

ADVANCES IN >> HYDROTHERMAL CONVERSION OF INDUSTRIAL BIOGENIC RESIDUES INTO INTERMEDIATE BIOENERGY CARRIERS

RESULTS FROM THE **F-CUBED PROJECT**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 884226.

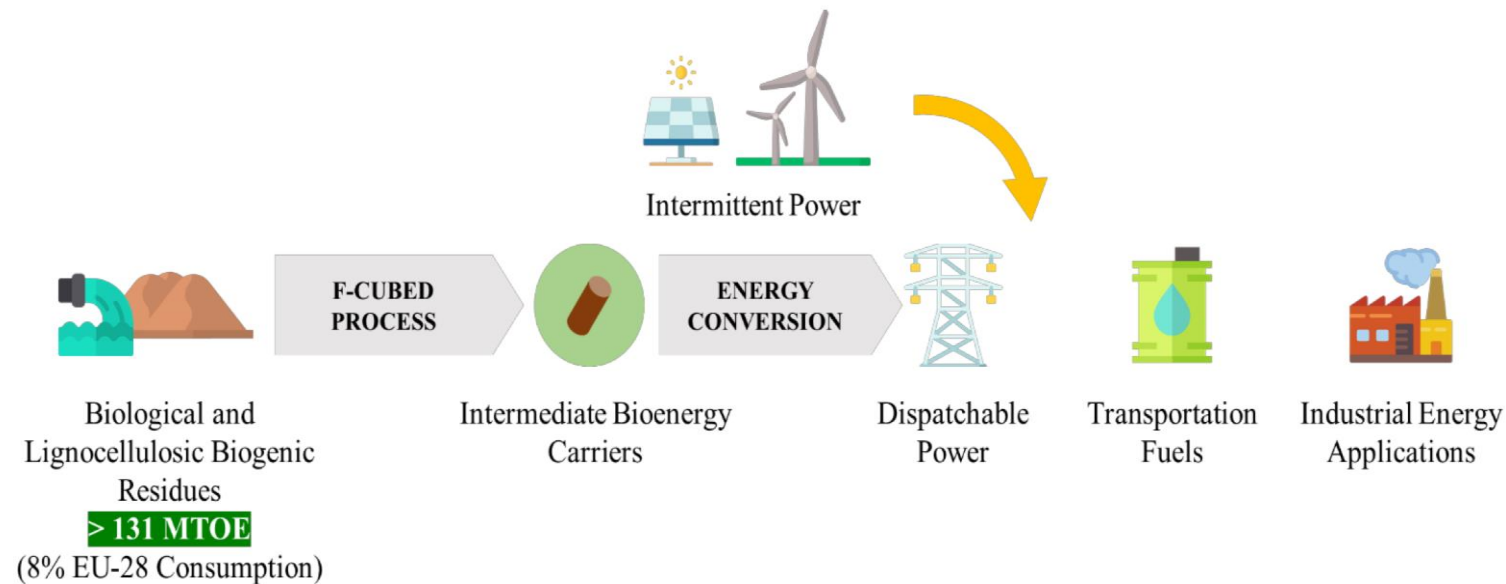
F-CUBED: Upgrading wet bio-
residues into intermediate
bioenergy carriers





The F-CUBED Concept

- Hydrothermal conversion (TORWASH[®] process) of low quality biogenic residues into intermediate bioenergy carriers, increasing the flexibility of a renewable energy system.





Biogenic Residues

- F-CUBED focuses on wet biogenic residue streams with high potential for energy generation
- Total Potential for F-CUBED: 131 MTOE

Biological Sludges

- Dairy sludge
- Raw and digested manure
- **Paper sludge**
- Raw and digested urban sludge
- Brewing sludge

Total Potential for F-CUBED technology:
65 MTOE

Lignocellulosic Residues

- City Cuttings
- Crops' Leaves and Grass
- **Fruit & Vegetable Wastes**
- **Waste Olive Pomace**
- Organic Municipal Solid Wastes

Total Potential for F-CUBED technology
66 MTOE



Objectives

- Main objective: validate the flexible conversion of biogenic residues to intermediate bioenergy carriers, at TRL5

