ABSTRACT

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ENERGY ATLAS

Future Concept
Renewable Wilhelmsburg

IBA_HAMBURG

Projects for the future of the metropolis

Introduction

The ENERGY ATLAS demonstrates that it will be possible to meet the electricity requirements of the buildings on the Elbe Islands by 2025, and that by 2050 almost all of their heating requirement will be covered by renewable and locally produced energy. The mechanisms and projects presented here will help us achieve a step-by-step conversion to 100 per cent renewable energy – culminating in climate-neutral Elbe Islands.

The discovery of fossil fuels together with the automation and acceleration of work processes paved the way for industrialisation. Electricity, mobility, mass production, speed and major infrastructural measures; ultimately all these can be traced back to the combustion of oil, gas and coal, and the availability of – historically unprecedented – amounts of energy. The key players in this are the cities. Today over 80 per cent of all of the world's resources are consumed in the cities. Climate change and dwindling resources have caused the European Commission to commit to a 20 per cent reduction of CO_2 emissions by 2020 as compared to 1990 levels. Germany has even set itself a target of 40 per cent, although this is tied in with raising European climate protection targets. Above all, the future development of our cities and the way we live in them are what will decide whether man will gain control over the worst effects of climate change. As one of Europe's large metropolitan areas, Hamburg has a key role to play.

Hamburg – the European Green Capital 2011 – has for this reason already defined its own climate protection targets: a 40 per cent reduction by 2020 and 80 per cent by 2050. The Internationale Bauausstellung (International Building Exhibition) IBA Hamburg and its key theme of Cities and Climate Change offer many starting points for the conversion of the somewhat abstract CO_2 reduction targets into concrete measures.

Can a whole district be supplied with carbon-neutral energy?

The ENERGY ATLAS presents practical evidence that it is possible for a whole district – the Elbe Islands Wilhelmsburg, Veddel and Harburger Binnenhafen – to supply itself with 95 per cent carbon-neutral energy by 2050. This will add to value creation in the district and improve the population's quality of life.

The ENERGY ATLAS is based on the ideal of high-density and mixed-use cities. The existing built up areas should if possible not be extended and new building construction needs to make efficient use of land and energy resources in order to improve the city's climate, and should include abundant green spaces and good air circulation. They should exploit every opportunity for producing energy through their own power generation, e.g. by using roofs and surfaces for photovoltaics and solar thermal energy. Achieving the target of climate-neutral Elbe Islands presupposes that the entire power supply is converted to renewable energy sources. In Wilhelmsburg these are solar and wind energy, geothermal energy, biomass and biogas (from waste wood, bio waste and waste water) as well as the use of industrial waste heat. Local resources should be used first in order to ensure that the process is sustainable, and to increase local value creation as well as minimising the need to import energy. In this respect the denser neighbourhoods on the Elbe Islands offer the advantage that, with the installation of regenerative heating networks, substantial carbon reductions can be achieved within a relatively short period of time. More extensive, local neighbourhood heating networks achieve a more efficient co-generation of heat and power compared to the supply of single buildings, and they also produce a larger proportion of the electricity requirement. The IBA excellence scenarios indicate that solar energy will account for 30 per cent of electricity production by 2050. However, wind power will generate by far the larger part of the electricity required.

The ENERGY ATLAS demonstrates that the target of converting the Elbe Islands to climate neutrality can be accomplished by 2050! And more: it will create local jobs and secure sustainable employment in the trades and commerce.

Image Page 2: Wilhelmsburg Central, 2007

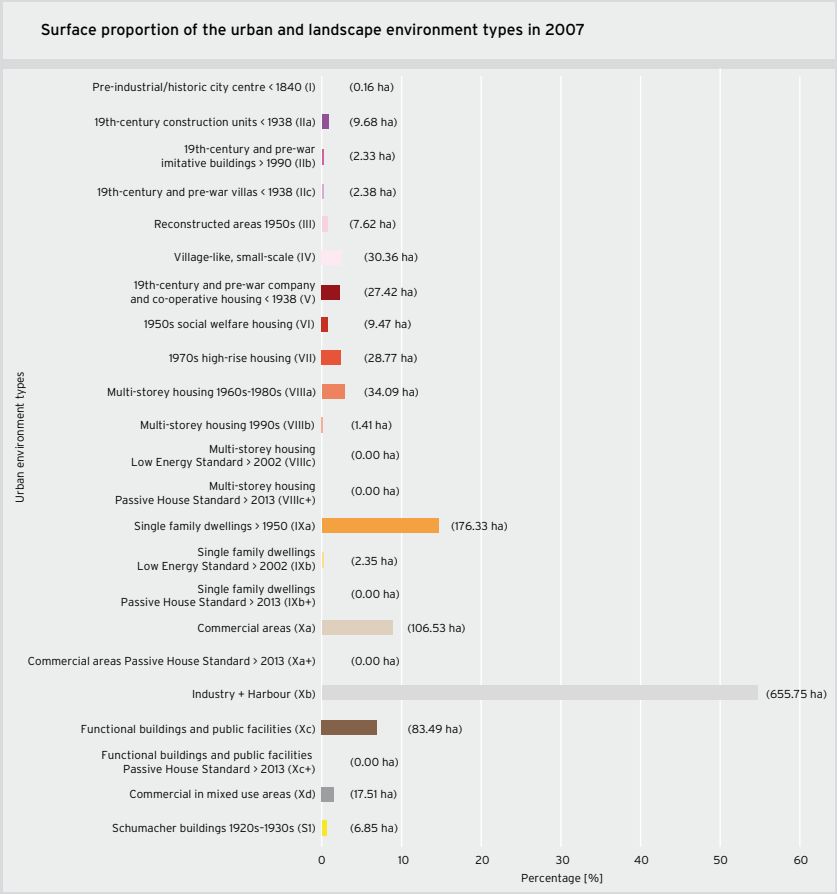
Image on left: A vision for Wilhelmsburg Central for 2030

