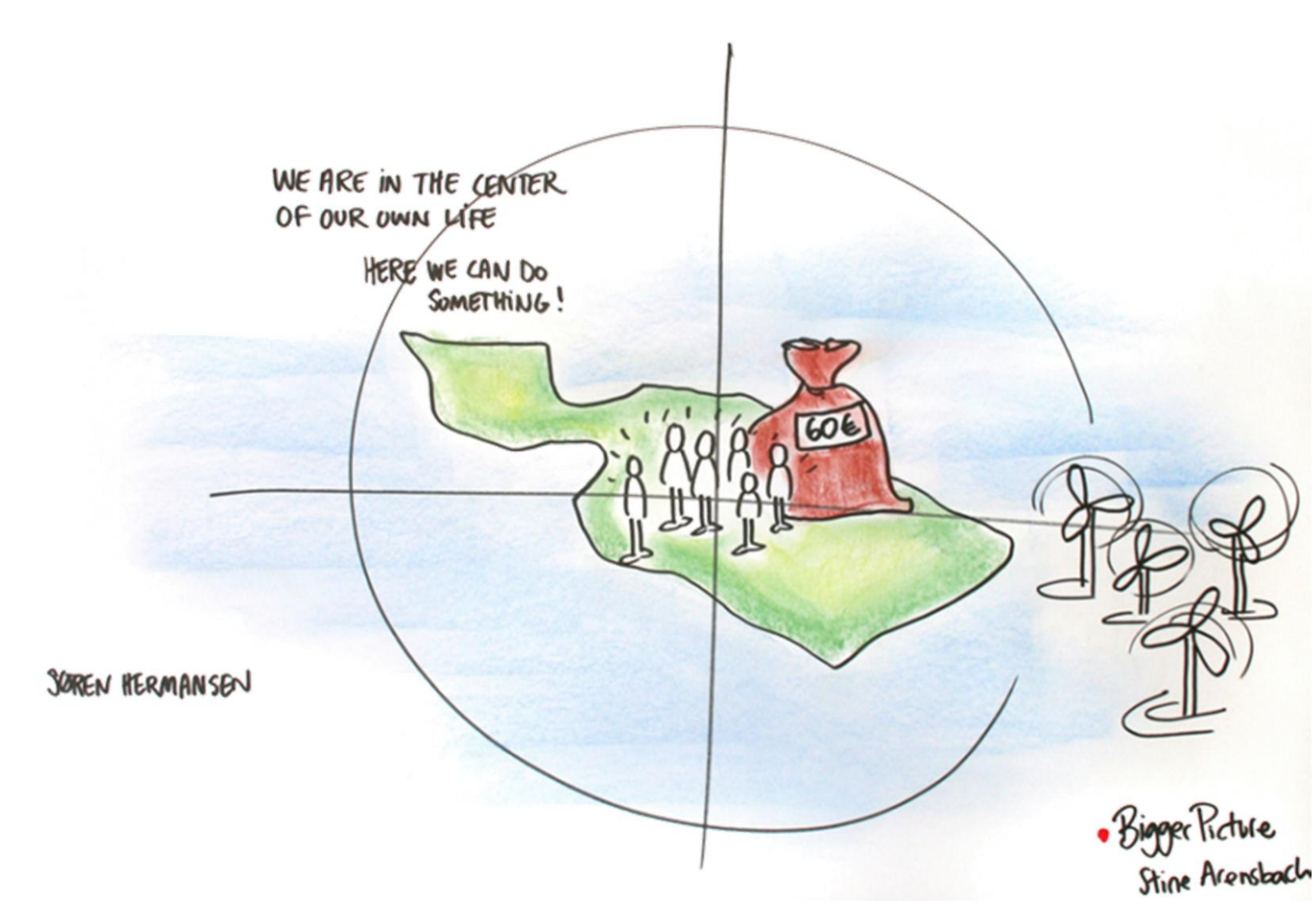
Bridge Life Cycle Optimisation

Test of Bridge LCA

Why?

