ARUP

Submission to Sharm el-Sheik mitigation ambition and implementation work program

Response to Mandate Decision 4/CMA.4, para 14 FCCC/PA/CMA/2023/L.16, para 9

Rev 1 | 3rd September 2024

The views and perspectives presented in this document are the result of a comprehensive consultation process among third party stakeholders in the Nordic countries funded by the Nordic Council of Ministers and undertaken by Arup. The results and recommendations are those of the dialogue platform and do not necessarily reflect the views and recommendations of the Nordic Council of Ministers and the Nordic governments.

Report Lead Author: Hannah Sutton
Contact details: hannah.sutton@arup.com

Ove Arup & Partners Danmark A/S
CVR: 18530775

Ove Arup & Partners Danmark A/S
Axeltorv 2K 3rd floor
Copenhagen
1609
Denmark
arup.com

1. Introduction

This submission responds to the recent call from the work programme's co-chairs for the non-Party stakeholder views on the **opportunities, best practices, actionable solutions, challenges and barriers** relevant to the Mitigation Work Programme (MWP)'s topic for 2024- Cities: Buildings and Urban Systems, with particular focus sub-topics of the 4th Global Dialogue:

- Spatial planning and low-carbon infrastructure
- Electrification and switching to net-zero emission resources
- Enhancing carbon storage through green and blue infrastructure

The views presented in this document are the result of a comprehensive consultation process funded by the Nordic Council of Ministers and undertaken by Arup. This process engaged approximately 100 stakeholders from various sectors, including academia, municipalities, industry leaders, and suppliers. Through a series of workshops and discussions, participants provided valuable insights into the challenges and opportunities related to the sub-topics. The consultation was designed to capture a broad and representative range of perspectives, ensuring that the views reflected in this submission are informed by diverse experiences across different regions and sectors. The outcomes of these consultations provide a well-rounded understanding of the actionable solutions, challenges, and barriers in implementing sustainable urban practices, particularly within the Nordic context. The results and recommendations are those of the dialogue platform and do not necessarily reflect the views and recommendations of the Nordic Council of Ministers and the Nordic governments.

2. Key context

It is vital for the Mitigation Work Programme (MWP) to build upon last year's discussions focusing on "accelerating just energy transition", enabling all parties to respond effectively to the collective commitments outlined in the first global stocktake (GST) and keep the 1.5-degree target within reach. From a Nordic perspective, the MWP is uniquely positioned to drive forward the mitigation outcomes, reflecting shared commitment to urgently scale up ambition and action in this critical decade. This year presents a significant opportunity to explore the implementation of mitigation strategies, particularly with a focus on sustainable urban development and the role of cities in leading the way.

This submission is following stakeholder consultation funded by the Nordic Council of Ministers. The Nordic Council of Ministers is an intergovernmental forum established to complement the Nordic Council and promote Nordic cooperation (covering Denmark, Finland, Iceland, Norway, Sweden, Greenland, The Faroe Islands and Åland) to support the Nordic Vision 2030[1]: to become the most sustainable and integrated region in the world by 2030.

2.1 Nordic perspective

The Nordic countries have distinguished themselves through their ambitious emission reduction goals, demonstrating a strong commitment to a sustainable, low-carbon future. Each nation has outlined bold plans for the coming decades, going beyond many global targets to set even higher standards. For example, while the EU aims for a 40% reduction in emissions by 2030 (from 1990 levels), many Nordic countries have set even more aggressive targets[2]. The Danish government has proposed to move the net zero target forward to 2045 and set a new net-negative target of 110% in 2050. Iceland is aiming for carbon neutrality by 2040, Finland by 2035, and Sweden has committed to reaching net zero emissions by 2045. Norway's carbon

[1] Our Vision 2030 | Nordic cooperation (norden.org)

[2] Policy Brief: Nordic Stocktake and Visions – Pathways to Climate Neutrality (norden.org)

neutrality by 2030 is particularly remarkable, as it involves offsetting any remaining greenhouse gas emissions by investing in projects like renewable energy initiatives abroad[3][4].

