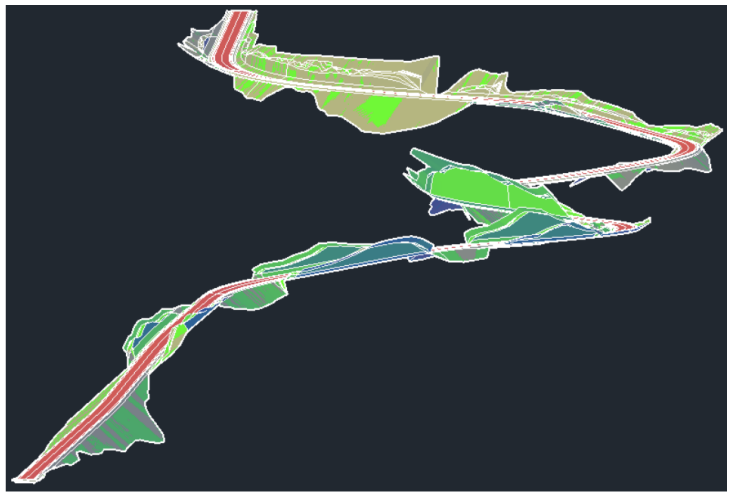
Implementing climate impacts in road infrastructure in the design phase by combining BIM with LCA

Roman Slobodchikov, Kjetil Lohne Bakke, Paul Ragnar Svennevig, *Reyn O'Born*



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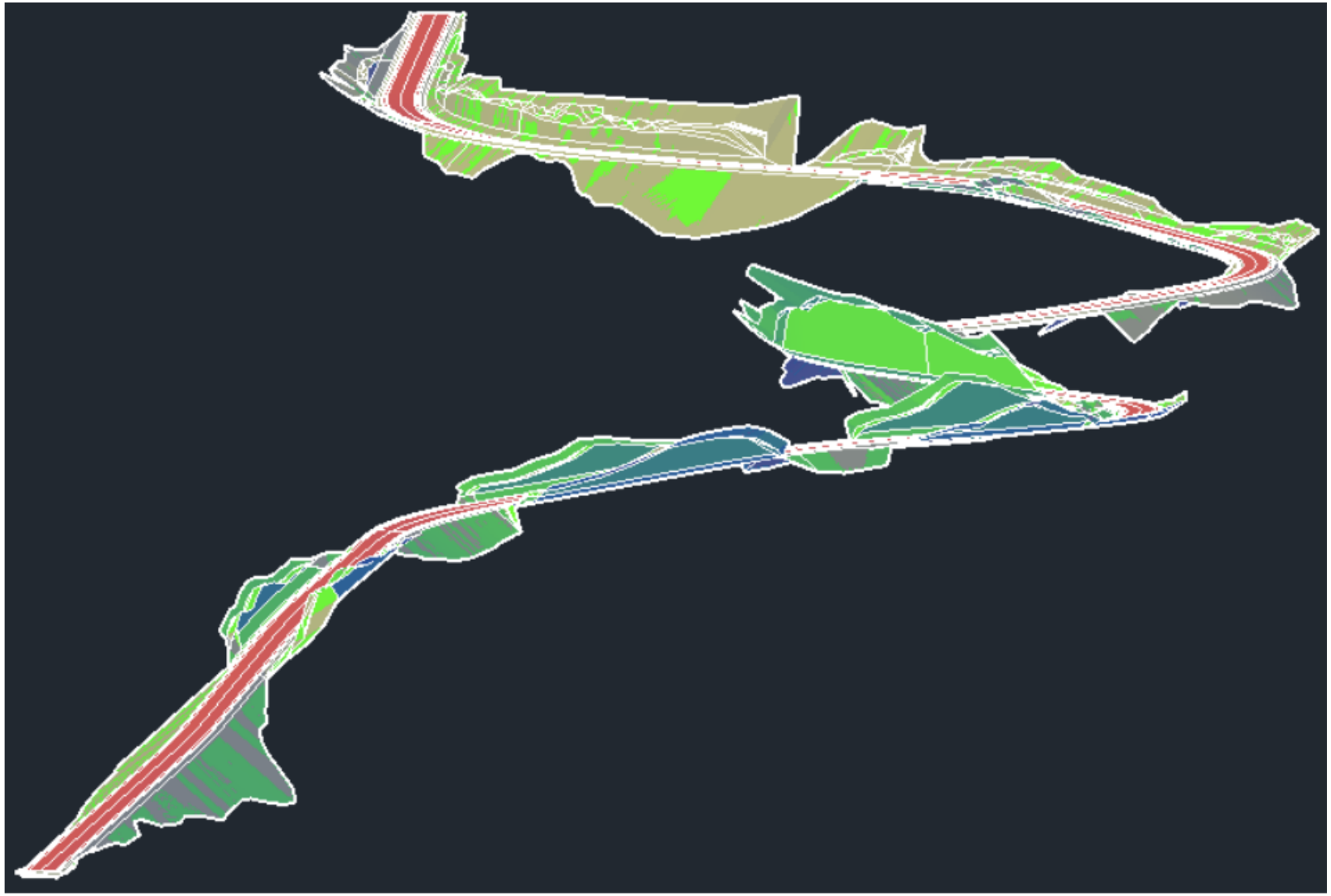
Introduction

