



# A Wood-to-Wood Cascade Upcycling Valorization Approach



Akrivi Korba<sup>1,\*</sup>, Konstantinos Chatziioannou<sup>1</sup>, Georgios Tsimiklis<sup>1</sup>, Fotios Konstantinidis<sup>1</sup>, Lucyna Lekawska-Andrinopoulou<sup>1</sup>, and Angelos Amditis<sup>1</sup>



<sup>1</sup>Institute of Communication and Computer Systems, National Technical University of Athens, 9 Iroon Polytechniou Str., Zografou Athens GR-157 73, Greece  
\*Corresponding Author {email: akrivi.korba@iccs.gr}



## 1. Abstract

According to projections, wood supply may be insufficient to meet European demand by 2030<sup>1</sup> due to its increasing use in energy generation, construction materials, and chemicals. Wood is becoming increasingly prevalent in construction and demolition waste (CDW) and furniture waste. Waste wood streams contain considerable amounts of fossil-based carbon from coatings, paints, plastics, and preservatives, that can be recycled using novel methods such as chemical recycling.

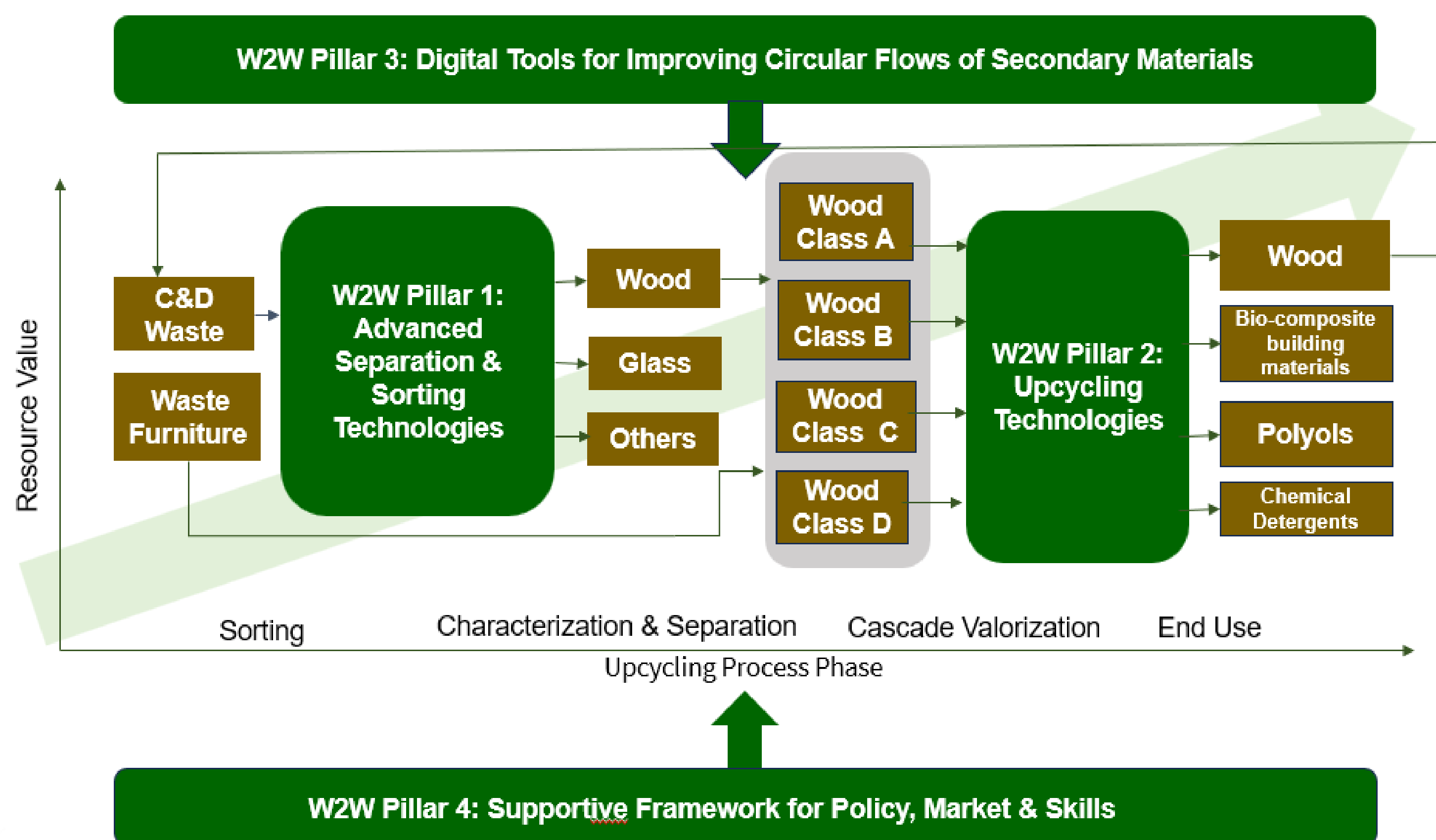
Nevertheless, recycling processes are complicated by the presence of additives and contaminating materials, and further research is needed to improve them. Other challenges are the irregular availability of such waste streams, the complexity of sorting and cleaning processes, and the gaps in existing regulations which may not fully support the use of upcycled wood materials. Subsequently, current wood waste management strategies still prioritize landfilled energy recovery, over material recovery.

