Design and Construction responding the CO_2e reduction targets

Teadmiste- ja arvutuspõhine arhitektuurne projekteerimine
– jätkusuutliku ehituse algus

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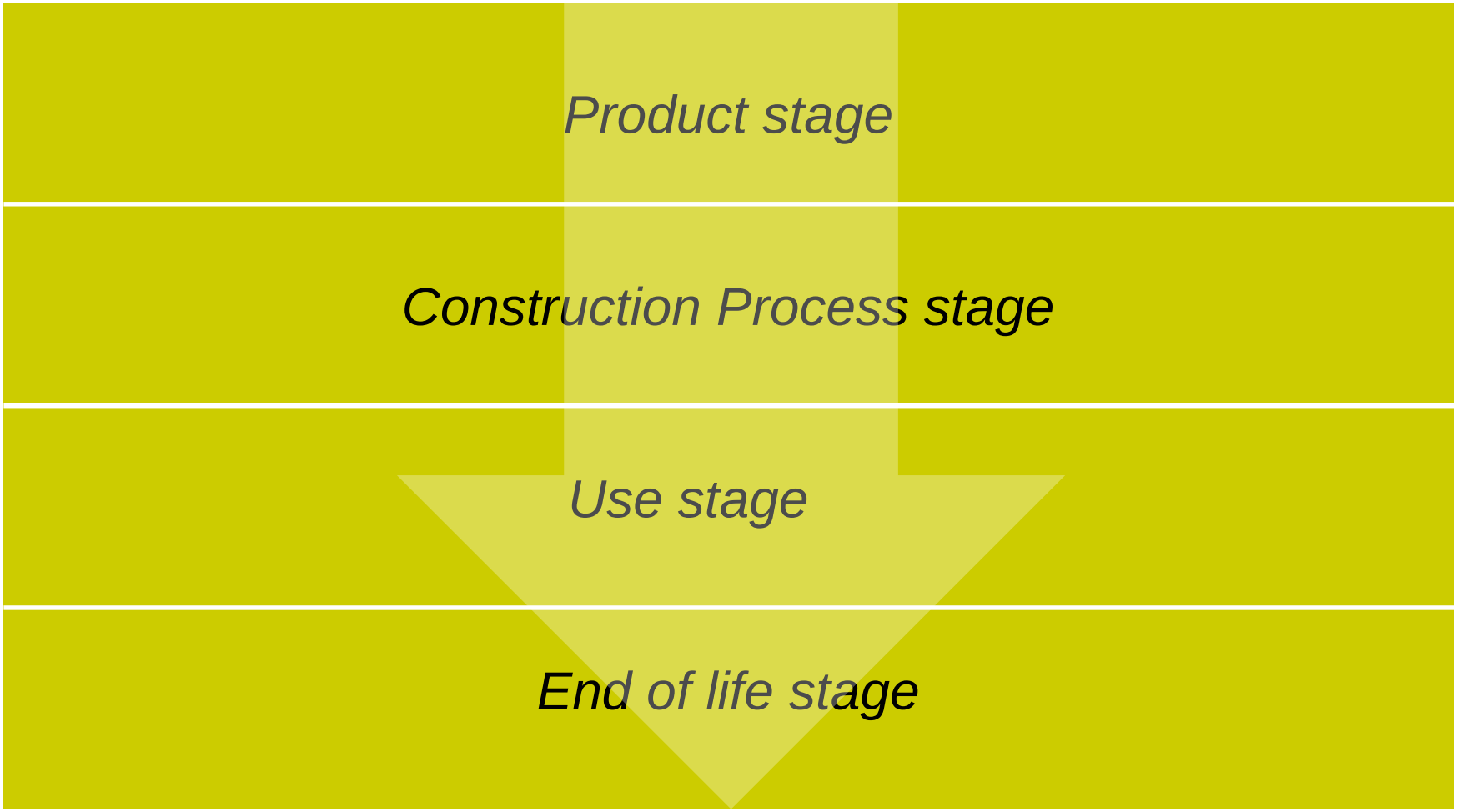
TEADMISPÕHINE EHITUS 2019

