



Take off the mask...

How to be competitive and profitable on the industrial metaverse

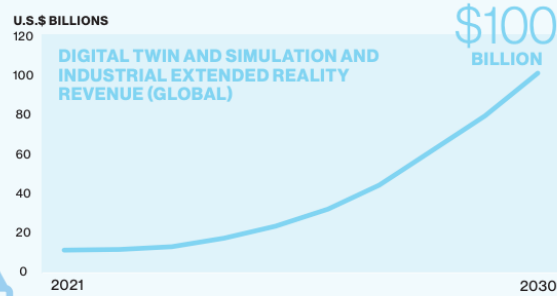
CarloAlberto Carnevale Maffè
SDA Bocconi School of Management

WMF - November 28th, 2023

Industrial

Simulated machines, factories, transport networks, and other complex systems, enabling real-world problem solving in industry and manufacturing.

MARKET PROJECTIONS (ABI RESEARCH)



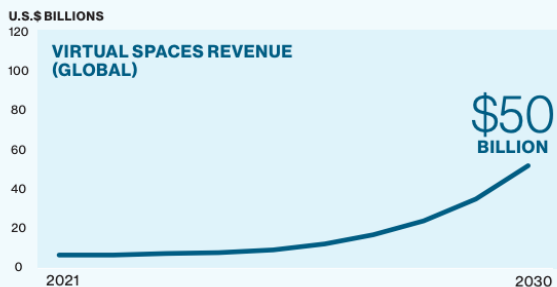
Enterprise

Technologies enabling immersive business collaboration, including productivity tools and virtual workspaces.



Consumer

Digital worlds and immersive spaces for shopping, gaming, socializing, and entertainment.



POTENTIAL OF THE INDUSTRIAL METAVERSE MARKET: 100 BL\$ BY 2030

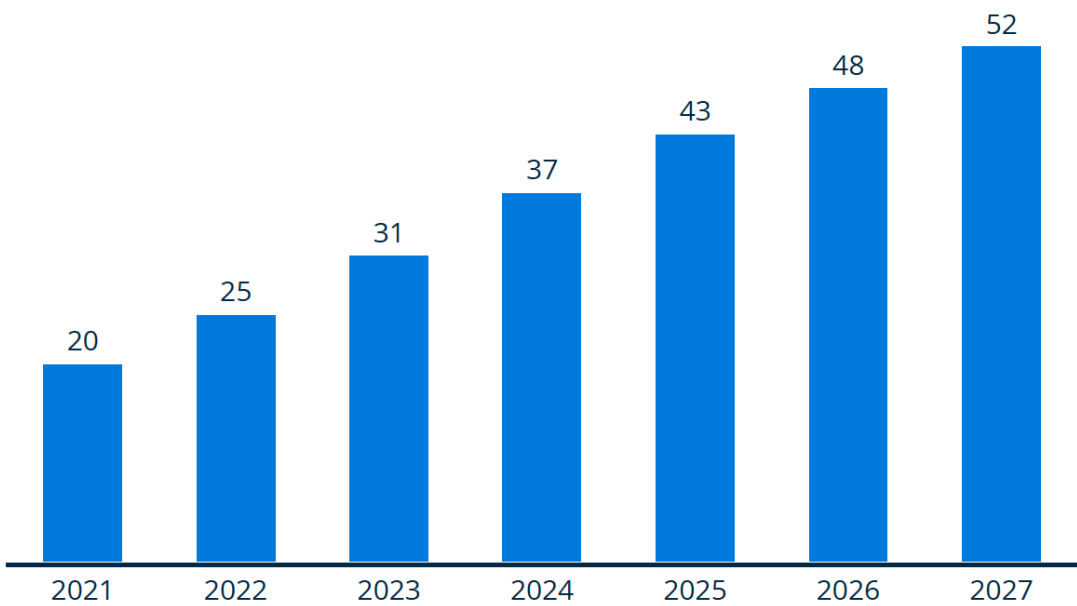
(PLUS 30 BL\$ FOR THE ENTERPRISE MARKET)

Industrial applications of AR/VR are growing strong

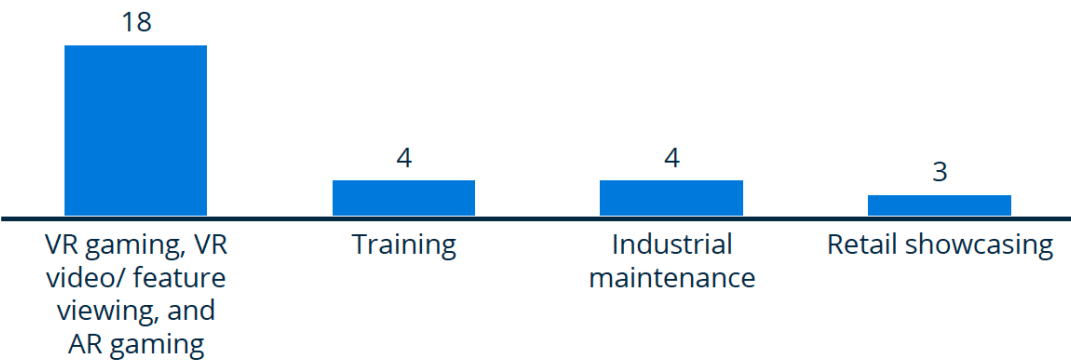
Augmented reality and virtual reality market to reach US\$52bn by 2027

Virtual and augmented reality: Overview (5/5)

Global augmented and virtual reality market in billion US\$



Investment in augmented and virtual reality technology worldwide by 2024 in billion US\$

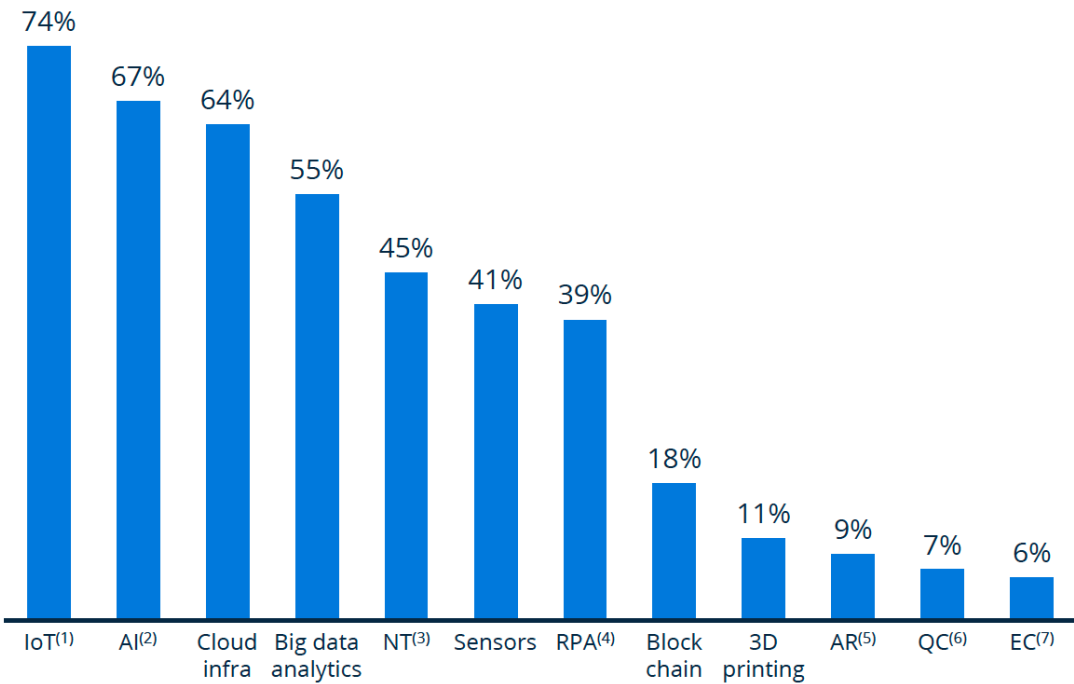


IoT & AI will have the greatest impact on business

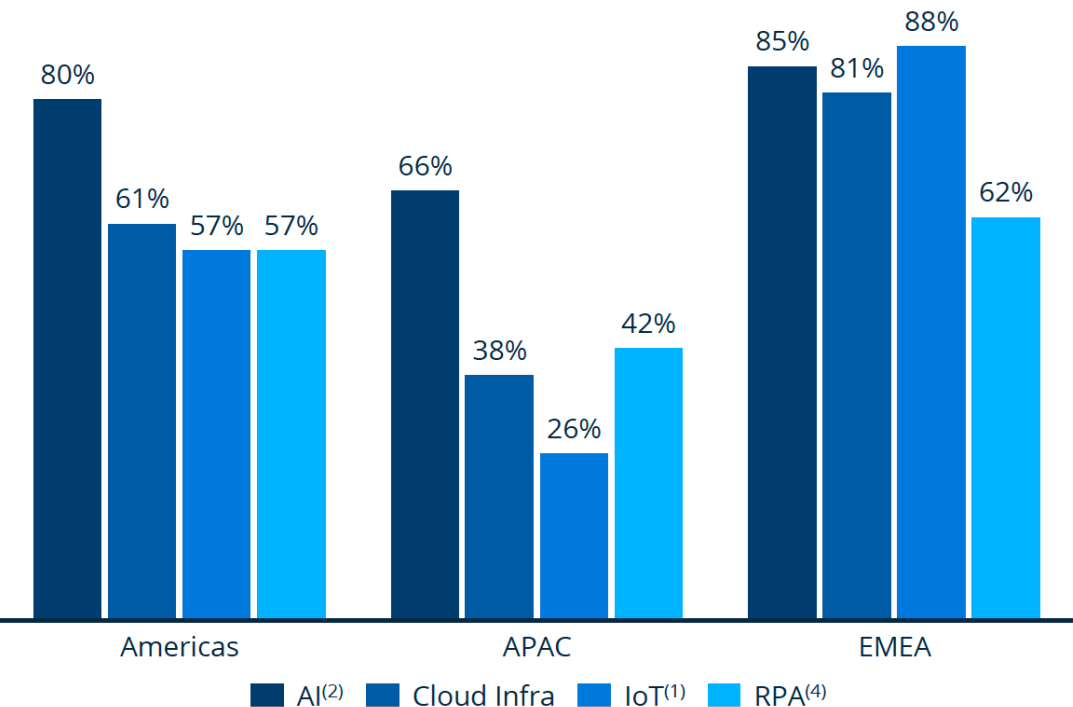
The IoT is anticipated to have the greatest impact on businesses

Impact of digitalization (7/7)

Technologies expected to have the most significant impact on businesses



Industry 4.0 technologies' expected impact



22 Notes: (1) Internet of Things (2) Artificial intelligence (3) Nano technology (4) Robotic process automation (also includes advanced robotics) (5) Augmented reality (6) Quantum computing (7) Edge computing

Sources: Deloitte Survey of 1,802 business leaders in technology, as of 2020; Deloitte

The impacts of «digital twin» for the industrial metaverse

**Digital twins
reduce costs
and time to
market**

McKinsey estimates
that digital twins
can enable

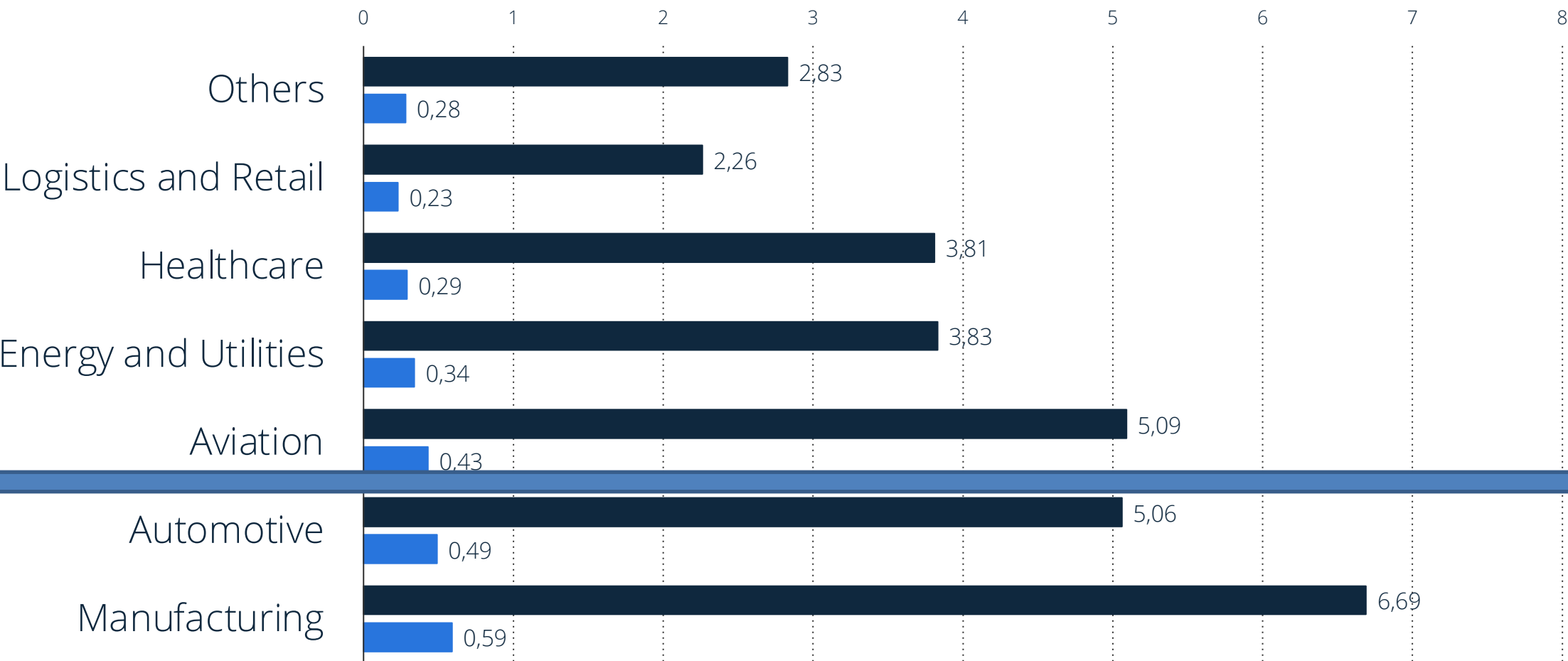


Source: Compiled by MIT Technology Review Insights, based on data from
“Digital twins: The foundation of the enterprise metaverse,” McKinsey, 2022.

