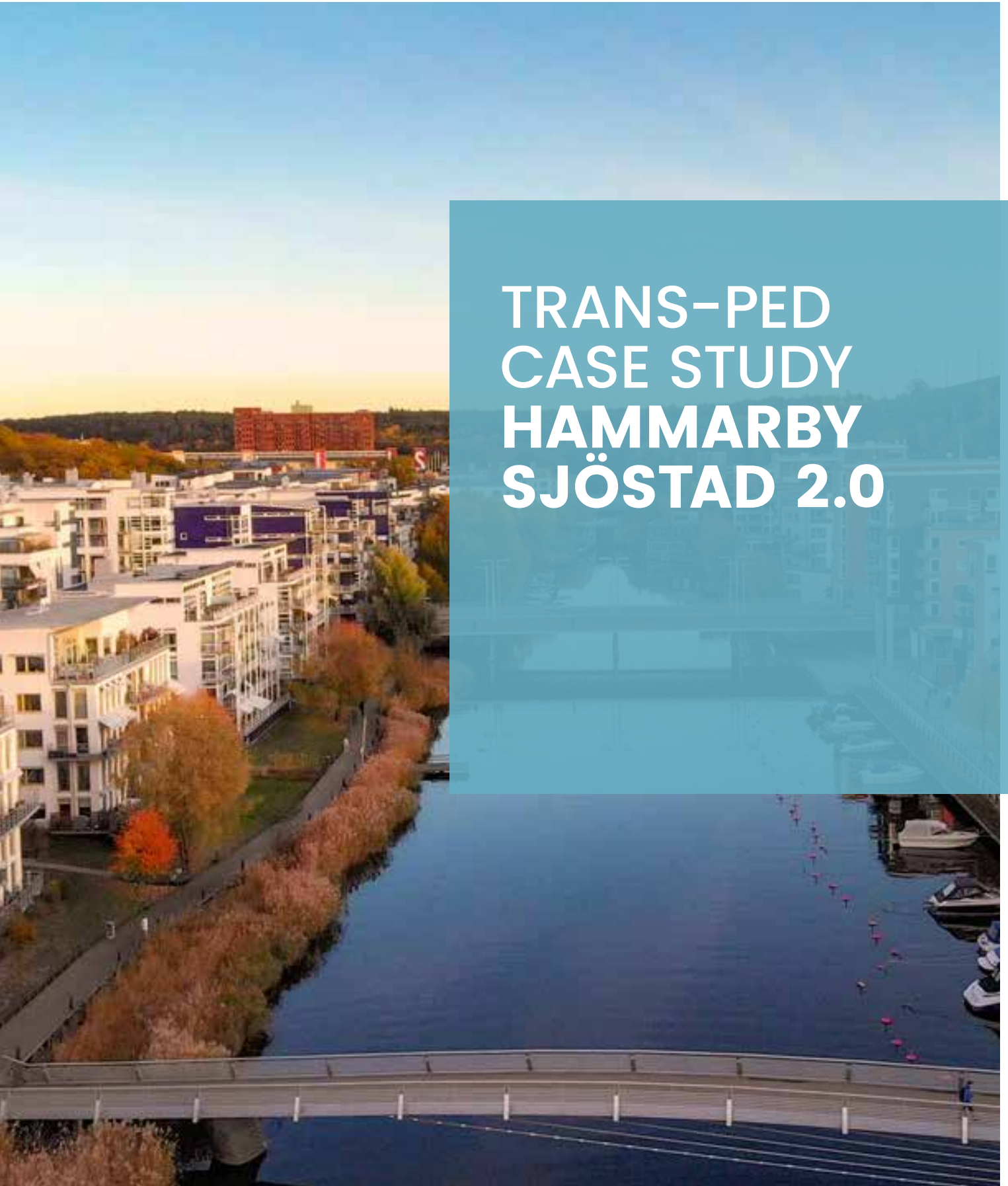


TRANS PED

TRANSFORMING CITIES
THROUGH POSITIVE
ENERGY DISTRICTS

TRANS-PED CASE STUDY HAMMARBY SJÖSTAD 2.0



TRANS-PED CASE STUDY HAMMARBY SJÖSTAD 2.0

Hammarby Sjöstad 2.0 is a project that ambitions to make the Hammarby Sjöstad PED a leader in climate change with the goal to be climate neutral by 2030. It is operated by ElectriCITY, a citizenship-driven innovation platform that was formed in 2012. In the project, Hammarby Sjöstad serves as a demo site and test bed for innovations in energy, transport, circular economy, digitalization and urban farming. ElectriCITY is trying to create a systems perspective for how energy / transport / circular economy and digitalisation are increasingly integrated. How systems become smarter and more cost-effective when they support each other. A business model for climate neutrality. ElectriCITY believes in sharing knowledge and experiences as a key part of a system shift towards climate neutrality.

DIMENSION 1

TIME**PROJECT HISTORY**

In the 1990s, Hammarby Sjöstad was one of the first urban projects that took the concept of sustainable development to the next level, by closing the environmental loops and developing synergies between utilities, buildings and users. When the building and construction of Hammarby Sjöstad began, the environmental goals were high. It would be a modern district, built on the latest environmental technology. The energy consumption in the properties would be low, more and more people would choose public transport, the waste would be converted into district heating and the food leftovers would be used as biogas that could be used locally by the citizens.

