Stormwater purification with construction and demolition waste - StoPWa

Webinar: Stormwater purification with construction and demolition waste - Insights from project StoPWa, 16-Jun-26

AGGLOMERATION OF MIXED CDW FOR STORMWATER FILTRATION

Associate Prof. Ville Lahtela, LUT Project Manager

Interreg
Co-funded by the European Union
Central Baltic Programme
StoPWa

LUT University – role and experts in the StoPWa project

- LUT teams and members:
  - **Department of Separation Science** → ***WP1: Characterization of CDW and adsorption test of selected CDW fractions***
    - *Teemu Kinnarinen, Associate Professor*
    - *Nazila Bolourieh, Junior Researcher*
  - **Fiber Composite Laboratory** → ***WP2: Development of pre-treatment systems for the CDW and design of the filtration basin structures (+ WP4)***
    - *Timo Kärki, Professor*
    - *Ville Lahtela, Associate Professor*
    - *Qaisar Munir, Post-doc. Researcher*
  - **Department of Sustainability Science** → ***WP3: Assessing the sustainability feasibility***
    - *Mika Horttanainen, Professor*
    - *Mari Hupponen, Post-doc. Researcher*
    - *Ishika Weerawardhana, Junior Researcher*
  - **LUT Business School**
    - WP4 tasks – *master thesis*
- Roles in the StoPWa
  - ***WP4: Assessing the economic feasibility***

LUT outputs: e.g. several publications

Theses

Doctoral thesis ongoing

- Nazila Bolourieh: Stormwater purification with construction and demolition waste
- Ishika Weerawardhana: Environmental Sustainability of Recycling challenging Construction and Demolition Waste

Master thesis

- Ishika Weerawardhana: "Stormwater treatment measures and their performance analysis for removing pollutants" https://urn.fi/URN:NBN:fi-fe202401081804
- Sanduni Adduwa Hewage Jayasekara: "Properties of construction and demolition waste as a stormwater filter medium : flow properties in deep bed filtration" https://urn.fi/URN:NBN:fi-fe2024111894738
- Zareen Suhail: "Feasibility analysis of pre-treatment actions and separation methods for CDW fractions" https://urn.fi/URN:NBN:fi-fe2024061753332
- Panchali Herath Mudiyanselage: "The features of agglomerate materials from recycled raw materials for stormwater purification" https://urn.fi/URN:NBN:fi-fe20251210116896
- Miika Pitkäkangas: "CIRCULAR BUSINESS MODEL DEVELOPMENT FOR WASTE-BASED STORMWATER FILTRATION " will be published later

Bachelor thesis

- Nooa Väisänen: "*Hulevesisuodattimen suunnittelussa huomioitavat näkökohdat*" https://urn.fi/URN:NBN:fi-fe20251013101272

Scientific articles

- Published
  - Bolourieh et al. "Utilizing construction and demolition waste particles as porous media for water filtration: Experimental characterization and ANN-based predictive modeling" Separation and Purification Technology https://doi.org/10.1016/j.seppur.2026.137268
  - Munir et al. "Recycling of construction and demolition waste fines for decentralized stormwater filtration: Environmental leaching and life-cycle cost assessment" Waste Management Bulletin. https://doi.org/10.1016/j.wmb.2026.100307
- Under review
  - Bolourieh et al. "Utilization of construction and demolition waste materials as sustainable stormwater filter media" in Journal of Hazardous Materials Advances
  - Weerawardhana et al. "Environmental sustainability of a biochar integrated nature-based solution in Finland: A comparative LCA with a rain garden and a sand filter" in Journal of Environmental Management
- In preparation
  - Bolourieh et al. "Evaluation of pollutant removal from synthetic stormwater using construction and demolition waste fractions as porous media"
  - Munir et al. "Techno-economic assessment of construction and demolition waste (CDW)–derived filter media for decentralized stormwater purification in Nordic climates"
  - Weerawardhana et al. "Life cycle assessment of utilizing construction and demolition waste for a stormwater treatment train system in Finland'

