

LESSONS LEARNT FROM THE DESIGN AND CONSTRUCTION STRATEGIES OF TWO NORWEGIAN LOW EMISSION CONSTRUCTION SITES

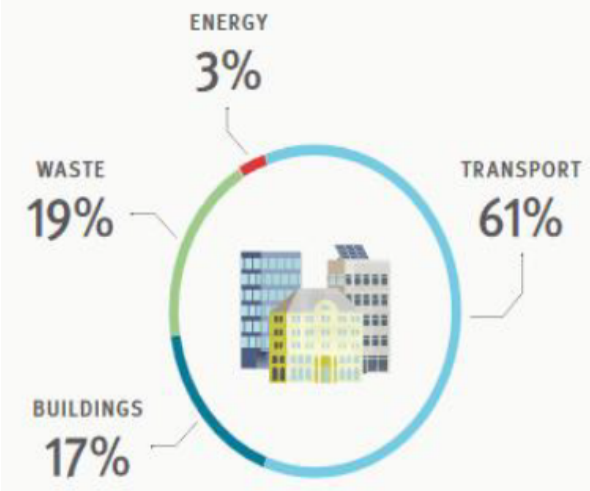
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Background

- Construction sites are a major source of greenhouse gas emissions
 - 5-10% of total emissions in cities¹
 - In Oslo, construction sites generate ca. 7% of total emissions²

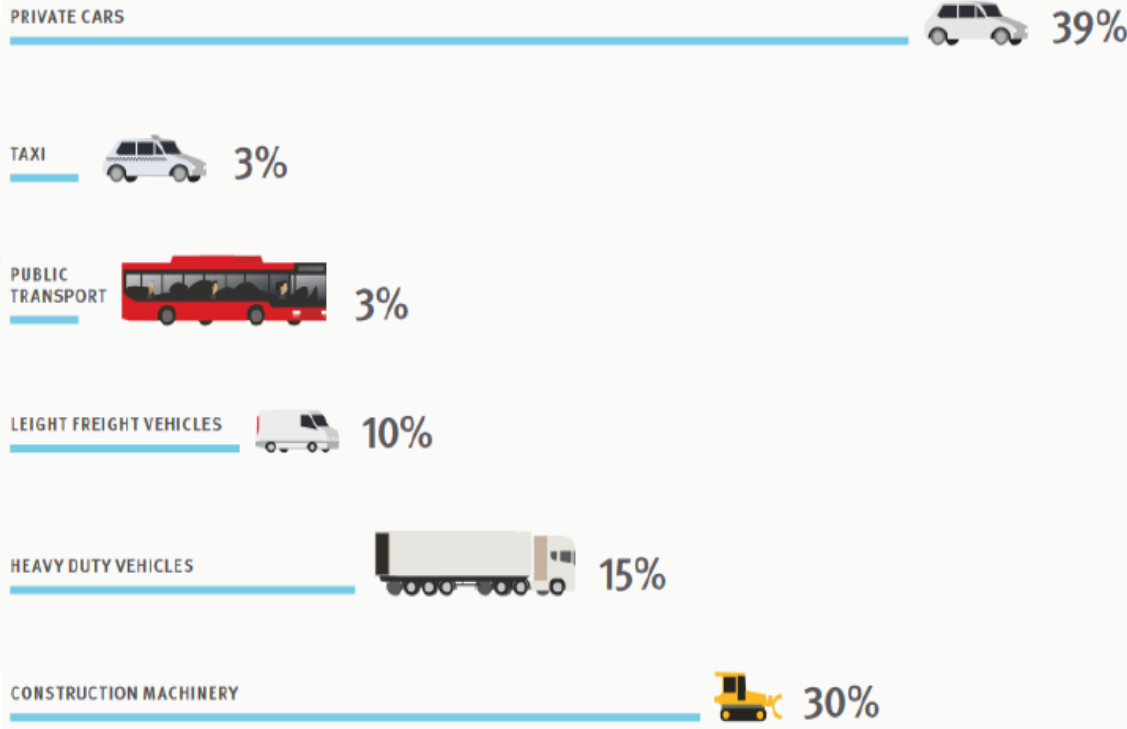
Main sources of greenhouse gas emissions in Oslo



Source: Statistics Norway combined with The City of Oslo's own numbers, 2013.

Distribution of emissions from transport

Source: Statistics Norway combined with The City of Oslo's own numbers, 2013.



