NOORD-HOLLANDSE ENERGIE REGIO

Draft RES

Amsterdam

Draft RES

The offer from
the Amsterdam
sub-region

Contents

Summary

This document sets out Amsterdam's aspirations and search areas with regard to the large-scale generation of wind energy and solar energy for 2030. It also contains an initial outline of the demand for heating and for heat sources (including potential heat sources). This is Amsterdam's contribution to the regional offer to be put forward by the Noord-Holland Zuid (NHZ) energy region in its upcoming Regional Energy Strategy (RES). Accordingly, this 'partial RES' is an intermediate product that will ultimately become part of the Draft RES for the entire Noord-Holland Zuid region.

Task

Amsterdam has a substantial demand for heating and power. Its current demand for power is 3.8 TWh (for homes and utilities such as commercial buildings, offices, and shops, as well as schools and hospitals). This means that Amsterdam accounts for about half of the Noord-Holland Zuid region's total power demand. Amsterdam's heating demand amounts to 6.9 TWh. Amsterdam does not have enough generation potential to meet its own demand for heating and power.

Amsterdam's contribution: the offer

The city authorities aspire to make Amsterdam climate neutral. In the Roadmap for a Climate-neutral Amsterdam, they show how this will take shape. The large-scale generation of renewable energy plays a key part in this. The offer (Amsterdam's contribution to the Draft RES for the NHZ energy region) gives details of the potential for the large-scale generation of renewable energy by 2030.

Amsterdam's offer

Amsterdam is offering to generate about 0.7 TWh (663 GWh) of electricity by 2030. This will consist of 127 MW (283 GWh) of wind energy generation, in seven search areas, plus 400 MW (380 GWh) of solar energy generation on large roofs and by means of the dual use of urban spaces. In the event that this is not feasible in the listed search areas or if central government expects the RES for Noord-Holland Zuid to perform an additional task, Amsterdam has indicated 'additional search areas' on the map, for wind energy and solar energy.

Aspiration with regard to wind energy

- 50 MW (127 GWh) of extra wind energy by 2030, in addition to the 66 MW that is already in place and the 11 MW that is planned. Accordingly, this amounts to a total of 127 MW (283 GWh) of wind energy by 2030.

- Keep seven tentative search areas and Waterland/IJmeer open as additional search areas. Waterland/IJmeer is an additional search area. This can be considered if it transpires that the other search areas are unable to achieve the target of 50 MW, or if an additional task is imposed by the central government.

Aspiration with regard to solar energy

- 400 MW (380 GWh) by 2030, which represents an increase of about 350 MW compared to 2019.
- Focus on solar energy generation on roofs, the dual use of space, and the temporary use of undeveloped sites.
- Waterland/IJmeer and other green areas and bodies of water as additional search areas, subject to a 'no, unless' principle, if it is not possible to fulfil the aspiration using the former search areas or if central government imposes an additional task.

Aspiration with regard to heating

- Amsterdam will be gas-free by 2040, and all new-build properties will be gas-free.
- The Regional Structure for Heating (RSW) follows on from the Transition Vision for Heat (TVW), which will be ready before the RSW is adopted.
- Amsterdam is focusing on new sources of energy that are renewable, affordable, and future-proof (geothermal energy, residual heat from data centres, aquathermal energy).

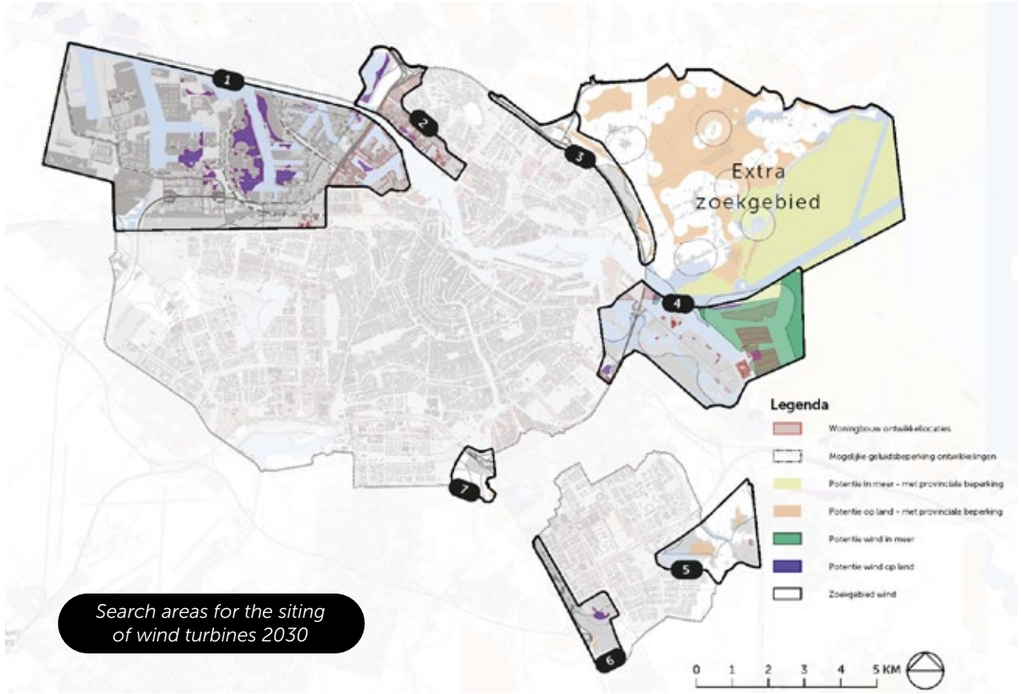
With regard to wind energy, the aspiration is to create an additional 50 MW of installed capacity on Amsterdam's territory (about 127 GWh) on top of the 11 MW that is scheduled for the port area by 2022, plus the existing 66 MW. With regard to the large-scale installation of wind turbines, Amsterdam is exploring seven areas that have the technical/theoretical potential to deliver wind energy:
1) The port area
2) Noorder IJplas
3) an area to the north of the A10 orbital motorway
4) Zeeburgereiland/IJburg/Science Park
5) Gaasperplas/Driemond
6) Amstel III and the surrounding area
7) Amsterdam-Zuid

Amsterdam has designated Waterland/IJmeer as an additional search area.

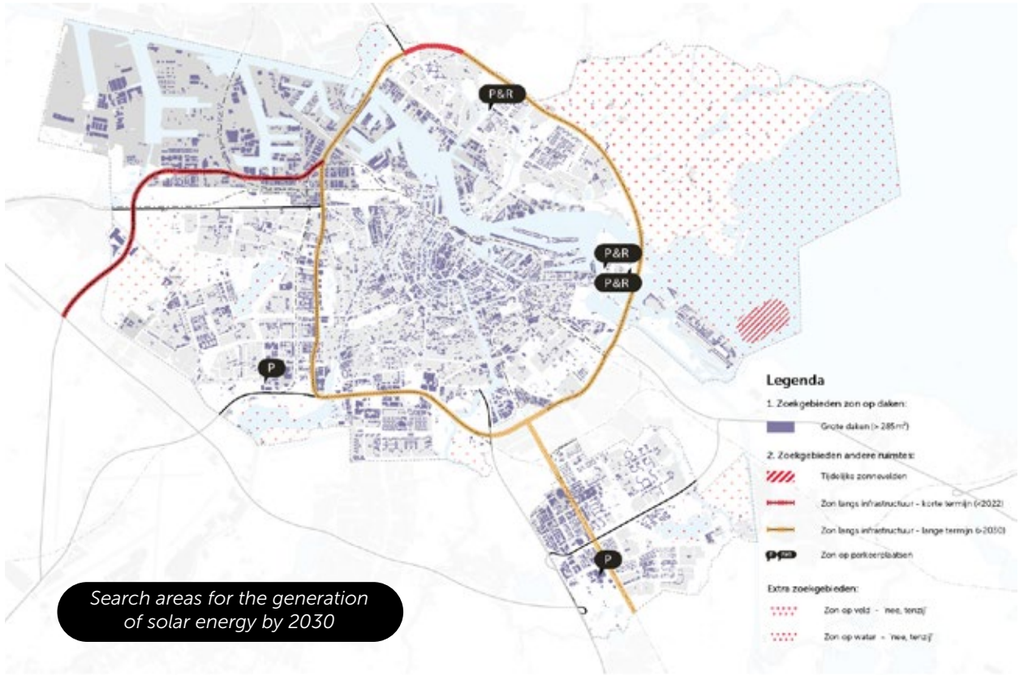
Search areas for the siting of wind turbines 2030

With regard to the generation of solar energy, the city is mainly exploring the option of large roofs and the dual use of space at P&R facilities, for example, and alongside infrastructure (such as embankments, noise barriers, or metro stations). The aim is to have 400 MW of solar energy capacity (about 380 GWh) installed by 2030. Waterland/IJmeer and other green areas and bodies of water are included as additional search areas for solar energy generation, subject to a 'no, unless' principle. Accordingly, these will only be taken into consideration if there is insufficient space in the other areas. Amsterdam is also fully committed to the use of small roofs (150 MW by 2030). However, these are not recorded within the RES system.

Search areas for the siting of wind turbines 2030



Search areas for the siting of wind turbines 2030



Search areas for the generation of solar energy by 2030

In its quest for a gas-free and renewable heat supply, Amsterdam is offering to investigate the potential of new renewable sources. Where appropriate, pilot projects will be initiated and scaled up (geothermal energy, residual heat from data centres, aquathermal energy).

Participation

This aspiration is based on a technical analysis of the potential, a broad-based process involving stakeholders and residents and, ultimately, a political decision. In the course of a number of workshops, experts, stakeholders, and residents each had an opportunity to contribute to the process. In summary, the workshop participants stated that Amsterdam should pursue an aspirational energy policy. This would require the municipality to involve residents, to guarantee people's quality of life in the city, and to protect green areas in and around the city. With regard to this aspiration, Amsterdam is aiming for a local ownership level of at least 50 percent.

Ensuring that the network has sufficient capacity, and providing appropriate legal and policy frameworks

In general, the power grid has sufficient capacity to handle the large-scale generation of wind energy and solar energy. However, there will be capacity bottlenecks at certain points and during specific periods. These challenges can be resolved by expanding the network. However, the bottlenecks in question can also be caused by other factors, such as the growth in electric transport (and public transport). Furthermore, Amsterdam's ability to achieve its aspirations is constrained by the central government's legal frameworks and regulations, and those of the provincial authorities.

Follow-up steps

While Amsterdam is making every effort to find solutions on its own territory, it remains dependent on energy imported from other regions. For this reason, the City of Amsterdam has initiated dialogues with the other municipalities in Noord-Holland Zuid, and with the provincial authorities. In this process, we must learn from one another, while making every effort to maintain a coherent approach. Given its in-house knowledge and capacity, the City of Amsterdam feels that it should take an active part in this endeavour. Amsterdam can also play a significant part in urging central government and the provincial authorities to provide the requisite instruments and frameworks. In addition, the issue of spatial integration/spatial design will be specified in greater detail during the follow-up process. Amsterdam will also embed the plans in its policy frameworks, in which the spatial vision in particular will play a key part.

1.

Introduction

The formulation of Regional Energy Strategies (RESs) was prompted by the 2019 national Climate Agreement. When working out the details of Amsterdam's 'partial RES', the guiding principle is the aspiration expressed in the 2018 coalition agreement. In this section we briefly discuss this background and context. We also specify the working method and principles used by Amsterdam in its quest to achieve its aspirations.

1.1 Towards a Regional Energy Strategy (RES)

The memorandum before you contains the first draft of the Regional Energy Strategy (RES) for Amsterdam. In this way, on behalf of its territory, Amsterdam is contributing to the Climate Agreement pledge (28 June 2019) to establish RESs.

Under the Climate Agreement, the Netherlands is subdivided into 30 energy regions. Amsterdam is a sub-region of the Noord-Holland Zuid (NHZ) energy region, which also includes the sub-regions of IJmond-Zuid-Kennemerland, Zaanstreek-Waterland, Amstelland, Gooi en Vecht, and Haarlemmermeer. Thus, the present document will not remain a distinct and separate product, but will eventually form part of Noord-Holland Zuid's overall RES.

In the Regional Energy Strategies, government bodies develop regional choices together with social partners, network operators (for gas, power, and heat), the business community, and, where possible, residents. Their goal here is the generation of renewable electricity (35 TWh) and the heat transition in the built environment (from fossil to renewable sources), together with the requisite storage and energy infrastructure. These choices are translated into areas and projects, and into the implementation and execution of those projects.

(Source: www.klimaatakkoord.nl)

Energy region Noord-Holland Zuid

Six sub-regions of the Noord-Holland Zuid energy region

The RES sets out the region's energy objectives for the large-scale, renewable generation of wind energy and solar energy. It also states how the region aims to achieve these goals.
The RES focuses on the tasks of two 'sector platforms' – 'Built environment' and 'Electricity'[1].
The RES explores the options for generating electricity, the distribution of sources (heating),
the demand for heating, and the impact on the heating and power infrastructure.

The Draft RES is scheduled to be submitted to central government in June 2020. In the upcoming months, Amsterdam will pursue its cooperative venture with the Noord-Holland provincial authorities, the regional municipalities, and its other partners, to meet this deadline for the RES for Noord-Holland Zuid. In the RES for NHZ, the situation and task at regional scale are sharply defined. The relationship between the various sub-regions – including Amsterdam – is also outlined.

1.2 RES for Amsterdam

Basis: the *Een nieuwe lente en een nieuw geluid (A new spring and a new voice)* coalition agreement

The city authorities aspire to make Amsterdam climate neutral. The *Een nieuwe lente en een nieuw geluid (A new spring and a new voice)* coalition agreement, which was concluded in May 2018, adopted this aspiration and took it a step further. It set the target of a 55 percent CO_2 reduction by 2030, and a 95 percent CO_2 reduction by 2050. The RES describes the potential contribution that solar energy and wind energy can make to this aspiration, and provides supporting evidence. With regard to solar energy, the coalition agreement has set the goal of boosting the amount of solar power generated in the city to 250 MW by 2022.
The coalition agreement also says it wants to make full use of the city's potential, in terms of wind turbines.
With regard to heating, the city authorities aspire to make Amsterdam gas-free by 2040, and to only erect gas-free, new-build properties. In 24 neighbourhoods, the process of making these areas gas-free will have become irreversible by 2022.

