The Steinfurt flex power plants

A REGION IMPLEMENTING THE ENERGY TRANSITION

Concept study

energieland 2050

Wir drehen das im Kreis Steinfurt!

Project duration

01/09/2014 – 31/12/2016

Programme: nip Nationales Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie

Funded by: Bundesministerium für Verkehr und digitale Infrastruktur

Coordinated by: NOW Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

hyTRUST PLUS

KREIS STEINFURT

IMPRINT

Spilett n/t GmbH
Linienstr. 160
10115 Berlin

www.spilett.de
info@spilett.de
Tel.: + 49 30 536 796 24

The HyTrust project was commissioned by the Federal Ministry of Transport and Digital Infrastructure (BMVI) under the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP), which is coordinated by NOW GmbH National Organisation Hydrogen and Fuel Cell Technology.

PROJECT TEAM

Nadine Hölzinger	Spilett n/t (hoelzinger@spilett.de)
Anke Schmidt	InnoZ (anke.schmidt@innoz.de)

CONCEPT CONTRIBUTORS

Ahlke, Ulrich	Steinfurt district
Echelmeyer, Rolf	Stadtwerke Steinfurt
Göckenjan, Gerhard	Bürgerwindpark Hollich
Höper, Jutta	Steinfurt district
Howe, Friedrich	Sauerstoffwerk Steinfurt
Klüppels, Michael	Regionalverkehr Münsterland
Möller, Thomas	Steinfurt district
Niehues, Pia	Steinfurt district town
Rahe, Eckhard	Westfalengas
Ruhe, Dieter	B & R Energie
Topphoff, Albert	Volksbank Saerbeck
Twilling, Christian	Kreissparkasse Steinfurt
Voß, Thomas	Die Energielandwerker
Wetter, Christof	Fachhochschule Münster

Additional information:

"The Steinfurt flex power plants – position paper of the regional stakeholders from the Steinfurt district"

www.innoz.de/sites/default/files/hytrustplus_positionspapier_steinfurt_0.pdf

The Steinfurt flex power plants

A REGION IMPLEMENTING THE ENERGY TRANSITION

Concept study

energieland 2050
Wir drehen das im Kreis Steinfurt!

TABLE OF CONTENTS

FIGURES AND TABLES

1 SUMMARY

From April 2015 – June 2016 stakeholders in Steinfurt, the second largest rural administrative district in North-Rhine Westphalia (NRW), developed a concept to further boost the energy transition in rural areas: Steinfurt flex power plants. This was done as part of the BMVI-funded NIP project: HyTrustPlus.

The figures and strategies in the "Master Plan 100% Climate Protection" developed in 2014, which establishes the framework for implementing regional energy transition in the Steinfurt district until 2050, formed the basis for analysing the upcoming challenges of the energy transition in the Steinfurt district: plant capacities of 2 GW for the energy utilisation of wind power, sun energy and biomass must be planned, installed, operated and integrated in the regional energy infrastructures by 2050 in order to achieve the objectives of the master plan. At the same time energy demand in all sectors must decrease: instead of an annual consumption of around 13 TWh in the district in 2010, there should be a demand of only around 6 TWh of energy in 2050 to be able to reach energy and climate policy goals and maintain quality of life in the district.

The aim of the HyTrustPlus strategy dialogue was to understand what role hydrogen and fuel cell technologies could play in achieving the master plan's objectives, what added value could be provided by hydrogen as an energy source for the region and how interaction with other technical and organisational solutions of the energy transition could work. Likewise significant barriers to and challenges of integrating hydrogen in the activities of the regional energy transition were to be identified.

The strategy dialogue assumes the technological feasibility of the hydrogen innovation system. The main questions in the discussions and deliberations focused on the:

- Appropriate technology and strategy concept (including requirements for the regional energy transition, positioning in existing energy infrastructures and markets)
- Economic efficiency of the approach (including current and required profitability, parameters for securing or increasing profitability, consequences of a lack of profitability)
- Associated risks of implementing the concept (risk distribution, strategies for minimising risk)
- Funding strategies, responsibilities and participation schemes required for implementing the concept as well as a
- Specific course of action for the realisation of an integrated "renewable energy/hydrogen economy" for the period up until 2050 (timetable).

With technical guidance, together the participants of the strategy dialogue developed the concept of the Steinfurt power plants, which technologically-speaking, is based on the power-to-gas approach. The role of flex power plants in the energy transition here is perceived to be less in the storage of surplus electricity generated from renewable energies in the context of grid management, but rather in a demand-oriented channelling of energy obtained from renewable sources into the electricity, heat and fuel markets. The kilowatt hour of electricity generated from wind and sun will only be made available to the electricity exchange and fed into the grid if it is actually in demand in the form of electricity at acceptable prices and is thus capable of reducing the extent of grid restructuring and expansion required for the energy transition as well as the EEG (Renewable Energy Law) surcharge for end users. At the same time this approach allows a timely and comprehensive expansion of renewable energies to provide sufficient amounts of CO_2-neutral energy in line with interlinking sectors of the energy transition.

2 THE STRATEGY DIALOGUE IN THE HYTRUSTPLUS PROJECT

HyTrustPlus is the socio-scientific accompanying study of the federal government's National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) for the period 2014 – 2016. The goal of NIP is to accelerate the establishment of hydrogen and fuel cell technology in Germany and to maintain and extend German industry's technological lead in this field of innovation.

The strategy dialogue within HyTrustPlus served to identify and develop regional utilisation and financing concepts for hydrogen technologies in the context of the energy transition. In a total of six strategy dialogues from April 2015 – June 2016, Steinfurt stakeholders assembled to discuss the potential of the hydrogen economy for regional energy transition and to develop solution strategies for integrating hydrogen technologies. Parallel to this a variety of individual meetings took place to bilaterally discuss identified obstacles and risks as well as to both prepare and follow-up on the content of the strategy dialogue.

At the time of the Steinfurt dialogue, there had already been first experiences with the demonstration of power-to-gas systems, whose basic technological suitability was examined as an additional consumer for the system stabilisation of the grid in surplus production. Discussions between experts on the energy transition focused on the power sector and mainly covered the following solutions:

- Virtual networks: Several power generators are connected to a virtual power plant, in order to better compensate for regional fluctuations of supply and demand or forecast deviations.
- Smart grid: The electricity consumer is motivated by incentives to match demand to supply and in this way contribute to grid stabilisation.
- Renewable energy development corridors: Expansion goals are defined, which when exceeded, lead to the reduction of compensation rates ("flexible ceiling").

Although the technologies for efficient hydrogen use in fuel cells in the stationary, mobile and uninterruptible power supply (USP) areas had been tested for several years at the time of the strategy dialogue, there was no experience of integrating these technologies in the strategies of a regional energy transition, and ideas were needed as well as experience with suitable business models. The development of concepts for building infrastructures in particular, and the distribution of benefits, costs and risks to current and future stakeholders acceptable to all sides therefore provided the focus of the Steinfurt strategy dialogue.

3 THE STARTING POINT IN THE STEINFURT DISTRICT

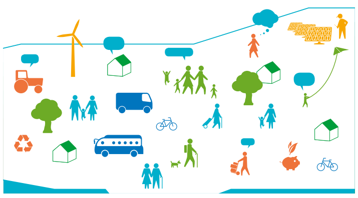
At the beginning of the strategy dialogue, individual interviews took place with the participants in order to better understand the starting point of the various stakeholders and sectors and to define goals and expectations, against which a successful integration of hydrogen technologies in the regional activities on energy transition must be measured.

3.1 ENERGY AND CLIMATE POLICY OBJECTIVES OF THE REGION

energieland 2050
Wir drehen das im Kreis Steinfurt!

In 2014 the district of Steinfurt lay the foundation for the strategic orientation of the region up to 2050 with the publication of the "Master Plan 100% Climate Protection", funded by the Federal Ministry for the Environment in the framework of the national climate protection initiative. According to the plan, the federal government's ambitious energy and climate policy goals (-95% CO_2 emissions, -50% energy consumption and 100% supply from regional, renewable energy sources) are to be realised in the region and expected opportunities arising from the energy transition exploited for the establishment and safeguarding of regional added value chains. The financial energy independence by 2050 pursued in the project "The future district of Steinfurt – energy independence 2050" is to be implemented to the greatest possible extent, i.e. more regional customers must be found for the energy and solutions must be developed to stabilise fluctuating energy supply from renewable sources for the planned expansion of renewable generation capacities.

3.2 ECONOMIC POLICY OBJECTIVES OF THE REGION



In the district of Steinfurt the regions "Steinfurter Land" and "Tecklenburger Land" have been funded by the European Union through the LEADER programme since 2007. One of the funding aims is to improve regional competitiveness, environmental and landscape protection as well as the quality of life in rural areas. Another goal is to diversify the regional economy for a sustainable value chain in rural regions. The integrated development concept underlying the LEADER activities in both regions identifies the following key economic action priorities for the region:

As a central pillar of the regional economy, agriculture is increasingly being challenged by structural change and supra-regional developments. Alternative means of income must be identified and exploited for local stakeholders and the existing range must be expanded to strengthen this economic sector in a sustainable way. Furthermore, the high potential for renewable energies available regionally should be tapped into and energy increasingly distributed on a regional basis.

The economic policy objectives are being achieved through the regional development strategies defined in 2007, which are based on the two pillars of innovation and sustainability. Like participation in pilot projects, similarly new types of products and services are to be developed on a cross-industry basis, focusing not only on strengthening the regional economy, but also on supporting future-oriented structural change throughout the whole region.

3.3 PRESSURE TO ACT AND INNOVATE ON REGIONAL STAKEHOLDERS

Because of today's adverse framework conditions and anticipated future developments, many regional actors must rethink, adapt or expand their current business models. In this context within the HyTrustPlus strategy dialogue they evaluated the role of hydrogen not only as a way of realising regional energy and climate policy objectives, but also in terms of a possible expansion of their own business activities to reduce pressure to act and innovate. Below the respective positions at the beginning of the dialogue process in early summer 2015 are outlined.

3.3.1 DISTRICT OF STEINFURT

The district of Steinfurt is facing structural change: strong medium-sized businesses cannot mask the fact that income in the region is below average for the state of NRW. Without active counter-measures, emigration of young workers is expected, which will exacerbate the skills shortage. If municipal revenue decreases due to emigration and population aging, investment in municipal infrastructures drops, social and cultural facilities must be scaled back, and local public transport services restricted. With diminishing user density, existing infrastructure becomes more inefficient and expensive, and the quality of primary healthcare declines. The danger is that following the waning appeal of the rural region, companies' succession planning can no longer be guaranteed, to the extent that the future sustainability of the currently strong medium-sized sector is threatened.

The district of Steinfurt is now facing the challenge of exploiting the opportunities of the regional value chain without negatively affecting the appeal of the living environment or the existing economic structure. Prospects for the youth generation must be created and increased financial latitude given to the municipalities. The first indications of a trend towards awareness of regional roots (identification with the region) and the associated opportunities for regional products and services have been observable over recent years.

Together with regional players, the aim of the Steinfurt district is to construct a sustainable economic system which is based on existing structures and develops new fields of business. It is important here that:

- The rural space is maintained and strengthened in terms of its appeal as a living space in order to attract new skilled workers and to build up the regional identity of the population,
- The capacity for municipalities' action is increased, and
- An ecologically sustainable policy is emphasised.

3.3.2 WIND FARM OPERATORS

Wind farm operators in the region are among the pioneers of the wind energy sector, and as a result, EEG funding is about to expire for the first of these wind farms. Not all locations can secure the continuation of funding through repowering measures, particularly when a heightening of the towers is prohibited by law because of existing spacing directives on housing development. Subsequent use of the facilities through selling wind power to the electricity exchange is not a viable alternative for wind farm operators, as in the recent past the average attainable revenue lies significantly under the wind farm operators' own costs, and this price level is also expected to remain in the future. After the expiration of the EEG remuneration, the only option left is the dismantling of fully-functioning facilities, should no alternative paths for exploitation be found for the power generated.

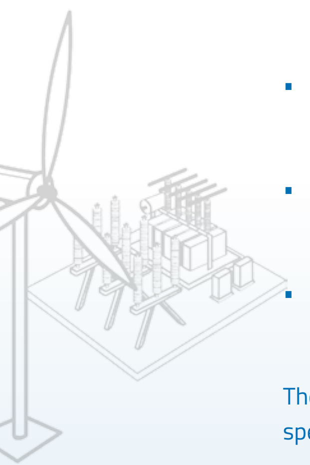
At the same time there will be massive investment in the development of wind power in the region - its energy and climate policy goals require current capacities to be increased five-fold by 2050. Because of the high level of uncertainty on the part of the stakeholders due to EEG reform and the unspecifiable, yet anticipated additional changes to energy legislation over the coming years, development will be given top priority. The continued use of facilities in existing locations would therefore not only be sensible from a technological and economic perspective, but these locations could also be secured as wind power locations for the future through the further operation of existing facilities there. The need for developing new areas is therefore reduced.

New locations and the accompanying encroachment on the natural scenery pose a challenge to the acceptance of the wind energy sector. In addition the sector is under increasing criticism that it is losing sight of the common good in favour of maximising its own profits. This refers to the externalisation of the costs of surplus electricity that is remunerated in the EEG and is borne by society through a levy. The methodology on calculating the EEG levy also contributes to this, as this increases when the purchase price of energy falls at the electricity exchange. The private end customer thus does not profit from the cost reductions caused by renewable energies.

Already ahead of 2030 there will not only no longer be a temporary surplus in electricity from renewable energies in the region, but the electricity amounts produced annually will also on balance exceed the overall electricity demand in the region. In this context delays in grid expansion are deemed critical, as missing networks to transport the energy quantities produced risk the economic viability of the facilities in the development phase and unnecessarily increase the price of energy from wind power facilities. Without sufficiently dimensioned networks or alternative sales chains, increasingly the new facilities must be turned off, and the economic benefit of the facilities decreases.

The aim of stakeholders in the wind energy sector is therefore to secure or expand their business activities for the future and:

- Bring about an economically viable continued use of old facilities, dispensing with EEG remuneration,
- "Refine" the wind power produced, i.e. tap into alternative sales chains for the reduction of dependency on network expansion
- Assume responsibility for achieving the energy and climate policy goals of the region and show that wind power is an important component and part of the solution,
- Take an active role in the discussion on market design in the electricity sector and demonstrate new prospects and solution paths.



There are similar challenges in terms of expanding photovoltaic plant capacities and these are not specified separately.

3.3.3 BIOMASS FARMERS

Compared to the expansion targets in wind power and photovoltaics, the use of bioenergy will be developed at a low level because of regional conditions in the district of Steinfurt. Thus it is planned to increase the 2010 installed electricity capacities from a 96 GWh/a, to a 422 GWh/a annual production by the year 2050. Identified limiting factors of operating bioenergy facilities are the temporary or absolute availability of regional biogenic educts as well as the disposal of waste. So as not to jeopardise the economic efficiency of the facilities, an annual minimum base turnover is needed in the plant. Alternatively increases in the energy yield per substrate use could be achieved by technological and process innovations.

The background for the political cap on developing bioenergy in the Steinfurt district is the accompanying ecological and economic disadvantages of growing energy maize as a co-substrate: if agricultural waste is fortified with maize silage to increase the system efficiency of biogas facilities, this must be regionally grown and increases the amount of digestate that has to be spread on the fields or removed at a cost. Energy maize therefore faces dual competition in terms of usage with alternative land management: on the one hand it reduces the amount of available land for growing forage crops or other agricultural products, on the other it proportionately occupies land for transport of biogenic residue and waste matter. Biodiversity gradually dissipates with single-crop farming of maize.

Through the revision of the fertiliser regulation, according to participating stakeholders the already unsatisfactory situation during the project period will worsen for many farmers and as a consequence, for operators of biogas facilities:

The times when manure may be spread will be restricted and at the same time digestate from biogas facilities will be newly integrated in the production upper limit. The aim of this restriction is to reduce nitrogen loads in soils and waters, the amounts of which have risen alarmingly in recent years and, in the Steinfurt district, lie far above the national German average (see nitrogen land balances for the years 2009-2011). Outside of this manuring period, quantities of manure, slurry and digestate may not be spread and must be disposed of at a high cost. Using waste from livestock and farming in bioenergy facilities could present an alternative utilisation path, the "Master Plan 100% Climate Protection" identifies a hitherto unused, high potential in the region. However this requires an admixture of maize silage for efficient management.

The aim of stakeholders in the bioenergy sector is to secure or expand their business activity for the future and:

- Build up utilisation paths for biogenic waste from livestock and farming and optimise regional nutritional balance (reduction of exports and imports)
- Find alternatives to using energy maize that enable a cost-efficient operation of biogas facilities, reduce the amount of digestate and reduce the nitrogen input in soils and waters, and
- Implement process innovations that enable a sustainable expansion of activities under given ecological and energy policy framework conditions (particularly reducing competition for land use by feed cultivation and tourism, avoiding single-crop farming, increasing biodiversity).

