EC HORIZON2020
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Call identifier: DT-FOF-09-2020
Project Start Date: 1st of November 2020

E2COMATION

Life-cycle optimization of industrial energy efficiency by a distributed control and decision-making automation platform

Project overview

European manufacturing industry today

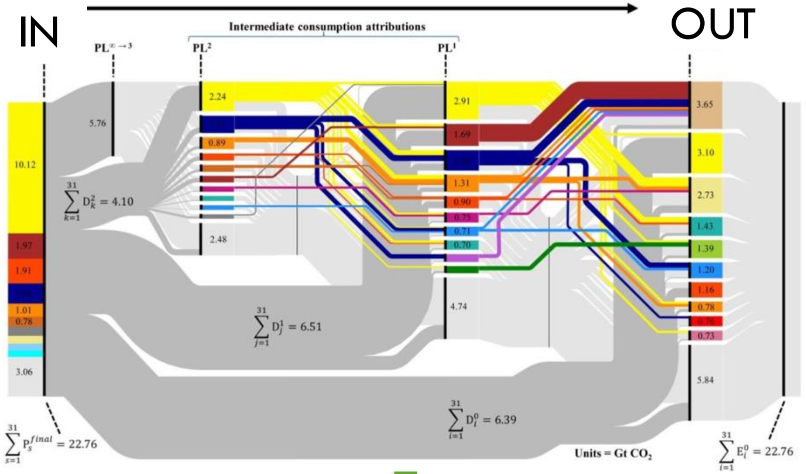
material

energy

...

water

IN

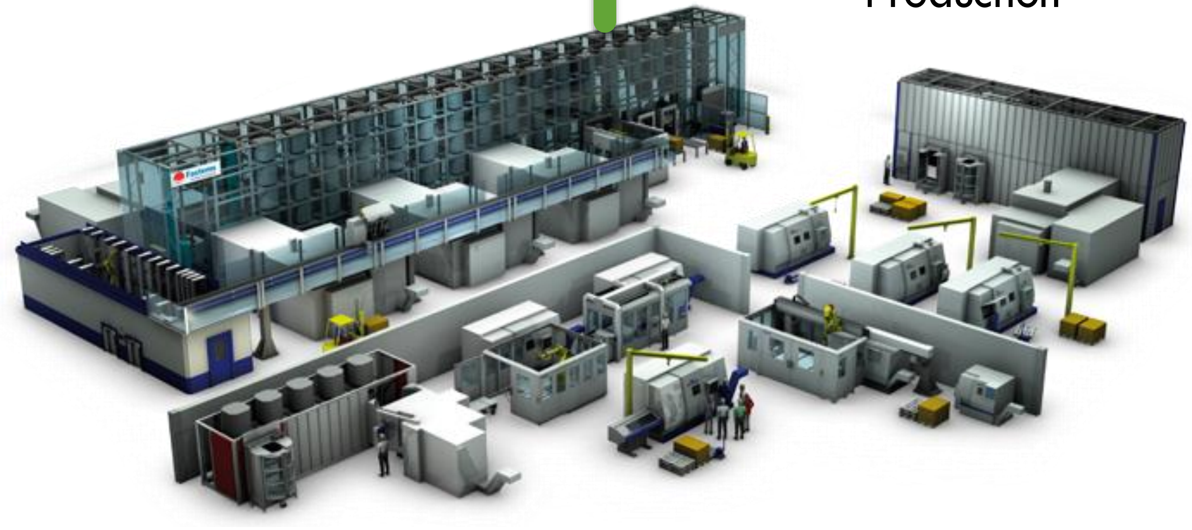


OUT

Energy and LC management

time

Production



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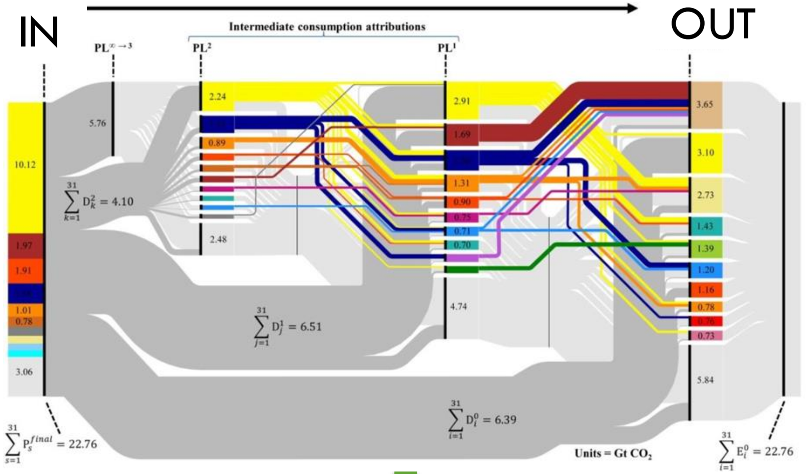


Energy and LC management

time

Production

energy (efficiency) and Life Cycle-related aspect management

➔ (eventually) understanding how (well/bad) the production performed **afterwards**

➔ non **homogeneous/incomplete** information granularity

➔ Impossibility to **transform information into** respective **actuation** level

European manufacturing industry need (2)

material

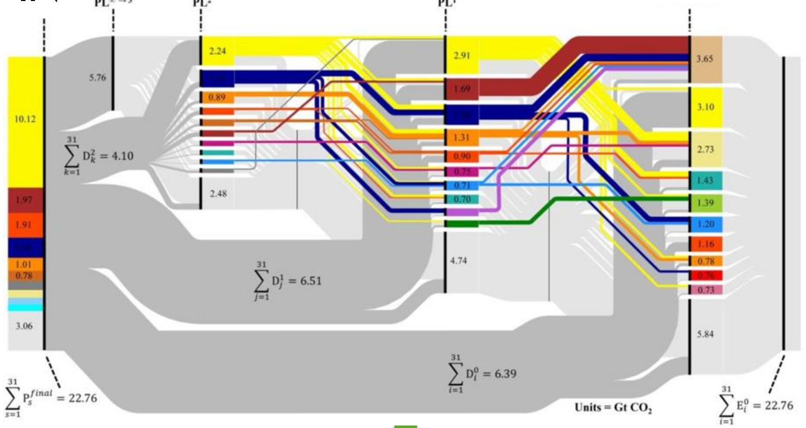
energy

…

water

IN

OUT



Energy and LC management

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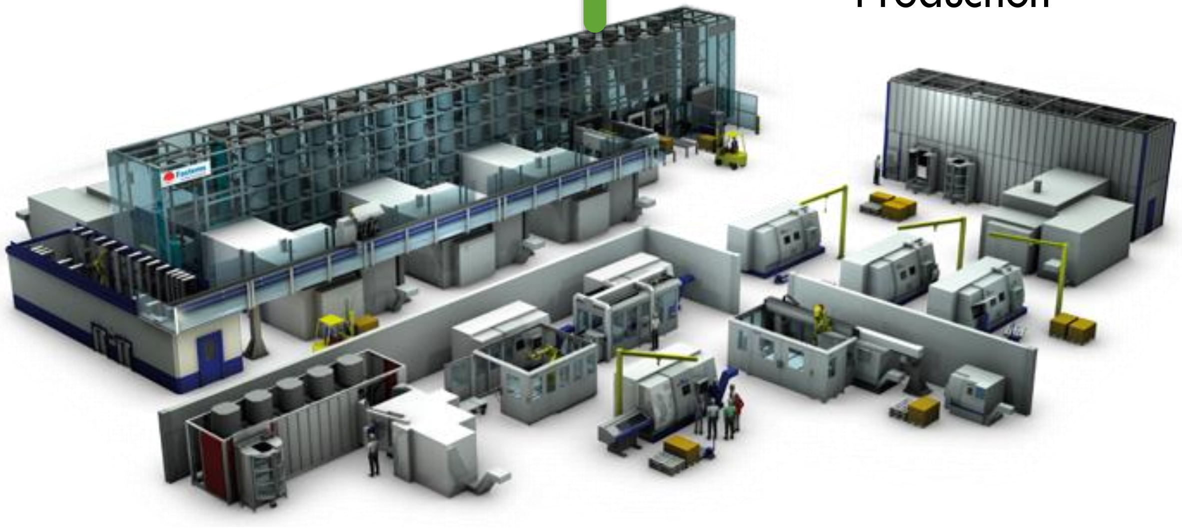

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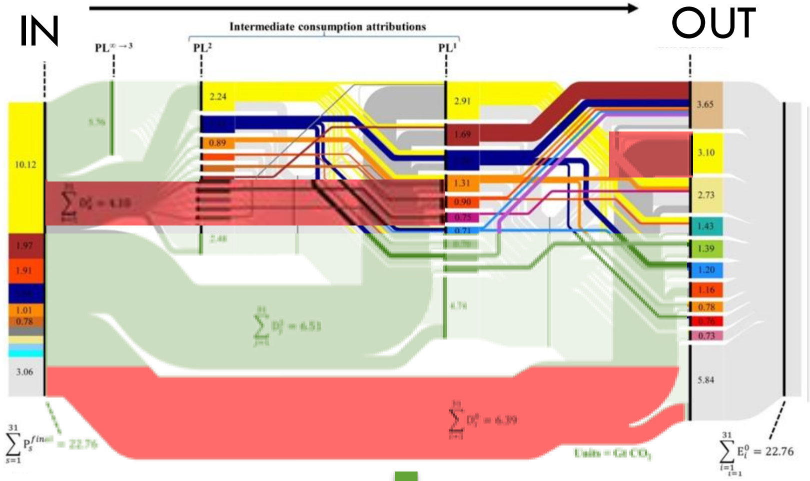


Anticipating: from "after" to "in between"

What does it imply?

- **Completing and characterising**: full production-, Material-, Energy-, Life-cycle-related information flow
- **Synchronizing**: in time information

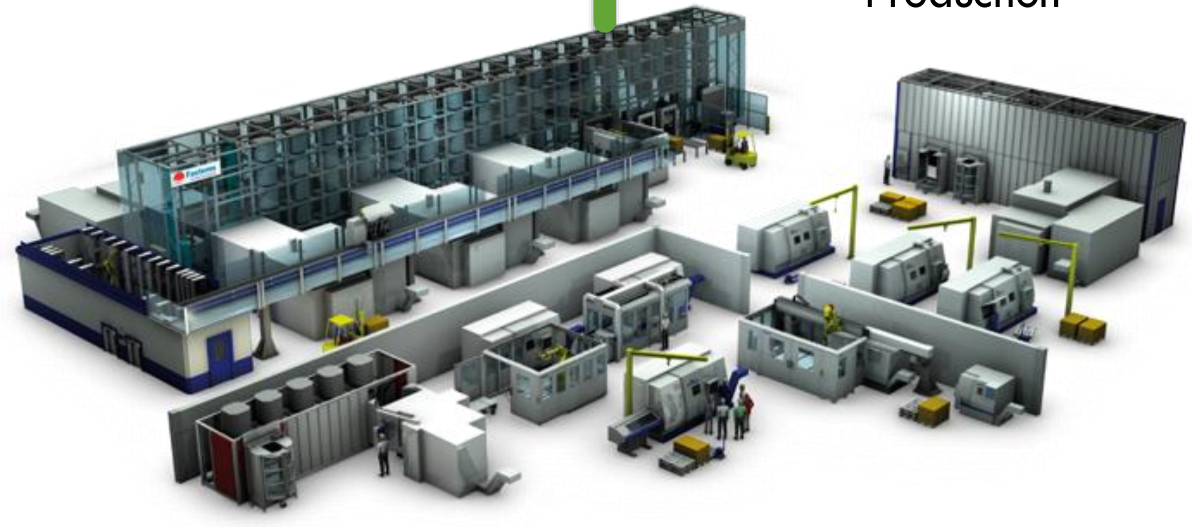
What does it offer?

- **Decision making**: "how can I <u>energy efficiently/ sustainably</u> steer production"

Energy and LC management

time

Production



European manufacturing industry need: the strategy

material

energy

…

water

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Energy and LC management

time

Production

Overall High-level Project Objective

A novel approach toward a
new integrated production paradigm
based on
energy efficiency and sustainable management.

Overall High-level Project Objective…

E2COMATION intends to address the **optimization of energy usage, at multiple hierarchical layers of a manufacturing process** as well as **considering the whole life-cycle perspective across the value chain**.

To this purpose, E2COMATION aims at providing a cross-sectorial methodological framework and a modular technological platform **to monitor, predict, evaluate impact of the behavior of a factory across energy and the life-cycle assessment dimensions**, **in order to adapt and optimize dynamically**

- not only its **real-time behavior** over different time-scales, but also
- its **strategic and sustainable** positioning with respect to the complex **supply and value chain** it belongs to.