Relationship with the Roadmap for a Climate-neutral Amsterdam and the Transition Vision for Heat (TVW)

Aside from the RES, various other major projects in Amsterdam are addressing the energy transition. In the first place, the RES process is closely intertwined with those of the *Roadmap for a Climate-neutral Amsterdam 2050* and the *Transition Vision for Heat*.
The RES describes the potential contribution that solar energy and wind energy can make to the Climate-neutral Amsterdam 2050 aspiration, and provides supporting evidence. The RES's aspiration is part of the *Roadmap for a Climate-neutral Amsterdam*, which will be published later in the spring. In addition, as the basis of the *Transition Vision for Heat*, the RES addresses the supply and demand (both current and expected) for heating – the so-called Regional Structure for Heating (RSW).

1 The other sector platforms are Climate Board, Industry, Mobility and Agriculture and Land Use. See also https://vng.nl/sites/default/files/tafels-klimaatakkoord-met-organisaties-aanp-26-april.pdf.

The spatial visions make up the formal assessment framework, the EIA committee provides advice

The legal, formal decision-making process concerning the exact locations of wind turbines, for example, does not take place in the RES. No environmental impact assessment (EIA) is drawn up for the RES for NHZ. However, the Draft RES will be submitted to the EIA Committee for advice. The results from the RES 1.0 are enshrined in the spatial policy by means of a formal assessment process, which features in the new Spatial Vision.

Spatial vision: comprehensive assessment of the RES in the context of Amsterdam

The RES is a key building block in the process of integrating climate and energy aspirations into the Spatial Vision that is currently being formulated.
The picture that the RES paints of the space required to achieve the energy aspiration is enshrined in the Spatial Vision. Indeed, it forms an integral part of this vision, together with other spatial interests. This is neatly encapsulated in the maxim 'Provide guidance and space'.

There is a growing demand for space for renewable energy and the associated infrastructure, while at the same time the city continues to grow and flourish. That growth is much faster than expected, in terms of the numbers of residents, jobs, and tourists.
The highly aspirational plans for housing construction and the space required for the energy transition, climate adaptation, circular business activities, green areas, and accessibility are triggering conflicting claims for space. While this growth certainly offers opportunities, it also leads to tensions and to adverse impacts on the city and the region.

This is giving rise to new insights regarding democratization, the economy, and health, as well as circular-based thinking and circular-based practices.
As a result, efforts to integrate the energy task cannot be limited to a purely technical approach. There is also a need for a clear vision of spatial integration and an equitable distribution of the benefits and burdens.

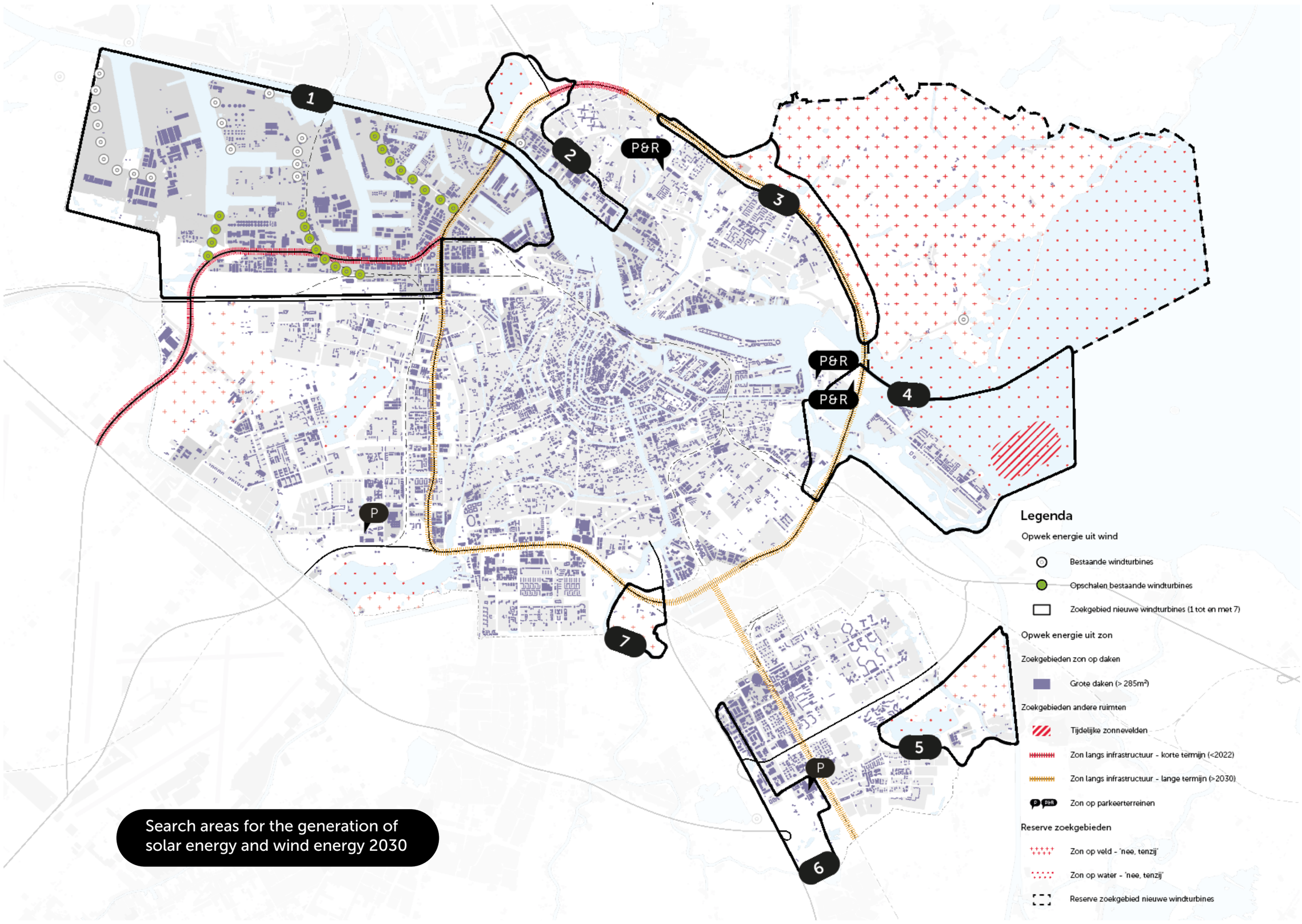
1.3 Search areas: focus on opportunities, with a view to vulnerabilities and limitations

The city authorities have great aspirations with regard to energy generation – they are keen to make Amsterdam climate neutral. Despite the limited amount of available space and other urban constraints, they are doing as much as possible in the area of energy generation.

Search areas for wind energy and solar energy

With regard to wind energy, there are seven search areas (map). Waterland/IJmeer serves as an additional search area if the city's aspirations cannot be fulfilled within these other search areas, or should central government impose an additional task.
In terms of solar energy generation, the municipality is focusing on large roofs, which is also where the greatest potential lies. In addition, sites are being sought that offer opportunities for the dual use of space. These include P&R facilities, for example, and areas alongside infrastructure (such as embankments, noise barriers, or metro stations).
Section 2 gives a more detailed description of the location of these search areas and of the potential that we see in them.

A tentative search area is a zone with the potential to generate wind energy and solar energy, and where the City of Amsterdam plans to further explore the specific options available. When a given area is designated as a tentative search area, this does not automatically mean that the entire area will be used for the generation of wind energy and solar energy.



Search areas for the generation of solar energy and wind energy 2030

Process involving stakeholders

The search areas for wind energy and solar energy were drawn up by means of a transparent process involving a large number of stakeholders. The results were presented to residents for the purposes of a support-base survey (see Section 3 for a description of this process). This process does not detract from the fact that the decisions and considerations underpinning the ultimate choice of a given aspiration and of specific sites for the large-scale generation of wind energy and solar energy remain an administrative matter.

Amsterdam's choice: leave no stone unturned

Amsterdam's city authorities have decided to exploit every single technically feasible site in their endeavour to achieve the large-scale generation of renewable electricity from the sun and the wind. No areas will be ruled out in advance. This translates into two types of search areas: 1) areas with an energy aspiration and 2) 'additional' search areas, subject to a 'no, unless' principle in relation to solar energy generation, if that aspiration cannot be realized in the former type of area.

Seeking the ideal contribution, with a view to residents' vulnerabilities and wishes

This classification into two types of search area is in keeping with the vulnerability of the areas in question, with the residents' wish to seek large-scale solar solutions on rooftops first, and with the various limitations involved. However, by designating additional search areas, Amsterdam is also sending a signal that it wants to make an optimum contribution to the energy transition in its own area, and not to exclude any areas.

2.

Further specification per theme

In this section we first develop the themes of wind energy and solar energy – what is the current situation, what are Amsterdam's aspirations in this regard, and where can we find the space? Next, we turn to the theme of heat – what is the anticipated trend in heat demand, what heat sources are available? The appropriate infrastructure is needed to facilitate these developments. In addition, spatial integration and any impacts on the living environment must be taken into account. These themes are discussed in subsections 2.4 and 2.5.

2.1 Wind

Current situation, planned projects, and aspiration

Current capacity: 66 MW + 11 MW extra in 2021

By the summer of 2019, 38 wind turbines with a combined capacity of 66 MW (128 GWh) had been installed in Amsterdam.

All of these wind turbines are situated in the port area (one is in the port area in the Noord neighbourhood). By 2021, it is expected that the total installed capacity in the port area will have increased by about 11 MW (28 GWh). This is because sixteen small wind turbines situated along the new Hemweg and Noordzeeweg have been removed, and will be replaced by 10 large wind turbines. Thus, by 2021, Amsterdam will have a total installed capacity of 77 MW (156 GWh).

Aspiration for an additional 50 MW
Furthermore, the Roadmap for a Climate-neutral Amsterdam makes provision for an additional 50 MW of energy generated by wind turbines. In line with this aspiration, the City of Amsterdam wants to make a substantial contribution to the national target, as specified in the Climate Agreement. An additional 50 MW (127 GWh) of installed capacity corresponds to the installation of 17 new wind turbines in the 3 MW category, the most commonly used type of wind turbine in the Netherlands. This equates to a total aspirational capacity of 127 MW (283 GWh). That is sufficient to provide around 150,000 households with renewable electricity. In accordance with the Climate Agreement, Amsterdam plans to issue the necessary permits as soon as possible (and no later than 1 January 2025), after which those involved can get started with the implementation phase.

Potential

Estimated potential 105 MW = 35 wind turbines
The RES process explored areas with a potential for generating wind energy. These are areas where – from the legal and technical viewpoints – there is scope for wind turbines (which are not covered by noise and safety requirements, for instance). Housing construction agreements were subsequently added as an additional constraint (ranging from plans to completed projects, in accordance with the Planned Housing Capacity for 2018).
This gives a potential of 105 MW (288 GWh), which equates to 35 wind turbines on the territory of Amsterdam.
This potential takes no account of provincial restrictions associated with nature conservation (Dutch National Ecological Network and Natura 2000).

Greatest amount of space in port areas
Most of the available space for wind energy generation appears to be in the port area. However, the restrictions take no account of the helicopter route. Wind turbines cannot be installed in the vicinity of this helicopter route, so the amount of space in the port area is actually less than the calculated potential.

Customization: possibility of greater potential
A great deal of research/customization is needed to identify sites for new wind turbines. The areas with a potential for generating wind energy, as listed in the RES, are not the only places where new wind turbines can be sited.
Firstly, because the RES analysis is based on risk contours derived from the Handbook on the risk zoning of wind turbines. The rules of thumb (distances to objects) listed in this handbook are fairly broad. Risk assessment calculations (which are mandatory) show that wind turbines can actually be sited closer to structures such as houses, commercial buildings, electricity pylons, and roads.

Secondly, because the RES analysis is based on the 3 MW category, the most commonly used type of wind turbine in the Netherlands. For example, smaller wind turbines (of 2 MW) could be installed instead, thus reducing the risk contours for noise and safety. The smaller the wind turbines, the closer they can be placed to other structures.

Search areas

Identifying suitable sites is a major challenge
In a highly developed urban environment like Amsterdam, where space is at a premium, the integration of wind turbines can pose an enormous challenge.
As previously stated, from a purely technical point of view, there is still sufficient space within the municipal boundaries. The map showing the seven tentative search areas (map) for wind turbines was drawn up on the basis of areas with a potential for generating wind energy, and following discussions with the people of Amsterdam, in various workshops.
Amsterdam has designated Waterland/IJmeer as an additional search area. If the aspiration cannot be realized within the seven search areas, further research will be carried out in the additional search area.

P. 18-19 Search areas for the siting of wind turbines 2030

The purple, blue, and yellow patches indicate areas with potential. If the calculations are based on different types of wind turbine (2 MW, for example, at other heights), then these patches can expand or contract, or new patches can form. Accordingly, additional research will be conducted. The orange patches are the sites of planned housing projects.

Customization and further research into realization, integration, construction, and operation
Finding space for wind turbines involves customization, as does the process of getting them up and running. Within the search areas, the City of Amsterdam and the Port of Amsterdam (in the case of the port area) will determine whether there are any spatial constraints that might affect the installation of various types of wind turbines. The maximum number of MW and the maximum number of turbines (in technical terms) are determined per area.

Subsequently, in-depth research is conducted into spatial integration, construction, and operation. This is carried out in cooperation with spatial planning experts, initiators (such as wind cooperatives), and local residents. Amsterdam is endeavouring to achieve at least 50 percent local ownership (members of the public and/or companies). If the land required is owned by the City of Amsterdam, it is usually allotted by means of a tender, in accordance with municipal policy.

Participation and drafting a community participation agreement
Finally, the ultimate initiator (the party that wishes to install the wind turbine) must launch a process to design a form of participation that is both desirable and feasible. That could involve process participation, financial participation, financial bonds, participation by dint of ownership, a community fund, or a combination of the above.

The City of Amsterdam will keep a watching brief on the situation, to ensure that these matters are indeed discussed by the initiators and the local community. The agreements reached with the local community are enshrined in a community participation agreement. Based on this, a project plan is drawn up, specifying the ideal form of participation for this project.

