Towards carbon neutral urban form

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Catch the carbon
CLIMATE SOLUTIONS IN THE LAND USE SECTOR

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Earlier: Dense cities were considered good climate policy

PERSPECTIVE

Cities, Productivity, and Quality of Life

Edward Glaeser[1,2]*

Technological changes and improved electronic communications seem, paradoxically, to be making cities more, rather than less, important. There is a st
economic development across countries, and within-
rises in dense agglomerations. But urban economic
urban curses of crime, congestion and contagious dis
suggests that these problems require more capable g
economic and engineering solutions. Though the sco
rural seem attractive, agrarian poverty has typically

The tight correlation between urbanization and economic development throughout the world reflects a global transition from po als co

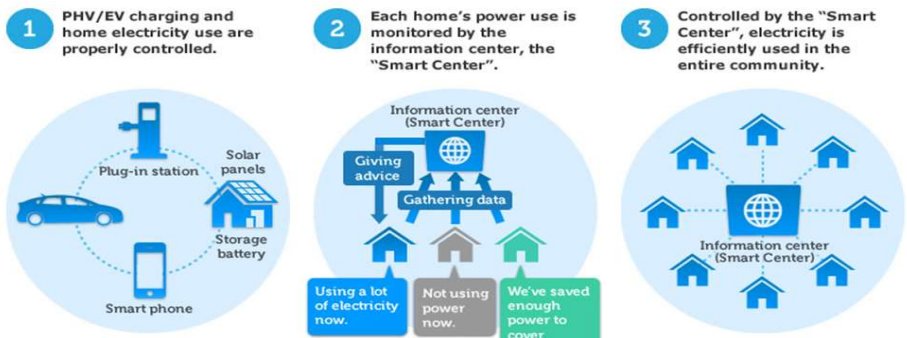
emissions are almost always lower in central cities than in suburbs, primarily because of decreased gasoline consumption and home electricity use. Across metropolitan areas, per-household emissions are lower in larger and more compact metropolitan areas.

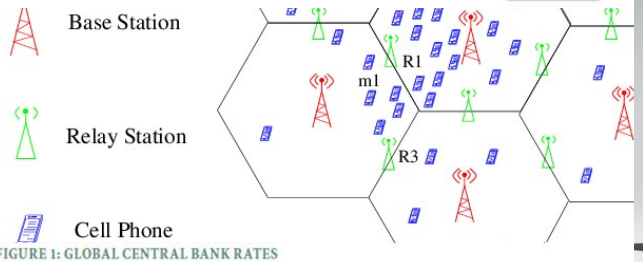
Policies for low carbon settlements

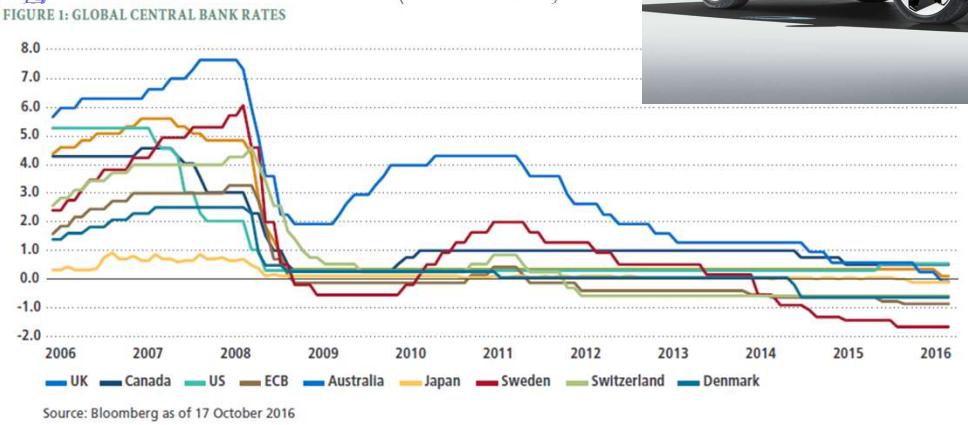
- Favour combined heat and power (CHP) production with district heating (energy efficiency >90% vs. <40% in power production)
- Reduce energy consumption of housing, favour apartment buildings
- Less driving & more public transportation
- Services instead of owning

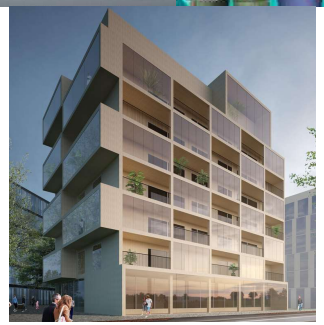
=> Urban cores can provide all of these, i.e. good climate policy

