

Report by the Senate to the Hamburg Parliament

Hamburg Climate Plan

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A. Rationale

With the presentation of the first Hamburg Climate Plan, the Senate has further developed the Climate Action Master Plan (official report 20/8493 of 25 June 2013) and the Adaptation to Climate Change Action Plan (official report 20/8492 of 25 June 2013), in terms of both methods and content, bringing together climate change mitigation and adaptation to climate change.

In addition, in the Hamburg Climate Plan the Senate reports to Parliament on the achievement of the targets set by the Climate Action Master Plan and the Adaptation To Climate Change Action Plan, the achievement of the objectives in individual areas of action and projects, and new developments.

B. Summary

Hamburg is conscious of its global responsibility and has been promoting climate mitigation for many years. At the same time, the measures required to adapt Hamburg to climate change are being put in place.

Hamburg has already pointed the way with its Climate Action Plans. Many cities – at home and abroad – have copied Hamburg. But so far only a few countries and cities have looked at both components – climate mitigation and climate adaptation – in an integrated way. Both aspects have already been reflected in the Hamburg Climate Action Plans, and the integration of adaptation into climate mitigation is also an important component of the overall concept in the Climate Action Master Plan agreed in 2013. The Adaptation to Climate Change action plan has been drawn up in parallel to this.

This first Hamburg Climate Plan provides Hamburg with a vision of a modern city of the future in which **climate mitigation and climate adaptation are fundamental components of our shared society. Hamburg will become a "Climate Smart City".**

What is needed are clear forward-looking aims that contribute to a positive image of Hamburg as a **smart, climate-friendly city adapted to climate change** and that are rooted in the city's society. These aims and measures are described in this **first Hamburg Climate Plan**. This provides an integrated study of climate mitigation and adaptation which significantly expands the thematic scope of the climate strategy.

Climate change already affects the quality of life in the city. In the future it will increasingly impact all areas of urban life. Extremes are to be expected in different directions: increased drought but also more heavy rainfall events. The Hamburg strategy therefore aims at making the city more resistant and robust in the face of climate events i.e. at increasing the city's resilience. The Climate Plan commits to **setting the course for adaptation to climate change** in good time and, in particular, takes on the challenge of implementing water management concepts aimed at minimising damage from flooding and heavy rainfall events to persons, property and the environment in the coming decades.

By 2050 Hamburg wants to gradually reduce CO₂ emissions **by at least 80 per cent** in comparison to 1990. **The target is to halve CO₂ emissions in Hamburg by 2030.** The city will therefore enhance the measures in its own jurisdiction and fully support the implementation of national policy action. In addition, **around 2 million tonnes of CO₂ emissions** are to be cut **by 2020** compared to 2012.

Climate mitigation requires an energy transition and a resource transition. The consumption of energy and resources in the cities must be reduced dramatically. We must push the expansion of renewable energies and the improvement of energy efficiency in buildings and in industrial production forward, in line with technological progress. However, concentrating on this alone will not achieve the climate mitigation and CO₂ reduction targets. A resource transition is needed in parallel to the energy transition. This means a more sparing use of energy just as much as a change in material flow management for a more efficient use of resources. Using resources carefully must become a key point in the Hamburg climate policy. Hamburg therefore plans to take appropriate measures in the areas of energy savings, mobility and consumption as well as buildings.

As part of its **long-term perspective 2050**, Hamburg has set out the following aims to be achieved by then:

- Using the instruments of city development and cross-sectoral measures at all levels of municipal policy and involving private urban stakeholders, Hamburg will have developed into a renewable city adapted to climate change.
- The measures needed for storm surge protection as well as flood protection on inland waters will have been put in place in order to avoid damage from the effects of climate change to the greatest degree possible.
- The challenges of the energy transition will have been overcome. Hamburg's energy demand will be substantially and reliably covered by competitive renewable energies tailored to demand.
- The most efficient technologies will be applied throughout the fields of trade, industry and port as far as possible. As part of an active environmental industrial policy, climate mitigation will have produced significant environmental innovations. In the Port of Hamburg, renewable energies will form the basis of a modern intelligent port system.
- In the building sector the aim is to achieve a final energy demand (heating and hot water) of an average of 40-45 kWh/m² for existing multiple family dwellings and 45-55 kWh/m² for single family homes. The aim for non residential buildings is a reduction in heat demand of 50 per cent. The city will live up to its role in setting an example and meet high energy efficiency standards in public buildings well before 2050.
- Traffic in Hamburg will be developed towards sustainability and be implemented primarily using alternative drive systems, e.g. drives based on green energy. Besides climate mitigation, this will also enable progress in noise and emission control. Air transport will be designed to be climate-friendly, based on progress achieved at international level.
- Hamburg will have developed into a site of excellence for climate-related further education and training. The research and science sector will have confirmed its position of international excellence in the sphere of climate research.

In order to work towards these goals for 2050, the city will make use of the adaptive management approach. The 2020/2030 action programme therefore defines targets and steps in 14 action fields with the focus on achieving the objectives for 2050. The new Hamburg Climate Plan supplements and develops this approach in terms of methods, topics and strategy by integrating climate mitigation and climate adaptation and in addition

- specifies the methodological framework for achieving the long-term perspectives as a process of transformation and
- looks not merely at individual areas of action but also introduces some selected cross-sectoral, strategic clusters.

Systematic changes are needed along the route to the Climate Smart City Hamburg. This requires the recognition and support of a cross-sectoral view plus synergies between individual action areas. The strategic clusters will provide examples of how partners can spur each other on and of how a positive trend can be initiated in Hamburg. Four aggregated strategic clusters¹ are considered:

- Transformation of urban spaces: city and neighbourhood development
- Green economy
- The city as a role model
- Climate communication

The following major aims are followed in these strategic clusters:

- Hamburg is to become a climate-friendly and climate-adapted city by integrating climate mitigation and climate adaptation into urban development. This integration will take place primarily at neighbourhood level.
- Hamburg takes up the challenge of a growing and climate-adapted city.
- Hamburg industry will live up to its responsibility in the society and make its contribution to the climate mitigation and adaptation targets.
- As part of its activities, the public sector will make an exemplary contribution to reaching the climate mitigation targets.
- As many city stakeholders as possible need to work on developing the Climate Smart City Hamburg.

These strategic clusters should indicate the fundamental direction of the transformation process towards a climate-friendly city adapted to climate change – all the way to the Climate Smart City Hamburg.

¹ The term cluster is used here in the literal sense (and not in the sense of Hamburg's cluster policy).

C. The Hamburg Climate Plan

I. National and international climate policy

1. Climate change

The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) has confirmed previous findings: scientists have now come to the definite conclusion that global climate change has already occurred and that anthropogenically driven global warming is progressing. Carbon dioxide concentrations have risen by 40 per cent since pre-industrial times. The Intergovernmental Panel on Climate Change anticipates far-reaching climatic disasters with serious losses, especially to agriculture, resulting in armed conflicts. If agreement is not reached at an international level, then climate change is likely to result in significant consequences for Europe and also Germany by the end of the century.

2. International climate change policy

The IPCC believes that a significant reduction in greenhouse gas emissions is necessary in order to control the effects of climate change. Following Kyoto, the international community is therefore trying to reach a new climate agreement which will be negotiated in Paris from the end of November 2015. The European Union (EU) wishes to contribute to this process as a role model and has set its own climate change objectives: a reduction in CO₂ of 40 per cent compared to the 1990 base year is to be achieved by 2030. In addition the EU has set a target of increasing the proportion of renewable energies and energy efficiency each by 27 per cent by 2030. By 2050 greenhouse gas emissions need to drop by 80 to 95 per cent compared to 1990.

Climate change mitigation is one of the European Union's key policy areas. Accordingly, it has agreed further targets and actions, aimed at guaranteeing the transformation to an energy-efficient and low CO₂ economy.

3. National climate change policy

At the national level the German Federal Government is sticking to its targets set as far back as 2007 and targets a 40 per cent reduction in greenhouse gas emissions by 2020 and 80 to 95 per cent by 2050. This will be achieved primarily by expanding renewable energies and increasing energy efficiency. These targets were already defined in outline in the 2010 energy concept.

However, the Federal Government is faced with the problem of having to find measures to make up the difference of at least 8 per cent points for reaching the 2020 target. In order to close this gap, the Federal Government, with support from the federal regions, agreed a national Action Programme on Climate Protection 2020 at the end of 2014 and a National Action Plan on Energy Efficiency (NAPE). Both programmes rely on a mix of measures and instruments with various immediate actions and other requirements. Examples of the key immediate actions in NAPE are:

- The introduction of new, more competitive, tenders for energy efficiency,
- An increase in the amount of funding for building refurbishment and the introduction of fiscal measures supported by the Federal Government and the federal states to fund efficiency measures in the building sector (was rejected by Hamburg),
- The creation of energy efficiency networks in cooperation with trade and industry.

Hamburg contributed to this with suggestions for action and also supported the partnership for action established by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). In addition, the Senate backed the Bundesrat's initiative for further implementation of the Government's measures.

The Federal Government is also developing a Climate Action Plan 2050 which describes the next steps for reducing emissions to achieve long-term climate change targets and which will be backed up by strategic measures in a thorough consultation process with local authorities, associations and federal states as well as with German citizens. The consultation process was begun in July 2015 and is supported by Hamburg.

4. National adaptation to climate change and its consequences

Regardless of all the efforts to combat the causes of climate change now and in the future, the climate will continue to change and require appropriate adaptation. The Federal Government therefore agreed the German Strategy for Adaptation to Climate Change (DAS) back in 2009 and the resulting first Action Plan at national level in 2011, after consultation with the federal ministries and federal states. The strategy is currently being evaluated and forwarded to the Government with a progress report.

The German Adaptation Strategy forms the according framework. The actual adaptation measures need to be planned and implemented in the federal states and local authority areas.

II. Hamburg climate policy

1. What have we done so far?

1.1 The responsibility of towns and cities

Up to 80 per cent of global greenhouses gases are produced by towns and cities. The cities therefore play a key role in achieving the international climate change objectives. However, the action taken by cities for climate change mitigation and climate adaptation are embedded in a changing environment marked by globalisation and demographic and social change characterised by the development of new lifestyles, technological progress and added value generated by the activities of government and industry, as well as by the declining financial resources of public authorities.

Hamburg is aware of its global responsibility and has been working for climate change mitigation for many years. At the same time, the measures needed for adapting Hamburg to climate change are being put in place.

At a European level Hamburg cooperates with its partners within the context of networks such as the Covenant of Mayors, the Climate Alliance and METREX (Network of European Metropolitan Regions and Areas), fosters exchange with other cities such as Copenhagen, Stockholm and Vienna and contributes by getting involved in EU projects. As part of the project TRANSFORM (Transformation Agenda for Low Carbon Cities) completed in summer 2015, Hamburg developed transformation concepts for a Smart Energy City along with Amsterdam, Genoa, Copenhagen, Lyon and Vienna, resulting in a Memorandum of Understanding amongst the six cities for further cooperation on climate policy (see also C.IV.2.1.5.1).

In the INTERREG IVC project CLUE (Climate Neutral Urban Districts in Europe) which finished at the end of 2014, in cooperation with partners from various major European cities such as Stockholm, Vienna, Barcelona, Rome and Turin, Hamburg developed a good practice guide with recommendations on the integration of climate factors in urban development.

1.2 Hamburg's climate action policy

Hamburg has been actively following a climate action policy since 1990. Examples to mention here are the "Work and Climate Protection" and "Companies for Resource Protection". In addition, the city's climate policy targets were incorporated in laws and regulations such as the Hamburg Municipal Climate Protection Act, the Hamburg Climate Protection Ordinance and the Hamburg Monument Protection Act. The **Hamburg Climate Action Plan 2007-2012** combined and expanded the activities in a single higher-level structure. This plan views climate change mitigation as a matter for the whole city. With the assistance of the Wuppertal Institute for Climate, Environment and Energy, Hamburg has drawn up a comprehensive strategy and defined targets which have been implemented with the assistance of a unique national funding programme and a portfolio of almost 500 measures as part of the Climate Action Plan 2007-2012. The Hamburg Climate Action Plan attracted great national and international interest.

Based on the climate policy targets set by the Senate and the experience gained from the Climate Action Plan 2007-2012, Hamburg drew up the **Climate Action Master Plan** which was agreed by the Senate in June 2013. The Climate Action Master Plan shows which options for action Hamburg can use to achieve the targets for 2050 set by the Senate, bearing in mind the interim goals particularly for 2020. The focus is on the most important approaches to solutions on which Hamburg can have an influence.

The measures in the Action Plan 2020 in particular continue to develop the Climate Action Plan 2007-2012. They guarantee the continuity of Hamburg's climate action policy by supporting specific individual measures such as launching or continuing Hamburg's support programme and the funding of innovative projects which promote climate change mitigation in the city.

1.3 Hamburg's policy for adaptation to the effects of climate change

Alongside the action on climate change mitigation, the Hamburg Senate addressed adaptation to climate change early on. It commissioned a study within a specialist reference framework on how Hamburg would be affected and decided in favour of an adaptation of the city in line with a moderate climate change scenario. Hamburg defined the most important action areas in relation to this in 2011 and agreed on the development of an adaptation strategy. In 2013 the Senate submitted the Hamburg Action Plan for Adaptation to Climate Change to the Hamburg Parliament. This laid down the scope for the effects of climate change on Hamburg in terms of temperature development, the change in precipitation intensity and frequency (heavy rainfall events), and the increase in sea level and the development of storm surge water levels. The action plan specified important elements of the adaptation strategy and described the status of adaptation activities in the various action areas of municipal responsibility. The Hamburg Strategy for Adaptation to Climate Change is seen primarily as the duty of the city to protect citizens from the effects of climate change and to safeguard essential infrastructures such as coastal protection, the harbours, waste water disposal and much more. The focus of attention has moved increasingly to coping with heavy rainfall events and inland flooding. The overheating of the city in summer heatwaves also remains on the agenda.

The adaptation strategy is complemented by monitoring the effects of climate, allowing the Senate to keep up-to-date with the degree to which Hamburg is affected and the efficacy of the measures put in place. Monitoring of climate effects is currently under development.

2. En route to a "Climate Smart City"

2.1 Guiding principle

Hamburg will continue to grow. The number of inhabitants is predicted to rise to around 1.9 million by 2030. This means that the housing stock needs to be expanded. This kind of growth is a challenge for Hamburg, but also an opportunity. Guidelines for the development of the city should continue to include the conservation and sustainable development of the environmental quality with green spaces, nature conservation and climate change mitigation. Environmental goals need to be balanced with social and economic responsibility.

In a modern vision of Hamburg as a Climate Smart City, climate change mitigation and climate adaptation are fundamental components of our shared society.

Climate change mitigation with the components of energy and resource transition is important in all smart city concepts. The National Platform for the City of the Future complements this approach, including aspects such as climate change, urban transformation and governance linked to ICT (information and communication technology) solutions. These

aspects must form part of the further development of modern cities that are worth living in. Hamburg therefore needs clear progressive goals which will contribute to a positive image of Hamburg as a smart climate friendly city adapted to climate change and will be firmly rooted in urban society. Attention must be focused on a transformation process which is compatible with society, business and the location.

The targets and measures for a climate friendly city adapted to climate change will be laid down in the first Hamburg Climate Plan.

The first integrated Climate Plan will consolidate Hamburg's pioneering role in climate policy and provide a model for other cities and federal states.

Hamburg has already pointed the way with its Climate Action Plans. Many cities – at home and abroad – have copied Hamburg. But so far only a few countries and cities have looked at both components – climate mitigation and climate adaptation – in an integrated way. Both aspects have already been reflected in the Hamburg Climate Action Plans, and the integration of adaptation into climate change mitigation is also an important component of the overall concept in the Climate Action Master Plan agreed in 2013.

With a climate plan which interlinks climate change mitigation and climate adaptation as municipal strategies and activities with the aim of achieving a climate friendly and climate adapted city, Hamburg is taking on a pioneering role and setting an example. The Hamburg Climate Plan will be developed across departments and by incorporating the districts as well as in cooperation with the city's stakeholders.

The adaptation to climate change has to be set in motion at the right time.

Climate change is already having an effect on the quality of life in the city. In future it will make itself increasingly felt in all areas of urban life. Extremes are to be expected in different directions: increased drought but also more heavy rainfall events. The Hamburg strategy therefore aims at making the city more resistant and robust in the face of climate events i.e. at increasing resilience.

Storm surge and coastal flood protection are a constant issue in Hamburg. In response to the climate forecasts for rising sea levels which can have a direct impact on Hamburg, a "climate allowance" of 50 cm for measuring the public flood defences has been introduced.

Climate change mitigation requires an energy transition and a resource transition.

The consumption of energy and resources in the cities must be drastically reduced. We must press ahead with the expansion of renewable energies and the improvement of energy efficiency in buildings and in industrial production, in line with technological progress. By 2050 Hamburg must create the conditions for an energy supply which can be secured by renewable energies as far as possible.

However, concentrating on this alone will not achieve the climate change mitigation and CO₂ reduction targets. A resource transition is needed in parallel to the energy transition. This means a more sparing use of energy just as much as a change in material flow management for a more efficient use of resources. Using resources carefully must become a key point in Hamburg's climate policy. Hamburg must therefore take suitable measures in the fields of energy savings, mobility and consumption as well as buildings.

2.2 Climate change mitigation and climate adaptation targets

Hamburg wants to gradually reduce CO₂ emissions by at least 80 per cent by 2050. The aim is to halve CO₂ emissions in Hamburg by 2030. The city will therefore improve the measures in its own jurisdiction and fully support the implementation of national policy action at a local level. In addition, Hamburg will increase its efforts in a city-wide process in order to play its part in achieving the national climate target of reducing CO₂ by 40 per cent by 2020.

Hamburg has set itself the following targets:

<u>Time axis</u>	<u>Climate change mitigation</u>	<u>Climate adaptation</u>
2050	Climate friendly city At least 80% CO ₂ reduction	Resilient to climate change, meaning a city adapted to climate change
2030	50% CO ₂ reduction	Integrated action as a matter of course
2020	Hamburg makes a contribution to the national target: 40% CO ₂ reduction	Climate adaptation kept constantly in mind (applies to government and civil society)

The quantitative **target of a reduction of nearly 2 million tonnes of CO₂ by 2020** should also be adhered to.

The Climate Action Plan has also established **targets for per capita emissions** from its citizens (currently 10.2 tonnes per person per year), which will be supplemented by targets for 2020 and 2030:

<u>Time axis</u>	<u>Per capita emissions / year</u>
2050	2 t CO ₂
2030	6 t CO ₂
2020	9 t CO ₂

The whole city needs to be involved in order to achieve these targets, targets which can only be portrayed in a process involving society as a whole.

The Senate is relying on its **partners in climate change mitigation and climate adaptation** such as the north German Federal States, the metropolitan area of Hamburg, industry (environmental partnerships / voluntary commitment by Hamburg industry), public enterprise, universities, schools, educational institutions and other Hamburg stakeholders. A priority task of the Coordination Centre for Climate Issues on behalf of the Senate is to bring together the climate policy stakeholders from government, industry and non-governmental organisations. The participatory process was therefore expanded when the master plan was updated. The group of stakeholders and the range of topics were significantly expanded. Besides chambers of commerce and associations, special interest groups from the fields of tenants' rights and mobility, public advisory bodies, large industrial companies and energy utility companies have taken part in the discussions. An agreement was reached to continue

the discussion process on various topics, such as integrated neighbourhood development and the funding of climate change mitigation measures.

Last but not least, the citizens of Hamburg form an already-present and crucial success factor. Many already have a keen awareness of climate change mitigation and try to lead a climate friendly lifestyle. The Senate believes that climate change mitigation is a community effort which can only succeed when everyone plays their part. This requires the provision of specific information and training opportunities.

2.3 From special task to mainstreaming to urban transformation

Climate change mitigation and climate adaptation are interdisciplinary tasks which need to increasingly become cross-sectoral components of urban policy at all levels.

The Climate Action Plan formulates the guiding principle of what is known as mainstreaming. According to this, climate change mitigation should likewise be integrated into the policies of the other Hamburg ministries. The aim is to have climate change mitigation recognised and practised in administration and in the public mind as a normal task in all areas of responsibility and action. The Senate contributes to climate change mitigation being "mainstream" and acquiring a fixed place in the everyday life of the city.

This approach to the integration of climate policy targets should be pursued and the development from a special task to mainstreaming all the way to urban transformation should be promoted. The implementation of climate change mitigation and adaptation in the policies of the other Hamburg ministries requires clear guidelines from the Senate. Targets and tasks will therefore be formulated for the departments responsible for the action areas in the Climate Plan. The Hamburg Climate Plan thus provides a reliable basis for Hamburg's climate policy in the coming years.

The Coordination Centre for Climate Issues supports the Senate in putting these targets into practice. It has been charged by the Senate to undertake the coordination and control functions for all the authorities.

III. Long-term perspective 2050

The existing **Climate Action Master Plan** mentions a long-term perspective for 2050, presenting clear structural changes both in the energy sector as well as in terms of economic, environmental and social conditions. Furthermore, by 2050 there are likely to be technical innovations and unforeseeable developments.

Hamburg has set itself the following main aims for action as part of the **long-term perspective 2050**:

- Using the instruments of urban development and cross-sectoral measures at all levels of municipal policy and involving private urban stakeholders, Hamburg will have developed into a renewable city adapted to climate change.
- The measures needed for storm surge protection as well as flood protection on inland waters will have been put in place in order to avoid damage from the effects of climate change to the greatest degree possible.
- The challenges of the energy transition will have been overcome. Hamburg's energy demand will be substantially and reliably covered by competitive renewable energies tailored to demand.
- In the fields of trade, industry and port it is a matter of applying the most efficient technologies throughout as far as possible. As part of an active environmental industrial policy, climate change mitigation will have produced significant environmental innovations. In the Port of Hamburg, renewable energies will form the basis of a modern intelligent port system.
- In the building sector the aim is to achieve a final energy demand (heating and hot water) of an average of 40-45 kWh/m² for existing multiple family dwellings and 45-55 kWh/m² for single family homes. The aim for non residential buildings is a reduction in heat demand of 50 per cent. The city will live up to its role in setting an example and meet high energy efficiency standards in public buildings well before 2050.
- Traffic in Hamburg will be developed towards sustainability and be implemented primarily using alternative drive systems, e.g. drives based on green energy. Besides climate change mitigation, this will also enable progress in noise and emission control. Air transport will be designed to be climate friendly, based on progress achieved at international level.
- Hamburg will have developed into a site of excellence for climate-related further education and training. The research and science sector will have confirmed its position of international excellence in the sphere of climate research.

The content of the long-term perspective 2050 will be updated when the Hamburg Climate Plan is updated in 2018.

The Climate Action Master Plan confines itself to fundamental goal-directed hypotheses and outlines realistic routes and new directions in important action areas enabling Hamburg to deal with the challenges of a Climate Mitigation Vision 2050.

The new Hamburg Climate Plan broadens and develops this approach in terms of method, content and strategy:

- The methodological framework for achieving the long-term perspective is specified in greater detail as a process of transformation (1).
- The thematic scope of a climate strategy is expanded by a summary overview of the integration of climate change mitigation and climate adaptation (2).
- Action areas are not only considered in isolation but some selected cross-sectoral, strategic clusters are introduced (3).

Methodological framework

In order to work towards the goals for 2050, Hamburg will make use of the adaptive management approach. Traditional planning methods are inadequate due to the complex feedback loops and unpredictability of a dynamic transformation process up to 2050: the traditional forecasting with the question, "What would happen if...?" under the basic assumption of an existing situation is not suitable. In order to reach the desired long-term perspective, it is more the case of developing answers to the question: "What needs to happen so that...?" (backcasting). The 2020/2030 action programme therefore defines targets and steps in 14 action areas with the focus on achieving the objectives for 2050.

In general the step-by-step strategy is not linear and needs to be able to be adapted – as is the case for example in a management cycle – with the steps Develop, Implement, Monitor and Adjust (adaptive management):

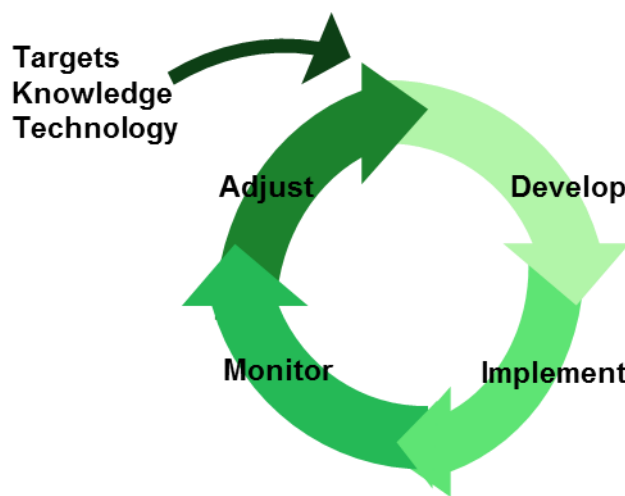


Fig. 1: Management Cycle

As a transformation process the climate strategy therefore appears as a non-linear sequence of management cycles with constant feedback loops, moving towards the vision 2050 with the intermediate goals for 2020 and 2030.

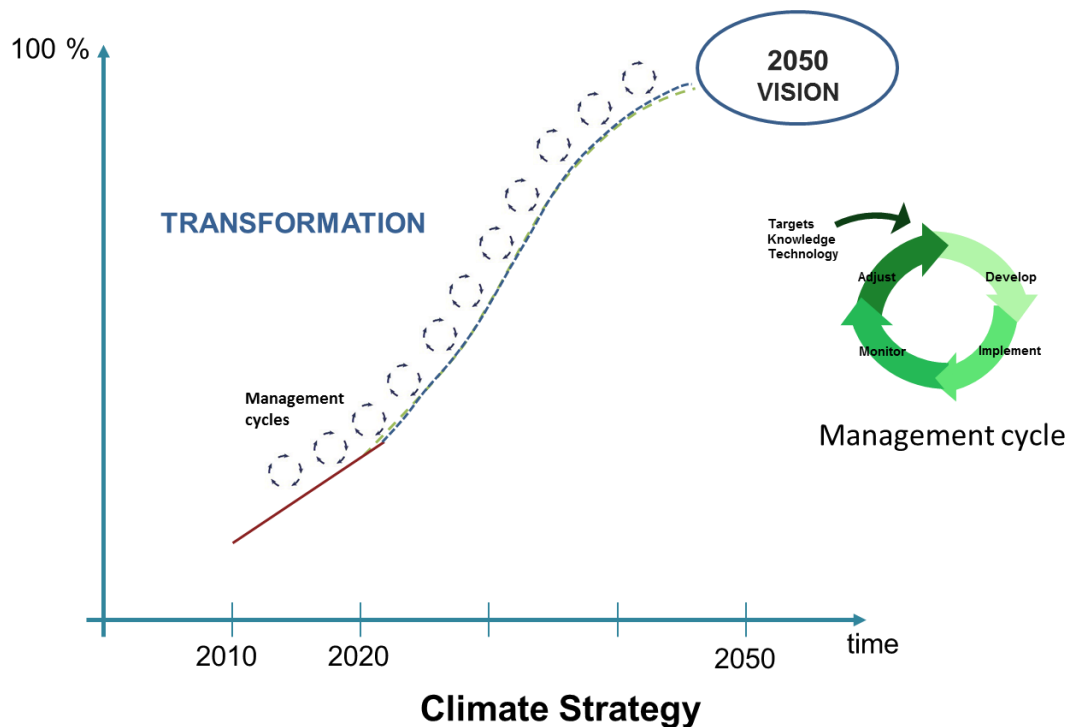


Fig. 2: Model of transformation management

(2) Integration of climate change mitigation and climate adaptation

While the existing master plan views a climate change mitigation strategy as key, it considers adaptation to climate change as a further action area with the following long-term aim: "Using cross-sector measures at all levels of urban policy, in 2050 Hamburg will be adapted to climate change so that damage will be avoided as far as possible." In addition, in 2013 a separate action plan for adaptation to climate change was agreed.

The city needs to become generally more robust and resistant, i.e. resilient to unavoidable climate-related changes and extreme events.

The new Hamburg Climate Plan not only expands the thematic scope of climate-related measures but calls for and implements an integrated double strategy of climate change mitigation and climate adaptation while guiding the transformation process towards the long-term perspective. This expanded Vision 2050 of a "city of the future" is therefore:

Hamburg as a smart, climate friendly and resilient city –
Hamburg as a Climate Smart City!

(3) Strategic Clusters

The expanded long-term perspective of an integrated climate strategy requires the further development of **interdepartmental and cross-sectoral** transformation management. This has also become clear from specialist discussions with the authorities and in the workshops with the city's stakeholders. This has highlighted **key areas** in which, for example, the

complex (cross) connections of important aspects of the areas of climate change mitigation and climate adaptation in the city are reflected.

Some of the key topic areas are given below:

- New urban key objectives and transformation into a "City of the Future"
- New key economic objectives,
- Ongoing cooperation between government and society (governance), even with a change of government,
- Stakeholder participation,
- Information, education, motivation of urban society,
- The role of research and technology in the transformation process.

These key areas will first be used in the Hamburg Climate Plan to form strategic clusters which will be used to help derive fundamental characteristics and the direction of the transformation process towards a climate friendly city adapted to climate change.

Systematic changes are needed along the route to the Climate Smart City Hamburg. This requires the recognition and support of a cross-sectoral view plus synergies between individual action areas. The strategic clusters will provide examples of how partners can spur each other on and of how a positive trend can be initiated in Hamburg. The Coordination Centre for Climate Issues will create the necessary working structures with the participation of the relevant sectoral ministries, public enterprise and the affected target groups from the private sector and will report on joint routes to achieve the targets in the next update of the Hamburg Climate Plan.

Four aggregated strategic clusters are considered below:

- Transformation of urban spaces (city/neighbourhood development)
- Green economy
- The city as a role model
- Climate communication

These strategic clusters should result in the basic direction-setting for the transformation process towards a climate friendly city adapted to climate change. The implementation and further development are an ongoing process (adaptive management):

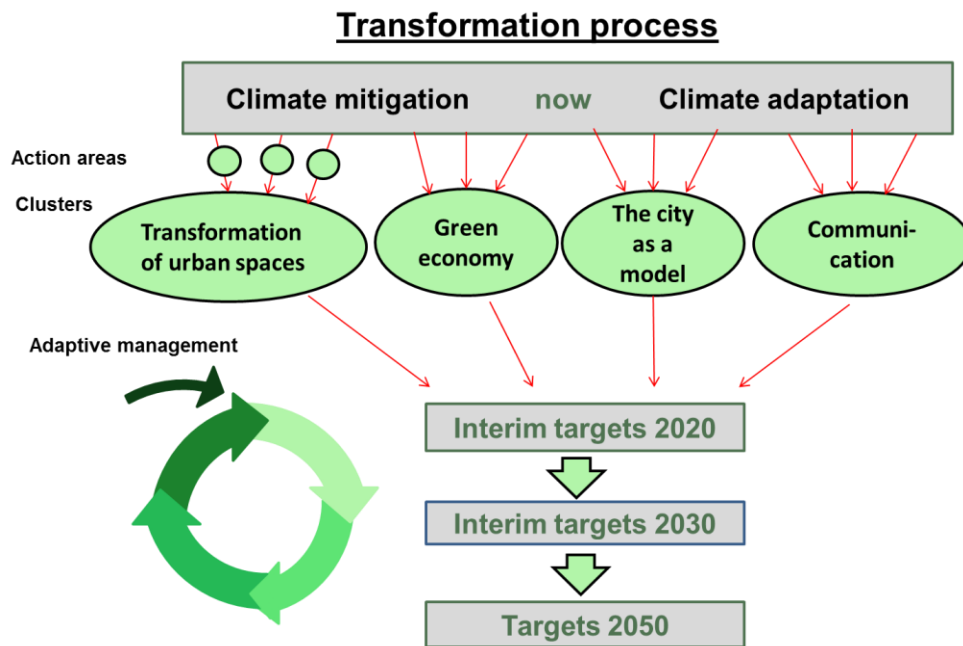


Fig. 3: Transformation process with strategic clusters

IV. Action plan 2020/2030

Besides the above-mentioned four strategic clusters, the new action plan contains the following 14 action areas from climate change mitigation and adaptation to climate change, plus "management and monitoring":

- Urban development
- Energy
- Buildings
- Mobility
- Economy
- Consumption and waste disposal
- Storm surge protection
- Water management and inland flood protection
- Nature and soil conservation
- Human health
- Infrastructure
- Emergency management
- Education
- Research

The targets for 2020 and 2030 for the four strategic clusters and the key cross-sector action points are described below.

1. Strategic clusters

1.1 Transformation of urban spaces: city and neighbourhood development

The "Transformation of urban spaces" cluster considers aspects of the topic areas of energy, buildings, mobility, waste disposal and climate adaptation together, thus spatialising the energy transition.