The ENERGY ATLAS scenarios

The ENERGY ATLAS considers different energy consumers including households, commerce, trade and service providers – industry and mobility are modules for later consideration.

The Climate Protection Concept is designed to help achieve a step-by-step increase to 100 per cent in the proportion of renewable energies used, at which point the conversion of the city from dependence on fossil fuels and nuclear power to sustainability and renewability will have been accomplished. The ENERGY ATLAS also demonstrates the importance of and opportunities for refurbishing and converting buildings. The ENERGY ATLAS' methodology is based on a spatial energy approach which subdivides the entire district into different zones or urban environment types. Following detailed analysis of the information relating to all the spaces within the IBA area, over 20 different urban environment type categories were identified. Ranging from the pre-industrial historic districts built before 1840 and 1970s high-rise estates to areas of modern detached single-family housing built to meet passive house standards, each of these categories is distinguished by its own specific values, such as their particular density of development and actual heat and electricity requirement.

The entire district is due to be supplied with renewable energy and reduce its CO_2 emissions to virtually zero by the target date of 2050. Along the way to achieving this aim, the ENERGY ATLAS shall examine three sample years:



Top: Urban environment and landscape types within the IBA area

2007, the year IBA started, 2013, IBA's last year, and the year 2020. Additionally, distinct reference scenarios and excellence scenarios are differenced for each of these years. Reference scenarios assume there will be a continuous development based on German energy saving requirements and the anticipated technical developments over the coming years – and does not take into account the IBA. Excellence scenarios are based on projects with excellent energy-related features and on IBA Hamburg's "Climate Protection Concept Renewable Wilhelmsburg". These progress renewable energy generation and the energy-saving modernisation of buildings faster and more decisively than the reference scenarios.

On account of the coal power station that is being built in Hamburg Moorburg the ENERGY ATLAS distinguishes between two reference scenarios. Reference scenario 1 describes the development without the Elbe Islands being connected to Moorburg power station's thermal energy network. By contrast reference scenario 2 considers the impact of the new power station's heating network on the renewable energy supply in the IBA area. The result of the study clearly shows that the inclusion of heat from the coal power station is an obstacle on the way to climate neutrality.

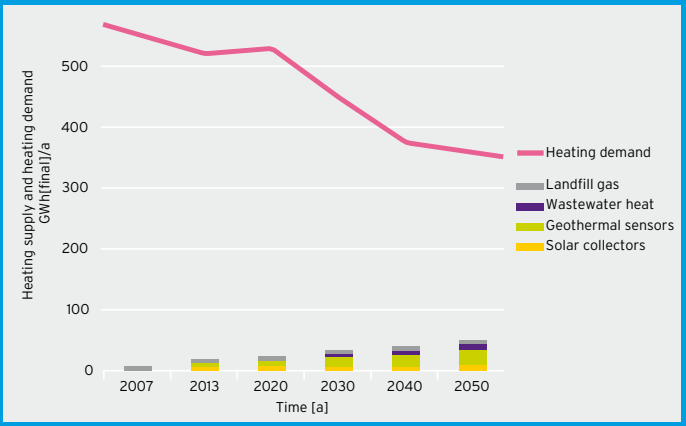
The reference scenarios serve as a standard of comparison for the excellence scenarios. The excellence scenarios describe a tailor-made strategy for Wilhelmsburg that will give the IBA area independence from fossil fuels through the extensive use of innovative and imaginative technologies and spatial strategies. The IBA's innovative projects (refurbishment measures, new buildings and lighthouse projects such as the Energy Bunker and the Energy Hill Georgswerder) have an important role to play as initiators and "drivers".