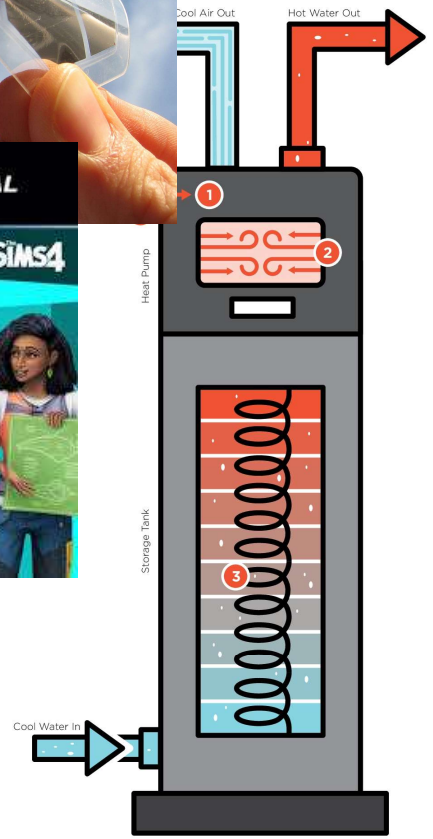
… but world is changing











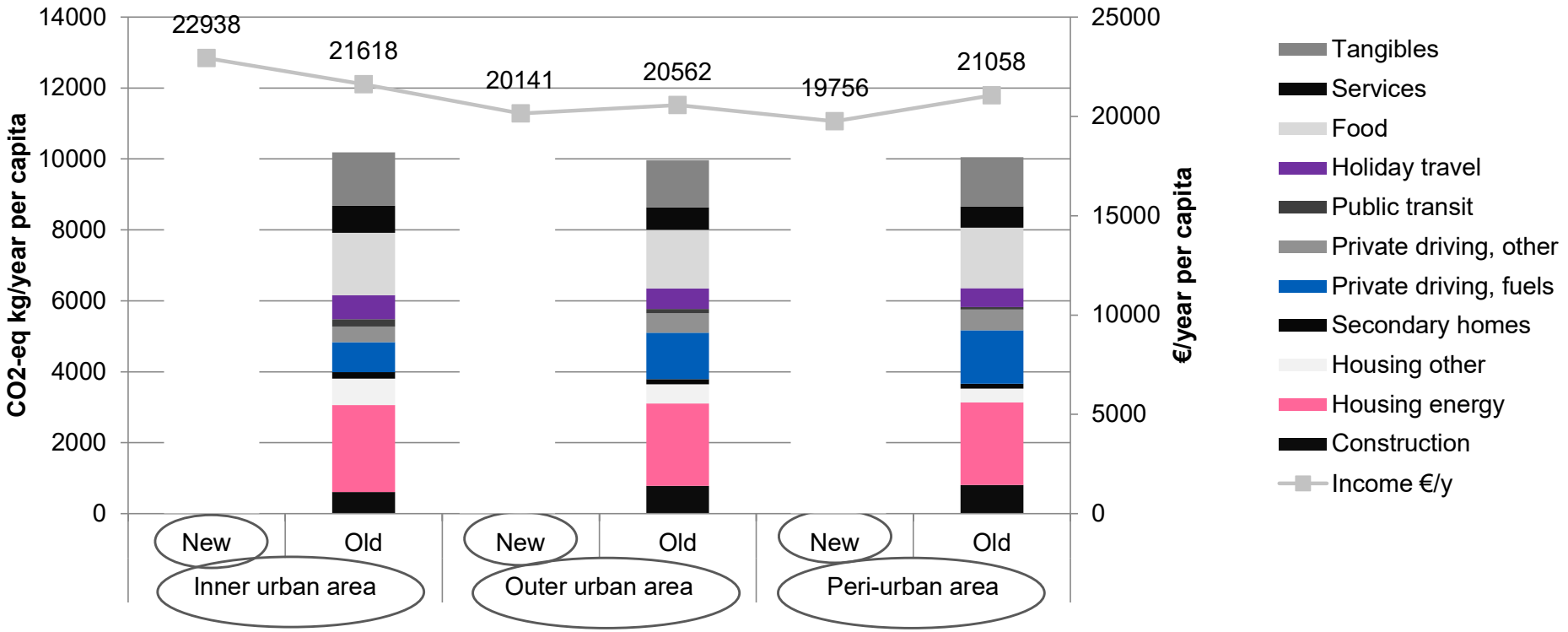
HOW DO HEAT PUMPS WORK?

By transferring heat rather than creating it, heat pumps deliver hot water **3-4 times more efficiently** than conventional water heaters.

1. Heat pump pulls warmth from the air.
2. Warm air is compressed, increasing its temperature.
3. Condenser coils transfer heat to the water.

