Vienna, aspern Seestadt

Implementation Plan

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With the transformation of the former airfield of Aspern, the city of Vienna aims for a new quality in urban development, providing a full-range mixed use area which will stimulate neighbouring urban quarters as well as the way urban development in the city of Vienna is being done in general. A main priority in this context is the strive for high quality of life for future residents, combined with affordability. In 2028, 240 ha of land will be developed, some 20,000 people and a similar number of workplaces are hoped to be established in the area by then. The masterplan foresees the development of a multifunctional district with a mix of residential, office, scientific, research and educationnal uses. In line with the Smart City Framework Strategy of Vienna (approved in 2014), the work of the development agency of “aspern_Seestadt”, named “Wien 3420”, has been guided by the vision for an ecological, resource-friendly and climate neutral city from the start of the planning process.

In implementing the first phase of aspern Seestadt, Wien 3420 put innovative measures in place and achieved high quality urban and transport planning as well as the development of attractive public spaces. Striving at high quality planning, best practices may be stated in terms of transport and mobility planning (by various innovative measures, like a new subway line, a mobility fund to finance innovative measures, neighbourhood garages only, inter-modal transport, car-sharing offers, attractive streets for cycling and walking, etc.). Also, developing a lively neighbourhood through quality public spaces, an active neighbourhood management and a special management agency for the public retail streets, supporting local supply.

The realization of more innovative approaches in the sphere of energy was based on the requirements stated in the environmental impact assessment and achieved by private contracts with property developers. So, in the first phase of implementation (aspern_Seestadt South), e.g. higher thermal building standards (as applicable then from building codes), and the obligatory preparation of buildings for solar use and for monitoring were defined. The area is serviced by the municipal district heating system. Finally, the research joint venture “Aspern Smart City Research” between Siemens and municipal institutions performs high level on-site research in the field of local renewable energy sources, demand-side management of energy flows and the provision and management of smart grids.

The aspern_Seestadt IP is covering the second phase of urban development – aspern Seestadt North. Here, for an area designed for 7,000 new apartments and 14,000 jobs, the main challenge is to take the step from researching innovative future energy systems to a complete roll-out in the area. Although considerable potential for the use of renewable sources and innovative systems is shown in various research projects, implementation is still dependent on a large number of actors with conflicting aims. Above all, a fundamental (political) commitment including specific quantitative energy targets is still missing for making aspern_Seestadt a model for new approaches. Thus Wien 3420, although highly interested in developing the area into a full-fledged smart urban district, as a development company is limited by financial and legal restrictions, difficult to overcome.

Furthermore, in the context of the Transform planning process, a more precise description of the future energy system for the SUL is needed – for the 'phase North' EIA compared to the Environmental Impact Assessment Act in 2010 for the 'phase South' area. The EIA-regulations require the determination of one solution for the entire area in advance, which is quite problematic in a fast changing energy environment. Also, in the course of the Transform process it has led to a rather conventional solution for the energy system, laid down in the EIA as a so-called "minimum" scenario. Furthermore, this minimum scenario is setting the framework for the elaboration of more innovative and sustainable system options, since the developer will want to avoid a reopening of the EIA approval process. Nevertheless, based on the ongoing process of elaborating such a 'smart city'-scenario for the energy system, some elements already have been included in the EIA-process in such a way as to which will allow for further innovative improvements without having to go through the approval process once more.

The current state of the IP-related process includes the following elements:

- There is an ongoing process with key stakeholders elaborating a 'smart city scenario' for aspern_Seestadt (phase North), which will possibly lead to an official statement on quantitative targets for the SUL and which will endorse the energy system concept as laid out in the IP.
- The intensive discussions at the Intensive Lab Session of TRANSFORM made clear, that integrated planning and the need for agreements between involved stakeholders have highest priority for smart city implementation, in aspern_Seestadt and elsewhere in the city. Intensive work has been started by the relevant

municipal departments in order to develop new procedures of integrated energy and urban development planning in Vienna.

- The key issue of financing is currently tackled by an in depth analysis and comparison of finance and business models for aspern_Seestadt.

These activities, strongly supported through the TRANSFORM process, will hopefully provide most valuable decision support for the key actors in Vienna. Helping to define tangible requirements for development in aspern_Seestadt, to provide the chance of becoming a model for 'smart city' development and – at the same time – to leave enough openness and flexibility for new framework conditions and technologies in the coming 15 years of implementation.

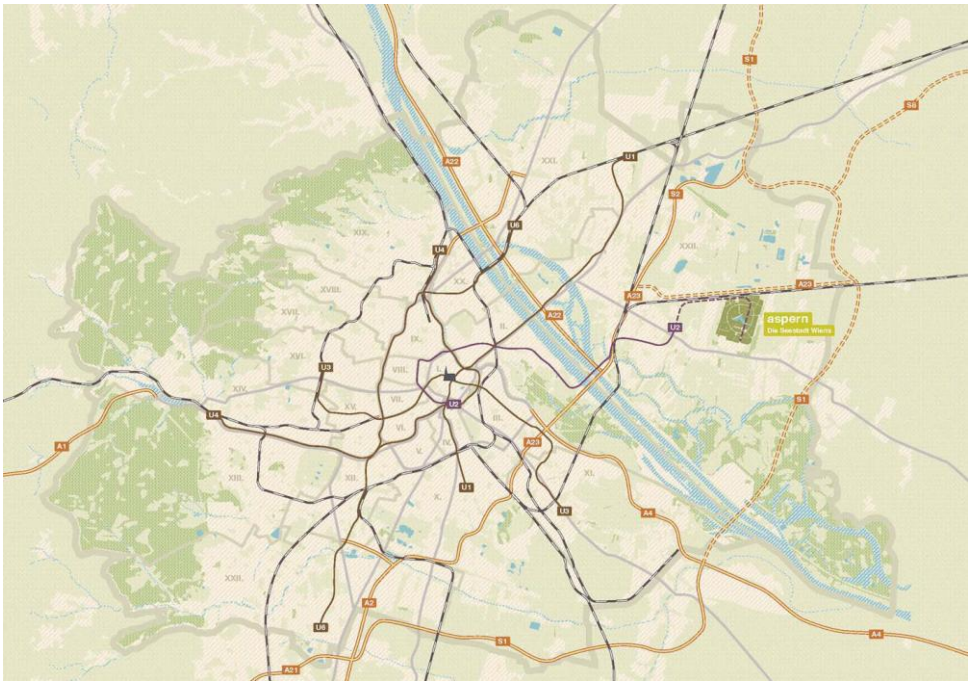
1. Background and context information on the SUL and the city

1.1 Description of the area and urban development context

Until 2028, 240 ha of land will be developed some 20,000 people plus about the same number of workplaces. The Masterplan foresees the development of a multifunctional district with a mix of residential, office, scientific, research and educational uses. A lake of 5 ha will be at the centre and give the new city district its characteristic name. Green – and public spaces, the proximity to the Natural reserve Donau-Auen and high quality urban infrastructures should guarantee enduring life quality in the newly build part of Vienna.

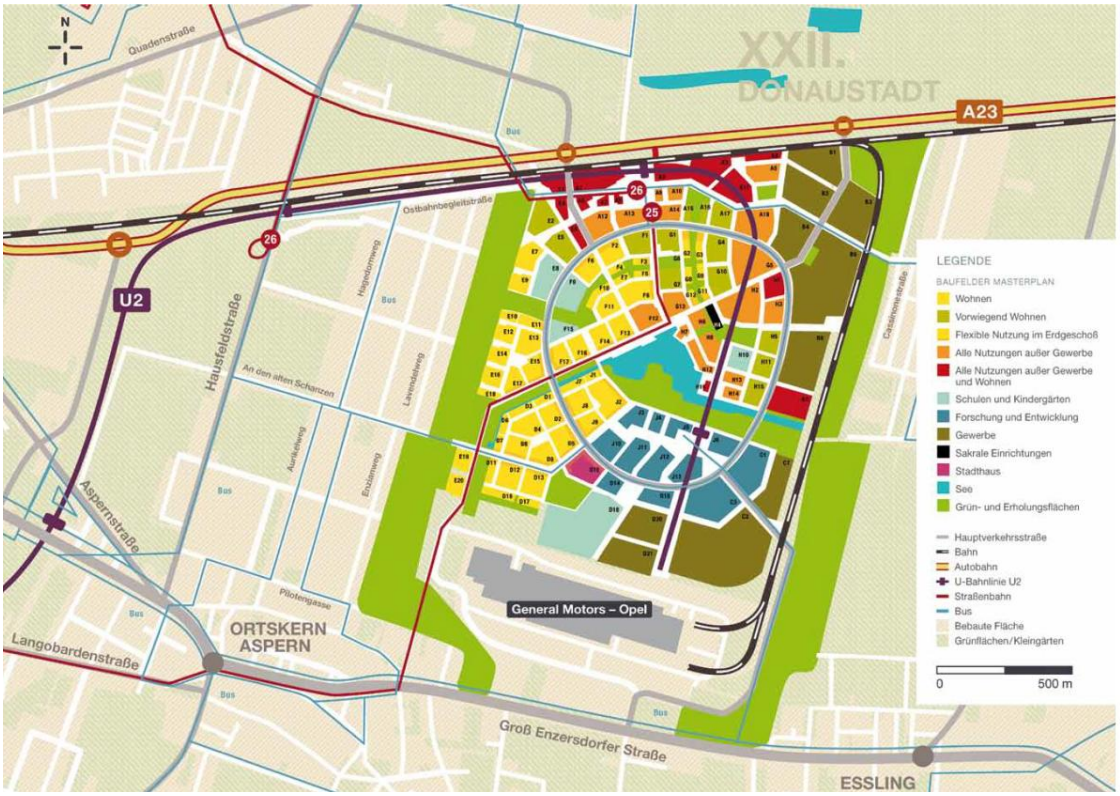
The area is located in close proximity to the old village centres of Aspern and Eßling, in between two urban development districts on its western and eastern side, the factory area of Opel Austria GmbH on its southern side, and the Ostbahn (Vienna-Marchegg-Bratislava), which borders on the district in the north.

Illustration 1: Location within city



Source : Wien 3420

Illustration 2: Area map aspern – Donaustadt



Source: aspern+ citylab (2010): Vision + Wirklichkeit. Die Instrumente des Städtebaus. Ein citylab Report von aspern Die Seestadt Wiens.

First steps in the started implementation were an already constructed new road connection from the former airfield to Großenzersdorfer Street in the south-east, and the beginning of the conception of green and public spaces. In the south-eastern part of the area, current land use permissions foresee the development of industrial and office uses. Housing will be constructed mostly in the south- and north-eastern part of aspern Seestadt, with a projected development of 4600 residential units south of the lake and 7500 residential units in the northern part of the lake. Since October 2013, aspern Seestadt is connected by subway to the public transport network. Two subway stations – one in the north and one in the centre of aspern Seestadt – are connecting the new city district to the rest of Vienna. The extension of U2 prior to the development of actual residential uses should work as an engine of urban development and stimulate use of public transport.

Illustration 3: Construction of U2 subway line in 2011

Source: Wien 3420 AG (photo: Fiedler)

1.2 Structure of population and businesses

Table 1: Basic data for the SUL

	Status quo (2013)	Projection (2030)
Total area	223ha	223 ha
... of which built up area	0	50 ha
Nr of population	0	ca. 26,000
Nr of households	0	ca. 12,000
Nr of enterprises, businesses	10	Dependent on type and size of companies
Nr of jobs total	1,200	ca. 23,000
Structure of jobs in % (e.g. office, commercial, other services, manufacturing, logistics ...)	0	75% offices and service business, 25% industries and manufacturing, research

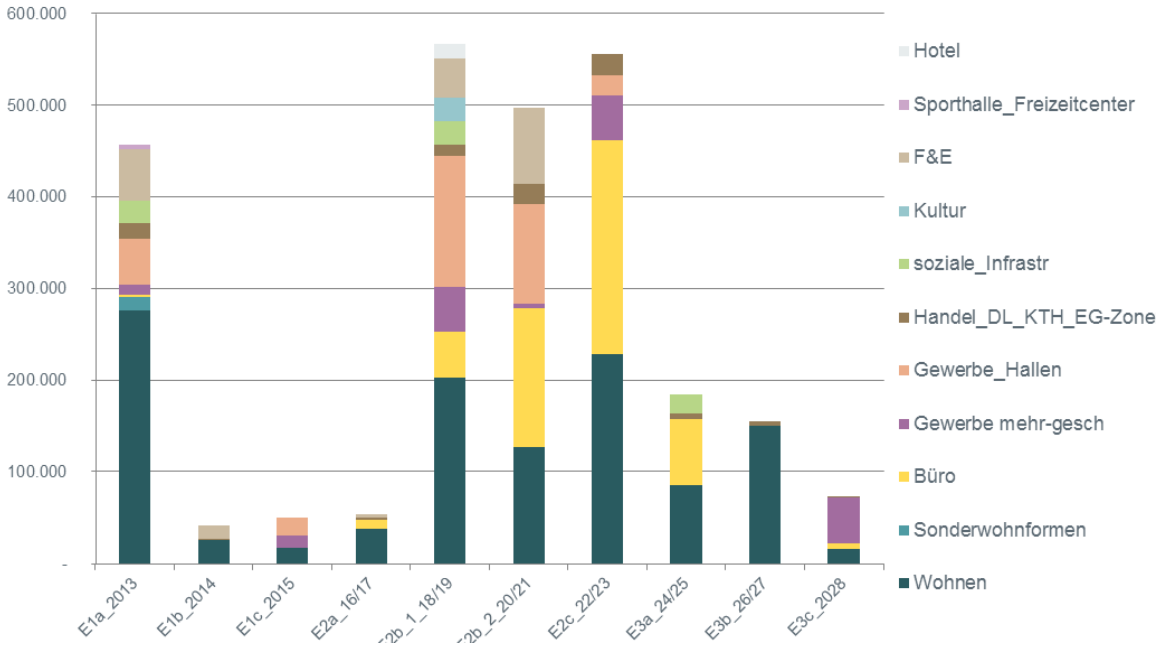
With the transformation of the former airfield Aspern, the city of Vienna would like to establish a new urban centre that should not only stimulate neighbouring areas but the development of the city of Vienna in total. A priority in this context is the fostering of

high quality of life for future residents and users. aspern Seestadt should reconcile the advantages of green-living with a feeling of urbanity. For this reason special attention is devolved to public space. About half of the area will be used as public space, composed of Streets, Piazzas, parkland and recreational areas. Business district, commercial estates and innovation cluster, just as residential uses, will be part of aspern Seestadt. The centrally located lake will make the core of the city and work as place of encounter for its inhabitants. aspern Seestadt should be integrative to age populations and lifestyles.

In 2012 works on the Technology-hub aspern IQ have been completed to form the first accomplished visible milestone in the development of aspern Seestadt. The 6,000 m^2 big building was financed by Vienna's Business Agency. Currently, the building is used by 8 companies, employing about 70 people in total. Swiss corporation Hörbiger Holding AG will be the first major company to settle in aspern Seestadt. From 2016 on, about 530 employees will start their work in the newly build premises. Form 2015/2016, the social organization Wien Work will provide attractive services for inhabitants, public institutions and firms. With 600 employees, Wien Work will be the biggest employer in the social sector, and entertains a decisive role for stimulating a mixed and lively neighbourhood development at aspern Seestadt.

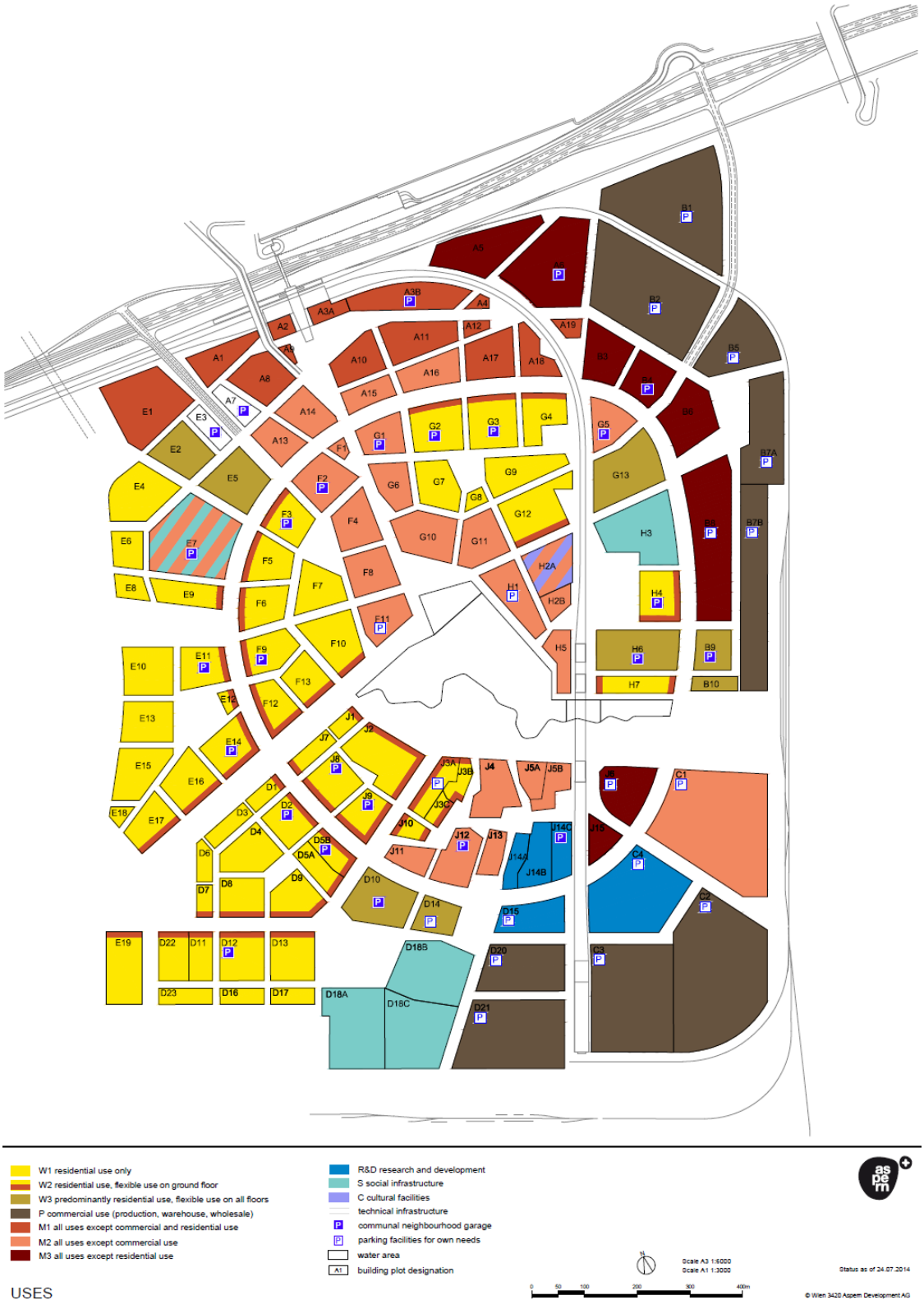
On the outer bounds of the ring-road, industrial and commercial uses will be located in the north-east, in the north-and-southwest almost exclusively residential and cultural infrastructure. On the inside of the ring-road, all types of uses are located with the exception of industrial and commercial uses (see Illustration 5). The highest densities are to be found in the northern part and the west; the lowest densities are foreseen for commercial and social premises in the southern part. The densest parts are high rises in the city centre and the entrances to the aspern Seestadt (see Illustration 6).

