



Project Title: **Demonstration of an innovative, environmentally friendly and economically feasible technology for the recycling and valorisation of ornamental stone waste**

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## **DELIVERABLE 3.1**

### **Report of the demonstration site ONE**

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Responsible Beneficiary: **ALFAMARMI**

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HISTORY OF CHANGES		
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28-03.2025	Rev.2	FINAL VERSION: last updates added

# 1. Executive Summary

The installation and set up of the ECOGEO plant, at the demonstration site ONE, has been implemented with the following steps:

- M7 (February 2024) : GEF+GEA (DRY treatment line)
- M16 (October 2024): GEM (completing the DRY treatment line)
- M16 (October 2024): GES+GEC (WET treatment line).

The DRY treatment line (as reported in the workprogram T.3.1 and detailed in Deliverable D.2.3, section 2,3,4) has operated from M7 to M18, as planned in the T.3.1, demonstrating the recycling of the stone waste by outcoming DRY end-products.

The WET treatment line (not very developed in the original project plans) was planned and manufactured during WP2 as a new finding (see GES: Deliverable D.2.3, section 5) and linked to the originally planned GEC. The WET treatment line has been fine-tuned during the last month of 2024 and, been new and not planned in the original T.3.1 it will need more time for getting the optimum results. For that reasons the partners will need to continue the trials and activities in the ALFA MARMI (site one) for one year more than planned, extending the T.3.1 until December 2025.

The demonstration activities carried on during 2025 will allow to “create” and test new receipt, by obtaining new WET end-products and to complete the certification processes which is progress with huge delays, due to the late answer of the local Public Authorities.



## 2. The demonstration site

The first pilot demonstration is hosted at ALFAMARMI premises, one of the bigger ornamental stone processing industries of Southern Italy, located in Napoli province. ALFAMARMI handles a wide variety of natural stones: basalt, marble, travertine, onyx, etc.



The ALFA MARMÍ premises occupies more than 100.000 sqm. In that area they stored also the “stone waste” SLUDGE, outputting from their manufacturing operations: a large “pool” (more 5,000 sqm) for wet sludge and a similar area for storing scraps. When the storing capacity is full, those wastes are generally transported and disposed in landfills. Close to the sludge storing area the project installed the ECOGEO plant, as shown in the following picture (Google image updated at June 2024 approx.).

SLUDGE STORING POOL



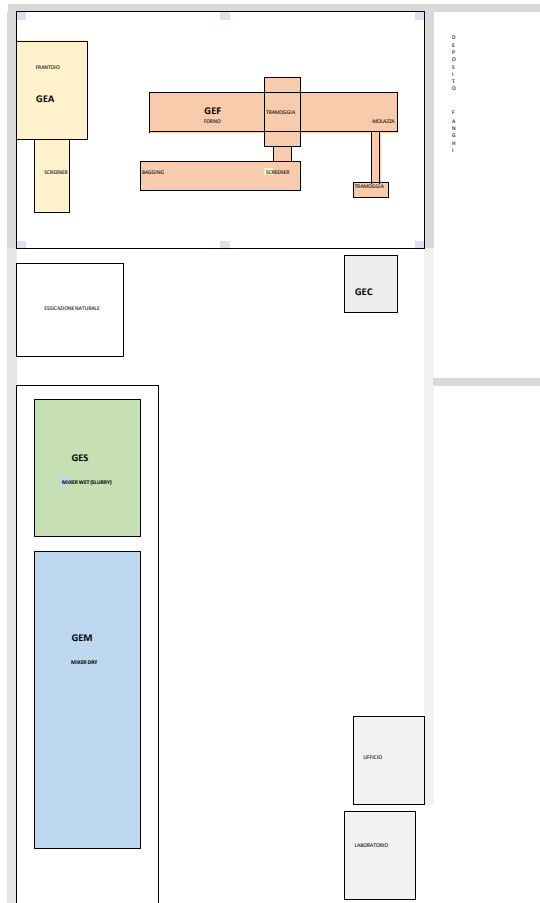
DEMO SITE

Detailed information related ALFA MARMÍ premises have been formerly collected into the Deliverable 2.1, section 2.

## 2.1 - Area dedicated to the installation and operation of the ZSW Plant

ALFAMARMI has dedicated to the demo site an area (around 750 sqm) close to of the sludge deposit, with the aim of easing the picking up from that deposit of the material to recycle. The overall ECOGEO plant and its accessories (ZERO STONE WASTE equipment) have been positioned in that area.