Bridge Life Cycle Optimisation



The big picture

Bridge Life Cycle Optimisation

➡ gain better basis for decisions

Phases of the project

Bridge Life Cycle Optimisation

- Raw materials
- Construction
- O&R and Repair
- End of Life (EOL)

Raw materials (+ production)

Bridge Life Cycle Optimisation

- Input in each phases of a project and for each part of the bridge
- The names are not the same in all Nordic countries
- Stainless steel is not included
- Possible to insert the raw materials for the bridge – not for the road
- Only few emission vector for cement and two for steel
- Applicable for all phases from feasibility to design
- The need for product specific data emerges

Construction

Bridge Life Cycle Optimisation

- Includes materials for adjoining parts of the bridge (embankment, soil protection etc.)
- …and energy (diesel and electricity)
- Can be hard to predict
- Low impact/importance
- Mainly applicable in later stages

Operation & Maintenance and Repair

Bridge Life Cycle Optimisation

- Ensures that no environmental burdens are pushed
- Little overall importance
- Does not link to the LCC tool
- Can be difficult to acquire data
- Daily traffic not included
- Traffic disturbance has little impact

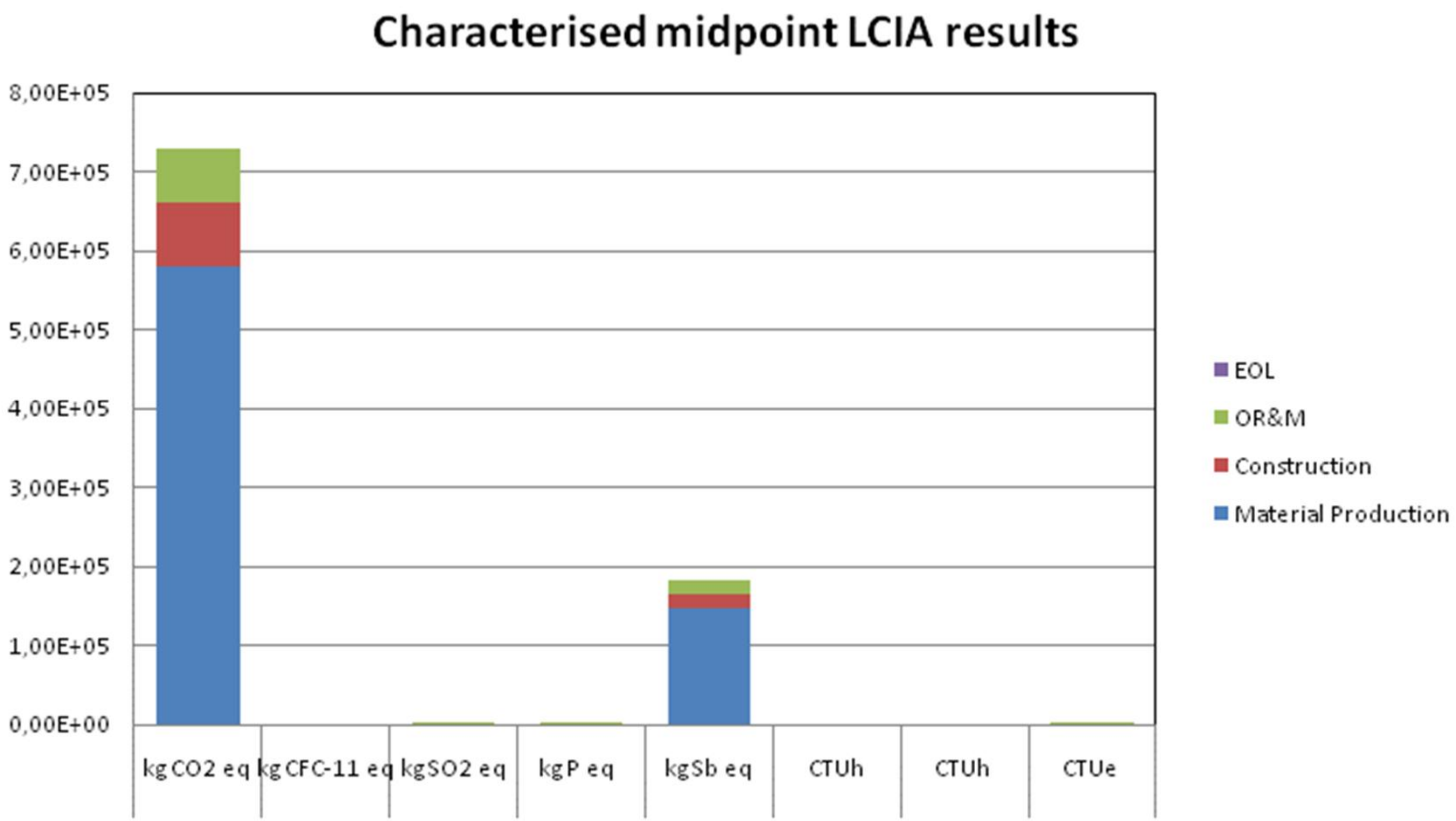
Bridge Life Cycle Optimisation

End Of Life (EOL)