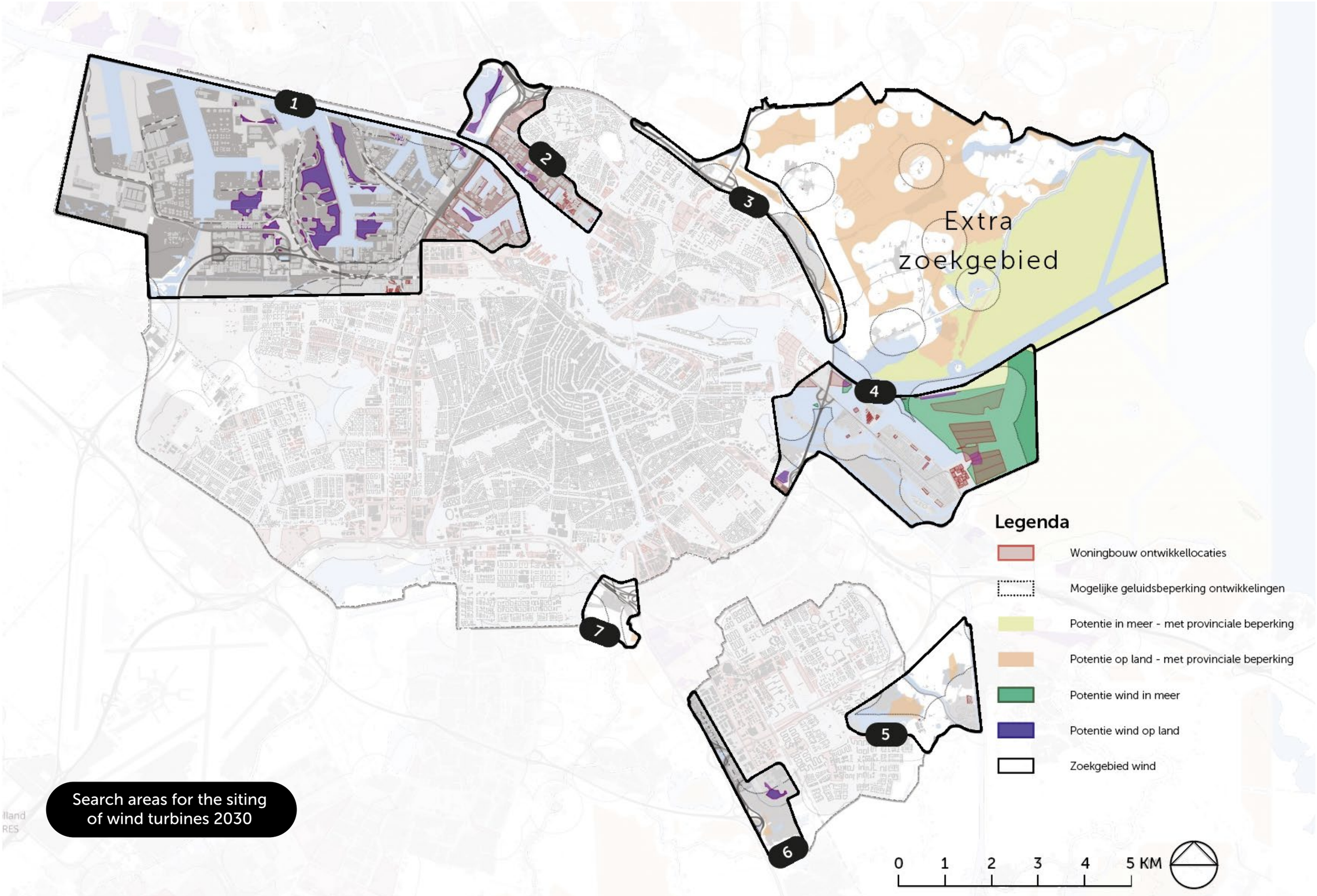
Scope for action

Achievement of a highly aspirational 50 MW
The bandwidth for the extra wind energy target ranges from 50 MW to 105 MW. Amsterdam aspires to install 50 MW (127 GWh) of extra energy generation (by means of wind turbines) by 2030.

Amsterdam's contribution

- **50 MW (127 GWh) of extra wind energy by 2030, in addition to the66 MW that is already in place and the 11 MW that is planned.**
- **Seven tentative search areas, keeping the option of Waterland/IJmeer open as an additional search area, if it transpires that the other search areas are unable to achieve the target of 50 MW, or if an additional task is imposed by the central government.**

The 50 MW target is a feasible aspiration, but this does mean that concessions will have to be made with regard to other programmes (housing construction, industrial sites, natural environments, etc.). Wind energy aspirations invariably involve a great degree of uncertainty, both before and after the award process. This is due to factors such as technical and spatial integration, the support base, the business case, and land positions. Given the enormous number of limitations, even 50 MW is highly aspirational for Amsterdam.



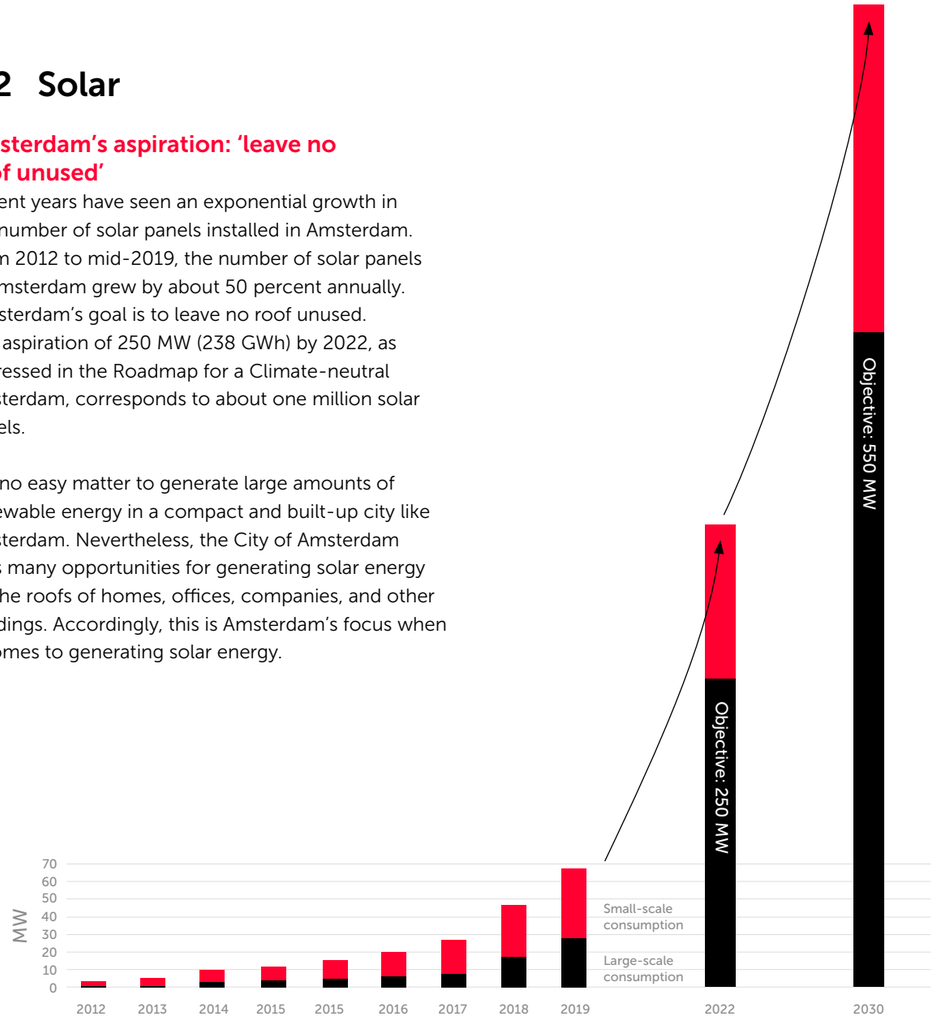
Search areas for the siting of wind turbines 2030

2.2 Solar

Amsterdam's aspiration: 'leave no roof unused'

Recent years have seen an exponential growth in the number of solar panels installed in Amsterdam. From 2012 to mid-2019, the number of solar panels in Amsterdam grew by about 50 percent annually. Amsterdam's goal is to leave no roof unused. The aspiration of 250 MW (238 GWh) by 2022, as expressed in the Roadmap for a Climate-neutral Amsterdam, corresponds to about one million solar panels.

It is no easy matter to generate large amounts of renewable energy in a compact and built-up city like Amsterdam. Nevertheless, the City of Amsterdam sees many opportunities for generating solar energy on the roofs of homes, offices, companies, and other buildings. Accordingly, this is Amsterdam's focus when it comes to generating solar energy.



Installed solar energy capacity

source: Statistics Netherlands | Graph based on: Liander data (data end of year, except 2019 up to and including September)

Amsterdam's contribution

- **400 MW (380 GWh) by 2030, which represents an increase of about 350 MW compared to 2019.**
- **Focus on solar energy generation on roofs, the dual use of space, and the temporary use of undeveloped sites.**
- **Waterland/IJmeer and other green areas and bodies of water as additional search areas, subject to a 'no, unless' principle, if it is not possible to fulfil the aspiration using the former search areas or if central government imposes an additional task.**

Maximizing the potential of solar energy generation on large roofs

Since its roofs have enormous potential and there is only limited space in the city, Amsterdam is focusing on the use of roofs for the generation of solar energy. The RES analysis for Amsterdam shows that, in the period up to 2030, the generation of solar energy on large roofs can deliver the lion's share of the renewable electricity generated. If just 60 percent of the total capacity of these large roofs is utilized, then it will be possible to generate about 400 MW (380 GWh) by 2030 (source: Zonatlas 2018).

The use of small roofs is a key factor in Amsterdam

Aside from these large roofs, small roofs in Amsterdam can also contribute significantly to the generation of renewable energy. According to calculations for the RES, in the run-up to 2030, the generation of renewable energy on small roofs will exceed the amount of solar energy generated at alternative sites, such as agricultural land, etc. This clearly demonstrates the importance of using small roofs to generate energy in urban areas.

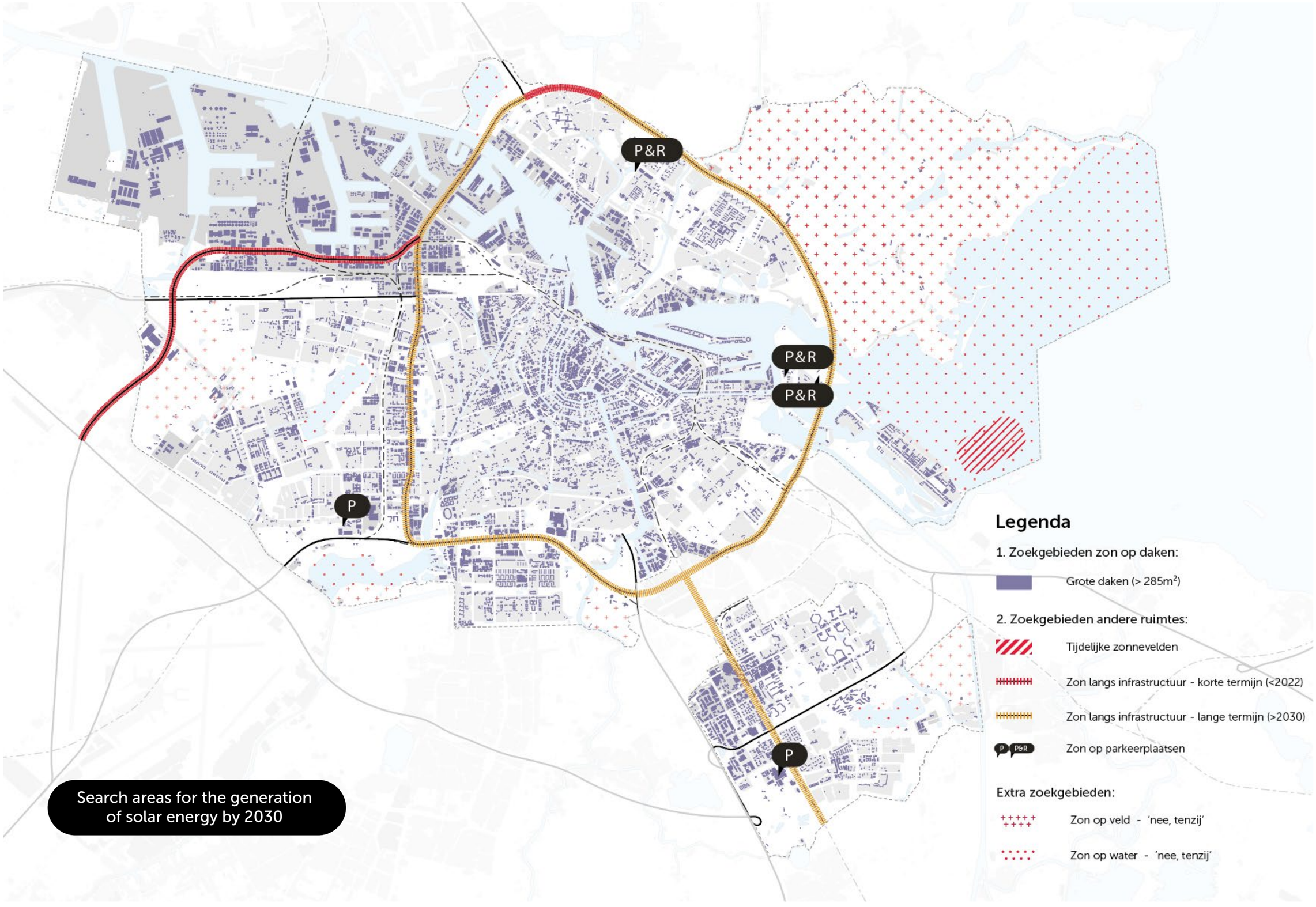
For the national RES system, calculations are based on the large-scale generation of electricity. This only covers roofs with sufficient space to install more than 60 panels. In Amsterdam, small roofs actually have considerable potential. In the Roadmap for a Climate-neutral Amsterdam, the City of Amsterdam indicates how this potential will be utilized.

The total potential of roofs (both large and small) as sites for solar energy generation is 1,100 MW. The aspiration is to install half of this capacity – or 550 MW (520 GWh) – by 2030, 400 MW (380 GWh) of which will be sited on large roofs.