Digital Twin global market: 8x from 2020 to 2025

Market value in billion U.S. dollars, by industry

■ 2025 ■ 2020

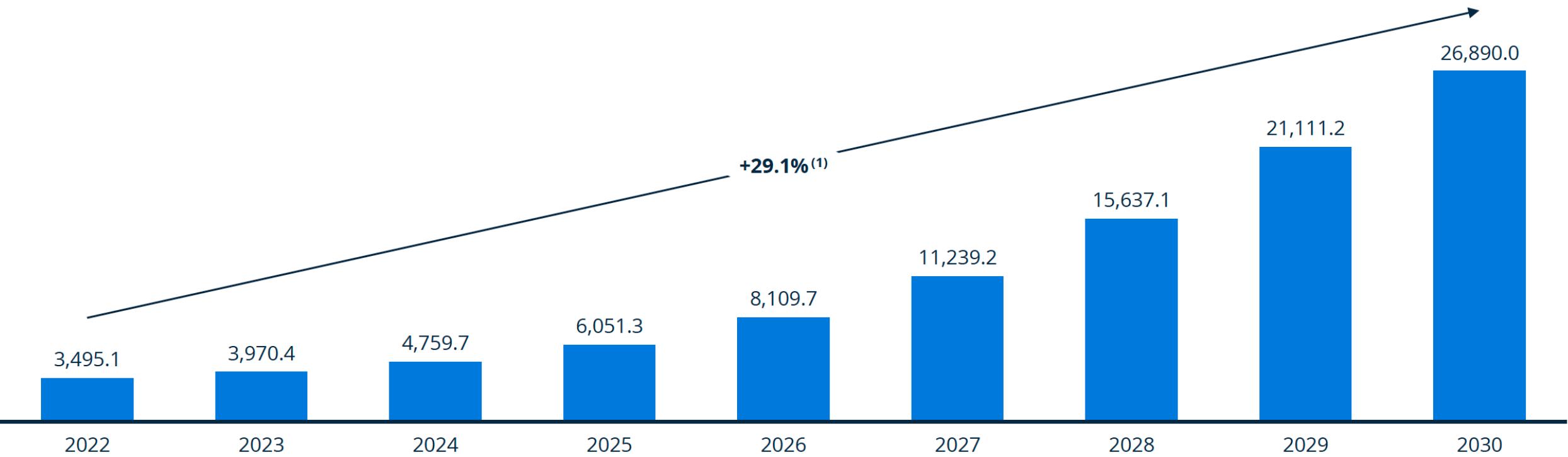


Note(s): Worldwide; Expert interviews and BIS Research analysis
Source(s): BIS Research; [ID 1296187](#)

Metaverse Workplace revenue is estimated to increase at a CAGR⁽¹⁾ of 29.1% from 2022 to 2030

Market Size: Global

Revenue forecast in million US\$



171 | Notes: (1) CAGR: Compound Annual Growth Rate / average growth rate per year

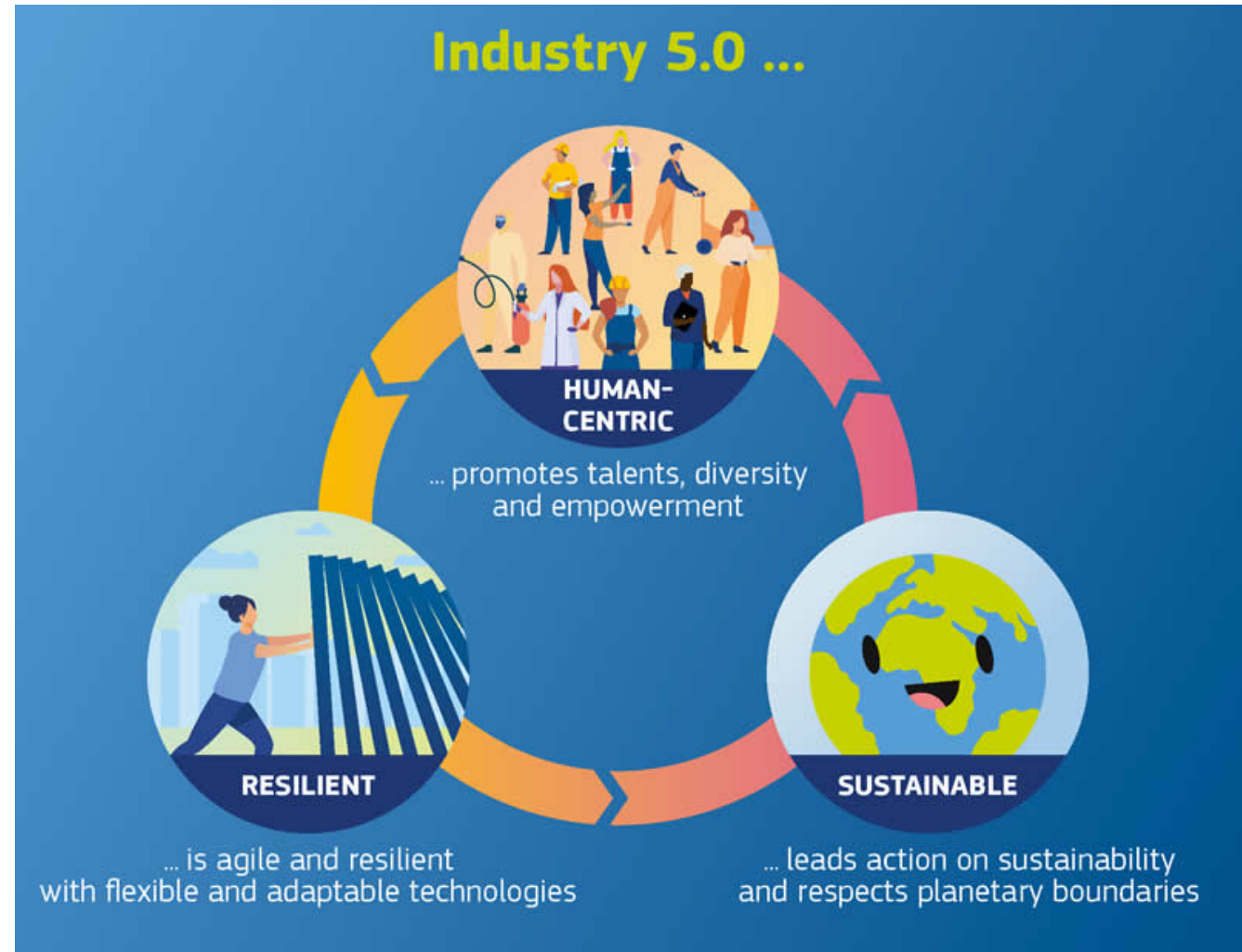
Sources: [Statista Advertising & Media Insights](#) 2023

Twin Transitions & the «Green Metaverse»



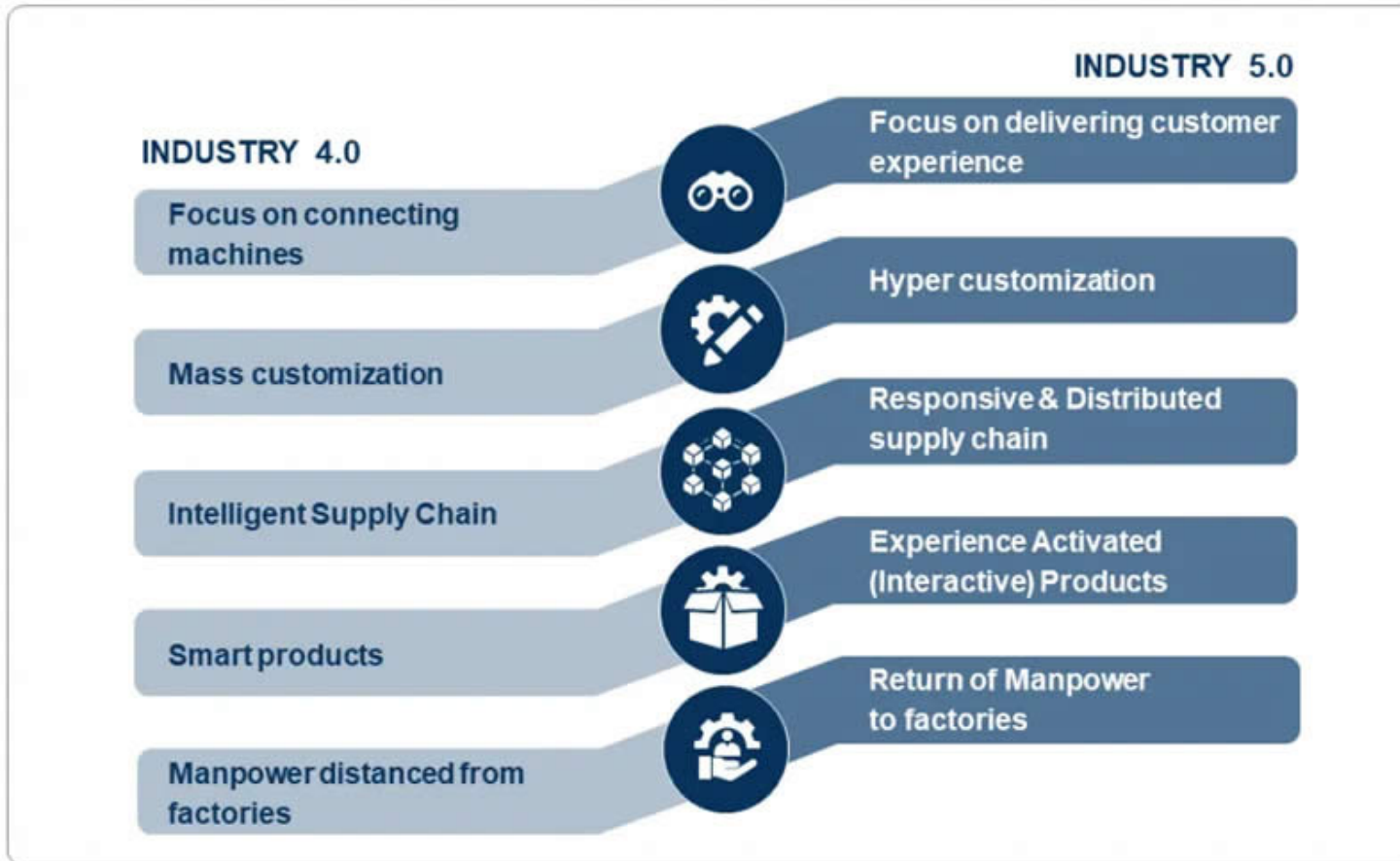
When four plus three makes five...

*Industry 5.0 =
4.0 + 3 (E.S.G.)*



Industry 5.0: end-to-end digitalization of processes becomes sustainable, inclusive and resilient