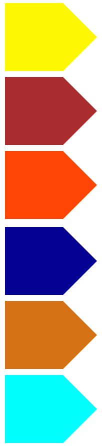
How to achieve E2COMATION factory transformation

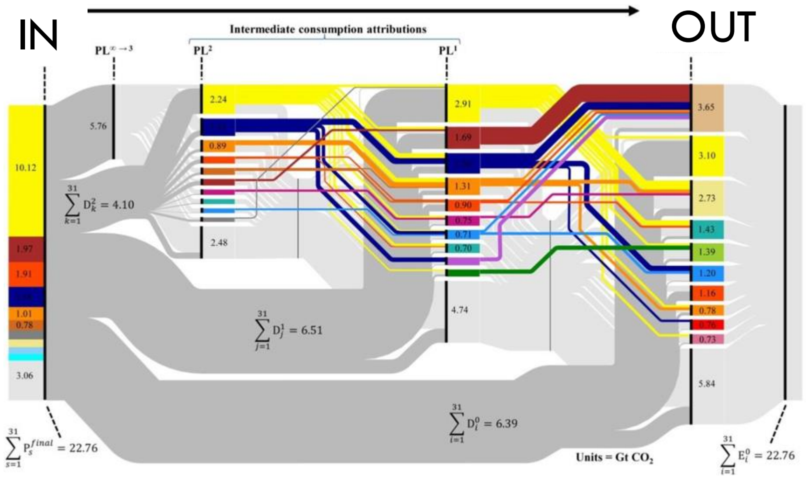
material

energy

…

water





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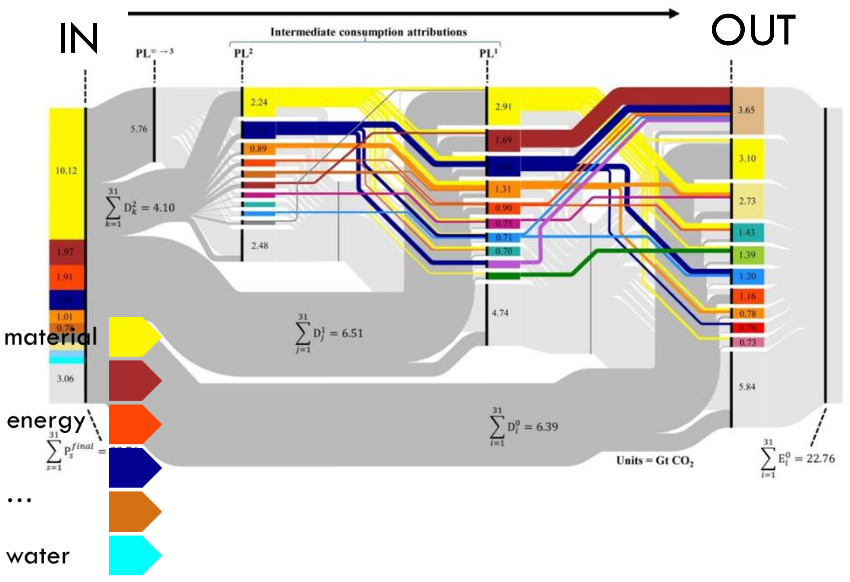

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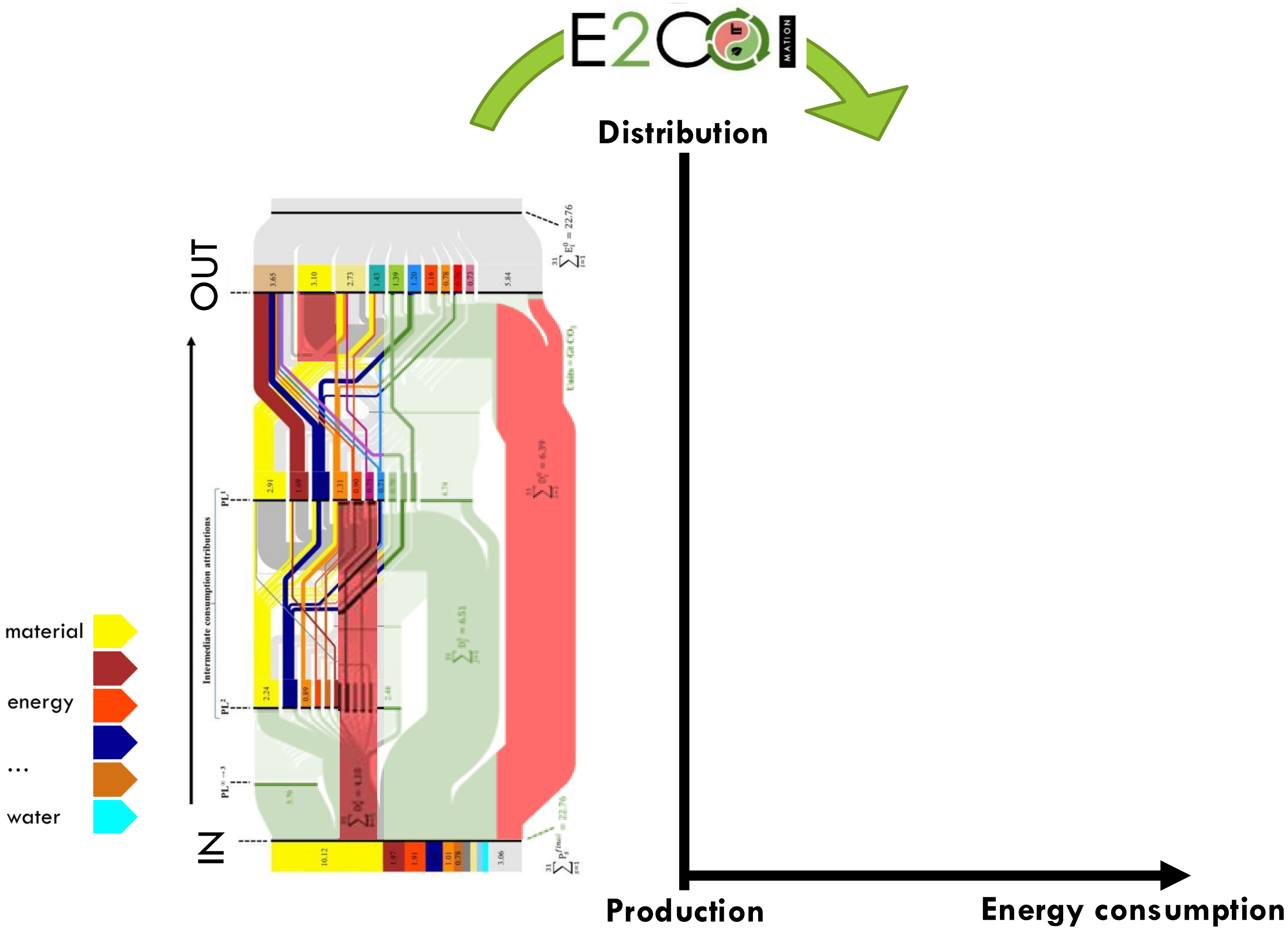

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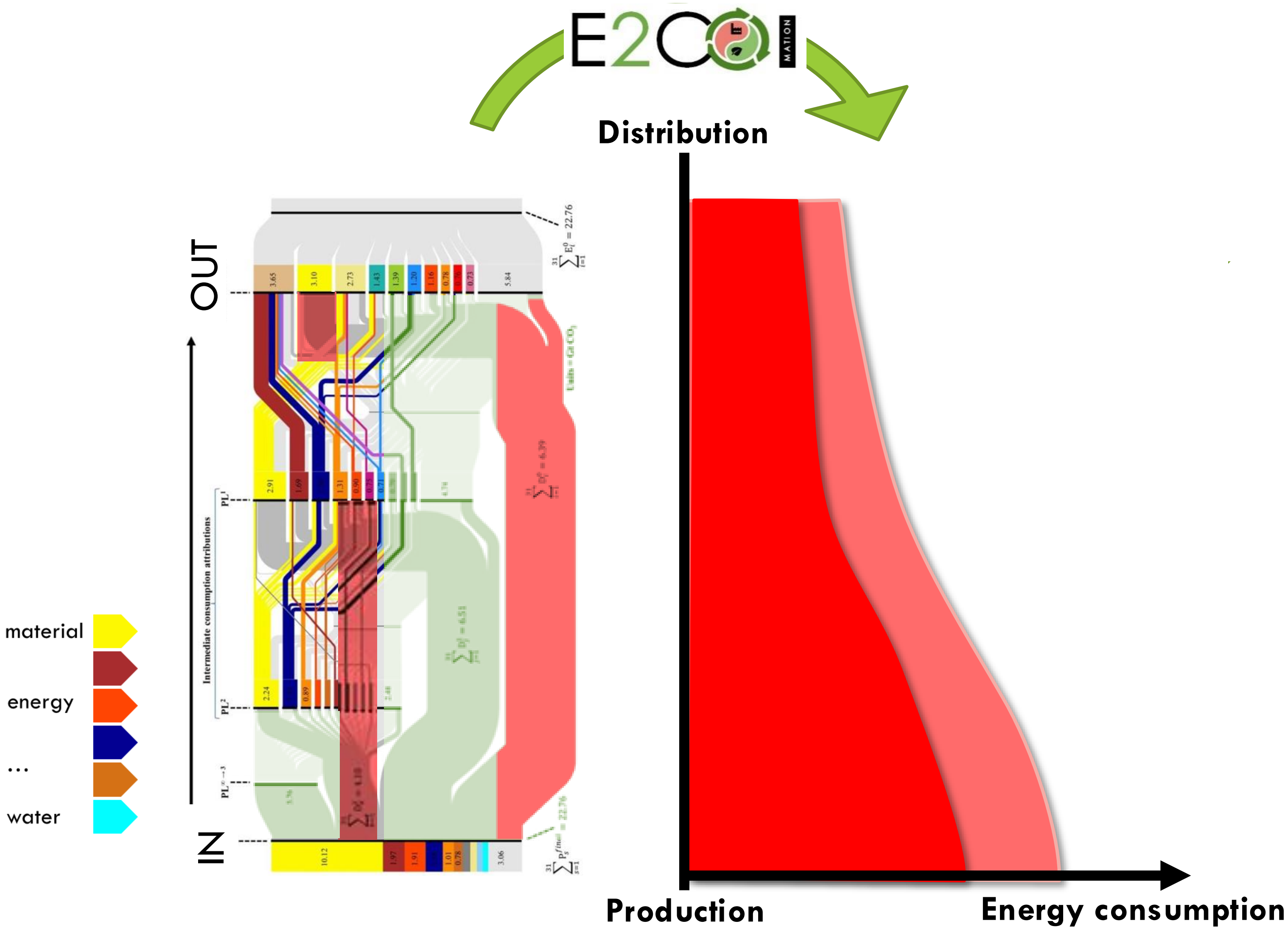

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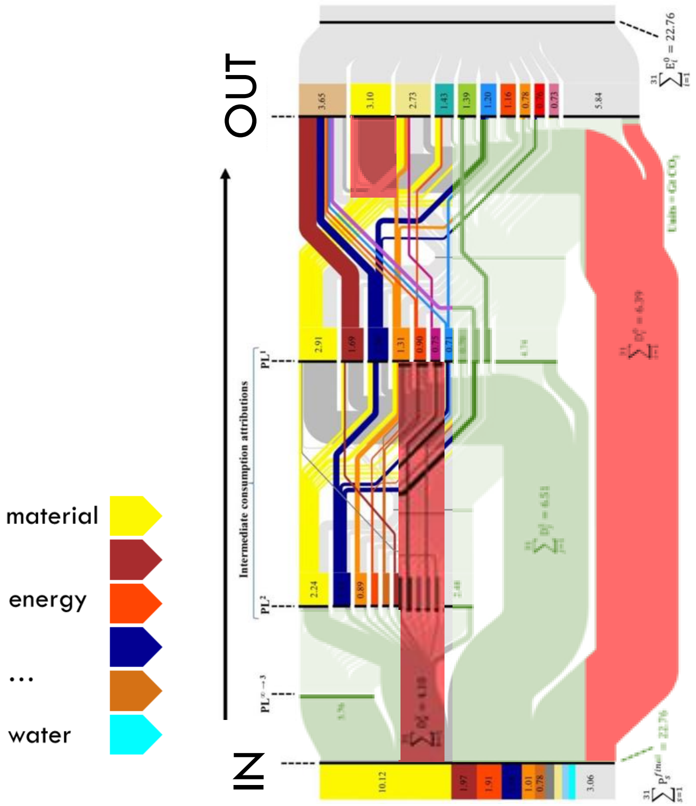