¹<https://www.klimaoslo.no/wp-content/uploads/sites/88/2019/06/Perspectives-on-zero-emission-construction.pdf>

²<https://www.smartcitiesworld.net/news/news/cities-commit-to-clean-construction-to-cut-building-emissions-by-up-to-44-per-cent--4665>

Background

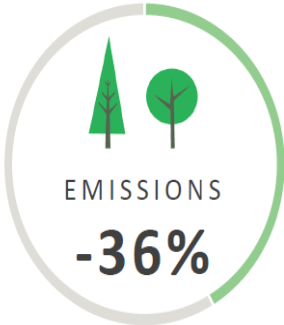
NORWAY

Main pledges and targets

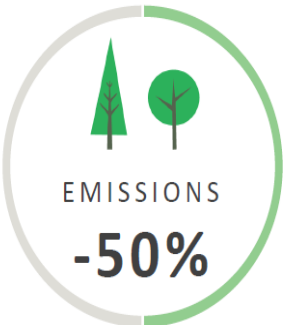


PARIS AGREEMENT	Ratified	Yes
	2030 unconditional target(s)	40% below 1990 by 2030 [44% below 2010 by 2030]
	2030 conditional target(s)	Carbon neutrality
LONG-TERM GOAL(S)	Long-term goal(s)	Low carbon society by 2050 Reduction in GHG emissions by 80–95% from 1990 reference

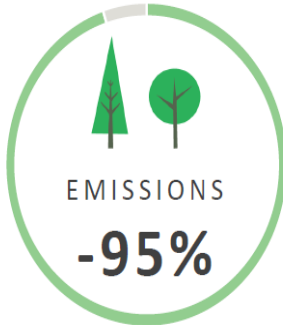
Reference: <https://climateactiontracker.org/countries/norway/>



by 2020



ASAP
(2022 by the earliest)



by 2030

Reference:
http://www.procuraplus.org/fileadmin/user_upload/Activities_files/Events/Oslo_2018/1__Green_Oslo_Climate_Budget_ICLEI_Procurea_Seminar_22032018.pdf

Objective

- To present the lessons learnt from the two Norwegian construction sites
 - Campus Evenstad in Hedmark
 - Lia nursery school in Oslo

Processes

Energy use

Optimisation /
digitalisation

LCA



Lia nursery school, Emission free construction site- pre-project funded by Regional research fund

- Fufa, S. M. (2018). GHG emission calculation from construction phase of Lia barnehage. SINTEF notes no. 29. ISBN:978-82-536-1586-8
- Fufa, S. M., S. Mellegård, M. K. Wiik, C. Flyen, G. Hasle, L. Bach, P. Gonzalez, E. S. Løe and F. Idsøe (2018). Utslippsfrie byggeplasser - State of the art. Veileder for innovative anskaffelsesprosesser. SINTEF Fag rapport nr. 49. ISBN:978-82-536-1589-9.