- Material extraction and construction emissions up to 50% of global GHGs
- LCA should be used to determine emissions as early as possible, preferably during design phase
- Current LCA models for roads require tedious input for the user
- LCA becoming a part of the tender process for road construction in Norway

- **The challenge:** Make a program for road construction that can calculate life cycle emissions in real-time by integrating LCA with BIM

→ BIM-LCA-ROAD (BLR) test model developed

The ideal outcome



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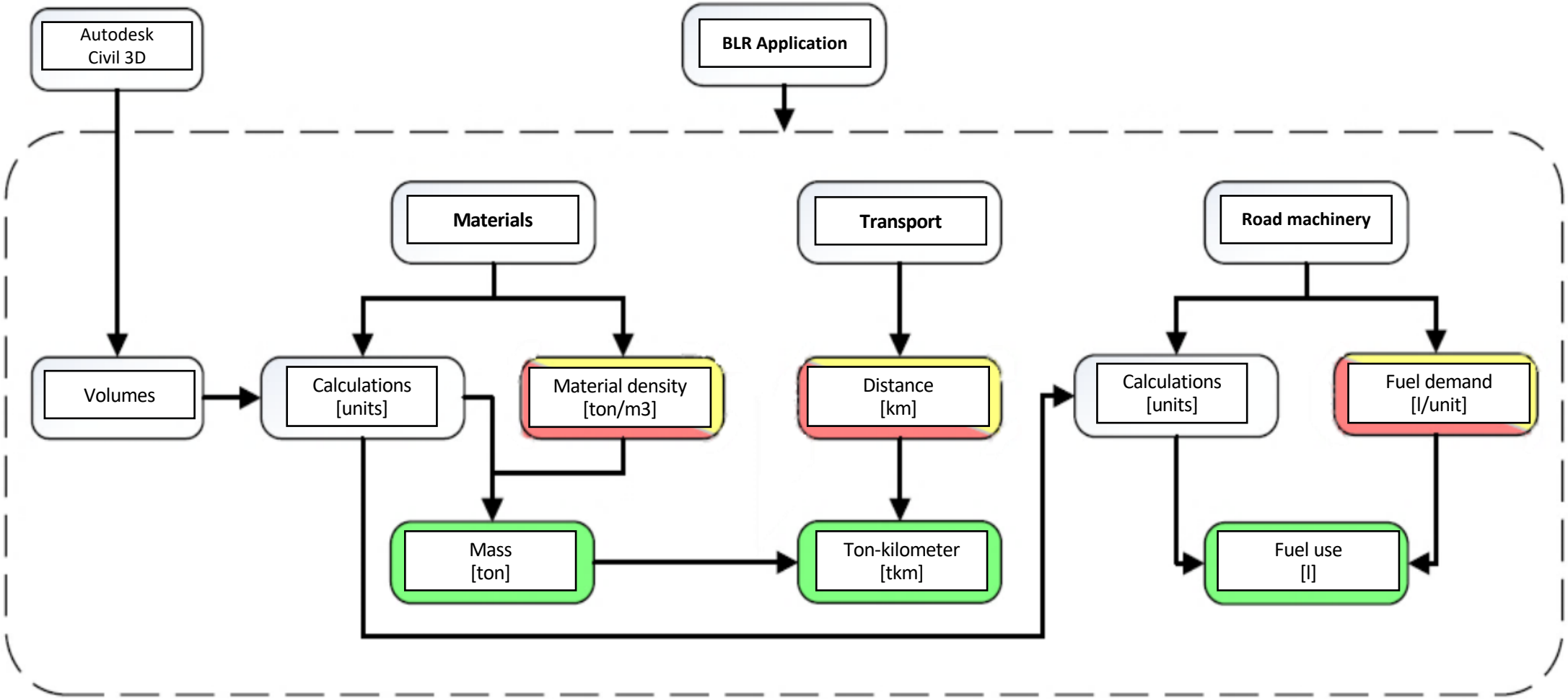
Methods