3.3.4 MUNICIPAL UTILITIES AND NETWORK OPERATORS

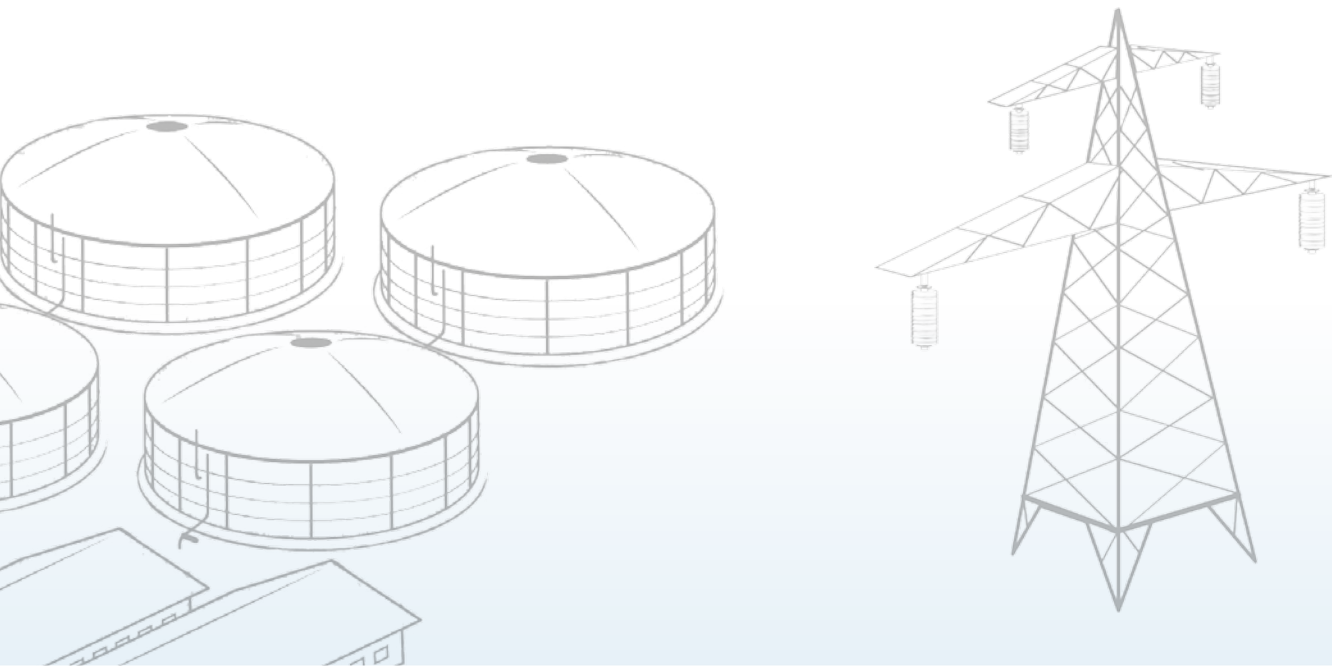
Municipal utilities and network operators in the region are facing the challenge of developing new business models to safeguard business activities. This is in the context of the master plan envisaging 100% climate protection, reducing energy demand in the electricity sector by 15% and in the gas sector by 49%.

The infrastructures for distributing and providing this energy (electricity grids, gas pipes and associated systems) cannot however, be reduced to the same extent, because the security of energy supply must be guaranteed at any point in time. In an energy economy increasingly based on renewable energy sources, the driving cost factors are the construction and maintenance of the energy infrastructures. The costs for the energy will diminish going forward.

Significant investment in the expansion and reorganisation of the supply infrastructures in the electricity sector is also necessary because of greater requirements in the functionality of the network: they must not only handle increasing amounts of volatile electricity from multiple locations, but electric mobility from the consumer side also requires intelligent networks to use renewable energies in the transport area. These foreseeable investment costs occur over a relatively short period and must be absorbed by a fair pricing system, which does not burden end customers with charges. Otherwise the danger is that acceptance of the regional energy transition will decrease and political support will be eroded.

The aim of the municipal utilities and network operators is to secure or expand business activity and to

- Keep energy supply from regional energy sources affordable for end customers
- Absorb forecasted changes in production and energy demand in flexible network infrastructures and services, in order to avoid bad investments in too large and thus expensive infrastructures in terms of procurement and maintenance
- Secure energy supply at any time, as well as
- Expand the portfolio in products and services.

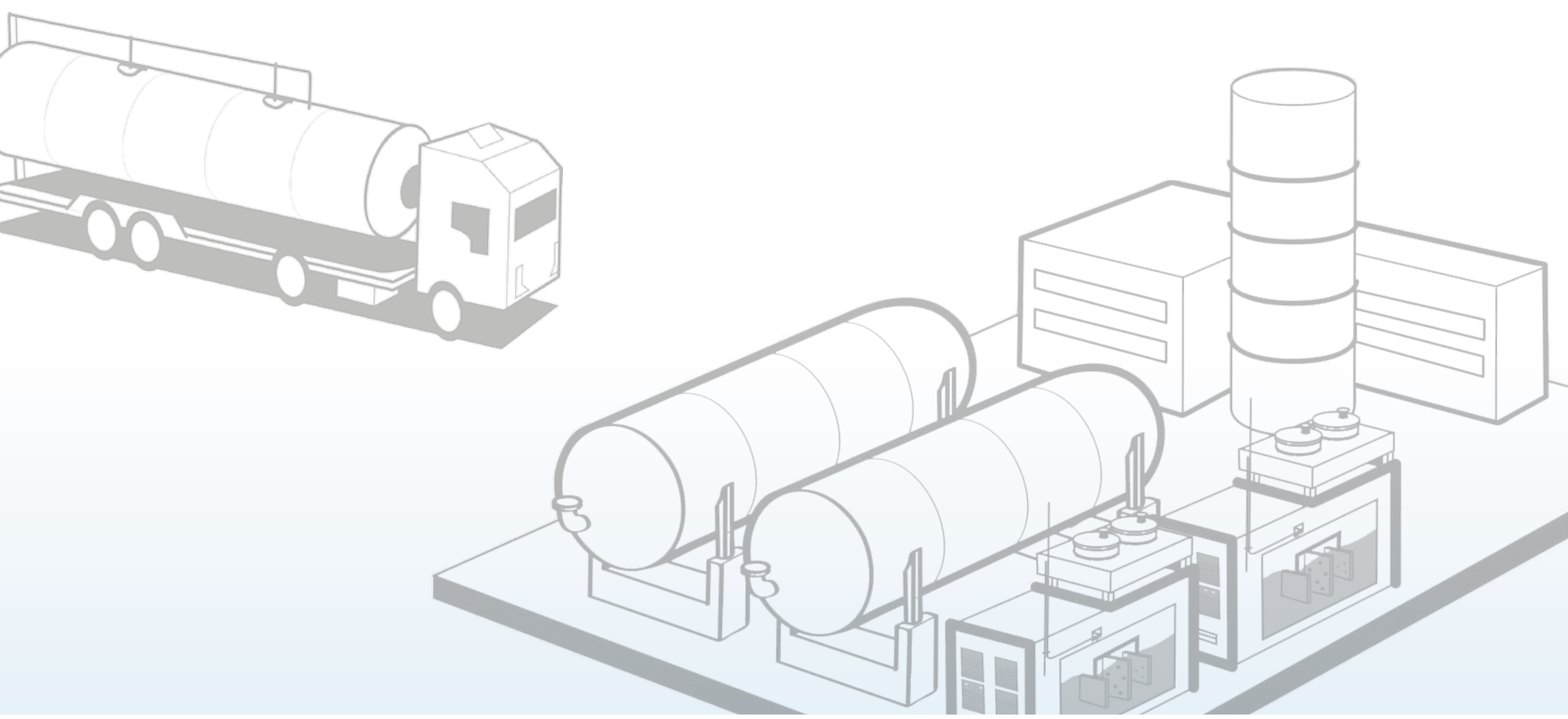


3.3.5 TECHNICAL GAS COMPANIES

Regional stakeholders in the area of technical gases have the required expertise in the sale and distribution of hydrogen and oxygen. The market for technical gases is highly competitive and offers little scope for quantative growth under today's framework conditions, as for example only 5% of the amounts of hydrogen used globally are traded. The majority is generated from industrial companies themselves. 90% of the 1.8 million tonnes of hydrogen produced annually in Germany is derived from fossil fuels. The market for green hydrogen, produced in a 100% climate-neutral manner, does not yet exist. Increased demand is expected however from the transport sector in the context of the energy transition.

The aim of stakeholders in the area of technical gases is to secure or expand their business activities and:

- Expand their own product portfolio with a climate-neutral hydrogen from renewable energies
- Develop additional potential sources for highly-purified oxygen
- Tap into new markets for hydrogen (sales in the transport area, regionally and nationally)
- Offer new services in the area of hydrogen and energy management (e.g. operating, maintaining and repairing hydrogen facilities for customers with the experiences of 'round the clock monitoring' from a control centre, or co-financing in the form of facility contracting)
- Gradually develop the market and test various concepts that are expected to yield a return



3.3.6 THE FINANCIAL AND BANKING SECTOR

With a long period of low interest rates expected to continue in the future, the regional financing and banking sector is facing the challenge of developing alternative business models that compensate for the fall in revenue and provide their customers with investment alternatives to the savings account.

In the past, regional financial service providers, together with citizens and companies from the region, invested in the development of renewable energies and advanced them. The EEG framework conditions thus far have made long-term investment products with manageable risks possible. Investment in citizen wind farms and photovoltaic facilities was made and accepted, with the expectation of return of most small or private investors comparatively low. The regional financial service providers positioned themselves as partners with the investors, and because of their regional know-how and local availability, they were able to provide added value compared to online banks.

EEG reforms and lack of network development to transport the energy away will lead to a stark increase in the risks of financial products in the renewable energy area as well as a decrease in the already low returns for investors. The growing risks are increasingly leading to curtailed lending and projects not being implemented. Declining revenues furthermore threaten citizens' willingness to invest and narrow the margin of the banks and the credit institutions.

The regional banks and financial institutions have a strong interest in strengthening the regional economy, because the resulting economic stability represents an essential pillar of their business activities.

The aim of the regional financial service providers is therefore to secure and expand their business activities and:

- Support the regional economy and its future viability
- Provide their customers with transparent and solid financial products
- Consolidate customer loyalty (added value over online banking through regional services) and
- Keep the financing of the regional energy transition in the product portfolio and develop it further.

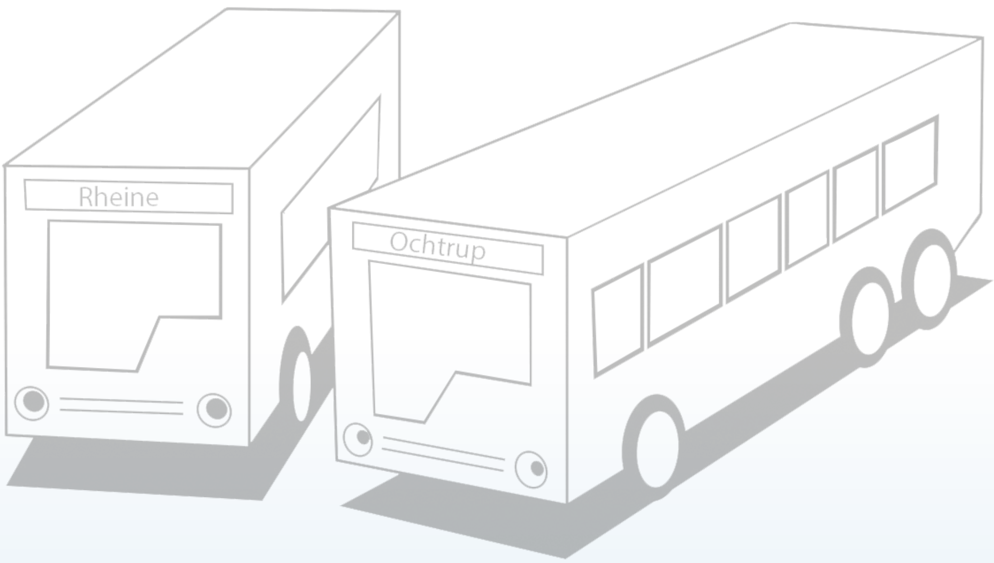
3.3.7 LOCAL TRANSPORT OPERATORS

Despite the high level of car usage, local public transport in the Steinfurt district is not just a public service, it is also an important locational factor and plays a decisive role in relieving the inner city street and parking situation as well as improving the air quality in the region. The regional transport companies are facing great challenges because of the tense situation of public budgets and declining numbers of school pupils, who are the main customers of regional public transport. At the same time an efficient bus and rail transport service must be guaranteed for an aging population in order for them to live an active and autonomous life. In order to address the problem of revenue losses due to falling numbers of pupils, new types of passengers must be acquired. One precondition for this is the appeal of the local public transport service, which despite strained public budgets, has to be further improved.

In this context is it assumed that the measures and investments planned in the "Master Plan 100% Climate Protection" in local transport, which is to be completely emission-free by 2050, must be achieved without additional sources of income in the core business. Costs pressure on local public transport will be exacerbated by the necessary investment in emission-free drive technologies, which makes cross-financing necessary.

The aim of the regional local transport operators is to secure or expand their business activities and:

- Maintain and develop the appeal of local public transport
- Find partners who can provide suitable fuel logistics for alternative fuels
- Find solutions for financing the conversion of a vehicle fleet to alternative drive concepts and energies
- Develop fuel strategies and an associated fair risk and cost distribution (additional costs)



4 REQUIREMENTS FOR A REGIONAL HYDROGEN ECONOMY

Building on the analysis of the regional starting position and of the individual challenges of the participating branches and stakeholders, the participants of the strategy dialogue specified their requirements for a regional hydrogen economy. Fulfilling these requirements will significantly influence whether and how hydrogen technologies will be accepted in this and in other regions over the next few years and regional activities integrated in the energy transition.

As a basic prerequisite, the regional hydrogen economy must address the innovation pressure on stakeholders and show how future collaborations can succeed in both solving the most urgent problems and in implementing sustainable structural change in the region. In particular, the solution should save time in modifying the energy infrastructures associated with the energy transition (production, transport, storage, conversion and use of energy), as well as reducing the urgency of decision-making and strategy development. In this way the participants of the strategy dialogue made clear right from the beginning that they are not limiting themselves to a single role of users of hydrogen and fuel cell technologies ("market consumers/ users"), but wish to actively co-design the construction and operation of renewably-produced hydrogen generation facilities.

In concrete terms it is expected that a regional hydrogen economy in the Steinfurt district:

1. Supports the goals of the "Master Plan 100% Climate Protection": a regional hydrogen economy must integrate the development of renewable energies forecast in the region into the energy system, solve the adaptation problems of supplying energy from renewable sources and open up the existing predominantly electric primary energy to other energy sectors (heating, transport) according to demand;

2. Promotes regionalisation of energy supply: a regional hydrogen economy must not only offer solutions for providing climate-neutral energy, but also appealing solutions for the efficient use of this energy on the demand side. It is important here to design the transformation process from a fossil-based to a renewably-based energy industry, secure energy supply for the population and businesses, keep it affordable and develop an added value compared to non-regional or fossil energy products;

3. Builds on existing strategies, structures and capacities: a regional hydrogen economy must build upon existing strategies, structures and capacities of the regional energy industry and facilitate an evolutionary, rather than revolutionary transformation of the fossil energy sector to an energy industry based on renewable energy sources. Acceptable solutions avoid dead capital from under-utilised or only temporarily required infrastructures and reduce simultaneous upheaval in multiple sectors. In this way technological and financial risks can be controlled.

4.Develops and maintains regional added value: a regional hydrogen economy must tap into economic prospects for the development of rural areas without endangering their appeal as a place to live and work for today's generation as well as future ones. Together with local stakeholders, innovative products, processes and services are to be provided in order to develop new added value chains in energy provision and to market the energy outside the district as well.

5 THE STEINFURT FLEX POWER PLANTS: CONCEPT

With increasing understanding of the technological possibilities and in the knowledge of anticipated developments in this innovation field, a solution became apparent for integrating hydrogen technologies in the regional energy industry, regarded as very promising by Steinfurt stakeholders under specified framework conditions: the Steinfurt flex power plants.

5.1 THE IDEA OF STEINFURT FLEX POWER PLANTS

Parallel to the development of wind energy, photovoltaics and biogas facilities, flex power plants will be installed tasked with channelling generated electricity as required: one portion of the renewable energies will be provided as electric energy, capable as far as possible of a base load, and integrated in a demand-oriented integrated electric network. The amount of renewable energies produced from wind energy and photovoltaics which is not in demand on the electricity market will be converted as an energy raw material by electrolysis into hydrogen and distributed to other markets. As a result, energy demand determines the system design *(Figure 1)*.

The hydrogen produced in the flex power plants

- Enables climate-neutral, motorised mobility as a fuel,
- Guarantees stationary energy supply of buildings and production as a combustible,
- Replaces energy maize in biogas plants with a simultaneous rise in methane yield,
- Forms the building blocks of a sustainable chemical industry as a chemical basis material together with oxygen.

The technologies used in the flex power plants can be categorised in the power-to-gas innovation field. At the time of the HyTrustPlus strategy dialogue, the use of power-to-gas facilities were predominantly discussed among expert bodies as an electricity transition solution: they were to be used for the stabilisation of the grids in times of oversupply of electric energy as an additional burden in the network (regulative). The resulting mode of operation would be a discrete rather than a continual operating mode with few annual load hours and high provision costs. There appears to be no prospect of economic viability for such an operation mode for the future.

These discussions on the role of power-to-gas technologies focusing on the electricity market, result from the understanding that temporary oversupply of electricity amounts had to be temporarily stored as hydrogen in order to be reconverted to electricity via fuel cells and fed back into the networks in times of undersupply of electric energy. This purpose, similar to that of battery systems, aims for electricity market optimisation and an even and better forecastable utilisation of the electricity transport grids. Following this logic, expanding renewable energies necessarily had to be accompanied by massive grid expansion for transporting away and distributing electric primary energy, comprehensive retrofitting of the existing grid for the continuous recording, evaluation and management of the energy flows (smart grid) and electrification of demand (incl. in heating as "power-to-heat" and in transport in the framework of "battery-electric mobility"). In this system logic, electricity supply determines system reconstruction and demand *(Figure 2)*.