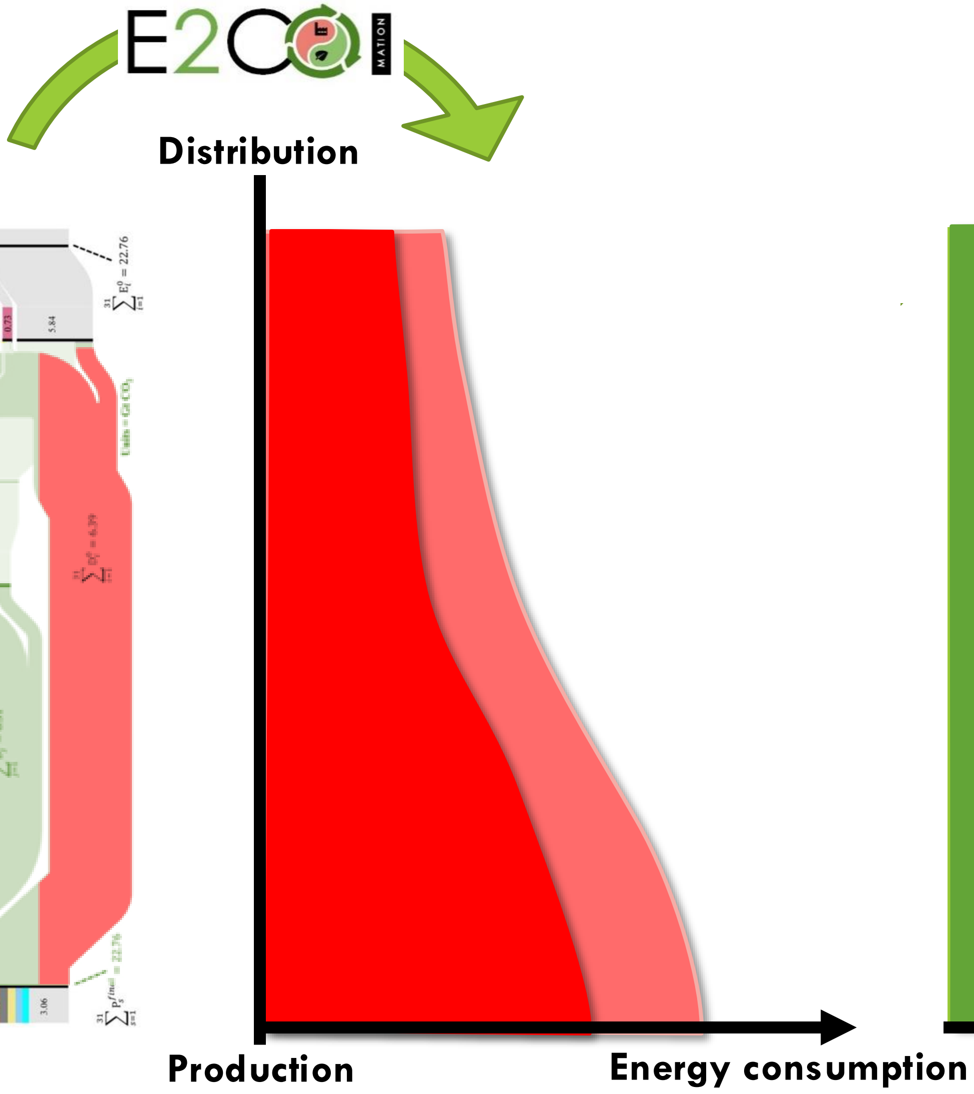

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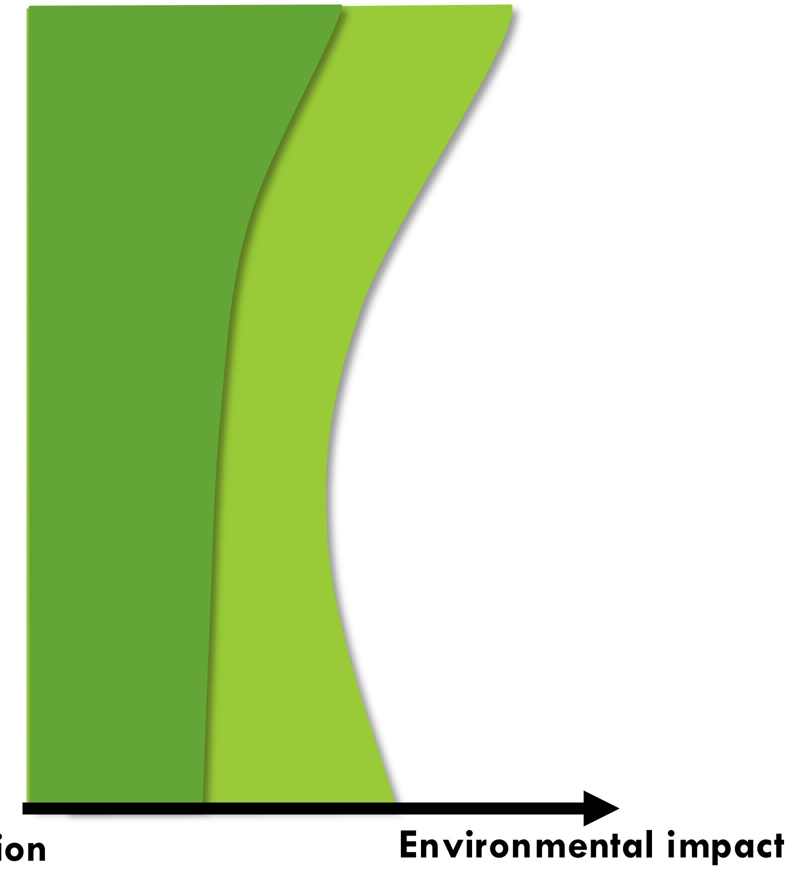

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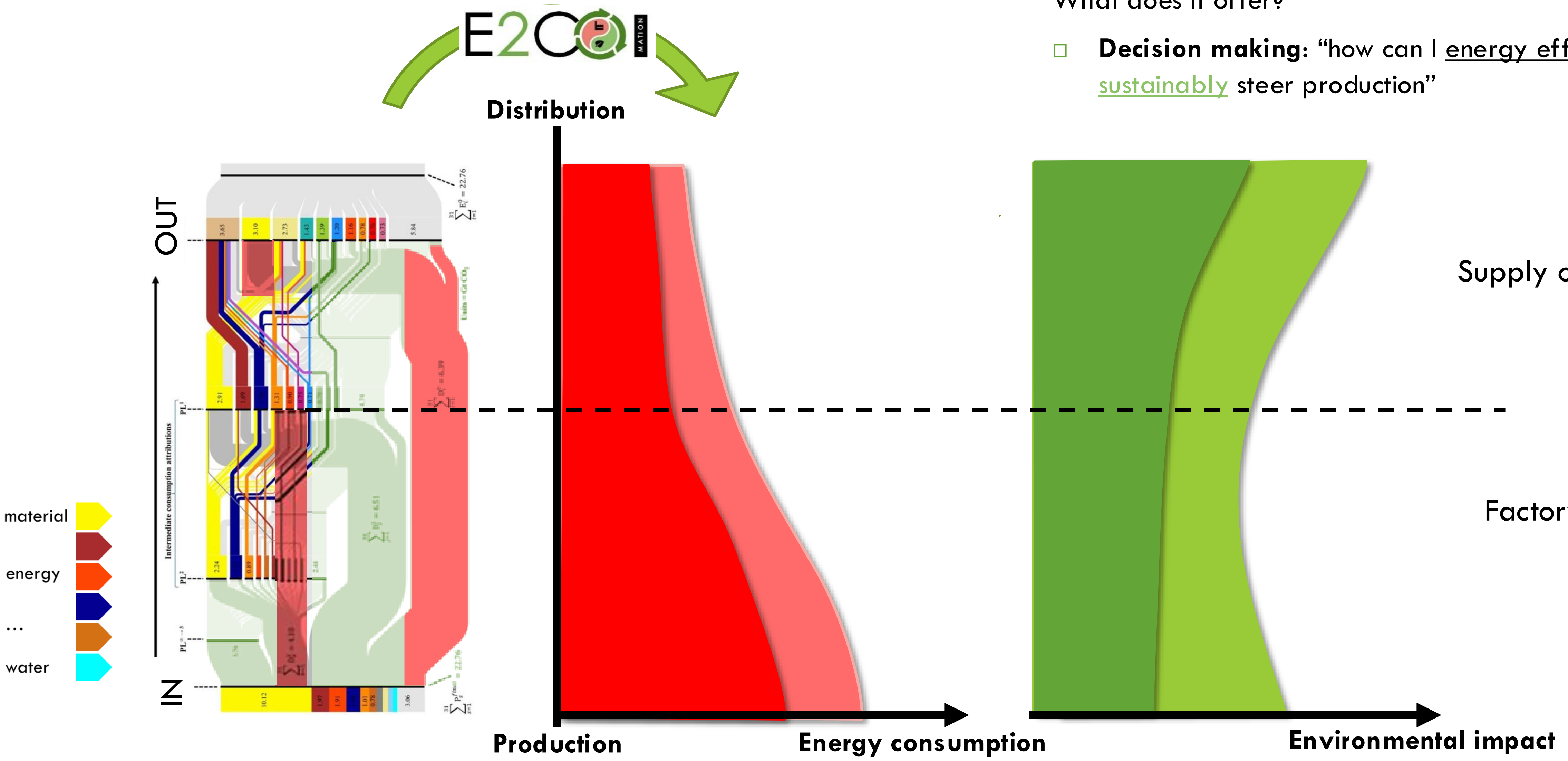
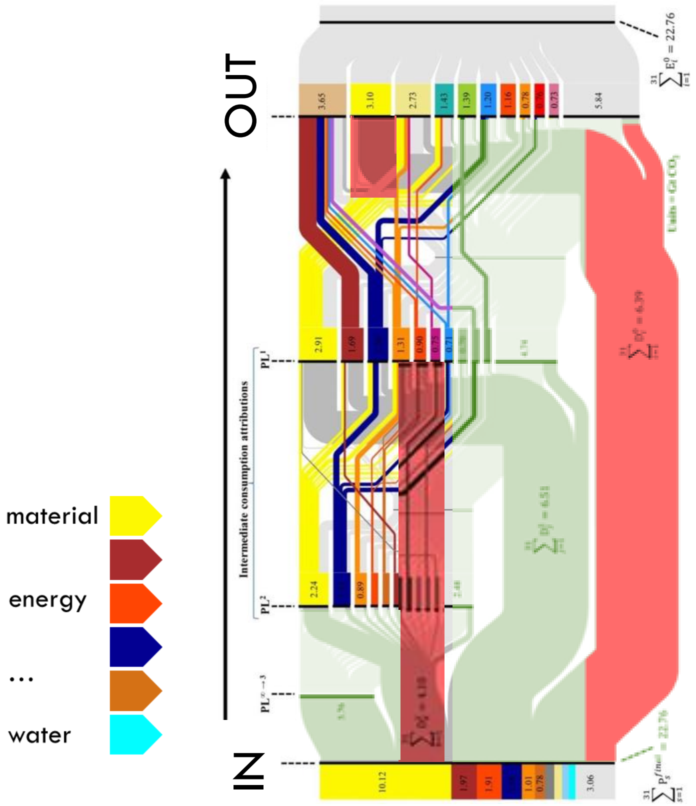
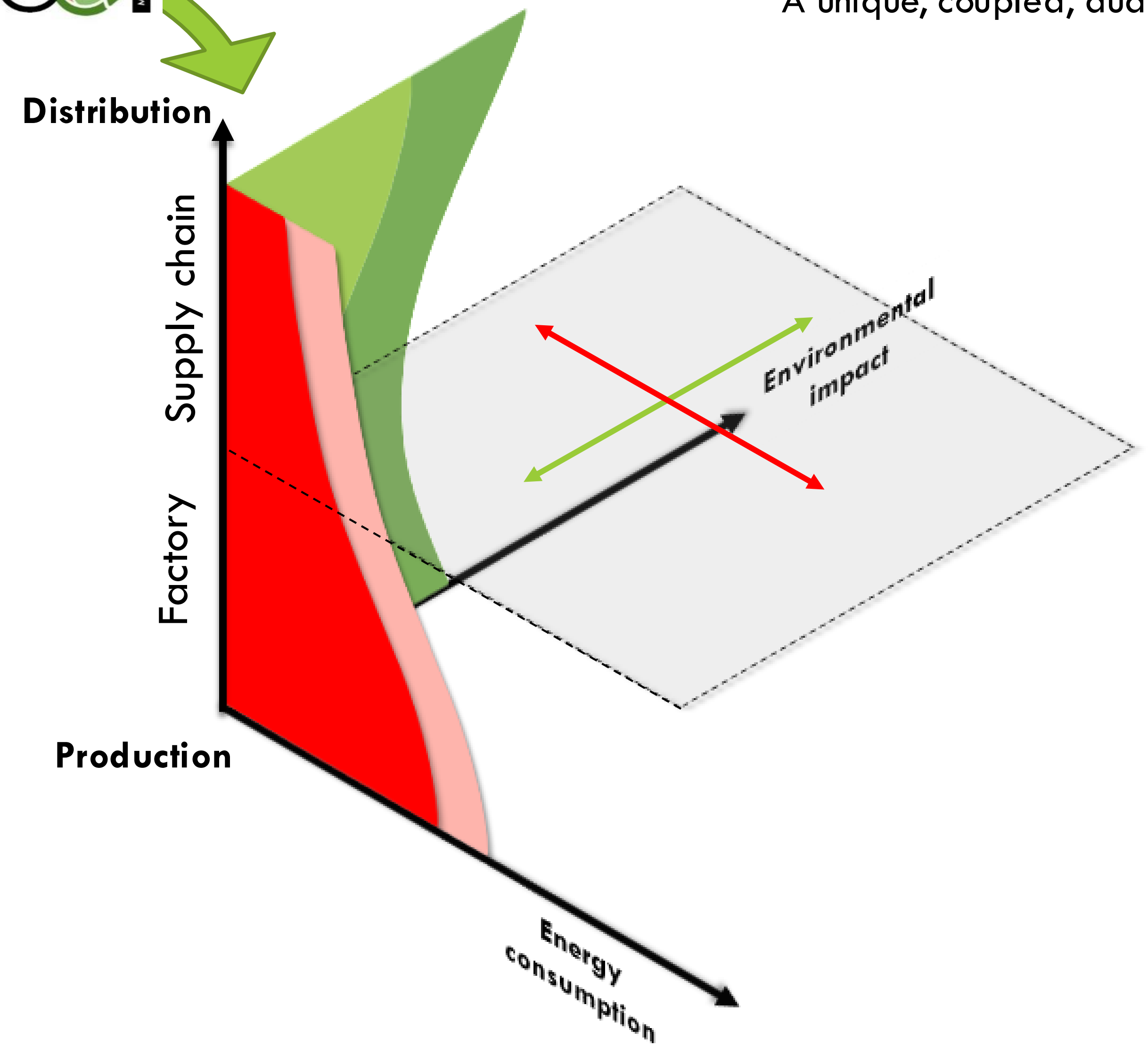


How to achieve E2COMATION factory transformation

Energy efficiency and Sustainable Management

A unique, coupled, dual problem..