Status quo and trend

In 2007, the IBA's first year, the buildings in its area had an annual heat requirement of 550 gigawatt hours and a total electricity requirement of 143 gigawatt hours. Most of it was generated with fossil fuels and caused annual emissions in excess of 200,000 tons of CO_2. Merely one per cent of the thermal requirement and approximately ten per cent of the demand for electricity are covered by regenerative sources.

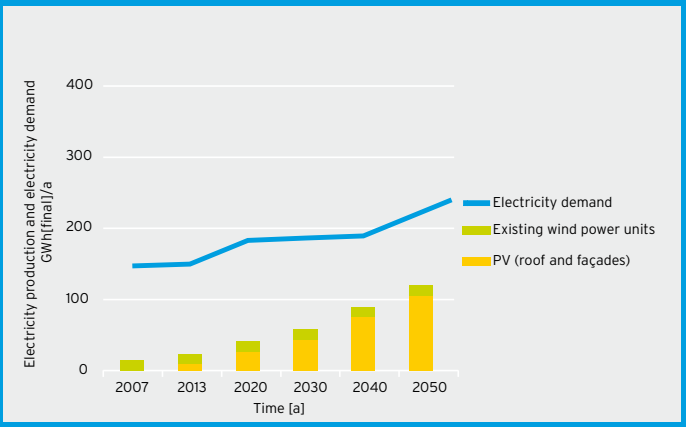
The reference and excellence scenarios both presume a change in the distribution of urban environment and landscape types. Comparison of area development in both scenarios shows that in the excellence scenarios fewer single-family homes will be built, while multi-storey housing will increase, and this will result in a greater urban density. In the excellence scenarios, industrial and port areas see a greater reduction than in the reference scenarios. This is caused by more extensive conversion of these areas for commerce, mixed-use and residential use, as seen in IBA's Wilhelmsburg Central project. Despite the additional building development and an increase in population numbers from around 55,000 to approximately 69,000, the reference scenarios will require about 35 per cent less thermal energy for heating, process heat and hot water by 2050. However, only around one-seventh will be met renewably. The situation is slightly improved as regards the supply of electricity. Whilst electricity demand, despite savings and efficiency measures, will rise by more than half between 2007 and 2050 due to population growth and new building developments, the reference scenarios will at least supply half of the electricity that will be required in 2050 by using renewable power sources, like existing wind power plants and photovoltaics.

Renewable heating yields and heating demand in the reference scenario (Moorburg)



The diagram shows the heating demand reduction (final energy demand) to the forecast time horizon in the reference scenario. This is contrasted with thermal energy yields in the form of renewable energy production (including waste water heat, geothermal heat pumps and solar panels as well as existing systems, such as landfill gas collected from the refuse site at Georgswerder).

Renewable electricity yields and electricity demand in the reference scenario (Moorburg)

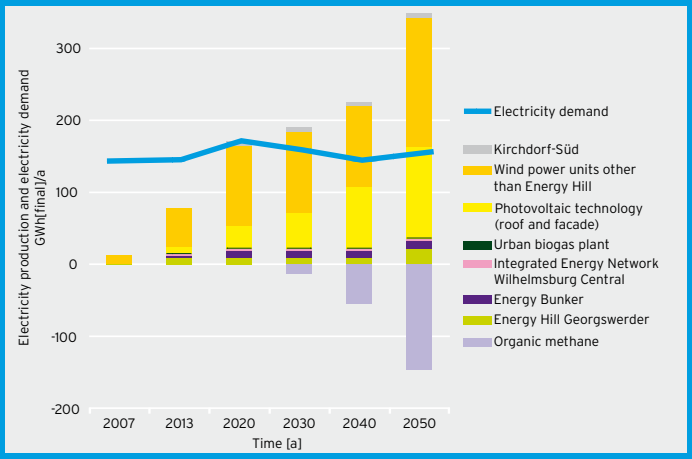


The diagram shows the development of electricity demand (final electricity demand) to the forecast time horizon in the reference scenario. This is contrasted with electricity yields from renewable energy (including photovoltaic units and existing wind power plants).

It is clear that not nearly enough energy is produced renewably in the reference scenarios to meet demand. In this study the Elbe Islands remain largely dependent on fossil fuel energy resources. Hamburg's climate protection target of reducing CO_2 emission by 80 per cent by 2050 cannot be met in this way.

