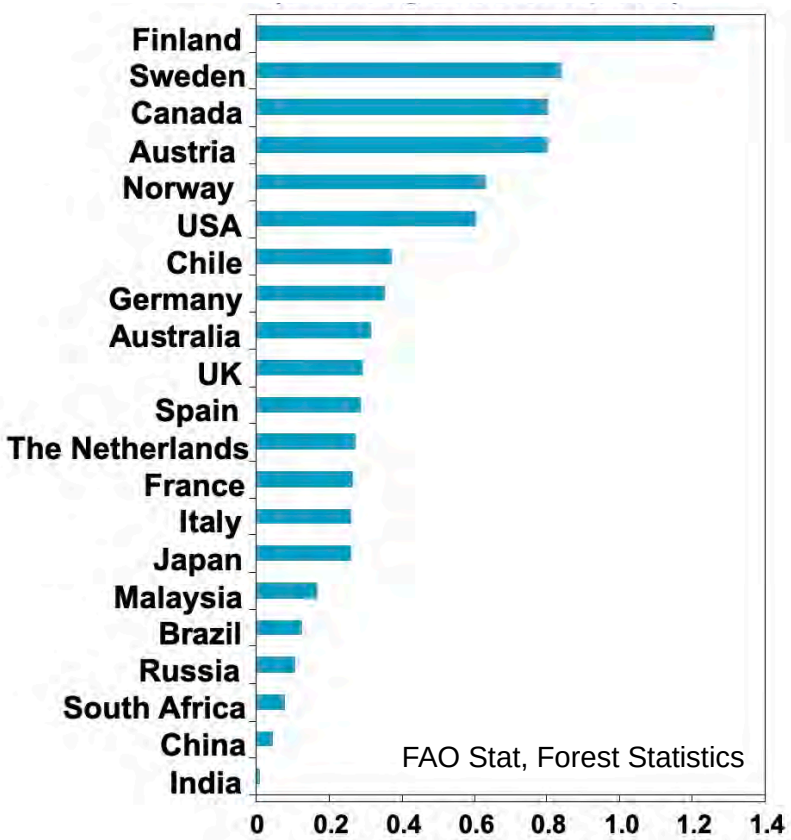
Timber as a sustainable urban building materials with a low carbon-footprint: presentation & discussion

Anders Q. Nyrud
NMBU Wood Technology

Consumption of solid wood construction materials (m^3/capita)

- Natural material
- Renewable
- Long history of use



Raulandsstova, ca 1300 (Norsk folkemuseum)

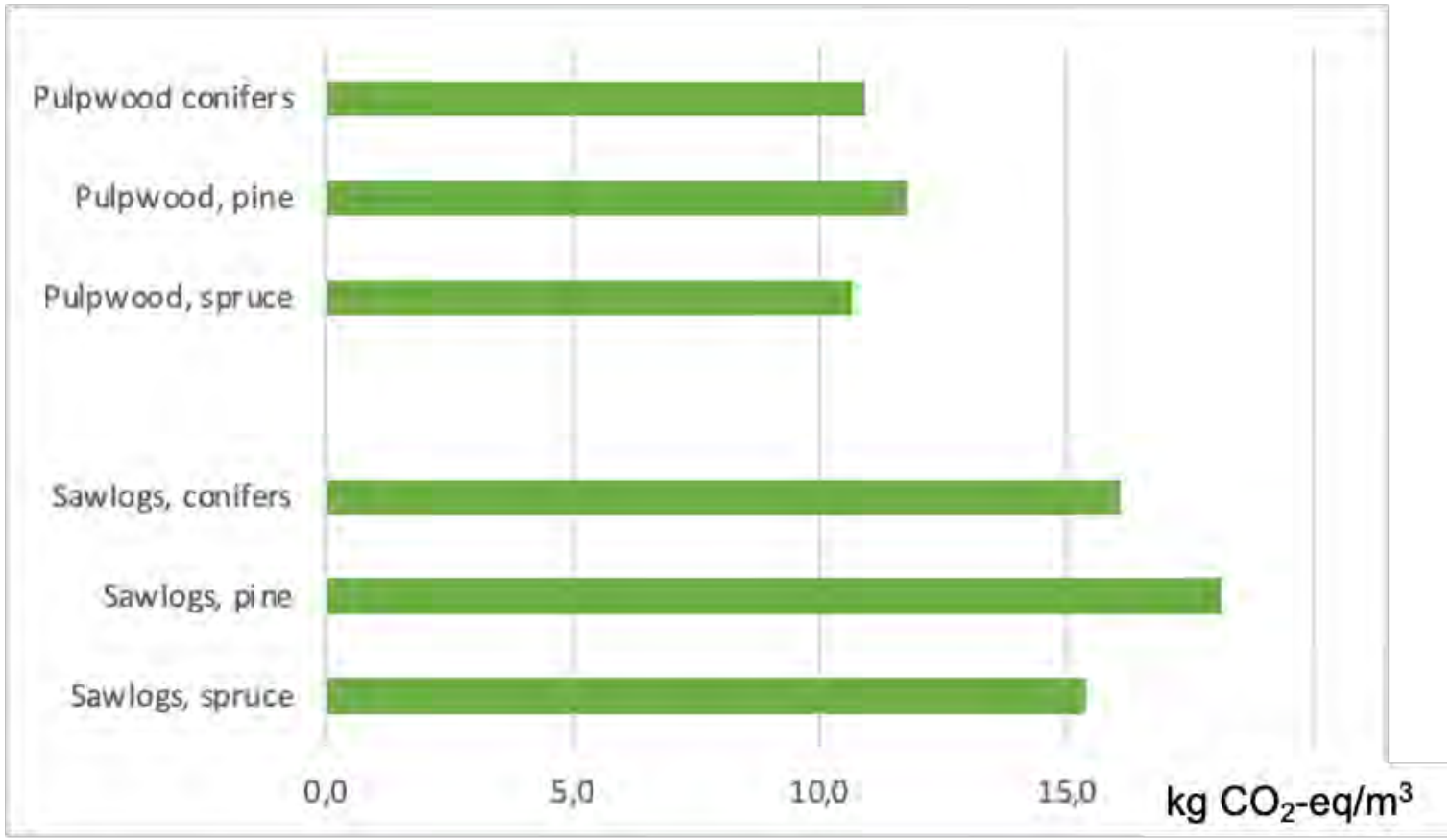
Detached house, Kolbotn 2020


Brumunddal

Mjøstårnet (www.moelven.no)

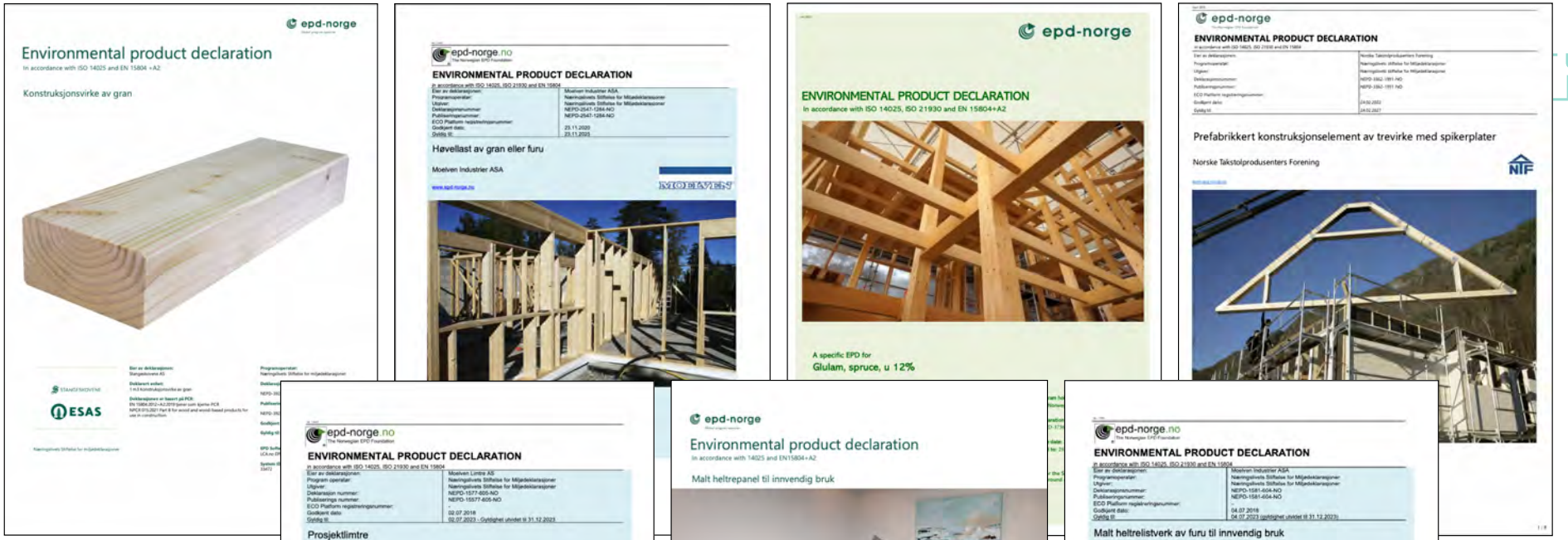
Hasle tre (www.oslotre.no)


