Case analysis

Ten Climate Technologies with Documented Impact in Danish Municipalities

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Smart City Insights

KL

RAMBØLL

Climate for money:

Ten Climate Technologies with Documented Impact in Danish Municipalities

In this case analysis, ten successful cases from municipalities are gathered to inspire other municipalities. The focal point is how municipalities get as much 'climate for money' as possible by utilizing new technology and digital solutions

The purpose of the analysis

The purpose of the case analysis is to inspire municipalities to implement digital climate solutions that other municipalities have successfully adopted. The analysis was conducted by Smart City Insights and Rambøll Management in close collaboration with the Local Government Denmark (KL) and the municipalities themselves.

In all ten cases, both the climate-related and economic benefits have been documented in the municipalities that have implemented the solutions. The analysis is based on the motto "climate for the money." The ambition of the analysis is to encourage more municipalities to reuse, share, and replicate the solutions that work, or to inspire them to adapt the solutions to their own needs.

Considerable time and effort have been invested in developing and implementing all ten climate solutions. Therefore, the more we can avoid reinventing the wheel and instead scale existing solutions, the more climate impact we get for the money. Speaking of money, most of the ten cases demonstrate that climate benefits and economic benefits often go hand in hand. It is indeed possible to achieve economic benefits while simultaneously reducing CO2 emissions or enhancing climate resilience.

These two bottom lines—economics and CO2 reduction—are not opposites, but are increasingly becoming prerequisites for each other.

Content of the analysis

In the ten cases, the application of climate technologies that address specific climate challenges is described. Each case includes a description of the challenge the municipality faced, the solution to the problem, and an explanation of the technology used. The climate benefits are quantified in terms of CO2 reduction, economic benefits, and the underlying investment made.

Additionally, the analysis outlines the potential for spreading the solution and what it takes for other municipalities to implement a similar solution. The analysis also provides guidance on how to calculate and document the CO2-related benefits and the prerequisites required to successfully achieve climate gains.

To make the material easy to understand, each case is scored on three parameters (on a scale from 1 to 5) regarding the solution's effectiveness and potential for replication. It's important to note that this score is solely based on a relative assessment in comparison to the other cases.

What is climate technology?

In the analysis, the term 'climate technology' is used widely to encompass digital solutions and the utilization of data to achieve climate benefits. Climate technology refers to the application of various technologies, including artificial intelligence, the Internet of Things (IoT), digital platforms, and other technological advancements, which are used to combat climate change and reduce its CO2 emissions

For example, it can involve advanced sensor systems used to monitor and control energy consumption in buildings or the use of data and data analysis to predict floods or the required number of vehicles in a municipal fleet. These applications fall under the umbrella of climate technology, contributing to the reduction of CO2 emissions and addressing environmental challenges.

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The Path to Substantial CO2 Reductions in Municipalities

There are no individual digital solutions that can significantly reduce the climate impact of municipalities. Therefore, it's the "many small contributions add up to a large sum" that will make municipalities significantly greener. The ten cases in this analysis represent different approaches to reducing CO2 emissions in municipalities and how to integrate climate considerations across various areas of expertise - from reducing food waste in municipal kitchens and minimizing the fleet of vehicles to energy efficiency in buildings.

If every department, institution, and area of expertise in all municipalities considers how to reduce their consumption of goods, energy, and CO2, it becomes a collective effort that adds up.

Municipalities shouldn't each individually seek solutions. It requires increasing knowledge about the technologies and initiatives with the greatest scaling and dissemination potential. It's essential to focus on documenting the effects of the many excellent projects already underway and ensuring that these contributions are included in the municipalities' own climate reporting.

The greenest energy is the energy not used. Therefore, the primary goal is to reduce municipalities' consumption of goods, electricity, energy, and gasoline, while also ensuring that the necessary products are produced as environmentally friendly as possible.

Advisory board and case owners

Throughout the analysis process, an attached advisory board has provided valuable input and comments on the individual parts of the analysis. A thank you to the ten case owners who have provided their cases, experiences, and insights for the analysis, and who are additionally available to other municipalities interested in learning more about the individual cases.

The cases have been selected as follows:

Emphasis has been placed on finding cases that, through the use of technology, have achieved documented climate benefits to an extent that makes them interesting for other municipalities. It has been important to select cases with significant potential for replication and cases that are relevant to as many municipalities as possible. The cases have also been chosen from areas where municipalities have direct decision-making authority.

The ten cases were identified using Rambøll's and Smart City Insights' knowledge of relevant projects. Additionally, KL (Danish Municipalities) has contributed cases and encouraged municipalities across the board to propose case ideas.

Participants in the advisory board

Michelle Moustgaard Birch, Odense municipality

Matias Wolder Steenberg, Copenhagen municipality,

Line Gerstrand Knives, Aarhus municipality

Tine Lai Andersen, Aarhus municipality

Morten Westergaard, Middelfart municipality

Signe Sloth Hansen, Gladsaxe municipality

Lasse Ziska, Syddjurs municipality

Morten Koed Rasmussen, Gate21

The 10 municipal cases

Solution	Area	Theme
Aarhus Municipality reduces the number of cars in home care by 30% via intelligent fleet management Data analysis identifies overcapacity in the car fleet.	**Traffic/mobility**	Fleet Management
Tårnby Municipality cuts 15% of heat consumption with sensors, weather data and artificial intelligence Heat consumption is controlled automatically based on weather forecasts and the temperature in buildings.	**Institutions and buildings**	Heat consumption
Hørsholm Municipality saves 6% on total CO2 emissions with data-based energy platform In just 10 months, the municipality has significantly reduced electricity, water and heat consumption.	**Institutions and buildings**	Energy management
Aarhus expects a 10-20% increased effect of the climate adaptation with data from the sewers Sensors provide data in real time about what is going on in the drainage system.	**Climate protection**	Sewerage and drainage
Svendborg Municipality reduces the annual risk of damage from floods by millions Digital damage calculator reduces the risk of damage by 33%.	**Climate protection**	Prioritization of climate protection efforts
Copenhagen Municipality reduces the CO2 load from mobile devices by 20% "Lifecycle method" has helped the municipality to increase recycling and better utilization.	**Green it**	Mobile devices
Gladsaxe Municipality reduces food waste by 30% by weighing and analyzing the food waste Digital platform provides new knowledge for menus with less food waste in municipal kitchens.	**Food waste**	Food waste
Aarhus Municipality cuts 12% CO2 from food purchases with intelligent climate accounting The use of artificial intelligence and internal CO2 taxes create more climate-friendly food purchases.	**Purchase**	Purchase of food
Haderslev Municipality saves 82% on street lighting by using sensors and LED Dynamic light control via an intelligent open source platform significantly reduces electricity consumption.	**Lighting**	Street lighting
Varde Municipality achieves a 21% reduction in waste collection with digital waste containers IoT sensor technology and real-time data are used on the municipality's large waste bins to optimize route planning and reduce the number of emptyings.	**Waste and transport**	Waste management and route planning

Appendix:

- Prerequisite analysis - What does it take to be able to realize climate gains successfully?
- How to calculate and document your climate gains.

Aarhus Municipality reduces the number of cars in home care by 30% via intelligent fleet management

Data analysis identifies overcapacity in the car fleet.

Situation: Aarhus Municipality has decided that their car fleet must be fossil-free by 2025. The current car fleet must therefore be replaced, and new leasing agreements with suppliers must be done on an ongoing basis.

Challenge: In the spring of 2022, home care in Aarhus Municipality was faced with having to enter into new leasing agreements for part of the total car fleet of a total of 200 cars. Own calculations showed a need to enter into a new agreement to lease a total of 43 cars.

Solution: Aarhus Municipality is participating in a major development work together with a number of municipalities to develop the AI tool FleetOptimiser to support the restructuring of the car fleet based on actual needs. They chose to use the tool in the home care area and carried out a thorough needs analysis based on driving patterns based on GPS data. The analysis showed that the home care had an excess capacity of 13 cars and thus could be content with leasing 30 cars for the next five years and still maintaining the same driving patterns.

What is intelligent fleet management?

An AI-based analysis tool that, on the basis of GPS driving data, is able to indicate proposals for an optimized car fleet - with associated optimized use. The solution can also simulate routes driven (with fossil-fuel cars) with new vehicles (bicycles and electric cars) and show the possible CO2 reduction. Based on a given desired financial saving or a given CO2 reduction, proposals for a new fleet composition and possibly requirements for future driving patterns.

AARHUS KOMMUNE

Area
Transport and mobility

Theme
Fleet management

Climate technology
Artificial intelligence for calculating future needs for car fleet and optimal use.

Municipality
Aarhus

Contact person
Joachim Daus-Petersen, fleet management coordinator, mayor's department. joada@aarhus.dk

Reductions

30%

reduction of the car fleet for part of home care

49.4

tonnes of CO2

reduction of the 13 cars that were not purchased over a 5-year period

Gains

25%

saving the cost of car fleet

for part of home care, includes both leasing and operation

3 million DKK

savings by leasing 13 fewer cars over 5 years

Investments

DKK 200,000

for the operation of FleetOptimiser

200

working hours

loading of GPS data + calculation

This is how the numbers are calculated

- Reduction of CO2 emissions in relation to production and operation of electric cars is calculated using Copenhagen Electric/Region H's tool (Elbilers climate impact (regionh.dk)). The calculation method is based on the Climate Council's work from 2018.
- The financial gain is based on leasing prices from suppliers and Aarhus Municipality experience with expenses for insurance, repairs, etc.
- Calculation of investments is based on Aarhus Municipality's assessesment of what it will require financially and in terms of resources if a municipality has to implement a similar initiative for a medium-sized municipality. For Aarhus Municipality it was part of a larger development project and thus not possible to calculate in isolation.

