



## Recommendations to the Danish Government from the Climate Partnership of the construction industry



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## We stand together regarding climate targets through green growth

We, the 13 climate partnerships, have worked intensely to resolve a both difficult and important task: at one and the same time to develop actual proposals to the Danish Government for which measures may contribute to reaching the target to reduce Denmark's CO<sub>2</sub> emission by 70% in 2030 and make Denmark a pioneering country to the rest of the world.

In relation to the task, our point of departure was that we should make Denmark and the Danes richer and the world more sustainable at the same time. If we are to reach the target, it requires large-scale investments. Therefore, sustainability and growth must go hand in hand. And therefore, as a society we must be ready to prioritise investments in the climate. The Danish business world is ready to take on our share of the task in a close partnership with the Government and the Danish Parliament - and the rest of the society.

Future economic growth is the basis for us being able to afford solving the climate challenges in a way in which we also have a good and well-functioning society. It requires that we ensure Denmark's competitiveness and create growth and new jobs while we convert climate ambitions into action.

The climate challenge is global. We must reach our national targets without pushing activities abroad. We must make an actual green transition of our society that measurably reduces the emission of climate gases on a global level - and it must be made through development

and not a shutdown. With our efforts as inspiration for action, we are going to work internationally under the auspices of the United Nations and the EU to ensure a reduction of the global emissions and to increase the development of green Danish solutions that we can export to the rest of the world.

In the 13 climate partnerships, we take joint action to contribute to Denmark living up to the political goals.

We look forward to seeing that the proposals are passed on to one concrete climate action plan which must comprise two clear targets. Contributing to solving the climate change in Denmark and globally while at the same time ensuring a strong business sector, more Danish jobs and a more affluent society.

For obvious reasons, the proposals from the 13 climate partnerships have not been coordinated, and many proposals are cross-sectorial and cross-industrial. The next step will therefore be one climate plan. In this context, it is vital that the total climate plan accounts for the consequences of each individual initiative and that the entire plan ensures that the green transition goes hand in hand with continued growth and prosperity in Denmark.

We hope that all our proposals will be seen in the spirit and context as we have described.



# 5 green building blocks

When we look at all the activities influenced by the construction industry, we look at a third of Denmark's CO<sub>2</sub> emissions.

From heat loss and operation of heating systems in buildings to builders' cars, building site cranes and concrete production, we can do things much better. The industry is ready to deliver its share of the green transition in cooperation with the Government, the Danish Parliament and the population so that together we can realise the large CO<sub>2</sub> reductions that we are finding.

Eight out of ten of existing buildings will still be in use by 2050, and they represent 80% of the total assets of society, so it is vital that we maintain and develop them into a new climate future. The most important things are not more money from the public purse, but a good framework, requirements and demand. The solutions already exist, so that we can build a greener Denmark. If we do it right, and if we use the transition to increase exports of materials and services, we will also become more affluent.

1

## **Intelligent energy management and energy renovations - 1.2 million tonnes of CO<sub>2</sub>/year.**

The green transition will become faster and less expensive by reducing energy consumption in the existing buildings and managing consumption intelligently. Thus, we are able to cut away 20-25% of the energy consumption in buildings by 2030. Implementation of energy efficiency measures can reduce costs by billions, while at the same time provide better health and well-being in accommodation, schools and nursing homes. As an industry, building owners and authorities, we are going to pull together, and involve the financial sector.

2

## **From fossil fuels to green heating - 1.8 million tonnes CO<sub>2</sub>/year.**

The fossil fuels need to go so that Danish buildings are only heated by renewable energy. That requires a general plan for replacing natural gas with climate-friendly alternatives at 400,000 buildings, and that RE-certified installers replace the last 100,000 oil boilers with heat pumps. Finally, we must undertake renovation of the buildings to ensure the best solution which saves money for electricity and heat to the homeowners.

3

## **CO<sub>2</sub> accounts for buildings - 1.1 million tonnes CO<sub>2</sub>/year.**

CO<sub>2</sub> accounts must be prepared for all buildings in the future. To enable this, we must know the CO<sub>2</sub> footprints of the materials so that we use the materials wiser and in the necessary quantities. Today, CO<sub>2</sub> accounts can be prepared, but only very few demand them. Therefore, CO<sub>2</sub> accounts must be a demand in the voluntary sustainability standard and the building regulations, already from 2021. There is similar potential as regards to civil engineering works such as roads, bridges and railways, and therefore there must also be requirements for CO<sub>2</sub> accounts.

4

## **Fossil-free building sites - 550,000 tonnes CO<sub>2</sub>/year**

No more gas and diesel at building sites. We must use electrically powered forklift trucks and cranes, and biofuels for the excavators. We want to replace diesel-powered generators and hot air generators for dehumidification of moist building materials with electricity and district heating. With the right efforts, CO<sub>2</sub> emissions from building sites will be entirely absent in a matter of 10 years. The Government can assist in securing access to green energy and bio fuels, and that bio fuel is financially competitive.

5

## **Energy labelling for all buildings**

Today, only one out of two buildings is energy-labelled. All buildings erected before 2000 should be energy labelled within five years. The label must include information about the current state and possibilities of reduction of heating, electricity and water consumption and improvement of the indoor climate. It must be developed into a continually updated dialogue tool between homeowners, energy advisers, builders and lenders. It is an important presumption to have private homeowners start energy renovation.

If we have implemented the actual proposals in this report by 2030, it would have resulted in a total CO<sub>2</sub> reduction of

**5,800,000** tonnes CO<sub>2</sub> per year



# The point of departure - where are we today?

Buildings, bridges and roads account for 30% of Denmark's CO<sub>2</sub> emissions. That stems from the building energy consumption, the building process in connection with new construction or renovation and production of building materials. The players of the construction industry all form part of these phases and therefore have a key role in the green transition.

The construction industry employs 180,000 employees, and to this figure should be added architects, advisers and employees of the building industry. They all contribute in different ways to constructing and maintaining Denmark's buildings and the vital infrastructure.

## **More than 20% of the CO<sub>2</sub> emissions derive from heating and performance and of the buildings stocks.**

Danes spend nine out of ten hours inside buildings. 40% of Denmark's energy consumption and 23% of the CO<sub>2</sub> emission derive from energy consumption in buildings. Our businesses can assist in the replacement of fossil energy sources such as oil and natural gas with energy renovation of the existing buildings and improvement of the indoor climate. And by using intelligent management of energy consumption we can reduce energy waste and use the energy when it is most green and inexpensive.

## **10% of Denmark's CO<sub>2</sub> emission stems from the production of building materials and the building processes.**

It is of great importance how we use materials in new construction and in renovation projects. Therefore, CO<sub>2</sub> accounts should be an integral part of the project material in the future. Today, the industry's own activities give rise to direct CO<sub>2</sub> emissions when construction machinery and vehicles use fossil fuels. The construction industry also plays an important role in the circular economy because building waste constitutes 4.5 million tonnes CO<sub>2</sub> a year, or well above 35% of all waste, of which 85%, however, is reused. Therefore, industry actors also contribute in the climate partnerships for waste, water and circular economy and for energy-intensive industries.

## **The construction industry helps other industries reduce CO<sub>2</sub>**

We have chosen to present solutions in all the areas where the industry actors can make a difference to the climate. When the buildings are energy-renovated, less production of district heating and electricity is needed. When smaller amounts of new materials are used in the building process, it means reduced CO<sub>2</sub> emissions from producers of materials and transportation firms. And when all fossil fuels for the construction sites are phased out, then we are contributing to implementing the necessary electrification of society.





# 40%

of Denmark's energy consumption is used in buildings



# 35%

of all waste stems from the construction industry



# 20%

of Denmark's CO<sub>2</sub> emissions stems from the energy consumption in our buildings



# 10%

of Denmark's CO<sub>2</sub> emission stems from the construction process and the production of building materials



Photo: Fredericia Municipality

# The 2030 vision of the construction industry

In 2030 we will have significantly reduced the CO<sub>2</sub> emissions from buildings. In a matter of 10 years, 25% of the energy consumption will have been cut in the existing buildings in Denmark. The last oil burners will have been scrapped and replaced by electric heat pumps, and we will no longer use natural gas for heating. Buildings will only seldom be demolished - it costs too much in terms of the CO<sub>2</sub> accounts. Instead we will renovate, change the use and create up-to-date green buildings. All of it will occur with fossil-free construction processes.

In 2030, there will be focus on reducing the energy consumption and the CO<sub>2</sub> footprint each time a building is constructed or renovated. Denmark adheres to the EU's Energy Efficiency First principle in the green transition. That has caused homeowners to realise that it is less expensive to save than just spending energy even if it is green. Homeowners, the state, municipalities and businesses are updating energy-efficiency each time they renovate. Installations have been optimised so that energy waste is reduced, and through flexible energy consumption buildings form active parts of the energy system.

This development has resulted in a better indoor climate for the benefit of health, well-being, learning and productivity, and it has liberated 760,000 tonnes of biomass a year to be used in large machinery, heavy transportation and heavy-duty industry. And perhaps more importantly, the energy savings have saved society from over-investing in energy production and many new high-voltage electricity masts.

A binding target for implementation of energy efficiency measures in buildings and industry of 30%, including a binding target for heat savings in buildings, has made the cost of the green transition DKK 14 billion cheaper. But the world does not come to a halt in 2030, and therefore we continue to work on implementing energy efficiency

**Targets:** If we implement the actual proposals in this report by 2030, it will have resulted in a total CO<sub>2</sub> reduction of

**5,800,000** tonnes CO<sub>2</sub> per year

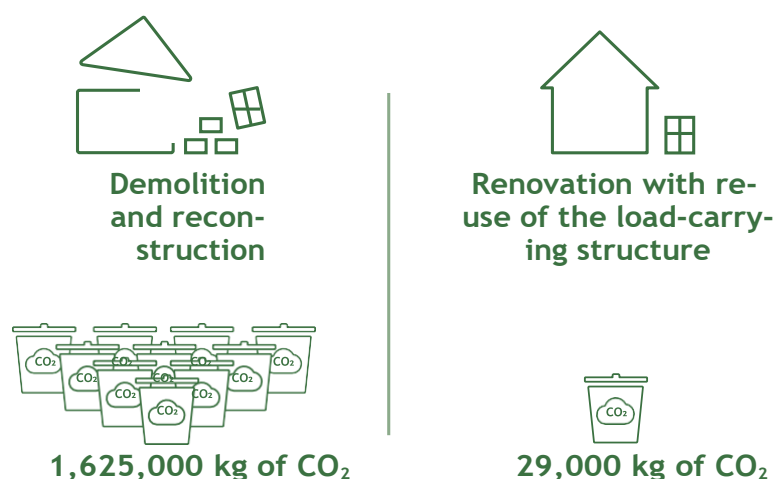
That corresponds to a fifth of the necessary CO<sub>2</sub> reduction in Danish society until 2030. At the same time, we will have cut the total energy consumption in buildings by up to 25%.

measures so that society can save DKK 120-160 billion towards a climate neutral Denmark by 2050.

In 2030, all buildings will have an energy label which gives a precise and continually updated picture of the status of the building and suggestions for improvements. Home buyers demand climate-friendly accommodation, and building owners use green loans to carry out energy improvements. Banks, municipalities and energy advisers assist in promoting the green choices. Public building owners and non-profit housing associations have long-term focus on durability, climate improvements and life-cycle costs and thus function as a driving force for the remainder of society. There are requirements for implementing energy efficiency measures, CO<sub>2</sub> footprints and indoor climate when renovations are made - adapted to the age and type of the buildings. The owners and homeowners build according to the ambitious requirements for CO<sub>2</sub> accounts when new buildings are erected and renovations are made. The green solution costs a bit more here and now, but it will pay back in the long term.



## CASE: 50 times less CO<sub>2</sub> emissions in renovations



### *Hedelunden: Renovation rather than demolition and new building reduces CO<sub>2</sub> emissions*

*The blocks of flats from the 1970s have been thoroughly renovated. It turned out that the renovation could be performed at a much lesser CO<sub>2</sub> footprint total than if the properties had been demolished and newly built. Inspired by Rambøll, 2018: Hedelunden CO<sub>2</sub> besparelse.*

The use of fossil fuels for the machines will have ended when we build and renovate buildings, roads and bridges. Machines and service vehicles use electricity, biofuels or electrofuels, whereas dehumidification of constructions only takes place through the use of electricity or district heating. When buildings are demolished, building parts and materials are recycled in direct reuse or are re-utilised for new materials in a circular building economy.

While the CO<sub>2</sub> emission in Denmark is being reduced, we are strengthening the development of Danish businesses' technology and know-how on sustainable solutions and thus the international competitiveness of the construction industry. New political initiatives and industrial initiatives have been developed for the purpose of integration in European cooperation, and Denmark has contributed to preparing common European guidelines in the form of directives, regulations and standards.

The Danish leadership in Europe contributes to ensuring sustainable growth and Danish jobs, because our products and services are demanded in Europe and the world.

Businesses and employees in the construction industry think along green holistic solutions, collaboration across professional disciplines, the right choice of constructions and building materials, high quality, long useful life and low maintenance need, and on minimising waste in the building process.

Employers and trade unions prepare businesses and employees for new solutions, requirements and frameworks in the construction industry. Measurable positive effects are stronger skills in businesses and employees, and construction work delivered on the agreed time.



From left: Vice Chairman Ingrid Reumert, Chairman Jesper Kristian Jacobsen and Vice Chairman Peter Kaas Hammer

### **The steering group of the climate partnership:**

- Chairman Jesper Kristian Jacobsen, Managing Director of Per Aarsleff A/S
- Vice chairman Ingrid Reumert, Vice President, Vexus A/S
- Vice chairman Peter Kaas Hammer, Managing Director of Kemp & Lauritzen A/S
- Jakob Brandt, Deputy Director, SMVdanmark
- Ib Enevoldsen, Managing Director, Rambøll Danmark A/S
- Lene Espersen, Managing Director, Danske Arkitektvirksomheder
- Michael S. Larsen, Managing Director, CG Jensen A/S
- Henrik Frank Nielsen, Senior Vice President, ROCKWOOL Group
- Gunde Odgaard, Head of Secretariat, BAT-Kartellet



# What are the obstacles, and what can be done?

The businesses of the construction industry live in an intense competitive situation in both Denmark and in our export markets in which the price is often of crucial importance. That means that some players cut corners and underbid businesses who are in the lead with long-term solutions. This also applies to the public building owners and the non-profit sector which are subject to framework that limits their possibilities of contributing to developing the market for green solutions.