- Credits are not given in this phase
- Energy for demolition
- Little importance
- No knowledge about future
- Happens after a long life time…

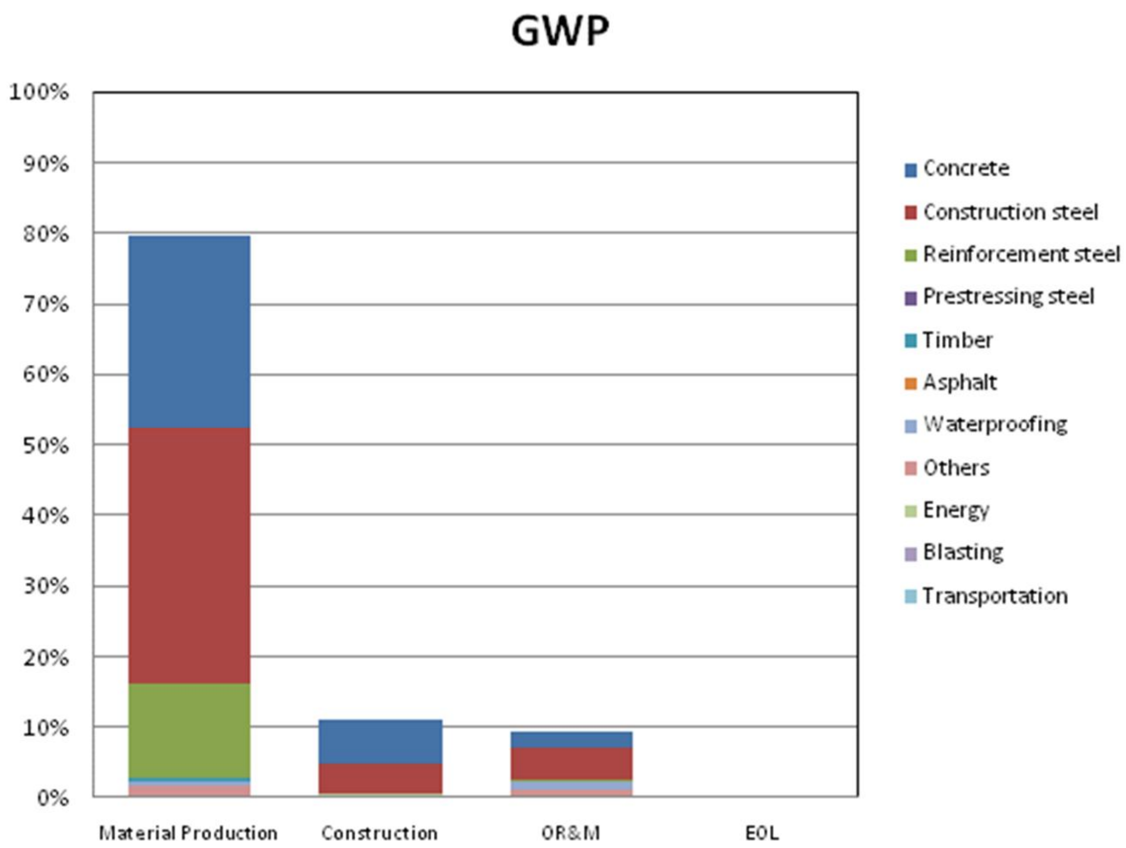
Results – the first step

Bridge Life Cycle Optimisation



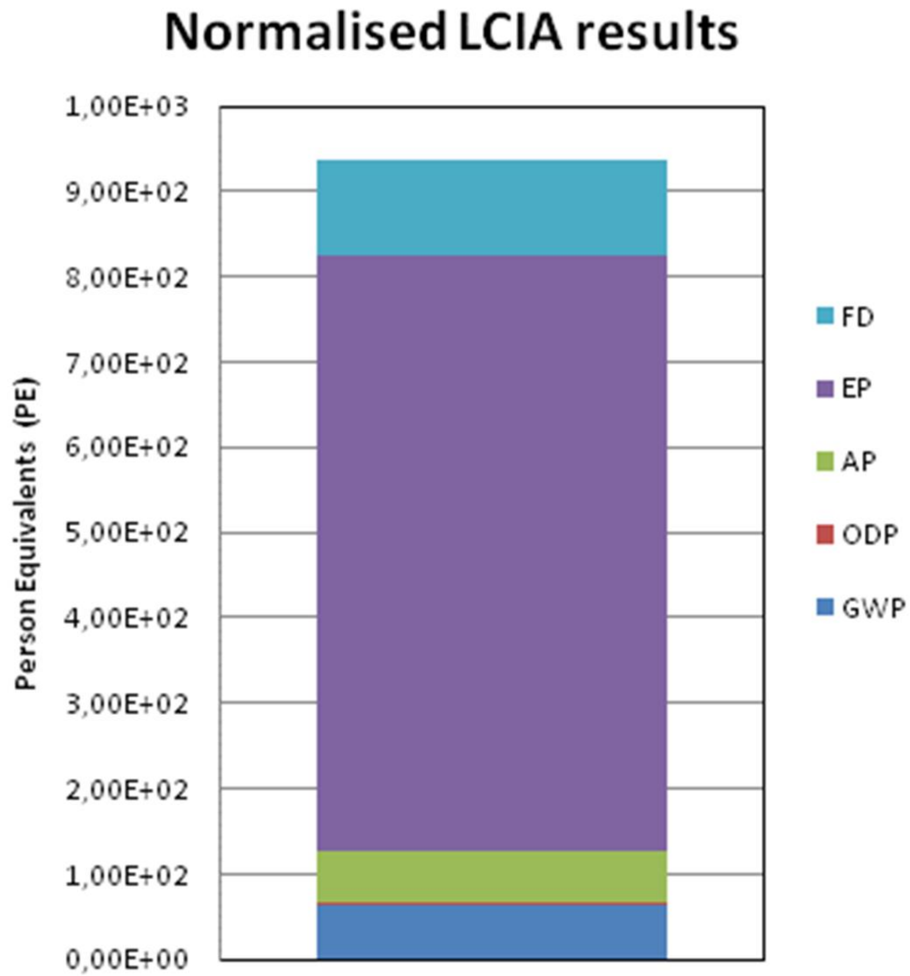
Results – an example

Bridge Life Cycle Optimisation



