

## Work Package 10: Rapid Planning “Entry Projects” in the Case Cities

### D10 Experiences in Infrastructure Development in the Reference City Frankfurt am Main

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*This document examines Frankfurt am Main, Germany, as a reference city for studying the planning and implementation processes of urban infrastructure development focused on sustainability and maintaining good quality of life. The first section of the document describes the diverse projects being implemented in the sectors of energy, water, wastewater, solid waste and urban agriculture. These projects serve as examples of environmentally-friendly urban development, as well as inter-departmental collaboration and continuity in the development of a sustainable city. This section also highlights the collaborative approach to urban infrastructure planning and management in Frankfurt. The second section of the document compiles the lessons learned from the previous analysis.*

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## List of Abbreviations and Acronyms

ABG Frankfurt Holding (German: Aktienbaugesellschaft)  
AG (German: Aktiengesellschaft)  
ARA (German: Abwasserreinigungsanlagen)  
AVA Nordweststadt GmbH (German: Abfallverbrennungsanlage Nordweststadt)  
BBF (German: BaederBetriebe Frankfurt GmbH)  
BUND (German: Der Bund für Umwelt und Naturschutz Deutschland)  
CHP Central Heat and Power  
e.V. (German: eingetragener Verein)  
FAS (German: Frankfurter Abfallmanagement- und Service GmbH)  
FES (German: Frankfurter Entsorgungs- und Service GmbH)  
FFR GmbH (German: Frankfurter Fußweg-Reinigung)  
FSG (German: Flughafen-Service GmbH)  
GmbH (German: gemeinnützige Gesellschaft mit beschränkter Haftung)  
GmbH (German: Gesellschaft mit beschränkter Haftung)  
GmbH & Co. KG (German: Gesellschaft mit beschränkter Haftung & Co. Kommanditgesellschaft)  
IFEU (German: Institut für Energie- und Umweltforschung Heidelberg GmbH)  
MHKW (German: Müllheizkraftwerk Frankfurt GmbH)  
Mm<sup>3</sup>: Million cubic metres  
MPCP: Master Plan 100% Climate Protection  
NRM (German: Netzdienste Rhein-Main GmbH)  
RMB (German: Rhein-Main Biokompost GmbH)  
RMS (German: Rhein-Main Solarpark GmbH)  
SEVA (German: Schlammmentwässerungs- / Verbrennungsanlage)  
SMR (German: StraßenBeleuchtung Rhein-Main GmbH)  
VGF (German: Verkehrsgesellschaft Frankfurt am Main mbH)

## SECTION 1: Documentation of the RP Relevant Experiences and Projects in Frankfurt am Main, Germany

### 1. The Rapid Planning Project

The fast pace of urbanisation in the world challenges the capacities of municipalities to provide public services and urban infrastructure to newly developed areas. The demand for adequate public infrastructure has led municipalities to implement reactive planning procedures aimed at solving emergent problems, instead of preventing future challenges. Moreover, traditional planning approaches allocate responsibilities onto different municipal agencies which, then, address specific urban problems from a sectoral perspective. Sectoral problem solving has resulted not only in inefficient and ineffective urban development projects but also discouraged communication between municipal agencies, hindering collaboration, along with efficient use of financial and technical resources. The challenges of urbanisation are likely to escalate with population increase, inequality and climate change; therefore, municipalities are in great need to find innovative planning approaches which provide the instruments to respond to urban challenges while preparing for future developments.

Urban planning practices have changed in the past decades, introducing multi-sectoral approaches and promoting collaboration and coordination of implementation among municipal actors in order to achieve a sustainable urban development process. Sustainable food production, renewable energies, water provision and waste management, among others, impact the quality of life of urban dwellers directly, becoming essential factors in improving the conditions of the built environment and enhancing the resilience of cities against climate change. Sustainable development demands a coordinated action for implementation of urban projects, efficient use of resources and a vision for a better future.

To propose a rapid planning methodology, the Rapid Planning project has adopted the principles of sustainable development proposed by the Future Megacities Programme as the basis for analysing the existent initiatives and proposing a sustainable vision for the future. Analysing planning systems through the Future Megacities Project principles, the Rapid Planning project has identified deficiencies in the use of synergies for the provision of public infrastructure, namely, redundancies in data management, material flows and joint work in the implementation of projects.

#### 1.1. Documentation of the RP Relevant Projects and Experiences in Frankfurt

The Rapid planning project is an action-oriented research aiming at improving the planning and implementation procedures in order to increase the effectiveness and efficiency of urban infrastructure development within five specific sectors: energy, water, wastewater, waste management and urban agriculture. The project focuses on increasing the efficiency of data gathering processes, promoting trans-sectoral planning and implementation of urban infrastructure and

stimulating decentralisation and collaborative planning approaches for highly dynamic metropolises in the developing world. The project seeks to identify, characterise and analyse those initiatives that have an impact on the sustainability of the city and could be transferred to the case cities selected for the implementation of the Rapid Planning methodology: Kigali in Rwanda and Da Nang in Vietnam. Likewise, the Rapid Planning Project has selected the city of Frankfurt as a referent city. As a reference city, a deeper study of its experiences, projects, achievements, but also problems and hindrances can contribute substantial knowledge to the Rapid Planning concepts, procedures and methodologies. The purpose of having a city from a developed country is to examine the planning and implementation processes for the provision of public infrastructure and identifying the possible strategies, projects, technologies or processes that could be transferred and applicable to other cities in the world. Frankfurt's experiences can illustrate ways and actions of planning, sequential arrangements of planning steps, the involvement of the civil society as well as legal frameworks and conjunctions with the political and economic spheres.

The city of Frankfurt am Main in Germany is a dynamic metropolis and the heart of the Rhein-Main Region. It is a relatively large European city, becoming an attractive location for local and international companies. Fuelled by economic development, Frankfurt am Main has experienced an unexpected population growth since 2008 and the projections indicate a continuity of this trend for the next decades (Dobroschke and Gebhardt, 2015). Population growth represents an opportunity for the city but also challenges the municipal and regional departments to respond to urban expansion while following sustainability principles. Despite these challenges, the city has achieved a balance by creating a livable environment with a good quality of life, focusing on the integration of environmental protection and sustainable development objectives. This integration has demanded collaboration between municipal departments as well as a city-wide vision for urban development. The Rapid Planning Project, therefore, selected Frankfurt as a reference city in order to study and understand the municipal dynamics in regards to the planning and implementation processes for public infrastructure.

Consequently, this first section presents and describes the public services and urban infrastructure provision experiences in Frankfurt am Main related to the five sectors of Rapid Planning i.e. energy, waste, water, wastewater, and urban agriculture. The research identifies the relevant practices, projects and experiences implemented in the city for planning urban infrastructure, along with the main actors within the city government and other organisations. In this sense, this section focuses on the trans-sectoral collaboration for infrastructure planning and provision, as well as on the collaboration among organisations. In this task, the core partners within the city government of Frankfurt, from the environment, energy and urban planning departments, from public utility and service companies, and other experts will be identified. Relevant campaigns, projects, and activities within the fields of sustainable urban development, environmental management, energy and urban infrastructure provision will be defined. For this, existing data and results of the identified campaigns and experiences will be collected, analysed and summarised. The data and results will be assessed to the context of the RP methodology, specifically to evaluate existing trans-sectoral interfaces between different sectors and actors within the city.

## 1.2. Research Methodology

The Rapid Planning Project is developed through the collaboration of teams from diverse academic and research institutes in Germany, as well as the UN-Habitat and the local offices in each one of the case cities. Each research team is in charge of project tasks in accordance with the team's strengths and emphasis. In the case of the reference city, Frankfurt am Main, the Rapid Planning team at the Frankfurt University of Applied Sciences (FRA-UAS) focuses on sustainable urban planning and development. This document aims at identifying the urban development practices which have led the city to become a good example for sustainable urban development.

The research about Frankfurt am Main examines the five main sectors of urban development selected by the Rapid Planning Project: energy, water, wastewater, waste management and urban agriculture. The project aims at exploring the initiatives implemented in the city for promoting sustainable practices, as well as the linkages and interconnection between the five Rapid Planning sectors. The implementation of urban projects in each of these sectors implies different processes as well as different actors involved. Therefore, the FRA-UAS team has designed a mixed methods methodology characterised as applied qualitative research and based on collaborative planning and trans-sectoral infrastructure implementation.

Applied research can identify the important features of the planning process while qualitative research goes beyond the numerical data to use empirical and a broader understanding of processes, interactions and relations between phenomena. As Jane Ritchie & Liz Spencer explain, applied research requires specific information and has the potential for implementation of the results in practice. The qualitative applied research, in this case, was chosen because the main objective of this document is to identify and describe the projects, initiatives and processes implemented in Frankfurt am Main in the five sectors. Ritchie & Spencer categorise this typology of research as *“Strategic: identifying new theories, policies, plans or actions”* (Ritchie & Spencer, 2002, p.307).

The research selected an array of projects covering the five sectors of the Rapid Planning projects from an extensive literature review of academic, official and municipal documents publicly available by any person on the internet or at each one of the municipal departments of the city. This data collection included infrastructure projects, initiatives for public education and programmes. From the available options, the research describes 24 experiences and selected 6 specific projects in the Rapid Planning sectors for a more in-depth description and analysis. The projects, initiatives and programmes selected presented important features that could be transferred to other cities or represent good practices in the infrastructure provision.

The analysis of the experiences in Frankfurt was made through a process of categorisation and pattern recognition, where the FRA-UAS team analysed the typology of the experience regarding each sector and the collaboration among the actors involved in the implementation. This analysis led to the definition of four collaboration typologies as well as three typologies of stakeholders involved in the experiences in Frankfurt.

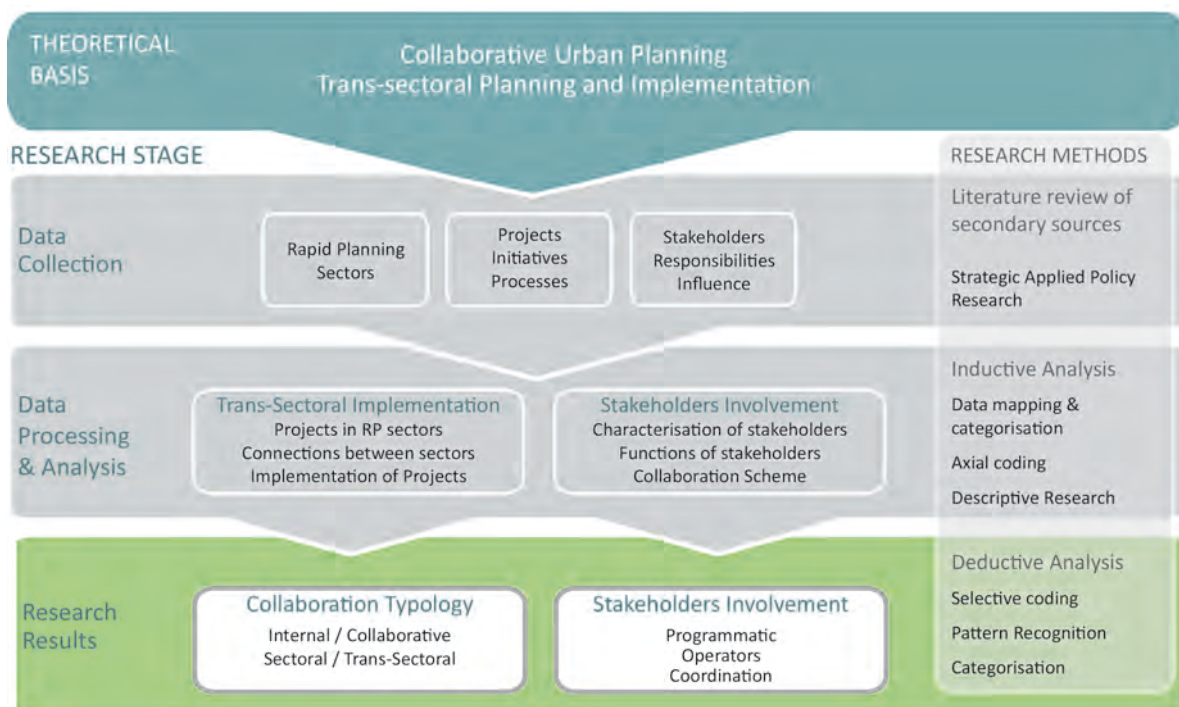


Figure 1: Research Methodology for Task 10.4

### 1.2.1. Criteria for Selection of Experiences and Projects

In order to define the scope of the research, the projects and experiences selected for this research were chosen according to four main criteria, in line with the interests of the Rapid Planning Project:

- Involvement, direct or indirect, in at least one of the five sectors of Rapid Planning
- Direct involvement in management processes of infrastructure provision i.e. production, collection, consumption.
- City-wide implementation
- Officially published and publicly accessible.

Nevertheless, the document also contains additional lists of organisations and experiences which are located beyond the established criteria, but present an interesting example for the case cities of Rapid Planning.

### 1.2.2. Section Structure

Chapter Two of this section describes the two main umbrella policies which are steering urban development and infrastructure provision in Frankfurt am Main, the *Master Plan 100% Climate Protection* and the *Frankfurt Green City* initiative. Both focus on maintaining the green profile of the city while improving the quality of life through sustainable consumption and development. Subsequently, the chapter briefly introduces the actors, i.e. public organisations, institutions and private companies, involved in the planning and provision of urban infrastructure for the five sectors of Rapid Planning. The chapter describes the typology of ownership for each actor, their involvement in the Rapid Planning sectors and their responsibilities.

*Chapters Three to Seven*, present the experiences, practices and projects selected sector by sector. The structure of these chapters introduces a relevant practice, project or initiative that has been identified as the most interesting in terms of its relevance for the sector or the possibilities for transferability to the Rapid Planning case cities. This relevant practice is described in depth explaining the main features, processes, and main stakeholders involved in the relevant practice. Later on, the chapters introduce other projects or initiatives also interesting for the Rapid Planning Project, providing an abridged description of each. The projects or initiatives have been categorised into Practice-oriented, Programmatic and Educational. The Practice-oriented, as the name indicates, are experiences and projects focused on the efficient delivery or collection of public infrastructure or services. The Programmatic experiences are policies and programmes promoted mainly by public institutions to transform building or service provision practices. These programmatic experiences are set in place in order to increase the feasibility of the city in achieving the goals proposed in the municipal visions. The Educational experiences are aimed at the public in order to raise awareness and educate residents in environmentally friendly practices and reduction of consumption of natural resources.

*Chapter Eight* presents a brief stakeholder assessment of the actors involved in the five sectors of Rapid Planning.

## 2. Sustainable Development Initiatives in Frankfurt

### 2.1. Master Plan 100% Climate Protection

As one of the first cities in Germany to comply with the Master Plan 100% Climate Protection Policy, Frankfurt has drawn up a specific set of guidelines for transitioning from fossil fuels to 100% provision of energy from renewable resources and reducing CO<sub>2</sub> emissions by 95% by the year 2050. The Master Plan 100% is focused on the sectors of heating, electricity, and transport. The Master Plan 100% Climate Protection –MPCP- produces a set of guidelines for the purpose of reducing the current energy consumption by 50% with extended impact on other sectors of development and services. The energetic demand will be met by renewable energy coming from the urban area of Frankfurt and the surrounding Rhine-Main region in equal parts (Stadt Frankfurt am Main, 2019b).

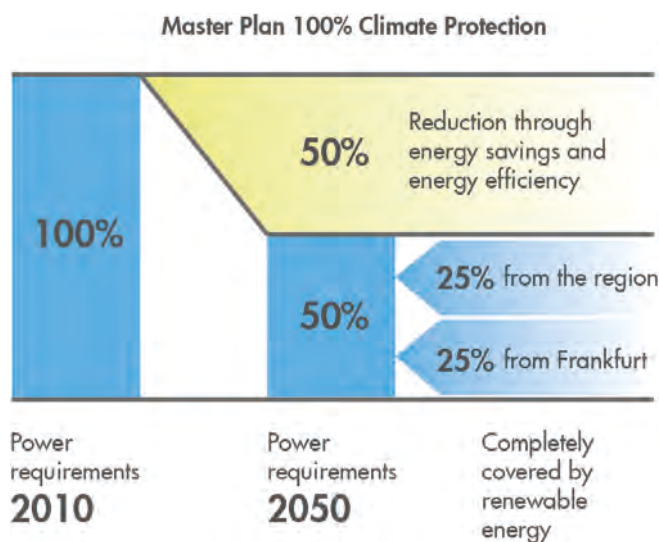


Figure 2: Energetic Demand Provision. Source: (Energierreferat Frankfurt am Main, 2015d)

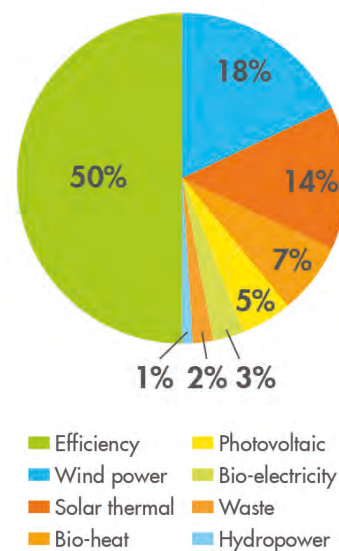


Figure 3: Energy Provision of Frankfurt am Main 2050 (scenario). Source: (Energierreferat Frankfurt am Main, 2015d)

The approach of Frankfurt proposes ambitious goals for energy production and reduction, which could only be achieved with the active participation and contribution of public and private organisations, institutions, companies, associations, etc., along with the citizens residing in Frankfurt and the Rhein-Main region.

Their participation and influence in the development of the strategy are essential even in its early stages (Stadt Frankfurt am Main, 2016g). In order to achieve these goals, the MPCP requires a wide promotion, as well as effective management of the projects and strategies; it is important that individual projects are implemented, and results are achieved. On the other hand, the MPCP needs cooperation and actions on all urban levels by various initiators and target groups (IFEU, 2010). It is important that the strengths of these stakeholders are used, and the existing weaknesses are minimised.

Each stakeholder performs a specific function in the different targets of the plan, and the involvement of the relevant stakeholders could occur in different stages of development of the MPCP (IFEU, 2010). Some of the main stakeholders, their functions and other information are listed in the figure below.



Figure 4: Stakeholders - Master Plan 100% Climate Protection. Source: (IFEU 2010)

- Promoter: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Energy.
- Client: City Frankfurt am Main – Magistrate – Department of the Environment and Health
- Management: Municipal Energy Agency
- Stakeholders: municipal departments, research institutes, construction and infrastructure provision companies.
- Financing: 80% of the BMUB; 20% of the city Frankfurt am Main

(Stadt Frankfurt am Main, 2016g)

Figure 5: Complementary Information about the MPCP

### 2.1.1. Feasibility of the Master Plan 100% Climate Protection

The Master Plan 100% Climate Protection was launched in Frankfurt at the beginning of 2013. The objective of reducing energetic demand and transitioning from fossil fuels to renewable energy represent a myriad of challenges for municipal departments and agencies, public and private businesses as well as the citizens. In order to propose the objectives and strategies for the Master Plan 100%, the city realised a series of urban and material flow studies that defined the feasibility of achieving the plan's objectives. The feasibility studies are the following (Stadt Frankfurt am Main, 2016g):

- Analysis of the current energy status of Frankfurt: current CO<sub>2</sub> balance, the current status of electricity, heating and transport sectors.
- Energy-saving potential and the use of renewable energies in the electricity sector for households, trade, industry and services, as well as for heating, characterising decentralised systems, energetic standards for new buildings, energy renovation of existing buildings, efficient system and heat distribution, network-related solutions, heat efficiency measures in the industry.
- Improvement of efficiency and sustainable mobility in the transport sector: traffic avoidance, motorised individual transport, public transport, marketing, contests, advertising campaign, developments in the transport sector in different scenarios.
- Revision of previous costs for energy in Frankfurt and the Rhein-Main region and the development of energy costs and savings, regional value, funding and financing models.
- Development of new scenarios for Frankfurt in 2050: demographic change and land development, scenarios for electricity, heating and transport sectors, energy scenario for 100% renewable power supply of Frankfurt.

These studies reveal that the city has good potential for reducing energy consumption and provision from the renewable energy. However, having these resources is not enough for achieving the objective of the provision of 100% renewable energy. The balance could be maximised when 50% of the energetic regional potential is combined with storage facilities and reduction of the demand. Also, the programme depends on the stakeholder's participation and their significant decisions and acceptance of the projects among citizens and businesses (Energierreferat Frankfurt am Main, 2016).

| Potential Scenarios | Photovoltaic     | Wind            | Biomass         | Hydro Solar-Thermal | Cogen       |                             |
|---------------------|------------------|-----------------|-----------------|---------------------|-------------|-----------------------------|
| City                | City*            | City            | City            | City                | City        | RA: Regional Authority      |
| City & Region       | City*<br>+50% RA | City<br>+50% RA | City<br>+50% RA | City                | City<br>+RA | S: State                    |
| City & State        | City*<br>+50%RA  | 11,6% S         | 11,6% S         | City                | City<br>+RA | *Roof+walls<br>+open spaces |

Figure 6: Potential Scenarios of Catchment Areas for Renewable Energy Sources

Source: (Stadt Frankfurt am Main, 2016g).

### 2.1.2. Strategies for the Master Plan 100%

The Master Plan 100% Climate Protection presents a very ambitious goal, which shows the necessity of collaboration between different municipality levels and stakeholders, clear management processes, and an understanding of the current status and potentials of the area. In this sense, it is possible to say that the strategy of the MCPC could be considered a strong basis for sustainability policies for Frankfurt. The objectives of the Master Plan 100% require the participation of diverse sectors of society. Thus the strategies are directed to different focus groups i.e. architecture and planning professionals; private businesses and organisations; and the general public.

**Strategies for constructors, architects and planners** (Stadt Frankfurt am Main, 2016g):

- Energy-efficient implementation measures: information sessions and workshops for planners, energy consultants, architects and artisans to reduce the energetic demand in buildings and transport.
- Cogeneration profitability calculations: recommended a retail study on cogeneration projects in Frankfurt with economic analysis and presentation of the CO<sub>2</sub> balance.
- Restoration: demonstration, documentation and examples. Documentation of model projects for energetic refurbishment of buildings
- Green Building *FrankfurtRheinMain*: architecture award for sustainable buildings in the Rhein-Main Region.

**Strategies for private organisations and companies** (Stadt Frankfurt am Main, 2016g):

- Frankfurt spart Storm -Frankfurt saves Electricity-: small and medium enterprises get financial benefits if they invest in electricity savings.
- Ökoprofit Frankfurt am Main –Ökoprofit-: an introduction to corporate environmental management and knowledge exchange with thematic workshops and on-site visits.

***Strategies for private households*** (Stadt Frankfurt am Main, 2016g):

- Frankfurt spart Storm (Frankfurt saves Electricity): the city of Frankfurt provides information and power-savings tips and economic rewards for reducing the energetic household demand.
- Klimaschutzstadtplan (Climate Protection City Plan): all energy-efficient buildings and related renewable energy production or reduction equipment are shown on an online city map.
- Climate tours: Excursions to municipal energy-efficient buildings organised by the city.
- Information packages and advisory lists: the Municipal Energy Agency provides information packages and lists of energy consultants and skilled artisans for solving various energy issues.
- Events: promotion and information about events in the energy sector by the Municipal Energy Agency

**2.1.3. Management and Implementation of the Master Plan 100% Climate Protection**

The MPCP management and implementation process comprises seven phases from an analysis phase to monitoring. The initiation and analysis phases describe the present condition of the issue, where the stakeholders propose strategies and projects to address problems and achieve the objectives. The institutionalisation phase adjusts the strategies to the local legal framework and defines a management board. The communication to citizens and participation of a wider spectrum of stakeholder occurs in the fourth phase of the implementation process, where the projects are developed and socialised with the community. After the concerns of the community are addressed in the decision phase, the process goes to the implementation phase, developing the projects. For the improvement of the process and capacity building of all stakeholders, the last phase of the project is a monitoring process evaluating and reporting to the management the successes and shortcomings. It is necessary to leave enough of freedom for this process. Moreover, that is why the phases are not considered under strict definition. However, especially for promoting this model, some important milestones are necessary. These milestones or phases will be described in more detail in the following section.

***Initiation Phase***

Depending on the local situation, it is beneficial to make a rough analysis to determine significant potentials and weaknesses of the areas to be impacted by the projects. At the same time, broad objectives for the development should be defined. The analysis and objectives define the first decision-making process, demanding an appropriate management structure within the municipality. Therefore, all administrative players (local council, mayor, etc.) must be involved and collaborate with each other. The role of the municipality is crucial for the general financing of the management structures and implementation processes. The co-financing from other organisations (housing association, smaller municipalities, associations, people with private interests, etc.) is approved in order to promote interests in the strategy (IFEU, 2010).

***Analysis Phase***

The comprehensive analysis and evaluation of the current situation of the energy, material and financial flows are necessary to ensure the successful management. Based on the results of the analysis, the potentials and possible projects are identified. In the case of the MPCP, the main goal of the analysis is characterising the detailed CO<sub>2</sub> balance, energy, materials and financial flows, as well as the identification of possible energy reduction opportunities and measures that could be

implemented. An analysis of the issues presented below is important for providing a comprehensive overview of the current situation and possibilities for further actions (IFEU, 2010):

- The general situation in neighbourhoods: description of urban infrastructure, economic structure, actors and networks and a retrospective of activities.
- Information about energy consumption and energy supply: net and gross energy consumption by the public, housing, industry and others sectors; information about existing buildings; the energy consumption of special consumers with available waste and heat sources.
- Information about transport structures: modal split, traffic loads, transportation planning.
- Analysis of other streams and fields of action: waste, wastewater, and their treatment, available biomasses from agriculture and forestry, landscape management and soil management.
- Assessment of future options for actions: possibilities for reduction of energy consumption, increasing efficiencies, cogeneration operation, improvement in policies, analysis of sources of renewable energy, etc.

### ***Internal Institutionalisation Phase***

The central milestone of institutionalisation is defining a climate protection board and its manager. As a part of the previous analysis of key actors, strengths and weaknesses, it is possible to determine already available actors within the administration, which will be responsible for coordination and monitoring of the process. The climate protection board has an advisory role initially. During joint meetings, the board will discuss topics concerning energy optimisation, the priority of implementation, and recommendations for the policy (IFEU, 2010).

### ***Measures Development / Master Plan / Communicable Mission***

The board discussions in joint work with other actors e.g. energy, financial transport institutions, planning agencies, and other organisations, etc., and objectives proposed for the MPCP should produce a set of measures or projects to address important aspects of the development such as (IFEU, 2010):

- Use of existing structures and strengths
- Participation of future initiators and target groups
- Setting realistic and effective measures to the results of the analysis (key partners, potentials, etc.)
- Development of balanced and concrete set of measures with short and medium-term implementation
- Development of measures for the use of economic and social potentials
- Preparation of possible future steps (for example by years)

In order to implement the proposed projects efficiently, a detailed action plan with priorities of actions, investments, business plan and personal investments is necessary, including (IFEU, 2010):

- The definition of cooperation partners for the implementation level (network management)
- Financing plan for each project
- Scheduling the implementation of projects
- Description of possible logistical and economic requirements for projects and cooperation

In this way, the detailed action plan plays the role of a concrete guideline for the strategies proposed in the Master Plan 100%. The aim of the strategy is a serious involvement of local actors in the regional economic development.

### ***Decision Phase***

The implementation of this strategy requires a high-level managerial body similar to the council or board level of companies. Therefore, when the strategies and possible projects are socialised to citizens, and other actors and the feedback is analysed, the board is in charge of deciding over the prioritisation or adjustment of measures and projects, in accordance with the information collected in the public discussions. Thus, the existing objectives of the strategy and defined projects represent a part of the political agenda (IFEU, 2010).

### ***Implementation Phase***

Depending on measures and initiators, various implementation processes are possible. The initiatives of municipalities and other interested actors might guide the implementation process towards a specific goal. It is important to establish or choose multiplayer organisations or private companies which will be responsible for the execution of projects. For example, local utility companies could optimise energy and material flows and also operate as managers and expand its classic services, develop new businesses in cooperation with other local and regional actors.

Despite the fact that these private companies have a profit-oriented nature, it is still necessary to keep the financing of projects as a municipal responsibility, which will make sure that the execution and progress of the Master Plan 100% are directed towards climate protection and energy efficiency.

The population also should be involved in the implementation activities. It is necessary because population represents one of the main target groups for achieving the Master Plan 100% goals. There are many different options of involvement, from interviews to financial participation (IFEU, 2010).

### ***Monitoring***

Monitoring phase has a goal of checking whether measures are implemented, and goals are achieved as well as changing conditions if it is necessary. Long-term success of the strategy can be guaranteed only with updating processes based on new scientific findings, technological developments, new demands, and new possibilities of optimisation. In order to do this, the management processes need regular inspection cycles for reviewing and providing further recommendations. Each actor within its area for its objectives should do the monitoring for better transparency and continuously involvement in the strategy (IFEU, 2010).