Today, it is clear that not all climate goals of this Hammarby Sjöstad 1.0 have been achieved. Most properties in Sjöstan have higher energy use than the stated goal and many suffer from a lack of technical maintenance. Nothing unique for Sjöstaden unfortunately, it is a very common problem overall. Therefore, the citizens' initiative Hammarby Sjöstad 2.0 was formed in 2012 and operates in the economic association ElectriCITY. The ambition is for Hammarby Sjöstad to be a leader in climate change with the goal to be climate neutral by 2030. The local project is called Hammarby Sjöstad 2.0 and serves as a demo site and test bed for innovations in energy, transport, circular economy, digitalization and urban farming. ElectriCITY believes in sharing knowledge and experiences as a key part of a system shift towards climate neutrality. ElectriCITY acts locally, but thinks globally. The platform's strength is to have leading companies, research institutions and universities as members and close partners while also working together with Sjöstadsföreningen's housing associations and residents in Hammarby Sjöstad.

PROJECT AMBITIONS

By 2025, Hammarby Sjöstad 2.0 wants to accomplish the following:

- At least 60% of the housing associations in Sjöstadsföreningen must be climate-neutral.
- Hammarby Sjöstad must be able to present at least one microgrid for local energy distribution
- A trading unit for energy/power must be tested in practice (2023)

By 2030, Hammarby Sjöstad 2.0 wants to accomplish the following:

- All housing associations in Sjöstadsföreningen must be climate-neutral. Larger proportion with self-produced renewable electricity and energy.
- All externally purchased energy (electricity and heat) which is not climate neutral, must be compensated locally with fossil-free energy production (solar power).
- A prototype of an energy community with a marketplace for energy and power will be tested.



figure 1: learning how the energy system of a building works through the eco-drives action (ElectricITY)

To achieve this, several initiatives have been developed to take the following actions:

- **Save Energy:** Ecodrives is an energy survey where one learns how properties work and how they can save energy through efficiency measures. It has resulted in up to 20% energy cost savings.
- **Community Energy Investments:** The community shares information about planned investments into renewable energy infrastructure. Joint procurement has led to increased investment as well as energy cost reductions by more than 50% for the housing associations.
- **Shared Energy Storage:** In a pilot project, renewable energy will be shared and stored in microgrids. This allows increased interaction between prosumers and consumers, and between system operators and local authorities.
- **E-Mobility:** The project called Charge at Home primarily focuses on smart charging at home, making it easier and more profitable to invest in an electric car. Carpooling is promoted, making sharing easier and electric cars more profitable.
- **Circular Economy:** In Framtidsspanarna, in a two-week period, pupils aged 10 to 13 develop new products or services that have a positive impact on the environment and climate, preferably to be used in Hammarby Sjöstad.
- **Data Lab:** A national platform is created to share data for the real estate industry. It aims to help develop new innovative digital services, such as smart control systems that reduce both energy consumption and the cost to residents.

MAIN REFERENCES

- [Hammarby Sjöstad 2.0 website](#) (in Swedish and English)
- [ElectriCITY Verksamhetsplan 2022](#) Activities and business plan for ElectriCITY Innovation 2022 (in Swedish)

DIMENSION 2

SPACE

GENERAL SPATIAL CHARACTERISTICS



figure 2: aerial view of Hammarby Sjöstad (TRANS-PED, base layer Google Maps)

BUILDING TYPOLOGY AND ACTIVITIES



figure 3: buildings along the waterfront (Laure Blanco)

Most buildings in Hammarby Sjöstad are recent large mid-rise building (5 to 8 storeys). They are constructed to ambitious building standards. The neighbourhood is mainly residential, but also houses SME's and commercial activities.

The ownership structure of housing in the neighbourhood can be divided over four categories: public housing, other rental apartments, housing associations and owner-occupied housing. Table 1 summarizes the amount of dwellings per type of tenure/ownership and per housing type in 2021.

TYPE OF WASTE	APARTMENT BUILDINGS / OTHER HOUSES	HOUSES	SPECIAL NEEDS HOUSING	TOTAL
public housing	435	0	102	537
rental housing	1342	0	107	1449
housing associations	4270	0	13	4283
owner-occupied housing	4	17	0	21
TOTAL	6051	17	222	6290

table 1: dwellings in Hammarby by housing type and type of tenure/ownership in 2021 (data: Stockholms Stad)

Table 2 gives an overview of the evolution of the size of the apartments in Hammarby Sjöstad from 2018 to 2021.

