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FROM NET-ZERO ENERGY FACTORY TO AN INDUSTRIAL RENEWABLE ENERGY COMMUNITY: A GERMAN CASE STUDY

AUTHORS

Pio Alessandro Lombardi, Fraunhofer Institute for Factory Operation and Automation IFF
Finn Bennet Schröder, Fraunhofer Institute for Factory Operation and Automation IFF
Stephan Balischewski, Fraunhofer Institute for Factory Operation and Automation IFF

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Agenda

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- Motivation
- Net-Zero Energy Factory: what is it?
- The FlexBIT Platform
- Net-Zero Energy Factory and Digital Trust solutions for new business models
- From Net-Zero Energy Factory to Industrial Renewable Energy Community: A German Case Study of the CETP Project “FlexBIT”

Motivation

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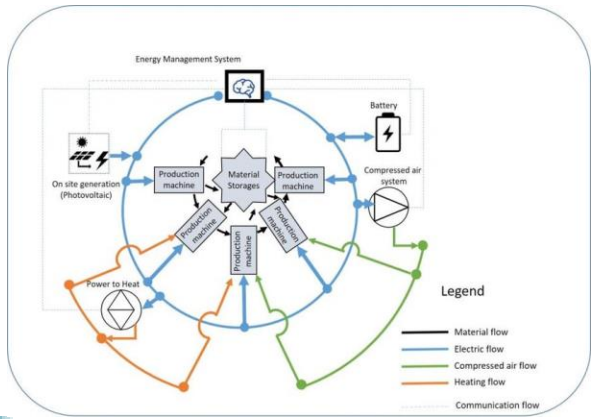
- Decarbonization of the European Energy System
- EU Directive 2018/2001 (RED II) on Renewable Energy Communities (REC)
- Net-Zero Energy Factory as planning concept to integrate volatile Renewable Energy Sources
  - Flexibility Options need to be optimally designed
  - High investment cost needed for the Flexibility Options



Net-Zero Energy Factory: what is it?

Common Definition: *„A Net-Zero Energy Factory (NZEF) is an industrial facility that produces as much energy from renewable sources as it consumes, over a defined time horizon (typically one year).”*

Our Approach: A NZEF

- **Generates renewable energy on-site** or in its immediate surroundings.
- **Maximizes self-consumption, avoiding energy export to the grid**.
- **Integrates energy use directly into the production system, through flexible processes and local storage**.
- **Imports from the grid only when strictly necessary**, without using it as a buffer or sink.

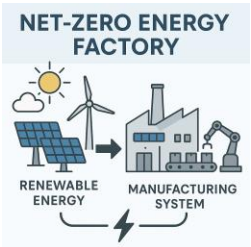


TABLE I. NET-ZERO ENERGY FACTORY: BENEFITS AND BENEFITS LEVELS

Category	Description of the Benefit	Benefit Level in %
Self-consumption of RES	Maximize local use of on-site generated RES electricity	100
Reduction of imbalance costs	Minimizes stress on the grid by reducing the need for balancing service	100
Grid efficiency	Decrease transmission losses thanks to localized generation and consumption	100
Energy independence	Increases autonomy from the electricity market and reduces exposures to price volatility	75
Reduction of local emission	Direct elimination of operational CO2 emissions on site	100
Industrial process flexibility	Encourages intelligent modulation of production processes	50
Energy resilience	Enhances continuity of operations in case of grid instability	50
Social acceptance/fairness	Does not externalize costs to other users (e.g. small consumers)	100
New business models	Opportunity to develop digital trust-based solutions to track the energetic sustainability of the industrial processes	100