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CO2 reduction
Due to fewer number of leased cars than previously

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Climate for money
Saves money and reduces the climate footprint at the same time

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Scaling Potential
Requires fleet adjustment

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Climate for money

Aarhus Municipality is working together with ten other municipalities (Aalborg, Esbjerg, Favrskov, Kerteminde, Copenhagen, Norddjurs, Ringsted, Slagelse, Syddjurs, Sønderborg) and two regions to further develop the AI tool FleetOptimiser, as there is great potential in also using the tool to estimate the right mix of means of transport and establish fleet sharing across internal organizational units in the municipalities.

The project has received support as an AI signature project in 2021 and 2022 and has received further support from 2023 onwards.

Read more about the FleetOptimiser project and how your municipality can be involved:
fleetoptimiser.aarhus.dk

Additional gains

- In addition to identifying excess capacity in car parks, the solution can also estimate the right mix in the use of bicycles, electric cars and fossil-fuel cars and thus ensure optimal utilization.
- The solution can also be used to come with proposal for changing the car fleet and usage pattern of cars and bicycles based on a desire for a given financial saving or CO2 reduction.
- The solution also provides the opportunity to estimate gains from sharing the car fleet across organizational units.

Be aware:

- That there are many emotions attached to having discretion over cars and thus also to when changes occur.
- That the initiative must be timed in relation to when it is possible to reduce its car fleet, cf. agreements and contracts entered into.

Scaling potential

Requires a relatively small investment held up against large economic and climate gains. Requires, however, that it is possible to change your car fleet cf. agreements and contracts.

Low barrier to implementing the solution, as you only remove excess capacity, and the previous driving pattern can thus be maintained.

Since the leasing and operation of car fleets today often takes place decentralized in the municipalities, there is great potential in working together across the municipality with the sharing of car fleets.

What does it take?

Technological:
GPS data of current driving patterns. If you use a fleet booking tool, it will typically be able to deliver this data. Operation of the AI tool FleetOptimiser.

Economic:
Relatively small investment - and working hours.

Organizational:
Anchoring close to decision-makers as well as political and managerial support to challenge habitual thinking and a "feeling of ownership" of the car fleet.

In terms of competence:
Some insight into cars and driving needs. Does not require major IT skills.

Legal/Ethical
GPS data must not be attributable to the individual users of the fleet.

Here's how to get started!

1. Investigate when it will be possible to change your car fleet, cf. agreements and contracts.
2. Ensure that there is political and managerial support for making changes to car fleets, including ownership and any introduction of other forms of transport such as bicycles.
3. Check whether GPS data is available or whether data must be entered manually from driving logs.

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Tårnby Municipality cuts 15% of heat consumption with sensors, weather data and artificial intelligence

Heat consumption is controlled automatically based on weather forecasts and the temperature in buildings.

Situation: Tårnby Municipality would choose a "classic" EMS (Energy Management System), which makes it possible to monitor, analyze and optimize energy consumption in the municipality's buildings. But they wanted a solution that suited the municipality's buildings and at the right price.

Challenge: In Tårnby Municipality, the heat consumption (gas and district heating) was the same year after year, regardless of whether there was variation in the weather (cold or warm winter). Therefore, the municipality wanted to investigate how they could effectively manage heat consumption across buildings at an affordable price.

Solution: Automatic forecast control steps in and affects the outside sensor, which controls the supply temperature, based on calculations of weather conditions and temperatures in buildings.

The solution from Kiona ensures a lower supply temperature, which is the temperature of the water that flows to the radiators from the heating system. In this way, kWh are saved because the water does not have to be heated to the same temperatures as before. This has resulted in an average saving of 15% - corresponding to 22.4 kWh/m2.

What is automatic forecast control of heat consumption?

Using sensors that measure temperatures in the individual rooms in buildings, as well as data on factors that affect heat/cold in buildings (sun, wind, downpour), it is possible to control heat consumption automatically based on weather forecasts, so that the heating system can be adjusted in time (manipulated) before the weather changes.
Artificial intelligence is used to continuously adjust the supply temperature more accurately based on different situations (weather, indoor climate, temperature).

TÅRNBY KOMMUNE

Area
Public buildings

Theme
Heat consumption

Climate technology
Sensors for measuring temperature and air quality as well as digital platform.

Municipality
Tower City

Contact person
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Reduction

365 tons
CO2 per year

15%
reduction of
heat consumption

Gains

5.84 million DKK
over a 5-year period.

Annual expected savings:
15%

Investments

Total investment of
3.8 million DKK
over a 5-year period.

+

Approx. 7.5
working hours/week

This is how the numbers are calculated

- The reductions are not exclusively a direct result of the forecast management. Here, a reduction of approx. 10% is expected.
- However, the reductions are still a result of the investment in the solution, as it has resulted in other more manual measures. An example is that several rooms had a temperature well above 21 degrees (before the 19 degrees it is today), which was the desired temperature. Insight into the temperature trip on the digital platform means that you can now act quickly if it is too hot.
- The investment of the 3.8 million DKK is over a 5-year period with a total installation cost of 1.4 million. DKK and a total subscription of 2.4 million DKK, distributed between the 37 buildings. See more calculations on the next page.

CO2 reduction
Savings across all buildings of over 10%

Climate for money
Saves money and reduces the climate footprint at the same time

Scaling potential
The solution requires 'only' access to data. In addition, it requires committed employees with responsibility for the individual buildings to agree to the idea.

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Climate for money

The business case is best for the complex buildings with a caretaker and CTS (Central Condition Control and Management).
The solution has been installed in 37 large buildings (schools, nursing homes, administration, sports, etc.) The total area for this type of building is 175,500 m2 (out of a total of 247,000 m2 spread over 220 buildings) with a total gas/heat consumption of 22.3 GW/h.
The result so far is that the old heat consumption of 84 kWh/m2 is reduced to 74 kWh/m2 – i.e. a saving of 10 kWh/m2.

The price of installation for the above 37 buildings is approx. 1.4 million DKK/ 37,850 DKK per building. In addition, there is a subscription of approx. 0.48 million DKK/year corresponding to 3DKK/m2. In total, the investment over 5 years (DKK 1.4 million + (480,000*5 years) has been DKK 3.8 million.

Many municipal buildings have a penalty imposed due to poor cooling of the return water. In the pilot case in Tårnby Municipality - Skottegårdsskolen - the penalty fee was DKK 25,000/year. Today, they get DKK 15,000 back instead. So far, DKK 250,000 per year has been saved. years on penalty charges alone.

Additional gains

- Before the temperature and humidity sensors were installed in the individual rooms in the buildings, the temperature or humidity was not known. Today, you can keep a more constant temperature and monitor the humidity, so that you ensure a better indoor climate for the people who use the premises.

- The monitoring of the temperature also means that it has become easier and faster for the people who are responsible for the individual buildings to react and find reasons for the temperature changes in the individual buildings or premises. Here you can see, for example, if the temperature drops in a room or if a window has not been closed.

Be aware:

- The digital platform has many features that can be difficult to learn. Therefore, it must be considered whether you want to train an employee internally in the municipality or assign an adviser from the delivery door. In Tårnby, they have chosen the last solution with a little help from an external consultant.

Scaling potential

The country's 98 municipalities own and administer a total of approx. 31 million m2 buildings, including primary schools, nurseries, kindergartens and sports facilities as well as administration buildings. Read more here.

It is a Plug & Play solution in municipalities with buildings that have data from existing EMS/CTS systems as well as weather data.

What does it take?

Technological:
It is a Plug & Play solution that can be installed on all buildings with an EMS/CTS. The solution simply uses data from either its own or existing data sensors.

Economic:
There are installation costs and subscription. In Tårnby Municipality, the installation costs came from the budget for energy improvements. Going forward, the subscription will be paid for by the operating costs/savings.

Organizational:
The project is anchored in the climate team, which in Tårnby consists of a single energy employee.

In terms of competence:
It has been necessary to have an energy employee with allocated time and skills to find the right solution and help with the dialogue with the caretakers. A consultant from the supplier of the solution has also been attached to fully utilize the potential of the solution.

Here's how to get started!

1. Collection and access to data is central to being able to analyze where and how energy can be saved.

2. You must be aware that it can take a long time to collect data. It can delay action and the solutions.

3. Make sure to document the effects, as they can be used as a business case for new investments, scaling, and more CO2 double bottom line reductions. Think of yourselves as salespeople of sorts.

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Hørsholm Municipality saves 6% on the total CO2 emission with data-based energy platform

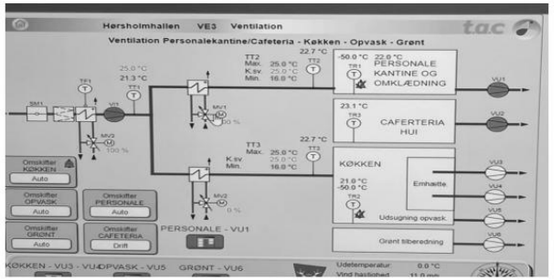
In just 10 months, the municipality has significantly reduced electricity, water and heat consumption.

Situation: In 2021, Hørsholm Municipality decided to investigate the possibilities for savings in energy consumption in the municipal buildings. The municipality set aside a budget for energy management and hired an employee to find the solutions.

Challenge: Hørsholm Municipality did not systematically collect data on energy consumption. There were only a few manual meters, which were largely unused. There was therefore a need to invest in an Energy Management System (EMS) as a starting point for data-based energy management.

Solution: In May 2021, Hørsholm Municipality implemented computerized energy management with artificial intelligence on the electricity consumption of all municipal properties. The solution from Ento Labs provides an hourly overview of all energy data.

The municipality has subsequently initiated a number of energy-saving initiatives on the basis of the collected data and information. This has now, in just under three years, resulted in a total saving of 6% of the total annual energy consumption.



How does data-based energy management with artificial intelligence work?

The solution collects building data, weather data, behavioral data and energy data from several data sources.

