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Agile Approach in Vocational Training in the Field of Electric Vehicles and Value Chain Components

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Executive Summary

Today, the demand for **Electric Vehicles** and their value chain components has shown a great increase (growth rates for 2024: EV sales 25%, EVSE installation 50%, driving battery 32%). Despite the rapid increase in production and sales, the **VET** system to meet the skills gap in the pre-production/sales and especially post-production/sales (service) areas of these vehicles has not yet been adequately established.

Needs analyses conducted to identify potential **skill gaps** in the automotive sector indicate that, if adequate vocational education and training is not provided/received, the global skill gap will grow significantly from 2028 onwards due to factors such as the increase in the number of EVs, battery degradation, accidents, fires, etc.

In this study, an **Scrum agile approach** is proposed for the VET system that can meet the skills gap emerging with this revolutionary transformation in the sector without harming social equality; in accordance with the flexible-fast-participatory structure of Industry 5.0 based on human-technology cooperation and customized and personalized education programs of Education 5.0.

Keywords: Electric Vehicle, Education / VET, Skills and Labor Market, Agile Approach., AI, Artificial Intelligence for EVs, Human-Machine / Computer Interaction.

1. Key Components in The Value Chain of Electric Vehicles

The automotive industry is one of the sectors where the economic size, employment, mobility and many other aspects are the largest both proportionally and in volume; and where **E-transformation** (**Electrification** and **Digitalization**) is the most vibrant in every sense.

In the automotive industry, as in many other areas, we live in an era where **Volatile-Uncertain-Complex-Ambiguous** (VUCA) situations must be addressed [1, 2]. The EV ecosystem involves a complex and inter dependency network of stakeholders across the entire lifecycle of an EV, from sourcing main components like batteries to recycling, supported by various enablers. High Voltage Electric Vehicles (EV) have formed a comprehensive value chain and ecosystem in the **green skill** spectrum [3].

In the following sections of the article; Electric Vehicles and Components in the Value Chain **or Electric Vehicles Ecosystem**; will be defined as **EVES**.

Key components in the value chain or EcoSystem of Electric Vehicles (EVES) are given below:

- Drive Battery Packs,
- Charging Stations (EVSE),
- Energy Storage Systems (BESS),
- Renewable and/or Clean Energy Production Plants (CEPS) etc.

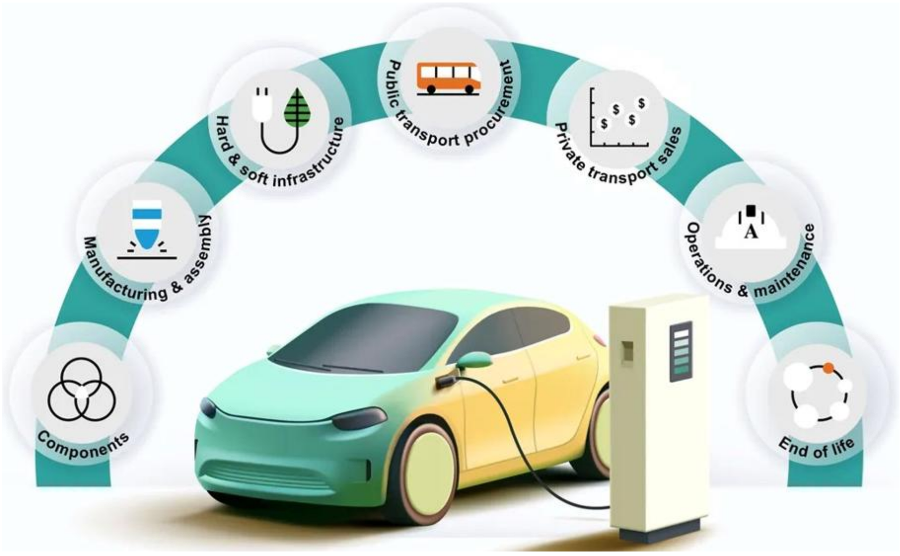

Figure 1: EV Ecosystem Inter dependency [4].

1.1. Electric Vehicles (EV's)

Currently, there are four main types of EVs, namely Battery Electric Vehicles (BEVs), Plug-in Hybrid EVs (PHEVs), Hybrid EVs (HEVs), and Fuel Cell EVs (FCEVs). The configuration of the electric drivetrains of each type of these EVs is shown in Figure 1. BEV and PHEV type vehicles constitute the majority of the electric vehicle market [5].

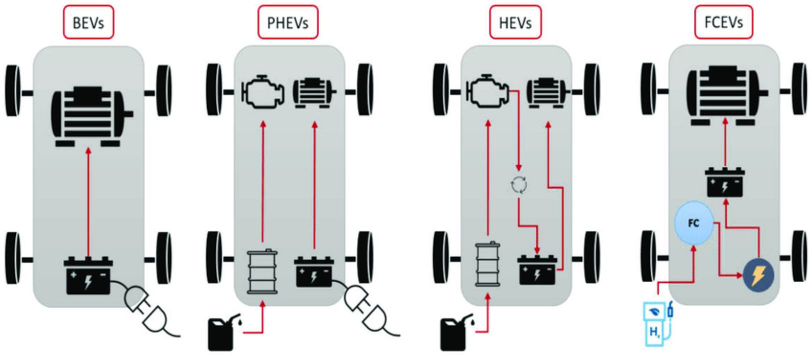

Figure 2: Types of electric vehicles and configuration of the drivetrain [5].