Search areas

The map showing the tentative search areas for solar energy was drawn up on the basis of areas with a potential for generating wind energy, as shown on the photograph of Amsterdam (exploratory survey for the RES), and following discussions with the people of Amsterdam, in various workshops. Amsterdam has designated the Waterland/IJmeer area and other green areas and bodies of water as additional search areas, subject to a 'no, unless' principle. Such areas will only be considered if the city's aspirations cannot be fulfilled within the other search areas, or should central government impose an additional task.

P. 22-23 Search areas for the generation of solar energy by 2030



Search areas for the generation of solar energy by 2030

Scope for action

Solar energy generation on roofs

Amsterdam's motto – 'leave no roof unused' – is always the guiding principle. This means that Amsterdam is focusing on solar energy generation on large roofs, with the aspiration of contributing 400 MW by 2030.

Dual use of space

In addition to roofs, Amsterdam is focusing on other options for the dual use of space. For instance, consideration is being given to solar projects at P&R facilities (in combination with charging points to support electric mobility) and scenarios are being developed for the creation of temporary solar fields on undeveloped sites (such as Strandeiland and IJburg). Amsterdam is also working with the Directorate General for Public Works and Water Management on the use of suitable sites alongside motorways (such as embankments, noise barriers, or other options). Amsterdam is initially focusing on the Westrandweg (the A5 motorway). The infrastructure here will not be modified for another 15 years, and the panels can easily be integrated into the surroundings.

Solar meadows

Amsterdam has no intention to generate energy in scenic areas or on bodies of water. Accordingly, these areas are subject to a 'no, unless' principle. Amsterdam uses the 'ladder for the landscape' system (Amsterdam, July 2019) when weighing the space claims associated with the energy transition against those of other landscape functions. For instance, adopting a dual use of space approach makes it preferable for initiatives to be implemented within the city limits or on industrial sites.

Another part of the ladder is the issue of whether the proposal is the result of co-creation or participation. The development of a solar meadow for Amsterdam is subject to the conditions that local residents have an opportunity to participate, and that the project is carried out in partnership with others in the area and with initiators, such as energy cooperatives. Amsterdam is endeavouring to achieve at least 50 percent local ownership (members of the public and/or companies).

Create the climate needed to fulfil the aspiration

To fulfil this highly aspirational plan, Amsterdam wants to create a climate in which any opportunities for the large-scale (and small-scale) generation of solar energy can be exploited to the full. A distinction is made between different target groups, namely housing corporations, homeowners associations (mixed), private homeowners and tenants, and business premises, including companies and social real estate (such as schools). The approach is aimed at shouldering the burden for the various target groups, in terms of their aspirations to install solar panels on roofs. It is also intended to inform, encourage, and facilitate them in this regard. To this end, the city authorities are focusing on both large and small roofs, as small roofs can also contribute significantly to the generation of renewable energy. Central government tools and resources are needed to facilitate the growth of solar energy generation (see Section 4).

2.3 Heat

Warmte in de RES

The section of the RES that concerns heat is entitled the Regional Structure for Heating (RSW). Every energy region draws up an RSW. The RSW specifies a logical, efficient, and affordable way of linking up the region's available heat sources and its potential heating demand. It also describes the resultant impact on the heating infrastructure. The RES will mainly address larger heat sources that are important to a number of municipalities (supra-municipal heat sources). In parallel to the RES process, various municipalities are developing a so-called Transition Vision for Heat (TVW). The TVW provides insight (at neighbourhood level) into the most suitable heating infrastructure (collective or individual). It also addresses the sequence in which neighbourhoods will be made gas-free.

It is the municipalities that bear responsibility for the TVWs, not the RES regions. The RES does not specify which type of heating infrastructure should be used where. The municipalities include these details in their TVWs. The TVWs and the associated Implementation plans are used as input for the RES and, accordingly, for a Regional Structure for Heating. Conversely, the RSW gives details of any available supra-municipal heat sources that can be included in the TVW. Accordingly, this interaction is an iterative process (figure).

Aspiration with regard to heating

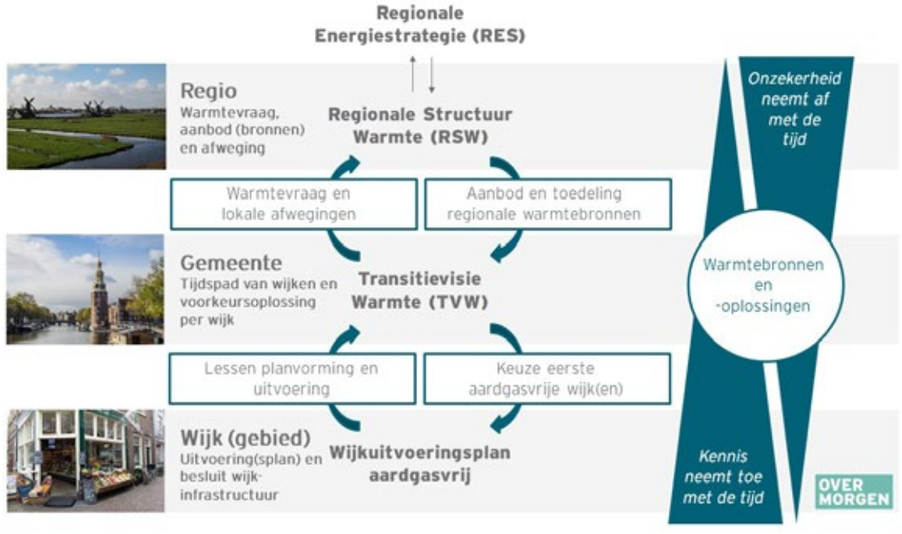
- **The City of Amsterdam plans to be gas-free by 2040. To this end, an irreversible process will be launched in 24 neighbourhoods by 2022, ensuring that they become gas-free. All new-build properties in Amsterdam will be gas-free.**
- **The Transition Vision for Heat [TVW] will be ready by 2020, before the Regional Structure for Heating is adopted. The TVW provides insight (at neighbourhood level) into the techniques to be used to make the city gas-free, and describes the various stages of this process.**
- **Amsterdam is also focusing on investigating, developing, and connection up any new sources of heat that are sustainable, affordable, and future-proof. Amsterdam is an initiator and leader of regional research into geothermal energy. It is also exploring the use of residual heat from data centres, as well as the potential of aquathermal energy and its various applications.**

The building blocks of Amsterdam's RSW

Amsterdam's RSW consists of four building blocks:

1. **Insight into heating demand**
2. **Insight into heating supply**
3. **Insight into heating infrastructure and space**
4. **Cooperation / consideration / process**

In addition, Amsterdam has various projects that are related to – and provide input for – the further specification of the RSW. These include the studies by City Deal, as well as Amsterdam-based thematic studies into heat and power. These projects are currently under development. As a result, it is not yet possible to make any definitive choices or to draw any conclusions concerning the RSW.



Cohesiveness RES, TVW, and the Gas-free Neighbourhood Implementation Plan

Source: The Overmorgen sustainable consultancy firm (2019)

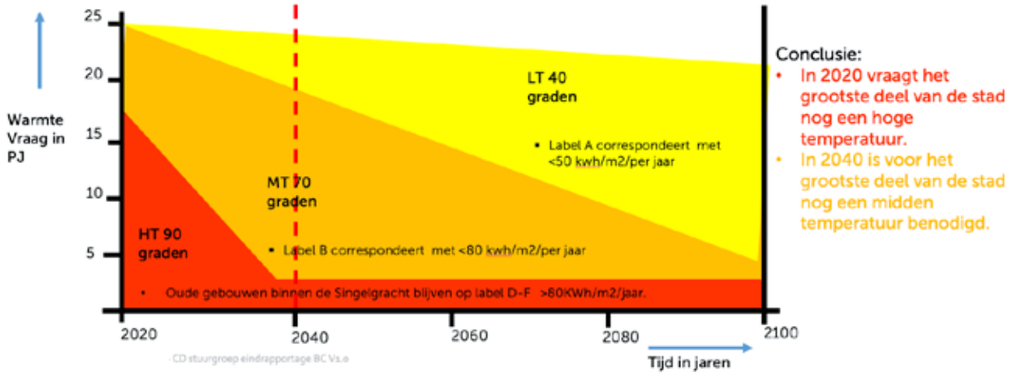
Heating demand

Amsterdam is working with the City Deal partners (such as housing corporations, Liander, Vattenfall, and Waternet) to explore and implement affordable, sustainable, and transparent alternatives to gas in Amsterdam. The figure shown below is based on the City Deal. It is a diagrammatic representation of the anticipated trend in the city's heating demand. This takes full account of the built environment, of utilities, and of the city's growth.

The development of the heating demand in the built environment determines the temperature levels at which the transition to gas-free neighbourhoods can take place. The heating requirements of many buildings in the city mean that they will need a high-temperature supply (HT) until 2040. In view of the retro-fitting of insulation that is scheduled for the upcoming decades, switching to a medium-temperature regime by around 2040 would seem to be a feasible option. New-build homes, homes built since the year 2000, and homes that have been renovated to a high specification [label A+] can be heated using a low-temperature supply (LT). It is expected that additional low-temperature networks and low-temperature heat sources will be required for these homes.

Alternative natural gas sources and techniques must conform to the heating demand and temperature regimes of buildings as closely as possible, in terms of availability, affordability, and sustainability.

The city is growing, yet its demand for heat will fall slightly in the upcoming decades, due to the measures taken to insulate structures in the built environment. As a result, it will be possible to replace high-temperature heat sources with medium temperature ones.



Source: City Deal Amsterdam (October 2019)

Anticipated trend in the city's heating demand

Heat supply (sources)

Amsterdam has a range of heat sources (including potential sources): aquathermal energy, biomass, and geothermal energy, as well as residual heat from industrial sites and data centres *(see the photograph of energy and space in the Amsterdam sub-region)*. In addition, the *Bronnenboek Amsterdam; warmtevraag en -aanbod in beeld (2019)* (Amsterdam Sources Book; heat supply and demand in focus (2019)) describes the current state of affairs regarding the various renewable heat sources that the city of Amsterdam has at its disposal now, and that it will have in the near future. Accordingly, this list provides a key basis for the TVW and the RES.

Current lack of sustainable, affordable, and future-proof heat sources

In the short term, we have sufficient fossil, high temperature (HT), and medium temperature (MT) sources available, such as the Combined Cycle Gas Turbine Plants (CCGT) and the Waste-to-Energy Plant (WTE). However, these sources are insufficient for the future. To this end, new sustainable, affordable, and future-proof heat sources must be developed, such as sources of geothermal energy or green gas. In both cases, however, it is still uncertain whether these sources will be able to deliver sufficient heat for – and in – Amsterdam.

City of Amsterdam's Bronnenboek (Sources Book)

Five supra-municipal HT heat sources that are relevant to Amsterdam

In addition, there are five supra-municipal HT heat sources that are relevant to Amsterdam These are the CCGT plants (combined cycle gas turbine plants) at Diemen and Hemweg, the Waste-to-Energy Plant, the Biomass Power Plant operated by AEB (a company specialized in extracting energy from waste), and, perhaps, geothermal energy:

- The Diemen power plant consists of two CCGT cogeneration plants. Diemen 33 (in operation since 1995) has a power capacity of 266 MW and a thermal capacity of 180 MW. Diemen 34 (in operation since 2012) has a power capacity of 435 MW and a thermal capacity of 260 MW.
- The combined cycle gas turbine plant (CCGT) at Hemweg 9 (in operation since 2013) can produce both power and heat. It has a power capacity of 435 MW and, from 2020 onwards, it will be able to supply 260 MW of heat.
- Waste-to-Energy Plant. The Amsterdam Waste and Energy Company (Afval Energiebedrijf Amsterdam or AEB) operates six waste incineration lines. The steam produced by the boilers is converted into heat and power. They have a maximum capacity of 155 MW. Heat exchangers with a capacity of 150 MW are available for thermal decoupling. This capacity will be expanded to 200 MW in the near future.
- Biomass power plant: In the Westelijk Havengebied area of Amsterdam, AEB is building a power plant that will run on biomass. Featuring a capacity of 30 MW, the plant will open in the summer of 2020. These installations in Amsterdam are being subsidized for a period of 12 years, by funds from the Renewable Energy Incentive Schemes (SDE).
- Geothermal energy: For the purposes of the RES, geothermal energy could potentially serve as a supra-municipal heat source. Geothermal energy offers opportunities to meet part of the city's heating demand in a sustainable way.

2 The Diemen power plant is included because Amsterdam uses it to heat some of its properties. However, the power plant itself is not located within the municipal boundaries of Amsterdam.

Amsterdam has various sources from which heat can be extracted, at three temperature levels. These are summarized in the box below.

Heating sources (including potential sources)

High-temperature sources

- **Biomass (about 120˚C).** The term 'biomass' refers to a wide range of natural materials that are used for various purposes, such as:
  - manure and residues from the food industry can be fermented to produce green gas;
  - vegetable oils and fats (including animal fats) can be burned to produce heat and/or power;
  - wood can be either gasified or burned to produce energy.

  In many cases, biomass must first be gasified or fermented into a biofuel, which is then used for combustion. Biomass consists of a range organic materials. More than 60% of the renewable energy produced in the Netherlands comes from biomass. Not all biomass is sustainably produced; indeed, sustainable biomass is in short supply. Biomass is seen as a transition source that can, to some extent, replace fossil fuels until completely clean alternatives can be used on a massive scale.
- **Geothermal energy (including deep geothermal energy).** Heat from the subsurface. The temperature of the subsurface rises by 3°C for each 100-metre increase in depth. Deep geothermal energy, which is available more than two kilometres below the surface, provides high temperature heat (>60°C-80°C). Each individual source lasts about 15-30 years. Geothermal energy is a major, clean, and future-proof resource.
  Further research into the deep subsurface is needed to better assess the availability of this resource.
- **Ultra-deep geothermal energy (UDG).** Ultra-deep geothermal energy supplies heat (>120°C) from a depth of more than four kilometres. It can also be used to generate power, by passing the steam it produces through generators.

Medium-temperature sources

- **Data centres.** The residual heat from a data centre has an output temperature of between 25°C and 35°C. As things stand, this heat is simply discharged to the outside air. Almost all data centres are technically capable of suppling their residual heat to a district heating grid (source: Dutch Data Center Association). A number of data centres are already supplying heat on a small scale. One example is a facility at the Science Park in the Oost Watergraafsmeer neighbourhood.
- **Aquathermal energy:**Aquathermal energy, which was originally an LT source, can be used as an MT heat source when transitional sources such as the Waste-to-Energy Plant and the combustion of biomass are phased out.