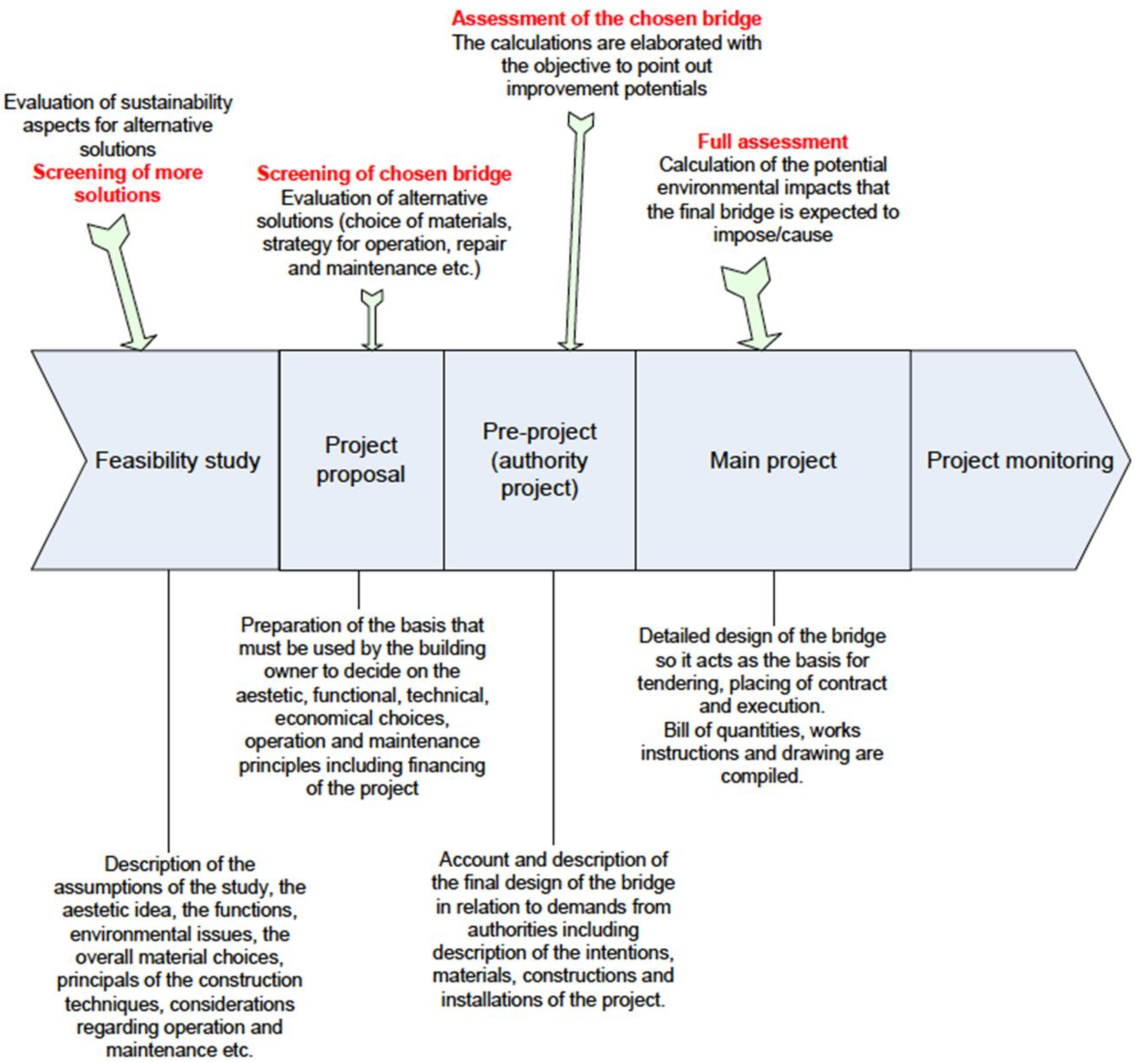
Normalised and weighted results

Bridge Life Cycle Optimisation



Overall conclusions

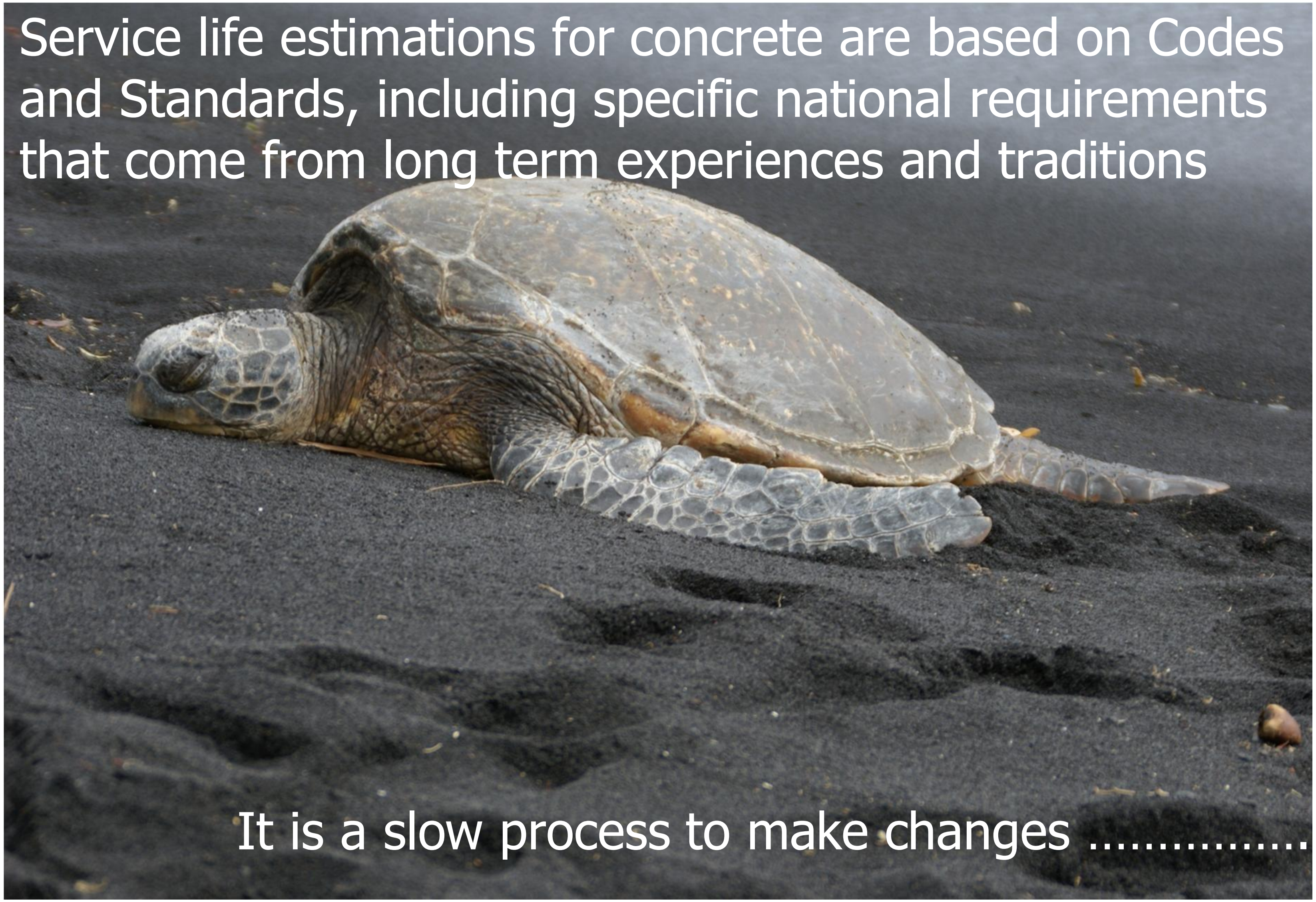
Bridge Life Cycle Optimisation



Bridge life cycle optimisation

Bridge Life Cycle Optimisation

Service life estimations for concrete are based on Codes and Standards, including specific national requirements that come from long term experiences and traditions



It is a slow process to make changes ....

Service life, standards and Vindingevej example

Bridge Life Cycle Optimisation

Extract of Contents page from report on cement for infrastructure projects in Denmark

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Vindingevej example, concrete