Highlights of Industry 5.0 compared to Industry 4.0



INDUSTRY 5.0



Human-
centric



Sustainable



Resilient

Interreg
Europe

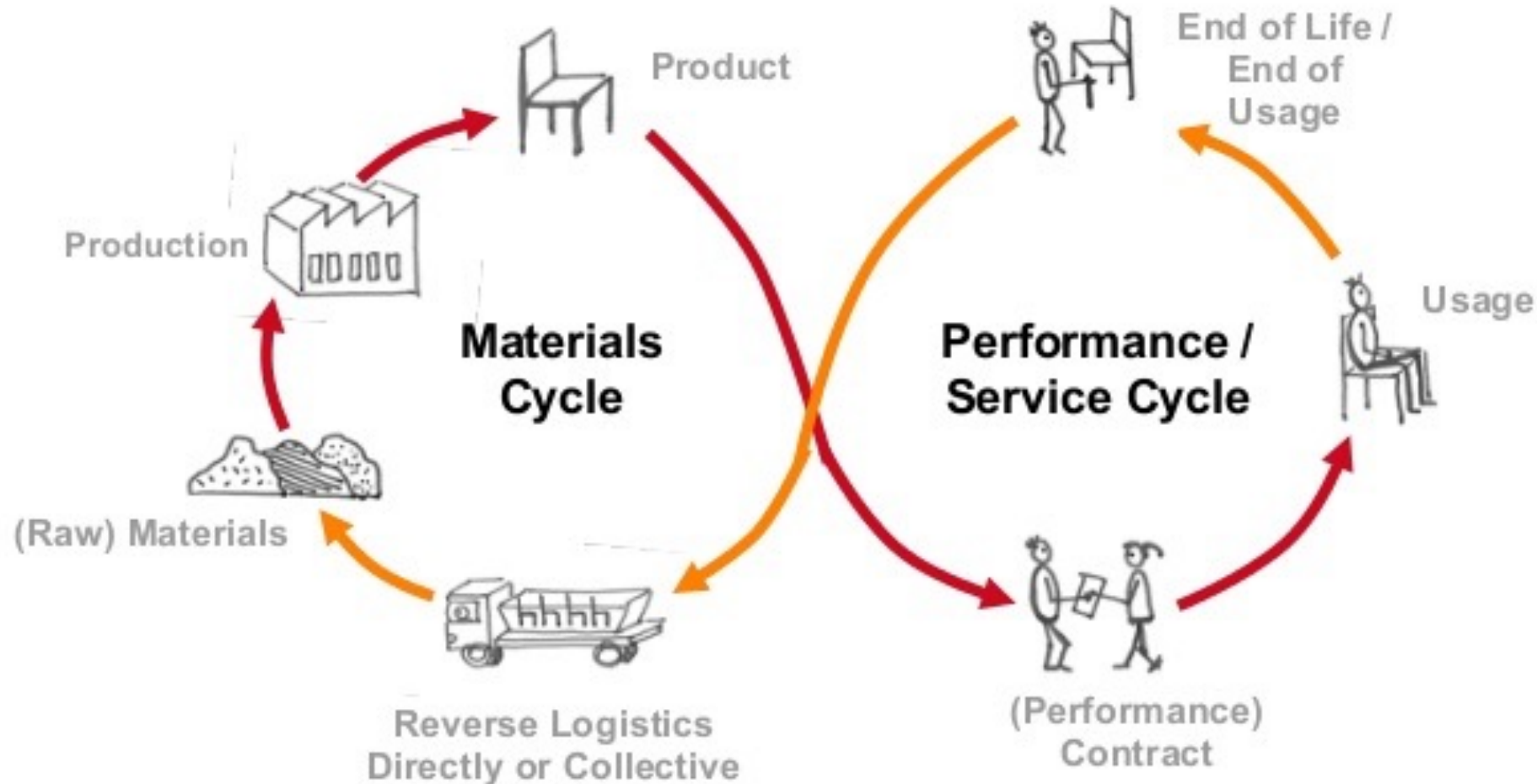


Co-funded by
the European Union

Industry 5.0: From theory to practice

The double cycle of sustainability

Circularity as a demand-side premium price for servitization



The electrification of everything

2050 energy flows

Consumer Transformation

System Transformation

Leading the Way

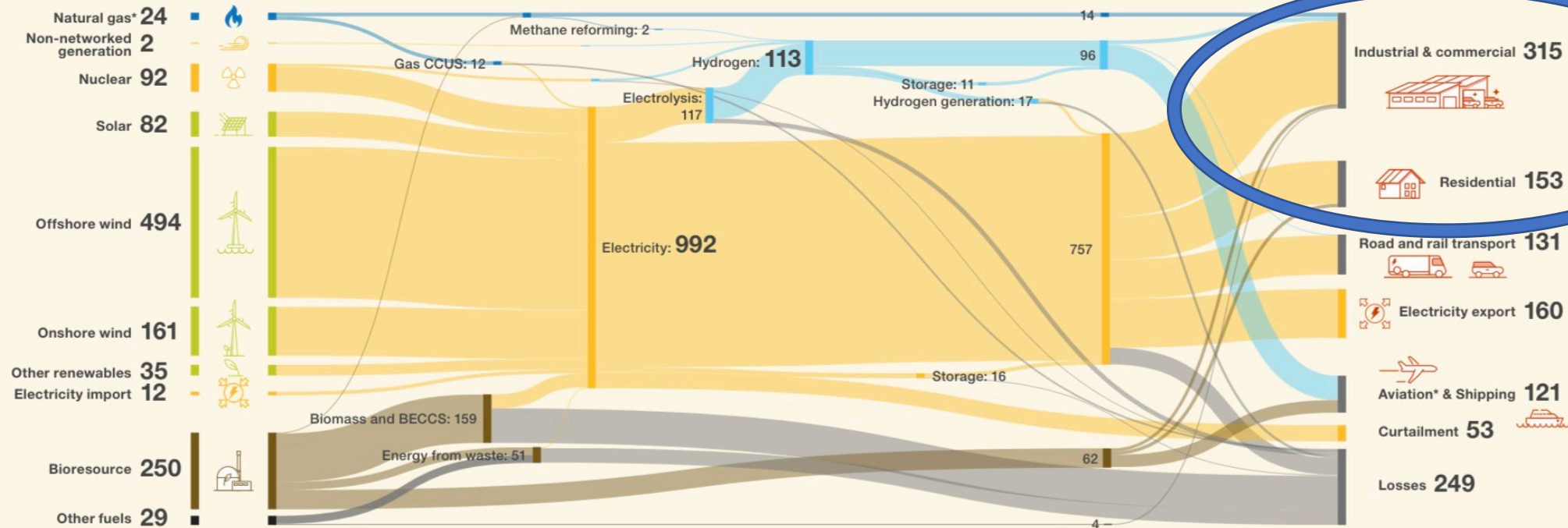
Falling Short

Consumer Transformation (1182 TWh)

- Home heating, transport and industry largely electrified
- High levels of energy efficiency combined with large-scale electrification lead to lowest end user energy demands across the scenarios
- Electricity generation capacity and output is highest in this scenario to meet high annual electricity demands
- High levels of renewable generation with low hydrogen production leads to highest levels of electricity curtailment across the scenarios



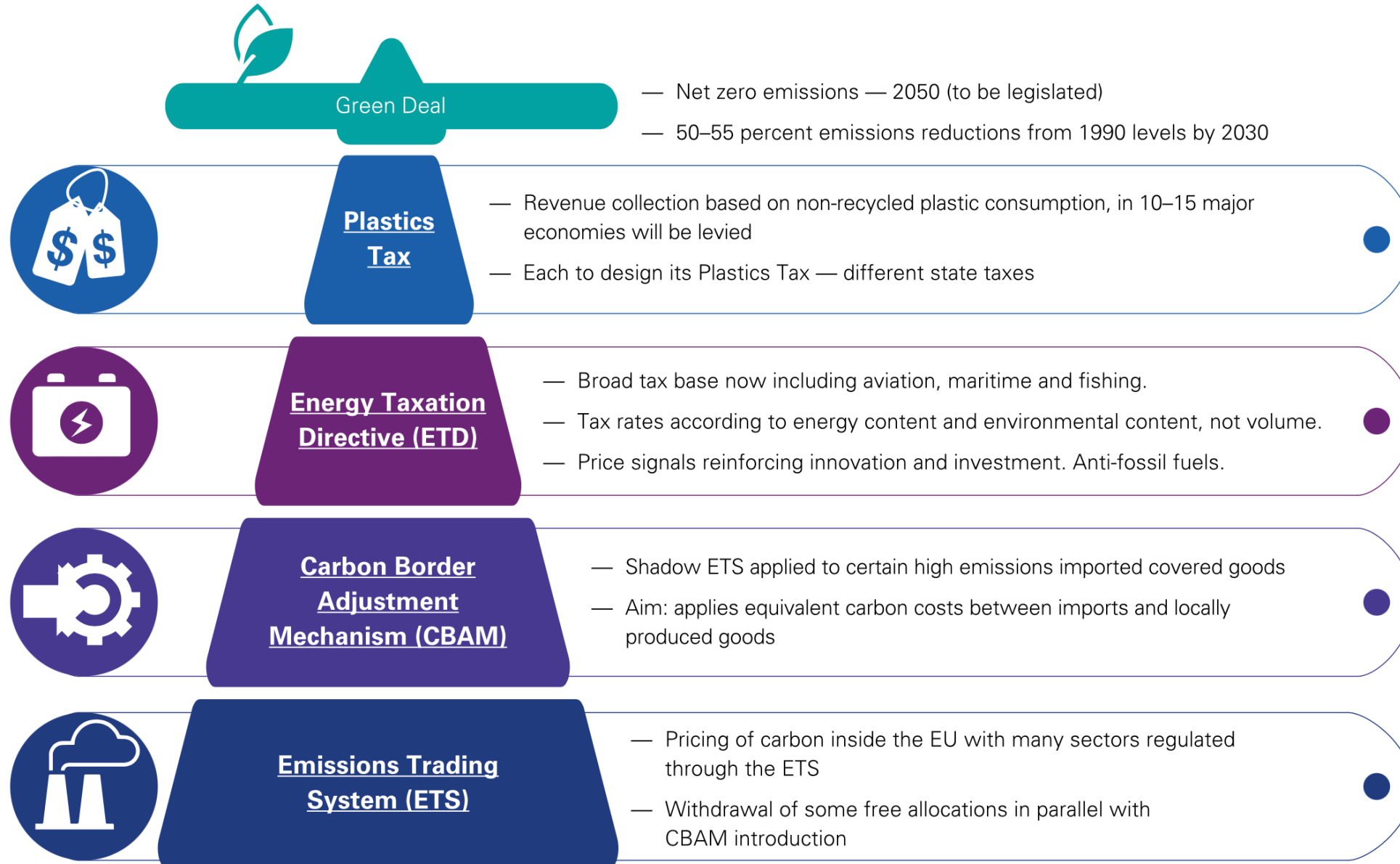
Hover over the scenario you wish to view.



*excluding exports

*Aviation excludes some demand met by petroleum products

Tax measures in EU Green Deal

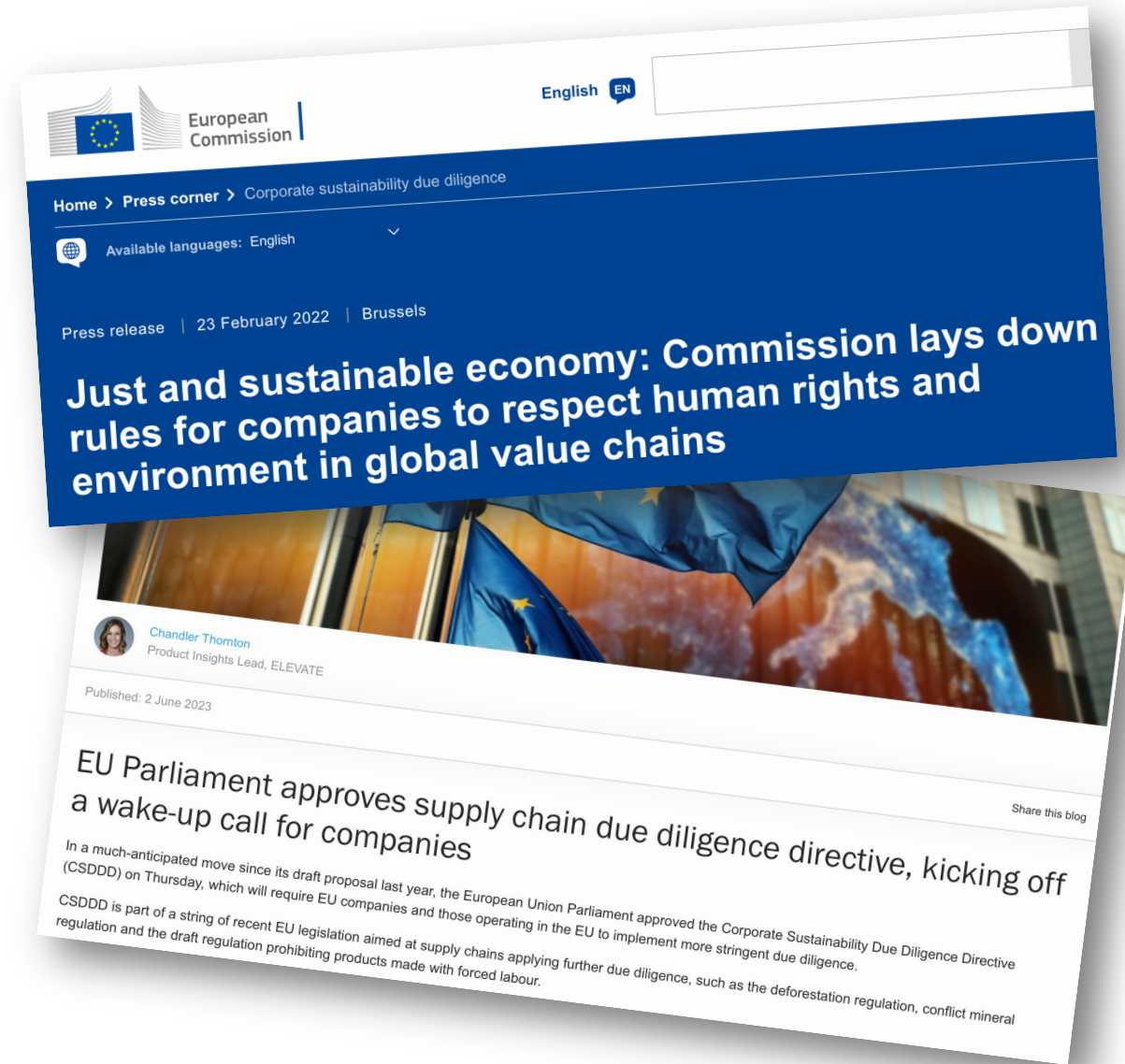


Supply Chain Due Diligence Directive licensed

Substantial penalties can be expected for non-compliance with the proposed Corporate Sustainability Due Diligence Directive (“CSDDD”) which oblige companies to implement due diligence processes to address their adverse impact on slavery, child labor, labor exploitation, biodiversity loss, pollution, and environmental degradation.

The CSDDD will apply to:

- EU companies with more than 500 employees and a global turnover of €150 million+
- Non-EU companies that generated turnover of €150 million+ in the EU market
- EU companies with more than 250 employees and a global turnover of €40 million+, with 50% generated in a high risk sector
- Non-EU companies that generated turnover greater than €40 million in the EU market, with 50% generated in a high risk sector



Carbon leakage occurs when industries transfer polluting production to other countries with less stringent climate policies, or when EU products are replaced by more carbon-intensive imports.