Illustration 4: Uses (Gross floor space in [m^2]) according to building phases/years



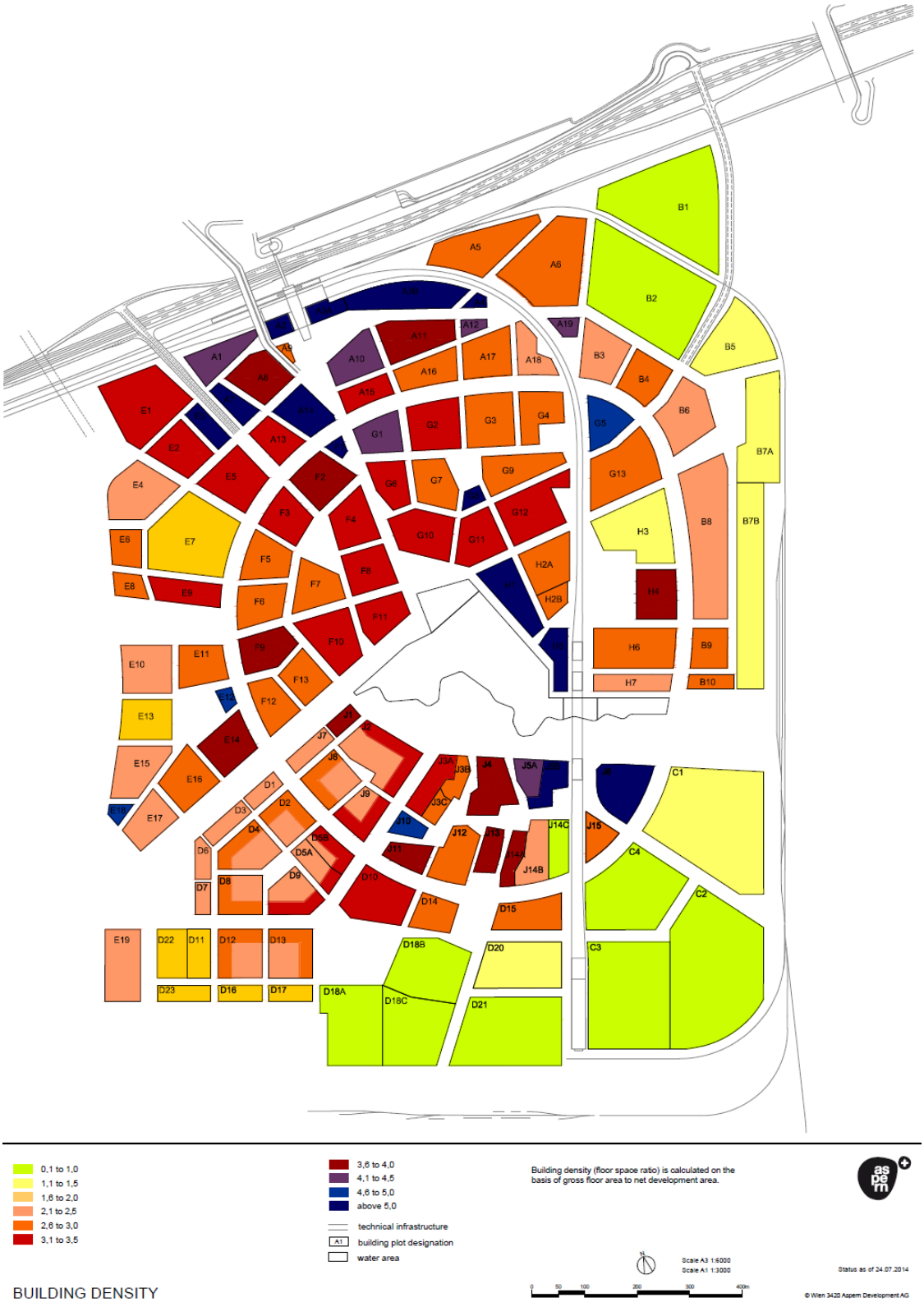
Source: AIT

Illustration 5: Planned uses in the area



Source: Wien 3420 AG

Illustration 6: Planned densities in the development area



Source: Wien 3420 AG

2. Development process (so far)

2.1 Insight in the ongoing development process

After the designation as a target area for new urban development in Vienna in the urban development plan 2005, an international masterplan competition was conducted, in order to create urban development proposals.

For this purpose, ten teams of regional and urban planners, architects, mobility and landscape planners were identified throughout Europe and invited to submit detailed proposals. Following a preliminary technical evaluation, the results were presented in November 2005 and reviewed by an international expert panel. In January 2006, the team of Tovatt Architects & Planners together with N+ Objektmanagement was awarded the contract.

In drafting the master plan, the planners were assisted by a project team composed of representatives of both Vienna's urban planning departments and the property owners. The first, preliminary draft of the master plan was presented in May 2006 to an audience of 600 in the respective district of Vienna. This start up was followed by a process involving a board of citizens from the area, whose suggestions were published and integrated. Several workshops served to discuss, detail and fine-tune the plans with these "local experts", while in parallel the municipal planning departments led the dialogue with political decision-makers at the city level. On 25 May 2007, the master plan was adopted by the Vienna City Council.

Governance of the development process

The "Wien 3420 Aspern Development AG" (subsequently named Wien 3420) was founded to develop and to promote aspern Seestadt as an urban centre within the City of Vienna. Within the scope of the different processes Wien 3420 develops concepts and defines planning guidelines, provides property and offers consultancy for development projects. It is therefore responsible for the development of the area and for the definition of the Implementation Plan and acts as an important player in all planning issues. Urban planning, general concepts as well as the realization of aspern Seestadt are organized and operated by Wien 3420. The owners of Wien 3420 are:

- GELUP GmbH: 73.4% (a limited liability company as a subcontractor of the Vienna Business Agency Group (Wirtschaftsagentur)[1], Vienna Insurance Group and the Bausparkassen der Österreichischen Sparkassen (a specialized bank, dealing mainly with financing of housing projects)
- Federal Real Estate Society „Bundesimmobiliengesellschaft BIG“: 26.6% (institution owning and managing federal buildings and estates) .

Financing and competencies:

- Wien 3420 is a stock corporation (Aktiengesellschaft) which is generating revenue through the sale of property: Wien 3420 buys undeveloped property from the landowners (which are founders of Wien 3420) and sells developed land including necessary technical infrastructure. The margin allows Wien 3420 to finance about 50% of the costs of infrastructure (technical infrastructure, streets, green areas, etc.)
- Wien 3420 started with a budget financed by a mix of owned equity and grants from the founding partners BIG and Wirtschaftsagentur, totaling to a sum of about 26 million Euros. Apart from these initial funds, further revenue could be generated through advance sale of land to the GELUP GmbH (about 26 million Euros, provided until 2013). A further 2.6 million Euros stem from an easement for the new Subway line given to Wiener Linien. This initial budget of about 55 million Euros – for the development of phase 1 – was thus entirely financed through private equity, with no further reliance on credit.
- The cost of building public infrastructures such as roads and public spaces, green spaces and water infrastructures are shared between Wien 3420 and the city of Vienna. For this purpose, negotiations are set up between Wien 3420 and the city in each phase of the development. Electricity, gas and district heating are independently built up by the companies of Vienna‘s main energy infrastructure utility (Vienna Networks); telecommunications by the Telekom; and social infrastructure (schools and kindergartens) is financed by the municipality.
- The city of Vienna is involved in the development of aspern Seestadt through the so-called „coordination unit aspern Seestadt“ (a project director with a team of

[1] The Vienna Business Agency Group is a service point for Vienna’s enterprises, its services are mainly funded by the City of Vienna.

several persons), which is directly responsible to the Director General of Urban Planning, Development Construction. It is responsible for the coordination of all tasks within the sphere of competence of the City of Vienna regarding the implementation of aspern Seestadt. In order to ease planning processes and to support the development of the SUL.

- Additionally there has been defined a general agreement between the city and Wien 3420 in terms of cooperation and intended building qualities and – based on this agreements – on the co-financing of infrastructure.
- Public spaces e.g. are to be taken over by the city in terms of operation and maintenance, which needs planning and construction in close coordination, following the requirements of the city administration.

Besides Wien 3420 the **most important stakeholders** involved in the planning and development of the area are:

- "Coordination unit aspern Seestadt" with its task to govern the cooperation between Wien 3420 and the administration of Vienna (city) as well as project related measures within the administration (municipal departments mentioned above as well as a number of further departments e.g. responsible for transport, water management, green space, waste, etc.).
- Municipal Department 18 – Urban Development and Planning: responsible for urban development concepts and strategic urban planning
- Municipal Department 21 – District Planning and Land Use: responsible for land use planning in Vienna
- Municipal Department 20 – Energy Planning is responsible for area related, integrated spatial and energy planning in Vienna and is coordinating energy related city concepts, examines energy related projects in the course of governmental procedures and develops pilot projects in order to support the introduction of innovative energy technologies.
- Municipal Department 28 (Road management and construction) , currently intensively involved in final planning activities in the area and commissions the mobility concept together with Wien 3420.
- Municipal Department 42 (Parks and gardens) , responsible for the maintenance of green areas and thus currently also involved in planning processes.

wohnfonds_wien (responsible for subsidized housing construction and renovation

in Vienna): On the basis of contractual agreements between Wien 3420, Business Agency Vienna and wohnfonds_wien, a substantial number of subsidized floor space will be erected in aspern Seestadt.

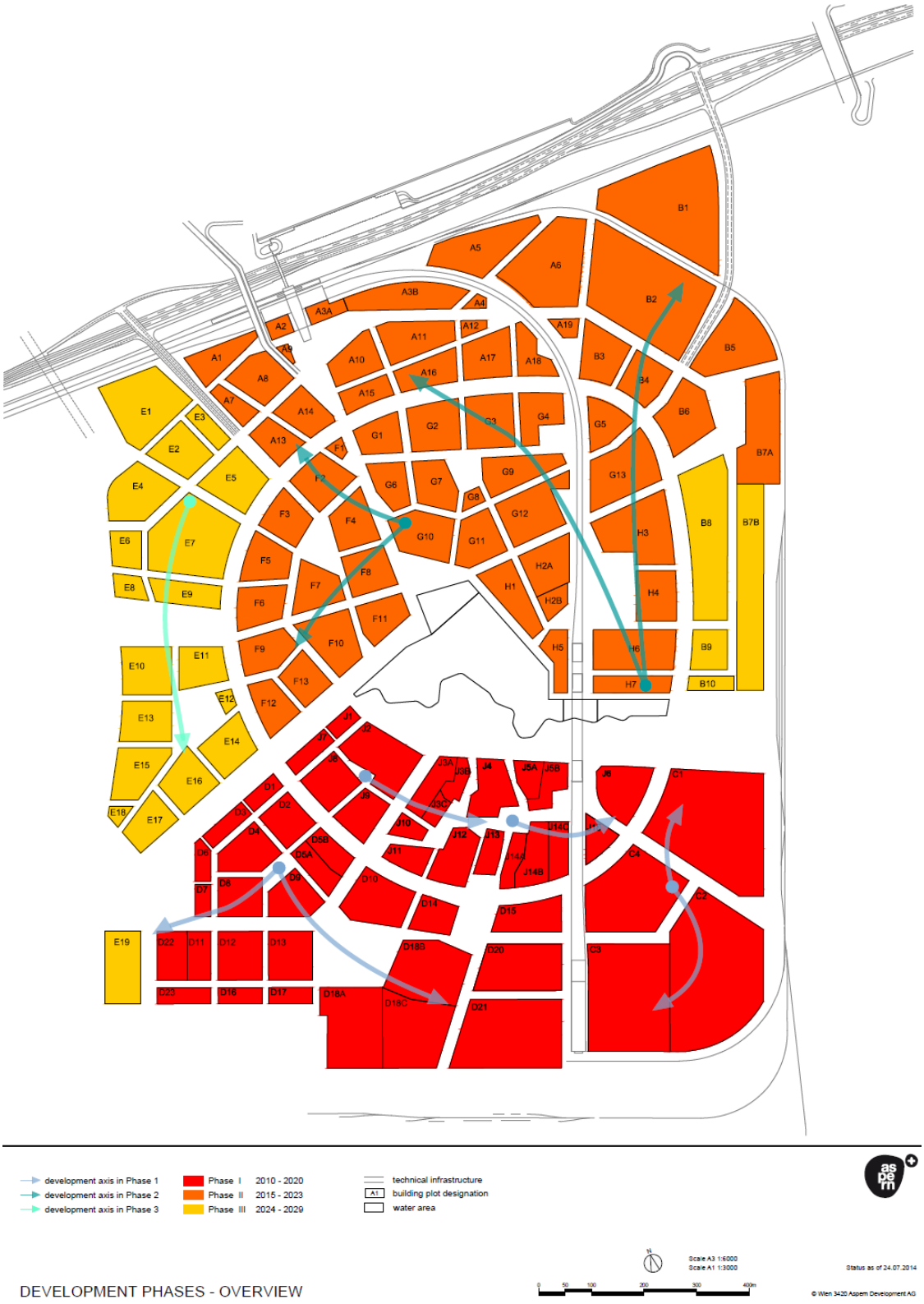
- Wiener Stadtwerke Group: Infrastructure service provider of Vienna, its commercial activities can be broken down into the segments energy, transport, cemeteries and car parks. Under the Holding Company of Wiener Stadtwerke most important for the SUL development are:
  - Wien Energie (energy service company), Wiener Netze (energy infrastructure utility): The energy segment covers the areas of production, network operation and sales, whereby the main focus is on ensuring reliable supplies of electricity, gas and district heating.
  - Wiener Linien (and Wiener Lokalbahnen), the segment of public transport provides a comprehensive range of services in the area of public transport.
- Aspern Smart City Research is a research institution (GmbH & Co KG) with locally based associates – Siemens AG Österreich (44.1%), Wien Energie GmbH (29.95%), Wiener Netze GmbH (20%), Wirtschaftsagentur Wien (4.66%), Wien 3420 Aspern Development AG (1.29%). It has been founded to examine new buildings in terms of technology, environment and energy in aspern Seestadt. ASCR has a budget of about 40 million Euros for 5 years, and about 30 persons from different scientific fields working for ASCR.

Development phases

In the development process, aspern Seestadt can be spatially and temporally separated in two different development areas and phases:

- Phase 1 aspern Seestadt southern part – Construction sites C, D und J
- Phases 2/3 aspern Seestadt northern part – Construction sites A, B, E, F und G

Illustration 7: aspern Seestadt North and South according to construction phases



Source : Wien 3420 AG

Phase 1 – aspern Seestadt South

The planning process for phase 1 has been completed; the construction of a part of about 4600 housing units totally has begun in 2012. 1700 will be part of the city´s social housing initiative (publicly subsidized by loans), the developers for about 800 subsidized housing units were chosen in a housing-development competition and several plots have been provided for joint building ventures (6 groups of actors in different buildings with common development of the building and innovative social and ecological approaches, about 210 housing units in total). 300 housing units will be located in a student housing facility (D5b). An area of approximately 24,000 m^2 in the southern part (D18) is dedicated to a combined schooling and kindergarten facility and another school is planned on D14. In the office and industrial sector, the first office building has already opened in 2012. Further sale of land to industrial enterprises have partly been concluded or are due in short time. This situation allows for using the practical experience from phase 1 planning procedures and technical solutions, drawing conclusions for the elaboration of the Implementation Plan, which will now focus on phase 2 development.

In phase 1, several main fields of activities have been developed, organised and are being implemented currently:

- A broad “city branding” process that led to the actual project name including a development vision and a set of values and goals
- A quality assurance process (plot guidelines, project supervision, constitution of an advisory board)
- Environment and Sustainability: Environmental Impact Statement for southern part (notification 2010), key research projects (partly funded by national research programs, e.g. integrated energy concept, research on options of energy efficient buildings, production of renewable energy, energy infrastructure, micro climate, monitoring)
- Mobility: construction of new subway-line and a tram line into the area; formulation of a mobility guideline; detailed research and studies on mobility, e-mobility, vehicle-sharing systems, and e-mobility, and elaboration of a mobility-concept for the area; setup of a “mobility fund” for investments in alternative mobility measures
- Public space: elaboration of a handbook on public space, planning processes for open and green spaces/parks (partly by staging planning competitions), detailed

design of roads and public space with a strong focus on pedestrian and cyclist's comfort

- Building parameters (urban planning concept, land use plan and built urban form): urban design implementation project, guideline documents, adoption of Municipal Planning Scheme by Vienna city council; these parameters are being used as inputs for developers' competitions, which are staged for specific lots within the phase 1 area.
- Additional management and collaboration models: to ensure the sought-after urban qualities – like lively ground floors, functional mix, creation of workplaces, participation, coexistence and social interaction – several and different structures of collaboration beyond the usual real estate process were set up:
  - The neighbourhood management (Stadtteilmanagement) for aspern Seestadt started with beginning of 2014. It constitutes a contact point and meeting place for residents of aspern Seestadt , but also for residents of peripheral communities. The focus of this enterprise is the development of neighbourhood and community oriented networks as well as the linking of old and new urban spaces.
  - Creation of a special purpose vehicle for the operation of a public retail street (aspern Einkaufsstraßen GmbH: 49% Wien 3420, 51% SES)
  - Creation of a joint venture with VBA and University of Technology (researchTUb GmbH) to establish a link between research and industrial production by installing a lab on site.
  - Concepts for innovative projects generating development impulses through a number of calls and developer-related procedures for various innovative buildings (e.g. aspern_IQ – a innovation and research quarter, community housing initiatives and competitions for private building societies etc.); there is also a business development branch attracting innovative production and service enterprises into the area
  - Ombudsmann aspern Seestadt. Since 2013, aspern Seestadt has an Ombudsmann that is a first contact point for residents of neighboring areas and the district concerning all questions related to building activities and other inquires related to the development of the site.

- **Aspern Smart City Research GmbH & Co KG (ASCR) exploring smart buildings and smart grids in the context of aspern Seestadt as demo-projects**

Accompanying these processes a number of participation events called “citylabs” have been conducted, in order to involve citizens and experts into development and planning processes. Citylabs covered topics in all main fields of activities, providing valuable input to further development process steps.

Based on these studies and research activities, decisions were made mainly by Wien 3420 together with relevant municipal departments, reviewed by its advisory board.

An overall energy concept (research project “Nach Aspern”) was elaborated by the Austrian Institute of Technology (AIT) during phase 1, under the guidance of Wien 3420. During the elaboration of this rather research driven energy concept, however, important stakeholders (e.g. Wien Energie, Wiener Netze) had not been involved intensively – this shall be changed in the process of developing the IP for the second phase. Meanwhile the project of a geothermal plant near aspern Seestadt was cancelled due to technical problems and thus one important framework condition of this concept changed.

Phase 2 and 3 – aspern Seestadt North

During phases 2 and 3 approximately 7500 residential units should be built and a great amount of working places will be offered until 2025. The detailed planning period started in 2012. Currently, the environmental impact assessment for the areas of urban planning and mobility is underway (planned for winter 2014/2015).

The EIA for urban planning and mobility are conducted by external partners supported by the aspern energy group formed by members of Transform+ for all aspects related to energy. Thus, the energy group is composed by essential actors from energy and spatial planning of Vienna (Wien 3420, MA20 energy planning department, MA18 urban planning department, Wien Energie, EnergieComfort, AIT) and is supported by ÖIR and other consulting and research partners. The results worked out in the energy group will influence the Climate- and Energy concept for the environmental impact declaration, another scenario will be the basis for a more innovative “smart city scenario”).

2.2 Basis for decisions – available data and detailed knowledge

Due to the status of aspern Seestadt as a newly built up area, quantitative data is mainly based on calculations or estimations of the future situation. Knowledge and availability of data differs between the considered issues in terms of accuracy and depth.

Available information and data

So far, the planning process focussed on urban development (master plan, land use, urban densities) and mobility and transport planning. Thus detailed quantitative data is available mainly concerning the urban development concept and its details (disaggregated at the level of building blocks):

- ★ estimated number of residents and jobs
- ★ land use, built up areas
- ★ building heights, building levels, use of buildings
- ★ gross floor space (per use)

In addition, especially concerning energy issues, research has been done in the course of several already completed projects as well as (most actual) calculations based on recent urban planning by the team of the TRANSFORM-project in Vienna.

In terms of the considered issues the relevant sources providing available up-to-date information are presented in the following table.

Table 2: Available quantitative information for SUL aspern Seestadt

Issue	Source: type of data/information
Energy systems and networks	Energy infrastructure utility (map): district heating network aspern Seestadt south TRANSFORM-project (Wien Energie and AIT): Calculations and planning as a basis for the environmental impact statement (minimum scenario) and for the project (smart city scenario),
Buildings, industry and services – energy demand and energy efficiency	Wien 3420 (thresholds): Heat demand of buildings for housing in the southern part of aspern Seestadt based on the guidelines for housing-development competition Building code (thresholds based on EPBD): Maximum heat demand of buildings (dependent on the year of construction) TRANSFORM-project (AIT): Estimation of heat and electricity demand in scenarios based on building codes and assumptions concerning energy use

Issue	Source: type of data/information
Local renewable energy sources	TRANSFORM-project (AIT): Solar potential (solar thermal and photovoltaics) based on assumptions about the extent of useable roof area according to the planned urban structures Federal Geological Agency/MA20 Energy planning (research project): Assessment of the geothermal potential in the administrative area of Vienna
Mobility	Technical University Vienna and Komobile (as consultants): (maps) Mobility concepts for the area of aspern Seestadt, main road network, cycling and walking infrastructure, collective garages, etc. Wien 3420: Estimation of average daily traffic and kilometers driven (conducted for the elaboration of the environmental impact statement, available soon)
Use of ICT and smart grids	Overall information on research by ASCR (smart grids) and smart meter roll out (Wiener Netze).
Water management	General information on planned rainwater management systems.

Due to the collaboration of the energy company of Vienna in TRANSFORM-project, information on technical issues of energy systems and cost-estimations are included in the discussion to some extent.

Lacking information/data

In general, the data situation in Vienna is complex. Responsibilities are situated with different bureaucratic arms of the municipal apparatus, while energy is an interdisciplinary field in need of collective action. Within municipal apparatus there is often enough confusion and uncertainty about the availability and existence of certain datasets.