These national strategies are not only ambitious but also deeply interconnected with efforts to enhance urban sustainability. As we transition to discussing the Mitigation Work Programme (MWP) topic for 2024—focusing on Cities: Buildings and Urban Systems—the Nordic countries' national targets have significant implications for urban planning and infrastructure.

Nordic countries are embedding their emission reduction goals into urban planning by developing low-carbon infrastructure, such as energy-efficient buildings and green spaces, to enhance quality of life and cut emissions. Central to these efforts is the electrification of urban systems and a shift to net-zero emission resources like renewable energy. For example, the City of Copenhagen's 2035 Climate Plan[5] aims to make the city carbon neutral by 2035. The plan includes initiatives like retrofitting buildings for energy efficiency, expanding cycling infrastructure, and increasing the use of renewable energy sources, such as wind and solar power. It should be noted that this is an update on the previously ambitious target from Copenhagen in their 2025 Climate Plan to reach carbon neutrality by 2025[6].

Additionally, many Nordic cities are investing in green and blue infrastructure—such as parks, green roofs, and wetlands—to boost carbon storage and urban resilience. A notable initiative is Oslo's policy called the Blue-Green Factor (Blågrønn Faktor)[7], which requires new developments to include both green and blue infrastructure elements such as green roofs, water features, and permeable surfaces that enhance stormwater management and improve urban biodiversity. High energy and carbon taxes in the Nordics further support the transition to renewable energy and sustainable practices, such as Iceland's carbon tax and Climate Action Plan[8] focusing on reducing emissions from transportation and promoting renewable energy, primarily geothermal and hydropower, and promoting energy-efficient buildings and electric vehicles. Similarly, Sweden's Climate Law and carbon tax[9], which is one of the highest in the world, has been pivotal in reducing greenhouse gas emissions. The tax incentivizes industries and individuals to transition to renewable energy and adopt more sustainable practices.

By integrating these national targets with city planning, the Nordic countries exemplify a holistic approach to climate goals and urban development. They encompass a wide array of measures, from tangible funding mechanisms for hard infrastructure to knowledge networking exchanges and practical tools or "urban labs" for experimentation. One example is through projects like Helsinki's Carbon-neutral 2035 plan[10] which involves a range of measures, including promoting energy-efficient construction, transitioning to electric public transportation, and enhancing green spaces throughout the city. One specific project is the redevelopment of the Kalasatama district[11], a smart city project that integrates sustainable building practices and energy-efficient technologies.

---

[3] Norway's eighth national communication (regjeringen.no)

[4] https://pub.norden.org/temanord2023-545/index.html

[5] Climate Plan 2035 | Urban Development (kk.dk)

[6] The CPH 2025 Climate Plan | Urban Development (kk.dk)

[7] 202308_Vervoort_-Green-roofs-in-Oslo-by-2030_-understand-their-impacts-through-life-cycle-assessment.pdf (urbag.eu)

[8] Government of Iceland | Climate Change

[9] Sweden's carbon tax - Government.se

[10] Carbon_neutral_Helsinki_Action_Plan_1503019_EN.pdf (carbonneutralcities.org)

[11] Smart Kalasatama - Smart City District of Helsinki | Knowledge Hub | Circle Economy Foundation (circle-economy.com)

3. Cities: Buildings and Urban Systems

Cities are responsible for the majority of global greenhouse gas (GHG) emissions, with this share steadily increasing. According to the IPCC[12], urban areas contributed 70% of global emissions by 2020, with 10% of households with the highest per capita emissions contributing 34–45% of global consumption-based household GHG emissions. The emissions are driven by urban population growth and land expansion and increasing infrastructure demands. Therefore, cities will play a critical role in achieving net-zero goals, especially as urban areas are expected to house 70% of the global population by 2050[13]. The United Nations estimates that urban infrastructure equivalent to the size of the Swedish capital Stockholm will be constructed weekly until 2050, underscoring the importance of sustainable construction practices.