W2W aims to design and evaluate a comprehensive approach for the multifaceted cascade valorization of wood waste from construction and demolition (C&D) and furniture. The project's primary objectives are to decrease the need for virgin materials, cut down on waste that is dumped in landfills or burned, and aid in the shift to a circular economy.

## 2. Concept of work

W2W multi-dimensional cascade valorization framework of wood from C&D and furniture waste consists of four key components or pillars:

- Advanced Separation and Sorting Technologies
- Upcycling Processes and Technologies
- Digital Tools for Improving Circular Flows of Secondary Materials
- Supportive Framework in Policy, Market, and Skills.



This approach reduces the need for virgin materials, reduces waste in landfills and incineration facilities, creates value-added products from waste, and promotes closed-loop systems to extend the useful life of materials, supporting the transition to a circular economy.

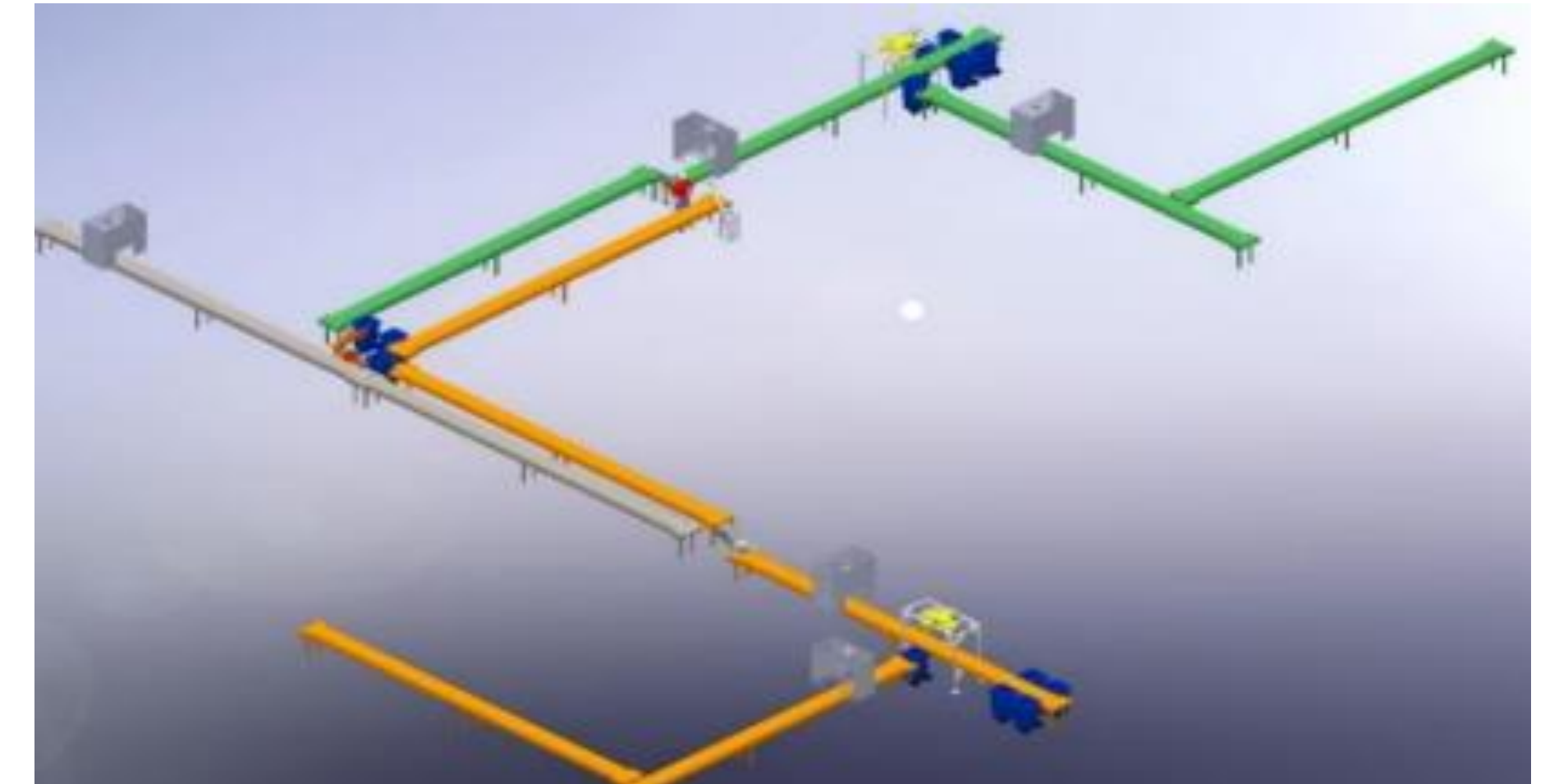
## 3. Wood Cascade Valorization Framework