Technological Objectives

- Long-duration testing in relevant environment of 3 biogenic residues (paper sludge, olive pomace and fruit & vegetable waste)
- Quality metrics for the upgraded solids produced
- Validate co-recovery of value-added products (nutrients)

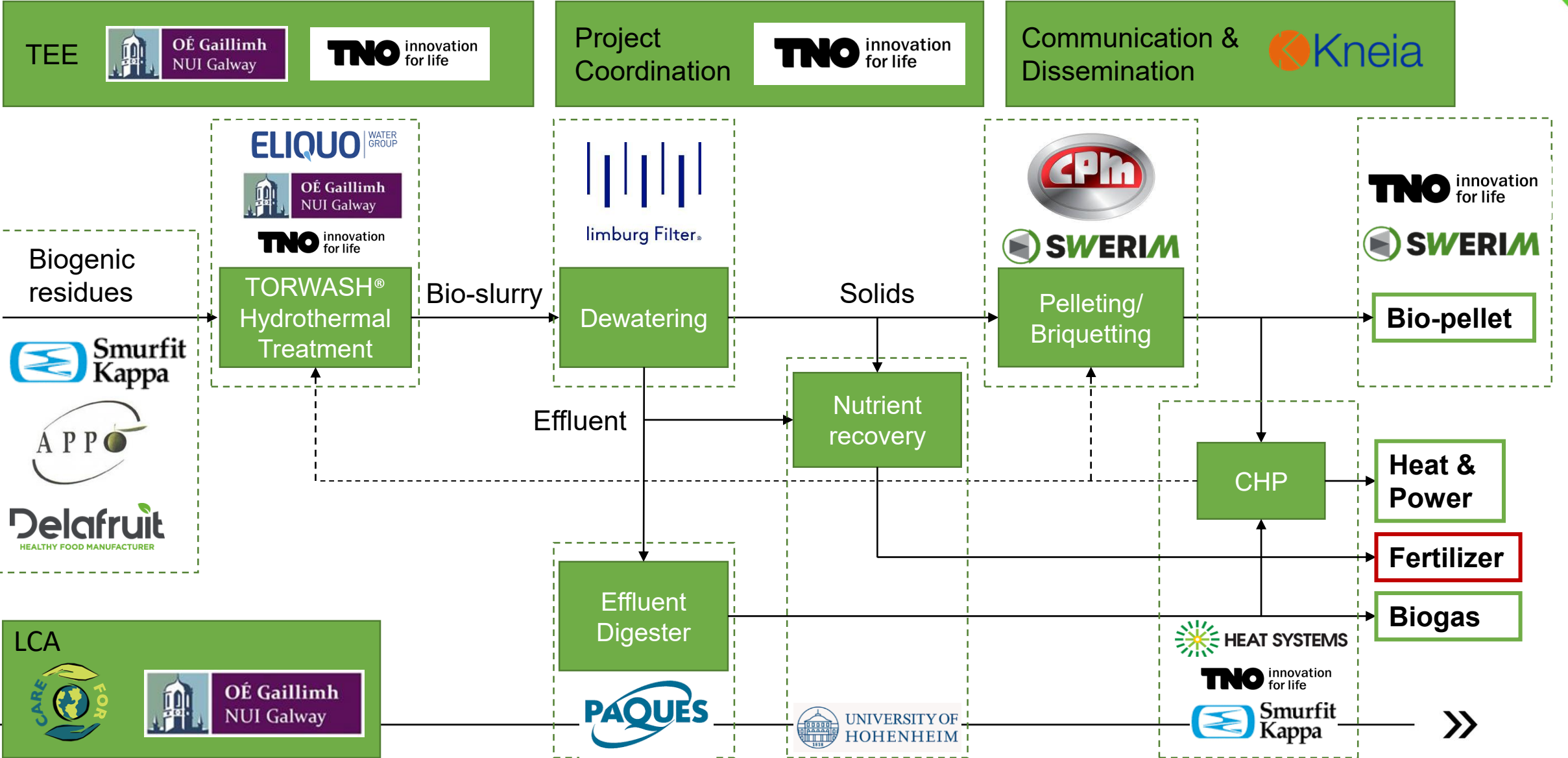
Sustainability Objectives

- GHG savings target >60% in use of pellets for heat and power generation
- GHG savings >50% relative to reference case for residue disposal practice