In the case of low-value sources such as data centres and aquathermal energy, heat pumps are needed to raise the heat to a usable temperature level.

Low-temperature sources

- **Thermal energy from surface water (about 20˚C).**In summer, a pump is used to draw off warm surface water, so that the heat it has absorbed can be stored. In the winter, the warm groundwater is pumped up again. There are collective systems with a central heat pump, and individual systems where the heat pump is located inside the house.
- **Thermal energy from waste water (about 20˚C).** Heat can be recovered from Amsterdam's wastewater. The heat recovered from the waste water produced by three houses is sufficient to fully heat one new-build home.
  The process of heat recovery is even more efficient if hot
  and cold waste water are kept separate.
- **Thermal energy from drinking water (about 20˚C)**
  Amsterdam's annual drinking water consumption amounts to 60 million m3. For half of the year this can be used as a source of cooling, and heat can be extracted from it during the remaining six months of the year.

Based on: Bronnenboek Amsterdam; warmtevraag en -aanbod in beeld (2019)

Infrastructure

Heating infrastructure and space

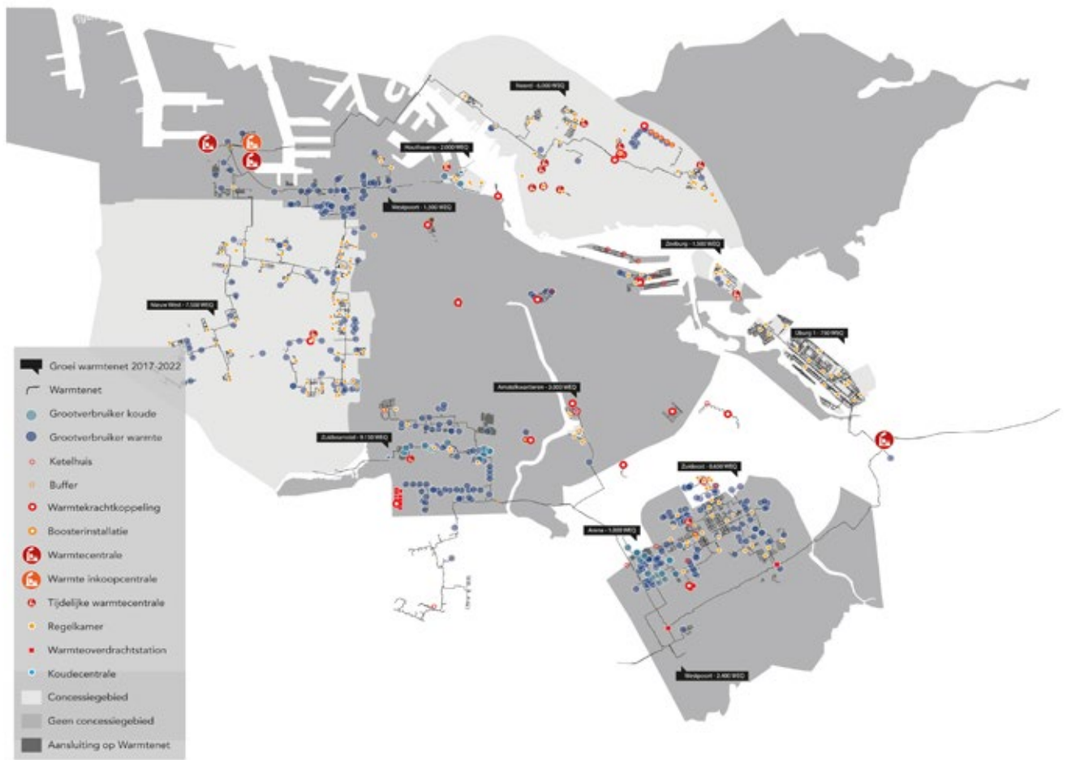
Amsterdam has an extensive district heating grid, and smaller district cooling grids in the south of the city. Some district heating grids are connected to district heating grids in the Amstelland sub-region (Diemen power plants). Most of the residual-heat sources that are capable of supplying HT residual heat are located in the port area (Waste-to-Energy Plant).
A large number of LT residual-heat sources, such as data centres, are located on the periphery of Amsterdam.

To meet the city's future need for renewable heat, the district heating grid must be expanded and made future-proof, in terms of temperature regimes. In the TVW, the most suitable heating infrastructure is specified at local level. This is a major challenge for Amsterdam.

At regional level, the heating infrastructure reflects the distribution of supra-municipal heat sources.

Geothermal energy and space

Once the facility is complete, the above-ground space requirements for geothermal energy are limited (no more than 10m x 10m). However, a working space many times larger than that is required for the initial drilling operations. For a doublet system capable of furnishing about 3,000 to 10,000 households with



Amsterdam's current HT and MT district heating grids (2017) *Source: Vattenfall GIS database*

heat, the space requirement amounts to an average of one football field.

Follow-up steps: coordination within the region

Distribution and allocation of supra-municipal heat sources

The explicit aim of the RES is to facilitate cooperation with others in the region. While work is proceeding on the partial RES for Amsterdam, and in conformity with that strategy, Amsterdam and the other sub-regions will discuss the best way to coordinate the use of supra-municipal heat sources. In addition, this discussion should explore the issue of coordination between heat sources and the distribution system. It should also address the efficient use of these facilities, and the 'where and when' of regional heat. In this context, the City of Amsterdam is already taking the initiative to find ways of giving this a more tangible form, together with the Amsterdam Metropolitan Area's Heating/Cooling programme.

Geothermal energy acceleration programme
Energiebeheer Nederland is conducting a national study to identify sites where the subsurface may be suitable for the extraction of geothermal energy. This study is scheduled to explore the Amsterdam area in January. The results, which are expected by the end of 2020, should clarify the potential of geothermal energy as a source in the transition to gas-free neighbourhoods.
In the context of the Geothermal Acceleration Project, the provincial authorities of Noord-Holland and Flevoland are tackling public-private coordination, in cooperation with the City of Amsterdam (Amsterdam gas-free programme).

Residual heat from data centres programme
The City of Amsterdam is running several pilot projects in the city to determine the extent to which residual heat from data centres could be used for the purpose of space heating in buildings. Together with a regional data centre strategy, the City's business location policy for data centres will specify choices that will determine the potential scope for the use of residual heat. This will be submitted for decision-making in the first quarter of 2020. The anticipated heating potential is expected to be in line with the 'low growth scenario' (Bronnenboek Amsterdam; warmtevraag en -aanbod in beeld (Amsterdam Sources Book; heat supply and demand in focus)).

Low Temperature Heat – Aquathermal Energy Programme
In the context of a formal cooperative venture, the City of Amsterdam and Waternet have launched the Low Temperature Heat – Aquathermal Energy Programme. This programme specifies the potential of aquathermal energy for the city, the ideal organizational structure for the heat chain, and which pilot projects appear to hold the greatest potential.

2.4 Infrastructure

Relationship between the RES and the power grid

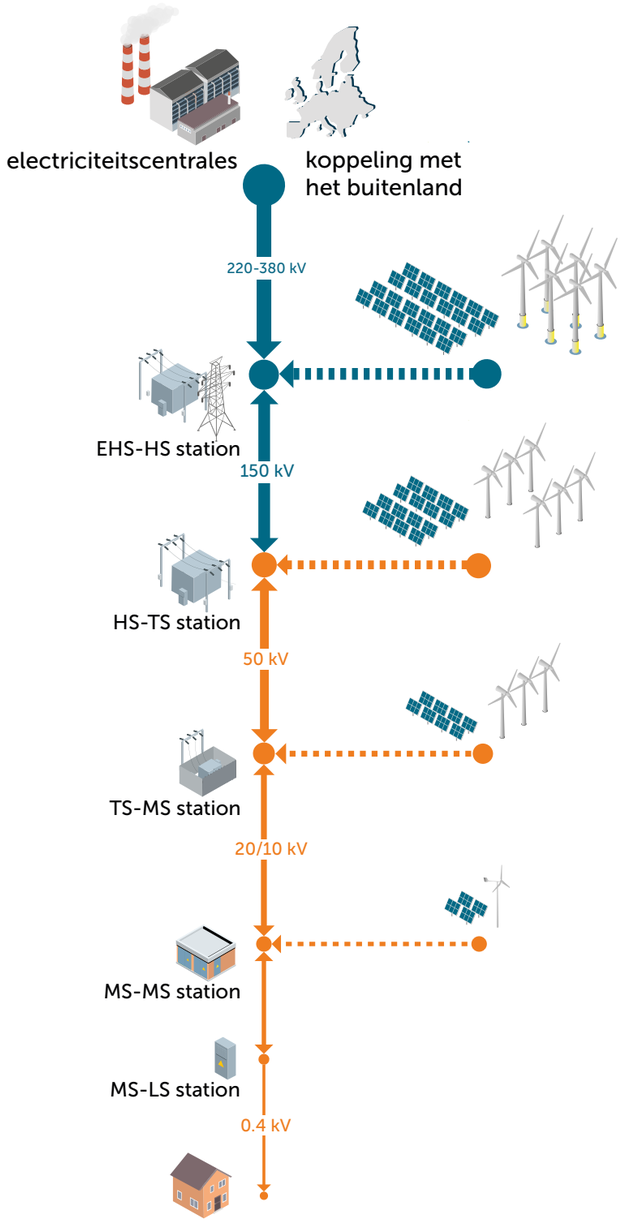
If we are to properly integrate facilities for the generation (or large-scale generation) of renewable energy, we need to have sufficient capacity on the power grid. This is taken into account in the spatial planning of future renewable generation capacity. On the other hand, Liander also takes the plans for renewable generation into account when planning Amsterdam's electricity infrastructure.

The power grid's capacity for large-scale generation

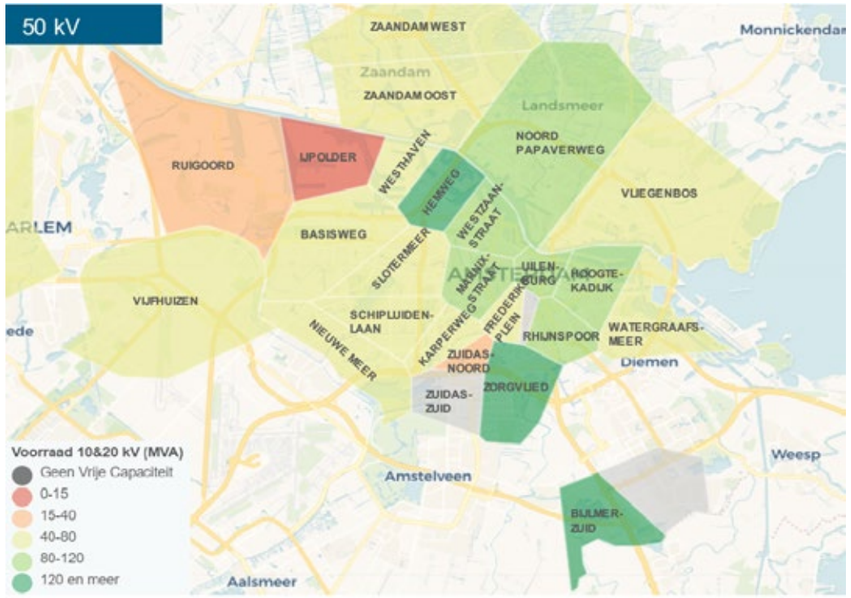
Liander has produced maps showing how much power Amsterdam's various substations are able to handle. These distinguish between 150 KV substations and 50 KV substations. These maps show that most substations in Amsterdam still have sufficient capacity to accommodate renewable generation. The port area (IJpolder substation) is the only site whose capacity is still limited in this regard.

Supply and demand of power

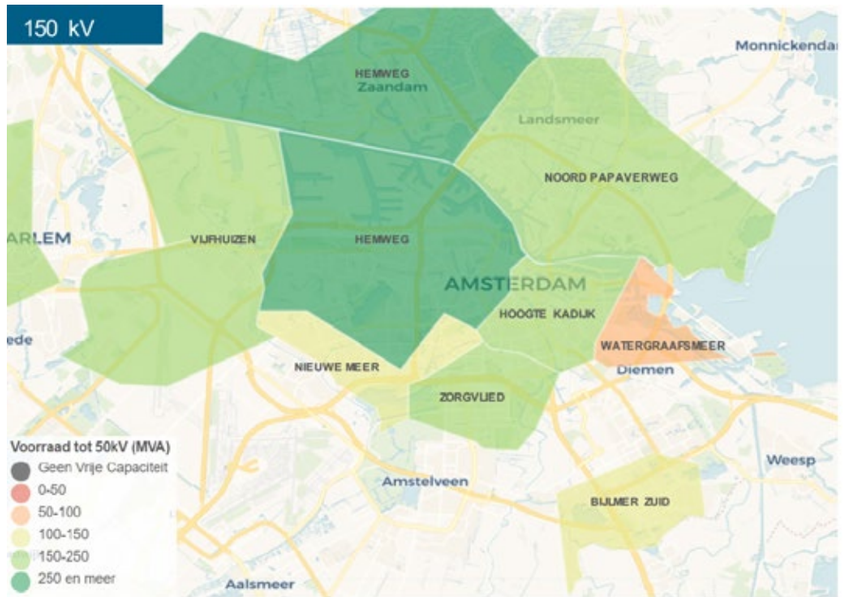
Renewable generation is not the only development that Liander has to take into account when planning Amsterdam's power grid. The network's configuration is also determined by electricity demand. This will be boosted by various developments, such as housing construction, gas-free neighbourhoods, the electrification of mobility, and the creation of data centres. In addition, the power grid itself will change as innovations are introduced.



Users are connected at different voltage levels, with larger users having higher kV levels



Capaciteit 50 kV onderstations



Capaciteit 150 kV onderstations

Thematic study into Amsterdam's Electricity

The City of Amsterdam and Liander have jointly explored the ways in which the plans for – and developments in – Amsterdam will impact the city's power grid. This Thematic Study into Amsterdam's Electricity (March 2019) explored the impact of the city's growth. It also addressed the aspirations and developments with regard to the energy transition and changing mobility. The Thematic Study into Amsterdam's Electricity is updated every two years, based on new insights. The first update, which is planned for the spring of 2020, will feature aspirational input from the RES.