## Lower energy consumption with intelligent management and energy renovations

The homeowners believe that they live in a modern home in terms of energy, but not many do. Therefore, many building owners postpone necessary and profitable investments. Lack of interest in the energy consumption in buildings forms a hindrance to renovations and intelligent management. Therefore, implementing energy efficiency measures in Denmark is going at too slow of a pace.

Financing is a problem. Lessors cannot add costs for energy improvements to the rent, municipalities hit the construction spending cap, and the politically approved budget of the National Building Fund impedes the implementation of energy efficiency measures in non-profit housing.

## This is what we should do

### The industry must:

- ▶ advise the building owners and recommend green solutions
- ▶ cooperate with the financial sector to develop new business models in which the homeowners can pay for implementing energy efficiency measures via the ongoing operations
- ▶ ensure better compliance with the building regulations.

### The Government must:

- ▶ improve the financial incentive to implement energy efficiency measures, e.g. through an improved deduction for builders, property taxes and energy taxes
- ▶ make demands on the use of life-cycle costs which prevents a narrow focus on the here and now cost and not on the long-term economy
- ▶ adjust the rules so that municipalities etc. invest in energy improvements and renewable energy - e.g. through ESCO models
- ▶ increase the budget of the National Building Fund so that 120,000 social housing accommodations can be energy-efficient and modern
- ▶ make demands for automation that prevents energy waste and uses the energy when it is greenest
- ▶ ensure better compliance with the building regulations.



## From black to green energy - scrap oil burners and natural gas

There are still 100,000 oil burners and 400,000 buildings that are heated with natural gas. The fossil heating is only slowly being phased out with the current policy. And then the future role of natural gas for heating of buildings remains unclear.

### This is what we should do

#### The industry must:

- ▶ have more committed players in the state RE approval scheme
- ▶ create new solutions that make it easy for the individual homeowner to switch to green alternatives.

#### The Government must:

- ▶ lay down requirements for the efficiency of heating installations
- ▶ implement a national plan for phasing out natural gas for heating
- ▶ phase out oil burners towards 2030.



## CO<sub>2</sub> accounts for buildings, bridges and roads

The focus in construction is still to deliver at a low price, because that is the most important thing for most customers today. The problem is that this does not create climate-friendly solutions except for individual showcase projects. For most people, it is a new and unfamiliar way of thinking regarding the CO<sub>2</sub> footprint and life cycle calculations in the entire life of the building because the demand is so small.

### This is what we should do

#### The industry must:

- ▶ develop its “mindset” from an economic to a life-cycle cost / climate bottom line
- ▶ work to promote that all constructions have CO<sub>2</sub> accounts, that material optimization is made and that product-specific environmental declarations of content is in demand,
- ▶ develop more and smarter solutions for calculating life cycle analyses
- ▶ reduce the footprint of CO<sub>2</sub> through increased innovation with producers of materials by using more renewable energy in the production.

#### The Government must:

- ▶ make demands for the CO<sub>2</sub> accounts of buildings in the building regulations from 2021 and set out a requirement level of 12 kg CO<sub>2</sub>/m<sup>2</sup>/per year
- ▶ adopt the voluntary sustainability class and set out a requirement level of 8.5 kg CO<sub>2</sub>/m<sup>2</sup>/per year
- ▶ revise the requirement levels on an ongoing basis and make a step-by-step increase by 2023, 2025 and 2030
- ▶ set up a working group to assess and further develop methods, tools, requirement levels etc.
- ▶ establish a “support office” for SMEs, so that we involve all in relation to developing EPDs (environmental product declarations), use the tool “LCA Byg” etc. as quickly as possible
- ▶ incorporate LCA methods for bridges and civil engineering works.

## Fossil-free green building sites

Today, almost all construction machinery runs on diesel or petrol. The electrically powered machines found are too costly to purchase. That also applies to delivery vans and cars in the industry. At the same time, large quantities of diesel oil is used for electric generators and hot air generators for dehumidification of moisture in the construction process.

### This is what we should do

#### The industry must:

- ▶ protect construction works better against moisture during construction and make energy requirements in connection with dehumidification,
- ▶ demand green machines and energy and implement the practical transition.

#### The Government must:

- ▶ obligate utility companies to deliver green energy for building sites when construction commences,
- ▶ promote CO<sub>2</sub> free production equipment by means of requirements and duties.



## Energy labelling for all buildings

The energy label is the key to implementing energy efficiency measures in our buildings, and all buildings should have one - and the quality of the labels must be ensured. Because there are quality problems. The current energy labels have been criticized for being defective, imprecise and rarely usable in practice.

As regards private homes, there is only a requirement of an energy label inspection in case of change of ownership. That means that implementation of energy efficiency measures having taken place since the change of ownership, e.g. replacement of windows, are not reflected in the energy label. Therefore, the energy label and the related recommendations for energy improvements quickly become obsolete.

### This is what we should do

#### The industry must:

- ▶ participate in the development of the future energy label for buildings in collaboration with the authorities - a reliable, digital and dynamic tool which is updated when projects are carried out. And which contains an actual plan for energy renovation
- ▶ contribute to developing the energy label so that the financing institutions may use it in their advice to homeowners and as a basis for loans for green investments.

#### The Government must:

- ▶ ensure that requirements are made for a mandatory energy label for all buildings erected before 2000,
- ▶ further develop the future energy label for buildings into a reliable, digital and dynamic tool, which is updated when projects are carried out, containing an actual plan for energy upgrading that can be used by lenders as the basis for loans for green investments.



# An introduction to the proposals from the working groups



Photos: Jeppe Carlsen

At the request of the Government, the climate partnership for the construction industry has reviewed possibilities for reducing CO<sub>2</sub> which the industry can help contribute to. It has been an intensive process over four months in which more than 100 business managers and specialists have been involved in the process, including owners, architects, consulting engineers, producers of materials, contractors, builders and selected experts.

## Dive into the proposals

Five working groups have each provided proposals for CO<sub>2</sub> reductions based on their themes:

- Energy renovation of existing buildings
- Reduce CO<sub>2</sub> emissions from operation of buildings
- Design and the CO<sub>2</sub> content of materials in buildings
- Reduce CO<sub>2</sub> emissions at the building site
- Reduce CO<sub>2</sub> emissions in the civil engineering sector

27 of the proposals are described on the following pages.

## Calculation of CO<sub>2</sub> effects

The calculations of how much the various proposals may reduce the emission of greenhouse gases take as their starting point, to the extent possible, in official statistics, such as the energy statistics from the Danish Energy Agency or statistics from Statistics Denmark. In cases where it has not been possible to base the calculations on these sources, experience from the industry has served as supplements. It may e.g. be for the CO<sub>2</sub> emissions from certain types of work in a building project. From there, it has subsequently been scaled up to a total number for the entire industry.

The potential savings are based on an estimate of how big a share of the emission can be saved. All estimates are of potential saving as many factors play a part in the development. It may be that it is required that bids are made in a new way, or that more electrically-powered machines must be developed. The estimates of the savings have been made by the various working groups of the climate partnerships consisting of representatives of the construction industry.

In the appendix report, all 63 proposals from the climate partnerships have been described in detail, including the assumptions of the estimated CO<sub>2</sub> reductions.

# Actual proposals from the construction industry

If we implement the actual proposals in this report by 2030, it will result in a total CO<sub>2</sub> reduction of 5,800,000 tonnes of CO<sub>2</sub> per year

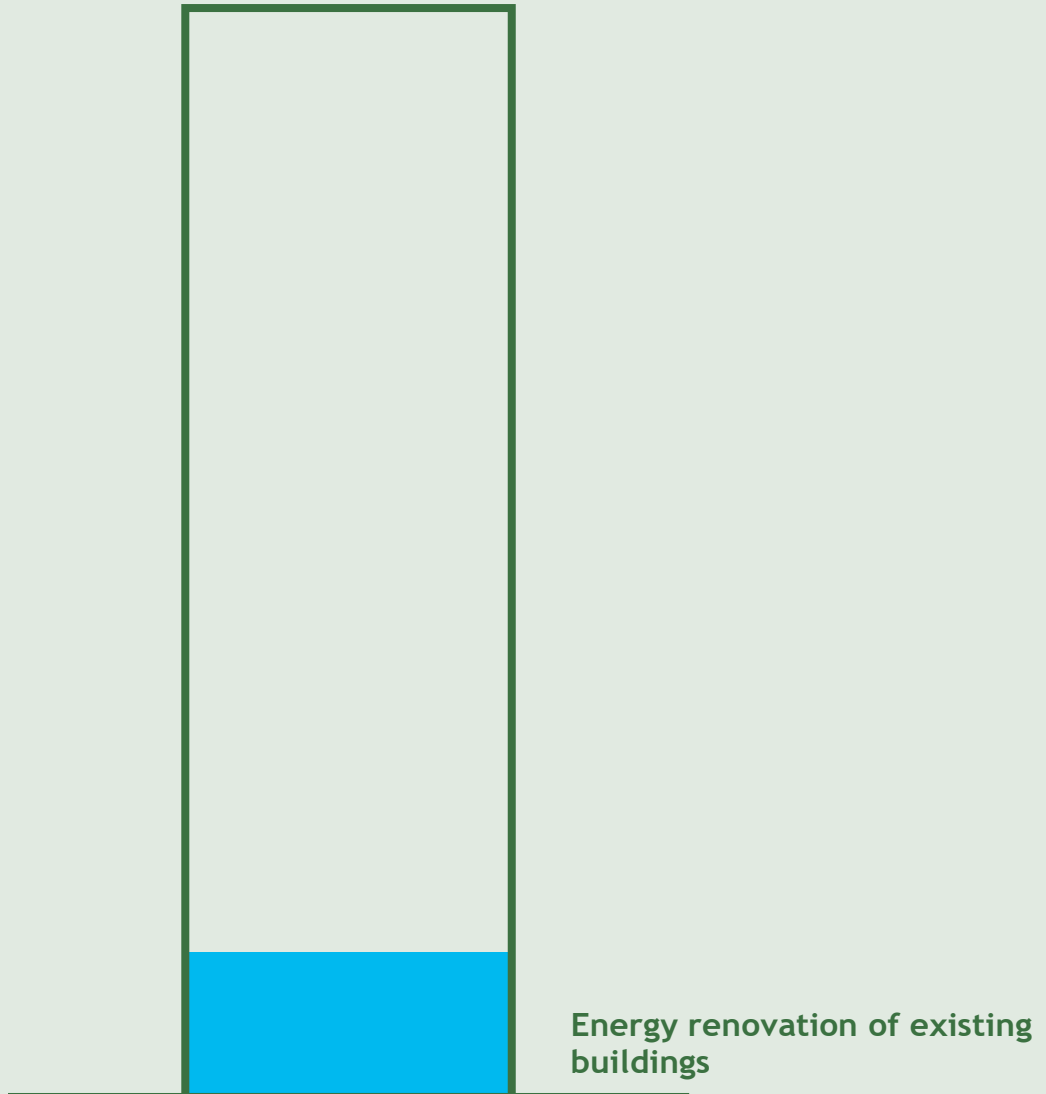
(corrected for overlaps). Here is the overview of all the 27 prioritised initiatives. “Enablers are necessary initiatives that pave the road for the others. “

	Initiatives	CO <sub>2</sub> reduction in tonnes	Page	Theme
1	Phasing out natural gas for heating	1,540,000	23	CO <sub>2</sub> reduction from operation of buildings
2	Conversion of builders' vehicles to being electrically powered	1,055,000	*	Transversal proposals
3	Dissemination of LCA and targets for CO <sub>2</sub>	608,000	29	Design and CO <sub>2</sub> in buildings
4	10% lower heat consumption	560,000	16	Energy renovation of existing buildings
5	Intelligent management of energy consumption	510,000	23	CO <sub>2</sub> reduction from operation of buildings
6	Project-specific climate accounts in tenders	304,000	29	Design and CO <sub>2</sub> in buildings
7	Replacement of oil burners	280,000	24	CO <sub>2</sub> reduction from operation of buildings
8	Fossil-free production equipment at the building site	275,000	36	CO <sub>2</sub> reduction at the building site
9	Reduce the material consumption and CO <sub>2</sub> emission in the design	220,000	30	Design and CO <sub>2</sub> in buildings
10	Fewer materials and less waste	200,000-600,000	37	CO <sub>2</sub> reduction at the building site
11	Fossil fuel and emission-free plant machinery	177,000	42	CO <sub>2</sub> reduction in the civil engineering sector
12	Transition to electric vehicles on the roads	162,000	42	CO <sub>2</sub> reduction in the civil engineering sector
13	Use of new types of cement	146,000	43	CO <sub>2</sub> reduction in the civil engineering sector
14	Optimized planning and layout at the building site	100,000	37	CO <sub>2</sub> reduction at the building site
15	CO <sub>2</sub> free dehumidification and heating	75,000	35	CO <sub>2</sub> reduction at the building site
16	Optimisation of heat pumps	70,000	24	CO <sub>2</sub> reduction from operation of buildings
17	Renovation of technical installations	70,000	24	CO <sub>2</sub> reduction from operation of buildings
18	Package solutions for energy renovations for homeowners	66,000	17	Energy renovation existing buildings
19	120,000 energy-efficient social housing units	61,000	16	Energy renovation of existing buildings
20	Climate-friendly asphalt	57,000	43	CO <sub>2</sub> reduction in the civil engineering sector
21	Digital solutions: Robots, Additive Manufacturing and digital twins	50,000	43	CO <sub>2</sub> reductions in the civil engineering sector
22	Public investments in heating savings	42,000	17	Energy renovation of existing buildings
23	The energy label must be an active tool for energy savings	Enabler	18	Energy renovation of existing buildings
24	Electricity and district heating at the building site	Enabler	35	CO <sub>2</sub> reduction at the building site
25	CO <sub>2</sub> accounts for the building site	Enabler	36	CO <sub>2</sub> reduction at the building site
26	Development of underlying data and systems	Enabler	30	Design and CO <sub>2</sub> in buildings
27	Requirements of the building regulations and sustainability class from 2021 with a step-by-step tightening towards 2030, and development of technical common ownership	Enabler	30	Design and CO <sub>2</sub> in buildings

\* Described in further detail in the appendix report



**5,800,000** tonnes of CO<sub>2</sub> per year





# Energy renovation of existing buildings

Most of today's buildings stem from a time without particular focus on energy efficiency, and 80% of them will also be used in 2050. Therefore, implementation of energy efficiency measures in the current buildings is vital to reach our climate targets.

