FertileCity II. Integrated rooftop greenhouses: symbiosis of energy, water and CO_2 emissions with the building – Towards urban food security in a circular economy

TORRES & EARTH
www.torres.earth

Mireia Ercilla-Montserrat[1,2], Xavier Gabarrell Durany [1,2,3,*], Pere Llorach-Massana[1,2,4], Ana Nadal[1,2], Anna Petit[1,2], Aniol Alabert[5], Eugènia Casanovas[1],Eva Cuerva[6], Carla Planas[6], Oriol Pons[7], Alejandro Josa[5,8], Juan Ignacio Montero[9,1], Pere Muñoz[9,1], Gara Villalba[1,2,3], Maria Rosa Rovira[2,12], Ivan Puig[5], Fernando Cortés[10], Mario Giampietro[2,13], Santiago Gassó[11], Perla Zambrano[1], Martí Rufí[1], Ana M. Manríquez[1], Isabel Pont[2,14], Joan Rieradevall[1,2,3]

[1]Sostenipra Research Group (SGR 01412), Z Building, Universitat Autònoma de Barcelona (UAB), 08193 Bellaterra (Cerdanyola del Vallès) , Barcelona, Spain.
[2]Institute of Environmental Sciences and Technology (ICTA) *(MDM-2015-0552)*, Z Building, UAB.
[3]Department of Chemical, Biological and Environmental Engineering, School of Engineering, Building Q, UAB.
[4]ELISAVA Barcelona School of Design and Engineering. La Rambla 30-32. 08002 Barcelona, Spain.
[5]Department of Civil and Environmental Engineering (DECA), School of Civil Engineering (Escola de Camins), Universitat Politècnica de Catalunya (UPC-BarcelonaTech), Jordi Girona 1-3, Building D2, Barcelona, Spain.
[6]Department of Project and Construction Engineering, School of Industrial Engineering (ETSEIB), UPC-Barcelona Tech, Avinguda Diagonal 647, 08028 Barcelona, Spain.
[7]Department of Architectural Technology, School of Architecture (ETSAB), UPC-Barcelona Tech, Avinguda Diagonal 649, 08028 Barcelona, Spain.
[8]Institute of Sustainability (IS.UPC), UPC-BarcelonaTech, Jordi Girona 31, Barcelona, Spain.
[9] Institute of Food and Agricultural Research (IRTA), Carretera de Cabrils, km 2, 08348 Barcelona, Spain.
[10] Institute of Robotics and Industrial Informatics (IRI), Management Technical Unit (UTG) of Mathematics field, UPC-Barcelona Tech, Pau Gargallo 14, 08028 Barcelona, Spain.
[11]Department of Project and Construction Engineering, School of Industrial, Aerospace and Audiovisual Engineering (ESEIAAT), UPC-Barcelona Tech, Colom 11, 08222 Terrassa, Spain.
[12]Department of Business, B Building, UAB.
[13]Catalan Institution for Research and Advanced Studies (ICREA) Passeig Lluís Companys 23, 08010 Barcelona, Spain.
[14]Department of Administrative Law, B Building, UAB