Artificial intelligence is used to analyze 16 different parameters that can influence a property's electricity consumption, e.g. wind speed, wind direction, solar radiation, etc. Based on this, a prioritized list of buildings with the greatest potential for energy savings is provided.

HØRSHOLM KOMMUNE

Area
Public buildings

Theme
Energy management

Climate technology
Sensors, digital platform and artificial intelligenc

Municipality
Hørsholm

Contact person
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Reductions

190
tonnes of CO2 per year.

993
MWh per year.

Approx. 6%
of energy consumption

Gains

2.09 million DKK
per year in savings on electricity and heat.
This corresponds to a payback period of approx. 1 year

Investments

2.1 million DKK
in total investment. The grant covers one-off investments for concrete solutions of DKK 2 million and 0.1 million DKK for the digital solution.

This is how the numbers are calculated

- The figures are all drawn from the EMS system, where reductions in CO2 and KWh are continuously calculated as part of the solution.
- The solution itself does not deliver savings as it is an energy management tool. The savings have been achieved by acting on the suggestions for improvements that the system proposes.
- The investments are one-off investments, whereas the savings are permanent. Therefore, the repayment period is 1 year.
- As far as Investments are concerned, the solution is implemented by the supplier, so not many working hours need to be used here. All the data is ready on day 1. The biggest task is to get data from the energy company.

CO2 reduction

The reduction depends on how much the municipality reacts to the information that comes from the system.
In Hørsholm, many low-hanging fruits have been found.

Climate for money

Very short payback period and quick savings in CO2.

Scaling potential

Great potential and the solution with artificial intelligence can be used across energy management systems.

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Climate for money

In addition to data on electricity consumption from EMS, Hørsholm Municipality also obtained data on water and heat consumption from the utility companies. Here, for example, it was discovered that 81% of all buildings paid a cooling fee, which is paid when the return water to the utility company is too hot and therefore needs to be cooled.

Hørsholm Municipality saw great effects by using data from main meters, but has itself made new investments to get the greatest possible CO2 savings. The municipality has purchased a system which is supplemented with bi-meters which are set up in several places in the buildings and give a more precise insight into where in the property there is consumption beyond the normal. That insight saves a lot of resources, as it is faster to identify where in the building one needs to act.

The municipality has drawn up an *energy management annual cycle* that helps to ensure that the service managers have recurring meetings where they have the opportunity to spar with each other. The energy team in the municipality will in the future hold meetings regularly, on the basis of data insights in the various buildings, where they meet with service managers and focus on specific measures.

Additional gains

- The solution automatically documents the effect, which can be used to deliver a business case to others energy optimization projects
- It is possible to visualize the results in front of the citizens and show how much CO2 has been saved.
- The solution also displays indoor climate data (CO2-concentration), which has an impact on health and learning
- Time/resources are saved, as the artificial intelligence calculates where it is necessary to insert. Before, the municipality had to find the problems themselves without data.

Be aware:

- The delivery time in relation to data will, however, depend on the resources and possibilities of the individual supply companies in relation to sharing data, and may therefore vary.

Scaling potential

The country's 98 municipalities own and manage a total of approx. 31 million m2 buildings, including primary schools, nurseries, kindergartens and sports facilities as well as administration buildings.
Read more here.

According to the interest organization SYNERGY, Denmark can save 10% of energy consumption in buildings by better utilization of data and digitization. Read more here.

The solution's potential can be tested for a small amount (DKK 25,000-30,000), and data is delivered after the first day the solution is installed

What does it take?

Technological:
It requires access to consumption data, which can take a long time to access for water and heat. It does not require bi-meters, but it will make the solution more efficient with more accurate measurements in the buildings.

Organizational:
The project is anchored in Team Energy, and the energy budget is centrally anchored. This means that the financial results have no influence on the budget and accounting results for the individual institutions - e.g. schools, nursing homes, etc.

Economic:
In terms of resources, it does not require much time, as the solution is easy to implement and the suppliers are responsible for it. It does not require large financial investments.

In terms of competence:
Two people are trained to use the system and understand the data presented by the solution. The two employees use the solution to initiate projects with service managers around the municipality's buildings.

Here's how to get started!

1

Try the solution for a shorter period It costs approx. DKK 25,000-30,000 to test the system for three months, and here you should already have achieved clear savings.

2

Get the supplier or other external advisers to obtain data from the utility companies.

3

A centralization of the budgets means that the individual service manager is not afraid to save energy in the individual buildings. If it is decentralized, it must be ensured that the savings are not removed from the budget in the individual building/institution or similar.

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Aarhus expects a 10-20% increased effect of the climate adaptation with data from the sewers

Sensors provide real-time data about what is going on in the drainage system.

Situation: In Aarhus municipality, there is a combined drainage system consisting of approx. 2,800 km of rain and waste water pipes. Annually, approx. 140 million DKK are invested in these systems, which is wanted to be used as best as possible for the benefit of the water environment and citizen services.

Challenge: Prioritization of the many renovation, remediation and climate adaptation needs is currently done primarily on the basis of information about the wiring network and mathematical models.
Real-time observations, which describe how the systems work in practice, are a valuable supplement to the priorities.

Solution: The combination of smart IoT sensors (currently 250 pcs) that measure the flow of water, in the rain and waste water systems, weather data, structured data processing and analysis platform provides a basis for increasing investment efficiency in the vital and shared water infrastructure.

The continuous observation data from the network of sensors and the automatic analyzes provide unique insights into the systems' real utilization rates.
In this way, a real and fairer decision-making basis is built for prioritizing the many needs, so that the most climate protection, renovation and remediation is achieved for the money.

What do you use IoT data from drainage systems for?

Sensors that are placed in various places in the rain and waste water system are directly connected to the network and can thus provide real-time data about what is going on in the drainage system. On top of this, a dedicated data platform has been built, where data is connected and combined with weather data using big data and artificial intelligence, so that you can utilize data and harvest data-driven insights and knowledge.

It provides a better opportunity than before to identify problems, relationships and real capacity in the drainage systems and thus implement where it gives the greatest effect.

AARHUS KOMMUNE

Area
Climate protection

Theme
Rain and waste water

Climate technology
IoT sensors in drainage systems

Municipality
Aarhus

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Reductions

Fewer discharges to the water environment and potential for better utilization of system capacity and resources in the waste water

More optimized water handling, and thus less CO2 emissions when establishing and operating new/larger plants

Reduced risk of wrong investments

Gains

10-20%

increased effect of investment preferably within climate adaptation, renovation and sanitation of the overall rainwater and waste water system

Between

14 and 28 million DKK

increased value of the investment preferably per year. within climate adaptation, renovation and sanitation of the entire rain and waste water system

Investments

Approx. DKK 7,500

per year for Total Cost of Ownership (TCO) per measuring point in the drainage system. Approx. 60% is for data collection and 40% is for data use.

This is how the numbers are calculated

- The increased effect and value of the investments is based on an assessment by Aarhus Water of a 10-20% increased effect by making decisions and prioritizing based on real observational data.
  Compared with the total annual investment of DKK 140 million. DKK gives it the mentioned increased value.
- Aarhus Water's assessments are based on more than 15 years of experience using observational data actively in the design, planning and operational phases of investments, as well as experience in investing in an actively controlled plant instead of traditional passive systems. An example of this is the Aarhus Å project (minimization of overflows and increased bathing water quality), where the switch to an actively controlled system from a traditional passive system reduced construction costs by 25% from DKK 455 million. to 340 million

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Reduced risk of injury
Targeted tool to ensure the greatest possible reduction

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Climate protection for money
Focus on the most climate protection for the money

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Scaling potential
Particularly relevant for municipalities with a high risk of flooding

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Climate for money

The benefits of using IoT observation data is that it provides a much better basis for prioritization than before. It helps identify where investments should be prioritized for maximum impact and how these prioritized efforts should be designed.

An example of use is that, in connection with the centralization of treatment plants and the creation of new pumping stations, IoT sensors were used in the rain and waste water systems to track down large amounts of extraneous water in the systems, which the pumping stations would otherwise have to handle. Through the targeted use of IoT data, it was identified which areas the extraneous water came from. In this way, targeted efforts could be made to reduce the extraneous water volumes considerably from these areas. This has meant that the new pumping station can be dimensioned on a more qualified basis, and with a smaller capacity, resulting in great savings.

Additional gains

- Option to monitor the function in real time and the capacity of the rain and waste water system – and thereby be able to act proactively instead of reactively on potential problems, including increasing capacity utilization through active integrated management of the drainage system and treatment plant, etc. However, the latter has some regulatory challenges due to potential liability and the way the sector is benchmarked.

- Possibility to streamline efforts within climate adaptation.

- Possibility of better data basis i watercourse management and discharge permits.

- Possibility of streamlining efforts within the water supply area by, for example, identifying leaks, breaks and reduced capacity performance.

Be aware:

- It requires organizational support to challenge the more traditional ways of working with planning, data and dimensioning.

- The use of IoT data opens up completely new ways of planning and prioritizing investments, as the states of the systems can be monitored continuously to an unprecedented degree.

Scaling potential

Around DKK 6 billion is used annually. DKK to clean up, renovate and expand rain and waste water systems in Denmark.

The use of IoT data has great potential to streamline these large investments by quantifying the decision-making basis. Thus, there are correspondingly large gains to be made.

IoT data has significant potential to improve current planning and dimensioning practices, which are based on a statistical approach using traditional structural and model data. Observational data from IoT sensors provides a unique opportunity to link the statistical assumptions with the observed conditions and data on the functionality of the systems. This reduces the risk of wrong investments.

What does it take?

Technological:
IoT sensors, data integration and data analysis optimized for hydrological and hydraulic problems.

Economic:
TCO (Total Cost of Ownership) over five years for a measuring point in the drainage system is approx. DKK 7,500/year, of which approx. 60% is data collection, and 40% is data use. This price point, however, requires the right experience and expertise in the municipality and supply.

