

## **Silent City - Europe's First Living Lab for Traffic Noise Paper for Euroregio BNAM 2022**

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### **Abstract**

Around Copenhagen, in the most noise emission plagued areas in Denmark, 11 municipalities and The Capital Region of Denmark have joined forces to improve citizens' health and quality of life. Traffic noise is one of the largest environmental problems in our society. The partnership encourages exchange of experiences across different local policies and geographical spaces. Since the start in 2015, we have helped to put traffic noise on the agenda, and on that basis implemented several concrete initiatives, including a public consultation at the Danish parliament, preparation of a white paper, targeted press efforts and concrete demonstration projects in a Living Lab. The partnership will help to put the participating municipalities and Denmark on the world map within urban noise control.

**Keywords:** Noise abatement, Municipality, Partnership, Policy, Living Lab

## **1 Together We are Stronger, and Wiser**

Around Copenhagen, in the most noise emission plagued areas in Denmark, 11 municipalities and the Capital Region of Denmark, have joined forces in the partnership “Silent City”, to improve citizens' health and quality of life. Silent City works with making knowledge available and supporting new solutions on traffic noise abatement towards lower traffic noise levels and higher quality of life for citizens.

### **1.1 The Core Value**

The Silent City partnership works on several levels with political influence, opinion-making, competence development and the establishment of a Living Lab. The core value lies in working together across thematic and organisational boundaries in a quadruple helix collaboration where public sector, companies, research institutions and citizens work together to reduce traffic noise and improve quality of life. Together we are stronger, and wiser.

The partnership started out in 2015 as an association of the municipalities immediately west and south of Copenhagen, with a common challenge of noise from the state highways. Since then, the partnership has expanded to include municipalities north and northwest of the capital, also struggling with heavy traffic noise from the state roads.

The partnership builds on Gate 21 renowned capacity to work with local municipalities in green innovation and green growth, combining the broad competence in understanding green transition and local policies, with the efforts to combat traffic noise.

## **1.2 The Living Lab – In Real Scale, In Real Life.**

The partnership test and develop innovative solutions for combating traffic noise on a 1:1 scale in natural urban environments. In Silent City Living Lab we demonstrate technologies in real scale, in real life.

The Living Lab is an obvious focal point for testing new solutions and practical knowledge sharing amongst municipalities and private actors. With urbanisation, increased mobility, and other human activity it is not always technically or economically feasible to remedy the noise. In that case, there should be more precise guidelines for subsidies for noise insulation, replacement, and expropriation at new facilities where the noise cannot be reduced sufficiently.

The complex problem of traffic noise gives partners the opportunity to combine several agendas where Denmark is strong: sound and acoustics, public transport solutions and mobility, environment and climate, urban development and quality of life, sustainable construction, and infrastructure. The Living Lab gives companies a reference to show how the technology works for future costumers and collaborators. It gives the public sector a picture of future possibilities beyond existing off-the-shelf items. The main criteria for a solution to be part of the Living Lab is in other words, the need of test and demonstration in a specific context to explore the effect, and the solution not being a commonly used solution on the market.

## **1.3 A Sound Transition**

Noise does not respect municipal boundaries. The dialogue between municipalities, region, and state on how we combat traffic noise is urgent and important. In Denmark, over 1.3 million people are estimated to be affected by traffic noise [1]. WHO has declared noise as one of the biggest environmental risks to health in Europe. The negative effects of traffic noise on people and society also speak its clear language; many healthy living and production years are lost as a result of high noise levels, and socio-economic calculations estimate that traffic noise costs society many billions of kroner annually. In the Capital Region alone, the costs due to traffic noise amounted to approximately DKK 2.4 billion in 2014 [2].

The Silent City Whitpaper "Noise Emission demand Action" from 2020 point out that EU has succeeded in putting focus on the challenges of traffic noise, among other things through a directive on noise mapping. But the directive has not been followed up with binding EU legislation that can concretely affect traffic noise levels in Europe. Many of the technologies are investment-intensive and extensive, innovation efforts in this area are limited, decisions are long-term and often it is not the one that pays the bill who benefits from the investment. The opportunities for the noise plagued citizens is also limited.