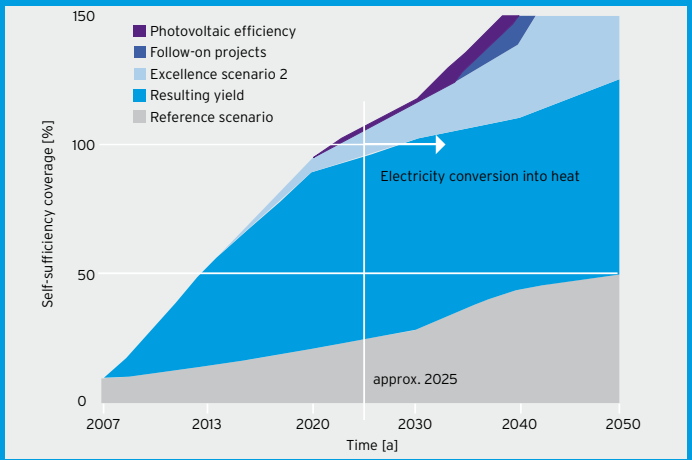
On the way to sustainability

Renewable electricity yields and electricity demand in the excellence scenario



Renewable electricity yields and electricity demand (final energy demand) to the forecast time horizon in the excellence scenario. By converting hydrogen and CO_2 into organic methane, surplus electricity is indirectly converted into heat. This electricity consumption is shown as negative electricity yield.

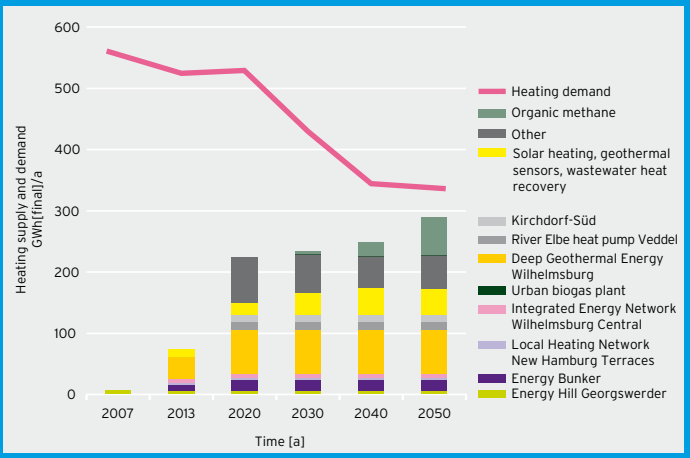
Electricity self-sufficiency



In comparison with reference scenario 1, renewable electricity production increases steadily in the excellence scenario. 100 per cent self-sufficiency will be achieved in around 2025. From then on, the surplus electricity can be used for the provision of thermal energy.

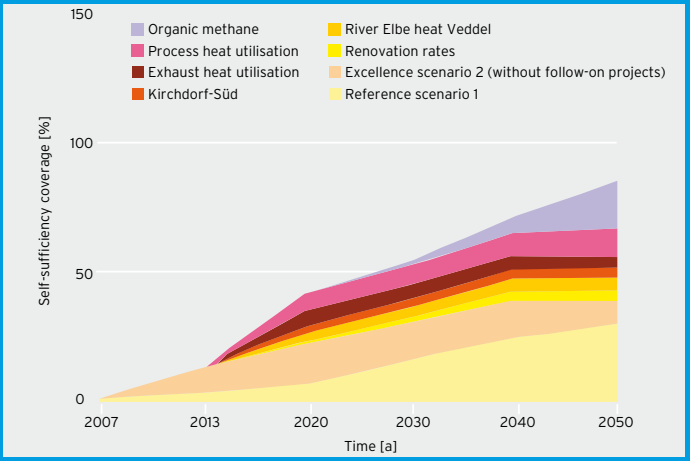
The excellence scenarios consider the energy potential including all the positive effects derived from the IBA Hamburg projects as well as the follow-on projects from this Climate Protection Concept: this provides for faster and more decisive promotion of surface area energy production on roofs, facades and with heat pumps. Additionally there are new buildings and conversions, more renovations of single building segments as well as specific IBA projects and subsequent follow-on projects. Consequently about half of the total heating demand will be met from renewable resources. A significant part is covered by the fast and extensive supply to existing buildings through the introduction of renewable

Renewable heating yields and heating demand in the excellence scenario



Renewable thermal energy yields and thermal energy demand (final energy demand) to the forecast time horizon in the excellence scenario.

Thermal self-sufficiency

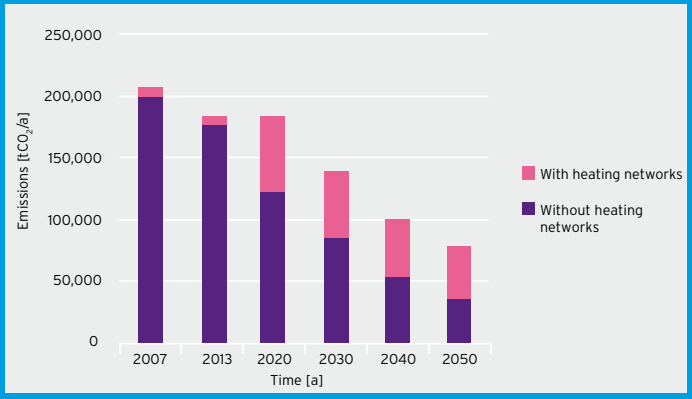


The excellence scenario sees a steady increase in renewable thermal energy supplies as compared to the reference scenario, first through the realisation of the IBA projects, then by means of possible additional projects (Veddel and Kirchdorf-Süd), and ultimately through the production of organic methane. In addition, thermal self-sufficiency will be 85 per cent achieved by the end of the forecast time horizon.

