

ECOFACT (ECO-innovative Energy FACTory Management System) - PM502423

Andrea Perego

Consulting & Marketing Director | @andreaangeloromoloperego 

Alder Moriggi

Software Developer Engineer | @alder-moriggi 



ECOFACT — a EU-funded R&D project

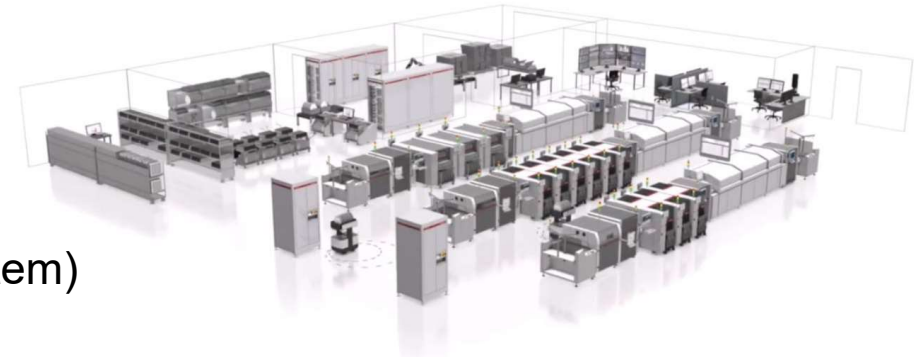
The project in a nutshell



THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S
HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER
GRANT AGREEMENT NO 958373

ECO-innovative Energy FACTory Management System based on enhanced LCA and LCCA towards resource-efficient manufacturing.

- **12 M €** budget
- Started in **2020**
- **48M** duration
- **Consortium** of 20 organizations
- Part of the **Horizon 2020** program
- **Digital Twin Platform** based on Forge (Energy & Resource Management System)



Learning objectives

Why should you attend this class

- Understand how to build up a Digital Twin Platform on Forge exploiting its APIs
- Deepen the knowledge on the whole ECOFACT platform, in which an Energy and Resource Management System (ERMS) is combined with a dynamic LCA/LCC approach.
- Assess the potential of an integrated platform and how it could support industrial processes optimization
- Learn how EU is contributing to boost sustainability through digitalization thanks to the Horizon 2020 (H2020) program



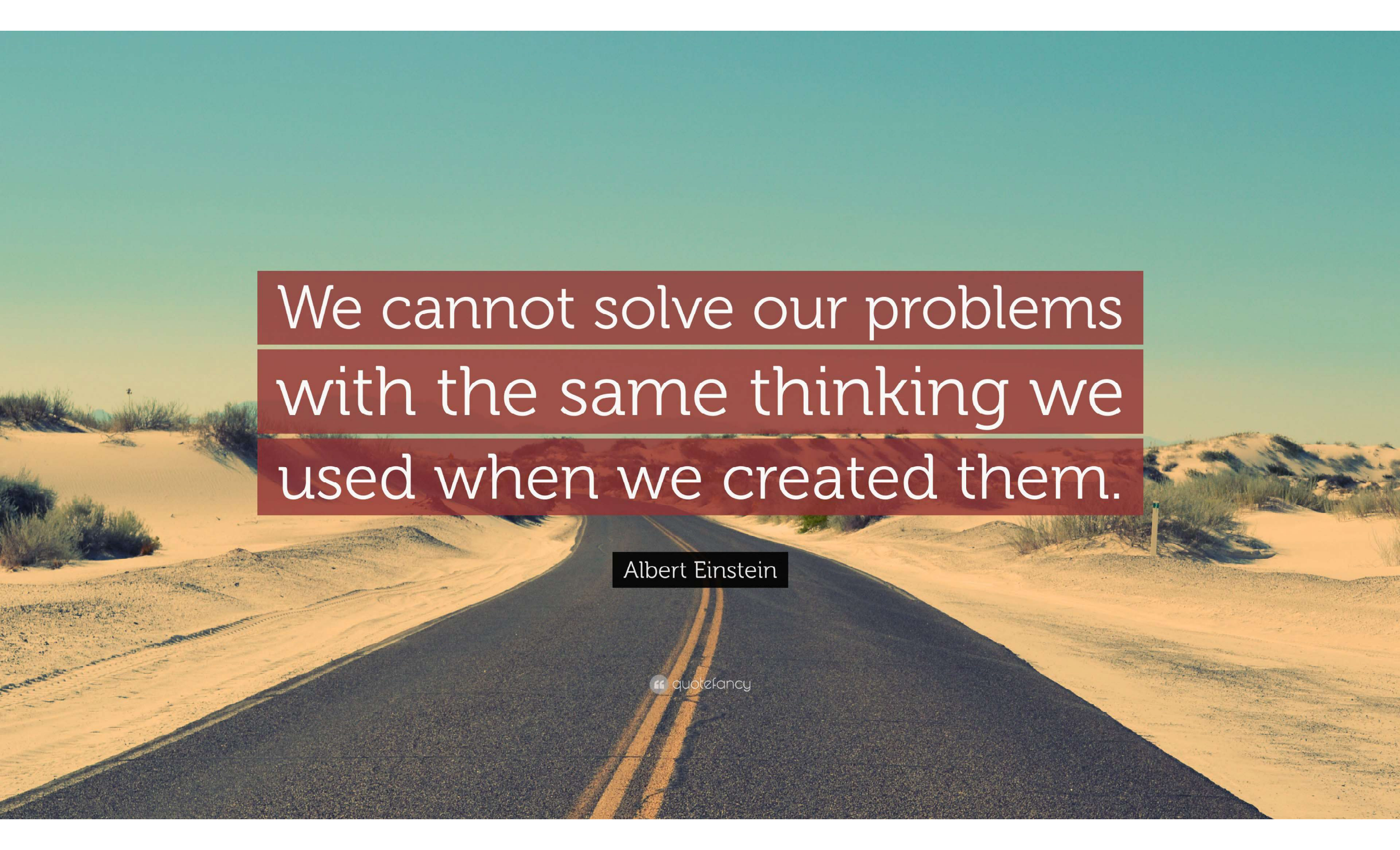
MORE
IS INEVITABLE



LESS
IS A REALITY



OPPORTUNITY OF
BETTER



We cannot solve our problems
with the same thinking we
used when we created them.

Albert Einstein

quote fancy

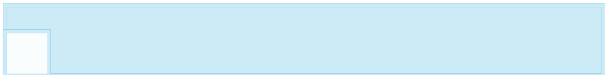


Horizon 2020

- H2020 was the EU's research and innovation funding program from **2014-2020** with a budget of nearly **€ 80 billion**.
 - **Cut greenhouse gas emissions** by at least 55% by 2030 sets Europe on a responsible path to becoming climate neutral by 2050.
 - H2020 provided grants to research and innovation projects through open and competitive calls for proposals.
 - The program has been succeeded by Horizon Europe.

One Team's EU-funded projects

BIM4EEB



☐ BIM based fast toolkit for Efficient rEnovation of residential Buildings

☐ One Team main task: BIM Management System development

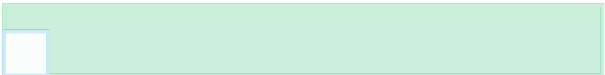
☐ BUDGET: 7M€

☐ DURATION: 42M

☐ PARTNERS: PoliMI, VTT, Suite 5, Regione Lombardia...

☐ LINK: <https://www.bim4eeb-project.eu/>

BIMReL



☐ BIM Regione Lombardia

☐ One Team main task: BIMReL Platform development

☐ BUDGET: 2M€

☐ DURATION: 24M

☐ PARTNERS: PoliMi, Traceparts, Regione Lombardia

☐ LINK: <https://www.bimrel.it/>

ECOFACT



☐ ECO-innovative Energy FACTory Management System based on enhanced LCA and LCCA towards resource efficient manufacturing

☐ One Team main task: Digital Twin modelling and Platform development on Forge

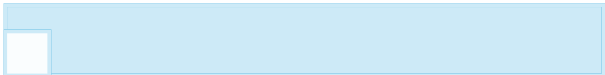
☐ BUDGET: 12M€

☐ DURATION: 48M

☐ PARTNERS: Cartif, Rina, Links, Wings, Schneider, Veolia...

☐ LINK: <https://ecofact-project.eu/ecofact-press-release/>

INFINITE



☐ INdustrialised durable building envelope retroFitting by all-IN-one Interconnected TEchnology solutions

☐ One Team main task: BIM-based design platform (CDE) development

☐ BUDGET: 10M€

☐ DURATION: 54M

☐ PARTNERS: Eurac, Greendelta, Huygen, Nobatek, Rubner, Bouygues...

☐ LINK: <https://infinitebuildingrenovation.eu/>



Horizon 2020
European Union Funding
for Research & Innovation

One Team 4 sustainability

One Team logo is a clear reference to the Earth, we always keep an eye on the protection of our Planet indeed. And our commitment is very concrete: we are currently working on very important **eco-innovative projects**, such as BIM4EEB, ECOFACT-project and INFINITE project, and we have chosen to use **only Renewable Sources** thanks to a special contract signed w/ A2A.

We strongly believe that preserving the **Earth** and its resources is very important, especially in this historical period.



Agenda

01

INTRODUCTION

Company Profile,
Speaker's Bio,

02

PROJECT OVERVIEW

Targets, Consortium,
Platform Overview

03

THE SOLUTION

Digital Twin Platform,
Industrial Energy Flex

04

WHAT'S NEXT?

Future challenges and call
to actions



Introduction

One Team, speakers



One Team – mission & business units

For over 25 years we have been transforming skills and technologies into VALUE by offering **consulting services** and the complete supply of **IT solutions** for the construction, civil, infrastructural and manufacturing industries.

We are one of the **top 10 Autodesk Platinum partners** in EMEA.