Fortunately, tools are already in place to limit nuisances and health effects from traffic noise. In Denmark, we have over the past 25 years implemented several noise reduction initiatives along the country's busy roads. Regardless of the scope of these efforts, there are still more than 720,000 homes affected by traffic noise above the Danish Environmental Protection Agency's guideline limit value [3]. At the same time, there is a sharp increase in traffic volumes on all highways in the Silent City parnter municipalities A condition that will further increase the noise level if no effort is made. The municipalities are experiencing increasing pressure from citizens, citizen groups and landowners' associations, who complain about the noise, lack of night sleep and the opportunity to stay outside their homes. The task is therefore far from solved. There is an urgent need for a sound transition.

#### 1.4 Location, location, location

The Silent City municipalities are placed on the top of national traffic noiseload statistics. The traffic noise is expected to rise in the coming years, due to increased traffic on the highways and expansions of the road network. In the municipalities, there is an ongoing need for competence building and knowledge sharing in order to qualify the local effort. At the same time, there is a need for the issue to be taken seriously from the national level.

The eleven municipalities; Albertslund, Brøndby, Hvidovre, Gentofte, Gladsaxe, Glostrup, Høje-Taastrup, Ishøj, Køge, Lyngby-Taarbæk, and Vallensbæk are challenged by traffic noise from four highways and a number of major traffic roads and rail links.