Electric vehicles have major differences compared to internal combustion vehicles. Therefore, people who will work in the field of development, testing, production, after-sales services and emergency response of electric vehicles and their components should have new skills suitable for this technology. Electrical vehicles and their key components contain high voltage (HV). The risks posed by high voltage can only be reduced by providing appropriate skills and adequate training. It is imperative that all relevant people, especially those working in the after-sales area, receive technical training with an agile approach. In recent years, sales of plug-in hybrid electric vehicles (PHEV) and extended-range EVs (EREVs) have been growing faster than sales of battery electric cars. **in April 2025's YOY** variation showed a rise of 34.1% for battery-electric and 20.8% for hybrid-electric cars, while plug-in-hybrid electric recorded a strong 31.2% growth [6].

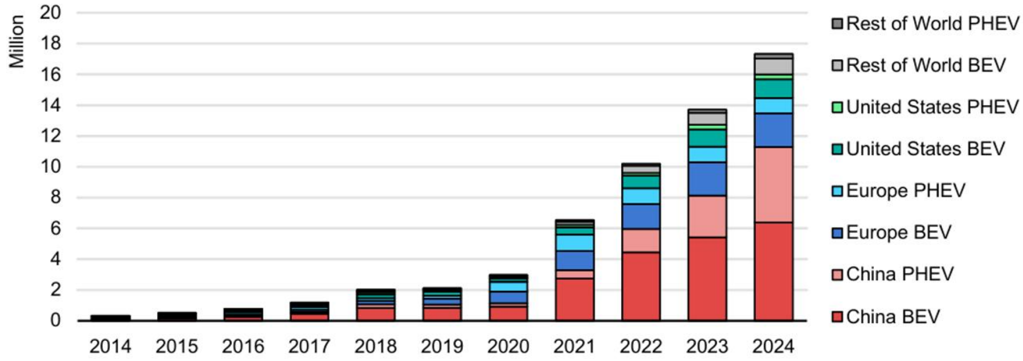

Figure 3: Global electric car sales, 2014-2024 [6].

1.1.1. EV Industry Growth Expectation / Future Perspective

Given the last five years of performance, the EV industry and its ecosystem is expected to continue to grow at an unprecedented rate [6, 7]. Electric vehicle (EV) research organization Rho Motion announced that passenger car and light-duty EV sales reached 17.1 million units sold in 2024, following a fourth consecutive global monthly record. More than 1.9 million EV units were sold in December 2024. Overall, global EV sales increased by 25% in 2024 compared to 2023 [8]. The total number of automobiles in the world has reached 1.5 billion and electric cars has reached 60 million. The huge gap is closing rapidly. It is expected that 1 in 4 cars sold by 2025 will be electric.

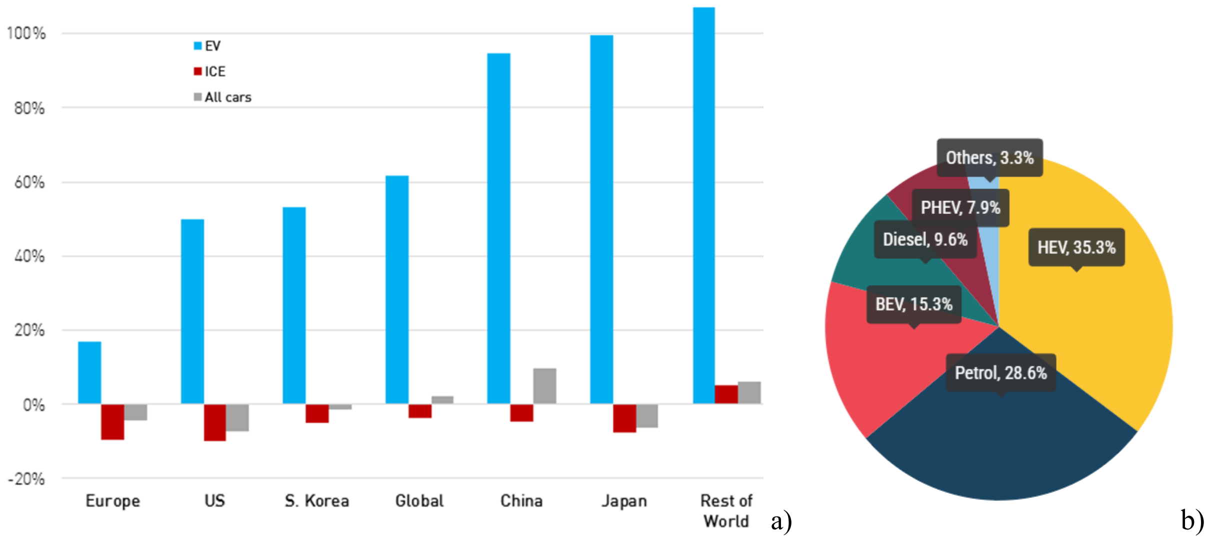

Figure 4: a)Automotive growht by drivetrain: ICE vs. EVs [9] b)New EU car registrations by power source [10].