CO_2

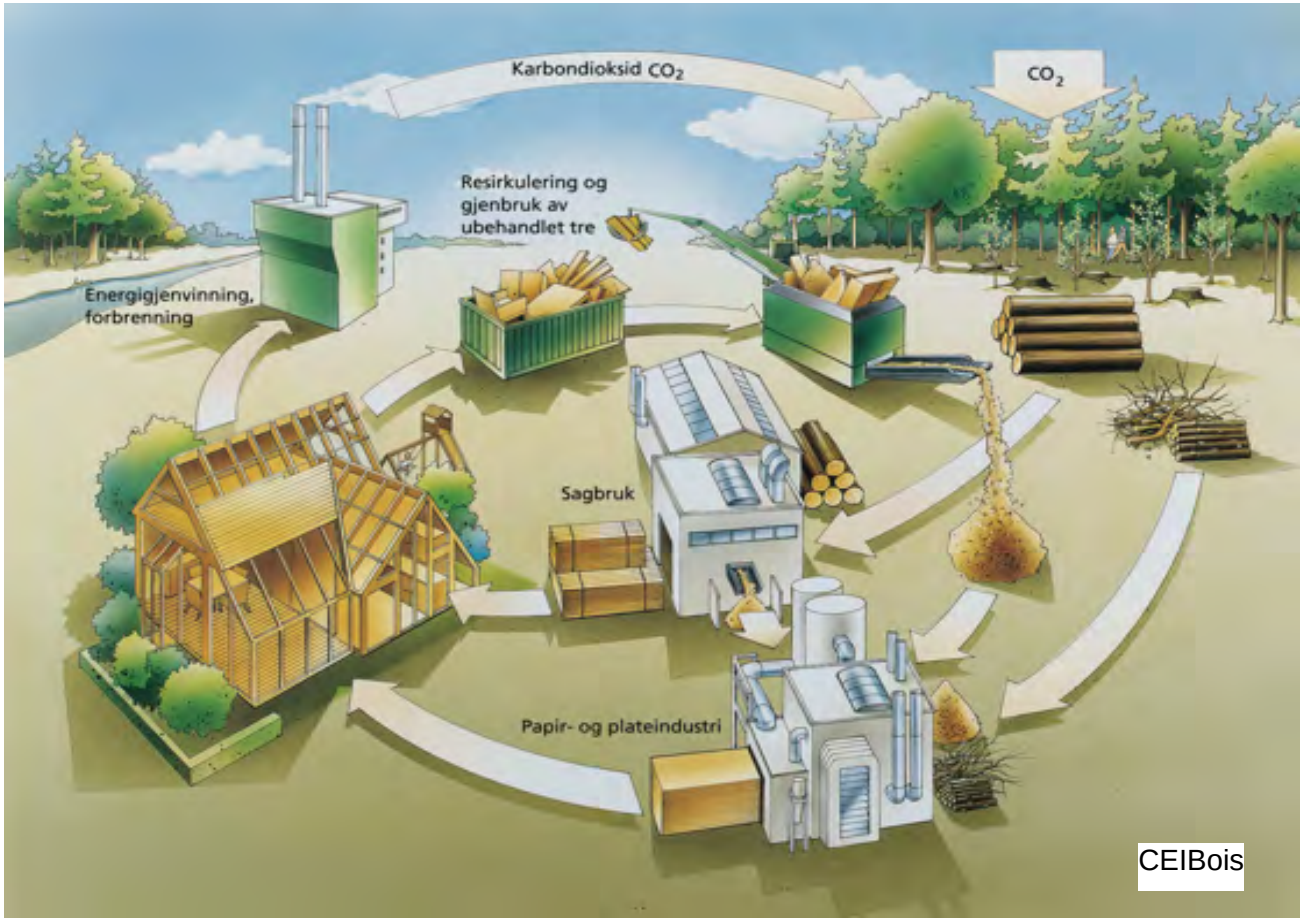

Pulpwood conifers
Pulpwood, pine
Pulpwood, spruce
Sawlogs, conifers
Sawlogs, pine
Sawlogs, spruce
0,0
5,0
10,0
15,0
kg CO_2-eq/m^3

1. Glulam/CLT:
   1000 cm^3 - 70 kg CO_2eq/m^3
2. Brics:
   200 cm^3 - 220 kg CO_2eq/ton
3. Concrete (B30 M60):
   160 cm^3 - 440 kg CO_2eq/m^3
4. Steel:
   3,5 cm^3 - 2,65 kg CO_2eq/kg
5. Aluminium:
   2 cm^3 - 13 (4-20) kg CO_2eq/m^3

Bård Solem/Eggen arkitekter, 2019



Norges miljø- og biovitenskapelige universitet


Karbondioksid CO_2
CO_2
Resirkulering og gjenbruk av ubehandlet tre
Energigjenvinning, forbrenning
Sagbruk
Papir- og plateindustri
CEIBois