Lower energy need in buildings contributes in a number of ways to the climate target:

1. Reduces the CO<sub>2</sub> emission
2. Lowers the cost of transition of the energy system to renewable energy
3. Releases climate-friendly energy, e.g. biomass which is currently used for district heating production, for use in the industry.

## Great profits to reap

Today, 30% of the energy is used for heating. A reduction of the energy consumption for heating at 10% until 2030 will reduce the CO<sub>2</sub> emission, which is today at about 6 million tonnes while at the same time providing a number of other gains:

That makes the bill of the green transition about DKK 6 billion cheaper up to 2030, i.e. as a result of lower resource consumption and larger efficiency of the energy system. Lower energy consumption entails fewer investments in expansion of renewable energy and thus makes the green transition easier and faster.

Also, it releases biomass which can be used in other sectors such as industry, which faces a big challenge in relation to the transition.

It is possible to witness a quick effect as the initiative relating to buildings can be started right away with well-tested and well-documented solutions.

14 initiatives that in 2030 will contribute to

- ▶ reducing heat consumption by 10%:  
5TWh (18 PJ) corresponding to the capacity of three Horns Rev 3 windfarms
- ▶ reducing the emission of CO<sub>2</sub> from heating with 560,000 tonnes per year
- ▶ releasing 760,000 tonnes of biomass/per year for use in industry which can thus reduce the emission of CO<sub>2</sub> by 620,000 tonnes per year
- ▶ reducing the price of the green transition by a total of DKK 6 billion.

## Top 5 initiatives

- 1 10% savings in heating through an increased renovation rate and compliance with energy requirements.
- 2 Renovation of 120,000 social housing units
- 3 Give the public sector the possibility of investing in heating savings
- 4 Package solutions for energy renovation for homeowners
- 5 The energy label must be an active tool for energy savings



## Potential in dwellings and public buildings

The large potential of heating savings is found in single-family houses and terraced houses, in social housing and public buildings. More than half of the total energy consumption for heating is used in single-family houses.

We spend more than 22 hours of the day and night indoors. Energy improvements often also contribute to a better indoor climate which is vital to our health and well-being. This derived effect increases the socio-economic gains of energy efficiency measures.

There is a large demand for maintaining and renovating buildings and creating attractive dwellings, both in the public sector and in social housing. The public sector alone has a maintenance backlog estimated at DKK 50 billion <sup>1</sup>. Many renovations are both necessary and profitable and give the possibility of reaping large savings in energy. A targeted effort in these sectors can create a larger scale to the benefit of the development of new solutions and products.

## Barriers

There are many decision-makers and stakeholders who have very different assumptions when millions of buildings in Denmark are going to be made more energy-efficient. The energy consumption for heating has been on the increase for the past years. That seems to indicate that energy renovations have not been carried out to the extent necessary. The most important barriers are:

- **Framework conditions**  
Many public building owners and the social housing sector have a professional approach to energy savings. But renovations are slowed down by framework conditions such as the construction spending cap and inadequate frameworks for the National Building Fund.
- **Knowledge and economic incentives**  
Many private homeowners lack the required knowledge and a financial incentive to undertake energy renovation.

## Solutions

The building and finance sector plays an important role as ambassadors for implementing energy efficiency measures. But we all need to be involved. To have our buildings made more energy efficient there is a need for both a carrot and a stick in the right combination of:

- **Requirements**  
For instance, municipalities and regions can make demands for an ambitious energy label when lease agreements are concluded such as the state already does today.
- **Incentives**  
A greener Housing-Jobs scheme deduction with the possibility of saving deductions for a number of years for large initiatives can lead to more and more in-depth energy renovations with homeowners.

- **Information**  
For instance, clearer energy requirements in the housing regulations and an enhanced energy label, which also focuses on indoor climate, can contribute to ensure energy savings that we fail to obtain today.
- **Financing**  
Grants and attractive loans promote energy improvements.

## Vision: In 2030 energy-efficient buildings will have contributed to faster and cheaper green transition.

With the right initiatives, we can have a housing stock in 2030 in which:

- **Heat consumption has been reduced by 10%**  
Clearer energy requirements in the building regulations ensure that the demands are complied with, so that neither building owners nor society fails to obtain profitable energy savings. Better possibilities of financing have increased the renovation rate.
- **Social housing units are renovated on an ongoing basis**  
The National Building Fund has financial frameworks to renovate and create attractive and energy-efficient social housing units without straining the public finances. Queues of tens of thousands approved renovation projects are a thing of the past.
- **The public sector is in front**  
The public sector has been given the opportunity to lead the way by making its own buildings more energy efficient and through dialogue and targeted activities motivate homeowners, building societies and businesses to enhance energy efficiency.
- **Far more homeowners implement energy renovation**  
A systematic effort with stronger financial incentives and better communication ensures that the homeowners no longer miss out on the possibility of energy optimisation.

## Main results: Saves 560,000 tonnes of CO<sub>2</sub> in 2030

Reduction of the heat consumption by 10% in 2030 corresponds to 5 TWh (18 PJ) - or the capacity of more than two large wind energy farms (Horns Rev 3). That will entail a reduction of a CO<sub>2</sub> emission of 560,000 tonnes/CO<sub>2</sub> per year.

The overall target has been supplemented by another four proposals for actual initiatives, that each contributes to reaching part of the target. But to realize the full potential, it is vital that an effort is made within private trade and service. The three initiatives are within four types of buildings in which there is large energy saving potential: single-family houses, terraced houses, social housing and the public sector. The proposals have been prioritised according to how quickly they can be implemented.

<sup>1</sup>: Dansk Byggeri 2019, Kommunernes rolle i klimakampen Analyse af potentialet for energibesparelser (the Danish Construction Association 2019: The role of the municipalities in the climate challenge; an analysis of the potential for energy savings)

## 1 10% lower heat consumption

If the energy requirements for existing buildings of the building regulations are complied with and the number of energy renovations are increased, the energy consumption for heating can be reduced by 1% a year.

Energy improvements pay off for the individual homeowner and society. The industry must take responsibility, but the initiative must be supported by a target in the climate action plan.

Energy improvements in buildings must be made in connection with the ongoing maintenance in order to be cost effective. That is why the building regulations contain energy requirements when various building parts are renovated. Towards 2050, DKK 727 billion must be invested in the basic renovation of the building envelopes. The extra investment of living up to the energy requirements of the building requirements is about DKK 40 billion <sup>2</sup>

Ultimately, it is the owner's responsibility that the energy requirements are complied with, but the industry must ensure that it takes place in far more cases than today. That must be done by informing the building

The estimated annual effect of the initiative in 2030

CO<sub>2</sub> reduction: **560,000 tonnes**

Savings in heating: **5 TWh** (about 18 PJ)

Saved biomass: **760,000 tonnes**

Can be initiated from **2020**

owner of rules and solutions and giving quotations and calculations of the project which are in compliance with the rules. Builders must have better knowledge of energy requirements, and it must be clearly specified in the building regulations how to meet the requirements.

In the future, failure to comply with energy requirements should be sanctioned.

2: SBI 2017, Varmebesparelse i eksisterende bygninger potentiale og økonomi (SBI 2017: Heat savings in existing buildings, potential and economy)



## 2 120,000 energy-efficient social housing units

The social housing sector can most quickly deliver large energy savings in the existing housing stock. A queue of approved renovation projects can be started at short notice.

Every tenth social housing unit faces renovation. This primarily takes place through the residents' own savings in the Danish Housing Fund (LBF). Use of the savings depends on the financial framework of LBF, which presently does not match the need. That has created a queue of approved renovation projects in 60,000 dwellings of DKK 17 billion.

Altogether, about 120,000 social housing units should be renovated by 2030. In addition to an important CO<sub>2</sub> reduction, it will save 500 GWh and 78,000 tonnes of biomass.

The estimated annual effect of the initiative in 2030

CO<sub>2</sub> reduction: **61,000 tonnes**

Savings in heating: **0,5 TWh** (about 1,7 PJ)

Saved biomass: **78,000 tonnes**

Can be initiated from **2020**

The assumption is that LBF's financial framework is increased in connection with the Housing Agreement 2020. The public finances are not strained as the funds in LBF are the residents' money.

### 3 Public investments in heat savings

It is a natural thing that the public sector takes action in the political climate target and reduces the energy consumption for heating in its buildings.

Many municipalities are ready to invest in necessary profitable energy initiatives in municipal buildings, but they are slowed down by limitations in the construction spending cap. There is much to be achieved. By way of example, 70% of the 23,000 municipal buildings have a poor energy label (D-G) to the detriment of both the climate, the indoor climate and the economy of the municipalities.

EU's requirement for 3% implementing energy efficiency measures in public buildings should also apply to municipalities and regions. If the potential for savings in heating must be met, energy-related projects must be exempted from the construction spending cap. By 2030, no public buildings should have an energy label poorer than C.

The estimated annual effect of the initiative in 2030

CO<sub>2</sub> reduction: **42,000 tonnes**

Savings in heating: **0.4 TWh (1.4 PJ)**

Saved biomass: **49,000 tonnes**

Can be initiated from **2021**

Further incentives for a better energy standard can be created for public institutions if the executive order stipulates that municipalities and regions make demands on an ambitious energy label when they enter into lease agreements - which the state must do today. Thus, the entire public sector can increase demand for energy-efficient buildings.



### 4 Package solutions for energy renovation for homeowners

The very large potential for savings in heating is found in single-family houses which represent 54% of the Danish energy consumption for heating. Six out of ten of these buildings have a poor energy label (D-G).

Even if it is a bargain, the homeowners do not energy renovate to an adequate extent. In order to get the market going, it is suggested to develop renovation packages adapted to archetypes of houses. The initiative can reap one third of the potential of 2.1 TWh (7.4 PJ) and 222,000 tonnes of CO<sub>2</sub>, respectively. It must be followed by other initiatives if the full potential is to be realised.

The packages should contain thoroughly prepared proposals for measures such as loft insulation, new windows, heat pumps etc. and should be offered sys-

The estimated annual effect of the initiative in 2030

CO<sub>2</sub> reduction: **66,000 tonnes**

Savings in heating: **0.7 TWh (2.5 PJ)**

Saved biomass: **113,000 tonnes**

Can be initiated from **2020**

thematically to homeowners. Builders and financing institutions are central communicators to the homeowners. The positive impact of the measures on indoor climate, comfort and functionality is included to increase motivation. These measures should be supplemented by better financing options, such as saving of deductions for builders over a number of years or better loan conditions for green investments.





## 5 The energy label must be an active tool for energy savings

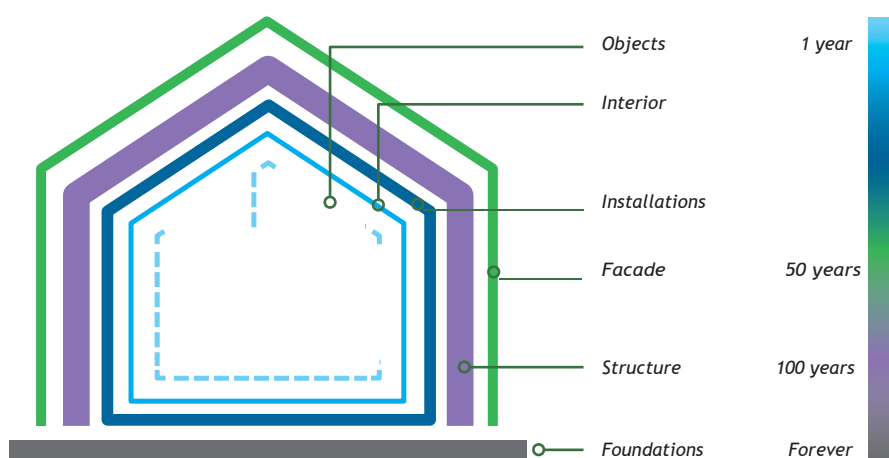
The energy label must be a dialogue tool when a builder or other adviser is in dialogue with the homeowner about improvements of the home. This also applies to the financing sector. However, it implies that the label give a truer, fairer and more understandable view and give actual measures. The energy label should be the action plan on which renovation measures can be planned based on the replacement rate for the individual building parts that have various useful lives, windows, roofs etc. In addition, the energy label should include indoor climate matters such as draft and chill, condensation and mould fungus, noise and daylight.

Estimated effect of the initiative

**Enabler for reduction targets**

Can be initiated from 2020

Digitalisation of the label must ensure that the energy label becomes a dynamic tool in which both the building owner and builders may add ongoing energy improvements.