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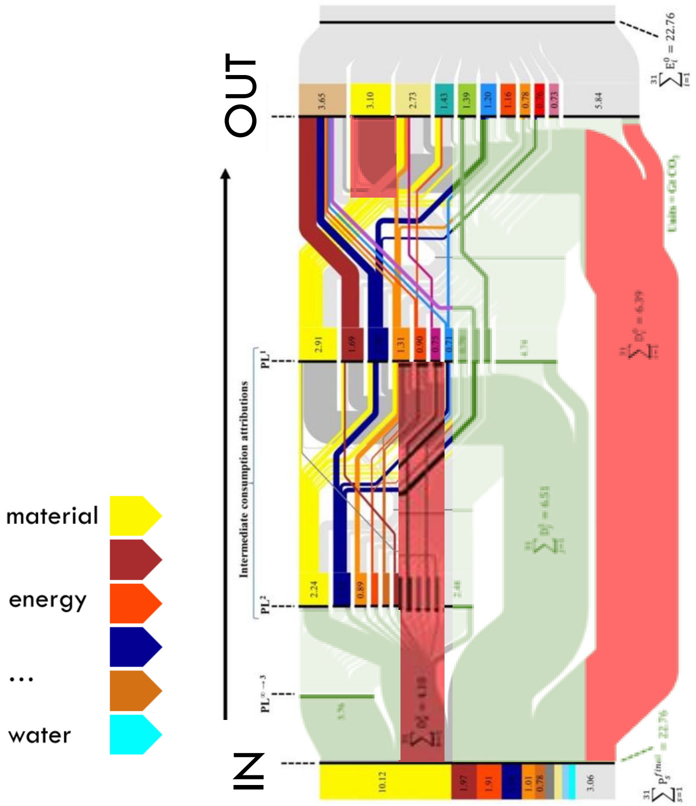
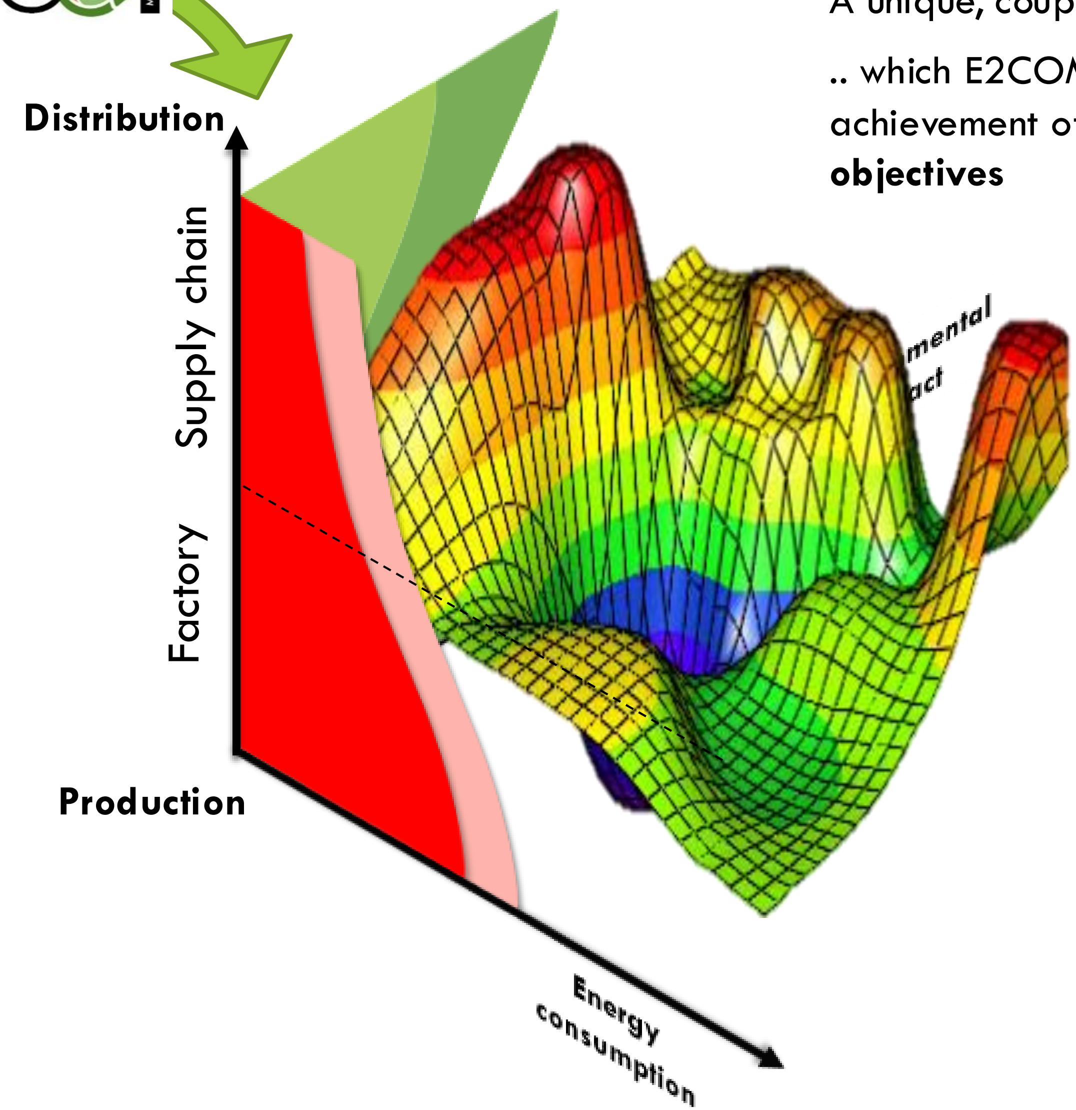




Energy efficiency and Sustainable Management

A unique, coupled, dual problem..

.. which E2COMATION will challenge **through** the achievement of dedicated **project pillars and specific objectives**

E2COMATION Reference framework

WP3/4

Distributed Stream Computing & Analytics

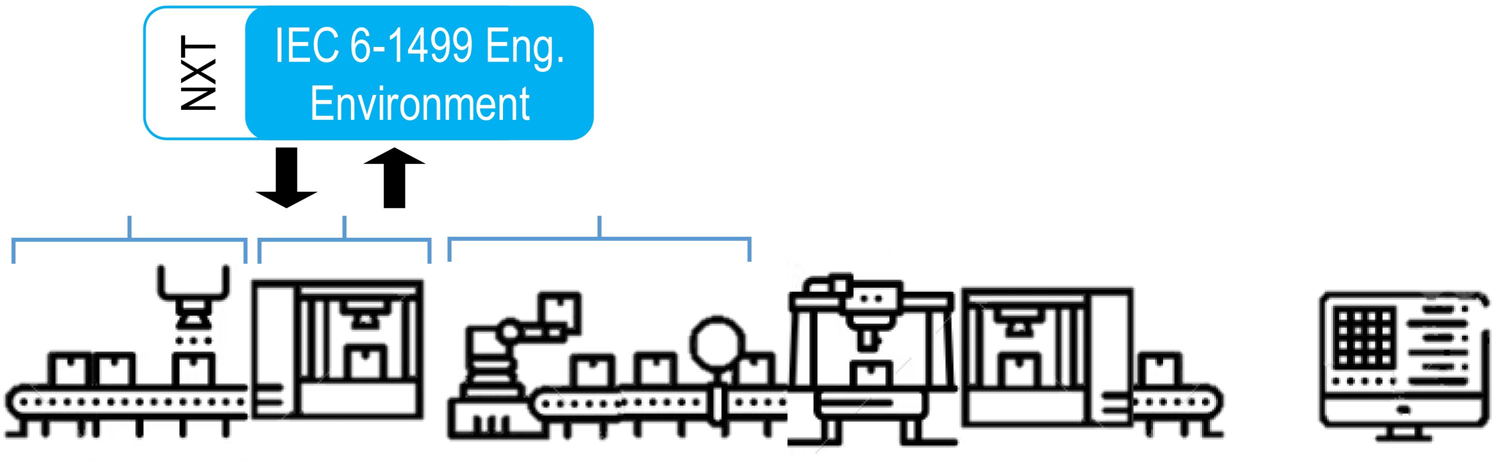
WP3/4

Energy & Production Data Gathering & Control

IEC 6-1499 Modular and reconfigurable distributed monitoring, automation and control.

A **scalable automation solution** to seamlessly move across the automation pyramid from machine, to cell, to line, till plant level.

- **Gathering data from all greenfield sensors and sending them to EMon (as unique collector)**
- **Providing the control action**



Production line

Factory Information Sys

SIGMATOOLS

WP3/4

Distributed Stream Computing & Analytics

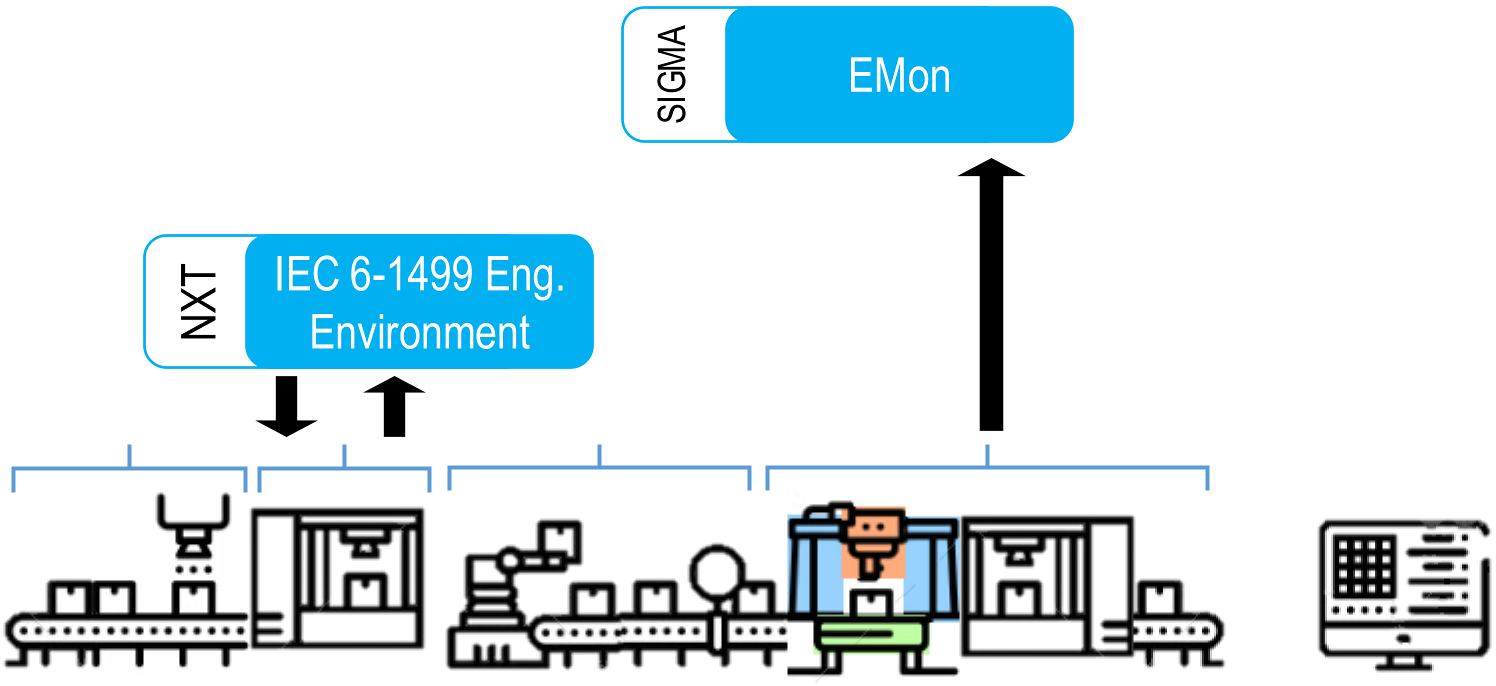
WP3/4

Energy & Production Data Gathering & Control

EMon – Energy Monitoring

A comprehensive and holistic strategy to **energy monitoring** which is based on **multichannel measurement methodology**

- **Fingerprint** measurement
- **Component** analysis / monitoring
- **KPI / EnPI**

