



# **Net Zero Carbon Construction**

*Future Ready Research*

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## Vi behöver öka takten i samhällsbyggandets klimatomställning

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Hur vi planerar, bygger och förvaltar hållbara samhällen är en av de största och viktigaste utmaningarna i Sverige och globalt.

Befolkningen växer, städerna växer och en stor del av våra byggnader och vår infrastruktur är föråldrad och behöver renoveras för att fortsatt kunna användas och fungera. Ett fortsatt samhällsbyggande är nödvändigt för Sveriges utveckling. Men framtidens samhällsbyggande kan inte se ut som idag. Det är inte hållbart.

Samhällsbyggnadsektorn står för en betydande del av både Sveriges och de globala utsläppen av växthusgaser. Samhällsbyggandet behöver ställas om så att vi kan fortsätta att utveckla våra samhällen, men med betydligt lägre utsläpp än idag.

WSP vill vara en ledande aktör i klimatomställningen. Givetvis tar vi ansvar för och minskar utsläppen från vår egen verksamhet – vi ska vara klimatneutrala 2030 – men det är genom våra uppdrag vi har störst möjlighet att göra skillnad. WSP har drygt 4 000 medarbetare i Sverige och över 50 000 globalt, och vi deltar årligen i tusentals projekt bara i Sverige. Det innebär en enorm möjlighet att påverka samhällsbyggandet.

WSP i Sverige och i Storbritannien har antagit mål om att vi ska halvera klimatpåverkan i våra uppdrag till 2030. Det är en utmanande uppgift, både att utveckla tillförlitliga metoder för att följa upp klimatpåverkan från våra tusentals projekt varje år och att halvera utsläppen som

våra uppdrag ger upphov till, men det behöver göras.

Som konsulter är vi beroende av att samverka med andra aktörer i samhällsbyggandets värdekedja. Klimatfrågan måste in i alla led. Vi måste ha en tidig och konstruktiv dialog med våra kunder så att rätt förutsättningar skapas redan innan projekten börjar. När ett projekt väl har startat ska vi se till att klimatfrågan hålls på agendan genom hela processen – från planering till projektering och byggledning, och vidare in i förvaltningskedet.

Mycket kan göras för att minska utsläppen redan idag, genom de tekniska lösningar som finns tillgängliga och genom att rätt beslut fattas vid rätt tillfälle i processen. Men det tar oss inte hela vägen fram till klimatneutralitet. För det krävs att vi jobbar mer med forskning och innovation. Vi måste också våga prova nya lösningar i riktiga projekt. Ett bra exempel på det är projektet förskolan Hoppet i Göteborg, som finns omnämnt i denna rapport.

Ingen aktör i samhällsbyggandet kan ta på sig hela ansvaret för hur sektorn ska bli klimatneutral, men alla aktörer bär en del av ansvaret. Med den här rapporten vill vi på WSP, förutom att dela med oss av vår kunskap, också utmana oss själva och staka ut vägen för hur vi ska leverera framtidssäkrade uppdrag med låg klimatpåverkan till våra kunder.

*Maria Brogren*

*Chef för Hållbarhet & Innovation WSP Sverige*

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## Summary

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The construction sector accounts for a considerable share of the global carbon emissions. Construction of buildings and infrastructure accounts for approximately 20 percent of global carbon emissions every year. When also adding the operational phase, the share of emissions is significantly higher.

In order to limit global warming, the construction sector needs to reach net zero carbon emissions, alongside other sectors of the economy. WSP takes part in thousands of construction projects every year, contributing with designs and advisory services. This means that WSP has a possibility, and responsibility, to contribute to lower carbon emissions in the construction sector through our designs and advice.

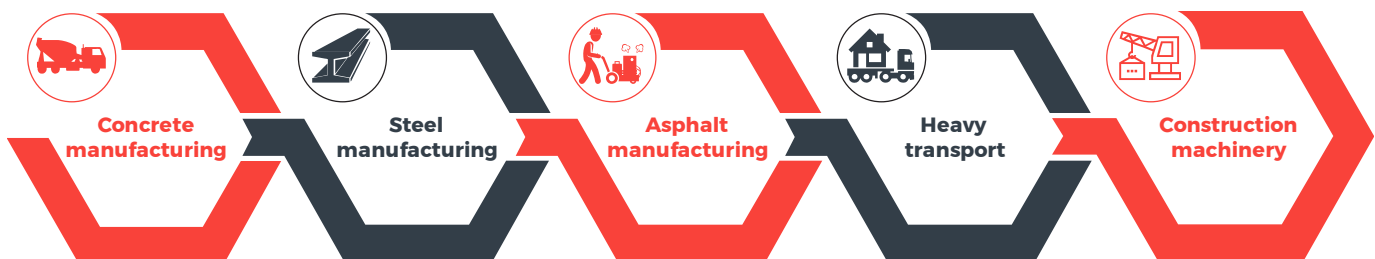
In this paper, we describe what WSP consider is necessary to decarbonize the construction of buildings and infrastructure. The focus is on capital carbon, i.e. emissions arising from the construction and production stages. Capital carbon includes all direct emissions from the construction processes, as well as indirect emissions stemming from production of materials and components.

We focus on capital carbon in this paper because we consider it to be less explored in comparison to operational emissions and energy use, but we acknowledge the need to always consider the whole life cycle of construction assets when analyzing, comparing and optimizing solutions.

These activity categories have together been estimated to account for approximately 87% of total emissions in construction of buildings, and approximately 80% of total emissions from infrastructure construction, in Sweden.

There are several different levels at which carbon needs to be considered and abatement measures taken, starting from the policy arena outside of any individual project, moving through project planning to design and construction. Much can be done before the actual construction phase is initiated.

Reducing capital carbon requires involvement from different stakeholders on different levels, both on an overarching societal level to change behavior and to set the framework and rulebook for construction, and within each project to implement the changes.





WSP supports stakeholders on all levels, ranging from development of policies and sector standards, to practical project planning and design as well as construction management at the production site.

We have identified five key principles that together forms a framework that we call the WSP Way. These principles are key to reach substantially lower capital carbon emissions in construction projects and will be applied in our projects.

1. Develop policies, client engagement and requirements for capital carbon reduction
2. Plan cities, buildings and infrastructure to avoid carbon emissions
3. Design buildings and infrastructure to enhance modularity, flexibility, multi-functionality and minimized carbon footprint
4. Use fossil-free transports and machinery during construction
5. Compensate for remaining carbon emissions

Implementing the abatement measures in the first four steps will lead to substantially reduced capital carbon emissions. It has been estimated that emissions could be reduced by up to 50% in construction projects using technologies that are already available on the market.

Currently, however, the toolbox that is available to us is not sufficient to reach zero carbon emissions. Therefore, compensational measures (offsets) are necessary until research, development and innovation regarding the remaining emissions has advanced sufficiently. It is unclear whether all emission sources can be fully eliminated over time despite our best efforts, and offsets may be needed also in a longer perspective to enable net zero carbon emissions.

We are heavily dependent on competent and engaged clients and on collaboration with our suppliers and stakeholders along the entire value chain to reach net zero. WSP are committed to do our share and to contribute with the best of our global expertise in our projects. We hope you want to join us.

#### **Our main messages:**

- Climate action needs to be on the agenda in every step of the construction process – from early planning stage to construction, operation and maintenance.
- There are measures available that can lead to substantially reduced carbon emissions in construction projects. They need to be implemented.
- Currently available measures are not enough to reach net zero carbon emissions. Conventional solutions must be challenged, and new innovative solutions needs to be developed and tried in real projects. Compensational measures (offsets) should be considered where abatement measures are not sufficient.
- All stakeholders in the value chain must contribute and implement the actions they can to reduce emissions. If all stakeholders work together it will be possible to reach net zero carbon emissions.
- WSP is levelling up our ambitions to reduce the climate impact from our projects. The five-principle framework “the WSP Way” presented in this report guides us.

## Sammanfattning

Samhällsbyggnadssektorn står för en betydande del av de globala utsläppen av växthusgaser. Uppförandet av nya byggnader och infrastruktur bidrar årligen till omkring 20 % av de globala utsläppen. Om dessutom utsläppen från användandet av byggnader, anläggningar och infrastruktur adderas blir utsläppen betydligt högre än så.

Samhällsbyggnadssektorn måste, liksom alla andra samhällssektorer, minska sina utsläpp av växthusgaser drastiskt de kommande decennierna för att nå netto noll i enlighet med Parisavtalet.