Cities and their inhabitants are highly vulnerable to weather and climate extremes, particularly heatwaves, because urban areas already are local hotspots. The IPCC[14] has acknowledged with very high confidence that the construction of new, and upgrading of, existing urban infrastructure through 2030 will result in a significant increase in GHG emissions and that cities can only achieve net-zero GHG emissions through deep decarbonisation and systemic transformation.

Addressing GHG emissions in the built environment will require coordinated action across policy, finance, and supply chains, considering regional contexts and priorities. Both existing and new buildings can achieve net-zero emissions by mid-century using low-carbon materials, energy demand reduction, energy supply changes and sustainable design practices. The integration of mitigation practices and resilience in the built environment is crucial. Efficient buildings can support resilient energy systems, while sustainable material choices can mitigate urban heat islands, highlighting the interdependence between decarbonization and resilience efforts.

To support the work of the MWP, the views expressed have been presented and framed by the three sub-topics outlined for the 4th Global Dialogue.

3.1 Spatial Planning and Low-Carbon Infrastructure

The Nordic region prioritizes spatial planning to achieve low-carbon urban development[15]. By integrating urban planning with environmental considerations, many Nordic cities reduce emissions and enhance residents' quality of life.

3.1.1 Opportunities and Best Practices:

- **Compact and Mixed-Use Development:** Many Nordic cities focus on compact, mixed-use urban forms to reduce transportation needs and promote sustainable mobility options like cycling and walking. This approach enhances public health through increased physical activity, improves air quality by reducing vehicle emissions, lowers energy bills, and creates jobs in local businesses and services.

  Case study: Smart Mobility (Bergen, Norway)[16]

  Mobility hubs in Bergen integrate car-sharing stations with public transport, bike routes, bike parking, real-time transport info, and pedestrian access. The city opened its first hub in Møllendal in May 2018, marking the first of its kind in Norway. Currently, nine more hubs are being planned or implemented, each featuring car-sharing spaces, bike parking, pedestrian access, and proximity

[12] IPCC, 2023: Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647 IPCC_AR6_SYR_LongerReport.pdf

[13] Urban Development Overview (worldbank.org)

[14] IPCC_AR6_WGIII_Chapter08.pdf

[15] Nordic Declaration on Low Carbon Construction and Circular Principles in the Construction Sector | Nordic cooperation (norden.org)

[16] Smart Mobility | Nordic Smart City Network (nscn.eu)

to public transport. The hubs are customized to fit local needs, such as including underground trash collection and rentable bike hangers in Møllenpris.

- **Public Transport and Active Mobility:** Investment in reliable, low-emission public transport systems and pedestrian infrastructure has significantly cut urban transport emissions. These investments contribute to better public health by reducing air pollution, improve air quality in urban areas, decrease household energy bills by reducing expenses (such as reliance on private vehicles), and generate employment opportunities in the transport and infrastructure sectors.

Case study: City of Oslo (Norway)[17]
Oslo drives widespread electrification of public buses, trams, ferries, private delivery vehicles, and heavy-duty construction machinery through public procurement and incentives. The city has implemented variable congestion charges targeting diesel vehicles and incentivizes contractors to use electric machinery in municipal projects. Oslo also promotes sustainable transport by adding 100 kilometers of cycling lanes, leading to a 51% increase in cycling since 2016, while also reducing street-side parking, converting them into bike lanes. Street transformations have made walking and cycling safer, with significantly reduced pedestrian and cyclist deaths. Additionally, electric charging stations are widely available for private vehicles.

- **Smart Cities and Digitalization:** The region invests in using digital tools for smart urban planning, optimizing energy use, and improving efficiency. This digitalization supports enhanced public health through improved environmental monitoring, better air quality from optimized energy systems, reduced energy bills due to efficient resource use, and job creation in the technology and data analytics sectors.

Case study: Smart Kalasatma (Helsinki, Finland)[18]

Kalasatama, a former brownfield district in Helsinki, was transformed into an experimental innovation platform from 2013, co-creating urban infrastructure and services with local stakeholders. The district actively promotes the sharing economy, with residents using digital applications to share cars and parking spaces. Smart locks in new buildings allow flexible use of various spaces for different activities. Kalasatama also features a smart grid that supports real-time smart metering, electric vehicle networks, and new electricity storage solutions. The area is powered by a solar plant and connected to an energy-efficient district heating and cooling grid.