The Climate Action Master Plan 2013 has already formulated an integrated approach to climate change mitigation in urban development and in the integration with climate change adaptation. Climate change mitigation and climate adaptation need to be included to a greater extent in spatial planning. The concept of inner city development and neighbourhood development are particularly relevant starting points for integrated city development.

During the workshops the stakeholders also repeatedly stressed the importance of the neighbourhoods for successful climate change mitigation.

Key target 1: Hamburg can only become a climate friendly and climate adapted city if climate change mitigation and climate adaptation are integrated into city development. This integration will occur primarily at the neighbourhood level.

Climate change mitigation and adaptation to the effects of climate change are cross-sectoral tasks which must reflect an integrated city development in its many facets. Besides the overall municipal perspectives on city development, climate friendly development must be promoted at neighbourhood level.

Neighbourhood development concepts are required, combining high building standards, intelligent power supply with renewable energies, an eco-friendly mobility concept, a modern waste management system and climate adapted open space design. These technical aspects must be incorporated in processes as soon as possible, e.g. in urban planning and landscape planning competitions and in urban land-use planning processes.

Increasing heavy rainfall events and strong wind events and longer-lasting heat-waves raise the question of proactive and effective long-term adaptation measures. These involve town planning structures, infrastructures, open-space design and health provision alike. Hamburg must face the challenge and, in particular, implement water management concepts including planning and legislative measures which are suitable for keeping damage to persons, property and the environment from floods and heavy rainfall events as small as possible over the coming decades. The RISA (Rain Infrastructure Adaptation) project – which presents a future-oriented solution for the successful management of floods and urban flood protection in neighbourhoods – forms an according basis. It needs to be further developed and tested to see which instruments and implementation steps are appropriate in the years ahead. Information for its implementation can be gathered by means of pilot projects. Civil

society must be informed at the earliest possible date and involved in the implementation processes as far as possible. The housing sector in particular should be involved in the further process at the earliest opportunity via the Alliance for Housing.

Key target 2: Hamburg will meet the challenge of a growing <u>and</u> climate adapted city.
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Hamburg will continue to grow and will increasingly become a densely populated metropolis, especially in the inner city. A strategy therefore needs to be developed which can take account of the requirements of adapting to the effects of climate change, such as more frequent heavy rainfall events in sealed built-up areas and heat islands in densely populated parts of the city.

Hamburg offers a good basis for this, as the population density is not very high compared to other cities and the city has a high proportion of open space. It is therefore important for Hamburg's adaptation to climate change that these green and open spaces are safeguarded, unsealed if necessary and greened over or converted to multifunctional areas with a high amenity value linked to the function of a rainwater retention basin. Cooling fresh air corridors, such as the landscape axes, must also be kept free of development. Hamburg's Landscape Programme with the "urban climate/ecosystem" thematic map currently under development aims to serve as a basis for preventative action for implementing adaptation requirements in urban development. The revision process for the Landscape Programme will be carried out over the next few years.

The neighbourhood level is of particular importance in relation to climate change mitigation and climate adaptation because, when planning for existing buildings and also new construction, several topic areas can be combined into a climate-friendly whole, depending on what is feasible in each individual case. The competent services will produce the necessary working and discussion structures in the near future.

Development towards a holistic viewpoint and from the individual project to the neighbourhood will increasingly be taken into account and pursued by, for example, the housing sector and other urban stakeholders. Besides a cross-sectoral approach, starting points for the neighbourhood strategy are therefore provided by close cooperation with the housing sector.

The city which we build today will define our future. The changes of direction required for a future-proof city therefore have to be made now.

Aim of the cluster:

By 2020 the competent planning departments and the urban stakeholders plus the housing sector will be aware of the need to include aspects of climate change mitigation and adaptation in the planning process. The aim is to establish a network between all the relevant stakeholders at neighbourhood level, such as the districts, the sectoral ministries, housing developers, energy providers etc. By 2030 integrated development concepts

including climate change mitigation and adaptation will be implemented in many neighbourhoods.

By 2050 the urban transformation into a resilient climate friendly city adapted to climate change will be well advanced in many parts of the city.

1.2 Green economy

Hamburg is amongst the most successful and dynamic business locations in Europe. The key business areas of ports and trade, a stable industrial base, successful skilled trades and a growing service sector have brought the city considerable prosperity.

The worldwide decline in the availability of natural resources, adaptation to climate change, the global responsibility for climate change mitigation and the reduction of CO₂ emissions require a constant increase in energy and resource efficiency in economic activity. In addition, commercial viability must be guaranteed, for example by safeguarding the city infrastructure by adapting it to climate change. The "Green Economy" cluster includes aspects of a climate friendly economy from the topic areas of economy, energy, buildings, mobility, waste disposal, education and research as well as their adaptation to climate change.

Hamburg's trade and industry had already made a commitment to its contribution to a sustainability strategy for Hamburg back in 2011 (position paper by Hamburg trade and industry signed by the chambers of commerce and trade associations on 08.02.2011). This makes a considerable contribution to the Senate's climate change mitigation and adaptation targets.

An international debate has been held on the subject since the United Nations Environmental Programme (UNEP) presented the concept "Towards a Green Economy" in the run-up to the Rio20+ conference in 2012. This concept focuses on the increased decoupling of economic growth and rising resource consumption – with the aim of organising an all-embracing materials management. Besides a sustainable climate and energy policy, key topic areas are responsible corporate and state action.

The objective of a Green Economy goes beyond what has already been achieved in Hamburg, for example to currently untapped gains in efficiency by industrial and commercial enterprises in both environmental and economic terms. A strategy built on advice, network development and support programmes can succeed in further reducing energy consumption in trade and industry, steadily improving the energy efficiency of the existing plant and equipment through successive replacement investments, making products more energy efficient and climate and environmentally friendly and using an increasing amount of renewable energies in the operating facilities.

Green Management should lead Hamburg business to the following consideration: how can economic processes, structures and products be innovatively designed so as to conserve the environment and resources on the one hand and achieve future-oriented sustained economic growth on the other? Economic processes, for example, can be designed to be "green" in many business areas. These range from key areas in research and development, through the design, manufacture and distribution of products all the way to organisational

changes and staff qualifications. Moreover, topics such as business mobility management and the use of low-emission vehicles (e.g. battery-powered vehicles, plug-in hybrids or vehicles with hydrogen fuel cells) could be promoted.

In addition, the effects of climate change such as heavy rainfall events and heat waves also require Hamburg companies to carry out adaptation measures to buildings, open spaces and infrastructure. On the other hand, the opportunities for Hamburg businesses in the areas of production and services created by climate change also need to be investigated.

Aim of the cluster:

<p>Hamburg's trade and industry will meet its responsibilities to the whole of society and make its contribution to the climate change mitigation and adaptation targets.</p>
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Hamburg's business community and the Senate will increase their efforts in the areas of resource and energy efficiency and in the use of renewable energies as well as in their advisory capacity, education and qualifications. This will give the Hamburg business community as well as public enterprises and administrative bodies the opportunity of once again becoming a model for other cities and of presenting themselves with best practice examples in the national and international context. This applies to both climate change mitigation and adaptation to climate change. New, innovative concerted solutions are required. There are certainly opportunities here for Hamburg companies in production and services.

The Federal Government supports these approaches with its current research funding which is specifically targeted at sustainability in production, services, infrastructure and mobility. The Green Economy cluster is the (virtual) place to combine these approaches and put them into practice. Appropriate measures will be developed accordingly, building on existing operational structures and in cooperation with the relevant target groups.

1.3 The city as a role model

Within the scope of its activities the public sector will contribute in an exemplary fashion to achieving the climate change objectives.

Hamburg's climate change funding policy will fulfil these objectives in particular by supporting wide-ranging energy-efficiency renovation and investment in systems technology in public buildings. This applies primarily to buildings with a renovation backlog and potential for increasing efficiency. In addition to this, Hamburg's climate plans already contain a large number of other measures such as e.g. regulations on the procurement of vehicles plus materials, business trips, green IT, energy supply to public buildings, new construction of public buildings, etc. with which Hamburg is fulfilling the stated objective of "the city as a role model". Furthermore, through the reacquisition of the energy networks, Hamburg has considerable scope for action, e.g. with regard to the use of renewable energies for heating. The following measures should therefore be assigned to the topic areas energy, buildings and consumption and disposal, or are designed as cross-sectoral measures. Moreover, the city has already achieved a great deal for its resilience to the effects of climate change and will continue to fulfil the necessary requirements for adaptation.

1.3.1 Reacquisition of the energy networks

The referendum on the Hamburg electricity, district heating and gas distribution networks specifies that the FHH must transfer the entire energy supply network to public ownership once more. Even in 2011 the city had a legal share of the electricity, gas and district heating distribution networks with 25.1 per cent of each of the supply companies. By buying back the energy supply companies, the city regains influence on energy policy. The FHH can again have a greater say in what the city's future energy supply looks like and can have a hand in the Hamburg energy transition.

1.3.2 Renovation concepts and road maps for public buildings

The Senate aims to achieve a comprehensive energy-efficiency renovation of public buildings by 2050. In order to further improve the coordination of this process, renovation plans and timetables for municipal property will be drawn up by the end of 2017 – for public buildings in the ownership of the FHH by the competent sectoral ministries and for municipal property managed under the landlord/tenant model by the municipal letting companies. Universities will not be included initially. The aim will be to expand the activities in universities by the end of 2017 in line with the Senate's climate policy targets for public buildings.

There is already a refurbishment timetable and energy management strategy for Hamburg's schools in the form of the framework plan for school construction.

1.3.3 CO₂-neutral administrative procedures

Hamburg has set itself the target for 2030 of making the carbon dioxide emissions of the federal state's administration as CO₂-neutral as possible or of offsetting this. This target will be achieved primarily through energy savings and by increasing energy efficiency and the proportion of renewable energy in energy consumption. The Senate is drawing up an action plan to achieve this target.

Measures which have already been put in place or are constantly being implemented are:

Green ICT: Over the last few years the finance ministry has made comprehensive records of the FHH's IT energy profiles and, based on this, has put forward and in some cases already implemented measures to reduce energy consumption. Dataport is now responsible for completing this task.

Environmentally friendly procurement: The Senate plans to introduce a guideline for environmentally-compatible procurement specifically adapted to the amendment of the Hamburg public procurement law.

More efficient use of paper: The Senate's decision for the FHH on the use of recycled paper has led to an increase in the proportion of recycled paper in the FHH from 72 to circa 75 per cent from 2011 to 2014. However, a satisfactory proportion of total consumption has not yet been achieved in all ministries. The proportion must therefore be increased further by 2020. In addition, the total use of paper has been decreased by circa 19 per cent in the same period. Some parts of the FHH are pioneers in using recycled paper, such as the Hamburg University of Technology (TUHH) which received the award of "Pioneer university for recycled paper" as part of the "Greener procurement" campaign from the German Federal Environment Agency and the Initiative Pro Recyclingpapier in 2013. In 2014 the TUHH plus several ministries and two district authorities had already achieved a recycled paper percentage of 93 to 97%: the use of recycled paper is to be increased in the other parts of the FHH. All recycled paper now meets the requirements of the Blue Angel eco-label, the highest standard for the durability of paper which is resistant to ageing and can be archived indefinitely.

Business trips by rail: The FHH's prioritisation of public transport methods for business journeys and short trips in itself leads to a reduction in CO₂ and pollutants compared to using passenger cars. Since 1 April 2013, all business trips with Deutsche Bahn AG in all long-distance trains within Germany make use of green electricity.

CO₂ offsetting for business flights: As part of the Hamburg Senate's climate change mitigation targets, the Hamburg Climate Action Plan 2007-2012 included CO₂ offsetting for air travel. Since the eighth amendment to the Hamburg travel costs law on 1 April 2008, the travel expenses offices of the FHH have made compensatory payments for the CO₂ emissions caused by business flights. The amount of compensation has been set as a flat rate by the administrative provisions of the Hamburg Travel Costs Act for internal flights (6 euros for a one-way flight and 9 euros for a return flight). The offset amount for flights to other countries is calculated using the emissions calculator by atmosfair (www.atmosfair.de).

Preliminary examination and a comprehensive feasibility study showed that the money from the offsetting fund could be used to develop a climate action project linked to an important development policy concept in the twin city of Dar es Salaam. As a result the development of a composting plant using organic market residues was considered to be a promising idea.

Under the municipal climate partnership between Hamburg and Dar es Salaam, it was possible to apply for additional German Federal Government funding from what is known as the climate facility. The CO₂-equivalent savings from the composting plant should offset all previous and future CO₂ emissions from business flights for a period of ten years.

Public authority vehicle fleet: Municipal vehicle fleets function as a role model and can make a direct contribution to reducing CO₂ emissions. Since 2013, the Senate has been systematically pursuing the aim of prioritising vehicles with electric drives along with the use of electricity from renewable resources in its Hamburg vehicle fleet. An assessment of the potential of the vehicle pool of the central administration carried out by the finance ministry and the Landesbetrieb Verkehr (LBV) has shown a substitution potential for electrically powered vehicles of 32%.

Vehicles are procured (purchase and leasing) based on the "Guideline for the procurement of vehicles with low CO₂ and pollutant emissions", which is an appendix to the updated General passenger vehicle regulations of the FHH of 1.8.2014 (in the 1.1.2015 version). Both were modified to implement the targets.

The requirements set out in the guideline will be regularly evaluated from 2015 onwards in order to update them in line with further developments in the technical possibilities for reducing harmful emissions. As at November 2015, there are 325 electric vehicles in use in Hamburg in the central administration, public enterprises and municipal companies, of which 306 are powered purely by electric batteries, 13 are plug-in hybrids and 5 are fuel cell vehicles.

In addition, there are 120 electric vehicles used in the fleets of the local authorities of the metropolitan region of Hamburg.

1.3.4 Resilience to climate change in all public sector activity

Hamburg has started to include the adaptation to climate change in all public works in order to become a city which is resilient to climate change. This is a long and far-reaching process which was started in 2007 and endorsed by two publications by the Senate and one by the Parliament. It covers development planning, the renovation of public buildings and climate allowances for dyke construction all the way to the identification of flood zones as described in each of the different topic fields. The most important partners in this process are the public enterprises involved in infrastructure and general services. The government is leading by example here.

Climate change does not progress in a linear fashion but in leaps and with extreme events. The greatest capital which the city possesses is therefore its ability to adapt. All ministries and public enterprises are working together to follow new findings and repeatedly check decisions and measures. The climate effects monitoring programme currently under development is designed for this purpose, and will enable climate change and its effects to be observed and the necessary measures put in place.

1.3.5 Public enterprises as climate partners

Public enterprises make an important contribution to the city's function of providing a role model for climate change mitigation and adaptation to climate change. They have been

included directly in government action on climate adaptation from the start. Their efforts ensure that the city is constantly adjusting to the new conditions.

When it comes to climate change mitigation, public enterprises have more of the role of municipal business units. Since 2009 the Senate has been working with the aim that public enterprises with relevant CO₂ emissions should produce climate change mitigation strategies with short-, medium- and long-term targets which are in line with the Senate's targets and report in an appropriate way on their company CO₂ balances. This has not so far happened to the desired degree in all the companies concerned.

The city's public enterprises are therefore called on to make a greater commitment to being the city's climate partners and to drawing up climate change mitigation strategies tailored to their companies. Climate change mitigation and energy efficiency need to appear in the company guidelines. Companies with over two million euros annual energy costs in particular need to include increasing energy efficiency in the company's mission statement. Public enterprises need to switch their electricity purchase – if this has not yet happened – to green energy with a more demanding eco-energy quality.

1.3.6 The districts' climate action plans

The district of Bergedorf was the first in Hamburg to draw up its own climate action plan. The Altona district office is carrying out the groundwork for a climate action plan for the district. Local climate action plans bring climate change mitigation to the attention of the inhabitants and thus help to achieve CO₂ reduction targets. The Senate supports the district authorities in setting up their own climate action plans.

1.4 Climate communication

The cluster "climate communication" incorporates all aspects which depend on the cooperation of the local residents and focus on topics for the resource transition for the following areas: consumption and waste disposal, mobility, energy supply, buildings (energy savings and energy efficiency), health and social aspects. An increase in public relations work on climate topics plus education in all areas of life are important in this respect.

Key target 1: As many municipal stakeholders as possible need to work on developing the Climate Smart City Hamburg

The roles of government and administration, industry and civil society have changed. In place of hierarchical control there is an increasing appreciation of a comprehensive governance in terms of information, network coordination and participation. Public and private companies and the city's stakeholders in particular must therefore be included in developing the climate policy in Hamburg. This will enable social innovation and allow as many urban stakeholders as possible to collaborate in the process of transformation.

The citizens of Hamburg who contribute to the success of the climate policy targets in their roles as tenants, property owners, mobile individuals, consumers, etc. must also be given opportunities to participate, especially in the planning process, and be provided with

information via the Internet and publicity campaigns as part of the city administration's public relations work.

Some measures from this topic area have already been covered in the Climate Action Plan and in the Climate Action Master Plan: the comprehensive view of the topic appears for the first time in the Climate Plan.

The Climate Plan is a dynamic instrument whose creation and further development require the involvement of the relevant city stakeholders from business, science and environmental associations. In presenting the key points of the Climate Action Master Plan, the authorities first initiated a discussion process on climate change mitigation targets and strategies for the whole city with a selection of stakeholders. This participatory process was expanded by the Coordination Centre for Climate Issues in 2014 as part of the updating of the Master Plan when they ran a launch event and four workshops. The group of stakeholders and the range of topics was significantly expanded during the workshops. Besides chambers of commerce and associations, they involved special interest groups from the fields of tenants' rights and mobility, public advisory bodies, large industrial companies and energy utility companies. An evaluation of the suggestions on climate change mitigation from the stakeholder events has been made for each of the topic areas. An agreement was reached to continue the discussion process on various topics, such as integrated neighbourhood development and the funding of climate change mitigation measures.

All the stakeholder workshops on climate change mitigation pointed out the key importance of communication and public relations work as determining factors in getting the Hamburg population on board. Irrespective of the diversity of interests to be represented, the stakeholders urged government and administration to place more emphasis on developing climate change mitigation as a common task. Public relations work and the provision of information and training should be made available to everyone in the city so as to establish climate change topics in society.

As part of an information event on adapting to climate change in 2014, stakeholders were informed about the status of government activities and opportunities for independent action were presented. While most of the city's stakeholders contribute enthusiastically to climate change mitigation, the subject of adaptation is only taken up unwillingly. There is still no sufficient awareness of the real degree of vulnerability and need for action. When it comes to the requirements for adaptation in the city, government and administration must orient their educational work and the provision of information to the needs of civil stakeholders. Specific suggestions for action, particularly to protect buildings and infrastructure, must be made available. This will be a government priority in the next few years. Initially, the categories of adaptation measures to be promoted are those which provide an immediately effective protection or lead to an immediate improvement in the living environment (what are known as no regret measures). Private property developers can therefore be encouraged to implement measures which go beyond the current standard degree of site drainage or protection of the living and working spaces from solar radiation and heating up. Possible synergies with climate change mitigation measures such as heat insulation and greening the roof or facade should be pointed out here. The Senate is therefore targeting Hamburg industry with information brochures and events.

Key target 2: Hamburg achieves a lot, but must demonstrate this.

In order to successfully pursue the aims of a climate friendly and climate adapted city, Hamburg must publicise its strategies and activities to the public and allow them to be involved. Hanseatic modesty is out of place in this context. The **Climate Smart City Hamburg must be established as a brand**. This will allow identification, inspire participation and initiate value creation.

2. The individual action areas

The 14 action areas with their aims, indicators (where available), example measures and key projects are listed below. Key projects were selected on criteria of technical relevance to the action area, political importance and innovative content.

For each of the key projects there is a project description, targets, indicators (where available), stakeholders and target groups plus the current status. A complete list of the projects is given in Appendix 1.

The indicators mentioned in the text are of varied types: in climate change mitigation the indicators are mostly related to achieving the targets, such as savings in CO₂ emissions. In contrast, the climate change indicators used so far mostly relate to changes already observed in the climate and to the changes to which the changing climate has contributed. These are impact indicators which show the degree to which Hamburg is affected and therefore the requirement for action. An explanation of the indicators is given in Section V.4 in the context of monitoring the effects of climate change.

2.1 Urban development

2.1.1 Aims

The Senate is pursuing the mission of a climate friendly and climate adapted "Climate Smart City Hamburg". This requires climate change mitigation and climate adaptation to be integrated into all levels of urban development. Climate change mitigation and adaptation to the effects of climate change are cross-sectoral tasks which must reflect an integrated city development in its many facets.

Besides the city-wide targets for urban development, climate friendly development must be promoted especially at neighbourhood level, because neighbourhoods play a central role in the climate friendly transformation of cities. At the neighbourhood level the key elements of governance, participation and climate friendly transformation are linked at the actual implementation level. Neighbourhood-related approaches are an important foundation, e.g. to shift the energy supply in the building sector in favour of renewable energies or to develop local multimodal integrated concepts for short-range mobility with users, the housing sector and providers. In developing these concepts, it makes sense to incorporate measures to

adapt to climate change, such as green roofs and façades, rainwater capture and percolation and the use of solar energy.

2.1.2 Indicators

Number of neighbourhoods in which the transformation to a climate friendly city adapted to climate change has been started.

Area of green roofs in Hamburg (under development).

2.1.3 Measures

To achieve these targets the Senate is taking various steps, including the following.

a) For climate change mitigation and adaptation in neighbourhood development

- Drawing up development and refurbishment plans for neighbourhoods and quarters which integrate elements such as high building standards, an intelligent energy supply with renewable energies, a climate friendly mobility concept, modern waste management and a climate adapted building and open space design.
- Improved alignment of the instruments and procedures in urban development planning, urban land-use planning, town planning competitions, etc. with climate change mitigation and adaptation to climate change.
- Increased integration of climate change mitigation and adaptation to the effects of climate change in preventative land and property management, e.g. by updating energy and other criteria of relevance to climate change mitigation and adaptation.
- Development of a supporting conceptual practical guide i.e. a guideline for climate change mitigation and climate adaptation in urban development with the main focus on neighbourhoods, as a contribution to the implementation of a climate friendly and resilient neighbourhood transformation. The practical guide will provide assistance for planning departments and offices and contain e.g. a checklist of the relevant action areas for urban planning projects.
- Optimised and combined use of European, national and city funding programmes.
- Further development of the role model of Wilhelmsburg for climate change mitigation and adaptation to the effects of climate change beyond the International Building Exhibition 2013.

b) For climate change mitigation in neighbourhood development

- Assessing cooperation with the Technische Universität Darmstadt (TU Darmstadt). As an instrument of integrated city development planning, the TU Darmstadt has developed energetic urban space types with structural and energy parameters for urban spaces as part of an Experimental Housing and Urban Development (ExWoSt) research project funded by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). In a second stage, the TU developed a tool which enables energy requirements and energy generation potentials in neighbourhoods to be determined based on the urban space type. The tool will be tested to see if it can be implemented and further developed using a practical example in Hamburg.

- Participation in the city of the future competition held by the National Platform City of the Future with the project "Climate Smart City Hamburg - Urban transformation laboratory in the Lokstedt quarter".

c) For adaptation to climate change in neighbourhood development

- Development of a vision of a climate friendly city adapted to climate change and adoption in the further development of the "Perspectives for city development" by the responsible authority.
- Enhancing the vision "Green and environmentally-friendly city", e.g. by maintaining a vigorous stock of trees, creating green roofs, expansion and funding of green corridors and adoption in the further development of the "Perspectives for city development" by the responsible authority.
- The Hamburg Landscape Programme has a greater role as a planning basis for implementing adaptation requirements for climate change, e.g. to protect open spaces and to retain, safeguard and develop the compensatory functions of green spaces and open spaces. An "urban climate/ecosystem" thematic map will be created accordingly, as part of the revision of the Landscape Programme.

2.1.4 Evaluating stakeholder workshops

In all the workshops the stakeholders attached particular importance to the matter of integrating climate change mitigation in neighbourhoods. The suggestions cover linking the neighbourhood and energy supply e.g. in the form of neighbourhood-level energy and heating solutions. A need is also recognised for mobility solutions for neighbourhoods. These should contain a short-range mobility concept at local level with suggestions for parked vehicles and a road design for all modes of transport.

It is suggested that plots of public land be awarded based on a concept competition in which energy criteria have more weight in the award than the status quo.

The stakeholders are in favour of a comprehensive alliance for neighbourhoods and suggest a practical guideline for integrating climatic factors into neighbourhood development. The need for on-site managers for the planning and implementation of the neighbourhood concepts was highlighted. A further point was that existing data should be used to a greater extent.

2.1.5 Key projects

2.1.5.1 Research project TRANSFORM

Description:

From the beginning of 2013 to summer 2015, the Free and Hanseatic City of Hamburg (FHH) took part in the research project TRANSFORM – Transformation Agenda for Low Carbon Cities (7th Framework Programme for Research, www.urbantransform.eu) – along with the project partners HAMBURG ENERGIE and IBA Hamburg GmbH. The objective was a practical guide for the next few decades to transform European cities into more climate friendly Smart Energy Cities.

Besides Hamburg, the cities of Amsterdam, Genoa, Copenhagen, Lyon and Vienna – which were selected for their pioneer positions in Europe – took part in the project with their respective partners (energy and grid operators, universities, institutions, etc.).

One district (or more) in each city which was currently undergoing a process of energetic restructuring and renewal was identified as a so-called Smart Urban Lab. In Hamburg this was Wilhelmsburg, including the International Building Exhibition.

Aims and stakeholders:

TRANSFORM supports local stakeholders who are responsible for setting policy objectives and investment decisions to achieve the ambitious CO₂ reduction targets through transformation agendas and practical implementation plans. These are aimed at the long-term and are combined with realistic projects. TRANSFORM stands for intelligent city development and a holistic approach which sees the integration of stakeholders as essential.

TRANSFORM provides information about the processes on the road to a Smart City and about methods for establishing integrative energy infrastructure plans and practical projects.

Status and results:

TRANSFORM results for specific cities are:

- A local "transformation agenda" for every city: in Hamburg this is based closely on the Climate Action Master Plan.
- An "implementation plan" for the Smart Urban Lab: in Hamburg this is based closely on the energy concept "Renewable Wilhelmsburg" and the updating of the energy atlas.

Generally applicable results which have been derived from the individual city results are:

- A generally applicable agenda for a transformation strategy for European cities.
- A quantitative decision-making tool (prototype): using individual city data, the effects of changing different parameters (e.g. CO₂, energy, time, costs, spatial context, etc.) can be tested and evaluated in an integrated manner – for sectoral energy planning and generating scenarios for CO₂ reduction.
- A Smart Energy City handbook for decision makers in other cities.
- A political memorandum of understanding which was officially signed on 3 June 2015 with which the six cities involved commit to implementing the TRANSFORM results.

2.1.5.2 Prototype climate neighbourhoods

Description: Since 2009 the Senate has followed the approach of prototype climate neighbourhoods with the support of the districts. Prototype climate neighbourhoods were identified and implemented based on a catalogue of priority targets and criteria. Three operational target areas were defined: a diverse range of examples in terms of content, a wide spectrum of areas and a high communication impact.

The prototype climate neighbourhoods aim to capture the important issues and options for action linked to climate change mitigation and climate adaptation, reflect the range of frequent building designs/urban structure types in the city and guarantee the external effect and transferability of specific projects and measures to other residential areas.

Aims: Prototype climate neighbourhoods are an instrument to organise relevant aspects of individual plans for climate change mitigation and adaptation in neighbourhoods, gather experience and make this available to other districts. In addition, they should assist a better integration of the topics of climate change mitigation and adaptation to the effects of climate change into the planning of housing development and open space.

Indicators: Number of prototype climate neighbourhoods

Stakeholders and target groups: Districts, sectoral ministries, housing associations, companies, planners.

Current status: In 2009, 19 prototype climate neighbourhoods were initially identified which have now attained very different stages of implementation and progress. Since then, two new neighbourhoods have been added: the planned residential neighbourhood of Tucholsky in the district of Altona and the Billbrook/Rothenburgsort business park. A cross-neighbourhood study on the implementation of low-temperature heat networks for neighbourhoods was carried out using the example of Heidbrook (formerly Röttiger Kaserne).

An expert overview currently under development on (energy) neighbourhood concepts in Hamburg also includes a record of the implementation status in the individual prototype climate neighbourhoods. The degree to which the contents of individual neighbourhood concepts can be transferred to others and standardised for use in spatial planning will be discussed afterwards in a further process between the sectoral ministries and the districts.

Two prototype climate neighbourhoods are described in more detail below:

a) **The prototype climate neighbourhood of Harburg-Neuland**

Description: In Harburg-Neuland a new logistics centre is being developed on a 27 ha marshland site. Currently the groundwater is just below the ground surface. Draining the area – especially after heavy rainfall – proves to be difficult. In drawing up the development plan, it has been stipulated that rainwater from the logistics centre must not escape into the surroundings. A concept for rainwater management was therefore created. This climate-focused integrated rainwater concept will be linked to the neighbourhood's energy supply. After elevating the site, the aim is to have as much rainwater as possible from the project area seeping away and evaporating (e.g. on green roof surfaces) and to use synergies from energy management, such as evaporative cooling and the use of photovoltaic. These measures will also improve the local climate. Experience with rainwater and energy management gained from this project will set a trend for Hamburg and should be transferred to other projects. The combination of rainwater management and energy supply for logistics centres is a novelty for Hamburg.

Aim: Implementation of requirements for climate change to a project area with a high groundwater level. Linking a water management concept for dealing with rainwater to energy management.

Current status: The Neuland 23 land-use plan will soon have preliminary planning permission (Permissibility of Development Projects During Preparation of the Plan acc. to Federal Building Code Para. 33). Provision of infrastructure and preparation of the logistics site for implementing the land-use plan will be carried out by the sectoral ministry responsible in cooperation with the Hamburg Business Development Corporation (HWF). In

spring 2015 an assessment of the ground conditions and detailed surveys including survey of the ditches was carried out. The surveys are an important basis for future plans to raise the ground surface and provide it with services. The entire planning process is being carried out in close cooperation with specialist hydrological planning services. Having the most precise information possible is the basis for implementing the project economically, with a careful use of resources and in line with climate goals. After completion of the preliminary planning phase in the fourth quarter of 2015, an expert report will be commissioned on the site specific prospects for reducing CO₂ and on the possible savings in the project area.

b) Prototype climate neighbourhood **Billbrook / Rothenburgsort**

Description: As part of the development project "Moving upstream along Elbe and Bille – Living and urban production in Hamburg East" the industrial and commercial sites in Rothenburgsort and Billbrook are to be developed in collaboration with the companies into an industrial and logistics centre of the future. For instance, it is intended to optimise the spatial qualities and integration into the urban space. In future, better use should be made of the potential of the industrial centre of Billbrook / Rothenburgsort in order to create new viable long-term jobs in the city. Besides securing the existence of established companies, this will be complemented by new development of high-added-value industry and logistics companies which will benefit from the proximity to the port, the excellent skilled worker potential and an adequate stable energy supply.

An action plan for the area is being produced with the participation of the companies as part of this development project. One element is the production of an integrated climate change mitigation sub-concept. This includes an analysis of the status of the energy demand (buildings and process heat), potential efficiency measures and the potential for using waste heat and the use of renewable energies.

Aim: Integrated treatment of requirements for climate change mitigation and adaptation to climate change in development planning for an existing industrial and commercial site as part of a future-proof area development.

Improving the image of the area and the companies located there. Cost reductions for companies which implement measures to increase energy efficiency and reduce resource consumption. Testing the site potential for innovative mobility solutions (e.g. electric vehicles, last-mile delivery concepts, autonomous driving).

Current status: The project is an action area as part of the rejuvenation and modernisation of the Billbrook / Rothenburgsort industrial park. Preparatory discussions are being held amongst the authorities involved, the IBA Hamburg GmbH and the Hamburg Business Development Corporation (HWF). In March 2015 funding was applied for from the Federal Funding Scheme for Local Governments in order to establish the climate change mitigation sub-concept. Permission was granted in September 2015, from which date the concept needs to be developed within one year, followed by the implementation phase.

2.1.5.3 Urban Climatic Concept (new Urban climate/Ecosystem thematic map)

Project description and aims:

The urban climatic concept which will become an "urban climate/ecosystem" thematic map in Hamburg's Landscape Programme in future, describes objectives and measures for functions of climatic importance at a whole-city level. It focuses on basic solutions for adapting urban development to climate change, primarily related to measures to reduce urban heat stress and to cope with rainwater. These measures include the preservation of urban climate compensation areas (relevant open spaces) and cool air corridors to ensure air exchange, key action points for greening in urban climate change mitigation areas (built-up neighbourhoods), advice on climate-adapted town planning and construction engineering and recommendations for prototype climate neighbourhoods, protection of soils of importance for the climate plus development areas for promoting seepage, evaporation and other measures to stabilise a water regime which is as natural as possible. Detailed information is given in the specialist maps on "Urban climate", "Water" and "Soils" and in the explanatory report with further development objectives and notes on the "Urban climate/ecosystem" thematic map. This revision is based on the 2012 expert report developed for the Landscape Programme entitled "Urban climate analysis for Hamburg + Climate change scenario 2050" and available data on soils and water (surface water and groundwater), measures for implementing the EU Water Framework Directive, results from the RISA – Rain Infra Structure Adaptation – project and the descriptions in the current Landscape Programme.

