



Towards climate neutral office buildings

Assessment of an office building in Gothenburg

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white

Illustration: Tengbom

A WORKING LAB, AWL

Byggstart: Maj 2017

Färdigställande: Augusti 2019

Hyresgäster: Näringsliv, främst inom samhällsbyggnadssektorn

Verksamhet: Samverkan akademi, näringsliv och samhällsaktörer

Gestaltande arkitekt: Akademiska Hus

Projekterande arkitekt: Tengbom Arkitekter

Miljösamordning: White arkitekter

Byggherre: Akademiska Hus

Samverkansentreprenör: ByggDialog

Bruttoarea: 12 400 kvm

Ort: Göteborg

Campusområde: Campus Johanneberg



Illustration Tengbom

AWL- WOOD/STEEL HYBRIDE STRUCTURE



Illustration Tengbom



- **Towards climate neutral buildings. Assessment of an office building in Gothenburg**
- ***How does the building perform in relation to the pilot version of NollCO2?***
- The goal of the project was to minimize CO2 emissions during the buildings lifecycle. The assessment was performed at a later stage in the building process.

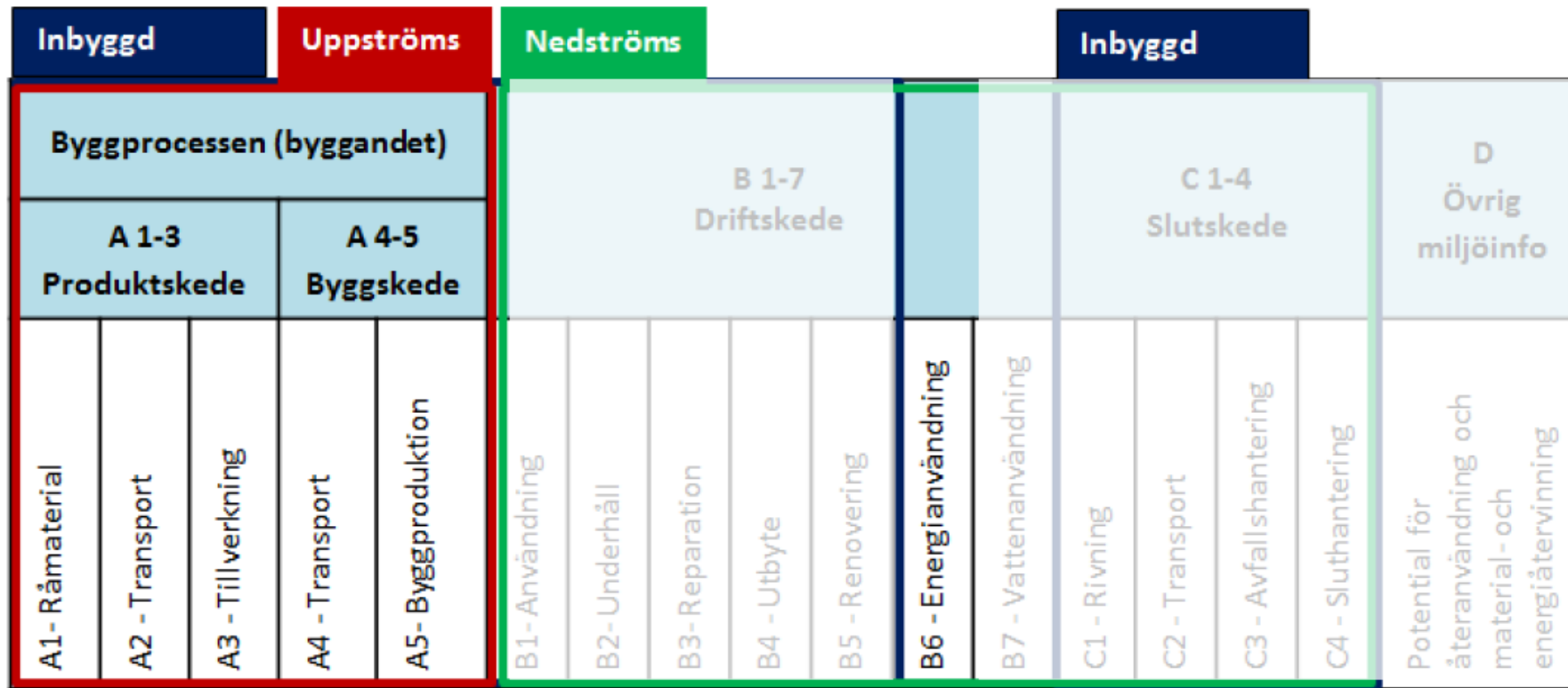
→ Demands

- The buildings should be certified with other top standard certification system (energieffektiv byggnad)
- "Green" tenant contracts (gröna hyresavtal)
- Energy and climate declaration