The elements of a building and their typical useful life before replacement is necessary. World Green Building Council: Bringing Embodied Carbon Upfront: <https://www.worldgbc.org/news-media/bringing-embodied-carbon-upfront>



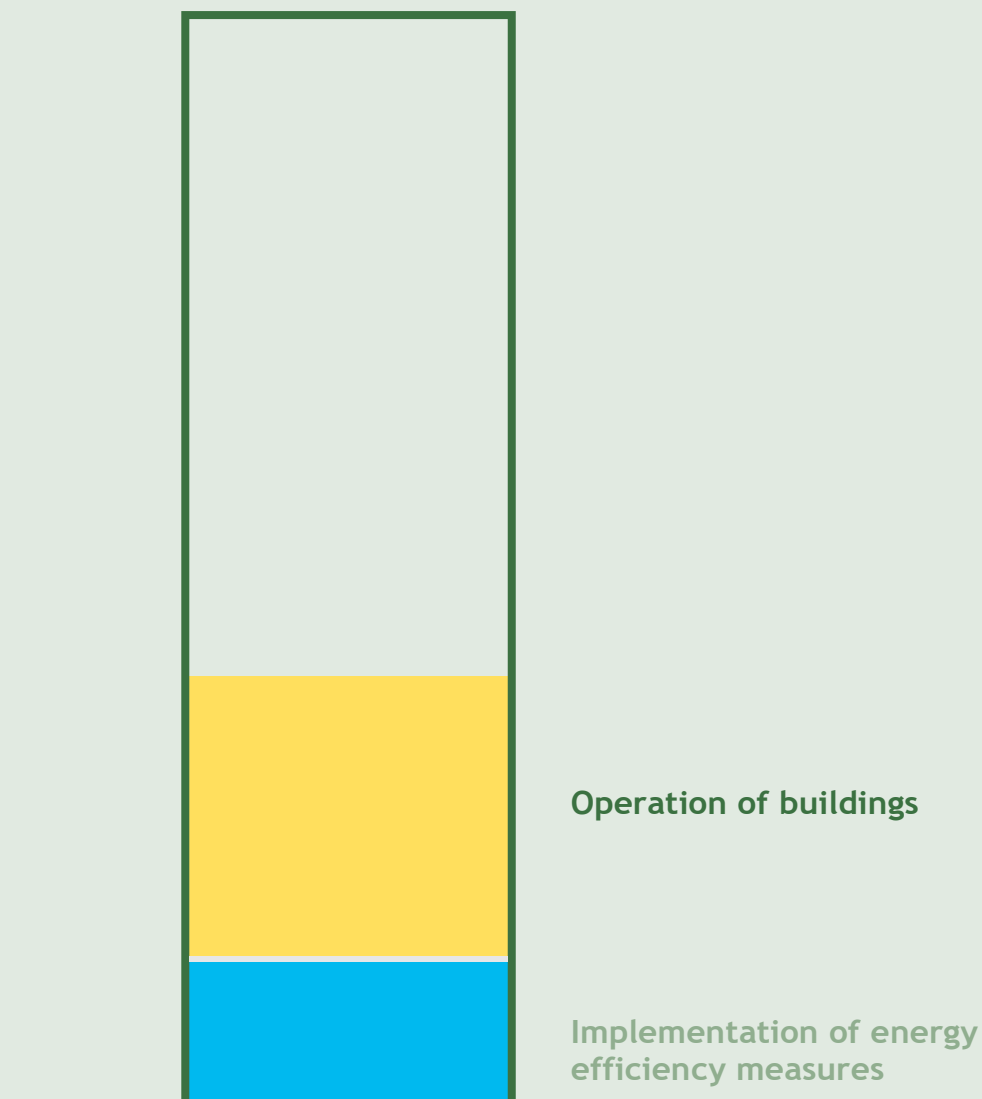
## Other initiatives for implementation of energy efficiency measures of existing buildings

1. Clear energy requirements in the building regulations
2. More precise calculations of impact from energy efficiency measures
3. Requirement for an ambitious energy label in case of lease of buildings
4. Better possibilities for municipal energy savings through exemption of all energy-related construction work from the construction spending cap
5. Greener deductions for home and jobs with the option of saving the deduction
6. A green element in the property tax
7. Revitalisation of renewal of buildings and maintaining the role of the Building Damage Fund in relation to implementing energy effective measures of privately owned multi-storey homes.

## Wishes for the Government

1. 10% binding targets for reduction of the energy consumption for heating in 2030
2. Clear energy requirements in the building regulations
3. True and fair calculation tools for renovation
4. Development of an extended energy label which contains indoor climate gains
5. Requirement for an ambitious energy label in case of lease of public buildings
6. Better possibilities for municipal energy savings through exemption of all energy-related construction work from the construction spending cap
7. Greener deductions via the Housing-Jobs scheme with the option of saving the deduction
8. A green element in the property tax
9. A requirement for portfolio management of the state of buildings and energy consumption for building owners with many properties
10. Revitalised building renewal and a role for the Building Damage Fund in the implementation of energy efficiency measures in buildings

**5,800,000** tonnes of CO<sub>2</sub> per year







# CO<sub>2</sub> reduction from operation of buildings

A large share of the Danish energy consumption and climate footprint is in the operation and heating of our buildings. That can be reduced significantly with green transition and implementation of energy efficiency measures.

In total, operations and heating of buildings in 2017 constituted about 40% of the Danish energy consumption, and about 23% of the CO<sub>2</sub> emission from energy. Towards 2030, the energy consumption for heating of buildings will slightly be decreasing.

The largest sources of CO<sub>2</sub> emissions in the building stock are heated with fossil fuels such as oil and gas. With a number of cost-efficient measures, it is possible to reduce the CO<sub>2</sub> emissions from the buildings significantly over the next 10 years. Operation of buildings thus involves large potential in the efforts to meet the targets of the Danish Climate Act of a 70% reduction.<sup>1</sup>

The five concrete initiatives mentioned below can reduce the CO<sub>2</sub> emission from the buildings by 86%.

## Cheaper transition for a more robust energy system

Our energy consumption must be moved from fossil fuels to electricity which is produced when the wind is blowing and the sun is shining. The increasing electricity consumption and the more varied production make new requirements on the energy system in 2030.

The pressure on the energy system becomes smaller when we optimise building operations so that we use less energy. The green transition will be significantly more expensive if no energy efficiency measures are implemented.<sup>2</sup>

14 initiatives with an estimated potential of

**2,500,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

## Top 5 initiatives

- 1 Phasing out natural gas**  
Natural gas for domestic heating is phased out and replaced by green alternatives.
- 2 Intelligent management of energy consumption**  
We need the energy when it is green and cheap.
- 3 Replacement of oil burners**  
There is a need for requirements and prohibitions to get rid of the remaining oil burners.
- 4 Optimisation of heat pumps**  
Requirements for service of heat pumps and fitters increase the energy efficiency.
- 5 Renovation of technical installations**  
Incentives and better observance of requirements ensure optimisation of the installations in buildings.

1: Green Transition Denmark: Bygningers andel af energiforbrug og udledninger (2019) (the share of buildings' energy consumption and emissions (2019), the Danish Energy Agency: 2019 Basic projection (2019)

2: EA Energianalyse: Analyse for det samfundsøkonomisk potentiale for energibesparelser (2019). (Analysis of the socio-economic potential for energy savings (2019). The study shows that it will be DKK 3-4 billion more expensive per year, if no energy efficiency measures are implemented in all sectors.

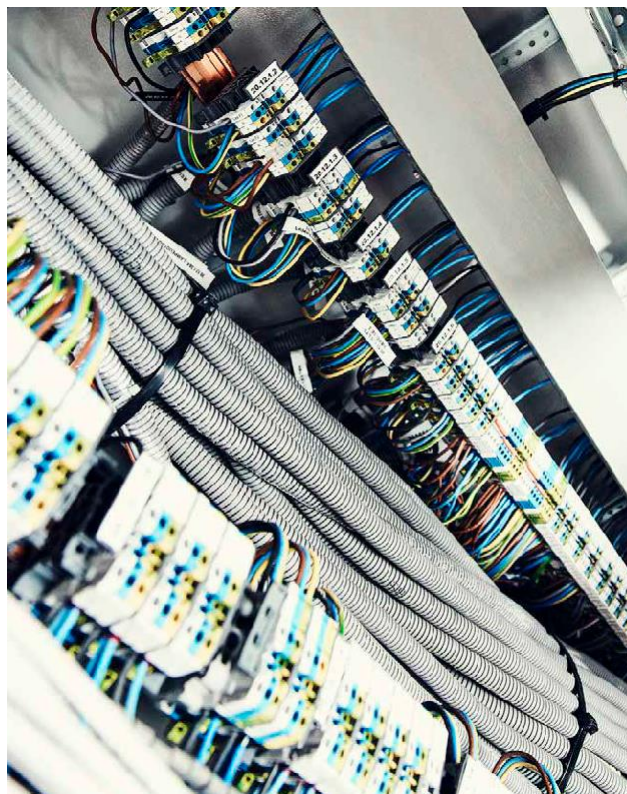
Optimised operation of buildings can contribute substantially to the green transition in two ways:

- **Cheap CO<sub>2</sub> reductions**  
Energy-efficient operation of buildings will reduce the energy consumption and is one of the cheapest socio-economic ways for the necessary CO<sub>2</sub> reduction towards 2030. The Danish Council on Climate Change assesses that energy renovation of buildings and dissemination of individual heat pumps are among the most appropriate elements of the transition.<sup>3</sup>
- **Robust and efficient energy system**  
Reduction and balancing of the energy consumption in buildings over the entire 24 hours reduces the need for importing energy and investing in electrical grids and larger energy production from i.a. solar cells and wind energy. By making the energy consumption for operation of buildings flexible by means of intelligent energy management, it becomes possible to move consumption to the periods when the power is green and cheap.

### This is how we speed up the transition

To get the most out of the concrete CO<sub>2</sub> reducing initiatives, there is a need for a number of supporting initiatives - so-called enablers. This applies to i.a.:

- **Making demands for total cost of ownership**  
A large share of new constructions, ongoing maintenance and renovation of buildings is made with a very narrow focus on the cost here and now, and not on the long-term economy. Total cost of ownership is a way to ensure that the building owner has long-term focus on erection and operation of the building so that the most optimal and thus energy-efficient solutions are chosen. Therefore, it is suggested that stricter requirements for using total cost of ownerships are made, that better basis for calculation and actual guidelines are developed, and that a total cost of ownership label is implemented for new constructions and in case of large renovations.
- **Focus on operations**  
Operation of buildings is typically not a focus area for businesses or homeowners. This means that energy consumption is not followed closely and ongoing optimisation of energy consumption is not a priority so that it does not increase over time. Operation of buildings can to a greater extent be put into focus by automatically collecting data on the energy consumption in the buildings and developing key figures that make it easy to follow the development and spot additional use.
- **Promote flexible energy consumption**  
A very large share of the Danish energy consumption is used for heating, ventilation and cooling of



buildings. Much of the consumption can be shifted without having any large practical difference in the use of the building. Shifting enables a balancing of the consumption, and that is of great importance to the price paid for the energy. Flexibility requires intelligent energy management of the installations, and it must be easy and financially attractive to the consumers to contribute with flexibility. For instance, through more dynamic energy prices and new business models.

- **Let the public sector be the driver behind the development**  
Together with the publicly supported construction in the non-profit sector, the public building owners are the largest Danish building owners. It will therefore have a significant impact if the public sector and the cooperative housing society lead the way and make climate requirements for their own buildings. It is also proposed that municipalities and regions are charged with preparing climate action plans for their own CO<sub>2</sub> emissions.

The right framework will take us a long way. Subsequently, five concrete initiatives are proposed which together can deliver a reduction of 2.45 million tonnes of CO<sub>2</sub> in 2030 and 41 PJ (petajoule) in energy consumption further in relation to the Danish Energy Agency's basic projection 2019. Together that will provide an 86% reduction in CO<sub>2</sub> emission and a 17% reduction in energy consumption in comparison to 1990.

3: <https://www.klimaraadet.dk/da/rapporter/omstilling-frem-mod-2030>



# 1 Replacing natural gas

**Natural gas for domestic heating must be replaced by green alternatives.**

Today, approximately 400,000 buildings are heated with natural gas. They must be transferred to renewable energy by replacing the natural gas with biogas or switching to district heating or heat pumps.

The necessary changes are expensive and take a long time to implement. It is vital that a central political decision is made in relation to what should happen to natural gas, as soon as possible.

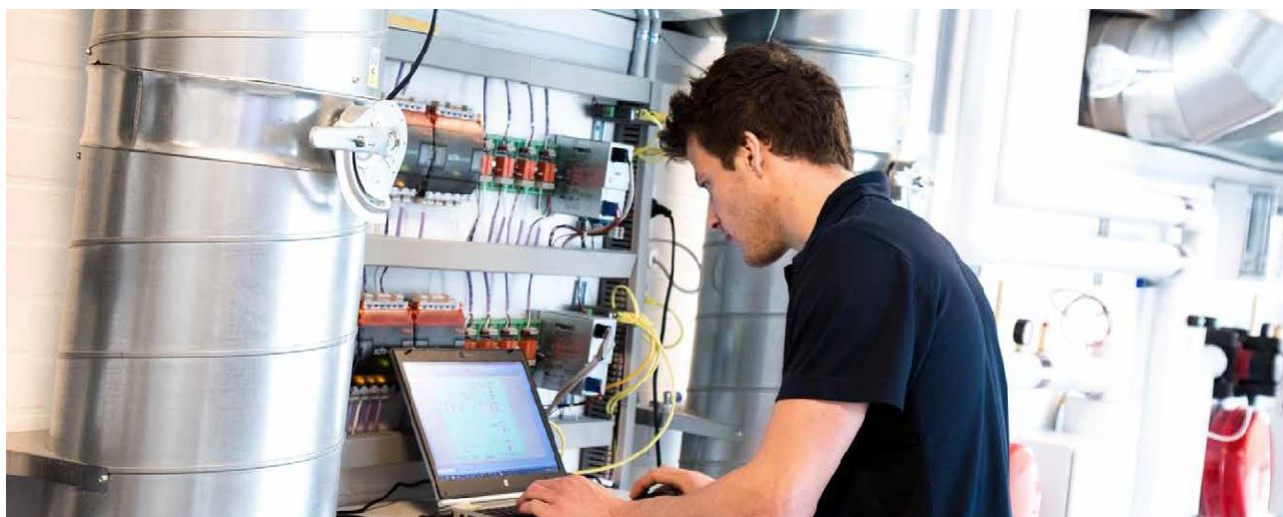
If gas is kept for heating of buildings, an efficiency requirement towards 2030, must be made which, re-

Estimated effect of the initiative

**1,540,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

duces the gas consumption by about 80%. If biogas should not be used for heating of buildings, the installation of natural gas boilers should be prohibited. So that other green solutions are promoted.