The Hamburg Landscape Programme is the city-wide instrument for taking account of the functions of nature and open spaces in built-up areas in the planning process, in accordance with the provisions of the German government's Federal law on the protection of nature and Hamburg's own law (BNatSchG, HmbNatSchG). This integrates development targets on climate-related aspects of the natural environment and the conservation of species and biotopes while guaranteeing recreation and quality of life for people.

During the forthcoming formal voting procedure to update the Landscape Programme, the topics in the draft of the "Urban climatic concept" are to be integrated into the Landscape Programme as an "Urban climate/ecosystem" thematic map, thus becoming a binding component of the Landscape Programme. The Landscape Programme is administratively binding and provides important planning guidelines for urban development which require to be expanded with detailed and binding planning procedures and implemented following assessment.

Stakeholders: Responsible authorities, districts

Target groups: Planning authorities for urban, landscape and development planning and for other planning of relevance to the area

Current status: After incorporating points from comments made by the sectoral authorities and districts, the expert paper is to be finalised as a draft of the "Urban climate concept". Subsequently, the paper will be made available as working material for forthcoming projects. The formal revision procedure in accordance with HmbNatSchG for the complete updating of the Landscape Programme is due to begin in the first quarter of 2016, when the "Urban climate/ecosystem" thematic map will become binding within the Landscape Programme. This process will require a strategic environmental assessment to be carried out. Approval will take place via the usual steps such as participation of the responsible public authorities and the public (information event and public display) plus the political bodies followed by submission for a decision by the Hamburg Parliament.

2.1.5.4 Green roof strategy

Description and Aims: The urban climatic concept will be supplemented by a green roof strategy for Hamburg which will combine the urban development policy aim of the growing densely-populated city with environmentally friendly building and the policy objectives of adaptation to climate change and climate change mitigation. An increasing number of green roofs could also improve temporary water retention, even during heavy rainfall events, raise biotope and diversity of species and increase the amount of green in heavily built-up parts of the city. Expenditure on roof greening leads to savings on rainwater retaining facilities on the ground. In addition, this decentralised storage avoids costly cases of damage and supplies pre-cleaned service water. Another factor is that, in the longer term, building maintenance costs (increased durability of the roofing, improved noise and heat insulation) are lower and run-off water charges for green roofs can even be halved.

Since January 2015, Hamburg property owners can apply for a subsidy for building a green roof. There is a total of 3 million euros available for green roof grants and the funding programme runs to the end of 2019. Grants can be made for voluntary roof greening measures above 20 m² roof area and apply both to commercial and private property owners. The funding conditions are laid down in the "Funding guidelines for the creation of roof greening on buildings". The funding programme is managed by the Hamburgische Investitions- und Förderbank (IFB).

Indicators:

- Area of green roof in Hamburg (under development)

Stakeholders: Responsible authorities, investment and funding banks

Target groups: Property owners plus those with right of access to public and private land

Current status: In 2015/2016, measurement data will be collected on the rainwater storage capacity of green roofs using the measuring system on the green roof of the HafenCity University and the planned measuring system in the Am Weissenberge housing development in Ohlsdorf (SAGA GWG). The results should provide sound evidence for the rainwater storage capacity during heavy rainfall events under actual climatic conditions.

Roof greening is currently being formally and legally codified in connection with the options for setting the conditions in urban land-use planning. The specification is based on design requirement grounds, on grounds for water retention and as a measure to compensate for interference in nature and the landscape.

Under the planned revision of the Hamburg building regulations in 2016 it is aimed to incorporate a new statutory basis which will enable the requirement of greening components of buildings on reasons other than those of design.

2.1.5.5 Adapting to the effects of climate change in inner city built-up neighbourhoods of Hamburg (KliQ)

Description and Aims: Heavy rainfall events cause problems in the increasingly built-up city because many of the existing sewers are already at capacity. It would be very expensive, difficult from a planning angle and legally problematic to adapt the sewers to the future effects of climate change. Other solutions for dealing with rainwater are therefore required such as roof greening or making use of rainwater, decentralised seepage and evaporation on private and public areas or cooling existing buildings using rainwater or buffering and temporary storage of rainwater on open spaces or areas used by traffic.

High-density inner city neighbourhoods are particularly susceptible to the effects of climate change due to the density of buildings and the high level of sealing. This means that it is essential to have improved urban flood protection during heavy rainfall and ways of dealing with drought periods plus measures for buildings to provide effective heat protection in summer. Action is required on the part of both city authorities and private house owners.

In this project climate-related adaptation measures are being developed and discussed with local stakeholders. As there is a rather limited potential for urban flood protection measures on private land, these need to be linked to concepts for public areas. In terms of buildings, the options for passive cooling of existing areas need to be assessed and – if possible and reasonable – coupled to active cooling using rainwater.

As a first step, inner city adaptation concepts from international reference cities will be analysed and their methods evaluated, for example the Copenhagen Climate Resilient Neighbourhood or London Green Infrastructure Audit. The transferability of these approaches will then be examined and modified if necessary using a Hamburg neighbourhood as a practical example. The results will be presented in the form of a guideline. The research project builds on the results of the KLIMZUG-NORD and RISA – Rain Infrastructure Adaptation – projects.

Stakeholders: HafenCity University, responsible authorities, local stakeholders

Current status: The project was started in 2015.

2.1.5.6 Urban trees and climate change

Description and Aims: The project "Urban trees and climate change" will develop an integrated concept for adapting the Hamburg tree stock to climate change. The first step is to study the vulnerability of the trees due to climatic changes and document this over the long-term. Measures and instruments will subsequently be developed with the aim of conserving and further developing the tree stock in times of changing climate. Adaptation options for Hamburg's urban trees will be discussed, setting the course for successful implementation.

Indicators: The project will develop a "Street tree condition" indicator.

Stakeholders: The project is a collaboration between the responsible authority, the University of Hamburg (Institute of Soil Science and the Biocentre Klein Flottbek) and the HafenCity University of Hamburg (Environmentally compatible urban and infrastructure planning). Close links will also be maintained with partners from the region, with

representatives from municipal authorities, associations, research institutes and arboriculture facilities. Partners from outside the region such as the City of Munich are also involved. This enables the observation of the effects of different climatic zones and the sharing of experiences.

Target groups: The executive urban tree management authorities of the districts; the transferability to other local authorities is also of prime importance in this project.

Current status: The project started in 2015.

2.2 Energy

2.2.1 Aims

The Hamburg energy transition is Hamburg's own contribution to achieving further significant reductions in energy consumption, converting the energy supply to a low-CO₂ supply and thus further increasing the proportion of renewable energies. This is a concerted effort by the whole city.

The Hamburg energy transition is based on three key components:

Energy efficiency: The best climate change mitigation consists of reducing energy consumption and the emission of CO₂ in the first place, without reducing the quality of life or economic strength. Examples of this are energy-saving buildings and efficient heating systems, modern power plants and the optimisation of commercial processes. The primary energy consumption and CO₂ emissions from Hamburg facilities for the generation and distribution of electricity and heat will be reduced. These changes will be implemented in such a way that the supply remains affordable for the citizens and businesses of Hamburg.

Future-proof grids: Hamburg has a very well developed grid-based network infrastructure for electricity, gas and district heating. For example, the natural gas grid is approx. 7,900 km in length, and the district heating grid approx. 770 km and, incidentally, in combination with the local heat networks, is the largest heat network in Germany.

Heat supply offers the greatest scope for development. The use of efficient gas-powered plants with combined heat and power will be expanded. In addition, more renewables will be used. The grid-based supply plays a particularly important role here. Customised solutions will be developed for suitable neighbourhoods.

Reacquisition of the Hamburg district heating network also offers the possibility for a significant reduction in CO₂ emissions in the long-term.

Expansion in renewable energies: The aim is to meet the remaining requirement for energy from renewables to an ever greater extent, even though Hamburg as a city state is subject to severe constraints. Wind energy generation, however, can be expanded to a certain degree and there is a potential for installing solar panels, especially on roofs.

The municipal subsidiary Hamburg Energie has created a company whose projects play a key role in the Hamburg energy transition. The percentage of renewable energies has been increased by projects such as the Georgswerder Energy Hill, public participation models with photovoltaic projects and the heat supply to the global neighbourhood in Wilhelmsburg using a high proportion of heat from renewable sources. Hamburg's city cleansing department also

makes an important contribution to expanding renewable energies. Its energy generation portfolio includes projects for the energetic use of biomass and the fermentation of biogenic residues and organic waste but also landfill gas, wind energy, photovoltaic and solar thermal projects.

The north German federal states are working ever more closely together on the energy transition. Hamburg contributes to improving energy efficiency and making consumption more flexible via its potential as a large centre of consumption in northern Germany. In this way it supports the dynamic expansion of renewable energies in the adjoining area states.

2.2.2 Indicators

Proportion of renewable energies in the gross final energy consumption

2.2.3 Measures

The Senate has opted for the following measures in the energy action area in order to reach the climate targets:

Expansion of the percentage of renewable energies:

- Funding programme for renewable heat
- Wind energy: support for expansion

Renewable energies in public facilities:

- Public facilities to purchase green energy
- Use of bio-gas in public buildings: In order to meet the special model role of the city, urban infrastructures – especially public buildings – need to play a leading role in obtaining energy from renewable sources. Since 01.01.2012 part of the quantity of natural gas required for public buildings and their associated institutions (theatres, museums, foundations, etc.) has been substituted by biogas. The current contract (natural gas supply from 2015 to 2017) also specifies the substitution of a proportion of natural gas by biogas of 10 million kWh/a.

Heat supply:

- Reacquisition of the supply networks
- Energy-efficiency neighbourhood planning
- Heat cadaster

Networks:

- Hamburg renewable energies cluster

2.2.4 Evaluation of stakeholder workshops

The stakeholder workshops gave rise to the following suggestions:

- Cadaster for energy sinks and sources; heat market
- Increased coupling of heat and electricity
- Urban heat network
- Expansion of renewable energies in the heat sector

These points are already being worked on by the responsible authority.

2.2.5 Key projects

2.2.5.1 Reacquisition of the network

Description: The referendum on the Hamburg electricity, district heating and gas pipeline networks has decided that the FHH must transfer the entire energy networks back into public ownership. In 2011 the city had a 25.1 per cent shareholding in each of the grid companies for the electricity, gas and district heating supply networks. By reacquiring the energy companies, the city regains its influence on energy policy. The FHH can once more have a greater say in how the city's energy supply looks in future and can be involved in developing it as part of a Hamburg energy transition. The potential for action is limited by the regulated and decentralised markets in the electricity and gas sectors. The stated aim is to expand and modernise the central district heating and to press ahead with the switch to climate friendly energies for the city's heat supply. The re-nationalisation of the central district heating expands influence not only to the heat network but also to the associated generating plants. In the long term these need to be converted to more environmentally friendly fuels, in the first place most importantly from coal to gas.

At the beginning of 2014 the city acquired the remaining 74.9 per cent of the Stromnetz Hamburg GmbH. Purchase options were negotiated with the majority shareholders for the complete acquisition of the gas grid company and the district heating company.

Aims:

- Complete implementation of the referendum on the energy networks.
- Regaining influence on energy policy. The options for action arising from the reacquisition of the networks are linked to medium- to long-term effects.

Indicators: Complete acquisition of the gas grid company in 2018 and the district heating company in 2019.

Stakeholders: Senate, ministries, companies involved

Current status:

- Stromnetz Hamburg GmbH has again become a fully municipal company since 2014.
- The FHH has a 25.1 per cent share in the gas network company Hamburg Netz GmbH. FHH can complete the purchase in 2018.

- The FHH has a 25.1 per cent share in the district heating company Vattenfall Wärme Hamburg GmbH. FHH can complete the purchase in 2019.

A cooperation agreement was made with the public electricity network company on a range of individual projects which will help the further expansion of renewable energies and will ensure insight into energy generation and consumption by means of transparency and information. This will also be aimed at with the other energy network companies.

The reacquisition of the supply networks is primarily a key political project along the value-added chain (energy generation, transport and supply). The resulting climate policy effects are of a medium- to long-term nature.

2.2.5.2 Energetic neighbourhood development illustrated by Bergedorf-Süd

Description: In 2011 on the basis of an integrated development concept (IEK / RISE), the Senate decided to designate the district of Bergedorf-Süd as an assisted area under the integrated urban development of the "Active City and Local Centres" Programme run by the Federal and state governments. Bergedorf-Süd was therefore selected as the Hamburg pilot area for the KfW programme "Energy Efficient Urban Re-development – grants for integrated neighbourhood concepts". The contract for establishing an integrated energy-efficiency concept was awarded at the end of 2012 to the joint venture Metropol Grund, MegaWatt and konsalt who completed the energy-efficiency refurbishment concept at the beginning of 2014. The concept was produced in close cooperation with the district and the responsible authority.

Aims: Taking into consideration all the other relevant aspects of town planning, preservation of historical sites and monuments, building culture, housing development and social needs, integrated neighbourhood concepts demonstrate which technical and economic energy saving potentials exist in the neighbourhood and which practical measures can be applied in order to reduce CO₂ emissions in the short, medium and long term. They form a central strategic decision-making basis and an aid for investment planning aimed at the total efficiency of energy measures in neighbourhoods, and serve to achieve Hamburg's climate targets (KfW programme relates directly to the Government's energy plan), particularly through

- Increasing the annual refurbishment quota and the sustainable energy-efficiency refurbishment of the buildings,
- Retaining important façades which are protected as monuments,
- The social acceptability of the refurbishment works,
- Making use of areas of new build and conversion (e.g. the new build areas Brookdeich, Glunz-Kaufhaus, Lichtwarkhaus, Rudolf-Steiner-Schule) in order to promote heat generation and distribution with renewable energies and combined heat and power for individual housing blocks.

Indicators: The energy-efficiency successes in the neighbourhood will be documented during the three-year neighbourhood management project.

Stakeholders: Authorities, district council, joint venture Metropol Grund, MegaWatt and konsalt, property owners on site

Current status: The joint venture was commissioned to implement the energy efficiency refurbishment concept at the end of 2014, funded as a three-year neighbourhood management project by the KfW and the responsible authority. The works have started.

2.2.5.3 Heat cadaster

Description: The aim of the project is to compile a heat cadaster to present the spatial distribution of heat demand and heat supply structures in the Free and Hanseatic City of Hamburg. The required databases will be collected and prepared in a geographical information system (GIS) to enable the information to be visualised. The heat cadaster should provide a basis for information and planning for energy and urban development stakeholders in order to identify savings opportunities and develop supporting measures to achieve the Hamburg CO₂ reduction targets.

Aims:

The heat cadaster should provide an aid for:

- The analysis of the required refurbishment and reduction opportunities and presentation of future heat demand scenarios,
- Identification of new supply areas for local and district heating,
- The planning of more efficient heat supply concepts and the decentralised feed-in of renewable heat,
- A planning basis for decision makers for defining and evaluating urban heat supply concepts.

Stakeholders: Responsible authority and public authority, research team within the 6th energy research programme government-funded GEWISS project (Geographical Heat Information and Simulation System Hamburg) with HafenCity University, Hamburg University of Applied Sciences, etc.

Target groups: Districts, urban development stakeholders, energy providers, final consumers, property owners, industry and commerce, Hamburg neighbourhood development project stakeholders

Current status: Developing the planned heat cadaster is primarily dependent on the availability of the relevant data. An examination is currently underway as to whether, and if so what, energy data can be provided and processed for a heat cadaster.

2.2.5.4 Green energy in public institutions

Description:

For many years, European funding procedures have ensured that the public buildings of Hamburg and their associated institutions (theatres, museums, foundations, etc.) are supplied 100 per cent with green energy. Green energy is defined here as electricity from direct marketing which is generated from at least 75 per cent renewable energy and to a

maximum of 25 per cent in high efficiency combined heat and power plants. In addition, since 2013, no more of these kind of certificates have been bought: the power must come "directly" from renewable energy sources or high-efficiency heat and power plants.

Electricity from renewable energy is produced from the following energy sources:

- Hydropower including wave, tidal, salt gradient and flow energy
- Wind energy
- Solar radiation energy
- Geothermal energy
- Energy from biomass including biogas, landfill gas and sewage gas and from the biodegradable component of household and industrial wastes

The procurement criteria also allow for the age of the generating plants in order to take account of the additionality of new plants for generating renewable energies.

Aim: 100 per cent power supply for public buildings and associated institutions using green energy

Indicator: Proportion of green energy in the FHH's power supply

Stakeholders: responsible authority, energy providers

Target groups: Operators of public buildings and associated institutions

Current status: From January 2013 to the end of 2015 the FHH's power supply came from Hamburg Energie; from 2016 onwards power is supplied by the company Energievertrieb Deutschland GmbH whose headquarters are in Hamburg. For 2016 to 2018 the supply of green electricity will be secured by a direct contract. This electricity will be generated in new hydropower plants with a specific greenhouse gas (GHG) avoidance factor even higher than those for solid biomass and wind power and which therefore has the greatest environmental benefit (report by the German Federal Environment Agency on GHG mitigation potential "Emission Balance of Renewable Energy Sources", 2009).

2.2.5.5 Funding programme for renewable heat

Description: Both companies and private individuals can obtain a grant for investment costs for replacing existing fossil fuel or electrically powered heat generators by heat generation concepts using renewable heat or waste heat. The programme can also be used to fund innovative heat supply concepts using renewable energy e.g. as part of neighbourhood concepts. The IFB (Investitions- und Förderbank) is running this programme on behalf of the responsible authority. Detailed technical advice for this funding programme and also for the installation of PV systems which are not part of the programme is provided by the SolarZentrum Hamburg, a project run by the Handwerkskammer (Hamburg Chamber of Crafts and Trades).

Aim:

- To increase the proportion of renewable heat in Hamburg's heat supply
- Further spread of innovative plant combinations with renewable energy
- Evaluation of model projects to present the results, including to other potential investors

Indicators: CO₂ reduction (t/a)

Stakeholders: Responsible authority, IFB, Chamber of Crafts and Trades, universities and associations

Target group: Companies and private individuals

Current status: The funding programme was run by the Hamburg Innung Sanitär Heizung Klempner up to the end of 2013 and by the IFB since 01.01.2014. Due to this transfer and the associated change in the target group (initially funding for tradespeople; from 2014 funding for investors) the programme has so far been unable to achieve the planned CO₂ savings targets. However, the relatively low uptake was also due to the significantly lower costs associated with fossil heat generation (i.e. funding and relatively low fuel prices) which were not offset by this support programme even when combined with the Government funding for renewable heat.

2.3 Buildings

2.3.1 Aims

The buildings action area is one of the most important, with a final energy consumption of 24 per cent. In Hamburg alone around 4.7 million tonnes of carbon dioxide emissions are caused by heat consumption in residential and non-residential buildings (not including energy consumption and process heat in industry). The building sector can make a disproportionate contribution to achieving climate change objectives due to its large potential for reducing energy consumption. It also offers the opportunity to prepare buildings for the future warmer climate with more extreme weather events.

Hamburg is attempting to achieve an almost climate neutral building stock by 2050 in line with the Government's target. This means that buildings have a very low energy demand and the remaining energy requirement is largely met by renewable energies. Hamburg's aim is to achieve a final energy demand (heating and hot water) of an average of 40-45 kWh/m² for existing multiple family dwellings and 45-55 kWh/m² for single family homes. The aim for non residential buildings is a reduction in heat demand of 50 per cent. This requires a reduction in energy consumption and an increase in energy efficiency. In 2014 an energy efficiency strategy for buildings was developed at national level with the aim of achieving an average portfolio standard in the housing stock equal to the efficiency house 55 by 2050 (cf. BMWi "Sanierungsbedarf im Gebäudebestand", 2014). The aim is to reduce final energy demand in comparison to the 2008 reference year by 20 per cent by 2020 and to reduce primary energy demand by 80 per cent by 2050. This can be achieved using the middle scenario in Figure 4 e.g. by a combination of savings in final energy of 50 per cent and having a renewable heat proportion of 60 per cent of the remaining final energy consumption.

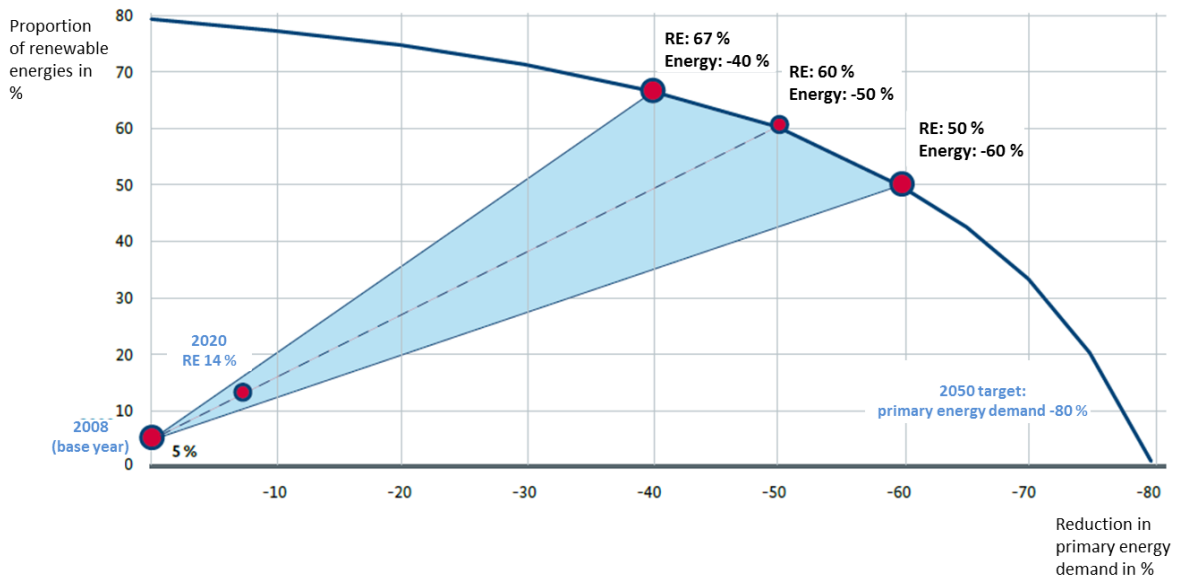


Fig. 4: (Possible) target corridor from energy savings and increasing the proportion of renewable energies from 2008 to 2050 in per cent (Source: BMWi, Sanierungsbedarf im Gebäudebestand, 2014)

As a growing metropolis, Hamburg has a special responsibility – especially in the housing sector – for supporting the national targets. The largest share of the consumption of room heat and hot water is accounted for by residential buildings constructed before 1978 (approx. 70 per cent of the housing stock), in other words buildings which were put up before the first Heat Insulation Ordinance and of which a large proportion will be modernised over the coming decades.

Non-residential buildings in commercial or public use account for a 40 per cent share of building-related energy consumption and CO₂ emissions (Ecofys 2010). 60 per cent of non-residential buildings were constructed before 1978.

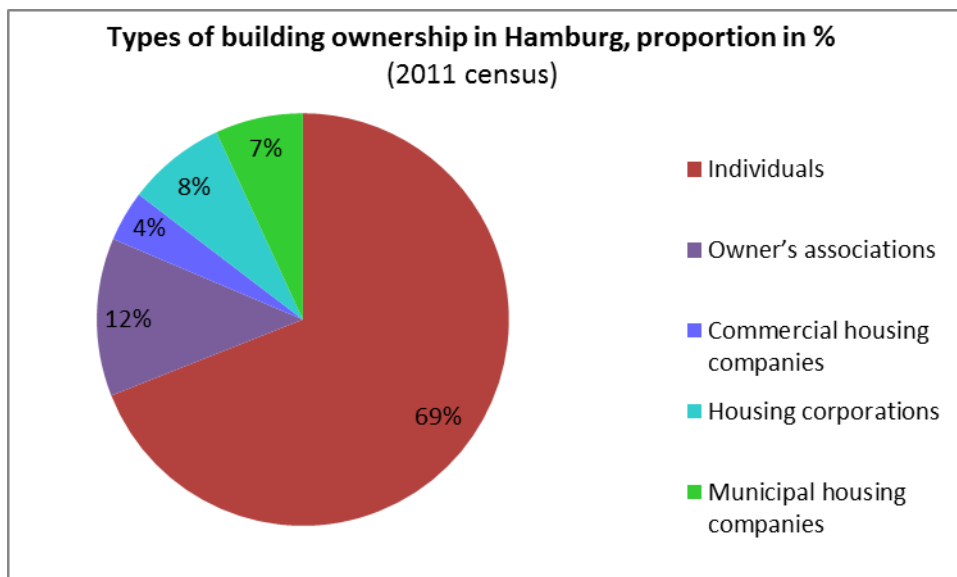


Fig. 5: Proportional distribution of forms of house ownership in Hamburg (Source: Census by the Office of Statistics for Hamburg and Schleswig-Holstein, 2011)

Eigentumsform der Gebäude in HH, Anteile in %	Types of building ownership in HH, proportion in %
(Zensus 2011)	(2011 census)
Privatpersonen	Private individuals
Wohnungseigentümer- gemeinschaften	Owner's associations
Privatwirtschaftliches Wohnungsgenossenschaft	Commercial housing association
Kommunale Wohnungsunternehmen	Municipal housing companies

Despite a wide range of advisory and support programmes, the extent of refurbishment work – including that in Hamburg – has not yet increased to the annual amount considered necessary in order to reach the Federal government's targets.

In order to achieve the long-term climate change objectives, building standards are needed – especially for the housing stock – which significantly exceed the current legal standards. In its 2020/2030 Action Plan the Senate is therefore pursuing the following objectives, with particular reference to the housing stock:

1. Reducing the final energy consumption and increasing the energy efficiency of buildings, taking into account social acceptability, historic buildings and the preservation of the cityscape,
2. Setting an example in public ownership, particularly with regard to refurbishment, energy-efficiency modernisation and the construction of new public buildings. The aim is to reduce final energy consumption by at least 30 per cent by 2030 and at least 60 per cent by 2050 in comparison to the consumption values of 2008.
3. Energy-efficiency modernisation in public buildings will be stepped up, implementing the further increase in the standards of the Energy Saving Ordinance (EnEV) 2016. Hamburg has always backed high standards and has contributed to the development and market launch of new technologies in the field of energy-efficient construction through pilot and model projects. The Senate also intends to fund projects which go beyond the legal standards in future. The Senate will also look for economical solutions in the realm of public buildings which enable them to more than meet legal standards.
4. Integration of renewable solar energies into buildings, including their roofs and façades.
5. Building methods and the design of open spaces will be adapted to climate change, e.g. project- or building-related rainwater management.

The "sustainable construction" aspect of energy-efficient building is to be further developed as a long-term contribution to CO₂ reduction. The approach must take more account of what is known as "grey energy"² and the whole life cycle of building materials. Building with

² Grey energy is the name given to the amount of energy needed for the manufacture, transport, storage, sale and disposal of a product. This takes account of all the upstream products back to sourcing the raw materials and adds the energy used for all the production processes applied. (Source: Wikipedia)

renewable raw materials will assume increasing importance. The additional funding already introduced in Hamburg for renewable insulation materials in the programmes on energy-efficient building will be retained. In addition, further funding for sustainable construction, e.g. timber construction, will be tested.

2.3.2 Indicator

Proportion of reduction in final energy consumption of buildings

2.3.3 Measures

The objectives will be achieved using e.g. the following measures:

Measures for the aim "Reduction of final energy consumption and increase in energy efficiency"

Measures for public and private buildings

- Refurbishment of the external envelope and use of energy efficient building services, e.g. heating systems, lighting, ventilation and cooling systems.
- Following on from experience with the International Building Exhibition, Hamburg aims to continue to implement innovative building with future-oriented construction methods such as timber construction (including for multi-storey buildings), modular construction, self-build, etc. and fund these where appropriate.
- Further develop the implementation of the Energy Saving Ordinance (EnEV), e.g. using spot checks for energy performance certificates, reports on air conditioning equipment inspections and property adverts.
- Adoption of a streamlined implementation of the Renewable Energies Heat Act (EEWärmeG).

Measures for private buildings

- Continuation, needs-based further development and advertisement of the existing support programmes for energy-efficiency modernisation of a high standard.
- Continuation and further development of the Alliance for Housing.
- In view of the high proportion of private owners and owners' associations (see Figure 5), this target group should be appealed to more using measures such as e.g. media campaigns and funding programmes.

Measures for the aim "Public authority role model, public buildings"

- Specification of refurbishment concepts and road maps for public buildings through the relevant portfolio holder in cooperation with the responsible sectoral ministries (see below).
- Specification of refurbishment standards in public building stock:
 - o For building measures in existing stock, energy-efficiency modernisation will exceed the statutory standards to the degree that this can be justified economically.
 - o When replacing and renewing the building services, the aim will be to install at least 30 per cent of renewable energies.
 - o When planning modernisation measures and selecting options and the quality of refurbishment measures, a balance will be recommended between environmental effects and a life-cycle cost assessment over 50 years in accordance with the Government's guideline on sustainable building.
- An increase in the procurement of national and EU resources for implementation,
- Increased use of photovoltaic systems and combined heat and power plants,
- Optimisation of the heating operation,
- Gradual retrofitting of LED lighting,
- Testing and, in suitable cases implementation, of intracting as a model for funding and returns in order to fund effective climate change mitigation refurbishment with high standards with the help of a revolving fund,
- Testing and – for suitable buildings – support of the portfolio holder for implementing third-party contracting to increase energy efficiency,
- Continuation and further development of the "fifty/fifty" programme for schools,
- Using Federal funds, such as funds from the Kommunalinvestitionsförderungsgesetzes (Act to support investment in financially weaker municipalities) for energy efficiency refurbishment of schools and universities.

2.3.4 Evaluating stakeholder workshops

Suggestions by stakeholders related mainly to the neighbourhood level with the approach of viewing "the neighbourhood as a project". The importance of an energy supply for multiple buildings plus quality assurance for energy efficiency renovations was emphasised. A need was seen for improving communication on building refurbishment and existing funding schemes.

The stakeholder event for adaptation to climate change showed that the housing sector is still unaware of its own vulnerability from climate change so that almost no precautionary measures have been taken for adaptation to climate change.

2.3.5 Key projects

2.3.5.1 Energy-efficiency refurbishment of public buildings

Description: Energy efficiency refurbishment is a key element of the building measures for existing public buildings owned by the city. It is carried out in many cases along with modernisation or building maintenance work. Planning (construction planning and building services engineering) are carried out together, in order to create the conditions for a low energy demand right from the building structure onwards. The Free and Hanseatic City of Hamburg implements a wide range of measures with a large investment volume as part of mainstreaming.

In order to further improve the coordination of this process, refurbishment plans and road maps for municipal property will be drawn up by the end of 2017 – for public buildings in the ownership of the FHH by the responsible sectoral ministries and for municipal property managed under the landlord/tenant model by the municipal letting companies. Universities will not be included initially. The aim will be to expand the activities in universities by the end of 2017 in line with the Senate's climate policy targets for public buildings.

The refurbishment plans for public buildings should contain criteria for selecting the buildings and measures as well as interim targets for 2020 and 2030. These criteria should focus on the cost effectiveness of each of the refurbishment measures, their contribution to achieving Hamburg's climate change objectives, the future use of the building and the costs associated with refurbishment.

Based on these refurbishment concepts, the responsible authorities along with other responsible public agencies (e.g. Sprinkenhof GmbH) will establish a refurbishment road map for their buildings above an as yet undefined net floor area with the aim of reducing the final energy consumption by 30 per cent by 2030 and the primary energy consumption by 80 per cent by 2050 in comparison to the consumption values related to the building alone in 2008. The refurbishment road map should show the implementation of the required refurbishments in chronological order. Besides the long-term reduction in energy consumption, the reduction target for final energy consumption should take account of the cost of the energy efficiency refurbishment in order to ensure that the measures are cost effective.

Aims (general): The Senate aims for a complete energy-efficiency refurbishment of public buildings. The primary energy demand of the public building stock is to be reduced by 80 per cent by 2050 through energy-efficiency refurbishment.

Indicators: Energy consumption by the buildings.

Project descriptions, aims and current status of individual categories of public buildings are given below.

a) Schools

Description: Based on the Senate documents on school building (Senate documents 19/4208 and 20/5317) and the state framework plan on school construction from 2011 to 2020, the Senate has pledged around two billion euros for the refurbishment and expansion

plus new building of schools for general education. As a rule these will be based on an energy-efficiency standard in line with the current Energy Saving Ordinance EnEV.