Economic Objectives

- Techno-economic feasibility, including improvement on residue treatment cost

F-CUBED Consortium





Work Packages

- WP1 – Enabling Pilot Testing
- WP2 – Paper sludge treatment
- WP3 – Waste olive pomace treatment
- WP4 – Fruit & Vegetable waste treatment
- WP5 – Value Chain assessment
- WP6 – Dissemination, communication and exploitation of Project results
- WP7 – Coordination and management
- WP8 - Ethics



Work Package 1

Enabling Pilot Testing

- Characterize feedstocks
- Optimize and de-risk Torwash at lab (and pilot) scale





F-CUBED Process



Paper sludge



Olive pomace



Orange peels



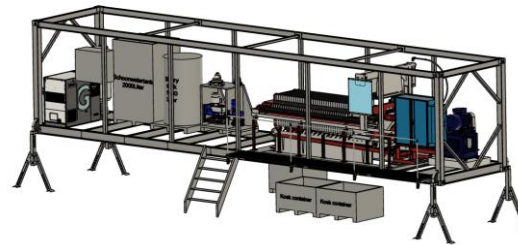
TORWASH®



Effluent



Mechanical Dewatering



Liquid fraction



Solid cakes



Anaerobic digestion to produce biogas

Nutrient Recovery

Solid fuel for boiler



F-CUBED Process Optimization

- Screening tests in small autoclaves: multiclave (<1 L)
- Larger tests in 20/30L autoclave
- Mobile pilot plant (25 – 50 kg/hr, continuous)
- *Suitable for long duration testing on-site*
- Optimizing temperature, residence time, concentration, mixing in reactor
- Target parameter → dewaterability





Work Packages 2, 3, 4

On-Site Testing

- Long-duration, continuous pilot testing @ industrial locations
- Dewatering of treated slurry
- Pellet production from solid fraction
- Biogas potential from liquid fraction
- NPK recovery



European tour

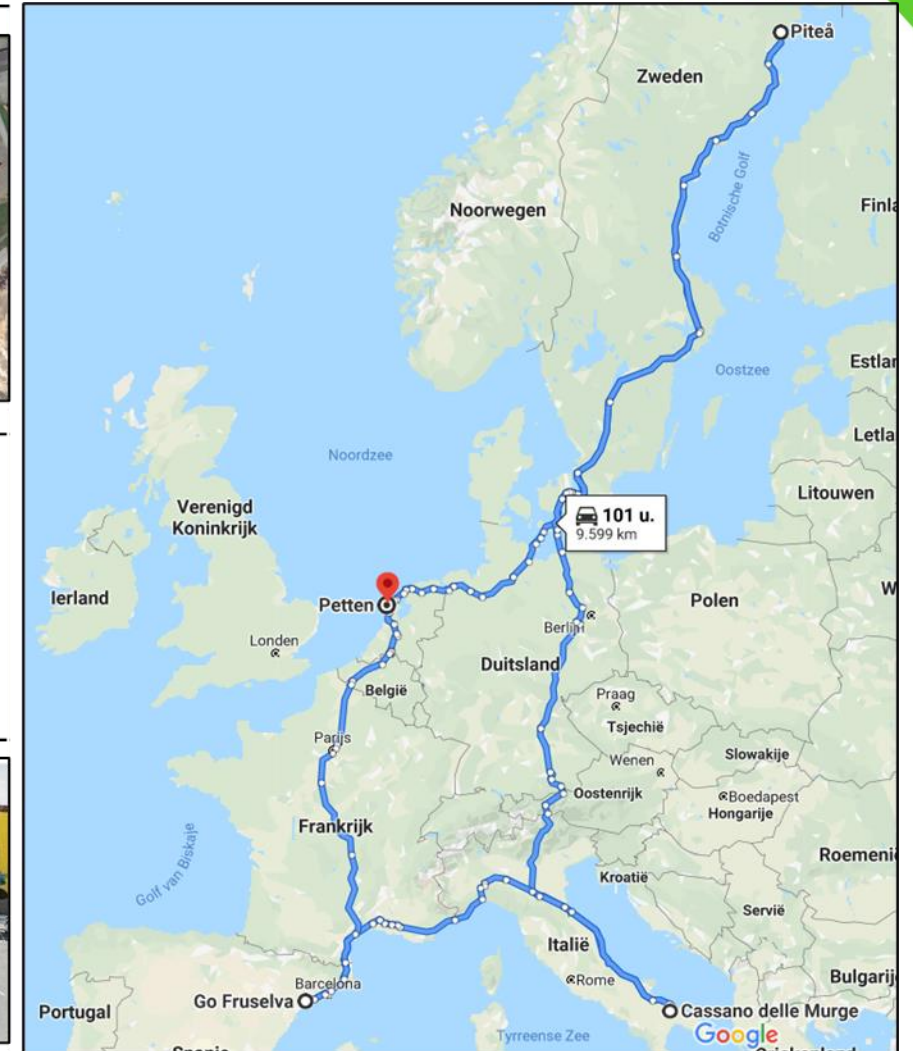
Smurfit Kappa
paper factory,
Piteå, Sweden