CARBON FOOTPRINT

LIFE CYCLE AS IN EN15804 and EN15978



PRODUCTION STAGE

CO_2e emission factor

$m^3 \times kg/m^3 \times gCO_2e/kg \; / \; a = gCO_2e/(m^2\,a)$

USE STAGE / ENERGY USE

CO_2e emission factor

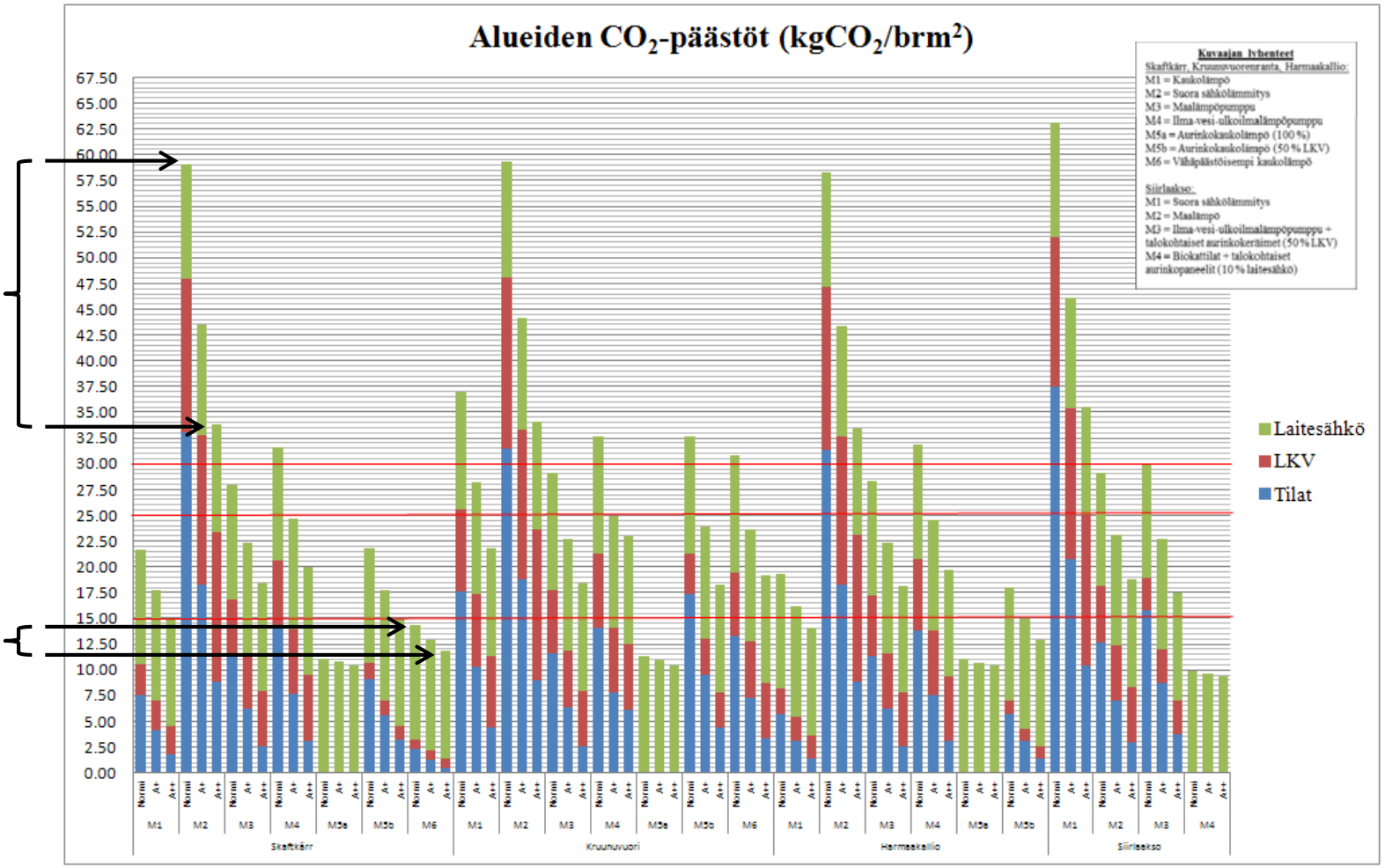
$kWh/(m^2\,a) \times gCO_2e/kWh = gCO_2e/(m^2\,a)$

- performance targets are no longer ”material neutral”
- longer service life means lower CO2e emissions
- material impact can be affected in two ways

  material selection in design phase

  energy source in manufacturing (country)

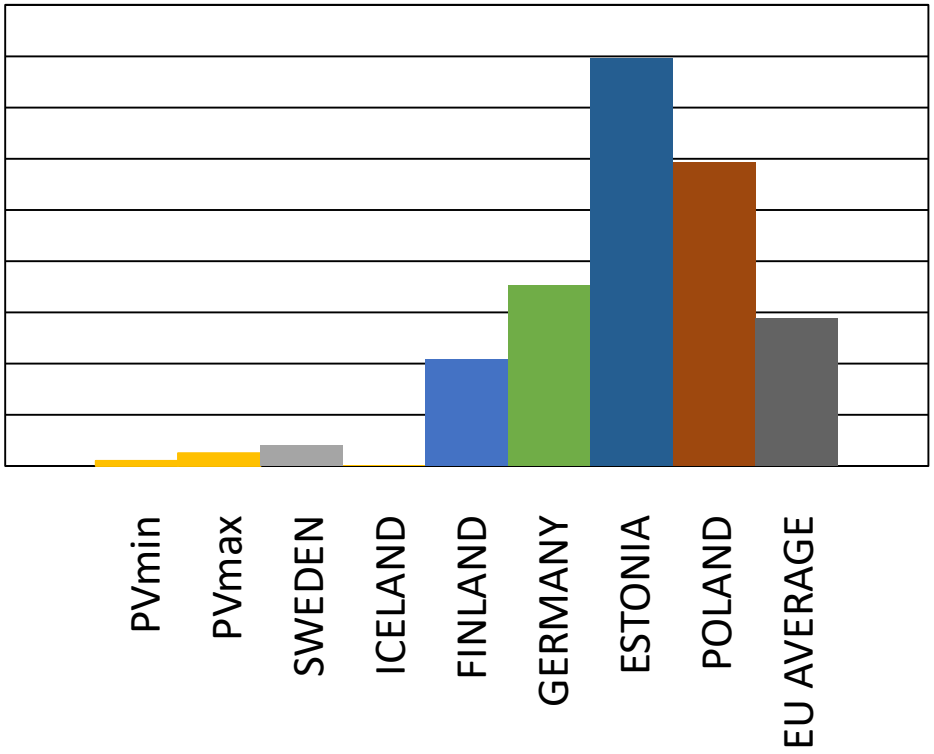
GHG EMISSIONS OF ENERGY USE IN FOUR RESIDENTIAL AREAS ($kgCO_2/brm^2$)