Figure 1:

Closed loop model of the energy transition with flex power plants (own representation)

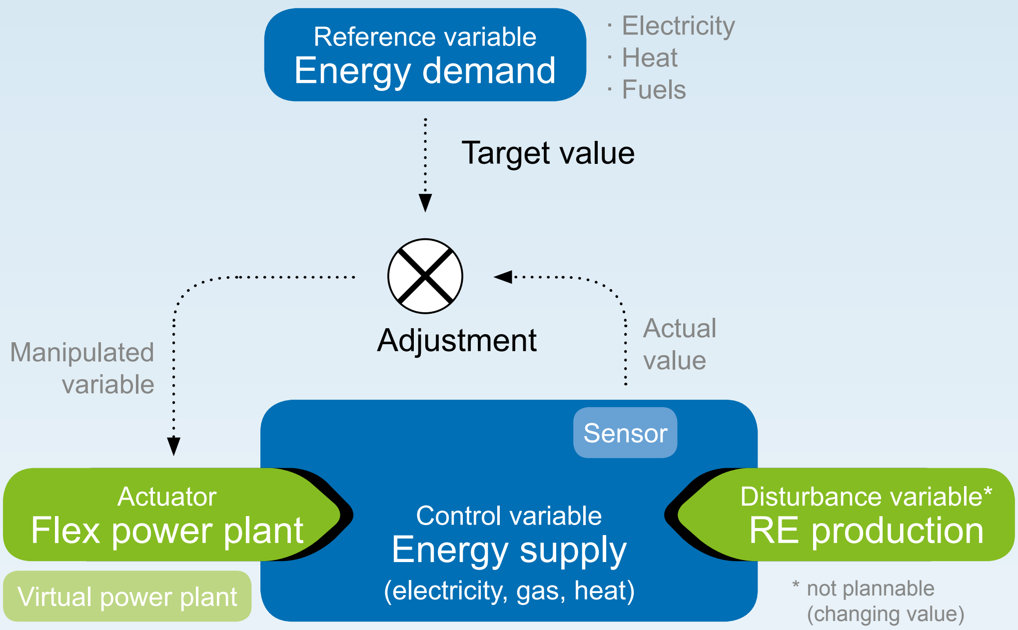
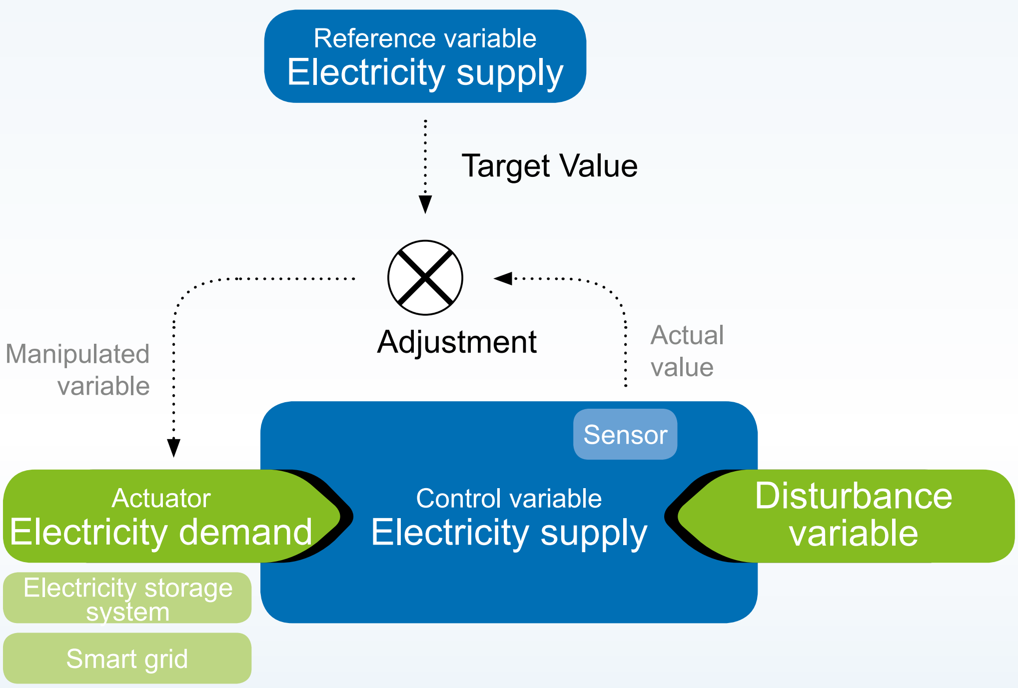


Figure 2:

Closed loop model of an energy transition focused on the electricity market (own representation)



The idea of the Steinfurt flex power plants is based on the understanding and the fact that neither now nor in the foreseeable future will there be surplus energy from wind power and photovoltaic facilities. Only the current limitation on using these renewable energies in the electricity market leads to bottlenecks in the grid due to lack of electricity demand and limited transport capacities.

The flex power plants will therefore be placed as a constant consumer in the system and thus enable a significant expansion of renewable energies, which no longer have to be exclusively integrated into the original electricity markets, but facilitate an off-grid application of electricity from renewable energies to supply the heating and transport sectors with climate-neutral energy.

Flex power plants can *additionally* be used as required for stabilising network services in the area of electricity supply:

- In *times of undersupply* of electrical energy, the flex power plants will be powered down, and the market demand for electricity prioritised. Potential demand bottlenecks for hydrogen from the heating and transport areas will be met with sufficient storage capacities during these times. It is also conceivable to provide an additional emergency electricity supply or heat supply on the basis of methane through synergies with the gas market (biomethane, CHP gas facilities), and thus free up hydrogen for the transport area.

- A *temporary oversupply* of electric primary energy is met by an increase in the production of hydrogen for the increased satisfaction of supra-regional demand. Furthermore it is conceivable to expand biomethane production through microbial methanisation of biogas and hydrogen or to directly feed hydrogen into the gas network.

Apart from the production of regional fuels and combustibles and chemical basic materials, the flex power plant thus fulfils the function of a balancing energy power plant, which has the potential to rectify two major weak points of today's electricity market design and at the same time to provide a vision for new added value in the rural area:

- Reserve power stations for the guarantee of electricity supply, as is required in the capacity market model of some stakeholders in the electricity industry, are losing their relevance, if the development of renewable energies takes place in parallel to the expansion of flex power plants, bringing with it increased network stability. Renewable energies become capable of providing base load power, and fluctuating generation mitigated by the flex power plants combined with the natural gas network and the demand from the transport area. Instead of orienting the development of renewable energies according to anticipated demand in the electricity market, they will be oriented according to the (regional) energy demand of all markets. The energy transition can take place in an accelerated way.

- Network bottlenecks or a drop in prices in the electricity market (and as a result of lowering returns for wind farm operators or rising EEG levies for consumers) are a thing of the past due to a temporary oversupply of electricity in the network, if alternative utilisation paths exist for electric primary energy from wind power or photovoltaics in the form of hydrogen or biomethane and are used increasingly. As has been the case in the past, the expansion of the electricity integrated network can continue to orient itself according to energy demand and must not be designed according to temporary oversupply. The value of energy will increasingly be determined once again by its use for society and less by the behaviour and expectations of brokers at the stock market.

Unlike other approaches to solutions of the electricity transition currently discussed, the Steinfurt flex power plants are positioning themselves as follows:

Smart grid	Supplementary/supporting	A smart grid regulates the energy flows in the electricity integrated grid. Depending on the electricity demand in the network identified by the smart grid, the operation of the flex power plant can be adapted, so that at any moment the electricity amounts required from renewable energy sources (wind, sun, biomass) can be delivered.
Virtual power plants	Supplementary/supporting	Different electricity generators in a region are connected and together meet the electricity demand. Flex power plants could be an important determining factor in this network, as they can provide electricity or load flexibly and thus stabilise and simplify the regulation and control processes of the virtual power plants.
Capacity markets	Alternative	The term capacity markets describes power plants that can boost their output when there is an electricity shortage. As these reserve power plants rarely produce electricity, and are nevertheless assigned an important role in securing uninterruptible power supply, a remuneration based on the installed capacity was discussed (provision compensation). Ideally reserve power plants beyond today's peak power plants would no longer be required in the flex power plant model, as the expansion of renewable energies to meet cross-sectoral energy demand will clearly exceed the amounts demanded in the electricity market.
Load management/ flexibility option	Supplementary/alternative	Flex power plants are load management facilities, as at any time they can power up or down their production as required or agreed without impairing their processes. Electrolysis can be carried out in a modular way, a systematic coupling with the gas infrastructures provide a back-up when there are electricity bottlenecks.
Network expansion	Supplementary/ alternative	The flex power plants regulate the feeding in of electricity from renewable energy sources according to demand. The network expansion for the transport away of surplus electricity ('disposal' of the electricity) can be significantly reduced. The dependency of the expansion of renewable energies on investment decisions and implementation periods of the network expansion can be reduced. The energy provided from alternative sources can be alternatively transported in the existing gas network and thus relieve the transmission grid over the long term.

Table 1:

Comparative overview of solution approaches for the energy transition in the electricity area ("Electricity transition")

The Steinfurt flex power plants illustrate the potential for supporting regional energy transition as outlined in the next chapters primarily through delinking electricity production and the electricity-market. Not every renewably-produced kilowatt hour of electricity must be sold to the electricity market - feeding into the integrated network ideally only happens in order to satisfy demand in the electricity market. The flex power plants are also a determining factor for the demand-oriented channelling of available energy amounts in the different markets and transport networks. Only in this way can the development of renewable energies required for the energy transition – far above the required capacities in the electricity market, succeed without unduly burdening individual regions or transport networks.

5.2 VISUALISING THE STEINFURT POWER PLANTS

Within the scope of the Steinfurt strategy dialogues a number of concerns were expressed by stakeholders that the construction of flex power plants could lead to acceptance problems within the population if the landscape as well as the quality of living were to be substantially impaired. It was important to understand how large the power plants would be and what kind of industry they could represent in the rural area.

Taking the example of a 5 MW flex power plant (alkaline electrolysis), different designs on the integration of the flex power plants in the existing infrastructures of the rural area were drafted. Positioning near wind and bioenergy facilities was chosen, in order to be able to estimate the size of the facilities required compared to known infrastructures and buildings. Fundamentally it can be said that flex power plants have the potential to transform the prevailing image of "industry" in people's minds: No tall chimney stacks are needed, there are no pollutants to the ground, air or waterways and the noise emissions, largely based on facilities for the compression of the gases hydrogen and oxygen (transport preparation, feeding-in), can be minimised by standard noise protection measures. Possibly the greatest impact of the facilities in normal operation for residents is the truck traffic transporting away hydrogen and oxygen by road. This can be reduced both in nature and scope (depending on production amounts) by technological as well as organisational means, e.g. through underground pipelines or feeding in hydrogen into the existing natural gas network.

In *Figure 3* the designs for a graphic depiction of the Steinfurt flex power plants are represented in different perspectives and situations. While the technologies for generating hydrogen can be housed in one building, the dimensions of which are in the same order of existing structures in the region, also in higher output capacities, the space requirement for the storage and filling or feeding in of hydrogen in the local natural gas network is dependent on the production amounts and the chosen supply logistics. The now commonplace storage tanks for storing or transporting hydrogen were also integrated illustratively in the pictures. Underground storing on site can also be envisaged in principle. Higher production capacities and storage amounts on site (with no feeding into the gas network) result in a greater space requirement if necessary.

Figure 3:
The Steinfurt power plants – visualisation in a regional context (illustrations: David Borgwardt)


Schulbus
H

5.3 HOW A FLEX POWER PLANT WORKS

The diagram in *Figure 4* provides an overview of the processes that take place in a flex power plant:

- **1** The electricity generated in wind power and photovoltaic plants is used in an electrolysis process to break down water into its components: hydrogen and oxygen. The separation of the molecular bond of hydrogen takes place with the aid of two electrodes that are submerged in water. A voltage is applied at these electrodes, the water has been made more conductive beforehand through the addition of electrolytes (e.g. potassium hydroxide solution).

- **2** Now there are

  - Hydrogen positive ions at the negatively charged electrode (cathode), which attach themselves to a gaseous hydrogen molecule and become visible as rising bubbles;

  - Oxygen anions at the positively charged electrode (anode), which also attach themselves to a gaseous oxygen molecule and become visible as rising bubbles.

The gases are collected separately and stored in gas containers. After the gases have been dried and compressed, they can be used for further application. Alkaline electrolysis is a process that has been used in the chemical industry globally for more than 100 years. Alternatively hydrogen can be produced through the splitting of water in PEM electrolysis, a similar process using a special exchange membrane instead of a potassium hydroxide solution.

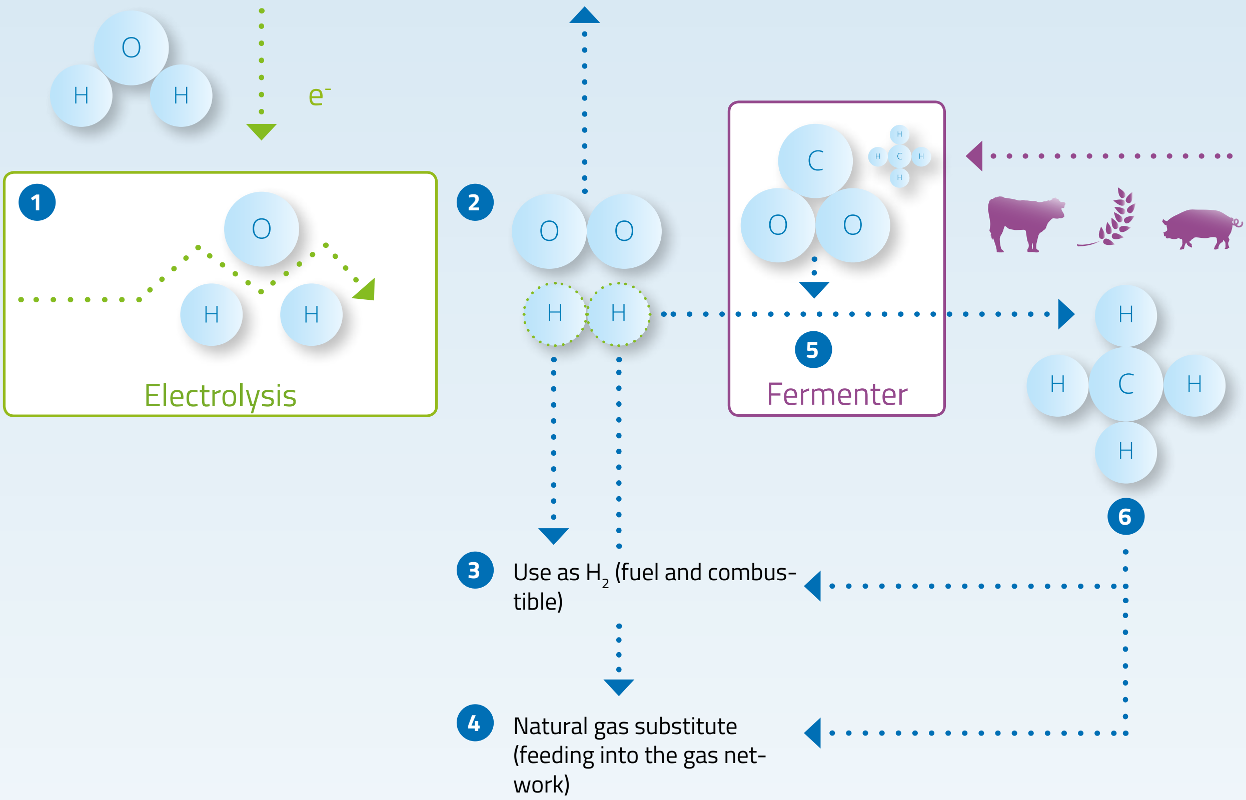
- **3** Hydrogen can be used as a gaseous fuel at public filling stations.
  It is converted to electricity in fuel cell vehicles, powering an electric engine and thus facilitating emission-free and quiet motorised mobility. Since the beginning of the millennium a multitude of cars and buses are on the road in demonstration projects, since 2015 the first automobile companies (Toyota, Hyundai) are selling fuel cell cars. In 2016 the first car-sharing service using fuel cell vehicles began in Munich (BeeZero).

  Fuel cells not only convert hydrogen into electricity and heat in vehicles that are driving, they can also be used in the stationary area, e.g. as a heating system or for emergency power supply. Since 2015 fuel cell heating appliances from different manufacturers have been available on the market in Germany, and are well suited to the energy supply of thermally-insulated buildings, as they have a high electrical efficiency compared to motor-operated systems. This means that there is less heat per kWh of electricity that must be put to use. Emergency power supply using fuel cells has been implemented in the telecommunications sector among other areas, which globally relies upon a grid-independent electricity supply of their remote pylon locations.

- **4** Hydrogen can also directly be fed into a local natural gas network and replaces the carbon-containing energy source. In this way the climate footprint of the combustible fuel is improved – there is less CO_2 in using this natural gas mixture. Because many contemporary gas appliances on the user side only tolerate a certain proportion of hydrogen in the gas and this tolerance threshold is not known in all cases, the regulatory bodies agreed on a conservative feeding-in limit of 2%. In 2016 the regulations have begun to be revised in order to allow higher feed-in amounts into the gas network. In the past hydrogen rates of up to 50% were used in the gas grid, like for example in the 90s in Berlin ("town gas").

Figure 4:

How a flex power plant works (own representation)



- 5 Alternative to direct feeding-in in the local gas network, hydrogen can be converted to methane in advance and is therefore no longer subjected to feed-in limits. The biological processes in the fermenters are usually limited to hydrogen: only as long as hydrogen is available do the microorganisms of the carbon dioxide (CO_2) "metabolise" to methane (CH_4). If the hydrogen is used up, the methanation process is ended. The biogas in conventional plants contains (depending on the composition of the biomass used) around 40-60% methane gas and a similarly high level of carbon dioxide that remains unused. If additional hydrogen is blown into the fermenters, the microorganisms convert a significantly higher proportion of carbon dioxide into methane. In research projects up to 100% methane could be generated in this way in biogas plants, with no need for a subsequent cleaning of the gases before the feeding into the gas network.

- 6 Methane from biogas plants is chemically identical to methane in natural gas, so it can be used not only now as a combustible gas, but also as a fuel in natural gas vehicles.

5.4 THE ROLE OF FLEX POWER PLANTS IN ENERGIELAND2015

The Steinfurt flex power plants will support the activities of the district of Steinfurt's "energieland2050" initiative (2050 energy state initiative), which pursue the implementation of the energy and climate policy goals described in the *"Master Plan 100% Climate Protection"*. The continued increase in the proportion of renewable energies funded in the "Master Plan 100% Climate Protection" to cover the regional energy demand from the electricity, heat and transport areas require:

- Installation and operation of additional facilities to use the regional energy sources of wind, sun and biomass of around 2 GW output overall until the year 2050

- Integration of these capacities in the regional energy systems (infrastructures and electricity, heat and transport sector markets)

- implementation of energy efficient measures and process changes which ensure that energy demand sinks by more than 50% by 2050 *(Figure 5)*.

As can be seen in *Figure 6*, now and in future more than ¾ of all energy consumption in the district of Steinfurt arises in only 6 of 22 demand clusters examined. To reach climate policy goals, efforts must be made to decarbonise in these sectors as matter of priority.