Indoor climate

I. **Thermal environment**
(hot, cold, draughts, humidity)

II. **Atmospheric environment**
(pollution, air quality, volume of fresh air)

III. **Acoustic environment**
(noise, perception of speech and sound)

IV. **Actinic environment**
(lighting, radiation, electromagnetic fields)

V. **Mechanical environment**
(ergonomics, anti-slip protection, vibrations, etc.)

VI. **Aesthetic environment**

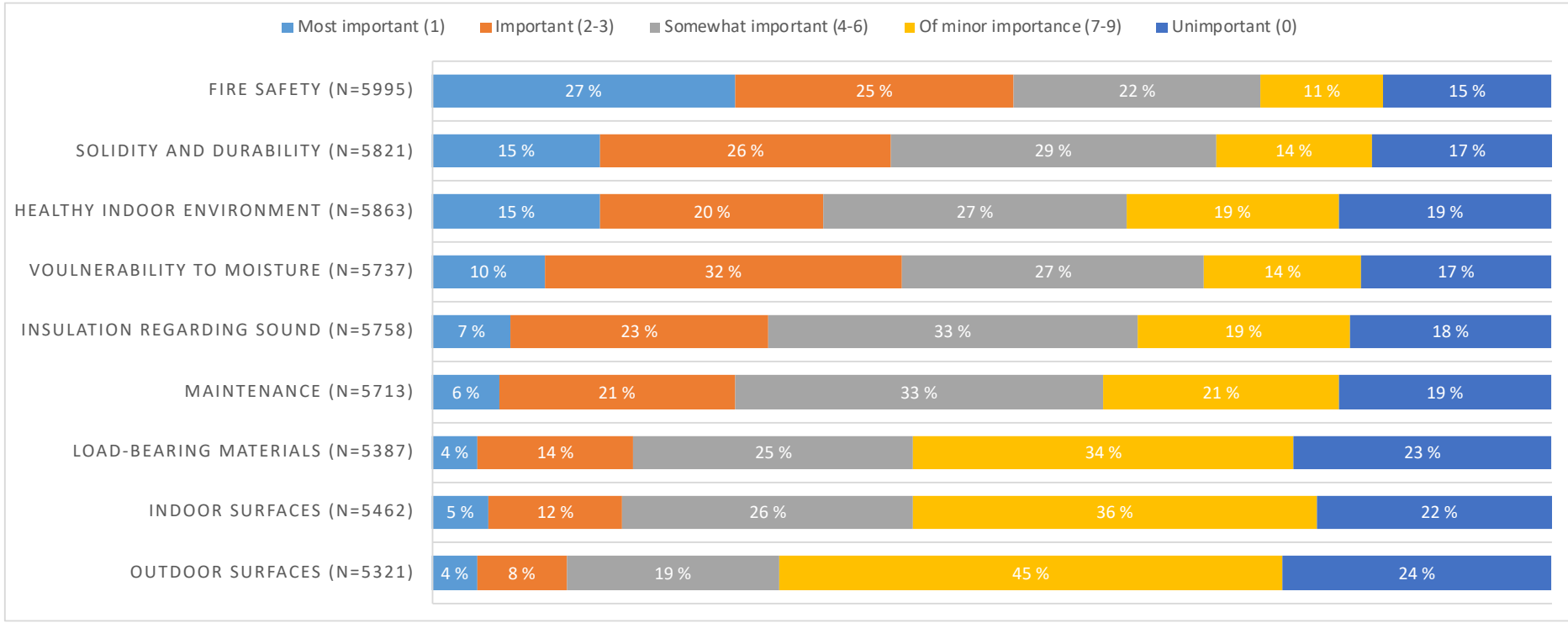
VII. **Psychological environment**

World Health Organization

TALLWOOD

Norges miljø- og biovitenskapelige universitet

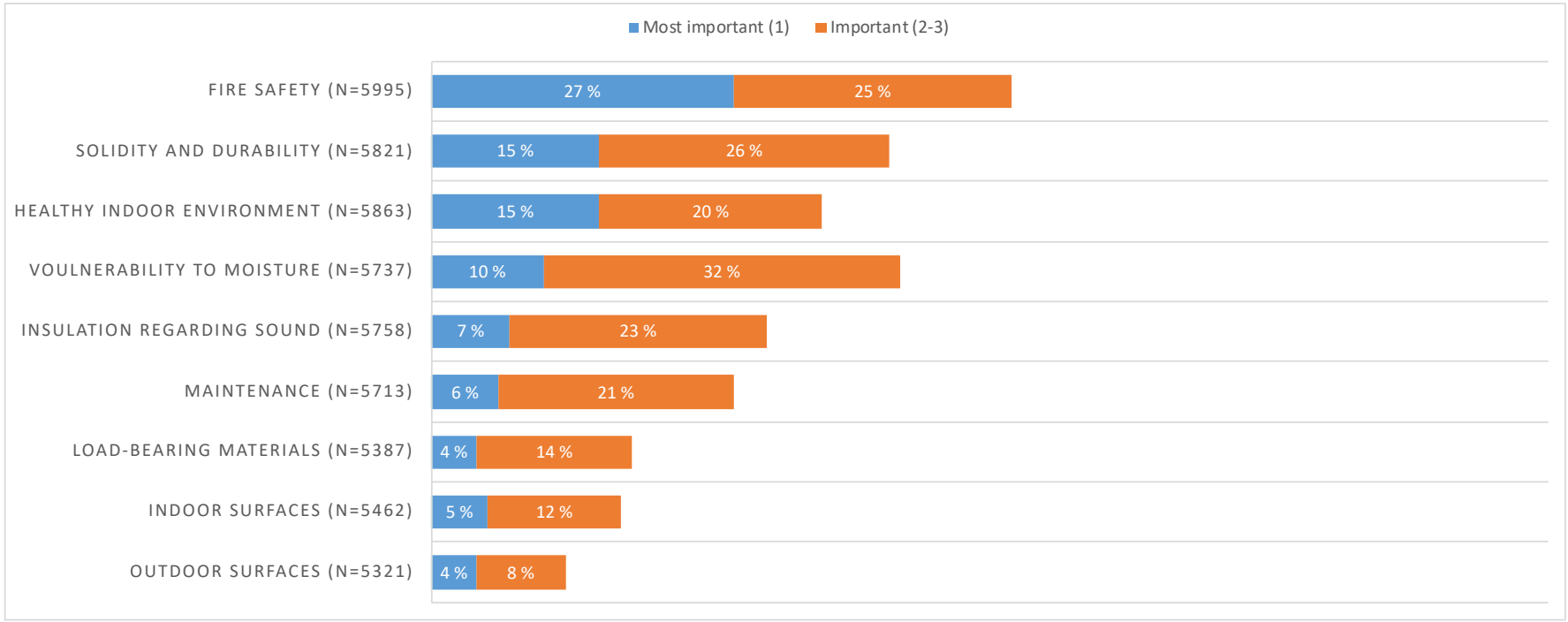
Importance of nine factors for the attractiveness of tall timber buildings



TALLWOOD

Norges miljø- og biovitenskapelige universitet

Importance of nine factors for the attractiveness of tall timber buildings



TALLWOOD

Norges miljø- og biovitenskapelige universitet

Importance of nine factors for the attractiveness of tall timber buildings

All	Austria	Denmark	Finland	Germany	Norway	Sweden	UK
Fire safety	Healthy indoor environment	Healthy indoor environment	Healthy indoor environment	Fire safety	Fire safety	Fire safety	Fire safety
Healthy indoor environment	Solidity and durability	Fire safety	Fire safety	Healthy indoor environment	Healthy indoor environment	Solidity and durability	Solidity and durability
Solidity and durability	Vulnerability to moisture	Vulnerability to moisture	Vulnerability to moisture	Vulnerability to moisture	Solidity and durability	Healthy indoor environment	Vulnerability to moisture

Appearance wood products and psychological well-being

Material	Warm	Natural	Relaxing
Glass	-0.13	0.06	0.05
Plastic	-0.39	-0.64	-0.43
Steel	-0.74	-0.34	-0.50
Wood	0.91	0.90	0.83
Painted surface	0.48	0.08	0.49
Wallpaper	0.37	-0.05	0.22
Leather	0.33	0.51	0.43
Concrete	-0.66	-0.33	-0.50
Ceramic	-0.05	0.13	0.06
Stone	-0.14	0.81	0.05

Rice, Kozak, Meitner og Cohen (2006)

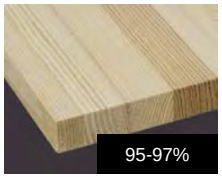
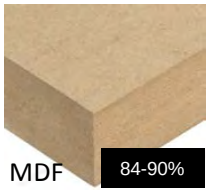
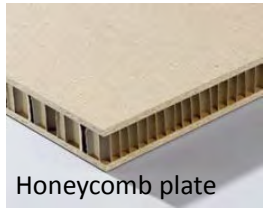
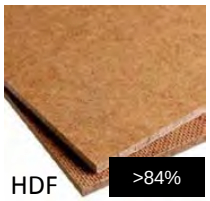
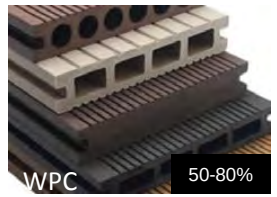
Appearance wood products and psychological well-being

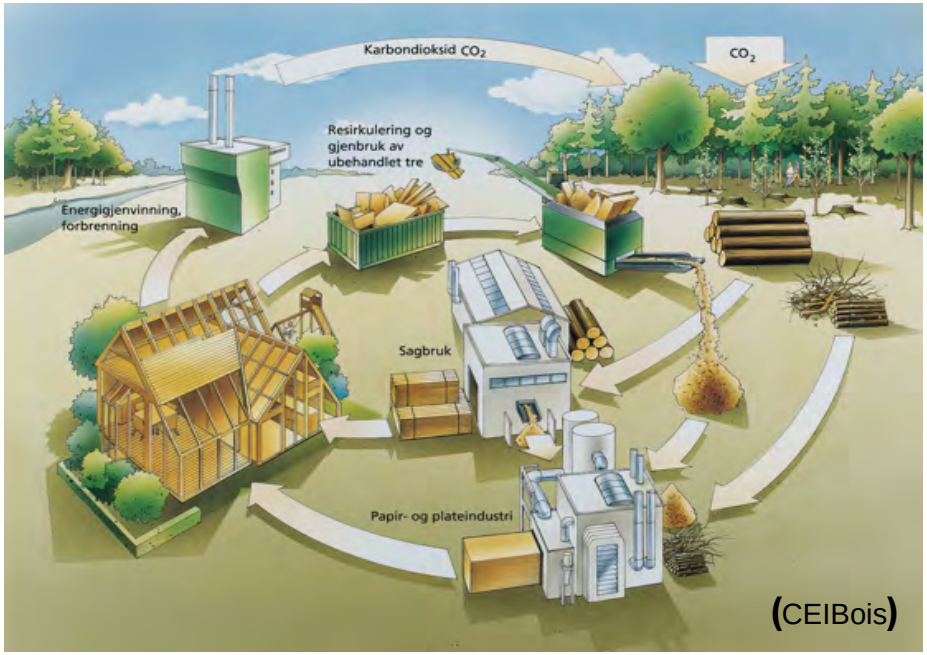
Material	Warm	Natural	Relaxing
Glass	-0.13	0.06	0.05
Plastic	-0.39	-0.64	-0.43
Steel	-0.74	-0.34	-0.50
Wood	0.91	0.90	0.83
Painted surface	0.48	0.08	0.49
Wallpaper	0.37	-0.05	0.22
Leather	0.33	0.51	0.43
Concrete	-0.66	-0.33	-0.50
Ceramic	-0.05	0.13	0.06
Stone	-0.14	0.81	0.05

Rice, Kozak, Meitner og Cohen (2006)

Psychological effects of wood use

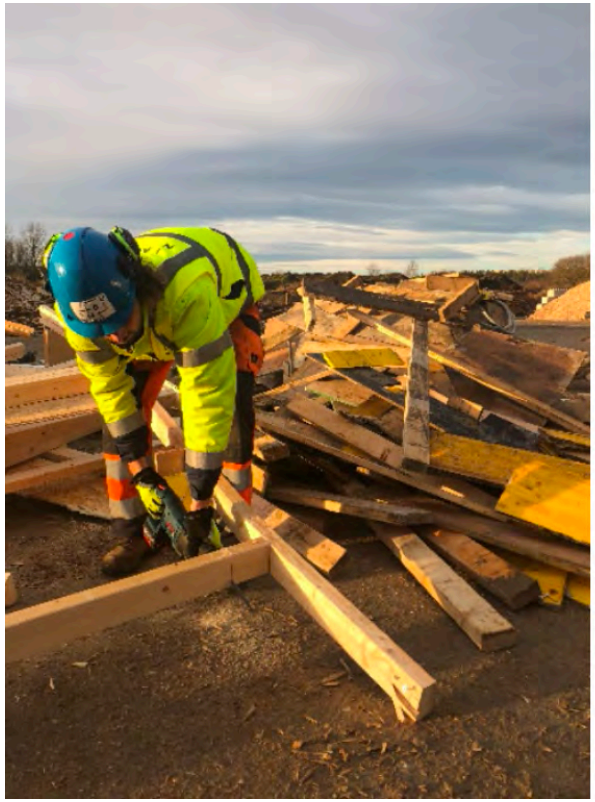
Nyrud, Brigslimark og Bysheim (2013)

Solid	VENEER	CHIP	FIBER	COMPOSITE
 95-97%	 LVL	 Particle-board 86-93%	 MDF 84-90%	 Blockboard
 Glulam 95-97%	 Plywood 90-95%	 Tublar board	 Insulation-board	 Honeycomb plate
 CLT 95-97%	 Parallam	 OSB	 HDF >84%	 WPC 50-80%