Smart Buildings & Infrastructures

Smart Manufacturing

Smart Territories

One Team key numbers



Primary speaker & co-speaker



Andrea Perego



Alder Moriggi

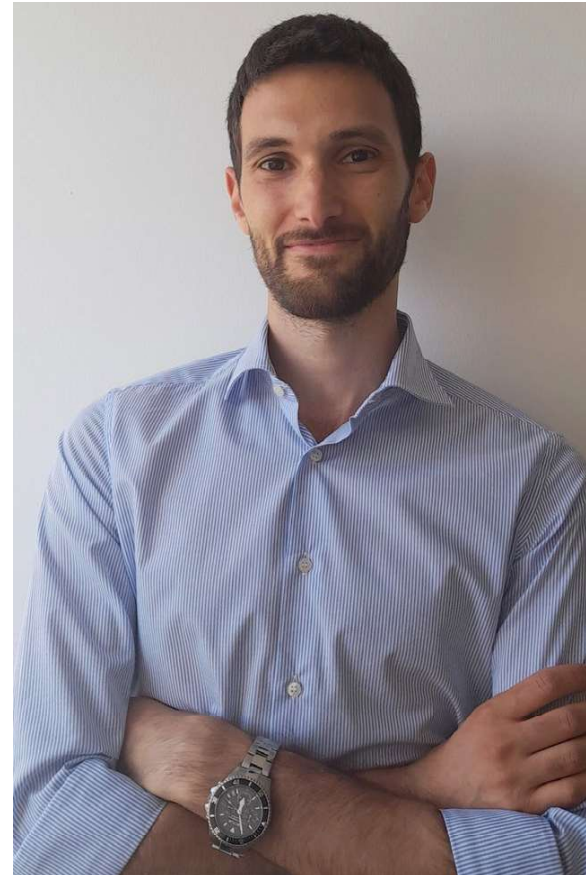
Working at One Team for ECOFACT



Diego Farina



Andrea Tino



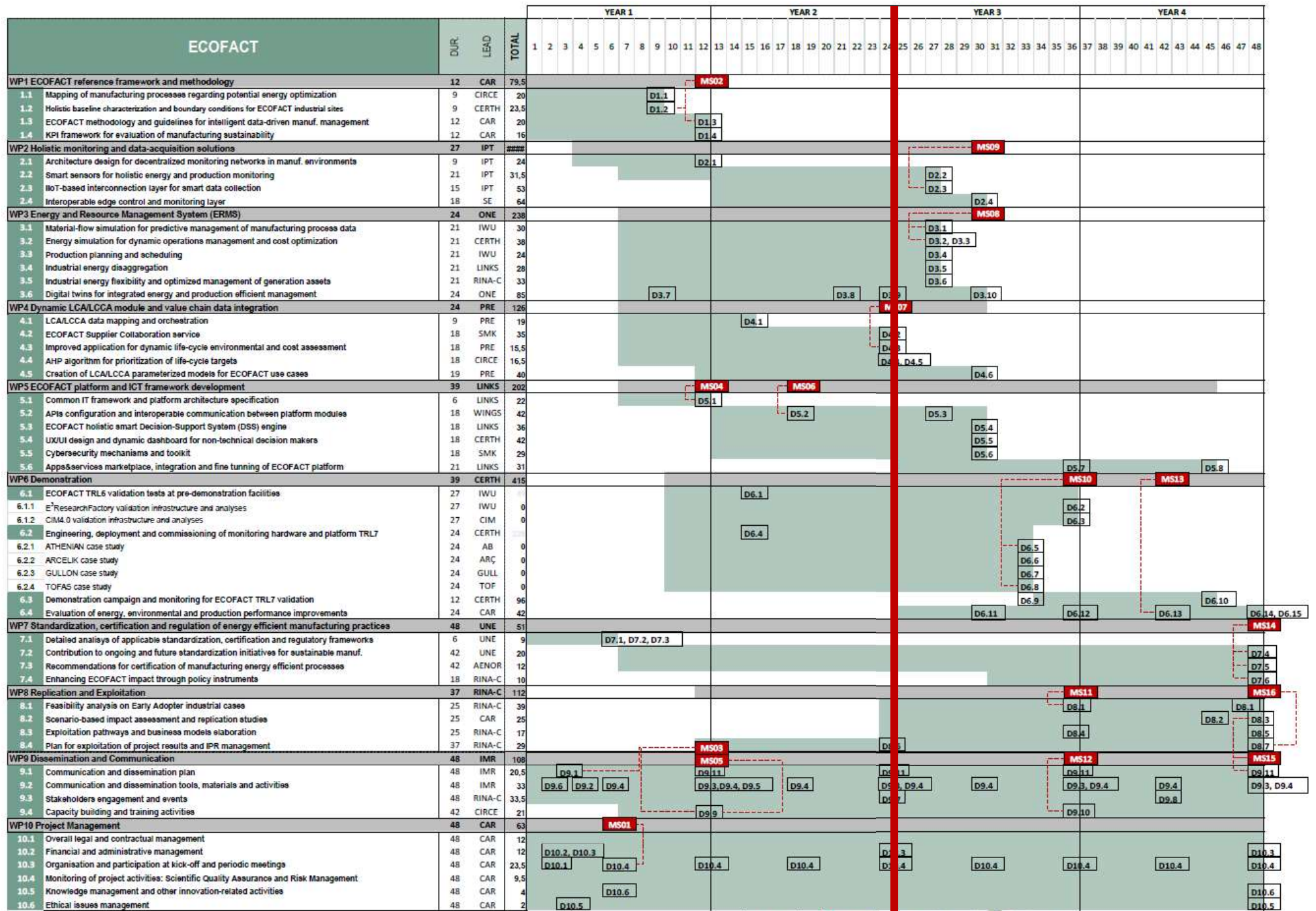
Riccardo Merizzi



Alessandro Valra

Project overview

Targets, consortium, demo sites and
ECOFACT platform



Scientific and Technological Objectives (STOs)



STO1

- Plug-and-play solution consisting of a hardware Smart Box for **interoperable connection** of different energy sensors (IIoT).
 - Target: reduction of network resources and costs by **20%**



STO2

- Helping O&M staff to forecast problems, do better planning and improve performance in the use of (energy and material) resources thanks to a prognosis-based **ERMS**.
 - Target: cut on the factory energy bill by average of **25 %**.

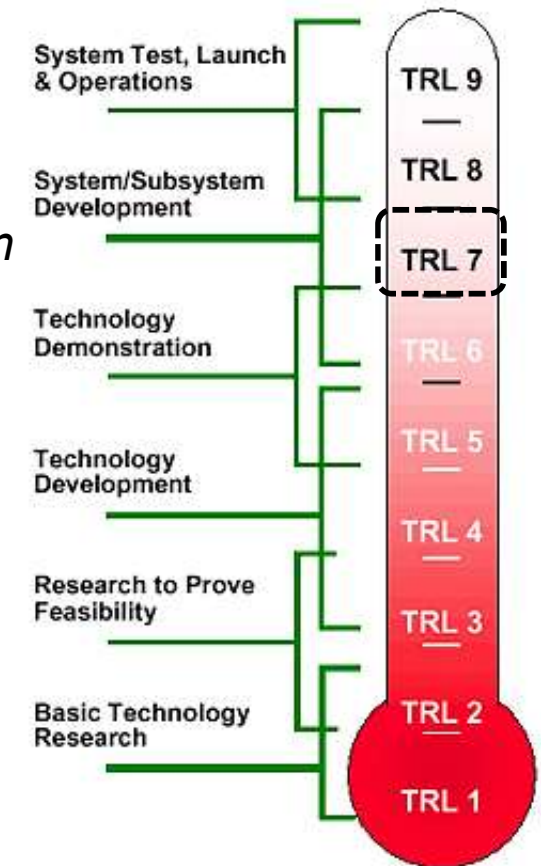


STO3

- Better control the **environmental signature** of manufacturing processes and supply chains, enabling green production and product design as a cost-saver and marketing tool for businesses.
 - Target: reducing environmental footprint of manufacturing processes by average of **4-8 %**.