Organizational:
A close match between the utility company and the municipality – and the right expertise. Willingness to think new and, in addition to the tradition of benchmarking in the water sector.

In terms of competence:
Interdisciplinary competence is necessary across IoT, hydraulics, data analysis as well as local knowledge of the drainage system.

Here's how to get started!

1

Focus on the hydraulic/ hydrological challenge and system coherence. From there, define how observation data can be collected simply, stably and continuously.

2

Focus on how the need for data for "here and now decisions" can be balanced with data for more long-term and larger investment decisions.

3

Focus on suppliers with a business model built around providing hydraulic/hydrological insights, open data interfaces and with an acceptance of an extremely fast evolving field.

KL RAMBØLL

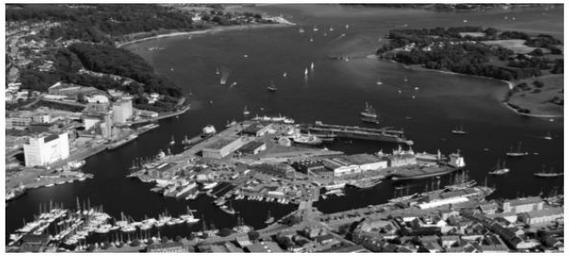
Svendborg Municipality reduces the annual risk of damage from floods by millions

Digital damage calculator reduces the risk of damage by 33%.

Situation: With its coastal location, Svendborg Municipality is vulnerable to rising seawater, cloudbursts and rain. This is especially true around Svendborg Harbour, where the greatest values can be lost due to climatic events.

Challenge: Svendborg Municipality was faced with having to carry out a detailed planning and prioritization of the climate adaptation at the port, where from a holistic perspective they wanted to get the most climate protection for the money and get the best possible basis for prioritizing efforts.

Solution: Svendborg Municipality has used a digital damage calculator to calculate the costs of flooding and has carried out risk mapping as a starting point for an assessment of investments in climate adaptation. These calculations show that Svendborg Municipality currently has a total annual damage risk of DKK 17 million. DKK at the harbor area. Based on various climate protection measures and scenarios, the effect in the form of a reduced risk of damage can now be calculated. This damage reduction is compared with the price for implementing the various measures.



What is a digital damage calculator?

The solution calculates costs in the form of damage and risk from floods. It converts water on the ground into an economic loss in damage areas such as businesses, public services (e.g. schools), critical infrastructure and buildings worthy of preservation.

The system is based on data input from e.g. SDFI's digital platforms. It is possible to insert different scenarios for floods in the form of 5, 10, 20, 50 and 100 year events and from this calculate the price of the annual damage risk. Damage calculator is an open source product offered by Geo Fyn and which is free to use

Svendborg Kommune

Area
Climate adaptation

Theme
Prioritization of climate protection efforts

Climate technology
Open source model and calculation tool.

Municipality
Svendborg

Contact person
Anna Als, Development consultant, Building and Urban Development anna.als@svendborg.dk

Reductions

33%

reduced damage risk based on implementation of the chosen strategy at the port

Gains

Reduced annual damage risk with

5.6

million DKK

The risk of damage before the climate protection effort was DKK 17 million. DKK annually and with the effort will be DKK 11.4 million. DKK

Investments

Approx.

1 year's work

For the implementation of a comprehensive damage calculator project for Svendborg Municipality.

This is how the numbers are calculated

- The first part of the strategy reduces the annual damage risk with DKK 5.6 million Two scenarios have also been drawn up for the second part of the strategy, which will further reduce the annual damage risk by DKK 13.1 million respectively. DKK and 16.3 million Here, the municipal board must choose which of the two scenarios to work on.

Reduced risk of injury

Targeted tool to ensure the greatest possible reduction

Climate protection for money

Focus on the most climate protection for the money

Scaling potential

Particularly relevant for municipalities with a high risk of flooding

KL RAMBØLL

Climate for money

The digital damage calculator has made important contributions to the preparation of Svendborg Municipality's Climate Action Plan 2022. The method has provided a basis for prioritizing the various efforts towards 2030 based on where the greatest risk reduction is achieved. The same applies to the preparation of an action plan for other priority risk areas until 2050.

Municipalities such as Nyborg, Aabenraa and Ringkøbing-Skjern are working with similar initiatives to use digital tools to calculate financial damage risk.

Read more about the digital claims calculator, which is also called Skadesøkonomi, here.

Additional gains

- You get important input for use in dialogue and the process of citizen involvement. At the same time, it creates a solid professional basis for debate.
- The digital damage calculator provides a solid basis for the political treatment and decision-making.

Pay attention to:

- When prioritizing, emotions are also at stake. It is important to be open about which data and prerequisites take priority - travel from.
- It is important to determine the defi - nitions. For example, what is included in critical infrastructure and public service.

Scaling potential

Addresses municipalities that are challenged by floods due to rising seawater, storm surges and streams.

Attractive to use, as it makes possible - to prioritize between different efforts based on how large a reduction tion of the damage risk the individual measures can contribute to.

It initially requires a relatively large effort to read the instructions and learn to use the tool and get the data base in place.

What does it take?

Technological:
Installation of open source tools and use of data from external data sources from e.g. SDFI. supply chain - generation of data in all areas that you want included.

Economic:
Primarily investment in working hours, as it is a free open source solution that is being worked on.

Organizational:
Naturally belongs under Technology and the environment.

In terms of competence:
Requires relatively large GIS competence and preferably experience with open source. Furthermore, solid planning knowledge is needed.

Legal/Ethical
It is important to be open and trans - parent with regard to the data on which the solution is based, including particularly in relation to the assumptions on which the calculations are based.

Here's how to get started!

Be clear about the purposes of the damage calculator. Identify where there is a need to prioritize between different efforts. Define what is most important for the area in question and how to prioritize.

Take the time to familiarize yourself with how the tool works. There are good guides to rely on.

It is important to convey the results in some easy-to-understand graphics and text. Look for inspiration in municipalities that have used the tool or at Geo Fyn.

KL RAMBØLL

Copenhagen Municipality reduces the CO2 load from mobile devices by 20%

"Lifecycle method" has helped the municipality to increase recycling and better utilization.

Situation: The Health and Care Administration i Copenhagen Municipality has over 6,000 mobile devices to its 10,000 employees. IT equipment has a large CO2 footprint, and this makes it important to make the degree of utilization of devices more efficient and thus reduce the climate impact.

Challenge: In the past, handing out and collecting devices was handled locally without fixed procedures and methods. In connection with the replacement of all devices, 1,200 devices were returned which have never been used. There were no fixed procedures for handing over defective devices.

Solution: Central management was introduced through a "Device Lifecycle" method. All devices are monitored in relation to whether they have been inactive in 30, 60, or 90 days. It takes place via an MDM app (Mobile Device Management).
In case of inactivity for 30 days, a message is sent to the local manager, after 60 days the device is locked, and after 90 days the device is considered lost. It will be closed and the office will be invoiced. This ensures that all devices are actively used.

Defective devices are collected and reviewed. 80% can be reused through updating or the like.

What is the "Device Lifecycle" method?

Methods and processes for the entire life cycle from acquisition to disposal, so that it is carried out in the most appropriate way from an overall economic as well as service and climate perspective. Special focus areas for the method are i.a. when purchasing, to go for models with the longest possible lifespan, to avoid inactive devices, to have procedures for swapping and handing over devices between employees, as well as handling defective devices, where a large proportion can often be reused.

Area
Green it

Theme
Sustainable life cycle for mobile devices.

Municipality
Copenhagen, Health and The care administration

Contact person
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Reductions

20%
reduction of CO2 the answer to the CO2 load of 1200 devices which early re were not used

78 tonnes of CO2
corresponding to the CO2 load of 1,200 devices that were not previously used

Gains

20%
better utilization of devices

80%
recycling of immediately defective devices

5.2 million DKK
corresponding to the value of the total of 1200 unused devices.
+

3.5 million DKK per year
via recycling of devices which are immediately handed in as defective

Investments

2 full-time hours
in support for handling "Device Lifecycle" the method.

This is how the numbers are calculated

- Reduction of the CO2 footprint is calculated based on the fact that there were previously 1,200 devices that had never been used, compared to the fact that all devices are actively used today.
- Reduction of the CO2 footprint is calculated based on a emission factor of an average of 65 kg per device.
- Better utilization of devices is based on the fact that the run the monitoring of all delivered devices today ensures that they are actively used. Otherwise, they are considered lost and the responsible offices must pay for them.
- High recycling of immediately defective devices often requires only the right use or simple software update.
- The financial gains are calculated based on purchases the price for devices.
- Investments are based on the additional resources used to manage the central active management of the method.

CO2 reduction Removal
of inactive devices and high recycling rate of immediately defective devices.

Climate for money
Saves money and reduces the climate footprint at the same time

Scaling potential
Requires the introduction of central control and a certain volume

Climate for money

In connection with the introduction of a new care system in the Health and Care Administration in 2017, they simultaneously switched to a "Mobile First" strategy and acquired 6,000 mobile devices (mobile phones and tablets) primarily for the municipality's home helpers and nursing home assistants. These devices were subsequently updated twice.

Throughout the process, the "Device Lifecycle" method has been continuously developed. From the start, the goal was to ensure efficient use of the new care system through the new devices.
The achieved effects in terms of better utilization of devices and reduced CO2 load have come to the side.

Additional gains

- High IT security, as devices do not disappear without being detected. Devices that have not been used for 60 days are locked, and after 90 days they are automatically presumed lost.
- Full control over the use of devices through the MDM (Mobile Device Management) solution (for example, you have no problems using TikTok).
- Greater ownership and responsibility by the end users.

Be aware:

- That it requires a solid organizational anchoring of the method, both centrally and decentralized at the institutions and units involved.
- That it requires decentralised and out with the individual user, is ready to take greater responsibility for the use of his devices.