# 2 Intelligent management of energy consumption

**More intelligent management of the energy consumption can help us in using the energy when it is green and cheap.**

Intelligent energy management can reduce the energy consumption and integrate various automatic building controls so that they do not counteract and move consumption to periods when the energy is green and cheap.

Automatic building controls are used on both individual installations for e.g. lighting, ventilation and heating and in more integrated systems and intelligent buildings. The large potential lies in large buildings, but more systems become available, targeted at private customers and thus smaller buildings.

Estimated effect of the initiative

**510,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2025

Much of the automatic controls should be mandatory in new constructions and renovations, and standards for building automatic controls must be made. Consumers must have access to energy data of buildings and installations from smart meters.



### 3 Replacement of oil boilers

There is a need for requirements and prohibitions to get rid of the remaining oil boilers.

100,000 homes were still heated by oil in 2017.<sup>4</sup> Despite many attempts to speed up the replacement, there will still be 40,000 active oil boilers in 2030 if further measures are not initiated. Information campaigns, energy savings grants and scrapping premiums are not enough.

It is suggested that requirements should be made that all oil boilers must be replaced by 2030 and prohibit installation and replacement of fossil oil boilers

Estimated effect of the initiative

**280,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

from 2021. The requirement is supported by an initiative of the industry to get more installers involved in the renewal certification scheme.

### 4 Optimisation of heat pumps

Requirements for service of heat pumps and fitters increase the energy efficiency.

A study<sup>5</sup> shows that nine out of ten heat pumps do not perform optimally. Some of the profit from switching from oil or natural gas boilers is therefore not gained. This problem gets bigger as we get more heat pumps. By ensuring a better installation and service of heat pumps, it is possible to improve heat pump performance by 16%.

It is proposed that the industry develops a joint industry standard for servicing heat pumps to ensure

Estimated effect of the initiative

**70,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2025

optimum operation. It is also suggested that public subsidy regimens make it mandatory to use a business which is a member of the state renewal certification scheme.

### 5 Renovation of technical installations

Financial incentives and better observance of requirements can optimise the existing installations in buildings.

Despite the fact that renovations of technical installations are energy-saving, financially profitable as well as having a short repayment period, they are rarely realised by the building owners. In particular small and medium-sized businesses have more focus on the day-to-day operations.

Renovations of ventilation, lighting, cooling and heating installations are promoted by adjusting the current financing scheme, e.g. the Housing-Jobs

Estimated effect of the initiative

**70,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2025

scheme, and spread municipal experiences with energy screenings. Authorities and the industry must clarify needs for documentation that certain requirements in the building regulations have been met.

4: <https://ens.dk/sites/ens.dk/files/Statistik/opvarmningsundersoegelsen.pdf>

5: The Technological Institute: Den gode installation af varmepumpe (2017)  
(The good installation of heat pumps)



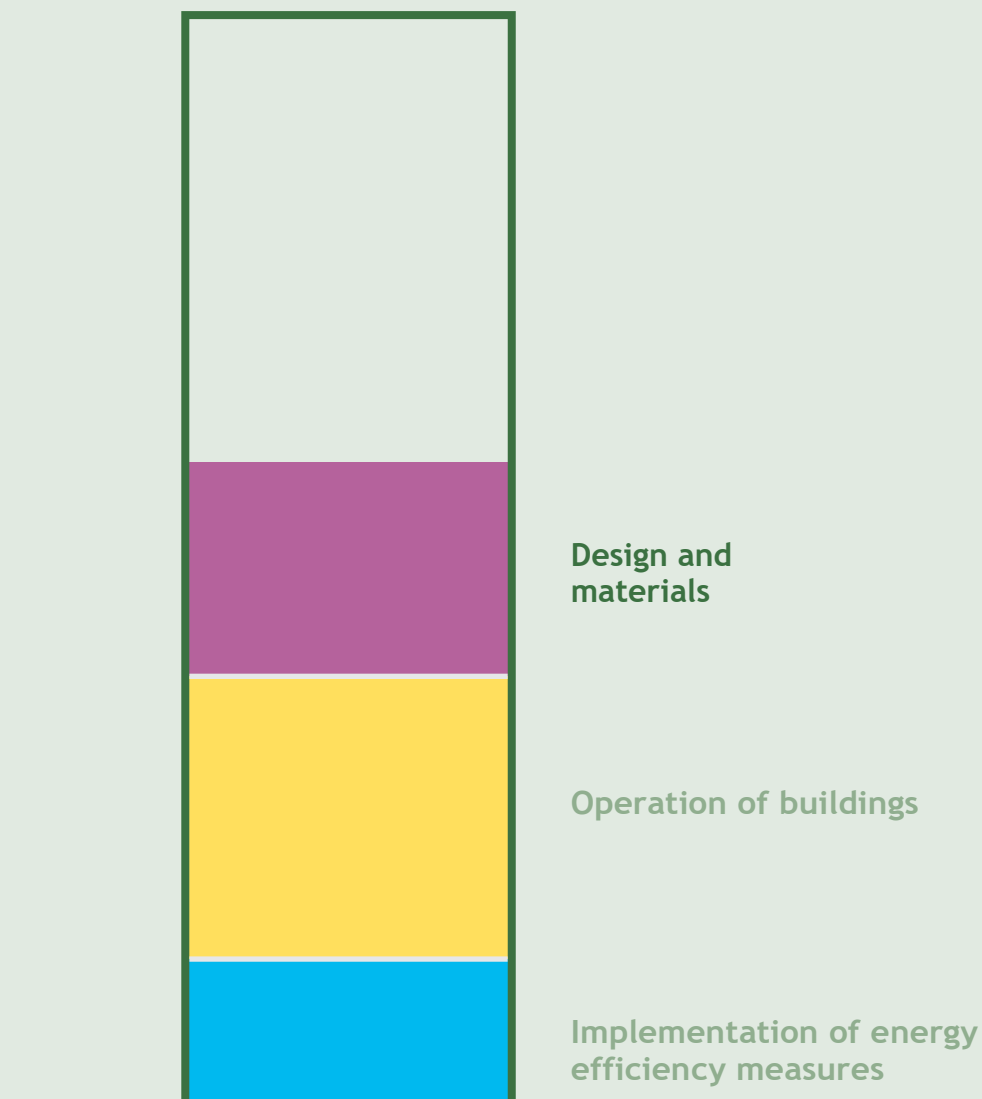
## Other initiatives for CO<sub>2</sub> reduction from operation of buildings

1. **Strengthen the possibilities for internal use of surplus heat**  
Surplus heat should also be used to avoid energy waste.
2. **Create easier access to energy data**  
Data on ongoing energy consumption strengthens the assumptions for optimising the operation.
3. **Strengthen ongoing service of buildings**  
The energy consumption of buildings increases over time if the technical installations are not maintained.
4. **Use buildings for storage of energy**  
With increasing quantities of fluctuating RE in the energy system, buildings must act as energy storage and balance consumption.
5. **Make energy sources competitive**  
Bring down barriers that discriminate CO<sub>2</sub> friendly energy types.
6. **Adjust tariff structure and payment of electricity, gas and district heating**  
The consumers' payments of energy should support flexible consumption and implementation of energy efficiency measures.
7. **Adapt the building regulations and strengthen compliance**  
The rules of the construction industry must ensure a low climate footprint and low energy consumption. The compliance is inadequate, and contravention is sanctioned too seldom.
8. **Focus on overall economy**  
Too much construction and renovation are completed with the focus on the lowest possible construction price and not on long-term operating efficiency and climate impact.
9. **Let the public and social housing sectors lead the way**  
Speed up the development by letting the public sector and the non-profit housing associations lead the way.

## Wishes for the Government

1. **Set targets for implementation of energy efficiency measures**  
It is a cornerstone in the green transition, and socio-economically beneficial to reduce energy consumption by 20-26% until 2030. The energy saving efforts have been under-prioritised for years.
2. **Clarify the future of natural gas**  
There is a need to get an overview of when the phasing out will take place in the individual areas and having a good and predictable framework for the transition for the building owners.
3. **Adapt energy taxes**  
Taxes should reflect the climate footprint and promote investments in implementation of energy efficiency measures and flexibility.
4. **Use public buildings and social housing as drivers**  
Innovation and development are among other things created through increased use of overall economy and renovation requirements.
5. **Use the building regulations**  
The rules should support the 70% target, and there is a need to strengthen compliance.
6. **Strengthen the overview of building owners**  
Strengthen access to energy data with clear guidelines, standards and instructions.

**5,800,000** tonnes of CO<sub>2</sub> per year







Multi-story housing construction in the Port of Aarhus.

# Design and the CO<sub>2</sub> content of materials in buildings

## Potential in new construction

10% of the CO<sub>2</sub> emission stems from production of building materials, and within new construction it can be reduced by 50% in 2030 through increasing focus on design and use of building materials.

Requirements in the building regulations and the upcoming sustainability class must be used to promote the development. The requirements must be made now and increased step-by-step until 2030.

About 80% of the reduction takes place in that the industry, before 2030, builds at the best known sustainability level in 2018. That requires that tools for implementing life cycle analyses (LCA-Byg) are completed and form part of all stages of the construction and in all construction work.

The last part of the reductions is made by implementing new innovative solutions, putting them into use as soon as possible, and by building material producers generally basing their production on greener energy mix. That takes place, i.a. by using new demo construction works as reference construction for industry.

LCA must be put into use in case of large renovation projects where it will also promote the recycling of materials. The potential for reducing CO<sub>2</sub> in renovation has not been estimated due to lack of data.

## Barriers can be broken down

The building industry is ready to use LCA in construction already now, and there is some knowledge and experience in Denmark and abroad. However, the building industry is fragmented, and there is a need to increase the skill level in all elements of the chain, and in both large and small businesses. Most of the industry's barriers are removed most easily by making demands for LCA calculations and about maximum CO<sub>2</sub> in the construction work, starting with 8.5 kg CO<sub>2</sub>/m<sup>2</sup> per year in the sustainability class and 12 kg CO<sub>2</sub>/m<sup>2</sup> per year in the building regulations. The requirements will be increased towards 2030.

20 initiatives with an estimated potential of

**1,130,000** tonnes of CO<sub>2</sub> per year

Estimated implementation: 2021-2030

## Top 5 initiatives

- 1 Use of life cycle analyses (LCA) and targets for CO<sub>2</sub> in tender material.**  
From 2020, the public sector and large owners make demands for LCA calculations, use of environmental product declarations and documentation of the construction.
- 2 Project-specific climate accounts in all tenders.** The industry develops and uses project-specific climate accounts in tender material.
- 3 Reduction of material consumption and CO<sub>2</sub> emission in design** Advisers and performers optimise with focus on use of land, recycling and materials with a low CO<sub>2</sub> footprint in the entire useful life of the building.
- 4 Development of a data basis for LCA in construction**  
The industry develops a transparent data basis as the foundation for statutory requirements regarding LCA in the construction.
- 5 Development of the sustainability class and revision of technical joint property** The sustainability class must make demands of maximum 8.5 kg of CO<sub>2</sub>/m<sup>2</sup> per year. Useful lives and other technical joint property must be updated, such as guidelines, contractual bases, norms etc.

Removing barriers entails that public authorities take responsibility to ensure:

- **Better data**  
The available data basis is limited and must be developed together with industry.
- **Better tools**  
The available tools (LCA-Byg) have been developed on an ad hoc basis and with private grants from foundations. There is a need to accelerate the development with the support and quality control from public authorities, and assistance with the use of tools by small and medium-sized businesses.
- **Recycling and re-use**  
Functional requirements in the legislation may be a barrier to the reduction of CO<sub>2</sub>, for instance by increasing material consumption or preventing new innovative solutions.

Altogether, towards 2023 there will be a need for public investments at DKK 35 million for development of data basis, tools, scrutiny of statutory requirements and revision of technical requirements and a support office for SMEs.

### Demonstration and innovation should be promoted

Advisers and producers of materials must increasingly use materials with a low CO<sub>2</sub> footprint in a life cycle perspective, reduce material consumption, use recyclable materials, optimise calculation methods, use new innovative solutions, share knowledge and contribute to developing technical joint property.

We must have more construction work that is designed with materials with a reduced CO<sub>2</sub> footprint in order to develop reference construction for the industry. The public sector and large owners must lead the way and invest in demo construction work.

### The sustainability class in play now

The upcoming voluntary sustainability class for construction supports the entire process. It can promote the development of the construction work and Danish export opportunities as was previously the case in relation to the voluntary low-energy classes of the building regulations.

The sustainability class should be seen as a regulation aspect. It must be possible to allow for solutions with long lifecycles. Already now, there should be a target for maximally 8.5 kg CO<sub>2</sub>/m<sup>2</sup> per year. Clear targets in the sustainability class will motivate the industry to innovate.

### Vision and ambition

By 2030, the embedded CO<sub>2</sub> in materials will be reduced by 50% seen in proportion to 2018. That has occurred by increasing demand for constructions with a lower CO<sub>2</sub> footprint:

The sustainability class must set out requirements for a maximum of CO<sub>2</sub> emissions in all phases of the new con-



*Requirements for materials and energy must be balanced with indoor climate requirements.*

struction. The requirement is set to 8.5 kg CO<sub>2</sub>/m<sup>2</sup> per year from 2021 and increased in 2023, 2025 and 2030

The building regulations must also make demands for a maximum of CO<sub>2</sub> emissions in all stages of the construction work. The demand starts at 12 kg CO<sub>2</sub>/m<sup>2</sup> per year in 2021 and is used to sort out the most CO<sub>2</sub> burdensome projects. The requirement will be increased step-by-step towards 2030. From 2023, LCA calculation and maximum CO<sub>2</sub> emissions become an alternative to energy calculation.

The public sector and large owners have led the way by using the sustainability class as a reference. Building societies, private owners and advisers have followed suit, when from 2020 financing models had already been developed to promote new construction with a low CO<sub>2</sub> footprint and use of climate accounts and contribute to those in charge of project work, advisers and performers use LCA by default in all stages of the construction work.