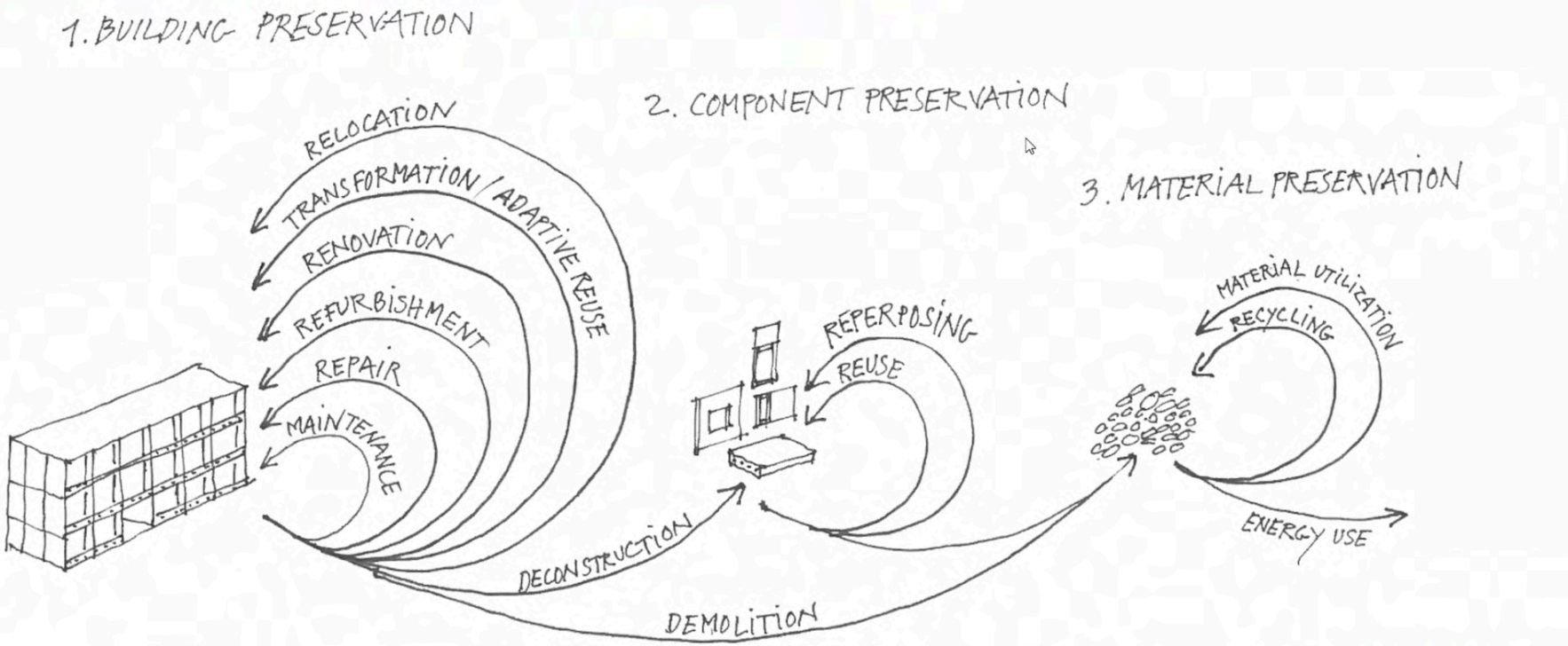
(CEIBois)

(Schandl et al. 2021)

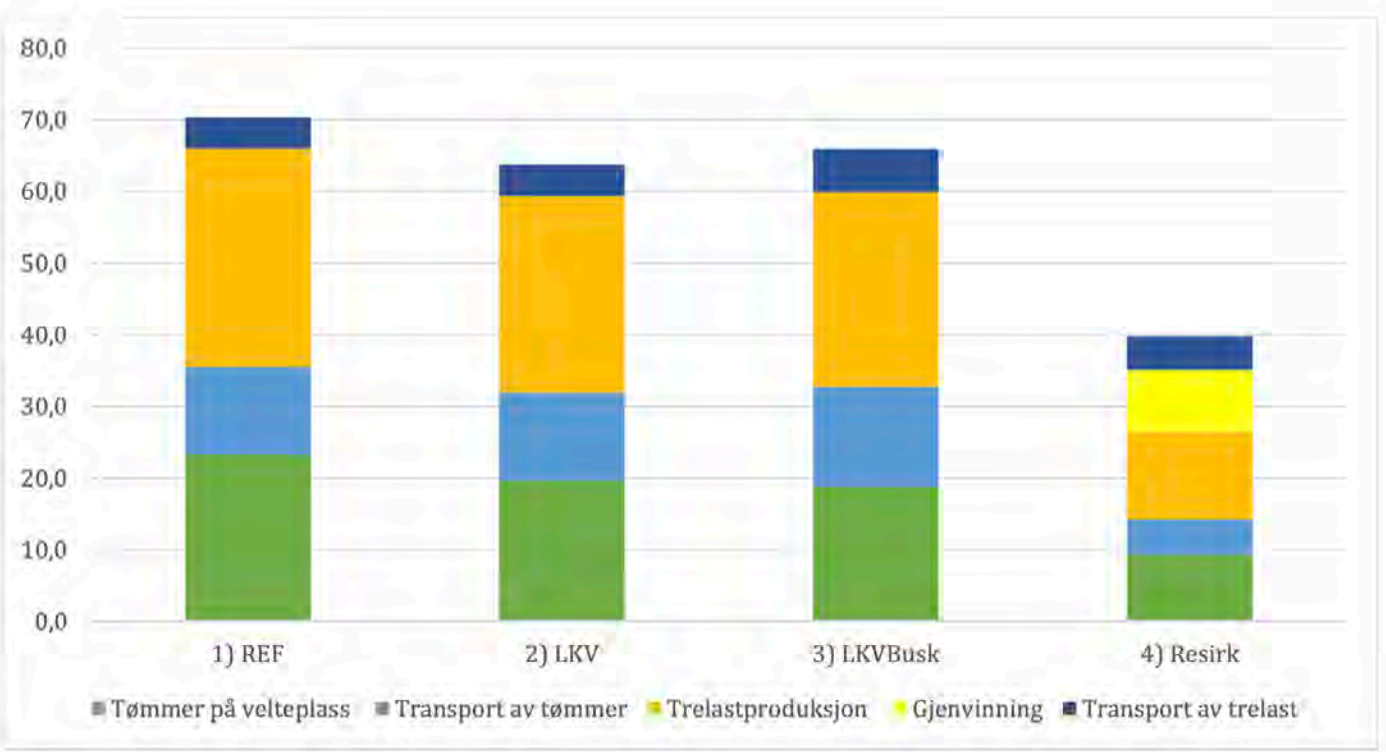



7

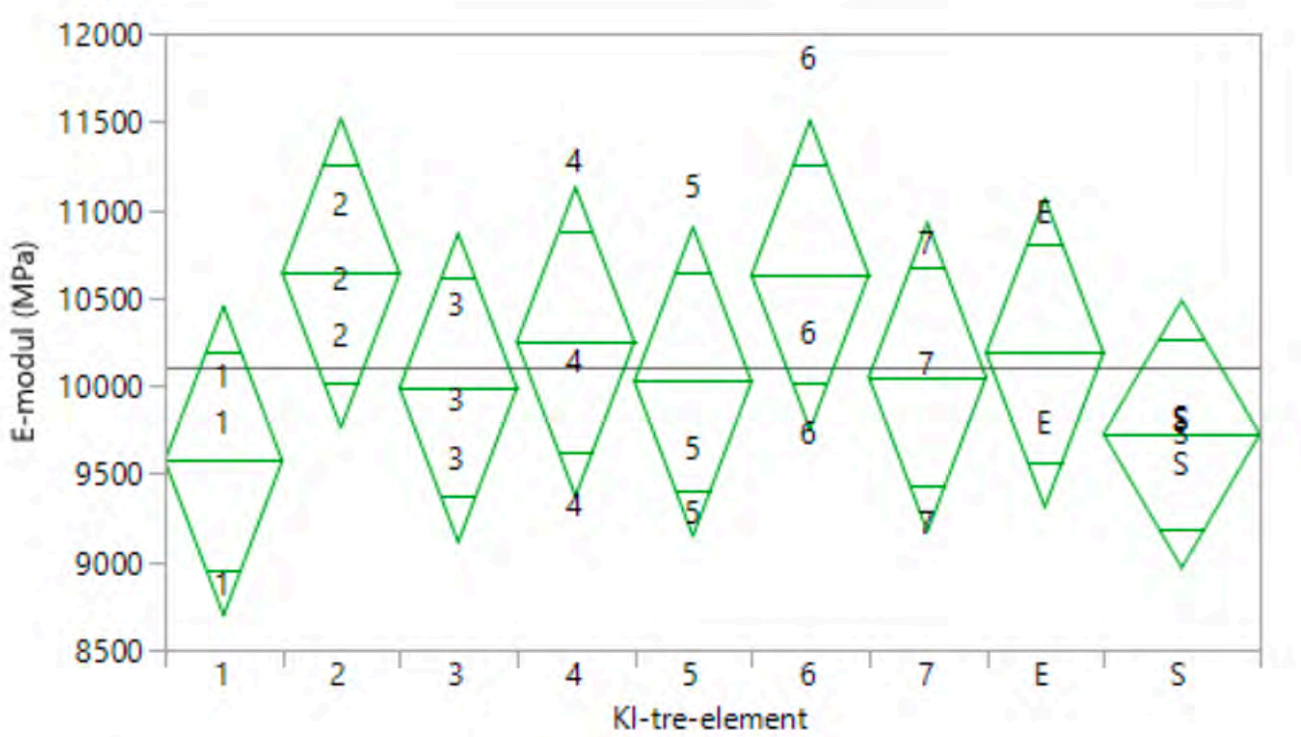
CE hierarchy for buildings



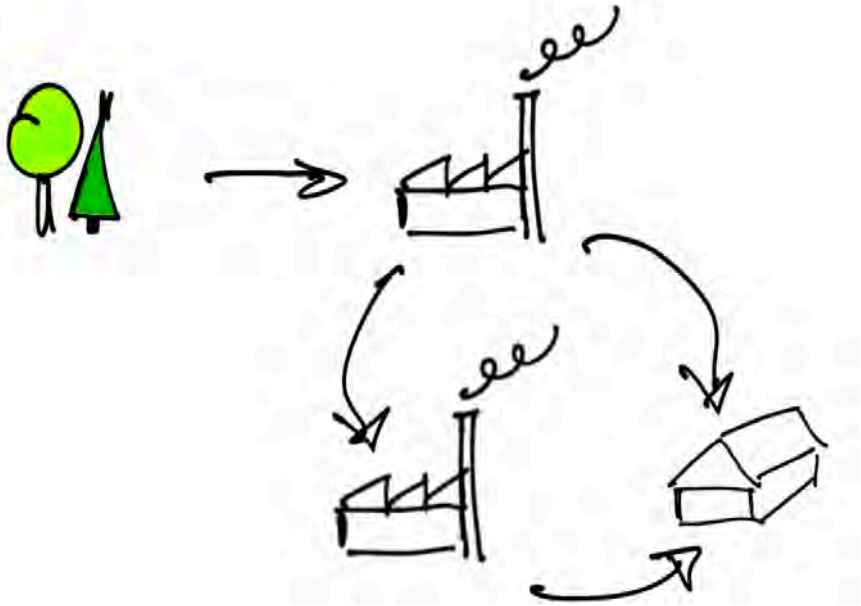
Source: Huuhka, S. & Vestergaard, I. (2019).

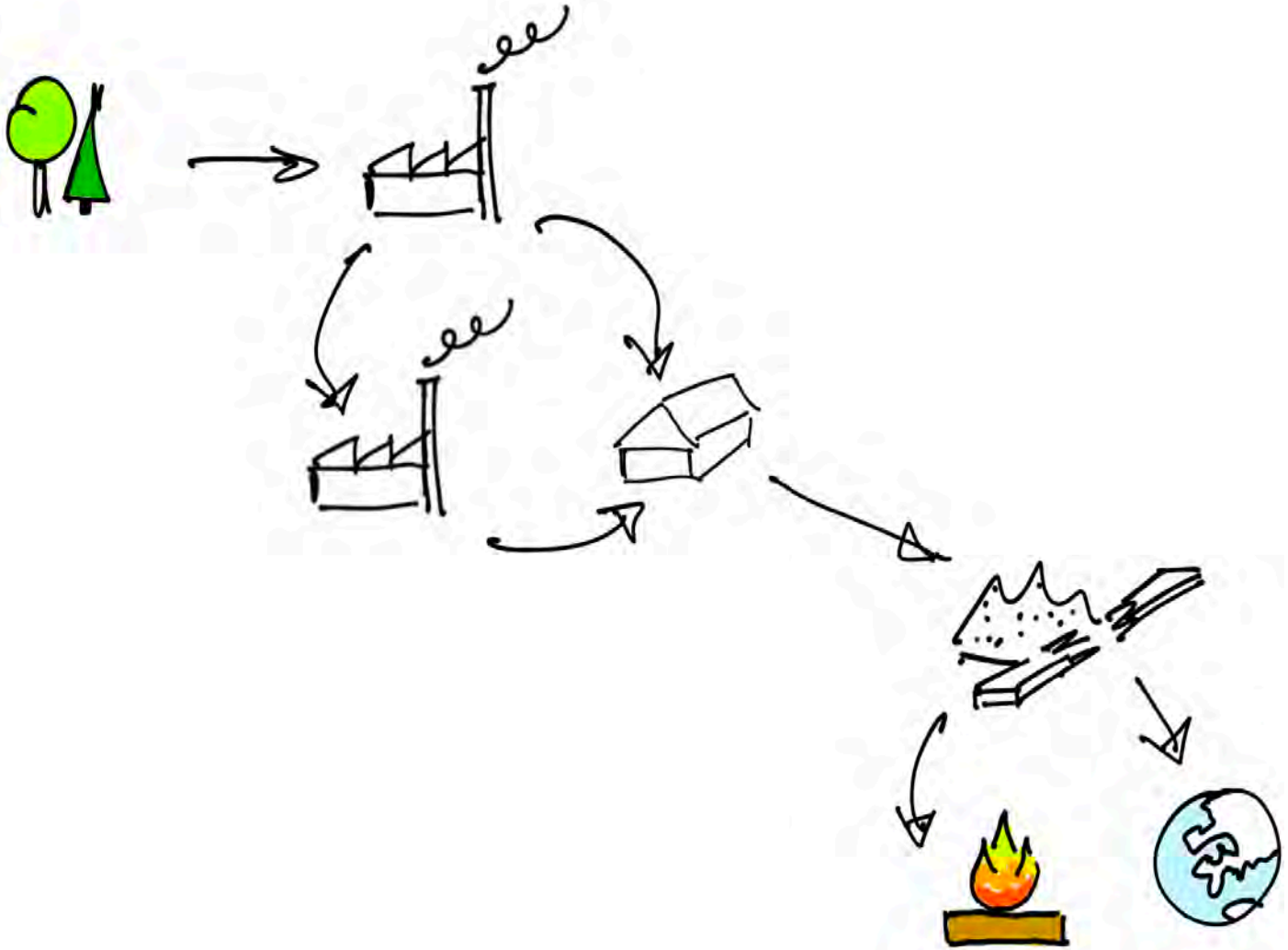


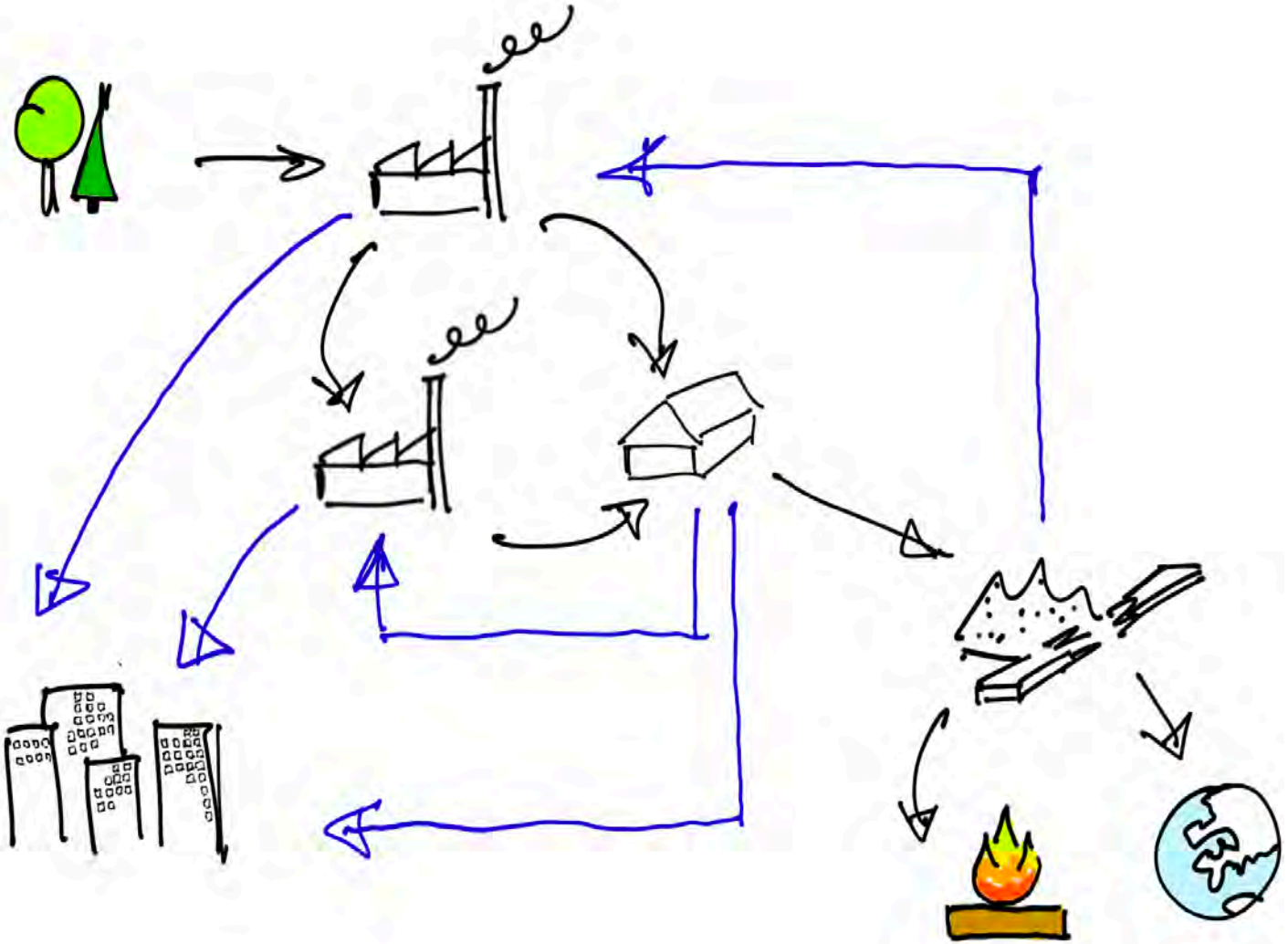
Figur 14. Klimagassutslipp for alternativ 1)-4) (100mm tykkelse) ved ulike livsløpsstadier. Presentert som kg CO_2-eq/m^3.



Figur 4-1: Standardavvik og variansanalyse i hver elementtype.







Reclaimed wood as raw material for industry

- Availability
  - Scale – industrial processing
  - Dimensions
- Quality
  - Strength properties
  - Visual properties
  - Moisture
  - Contamination – foreign bodies
  - Contamination – chemical
  - Contamination – biological
- Trust – consumers, owners, public entities, insurance …

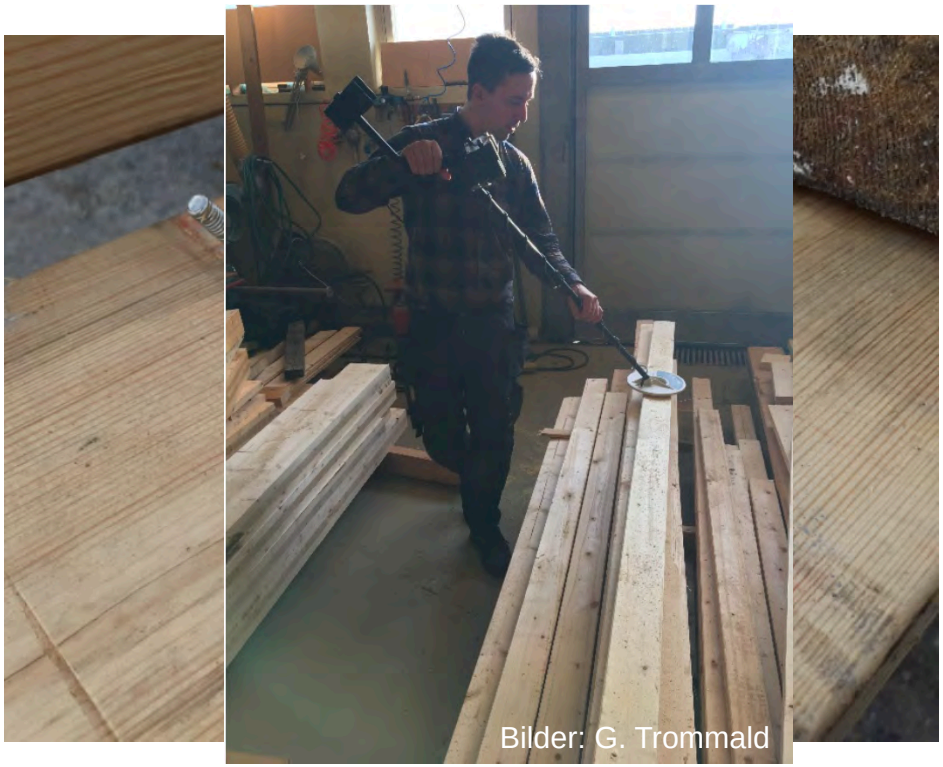

Bilder: A.Q. Nyrud

Reclaimed wood as raw material for industry

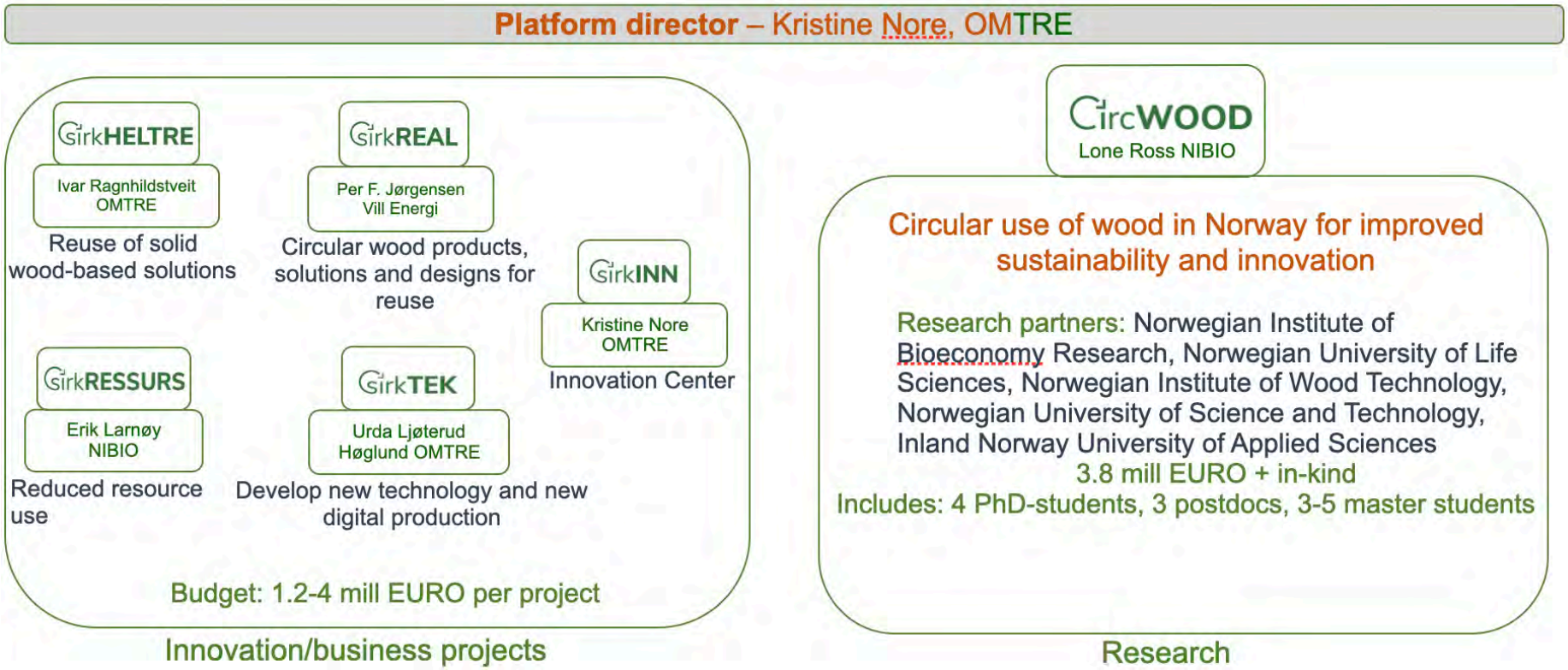
Availability
- Scale – industrial processing
- Dimensions

Quality
- Strength properties
- Visual properties
- Moisture
- Contamination – foreign bodies
- Contamination – chemical
- Contamination – biological

Trust – consumers, owners, public entities, insurance …



CircWOOD


Platform director – Kristine Nore, OMTRE
CircHELTRE
Ivar Ragnhildstveit
OMTRE
Reuse of solid wood-based solutions
CircREAL
Per F. Jørgensen
Vill Energi
Circular wood products, solutions and designs for reuse
CircINN
Kristine Nore
OMTRE
Innovation Center
CircRESSURS
Erik Larnøy
NIBIO
Reduced resource use
CircTEK
Urda Ljøterud Høglund OMTRE
Develop new technology and new digital production
Budget: 1.2-4 mill EURO per project
Innovation/business projects
CircWOOD
Lone Ross NIBIO
Circular use of wood in Norway for improved sustainability and innovation
Research partners: Norwegian Institute of Bioeconomy Research, Norwegian University of Life Sciences, Norwegian Institute of Wood Technology, Norwegian University of Science and Technology, Inland Norway University of Applied Sciences
3.8 mill EURO + in-kind
Includes: 4 PhD-students, 3 postdocs, 3-5 master students
Research

CircWOOD – Work Packages

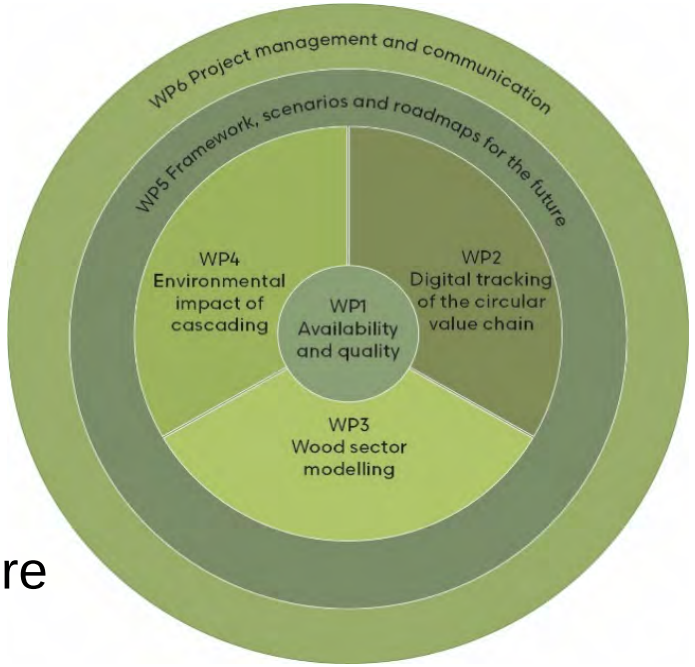
WP 1 Availability and quality

WP 2 Digital tracking of the circular wood value chain

WP 3 Forest sector modelling

WP 4 Environmental impact of cascading

WP 5 Framework, scenarios, and roadmaps for the future



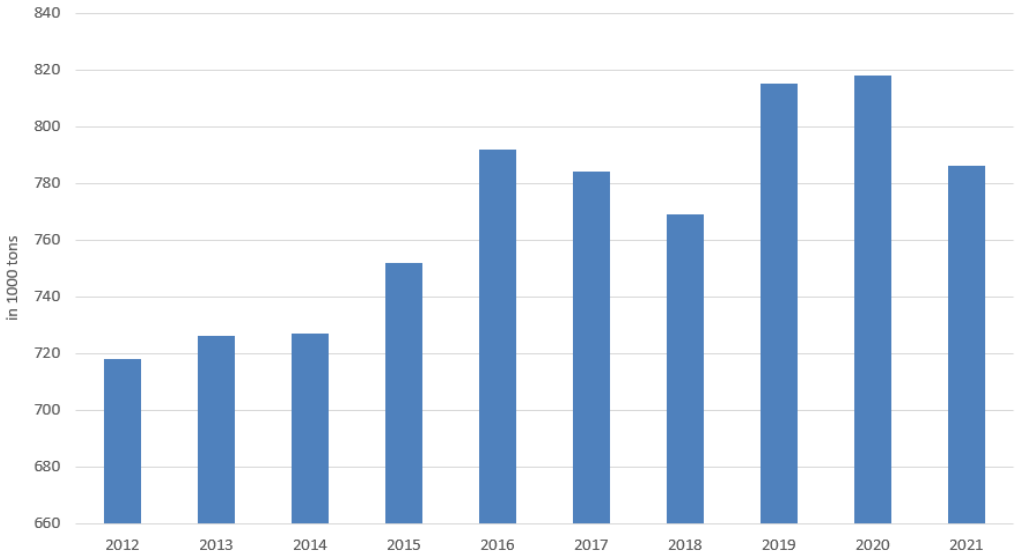
CircWOOD – Availability of wood for recovery