In addition, there is no legal instrument in order to assure access to information as for example capacities of district heating networks and heat plants. Even though Vienna's energy utilities are partner in the research project and willing to contribute, the need for considering trade secrets and maintaining competitive advantages as well as uncertainties concerning privacy protection remain.

Most serious data-lacks as well as uncertainties to be dealt with in the planning process of aspern Seestadt are:

- Type of companies and their production processes located in the industrial area in future are unknown yet. As the potential of waste heat is dependent on the type of industries, branches and technical issues, there is no information available on available waste heat so far.

- Knowledge on geothermal potential (near surface as well as deep geothermal potential) is rather vague. Even though in the study on geothermal potential in Vienna the area of the SUL was analysed in more detail, more precise information will be needed for decision making. Furthermore already acquired rights for the use of groundwater will have to be investigated and taken in to consideration.

2.3 Legal framework, tax incentives, aid schemes

The development of aspern Seestadt inserts itself in a complex and variegated regulatory framework. While development of aspern Seestadt is subjected to the same city wide regulations and conditions as anywhere else in Vienna, its exemplary status as a model district for future urban living has sometime allowed for particular interpretations of existing legal arrangements. In the following we would like to give some examples of the most import regulations and incentives in place, and the particular use that is made of them in the context of the SUL.

Environmental impact assessment for urban development projects

For an urban development project of this size, an environmental impact assessment is obligatory in Austria.

For the southern part of aspern Seestadt, EIA has been already conducted with its approval in 2010 (official notification). Concerning energy issues, EIA for aspern Seestadt south contains specifications on the thermal quality of the buildings (higher than the relevant building codes at this time, these were used as a minimum requirement for housing-development competitions) and a general description of the energy system. For the total southern area of the SUL, district heating has been determined as main heat supply source in order to prevent the area from air pollutants:

- all buildings except industrial/commercial buildings and buildings used for research have to be connected to the district heating network (100%) to cover space heating and hot water demand.
- industrial/commercial and research buildings have to use district heating to an extent of 70%, the remaining 30% will be covered by fossil gas.
- a district cooling network can be connected to buildings of industrial or office use

The definitions laid down in the EIA have become legally binding for the implementation of aspern Seestadt south by its notification, changes of these plans with substantial negative impacts on any of the specified subjects of protection would result in the need for a reopening of the EIA approval process.

The EIA process (elaboration of an environmental impact statement) for the northern part of aspern Seestadt has been started in 2013. Due to an amendment of the Environmental Impact Assessment Act in 2010, the EIA for aspern Seestadt north will have to be more precise in terms of the planned energy system for the SUL. Following the requirements of the EIA-Act following information is needed:

- Description of the energy supply in the area: technical infrastructure and energy supply are defined as a central part of the EIA and thus legally binding, the description has to inform about foreseen energy sources and energy infrastructure.
- As additional information a climate and energy concept has to be presented, which describes energy demand and green-house-gas emissions as well as energy efficiency measures affecting climate protection. This concept has to be confirmed in terms of meeting the 'state of the art' by a technical consultant but is not binding in principle. Nevertheless, an imperative to abate immission is in place according to the EIA-Act.

The main challenge of this legal framework is the obligation to define an energy system and its impacts on all specified subjects of protection for the whole area for a rather long period in advance (about 15 years) and without having full information e.g. about renewable resources and waste heat in the area. Changes of the energy system with impact on the analysed subjects of protection may result in a reopening of the EIA-approval process. Even if an alternative implementation would provide for lower green-house-gas emissions in total, this would be necessary in case of possible impacts on another subject of protection[2]. A presentation of different, alternative energy supply options (even if including all needed information on the impact on subjects of protection) is not foreseen.

[2] e.g. groundwater use instead of the use of a fossil gas plant would decrease the impact on "air", but at the same time the impact on "water" would have to be analysed and approved.

Due to this lack of flexibility of the EIA notification during the implementation of the urban development project, decisions about the energy system laid down in the EIA are taken very carefully and have to be seen as the background of the “minimum scenario” presented subsequently.

Building code in Vienna (including implementation of EPBD2010)

In terms of the quality of the thermal envelope for new buildings a minimum standard is laid down in the building code for Vienna, with increasing requirements meeting the defined standard of “nearly zero-energy buildings” in 2020.

Concerning the energy supply and use of renewable energy, the local building code defines that new buildings have to use highly efficient, alternative systems (if technologically, ecologically and economically feasible). Such systems are:

- decentral energy supply systems from renewable sources
- combined heat and power plants (CHP)
- district heating or cooling systems, especially when fed from renewable sources or highly efficient CHP
- efficient heat pumps (minimum seasonal performance factor ≥ 3.0)

These requirements also affect the scope of the energy scenario for the northern part of the SUL.

Aid schemes for higher thermal standards and the use of renewable energy

In general, there are a number of different aid schemes in place in Vienna concerning thermal standards and the use of renewable sources. Currently following aid schemes are being provided (mainly subsidies):

- thermal renovation of existing buildings, isolated windows and the change to efficient heating systems
- Solar thermal appliances
- Photovoltaic installations an electricity production from renewable sources (under certain conditions)
- residential building subsidies with higher requirements on CO_2-emissions than building code (thermal envelope, energy sources)
- environmentally relevant, resource efficient measures in companies

These aid schemes are currently in force, but guaranteed only for the next years.

In terms of tax incentives or aid schemes there are no specific regulations in place for the SUL aspern Seestadt.

Law on parking space to be provided

The creation of parking spaces is mandatory under Vienna's garage law. For every apartment there needs to be one parking space, for office uses this means a parking space for every 80 m^2 used.

Under certain conditions, that are determined in this law, zoning plans can define particular arrangements for the set up of parking lots whereby mandatory provision can be reduced by up to 90%. Land use and zoning plans can also determine the type of parking spaces to be made available, the number of garages, as well as the number of parking spaces in public space.

- In the southern part, aspern Seestadt meets the necessary requirements for a reduction of compulsory parking spaces by 30%, which is of importance to the overall energy ambitions and mobility concept pursued.
- For the later implementation of the northern part of aspern Seestadt, a proportion of one parking space per 100 m² useable living area was defined. In terms of the Vienna's garage law, this is a general reduction of compulsory parking spaces by about 25% and a higher reduction near subway stations (by 40%).

2.4 Achievements and experiences

The main difference in aspern Seestadt as against the "usual" way of (smaller) new developments in the city was to put a development agency in place for the development of the new district. This measure allows for concentrating planning activities and for focussing on the big picture. Nevertheless, besides infrastructure investment which is partly financed by this development company, still main investors are the different user groups, mainly property developers (housing), energy utility company (energy system) and Vienna or federal authorities (social infrastructure, kindergardens, school campus).

Wien 3420 achieved the implementation of more innovative approaches mainly by private contracts with property developers, based on the requirements laid down in the

EIA. So, in the first phase of implementation (aspern Seestadt South), higher requirements for the thermal quality of buildings (than applicable building codes) were defined. Especially, the minimum requirements for the quality of the residential building envelope were ambitious and defined at a level of about 46% below the (conventional) building code.

The table below presents defined requirements on electricity and heat demand (according to EIA south).

Table 3: Requirements on the quality of building envelope and electrical appliances per residential, office and retail use (EIA south)

final energy kWh/m2.a	residential uses		offices			commercial/retail use		
	electr.	heat	electr.	cooling	heat	electr.	cooling	heat
requirement EIA South	40	46	51	20	59	58	25	59
conventional	65	90	80	30	61	90	38	61
reduction against conv.	*-38.5*	*-48.9*	*-36.3*	*-33.3*	*-3.3*	*-35.6*	*-34.2*	*-3.3*

Source: Wien 3420 AG UVE Süd

In addition, Wien 3420 forced property developers to (at least) prepare buildings for the installation of solar appliances (as a first step).

Another achievement is the provision of a selected area of the SUL to joint building ventures. In participative planning processes 6 groups of actors (about 210 housing units) developed alternative approaches of common living, social life and more sustainable life-styles by e.g.:

- higher thermal building standards (partly passive house standard), ecological construction materials
- high share of common open spaces and/or commons (as land belonging to the whole of the community), urban gardening
- common infrastructure (sauna, laundry, roof terrace, recreation rooms, etc.)
- flexible floor plans, use for different generations and life-styles
- cultural uses, offers for neighbourhood development

Challenges

Main challenge for the realization of aspern Seestadt is to take the step from research on innovative systems to implementation. A number of research projects have been

completed, showing large potential for the use of renewable sources and innovative systems.

Nevertheless, implementation is still dependent on a large number of actors with conflicting aims and a fundamental (political) commitment is missing for making aspern Seestadt a model for new approaches (including higher investment costs at least in the beginning). Thus Wien 3420, although highly interested in developing the area to a smart urban district, is bound by financial and legal restrictions, difficult to overcome.

The “use” of EIA in the southern part provided a chance to set binding requirements for higher thermal building standards, while it was not describing the energy system in a more detailed way. After the amendment of the Environmental Impact Assessment Act in 2010, a more precise description energy system for the SUL is needed.

This situation causes a major difficulty in the planning process: While, within the planning group a general consensus can be stated about trying to implement as innovative and sustainable systems as possible, the requirement of EIA defines the need of determining one solution for the entire area in advance. This leeds to a rather conventional solution for the energy system laid down in the EIA as a “minimum” solution (to be on the safe side financially-wise), and is at the same time setting the framework for the discussion of other (more innovative and sustainable) solutions which need to consider this starting basis in order to avoid the reopening of the EIA approval process.

3. Status of the energy system and related themes and enabling themes

Due to the situation of aspern Seestadt as an area currently being built up, the major part of the description of the energy system and its context presents the current status of planning decisions for aspern Seestadt North.

Illustration 8: Status quo in aspern Seestadt south (07/2014)

Source: OIR

3.1 Energy systems and networks

Heat supply aspern Seestadt South

For southern part of aspern Seestadt (phase 1), currently under construction, energy for heating and hot water generation will mainly be supplied through a district heating network, operated by Wien Energie, the municipal district heating company.

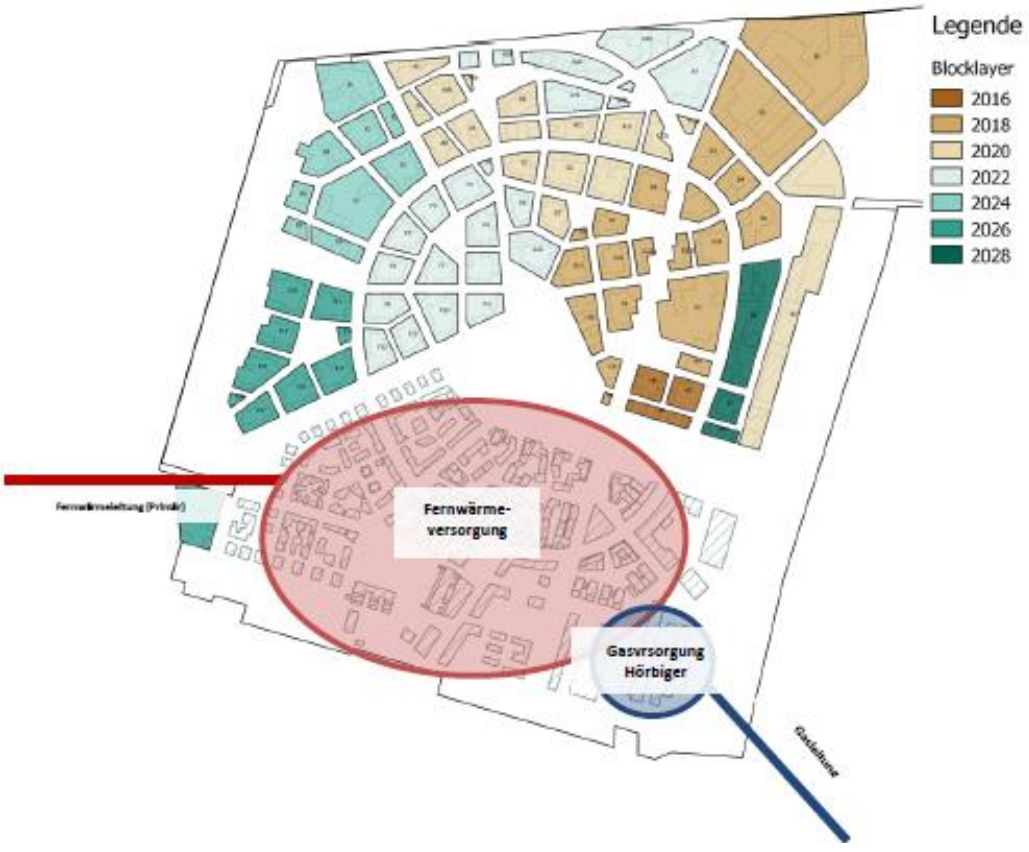
District heating as the heat supply for aspern Seestadt south is determined mainly for housing and offices through the officially approved environmental impact statement for this area.

However an alternative heat supply for residential and office buildings is possible if that leads to comparable or even better performance figures in terms of environmental

impacts. There is a number of passive houses being built in the area (aspern IQ office building, students home, several residential buildings), some of them using heat pumps. ASCR runs a research project to explore a smart local grid solution with on-site renewable energy generation, integrating several buildings in the area. Here the energy supply including heat is fully based on electricity.

The industrial area in the aspern Seestadt south was excluded from the district heating obligation because of the potential need for high temperature process heat. Companies will be supplied with natural gas. This is already the case for the first large industrial plant under construction, a tech company in the field of compressor technology, automation and drive engineering.

Illustration 9: Heat supply concept in aspern Seestadt South



Source: AIT

Heat supply concept aspern Seestadt North – two scenarios

For the northern part of aspern Seestadt there is currently only a master plan outlining the different building areas and the planned timeline for construction, which should start in 2016 and last until 2028 (see chapter 2.1). It is very likely that during this rather long period of time framework conditions, energy markets and financial constraints will change drastically. But it is hard to predict how and when. This makes it difficult to design a robust and resilient energy system for aspern Seestadt North.

However, to continue with the development process, Wien 3420 needs to apply for the environmental impact statement (EIS) already in December 2014, which will after approval, determine the baseline parameters for the energy supply for aspern Seestadt North. That means on the one hand that there is a need for an energy supply concept, which can be implemented parallel to the starting construction phase beginning in 2016. But on the other hand there is also a need for a longer term smart city vision taking into account future obligations and opportunities.

For that reason it was decided to develop two energy supply scenarios for aspern Seestadt North:

- a “minimum scenario” (for EIS application) with building standards according to legal requirements as of 2020 (nearly zero energy buildings) combined with an energy supply that meets the predefined standards of the energy authority in the city administration.
- a “smart city scenario” with higher building standards than legally required combined with an innovative energy supply.

The minimum scenario as a basis for the EIS

In the minimum scenario energy used for space heating and hot water together should not cause emissions exceeding 150 g CO_2 per kWh. This limit is set by the energy authority of the city administration.

The minimum scenario was developed by Wien Energie (municipal utility) under the constraint that Wien Energie should be able to provide the proposed energy supply.

The scenario proposes 3 local heat grids (see illustration 10):

- Heat grid east (65°C forward temperature), supplied by a natural gas powered heating plant

- Heat grid west (65°C forward temperature), supplied by the municipal district heating grid
- optionally a heat grid north (12°C forward temperature), supplied by ground water and combined with heat pumps.

A natural gas fired heating plant situated in the north-east is feasible because a gas network is planned for the industrial plants at the eastern fringe of the area.

The heat grid north supplied by ground water using heat pumps for space heating and hot water supply is dependent on its financial feasibility. The size will depend on the expected minimum of usable geothermal energy from the ground water stream in the area.

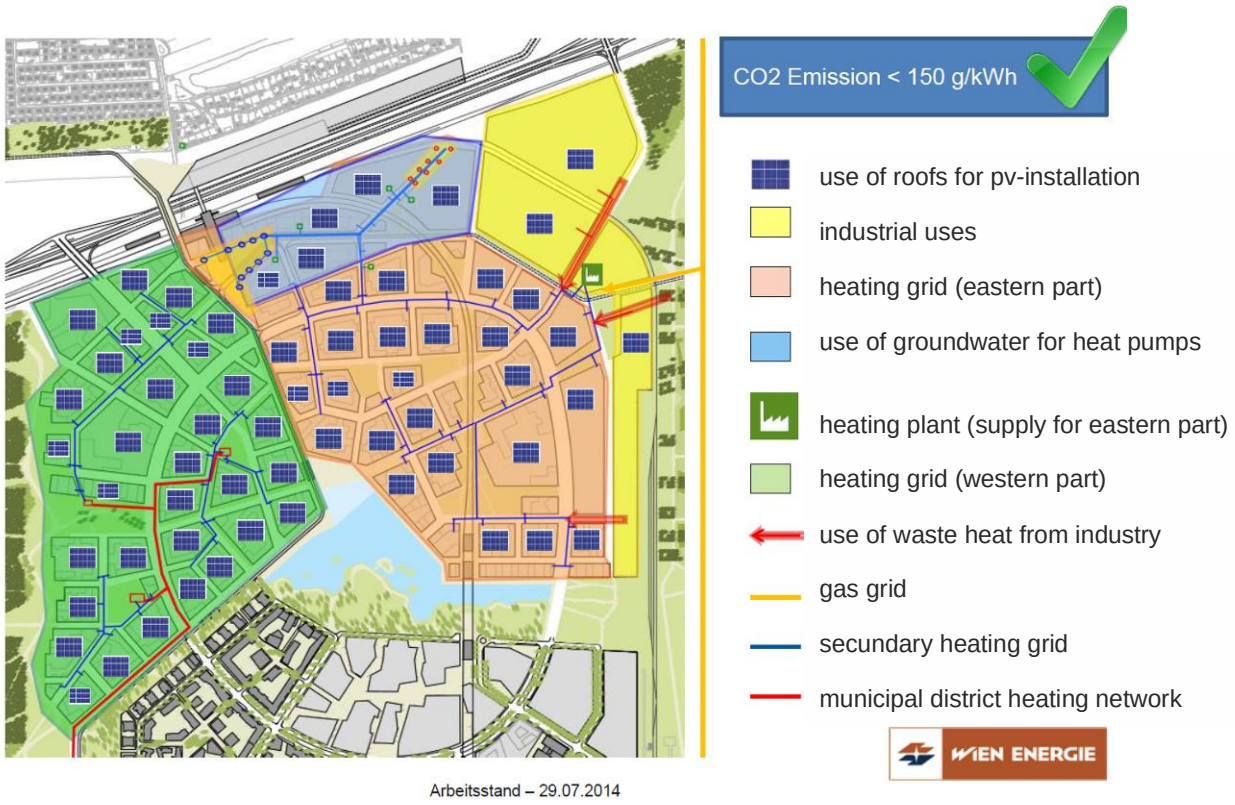
The installation of photovoltaic appliances in the entire area is foreseen (and included in the minimum scenario), but not necessarily covered by Wien Energie.

The minimum scenario would cause CO_2 emissions of 132 g per kWh (for space heating and hot water provision), but only as an overall average for the whole area. Parts of the area, e.g. the natural-gas supplied heat grid east exceed by far the limit of 150g per kWh.

A full supply of aspern Seestadt North with heat from the municipal district heating network is, from Wien Energie's point of view, currently not feasible. This is mainly because existing main supply pipeline allows only a connection from the south-western corner (aspern Seestadt South), but construction for aspern Seestadt North starts in the north-east. This would mean to pre-finance a main district heat supply pipeline from the south-west to the north-east.

Originally it was planned to supply district heat for aspern Seestadt from a geothermal plant close to the area. But drilling down several thousand meters was not successful up to now and is has stopped therefore. A future successful exploration could provide a nearly CO_2 free renewable heat source. Even though the use of geothermal heat is still planned in Vienna in general, the timeframe for next steps is not decided yet. However, the questions of costs and sharing of risks are decisive for a future realization.

Illustration 10: Heat supply concept for aspern Seestadt North – minimum scenario



Source: Wien Energie, 2014

Smart city scenario – innovative and flexible

The smart city scenario was elaborated by the "aspern Seestadt energy group", combining knowledge from experts in energy and urban planning, authorities, the development agency and the energy supplier.

The smart city scenario is the attempt to come up with innovative and ambitious design options for the energy supply for aspern Seestadt north. It is based on the long-term aim of Vienna – as stated in its Smart City Framework Strategy 2014 – to follow the idea of 2000-Watt-society (which equals 17,500 kWh primary energy consumption per capita for the whole energy demand) and to lower CO_2 emissions to maximum of 1t per person.

Furthermore the goal is to cover as much of the energy demand as technically feasible from renewable sources. This is only possible if the energy demand from residents and businesses could be considerably reduced. Therefore new figures for the estimated energy demand (heat and electricity) had been elaborated by the energy group based

on recent research for aspern Seestadt. A yearly consumption of 101 GWh per year compared to 149 GWh for the minimum scenario is estimated (see next chapter).