In its first phase, the CBAM will focus on goods most at risk of carbon leakage:



CEMENT



IRON & STEEL



ALUMINIUM



FERTILISER



HYDROGEN

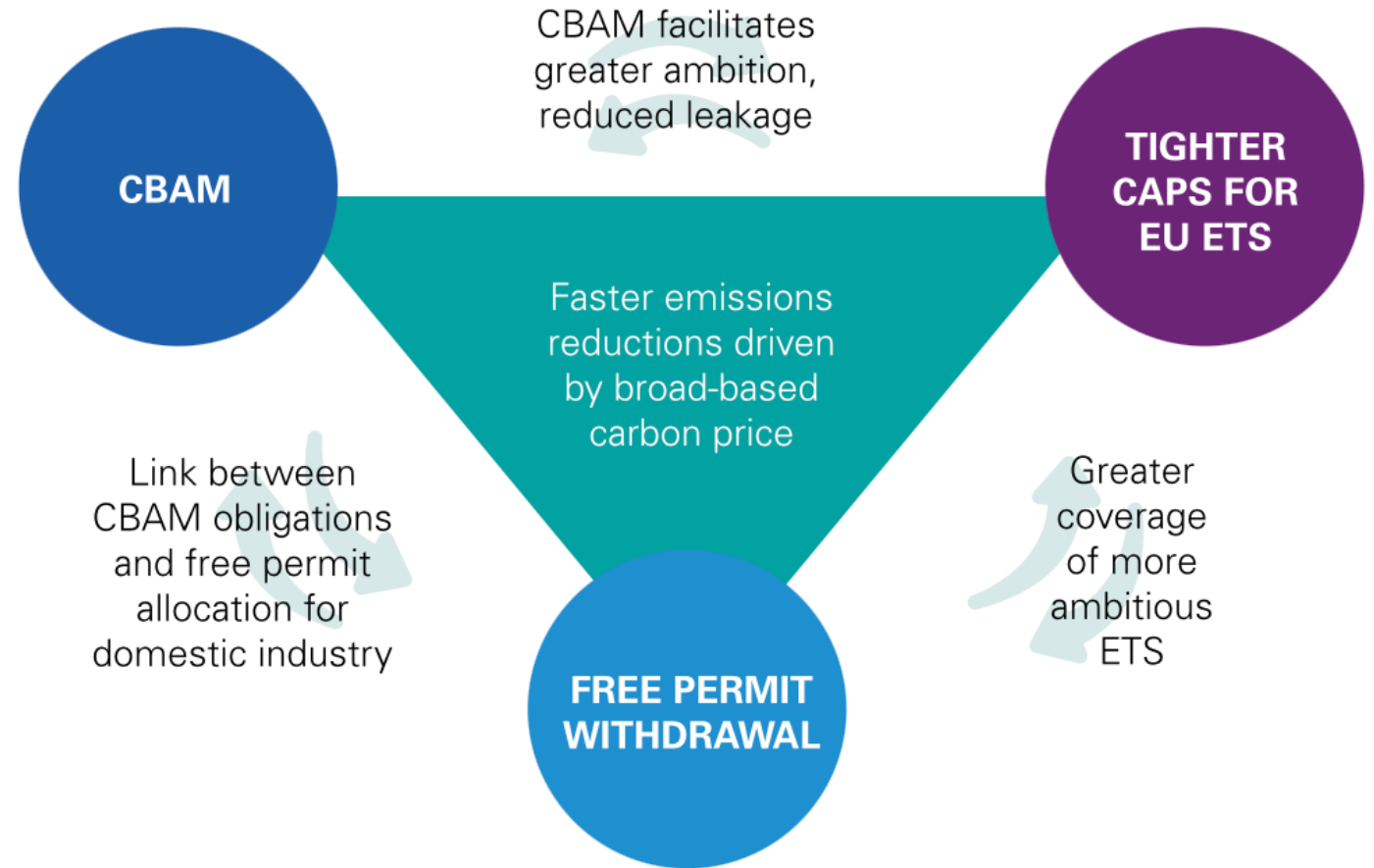


ELECTRICITY

Reforming carbon pricing

There are four key pillars to the reforms that represent a game changer for carbon pricing:

- A step change tightening of emissions cap under the EU ETS to align the ETS ambitions with the EU's carbon reduction targets.
- Expanding the sector coverage of the existing ETS to cover maritime transport, and introducing a separate but adjacent ETS covering buildings and road transport.
- The progressive withdrawal of free permits for emission-intensive trade-exposed (EITE) sectors under the EU ETS.
- The introduction of a CBAM, which establishes a 'shadow ETS' for certain goods being imported into the EU to avoid further carbon leakage from these more ambitious reforms.



Money will have a «carbon price»

First and alone, the ECB has included climate change targets in its monetary policy mandate

EUROPEAN CENTRAL BANK | EUROS

Home > About > Climate change and the ECB

Climate change and the ECB

Climate change poses risks to our economy and the financial sector. We need to assess how climate change and the transition to a carbon-neutral society affect our economy, so that we can account for their influence on our work as a central bank and banking supervisor. This will help us to keep prices stable and banks safe.

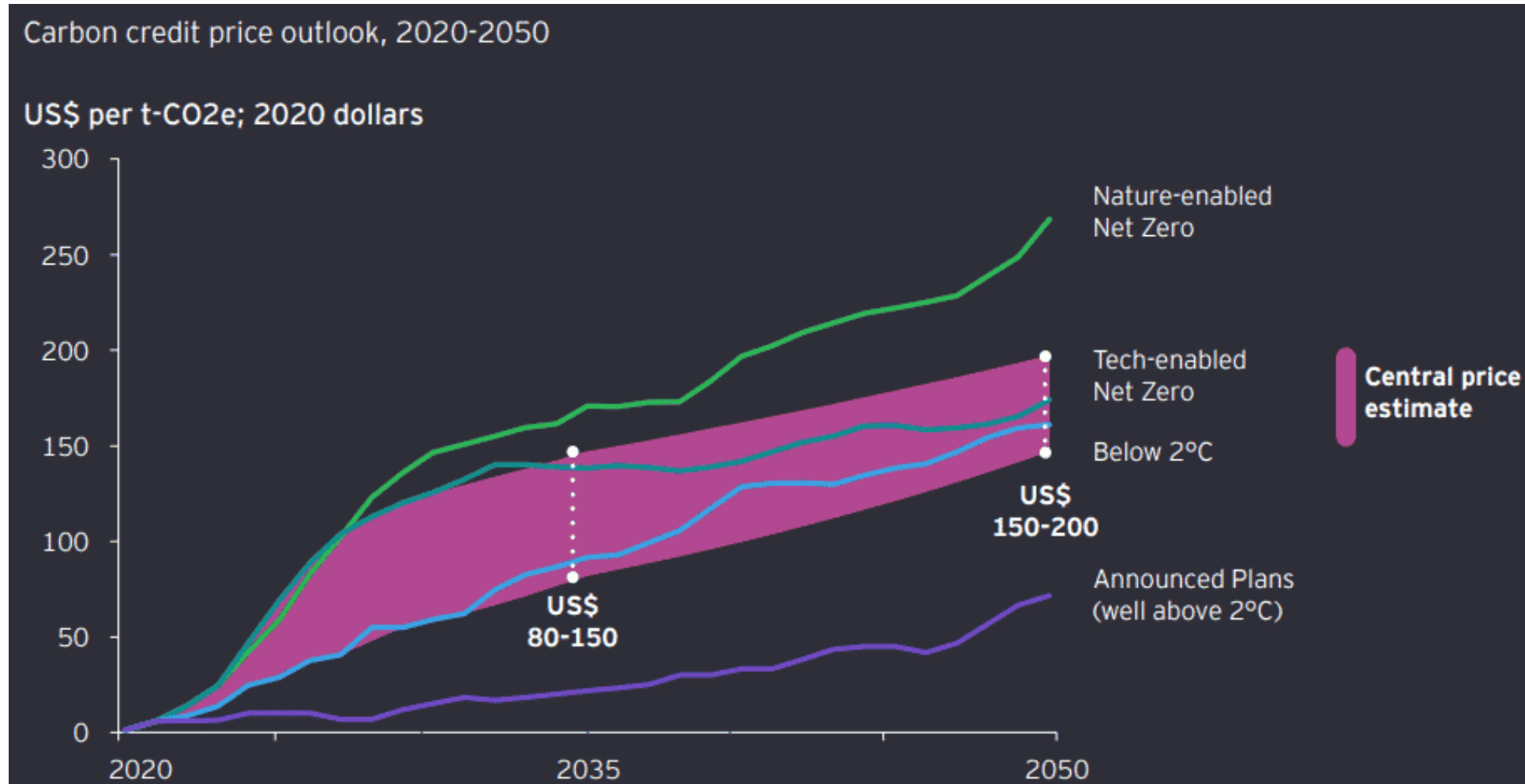
Our work on climate change focuses on three main objectives. These help our policies to remain effective and fit for a changing world.

- Managing climate-related risks**
We work to better understand, monitor, and manage climate-related risks in our monetary policy and investment operations as well as in the financial system. We also assess the economic impact of climate change and mitigation policies.
- Supporting the green transition**
We support an orderly transition to a carbon-neutral economy with measures that are within our mandate. This includes promoting the development of sustainable finance and creating incentives for a greener financial system.
- Fostering wider action**
We help improve the overall understanding of climate-related risks and work closely with European and international partners on climate and sustainable finance topics. We also work to improve the transparency of our activities, and reduce our own environmental impact.

We are firmly committed to doing our part to address climate change, within our mandate.

The high price of «hot air»

Carbon credit prices can skyrocket over the next 10-20 years



Sell the process, not just the product

In the Industrial Metaverse, the new name of «quality» is «accountability»

In the new regulatory and market context, selling the products is no longer enough: processes are the new name of «quality»



Every kilogram of «iron» will need a terabyte of data

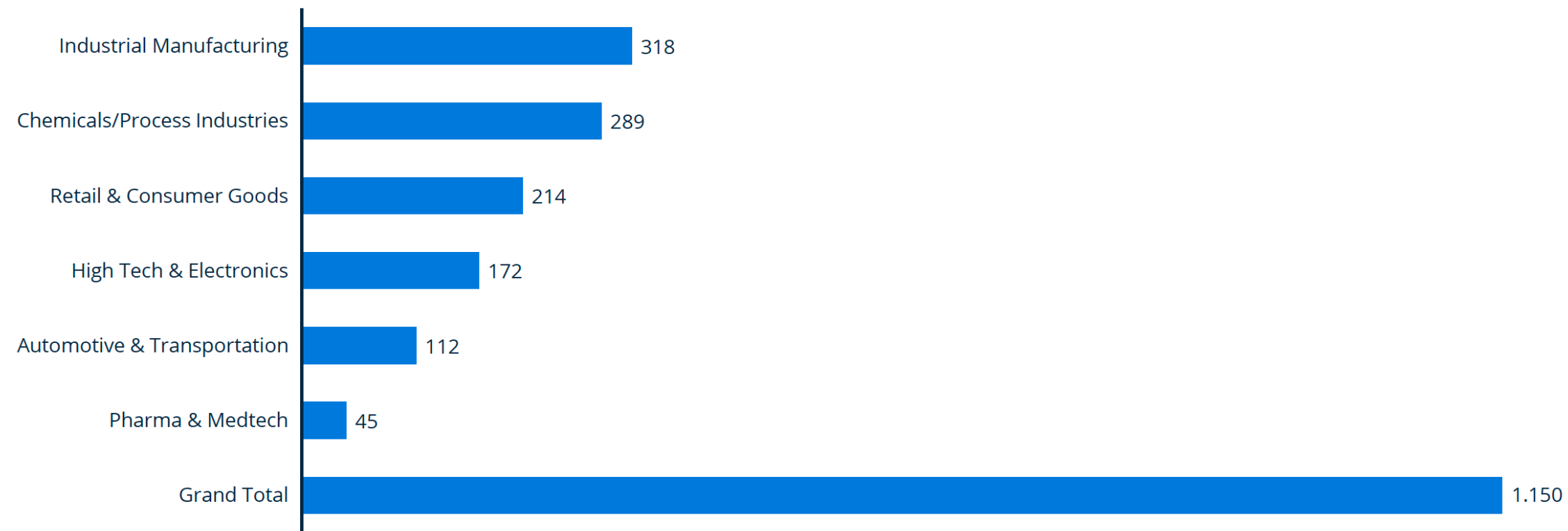


Industrial Manufacturing leads in “digital factory transformation”