Bridge Life Cycle Optimisation

Near Roskilde Festival

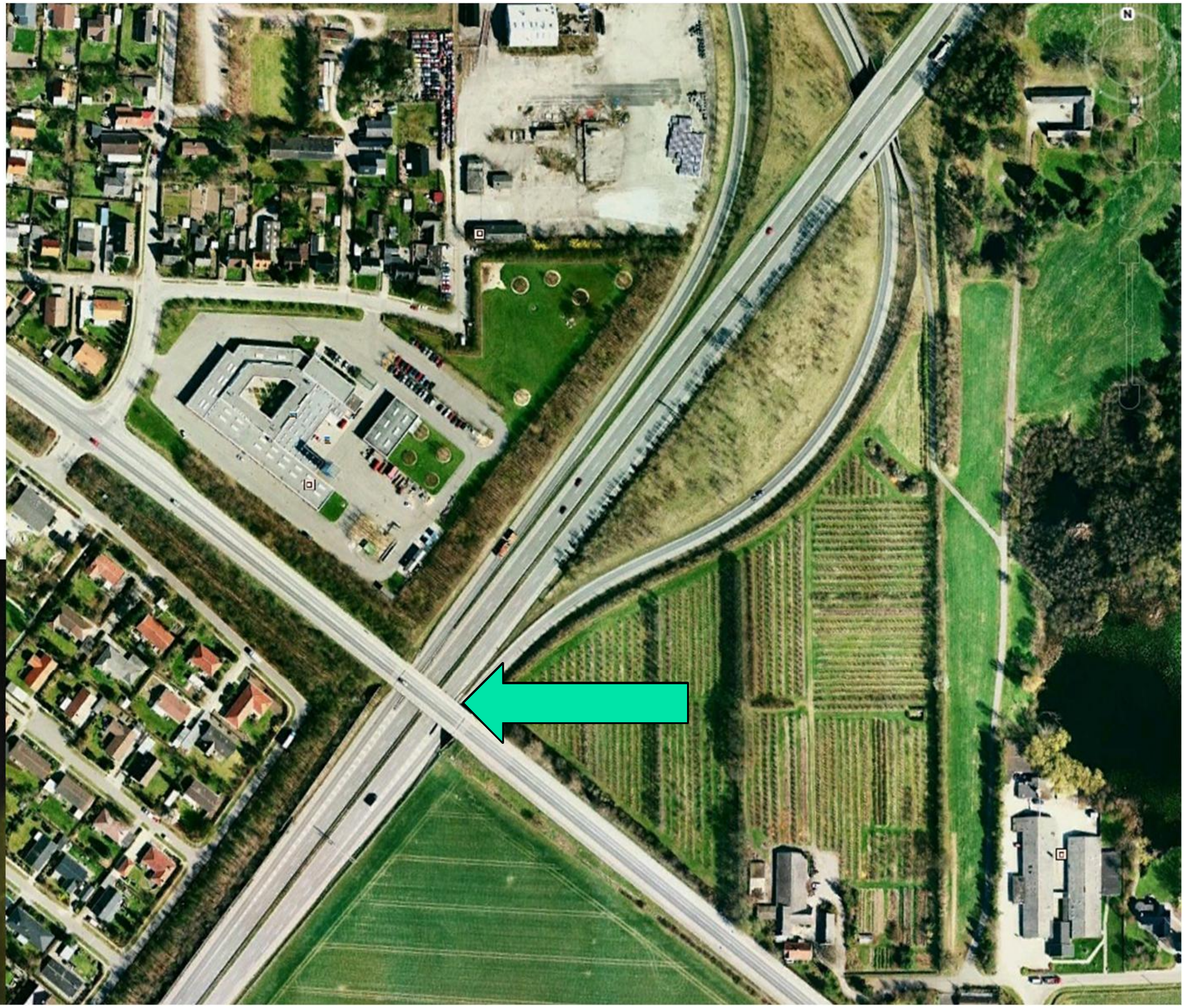

Table 7-1: Data for concrete used at Vindingevej based on CO_2 emission from cement.
**Data from cement supplier*

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Vindingevej example, concrete

Bridge Life Cycle Optimisation

Bridge part	Concrete m^3	Cement content, kg/m^3	CO_2 emission* cement, kg/tonne	CO_2 emission, total, tonne
Foundation	54	285	926	14.3
Columns, walls	206	341	926	65.0
Bridge deck, edge beams	551	341	926	174.0
$\sum$				253.3

*local data

Concrete maintenance and repair, 100 years	**40**	**341**	**926**	**2.6 (~5%)**

Table 7-1: Data for concrete used at Vindingevej based on CO_2 emission from cement.
**Data from cement supplier*

Vindingevej example, concrete optimised (inside standards)

Bridge Life Cycle Optimisation