SIERRA CLUB

Carbon footprint development in different urban structures



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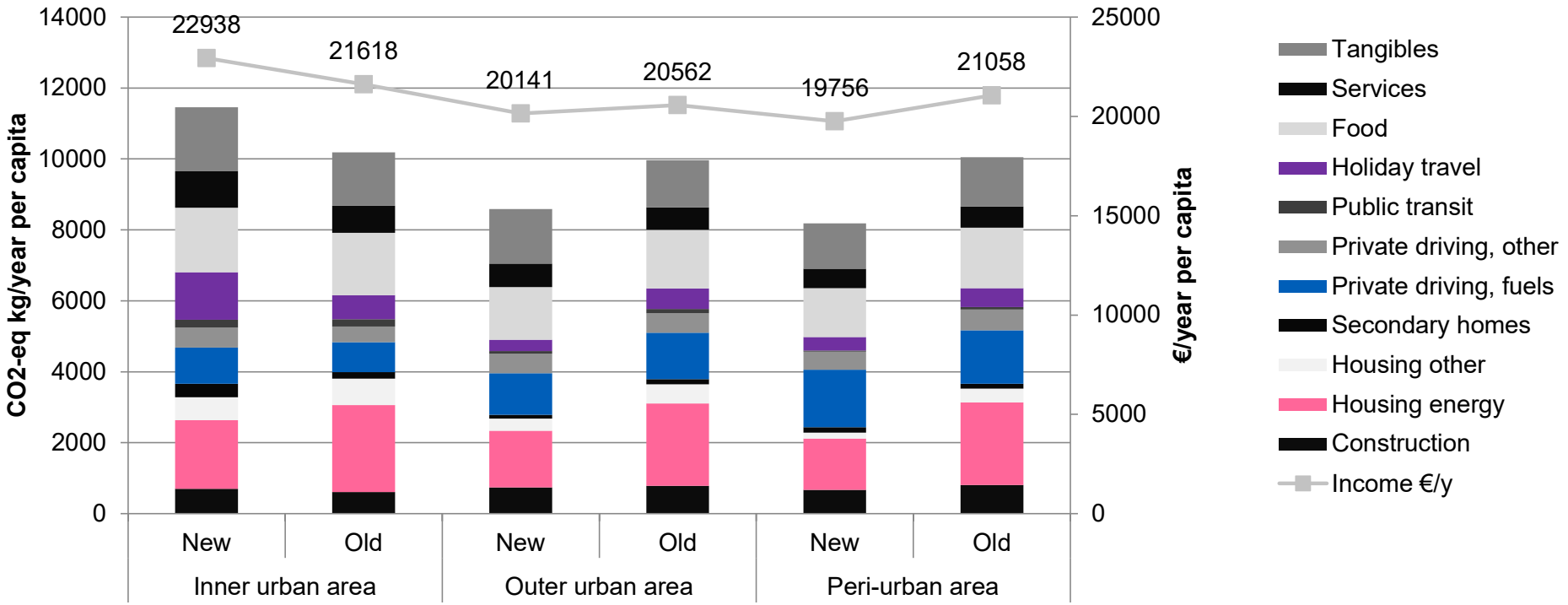
**New energy efficient housing has reduced carbon footprints in outer but not in inner urban areas*
J Ottelin, J Heinonen, S Junnila - Environmental science & technology, 2015

Carbon footprint development in different urban structures



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Carbon neutrality by 2050 (2035)

- Carbon neutrality means **balance** between emitting and absorbing carbon
- Carbon absorbing
  - Main **carbon sinks** are forests, soil & oceans
- Carbon offsetting
  - **Temporal way** to carbon neutrality is to offset emissions in one sector by reducing them somewhere else

Conclusion for smart density

1. Carbon neutrality is a paradigm shift for sustainable urban planning
   - carbon absorption very low in urban areas
2. Smart density seems to be moderate for low carbon settlements, not extreme
3. Sustainable lifestyles have been easier outside urban core

=> Recreate the concept of sustainable urban landscape

Smart density

=

Less intensity

Challenge of green construction

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Building life cycle emissions (traditional approach)

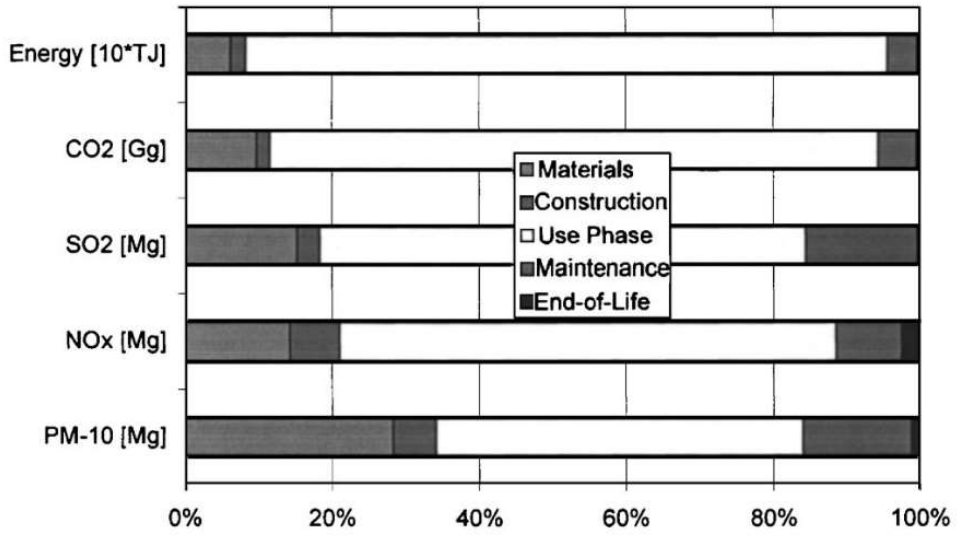


Fig. 1. European case study proportions of emissions attributed to each life-cycle phase