- Fetched designs in Trimble Novapoint → exported files in LandXML format → imported to Autodesk Civil 3D
- Developed add-on in Autodesk Civil 3D using Visual Studio
  - Programmed in C# and .NET framework
- Collected emissions factors on Norwegian roads from Norwegian LCA model EFFEKT 6.6 (CED and GWP are included)
- Carried out an analysis in SimaPro (using EFFEKT 6.6 factors) and BIM model material requirements to compare to BLR model LCA calculations with ReCiPe 2016 method

BLR system architecture



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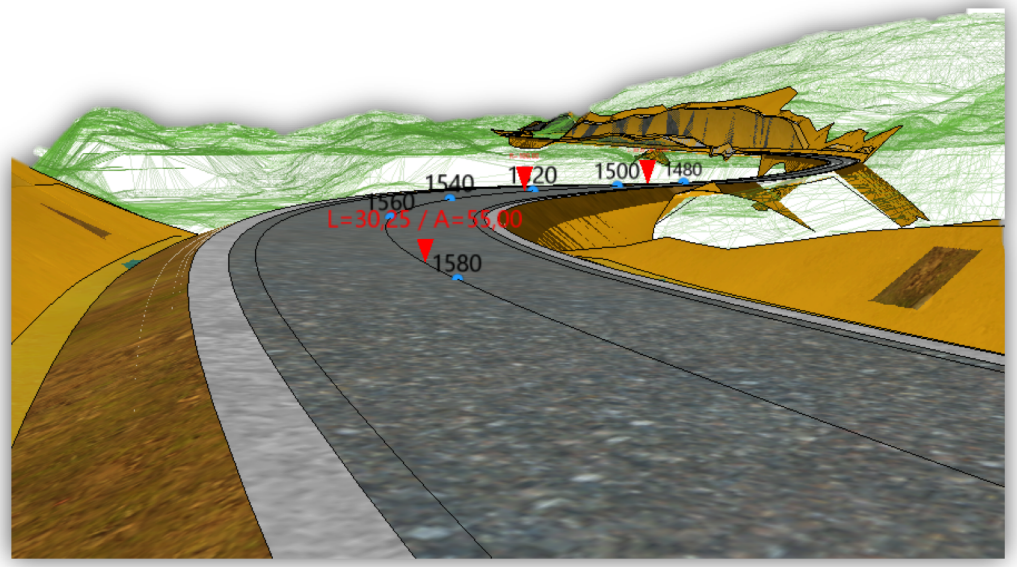
BLR model system boundaries

System boundaries according to EN15804																			
Product stage			Construction stage		Use stage							End-of-life				Benefits and loads beyond the system boundary			
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3	D4
Raw material extraction	Transport	Manufacturing	Transport	Construction and installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling	Exported energy potental
x	x	x	x	x															

