Establishing North Denmark as a Large-Scale Test Bed for Carbon Capture, Storage and Utilisation

Action Plan for the Interreg Europe project:
DECARB - Supporting the Clean Energy Transition of Coal-Intensive EU Regions.

November 2021

DeCarb
Interreg Europe

European Union
European Regional
Development Fund

Aalborg Kommune

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Executive Summary

Aalborg Municipality decided to join the DECARB project to gain knowledge about how decarbonisation efforts in other parts of Europe could help Aalborg Municipality reach the EU, national and municipal CO2 reduction targets.

Denmark's National Operational Programme for the European Regional Development Fund 2014–2020 comprises four priority axes focusing on ensuring Denmark's productivity growth and competitiveness. It places particular emphasis on the areas of energy technologies in the transition towards a low-carbon economy in order to ensure the development of renewable energy capacity and development-and-demonstration projects, as well as energy-efficient and resource-efficient enterprises and the promotion of research and innovation in, and adoption of, low-carbon technologies.

One of the main objectives in Aalborg Municipality's Sustainability Strategy 2016-2020 is to become a fossil-free municipality, and the The Utility Strategy of Aalborg Municipality 2020-2023 aims at 100 percent decarbonisation in 2028. Aalborg Municipality's actions in the DECARB project will improve these two policy instruments.

The present Action Plan aims to increase knowledge on new and innovative technologies to decarbonisation, such as carbon capture, storage and utilisation (CCUS) and power-to-x (P2X) - not only in the municipality, but in the entire North Denmark region. Inspiration was drawn from the presented good practices and discussions with the DECARB project partners, especially from the workshop on the introduction of large-scale renewables in the national and regional energy production.

This Action Plan focuses on the large-scale process of turning the North Denmark region into an global hub for CCUS and P2X through the establishment of a knowledge-sharing network of heavy industries, an analysis of future green infrastructure, a guidanc for SMEs in CCUS-oriented business models, nine cases of demo projects for CCUS, and internationalisation of the technologies developed and knowledge gained.

These actions will produce both qualitative and quantifiable results by the end of Phase 2, as the massive funding for the actions, stemming from the REACT-EU funds, have to be spent by June 2023.

Project acronym: DECARB
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NUTS2 Region: North Denmark

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General Introduction to DECARB

The Interreg Europe project *DECARB - Supporting the clean energy transition of coal-intensive EU regions* aims at transitioning from a carbon-intensive era towards the clean energy future.

Through exchange of experiences and the transfer of knowledge, the DECARB project supports the participating regions in securing sustainable development, economic and societal stability, and a role in the 2030 energy mix.

The DECARB project has a total budget of 1.807.730 EUR and runs from 1 June 2018 to 31 May 2023. During the first phase in 2018 – 2021, the project partners have identified and shared good practices and knowledge, discussed decarbonisation, environmental restoration and reskilling of the coal-related labour force with local stakeholders.

As a result, the partners have created nine Regional Action Plans that will help turn the intentions of the DECARB project into practice. These actions and their effects will be monitored by each partner during the second phase of the DECARB project in 2021–2023.

The present Action Plan has been created by Aalborg Municipality in collaboration with the local stakeholder group, which consists of representatives from Green Hub Denmark (a public-private partnership that gathers all major energy stakeholders in the region).

The inspiration for the actions described comes mainly from the Interregional Workshop on the Large-Scale Introduction of Renewables in Partners' Energy Mix held in Badajoz, Spain, in March 2019 as well as general discussions during partner meetings and events on how to substitute coal for renewables.

1 Stara Zagora Regional Economic Development Agency (Bulgaria)

2 Lodzkie Region (Poland)

3 Eszak-Alfold Regional Energy Agency (Hungary)

4 South-West Oltenia Regional Development Agency (Romania)

5 Ministry for Economic Affairs & Energy in the State of Brandenburg (Germany)

6 Aalborg Municipality (Denmark)

7 Regional Association of Local Governments of Western Macedonia (Greece)

8 Energy Agency of Savinjska, Saleska and Koroska Region (Slovenia)

9 Extremadura Energy Agency (Spain)

Policy Context for the Aalborg Municipality Action Plan

☒ Investment for Growth and Jobs Programme
☐ European Territorial Cooperation Programme
☒ Other regional development policy instrument

Denmark's National Operational Programme for the European Regional Development Fund 2014–2020
The Danish Operational Programme comprises four priority axes focusing on ensuring Denmark's productivity, growth and competitiveness. It places particular emphasis on the areas of energy technologies in the transition towards a low-carbon economy in order to ensure the development of renewable energy capacity and development-and-demonstration projects.