The FlexBIT Platform

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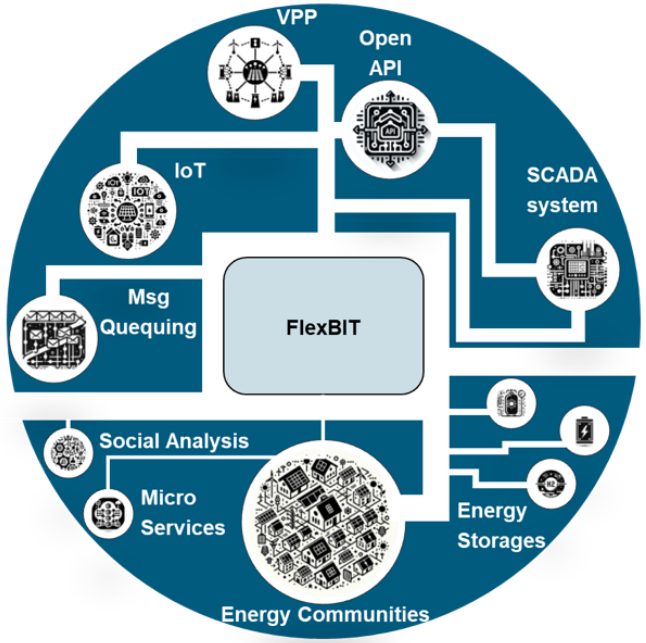
01
Seamless System Integration

02
Unlocking Flexible Operation

03
Leveraging Different Energy Storage Technologies



04
Building a Robust Digital Infrastructure

05
Ensuring Sustainability and Resilience

Net-Zero Energy Factory FlexBIT Demonstrator

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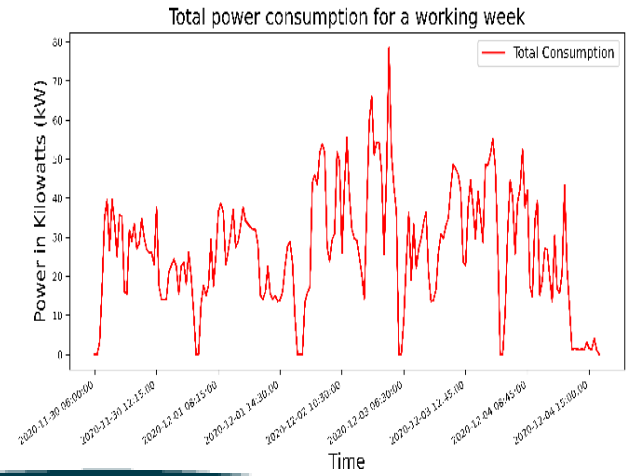
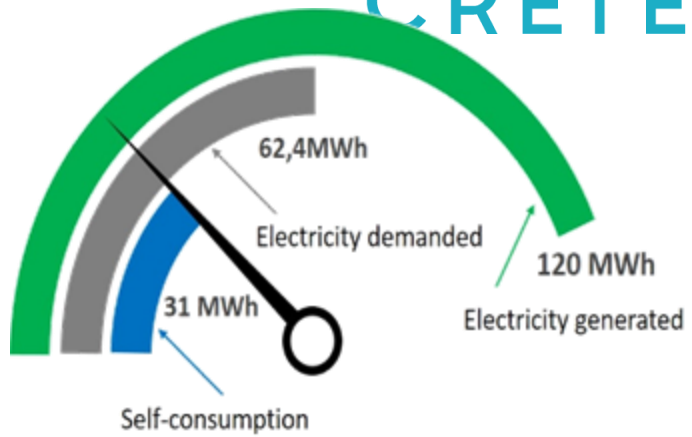
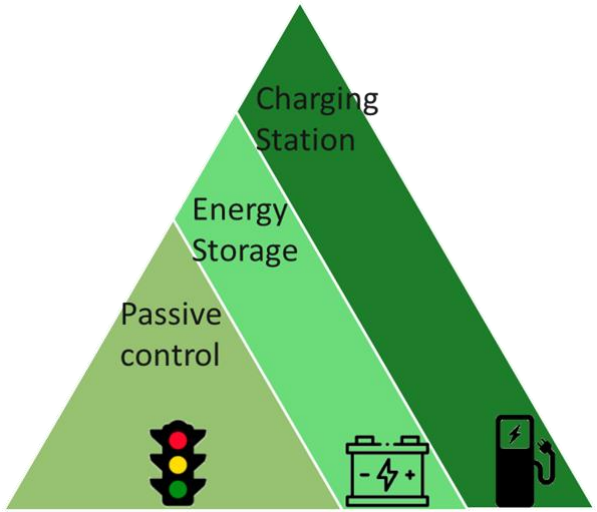


