

## Wind energy

A majority of the renewable energy unsteadily fed into the electricity supply is generated by wind energy. The more flexibility and optimisation potential is included, the more successful the complete integration of wind turbines into the grid will be. It includes:

- increasing wind turbine efficiency and generation capacity and also
- upgrading wind turbines for innovative capabilities that are beneficial to the grid.

In order to promote societal acceptance of wind energy, it becomes more and more necessary to find innovations that improve its environmental friendliness, for example the protection of flora and fauna and also the reduction of the wind turbines' light and noise emissions.

## System integration

Coupling the electricity sector with other large consumer sectors, such as heat and mobility, using modern algorithms serves to stabilise the grid. The success of the overall concept decisively depends on

- a system integration of the various energy technologies and sectors, and also
- their systematic control and regulation in the decentrally networked communication structure.

In order to technically control the renewable energies, it is necessary to have suitable coordination structures for the system components, as well as learning and predictive regulations and systematically designed sub-control circuits.

## Energy storage systems

The necessary synchronisation of consumption and generation must be supported in electricity grids with an increasing share of renewable energies by way of efficient energy storage systems, so that

- short-term load and generation fluctuations are balanced, and
- long-term electricity surpluses can be expediently absorbed.

Power-to-X concepts (PtX) make electricity surpluses available in the long term for periods with low generation. Heat and electricity storage systems are short-term alternatives, whose regulations must take their dynamic properties into account.

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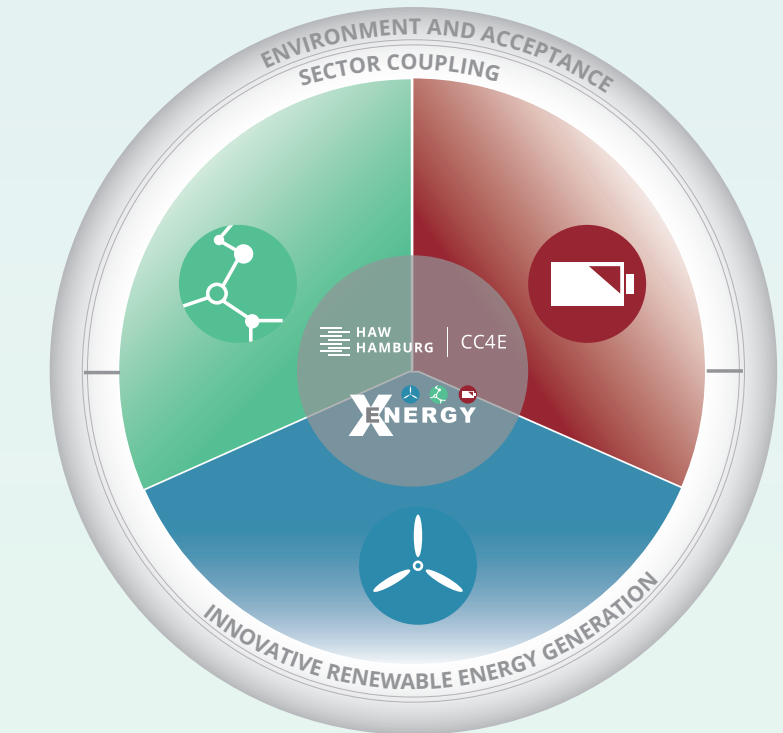
Innovation Centre for Wind Energy,  
System Integration and Storage Systems

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## Strategy and goals

Effective climate protection requires the successful implementation of the energy transition. In this regard, the electricity system must be successfully transformed from a demand-driven to a generation-driven flexible electricity system by way of a change that is open to new technology.

The X-Energy project supports this change through three areas of research: **wind energy, system integration and energy storage systems**. These topics are of particular importance for the expansion of the energy transition. In the X-Energy project, these research areas are attributed to the three areas of action: "environment and acceptance", "innovative renewable energy generation" and "sector coupling".



By way of the interdisciplinary X-Energy project initiative, the University of Applied Sciences Hamburg (HAW Hamburg) wants to become a leading innovation centre in the development of solutions to future-proof the energy system and therefore also wants to become an important innovation driver in the Hamburg Metropolitan Region. In the context of X-Energy, a network of regional and national business partnerships with numerous individual projects is established.

In doing so, HAW Hamburg would like to

- become an impulse generator for **excellent research**,
- promote a successful **transfer of knowledge** and
- ensure the market launch of **innovative products** and services.