The issues tackled by the DECARB project are relevant to Priority Axis 3: Energy-efficient and re-source efficient enterprises. Here, the in-vestment priority 4f under the Thematic Objective 4 states: Promoting research and innovation in, and adoption of, low-carbon technologies.

Even though Denmark excels in the area of renewable energy and decarbonisation, there is still room for improvement in the implementation of the country's energy efficient planning through the operational programme. The participation of the private sector in renewable energy projects is still below desired levels, and the actions of the policy instrument do not specifically target the existing coal-based sector.

In the wake of the corona virus pandemic, the European Commission launched a recovery plan in December 2020: The Recovery Assistance for Cohesion and the Territories of Europe (REACT-EU). REACT-EU tops up the 2014-2020 European Regional Development Fund and supports investment projects that foster crisis-repair capacities and contribute to a green, digital and resilient recovery of the economy.

The actions described in the present Action Plan improve this policy by supporting new projects that both include the private sector and targets the existing coal and carbon-based industry.

Denmark's Integrated National Energy and Climate Plan 2020-2023 & the Danish Climate Action Plan 2020
The EU Regulation on the Governance of the Energy Union and Climate Action went into force in December 2018. One of the key elements of the new regulation is that Member States must work out an integrated national energy and climate plan (NECP) for the period 2020-2030. According to the Governance regulation, all member states had to submit their NECP to the EU Commission before the end of 2019.

Denmark submitted its NECP on 20 December 2019: Denmark's Integrated National Energy and Climate Plan 2020-2030. The NECP includes legally binding targets:

- Reduce greenhouse gas emissions by 70% by 2030,
- Reach net zero emissions by 2050 at the latest, and
- Set milestone targets based on a five-year cycle.

A reduction target of 70% by 2030 is a very ambitious goal, and the policy states that it will be particularly difficult to realise the last part of the goal, i.e. from 65% to 70%. This will require currently unknown methods and, therefore, also a close collaboration with experts and other relevant stakeholders.

In order to ensure that the national reduction targets in the NECP are met, the Danish government will present a comprehensive climate action plan with a ten-year aim every five years.

The Danish Climate Action Plan 2020 translates the NECP into five tangible climate sector strategies, one of which being the Energy and Industry strategy. This holds, amongst others, the following two key initiatives:

- Energy islands: test sites with large-scale energy production and investments in next generation technologies

- Surplus heat: The utilization of industrial surplus heat in the district heating system, which translates into economic profit for the industry as surplus heat becomes a commodity.

The action described in the present Action Plan improve the two policies by supporting new projects that can help identify the still unknown energy production methods needed to reach the hard-to-reach percentages between 65-70%

Aalborg Municipality's Sustainability Strategy 2016-2020 & Utility Strategy 2020-2023

The Sustainability Strategy is the overall strategy that translates the political framework for the sustainable development in Aalborg Municipality, and it ensures the coherence between the municipal sub-strategies, such as the municipal utility strategy.

The Sustainability Strategy's thematic objective 4, Sustainable Energy Supply, states that the municipal energy production should be based entirely on renewable energy sources, and that the goal is for Aalborg Municipality to be a fossil-free municipality by 2050.

The actions to reach this goal is described in the Utility Strategy 2020-2023 that outlines how to provide Aalborg Municipality's 225.000 citizen with heat and electricity in a sustainable manner. The Utility Strategy states a test and demonstration site as the main driver in decarbonising the energy production:

"*We focus on the establishment of a test and demonstration site, in which we actively can develop and test the green solutions of tomorrow in collaboration with researchers, suppliers, other utility companies and the consumers (...). The test site is one of the most important initiative in the current strategy period.*"

The actions described in the present Action Plan improves these two policies by supporting new projects that can help realise Aalborg Municipality's target of being a fossil-free municipality by 2050 and having a fossil-free utility by 2028.

Also, by focusing of the establishment of a test site, these policies support the main policy of the DECARB project, Denmark's National Operational Programme for the European Regional Development Fund 2014–2020, that emphasises development and demonstration projects.

Action of Aalborg Municipality

Establishing the North Denmark region as a large-scale test bed for carbon capture, storage and utilisation.

Background
Nordjyllandsværket is the coal-fired power plant that provides Aalborg Municipality's 225.000 citizens with heat and electricity. The energy production at Nordjyllandsværket is inextricably linked to Aalborg Portland, situated across the fjord, as the surplus heat generated from Aalborg Portland's cement manufacturing constitutes a large part of Nordjyllandsværkets energy mix.