→ Indicators

- 1. Total CO₂-e balance
- 2. CO₂-e emissions from building components < 240 kg CO₂-e/m² (Atemp)
- 3. CO₂-e from the building site < 60 kg CO₂-e/m² Atemp

INITIAL- AND YEARLY CLIMATE DEBT



- Initial climate debt – CO2 emissions from building components and building site
- Yearly climate debt – building- and user energy demand

SIMPLIFICATIONS OF PILOT VERSION OF NOLLCO2

- **The same energy factor have been used for the hours of a day instead of hourly based energy demand and hourly based emission factors for energy production.**
- **Future scenario emission factors have not been used**
- **CO2 emission reduction for renewable energy accounted for 100% instead of 80%**
- **Embodied CO2 emissions from external renewable energy production has not been accounted for**
- **Emission factor for nordic electricity mix have been set to 125 g CO₂-e/kWh**

→ Certification system

Miljöbyggnad 2.2 (demand is MB3.0 Gold)

→ Green tenant contracts

Not included in the existing contracts

→ Energy- and climate declaration

**System interaction with local energy distribution network
not calculated**

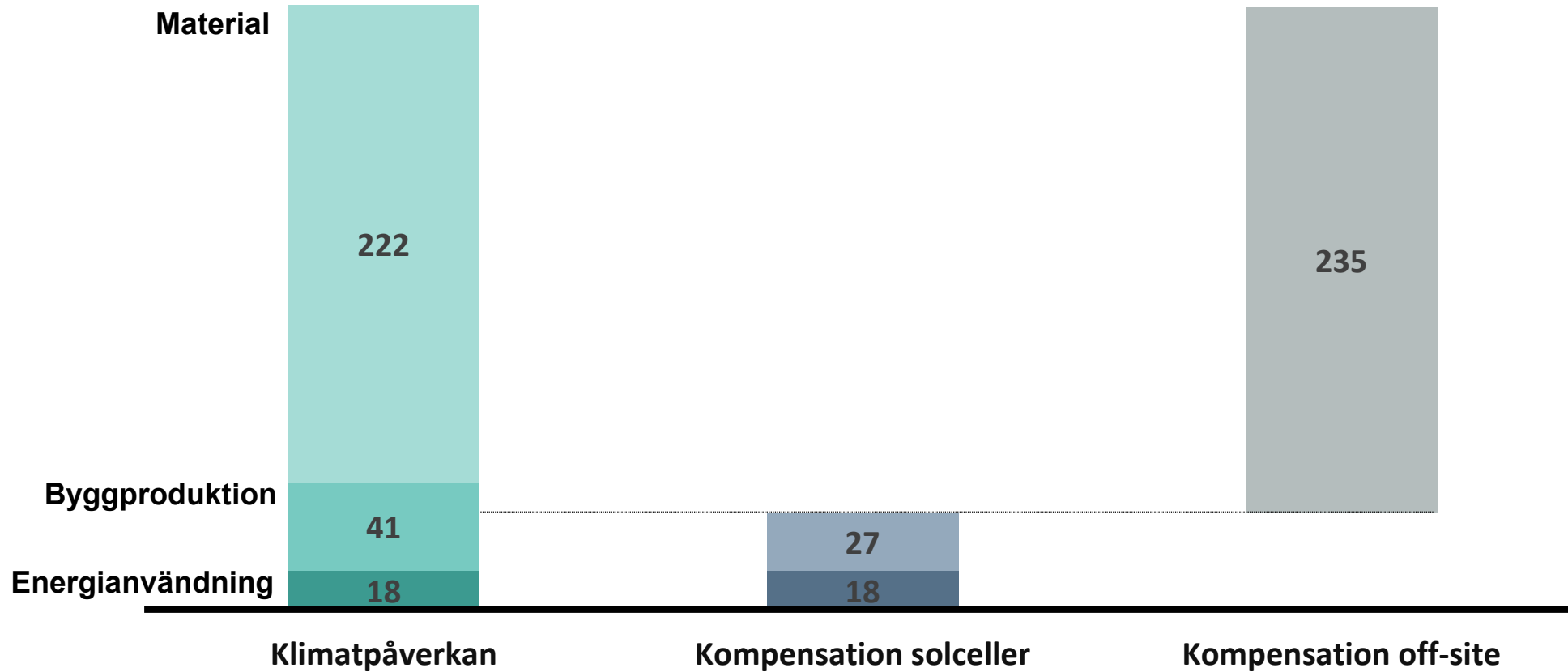


INDICATOR 1 TOTAL CO2 BALANCE

Klimatpåverkan	Kompensation solceller i projektet (26 års drift)	Extern kompensation (26 års drift)
Material- 222 kgCO ₂ -e/m ² A _{temp}		
Byggproduktion- 41 kgCO ₂ -e/m ² A _{temp}	27 kgCO ₂ -e/m ² A _{temp}	
Energi (drift 26 år)- 18 kgCO ₂ -e/m ² A _{temp}	18 kgCO ₂ -e/m ² A _{temp}	
281 kgCO ₂ -e/m ² A _{temp}	45 kgCO ₂ -e/m ² A _{temp}	235 kgCO ₂ -e/m ² A _{temp}

INDICATOR 1 TOTAL CO2 BALANCE

[kgCO₂-e/m² Atemp]



*Energianvändning och produktion under 26 år

INDICATOR 2

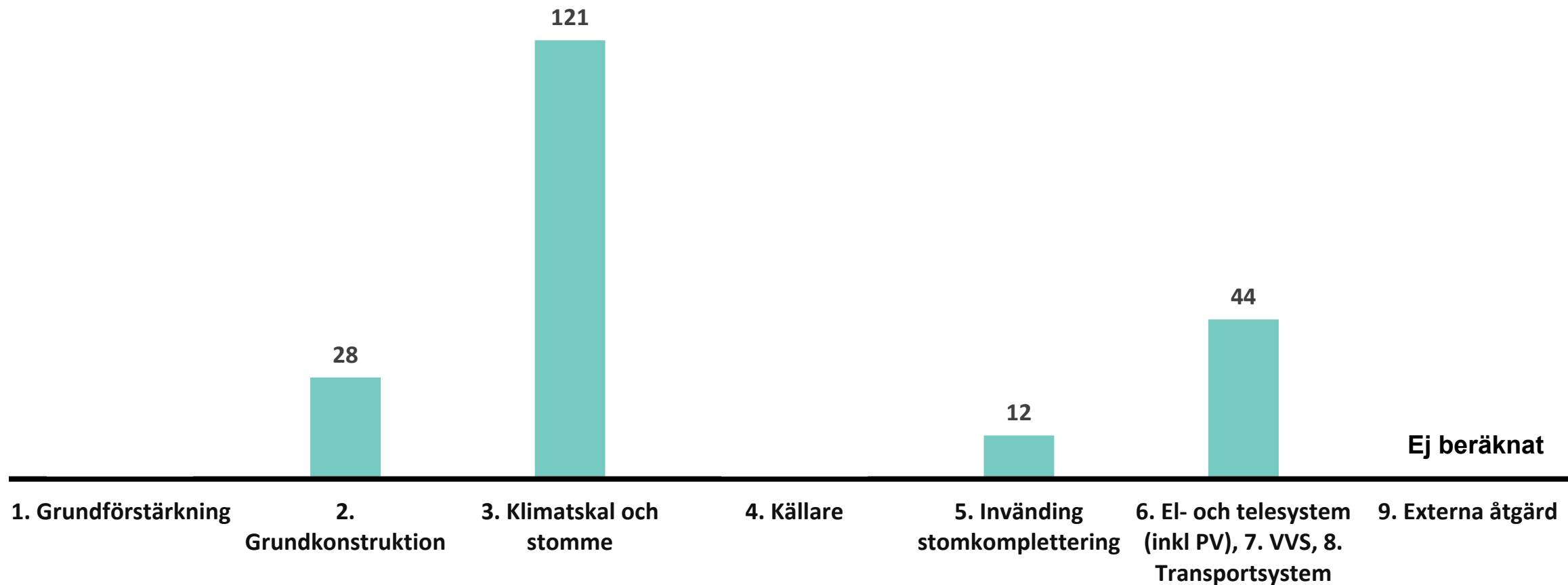
CO2 emissions from building components

- Maximum CO2 emissions: $240 \text{ kg CO}_2\text{-e/m}^2 A_{\text{temp}}$
- Project CO2 emissions: $205 \text{ kg CO}_2\text{-e/m}^2 A_{\text{temp}}$
- Indicator fulfilled