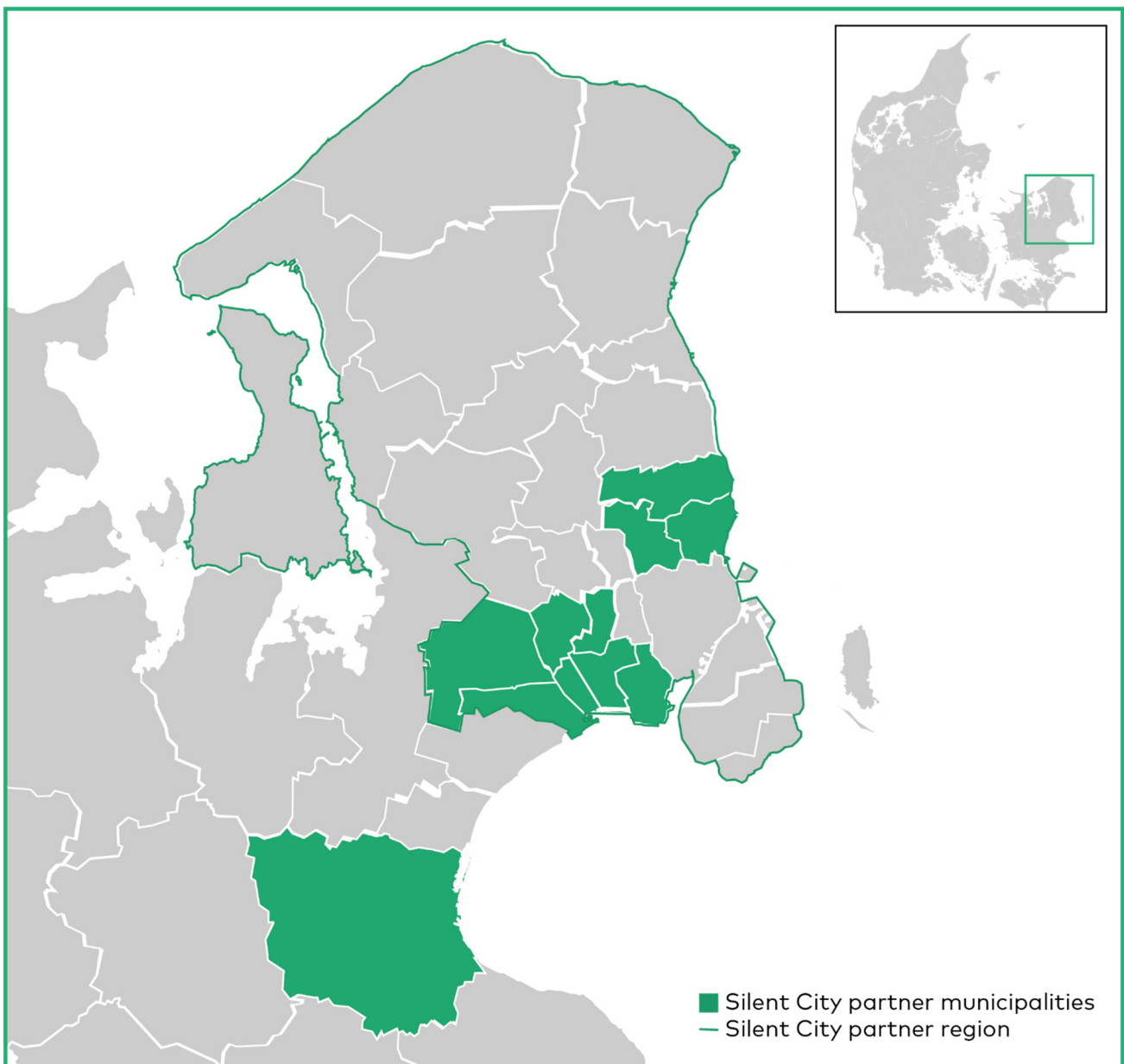


Figure 1: Silent city consists of 11 municipalities and one region. This includes Albertslund, Brøndby, Hvidovre, Gentofte, Gladsaxe, Glostrup, Høje-Taastrup, Ishøj, Køge, Lyngby-Taarbæk, and Vallensbæk municipalities and the Capital Region.