Nordjyllandsværket was built in 1967 to operate as the main supplier of district heating to Aalborg Municipality, and electricity from the mid-1980s. In 1998, the unit NJV3 was built as the first coal-fired energy production unit in Denmark to be equipped with an integrated SNOX system for exhaust cleaning. Today, the NJV3 unit is the most fuel-efficient coal-fired unit in the world with a record-breaking utilization level of 91% during combined heat and power production.

In 2015 Aalborg Municipality purchased Nordjyllandsværket in order to steer the decarbonisation process. Regardless of the high utilization level of the NJV3 unit, Aalborg Municipality still wanted to decarbonise all activities at the power plant by 2028.

Cement factory Aalborg Portland emits 3,2 mio. tonnes of CO2 each year. In comparison, Nordjyllandsværket emits 0,7 mio. tonnes of CO2 (2020), a number that would have been very much higher, if Nordjyllandsværket did not benefit from Aalborg Portland's surplus heat. It is difficult to reach the high temperatures needed in cement production with other fuels than coal, but still Aalborg Portland seeks to reduce its CO2 emission by 30% by 2030. These means that Aalborg Portland needs to find innovative solutions to curb their emission. One way could be through carbon capture, storage and utilisation.

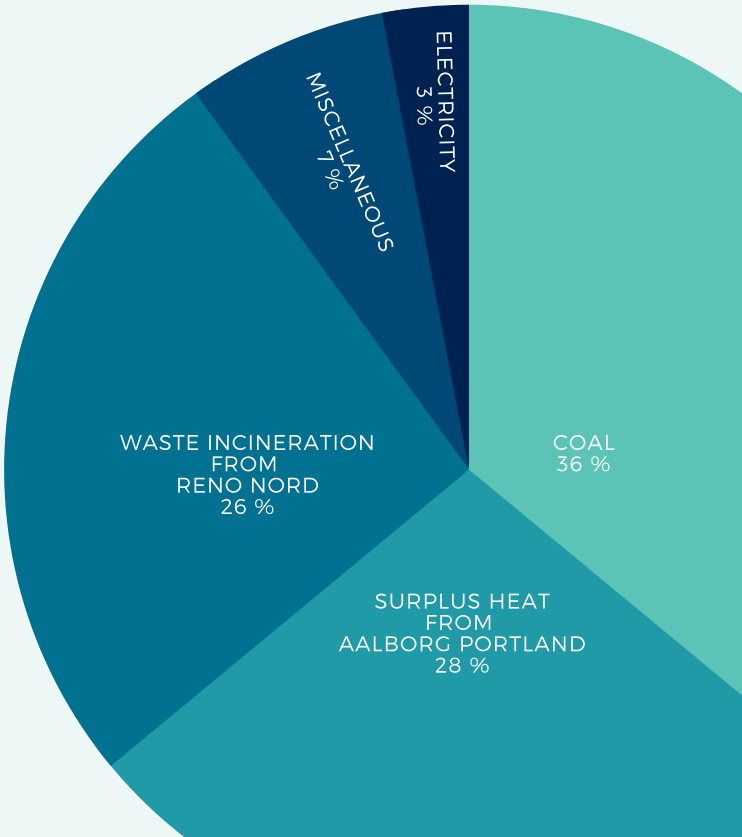

Figure 1:
Energy mix at Nordjyllandsværket
Even though Nordjyllandsværket is categorized as a coal-fired power plant, only 36% of the energy production at the plant is generated by means of coal

54% of the heat production comes from surplus heat, split into 28% from Aalborg Portland and 26% from the waste incineration plant, Reno Nord, a few kilometers away. The remaining part of the energy mix comes from miscellaneous sources, amongst others, an electricity-based boiler.

Action
The following action of Aalborg Municipality improves the policy addressed by Aalborg Municipality in the DECARB project as well as the other national and municipal policies mentioned in the chapter on policy context by supporting a new project that includes the private sector, targets the existing coal and carbon-based industry, identifies still unknown energy production methods, and realises Aalborg Municipality's target of being a fossil-free municipality by 2050 and having a fossil-free utility by 2028.

Carbon capture, storage and utilisation plays a large role in Denmark's national target of 70% reduction in CO2, as it has the potential to deliver the entire reduction. It is a priority for Aalborg Municipality to spread out the activities of action to the entire region, and as such, the action not only focuses on Aalborg Municipality, but the entire North Denmark region.

In March 2021, The Danish government formed seven Regional Growth Teams in order to determine how best to invest the Danish funding from the REACT-EU Programme - a Covid response top-up of the existing European Regional Development Fund 2014–2020.

