WP2

D2.3: Competences and Skills Gap

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SEB CoVE
SMART ELECTRICITY FOR BUILDINGS

D.2.3: COMPETENCES AND SKILLS GAP

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Acronyms

AI: Artificial Intelligence

AS: Automation Systems

BA: Building Automation

BACS: Building Automation and Control Systems

BAS: Building Automation Systems

BEMS: Building Energy Management Systems

BIM: Building Information Modeling

COVE: Centers of Vocational Excellence

ECVET: European Credit System for Vocational Education and Training

EMS: Energy Management Systems

EPBD: Energy Performance of Buildings Directive

ESCO: European Skills, Competences, Qualifications and Occupations

ESS: Energy Storage Systems

EU: European Union

EV: Electric Vehicle

GDPR: General Data Protection Regulation

HAS: Home Automation Systems

HVAC: Heating, Ventilation, and Air Conditioning

ICT: Information and Communication Technology

IoT: Internet of Things

ML: Machine Learning

PV: Photovoltaic

RES: Renewable Energy Sources

SEB: Smart Electricity for Buildings

SEBCoVE: Smart Electricity for Buildings Centers of Vocational Excellence

V2G: Vehicle-to-Grid

VET: Vocational Education and Training

ZEB: Zero Energy Buildings

Competences and Skills Gap in the Smart Electricity for Buildings (SEB) Sector

Executive Summary

This report, as part of Tasks 2.3 and 2.4 outputs of the SEBCoVE project, provides a comprehensive analysis of the current and emerging competencies required in the SEB sector, as well as included actionable skills and foundational knowledge essential for professionals to effectively meet the demands in the Smart Electricity for Buildings sector. It identifies gaps within the Vocational Education and Training (VET) programs across six focus regions: Crete (Greece), Brandenburg-Berlin (Germany), Lombardy (Italy), Basque Country (Spain), North Macedonia, and Porto (Portugal). The structure of the report is as follows:

- **Chapter 1** outlines the methodology used for identifying competency gaps.
- **Chapter 2** applies this methodology to reveal specific competency gaps within the SEB sector.
- **Chapter 3** derives actionable skills and foundational knowledge required for professionals to meet the challenges of the SEB sector effectively.

Key Findings:

Technological Drivers:

- Smart Building Automation: Increasing adoption of IoT (Internet of Things), Building Automation Systems (BAS), and EMS.
- Renewable Energy Integration: Emphasis on solar PV, wind energy, and hybrid energy storage systems (ESS).
- Artificial Intelligence (AI): AI applications for predictive maintenance and energy optimization are emerging but underrepresented in VET.
- Cybersecurity: Digitalization creates vulnerabilities, highlighting the need for IoT network protection.

- Sustainability: Focus on Zero Energy Buildings (ZEB) and circular economy practices.

Competency Gaps:

- Building Automation & IoT: Limited training in advanced BAS and IoT integration.
- AI & Data Analytics: VET programs lack AI modules for predictive energy management.
- Cybersecurity: Inadequate training in IoT security and data privacy.
- Renewable Energy: Limited hands-on training for hybrid systems and ESS.
- EV Infrastructure: Basic training exists; Vehicle-to-Grid (V2G) integration remains a gap.

Regional Analysis:

- Crete: Strengths in renewable energy but lacks AI, cybersecurity, and hybrid system training.
- Brandenburg-Berlin: Strong renewable energy and BAS coverage; gaps in AI and cybersecurity persist.
- Lombardy: Advanced VET infrastructure but resource constraints hinder AI and EV grid integration.
- Basque Country: Well-developed energy systems but cybersecurity and AI are underrepresented.
- North Macedonia: Growing renewable energy focus, with major gaps in advanced smart building technologies.
- Porto: Emerging capabilities in energy efficiency and EV training but lacking advanced AI and cybersecurity skills.

Recommendations:

Modernize Curricula:

- Integrate AI, machine learning, and predictive analytics into VET programs.

- Develop cybersecurity modules for IoT and smart energy systems.

Expand Renewable Energy and Storage Training:

- Introduce hybrid system training combining PV, wind, and ESS.

Enhance EV Infrastructure Programs:

- Focus on advanced V2G technologies and smart grid compatibility.

Strengthen Industry Collaboration:

- Align VET programs with industry needs through partnerships and apprenticeships.