thermal energy networks. In 2050 85 per cent of the thermal energy demand will be covered by renewable energy sources – and this despite the fact that we can assume that the IBA projects will lead to greater population growth, from 55,000 to 73,000, as compared to the reference scenarios. 100 per cent of the electricity demand in the excellence scenarios will be covered by renewable resources by as early as 2025. From then on the surplus electricity can be used for electric mobility, industrial purposes or for the thermal energy supply, to ensure that the total demand for heat is also covered by renewable energy sources.

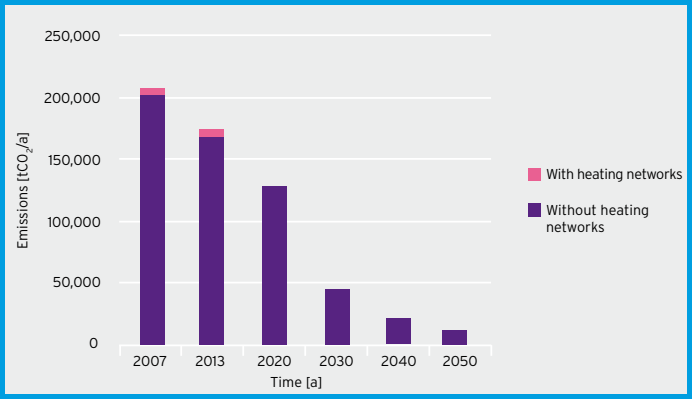
Climate neutrality is possible

Reference scenario



Annual CO_2 emissions for energy supply to households as well as commerce, trade and the service providers to the forecast time horizon. In reference scenario 1, more fossil fuel/nuclear energy is substituted by renewable energy than in reference scenario 2. By the end of the forecast time horizon, the emissions from the Moorburg thermal energy network will constitute about half of all emissions in the IBA area.