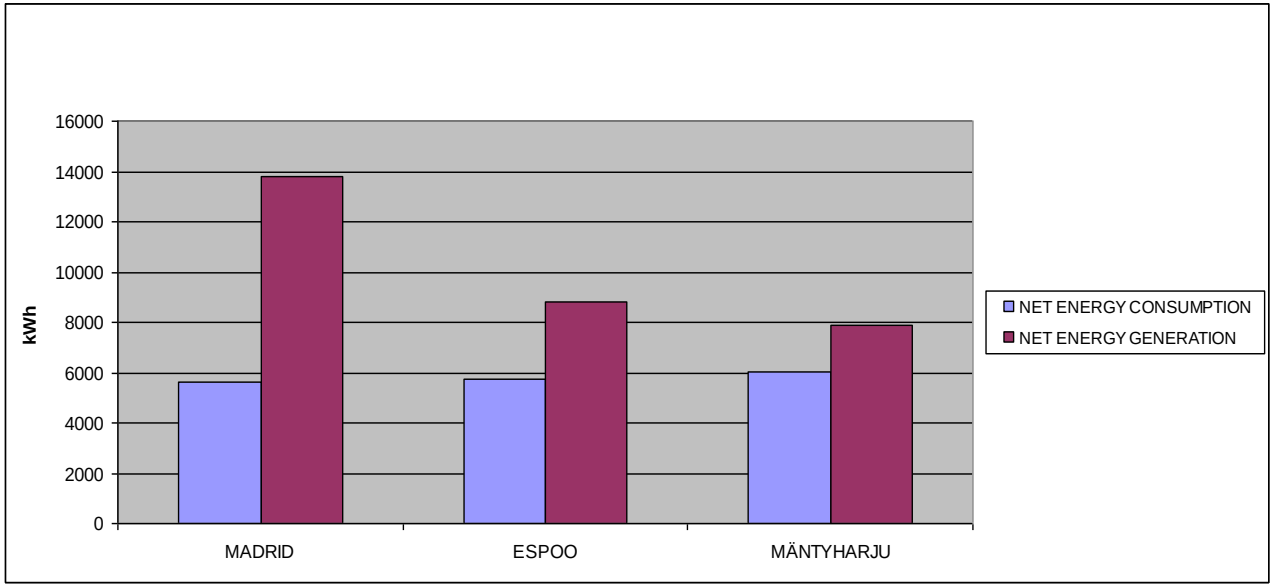
PORVOO **HELSINKI** **LOVIISA** **MÄNTYHARJU**

SOURCE: Tuukka Vainio, Aalto University, Energiakaavoituksen mallit project, 2011.

LCA-BASED CO2 EMISSION FACTORS FOR PV ELECTRICITY AND GRID ELECTRICITY IN SOME COUNTRIES

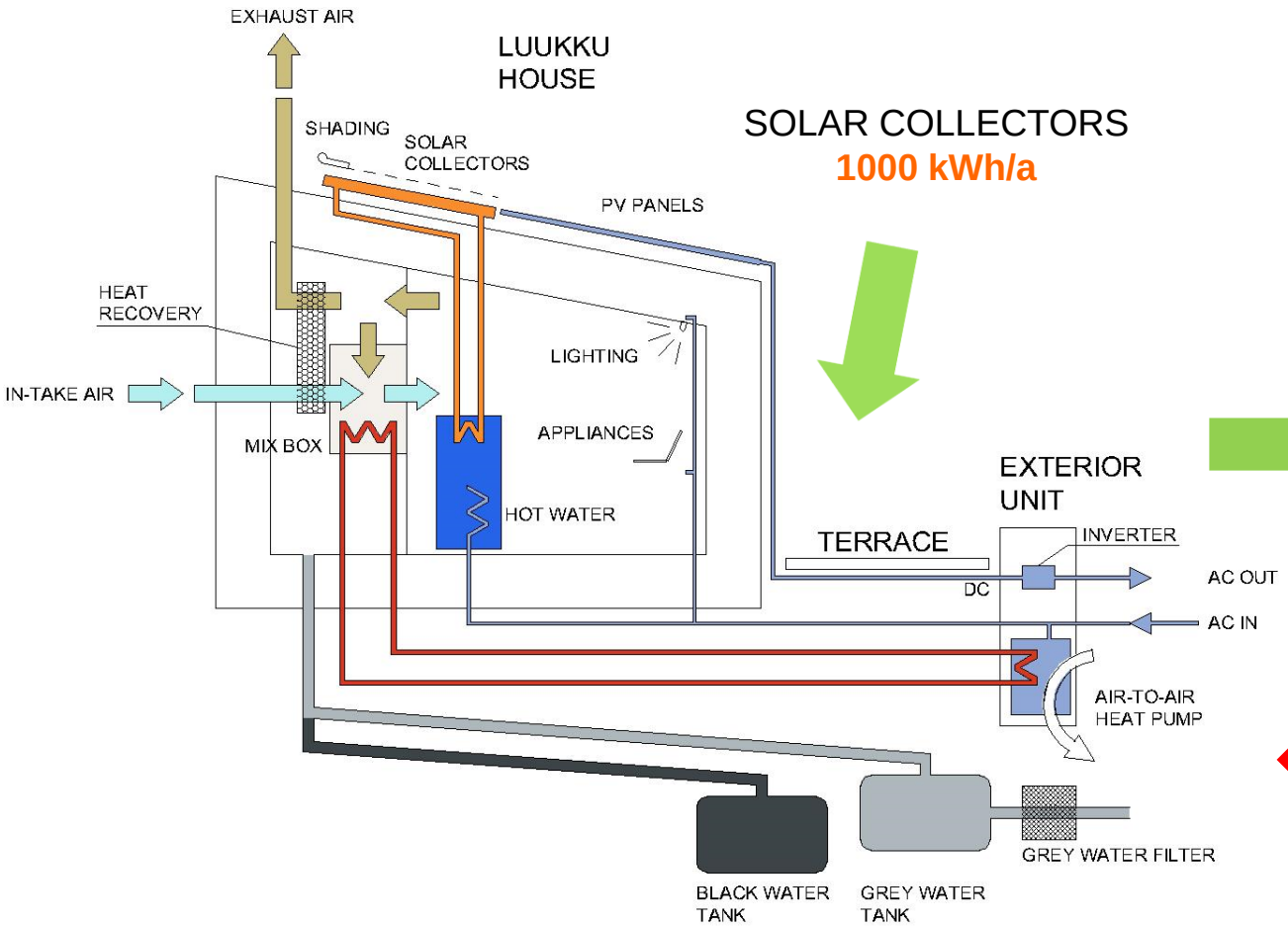


- High emission factor of grid electricity may be a challenge in export for the Estonian industry
- Renewable energy production in buildings has high potential for CO_2e reductions in Estonia