INDICATOR 2 BUILDING COMPONENTS

→ Emissions from building components:
205 kg CO₂-e/m² A_{temp}

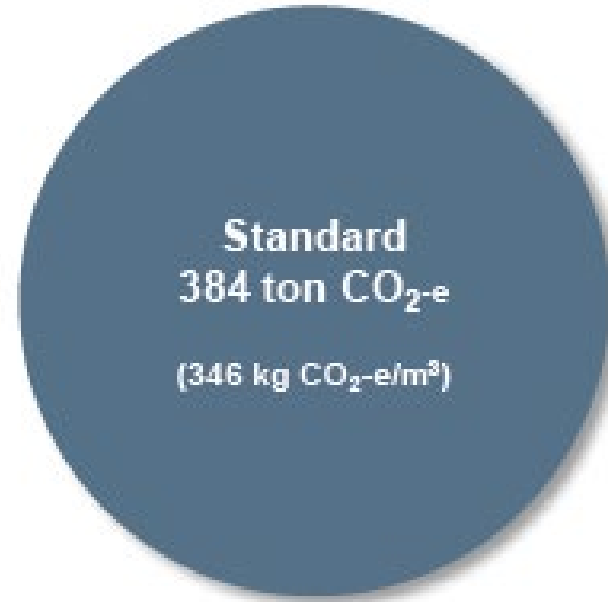
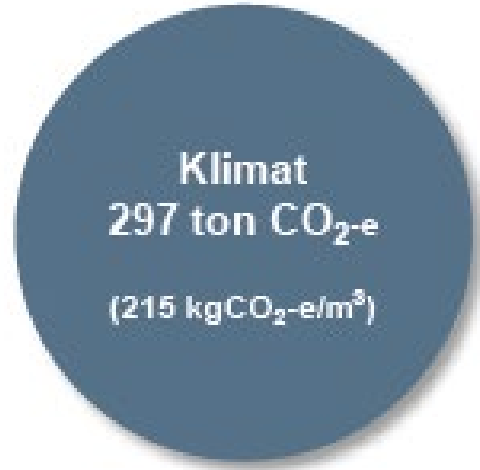


LOW CLIMATE IMPACT STEEL



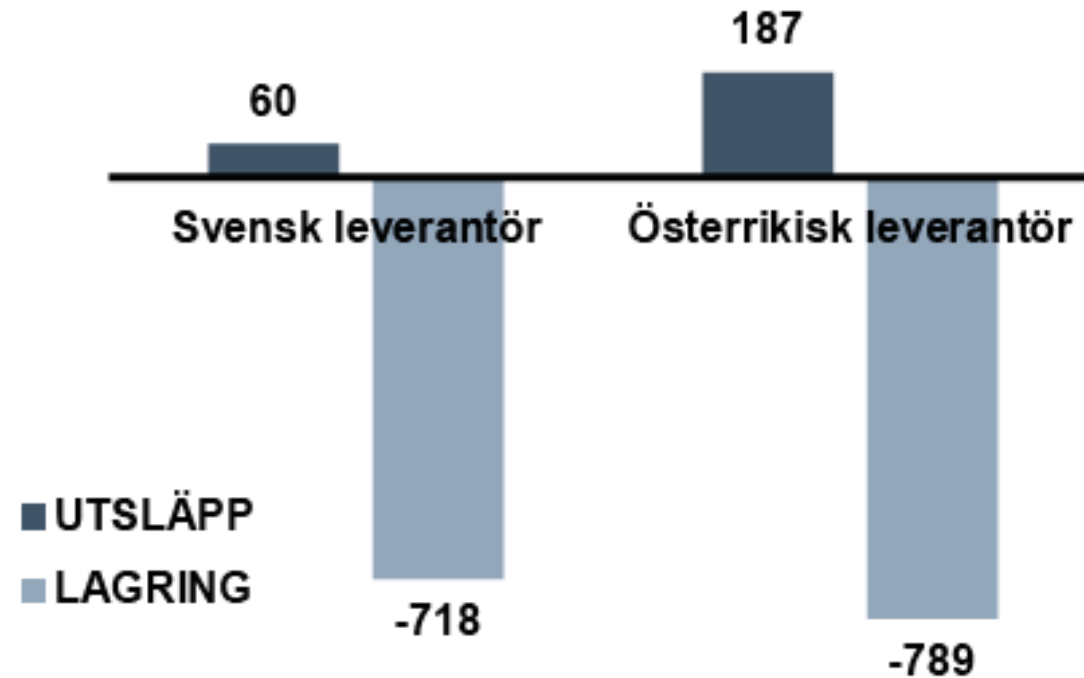
Comparison between the two producers of reinforcement steel with the highest and lowest climate impact found in the project in tonnes CO2e.