Local stakeholders and decision-makers in the seven Danish regions determined which regional business strongholds to focus on when kickstarting the post-Covid economic growth in the respective regions. Two months later, in May 2021, Aalborg Municipality, as part of the Growth Team in the North Denmark region, delivered a number of recommendations on how to turn the North Denmark region into a global CCUS business beacon.

This fits the policy addressed by Aalborg Municipality: Denmark's National Operational Programme for the European Regional Development Fund 2014–2020. Specifically as Aalborg Municipality has to target the programme's Priority Axis 3 (Energy-efficient and resource-efficient enterprises), and in particular, the axis' thematic objective 4 and investment priority 4f: Promoting research and innovation in, and adoption of, low-carbon technologies.

Just before the end of the extended phase one of Decarb, in October 2021, the Danish Business Authority (the managing body of the Danish ERDF) announced a call for the Danish REACT-EU funds, based on the recommendations of the seven Regional Growth Teams. Aalborg Municipality as lead partner for the Green Hub Denmark consortia submitted a project application on November 24th, 2021. Aalborg Municipality will know on February 4th, 2022, if they will be awarded the funding.

The project's vision is for North Denmark to be an international CCUS hub by 2030 with 50 carbon capture sources as well as a pipeline infrastructure system to transport and store both hydrogen, methanol and CO2.

Aalborg Municipality will lead the following four sub-actions:

1. Road Map
Aalborg Municipality will create a network of the entire value chain of CO2 intensive industries in the region. Based on a mapping of existing analyses and new empirical data, the network will draw up a new analysis focusing on future green infrastructure and the potential of ports as temporary CO2 storage facilities.

2. Test and Demonstration
Aalborg Municipality will initiate nine CCUS test and demonstration sites throughout the region focusing on existing CO2 emission locations. The various locations will focus on capture, storage and/or utilization.

3. SME Guidance
Aalborg Municipality will identify, screen and develop business models for SMEs that already have or have the potential to contribute to the future supply chain of CCUS. Emphasis is put on not overlapping with the many existing ERDF projects in the region.

4. Internationalisation
Aalborg Municipality will conduct desk research to identify international best practices as well as facilitate a fact-finding mission to the most suitable international CCUS hub. Finally, Aalborg Municipality will attract international actors through a delegation visit to North Denmark.

Players involved
A partnership consisting of some of the region's most significant energy stakeholders joined forces in May 2020 to establish the public-private partnership, Green Hub Denmark.

The idea of Green Hub Denmark is to create a formal partnership that apply for national and international funding as a strong coherent group as well as creating a single point of entry for all companies, national as well as international, wanting to create growth and new green jobs through partnerships on R&D projects and large-scale green energy test projects.

Green Hub Denmark is the main stakeholder of Aalborg Municipality in the DECARB project and it gathers all the organisations, and more, that otherwise would have been single stakeholders in the project. Green Hub Denmark is headed by a secretariat consisting of Aalborg Municipality and Aalborg Utility. For a coherent list of partners in Green Hub, please see here.

Aalborg Municipality is lead partner on the REACT-EU project, but the following stakeholders are participating as cases in the project:

- Aalborg Portland
- Renovation North
- Port of Aalborg
- Frederikshavn Municipality
- Thisted Power Plant
- Port of Hanstholm
- Port of Hirtshals
- Hydrogen Valley
- Vesthimmerland Biogas
- Vindø Brick Factory

Costs, budget and funding
The budget for the action is 13,4 mio EUR from the REACT-EU Programme distributed by The Danish Business Authority.

Time frame
- 03/2021: Formation of regional growth teams for advisory on allocation of REACT-EU.
- 05/2021: Growth teams send recommendations to Danish Business Authority.
- 10/2021: Call for REACT-EU opens.
- 11/2021: Application for REACT-EU is sent to the Danish Business Authority by Aalborg Municipality.
- 02/2022: Answer from Danish Business Authority.
- 04/2022: Kick-off of project.
- 06/2023: End of project

Impact expected
With the actions described in the present action plan it is a vision that the North Denmark region in 2030 is an international pioneer region for carbon capture, storage and utilisation, where CO2 is captured from the 50 largest CO2 sources.

At the same time, a pipeline infrastructure system has been established for the transport of both hydrogen and CO2. The infrastructure can be accessed by companies for transport and utilisation, which will enable the largest CO2 emitters in the region to capture emissions and give other companies the opportunity to produce products, incl. green fuels for heavy transport and the aviation sector.

At the same time, several intermediate storage facilities have been established at the ports, among other places, and CO2 and hydrogen are stored in suitable structures in the subsoil.

By 2030, 5,000 new jobs will be created in the CCUS industry.