In this regard, HAW Hamburg's project coordination of the collaborative X-Energy project is designed so that the project results are maximally utilised. The goal is to integrate findings, research results, products, procedures and services into commerce scientific teaching and to transfer knowledge within the partnerships.

## WIND ENERGY

## SYSTEM INTEGRATION

## ENERGY STORAGE SYSTEMS

### Project Overview

**Funding provider:**  
German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung - BMBF)

**Funding measures:**  
Starke Fachhochschulen – Impuls für die Region (FH-Impuls)

**Funding amount:**  
6 M EUR

**Third party funding – businesses:**  
approx. 1 M EUR

**Project duration:**  
2017-2020

### X- SmartWind

Questions regarding grid and system integration when planning the location of wind turbines will become more important in the future. **Tools for project planning, location analysis and evaluation for wind farms** are being developed. They consider the expedient application of technical solutions for the improved grid integration of the wind farms (e.g. avoiding grid bottlenecks) at the respective location.



### morFLEX

In the course of the energy transition, methods for the trade-optimised planning of industrial loads are to be realised. The goal is to develop generic hard and software solutions to make **the electricity consumption of industrial plants flexible** with a focus on the scalability of flexibility by way of demand side management in the electricity system.



### X-Eptance Impulse

The goal is to develop a good value, synchronous and multi-channel measurement system for acoustic signals using the most modern and highly integrated components. It serves to permanently **measure noise emission from wind turbines** and to minimise it by way of the system control. In addition, a **noise data bank** for acoustic early detection of faults is being developed.



### X-Radar

The deployment of **radar support technology to reduce the night-time obstruction lighting of wind turbines** is being investigated for its acceptance effects among the population. Positive acceptance effects could influence the marketability of such systems and promote willingness regarding the expansion of wind turbines among the citizens.



### FLEDERWIND

In order to **protect bats**, the causes of collisions with wind turbines are being investigated and risk minimisation activities as well as a bat-friendly lighting on onshore wind turbines are being developed. The spatial recording of the number and type of bats and their flight behaviour is performed with the help of an innovative combination of radar systems, batcorders and infra-red cameras.



### VIBROAKUSTIK

The goal is to develop constructive measures for the **acoustic optimisation** of the main components of the turbine drive trains in order to reduce noise emission with the help of simulations. The focus is on the acoustic optimisation of the gearbox and generator housing. Vibroacoustic is being used as the methodological basis here.



### X-Eptance Explore

The goal of this sub-project is the development of an **immersive, mobile virtual reality system which combines the visualization and auralization of a wind energy turbine** during different operation states. The realization is based on the measurement technology and data of X- Eptance Impulse. The target of the sub-project is to improve the societal acceptance of planned wind turbines.

### X-Rotor

Electricity generation costs must be further reduced to increase the number of wind turbines. For this purpose, innovative concepts regarding **two-bladed and multi-rotor turbines** are compared with the conventional three-blade turbines. In the case of positive effects, impulses for future wind turbines can be set and the construction of a prototype can be speeded up.



### ClosedCarbonLoop (CCL)

At the Energy Campus of the CC4E, the system complex consisting of combined heat and power station (CHP), electrolysis and methanisation is to be expanded with a **CO<sub>2</sub> adsorption system**. In this way, the carbon loop, will also be closed in a climate neutral manner in addition to the already established "electricity loop" (renewable electricity & CO<sub>2</sub> from air → power to gas → reconversion to electricity in CHP & release CO<sub>2</sub> to atmosphere). Control algorithms for a grid-beneficial operation shall be tested and evaluated.