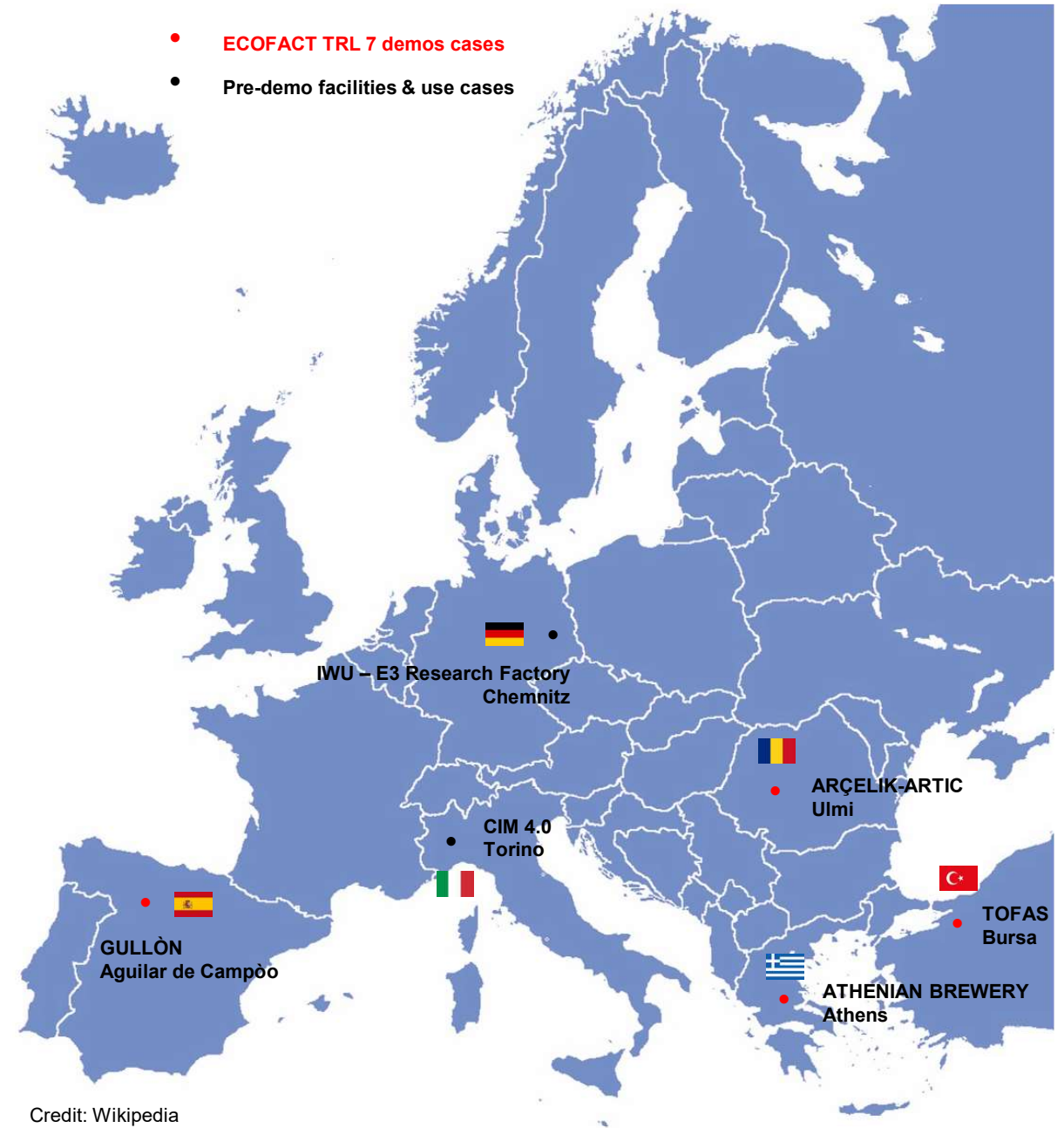
Other Objectives

- Other Scientific Technological Objectives.
 - *STO 4: ECOFACT methodology and platform for holistic manufacturing.*
 - *STO 5: demonstration of ECOFACT at TRL (Technology Readiness Level) 7 in four different demo sites.*
- Non-technological Objectives.
 - *NTO 1: inputs to new standardization, certification and regulation schemes.*
 - *NTO 2: exploitation for attractive business cases and fostering replication.*
 - *NTO 3: dissemination, communication and capacity building.*



Consortium

- 20 partners
- 7 different countries (6 of the EU)
- 5 research institutions
- 8 large industries
- 5 SMEs
- 2 associations across the manufacturing environment



Credit: Wikipedia

Discrete Manufacturing Demo Sites

Arçelik and Tofaş



Arçelik



Tofaş

Continuous Manufacturing Demo Sites

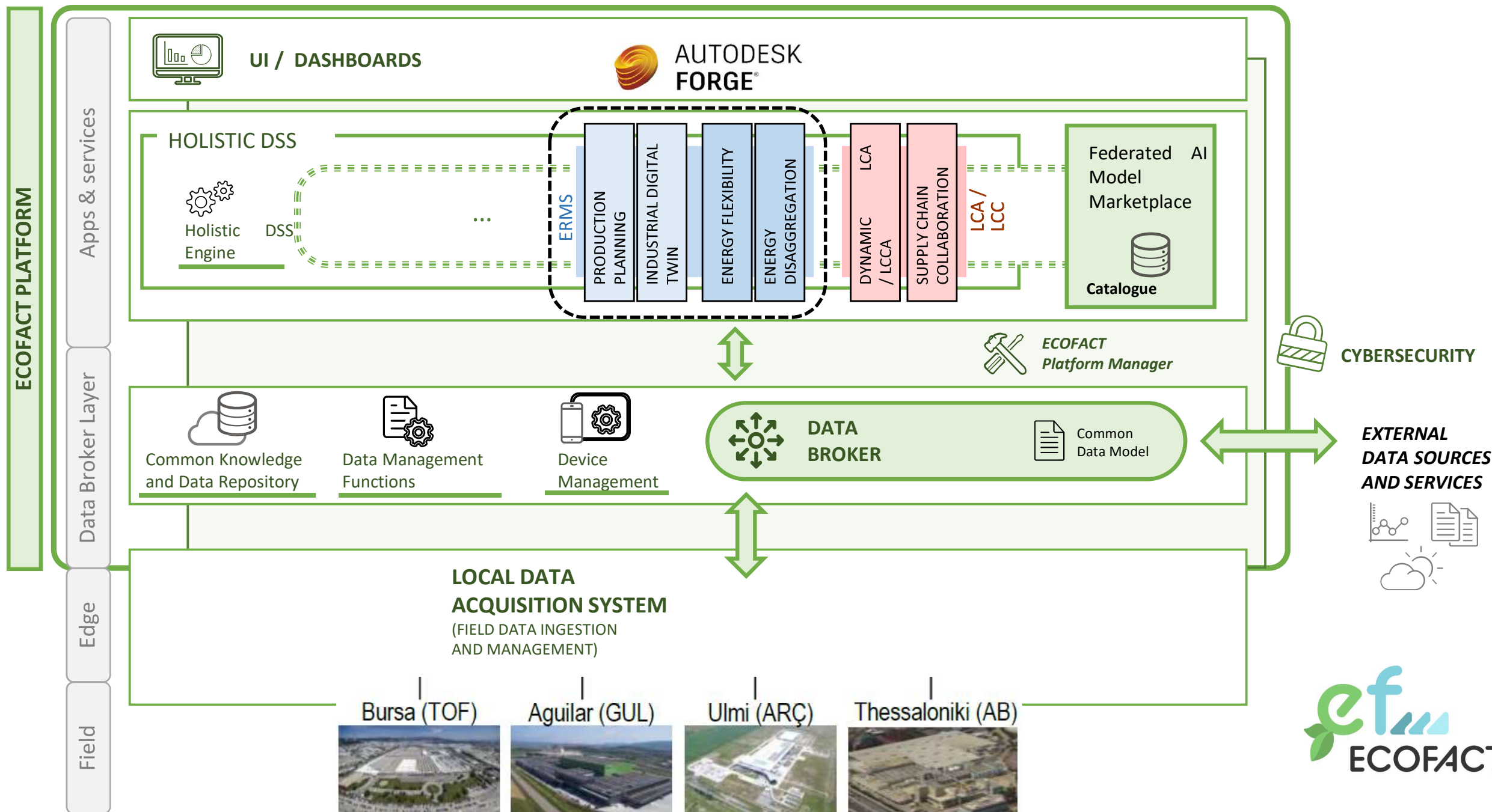
Athenian Brewery and Gullon



Athenian Brewery



Gullon



4-step ECOFACT concept



Local Data

Holistic monitoring and data-acquisition solutions:

- network for interoperable integration of smart sensors under **IIoT premises**;
- interaction with several levels (sensors, actuators, PLCs, SCADA etc.) within the **industrial processes pyramid**.

Data Broker

- Developed to manage information streams that can be accessed through a series of APIs by data producers, consumers or stream processors.
- Based on an open-source stream-processing software **platform (Kafka)** enhanced with other functionalities.

Holistic DSS

Including:

- the Forge-based **Digital Twin Platform** (DTP) as an Energy and Resource Management System (ERMS);
- a **supply chain** collaboration service and a dynamic **LCA/LCCA approach** leveraging SimaPro.

UI

In which production managers:

- **interact with the DSS**, receiving operational and scheduling suggestions and alerts/alarms and running production scenarios;
- **access different data** (both historical and in real-time) at different granularity.

Digital Twin Platform

Digital twin introduction and DTP sections –
digital twins, energy and resource tools and
data-exchange

Digital twin concept

Definition and maturity levels

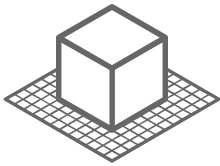
- “A sensor-enabled digital model of a physical object that simulates the object in a live setting.” Dr. Michael Grieves first introduced the concept in 2003 in Digital Twin: Manufacturing Excellence through Virtual Factory Replication.
- The digital twin allows to manage the life cycle of buildings, infrastructures and industrial machineries, from the design to the O&M phase.



DTP sections

Digital twins, energy and resource tools and data-exchange

Web platform powered by Forge



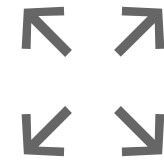
Digital twins:

- accessible through **Forge Viewer**, with the related 3D models realized using **Inventor**;
- relevant documents.



Tools:

- **OptimiST** for the industrial energy flexibility and optimized management of generation assets;
- three other applications for four more purposes.



Data-exchange layer:

- authorization API;
- resource APIs;
- user APIs.

Digital twins

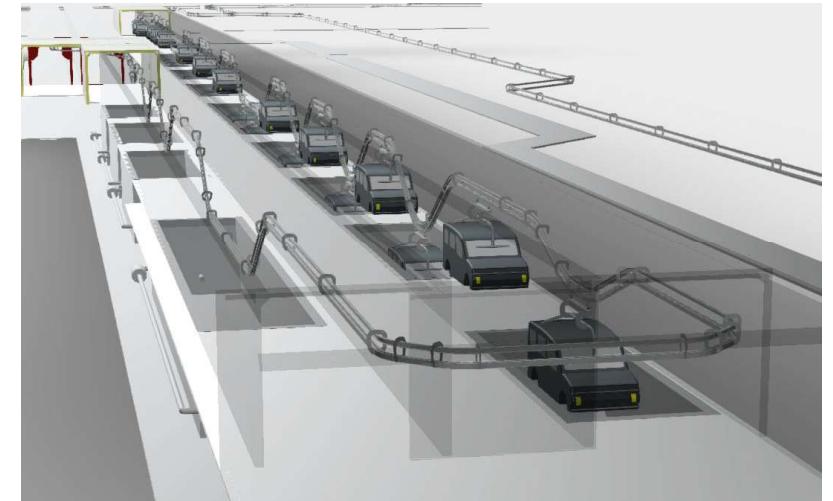
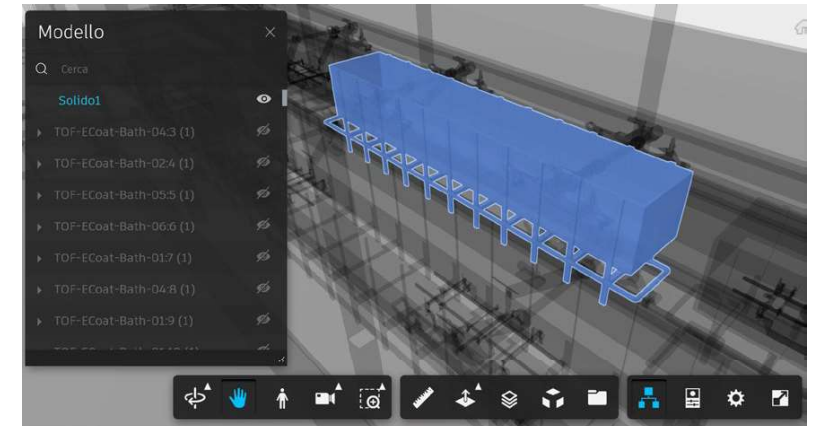
Digital twins for integrated energy and production efficient management



- Software used for the 3D models.
- Machineries and products are combined into an assembly to create the lines.