16000
14000
12000
10000
8000
6000
4000
2000
0
kWh
MADRID
ESPOO
MÄNTYHARJU
NET ENERGY CONSUMPTION
NET ENERGY GENERATION

ON-SITE RENEWABLE ENERGY GENERATION
~ 60 m² photovoltaic panels
~ 5 m² solar thermal collectors

PLOT BOUNDARY



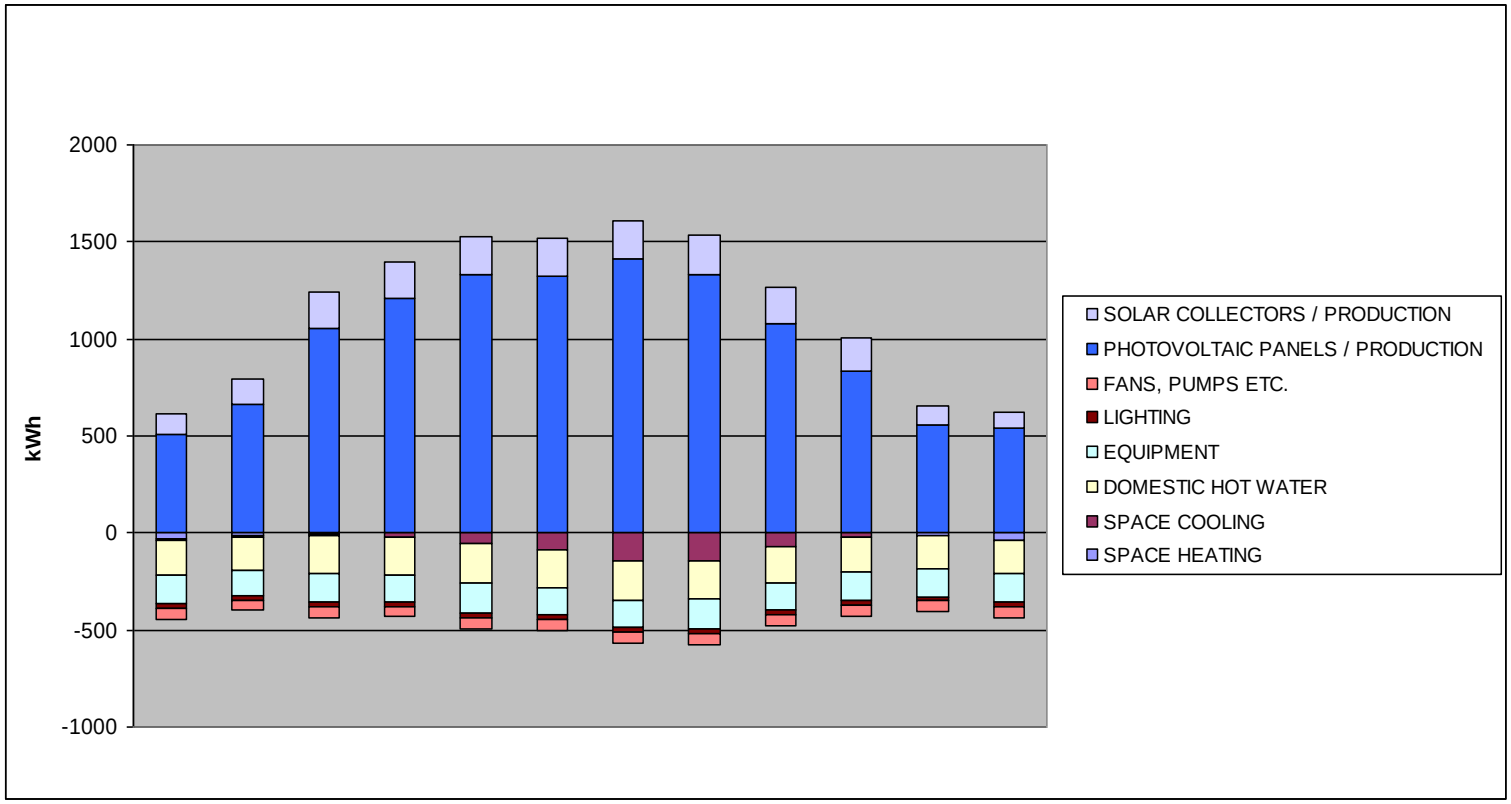
SOLAR COLLECTORS
1000 kWh/a

EXPORTED RENEWABLE ENERGY
6900 kWh/a