Figure 5:

"Master Plan 100% Climate Protection" – proportion of regional renewable energies represented in the energy demand in the district of Steinfurt (own representation)

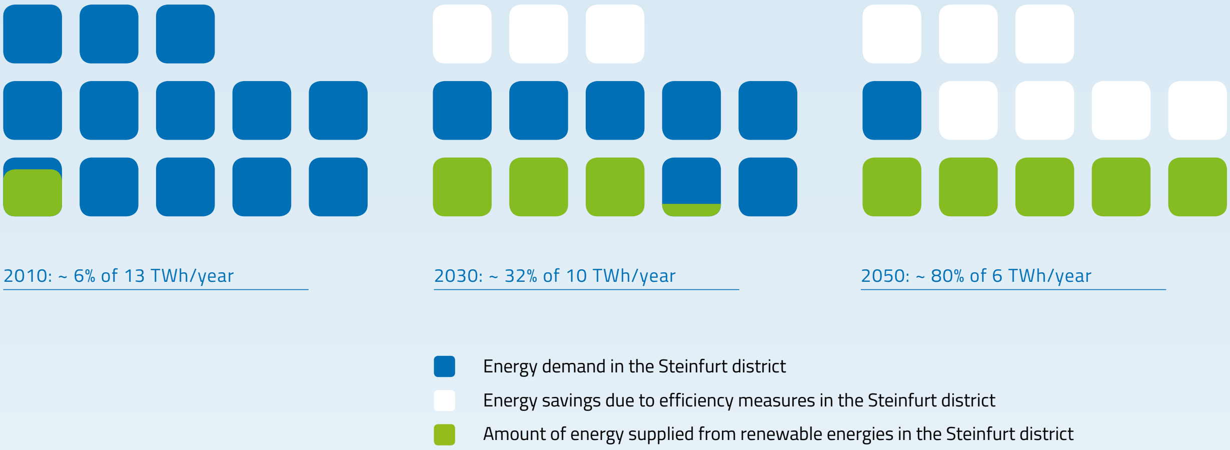
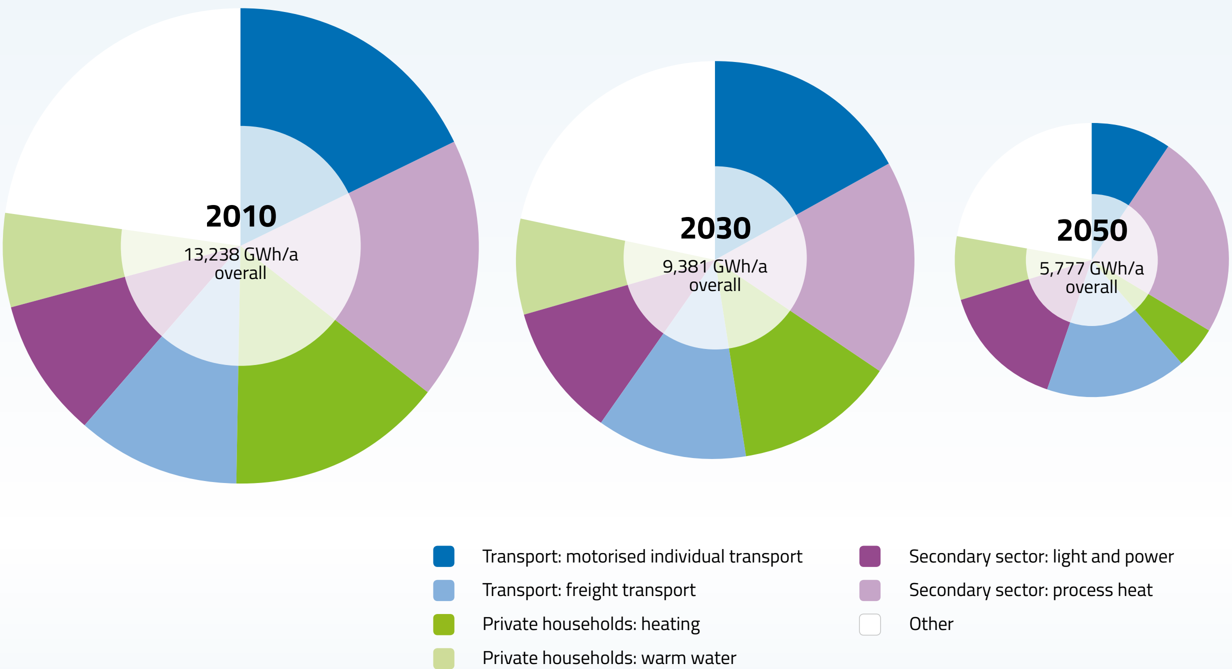


Figure 6:

Top 6 energy consumers in the Steinfurt district (source: "Master Plan 100% Climate Protection", own representation)



5.4.1 BUILDING UP RENEWABLE ENERGIES CAPABLE OF PROVIDING BASE LOAD POWER

In the Steinfurt district in 2015, there were already 436 MW wind energy plants, 324 MW photovoltaic plants and 54 MW bioenergy plants installed and in operation. The amount of renewable power generated from these facilities in 2015 was 1,358 MWh. For comparison: the demand for electricity in the same time period was 2,793 MWh.

Building up renewable energies should be advanced up to 2050 as shown in Figure 7. Despite intensive activities in the area of implementing efficiency measures, the demand for "power and light" (current electricity consumers) only moderately decreases over the same time period.

Without a comprehensive electrification of the transport area (mobility electricity for battery-electric vehicles, electrolytic current for generating hydrogen for use in fuel cell vehicles), the amount of power produced in the district will – from a financial perspective – exceed regional demand for electricity before 2030 with the result that:

- Should the planned network expansion not be able to keep pace with these developments, there is the threat of massive losses because of inadequate network capacities and plant capacities being shut down;
- The expansion goals are jeopardised because of a lack of profitability and increasing risks, if the lending institutions determine that there are insufficient prospects and deposit protection for the investor is no longer possible;
- A lack of or low demand for the amount of energy generated leads to a fall in price for electricity at the market and allows for an increase in EEG levies;
- Fully functional, older EEG facilities must be powered down or dismantled, because they can no longer be operated at a profit.

At the time of the HyTrustPlus strategy dialogue, the plant operators in the district were not yet majorly impacted by deactivations as a result of network bottlenecks in the power grid. The planned expansion of renewable energy plants and the speed of the network development observed in the past will however be taken into consideration going forward. Particularly the geographic circumstances in the Steinfurt district, which have led to a separation of generation (south-western area) and demand (north-eastern area), heavily influence the distribution of the electrical load in the Steinfurt district (see Figure 8). Because of the current settlement structures, an even distribution of plants for the production of renewable electricity currently seems feasible only to a limited degree, not least because of the population's acceptance levels.

Aside from decisions on the type and scope of the energy infrastructures to be established, the central challenge of the regional energy transition in the Steinfurt district lies in the proactive site planning (identifying and securing the location) for these plants and supply infrastructures as well as an accompanying acceptance management. Energy obtained from decentralised plants in the region to cover regional demand are also increasingly experiencing regional visibility. Intensive and comprehensive discussion processes are to be managed with all concerned in the region, in order to support acceptable and sustainable decision making not only for solving the most urgent problems, but also for the forward-looking design of a future-oriented energy system for society.

Figure 7:

Energy transition in the Steinfurt district – generation capacities and electricity demand in GWh/year (source: "Master Plan 100% Climate Protection", own representation)

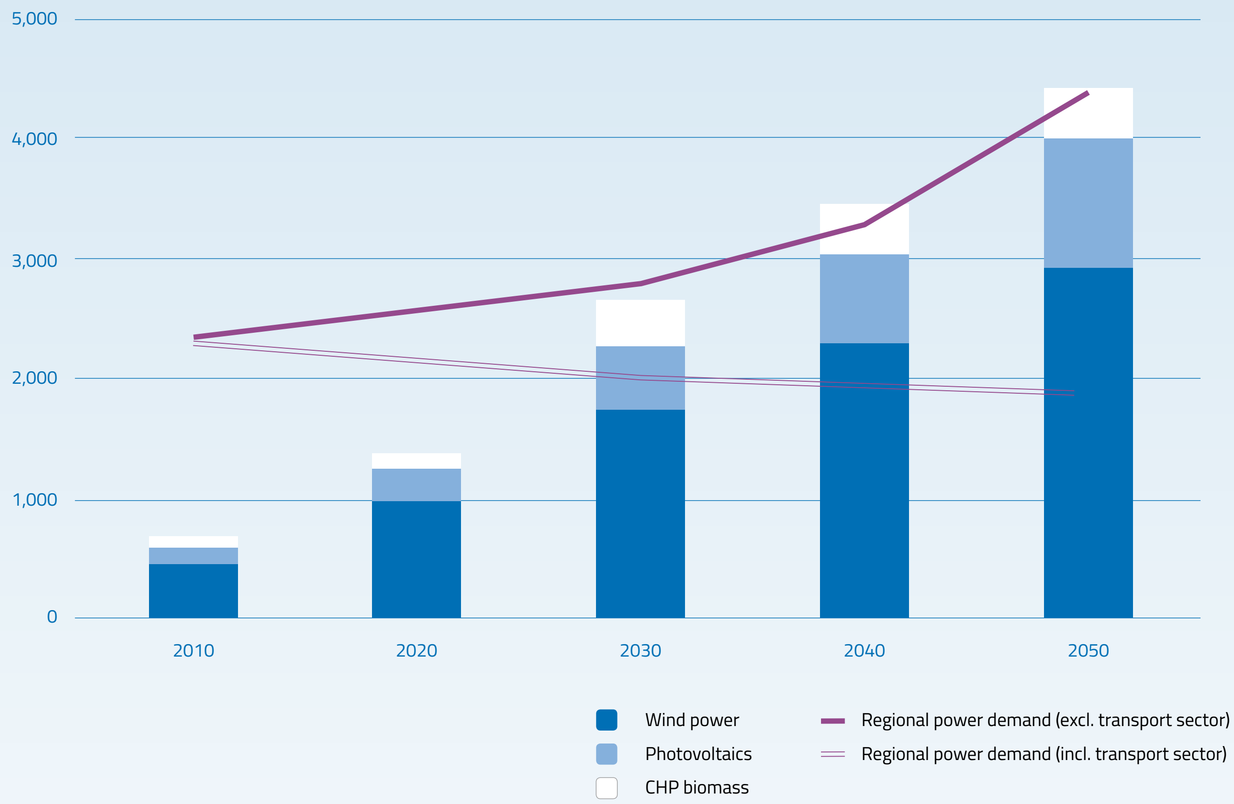
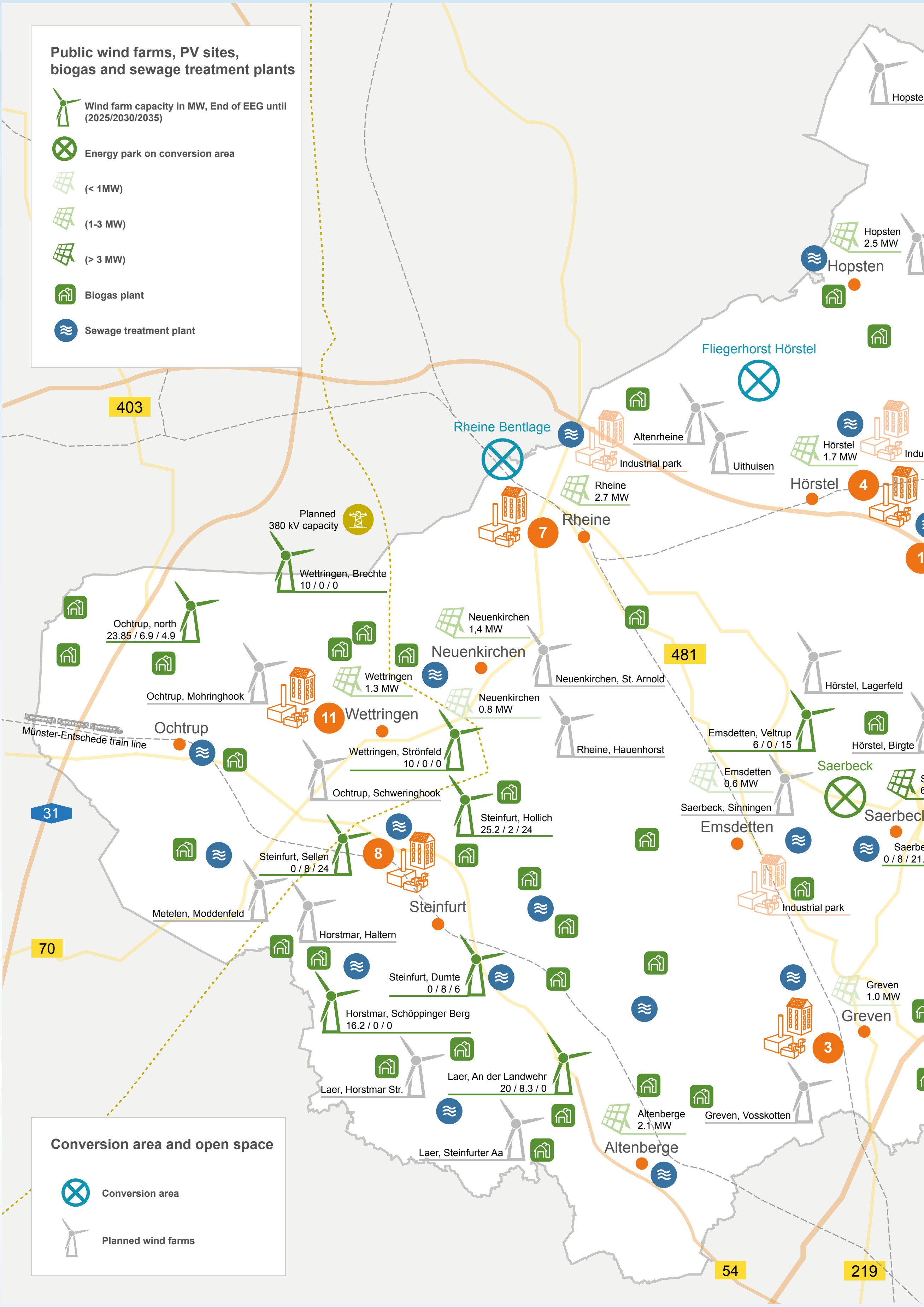
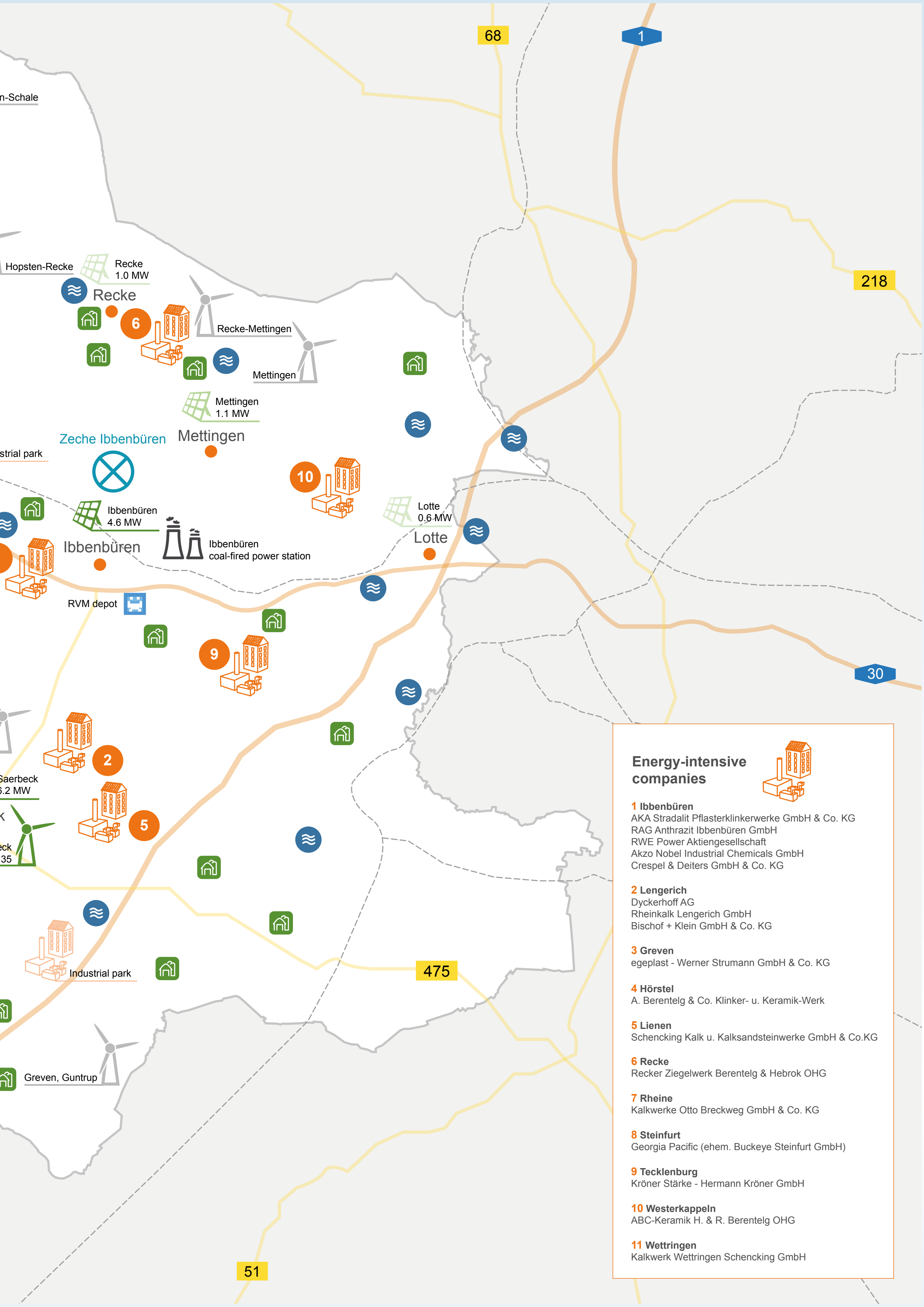


Figure 8:

energieland2050 – current situation in 2016 (source: Steinfurt district, own representation)





Energy-intensive companies

1 Ibbenbüren
AKA Stradalit Pflasterklinkerwerke GmbH & Co. KG
RAG Anthrazit Ibbenbüren GmbH
RWE Power Aktiengesellschaft
Akzo Nobel Industrial Chemicals GmbH
Crespel & Deiters GmbH & Co. KG

2 Lengerich
Dyckerhoff AG
Rheinkalk Lengerich GmbH
Bischof + Klein GmbH & Co. KG

3 Greven
egeplast - Werner Strumann GmbH & Co. KG

4 Hörstel
A. Berentelg & Co. Klinker- u. Keramik-Werk

5 Lienen
Schencking Kalk u. Kalksandsteinwerke GmbH & Co.KG

6 Recke
Recker Ziegelwerk Berentelg & Hebrok OHG

7 Rheine
Kalkwerke Otto Breckweg GmbH & Co. KG

8 Steinfurt
Georgia Pacific (ehem. Buckeye Steinfurt GmbH)

9 Tecklenburg
Kröner Stärke - Hermann Kröner GmbH

10 Westerkappeln
ABC-Keramik H. & R. Berentelg OHG

11 Wettringen
Kalkwerk Wettringen Schencking GmbH

The possible role of the Steinfurt flex power plants in energieland2050 can be outlined in this context as follows:

- (1) The Steinfurt flex power plants reduce the urgency of decision making on the regional energy transition's infrastructure conversion and reduce the associated investment and operational risks, as they facilitate right from the start a close interconnection with the already established gas infrastructures. They provide a fallback level during the transition period, when the demand side is progressively switched to gas supply and the infrastructures and market applications in the hydrogen sector are still not fully established. With the aid of the flex power plants, the conversion of the infrastructures can take place successively and provides the opportunity to gain experience and continually integrate practical knowledge into optimised facility designs and management strategies. Unlike the strategy of extensive electrification of demand, which requires a prompt and massive expansion of grid infrastructures and creates a path dependency for the rest of the century, it is expected that with flex power plants the required corrections can be realised quicker, better securing supply and also possibly cheaper. This is because of changing market structures, improved energy efficiencies (and as a result decreasing energy demand) and political decisions in a decentrally-organised, regional energy economy. In addition, outages because of network overload, climatic events (storms), material failure or sabotage in the integrated electric network are expected to have a less dramatic effect on security of supply to society, if the energy no longer primarily supplied through a transport route and the everyday penetration is smaller due to diversification of energy sources.