800 000 tones of wood waste (not including CCA / Cu / creosote)

36% is household waste

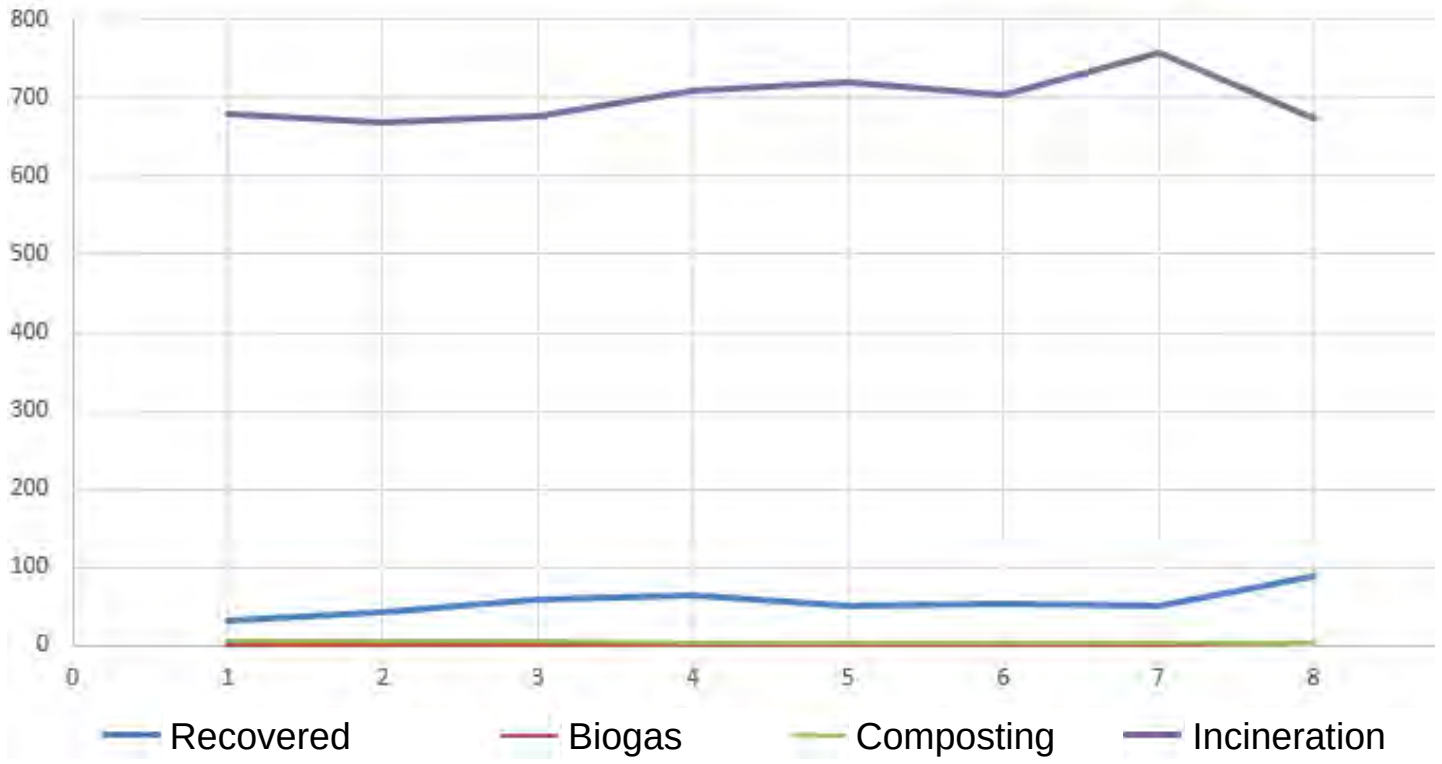
30% from construction

34% from industry and service

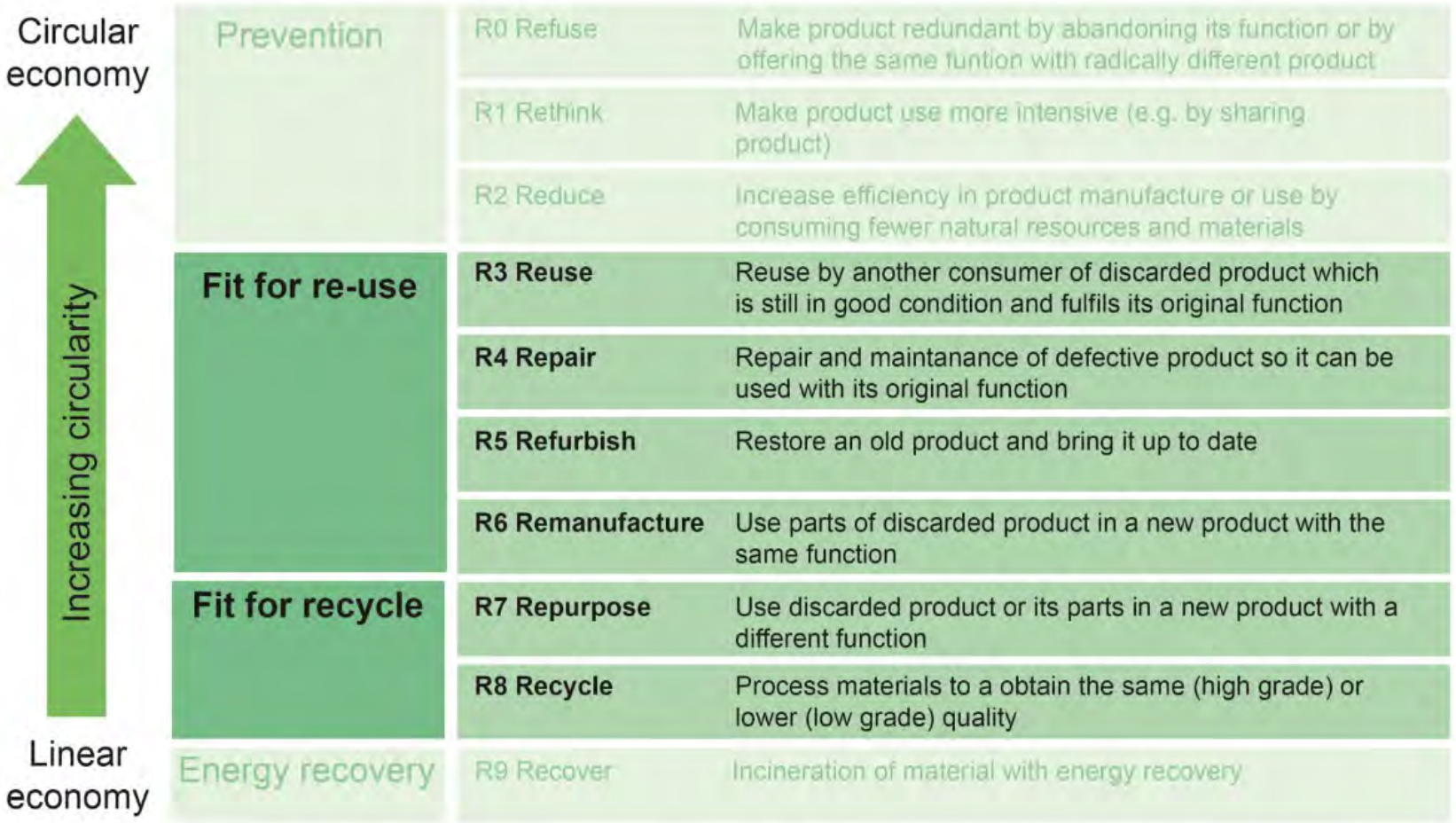


Statistics Norway

CircWOOD – Availability of wood for recovery

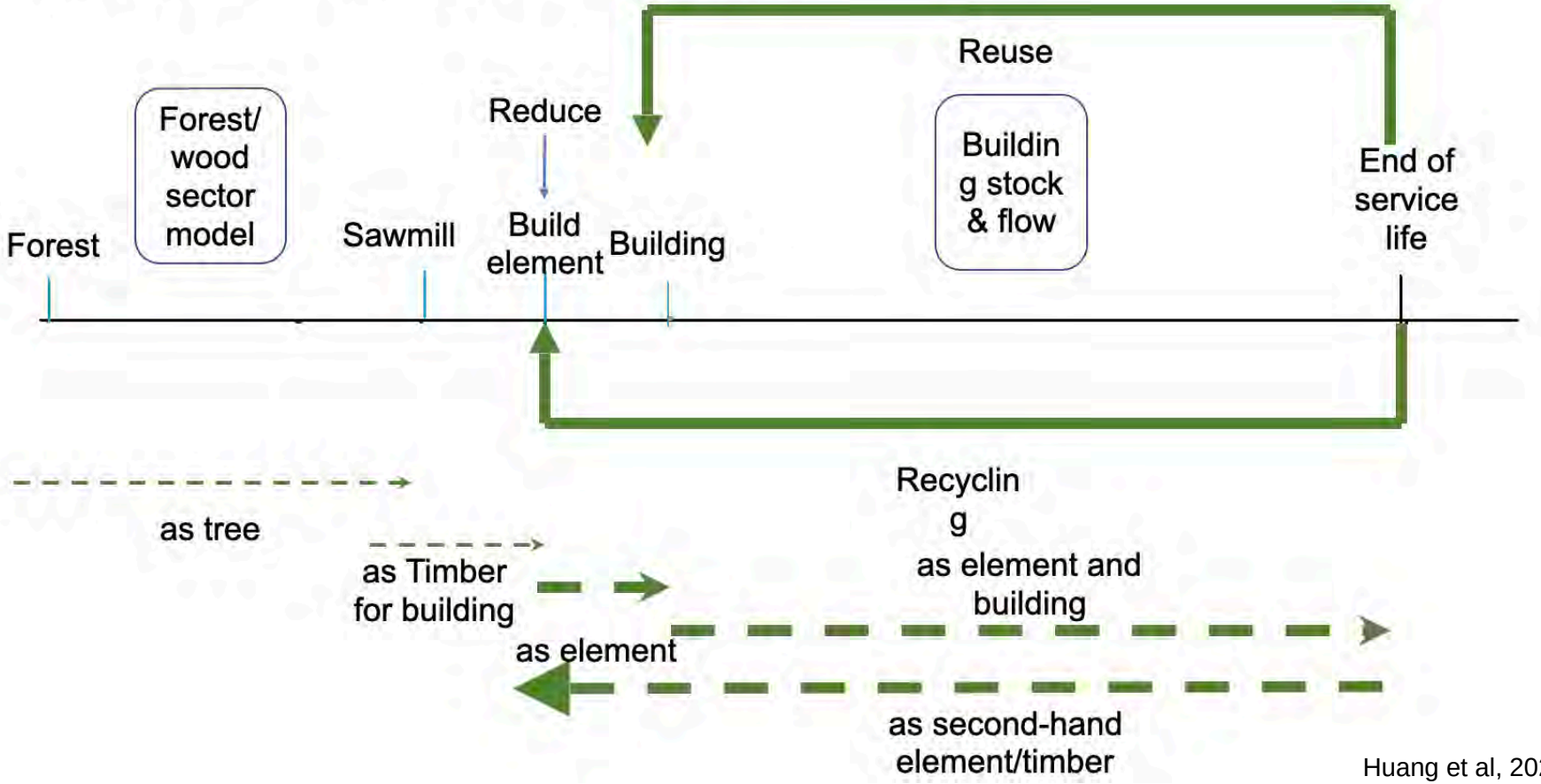


Statistics Norway

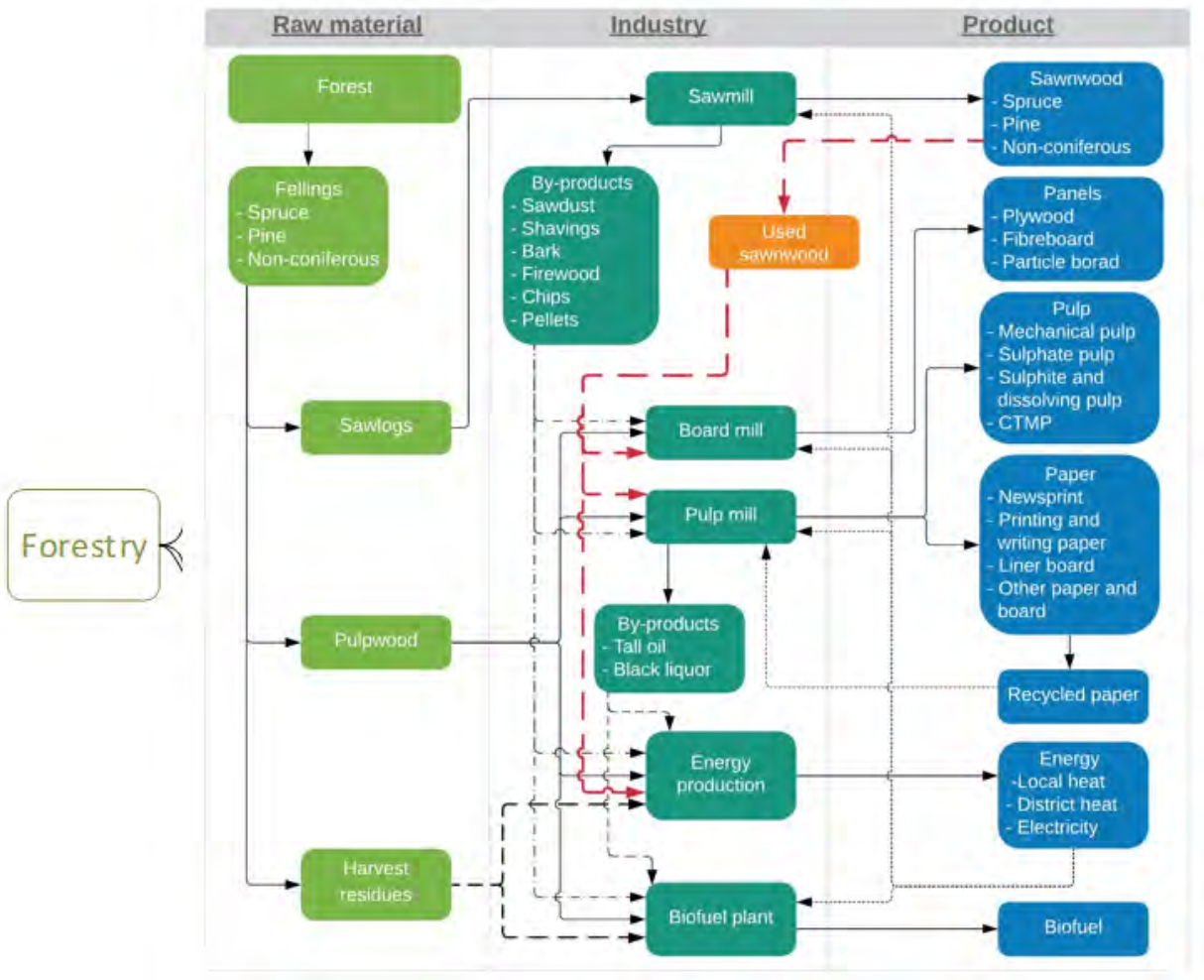


Ref: regenerated from Rli 2015/03, NUR740, ISBN 978-90-77323-00-7). Council for the Environment and Infrastructure

Following the resources - tracking value chain



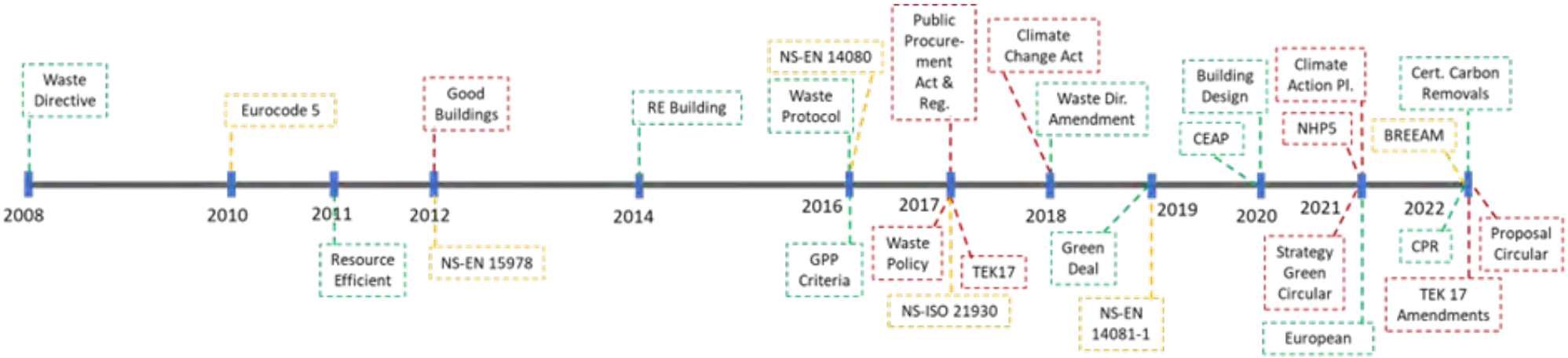
Huang et al, 2023



Thorkildsen et al., 2023

Norges miljø- og biovitenskapelige universitet

Timeline: EU policies and national efforts



Kathy et al. 2023

CircWOOD

Norges miljø- og biovitenskapelige universitet

Partners:

NIBIO, Norwegian University of Life Sciences (NMBU), Norwegian Institute of Wood Technology, Norwegian University of Science and Technology (NTNU), Inland Norway University of Applied Sciences Search (HINN), Trefokus, RagnSells, OsloTre, Norwegian Wood Cluster, OMTRE, Norwegian Forest Owners' Federation, Veidekke Entreprenør, Statsbygg and Norwegian Construction Products Association.

anders.qvale.nyrud@nmbu.no