TO GRID

PURCHASED ENERGY
5000 kWh/a
FROM GRID

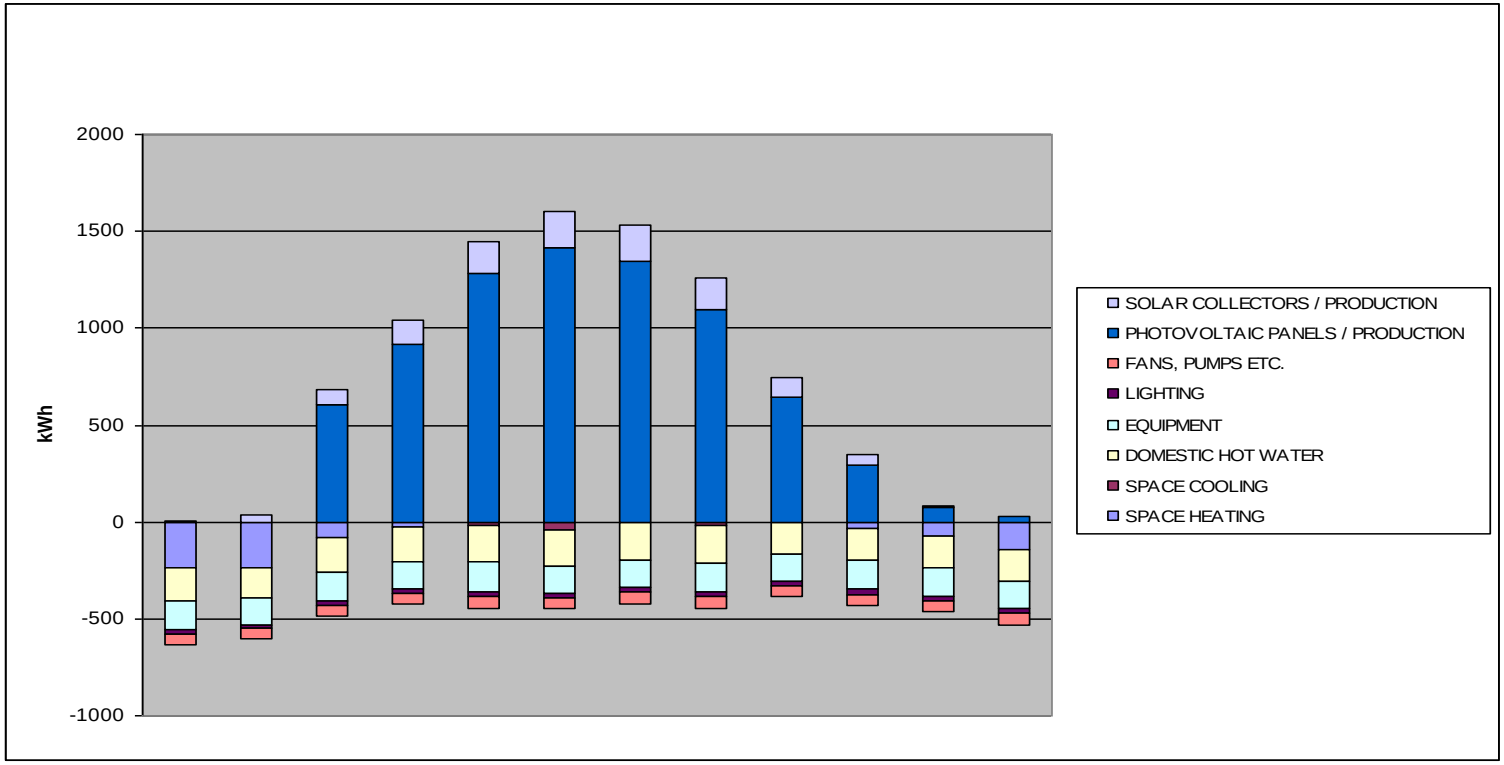
SOURCE: Wood Construction / Aalto University, Department of Architecture 2010.

LUUKKU HOUSE: MONTHLY ENERGY BALANCE IN MADRID



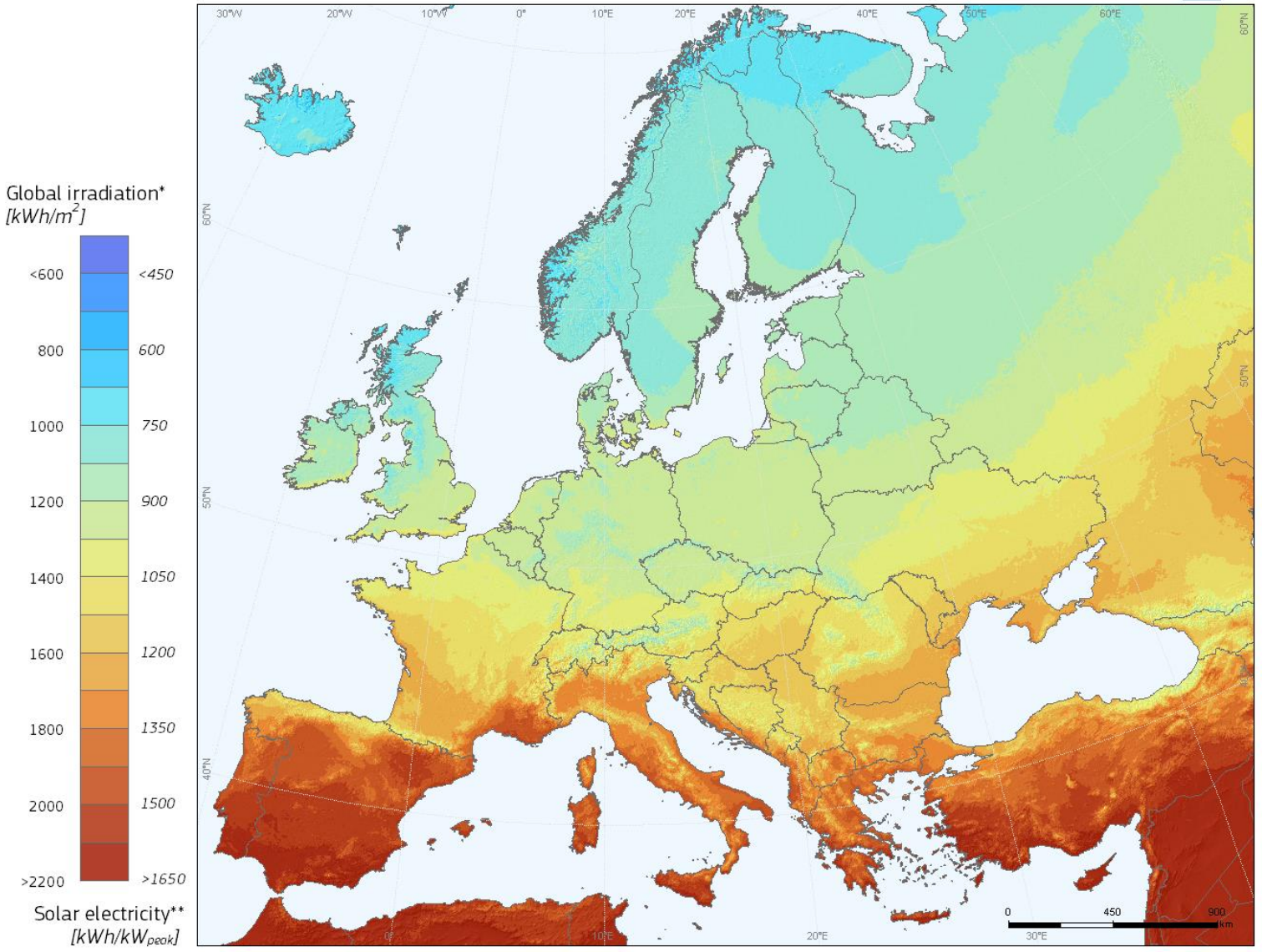
SOURCE: Wood Construction / Aalto University, Department of Architecture 2010.

LUUKKU HOUSE: MONTHLY ENERGY BALANCE IN ESPOO



SOURCE: Wood Construction / Aalto University, Department of Architecture 2010.

Photovoltaic Solar Electricity Potential in European Countries



* Yearly sum of global irradiation incident on optimally-inclined south-oriented photovoltaic modules

***Yearly sum of solar electricity generated by optimally-inclined 1kWp system with a performance ratio of 0.75*

© European Union, 2012

PVGIS http://re.jrc.ec.europa.eu/pvgis/

Authors: Thomas Huld, Irene Pinedo-Pascua
EC - Joint Research Centre
In collaboration with: CM SAF, *www.cmsaf.eu*

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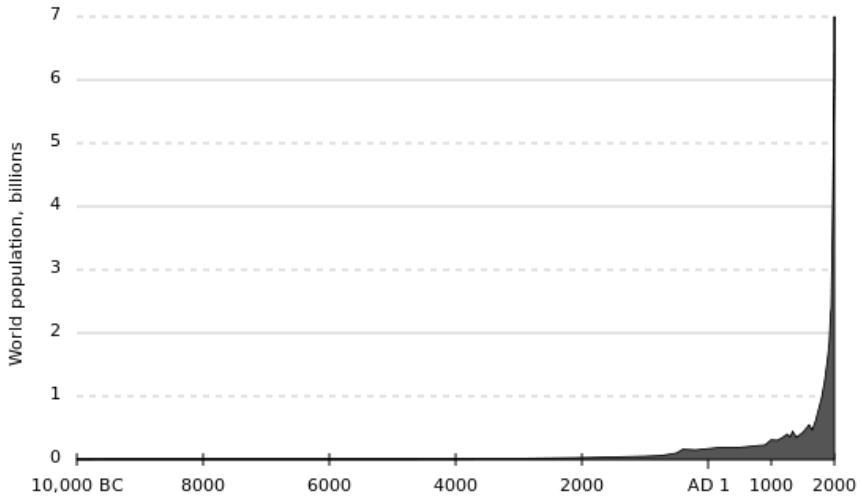
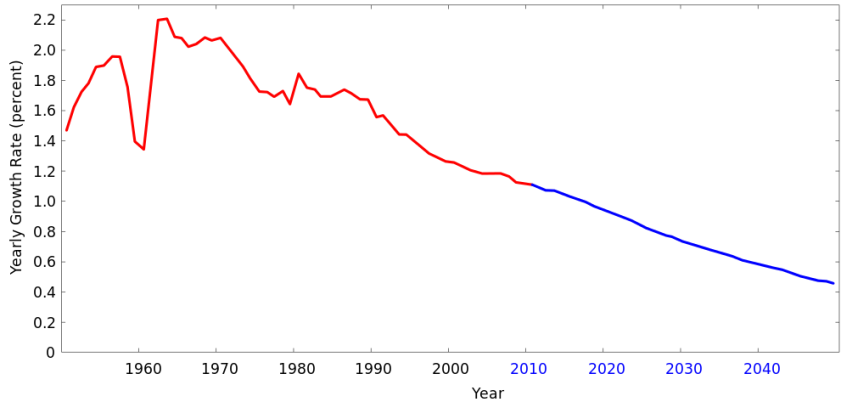
SOURCE: PVGIS © European Union, 2001-2012

THE ROOT CAUSE FOR ENVIRONMENTAL PROBLEMS

POPULATION GROWTH





floor area allocation

$$gCO_2e/(m^2\ a) \times m^2/person = gCO_2e/(person\ a)$$

- less is less
- cannot be driven by regulation: based on voluntary action

ONE TONNE LIFE

BEST WEEK DURING THE ONE TONNE LIFE EXPERIMENT:

1.5 t CO2-eqv / person, a

IPCC: sustainable level

1.0 t CO2-eqv / person, a

PRODUCTION OF COMPONENTS:

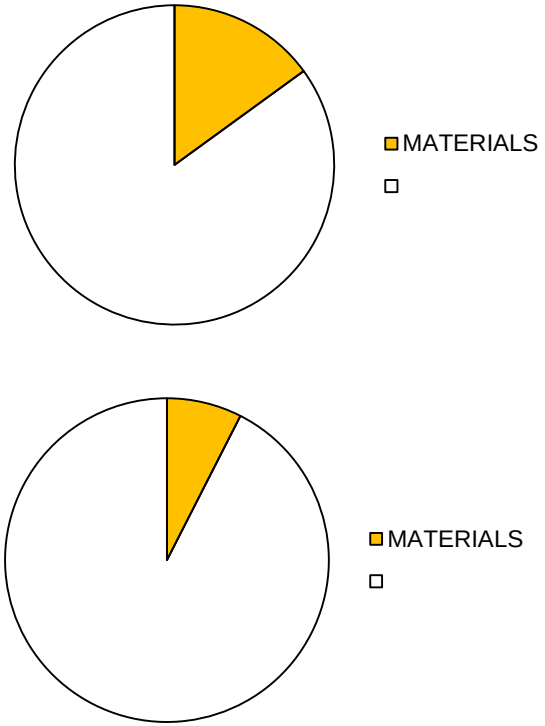
“backpack” of 0.9 t CO2-eqv / person, a

SOURCE: http://onetonnelife.com; photo: Kimmo Lylykangas

PHOTO Kimmo Lylykangas

HOW MUCH IS LEFT FOR ONE TONNE LIFE?

1 t CO_2eqv/person,a



LUUKKU HOUSE
2 persons
50 years life

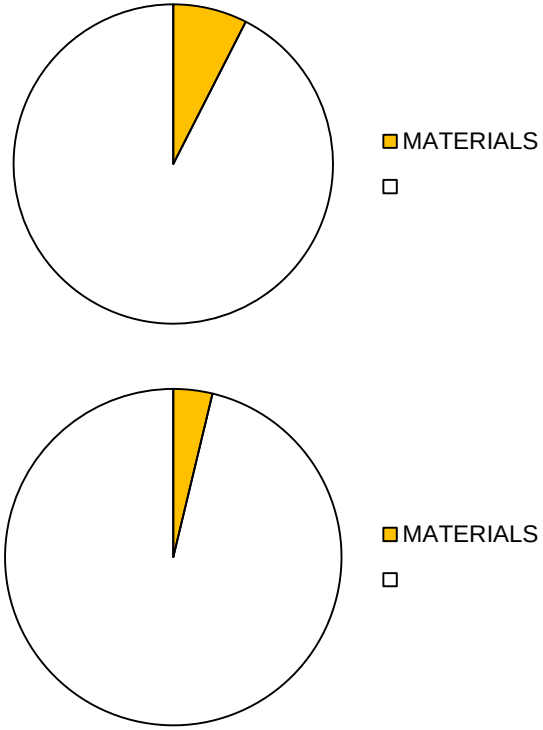
►0.15 t CO_2eqv / person,a

LUUKKU HOUSE
2 persons
100 years life

►0.075 t CO_2eqv / person,a

HOW MUCH IS LEFT FOR ONE TONNE LIFE?