- (2) The Steinfurt flex power plants support an accelerated expansion of renewable energies and thus the achievement of the goals of the "Master Plan 100% Climate Protection", as they are in a position to feed electricity broadly capable of base load power from renewable energy sources into the networks and thus enable a timely and local decoupling from the plans and advances for network expansion. The existing network infrastructures, which have grown historically and which in supplying society with electricity especially, orient themselves towards the necessity of removing amounts of electricity not in demand either in terms of time or location, can continue to be used and provide in so far as is possible sufficient capacities for the basic supply of the population. The site identification for the renewable energy facilities can consider in future reinforced off-grid locations, if coupling with flex power plants occurs and the energy is used exclusively for the generation of fuels.

- (3) The partial or total abandonment of co-substrates like energy maize facilitates developing bioenergy, which is crucial for energy security (as it is storable and controllable) while simultaneously reducing land use in the region. It remains to be examined to what extent the use of wild plants for biodiversity reasons as co-substrates of the biogas plant is economically efficient, if the facility profit increases due to microbial methanisation coupled with the flex power plants. The portion of waste from livestock and agriculture in biogas facilities can increase by dispensing with energy maize, and because of land use competition, the politically limited development potential of biogas facilities can be used more intensively. Using hydrogen as a co-substrate also reduces the amount of fermenting residues to be moved and relieves the regional situation for agriculture.

- (4) The development of new utilisation routes for renewable energy produced in the region reduces dependency on energy legislation and adaptation to compensation policies in the EEG.
The development corridors anchored in the EEG today serve to protect the integrated electricity network which only has certain transport capacities at its disposal and may not be exposed to too high fluctuations for uninterruptible energy supply. Should the power generated be used in an "(integrated) off-grid" way, as envisaged for the flex power plants, the development corridors can be dispensed with or substantially expanded as required. Ideally a future EEG includes a non-discriminatory compensation arrangement for electricity from renewable energies (independent of its application in the electricity market or other energy markets).

5.4.2 REGIONALISING AND DECARBONISING THE FUEL MARKET

In 2010, a sum of almost 5 TWh of energy (natural gas and heating oil) was imported to the Steinfurt district along with the use of 550 GWh of heat from regional renewable energy sources. This was in addition to a further 32 GWh of district heating from non-renewable sources. By 2050, 100% of the demanded heat is to be provided by regional, climate-neutral sources, of which 1,350 GWh/year through power-based fuels from the region (power-to-gas, power-to-heat), and 1,660 GWh/year heat from regional renewable energy sources. These figures show that massive adjustments to the provision of energy in the heating sector are to be expected over the coming years, in order to attain the targeted 50% efficiency increase *(see Figure 9)*.

For this reason, a concerted heating concept was commenced early on in the Steinfurt district based on a heating cadastre on the existing infrastructure and facilities in the district, which establishes a heat usage plan and develops various renovation or renewal scenarios and heating network plans as is aligned in an overall energy concept *(see Figure 10)*.

The possible role of the Steinfurt flex power plants, which in energieland2050 (the 2050 energy state initiative) would assume the role of gasworks that today hardly exist in Germany, can in this context be outlined as follows:

- (1) In the area of the supply of heat to buildings (room heating and hot water), gas-based residential area concepts are increasingly planned in energieland2050: The individual heating plant in the building's boiler room is replaced by a direct supply of heat in the local heating network of a natural gas, biomethane or hydrogen-run combined heat and power plant. This supplements the provision of heat from other sources, such as solar thermal energy or power-to-heat plants. The connected user benefits from the lower space requirements for house-based technology, reduced risks (supply and cost security) due to the outsourcing of the technology and the joint use of a plant that is operated, maintained and repaired by the local heating provider. Similar to the case of leasing vehicles, the customer only pays for the use (the heat) instead of the ownership and operation of his or her own plant. With the feeding in of hydrogen or methane in the regional gas networks, flex power plants can help reduce the necessary energy imports of natural gas for the heating market. Moreover, they enable new business and participatory models for the regional stakeholders, which may not only be users in regional residential area management, but at the same time can also be producers of regional fuels through participation in the flex power plants and the wind farms and photovoltaic plants. Integration in further heating sources in the heating network (e.g. solar thermal, geothermal) can be easily achieved on a technological level and can reduce costs as well as deliver the required flexibility of the overall system (capacity utilisation for winter and summer operations) to ensure supply security.

- (2) Society obtains the opportunity to improve its regional climate footprint with limited financial and infrastructural effort: With the change to the origin of the gas being used in the combined heat and power plants, even subsequent adjustments taking stricter energy regulations and climate protection goals into account are possible – right up to 0% carbon footprint by using 100% energy sources from the region. This thereby also enables large-scale industrial users, which due to their investment cycles and existing plant approvals (financial and legal risks) would otherwise not be initially able to change their plant technology for the production of process heat, to swiftly bring about an improved climate footprint. The relevance of this factor becomes particularly clear when one considers that process heating in secondary sectors (industry, manufacturing, mining) is and will remain the largest area of energy use by a substantial margin in the Steinfurt district, and that only below average efficiency gains are predicted when compared with other sectors and fuels. The Master Plan 100% Climate Protection calculated that the share of overall energy demands of this cluster in the Steinfurt district will increase from 25% in 2010 to 34% in 2050.

Figure 9:

Development of demand for heat in energieland2050 (source: Master Plan 100% Climate Protection, own representation)

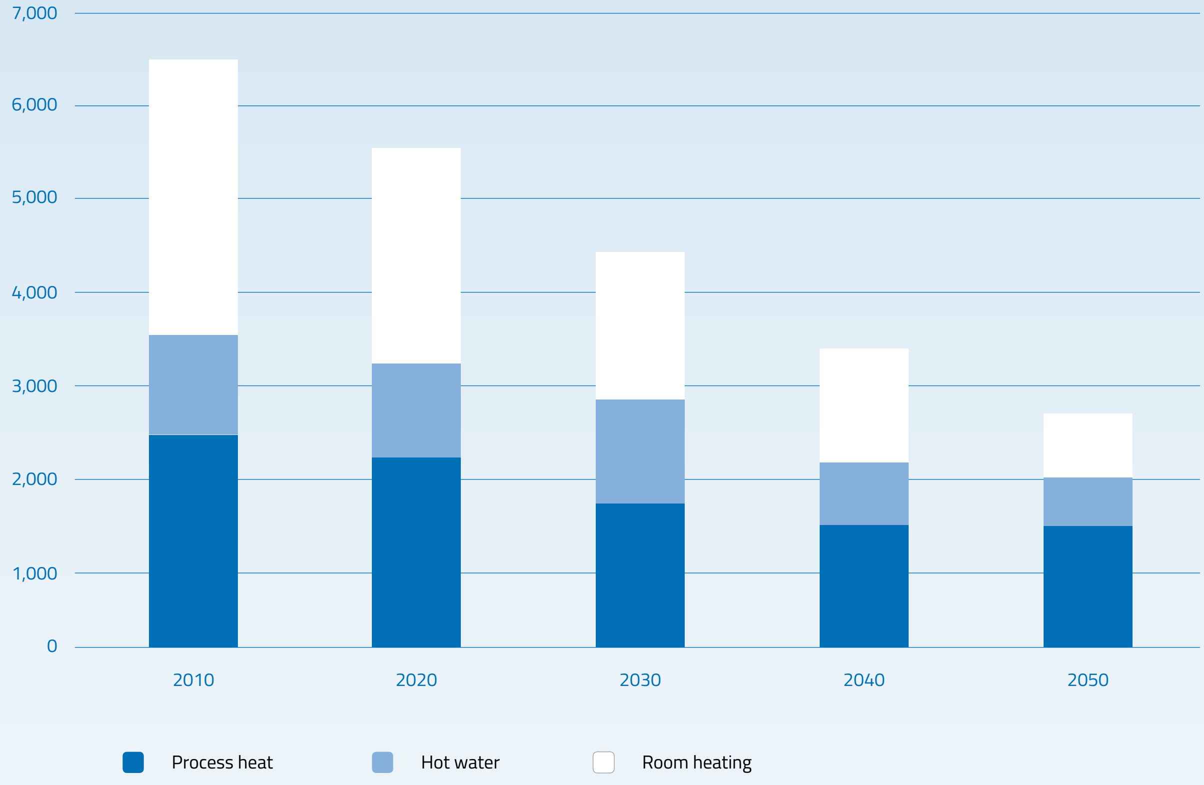
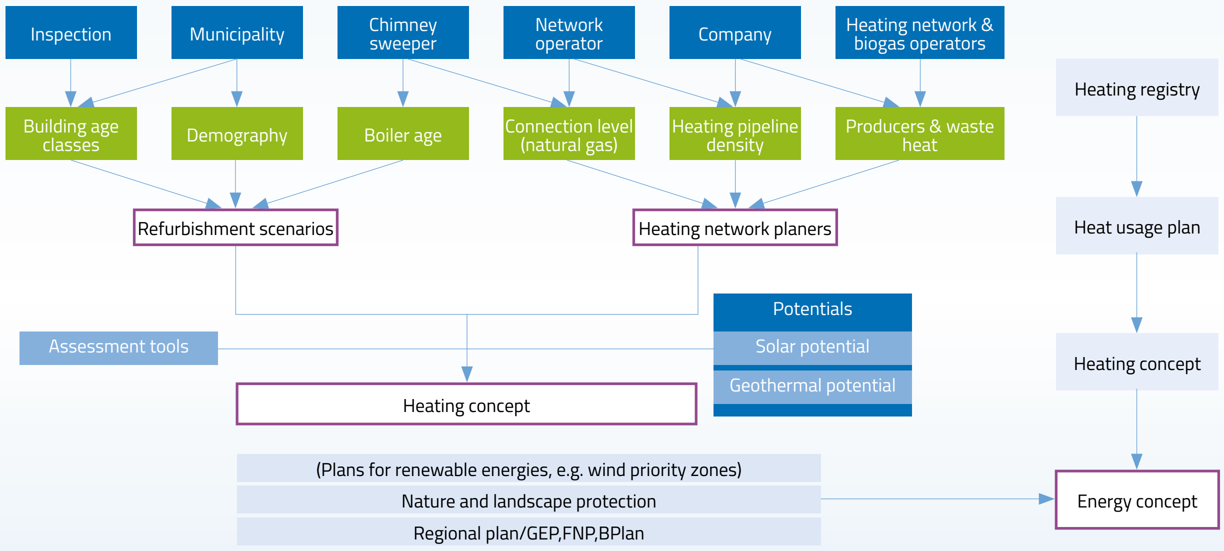


Figure 10:

Approach of the integrated heat and energy concept in the Steinfurt district (source: FH Münster 2015, own representation)



- (3) The demand-side adjustments (decarbonisation, increased efficiency) required to achieve the Master Plan goals in the heating market occur prior to or during the establishment of the flex power plants on the supply side, and thereby enable an aligned approach: The flex power plants provide and evolutionary restructuring of the heating market as they build on existing gas infrastructure or on infrastructure that is in near-term development to thereby benefit from the existing maturity during a transitional period. A natural gas-based back up exists in the case of unforeseen challenges or delays in the innovation process or in a regulatory or competitive context. In particular however, due to the growing decarbonisation and regionalisation of the fuel, flex power plants allow for the continued use of existing gas infrastructure and thereby avoids the situation of dead capital. In contrast to the approach of electrifying the demand – which ultimately leads to the perspective of doing away with the gas infrastructure or means that two parallel infrastructures need to be installed on the demand side, the use of existing infrastructure in the gas sector can thereby provide the supply security and cost containment necessary to realise the energy transition.

- (4) For regional value creation, the increasing substitution of fossil natural gas with hydrogen and biomethane in the heating market will mean that expenditure for energy imports will reduce while income from the production and provision of renewable gas (along with the potential for exports) will increase: The energy costs thereby don't merely comprise funds that are "lost" through its trade for energy by the region and its inhabitants, but rather represent an investment in the regional economy, can invigorate the local job market and through the increased tax revenues provide greater scope for the region for financing other regional social services (education, mobility, medical care, culture, etc.).

5.4.3 REGIONALISING AND DECARBONISING THE COMBUSTIBLE FUEL MARKET

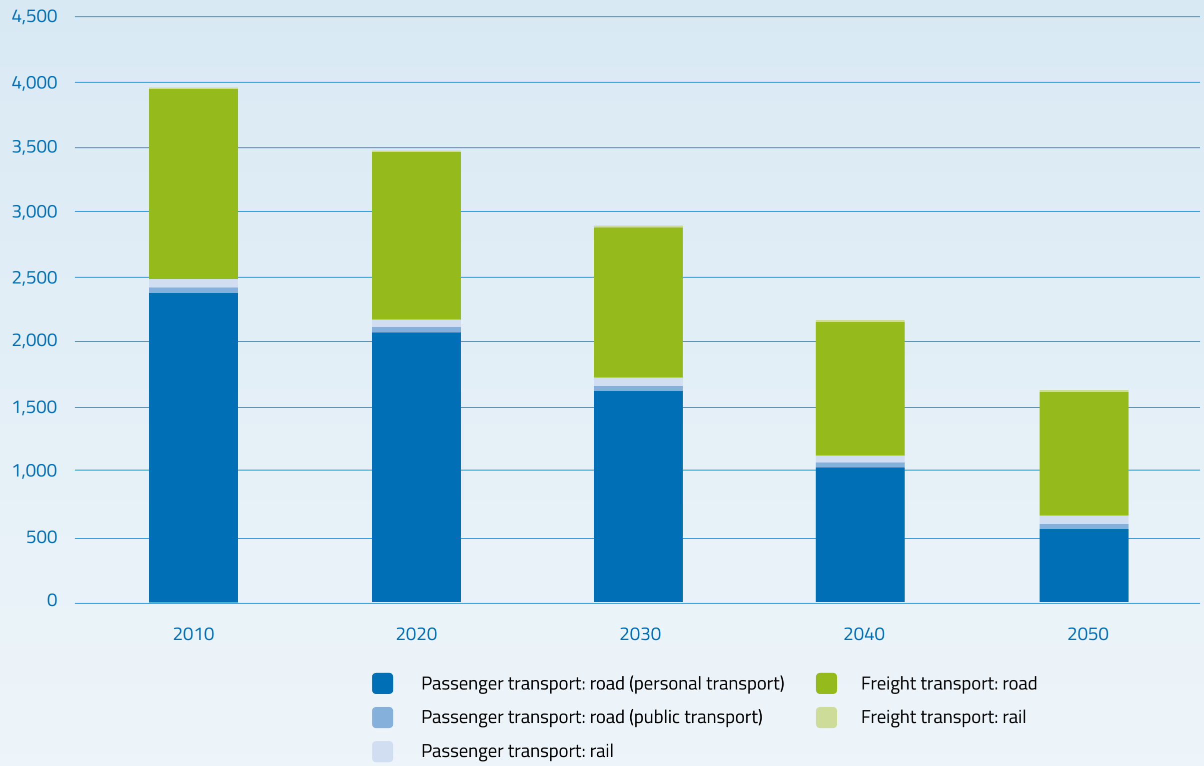
In 2010, a sum of around 4.5 TWh of energy in the form of combustible fuels was imported in Steinfurt district (gasoline, diesel, kerosene). By 2050, almost 100% of combustible fuels are to be produced from regional, climate-neutral sources in the form of electricity, hydrogen and biomethane, in order to achieve the energy and climate policy goals of the Master Plan. Through comprehensive efficiency measures and behavioural changes, the annual demand from the transport sector in the Steinfurt district for climate-neutral combustibles and mobility electricity is to reduce to 1.6 TWh in 2050 *(Figure 11)*.

The necessary reduction to a third of the energy demands from the transport area can be achieved, on the one hand, through the deployment of more efficient vehicle technologies, and on the other hand by way of a reduction of individual energy demands for mobility due to the increased use of shared means of transport (local and long-distance public road or rail-based transport). The Master Plan 100% Climate Protection of the Steinfurt district does not assume that the passenger kilometres (pkm) will significantly reduce over the coming years. Rather, largely constant figures in the timeframe 2010-2050 are anticipated, reflected in the reference year of 2010 with 11.6 billion pkm, which is typical for medium and long-distance mobility in a rural region.