	WITHOUT KITCHEN	1 ROOM	2 ROOMS	3 ROOMS	4 ROOMS	5 ROOMS	NO DATA	TOTAL
2021	227		3153	1208	423	95	2	6051
2020	224	938	3138	1208	423	95	2	6028
2019	219	933	3139	1207	423	95	2	6019
2018	218	929	2976	1178	366	88	2	5757

table 2: apartment sizes in Hammarby from 2018 to 2021 (data: Stockholms Stad)

MAIN REFERENCE

- [Områdesfakta Hammarbyhöjden Stadsdel](#) [statistical factsheet], 2022 (in Swedish)

DIMENSION 3

SOCIAL**SOCIO ECONOMIC PROFILE**

Today, there are about 25,000 inhabitants and workplaces for 10,000 people. As Hammarby is still being developed further, these numbers will rise to 35,000 inhabitants and workplaces for 20,000 people in 2032. Compared to the rest of Stockholm, the neighbourhood has a higher share of inhabitants between 25 and 35 years old and a smaller share of inhabitants that is younger than 20 years. In 2021, 66,9% of the inhabitants between 25 and 64 had a higher education degree (*eftergymnasial*). Only 2,1% of the active population of Hammarby is unemployed, while the average in Stockholm is 3,4%. The average income of the working population in 2020 was 396.300 Swedish kroner (circa €39.500). An overview of the ownership structure of the residential buildings in Hammarby can be found in table 1 from layer 2: space.

MAIN REFERENCE

- [Områdesfakta Hammarbyhöjden Stadsdel](#) [statistical factsheet], 2022 (in Swedish)

ENERGY-RELATED SOCIAL ASPECTS

GRANT SCHEMES

The Swedish government wants to promote solar energy and has allocated funds to support the expansion of solar panels. In Sweden, the County Administrative Board (Länsstyrelsen) is responsible for handling and deciding which candidates are eligible for a solar panel grant. Both companies and private households can apply for it.

- The grant applies to all types of solar panel systems that are connected to a network
- You can receive a maximum of 20% of the installation (both material and work)
- You can receive a maximum of SEK 1.2 million per system and property
- The grant cannot be combined with other grants, such as the ROT deductions (a tax relief for specific labour costs).

The Swedish Environmental Protection Agency (*naturvårdsverket*) supports the installation of charging stations for electric vehicles. The initiative Klimatklivet can provide support for non-public and public charging infrastructure and for public charging for passenger cars. Ladda Bilen is a support for the installation of a non-public charging station at home or workplaces. Those who live in the home or those who are employed at the workplace must be the main users. The grant is given as a lump sum with a maximum of 50 percent of the eligible costs and a maximum of SEK 15,000 per charging point.

The Swedish Energy Agency (*Energimyndigheten*) supports the ongoing microgrid project in Hammarby Sjöstad. The grant is used for salaries, purchased services, equipment and technologies.

MAIN REFERENCES

- [Subsidies for solar panels](#) at the Länsstyrelsen Stockholm website (in Swedish)
- [Klimatklivet](#) at the Naturvårdsverket website (in Swedish)
- [Ladda Bilen](#) at the Naturvårdsverket website (in Swedish)
- [Swedish Energy Agency](#) website (in Swedish and in English)

ENERGY AT HOME (*ENERGI HEMMA*)



figure 4: Energy at Home (ElectriCITY)

One of the initiatives by EnergyCITY for the Hamarby Sjöstad 2.0 project is called Energy at Home, or Energi Hemma in Swedish. The initiative focuses on concrete and often practical work to increase knowledge on energy systems and on how to fix problems. It encourages money-saving investments and reduces energy costs. It includes the following actions:

- ‘Energy meetings’ are a platform where neighbours are informed by each other’s investments, where knowledge is shared and new innovations are presented: *“If my neighbour saves half a million annually by installing an exhaust air heat pump, our housing associations can do it as well.”*
- ‘Ecodrives’ is an energy survey where the energy managers and boards of the housing associations learn how their properties work and, above all, how they can save energy through efficiency. For many properties in Sjöstaden, Ecodrives has led to up to 20% reductions on energy costs.
- Joint procurements enable the partners to realize substantial economies of scale (see figure 5): better terms, lower prices, and reduced risk. This has led to increased investments and to energy costs reductions by more than 50% for the housing associations. To realize this, EnergyCITY brought together all the energy efficiency projects from 12 housing associations into a single program and introduced a joint procurement process by ‘strategic partnering’. ElectriCITY experienced that not only did system integrators get more interesting volumes and so could offer better terms and lower prices. Housing associations felt more secure. Also the exchange of experiences between the associations contributes to a large response for participation in the joint procurements.