Based on this lower energy demand the proposed energy supply concept shall be able:

- to use local renewable energy sources to a high extent (mainly solar energy, ground water and local waste heat sources of different temperature levels);
- to be flexible enough to cope with the large uncertainty of future usable waste heat in the area (future industrial uses are still unknown and therefore also the amount and temperature levels of available waste heat);
- to allow a stepwise development of the energy supply network parallel to the ongoing urban development of the area and based on increasing knowledge about energy use and available waste heat as well as technical innovation;
- to provide considerably lower specific CO_2 emissions than the minimum scenario in order to show the range of feasible reduction;

In order to be able to use as many decentralized and yet unknown sources of waste heat as possible and to balance demand a local low-temperature heat grid seems to be a necessity and a kind of basic infrastructure.

The proposed heat grid for the Smart City Scenario follows the same zoning as in the minimum scenario:

- heat grid east (45°C) supplied by a biomass heating plant for constant load and natural-gas heating plant (east) for peak loads
- heat grid west (45°C) supplied by municipal district heat
- alternatively a heat grid north (12°C “cold ground water grid”)

All grids should be interconnected to balance supply and demand. With 45°C supply temperature in the grids east and west, energy losses would be comparatively low and various energy sources could be utilized (e.g. waste heat from industry, offices, shops, waste water etc.). The supplied heat could be used directly for radiant panel heating in the buildings without any additional equipment.

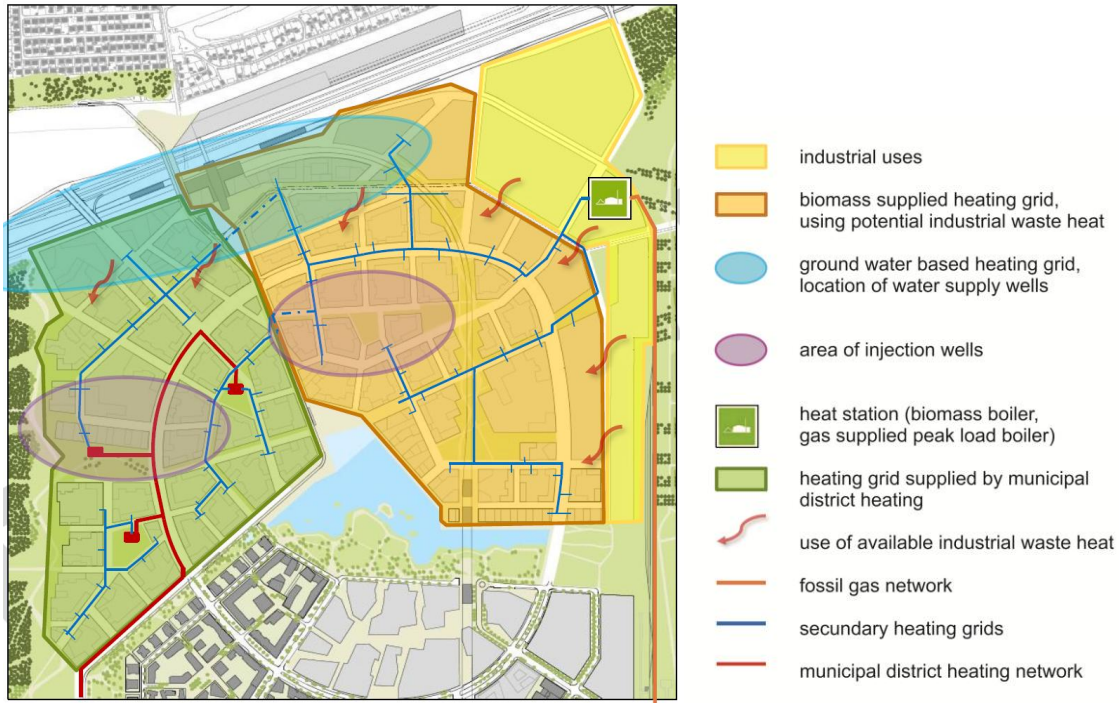
Due to the low temperature of the heat girds additional energy for hot water generation is necessary to raise temperature from 45°C to 55-60°C. This energy could be provided through solar thermal collector and/or heat pumps combined with photovoltaic power generation. Heat pumps may work with high efficiency due to low difference between the grid and the target temperature for hot water. In order to maximise the use of local

renewable energy, central hot water provision together with storage facilities has been proposed (enlarging the daytime/seasonal use of renewable resources).

To utilize the ground water energy potential a “cold water” grid north (12°C) is proposed. In the north a high share of offices is expected and thus a related cooling demand. The cold water grid combined with heat pumps could deliver both the necessary temperature level for heating and for cooling. Hot water generation is similar to the other areas.

For the best combination of options in the Smart City Scenario CO_2 emissions for heat supply could come down to 65 g per kWh, which is less than half compared to the minimum scenario (see chapter 4.1).

Illustration 11: Heat supply concept for aspern Seestadt North – smart city scenario



Source: Wien Energie, 2014

3.2 Buildings, industry and services – energy demand and energy efficiency – energy scenarios

Knowing that 80% of the buildings are of older date, stemming from the period before 1975, in average, space heating demand of a typical existing residential building in Vienna is at around 117 kWh/m²a (existing building stock). Current regulations foresee

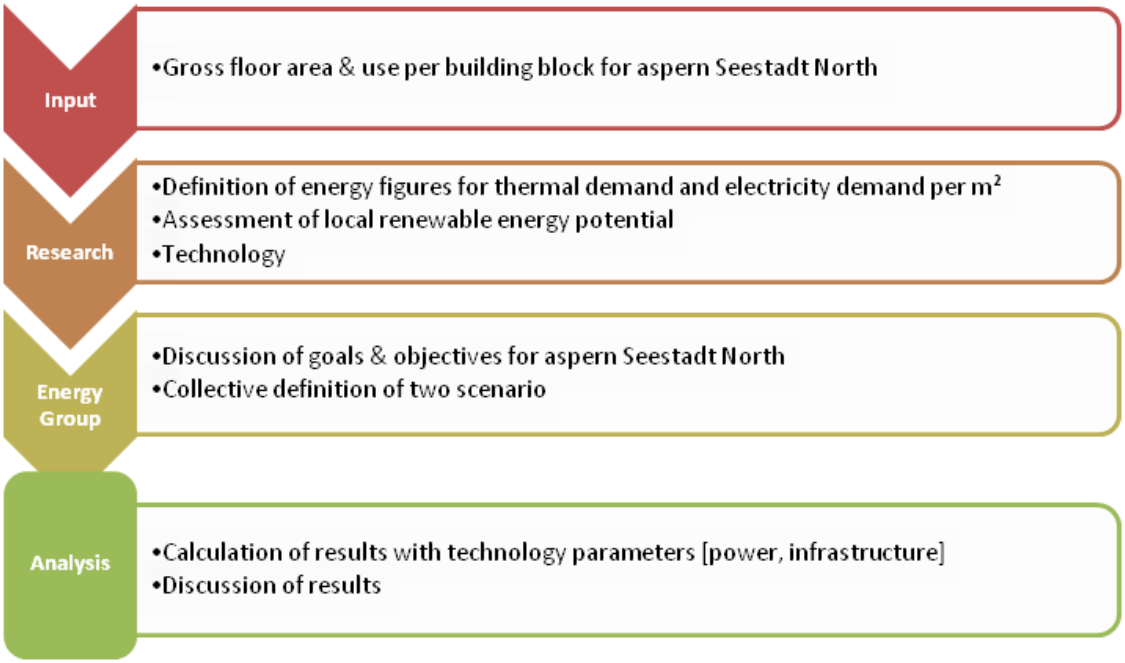
that city wide heating demand for new buildings post 2010 cannot legally exceed 66.5kWh/m² BGF (gross floor area – GFA). According to EPBD, post-2020 new buildings will have to achieve a “nearly zero energy efficiency” standard.

In aspern Seestadt, the development of energy demand is driven by the gradual influx of residential and working population into the area, starting with the first building in 2013 (office building Aspern IQ). The development of energy demand is alas influenced by the planned distribution and density of uses, and mainly driven by heating, cooling and electricity consumption of residential, industrial and office uses. Due to the fact, that the energy system for the southern part of aspern Seestadt is defined already, analysis and scenario building currently concentrate on the future energy system of aspern Seestadt North.

For the estimation of the energy demand (heating, cooling and electricity), two scenarios have been considered based on assumptions on the efficiency of thermal building standards and energy use options (conventional, saving use). Thus subsequently, results for a minimum scenario and an efficiency scenario (as an energy demand basis for the smart city scenario) are presented for the primary planning area aspern Seestadt North.

Furthermore the heat load has been assessed for the design of the thermal heating grid. By multiplying the assumed full load hours the energy consumption is assessed. The values for the different usages have been compiled out for the two scenarios in the energy group aspern Seestadt reflecting the experiences of the energy utility.

Illustration 12: Methodology



Analysis of usage and temporal development aspern Seestadt North

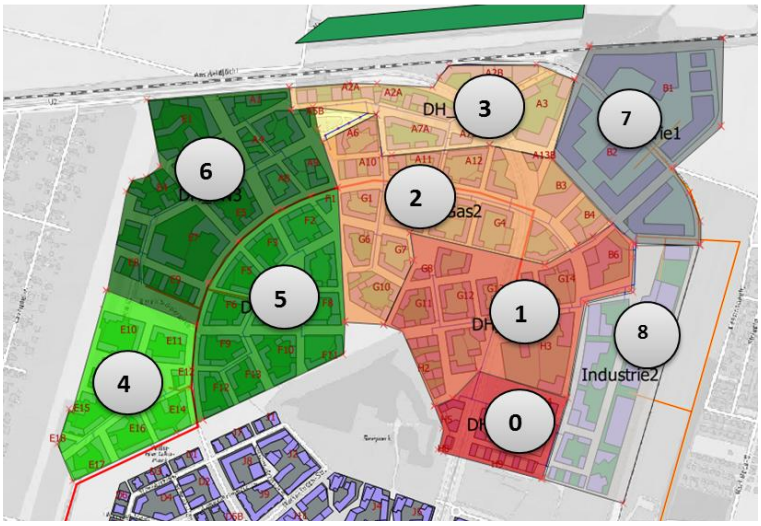
As mentioned, the spatial and temporal development of Seestadt Aspern Nord is a key parameter that needs to be considered for the design of the energy system. According to the input for the minimum scenario, the following illustration shows aspern Seestadt North divided into different sub-areas, depicting supply areas of subordinated heating grids according to implementation phases and planned uses.

In the further considerations sub-areas 7 and 8 with foreseen industrial use are not included, because:

- Up to now, there is lacking knowledge on the type of industries and industrial branches which will be sited in aspern Seestadt.
- Therefore, a realistic approximation of energy demand is not possible due to the considerable spread within the range of specific energy use between different branches.
- In addition, the need for a connection to the gas network – and thus the final energy systems in place – will be only decided in dependence of the branches and enterprises sited.

Thus, in the course of elaboration of the two scenarios, it was decided not to consider the energy demand of the industrial area (in this planning phase).

Illustration 13: Division of aspern Seestadt North into sub-areas of supply



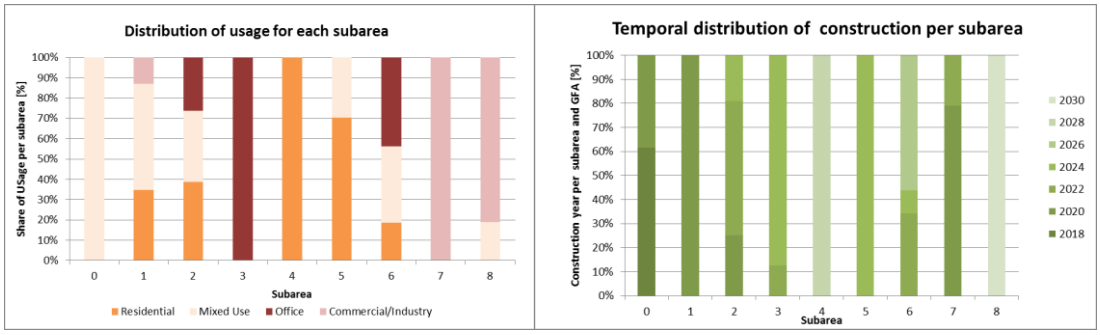
Source: AIT

Illustration 14: Exemplary Building Construction of Aspern Nord (including pipes of district heating and gas supply)

Source: AIT

As a basis of the energy concept, the temporal process of planned implementation phases and the distribution of uses were analysed and considered.

Illustration 15: Uses and completion dates of the 8 predefined supply areas



Source: AIT

3.2.1 Energetic input parameters – assumptions for the example of the minimum scenario

Heating and hot water consumption

As a general basis, the requirements of the Austrian Norm Standard according to 'Nationaler Plan' (national requirements) have been considered for the assessment of the **heat demand of residential and non-residential buildings**. According to this specification and EPBD, nearly zero energy building standard is stated for buildings after 2020. From the perspective of heat demand for space heating and hot water, this was defined as presented in the following table.

Table 4: Specific heat demand for space heating, average building per use (kWh/m² gross floor area and year) – minimum scenario

Heat demand	*Unit*	residential uses	offices	industrial uses (multi-storey)	commerce, services	social infra-structure	cultural uses
Space heating	*[kWh/m² GFA*a]*	***22.00***	***20.87***	***21.21***	***20.78***	***26.40***	***20.82***
Hot water	*[kWh/m² GFA*a]*	***12.78***	***4.71***	***4.71***	***5.55***	***4.71***	***12.78***

Source: AIT

These specific demand figures only reflect the demand for space heating and hot water under certain standardized circumstances. They do not consider losses due to storage, distribution and provision and they do not reflect the expected consumption depending on the quality of the building or lower demand of space heating due to high internal gains especially in non-residential buildings. In addition, also ventilation and

humidification respectively dehumidification of spaces is necessary, which can also lead to heat losses.

Therefore, the energy group aspern Seestadt agreed to use a different approach for further analysis – the consideration of necessary **heat load and full load hours**. In addition, this approach better considers technology aspects especially when it comes to central energy supply concepts. As a basis for the assessment, relevent values have been defined, reflecting actual experience about user behaviour (e.g. room temp. 25 °C instead 21°C, use of hot water etc.).

Table 5: Assumption of heat load and hot water – minimum scenario

	Unit	*Residential uses*	*Offices*	*Industrial uses (multi-storey)*	*Commerce, services*	*Social infra-structure*	*Cultural uses*
Space heating							
Heat load	*[W/m² GFA]*	***38***	***40***	***40***	***40***	***40***	***38***
Full load hours	*[h/a]*	***1,100***	***1,000***	***1,000***	***1,000***	***1,000***	***600***
Hot water provision							
Heat Load	*[W/m² GFA]*	***15***	***4.23***	***4.23***	***4.98***	***4.23***	***15***
Full load hours	*[h/a]*	***2,300***	***2,300***	***2,300***	***2,300***	***2,300***	***2,300***

Source: Energy group aspern Seestadt

As a further assumption building blocks with a relevant share of residential use have been considered supplied with central hot water provision, whereas all other building blocks (e.g. offices) are supplied with hot water decentrally. Due to the considerably lower hot water demand in these buildings electric boilers could be used providing with less losses within the system (distribution, losses and storages). In contrast to the calculation of centrally provided hot water consumption, these figures for decentral hot water use describe the demand (chapter 3.2.2).

As previously described, the assessment of the energy consumption is based on installed power multiplied by full load hours. Furthermore three factors have been added for the design of the Thermal Heat Grid (THG). One factor is accounting for the losses in the grid, a distribution factor of the use and an additional factor to account for the additional safety factor added by the planners leading to higher power installations at the buildings.

Table 6: Added factors for clearance to define thermal heat grid design – minimum scenario

Function	Factor	Unit	Value
Thermal Heat Grid (THG) design	*Loss factor Grid*	*[%]*	*+ 05*
THG design	*User Distribution factor*	*[%]*	*- 10*
THG design	*Planner addition*	*[%]*	*- 15*

Source: Energy group aspern Seestadt

Electricity demand

In order to assess the future electricity demand, a recent research study was analysed and actualized for the currently planned configuration of aspern Seestadt.

The following table presents the specific values (per m^2 GFA) for electricity demand for different uses, as defined for the minimum scenario.

Table 7: Calculated electricity demand – minimum scenario

Electricity demand	Unit	residential uses	offices	industrial uses (multi-storey)	commerce, services	social infra-structure	cultural uses
Operation	*[kWh/m² GFA *a]*	*15*	*40*	*50*	*40*	*10*	*50*
Lighting	*[kWh/m²*GFA*a]*	*5*	*15*	*20*	*20*	*10*	*20*
Ventilation	*[kWh/m²*GFA*a]*	*8*	*8*	*8*	*8*	*8*	*8*

Source: Bednar et al., Aspern-plus – Roadmap final, 2012]; [AIT]

According to the national requirements no ‘active’ ventilation system is foreseen for residential buildings in the minimum scenario.

Cooling demand respectively consumption

Due to the increasing importance of energy demand for cooling, a rough estimation of its energy demand has been elaborated as well. Nevertheless, this has to be seen as a first approximation, since the actual assumptions and values will have to be discussed in the further process.

Table 8 and Table 9:
Calculated cooling demand and cooling load plus full load hours – minimum scenario

Electricity demand	*Unit*	*residential uses*	*offices*	*industrial uses (multi-storey)*	*commerce, services*	*social infra-structure*	*cultural uses*
Operation	*[kWh/m² GFA *a]*	*0*	*30*	*30*	*30*	*30*	*30*

Source: OIB Leitfaden 2011

Cooling demand	*Unit*	*residential uses*	*offices*	*industrial uses (multi-storey)*	*commerce, services*	*social infra-structure*	*cultural uses*
Heat Load	*[W/m² GFA]*	*0*	*40*	*50*	*50*	*38*	*38*
Full load hours	*[h/a]*	*0*	*1000*	*1000*	*1000*	*1000*	*600*

Source: Energy group aspern Seestadt

The presented figures depict the cooling demand for offices mainly (no demand stated for housing). Again, whereas the figures above (operation) do not consider any technology interpretation, the calculation by cold load and full load hours also includes these aspects.

3.2.2 Expected energy consumption according to the minimum scenario

Total consumption (heat and electricity)

According to the actual estimation, the total energy demand for heat and electricity for aspern Seestadt North aggregates to about 149 GWh/year (without the sub-areas 7 and 8) in the minimum scenario.

These 149 GWh/year sum up from 90 GWh for space heating and hot water (about 50%) and 59 GWh for electricity (40%). In addition a cooling demand of about 29 GWh has to be expected.

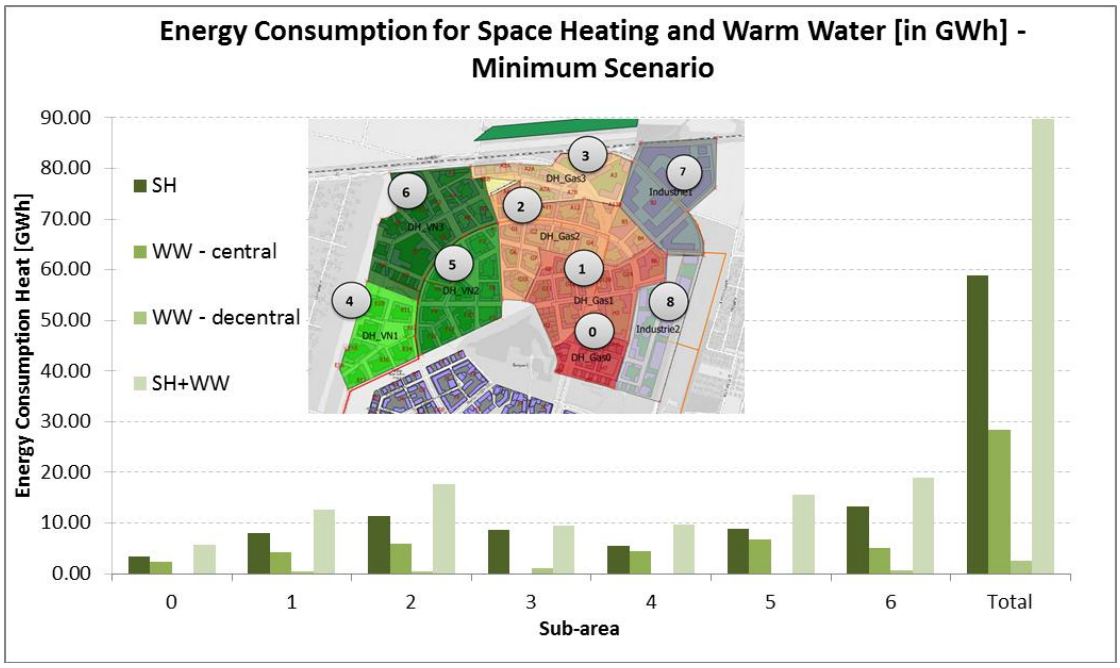
Heating and hot water

The expected overall heating and hot water consumption for total aspern Seestadt North (except industrial areas) sums up to 90 GWh per year.