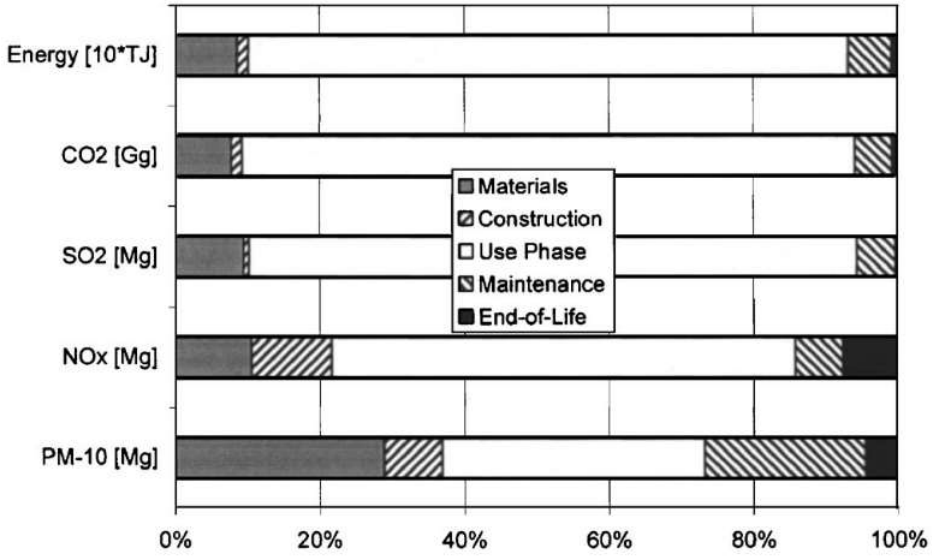
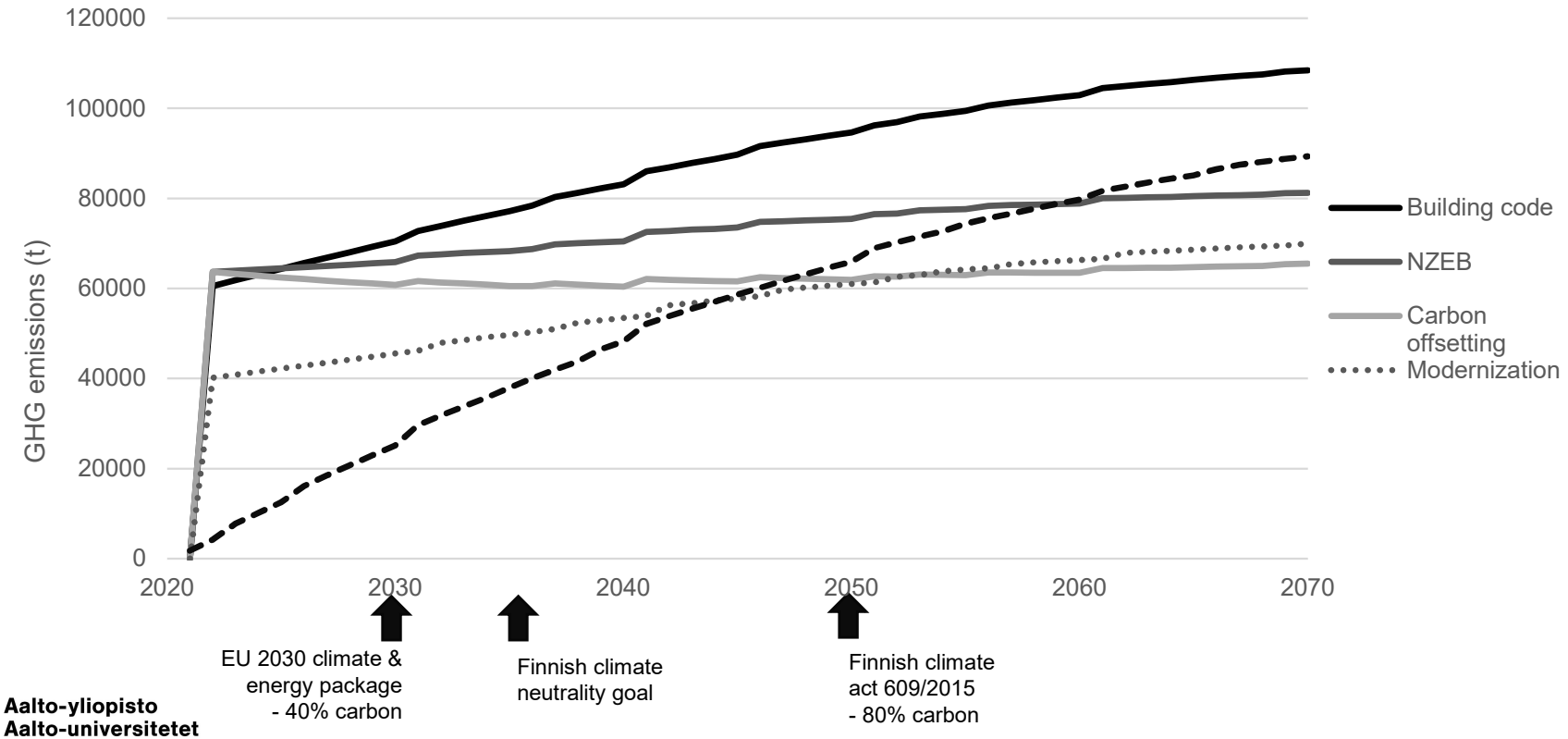