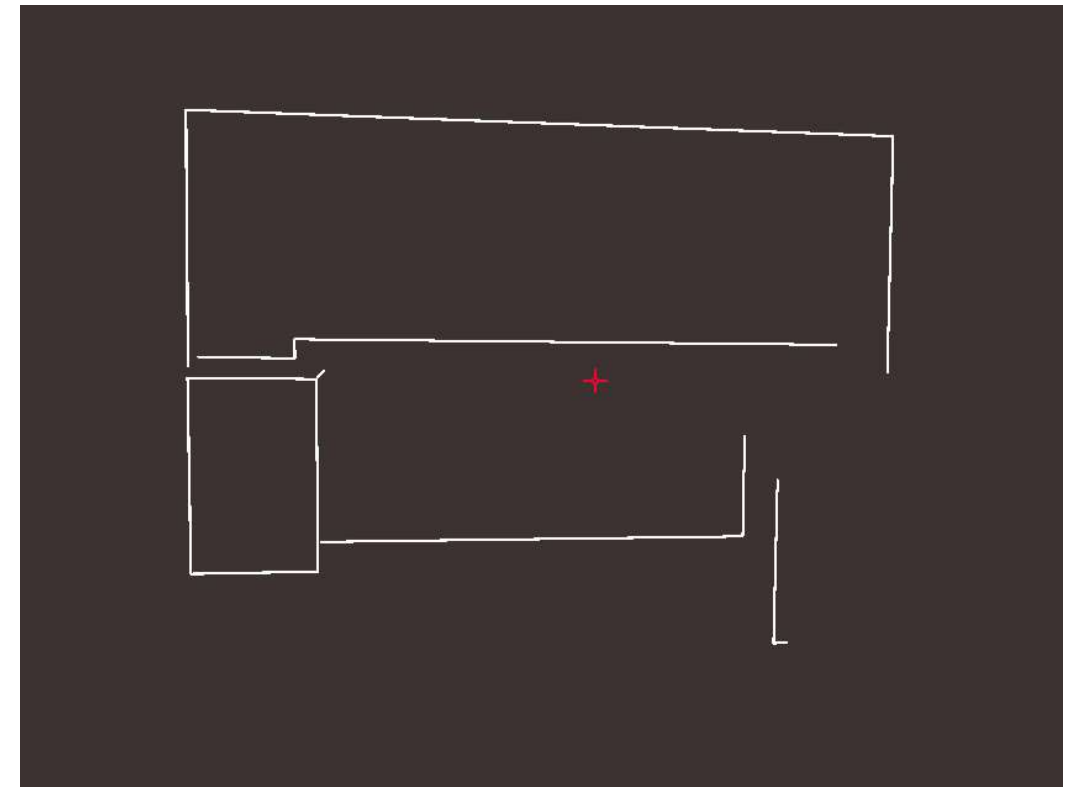
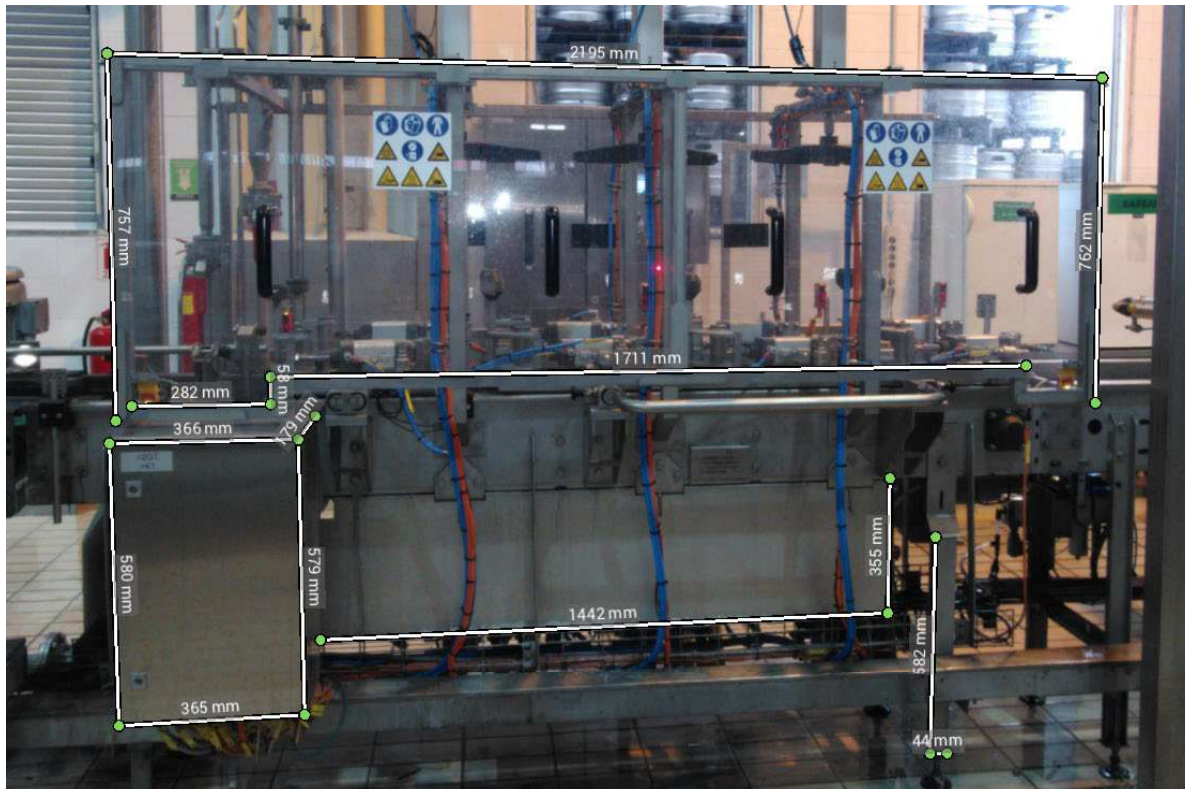


- Development environment for the **Digital Twin Platform**.
- The Viewer allows to visualize the digital twins of lines and machineries.