Aims: Annual reduction of CO₂ emissions of 1,300 t per year. Starting from around 109,100 t in 2012, this should reduce CO₂ emissions by around 10,400 t to around 98,700 t in 2020.

Alongside this aim it must be borne in mind that the positive effects of construction measures, operational optimisation and fifty/fifty are counteracted by effects which increase energy consumption: rising pupil numbers, increasing all-day opening including new school kitchens and an increasing use of technology.

Current status: The framework plan on school construction provides a refurbishment road map for school buildings with ongoing implementation. The energy-efficiency standard is usually in accordance with the current EnEV. An energy standard above the level of the EnEV has been chosen for some buildings. One example is the education centre "Tor zur Welt" which was built according to the passive house standard, or the new building for the Klein Flottbeker Weg primary school which was constructed as a CO₂ neutral building with a passive house quality building envelope and renewable energy supply.

In addition, more photovoltaic systems and combined heat and power units should be installed for making the Hamburg schools self-sufficient in power and heat. These measures are not only good for the environment but, with on-site power consumption, are also cost effective. The responsible authorities are currently developing a model for the efficient implementation of the construction, operation and funding of photovoltaic units and combined heat and power plants.

Besides the refurbishment and new building, the Senate attaches importance to optimising the operation of the heating system. This offers a major energy-saving potential which can be gradually increased by low investment measures, e.g. by optimising the heating controls, replacing thermostat valves, hydronic balancing or by training the janitor.

The fifty/fifty incentive system will be continued and optimised as an important component of energy management in Hamburg schools. Energy consumption can only be successfully reduced in the long-term by repeated motivation of the school management, teaching staff and pupils.

b) Vocational schools as PPPs

Description: The FHH is the sponsoring body of 47 vocational schools. The Senate established the project "Vocational Schools in Hamburg" ("HIBB tranche") as a public/private partnership for the refurbishment and new build of 15 vocational schools. The planning, new building, conversion, refurbishment, management and some of the funding for eighteen selected vocational schools at eight sites were commissioned via the Landesbetrieb Immobilienmanagement und Grundvermögen (LIG) as part of a PPP for a contract period of 30 years. The area put out to tender is divided into 65 individual buildings, comprising a floor area dedicated to schools of approx. 43,000 m² for new buildings, 3,000 m² for conversions and approx. 45,000 m² for buildings requiring refurbishment. The company HEOS Berufsschulen has taken on the maintenance of the school properties since 2012. Over a period of five years from the award of contract the schools will be refurbished according to a

priority plan and new buildings and conversions undertaken. The contracted construction volume in the period up to 2017 is around 300 million euros.

The refurbishment, conversion and new buildings for the currently 33 vocational schools supported by the responsible department which are not part of the HIBB tranche are being carried out on the basis and aims of schools for general education.

Aims: The aim is to run the buildings in a highly energy-efficient and economically reasonable manner. Under the PPP contract, new buildings must be constructed to the standard of a primary energy demand at least 30 per cent below and transmission heat loss at least 15 per cent below the EnEV 2009. Refurbishment measures must optimise energy-efficiency while retaining the building's character and in compliance with a specified minimum transmission heat saving related to the individual building above the requirements of EnEV 2014. For HEOS the basis is the EnEV 2009 minus 30 per cent.

Current status: The building work was begun at several sites in parallel at the end of 2012. As of 30 June 2015, new buildings with a net floor area of 34,489 m² have been completed and existing buildings with a net floor area of 26,548 m² have been refurbished in accordance with the contractual energy-efficiency standards. After further investigation of their economic efficiency, the existing buildings at two sites which were under contract to be refurbished were pulled down and replaced by high efficiency new buildings. After completion of the construction measures the overall energy demand was reduced.

All buildings for refurbishment are upgraded in terms of energy efficiency. The calculated contractually agreed savings measures for new buildings (30 per cent below EnEV 2009) and the specified transmission heat savings for refurbished buildings were met in full or exceeded by HEOS. In addition, the energy efficiency of the systems technology in existing buildings was optimised.

Besides the energy-efficiency upgrading of the buildings, a further lever for long-term resource conservation in buildings is the amount of land required. During the five-year building and refurbishment phase, the area in the HIBB tranche increased by around 50 per cent due to space requirements and the inclusion of additional schools in accordance with school development plans. This resulted in the positive effects such as a reduction in CO₂ emissions from the refurbishment and new buildings being at least partly offset by an increase in the school area and increasing pupil numbers during the project.

The energy-efficiency standards, redensification, optimising area and usage and giving up school sites take proper account of economic and environmental aspects.

c) Universities

Description: The Hamburg universities and the Hamburg State and University Library Carl von Ossietzky (Stabi) have an area of around 500,000 m² of usable space categories 1-6 according to DIN 277 in over 150 buildings or parts of buildings (excluding the Eppendorf University Hospital). Of this approx. 50 per cent was built between 1950 and 1980 while around 20 per cent of the building fabric is over 65 years old. The need for refurbishment and renewal is correspondingly high. As a basis for the refurbishment and modernisation plans and for new buildings, area and function programmes will be established for the

universities so that the available floor space can be optimised by making use of synergy effects.

The universities and the responsible authority are working on the implementation of the targets of the Hamburg Action Plan 2020/2030.

Current aims: Improvement of energy-efficiency standards in university buildings and a reduction of energy consumption by constructing new buildings and modernising existing buildings to reduce the refurbishment backlog. This will also enable the university to stop using the buildings in need of refurbishment. The main focus – even for smaller single measures – is on increasing the energy efficiency of building services.

The energy-efficiency standard used as a basis for all building measures by the responsible authority and the universities is generally the applicable EnEV.

Stakeholders and target groups: The stakeholders and target groups comprise those responsible for implementing the works, the universities and the Stabi. The universities act independently in the area of building and building maintenance in the case of measures with a volume below 1.5 million euros. For building measures with costs over 1.5 million euros the responsible authority is responsible. The measures can be implemented by the universities, if this is agreed between them and the responsible authority. Above a cost volume of 6 million euros, the projects are implemented as a rule in the tenant/landlord model by sponsoring companies.

Current status: In the concept currently being implemented for the University of Hamburg on the Bundesstrasse, parts in need of refurbishment can either be replaced by new building or they can be vacated for modernisation (cf. Senate document 20/3770).

The new building for the Geomatikum has an energy standard which goes beyond that in the EnEV: the area-based balance is presented in detail in the Senate document 20/11997. In the course of rebuilding the MIN Forum and Department of Informatics, the university site at Stellingen, which is very badly in need of refurbishment, will be given up entirely. This will reduce the modernisation requirement by about 14,000 m² of usable space 1-6. Following this the Geomatikum can be completely modernised and brought up to the state-of-the art in terms of energy efficiency, while its users will mainly move to the new building at the Geomatikum and the MIN Forum. At Hamburg University the internal modernisation of what is known as the Philosophenturm is currently being planned.

The Hamburg University of Applied Sciences is to have a replacement for the "Elektrohochhaus". The basic design is currently being produced.

The current refurbishment of the Trautwien building of the Hamburg Hochschule für Musik und Theater is focused on urgent energy-efficiency and safety-related measures, mainly involving the external envelope and the building services.

In addition to these large projects, the universities are undergoing numerous smaller modernisations and additions which make a contribution to lowering the energy demand by optimising energy use.

d) Police and fire stations

Description: Since 2008 – under the framework of the Climate Action Plan – the responsible authority has approved numerous measures for the energy-efficiency refurbishment of police and fire stations in the form of allocations to the HGV, and had these carried out by the IMPF Hamburgische Immobilien Management Gesellschaft mbH.

Aims: Energy efficiency refurbishment of buildings

Stakeholders and target groups: Responsible authorities, HGV, IMPF

Current status: Increasing attention is given to including climate change mitigation aspects in the ongoing measures required to maintain and protect the building fabric of rented property, especially police and fire/rescue stations, e.g. for the planning of maintenance measures and also for the choice of what materials to use. The provisions of the EnEV are taken into account in current building measures and energy-efficient systems are given preference when selecting technical systems.

It is ensured in particular that:

- The EnEV specifications are complied with for new buildings,
- For the refurbishment of façades, the current specification for insulation thicknesses are installed, as far as technically possible,
- Energy-efficient HVAC (heating, hot water, ventilation, etc.) are installed including intelligent building control systems,
- Use is made of ventilation systems with heat recovery,
- Depending on the level of refurbishment of the building or part thereof, specific energy characteristic values must be complied with upon completion of the works.

e) Rental from private providers

Description:

Many of the FHH's buildings are not owned by the FHH but rented. The Immobilien-Service-Zentrum der Sprinkenhof GmbH (Sprinkenhof GmbH property service centre) manages the building rental. The ISZ carries out tasks such as managing a tenant's rental contract along with the space requirements of all the ministries, offices, municipal enterprises and universities. The spaces are rented by third-party providers and municipal companies. The ISZ manages over 800 contracts covering a total area of approx. 1,500,000 m², including 280 contracts with approx. 810,000 m² office space. New rental contracts are based on areas defined by DIN 277-2. As part of the annual building controlling, building costs are currently being calculated for approx. 130 rentals, including the energy costs for heat and power. The aim is to extend the recording of energy costs to other rented property (without being involved in the building controlling).

Aim: Energy-efficiency framework data for rental contracts will be checked and updated if necessary with the cooperation of the responsible sectoral authorities. Recording and, in particular, evaluation of the energy-efficiency data need to be optimised. In future a greater emphasis will be placed on efficiency requirements when renting office space and as yet unspecified energy characteristic values will be adhered to as far as is cost effective for each individual case.

Stakeholders and target groups: Responsible authorities, municipal property companies such as GMH, Sprinkenhof GmbH (ISZ), HGV.

Current status: The responsible authority and the Immobilien-Service-Zentrum der Sprinkenhof GmbH are jointly agreeing the energy-efficiency framework data and characteristic values. The energy-efficiency framework data must be incorporated in the decision-making on property rental.

2.3.5.2 Modernisation of rented apartments funding programme

Description: Funding applies to the energy-efficiency modernisation of rented flats in rental housing with at least three rented living units, residential facilities for students, residential facilities for apprentices and residential facilities in accordance with Para. 2 Section 4 of the Hamburgisches Wohn- und Betreuungsqualitätsgesetz (Hamburg Law on Care and Living Quality) (Segment A), plus improvements to fixtures and fittings and complete modernisation of rented apartments in rental housing with at least three rented living units with increased grants, and rent and occupancy commitment (Segment B). The funding programme is managed by the Investitions- und Förderbank.

Aims: Stimulation of comprehensive energy-efficiency modernisation in rented flats with the aim of considerably reducing operating costs for tenants, reducing rent increases after modernisation and supporting the achievement of the Senate's climate change objectives.

Indicators: Number of energy-efficiency refurbished living units

Stakeholders and target groups: Housing developers and private owners.

Current status: The "Modernisation of rented flats" funding programme is an ongoing funding structure to support the achievement of the Senate's climate change objectives in the housing sector. The current technical requirements and funding conditions can be accessed at www.ifbhh.de. In 2014 the programme figures of 3,000 living units in programme segment A and 600 in segment B were not quite achieved in A (with 2,472) but exceeded in B (with 800). 91 per cent of the planned programme funds were used up due to the higher costs in programme segment B.

2.3.5.3 Database for CO₂ savings in public buildings

Description: In 2013 the Senate gave the responsible authorities the task of compiling a database for new build and refurbishment measures in terms of CO₂ emissions for public buildings. The responsible authorities and public bodies are to report in electronic form on the new build and refurbishment measures for the public buildings under their jurisdiction.

Aims: Recording the reduction in CO₂ emissions achieved in public buildings through appropriate new build and refurbishment measures. Optimising existing data collection and its evaluation.

Indicators: Reductions achieved in CO₂ emissions

Stakeholders and target groups: Responsible authorities and units assigned for property management.

Current status: For the public buildings recorded in this project a distinction must be drawn between the FHH's stock of property and rented property managed by the Immobilien-Service-Zentrum Sprinkenhof GmbH. A large proportion of public buildings is not owned by FHH but rented. It is therefore even harder to collect data and have an influence on energy-efficiency criteria in the rented property than it is for property owned by FHH.

In the case of public buildings owned by the FHH, sub-projects were set up with a focus on schools, vocational schools and universities.

Sprinkenhof GmbH manages approx. 800 rental contracts (of which approx. 280 are for the use of offices) and regularly produces building controlling reports for some of the rented properties. These reports also contain information on the energy demand of the rented property, if this is available. However, the data are incomplete and no further evaluation is carried out.

In order to obtain the data from the Senate's assignment, a methodical approach was initially followed of recording the forecast data of anticipated reductions in CO₂ emissions for new build and larger refurbishment measures on public buildings, in order to get an overview of the possible CO₂ reductions to be reached by 2020. Many of the authorities concerned believe the forecasts to be too imprecise and the procedure too complicated. The computational prediction does not reflect changes to the framework conditions such as e.g. higher area requirements, rising demands for teaching technology and higher pupil numbers. It also became clear that the reported energy consumption figures sometimes related to differing area bases. Suitably reliable data collection would therefore be very expensive.

Due to experiences from the analysis of the existing stock, the Senate initially focused on uniform conditions for recording data relevant to energy consumption from individual buildings and groups of buildings. It is considered that annual submission of the data, the data quality, further development of existing databases and evaluations are important. Building on this it should be possible to assess the CO₂ reduction actually achieved and also to identify the need for action to increase energy efficiency for individual public buildings.

The Senate will further optimise the general conditions for data collection and evaluation, in particular, data on buildings and types of use need to be systematically combined. In addition, a data catalogue will be developed with requirements for the data collection and calculation. This depends on the availability of the energy consumption-related data, particularly usable area and type of building including changes to the building stock.

The aim is to have a central record of the annual energy consumptions and CO₂ emissions of the municipal and rented public buildings in the responsible authority areas and from Sprinkenhof GmbH. There is a need for optimisation of data collection from individual buildings, their supply and evaluation.

Furthermore, key energy-efficiency criteria need to be defined for the refurbishment of public buildings owned by the city.

2.4 Mobility

2.4.1 Aims

Transport accounts for a 24 per cent share of final energy consumption and Hamburg CO₂ emissions (Statistikamt Nord 2013). In order for transport to make an appropriate contribution to the climate change mitigation and energy saving targets despite increasing volume, the Senate supports the significant potential in the mobility action area by using more efficient new technologies, implementing innovative intermodal provisions targeted at changing mobility behaviour and changing the modal split. The Senate supports a change in the framework conditions in favour of sustainable climate friendly mobility in all transport sectors.

Traffic volume, energy consumption and the fuels and vehicles used have an important effect on the greenhouse gas emissions in this action area. Based on the outline regulations currently in force and those which might be expected e.g. under European and national law, the Senate is pursuing the following aims to reduce mobility-related emissions:

1. Encouraging environmentally friendly modes of transport,
2. Systematic integration of renewable energies and intelligent transport technology in all transport sectors plus making use of the potential of more efficient, innovative drive technologies and energy sources in all transport sectors,
3. Increasing the proportion of passenger cars with low emission drives such as hybrids or plug-in hybrids to 10 per cent of new registrations by 2020 and 30 per cent by 2030. Increasing the proportion of vehicles with zero emission drives (battery, fuel cells) to 5 per cent of new registrations per year by 2020 and 25 per cent per year by 2030, provided that national funding continues.
4. Optimising the planning outline regulations and instruments for implementing climate friendly mobility in neighbourhood plans such as e.g. town planning policies.

2.4.2 Indicators

Change to the modal split in favour of more environmentally friendly modes of transport and the proportion of annual mileage by vehicles with low emission or zero emission drives.

2.4.3 Measures

To achieve the specified targets the Senate is adopting the following measures:

a) Encouraging environmentally friendly modes of transport

- Developing Hamburg into a cycling city, particularly by improving the infrastructure, expanding the StadtRAD-System (city bikes) and Bike+Ride facilities. Increasing the bicycle proportion of total traffic to 25 per cent by the 2020s.
- Supporting the local public transport system to increase environmentally friendly low emission mobility behaviour e.g. a bus priority programme, expansion of the rapid transit railway lines U4 and S4, optimising accessibility to the U and S stations, constructing mobility service points.

- Increasing the adoption of intermodal networking structures by expanding the infrastructure to link up different forms and provision of mobility, taking account of the necessary economic and policy framework for the specific business and operating models e.g. further development of mobility service points such as "switchh" by expanding the provision at all larger rapid transit stops close to the inner city, expansion of StadtRAD (city bike) and a flexible and locally-based car sharing scheme.
- Optimising the use of waterways between Finkenwerder and Landungsbrücken and in the HafenCity as efficient transport routes for freight and the local public transport system.
- Optimising the parking provision for CarSharing vehicles within the city with priority for electric vehicles.

b) Systematic links

- Developing strategies for efficient low-emission or zero-emission commercial transport, developing intelligent transport networks and expanding intelligent transport systems for inland shipping.
- Further development of the efficient traffic management system linked to modern information and communication technologies (ICT) into an intelligent transport system (ITS), e.g. as a "learning system" linked to the specific traffic volume, weather and/or time of day.
- Supporting business mobility management to fund climate friendly clean mobility.
- Reducing CO₂ emissions from shipping by using onshore power and low-emission energy carriers such as LNG (liquid natural gas) or methanol and the expansion of the necessary supply infrastructure for seagoing vessels. Using state-of-the-art exhaust filter systems for ferries and a gradual conversion to (partially) electrical drives (hybrid, battery, fuel cells).

c) Increasing the proportion of electrically operated passenger cars

- Increasing the overall proportion of vehicles with electrical drives by taking account of different technologies and energy carriers (vehicles running on batteries alone, fuel cell vehicles and plug-in hybrid electric vehicles) by e.g.
- increasing the proportion of electrically driven passenger cars (as defined by the FHH's Guideline for the Procurement of Vehicles with low CO₂ and pollutant emissions) in the FHH's vehicle fleet to 50 per cent by 2020. Current exemptions to this are emergency vehicles belonging to the police, fire brigade and the State Office for Protection of the Constitution, as long as there are still no electric vehicles tested for their technical suitability for these particular official requirements available on the market.
- The Senate will work towards increasing the proportion of electrically operated passenger vehicles and light commercial vehicles (<3,500 kg) in public companies with a vehicle pool, from the current level of 17% to 35% by 2020 as far as economically

feasible, and towards increasing the proportion of public companies with a vehicle pool which use electrically powered vehicles from the current approx. 36% to at least 50%.

- Staged integration of low-emission drives in taxi fleets in Hamburg plus the gradual electrification of the provision in complementary mobility (switchh),
- Further electrification of commercial transport in cooperation with the Chambers of Commerce and Crafts and Trades.
- Expanding publicly accessible fast-charging stations for electric vehicles and the existing hydrogen infrastructure.

d) Optimised planning framework specifications and instruments

- Expanding and implementing neighbourhood plans (existing stock and new build) in order to systematically integrate mobility concepts with elements such as the reduced use of passenger vehicles, a high proportion of intermodal mobility provision, infrastructure for the common use of electric vehicles, car sharing, local public transport systems and a policy for parked vehicles (car park management, multifunctional space use, secure parking options for bicycles and cargo bikes, etc.).

Note: battery power and fuel cell drives are considered to be zero emission if the electricity used comes from renewable sources or the hydrogen in the fuel cell is from renewable energies.

Further information, particularly on the targets and measures, is contained in the transport development plan currently being drawn up. Attention is also drawn to the Mobility Programme 2013 (Senate document 20/9376).

2.4.4 Evaluating stakeholder workshops

Suggestions from the stakeholder workshops included the following

- Facilitate climate friendly mobility by increasing the capacity of local public transport,
- Develop logistics concepts for commercial traffic in the city,
- Move road traffic onto other modes of transport,
- Reduce CO₂ emissions in the mobility sector by means of a company mobility management strategy with incentives for staff,
- A greater focus on neighbourhoods, developing cross-sectoral concepts for promoting low-emission local mobility at this level, e.g. with integrative car-sharing schemes in cooperation with the housing sector, more bicycle storage space, etc.,
- Develop a mobility footprint (specific footprint per person and product) as a monitoring tool.

Most of these points are being implemented by the Senate by means of the measures listed in the action area.

2.4.5 Key projects

2.4.5.1 Developing Hamburg into a cycling city

Description: The "Cycling strategy for Hamburg" (Senate document 18/7662) has formed a systematic basis for promoting cycling in Hamburg since 2008. Other incentives to boost funding for cycling have and are being made by various civic campaigns for cycle transport and by the annual cycle workshop run by the First Mayor. The Senate has set itself the goal of developing Hamburg into a cycling city and of increasing the proportion of cycling traffic in the modal split to 25 per cent by the 2020s. Progress is documented at regular intervals – most recently in the "2015 progress report". According to the cycle traffic strategy, the activities for promoting bike transport cover nine action areas: good routes for cycle traffic, good parking provision for bicycles, better links between cycling and public transport, environmentally aware mobility behaviour and better traffic safety, public relations work for a better cycling environment, exploiting the potential for cycling tourism, more bicycle-related services, structures for implementation, quality assurance and progress monitoring. All these activities should contribute to creating a "welcoming environment" for cyclists. A cycling coordinator has been appointed to the responsible authority in order to coordinate the Senate's objectives.

Aim: The proportion of bicycle transport should be increased to 25 per cent by the mid 2020s.

Indicators: The proportion of cycling in the modal split (survey every 6-8 years), number of established kilometres of cycle paths.

Stakeholders: Sectoral ministries, districts, Landesbetrieb für Straßen, Brücken und Gewässer (State Agency for Roads, Bridges and Waters of the city of Hamburg), Park+Ride GmbH, DB Rent GmbH

Target groups: Members of the public

Current status: In 2008, the last year of the "Mobility in Germany" study, the proportion of cycle traffic was approx. 12 per cent. Approx. 80 km of the 280 km cycle route network was completed by the end of 2014. The new pedestrian and cycleway along Oberhafen / Grossmarkt and the LOOP Wilhelmsburg are infrastructure projects which also send a positive signal. In addition, a start has been made to increasing capacity by expanding the Alster cycling axis. In 2014 the extremely successful public bike rental system StadtRAD Hamburg reached another hire record of over 2.4 million trips and will be expanded to over 200 stations by the end of 2015.

2.4.5.2 Company mobility management

Description: In order to improve air quality, in September 2012 the responsible authority and Hamburg businesses, represented by the Hamburg Chamber of Commerce and the Chamber of Crafts and Trades, agreed a partnership for air quality and low-emission mobility. The partnership raises awareness of the topic of low-emission company mobility and gives advice on the implementation of practical measures in the areas of vehicle fleets, business travel and staff mobility. This includes the provision of information on company mobility management, the communication of best practice examples and the development of a network for companies to share their experiences. When they join, companies make a

commitment to reducing transport-related emissions in our city. The agreement runs until 31.12.2015 and will hopefully be extended.

Aims: Promotion of company mobility management and emission reduction by voluntary clean air measures by the initial partners and partner companies.

Indicators: Number of participating companies

Stakeholders: Ministries, Chamber of Commerce, Chamber of Crafts and Trades and companies.

Target groups: Companies

Current status: There are 175 companies taking part in the air quality partnership (as at 10.07.2015). Running six member forums and two action weeks in which, in 2014, 18 companies and initial partners brought the topic of low-emission mobility to the attention of their 12,000 staff, plus publications, advice and events such as the annual award for "air quality partner of the year". The Chamber of Commerce's procurement initiative "Hamburg gets e-mobile" and the advisory project Mobil.Pro.Fit were also set up.

2.4.5.3 Electromobility

Description: The German Federal Government's Action Programme on Climate Protection 2020 aims to increase the market share of electric vehicles to one million by 2020 and six million by 2030.

In 2009 Hamburg was selected as one of eight "Model Regions for Electromobility" and received corresponding funding from the German national Government's Economic Stimulus Package II. The aim was to install a charging infrastructure in public places and the practical testing of electrically driven road vehicles, especially those in vehicle fleets. The electricity for charging electric vehicles in public places comes solely from renewable sources. The first project phase of the model region programme financed by the national Government was completed at the end of 2011. The Federal programme continues in a second project phase which started in September 2012 and will probably run until mid-2017. All the projects in Hamburg financed by the Federal Ministry of Transport and Digital Infrastructure (BMVI) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) are currently under implementation. The Senate has created the legal and procedural conditions in many areas to promote the expansion of electromobility with clearly targeted measures, e.g. in the procurement of municipal vehicles, in the allocation of land, in planning law and by creating a charging infrastructure.

On 29th September 2015 the city amended the parking fee regulations, thus being the first city in Germany to make use of the authorisation which came into force on 26th September 2015 to implement free parking for designated electric vehicles. This creates an additional incentive for increased use of electrically powered vehicles.

A key condition for increasing the use of electric vehicles is the "Charging Infrastructure Master Plan", which aims to expand the number of public charging points to 600 by 2016. There are currently four hydrogen filling stations for fuel cell vehicles and another will probably be built by the end of 2015.

The Hamburg Chamber of Commerce and the Chamber of Crafts and Trades are actively pursuing contact with and involvement of potential users of electric vehicles amongst their

member companies in order to achieve high target numbers when changing the existing stock of vehicles to electric drives.

In addition, since 01.01.2014, an amended General Vehicle Regulation has been in force containing a guideline for procuring vehicles with low CO₂ and low pollutant emissions for the FHH vehicle fleets with a preference for electric vehicles.

The introduction of electrically driven vehicles does not reduce the volume of motorised traffic, but produces a continuing reduction in emissions.

Aims: 3,000 battery-powered vehicles by 2017 in Hamburg (meaning electric vehicles, plug-in hybrids and fuel cell vehicles). Long-term reduction in emissions by using low-emission vehicles.

Indicators: Number of battery-powered vehicles and number of kilometres of driving replaced per year.

Stakeholders: hySOLUTIONS, responsible authorities, Chamber of Commerce, Chamber of Crafts and Trades, public and private companies.

Target groups: Fleet operators such as the elevated railway, ministries, taxis, bus companies, companies, tradesmen

Current status:

In order to achieve the best possible success in reducing emissions, the various initiatives and projects are aimed primarily at fleet vehicles, as these are generally responsible for a higher mileage. In addition, the normal daily mileage in this segment can usually be covered by the comparatively limited range of electric vehicles. Vehicle fleets will continue to be targeted in future, although more attention should be given to vehicles used for considerably higher mileages such as taxis. Fuel cell vehicles using hydrogen as the energy carrier – which are characterised by being able to do up to 500 km on one fuelling process – will be added.

Federal Government funding projects such as "Hamburg – Wirtschaft am Strom" (Hamburg – business powered by electricity) and "E-Powered Fleets" support the integration of electric vehicles in Hamburg region's fleets. The "eQuartier Hamburg" project, on the other hand, is aimed primarily at private households which share the use of electric vehicles in neighbourhood vehicle pools. This project should reach up to 2,000 users at up to ten sites selected on town planning criteria amongst other things.

As at October 2015, there are already over 1,750 electric vehicles in use in Hamburg and the metropolitan region, of which 900 vehicles are in the projects "Hamburg – Wirtschaft am Strom" and "E-Powered Fleets" plus 440 vehicles funded by local authorities.

The number of publicly accessible charging points will be gradually increased. In the first expansion phase up to the end of 2015, the 140 existing publicly accessible charging points in the city of Hamburg are being supplemented by 27 sites (54 charging points) currently under construction and a further 18 sites are being planned with the districts.

2.4.5.4 Bus transport switch to zero-emission drives

Description: Public service buses run by HOCHBAHN and other bus transport companies make a contribution to reducing emissions which are harmful to the environment compared

to the use of passenger vehicles. However, the use of internal combustion engines run on diesel inevitably results in the production of carbon dioxide. In view of this the Senate has decided that, from 2020, only zero emission public service buses will be procured. In order to evaluate which drive technology (hybrid, plug-in hybrid, battery, fuel cell, battery bus with fuel cell as a range extender) can meet the operational, technical and economic requirements, a range of buses will be tested in full operation on what is known as the innovation line 109 (ZOB Hauptbahnhof, U-Alsterdorf) and evaluated according to uniform criteria. Besides the completely electric (and therefore locally zero emission) electric buses, hybrid buses are used as a bridging technology.

Aims: From 2020 only zero-emission buses will be procured. The energy carrier used (electricity, hydrogen) should come from renewable sources as far as possible.

Indicators: CO₂ emissions per vehicle, annual reduction of at least 7 per cent

Stakeholders: HOCHBAHN, Verkehrsbetriebe Hamburg-Holstein AG (VHH), ministries

Target groups: Transport companies, passengers

Current status: Since April 2015 the bus drives considered by HOCHBAHN as suitable have been tested on the innovation line 109. Deployment of three battery-driven buses by VHH is planned on the Metro bus route no. 3 from 2016.

2.5 Economy

2.5.1 Economy – general

Around 51 per cent of total CO₂ emissions in Hamburg are caused by industry, commerce, trade and services (Verursacherbilanz 2013, Statistikamt Nord). The economic sector therefore has a key part to play in the Climate Plan by rapidly implementing real measurable steps for a reduction in CO₂, often of a considerable order of magnitude. The worldwide decline in the availability of natural resources, adaptation to climate change, the global responsibility for climate change mitigation and the reduction of CO₂ emissions require a constant increase in energy and resource efficiency in economic activity. In addition, commercial viability must be guaranteed, for example by safeguarding the city infrastructure by adapting it to climate change. While the "Green Economy" cluster looks at the aims of climate friendly business in general, the economy action area identifies specific aims for individual economic sectors and key projects.

In the economy action area the elements of climate change mitigation and adaptation to climate change generally work side by side. In terms of adaptation to climate change it is primarily the large public companies for infrastructure and public services which guarantee the basis for Hamburg's economy, even under changing climatic conditions (see infrastructure action area).

Up until now the sectors which have taken the biggest steps in adapting to climate change are the port industries, agriculture and horticulture and the forestry and timber industries. These sectors will therefore be presented separately.

2.5.1.1 Aims

Important aims of climate change mitigation are saving energy, increasing energy efficiency, using resources more efficiently, reducing CO₂ emissions and at the same time reducing operating costs. Climate change mitigation measures can also create a better image and boost sales. With regard to climate change, companies need to protect themselves and their staff from personal injury and material damage on the one hand, and adapt production and processes to the changed conditions on the other, so that the business location of Hamburg can cope with climate change without being weakened but – in the best-case scenario - actually strengthened.

2.5.1.2 Indicators

Climate change mitigation: CO₂ reduction, percentage increase in efficiency, percentage renewable energies, resource savings

2.5.1.3 Measures

In order to be able to achieve these aims, Hamburg companies will be supported by the expansion and possible reorientation of the established communication structures, by know-how networks aimed at the target groups and by advisory services. Barriers to investment will be reduced by financial incentives and advisory services. Adaptation measures will be recognised as environmental performance under the Hamburg Environmental Partnership.

2.5.1.4 Evaluating stakeholder workshops

The stakeholders suggested making further improvements to energy efficiency in companies and setting up an energy efficiency network in Hamburg accordingly. In addition, associations and chambers should cooperate better.

The stakeholder event for adaptation to climate change showed that the commercial sector in particular is still unaware of its own vulnerability from climate change, so that almost no measures have been taken for adapting to climate change. The public infrastructure companies and public services are a positive exception to this.

2.5.2 Port industries

The North German maritime industry is of major importance to the whole economy. 95 per cent of the intercontinental trade in goods takes place by sea. The global division of labour and the international freight transport are still increasing. In addition, shipping and ports are steadily growing markets. The Port of Hamburg is the leading German logistics centre and one of the largest contiguous industrial areas in Germany and Northern Europe. As a major energy consumer, the port and the industrial companies based there can make a significant contribution to the energy transition.

With the rise in sea level, further increases in the tidal range and the predicted lower water volumes from upstream in summer, sediment transport upstream is expected to rise, with a resulting increase in dredged volumes. This could threaten the existence of the Hamburg ports. Silting up of the shallow water areas between the mouth of the Elbe and Hamburg also enhances this effect. The increased sedimentation rate in the navigation channels and the harbour basin will also need to be taken into account in future.

2.5.2.1 Aims

Aims for adapting to climate change:

- Guarantee the seaward access to the Port of Hamburg
- Accessibility via inland waterways
- Guarantee the landward access to the Port of Hamburg

Climate change objectives:

- Develop innovative technologies for energy generation from renewable energy sources
- Increase energy efficiency
- Develop innovative mobility concepts

2.5.2.2 Indicators for climate change

- Tidal conditions: mean high tide, mean low tide, mean tidal range
- Number and intensity of storm surges
- Number of locking tides

For indicators for climate change mitigation see the SmartPort key project.

2.5.2.3 Measures

Measures to deal with this include sediment management and the maintenance and creation of areas of shallow water around Hamburg or nearby downstream from Hamburg. This is intended to effectively damp down the tidal processes and guarantee the long-term maintenance of the waterways under economic conditions. At the same time it will counteract the further silting-up of the adjacent areas. These measures can effectively counteract the anticipated effects of climate change in order to maintain the Elbe as a vital line of communication for the metropolitan region of Hamburg in the long term.