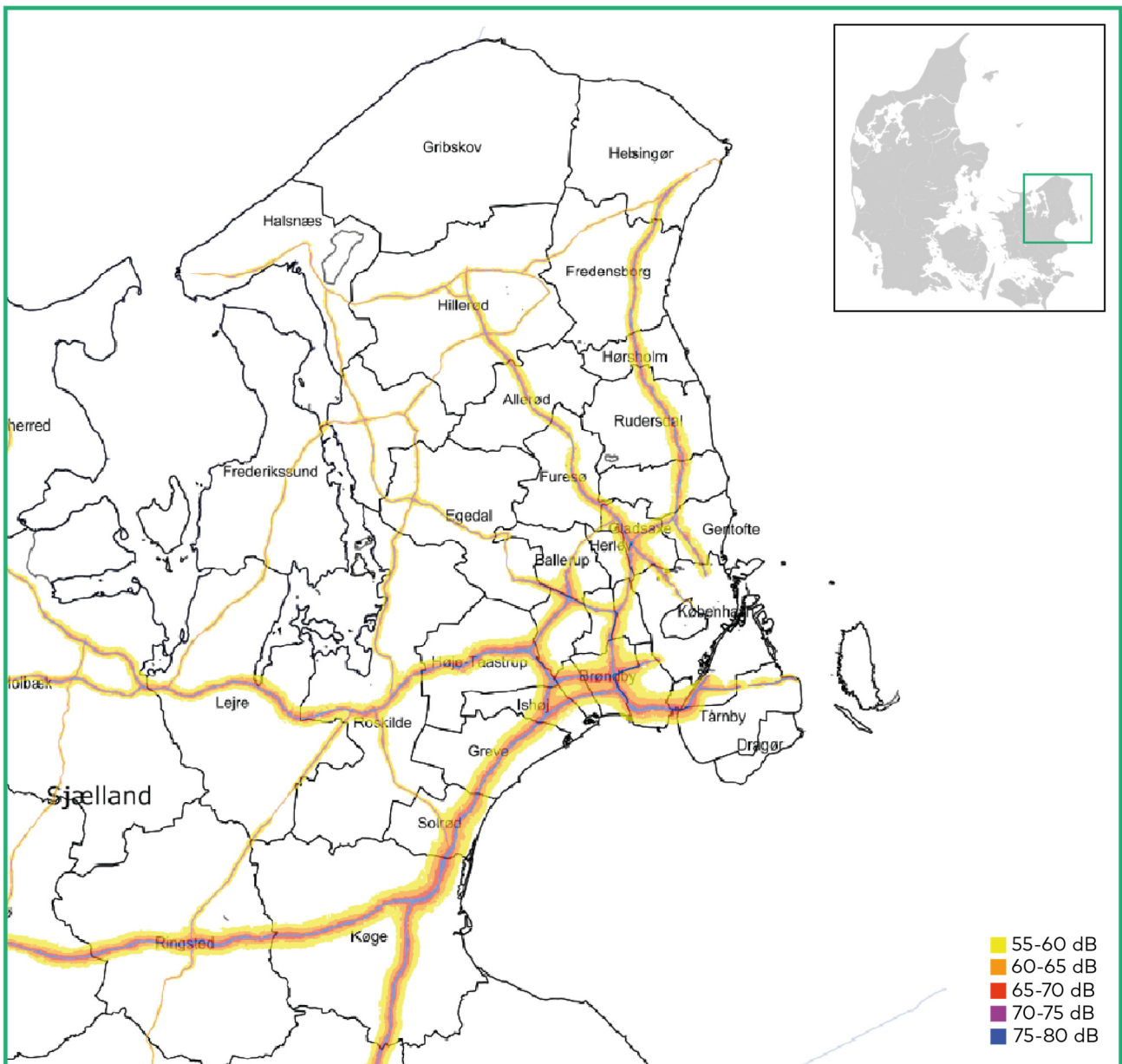


Figure 2: Noise loads from the state motorways in the Silent City geography [4]. The eleven municipalities are challenged by traffic noise from four highways and a number of major traffic roads and rail links.

## 2 Policy Instruments on The Noise Agenda

The Silent City partnership have made considerable developments on political awareness raising and joint development on policy measures such as urban development with noise considerations, citizens dialogue and strategic knowledge sharing between local governments. Here we give some examples on how our partnership have worked with policy instruments on the noise agenda with three examples, national infrastructure plan, speed limitations and political open fora.

## **2.1 Joint Statement to the National Infrastructure Plan**

In April 2021, a historically large and comprehensive plan for Danish infrastructure of more than DKK 160 billion DKK was announced by the Danish government [5]. The plan includes massive investments in reducing congestion on Danish roads, a significant boost in public transport and initiatives to support the green transformation of the transport sector. Several elements in the plan have a positive effect on traffic noise and about DKK 3 billion will contribute to the solution. This allocation is a very good start; however, the scale of the problem is greater and will require further financing to solve.

The Silent City municipalities made a joint statement for the national plan, showing a direction for cooperation on noise abatement. The main points in the joint statement are twofold; invest where it helps the most citizens, and to give priority to help existing noise plagued citizens. The Danish noise map show a concentration of more than 50 percent of homes that are noisy due to noise from state roads in the metropolitan area, so at least 50 percent of the noise reduction funds around should be set aside in the capital region.

Priority must be given to helping the existing noise plagued citizens, rather than new infrastructure projects triggering investment in noise reduction actions. Proposed highway projects will not only have consequences in new areas, but also have derivatives. Include the proposed noise surcharge principle for expansion of the highway network to include existing highways.

## **2.2 Capacity Building on Speed Regulations and Traffic Adjustments**

The faster a vehicle drive, the noisier it is. Speed regulations should be used as a tool to reduce traffic noise in residential areas. Silent City have created collaborations and knowledge exchange on municipalities ability and jurisdiction to create speed regulations and traffic adjustments to combat traffic noise.

In 2019, the municipalities of Hvidovre, Vallensbæk and Brøndby made a joint request to the national authority for a speed reduction to 90 km per hour on the highway passage in their municipalities. For state roads, municipalities have limited legal or sufficient financial means to act. However, following a new regulation in December 2017, a municipality may request speed reduction to the national authority in special cases, even as low as 60 km per hour solely for the sake of reducing the noise level [6].