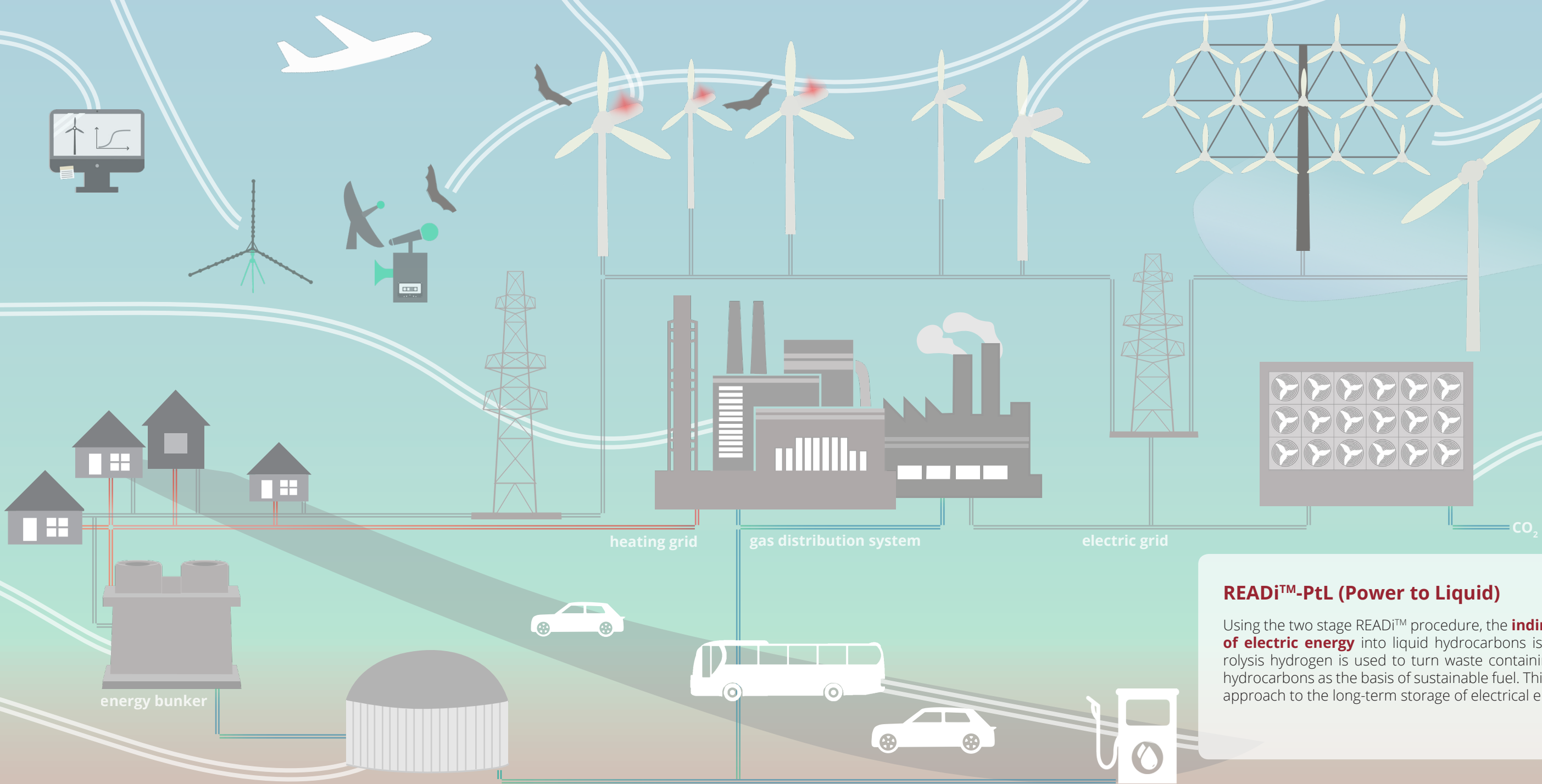
### X-Store

Modern model-based methods for control and regulation technology are being further developed. These methods ensure the **optimised operation of storage system components** with different dynamic properties and in this way improve the energy management of decentralised energy/heat grids. The application is tested on a demonstration property, such as the energy bunker in Wilhelmsburg.



### DUEME

The goal is to research the electromethanogenesis, the direct biogenic **conversion of electricity to methane** in a single step (without intermediary electrolysis). The findings gained here offer the possibility of developing a biotechnological process to store electricity using methane formation from renewably generated excess energy.



### READi™-PtL (Power to Liquid)

Using the two stage READi™ procedure, the **indirect conversion of electric energy** into liquid hydrocarbons is achieved. Electrolysis hydrogen is used to turn waste containing fat into liquid hydrocarbons as the basis of sustainable fuel. This is an innovative approach to the long-term storage of electrical energy.



### Projects

Project management

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### About the Competence Center for Renewable Energy und Energy Efficiency (CC4E)

The Competence Center for Renewable Energy and Energy Efficiency (CC4E) pools diverse inter-faculty activities in the field of renewable energy at HAW Hamburg. With the project X-Energy, the CC4E is also striving to become the leading innovation centre for the energy transition in the Hamburg metropolitan region. In terms of topics, the focus is on wind energy, acceptance and environment, system integration and also sector coupling and storage systems.