1.1.2. Battery Industry Growth Expectation / Future Perspective

The global electric vehicle battery market is expected to grow from $106.18 billion in 2025 to $370.77 billion by 2034, with a CAGR of 21.50% during the forecast period between 2025 and 2034. “Those who resist change the longest;” Toyota, opens new tab is investing to electrify vehicles and produce more batteries, and expectss (BEVs) in 2030 [11].

Since 2010, the cost has dropped from US$1,400 per kilowatt-hour to US$140 in 2023 a %90 reduction. With prices falling, electrification has also become a viable option for heavy-duty trucks and buses. This will create different skills gaps in a different EV field [13]. Battery recycling industry players are already getting ready for the 2030s [7].

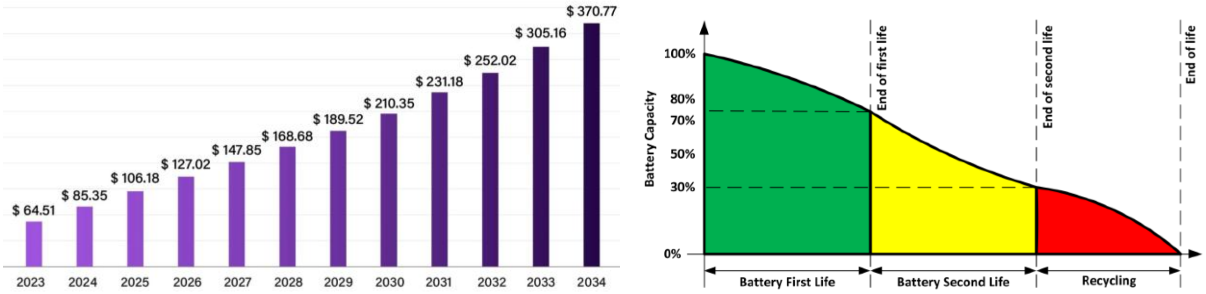

Figure 5: a) EV Battery Market Revenue (USD Billion) [12]. b)EV battery life range / battery capacity [13].

2.1.3 Electric Vehicle Charge Systems (EVSE) Growth Expectation / Future Perspective

Public chargers have doubled since 2022 to reach more than **5 million**. In Türkiye, where the charging network grew most balanced, the total number of charging sockets was recorded as 28,717 (16,900 AC and 11,817 DC) as of March 2025 [14]. EV charger market is expected to see exponential growth over the next few years. Key trends during the forecast period include fast and ultra-fast charging solutions, wireless charging technologies, smart grid integration and demand response, and autonomous charging stations. In addition, battery swap stations are rapidly moving towards becoming a key component of the value chain. These developments are creating new skill areas and gaps. Electricians, planners, construction workers, other electrical professionals are some of the professionals who can expect to see an increase in job prospects.

2. Skills Gap and Needs Analysis in Electric Vehicles Ecosystem

A skills gap is the difference between the skills and knowledge that are desired or needed in the short, medium and long term and the skills and knowledge that workers/candidates currently possess/can offer. 'gap analysis' or 'needs analysis' methods are used to identify the skills gap. Sustainable environmental hopes and technological developments (Industry 5.0, Education 4.0, Tribology 4.0 etc.) based on the human touch have led to a rapid rise in demand for Electric Vehicles and their value chain components. While production and sales in the sector are rising, the VET system to meet the skills gap in pre-production/pre-sales and post-production/post-sales (service) areas has not yet been adequately established.

Platforms such as EU Online Job Ads (**OJAs**), **Global Lighthouse Network**, **LinkedIn** data analytics, **Selfie**, etc. are important tools for needs analysis and identifying skills gaps. Needs and gap analyses conducted in different countries show that if agile and lean approaches are not adopted and rapidly implemented in VET; a global skills gap will increase rapidly starting from 2028 due to the increase in the number of EVs, battery aging, vehicle aging, accidents and fires [15, 16]. Although it varies according to the type of electric vehicle (BEV, HEV, PHEV etc.), there are major differences between EVs and ICEs. The most important of these differences is the risks that arise due to High Voltage. If the necessary training is not received and the qualifications are not provided, situations that result in death and serious injuries occur.

Green Transformation : Electric Vehicles and the EcoSystem they create are directly and indirectly related to many segments of the green transformation spectrum. In order to meet the skills gap without harming the social equality of the workforce and employers in the sector, there is a need for a VET system that effectively implements Industry 5.0, which is the current form of digital and green transformation, which will enable communication and collaboration between people and technologies, with flexible, fast, adaptable, participatory, agile approaches. If current trends continue, by 2050 the gap between the supply and demand for green talent will skyrocket to 101.5%. Unless we at least double the size of the green talent pool projected to exist that year, we will put sustainability goals at risk [17].

Table 1: Key findings for Green Tranformation and Green Skills [17].

Between 2023 and 2024, global demand for green skills grew twice as fast as supply, with demand increasing by 11.6% and supply by 5.6%.	**11.6%**
Halfway to the deadline for meeting nationally determined contributions (NDCs) by 2030, one in five jobs will lack the green talent to fill the position. By 2050, this gap will increase to one in two jobs.	**1 in 2 50%**
Job seekers with green skills or titles have a 54.6% higher hiring rate than the general workforce.	**54.6%**

Global Leaders in EV Skills : The share of automotive industry workers with green skills has been steadily increasing, in parallel with EV car sales. These green skills include battery testing, automotive electrical systems, and capabilities specific to developing lithium-ion batteries. Within the automotive industry, 4.4% of workers have skills related to EVs. Between 2016 and 2024, the share of EV-skilled workers grew by an average of 16% a year. Sweden continues to lead the way, with %9,32 of every 100 automotive workers possessing EV-related skills. Germany is not far behind at %8.89 and Turkey %4.82 [17].

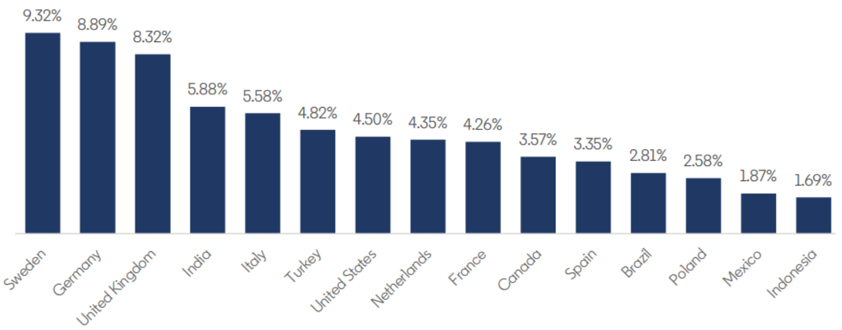

Figure 6 : Share of Automotive Industry Members with >=1 EV skill (2024) [17].

3. Vocational Education and Training (VET)

VET provides learners with essential skills enhancing their employability, supporting their personal development and encouraging active citizenship; boosts enterprise performance, competitiveness, research and innovation. In the programming and implementation of vocational training; an optimum balance must be achieved in terms of both Upskills and Reskills. Optimization can only be achieved through an adequate and effective gap analysis and needs analysis. Focusing on VET in EVES is imperative for the modern automotive industry. EVES represents the innovation and driving force of the future, along with the rapid transformation that is taking place. In the increasingly globalised and connected world, jobs and learning opportunities are accessible across borders; employers can recruit staff from abroad and contract work out to people in other countries. As people move more frequently for work and study than in the past, their qualifications and skills need to be properly understood to be able to match, use and develop them appropriately.

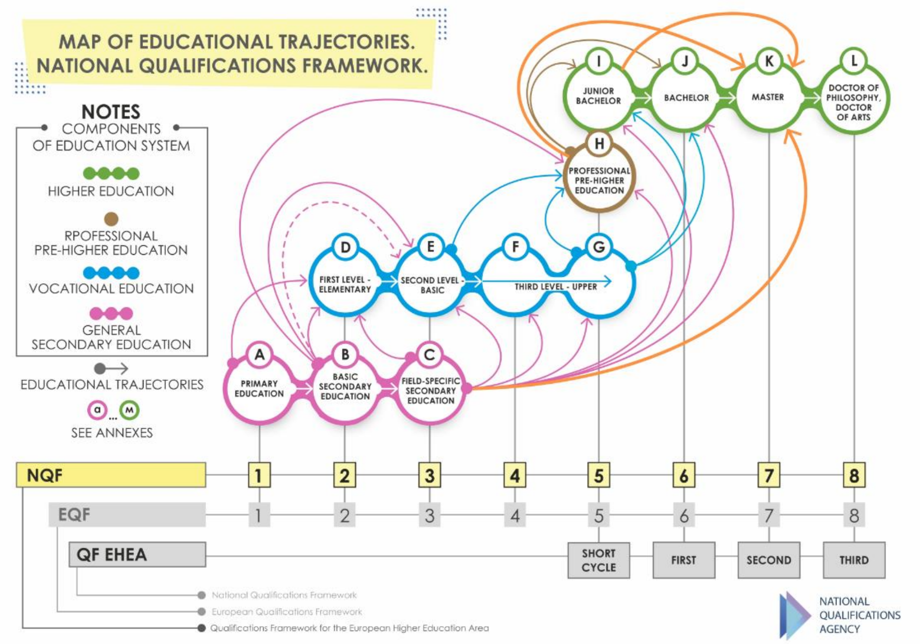

Figure 7: Map of Educational Trajectories. National Qualification Frame work [19].

This diversity may hamper mobility across national and institutional borders. Therefore, there is a need for a translation tool (e.g. EU - EQF) between the different qualification systems and frameworks of countries. The EQF is a European qualifications framework that applies to any qualification system. It has eight levels and each level is described through the learning outcome descriptors for each level. Learning outcomes are divided into three categories: "knowledge", "skills" and "competence". Using proficiency tests from different countries as references in the EQF facilitates the scope and comparison of qualifications between European countries.

Identification of Priorities: The range of skills in EVES is quite wide. Research and assessments show that the skills gap is not and will not be the same across the entire spectrum. This natural state of affairs needs to be carefully assessed; priority and weighted skill areas need to be identified and processes developed and implemented. For example, the skills gap in pre-production/pre-sales and production is much lower than the skills gap in production/after-sales services. Referring to the study published by Cedefop [18], the common qualification levels acquired through school-based vocational training or apprenticeships in EVES can be considered as "the areas where the skill shortages/gaps are most concentrated; EFQ Level 3 and Level 4".

3.1. VET in EVES in the Context of Industry 5.0/Education 5.0

Industry 5.0, encourages a collaborative approach between people and technology, has profoundly affected the automotive industry, where electric mobility is prominent, and has further increased the importance of vocational training in preparing today and future workers for employment. Leng et al [20] highlighted three key characteristics of Industry 5.0: human-centeredness, sustainability and resilience.

Education 4.0: This is the period when rapid developments in information and communication technologies and innovation-oriented changes dominate the education system. From a technical point of view, Education 4.0 can be defined as the modernization process of education in which the technologies defining Industry 4.0 are adapted to the VET system.

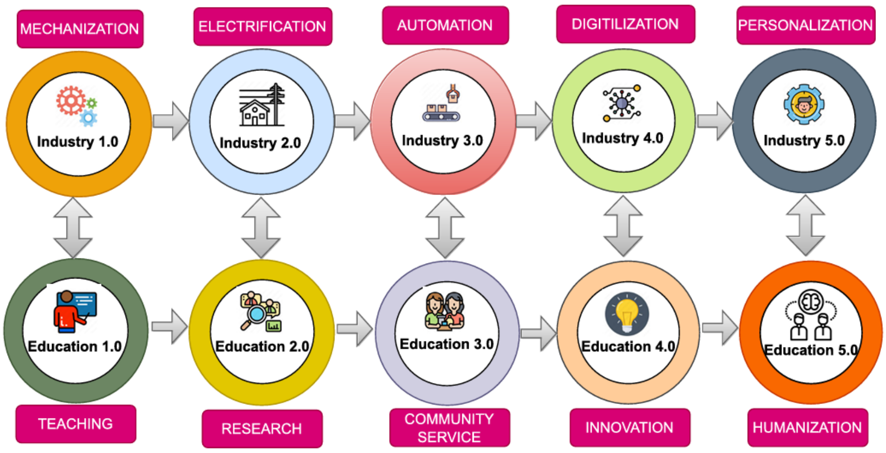

Figure 8: Transition from Industry 1.0 to Industry 5.0 and Education 1.0 to Education 4.0 [21].

Education 5.0: This period, defined as Education 5.0, has brought a number of opportunities such as learning from anywhere, anytime by removing the boundaries of the classroom; allowing users to directly interact with the content and participate in a virtual environment, using many learning materials from the digital world and creating materials and producing by performing creative activities together. Education 5.0 will help to emphasize and prioritize human qualities at the heart of the education system by identifying the most appropriate skills and roles for any student. It can help people to show their unique talents, increase their creativity, develop their critical thinking skills, design and problem-solving skills [21, 22].

3.1.1. The Role of Key Enabling Technologies in EVES-VET

With the key enabling technologies of Industry 4.0 such as Big Data (BD), Internet of Things (IoT), Blockchain (BC), Edge Computing (EC), Augmented Reality (AR), Virtual Reality (VR), and beyond; with the use of innovations of Industry 5.0 such as Human-Machine Collaboration, Digital Twins (DT), Cobots, Artificial Intelligence (AI) and beyond in education, Vocational Education in the Electric Vehicle Ecosystem will expand, become flexible, adaptable, personalized, specialized and accelerated from just human interaction and knowledge sharing to include human-technology interaction. This key enabling technologies enormous potential to help education when combined with various, cognitive capabilities, innovation and creative.

Big data, when integrated with Blockchain, ensures that educational records and certificates remain secure. **The Internet of Things (IoT)** is a network of physical objects, including vehicles, components, devices and other items equipped with sensors, software, data collection and exchange capabilities. IoT is an efficient VET tool. **Edge Computing** enables students and teachers to interact quickly and seamlessly in virtual classrooms. **Augmented Reality (AR)** significantly improves the effectiveness of education and training by providing a dynamic and interactive environment. Its virtual examples facilitate faster understanding and recall of concepts, contributing to the efficiency of self-learning. The inclusiveness of AR adapts to a variety of learning styles and abilities, especially benefiting students with disabilities. In areas where hazardous or complex training is required, **Virtual Reality (VR)** offers a safe and cost-effective virtual solution. Immersive learning experiences enabled by VR accelerate skill development, support personalized learning, and facilitate remote collaboration. **Digital Twins** renables the use of virtual replicas of real-world equipment that enable students to conduct experiments; provides remote access to physical objects and systems. Collaborative robots (Cobots) perform dangerous tasks, reducing the risk of accidents for students and teachers. 6G enables IoT devices to be comprehensively integrated into educational environments [21].

The new generation 19-core optical fiber cable developed under the leadership of Japan-NICT and Sumitomo Electric has achieved data transmission of 1.02 petabits (1 million gigabits) per second. A distance of exactly 1,808 kilometers. In the post-5G era, data demand is approaching an explosion point. This level of bandwidth is now essential for artificial intelligence, autonomous systems and real-time digital communication [22].

3.1.2. **Artificial Intelligence (AI) in EVES-VET**

"Artificial Intelligence is a set of tools designed to enhance human capabilities, not replace them."It covers digital tools used to simulate real-world scenarios to modernize learning environments, enhance skills and adapt to the demands of a rapidly evolving workforce, such as in the field of Electric Vehicles, personalize learning experiences, automate routine tasks, prepare trainers and learners for the needs of working life and the world of innovative entrepreneurship. Here are some AI tools that can significantly enhance your teaching practices and make your classroom more dynamic and efficient: Tools such as **ChatGPT, Claude or Perplexity** AI can help in creating lesson plans, providing answers to student questions or creating assessments. **Kahoot!** with AI-powered insights: Use AI-powered quiz tools to assess student understanding in real time. **Canva's** AI features: Quickly create engaging visual content for presentations, course materials, and assessments. **Deeply, Google Translate, Grammarly**: Streamline multilingual classrooms by eliminating language barriers.

"**Google Meet Speech Translation**" is one of the most important AI achievements of 2025; has the potential to revolutionize communication and interaction globally.

These technologies are making VET more accessible, reducing costs, improving security, and increasing flexibility while maintaining high standards of skill development.

3.1.2.1 **Setting Up Your AI Assistant:** Choose the right platform (ChatGPT, Siri, etc.), Define its role (Quiz creation, etc.), Experiment and iterate (Start small, test the assistant's capabilities, and refine its use based on your experience and student feedback).

Example Application: VET teacher working in the EV field uses ChatGPT to create personalized quizzes for each student's skill level. They enhance classroom presentations with AI-generated visuals from Canva and use Grammarly and/or Google Meet Speech Translation to improve communication in multilingual environments. They seamlessly integrate AI into their teaching practices while maintaining a student-centered approach by ensuring transparency with their students and keeping ethical guidelines in mind.

Curriculum Development and Sample Prompts: AI tools can help you align your curriculum with industry standards, design competency frameworks, and create innovative course content:
- Create a competency matrix for an EV certification course including safety, equipment usage.
- Help me align my automotive repair curriculum with industry standards for EV maintenance.
- Create learning outcomes installation course focused on charger installation and/or maintenance.

AI-Enabled AR/VR Platforms: Tools like Oculus or Hololens combine AI with augmented and virtual reality to create immersive learning environments for technical skills like machine operation.

Example Application:
- VR, AR, MR, IMR, XR technologies; AI-enabled simulations like EVES-VET Safety, securing/disarming, Charger Installation Procedures allow students to gain hands-on experience without compromising safety or material costs. Repeatable scenarios can be implemented at the novice stage, away from high voltage risks.
- Generative AI for Content Creation: Emerging tools can produce highly realistic simulations, industry-specific scenarios, and course materials that can be tailored to individual student needs.
- Industry Collaboration: Partner with businesses that use AI to offer internships or co-op programs and give students firsthand experience in AI-enabled environments.

Embrace a Growth Mindset; encourage educators and students to view AI as an ongoing learning opportunity rather than a one-time change. Embrace Lifelong Learning; provide ongoing education opportunities for graduates. Stay Informed; join professional networks to stay up-to-date on industry updates and AI developments. Building an AI-Enabled Community of Professional Edu-Instructors;

Collaborative Platforms; Create forums, webinars, social media groups where professional education instructors can share their experiences, best practices, resources. Conduct Mentorship Programs to foster peer-to-peer learning and support by pairing trainers experienced in AI integration with those new to the field. Engage with international prof-education organizations leading AI initiatives to bring global insights to local programs.

4. Agile Approach in Vocational Education

In the automotive industry, as in many other areas, we live in an era of intensified Volatile-Uncertain-Complex-Ambiguous (VUCA) situations [1, 2]. The VUCA situations requires a vision, understanding, clearity and agility approach in EVES-VET.

Agile Upskilling and Reskilling: The revolutionary situation created by digital and green transformation makes it imperative to have and update up-to-date skills for sustainable success. This imperative presents opportunities as well as threats. As we navigate the complexities of cloud modernization, artificial intelligence and cybersecurity, the need for agile skills development has never been more urgent and challenging. The goal is not only to catch up with current technology trends, but also to create a workforce that is adaptable, innovative and future-ready. Remember, agile upskilling is an ongoing process, not a one-off solution [23].

Agile Implementation Methodology [23]: To bridge this gap, countries, organizations, persons need to adopt an agile approach to upskilling. This means moving away from traditional, rigid training programs and embracing a more flexible, continuous learning model. Assess and Map Skill Gaps Regularly:
- Conduct quarterly assessments of your IT team’s capabilities against your 12–18-month strategic goals. This provides an agile roadmap for skills development.
- Foster a Culture of Continuous Learning: Create an environment that actively encourages ongoing professional development through workshops, certifications, and online courses.
- Prioritize Soft Skills and Leadership Development: Balance technical skills with soft skills like problem-solving, communication, and adaptability.
- Align Skills Development with Business Goals: Ensure upskilling initiatives directly support your organization’s strategic objectives to maximize impact.
- Leverage Partnerships and Collaborations: Form strategic partnerships with educational institutions,

technology companies, and service providers to access cutting-edge resources and expertise.
- Measure and Adjust Continuously: Regularly review the effectiveness of your skills development efforts and be prepared to pivot as needed.

Agile methodology is one where the total project is broken down into workable components, and each component is addressed in short two- to four-week cycles called sprints. At the end of each sprint, the project team reviews the results with the customer, receives their feedback, and incorporates that feedback into upcoming sprints. An agile implementation plan is a flexible approach that allows for continuous improvement as the development team incorporates the feedback from each successive cycle or sprint. This incremental approach allows you to: Focus on addressing specific skill gaps, Quickly adapt to changing technological landscapes, Minimize risk and maximize learning opportunities, Build confidence and momentum within your teams.

Implementing agile project is governed by the four core principles of agile. They are: Individuals and interactions over processes and tools, Working software over comprehensive documentation, Customer collaboration over contract negotiation, Responding to change over following a plan

Conclusions and Recommendations

It is possible to transform the revolutionary transformation that has taken place in the **Electric Vehicles Ecosystem (EVES)** in the last five years into an opportunity in the field of skills by applying an agile approach in EVES-VET. The EV transition has become an economic engine. With increasing environmental awareness, technological advances and government incentives, the EV industry and other industries in the value chain continue to grow rapidly and redefine mobility. In the field VET of EV Ecosystem (EVES-VET); countries, institutions and organizations and even individuals that invest in **pre-sales** (design, R&D&I, testing, production etc.) and **sales/after-sales** service (maintenance, repair, renewal, recycling, expertise, emergency response, charging, ICE to EV conversion, insurance, finance etc.) will gain; countries that weaken their policies and fall behind in the EV race will weaken their ability to compete. The VET system in the EVES area; together with all its stakeholders and components, should adapt to developments in production and services (Industry 5.0 and future ages) (Education 5.0 and future ages) and even lead in some cases. Utilizing new technology in the planning, content revision, curriculum changes, designing customized and personalized education programs is the main goal of Education 5.0.

However, it is not enough for students (trainees) to have competencies in accordance with the requirements of X 5.0 (Industry 5.0 and Education 5.0 etc.); at the same time, teachers (trainers) need to develop their basic, specialized and professional competencies. "***It is not realistic for an educator who is ignorant, incompetent and therefore inadequate to contribute to the development of knowledgeable, skilled and competent individuals."*** EVES, which sprouted in the same period as Industry 5.0, is directly and indirectly related to both components of the twin transformation (digital transformation and green transformation). The green skill potential and opportunities of the EVES are one of the most important levers to overcome this threat and turn it into an opportunity.

VET should adapt to the **VUCA** (**Volatile-Uncertain-Complex-Ambiguous**) environment; it should not disrupt the current employment balances; should balance the skill gaps that have formed and are foreseen for the future; should adopt, internalize and implement paradigms such as **Industry 5.0, Education 5.0, Tribology 4.0** built on the foundations of **Human Centric-Resilience-Sustainable**.

Tribology is the science and technology of friction, one of the most significant sources of energy consumption; wear, the most significant cause of material failure; and lubrication, which is applied to optimize these factors [24]. Tribology 4.0 [25], in conjunction with sensor technology, the Internet of Things (IoT), and cloud technologies, has opened the door to unprecedented improvements in the field of electric vehicles. In particular, EV tires are components where wear increases due to high vehicle weight and different torque characteristics. In electric machines (M/G), friction-wear-lubrication behaviors different from ICE's emerge depending on the electric current. Similarly, due to regenerative braking, the tribological behaviors of the brake pad and disc pair change. What is important here is addressing the long-standing **gaps in skills and interest** in the field of tribology through VET [26].

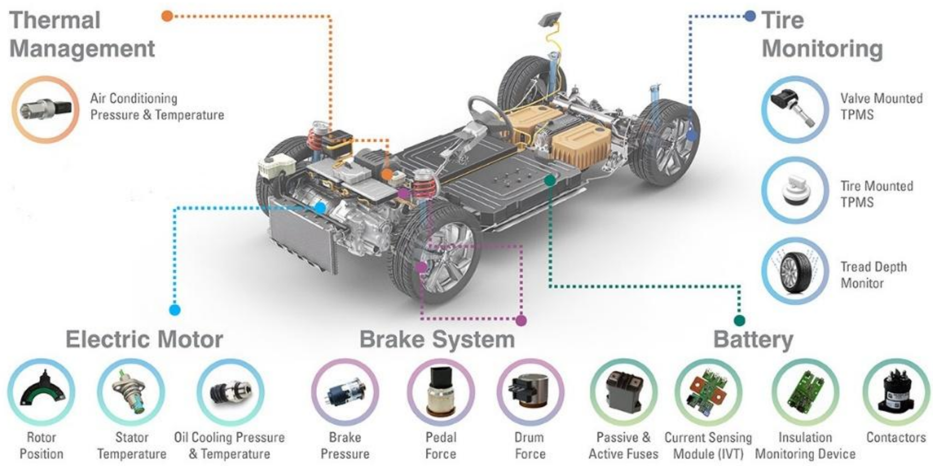

Figure 9: An overview of EV sensor placement (Image: Sensata Technologies) [27].

In this study, agile suggestions are presented to prevent skill shortages by using the Proactive SCRUM Approach for the VET system in the Electric Vehicle Ecosystem and accelerate the digital and green skills revolution. ***“Agile skill development is not a one-time solution; it is an ongoing process.”*** In order for the developments in the Electric Vehicle Ecosystem to adapt to the digital, green and social transformation without harming social peace, the requirements of Education 5.0 must be implemented with a **Collaborative, Flexible and Agile** paradigm.

VET is one of the most important tools for preparing the workforce of the future and evaluating the opportunities that arise with the transformation. VET institutions and systems should provide an optimum balance in Upskilling and Reskilling, which is a basic condition for the transition to be fair and inclusive. Optimization can be achieved through an adequate and effective gap analysis and needs analysis. For example, Germany’s removal of subsidies for EV sales in 2024 had a devastating impact on the European market. However, Germany has done a very good job of balancing the skills gap during this period. BEV sales increased by 43% in the first quarter of 2025, demonstrating its commitment to Electrification.

Root of the Challenge: The skills gap is not just a talent shortage; the dizzying pace of technological advancement is making it worse. Skills in demand today may become obsolete tomorrow, creating a vicious cycle of talent scarcity. This environment requires a new approach to learning and development. In previous industrial transformations, the timeframe for skills to adapt was large and transitions were slow, but Artifucal Intelligent (AI) is expected to spread more rapidly and widely, which will have a profound impact on the labor market at a pace never experienced before, leading to changes in desired skills. *“Technological developments in the EV ecosystem, accelerated by twin transformations (green and digital), are shortening the lifespan of skills in the sector, Up-Skilling, Re-skilling, or New-hiring a necessity”*

Real-time skills intelligence is key to accelerating the skills revolution. An efficient, sustainable, humane, democratic, and ethicratic (based on ethical values) skills revolution is based on reliable skills intelligence that is up-to-date and forward-looking: information about labor market trends and skill needs, in short, needs analyses that identify skill gaps/shortages. Such intelligence can support the data-driven decision-making needed for policymakers and educators to align skills development with industry needs, support competitiveness, and mainstream and upgrade skills for the twin digital and green transitions.

Analysing the content of **online job advertisements** (OJAs) and education and training programme descriptions provides a valuable source of skills intelligence. It provides opportunities for real-time insights into the mismatch between the skills employers need and the skills that skills education and training systems provide. Real-time insights from the **Global Lighthouse Network**, a WEF initiative in partnership with McKinsey, are an important tool. **LinkedIn data analytics** provide opportunities for real-time insights into the mismatch between the skills employers need and the skills education and training systems provide. This system, which provides real-time information on which jobs are most promising and rising, and which are declining, is a real-time dataset updated more than 5 million times per minute, and also reduces data garbage.

Graduate tracking is an important VET management tool that aims to enable stakeholders to enhance the employability of graduates, address skills gaps and mismatches, ensure social inclusion and enable potential students to make informed choices about possible career paths.

European **Quality Assurance Framework** for VET (EQAVET): Focusing on online/distance learning, green skills, social inclusion and student mobility, it helps students, teachers, trainers and in-company trainers to stay informed about policy initiatives at European level and to collaborate on finding attractive tools and financial resources for vocational education and training.

Micro-Certificates, Micro-Competencies and **Digital Badges** enable learners to acquire specific skills and knowledge through short, focused courses that are currently in demand, and which can be converted into verifiable certificates, further enhancing employability.
Competence-Based Education (CBE): Unlike traditional educational models that emphasize the accumulation of credit hours and completion of a predefined curriculum, CBE is designed to demonstrate mastery in urgently needed specific areas. CBE principles include personalized learning paths where students progress at their own pace; assessments based on demonstration of competencies rather than time spent in the classroom; and strong alignment with industry standards to ensure that skills acquired are directly relevant to the job market [28].

"The key difference between Competency-Based Education and traditional education, models is the focus on outcomes rather than processes."

Key advantages of CBE are as follows: Personalized education and training, Self-paced progress, Mastering desired skills (aligning educational outcomes with industry needs), Job matching and early employment, Saving time and money, Student satisfaction, Increased prosperity, Economic recovery [29].

Generative AI (GAI) is transforming the global economy, driving innovation and creating new opportunities, but to realise its full potential, workforce skills need to be invested in.

"Equipping our talent pool with up-to-date skills is not only an opportunity but also a necessity for a sustainable, resilient and humane future of work where Generative AI is enabled."

A variety of key enabling technologies such as Big Data, IoT, BC, Edge Computing (EC), AR, VR, MR, IMR, DT, Cobots, Advanced Sensors, 6G and beyond; Integration of advanced technologies such as AI and Machine Learning into VET curricula and delivery methods Digital and online learning platforms have enormous potential to aid education when combined with competence-based education (CBE), cognitive skills and innovation, each with different and complementary impacts on outcomes. The combined effects of these innovations create powerful synergies that amplify their individual economic impacts. Automation of administrative tasks using IoT devices significantly reduces the workload of teachers, allowing them to focus on value-added academic activities, making the system more agile and lean [21, 22].

In particular, **SELFIE** (Self-Reflection on Effective Learning by Promoting the Use of Innovative Educational Technologies), recommended by the European Commission, is a very effective, efficient and that supports the digitalization of schools free tool. This tool can identify the strengths and weaknesses of educational institutions.

Centres of Vocational Excellence (CoVEs): The European Commission has adopted the Council Recommendation on VET for sustainable competitiveness, social resilience and durability, key components of Industry 5.0. The recommendation defines the basic principles to ensure that vocational education and training is not undermined, adapts rapidly to the market and provides quality learning opportunities for all age groups. To support these reforms, the Commission is supporting CoVEs that bring together local partners to develop "skills ecosystems" [30]. This support from the Commission is invaluable for Europe and should be a model for the rest of the world. The contribution of these centers, those related to battery technology Albatts [31], etc.), to the skills ecosystem in is a successful example. These examples can be taken as a starting point, as centers of excellence are classified as reference points worldwide, both in initial training and in ongoing skills development and reskilling. The CoVE program should be developed and maintained.

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Presenter Biography

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