WSP deltar årligen i tusentals projekt inom samhällsbyggnadssektorn och bidrar med design, projektering, rådgivning och tekniska lösningar. Genom detta har WSP en stor möjlighet, och därmed också ett ansvar, att bidra till minskade utsläpp.

I den här rapporten beskriver vilka lösningar och utvecklingsvägar vi tror blir nödvändiga för att minska utsläppen från samhällsbyggandet, med fokus på planerings-, projekterings- och byggnationsfaserna, och hur vi arbetar för att nå dit. Fokus ligger alltså inte på utsläpp under driftsfas som uppstår bland annat från uppvärmning och energianvändning, men det är av yttersta vikt att ett livscykelperspektiv alltid tas vid planering och jämförelse av nya projekt. Vi berör både direkta utsläpp kopplade till byggandet, samt indirekta utsläpp som kommer från framförallt tillverkning av byggmaterial.

Växthusgasutsläppen i sektorn kommer från fem huvudsakliga källor, som i Sverige har uppskattats att tillsammans stå för omkring 87 % av utsläppen från uppförandet av byggnader och ca 80 % av utsläppen från anläggning av infrastruktur. Dessa fem källor är:

För att minska dessa utsläpp krävs åtgärder på alla nivåer och i alla processer, vilket sträcker sig från utformning av styrmedel och uppdatering av bygg- och materialstandarder till planering, utformning och produktion av specifika projekt. Mycket kan – och behöver – göras innan själva byggandet startar, där behov och förutsättningar behöver klargöras och konventionella lösningar ifrågasättas.

Alla aktörer i värdekedjan behöver bidra: politiker, branschföreträdare, forskare, intresseorganisationer såväl som beställare, projektörer, entreprenörer och materialleverantörer inom specifika projekt. WSP arbetar på alla nivåer med allt från strategisk rådgivning kring policy, stadsutveckling och branschstandarder, utformning av planer och konstruktioner till bygg- och projektledning på byggarbetsplatser.

För att bidra till betydande utsläppsminskningar i samhällsbyggandet har vi identifierat fem principer som ska genomsyra våra uppdrag. Dessa formar tillsammans ett ramverk som vi kallar för "WSP Way".



1. Utveckla strategier och krav som leder till minskade utsläpp samt bidra till ökad kunskap hos beställare och andra beslutsfattare.
2. Planera samhällen, stadsdelar och infrastruktur för att undvika eller minska utsläpp.
3. Utforma byggnader och infrastruktur på ett sätt som främjar flexibilitet, modularitet och multi-funktionalitet samt minskar klimatpåverkan.
4. Skapa förutsättningar för fossilfria transporter och arbetsmaskiner.
5. Utred och föreslå kompensation för kvarvarande utsläpp.

Vi tror att betydande utsläppsminskningar kan uppnås om vi arbetar efter steg 1–4, både som direkta resultat av implementering i nya projekt och genom de förutsättningar vi ger andra aktörer som är beroende av vårt arbete. Det är däremot svårt att helt nå noll utsläpp, även på längre sikt. Kompensation av utsläpp blir under dessa förutsättningar nödvändigt för att samhällsbyggandet ska kunna nå netto noll. Kompensation ska däremot inte betraktas som ett långsiktigt alternativ för områden där utsläppsminskningssåtgärder finns.

De åtgärder som redan finns tillgängliga kan ta oss en bra bit på vägen. Till exempel skulle utsläppen i vissa typer av projekt kunna halveras om tillgänglig teknik och lösningar implementeras. För att nå ett klimatneutralt samhällsbyggande behövs dock fortsatt stora satsningar på forskning, utveckling och innovation. Till exempel kring nya typer av byggmaterial, nya tillverkningsmetoder för befintliga material och fossilfria transporter till, från och på byggarbetsplatserna.

WSP är beroende av att samarbeta med kunder, leverantörer och samarbetspartners i hela värdekedjan för att kunna nå netto noll utsläpp

i samhällsbyggandet. Alla aktörer behöver vara engagerade, kunniga och ta sitt ansvar. WSP har stora möjligheter att bidra genom vår globala närvaro och vår samlade kompetens. Vi är beredda att ta vårt ansvar och hoppas att ni vill arbeta tillsammans med oss på vägen mot en klimatneutral samhällsbyggnadssektor!

#### Våra huvudbudskap:

- Åtgärder för minskad klimatpåverkan måste vara på agendan i alla steg i samhällsbyggnadsprojekt – från tidig planering till byggnation, underhåll och drift.
- Det finns tillgängliga lösningar och åtgärder som skulle leda till drastiskt minskade utsläpp. Dessa behöver implementeras.
- Dagens tillgängliga lösningar och åtgärder är inte tillräckliga för att nå netto noll. Vi måste därför utveckla nya lösningar, kunna ifrågasätta dagens konventionella lösningar och metoder samt våga testa nya innovativa lösningar i verkliga projekt. Kompensation bör utvärderas och övervägas där utsläppsminskningssåtgärder inte finns eller är otillräckliga.
- Alla aktörer i värdekedjan behöver bidra och vidta de åtgärder de har rådighet över. Om samtliga aktörer tar sitt ansvar och arbetar tillsammans är det möjligt att nå netto noll utsläpp.
- WSP ökar klimatambitionerna och vidtar åtgärder för att minska klimatpåverkan från våra uppdrag. De fem principerna i ”WSP Way”, som presenteras i denna rapport, vägleder oss i detta arbete.







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## INTRODUCTION

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This paper describes the way in which WSP views the future of construction with respect to reduced climate impact. We describe the solutions that we have identified as necessary and are currently implementing in projects, where we need to improve and where technical innovation and policy support is needed. The purpose is to share knowledge, inspire others to use similar solutions and pinpoint where other stakeholders need to contribute.

In the term “construction” we include the production of both buildings and infrastructure as well as all planning activities that precedes the production phase. By buildings, we refer to buildings of all purposes, e.g. residential, industrial, public and office buildings.

In this paper, we use the term “carbon” as short for carbon dioxide equivalent of all emissions of greenhouse gases. These emissions are expressed in tonnes of carbon dioxide equivalents (tCO<sub>2</sub>e).

The focus of this paper is on capital carbon, i.e. emissions arising from the construction and production stages. Capital carbon includes all direct emissions from the construction processes as well as indirect emissions stemming from production of materials and components. A life-cycle perspective is applied throughout the paper.

Operational carbon is the emissions stemming from the operational phase. Operational carbon and the operational phase of buildings and infrastructure will only be touched upon briefly in this report, because the route to decarbonization of the

operational phase is already relatively clear.

We define Net Zero Carbon Construction as zero net capital carbon emissions associated with construction assets, allowing for investment in carbon offsets to compensate for remaining emissions that cannot be removed entirely from the construction phase.

### **Mission Statement**

WSP fully endorse the ambition of a net zero carbon construction sector. It is an extremely challenging task to achieve net zero emissions from construction, but it needs to be done to keep the global temperature rise below 1.5 °C. As a global professional services company, we want to accelerate the development of future-proof and low-carbon societies all around the world. We will do this by raising awareness and inspire through thought leadership and innovative thinking. By sharing best practices among our 50,000 employees around the globe, we ensure that we make the most out of our experience and combined resources.

When decarbonizing the construction sector, there is large potential for synergies with other sustainability targets, including most of the UN’s 17 Goals for Sustainable Development. It is important to find solutions that contribute to all dimensions of sustainability and avoid sub-optimizations.

Cooperation between stakeholders in the whole value chain for buildings and infrastructure is crucial. A net zero carbon construction sector is only possible if all parts of the value chain are decarbonized, i.e. has net zero emissions. All stakeholders need to not only take responsibility for their own emissions, but also for supporting other parts of the value chain, clients as well as suppliers. As one of the world's leading professional services firms, we see that we have a great potential – and responsibility – to help our clients reduce their carbon emissions.

It is in the projects and advice we provide to our clients that we have the largest potential to reduce emissions. WSP Sweden and WSP UK have committed to halve the emissions associated with our designs and advice by 2030 and the rest of our regions are not far behind.

In Sweden, over 20 business sectors have developed roadmaps toward becoming fossil free or carbon neutral by 2045.<sup>1</sup> WSP Sweden has signed and participated in the development of the roadmap for the construction and civil engineering sector.<sup>2</sup>

Several of the other roadmaps are also relevant for the construction sector, such as those for material production, the power and heating sector, the heavy vehicles industry and the heavy road haulage sector.