Industrial manufacturing leads in digital factory transformation

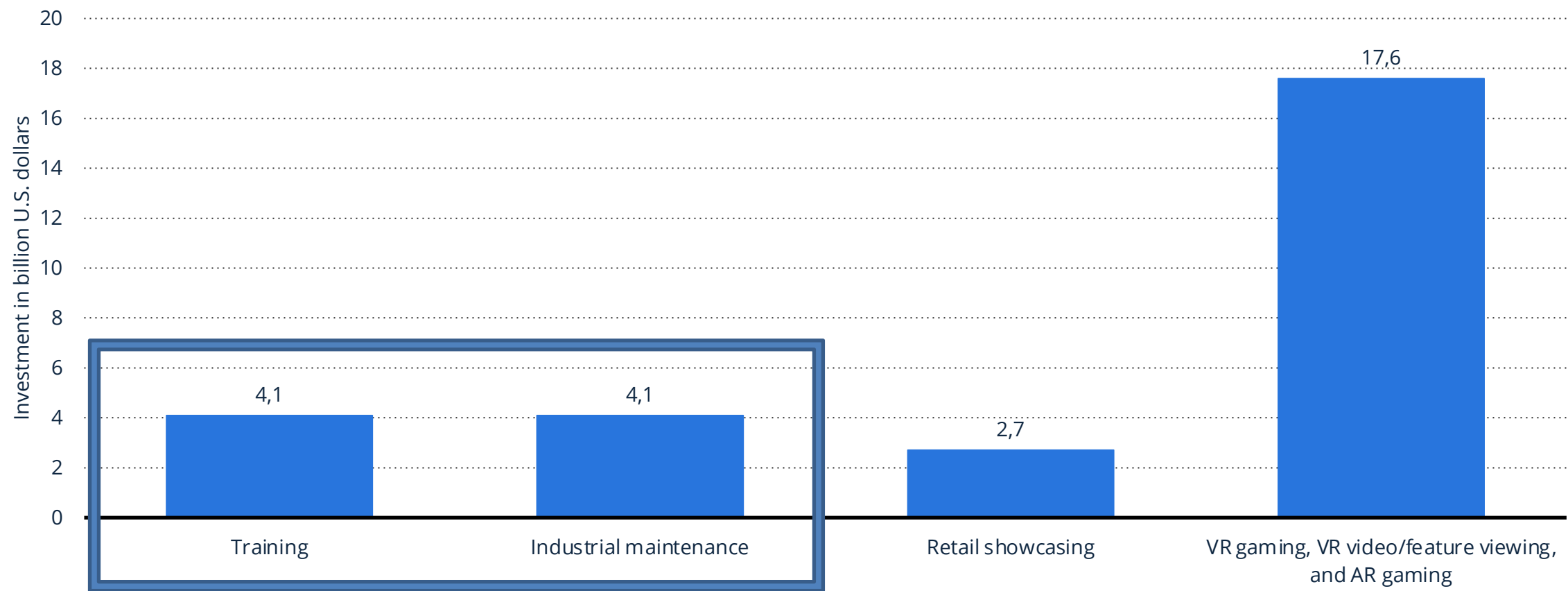
Industry 4.0 investment

Annual investments in digital factory transformation 2022 in billion US\$



Investments in AR/VR: segments of applications

Investment in AR/VR technology worldwide in 2024, by use case



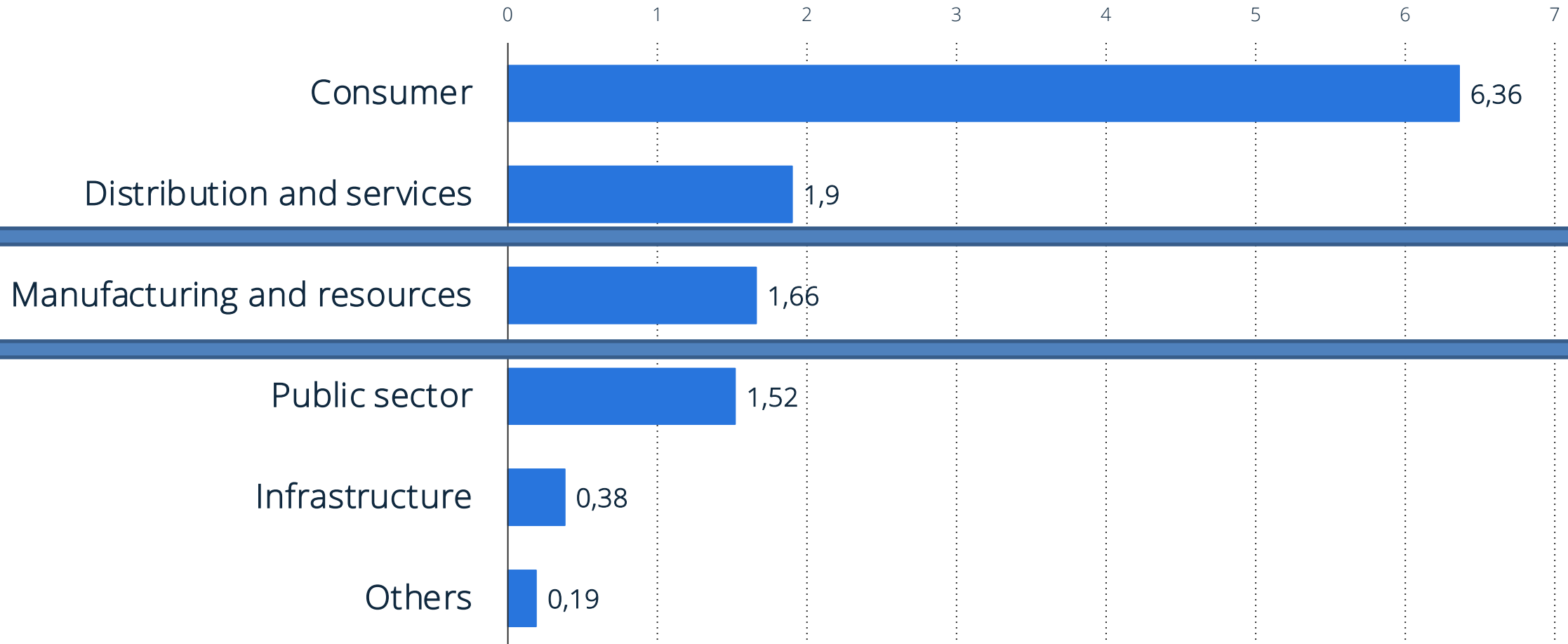
Description: The commercial use cases for augmented and virtual reality (AR/VR) that are expected to receive the largest investment in 2024 are training and industrial maintenance with 4.1 billion U.S. dollars forecast to be invested in both fields. VR gaming, VR video/feature viewing, and AR gaming make up the three largest consumer use cases for augmented and virtual reality (AR/VR), with 17.6 billion U.S. dollars expected to be spent in 2024. [Read more](#)

Note(s): Worldwide; 2020

Source(s): IDC

Investments in Augmented/Virtual Reality by segment

Spending in billion U.S. dollars



Note(s): Worldwide; 2020

Source(s): IDC; Statista; [ID 737615](#)

Overview: Worldwide

52% of employees are open to using immersive application in the professional metaverse

The metaverse is coming to work

We also asked respondents about emerging technologies at work.

- 52% of employees are open to using digital immersive spaces in the metaverse for meetings or team activities in the next year.
 - 47% of employees are open to representing themselves as an avatar in meetings in the next year.
 - 51% of Gen Z and 48% of Millennials envision doing some of their work in the metaverse in the next two years.
 - 16% of employees say they never expect to do any work in the metaverse.
 - 13% of employees say they don't know what the term 'metaverse' means.
- "Avatars and the metaverse bring us one step closer to making people feel like they're together even when they are physically apart," says Mar Gonzalez Franco, principal researcher at Microsoft Research. "Our early research shows that when compared to an audio-only call, people feel more engaged, more present, and even more comfortable

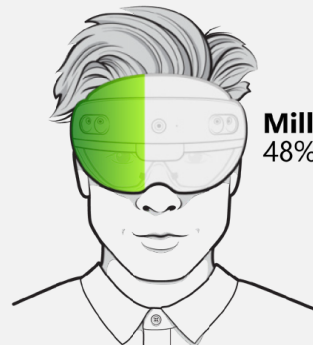
when using an avatar in a meeting. The people you are speaking with are better able to see your body language, and back-and-forth conversations feel more natural."

Leaders need to consider how emerging technologies like the metaverse and AI can augment collaboration and facilitate co-creation and creativity in a distributed work world.

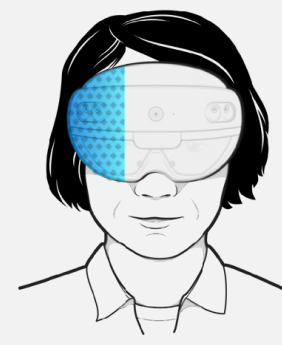
Millennials and Gen Z are more likely to envision doing some of their work in the metaverse in the next two years.



Gen Z
51%



Millennials
48%



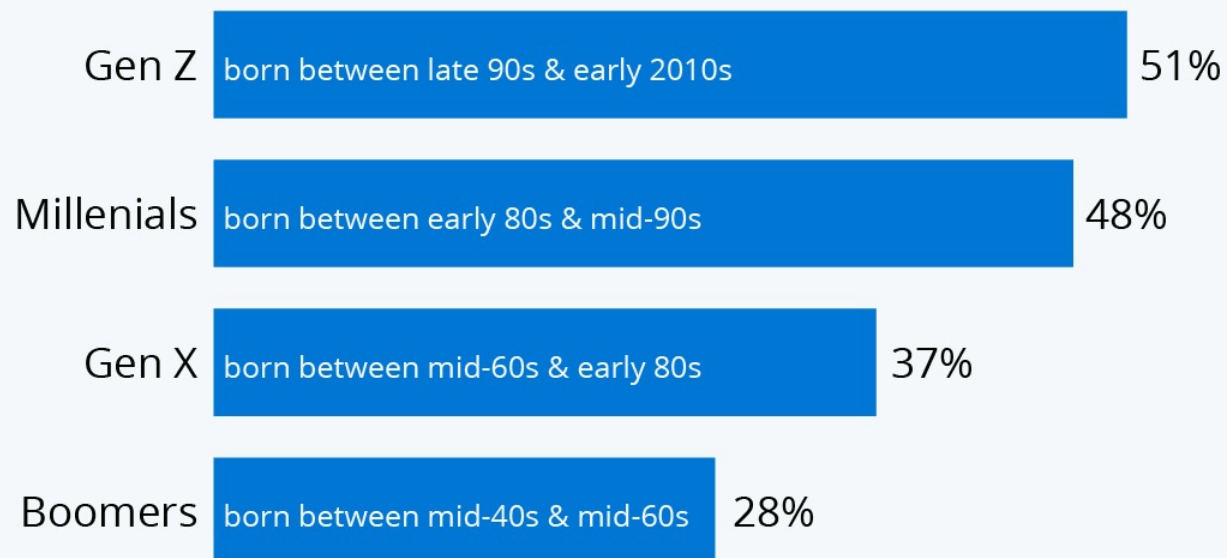
Gen X
37%



Boomers
28%

Will the Metaverse Lead to Metawork?

Share of respondents envisioning partly working in the metaverse in the near future by generation



Overall respondents not expecting metaverse work at all 16%

Based on surveys of 31,102 full-time employed or self-employed workers in 31 countries; Jan-Feb 2022

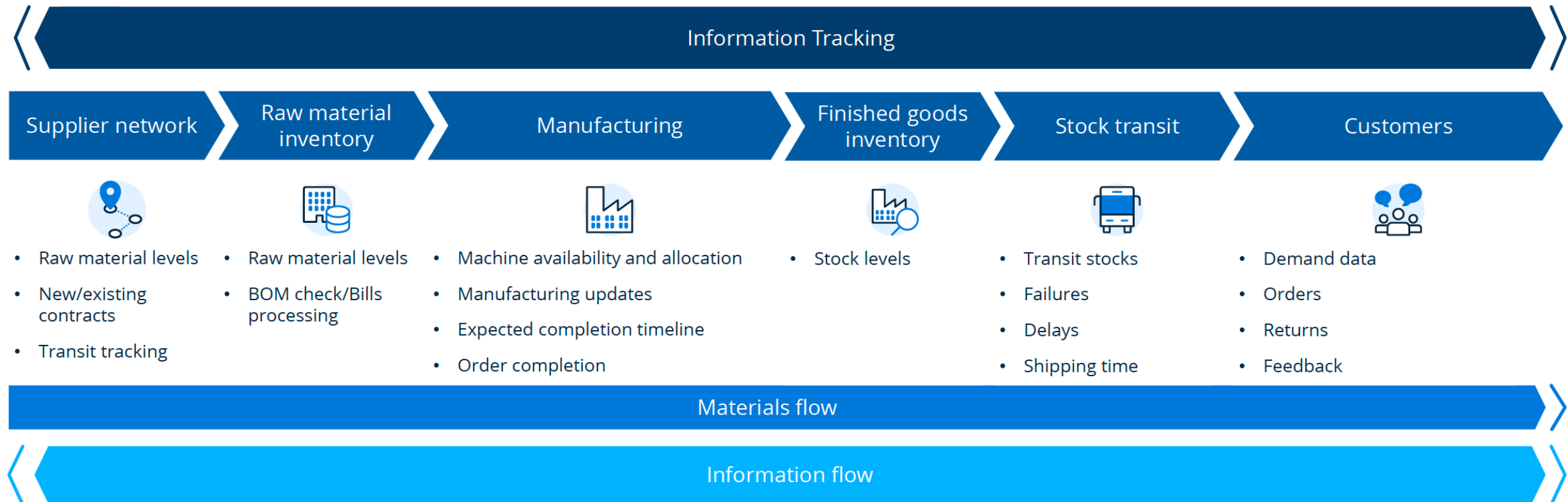
Source: Microsoft 2022 Work Trend Index

**Farewell Smart Working.
Welcome, Metaworking ...**

Connected supply chains facilitate the integrated production processes in smart factories

Automotive: Connected supply chain

Illustration of a connected supply chain



“Data Spaces” of supply chains active on European Gaia-X



<https://catena-x.net/en/>

Automotive Supply Chain



<https://agdatahub.eu/en/>

Agriculture



<https://bit.ly/3aJYgZL>

Manufacturing, Industry 4.0



<https://smart-connected.nl/en>

Electronics Supply Chain



<https://euprogigant.com/en/>

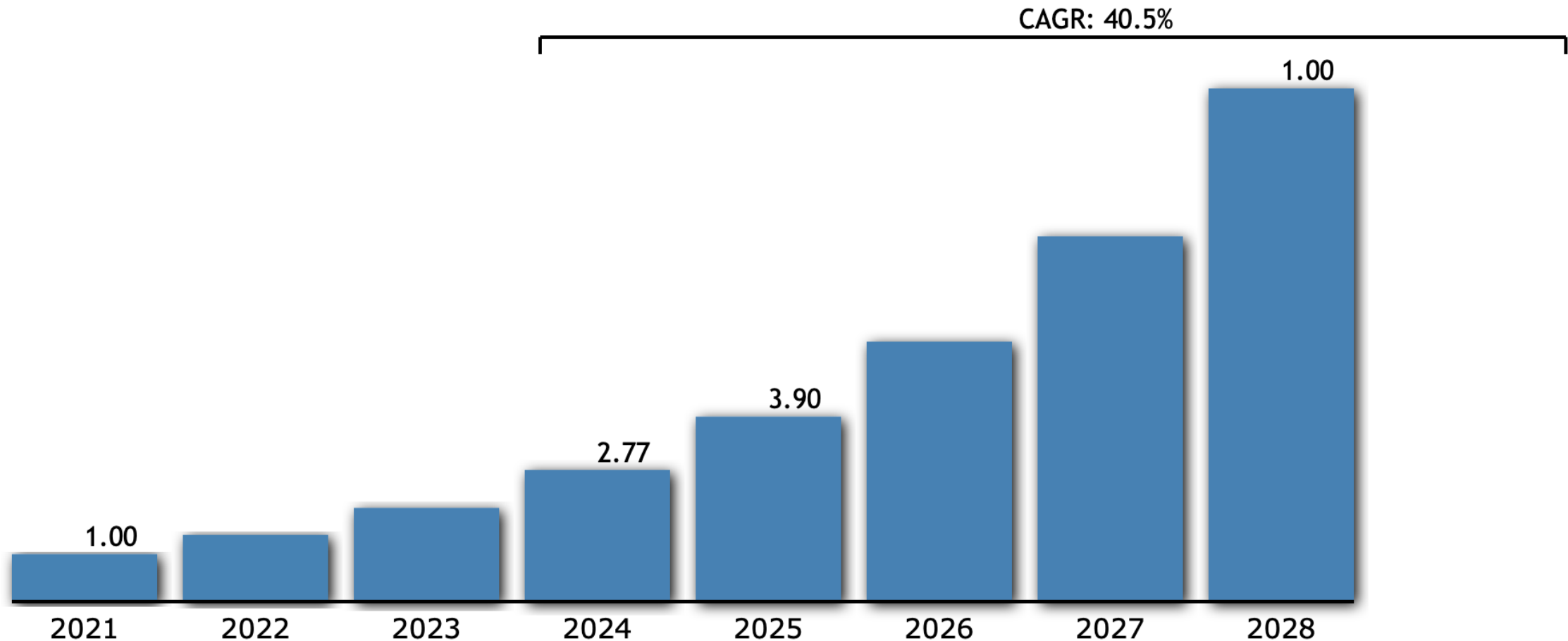
Manufacturing, Industry 4.0



<https://mobility-dataspace.eu/>

Mobility

METaverse IN AUTOMOTIVE MARKET SIZE 2021 TO 2028 (USD BL)



Renault Group launches the first industrial Metaverse

Renault Group is reaching a new step in its digital transformation by launching the first industrial Metaverse. It is based on four dimensions: mass data collection, digital twins of processes, connecting the Supply Chain ecosystem and a set of advanced technologies. By 2025, the Metaverse will generate savings of €320 million, plus €260 million in inventory savings, a 60% reduction in vehicle delivery time, a 50% reduction in the carbon footprint of vehicle manufacturing and a contribution to the 60% reduction in warranty costs targeted by the Group. Renault Group presents its Metaverse ambition, illustrated by 32 use cases, during its Tech Industry Days at the Refactory in Flins.