Scaling potential

With the increasing use of mobile devices, it is an obvious place to put in - to save money and reduce climate impact at the same time.

Based on experience from the Municipality of Copenhagen, quite large economic and climate benefits can be reaped

Copenhagen Municipality has received many inquiries from other municipalities about their model.

It requires a willingness to introduce central management and the ability to ensure organizational anchoring.

The Municipality of Copenhagen has now decided to broad solution to cover the entire municipality.

What does it take?

Technological:
Use of an MDM (Mobile Device Management) app.

Economic:
Investment in additional staff to administer the method.

Organizational:
Solid organizational anchoring with clear division of roles and responsibilities. Use of well-defined service concept and establishment of effective support organization.

In terms of competence:
Professional staff are given greater responsibility and must, among other things, be responsible for unpacking the vices and installation yourself (in the same way as with a private purchase).

Legal/Ethical
GPS data must not be available, as this allows for monitoring.

Here's how to get started!

1. Enter into dialogue with the organizational units that use devices and get them engaged.
2. Make sure that there is easily accessible and competent support. Users must have one simple entry point for help.
3. Determine the overall service concept - including how to ensure incentives for efficient use of all devices and a high degree of recycling.

KL RAMBØLL

Gladsaxe Municipality reduces food waste by 30% by weighing and analyzing the food waste

Digital platform provides new knowledge for menus with less food waste in municipal kitchens.

Situation: Gladsaxe Municipality is the first municipality in Denmark to map its food waste in order to obtain a baseline to reduce food waste by 50% in 2030.

Challenge: The challenge is that you do not know where the food waste occurs and how much it involves talk about.

Solution: The municipality has tested and implemented a digital platform solution from FoodOp with digital scales that show the food waste in kindergartens and care centers in the individual departments. The kitchen and institutional managers get an insight into food waste and the CO2 footprint from the menus after the food has left the kitchen. After a successful pilot project, where the institution reduced its food waste by as much as 40% via new menus, based on the collected data, the project has been scaled to a further five care centers and 13 children's institutions in the municipality. Six local companies are also participating in the project.

What is digital measurement of food waste?

When kitchens send food out to the departments, it can be difficult to know what is happening outside the four walls of the kitchen. Using digital scales under bins with organic waste, food waste can be measured automatically and data stored in a digital platform.

In this way, the kitchen gets the opportunity to build profiles for the various departments that, among other things, shows the extent of food waste, the CO2 footprint from the menus and whether the recipients get the right nutrition.

GLADSAXE KOMMUNE

Area
Institutions and buildings

Theme
Food waste

Climate technology
Digital platform for measuring food waste

Municipality
Gladsaxe

Contact person
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Reductions

400 tons CO2 reduction
in a 9-month period for 13 children's institutions and 5 nursing homes.

29% reduction
of food waste in children's institutions and

30%
At a nursing home.

Gains

Approx.

DKK 435,000
of 9 months for nursing homes and 6 months for children's institutions.

Investments

DKK 3500
In one-off investment in implementation per institution.

DKK 500
in monthly subscription for children's institutions and

DKK 3,500
for nursing homes

This is how the numbers are calculated

- The figures cover a period of 9 months for the nursing homes and 6 months for the children's institutions.
- The calculation of CO2 is based on Concitos me tode, where the rule of thumb is that 1 kg of food waste corresponds to approx. 10.52 kg of CO2 . read more here
- The calculation of the financial gains is made by the supplier on the basis of the weight of organic material thrown away in the kitchen and from the departments, as well as an average price for the food.
- The exact financial gain is difficult to calculate due to rising food prices in 2021 and 2022.

CO2 reduction
Less food waste and less food purchases

Climate for money
Less shopping and a reduced climate footprint at the same time

Scaling potential
Can be implemented in all municipal kitchens

KL RAMBØLL

Climate for money

In the 13 children's institutions where the solution has been implemented, food waste was reduced by 29% - corresponding to a reduction of 4.5 tonnes of food waste per year (or 4,500 kg x DKK 30 (average purchase price per kg of food) = DKK 135,000) . In addition, the five care centers where there has been an average reduction of 30%, corresponding to a saving of DKK 300,000 (10,000 kg x DKK 30)

The solution has cost DKK 500 per month in the kindergartens and DKK 3,500 per month in the nursing homes. In addition, the municipality has paid approx. DKK 3-4,000 in lump sum for start-up per care center.
Due to implementation costs, the investment is at most the first year.

In the first year, the municipality creates an overview of food waste, after which the solution, which is a monthly subscription, can be reduced to a test 1-2 months a year. The price of measurement for individual months has not been fixed, but it will be cheaper than measuring every month.

Additional gains

- The food in nursing homes is portioned, where you follow the authorities' recommendations for protein and energy content, for example. By reducing food waste - and by changing the content of the meals - residents get the recommended amount of nutrition. Gladsaxe Municipality continues to work on the menu planning with new insights from the project.

- It gives pride among the employees at care centers and in kindergartens to participate in a new digital project which improves the daily lives of the elderly and children.

- Private companies in Gladsaxe Municipality also have was involved in the project and has implemented the solution. It is important to reduce overall food waste in the municipality.

Be aware:

- The staff at care centers and in children's institutions must be motivated to participate. The solution can be scaled down after food waste has been reduced.

Scaling potential

According to the Climate Council, Danes have one of the highest climate footprints from food consumption in the world, measured per inhabitant. Here, **public kitchens** play an important role, as they **feed approx. 650,000 people a day.** Many of the public kitchens have a way of working that is characterized by a high level of food waste.

The solution is technically easy to implement, as the digital platform is handled by the supplier.

According to Gladsaxe Municipality, the kitchen has - as in many other municipalities - optimized in relation to food waste in production.
However, Gladsaxe Municipality is the first to measure and get an overview of the food waste at the individual institutions.

What does it take?

Technological:
The majority is controlled by a supplier, which makes it easy to implement the solution.

Economic:
The measurement of food waste is by subscription with a low implementation cost.

Organizational:
In the Gladsaxe **Strategy,** Gladsaxe Municipality has ensured a broad anchoring in all the municipality's departments. A cross-cutting strategy for e.g. CO2 savings will facilitate the work of e.g. investing in projects that must reduce CO2, but where the wider societal benefits are also made clear. This makes it easier to argue for an investment in new technology, as long as the effects (including the economic ones) are measured.

In terms of competence:
The solution requires manual work by the employees in the departments, where the food waste must be delivered into the waste bins with digital scales. It also requires that the managers of either the kitchen or the institution receive training in working with the digital platform and the data it provides.

Here's how to get started!

1

Make sure to describe both the economic and CO2 financial savings as well as the major improvements in health and quality of life – especially in the care centres.

2

Find a good pilot case with a passionate person who can spread the message in other institutions.

3

Create a realistic budget that shows that the work effort and investment will decrease as the solution is fully implemented.

KL RAMBØLL

Aarhus Municipality cuts 12% CO2 from food purchases with intelligent climate accounting

The use of artificial intelligence and internal CO2 taxes create more climate-friendly food purchases.

Situation: Aarhus Municipality has a goal of being CO2 neutral in 2030. With a total annual procurement budget of approx. 7 billion DKK, the municipality has a great focus on reducing the CO2 load in this area. Today, the total purchase emits 330,000 tonnes of CO2.

Challenge: It has been decided that there must be a 25% reduction in the CO2 footprint of purchased food by 2025.
There will later be requirements of a similar size for all consumption-based purchasing in the municipality.

Solution: Aarhus Municipality has chosen to take a holistic approach to the task of introducing internal climate taxes on selected foods in order to create incentives for climate-friendly purchasing patterns.
The tax appears in the purchasing system, and it is the food suppliers who collect the tax, which is then sent back to the municipality. The fee, which corresponds to approx. 3% of the total purchase is then sent back to the individual purchasing units in the municipality. In this way, it is not a question of a savings exercise, but of creating incentives for more climate-friendly purchases in the purchase situation itself.

How is artificial intelligence utilized to support climate-friendly purchasing?

With the help of artificial intelligence, all invoices are collected and divided into 1,500 different purchase categories. Based on emission factors for the individual categories, the total CO2 load is then calculated. There are no separate emission factors for all 1,500 categories. There is also an opportunity to prioritize and target climate efforts by identifying the categories with the greatest potential. Food shopping has been selected here. Aarhus municipality has chosen to use a solution from the company Konsidi.

AARHUS KOMMUNE

Area
Purchase

Theme
Purchase of food

Climate technology
Artificial intelligence creates an overview of all the municipality's purchases and calculations CO2 load.

Municipality
Aarhus

Contact person
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Reductions

12%

Reduction of the CO2 load from food shopping

for example, the consumption of beef has been reduced by 40%

Corresponds to a reduction of

275 tonnes of CO2

Investments

1/2-1 year's work

for implementation of overall development project in Aarhus Municipality. The subsequent operation runs automatically and draws virtually no resources.

Note! For other municipalities, it will only require 200-400 working hours, as Aarhus Municipality's development work can be used as a starting point.

This is how the numbers are calculated

- The internal climate charges are calculated based on a price corresponding to DKK 1,000 per tonnes of CO2. This unit price will rise to DKK 1,500 in 2030.
- Reduction of the CO2 load has been calculated on an annual basis. The internal climate taxes have only been introduced for three months, which means that the effect has not yet taken full effect.
- The reduction of the 275 tonnes of CO2 has been calculated by comparing Q4 in 2021 with Q4 in 2022. The calculation must be taken with reservations, as the effect cannot necessarily be attributed to the climate tax alone.

●●●●●

CO2 reduction
Procurement covers the vast majority of the municipalities' total CO2 discharge.

●●●●○

Climate for money
Big effect with relatively little effort.

●●●●○

Scaling potential
Can be used in many types of procurement and has the potential to be rolled out in many municipalities.