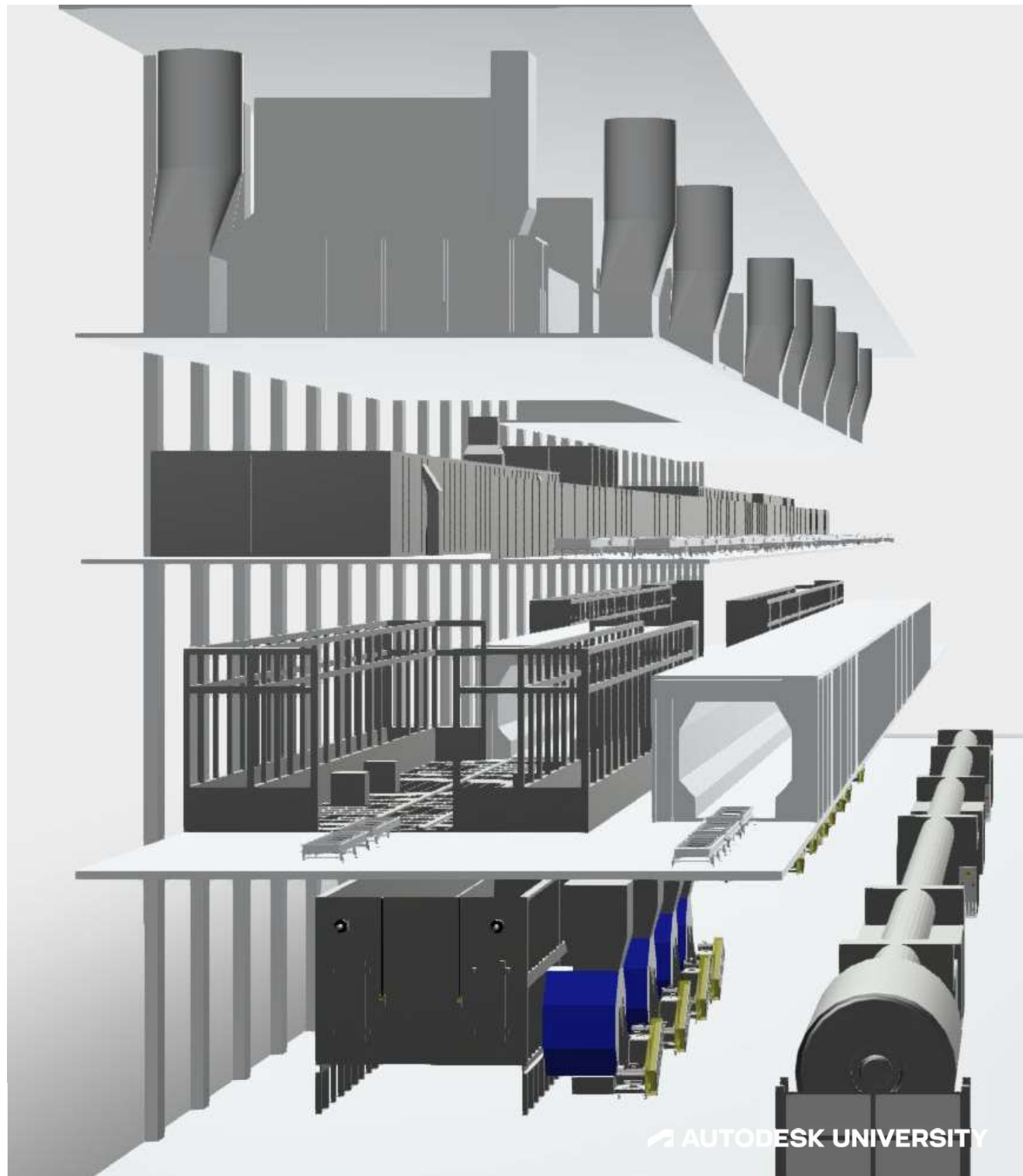
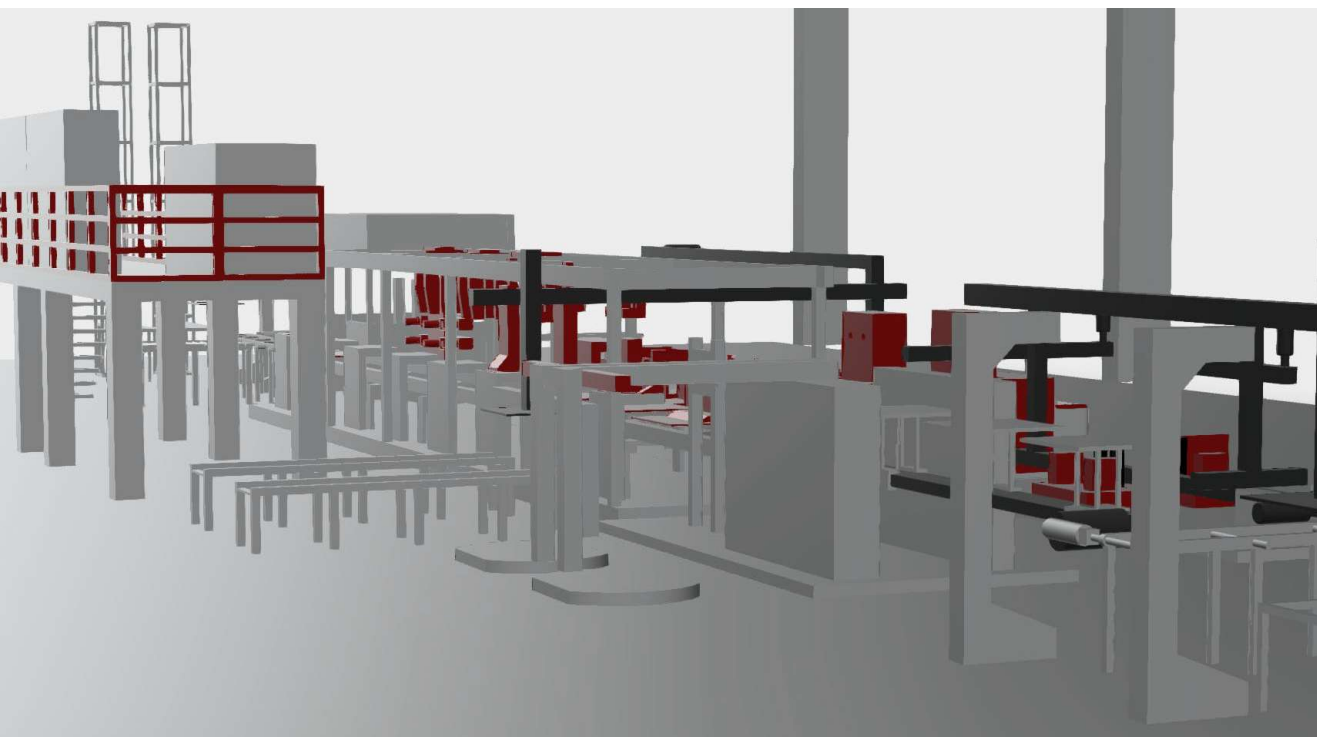
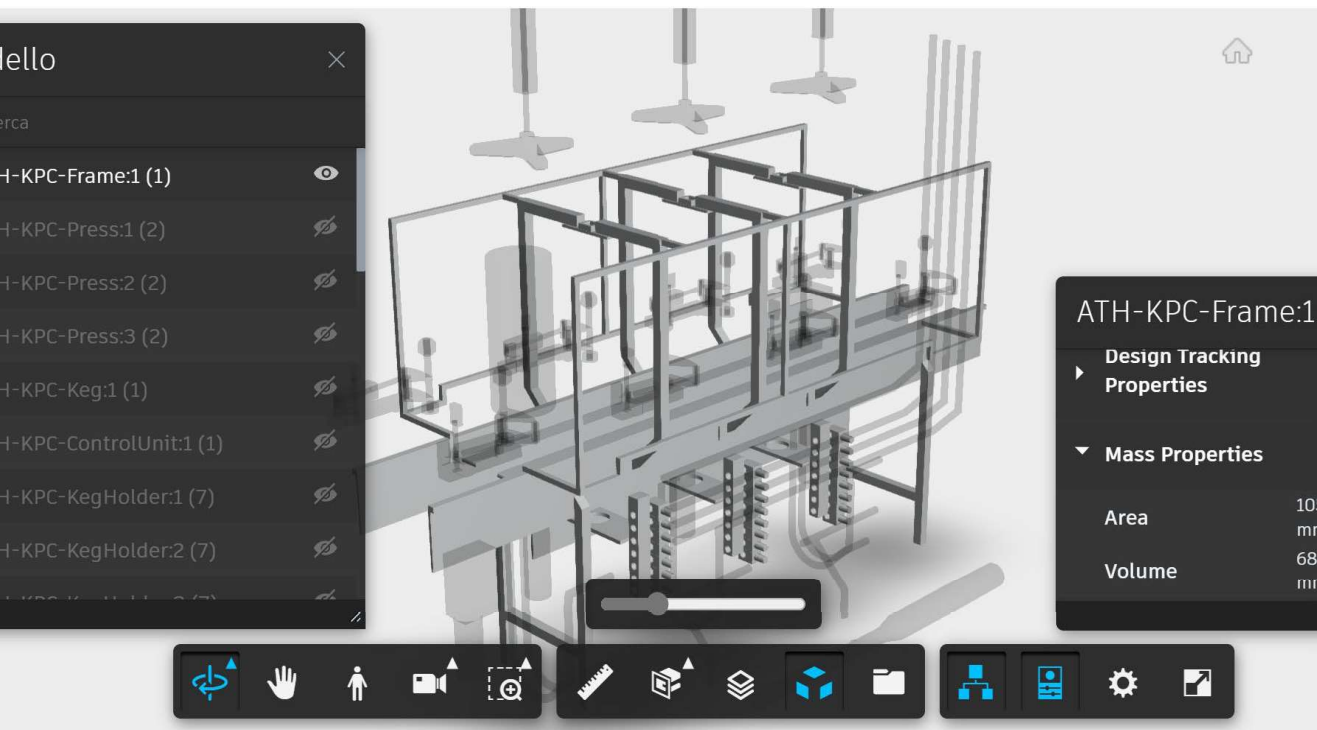


Digital twins

Integration of laser scan technologies with design tools for the 3D models



Credit: Wikipedia, Leica Geosystems



Digital twins

Sensors' data – TOF demo site

Admin

User

Group

Permission

Demo Site

Demo Site

- Digital Twins
- Digital Twins Edit
- Deleted Digital Twins
- Documents
- Documents Edit
- Deleted Documents
- Data Exchange

Tools

- Tool

Credits

Log Out

Help

Collapse

Copy

Excel

PDF

Search:

ACRONYM	NAME	DESCRIPTION	STATUS	CITY	COUNTRY
AB	ATHENIAN BREWERY	Food and beverage (brewery)	ACTIVE		
ARC	ARÇELIK	White goods manufacturing	ACTIVE		
E3	E3-Research Factory	E3-Research Factory	ACTIVE		
GUL	GULLON	Food and beverage (cereal bars)	ACTIVE		
OT	ONE TEAM	One Team Dev Demo Site	ACTIVE		
TOF	TOFAS	Automotive	ACTIVE		

Showing 1 to 6 of 6 entries

First

Previous

1

Next

Last

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 958373



Forge APIs

Why & What



- **Authentication APIs**

For authentication and authorization, in order to let application use other Forge APIs



- **Model Derivative APIs**

To access data across Forge buckets, to manage folders & files (upload Inventor models)



- **Viewer APIs**

To build a custom viewers inside the Digital Twin Platform, to extract data required (with GetBulkProperties). We used also some extensions like PDF Extension

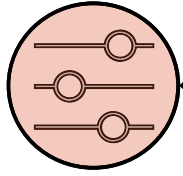


- **Data Visualization APIs**

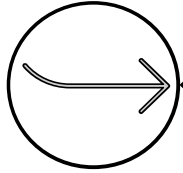
To visualize sensors and data from sensors

Energy and resource tools

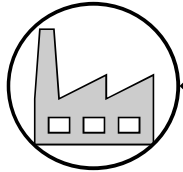
OptimiST and others



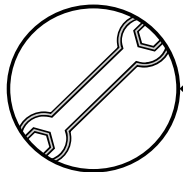
Industrial energy flexibility and optimized management of generation assets – **OptimiST**.



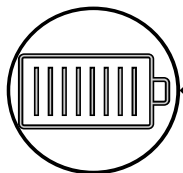
Material-flow simulation for predictive management of manufacturing process data (based on **Siemens plant simulation tool**).



Production planning and scheduling (based on **Gurobi solver**).



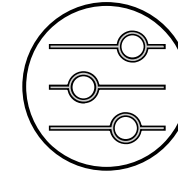
Energy simulation for dynamic operations management and cost optimization (energy modeling based on **TRNSYS**) – predictive maintenance.



Industrial energy disaggregation – by products.

