Partially dynamic life cycle assessment of windows indicates potential thermal over-optimization

Lise Horup, Michael Reymann, Jakob Thaysen Rørbech, Morten Ryberg, Morten Birkved*

*Presenting author, SDU Life Cycle Engineering, University of Southern Denmark

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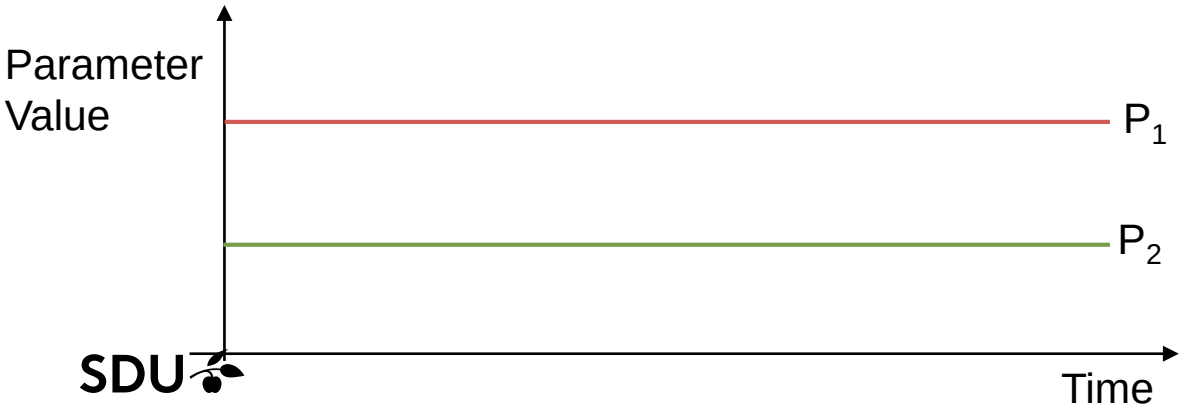
Life Cycle Assessment of Buildings vs. regular “stuff”

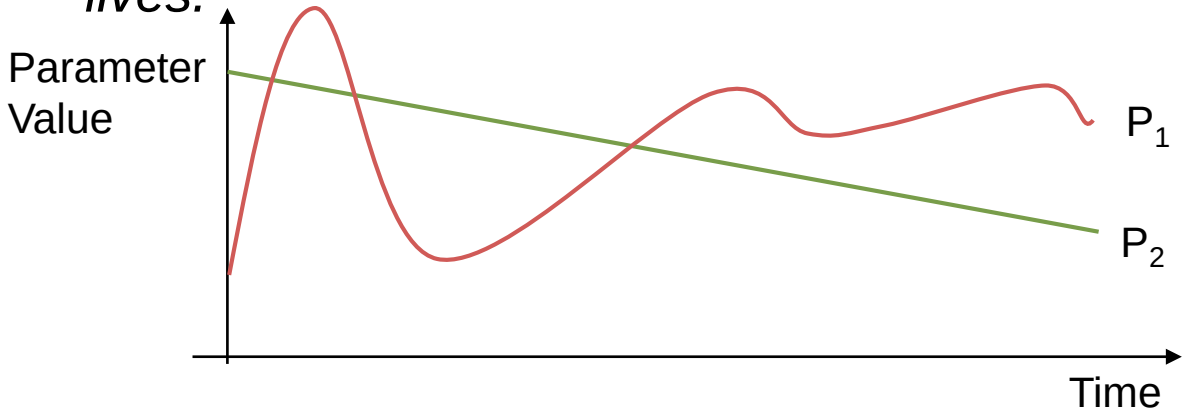
- Life Cycle Assessment of buildings and building components are unique among assessments of most other commodities
- Buildings and building components have, compared to other commodities, excessively long durabilities/service-lives
- The long service lives imply that during the service lives and hence the typical temporal scope of a building/building component LCA:
  - Buildings are often renovated/components are replaced during their service lives
  - The systems around supplying the building with e.g. energy and materials changes
- Most often are the changes in the surrounding society neglected in building LCAs, since these are considered too complicated to account for
- The main question is however if these changes in the sourrounding society, if accounted for, can affect the outcome of a building/building component LCA