Excellence scenario

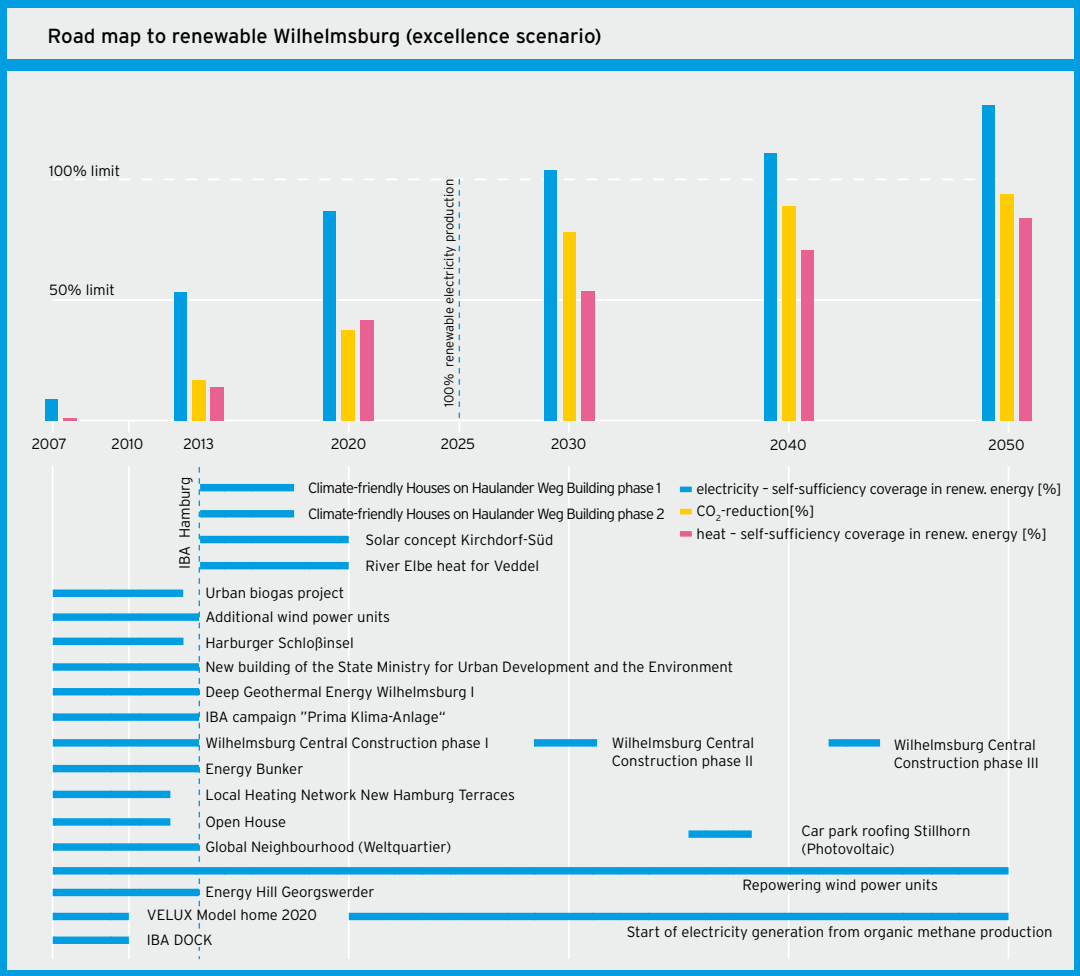


Annual CO_2 emissions for households and commerce, trade and the service providers in the excellence scenario.

The excellence scenarios show that efficiency measures and targeted replacement of fossil fuel/nuclear energy with renewable energy will result in a considerable reduction of CO_2 emissions. By the end of the IBA in 2013 approximately 50 per cent more greenhouse gases will already have been saved than would be the case in the reference scenarios. By the end of the forecast time horizon in 2050, emissions in the excellence scenario amount to only five per cent of 2007 emissions. As regards the energy users that have been considered (i.e. households, commerce, trade and service providers), the IBA area is virtually climate-neutral while in the reference scenario greenhouse gases still amount to almost 40 per cent of 2007 emissions, and this will still have a considerable impact on the climate.

This ambitious target of climate-neutrality can only be accomplished in cooperation with the local population, institutions and local businesses as well as tenants' and property owners' associations.

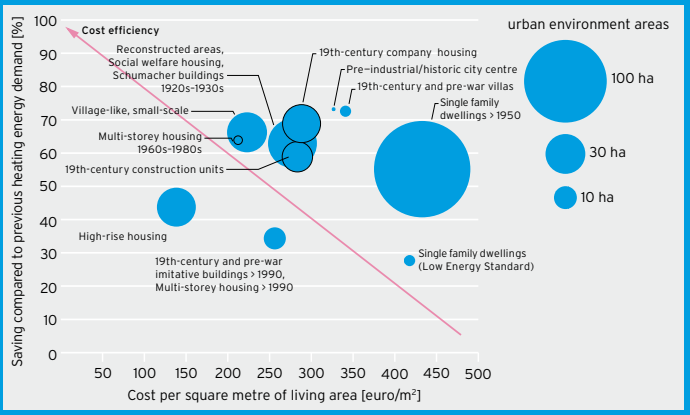
Road map to renewable Wilhelmsburg (excellence scenario)



By 2025 the Elbe Islands and Harburger Binnenhafen will already be 100 per cent renewable in terms of their electricity supply, and by 2050 they will be virtually carbon-neutral with regard to both electricity and thermal energy supply.

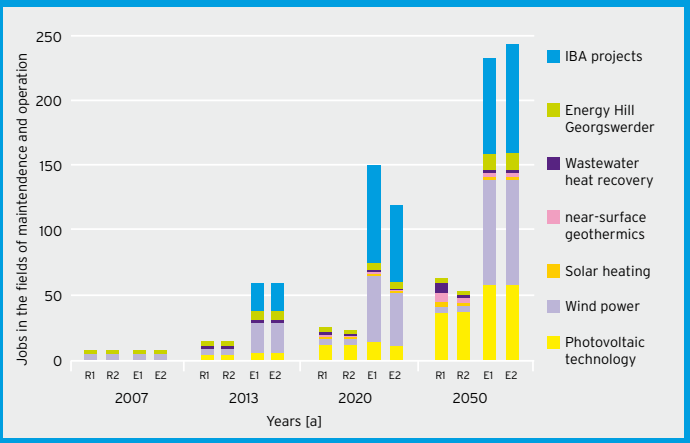
Sustainable investment in the future

Cost effectiveness of the renovation measures



Attainable cost-efficiency of renovation measures for different urban environment types in the IBA area. The y-axis indicates the savings potential for heating energy requirements as compared to consumption to date as a percentage. The x-axis indicates the cost of renovation measures per square metre of living area. The size of the circles shows the proportion of land taken up by the respective urban environment types in the IBA area in 2007. The ideal is to achieve the greatest possible savings together with maximum costs reductions.