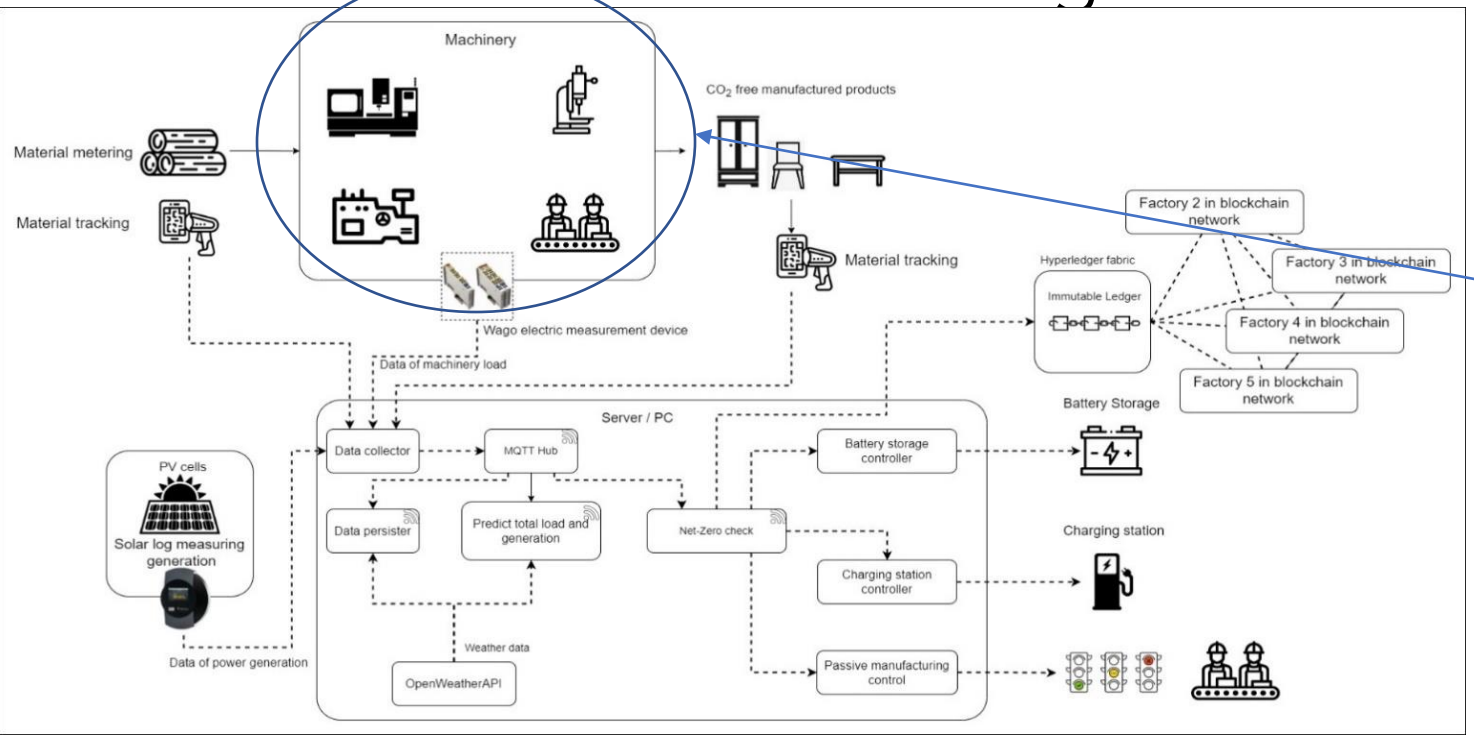
▪ PV Plant: 125 kW
▪ Battery : 20 kW;40 kWh
▪ Charging Station for EVs
▪ Smart Compressed Air
	▪ Flexible Processes:
	  ▪ Sawing
	  ▪ Drilling
	  ▪ Grinding
	  ▪ Banding