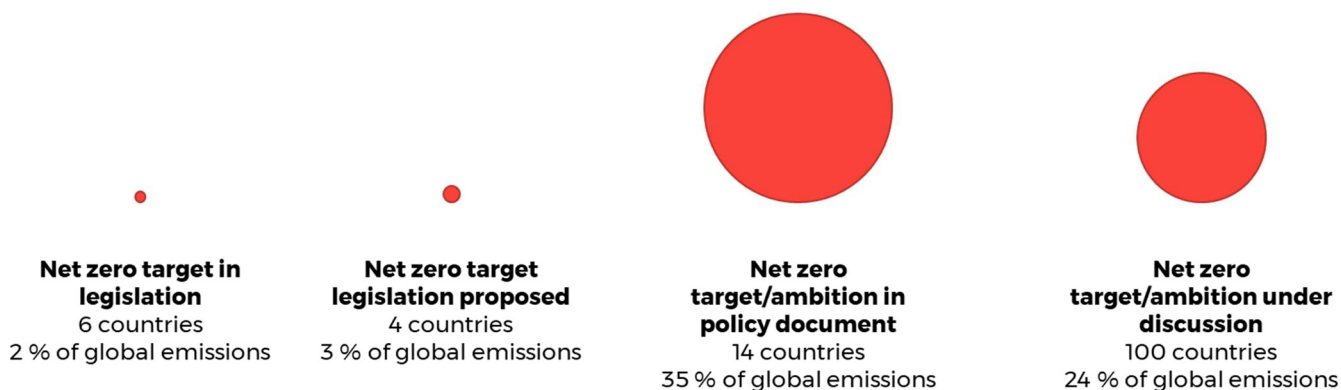
In this report we want to highlight the actions and activities that WSP believe is key in the development of a net zero construction sector. We call it “the WSP way”, as it is the way we see ourselves working in our future projects.

### The challenges – Key trends

#### Net zero ambitions and policies put pressure on the construction sector

To reach the Paris agreement target of keeping the global temperature rise well below 2 °C and pursue efforts to limit the increase to 1.5 °C, the global carbon emissions must be drastically reduced during the coming decades and reach net zero by 2050. An increasing number of countries have decided on net zero carbon targets or have net zero ambitions proposed or under discussion.

**Figure 1: Number of countries that have implemented, proposed or discussed net zero ambitions and the corresponding share of global carbon emissions.** <sup>3</sup>



<sup>1</sup> Fossil Free Sweden, <https://fossilfritt Sverige.se/fardplaner/>

<sup>2</sup> Fossil Free Sweden, [https://fossilfritt Sverige.se/wp-content/uploads/2020/10/ffs\\_bygg\\_anlaggningssektorn.pdf](https://fossilfritt Sverige.se/wp-content/uploads/2020/10/ffs_bygg_anlaggningssektorn.pdf)

<sup>3</sup> Data from Energy & Climate Intelligence Unit, 2020 scorecard. The numbers relate to the situation December 1, 2020.

In addition to national targets, states, cities and municipalities, such as California, Stockholm, Montreal and London, have committed to net zero targets. Cities are important clients for both buildings and infrastructure projects and are beginning to put pressure on the construction sector to change.

*Emissions from the construction sector are significant*

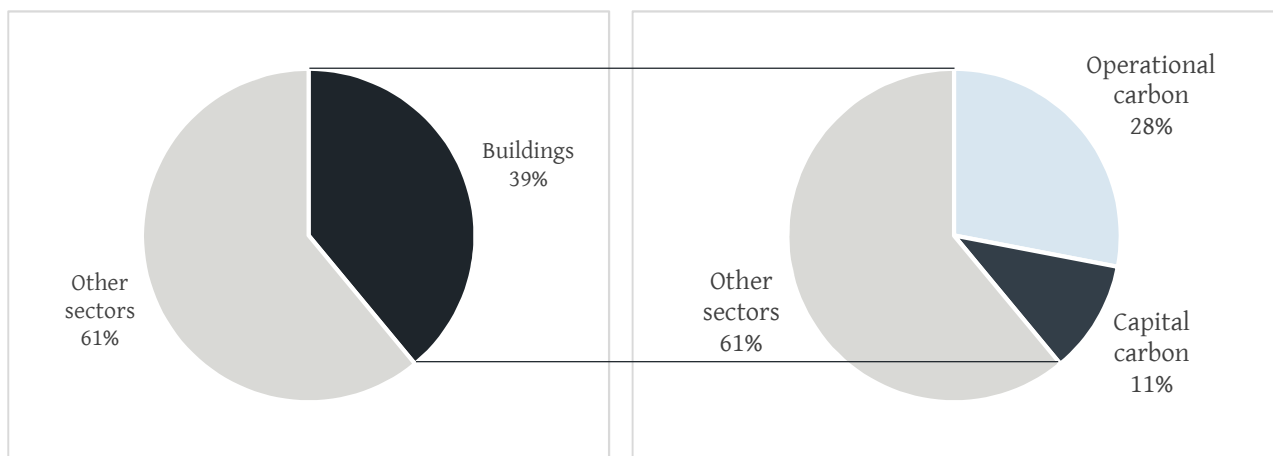
The construction sector accounts for a considerable share of global emissions. The exact amount of emissions is difficult to calculate, due to lack of reliable and cohesive data from all countries. Estimates have shown that the construction of buildings and infrastructure accounts for around 7 Gt CO<sub>2</sub>e, or 20 percent of global carbon emissions. 4 Gt CO<sub>2</sub>e were associated with materials used for construction.<sup>4</sup>

When including the operational phase of buildings and infrastructure, the share of global emissions is much higher. Up to 70 percent of global carbon emissions can be traced to construction and operation of buildings and infrastructure (including energy production and use, traffic etcetera).<sup>5</sup>

Buildings alone account for around 39 % of global carbon emissions. 28 % relates to operation of buildings, while 11 % comes from energy and construction materials used to produce buildings.<sup>6</sup>

**7 Gt CO<sub>2</sub>e**  
were the estimated global emissions from construction of buildings and infrastructure in 2015, which equals  
**20 %** of global emissions

**Figure 2: Share of global emissions stemming from the buildings sector. To the right, operational carbon and capital carbon for the buildings sector are presented separately.** <sup>7</sup>



<sup>4</sup> Hertwich, 2019, The Carbon Footprint of Material Production Rises to 23 % of Global Greenhouse Gas Emissions. <https://doi.org/10.31235/osf.io/n9ecw>

<sup>5</sup> World Bank <https://blogs.worldbank.org/ppps/low-carbon-infrastructure-essential-solution-climate-change>

<sup>6</sup> World Green Building Council, [https://www.worldgbc.org/sites/default/files/WorldGBC\\_Bringing\\_Embodied\\_Carbon\\_Upfront.pdf](https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf)

<sup>7</sup> Data from World Green Building Council, [https://www.worldgbc.org/sites/default/files/WorldGBC\\_Bringing\\_Embodied\\_Carbon\\_Upfront.pdf](https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf)



Since the construction sector accounts for such a significant share of the total global emissions, it is crucial that the emissions from the sector are drastically reduced. Such reductions will be needed with respect to both operational and capital carbon.

In 2018, manufacturing of building materials accounted for 11 % of all CO<sub>2</sub>-emissions globally.<sup>8</sup> The share had increased by 2 percentage points compared to 2017, driven by a growing demand for building materials. Most of the capital carbon emissions come from a few categories of materials, including cement, steel and asphalt.