Campus Evenstad, ZEB pilot building



The Research Centre on
Zero Emission Buildings

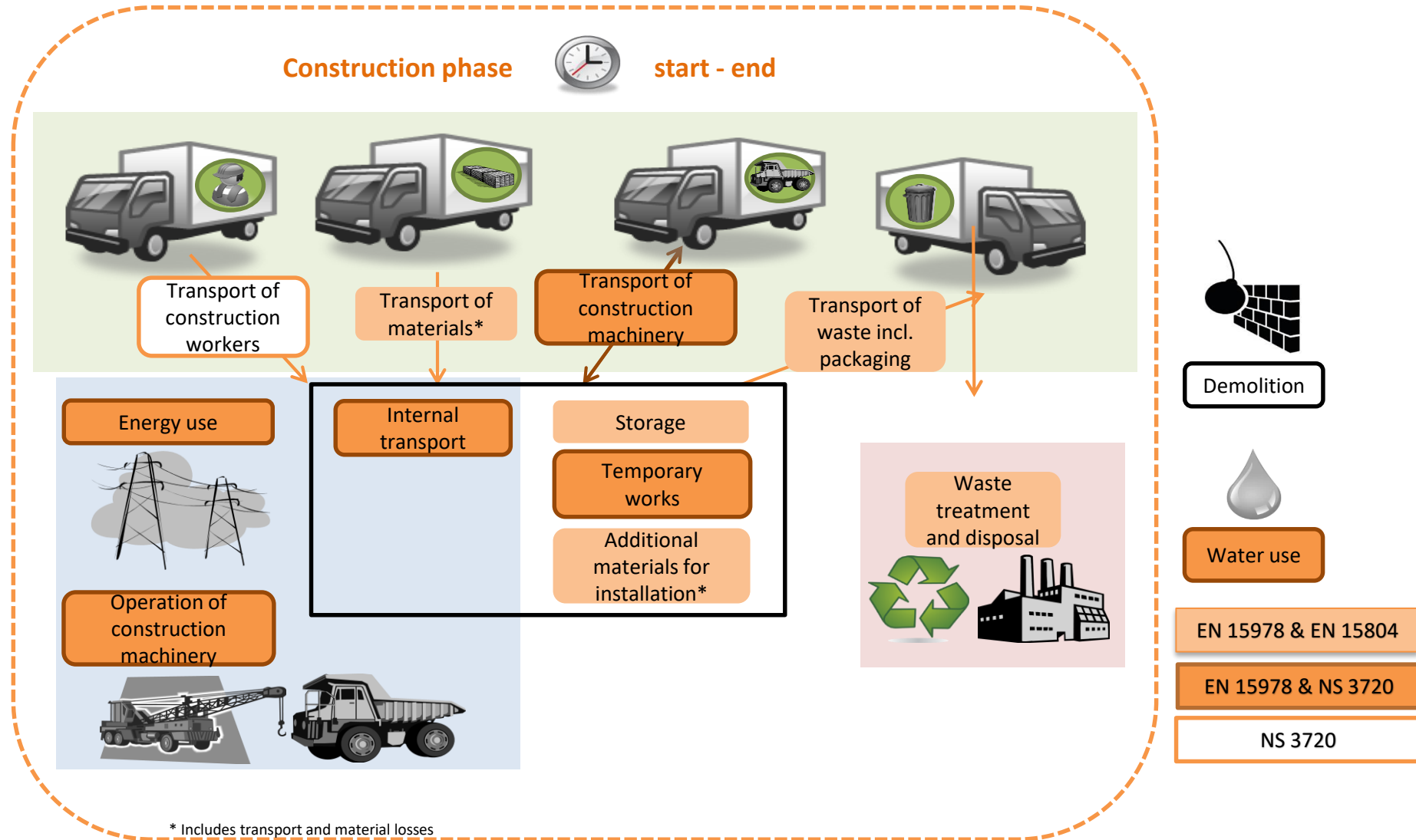


- Eivind Selvig, Marianne Kjendseth Wiik, Åse Lekang Sørensen. Campus Evenstad - Jakten på nullutslippsbygget ZEB-COM. 2017.
- Wiik MK, Sørensen ÅL, Selvig E, Cervenka Z, Fufa SM, Andresen I. ZEB Pilot Campus Evenstad. Administration and educational building. As-built report. The Research Centre on Zero Emission Buildings. ZEB Project report no 36.; 2017
- Fufa, S. M., M. K. Wiik and I. Andresen (2019). Estimated and actual construction inventory data in embodied GHG emission calculations for a Norwegian zero emission building (ZEB) construction site. Smart Innovation, Systems and Technologies P. Kaparaju, R. J. Howlett, J. Littlewood, C. Ekanyake and L. Vlacic. Switzerland, Springer Nature Switzerland.

Definition

- Emission free construction site: is a construction site that does not have any direct or indirect greenhouse gas (GHG) emissions from its construction activities
 - ✓ Electric or hydrogen-powered construction machinery, electricity or district heating for temporary heating and drying, use of zero emission vehicle transport to, from, and at building sites
- Fossil free construction site: is a construction site that does not use any fossil fuels in any of its on-site construction activities.
 - ✓ Bioenergy and biofuels (i.e. HVO or wood pellets) or alternative renewable energy resources such as electricity or hydrogen.

System boundary



Standards: EN15978, on environmental performance of construction works (orange text box & orange text box with brown frames)

EN15804, on rules for environmental product declarations of construction products (orange text box)

prNS3720, Method for greenhouse gas calculations for buildings (orange text box; orange text box with brown frames & white text box with brown frames)

Case studies

○ Campus Evenstad: administration and educational building

- Located in Hedmark, Norway
- 1141 m² BRA
- ZEB-COM
- Consists of a solid wood construction, wood fibre insulation, and timber cladding
- 15.12.2015 – 22.12.2016 (374 days)