Adopt European Frameworks:

- Standardize competencies using ESCO, EQF, and ECVET frameworks to ensure quality and relevance.

CHAPTER 1

Methodology for Competences GAP identification

Introduction

The SEB sector is undergoing rapid technological transformations, driven by advancements in building automation and IoT, renewable energy technologies and energy storage (batteries), BEMS, and electrification through EVs and Heat Pumps. This report aims to identify both the needed and the missing competencies required for the workforce in this sector, bridging the gap between current VET offerings and market demands.

Objectives

- Identify current and future competence requirements in the Smart Electricity Sector for the SEBCoVE regions.
- Evaluate the existing VET offerings in relation to these competencies for the SEBCoVE regions.
- Develop a framework for addressing gaps in competencies through updated or new training programs.

The methodology used for identifying needed and Missing Competences included the following steps:

Step 1: Conducting a Sectoral Skills Analysis

This step involves analysing the smart electricity sector to understand current and future trends and the relevant needs. The analysis focuses on understanding the evolving landscape and the competencies required to meet emerging sector demands.

Process:

1. **Desk Research**
   - Gather information from relevant reports such as skills trends analyses, future skills gap assessments, and industry white papers.
   - Review policy documents like the European Green Deal, energy performance directives, and technology adoption forecasts for the SEB sector.
2. **Engage Stakeholders**:
   - Organize workshops with stakeholders from industry, associations, and VET providers to identify technological drivers impacting the sector (Digitalization, IoT, AI, Energy Transition, SEB).
   - Interview industry and professional experts to capture insights on job roles, technological advancements, and future competency needs in the SEB sector.

Step 2: Region-Specific Analysis

- Conduct Regional Scenario Analyses to capture geographic variances in technology adoption.

Step 3: Identification of Emerging Job Roles and Competencies

With the sectoral analysis complete, the next step is identifying the specific job roles and corresponding competencies that are essential in the SEB sector.

Process:

Mapping Technological Advancements to Job Roles: (D7.2 Skills trends)

- Identification of emerging technologies such as building & home automation, renewable energy systems & energy storage, EVs charging, smart grids and new electricity markets.
- Determination of the new job roles that these technologies will generate (e.g., BIM Manager, Energy Data Analyst, Smart Home Integration Specialist).

Definition of Competences:

- Breaking down each job role into specific competencies, distinguishing between technical competencies and transversal skills (e.g., critical thinking, teamwork, cybersecurity awareness).

Step 4: Categorization of Competences into Thematic Areas:

Competences have been grouped into thematic areas relevant to the SEB sector:

- Smart Buildings & Home Automation (BAS & HAS)
- BEMS
- Renewable Energy and Storage Integration
- Electrification through EVs and Heat Pumps
- Cybersecurity for SEB systems
- Data Analytics and AI for Predictive Maintenance

Step 5: Conducting a VET Program overview

Evaluation of the existing VET programs in the context of the competencies identified in the SEB sector. The process includes:

- Competency Matching: Mapping the competencies offered in existing VET courses to the competencies required for emerging job roles.
- Identification of any misalignments (e.g., outdated curricula that don't cover buildings and/or home automation, renewable energy technologies or EVs charging integration).
- Assessing Curriculum Relevance: Evaluating whether the existing curriculum addresses the SEB sector digital transformation needs, such as AI integration, real-time data management, and advanced cybersecurity.

Step 6: Stakeholder Feedback

Stakeholder feedback, from previously conducted a Sectoral Skills Analysis, through workshops and interviews with industry professionals and associations, is analysed to assess the effectiveness of currently provided programs.

Step 7: Gap Analysis: Identifying Missing Competencies

The gap analysis highlights the differences between the needed competencies and those currently provided by the VET system. The process includes:

Competence Gaps Identification:

- Compare the required competencies for future roles against those offered in VET programs.
- Identify missing competencies in areas as:
  - Buildings/Home Automation & IoT & Cybersecurity
  - Renewable Energy Technologies & Storage
  - Smart grid integration & Electricity Markets.
  - Electric Vehicles (EV) Charging Integration

Future-Oriented Competencies:

- Identify the forward-looking competencies that are currently not included in VET offerings but will be essential for future SEB sector professionals (e.g., AI-driven monitoring and control systems, predictive analytics, V2G technology).