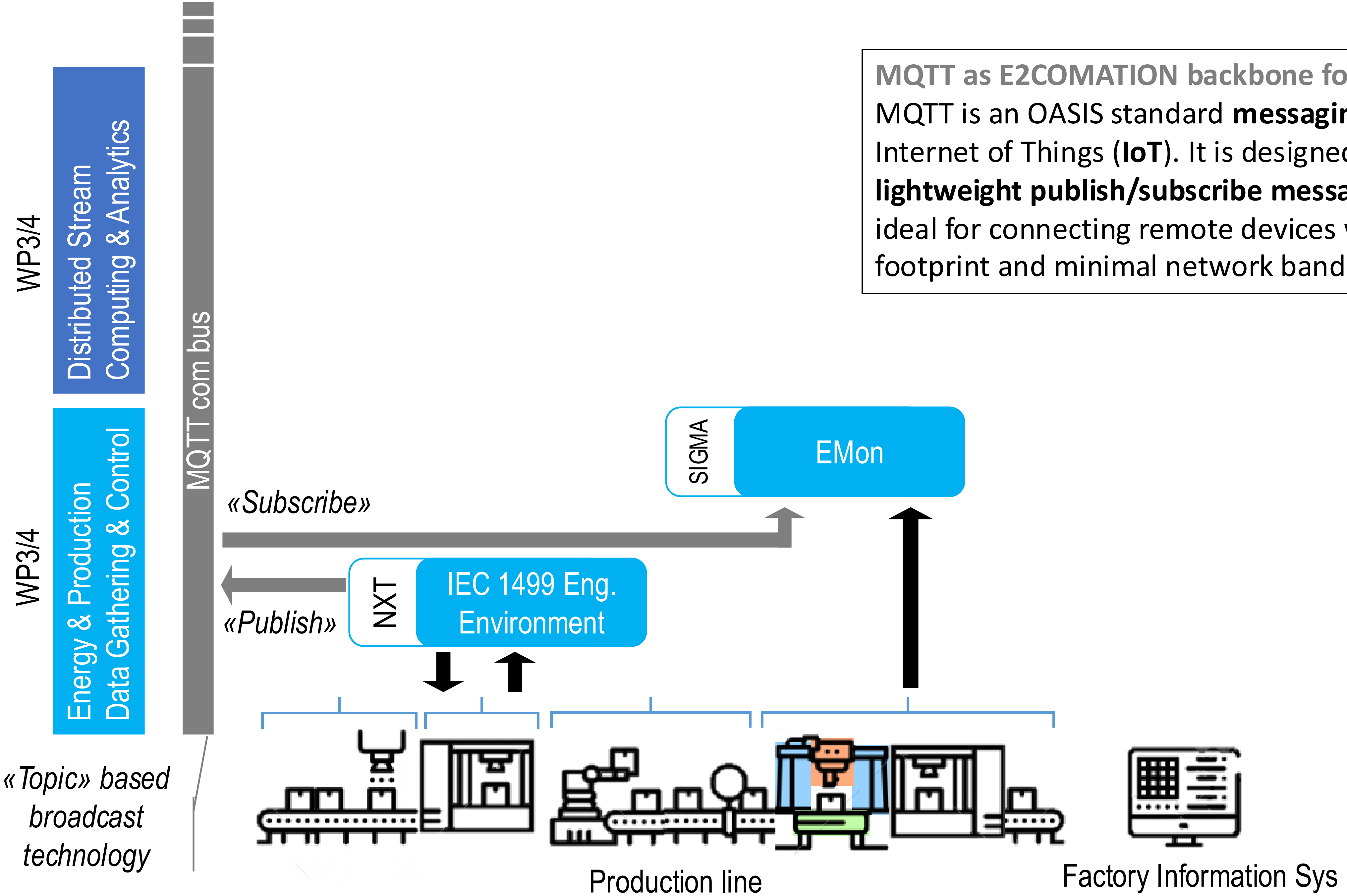


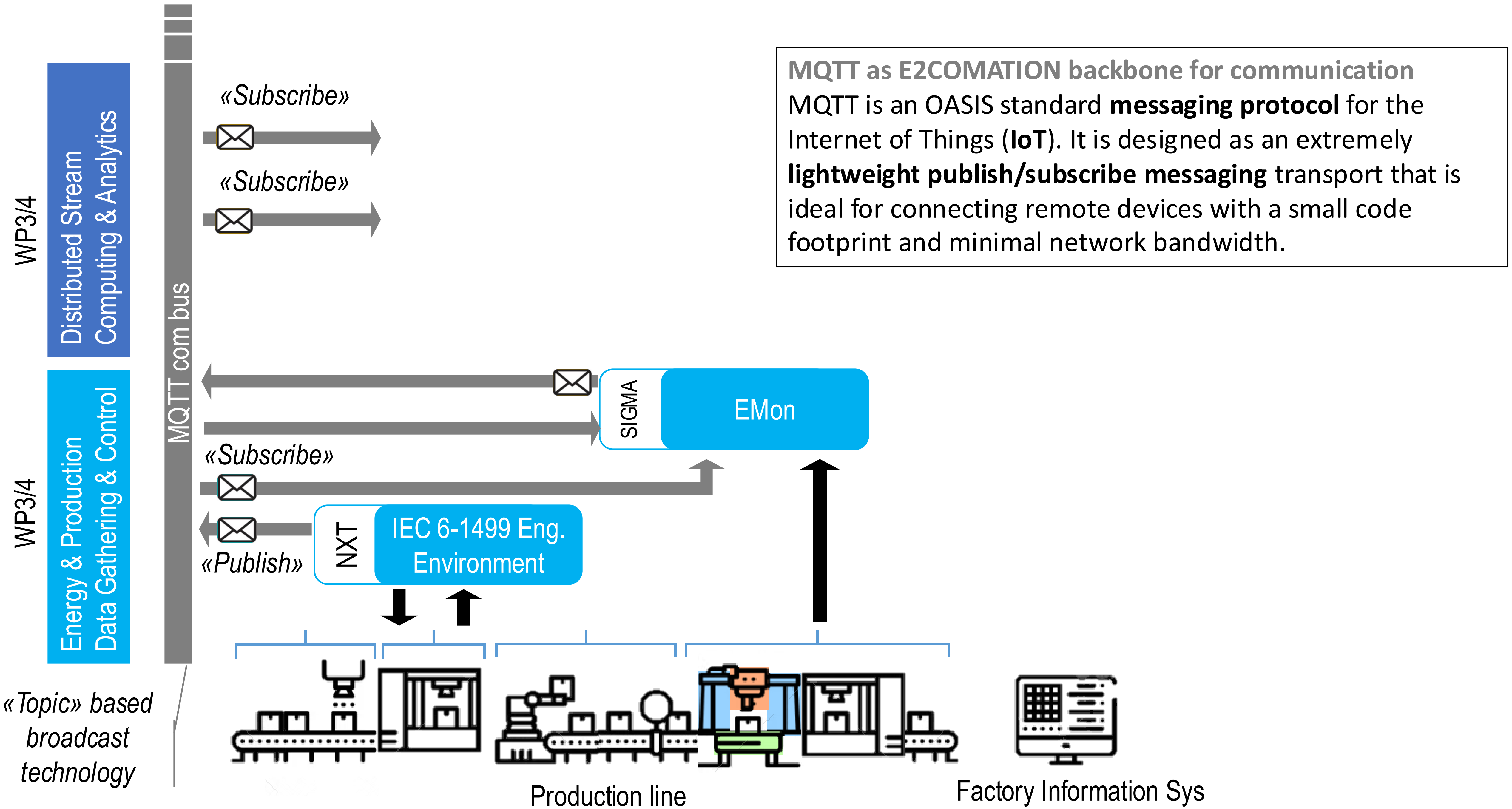
Production line

Factory Information Sys

MQTT as E2COMATION backbone for communication

MQTT is an OASIS standard **messaging protocol** for the Internet of Things (**IoT**). It is designed as an extremely **lightweight publish/subscribe messaging** transport that is ideal for connecting remote devices with a small code footprint and minimal network bandwidth.

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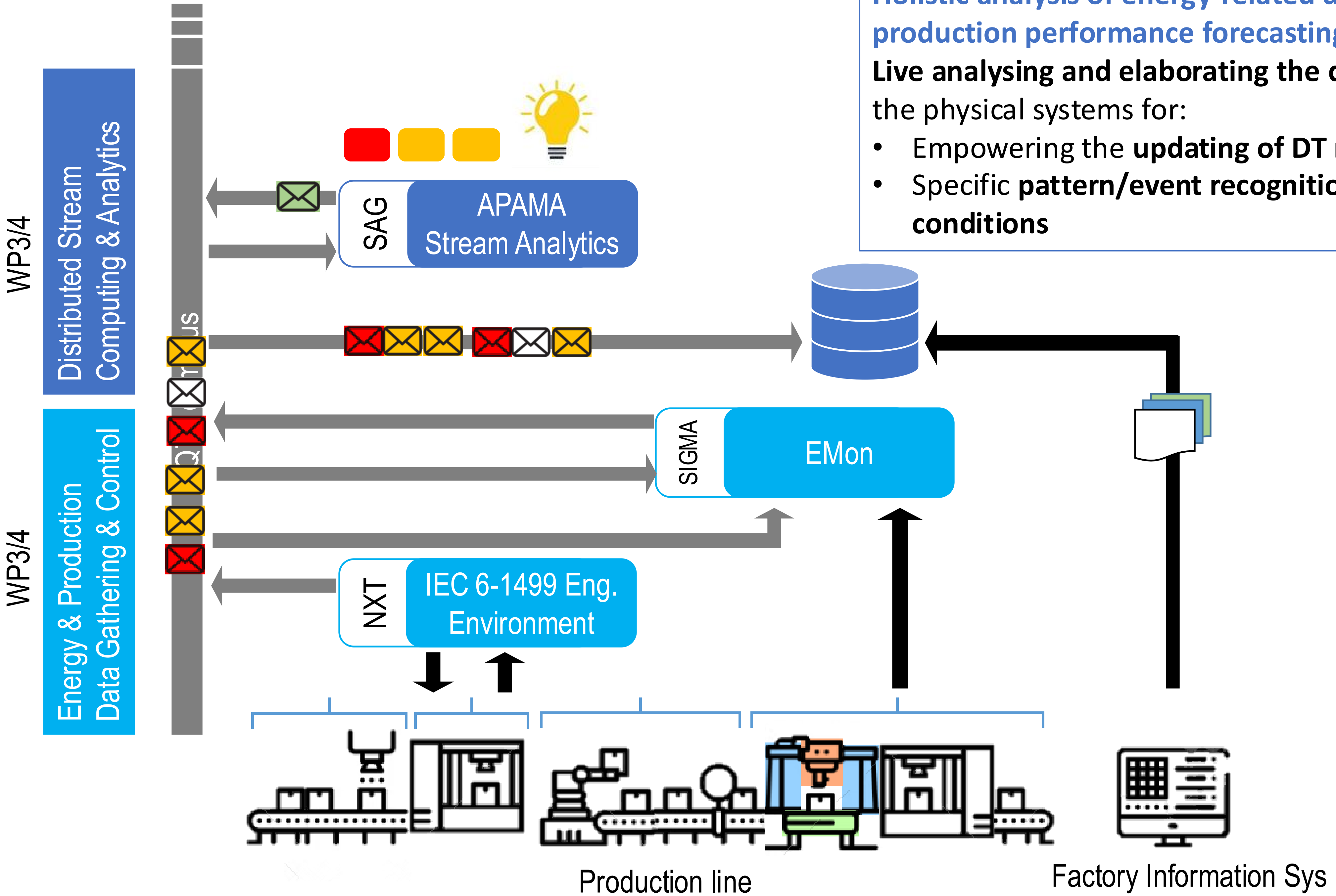
WP3/4
Distributed Stream Computing & Analytics
WP3/4
Energy & Production Data Gathering & Control
MQTT com bus
«Subscribe»
«Subscribe»
«Subscribe»
«Publish»
SIGMA
EMon
NXT
IEC 6-1499 Eng. Environment
«Topic» based broadcast technology
Production line
Factory Information Sys

Holistic analysis of energy-related data streams for production performance forecasting

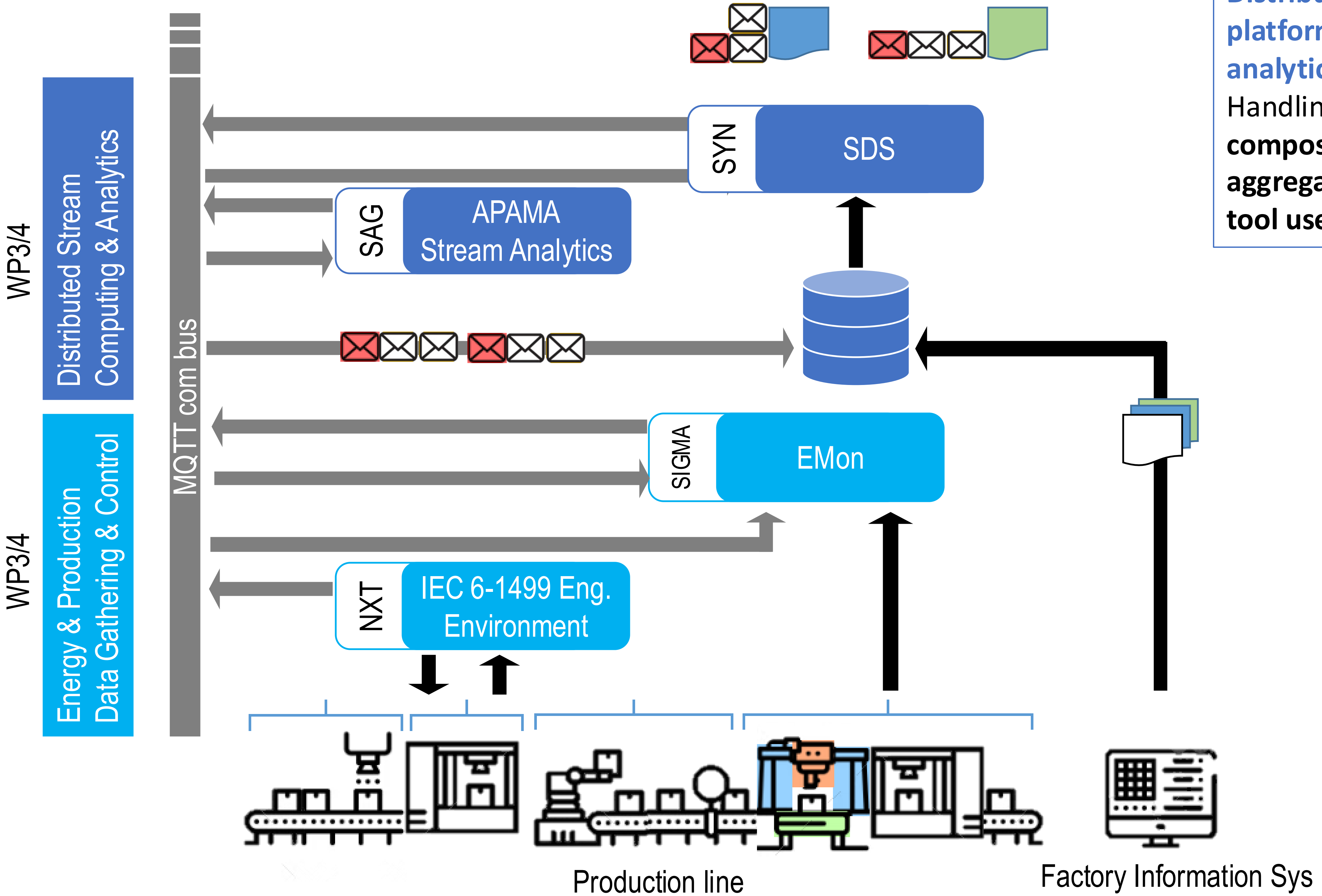
Live analysing and elaborating the data flows coming from the physical systems for:

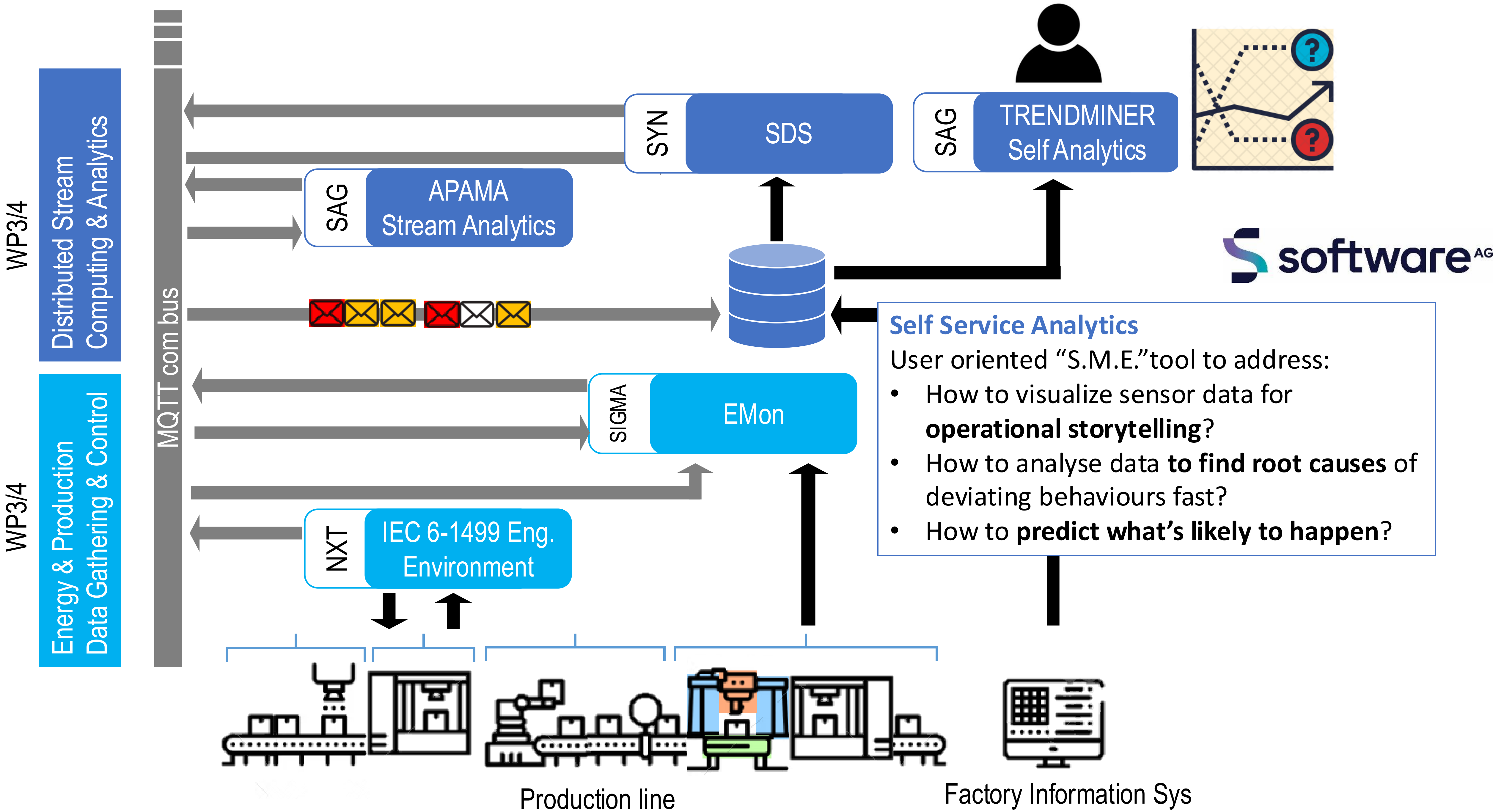
- Empowering the **updating of DT model**
- Specific **pattern/event recognition to detect triggering conditions**



Distributed Stream Computing platform for life-cycle data analytics

Handling, **complementing, composing and offering aggregated views for high level tool use**.