- **Integrated Spatial Planning:** Strategies such as high-density residential and job areas, mixed land use, and transit-oriented development (TOD) can reduce GHG emissions by more than 20% by 2050. These planning strategies improve public health by lowering pollution levels, enhance air quality, reduce energy bills, and create jobs in construction, urban planning, and local businesses.

Case study: Västra Hamnen (Malmö, Sweden)[19]

Västra Hamnen is a model for integrated spatial planning with high-density residential and job areas, mixed land use, and transit-oriented development (TOD). The district features a mix of residential, commercial, and office spaces, encouraging walking and cycling. It is well-served by public transport, reducing car dependency. These planning strategies improve public health, enhance air quality, lower energy bills, and create jobs in construction and local businesses.

[17] Oslo's 'Climate Budget' Is Building a Cleaner City | World Resources Institute (wri.org)

[18] Smart Kalasatama | Nordic Smart City Network (nscn.eu)

[19] Västra Hamnen - Innovative district in Malmö | GuidebookSweden (guidebook-sweden.com)

- **Modular and Adaptable Buildings:** Modular and adaptable buildings are key to reducing carbon footprints. By designing structures that can be relocated and reused, emissions can be cut by up to 60% compared to permanent buildings, with reuse potentially reducing footprints by 90-92%. This approach improves public health by decreasing construction-related pollution, enhances air quality, lowers energy bills through efficient use of materials, and generates jobs in modular construction and design.

  Case Study: Rikshospitalet (Oslo, Norway)
  The company Adapteo provided a modular building floor on the roof of an existing hospital to allow for more office space. The retrofit can be relocated and reused, offer up to 60% lower carbon footprints compared to permanent structures. Reusing these modules can cut the footprint by 90-92%.

- **Low carbon buildings materials:** Many Nordic cities are leading the way in adopting low-carbon building materials to advance sustainable construction practices. By using innovative, low-impact materials and techniques, these cities significantly reduce the climate impact of their buildings. This approach not only lowers the carbon footprint of construction but also enhances public health through reduced pollution, improves air quality, and cuts energy bills due to more efficient buildings. Additionally, it creates job opportunities in the sustainable building sector and supports the development of eco-friendly urban environments.

  Case Study: Gothenburg's Hoppet preschool (Gothenburg, Sweden)[20]

  Gothenburg's Hoppet preschool, Sweden's first nearly fossil-free building, exemplifies advancements in sustainable construction. Completed in 2021, it welcomes 144 children and reduces the climate impact of building materials by 70% compared to traditional methods. This was achieved through conscious material choices and careful planning. Supported by the EU's Northern Connection project, 27 suppliers from five countries contributed innovative solutions. The building features low-carbon materials, reused products, and locally sourced wood, showcasing the potential of fossil-free construction without compromising quality.

  Case Study: Mjøstårnet (Brumunddal, Norway)[21]
  Mjøstårnet, completed in March 2019, is the world's tallest timber building at 85.4 meters. Located in Brumunddal, near Oslo, this 18-storey tower symbolizes sustainable construction using local materials. It houses a hotel, apartments, offices, a restaurant, and a wooden swimming hall. Built with glulam and Cross Laminated Timber (CLT) by Moelven Limtre, Mjøstårnet holds a Guinness World Record and has received multiple awards, including the New York Design Awards and Council on Tall Buildings and Urban Habitat (CTBUH)'s Award of Excellence.