Already in 2021, the necessary tools and guidelines will have been developed to carry out a transparent LCA calculation for the construction work in its entire useful life. There will also be sufficient data to make CO<sub>2</sub> requirements for the entire useful life of the construction work. All tools and methods have been developed in collaboration with relevant government agencies, experts and representatives of the construction industry. Methods are developed in accordance with European methods, including EN 15804.

Producers of materials and industries have also developed the required environmental product declarations (EPD) which are subject to relevant control and traceability of data and which prepare material passports. Municipalities and private owners have established demo platforms that contribute to innovative and optimised construction.

# 1 Dissemination of LCA and targets for CO<sub>2</sub>

The public sector and large owners must set CO<sub>2</sub> targets for the total construction during its useful life in connection with tenders and make demands for the use of LCA calculations in order to document compliance with the demands.

This is made visible in climate accounts which are also an element of the requirements of the tender material. Thus, the owner encourages the players of the construction work to undertake responsibility and each contribute to the total reduction.

Digital, product-specific environmental product declarations for the most substantial building parts and material passports and building passports must be in demand.

Estimated effect of the initiative

**608,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2020-2030

The voluntary sustainability class sets up ambitious requirements from 2021. The state, municipalities and private owners use these in bids and in the development of local plans.



Typical standard house built for low energy class 2015.

# 2 Project-specific climate accounts in tenders

An industry standard is developed for project-specific climate accounts based on LCA calculations of the entire construction work and of materials and a building passport.

The requirement for use of climate accounts is incorporated into tender material, including requirements for ongoing follow-up through the stages of a project, which oblige the adviser and contractor to inform the owner about the total CO<sub>2</sub> footprint.

The tool LCA-Byg is used to develop data so that the building process is optimised. That will reduce waste and CO<sub>2</sub> emission in all stages and increase the possibility of reuse and recycling.

Estimated effect of the initiative

**304,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2023-2030

Requirements are used to create demand for product-specific environmental declarations for the most substantial building parts.



### 3 Reduction of consumption of materials and CO<sub>2</sub> emission in design

The public sector and large owners must contribute to the demo construction work which demonstrates proposals for solutions based on CO<sub>2</sub> targets for the building in its entire useful life.

Municipalities and private owners can promote demo constructions in collaboration with advisers and suppliers.

The LCA-Byg tool must be used to develop new solutions. All actors must work towards the same CO<sub>2</sub> targets/m<sup>2</sup> by means of a standardised LCA procedure.

The voluntary CO<sub>2</sub> targets must help the construction actors avoid over-dimensioning and waste, plan

Estimated effect of the initiative

**220,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2021-2030

optimal logistics at the building sites and choose materials with a minimal CO<sub>2</sub> footprint in its entire useful life.

The initiative will make demands regarding purchases and the supply chain and is estimated to contribute 1% reduction per year towards 2030.

### 4 Development of underlying data and systems

An effort to reduce targeted embedded CO<sub>2</sub> in materials starts with the development of reliable data.

Reliable data is a basic assumption for transparency, traceability and effective documentation of construction products, including product-specific environmental product declarations and materials passports.

The CO<sub>2</sub> emission from the construction is best minimized by building energy and resource efficiently and looking at the entire useful life of the building. LCA and data must be developed to support this.

Estimated effect of the initiative

**Enabler for reduction of targets**

Can be implemented: 2020-2022

A basis and market for recycling and reuse of materials must be created so that construction industry actors can choose materials that contain recycled materials and can be circulated efficiently.

Materials liberated in demolition must be reused or recycled as materials of new products.

### 5 Development of the sustainability class and technical joint property

Authorities and the construction industry use the sustainability class to develop construction and ensure the content of all material parameters for sustainable construction work.

Authorities and the industry must work for the development of the right framework conditions and guidelines, and that experiences are made available in BBR (the Danish Buildings and Homes Register), energy label and other databases.

The industry will influence and support the updating of technical joint property (contractual basis, norms, BYG-ERFA) and will enter into cooperation to look

Estimated effect of the initiative

**Enabler for reduction of targets**

Can be implemented: 2020-2022

into legal requirements in construction, including revision of security factors, labelling schemes, norms etc.

The industry works for the visual profiling of particularly sustainable construction work, e.g. in that DGNB makes projects that especially reduce the CO<sub>2</sub> emission per m<sup>2</sup>, visible.



Project: FBAB Lisbjerg for Al2bolig. Architect: Vandkunsten. Photo: Helene Hoyer Mikkelsen

## Other initiatives for design and the CO<sub>2</sub> content of the material in buildings

### Use LCA in all stages

1. Owners and advisers use product-specific EPDs
2. Owners use climate accounts and set targets for CO<sub>2</sub> levels and reuse - waste must be rendered visible
3. Increased documentation of construction
4. Develop an industry manifesto for sustainable construction

### Climate accounts to be put up to tender

5. Develop and use industry standard for climate accounts in tenders and BBR
6. Reference targets for CO<sub>2</sub>/m<sup>2</sup>
7. Procurement rules are scrutinised

### Reduce consumption of materials

8. Set CO<sub>2</sub> targets for all construction work and renovations
9. Design circular construction with focus on resource-demanding building parts and reducing waste
10. Use LCC-Byg as a calculation tool and employ existing frameworks for overall economy

### Tools

11. Develop product-specific EDPs, material passports, digital building passport and EDP at system level
12. Develop structure and standards for reuse and flow of material for recycled materials
13. Producers set targets for resource consumption and consider a Product Service System where feasible
14. LCA-Byg must be further developed into a standard tool on par with BE15 and include waste in LCA
15. Strengthen the international standardisation work

### Update technical joint property

16. Documentation and traceability of the resource consumption of the construction are included in public databases
17. Develop reference buildings
18. Develop a replacement database
19. Update guidelines, lists of examples and calculation models
20. Change calculation rules for construction work, i.a. safety coefficients and calculation of areas.

## Wishes for the Government

### Legal framework

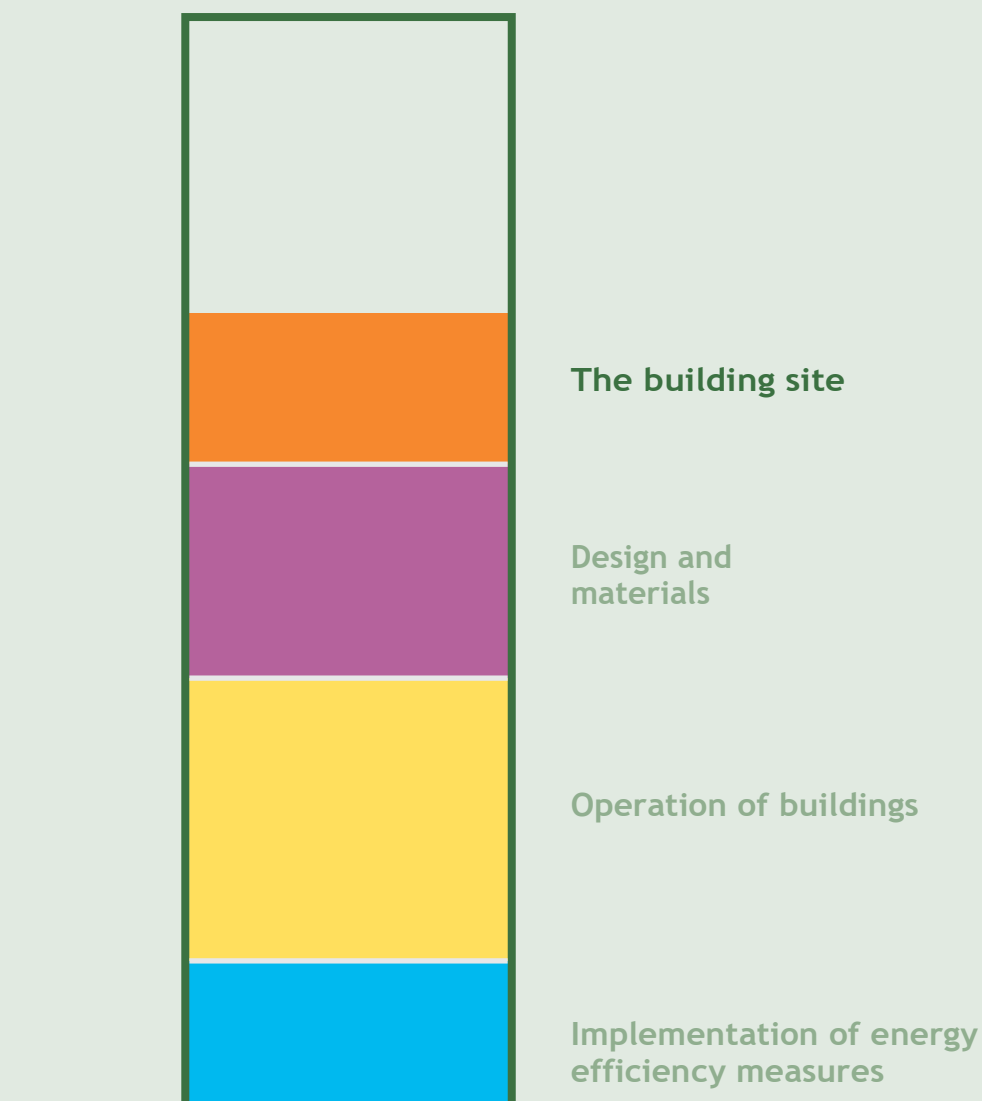
1. Implement a sustainability class with a total CO<sub>2</sub> target for all stages of LCA
2. Set out CO<sub>2</sub> requirements in the building regulations and use them as an alternative to energy requirements in the building regulations from 2023
3. Climate accounts in the Public Procurement Act
4. Make demands for use of LCA as a documentation basis
5. Identify barriers for the use of wood, including fire requirements
6. Develop model requirements and reference building for CO<sub>2</sub>

7. Support the development of experimental construction
8. Update primary energy factors on an ongoing basis

### Financial incentives

9. Identify how incentives can be created to reduce embedded CO<sub>2</sub> in the construction, among other things by foundations making demands for CO<sub>2</sub> levels in connection with subsidies for construction and that the framework amount increased for subsidised construction with a low CO<sub>2</sub> footprint
10. Municipalities and public owners should support the development.

**5,800,000** tonnes of CO<sub>2</sub> per year







# CO<sub>2</sub> reduction at the building site

## The CO<sub>2</sub> free building site is a possibility

Today, there are a number of CO<sub>2</sub> sinners at the building sites, i.e., large diesel-powered machines, building waste, damaged or erroneously ordered materials and diesel generators to hot air generators that run continuously to dehydrate the construction work and render working conditions acceptable.

With the proper technology, planning and a long haul towards other habits and collaborative relationships, we can rid ourselves of the sinners and remove the vast majority of the CO<sub>2</sub> emissions from building sites before 2030.

The majority of the initiatives that we describe are “known materials”. A number of large businesses already have good experience from e.g. halving the fuel consumption in digging machines based on hybrid technology and reducing the waste of materials by 50% from the first house until the last house which is erected.

The good cases show that CO<sub>2</sub> and economy thrive together. But there is still a long way to the CO<sub>2</sub> free building site.

## Price focus and practical barriers

The good examples we have found all stem from large actors in the construction industry. But the vast majority of businesses at Danish building sites are businesses that focus on delivering the ordered construction work on time, at the agreed price and to the agreed quality. Most opinions reveal that CO<sub>2</sub> is not a focus.

The construction market is, to a wide extent, based on the cheapest price. Proposals that make the work more difficult without gains in relation to time, price or quality cannot function without demands from owners, incentives or through legislation, so that all players in the industry are put on an equal footing.

*\*the initiatives are based on savings in relation to the current stage. Electricity is considered CO<sub>2</sub> neutral in all initiatives.*

6 initiatives that can save

**850,000** tonnes CO<sub>2</sub> per year\*

will be implemented from 2021-2030

## Top 6 initiatives

- 1 Enabler- setting up power supplies at the building site**  
Setting up electricity (and district heating) at the building site before the construction commences, removes energy consumption from diesel to green energy.
- 2 CO<sub>2</sub> free dehydration and heating**  
Greener energy for heating and dehydration and focus on closing early.
- 3 Fossil-free production equipment at the building site**  
Moves all energy consumption to fossil-free energy sources such as electricity and biodiesel (for a transition period).
- 4 Enabler - CO<sub>2</sub> accounts for the building site**  
Requirements for CO<sub>2</sub> accounts promote the reduction of CO<sub>2</sub> at the building site.
- 5 Fewer materials and less waste**  
With consideration, we can reduce waste and the quantities of waste - and over time be better at reuse.
- 6 Better planning and procedure at the building site**  
Better planning of the building process and the building site minimises CO<sub>2</sub> emissions.



## Challenges can be dealt with, but it does not happen automatically

It requires a broad range of solutions to as many challenges to reach the finish line:

- **We must know the emission through CO<sub>2</sub> accounts**  
Accounts will require that the industry reach a common goal. But it requires tools that are easy to use and more knowledge which we do not have now. Assisted by CO<sub>2</sub> accounts, detailed planning of procedure, materials and logistics will lower the CO<sub>2</sub> emissions.
- **Electricity at building sites**  
Electricity will convert diesel consumption into green electricity (or district heating), but that requires that the utility companies become faster at delivering the necessary supply so that the energy-intensive dehumidification and heating are limited.

- **Save and reuse materials**  
Good for the CO<sub>2</sub> accounts, but it takes time. The materials must be dismantled with care and find new owners. Recycled materials can have changed properties (e.g. wood does not have the same strength, or the materials may have absorbed substances dangerous to the environment or health). It requires that we know what we are doing and adapt the legislation.
- **An end to diesel for construction equipment**  
Most can already be powered on biodiesel, but biodiesel is more expensive. Electricity/battery powered machines are still in the making, and in many cases they cannot be delivered yet. There is a trend for good financial/CO<sub>2</sub> win-win situations, and in Denmark we would like to be the showcase.