The joint statement from the three municipalities is justified because, nowhere in Denmark, do so many people live so close to very busy highways. A total of 24,000 homes in the 3 municipalities are affected by noise above the recommended limit value of 58 dB, corresponding to more than 50% of the municipalities' homes. 60% of noise-affected homes are above the limit value solely due to noise from highways. The Danish Road Directorate's own noise survey shows that the three municipalities are in the top when it comes to the proportion of citizens who are affected by noise from the state's highways [7].

On their own roads, a municipality may request the police to reduce the speed limit in noisy residential areas. Silent City partnership has worked on sharing knowledge between municipalities on how to make traffic analysis with simulations on speed regulations and traffic adjustments. A traffic analysis can be used to show where the greatest noise reduction can be achieved and how many homes it will affected. Subsequently, the traffic analysis can be used to prioritize the speed reductions that provide the greatest value for as many people as possible.

Municipalities have gained knowledge on parameters important to speed limitation, for example travel times might be counted as a socio-economic cost, and how to avoid unwanted redistribution of traffic. The partnership has also raised awareness of other traffic regulations, for example green waves, with a more even flow in traffic, to avoid the noise from braking and acceleration. And by narrowing the roadway, introducing road bumps or other interventions in the physical infrastructure, you reduce the average speed of traffic.

### **2.3 Joint Understanding of Noise Mapping**

Every fifth year, the European noise directive stipulate an update of the mapping of noise from major roads and in major urban areas. The next mapping is ongoing and must be submitted to the European Union in summer 2022. This year's mapping will, however, be slightly different from previous mappings, as EU has introduced a new common calculation model, CNOSSOS.

The implementation of the new CNOSSOS model is positive in the sense that all member states will use the same methods and will have comparable mappings. However, the model previously used in Denmark, Nord2000, is more advanced in aspects like propagation and meteorological conditions, which will result in generally lower noise levels for CNOSSOS than for Nord2000 calculations [8]. Therefore, Denmark will continue to use the Nord2000 model parallel to the new EU model.

For the Danish municipalities, the transition, and the double mapping, will undoubtedly cause some challenges. This is both in terms of the mapping, which serves as the underlying elements for the subsequent action plans, but especially also for the communication towards citizens. We will use the cooperation between the municipalities in the Silent City partnership and work together to ensure a common and well-founded understanding of the results from the new model. The work will aim at raising the technical knowledge of city planners, as well as creating suitable communication strategies to inform citizens on the consequences of the new mapping.

### **2.4 The Creation of a Policy Arena**

With a joint political mandate from several local administrations and the Capital Region, Silent City have managed to help creating a momentum for political awareness of traffic noise emissions being one of the largest environmental problems in our society. The partnership has been able to raise the issue broader and on a more strategic level, than a single noise plagued municipality would be able to do alone. Under a joint flag and joint understanding of the problem, mayors of Silent City municipalities and the Capital Region have managed to create a conference in the Danish parliament, as well as more local events directed towards citizens.

In May 2016, the Silent City partnership, in collaboration with other strategic partners, launched the first whitepaper for traffic noise in Denmark and opened the doors to the conference 'Traffic noise: An overlooked societal challenge'. Here, media, politicians, professionals, and citizens were invited to a joint debate on how we can bring traffic noise down in Denmark. Local and parliamentary politicians and the leading Danish companies in the field got together and listen to the latest international research on health and socio-economic consequences of traffic noise and the perspectives and opportunities and challenges with solutions existing on the market.

Silent City have also created several citizens focused events. For example, the events "It's Still Noisy" in October 2018 and "Traffic Noise Demands More Action!" in September 2021, attracted several hundred of citizens and national and local media. In an open forum, citizens were invited to a one-on-one with their local politicians, listen to experts talking about noise and health, and get a firsthand idea on how to mitigate noise in their surroundings. Additionally, these events have sent a strong signal to the Danish parliament that traffic noise is an issue that affects and worries many citizens in the Greater Copenhagen area.





Figure 3: Panel of mayors debate the future of collaborative noise abatement and noise reduction with citizens at the event “Traffic Noise Demands More Action!”.