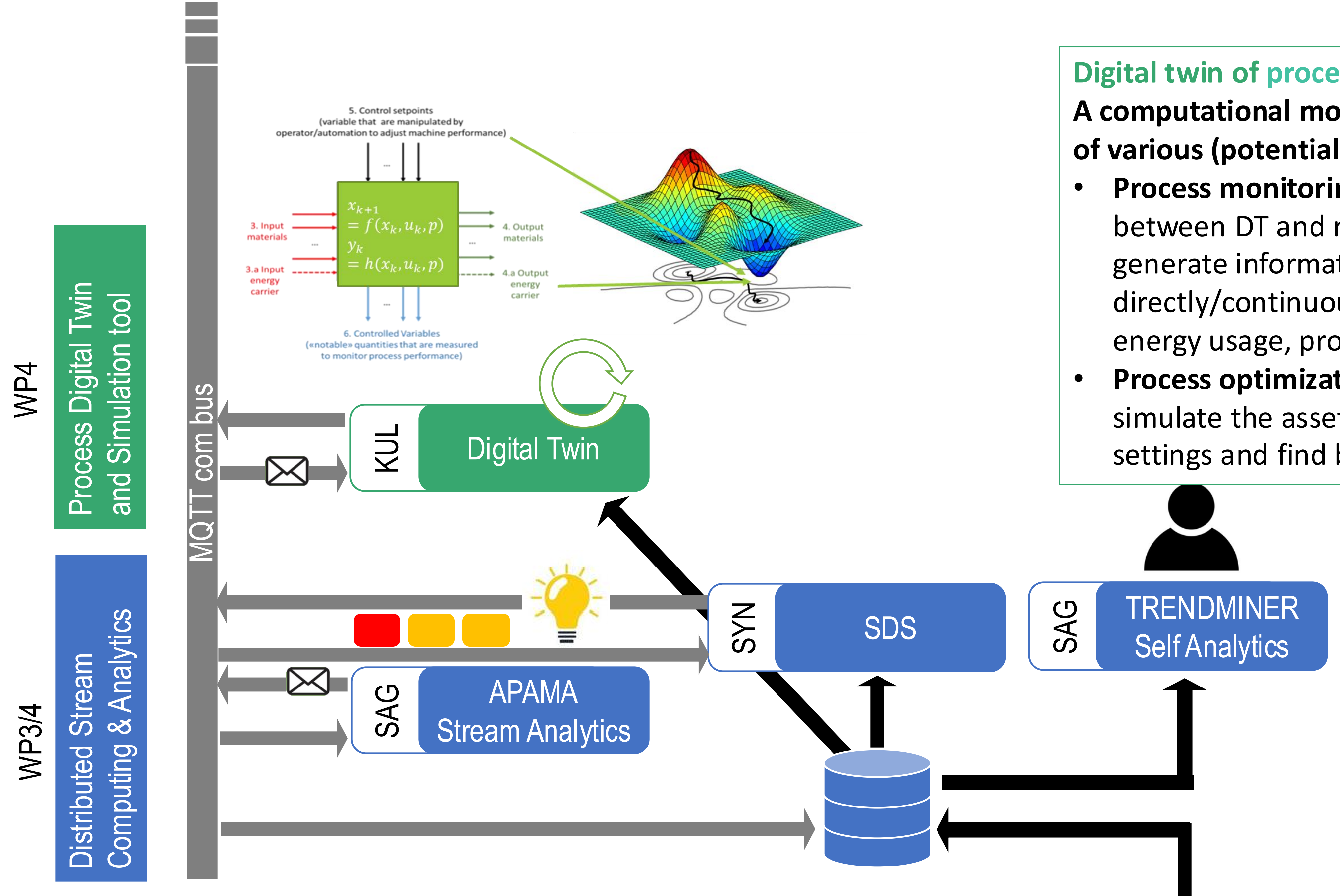

WP3/4
Distributed Stream Computing & Analytics
WP3/4
Energy & Production Data Gathering & Control
MQTT com bus
SYN
SDS
SAG
TRENDMINER Self Analytics
SAG
APAMA Stream Analytics
software AG
SIGMA
EMon
NXT
IEC 6-1499 Eng. Environment
Self Service Analytics
User oriented "S.M.E."tool to address:
• How to visualize sensor data for **operational storytelling**?
• How to analyse data **to find root causes** of deviating behaviours fast?
• How to **predict what's likely to happen**?
Production line
Factory Information Sys

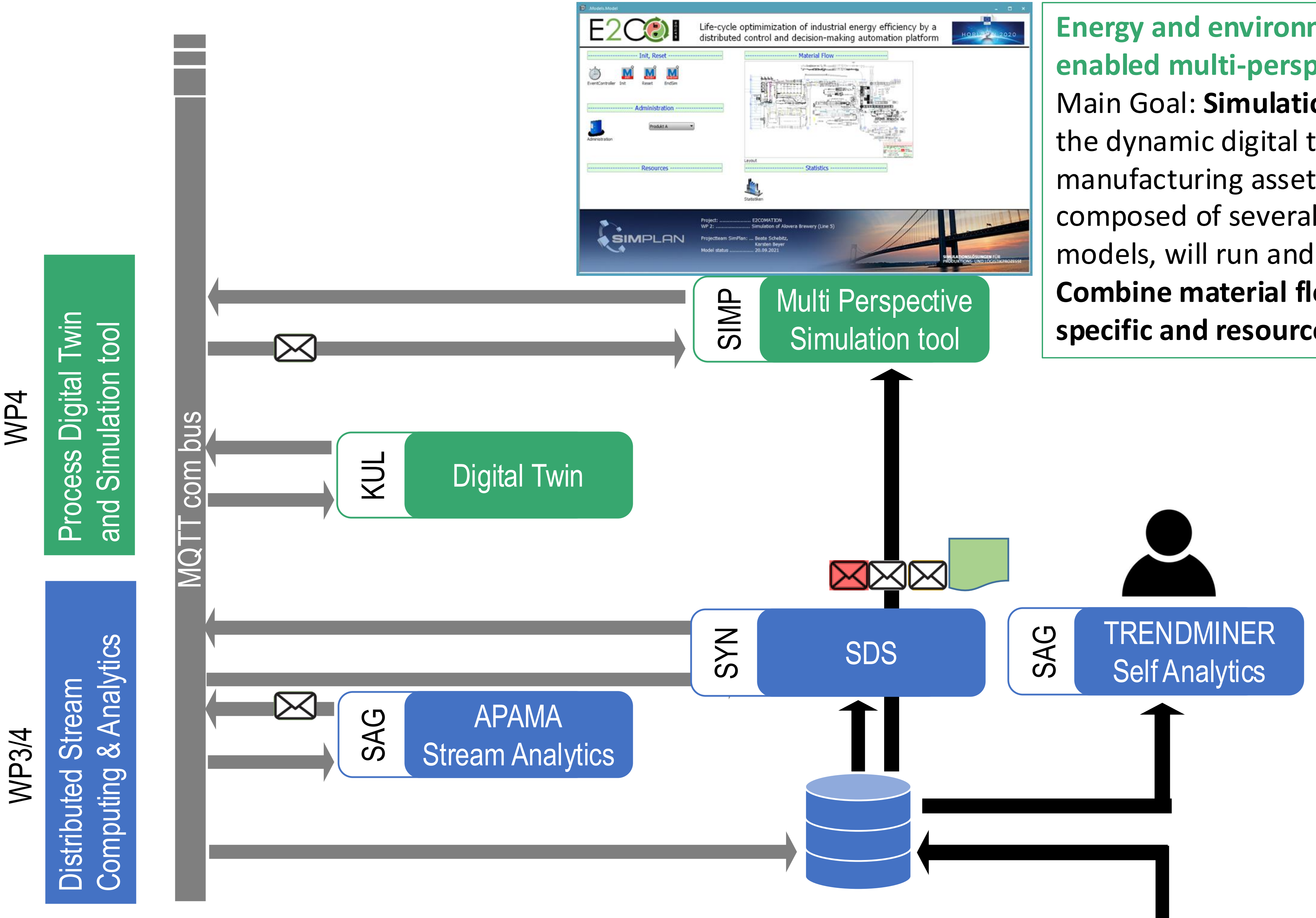
KU LEUVEN

Digital twin of process factory asset

A computational model to assess the effect of various (potential) changes in the process:

- **Process monitoring**: detect deviations between DT and real process, and generate information that's not directly/continuously measurable e.g. total energy usage, product quality,…
- **Process optimization** – Using DT model to simulate the asset for different operational settings and find best control setpoints

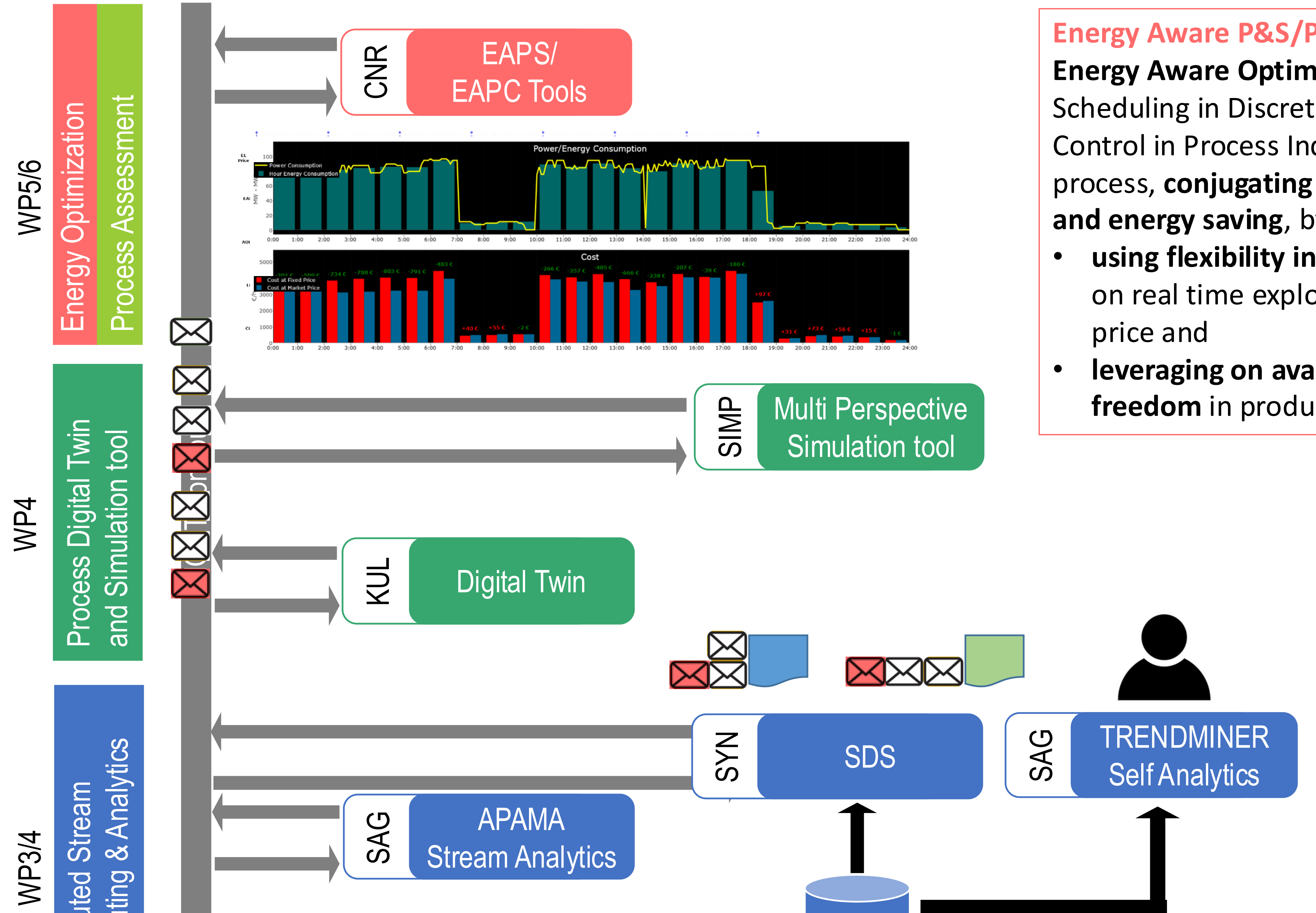




Energy and environmental performance-enabled multi-perspective simulation

Main Goal: **Simulation framework** in which the dynamic digital twins of the manufacturing assets of the factory, composed of several independent behavioral models, will run and interact.