KL RAMBØLL

Climate for money

Aarhus Municipality will gradually expand its climate-friendly purchasing model to include more product groups than food purchases. The focus will be on the product groups with the largest CO2 footprint and where there are some real climate-friendly alternatives.

In connection with future tenders, shadow prices corresponding to DKK 1,000 per tonnes of CO2 that the offered goods will emit. This CO2 price will be added to the pure purchase price and appear as a total offer price.

Municipalities such as Copenhagen, Odense, Herning and Vejle are working with similar initiatives to ensure climate-friendly purchases

Additional gains

- Opportunity to use its procurement muscle to influence the market and suppliers in a more climate-friendly direction.
- Creates general greater awareness among managers and employees about the climate aspects of its purchases.
- Can contribute to limiting food waste, as it provides greater awareness of the climate impact in the purchasing situation itself
- Great support from kitchen staff, who see it as a help in their work to create more climate-friendly meals.

Be aware:

- It requires a holistic approach approach and thus more initiatives to have the full effect. For example, training of kitchen staff and close cooperation with suppliers.
- It is appropriate only to use internal taxes on the product categories where there are some real climate-friendly alternatives.
- You can start with an advantage relatively few product categories and then expand gradually.

Scaling potential

Extensive diffusion potential, as Danish municipalities purchase over DKK 100 billion. DKK per year and constitutes by far the majority of the municipalities' CO2 imprint.

Attractive to start with, because Aarhus Municipality has completed the development work. This significantly reduces the requirements for the efforts of other municipalities.

Forms an attractive political platform for action in the climate area.

What does it take?

Technological:
IT-based analysis tool, integration to financial system, data washing and climate taxes, which must be set up in the procurement system.

Economic:
Relatively small investment – both financially and in number of working hours.

Organizational:
Placement of the initiative will naturally be in a procurement and procurement department.

In terms of competence:
Requires a great communication effort.

Legal/Ethical
You have to be prepared to meet an attitude that "you take the pork roast from the old people". However, the return model provides the same economic opportunities for purchases as before!

Here's how to get started!

1

Contact Aarhus Municipality to hear about their experiences. Adapt the approach so that it best fits into your municipality.

2

Investigate opportunities for coherence and synergy with other climate measures, so that a unified effort is created.

3

Work to secure broad political support for the initiative. This makes it much easier to get support for the implementation and to carry out the necessary behavioral changes.

KL RAMBØLL

Haderslev Municipality saves 82% on street lighting by using sensors and LED

Dynamic light control via an intelligent open source platform significantly reduces electricity consumption.

Situation: New solutions for street lighting have long been known to the municipalities. Many have switched from conventional incandescent bulbs to LED lighting, but few have made use of dynamic control of street lighting.

Challenge: In order to reduce energy consumption in Haderslev Municipality, since 2015 work has been done on the replacement of the street lighting - and replaced 6,500 fittings with new intelligent street lamps with motion sensors.

Solution: The municipality found a solution with dynamic light control and motion sensors, which provide greater savings and more options for controlling the lighting.

The effect has been great, and in 15 smaller towns in the municipality there has been an energy saving of no less than 82%.

In addition to the municipality's own roads, the municipality has chosen to invest in LED lamps for all private shared roads where the municipality pays for the energy consumption. This has resulted in a saving of 76%.

What is dynamic street lighting?

Dynamic street lighting is street lamps controlled with motion sensors, where the lamps can be controlled via a platform.

The solution provides real-time information on the status of all street lamps in the municipality, which thus saves driving for manual checks of all street lamps.

The solution is open source, so you can use lamps from all manufacturers that use sensor control and thereby avoid vendor lock-in.

Haderslev Kommune

Area
Lighting

Theme
Energy savings

Climate technology
Dynamic control of street lighting

Period
2015-2023

Municipality
Haderslev

Contact person
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Reductions

72 tonnes of CO2
compared to 2015

511,000
KW/h

82%
reduction in KW/h with dynamic light control and LED compared to 2015.

Gains

approx.

4 million DKK

per year in savings.

This gives a payback period of approx. 8-10 years for a total investment of DKK 36 million. DKK

Investments

36 million DKK

In investment for the total replacement of the street lighting.

It requires approx.

1/2 year's work
in the implementation phase.

This is how the numbers are calculated

- Data (KW/h) comes from the meters and the digital platform that collects measurements from all luminaires in the street lighting. Reductions in KW/h are 2022 figures compared to the most recently calculated figures from the original street lamps in 2015.
- The CO2 saving is calculated using Climate compass. A factor has been used which corresponds to 142 grams of CO2 per KW/h.
- The calculations have been made for the total effect for the dynamic street lighting and replacement for LED.
- The calculations do not include the LED replacement on the private public roads.

CO2 reduction

Large reduction in energy consumption in street lighting (KW/h)

Climate for money

Both large financial savings and a large CO2 reduction, but a long payback period

Scaling potential

Requires relatively large investments and has a relatively long payback period

KL RAMBØLL

Climate for money

The total investment in the replacement for intelligent street lamps in Haderslev Municipality is DKK 36 million. This includes the replacement of 6,500 lamps. Due to the large savings on energy consumption, the payback time is expected to be only approx. eight to ten years for the total solution.

The total saving in KW/h is 82% across the entire municipality for the dynamic street lighting, but in the smaller towns the savings have been as high as 97% in two of the 15 towns.

In addition to the direct saving on CO2 from the technology, Haderslev Municipality has also entered into partnerships with energy companies. The energy companies buy the energy savings that have been achieved with the help of the technology, and this helps to finance the project – thereby ensuring more climate for the money from a municipal perspective.

Additional gains

- The solution helps against light pollution, as there is only light when it is needed on the road.
- Digital real-time overview of the condition of all street lamps means that employees do not have to drive out in vain to check the lighting manually. This has saved both time and CO2 on driving.
- Easy to adapt the lighting to cultural events and other events in the municipality via the light management platform. .
- Several energy companies signed up to buy energy savings, which has provided co-financing for scaling the solution.

Be aware:

- Many inquiries from citizens about everything from concern about whether it was too dark to whether it will bother you to switch the lights on and off. It takes time to engage in dialogue with citizens. After implementation, there have been no problems.
- There are many different ones solutions, but some of them are not open source.

Scaling potential

According to the Danish Outdoor Living Lab, only two out of the 98 municipalities have used dynamic street lighting on a large scale (Haderslev and Bornholm). Several (approx. 50%) have changed to LED, but here it is for approx. half still possible to implement dynamic lighting control.

The solution is implemented by the supplier, and the employees are trained to operate the new digital platform, which has produced good results.

What does it take?

Economic:
It requires a larger investment, so it requires a good and clear business case. The business case is broader than the payback period (which, however, is absolutely central). It also means freeing up resources and a greener profile. for Haderslev, they required a longer market dialogue to find the right solution, but it was worth the time.

Organizational:
Close cooperation with the energy companies has helped to ensure that it will be an economically profitable project. Project

tet is rooted in the lighting department, but to get the full effect, collaboration with other departments must be done.

In terms of competence:
It does not require special competences, but more interested workers who receive training in the system in the process. Support from those who will work with the solution after it has been implemented is also important.

Here's how to get started!

1

Get hold of your energy companies and get agreements with them to buy energy savings before you get started. This will strengthen your business case.

2

The solution is most relevant and gives the greatest effect in the smaller towns and on residential roads, where there is not much traffic at night, and where it is therefore not necessary to have full lighting at night. So start here!

3

It is absolutely central to show savings in operations and ROI to convince the decision makers to invest in the solution.
CO2 and the green profile are also important, but the economic argument is often what gives the green light.

KL RAMBØLL

Varde Municipality achieves a 21% reduction in waste collection with digital waste containers

IoT sensor technology and real-time data are used on the municipality's large waste bins to optimize route planning and reduce the number of emptyings.

Situation: Varde Municipality decided back in 2013 to replace 160 small overflowing rubbish bins – at the beaches along the North Sea and at rest areas – with large semi-buried containers. Today there are 30 of these containers. This gives a total emptying run of approx. 200 km.

Challenge: With over 30 containers, it became a logistical challenge to keep track of when the individual containers had to be emptied. Therefore, all containers were emptied each time, but it could no longer be done in one day. Therefore, Varde Municipality wanted to find a solution that could optimize emptying runs.

Solution: Varde Municipality found a solution with sensors (full detectors) in all 30 containers to be able to monitor the need for emptying.

The solution from Nordsense now means that Varde Municipality can plan emptying routes as needed. They have fewer runs and can almost always complete the route in 1 working day, which means that time and money are saved. Varde Municipality very rarely experiences a container being overfilled, which provides a better citizen experience.

What are intelligent waste containers?

Sensors (fill detectors) are placed in a garbage container and provide real-time data about the filling level. Data is collected in a digital platform at the supplier.

Employees in the municipality receive regular reports and an automatic message when a container reaches 70% full. Based on this data, the emptying frequency and routes are calculated.

The solution also includes network access to the sensors, which are located in the containers.

Varde Kommune

Area
Waste and transport

Theme
Waste management and route planning

Climate technology
Waste containers with filling detectors/sensors for real-time measurement of the filling level

Municipality
Varde

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Reductions

1.6 tonnes of CO2

Only based on the one garbage truck that drives to the large waste containers

1,600 km drive to emptying saved

reduction of emptying trips equivalent to 1,600 km. However, this is only about 1 garbage truck.

Gains

Approx. 40,000 DKK per year

Through reduced diesel consumption and employee hours.

Which is more than the investment of DKK 30,000.

Investments

DKK 30,000 per year

DKK 1,000 per garbage container (30 pcs.) incl. maintenance, service and data handling/analysis.

This is how the numbers are calculated

- Varde Municipality has continuously upgraded with more containers, but the number of annual runs is the same. It is a qualified estimate from Varde Municipality, that if they did not have sensors on them, they would have expected to have approx. eight more emptying runs per year. It is these eight emptying runs on which the reductions and gains are calculated.
- The financial savings are calculated based on the price of an employee and the car.
- The environmental savings are calculated based on the number of kilometers and diesel consumption per driving, which corresponds to 615 liters of diesel, and based on the fact that 1 liter of diesel creates a CO2 emission of 2.7 kg.