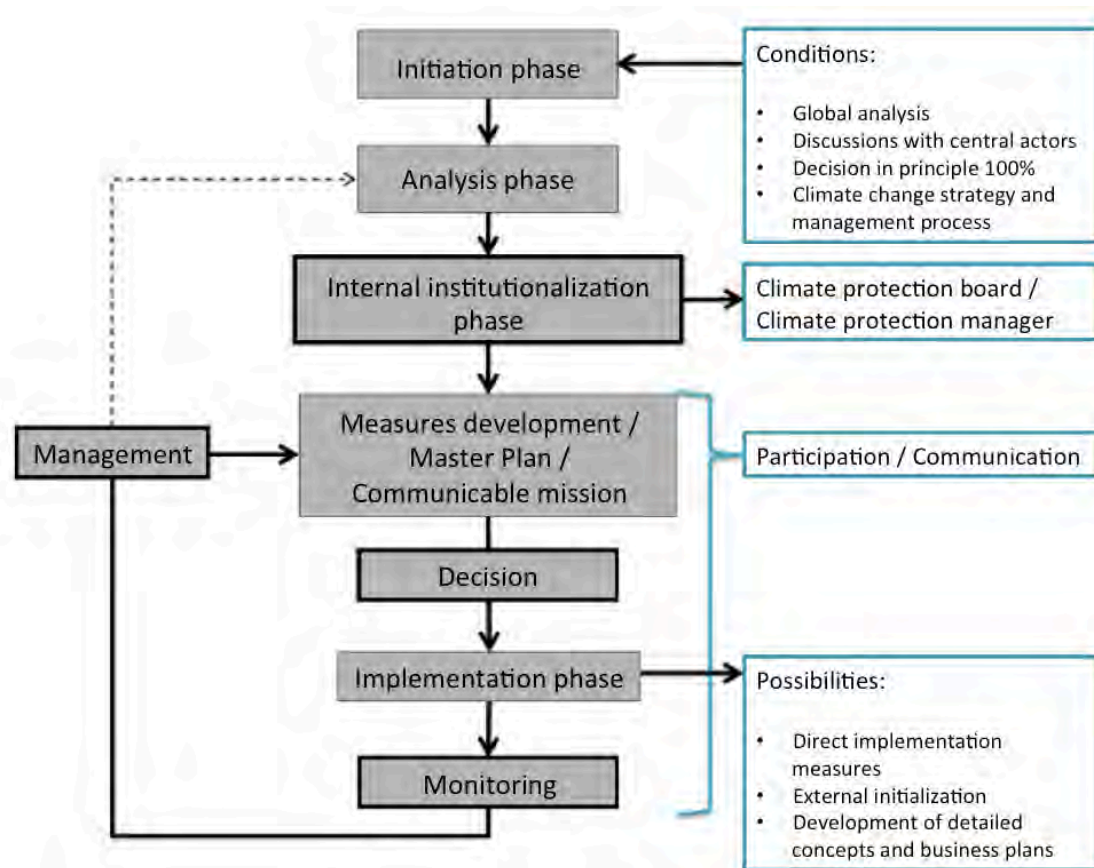


Figure 7: Phases of the Master Plan 100% Climate Protection

Source: (IFEU, 2010)

#### 2.1.4. Timeline for Municipal Energy Policy since 1990

1990 - Establishment of the Energy Department as the Municipal Energy Agency.

1990 - Co-founding and joining the Climate Alliance.

1992 - Decision for cogeneration for Frankfurt.

2006 - Passive house construction as a standard for municipal buildings.

2008 - Second place in Climate Protection Capital.

2012 - Finalist in the Green City of Europe competition.

2012 - Decision to transition to 100% renewable energy by 2050.

2013 - Start of the project Master Plan 100% Climate Protection.

2014 - Constitution of Frankfurt Climate Protection Advisory Board.

2015 - Publication of the Master Plan 100% Climate Protection.

2016 - Intensify the implementation of measures from Master Plan 100% Climate Protection.

Since 1990, the city already has achieved a reduction of CO<sup>2</sup> emissions by 15% per capita (Stadt Frankfurt am Main, 2016g).

## 2.2. Frankfurt Green City

The European Commission established the *European Green Capital Award* in 2010, as a motivation for implementing urban development strategies, with the aim of enhancing the sustainability of cities. The award is part of a set of environmental action plans and policy instruments promoting sustainable development across Europe. The award recognises local projects and policies aimed at improving the condition of the built environment along with the economy and quality of life (European Commission, 2016). Every year cities compete for the award by presenting the sustainability-oriented projects implemented in the city. Stockholm, Hamburg and Copenhagen among others have won the award in past years. Frankfurt competed in 2014 and became one of the finalists along with Copenhagen and Bristol.

The submission of Frankfurt was based on three service provision sectors: energy performance, sensible water usage and e-mobility (European Commission, 2016). Although Copenhagen won the award in 2014, the selection as a finalist served as the basis to promote more sustainable development projects and create a sustainable vision for Frankfurt. The city extended the scope of the green city vision to include other urban sectors, defining four core areas to promote sustainable urbanisation: “Economy and consumption”, “Sustainable mobility culture”, “Planning and construction in dense urban areas” and “Climate and open spaces”. Each core area comprises a collection of exemplary landmark projects (Stadt Frankfurt am Main, 2011) as a response to the urbanisation challenges experienced by the city.

Nowadays the Frankfurt Green City Initiative is accessible to the general public through an online platform managed by the Environment Department as the means to connect with the citizens and provide extensive information about policies and projects implemented in the city (Peterek, 2015). The Frankfurt Green City initiative became much more than an internet platform for the award. The initiative generated awareness about the challenges for the Frankfurt city and region, as well as identified the main aspects of preparing the vision of development for future years. The idea of the Frankfurt Green City is still relevant in the vision of the municipality and, although the initiative lacks explicit guidelines for the formulation of projects, it serves as a starting point for the development of environmental and sustainable development policy for the city.

### 2.2.1. Economy and Consumption

The functions and facilities offered by Frankfurt and the metropolitan region have strengthened the position of the city as a financial hub, exhibitions centre and an important location for a diversity of multinational companies and institutions, e.g. finance, insurance businesses, IT & telecommunications industry, logistics & mobility, etc. The diversity of activities and functions offered by the city not only increase the attractiveness of the metropolitan area but also facilitate interdisciplinary work, knowledge exchange and stimulate exchanges between science and economy. Moreover, transport infrastructures, such as the international airport and train connections to many important German and European cities, have stimulated the local hotel and gastronomy sectors, attracting around 3,7 million visitors a year (Stadt Frankfurt am Main, 2011), and boosting the economy and the production of workplaces in the tourism sector.

### 2.2.2. Sustainable Mobility Culture

Compared with other large European cities, Frankfurt could be considered a medium size metropolis; however, the transport networks developed by the metropolitan region is based on an extended polycentric urban and regional pattern and allows residents of other metropolitan centres to commute daily to the city in a safe, sustainable and fast way. Furthermore, the size of the city combined with the transport facilities provided by public or non-motorized transport modes, promote the use of bicycles or mass transport systems, reducing the carbon footprint of the city along with carbon emissions and improving the quality of life of the inhabitants.

### 2.2.3. Planning and Construction in Dense Urban Areas

Contrary to the demographic trends in many other German regions, the metropolitan centres that compose the Rhein-Main region are in continuous growth regarding population increase as well as the creation of employment opportunities. Frankfurt city, as the core of the region, faces the challenge of densification without compromising the quality of life and providing open and green spaces for the inhabitants. Building renovation, redevelopment of former industrial areas and a mixture of land uses are some of the instruments implemented by the city to prevent the expansion of the urban perimeter and respond effectively to the demand for housing and office space.

### 2.2.4. Climate and Open Spaces

With the densification of the city comes the challenge of offering the inhabitants an appropriate urban environment. The quality of life is directly linked to the quality of the urban environment. Thus the city is adamant in reducing the CO<sub>2</sub> emissions by increasing the efficiency of energy production plants, improving the operation of public transport systems and vehicles, along with promoting a reduction in the use of motorised transport in the inner-city.

Moreover, the protection and transformation of open spaces into green areas for recreation and leisure have been a tradition and an important component in the quality of life of the residents. The transformation of the city-wall into an inner-city green park inspired the creation of the Frankfurt Green Belt, which nowadays extends along 80 km<sup>2</sup> surrounding the city (Stadt Frankfurt am Main, 2011).

## 3. The Energy Sector in Frankfurt am Main

### 3.1. Relevant Practice: Combined Heat and Power - Cogeneration

Germany as a nation is aiming to transition fast from fossil fuels and nuclear energy to renewable clean energy sources. Consequently, power plants using waste or renewable sources such as biomass are supported by federal law to obtain revenues from the production of energy. This is a legal measure for climate protection and reducing dependence on fossil fuels (Mainova, 2009). Combined heat and power –CHP- generation systems are an efficient way of producing energy as electricity and heat simultaneously. The waste heat that is generated in the production of electricity is used for district heating purposes, combining energy generation with a central district heating system for distributing generated heat, hence the term *Cogeneration*. These are a form of energy production

which normally runs on natural gas or fossil fuels. However, in the case of Frankfurt some of these units are utilising bio-waste products or biomass for producing simultaneously energy and heat. The main advantage of cogeneration is that the system uses 90% of the engaged energy and saves up to 40% of primary energy, whereas in conventional power stations 60% to 70% of the primary energy is lost in production. This process reduces carbon emissions, as well as the carbon footprint of the city and these power plants are lucrative and eco-friendly (City of Frankfurt am Main, 2010; Stadt Frankfurt am Main, 2016g).

In Frankfurt cogeneration is an essential part of energy planning. The city is committed to the European programme *CHP goes Green* that promotes an increased use of renewable energy sources from cogeneration. Frankfurt operates more than 200 decentralised facilities and has three major cogeneration-based district heating networks: coal, natural gas and waste e.g. old wood, domestic biowaste, industrial bio waste, and sewage sludge<sup>1</sup>. All together they efficiently produce about 50% of the power and supply large parts of the city with heating like Frankfurt Airport and office skyscrapers

### 3.1.1. Cogeneration Processes

The design of cogeneration power plants in Frankfurt is linked to urban planning. The Municipal Energy Agency collects yearly information about the cogeneration processes and results. The analysis of these data, its impact and possible improvements are discussed with the operators of the power plants in order to improve the cogeneration process. The discussion and sharing of experiences between the involved stakeholders are very important for achieving the sustainable goals of the city. To promote the use of clean energy the Municipal Energy Agency and Mainova offer free consultations for interested organisations, companies and citizens (Umweltamt, 2012; Energiereferat Frankfurt am Main, 2015c; Stadtwerke Frankfurt am Main Holding, 2015a).



Figure 8: Biomass Power Plant Fechenheim, Frankfurt am Main

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<sup>1</sup> Cogeneration facilities that use bio-waste and sewage sludge are discussed separately in waste and wastewater sectors.

There are four large and ten smaller decentralised heating networks in Frankfurt fed by 350 decentralised block-type thermal power stations and five combined heat and power stations, which include two biogas plants and a wood-fired plant. These power plants produce more than 50% of the power efficiently and supply large parts of the city with thermal heat. There is also one plant that produces electricity and heat out of waste products, the *MHKW Nordweststadz* (City of Frankfurt am Main, 2010; MHKW GmbH, 2015b). Among CHP plants, two are of particular interest because they are powered by renewable resources: *Biomasse-Kraftwerk* in the district of Fechenheim, which operates with waste wood and timber; and *MHKW Nordweststadt*, which works in cooperation with the waste collection company FES, using waste products as fuel for energy and heating (Mainova AG, 2016).

### 3.1.2. Biomass Cogeneration Process

Biomass power plants have different capacities and efficiencies, depending on location and type of biomass. In the case of Frankfurt, the cogeneration plant in Fechenheim uses all types of residual and waste timber, producing energy from the green waste of broken wood and waste wood. The power station generates around 80,000 MWh, which is enough electricity for approximately 20,000 households. The plant uses the excess heat to supply industry and commerce. At full capacity, the plant could meet the heat demand of 8,000 households.

The plant needs approximately 13 tonnes of wood per hour. Every day 15 lorries with a capacity of 90 m<sup>3</sup> each reach the Fechenheim cogeneration plant to cover the fuel demand. The fire incinerator must always be burning biomass for the efficient functioning of the plant (Mainova, 2009). Managing the constant supply of fuel is a considerable logistical challenge. In order to do so, the location of the plant is strategic so that the lorries for the fuel delivery do not need to travel long distances, therefore preventing an unnecessary amount of related emissions. The majority of the wood is extracted from a 70 km radius, and there is also the possibility to transport it by rail or ship (Mainova, 2009). The delivered wood is first collected in a vast fuel storage building. Only extremely rough wood must be shredded separately. The storage building has a capacity of 3,000 tonnes of wood, which is enough to keep the plant going for about a week at full load. The wood is then grabbed gradually by a large crane and transported through conveyor belts to the highest point, where it is dropped into the incinerator. The fire burns evenly at a temperature of 850 to 950°C, consuming 13 to 14 tonnes of wood per hour. The incineration process produces steam to power a generator turbine producing energy. The resulting flue-gas emissions are filtered thoroughly after they have cooled down. The quality of the released emissions is constantly monitored by the State authorities. The resulting ashes are safe and collected in separate containers to be professionally discharged. They are treated to collect metal residuals and stored in landfills. All the process is controlled from a modern control room, where employees monitor all major operations from computer screens (Mainova, 2009).

The plant reduces the carbon emissions of the city by 85,000 tonnes per year. That is around 1.5% of Frankfurt's carbon footprint (Umweltamt, 2016c; Mainova, 2009). This cogeneration process is environmentally friendly because it maximises the amount of energy obtained from local wood. Each year around 120 to 150 Mm<sup>3</sup> of biomass can be obtained from the forests without jeopardising the sustainability of woodlands. The combustion of biomass produces only as much carbon dioxide as the nature can absorb (Mainova, 2009). This plant has an exemplary environmental performance because of the short transport routes in the timber delivery and the proximity to the heat customers. Therefore, the biomass power plant has received special attention from the city of Frankfurt with the Climate Star of 2004 award (Mainova, 2009).

### 3.1.3. Waste Incineration Cogeneration Process

Power from the incineration of waste products is currently the most effective method for managing solid waste products, eliminating the treatment process as well as the amount going into landfills. After combustion, the resulting material can be categorised into recyclable e.g. construction materials, metals, glass, etc., and non-recyclable materials, which would be safely deposited in landfills following the regulations. The waste incineration process requires, however, careful attention to toxic waste and strict compliance with environmental standards (MHKW GmbH, 2015a).

The MHKW Nordweststadt is one of the most modern CHP plants in Germany. It has an innovative engineering process which combines waste incineration with energy generation. Solid waste has enormous energy potential, and incineration generates less carbon dioxide than other waste treatments methods. The plant started operations in 1967 in order to supply energy to the neighbouring districts of Niederursel and Heddernheim. The concept of the service supply of this new development was the centralisation of energy and heat production rather than the distribution in different areas. The project was publicised by the local newspapers as *a district with only a fireplace*. From the beginning, the plant worked producing both electricity and district heating through waste incineration; however, both plants operated more or less independently. In January 2007, the incinerator and the power generator merged into one plant. The annual incineration capacity is 525,000 tonnes of waste. The MHKW thus is burning waste products instead of 175,000 tonnes of coal a year. The residual waste is carbon neutral (Mainova, 2011; MHKW, 2016).



Figure 9: Waste Incineration Cogeneration Plant Nordweststadt, Frankfurt am Main

The waste incineration plant works in a similar way to the wood incineration plant in Fechenheim. Upon arrival to the plant, solid waste collected in the Frankfurt region is weighted and stored. The waste products are then transported with cranes into the incineration lines, where the waste is burned with light fuel oil until it reaches the operating temperature. There are four incineration lines,

three of them working continuously. Each line has a capacity of 20 tonnes of waste per hour burning at a temperature up to 1000°C. In the combustion, the energy released is used to produce heat with a temperature of 500°C. This energy becomes the source for the production of district heating and electricity.

After this process, the waste becomes ash. There is also about 200 to 250 Kg of reusable materials such as glass and metal in each tonne of waste. These are separated and collected from the resulting ashes and treated for reuse in a different plant. At the end of the process, about 50 to 60 Kg of ash are collected and deposited in a landfill. The exhaust fumes are given special attention; emissions are treated and cleaned from dust and pollutants in a two-step process (Mainova, 2011; MHKW, 2016).

#### **3.1.4. Biogas Cogeneration Process**

All private and commercial bio-waste is recovered in Frankfurt since 1999. This is used to produce compost and energy through a combination of methods of fermentation and composting. Both, compost and biogas are generated in the plant and then the biogas is converted into electricity and heat. The energy generated is used to operate the system, and the residual energy is fed to the public grid (FES Frankfurter Entsorgungs- und Service GMmbH, 2016c).

The bio-waste collected in Frankfurt, including green waste from parks and gardens is used by the company *Rhein-Main Biokompost GmbH* to produce approximately 1.65 Mm<sup>3</sup> of biogas each year, closing the cycle of biological waste in Frankfurt. The facility allows the city to recycle several kinds of green waste from public spaces and private households, and commercial waste from fruit and vegetables. The organic waste takes 21 days to be fermented into biogas. The biogas is then converted into electricity and heat at two block-type thermal power stations. They cover their energy needs completely, and the excess of electrical energy is fed into the public grid. The bio-waste treatment plant saves around 1.100 tonnes of carbon dioxide per year.

The plant runs both composting and fermentation processes. Therefore they also offer high-quality compost that enables plant growth without pollutants, germs and chemicals in the home garden. Around 12.000 tonnes of high-grade compost is produced and marketed each year. The compost is sold nationwide and can also be purchased at the RMB shop (FES, 2016c; Umweltamt, 2016c). The biomass processing plant also produces wood chips out of waste wood pieces, which are sold as coveted heating alternative to biomass power plants. This process is more efficient than composting the waste wood (FES, 2016c).

In addition to the previous examples, combined heat and power is also recommendable for industrial and commercial activities. CHP units are profitable when they run more than 5.000 hours per year, and it is advisable to use them in office units when the heat demand is higher than 10.000 kWh. It is especially beneficial to use cogeneration processes for bakeries, meat markets, laundries, printers, greenhouses, farming, office blocks, hotels, asylums, multi-family houses, etc. (Stadt Frankfurt am Main, 2016a).

## 3.2. Practice-Oriented Experiences

### 3.2.1. Passive Buildings

Passive buildings are energy efficient, demanding around 90% less energy than regular buildings. As one of the strategies to achieve the goals of the Master Plan 100% Climate Protection, all city-owned buildings and any other municipal projects must be constructed following passive standards, and use energy efficient components for new constructions or refurbishment work. The decision of the municipality to take public buildings up to the passive house standards has made Frankfurt into a hub for passive houses in Europe.

The city holds the record for passive buildings, with over 1,500 apartments and over 150,000 square meters of floor area including schools, day nurseries, sports halls, and office buildings. In addition, city-owned and city-shared companies provide advisory in energy efficient housing and programmes which encourage construction and lease of passive houses (Umweltamt, 2012; Energiereferat Frankfurt am Main, 2015b, 2015c; Stadt Frankfurt am Main, 2016d).

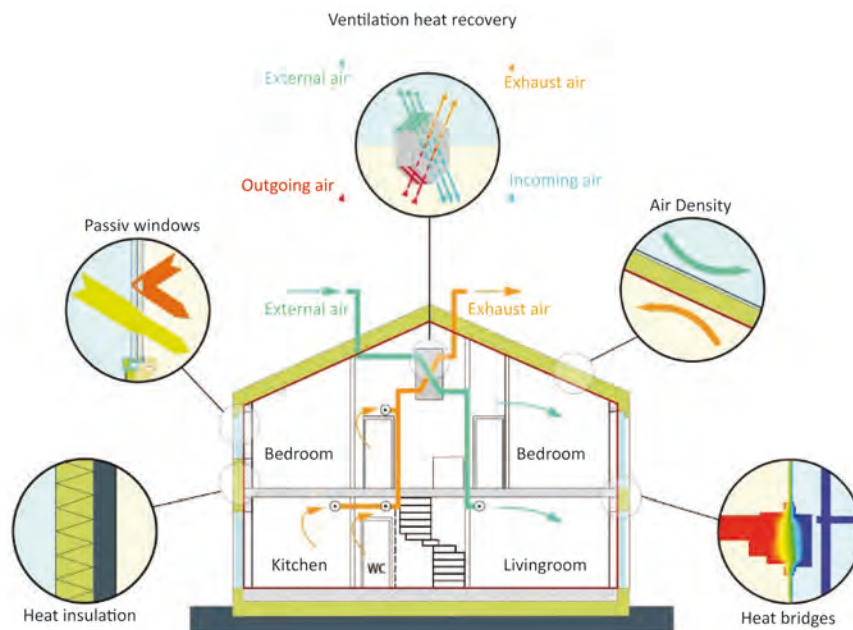


Figure 10: The Five Basic Principles of Passive Houses. ©Passivhausinstitut

### 3.2.2. Photovoltaic

Photovoltaic systems present an environmentally friendly option for producing energy, and therefore the city of Frankfurt has no restrictions on their size, with no requirements on an individual or public power supply. The city has more than 700 solar power plants with 12,000 kW peak power output for heating and electricity. Currently the potential of photovoltaic power in Germany could cover between 35%-50% of the demand of energy (Schneider, 2017, p.6). Several photovoltaic systems have been developed with public participation and support from ABG Frankfurt Holding. This public housing construction company offers the tenants an opportunity to purchase a share in the photovoltaic plants. This means that photovoltaic systems help not only to produce environmentally friendly electricity and to involve citizens, but also to earn money for the city. Also, the Energy Agency and

Mainova AG provide informational and technical support for all interested organisations i.e. they offer a solar register – *SolarDachFrankfurt* –, where homeowners check the feasibility of using photovoltaic power on their rooftops (Umweltamt, 2012; Energiereferat Frankfurt am Main, 2015a; Stadt Frankfurt am Main, 2016j).

### **3.2.3. Energy Renovation**

Energy renovation of existing buildings through better insulation and also the implementation of passive house components is a common practice in the city. Besides the energy consulting for all interested organisations and citizens, the Energy Agency provides information on planning and implementation measures for legal requirements and special features of historical buildings (guidelines for the energy-saving renovation). Moreover, the city has several support programmes from the City Planning Department, Reconstruction Credit Institute (Kreditanstalt für Wiederaufbau), and Database Energy Development (Datenbank Energieförderung) that help to finance the modernization (Umweltamt, 2012; Energiereferat Frankfurt am Main, 2015a; Stadt Frankfurt am Main, 2016j).

## **3.3. Programmatic Experiences**

### **3.3.1. Ökoprofit**

*Ökoprofit* is a collaboration programme between the Municipal Energy Agency and the local economy, which is supported by effective public relations, and run by external experts. It aims at reducing operating costs while protecting the natural resources. The programme is a pillar of the Master Plan 100% Climate Protection in the corporate sector and is directed at city companies and operational facilities which want to improve their ecological performance and retrieve some profit from improved climate-friendly technologies and practices. The programme gives companies access to environmental and energy management systems which save costs, use natural sources and reduce negative effects on the environment. The *Ökoprofit* focuses on individual counselling, joint workshops and networking among participating companies, where the exchange experience is central. More than 40 companies in Frankfurt have already been introduced to the programme at the beginner stage. Among participants, there are organisations such as the Environment Department, Health Department, Green Spaces Department, and FES (Umweltamt, 2012; Energiereferat Frankfurt am Main, 2015a; Stadt Frankfurt am Main, 2016j).

### **3.3.2. Frankfurt Saves Electricity**

Frankfurt saves electricity is a support programme from the Municipal Energy Agency, which combines environmental and economic benefits for its participants e.g. Frankfurt's private households, companies, associations, and community centres, and the city as a whole. The programme helps small and medium-sized enterprises to analyse their energy consumption and to implement saving measures. The programme also offers a financial incentive in the form of a cash bonus reward in conformity to the households' electricity savings (Energiereferat Frankfurt am Main 2015a; Umweltamt 2012; Stadt Frankfurt am Main 2016i; Energiereferat Frankfurt am Main 2015c).

### 3.3.3. Cariteam – Energy Saving Service

The *Cariteam* energy saving service is a programme through which social support makes a contribution to climate protection. The programme focuses on training the long-term unemployed population to become energy-saving advisors and assistants, providing free energy consulting service for low-income households and supplying them with energy-savings items. The programme is organised by the Rhein-Main Job Centre and supported by the Municipal Social Department, together with the Municipal Energy Agency, the Environment Department and Mainova (Caritas Frankfurt, 2015; Stadt Frankfurt am Main, 2016j).

## 3.4. Educational Experiences

### 3.4.1. Climate Tours

Climate tours present an opportunity for professional audiences to visit energy-efficient buildings and look “behind the scenes” of energy saving and energy reduction systems installed in the municipal buildings and districts of Frankfurt. Within the climate tours, it is possible to observe how cogeneration plants operate, how passive houses work or how low-energy office cooling systems function. Climate tours are developed by the Municipal Energy Agency and a municipal communication platform called AiD (Energierreferat Frankfurt am Main, 2015c; Stadt Frankfurt am Main, 2016j).

### 3.4.2. Exhibitions of the Municipal Energy Agency

The Municipal Energy Agency offers three mobile interactive exhibitions to hire: “Frankfurt Light” which introduces knowledge on the subject of light and lighting; “Green It!”, an exposition on environmentally friendly production, use and recycling of electronic equipment; and “Climate-Gourmet” exhibition on a climate-friendly diet (Energierreferat Frankfurt am Main, 2015c; Stadt Frankfurt am Main, 2016j).



Figure 11: Frankfurt Light – Lichttheke. Source: (Energierreferat Frankfurt am Main, 2015c)

### 3.4.3. Climate Protection Map (*Klimaschutzstadtplan*)

The Climate Protection Map is managed by the Municipal Energy Agency and shows climate protection projects in the city of Frankfurt. The map provides a full description of buildings and

facilities as well as details on available further information (see Figure 10) (Energierreferat Frankfurt am Main, 2015a).

#### 3.4.4. Travel Guide: Energy-Efficient Frankfurt

The travel guide has been created by the Municipal Energy Agency, offers routes through areas with energy-saving and high-quality architecture design and provides extensive information for people who want to learn more about energy-efficiency of the city (Energierreferat Frankfurt am Main, 2015a).

#### 3.4.5. Other Experiences within the Energy Sector

- Clever mobil: "Clever mobile" was the slogan of the Europe-wide campaign "In town without my car!" for the climate change. The city of Frankfurt offers numerous transportation options for a sustainable and environmentally friendly mobility.  
[http://www.frankfurt.de/sixcms/detail.php?id=3078&\\_ffmpar\[\\_id\\_inhalt\]=67278](http://www.frankfurt.de/sixcms/detail.php?id=3078&_ffmpar[_id_inhalt]=67278)
- eClub Frankfurt: The eClub is a free and neutral platform for households that want to reduce their energy consumption, which is moderated by the City of Frankfurt Energy Efficiency Forum.  
<https://www.eclub-frankfurt.de>
- Energiepunkt – FrankfurtRheinMain e.V.: a non-profit association that supports advisors, modernizers, tenants and other interested parties as well as small and medium-sized enterprises in all energy questions. <http://www.energiepunkt-frankfurt.de/index.php?id=216>
- Green Building Award FrankfurtRheinMain: The application for Green Building FrankfurtRheinMain is open for new construction projects as well as renovation projects for non-residential and residential buildings. The projects must comply with the guidelines for energy efficiency construction. <http://www.greenbuilding-award.de>
- Klima- und Energieprojekte – Region Frankfurt/Rhein-Main handelt. Wettbewerb Klimaprojekt 2015: In addition to formal planning, the Regional Authority is responsible for tasks and projects in the region as energy regeneration, climate protection and climate change adaptation in the FrankfurtRheinMain region. <http://www.klima-energie-frankfurtrheinmain.de>
- Klima Sparbuch Frankfurt 2016: The Klimasparbuch is a practice-oriented guidebook for climate protection in all areas of everyday life. <http://www.oekom-verein.de/projekte/das-klimasparbuch/>, <http://www.klimasparbuch.net/home.html>
- Mainova Klima Partner Programm: Mainova Climate Partner Program offers efficiency measures for an environmentally friendly energy generation and use.  
[https://www.mainova.de/privatkunden/energie\\_sparen/klima-partner-programm.html](https://www.mainova.de/privatkunden/energie_sparen/klima-partner-programm.html)
- FrankfurtRheinMain100% effizient und erneuerbar: The city of Frankfurt am Main, and the regional association FrankfurtRheinMain work together with all municipalities and stakeholders to develop the regional energy concept FrankfurtRheinMain.  
<http://www.energiewende-frankfurtrheinmain.de/home/>
- Solaroffensive Rhein-Main: Members of the environmental forum, including solar companies and financing banks are actively assisting citizens and companies in their solar projects: giving information; offering on photovoltaics and solar thermal energy; and financing.  
<http://www.umweltforum-rhein-main.de/projekte/solaroffensive-rhein-main>
- Städtische Liegenschaften: Energy efficiency is the main goal of the city-owned properties. The city of Frankfurt am Main enhances energy efficiency and coordinates investment in climate protection to reduce electricity, heating energy and water consumption in the public

properties. <http://www.frankfurt-greencity.de/en/environment-frankfurt/climate-protection-and-energy-supply/city-owned-real-estate/>

### 3.5. Stakeholders in the Energy Sector

- **Municipal Energy Agency (Energierreferat):** The Municipal Energy Agency is the leader in the energy sector. The agency promotes, develops and implements the energy and climate protection policies for the city. One of the agency's main goals is to promote the use of renewable energies and the combined heat and power supply. It is involved in the CHP goes Green (IEE) project from the EU. (Stadt Frankfurt am Main, 2016c)
- **Mainova AG:** provides the service to customers, playing the main role for provision and maintenance of technical equipment. The company has a network of 11 cogeneration plants in Frankfurt with 7.8 MW of thermal and 5.5 MW of electrical power. Also, they operate various decentralised systems together or on behalf of partners, and are part of an interconnected national system. (Mainova AG, 2016)
- **FES Frankfurt Disposal and Service GmbH:** provides services of waste collection and management.
- **MHKW Müllheizkraftwerk Frankfurt GmbH:** operator of the waste incineration plant since October 2006. Shares are equally divided between FES and Mainova AG. (MHKW GmbH 2015).
- **RMB Rhein-Main Biokompost GmbH:** a subsidiary of FES. They operate a biological waste treatment plant, which is one of the most modern facilities of its kind. Bio-waste is used to produce approximately 1.65 Mm<sup>3</sup> of biogas each year. (FES Frankfurter Entsorgungs- und Service GMmbH, 2016c; RMB Rhein-Main Biokompost GmbH, 2016)
- **Environment Department (Umweltamt):** The Municipal Environment Department has an indirect involvement in the energy sectors, performing monitoring and control functions on the waste products discarded by the incineration and compost plants.