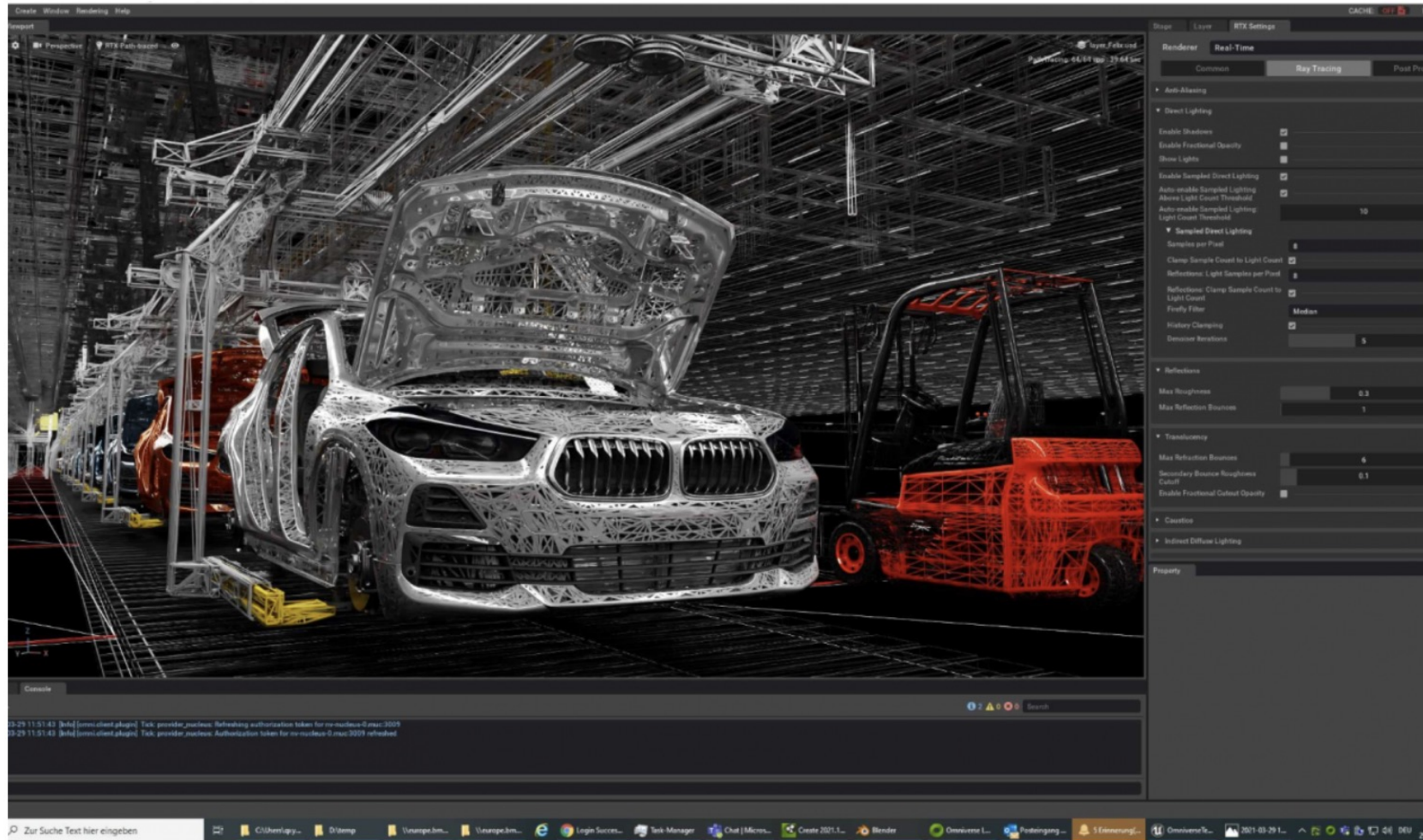
14 November 2022 14:00

<https://youtu.be/I2NtmlahbDU>



Boulogne-Billancourt, November 14, 2022 – Renault Group is accelerating its digitalization with the first industrial Metaverse. Today, 100% of production lines are connected (8,500 pieces of equipment), 90% of supply flows are constantly

BMW & NVIDIA OMNIVERSE



The BMW Group and NVIDIA are generating a completely new approach to planning highly complex manufacturing systems with the Omniverse platform

<https://youtu.be/6-DaWgg4zF8>



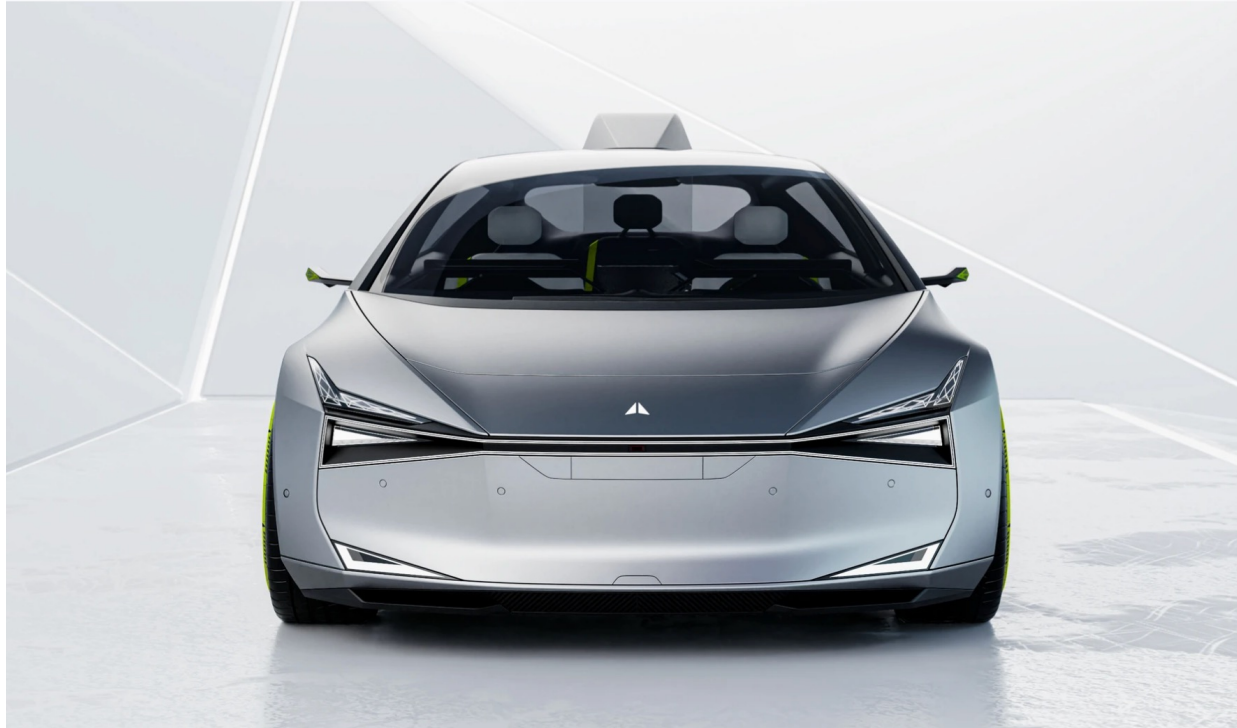
INDUSTRY NEWS

Microsoft Introduces Solutions from Assembly Line to Metaverse

The company's technology powers General Motors' latest vehicle software platform, Mercedes-Benz factories and Fiat's new virtual showroom.

Microsoft executive Judson Althoff (left) discusses MO360 Data Platform with Mercedes-Benz leaders Jan Brecht (center) and Jörg Burzer.

WayRay unveiled the world's first Metaverse on Wheels



Metaverse

Metaverse changes the way we engage with each other—learning, growing, working, and playing together in a shared virtual reality. This is a completely new way of traveling.

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Siemens e EPF: un concentrato di tecnologia al servizio dell'automazione industriale

Intelligenza artificiale e metaverso industriale anticipano quello che non c'è

Location: Carrù (CN), Italia

Highlights:

- AI: guida il robot nella ricerca della presa dell'oggetto
- Metaverso industriale: simulazione in ambiente fotorealistico per ottenere dati da analizzare e allenare l'AI
- Monitoraggio delle performance della macchina grazie a Siemens Industrial Edge



EPF

Fondata nel 1961, EPF è un'azienda italiana che si occupa dello sviluppo di soluzioni di robotica e di automazione industriale. Il core business è la realizzazione di impianti personalizzati per clienti dei settori automotive, food, toys, gadget e farmaceutico, con la missione di fornire soluzioni flessibili e innovative.

Soluzione/Portfolio

Supata è un'isola robotizzata pensata per adattarsi alle più svariate configurazioni impiantistiche in diversi settori merceologici industriali. Insieme a EPF, Siemens ha sviluppato una soluzione software che, integrandosi in un hardware ad hoc, abilita il deployment di modelli di Artificial Intelligence. L'integrazione con l'AI offre anche la possibilità di inserire in produzione nuovi pezzi senza riprogrammare la macchina, che li processa autonomamente e si imposta in automatico. I clienti di EPF chiedono flessibilità crescente. Grazie a la simulazione in ambiente fotorealistico, all'interno di un metaverso industriale, è possibile ottenere dati sintetici e allenare l'intelligenza artificiale, prima ancora che esista il nuovo pezzo. L'uso di modelli AI comporta la necessità di verificarne l'integrità nel tempo. Per questo si è resa necessaria l'implementazione della piattaforma di Industrial Edge di Siemens per monitorare le performance della macchina Supata, attraverso una app industriale.

Benefici

Oggi, a guidare il robot nella ricerca della presa dell'oggetto è l'AI, attraverso un processo ottimizzato in cui sono gli algoritmi a pianificare il minor numero di vibrazioni necessarie. Creare una simulazione in ambiente fotorealistico, all'interno di un metaverso industriale, grazie all'integrazione con la piattaforma di simulazione Omniverse di NVIDIA, permette al cliente di meglio comprendere come risolvere eventuali problemi o migliorare alcuni cicli produttivi.

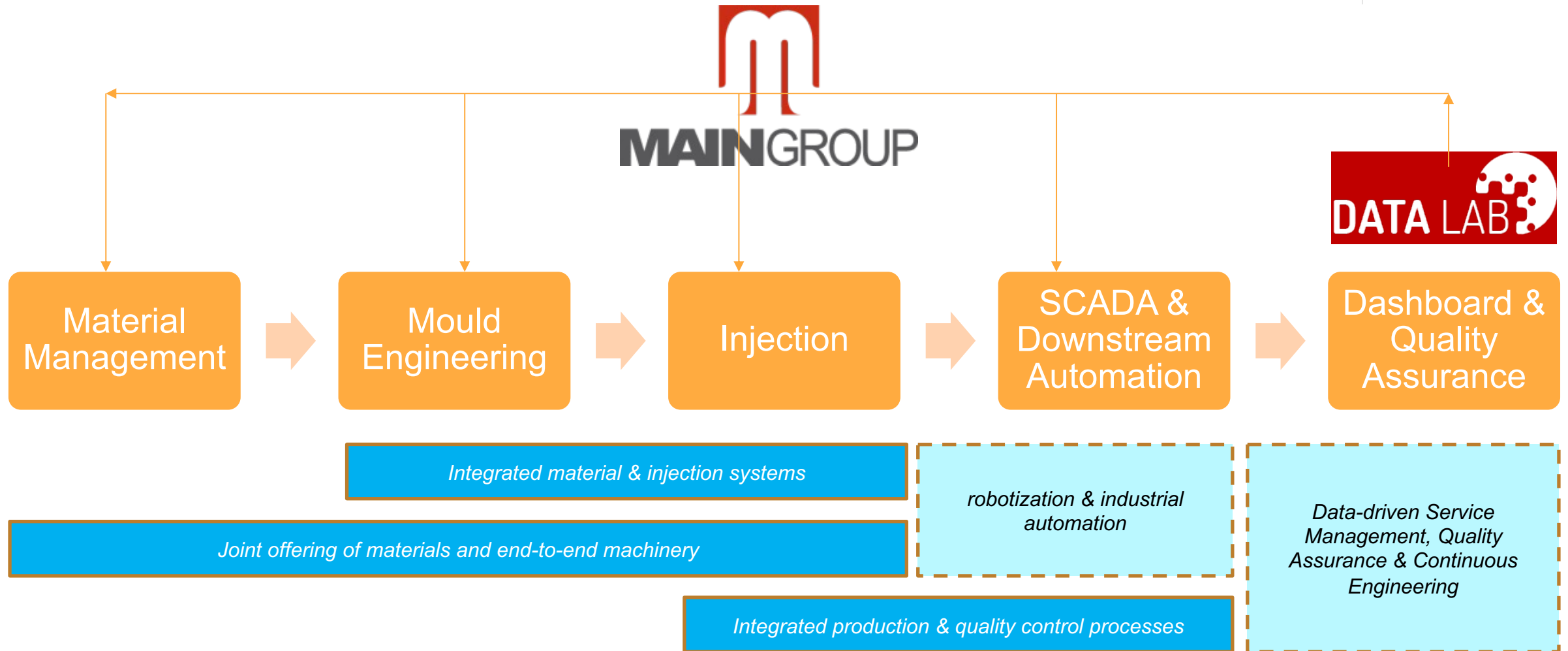
«Siemens non è più un semplice produttore e fornitore di componenti con cui equipaggiare le nostre macchine, ma un partner valido e competente nello sviluppo e implementazione di soluzioni innovative»

Franco Filippi, CEO EPF



SIEMENS

«Metaverse Factory» for sustainable production of shoes



Global Services & Datalab Offering

**IOT
PLATFORM:
KPIs INTELLIGENCE
FOR THE MANAGERS**



Turn data into insightful KPIs in 3 steps:

Visibility

Alerting

Predictive capacity

SCRAPS

COST

OEE

MAINTENANCE

TRACEABILITY for the most precise problem solving & history, enabling **SUSTAINABILITY** certifications

REAL-TIME AUTOMATIC ANALYSIS of the injection parameters and **SELF-ADJUSTMENT** to manufacture the perfect product