Energy and resource tools

OptimiST – AB demo site



How it works

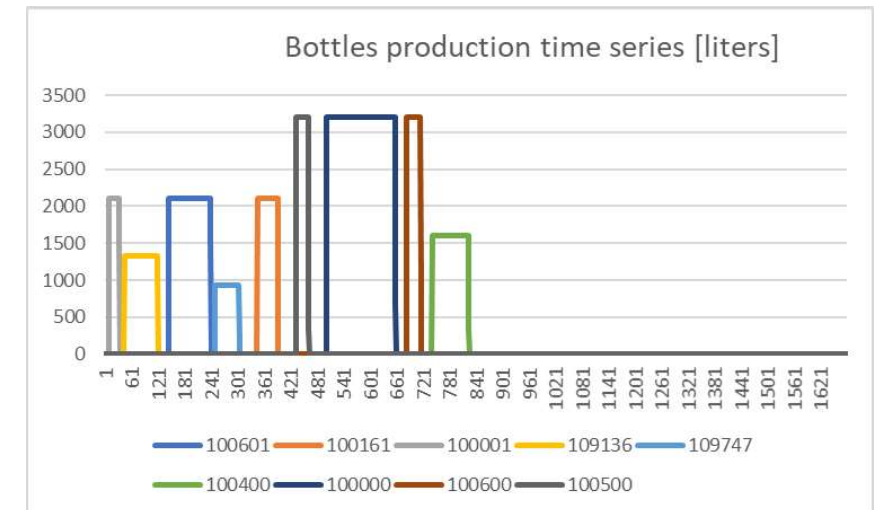
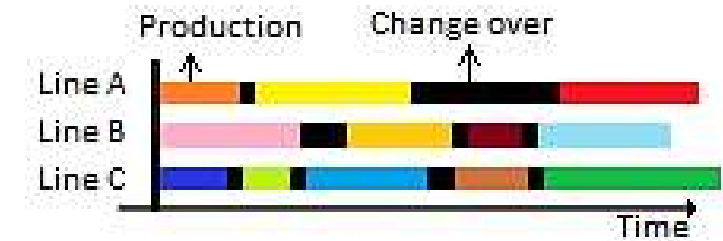
- Minimization of changeover time (black interval) defining the production scheduling.

Output

- Production scheduling for three packaging lines (for bottles, cans and kegs).

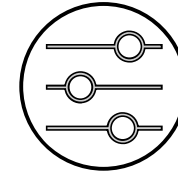
Result

- The bottles makespan has been reduced by **20 %** (from 102 to 82 hours), the change over time, thermal energy consumption and CO₂ emissions by **16 %**.



Energy and resource tools

OptimiST – AB demo site



Results

- 20 %

Bottles makespan

- 16 %

Changeover time

- 16 %

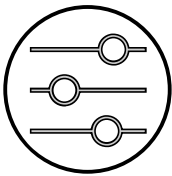
**Thermal energy
consumption**

- 16 %

CO₂ emissions

Energy and resource tools

OptimiST – AB demo site



INPUT

Consumption

(Thermal energy:) specific consumption Bottles

54,35

(Thermal energy:) specific consumption Cans

28,35

(Thermal energy:) specific consumption Kegs

76,72

(Electrical energy:) cost Bottles

4,38

(Electrical energy:) cost Cans

1,58

(Electrical energy:) cost Kegs

2,84

(Water:) cost Bottles

4,38

(Water:) cost Cans

1,58

(Water:) cost Kegs

2,84

First day date

Scegli il file

Time horizon

1

Kegs

Produced items codes

Scegli il file

Smaller items codes

Scegli il file

Bigger items codes

Scegli il file

Items production rate

Scegli il file

(Change overs:) Time matrix

Scegli il file

Items demand

Scegli il file

(Production capacity:) Maximum

Scegli il file

(Production capacity:) Minimum

Scegli il file

Cost

(Thermal energy:) cost

0.006

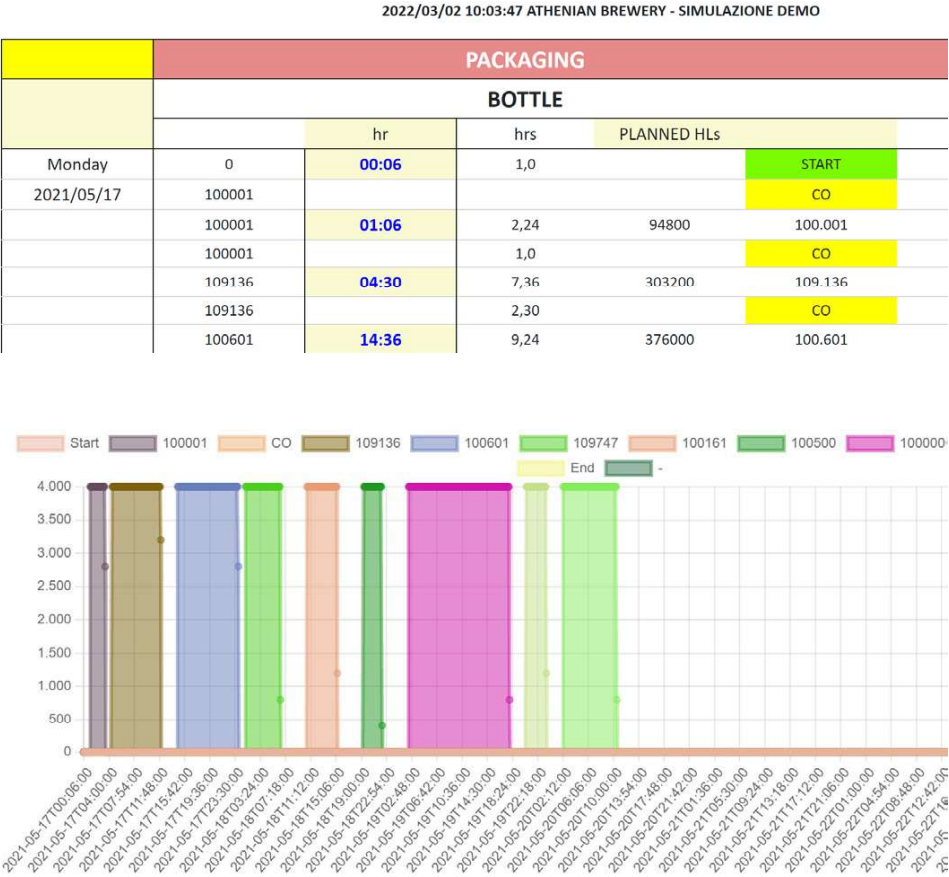
(Electrical energy:) cost

0.08

(Water:) cost

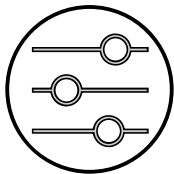
0,105

OUTPUT



Energy and resource tools

OptimiST – AB demo site



Site: ARÇELİK 654321 [v. 2.0.0.1]

Admin

User

Group

Permission

Demo Site

Demo Site

- Digital Twins
- Digital Twins Edit
- Deleted Digital Twins
- Documents
- Documents Edit
- Deleted Documents
- Data Exchange

Tools

Tool

Credits

Log Out

Help

Collapse

CopyExcelPDF

Search:

ACRONYM	NAME	DESCRIPTION	STATUS	CITY	COUNTRY
Search	Search	Search	Search	Search	Search
AB	ATHENIAN BREWERY	Food and beverage (brewery)	ACTIVE		
ARC	ARÇELİK	White goods manufacturing	ACTIVE		
E3	E3-Research Factory	E3-Research Factory	ACTIVE		
GUL	GULLON	Food and beverage (cereal bars)	ACTIVE		
OT	ONE TEAM	One Team Dev Demo Site	ACTIVE		
TOF	TOFAS	Automotive	ACTIVE		