ALFAMARMI provided electricity and the other necessary installation (water, etc.).



## 2.2 – The ECOGEO plant installation and set up

In the area shown before, TEKSPED installed all the equipment manufactured during the first project phase (WP2) and before the project start. Actually, the plant installed at ALFA MARMI represents the most complete configuration, meaning that it includes all the equipment and machines developed by TEKSPED, in collaboration with ISIM, for the recycling and valorization of the different type of stone waste: WET sludge and DRY scraps.



Following the project schedule, after the delivery of the ECOGEO equipment by TEKSPED at ALFA MARMI premises, during January and February of 2024 the DRY production line (GEF and GEA) has been installed and tested. The set up was completed in February and the DRY treatment line started to operate recycling sludge (drying them by GEF) and scraps (grinding by GEA).

The DRY materials output from the first “treatment” step: eco-filler and eco-aggregates, called MPS (Materia Prima Secondaria), after chemical-physical analysis, resulted to be “not harmful” and in line with the quality parameters related to toxic elements. The MPS constitute the basic components for the following “valorization” step.

As planned in the schedule, during the second half of 2024 the big (industrial scale) GEM has been installed and set up, thus completing the DRY treatment line. That equipment is driven by a very sophisticated electronic programmable system and it allows to automatically mix big quantities of different components and to add exact quantities on additives and polymers, thus obtaining an “infinite” set of different END-PRODUCTS.

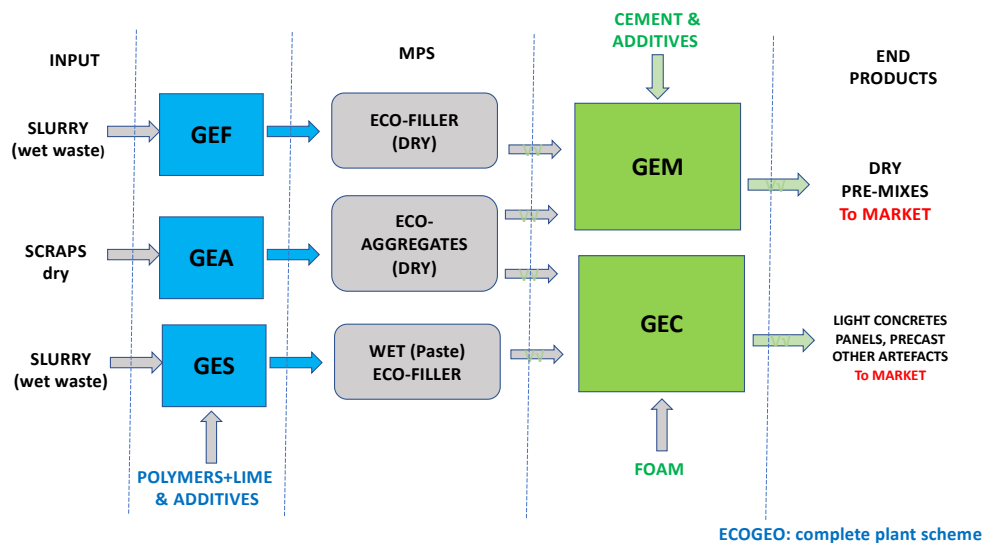
During the last months of 2024 the DRY MPS have been mixed with the GEM with different types of additives, cement and polymers, trying several different “mix receipts” with the aim of obtaining high quality and performance END-PRODUCTS in powder.

Starting from July 2024 TEKSPED installed and set up the WET treatment line (GES and GEC) with the aim of treating the sludge “as it is” (without drying it). The GES is a double effect mixer which allows to directly mix all the components obtaining an highly homogenized “paste”, which is the basic MPS for the next step. The second step: the “valorization of the stone waste (the sludge in this case), is done by adding some products (to the MPS) directly into the GES. Changing the recipe (i.e. the aggregates, additives, etc.) both in quantity and quality, different “humid” END-PRODUCTS are obtained as output of the process. At December. 2024 (in time with the project timetable .. task T.3.1) the ECOGEO plant is fully operative and a number of receipts have been trailed, producing small quantities of END PRODUCTS which have been employed in some small constructions with very positive outcomes in term of quality and affordability. Unfortunately, the certification process, started in March 2024, is still in “waiting” as the plant needs the AUA (Autorizzazione Unica Ambientale) which is delayed more than the foreseen. Probably the AUA will be released in the first months of 2025 and the Certification process could allow to mark the END PRODUCTS with the CE and CAM, mandatory for selling them.