In more detail, the expected energy consumption for space heating and hot water – differentiated between the defined sub-areas – shows major differences according to the varying uses. According to the previously described assumptions, hot water

consumption (WW-central, WW-decentral) is lower in office areas. In addition, only very little total decentral hot water demand is shown in the following figure.

Illustration 16: Energy consumption for space heating and hot water – minimum scenario [in GWh]

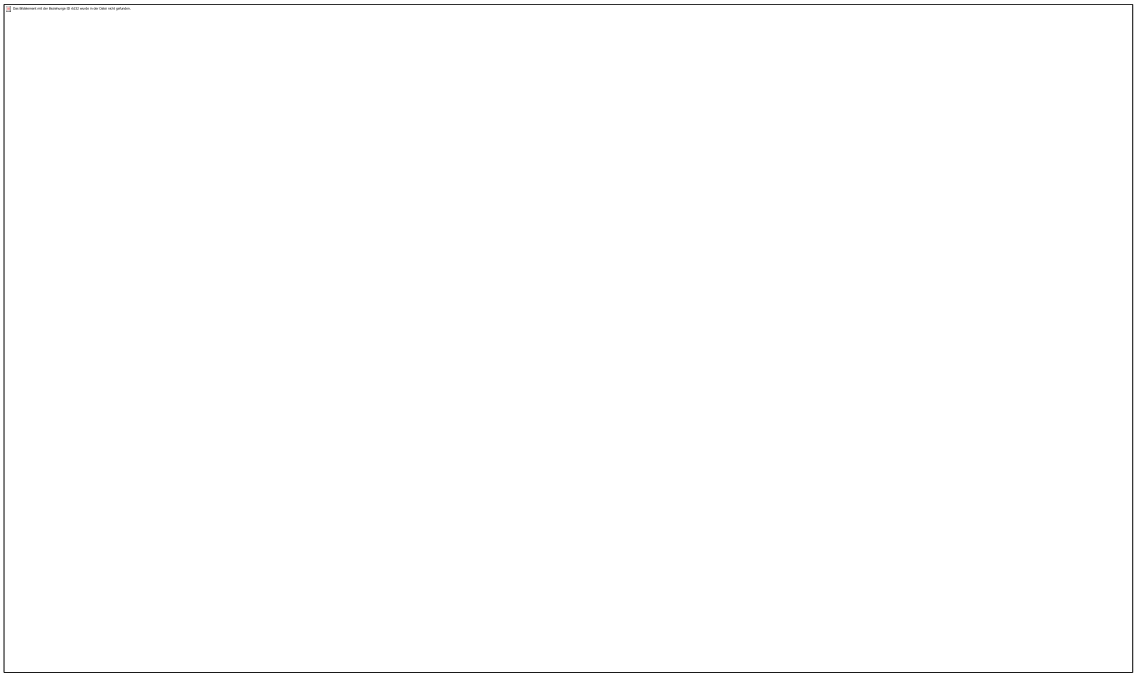


Source: AIT

Electricity

Electricity consumption is expected at a height of 59 GWh per year, with the highest share the operation of electrical appliances (39 GWh) followed by lighting (15 GWh) and ventilation (5 GWh).

Illustration 17: Calculated Electricity Consumption [in GWh] for Lighting, Operation (Appliances) and Ventilation



Source: AIT

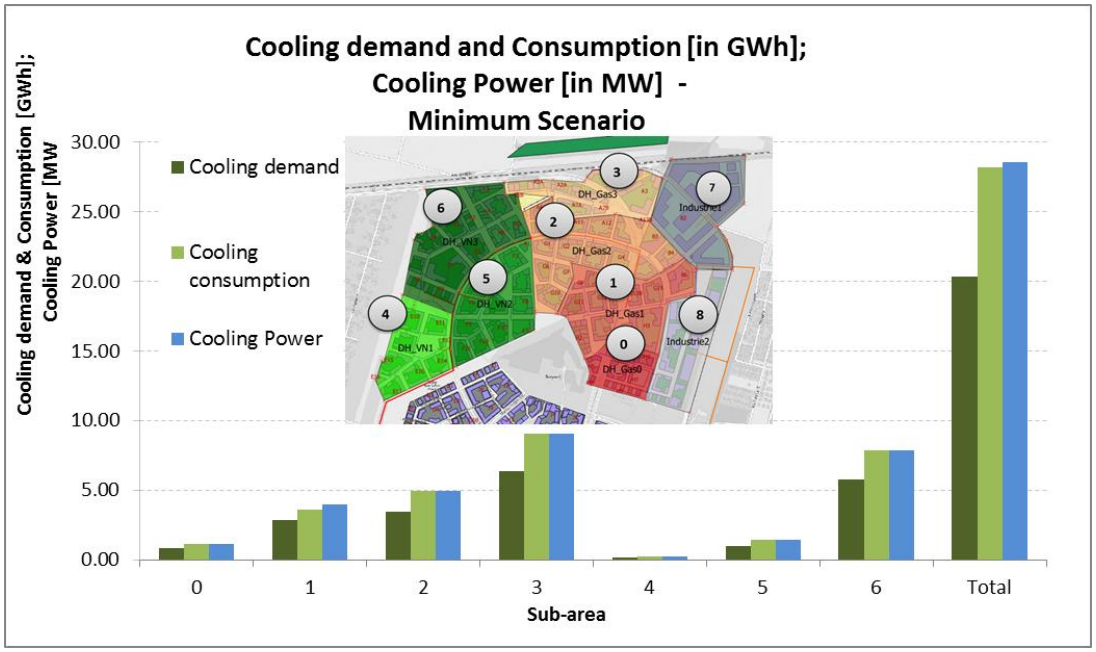
Opposite to heat consumption, electricity consumption is especially higher in areas of office and mixed use.

Cooling – preliminary results

As stated above, results on energy demand for cooling are to be seen as a preliminary input for the discussion with need for further work and agreement on underlying assumptions.

The Cooling demand (only for non-residential buildings) adds up to around 28 GWh in the minimum scenario. This again reflects only the demand depending on the quality of the hull. The demand could be decreased by further passive measures.

Illustration 18: Calculated Cooling demand; Exemplary Cooling Consumption and Cooling Power



Source: AIT

3.2.3 Comparison of minimum and efficiency scenarios

In order to come to a more innovative and ressource efficient scenario, it is necessary to challenge both, energy demand and energy production in the area. Thus, as a first step, reasonable assumptions have been elaborated depicting the potential enhancement concerning requirements for building standards and energy use respectively user behaviour in aspern Seestadt.

These assumptions go considerably beyond the legal requirements for 2020 and stand for the need of major changes in terms of the energy use of inhabitants (e.g. temperature levels of space heating, consumption of highly energy efficient equipment).

Nevertheless, in visioning a future smart urban area, the energy group aspern Seestadt agreed to base its smart city scenario on these ambitious (but still feasible) energy demand figures, in order to show the overall aim and the potential range of effects a smart development can have against the previously presented minimum scenario.

Table 10: Energy efficiency gains – Summary of assumptions

Type	*Minimum scenario*	*Efficiency scenario (basis for smart city scenario)*
Thermal standard of buildings	according to building codes 2020	passive house standard, -44%
Hot water demand	according to common Austrian engineer standards, dependent on usage;	same as minimum scenario
Heat – power&consumption	heat Load and full load hours (energy group aspern Seestadt)	heat load -47%, same full load hours
Electricity, appliance/operation	according to actual average consumption	efficient equipment, -36%
Electricity, lightning	according to actual average consumption	efficient equipment, -50%
Electricity, ventilation	according to literature	efficient equipment; -40%
Cooling	OIB Leitfaden (national requirements)	less need for cooling due to higher thermal standards and efficiency measure (shading), -33%
Cold – power & consumption	cold load and full load hours (energy group aspern Seestadt)	cold load -31%, same full load hours

Source: AIT

These assumptions lead to a considerably lower estimation for energy consumption of the total area reducing the heat consumption to 66 GWh/year (-27%) and the electricity consumption to 35 GWh/year (-41%).

In total, the energy consumption (without considering cooling demand) could decrease from 149 GWh/year in the minimium scenario to 101 GWh/year in the efficiency scenario (-32%).

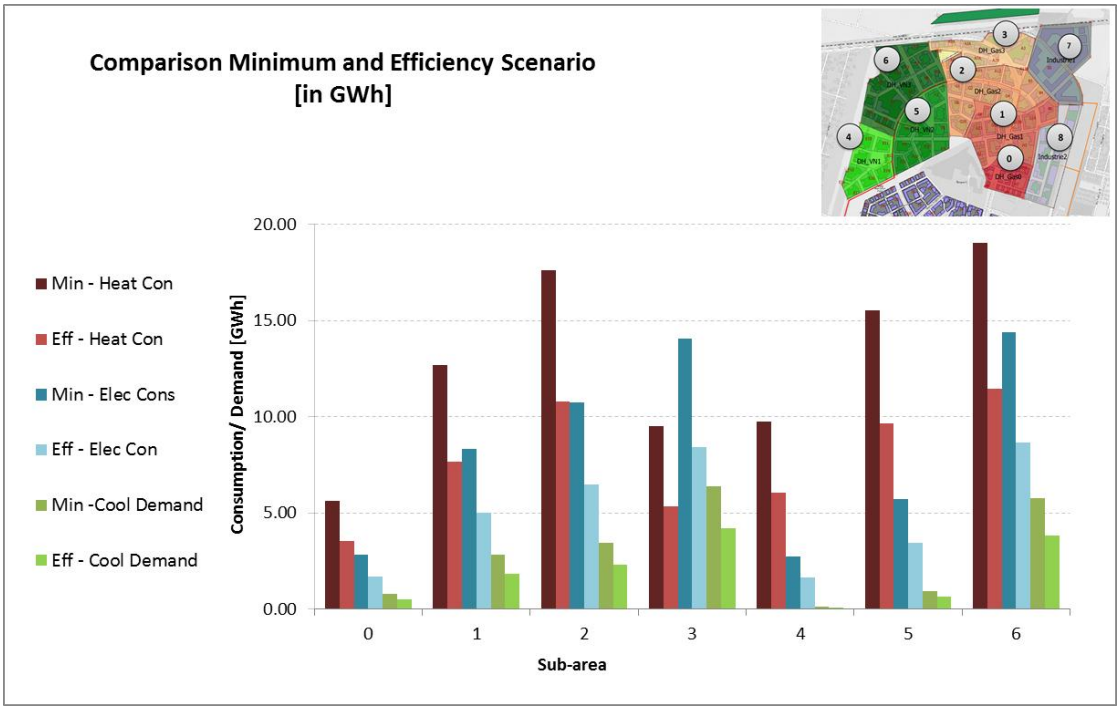
Table 11: Estimated energy consumption or demand for Heat, Cold and Electricity – aspern Seestadt North

[GWh per year]	**Minimum scenario**	**Efficiency scenario**	**Reduction**
Heat consumption (space heating and hot water)	90	66	-27%
Electricity consumption	59	35	-41%
Total (heat and electricity)	**149**	**101**	**-32%**
Cooling demand	*29*	*20*	*-31%*

Source: AIT

The following figure presents the range of changes between minimum and efficiency scenario when looking at the sub-areas of aspern Seestadt North.

Illustration 19: Comparison of minimum and efficiency scenario per sub-area – without technology assessment



Source: AIT

3.3 Local renewable energy sources

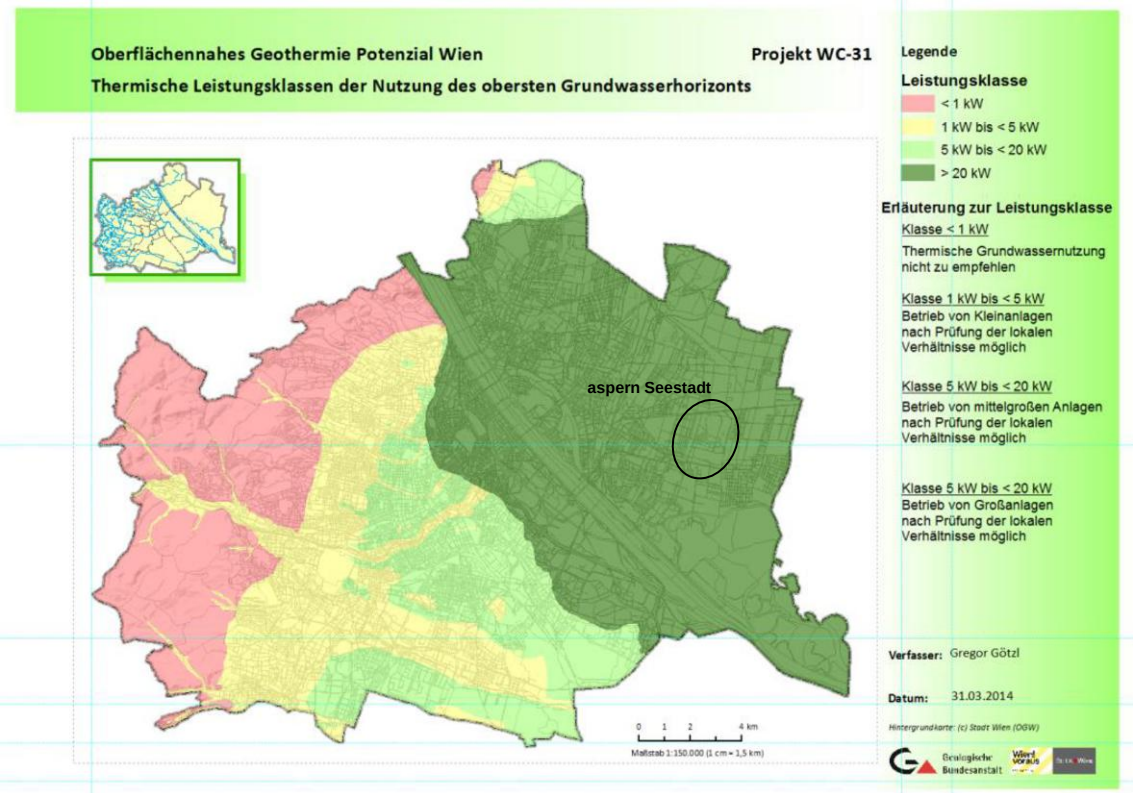
In the area of the SUL, substantial renewable energy is to be expected in the field of solar energy (mainly roofs) and good geothermal potential.

Geothermal potential

According to a recent study from the Federal Geological Agency (Assessment of the geothermal potential in the administrative area of Vienna), aspern Seestadt provides with a good geothermal potential, especially in terms the use of near surface ground water. Its suitability for borehole heat exchangers is average from the city's point of view.

In total, experts estimate an exploitable potential of about 5-6 MW for the use of ground water in the area of the SUL. Further investigation on this matter is ongoing.

Illustration 20: Near surface geothermal potential in Vienna



Source: Geologische Bundesanstalt (Federal Geological Agency), 2014

Solar potential

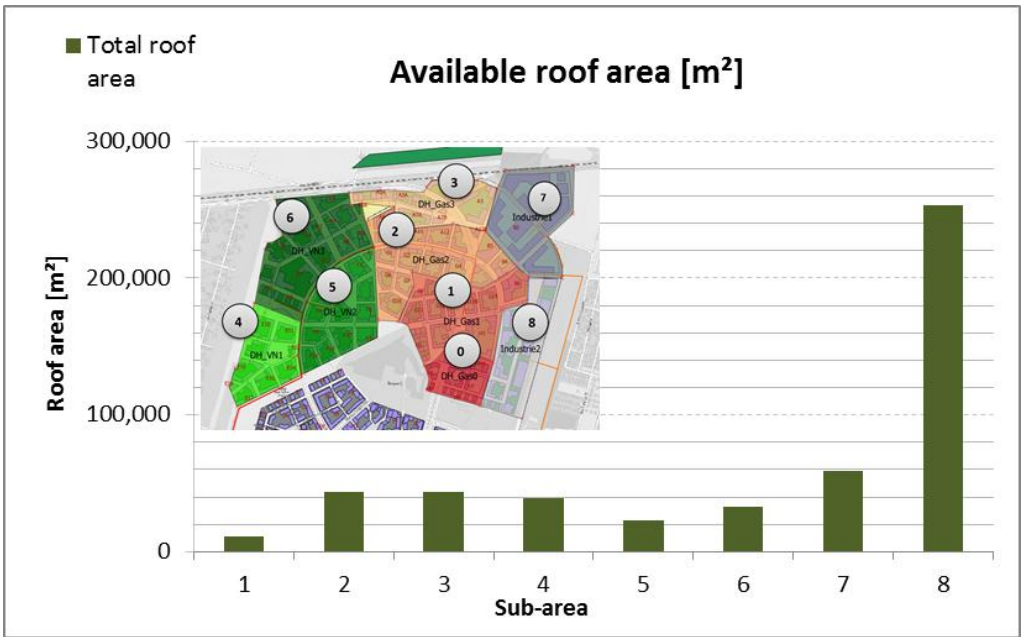
In addition to the geothermal potential, the use of solar energy is planned to a high degree. Generally, the use of open land for solar installations is not foreseen in Vienna (as in urban areas generally). Thus, in the course of TRANSFORM-project, the total available roof area (all uses) has been estimated.

Besides residential buildings industrial buildings (production halls) show the highest potential for the use of roofs in terms of space. Whereas in residential buildings the difficulty of at least partly conflicting use options has to be considered (as e.g. intensively used green roofs, terraces), this is usually not the case for industrial buildings.

The following figure shows an estimation of the available roof area in all sub-areas of aspern Seestadt, including the industrial areas. This especially shows the high potential of the industrial areas for the use of roofs (sub-areas 7 and 8). Nevertheless, due to the

general decision not to include these areas in the assessment of energy issues at hand, the figures of potential solar gains do not include industrial roofs.

Illustration 21: Available roof area Seestadt Aspern North



Source: AIT

The need for service and operation allows only the effective use of a part of roof area and photovoltaic panels gain different usable energy demand when compared to solar thermal panels. These circumstances are considered by using the below presented values for the estimation of the solar potential of the area.

In case of a 100% use of the available roof area, the maximum useable area for photovoltaic use adds up to 253,000 m² of used area of which around a third is needed for service and mounting systems.

Table 12: Factors for calculation of solar potential – Assumptions

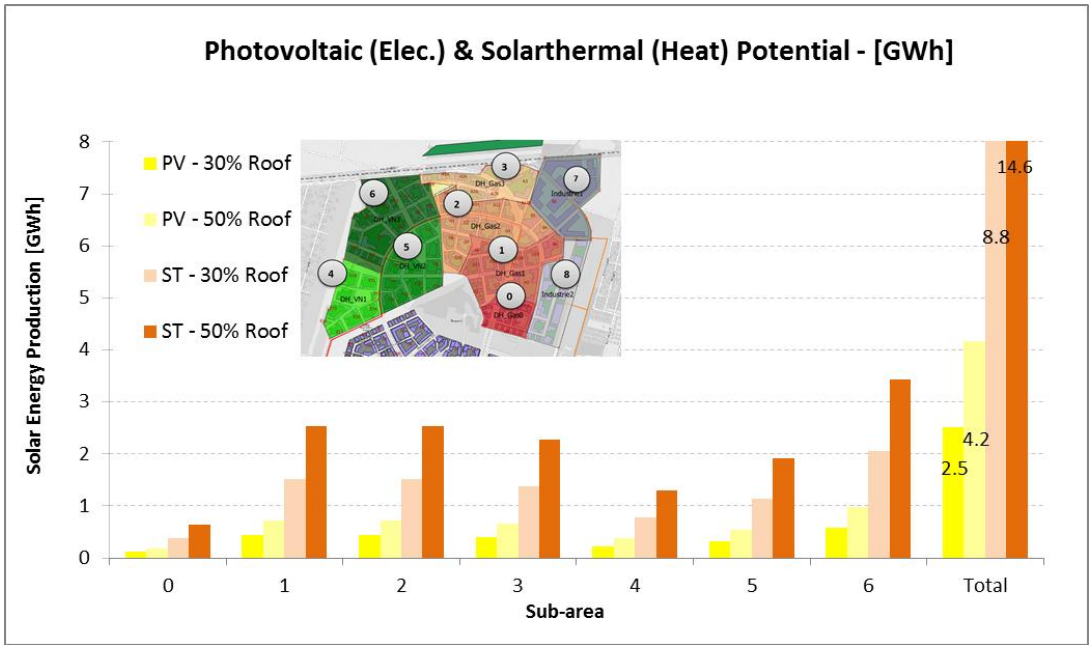
Function	*Factor*	*Unit*	*Value*
PV&Solar Potential	***Ratio panel area to roof area***	***[%]***	***33***
PV-Potential	***Photovoltaic gain (Electricity)***	***[kWh/m²Panel*a]***	***100***
ST-Potential	***Solarthermal gain (Heat)- incl. losses***	***[kWh/m²Panel*a]***	***350***

Source: Energy group aspern Seestadt

According to this calculation a maximum electricity production is resulting in around 8.4GWh per year. By installing 100% of the roof area with solar thermal collectors instead, around 29 GWh heat could be produced (including losses in the system, flat collector).