LOW CLIMATE IMPACT CONCRETE



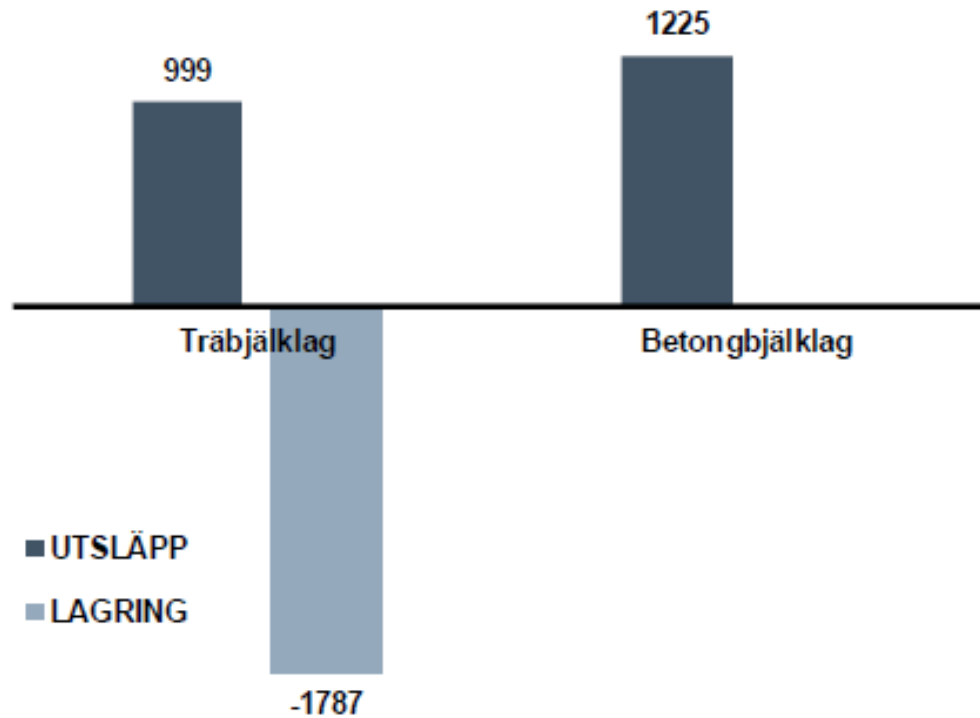
CO₂ savings with optimized concrete utilized in AWL, compared to industry standard.

CROSS LAMINATED TIMBER

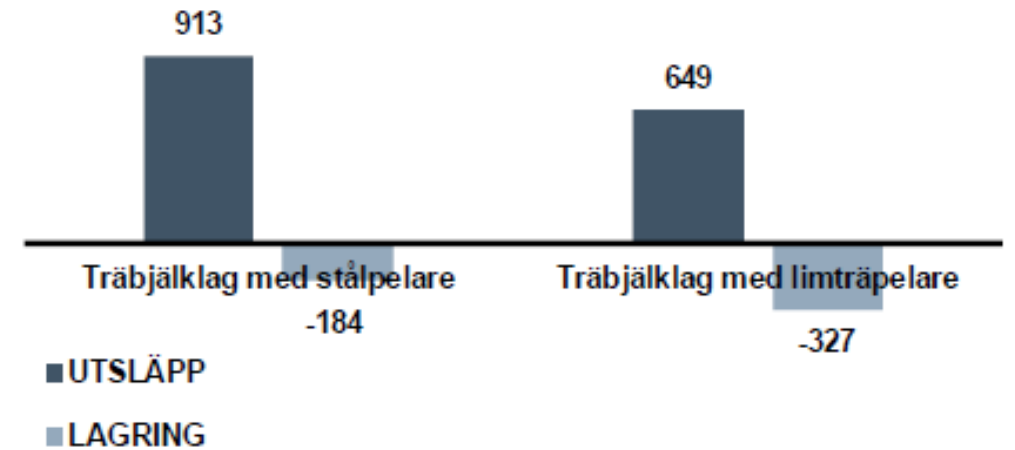


CO2 emissions from CLT. The Austrian producer was chosen because of capacity challenges of local producers.