Combine material flow analysis with energy specific and resource specific flows

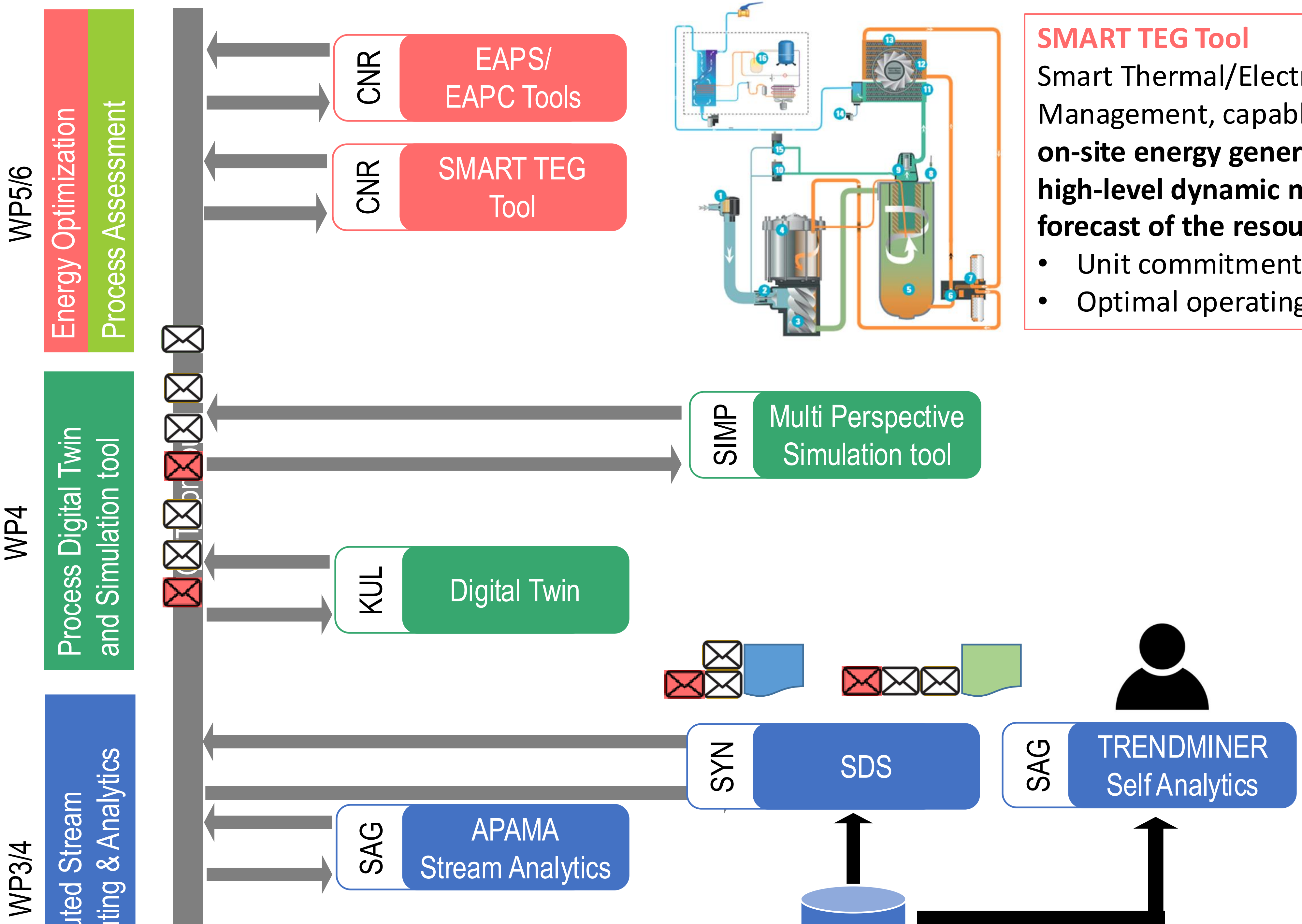


Energy Aware P&S/Process Control

Energy Aware Optimization (Planning & Scheduling in Discrete manufacturing/Process Control in Process Industry) of production process, **conjugating production efficiency and energy saving**, by:

- **using flexibility in energy contracts** based on real time exploitation of energy hourly price and
- **leveraging on available degrees of freedom** in production process

STIIMA
Sistemi e Tecnologie Industriali Intelligenti per il Manifatturiero Avanzato



SMART TEG Tool

Smart Thermal/Electric Energy Grid Management, capable of **optimally controlling on-site energy generation units based on high-level dynamic models and forecast of the resource demand (from EAPO)**:

- Unit commitment of generators
- Optimal operating point (set-point)

STIIMA
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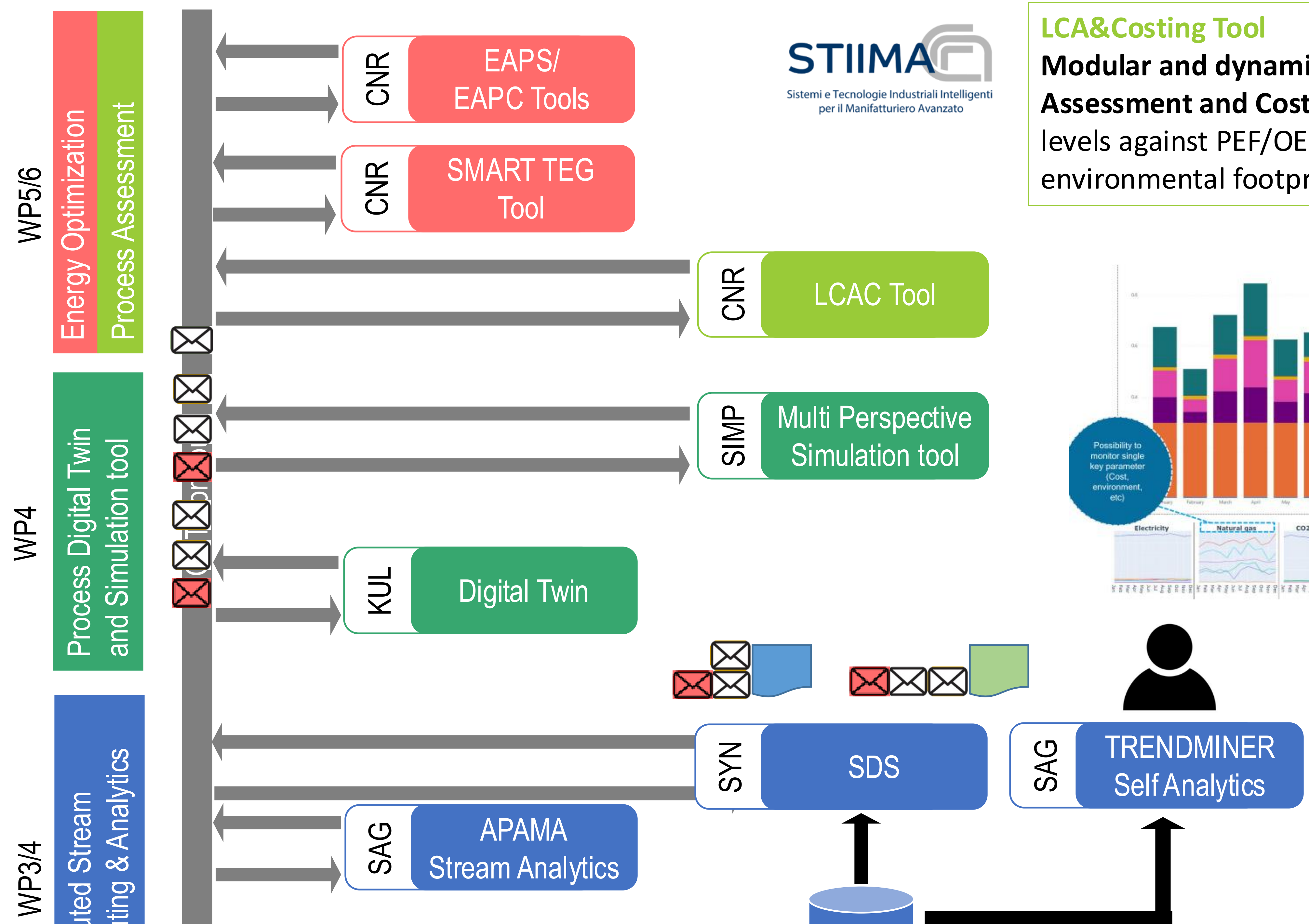
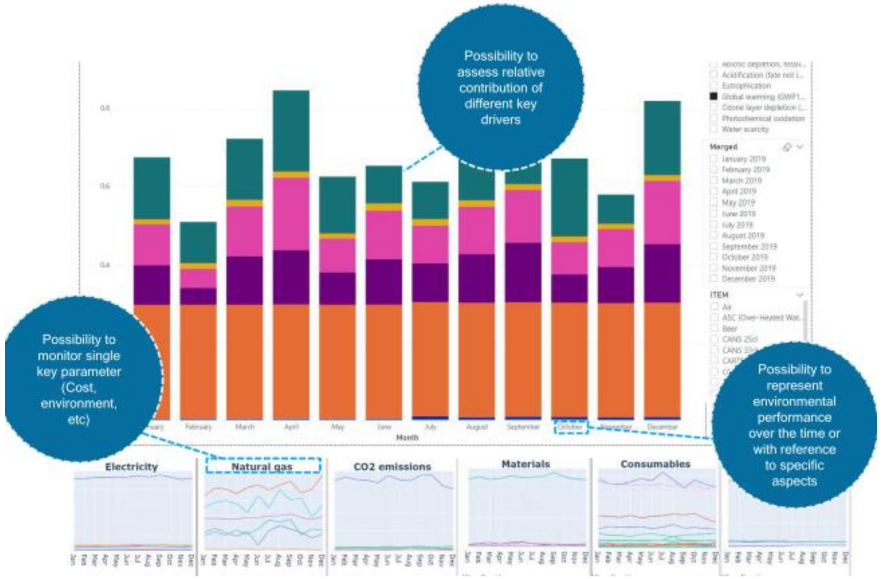
LCA&Costing Tool

Modular and dynamic tool to assess Life Cycle Assessment and Costing at factory/value chain levels against PEF/OEF, and also to predict environmental footprint