  Case Study: Fyrstikkbakken 14 (Oslo, Norway)[22]
  Fyrstikkbakken 14 is built in CLT and low-carbon concrete and has an energy consumption in operation that corresponds to a minimum of near-zero energy. In total, the reduction of GHG is 53% compared to a business-as-usual reference building. The housing project experiments with new forms of housing, and is particularly known for the concept of dividing meters – square meters you share with others

[20] Hoppet - Sweden's first fossil-free preschool | News - Smart City Sweden

[21] Mjøstårnet (moelven.com)

[22] https://www.futurebuilt.no/Forbildeprosjekter#!/Forbildeprosjekter/Fyrstikkbakken-14

- **Progressive National building strategies:** Nordic countries are advancing national building strategies to enhance sustainability and reduce carbon emissions in the construction sector. These strategies typically include stricter CO2e limits for new buildings, with progressive targets that tighten over time. By implementing rigorous standards and emission limits, these countries aim to significantly improve climate performance across a substantial portion of new constructions. This approach helps reduce construction-related emissions, improve air quality, lower energy bills through more efficient building practices, and create jobs in the green construction sector.

Case Study: Denmark National Strategy for Sustainable Construction (Denmark)[23]
Starting in July 2025, Denmark will enforce a stricter CO2e limit of 7.1 kg CO2e/m²/year for new buildings, exceeding the 2021 strategy targets. The agreement introduces varied limits for different building types and includes new categories, with a focus on reducing emissions from construction sites. For example, large single-family homes will face progressively tighter limits, reaching 5.4 kg CO2e/m²/year by 2029. This ensures that 85% of new constructions will achieve better climate performance than in 2021. https://www.futurebuilt.no/Forbildeprosjekter

3.1.2 Challenges and Barriers:

- **Balancing Growth and Protection:** Expanding cities must balance development with the protection of natural landscapes.
- **Retrofitting Infrastructure:** Transitioning existing infrastructure to low-carbon alternatives requires significant investment and coordination.
- **Shifting Perceptions:** There is a misconception that new construction is superior, leading to resistance against circular solutions like reuse and recycling. Modular buildings, particularly reused ones, are often perceived as lower quality compared to traditional methods. This perception influences policy and regulatory attitudes, with policymakers hesitant to fully embrace modular construction. Overcoming this requires increased knowledge, understanding, and clear requirements for circular practices, demonstrating that these sustainable solutions offer comparable quality while significantly reducing environmental impact.
- **Lack of Uniform Regulations:** Inconsistent standards and varying interpretations of building codes by local authorities' complicate approval processes and hinder resource efficiency. Regulatory fragmentation across municipalities and countries leads to differing requirements, making it difficult to implement modular construction projects consistently. Standardization focused on functionality rather than technical details is essential to reduce the construction industry's material footprint.
- **Rigid Building Codes:** Traditional building codes, designed for conventional construction methods, often do not align with modular construction principles. These codes are generally prescriptive rather than performance-based, which hampers innovative modular methods that rely on off-site fabrication. To maximize sustainability and circularity, the focus should be on function rather than detailed specifications.
- **Zoning and Planning Issues:** Zoning laws can be restrictive for modular buildings, especially temporary or adaptive structures. Long and complex approval processes, not always adapted to modular construction needs, complicate the deployment of these solutions. This impedes the efficiency and flexibility that modular construction offers.

3.2 Electrification and Switching to Net-Zero Emission Resources

Nordic countries lead in the transition to net-zero emission energy sources, including electrification, as a key strategy for urban decarbonization.

[23] Danish Political Agreement Tightens the Limit Values for New Buildings and Extends the Impact | Nordic Sustainable Construction

3.2.1 Opportunities and Best Practices:

- **Renewable Energy Integration:** Significant progress has been made in integrating wind, and hydro, power, and geothermal energy into urban systems.

Case study: Reykjavik's Geothermal District Heating System (Iceland)[24]

The geothermal district heating system in Reykjavik is a leading example of renewable energy integration. Geothermal energy not only provides 90% of the city's heating needs but also contributes 20-25% of Iceland's electricity generation. This extensive use of geothermal resources reduces reliance on fossil fuels, enhances energy efficiency, and improves air quality. The integration of geothermal energy into both heating and electricity systems significantly lowers greenhouse gas emissions, reduces energy bills for residents, and supports job creation in the renewable energy sector.[25][26]

- **District Heating and Cooling:** Adoption of district heating and cooling systems supplied by renewable energy has reduced building emissions.