Manufacturing of building materials accounts for

**11 %** of global emissions

In addition to the capital carbon, fossil fuel use for transporting material, equipment and machinery to, from and within construction sites is the main emission source during the construction phase. Emissions arising from construction are dominated by five activity categories:

- Concrete manufacturing
- Steel manufacturing
- Asphalt manufacturing
- Heavy transports
- Construction machinery

In Sweden, these activity categories have been estimated to account for approximately 87 % of total emissions from construction of buildings, and approximately 80 % of total emissions from infrastructure construction.<sup>10</sup>

### Cement<sup>9</sup>

*4.1 billion tonnes of cement was used globally in 2018. China alone accounted for 52 % of the demand. The production of cement is responsible for 5-8 % of global carbon emissions.*

### Steel<sup>11</sup>

*919 million tonnes of crude steel was used in the construction sector in 2019. The steel used in the construction sector accounts for 3.5-5 % of global carbon emissions.*

<sup>8</sup> Global Alliance for Buildings and Construction <https://globalabc.org/sites/default/files/2020-03/GSR2019.pdf>

<sup>9</sup> Steel used in construction sector: World steel association <https://www.worldsteel.org/en/dam/jcr:f7982217-cfde-4fdc-8ba0-795ed807f513/World%2520Steel%2520in%2520Figures%25202020i.pdf>; Emissions from steel production World Green Building Council [https://www.worldgbc.org/sites/default/files/WorldGBC\\_Bringing\\_Embodied\\_Carbon\\_Upfront.pdf](https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf)

<sup>10</sup> Toktarova, A., Karlsson, I., Rootzén, J., Odenberger, M., 2019 MCE Technical Roadmaps – Steel, cement, buildings and transport infrastructure

<sup>11</sup> Global cement production: Global Cement and Concrete association <https://gccassociation.org/key-facts/>; Carbon emissions from concrete production World Green Building Council [https://www.worldgbc.org/sites/default/files/WorldGBC\\_Bringing\\_Embodied\\_Carbon\\_Upfront.pdf](https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf)

## Global population growth and urbanization

By 2050, the UN projects that the global population will grow to 9.7 billion, an increase by 26 % compared to 2019. This will drive an increasing demand for the construction of new buildings and infrastructure.<sup>12</sup>

Along with the increase in population, relocation of citizens will create a further need to accommodate inhabitants in new places. In 1950, the population in urban areas was only 751 million. In 2018, 4.2 billion people lived in urban areas, 55 % of the world population. The UN projects that urbanization will continue. In 2050, 68 % of the world's population is projected to live in urban areas.<sup>13</sup>

As the world population increases, urbanization continues, and the economy grows, the carbon emissions from construction will keep rising if we do not change the way we build. New materials, smarter processes, better cooperation, optimized use of resources and fossil-free energy are needed.

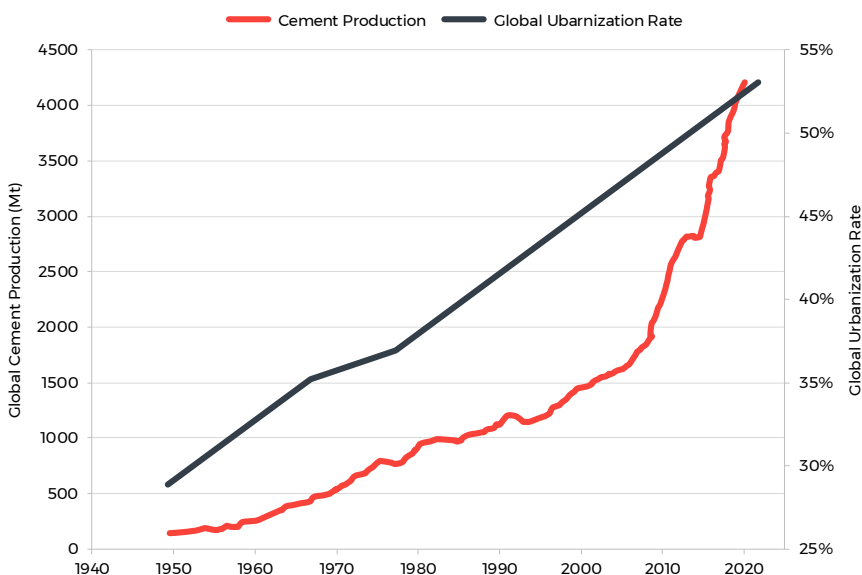
How we plan and design cities and communities is also of great importance.

## The existing building stock and infrastructure need renovation and upgrades

Aside from the trends driving the need for new buildings and infrastructure, the existing built environment is in need of upgrade. The aging building and infrastructure stock combined with insufficient maintenance creates a deficit which needs to be paid to avoid premature retirements and unnecessary new construction. As an example, it is estimated that 800,000 apartments in Sweden are in need of renovation, of which 300 000 are in acute need.<sup>14</sup>

Obsolete assets is another driver for upgrades. Climate change effects, such as the rise of sea levels, flooding and higher temperatures, will result in a need to upgrade or move existing buildings and infrastructure in order to make the built environment more resilient.

**Figure 3: Correlation between urbanization rate and global cement production.**



Source: BETCRETE

<sup>12</sup> UN [https://population.un.org/wpp/Publications/Files/WPP2019\\_10\\_KeyFindings.pdf](https://population.un.org/wpp/Publications/Files/WPP2019_10_KeyFindings.pdf)

<sup>13</sup> UN <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>

<sup>14</sup> WSP Sweden, Sverige Behöver Renoveras, 2020

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## ROADMAP FOR NET ZERO CARBON CONSTRUCTION

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### *A framework for action*

In order to reduce emissions, there are several different levels at which carbon needs to be considered and abatement (mitigation) measures taken, starting from the policy arena outside of any individual project, moving through project planning to design and construction. Much can be done before the actual construction phase is initiated. It is key that emissions from the whole life cycle of construction assets are analyzed and compared for abatement measures.

In general, the following type of sequential framework for reducing capital carbon is useful:

- **Build nothing** *Evaluate the basic need for an asset and/or program of works and explore alternative approaches*
- **Redefine assets** *Evaluate the potential for reusing and/or refurbishing existing assets to reduce the need for new construction*
- **Reduce and replace materials and structures** *Design and engineer to reduce the volume of materials and structures used, and use other construction methods to enable lower emissions. Consider carbon-intensity when choosing between products for a defined purpose*
- **Build minimizing transportation and emissions** *Plan for construction to reduce resource consumption and transportation needs, and use low-carbon fuels*



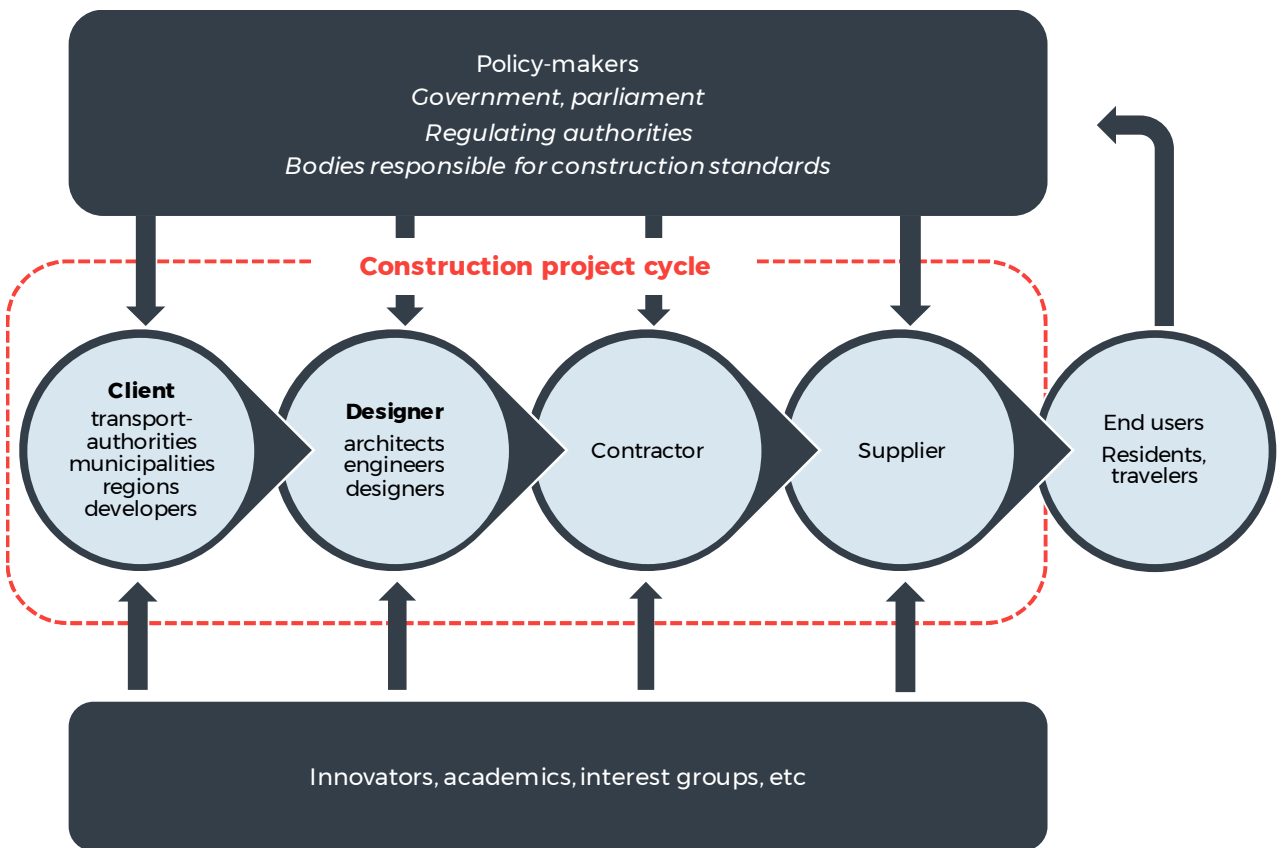


Reducing capital carbon through these steps requires involvement from different stakeholders on different levels, both on an overarching societal level to change behavior and to set the framework and regulation for construction, and within each project to implement the changes. The principal stakeholders as we see it are illustrated below.