Conferences abstracts

- Nuortila-Jokinen, J., Lahtela, V., Kärki, T., Kinnarinen, T., Horttanainen M., Stormwater purification with construction and demoliton waste (StoPWa), 19th Nordic Filtration Symposium, 13-15 June 2023, Lappeenranta, Finland.
- Lahtela, V., Kinnarinen, T., Bolourieh, N., Hupponen, M., Horttanainen, M., Nuortila-Jokinen, J., Kärki, T., Construction and Demolition Waste as a Filter for Stormwater, Lahti Science Day 21.11.2023
- Jayasekara, S., Bolourieh, N., Faitli, J., Kinnarinen, T., Flow through porous media developed using concrete waste fractions, 18th European Symposium on Comminution & Classification, Miskolc, Hungary, June 24-26, 2024.
- Jayasekara, S., Bolourieh, N., Kinnarinen, T., Development of a stormwater filter from construction and demolition waste: initial flow properties in deep bed filtration. FILTECH 2024, Koelnmesse, Cologne, Germany, November 12-14, 2024.
- Jayasekara, S., Bolourieh, N., Kinnarinen, T., Preliminary flow tests aiming at utilization of construction and demolition waste as stormwater filter media. NoFS 2024, Copenhagen, Denmark, December 2-4, 2024.
- Bolourieh, N., Kinnarinen, T., Jayasekara, S., Nuortila-Jokinen, J. Stormwater purification with construction and demolition waste (StoPWa). ESCC 2024, Miskolc, Hungary, 24–26 June 2024.
- Bolourieh, N., Kinnarinen, T. Development of sustainable stormwater filter media using construction and demolition waste (CDW) materials. 1st EULiST Student Conference 2024, Vienna, Austria, 30 June - 4 July 2024.
- Bolourieh, N., Kinnarinen, T. Evaluation of TSS removal from synthetic stormwater using construction and demolition waste fractions as porous media. 14th WORLD FILTRATION CONGRESS (WFC 14), Bordeaux, France, 30 June - 4 July 2025.
- Bolourieh, N., Kinnarinen, T. Evaluation of TSS removal from synthetic stormwater using construction and demolition waste fractions as porous media. LUT DS Science Conference 2025, Lappeenranta, Finland, 20 May 2025.
- Weerawardhana, I., Hupponen, M., Horttanainen. M., Environmental sustainability of utilizing construction and demolition waste for stormwater treatment: insights from a comparative life cycle assessment. LUT DS Science Conference 2025, Lappeenranta, Finland, 20 May 2025.

AGGLOMERATION OF MIXED CDW FOR STORMWATER FILTRATION

RESEARCH GROUP OF FIBER COMPOSITE

INTRODUCTION / BACKGROUND

StoPWa-project, WP 2 ”*Design, manufacturing and testing of the CDW stormwater biofilter system*”

- Aim: How should the suitable CDW be treated before use in stormwater biofilters?
- LUT actions:
  - CDW pre-treatment (e.g. technologies and methods)
  - Design and testing of the stormwater filter

→ **AGGLOMERATION & PROPERTIES**
- **Mechanical properties**
- **Long-term durability**

ADVANTAGES OF CDW FOR STORMWATER PURIFICATION

- The availability of CDW
  - *E.g. EU: 1/3*

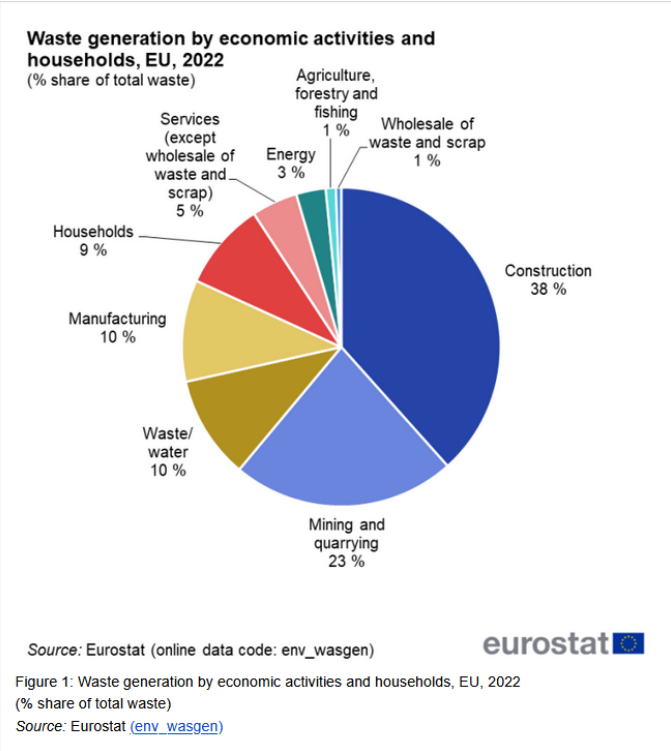


Figure 1: Waste generation by economic activities and households, EU, 2022 (% share of total waste)
Source: Eurostat (env_wasgen)

- Traditional ”sand filters”
  - *Natural aggregates (sand and stones) have restricted capacity for adsorption*


Photo. Lahti City

- The composition of CDW
  - *E.g. FIN case study; wool 5%*
- Processing effect vs. Adsorption
  - *Particle size? Air cavities? …*

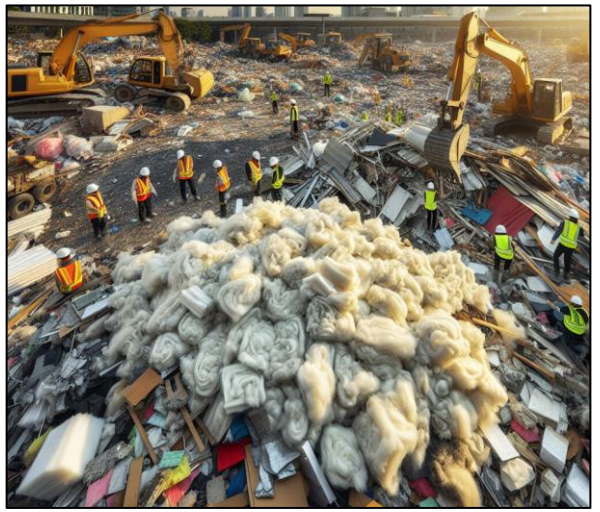


Photo. “CDW including mineral wool”. Generated using Microsoft Copilot.

WAY TO FOLLOW CIRCULAR ECONOMY AIMS AND PRACTICES!

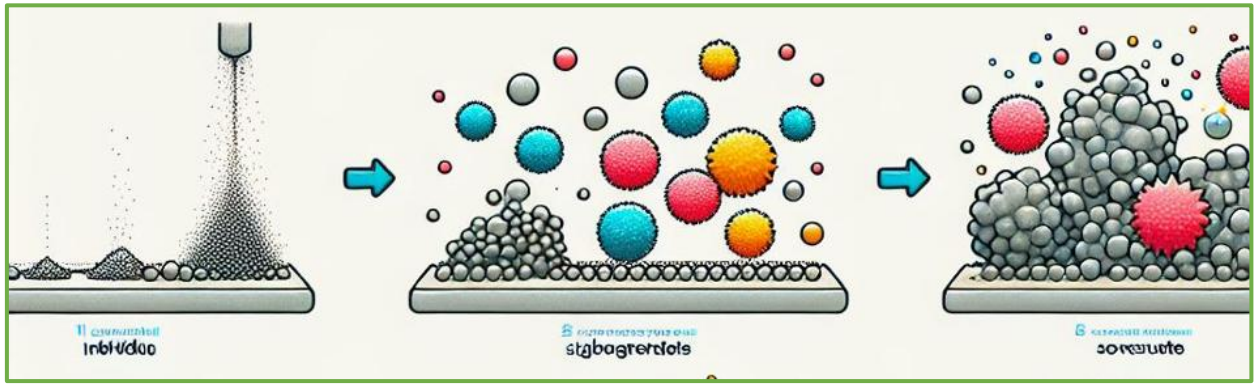
WHAT MEANS AGGLOMERATION?

Photo. Agglomeration apparatus. LUT Fiber Composite Laboratory.

AGGLOMERATION

- Particles stick together (fine particles → ”aggregates”)
- Three ways for ”sticking”
  1. Physical or chemical forces between individual particles
  2. Adhered binders on the solid surfaces → material bridge between particles
  3. Chemical or physical modifications of the solids (specific process)
- Agglomeration of CDW materials in the StoPWa project:
  - CDW fine rejects + plastic
  - Mixing of material → creates FRICTION → HEAT → INCREASED AVERAGE PARTICLE SIZE

Figure on right: AI-generated agglomeration process (Copilot, 2024. Cartoon illustration of the agglomeration process. Generated using Microsoft Copilot. 22.10.2024)



CDW RAW MATERIAL in the StoPWa

LoW 17 09 04 → ~1/4 fine fraction

Mechanical sorted CDW

“sticks” etc.