Static vs. dynamic product system models

Static/conventional product system models:
The base assumption for static product system models, is that all model parameters are independent of time, *which makes sense for most products/services with a short service-life (e.g. plastic cup) or products/services that do not interact with the with the fore and background systems during their service-lives.*



Dynamic product system models:
The base assumption for dynamic models is that some/all model parameters are dependent of time, *which makes sense for some products/ services with (very) long service-lives (e.g. building, infrastructure, technology etc.) and hence products that are interacting with the fore andbackground systems during their service-lives.*

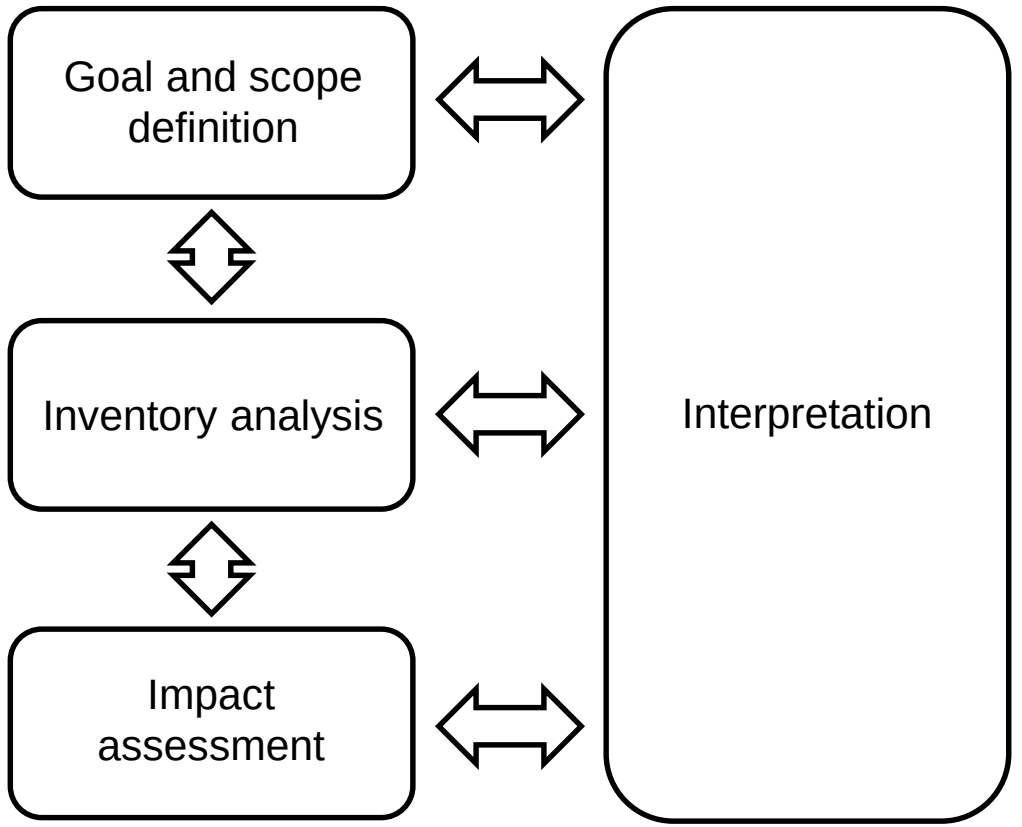


Different extents of dynamic product system modelling

There are several ways in which an LCA can be considered dynamic:

1. Dynamic goal and scope, e.g. dynamic geographical scope
2. Dynamic inventories, e.g. changing energy grid composition
3. Dynamic impact assessment i.e. time dependent characterization factors
4. Dynamic interpretation e.g. dynamic normalization factors (and weighting factors)