Bridge part	Concrete m^3	Cement content, kg/m^3	CO_2 emission* cement, kg/tonne	CO_2 emission, total, tonne
Foundation	54	240	876	13,0
Columns, walls	206	304	876	54,9
Bridge deck, edge beams	551	341	926	174,0
Σ				241,9

*local data

Reduction in CO2: 4,5 % (11,4 tonne CO2)
- fulfilling durability requirements in EN standards, national annex and Road Directorate AAB

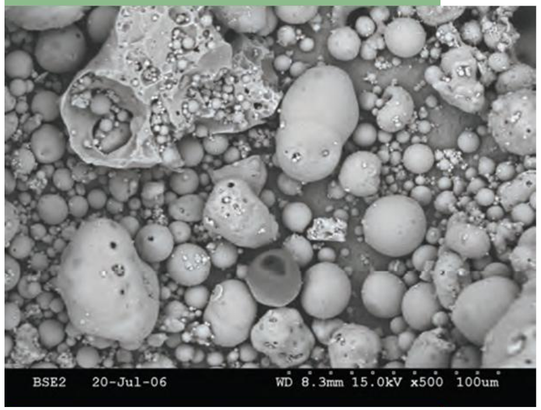
Table 7-1: Data for concrete used at Vindingevej based on CO_2 emission from cement.
**Data from cement supplier*

Vindingevej example, concrete optimised (inside standards)

Bridge Life Cycle Optimisation

Bridge part	Concrete m^3	Cement content, kg/m^3	CO_2 emission* cement, kg/tonne	CO_2 emission, total, tonne
Foundation	54	240	876	13,0
Columns, walls	206	246	876	44,4
Bridge deck, edge beams	551	246	926	125,5
Σ				182,9

