, 2016.