Consequently, the relevant players in the Steinfurt district face the following challenges on their path to achieving their mobility goals: Not only will the residents and companies need to be primed to demand the "right" drive technologies in the future to ensure a mobility transition away from diesel and gasoline-based vehicles to electric and gas-based vehicles – despite the anticipated higher costs in the initial years. They must also change their mobility behaviour to increasingly use public transport in order to substantially reduce the energy consumption per kilometre travelled. Without the increased use of regional road or rail-based public transport services, the goals of the Master Plan can only be realised by a massive penetration of battery-electric vehicles for personal transport – which also does not deliver the full perspective of being able to service all routes in the Steinfurt district without some mobility restrictions, due to the limited range provided by the battery capacity.

Figure 11:

Energy demands of the transport area in the Steinfurt district. In GWh, without air or sea transport (source: Master Plan 100% Climate Protection, own representation)



The possible role of the Steinfurt flex power plant, which in energieland2050 would assume the function of today's refineries, can be outlined in this context as follows:

- (1) Akin to the substitution of fuel through hydrogen and biomethane as described in the previous chapter, there is also the prospect of a complete substitution of fossil combustible fuels through combustible fuels of biomethane, hydrogen and electricity produced by the flex power plants. Generally much time will pass until the new types of vehicle drivetrains will be present in large numbers of vehicles, even if the acceptance and uptake by new vehicle buyers is high and leads to a strong demand, as the following consideration illustrates:

  Let us assume that the operating life of a vehicle comprises 10 years and a strong demand for climate-neutral and efficient drive technologies leads to every fifth newly purchased vehicle being equipped with such technology. In such a case, the share of these vehicles among all vehicles will grow by just 2% annually. Such a scenario would mean it would take 50 years before all vehicles had been substituted.

  In the Steinfurt region, the changeover is to be completed within 34 years. To achieve this goal in the transport area it is therefore necessary to immediately commence with the preparations for this changeover and start developing the market today for the demand of regional combustible fuels from flex power plants. Especially methane and electric-based vehicles in diverse classes and as commercial vehicles are already today available on the market and can fall back on existing infrastructure or that which can be established in the short term (recharging columns, natural gas refuelling stations). Methane and electricity can already be supplied directly or via a certification in the Steinfurt district today.

  In the area of fleet operations of commercial vehicles, first experiences can and should be made with hydrogen-based fuel cell vehicles in order that sufficient experience has been gained with these technologies by the time of the next vehicle procurements, and to avoid vehicles being exchanged before the end of their lifetime. Particularly those fleet operators with their own refuelling supply infrastructure must not only take the vehicles themselves into consideration but also the consequences of a changeover on their refuelling infrastructure. Already today, hydrogen is deployed as a fuel in local public transport buses in various European cities and the establishment of corresponding infrastructure has commenced. A supply of hydrogen by regional technical gas companies is already possible before the flex power plants in the Steinfurt district take up operation.

- (2) Besides the resulting positive impact on value creation in the region, fleet operators of road and rail vehicles will obtain cost certainty in the area of prospective energy procurement.
  The production of regional combustible fuels in flex power plants is not subject to the fluctuations of energy prices on stock exchanges or global markets – under the condition that the regional business markets will be serviced with priority and the regulatory framework conditions do not change and lead to a disadvantage towards flex power plants. Through long-term supply contracts or individual participation in the fuel production, fleet operators can obtain the opportunity to become their own fuel supplier.

- (3) Similarly, Steinfurt district citizens can become fuel suppliers to the regional public transport providers through participation schemes involving the flex power plants. The urgently required boost to the appeal of public transport to achieve the efficiency targets of the Master Plan in the transport area could be initiated through new services and offers in the mobility area. A reliable large-scale customer regularly purchasing a reliable amount at a correspondingly interesting volume would reduce the operational risks of a flex power plant. A win-win situation for both parties could be the result if the regional companies and citizens that are participating in the flex power plant were to be motivated to change their mobility behaviour – through new or more individualised local transport products and services – and thereby help raise the profitability of the infrastructure in which they have invested.

5.5 THE POTENTIALS OF THE FLEX POWER PLANTS FOR THE REGIONAL STAKEHOLDERS

The goals of increasing efficiency and decarbonising the supply of energy in the Steinfurt district as outlined in the Master Plan 100% Climate Protection are prospectively also able to be attained through solutions offered by players outside of the region or those organised via centralised supply structures. It is, however, unlikely that the transformation of the energy sector will be successful without the active support of society as – at least in a transitional phase – the investments in new infrastructure and products will lead to higher prices and will require a change to consumer and user behaviour. It is important that a balanced effort-usage relationship exists, which culminates in the preparedness of people and firms to become involved in the process and also take over the risks.

The regionalisation of the energy transition with the support of the flex power plants can capitalise on the benefits of a decentralised energy sector for the processes involved in the conversion of infrastructure arising from the integration of users and citizens in participatory models as well as local policy and entrepreneurial flexibility due to the nearness of the wishes and demands of the market. In a regional context it is common for players to be networked and in regular exchange with each other, they know and trust each other due to long-term existing relationships, and feel connected with their home and living environment. They generally act responsibly and think ahead strategically with not solely their own interests in mind. They cannot simply "disappear" in the case something goes wrong but in such instances must rather take responsibility for the consequences of their actions. They unite the entrepreneurial/professional perspective with private interests and as citizens of the region can also benefit form the indirect effects of their activities.

The discussions of the strategy dialogue therefore did not only focus on the effects of the Steinfurt flex power plants in terms of the region's energy and climate policy goals, but also on the effects on the respective individual working and living environments – of which the following three example areas will be presented in greater detail.

5.5.1 CREATING NEW PERSPECTIVES FOR ONE'S OWN BUSINESS ACITIVITIES

The flex power plants offer – dependent on a to-be-defined business model – business perspectives for numerous regional stakeholders:

- Wind farm and photovoltaic plant operators can market their electricity directly to the flex power plants or integrate their plants in the flex power plants to then not only be an electricity supplier but also a producer of hydrogen (expansion of value creation, tapping into new markets, diversification of distribution channels). At the same time, the independent marketing of the produced power enhances the operator's flexibility and image, as they demonstrate responsibility and face up to the social challenges brought about by the energy transition.

- Biogas plant operators can expand their area of business by increasingly positioning themselves as a recycler of waste stemming from agricultural animal husbandry. Partly or completely abstaining from the cultivation or use of energy maize along with the resulting reduction of the required space for storing the biogas plant's fermentation residues saves costs and results in the sector appreciating. In addition, the integration of the biogas plant in the flex power plants can reduce the share of energy maize in the substrate and as such reduce the soil's nitrogen load. With corresponding replacement crops, the biodiversity of the fields can be enhanced. It is yet to be assessed to what degree more waste from agriculture and livestock could be regionally used in this way, leading to a reduction in the distances otherwise needing to be travelled to disposal areas as well as decreasing fertiliser imports.

- Public utility companies expand their area of business with the production of fuel and gas. Through the demand-oriented feeding in of electricity from renewable sources, network expansion and network management costs can be reduced. Synergies with other fields of business such as sewage treatment/drinking water treatment through the utilisation of oxygen from electrolysis, or participation in the energy balancing market, open up new sources of income or allow cost saving potentials to be tapped into. In addition, combined services such as in the areas of neighbourhood management and fuel management can lead to enhanced customer loyalty.

- Technical gas suppliers gain access to a source of input for "green hydrogen" (regional, climate-neutral), which through their existing distribution channels they can particularly deliver to customers in the transport sector (expansion of the product range, tapping into new markets). They similarly gain access to a source of input for extremely pure oxygen, which can then be deployed for the processes of the district's sewage treatment plants. The technical gas suppliers are furthermore involved in the technical processes as gas handling experts on site (expansion of portfolio through services associated with the flex power plants and hydrogen refuelling).

- Local transport companies (bus and rail) obtain access to regional, emission-free and climate-neutral fuels and support the local economy through their constant and reliably calculable purchase of large fuel amounts, allowing for special conditions to be attained during price negotiations. Alternatively, participation of the transport companies in the flex power plants can make economic sense if long-term energy costs can be thereby planned. The political domain can obtain a direct steering instrument for the realisation of its energy and climate policy goals through its ability to create local transportation plans and in its role as the owner or joint owner of the respective transportation companies.

- Regional financial services providers not only benefit directly within the scope of services associated with the financing of flex power plants, but also indirectly through the subsequent increase in regional value creation in the activities initiated in the Steinfurt district. The strengthening of the companies in the region, to which long-term customer loyalty exists, and the expansion of this customer base due to the activities surrounding the Steinfurt flex power plants and the network structures initiated through the energy transition, also strengthen the position of the regional service providers over competing online banks.

- Tertiary institutions and vocational training centres provide training services that are close to the market and qualify future specialists in cooperation with the future employers. The appeal of the university location for prospective students is enhanced and the reputation of the location for research, through practice-oriented research, is internationally strengthened.

5.5.2 RETAINING AND STRENGTHENING SOVEREIGNTY

An important criterion that was raised repeatedly in the discussions during the HyTrustPlus strategy dialogues and one that significantly influenced decision-making was the sovereignty of the regional stakeholders. The prevailing upheavals in energy law at the time of the dialogue, the unresolved perspectives for a decentrally organised citizen energy movement during the energy transition along with the market distortion observed in the international energy markets leading to massive falls on the stock markets unsettled the stakeholders and illustrated the dependence of their behaviour and business actions on factors beyond their own sphere of influence.

As such, the goal of the Steinfurt flex power plants was also to retain and strengthen regional sovereignty and to minimise the dependence on external influences for business prospects. In conjunction with the further regionally driven expansion of renewable energy, it is possible to strengthen the sovereignty of the regional stakeholders and reduce the associated risks with the Steinfurt flex power plants – particularly in the following areas:

- (1) Flex power plants reduce the dependency on single markets and sales chains

  At the time of the strategy dialogues, there was de facto only one single economically-feasible distribution path for the renewable energy: the electricity grid. Even the biogas plants only receive payment via conversion to electricity in heat and power plants. Feeding it into the natural gas network was only possible through direct marketing outside the scope of the EEG (German renewable energy act).

  The conversion of electricity to hydrogen and the upgrading of the produced biogas through microbacterial methanisation in the flex power plants enable stakeholders to increasingly supply their energy to other markets as well as via additional distribution channels. Market regulation or insufficient network capacities thereby no longer automatically endanger the business activities and expansion plans of the stakeholders. A socially useful limitation of electricity from renewable sources in the original electricity markets leads to: a stabilisation of prices at the stock exchange; lower costs for grid operations; and a reduced EEG levy. A greater willingness to pay in other markets, either temporarily or on an ongoing basis, opens new perspectives for profitability.

  The diversification of the sales markets can additionally reduce risks affecting only a single market and thereby enables the improvement of prospects of the plants, which can be seen as being a prerequisite for financing from banks – and subsequently for the involvement of citizens and private investors in the regional energy transition (utilisation of private capital).

- (2) Flex power plants reduce the path dependencies in the energy transition

  The developments in the energy market over the past 20 years have shown: the transformation processes have their own dynamics, and neither technology systems nor the development of costs, the regulatory framework conditions or market forces in a functioning or not functioning competitive environment can be reliably predicted or planned for the long term.

  The problem of today's energy sector is that the central infrastructure such as networks and large power stations have a long lifetime and due to the high costs can only pay off in the long term. As such, solutions are planned and constructed today that are based on current framework conditions, knowledge and forecasts – and are to remain in operation for the next 40-80 years. A massive renewal of existing infrastructure (power stations and networks) aged several decades and outdated, is urgently required. The new infrastructure that is to be realised today must be dimensioned for current energy demands and simultaneously be capable of dealing with the politically and socially necessary reduction in demand through efficiency gains (50% reduction in energy consumption by 2050 compared with 2010 levels) on both a technical and economic level. This entails ensuring that below capacity operation of the infrastructure does not lead to reduced supply security and at the same time ensuring that the costs per provided kilowatt hour of energy remain affordable for the consumer despite the relative higher costs for the operator.

For the first time in the history of the energy sector is it foreseeable that the implemented systems will need to be designed for a reduction in demand rather than an increase. Similar developments have been observable over the past decades in the supply of water and waste collection: too generously dimensioned infrastructure led to higher costs for the consumers and problems in terms of maintaining the systems.

Flex power plants enable a step-by-step replacement and renewal of existing structures through their affiliation with existing gas and power infrastructure. As gas supplier they can be operated in parallel to existing gas supplies and through the feeding in of hydrogen or biomethane in the natural gas grid contribute to the decarbonisation of the gas supply. Their positioning between wind farms or photovoltaic fields and the electricity grid enables a continuation of the existing electricity network, which is operated on a demand basis. The power-to-gas technologies used in the flex power plants can be relocated by truck and thereby proves flexible not only in terms of being able to adapt to changes in the energy supply and demand of the various markets, but also in terms of location, if required. The subsequent scalability of the electrolysis unit is possible in both directions and does not require any significant extra space. With forward-looking planning (approvals, site preparation), a subsequent adjustment to the size of the flex power plant is therefore possible without extensive effort or expense compared with today's conventional power stations. This characteristic of flex power plants is important for cushioning the effect of reduced energy consumption as a result of greater efficiency and/or changes to the population structure, which is necessary for the sake of the energy transition, and to thereby avoid costly oversized or underutilised infrastructure.

- (3) Flex power plants reduce risks due to a successive replacement of existing infrastructure and markets

The energy transition demands a restructuring of the entire supply of energy. This must be conducted during running operations and cannot endanger the reliable supply of energy to citizens and businesses at any time. Specifically this means: new fossil-free raw materials and sources of energy must be procured and distributed for the decarbonisation of the energy sector; to enable efficiency increases, plants for the production of power/movement, light and heat must be newly installed or aligned with the new energy sources. The energy transition therefore entails a massive renewal in three areas simultaneously – the supply of energy (production and storage), demand for energy (products and processes), and the transport of energy (networks). If this renewal of the three areas is to occur on a sequential basis, the success is jeopardised if the systems are only partly compatible with each other during the transitional phase. However, if all three areas are to be renewed simultaneously, the risk for all involved parties increases, should the case of even just one of the solutions not working or being delayed occur.

The foreseeable, yet difficult to predict, dynamics of energy demand over the coming years requires careful planning of the energy transition. Time, discussions and comprehensive expertise is required to come to an agreement on the social goals of the energy transition, to come to terms with the complexity of the system and the effects of decisions, as well as for prioritising activities. The flex power plants provide decision makers from politics, business and society the time to plan and implement a replacement of the system in a manner that is sustainable an in the best interests of all involved, within the scope of the energy transition. This is because as small, decentralised units, they alleviate the burden on the electricity grid and can commence the renewal of the supply of gas without needing to enter into any unnecessary path dependency. They can be used as an interim solution or as a final element of the new energy system and do not prejudice any decision on the future mix of energy sources: no matter if electricity, hydrogen or biomethane – today's infrastructure can continue to be used as required, while the urgently required decarbonisation of the energy sector is simultaneously propelled forward.

5.5.3 RAISING REGIONAL VALUE CREATION

The total annual sum expended for energy in the Steinfurt district in 2010 amounted to 1.47 billion euros. During this time the value of imported energy amounted to 1.3 billion euros. The Master Plan 100% Climate Protection quantifies the economic potential of a regional energy supply with renewable sources of energy at around 1.2 billion euros annually, of which 90 million euros come from income arising due to energy exports.

Not considered in the calculation of the Master Plan are the changes brought about by the flex power plants bringing not only financial but also a largely real energy self-sufficiency. To what extent this may lead to additional costs or to increased regional value creation with greater income for the stakeholders or municipality, must be evaluated separately. In any case, additional costs due to avoidable expansions to the network and unnecessary network services can be saved.

Furthermore, the regional production and use of emission-free fuels reduces the pollution of air from nitrogen oxides and fine particulate matter, and the prospective replacement of the coal-based power station with wind and solar energy will further reduce emissions in the air, water and soil. The social costs arising due to negative environmental factors are not yet incorporated in the calculation of regional value creation, yet they involve costs incurred for eliminating their effects, for preventative measures in other sectors in order to comply with European law and avoid the payment of fines.

It is likely that further value creation potentials can be tapped into in other sectors following an increase in the appeal of the region, which will occur through the reinvestment of additional tax income from the flex power plants into the expansion of local public transport, education, the arts and other public service areas.

6 THE STEINFURT FLEX POWER PLANTS: TIMETABLE

The strategy dialogues conducted in Steinfurt between June 2015 and June 2016 have initiated a regional discourse on the integration of hydrogen technologies in the activities and strategies of the regional energy transition. The participants agreed in April 2016 to continue the discussions and activities even following the conclusion of the project.

At the forefront of the strategy dialogue discussions were questions and arguments regarding the economic feasibility of the flex power plants, financing strategies, risks and a possible model. Many topics referred to the immediate future, others outlined the required scenarios for the further development and integration of the flex power plants in the regional energy infrastructure.

Aim of the dialogue was to identify regional usage models for the hydrogen technology to support energy transition activities. Discussed in this regard was if and how the technologies can be wisely integrated in existing structures and strategies.

The technological feasibility of the solutions was taken as a basic assumption in the dialogue process. A large number of demonstration projects showed that the technologies work and that potentials to increase the reliability of components and materials, service life and efficiency will be realisable.

Also assumed was that the technologies will be available on the market and that these will be principally accepted by the public. The participants were aware that there is currently no comprehensive hydrogen supply network and that a very low level of awareness for hydrogen technology exists among the general public – and that in the case of the realisation of a regional energy sector, active communication and acceptance management measures would be necessary.