Chimienti olive
oil mill, Bari,
Italy



Delafruit,
healthy food
manufacturer
Tarragona,
Catalonia, Spain



Paper Sludge



- Different types of paper sludge

- **Biological (bio-sludge)**

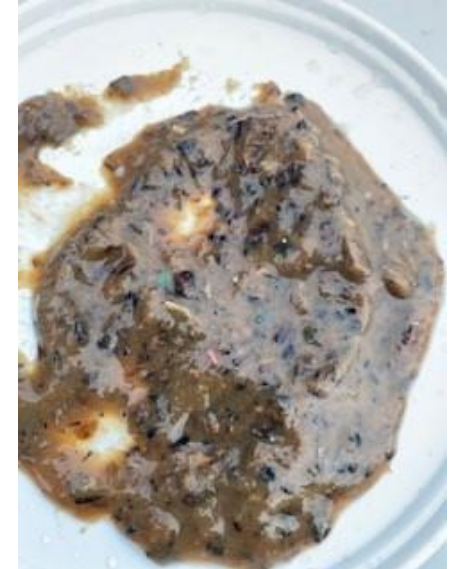
- By-product of the wastewater treatment plant (aerobic/biological treatment) at the paper mill
- Dry solids content varies from 1 – 4%
- Difficult to dewater

- **Fiber sludge**

- By-product of paper production containing solids in the form of short cellulose fibers
- Easy to dewater
- Can be re-used on site to make paper

- **Mixed sludge**

- Mix of bio-sludge (40%) and fiber sludge (60%)
- Dewatered to a dry matter content of 30 – 35% with polyelectrolyte addition



Paper sludge @ Smurfit Kappa



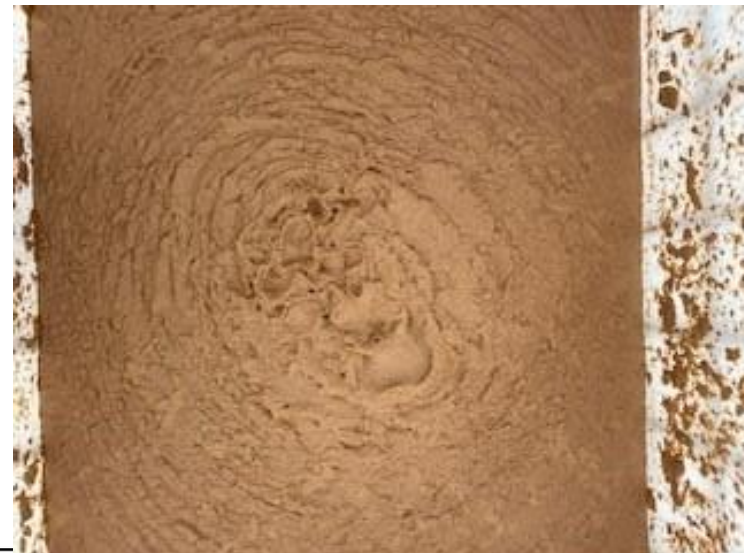
OLIVE POMACE



Chimienti Olive Mill location close to the TORWASH field testing «campus». *Source: APPO*