Fig. 2. U.S. case study proportions of emissions attributed to each life-cycle phase

**Life-Cycle Assessment of Office Buildings in Europeand the United States Junnila et al. J. Infrastruct. Syst., 2006*

Carbon neutral operation vs. Construction carbon spike in current policy window



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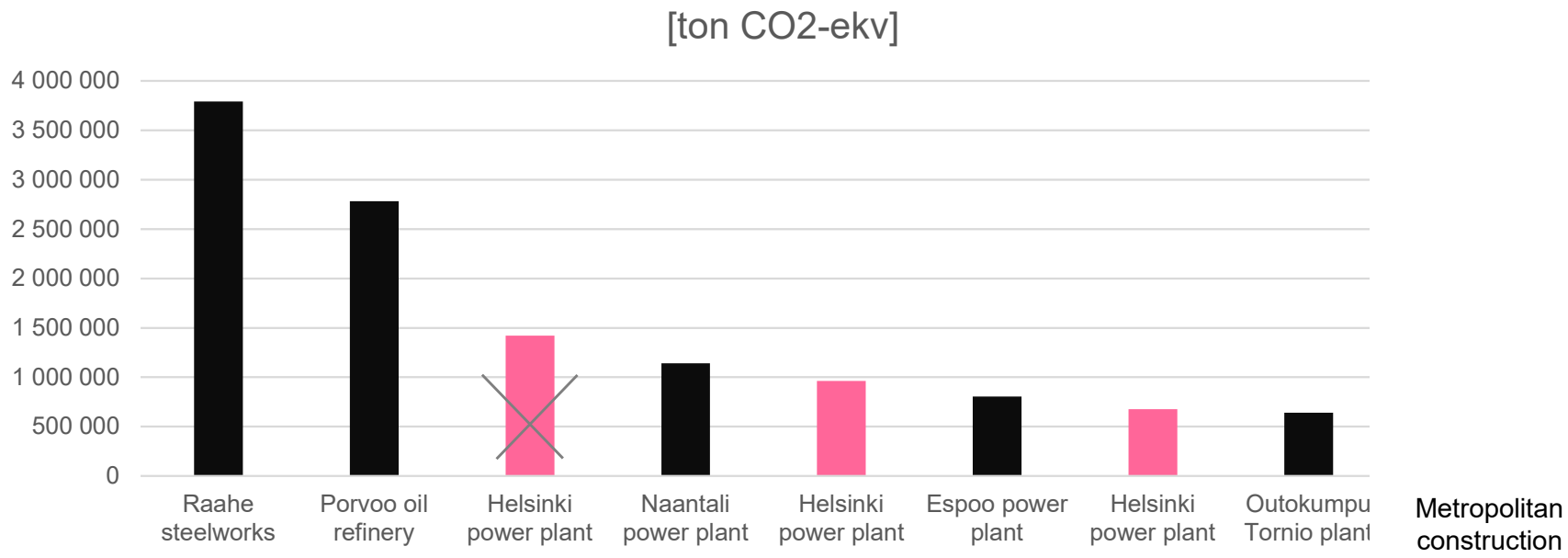
**A scenario analysis of the life cycle greenhouse gas emissions of a new residential area*
A Säynäjoki, J Heinonen, S Junnila 2012
Environmental Research Letters 7 (3), 034037