Prioritize Gaps:

- Prioritize the most critical competence gaps based on market demands and current technological advancements.

Step 8: Developing a Competency Framework for SEB Sector

Process

Structure Competency Framework:

- Develop a structured competency framework that defines specific learning outcomes, mapped to the job roles and future skills trends in the SEB sector.

Incorporate Industry Standards:

- Align the framework with industry standards such as ESCO, EQF levels (3 to 6), and other relevant VET certification frameworks.

Adapt to Regional Needs:

- Ensure the framework is adaptable to different regional scenarios, considering the technological advancements and electricity market policies specific to each region (e.g., solar PV for southern Europe, wind energy for coastal regions, smart grid integration).

CHAPTER 2

Competences Gap in the SEB sector

Introduction

Based on the methodology described earlier in this report, competencies needed and missing are identified within the current VET landscape in SEB across the SECoVE regions. Using survey responses workshops and interviews from these regions, the analysis highlights existing gaps in training, focusing on technological competencies and practical skills critical for the SEB sector's evolving demands.

STEP 1: Sectoral Skills Analysis

The SEBCoVE report “State of the art in the Smart electricity for Buildings” (D2.2), outlines current trends and highlights the skills gaps, positioning VET systems to address emerging competency needs *(PED_D2.2).*

The step of Conducting a Sectoral Skills Analysis is analysing the smart electricity sector to understand current and future trends and the relevant needs. The analysis focuses on understanding the evolving landscape and the competencies required to meet emerging sector demands.

Key Technological Trends in SEB

1. Smart Building Infrastructure

- The adoption of smart building technologies is accelerating globally, driven by energy efficiency goals and digitalization *(PED_D2.2).*

Key technologies include:

- BAS: For managing lighting, HVAC, and energy systems.

  - IoT and Sensors: Enabling real-time data collection and system optimization.
  - Connectivity: Advanced protocols like 5G, Wi-Fi, and LoRaWAN (PED_D2.2).
- Countries like Germany and Netherlands lead in deployment, while nations like Greece and North Macedonia are focusing on retrofitting older infrastructure (PED_D2.2).

2. Energy Efficiency and Renewable Integration

- EMS are critical for optimizing energy use through real-time monitoring and predictive analysis.
- Increasing integration of Renewable Energy Sources (RES) and ESS addresses sustainability goals *(PED_D2.2).*
- Solar PV systems and wind energy are prominent, with hybrid systems (RES + traditional energy) gaining traction in Spain and Italy *(PED_D2.2).*

3. AI and Automation

- AI and Machine Learning are advancing real-time monitoring, predictive maintenance, and energy optimization *(PED_D2.2).*
- Integration of smart grids allows demand-response balancing, enhancing grid flexibility.

4. Cybersecurity and Data Privacy

- Increased digitalization introduces vulnerabilities requiring robust cybersecurity skills to secure data and IoT networks (PED_D2.2).
- Compliance with regulations like GDPR and regional energy efficiency directives (e.g., EPBD) is essential (PED_D2.2).

5. Sustainability and Circular Economy

SEB focuses on:

- ZEB.

- Sustainability practices: Waste reduction, energy conservation, and resource efficiency (PED_D2.2).

Competency Needs in the SEB Sector

The transformation in SEB highlights critical workforce skills gaps across multiple domains:

1. **Building Automation and IoT Integration**:
   - Competencies: BAS installation, IoT configuration, data analytics, and predictive maintenance.
   - Gaps: Limited training on smart system implementation in VET curricula.
2. **Renewable Energy and Energy Storage**:
   - Competencies: Solar PV, energy storage integration, hybrid energy systems, and grid balancing.
   - Gaps: Need for hands-on training in renewable energy system deployment.
3. **AI and Data Analytics**:
   - Competencies: AI-driven system optimization, data interpretation, and machine learning for predictive energy management.
   - Gaps: Limited expertise in AI applications for smart buildings.
4. **Cybersecurity**:
   - Competencies: Securing IoT networks, data privacy regulation compliance, and cyberattack prevention.
   - Gaps: Integration of cybersecurity modules into existing VET programs.
5. **Sustainability and Circular Economy**:
   - Competencies: ZEB design, resource-efficient practices, and compliance with environmental standards.
   - Gaps: Focus on sustainability practices within smart building training modules.