### 3 Show – Don’t Tell – Real Scale Living Lab

In the Silent City Living Lab, municipalities allow concrete demonstration in the real traffic conditions. In triple helix collaborations between cities, technology owners and knowledge institutions, the demonstrations give the public sector and the citizens a picture of future possibilities beyond existing off-the-shelf items. In the following part, we give you some examples of how demonstrations projects in Silent City comes into play, the silent bench, noise absorbing guardrails, and real time monitoring of noise. From demonstration to market is still a bumpy path, and not all solutions will succeed to market. But with real life measurements of effect, citizen evaluations, communication, and on-site visitor service, the Living Lab facilitate innovation and open possibilities for new solutions.

#### 3.1 A “Silent Bench” Can Halve the Perceived Noise

South of Copenhagen, at a recreational area with a football golf course situated next to a major railway and highway corridor, you will find the Silent Bench. The bench consists of a 2-meter high, slightly angled, and curved noise screen and is a result of a collaboration between technology experts FORCE Technology, developing engineers G9 Landskab, and Vallensbæk Municipality. On the inside, the bench is lined with perforated sheets with sound-absorbing material. Thus, the back of the bench acts as a shield for both sound and wind, while the sound that may still creep over or around the screen can be absorbed in the porous plates on the inside. It is important to consider wind direction and potentially reflective surfaces when choosing the location.

The open landscape location provides a good protection against the noise. It also provides a visual shielding of the traffic, which can have an impact on the perceived noise level. In denser urban spaces, the reflection of sound between the hard surfaces will change the measured effect, and one will not be able to expect the same high degree of attenuation. In some noise spectra, the noise level inside the bench is reduced by 13-14 dB, this equates to the noise being more than halved [9]. The reduction of noise is highest in the most intrusive and sharp sound levels.