During the strategy dialogues, three phases were identified that need to be accompanied by activities with varying areas of focus in order to establish a sustainable system. Through the definition of milestones that must be achieved at the end of phases 1 and 2, it is ensured that:

- The technological and economic risks associated with the establishment of the Steinfurt flex power plants are minimised
- Successive changes to the energy system take place in a coordinated manner in the areas of energy provision, energy distribution and energy usage
- The information and cooperation models necessary for an investment decision and the participation of various stakeholders are available

Figure 12:
System boundaries of the HyTrustPlus strategy dialogue (own representation)

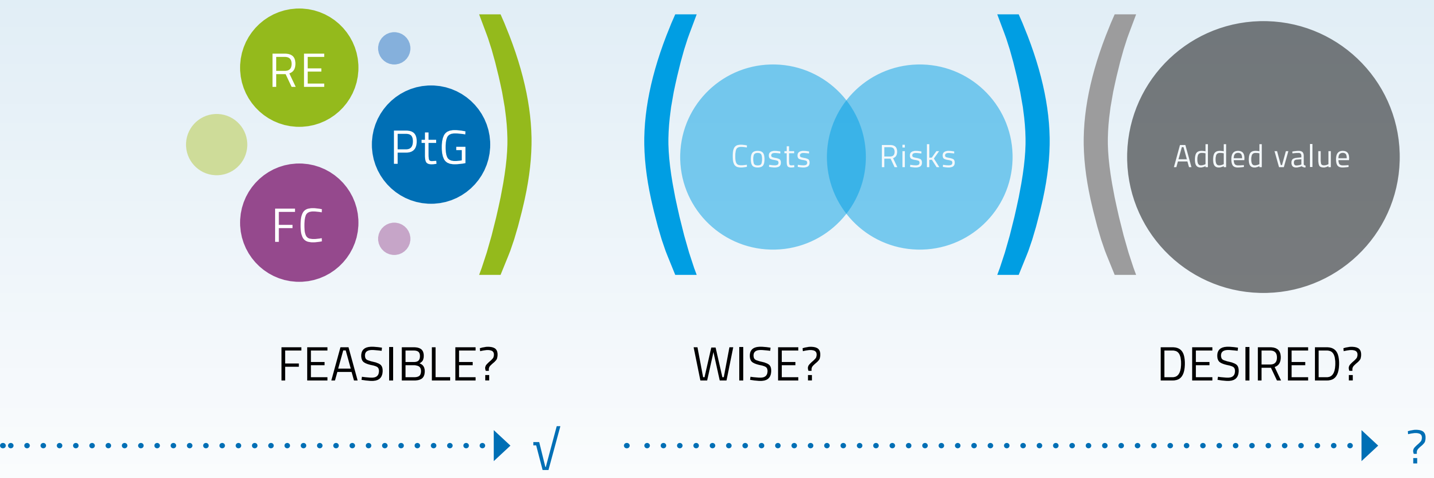


Figure 13:
The Steinfurt flex power plant timetable (own representation)

6.1 DEMONSTRATION PHASE (2017-2021): ENABLE ECONOMIC FEASIBILITY

Aim

This phase serves to conduct a potential analysis of flex power plants taking real economic and technological aspects into account as well as evaluating the acceptance of the products among the general public, the companies in the region, and in politics.

Context

EEG (renewable energy act) support for the first wind farms in the Steinfurt district ends in 2021. As such, from 2022 onwards, new purchasers for growing amounts of wind energy will be sought in order to enable continued economically feasible operation of these plants. To the year 2025 alone, this applies to plants with a total capacity of 125 MW. Before these plants can be integrated in the operation of flex power plants, a validation of the economic feasibility of the concept and potential markets for the products must be undertaken.

Key challenge and necessary activities

The dialogue has highlighted: the information and experiences available today on technological maturity, technology costs and possible markets are currently insufficient for convincing investors and potential operators of flex power plants to actively support this idea. They do not allow for any reliable and conclusive statement on the prospective economic viability of flex power plants, the information is partly contradictory, incomplete or not able to be generalised for differing locations, varying plant designs or management approaches.

Therefore, as part of a demonstration phase answering unresolved issues and taking the prevailing energy, organisational and regulative framework conditions that exist today in the Steinfurt district into account, the concept is to be evaluated, specific business models must be developed for the region, and the economic viability of the operation of flex power plant analysed in a separate demonstration project.

The result of the demonstration phase will be a regional business plan for the Steinfurt flex power plants, which is specifically based on practical experience gained in the operation of a demonstration plant in the Steinfurt district along with framework conditions specific to Steinfurt (energy infrastructure, energy markets, products and services, as well as cooperation and participatory models), and provide initial answers to the following questions:

- What is the cost of a kilowatt-hour of hydrogen from the Steinfurt flex power plant?
- On what factors are the costs of a flex power plant (OPEX and CAPEX) dependent on, how can costs be reduced, and which cost reductions can be expected?
- What investments are associated with the realisation of a flex power plant in the Steinfurt district and which costs can be saved (through the avoidance of expanding and renewing infrastructure in other areas)?
- What regional benefits are associated with the operation of the Steinfurt flex power plants (energy supply, sovereignty, regional value creation, opportunity costs, etc.)?
- How can flex power plants be wisely integrated in the existing energy infrastructure and markets?
- What income can be attained in which markets?

- What strategies are suitable for the areas of cooperation/participation, financing, risk management and acceptance management to ensure a clear delineation of activities and responsibilities, and to enable participation?

As the broad participation of the public and regional firms in flex power plants appears to be wise from today's perspective – similar to the case in wind energy projects – the business plan must enable a prospectus of the Steinfurt flex power plants. This means that besides providing details on the economic viability and the anticipated return, it should also provide detailed information on the risks associated with the investment and the assumptions made in regard to the framework conditions that need to be met for realisation.

If prospective economic viability for the flex power plants under the real framework conditions of the regional energy transition in Steinfurt district is not foreseeable by the end of this phase – even under optimistic assumptions – this phase can be extended (in the case of still pending technological innovations or unfavourable regulatory framework conditions) or a decision against the realisation of flex power plants in the Steinfurt district can be made.

6.2 TRANSFORMATION PHASE (2021-2030): MINIMISE RISKS

Aim

This phase serves to establish and integrate the flex power plants in the regional energy systems and the realisation of concepts for tapping into markets.

Context

The innovative system will be brought to market and mass production readiness through research and development (decreasing system and operating costs, increasing reliability, growing market penetration and technology availability).

The market demand of hydrogen as well as hydrogen and fuel cell technologies is still low at the beginning of the phase but increases towards its end. The learning curve is steep, resulting in the timing of investment being dependent on the economic viability and plants/products of earlier generations being disadvantaged against those of later generations.

Key challenge and necessary activities

The risks associated with the establishment of the flex power plants for operators at the beginning of the phase due to incomplete innovation processes of the technologies as well as needing to tap into new markets in competition with established fossil-based competitors, must be minimised through suitable financing structures and cooperation models along with government assistance and require broad participation of all players in the energy transition. A successive renewal of the energy system and establishment of the flex power plants will:

- Enable the integration of experiential knowledge in each successive new plant so that here too the accompanying economic and technological hurdles existing early in the phase may be reduced through possible optimisations in terms of system design/interaction, nonexistent or unreliable supply chains and/or material and component suitability.
- Assume that fair compensation (risk sharing and financing) will exist between the "pioneers" and "fast followers" who benefits from the experiences made in the pioneer plant.
- Provide the stakeholders with sufficient time to tap into new markets in the fuel market (road and rail), heating market (companies, districts, and private customers) as well as the electricity market (direct marketing, network services, emergency power supplies, isolated supply).
- Benefit from the growth of experience in other regions and technology areas of the energy transition.

From the perspective of the regional stakeholders in Steinfurt, it is imperative that long-term contracts with predefined purchase volumes and prices are concluded with "anchor markets" in order to reduce the economic risks. Alternatively, a modified EEG (renewable energies act) that provides a subsidy for energy outside of the electricity market could replace such an "anchor market participant" in the beginning phase. The goal should be, however, that the flex power plants can be operated in line with the market by the end of the transformation phase.

6.3 REGIONAL RENEWABLE ENERGY – HYDROGEN – BUSINESS (2030+): REGULATE MARKETS

Aim

This phase serves to replace the fossil-based energy system with the renewable energy system.

Context

By this point in time, the innovation processes of hydrogen and fuel cell technologies will be concluded to such a degree that the products for the production, provision and use of hydrogen as a fuel in the stationary and mobile area will be available on the market in sufficient quantities, at an adequate level of quality, and at an acceptable price.

Key challenge and necessary activities

The HyTrustPlus strategy dialogue participants agree: the economic viability of the flex power plants, even with ideal operating conditions and integration in the regional infrastructure, remains permanently at risk through the failure of the market in the area of setting prices for fossil energy raw materials (lacking consideration of social costs) as well as the competitive behaviour of powerful competitors in market (dumping). Clear social and political framework conditions are required that will enable fair and sustainable competition in the energy sector.

In the future, besides stricter regulations for the prevention of unfair competition, a further energy component should be introduced in public and private tenders to begin with, which goes beyond the mere kilowatt-hour to also include emissions and sustainability-based criteria, to later become established and entrenched in the sector.

A detailed description of the timetable for the Steinfurt flex power plants along with the adjustments to the regulatory framework necessary for their realisation can be obtained in the position statement of the regional stakeholders, published in June 2016[1].

1 N. Hölzinger, U. Ahlke "Die Steinfurter Flexkraftwerke – Positionspapier der regionalen Akteure aus dem Kreis Steinfurt", Kreisverwaltung Steinfurt 2016

7 THE STEINFURT FLEX POWER PLANTS: KEY QUESTIONS FOR TRANSFORMING THE SYSTEM WITHIN THE SCOPE OF THE ENERGY TRANSITION

The discussions with the Steinfurt stakeholders have highlighted: hydrogen has the potential to become an important component in the regional energy transition and the flex power plants can provide the breathing space to provide the necessary time for the transformation of the energy system, which is required to enable a responsible, strategic, decision making process.

In an ideal world the planning and realisation of the flex power plants would occur in a technology and energy-optimised manner: They will be located at suitable sites in sufficient sizes in order to stabilise the entire system and ensure supply reliability across sectors. Various technological solutions exist simultaneously and are aligned in terms of size and technology with one another. They play a role on an equal footing in the supply of energy according to their capabilities and are only limited in the type and scope of energy demanded and the available supply of energy.

In the real world the economic viability and the corresponding current regulatory framework limit the opportunities. The existing energy system also possesses a path dependency that must be taken into account and thereby limits flexibility. Decisions need to be made on the amount of effort one is willing to expend and the risks one is willing to take in order to transform the system. Decisions on the speed of the transformation and reaching the target must be made, which in turn have an influence on the risks of the undertaking and can result in changes to the power structures among the players. In order to minimise the risks and to acquire the necessary capital for investment, priorities must be set and synergies exploited. It may be necessary to bring forward activities or reschedule these in order to get or retain key stakeholders on board or to provide them with the requisite time to allow their system world to be adjusted to the changes.

The following chapter provides an insight to the discussions and world of ideas arising from interviews and strategy dialogues with the Steinfurt stakeholders. Some ideas were developed further within the scope of the concept creation through additional research and analysed in terms of their consequences for the further planning process for the realisation of the Steinfurt flex power plants – in the Steinfurt district as well as other interested regions. Not all ideas reflect the opinion of the entire group. Contradictory views and opinions along with unfinished trains of thought and theses exist, which still require further examination. They are nevertheless included in this concept paper in order to initiate a broad social discourse on the continued development of the Steinfurt flex power plants.

7.1 ECONOMIC VIABILITY: CAN WE AFFORD AN ENERGY TRANSITION WITH FLEX POWER PLANTS, AND DO WE WANT TO?

The discussions on the economic viability of the flex power plants were intensively pursued and could not be concluded within the scope of the strategy dialogues. The participants agree that the linking of the electricity, heat and transport sectors, as would be the case with the flex power plants, is vital for achieving the regional energy and climate policy goals. There was also consensus that the idea of the flex power plants supplements and supports the further activities in the region and should therefore continue to be pursued. The costs for realisation, however, appeared too high for the stakeholders, along with the subsequent risks resulting from the incomplete existing information and the partly contradictory data that is available on the technology and the further innovation process.

The basis of the discussions on the economic viability of flex power plants

Research undertaken during the time of the discussions using publically available experiential and anticipated data on the production costs of hydrogen by the flex power plants' underlying power-to-gas technologies identified values of 2.8-22.6 euros/kg H_2 at electricity supply costs of 4-8 cents/kWh[2]. The costs are highly dependent on the size of the plant, the operational hours and the price of electricity needing to be paid. To further specify the discussion, a plant size of 3-6 MW was defined with 4,000 annual operational hours (full load) at electricity supply costs of 4-6 cents/kWh, which under certain regulatory framework conditions can be assumed to be a realistic value for a larger wind farm site in the Steinfurt district. The effects of additional part load operation on the production costs could not be resolved within the strategy dialogue and will be the subject of the continuing discussions with technology suppliers in the demonstration phase (2017-2031).

Using these figures for the framework conditions in the Steinfurt district, and assuming that no taxes/duties are due for the electricity sourced from the wind farms, production costs of around 3.3-7.1 euros/kg H_2 can be achieved. The lower end of the cost spectrum includes the anticipated cost reduction potentials of future PEM electrolysis, the upper end reflects today's costs of alkaline electrolysis as well as conservative assumptions and a high premium for risks and/or maintenance. Even under the unrealistic assumption of zero electricity supply costs and under the mentioned framework conditions, the study authors would still anticipate production costs of 1.7-3.3 euros/kg H_2.

The production of biogenic storage gas through microbial methanisation of the hydrogen produced via electrolysis would today have production costs at a total of 0.16-0.24 euros/kWh[3], depending on the size of the plant.

2 *G. Müller-Syring et al. "Entwicklung von modularen Konzepten zur Erzeugung, Speicherung und Einspeisung von Wasserstoff und Methan ins Erdgasnetz/Management Summary", DVGW 2013*

3 *Dr. F. Graf et al. "Techno-ökonomische Studie zur biologischen Methanisierung bei Power-to-Gas-Konzepten/Abschlussbericht", DVGW 2014*

Irrespective of the quality of the currently available information accessible to outsiders on the subject of hydrogen and fuel cell technology, the consequences for the challenges of the establishment of the Steinfurt flex power plants are clear: Should the flex power plants be limited to only producing hydrogen and biomethane from renewable energy sources – which is to then to be sold in competition with fossil fuels on the market that with their higher financial return can better satisfy investors – then economically feasible operation appears to be difficult to realise, not just in the present but also prospectively.

For clarification: Purchasing prices up to a maximum of 5 euros/kg H_2 are necessary so that a refuelling station operator can provide a price that is acceptable to consumers and comparable to today's costs for fossil-based mobility. In the area of public transport, even lower prices are currently acceptable due to the prevailing very low costs for diesel and the refuelling of buses. Also the use of hydrogen as a fuel for the supply of process energy and energy for buildings cannot be realised in an economically feasible manner at the market prices prevailing for natural gas – which would compete with biomethane – at the time of the strategy dialogue: at 0.016 euros/kWh, fossil-based natural gas is currently available to customers for a tenth of the production costs for biomethane made by microbial methanisation.

The dialogue could have been broken off at this point due to the lack of a perspective for the economic feasibility of the flex power plants now and in the future from today's viewpoint: Among the key arguments for the continuation of discussions and the further development of the concept for the establishment of the Steinfurt flex power plants were:

- *Experiences from the innovation process of renewable energies:* The development of costs and markets of innovative technologies are fundamentally considered to be difficult to predict and have only a limited level of validity. The example of renewable energies highlighted to the players that cost reductions due to economies of scale and learning curves have been significantly underestimated in the past.

- *The understanding that for the assessment of the economic feasibility of flex power plants, only the relative costs in comparison to the competing energy products are relevant:* Today's seemingly too high production costs of renewable energies and the flex power plants are compared with energy prices on the market that are currently not representative and far too low, and that are determined by existing (but due to their age soon needing to be replaced) infrastructure, geopolitical influences and trade on stock markets or a missing regulatory framework for ensuring a socially sustainable energy market and are not representative for future costs of a secure energy supply.

- *The anticipated regional and commercial added value through the integration of flex power plants in the regional energy transition activities,* which to date are not taken into account in the plant-specific economic feasibility assessment. Considered as being particularly important arguments in this context were the increased sovereignty in the energy area and the anticipated positive impulses on the economic developments in rural areas.

The regional stakeholders in the Steinfurt district subsequently identified and discussed three strategic approaches for the improvement of the economic feasibility of the flex power plants:

Strategic approach 1: Reduce system and operating costs

From the viewpoint of the regional stakeholders, besides the provision of functional technology products that satisfy both market demands and the requirements of the energy transition, the aim of all further activities within the technological innovation process must be to use and exploit all cost reduction potentials possible. Today's depiction of the innovation system's economic feasibility will otherwise clearly thwart the transformation process and endanger long-term support by regional stakeholders. In any case, for the further involvement – including that of a financial nature – of regional stakeholders in the Steinfurt district, it is a prerequisite that transparent and verifiable statements are made regarding the strategy for reducing costs, the anticipated cost levels of the various components and systems along with influencing factors on the technology costs (investment and operation). Only in this way can the necessary trust be built up, which is the prerequisite for the acceptance of risks in the transformation phase of the energy systems.

Strategic approach 2: Increase income

The economic feasibility of a system is determined by the relationship of costs and income. As such, growth in income can also lead to increased economic feasibility if costs stagnate or even rise. The achievement of greater income can be supported through a better utilisation of the plant due to higher market demands, due to the preparedness of the market to pay higher prices, or because of the following activities and framework conditions:

- *Diversification of the product range (generate additional income at the same cost structure):* hydrogen, oxygen, biomethane, CO_2 certificates, electricity, heat, network services in the areas of network stabilisation and emergency power supply, energetic utilisation of agricultural waste, etc.

- *Diversification of the sales markets (exploit the different levels that varying markets are willing to pay):* regional/supra-regional fuel markets, electricity markets, certificate markets (biogas, green power and CO_2), markets for technical gases (especially chemical industry and refineries).

- *Increase of the market's willingness to pay (increase value):* integration of personal or regional added value, increase costs of competing fossil-based energy products to effectively reduce the price difference for customers.