○ Lia nursery school

- Located in Oslo (Harald Sohlbergs vei 21)
- 1600 m² BRA
- Plus building, BREEAM-NOR very good; fossil free
- Prefabricated timber elements, hollow concrete slab flooring, and light weight concrete roof elements
- 10th April 2017 - 27th November 2017 (166 days)



Early planning



More time and resources were used in the early planning of the construction sites

- Ambition, definition, concepts, challenges and opportunities were discussed
- Good transport logistics planning to, from and within the construction site
 - urban setting (lack of space, storage area and close by school)
- Shorter construction period (project being completed one month before schedule) and
- Emission reduction measures were discussed and evaluated
 - GHG emission calculations
- Transport logistics plan was implemented to avoid driving empty or partial loads
- 33% decrease in emissions from person transport and a 25% decrease in emissions from the transport of building materials

Construction methods and energy sources

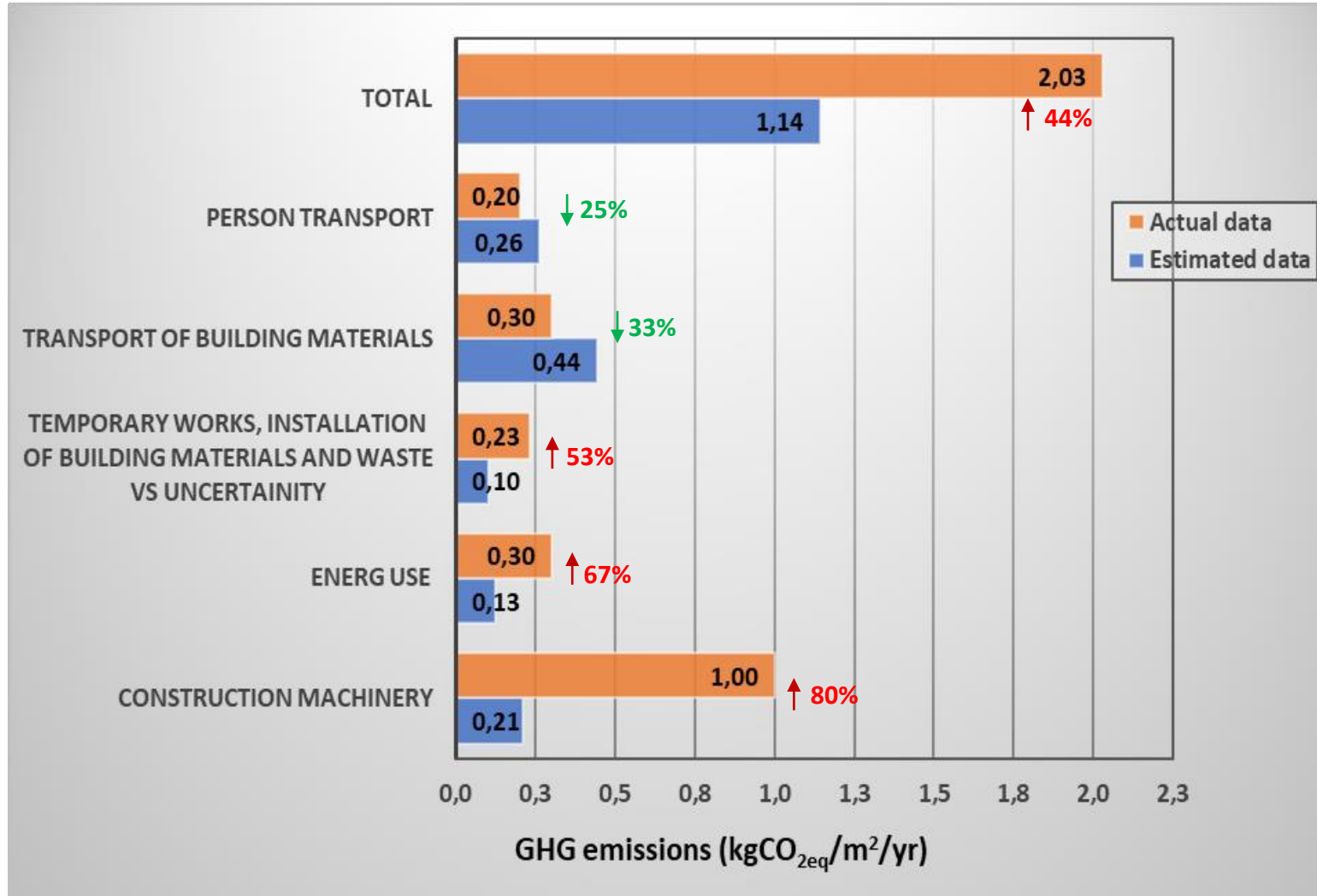


- Prefabricated construction solutions (shorter construction period)
- Locally produced elements
- Fossil free alternative energy sources
 - Electricity (from the electricity grid)
 - Lack of electric machineries
 - Construction machineries delivered with tank full of diesel