With the six initiatives, we can reduce the CO<sub>2</sub> emissions from building sites significantly. The initiatives 1 and 4 are so-called enablers, which do not in themselves have any CO<sub>2</sub> impact, but are basic conditions for the other measures to be able to have full effect.



# 1 Electricity and district heating at the building site

Electricity supply and district heating at the building site make it possible to convert machines and dehumidification into CO<sub>2</sub> neutral propellants.

An adequate electricity supply and established district heating plugs for building sites are no matters of course when a building site starts. If it were, the energy consumption could be converted from all types of machines and from dehumidification and heating into green energy types.

Therefore, it is suggested that demands are made for an adequate electricity supply and district heating (where possible) before the building site

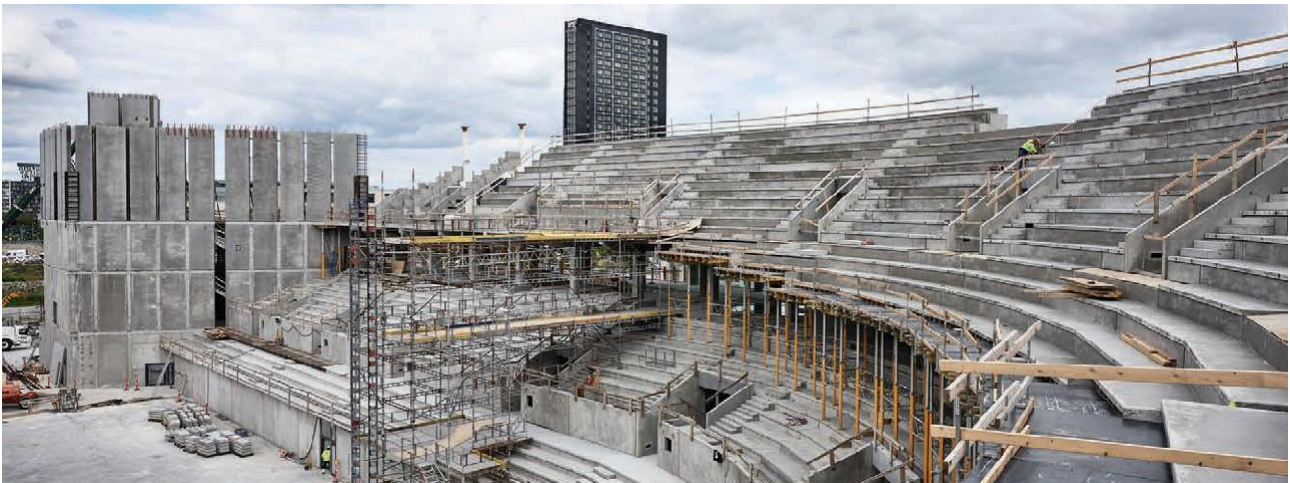
Estimated effect of the initiative

**Enablers to other measures**

Can be implemented: 2021

commences. The initiative does not cover construction of e.g. bridges and roads.

That will imply changes to the planning before commencement and propellant requirements for tools and machines as well as demands on the utility companies for timely delivery.



# 2 CO<sub>2</sub> free dehumidification and heating

A large share of the energy consumption in the building process can be CO<sub>2</sub> free.

In the building process the consumption is what corresponds to two or four years of heating of the subsequent construction work. The vast majority of the energy consumption is used in dehumidification of moist materials and heating of the construction.

There are good possibilities of obtaining CO<sub>2</sub> neutral dehumidification and heating by:

- Demanding heating and dehumidification by means of electricity or district heating
- Placing isolated site accommodation in clusters to be heated with heat pumps
- Using concrete elements which have been dehumidified and concrete types with a smaller water content

Estimated effect of the initiative

**75,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2021

- Covering constructions so that they are not exposed to precipitation thus needing subsequent dehumidification
- Demanding permanent or isolated windows and doors before dehumidification
- Planning dehydration outside the winter season and close shells in the winter
- Create incentives for savings, such as payment of energy consumption at the building site.



### 3 Fossil-free production equipment at the building site

There is large potential in converting construction vehicles into fossil-free energy.

Diesel is the primary propellant in the machines at the building site. By converting to fossil-free propellants, we can remove both CO<sub>2</sub> and air pollution.

It is proposed that:

- small machines of less than 75 kW may only be powered by electricity/battery from 2025
- large machines of more than 75 kW may only be powered by electricity, batteries or fossil-free fuel, such as hydrogen, by 2030 at the latest. For a transitional period leading up to 2030, the barriers (price)

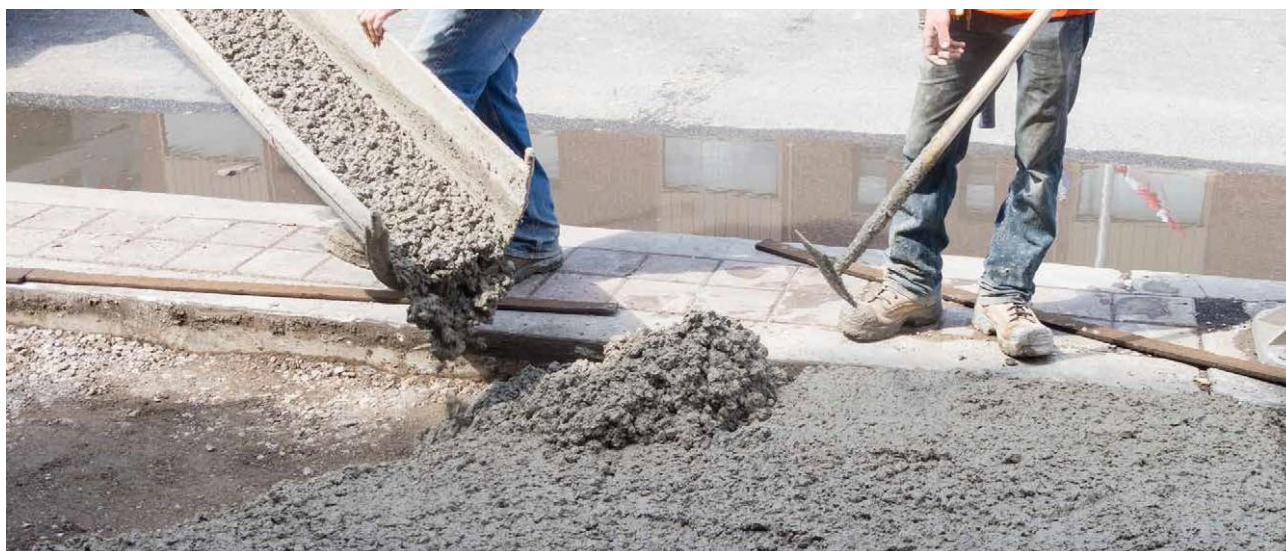
Estimated effect of the initiative

**275,000\*** tonnes CO<sub>2</sub> per year  
Estimated implementation 2021-2030

for biofuels must be removed.

That will require a strategy for an implementation of CO<sub>2</sub> neutral propellants, including taxes.

\* The impact of the initiative constitutes 60% of a total effect at 442,500 tonnes CO<sub>2</sub> for the three part initiatives concerning machinery as calculated and detailed by working group 5.



### 4 CO<sub>2</sub> accounts for the building site

CO<sub>2</sub> accounts for the building site strengthens the focus on CO<sub>2</sub> of all parties.

When we know the CO<sub>2</sub> emissions from a building site, we can make efforts in the right places, e.g. by reducing orders made in error, ensuring building materials in due time and location and reusing building waste in a circular way.

It is suggested that demands are made for CO<sub>2</sub> accounts for all large building sites.

But doing it is not so easy. The calculation:  $CO_2 \text{ for purchased materials} \div \text{returned goods and (minus any deductions for materials that can be reused)} + CO_2 \text{ for transportation of materials} + CO_2 \text{ for energy}$

Estimated effect of the initiative

**Enabler to other measures**

Can be implemented: 2022

*consumed at the site including builders' vehicles ÷ CO<sub>2</sub> for built-in materials* is not possible today, and will quickly become a large administrative cost. To get the most out of the efforts, the CO<sub>2</sub> accounts should be closely connected to a life cycle analysis (LCA). In the long term, targets should be made for the CO<sub>2</sub> emission of building sites, and a tool for the calculation of CO<sub>2</sub> should be developed.

## 5 Less waste from the building site

There is great potential in changing habits and plans for recycling and reusing more on building sites.

About 7-15% of the total material consumption in building sites ends up as waste. That contributes to creating the 4.5 million tonnes of waste per year from the construction industry.

It is suggested that a better nationwide structure be established for the reuse of waste so that it becomes easy to sort for recycling and promote a circular economy. In general, more knowledge and experiences are needed if we are going to increase reuse and recycling of materials in the building industry to a large extent.

Estimated effect of the initiative

**200-600,000** tonnes CO<sub>2</sub> per year

Step-by-step implementation

Much of the initiative is also about habits such as ordering the right quantities and sizes, being more careful with the materials and using the waste better. The initiative is to a large degree promoted by the CO<sub>2</sub> accounts.



## 6 Optimised planning and layout of the building site

Better planning reduces CO<sub>2</sub> emissions at building sites.

Better planning of the layout of the building site and material flow give rise to a better building procedure with fewer errors, efficient use of materials and manpower, a lower CO<sub>2</sub> footprint, lower costs, better collaborative relations and a shorter building period.

It is suggested that the planning is strengthened by:

- ordering “bits and pieces” which you would otherwise have to drive extra to collect
- using digital warehouse containers to ensure that the right building materials are present
- planning in detail to a larger extent, such as the size of gypsum boards to get the best use

Estimated effect of the initiative

**100,000** tonnes CO<sub>2</sub> per year

Can be implemented: from 2021 to 2030

The industry itself can make an effort to improve habits and further incentives so that the one who makes the planning also gets a share of the profit. Requirements for CO<sub>2</sub> accounts will also be of help.



## Other initiatives for CO<sub>2</sub> reduction at the building site

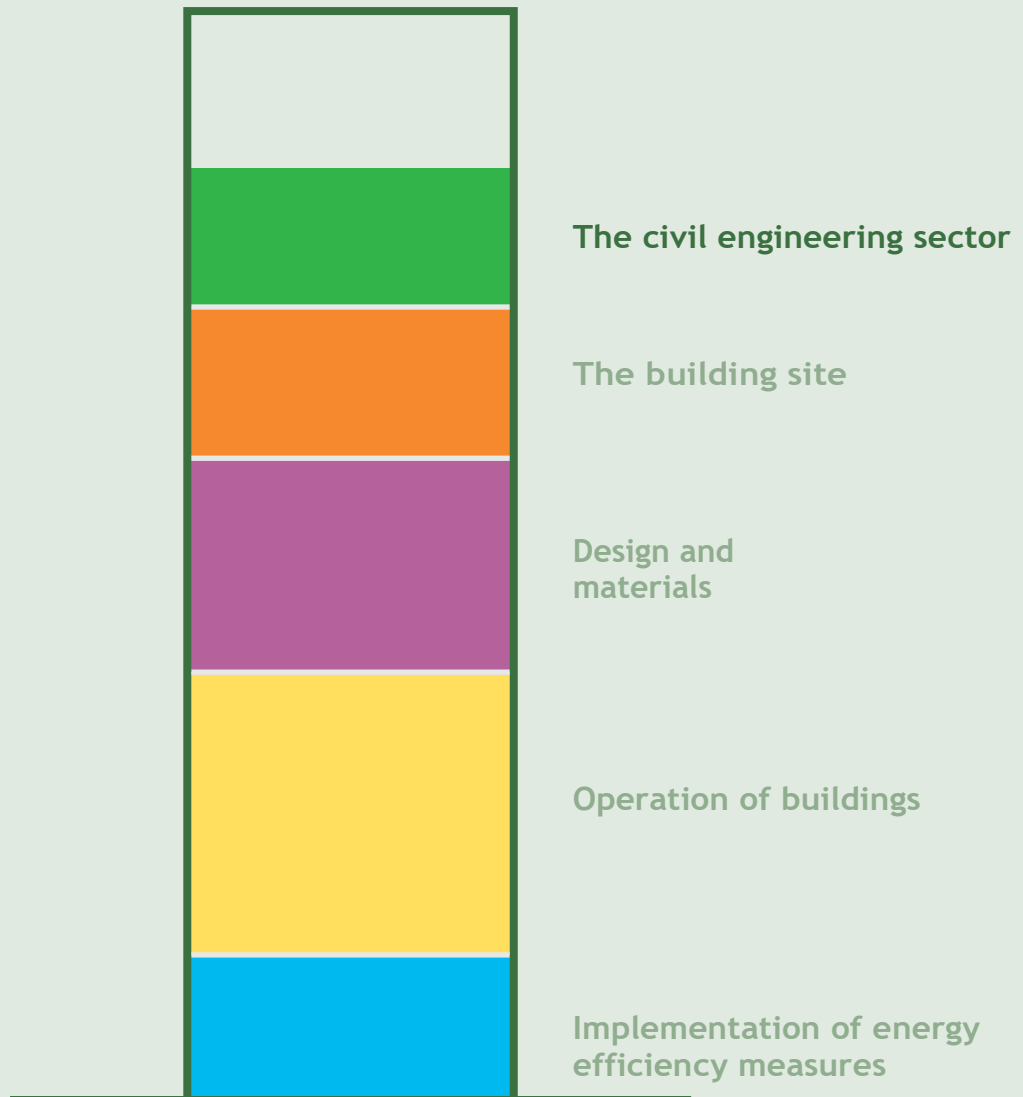
- Plan ordering of electricity and district heating for sites in due time
- Convert machines and equipment into fossil-free fuel or electricity/district heating
- Plan site accommodation in clusters and with heat pumps or district heating
- Plan the use of concrete elements (which have been dehydrated) and concrete types with a smaller water content
- Cover constructions so that they are not exposed to precipitation thus needing subsequent dehumidification
- Plan and install permanent or isolated windows and doors before dehumidification
- To the extent possible, try to avoid construction in the wintertime which requires dehumidification. Construction in the winter period should be made indoors
- Participate in establishing frameworks for CO<sub>2</sub> accounts for the building site to get the largest effect with as little trouble as possible.
- Incorporate incentives in tenders, such as calculation methods for saving energy at the building site. Focus on CO<sub>2</sub> - also before it becomes a requirement. There is both CO<sub>2</sub> and money to obtain. For instance, plan which size of gypsum boards provides the best use, or order pre-fabricated boards in case of repeated work
- Order and spend the required time on planning of general logistics, such as location of cranes, access roads and placing of materials
- Order and spend the required time on planning the flow at the building site, including which materials should be used when
- Carry out weekly planning when plans for the upcoming weeks are matched against materials, and “bits and pieces” are ordered which you would otherwise drive extra to collect. Or use digital storage containers at large building sites; they are getting a foothold now.