Nevertheless, this is conceived as an unlikely maximum scenario, since other use of roof areas will take place as well (esp. terraces). In addition it has to be considered, that new buildings have to provide a minimum share of 60% roof area for green roofs. In the following illustration two scenarios for photovoltaic and solarthermal installation are shown depicting the potential solar gains for 30% and 50% use of the total available roof area.

Illustration 22: aspern Seestadt North – PV&Solar Thermal Potential on the roof



Source: AIT

Even though the combined use of roofs (extensive green roofs and solar installations) is possible and even beneficial for the efficiency of PV, this regulation defines certain conditions for solar use. Thus, in case of the use of e.g. 30% of roof area (about 76,000m² roof area and ca. 25,000 m² of panels), the potential energy gain would reduce to 2.5 GWh electricity (in case of PV installation) or 8.8 GWh heat (in case of solar thermal installation).

Wind

Mainly due to the high population density in aspern Seestadt (interference by shadowing, ice shedding, noise, etc.) and current legal provision, wind plants producing electricity are not an option in the area. Since in the North East of aspern already different wind park exist the use of wind energy from the outskirts could be used to increase the renewable share. Within the project respectively this issue has not been discussed further by the energy group aspern Seestadt.

3.4 Mobility

The development of aspern Seestadt implicates an integrated Mobility strategy tailored to the needs of a multiplicity of different users. This strategy has the dedicated aim to deeply influence the mobility patterns of incoming residents, for chances to alter individual behaviour are thought to be greatest when associated to changing living and working conditions in general. aspern Seestadt should allow for sustainable development of car-free mobility patterns.

Planners project a future modal split of 40-20-20 (Public transport-Walking&Cycling-Car) unto the territory. To reach this ambitious target, several structural and regulatory issues have to be resolved upfront. Walking, Cycling and Public transport are priority uses for Seestadt. This means that resources have to be invested in the attractiveness of public transport linkage, but also in the quality of public space and availability of utility services. The main regulatory and framework conditions to enable such development are:

- The subordination of motorized traffic to other mobility uses
- Superior connection to high quality public transport (extension of U2, planned connection to train network, development of local Bus-and Tramway network.)
- Dense, visually appealing walking network in all parts of aspern Seestadt.
- Safe, comprehensive and attractive routes for cyclists, with additional investment in bike storage facilities close to public nodes.
- Collective, multi-car parking facilities to enhance equality of opportunities related to modal choice (distance to car parking should be equal to walking distance towards public transport)
- Qualitative design of streetscape

- Green- and public spaces as recreational areas close to residential uses.
- Public services in reach of working and living environments

The subordination of motorized traffic frees up existing street space for alternative public uses that will be stimulated through the integration of different functions. Through the extension of the street-space to other functions, without further consumption of space, a net gain in public space is expected. From the combination of a reduction of motorized traffic with a constant rate of vegetation, planners expect the development of high ecological standards in air, quality and biodiversity. The dissolution of barriers between street-green- and city areas should promote a unitary picture of public space. A further positive impact is the reduction of safety issues related to motorized traffic in public space.

Organization of private and public transport

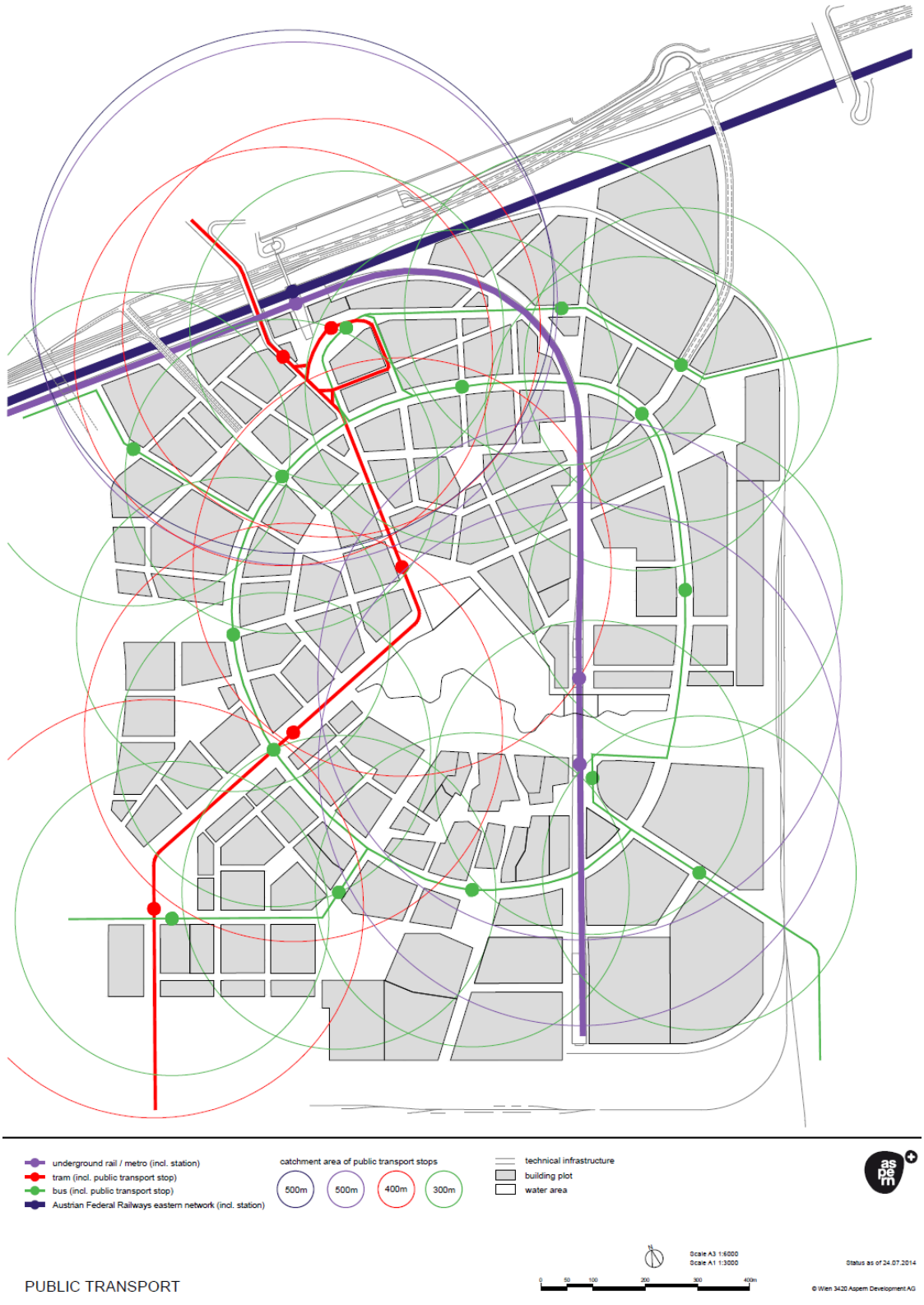
aspern Seestadt can be reached in approximately 30 min from the centre of Vienna by the subway line U2. The two subway stations „Aspern Nord“ and „Seestadt“ are the most important transport nodes in terms of passenger frequency. Next to establishing a connection from the centre, the two subway stations should also serve the near periphery in the region. Subway facilities are complemented with biking storage facilities, and at the light rail and railway station “Aspern Nord” a car-parking facility will be featured to cater for the needs of incoming commuters from the nearby region.

Additionally, aspern Seestadt will be connected to the public transport network of the wider metropolitan region, through the following measures:

- Light rail and railway station Aspern Nord
- Linie 25: Crosses aspern Seestadt from the South-west through the Shopping street to the U2 station „Aspern Nord“.
- A second tramway station from the U2 station „Hausfeldstraße“ is planned,
- Connections to bus network

The following illustration shows the catchment area of public transport for aspern Seestadt. The strong overlap of catchment areas is an indicator of high quality of public transport in the area.

Illustration 23: Public transport network aspern Seestadt



Source: Wien 3420

A major connection to the inter-regional road network is the Stadtstraße/S1-connecting road, which will be completed by end of 2018/2019. The central road network in aspern Seestadt is structured around connecting axes going out of the city, the ring road as an internal traffic distributor and the access ways towards the proposed collective garages. The road network includes all streets that will be most strongly affected by traffic. These will as a consequence be configured according to the principle of segregation between traffic modes.

Walking and cycling

Walking networks for pedestrians are organized according to the following criteria:

To prevent detours, important source and target points will be directly connected to each other. On the basis of actual planning, major target points are the subway stations, the central shopping street, the lake and the two schools.

A tight-knit network is planned as a consequence; around major building sites the rationale for crossings will be closely examined. Route guidance through car-free spaces guarantees a high degree of security for pedestrians.

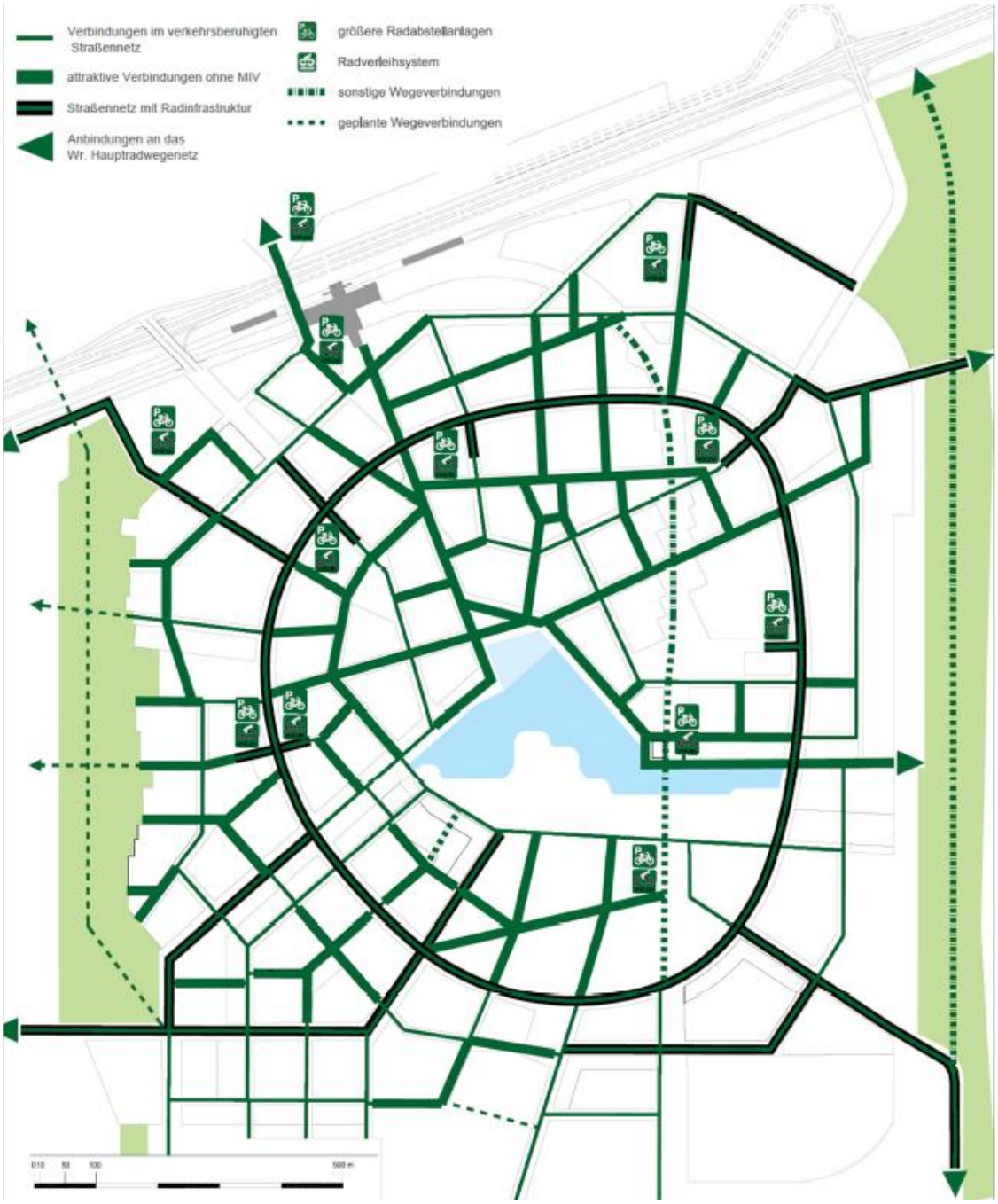
The following planning principles are taken into consideration:

- Barrier free accessibility
- Attractive design of public space
- Safety and security

aspern Seestadt is connected to Vienna's bicycle lane network. Moreover there will be north-south and east-west connections in the territory. With the completion of buildings, further bicycle lanes shall be developed to be made available for residents when the move in.

The bicycle lane network should be conforming to the same principles as the walking network (see above). Additionally, biking infrastructure will be comprehensively available on the secondary road networks of aspern Seestadt.

Illustration 24: Planned Bicycle lane network



Source: Aspern Seestadt Nord Vertiefung verkehrliche Organisation und öffentlicher Raum (2013), S. 19

Organization of parking space

Mobility patterns are strongly influenced by the availability of parking space in immediate proximity of target and source points. The more proximate a car is parked to the flat, the more often it is used. The organization of parking space is an important element in the attainment of the ambitious modal split target of 40:20:20 (public transport/walking &cycling/motorized traffic).

aspern Seestadt meets the necessary requirements for a reduction of compulsory parking spaces by 30%. In this context, a demand of 11,475 parking spaces (for northern part) can be computed that divides into 5,780 parking lots for residential and 5695 parking lots for office uses and 2000 parking lots for employees in retail.

The length of walking times necessary to reach public transport nodes has a decisive impact on the degree of attractiveness of particular transport modes. Planners have thus decided to have parking lots in collective garages and public transport nodes at equidistance from residential and office quarters. A network of public transport nodes is complemented with a network of collective garages. For people with limited mobility capacities, public service vehicles and delivery services temporary parking modalities will be available.

In addition, collective garages are configured as mobility points, combined with car sharing and bike sharing facilities and providing space for additional bike storage.

The amount of collective garages and their distribution will be accomplished according to the following criteria:

- Equidistance: intake radius for a station is 300m for bus, 400m for tramways and 500m for subways. Collective garages will placed at a radius of 300m.
- The access to collective garages will follow directly from ring road and the access points of S1, which is a major connecting road.
- The garages will not be located in immediate proximity of subway stations to prevent them to be used for park and ride.
- Part of parking lots will also be available for visitors of aspern Seestadt.

Illustration 25: Organization of parking space

Source: Wien 3420

From traffic planning perspective collective garages will constitute important source and target points. Parking garages will not be mono-functional spaces but allow residents to access a multiplicity of services and uses (repair, bike rental, car sharing).

The will be only 870 parking lots in public space distributed in the following streets:

- Ring road: 370 spaces.
- Connecting roads: 260 spaces.
- Access driveways in retail area: 240 spaces.

3.5 Use of ICT and smart grids (enabling theme)

ICT in the context of mobility

A number of ICT applications are currently planned to assist mobility in the district.

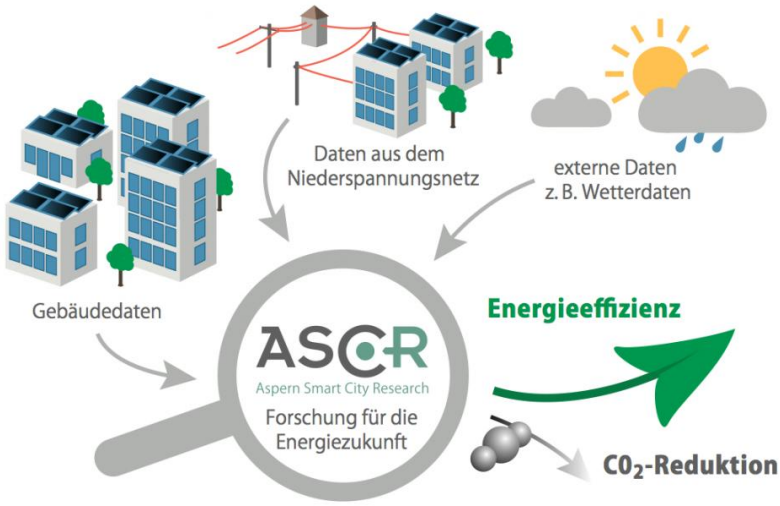
Mobility centre/Digital blackboard: A mobility centre for all mobility measures is planned that will be delivered in the form of a smart phone app. With this service travel demand for certain services and be managed and directly booked.

Mobility card Seestadt: A mobility card for Seestadt is planned, that should ease access and provide a universal key to all mobility services in the district.

Demo-projects lead by ASCR

In the context of aspern Seestadt, a research organization the Aspern Smart City Research GmbH & Co KG (ASCR) has been set up to establish how renewable power sources, smart buildings and highly metered, intelligent grid technologies might best be combined to power a thriving, eco-friendly residential and commercial community. The research organization is a 40 million Euros joint venture formed in 2013 between the associates of Siemens AG Österreich (44.1%), Wien Energie GmbH (29.95%), Wiener Netze GmbH (20%), Wirtschaftsagentur Wien (4.66%), Wien 3420 Aspern Development AG (1.29%).

Illustration 26: Research priorities of ASCR



Source: ASCR

The research of ASCR within the following 5 years shall concentrate on research by using real-time data referring to:

- Smart Building – intelligent management of buildings (energy use, production and storage of energy): facility management, improvement and optimization of energy flows and efficient use of energy, building-groups as active market participants, analysis of user behaviour in terms of new technologies, new tariff models, etc.
- Smart Citizen – inclusion of users in the context of energy: users and clients shall be involved in research and innovation programmes; together with users, ASCR will analyse usability and data security issues of new technologies
- Smart Grids – intelligent management of distribution networks (integration of decentral energy production): focus will be laid on low voltage systems, e.g. automatic screening of status quo in the system, grid monitoring, integration of decentral variable voltage control during mains operation, grid analysis and maintenance
- Smart ICT – integration of buildings and energy distribution networks by ICT: analysis and handling of various information in the context of a city, embedding of decentral energy production, consideration of regulators requirements, analysis of user behaviour in terms of ICT-technologies

Successful projects and experiences shall be roll out in following development phases of aspern Seestadt by the involved partners.

Installation of smart grids

At the moment, **smart grids** research activities are planned by ASCR taking place on specific areas at the southern part of aspern Seestadt. For that specific measurement levels (activities) will be realised in the low voltage distribution electricity grid.

- First level (metering): Approximately 530 smart meters will be installed in buildings monitor out the current load and demand situation (start in June 2015).
- Second level (house connection boxes): Additional sensors will be installed in house connection boxes for more detailed grid information concerning the power quality. The installation of the sensors in house connection boxes will start in January 2015.
- Third level (transformer stations): Low voltage measurement equipment (for power quality, short circuit etc.) will be installed in 11 transformer stations to find out about specific conditions on the secondary side of the transformer. Furthermore there is a control system to manage the high voltage cable feeders. Additionally a variable ratio transformer ("regelbarer Transformator") will give the chance for research activities on different load conditions and adapting the voltage level accordingly.

Concerning ICT different communication technologies are required:

- PLC Technology (Power Line Communication): Last mile communication to metering and sensor devices
- Fiber optic technologies: communication to transformer stations and further to the IT-control centre
- An IT-control centre with all backend-systems for grid data analysis is currently being realised and will start operating in September/October 2015.

Smart meter roll out

According to the energy efficiency directive, at least 80% of end users have to be connected to smart meters until 2020. Generally, in Austria 95% of all meters have to be replaced by **smart meters** until 2019. The Austrian enactment „Intelligente Messgeräte-Einführungsverordnung (IME-VO)" for electricty lays down following milestones:

- 10% of meters (without load profile meters) until the end of 2015
- 70% of meters until the end of 2017

- 95% of meters until the end of 2019

The main rollout is currently being prepared, the start of roll out is to be expected in 2015. In addition, Wiener Netze actually realises a pilot project in the distribution area of Wiener Netze, installing approximately 2550 smart meters in defined project areas for research activities.