Showing 1 to 6 of 6 entries

First

Previous

1

Next

Last



Energy and resource tools

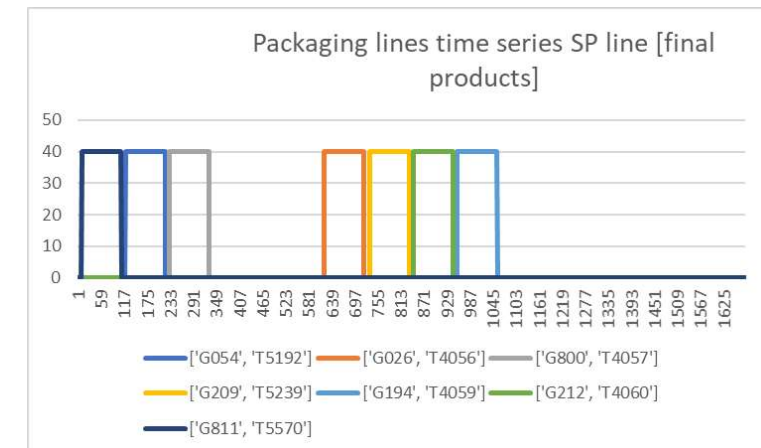
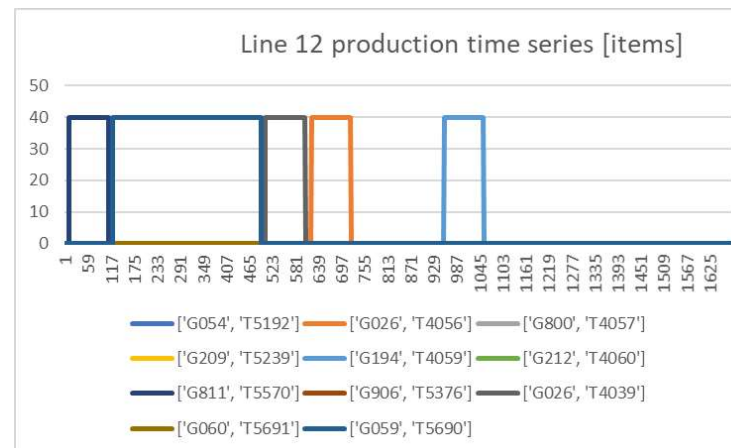
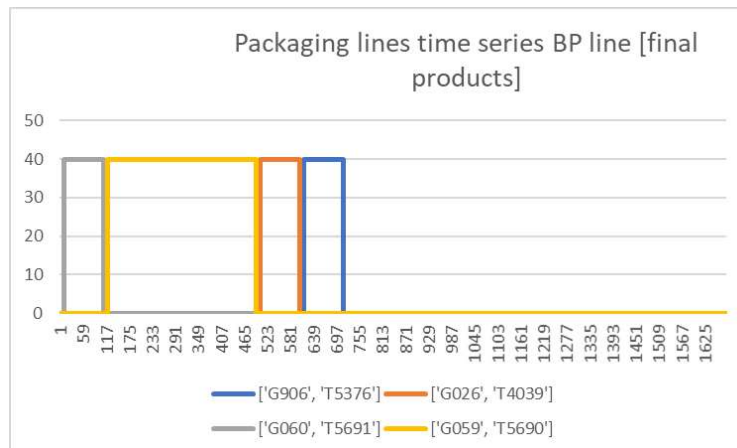
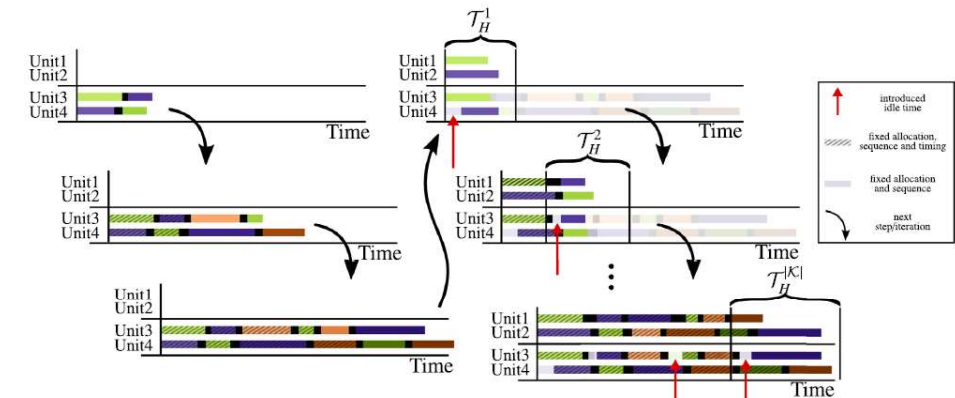
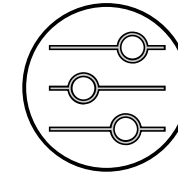
OptimiST – GUL demo site

How it works

- Minimization of changeover time (black interval) defining the production scheduling.

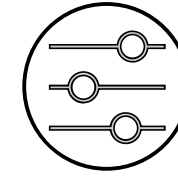
Output

- Production scheduling for each line (two packaging and three formation lines).



Energy and resource tools

OptimiST – ARC demo site

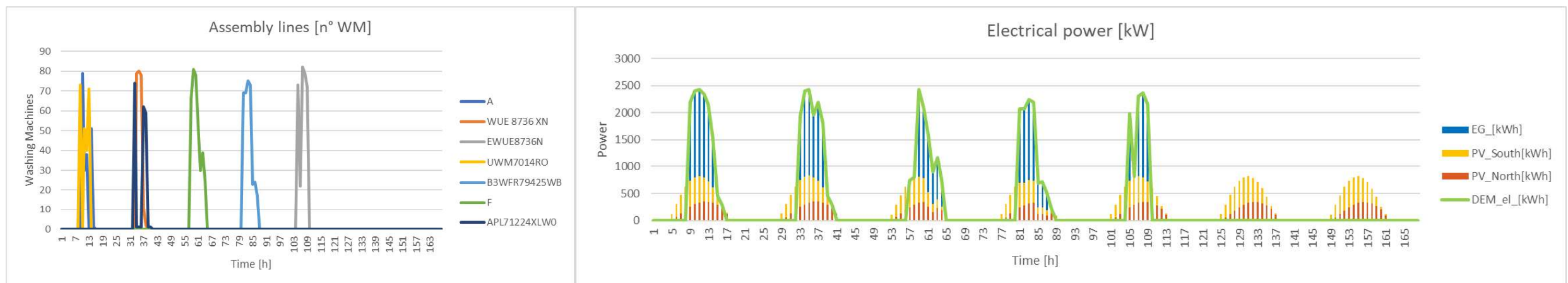


How it works

- Minimization of energy bill defining the production scheduling.

Output

- Production scheduling for each line (two assembly, two drum and two cabinets lines, in addition to plastic injection section and buffers).
- Electrical energy assets management plan.



Energy and resource tools

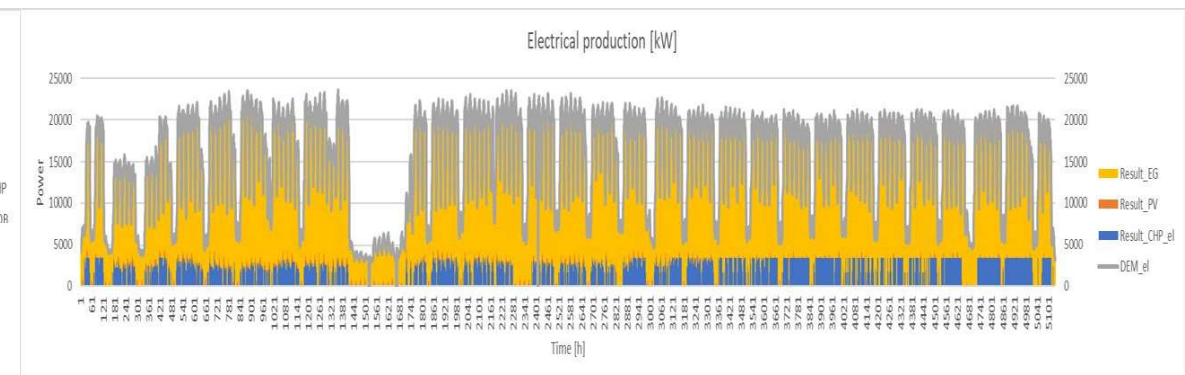
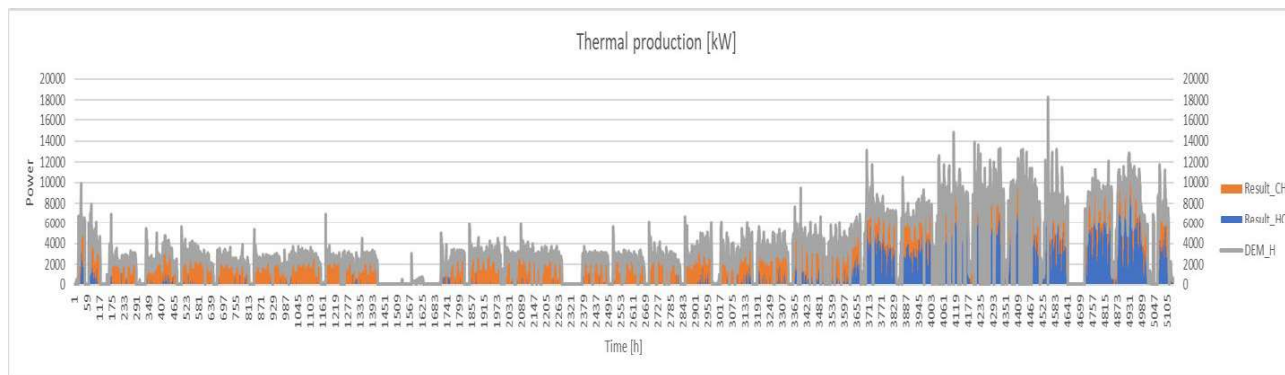
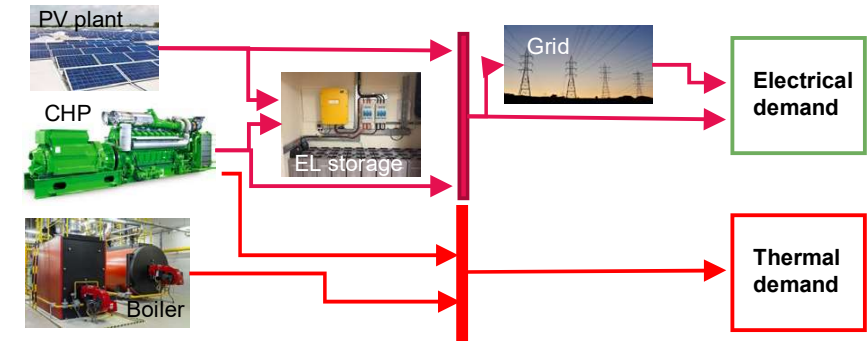
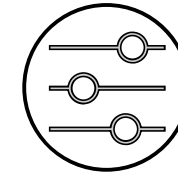
OptimiST – TOF demo site

How it works

- Minimization of energy bill managing the available energy assets.

Output

- Economic parameters (NPV, PBP, IRR, CCF and ACF).
- Thermal and electrical and energy assets management plan.

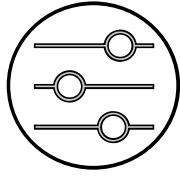


What's next?

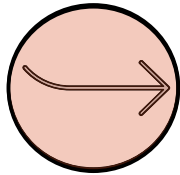
Future challenges and call to actions

Future challenges

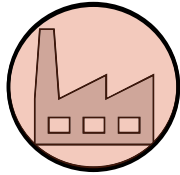
Other tools within DTP, LCA/LCC within DSS together with DTP



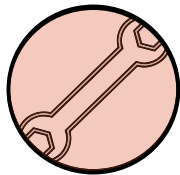
Industrial energy flexibility and optimized management of generation assets – **OptimiST**.



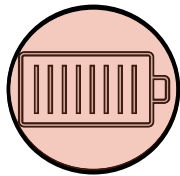
Material-flow simulation for predictive management of manufacturing process data (based on **Siemens plant simulation tool**).



Production planning and scheduling (based on **Gurobi solver**).