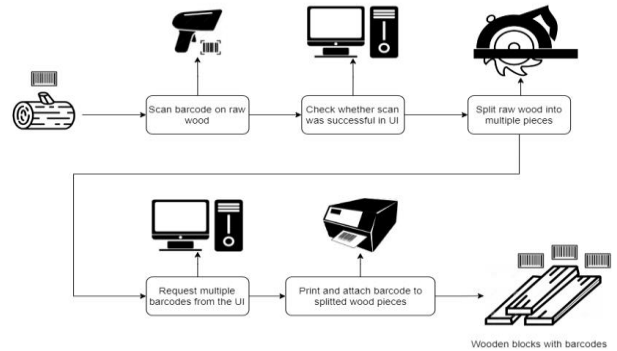
▪ Digitalization of energy flows and throug smart meters ▪ Digitalization of Material flows by IoT Sensors	▪ Identification of Flexibility ▪ Quatification of Flexibility ▪ Exploitation of Flexibility ▪ Design new flexibility options





Net-Zero Energy Factory
FlexBIT Demonstrator- Digital Trust





RawWood

BarCode	StartOfMachining	EndOfMachining
1000001	2023-03-15T13:28:17	2023-03-15T13:35:02

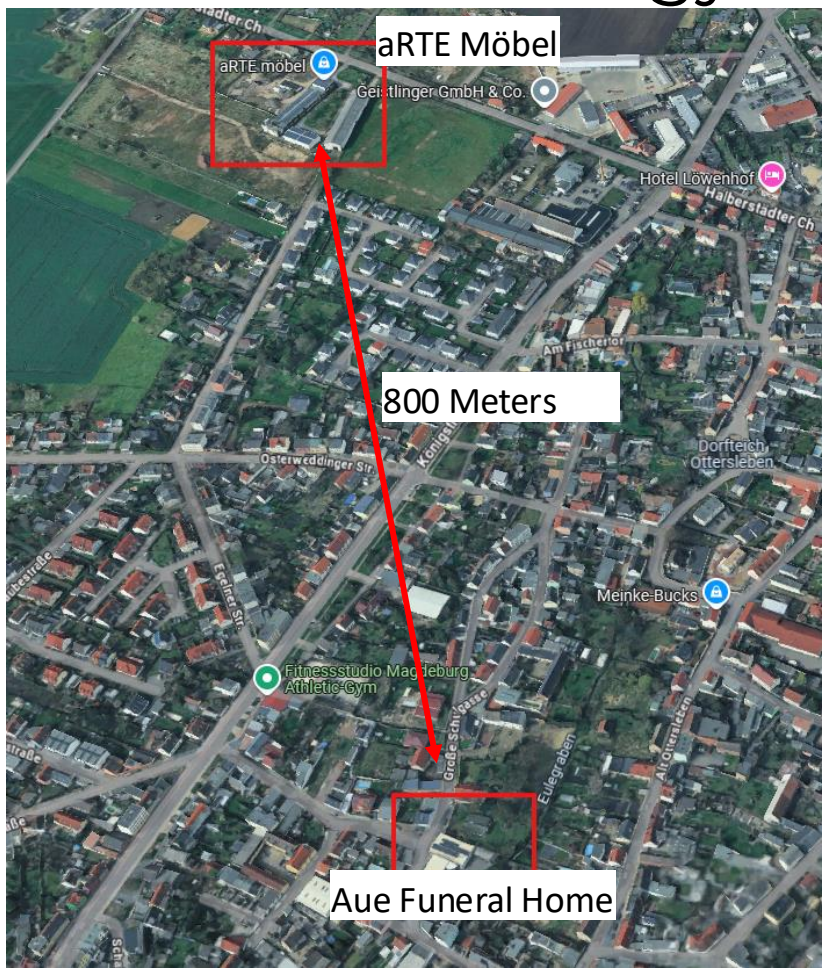
Start and end of wood splitting operation are updated