### 3.6. Conclusions of the Energy Sector Experiences

Energy sector experiences are prolific in the city of Frankfurt, they cover a wide range of activities, from technical aspects to promotional and educational programmes to reduce the consumption of energy for businesses, households and industrial facilities. The diversity of projects and programmes is a result of the strong environmental focus of the city and the region. The city has an ambitious environmental policy. Thus the energy sector appears to be more politically oriented than other sectors and complying with national and regional environmental policy.

The abundance and diverse typology of the experiences in the energy sector suggest solid support from the municipal departments and a leading role in establishing the guidelines for sustainable urban development in the city. The energy sector influences urban planning through the location of cogeneration and energy production facilities, while housing developers and household owners are encouraged to increase the energetic efficiency of the building by learning about new technologies. Activities directed to the citizens are mostly in the form of promotional programmes and consulting

services. These are oriented to a wider set of stakeholders ranging from the organisational level of administrations, institutions, companies, businesses and communities to the individual like ordinary citizens.

|  | RP Sectors |       |             |       |               |
|--|------------|-------|-------------|-------|---------------|
|  | Energy     | Water | Waste water | Waste | Urb. Agricul. |
| <b>Experiences - Energy Sector</b>       |            |       |             |       |               |
| Ökprofit                                 |            |       |             |       |               |
| Frankfurt saves electricity              |            |       |             |       |               |
| Cariteam - Energy Saving Service         |            |       |             |       |               |
| Climate Tours                            |            |       |             |       |               |
| Exhibitions of the Energy Agency         |            |       |             |       |               |
| Climate Protection Map                   |            |       |             |       |               |
| Travel Guide: Energy-Efficient Frankfurt |            |       |             |       |               |
| Cogeneration and district heating        |            |       |             |       |               |
| Passive buildings                        |            |       |             |       |               |
| Photovoltaics                            |            |       |             |       |               |
| Energy renovation of buildings           |            |       |             |       |               |

Table 1: Analysis of Experiences in the Energy Sector

Most energy-based activities and experiences of the city are leaning towards a sectoral planning and implementation procedures. However, the sustainability goals of the city have forced the technicians to find new technologies to produce energy in a more efficient way. The result of this demand for new renewable energy technologies is the implementation of Cogeneration in Frankfurt. Despite the sectoral character of the energy sector, Cogeneration is broadening the scope of implementation, bringing the waste and urban agriculture sectors together with the energy production sector. This is an example of efficient multi-sectoral planning and implementation, as well as an efficient way of utilising waste products and close the consumption circle. The broader scope of the Cogeneration process also demands the involvement of other municipal actors in the planning and implementation process, such as the Environment Department for environmental control and monitoring and FES as the waste management company. It is, then, relevant to highlight the effective synergies localisation between waste management, energy production and urban agriculture.

Producing heat and electricity is especially effective when renewable sources are used for producing energy. In order to make cogeneration resource-efficient and sustainable when using biomass, there are important points to be taken into account. For example, the availability of local resources, the amount of space needed for the storage of biomass, the considerable logistics efforts, indirect emissions of CO<sub>2</sub> (for example, using of tractors in growing cereals for powering biomass plants), etc. CHP is increasingly linked to the use of bio-energy. Four CHP plants use energy from biomass - old wood -10 MWe<sup>2</sup>-, domestic biowaste -500 KWe-, industrial biowaste -4 MWe- or sewage sludge -4 MWe- (Umweltamt, 2012). The quantity and quality of related emissions are other important aspects. The environmental office in Frankfurt plays a vital role in evaluating and monitoring that all released emissions are filtered accordingly, and no harmful levels of nitrogen oxides and particulate matter are

<sup>2</sup> Megawatt electricity

released into the air. It also plays the role to promote cooperation and experience exchange among actors involved in energy production, inside and outside Germany. (Mainova, 2009).

## 4. The Water Sector

### 4.1. Relevant Practice: Water Protection

Frankfurt as a growing large German city faces an important challenge in water provision. Within the city's perimeter only 15% of the water demand can be met, the 85% left has to be transported from other areas of the region (Umweltamt Frankfurt am Main, 2014). Therefore, in the water sector the city is dependent on the collaboration of other surrounding municipalities. This collaboration is essential and coordinated through the Frankfurt/RheinMain Metropolitan Region.

The health standards for the provision of water to urban areas are strictly regulated by federal law. The mineral composition of drinking water, along with the taste, is determined by the geology of the catchment area, location of groundwater wells and the distribution system (Hessenwasser GmbH & Co. KG, 2016b); the quality of the drinking water provided to urban areas depends on conditions of the soil; hence, water protection means environmental protection of catchment areas and monitoring of possible pollutants. In problematic areas, such as the airport and roads, the runoff water is pre-treated in locations isolated from the water catchment areas before being fed to the system (Umweltamt Frankfurt am Main, 2014). The quality of drinking water is inspected every day in laboratories and controlled by online monitoring systems.

#### 4.1.1. Quality Control of Drinking Water

Concerning the quality of drinking water, the main priority for the city is the preservation of the natural water supply in the region. Therefore, Frankfurt set specific guidelines for environmental protection around the aquifers available in the green areas of the city: i) The quality of extracted water may not have a negative impact on the groundwater balance; ii) The quality of the extracted water must constantly be monitored, and the catchment area for water extraction must be specially protected against contamination. Thus, the quality of drinking water, the state of technical systems for water supply, treatment and distribution is continuously controlled by the drinking water regulations by the Health Department and analysed by Mainova and Hessenwasser (Gesundheitsamt, 2015b; Mainova AG, 2015; Hessenwasser GmbH & Co. KG, 2016b).

#### 4.1.2. Water Extraction

The city obtains its drinking water from different sources: 17% is extracted from the city area in the municipal forest; 36% comes from the Hessian reed marsh; and almost 50% is piped from the nearby Vogelsberg area, the Spessart and the Kinzig Valley. Potable water extraction, quality control and transportation are the main tasks of the Hessenwasser. Mainova, on the other hand, offers ten pumping stations in the region and, at the same time, is also responsible for distribution of water (see Figure 13) (City of Frankfurt am Main, 2010; Gesundheitsamt, 2015b).

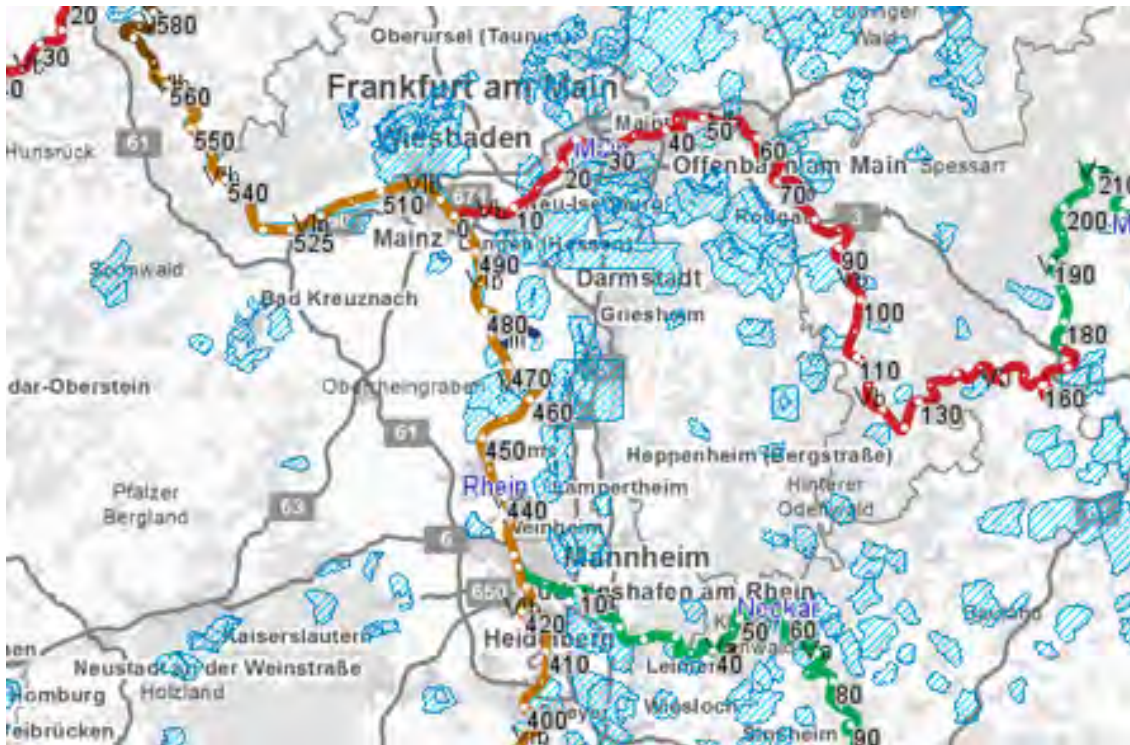


Figure 12: Water Protection Areas in the Southern Part of Frankfurt/RheinMain Metropolitan Region

Source: (Zentrale Kompetenzstelle für Geoinformation, 2015)

## 4.2. Programmatic Experiences

### 4.2.1. The Frankfurt Lead Project

The *Frankfurt Lead Project* was launched in 1997 by the Health Department in order to solve the household problem of old lead pipes, which affected the quality of drinking water for the public. The programme includes water testing for lead and a replacement of domestic water pipes in special cases. So far, the results of the programme have reduced the number of households with lead pipes in the city significantly (Umweltamt Frankfurt am Main, 2014; Gesundheitsamt, 2015b).

### 4.2.2. Sensible Water Use in Frankfurt am Main

*Sensible Water Use in Frankfurt am Main* is a city programme implemented between 1990 and 2000 that caused a reduction of the drinking water consumption and continues to have an effect in the consumption practices of private and commercial users.

*“The measures were designed to encourage a sensible approach to water and to publicise the opportunities for upgrading water-saving devices in the home. The public utility (today Mainova AG) worked together with plumbing companies to replace toilet cisterns and to equip whole residential areas with water-saving taps. The aim of the campaign – to reduce water consumption by 20% by 2000 – was achieved in 1998. Much of the success was attributable to the housing construction sector and to industry.”* (Stadt Frankfurt am Main, 2013)

The programme supplied 4,000 apartments of a district with water saving fittings with the objective to reveal the state of fitting in private households, to develop a smooth and fast introduction to water savings applications and as a result, to reduce the overall consumption of potable water in the city (Stadt Frankfurt am Main, 2013; European Commission, 2016; Stadt Frankfurt am Main, 2019a). The project has been organised by the city works company with technical equipment from Mainova AG.

| Typology/Year                | 1990        | 2001        | 2010        | 2012        | 2013        |
|------------------------------|-------------|-------------|-------------|-------------|-------------|
| Household & Small Businesses | 40,9        | 35,3        | 35,2        | 34,8        | 38,3        |
| Industry & Large Businesses  | 12,1        | 6,7         | 6,5         | 6,5         | 6,7         |
| <b>Total</b>                 | <b>53,0</b> | <b>42,0</b> | <b>41,7</b> | <b>41,2</b> | <b>45,0</b> |

Figure 13: Water Consumption Decrease (Mm<sup>3</sup>/year). Sensible Water Use Programme

Source: (Stadt Frankfurt am Main 2010, p.39)

#### 4.2.3. Other Experiences of Frankfurt am Main within the Water Sector

- Bachpatenschaften: is a sponsorship program for citizens, clubs, schools or other groups interested in preserving and protecting streams and rivers.  
[https://www.frankfurt.de/sixcms/detail.php?id=2848&ffmpar%5B\\_id\\_inhalt%5D=90985](https://www.frankfurt.de/sixcms/detail.php?id=2848&ffmpar%5B_id_inhalt%5D=90985)
- Die Nidda: The small river Nidda is a good example of urban river revitalization. Substantial efforts have been made to reverse the poor water quality channel back to a living landscape.  
<http://www.frankfurt-greencity.de/en/environment-frankfurt/surface-water-in-frankfurt/the-nidda/>
- Virtuelles Wasser: Virtuelles Wasser is an environmental educational project aiming to describe the amount of water contained in a product, in a service or the amount used for its production. The guide and all other publications show the amount of virtual water hidden behind everyday products and also help people to look for water-saving products when shopping.  
<http://www.frankfurt-greencity.de/umwelt-frankfurt/frankfurts-trinkwasser/virtuelles-wasser/>  
[http://www.virtuelles-wasser.de/virtuelles\\_wasser.html](http://www.virtuelles-wasser.de/virtuelles_wasser.html)

#### 4.3. Stakeholders in the Water Sector

- **Regional Authority** (*Regionalverband FrankfurtRheinMain*): the areas for water catchment and protection are defined in the Preparatory Land-Use Plan for the region, which is drawn by the Regional Authority. This serves as the means to negotiate with municipalities and other stakeholders and have a higher control and regulations to protect the health of the population.
- **Hessenwasser GmbH & Co.KG**: the company is responsible for the sustainable extraction, processing, quality control and transportation of drinking water in the Rhein-Main Region, along with the protection of catchment areas and groundwater reservoirs. Through the Regional

Authority in cooperation with the municipalities with regards to spatial planning and environmental protection, the company provides a sustainable water management strategy that requires a comprehensive technical, environmental and economic know-how (Hessenwasser GmbH & Co. KG, 2016a).

- Mainova AG:** supplies the city and the region with electricity, natural gas, heat and water.

#### 4.4. Conclusions of the Water Sector Experiences

The water sector in Frankfurt addresses all activities related to drinking water, ground water and surface water. Water is essential for urban life and represents an important challenge for a growing city like Frankfurt to provide for a growing population and dynamic economic activities. This makes this sector strongly oriented towards environmental protection and regulation measures, as well as public health.

The experiences in the water sector are coherent with the municipal climate protection policies, although implemented in a sectorial but collaborative approach, which involves other municipal departments i.e. Environment Department and the city shared company in charge of water provision. The participation of other actors in the extraction, transport or collection processes is restricted due to the technical requirements of water provision. Water sector programmes for stakeholders outside the municipal departments and companies take the form of promotional programmes educating citizens to reduce consumption and control the water quality. The water sector in Frankfurt also seems to have no direct contribution to the other sectors of energy, waste, waste management and urban agriculture.

| Experiences - Water Sector               | RP Sectors |       |             |       |               |
|--|------------|-------|-------------|-------|---------------|
|  | Energy     | Water | Waste water | Waste | Urb. Agricul. |
| Quality control of drinking water        |            |       |             |       |               |
| Frankfurt Lead Project                   |            |       |             |       |               |
| Efficient Water Use in Frankfurt am Main |            |       |             |       |               |

Table 2: Analysis of Experiences in the Water Sector

## 5. The Wastewater Sector

### 5.1. Relevant Practice: Quality of Wastewater

Wastewater in Germany is considered as water whose properties have changed after being used or has been polluted. The collection system channels together with runoff water, into the wastewater network system. After being treated, wastewater is reintegrated into the Main River. Therefore it is important to ensure the quality and prevent harmful substances from being released into the ecosystem. Wastewater from industrial and commercial enterprises is examined periodically in order to prevent harmful discharges that could be a potential threat to the wastewater network, the treatment plants and its operating staff or the environment (Umweltamt Frankfurt am Main, 2014; Stadt Frankfurt am Main, 2015).

#### 5.1.1. Sewage Network and Rainwater Collection

In Frankfurt and surrounding towns connected to the Frankfurt sewage plants, around 300 million litres of wastewater are produced each day. The wastewater is collected in a network of sewers that is approximately 1,600 km long and channelled to the wastewater treatment plants in Niederrad and Sindlingen, where it is filtered. The remaining sludge is drained of water and burned. All plants use state-of-the-art technology and are regularly upgraded to comply with new regulations. The standards of quality of wastewater to be released back into the river mean that after treatment, the chemical and physical properties of the wastewater are better than the water flowing on the Main River. Sewage charges are based on the amount of fresh water used and are currently €1.76 per m<sup>3</sup> (City of Frankfurt am Main, 2010).



Figure 14: AVA Niederrad / Griesheim

Source: (Stadtentwässerung Frankfurt am Main, 2015a)



Figure 15: ARA/SEVA Sindlingen. Source (Stadtentwässerung Frankfurt am Main, 2015a)

The current practice is to separate the runoff water from wastewater to prevent overflowing in heavy rain events and reduce the demand on the wastewater treatment plants. At the moment almost 25% of the city is connected to a separated wastewater collection system, and runoff water is fed directly into a body of water. The remaining city area has a mixed system, with overflow systems and rainwater reservoirs to provide relief for the sewage network (City of Frankfurt am Main, 2010).

### 5.1.2. Importance of Wastewater Quality

Frankfurt was one of the first cities in the Federal Republic of Germany, to begin with a systematic wastewater quality monitoring 50 years ago when the increasing inputs of harmful substances represented a hazard to the population's health.

Nowadays this practice of monitoring protects the treatment plants and the city's investment. The sewage system has numerous special structures such as pumping stations, storm water tanks and storage pipes which are intensively maintained and expanded. Therefore, sewage is a major investment hidden underground in the city. By ensuring that the built infrastructure is kept in good conditions, the Environment Department also ensures the city's investment is being protected. The quality of wastewater influences the efficiency of wastewater plants. The radio capacity of these plants is also influenced by the quality of wastewater. Avoiding harmful substances in the system keeps the service fees low. The increased discharge of fats, by deposits and corrosive attacks on the drains, leads to a significant increase in renovation and maintenance costs and therefore also to the wastewater tariffs. Monitoring the wastewater coming from companies and offering them counselling ensures the service fees remain low (Umweltamt Frankfurt am Main, 2014).

### 5.1.3. Sludge Dewatering and Incineration Facility

The city of Frankfurt and its City Drainage Department initially decided to build a central sludge dewatering and incineration facility based on unavailable landfill space and not sufficiently large agriculture area for utilisation of the sludge from the wastewater treatment - ARA/SEVA Sindlingen. It was one of the most environmentally friendly and economically effective methods to dispose of the sewage sludge for city standards. Nowadays the sewage sludge incineration plant is connected to both wastewater treatment plants and has four incineration lines, three of which can operate simultaneously, and operates as a cogeneration power plant for efficient use of energy (Umweltamt Frankfurt am Main, 2014; Stadtentwässerung Frankfurt am Main, 2016).

### 5.1.4. Monitoring of Wastewater

Wastewater quality is measured by a systematic and continuous programme in strategic points. The wastewater comes mainly from the city of Frankfurt, but also from the adjacent surrounding communities e.g. Offenbach, Neu-Isenburg, Kelsterbach, Kronberg, Steinbach, Eschborn, Maintal and wastewater associations from the Main-Taunus and Westerbach. These municipalities do not have their treatment plants. Thus they are connected to the sewage system in Frankfurt. The wastewater coming from surrounding municipalities is monitored in the intersections with the Frankfurt sewage. Special attention is also paid to environmentally sensitive areas to ensure the protection of drinking water (Umweltamt Frankfurt am Main, 2014).

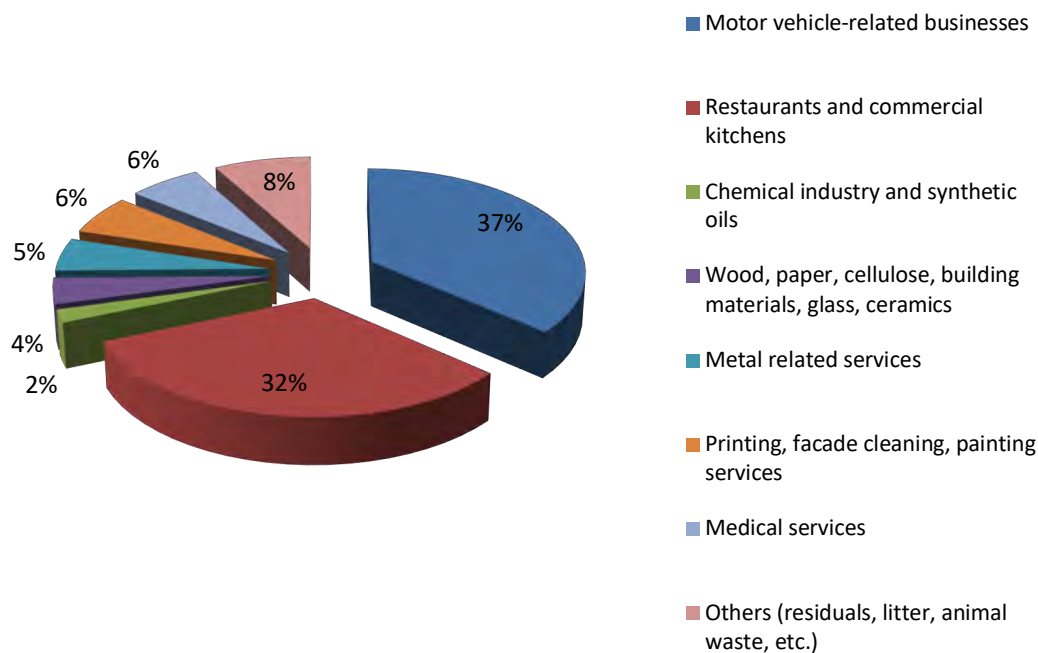


Figure 16: Industry Distribution - Indirect Discharge. Source: (Umweltamt, 2012)

Wastewater discharges come mainly from motor vehicle-related businesses (37%), including garages, car wash stations, gas stations, transport companies, as well as from food manufacturers, restaurants and commercial kitchens (32%). Most of these businesses are equipped with separation systems to avoid discharges of harmful chemicals and substances to the system (Umweltamt Frankfurt am Main, 2014).

### 5.1.5. Data Collection

Regular wastewater tests require individual data from the industrial and commercial enterprises connected to the wastewater network. At the beginning of the monitoring project, examples from other cities were not available for comparison. The city developed a system by which all wastewater-relevant facts from individual fixed discharges could be collected and processed. Using this data, the city identified and classified risk groups, which served as a basis for defining the frequency and intensity of the wastewater monitoring. The FrankfurtRheinMain Metropolitan region has over 30 sampling sites where the sewage quality is measured. The study is conducted at fixed intervals through targeted samples to identify polluters.

#### *Wastewater Analysis Criteria*

The Environment Department monitors: the pH levels, as low pH levels can corrode the piping infrastructure, while high pH levels can cause harmful ammonia and cyanide fumes. Temperatures above 35°C damage duct seals and promote biological degradation processes in the channels, leading to a decrease in oxygen, which can cause bad odours and corrosion. Suspended solids can lead to channel blockage and sedimentation. Organic solvents e.g. alcohols or gasoline are flammable and poisonous at higher concentrations. Mineral oils and fats are toxic and flammable in higher concentrations. Non-volatile lipophilic substances i.e. organic oils and grease from the kitchens promote clogging, and degradation processes, as well as the corrosion of channels. Heavy metals such as cadmium, copper, mercury, lead have an inhibitory effect on bacteria at the sewage treatment plant. Moreover, they accumulate in the resulting sludge, which makes sludge disposal more expensive or makes it more difficult to exploit (Umweltamt Frankfurt am Main, 2014).

These parameters: temperature, pH, conductivity, odour and turbidity are investigated in every case. In addition, there are more than 1,000 analyses for non-volatile lipophilic substances (fats) that the Environment Department often tests, mainly from commercial kitchens and canteen areas. This value is used to reduce the amount of fat in the channels. The tests have shown that about half of the samples fulfil the established limit of 100mg/L; however, in some individual cases, the values measured are significantly above the allowed values.

## 5.2. Programmatic Experiences

### 5.2.1. Flood Prevention

Despite planning, due to exceptionally heavy rain, some parts of Frankfurt can be flooded i.e. banks of rivers and riverside areas with roads, streets, subways and cellars. The Environmental and the City Drainage Departments provide extensive information for citizens about how to avoid damages – secure property and life, while the city is working on a flood prevention concept (see Figure 17) (Umweltamt Frankfurt am Main, 2014; Stadtentwässerung Frankfurt am Main, 2016).

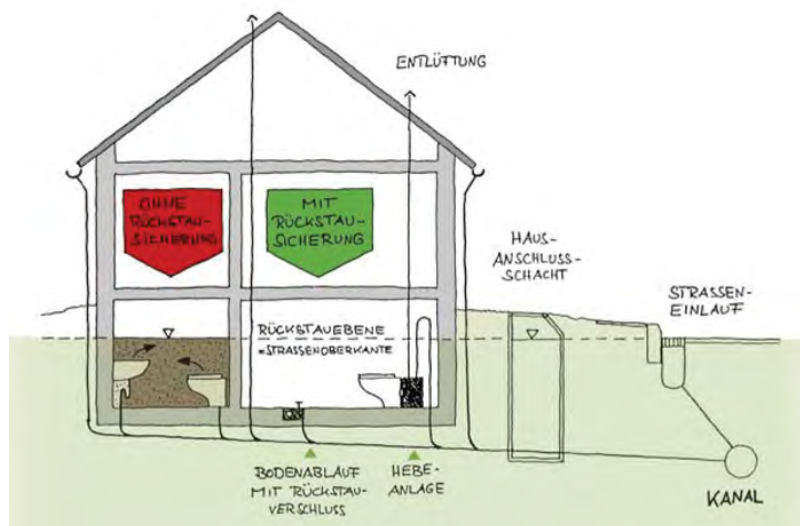


Figure 17: Flood Prevention Measures

Source: (Stadtentwässerung Frankfurt am Main, 2015)

### 5.2.2. Water Engineering and Water Maintenance

The water maintenance is defined by the State of Hessen and presents one of the tasks of the City Drainage Department in Frankfurt. The main goal is to make sure that all water is drained. It includes the operation of flood control and rainwater facilities, development and maintenance of the riverside areas for natural bank protection and even creation of favourable habitat for plants and animals (Umweltamt Frankfurt am Main, 2014; Stadtentwässerung Frankfurt am Main, 2016).

In Frankfurt, wastewater as a sector includes the sanitation/sewage as well as rain water regarding both water engineering and water maintenance systems. It is noticeable that the border between this sector and the previous one, water, is rather thin with some interrelations. This indicates a strong connection with environmental protection, which affects city planning regarding regulating the implementation of the needed facilities and infrastructure within the collaborative approach. Wastewater sector in Frankfurt has an interesting contribution to the field of energy production, which qualifies it as a trans-sectoral case.

### 5.2.3. Other Experiences within the Wastewater Sector

- Regenwassernutzung: information about the rainwater harvesting and the rainwater reuse. [http://www.frankfurt.de/sixcms/detail.php?id=13668396&ffmparf\\_id\\_inhalt\]=23867](http://www.frankfurt.de/sixcms/detail.php?id=13668396&ffmparf_id_inhalt]=23867)

## 5.3. Stakeholders in the Wastewater Sector

- **City Drainage Frankfurt am Main:** The City Drainage is the leading company for the sanitation and water body development in the Rhein-Main Region. It is responsible for the planning, construction, maintenance, operation and management of systems for capturing and draining wastewater, wastewater treatment, sludge recycling and incineration. Among its main tasks, it is also included the training of specialists for wastewater engineering, the enforcement of compulsory connection and use of the public drainage systems and the participation in building permit procedures. (Stadtentwässerung Frankfurt am Main, 2015)

- Wastewater Monitoring Office:** The Frankfurt Wastewater Monitoring Office was established in 1965 to prevent harmful substances such as mineral oils and greases, tars and acids in the public sewage system. As an independent monitoring authority, within the wider frame of the Environment Department, it acts as a state-approved investigative body. It carries out the wastewater monitoring and laboratory tests to ensure that the wastewater quality in the channels meets the corresponding standards (Umweltamt Frankfurt am Main, 2014).
- Environment Department:** The Wastewater Monitoring Office is part of the Environment Department, by which it is offered advice and support and provided the laboratory. The laboratory carries out the analysis for the monitoring of wastewater treatment plants, the monitoring of polluters and all related special projects. The laboratory has numerous analysers, modern technology and expertise of currently more than 600 different analysis methods, of which the wastewater monitoring uses about 60 routinely. In field, 13 employees work for the Wastewater Monitoring Office of the Frankfurt Environment Department including biologists, chemists, and environmental engineers (Umweltamt Frankfurt am Main, 2014).