2.5.3 Agriculture and horticulture

Agriculture and horticulture are significantly affected in a variety of ways by the changes taking place in the climate. They therefore need to get ready for the effects of climate change or adapt as much as possible through suitable measures. However, it is impossible to predict which of the climate scenarios currently predicted will actually happen. This causes uncertainty and causes economic risks in taking appropriate measures.

The annual national greenhouse gas emissions from agriculture (without LULUCF = Land Use, Land-Use Change and Forestry) constitute a 7.1 per cent share of the total greenhouse gas emissions in Germany (2010). In contrast, the contribution of agricultural and horticultural emissions in Hamburg is insignificant. The reasons for this include the small area involved and the mainly extensive forms of cultivation in agriculture and horticulture thanks

to the ditch system, the very low density of cattle, the high proportion of low-input speciality crops and the high proportion of extensively-managed areas. In terms of an overall view, the climate impact achieved by CO₂ capture by the plants and trees – the positive effects e.g. from roof greening, interior plant design, green spaces, parks, etc. – should not be ignored.

The need for adaptation and action varies depending on the different agriculture and horticulture sectors:

There will be a particular need for adaptation in the agricultural sector due to changes in rainfall distribution and rises in temperature, linked to changes in the start and end of the growing season. The opportunities provided by a potential increase in the growing period and for cultivating new species are offset by the risks presented by changes in attacks by weeds, pests and diseases and possible damage caused by extreme weather events (e.g. hailstorms, heavy rainfall events) which have to be dealt with. Adaptations are also required in crop growing and animal husbandry (coping with heat stress).

Seasons may arrive early for some branches of horticulture which could result in increased yields for some crops. An increase in the populations of pests and pathogens is also to be expected, plus damage from hail, storms and heat and water shortages. Moreover, there will be changes in the species and varieties suitable for cultivation. Fruit growing will experience a trend towards decreased damage from late frosts and increased pest stress on fruit trees due to the above-mentioned populations. In the tree nursery sector the demands on street trees and landscaping shrubs will change significantly due to climate change. Due to the long lead times, tree nurseries have to adapt their product range now – despite the lack of clarity over the climate scenarios which may arise. This amounts to a very high degree of uncertainty and a high commercial risk compared to the other sectors. In the ornamental plant-growing sector it may be assumed that the risk of damage to greenhouses and the pressure from populations of pests and diseases are likely to increase considerably.

2.5.3.1 Aims

In Hamburg with its sectors in ornamental plant, tree nursery and fruit and vegetable growing, the aim of adaptation in agriculture and horticulture is to maintain the regional production even in the face of changing climatic conditions and to do this in line with the aims of the Agricultural Policy.

2.5.3.2 Indicators

- Irrigation in agriculture
- Growing period

Other potential indicators

- Temperature profile
- Distribution of precipitation
- Extreme weather events
- Changes in attacks by populations of pests and diseases
- Weeds

- Choice of species and varieties
- Growing methods

2.5.3.3 Measures

The necessity of adapting to climate change in the agricultural industry is generally recognised as a challenge and has been taken up by politicians, administrators and scientists. While focusing on Hamburg, developments in northern Germany and at national level should not be ignored. For example, at national and regional level research is underway in the Federal Research Centres and agricultural departments; a start has already been made by the agricultural advisory services to put results into practice and a suitable administrative framework is being set up.

In Hamburg climatic elements are already an established component of various measures in the "Agricultural policy 2020". Under the Senate's agricultural support policy, companies are putting measures in place which include an integrated "climate relevance" indicator.

Moreover, within the scope of their powers, the Landwirtschaftskammer Hamburg (Hamburg Chamber of Agriculture) and the Kompetenzzentrum Pflanzenschutz (competence centre for plant protection) provide support to farmers and gardeners in adapting to climate change. Mention can be made of such topics as the selection of varieties and growing methods for "minimising stress and susceptibility in plants". Research at the Hamburg Plant Protection Service in the fields of biological control and reliable diagnosis contributes to controlling the effects of climate change and to the sustainable development of rural areas.

There is also close cooperation with the ESTEBURG Fruit-Growing Centre Jork, the north German competence centre for horticulture and the Chambers of Agriculture for Schleswig-Holstein and Lower Saxony. The now completed research project KLIMZUG-NORD carried out detailed research on new pests on apples and apple trees. There is a need for further research in fruit-growing. KLIMZUG-NORD also drew attention to the need for research in the other sectors of horticulture, for ornamental plants, vegetable growing and the tree nursery industry.

The development process of the "Sustainability strategy for productive horticulture in Hamburg" will also produce practical measures for dealing with the adaptation requirements in the horticulture sector. Results are expected in the first quarter of 2016.

It is already clear that besides adaptation measures in agricultural enterprises (choice of varieties, growing methods: irrigation, plant protection, equipment, agricultural buildings, etc.) there is a need for research and special advisory skills to put this into practice. Lasting success can only be achieved if the institutions and companies involved work alongside administrative and government authorities across disciplines and departments. Consumer advice will also become increasingly important here.

2.5.4 Forestry and timber industries

Climate changes mainly pose risks and present new operational requirements for forest management. Forests are complex, long-lived and stable ecosystems with largely natural structures. Forest trees and the woodland ecosystems connected to them are only able to

cope to a limited degree with comparatively rapid, significant climatic changes occurring within a few decades, not least due to their site requirements and long lifecycle. A key effect of climate change on forests and forest management is the modification of the site conditions and therefore the suitability of and risks to various species of trees and forest communities or stand types. The climatic changes which have already occurred and are predicted for the future pose major environmental, economic and social challenges for forest management which also affect Hamburg.

2.5.4.1 Aims

- Promote stable forest ecosystems
- Maintain forested areas
- Safeguard the recreational and protective functions of woodlands

2.5.4.2 Indicators

- Forests managed as semi-natural woodland in Hamburg
- General climate change indicators such as frost days, number of tropical nights, amount and distribution of precipitation

2.5.4.3 Measures

As an appropriate response to the anticipated climatic changes, semi-natural forestry must be developed further, thus promoting the conversion to tree species suited to the site. The primary aim of silvicultural operations must be the long-term conservation of well-adapted woodland ecosystems. This requires

- An improvement of the forest water regime,
- Active management of woodland edges and
- Adaptation of silvicultural methods.

The existing forested areas in Hamburg must be preserved at all costs, not least for their positive effect on the urban climate. Unavoidable exploitation must be made good by compensatory measures. These measures are to be implemented in the course of routine forest management. Their effectiveness and new approaches must be assessed with every periodic forest management plan, re-evaluated and adapted for the subsequent planning period if necessary. For example, stable, multi-layered structures should be created using suitable mixtures of tree species and, most importantly, by early silvicultural intervention.

2.5.5 Key projects

2.5.5.1 Eco-Partnership Hamburg

Description: The Hamburg programmes and action plans on corporate climate change mitigation are packaged in the Hamburg Eco-Partnership (2013-2018). The Hamburg Eco-Partnership (UPHH) is an alliance of the Senate and Hamburg businesses to support sustainable business management by Hamburg companies. One key area is support for voluntary climate and environmental mitigation in Hamburg companies, the other is close cooperation between environmental authorities and the business community. The most

important topics in the new working programme up to 2018 include environment and energy management, on-site advice for businesses by the Chamber of Commerce and Chamber of Crafts and Trades and a modern management system for service and execution, besides the energy transition, raw material efficiency / recycling industry and air pollution control. These topics have been worked out in detail in terms of the performance in respect of adaptation to climate change.

Aims: To reach 900 to 1,200 eco-partners.

Every eco-partner needs to have performed at least one new approved voluntary environmental service in order to extend their eco-partner status for another five years.

Eco-partners should undertake an average of three services between 2008 and 2018.

Indicators: Number of eco-partners, number of services performed, CO₂ savings, resource savings

Stakeholders: Responsible authorities, Chambers, associations, public and private companies

Target groups: Public and private companies

Current status: As at mid 2015 there were 1,010 eco-partners.

Some of the UPHH good practice measures are described below.

a. Voluntary commitment by industry

Description: Voluntary commitments enable companies to decide for themselves which measures will achieve climate change mitigation targets most successfully. Under the voluntary commitment agreed in March 2013 to implement company CO₂ reductions from 2013-2018, fifteen large industrial companies in Hamburg committed to reducing their energy consumption through additional investment in production equipment and production processes. This continues and expands the voluntary commitment begun in 2007 under which eleven Hamburg companies have already reduced CO₂ emissions by over 500,000 tonnes per year from 2012. Voluntary commitment enables companies to make an active contribution to climate change mitigation. They are thus acknowledging their responsibility for protecting the natural environment and at the same time the future of the business and employment centre of Hamburg. The following companies have signed up to the voluntary commitment: ADM Hamburg AG, ArcelorMittal Hamburg GmbH, Aurubis AG, Daimler AG Mercedes-Benz Werk Hamburg, Deutsches Elektronen-Synchrotron DESY, H & R Ölwerke Schindler GmbH, HHLA Hamburger Hafen- und Logistik AG, HOLBORN Europa Raffinerie GmbH, Hydro Aluminium Rolled Products GmbH, INDAVER Deutschland GmbH, Ingredion Germany GmbH, Lufthansa Technik AG, SASOL Wax GmbH, Stadtreinigung Hamburg AöR and TRIMET ALUMINIUM AG.

Aims: A reduction in CO₂ emissions of at least a further 150,000 tonnes from the end of 2018.

Indicators: CO₂ reduction achieved per year.

Stakeholders: Responsible authorities, companies, IFB, Chamber of Commerce, Industrieverband Hamburg

Target groups: Industrial companies

Current status: The companies had already reached 99,516 tonnes of CO₂ emissions by the end of 2014 through various measures to increase energy efficiency. There has been a reduction of 87,989 tonnes of CO₂, not counting measures supported by the funding programme Companies for Resource Protection and electric vehicles funded and counted under "Hamburg – business powered by electricity". The city cleansing company Hamburg AöR is implementing part of the recycling offensive with its services (see Chapter C.IV.2.6.4.2).

b. Funding programme Companies for Resource Protection

Description: The Companies for Resource Protection (UfR) programme has been run by the Free and Hanseatic City of Hamburg since 2001 in order to systematically develop the resource-saving potential for energy, water and raw materials in Hamburg's industrial establishments. A programme is being implemented in close cooperation with the umbrella organisations of the Hamburg business community which reaches a large number of companies – from small and medium-sized companies all the way to industrial concerns – by lowering the existing investment barriers to energy efficiency measures. In order to initiate voluntary investment in resource efficiency and climate change mitigation measures which exceed the statutory provisions, the IFB acts as a one-stop provider of a combination of offers: on-site advice, support for project implementation all the way to completion, provision of technical experts and financial support. Information networks are run for the companies with cooperation partners from the sectors of business, technology and science, and public information events, special workshops and technical seminars are provided.

To date around 2,500 companies have taken up the programme's provisions and voluntarily invested around 348 million euros in resource efficiency measures. This avoids around 281,600 tonnes of carbon dioxide per year.

Aims: Up to a further 178,000 tonnes of CO₂ reductions per annum could be achieved by 2020, depending on the annual funding available.

Indicators: CO₂ reduction, voluntary investment in resource protection

Stakeholders: Responsible authority, industrial, commercial and service industries and tradesmen plus institutions with comparable objectives, IFB. Close contact to the target group is ensured by cooperation with 24 partners from business, science and technology such as Hamburg Chamber of Commerce, Hamburg Chamber of Crafts and Trades, Industrieverband Hamburg, the housing sector, trade guilds, trade associations, universities, Unternehmensverband Hafen Hamburg and engineering associations.

Target groups: Industrial, commercial and service industries and trades plus institutions with comparable objectives

Current status: The entire UfR programme and its sub-programmes have been managed by the IFB since 01.01.2014. The programme could not be executed to its former extent in 2013 and 2014 due implementing the transfer. By the end of August 2015 more projects had been initiated and supported by the IFB than in the entire previous year. It can be assumed that the programme will run normally again in future.

c. Funding programme Resource Efficiency Eco Innovation

Description: Support for companies which produce particularly innovative projects aimed at new or significantly improved products, processes and services, therefore contributing to savings in resources and emissions. The programme focuses primarily on projects which lead to marketable products or where the manufacturing process, product utilisation and/or the subsequent recycling are particularly resource-efficient (product-integrated environmental protection).

Aim: The main aim of the R&D funding programme is to save resources (raw materials and energy) and avoid environmentally damaging emissions both through innovative development and through improvements to products, processes and services.

Indicators: Savings in CO₂ and materials, implemented measures

Stakeholders: Responsible authorities, IFB, public and private companies, universities and associations

Target groups: Public and private companies

Status: Two applications were approved between July 2014 and July 2015 with a forecast reduction in CO₂ of approx. 29,000 t/a. It should be noted that by marketing large numbers of these optimised solutions, the amount of potential savings in emissions increases exponentially.

d. On-site business advice from the chambers of commerce

Description: The on-site free advisory visits by the "HK-Energie-Lotsen" Chamber of Commerce and the "ZEWUmobil" Chamber of Crafts and Trades were established in order to make the first contact with companies and identify suitable proposals. Their main target groups are small and medium-sized enterprises (SMEs). The benefit of approaching companies through the Chambers of Commerce is their neutrality and high level of acceptance as representing all the interests of the Hamburg business community. This also makes use of the varied avenues for approaching the member companies.

The on-site advice from the HK-Energie-Losten and ZEWUmobil provides an initial introductory advisory service, develops potential for improving energy efficiency and environmental protection and is also an important instrument for raising the performance and competitive capacity of the companies. The on-site advisory service aims to demonstrate possible economic approaches linked to a careful and efficient use of energy and resources.

As a further action area, trades businesses are also made aware of the new requirements for using resources carefully in order to meet rising customer demands and open up future markets. The range of advice covers energy efficiency, material efficiency, climate change mitigation, electromobility, support programmes, environmentally-friendly product design and biodiversity and provides an exchange of specialist information.

Aims: To win over companies who had not previously done anything in this area for activities in climate change mitigation and environmental protection. The aim is to make around 200 company visits every year and win over the largest possible number for implementing measures to increase energy and resource efficiency.

Indicators: Number of advisory sessions, subsequent measures put in place

Stakeholders: Responsible authorities, Chamber of Commerce, Chamber of Crafts and Trades, IFB, public and private companies

Target groups: Trades businesses, public and private companies

Current status: Up to 31.12.2014 HK-Energie-Lotsen from the Chamber of Commerce and ZEWU mobil from the Chamber of Crafts and Trades had made 3,300 on-site advisory visits.

2.5.5.2 Companies in the energy transition

Description: Large cities like Hamburg are consumption centres for electricity while electricity production from renewable sources is increasingly moving to rural or coastal regions with low population densities and low energy consumption. In order to make an effective input to the energy transition, Hamburg is therefore directing its activities towards solutions for the increased integration of renewable energies which large cities in particular can contribute due to their energy demand structure. A significant contribution to achieving a climate neutral supply and use of energy consists in changing from the current demand-oriented energy generation to a supply-oriented energy utilisation. Hamburg's industrial and commercial companies can play a key role here due to their large share in the metropolitan region's energy demand. The Senate therefore wishes to actively involve companies in shaping the energy transition through additional support programmes.

Through its "Energy Transition in Companies" programme under the European Regional Development Fund (ERDF), the Senate is providing around 22 million euros in funding for investment in technical systems to introduce load flexibility in companies (e.g. Demand response, controlling their own energy generation, virtual power plants, power to heat and to product, energy storage in production processes). Contributions to balancing energy demand and supply through load management improve the potential for using RE electricity in the network, support a secure and stable electricity grid operation and can generate additional revenue for the companies through participating in the electricity market.

Aims: Improved integration of renewable energies in the power grids, increased flexibility of energy consumption and generation in companies to adapt the energy demand to the increasingly volatile electricity supply in the grid, interactive integration of the companies' own plants and external control through the energy grid (demand response, virtual power plants, market-led CHP plants), increasing energy efficiency, stabilising the power grids, using waste heat outside the company.

Indicators: Reduction in CO₂ emissions through integration of RE electricity, number of companies with grid-supporting load management

Stakeholders: Responsible authorities, Hamburg's industrial and commercial companies, transmission and distribution system operators, energy providers, electricity traders, the Norddeutsche Energiewende (Northern German Energy Transition) NEW 4.0 consortium, IFB

Target groups: Hamburg's industrial and commercial companies

Current status: The operational programme and the administration and control system for the funding programme have been set up with the authorities administering the ERDF. Not

all documents have yet been received from the EU. The funding guidelines with a supplementary information leaflet, the range of measures and the audit trails have been developed and are currently under consultation. The programme contracts with the IFB – which is delivering some parts of the programme – are being agreed. Some companies have made suggestions for projects which are being evaluated.

As part of the Hamburg Eco Partnership, the ERDF programme complements the "Smart Energy Showcases – Digital Agenda for the Energy Transition" (SINTEG) funding programme announced by the Federal Government by providing specialist support and additional funds. The Senate and Schleswig-Holstein jointly support the application by a consortium of around 60 companies and scientific institutions from Schleswig-Holstein and Hamburg (Norddeutsche Energiewende – NEW 4.0) for this programme. A "showcase" region will demonstrate how and under what conditions the future energy supply with its high proportion of fluctuating RE energy supplies can best be run in practice, both technically and organisationally. If the project receives the award, then Federal Government funds will be available to develop and implement ways of making consumption more flexible, innovative approaches for a Smart Grid, storage technologies, communication networks and optimising the regulatory conditions in the energy market. The current close cooperation between the stakeholders from all the energy-related sectors, consumers and research bodies during the conception phase means that the metropolitan region of Hamburg has a valuable competitive edge.

2.5.5.3 smartPORT energy

Description: As a major energy consumer, the port and the industrial companies based there can make a significant contribution to the energy transition. In view of this the Hamburg Port Authority (HPA) and the responsible authorities set up the smartPORT energy project with the aim of developing the port as a showcase for renewable energies. Not only the port and the city but also the businesses based there have benefited from the project because, besides reducing environmental pollution, the increase in efficiency also created direct economic benefits. The project had a fixed-term until June 2015. SmartPORT energy is to be continued. The HPA and the ministries involved are currently working on operationalising this continuation.

The key components of the programme to date:

1. Developing innovative technologies: the main points of the energy transition are efficient use of energy and expansion of the energy grids, but first and foremost the opportunities for producing energy from renewable energy sources (including wind energy and photovoltaic).
2. Increasing energy efficiency: Energy efficiency can be increased and energy consumption harmonised with the fluctuating energy production from renewable sources by the appropriate networking of generation and consumption plants, new energy storage systems and appropriate communications technology.
3. Developing innovative mobility concepts: The primary goals are to avoid unnecessary traffic, moving traffic from road to rail and water, and reducing harmful emissions. In order to supply cruise ships with electricity, the HPA constructed the onshore

infrastructure for an LNG hybrid barge in the HafenCity and set up a shore-based power supply at the Altona cruise ship terminal.

Aims: Energy-efficiency reorganisation of the port: less dependency on conventionally generated energy, savings in energy consumption and energy costs, reduced emissions.

Measures: The main measures to be pursued in future are currently being identified.

Indicators: Dependent on the measures still to be defined.

Stakeholders: HPA and responsible authorities

Target groups: Dependent on the measures still to be defined.

Status: Continuation of the project is currently being operationalised.

2.5.5.4 Sediment management

Description: The future sustainability of the Port of Hamburg depends on the continuation of the river engineering and sediment management strategies for the tidal Elbe. The existing river engineering and sediment management strategy is constantly updated to ensure the seaward accessibility of the Port of Hamburg under changing hydrodynamic conditions in the tidal Elbe.

The continuation of the river engineering and sediment management strategy aims in particular at stabilising the sediment load in order to reduce the quantities for dredging, besides improving the sediment quality by cleaning up pollutants close to their source in the catchment areas of the Elbe and thus expanding the scope for handling the sediments. This can be achieved by an optimised sediment management which relieves the upper area of the tidal Elbe of excessive fine material and by appropriate river engineering works which lessen the tidal action and the upstream transport of sediment which this causes.

Aim: Safeguard the seaward accessibility of the Port of Hamburg under changing hydrodynamic conditions in the tidal Elbe

Stakeholders: HPA

Target group: Shipping and port industries and logistics

Status: Permanent task

2.5.5.5 Pilot project Kreetssand – Development of a tidal shallow water area

Description: To create additional tidal volumes, areas of shallow water have to be recreated. A pilot project has been started for the Kreetssand area: establishment of additional areas are to be assessed as part of a new estuary partnership.

The creation of the new Kreetssand tidal area is the first river engineering project under the "River engineering and sediment management strategy for the tidal Elbe" developed jointly by the HPA and the German Waterways and Shipping Administration (WSV).

Since 2012 this project has created an approx. 30 ha area of shallow water on the eastern side of the Elbinsel Wilhelmsburg where the tide can rise and fall freely. Thanks to the additional tidal volume of approx. 1 million cubic metres, the tidal processes are reduced and

an effective contribution made to reducing the flow relationship between high and low tides which is crucial for the upstream transport of sediment. The Port of Hamburg benefits from a reduction in sedimentation and at the same time the new area of shallow water creates valuable habitats, for example for the Elbe water dropwort (*Oenanthe conioides*) which is endemic to the Elbe and at risk of extinction.

The pilot project is accompanied by an appropriate public relations exercise which aims to enhance public understanding of the interrelationships in the tidal zone and to increase awareness of tidal dynamics. Moreover, this pilot project could produce important findings for developing further measures.

Aim: Reduction in sediment transport in the Port of Hamburg by increasing the tidal volume, thus leading to a damping of tidal processes and reduction of currents and sediment transport.

Stakeholders: HPA

Target group: The whole Port of Hamburg including all businesses based there

Current status: Under implementation

2.5.5.6 Public enterprises as climate partners

The role of public enterprises has already been presented in the Cluster City as a role model. The climate change mitigation measures of two public companies will be presented as a model for the key project "Public enterprises as climate partners".

a) HAMBURG WASSER

Description: HAMBURG WASSER was formed from the merger of Hamburger Wasserwerke GmbH (HWW) and Hamburger Stadtentwässerung AöR (HSE) and currently employs around 2,100 staff.

By buying certified green energy (guarantees of origin) and producing their own renewable electricity, the HAMBURG WASSER group has been able to meet 100 per cent of its electricity requirement from renewable energies since 2011. Hamburg Stadtentwässerung's overall balance of CO₂ emissions has been offset since 2011. The CO₂ emissions from the heat and fuel consumption side have been fully offset by savings in CO₂ emissions from the generation, use and sale of the renewably-generated biogas (100 per cent zero CO₂) which they produce. Since 2012 the group has produced a compensated overall balance by offsetting the emissions of HWW with those of HSE; i.e. HAMBURG WASSER contributes computationally to offsetting CO₂.

There is significant potential for achieving environmental and climate change mitigation targets by reducing energy consumption and producing their own electricity, heat and biogas. Another important opportunity for reducing CO₂ emissions lies in the sustainable management of HAMBURG WASSER's vehicle fleet.

Aims: HAMBURG WASSER sets ambitious targets for climate change mitigation both on the drinking water side and for waste water discharge and treatment as well as in cross-company elements such as the vehicle fleet and building management. For both companies in

HAMBURG WASSER this gives a predicted reduction in CO₂ emissions of >100 percent by 2020 in comparison with the base year of 1990, corresponding to an actual reduction of approx. 98,000 tonnes of CO₂. This means that by 2020 the climate change mitigation aims will not only meet the Hamburg Senate's medium- and long-term targets, but actually exceed them.

Indicators: CO₂ emissions

Stakeholders: HAMBURG WASSER

Target groups: Free and Hanseatic City of Hamburg

Current status: HAMBURG WASSER carries out regular assessments of the environmental impact of the group's activities in order to identify the correct areas for improving the group's environmental performance. This process serves to define the general direction of the environmental and climate targets for the next few years. In addition, the effects of the climate change mitigation strategy on CO₂ emissions is documented annually. A revision every three to five years is planned. HAMBURG WASSER intends to set up a central energy management team whose staff will report to the chief technical officer.

b) "Elbkinder" Vereinigung Hamburger Kindertagesstätten gGmbH

Description: The "Elbkinder" (Elbe Children) is a public company with a private legal status. It currently maintains 182 day nurseries and, with around 25,000 children, is the largest nursery authority in the city. With around 5,000 staff it is also one of Hamburg's largest employers. The company has two subsidiaries, the Vereinigung Kita Service GmbH and the Vereinigung Kitas Nord gGmbH. The main action areas arise from new building and refurbishment and from running the day nurseries. There is potential in energy optimisation of the buildings' external envelope (windows, roof, façades, foundations) and in the use of renewable energies for the heating and energy supplies of all the nurseries. Since 2013 the "Elbkinder" have been involved in the "fifty/fifty junior" nursery project which aims to optimise climate change mitigation in the nurseries' internal functions and the behaviour on site.

Aims: Savings of 155 t CO₂ annually by 2020. This calculation is based first on the completed energy-efficiency measures for all nursery buildings and second on the buildings where energy-efficiency refurbishment has been carried out. The evaluation is based on specifically developed data tables with an analysis of the annual CO₂ balance.

Indicators: Number of energy-efficiency optimisations to the external envelope (windows, roof, façades, foundations), percentage of renewable energy used for heating and energy supply for all nurseries, CO₂ savings.

Stakeholders: "Elbkinder" building department, nursery management, external companies

Target groups: "Elbkinder" staff plus all children and parents

Current status: To date 19 day nurseries have undergone energy-efficiency refurbishment and corresponding CO₂ savings have been made. In addition to this, CO₂ savings will be gradually introduced in all nurseries through optimised behaviour (fifty/fifty-junior). The strategy will be implemented systematically and other optimisation options developed at the same time.

2.6 Consumption and waste disposal

2.6.1 Aims

According to the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, over 70 per cent of greenhouse gases in Europe – and also in Germany – are caused directly or indirectly by consumer decisions. These emission levels are particularly high in the areas of housing, mobility and food. Consumption in private households alone is responsible for over a quarter of all greenhouse gas emissions in Germany, although the production of consumer goods is not even included in this figure. The consumption of products therefore has an increasing effect not only on people's economic and social situation, but also on the condition of the environment. We therefore need to aim for consumption which is both environmentally friendly and conserves resources while being socially just and future-oriented.

It follows that the manufacture and use of products offers huge potential for reducing impacts on the environment. The key is to recognise and use this potential. Moreover, sustainable consumption also applies to the use and disposal of resources in everyday life.

If we are to follow the principle of sustainable development, then consumption is sustainable if it "meets the needs of the current generation without undermining the ability of future generations to meet their own needs and choose their own lifestyle"³.

A reduction in CO₂ emissions of 80 per cent by 2050 means a reduction of the per capita output of Hamburg's citizens from the current approx. 10.2 tonnes per year to 2 tonnes per year. Hamburg's residents must therefore consciously include climate change mitigation as a decision factor in the course of action they choose for their consumption and disposal behaviour.

The same applies to tourism in Hamburg: due to climatic changes the city now has more hours of sunshine than even a few decades ago. Thanks to this and other reasons the city is a very popular holiday destination. This gives the tourism sector all the more opportunity to boost its image with environmentally friendly tourism.

2.6.2 Measures

Measures are primarily aimed at developing structures and incentives for behavioural changes to protect the environment.

Consumption:

- "Klimateller" (climate dish)
- Supporting local products

Procurement:

- Environmentally friendly procurement
- Green ICT

³ World Commission on Environment and Development (Brundtland Report), 1987

- More efficient use of paper (reducing the use of new paper by using recycled paper and reducing total use of paper)
- Climate neutral parcel shipment

Disposal:

- Recycling offensive

2.6.3 Evaluating stakeholder workshops

The stakeholder workshops gave rise to the following suggestions:

- Procurement guidelines for public companies: these were mentioned in connection with environmentally friendly food
- Improving information and communication technology (for procurement, operation and disposal). The FHH is already implementing this via the Green ICT project run by the finance ministry.
- Better information on recycling of materials and building materials, in order to combat reservations.
- Increased use and better marketing of seasonal and regional products.

2.6.4 Key projects

2.6.4.1 Environmentally friendly procurement

Description: The responsible authority has commissioned the Berliner Energieagentur to draw up a new environmental guideline for the procurers of the FHH. The guideline is to be made binding. Its introduction will be accompanied by training and information events. The guideline will be updated and expanded if necessary over the next few years.

The environmental guideline will provide the procurers with environmental criteria for over 20 groups of products which they can use directly for the tenders. It will also contain calculation aids for analysing the lifecycle costs for each of the product groups.

Aims: Drawing up the environmental guideline and updating and expanding it over the next four years.

The most important subsidiary aims are: taking account of all environmental aspects during the tendering process and paying more attention to product lifecycles in the procurement process.

Training and information sessions for procurers on implementing the guideline.

Stakeholders: Responsible authorities, districts, contractor: Berliner Energieagentur

Target groups: All procurers in the FHH

Current status: The environmental guideline is under consultation.

2.6.4.2 Recycling Offensive

Project description:

The recycling offensive was started in 2009. The "Hamburgische Wertstoff-Verordnung" (Hamburg recycling ordinance) which obliges households to separate organic wastes and waste paper came into force on 01.01.2011. In addition, in May 2011 collection of non-packaging materials of the same type (metal and plastic) was introduced (yellow recycling bins). A round table was set up with the housing sector at the end of 2011 to improve the separation of waste in this sector. An agreement with the housing sector on implementing the recycling offensive was signed on 24.05.2012. Optimising waste management will be pursued systematically up to 2020 and beyond.

Besides the recycling offensive for private households, companies also need to do more in terms of separating and subsequent sorting of recyclable materials such as glass, paper/cardboard, plastics and metal.

Aims: 70 to 75 per cent of households provided with waste paper recycling bins and 60 per cent with organic waste bins by 2020.

Indicators:

- Number of private households with waste paper and organic waste bins
- Percentage of paper, organic waste, garden waste, glass and recyclable waste in the total waste volume from private households

Stakeholders: Responsible authority, Hamburg city cleansing department, waste disposal companies

Target groups: Housing sector, Hamburg residents

Current status:

At the end of 2014, 62 per cent of households had access to waste paper recycling bins and 45 percent to organic waste bins. The recycling offensive will be continued with targets for 2020 and 2025 which have been incorporated in the draft of the waste management plan for residential waste. This is currently under consultation. From the current perspective the targets for 2020 are achievable but depend on the future economic, legal and political framework.

The Steller Moor waste incineration plant was closed down in mid-2015. As it had the lowest energy efficiency of all the Hamburg waste incineration plants, the average energy efficiency of all the (remaining) Hamburg waste incineration plants will rise in future. This will be reflected in the calculations of CO₂ savings from 2015 onwards.

2.7 Coastal flood protection

2.7.1 Description and aims

In view of the accelerated rise in sea level, the new design water levels for public flood protection systems resolved by the Senate in October 2012 specify a climate allowance of

20 cm up to 2050 and 50 cm up to 2100. The European Directive on the Assessment and Management of Flood Risks (2007/60/EC) requires the identification of areas at risk and the preparation of flood risk maps and risk management plans which take into account the effects of climate change. Consequently, an effective flood risk management programme for Hamburg is extremely important.

The remit of coastal flood protection is to reduce the flood risk for Hamburg and to protect the municipal area of Hamburg from storm surges in the long term. Strategically the aim is to link technical flood protection with area-related and behavioural precautions.

2.7.2 Indicators

- Tidal conditions: mean high tide, mean low tide, mean tidal range
- Number and intensity of storm surges
- Number of locking tides
- Rise in sea level

2.7.3 Measures

The measures stated in the Action Plan 2013-2014

- Reinforcement of public flood protection structures
- Designations in planning law and building approval
- Adaptation of the private flood protection in the port and the city, and
- Risk communication

are ongoing measures and will be continued in the coming years.

2.7.4 Key projects

2.7.4.1 Reinforcing public protection structures

The key project to mention is the reinforcement of public protection structures, because these are what provide Hamburg with permanent protection from the effects of climate change with its – anticipated – increased storm surge risk and rising sea level.

Description: The city is constantly adapting the dyke heights to the requirements. These are redefined at intervals of a few years, most recently in the parliamentary publication Drs. 20/5561 "Food protection in Hamburg".

Indicators: as above

Stakeholders: Responsible authority, Landesbetrieb für Strassen, Brücken und Gewässer (State Agency for Roads, Bridges and Waters of the city of Hamburg)

Target group: Residents and businesses in the flood risk zone of the tidal Elbe

Current status: Work is continuing to fulfil the provisions agreed by the Senate and Hamburg Parliament

2.7.4.2 Private flood protection in the port

Description: The Port of Hamburg makes an important contribution to coastal flood protection (cf. publication 20/8492). In addition to adapting the public flood protection defences, the private flood defences in the Port of Hamburg and on the northern bank of the Elbe will also be adapted to new safety standards. In Drs. 18/6206 the Senate informed the Hamburg Parliament of the adaptation requirements of private flood protection to the measurement criteria currently in force.

