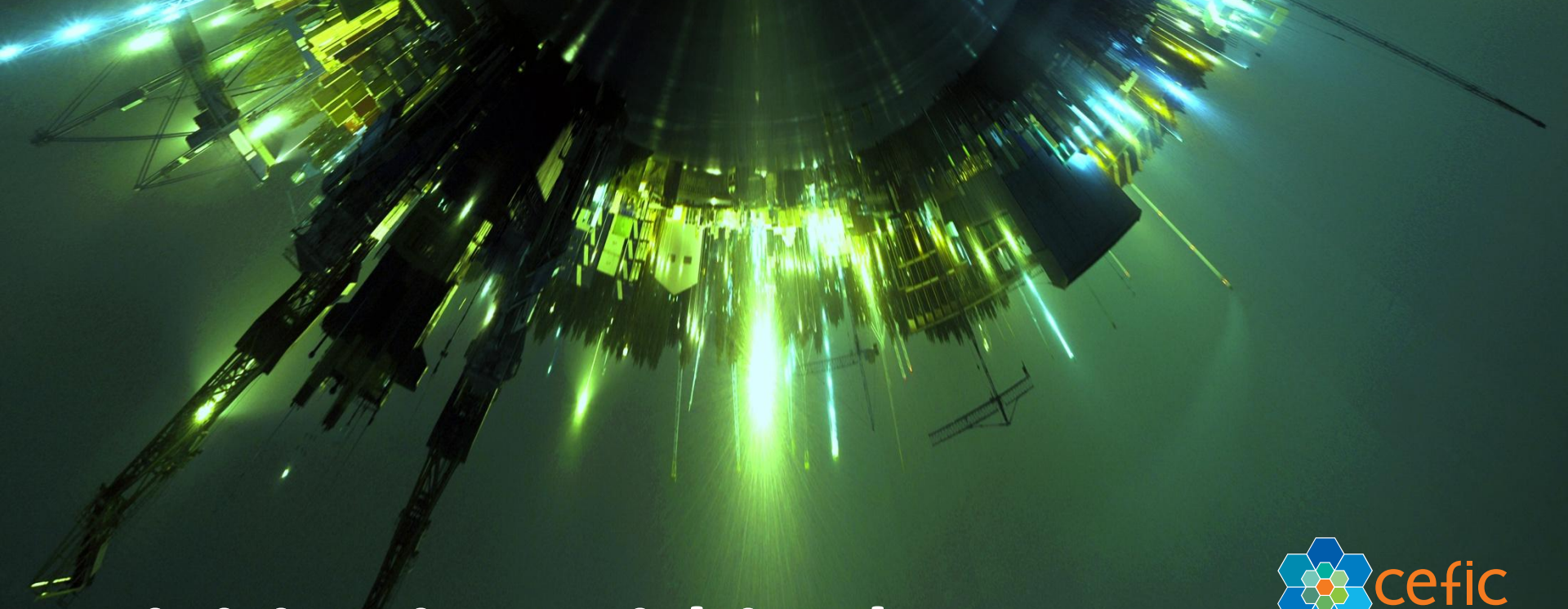


Digitization within the Chemical Industry

ECRN Event on Digitizing European Industry

22 March 2017

Martin Winter

Responsible Care®
OUR COMMITMENT TO SUSTAINABILITY

Profile of the EU Chemical Industry

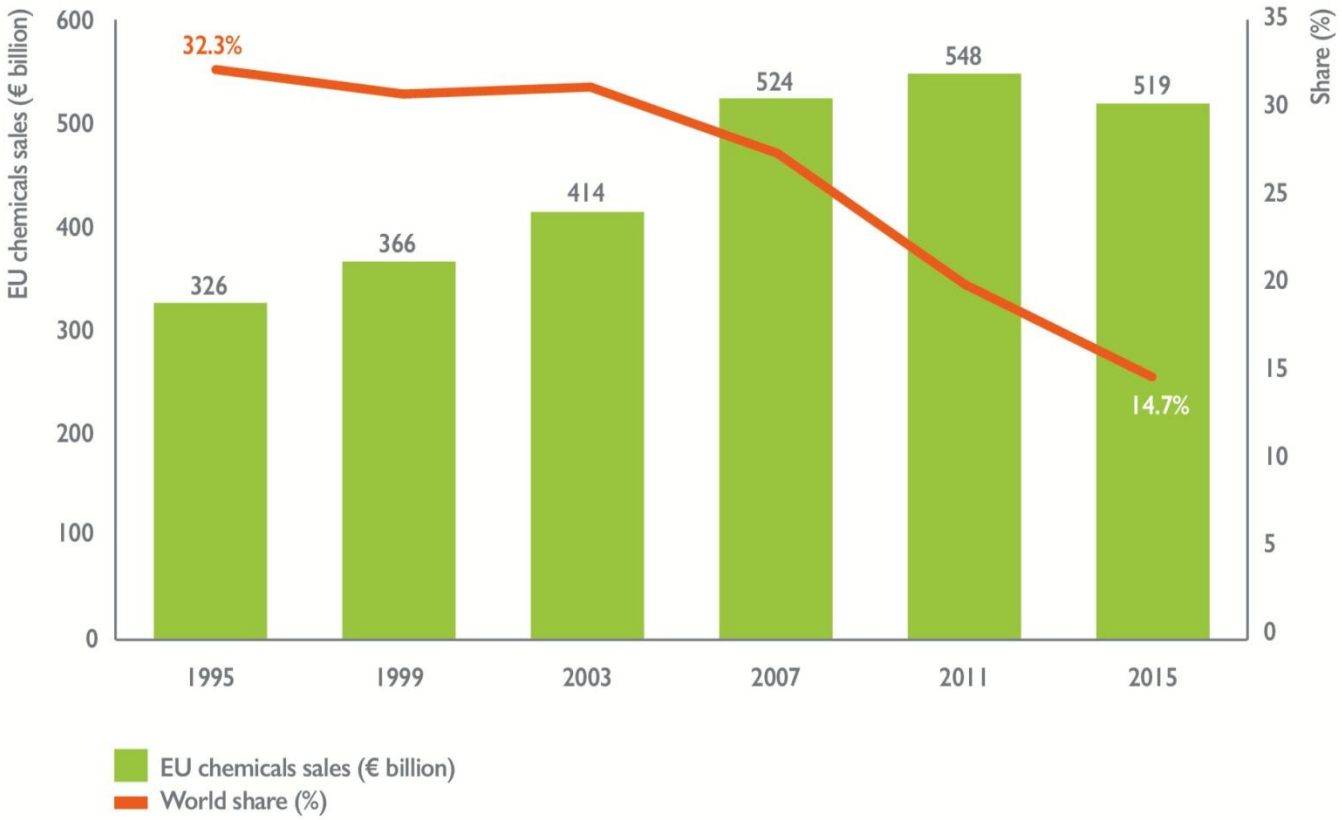
- 29 000 companies, 96% SMEs
- 1.17 million of jobs