Case study: Sara Kulturhus (Skellefteå, Sweden)[27]
The cultural centre "Sara Kulturhus" in the Swedish town Skellefteå is one of the world's tallest wooden buildings at 20 stories tall. The building features solar panels and batteries, and a heat pump system. Even the sprinkler system is powered by renewable energy. It uses AI technology optimizes building operations by analysing performance and external factors, ensuring maximum comfort and energy efficiency with minimal human intervention. Sara Kulturhus also shares excess electricity with the city and stores it in on-site batteries. All waste heat is reused, and the building operates on 100% renewable energy.

- **Electrification of Transport and Construction Equipment:** Rapid growth in electric vehicle adoption, supported by extensive charging infrastructure and incentives, facilitates the decarbonisation of urban transport and construction.

Case study: Oslo's Emissions-Free Construction Policy (Oslo, Norway)

Norway's capital city Oslo aims to make all municipal construction projects emission-free by 2025. Construction machinery accounts for nearly a fifth of the city's CO2 emissions. To address this, Oslo requires zero-emission construction processes, including electric machinery and emission-free transport. Stovner Bad, a new swimming pool facility being built in Oslo, is a key example[28] using electric and biodiesel-powered equipment, with plans to be fully emission-free by 2025. This initiative supports Oslo's broader goal of reducing greenhouse gas emissions by 95% by 2030.

Case study: Miljøgate (Gran, Norway)[29]
Achieved 98% emission-free status, incorporating hydrogen charging tests. This project is the first in Norway where machine operators have access to a hydrogen-powered heavy-duty truck charger.

[24] Green by Iceland - 90% of house heating in Iceland is geothermal! (islandsstofa.is)

[25] https://www.government.is/topics/business-and-industry/energy/geothermal/

[26] https://www.government.is/publications/reports/report/2022/10/06/The-State-and-Challenges-of-Energy-Affairs/

[27] Sara kulturhus's energy solution is sustainable and kind - Sara kulturhus

[28] Stovner Bad - Oslo Municipality

[29] Anlegg Øst well underway with the electrical construction work at Gran | Norwegian Public Roads Administration (ntb.no)

The charger generates electricity without greenhouse gas emissions. The Norwegian Public Roads Administration and Hafslund are testing this hydrogen-powered charging point in the project.

Case study: Sophies Minde School (Oslo, Norway)[30]
The Sophies Minde project, converting an old clinic into a nursery and maternal health centre, is 100% emission-free. Thanks to The City of Oslo's climate policy, construction uses electric machinery and other methods to eliminate greenhouse gas emissions. This approach has significantly reduced noise and fossil fuel use, leading to improvements across various sectors and serving as a model for other cities.

- **Heat pumps:** Heat pump adoption, using them extensively for efficient heating and cooling. These systems, which transfer heat from air, ground, or water, reduce reliance on fossil fuels and lower emissions. Technological advancements, government incentives, and integration with renewable energy sources have driven their success, setting a model for other regions.

Case study: Tøyenbadet (Oslo, Norway)[31]
One of Norway's most modern and energy-efficient swimming centres. It features the use of environmentally friendly materials and recycling, including wood in parts of the building. The facility is being built as an energy-efficient passive house, incorporating heat pumps, energy wells, solar energy, and district heating. A blue-green roof will manage stormwater, enhance air quality, and boost biodiversity. The new swimming facility will also reuse treated rainwater for the pool, reducing reliance on the public water supply. Additionally, the construction site is fossil-free, utilizing only electric and biofuel-powered machinery.

3.2.2 Challenges and Barriers:

- **Grid Capacity and Stability:** Increased electrification challenges grid capacity and stability, necessitating investments in modernization, control systems and energy storage.
- **Affordability and Equity:** Ensuring an affordable and equitable transition to electrification remains a priority.

3.3 Enhancing Carbon Storage through Green and Blue Infrastructure

Many Nordic cities integrate green and blue infrastructure to enhance carbon storage, improve biodiversity, and increase climate resilience.