Aim: By means of the recently-launched funding programme, the Senate aims to provide financial support for the owners of private flood protection systems to adapt these to the more rigorous requirements.

Indicators: as above

Stakeholders: Hamburg Port Authority, private owners

Target group: The Port of Hamburg and all businesses in the port area and on the northern bank of the Elbe not protected by dykes.

Current status: Various measures have already been started. Current assessment indicates that the planned delivery of the funding programme will last until 2019.

2.7.4.3 Risk communication for the ports

Description and aim:

Warning and informing the public and businesses in the port (risk communication) is a further important measure for storm surge protection. Even though Hamburg's flood protection structures meet a very high standard, the public's awareness of the danger of storm surges must be maintained at all times. The task of risk communication becomes even more important due to climate change.

Storm surge forecasting and flood information services were developed and implemented (WADI, FLUTWARN) to inform the public and business community in the port and information leaflets were produced. The Hamburg Port Authority's (HPA) storm surge warning service WADI is constantly evaluating the measurement data of various water levels and weather information and using this to produce precise forecasts for the occurrence of high tide in the Port of Hamburg. FLUTWARN port is an SMS warning system with which the HPA sends warnings and safety practices per SMS and e-mail to those affected in the harbour area when there is a risk of storm surges. Due to climate change and the anticipated changes it is important that people are given an explanation of the existing and constantly changing dangers. Storm surge leaflets and brochures produced by the HPA serve to inform the inhabitants in the flood-prone parts of the Port of Hamburg of the storm surge risk and of specific behavioural guidelines in case of a storm surge.

On informing the public outside the port area see 2.12.

Stakeholders: Hamburg Port Authority

Target group: Inhabitants of flood-prone areas in the Port of Hamburg.

Status: Permanent task

2.8 Water management and inland flood protection

Besides storm surge protection which is of vital importance to Hamburg, in recent years the topic of inland flood protection and urban flood protection has again moved more to centre stage. The reasons for this are first the large inland floods on the Elbe and Danube with breaches of the dykes and serious damage. Secondly, there is repeated heavy rainfall in inner city areas in summer causing flooded underpasses, basements and underground car parks. Climate change with its rising temperatures will result in these events becoming more frequent in future and the effects more severe.

Sustainable rainwater management and a proactive urban planning scheme are appropriate measures to avoid flood damage right from the designation of new areas for building. This action area covers all the adaptations to climate change in the field of water management with the exception of coastal flood protection. The adaptation strategy for water management is aimed at coping with both heavy rainfall events with resulting floods and droughts which are largely caused by climate change, and to ensuring that in future human action does not exacerbate but mitigates these extremes.

The joint venture RISA – Rain Infrastructure Adaptation – is aimed at practical improvements to urban flood protection and to adapted building methods which permit both future urban development with ever increasing surface sealing and a continued high standard in urban drainage.

All measures carried out in connection with inland flood protection will be checked for compatibility not only with the Directive on the Assessment and Management of Flood Risks (EC FRMD) but also with the important EC Water Framework Directive and vice versa.

2.8.1 Aims

The aims of water management in adapting to climate change are:

- Water management in Hamburg must be designed for the long term,
- Mitigate the effects of extreme conditions (flood run-off and drought periods),
- Ensure a high standard of urban flood protection,
- Guarantee the quality of water bodies in the long term,
- Guarantee a uniform soil moisture for vegetation across extensive areas and in addition
- Guarantee groundwater recharge and the supply and quality of drinking water for the long term.

The aim of inland flood protection is to reduce the flood risk by:

- Proactive inland flood protection,
- Improved, primarily decentralised rainwater retention and
- Risk reduction

The aim of urban flood protection is to reduce the overload on the sewer system by:

- Rainwater retention (roof greening, increasing storage capacity, infiltration) and
- Improving decentralised drainage options.

2.8.2 Indicators

Indicators for water management and urban flooding are:

- Run-off characteristics of the surface waters and rainwater drains (without the tidal Elbe)
- Number of mixed water overflow events
- Number of fire brigade operations to pump out basements and underpasses
- Water temperature of the Elbe, Alster and Bille
- Oxygen concentration in the Elbe, Alster and Bille.

2.8.3 Measures

A wide range of measures have already been in place over many years:

The RISA – Rain Infrastructure Adaptation – project studied and evaluated the basic principles of rainwater management in a joint project involving all the responsible authorities. A range of working papers and supporting documents were produced by four different working groups. These have now been published on the RISA web sites www.hamburg.de/risa and www.risa-hamburg.de. The results of this wide-ranging study are compiled in the "RISA Strukturplan Regenwasser 2030" (RISA Structural Plan Rainwater 2030) which is due to be published soon.

Some important elements have already been implemented in association with the RISA process. The introduction of the "split waste water tariff" on 1 May 2012 created a financial incentive to stop piping rainwater into the sewers subject to a charge but to think about decoupling measures. Measures of this kind are of particular interest to property owners with large sealed areas connected to the sewer system, e.g. Hamburg schools.

The Senate's green roof strategy also makes an important contribution to the RISA aspect in the form of water retention and evaporation. Green roofs lead to a reduction in the rainwater tax.

A fact sheet was compiled for the water-sensitive road construction which shows by means of examples how the RISA aspect can be included when designing roads. Besides retaining water, the separation of different types of rainwater and the purification methods comprise an important criterion for water quality. The Structural Plan Rainwater 2030 will document the RISA process to date.

A warning service has already been set up for urban flooding, providing information on the Internet for citizens and departments. Besides the current flood conditions, warnings can be published in advance of flood events. The warning service is integrated in the national flood portal run by the Federal states.

Areas at risk have been identified and documented and published in the form of maps as part of the implementation of the Directive on the Assessment and Management of Flood Risks (EC FRMD). The maps show the areas in the FHH which are at risk of flooding and property owners can make appropriate provisions.

Changes due to the changing climate are incorporated in the relevant flood hazard and flood risk maps by incorporating current hydrological data – in which certain trends can already be detected – in the modelling process.

2.8.4 Key projects

2.8.4.1 Structural Plan Rainwater 2030

Description and aims:

The responsible authorities and the company HAMBURG WASSER have jointly established the RISA – Rain Infrastructure Adaptation – project with the aim of developing sustainable ideas and concepts for dealing with rainwater. The primary aims of the project – a near-natural water regime, protection of water bodies and urban flood protection – require interdisciplinary cooperation which is reflected in the project structure: future-oriented solutions were developed with scientific support from universities and engineering consultants both for water management and for city, landscape and traffic planning. Recommendations for action for dealing with rainwater in the city were presented, including new forms of water storage for drought periods. The aim of the project is to keep rainwater out of the sewers so that past successes in protecting water bodies are not put at risk and future incidents are avoided. Now that the basic principles and project results (see above) in the form of numerous supporting documents have been completed, the findings from the RISA project must be implemented in administrative procedures and in practice.

A range of maps has already been published for Hamburg, such as those for the depth of the groundwater table, groundwater contours and infiltration potential. These maps provide planning guidelines for the regionally very diverse hydrogeological conditions, such as the infiltration potential in the FHH. The next step for the RISA project is for HAMBURG WASSER to carry out a spatial analysis for identifying the decoupling potential. The aim of this is to identify the potential for decoupling areas from the sewers of the city's drainage systems in order to relieve the systems from largely unpolluted precipitation water (e.g. from roofs and quiet streets in residential areas) and reserve them for more highly polluted waste water (e.g. from busy streets). The waste water with low pollution levels can then be returned directly to the (natural) water cycle. With the ever increasing surface sealing of private and public areas in the city and the predicted rise in rain intensity and frequency, it is important to promote infiltration and evaporation wherever possible by retaining water on all areas. Future overload of the sewers and potential flooding plus the increase in hydraulic stress in water bodies and their pollution by contaminated rainwater e.g. from streets, must be avoided.

The key point is to ensure that, in the case of new build or reconstruction projects in Hamburg, suitable measures are taken so that precipitation infiltrates or evaporates as much as possible on site or is returned slowly to the surface waters without mixing with waste water. The controlled discharge, particularly via open drainage systems or storage systems close to the surface, should take place in as decentralised and natural a way as possible. This is essential if Hamburg is to be able to design rainwater drainage and sustainable urban development against the background of the predicted effects of climate change and increasing surface sealing.

It must also be ensured that past successes in protecting water bodies e.g. through the large improvement programmes for the Elbe, Alster and Bille achieved at very high financial and technical cost, and the achievement of the targets of the Water Framework Directive (2000/60/EC, EC WFD), are not put at risk.

The Structural Plan Rainwater 2030 summarises the numerous results from the RISA project. It presents the technical principles, recommendations and guidelines for action by administrators, experts and land owners for dealing with rainwater in Hamburg in a sustainable manner. The next step is to implement the RISA recommendations in urban, landscape and traffic planning, so that the measures are effective and the adaptation of rainwater management to the challenges of a growing city can succeed, even though design rainfall is increasing.

Stakeholders: Responsible authorities, district authorities, HAMBURG WASSER, other project partners

Target groups: All ministries and public bodies, planners and property developers, landowners

Current status: The RISA results are contained in the Structural Plan Rainwater 2030 including comprehensive supporting documents. Mention should be made, for example, of the RISA planning handbook "Regenwassermanagement an Hamburger Schulen" (rainwater management at Hamburg schools), the fact sheet "Hinweise für eine wassersensible Straßenraumgestaltung" (advice for water-sensitive road design), the Information 02 "Niederschlagswasserbehandlung" (dealing with storm water) by the Association of Municipal Utilities (VKU) and the revised brochure "Wie schütze ich mein Haus vor Starkregenfolgen" (how to protect my house from the effects of heavy rainfall) plus the final report "Integriertes Regenwassermanagement in Hamburg: Veränderungsnotwendigkeiten und Handlungsoptionen für Planung und Verwaltung" (integrated rainwater management in Hamburg: required changes and options for action for planners and administrators). Apart from the structure plan which will be published soon, all the supporting documents have already been published on the Internet (see above).

2.8.4.2 Increasing surface water retention

Description and aims: Since the 1984 environmental action programme, the retention and controlled infiltration or discharge via open drainage systems with appropriate retention areas have contributed successfully to stabilising local water cycles. The competence network of HAMBURG WASSER has developed general principles and initial strategies for decentralised rainwater management under changing climatic conditions in Hamburg. These were subsequently continued and systematically developed in the RISA project (see above). A measure currently being implemented is the retention and increased decentralised infiltration of precipitation water (partly as a consequence of the split waste water charge and the specification of limits to the volume discharged into the public sewers by the responsible authorities).

Examples:

- Altona Altstadt 59: drainage of the new build area by retention and controlled infiltration. In this case the load on the mixed water sewage system was also reduced and, ultimately, that on the pumping stations and sewage treatment plant, thus enabling cost and energy savings to be made.

- Retention, controlled discharge or complete decoupling from rainfall sewers: Wegenkamp primary school, Corveystrasse grammar school, Leuschnerstrasse primary school and Moorflagen primary school.
- The aim is also to design a model water management system for the planned technology park in the B-plan area of Vorhornweg in Lurup (see Drs.19/1113).

Stakeholders: Responsible authorities and HAMBURG WASSER

Target groups: Architects, landscape architects and building contractors, developers, building inspectors

Current status: Under implementation.

2.9 Nature and soil conservation

2.9.1 Nature conservation

Nature conservation in Hamburg will face increasing demands in terms of its broad range of objectives and tasks as a result of climate change. It must ensure that nature can continue to exist in Hamburg and at the same time provide people with experiences of nature and recreation.

2.9.1.1 Aims

- Maintain biodiversity
- Ensure the productive and functional capacity of the environment
- Maintain the diversity, uniqueness and beauty of nature and the landscape
- Buffer and contain climate changes and extremes
- Guarantee human relaxation and recreation in the long-term

2.9.1.2 Indicators

- Development of the population of species sensitive to climate (birds)

2.9.1.3 Measures

The strategy is to maintain the existing environmental conditions, site diversity and patchwork of structures as a requirement for biological diversity. The functional capacity of habitats must be improved. This includes the conservation of semi-natural landscapes with an adequate size and connectedness. This should enable the survival of the species already present in connection to climatic changes. At the same time new species can colonise and enhance biodiversity. The according key project is the biotope network to safeguard existing species and enable the migration of new species.

2.9.1.4 Key project – Biotope network

Description and aims: The biotope network, which is a statutory provision, aims to create a coherent network of biotopes through the conservation and development of areas, connecting elements and stepping stones to safeguard the habitat of native species of plants

and animals and for the maintenance, restoration and development of functioning ecological interactions.

Indicators: The indicators are the size of the areas for nature conservation and the percentage of the biotope network in the area of Hamburg.

Stakeholders: The department for nature conservation is responsible for the biotope network in Hamburg. It works closely with neighbouring local authorities.

Current status: Implementation of the cross-state biotope network of Hamburg is currently being achieved through integration in the species and biotope conservation maps of the landscape programme.

2.9.2 Soil conservation

Soil conservation acts via its evaporation and cooling potential on soils as part of adapting the city to climate change.

2.9.2.1 Aims

- Maintain soil functions (e.g. water storage, carbon sequestration)
- Promote evapotranspiration (in simple terms: evaporation) from the soil

2.9.2.2 Measures

Evaluate the cooling effects of evapotranspiration from the soil on hot summer days.

In 2015 the soil evaporation potential map for the entire FHH will be developed further. For this purpose, comprehensive simulations and scenario analyses using a soil water management model were carried out in 2014 and 2015 by an external contractor. In a first step these enable the exact quantification of the differences in the actual evaporation capacity of different soils in the FHH on hot summer days. The next step is to apply a newly developed evaluation method to the simulation results so that the evaporation capacity of different soils with a variety of plant growth can be concisely plotted and visualised.

It is anticipated that this further development of the evaporation potential map will provide considerably improved supporting arguments to minimise the future surface sealing of areas with a high potential evaporation capacity and to protect previously unsealed soils with a natural vegetation cover, especially green areas, from being built on. The results are also applicable to the urban climate concept in the landscape programme.

2.10 Human health

2.10.1 Aims

The action area "human health" aims to prevent health risks and negative effects on people due to climate change to the greatest degree possible. This mainly concerns protection from heat-related illnesses and protection against new, especially tropical, infectious diseases.

2.10.2 Indicators

- Heat stress in the city
- Hot days
- Tropical nights
- Heat warnings
- Occurrence of the tiger mosquito

2.10.3 Measures

While protection from heat-related illnesses will be achieved by a package of measures by various stakeholders – from urban planners and building services all the way to heat warning services and drinking plans for children, the elderly and the sick – protection from infectious diseases favoured by a warm climate is the task of the responsible municipal authority.

2.10.4 Key project – Monitoring disease vectors

Description: Pathogens or disease vectors which were previously unable to survive in Germany could be introduced to Central Europe. The rise in temperature increases their ability to survive in northern Germany. Being a densely built-up city, Hamburg has higher temperatures than the surroundings, which could further increase the ability of these kinds of pathogens or disease vectors to survive.

Hamburg is therefore involved in monitoring the possible introduction of the tiger mosquito (*Aedes albopictus*) which has been spreading in southern Europe for years and which is a carrier of a number of tropical viruses. If *Aedes albopictus* is found in Hamburg, measures need to be taken to prevent it becoming established. The appearance of species like these is therefore also part of Hamburg's climate change monitoring programme.

Indicators: The indicator is the number of confirmed occurrences

Stakeholders: Hamburg Institute for Hygiene and Environment

Target group: Indirectly, the whole population of Hamburg

Current status: To date no occurrences have been detected.

2.11 Infrastructure

2.11.1 Description and aims

Infrastructures in the energy, waste water, waste disposal and transport sectors are particularly challenged by climate change and climate-related extreme events, because the

community is generally reliant on these infrastructures being able to function, particularly in extreme situations.

The aims for adapting the infrastructure are therefore:

- Ensuring Hamburg's energy supply
- Ensuring Hamburg's drinking water supply
- Ensuring waste and waste water disposal in Hamburg
- Ensuring that the traffic infrastructure functions

The energy supply is affected by climate change in a variety of ways:

Above-ground power lines are particularly at risk from hurricane-type wind events which could occur more frequently than previously in northern Germany due to climate change.

Due to the network system, power cuts and grid overload have an effect across regions and can also lead to – at least short-term – power cuts in Hamburg. The energy supply for the city of Hamburg cannot be met from our own resources but is dependent on supplies from all over Germany. Weather-related power cuts and supply bottlenecks threaten infrastructure such as hospitals – which is why they have emergency generators – as well as manufacturing industries.

In the short term there is no need for action for the energy supply, partly because of the good ring supply for electricity in Germany and the storage capacity for gas.

The public drinking water supply in Hamburg and the surroundings which is obtained 100 per cent from groundwater resources must be safeguarded in the long term. From today's perspective, however, it is not expected that climatic changes will lead to a negative effect on Hamburg's drinking water supply in the short or medium term. Nevertheless, the effects of climate changes on the groundwater – as the basis of Hamburg's drinking water supply – must be carefully monitored.

Hamburg's waste disposal must also be guaranteed in times of climate change. Waste disposal is easily affected by extreme events of all kinds. Periods of extreme heat lead to much stronger odours in stored wastes. Heavy rainfall events, black ice, heavy snowfall and other weather extremes can delay waste disposal and give rise to hygiene issues and other problems.

In terms of transport the main issue is to make transport infrastructures resilient in the face of climatic changes such as heat and high volumes of precipitation, particularly heavy rainfall events. The transport infrastructure must be designed to be future-proof in face of the rising precipitation and inflow volumes, in terms of a responsible flood protection and safeguarding of water bodies.

Snowfall is a special case. Less snow is to be expected in future, however snow conditions have already changed: at higher temperatures snow is heavier, meaning higher loads on roofs and requiring higher powered snowploughs. Coping with heatwaves requires the use of heat-resistant materials for road construction and rail transport.

2.11.2 Indicators

The indicator "number of mixed water sewer overflows" is currently under development for the transport sector. It indicates the need for action for coping with heavy rainfall events.

2.11.3 Measures

In order to guarantee the energy supply during disasters and extreme events, an agreement has already been reached for prioritising electricity supplies in cases of a power failure.

The Stadtentwässerung Hamburg is constantly adapting the sewer system to future requirements. It must be prepared for both longer dry periods and sudden high volumes of rainwater and waste water.

The entire sewer system is continuously checked for any weak points and these are then dealt with as part of the high investment and maintenance levels. The anticipated fluctuations in the volume of waste water due to climate change is therefore already being addressed.

The Bergedorf sewer repair and upgrade will be completed in 2016. Thanks to a comprehensive package of measures with investments of 23 million euros, it has been possible to make significant improvements to urban flood protection and the protection of waterways in the Bergedorf town centre. The planned discharge frequencies from the mixed sewer system in the 1995 Bergedorf refurbishment plan were achieved or exceeded. The volumes discharged to the Bergedorf water bodies have fallen by approx. 97 per cent overall, from an average of 7,800 m³/a to 200 m³/a. In addition, urban flood protection during heavy rainfall has been significantly improved. The drainage capacity has been increased tenfold by building the Bergedorf East branch sewer. This will mean that floods like those in 2011 will be much less common in future.

The city centre discharge plan is currently in the implementation phase and on schedule. Thanks to an investment volume of around 60 million euros, the central drainage axes in Hamburg's city centre are being expanded with redundant deep transport sewers. This is necessary to enable the future renovation of the historical sewers which are already over 110 years old and to ensure the reliable drainage for the city centre in the long term. The inner city water bodies have also been further protected from mixed water discharges by the creation of additional storage volume. The various construction measures will probably last until 2018.

For the transport infrastructure, the first step has been to produce a fact sheet for street reconstruction, see key project. The responsible authorities believe any further practical measures to be unnecessary at present. In detail:

The Hamburger Hochbahn (elevated railway) believe that, for the U-Bahn infrastructure, the rise in average annual temperatures of a few degrees Celsius discussed in connection with climate change will not have any effect on the U-Bahn rails. Steel structures – such as HOCHBAHN's U-Bahn rails – only lose their load-bearing capacity in the case of fire above a temperature of around 600 degrees Celsius. So even surface temperatures of 60 to 65 degrees Celsius due to intense solar radiation during the summer months will not have any effect on the characteristics of the steel and its use in the U-Bahn operation.

The Deutsche Bahn AG rails for the long-distance railway and S-Bahn infrastructures are designed for a temperature range of -25 °C to +65 °C. It is assumed that this is adequate in the medium term.

Hamburg Port Authority (HPA) for the port railway infrastructure: the material used by the HPA complies with all standard requirements in terms of any "heatwaves" (heatwaves = warming of the climate at our latitude by approx. 2-3 °C).

Streets: heat damage is known from the concrete road construction in Germany (mainly on the national motorways). These so-called "blow-ups" occur due to positive changes in length at high summer temperatures which cannot be accommodated by the joints so that individual slabs then slide over each other. This produces a sudden and extreme accident hazard. However, concrete street construction only has a minor role in the FHH's city street network. Since 1995 only the areas under heavy use by bus traffic (bus stops at the edge of the lanes, bus-stop bays and special profiled kerbs) have been surfaced with concrete. The traffic area involved is insignificant, and the length of sections which is generally less than 100 m minimises the risk of "blow ups", so that there has been no known case in Hamburg so far.

The use of asphalt surfacing in Hamburg has also more than proved its worth in relation to peak summer temperatures. Air temperatures this summer (2015) reached around 42 °C in Germany without the occurrence of any appreciable damage to asphalt surfaces. For the road sections in Hamburg subjected to heavy use by HGVs (load class 3.2 to load class 100), the deformation resistance of the asphalt surface is increased by using artificial brightening stones. The light surface to the carriageway causes increased reflection of the solar radiation, reducing core temperatures in the asphalt by up to 8 °C. At night, in the absence of solar radiation, the core asphalt temperature falls so much that even a series of hot summer days does not generally lead to any deformation worth mentioning.

Road coverings are designed for maximum temperatures of approx. 42 °C, depending on the formula of the asphalt mix and the local parameters.

2.11.4 Key project – Fact sheet for water-sensitive road design

As part of the RISA project, the points of importance for water management in road design were identified and a checklist drawn up to be used by road planners as an aid for recording and allowing for rainwater problems. The results have been incorporated in the Hamburg fact sheet "Hinweise für eine wassersensible Strassenraumgestaltung" (Advice for water-sensitive road design) which was published in January 2015. It serves as a collection of examples and a guideline and should always be referred to when planning and designing roads.

Stakeholders: Ministries, in particular the transport ministry

Target groups: Traffic planning

Current status: The checklist is complete.

2.12 Emergency management

2.12.1 Aims

The aim is to prepare the staff and operational structures of the emergency management forces for weather and climatic extremes and to ensure that the public is adequately informed.

2.12.2 Measures

Many measures have already been completed. An agreement was made about power distribution in emergency situations. Other tasks such as involving voluntary helpers or adapting guidelines to the changed conditions are ongoing.

Information brochures on the risk of storm surges were produced last year for the various parts of the city affected and distributed to residents. Additional and updated versions will be required.

2.12.3 Key project – Information brochures

Description: As part of the "Informing the public about the risks from climate change" project, an approach was made to 360,000 Hamburg residents (204,445 households) whose place of residence will in future be at an increased climate-related storm surge risk or whose place of residence will soon be added to the area of Hamburg at risk from storm surges.

Changes in the population structure of parts of the city, such as the current high influx of refugees, mean that a large number of Hamburg residents have not yet been informed of the increased risk of storm surges due to climate change. The demographic change in Hamburg, urban development and changes in the disaster response capacity planning require the project to be continued in 2016 with the objective of adapting the public information on the risks from climate change to current conditions, thus ensuring that all residents of the city living in areas at risk from storm surges are informed about the dangers and the options for adapting their behaviour. The residual risk for affected persons can only be minimised by behavioural adaptations.

Stakeholders: Responsible authority

Target group: All affected Hamburg residents (approx. 250,000 households)

Current status: A new expanded edition is in preparation.

2.13 Education

2.13.1 Aims

The aims for climate change mitigation and adaptation to climate change can be promoted through statutory provisions and economic incentives. However, to actually reach these objectives, the conscious actions of citizens and their interest groups are also required.

For this reason, in addition to support and regulatory measures, awareness raising and education are an important pillar of Hamburg's climate activities.

All the elements connected to the requirements for climate mitigation and the causes and effects of climate change need to be brought to the attention of the broad public, and related provisions implemented in education, qualifications and advisory services. Climate change mitigation and climate change need to be part of the daily life of all citizens and be included in all decisions.

Informed action by citizens and companies is essential, especially when it comes to energy saving. Individual action is needed, expected and effective, particularly in this area.

Educational facilities should serve as models for energy efficiency, in order to raise the awareness of citizens about the importance of climate change mitigation and to present options for action.

2.13.2 Measures

The above-mentioned aims will be achieved by involving all levels of education (nursery, school, university, further education, advisory services, etc.), including via the following measures:

Nursery:

- fifty/fifty junior

School:

- Implementing the measures from the school climate action plans
- No school over 200 kWh/m² – advice to energy-intensive Hamburg schools
- No school over 200 kWh/m² – pupils help out
- fifty/fifty
- SchulBaustelle Klima (school building site: climate)
- Fotoklima 2015/2016 – Educational project for schools

Vocational college:

- Ressourcen-, Umwelt- und Klimaschutzbeauftragte (RUK) (representatives for resources, environment and climate change mitigation)

University:

- Climate savings book for Hamburg universities

Extra-curricular education:

- Climate friendly days on the Gut Karlshöhe (Karlshöhe Farm)
- Exhibition "jahreszeitHAMBURG" (HAMBURG seasons) and energy education workshop on the Gut Karlshöhe

Advice:

- Energy advice for low-income households (energy-savings check)
- Climate change mitigation guides / energy and climate hotline in the consumer advice centre

2.13.3 Evaluating stakeholder workshops

The stakeholder workshops gave rise to the following suggestions:

- Advice: on-site advice
- Education (schools and nurseries): put the topic more firmly in the curriculum (this has already been done); provide resources for climate change mitigation in nurseries and schools; continue the successful fifty/fifty and fifty/fifty-junior models.
- Vocational training: action weeks, e.g. energy days or a marketplace in the company, integrate climate change mitigation in career guidance
- Create incentives

2.13.4 Key projects

2.13.4.1 Implementing the CO₂ reduction measures from the climate schools' climate action plans

Description: 70 Hamburg schools have developed their own climate action plans as part of the "Climate change mitigation in schools" project (duration: 2009 to 2012) which contain technical measures in addition to educational ones. The plans generally contain CO₂ mitigating measures in the action areas heat, electricity, waste, food, mobility and procurement. 70 climate action plans with a total of 2,600 measures were developed up to the end of 2012. Not all the planned measures require funding: however, to be able to realise savings opportunities – for which a financial outlay is required – and thus increase the schools' capacity to implement the climate change mitigation measures, each of the 70 participating schools received a grant in 2013 and 2014 from climate change mitigation funds. This contribution was primarily intended as an incentive for the climate schools to tackle climate mitigation measures and to make up any deficit from elsewhere. It was left up to the schools as to which of the measures they implemented with the grant. Additional funding for specific CO₂ mitigation measures was provided in both years for approx. 30 climate schools.

Aims: The aim of the "Climate change mitigation in schools" project was to develop climate action plans within the schools specifying how CO₂ savings can actually be made, and establishing and implementing the topic of "climate change and climate change mitigation" in the curriculum. The aim in this phase is to implement the measures, some of which will result in real savings in CO₂.

Indicators: Number of measures from the climate action plans implemented, reduction in energy consumption, number of climate action schools

Stakeholders: Responsible authority, schools

Target groups: The participating schools; pupils, teaching staff, school management, administrative and technical staff, parents.

Current status: There are currently 66 climate schools in Hamburg whose quality seal is valid until the end of 2016. These comprise 17 primary schools, two special schools, 16 neighbourhood schools, 21 grammar schools and 10 vocational schools. The climate schools are planning a total of approx. 2,500 measures up until 2020 under the motto: "Climate – we're acting!" The Hamburger Klimaschutzstiftung für Bildung und Nachhaltigkeit

(Hamburg climate action fund for education and sustainability) is planning to recruit about 10 additional schools as climate schools per year from 2016 with the KlimaschulenPLUS project.

2.13.4.2 fifty/fifty-junior

Description: The project fifty/fifty-junior, based on the successful fifty/fifty strategy in schools, started at the end of 2012, supported by funds from the National Climate Action Initiative and the Hamburg Climate Action Plan.

The fifty/fifty energy-saving action plan in schools has been extended to nurseries: it is aimed at the day nurseries of a wide range of Hamburg providers. The main focus is on the behaviour-related savings potential. It was intended to involve around 200 of the total of 900 Hamburg day nurseries.

Aims: Reducing energy consumption should make a demonstrable contribution to climate change mitigation, make the teachers and hence the children aware of climate change mitigation, and finally make a contribution to reducing the costs of the nurseries.

Indicators: Number of participating nurseries, reduction in energy consumption (heating and electricity).

Stakeholders: Previously the fifty/fifty-junior project team in the responsible authority. In future the new responsible authority, environmental foundation Save Our Future (S.O.F.).

Target groups: Day nursery providers; within the nursery the caretaker, teachers, children, parents

Current status: The project aim has been reached in qualitative terms. The (purely behaviour-related) reduction rates for 2014 are 12.5 per cent for heating energy (following 10.3 per cent in 2013), 14.6 per cent for electricity (9.8 percent) and 9.8 per cent (9.0 per cent) for water above the rates achieved with fifty/fifty in schools – and therefore above expectations.

The underlying fifty/fifty concept, the combination of climate change mitigation as an educational ideal and simple practical implementation "on-site" in the daily running of the nursery combined with a material incentive also proved successful and effective in the nurseries. However, the project aim was not achieved from a quantitative viewpoint. With currently 60 (out of almost 100 signed up) nurseries assessed (some still incompletely), the basis for the project's financial independence is still too narrow. The main reason for this is/was the unexpectedly poor consumption data held by the nursery providers which meant that acquiring new participants had to be discontinued at the start of 2014.

The current project finishes at the end of 2015. If the concept is to be continued in the interests of climate change mitigation and is to be financially independent, then the base must be expanded as quickly as possible to around 150 to 200 nurseries and the nursery providers need to become involved in the financial responsibility, i.e. fifty/fifty-junior must be transformed into a commercially costed service concept. The environmental foundation S.O.F. has decided to take on and develop this transformation process. The aim is to make the measure profitable for the nursery providers over the next three years so that they then take it on themselves.

2.13.4.3 Climate change mitigation guides / energy and climate hotline in the consumer advice centre

Description: This measure, run by the consumer advice centre since 2008, gives all Hamburg households (including those with no affinity towards the environment and climate change mitigation) easy access to information and offers assistance with putting measures in place for climate change mitigation, energy saving and energy efficiency. Households are given practical guidance when requesting information on personal energy (savings) advice, energy certificates, energy saving options, energy efficiency (activation function), tradesmen and architects, financing and funding and the Hamburg partners network (guiding function).

Aims: Advisory and guidance function by providing advice over the telephone and by post, increasing the number of contacts.

Indicators: Number of contacts (by telephone and in writing)

Stakeholders: Consumer advice centre

Target groups: Hamburg citizens

Current status: This measure has been successfully continued according to the agreed objective. Advice and referrals totalled 5,096 in 2014 (425 per month on average), with enquiries about HVAC (1,202) and thermal insulation (1111) taking up the largest share. There were 2,968 referrals (guidance function). The number of enquiries in 2014 remained roughly equal to the previous year. This indicates that the energy and climate hotline in the consumer advice centre has become established and is consistently used.

2.13.4.4 Information and advice service "Climate adaptation made easy"

Mention must be made of a new project by the Hamburg Metropolitan Region (MRH) "Climate adaptation made easy – From research into practice: MRH information and advisory service for initiating projects for dealing with climate change".

Description and aims: The results of the KLIMZUG-NORD research project have been available in various publications since the end of 2014. Following on from the project, these comprehensive results need to be disseminated, integrated in practice, i.e. in administrative action and political decision-making, and implemented in actual measures and projects as soon as possible. The Hamburg Metropolitan Region has set up this project for this purpose. Its aims are to:

- promote knowledge transfer and present the research results at local authority level,
- supply ideas for implementation options by presenting best-practice examples and thus motivate and activate partners in the region (multipliers) who are involved with climate change mitigation and climate adaptation to develop their own projects on climate adaptation,
- train multipliers in the MRH through information on options for action for climate adaptation and funding opportunities, with the aim of promoting the topic in the region and putting it on the political agenda,

- create incentives for establishing (inter)-municipality projects through on-site advice.