- €551 billion of revenues
- 15% of the world's chemical sales

= key EU economic sector

Source: Cefic Chemdata International - data for 2014

EU chemicals sales increase by nearly 60% in 20 years, while its world market share halves

EU share of global chemicals market



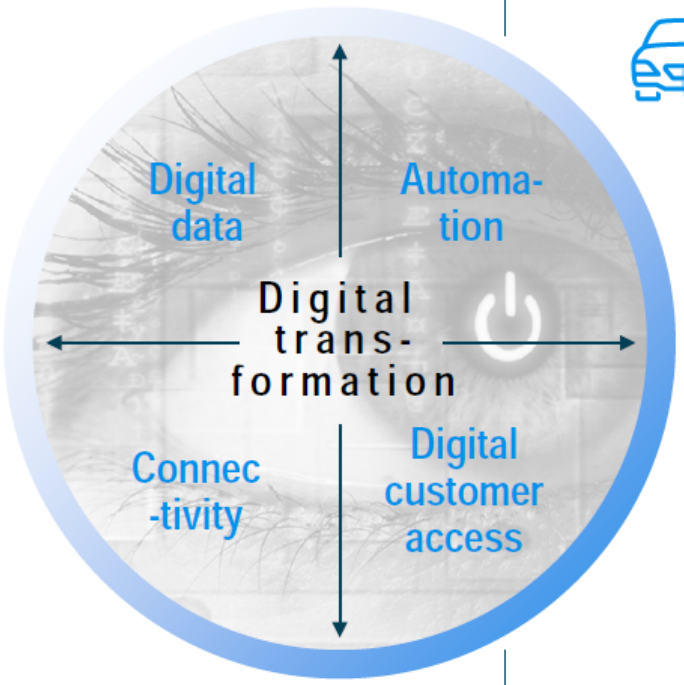
Source: Cefic Chemdata International 2016