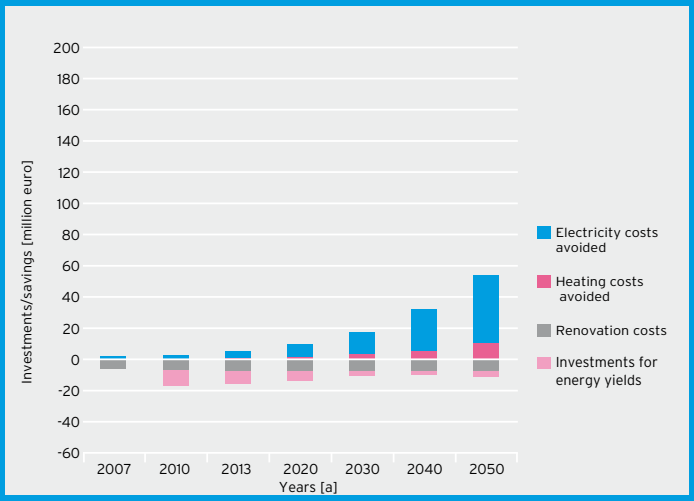
Employment in maintenance and operation



Employment generated by the maintenance and operation of different energy technologies in both the reference and excellence scenarios. Reference scenario 2 includes the thermal energy supply provided by Moorburg power station. Excellence scenario 1 presupposes several deep geothermal sites, while excellence scenario 2 assumes a diversified portfolio of renewable energy.

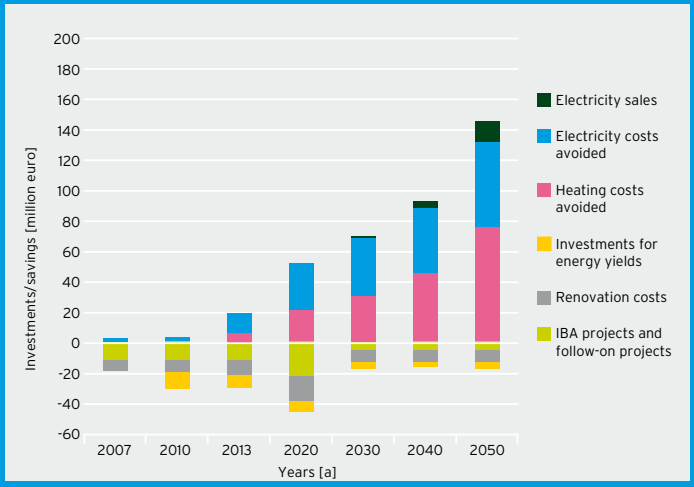
The efficiency study shows that the investment required for the implementation of the Climate Protection Concept for a renewable Wilhelmsburg will be more than compensated for by future savings. It becomes clear that the effects achieved in the reference scenarios and those in the excellence scenarios differ greatly; although there is only a slight difference between the investment costs.

Reference scenario



Annual investments and savings for the reference scenario.

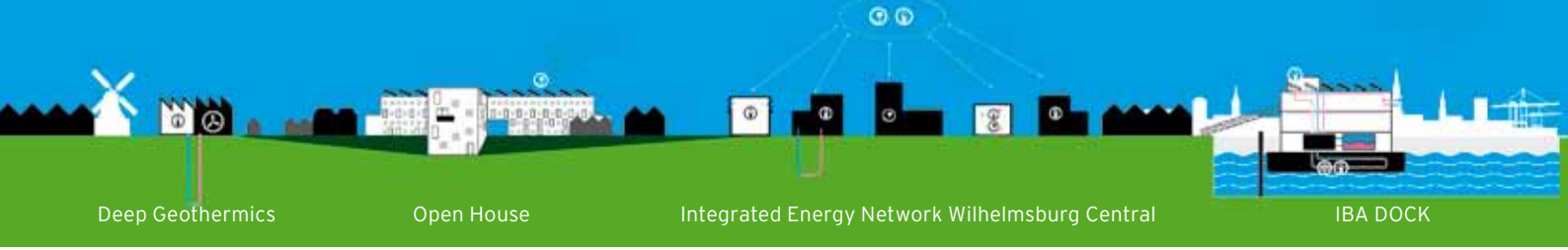
Excellence scenario



Annual investments and savings for the excellence scenario.

Development of the IBA area into a CO_2-neutral district will have an impact on the local economy and promote employment and training. The reference scenarios anticipate that between 50 and 60 new jobs in the field of maintenance and operation of renewable energy technology will be created by 2050, while the excellence scenarios provide for approximately 230 jobs, four times as many.

The strategy developed in the excellence scenarios is tailored to suit the individual urban environments. In addition to the IBA projects and their follow-on projects, decentralised energy production, renovation measures and efficiency initiatives are promoted. The IBA area will be self-sufficient, climate-neutral and sustainable.



Recommendations

The ENERGY ATLAS demonstrates that it is possible to use renewable and locally produced energy to meet the electricity demand of buildings by 2025 as well as almost the entire thermal energy requirement by 2050. The excellence scenarios allow us to accomplish a step by step conversion to 100 per cent renewable energy and ultimately to achieve climate-neutral Elbe Islands.
What are the major elements and success factors on the way to this goal?