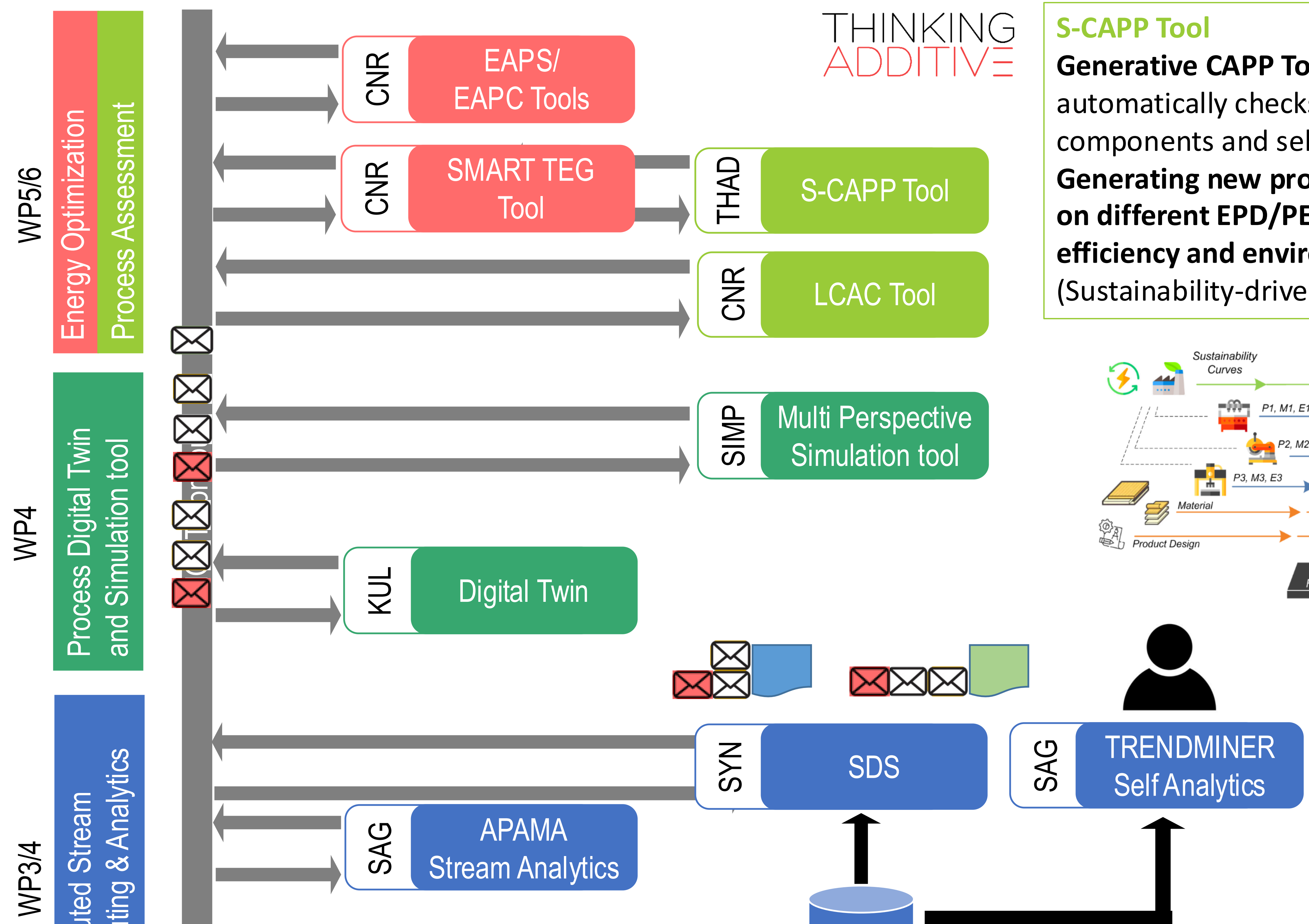


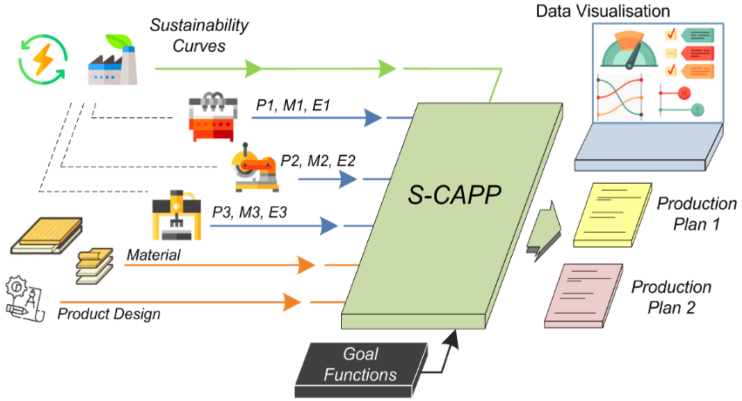


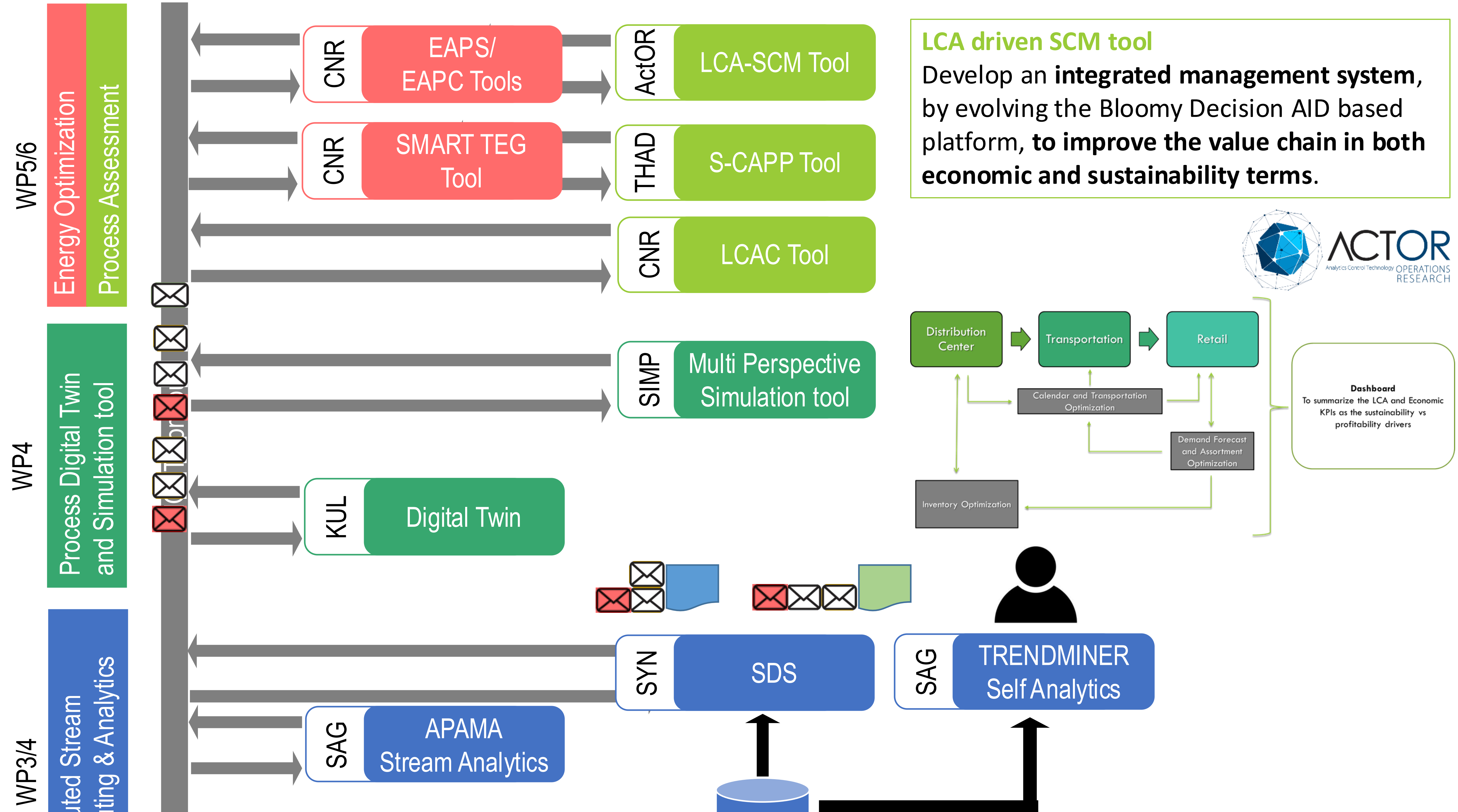
S-CAPP Tool

Generative CAPP Tool where the system automatically checks for requirements of components and selects the right processes

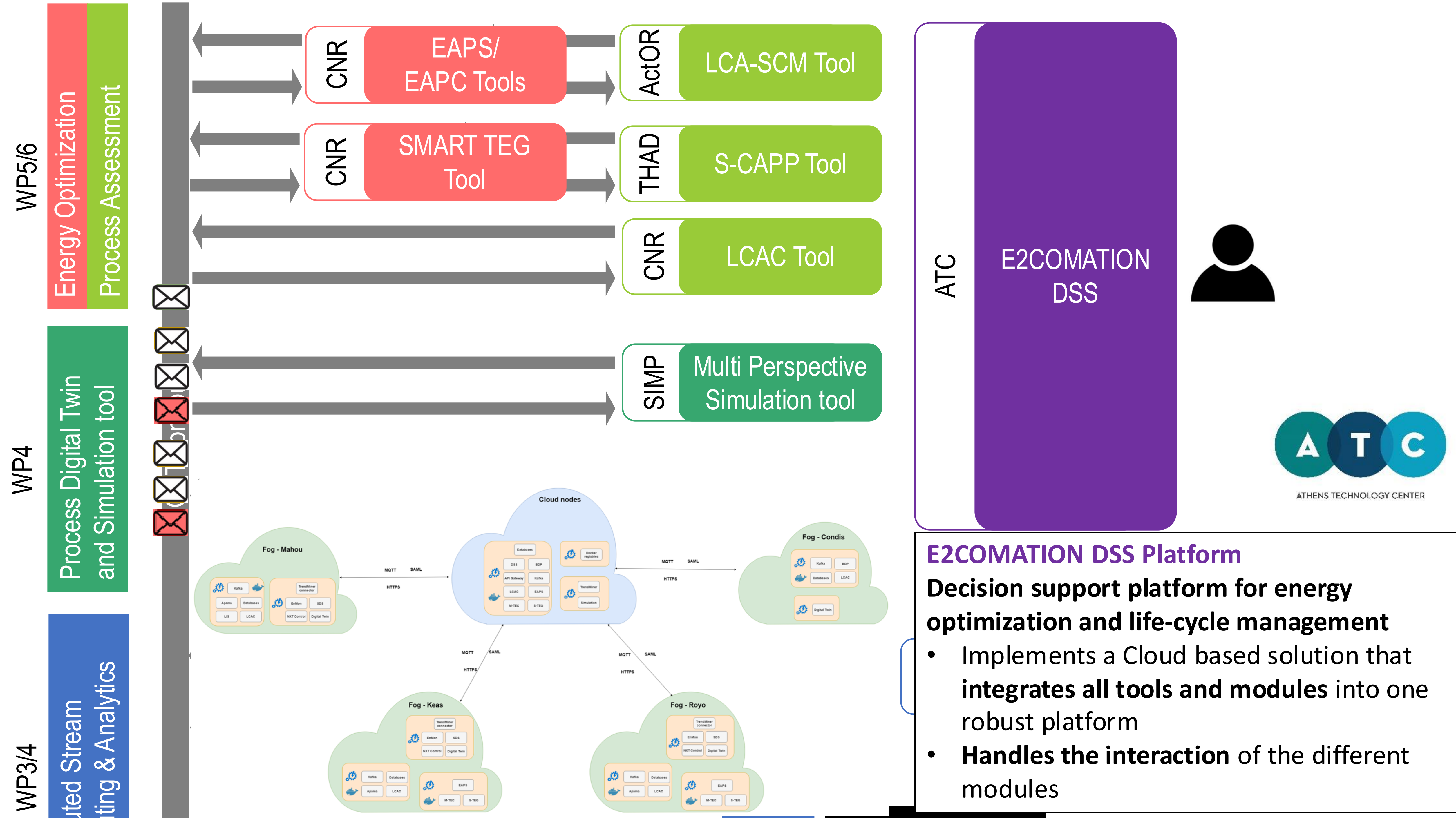
Generating new production pipelines based on different EPD/PEF factors of energy efficiency and environmental impact (Sustainability-driven)







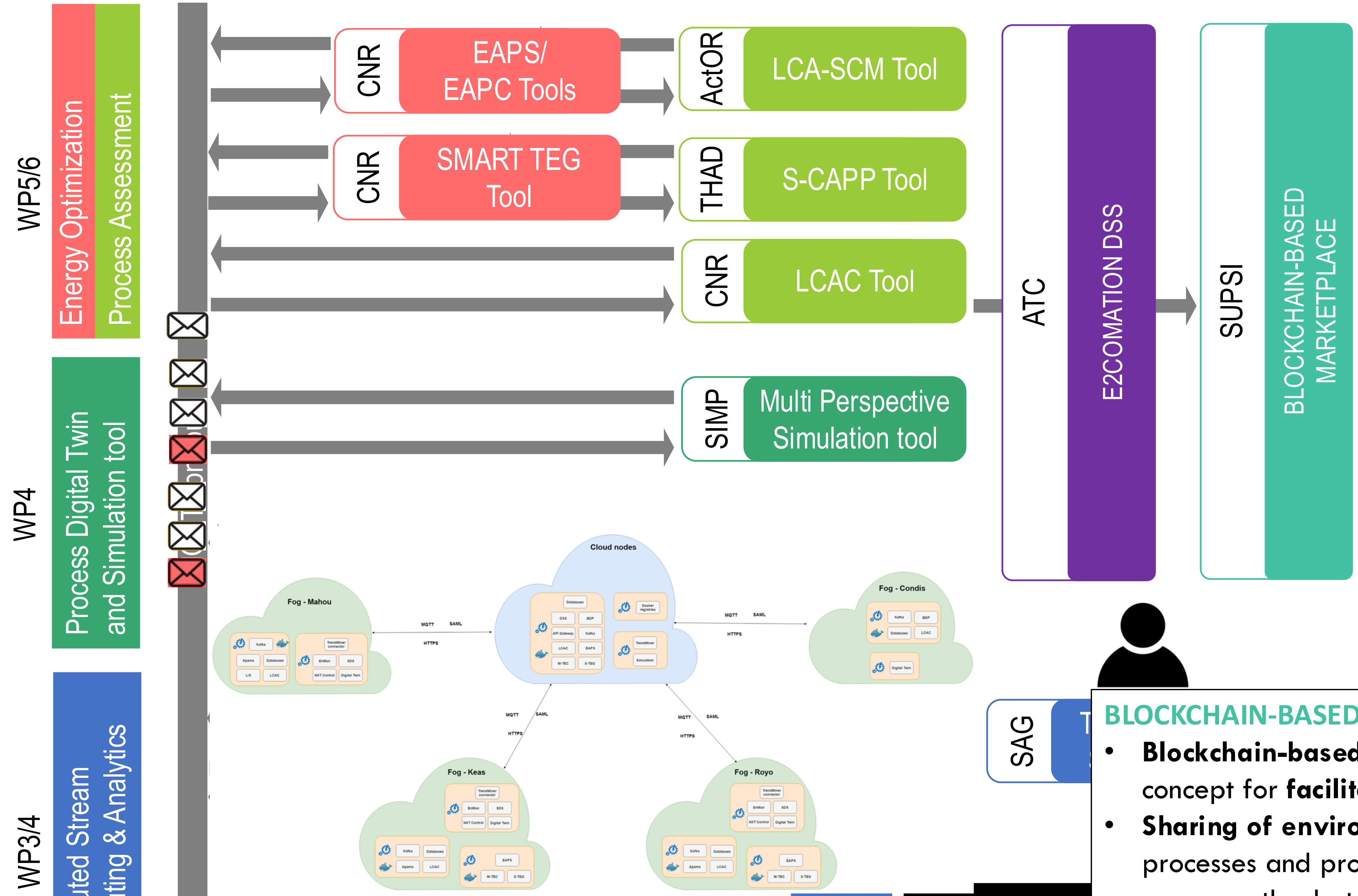
WP5/6
Energy Optimization
Process Assessment
CNR
EAPS/
EAPC Tools
ActOR
LCA-SCM Tool
CNR
SMART TEG
Tool
THAD
S-CAPP Tool
CNR
LCAC Tool
LCA driven SCM tool
Develop an **integrated management system**, by evolving the Bloomy Decision AID based platform, **to improve the value chain in both economic and sustainability terms**.
ACTOR
Analytics Control Technology OPERATIONS RESEARCH
Distribution Center
Transportation
Retail
Calendar and Transportation Optimization
Demand Forecast and Assortment Optimization
Inventory Optimization
Dashboard
To summarize the LCA and Economic KPIs as the sustainability vs profitability drivers
WP4
Process Digital Twin
and Simulation tool
SIMP
Multi Perspective
Simulation tool
KUL
Digital Twin
WP3/4
SYN
SDS
SAG
TRENDMINER
Self Analytics
SAG
APAMA
Stream Analytics



E2COMATION DSS Platform

Decision support platform for energy optimization and life-cycle management

- Implements a Cloud based solution that **integrates all tools and modules** into one robust platform
- **Handles the interaction** of the different modules



BLOCKCHAIN-BASED MARKETPLACE

- **Blockchain-based data management** concept for **facilitating LCA**
- **Sharing of environmental impact data** processes and products accessible by

2 Different Industrial Sectors with 4 Use Cases

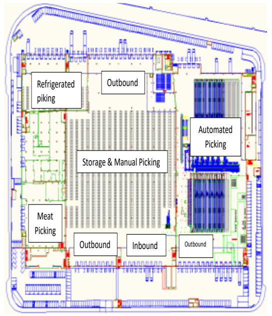
woodworking

MDF production

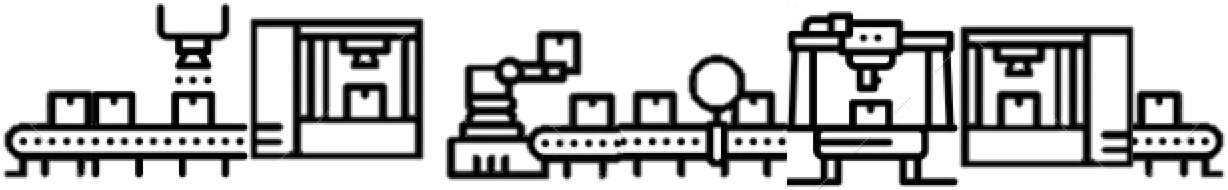
Bath Furniture manufacturing

food&beverage

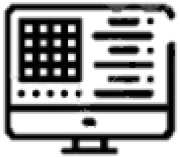
Brewery bottling line



Distribution & retail



Production line



Factory Information Sys

Thank you for the attention!