4. Recommendations for VET Systems

To bridge current gaps, VET programs must:

- Integrate AI and Machine Learning modules for energy optimization and predictive analytics.
- Incorporate cybersecurity training focused on IoT systems.
- Develop renewable energy integration courses, including hands-on training for PV, ESS, and grid systems.
- Promote interdisciplinary collaboration: Engineers, software developers, and energy specialists must work together.
- Embed sustainability competencies, ensuring alignment with EU policies like the European Green Deal and EPBD.

Conclusion

The SEB sector's evolving landscape demands a multidisciplinary, tech-savvy workforce capable of integrating digitalization, renewable energy, and sustainability practices. VET systems must adapt rapidly to equip workers with emerging competencies and address sector demands, ensuring a resilient, sustainable future for smart electricity in buildings.

STEP 2: SEBCoVE Region-Specific Analysis

The analysis is based on a comparative analysis of the SEB sector across the six regions: Crete (Greece), Berlin-Brandenburg (Germany), Lombardy (Italy), Basque Country (Spain), North Macedonia, and Porto (Portugal). The analysis was based on the “D2.2: State of the Art in the Smart Electricity for Buildings” report that was published as a deliverable (PED_D2.2) and identifies regional strengths, challenges, and opportunities for workforce development in the SEB sector, focusing on emerging technologies, renewable energy systems, and the need for specialized skills.

Region-Specific Analysis: SEB Sector in Crete, Greece

1. Overview of the Region’s SEB Landscape

Crete, as one of Greece's prominent regions, has significant potential for renewable energy adoption, smart building automation, and energy efficiency due to its abundant natural resources and regional development priorities. National and European policies, including the European Green Deal and Energy Efficiency Directives, are key drivers for the SEB sector in Crete.

Key trends shaping the SEB sector in Crete include:

- Renewable Energy Integration: Strong focus on solar photovoltaic (PV) and wind energy, with opportunities to integrate ESS.
- Building Automation and IoT: Emerging interest in IoT-enabled BAS for energy efficiency.
- EV Infrastructure: Increasing deployment of EV charging stations; however, V2G technologies remain underdeveloped.
- Energy Efficiency Goals: Retrofitting older buildings for energy efficiency, aligned with national ZEB objectives.

2. Existing VET Programs and Competency Coverage

The analysis of VET programs in Crete reveals the following status:

Competency Area	Training Status	Observations
Building Automation & IoT	Partially covered	Basic courses on IoT device installation and energy management exist; limited focus on advanced BAS.
Renewable Energy Systems	Moderate coverage	Training emphasizes solar PV systems; hybrid solutions and energy storage remain underdeveloped.
Energy Efficiency	Strong	Programs include building audits, HVAC optimization, and lighting efficiency.
AI	Lacking	No formal training on AI or machine learning for predictive energy optimization.
Cyber security	Insufficient	Limited or no cyber security training for smart systems and IoT networks.
EV Infrastructure	Emerging	Basic training in EV charging station installation; gaps in V2G integration.

3. Regional Trends and Challenges

Strengths:

- Renewable Energy Leadership: Crete benefits from abundant solar and wind resources, driving interest in renewable energy technologies.
- Energy Efficiency Focus: Active efforts to upgrade older buildings through retrofitting and energy-efficient solutions.

Challenges:

- Limited AI Integration: Lack of training for AI-based predictive maintenance and EMS.
- Cybersecurity Gaps: Absence of specialized modules for securing IoT networks and smart energy systems.
- EV Infrastructure Development: Training programs on EV installation exist but lack advanced knowledge of V2G systems and smart grid compatibility.

Opportunities:

- Develop advanced training programs on AI applications and machine learning for energy systems.
- Expand VET offerings to include hybrid renewable energy systems integrating PV, wind, and energy storage.
- Strengthen cybersecurity education for smart energy infrastructure.
- Leverage Crete's renewable energy potential to become a pilot hub for smart building solutions.

4. Recommendations for VET Providers in Crete

Modernize Curricula:

- Introduce modules on AI-driven optimization, machine learning, and predictive maintenance.
- Add specialized training for cybersecurity in IoT-enabled smart systems.