OPTIMIZATION POTENTIAL - STRUCTURAL SYSTEM

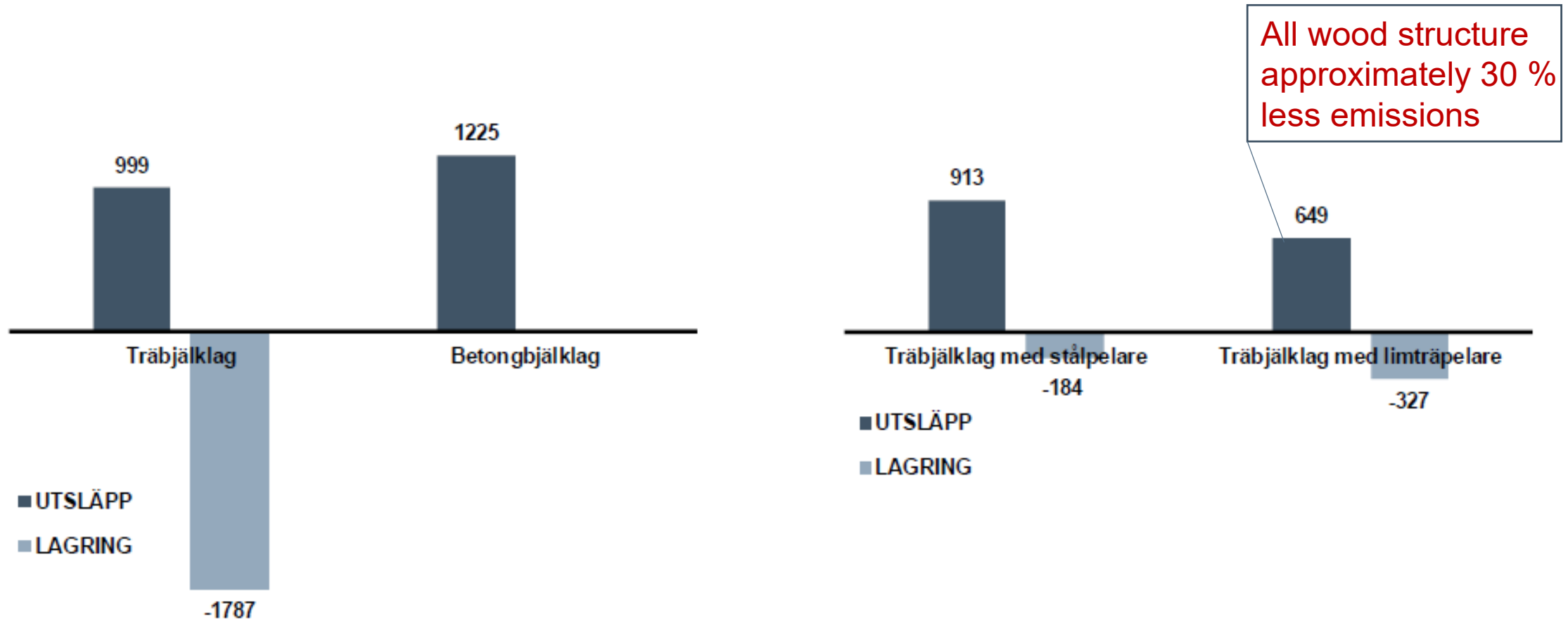


Comparison between CLT decks and concrete slabs, tonnes CO2e.



Comparison of climate impact between hybrid CLT decks and steel pillars and all CLT wood structure, tonnes CO2e.

OPTIMIZATION POTENTIAL - STRUCTURAL SYSTEM



Comparison between CLT decks and concrete slabs, tonnes CO2e.