Top carbon emiters in Finland 2018



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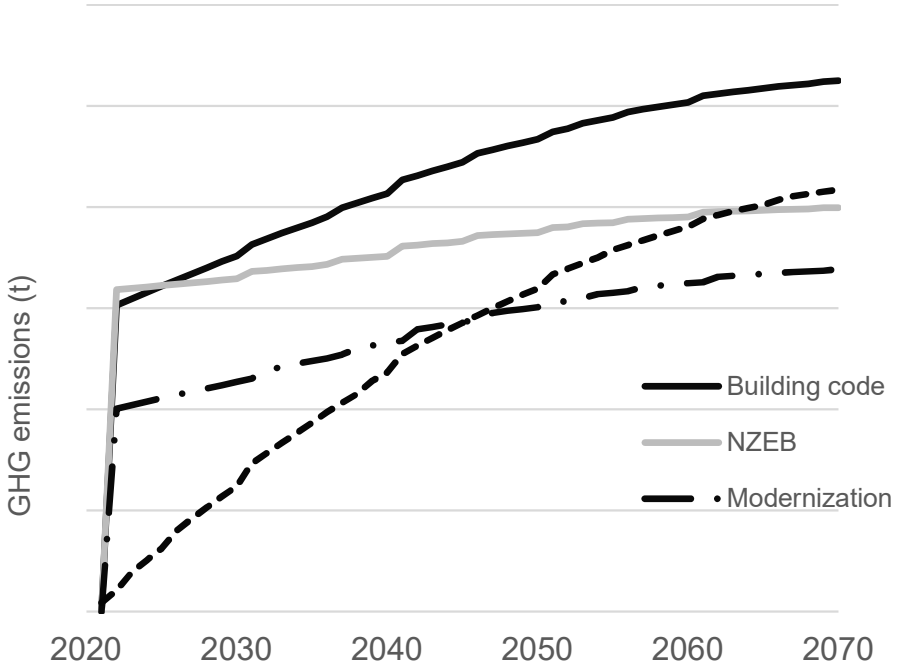
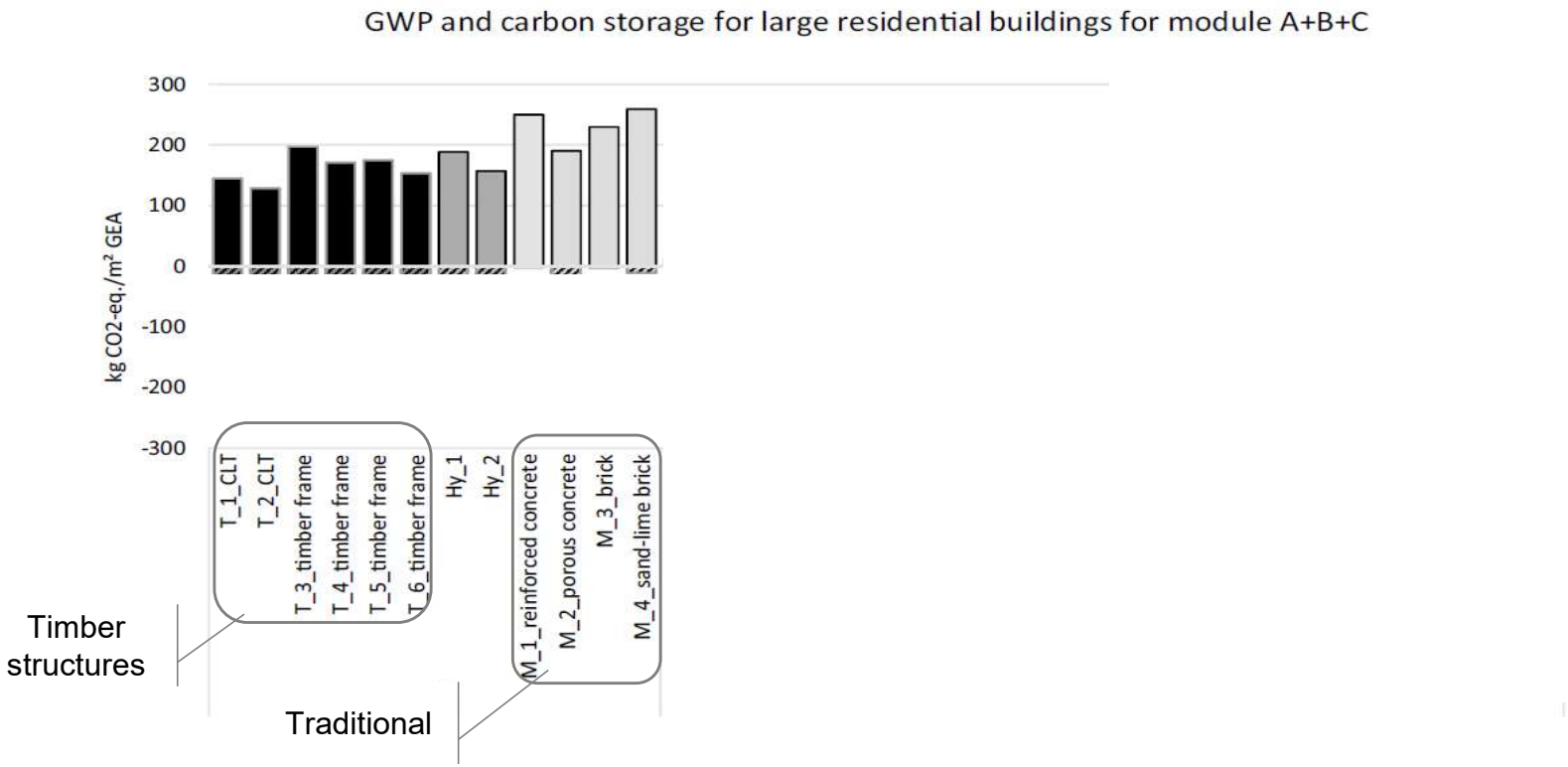
*https://www.energiavirasto.fi/
Can life-cycle assessment produce reliable policy guidelines in the building sector?
A Säynäjoki, J Heinonen, S Junnila, A Horvath - Environmental Research Letters, 2017