Providing the essentials through the value chain

Digital deeply impacts all industries including the Chemical sector

300 decision makers were surveyed, 30 CEOs interviewed, expert workshops held on:

The **four levers** of the digital transformation …



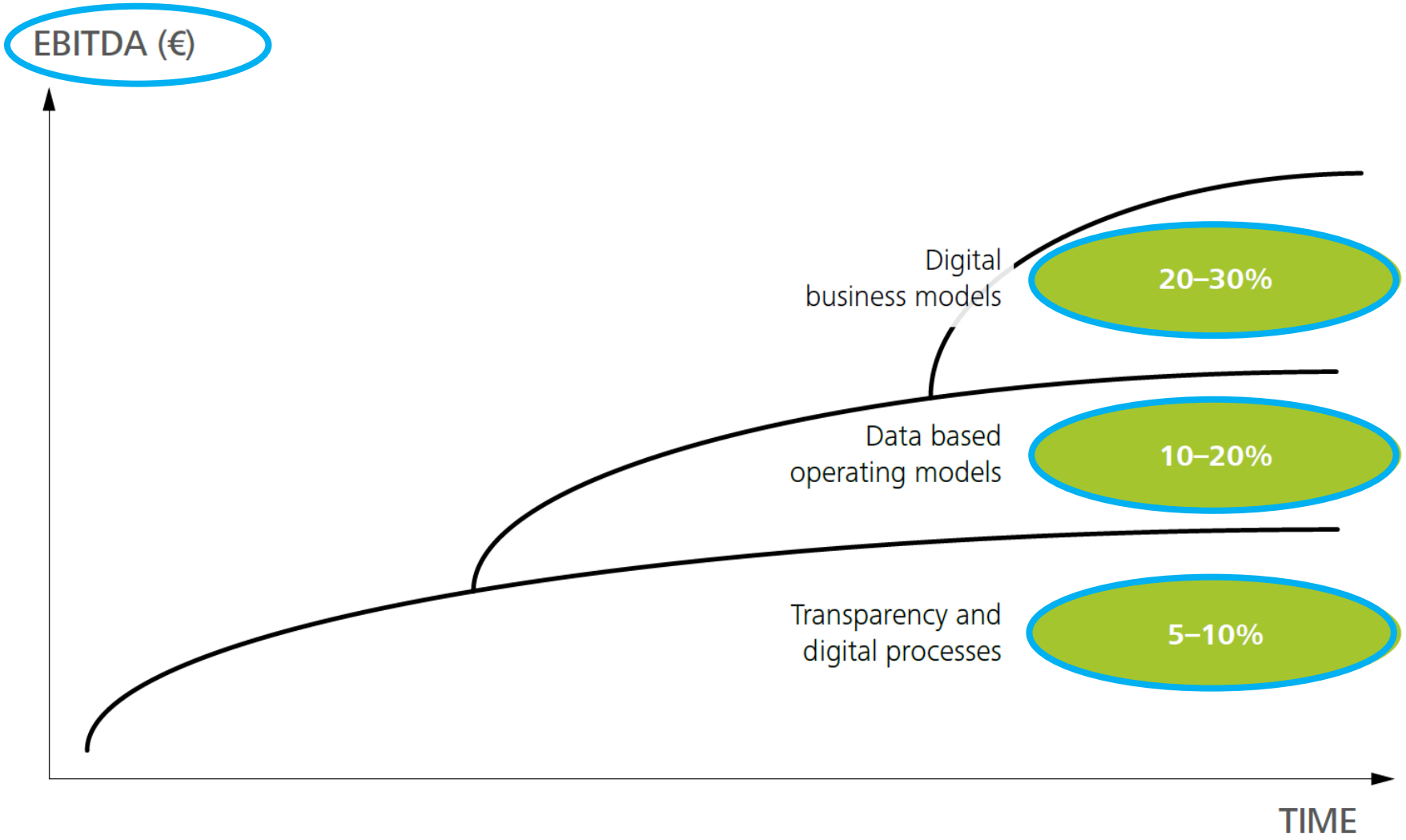
… and their impact on the **industrial heart** of Europe [bn GVA][1)]