WSP supports stakeholders on all levels, ranging from development of policies and sector standards, to practical project

planning and design as well as construction management at the production site. We are also involved in development projects together with contractors and in academic research.

This over-arching set of principles and ecosystem of stakeholders form the foundation for the WSP Way. In the subsequent chapters, we present our view of necessary changes and actions that are required to reach net zero carbon construction.



## Net Zero Carbon Construction – the “WSP Way”

In this chapter, we present five steps that we think are key to reach substantially lower capital carbon emissions in construction projects. Some of the measures are already widely implemented in our projects, others are still under development. All steps are key solutions and measures that WSP will integrate in our projects to support our clients to significantly reduce the carbon emissions. In each step, we describe the actions we at WSP have taken and what services we offer our clients to help them make decisions that lead to reduced carbon emissions.

### 1. *Develop policies, client engagement and requirements for capital carbon reduction*

We support governments, authorities and private sector actors with analysis and development of strategies and policies for carbon reduction on national, regional and local levels. High-level goals and policies are important and can be used by fore-runners, both organisations and individuals, to sanction ambitious initiatives that contribute to setting new industry standards.

#### **WSP project example: Net-zero roadmap for Gävle municipality**

In several projects, WSP has supported local governments in mapping emissions and suggesting actions for reducing them. In Gävle municipality (Sweden), a roadmap was developed suggesting cost-effective and evidence-based actions adapted to their specific conditions. The actions primarily focused on increasing the relative attractiveness of public transport and reducing emissions from heavy transportation of goods and services through planning, and efficient distribution centres.

“

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Requirements in private and public procurement processes can have a large impact in steering designers, contractors and suppliers towards choosing smarter solutions, both by stretching performance requirements but also with economic incentives if requirement levels are surpassed. It is important that requirements are designed to be effective in influencing all relevant decision-makers in the supply chain, that transaction costs for implementation of requirements are considered, and that focus stays on carbon mitigation measures rather than calculation issues. We help clients to develop adequate carbon requirements for private and public procurement.

Sustainability assessments and disclosure schemes, like CEEQUAL, BREEAM, Citylab, Miljöbyggnad, SBGC's NollCO2, GRESB, CDP, TCFD, are tools we use both as frameworks for planning and design, and for follow up of policies and requirements in close collaboration with our clients. Climate declarations for new buildings helps bring knowledge and attention to the climate impact from construction of new buildings and has potential to foster carbon reductions.

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### **WSP project example: International study on Procurement Requirements for Carbon Reduction in Infrastructure Construction Projects**

In the international research project Impres, WSP investigated, together with other project partners, the institutional and organisational contexts, policies, procurement requirements and implementation strategies used to drive greenhouse gas reduction in large infrastructure projects in five countries world-wide: Australia, the Netherlands, Sweden, the UK and the US. The study was based on interviews with key partners on the client side and in the supply chain. Thus, the project traces the pathway from political and organisational goals to actual realisation in projects.

Some of the concluded key recommendations to the decision-makers were.:

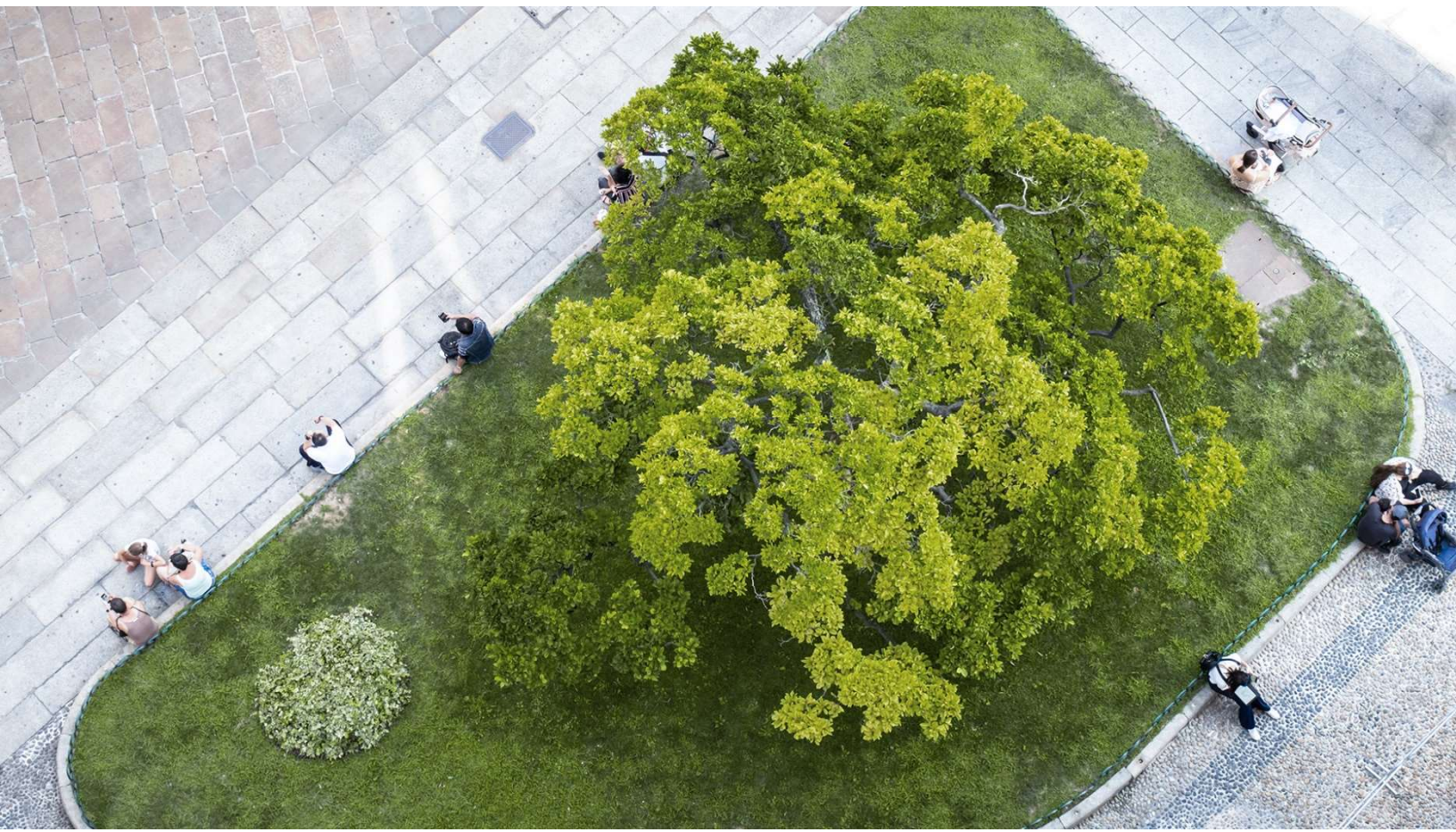
1. Set high-level goals and policies for carbon reduction in order to sanction ambitious initiatives that contribute to setting new industry standards.
  2. Develop guidelines, tools and training programs to help build industry capabilities.
  3. Establish systematic long-term innovation processes by combining small pilot projects with implementation in larger projects.
  4. Enable and legitimise long-term, strategic collaborative alliances.
- ”



### WSP project example: Reference values for embodied carbon for new buildings

WSP develops reference values for climate impact for new buildings, together with, among others, Royal Institute of Technology. This is part of the National Board of Housing, Building and Planning's government assignment "Assignment to promote reduced climate impact in public procurement of construction, infrastructure and real estate contracts". The reference values will be used for procurement requirements. It is also part of the decision basis for a possible future legislation regarding limit values for maximum climate impact from new buildings. The analysis includes the climate impact from cradle until the construction is completed.