Pointing to parent wood

WoodPiece

BarCode	ParentRawWood
1210001	1000001
1210002	1000001
1210003	1000001
1210004	1000001

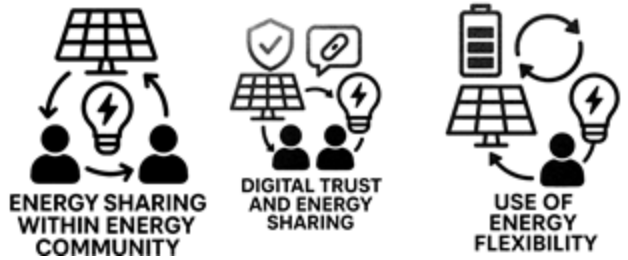
From Net-Zero Energy Factory To Industrial Renewable Energy Community-FlexBIT Demonstrator

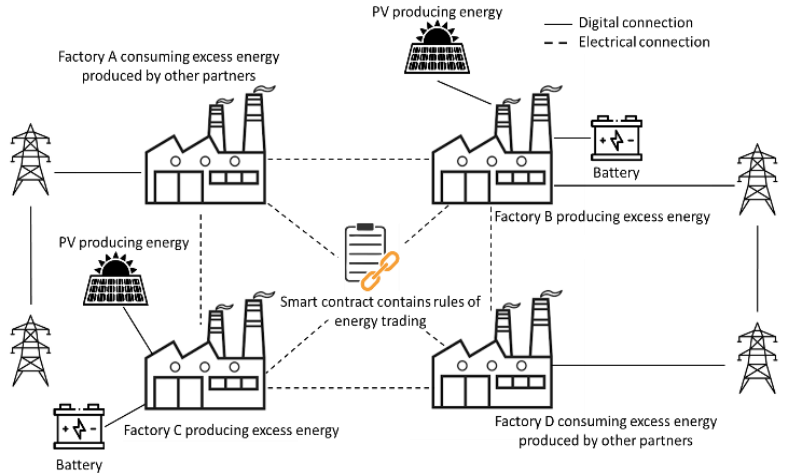


Source: Google Maps

	aRTE Möbel	Aue Bestattungen
RES (PV)	125 kW	29 kW
Battery	20 kW; 40 kWh	20 kW; 20 kWh
EV	1x	2x (Hybrid Plug-in)
Additional Flexibility	Industrial processes Smart Compressed air	Cooling Aggregates

- Energy Sharing
- Digital Trust durch Energy Sharing
- Nutzung der Flexibilität





Conclusions

- The transition from **Net-Zero Energy Factory (NZEF)** to Industrial Renewable Energy Community (IREC) offers a more scalable and economically viable path for industrial decarbonization.
- While NZEFs promote on-site renewable energy use, they often require **costly investments** in storage, flexibility, and digital control—challenging for SMEs.
- IRECs enable **energy sharing and coordination** among multiple industrial actors behind the same distribution transformer, **reducing individual costs** and increasing overall efficiency.
- The FlexBIT project demonstrates the feasibility of IRECs, defining a robust architecture **for real-time coordination, digital traceability, and automated smart contract settlement.**
- A practical example—**carpentry and funeral home collaboration**—shows how diverse assets (e.g., smart compressors, EVs, refrigeration) can be managed via a shared digital infrastructure.

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