Enhance Renewable Energy Programs:

- Develop courses on hybrid systems that combine solar PV, wind energy, and ESS.

Strengthen EV Infrastructure Training:

- Expand EV-focused training to include V2G technologies and energy flow management in smart grids.

Promote Industry Collaboration:

- Collaborate with energy companies, technology providers, and policymakers to align VET programs with market demands.

Adopt European Frameworks:

- Use frameworks like ESCO, EQF, and ECVET to standardize competencies and benchmark training quality.

5. Conclusion

Crete's SEB sector demonstrates strong potential, particularly in renewable energy and energy efficiency. However, significant gaps exist in AI, cybersecurity, and hybrid energy systems training. By modernizing VET curricula, fostering industry partnerships, and adopting advanced energy technologies, Crete can effectively prepare its workforce to meet the evolving needs of the SEB sector and drive regional energy transformation.

Region-Specific Analysis: SEB Sector in Brandenburg-Berlin, Germany

1. Overview of the Region's SEB Landscape

The Brandenburg-Berlin region stands out as a key player in the SEB sector within Germany, fuelled by strong industrial infrastructure and sustainability-focused policies. Supported by the national energy transition strategy (*Energiewende*) and EU-level goals, the region has emerged as a hub for renewable energy systems, digital building technologies, and smart grids.

Key technological drivers include:

- Renewable Energy Leadership: Strong focus on solar PV, wind power, and hybrid energy solutions integrated into the grid.
- Smart Building Automation: Growth in advanced BAS, IoT-enabled devices, and real-time energy data management systems.
- EV Infrastructure: Significant expansion of EV charging infrastructure, with increasing emphasis on V2G technologies.
- Energy Efficiency: Retrofitting of existing buildings and integration of ZEB standards.

2. Existing VET Programs and Competency Coverage

The current state of VET programs in Brandenburg-Berlin reveals robust training initiatives with room for further development:

Competency Area	Training Status	Observations
Building Automation & IoT	Well-developed	Strong focus on **smart sensors**, **BAS systems**, and IoT integration.
Renewable Energy Systems	Comprehensive	Includes solar PV, wind energy, and grid-connected hybrid solutions.
Energy Efficiency	Strong	Training emphasizes **HVAC optimization**, building audits, and smart lighting systems.
AI	Emerging	Limited modules on AI-driven predictive maintenance and energy optimization.
Cybersecurity	Underdeveloped	Insufficient coverage of **IoT and BAS cybersecurity** needs.
EV Infrastructure	Well-developed	Advanced training in EV charging stations; gaps remain in **V2G technology** integration.

3. Regional Trends and Challenges

Strengths:

- Renewable Energy Expertise: The Brandenburg-Berlin region leads in solar and wind energy adoption, with increasing focus on smart grid integration.
- Technological Innovation: High adoption rates for BAS and IoT technologies in commercial and residential buildings.
- EV Infrastructure Growth: Strong development of EV charging networks, positioning the region as a leader in electrification initiatives.

Challenges:

- AI and Predictive Systems: Existing VET programs lack sufficient training in AI-driven energy optimization and machine learning applications.
- Cybersecurity Gaps: Limited focus on protecting IoT networks and smart building systems from cyber threats.
- Advanced Grid Integration: While VET programs address EV infrastructure, training on V2G systems remains underdeveloped.

Opportunities:

- Integrate AI and machine learning modules into VET curricula to support energy management innovation.
- Develop specialized cybersecurity training to secure BAS and IoT-enabled systems.
- Promote advanced V2G technology training to enhance EV-smart grid compatibility.

4. Recommendations for VET Providers in Brandenburg-Berlin

Modernize Curricula:

- Introduce advanced courses on AI-driven predictive energy systems and machine learning for energy optimization.
- Develop cybersecurity modules focused on securing IoT and smart energy infrastructure.

Enhance Renewable Energy Training:

- Include hybrid energy systems that combine solar PV, wind energy, and ESS.

Expand EV Infrastructure Training:

- Develop specialized training programs for V2G integration and energy flow management.

Strengthen Industry Partnerships:

- Foster collaborations between VET institutions, industry leaders, and technology providers for hands-on training and apprenticeships.

Adopt European Frameworks:

- Align VET programs with ESCO, EQF, and ECVET standards to ensure quality and relevance to market needs.