The wood cascade valorization framework is assessing all available pathways and routes for the provided wood feedstock. To determine the ideal valorization pathways, a list of readily available technologies alongside newly developed ones, from W2W are being evaluated. The characterization of the available feedstock as well as the dynamic Life Cycle Assessment (LCA) calculation shall also be provisionally considered for the selection of each potential route.

Additional elements related to offer vs demand, logistics optimization, and supply chain management, will set the base towards a dynamic valorization framework aiming to maximize the source recovery potential, based on the principles of circular management and building on frameworks for circular economy and industrial symbiosis.<sup>2</sup>

## 4. Advanced Separation & Sorting Technologies

ICCS is developing an adaptive cyber-physical system for sorting wood waste collected from CDW using cascade valorization to separate different sorts of wood based on their potential for recycling.



- Initially, wood will be separated from other CDW using a robotic arm, then divided into two flows based on the presence of assembly parts.
- Wood trash mixed with metallic or other components will be routed to a different conveyor line via Human-Robot Collaboration.<sup>3</sup>
- Wood with no foreign elements will be divided into four categories based on quality and value potential.
- Wood containing pollutants will be directed to a different conveyor to be characterized again using a variety of methods, and then separated by either mechanical or chemical processes.

## 5. Summary & Future Work

W2W employs a holistic strategy combining cutting-edge technologies, digital tools, and a supporting policy framework to recycle wood waste and convert it into valuable resources.

A comprehensive wood cascade valorization framework as well as advanced wood separation and sorting techniques, are being developed as the cornerstones for the creation and implementation of innovative wood upcycling technologies.

Future work will focus on research and developing innovative techniques and technologies for wood valorization, as well as creating and making use of digital tools to improve the flows of secondary materials. Three distinct application scenarios will be employed for assessing the effectiveness and sustainability of these value chains.

## 6. References

1. Forrest, A., Hilton, M., Ballinger, A., and Whittaker, D., (2017). Circular Economy Opportunities in the Furniture Sector, European Environment Bureau.
2. Akrivou, C., Łekawska-Andrinopoulou, L., Manousiadis, C., Tsimiklis, G., Oikonomopoulou, V., Papadaki, S., Krokida, M., and Amditis, A. (2022). Industrial symbiosis marketplace concept for waste valorization pathways. E3S web of conferences, 349, p.11005-11005. doi: <https://doi.org/10.1051/e3sconf/202234911005>.
3. Konstantinidis, F.K., Sifnaios, S., Arvanitakis, G., Tsimiklis, G., Mouroutsos, S.G., Amditis, A. and Gasteratos, A. (2023). Multi-modal sorting in plastic and wood waste streams. Resources, Conservation and Recycling, [online] 199, p.107244. doi: <https://doi.org/10.1016/j.resconrec.2023.107244>.



Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HAEDA. Neither the European Union nor the granting authority can be held responsible for them.