## Wishes for the Government

1. The utility companies must establish (green) power supply and district heating (where possible) at building sites for six to eight weeks. Time: now
2. Dehydration of building and building elements may only take place by means of electricity/district heating. Time: now
3. Small machines of less than 75 kWh should only be driven by electricity. Time: from 2025 (to be decided now)
4. Large machines of more than 75kWh must be powered by fossil-free propellants before 2030. For a transitional period, the barriers for biofuels must be removed
5. Requirements for CO<sub>2</sub> accounts for all construction work (more than a trivial limit)
6. Systematic basis assumptions for reuse of materials across the country
7. Remove legislative barriers to trade and distribution of recyclable construction products
8. Let the public sector lead the way with requirements for CO<sub>2</sub>-saving planning of public buildings and building sites
9. Create knowledge and share experiences about CO<sub>2</sub> consumption and re-fitting of materials.



5,800,000 tonnes of CO<sub>2</sub> per year





# CO<sub>2</sub> reduction in the civil engineering sector

The civil engineering sector uses many energy-intensive materials and large machinery

For the past years, the investment level in the construction market has been about DKK 50 billion including municipal road maintenance and the Danish Road Directorate's operation and winter services.

The CO<sub>2</sub> footprint for the civil engineering primarily comprises two individual areas:

- The activity at the building site by using materials and machines
- Use of the dominating types of material, asphalt and

Therefore, there has been special focus on CO<sub>2</sub> reductions in these areas, but of course also contemplation of processes, other types of material etc.

Based on the work, a wide range of initiatives have been identified, which have been boiled down to 17 particularly interesting initiatives.

The condition for the selected initiatives in the civil engineering sector was that they:

- would involve larger potential for a reduction of the carbon footprint
- could be implemented by 2030.

## What is the civil engineering sector?

The civil engineering sector performs construction work including motorway bridges, port facilities, pumping stations, road systems, surfacing, draining, supply plants and special products.

17 initiatives with an estimated potential of

**683,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

## Top 5 initiatives

- 1 Fossil and emission-free plant machinery**  
New production equipment is being developed so that it will be emission-free during the 2020s.
- 2 Transition to electric vehicles on the roads**  
The majority of the civil engineering sector's fleet of vehicles can be powered by electricity in 2030.
- 3 Use new types of cement with fewer cement clinkers**  
It may reduce the load of carbon footprint by production of cement by 30%
- 4 Climate-friendly asphalt**  
Climate-friendly asphalt reduces the rolling friction of the road, so that less fuel is used in road traffic.
- 5 Robots, Additive Manufacturing and digital twins**  
More technologies that are capable of contribution to a lower CO<sub>2</sub> footprint will gain ground within the next 35 years and may comprise 30-40% of the production before 2030.



## The possibilities of the industry

### Common visions

Large parts of the CO<sub>2</sub> emissions of the construction work stems from the use of concrete. Therefore, climate partnerships have worked together with the concrete industry, and its vision about a 50% CO<sub>2</sub> reduction from 2019 to 2030 is fully consistent with the vision of the civil engineering sector.

### Machines and equipment.

With contributions from all the significant actors (owners, contractors, advisers and lessors of machinery), the industry has fine opportunities of activating the potential of CO<sub>2</sub> reductions from the use of materials and machinery at the building site.

Of course, it is very obvious that conventional diesel-driven machines are not used. Electrically powered machinery is the target, but it requires replacement of the equipment, and as regards the largest machines the conversion to electricity will entail considerable development work, which is not likely to take place within a short time horizon. In a transitional period the use of biofuel can reduce the carbon footprint considerably. Most diesel-powered machines can be converted to use biofuel without significant changes.

### Types of material.

When the construction work is so material-intensive, it is of great importance that the producers of materials, in particular within concrete and asphalt, continue to improve production methods and develop more climate-friendly materials.

### Digital tools and design.

However, it is not solely technical changes of the machines with conversion to more climate-friendly propellants that involve interesting potential of CO<sub>2</sub> reductions.

The use of digital tools and models in connection with design and performance of construction work has considerable possibilities of optimising the projects so that the construction work is minimised, and machines can perform the works with much less hour consumption and consequently a smaller carbon footprint.

## The influence of the civil engineering sector in other areas

Initiatives in the civil engineering sector with a modest impact on the direct carbon footprint can have a large effect on other areas. The transition to climate-friendly asphalt not only has a positive effect in the civil engineering sector, but also for the cars that are driving on the roads, because lower rolling friction gives less fuel consumption and thus a smaller CO<sub>2</sub> emission.

Another example is climate proofing, because carefully prepared construction work for protection against floods can be performed at a much lower CO<sub>2</sub> footprint than the carbon footprint connected with dehumidification, renovation, demolition and rebuilding of houses and construction work after the many more and more dramatic floods which are also expected in the years to come.

## Legislation, barriers and incentives

The construction industry has considerable possibilities, by means of new processes, of improvement of materials and use of digital tools to reduce the carbon footprint. However, in some areas there may be a need to create incentives, make demands or create the necessary framework conditions.

Thus, there will be a need that public and private owners base the projects on, and make demands for the use of digital solutions and other CO<sub>2</sub> reducing processes. The requirements can be supplemented so that it becomes mandatory to prepare CO<sub>2</sub> accounts and a low carbon footprint will have a vital importance for granting the assignments.

Among the framework conditions, it is important that no requirements are made for use for machines that are powered by biofuel or electricity, without:

- an investment possibility being provided
- the necessary biofuel being available
- the necessary charging points being established.

It will therefore be necessary that political decisions ensure the availability of CO<sub>2</sub> friendly energy and perhaps through fiscal legislation promote conversion into electricity as a propellant.



# 1 Fossil fuel and emission-free plant machinery

New machines are developed so that the production equipment can be emission-free during the 2020s.

In the transition period to electricity, alternative propellants are used such as biogas. There will be a need to adapt taxes, create security of supply of bio propellants and improve charging points.

The development must be driven by requirements, at first for the four environmental zone cities, and later by requirements in tender material from the state and municipalities for fossil-free and emission-free construction work.

In addition, there must be focus on user conduct.

Estimated effect of the initiative

**177,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

CO<sub>2</sub> on the construction sites and mandatory training of machine operators will reduce the fuel consumption of the machinery.

It will further the development if the environmental zone legislation in Denmark will comprise EU's stage norms for construction machinery.



# 2 Transition to electric vehicles on the roads

Most of the car fleet of the construction industry can be converted into electrically powered vehicles with the existing technology.

The large car fleet of the construction industry (personnel carriers, platform trucks and ordinary cars) are driven by diesel and petrol to a large degree. A transition to electrically powered vehicles can give rise to considerable reductions in the emission of greenhouse gases.

The conversion can be made on an ongoing basis in line with the replacement of the car fleet, and that there will also be more and more choices for electrically powered vehicles.

The gradual replacement of the car fleet can be made on an ongoing basis from 2021 and be con-

Estimated effect of the initiative

**162,000** tonnes CO<sub>2</sub> per year

Can be implemented 2030

cluded in 2030 when the technological development is expected to render it possible to also convert the largest vehicles to the effect that all diesel and petrol-powered vehicles will be phased out.

### 3 Use new types of cement with a smaller contents of cement clinkers

New alternative materials for replacement of cement clinkers can reduce the carbon footprint in the production of cement by 30%

The production of cement for concrete constitutes about 90% of the total CO<sub>2</sub> emission of the concrete. The CO<sub>2</sub> emission from the production of cement stems both from the energy consumption for heating of the ovens and from the chemical process that takes place when chalk is heated and transformed into cement clinkers.

Aalborg Portland A/S develops new alternative materials that can replace about 30% of the cement clinkers. The materials are produced at lower temperatures,

Estimated effect of the initiative

**146,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

so that the total CO<sub>2</sub> footprint is reduced by 30%.

The new cement type is covered by the European cement standard, but it has not yet been approved by Danish concrete standards or road regulations.

### 4 Climate-friendly asphalt

Climate-friendly asphalt (KVS) reduces the rolling friction of the road and hence reduces the CO<sub>2</sub> emission from the road traffic due to savings of the quantity of fuel.

It is suggested to use climate-friendly asphalt (KVS) in both the national road network and the municipal 'high-class' roads which can be done without relaxing traffic security or the durability of the surfacing.

On the part of the politicians, there is a need for acceptance of an increased budget for construction of roads by the use of climate-friendly asphalt. By contrast, already from day no. 1, savings are obtained in the consumption of fuel and the CO<sub>2</sub> emissions.

Estimated effect of the initiative

**57,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

KVS also has a longer expected useful life than standard asphalt, which in the long term will lead to further CO<sub>2</sub> savings and savings for maintaining and replacing asphalt.

After 2030, the savings potential is expected to be even larger.

### 5 Digital solutions

More technologies that can contribute to a lower CO<sub>2</sub> footprint will gain ground within the next three to five years, and can constitute 30-40% of the production before 2030.

This applies to i.a. robots and Additive Manufacturing, which can build items layer by layer. In 2030, efficient use of robots and Additive Manufacturing can potentially reduce the material consumption by about 30 %, reduce waste from 8% to 2% and reduce transportation by more than 40%. There is also potential in digital twins, virtual mirroring of physical assets that

Estimated effect of the initiative

**50,000** tonnes CO<sub>2</sub> per year

Can be implemented: 2030

collect data to optimise use and operation. Cases from the construction industry and off-shore indicate that digital twins can save 5% of the costs of construction and the consumption of materials and 10% of energy and resource consumption in operations.



## Other initiatives for CO<sub>2</sub> reduction in the civil engineering sector

1. Use less cement in concrete for construction work
2. Use new types of cement with fewer cement clinkers
3. Use electrically-powered machinery in the concrete industry
4. Use climate-friendly asphalt
5. Production of 'green' asphalt and cold-mix asphalt
6. Longer useful lives of asphalt as a result of less digging and better restorations
7. Other selection of materials and types (steel, glass fibre, wood)
8. Change of norms and calculation models with focus on the climate
9. Design optimisation, reduction of quantities
10. Fossil and emission-free construction machines in 2030, strategic replacement of the production equipment
11. Alternative propellants, fuel
12. "Sharing economy perspective" and "Full use of the capacity of machines: weighing and height /yaw break system"
13. Optimised internal logistics and freight
14. Robots, Additive Manufacturing and digital twins
15. Efficient machines and machine control
16. Climate proofing, avoidance of risks
17. Transition to electric vehicles on the roads

## Wishes for the Government

1. Municipalities and the state make requirements about fossil-free plant machinery
2. Owner's requirements for reduction of the CO<sub>2</sub> emission in the projects
3. Higher purchase prices require that the use of battery-powered machines is made competition-neutral
4. Charging possibilities and higher electricity capacity in event of construction work must be established
5. The tax on bio propellants is adjusted to that of diesel, and availability must be ensured
6. Legal requirements to convert all diesel-powered machines for biofuel or electricity
7. Ensure CO<sub>2</sub> optimal replacement of the current machine capacity - including a sharing economy
8. Tender requirements of optimum choice of machines - size, stage 5 approved, run on electricity and capacity use
9. Requirements for CO<sub>2</sub> accounts
10. Approval in standards and road regulations of new types of cement



# Participants in the five working groups

## Implementation of energy efficiency measures in existing buildings

- Chairman: Senior Vice President Henrik Frank Nielsen, Rockwool
- Research Manager Søren Aggerholm, SBI / AAU
- Vice Chairman Niels Braaby, Blik & Rør
- Senior Adviser Søren Dyck-Madsen, Concito
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- Partner Niels Jakubiak, Krydsrum arkitekter
- Senior Advisor Public Affairs, Susanne Kuehn, Rockwool
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- Manager Henrik Lindved Bang, Bygherreforeningen (Danish Association of Construction Clients)
- Chief Economist Solveig Råberg Tingey, BL
- Managing Director Henrik Mielke, Enemærke & Petersen
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- Expertise Manager of indoor climate, energy and sustainability Peter Noye, NIRAS
- Manager of Property Financing, Peter Jayaswal, Finans Danmark
- Secretariat: Dansk Industri (Confederation of Danish Industry)

## CO<sub>2</sub> reduction from operation of buildings

- Chairman: Managing director, Peter Kaas Hammer, Kemp & Lauritzen
- Development Manager Lars Andersen, NCC
- Vice President, Application and Technology Atli Benonysson, Danfoss Heating
- Managing Director Mogens Brusgaard, Wexøe
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- Technical Consultant Martin Mortensen, Dansk Elforbund
- Manager of Properties Marius Møller, Pension Danmark
- Vice Manager Signe Primdal Lyndrup, Bygningsstyrelsen (The Danish Building and Property Agency)
- Owner and Managing Director Michael Søgaard Rasmussen, Spangenberg & Madsen
- Project Manager and Editor of white paper on operation of buildings, Graves Simonsen, Bygherreforeningen
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- Unit Manager Heine Knudsen, Region Hovedstaden (Region H)
- Secretariat: TEKNIQ Arbejdsgiverne

## Design and the CO<sub>2</sub> content of materials in buildings

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# 40%

of Denmark's energy consumption is used in buildings



# 35%

of all waste stems from the construction industry



# 20%

of Denmark's CO<sub>2</sub> emission stems from the energy consumption in our buildings



# 10%

of Denmark's CO<sub>2</sub> emission stems from the building and construction process and the production of building materials