The study formulated four scenarios: low, medium, high, and 'special'[3]. The determining factors/themes involved are the city's growth, making the housing stock gas-free, solar, electric mobility and industry, data centres, and large-scale generation.

Very rapid rise in demand, with a large margin of error

The pace of development is extremely rapid. By 2050, the demand for power will be two and a half times (low scenario) to five times (high scenario) higher than it was in 2018. Data centres have the greatest 'net impact'. Capacity will be determined by the so-called substations (urban scale). The Thematic Study into Amsterdam's Electricity (2018) shows that, in a 'medium' scenario, the capacity of 17 of the 24 substations will be exceeded by 2030. In addition, space for extra infrastructure is required at neighbourhood level. The integration of infrastructure into the subsurface is an issue that requires extensive consideration.

Strategy: three tracks

To achieve a future-proof power grid in light of these developments, Liander and the City of Amsterdam are cooperating closely on three tracks:

1. Spatial planning of the requisite expansion.
2. Investigating and testing innovative applications designed to reduce the impact on the grid (and the impact caused by the grid itself).
3. The strategic and integrated planning of aspirations and tasks.
   The RES's outcomes serve as input for this purpose

Consideration in the context of the RES

In general, the integration of generating capacity is not a problem in the urban context of Amsterdam. This is because the peak power demands in virtually every part of the city will exceed the peak supply that can be technically delivered. In terms of the capacity of the grid as a whole, supply and demand can be offset against each other. At local level, the integration of solar panels and wind turbines can still create some challenges. These challenges can be resolved, however, simply by expanding the grid. That is why efficient scheduling is essential, especially in the case of large roofs with numerous solar panels. With regard to wind power, the procedures involved in integrating a wind turbine take up more or less the same amount of time as those involved in expanding the power grid.

Follow-up steps

In the near future, we will endeavour to achieve greater conformity with the RES results. What power supply will be involved? When will this happen, and where? Next, a constraint analysis is carried out, after which a strategy is formulated to tackle the bottlenecks involved.

3 The 'special' scenario explores the impact of full electrification of the various themes by 2050, assuming that the city achieves the maximum level of growth.

2.5 Living environment and space

The analyses concerning the generation of electricity, in particular, are rather technical in nature.
The analyses described above have not yet formed the basis for any spatial designs. Sketching exercises show that, from a spatial point of view, there are a number of large-scale landscape elements that can create added value in spatial integration, in a regional context. The figure in the box below identifies various spatial leads.

Spatial opportunities

- **As an industrial line bisecting the landscape, the Amsterdam Rhine Canal is well suited as a site for two rows of wind turbines, one along each bank. There is an opportunity to tackle this and work out the details, in cooperation with Diemen and Weesp.**
- **Waterland: small-scale peat and polder landscape, where integration into the landscape has the highest priority. From a spatial perspective, a useful option would be to integrate smaller wind turbines (or other variants).**
- **As a major industrial canal adjoining several key nodes of the energy network, the North Sea Canal is well suited as a site for two rows of wind turbines, one along each bank. Tackle this in cooperation with Zaanstad, Haarlemmermeer, and IJmond.**

Sketch spatial opportunities for wind energy in a regional context

The energy transition is having a major impact on the physical living environment. It will be one of the greatest spatial planning challenges of the upcoming decades. The renewable energy systems concerned require more space than the fossil alternatives. In addition, different systems will have to co-exist, albeit on a temporary basis. Renewable energy also tends to have a much greater visible impact. This transition will change the look of our cities and landscapes. As a result, the transition will directly impact people's living environments, in ways that are both visible and tangible. In every municipality, the energy task must be combined with other transitions and major challenges, such as housing construction and climate adaptation.

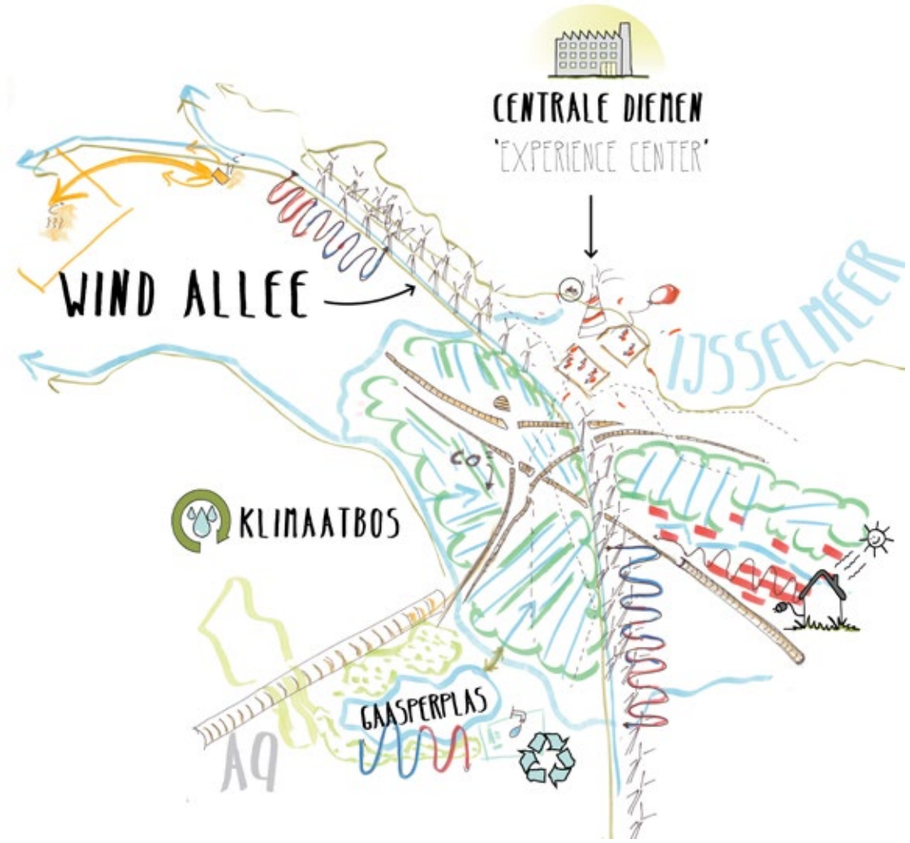
Important points concerning space and the living environment

The generation of renewable energy takes up a lot of space
The large-scale generation of renewable energy requires space. In a compact and growing city like Amsterdam, such space is in short supply. The city, conurbation, and metropolitan area make up a palette of very diverse landscapes. There are industrial sites, the port, central urban areas, garden cities, dunes, large open bodies of water, peat meadow areas, wooded areas, and linear elements such as canals, motorways, railway lines, infrastructure, etc. The differing spatial structures and cultural histories of these areas present opportunities for – and pose obstacles to – the generation of energy.

Collating the various tasks
Aside from their different core qualities and spatial characteristics, each of these areas have their own specific tasks or challenges. In some cases it is the rapid growth of the city, in others it might be climate adaptation, soil subsidence in the peat meadow area, declining biodiversity in rural areas, a port area that is seeking sustainable avenues for the future, growing mobility, etc. None of these tasks can be seen as distinct and separate from the task of generating energy. Smart combinations are being created (and opportunities exploited) that also yield spatial quality.

Finding solutions together
The City of Amsterdam is convinced that, if we are to achieve integrated solutions, knowledge must be shared at every organizational level. It is committed to advancing plans for the large-scale generation of energy and for heat sources, as well as for the requisite heating and power infrastructures.

Visualization and the exploration of new techniques
The process of picturing and sketching potential visions of the future makes them more tangible, opening the way for discussions of what people do – or do not – want. In doing so, there must be scope to think outside the box (or outside the legal framework), to deliver ideal, integrated solutions of the highest spatial quality. Consideration should also be given to a range of currently available, innovative techniques for generating solar energy, wind energy, and heat energy. So, aside from existing large wind turbines, this could involve smaller versions (or other variants) that could be more effectively integrated. Small wind turbines are very inefficient, so awareness and visibility are key aspects here.



Visualization of Diemen's 'wedge' (green area)

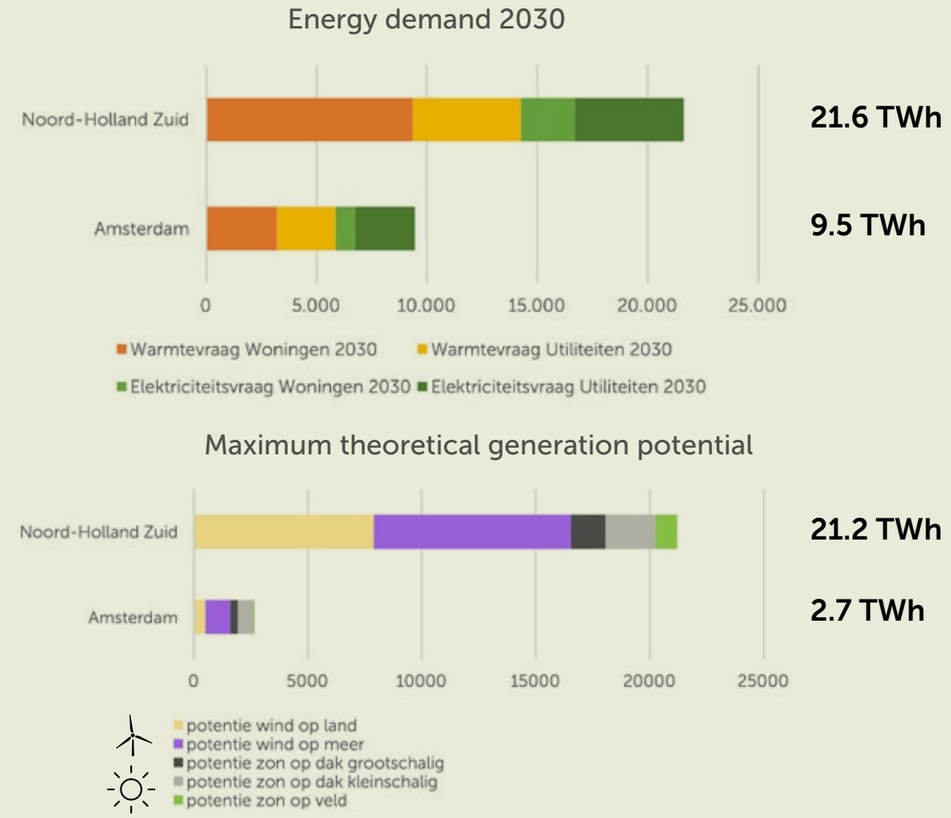
3.

Process: analysis, scenarios, and workshops

Amsterdam is contributing to the Noord-Holland Zuid energy region's joint process for arriving at a Draft RES. Amsterdam has now completed steps 1 to 4: the task, scenarios, local enrichment, and an administrative offer. In this section, we explain the approach behind these four initial steps and list the results obtained, before outlining the follow-up process.

3.1 Step 1: The task

At the beginning of 2019, the RES process started by visualizing the task at hand. What is the current demand for heat and power, and what trend will this follow in the run-up to 2030? The current supply (and potential) of electricity generation capacity and heat sources have also been visualized. This evidence base – a series of analysis maps – was captured in a so-called 'photograph'. In the course of four workshops (three regional ones and one specifically for Amsterdam), various experts, civil servants, stakeholders, and council members provided supplementary information. The analysis conducted by Amsterdam and Liander in the Thematic Study into Amsterdam's Electricity (March 2019), the Bronnenboek Amsterdam; warmtevraag en -aanbod in beeld (Amsterdam Sources Book; heat supply and demand in focus) (end of 2019), and the 'photograph' all complement one another.



Energy demand (heat and power) for Amsterdam and the Noord-Holland Zuid energy region, and their theoretical energy potential.

As a region, Amsterdam has a relatively high level of demand for heating and power for its built environment (homes and utilities such as commercial buildings, offices and shops, as well as schools and hospitals). Its demand for power is 3.8 TWh, which accounts for about half of the Noord-Holland Zuid region's total power demand. The expectation is that the electricity demand for the built environment (homes and utilities) will decline in the run-up to 2030. However, the expected electrification of the heating demand has not been taken into account as it cannot easily be quantified. Nor does the RES analysis take the future growth of electric mobility, industry, and data centres into account. In the Thematic Study into Amsterdam's Electricity, assumptions are made concerning the speed and impact of these trends on the demand for power (see subsection 2.4). The current heating demand of Amsterdam's built environment amounts to 6.9 TWh, which will probably fall to 6.1 TWh by 2030. Amsterdam does not have sufficient generation potential to meet its own demand for heating and power. Not even when every single option for energy generation is exploited as effectively as possible.

Amsterdam anticipated events in the other regions by starting work on the scenarios during the last two meetings. Those present identified various priority areas and aspirations in the region, and then considered ways of incorporating them into the energy transition. This resulted in the formulation of an initial sketch of the scenarios ('guiding principles'), as a prelude to the extremes (the 'vertices') of the energy transition in the Amsterdam sub-region. The scenarios addressed during this phase were: Euros, Super liveable, healthy and green, and Maximum energy generation. This formed the input for a more detailed specification of the scenarios in step 2.

Result of Step 1: 'Photograph energy and space'

The photograph labelled *Energie en ruimte deelregio Amsterdam* (Energy and space in the sub-region of Amsterdam) is one of the results obtained in step 1. The photograph provides insight into the current and future task. It also reveals the available options for the generation of renewable energy, as well as the sub-region's landscape characteristics and spatial constraints. Finally, it indicates the levels of involvement and ideation among stakeholders and civil servants.

The results are set out in a document containing all the map images and factual descriptions[4].

The photographic document consists of a set of analysis maps. It addresses the themes of landscape, heating, and power. The main conclusions for Amsterdam are:

- In general, there is limited space available in Amsterdam for the generation of renewable energy.
- However, thanks to a new provincial policy ('yes, provided that'), more space can potentially be created for the generation of wind energy. On the other hand, calculations of the potential do not include the helicopter route above Amsterdam, which will reduce the potential amount of available space in the port area (if the helicopter route cannot be moved).
- The potential analysis (maximum) for solar energy shows that the space available for solar energy generation on roofs is much greater than the solar energy potential on agricultural land. The solar energy potential on roofs is 75 percent of the total. The remaining 25 percent is the solar potential on agricultural land, on bodies of water, and on all of the remaining types of substrates combined.
- Throughout most of the region, the grid has sufficient capacity to handle renewable energy.
- Amsterdam has an extensive district heating grid, and smaller district cooling grids in the south of the region. There are also a range of heat sources that – in combination with a heat pump – can supply heat (data centres, port area, etc.). Currently, AEB and Vattenfal are the main residual-heat sources. In addition, Amsterdam is currently using supra-municipal heat sources, in the form of the Diemen power plants.