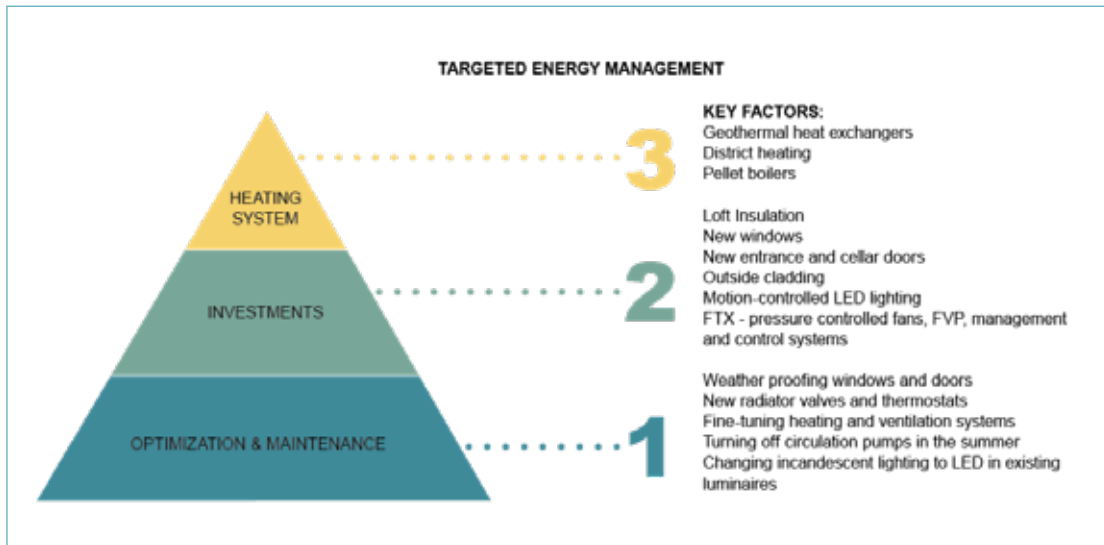


figure 5: Targeted Energy Management is a long-term, transparent agreement between a contractor and the housing association's board whereby a compound set of goals serve to reduce energy consumption while ensuring lower energy costs. (ElectricITY)

20 Housing associations in Hammarby Sjöstad have made investments in energy efficiency improvements, control systems, geothermal heat and solar cells. The result is that the associations have reduced their energy costs by more than 50%. The return on investment varies between the different projects depending on the conditions, but is normally in the range of 8-12%.

MAIN REFERENCE

- [Energi Hemma](#) on the Hammarby Sjöstad 2.0 website (in Swedish and in English)

DIMENSION 4

ENERGY (AND OTHER METABOLIC FLOWS)

MAIN ENERGY FLOWS



figure 6: the areas serviced by each of the substations in Hammarby Sjöstad (Monika Topel)

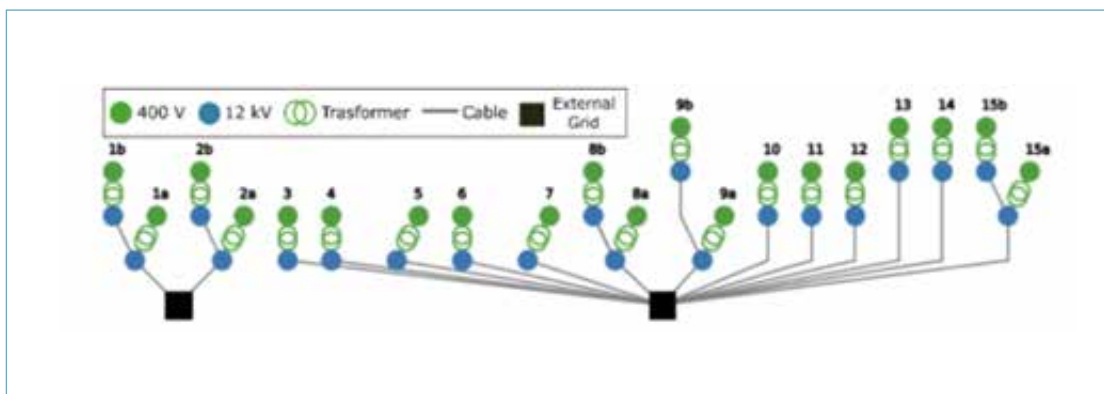


figure 7: scheme of the public distribution network in Hammarby Sjöstad (Monika Topel)

The electricity that is consumed in Hammarby Sjöstad is a mix of electricity from the distribution network and locally generated electricity (mainly photovoltaic). The neighbourhood has two feeding points to the distribution network and 19 substations (12kV to 400V) in total.

Since there is already a lack of capacity in the regional electricity grid, the city of Stockholm grows, and the need for electricity increases, there is a risk of power shortages in Stockholm. Investments in new grids to increase the supply of electricity to Stockholm will take up to a further 10 years. Therefore, there is a great need to ensure local electricity production capacity and be able to meet the demand for electricity in Stockholm, especially when the needs are greatest during the winter. To further optimize the use of the local electricity grid in Hammarby Sjöstad, ElectriCITY is helping to set up a smart micro-grid in the neighbourhood (see infobox).

Originally, all the buildings in Hammarby Sjöstad were connected to the neighbourhood's district heating system. This district heating is fuelled by the incineration of combustible waste and biofuels. Since then, however, several housing associations have invested in geothermal, (and to a lesser extent in solar) heating systems. These systems prove to be able to cover the heat demand at a lower cost. It is foreseen that in the future all buildings will be disconnected from the district heating and switch to geothermal heating systems.

MAIN REFERENCES

- [Ellevio website](#) (in Swedish and in English), network operator in Hammarby
- Information on the infrastructure and energy performance of Hammarby sjöstad can be found on the [Hammarby Sjöstad 1.0](#) section of the Hammarby Sjöstad 2.0 website (in Swedish and [in English](#))
- [Hammarby Sjöstad 2.0 website](#) (in Swedish and English)

ENERGY CHARACTERISTICS

CLIMATE NEUTRALITY

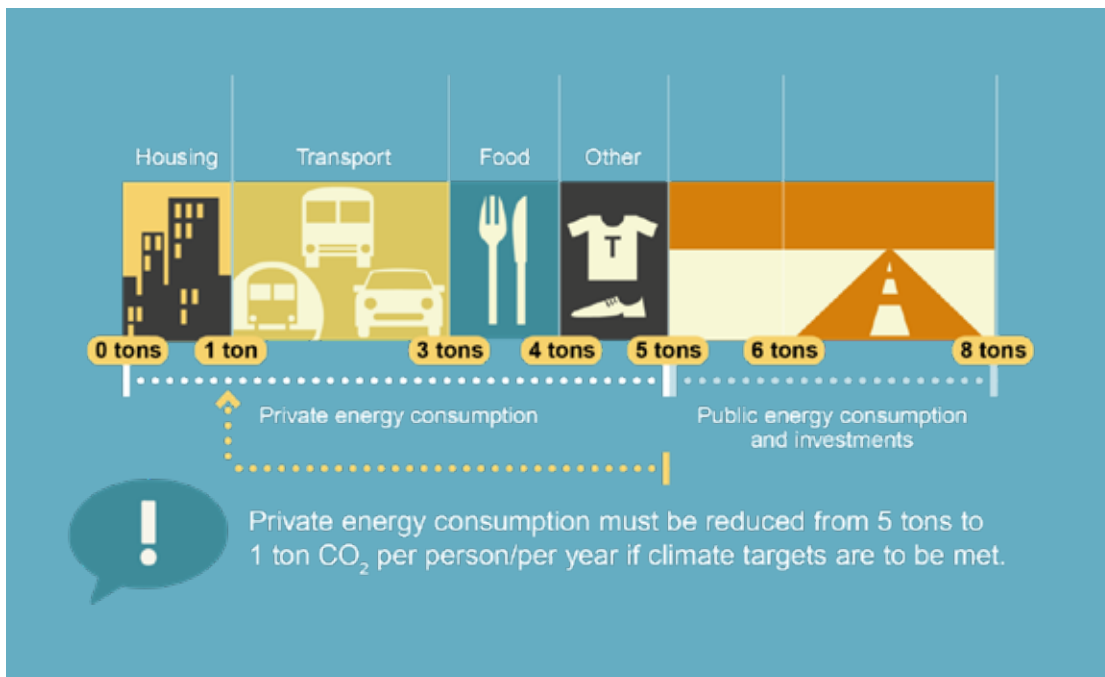


figure 8: the reduction of private energy consumption needed in light of the climate targets (ElectriCITY)

Stockholm ambitions to be fossil free and climate positive by 2040 and have in 2030. Hammarby Sjöstad 2.0 wants to lead by example and is therefore aiming to reach the city's climate targets by 2030. Together with the Royal Institute of Technology (KTH), ElectriCITY is currently defining which measures are required. It is already clear that energy efficiency enhancements, investments in renewable energy sources and an increase in the number of charging points for electric vehicles means important steps have been taken to achieve these aims.

MAIN REFERENCES

- [Environmental goals](#) on the Stockholm City website (in English)
- [Environment Programme 2020-2023](#) for the City of Stockholm, 2020 (in English)
- [Climate Action Plan 2020-2023](#) for the City of Stockholm, 2019 (in English)

OTHER METABOLIC FLOWS



figure 9: the metabolism model that was developed during the '1.0 phase' of Hammarby Sjöstad

Connecting the different material flows of Hammarby Sjöstad has been a key challenge during the redevelopment of the neighbourhood that started in the 1990's. Although the project was successful in doing so, it was only able to partially realize the high ambitions on energy consumption reduction. The Hammarby Sjöstad 2.0 project wants to further reduce the energy consumption and greenhouse gas emissions of the neighbourhood.

DIMENSION 5

GOVERNANCE AND POLICY CONTEXT

PROJECT'S GOVERNANCE STRUCTURE

Hammarby Sjöstad 2.0 is the overall project name of ElectriCITY's operations. ElectriCITY is a citizenship-driven innovation platform that was formed in 2014. The organization aims to create Hammarby Sjöstad into the most climate-friendly district in Sweden and reach the Paris Agreement goals already in 2030.



figure 10: group photo after a meeting with the housing associations (ElectriCITY)



figure 11: the quadruple helix model

ElectriCITY is an economic association and has about 70 members and partners from business, research institutes and the City of Stockholm. In close association with the inhabitants and housing associations of the neighbourhood, they organize the use of Hammarby Sjöstad as a test bed and demo site for new sustainable solutions, that can be copied to other districts – both in Sweden and abroad. Within the organization there are about 30 sustainability and environmental projects, several of which take place in collaboration with companies, research organizations and universities.

For many of its projects, ElectriCITY works within the quadruple helix model of innovation. This refers to the organization of a set of interactions between academia, industry, government and civil society to foster economic and social development. Also the microgrid project is a collaboration between these four types of actors.

MAIN REFERENCE

- [ElectriCITY website](#) (in Swedish and English)

POLICY CONTEXT

The EU has introduced the concept of energy communities in its legislation (notably those of citizen energy communities (CEC) and renewable energy communities (REC)) aiming for member states to provide a regulatory framework adapted to their local contexts. In 2019, the Swedish Energy Markets Inspectorate (EI) was assigned to analyse what is required in order to implement the Electricity Market Directive and the Renewable Energy Directive. EI was also tasked to analyse what measures are required in Sweden in relation to the Electricity Market Regulation and the Risk Preparedness Regulation. In the report “Ren energi inom EU - Ett genomförande av fem rättsakter”, EI presents an analysis of to what extent the terms are already implemented in the Swedish legislation, proposals for new legal terms and regulations and an investigation of possible outcomes. The outcomes of the new legislation will highly impact the project and how the energy community will be organised.

MAIN REFERENCE

- [Ren energi inom EU - Ett genomförande av fem rättsakter](#) on the website of the Swedish Energy Markets Inspectorate (in Swedish)

HIGHLIGHTS

TOWARDS A MICROGRID FOR HAMMARBY SJÖSTAD

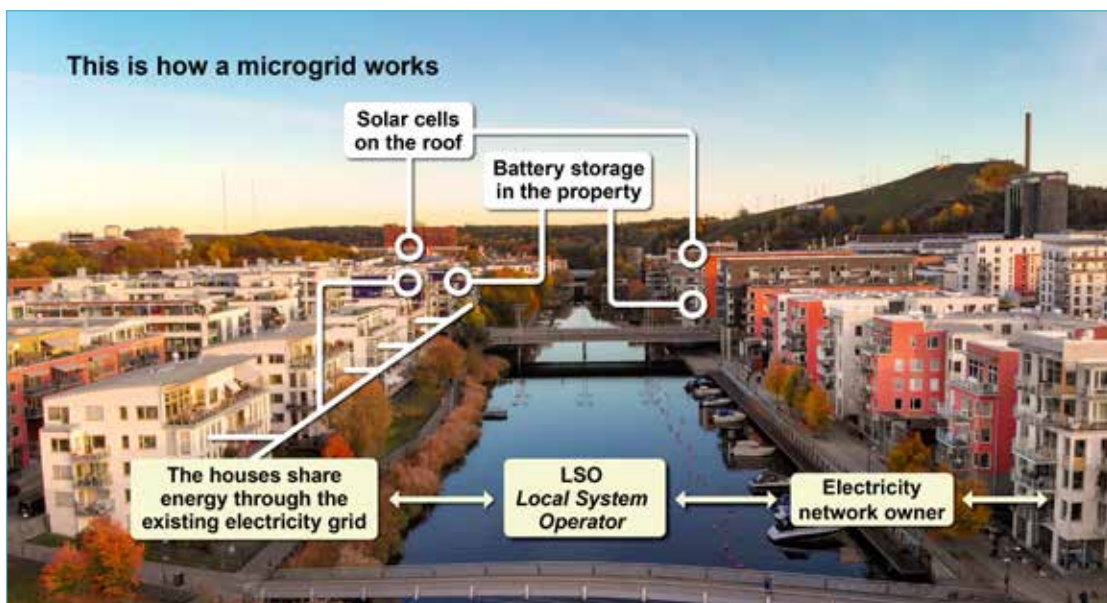


figure 12: the Hammarby Sjöstad microgrid (ElectriCITY)

One of the ongoing projects in Hammarby Sjöstad 2.0 is to set up local microgrids that enable to share and store energy. In Sweden, there is an acute risk of power shortages in and around a number of cities (including Stockholm). Microgrids can contribute to a solution for this problem. The overall goal of the project is to demonstrate how active innovative governance in existing built urban environments creates a better energy system and a new market for energy innovations and energy services compared to traditional procurement and district governance. As such the project aims to renew the Swedish energy system so it is able to meet future energy needs while at the same time also protect the climate and the environment.

In May 2021, ElectriCITY, together with a number of partners, received a grant from the Swedish Energy Agency to carry out a comprehensive project with flexible energy: *"Systemförändring för lokalt delad energi"*. The project will develop efficient solutions for measuring, storing and sharing local energy in energy communities through a flexibility market. It also includes the development of business and legal models that can make the systems profitable. From a sustainability perspective, the project is expected to lead to both financial, energy and environmental improvements. The consortium is also built to prepare for upscaling and replication.

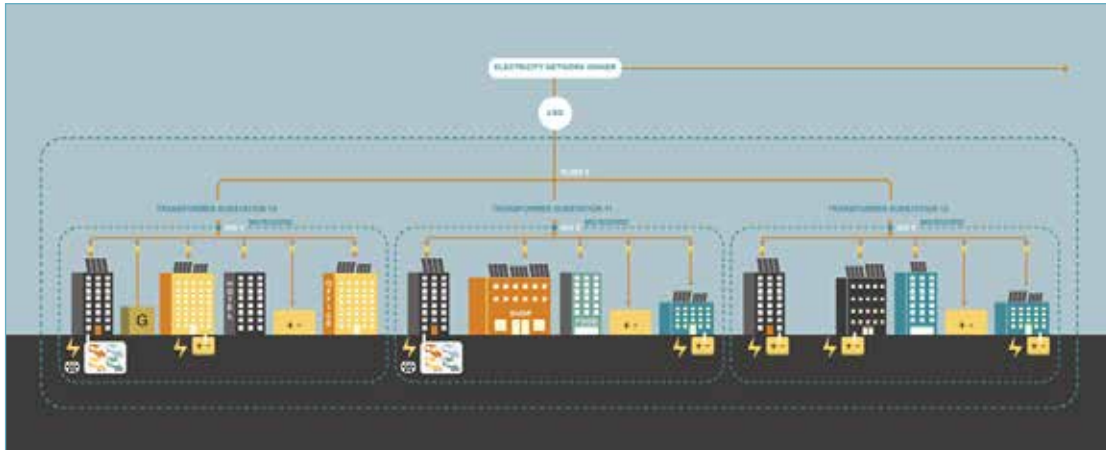


figure 13: organization of the microgrids in Hammarby Sjöstad (ElectricITY)

ElectricITY takes part in the project from a citizen-driven bottom-up perspective. It will help housing associations to take energy-saving measures for their properties, which will lead to a reduction in the properties' energy needs. Currently, 20 housing associations and 30 local business owners have shown interest in the microgrid project. By the end of the project, the ambition is to increase the number of participants and energy communities in the area.



figure 14: scheme of the buildings per substation for the microgrid project (Monika Topel)

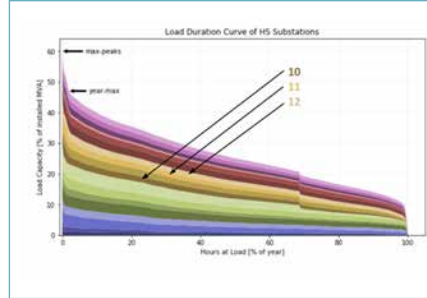


figure 15: load duration curve of the Hammarby Sjöstad substations (Monika Topel)

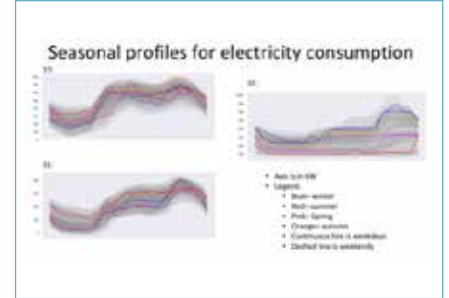


figure 16: seasonal profiles of electricity consumption for each of the Hammarby Sjöstad microgrid project substations (Monika Topel)

Figure 14 shows the neighbourhood included in the Microgrid project (see also figure 6). The red buildings represent substation 10 and consist of mainly SMEs and a couple of housing associations. The green buildings represent substation 11 and has a mix of both SMEs and housing associations, while the blue buildings represent substation 12 and consist of housing associations and a few SMEs. Substations 10, 11 and 12 have a capacity of 2x1600 kVA, 2x1000 kVA and 2x800 kVA respectively. In 2018, the power peaks in these three substations were 937 kVA, 828 kVA and 1216 kVA.

PROJECT AMBITIONS AND GOALS

- Reduce purchased energy (electricity and heat) through efficiency and active control by 30% in the area compared to today's traditional system. The goal is to reach an energy consumption (purchased energy) of 75 kWh / m² and year at apartment level and 90 kWh / m² and year at house level (excluding solar).
- Increase local renewable energy production and use by 20% in existing buildings at neighbourhood level.
- Implement and demonstrate innovative energy technologies to reduce peak power requirements with at least 33% through energy control between buildings, load control, storage and V2G solutions in new construction and existing built urban environments. It will contribute to a transfer from technology readiness level (TRL) 4 to TRL 7.
- Raise business readiness level (BRL) for energy innovations and for energy system development through active governance in the built environment from BRL4 to BRL7.
- Describe and document the governance process to enable replication and upscaling, both for cities and municipalities but also for future business owners in other countries. The deliverables are process maps and business models.
- Presentation of results from the pilot in at least 10 national and at least 10 international networks
- Increase customer readiness level (CRL) from 4 to 7 by gathering insights and knowledge about customers' different incentives, driving forces, knowledge, identity and conditions for participating in energy communities. Pricing systems and regulations are in place (the need for change established).
- Find out to what degree the future legislation regarding energy communities (CEC and REC) provides the opportunity to create local energy communities and which conditions apply to this. Within the framework, there is an opportunity to, for example, take a closer look to define the boundaries of the distribution or roles and identify potential shortcomings in the future legislation in relation to what the legislator wants to achieve.

CONSORTIUM

The project group has a broad competence in both technical solutions, business models, systems studies and user perspective. The project group includes the initiating parties for the project and coordinators for the pilot projects. The group has legal expertise which is also supplemented with external legal expertise. The composition of the consortium makes it possible to take a holistic approach to the innovative design of business models in the energy system.

The project group has a broad network of contacts both in Sweden and internationally. This includes export platforms and many competence networks: for sustainability and climate work in local authorities around the world and Sweden, for sustainable cities in Europe and in Sweden, for property owners and clients in Sweden. Through these channels, the project actors will disseminate results and work for the use of both demonstrated technical system solutions as well as the design and management of energy communities.

ACADEMIA

- **RISE (Research Institutes of Sweden)**: Project coordinator. RISE has experience as a techno-economic and socio-economic analyst for upscaling from energy systems and market perspectives, business models and policy analysis. RISE works as experts for The Swedish Energy Agency and the Swedish National Board of Housing.
- **KTH (Royal Institute of Technology)**: Responsible for developing techno-economic models of the project's pilots by creating a digital twin for electricity and heat in the area.

INDUSTRY

- **Enstar**: Offers property owners services for energy efficiency, energy contracting and energy management. System integrator and aggregator for new business models for energy communities in the pilot in Hammarby Sjöstad.
- **KTC**: Technology supplier for the pilot.
- **Siemens**: Technology supplier for the pilot.
- **Ferroamp**: Technology supplier for the pilot.
- **Ellevio**: Grid owners. Provides electrical data from users that can be used to demonstrate goal fulfilment. The data is also used in the digital twin developed by KTH.

PUBLIC AUTHORITY

- **Örebro Bostäder, ÖBO:** Municipality in Sweden that wants to spread the project within the city and to other cities

COMMUNITY

- **ElectriCITY Innovation:** A citizen-driven association in Hammarby Sjöstad with the goal of creating a climate-neutral district by the year 2030 and to inspire other housing associations to replicate. The organization runs about 30 sustainability and environmental projects in close collaboration with companies, research organizations and universities. Leads the pilot in Hammarby Sjöstad.

Collaborations with platforms/networks at national and international level to spread and inspire replication and upscaling

MAIN REFERENCES

- [Ren energi inom EU - Ett genomförande av fem rättsakter](#) on the website of the Swedish Energy Markets Inspectorate (in Swedish)
- [ElectriCITY website](#) (in Swedish and English)

Resources for PED practitioners & researchers

For more resources and project results from the Trans-PED project, visit the results section on its [website](#).



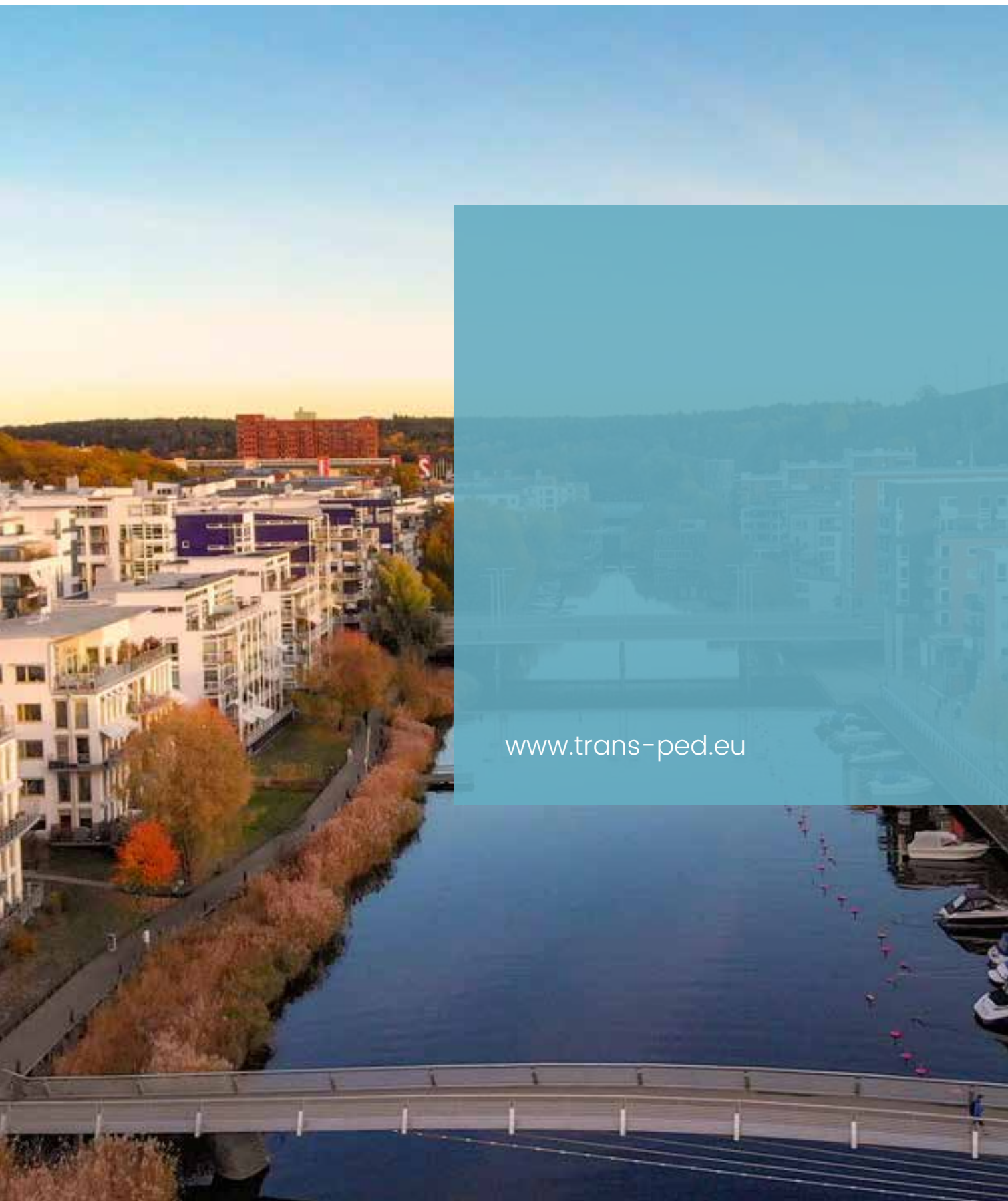
All about the Trans-PED project

Check out the Trans-PED [website](#) for details on the project, the international consortium of partners, as well as the participating PEDs.



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