1 t CO_2eqv/person,a



FIVE TREES HOUSE
4 persons
50 years life

►0.075 t CO_2eqv / person,a

FIVE TREES HOUSE
4 persons
100 years life

►0.038 t CO_2eqv / person,a

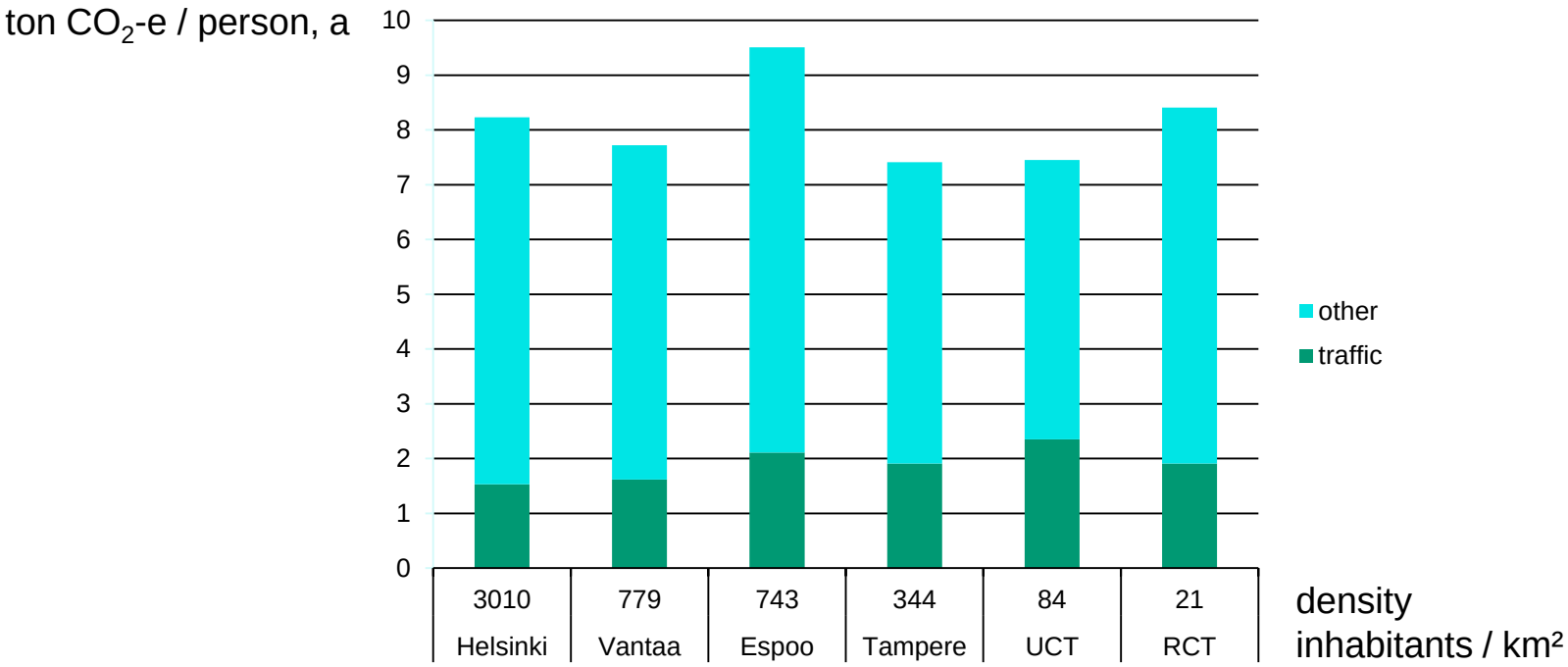
PHOTO Kimmo Lylykangas

URBAN DENSITY AND CARBON FOOTPRINT

TIERED HYBRID LCA METHOD BY HORVATH AND JUNNILA

*"Interestingly, the results show that **the type of the urban structure**, whether a dense metropolitan core with apartment buildings or a less dense suburban area with primarily detached housing, **has quite a small effect on the carbon emissions**."*

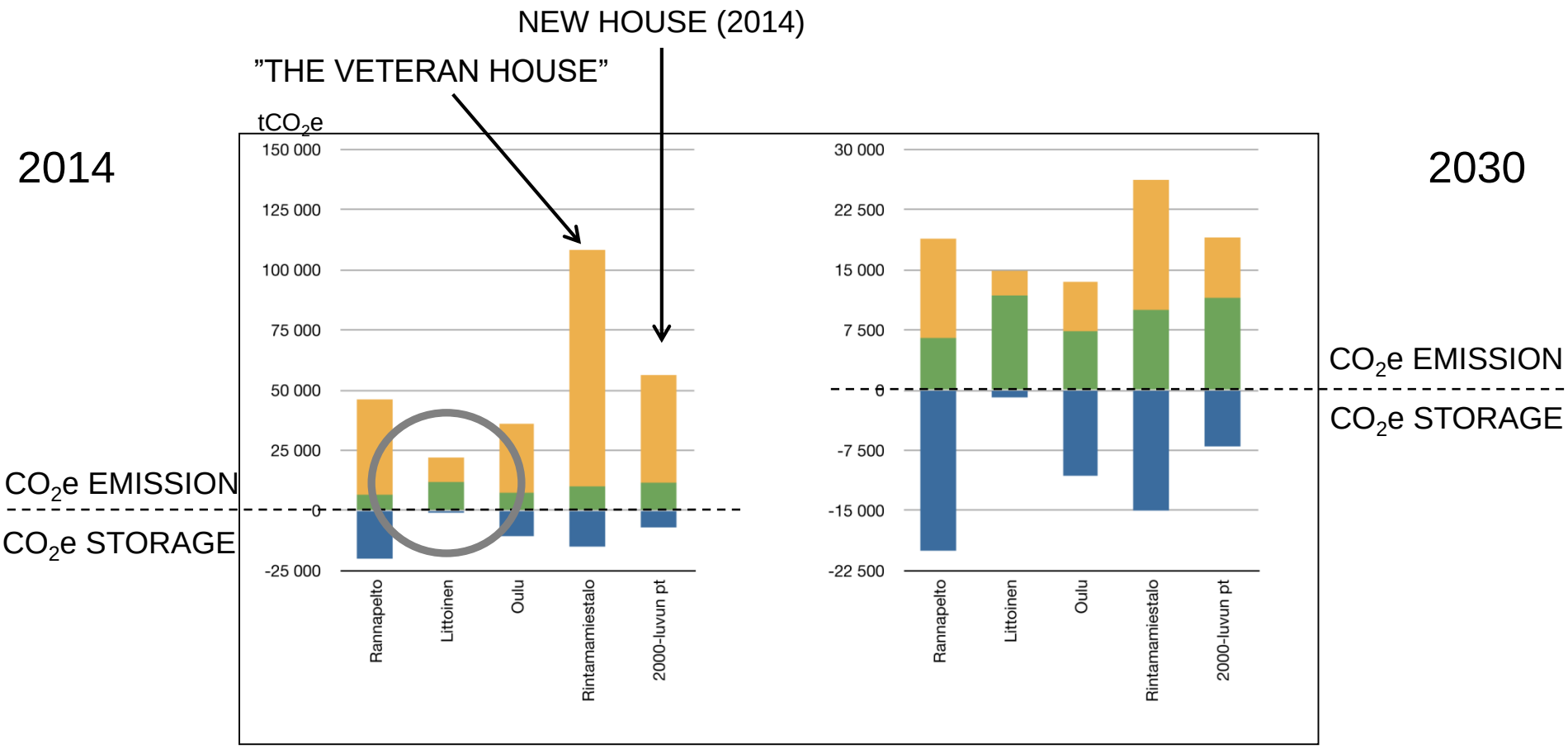
In 2014, the results are noted in the Fifth Assessment Report of the IPCC .



SOURCE: Heinonen, Jukka & Junnila, Seppo: Implications of urban structure on carbon consumption in metropolitan areas. Environmental Research Letters Volume 6 number 1 (2011).

MEASURED ENERGY CONSUMPTION AND CO_2

TWO NEW PARAMETERS: GRID ENERGY AND THE USE PROFILE



SOURCE: Hänninen, Pekka: Pientaloasumisen ekologinen kestävyys 2014.

SOURCE: www.onetonnelife.com

AITÄH

THANK YOU FOR YOUR ATTENTION