

## SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

**Action number: 17133**

**STSM title: Rethinking nature based solutions for creating really sustainable green infrastructures – Potential of natural and recycled green roof materials to improve their ecological footprint**

**STSM start and end date: 09/09/2019 to 07/10/2019**

**Grantee name: Laura Tams**

### PURPOSE OF THE STSM:

(max.200 words)

Nature-based solutions are discussed to sustainably regulate urban climate, to mitigate urban heat islands and thus to counteract urban heat stress. As such, green roofs are extremely important especially for South Europe. The discussion of green infrastructures focused mainly on their ecosystem services while the ecological burdens have not been considered with the same weight. In the case of green roofs, especially the materials are often not considered to be replaceable. Nevertheless, earlier studies show that alternatives for the substrate and the synthetic liners show a great potential to improve the ecological footprint of green roofs and really create sustainable green infrastructure.

Within this STSM, we want to assess the use of insulation cork board (ICB) as an alternative for the conventional drainage layer materials. ICB, made out of cork granules, a byproduct in the cork industry or could be produced from recycled cork and is expected to have a less negative influence on the CO<sub>2</sub> emissions than the conventionally used synthetic materials. The possible alternatives for the substrate usage will also be discussed. To assess the influence of the different construction materials on the CO<sub>2</sub> emissions of green roofs, a comparative live cycle assessment was conducted.

### DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

The cooperation started out with defining the scenarios following the guide line of the general objectives in the work plan. Three different scenarios are in the focus of this evaluation:

1. Conventional layers and substrate
2. Cork (ICB) implemented as a drainage layer and technical substrate
3. Cork (ICB) implemented as drainage layer and alternative substrate

The evaluation of the insulation cork board was carried out in cooperation with Neoturf and Amorim Isolamentos. The visit of the cork factory was of great importance to understand the manufacturing procedure and gave us the opportunity to clear open questions. Furthermore Amorim Insolamentos agreed to provide us with the technical details needed.

The further research for the possible products used to install a green roof included the recommendation of an independent architect bureau. To complete the life cycle inventory for each material used in the different products a detailed literature research was undertaken. The data bases Ökobaudat and Probas (publicly available) built the foundation for the material. The substrate compositions are due to companies secrets taken out of already existing practices in research. An alternative substrate is investigated as well to show the opportunity of adaption to surrounding and possible change in CO<sub>2</sub> footprint due to that

reduction. As the transport of the products plays a key role in the CO<sub>2</sub> emissions, the comparison of a green roof in Portugal or Germany (cooperation countries) is included. The water consumption and land conversion aspects are collected as well.

The calculation of the scenarios are used to make the number more representable.

To raise awareness for the implementation of recycled and natural materials in nature-based solutions as well as the Cost Action circular city and the framework of STSM a poster was submitted to be presented:: Tams L., Nehls T., Calheiros C. S. C. 2019. Potential of natural and recycled green roof materials to improve their ecological footprint. 3<sup>o</sup> Encontro em Biologia Funcional e Biotecnologia de Plantas, FCUP. 11/10/2019. Porto. Portugal (Poster).

## **DESCRIPTION OF THE MAIN RESULTS OBTAINED**

### **500 words**

The reduction due to the replacement of the synthetic liner with recycled insulation cork board is immense. (-198 kgCO<sub>2</sub>/m<sup>3</sup>). Considering the scenario of an extensive green roof with a cork drainage layer of 10 cm the CO<sub>2</sub> sequencing accounts -19.8 kgCO<sub>2</sub>/m<sup>2</sup> roof. The only thing that has to be added when talking about a green roof installation in Germany is the transport of the cork board to Germany. This reduces the positive impact of the cork board by approx. 3.9 kgCO<sub>2</sub>/m<sup>2</sup> to -15.9 kgCO<sub>2</sub>/m<sup>2</sup> (can change due to different mean of transport).

The synthetic layer varies in composition depending on the company. Typical materials are polyolefin or EPS. Zinco, a Company in Germany, uses recycled polyolefin. The CO<sub>2</sub> emissions vary approx. in between 4.8 and 6.3 kgCO<sub>2</sub>/m<sup>2</sup>. These emissions are lower than initially expected, but can change due to differences in the processing. Especially about the recycling process no data could be found and a close cooperation with Zinco would be needed. Comparing the different drainage materials the cork drainage layer still has a big positive impact on the carbon footprint. Further advantages of cork are characteristics like durability, noise reduction and high thermal insulation and the cork sector is a very important economic driver for Portugal. Cork trees have a very low water footprint (used to grow in dry and hot regions) but the processing of the insulation cork board uses water steam for the autoclave process as well as for cooling the cork. Most of the water is reused in an intern water cycle.

Considering the substrate as another factor to reduce the CO<sub>2</sub> footprint of a green roof, different materials are considered: Expanded clay, pumice, sand, recycled brick and compost.

The technical substrate consists of expanded clay and compost only. A substitution due to its natural porous structure is pumice, but the resources in Germany are very limited. An alternative substrate consisting of sand and expanded clay was also investigated. A disadvantage of sand is that is a lot heavier. The plant based compost is considered to have no significant impact. Due to the sequencing and later release of CO<sub>2</sub> a balance is created. For a scenario with a substrate depth of 9 cm the CO<sub>2</sub> emissions for the conventional substrate (70% expanded clay and 30% compost) 47.2 kgCO<sub>2</sub>/m<sup>2</sup>. A substitution with pumice reduces the CO<sub>2</sub> emissions to 1.98 kgCO<sub>2</sub>/m<sup>2</sup>. An alternative substrate with sand (30% expanded clay, 40% sand and 30% compost) reduces the CO<sub>2</sub> emissions to 24.9 kgCO<sub>2</sub>/m<sup>2</sup>. The usage of recycled brick instead of expanded clay is estimated to reduce the emissions to 1.442 kgCO<sub>2</sub>/m<sup>2</sup> (conventional substrate) and 1.025 kgCO<sub>2</sub>/m<sup>2</sup> (alternative substrate). The recycled brick calculations is only based on assumptions, the exact process is not clear due to a lack of information about the recycling process and the availability. But it will be further investigated and should be considered as an important resource.

## **FUTURE COLLABORATIONS (if applicable)**

### **500 words**

The concept and idea including the content of the Action CA17133: Circular City were presented in a poster: Tams L., Nehls T., Calheiros C. S. C. 2019. Potential of natural and recycled green roof materials to improve their ecological footprint. 3<sup>o</sup> Encontro em Biologia Funcional e Biotecnologia de Plantas, FCUP. 11/10/2019. Porto. Portugal (Poster)

Furthermore an abstract for the: Dresden Nexus Conference 2020: Circular Economy in a Sustainable Society was submitted to further develop the idea and present the specific results to a broader audience. With the insulation cork board we only introduce a specific recycled resource that can replace the synthetic drainage liner. To further substitute all of the other synthetic materials that are being used to implement nature-based solutions a lot more research is needed. Especially the city as the end consumer hides so many resources that have not been further considered yet for recycling. The ambition to introduce green roofs as a nature-based solution that can actually be recovered out of the city's own resources is the only way to "really" make them sustainable.

Further cooperations are also considerable when talking about other nature-based solutions like

constructed wetlands or floating wetlands and their carbon footprint. But for this no specific agreements have been made.