AGGLOMERATION

Piloting / LUT Fiber Composite

+ LDPE 20 %
Plastic from industry stream, classification by NIR

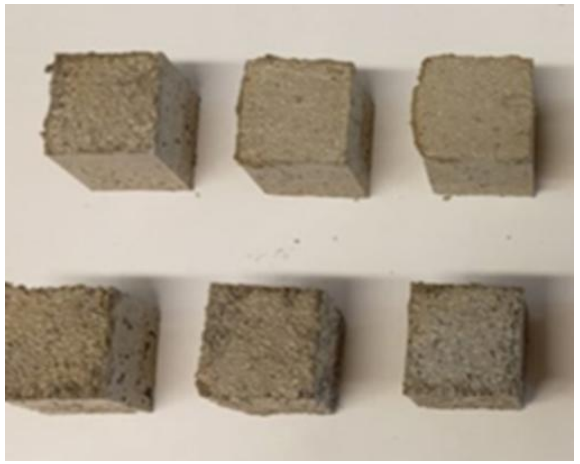
AGGLOMERATION in the StoPWa

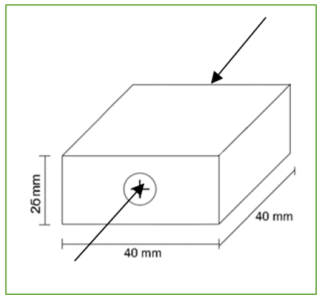
Agglomerated CDW

- *Mixed CDW (80%)*
- *LDPE plastic (20%)*
- *Delivered to TalTech*
  - *< 4 mm*
  - *> 4 mm)*