***Corresponding author:** Mireia Ercilla Montserrat <Mireia.Ercilla@uab.cat>

Fertilecity®

www.fertilecity.com/en

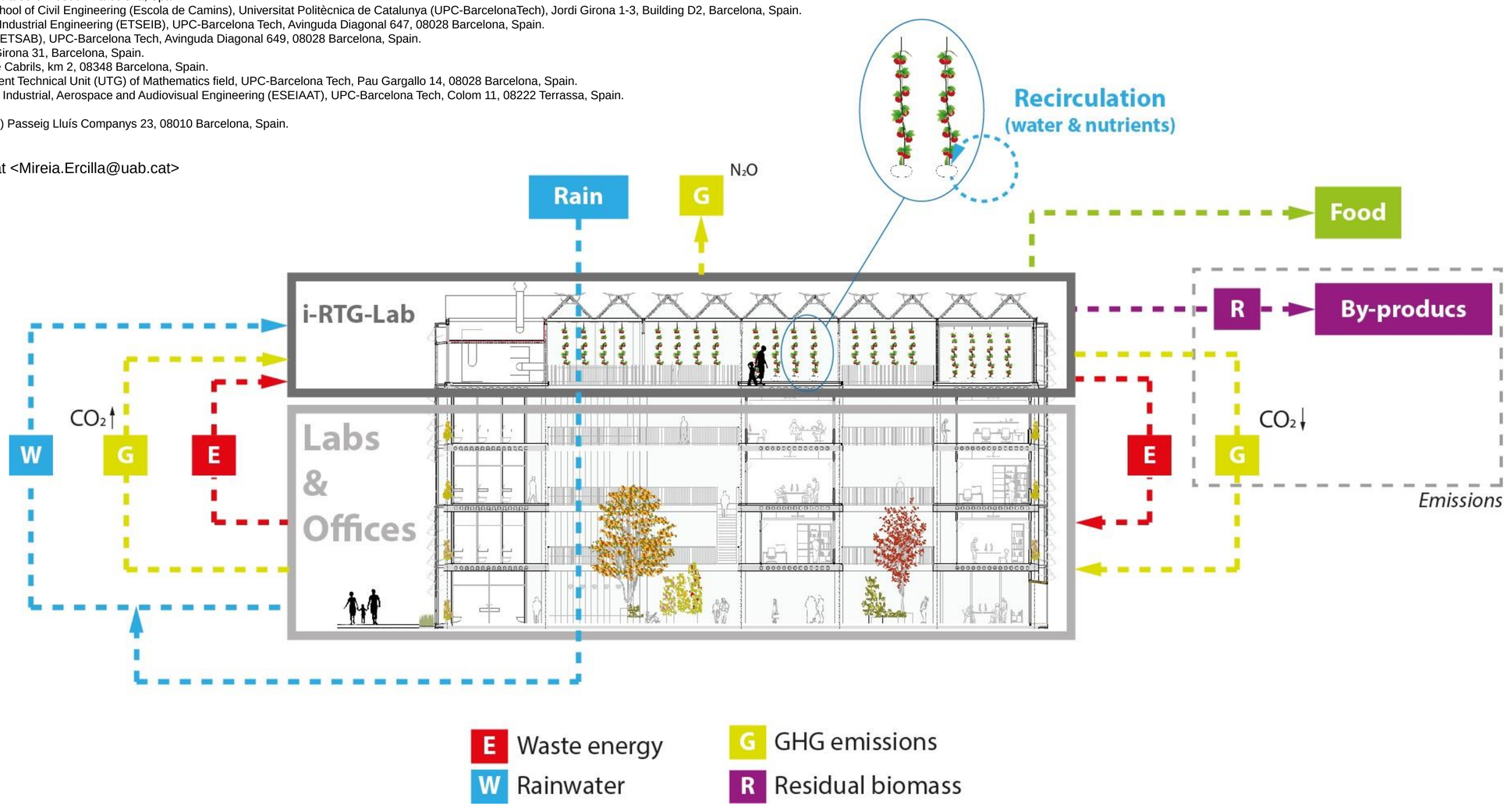

Figure 1.
Exchange of flows between the ICTA-ICP building, Edifici Z at UAB campus, and its greenhouse on the roof.

1 FertileCity I: Unidirectional connection

Urban areas are increasingly larger and more numerous. They use nearly 70% of energy and are responsible for 75% of world greenhouse gas emissions. Urban areas are strongly dependent on food and water, and this makes them vulnerable and responsible for high environmental impacts. Within cities, most energy is required for housing, which is a major source of emissions. Besides, food production relies on energy (particularly for transportation) and water (in Southern Europe irrigation uses about 80% of deep groundwater).

FertileCity I project (CTM2013-47067-C2-1-R; 2014-2016) started research activities on a new horticultural production system based on multy-disciplinary tools (environmental analysis, economic and sustainability in life-cycle, energy efficiency). FertileCity I was also founded on agricultural methodologies to analyse crop response and development viability. Rooftop Greenhouses (RTG) are still in early stages of research and implementation. In Europe, such type of production is still beginning, and current pilot RTGs are always disconnected, in terms of water, energy and CO_2, from the building underneath.