- Automotive 140
- Aerospace & aviation 35
- Chemicals 124
- Electrical engineering 87
- Medical technology 43
- Logistics 271
- Mechanical & plant engineering [2)] 299

1) GVA = Gross value added, 2013, EU-15 states plus Norway, Turkey 2) Including energy systems

Source: Roland Berger

Digitization as key element to industry challenges and competitiveness



Source: Deloitte 2015

Emergence of new digital technologies – development goes faster and faster

5G

Cognitive Computing

Cloud Technology

Digital Twins

IoT

Virtual Reality

Data Fusion

Gamification

PAT

Track & Trace

Big Data

RFID

HPC

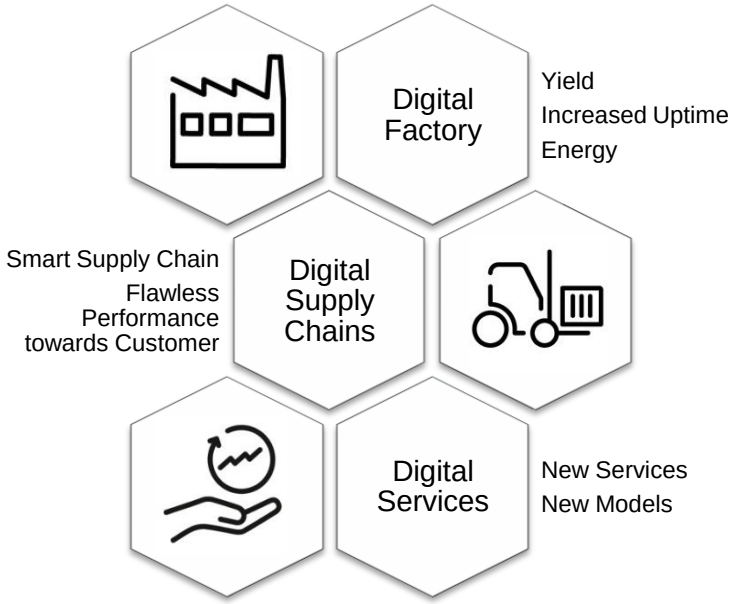
Deep Learning

Social Media

Transforming data in knowledge will be key to transform the industry

Data Management and Analysis

Key enablers in all fields of Process Industry



Discover Value out of Big Data

Novel methods are required to capture relevant information from many independent data sources

Digitization transforms the Chemical Industry rapidly across its entire horizontal value chain

Big-data/ advanced analytics in OpEx/ CapEx: Big data-driven raw material analytics to optimize feedstock costs

End to end supply chain integration: Production data sharing with suppliers/ real-time supply tracking

Process automation: Sensor-based production control and real-time optimization of YETQ[1]

Integrated lean system: IT-based integrated lean system to drive manufacturing excellence

Engineering/ R&D 4.0: Machine-learning-driven recipe and formulation improvements

New roads to market: Using online/marketplace sales channels

Digitization of customer experience: Customer self-service platform

THE DIGITAL CHEMICAL COMPANY

Digital procurement tools: Digital tools enabling more efficient procurement processes