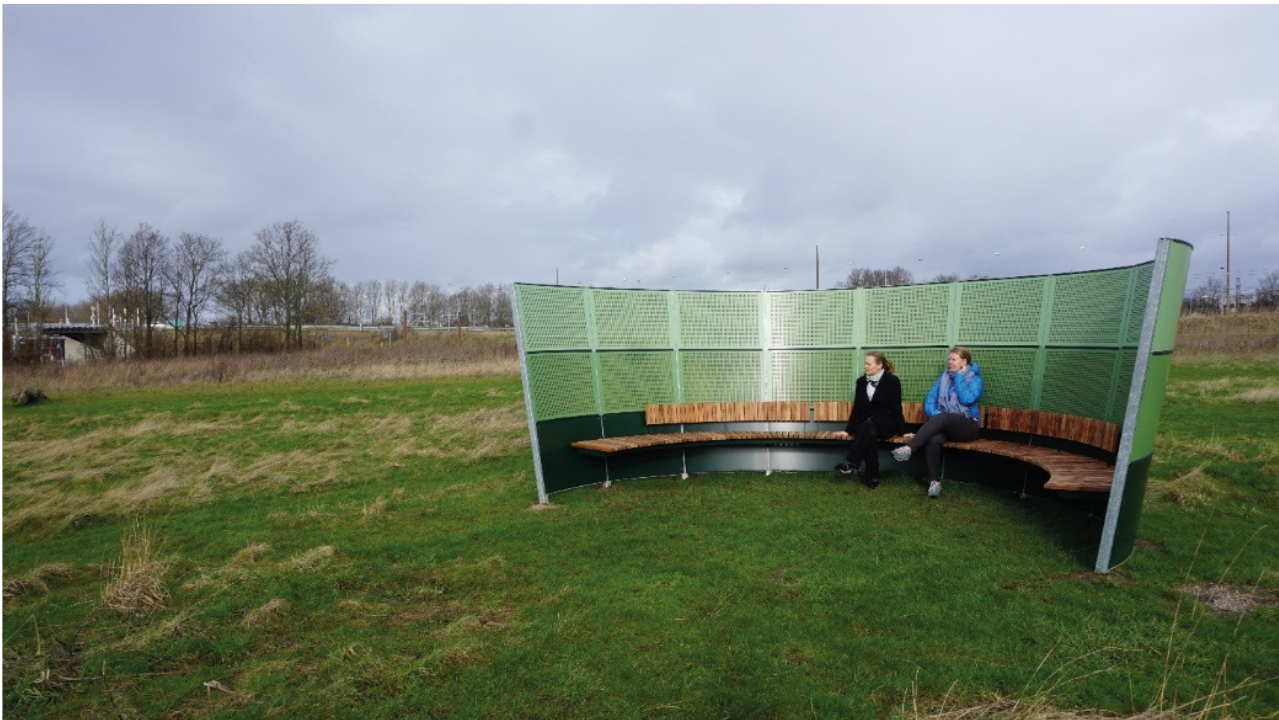


Figure 4: The "Silent Bench" at the football golf course in Vallensbæk

### 3.2 From Pilot to Product on Noise Absorbing Guardrails

On Vejlegårdsvej in Vallensbæk and on Ishøj Stationsvej you will find the country's lowest noise screens with reduction effect. Here the company NAG 1 ApS, as part of Silent City Living Lab, and with support from Danish start-up funds, has tested noise absorbing guardrails. The Silent City partnership helped the company from pilot, to launching of final product, by allocating demonstration site and reference surroundings with citizens involvement. The guardrails are now a patented CE-standard crash barrier. The technology can be integrated in existing guardrails and the low noise screen has good effect on this stretch because it is installed directly at the wayside, close to the source and especially attenuates that part of the noise coming from the tire-to-road contact.

A survey shows that 67 percent of the residents next to Vejlegårdsvej believe that noise reduction protection has had a good effect. They experience a moderate noise reduction that corresponds to the expected power of between 3 and 5 decibels for homes closest to the road. 3 to 5 decibels are experienced as an audible change. Only 10 percent of residents says they experience no - or very little - noise reduction [8].



### **3.3 Real Time Noise Measurements Improve Decision Making**

Silent City have demonstrated a dynamic noise chart using real-time noise measurements in an area. The technology is developed by the company SoundEar and the GTS institute FORCE Technology. A set of microphones connected to a computer show both the area's current and past noise levels, which are presented in a dynamic noise map. The map shows day by day, hour by hour, how noise development is in different areas.

Official noise mapping in Denmark shows average values over a year. These maps can be good to point out which areas are exposed to traffic noise; how many are exposed to noise and help to prioritize the noise reduction effort. But they do not say much about the current situation, and they cannot be used as a basis for understanding daily fluctuations or the perceived nuisance of noise. As a municipality it can be challenging to deal with complaints from citizens about elevated noise levels if the noise mapping does not indicate averages above the limit values.

The dynamic noise chart has embedded meteorological data and can take height of wind direction and strength into account. The real-time measurements and the dynamic noise maps can give noise-disturbed citizens a better insight into the noise that they experience. The program can also show where and when noise limits are exceeded, and the map can calculate the proportion of highly disturbed citizens in the area.

The map can also be used to calculate the effect of different noise reduction measures, such as noise barriers, noise walls or reduced speed in a particular area. This can provide better decision-making basis for new noise reduction measures and give citizens a better incentive to seek municipal noise pools or co-finance the measures.

## **4 Conclusions**

Silent City is a collaboration between some of the most noise plagued municipalities in the capital region of Denmark. The goal is to reduce traffic noise, increase traffic noise abatement and promote the quality of life and health of citizens. Through the Silent City Living Lab and cooperation with companies and knowledge institutions, the partnership takes part in the necessary development of instruments needed for the traffic noise abatement. The partnership shows the benefit of a joint effort to raise awareness on one of the largest environmental problems in our society. Since 2015, the collaboration has strengthened political cooperation between municipalities, and to speak with a strengthened voice towards the national level. Silent City have demonstrated state of the art technology and methods to target traffic noise and disseminate the latest knowledge about traffic noise strengthen dialogue with citizens on joint initiatives.

## Acknowledgements



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