The reference values will be based on building data from around 60 real Swedish buildings and analyzed regarding how different kind of building properties affect the climate impact.



### **WSP project example: Development of carbon requirements in construction projects**

WSP was appointed by the Swedish procurement agency (Upphandlingsmyndigheten) to coordinate the development of criteria for carbon requirements for public procurement of construction projects, both buildings and infrastructure. Based on long experience and deep knowledge of such requirements, WSP has developed draft carbon requirements for materials, carbon management processes, management of soil and rock masses, entire buildings, and more. The drafts have been reviewed by reference groups in a systematic process for supply chain involvement. The final requirements will be published in the procurement agencies' criteria database during 2021, ready to be used by municipalities and others as support for driving the decarbonization of the construction sector.

## *2. Plan cities, buildings and infrastructure to avoid carbon emission*

Including climate perspectives at strategic planning level is necessary. For example, we support clients in master planning processes to consider carbon reduction. We analyze the planned development through a low-carbon lens and evaluate which new urban or infrastructure development will create the most benefits while giving the least carbon emissions from construction material, construction work and long-time operation and maintenance.

Historically, the starting point for infrastructure and city planning has often been forecasts for transportation and housing needs.

To be able to plan for a sustainable future, however, we see that the starting point should be goal-oriented, and planned for a future that we want. Sustainability goals should be taken into account which might imply that transports and construction of new buildings have to be constrained, by for example introduction of congestion fees for infrastructure and models for sharing of office spaces. Other means that we consider for more effective use of existing assets is automation and digitization to reduce the need for transport and to optimize the transport that can't be avoided.

### **WSP project example: Master planning for low carbon development**

WSP conducted in-depth sustainability assessments of the master plans developed by the municipalities of Lund and Halmstad in south of Sweden. In addition to the legal requirements, WSP added supplementary analyzes:

1. In-depth analysis of the current situation with regards to e.g. socio-economic aspects, access to public transport, access to pedestrian and bicycle road networks in different areas, access to green areas and parks.
2. Development of a tool where different options could be compared and assessed against each other. The assessments were based upon the in-depth analysis of the current situations as well as an analysis of the different option's sustainability contributions to areas where the municipalities currently have issues or challenges. One of the issues addressed was reducing carbon emissions, and some assessment parameters were development of sustainable transports, resource efficiency, renewable energy production and carbon storage potentials.
3. Based on the assessments in steps 1 and 2, recommendations were given on which options would give the best contributions to a sustainable low carbon development.

When supporting in detailed development processes that set the conditions for construction, we strive to take carbon into account. We aim to allow for and drive low-carbon construction strategies and materials, such as timber buildings and bridges and other innovative light-weight and high-performance materials.

Both at strategic and detailed planning levels, it is important to recognize and handle conflicting sustainability goals. Over-decking strategies to remove physical barriers and increase availability in urban development can, for example, result in high carbon emissions as a consequence of use of large quantities of concrete and steel.

Shortening road and rail bridges to reduce carbon emissions can increase barrier effects for wildlife.

We also work together with municipalities and regions, to develop strategies for how housing and transport needs can be met with smarter use of existing buildings and infrastructure rather than building new assets. This can be done through evaluation of existing asset stocks and identification of opportunities to upgrade or refurbish, discontinuation of assets, introduction of technical and economic systems for sharing, steering or limiting use of assets. A basic principle is that assets should be optimized from a whole life service perspective, promoting renovation/retrofit as opposed to new construction, when motivated from a carbon perspective.

#### **WSP project example: Smart handling of excavated masses in Railway project**

In the railway project Ostlänken, WSP has been working to cut down transport of excess soil and rock masses by looking to alternative use in the nearby area of the railroad. Long transports to distant landfills is very costly and results in high carbon emissions. The total volume of excess soil and rock masses that was cut was about 2 000 000 m<sup>3</sup>. Since the project demand for landfill was less than the excess masses, we worked together with landscape architects to find alternative uses of the excess masses next to the railway in order to bring higher value to the facility and minimize barriers and the visual impact of the new railroad.



### 3. Design buildings and infrastructure to enhance modularity, flexibility, multi-functionality and minimized carbon footprint

When location and scope of a project is decided, continuing to minimize the carbon footprint during detailed design and production planning is key. Specifications for contracts should be developed collaboratively to make use of the latest knowledge and technology available. Integrated project teams with all relevant

parties in the supply chain is the optimal way to enable innovative design optimizations as well as green product choices and assessment of material and energy use during operation and maintenance using Life Cycle Cost (LCC) analysis.

#### WSP project example: Expansion of train depot in Högdalen

New concrete tunnels are planned to be built in the train depot in Högdalen in Stockholm. It was estimated that the tunnels would require 3 250 m<sup>3</sup> of concrete. WSP suggested a number of optimization measures in the design of the tunnels. For example:

- Changing the quality of concrete used
- Reducing the use of concrete by suggesting rock tunnels instead of concrete tunnels where possible
- Shape optimization and optimizing of sections

The measures suggested by WSP would reduce the carbon emissions from the project by almost 33% compared to the original preliminary design.

For design optimization we often use automated computer-based models to find the most resource efficient way of meeting functional requirements and at the same time considering aspects like aesthetics, circularity, productivity, maintainability etc. Using options for IoT-solutions (Internet of Things) with built-in sensors and connected constructions is also a powerful tool for us to verify and monitor status and characteristics of constructions and processes.

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*Klimatdata Light is a tool developed by WSP Construction Design in Sweden. The tool helps calculate and compare climate footprint of different designs. Material choices can be assessed as well as the share of emissions from different parts and components of a building. The tool can be used to find the most optimized design from a climate perspective.*



We use a systematic process for carbon footprint calculations of projects to identify capital carbon sources and opportunities for reduction. Carbon calculation can be done by using stand-alone tools prescribed by clients or by using BIM-integrated tools that we have developed ourselves. Established calculation methods are needed and the system boundaries for calculations needs to be transparent, and preferably standardized to foster comparability between projects.

The process includes workshops for identification of prioritized reduction measures by the project team and systematic follow-up of the implementation. Aspects that needs to be considered include:

- Life cycle perspective on operation and maintenance to minimize whole-life energy use and carbon emissions
- Include choice of low carbon materials in design
- Design for deconstruction and flexibility and reuse of modular components
- Design for multifunctionality (e.g. integrated energy production and ecosystem services).
- Minimizing need for rock and soil excavation and geotechnical reinforcement
- Planning and mapping for local reuse of rock and soil masses as far as possible, including co-operation with surrounding projects and relevant actors and authorities
- Allowing for alternative production methods (on-site, off-site, 3D-printing, etc.)



### *WSP project example: Building new storeys on an existing office building*

Skellefteå Kraft has an office building from the 1960s. In 2016, the company needed more floor area and asked WSP to investigate the possibility of expanding the existing building with additional storeys. WSP assessed the construction and came to the conclusion that it would be possible to build new storeys in a glulam construction. Wood was chosen because of its light weight in comparison to the bearing capacity. The result was that two new storeys were built on top of the existing building. By expanding the existing building, it was possible to make use of the already existing foundation etc and a completely new building could be avoided.

When choosing materials and products, it is important to have good market knowledge and to cooperate with purchasing departments to

evaluate different options based on whole life carbon performance using third party verified Environmental Product Declarations (EPD).

### WSP project example: High-shares of GGBS-concrete in design stage

On HS2 Phase 1 (North) Enabling Works, bridges are being produced using a DfMA (Design for Manufacture and Assembly) technique, where concrete “shells” are precast in a factory environment using 38% GGBS. These are then transported to site, placed in position and filled in-situ with a 66%+ GGBS concrete core. The 38% GGBS alone provides a 20% carbon saving (against an assumed baseline case of 20% GGBS).

As described in the introduction of this report, cement and steel are two of the largest contributors to carbon emissions from construction. Ultimately, this must be solved either by decarbonizing the manufacturing processes or by replacing cement and steel with less carbon intense materials. There are also measures to take

in the short term that could reduce the emissions significantly.