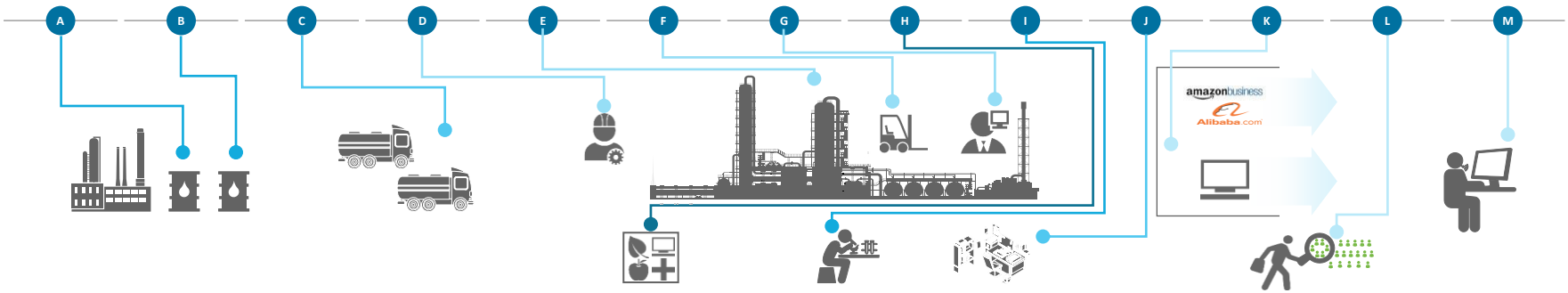
Predictive maintenance Advanced analytics-based predictive and risk-based maintenance

Digital manufacturing Production automation by application of autonomous logistics, drone inspections

Risk management: Advanced analytics-based risk manage-ment/cyber security

G&A 4.0: Back office automation, e.g., no touch orders

Commercial engines: Use advanced analytics for lead generation, etc.



PLUS: new, radically different business models

1 Yield, energy, throughput, and quality

SOURCE: GEM Digital Task Force

1) Digital Plant

Digitalization enables the entire manufacturing chain for more efficient operations

a. Real-time capability - provide correct process information to authorized users in real-time

b. Feedback control to detect deviations and adjust operations immediately decision support

c. Asset performance management/predictive maintenance

d. Advanced operator support

e. 'Digital Twin' (virtual plant models) to predict the of impact of (design) decisions and to anticipate looming events and bottlenecks

f. Integrated production planning

g. Information integration across operations and enterprise technology layers

h. End-to-end (financial) visibility from top-floor to shop-floor

- ✓ Higher plant availability and throughput
- ✓ Better predictability of manufacturing
- ✓ Reduced lead times
- ✓ Higher flexibility and agility/remote operations
- ✓ Less quality issues
- ✓ Less consumption of energy and raw materials
- ✓ Less costs for lab analyses
- ✓ More efficient plant maintenance
- ✓ More efficient allocation of staff

….

Source: SusChem/SPIRE Working Groups, Accenture

2) Digital Marketing & Sales

Exploit new revenue opportunities incl. radically different business models

a. Pricing excellence
b. Sales and service excellence
c. Marketing excellence
d. Marketing & sales channel optimization

- ✓ New business models
- ✓ Increase revenue/decrease cost-to-serve
- ✓ Seamless multi-channel experience
- ✓ Better understanding of evolving market needs
- ✓ Improved insight into the competitive landscape
- ✓ Ability to more quickly react to market demand and cyclicality
- ✓ Tailored products
- ✓ Customer awareness

Source: SusChem/SPIRE Working Groups, Accenture

Example innovation in process digitization

Advance the production of high-value products that meet high quality demands in flexible intensified continuous plants: Not possible without fast and accurate **online sensing of key product and process parameters including closed-loop control and online optimization**

Characteristics

- Miniaturized equipment
- Intensified heat & mass transfer
- Possibly modular setup

Benefits

- Product uniformity
- Sustainability
- Fast adaption to market demand
- Innovative products

CONSENS INTEGRATED CONTROL AND SENSING

SPIRE Sustainable Process Industry through Resource and Energy Efficiency

SusChem European Technology Platform For SUSTAINABLE CHEMISTRY

Source: CONSENS

Investment in digital innovation to strengthen competitiveness of industry is required