- Low carbon materials
 - Solid wood construction system with wood fibre insulation and timber cladding
- Locally available materials
- Fossil free alternative energy sources
 - Electricity from the electricity grid and CHP
 - Uncertainties in the use of biodiesel
 - lack of technological developments of construction machinery

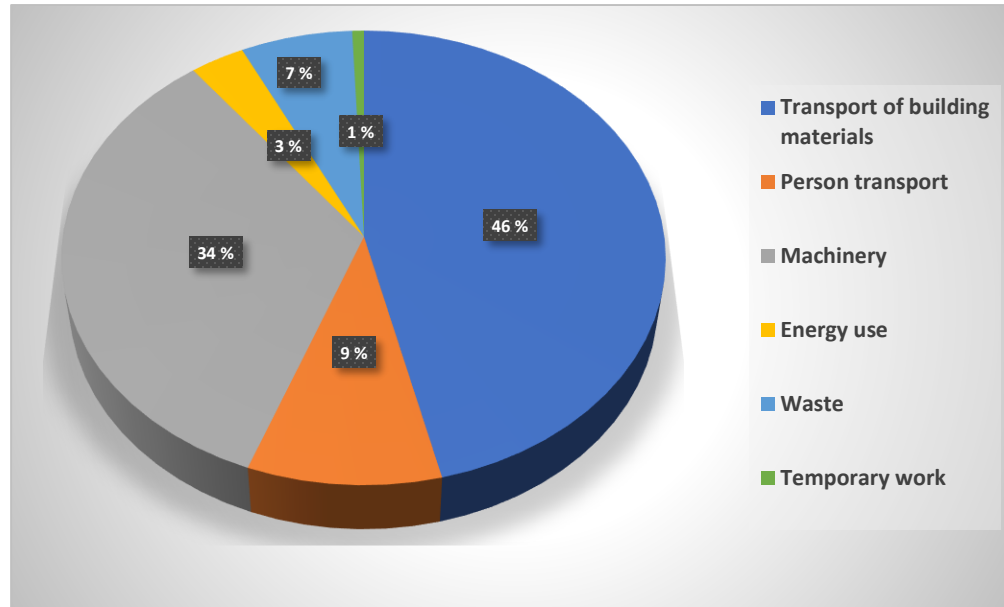
GHG emissions



GHG emission results from Campus Evenstad using estimated and actual data

- The estimated results were used to evaluate, plan and reduce emissions
 - Using locally produced building materials
 - Restructuring deliveries to cut trips
- Emissions from construction machinery was largely underestimated
 - Lack of technology
- Reducing energy consumption

GHG emissions



GHG emission results from Lia nursery school actual data

Construction site activities	Campus Evenstad		Lia nursery school (kgCO _{2eq} /m ² /yr)
	Design phase (kgCO _{2eq} /m ² /yr)	As-built phase (kgCO _{2eq} /m ² /yr)	
Transport of building materials	0,44	0,30	0,55
Installation of building materials	0,00	0,20	N/A
Construction machinery	0,21	0,96	0,4
Energy use	0,13	0,34	0,04
Person transport	0,26	0,21	0,11
Temporary work	0,00	0,02	0,01
Waste	0,00	0,01	0,08
Uncertainty	0,09	N/A	N/A
Sum (kgCO_{2eq}/m²/yr)	1,14	2,03	1,19

Conclusions

- Achieving a fossil or emission free construction site
 - Challenging
 - ✓ Lack of knowledge and experience amongst stakeholders, high costs, lack of access to fossil-free or emission-free solutions and use of new technologies
 - Achievable through
 - ✓ Good planning in the early phase, with consideration of external factors
 - ✓ Collaboration between all involved stakeholders
 - ✓ Clear definition of ambitions and requirements
 - ✓ Setting transparent, measurable and comparable requirements in the procurement process (enable the building industry to develop and implement new and innovative emission free solutions)
 - ✓ Use of quantitative evaluations methods (e.g. LCA methodologies) to evaluate the actual emission reductions



Teknologi for et bedre samfunn