For example, there is large potential to reduce emissions in maximizing the use of SCMs (Supplementary Cementitious Materials) like GGBS (Ground Granulated Blast-furnace Slag), fly-ash and other alternative binders, and to minimize the amount of cement in concrete by not choosing higher concrete qualities than necessary.



### WSP project example: Train stations at San Francisco airport

San Francisco Airport is currently undertaking an extension of their rail public transportation system to include two new stations. The project aims to achieve LEED v4 Gold level certification as well as implement SFO’s Sustainability Plan that requires carbon accounting for all new projects. WSP was engaged in the embodied carbon aspect of the project during the early Design Development phase to analyze and provide recommendation for lowering the embodied carbon footprint of construction.

WSP’s recommendation to the project team was to increase the fly ash content to a minimum of 15%. The analysis showed that increasing the fly ash had the potential to reduce the embodied impact of the project by 10% in global warming potential and several other impact measures. Working with the structural engineers and SFO team changes to the concrete design were implemented, the final concrete design included 25% fly ash. WSP then did a final comparative whole building life cycle study comparing earlier iterations of the design to the final; with the concrete design changes, changing several glass canopies to metal, and changes to the skylight design, the project had a 9.6% reduction in GWP, 12.6% reduction in Acidification, and 11% reduction in Ozone formation.

#### 4. Use fossil-free transports and machinery during construction

When a project goes into the construction phase it is important to maximize the use of low-emission vehicles and machinery for heavy transport and construction processes. The possibility to use electrified vehicles and machines can be limited by the access to enough electrical power. Therefore, it is necessary to include planning of power supply options in design and production planning together with the client, contractor and subcontractors. This includes investigating possibilities for grid connection as well as looking at off-grid solutions by using hydrogen/fuel-cells and/or battery power banks.

The market availability of electric and fuel-cell heavy vehicles and machines is still limited, so sustainable biofuels is a necessary substitute while the market is developing. Biofuel supply varies regionally, so it is crucial to assess the availability and find suppliers in good time before construction work starts. It is also necessary to ensure that the biofuels come from sustainable sources.

The potential of future electrified and autonomous construction equipment and vehicles is greater if paired with digital and connected machine control systems. Such systems can make logistics planning much more effective and reduce energy use and waste significantly.<sup>15</sup>



#### WSP project example: Fossil-free construction sites

The city of Gothenburg has an ambition that all construction sites in the region related to public procurement should be carbon neutral by 2030. WSP was hired to assess and develop recommendations for procurement requirements that would support this ambition. Besides reducing emissions, the city wants to contribute to an increased demand for fossil-free work machines on the market through introducing appropriate procurement requirements. WSP developed five different requirement recommendations. Among the most important success factors that were identified was adequate political targets, systematic follow-up, increased knowledge and cooperation with the industry.

In the project, WSP also estimated that the carbon emission reduction potential if all the construction sites in the region during 2020 would have been fossil-free was 30 000 tonnes of CO<sub>2</sub>e.

<sup>15</sup> Volvo CE <https://www.volvoce.com/global/en/this-is-volvo-ce/what-we-believe-in/innovation/electric-site/>



## 5. *Compensate for remaining carbon emissions*

Presently and in the near-term future, the consensus is that full decarbonization of construction projects is not technically possible. Concrete, for example, will be difficult to replace due to its favorable properties, and cement is not likely to be fully replaceable in concrete by other supplementary materials such as fly ash and GGBS. In the long term, carbon capture and storage (CCS) may be able to capture and store the remaining emissions resulting from cement production and other emission sources.

Steel will also be difficult to fully replace with other materials in the short-term. To decarbonize the production of steel from iron ore will also take time, since that requires a completely new manufacturing process or the implementation of CCS. Research and development is underway, but it will take time to implement. One measure is to use more recycled steel, but as the market and demand for steel keeps growing, it will still be necessary to produce new steel from iron ore.

The conclusion is therefore that in the short term, other forms of compensation efforts will be necessary to enable Net Zero Carbon

classifications of construction projects and actors. Compensation efforts refer to any action, typically an investment, that eliminate emissions that are not a result of “your own” actions as a corporation or an individual, but someone else’s, which is then accredited the financier, offsetting their own emissions by some amount. What constitutes a “valid” offset is still debated, and an ongoing discussion. Currently, for example, many platforms where offsets can be acquired equate offsets which contribute to negative emissions, i.e. where the concentration of greenhouse gases in the atmosphere is reduced, and offsets which contribute to lower emissions than would otherwise be the case. These two types of offsets are clearly different with respect to the effect on climate change which need to be considered.

To ensure credibility for compensation measures over time, it is clear that certain questions need to be solved. Looking beyond current uncertainties and issues, it will always be necessary to pay attention to ensuring lasting effects, additionality and transparent accounting when using compensation measures.





## How far does this take us?

Estimates has shown that it will be very challenging to reach absolute zero emissions from construction, particularly as a result of emissions from land use change and chemical process emissions being hard to reach.

Certain reductions can be reached through careful planning and directed actions. By building less and smarter, demand for new construction and thereby emissions can be reduced. In dealing with the remaining

emissions, however, technical solutions are needed, which comes down to addressing and decarbonizing the five key activity categories that account for the majority of construction emissions; concrete, steel, asphalt, transportation and construction machinery. As these categories contribute in similar ways to the total emissions of the construction of buildings and infrastructure, we can reduce emissions from both subsectors through changes to just a handful of activities.

Carbon emissions in construction projects could be reduced by **50 %** if already existing decarbonizing solutions were implemented

Some technical solutions that have been identified as key are already technically and commercially available and used to different extents in construction projects. It has been estimated that emissions could be reduced by 50% in construction projects using technologies that are already available on the market. The largest share of the 50 % reduction potential comes from fuel substitution in asphalt plants, excavators, haulers and trucks.<sup>16</sup>

However, our experience is that there is a gap today between the reduction potential for a project and the reduction measures that are being realized. Prevailing processes, standards, culture and norms in the sectors often need to adapt first, which is a slow process.

To overcome the gap, it is necessary to raise awareness at all levels in projects and make sure that carbon reductions gets a higher priority in projects. For WSP as advisors, our responsibility is to help our clients gain awareness and knowledge about possible solutions that would reduce emissions.

When assessing the different measures needed to decarbonize the five key activity categories, it becomes clear that a lot of the responsibility falls on the production industry (materials and vehicles/machinery). However, design, engineering and consulting companies, like WSP, also have an important part to play as described in the five steps of the WSP Way.

<sup>16</sup> Karlsson, L., Rootzén, J., Johnsson, F. Reaching net-zero carbon emissions in construction supply chains – Analysis of a Swedish

road construction project, 2020. Renewable and Sustainable Energy Reviews 120, 109651.



## Innovation - challenges, pioneering projects and needs

Reaching Net Zero Carbon Construction is contingent upon innovation and technical development on several fronts, together with a willingness and capability from the customers and industry to use it. WSP has a responsibility to advance the parts of the industry where we are frontrunners, and to continuously adopt new best practices in the field. But we are ultimately a link in a chain of stakeholders that all need to make progress for the sector to reduce its emissions and eventually reach net zero. New policy, innovative planning and new types of materials and construction methods are all key areas where progress is needed, and policy-makers and the industry must work together.

### *Challenges*

Developing and implementing the new processes, materials and products necessary for reaching Net Zero Carbon Construction is challenging and associated with various innovation needs and barriers. Some of the necessary solutions currently face barriers at a “system level”, preventing them from being used in projects. For example, CCS technology is in need of further research and testing to prove its technical and financial viability, before it can be used to reduce emissions. Other innovations, such as new alternative binders that can replace cement in concrete, are currently not included in relevant construction standards which represents another type of barrier.

Some new products and processes instead face barriers related to market conditions, being technically tested and accepted but too expensive to use. Often, cost is the dominant factor determining the choice of a material or process. New alternatives need to reach competitive cost levels to become widely used.

Even if available to the market at a competitive cost, whether the new and less carbon-intensive products and processes are actually implemented in the end depends on decisions made by the stakeholders in a construction project – the clients, architects, designers, construction companies and suppliers. Regardless of the economic competitiveness, someone, at some point, needs to decide to use a less carbon intensive product, material or process as opposed to the conventional solution. Here, the workplace culture, norms, skepticism and incentives to the person or team making the decision become important.