### 5.4. Conclusions of the Wastewater Sector Experiences

The wastewater sector is an important part of the urban infrastructure for the protection of the environment and prevention of health risks among the population. The German law has strict standards for the residual water that is reintroduced to the bodies of water and the system must keep up with innovations in technology and network upgrading in order to maintain the quality of wastewater. Monitoring is important to ensure that no toxic or harmful substances are being integrated into the ecosystem. The city of Frankfurt regularly tests wastewater samples coming from industries and strategic points. The main challenge Frankfurt faces is to reduce the number of substances (like fats, heavy metals, etc.) that potentially damage the wastewater network or that cannot be treated successfully and are therefore released into the environment (pharmaceuticals, nitrates and pesticides) (Hessenwasser, 2014; Umweltamt Frankfurt am Main, 2014).

|   | RP Sectors |       |             |       |               |
|---|------------|-------|-------------|-------|---------------|
|   | Energy     | Water | Waste water | Waste | Urb. Agricul. |
| <b>Experiences - Waste Water Sector</b>     |            |       |             |       |               |
| Water engineering and water maintenance     |            |       |             |       |               |
| Flood prevention                            |            |       |             |       |               |
| Sludge dewatering and incineration facility |            |       |             |       |               |

Table 3: Analysis of Experiences in the Wastewater Sector

Due to the waste products and the technicality of the wastewater treatment process, this sector is dominated by a public company in cooperation with other municipal departments for some trans-sectoral projects such as incineration in cogeneration plants. In the fields of rainwater harvesting and flood protection measures there are connections to environmental planning and protection, water engineering as well as urban planning.

## 6. The Solid Waste Sector

### 6.1. Relevant Practice: Waste Collection Services

Waste collection services in the Rhein-Main region are provided by the Frankfurt waste disposal company FES<sup>3</sup>. The waste management system relies on the efficient operation of FES, as well as the cooperation of the residents and businesses in separating correctly waste products. The city has reduced the waste production in households by 13% from 2000 to 2010 through educational programmes and recycling strategies which allow FES to reuse some materials or efficiently dispose of non-reusable waste products (City of Frankfurt am Main, 2013).

Waste products are categorised as household and commercial waste, paper, bio-waste, glass, lightweight packaging, bulky waste for recycling, bulky waste for collection, green waste, electrical scrap, wood, textiles, demolition rubble and metal waste. The company offers a variety of colour coded garbage containers for households i.e. grey is for household and commercial waste, brown is for bio and green waste, yellow is for lightweight packaging and green for paper and cardboard. Likewise, for the collection of glass, FES provides collection centres, where also colour coded containers are placed in strategic points of the neighbourhoods. Electrical waste and discarded furniture and wood are collected as bulky waste, on demand, and taken to a recycling centre where they are resold, if suitable, or dismantled for material recycling (City of Frankfurt am Main, 2010).

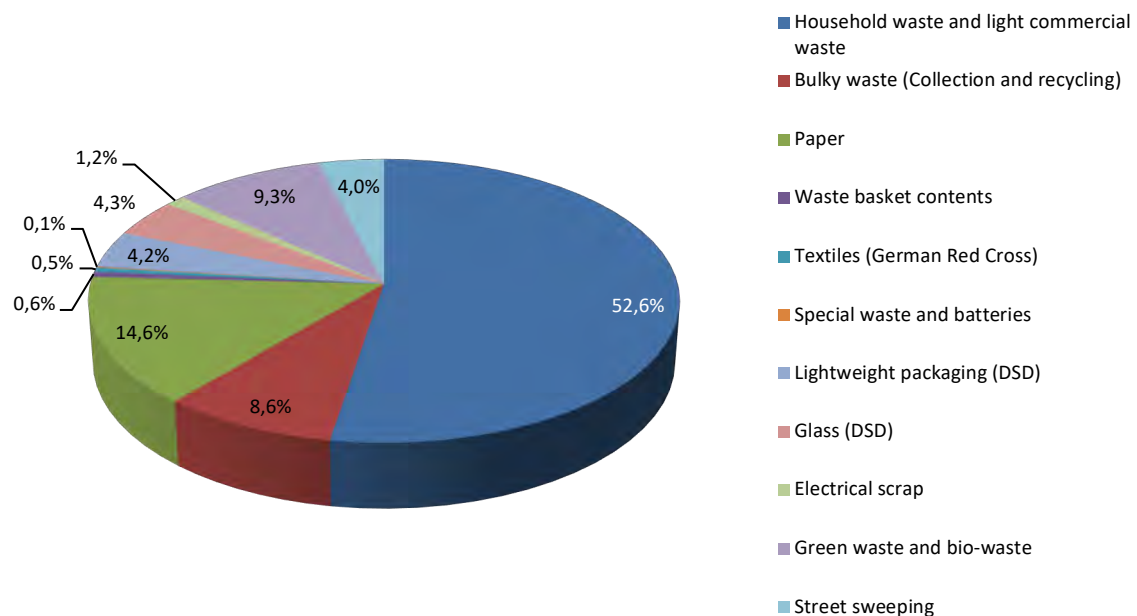


Figure 18: Waste in Frankfurt in 2009, by Type (in percent; total: 312,697 tonnes)

Source: (City of Frankfurt am Main, 2010)

<sup>3</sup> For more information about FES see section 8.12.

The figure above shows the percentages of waste products collected by FES, in which household and light commercial waste comprise 53% of the total. The waste collection system is based on the separation of different types of waste products, which would later be subjected to waste management processes such as thermal recycling, material recycling, direct recycling and composting (City of Frankfurt am Main, 2010).

#### **6.1.1. Waste Recycling Processes**

In Frankfurt, there are waste collection systems provided by the public-private enterprise FES and by the national waste collection system established under private law – Dual System Germany (Duales System Deutschland - DSD), also known as the Green Dot (Grüner Punkt). DSD collects waste from the light packaging bin and includes the cost of its disposal in the price of the packaged item. There is another system called the “bring system”, where people themselves bring certain waste to the collection points. For a fee, the company can take building site waste and rubble to the waste transfer station. DSD is responsible for collection, sorting and recycling of packaging made of glass. It is important to note that dealers are obligated to take back used car tires, used oil and used dry-cell batteries if such items are a part of their product range (City of Frankfurt am Main, 2010; FES, 2015a).

##### ***Thermal Recycling***

Recycling and reuse of waste products are the main goals of the waste management system in Frankfurt; however, households and commerce produce waste products unsuitable for reuse in the original form or as materials. These residual waste products are incinerated in one of the cogeneration or incineration plants. The incineration process produces heat and steam sub-products that, in former times, were released to the environment after decontamination processes. In 2005 a national law concerning the management of waste was introduced, with the aim of reducing the amount of waste taken to the landfills. The law stated that all waste products unsuitable for recycling should be thermally or biologically treated, forcing the modernisation and renovation of incineration plants throughout Germany. Taking advantage of the modernisation processes, the FES and the Municipal Energy Agency started a collaborative initiative to transform some waste incineration plants into cogeneration plants (see section 3.1), where the sub-products of incineration would be used to provide energy and heat to the surrounding neighbourhoods (MHKW GmbH, 2016).

##### ***Materials Recycling***

Lightweight packaging such as metal cans, plastic packaging for comestibles, non-reusable plastic containers, carton containers, non-reusable textiles and synthetic waste are collected in the yellow waste container (Stadt Frankfurt am Main, 2016e). Together with glass, paper, and waste collected from street cleaning, waste products are taken to the unloading station to be sorted and sent to the correspondent processing station.

##### ***Direct Recycling***

Large electronic appliances e.g. televisions, refrigerators, washing machines, etc., are collected on demand and taken to the recycling centre, where they are assessed and in many cases repaired and resold. In the case that the appliance is unusable, it is dismantled by hand to avoid further contamination and retrieve raw materials. This bulky waste management system has developed a social dimension. The recycling centre is managed by a private company associated to the Werkstatt Frankfurt, sponsored by the local and the Federal Employment Agency, with the purpose of offering

employment and vocational training opportunities (City of Frankfurt am Main, 2016; Recyclingzentrum Frankfurt, 2016).

### ***Compost - Biomass Power Plants***

In the city of Frankfurt, there are three different biomass power plants which produce compost, energy and heat. The biomass power plant in Frankfurt Fechenheim from Mainova AG uses all types of residual and waste timber to generate electricity for households and heat for industry and commerce. RMB Rhein-Main Biokompost GmbH uses city household and commercial bio-waste along with green waste from park and gardens to produce high-quality compost for further use and biogas, which is then converted to electricity and heat. Waste-to-Energy Power Plant Frankfurt (MHKW Müllheizkraftwerk Frankfurt GmbH), burns city household waste and light commercial bio-waste and generates both electricity and heat as a cogeneration plant for city districts. In this way, the city makes a significant contribution to waste recycling and to produce of valuable materials, as well as reduction of CO<sub>2</sub> emissions (Frankfurter Entsorgungs- und Service, 2015c; Umweltamt, 2016c; Umweltamt, 2015i).

## **6.2. Practice-Oriented Experiences**

The city has two combined ways to take waste fees that finance waste management: (1) standing charge and (2) variable charges. The main concept behind these charging systems is financial incentives for environmentally friendly behaviour – properly separated waste and the reducing of its amount allow saving money. In addition, the free removal of bulky waste (collected as often as required) and harmful substances (collected through the bring system) helps to avoid illegal dumping and environmental damage. The Environment Department is officially responsible for waste management and street cleaning, while FES provides service and all the necessary equipment (City of Frankfurt am Main, 2010).

### **6.2.1. Standard and Variable Fees for Waste Collection**

As explained in former sections, the waste collection services in the city of Frankfurt are provided by different companies associated to FES. The city finances the waste management operation with the fees charged to the residents and businesses, which operate under two payment modalities: *Standard* and *Variable Fees*. These fees finance the collection services motor park, personnel, administration as well as the management of sorting, recycling and disposal.

The Standard Fee is a fixed amount paid by every household and commercial establishment in Frankfurt. With the standard fee, FES provides the different waste disposal containers. The collection of bulky waste is also included free of charge up to 13 times a year. The standard charge is the same for every residential and another unit, which means that commercial companies are also included in the financing.

The Variable Fees are charged accordingly to the volume of the waste and the frequency of the collection service. The Variable Fees promote the reduction of waste production in residential areas by decreasing the costs for waste collection (City of Frankfurt am Main, 2010). The variable charges depend on the amount of residual waste and the frequency with which it is collected. This type of fee also applies to commercial companies, since they have to pay for a minimum volume of residual

waste. The colour coded garbage containers for common waste, bio-waste, paper and packaging are provided for free to everyone who pays the charges.

### 6.2.2. Fight against Littering

The city provides information about the correct ways to separate and recycle waste products for residential and commercial establishments. However, due to the emergence of illegal waste dumping sites in some open areas and streets, the city has developed a penalization programme to prevent the pollution of public spaces and control the collection of waste products. The penalizations were socialised with the residents through the campaign against littering, reaching almost 90% of the inhabitants (Stadt Frankfurt am Main, 2016f). The fines start at 20 € and punish, among others, littering the streets with bottles, cans, cigarettes, bubble gum, napkins, as well as not collecting pets faeces and dumping garbage in unauthorised places. The fight against littering, including illegal bulky waste, presents one of the main tasks of the Clean Frankfurt Office<sup>4</sup>. This policy includes fines for people or collectives who dump waste in unauthorised places, and advertising campaigns (see figure below). Through these strategies, the office promotes correct behaviour and improves cleanliness in the city (Stadt Frankfurt am Main, 2016i).

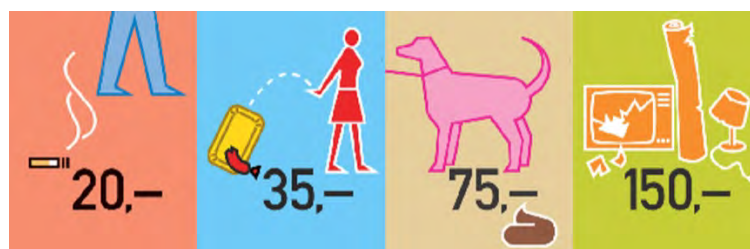


Figure 19: Posters – Fight against Littering

Source: (Sauberes Frankfurt, 2015f)

## 6.3. Programmatic Experiences

### 6.3.1. Ffmtipptopp

The Clean Frankfurt Office and FES have created the working group *Ffmtipptopp* to improve cleanliness in specific areas of the city. Within this group, residents employed by the programme collect small waste, remove stickers and notify waste management companies about illegal bulky waste. In this way, the project has two positive effects, it improves cleanliness and enhances citizens' awareness and creates new jobs giving new opportunities for unemployed people through training at the cleaning service (Ffmtipptopp, 2015; Stadt Frankfurt am Main, 2016i).

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<sup>4</sup> See Section 2.3

## 6.4. Educational Experiences

### 6.4.1. Clean Tale Hessen

Through activities in different social groups, the campaign *Clean Tale Hessen* promotes cleanliness in Frankfurt am Main and other cities with support from the municipalities and other sponsors. The main tasks of the campaign are to promote clean city landscapes and to inform about the correct behaviour of citizens through posters, brochures and presentations. The programme also supports community activities in regards to waste collection and the fight against littering in children institutions and citizens groups (Sauberhaftes Hessen, 2015; Stadt Frankfurt am Main, 2016i).

### 6.4.2. Fessie

*Fessie* is an online portal for children, teachers, and parents from FES that provides extensive information about the city waste management and services of the company in the form of posters brochures, videos, workshops, and different games (FES, 2015b).



The poster is titled "Umweltfreundlicher Papierkonsum" in large, bold, purple letters. It features two cartoon characters: a boy on the left wearing a yellow hard hat and a blue shirt, holding a large roll of paper; and a girl on the right with blonde pigtails, wearing a pink dress and holding two sheets of paper. The background is a solid yellow-green color. Below the title, the text "Welche Kennzeichnungen gibt es für Papier?" is written in purple. A paragraph explains that buying environmentally friendly paper requires knowledge of various symbols. The poster is divided into three sections: 1. "Empfehlenswert!" (Recommended!), which lists "Blauer Engel" (guaranteed 100% recycled paper) and "Ökopa / Ökopapirus" (100% recycled paper). 2. "Irreführend!" (Misleading!), which lists "Aqua pro Natura / Welpark Tropenwald" (fresh pulp), "holzfrei" (100% wood, but misleading), and "ohne Kennzeichnung" (fresh pulp, but no chlorine-free guarantee). 3. "Außerdem gibt es:" (Additionally, there is:), which lists "FSC 100%" (100% sustainable wood). The FES logo is in the bottom right corner. Small text on the left edge reads "© 2008 UMWELTLERNEN IN FRANKFURT e.V., Gestaltung: Anja Kleiss, PURE-design, Wiesbaden". Small text on the right edge reads "schöne Kunst auf dem blauen Engel" and "Papier sammeln".

**Umweltfreundlicher Papierkonsum**

**Welche Kennzeichnungen gibt es für Papier?**

Wer umweltfreundliches Papier kaufen möchte, muss sich gut auskennen, denn es gibt eine verwirrende Vielzahl an Symbolen.

**1. Empfehlenswert!**

- Blauer Engel:** Garantiert umweltfreundlich, weil aus 100 Prozent Altpapier ohne Chlorbleiche
- Ökopa / Ökopapirus:** 100 % Altpapier ohne Chlorbleiche, Eigenmarke der Firma Venceremos

**2. Irreführend!**

- Aqua pro Natura / Welpark Tropenwald:** Papiere werden aus frischem Zellstoff hergestellt, z.B. auch aus nordischen Urwäldern
- „holzfrei“:** Besteht immer zu 100% aus Holz, der irreführende Fachbegriff „holzfrei“ bedeutet reiner Zellstoff
- ohne Kennzeichnung:** Papier aus frischen Zellstoff, chlorhaltige Bleiche nicht auszuschließen

**3. Außerdem gibt es:**

- FSC 100%:** Papierzeugnisse, die zu 100 % aus Holz aus nachhaltiger Waldwirtschaft hergestellt werden.

FES

Figure 20: Poster about Environmentally Friendly Paper Consumption

#### 6.4.3. Other Experiences of Frankfurt am Main within the Waste Sector

- Feger Flotte: the Feger Flotte is a permanent project, complementary to the FES, responsible for the waste collection in the Frankfurt train station area.  
[http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar\[id\\_inhalt\]=40217&ffmpar\[id\\_eltern\]=2873](http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar[id_inhalt]=40217&ffmpar[id_eltern]=2873)
- Saubermäuse in der Albrecht-Dürer-Schule: The project was established by the Albrecht Dürer School in Sossenheim with the support of FES to collect the surrounding rubbish on the landscape conservation area of Sossenheimer Unterfeld.  
[http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar\[id\\_inhalt\]=40218&ffmpar\[id\\_eltern\]=2873](http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar[id_inhalt]=40218&ffmpar[id_eltern]=2873)
- Schulwettbewerb "Saubere Stadt - Schmutzige Stadt": This project organised a creative contest for the "Clean City - Dirty City" competition in the 2002/2003 academic year. The goal was to stimulate students about the cleanliness at schools and to give them the opportunity to develop creative solutions.  
[http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar\[id\\_inhalt\]=40225&ffmpar\[id\\_eltern\]=2873](http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar[id_inhalt]=40225&ffmpar[id_eltern]=2873)
- Recyclingzentrum Frankfurt GWR GmbH: The goal of the recycling centre and the non-profit company GWR is the prevention and reduction of electronic waste by the reuse and recycling of materials and equipment.  
<http://www.recyclingzentrum-frankfurt.de/index.html>

#### 6.5. Stakeholders in the Waste Management Sector

- **FES:** Frankfurt Disposal and Service GmbH focuses on providing cleaning services with the efficient use of resources and low environmental impacts. The company uses environmental criteria in waste collection procedures, demonstrating exemplary behaviour in the case of waste management and cleanliness, and rising awareness among customers and the public in environmentally friendly behaviour regarding waste disposal (FES, 2015c; Rhein-Main Abfall, 2015).
- **FFR GmbH:** Created as the Frankfurt Pedestrian Cleaning company, FFR is now a subsidiary company of FES, in charge of street cleaning, street winter maintenance, water supply for major events, traffic light maintenance and care of green areas (FES Frankfurter Entsorgungs- und Service GMmbH, 2016a)
- **Rhein-Main Biokompost GmbH:** A subsidiary company of FES in charge of the collection and management of private and commercial bio-waste. Bio-waste is treated through biological processes which have as sub-products compost and biogas. The latter is then used in energy generation to operate the system and feed the public electric grid. Compost is used in public gardening and sold to the general public (FES Frankfurter Entsorgungs- und Service GMmbH, 2016c)

- **FES Abfallmanagement- und -service GmbH:** As the main branch of FES, it is in charge of collection and assortment of lightweight packaging and recyclable waste (FES Frankfurter Entsorgungs- und Service GMmbH, 2016a)
- **MHKW Müllheizkraftwerk Frankfurt am Main GmbH:** A joint company between FES and the Mainova AG. with certification for the management and operation of the waste incineration and cogeneration plants in Frankfurt (FES Frankfurter Entsorgungs- und Service GMmbH, 2016b)
- **TRAPP Handelsgesellschaft mbH:** Subsidiary company of FES for the collection and management of paper and cardboard waste (FES Frankfurter Entsorgungs- und Service GMmbH, 2016a)

### 6.6. Conclusions of the Waste Sector Experiences

Waste collection has been a process of evolution of technology in Frankfurt, guided by the adjustment and transformation of Federal and European laws regarding the disposal and controls of waste products. In order to make the collection and disposal services more efficient, the municipality and the city-shared company FES have been developing programmatic strategies to promote waste products discrimination, reuse, recycling and reduce the overall amount of waste produced by the public. Although some new residents need guidance about recycling practices, waste separation is a feature in German culture. Therefore, educational programmes are the foundation of the collection and disposal services, as the efficiency of this sector in Frankfurt depends directly on the engagement of the residents and their commitment to discriminate waste products and dispose of them in the adequate container.

| Experiences - Waste Sector                         | RP Sectors |       |             |       |                |
|--|------------|-------|-------------|-------|----------------|
|  | Energy     | Water | Waste water | Waste | Urb. Agricult. |
| Standard and variable charges for waste collection |            |       |             |       |                |
| Cogeneration, biomass & compost                    |            |       |             |       |                |
| Fight against littering                            |            |       |             |       |                |
| Clean Tale Hessen                                  |            |       |             |       |                |
| Ffmtipptopp  |            |       |             |       |                |
| Fessie   |            |       |             |       |                |

Table 4: Analysis of Experiences in the Waste Sector

Beside disposal systems, waste-sector-related activities represent mostly the service of waste collection and waste management itself and seem not to need much of specific infrastructure demanding special coordination measures with city planning. The gradual increase in the efficiency of waste management in Germany and Frankfurt is a consequence of the innovation in waste disposal and recycling technologies and the willingness of the city to implement new strategies for urban infrastructure. New technologies look more into the reduction of waste going to the landfills, implementing a more collaborative approach between urban sectors, i.e. cogeneration plants reuse bio-waste to produce energy and heat, leading the waste sector towards a more trans-sectoral planning and implementation procedures for urban infrastructure.

## 7. The Urban Agriculture Sector

### 7.1. Relevant Practice: Compensation Areas

Interventions on the natural environment caused by urban development weaken or destroy ecological systems. Thus the policy aims at the recovery of the natural environment with the involvement of citizens, public and private companies as well as municipalities (Stadt Frankfurt am Main, 2016j). Land, whether urban or rural is not a renewable resource, and growing cities need to address the problem of urban expansion and growth in a sustainable way. Therefore, the city explores many variations of policies and regulations to reduce the impacts of urbanisation on the natural environment while providing the necessary conditions for the citizens to experience a high quality of life (Stadt Frankfurt am Main, 2016j).

This policy acts as the means to balance urban interventions with environmental protection, sustainability and enhance the quality of life in the city. Based on the Frankfurt Green City concept, *Compensation Areas* are part of the planning framework and regulations for minimising the impact of urban development on the environment. The concept of *Compensation Areas* includes different land use typologies, including protection of the existing areas and redevelopment. In this way, the policy covers not only agricultural land, but also the water and wastewater sectors helping with the protection of water reservoirs and control of water bodies. The compensation process is to be ecologically meaningful, effective and affordable in the long term.

In Frankfurt examples of compensational areas take a form of orchards (fruit meadows)<sup>5</sup>, “fish ladders”, or biotope improvement measures in the city forest. For example, in order to balance a building construction, the policy considers unused sealed areas. It is important to notice that although valuable agricultural plots are unsealed areas, they could be considered in the future as areas for possible urban interventions (Stadt Frankfurt am Main, 2019a).

#### 7.1.1. Process for Compensation Areas

The *Compensation Areas* database has existed since 2001 and is included in the planning procedures as a concrete concept structuring and developing the green city. The basis of this cadastre is primarily urban landscape plans which define the landscape planning objectives for certain districts. The Environmental Department together with interested developers is responsible for the continuously updating of this database and provides an overview of opportunities for landscape development within the nature conservation law (Umweltamt Frankfurt am Main, 2014).

#### 7.1.2. Practice-oriented Example: Project – Frankfurt Green Belt

The Frankfurt Green Belt is an area of approximately 80 Km<sup>2</sup> surrounding the city, which has been protected and developed since 1991, following an executive decision of the City Council. The Green

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<sup>5</sup> Orchards are traditional part of the local landscape of countryside and represent a group of fruit trees. They are known for their high ecological value as favorable habitat for numerous native species like little owls, wrynecks, various insect and bats. Moreover, orchards are the source of local important and famous cider. However, due to settlement expansions and the decline of economic importance of fruit production (lack of interest, maintenance, and replanting), orchards are under extinction. In this way, if there are more than 10 fruit trees, the area is considered as under the special protection of the Hessian Nature Conservation Act (Umweltamt, 2016d).

Belt is part of a larger landscape protection area covering 108 Km<sup>2</sup>. Since 1998, the Green Belt is the heart of the Rhein-Main Regional Park, connected to a wider network of green and open spaces within the Frankfurt/RheinMain Metropolitan Region.

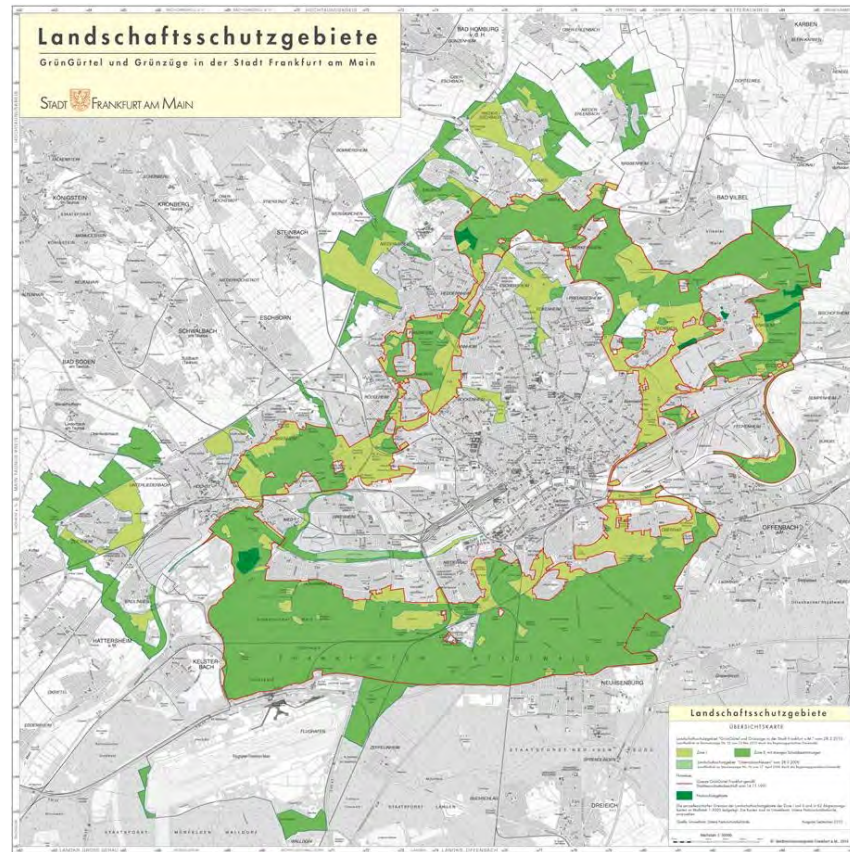


Figure 21: Frankfurt Green Belt and Landscape Protection Areas. Source: Hartmanshenn, 2016

The Green Belt includes, among other green infrastructures: the Nidda river as a linear park and central recreational area; the Nidda Valley for environmental protection and as corridor for fresh air into the city; the surrounding hillsides as locations for public orchards and fresh air production; the city forest -*Stadtwald*- which is Frankfurt's green lung; areas for allotment gardens and communal gardening; as well as leisure and recreation areas along the Main river, and more than 60km of bicycle routes.

The main value, output and capacity of the Frankfurt Green Belt relies not only on biotic<sup>6</sup> and abiotic<sup>7</sup> values but also on recreation and health potentials as well as the generation of economic income from agriculture, forestry and catering industries. Likewise, the Green Belt has an important role in environmental education for the public in general.

<sup>6</sup> species and biotypes

<sup>7</sup> climate, soil, water, air

## 7.2. Relevant Practice: Urban Community Gardens

The broad sustainable policy and cooperative planning of Frankfurt and the region create favourable conditions for urban community gardening as part of development about climate protection, globalisation, and demographic changes. The promotion of urban gardening comes from not only public but also from municipal structures.

Urban community gardening is an initiative by a group of people to cultivate an otherwise unused area inside the urban perimeter. In most cases, gardens have no individual ownership, all members here are expected to participate in cultivation and are rewarded with an equal share of the harvest. Often, urban community gardens have a form of mobile raised beds, which gives them a possibility of relocating the garden in case of changing plans of landowners with whom gardeners usually have an agreement of cooperation.