5. Conclusion

The Brandenburg-Berlin region is a frontrunner in renewable energy adoption, smart building technologies, and EV infrastructure development. However, addressing gaps in AI integration, cybersecurity, and V2G technologies is essential. By modernizing VET programs, fostering industry collaborations, and incorporating advanced technologies, the region can solidify its position as a leader in the SEB sector.

Region-Specific Analysis: SEB Sector in Lombardy, Italy

1. Overview of the Region's SEB Landscape

Lombardy, as one of Italy's most industrialized and technologically advanced regions, plays a pivotal role in the SEB sector. The region is influenced by European directives (Green Deal, EPBD) and Italy's national energy policies promoting decarbonisation, energy efficiency, and digital transformation.

Key regional drivers include:

- Building Automation and IoT: Increasing demand for smart BAS and IoT-enabled energy management.
- Renewable Energy: Significant integration of solar PV and ESS.
- Electrification: Growth in EV infrastructure supported by local energy grids and smart charging technologies.
- Sustainability: Focus on ZEB to meet energy efficiency targets.

2. Existing VET Programs and Competency Coverage

An analysis of current VET offerings in Lombardy reveals the following:

Competency Area	Training Status	Observations
Building Automation & IoT	Well-represented	Strong focus on BAS and IoT sensor integration.
Renewable Energy Systems	Covered but basic	Training exists for PV systems but lacks hybrid system integration.

Energy Efficiency	Emphasized	Comprehensive programs on energy-efficient HVAC and lighting.
AI	Limited coverage	Minimal training on AI applications for predictive energy systems.
Cybersecurity	Underdeveloped	Insufficient focus on IoT network security.
EV Infrastructure	Emerging but uneven	Training on EV station installation; gaps in V2G technologies.

3. Regional Trends and Challenges

Strengths:

- Advanced Industry Ecosystem: Lombardy's established industrial base supports innovation in smart energy systems and IoT integration.
- Renewable Energy Focus: Strong adoption of solar and energy efficiency solutions, driven by regional and national policies.
- Strategic Location: Lombardy serves as a hub for renewable energy technology providers and smart building solutions.

Challenges:

- Skills Gap: Limited emphasis on advanced technologies like AI-driven predictive maintenance, machine learning, and cybersecurity for IoT.
- Resource Constraints: VET programs report a lack of funding for advanced training modules and laboratory infrastructure.
- EV Infrastructure: While EV charging installation is covered, integration with smart grids and V2G remains a gap.

Opportunities:

- Enhance VET programs by introducing modules on AI-driven optimization, energy storage, and cybersecurity.
- Promote partnerships between VET providers and industry stakeholders to bridge skills gaps through hands-on training.

- Leverage European funding opportunities to upgrade lab infrastructure for advanced renewable and energy systems training.

4. Recommendations for VET Providers in Lombardy

Modernize Curricula:

- Integrate AI and machine learning modules for predictive energy management and data optimization.
- Develop cybersecurity-focused training tailored to IoT systems and smart energy networks.

Focus on Renewable Energy Systems:

- Expand training for hybrid energy systems, combining PV and ESS.

Strengthen EV Infrastructure Programs:

- Include advanced topics such as V2G technologies and energy flow management in smart grids.

Promote Industry Collaboration:

- Encourage partnerships with energy providers and tech companies for apprenticeships and practical learning.

Adopt European Frameworks:

- Align VET programs with ESCO, EQF, and ECVET standards for consistent and high-quality training delivery.

5. Conclusion

Lombardy's SEB sector benefits from a robust industrial base and strong adoption of renewable energy and energy efficiency technologies. However, gaps persist in advanced competencies, particularly in AI, cybersecurity, and V2G technologies. By modernizing VET curricula, strengthening industry partnerships, and leveraging European frameworks, Lombardy can effectively prepare its workforce for the evolving SEB landscape

Region-Specific Analysis: SEB Sector in Basque Country, Spain

1. Overview of the Region's SEB Landscape

The Basque Country is a leading industrial and technological hub in Spain, with strong regional policies aimed at fostering sustainable energy systems, smart building technologies, and digital innovation. As part of Spain's commitment to the European Green Deal, the Basque Country focuses on renewable energy integration, smart grid solutions, and digitalized EMS.