Sinergy with IoT Platform to analyze the real data and define the most effective self-adjustments parameters

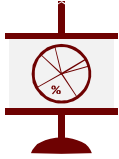


FINANCING: PAY-PER-USE FACILITIES & ASSET LIFECYCLE MANAGEMENT

**EDGE COMPUTING:
SMART MACHINES
FOR THE OPERATORS**



SERVICE MANAGEMENT & FINANCING
*GOVERNANCE DASHBOARD FOR FULL
SERVITIZATION AND «PAY-PER-USE»*

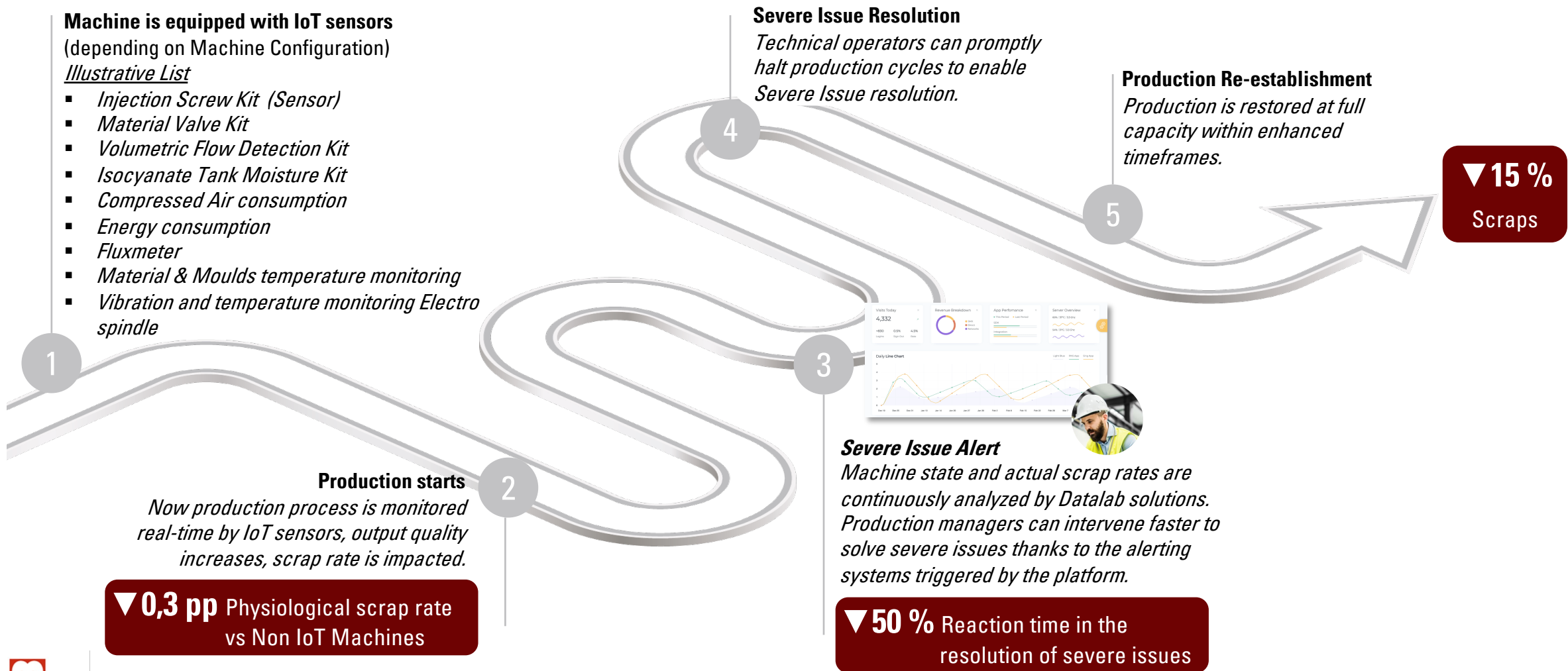
Expected Value | Areas of Impact

KPI	Area of Impact	Benefits from IoT & Datalab Solutions	Expected Impact
 <p>SCRAPS & COSTS <i>Scraps Causals Planned vs Actual Consumption Detail</i></p>	Scraps	<ul style="list-style-type: none"> ▪ Reduction in physiological scrap rate from 3% to 2,7% correlated to the overall production process monitoring and optimization unlocked thanks to the onboarded IoT Solutions ▪ Reduction in reaction times from 60 min. to 30 min. in case of severe issues that leads to peaks in scrap rate thanks to the alerting and reporting views unlocked through Datalab Solutions 	<p>▼ 15 %</p> <p>Scraps</p>
 <p>OEE <i>Injection Alert OEE Alert OEE Trend Analysis</i></p>	Productivity	<ul style="list-style-type: none"> ▪ Reduction of actual machine downtimes and micro stops in terms of length and occurrence thanks to advanced machine condition monitoring unlocked by both IoT Solutions and Datalab alerting and reporting systems ▪ Machine health state monitoring and reduction of extraordinary maintenance interventions during production time 	<p>▲ 0,6 %</p> <p>Machine Uptime</p>
 <p>MAINTENANCE <i>Machine Monitoring Monitoring Improvement</i></p>	Maintenance Interventions	<ul style="list-style-type: none"> ▪ Reduction of the “problem identification” phase during maintenance interventions thanks to the continuous machine parameters monitoring unlocked through Datalab solutions 	<p>▼ 5 %</p> <p>Costs for Maintenance Interventions</p>

Expected Value | User Journey_(1/3)