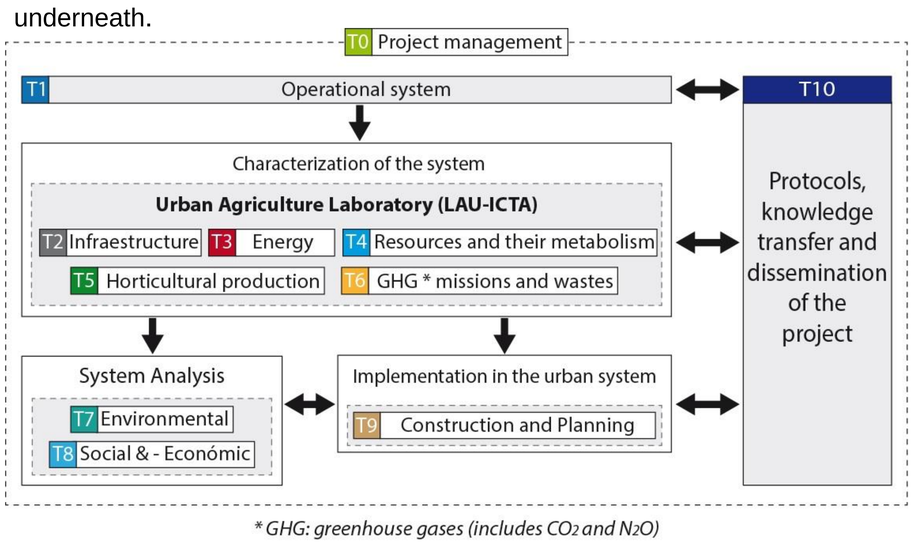

Figure 2. Tasks of the FertileCity II Project

2 FertileCity II: Towards a bidirectional connection

The objective of FertileCity II (2017-2019) project (CTM2016-75772-C3-1-R, CTM2016-75772-C3-2-R, CTM2016-75772-C3-3-R) is deepening on research of urban agriculture in RTGs integrated with the building, providing information and tools that make integrated RTGs possible. During FertileCity I, a new facility started to operate on the ICTA-ICP building roof (UAB). Between January 2014-2016 different lettuce and tomato crops were grown. Such facility is currently connected to the building in terms of water, energy and CO_2, but only one-way, from the building to the greenhouse.

FertileCity II will focus on establishing a two-way greenhouse-building connection. The project will address subjects such as the recirculation of water for agricultural production; detailed energy modelling of the greenhouse-building system and its comparison with conventional greenhouses; the architectural and constructive study both on a building scale and on a neighborhood scale; the use of generated agricultural residues; the analysis of the system sustainability (environmental, economic and social viewpoints); the identification of business models; and the dissemination and transfer of the project and its results.

Such symbiosis greenhouse-building (energy, water, CO_2…) requires a multi-disciplinary approach which is covered by researchers from UAB (with expertise on environmental matters, water cycle in urban areas, waste and economy), UPC (expertise on energy, architecture, construction, and sustainability assessment) and IRTA (expertise on agronomy and greenhouse effect). FertileCity II is organised around ten tasks which are structured into five blocks: system (T1) with the adaptation of the experimental greenhouses to the project's requirements; technical and environmental system characterisation (T2-T6) focussed on the study of materials, energy, water, nutrients, food, greenhouse gases and wastes; analysis of environmental and socio-economic sustainability (T7-T8); urban system implementation (T9) and dissemination and exploitation of the project results (T10). The aim is to respond to the challenge of food safety and quality in cities through the production of sustainable food (reduction of products coming from far away, less environmental impact), quality (complete plant maturation) and contribution to the "Safe energy" and "Climate change" challenges by increasing the energy efficiency of buildings and CO_2 capture and storage, as well as reducing emissions and transporting food.

Acknowledgements

CTM2016-75772-C3-1-R, (AEI/FEDER, UE);
CTM2016-75772-C3-2-R, AEI/FEDER, UE);
CTM2016-75772-C3-3-R) (AEI/FEDER, UE);
ICTA. Unidad de excelencia «María de Maeztu» (MDM-2015-0552).

Entities: sostenipra Sostenibilitat i Prevenció Ambiental · UAB Universitat Autònoma de Barcelona · icta · UPC · IRTA RECERCA I TECNOLOGIA AGROALIMENTÀRIES

Project FertileCity II (CTM2016-75772-C3-1-R, CTM2016-75772-C3-2-R, CTM2016-75772-C3-3-R) (AEI/FEDER, UE); January 2017

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD