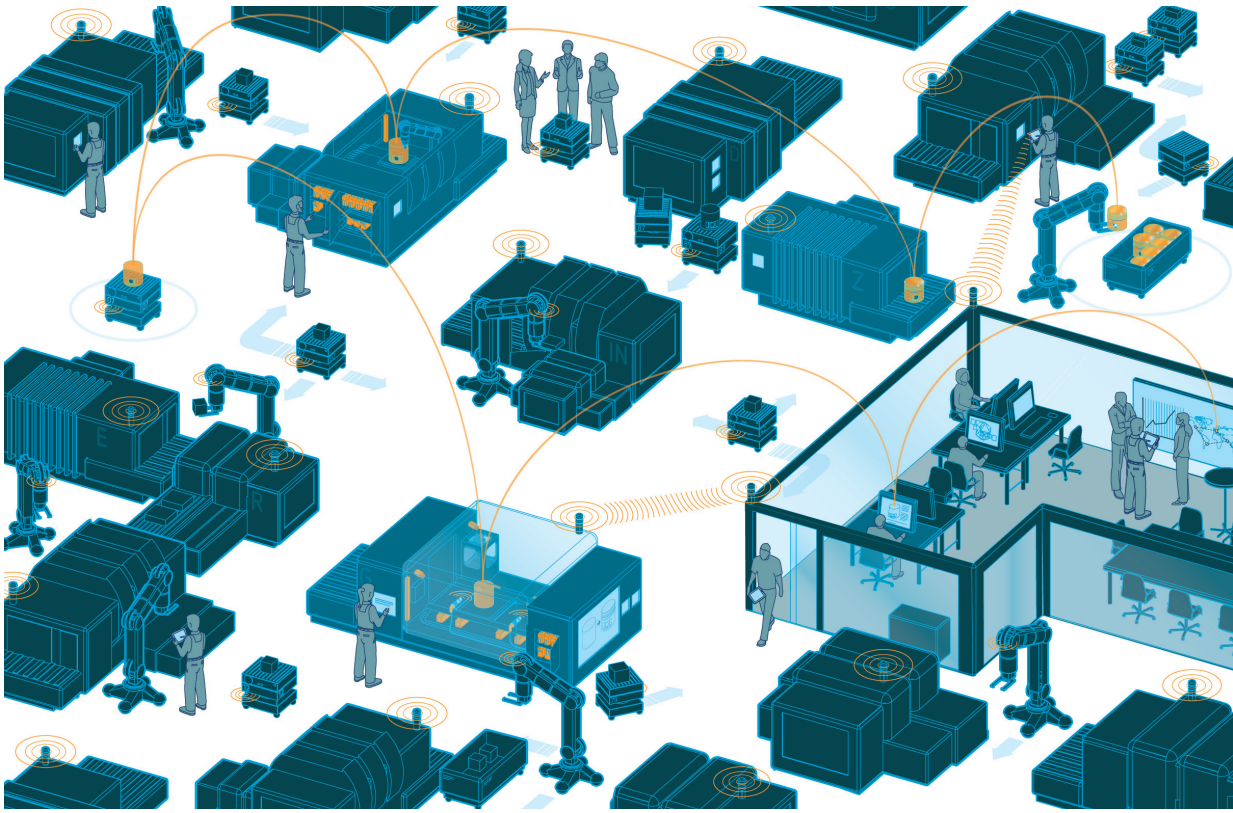
ZVEI:
Die Elektroindustrie

Position Paper

Industrie 4.0: On the way to the smart factory – the electrical industry is pushing forward



German Electrical and Electronic Manufacturers' Association

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Impressum
Position Paper
Industrie 4.0: On the way to the smart factory – the electrical industry is pushing forward

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1. What is Industrie 4.0?

The impact of digitization is already very clear to see in many industries: prominent examples include streaming services in the music industry, the taxi service Uber, 3D printing and the digitization of the media industry. Many of these examples are disruptive technologies that shake up traditional business models and can even make them obsolete. Disruptive technologies result in major changes in value creation.

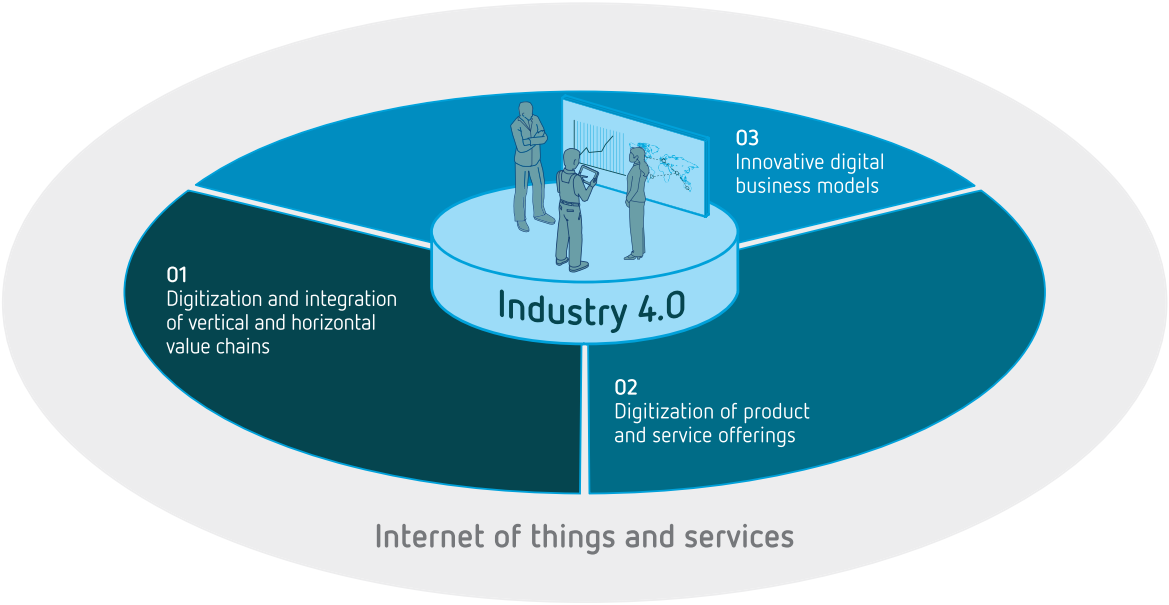
The advancing digitization and networking of production is also changing value chains in industry – this transformation is known in Germany as Industrie 4.0. The term "Industrie 4.0" stands for the interaction of three factors: the digitization and integration of vertical and horizontal value chains, the digitization of products and service offerings, and new digital business models. This results in new solutions being created for the Internet of Things, Services and People. Figure 1 summarizes these three aspects of Industrie 4.0.

The digitization and integration of the value chains means that data from various phases of the product life cycle is available across companies – from the quotation process through to production and on-site service. All companies in the value creation network can thus access the data they need at any time. For example, mechanical engineers receive the component supplier data that is relevant to them, and users integrate the mechanical engineers' digital construction data into the design of their factory buildings in advance. This results in increased efficiency, which benefits all those involved.

For this purpose, however, information regarding products and services must be available in digital format. The digitization of products and services means the complete virtual description of services and products.

However, end-to-end digitization also facilitates completely new digital business models. Services and offerings are created that bring the user decisive advantages using data that is, for instance, in the cloud: examples are more efficient and predictive maintenance of equipment.

Fig. 1: The three central aspects of Industrie 4.0



Source: ZVEI, based on PwC

2. Industrie 4.0: ZVEI leads the electrical industry

The German electrical industry plays a key role when it comes to implementing smart factories in the manufacturing and smart plants in processing industry. Its know-how, equipment and systems are the enabler for the transition to digital production that transcends geographical boundaries.

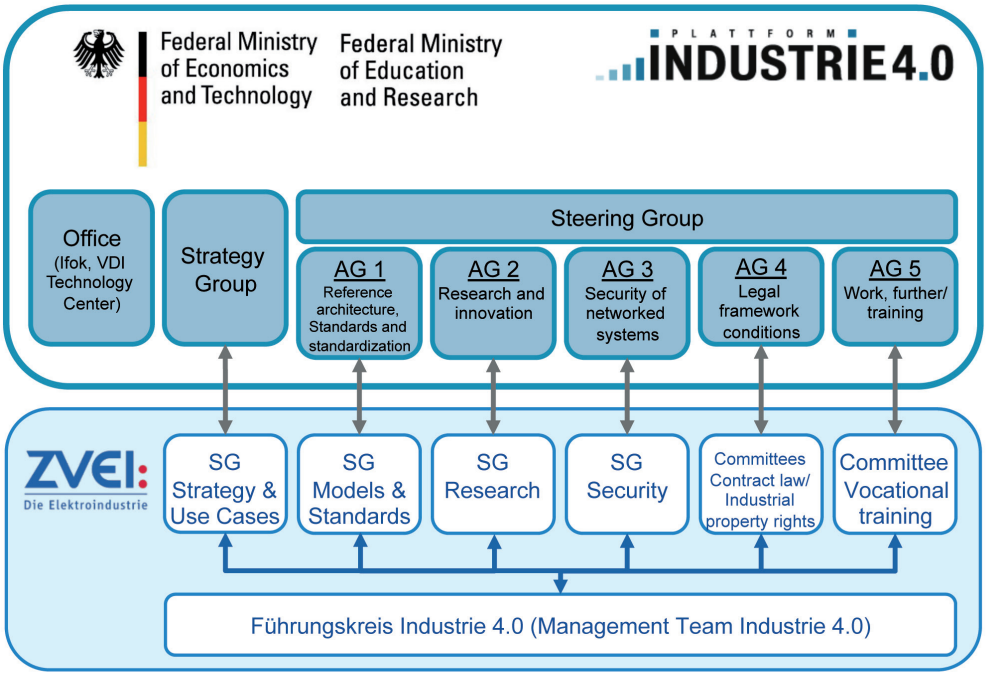
ZVEI member companies undoubtedly have the knowledge of manufacturing and business processes in the manufacturing and process industry as well as the expertise to produce Industrie 4.0 technologies. Automation forms the interface between machines and production in the Internet of Things, Services and People. It both equips and uses Industrie 4.0. For this reason, a holistic understanding of Industrie 4.0 developed here first.

This is the basis on which member companies in the ZVEI-Führungskreis Industrie 4.0 (Management Team Industrie 4.0) are working on architecture models and the associated standards. As Figure 2 shows, this work is carried out in the Plattform Industrie 4.0 in close cooperation with many different parties, including the mechanical engineering and ICT sectors.

ZVEI has worked in cooperation with the VDI/VDE-Society for Measurement and Automatic Control (GMA) to make a crucial contribution to the Plattform Industrie 4.0 using the Reference Architecture Model Industrie 4.0 (RAMI 4.0) and Industrie 4.0 component (see details in Section 6).

The most important point is for companies to implement this now. Digitization represents both an opportunity and a challenge for every company – whether it is a corporate group, a mid-sized enterprise or even a small business.

Fig. 2: ZVEI-Führungskreis Industrie 4.0 supports the Plattform Industrie 4.0



AG: Arbeitsgruppe – Working Group
SG: Spiegelgremium – Mirror Group

Source: ZVEI

Firstly, new – sometimes disruptive – opportunities arise to become established in markets and new fields of business. Secondly, there is a risk that companies may miss the boat when it comes to new trends. This jeopardizes the future viability of companies, particularly if they are unaware of these challenges or simply ignore them.

With this in mind, ZVEI is introducing the topic of Industrie 4.0 in particular to the small and medium-sized companies that play such an important role in the German economy, as well as highlighting the far-reaching implications for our sector and markets.

RAMI 4.0 and the Industrie 4.0 component form the basis for Industrie 4.0. Now the important point is to find reliable approaches for implementation.

3. Making Industrie 4.0 feasible (and understandable)

It is not sufficient to describe Industrie 4.0 as models. The benefits of the new technology must be clearly demonstrated if the vision of fully networked and digitized production is to become reality. For this reason, the ZVEI use cases focus on typical problems that confront users of automation technology in their production facilities and which can be solved with Industrie 4.0 technologies. This clearly illustrates the added value and benefits of these solutions in an actual production environment. Furthermore, the ZVEI use cases also allow Industrie 4.0 to develop along standardized lines using the Reference Architecture Model Industrie 4.0 and the Industrie 4.0 component, and it also allows the models themselves to develop.

When doing this, ZVEI works closely with companies across the spectrum of industrial production – including the process industry, mechanical engineering and the automobile sector – and creates demonstrators for this.

The policy can help to establish Industrie 4.0 on a broad front and create orientation for companies. When it comes to the use cases, the ZVEI progresses the project with the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) and implements the theoretical work of the Industrie 4.0 platform practically. Full, academically led implementation of the use cases into Industrie 4.0 solutions along RAMI 4.0 can be supported by selective research funding. When granting funding, it is essential that Government-funded projects should take the application and work with RAMI 4.0 into account.

4. Industrie 4.0 has new players

Integration of value-adding chains and digitization of products require more IT expertise in automation: companies develop their software expertise and new players from the software sector dare to enter the factory and equipment environment with their business ideas. This creates new partnerships but also new competitors.

ZVEI encourages the exchange between established companies in the electrical industry and start-ups from the software sector. Here the Association is the platform where automation companies with their high level of expertise in the sector come together with suppliers of digital services and solutions from the software sector. At the same time, established companies from the electrical industry have what it takes to become suppliers of new, smart services and to penetrate further into the ICT sector.

Industry-orientated start-ups need special support in Germany. ZVEI is demanding that demonstration centers and projects, in particular, need to receive greater state support as a suitable test environment for start-ups and SMEs. Improved tax framework conditions for young companies and venture capital investors are also required.

5. Networking starts in people's heads

Industrie 4.0 needs competent employees: Industrie 4.0 is not about "men or machines" but it is actually about "men with machines". It is men who orchestrate Industrie 4.0. They must interpret information correctly and make decisions.

Employees must therefore be qualified for future tasks. The work in the smart factory of the future will place greater demands on the individual skills of employees in relation to complexity, and abstraction and problem-solving capabilities. Apart from these new demands, Industrie 4.0 also offers tremendous opportunities for enriching the quality of work, reducing the physical burden of hard work activities, giving more individual responsibility and therefore offering the employee increasing self-fulfillment.

The electrical professions that ZVEI has co-developed are, even now, system oriented and designed for cross-sector cooperation. Flexible training regimes permit the necessary adaptation to business requirements and technical development and therefore also to Industrie 4.0. Continuous further training puts employees in a position to keep pace with rapid technical development. Therefore, in the coming years the focus must be on further training. Software expertise and the ability to model complex industrial processes and implement them in digital systems are becoming increasingly important for engineering degree courses at universities and colleges. For this reason, the amount of IT taught must not be reduced in engineering degrees.

In order to counteract the lack of skilled labor in Germany, ZVEI sees three areas where policymakers must act:

- The early nurturing of young talent in what are known in German as the MINT subjects, i.e. math, information technology, natural sciences and technology, by teaching math and natural sciences at schools, which arouses pupils' interest in technology at an early stage,

- The comprehensive development of childcare in order to make it easier to combine work and family commitments,

- The rapid integration of qualified immigrants. These include, among other measures, further simplification of the recognition of foreign school, university and vocational qualifications.

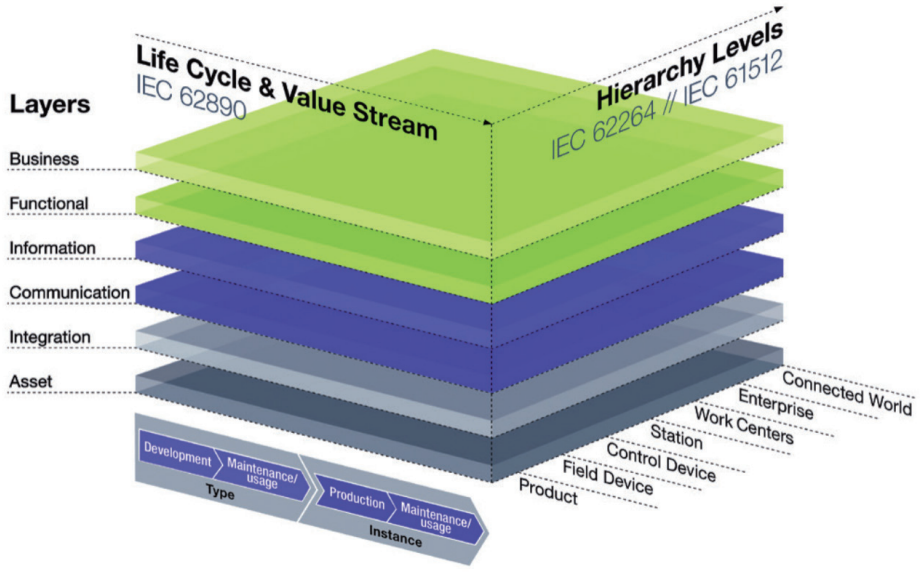
6. Global standards for Industrie 4.0

It is intended that, in future, workpieces and machines will communicate between each other autonomously within and between smart factories. To do this, the workpiece and production system must be networked to each other intelligently. This only operates via standards that describe the communication between the components. Furthermore, the smart factory is part of a global value creation network: it therefore needs global standards, preferably from the internationally recognized standards organizations.

Parallel to this and initially, technical specifications, i.e. not fully consensus based and therefore documents that can be published more quickly such as the DIN SPEC or VDE application rules, of special user groups (e.g. the electrical industry) become guidelines for the development of a common standard. This also includes radio links according to IEEE standards, product characteristic descriptions such as offered by eCl@ss, or machine communication in accordance with standards such as OPC UA (transferred into standards, DIN EN 62541).

Apart from consensus-based standardization, the Association also supports the use of specifications. They can frequently be tried out and applied on the market. The German electrical industry has produced the reference architecture model RAMI 4.0 and the Industrie 4.0 component with the decisive involvement

Fig. 3: Reference Architecture Model Industrie 4.0 (RAMI 4.0)



Source: ZVEI, Plattform Industrie 4.0

of ZVEI experts. The architecture model is a type of three-dimensional map for Industrie 4.0 solutions. The model provides guidance in respect of existing standards and gaps in standardization and therefore creates a shared understanding.

The Industrie 4.0 component is a model for objects in the Industrie 4.0 production environment. It describes the association of a physical object to the digital world via a virtual representation of the administration shell. The model therefore acts as a template so that hardware and software components with Industrie 4.0 capability can be developed.

Both models are now transposed into a DIN SPEC and then incorporated into international standardization. The Association also describes practical fields of application with the help of Industrie 4.0 application scenarios, the so-called ZVEI use cases, and calculates the standardization requirement via RAMI 4.0.

Currently, the ZVEI-Führungskreis Industrie 4.0 is working on standardized semantics and standardized descriptions of characteristics in order to make it possible for machines to communicate across domains.

The current statutory regulations are adequate and new regulatory interventions are not required. However, political support can be provided by putting forward the case for the use of international standards and specifications in other regions of the world as well.

7. Communication infrastructure 4.0 is required!

In order to create a communications infrastructure for Industrie 4.0, broadband expansion and the use of wireless radio links in production are required.

Broadband expansion

ZVEI is demanding a rethink in the perspectives for German policy in the promotion of broadband. The Association is speaking out in favor of simplified framework conditions and concentration on a sustainable, comprehensive expansion using fiber optics.

It is the ZVEI's view that Germany's international competitiveness over the next 10 to 15 years depends crucially on the expansion of the broadband infrastructure. The aim must be to occupy one of the top positions among industrial nations when it comes to broadband services. Resources and investment must therefore concentrate on rolling out the network so that it also has adequate reserves for the coming decades.

ZVEI is demanding that the government expands the short-term broadband objectives to include objectives with perspectives for the period up to 2030. By then companies and private households require comprehensive access to broadband in the gigabit range. Here, consideration must not only be given to download rates. Higher upload speeds must be obtained and better quality connections must be ensured, especially if Industrie 4.0 is to be successfully implemented.

Radio links

The communication capability of all components, workpieces and machines right down to the lowest production level is the prerequisite for highly dynamic and flexible Industrie 4.0 production. Only wireless communication per-

mits mass networking of all production units. It therefore takes on a key role in the implementation of Industrie 4.0.

Industrie 4.0 therefore makes increasing use of radio networking techniques in the 2.4 GHz band, as this will allow the cost-efficient expansion of networks, which require less maintenance and are more flexible in an industrial environment. "Robust" wireless technologies that meet real-time requirements are required for this. These are wireless technologies that allow radio transmissions at a defined time (determinism) and with fast response times (minimal delay) in production. As an example, in discrete manufacturing, for instance, it involves a few milliseconds. Robustness is required, as the availability of the radio link and the management of various applications simultaneously must be ensured.

For over ten years, ZVEI has been promoting the development of these wireless technologies in industrial applications. In doing this the Association is representing the interests of the automation specialists in standardization and frequency policy. Since 2009 the Association has been intensively engaged in European standardization work (ETSI ERM TG11). The aim is to guarantee that the requirements of industrial automation are taken into account in the ETSI standards.

The current developments of European standardization considerably restrict the use of innovation potential of industrial radio applications. In order to safeguard Europe as a production base, it must also be possible in the future to deploy industrial radio applications in the 2.4 GHz spectrum that is used globally. From an industrial point of view, there is an appropriate solution concept: the 10-mW factory. It has been examined as an example and confirmed by the German Federal Network Agency. The concept needs to be accepted throughout the EU and must be asserted politically.

In the long term, an exclusive frequency range of at least 80 MHz in the range 1.4 – 6 GHz is required for wireless applications in industrial environments. The ZVEI is working for this subject to be tabled at the next World Radiocommunication Conference (WRC).

8. Industrie 4.0 – But reliably!

The increasing networking of things and systems in the Internet of Things, services and people, which in the past have primarily been seen in the consumer sector and in the commercial and administrative areas of companies, is entering the production halls with Industrie 4.0. In the smart factory of the future objects – workpieces, tools, machines, etc. – will communicate with each other and the person who "orchestrates" them. This means that many different players generate large quantities of data within the factories, some of which is time critical, and also information across factory limits. This changes the role of IT security: additions implemented retrospectively are no longer sufficient. IT security must be an integral part of business processes, systems and products right from the start. Cross-company networking cannot be achieved without (tiered) safeguards.

Safety concepts, architectures and standards

ZVEI has already started to answer today's urgent questions about cyber security with active involvement in the VDI/VDE directive 2182, which is currently being incorporated in the international Standard IEC 62443, and

involvement in the NAMUR recommendation (NE) 153. The description does not only cover the requirements for current systems and automation technology: it also includes clear procedures for manufacturers, operators and integrators. This work forms the basis for the Industrie 4.0 security concepts that are to be developed as part of an evolutionary procedure.

With the Industrie 4.0 component the Association has developed, together with its partners, a model for the smart factory of the future, which allows generators of data to exchange data with partners – indirectly and controlled – via the administration shell, in other words a "digital data rucksack". Further security concepts, architectures and standards must be developed on the basis of this so that, in the future too, the confidentiality, integrity, authenticity and, in particular, availability can be ensured. It is clear that the data must be and remain usable. This is because new, smart business models in automation, which are decisive in global competition, are based on data.

It is inevitable that a hybrid path must be adopted to overcome the security problems. Because of the long life cycles of industrial production systems, both retrofittable solutions for Industrie 4.0 integration of existing machines and systems as well as "Security-by-Design" concepts for new products and systems are developed. What is important is to establish a consensus in respect of the safety architecture throughout the entire value chain.

Safety & Security

Security consists of the dimensions operational safety and protection against (targeted) manipulation. There is no doubt that the interaction of both dimensions is critical for the success of Industrie 4.0. For this, the interactions between the two dimensions must be investigated and formalized in an initial step. For instance, an important point here is the extent to which cryptographic procedures influence time-critical functions of functional security or vice-versa, or whether certain security-critical functions of a partial system provide vulnerabilities for cyber-attacks.

Strengthening trusted IT infrastructures in Europe

Highly trusted technical solutions can become a feature that distinguishes Germany and Europe. Even now, many highly specialized providers of solutions for cyber security have their headquarters in Germany. The establishment of trusted IT infrastructures as a contribution to the digital sovereignty of Europe must be progressed systematically. However, this must be supported by appropriate political initiatives. The aim is to strengthen the security competence and trustworthiness of German and European companies as a decisive competitive factor. This unique opportunity for Europe must finally be recognized and grasped.

9. What must be done – Make Industrie 4.0 possible

1. Make Industrie 4.0 feasible (and understandable)

Further state support for case studies right up to the implementation of demonstrators is required to develop Industrie 4.0 solutions along RAMI 4.0. State funding should only be granted expressly for the application of and work with RAMI 4.0.

2. Industrie 4.0 has new players

ZVEI is demanding that demonstration centers and projects, in particular, need to receive greater state support as a suitable test environment for start-ups and SMEs. Improved tax framework conditions for young companies and venture capital investors are also conceivable.

3. Networking starts in people's heads

Continuous further training puts employees in a position to keep pace with rapid technical development. Therefore, in the coming years the focus must be on further training. Parallel to this, measures must be taken to counteract the lack of skilled labor in Germany. ZVEI sees three areas where policymakers must act:

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- **Broadband expansion**
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- **Radio links**
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6. Industrie 4.0 – But reliably

- Today German industry must ask itself how it can design Industrie 4.0 securely and drive it forward. It needs both retrofittable solutions and Security-by-Design to be developed

- **Strengthening trusted IT infrastructures in Europe**
  The development of digital sovereignty must be pursued vigorously throughout Europe. This unique opportunity for Europe must finally be recognized and grasped.

Further information on Industrie 4.0:

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- ZVEI provides a short and concise explanation of the Reference Architecture Model Industrie (RAMI) 4.0 and the Industrie 4.0 component. You can find all information that the ZVEI provides about Industrie 4.0 here: **www.zvei.org/Themen/Industrie40**

- To the ZVEI image film "Industrie 4.0: Integrated Industry reaches the next level" **youtu.be/ccB6e18VwsQ**

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