Case study

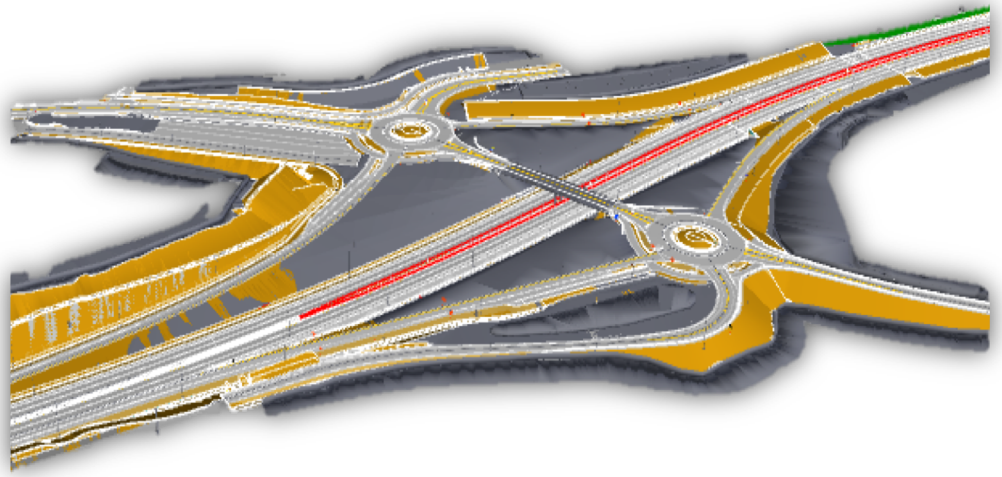
- Case 1, Nørholm

Molland, Grimstad, Norway



- Case 2, S03 E6 Arnkvern

Moelv, Ringsaker, Norway



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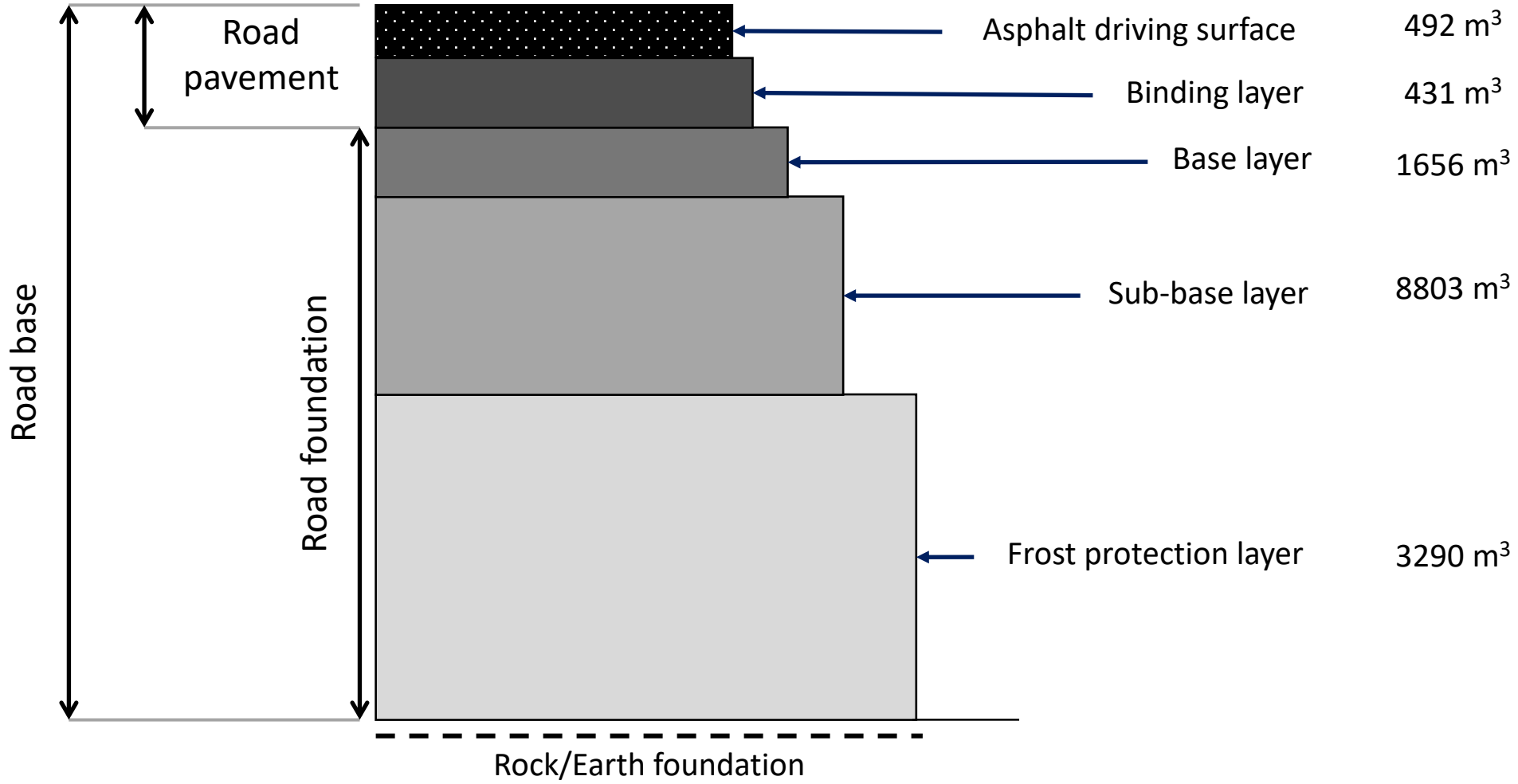
Life cycle inventory results (BIM model)