Measures and projects for climate adaptation must be implemented at a local level. The question of funding and the transformation of ideas into real inter-municipality projects always presents a challenge, especially in rural areas and sub-areas with small-scale administrative structures. The MRH wants to help with overcoming these hurdles and a key point of this project is therefore free advice and support for project development, i.e. support from the initial idea to a structured project description plus advice on funding options and the acquisition of funds (incl. advice on completing applications).

Stakeholders: This project is a collaboration between the MRH, the Coordination Centre for Climate Issues, the rural district of Heidekreis and other districts, rural districts and towns independent of an administrative district in the MRH.

Target groups: The project is aimed at local government political decision-makers and multipliers in the local government authorities of the MRH.

Current status: The MRH steering committee agreed the project funding through the MRH development fund in April 2015. The organisation of the events and advisory services are being commissioned by the project sponsors; the first event is due to take place in November 2015. The project is expected to run until December 2016.

2.14 Research

Climate research is of the utmost importance to Hamburg, both research into climate change itself and also research on the effects of climate change and on adaptation. The scientific community is an important partner of the city here.

2.14.1 Aims

The action area has two aims. The first is to contribute to good climate research from which the city will also benefit: in other words, to strengthen, maintain and further develop the top quality and internationally recognised research location of Hamburg – including for research into the effects of and adaptation to climate change. The second aim is to combine adaptation research with practice in such a way that both sides benefit and progress is made both in knowledge and application.

2.14.2 Measures

The larger research projects, such as the comprehensive KLIMZUG-NORD research project on adaptation to climate change or the city climate research feasibility study, are now finished.

The KLIMZUG-NORD collaborative research project which was supported by 15 million euros of federal funds finished in April 2014. The results of this project, which studied the effects of climate change and options for adaptation in a wide range of action areas throughout the Hamburg Metropolitan Region, have been published in several volumes which present the adaptation options for the regions in a clear and understandable way. The "textbook" – which summarises the results in a condensed form which non experts can also understand – was written for decision-makers in government and society.

The studies which are of the greatest relevance for Hamburg as a city state are those on nature conservation in a changing climate, water management measures and participation formats. New participation formats were used in particular in the catchment of Wandse. The surveys, for example of the Wilhelmsburg district, contain important background information on things like groundwater recharge which must be borne in mind for every subsequent urban redevelopment.

These findings now need to be used and pilot projects for adaptation measures developed which are scientifically supported and evaluated. The attempt will also be made to maintain the network set up under the KLIMZUG-NORD project and to further disseminate the knowledge gained in the Hamburg Metropolitan Region.

Besides this large collaborative research project, other research projects have taken place whose results will now be used in practice. Hamburg has provided particular support for research on the urban climate. The findings on the large- and small-scale effects of additional development, green roofs and open spaces on the micro-climate must now be incorporated in planning. Therefore, a portal is to be set up, which will make the results available to private users as well.

2.14.3 Key projects

2.14.3.1 Hamburg Climate Campus

Description and aim: The Hamburg Climate Campus is a network formed by universities, research institutions and Federal ministries to undertake climate research, to discuss and reach agreement and to jointly run activities such as e.g. the Climate sciences day 2014, the 10th German climate conference in September 2015 and other joint activities in public relations work. One current joint project is to produce a climate report for the Hamburg Metropolitan Region Part 2 (continuation of the first 2013 report). The climate report is due to be submitted in summer 2017. The aim of the activities is to combine scientific findings, reach a broad public and create the basis for political decisions.

Stakeholders: The partners in the Hamburg Climate Campus network are: Bundesanstalt für Wasserbau (Federal Waterways Engineering and Research Institute), Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency of Germany), Centrum für Erdsystemforschung und Nachhaltigkeit (Center for Earth System Research and Sustainability), University of Hamburg, Climate Service Center Germany (GERICS), Deutsches Klimarechenzentrum (German Climate Computing Centre), HafenCity University, Hamburgisches WeltWirtschaftsinstitut (Hamburg Global Economic Institute), Institut für Friedensforschung und Sicherheitspolitik an der Universität Hamburg (Peace Research and Security Policy at the University of Hamburg), Institut für Küstenforschung, Helmholtz-Zentrum Geesthacht (Institute for Coastal Research at the Helmholtz-Zentrum Geesthacht), Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology), Seewetteramt Hamburg des Deutschen Wetterdienstes (Hamburg Marine Weather office of the German Weather Service), Technische Universität Hamburg-Harburg (Hamburg University of Technology). Support: Hamburg Ministry for Environment and Energy (BUE), Ministry of Science, Research and Equality (BWFG).

Target groups: Climate research and everyone with an interest in it – government, the public.

Current status: A permanent and ongoing task, regular events organised

2.14.3.2 Further development of the excellence cluster "Climate System Analysis and Prediction – CliSAP"

The excellence cluster CliSAP and the large range of sub-projects it contains are supported by the federal and state excellence initiative in the current funding period from 2012-2017. Based on the research results obtained, the excellence cluster will develop strategically and, after 2017, participate in the successor to the excellence initiative with a new funding application. The excellence cluster needs to be expanded, especially by social science and economic sub-projects which address the social and economic effects of climate change and adaptation to climate change. The application will likely be made in 2016/2017 after the call for tenders (the tenders for the follow-up to the excellence initiative are currently still being prepared).

2.14.3.3 Fraunhofer Application Centre for Power Electronics

Description: The Fraunhofer Institute for Silicon Technology (ISIT) and the Competence Center for Renewable Energies and Energy Efficiency (CC4E) at the Hamburg University of Applied Sciences (HAW Hamburg) are jointly developing an application centre for power electronics and renewable energies.

The centre is to focus on the decentralised electrical energy supply. The areas include the use of renewable and fluctuating generation of electrical energy, efficient and reliable electronic power components and systems for transforming electrical energy and efficient electrochemical energy storage based on a new type of lithium batteries plus intelligent battery sensors.

Aim: to provide excellent research and services for the renewable energy industry, raise the educational quality of the HAW Hamburg and make use of synergies with the Hamburg Technology Centre Energy Campus.

Stakeholders: HAW, Fraunhofer Institute for Silicon Technology.

Current Status: the project started at the end of 2014. The total financial framework for the application centre comprises 4.4 million euros, of which 3.4 million euros are being met by the state of Hamburg and an additional 1 million euros are being raised by the Fraunhofer Society. The project runs for a total of five years.

2.14.3.4 Hamburg Technology Centre Energy Campus

Description: Renewable energies have developed very rapidly into an important element of economic policy in recent years. The Competence Center for Renewable Energies and Energy Efficiency (CC4E) at the Hamburg University of Applied Sciences (HAW) therefore set up the "Hamburg Technology Centre Energy Campus" as a research centre for wind energy and intelligent power grids on its own campus, with funds including around 3.5 million euros from the European Regional Development Fund (ERDF). The energy transition and the expansion of renewable energies offers an enormous economic potential which will be able to be exploited even better in future thanks to the energy campus.

This flagship project should enable the Hamburg Metropolitan Region to remain internationally competitive and create a transition to sustainable forms of energy.

Aims: The objective of the Energy Campus is to create a network between companies, universities and institutions for developing applied solutions and innovations for renewable energies which should produce a high level of utility for the general public. The Energy Campus is focussing specifically on the three core areas of knowledge orientation, citizen orientation and company orientation.

Stakeholders: HAW – CC4E

Target groups: Other universities, companies, citizens

Current status: The new "Hamburg Technology Centre Energy Campus" was opened on 3rd February 2015 in the Schleusengraben in Hamburg-Bergedorf.

The CC4E want to set up a research facility with a wind laboratory and a Smart Grid/demand side integration laboratory as the nucleus of the expanding Energy Campus.

They plan to install wind turbines in the 2 to 3 megawatt class. The integrated network of research facilities with the wind park will enable the creation of numerous research projects and potential synergies. Examples of this are research on the integration of wind power into the electricity grid and enabling fluctuations to be balanced through load management and storage components.

Thanks to the direct connection of the planned wind park to the technology centre, the turbines can be studied directly in the wind laboratory.

The Smart Grid laboratory will be used to develop and test efficient and intelligent solutions in the interplay of energy generation, consumption and storage (interplay of demand side integration, grid-supporting heat generation, energy storage and building services).

The Hamburg Technology Centre Energy Campus will also be expanded into a public information centre which provides information on renewable energies, increases understanding and creates an open dialogue with members of the public.

It is hoped that the opportunity to visit laboratories and wind energy and photovoltaic systems and to use interactive information platforms will arouse interest and generate knowledge. Events are planned, especially for schools.

V. Controlling and Monitoring

1. Controlling, reporting and updating

As a long-term development plan for climate change mitigation and adaptation to the effects of climate change in Hamburg, the Climate Plan needs to be regularly adapted and revised in line with current developments. The Senate therefore updates it regularly. The update describes the monitoring results on achieving the objectives in different action areas and projects, project development (completed and newly launched measures) and changes to the framework conditions in varying amounts of detail. The criteria for project funding are developed further. The responsible ministry involves the other ministries and external partners in preparing the report.

The Senate has commissioned the Coordination Centre for Climate Issues with coordinating the climate change mitigation and adaptation measures for all the ministries. This includes

the recording and evaluation of monitoring the measures, financial controlling and CO₂ monitoring. The Coordination Centre for Climate Issues has discontinued the previous controlling procedure using the eBIS Klima Software and developed a modern procedure using SharePoint Klima in the FHH intranet. There is an annual request about the progress of the measures, information on funding and the CO₂ reductions achieved if relevant, both for funded measures and for the so-called FHH mainstreaming measures. Measures which have received funds from the central programme of the Climate Action Master Plan (PG 265.04 / from 2016 292.14) also require an annual report with detailed descriptions.

Of the 175 measures included in Annex 1 to the Hamburg Climate Plan, 45 have been awarded funding by the central programme. 35 projects make direct savings in CO₂ emissions and a further nine projects are predicted (as at November 2015) to make savings in CO₂ by 2020. Some measures from the Climate Action Plan 2007-2012 have only been included due to the return flows of funds, but have not been developed further and are mentioned here for the last time, as are other completed measures which were not pursued further and have been transferred to another project because they do not save any CO₂.

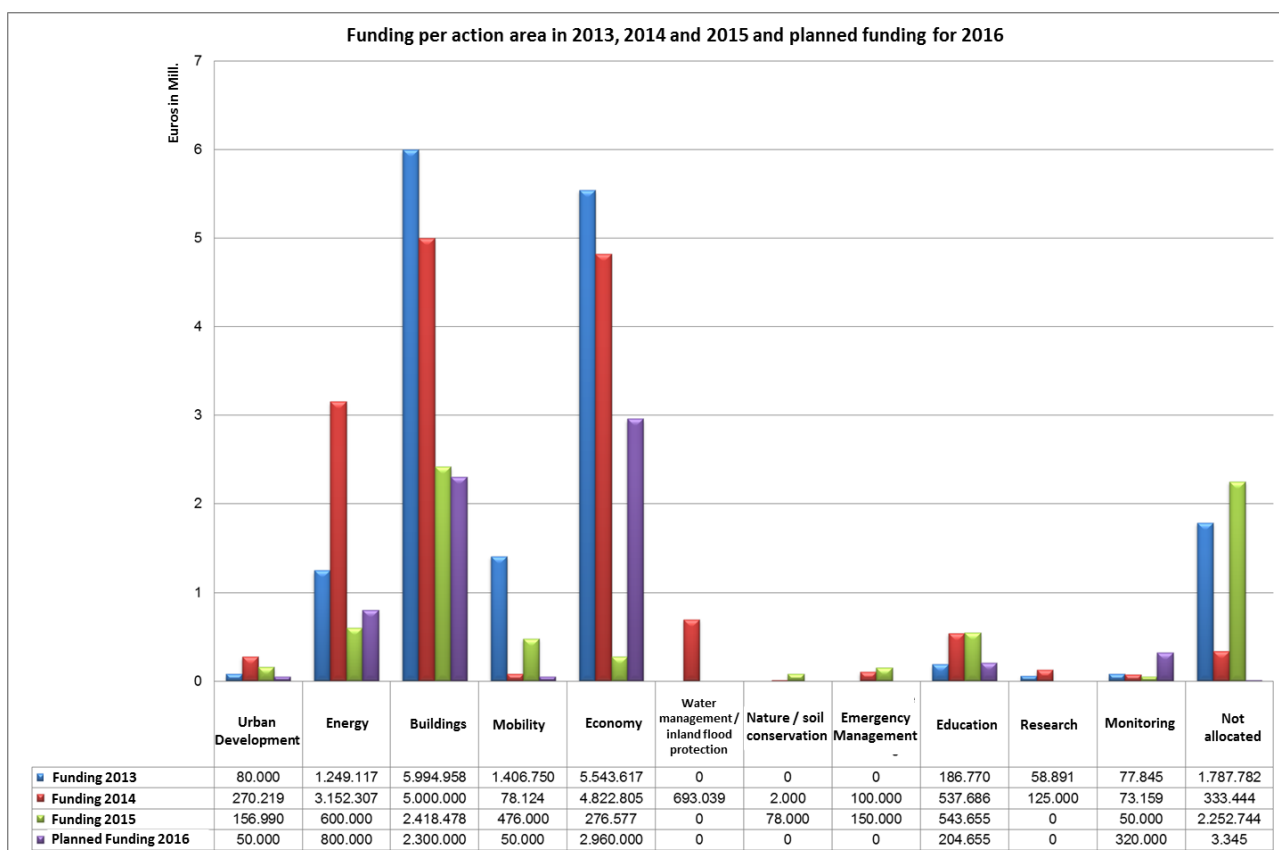
2. Managing fund allocation and other funding options

Managing fund allocation

The Hamburg Climate Plan covers measures with very different funding requirements. A significant proportion of this funding requirement is met from the budgeted cost authorisations from each of the sections or through third-party funding. What are normally supplementary authorisations from the Hamburg Climate Action Plan are allocated to the ministries and district offices during the year upon application for a transfer of funds. Authorisations which have not been used or are not allocated (planned for) in the Hamburg Climate Plan are returned to the central programme of the Climate Action Master Plan (PG 265.04 / 292.14 from 2016) and used for other climate change measures.

The programme could not be delivered at its previous level while the funding programme was being transferred to the Hamburgische Investitions- und Förderbank (IFB) in 2013 and 2014. Additional time and staff resources were required for developing new administrative structures and process flows in the IFB, the transfer of activities related to specific programmes to new personnel and the organisational and contractual division of the tasks between the sectoral planning authorities and the IFB. This also explains the high return flows of unused funds for some funding programmes, which sometimes resulted in low or negative funding figures in 2015. After completion of the transfer phase it can be assumed that, from 2015 onwards, the IFB will again initiate and support more projects.

The distribution of climate funds during 2013-2015 and the planned fund distribution for the different action areas for 2016 are shown in euros in Table 1 and the percentage distribution in the individual years in Figures 6-9. The distribution of climate funds amongst the separate measures is shown in Appendix 1. Negative figures occur where the return flows of unused funds were higher than the approved grants for that year.



Tab. 1: Funding per action area in 2013, 2014 and 2015 and planned funding for 2016 in euros

Financial year 2013

For the financial years 2013 and 2014, 8,040 thousand euros were budgeted for the heading 6800.893.19 Climate Action Master Plan (investment) and 5,360 thousand euros for 6800.971.19 Climate Action Master Plan (consumption). In 2013 there was therefore a total allocation of 13.4 million euros available. In addition there was a balance from the Climate Action Plan of 2,985,730 euros not included in the implementation and return flows during the year of unused funds of 978,752 euros, which raised the funds available in 2013 to 17,364,482 euros. Funds of 15,576,700 euros were used in the implementation.

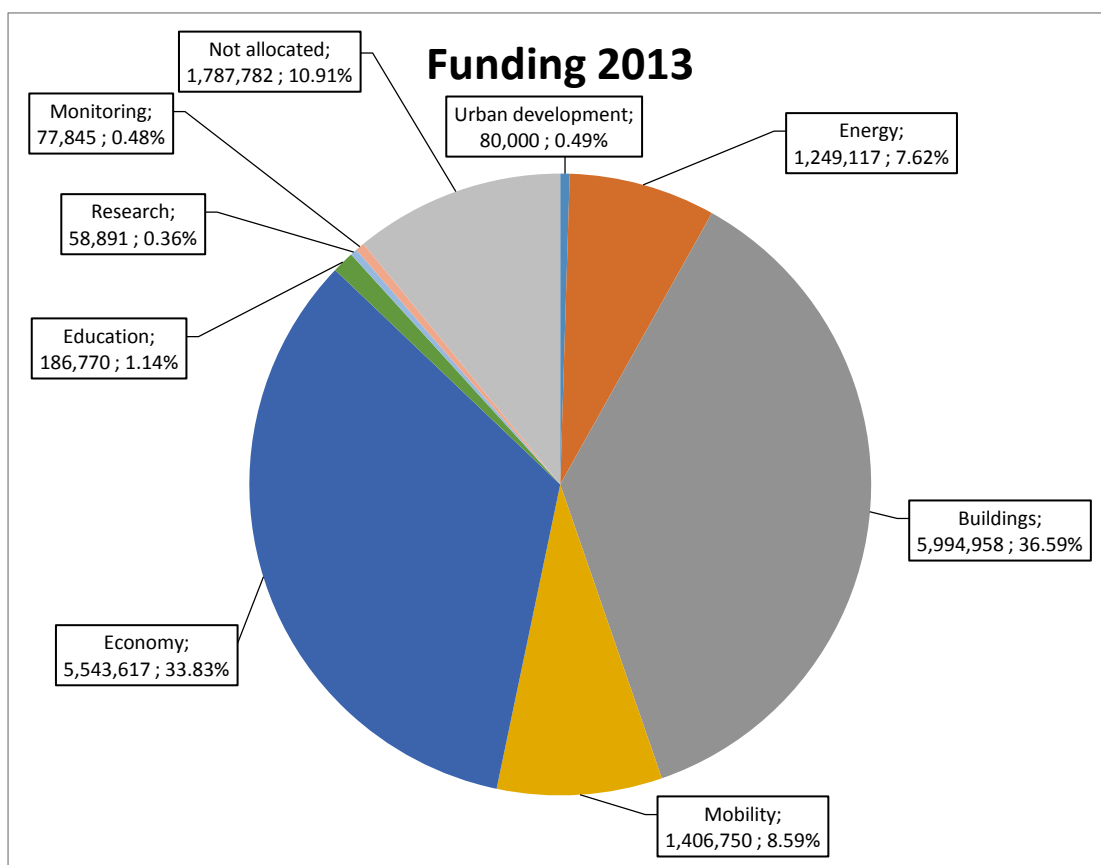


Fig. 6: Fund distribution in 2013 by action area

Financial year 2014

By transferring the section 6 to the double-entry structures of the strategic reorganisation of the budget in accordance with para. 15a LHO (State budget code), the entire allocation for 2014 was moved to the central programme of the Climate Action Master Plan (product group 265.04). The balance of 1,787,782 euros not used in the implementation in 2013 was also transferred to the central programme of the Climate Action Master Plan after 2014. In addition, in 2014 there were return flows of 619,085 during the year which raised the available authorisations to 15,806,866 euros. 15,473,423 euros were used in the implementation.

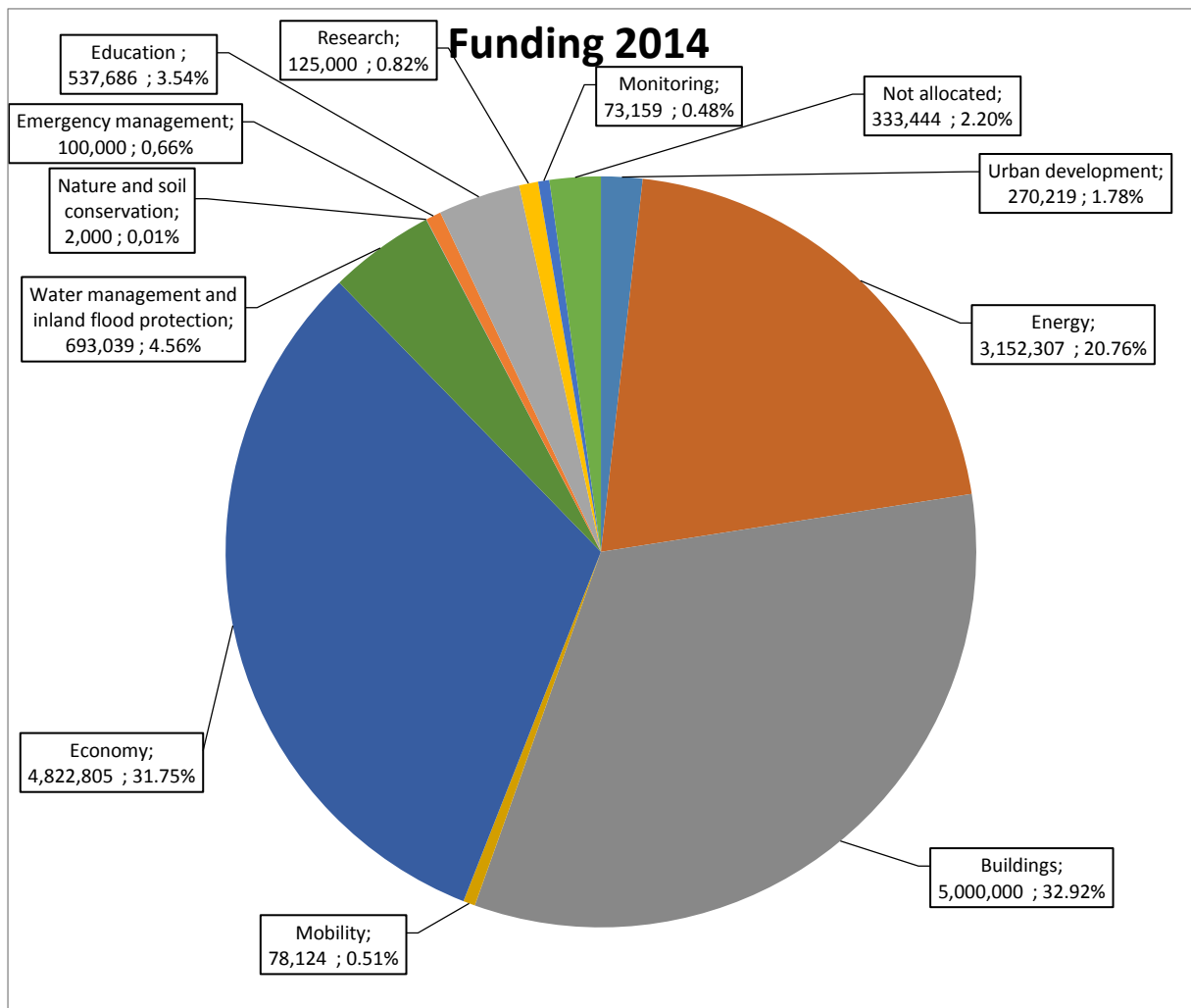


Fig. 7: Fund distribution in 2014 by action area

Financial year 2015

In 2015 there was a total of 6,669 thousand euros available. The balance of 333,444 euros not used in 2014 was transferred to the central programme of the Climate Action Master Plan after 2015. In addition, there were 3,168,606 euros of return flows during the year which raised the available authorisations to 10,171,050 euros. 7,918,306 euros were used (as of November 2015). Further applications are being processed.

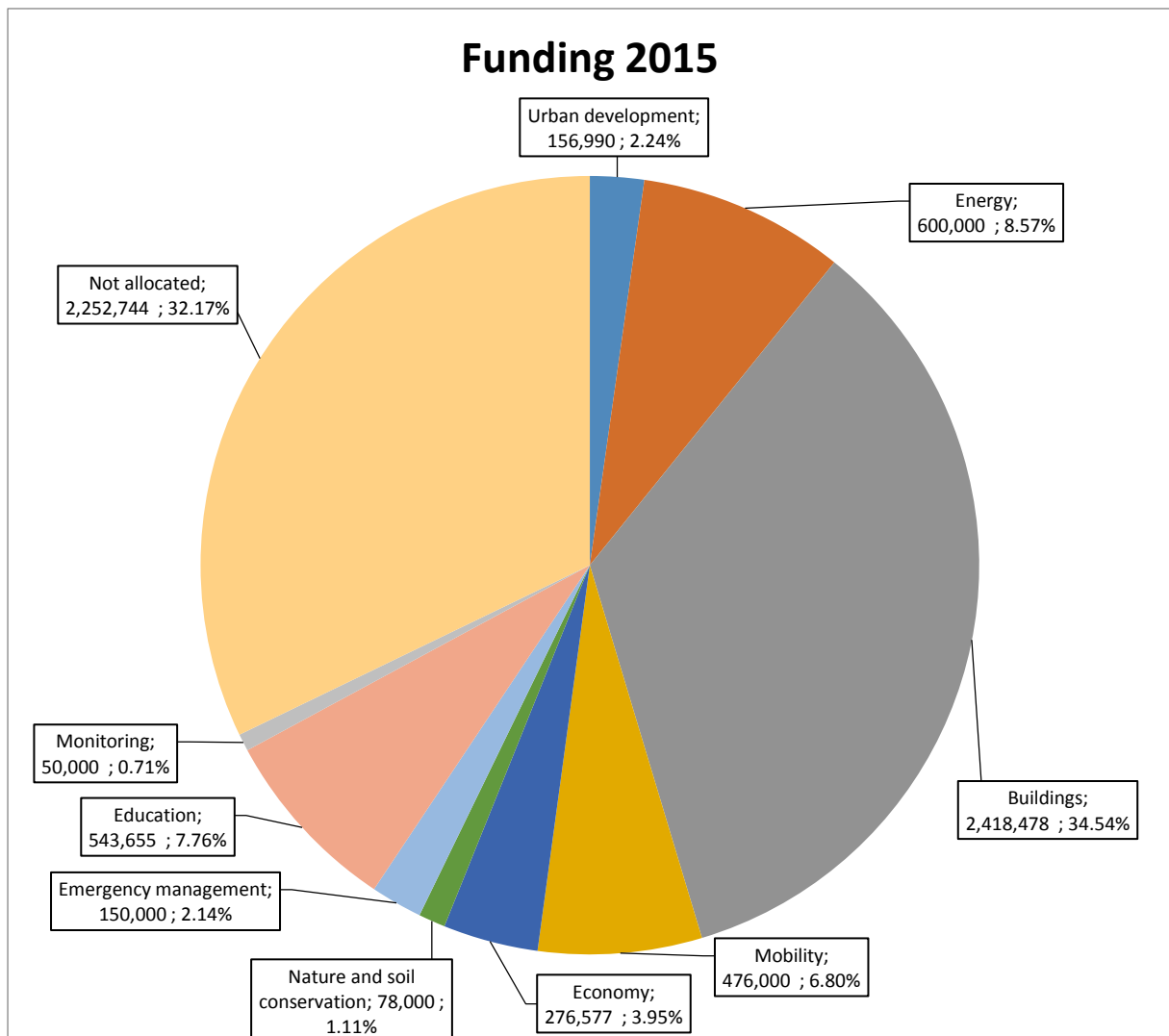


Fig. 8: Fund distribution in 2015 by action area

Financial year 2016

There are 6,688 thousand euros available as authorisation in 2016. The authorisations should once again be used more for FHH's own measures and CO₂ reducing measures, in order to reach the CO₂ reduction targets.

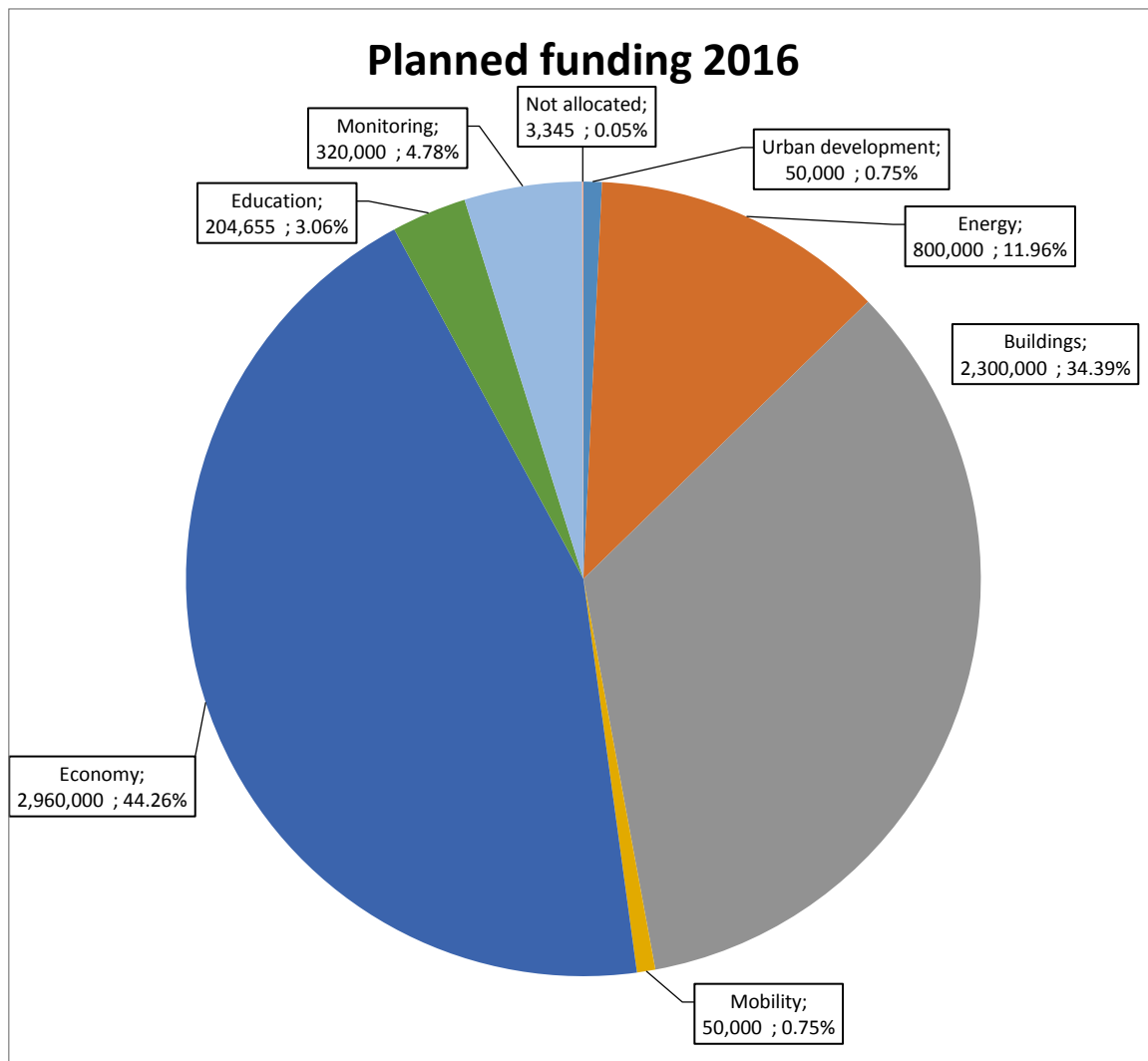


Fig. 9: Fund distribution in 2016 by action area

Other funding options

Besides funding through authorisations from the Climate Plan, more third-party funding (federal and EU funds) is being attracted. European, national and state funding sources must be coordinated and used in the best way possible. Funding programmes can only develop their full impact if they are adopted by the relevant target groups. This means that the funding programmes have to be advertised all the way to acquisition in the companies. Adequate funds must be made available over a specific period, the funding arrangements must be as simple as possible and advice to potential clients must be well-founded and flexible.

An anticipated 24.4 million euros is to be used from the Kommunalinvestitions-förderungsgesetz (Act to support investment in financially weaker municipalities) for refurbishing schools and universities and another 30 million euros for funding cycling measures.

3. Greenhouse gas accounting

3.1. CO₂ monitoring

3.1.1 Bottom-up balance sheet

A bottom-up CO₂ accounting based on the measures funded by the Senate as well as non-funded measures and mainstreaming (as far as possible) is being carried out to check the effectiveness of the climate change mitigation measures.

This method directly records the reduction in CO₂ emissions of specific measures under the Climate Plan and also the effectiveness of climate change mitigation funding. In addition, it opens up the possibility of the early adjustment of measures such as e.g. funding programmes. This tried and tested method which has already been used at the recommendation of the Wuppertal Institute for Climate, Environment and Energy within the Hamburg Climate Action Plan 2007-2012, has now been taken up by many other cities. The recording and monitoring of the reduction in CO₂ achieved is thus based methodologically on the experiences from the Climate Action Plan 2007-2012 which received scientific support from the Wuppertal Institute for Climate, Environment and Energy.

The Climate Plan is confined to the reduction potentials which can be influenced and assessed by Hamburg. Federal measures cannot in fact be influenced by Hamburg but form important synergies with Hamburg's measures. The Master Plan focusses on measures with a high reduction potential for CO₂ emissions and high level of cost efficiency in terms of funding from climate change funds.