Olives ready to be processed. *Source: CFE*



Olive pomace



ORANGE PEELS



CITRUS PLANT RAW MATERIAL



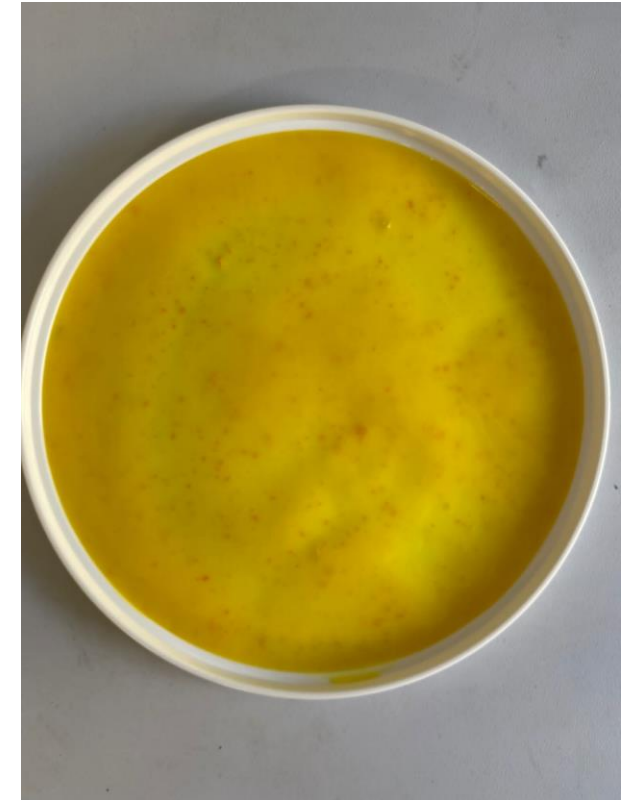
CITRUS PLANT WASTE



COLD PRESS VEGETABLE RAW



COLD PRESS VEGETABLE WASTE



Torwash on site





Work Package 5

Value Chain Assessment

- Evaluate the F-CUBED process based on technical, economic and sustainability criteria, for the treatment of the chosen residue streams





WP5 – Value Chain Assessment

4 models to measure the performance of the **F-CUBED process**

1. Process modelling to determine the energy efficiency of the process
2. Techno-Economic Evaluation (TEE) of the F-CUBED treatment process
3. Techno-Economic Evaluation (TEE) of the entire value chain (bioenergy supply chain): from residue transportation to power generation and by-product recovery
4. Comprehensive life cycle assessment (E-LCA) and Social LCA





Work Package 6

Dissemination & Communication

- Disseminate results to relevant stakeholders
- Communicate project findings to the scientific community and general public



WP6 – Dissemination & Communication

Website: www.f-cubed.eu

LinkedIn and Twitter: **@F_Cubed_H2020**

Stakeholder platform: <https://stakeholders.f-cubed.eu>

Links to scientific publications, deliverables, reports, etc.



F-Cubed: Presentation at Circular Materials Conference

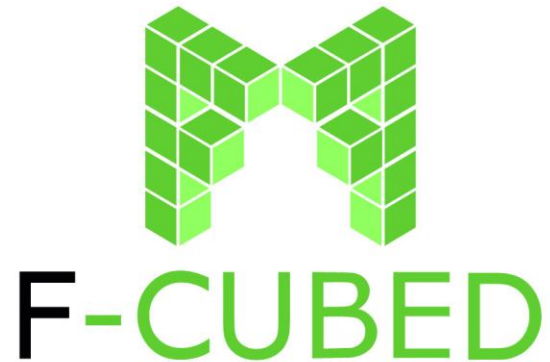
23 September 2022

F-CUBED project partner Swerim AB presented their research findings from Work Package 2 “Paper Sludge Treatment” at the Circular Materials Conference held in Skellefteå, Sweden on the 14th and 15th September 2022. The conference is the leading Nordic forum concerning the industrial, scientific and commercial progress of the use of circular materials.



THANK YOU

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