*local data

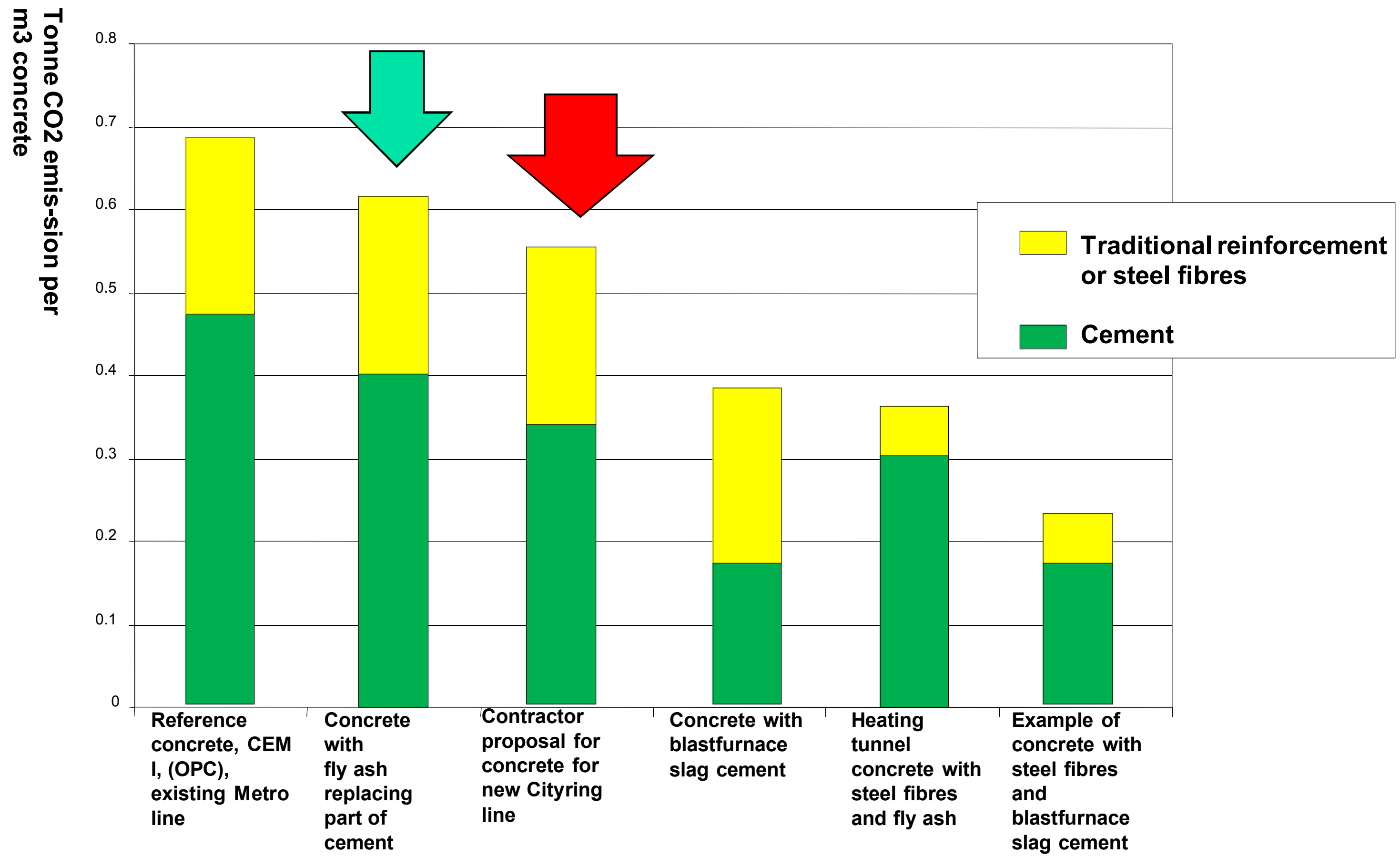


Reduction in CO2: 28% (70,4 tonne CO2)

Possible scenario with high additions of fly ash or slag – but not fulfilling Road Directorate AAB

Copenhagen Metrocityring, example

Bridge Life Cycle Optimisation



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Metrocityring project

Bridge Life Cycle Optimisation

Up to 2009/2010 the only cement in Denmark acceptable for use in concrete for infrastructure projects emitted:

- 1,240 kg CO_2 per tonne cement (wet production process)

Now, 2-3 years later, for the same type of cement, the cement manufacturer has reduced emissions to:

- 926 kg CO_2 per tonne cement

(~25 % REDUCTION)

Average values for Europe ~850 kg/tonne cement

ETSI

Recommendations

Bridge Life Cycle Optimisation

- Education and Guidelines to be introduced for stakeholders at different project stages

- Recognize that optimising environmental and cost parameters is a specialist area – not only a pocket calculator for CO_2

- Innovative trials to be initiated for bridge structures to reduce environmental impacts from materials