- **Modeling, Simulation and Forecast:** integrate modelling of single processes into production routes and value chains
- **Digital Twin - Virtual Plant Models**: predict the of impact of (design-) decisions and to anticipate looming events and bottlenecks
- **Real Time Data Availability:** through reliable, fast, accurate and intelligent self-optimizing measurement systems (sensors), product quality, plant equipment
- **Transforming 'Big Data' to relevant Information:** identify universal and reliable solutions to "mine", handle and interpret data, high performance computing
- **Condition Based Advanced Maintenance:** develop tools and methods allowing remote control of equipment, prediction and prevention of failures
- **Resource and Energy Life-Cycle Assessment:** enable monitoring of environmental targets into all control systems to optimize performance
- **Data Security:** develop advanced security solutions to prevent misuses of stored / cloud data
- **Standardization:** software and hardware platforms
- **Human-Machine Interface:** develop intuitive and user friendly interfaces
- **Operator Skills:** The digital engineer and plant operator

Summary

1. Companies supply chains, manufacturing plants & sites, sales & marketing organization more and more benefit from integrating digital innovations such as novel sensors, data capturing, planning and control, modelling and simulation, cloud computing and (big) data analysis into their operations
2. Manufacturing is both “discrete” and “continuous”: Needs of process/continuous industries should be equally considered in comparison to discrete manufacturing to avoid lacking behind. The European chemical industry strongly contributes to the economic roots of the European economy by transforming raw materials into intermediate as base for end-user products
3. Beyond extensive use of digital technology the chemical industry is a key provider of many materials and manufacturing technologies which enable many of todays and future ICT solutions
4. Further investments in innovation (e.g. by the SPIRE cPPP funding instrument on European level) is required to support the development and demonstration/implementation of fast emerging digital technologies

Thank you for your attention

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www.twitter.com/Cefic

Digitization transforms the Chemical Industry rapidly

Supply Chain/Raw Material Sourcing

- Supplier management
- Inbound logistic
- Warehouse management

Manufacturing Operations
Production planning
Quality management
Blending/customizing
Optimization
Maintenance

Distribution
Filling/packaging/labeling
Order processing
Outbound logistic
Warehouse management
Claims/returns management

Delivery
Transport management
Customer relationship
Differentiated service

Digitization transforms the Chemical Industry rapidly across its entire chain

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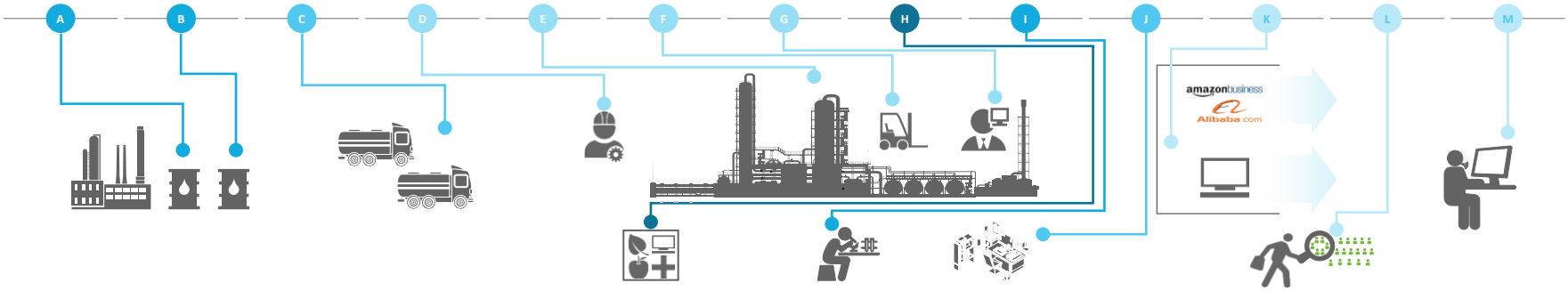

PLUS: new, radically different business models

DIGITAL ENABLERS

N

Strategy: Long-term oriented digital strategy, aligned with corporate goals and centered around customer needs

O

Capabilities: Technology infrastructure, advanced analytics skills, big data, machine learning etc.

P

Organization: Well-performing digital organization based on digital talent/leadership, governance/KPIs, and clear digital roles/ responsibilities

Q

Culture: Digital-embracing culture with highly agile digital organization, "test and learn" environment, and strong digital risk appetite

1 Yield, energy, throughput, and quality

SOURCE: GEM Digital Task Force