3.3.1 Opportunities and Best Practices:

- **Urban Green Spaces and Forests:** Parks, green roofs, and urban forests are crucial for carbon sequestration and mitigating urban heat islands.

Case study: Hammarby Sjöstad (Stockholm, Sweden)[32]

Hammarby Sjöstad is a pioneering eco-district in Stockholm that integrates extensive urban green spaces, including parks and green roofs. The development emphasizes carbon sequestration and reduces urban heat islands through its green infrastructure. These spaces improve air quality,

[30] Oslo's 'Climate Budget' Is Building a Cleaner City | World Resources Institute (wri.org)

[31] New Tøyenbadet - Oslo municipality

[32] Hammarby Sjöstad, Stockholm, Sweden | Urban Green-blue Grids (urbangreenbluegrids.com)

provide recreational areas, and enhance urban biodiversity while contributing to the district's overall sustainability.

- **Blue Infrastructure:** Enhancing water bodies in urban areas supports carbon sequestration, flood resilience, and water quality.

Case study: The River Renewal Project (Oslo, Norway)[33]
Oslo's River Renewal Project enhances rivers and waterways by improving water quality, creating natural flood defences, and integrating blue infrastructure. A notable example is the Teglverksdammen Project, completed in 2015, which reopened 650 meters of the Hovinbekken stream with a NOK 110 million investment. It features natural cleaning systems and has become a popular area for recreation and biodiversity. Since 2016 there is a NOK 140 million City Investment Budget to support carbon sequestration and flood resilience.

- **Biobased Building Materials:** Sustainable materials like hemp insulation, cork, and wood fibre are leading a shift towards environmentally friendly construction practices.

Case Study: The Biological House *"Det Biologiske Hus"* (Middlefart, Denmark)[34]
This sustainable housing concept is built entirely from bio-based materials sourced from agricultural waste, such as grass, straw, seaweed, and eelgrass. Designed with Cradle-to-Cradle principles, the house is fully biodegradable at the end of its lifecycle. It introduces a new construction method to Denmark's prefabricated housing market, focusing on material upcycling and closed material cycles. The modular design offers a concrete solution to future climate and economic challenges while maintaining high architectural quality.

Case Study: Heerup Skole (Vanløse, Denmark)
Heerup Skole is a school being developed as a two-story building constructed with Cross-Laminated Timber (CLT), showcasing a commitment to sustainability. The project emphasizes the use of emissions-free machinery, limited to under 2.5 tons, aligning with modern environmental standards. This approach not only reduces the carbon footprint of the construction process but also highlights the school's dedication to incorporating sustainable materials and practices.

3.3.2 Challenges and Barriers:

- **Competing Land Uses:** In densely populated urban areas, allocating land for green and blue infrastructure is challenging due to competing demands for housing, commercial development, and other urban uses.
- **Maintenance and Long-Term Sustainability:** Sustaining the maintenance and effectiveness of green and blue infrastructure requires ongoing funding and community engagement, which can be difficult to maintain alongside other urban priorities.
- **Uncertain Technology Future:** There are various options for carbon capture and negative emissions technologies, and it remains unclear which will become dominant in the future.
- **Biobased Materials:** Challenges include fire safety regulations, moisture handling, outdated codes, and scepticism about new materials. A holistic approach is needed, considering lifecycle emissions and broader benefits.

[33] Oslo_Reopening_Waterways (urban-waters.org)

[34] Det_Biologiske_Hus.pdf (3xn.dk)

4. Conclusion

The Nordic region's experience in spatial planning, renewable energy, electrification, and green infrastructure offers a blueprint for how cities globally can advance towards net-zero emissions. However, achieving these goals requires addressing significant challenges, including the need for substantial investments, coordinated action across sectors and actors, and policies that ensure an equitable transition for all residents. The Mitigation Work Programme’s 2024 focus on cities, buildings, and urban systems presents an invaluable opportunity to leverage these insights and catalyse the deep decarbonization and systemic transformation needed to create sustainable, resilient urban futures.