Key regional drivers include:

- Renewable Energy: Strong adoption of solar PV systems and wind energy solutions.
- Building Automation and IoT: Increasing implementation of smart BAS and IoT devices.
- EV Infrastructure: Growth in EV charging infrastructure, including pilot initiatives for V2G technologies.
- Sustainability: Emphasis on energy-efficient buildings, ZEB, and circular economy principles.

2. Existing VET Programs and Competency Coverage

The analysis reveals the current VET programs in the Basque Country and identifies areas of strength and gaps in coverage:

Competency Area	Training Status	Observations
Building Automation & IoT	Well-developed	Strong focus on IoT-enabled BAS integration and smart sensors.
Renewable Energy Systems	Comprehensive	Training includes solar PV installation and maintenance, but limited focus on hybrid systems.
Energy Efficiency	Strong	Programs emphasize energy audits, HVAC

		optimization, and efficient energy management.
AI	Limited coverage	Training in AI applications for predictive energy management is underdeveloped.
Cybersecurity	Emerging but insufficient	Basic training on cybersecurity for smart systems; gaps in advanced IoT security modules.
EV Infrastructure	Growing rapidly	Programs cover EV charging station installation, with pilot initiatives on smart grid integration.

3. Regional Trends and Challenges

Strengths:

- Renewable Energy Leadership: The Basque Country has a strong foundation in solar and wind energy, supported by regional policies promoting energy transition.
- Technological Innovation: Increasing adoption of IoT and smart automation technologies for energy management in buildings.
- EV Infrastructure: Rapid expansion of EV charging networks and experimentation with V2G technology.

Challenges:

- AI Integration: Limited emphasis on AI-driven predictive energy systems and machine learning applications.
- Cybersecurity: Insufficient coverage of cybersecurity for IoT systems and energy data management.
- Hybrid Energy Systems: Training programs lack a focus on integrating renewable energy with ESS.

Opportunities:

- Expand VET curricula to include AI applications, predictive maintenance, and hybrid energy systems.
- Develop advanced cybersecurity training for IoT-enabled smart buildings.

- Leverage industry collaborations to strengthen training in V2G technologies and smart grid solutions.

4. Recommendations for VET Providers in the Basque Country

Modernize Curricula:

- Introduce advanced modules on AI, machine learning, and predictive energy management.
- Include comprehensive training on cybersecurity for IoT and smart grid systems.

Strengthen Renewable Energy Integration:

- Develop courses on hybrid systems, combining PV, wind, and ESS.

Enhance EV Infrastructure Training:

- Expand programs to cover V2G technology and EV-smart grid integration.

Foster Industry Collaboration:

- Partner with local energy companies, tech innovators, and government bodies to offer apprenticeships and hands-on training in smart energy solutions.

Adopt European Frameworks:

- Use ESCO, EQF, ECVET, and EQAVET frameworks to standardize training and benchmark skills.

5. Conclusion

The Basque Country is well-positioned to lead in the SEB sector through its strong focus on renewable energy, energy efficiency, and digital innovation. However, VET programs need to address gaps in AI integration, cybersecurity, and hybrid energy systems. By modernizing curricula, fostering industry partnerships, and aligning with European standards, the Basque Country can equip its workforce with the advanced skills needed to drive the region's smart energy transformation.

Region-Specific Analysis: SEB Sector in the Republic of North Macedonia

1. Overview of the Region's SEB Landscape

The Republic of North Macedonia is in the early stages of transitioning towards smart electricity systems and sustainable energy solutions, driven by EU alignment policies and regional energy efficiency initiatives. While the SEB sector is growing, challenges related to infrastructure, training systems, and technological adoption persist.

Key technological drivers include:

- Building Automation and IoT: Emerging demand for smart systems, particularly in new construction projects and retrofitting older infrastructure.
- Renewable Energy: PV installations are gaining momentum, supported by policy incentives.
- EV Infrastructure: Early stages of development, with basic training on EV charging station installations but limited progress in V2G integration.
- Energy Efficiency: Emphasis on improving building energy performance through insulation, HVAC optimization, and energy audits.