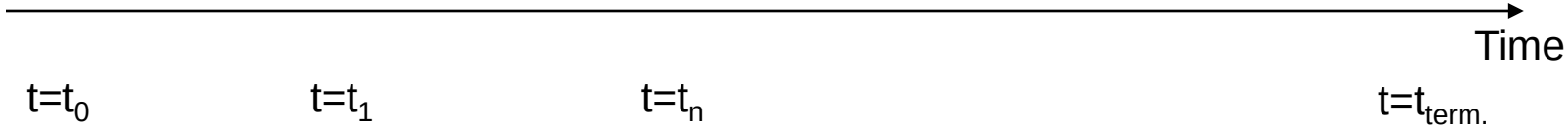
Accounting for time dependency in all 4 phases should yield a (truly) dynamic LCA (so-called DLCA) accounting for parts of the dynamism yields a partial dynamic LCA (so-called pDLCA)



Different resolutions of dynamic product system modelling

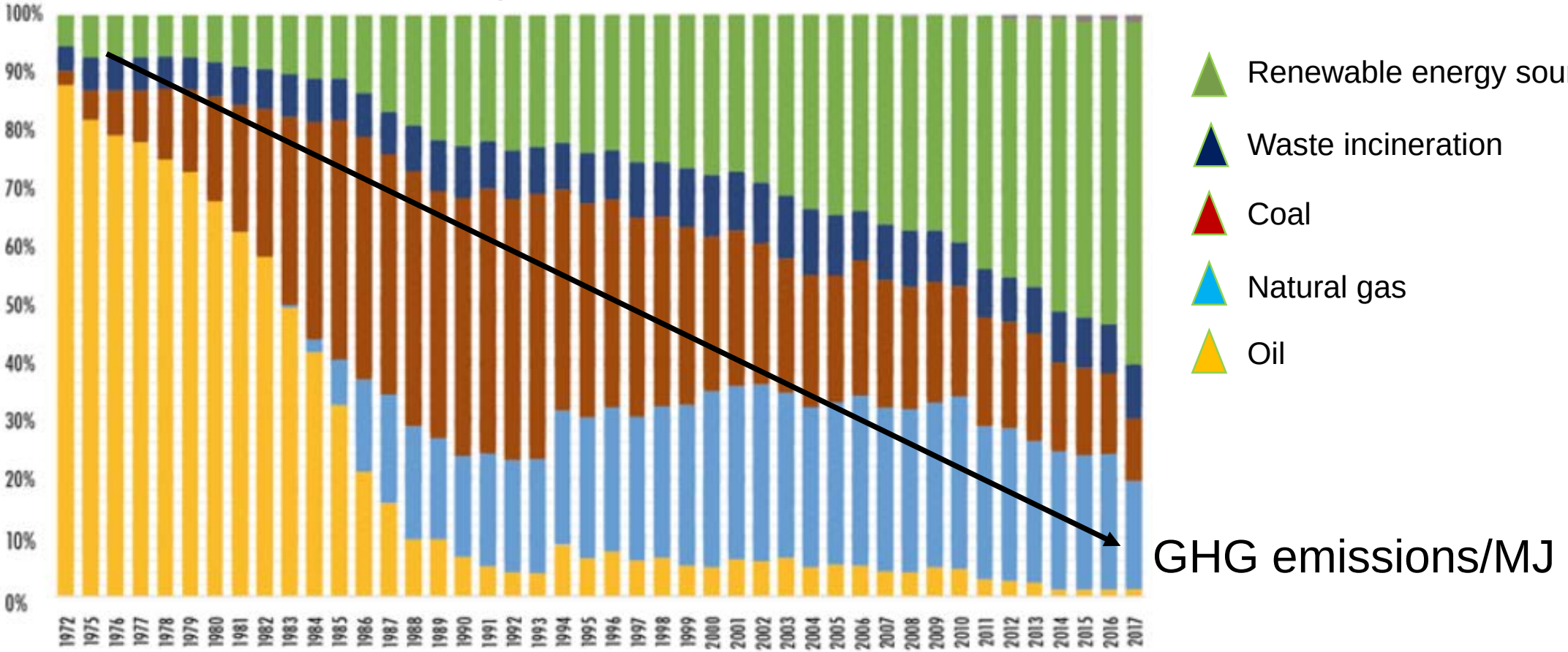
Prospective LCA $P_{n,t0}=a$ $P_{n,term.}=d$