User Journey / Scraps





FOOD METAVERSE PLATFORM

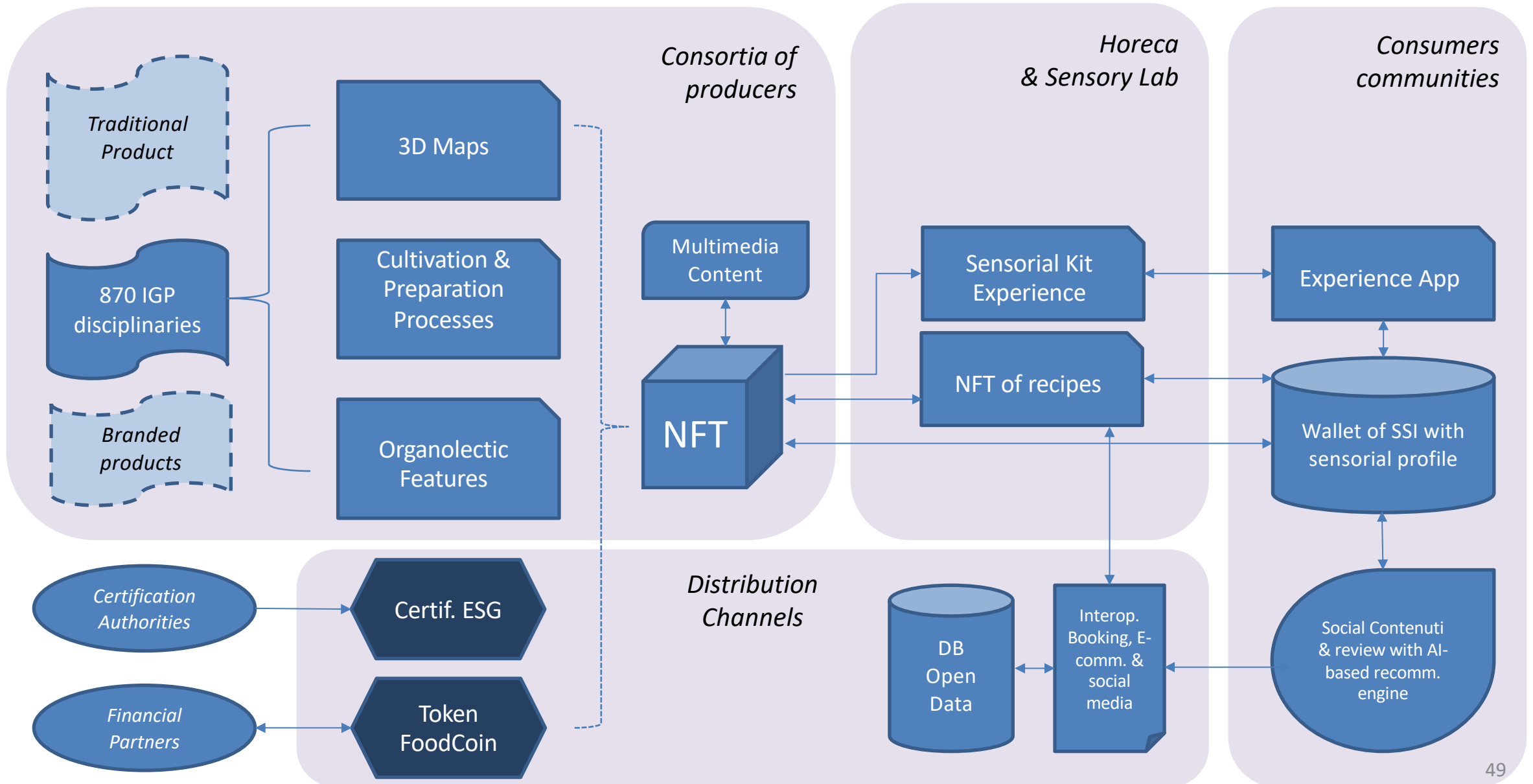
Protection
with NFT

ESG
Certification

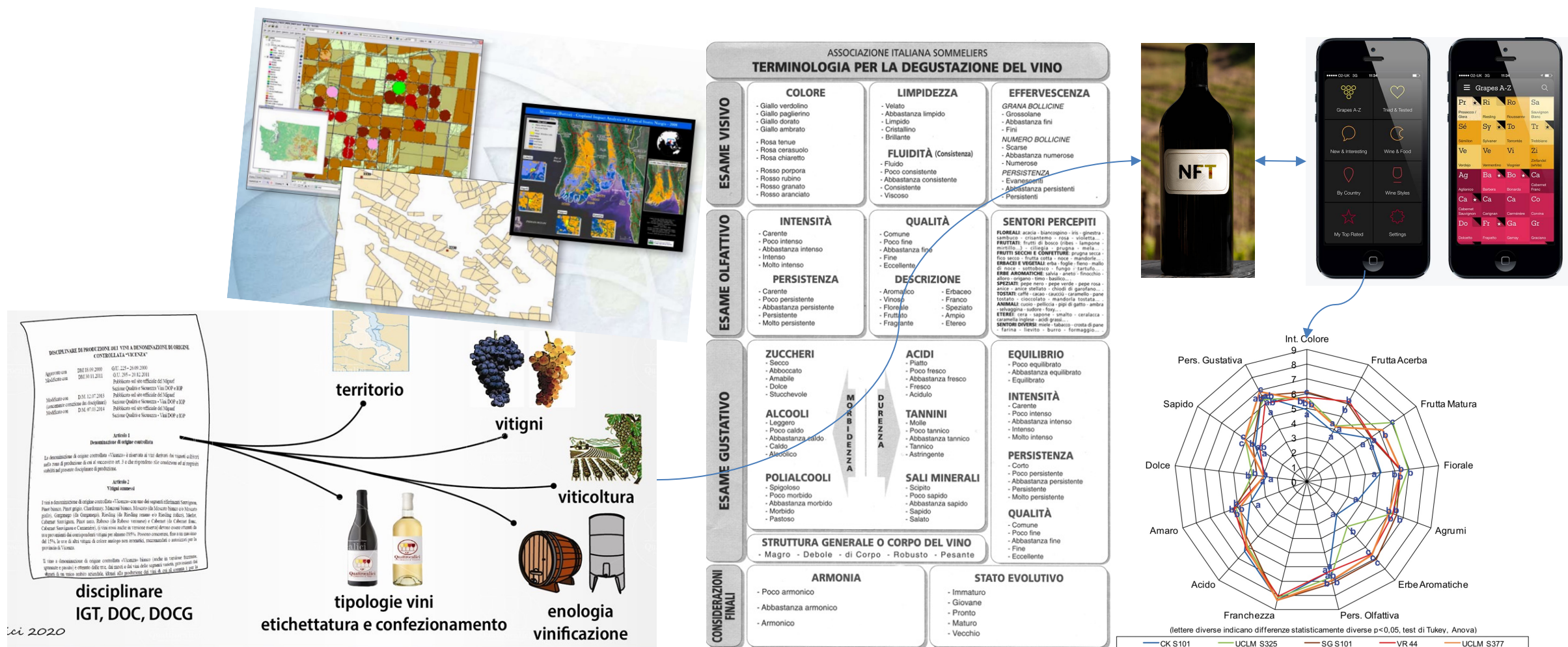
FoodCoin

Sensorial
Mapping

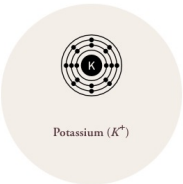
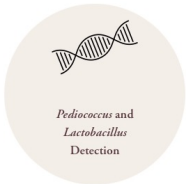
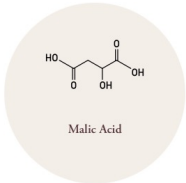
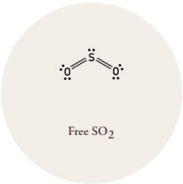
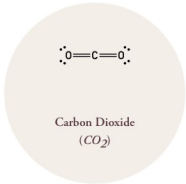
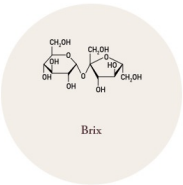
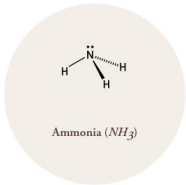
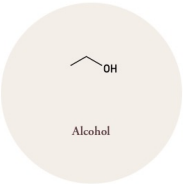
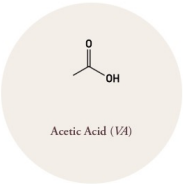
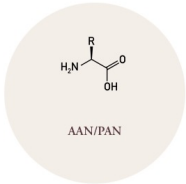
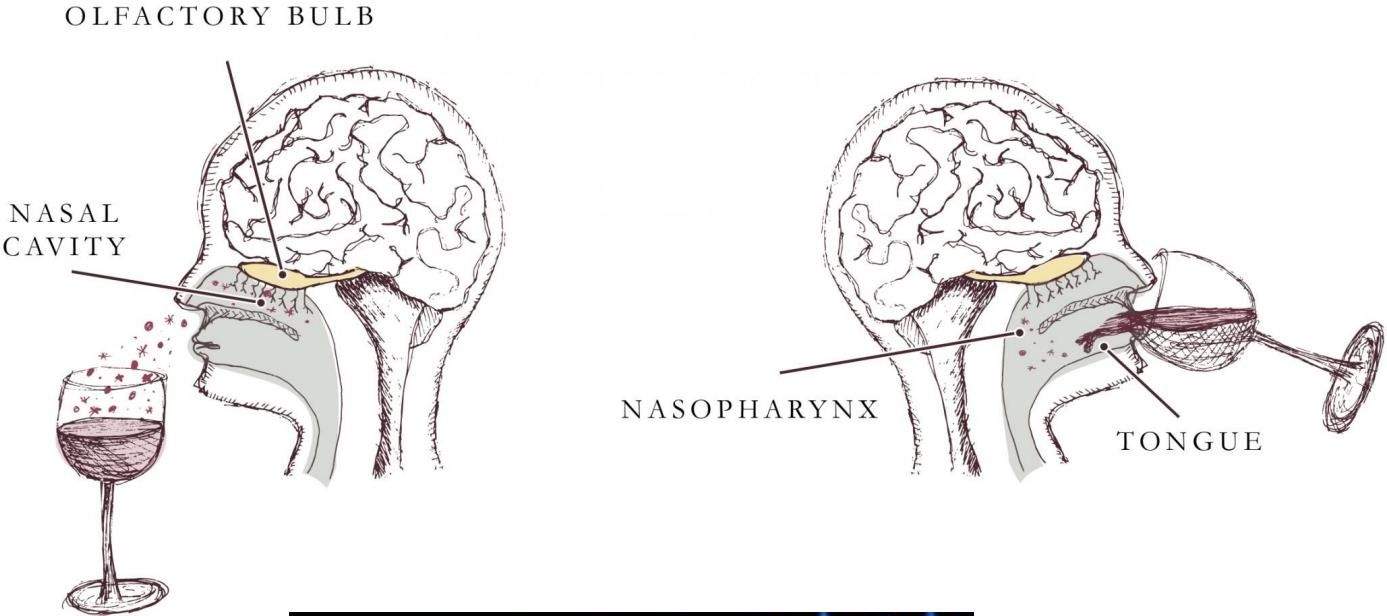
Food Metaverse Platform



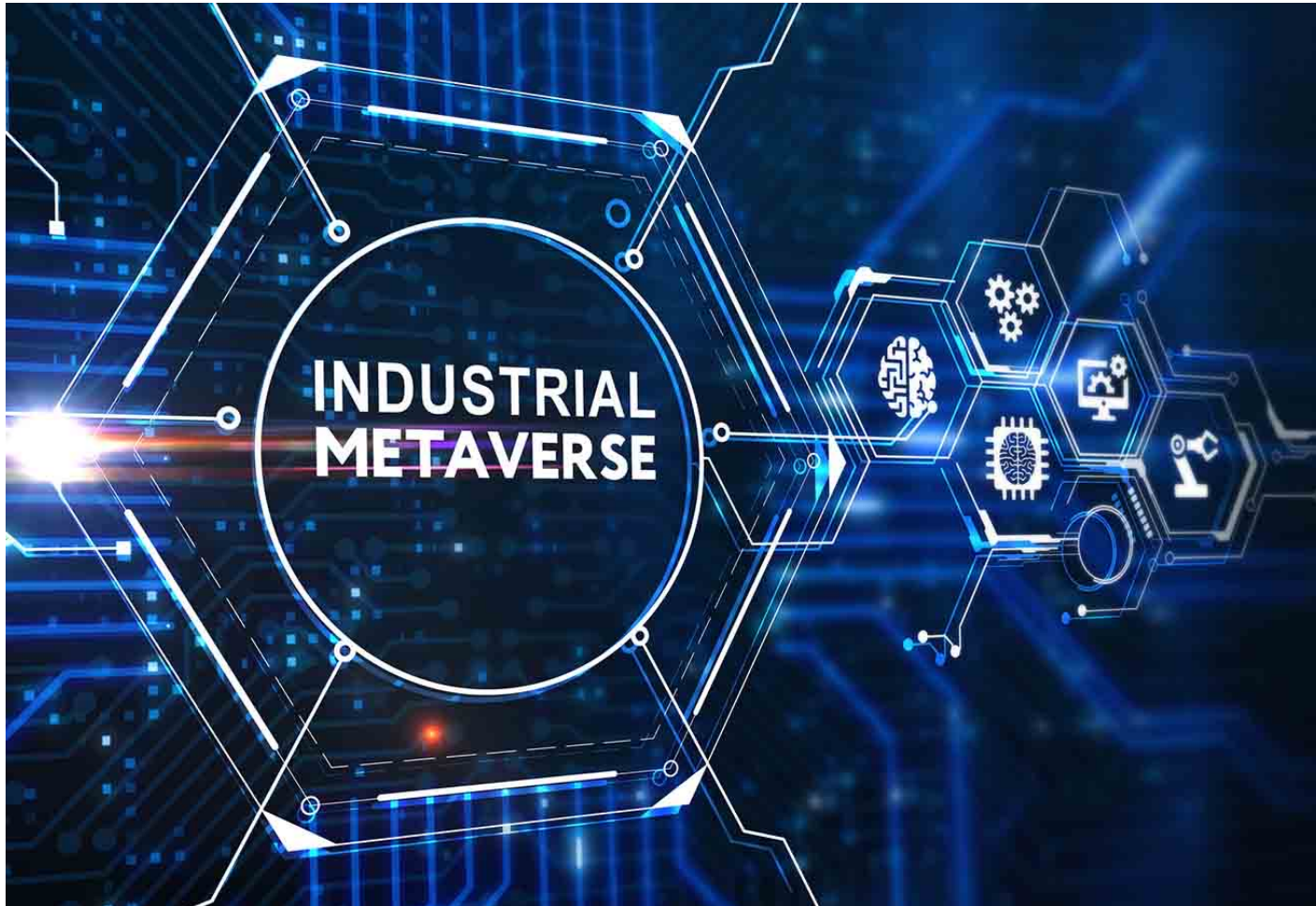
User Experience: the Wine Metaverse Platform



Neuroscience of «wine tasting»



Industrial Metaverse & SMEs: is it available?



It's already in the technology, but...

It's not yet in the organizational culture and in the business model of corporations.

Time to make it happen

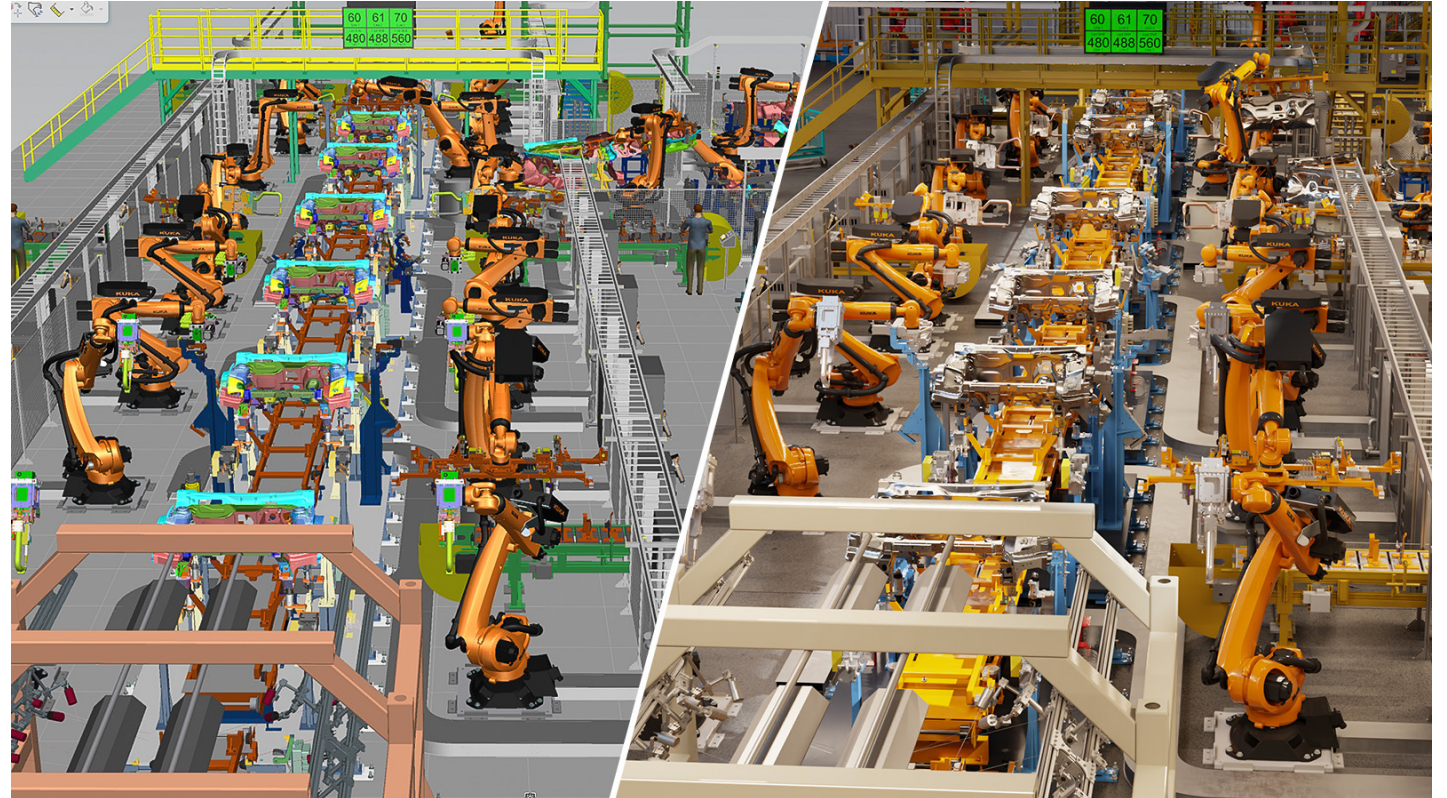
Industrial Metaverse & SMEs: How much does it cost?

It's a cloud-based logic, so it requires variable Opex, not fixed Capex.

But it calls for a new organizational culture and a new business model.

There's room for you, SMEs. It's not just for the big guys.

There's a cost for waiting: not participating implies losing the first mover advantage.

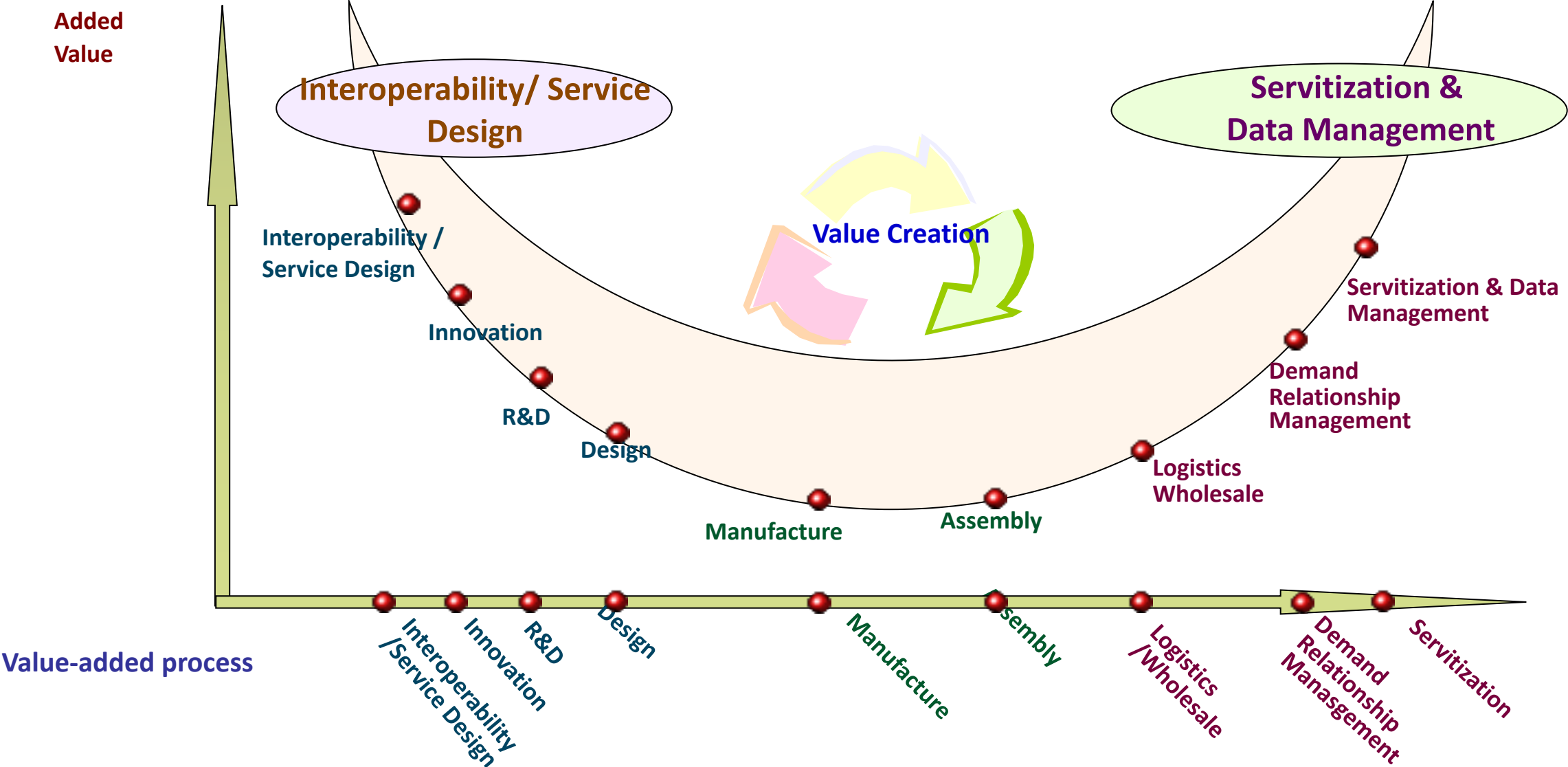


The Industrial Metaverse requires «connecting the dots» of organization and industrial processes



And now, smile! Value-added goes to the borders

(Adapted from source: Business Week International)



Thanks!

Arrivederci...

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