The overriding quantitative aim is to make a reduction of 2 million tonnes of CO₂ emissions by the end of 2020 in comparison with 2012.

	CO ₂ reduction up to 2013 (in t)	CO ₂ reduction up to 2014 (in t)
Climate Action Master Plan / Climate Plan	171,640	304,564
Amount carried over from Climate Action Plan 2007-2012	96,403	96,403
Total	268,043	400,967

Tab. 2: CO₂ emission reductions without green energy measures

After the bottom-up CO₂ monitoring for the individual measures in the Climate Plan, a total of 400,967 tonnes of CO₂ emissions had been saved by the end of 2014 in comparison to the base year of 2012, see Table 2. The projects included were those funded by the Senate's climate action funds, mainstreaming measures (i.e. projects run by Hamburg ministries which include climate change mitigation as part of the task fulfilment but without direct funding) and projects without funding from climate action funds (e.g. voluntary commitment by industry). A list of the projects which have contributed to CO₂ accounting with the

reduction in CO₂ emissions achieved in 2013 and 2014 compared to the base year of 2012 is attached as Appendix 2.

The Climate Plan also contains measures which contribute indirectly to reducing CO₂ emissions, e.g. projects on education, research and adaptation to climate change which are nevertheless very important for the success of the Climate Plan and for achieving the Senate's specified climate goals.

The result of the reduction in CO₂ emissions (see Tables 2 and 5) includes 96,403 tonnes which were initiated in the course of the Climate Action Plan 2007-2012 by the Companies for Resource Protection funding programme (86,445 tonnes) and CHP initiative (9,958 tonnes), but which only took effect after their completion in 2013. This amount carried over is shown separately in the Climate Plan balance for methodological reasons. The Senate supports electricity generation from renewable energies. It has therefore been buying green energy for its public institutions and some of the public companies for years. The CO₂ reduction due to green energy measures is shown in Table 4.

Measure	2013 in t CO ₂	2014 in t CO ₂
Green energy in public facilities	209,875	209,875
Green energy for business trips by rail	1,814	3,980
Total	211,689	213,855

Tab. 4: Reduction in CO₂ emissions from green energy measures

In total, CO₂ emissions were reduced by 614,822 tonnes by the end of 2014 in comparison to the reference year of 2012.

	CO ₂ reduction up to 2013 (in t)	CO ₂ reduction up to 2014 (in t)
Master Plan / Climate Plan	383,329	518,419
Amount carried over from Climate Action Plan 2007-2012	96,403	96,403
Total	479,732	614,822

Tab. 5: Reduction in CO₂ emissions including green energy measures

The reduction in CO₂ emissions for the individual action areas of the Climate Plan are divided as follows: the largest component is due to the action area economy with 46 per cent, followed by the action area energy with 33 per cent (see Figure 12). If green energy is taken into account, then the energy action area leads with 60 per cent followed by the economy action area with 27 per cent (see Figure 13).

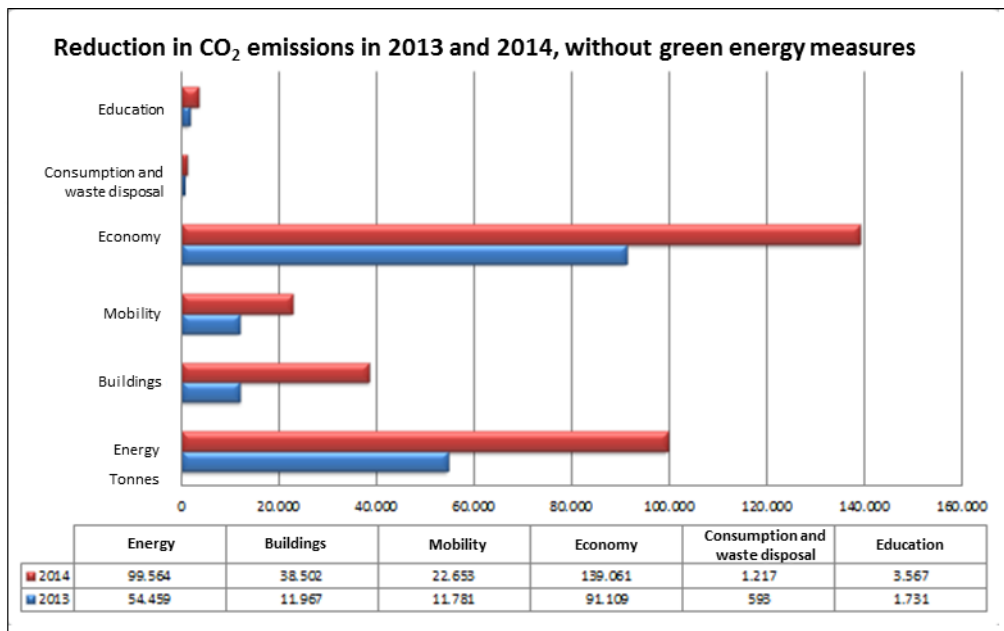


Fig. 10: Annual reduction in CO₂ emissions in 2013 and 2014 by action area, without green energy measures

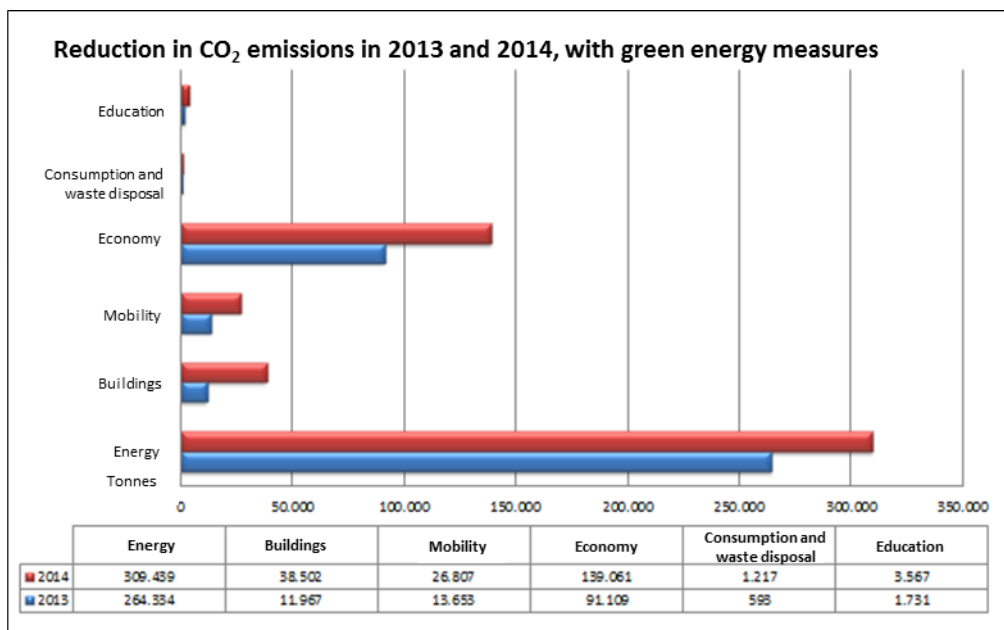


Fig. 11: Annual reduction in CO₂ emissions in 2013 and 2014 by action area, with green energy measures

The percentage distribution by action areas is as follows:

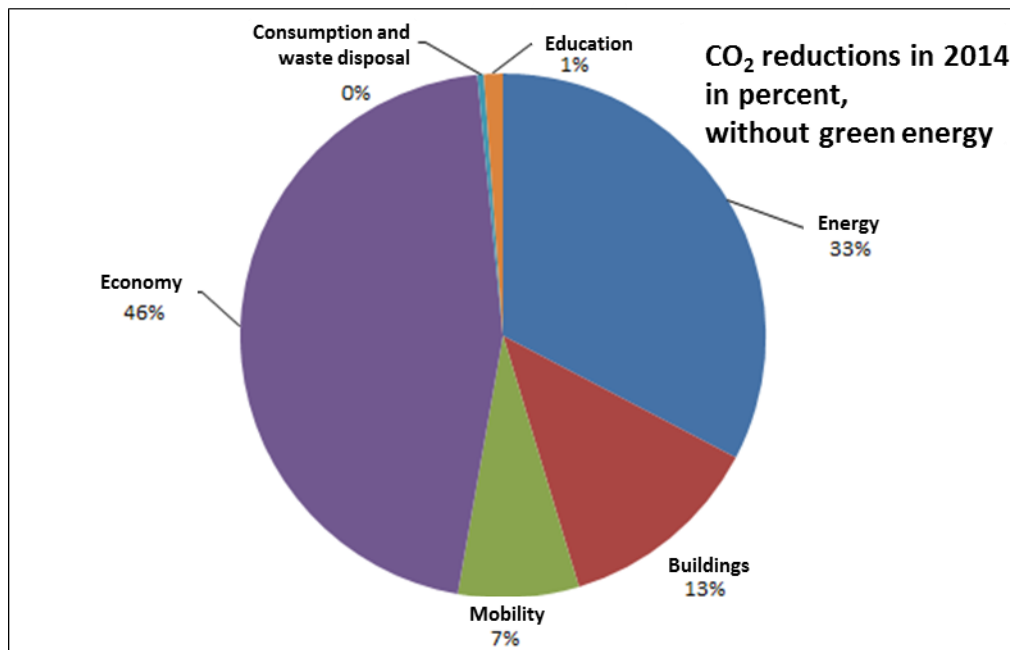


Fig. 12: Annual reduction in CO₂ emissions by the end of 2014 by action area, without green energy measures

Taking green energy measures into account, the percentage distribution for the action areas is as follows:

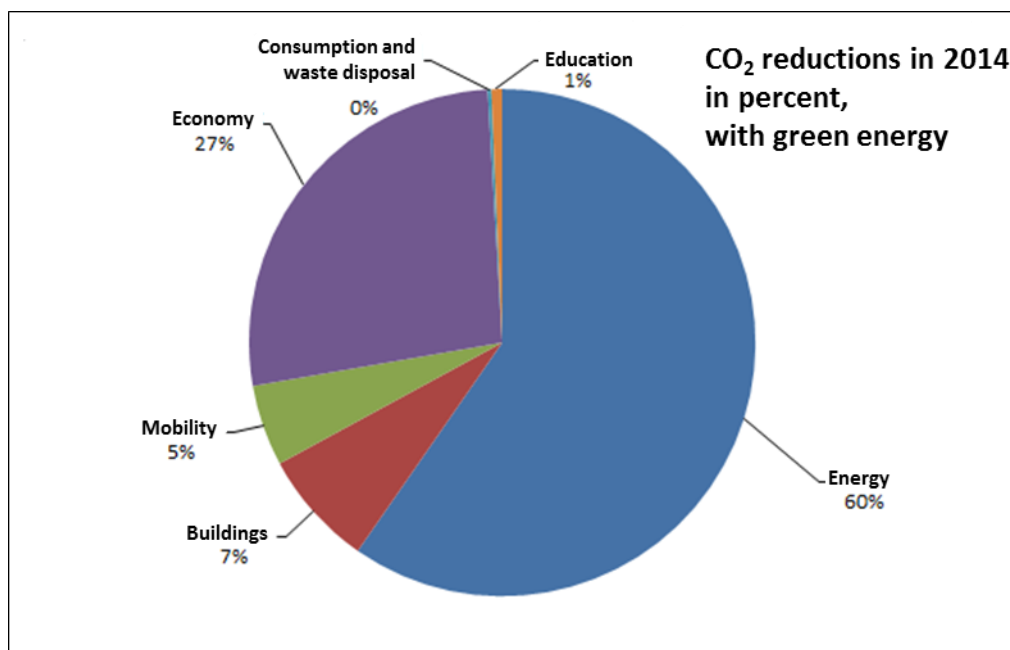


Fig. 13: Annual reduction in CO₂ emissions by the end of 2014 by action area, with green energy measures

Evaluation: Looking at the direct CO₂ reduction figures reached in 2013 and 2014, it is apparent that the predicted reductions of 200,000 and 225,000 tonnes per year for each of the years were not quite achieved. The reasons for this include e.g. difficulties during the transfer of the funding programmes to the newly established IFB from 2013 and the discontinuation of the measures included in the Climate Action Master Plan within the cooperation agreement with the energy providers Vattenfall and E.ON. The highest reductions in CO₂ emissions were achieved through voluntary commitment by industry with 87,989 tonnes and by the expansion of large-scale bioenergy plants with 81,386 tonnes.

3.1.2 Hamburg consumers' balance sheet (top-down)

Parallel to the measure-related survey of reductions in CO₂ emission in the Climate Plan, the Statistikamt Nord (Northern Germany Statistical Office) also records and evaluates Hamburg consumers' energy account.

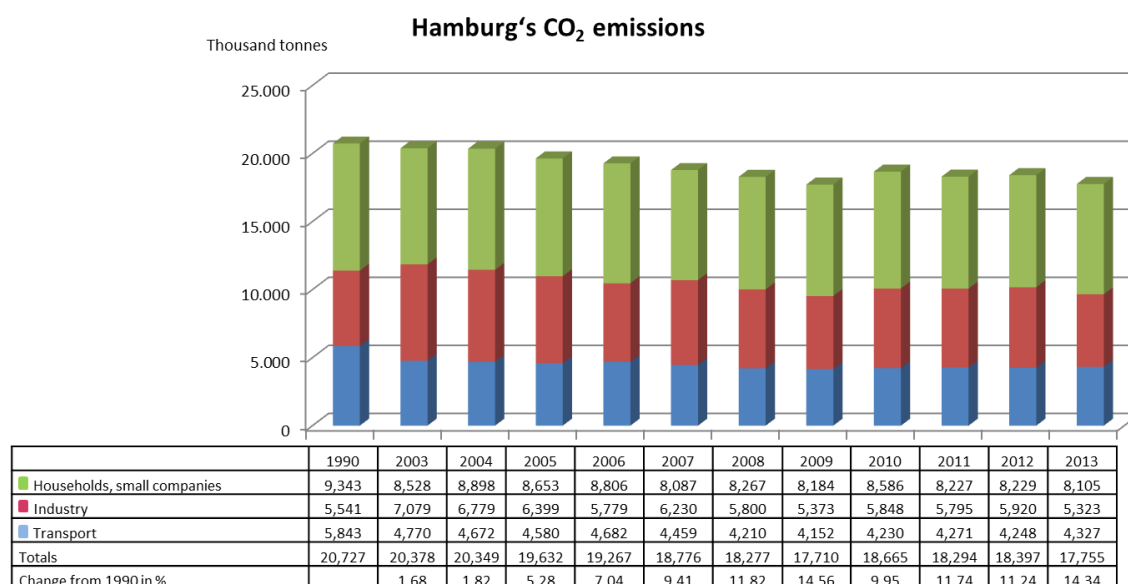


Fig. 14: Hamburg's CO₂ emissions: consumers' balance sheet (source: Statistikamt Nord, as at November 2015)

The CO₂ emissions have fallen significantly with 17.7 million tonnes in 2013 compared to 18.4 million tonnes in 2012. This gives per capita emissions of 10.2 t. The economy's greenhouse gas intensity has also fallen considerably with 178 kg per € 1000 gross domestic product (GDP).

The most important factor for the fall in emissions is the sharp drop in the consumption of natural gas and petroleum products in industry, despite the generally strong economic growth. However, a significant part of this is due to a few large industrial consumers in the petroleum and metalworking industries, whose production is normally subject to fluctuations. It therefore remains to be seen what proportion of this will contribute to a permanent drop in emissions.

The fall in CO₂ emissions from power consumption in the household/business, trade and services areas can largely be put down to the commercial sector. There is no trend visible here at present. Emissions from traffic have increased again for the first time in a while.

Looking at the changes over the last ten years, the most important factor in the fall in energy consumption is due to all the significant energy carriers in industry.

The most important influence from the area of climate change policy on Hamburg is the Erneuerbare-Energien-Gesetz (EEG) (Renewable Energy Act). The expansion in renewable energies has resulted in the electricity in the German grid being significantly cleaner.

The Hamburg climate change policy has had more of an influence on the fall in consumption of natural gas and heating oil in the areas of households/business, trade and services. This is due mostly to a lower consumption of heating energy. The improvement in efficiency in the housing sector is even more noticeable if the increase in living space is taken into account.

Note: the time series presented here have been subject to various methodological changes in the state working group on energy balances. In particular, adaptations to the emission factors are made basically every year. One important change is the separate booking of types of industrial waste (minus a biogenic component) and house waste (with a biogenic component of 50 per cent) from 2008. These types of waste were previously recorded with an emission factor. This methodological change has now been applied all the way back to 2003 for Hamburg. In addition, an incorrect entry for several years by industry on the statistics of industrial energy consumption has been corrected.

Evaluations

The population of Hamburg rose by 94,342 in the period from 1990 to 2013. The gross domestic product rose by 17,448 million euros from 82,020 million euros in 2003 (no comparable data available for 1990) to 99,468 million euros in 2013. The greenhouse gas intensity fell in the same period by 70 kg per € 1000 GDP.

This illustrates that Hamburg is a growing city, both in terms of the number of inhabitants and economic strength. In terms of the consumer balance sheet, Hamburg's CO₂ emissions only changed by 14.3 per cent up to 2013 compared to the base year of 1990. Allowing for the rise in the number of inhabitants and the increase in the gross domestic product, CO₂ emissions per capita declined by around 14 per cent in comparison to 2003 and greenhouse gas intensity – a reflection of CO₂ emissions compared to Hamburg's GDP – fell by around 28 per cent.

Changes as at 2013 compared to the base year of 1990 or 2003	
Total CO ₂ emissions (acc. to the consumer balance sheet Statistikamt Nord)	-14.3%
Emissions per capita in t compared to 1990	-19 %
Emissions per capita in t compared to 2003	-13.5%
Greenhouse gas intensity (CO ₂ emissions in relation to gross domestic product) compared to 2003	-28.4%

Tab. 6: Changes in CO₂ emissions in comparison to 1990 or 2003 (Source: Statistikamt Nord, as at Nov. 2015)

The graph below gives an overview of the most important changes since 2003. It highlights two areas in which the climate change policy has been particularly successful.

1. The consumption of heating fuels has declined (both reference years show a similar winter temperature level). In view of the 13 per cent rise in living space, this is an incontestable success for the measures to improve energy efficiency in buildings.
2. Electricity has now become cleaner, due to the nationwide high proportion of renewable energies. This means that the EEG continues to have the most important influence on improving Hamburg's balance sheet, although the greenhouse gas intensity of the German power mix has increased again since 2009 due to replacing nuclear power with coal.

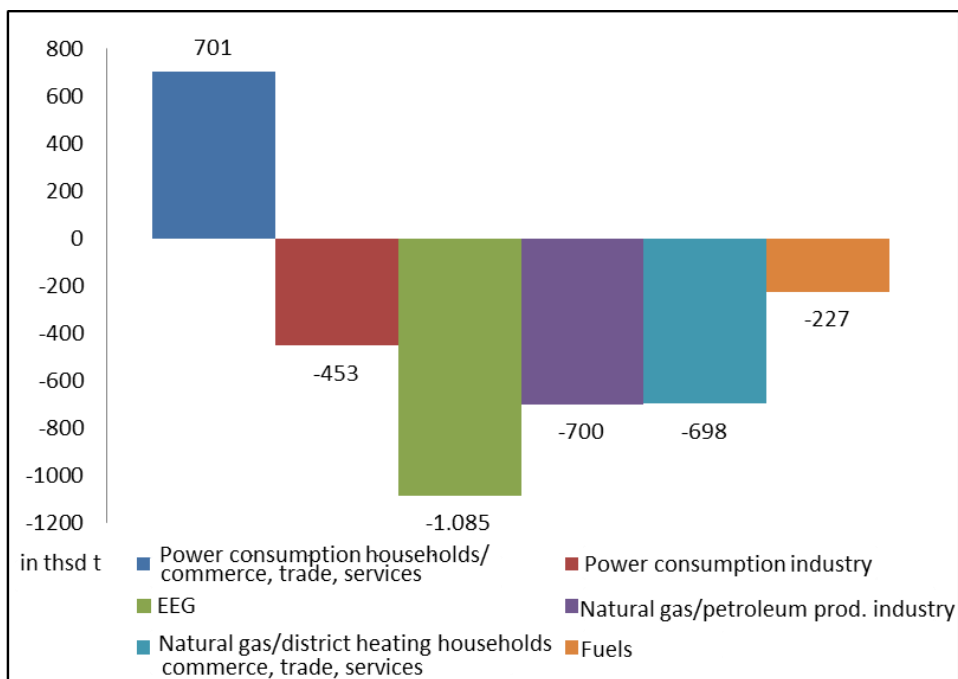


Fig. 15: Changes in CO₂ emissions in Hamburg from 2003 to 2012 (Source: Statistikamt Nord and calculations by the Hamburg Ministry for Environment and Energy, Nov. 2015)

3.2. Accounting for other greenhouses gases

The Kyoto Protocol covers other greenhouse gases besides CO₂ emissions. At state level calculations are made for the greenhouse gases CH₄ (methane) and N₂O (nitrous oxide) in addition to CO₂. In Hamburg both greenhouse gases are of lower importance than CO₂ emissions because Hamburg has e.g. a lower proportion of agriculture and no mining compared to area states where these two greenhouse gases are more important. Since 1990 emissions of methane have dropped by 25 per cent (61,000 tonnes of CO₂ equivalents) and of nitrous oxide by 16 per cent (38,000 tonnes of CO₂ equivalents).

Fluctuations in these two greenhouses gases are due to the groups which produce these emissions. For transport, the annual mileage of the increase in the number of vehicles over the year is used. For waste management and waste water treatment, the calculation is based on the increase in population which has taken place over the past few years in Hamburg. In agriculture the use of mineral fertilisers varies.

Hamburg is concentrating on CO₂ emissions.

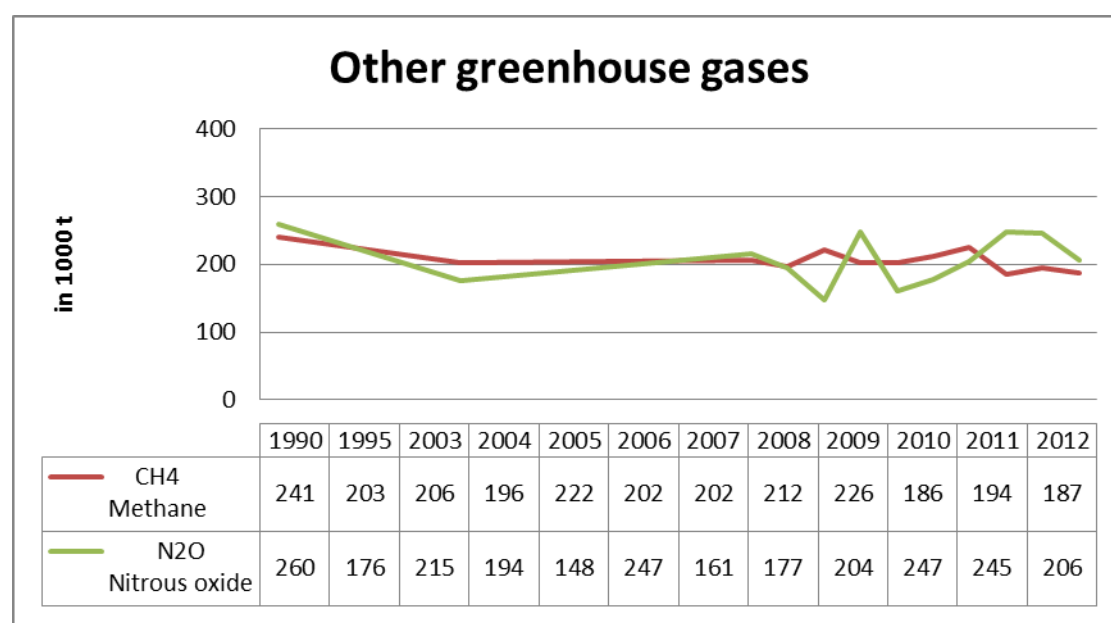


Fig. 16: Other greenhouse gases (System of Environmental-Economic Accounting (SEEA), Statistikamt Nord, as at Oct. 2015. The data for 2012 and 2013 are provisional)

Note: CH₄ (methane) and N₂O (nitrous oxide) are direct emissions which cannot be calculated or compared with the consumer balance sheet.

3.3. Development of greenhouse gas emissions in Germany from 1990 to 2013

According to the German Federal Environment Agency, greenhouse gas emissions in Germany have been significantly reduced since 1990. The total emissions converted into CO₂ equivalents (minus CO₂ emissions from land use, land use change and forestry) dropped by around 297 million tonnes or 23.7 per cent up to 2013. Total emissions of 953 million tonnes were reported for 2013, around 5.5 million tonnes more than in the previous year, but around 14 million tonnes less than in 2011.

A recent estimate by the German Federal Environment Agency for 2014 shows a clear decrease in emissions to 912 million t CO₂ equivalents (- 4.3 per cent compared to 2013) and therefore a reduction of 27 per cent compared to 1990, see Fig. 17.

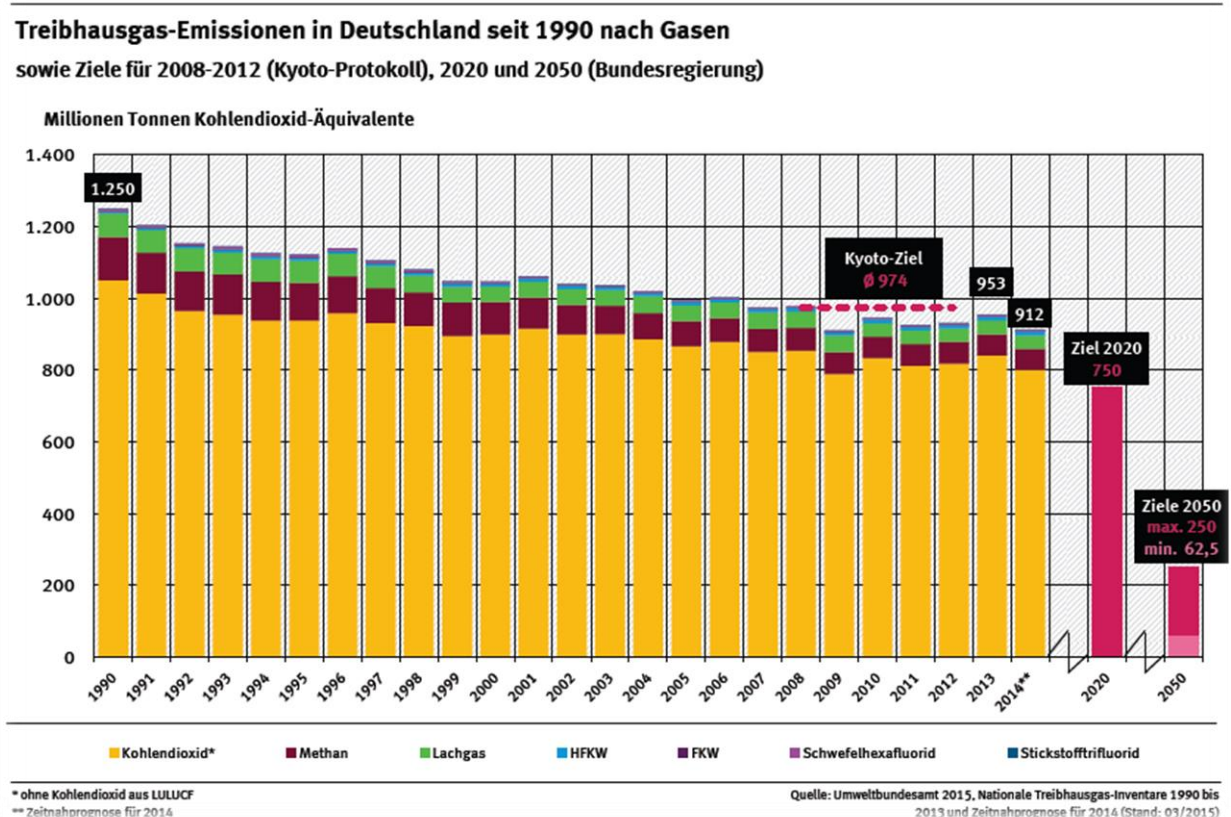


Fig. 17: Emissions of greenhouse gases in Germany from 1990 to 2014

Treibhausgas-Emissionen in Deutschland seit 1990 nach Gasen	Greenhouse gas emissions in Germany since 1990 by gases
sowie Ziele für 2008-2012 (Kyoto-Protokoll), 2020 und 2050 (Bundesregierung)	and targets for 2008-2012 (Kyoto Protocol), 2020 and 2050 (German Federal Government)
Millionen Tonnen Kohlendioxid-Äquivalente	Million tonnes of carbon dioxide equivalents
Kyoto-Ziel	Kyoto target

Ziel 2020	2020 target
Ziele 2050	2050 targets
Kohlendioxid*	Carbon dioxide*
Methan	Methane
Lachgas	Nitrous oxide
HFKW	HFC
FKW	PFC
Schwefelhexafluorid	Sulphur hexafluoride
Stickstofftrifluorid	Nitrogen trifluoride
*ohne Kohlendioxid aus LULUCF	*minus carbon dioxide from LULUCF
** Zeitnahprognose für 2014	** Recent prediction for 2014

4. Climate change monitoring

The Hamburg climate change monitoring programme aims to provide detailed information on climate change and its effects on Hamburg as well as on the success of the adaptation measures. This is essential in order to be able to set a wise medium- and long-term course for adapting to the advancing changes in the climate.

Some of the consequences of climate change can already be observed but others will only become apparent in the coming decades. The climate change monitoring programme will serve as an aid by giving an overview at any point of how the various climate parameters have developed over the years and decades and will indicate when there is a need for action. In addition, it will enable an evaluation of whether the responsible authorities in the city have dimensioned their adaptation measures appropriately.

It is important to design the measurement programmes for the long-term and to guarantee that they will last. There are no additional costs involved because all the indicators defined to date come from existing measurement programmes. A large part of the data is owned by the German Weather Service which is prepared to make the climate indicators available to the city in the long term as part of their cooperation.

The Hamburg climate change monitoring programme will be developed in three stages.

1. Monitoring the Hamburg climate over decades using state indicators:

A list of north German climate indicators was drawn up to this end, in cooperation with all the north German states, the German Weather Service (DWD) and the North German Climate Office. The data are constantly recorded by the DWD and show how

the climate has already changed. They are available on the Norddeutscher Klimamonitor at <http://www.norddeutscher-klimamonitor.de/>.

2. Monitoring Hamburg's vulnerability:

Impact indicators can be used to highlight and display data of specific importance to Hamburg. In the first instance these are data which have already been collected in the past and are available in the city, such as water levels for the Elbe and its tributaries. The measurement programmes may need to be expanded at a later date. The list of indicators will be added to over the next few years.

3. Monitoring the effectiveness of adaptation measures:

The third step is to develop response indicators which show the adaptation measures already taken in characteristic values. Comparing these with the impact and state indicators enables the effectiveness of the measures to be evaluated. This stage has not yet been started.

Climate change monitoring is a long-term instrument due to the time periods which are involved in climate change and therefore has to be carried out over decades. It may be of crucial importance to the city. It is therefore important to have the necessary resources permanently available and to continue with existing measurement programmes.

Monitoring of climate effects is currently under development. The state indicators of relevance for Hamburg are shown in the "Norddeutscher Klimamonitor". This was developed and implemented by the North German Climate Office of the Helmholtz-Zentrum Geesthacht and the Hamburg Regional Climate Office of the German Weather Service. The climate monitor presents such things as the climatic conditions and climate developments over the last 60 years (from 1951 to 2010) for the Hamburg Metropolitan Region and other regions in northern Germany. The individual state indicators are illustrated on the climate monitor website in a user-friendly manner by means of maps and diagrams. For further information see www.norddeutscher-klimamonitor.de.

D. Budgetary implications

Hamburg's Climate Plan includes measures with very varied funding requirements. A large part of this funding requirement is met from the funds budgeted in each of the product groups or through third-party funds. The Hamburg Climate Plan funds are allocated to the ministries and district offices during the year upon application, by way of the debit transfer. In the section of the Hamburg Ministry for Environment and Energy, product group 265.04 (or 292.14 from 2016) there are 6,669 thousand euros budgeted for the product "Climate Action Master Plan central programme" for 2015 and 6,688 thousand euros for 2016.

Appendix 1 shows the allocation of funds for 2013, 2014 and 2015 and the designated allocation of funds for 2016.

The Senate will report on the implementation and updating of the Hamburg Climate Plan in 2018 and then every two years in parallel with the budgetary deliberations.

E. Petition

The Senate requests that the Hamburg Parliament will take note of this report on the "Hamburg Climate Plan".

F. Appendices

1. Lists of measures and funding from the central programme "Climate Action Master Plan" for 2013, 2014, 2015 and planned for 2016
2. CO₂ monitoring – list of measures of reductions in CO₂ achieved