4 The full document can be found at https://energieregionhz.nl/documenten.

3.2 Step 2: Scenarios

In the summer of 2019, Amsterdam held two 'workshops for the future'. Those taking part in the first of these workshops presented five scenarios – Liveable, Euro economy, Euro cost effectiveness, Energy, and Maximum CO_2 reduction. To facilitate the workability and clarity of the discussion, these were reduced to three scenarios, which were then specified in greater detail. These scenarios are: 'Maximum Energy', 'Cost Effective', and 'Liveable'.

Scenarios are images of potential futures. They are intended to provide insight into the associated choices and impacts. The scenarios are not intended to be substantive scopes for action that require us to choose between them. Instead, they are tools for facilitating the conversation.
Various partners from the municipality, professional stakeholders, and society at large were involved in drawing up these scenarios.
The starting point for all these scenarios is the current objective of the City of Amsterdam Executive's agreement and of the Roadmap for a Climate-neutral Amsterdam, as described in subsection 1.2.

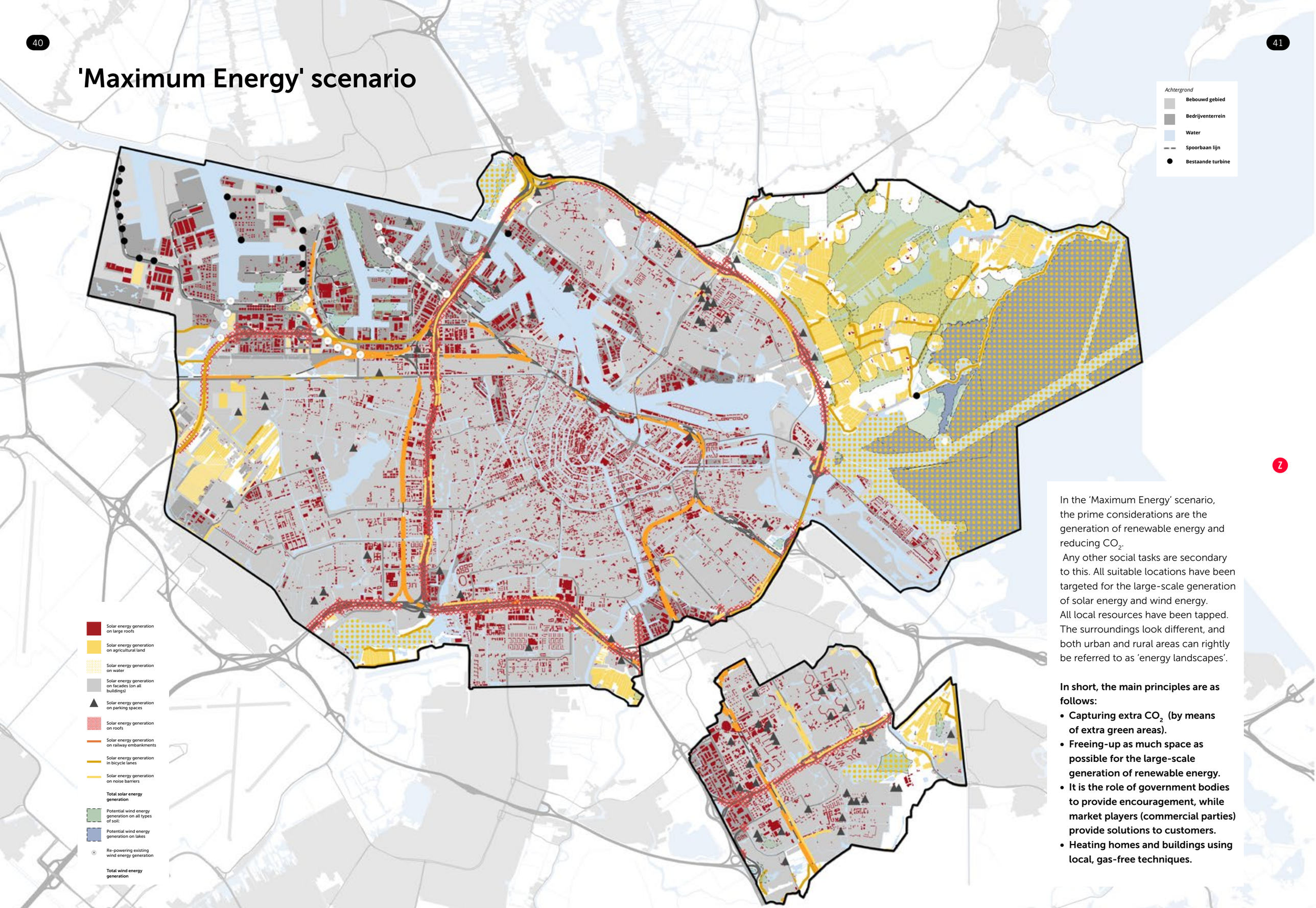
The three scenarios that had been formulated were presented in the second workshop for the future, but this time they included the impacts per scenario. The aim of this session was to ask the participants whether the scenarios are clear, to identify key areas of tension between the starting points in the scenarios and current tasks in Amsterdam, and to specify the roles of various stakeholders in the scenarios. The resultant input from the participants has been incorporated into the final scenarios.

'Building blocks' for constructing scenarios
Each scenario is made up of various so-called 'building blocks'. A building block corresponds to a given energy generation technique (e.g. a wind turbine), in a given place (e.g. agricultural land), under given conditions (e.g. alongside the motorway). This particular building block will then be referred to as 'wind turbine on agricultural land alongside the motorway'. The scenarios were constructed using different types of building blocks.

Result of step 2: Three scenarios: 'Maximum Energy', 'Cost Effective' and 'Liveable'
The workshops for the future delivered three scenarios – 'Maximum Energy', 'Cost Effective', and 'Liveable', which are summarized in map images. The building blocks of these scenarios have been described and their impact calculated using mathematical models. These include impacts such as generated power, contribution to CO_2 reduction, costs and yields, as well as the impact on the natural environment and the landscape. The scenarios are used to facilitate an optimal choice of building blocks for Amsterdam's ultimate contribution. So there is no question of choosing one scenario in preference to another.

Details of the scenarios, building blocks, and impact calculations are set out in posters. These can be found at https://energieregionhz.nl/documenten.

'Maximum Energy' scenario

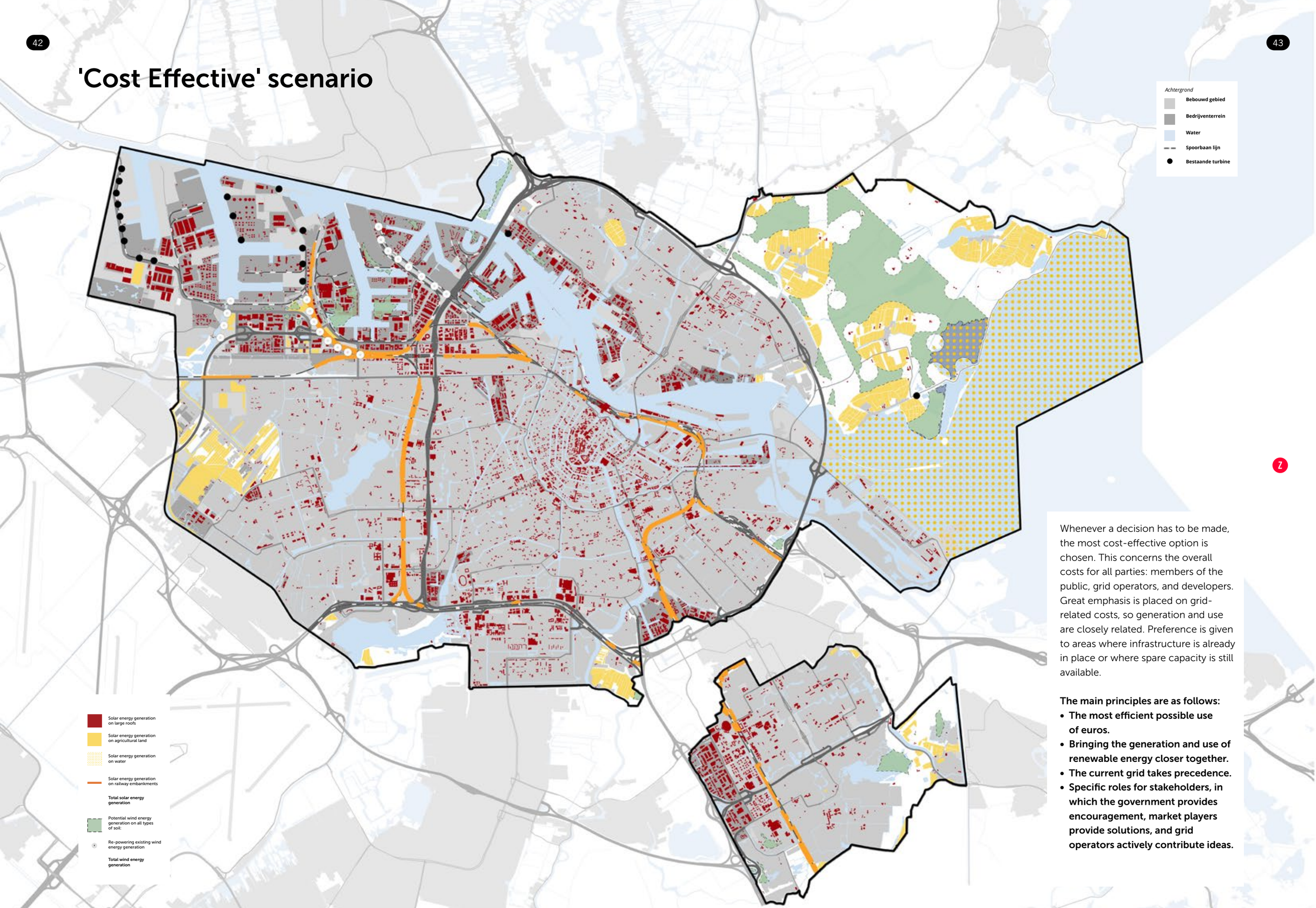


In the 'Maximum Energy' scenario, the prime considerations are the generation of renewable energy and reducing CO_2.
Any other social tasks are secondary to this. All suitable locations have been targeted for the large-scale generation of solar energy and wind energy.
All local resources have been tapped. The surroundings look different, and both urban and rural areas can rightly be referred to as 'energy landscapes'.

In short, the main principles are as follows:

- **Capturing extra CO_2 (by means of extra green areas).**
- **Freeing-up as much space as possible for the large-scale generation of renewable energy.**
- **It is the role of government bodies to provide encouragement, while market players (commercial parties) provide solutions to customers.**
- **Heating homes and buildings using local, gas-free techniques.**

'Cost Effective' scenario

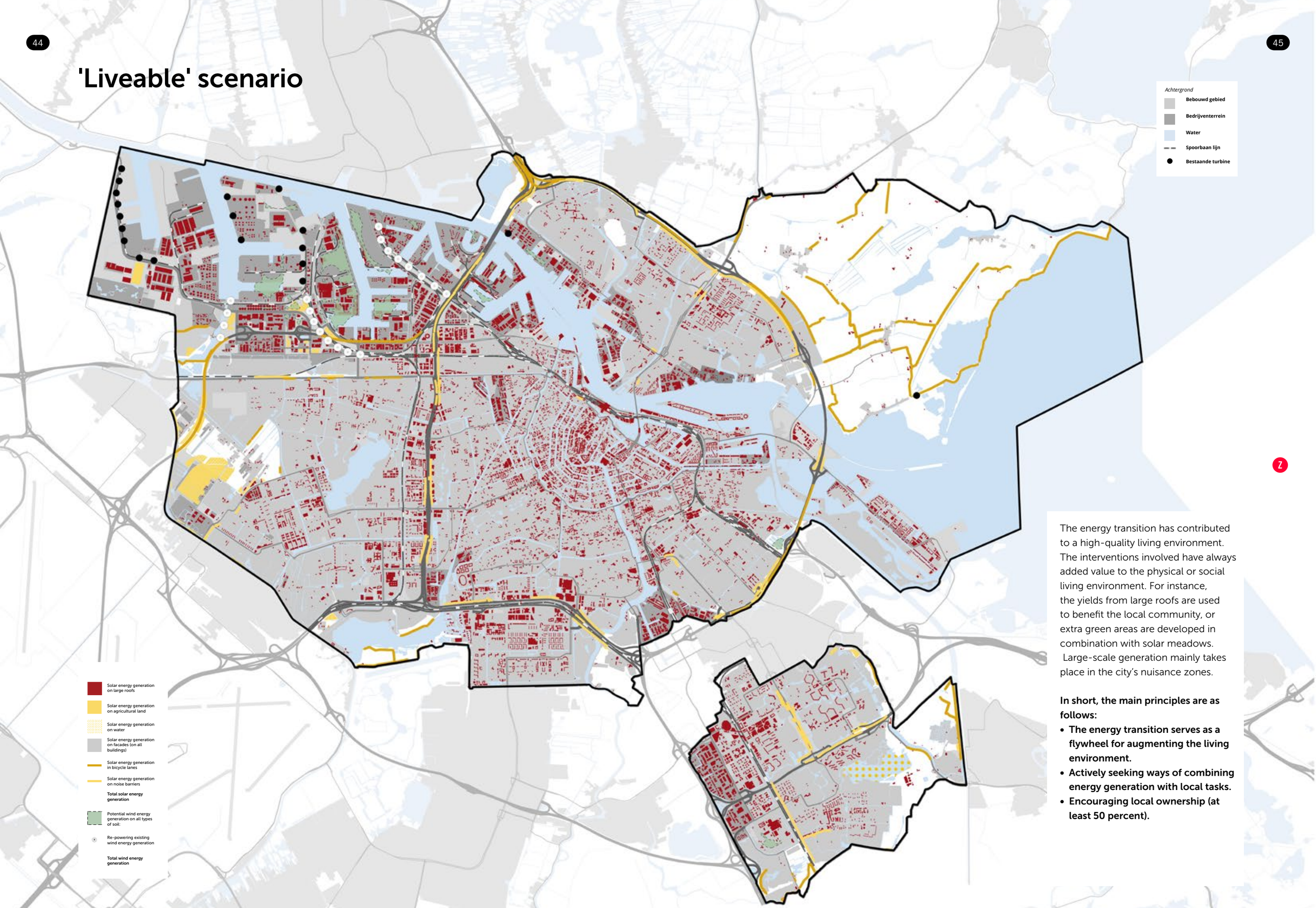


Whenever a decision has to be made, the most cost-effective option is chosen. This concerns the overall costs for all parties: members of the public, grid operators, and developers. Great emphasis is placed on grid-related costs, so generation and use are closely related. Preference is given to areas where infrastructure is already in place or where spare capacity is still available.