Dynamic LCA $P_{n,t0}=a$ $P_{n,t1}=b$ $P_{n,tn}=c$ $P_{n,term.}=d$



- **If one or several parameters changes value once** at the initial and terminal ends of the temporal scope of the LCA - *the LCA is referred to as a prospective LCA***.**
- **If one or several parameters changes value more than once** over the temporal scope of the LCA - *the LCA is referred to as a dynamic LCA.*

Development of the composition of the thermal energy for space heating in Denmark

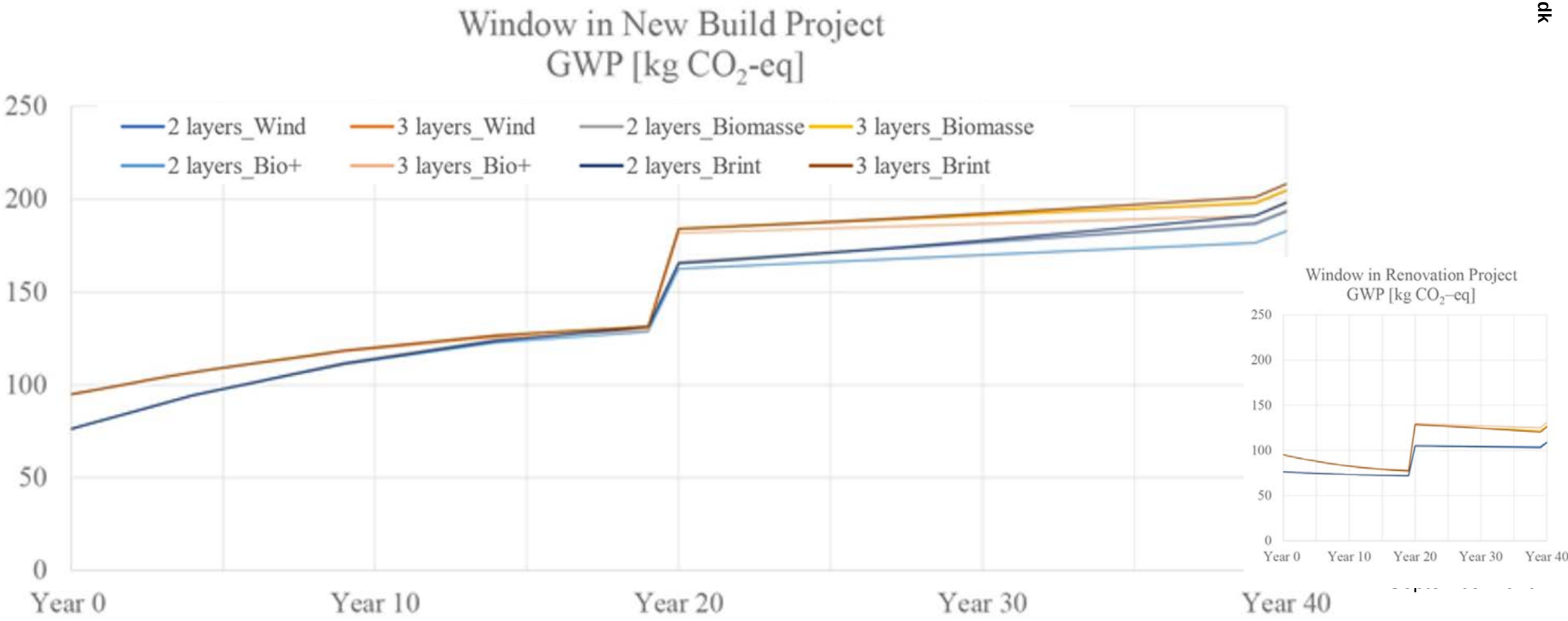


Dynamic assessment of skylight windows

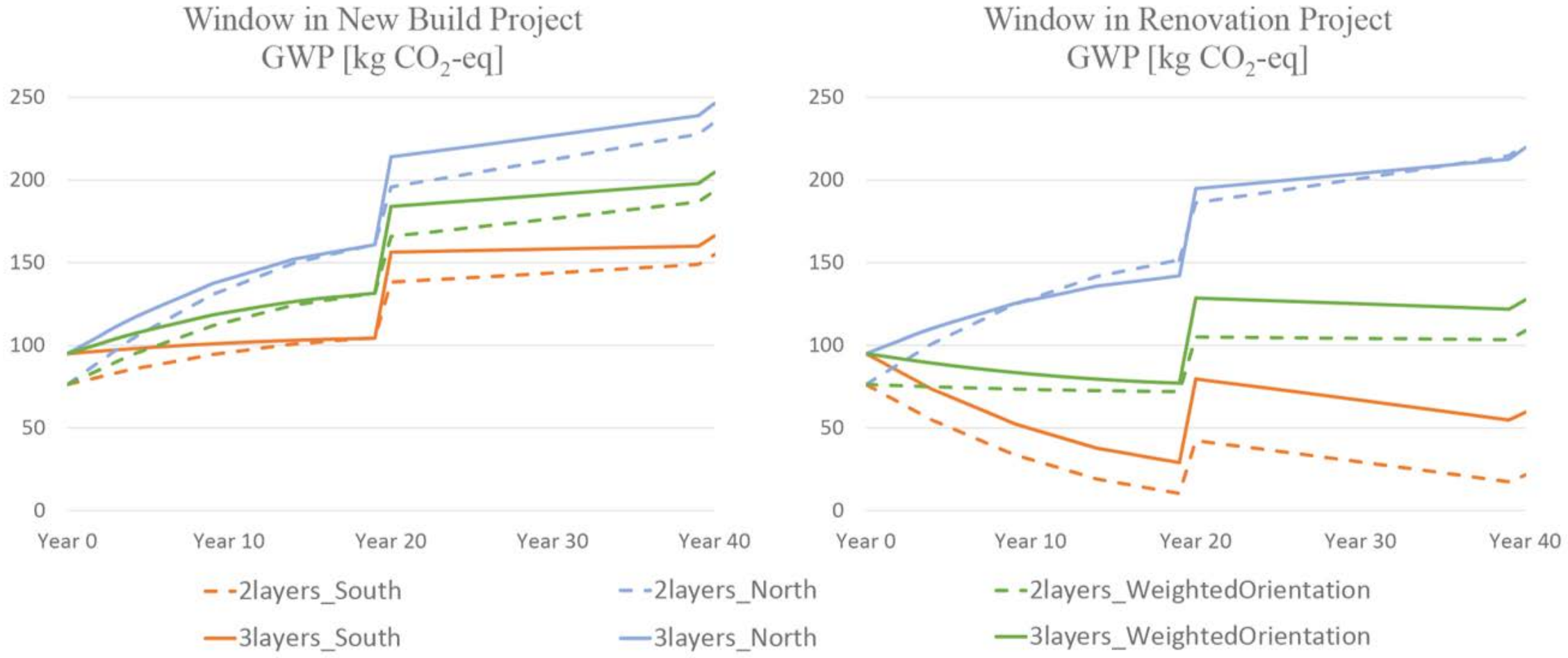
We conducted a range of LCAs of a VELUX skylight window with 2-layer and 3-layer glassing, taking into account:

- That the energy savings obtained from an additional glass layer depend upon whether the skylight window is installed in a new (well insulated building) or in an older (less insulated building)
- That the orientation of the window will affect the net energy saved
- That the heat saved by the extra glass layers (3-layers) will vary in terms of sources over time
- That the impacts induced/avoided per MJ consumed/saved hence also will vary over time

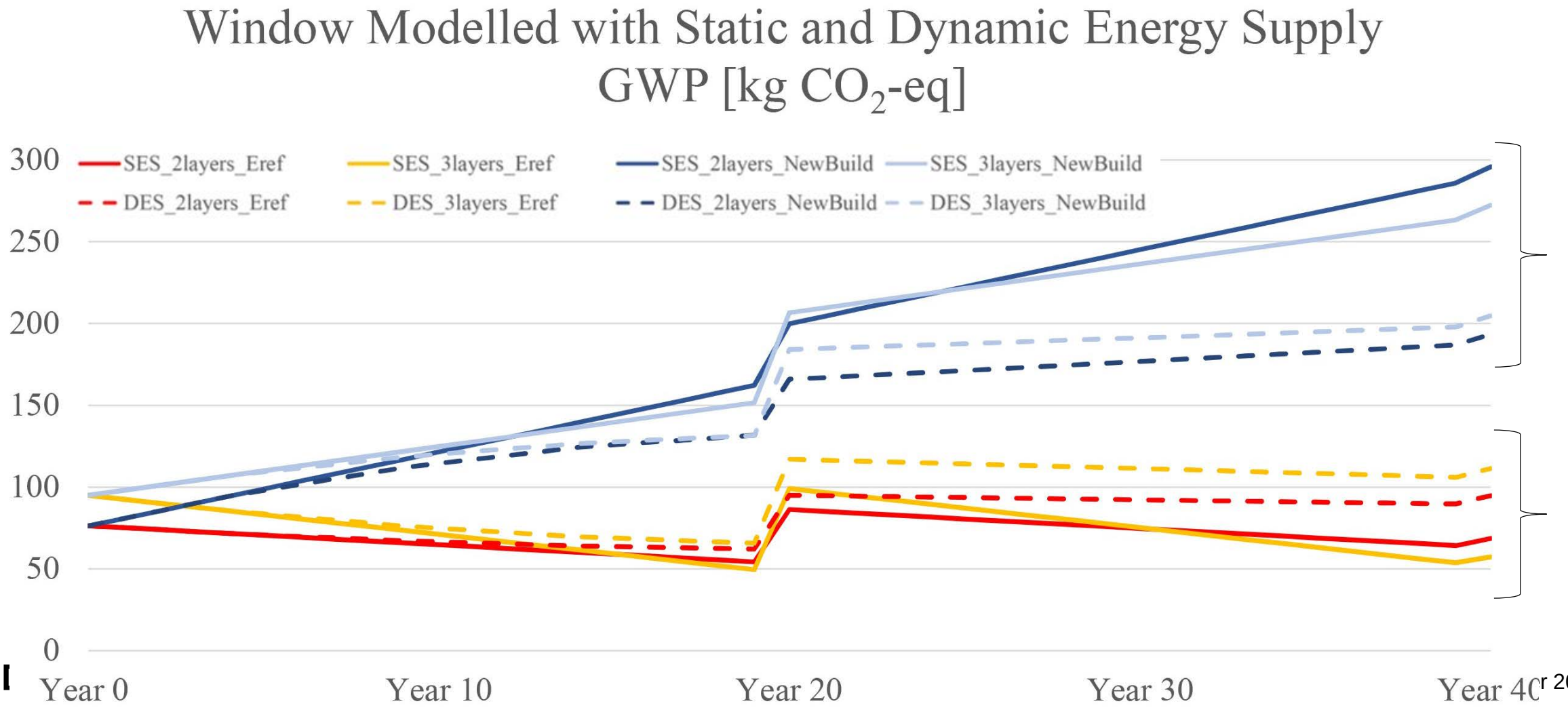
Dynamic assessments of installation of the skylight in new and old buildings