An increase in the economic feasibility of the flex power plants through government support measures was intensively and thoughtfully discussed. While grant funding was considered to be useful and important at the commencement phase to compensate for the high costs and risks due to the lack of technological maturity or the nonexistence of a market, the necessity for "perpetual funding" will reduce the motivation in the longer term for the stakeholders' involvement: the technology appears to be "not worth it", and will be perceived as not being strong or capable enough to prove itself in the market and thereby remains dependent on the good will of policy. Under such framework conditions, long-term investment decisions appear risky, especially upon the backdrop of a national and international energy policy that is deemed as being unreliable. It is however also accepted that the energy market as a whole is determined by governmental support and that a large number of subsidies are influencing market behaviour. In addition, the subsequent costs are not compensated for on a polluter-pay principle nor are they taken into account in pricing, but are rather carried by society (health issues, climate, environment). As such, the integration of the Steinfurt flex power plants in line with the market requires the attainment of equality through either the internalisation of the external costs by the fossil and nuclear energy sector, or through equal government support towards energy transition activities (compensation measures).

Strategic approach 3: Reconsider economic feasibility

The discussions on the economic feasibility of the flex power plants also encompassed critical questions regarding the necessity to maximise economic feasibility and profits. The majority of stakeholders agreed that a "break even" phase would be acceptable at the commencement of the transformation process. Naturally, high profits would also be acceptable yet were not a precondition for involvement and the provision of private capital. Insofar as there were to be adequate protection against risks, the "break even" phase could also be extended, as it is anticipated that the use of the regional flex power plants will also make an impact in other areas (including regional economic development, strengthening of sovereignty in the energy sector, improvement of environmental and climate protection, independence from energy imports and developments in international markets). While some of the stakeholders expressed a clear expectation for prospective profits (even if only in the single-digit realm), others even questioned the "break even". Here the consumer perspective was in focus. Based and expanding on the "increase of the market's willingness to pay" strategy that was introduced above, a "willingness of players participating in flex power plants (consumers) to pay" was discussed. In the Steinfurt district, many energy plants with citizen participation have been established that combine the dual role of the business and consumer perspective. The comparison with the conscious decision to "want to afford things yet not always choose the cheapest alternative" was introduced and underscored with behavioural examples from the areas of leisure (expensive tickets for better seats in the stadium, tennis club membership), mobility (sports car instead of family wagon), and nutrition (organic products rather than cheap meat). Subsequently, the preparedness for the not-for-profit operation of a flex power plant was discussed. Such a "consumer perspective" in which money is "invested" in energy and the regional economy considers energy supply to be less of a business sector that must produce profits, but rather sees it more as a social necessity and a service to people. It redirects the discussion on the energy transition back to the question of what individual people and society as a whole is prepared to invest – and ultimately pay. Similar to discussions on the funding of the education and health systems, this approach does not primarily consider cost reductions and profit maximisation but rather the maximisation of value for the individual and society as a whole. Discussed in terms of the value for the individual was the personal self image ("I believe it is important that we establish a clean/regional energy supply") and the anticipated positive effects on life quality (e.g. job security/creating new jobs, tax income for more funding for schools, the arts and mobility). Brought up as factors increasing value for society were the strengthening of sovereignty, reduction of energy imports and greater scope for action in the area of climate protection.

A precondition that also applies to this third strategic approach is the responsible use of the funds provided by citizens, firms and cooperative members. A transparent and verifiable data basis is considered a prerequisite for a conscious investment decision and participation.

7.2 FAIRNESS: WHO WISHES TO, CAN, AND SHOULD ASSUME THE RESPONSIBILITY FOR THE REALISATION OF THE ENERGY TRANSITION (WITH FLEX POWER PLANTS)?

The answer given by the regional stakeholders in Steinfurt was clear: the realisation of the flex power plants should occur in a decentralised manner with the involvement of regional stakeholders. Only in this way can the anticipated value for the own business activities, the regional economy and the strengthening of sovereignty be successfully tapped into with the flex power plants. Assuming acceptable economic feasibility (as outlined in the previous chapter), the stakeholders are prepared and in the position to provide the necessary financial resources and to invest in flex power plants with their own capital. The realisation of the flex power plants with the participation of citizens, as practiced in the Steinfurt district for many years in the area of renewable energies already, nevertheless demands that the capital entrusted for this purpose – which primarily comprises private capital assets and capital for retirement – is used responsibly. At the same time, a prudent use of the available areas and infrastructure in the district must occur. The attainment of the efficiency goals is imperative for the minimisation of the impact of the associated energy infrastructure and on the appeal of the region and the quality of life of those living and working in the Steinfurt district.

The regional stakeholders in the Steinfurt district subsequently identified and discussed two preconditions for their own participation in the realisation of the flex power plants:

Strategy 1: Fair funding and participatory models

On the basis of the available information and experiential values with demonstration plants, a prospectus of the flex power plants as an investment product was not conceivable according to the assessment of the financial institutions involved in the strategy dialogues at the time. The risks were assessed as being significantly too high, arising due to the lacking sales markets at the present time as well as the contradictory or only very limited available data basis regarding the situation of costs. Should these risks not be able to be significantly reduced within the scope of the planned study in the demonstration phase (development of a regional business plan), participation from private investors or within the scope of an energy cooperative would appear unrealisable.

A federal or state guarantee could, however – conditional on acceptable economic feasibility under realistic assumptions and framework conditions – provide the necessary security and lead to a positive funding approval with the participation of citizens' capital. The guarantee could ideally provide protection for the capital in the following situations that are outside the private investors' (citizens and companies) sphere of influence and exert a significant amount of influence on the economic feasibility of the flex power plants.

- The production of hydrogen and fuel cell technology is discontinued, the subject is dropped, the products are not available in sufficient numbers on the market (vehicles, heater, electrolysers, compressors, refuelling stations, etc.)
- The energy-specific regulatory framework conditions are changed to the disadvantage of flex power plants and inhibit operation or have a significant detrimental effect on the economic viability
- Competitors abuse their market power and engage in long-term inappropriate market behaviour (price dumping)

All three areas lie largely within the political and social scope for decision making and action, and can be (re)directed through corresponding regulatory framework conditions (support or sanctions). From the perspective of the stakeholders, a regional or public guarantee of the invested capital could result in a fair distribution of the risks and would be preferred over incentives for investments.

Strategy 2: Fair sharing of burdens and benefits

The establishment of the flex power plants is associated with the expansion of renewable energies. The goals of the Master Plan 100% Climate Protection can only be achieved if 1.5% of the district's surface area is set aside for the new energy sector. The demand for this amount of required surface area assumes a reduction in energy consumption in the rural region by 50%. The dimensioning of energy infrastructure for the supply of energy beyond the native population, such as for the supply of major regional centres or conurbations, would be associated with greater surface area demands for wind farms, photovoltaic parks and flex power plants. It quickly becomes apparent that the energy transition cannot be achieved without comprehensive efficiency measures and a fair distribution of the burdens between rural regions as the primary energy producers and the major regional centres and cities as the key energy demanders. It remains to be clarified what potential operational models for the supply of ("energy hungry") densely populated centres with little surface area could look like that do not endanger life quality in the rural regions. The question needing to be answered is: How many square metres are required for the energy transition for what level of energy consumption, and where these areas are used for the production of energy to the burden and benefit of whom?

It is conceivable that economically feasible operation of the flex power plants, which require a yet-to-be-defined minimum turnover, is only possible through the integration in the energy markets outside of the region or must need to be able to fall back on supra-regional "anchor markets", at least in the commencement phase. As long as these supra-regional distribution paths are desired in the Steinfurt district, along with the associated higher turnover and expansion of renewable energy, there is nothing to be pitted against it. It is, however, important to remain in continuous dialogue with the local population in order to identify and respect the boundaries of what is acceptable. The strategy dialogue stakeholders have made it very clear that for all decisions the priority is to be on assuming responsibility for shaping a worthwhile future in the Steinfurt district and not merely the maximisation of profit.

7.3 SYSTEM ESTABLISHMENT: HOW DO WE CREATE THE BASIS TO REALISE THE REGIONAL ENERGY TRANSITION WITH FLEX POWER PLANTS?

Numerous technological solutions exist for the realisation of the energy transition. The focus of debate is often on the effectiveness of the plants or systems, and is followed by the technology costs (investment and operating costs). What is largely missing when regarding it in such an economic sense are the costs and risks that society must bear for the system changeover. What infrastructure already exists, how will this be renewed or replaced, and how will an uninterrupted supply of energy be ensured in the transitional period?

The establishment of a new branch of industry, the Steinfurt flex power plants, enables a successive replacement of today's fossil-based fuel and combustible fuel industry and the reduction of risks involved in the system changeover. As long as both systems, the fossil and post-fossil systems, exist parallel to one another – as will be the case for several decades, according to the Steinfurt stakeholders – solutions for integrative infrastructure are necessary in order to secure acceptance on the demand side and to avoid unnecessary costs ("dead capital"). Integrative infrastructure that enables the parallel use of both old and new energy facilitates the changeover for users. The systems are not in competition to one another – the old system is gradually phased out while the new system continually takes on more relevance and responsibility.

For the replacement of existing infrastructure, besides the outlined approaches for funding, fair risk distribution and the timetable for the regional energy transition with flex power plants, the social and political framework conditions supporting the restructuring of the energy sector must be promptly created, along with securing public acceptance of the effects associated with the restructuring on the day-to-day lives of the affected people and companies. Society must be conscious of the fact that the energy prices attained on stock exchanges and global markets are neither representative of a fossil-based energy system nor are they representative of a post-fossil energy system of the future. Even without an energy transition, the renewal of existing energy infrastructure over the coming years will require investments in the billions – which will be carried by society and energy customers. In each case, the reduction in costs through enhanced measures to reduce the demand for energy is required along with the promotion of more efficient technologies and processes to be implemented.

The establishment of a sustainable energy system is a process that already commenced 20 years ago and one that must continuously be realigned to the constantly changing social (geo)political and technological framework conditions. Decisions on the transformation of the energy systems need to be made that ideally do not result in path dependencies and that are technically capable of dealing with the anticipated reductions in energy demand without incurring unnecessary expenses. In combination with the existing electricity and gas infrastructure, the Steinfurt flex power plants are in the position to integrate this required flexibility into the system.

Specific recommendations for action for policy makers to shape a regulatory framework supporting the integration of flex power plants in the energy system include the adjustment of the renewable energy act (EEG) to support usage of renewable energy outside the direct electricity market (sector coupling) and the privileging of heat and electricity used in private networks of, e.g., in neighbourhood management (reduction of tax and emissions). In addition, for the market-based integration of renewable energies and flex power plants, political solutions must be identified to prevent dumping or other anti-competitive measures being conducted by competing providers. The complete, detailed list of recommendations for action for policy makers is incorporated in the Steinfurt flex power plant stakeholders' position paper.

(Steinfurt, June 2016. To be continued...)

ANNEX: PROFILES OF THE STEINFURT STAKEHOLDERS

(In alphabetical order)

BÜRGERWINDPARK HOLLICH SELLEN GMBH & CO KG (CITIZEN'S WIND PARK)

Together, Windpark Hollich GmbH & Co. KG and Bürgerwindpark Hollich Sellen GmbH & Co. KG. represent Bürgerwindpark Hollich-Sellen with currently more than 200 shareholders from Steinfurt in the Münsterland region. Renewable power has been produced since 2001 at Bauerschaft Hollich in Steinfurt. The 35 wind turbines in Hollich Sellen generate up to 180,000 MWh of electricity annually. In 2014, "Energielandschaft Hollich" (energy landscape Hollich) won the European Solar Prize in the category "Local or regional associations promoting renewable energy projects".

B&R ENERGIE GMBH

B&R-Energie GmbH represents experience and expertise in the area of solar and wind power. It focuses on delivering regional value creation, facilitating entry for investors into climate-neutral energy production, and views itself as an on-location promoter of the energy transition. B&R-Energie GmbH establishes and operates photovoltaic and wind power plants within the scope of investment companies. It is particularly aimed towards investors who attach importance on proximity to their investment plant as well as on management by a local company. Besides an attractive return for the investors, other factors play an important role during the planning and realisation of projects: regional value creation (contracts to regional firms, investors from the region), support of municipal goals, and participation of as many citizens as possible. The expansion of the recharging infrastructure for electric mobility has been a further field of activity for some time already. Moreover, the factors of local value creation and the proximity to citizens also play important roles.

KREISSPARKASSE STEINFURT (DISTRICT SAVINGS BANK)

The Kreissparkasse is the largest credit institute in the Steinfurt district. We consider ourselves as partners of our regional retail and corporate customers and are keen on promoting positive economic developments in the region. In the field of renewable energies, we have been a partner from the outset and look forward to actively accompanying and shaping the continuing development of the regional energy transition within the scope of the Master Plan.

MÜNSTER UNIVERSITY OF APPLIED SCIENCES

The Münster University of Applied Sciences (FH Münster) is one of Germany's top research universities. Founded in 1971, today 13,000 students conduct research and study across 12 disciplines. In the "Bau | Umwelt | Ressourcen" (construction, environment, resources) faculty, the university researches issues including urban and regional infrastructure in the areas of supply, disposal and transport. An important focus hereby is on the sustainable use of resources to protect the environment and thereby enhance quality of life.

RVM – REGIONALVERKEHR MÜNSTERLAND (PUBLIC TRANSPORT AUTHORITY)

RVM Regionalverkehr Münsterland GmbH is a municipal public transport company that is mainly backed by the Münsterland districts of Borken, Coesfeld, Steinfurt and Warendorf. With over 370 bus routes, the RVM provides an important infrastructure for the Münsterland districts – indispensible within the scope of providing municipal services to the public and a significant factor for environmentally friendly mobility. With its 135 own and 490 leased buses, each year the RVM transports around 30 million passengers to their destinations safely – no matter if to work, school or for leisure. Over 300 people work in the workshops, as bus drivers or in the administration across the locations in the for Münsterland districts. As the largest regional transport company in Münsterland, the RVM is also a contractor for approximately 100 medium-sized bus and taxi firms.

SAUERSTOFFWERK STEINFURT E. HOWE GMBH (GAS PRODUCTION & SERVICES)

Sauerstoffwerk Steinfurt E. Howe GmbH & Co. KG is a modern, long-standing company that draws on more than 100 years of experience. The range of services encompasses services associated with the supply of technical and medical gases, combustion and heating gases, inert welding gas as well as special and liquid gases. The distribution network extends to a radius of 250 km around Steinfurt, with supply to the remaining national regions undertaken in cooperation with forwarding agents.

STEINFURT CITY

Cities and communities can make an important contribution towards climate protection and therefore against climate change. Together with numerous players from the fields of politics, business and civil society, the district city of Steinfurt therefore took steps towards implementing projects and measures for climate protection. Establishing cooperative models, partnerships and working in networks are significant factors for success in this regard. As such, the city supports joint projects for climate protection in the district.

STEINFURT DISTRICT – OFFICE OF CLIMATE PROTECTION AND SUSTAINABILITY

"Shaping the energy transition on a local level and promoting rural development, together with municipalities, companies, institutions, associations and citizens." These are the goals that the Steinfurt district has firmly in its sights. The key organisational and managerial unit in this process is the Office of Climate Protection and Sustainability, which supports and structures the issues relating to sustainable regional development in the Steinfurt district. Special focus in this regard relates to the involvement of regional stakeholders, the strengthening of the regional economy and the expansion of knowledge transfer.

Issues, projects and networks are attended to in an interdisciplinary and interdepartmental manner with the targeted support of the municipalities. The work of the Office of Climate Protection and Sustainability is particularly involved in the following areas:

- Climate protection and climate change
- Expansion of renewable energies and energy efficiency
- Strengthening regional value creation
- Development of rural areas
- Strengthening civic responsibility

STADTWERKE STEINFURT (PUBLIC UTILITIES)

Stadtwerke Steinfurt provides electricity, gas, water and heat from a single source and is the local point of contact for all questions concerning the issues of energy services, energy efficiency and renewable energies. As a regional service company, it actively strengthens and supports Steinfurt as a location for doing business and has done so since the beginning of the last century.

In 2012, the Steinfurt district received the German Solar Prize from EUROSOLAR for its political will and cooperative efforts towards energy autonomy by 2050. The future-oriented "Unser Landstrom" (Our Shore Power) project of cooperation partners Stadtwerke Greven, Stadtwerke Ochtrup, Stadtwerke Rheine and Stadtwerke Steinfurt is an element of this prize. Furthermore, in August 2014, the Steinfurt district was distinguished as a place of progress for the project "Energieland 2050 – die Region der Netzwerke mit zukunftsfähigen, nachhaltigen und innovativen Projekten" (Energieland 2050 – the region of networks for future-oriented, sustainable and innovative projects).

THE ENERGIELANDWERKER (ENERGY LAND WORKERS)

The Energielandwerker is a project that was initiated by the four companies: Windpark Hollich GmbH & Co. KG, Windpark an der Landwehr GmbH & Co.KG, Bioenergie Steinfurt GmbH & Co.KG as well as Windpark Schöppinger Berg GmbH & Co.KG. It is responsible for bundling producers of renewable energy in the region and marketing this as regionally as possible, drawing upon the assistance of various service providers. In addition, it also supports producers in energy sector-related issues and identifies new marketing concepts for the plants, including for the time after the EEG support comes to an end.

VOLKSBANK SAERBECK EG AND THE VOLKSBANKS IN THE STEINFURT DISTRICT

Volksbank Saerbeck eG is one of six cooperative banking institutions in the Steinfurt district. As partner in the region, the Volksbanks provide financial services to retail customers and freelancers as well as industrial, medium-sized and agricultural enterprises from a single source. The Volksbanks are in the position to bundle capital regionally, enabling it to be used for investment purposes. The cycle enables capital providers to be offered a return opportunity, whereby infrastructure projects within the scope of the EEG (renewable energy act) can be developed to ensure sustainability and stability. Parties seeking capital have the opportunity to receive capital from the region. All involved parties benefit from this regional value creation.

WESTFALEN GROUP

The Westfalen Group is active as a technology company in the energy sector with a total of 23 subsidiaries and investment companies in Germany, Austria, Belgium, Czech Republic, France, the Netherlands, Poland and Switzerland. Founded in 1923, the family business with more than 20 production locations in Europe is headquartered in Münster. The areas of business include gases, the supply of energy and fuel stations. With currently over 1,600 employees, the Westfalen Group generated turnover totalling some 1.8 billion euros in the 2014 business year.