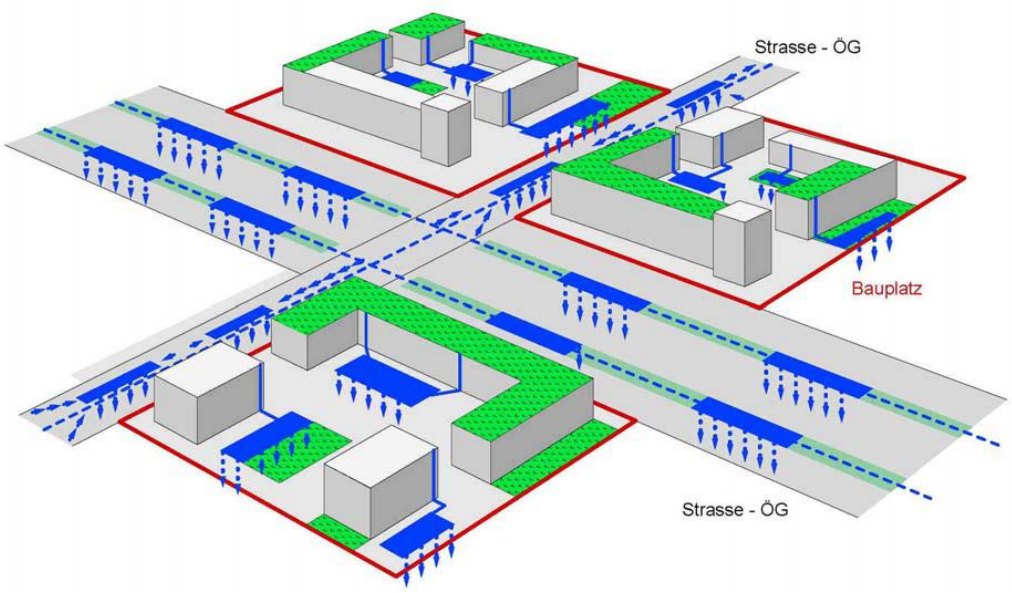
3.6 Other important issues – rainwater management

Referring to rainwater management systems, there are two general regulations in Vienna with major importance for rainwater management:

- According to the legal requirements for new development areas, the minimum share of aquifer intake area is 10% of the building plot.
- New buildings have to provide a share of minimum 60% of the roof area for green roofs.

Above these general regulations, a feasibility study for a rainwater management system for the northern part of the SUL was issued by Wien3420 in 2013. In this study, a decentralized infiltration system is recommended for building lots and a semi-decentralized infiltration system for adjacent public green spaces. Street spaces should be drained by decentral infiltration systems.

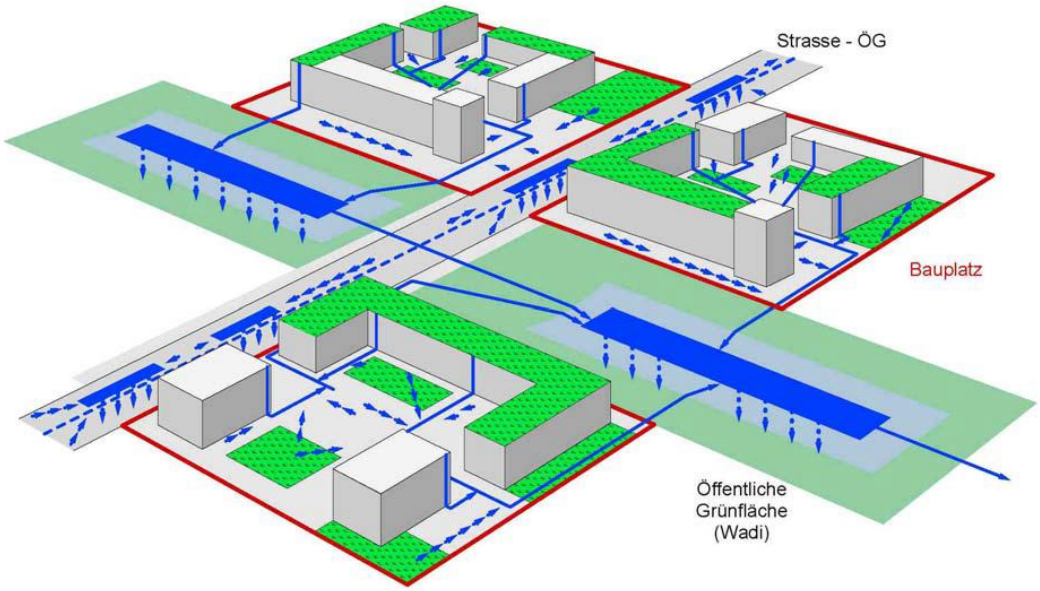
Illustration 27: Decentral System



Source. RWM Endbericht 2013

The study also recommends the use of retention soil filters as clarification biotopes at the lake and as surface water protection systems on heavily used roads. The backbone of the semi-decentral system is the so-called „Grüne Wadi“. This is the green space alongside the U2 subway line conceived as a retention and infiltration space. These infiltration spaces can be made usable for different functions.

Illustration 28: Semi-decentral system with „Grüner Wadi“



Source: RWM Endbericht 2013

Based on the study and on other factors, the following decisions have been taken for the implementation:

Building lots are not allowed to discharge rainwater into the sewer. Thus, for these areas, infiltration and evaporation of rainwater has to be foreseen by green roofs and by permeable surfaces on ground level.

In terms of streets and traffic areas, rainwater management is organized by three different systems, depending on the type of street:

- main streets will be discharged into the conventional sewer
- in larger neighbourhood streets and the alley (bus traffic) rainwater management is organized by a combination of infiltration and discharging into the sewage
- for secondary streets, neighbourhood paths and play streets infiltration of the total rainwater is foreseen.

4. Overall development visions, objectives and targets, future organization and management of the SUL from the policy perspective

4.1 Objectives, targets and KPIs, development vision and end-state of urban development

Objectives and targets for the city of Vienna and aspern Seestadt

Starting with the designation of aspern Seestadt as a target area for new urban development in Vienna (urban development plan 2005), the development process started with the elaboration of a masterplan for the area.

As formulated in this masterplan urbanity and high quality of life shall be *"the hallmarks of the new, multifunctional city quarter, which is to offer attractive housing options, jobs, a modern range of shopping and service facilities as well as an innovative science and education campus of supra-regional importance. Spacious green zones, an attractive environment for commerce and industry, social, leisure, recreational and cultural facilities, efficient connections to the traffic and public transport systems (Underground, road network) and vicinity to major recreational areas "just around the corner" are key characteristics of this location."(Masterplan, 2008)*

In addition, the masterplan contains statements in the context of climate and environmental protection. It was stated, that "The urbanistic design and the principles of the master plan – short distances, mixed uses, construction types with low land consumption – contribute significantly towards protecting the environment."

- Strategy 1: Avoiding motorized traffic by a traffic and transport concept and an urban design, keeping trips by car to a minimum, attractive and safe footpaths and cycling infrastructure, highly efficient public transport, access to all functions of life
- Strategy 2: Energy-saving city quarter layout: optimization measures to reduce the energy consumption of buildings, e.g. ample green spaces with their positive effects on the microclimate, dense and compact built structures to avoid energy losses, maximised energy efficiency due to high thermal standards
- Strategy 3: Use of geothermal energy (this strategy has been meanwhile postponed due to technical difficulties)

- Strategy 4: Material management for the three large-scale terrain modifications, in order to minimise energy input and the emission of noise and dust.

In 2005 the development agency for aspern Seestadt “Wien 3420” was founded in order to develop this new urban district. Guiding ideas of Wien 3420 are:

- quality-focussed urban development
- new paths of site development
- willingness to experiment, creativity and spontaneity
- sustainable development perspectives with social, economical and ecological orientation

According to the policy paper of Wien 3420 on strategies and emphasis, measures and guidelines for an ecologically sustainable development of an urban quarter (draft paper, 18. 8. 2011), the overall development framework of aspern Seestadt is guided by the ***vision for an ecological, resource-friendly and climate neutral city.***

The planning principles defined in this paper are in line with the strategies in the masterplan and form an important part of this qualitative vision:

- **Urban form:** Dense, compact form, qualitative green and social spaces, functional and social mix, flexible and open building structures, high quality location for industry, education and research
- **Mobility and transport:** Excellent connection to public transport, fostering of biking, walking and inter-modality, reduction of motorized traffic, fostering of alternative mobility

In addition, the position paper defines a number of focal points, of which most important is the definition of objectives concerning energy use (from viewpoint of smart urban development). There, minimizing demand for useful energy for all uses (heating, cooling, ventilation, lightning and other electrical appliances) is defined as an important requirement for saving resources and climate protection:

- In terms of space heating at least very low energy standards are foreseen, in addition, thresholds for total energy efficiency (GEE ≤ 0.85) and efficiency of primary energy demand ($PEB_{BGF,RK}$ ≤ 50 kWh/m^2 for all energy uses) shall be considered.
- Urban density is seen as a basis for the implementation of energy networks (district heating, partly district cooling, intelligent electricity grid prepared for feed-in

of decentral local energy production). The equipment of all buildings shall allow for an active participation in these grids networks.

- In order to provide with renewable electricity, a wind park is intended near aspern Seestadt.
- In addition, the production of renewable heat and electricity by a geothermal plant near the SUL was foreseen. This project has been stopped due to technical reasons.

Finally, from an overall perspective, the smart city framework strategy of Vienna, (municipal council resolution 2014) has become another important new basis for a future sustainable development of Vienna. This strategy constitutes the long-term objectives of Vienna in concerning of climate change and energy. Most important for SUL aspern Seestadt are:

- overall goal: 80% reduction of CO_2 emissions per capita till 2050 (1990 reference), at least 35% till 2030
- energy efficiency to reduce energy consumption per capita by 40% in 2050 (2005 reference)
- 50% gross energy consumption coming from renewable 2050, 20% already in 2030
- 2000 Watt steady power supply per capita, 1 ton CO_2 per capita
- motorized traffic: 20% share of all trips till 2025, and 15% till 2030
- motorized traffic: new engine technologies till 2030 (e.g. e-mobility), and no more conventional engines till 2050
- city logistic 100% CO_2-free till 2030
- zero energy standard new buildings 2018/2020

Quantitative targets and KPIs

The following key performance indicators presented for the minimum and smart city scenarios do not describe a status quo of committed targets, but rather show the range

of expected (respectively aimed) energy demand and emissions (based on the analyses and technical assessments presented above)[3].

In the area which is zoned for industrial uses, the parameters of its future energy demand are still unknown due to the huge differences between branches and energy concepts of enterprises. A similar situation has to be considered in terms of the availability of waste heat. Thus, the following tables do neither include the energy demand for industrial uses (areas used for industry) nor potential waste heat sources. Whereas the former would increase the overall energy demand, the latter has the potential to substitute energy imports (as e.g. biomass or gas) and would thus further reduce CO_2-emissions.

Table 13: Basic KPIs for the SUL – minimum scenario (aspern Seestadt North)

	minimum scenario (2030)
Space heating and hot water demand	
Energy demand	90,700 MWh/a
Emission of CO_2 (specific CO_2-equivalent)	11,980 t CO_2/a (132g/kWh)
Local energy production from renewable energy sources	-
Electricity	
Energy demand	85,700 MWh/a
Emission of CO_2 (specific CO_2-equivalent)	34,700 t CO_2/a (405 g/kWh)
Local energy production from renewable energy sources (50% of all roofs excluding industrial buildings)	2,500 MWh/a*

* renewable electricity balanced against electricity demand (emissions), considered in CO_2-emissions for electricity

Source: energy group aspern Seestadt

[3] The different numbers between the energy consumption described in chapter 3.2 and above numbers stem from a slightly varying perspective of assessment and thus different methodology. In general, the same input values have been used for the energetic assessment in both cases.
The focus of the above described assessment from the energy utility (agreed within the energy group aspern Seestadt) has been the deployment of two heat supply concepts (minimum scenario and smart city scenario) in a way that could be implemented in the future.
The assessment presented in chapter 3.2 used a slightly different approach by using the defined sub-grids of the minimum scenario as reference area to assure the comparability of both scenarios. Furthermore two building blocks (B9 and B10) have not been considered due to the later construction in comparison to the building blocks H6 and H7 (2018 vs. 2028).
In short: Variation in the minimum scenario mainly due to less building blocks, variation in the efficiency/smart city scenario due to different assignment of technology (heat pump).

The analyzed smart city scenarios are presented in chapter 3.1. They comprise four different scenario-combinations of low temperature district heating grids differentiated by energy supply and local renewable energy production for hot water provision:

- energy supply: (1) a mainly biomass supplied network (heat grid east) and a network connected to the municipal district heating grid (heat grid west) or (2) these two networks together with a groundwater supplied coldwater network (heat grid north);
- local renewable energy production for hot water provision: (a) by use of heat pumps combined with photovoltaic or (b) combined with solar thermal energy production;

In terms of CO_2-emissions, scenario 1a shows the highest emissions within the four smart city scenarios (two biomass and district heating networks, heat pumps combined with photovoltaic installations), whereas scenario 2b (including groundwater-network, heat pumps combined with solar thermal installations) has the lowest emissions. This range of emissions is presented in the table below.

Table 14: Basic KPIs for the SUL – range of smart city scenarios (aspern Seestadt North)

	smart city scenario "1a" – two networks plus photovoltaic installation (2030)	smart city scenario "2b" – three networks incl. groundwater use plus solar thermal installation (2030)
Space heating and hot water demand		
Energy demand (incl. electricity for heat production – heat pumps)	56,650 MWh/a	56,650 MWh/a
Emission of CO_2 (specific CO_2-equivalent)	5,350 t CO_2/a (94g/kWh)	3,660 t CO_2/a (65g/kWh)
Local thermal energy production from renewable energy sources (50% of all roofs)	-	8,600 MWh/a
Electricity		
Energy demand	47,400 MWh	47,400 MWh
Emission of CO_2 (specific CO_2-equivalent)	19,770 t CO_2/a (417 g/kWh)	19,770 t CO_2/a (417g/kWh)
Local electricity production from renewable energy sources (50% of all roofs excluding industrial buildings)	2,500 MWh/a*	-

* electricity used for heat production (heat pumps), considered in CO_2-emissions for heat

Source: energy group aspern Seestadt

Summarizing these assumptions, the comparison of expected energy demand and emissions between minimum scenario and smart city scenarios differ considerably due to both: lower energy demand (energy efficiency in the use of electric energy and higher building standards) and a higher share of renewable energy usage (esp. biomass, alternative solar thermal instead of photovoltaic installations).

Table 15: Comparison of KPIs between minimum scenario and smart city scenarios (aspern Seestadt North)

	smart city scenario "1a" (2030)	smart city scenario "2b" (2030)	*smart city scenario "1a" (2030)*	*smart city scenario "2b" (2030)*
	in absolute figures against minimum scenario		*against minimum scenario in %*	
Space heating and hot water demand				
Energy demand	-34,050 MWh/a	-34,050 MWh/a	*-38%*	*-38%*
Emission of CO_2 (specific CO_2-equiv.)	-6,630 t CO_2/a (-38 g/kWh)	-8,320 t CO_2/a (-67 g/kWh)	*-55%* *-29%*	*-69%* *-51%*
Electricity				
Energy demand	-38,300 MWh/a	-38,300 MWh/a	*-45%*	*-45%*
Emission of CO_2 (specific CO_2-equiv.)	-14,930 tCO_2/a (+/-0 g/kWh)	-14,930 tCO_2/a (+/-0 g/kWh)	*-43%* *+3%*	*-43%* *+3%*

Source: energy group aspern Seestadt

According to the above presented assessment carried out by the energy group, potential savings of smart city scenario implementation would sum up to -38% energy demand for heat and -45% electricity demand. Considering varying CO_2-emission factors, this would lead to a reduction of CO_2-emissions in the range of -55% to -69% for heat and -43% for electricity.

Quantitative targets in terms of mobility

The assessment of the energy demand and CO_2-emissions of mobility, has not been finalized yet. Due to the planned modal split of 40% public transport, 20% walking & cycling and only 20% car traffic unto the territory, emissions are expected to be lower than city wide. These ambitious targets are supported by a very good connection to the high level public transport, by an attractive design of streets and various offers for pedestrians and cyclists as well as by a number of restrictions for the motorized traffic.

4.2 Development strategies and priorities of future development activities

General principles for future development

Building upon the masterplan of aspern Seestadt, following general principles are the basis of the strategies followed by Wien3420 and the city of Vienna in order to develop this new urban quarter:

- **Sustainable urban lifestyle**: new quarter with urban densities providing with all services of a city, no need for car-use, attractive public spaces and green infrastructure
- **Sustainable mobility**: Focus on walking and cycling, attractive public transport, financing instrument for sustainable mobility investments
- **Low energy demand**: High thermal quality of buildings, energy-efficient appliances, resource-aware lifestyles
- **Energy supply infrastructure**: Future innovative energy system options for the northern part of the SUL aspern Seestadt (phase 2 development)
- **Local energy production**: High share of local renewable energies
- **Research on new smart grid and building technology solutions**

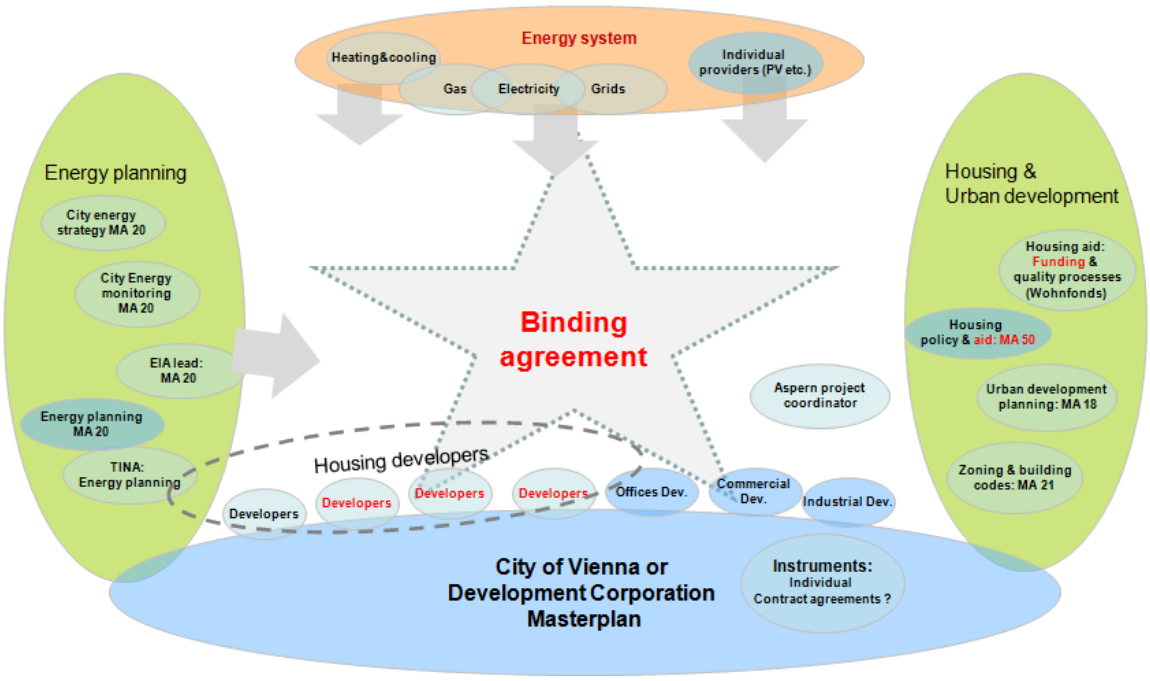
Although broadly applied, the implementation of these principles in practice need the development of new approaches to some extent. Whereas strategies for the support of sustainable urban lifestyle and mobility have been implemented partly in a very innovative way (e.g. restrictions for motorized traffic, parking garages, mobility fund, neighbourhood management, shopping street management, etc.) this is especially true for the question of how to develop innovative energy systems for urban quarters in a forward looking, still flexible way .

Further development of energy concept – integrated planning approach

A crucial need for further “smart” development is the decision on a tailor made area-focused integrated development approach, encompassing energy supply, (local) energy production and the production of new or the refurbishment of existing buildings in Vienna. With the adoption of the Smart City Framework Strategy and the new Urban Development Plan 2025, the task has been formulated to elaborate new procedures

and methods to integrate the urban development and energy fields with respect to energy and climate protection targets.

Illustration 29: Approaches for integrated urban and energy planning



Source: ILS Vienna/OIR

Due to the impulse from other cities' experiences during the ILS in Vienna (September 2014) an intensive discussion on the concrete implementation of new development processes for integrated energy and spatial planning for the case of aspern Seestadt (and other areas) has begun and is still ongoing both, at the SUL-level as well as at the level of the entire city.

The aim of these activities is to develop a new, systematic approach for integrated urban and energy planning for urban districts, possibly including tender procedures, concessions and contracting. As a result of such an approach a binding agreement between relevant stakeholders is needed for future integrated, smart city development. The leading institution relating to this task is Wien 3420 together with the Energy Planning Department (MA 20) for the case of aspern Seestadt.

Development of business and financing models as a support for implementation

As a contribution to the decision on future energy systems (connected with the need for specific requirements e.g. for housing developers in terms of building standards or heating systems), the energy group currently elaborates the knowledge basis for the discussion on various business and financing models. These models shall provide with the opportunity to compare investment costs and costs of operation for different qualities of building construction and varying energy system configurations, allowing higher investment costs for energy systems to be related to overall construction costs as well as to possible reductions of costs in operation. Furthermore these analyses shall also provide with a break-down of costs to be covered by different actors (development agency Wien 3420, building developers, energy grid company, energy supplier, industry, offices, end users, etc.).
The planned discussion on alternative business and finance models with different stakeholders shall help to come to an estimation on willingness and acceptance of stakeholders to start the implementation of innovative solutions. The outcomes of this discussion will contribute to recommendations on following steps of implementation.