CO2 reduction The CO2 reduction per trip is too high for each group, but since Varde Municipality only has one garbage truck for that type of route, the overall reduction is limited.

Climate for money
Low costs and relatively large CO2 reduction.

Scaling potential
Greatest value in municipalities with large distances between waste containers.

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Climate for money

An emptying run generally takes one working day. A working day is 7.75 hours, and the price for car and employee was DKK 642 in 2022. This gave an **annual financial saving** in 2022 of 7.75 (hours)*8 (days)*642 (DKK) = **39,800.00 DKK**

The economy of the sensors is approx. DKK 1,000 per sensor per year. The price includes renting the sensors, operation and maintenance. If, for example, a sensor runs out of power, this is handled by the supplier. The price also includes access to the digital platform from which Varde Municipality receives data. With 30 waste containers, there is **an annual operating cost of DKK 30,000,** so the solution provides a saving of approx. DKK 10,000

The environmental benefit is also worth considering. An emptying run is approx. 200 km, and the truck drives approx. 2.6km/L. So 1,600 km / 2.6 km per L = 615 L of diesel for the eight runs. This gives approx. 1.6 ton in CO2 savings.

Additional gains

- The strong reduction of the 160 small bins also mean that significantly fewer lifts have to be carried out. It has improved the working environment.
- The automatic monitoring of the waste containers means that they are very rarely full. It provides a better citizen experience.
- The solution also saves resources (time), which can used for other tasks.

Pay attention to:

That it will be a development project, and there may be "kidney sickness - judgments" until the solution is fully implemented.

- That more people should be able to understand and are trained in the solution from the start (vacation, new job, etc.).

Scaling potential

According to Varde Municipality, several other municipalities are looking at the large semi-buried containers. This is where the potential of sensors is greatest.

The potential is great in municipalities with large geographical areas, where many kilometers are driven to empty the containers or bins.

Great potential in municipalities with several beaches, rest areas, nature areas - there or other tourist attractions.

What does it take?

Technological:
The implementation of the solution is carried out by the supplier, and the digital platform is also handled by the supplier, who supplies data to the municipality.

Economic:
Small investment in kroner and øre. There is a small consumption of staff - hours in the implementation phase, but afterwards it is very little with 20 minutes per week.

Organizational:
The solution is anchored in "Vej og Park". This is also where the development project took place.

In terms of competence:
The supplier is responsible for the collection, processing and analysis of data. However, it requires that employees understand the data being sent and react to it.

Legal/Ethical
Driving is not measured, but on the waste containers themselves, so there are therefore no challenges with GDPR.

Here's how to get started!

1

Find out what is important to you? Is it CO2, the savings, the working environment, the economy or something else entirely. Therefore, examine all the gains.

2

Make sure that there is a committed employee who is interested in running the development project, as it can take time and challenges can arise with e.g. sensors.

3

The solution is not always a savings, so examine the business case. It is probably best at longer distances.

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Assumption analysis

Prerequisites for implementing successful climate projects across the ten cases

Economic prerequisites	Technological prerequisites	Organizational prerequisites	Competence-related prerequisites	Legal and ethical prerequisites
Budgets for investments in climate technologies mostly come from cross-cutting budgets (climate, energy, etc.)	The implementation of the technologies typically takes place in collaboration with the suppliers and is often delivered with access to an external digital platform and/or dashboard.	The utility companies play an essentially equal role in several areas, including as a data supplier, financing partner and innovation partner.	Many technical functions are handled by the technology supplier, and training of the people who must work with the solution is often included (often the train-the-trainers concept).	It is important to be open and transparent with the data and the underlying assumptions" that are used for analysis and assessments.
Insight into the payback period and business cases in operations are central to the grants in the municipalities being granted - even if climate/CO2 is high on the agenda.	The solutions often need access to internal data from the specialist areas (mobility, energy, heating, electricity, procurement, etc.) or from external data owners such as the utility companies.	The projects are often anchored in climate-focused departments in the development phase, but can also arise where the solution is integrated. No matter where, the broad anchoring is important.	There are several examples of the need to hire new staff to develop/find/implement the solutions. It usually does not require great IT skills.	For the citizens, it is important to have transparency about the projects when using data - especially in the case of artificial intelligence.
Access to internal data or data from, for example, the utility companies can require many working hours.		Political focus and support (budgets) are important to secure the foundation for climate technology projects.	The competences to run the projects are found in special functions in the municipalities. The functions often aim to reduce the climate footprint in various areas (energy in buildings, street lighting, mobility, purchasing, etc.) in collaboration with the individual technical departments.	Ethical considerations about the use of digitization and data, even if projects do not exceed GDPR legislation. Examples of this are the measurement of activity in buildings, dynamic street lighting, which makes the streets darker and citizens unsafe, as well as driving monitoring of employees' cars.
			It is important to communicate clearly about the projects and their value. The time to be set aside for internal communication can vary from project to project.	

Prerequisite analysis 1

Economic prerequisites

1

Budgets earmarked for CO2 savings

Most case municipalities had set aside central budgets for climate measures and CO2 savings either in general or within the specialist areas (energy, water, mobility). When climate technologies have been implemented and the business cases are in place, the projects transition to operations, which after a short time are financed by the financial savings.

Recommended measures:

- Focus on Climate for the money and the business case. The business case (payback period) must be calculated and there must be a plan for the operation (expenses) until the savings take effect.

2

Document all the effects!

Many cases had documented economic effects and reductions of e.g. KW/h or kilometers driven, but only in a few cases on CO2.
The latter also means that it is not included in the overall CO2 account. Many cases had a positive bottom line both financially and CO2-
in terms of The more effects that are documented, the better the business case.

Recommended actions:

- Document both the effects on CO2 and the financial savings.
- Investigate how CO2 savings can be used as a financing tool (e.g. purchase of savings from the utility companies)
- Use the results to prove that grant ling was a good investment and that further investment can be made (scaling).

Technical prerequisites

3

Acquisition of data for projects with artificial intelligence

The projects, which contain an element of artificial intelligence, often require the acquisition of both internal and external data. Our cases have shown that it is both time consuming and requires a certain level of data handling knowledge.

Recommended actions:

- Consider collaborating with suppliers on acquisition of external data sources.
- Start collecting data. It is often time-consuming.

4

The supplier handles the difficult technical elements

Across the ten cases, a picture emerged that the majority of the technical elements – from installation, data handling/
calculations and, in certain cases, operation – are handled by the supplier. The employees in the municipalities, on the other hand, get access to a clear tool (typically a dashboard), and in several cases the municipal employees received training in the use of the solution.

Recommended actions:

- Test with the supplier what the options are for support and how the solution is delivered.
- Consider whether some functions can be outsourced to the supplier (in several cases it proved to be economically viable)

Prerequisite analysis 2

Organizational prerequisites

5

Close cooperation with the supply companies

Several cases showed how close cooperation with the utility companies can promote work with climate technology projects.
The supply companies can have several roles. One of these is the delivery of supply data, which is used for many of the climate projects within water, heat and electricity. In addition, electricity companies can buy energy savings from the municipalities – and in that way help to finance energy savings.

Recommended measures:

- Contact local utility companies and investigate the possibilities of cooperation on CO2 reduction
- Investigate whether it is possible to sell energy savings to the electricity companies
- Enter into partnerships on data sharing.

6

Anchoring of climate technologies must take place in development and operation

Organizationally, there are many different solutions. Often, the projects are associated with a professional expert or a person who is employed directly to create savings on CO2 or other areas (energy, water, climate adaptation), but with close cooperation with the people and departments who must ensure operations when the solution is implemented.

Recommended measures:

- It is important that the projects are anchored across 'climate departments' and at the same time include professional units.

Competence-related prerequisites

7

Communication and collaboration are more important than technical skills

A large part of the technical work is handled by the supplier, and training is often offered to employees. Many cases require new thinking and do away with habits and with "that's what we usually do". Good communication about the projects, which ensures interest and security in the professional units/ operations, is necessary to ensure success, as the employees have to work with the new solutions.

Recommended measures:

- Prepare a convincing narrative about the benefits of the projects
- Ensure that the employees (operations) feel ownership and pride in the results achieved
- Involve the affected employees from the start.

8

Employees with 100% focus on CO2 reduction ensures success

In connection with this case collection, it becomes clear that the employment of passionate employees whose aim is to achieve "Climate for money" plays a major role in ensuring a proven effect - also in the digital department. For many municipalities, it was the first time they had hired an employee to work only with either climate improvements or CO2

or financial reductions. Municipalities that have employees focused on "Climate for money" achieve good results.

Recommended measures:

- Hire an employee with 100% focus on 'Climate for money'
- Set a realistic budget and follow up by demanding documented impact.

Prerequisite analysis 3

Legal and ethical prerequisites

9

GDPR must be considered in the projects

The ten cases did not show major legal or ethical challenges, but with both large amounts of data and artificial intelligence, GDPR was nevertheless an important element. Ethics often occurs as an indirect result of the use of data or technology. It can be about safety (with less street lighting), about monitoring via sensors in buildings or about consumption data.

Recommended actions:

- Make sure you comply with the GDPR regulations.
- Talk to your suppliers about GDPR, especially in connection with artificial intelligence projects
- Consider whether the digital solutions provide give rise to some ethical considerations which must be discussed.

Other recommendations

10

Municipalities have valuable knowledge about how to ensure climate for money in projects

Many municipalities have experience with climate technologies with documented effects in various fields (this analysis presents just ten examples). Several municipalities are already out to talk about their experiences.
Their insights from various subject areas can provide the necessary insights and arguments to get started.