The construction sector is conservative due to risks and consequences of buildings and infrastructure not functioning as planned. Understanding which barriers that currently exist for the developments that are needed and subsequently finding solutions to them is key to reduce emissions.

### *Innovative projects*

Pioneering projects where new and innovative ideas and solutions are tested will be crucial. Stakeholders must be bold and dare to challenge prevailing standards and methods. The industry must work together with public actors, academia and institutions in this task.

Preschool Hoppet in Gothenburg in Sweden is an example where a number of actors have come together to explore new methods and challenge current standards. Another example is 22 Bishopsgate in London, a 62 storey building built on the foundation of an abandoned construction project, where the end result is a 40 % reduction of embodied carbon. These are both examples of innovative projects where focus has been on finding new low-carbon and resource efficient solutions rather than taking the easy and well-known paths.





### **WSP project example: Preschool Hoppet**

The city of Gothenburg has initiated the innovation project “Hoppet”, in which the aim is to design and build a preschool only based on fossil free methods and materials. WSP has participated as one of several actors in the project and has been working with different parts of the construction, for example the foundation. Evaluating and comparing the carbon emissions of different materials and constructions was an important part of the project. This resulted in:

- a foundation partly based on cell glass made from recycled glass (koljern foundation)
- floors and bearing inner walls of cross laminated timber
- timber framing the outer walls
- roof of timber trusses

In comparison with a reference project, the carbon emissions in Hoppet was reduced by 70 %.



### **WSP project example: 22 Bishopsgate, London**

Located on the site of an abandoned project in the heart of London's financial district, 22 Bishopsgate came with constraints above and below ground that inspired WSP UK's team to think creatively and seize the opportunity to cut embodied carbon dramatically. When construction of The Pinnacle was halted in 2009, it left behind a three-storey basement with nine floors of concrete core and piles embedded more than 50m into the ground. Rather than excavating this ‘stump’ and beginning again, our team successfully re-used 100% of the existing foundations and 50% of the basement in a design that also made use of older existing buildings on the site to create 30% more lettable area than The Pinnacle would have had.

This approach reduced the embodied carbon and construction emissions of the foundations by 70%.

Our design for the core reduced the reinforcement required in the lift front walls by 25%. All the floors were built with concrete that is 30% lighter than the standard mix – producing savings across the board, from foundation size to crane time. We were also able to optimise the size of the beam-to-column connections, reducing them by 40%.

In total, the project has achieved the 2020 target for embodied carbon reduction recommended by the London Energy Transformation Initiative (LETI) in its roadmap to net zero – placing it more than 40% below LETI's business-as-usual benchmark. The building will have a total of 591 kgCO<sub>2</sub>e embodied carbon per m<sup>2</sup> floor area.



## Innovation needs

The solutions that exist today are not sufficient to decarbonize the construction sector. Several innovations are needed. We see that there are innovation needs in mainly four areas: alternative construction materials, new

industrial processes, zero emission construction sites and zero emission transport systems. Below, we exemplify some areas that we think are interesting to explore and innovate further.

### Zero emission construction sites

*What solutions could help decarbonize construction machinery at construction sites?*

#### Electric construction sites

In cities, more than 20% of the total CO<sub>2</sub> emissions usually comes from heavy-duty construction equipment. This gives a large potential of reducing carbon emissions through development of zero-emission technologies such as battery-powered machinery. One example where this has been tested is in Oslo, where the first electric excavator with an integrated fast-charging interface was used.<sup>17</sup>



<sup>17</sup> <https://cleantechnica.com/2020/04/09/worlds-first-zero-emission-electric-construction-site/>

## Zero emission transport

*How to decarbonize the heavy transports needed to supply construction sites with materials?*

### Electrified roads

Electrified roads, where trucks and busses are continuously charged while moving, is one possible solution to decarbonize the heavy transport sector. A minor pilot has been up and running in Sweden for some years with positive results. The Swedish national transportation authority is now planning for a full-scale pilot. WSP is part of the project by developing the road plan. Except reducing the carbon emissions from heavy transports, there are also indications that electrified roads could contribute to a higher energy efficiency and reduced costs.

### Hydrogen/fuel cells

Fuel cells has potential to become a solution for decarbonizing heavy transports, either as a stand-alone solution or in combination with e.g. batteries. Fuel cells could possibly enable longer ranges than batteries alone. The potential for fuel cells is closely connected to the possibilities to produce and distribute hydrogen at competitive prices. Since hydrogen is produced from electricity, the potential is closely linked to the development of the power system.

## New industrial processes

*What new industrial processes could decarbonize manufacturing of construction materials?*

### Hydrogen-based steel making

The process to make steel from iron ore is today based on the use of coking coal. HYBRIT is a project initiated by the Swedish steel industry that aims at completely replacing the traditional fossil fuel-based steel production process with a new fossil-free hydrogen-based process. If the project succeeds, it would completely revolutionize the steel-making process.

### Electrified cement production

CemZero is an innovation project initiated by the cement producer Cementa together with the energy company Vattenfall. The scope of the project is to investigate the possibilities to electrify the cement-making process. Electrification of the process would reduce emissions, but not remove the need for CCS. It could also potentially make it easier to separate and capture the carbon emissions.

### Full-scale carbon capture and storage

Carbon capture and storage (CCS) is the process of capturing CO<sub>2</sub>, transporting it to a storage site and depositing it so it will not enter the atmosphere. CCS applied to a modern conventional power plant or a cement factory could reduce CO<sub>2</sub> emissions to the atmosphere by approximately 80–90% compared to a plant without CCS. It is also possible for CCS, when combined with biomass, to result in net negative emissions. Each of the three vital elements of CCS – capture, transportation and storage – is proven to be technically possible. What's been missing is how they could be integrated into a chain that benefits all parties. Without this chain, it's a question of who should take the risks and how to allocate the costs. CCS is also strongly reliant on predictable and robust legislation, both nationally and internationally. It is likely that the value chains cross over national borders. Today, it seems likely that CCS will be a necessity to decarbonize cement production. Current CCS technology captures about 50 % of carbon emissions from the cement manufacturing process. This needs to be developed. The first full-scale CCS application on a cement plant is believed to be in place in Norway in 2024.

## Alternative Construction materials

*Which new materials could replace traditional carbon intense materials like steel, cement and asphalt?*

### Sea-grown constructions

Will it be possible to grow constructions out of the ocean in the future? This was an idea in an innovation competition in Sweden. The idea was to grow a bridge in bio-concrete using carbon dioxide and lime from the ocean. By connecting a low electric voltage to a conductive material placed in sea water, a solid concrete-like material is created. This could be a low-carbon option compared to standard concrete bridges. By continuously applying an electrical voltage, the construction also becomes self-repairing and maintenance free. In the process hydrogen is produced, that can be recovered and used as energy.

### Bio-based asphalt

Asphalt is traditionally produced with the oil-based binder<sup>18</sup> bitumen. Substituting bitumen with bio-based alternatives is a promising solution to reduce emissions from asphalt production significantly. In the EU-financed research project Rewofuel, tests are currently taking place where bitumen is partly replaced by lignin.

### Graphene

Graphene is a very light material, but at the same time multiple times stronger than steel. Could graphene become competitive enough in the future to compete and potentially replace traditional construction materials in different applications? The Norwegian Public Roads Administration and Chalmers University of Technology has together looked at potential uses of graphene in transport infrastructure, and concluded that there are several possible applications where graphene could be an alternative.

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<sup>18</sup> Swedish Environmental Protection Agency  
<https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6855-4.pdf?pid=23825>

## Call for action

WSP is committed to the target of a net zero carbon construction sector before the middle of this century. It is an extremely challenging task, but possible if policy, incentives and ambitions of all stakeholders become aligned in the right direction along with innovation and technical discovery. Our intention with this paper is to highlight actions and activities that we believe are key in the development of a net zero construction sector. We call it “the WSP way”, as this is the way in which we see ourselves engage in projects from now on.

The WSP Way will need to change and evolve over time as the global knowledge base expands and the sector progresses, and we are committed to always look for new best practices and question the past.

However, we cannot do this alone. We are heavily dependent on competent and engaged clients and on collaboration with our suppliers and stakeholders along the entire value chain. WSP are committed to do our share and to contribute with the best of our global expertise in our projects. We hope you want to join us.



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