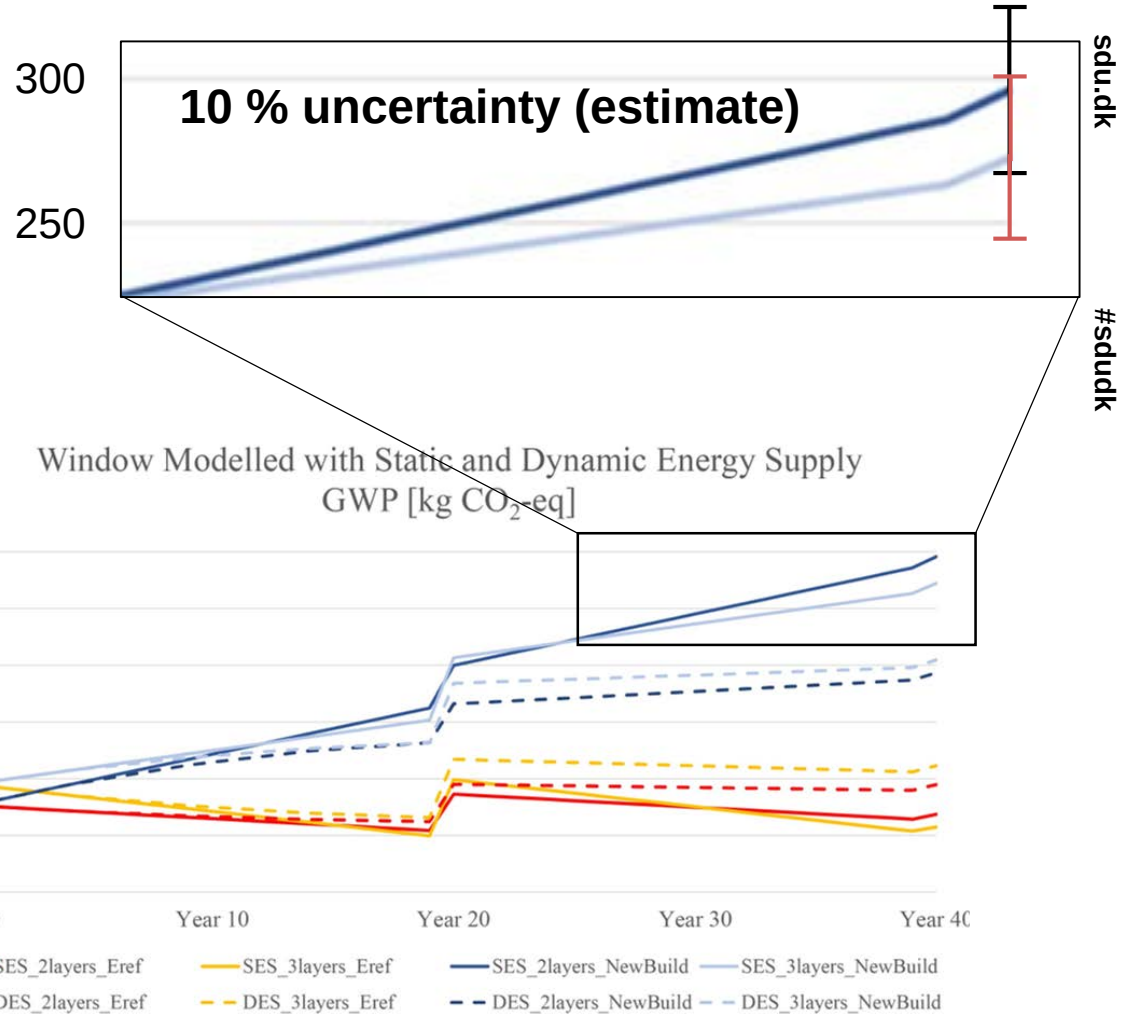
Window orientation and installation context – influence on the results



Energy balance – influence on the results



Discussion and clonclusion



As illustrated is the environmental performance of the skylights assessed here obviously closely related to the environmental induced by the avoided energy consumption.