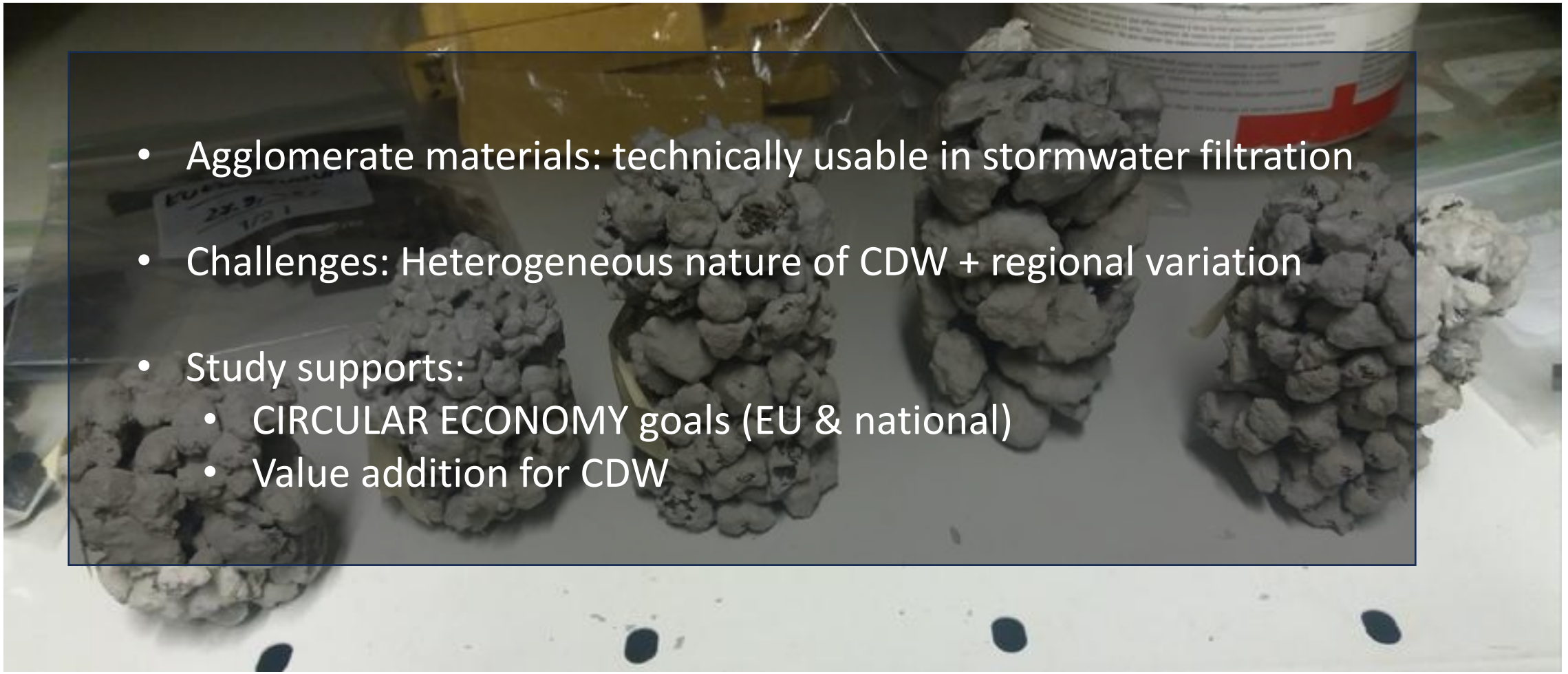
PROPERTIES OF AGGLOMERATED CDW

- Agglomerate analyses (D.2.3.2: Test of agglomerated properties)
  - 2 CDW sources (Lahti area)
    - Fine rejects + 20% LDPE
  - Tested (Samples: 40 x 40 x 40 mm, ”agglomerate as a gravel role in concrete”)
    - Compression strength (EN 12390-3)
    - Cyclic stress → Freeze-thaw resistance (CEN/TR 15177:2006)
    - Freeze/thaw resistance with de-icing salt (EN 1338:2003)
- Properties of agglomerates → reported exactly in the thesis ”*THE FEATURES OF AGGLOMERATE MATERIALS FROM RECYCLED RAW MATERIALS FOR STORMWATER PURIFICATION*” available via LUTPub https://urn.fi/URN:NBN:fi-fe20251210116896





CONCLUSIONS



- Agglomerate materials: technically usable in stormwater filtration
- Challenges: Heterogeneous nature of CDW + regional variation
- Study supports:
  - CIRCULAR ECONOMY goals (EU & national)
  - Value addition for CDW

Thank you!

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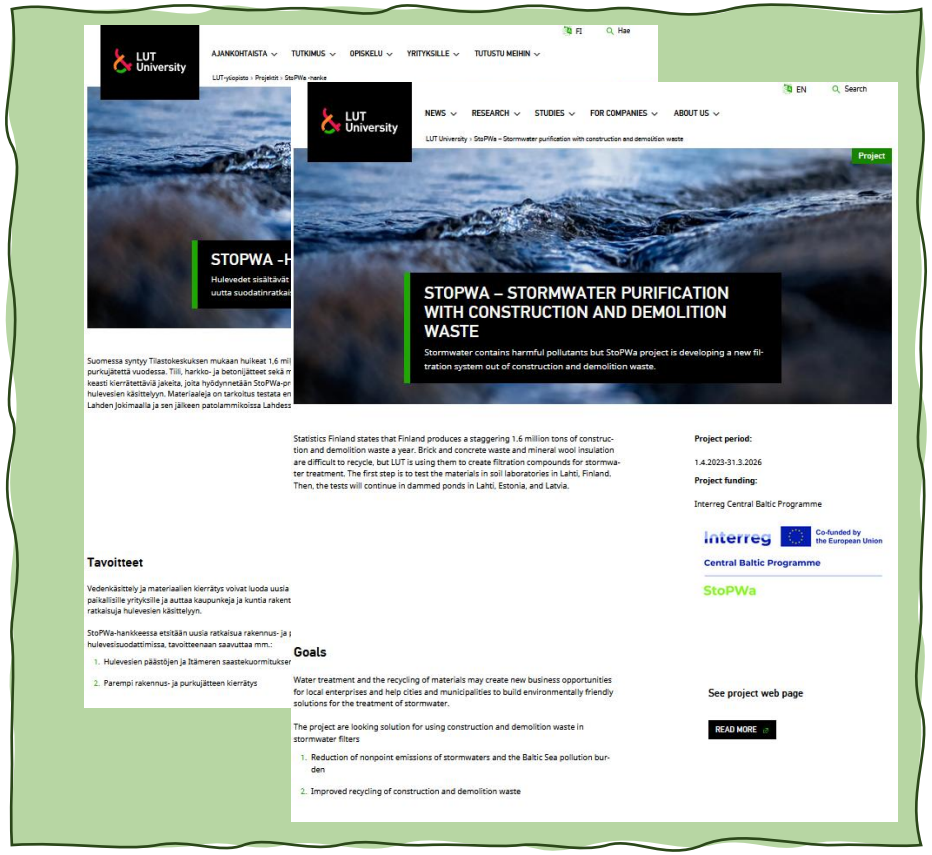

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