The main principles are as follows:

- **The most efficient possible use of euros.**
- **Bringing the generation and use of renewable energy closer together.**
- **The current grid takes precedence.**
- **Specific roles for stakeholders, in which the government provides encouragement, market players provide solutions, and grid operators actively contribute ideas.**

'Liveable' scenario



The energy transition has contributed to a high-quality living environment. The interventions involved have always added value to the physical or social living environment. For instance, the yields from large roofs are used to benefit the local community, or extra green areas are developed in combination with solar meadows. Large-scale generation mainly takes place in the city's nuisance zones.

In short, the main principles are as follows:

- **The energy transition serves as a flywheel for augmenting the living environment.**
- **Actively seeking ways of combining energy generation with local tasks.**
- **Encouraging local ownership (at least 50 percent).**

Unsurprisingly, the ‘Maximum Energy’ scenario delivers the highest energy yield and the greatest CO_2 reduction. However, it also has adverse impacts on land use, landscape, and biodiversity. The ‘Liveable’ and ‘Cost Effective’ scenarios cost less money and take up less space, but they also provide less energy and achieve smaller reductions in CO_2. The impacts are valued in relation to each other, with the exception of the impacts on the natural environment and the landscape. Each and every scenario involves adverse impacts on the landscape and on biodiversity.

3.3 Step 3: Local enrichment

Four local workshops involving residents

The three scenarios were presented in local workshops for the people of Amsterdam. Here, an assessment was made of the support base for each of the scenarios and for the various types of renewable generation featured in them. A total of four local workshops were held, for the following subareas – Noord, Oost/Zuidoost, Havengebieden/West/Nieuw-West, and Centrum/Zuid, plus an additional meeting for Zuidoost. In the course of these evenings, the following question was posed: “Where, in what form, and subject to which conditions is renewable energy generation suitable for Amsterdam?” The scenarios were jointly discussed in small groups, and people’s questions were answered. Next, the favourite and least popular building blocks were marked with stickers.

Open invitation – “Join the conversation about the large-scale generation of renewable energy”

Members of the public and representatives of the people of Amsterdam were all invited. Invitations were sent out through the City of Amsterdam’s channels (outlying districts and the central region of the city) both online and via social media, through energy transition trailblazers, and through municipal contacts. Representatives of the city council, the district committees, and the Provincial Council were also invited, together with administrators from the various districts. The tone of the meetings was positive, profound, and very much focused on the content. Each of these meetings were reasonably well attended (around 30 people).

Most of those who attended these local workshops expressed a preference for the ‘Liveable’ scenario, followed by ‘Maximum Energy’. In the workshop held for the Centrum/Zuid districts, ‘Maximum Energy’ was the most frequently chosen scenario, followed by ‘Liveable’.

Preference for the ‘Liveable’ and ‘Maximum Energy’ scenarios

Generally speaking, the appeal of the ‘Liveable’ scenario was due to its underlying guiding principles concerning the involvement of members of the public and residents, and to the preservation of green space for a liveable (quite literally) city. At the same time, there was some concern that the ‘Liveable’ scenario would not deliver sufficient renewable generation capacity. For this reason, the participants of several workshops selected additional building blocks, mainly from the ‘Maximum Energy’ scenario. Aside from the level of renewable generation capacity involved, people also found the pace of the ‘Maximum Energy’ scenario quite appealing. Both residents and stakeholders stated that the energy transition can no longer be delayed.

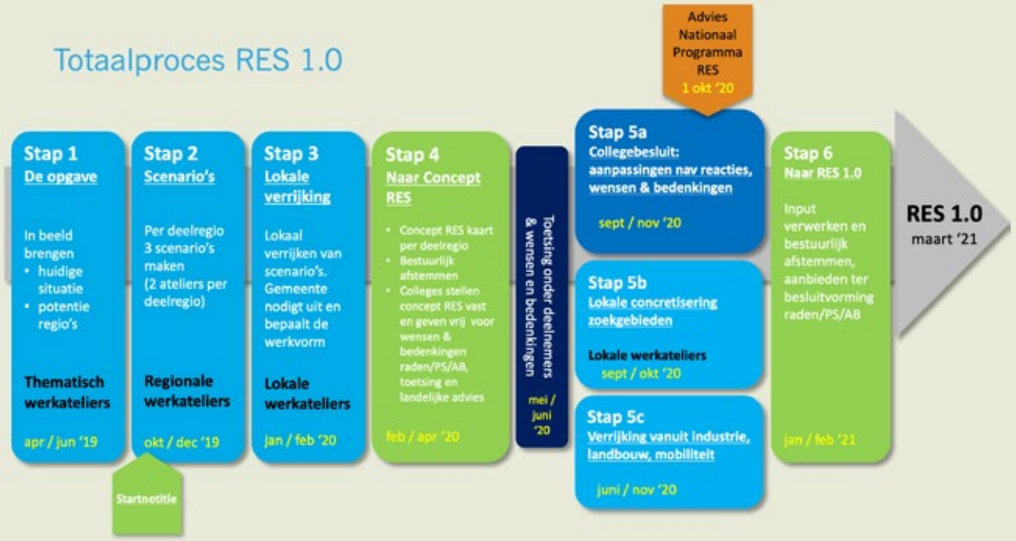
‘Cost Effective’ was the least popular of the three scenarios. Residents and stakeholders take the view that, if we rely on market forces to bring about the energy transition, the process of change will be too slow and it won’t go far enough. In addition, this scenario offers too little scope for the involvement of members of the public.

In summary, during the workshops, the residents and stakeholders stated that Amsterdam should pursue an aspirational energy policy. In this connection it is important for the municipality to involve residents, to guarantee people’s quality of life in Amsterdam, and to protect green areas in and around the city.

Photographs from the RES workshops for residents ▶

3.4 Step 4: Towards an offer

Having made its choice, Amsterdam has designated specific search areas and drawn up an offer. In step 4, the contributions of each of the sub-regions are combined to create the Draft RES for the Noord-Holland Zuid energy region. When this information is collated, it will show which tentative search areas and potential heating/cooling solutions augment one another or, perhaps, trigger a lively debate, while offering the scope to explore options beyond the city's (or sub-regional) boundaries. The Draft RES will be discussed at the administrative level, and the city's districts will also have a part to play in this process.



RES process steps for Noord-Holland Zuid

4.

Follow-up steps

RES for Amsterdam will become part of the RES for Noord-Holland Zuid

The Regional Energy Strategy of the Amsterdam sub-region is part of the overall energy strategy for the entire Noord-Holland Zuid (NHZ) region.
To ensure that the Draft RES for NHZ is a spatially coherent analysis and strategy, the Amsterdam sub-region's results will be collated with findings from other sub-regions.
This will show which of the selected search areas and heating/cooling solutions augment one another or, perhaps, trigger a lively debate.

ollating the results from different sub-regions

The follow-up step in the process is to collectively draw an overall conclusion from these results, to augment one another across local (or sub-regional) boundaries, to provide coherence, to learn from one another, and to ensure that one plus one equals three. This follow-up step will be completed by the energy region's representatives. Together with the responsible portfolio holders and (for Amsterdam) the city districts, they will initiate a dialogue with one another. The goal is to shine a light on potential choices and considerations, which can then be translated into wishes and concerns.

Submitting the Draft RES to central government and to the workshops' participants, for consultation purposes

In June 2020, The Draft RES for the NHZ energy region will be submitted to the PBL Netherlands Environmental Assessment Agency and to the National RES Programme, for processing by mathematical models. Copies of the Draft RES will also be submitted to all of those who participated in previous workshops, for consultation purposes.

From Draft RES to RES 1.0

Once the Draft RES has been sent to the PBL Netherlands Environmental Assessment Agency and to the National RES Programme, the process of drawing up RES 1.0 will commence. A key part of this process involves specifying potential sites for wind turbines or solar meadows. We will explore this issue in local workshops. This is incorporated into RES 1.0, together with the results obtained from the PBL Netherlands Environmental Assessment Agency's and the National RES Programme's mathematical models, plus the responses to the Draft RES in the course of the consultation period. From that point onwards, the RES will be updated every two years. A similar development process is being drawn up for this purpose as well. That will provide ample scope for residents to make their voices heard.

What do we need from central government?

Current central government resources and instruments are not all sufficiently suitable – or sufficiently clear – to make an effective contribution to the energy transition. The issues include:

- Clarity concerning new or replacement schemes for net metering, the Reduced Tariff Scheme (also known as a postcoderoosregeling or 'postcode-targeted scheme')[5], and the Renewable Energy Incentive Scheme (SDE).
  By influencing the payback period for solar panels, these government schemes can impact the growth in the number of solar panels in Amsterdam. The current schemes are nearing their end dates, and the resultant lack of clarity is causing roof owners to postpone any related initiatives.
- It should be possible to submit applications for Renewable Energy Incentive Scheme subsidies at any time of year, to avoid delaying projects for the large-scale generation of energy on roofs.
- Central government has announced that it will give municipalities the option of making it mandatory for specific roof owners to install solar panels. We need clarity about these schemes, to encourage roof owners to take action. The City of Amsterdam would very much like to see central government develop an instrument of this kind. Ultimately, schemes like this are also needed to spur any laggards into action.
- It is still the case that, in some new buildings with large roofs, little or no renewable energy is generated on this roof space. Moreover, some of these roofs are totally unsuited to the installation of solar panels. If we are to hit our targets, then the Buildings Decree needs to be amended to address this issue.

Furthermore, from the grid operators' viewpoint, a number of measures are needed to achieve the Climate Agreement goals. These mainly concern:

- Measures to give grid operators greater scope to manage the current infrastructure more efficiently. This could involve speeding up efforts to connect renewable energy projects to the grid.
- Measures to ensure that more effective use is made of the grid (supply and demand) by producers and consumers.
- Greater legal and financial scope for grid operators to be able to anticipate future developments.

In short, Amsterdam has great aspirations. We want to generate as much clean energy as possible on our own territory. Amsterdam cannot do this alone. The City of Amsterdam is committed to cooperating with partners in this endeavour, especially other local authorities that are responsible for providing the requisite preconditions. Finally, Amsterdam is mainly focusing on the local energy of people in the city, people who are aware of the need for an energy transition and who are keen to play an active part in this.

5 Under this scheme, the members of a cooperative are entitled to an energy tax discount on their energy bills, provided that their electricity is generated locally and renewably.

Annex 1. Sources

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Annex 2. Glossary

Gas-free
Not connected to a gas (fossil fuel) supply. However, the use of green gas is permitted.

Aquathermal energy
Sustainable local heating system based on surface water.

Biomass
Vegetable and animal material (residual waste) that is used as raw material for energy generation or directly, as biofuel.

CO2 neutrality
Reducing the CO2 footprint by minimizing CO2 emissions. The ultimate goal is to neutralize greenhouse gas emissions, partly by means of compensatory measures.

Renewable energy/heat sources
Renewable energy is generated from sources that cannot become exhausted. A more limited definition of renewable energy is occasionally used, namely: energy from sources that cannot become exhausted and that do not pollute.

Energy cooperative
An energy cooperative is a cooperative that focuses on promoting the use of a given renewable energy supply.

Energy neutral
A situation in which the energy consumption of a built structure (house, building, neighbourhood, engineering structure, and the like) is no more than zero (measured over the course of a year).

Energy region
The Netherlands has been divided into 30 energy regions for the purposes of the Regional Energy Strategy process. Each of these regions is required to indicate how much renewable heat and power can be produced on its own territory.

Energy transition
Structural shift to a renewable energy system.

Geothermal energy
Geothermal energy uses the Earth's natural inner heat.

GWh
Gigawatt hour: unit of energy that can be supplied on an annual basis.

Renewable energy
Clean, sustainable, and inexhaustible energy that does not harm the environment.

Climate neutral
The phrase 'climate neutral' refers to specific activities that have no adverse effect on the climate. In other words, they produce no CO2 emissions.

Thermal energy (cold/hot) storage
The storage of cold or heat for the purpose of cooling or heating water (tap water) or buildings, for example.

MW
Megawatt: unit of electrical power.

National Climate Agreement
The Dutch interpretation (June 2019) of the Paris Climate Agreement, consisting of more than 600 agreements between companies, civil society organizations, and local governments, to halve greenhouse gas emissions by 2030, relative to 1990.

Spatial vision
Central government, the provincial authorities, and the municipalities will each draw up a spatial vision. This will take the form of a strategic, long-term vision for the entire physical environment.

Regional Energy Strategy (RES)
The National Climate Agreement's national agreements will be formulated into 30 Regional Energy Strategies. Each region is required to examine its own demand for heat and power, and to indicate how much renewable heat and power can be produced on its own territory.

Regional Structure for Heating (RSW)
The section of the RES that covers heat is referred to as the RSW. That abbreviation stands for Regionale Structuur Warmte (Regional Structure for Heating). The RSW identifies the supply and demand for heat, as well as the associated infrastructure.

TWh
Terawatt hour: unit of energy that can be supplied on an annual basis. 1 TWh is 1,000 GWh.

Transition Vision for Heat
The Transition Vision for Heat stipulates the period within which districts must become gas-free. It also identifies the most obvious alternative heat supply.

Thermal energy (hot/cold) storage
See: Thermal energy (cold/hot) storage.

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www.energieregioNHZ.nl

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