- ~~The easy obvious is that 2-layered skylights are environmentally superior to 3-layered skylights if the greening of the saved/avoided energy and installation context are accounted for~~

This is however not necessarily the case if the uncertainty of the assessment is taken into account. A more correct conclusion is hence

- The 3-layered window is not preferable relative to a 2-layered window if the greening of the saved/avoided energy and installation context are accounted for

Want to know more about Dynamic LCA?

Defining Temporally Dynamic Life Cycle Assessment: A Literature Review

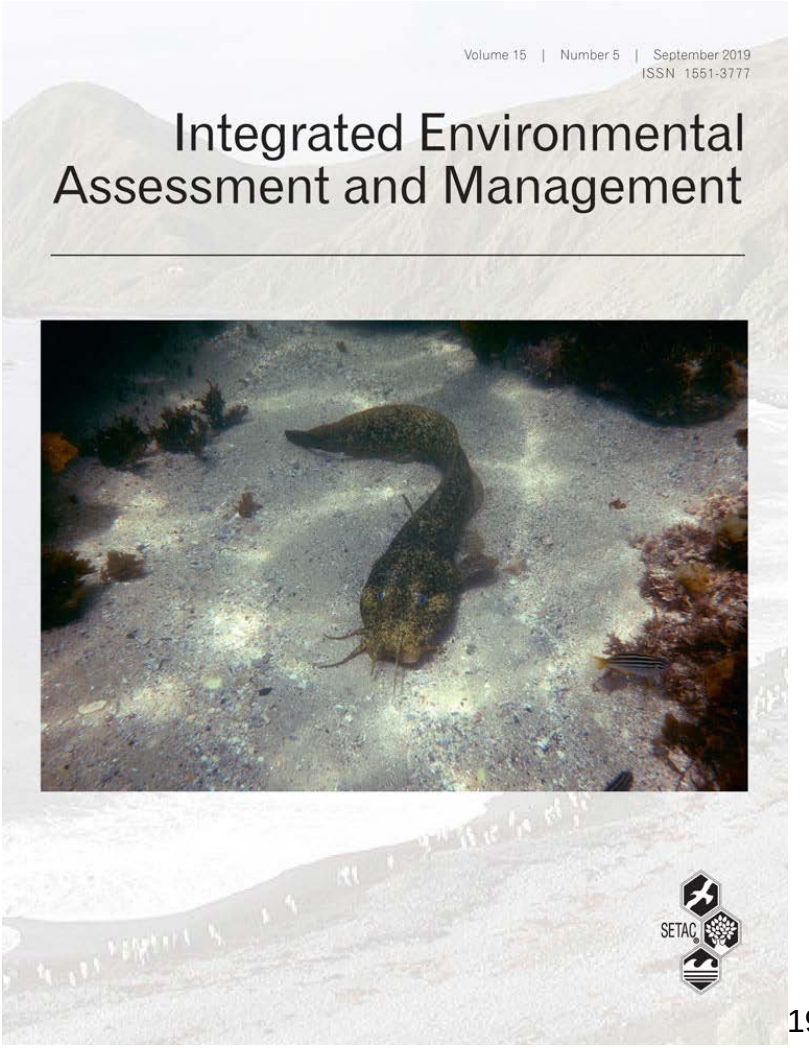
By: Joshua Sohn[1], Pradip Kalbar[2], Benjamin Goldstein[3], and Morten Birkved[4]

DTU Technical University of Denmark

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

UNIVERSITY OF MICHIGAN

SDU University of Southern Denmark



Want to know more about Dynamic LCA?

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Life-cycle based dynamic assessment of mineral wool insulation in a Danish residential building application

Joshua L. Sohn [a] ✉, Pradip P. Kalbar [b] ✉, Gary T. Banta [a] ✉, Morten Birkved [b] ✉

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