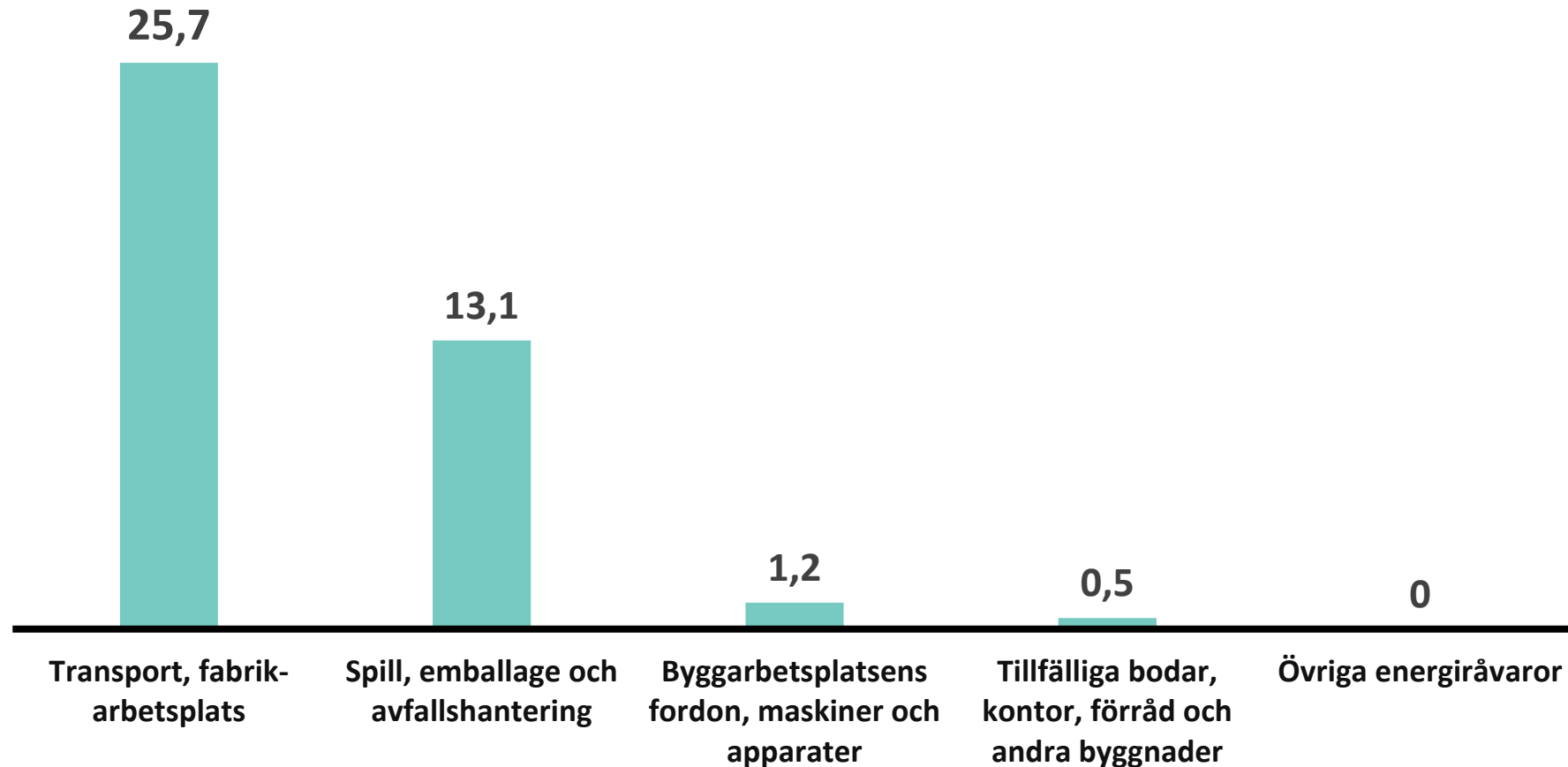
Comparison of climate impact between hybrid CLT decks and steel pillars and all CLT wood structure, tonnes CO2e.

INDICATOR 3 BUILDING SITE

- Demand 60 kg CO₂-e/m² A_{temp}
- Project emissions 31 kg CO₂-e/m² A_{temp}
- **Indicator fulfilled**

INDICATOR 3 BUILDING SITE

→ **Building site: 41 kg CO₂-e/m² A_{temp}**



INDICATOR 1 YEARLY CLIMATE DEBT

→ Energy consumption

	Energibehov [kWh/m ² A _{temp} , år]	GWP [kgCO ₂ -e/kWh]	Utsläpp [kg CO ₂ -e/m ² A _{temp} år]	Källa
Värmebehov	25	0,015	0,365	Akademiska Hus
Kylbehov	9	0,012	0,107	Akademiska Hus
Elbehov	47	0,005	0,235	Enligt mail från Peter Karlsson (Akademiska Hus)
TOTAL			0,707	