4.3 Future management and organization of the SUL

The development agency, Wien 3420, has the mandate to develop the area at least until realization of the entire SUL (planned for about 2030). There are no further agreements concerning the time after finalization so far.

Monitoring activities are steered by Wien 3420 mainly in the framework of different research project in the moment. Although the installation of smart meters and monitoring was planned for aspern Seestadt from the beginning (laid down in the requirements for aspern Seestadt South), implementation is actually hindered by legal constraints (privacy matters). Negotiations with building developers and end-users are still ongoing. In addition, ASCR will monitor the energy flows in those buildings which are part of the ASCR-research project for five years in a very detailed way.

The neighbourhood management (Stadtteilmanagement) for aspern Seestadt is intended for an important contact point and meeting place for residents of aspern Seestadt and population of neighbouring settlements and started in 2014. The focus of the neighbourhood management is neighbourhood and community-oriented

development of the SUL and bridging the connection between the old and new parts of the city. Activities shall facilitate the arrival of the new residents and the development of an attractive and lively district by encouraging to explore and learn about new urban quarter, organizing meeting spaces, exchanges and cooperation and a variety of events that deal with housing, leisure, culture, sustainability, employment and education. The mandate for its work is temporary, but there are reasonable options for continuation.

5. Implementation measures, key actors for future realization

5.1 Energy systems and networks

ASCR – demo projects in the field of smart grids			
Start of implementation	2014	**(Planned) Completion**	2019
Description of the measure	Research in the field of smart Grids – intelligent management of distribution networks (integration of decentral energy production): focus will be laid on low voltage systems, e.g. automatic screening of status quo in the system, grid monitoring, integration of decentral variable voltage control during mains operation, grid analysis and maintenance		
Key-actors	Aspern smart city research		
Target group	grid operator, prosumers, facility managers/property owners user behaviour of residents		
Financing	ASCR budget, additional research projects		
Publicity, participation	involvement of users and clients in the area within the project		

5.2 Buildings, industry and services – energy demand and energy efficiency

Minimum thermal standards beyond building code			
Start of implementation	2017	**(Planned) Completion**	2030
Description of the measure	Definition of minimum standards for buildings in aspern Seestadt, higher standards than building codes in Vienna. This can be implemented by laying down such energy efficiency criteria in the environmental impact statement, which is becoming legally binding after approval (EIA).		
Key-actors	Wien 3420 (via EIA and private contracts)		
Target group	public and private property developers (construction phase)		
Financing	no additional costs for the municipality/development agency, funding schemes as for the entire city (financial aid for higher energy efficiency than according to building codes) available		
Publicity, participation	not relevant		

5.3 Local renewable energy sources

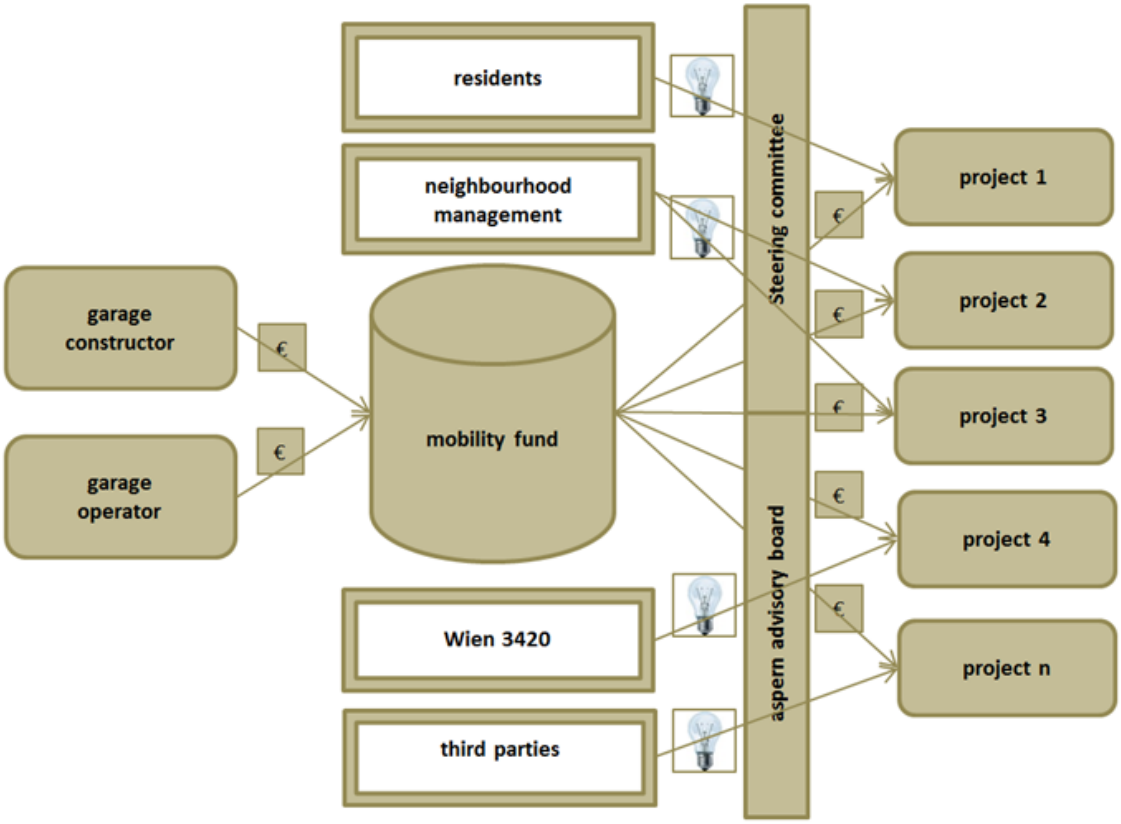
Use of groundwater potential – cold water network			
Start of implementation	2017	**(Planned) Completion**	2022
Description of the measure	According to pilot-studies in the area, there is a substantial geothermal potential to be used in a financially feasible way. Due to the availability of this local energy source, geopotential (ground water) in the area shall be used for the implementation of a cold-water grid as a basis for decentral heat pumps.		
Key-actors	Wien 3420 (foreseen as an option in EIA) energy utility company Wien Energie (implementation of grid, potentially also maintaining heat pumps as an energy service provider)		
Target group	public and private property developers (conception of energy systems of the building in the construction phase)		
Financing	not defined yet		
Publicity, participation	not relevant		

Obligatory solar use			
Start of implementation	2017	**(Planned) Completion**	2030
Description of the measure	Definition of obligatory solar use for all buildings in the SUL. According to the valid laws (building codes), new buildings have to be supplied by renewable energy to a certain defined extent (except being connected to the district heating network). In EIA South, a requirement has been fixed for all buildings to at least be prepared for use of solar energy. This requirement should be kept for EIA North in order to provide good pre-conditions for increased local energy production later. A final decision on this question has not been taken yet.		
Key-actors	Wien 3420 (definition in EIA) public and private property developers (implementation) third parties/ESCOs (potentially)		
Target group	public and private property developers (conception of energy systems of the building in the construction phase)		
Financing	funding schemes as for the entire city (only in case of realization of solar installations)		
Publicity, participation	not relevant		

5.4 Mobility

Mobility fund aspern Seestadt			
Start of implementation	2015	**(Planned) Completion**	ongoing
Description of the measure	The mobility fund shall support various mobility measures with focus on sustainable mobility, especially such with need for investment e.g. a bike driven delivery service system and a digital travel demand management system for the use of these alternative services. A number of projects is fixed already, e.g.: – e-biking fleet with 6 stations and about 40 bikes in the first phase (20 e-bikes, 20 conventional bikes), 3 cargo bikes, seestadt bike (design and assembly in aspern Seestadt) – shopping trolley „Lotte“: in addition to cargo bikes, bike trailer to be used as shopping trolley, 100 pieces will be provided to residents (e.g. common use per floor) – “Hallo Dienstmann!”/“Hallo Butler”: delivery service, home delivery by social institution in the area – bicycle storage boxes: theft and weather protection in the area – car sharing for residents within a radius of 350m. – digital black board: information for residents and their feedback – mobility related information (availability of shared bikes or cars, accessible bike boxes, public transport services, – Aspern Seestadt Card: access to mobility measures with one card, on stop shop ticketing (in the future)		
Key-actors	Wien 3420 (administration of funding) The funding of diverse further mobility measures from the fund will be conducted in coordination with property developers, future residents as well as the Aspern steering group (consultative board); district management authority, residents		
Target group	The mobility fund shall provide with sustainable mobility options for residents and working persons in the SUL		
Financing	The business model of the mobility fund rests on the idea that income from investments in motorized traffic are redirected towards investments in public transport. Garage owners will contribute 1000Eur/per parking lot on a one time basis. From the 6th year after their inception, owners will additionally have to pay 2% of their collected rents as a mobility fee to the fund.		
Publicity, participation	It is planned that inhabitants can regularly provide feedback on the mobility fund through the intermediary of the District management authority.		

Illustration 30: Mobility fund aspern Seestadt



Source: Wien 3420

5.5 Use of ICT and smart grids

ASCR – demo projects in the field of smart building and smart ICT			
Start of implementation	2014	**(Planned) Completion**	2019
Description of the measure	Smart Building – intelligent management of buildings (energy use, production and storage of energy): facility management, improvement and optimization of energy flows and efficient use of energy, building-groups as active market participants, analysis of user behaviour in terms of new technologies, new tariff models, etc. Smart ICT – integration of buildings and energy distribution networks by ICT: analysis and handling of various information in the context of a city, embedding of decentral energy production, consideration of regulators requirements, analysis of user behaviour in terms of ICT-technologies		
Key-actors	Aspern smart city research		
Target group	grid operator, prosumers, facility managers/property owners		
Financing	ASCR budget, additional research projects		
Publicity, participation	involvement of users and clients in the area within the project		

Pilot project – Smart Citizen Assistant			
Start of implementation	2013	**(Planned) Completion**	2016 (prototype)
Description of the measure	The smart citizen assistant (SCA) is a platform for diverse smart city applications based on data available in a city, visualizing smart city data to the residents. The aim is to provide a novel interface through which relevant data can be accessed individually and in a timely manner. Citizens of aspern Seestadt will benefit from the research activities as they will have novel means of influencing their energy consumption. The motivation of the users should be increased with innovative ways of presenting the data and exploiting this to reduce financial burdens of the end-users. The Smart Citizen Assistant prototype will provide a standard interface for applications running on mobile devices such as smart phones or tablets.		
Key-actors	Siemens, Wiener Netze (grid operator)		
Target group	residents in the area of aspern Seestadt,		
Financing	national research project (Transform+)		
Publicity, participation	involvement of users and clients in the testing phase of the project		

5.6 Other important issues – development of a lively urban quarter

Neighbourhood management as an intermediate institution			
Start of implementation	2014	**(Planned) Completion**	ongoing
Description of the measure	The neighbourhood management (Stadtteilmanagement) for aspern Seestadt started with beginning of 2014. It constitutes a contact point and meeting place for residents of aspern Seestadt, but also for residents of peripheral communities. The focus of this institution is the development of neighbourhood and community oriented networks as well as the linking of old and new urban spaces. In addition the neighbourhood management can function as a link between residents needs and public authorities also in terms of mobility, public space and energy issues. Tasks: – communication and participation – socio-culture and identification of residents – landscape and public spaces – infrastructure and city services – economic activities and small businesses – management of customers' complaints – development of a platform for residents – motivation of residents		
Key-actors	neighbourhood management as a publicly financed institution		
Target group	residents in aspern Seestadt		
Financing	budget/year ca. 400,000 Euros (provided by a cooperation between municipal department MA 25 () and Wien 3420)		
Publicity, participation	one of the main aims of the measure		

Management agency for the public retail streets			
Start of implementation	2014	**(Planned) Completion**	ongoing
Description of the measure	In order to enhance the quality of shopping facilities and the use of retail spaces, a special purpose vehicle has been founded for the operation of the public retail streets (aspern Einkaufsstraßen GmbH: 49% Wien 3420, 51% SES). In principle this "shopping street management" is working similar to the management of a shopping center. Tasks: – concept, realization and management of local supply and retail spaces in ground floor areas in the SUL – renting of shops in a specific mixture of shopping facilities, for service enterprises and gastronomy		

Key-actors	aspern Einkaufsstraßen GmbH
Target group	residents in aspern Seestadt
Financing	business model of experienced shopping mall operator with contribution from Wien 3420
Publicity, participation	no information on publicity/participation available

5.7 Measures concerning the legal framework, tax incentives and aid schemes

No specific measures are foreseen concerning legal framework, tax incentives or aid schemes at the moment.

6. Reflection – preliminary assessment

The development of a greenfield area of such size as aspern Seestadt into an attractive urban neighbourhood for the future is a challenging task. It requires high quality planning, openness for technical and social innovation and a strong and committed management especially with regard to the broad variety of stakeholders. Another challenge is the timeline of over 20 years which calls for immediate and long-term decisions in parallel.

Best practice

The decision of the city government to set up a dedicated **development company** Wien 3420 and to hand over the responsibility for the development of the whole area from the very beginning was a new (for Vienna) but up to now promising way to meet the challenges associated with such a project. Wien 3420 is land-owner and therefore able to define requirements when selling the land to housing developers or other future owners. The fact that Wien 3420 has the mandate as well as sufficient influence and human resources facilitates a comprehensive approach, focusing not only on economic but also on ecological and social aspects – summarized as smart city thinking – in planning, preparation and contracting. Wien 3420 participated in several smart city research projects, commissioned respective studies for informed decision-making and organises public participation processes.

A first proof of the Wien 3420 approach was the **guidance for investors** in the course of developers' competition for housing areas and selling land to property developers at aspern Seestadt South. Wien 3420 defined a number of requirements potential developers and housing companies had to accept when buying land:

- Secure an accompanying process of quality assurance (plot guidelines, project supervision, constitution of an advisory board)
- Consider the handbook on public space in their planning
- Fulfill specified building parameters and specific requirements (e.g. the need to prepare the buildings for later solar energy installations, the design of ground floor spaces in shopping streets, restrictions for in-house car parking space)

One of the results of the comprehensive planning approach is a far-reaching mobility concept for the area aiming to foster environmentally friendly forms of mobility and

thereby creating attractive public spaces. Individual car traffic should be reduced to the minimum possible through measures like: Neighbourhood garages instead of parking lots in each building, car-sharing, very limited parking space on streets, shared spaces with much room for cycling and walking and high-quality public transport.

A key instrument for realizing various measures and ideas is the **aspern mobility fund** to which owners of car parking facilities (neighbourhood garages) have to contribute. At the same time, this fund provides the necessary financial resources for implementation of the innovative mobility measures and allows for active participation of residents.

One of the major aims of the development of the SUL aspern Seestadt is the socially sustainable development of a new urban quarter, providing with highest quality of life. A high share of housing projects are funded by the city of Vienna, thus social mix is expected to develop similarly to the overall city. The publicly funded **neighbourhood management** is a well-established and successful instrument in Vienna to support participation and a lively development of the urban area. Therefore it was also established at aspern Seestadt, funded by the city of Vienna together with Wien 3420. The neighbourhood management is also central for planning institutions to get in contact with inhabitants and thus important for the co-operation between and with smart citizens in the area.

Another innovative idea was implemented in order to develop lively streets and public spaces which offer a broad choice of shops, restaurants and other services. As a precondition for such uses, suitable ground floor spaces in buildings for retail , was provided by Wien 3420 by guidance for investors. However it needs a strong effort and management to attract and maintain such businesses, especially in new urban quarters. For that reason Wien 3420 commissioned the task of a **central shop management** for aspern Seestadt to an experienced company which will transfer its know-how from shopping-center management to the open air shopping areas (shopping streets) in aspern Seestadt.

To use the research opportunities at the Smart Urban Lab aspern Seestadt a special research institution was set up. **Aspern Smart City Research** (ASCR) is a joint-venture between Siemens, Wien Energy (municipal utility), Wiener Netze (municipal

grid company, Vienna business agency and Wien 3420[4]. The combination of industrial and municipal actors provides not only the necessary resources for innovative and challenging research tasks but also the access to all relevant stakeholders. Collaboration with the first inhabitants at aspern Seestadt allows testing concepts and technical solutions against real smart citizens' behaviour. The consortium behind ASCR also secures a more likely later implementation of successful research results.

Implementation barriers

The commitment of the city of Vienna to become a smart city and the general targets defined in the recently adopted Smart City Framework Strategy are guidance for Wien 3420. However this is not enough to secure high smart city standard to be implemented in aspern Seestadt. Wien 3420 often has to consider a lot of different, several times conflicting targets and requirements in decision-making. What is lacking so far are ambitious **official quantitative targets** and operating principals for the SUL aspern Seestadt together with a clear and stronger backing from cities' authorities. There is an ongoing process between Wien 3420 and city administration to define such targets and principles. Further meetings are scheduled in 2015.

A specific difficulty in aspern Seestadt is the time line of more than 20 years from initial planning to last constructions. It demands in some cases **decisions now with unknown framework conditions**, technological changes and innovative opportunities years later. This is for example the case for the development of the energy concept of aspern Seestadt North.

For the southern part, which is now already under construction, the environmental impact assessment (EIA) was used as a legal support for implementation of smart city targets (e.g. higher building standards, preparation of buildings for later solar energy installations and energy monitoring, obligatory connection to the district heating grid).

But the situation considerably changed with the recent amendment of the EIA law. The new requirements demand a binding energy concept with a relatively precise description of the energy system for the whole northern area now, whereas real

[4] Shareholders of ASCR: Siemens AG Österreich (44,1 %), Wien Energie GmbH (29,95 %), Wiener Netze GmbH (20 %), Wirtschaftsagentur Wien (4,66 %), Wien 3420 Aspern Development AG (1,29 %)

construction activities in major parts of the area will start between 2020 and 2028. To be on the safe side technically and financially this situation had led to a rather un-ambitious energy concept for aspern Seestadt North, based on the “minimum scenario”, with which Wien 3420 will apply for EIA approval. If successful any other, more innovative and sustainable solution needs to consider the minimum scenario design in order to avoid reopening the EIA approval process.

Nevertheless, based on recent discussions about the ambitious smart city scenario, some elements may be included in the EIA application which will allow the realization of more ambitious measures (e.g. use of groundwater) but avoiding to go through the approval process again.

Integrated urban and energy planning in Vienna

The TRANSFORM Intensive Lab Session in Vienna has underlined the major importance of integrated planning and the need for agreements between involved stakeholders in order to achieve higher liability of planning when developing new urban quarters in respect to energy and climate protection targets.

These findings support the ongoing development of a tailor made, area-focused integrated planning approach for the construction of new or the refurbishment of existing buildings, encompassing energy supply, (local) energy production and urban planning and development. Such an integrated planning approach is also demanded in the Smart City Framework Strategy and the new Urban Development Plan 2025.

The responsible energy department together with the department of urban development started with an assessment of different aspects, e.g.

- Typology of Vienna’s built up areas in terms of energy issues, building structures and socio-economic parameters,
- Analysis of existing approaches to integrate urban development and energy issues in the current planning practices of different departments;
- Pilot study on energy concept options for a specific area in Vienna as basis for further agreements;
- Evaluation of the legal framework for the necessary agreements between stakeholders in the city.

Financing

Financing is one of the key issues for the transformation of our cities – especially in times of a difficult economic situation and common budget restrictions.

Even if it obvious and common understanding that decisions for some investments today will lower future costs, they are often not taken. Main reasons are short term financial calculation and pay-off periods instead of life-cycle cost accounting and the uncertainty of the future development of the energy markets.

In order to support the necessary discussion on investment needs and operational costs for various energy systems, the “energy group aspern Seestadt” currently elaborates different options for business and financing models. This includes reference cost figures (investment and operating costs for buildings and energy supply) for different options, split for different actors and considering approaches from different cities.

PESTLEGS categorization

In terms of decisive aspects of best practice and barriers referring to the PESTLEGS categories the following table presents the categorization of above mentioned aspects for aspern Seestadt.

Table 16: Overview on best practice and barriers for implementation – PESTLEGS

Short description	Categorization by PESTLEGS
Best practices	
Development company for the area	**P E S T L E . S**
Guidance for investors	**. E . T L E . .**
Neighbourhood Management	**. . S . . . . .**
Central shop management	**. . S . . . . .**
Mobility fund	**. E S . . E . .**
Aspern Smart City Research (ASCR)	**. . . T . E . .**
Barriers for implementation	
Lack of official quantitative targets/requirements (commitment of the city)	**P . . . L . . .**
Difficulty to take long term decisions about a future energy concept in times of rapidly changing framework conditions and innovation	**. E . T . . . .**
Legally binding agreements between developers, energy providers and end users are missing	**. E . . . L. . . S**

PESTLEGS:
Political, Economic, Social/Demographic, Technological, Legal, Environmental, Global, Spatial