The partners ALFA MARMI, TEKSPED and ISIM planned to go on working on the pilot site ONE for one year more (all 2025), with the aim of optimizing the equipment, the processes and mix receipt, trying to make the plant more productive with some new equipment, for instance. More time is also necessary to complete the certification activities and to experiment new mixtures and new types of END-PRODUCTS. All the optimization and amelioration could be very useful for a better and more productive implementation of the next two pilot sites. For the abovementioned reasons the partners will need to continue the trials and activities in the ALFA MARMI for one year more than planned.

### 2.3 – The ECOGEO product lines and equipment

The detailed layout and characteristics of the equipment which compose the ECOGEO plant could be found in the Deliverable 2.3. We report here just a short summary evidencing the most important features of the plant and of each equipment:



The left column (blue) evidences the equipment which perform the FIRST STAGE of the process (STONE WASTE to MPS). The right column (green) shows the equipment which, mixing MPSs with different aggregates and additives, generate the END-PRODUCTS.

The Upper line of the picture shows the **DRY treatment line** where the dry “MPS” produced (from slurry) is mixed with water, cement and additives obtaining different types of DRY pre-mixed. In the wet seasons, approximately 4 tons of eco-filler are produced per day, reaching 6 in dry and non-rainy seasons. The main equipment which encompasses the “DRY line” are:

**a) GEF (Geo Eco-Fillers):** an infrared oven to dry the slurry, with some accessory devices for sieving and for additional treatment.



The following equipment compose the GEF:

-A natural pre-drying system (inside a greenhouse or outside in summer). In ideal conditions it can bring the wet slurry from 30% humidity to 5% Relative Humidity, even using forced ventilation inside the greenhouse.

**GRINDER:** 500 Lt of capacity, equipped with hood, forced ventilation system and discharge on conveyor belt. The grinder is loaded manually and can grind about 1 ton of sludge in 10-15 minutes. A conveyor belt takes the sludge to a screen with a mesh (0.1 mm or less) for a first screening and then to the conveyor belt of the oven.



**DRYING OVEN:** The installed oven is composed by a three-meter-long rotating conveyor belt, made of plastic resistant to high temperatures, equipped with an automatic system for regulating the advancement speed. The oven is equipped with batteries of 2+3 low consumption infrared lamps (< 1,000 watts). A pair of toothed sheets at different distances regulates the thickness of the layer to be dried. The oven exceeds 100°C and is equipped with a probe that measures the temperature. The rotating conveyor belt passes the same material several times until it is all well dried; it takes about 1 hour to dry 1 ton of sludge starting from a RH of 25% reaching the 3%.



- **SCREENING.** Once dried, the powder is "diverted" to the vibrating screen (a system with two oscillating motors) where an eco-filler with a grain size between 500 microns and 50 microns is obtained. For very fine meshes, the process requires to "pass" the filler again with the grinder.
- **IRON DEFERRATION.** The dried powder passes through a magnet to eliminate from the filler the iron particles of the stones or rust from the machinery.



**BIG BAG LOADING AND WEIGHING.** An auger loads the big bag automatically and once the predefined weight is reached, it unloads the big bag.

**b) GEM (Global Eco Mixer)** is a multipurpose and sophisticated mixer system for dry materials, able to produce many different types of eco pre-mixed, and to automatically pack them in bags. The GEM is very flexible with electronic devices which allows to easily changing the recipe of the mixtures. The GEM version installed at ALFA MARMÍ is capable to produce around 2 tons / hour of mixed END PRODUCT, for instance using 0,5 tons of eco-filler and 0,8 – 1 ton of eco-aggregates. It follows some images of the GEM installed at ALFA MARMÍ.



The Lower line of the above scheme shows the **WET treatment line**, where the “MPS obtained is a wet eco-filler. It will be mixed with polymer and/or cement and other additives for obtaining different types of (wet) END PRODUCTS: light concretes, mortars, panels and other artefacts. This WET treatment line includes the following equipment:

**GES (Global Eco Sludge):** special mixer with double rotation motions, developed for amalgamating **WET PASTES**, using water and some specific additives. The GES special mixing system could develop quickly a strong deflocculant action of the sludge which allows to obtain a high-quality MPS (in form of a PASTE). That MPS could be mixed with cement and several other materials. Namely the use of different type of acrylic polymers as additives allows to obtain different types of END PRODUCTS with very different mechanical characteristics. The GES easily allows to develop different recipes and to use low rates of cement.