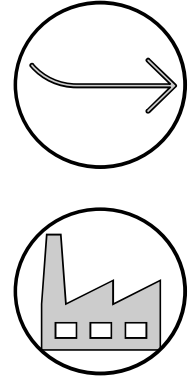


Energy simulation for dynamic operations management and cost optimization (energy modeling based on **TRNSYS**) – predictive maintenance.



Industrial energy disaggregation – by products.

Material-flow simulation for predictive management of manufacturing process data & production planning and scheduling

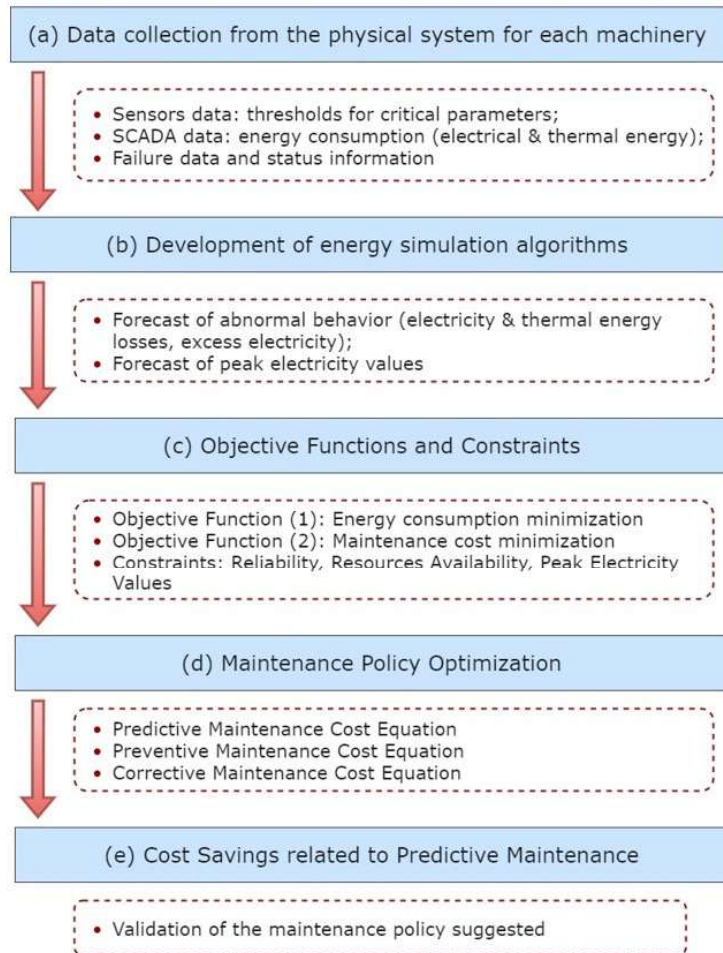
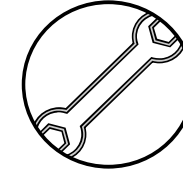


Material-flow simulations are conducted through the Siemens plant simulation tool: focus on the interaction between energy consumption, power, production, storage and transport. Considering more material flows (two lines at ARC) in a whole simulation model guarantees a better output.

Production optimizations are instead based on the Gurobi solver. Two different solution concepts evaluated at TOF: one with basic batching without return and the other with a two-stage batching with buffer lane for looping.

Future challenges

Energy simulation for dynamic operations management and cost optimization



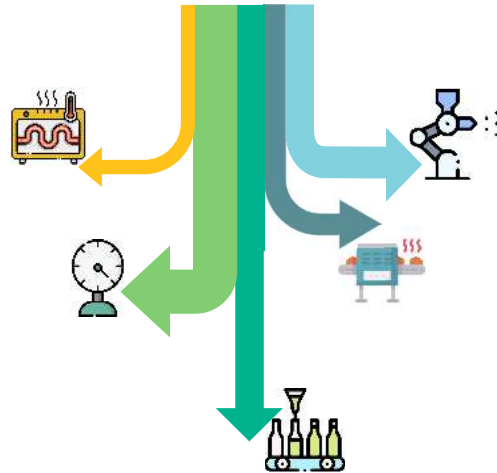
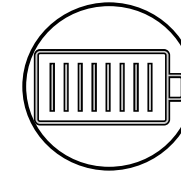
It is dedicated to the predictive management of production operations with the dual aim of reducing manufacturing energy costs (related to maintenance programs) and increasing system robustness.

Implementation methodology:

- data collection from sensors and SCADA systems (of each machinery operation);
- development of energy simulation algorithms to forecast abnormal behaviors (e.g. electricity and thermal energy losses or electricity excess/peak);
- development of **predictive maintenance model** (which will lead to the most cost-effective and energy efficient operations).

Future challenges

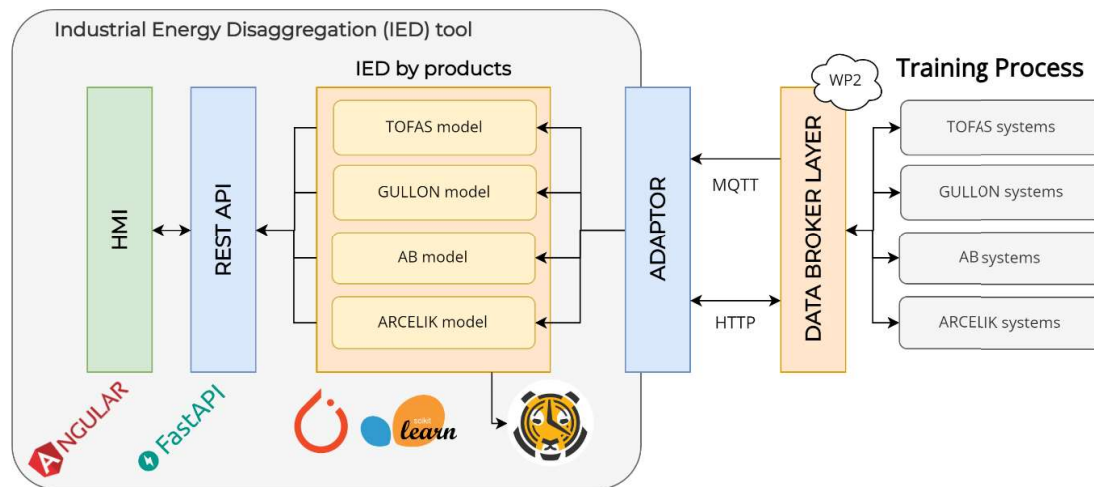
Industrial energy disaggregation



Industrial Energy Disaggregation (IED) is essentially referred to the task of separating different components from the energy signal(s).

- **ED by products for forecast and wise long-term planning in terms of energy.**
- Non-intrusive load monitoring (NILM) study for research purposes.

Sample data gathered from the demos to start training and testing the models.

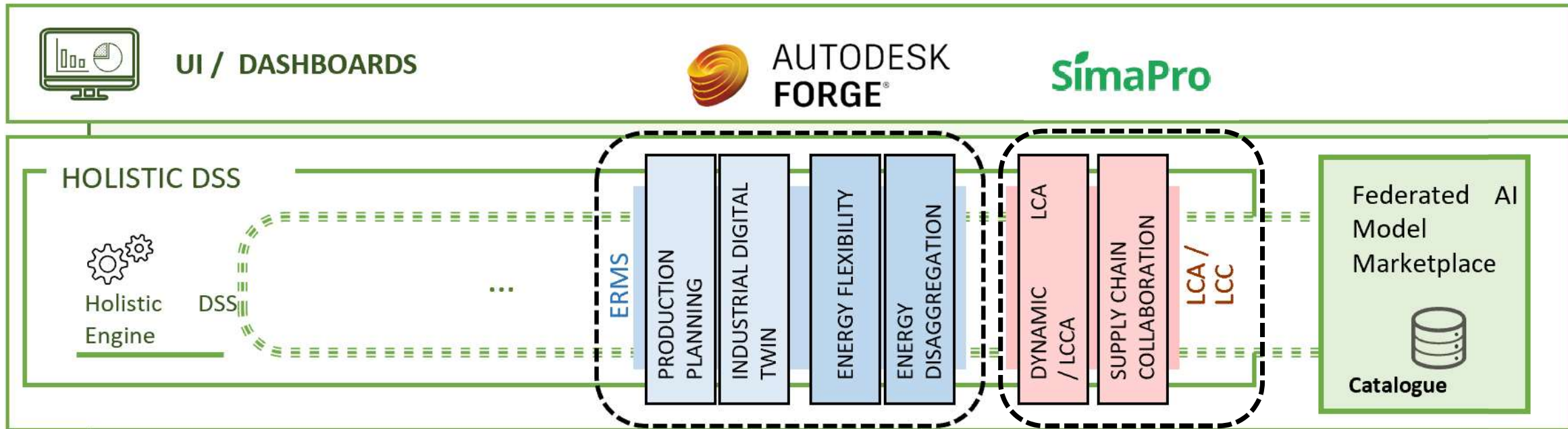


Draft of the tool's general architecture:

- web platform linked to the DTP;
- tool made available thanks to REST APIs with HMI interface.

Future challenges

LCA/LCC together with DTP within the holistic DSS



Call to action

Be part of the ECOFACT project



For exploitation ECOFACT is looking for up to five other demo sites.



Further investments needed for full marketability of the solution by 2028-2030 (from TRL7 to TRL9).



Download our handout!

Follow us!

LinkedIn, website, Twitter, newsletter



✉ Subscribe

www.ecofact-project.eu

[@ECOFACT-project](https://www.linkedin.com/company/ECOFACT-project)

[@Ecofact_Project](https://twitter.com/Ecofact_Project)

[ECOFACT Project](#)

ecofact-project.us1.list-manage.com



andrea.perego@oneteam.it

alder.moriggi@oneteam.it

“Do not go where the path may lead, go instead where there is no path and leave a trail.”





Autodesk and the Autodesk logo are registered trademarks or trademarks of Autodesk, Inc., and/or its subsidiaries and/or affiliates in the USA and/or other countries. All other brand names, product names, or trademarks belong to their respective holders. Autodesk reserves the right to alter product and services offerings, and specifications and pricing at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document.

© 2022 Autodesk. All rights reserved.