*Figure 22: Allotment Garden*

*Source: Frankfurter Beete, 2015*



*Figure 23: Urban Community Garden*

*Source: Frankfurter Garten, 2015*

The gardens combine different civic activities in social and ecological fields. They are managed mainly by local neighbourhoods with municipal and organisational financial support and quite often involve sponsorship and donations. Thus, community gardening promotes the greening of city spaces, socialisation, and civic engagement. This social project initiated originally in North America as a practice of gardening on non-developable territories and is still a young phenomenon in Frankfurt. The Green Spaces Department promotes urban community gardening in the city and has a mission to provide green space for the people who are interested in this subject (Grünflächenamt, 2015a). In Frankfurt, this kind of projects started to emerge in 2013 and have become spaces for social interaction, where people with different background and generations meet and exchange ideas. Thus, urban community gardening is seen as a creative and productive way to establish a dialogue between the city and its citizens and to enable a new form of civic engagement in this context (Grünflächenamt, 2015a).

Urban gardens are considered as a part of important green areas for city development (KulturRegion FrankfurtRheinMain, 2016a). Therefore, this topic has support from both governmental and social levels. All promoters, which share common interests, try to organise mutually beneficial cooperation.

**Public Stakeholders:** *KulturRegion FrankfurtRheinMain, Environment Department and Green Spaces Department:* Regional support of urban gardening is represented through the *KulturRegion FrankfurtRheinMain* with the main goal of joint culture regional development and participation in planning associations. As the core of the region, Frankfurt combines a wide variation of green areas and green systems inside and outside the city boundaries; therefore, the Environment Department and Green Spaces Department encourage citizens' interest in informational and organisational issues (Grünflächenamt, 2015a).

**Citizens registered gardening associations and Frankfurter Beete:** the most significant promotion of urban gardening practices comes from grassroots projects in the form of different registered gardening associations. These registered associations function as a corporate body and, thus, have legal authority over the land. Also, a social cooperation of city gardeners in and around Frankfurt is presented in the blog Frankfurter Beete. It discusses current issues of urban gardening and sustainable self-sufficiency with the wide involvement of all citizens.

### 7.3. Practice-oriented Example: Project – Urban Community Gardens

The most famous example of urban community gardening in Frankfurt am Main is represented by the Frankfurter Garten project. The project was launched in 2013 covering a total area of 2,500 m<sup>2</sup> and looks like a small fenced city park. The area became a traffic island between several main large streets. The land belongs to the city, with a temporary contract for a free land rental that is renewed periodically. Today Frankfurter Garten has the contract with the city for two more years until 2017 (with an option to further extend as long as no other development will take place on that area). When the reconstruction process is started, the project will be moved to a new location.

The territory of Frankfurter Garten has three main zones:

- The *cultivation zone* is characterised by lines of movable raised beds in the centre and placed around the perimeter bags, in which gardeners cultivate various edible, medicinal, and ornamental plants. The garden has a greenhouse for growing seedlings and an open summerhouse with plants and books for recreation and reading. For irrigation, there is a movable water pond with watering cans and also water hoses that are connected to the city water supply. This zone includes small projects such as beehives, butterfly oasis, and an experimental water pond with plants and fish. Also, the cultivation zone includes one container for storing working tools and materials and two other containers used for holding various entertaining and educational meetings and events.
- The *recreation zone* is located between two elongated plots with sandboxes for children, benches and a table. Also, there are possibilities of playing table tennis, boules, and cooking barbecue. This part of the garden is used for markets, festivals, as well as for private events.
- The centre of the *community zone* of the project is a summer café in the form of container with a usable rooftop. In this zone, there is also a kiosk for selling products. The area also has a small container that is used as an office of Frankfurter Garten.

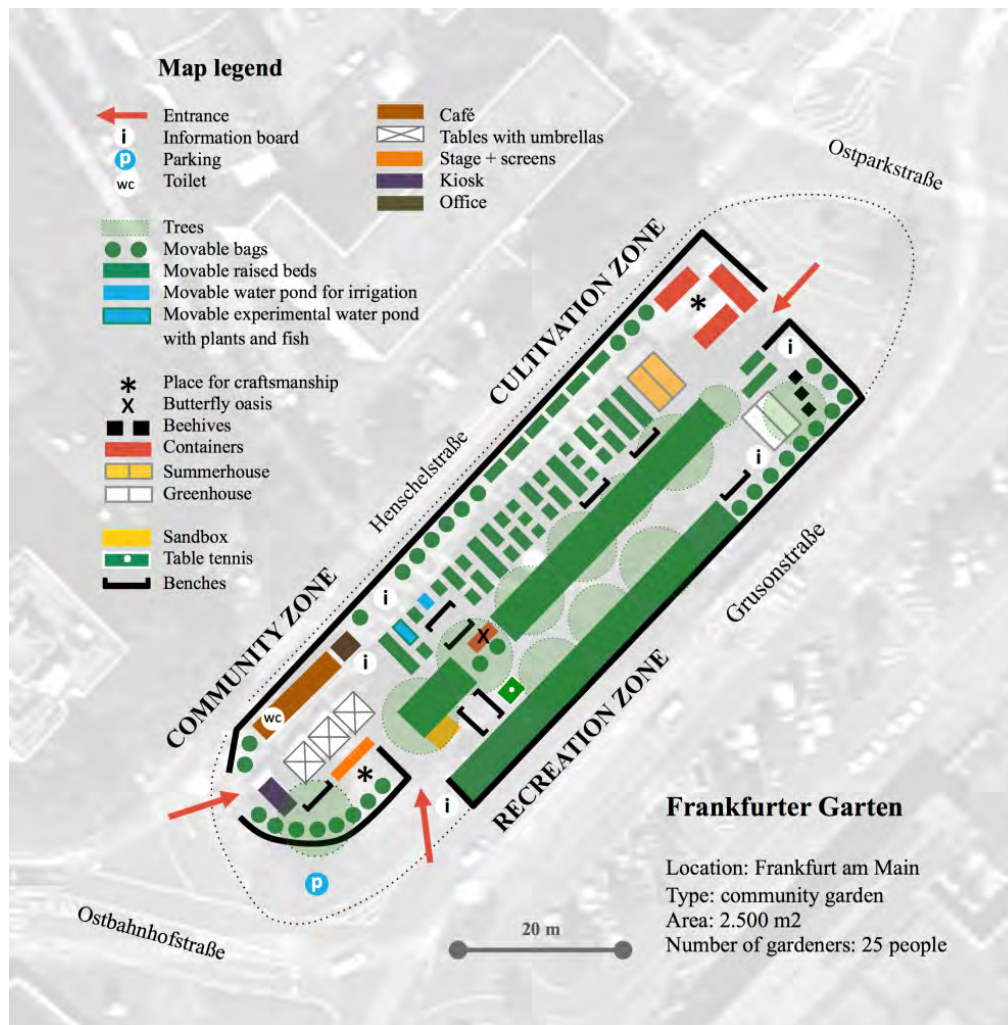


Figure 24: Scheme of the Frankfurter Garten Project ©Olga Korovina, 2013



Figure 25: Frankfurter Garten Project. © Debora Ayres

## 7.4. Programmatic Experiences

### 7.4.1. Landscape Planning

Landscape planning is a key instrument of sustainable urban development. Frankfurt has this planning in two forms, such as the *Landscape Plans – Landschaftspläne*; and the *Open Space Development Plan – Freiflächenentwicklungsplan* (Stadt Frankfurt am Main, 2019c). The Landscape Plans are specialised plans for unpopulated urban areas, with the objectives of securing climate protection functions, protection of animals and plants, and the development of landscape within and outside of the city. The landscape plans have been widely adopted by the city council. They are developed at the city level by the Environment Department and are a relevant input for the Preparatory Land-Use Plan on the regional level, developed by the Regional Authority FrankfurtRheinMain.

The Landscape Plans do not have a legally binding character from the beginning but come into legal force after coordination with other tasks and other legal plans. Therefore close cooperation for landscape use, landscape protection and city planning is necessary. The Open Space Development Plan aims at preserving and improving the diversity of landscapes in the city of Frankfurt am Main. It combines an inventory that shows the actual situation and a goal plan that represents the desired future development of open spaces. Within this plan, all single open spaces in the urban areas are divided into six categories: i) areas with high importance for nature conservation e.g. forests, territories of protected species, floodplains; ii) areas with priority for agriculture use; iii) areas with high importance for recreational; iv) important green links in connection to recreation and spatial organisation; v) space forming and landscape-shaping alleys; and vi) water bodies (Regionalverband FrankfurtRheinMain, 2015).

### 7.4.2. Landscape Conservation Areas - Landschaftsschutzgebiet

The city of Frankfurt am Main is surrounded by open countryside. The Environment Department considers important to preserve these landscapes because they have become recreational areas and productive environments for animals and plants. Moreover, these have a positive effect on the urban climate and enhance local culture and traditions. In this way, the landscape conservation areas aim at protecting and preserving the environmental characteristics and diversity, functioning ecosystems, natural products and its recreational value. The concept of conservation area prevents the development of urbanisation on these territories, preserving the natural open countryside.

The landscape conservation areas in Frankfurt are divided into two zones: a *zone for landscape use*<sup>8</sup>, specifically usable green areas for public and private needs, territories for sport and recreation, areas for agriculture and gardening; and *zones for protection and conservation of nature at the foreground*, ecologically significant meadows, extensively used arable land, floodplains and wetlands, forest areas, public parks. A good example for the Rapid Planning Project is the protection of orchards, which provide a protective environment for rare species, besides their valuable traditional harvest for the local culture (Stadt Frankfurt am Main, 2019c).

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<sup>8</sup> According to the preparatory land use plan

#### 7.4.3. Allotment Gardens

Allotment gardens are usually organised as small fenced land plots that can be rented by the citizens. These plots are available for non-commercial, individual and family gardening or food production. They function not only as a recreation area but also as a place for meetings and socialisation. These are registered associations and considered as urban community gardens. Often, allotment gardens are located on territories near the railways or other areas that are not attractive for residential use, but suitable for other activities. The Green Spaces Department is responsible for numerous allotment gardens in Frankfurt, responsible for the technical supervision and plays the main role in the case of their promotion and planning (Grünflächenamt, 2015a).

#### 7.4.4. Other Experiences of Frankfurt am Main within the Urban Agriculture Sector

- Das Mainufer: The renovation of the Main river banks increased the quality of life. A green area in the extension of the ramparts was created. The residents of Frankfurt city enjoy the view of the opposite promenade and the skyscrapers, often until late at night.  
<http://www.frankfurt-greencity.de/umwelt-frankfurt/frankfurt-die-gruene-stadt/das-mainufer/>
- Der Stadtwald: Frankfurter Stadtwald is one of the largest municipal forest areas in Germany, and it is a landscape conservation area.  
<http://www.frankfurt-greencity.de/umwelt-frankfurt/frankfurt-die-gruene-stadt/der-stadtwald/>
- Erfassung und Recycling belasteter Flächen: data of contaminated sites are available to all interested parties. This information is important for urban land and soil management, development measures and the planning of new schools, kindergartens and parks.  
<https://frankfurt-greencity.de/umwelt-frankfurt/frankfurt-die-gruene-stadt/flaechenrecycling/>
- Europäische Grüne Hauptstadt: the city of Frankfurt am Main has applied for the title "European Green Capital" for the year 2014 and together with Copenhagen and Bristol made the leap into the final round.  
<http://ec.europa.eu/environment/europeangreencapital/winning-cities/previous-finalists/frankfurt/index.html>  
<https://frankfurt-greencity.de/frankfurt-vernetzt/auszeichnungen-und-preise/european-green-capital-award/>
- Europäische Stadt der Bäume: The European Arboricultural Council (EAC) marked the city of Frankfurt as a "European City of the Trees 2014". The association of tree specialists from all over Europe pays tribute to Frankfurt's pioneering role in the care of the urban tree.  
[http://www.frankfurt.de/sixcms/detail.php?id=2818&ffmpar\[id\\_inhalt\]=20554060](http://www.frankfurt.de/sixcms/detail.php?id=2818&ffmpar[id_inhalt]=20554060)
- Frankfurter Beete: Frankfurter Beete is a blog for all city gardeners in Frankfurt and the surrounding area. Information about traditional crops ranging from urban gardening and sustainable self-sufficiency are available.  
<http://frankfurter-beete.de>
- Parkwächter: The green parks in Frankfurt use a private security company to monitor in compliance with urban green space rules.  
[http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar\[id\\_inhalt\]=40230&ffmpar\[id\\_eltern\]=2873](http://www.frankfurt.de/sixcms/detail.php?id=3862&ffmpar[id_inhalt]=40230&ffmpar[id_eltern]=2873)

- Umweltzone Frankfurt am Main: Only vehicles with the Grüne Plakette (green sticker) can circulate within the city to reduce the concentration of fine dust and nitrogen dioxide to maintain the air limit values.  
[http://frankfurt.de/sixcms/detail.php?id=3060&ffmparf\\_id\\_inhalt=4309350](http://frankfurt.de/sixcms/detail.php?id=3060&ffmparf_id_inhalt=4309350)

## 7.5. Stakeholders in the Urban Agriculture Sector

- **Environment Department:** The city of Frankfurt has a special database of *Compensation Areas* from the Environment Department that provides a wide range of search options. In this way, the Environment Department becomes an important actor in the management of *Compensation Areas* (Stadt Frankfurt am Main, 2019a).
- **City Planning Department:** At the same time the City Planning Department plays a policy implementation role. *Compensation Areas* are an essential part of the Green Concept, green planning for better living conditions and environmental protection and the Green Belt<sup>9</sup>, a protected green area around the city for environmental protection and leisure activities (Stadtplanungsamt Frankfurt am Main, 2016b).

## 7.6. Conclusions of the Urban Agriculture Sector Experiences

It is necessary to highlight that the term of urban agriculture in Frankfurt might have a double meaning. On the one hand, urban agriculture according to city administrations seems to refer to larger agriculture fields that are still located within the city boundaries on a private land and used only for commercial production. Hence, regarding policies, urban agriculture is involved in city planning regarding protection and regulation measures and has a close collaboration with water and wastewater sectors (Regionalverband FrankfurtRheinMain, 2015; Stadt Frankfurt am Main, 2019c).

| Experiences - Urban Agriculture Sector | RP Sectors |       |             |       |               |
|--|------------|-------|-------------|-------|---------------|
|  | Energy     | Water | Waste water | Waste | Urb. Agricul. |
| Landscape planning                     |            |       |             |       |               |
| Landscape conservation areas           |            |       |             |       |               |
| Compensation areas                     |            |       |             |       |               |
| Allotment gardens                      |            |       |             |       |               |
| Urban community gardens                |            |       |             |       |               |

Table 5: Analysis of Experiences in the Urban Agriculture Sector

On the other hand, urban agriculture according to the public point of view tends to mean the small plots like allotments and community gardens that are located in private or public territories and

<sup>9</sup> See section 7.1.2.

intended only for non-commercial use. Hence, regarding practice, citizens represent the main actor in the scene with not forgetting to mention the cultural and informational support of the city administrations (Grünflächenamt, 2015b; KulturRegion FrankfurtRheinMain, 2016a).

Urban agriculture as a sector shows an extended range of trans-sectoral progress in general and represents in the case of “Frankfurt Green City” an ideal example of a trans-sectoral project covering all the addressed sectors. Based on the example of the Frankfurter Garten, it is possible to conclude that the general value of urban community gardening is mainly focused on the creation of stronger communities. The promotion of urban gardening reflects an initial understanding of local demands with opportunities and links to the implementation of multifunctional space (Smit & Bailkey, 2006) e.g. ecological development, environmental responsibility and education, advancing food production, increasing of physical quality of urban environment. In this way, urban community gardening as a social-driven and community-based activity is a vehicle for sustainable community development with a result of a sense of inclusion, dignity and accomplishment, despite the obvious positive influence on people in case of health, education and skills practising.

## 8. Stakeholders Involved in the Urban Infrastructure Sectors

The city of Frankfurt operates through diverse typologies of public<sup>10</sup>, private and public-private partnerships with different shares of investment or involvement of the municipality. The city is directly or indirectly involved in approximately 200 partnerships from which 20% are in the sectors of transport, water and energy provision and management (Stadt Frankfurt am Main, 2014, p.14).

### 8.1. Environment Department<sup>11</sup>

The Environment Department is an important municipal organisation providing information and advice to policy makers about environmental issues and possibilities. The Department also conducts environmental research and monitors the quality of the natural environment in the city and surrounding region. The Environment Department comprises five divisions in charge of: central environmental affairs; environmental protection; environmental monitoring water, air and soil; environmental monitoring wastewater and laboratory; and waste management.

Environment, climate change and sustainable urban development are interconnected topics. Therefore, through cooperation with the city administration, companies, citizens, and other municipalities, the Environment Department aims at improving the environment and quality of life i.e. energy consumption, waste management, noise protection, quality of air, water consumption, sewage, improvement of green city areas. The department is in charge of preserving natural resources such as surface water, soil, landscape, flora and fauna and promote their efficient use (Stadt Frankfurt am Main, 2016j).

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<sup>10</sup> Municipal Departments are referred as *Ämter* and municipal agencies as *Referate* in German.

<sup>11</sup> *Umweltamt*

## 8.2. Municipal Energy Agency<sup>12</sup>

The Municipal Energy Agency is in charge of the energy management and energy-related climate protection in Frankfurt. The agency provides expert support and advice to organisations and citizens about climate protection issues, from energy saving to guidance for corporate environmental management. The work of the agency is focused on energy saving, energy planning, combined heat and power supply, reduction of energetic demand, and transition to renewable energies. As one of the founders and a member of the Climate Alliance<sup>13</sup> of European cities, the agency promotes and implements the Master Plan 100% Climate Protection for Frankfurt, which presents a sustainable vision for the city in 2050 (see section 2.1). The Agency is supported by numerous local, national and international partners (Stadt Frankfurt am Main, 2016c). The Municipal Energy Agency is not a competitor to consultants, planners and investors. It helps to organise projects which are carried out by partners. This way energy efficiency and climate protection can be combined with economic development and job creation (Stadt Frankfurt am Main, 2016h).

## 8.3. City Planning Department<sup>14</sup>

The City Planning Department is a vital institution in the city in charge of land use and urbanisation management and coordination of urban development projects. Some of the responsibilities of the planning department are: participation in regional land use planning; compiling the basic materials for urban planning and urban development; formulation of legal frameworks for development plans; the elaboration of legally binding land use plans and statutes, including the related landscape and traffic planning and taking into account water and wastewater infrastructure; providing construction advisory services and evaluation of building applications; improvement of public spaces and streets; promotion of urban renewal, also with regards to the energy sector; support of residential construction; and implementation of urban development projects. (Stadtplanungsamt Frankfurt am Main, 2016c).

## 8.4. Building Construction Department - Energy Management<sup>15</sup>

The Building Construction Department is in charge of the planning, construction and maintenance of passive house standard public buildings for education, welfare, social, cultural and sports activities in the city. Along with the construction, the Building Department supports and promotes sustainable energy management to reduce the costs of electricity, heat energy and water for the city-owned real estate. The service of energy management includes (1) energy controlling; (2) operational optimisation; (3) energetic quality assurance; (4) development of object-related energy concepts of the city. The Building Department also works on the maintenance of public buildings, cleaning graffiti and maintaining the facades (Stadt Frankfurt am Main, 2016f).

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<sup>12</sup> *Energierreferat*

<sup>13</sup> *Klima-Bündnis*

<sup>14</sup> *Stadtplanungsamt Frankfurt am Main*

<sup>15</sup> *Hochbauamt – Energiemanagement*

### **8.5. Clean Frankfurt Office<sup>16</sup>**

The Clean Frankfurt Office acts as an interface between all municipal offices, city communities and other bodies related to clean public spaces. It aims to improve cleanliness in the city of Frankfurt through various actions in PR work and notification of incidences of excess rubbish that include the accelerated renewal of illegal waste deposits, the fight against littering and support of different projects (Stadt Frankfurt am Main, 2016i).

### **8.6. City Drainage Frankfurt am Main<sup>17</sup>**

The City Drainage is the leading company for the sanitation and water body development in the Rhein-Main Region. The department is responsible for wastewater management that includes promotion of effective and responsible water use, sewer, disposal, treatment as well as ground water conservation. Thus, it takes care of constant improving its infrastructure with the increasing ecological, economic, and legal requirements (Stadtentwässerung Frankfurt am Main, 2016).

### **8.7. Health Department<sup>18</sup>**

The Health Department takes care of the quality of water, soil, air, and food, which has a direct impact on human health. Therefore, the department controls the environment through statutory regulations, policies, limitations, and cooperation with investigation institutes of the region. At the same time, the department promotes extensive information for citizens for a more healthy and environmentally friendly lifestyle (Gesundheitsamt, 2015a).

### **8.8. Green Spaces Department<sup>19</sup>**

The Green Spaces Department takes care of planning, construction, management and maintenance and cleaning of public green areas, recreational spaces, and other landscapes like cemeteries and the municipal forest together with their infrastructures; in some cases as a part of various environmental motives. Amongst its responsibilities are the consultation, construction, and design of allotment gardens and small animal breeding; the development of plans, policies, programmes, activities, and competitions; and the planning, construction and maintenance of projects in the Green Belt of Frankfurt (Grünflächenamt, 2015a; Stadt Frankfurt am Main, 2016i).

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<sup>16</sup> *Sauberes Frankfurt - Stabsstelle*

<sup>17</sup> *Stadtentwässerung Frankfurt am Main*

<sup>18</sup> *Gesundheitsamt*

<sup>19</sup> *Grünflächenamt*

## 8.9. Stadtwerke Frankfurt am Main Holding Group

*Stadtwerke Frankfurt am Main* is an umbrella company that brings together subsidiary companies<sup>20</sup> for energy, transport, recreation services and other municipal interests, essential for the development of infrastructure and services for citizens as well as businesses in the city and the region. The company has a strong focus on the provision of energy, natural gas, heat, water, and management of environmentally friendly waste incineration and public transportation. The efficient use of energy and water within the challenges of climate change guide the interests and focus of the corporate group, leading towards sustainable development and sustainable businesses (Stadtwerke Frankfurt am Main Holding, 2015b)

## 8.10. Mainova AG

Mainova AG is a subsidiary company of the Stadtwerke Frankfurt am Main Holding Group and presents an environmentally friendly multi-utility structure, oriented to providing efficiency and the highest technology. Mainova AG supplies energy for the Rhine-Main region. It is a private company, but 75% of its shares are owned by the City of Frankfurt (MHKW GmbH, 2015b). The company supplies the city and the region with electricity, natural gas, heat and water. Mainova promotes renewable energy usage and operates modern power systems for cogeneration, solar, wind and hydropower plants, etc. Mainova's subsidiaries<sup>21</sup> develop innovative approaches to energy supply and provide consultations for customers and free extensive information for online users for efficient and responsible use of energy and natural sources (Stadtwerke Frankfurt am Main Holding, 2015a; Mainova AG, 2016).

## 8.11. ABG Frankfurt Holding GmbH

ABG Frankfurt Holding is the largest housing construction, and investment company in Frankfurt am Main, owned and controlled by the city of Frankfurt. Together with subsidiaries, the company owns more than 50,000 apartments and other rental units for commercial, municipal and cultural purposes for all population groups. The ABG Frankfurt Holding also develops and maintains real estate projects with participation of private partners, in the context of its subsidiaries<sup>22</sup>. Based on a vision of affordable housing in times of rising energy prices, the company improves energy efficiency in the buildings to reduce the costs for tenant (ABG Frankfurt Holding, 2015). It is also one of Germany's foremost actors in the field of passive house constructions.

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<sup>20</sup> *Verkehrsgesellschaft Frankfurt am Main, Mainova AG, Abfallverbrennungsanlage Nordweststadt, BäderBetriebe Frankfurt GmbH, Fraport AG, Süwag Vertrieb & Co. KG.*

<sup>21</sup> *NRM Netzdienste Rhein-Main GmbH, Mainova ServiceDienste GmbH, Mainova EnergieDienste GmbH, SMR Straßen-Beleuchtung Rhein-Main GmbH*

<sup>22</sup> *Frankfurter Aufbau AG, HELLERHOF GmbH, WOHNHEIM GmbH, MIBAU GmbH, SAALBAU Betriebsgesellschaft mbH*

## 8.12. Frankfurt's Disposal and Service – FES –<sup>23</sup>

FES is a contracted partner of the regional company for waste management -*Rhein-Main Abfall GmbH*- Together with its subsidiaries<sup>24</sup> and associated companies, FES forms a waste management company that provides disposal and surface cleaning services for municipal, industrial, commercial and private customers in the city and the region. FES forms a group of companies with around 1,700 employees, including its subsidiaries. The tasks include disposing of waste properly and consequently with the legal provisions of the *Recycling and Waste Management Act* and the *Commercial Waste Ordinance* and operate recovery and purification equipment with the latest technology. The company's aim is to be reliable, flexible and ecologically sensible. The FES is 51% owned by the City of Frankfurt am Main, 49% of the shares are held by REMONDIS AG & Co. KG. FES is a successful example of public-private partnership (MHKW GmbH, 2015b).

FES considers waste as an economically and ecologically valuable raw material, which the company returns to the economic cycle and makes more usable. It operates recycling and treatment equipment and works with the latest technology with bright environmental criteria. FES focuses on providing cleaning services with efficient use of resources and low environmental impacts; the use of environmental criteria in procurement procedures; the demonstration of exemplary behaviour in the case of waste management and cleanliness; and customers and public awareness of environmental friendly behaviour in terms of waste disposal (FES Frankfurter Entsorgungs- und Service GMmbH, 2016b, 2016a; Stadt Frankfurt am Main, 2016b).

## 8.13. Regional Authority FrankfurtRheinMain<sup>25</sup>

Since a few decades, the cities in Germany have been cooperating and establishing metropolitan regions for mutual support and increase the opportunities for regional competition. The Rhein-Main region answered to the need for a regional association through the establishment of the *Regional Authority FrankfurtRheinMain*, which congregates 75 municipalities and towns, managing and coordinating regional development in the central part of the Rhein-Main region. The Regional Authority promotes sustainable development, with the objective of attracting investors, green businesses and ideas that produce employment and increase the attractiveness of the region.

The purpose of the Regional Authority is to ensure a sustainable future for the region, also to the development of various programmes and services for organisations and citizens in the areas of energy and environment. Among the responsibilities of the Regional Authority is the development of the *Regional Preparatory Land Use Plan*<sup>26</sup>. This plan is used as a basis for strategic decision making in urban and rural development and allocation of land and resources for the region. The plan characterises the land uses following the agreements reached among the participants. The German Law requires each municipality to draw up a Preparatory Land Use Plan; however, the municipalities

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<sup>23</sup> *Frankfurter Entsorgungs- und Service GmbH*

<sup>24</sup> *FFR GmbH, RMB Rhein-Main Biokompost GmbH, FES Abfallmanagement- und Service GmbH, MHKW Müllheizkraftwerk Frankfurt GmbH/AVA Nordweststadt GmbH, TRAPP Handels GmbH, RMS Rhein-Main Solarpark GmbH, FSG Flughafen-Service GmbH*

<sup>25</sup> *Regionalverband FrankfurtRheinMain*

<sup>26</sup> *Regionaler Flächennutzungsplan*

Source: (Regionalverband FrankfurtRheinMain, 2018)

*Hessenwasser* (Waterworks Hesse) is responsible for the extraction, processing, quality control and reliable provision of drinking water in the Rhein-Main Region. The company provides a sustainable regional water management system that requires a comprehensive technical, environmental and economic know-how. The water management requires the cooperation among municipalities, also necessary for the spatial planning of protection of water extraction areas (Hessenwasser, 2014). The infrastructure for the provision of water is provided by each municipality, but the service is in the hands of the Waterworks Hesse.

The *Cultural Region* is an association of 45 municipalities and the Regional Authority in the metropolitan region FrankfurtRheinMain. The purpose of the Cultural Region is joint cultural, regional development. The association promotes joint work for cultural purposes and provides a network of diverse topics and cultural projects within the environmental and the social sectors (KulturRegion FrankfurtRheinMain, 2016b).

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## 8.16. Other Organisations in Frankfurt am Main

The organisations listed below are involved in the management or implementation of special infrastructures i.e. the International Frankfurt Airport, new co-Generation plants or developing promotional and educational projects outside the Rapid Planning sectors. They are mentioned in this document because they have the potential to contribute an influence on sustainability in the city, which would be indirectly relevant to Rapid Planning.

### ***BioFrankfurt – Das Netzwerk für Biodiversität***

An association of 14 institutions and organisations with the purpose of raising awareness about the importance of biodiversity and its conservation in the media and the public through cooperation and information exchange, and engaging in the Rhein-Main region in the areas of research, protection and education (BioFrankfurt, 2016).

### ***BUND Kreisverband Frankfurt e.V.***

An association without legal capabilities, under the rule of the BUND-Landesverband Hessen and the German Federal Alliance for Environment and Nature Conservation. The purpose of this Association is to provide education and training oriented towards environmental protection and conservation, animal welfare, as well as noise reduction. The association also promotes healthy living environments and healthy living lifestyle (BUND Kreisverbandes Frankfurt, 2016).

### ***FrankfurtRheinMain - Die Wirtschaftsinitiative***

120 companies and organisations with the common goal of bringing together the minds and entrepreneurs of the region who want to make a difference – for and in FrankfurtRheinMain. The members share the conviction that only a jointly operating economic space can exist in national and international competition, making the metropolitan area FrankfurtRheinMain more attractive for people and companies (Wirtschaftsinitiative FrankfurtRheinMain e.V., 2016).

### ***FrankfurtRheinMain Verein zur Förderung der Standortentwicklung e.V.***

The Association FrankfurtRheinMain creates a close cooperation between politic, economy, science and culture. The FrankfurtRheinMain metropolitan region aims to develop a leading collaborative decision-making process establishing the region as an international attractive and competitive location. The work of the regional institutions in the Association FrankfurtRheinMain is based on a wide social anchoring (Geschäftsstelle FrankfurtRheinMain, 2016).

### ***Fraport AG***

Fraport AG operates the Frankfurt Airport, one of the world's most important air transportation hubs. Frankfurt Airport is the largest employment complex in Germany, with more than 500 companies and organisations providing jobs for more than 81,000 people. As an experienced airport manager, Fraport is expanding Frankfurt Airport together with partners into Frankfurt Airport City – an outstanding real-estate location and gateway of mobility and excitement. In addition to covering the full range of airport services, Fraport AG is a competent partner in airport retailing and real-estate development (Fraport AG, 2016).

### ***MainÄppelHaus Lohrberg - Streuobstzentrum e.V.***

An association aiming at preserving and shaping the habitat of orchards in the diversity of the region, as well as to cultivate apple culture as an element of regional identity. The MainÄppelhaus Lohrberg is supported by the commitment of its members, voluntary helpers, donors and partners.

### ***MHKW Müllheizkraftwerk Frankfurt GmbH/AVA Nordweststadt GmbH***

MHKW Frankfurt am Main is a highly modern waste incineration plant implemented by AVA and HKW - FES GmbH and Mainova A. The plant started supplying the district of Nordweststadt. The power supply network and the enormous energy decoupling have enabled the supply network to be expanded to other districts, such as Campus Westend, the Riedberg, Eschersheim and Bockenheim. By using domestic waste as a fuel for energy generation, the MHKW waste incineration plant Frankfurt am Main GmbH contributes significantly to the reduction of carbon dioxide emissions. There are also savings in oil, coal and natural gas resources. Also, the renewal of flue gas cleaning also reduces the environmental impact (MHKW GmbH, 2016).

### ***Naturschule Hessen***

Naturschule Hessen provides an extensive program of events for school classes, children groups and families to explore the Green Belt in Frankfurt. Guided tours of nature and active protection of species are the main focus of the events, which are sponsored by the Environment Department of Frankfurt. The school also offers a wide range of paid services and programs following the subjects: amphibians, urban gardening, the native bird world, herbs and medicinal plants, as well as rivers (Naturschule Hessen, 2016).

### ***Regionalpark RheinMain***

The Regionalpark RheinMain represents an organisation that manages a network of natural and green areas, along with green routes in the Rhine-Main area. The organisation was established to protect open spaces and green areas between settlements and secure these areas for recreation. In this way, the main idea of the regional park is to improve the landscape of the metropolitan area as a multifunctional recreational space within the context of the regional image. Currently, about more than 200 projects have been implemented and connected through the regional park route network of 190 km., which allows mobility throughout the whole region (Regionalpark Ballungsraum RheinMain GmbH, 2016).

### ***Umweltforum Rhein-Main e.V.***

The Umweltforum organises events to discuss current topics and to share a common strategy for the planning and execution of projects in the Rhine-Main area. Members of the environmental forum, representatives of companies and interested guests, meet regularly to plan and implement joint projects. The topics selected for discussions are environmental protection, energy, sustainability and organic food (Umweltforums Rhein-Main, 2016).

### ***Umweltlernen in Frankfurt am Main e.V.***

Umweltlernen is oriented on the concept of education for the sustainable development. The association develops educational projects related to the following purposes (Umweltlernen Frankfurt am Main e.V., 2016)

- Support schools and children's day-care centres in environmental education projects.

- Foster creative competency, social learning and participation processes.
- Advise schools and children's day-care centres, moderate projects and qualifies multipliers.
- Develop a cooperative learning city network in the city centre with the following aspects: environment, natural sciences, culture, nutrition, health.

### ***Wissensregion FrankfurtRheinMain***

Wissensregion FrankfurtRheinMain was initiated by Industrie und Handelskammer Frankfurt am Main, Regionalverband FrankfurtRheinMain and FrankfurtRheinMain – Die Wirtschaftsinitiative. The three project partners have teamed up to enhance the knowledge base FrankfurtRheinMain, to organise a joint action at the level of the metropolitan region and thus to promote a positive economic development. The initiative's work is based on four topics: "Living and working in an attractive region", "Excellence in Teaching and education", "Networking of business, science and culture "and "Innovative power". More than 1,000 experts from ministries, universities, research institutes, companies, chambers, associations and organisations have been involved in the communication and work process within the Initiative Knowledge Region. One of the main tasks of the initiative is the continuous collection of benchmark data, to sharpen the communication profile of the FrankfurtRheinMain knowledge region and the identification of actions for decision-makers (Wissenregion FrankfurtRheinMain, 2016).

## **9. Summary of Findings**

Urban policy in the city of Frankfurt is focused on sustainable urban development and the protection of the environment. The development of urban infrastructure is important for urban sustainability and maintaining a good quality of life. The city is concerned about climate change and has developed a set of proactive strategies guiding the city towards renewable energies and efficient and sensible use of natural resources. This inclination towards sustainable development is illustrated by the abundance and extent of programmes, projects and activities related to the energy sector. The projects range from technical facilities for cogeneration of electricity and heat, to involving social welfare in the education of citizens for the reduction of the energetic demand, and the use of renewable resources for energy production. The analysis of the experiences in all sectors suggests that the city has a special emphasis on energy and it is this sector the one leading the change in urban policy, urban planning and infrastructure development.

From the analysis of experiences, it could be deducted that there are experiences in which maximum three sectors are collaborating for planning and implementation of the provision of infrastructure. However, practice-oriented or programmatic experiences exhibit a *Dual-Collaboration/Sectoral* approach, meaning that they are planned or implemented by more than two stakeholders but aimed at the provision of urban infrastructure in one single sector. The sectoral character is explicit for educational programmes, but the more complex and technical the project, the more trans-sectoral it becomes. Experiences with high technical and managerial complexity e.g. cogeneration, sludge dewatering and incineration, exhibit the highest degree of trans-sectoral planning and implementation. This could represent a challenge for the implementation of a trans-sectoral methodology since the combination of several sectors in one project demands different levels of managerial and technical knowledge by the stakeholders involved.

In the previous section, the FRA-UAS team identified diverse projects in the five sectors of urban infrastructure, i.e. water, waste water, energy, waste management and urban agriculture. The analyses of the relevant experiences in infrastructure planning in Frankfurt am Main produced results regarding the influence of climate change and environmental protection in the city visions and policy formulation. Likewise, the research results of the first section suggested a project-driven multi-sectoral collaboration among municipal departments for planning urban infrastructure, and public-private management schemes for the implementation and provision of services in the city.

This second section will expand on the results of the previous research in order to explore more in-depth the dynamics within the municipal departments in Frankfurt. The purpose of this section is to identify those practices, procedures or processes in urban infrastructure planning and implementation which would support the implementation of the Rapid Planning methodology and are transferable to other contexts.

## SECTION 2: Report on Potential Inputs and Lessons Learned from Frankfurt for the Rapid Planning Approach

### 10. Ambitious Policy for Sustainable Urban Development Goals

The city of Frankfurt has defined ambitious goals for urban development, following the guidelines of the German Federal Government and the European Union. However, the city has taken the national and international mandate further in terms of energy and green spaces, which have a direct impact on the provision of urban infrastructure in the city and the region. Meeting the demand for public services and infrastructure in a growing city requires a clear vision for the future, as well as negotiations and the establishment of relationships with the neighbouring towns and cities. Frankfurt is a large city in the German context and demands natural resources that would only be found outside the borders of the city. Therefore, the existence of the Regional Authority, as the place for expressing and resolving inter-municipal conflicts, is essential for the quality of life for urban dwellers in Frankfurt and surroundings.

The sustainability vision includes, among others, the promotion of renewable energies, reduction of the demand for energy and water along with the CO<sub>2</sub> emissions; protection of green areas inside and outside the urban perimeter; reduction of waste products and increased efficiency in management of waste; and meeting the growing housing demand without jeopardising the good quality of life in the city.

The responsibility of promoting sustainable urban development, clean energies and reducing consumption starts with the municipal parliament by enacting urban policy which directs the development of the city towards a more environmentally friendly approach. The municipal departments, i.e. Municipal Energy Agency, Environment Department and City Planning Department, are the three main stakeholders in the implementation of sustainable urban policy in the city, and as such, they have cooperated in bringing the city infrastructure towards new technologies, which would make the achievement of the ambitious goals of the city feasible. In the following sections, the document will present those projects and measures adopted in Frankfurt in the different sectors, aiming at the improvement of the life quality and the implementation of environmentally friendly urban policy.

#### Lessons for the Rapid Planning Project

- Environmental policies, urbanisation trends, and globalisation have led the city to adopt a sustainable approach towards urban planning.
- Climate protection demands innovation in municipal visions, objectives, planning processes and technologies.
- Environment protection impacts all sectors of urban infrastructure, i.e. renewable energies and clean energies from biomass and bio-waste, cogeneration, quality of potable and treated waste water, and protection of areas for water and agriculture.

## 11. Lessons from the Frankfurt Experiences in the Rapid Planning Sectors

### 11.1. The Dominance of the Energy Sector in Urban Projects

#### 11.1.1. Clean Energy for Climate Change

The establishment of ambitious environmental goals regarding energy reflects well the vision of the city to become CO<sub>2</sub> neutral by 2050. The methods to achieve this objective are the reduction of harmful emissions as well decreasing the consumption of resources in different sectors, e.g. energy, water, and a reduction in waste products going to landfills.

The city leads by example in the reduction of energy consumption by implementing urban development policies in which all public buildings adopt the passive house premise, utilising solar, wind, thermal, and insulation technologies in the construction. The city also promotes and encourages the use of renewable energy sources for private developers by providing advisory services.

Renewable energies are changing the process of planning for buildings and urban infrastructure along with the perception of the city. These policies are collected in the „Master Plan 100% Climate Protection“, which establishes the goals for the city. The Master Plan defines different scenarios for the production of clean energies, as well as the goals for reduction of CO<sub>2</sub> and consumption of fossil fuels in the city (see figure below) as the general guidelines for the public and the private sector in terms of energy planning.

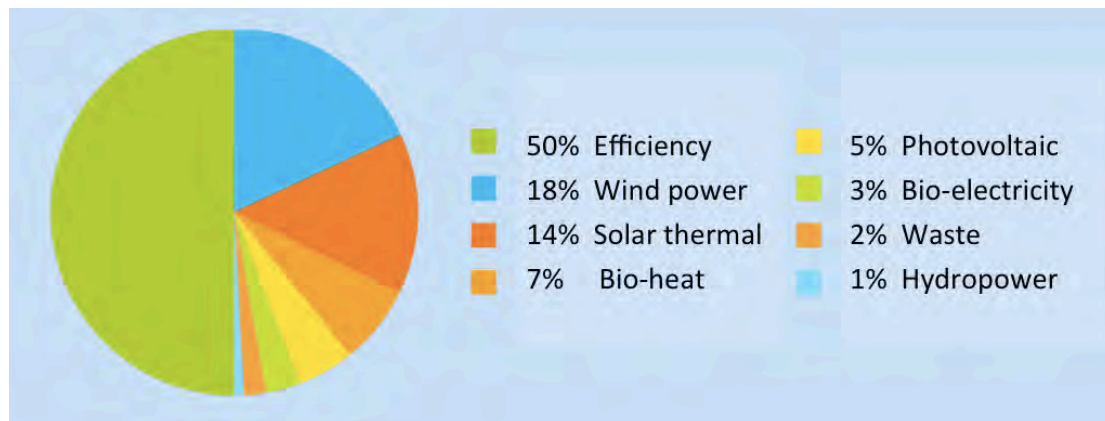


Figure 27: Energy sources of Frankfurt am Main 2050 (scenario)

Source: (Energieferrat Frankfurt am Main, 2015d).

The sustainability mandate of the city has led to the implementation of a diverse set of measures for the production of clean energy, such as district cogeneration plants, encouraging the use of photovoltaics and bringing together diverse urban infrastructure sectors to reduce the input of resources as well as the output of waste in the city, reusing the latter for the cogeneration of heat and energy from biomass and solid waste products.

#### 11.1.2. The Diversity in Energy Sector Programmes

The Municipal Energy Agency in Frankfurt is a specialised public institution with the same function as the municipal departments. The Agency is in charge of formulating regulations and programmes for the promotion and development of the Master Plan 100% Climate Protection policy, as well as advising the city about new technologies for the provision of renewable energies in a neighbourhood scale, e.g. cogeneration and centralised district heating, or private households and developers in issues concerning the implementation of clean energies. As energy production is one of the main issues of contemporary urban development, the sustainability vision of the city has focused on the promotion of clean energies in order to move towards the elimination of consumption of fossil fuels from the city through urban development policy, raising public awareness and guidance to the public and private developers about new technologies to be used in new developments and refurbishments all over the city.

The energy sector in Frankfurt is the most prolific in terms of amount and diversity of programmes and projects. Most projects are practice-oriented, focused on meeting the demand for energy from renewable sources. These practice-oriented experiences are aimed at the public as well as at the private sector, with advisory services and consultancy for the implementation of clean energy production in businesses and households, e.g. cogeneration from biomass and waste, passive houses, photovoltaic, and energy renovation. The other typologies of projects are programmatic such as Ökoprofit, Frankfurt Saves Electricity, and Cariteam - Energy Saving Service, or educational such as Climate Tours, exhibitions of the Municipal Energy Agency, the Climate Protection Map, Travel Guide, among others. These programmatic and educational projects are directed at the citizens and businesses, raising awareness about climate change and the responsibility of urban dwellers in the protection of the environment are the main focus.

As a result of the climate change policies implemented in the country and the city in the past years, the use of clean energy has been accepted and has grown in the city, covering 50% of the demand in 2014 (Graf, 2014, p.13). Technologies such as photovoltaics, thermal, wind power and cogeneration from waste and biomass have become of common use for public and private buildings, also making these new technologies a possible source of income for households and businesses, e.g. photovoltaic panels on roofs and facades as private investment.

### 11.1.3. The Challenge of Renewable Energies

The advancement of the Master Plan 100% Climate Protection is underway. Public and private have adopted many measures to reduce consumption and production of CO<sub>2</sub>, making feasible the achievement of the ambitious goals proposed. The main challenges in terms of energy are the capacity of storage for energy produced by wind or solar power. Storage is essential for the energy supply during the peak hours of the morning and night and in the winter months where the sunlight is less available. In this case, the city is looking into new technologies to select the appropriate method to cover the needs for power storage.

The feasibility of achieving the 2050 goals of the city of Frankfurt relies on the decrease of demand and increase of offer of clean energy options. Therefore, the implementation of programmes and projects for the public and the private sector raising awareness about the importance of reducing the consumption of energy and utilising energy efficient electric appliances is crucial for the city goals.

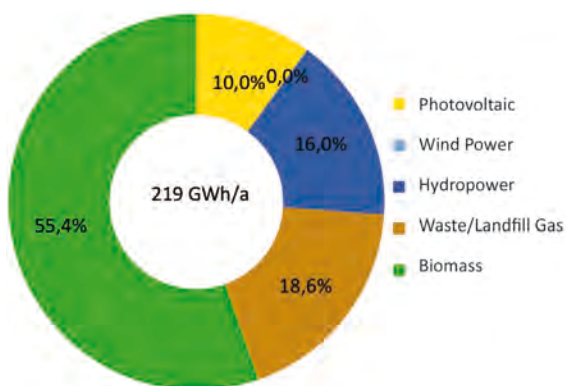


Figure 28: Local Use of Renewable Energies in Frankfurt am Main (Graf, 2014, p.5)

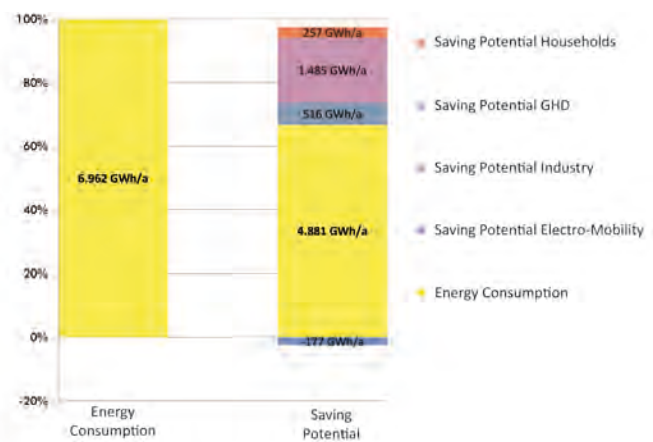


Figure 29: Energy Saving Potential in Diverse Urban Aspects (Graf, 2014, p.5)

#### Lessons for the Rapid Planning Project

- The Master Plan Climate Protection 100% shows that meeting the energetic demands of the city exclusively from renewable resources is possible and depends on the involvement of all sectors of society.
- Energy can work as a catalyst for sustainable development, with the leadership of the Municipal Energy Agency as the key for advancing the clean energy agenda.
- A clear municipal vision can lead to the inclusion of climate protection measures into urban planning regulations, reducing consumption and introducing new technologies for renewables.

### 11.2. Environmental Protection and Climate Change Resilience through Water Regulations

The participation and involvement of the city in the Regional Authority are crucial for securing the provision of drinking water. Similar to the environmental policies, i.e. Green Belt, regulations to protect the green areas around the urban perimeter facilitate the monitoring and quality control of the water delivered to the households. These regulations are found in the Regional Preparatory Land Use Plan – *Regionaler Flächennutzungsplan* –<sup>28</sup> prepared by the Regional Authority for the definition of land uses on a regional scale. The regulations for water protection areas also have a direct impact on the planning process in the urban scale for each one of the municipalities in the FrankfurtRheinMain Region, strengthening justifications for the conservation and protection of green spaces in and around the city.

As mentioned before, the city obtains its drinking water from different sources: 17% is extracted from the city area in the municipal forest; 36% comes from the Hessian reed marsh; and almost 50% is piped from the nearby Vogelsberg area, the Spessart and the Kinzig Valley. Potable water extraction, quality control and transportation are the main tasks of the Hessenwasser. Mainova, on the other hand, offers ten pumping stations in the region and, at the same time, is also responsible for distribution of water (City of Frankfurt am Main, 2010; Gesundheitsamt, 2015b).

The strict federal regulations that the city must follow in the quality control of drinking water demand a strong involvement of municipal departments in the management of water sources and delivery systems. Therefore, the main actors involved in the water sector are the Environment Department as a control and monitoring institution and a city-shared company in which the municipality has a majority in the decision-making. Other actors are involved in educational and programmatic programmes focused on raising awareness about the need to reduce water consumption in the household and industries, as well as promoting new technologies for increasing the efficiency of water use, especially in the industrial sector.

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<sup>28</sup> For more information about the Preparatory Land Use Plan see the Rapid Planning Deliverable D07 Review of the Urban Development in Frankfurt am Main and the Lessons Learned for the Transsectoral Planning

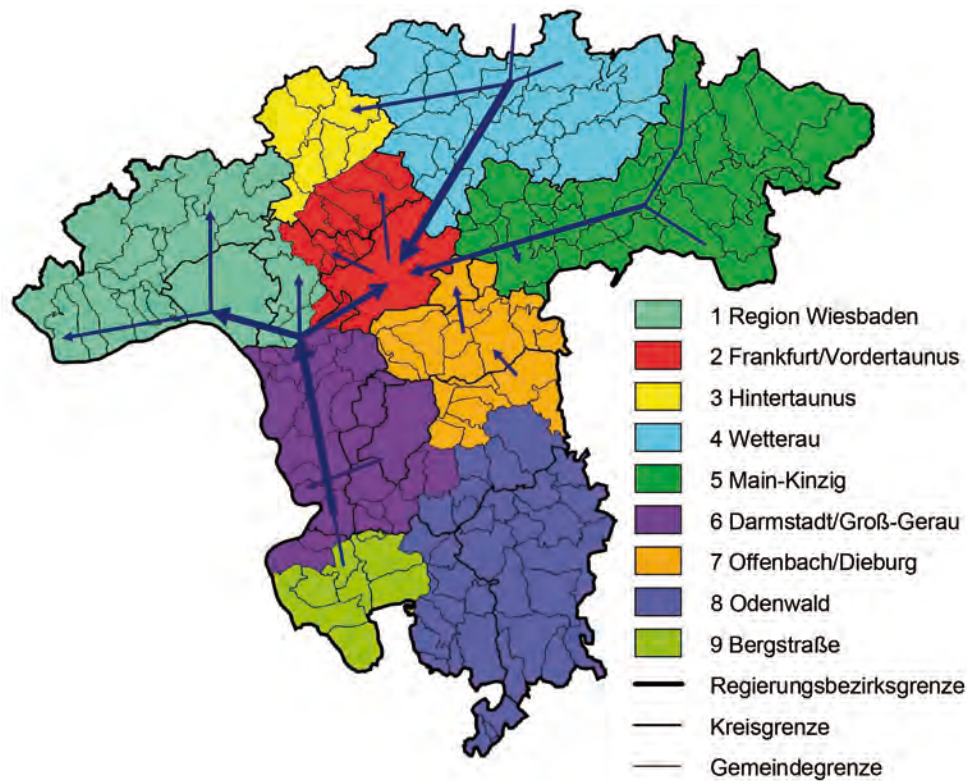


Figure 30: Water Provision Structure in the South Hesse (Roth, 2016, p.20)

Some of the efforts in decreasing water consumption have had an effect on the demand for water in the FrankfurtRheinMain region; the total consumption per person has declined from 223 litres a day in 1980 down to 158 Lt./day in 2014 (Roth, 2016, p.20). This decrease in consumption trend corresponds to a series of programmes implemented by the country and the city, renovating and making more efficient the water provision system and creating a climate protection culture among the inhabitants.

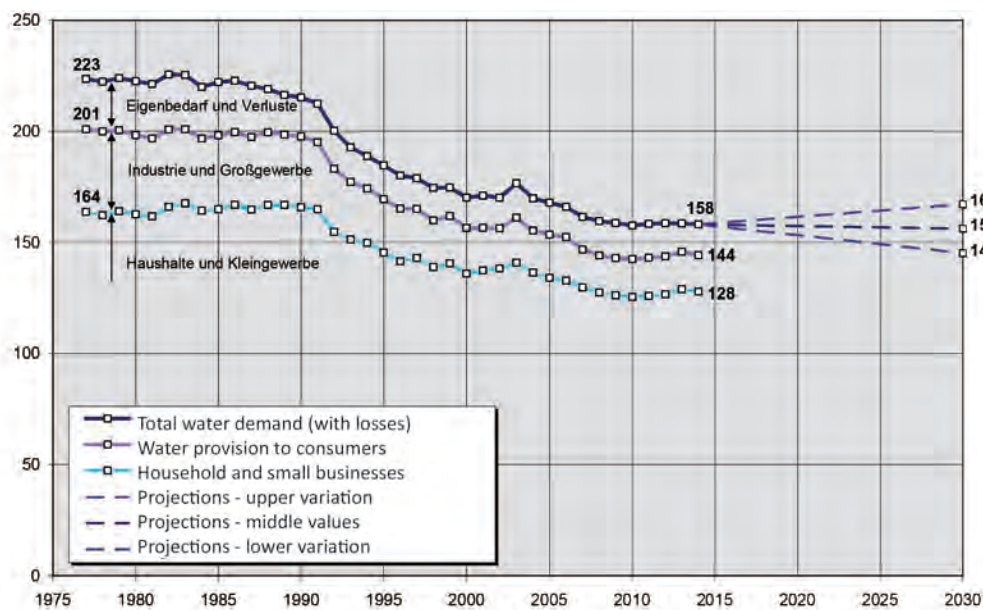


Figure 31: Water Consumption in the Rhein Main Region (Litres per capita/day) (Roth, 2016, p.36)

### 11.2.1. Trans-Sectoral Potential

Water provision is a health sensitive issue in cities and must be managed with the highest quality standards and specific legal regulations. The protection of aquifers demands an absence of polluting activities in the surrounding areas, therefore the implementation of water sector projects which involve other infrastructure sectors is difficult due to the federal regulation for water protection and the health hazards of mishandling water sources. However, there is a clear relationship between clean water and the urban agriculture sector; a responsible organic agricultural production free of pollutants could be coupled with water provision planning for protecting the aquifers while utilising efficiently the soil around the protection areas. Likewise, the areas protected for water extraction have become recreational open spaces for the urban dwellers, protecting the green spaces around the city.

#### Lessons for the Rapid Planning Project

- Water management and provision is a regional issue that requires monitoring and land use planning.
- The water sector can be linked with recreational and environmental protection activities and programmes.
- Educational and programmatic projects raising awareness about climate change and water usage have proven effective in reducing the consumption patterns of the residents and the industrial sector.

### 11.3. The Wastewater Sector, a Public Responsibility

Wastewater treatment is kept to the highest standards in the city, also implementing new technologies and initiating trans-sectoral projects in order to reduce the output of waste products. Similar to the situation of the drinking water sector, the wastewater sector is regulated by federal laws which ensure that the treated wastewater is free of harmful pollutants and could be delivered back to the water bodies, where the treated water infiltrates into the soil. However, in the case of wastewater the stakeholders are 100% public and, except for special agreements with neighbouring municipalities, the wastewater sector is concerned only with the collection, transport and treatment of wastewater within the city borders.

#### 11.3.1. Wastewater, Rainwater and the Public

The challenges of the wastewater sector are related to the capacity of the sewage system for collection of an increasing flow of wastewater from urbanisation growth.

The sewage system in Frankfurt is in needs of expansion and renovation to keep up with the population and housing growth. In the new development in the city, i.e. the Riedberg District, the city has implemented a system of separating rainwater collection in flood-prone green areas, facilitating the direct infiltration of the rainwater into the soil.



*Figure 32: Rainwater Collection and Infiltration Areas. Riedberg, Frankfurt*

The rainwater collection technique also reduces the flow of sewage water going into the system, thus reducing the amount of water to be treated along with the need for expansion of the sewage system. Reuse of rainwater for gardening or industrial purposes has also been promoted in the city in order to reduce the demand for clean water extracted from the protection areas as well as raising awareness about the possibilities of using non-potable but otherwise clean water for industrial processes and other human activities without endangering the health of the population. In the same way, the rainwater collection areas are also green public spaces which in dry days can be used for recreation and leisure for the community.

### **11.3.2. Trans-Sectorality of the Wastewater Sector**

The inclusion of rainwater collection and infiltration areas in the urban design of new neighbourhoods in Frankfurt highlights the collaboration between the City Planning Department and the Municipal Environmental Department. Both departments worked together to introduce the planning procedures elements of environmental planning and climate change resilience. There is a clear trans-sectoral connection between the wastewater sector and the environment, which is important not only to face the challenges posed by climate change but also for the water and urban agriculture sectors. Rainwater infiltration and adequate treatment of wastewater delivered to the water bodies will feed the aquifers for potable water and irrigation of agricultural fields. Additionally, the waste outputs produced by the wastewater treatment plants, instead of going to landfills, are used for cogeneration of power plants. The sludge dewatering project combines the energy and wastewater by producing energy and heat from burning sludge left by the wastewater treatment process.

#### Lessons for the Rapid Planning Project

- Wastewater is directly linked with the water consumption patterns of the population and industry.
- Separation of wastewater and rainwater can reduce the pressure on the capacity of the sewage system, extending the lifespan of the system and reducing the flow rate of wastewater and output delivered back to the rivers.
- Rainwater collection and infiltration areas can be included in urban design as recreation areas for the residents, while working as flood protection areas

### 11.4. Reducing, Reusing, Recycling for Waste Collection

Waste as a business attracts the attention of private investors. The involvement of the private sector provides an enterprise-like management style, increasing efficiency and facilitating the process of decision-making for infrastructure planning. However, in Frankfurt, the experience of waste management is controlled by the municipality working in partnership with the private sector for the provision of waste management services. The company providing the collection and disposal services, FES and its subsidiaries are city-shared companies in which 51% of the shares are owned by the municipality. This ownership gives the municipality power over the decision-making, but also allows the company to function as a private enterprise.

#### 11.4.1. Waste Management, a Multi-Stakeholder Sector

Waste management is a good example of joint work between citizens, the private and the public sector in Frankfurt. The collection and disposal of waste products rely strongly on the education of the citizens regarding waste products discrimination and appropriate disposal, engaging the household members in the process of recycling, reusing or disposing of waste. The engagement of citizens aims at discriminating the typology of waste products at the source, e.g. biodegradable, light packaging, paper, and residual waste, etc., reducing the amount of waste produced by the citizens and businesses. The discrimination of waste and reduction in the total amount of residual waste allows the citizens and businesses to select one of the tariff schemes offered by the waste management company. The options are standard fees for the collection of the containers, which is usually chosen by households, and the variable fees which are proportional to the weight of the waste produced, normally selected by businesses.

In the same way, in order to reduce the consumption of plastic bottles and bags, the country has implemented a recycling system in which the citizens pay for the plastic bags<sup>29</sup> and pay a refund fee when purchasing plastic or glass bottles. The citizens are engaged in the recycling process for plastic

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<sup>29</sup> During the development of this research and this document, there is a trend spreading throughout Germany towards the further reduction in use of plastic bags. The supermarkets have stopped offering the option to purchase plastic bags, replacing them with paper or reusable bags made from recycled materials.

and glass bottles and can collect the deposit back when the empty bottle is returned to the recycling station. This recycling process prevents littering on the streets, promotes reuse of plastics and also encourages the citizens to reduce the consumption of plastic bottles by charging an extra fee on these.

#### 11.4.2. Waste Management: a Trans-Sectoral Opportunity

The waste management process includes four recycling processes: reuse, recycle, transformation and compost. The first process, direct recycling, is focused on reuse; large electronic appliances and furniture are collected and fixed or repurposed for further use. The plastic, paper and metal waste products go to the second waste management process, materials recycling, where they are sorted and sent to the processing station for recycling. The third process is the thermal recycling, transforming the residual waste products into heat and energy by means of incineration in cogeneration plants. Finally, the outputs of the thermal recycling are processed into compost to be utilised in agriculture and gardening.

The procedures in the waste sector are ruled by German federal law and local urban policy, but the collection and treatment of waste products are managed by a public-private company. Processing of waste products has become a niche for business enterprises, making a profit from the recycling, reuse or repurposing of waste products. Also, the process of waste collection opens opportunities for employment and social programmes implemented by the city with the support of the private sector, e.g. FFMTipptop.

The concept of reducing consumption is widely implemented throughout the environmental and infrastructure policies in Frankfurt. It can be observed in the programmes raising awareness about climate change and the need for reducing the urban footprint by reducing the consumption of all kinds of resources. In this sense, the waste sector is also part of the concept promoting the reduction of waste products, biological, chemical or plastic, going into landfills. This reduction means that the city must reuse or repurpose these waste products. This has been carried out by introducing new technologies and engaging several urban infrastructure sectors in one single project, e.g. cogeneration and compost. Furthermore, the development of the cogeneration technologies has allowed the city of Frankfurt to introduce into the planning process a trans-sectoral vision in the terms of production of sustainable energy on the scale of a city district, reducing the outputs of waste products going to landfills as well as the need for bringing energy from outside the city boundaries.

##### Lessons for the Rapid Planning Project

- Discrimination of waste products is essential for the efficiency of the waste management system.
- Waste management is a responsibility of all the actors in society: public for planning, regulations and monitoring; industries and private sector for efficiency, management and innovation; and citizens for waste products discrimination.
- The waste sector has great potentials for trans-sectoral planning and implementation, especially with the energy and agriculture sectors.

## 11.5. Urban Agriculture for Environmental Protection and Social Integration

The urban agriculture sector in Frankfurt is directly dependent on the resources the FrankfurtRheinMain Region provides. The municipality has developed a Green Belt<sup>30</sup> project focused on environmental protection of the areas surrounding the city. Within the Green Belt coexist a multiplicity of uses for green areas; the Regional Park, forestry, brown field redevelopment, agriculture, environmental protection and recreational areas. The Frankfurt Green Belt is part of a larger landscape protection area covering 108 Km<sup>2</sup> surrounding the city. Since 1998, the Green Belt is the heart of the Rhein-Main Regional Park, connected to a wider network of green and open spaces within the FrankfurtRheinMain Metropolitan Region. The main value, output and capacity of the Frankfurt Green Belt relies not only on biotic<sup>31</sup> and abiotic<sup>32</sup> values but also on recreation and health potentials as well as the generation of economic income from agriculture, forestry and catering industries. Likewise, the Green Belt has an important role in environmental education for the public in general.

### 11.5.1. Inter-Departmental Collaboration Approach

The approach of the city of Frankfurt towards urban agriculture requires the collaboration of different municipal departments, as well as the Regional Authority. The Regional Preparatory Land Use Plan drafted by the Regional Authority, establishes, among others, the areas for urban expansion, urban development, industrial and agricultural use, environmental protection, etc. The City Planning Department defines the regulations for the specific uses in each area, including specific planning instruments in order to minimise the impact of urban growth on the environment. In the same way, the Environment Department is in charge of devising programmes and projects to protect urban and rural green areas, performing a programmatic, educational and monitoring function.

The inter-departmental collaboration is crucial also to the achievement of the Frankfurt Green City programme, allowing the protection and conservation of green areas within the urban perimeter; parks, the river banks, the inner-city green belt and urban gardens. Urban gardens have become an important space for recreation, social cohesion, integration and in some cases production of food in the different neighbourhoods of the city. The maintenance and protection of these green infrastructures in the city is a task that involves the City Planning Department for the regulations of urban development, the Environment Department for regulations about the condition and monitoring of green areas, as well as the involvement of city-shared companies such as FES for the cleaning and maintenance, and the citizens through educational programmes for environmental awareness.

### 11.5.2. Impact of City Planning in the Urban Agriculture Sector

Land, whether urban or rural, is not a renewable resource and growing cities need to address the problem of urban expansion and growth in a sustainable way. Therefore, the city explores many variations of policies and regulations to reduce the impacts of urbanisation on the natural environment while providing the necessary conditions for the citizens to experience a high quality of

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<sup>30</sup> For more information about the Green Belt see section 7.1.2.

<sup>31</sup> species and biotypes

<sup>32</sup> climate, soil, water, air

life (Stadt Frankfurt am Main, 2016j). One example of the policy innovation is the Compensation Areas<sup>33</sup> policy. The concept of *Compensation Areas* includes different land use typologies, including protection of the existing areas and redevelopment. In this way, the policy covers not only agricultural land, but also the water and wastewater sectors helping with the protection of water reservoirs and control of water bodies

Protecting the green and agriculture areas inside and surrounding the city signifies protection of natural areas for public recreation and leisure activities. These activities include sports, education about agriculture and the environment and also agricultural activities. The agricultural products grown in the region are marketed in the local supermarkets and farmers' markets, increasing the offer and providing environmentally aware citizens with an option to reduce the ecological footprint.

#### Lessons for the Rapid Planning Project

- The urban agriculture sector is dependent from regional and city planning procedures and regulations.
- Protection of agriculture areas surrounding the city can enhance the quality of life within the city.

## 12. Characterisation of Experiences in Frankfurt

The projects, programmes and activities within the five sectors of urban infrastructure could be classified into three main categories: *practice-oriented*, *programmatic* and *educational*. From the study of the different experiences implemented in Frankfurt in the five sectors of Rapid Planning it could be observed a strong trend towards practice-oriented projects, and two other typologies of experiences aimed at producing programmes and educational initiatives to support the sustainability focus of urban policy. The following section will give a description of each typology.

From the analysis of experiences, it could be deduced that trans-sectoral planning in Frankfurt involves at least three infrastructure sectors, and the implementation promotes a collaborative approach. Practice-oriented or programmatic experiences exhibit a *Dual-Collaboration/Sectoral* approach, in which several stakeholders are involved in the implementation while the stakeholder responsible for the management of the infrastructure sector acts as a key coordinator for the planning and implementation process. Practice-oriented experiences present a high technical and managerial complexity, which demands the involvement of stakeholders for the development of new technological approaches or the coordination of complex infrastructure provision processes with a scope reaching over two or three urban infrastructure sectors, e.g. cogeneration, sludge dewatering and incineration, exhibit the highest degree of trans-sectoral planning and implementation. One of the challenges of trans-sectoral implementation is bringing together these different stakeholders to work in the planning and implementation of a project while balancing their interests, contributions and expected benefits. In the case of educational projects, the low degree of complexity and their purpose of raising awareness facilitate the implementation without the need to involve many stakeholders.

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<sup>33</sup> For more information about Compensation Areas see section 7.1.

### **12.1. Practice-oriented Experiences**

Practical experiences have a more technical focus for the provision of urban services. The scope of these experiences covers the five Rapid Planning Sectors, and it is in this category where trans-sectoral planning can be found. The projects implemented in Frankfurt have a high degree of technological complexity, exemplified specially by the proliferation of project in the energy sector based on the production of energy from renewable clean sources. The use of multi-sectoral new technologies requires the involvement of different stakeholders and collaboration between infrastructure sectors. Likewise, the implementation of multi-sectoral projects demands a high level of decentralisation for the coordination of the planning and execution process, as well as well established communication channels among the different municipal departments and other stakeholders.

Technological advances have played a crucial role in making sustainability policies feasible and facilitating the participation of different actors, from private to citizens, in the implementation and provision of urban infrastructure with a focus on the protection of the built environment. The environmental focus is driven by the need to reduce consumption of natural resources, while shifting from the use of fossil fuels to renewable energies, as illustrated by the proliferation of energy-related project and the evolution of waste and wastewater processes in Frankfurt; experiences such as cogeneration and the sludge dewatering and incineration for wastewater treatment involve three urban infrastructure sectors, reducing the amount of waste going into landfills as well as the natural resources utilised in the production of clean energies.

### **12.2. Programmatic Experiences**

Programmatic is a term used in the research to describe experiences aimed at the formulation of programmes and projects which do not have a spatial implementation phase. These experiences are either projects or programmes formulated by the city departments with specific objectives in each one of the sectors. These programmatic experiences are found among every sector of urban infrastructure, and their scope ranges from promotional programmes for the use of renewable energies, to social programmes for disadvantaged citizens and environmental protection. The municipal departments or agencies advise the citizens and the private sector on infrastructure related issues, in order to achieve the sustainability goals proposed by the city, e.g. energy efficiency, reduction of water consumption, flood prevention, etc.

A common characteristic of these experiences is the dual stakeholder and bi-sectoral collaboration scheme observed; one of the stakeholders is generally is a municipal office or department, while the other is a city-shared company or a stakeholder from the private sector. The collaborative approach suggests an opportunity for increasing the sustainability of urban areas through the involvement of the private sector or profit oriented organisations in the planning process and provision of urban infrastructure.

### **12.3. Educational Experiences**

Educational or promotional experiences are focused on raising awareness and educating citizens in consumption-related issues while promoting a sense of place and commitment to helping the city achieve the sustainability goals. These experiences exhibit a strong sectoral approach, with many of them implemented by the Municipal Energy Agency. Educational initiatives have a sectoral character, and are generally developed by one municipal actor.

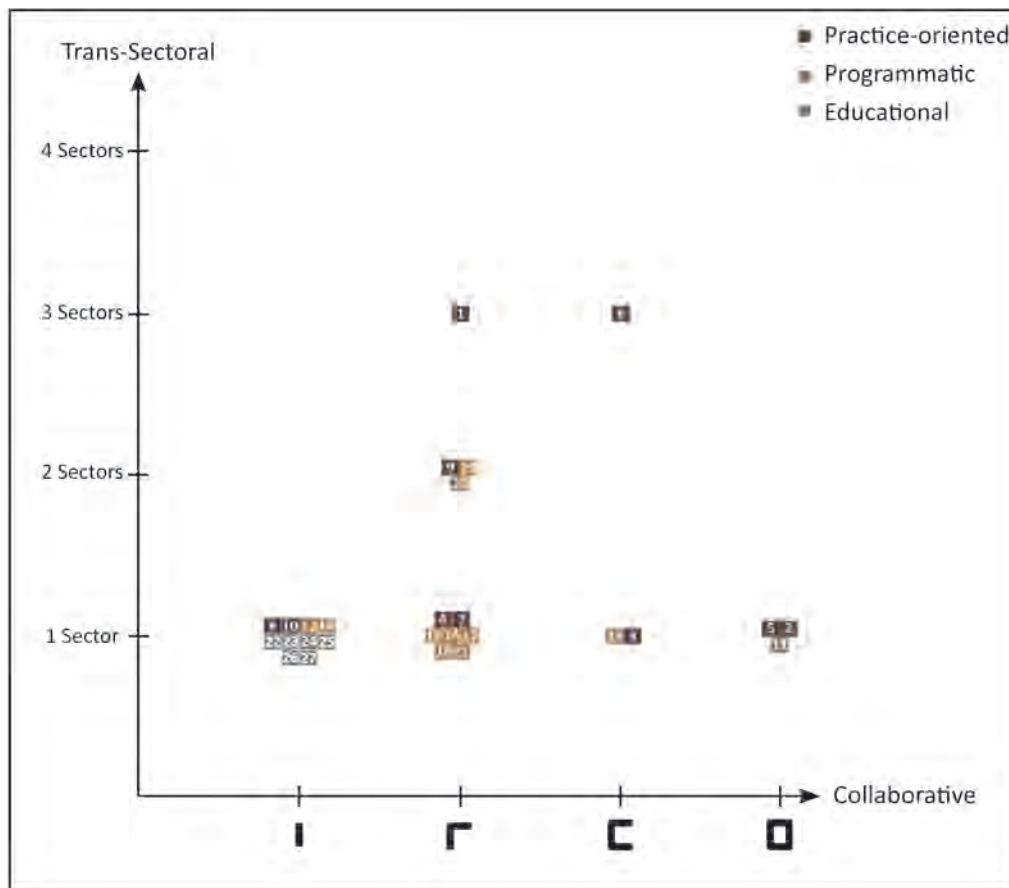


Figure 33: Analysis of Experiences in Frankfurt – Characterisation

#### Practice-oriented

1. Cogeneration
2. Passive Buildings
3. Photovoltaic
4. Energy Renovation
5. Quality control of drinking water
6. Sludge dewatering and incineration
7. Standard and variable fees for waste collection
8. Fight against littering
9. Compensation areas
10. Urban community gardens

#### Programmatic

11. Ökoprofit
12. Frankfurt saves electricity
13. Cariteam
14. Frankfurt lead project
15. Efficient water use
16. Flood prevention
17. Water engineering and maintenance
18. Ffmtipptopp
19. Landscape planning
20. Landscape conservation areas
21. Allotment gardens

#### Educational

22. Climate tours
23. Exhibitions of the Energy Agency
24. Climate protection map
25. Travel Guide
26. Clean tale Hessen
27. Fessie

These educational projects are mostly aimed at children, which suggest a low degree of complexity in the topics, as well as in the presentation of the information to the citizens. This low degree of complexity is reflected in the facility of planning and implementation process, which can be executed by one actor, even if the initiative has as purpose educate the public about the importance and impact-of trans-sectoral projects. However, the education of the public has had a trans-sectoral impact in the consumption patterns of the population, resonating among the energy, water, wastewater and waste management sectors. This trans-sectoral impact has helped the city achieve partial goals in the reduction of resources and footprint as well as the transition from fossil fuels towards clean and renewable energies.

## 13. Stakeholder Assessment

The actors and organisations involved in the provision of urban infrastructure in Frankfurt have three main organisational profiles, each with a specific function in the infrastructure planning process. This categorisation is focused on the typology of involvement in infrastructure provision as well as the characteristics of the partnerships between stakeholders. The three profiles are *Programmatic*; *Operative*; and *Monitoring/Coordination*.

### 13.1. Programmatic Actors

Municipal departments and agencies are involved in the infrastructure planning process regarding the regulations for the uses of the land, use of natural resources, coordination, collaboration for multi-sectoral or trans-sectoral programmes and projects and the education of the population in environmental issues. The responsibilities of these programmatic stakeholders are to formulate programmes and regulations for the provision of urban services, monitor urban and environmental conditions, and give advice to policymakers as well as to developers and residents about sustainable development, climate change, energy efficiency and environmental protection. Likewise, municipal departments and agencies act as advisory boards to the city council in the formulation of public policy, providing practical and professional feedback and advise for decisions about the city's future, thus guiding the development of the city. This advisory responsibility extends also to investors and citizens in the cases of urban development or housing improvement.

The programmatic actors are departments and agencies 100% publicly owned, managed and regulated by the city government. Only one public institution is involved in the actual service provision, the City Drainage Frankfurt am Main, responsible for the collection and treatment of wastewater (City of Frankfurt, 2016). Under this programmatic profile are the following municipal departments and agencies:

- Environment Department
- Municipal Energy Agency
- City Planning Department
- Building Construction Department
- Clean Frankfurt Office
- City Drainage Frankfurt am Main
- Health Department

- Green Spaces Department

Although most municipal actors are involved directly in only one specific sector of urban infrastructure, the collaboration approach suggests the indirect involvement of the other municipal departments or offices in programmes and activities outside their specific sector; the research has identified a project-driven collaboration disposition among the main municipal departments, i.e. Environment Department, Energy Agency, and the City Planning Department to coordinate programme formulation, urban planning procedures and negotiate urban plans. These departments are in constant communication for the planning and implementation of sustainable development projects, and finding opportunities for multi-sectoral implementation of projects, making urban development planning more efficient. The role as general coordinator is taken by one of these three departments, in accordance with the main characteristics of the project, and it is this coordinator who invites the officials and stakeholders from other municipal departments or external, who could be relevant to the project from other infrastructure sectors.

The Environment Department is intensively involved in the implementation of urban policy focused on environmental protection and sustainable urban development. The emphasis of Frankfurt's public policy on sustainable developments highlights the importance of the Environment Department as an advisory body or involved in the formulation of projects and programmes; thus, the Environment department is one of the municipal departments with most involvement, direct and indirect in projects developed by all the sectors of urban infrastructure. The Environment Department has an important role in the definition of regulations, monitoring and control of the quality of the green infrastructures in the city i.e. protection of greenery, agriculture fields and aquifers, also involved in the energy sector raising awareness about the need for renewable energies and the importance of climate protection.

| Programmatic                 | RP Sectors                    |                               |                                    |                                    |  |
|------------------------------|-------------------------------|-------------------------------|------------------------------------|------------------------------------|--|
|                              | Energy                        | Water                         | Waste water                        | Waste                              | Urb. Agricul.                            |
| Environment Department       | Key Actor - Energy            | Indirect involvement - Energy | Indirect involvement - Water       | Indirect involvement - Waste water | Key Actor - Urban Agriculture            |
| Energy Agency                | Key Actor - Energy            | Indirect involvement - Energy | Indirect involvement - Water       | Indirect involvement - Waste water | Indirect involvement - Urban Agriculture |
| City Planning Department     | Indirect involvement - Energy | Indirect involvement - Water  | Indirect involvement - Waste water | Indirect involvement - Waste       | Indirect involvement - Urban Agriculture |
| Building Construction Office | Indirect involvement - Energy | Indirect involvement - Water  | Indirect involvement - Waste water | Indirect involvement - Waste       | Indirect involvement - Urban Agriculture |
| Clean Frankfurt Office       | Indirect involvement - Energy | Indirect involvement - Water  | Indirect involvement - Waste water | Indirect involvement - Waste       | Indirect involvement - Urban Agriculture |
| City Drainage                | Indirect involvement - Energy | Indirect involvement - Water  | Indirect involvement - Waste water | Indirect involvement - Waste       | Indirect involvement - Urban Agriculture |
| Health Office                | Indirect involvement - Energy | Indirect involvement - Water  | Indirect involvement - Waste water | Indirect involvement - Waste       | Indirect involvement - Urban Agriculture |
| Green Spaces Office          | Indirect involvement - Energy | Indirect involvement - Water  | Indirect involvement - Waste water | Indirect involvement - Waste       | Indirect involvement - Urban Agriculture |

Table 6: Involvement of Stakeholders in the RP Sectors

The City Planning Department is the municipal organisation in charge steering the urban development vision of the city. The involvement of the City Planning Department in the infrastructure sectors is indirect, since it is the responsibility of the department to produce the urban development plans which would later be used for the implementation and execution of urbanisation and other development projects. The planning department regulates the expansion, development and

redevelopment of urbanisation in the city, defining densities, plot coverage and heights, among other factors, which later define the urban infrastructure requirements for each sector.

### 13.2. Operative Stakeholders

The responsibility of the operative stakeholders in Frankfurt is the delivery of the public services in the city and some areas of the region. Most of these stakeholders are companies in which the shares are held by both public and private actors, with the municipality having control of the at least 51% of the total shares. The city has emphasised the need for these companies to be controlled by the municipality in order to avoid the privatisation of public services in the city and controll of tariffs. Nevertheless the approach to management of these companies is business-oriented, as these work as a profit-oriented company and the profits are reinvested in the development of the city. Under this category fall the following organisations as main actors in the five sectors of Rapid Planning:

- Stadtwerke Frankfurt am Main Holdings Group - Energy and Water sectors
- Mainova AG. – Energy and Water sectors
- ABG Frankfurt Holding Group – Energy sector
- Frankfurt Disposal and Service – FES – Waste Sector
- Müllheizkraftwerk Frankfurt GmbH/AVA Nordweststadt GmbH – MHKW – Energy sector / Cogeneration

|                              | RP Sectors |       |             |       |               |
|------------------------------|------------|-------|-------------|-------|---------------|
|                              | Energy     | Water | Waste water | Waste | Urb. Agricul. |
| <b>Operative</b>             |            |       |             |       |               |
| Stadtwerke Frankfurt am Main |            |       |             |       |               |
| Mainova AG.                  |            |       |             |       |               |
| ABG Frankfurt Holding        |            |       |             |       |               |
| FES                          |            |       |             |       |               |
| MHKW                         |            |       |             |       |               |

Table 7 Analysis of Involvement of Operational Stakeholders in the RP Sectors

The city shared companies are bringing efficiency and innovation to the city, as well as extending their scope from one single sector to implementing trans-sectoral infrastructure provision projects such as the increasing joint work between the energy and waste sectors. The use of new technologies for the production of energy from waste products is leading the trans-sectoral thinking in the city. These two sectors are showing increasingly possibilities for collaboration and involving even further sectors like agriculture in the trans-sectoral energy production process.

The wastewater sector is the only sector that is completely managed and executed by the municipality. Wastewater does not attract private investment and the federal and state regulation for the management of wastewater requires high degrees of control and monitoring, which is more feasible to be achieved by the municipality. Sanitation and treatment of wastewater is crucial for the public health and sustainable environments.

### 13.3. Monitoring/Coordination Stakeholders

The increasing population in Frankfurt demands the provision of natural resources that in their totality are only available beyond the city borders, from the surrounding Rhein-Main metropolitan region, i.e. renewable energy sources, water and agricultural production. The coordination stakeholders are public organisations or public-private partnerships with the city represented by one of its directorates. The involvement of the city in the Regional Authority is crucial for the access to renewable sources of energy and water. Within the Regional Authority, the municipalities negotiate land uses, and coordinate efforts towards sustainable regional development, giving larger municipalities the possibilities to meet the demand for resources from areas outside the municipal perimeters.

| Coodination/Monitoring             | RP Sectors |       |             |       |               |
|------------------------------------|------------|-------|-------------|-------|---------------|
|                                    | Energy     | Water | Waste water | Waste | Urb. Agricul. |
| Regional Authority                 |            |       |             |       |               |
| Hessenwasser                       |            |       |             |       |               |
| Cultural Region FrankfurtRheinMain |            |       |             |       |               |

Table 8: Analysis of Involvement of Regulatory Stakeholders in the RP sectors

## 14. Trans-sectoral Planning in Frankfurt

### 14.1. Integrated and Proactive Planning for Environmental Protection and Climate Change Resilience

Some German regions are facing a demographic challenge, with their population migrating to larger metropolises especially those located on the west and south of the country. Frankfurt is one of the cities which absorb a large proportion of the migration force, attracting residents from Germany as well as from abroad. The attractiveness of the city resides in the opportunities for employment in different sectors, e.g. banking, service, air transport, etc., along with the facilities provided by the international airport and the location of the city in the heart of continental Europe. The incoming population poses a challenge for the city departments regarding housing, infrastructure and transport. However, the city has accepted the challenge and turned it into an opportunity for defining an urban vision through a participatory planning process which considers different aspects of urban development, identifying the major issues and problems with the involvement of the residents.

The planning process called “Integrated City Development Concept” – *Integriertes Stadtentwicklungskonzept (INSEK)* – has been in implementation since 2014 and aims at preparing an urban vision for Frankfurt in 2030, developing a common vision and policy for all municipal departments, agencies and offices, in order to formulate holistic and integral strategies for development. As part of the INSEK, the city has prepared a Status Report describing the main characteristics of the city and summarising the initial analysis of the city in terms of transport, housing, environmental protection, among others (Stadtplanungsamt Frankfurt am Main, 2016a). The Status Report served as the basis for

the participatory planning process called Frankfurt Your City – “*Frankfurt Deine Stadt*” – implemented in 2016-2017. The involvement of residents highlighted the concerns about balancing urban and economic growth while preserving the quality of life in the city. The main concerns of residents were directed at the need for affordable housing in the urban core without decreasing the number of green spaces and parks already existent in the city.

One of the challenges encountered by the INSEK process has been the difficulty of engaging different sectors of society, i.e. most attendees involved in the planning process were older residents, with a notable absence of younger residents. The INSEK process also involved environmental, architecture and urban planning professionals in special sessions to discuss the issues and challenges of the city. The preliminary analysis and the participatory process served as information sources for the City Planning Department to draft an urban development vision and concept for the city. The process is in its final stages.

## 14.2. Project-Driven Trans-Sectorality

The experiences in Frankfurt’s infrastructure sectors suggest that the concept of trans-sectorality in the city has been permeating the infrastructure planning process for years, developing a project-driven collaboration scheme which depends on the communication channels among municipal departments and the establishment of a city vision for the future. Initiatives such as the Master Plan 100% Climate Protection and the Frankfurt Green city look at urban development in a holistic way, involving not only different sectors of society in the process but also different sectors of urban infrastructure. Energy projects are looking at utilising waste products for reducing the consumption of natural resources, i.e. cogeneration from household bio-waste and sludge from wastewater treatment. These energy projects demand a trans-sectoral collaboration between the Municipal Energy Agency, the City Planning Department, the waste management company and community organisations in the case of residues from the cogeneration used for compost.

Moreover, examining the experiences in Frankfurt it can be observed that the Municipal Environment Department and the City Planning Department are involved in most sectors of urban infrastructure. The Municipal Environment Department acts as a control and protection institution for the green infrastructure in the city and its surroundings; the Environment Department is involved in the decisions about urban expansion, redevelopment and provision of infrastructure to old and new rural as well as urban areas. These decisions include areas and processes for the production of clean energy, agricultural produce, most of them located on the green belt. Also, the Environment Department is in charge of the monitoring and supervision of the quality of water and air in the city, responsibilities which take the Environment Department into the water, wastewater and waste management.

The City Planning Department is responsible for formulating the regulations for the urban development of the city through the issuance of project-driven localised legal zoning plans – *Bebauungsplan*<sup>34</sup> -. The legal zoning plans outline the character and regulations for buildings within a

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<sup>34</sup> For more information about the Legal Zoning Plan and the Preparatory Land Use Plan see Deliverable D07 Review of the Urban Development in Frankfurt am Main and the Lessons Learned for the Transsectoral Planning.

defined perimeter of the city, along with the specifications for urban infrastructure, areas for public green and open spaces, roads, as well as compensation areas and special measures for specific urban development projects. The localised legal zoning plans conform to the legal framework established by the Regional Authority in the Regional Preparatory Land Use Plan defined for the FrankfurtRheinMain region.

The responsibility of characterising urban development suggests also a responsibility in the coordination of collaboration procedures for the involvement of the other municipal departments and agencies in the decision-making process for the formulation of a legal zoning plan. The integral character of the legal zoning plans demands consultation with the Municipal Energy Agency for implementing new renewable energy technologies or improving the efficiency of existing projects. Likewise, the plans demand consultation with the Municipal Environment Department for the protection of green infrastructures as well as discussions about the implications of expanding urban areas in the city perimeter or redevelopment in the city core. Therefore, this research identifies the dynamics among municipal departments and agencies in Frankfurt as a project-driven trans-sectoral collaboration, in which the necessary actors come together for specific planning processes.

#### Lessons for the Rapid Planning Project

- Climate change and population growth as the main challenges for Frankfurt are being addressed through a sustainable development and integrated planning approach.
- Although the city has formalised channels of communication between departments, the collaboration for urban infrastructure is project-driven, with one major department as key actor and coordinator bringing in the other departments when necessary.
- The City Planning Department and the Environment Department are involved directly or indirectly in all sectors of urban infrastructure.

### 14.3. Example of Legal Zoning Plan: Riedberg – Integrated Planning Process

As a response to the increasing housing demand that was already present in Frankfurt from the early 1990's, and after conducting preliminary investigations between 1993 and 1995 about the area's suitability, in 1996 the City Council decided to put into practice what at the time was a new instrument provided by the Federal Building Code (*Baugesetzbuch*) called the Urban Development Measures (*Städtebauliche Entwicklungsmaßnahme*). This instrument allowed the city to swiftly acquire 267 hectares of unused land located 8 km away from downtown in the northwest part of Frankfurt, at a price not yet influenced by the potential development. This way, the city was able to sell the newly developed building plots at a higher price, financing with the difference the development of the area, the required social and utility infrastructure, as well as other elements like parks and greeneries (Stadtplanungsamt Frankfurt am Main, 2017).

Officially started in 1997, this project, which is currently one of the largest urban development projects in Germany, is divided in 94 hectares of parks, greeneries and landscaping, 89 hectares of net building land, 45 hectares of mobility infrastructure, streets and public spaces, 17 hectares of building land for social welfare and sports facilities, and 22 hectares for the Natural Sciences Faculty of Frankfurt's Goethe University. Composed of seven different quarters, each one with its own legally binding land-use plan, once it is completed is expected to be a lively mix-use mix-income development with approximately 16,000 inhabitants residing in around 6,000 different-size apartments/houses, providing 3,000 jobs, hosting a community of around 8,000 students and offering different shopping opportunities and public amenities just 20 minutes away from downtown Frankfurt by LRT (Stadtplanungsamt Frankfurt am Main, 2017).

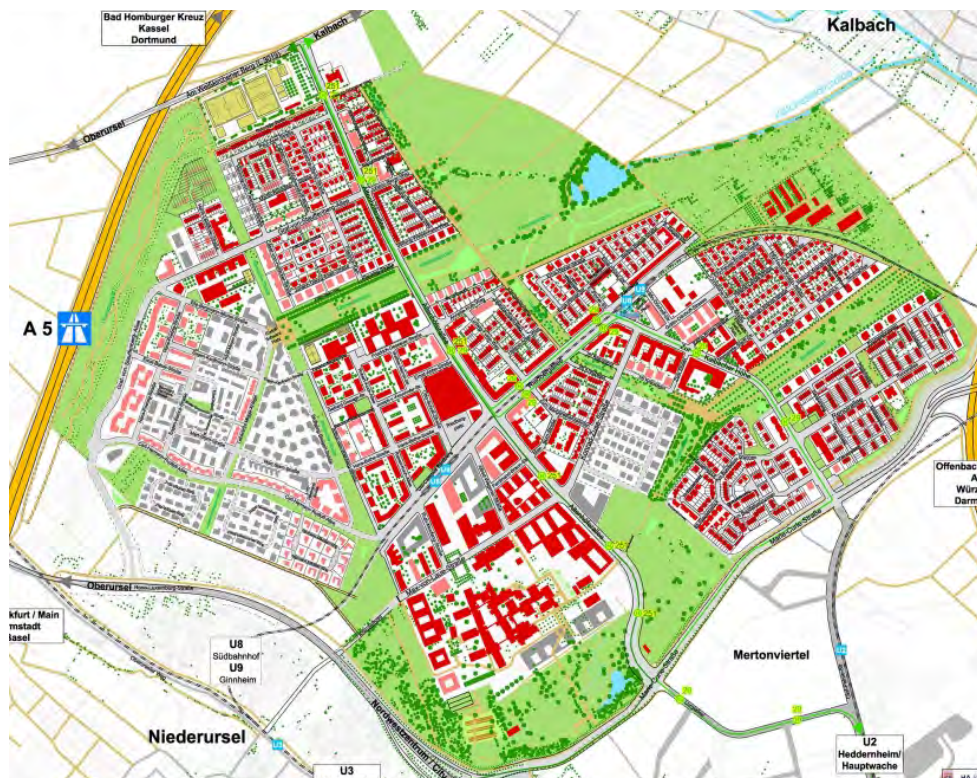


Figure 34: Riedberg Development Plan. ©HA Stadtentwicklungsgesellschaft mbH, 2003

#### 14.3.1. Public Transportation

Located in the north of Frankfurt, 9 km away from the city centre, the Riedberg district is quickly and comfortably connected, both by roads and public transport network, with the city centre, the surrounding districts, the Frankfurt Airport and the region. It is thanks to these connections, like the A661 motorway, the underground lines U8 and U9, and the bus lines 29 and 251, that it is possible to reach the city centre in about 20 minutes.

#### 14.3.2. Co-generation

Riedberg is also a district with high sustainability goals. The main elements of its overall sustainability concept include energy supply through a district heating system covering the whole area and high

energy-efficient construction standards, to encourage the development of passive energy buildings (HA Stadtentwicklungsgesellschaft mbH, 2015).

#### **14.3.3. Mixed-use**

Riedberg is a district in which diversity of uses, activities and socio-demographic structures has been considered since the early design phases, to offer a variety of opportunities and options within the same area to create an active community. In terms of education facilities, it offers kindergartens, day-care centres, elementary and middle schools, the Natural Sciences Faculty of Frankfurt's Goethe University and even some postgraduate studies. With regard to the religious facilities, it includes an Evangelic and a Catholic church. In terms of the shopping and dining opportunities, around the Riedbergplatz and in the Riedberg-Zentrum there is an attractive commercial district with different shops and restaurants. A family centre and the several events organized throughout the year also provide different leisure and cultural opportunities, creating a lively district. And lastly, with regard to the health facilities, different doctor's practices and pharmacies complement this mix of uses (HA Stadtentwicklungsgesellschaft mbH, 2015).

#### **14.3.4. Open Space**

As part of the general open space strategy, over one third of the total area of the district was destined to the creation of a network of parks, plazas, green trails and other landscaped areas not only for environmental, climatic and noise-cancelling purposes but also for leisure activities (HA Stadtentwicklungsgesellschaft mbH, 2015, pp. 23–24). This green network, which is also connected to Frankfurt's green belt, links different areas or playgrounds, sports fields and green spaces to be able to promote different activities such as walking, cycling and jogging throughout the district. The main elements of this network include the Bonifatiuspark of 7.5 ha, the Kätcheslachpark of 10.2 ha, the Topographic Route of 2.2 ha and the Römische Straße of 3.1 ha (Stadtplanungsamt Frankfurt am Main, 2009, p. 11).

#### **14.3.5...Rainwater Retention Concept**

Based on the particular ecological aspects of the district, a comprehensive rainwater retention concept was designed to be integrated into the open space strategy, including open water retention areas in the Kätcheslachpark and the Bonifatiuspark (HA Stadtentwicklungsgesellschaft mbH, 2015).

## **15. Conclusions**

The city of Frankfurt has been shaping its urban planning procedures and measures in accordance with the challenges and needs of the population. These challenges are mainly associated with managing population growth and climate change while accommodating more residents within the existent urban perimeter without reducing the proportion of open green spaces per capita in the city. For the local residents, green infrastructures and open spaces are essential for a good quality of life, as it is also the availability of affordable housing and provision of adequate urban infrastructure.

Population growth challenges the urban infrastructure system in Frankfurt since the city relies on the region for the provision of energy, water and agricultural produce. Through the Regional Authority,

the city and many other towns in the region have the opportunity to negotiate among them the provision of resources for satisfying the needs of the urban and rural residents while preserving the natural environment in the region. This collaboration is crucial for cities such as Frankfurt, in order to achieve their ambitious objectives of transitioning from fossil fuels to a renewable energy society in the next decades.

The energy sector is leading the formulation of sustainable projects directed towards reducing consumption and opening the doors to renewable energies in households, businesses and industries. The projects address the sustainable energy objectives of the city, while also demanding technological innovation and trans-sectoral collaboration with the waste and wastewater sectors. The technological trans-sectoral collaboration illustrates the potentials for trans-sectoral synergies created from high-achieving municipal development policy and a decentralised management structure, where municipal departments have the possibilities to collaborate on a project-driven basis.

A project-driven collaboration approach allows the municipal departments to interact with each other only when the projects require it, and also include the relevant stakeholders for each case. The decentralised structure and project-driven collaboration also permit flexibility in the programmes and projects developed by the municipal departments, the private sector and city-shared companies. This research has identified three typologies of stakeholders involved in the provision of urban infrastructure and the implementation of infrastructure project in Frankfurt within the 5 sectors of Rapid Planning: *programmatic stakeholders* in charge of formulating regulations and policy for the provision of urban infrastructure; *operative stakeholders* composed mostly by city-shared companies as public-private partnerships which provide the services directly to the residents; and the *monitoring stakeholders* who perform a regulatory, coordination and monitoring function.

Along with the stakeholders, the research identifies also three categories of experiences implemented in the city: *programmatic experiences* which provide the legal and regulatory foundation for the programmes and projects; the *practice-oriented experiences* implementing tangible and physical projects in relation to the physical infrastructure of the city and the provision of services; and the *educational experiences* aimed at raising awareness among the population about consumption, climate change and sustainability issues, and educating them in better practices.

Decentralised collaboration is the key word in the experience of Frankfurt. The environmental approach that the city has taken towards development is promoting the advancement of a sustainable agenda in every front, as well as the implementation of innovative solutions to the challenges of providing urban infrastructure to a growing population in a sustainable way. Collaboration among municipal departments, between the public and the private sector, and engagement of the citizens is paramount in the responsibility of reducing the urban footprint and changing the consumption patterns of the society.

## Appendix A: Contacts of the City Organisations of Frankfurt am Main

### **ABG Frankfurt Holding GmbH**

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+49 (0)69 212 33186 StadtForst  
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## References

- ABG Frankfurt Holding (2015) *Wir über Uns*. Available at: <http://www.abg-fh.com/unternehmen/wir-ueber-uns/> (Accessed: 15 June 2015).
- BioFrankfurt (2016) *BioFrankfurt - Das Netzwerk für Biodiversität e.V. (The Biodiversity Network)*. Available at: <http://www.biofrankfurt.org/> (Accessed: 7 November 2016).
- BUND Kreisverbandes Frankfurt (2016) *BUND-Kreisverbandes Frankfurt ist*. Available at: <http://www.bund-frankfurt.de/startseite/> (Accessed: 7 November 2016).
- Caritas Frankfurt (2015) *Cariteam-Energiesparservice*. Available at: <http://www.caritas-frankfurt.de/60531.html> (Accessed: 18 July 2015).
- City of Frankfurt (2016) *Frankfurt am Main Verkehr, Ver- und Entsorgung*. Available at: [http://www.frankfurt.de/sixcms/detail.php?id=3511&\\_ffmpar\[\\_id\\_inhalt\]=64344](http://www.frankfurt.de/sixcms/detail.php?id=3511&_ffmpar[_id_inhalt]=64344) (Accessed: 26 October 2016).
- City of Frankfurt am Main (2010) 'Environment Frankfurt 2010 Status and Trends', *Department for Environment and Health*.
- City of Frankfurt am Main (2013) *European Green Capital Award – Frankfurt am Main 's application. Environmental indicator 07 Waste production and management*.
- Dobroschke, W. and Gebhardt, P. (2015) 'Regionalisierte Bevölkerungsvorausberechnung für Frankfurt am Main bis 2040', in Bürgeramt, S. und W. am M. (ed.) *Frankfurter Statistische Berichte 2015*. Frankfurt am Main: Stadt Frankfurt am Main, pp. 62–71. Available at: [https://www.frankfurt.de/sixcms/media.php/678/2015-3\\_Bevölkerungsprognose.pdf](https://www.frankfurt.de/sixcms/media.php/678/2015-3_Bevölkerungsprognose.pdf).
- Energierreferat Frankfurt am Main (2015a) *Infopakete Energie*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=3078>.
- Energierreferat Frankfurt am Main (2015b) *Internet Stadtplan Frankfurt*.
- Energierreferat Frankfurt am Main (2015c) *Kampagnen*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=7230737> (Accessed: 7 April 2015).
- Energierreferat Frankfurt am Main (2015d) *Masterplan 100% Klimaschutz*. Available at: <http://www.frankfurt-greencity.de/umwelt-frankfurt/klimaschutz-und-energieversorgung/masterplan-100-klimaschutz/> (Accessed: 7 April 2015).
- Energierreferat Frankfurt am Main (2016) *Masterplan 100 % Klimaschutz - Frankfurt am Main: Generalkonzept*. Available at: [https://www.frankfurt.de/sixcms/media.php/738/MasterplanBroschüreFinal\\_web\\_bf.pdf](https://www.frankfurt.de/sixcms/media.php/738/MasterplanBroschüreFinal_web_bf.pdf) (Accessed: 7 August 2016).
- European Commission (2016) *European Green Capital*. Available at: <http://ec.europa.eu/environment/europeangreencapital/about-the-award/policy-guidance/index.html> (Accessed: 3 April 2016).

FES (2015a) *Gewerbe: Entsorgung*. Available at: <http://www.fes-frankfurt.de/gewerbe/entsorgung> (Accessed: 30 August 2015).

FES (2015b) *Infomaterialien, Fessie*. Available at: <http://www.fessie.de/erwachsene/paedagogen/infomaterialien> (Accessed: 30 August 2015).

FES (2015c) *Unternehmen*. Available at: <http://www.fes-frankfurt.de/unternehmen> (Accessed: 30 August 2015).

FES Frankfurter Entsorgungs- und Service GMmbH (2016a) *Die Rhein Main Macher*. Available at: <https://www.fes-frankfurt.de/unternehmen/toechter-und-beteiligungen/trapp-handelsgesellschaft-mbh> (Accessed: 17 April 2016).

FES Frankfurter Entsorgungs- und Service GMmbH (2016b) *MHKW Müllheizkraftwerk Frankfurt am Main GmbH*. Available at: <https://www.fes-frankfurt.de/unternehmen/toechter-und-beteiligungen/mhkw-muellheizkraftwerk-frankfurt-am-main-gmbh>.

FES Frankfurter Entsorgungs- und Service GMmbH (2016c) *RMB Rhein-Main Biokompost GmbH*. Available at: <https://www.fes-frankfurt.de/unternehmen/toechter-und-beteiligungen/rmb-rhein-main-biokompost-gmbh> (Accessed: 18 August 2016).

Ffmtiptopp (2015) *Unser Profile*. Available at: <http://www.ffmtiptopp.de/index.php?id=6> (Accessed: 30 August 2015).

Fraport AG (2016) *Frankfurt Airport*. Available at: <http://www.fraport.de/de.html> (Accessed: 21 February 2016).

Geschäftsstelle FrankfurtRheinMain (2016) *FrankfurtRheinMain*. Available at: <http://www.verein-fm.de/> (Accessed: 21 February 2016).

Gesundheitsamt (2015a) *Das Frankfurter Bleiprojekt*.

Gesundheitsamt (2015b) *Trinkwasserqualität*. Available at: [http://www.frankfurt.de/sixcms/detail.php?id=13668396&\\_ffmpar\[\\_id\\_inhalt\]=54305](http://www.frankfurt.de/sixcms/detail.php?id=13668396&_ffmpar[_id_inhalt]=54305) (Accessed: 23 May 2015).

Graf, A. (2014) *Praxisleitfaden - Online- Hintergrundinformationen und Grundlagen, Projektleitung Masterplan Klimaschutz*. Frankfurt am Main.

Grünflächenamt (2015a) *Grünflächenamt*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=3051> (Accessed: 7 April 2015).

Grünflächenamt (2015b) *Urban Gardening - die Stadt als Garten*. Available at: [http://www.frankfurt.de/sixcms/detail.php?id=3051&\\_ffmpar\[\\_id\\_inhalt\]=19284341](http://www.frankfurt.de/sixcms/detail.php?id=3051&_ffmpar[_id_inhalt]=19284341) (Accessed: 7 April 2015).

HA Stadtentwicklungsgesellschaft mbH (2015) *Frankfurt am Main neu Entdecken Riedberg, Urbaner Stadtteil im Grünen*. Frankfurt am Main. Available at:

<http://www.riedberg.de/files/content/downloads/Riedberg-Frankfurt-Basisbroschuere.pdf>.

Hessenwasser (2014) 'Gesundheit geht vor', *Inside/Out*, pp. 6–9.

Hessenwasser GmbH & Co. KG (2016a) *Aufgaben und Ziele*. Available at:  
<http://www.hessenwasser.de/index.php?id=61> (Accessed: 8 August 2015).

Hessenwasser GmbH & Co. KG (2016b) *Qualität ist unsere Stärke*. Available at:  
[file:///C:/Users/Elvia.Mercado/Downloads/Qualität ist unsere Stärke.pdf](file:///C:/Users/Elvia.Mercado/Downloads/Qualität%20ist%20unsere%20Stärke.pdf) (Accessed: 21 August 2016).

IFEU (2010) *Masterplan 100% Klimaschutz - auf dem Weg zur Null-Emissions- Kommune*. Available at:  
[https://www.klimaschutz.de/sites/default/files/page/downloads/masterplan\\_100prozent\\_klimaschutz\\_ifeu.pdf](https://www.klimaschutz.de/sites/default/files/page/downloads/masterplan_100prozent_klimaschutz_ifeu.pdf) (Accessed: 8 August 2015).

KulturRegion FrankfurtRheinMain (2016a) *GartenRheinMain*. Available at:  
<http://www.krfrm.de/c/grm/index.html> (Accessed: 25 July 2016).

KulturRegion FrankfurtRheinMain (2016b) *Über uns*. Available at:  
<http://www.krfrm.de/c/grm/index.html> (Accessed: 17 March 2016).

Mainova (2009) *Energie im Fokus : Biomasse*. Frankfurt. Available at:  
[https://www.mainova.de/static/de-mainova/downloads/Biomasse\\_Mainova.pdf](https://www.mainova.de/static/de-mainova/downloads/Biomasse_Mainova.pdf).

Mainova AG (2015) *Wasserhärte und Trinkwasseranalyse*. Available at:  
<https://www.mainova.de/privatkunden/kundenservice/wasserqualitaet.html> (Accessed: 16 June 2015).

Mainova AG (2016) *Erzeugungsanlagen der Mainova AG*. Available at:  
[https://www.mainova.de/ueber\\_uns/unternehmensprofil/erzeugung.html](https://www.mainova.de/ueber_uns/unternehmensprofil/erzeugung.html) (Accessed: 3 August 2016).

MHKW GmbH (2015a) *Klimaschutz*. Available at: <https://www.mhkw-frankfurt.de/klimaschutz>.

MHKW GmbH (2015b) *Wer betreibt das Müllheizkraftwerk?* Available at: <https://www.mhkw-frankfurt.de/wer-betreibt-das-muellheizkraftwerk>.

MHKW GmbH (2016) *Müllheizkraftwerke Frankfurt*. Available at: [https://www.mhkw-frankfurt.de/das-müllheizkraftwerk-frankfurt](https://www.mhkw-frankfurt.de/das-muellheizkraftwerk-frankfurt) (Accessed: 22 April 2016).

Naturschule Hessen (2016) *Naturschule Hessen*. Available at: <http://www.naturschule-hessen.de/> (Accessed: 21 February 2016).

Peterek, P. . D.-I. M. (2015) 'Climate Protection and Green City Policies in Frankfurt am Main , Germany', in *Ciudades en Transformación. Cambio Climático Global, Desastres Naturales y Resiliencia Urbana*. Concepción.

Recyclingzentrum Frankfurt (2016) *Recycling Zentrum Frankfurt*. Available at:  
<http://www.recyclingzentrum-frankfurt.de/ueber-uns.html> (Accessed: 27 April 2016).

Regionalpark Ballungsraum RheinMain GmbH (2016) *Regionalpark RheinMain*. Available at:

<http://www.regionalpark-rheinmain.de/de/> (Accessed: 21 February 2016).

Regionalverband FrankfurtRheinMain (2015) *Landschaftsplanung*. Available at: <http://www.region-frankfurt.de/Planung/Landschaftsplanung> (Accessed: 14 July 2015).

Regionalverband FrankfurtRheinMain (2018) *Die Region FrankfurtRheinMain in Zahlen und Fakten*. Available at: <https://www.region-frankfurt.de/Regionalverband/Region-in-Zahlen> (Accessed: 31 January 2018).

Rhein-Main Abfall (2015) *Die Struktur der RMA*. Available at: <http://www.rmaof.de/wer-sind-wir/struktur-der-rma.html> (Accessed: 15 July 2015).

Ritchie, J. and Spencer, L. (2002) 'Qualitative Data Analysis for Applied Policy Research', in Huberman, M. and Miles, M. (eds) *The Qualitative Researcher's Companion*. Thousand Oaks: Sage Publications.

RMB Rhein-Main Biokompost GmbH (2016) *RMB Rhein-Main Biokompost GmbH*. Available at: <https://www.fes-frankfurt.de/rmb> (Accessed: 4 August 2016).

Roth, D.-I. U. (2016) 'Situationsanalyse zur Wasserversorgung in der Rhein-Main-Region', in. Groß-Gerau: Arbeitsgemeinschaft Wasserversorgung Rhein-Main.

Sauberhaftes Hessen (2015) *Eine Kampagne mit und für Bürger/innen*. Available at: <http://www.sauberhaftes-hessen.de/mehr-erfahren/die-kampagne-sauberhaftes-hessen.html> (Accessed: 15 July 2015).

Schneider, K. (2017) 'Recent Facts about Photovoltaics in Germany'.

Stadt Frankfurt am Main (2011) *Frankfurt Green City – Frankfurt in allen Farben*. Frankfurt am Main. Available at: [https://www.frankfurt.de/sixcms/media.php/738/Frankfurt Green City Flyer.pdf](https://www.frankfurt.de/sixcms/media.php/738/Frankfurt%20Green%20City%20Flyer.pdf).

Stadt Frankfurt am Main (2013) *European Green Capital Award – Frankfurt am Main 's Application Environmental indicator 08 Water Consumption*. Frankfurt am Main.

Stadt Frankfurt am Main (2014) *Beteiligungsbericht 2014: Gebündelte Kompetenz für ein nachhaltiges Frankfurt*. Frankfurt am Main: Stadt Frankfurt am Main.

Stadt Frankfurt am Main (2015) *Abwasser*, [www.frankfurt.de](http://www.frankfurt.de). Available at: [http://www.frankfurt.de/sixcms/detail.php?id=3060&\\_ffmpar%5B\\_id\\_inhalt%5D=54585](http://www.frankfurt.de/sixcms/detail.php?id=3060&_ffmpar%5B_id_inhalt%5D=54585) (Accessed: 26 July 2016).

Stadt Frankfurt am Main (2016a) *Cogeneration*. Available at: <http://www.frankfurt-greencity.de/en/environment-frankfurt/climate-protection-and-energy-supply/combined-heat-and-power-generation/> (Accessed: 12 September 2016).

Stadt Frankfurt am Main (2016b) *Frankfurt am Main: Energiemanagement im Hochbauamt*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=7688862> (Accessed: 22 August 2016).

Stadt Frankfurt am Main (2016c) *Frankfurt am Main: Municipal Energy Agency*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=3077> (Accessed: 18 August 2016).

Stadt Frankfurt am Main (2016d) *Hochbauamt - Energiemanagement*. Available at: <http://www.energiemanagement.stadt-frankfurt.de/> (Accessed: 22 August 2016).

Stadt Frankfurt am Main (2016e) *Leben in Frankfurt, Frankfurt.de*. Available at: [http://www.frankfurt.de/sixcms/detail.php?id=2828&\\_ffmpar\[\\_id\\_inhalt\]=2083232](http://www.frankfurt.de/sixcms/detail.php?id=2828&_ffmpar[_id_inhalt]=2083232) (Accessed: 4 April 2016).

Stadt Frankfurt am Main (2016f) *Leben in Frankfurt, Frankfurt.de*.

Stadt Frankfurt am Main (2016g) *'Masterplan 100 % Klimaschutz' – Frankfurt am Main. General Konzept*. Frankfurt am Main.

Stadt Frankfurt am Main (2016h) *Municipal Energy Agency*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=3077> (Accessed: 3 August 2016).

Stadt Frankfurt am Main (2016i) *Sauberes Frankfurt - Stabsstelle*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=2873> (Accessed: 22 August 2016).

Stadt Frankfurt am Main (2016j) *Umweltamt, Frankfurt.de*. Available at: <http://www.frankfurt.de/sixcms/detail.php?id=3060> (Accessed: 2 September 2016).

Stadt Frankfurt am Main (2019a) *Ausgleichsflächen*. Available at: [https://www.frankfurt.de/sixcms/detail.php?id=418762&\\_ffmpar\[\\_id\\_inhalt\]=30234](https://www.frankfurt.de/sixcms/detail.php?id=418762&_ffmpar[_id_inhalt]=30234) (Accessed: 16 October 2019).

Stadt Frankfurt am Main (2019b) *Frankfurts Energie erneuern. Masterplan 100 % Klimaschutz: Die Stadt vollständig aus erneuerbaren Energien versorgen, Frankfurt Green City*. Available at: <https://www.frankfurt-greencity.de/status-trends/klima-freiflaechen/masterplan-100-klimaschutz/> (Accessed: 17 October 2019).

Stadt Frankfurt am Main (2019c) *Landschaftsplanung*. Available at: [https://www.frankfurt.de/sixcms/detail.php?id=418762&\\_ffmpar\[\\_id\\_inhalt\]=30350](https://www.frankfurt.de/sixcms/detail.php?id=418762&_ffmpar[_id_inhalt]=30350) (Accessed: 16 October 2019).

Stadtentwässerung Frankfurt am Main (2015) *Aufgabengliederungsplan*. Available at: <http://stadtentwaesserung-frankfurt.de/index.php/ueberuns/unsereaufgaben/aufgabengliederungsplan.html> (Accessed: 1 January 2015).

Stadtentwässerung Frankfurt am Main (2016) *Stadtentwässerung Frankfurt am Main*. Available at: <http://stadtentwaesserung-frankfurt.de/index.php> (Accessed: 22 August 2016).

Stadtplanungsamt Frankfurt am Main (2009) *BAUSTEIN 1/09, Städtebauliche Entwicklungsmaßnahme Riedberg*. Frankfurt am Main.

Stadtplanungsamt Frankfurt am Main (2016a) *Integrated Urban Development*. Available at: <http://www.stadtplanungsamt->

frankfurt.de/2030\_frankfurt\_main\_integrated\_urban\_development\_approach\_\_14156.html?psid=90d32do6qtn8k91luv7fo4ani7 (Accessed: 19 September 2016).

Stadtplanungsamt Frankfurt am Main (2016b) *Konzeption des GrünGürtelparks*. Available at:

[http://www.stadtplanungsamt-](http://www.stadtplanungsamt-frankfurt.de/konzeption_des_gruenguertelparks_5047.html?psid=ettrs4k85pd7nqq4souk7ab5q7)

[frankfurt.de/konzeption\\_des\\_gruenguertelparks\\_5047.html?psid=ettrs4k85pd7nqq4souk7ab5q7](http://www.stadtplanungsamt-frankfurt.de/konzeption_des_gruenguertelparks_5047.html?psid=ettrs4k85pd7nqq4souk7ab5q7)

(Accessed: 25 July 2016).

Stadtplanungsamt Frankfurt am Main (2016c) *Über uns*. Available at: [http://www.stadtplanungsamt-](http://www.stadtplanungsamt-frankfurt.de/about_us_5645.html?psid=dl739d7bgif48jppmsmhcgdsd21)

[frankfurt.de/about\\_us\\_5645.html?psid=dl739d7bgif48jppmsmhcgdsd21](http://www.stadtplanungsamt-frankfurt.de/about_us_5645.html?psid=dl739d7bgif48jppmsmhcgdsd21) (Accessed: 22 August 2016).

Stadtplanungsamt Frankfurt am Main (2017) *Riedberg*. Available at: [http://www.stadtplanungsamt-](http://www.stadtplanungsamt-frankfurt.de/riedberg_5309.html?langfront=en&psid=9is7l13i7cfsiajvrcb4la8di0)

[frankfurt.de/riedberg\\_5309.html?langfront=en&psid=9is7l13i7cfsiajvrcb4la8di0](http://www.stadtplanungsamt-frankfurt.de/riedberg_5309.html?langfront=en&psid=9is7l13i7cfsiajvrcb4la8di0).

Stadtwerke Frankfurt am Main Holding (2015a) *Mainova*. Available at: [http://www.stadtwerke-](http://www.stadtwerke-frankfurt.de/164.html)

[frankfurt.de/164.html](http://www.stadtwerke-frankfurt.de/164.html) (Accessed: 9 June 2015).

Stadtwerke Frankfurt am Main Holding (2015b) *Stadtwerke Holding*. Available at:

<http://www.stadtwerke-frankfurt.de/27.html> (Accessed: 3 June 2015).

Umweltamt (2012) *European Green Capital Award – Frankfurt am Main ’s application Environmental indicator 12 Energy performance*. Frankfurt am Main.

Umweltamt Frankfurt am Main (2014) *Überwachung der Abwasserqualität*. Frankfurt am Main.

Umweltforums Rhein-Main (2016) *Umweltforums Rhein-Main*. Available at:

<http://www.umweltforum-rhein-main.de/> (Accessed: 21 February 2016).

Umweltlernen Frankfurt am Main e.V. (2016) *Umweltlernen Frankfurt am Main e.V.* Available at:

<http://www.umweltlernen-frankfurt.de/> (Accessed: 22 February 2016).

Wirtschaftsinitiative FrankfurtRheinMain e.V. (2016) *FrankfurtRheinMain - Die Wirtschaftsinitiative*.

Available at: <http://www.die-wirtschaftsinitiative.de/die-wirtschaftsinitiative/unsere-aufgaben-und-ziele.html> (Accessed: 7 November 2016).

Wissenregion FrankfurtRheinMain (2016) *Wissensportal FrankfurtRheinMain*. Available at:

<http://www.wissensportal-frankfurtrheinmain.de/> (Accessed: 22 February 2016).

Zentrale Kompetenzstelle für Geoinformation (2015) *Geoportal Hessen*. Available at:

<http://www.geoportal.hessen.de/portal/themen/umwelt.html> (Accessed: 1 January 2015).