**GEC (Global Eco Cellular-Cement)** is a modified concrete mixer with a special feeding equipment made for automatically entering the WET PASTES and DRY MIXTURES into the mixer, with other additives. The GEC main capacity is to produce (light) wet END-PRODUCTS which could be used for producing panels, blocks and other special artefacts for architectural use. Acrylic polymers and foams could be added for making extra-light products, too.



The line in the middle of the above scheme shows the **GEA (Geo Eco-Aggregates)** which grinds the scraps for producing aggregates. GEA uses a steel jaw crusher, with teeth at variable distances, to transform the solid fragments of waste shards and slabs of stone residues into fine aggregates with different grain sizes (for example: 0/0.6 mm or 0.6/1.2 mm or 1.2/6 mm, 6/25 mm, etc.). The maximum size of the stone shards must be less than 20-25 cm per side to be able to enter freely into the loading mouth of the crusher. The small GEA installed at ALFA MARMI grinds around 1 ton / he but they planned to buy and put in operation a bigger crusher (8-10 tons/hr) during 2025, for the production at industrial level.



## 2.4 – The Certification processes

As planned in the work program (T3.4), the activities necessary to get the CAM and CE certification for the END-PRODUCTS outputting for the DEMO SITE ONE started in January 2024, before from M13 planned into the project.

The first activity completed has been the chemical-physical analysis:

- the characterization of the MPS by a private laboratory (MM STUDIO srl);
- the radioactivity measure by the Earth Science Department and Environmental Department of the University of Napoli.

ALL THE PARAMETERS WERE BELOW THE THRESHOLD REQUIRED IN TERMS OF PRESENCE OF HARMFUL ELEMENTS; THE TESTS DEMONSTRATES THAT THE MPS PRODUCED ARE NOT TOXIC NOR RADIOACTIVE.

In March 2024 ALFA MARMI apply for obtaining the extension of its original AUA (Autorizzazione Unica Ambientale) to the stone waste processing. The Province of Napoli, in charge of that diligence, granted to release the requested AUA in around six months. At the current date (March 2025) the AUA has not been released and it will probably takes one or two months more. It's caused by the well-known slowness of the Public Authority in Italy and it's independent from the work done by the partners.

When the AUA will be released, the appointed Certification Authority (SGS spa) could release the CE mark and the CAM certifications for the MPSs and for the END-PRODUCTS. Subsequently after completing a "performance test" on each end-product, they could be introduced in the market.

All the details related to the task T3.4 will be reported into the specific deliverable D3.4 (Certification of the products) which will be published the M42, as planned in the project workprogram.

## 3. The recycle and valorization processes

### 3.1 - Quantities and composition of the waste generated by ALFAMARMI

ALFAMARMI processing operations generate daily approximately 7.5-8 tons of wastes, mainly coming from basalts (black stone), which constitute around 70% of the stone processed, and of the wastes produced as a consequence.

Two main outputs (MPS) produced during the cutting/polishing activities:

- 1) Stone sludge, (25% of the produced wastes = **3-4 tons/day**) which consists of powder mixed to water. It could be recycled by GEF (drying) obtaining a DRY filler (called eco-filler: 50-200 µm) or by GES directly WET, obtaining a wet eco-paste. The quantity of sludge is lower than the one we indicated in the project as ALFA MARMI in these last two years increase the performances of their cutting and polishing tools, with a huge decrease of the sludge produced.
- 2) Stone scraps (75% of the produced wastes = **5 tons/day**) which will be grinded by GEA producing eco-aggregates of fine particulate sizes / mesh: 0/0.5 mm, 0.6/1.2 mm / 1.2/6 mm, 6/25 mm.

The ECOGEO plant at ALFA MARMI is producing the **following MPS**, in this demonstrating stage:

- DRY process line (GEF): 1 ton/hr of SLUDGE into **DRY ECO-FILLER** (mesh below 50 µm)
- WET process line (GES): 0,5 tons/hr of sludge into **WET ECO-PASTE**
- GEA could grind 2-3 ton/hr of scraps, producing a **COARSE AGGREGATE** (above 500 µm), depending on the need of the next phase.

The prototypal plant installed at ALFA MARMI for demo purposes is dimensioned for processing / treating only a part of the stone wastes produced; for that reason in the next years it will need more powerful equipment for recycling all the stone wastes produced at present plus eventual increasing.