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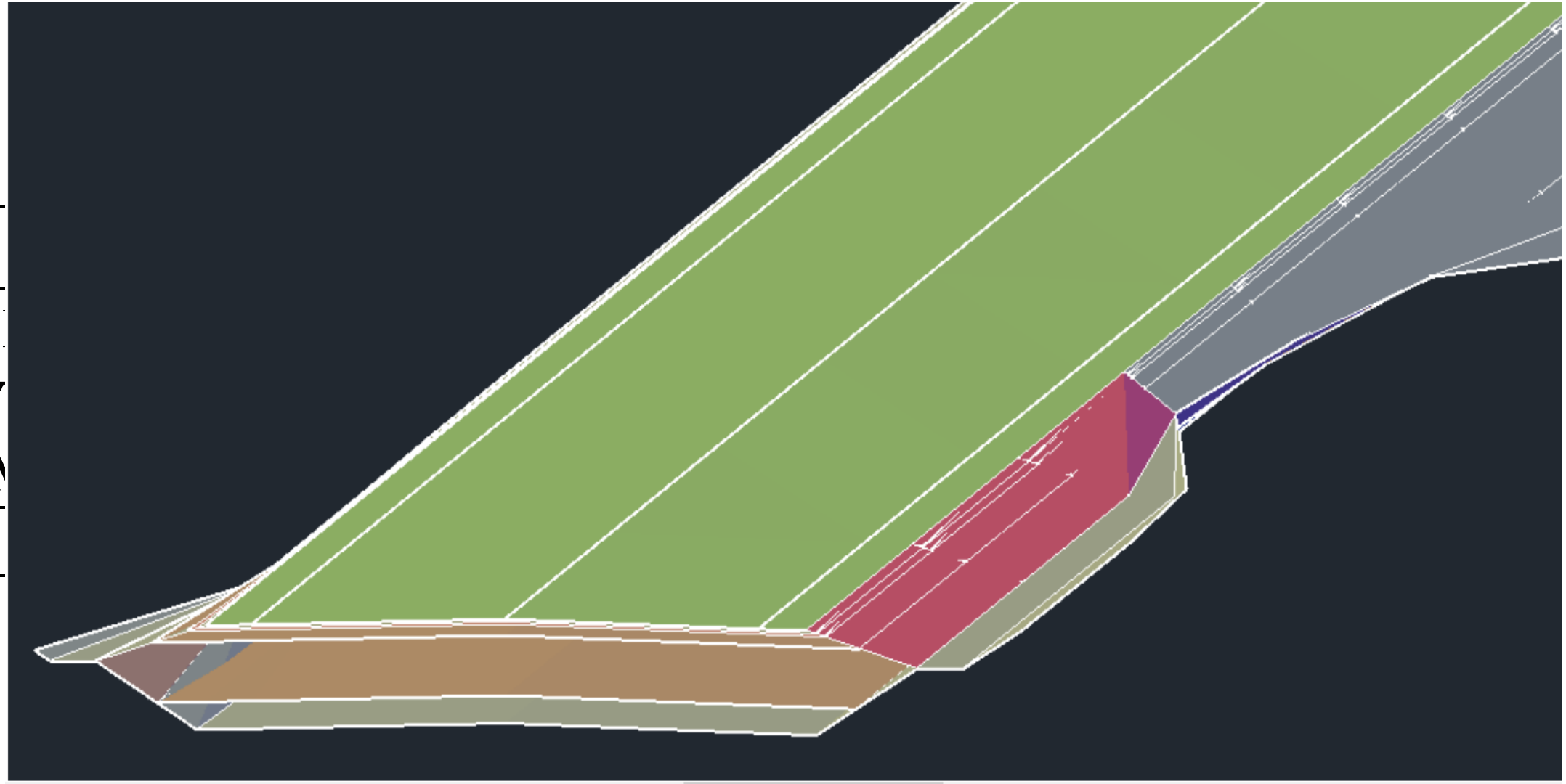
LCIA results (Case 1)



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BLR model results

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Conclusions

- Possible to combine BIM and LCA in road construction
- Results between BLR model and SimaPro model were not very large
- BLR model can be developed further to be a useful tool for road designers

Future work

- Develop better background data set for emissions factors
- Develop program fully to encompass more processes and more impact categories
- Reduce uncertainty and improve model precision
- Include costs in model
- Make the BLR model applicable to other types of infrastructure?

Thank you!

E-mail/Skype: reyn.oborn@uia.no
Mobile/WhatsApp: +47 4512 8535