Recommended actions:

- Share your experiences when documented effect
- Seek out municipalities that have obtained documents tered results.

How to calculate and document your climate gains!

Identification and selection of the climate-related target

First, you identify which beneficial climate effects you expect to achieve by using climate technologies. This could be a reduction in CO2 emissions or a reduction in the expected risk of damage from, for example, cloudbursts or rising sea levels

Choice of method for evaluating effect

…then you choose a method to evaluate the effect. It will typically be based on a scenario calculation methodology, where, for example, CO2 emissions with and without climate technology are compared.

Calculation of effect and possibly conversion to kroner and eur

...based on a scenario calculation methodology, you calculate the specific CO2 reduction or climate protection effect. You can subsequently convert these effects into kroner and øre, which makes it possible to make a profitability analysis

Assessment of the profitability of climate technology

By converting the climate effects into DKK you can calculate the profitability of the climate technology. You do this by comparing the value that the introduction of the climate technology creates with the costs of the climate technology. In terms of calculations, you can do it in two ways:

1

A **cost-benefit analysis** compares the present value of the expected effects with the present value of all the associated costs. That way you get a benefit-cost ratio **(BCR)**

$$BCR = \frac{\text{Present value of direct effects + expected buyback*}}{\text{Present value of costs}}$$

BCR can answer whether the value created by a climate technology overshadows the costs associated with it.

2

Marginal Value of Public Funds (MVPF) compares the present value of the direct value with the present value of the expected the net costs.

$$MVPF = \frac{\text{Present value of direct effects}}{\text{Present value of costs – expected buyback*}}$$

MVPF thus shows how much value is created per krone invested in climate technology. This can help to prioritize between different intervention options.

**Returns represent the indirect value or the derived effects that can arise from the climate technology. For example, climate protection can cause house prices to rise, which can result in the incomes of citizens in the area increasing, which will create a larger tax base for the municipality.*

Relevant databases and empirical sources

EXIOBASE: The most comprehensive and recognized database of scope 3 emissions. Is based on input-output tables that enable calculation of CO2 per purchase crown on individual product and service groupings.

Energy statistics: The Danish Energy Agency prepares monthly and annual statistics on energy production and consumption across oil, electricity, coal and natural gas, where basic data is publicly available.

Energy projections: The Danish Energy Agency and the International Energy Agency publish annual reports with a technical assessment of how the emission of greenhouse gases as well as energy consumption and energy production will develop.

Publications from the Climate Council and the National Center for the Environment (DCA) can help shed light on the greenhouse gas emission effects from various measures such as electric cars.

The following tools can be helpful in calculating the climate technology effects:

The climate compass: With this tool, you can get an overview of a company's emissions of greenhouse gases and get ideas on how you, as a company, can purposefully reduce your climate footprint. It follows the recognized GPC standard.

Rambøll's climate management model: Makes it possible for municipalities to document their CO2 emissions from their purchases at UNSPSC level and to carry out various scenario calculations pba. future purchases.

Calculation and documentation of C02 reductions

1
When the impact of climate technologies on CO2 emissions must be documented...

When the effect of climate technology must be documented, it depends on the purpose of the climate technology:

Climate technology can either reduce CO2 emissions by **reducing existing consumption**

... or by **replacing the existing climate-damaging consumption with a greener alternative**

2
... a scenario calculation methodology is often used ...

The methodical approach to calculating the CO2 reduction is typically based on a **scenario calculation logic.**

Here you calculate the positive impact of climate technology on CO2 emissions by **comparing CO2 emissions in a business-as-usual (BAU) scenario with a climate technology project scenario.**

Is the BAU scenario expected to be constant or evolve over time?

If no development is expected, CO2-the emissions from the climate technology are directly compared with a BAU scenario.

If a development is expected, the emissions with the climate technology should be compared with a projected BAU scenario.

3
... which can vary across climate technology purposes...

In calculating the effect of climate technologies that aim to **reduce existing consumption,** you can use the following simple formula:

CO2-reduction = BAU (CO2-discharge) − % CO2 savings through climate technology

In calculating the effect of climate technologies that aim to **replace the existing climate-damaging consumption with a greener alternative,** you can use the following simple formula.

CO2-reduction = BAU (CO2-discharge) − Climate technology (CO2 emissions)

4
... to quantify the concrete CO2 reductions

When calculating, it is important that you find out which scope* of CO2 emissions are reduced. It must be used to specify the analyzed effect, and thus to choose the right CO2 emission database.

Scope 1 and 2 databases: For example Energy Statistics, The Climate Council's and DCA's publications, The Danish Energy Agency's basic projections

Scope 3 databases: Fx Klimakompasset, EXIOBASE, CONCITO

The CO2 reduction can then be converted into DKK which makes it possible to use the evaluation of the climate technology in a **cost-benefit context.** This can be done…

1 …**based** on the Climate Council's assessment of a tonne of CO2...

2 …or based on the cost of removing the CO2 from the atmosphere.

Simplified example: Electrification of existing car fleet

By electrifying an existing fossil car fleet, a climate-burdening consumption is replaced with a greener alternative.

The BAU scenario is defined as the total CO2 emissions from an otherwise constant fossil car fleet, while the climate technology scenario is the total CO2 emissions from an electrified car fleet.

The annual CO2 emission for the fossil car fleet is 200 tonnes of CO2, while with the climate technology it amounts to 50 tonnes of CO2. Climate technology's annual CO2 reduction effect is thus 150 tonnes.

The CO2 reductions apply to scope 1 savings. By converting CO2-the saving has an annual value of Climate Technology of DKK 225,000, where CO2 is valued at DKK 1,500 per tons

**Scope 1 emissions are emissions that you directly cause yourself (burning of e.g. petrol). Scope 2 emissions are the indirect emissions through the energy you buy. Scope 3 emissions are in connection with the emissions that occur when purchasing goods and services.*

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Calculation and documentation for climate adaptation and reduced extent of damage

1
Documentation of effects of climate adaptations...

To evaluate the effect of climate adaptations, you must make two analytical choices:

1 **What beneficial effects is the adaptation to climate expected to have?** Beneficial effects will often be in the form of reduced damage costs in extreme weather events or value creation in the form of increased housing prices or reduced insurance premiums. It may also include indirect costs, which may relate to lost production or working time, as well as non-economic losses such as enjoyment of life or safety.

2 **Over which time horizon should climate technology be evaluated?** Climate adaptations rarely show their beneficial effects in the short term. Therefore, the value of beneficial effects of climate adaptation, which manifest themselves over a number of years, should be assessed on the basis of the expected future value over a longer time horizon. Often chosen time horizons are 50 or 100 years.

2
... uses extreme scenarios...

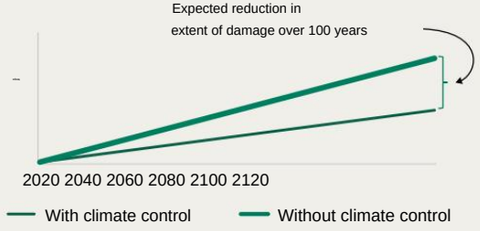
In order to document values of climate adaptation, **a number of extreme scenarios are often used,** which are expected to occur within a given time horizon. This forms the basis for an evaluation of the effect of climate adaptation. Extreme scenarios are the most extreme weather situation that is expected to occur within a given number of years.

For the selected beneficial consequences, **the direct extent of damage is calculated** for each of the extreme scenarios – both with and without climate adaptation. This could be, for example, the number of flooded properties. Here you can advantageously use sophisticated simulation methods as well as data from Statistics Denmark's BBR and BEF registers to map the scope. In addition, you can add the **indirect extent of damage** calculated as, for example, the number of people affected and their physical and personal losses.

3
...to calculate an expected annual amount of damage...

Based on the calculated extent of damage in extreme scenarios, an expected annual extent of damage in e.g. m2 can be calculated both with and without climate adaptation. This is done by multiplying the extent of damage in the extreme scenarios with and without the climate adaptation by the annual probabilities of the scenarios occurring.

By subtracting the extent of damage with climate adaptation from the extent of damage without climate adaptation, you get the annual damage reduction. This can be implemented for all beneficial effects. **The annual damage reduction can be scaled up with the selected time horizon.** Graphically, the distance represents the accumulated reduction i the extent of damage from a beneficial effect.



4
... to be able to quantify the value of climate adaptation

The calculated reduced scope of damage can then be converted into kroner and eur. This is done by multiplying unit costs by the expected reduction in the number of damaged units. Examples of unit costs are renovation costs or housing price deterioration due to the risk of flooding.*

This is carried out for the range of beneficial effects. The sum of these damage cost reductions can thus be considered the effect of the climate adaptation in monetary value.

$$\text{Value in kroner and ear} = \sum \text{Unit costsi} \times \text{Expected reduction}$$

where *i* represents the different types of reduced damage.

The value in kroner and eur should be discounted back to present value. Here the Ministry of Finance can recommendations for discount rates are advantageously used.

Simplified example: Rainwater protection

Rainwater protection aims to reduce the risk of flooding of private homes.
It is evaluated over a span of 50 years.

Extreme weather scenarios are simulated to calculate a direct and indirect extent of damage for 10-year, 20-year and 50-year events both with and without rainwater protection.

The annual expected extent of damage is calculated with and without the rainwater protection.
Annual expected extent of damage for 100-year rain flooding 200,000 m2 of basements:

$$\frac{200{,}000\ \text{m2}}{100\ \text{years}} = 2{,}000\ \text{m2 per year.}$$

2,000 m2 less expected flooded cellars annually with a value of DKK 400 per m2 gives the climate adaptation a value of DKK 400 x 2,000 m2 x 50 years = DKK 40 million. DKK
The value should then be discounted back.

Note: Building and Housing Register (BBR) and Population Register (BEF)
**Beneficial effects such as house price increases due to climate protection should not be scaled up with a time horizon, as this will be a one-off increase in the price of the house.*