Concerning the quality and composition of BASALT (including wastes), it contains small percentages of potassium, zinc or barium among others (very useful for enriching soils in bio-agriculture, too). The details concerning the quality and composition of the END-PRODUCTS obtained into the ALFA MARMI pilot site will be reported in the deliverables into D3.4.

### 3.2 - Quantities and composition of the END-PRODUCTS

The second step of the process is the VALORIZATION of the MPS, mixing them with other components for obtaining some valuable products (END-PRODUCTS) to sell on the market:

- DRY END-PRODUCTS: the GEM could produce a large variety of premixed adhesive; Its average production is around 3 tons /hr, by mixing 20-30% of ECO-FILLER (coming from GEF), the eco-aggregates (from GEA) and different types of other components (polymers, chemical additives, small quantities of cement, etc.). As told before, the GEM (electronically driven) could easily change the “mix recipe”; at present the trials done in 2024 get to the production of adhesives for the installation of marbles or tiles. Several other type of END-PRODUCTS will be tested in the next future, giving preference to the most valuable ones.
- WET END-PRODUCTS obtained directly into the **GES** by mixing the basic ECO-PASTE with cement, liquid polymers, additives and other components. Different receipts (meaning changing the percentages of the added components) carry to different products. The first trials in ALFA MARMI carried to obtain high quality adhesives and self-levelling mortars, packed in small bags (25 Kg) for the market. By processing the ECO-PASTE produced, this second step could output around 1 tons/hr of the selected END-PRODUCT.
- PRECAST END-PRODUCTS: the next trials planned will be addressed to mixer (into the GEC) the ECO-PASTE and with cement, additives, water and foam (by a foam generator) to obtain a special concrete conglomerate which will be dried into steel molds for producing panels, blocks and artefacts for eco-architecture and for light construction.

## 4. Planning for the future

The project partners ALFA MARMI, TEKSPED and ISIM have planned to extend the duration of the T.3.1 of one year more, until 2025, with the aim of:

- Getting the Autorizzazione Unica Ambientale (AUA) from Napoli province and completing the certification (CE+CAM) of the END-PRODUCTS already tested and ready for the market.
- Completing the performance certifications for those products and start to propose them to the local market
- Following the test and trails for fine-tuning new END-PRODUCTS
- Going on with the optimization of the equipment and of the processes.

All the activities necessary for obtaining the results listed above will be possible as the ECOGEO plant operating at ALFA MARMI will not be moved at the second pilot site (MARINI MARMI). Actually, the second pilot partner and ISIM decided to install at Marini premises only the WET process line (GES) for recycling the sludge into **WET ECO-PASTE** and a **GEC** mixer with will be used for producing only PRE-CAST, which are the most valuable and easy-to-sale recycled products in the Milano area, for instance. For that reason, the manufacturing (by TEKSPED) of a second GES + GEC, paid by ISIM, was reputed the best way for going on and maximize the results with small additional efforts.

### 4.1 – Completing the certification processes

- a) As explained before, the certification company in charge of releasing the CE+CAM certification, required : the chemical-physical analysis of the materials (sent at the beginning of 2024) and the AUA, which release is delayed due to the slowness of the Public Authorities, quite common in Italy. We suppose that there will be no problem in getting the AUA and SGS could release the certification in short time, we estimate within June 2025
- b) After the CE+CAM certification, a number of “performance tests” will be conducted (by MM Studio) on the END-MATERIAL which will be selected for be sold on the market (expected end 2025)

### 4.2 – New END-PRODUCTS

ISIM and ALFA MARMI decided to go on for the overall 2025 in trialing new mix recipes with the aim of obtaining new products for the construction market.

The objective is to get more valuable products, for instance PRE-CAST (blocks, panels, etc.) to be used for wall covering or as light “bricks” in building constructions. The resulting pre-cast could be light and very insulating, ideal for external walls, mainly in industrial buildings.

The pre-cast could be easily obtained by the WET MPS, adding the less cement than possible for making them more eco-sustainable.

For answering to the request of the arising “eco-architecture” market, specific procedures will be studied for valorizing as much as possible the marble slabs inside the pre-cast panels.

### 4.3 – Optimization

With the purpose of answering to the needs of increasing the quantity of stone waste processed, and consequently the quantities of END-PRODUCTS, the partners will study how to optimize the operativity (less time and effort for each step), reduce the energy required and the movement of materials, which require personnel.

Moreover, for future installation, both in ALFA MARMI or at other industries, TEKSPED will study and propose new configurations and new equipment, mainly for processing directly the WET sludge.