INDICATOR 1 REPAYMENT WITH LOCAL RENEWABLE ENERGY PRODUCTION

→ On site PV production

	Energiproduktion [kWh/m ² A _{temp} , år]	GWP (nordisk el mix) [kg CO ₂ -e/kWh]	Kompenserat utsläpp [kg CO ₂ -e/m ² A _{temp} år]	Källa
Solceller	14	0,125	1,75	Naturvårdsverket



INDICATOR 1 YEARLY EMISSIONS

→ CO2 emissions from energy consumption and renewable energy production

Utsläpp
energianvändning

[kgCO₂-e/m² A_{temp}, år]



Kompenserat utsläpp
energiproduktion solceller

[kgCO₂-e/m² A_{temp}, år]



INDICATOR 1 EXTERNAL COMPENSATION

→ Emissions to balance

$235 \text{ kgCO}_2\text{-e/m}^2 A_{\text{temp}} = 100970 \text{ kgCO}_2\text{-e/år (26 år)}$

→ Approximation of equivalent electricity production 807,8 MWh/år

INDICATOR 1 EXTERNAL COMPENSATION

- **Energy demand of 180 kWh/m² is approximately equates to a PV area of about 4500 m².**
- **External PV production about 4,5 x the PV area installed on AWL**
- **With linearly diminishing emission factors for Nordic electricity-mix the area equates to about 9000 m².**

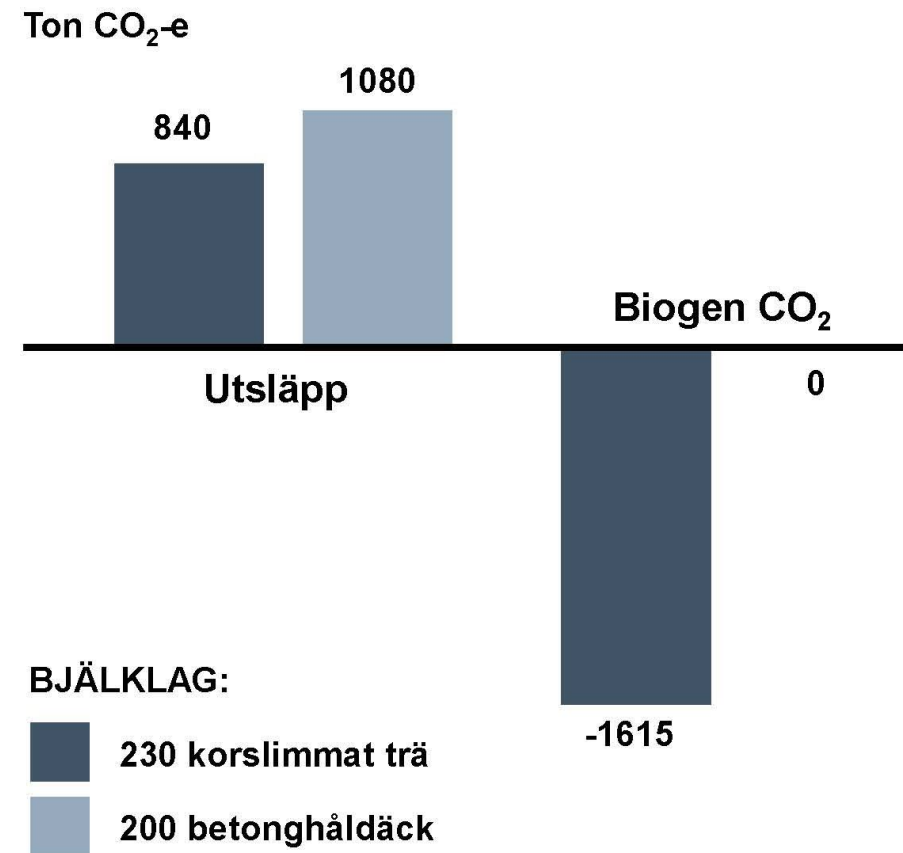


BIOGENIC CARBON

→ Repayment of initial climate debt with biogenic carbon?



A WORKING LAB- TRÄBJÄLKLAG



(Biogen CO₂= kollagring i trä)

CONCLUSION

- **CLT decks give a reduction of climate impact of the structure of about 20% compared to concrete slabs**
- **Steel beams in the structure increased the climate impact of about 40% compared to CLT wood beams, but allowed for an additional floor**
- **Low impact climate concrete in the basement decreased climate impact by about 35% compared to standard construction concrete**
- **Reinforcement steel with least climate impact gave a reduction of about 50% compared to the product with the greatest climate impact on the market**

THANK YOU!

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