Construction carbon spike mitigation

- Circular economy
  1) Sharing spaces
  2) Reuse of buildings
  3) Reuse of building parts
  4) Reuse of building materials
- Materials with Carbon sink
  - Timber
  - New innovative materials to come…
- Low-carbon manufacturing
  - New manufacturing processes, renewable energy, etc.
  - Carbon offsetting

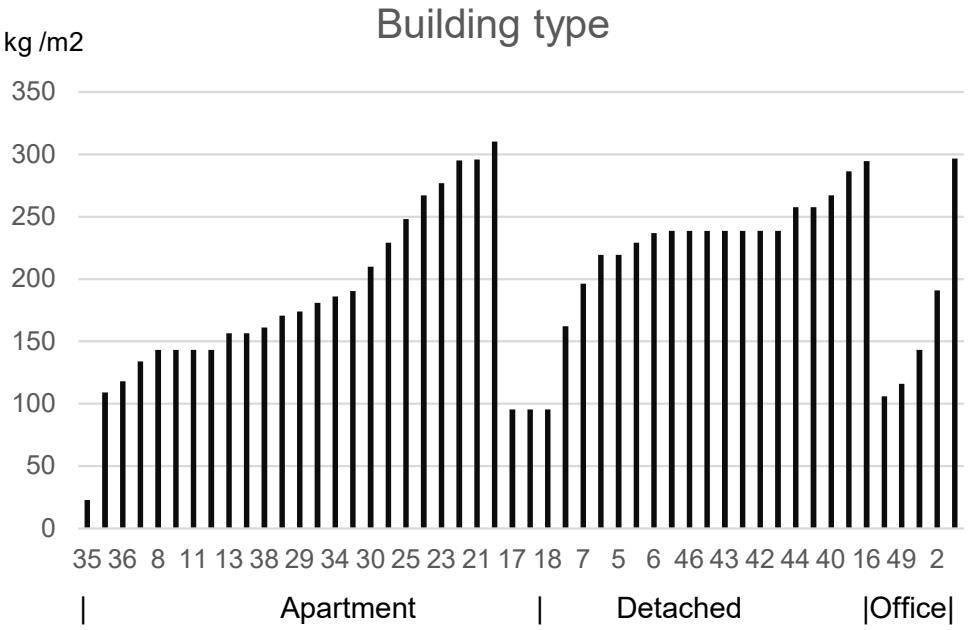


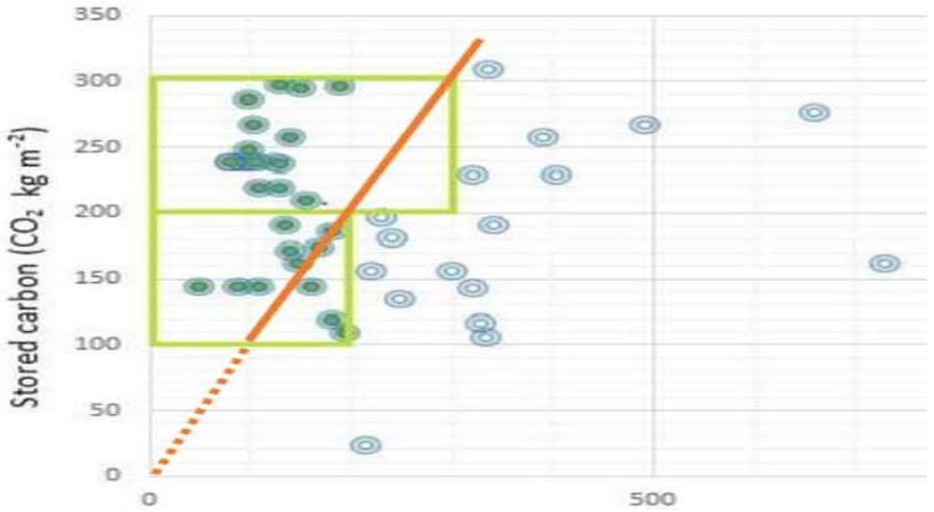
Wood vs. traditional structures



*"Environmental aspects of material efficiency versus carbon storage in timber buildings", Hafner, A. & Schäfer, S. Eur. J. Wood Prod. (2018) 76: 1045.

Carbon neutral wood buildings?





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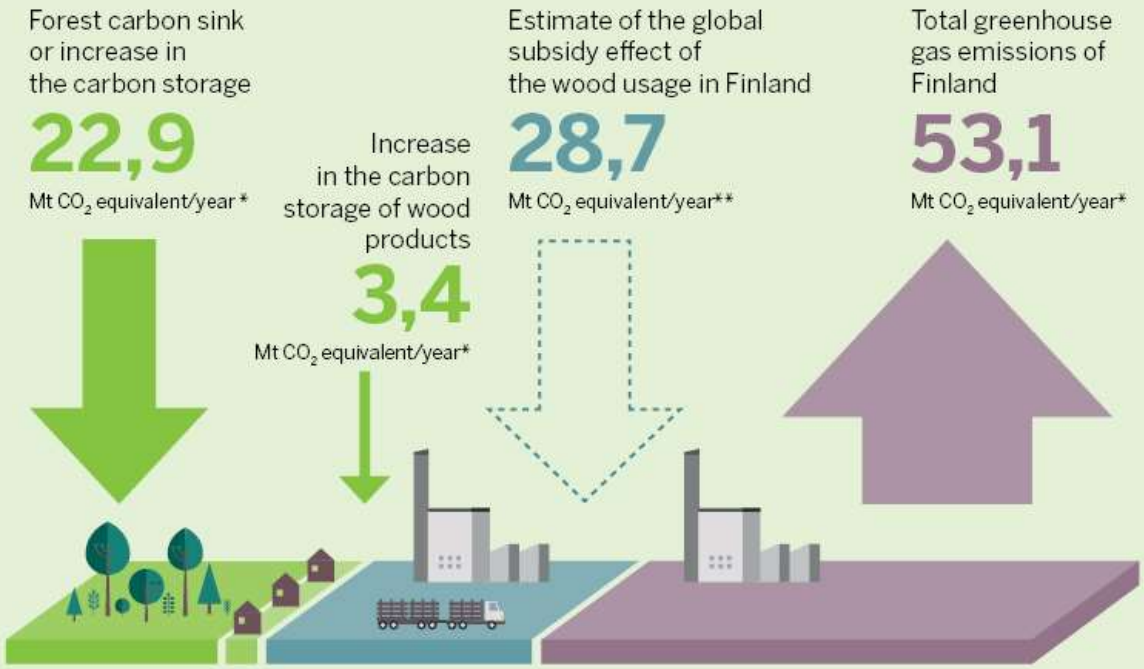
Cities as carbon sinks—classification of wooden buildings,
Amiri *et al* 2020 *Environ. Res. Lett.* **15** 094076

Carbon Sinks and Substitution Effect of Wooden Products in Sustainable Forestry

INFO

The impacts of forest on the climate

Fossil greenhouse gas emissions avoided due to wood products produced in Finland are estimated to be roughly of the same size as forest carbon sinks. This corresponds to about half of Finland's greenhouse gas emissions. If half of all existing side streams could be utilized first for new products and only then for energy, the figure could even double, which would be enough to compensate greenhouse gas emissions in Finland as a whole.



Preliminary data for 2019 (Statistics Finland, Natural Resource Institute Finland)

** The situation in 2016 (Hurmekoski et al. 2020). Total emissions without LULUCF sector. The forest industry emissions are included in total emissions, but they have been deducted from the substitution effect estimates. Source: Ministry of Agriculture and Forestry of Finland)

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Wood in construction carbon spike mitigation

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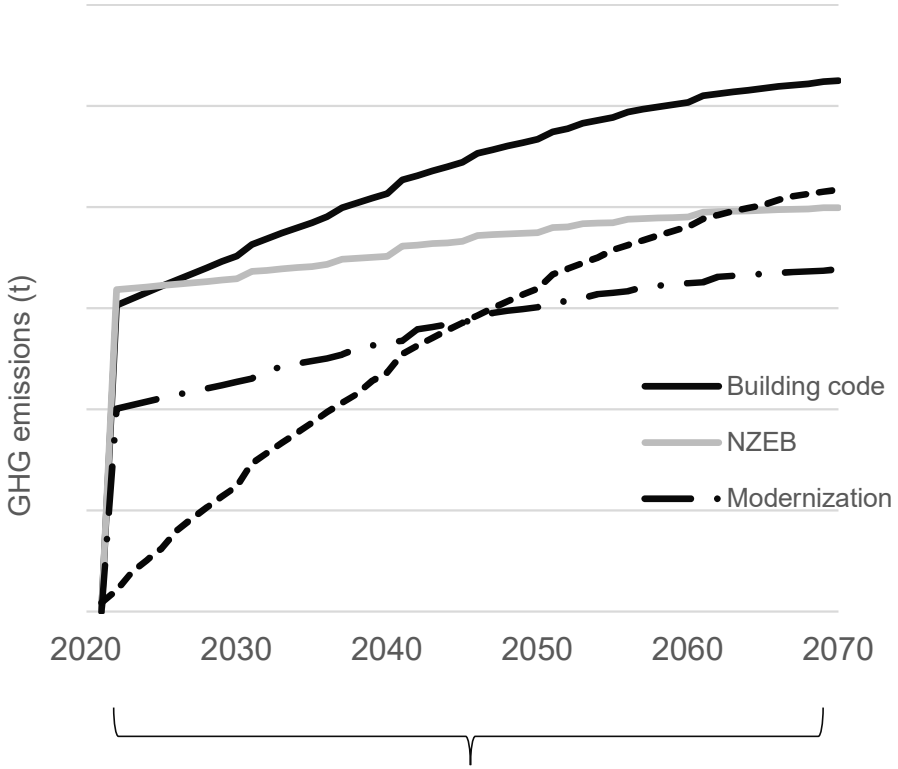

Conclusion

1. Timing of carbon emissions in green buildings have become critical
2. The options for mitigating the carbon spike of new construction
    - Circular Economy approach
    - Materials with carbon sinks
    - Low carbon manufacturing with carbon offsetting