City and buildings

Climate protection excellence for existing and new buildings

The success of a comprehensive urban climate change mitigation strategy is largely determined by the condition of the existing building stock. However, this does not reduce the importance of excellence in the energy performance of new builds. Any new building that does not have excellent climate performance will be a climate hazard in the future.

Renovating existing buildings

- Increase the rate of renovation, especially in the private, municipal and co-operative housing sectors (e.g. SAGA GWG's IBA project Weltquartier / Global Neighbourhood)
- Targeted support for the renovation of the large number of single-family homes (e.g. IBA campaign "Prima Klima-Anlage")
- Further develop Hamburg's climate change mitigation regulations with the aim of achieving an environmentally sound and socially acceptable renovation of existing buildings
- Retain and develop funding programmes
- Provide organisational support to help people find qualified tradesmen and energy consultants and to assist with funding applications
- Renovate public facilities to an exemplary standard
- Considerate energy improvements to landmark structures and building groups in the neighbourhood (e.g. Schumacher buildings on Veddel)
- Promote climate awareness by creating objects of identification with relevance to everyday life, and by widely communicating exemplary renovation measures (e.g. the IBA project "VELUX Model Home 2020: LichtAktiv Haus / Light-Active House").

New Buildings

- Further develop Hamburg's climate protection regulations with an early introduction of passive house standards and the EU's 2020 standards
- Place the focus of urban planning on the concept of denser, mixed-use cities
- Rigorously use every opportunity for buildings to produce their own energy (e.g. IBA project "Open House")
- Utilise building surfaces for photovoltaic units, thereby adding to the efficiency gains from connecting to renewable heating networks (e.g. the IBA project "Bauausstellung in der Bauausstellung" / "Building Exhibition in the Building Exhibition")
- Give priority to redensification, infill development, the addition of storeys on existing buildings and land recycling over greenfield development.

Energy Systems

The prerequisite for achieving the goal of climate-neutrality for the Elbe Islands is the complete conversion of energy supplies to renewable energy.

Efficiency

- Review the efficiency potential of existing technical installations.

Renewable Heat Generation

- Obligation for new buildings to be connected to and utilise renewable heat networks; incremental connection of existing buildings
- Promotion and development of open heating networks.
  In this respect, generally binding regulations, comparable to the German Renewable Energy Act (EEG), should be developed for the power supply system on the basis of the IBA's pilot project ("Energieverbund Wilhelmsburg Mitte" / "Integrated Energy Network Wilhelmsburg Central")
- Early securing of heating consumers to reduce the investment risk to energy companies.
  In this respect the municipalities should lead the way with their own buildings and municipal facilities (IBA project "Energy Bunker" with HAMBURG ENERGIE and SAGA GWG)
- Use heating networks as heat storage facilities and incorporate additional heat storage capacities (IBA project "Energy Bunker")
- Exploit urban biomass as a source of energy
- Municipal investment in deep geothermics.

Renewable Electricity Production

- Safeguard land for wind energy at an early stage by means of urban land-use planning
- Comprehensively involve and inform the citizens and public agencies
- Use urban infrastructure and land for solar energy: the facades and roofs of buildings, (noise) barriers, landfill areas, roof canopies over parking areas (e.g. Stillhorn motorway service area), bus stops, public squares and many more
- No new buildings or energy renovation without consideration of photovoltaic technology
- Link the gas, heat and electricity supply to enable common load management and the expansion of their respective storage capacities
- Manage demand by means of "intelligent meters" and diversify electricity tariffs accordingly
- Develop electrical mobility and use of batteries for interim electricity storage.

Process-Involvement and economic participation

Investing in energy plants and buildings brings about a sustained reduction in the buildings' energy-related operating costs, creates jobs and local employment, and leads to a marked reduction in energy import costs. What's more, they produce benefits by avoiding environmental and climate damage.

- Persuade the city's key energy protagonists and disseminators to join alliances (e.g. IBA campaign "Prima Klima-Anlage")
- Promote training and qualifications (e.g. Elbcampus – Kompetenzzentrum der Handwerkskammer und Ausbildungszentrum-Bau / Elbcampus – Competence Centre of the Hamburg Chamber of Trade and Construction Training Centre)
- Support local businesses (e.g. Beratungsteam Elbinselhandwerk / Elbe Islands' Trade Advisory Team)
- Provide low-threshold opportunities for involvement (e.g. Solargenossenschaft Open House / Open House Solar Cooperative)
- Include tenants' and propety owners' associations
- Prompt and transparent information of the public and political bodies.

The ENERGY ATLAS illustrates a possible route towards renewable Elbe Islands. Moreover, it aims to provoke further thought around the issues at hand, develop new projects that adhere to the spirit of the Climate Protection Concept and entice people take action themselves.

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