2. Existing VET Programs and Competency Coverage

The current state of VET offerings in North Macedonia reveals some foundational programs but also highlights significant gaps:

Competency Area	Training Status	Observations
Building Automation & IoT	Emerging but limited	Basic training on IoT sensor installation; lacks BAS depth.
Renewable Energy Systems	Partially covered	Programs focus on PV systems but lack hybrid system integration.
Energy Efficiency	Moderate coverage	Training includes energy audits and HVAC optimization.
AI	Very limited	No existing training programs for AI applications in energy systems.
Cybersecurity	Insufficient	Absence of dedicated cybersecurity training for IoT and smart systems.
EV Infrastructure	Basic training	Covers EV station installation but lacks V2G integration and smart grid compatibility.

3. Regional Trends and Challenges

Strengths:

- Renewable Energy Adoption: Growing focus on solar PV systems, especially in urban areas, aligned with national energy policies.
- Emerging Interest in Smart Buildings: New construction projects are gradually integrating IoT devices for energy management.

Challenges:

- Outdated Curricula: Existing VET programs lack coverage of emerging competencies such as AI, machine learning, and advanced BAS systems.
- Limited Infrastructure: VET institutions face funding challenges, preventing the development of advanced training labs.
- Cybersecurity Gaps: No formal training programs address IoT and smart grid cybersecurity needs.

Opportunities:

- Leverage EU funding and cross-border collaborations to modernize VET curricula.
- Expand renewable energy training to include hybrid systems and ESS.
- Develop specialized programs in EV infrastructure with a focus on V2G technologies.

4. Recommendations for VET Providers in North Macedonia

Modernize VET Curricula:

- Integrate emerging technologies such as AI, machine learning, and predictive energy systems.
- Develop cybersecurity-focused modules tailored for smart building systems and IoT networks.

Enhance Renewable Energy Training:

- Include training for hybrid energy systems, combining PV, wind energy, and ESS.

Promote Industry Partnerships:

- Foster collaborations with industry stakeholders to provide apprenticeships and practical training opportunities.

Strengthen EV Infrastructure Programs:

- Introduce advanced modules on V2G technology and smart grid energy management.

Leverage European Frameworks:

- Adopt ESCO, EQF, and ECVET standards to ensure alignment with EU skill benchmarks.

5. Conclusion

The Republic of North Macedonia has significant potential to develop its SEB sector through improved renewable energy integration, smart building systems, and EV infrastructure. Addressing gaps in VET programs, particularly in AI, cybersecurity, and advanced EMS, is critical. Modernizing curricula and fostering industry partnerships will ensure the workforce is equipped to meet emerging technological and sustainability challenges in the SEB sector.

Region-Specific Analysis: SEB Sector in Porto, Portugal

1. Overview of the Region's SEB Landscape

The region of Porto, Portugal, is experiencing growth in smart energy systems and sustainable construction, driven by EU policies like the European Green Deal and national strategies for energy efficiency. Porto is positioned as a key innovator for integrating renewable energy systems, smart building automation, and EV infrastructure.

Key drivers include:

- Renewable Energy Adoption: Widespread use of solar PV systems in urban and rural areas, supported by regional incentives.
- Smart Building Automation: Growth in the installation of BAS and IoT devices for energy monitoring.
- EV Infrastructure Development: Increasing deployment of charging stations, with growing interest in V2G technologies.
- Energy Efficiency Goals: Strong focus on retrofitting older buildings to meet ZEB standards.

2. Existing VET Programs and Competency Coverage

An analysis of existing **VET** programs in the Porto region highlights the following:

Competency Area	Training Status	Observations
Building	Well-developed	Strong focus on **BAS installation**, IoT

Automation & IoT		systems, and energy data management.
Renewable Energy Systems	Comprehensive but evolving	Programs focus on solar PV systems but lack hybrid energy storage training.
Energy Efficiency	Strong	VET programs emphasize energy audits, retrofitting, and HVAC optimization.
AI	Limited coverage	Training in AI for predictive energy management is not yet widespread.
Cybersecurity	Emerging but underdeveloped	Basic training exists but lacks advanced cybersecurity for smart grids and IoT.
EV Infrastructure	Growing	EV station installation training is offered; V2G is emerging but not fully integrated.

3. Regional Trends and Challenges

Strengths:

- Strong Renewable Energy Focus: Portugal's renewable energy targets are driving training for solar PV installations and energy efficiency solutions.
- Technological Innovation: Porto has a growing ecosystem for smart building automation and IoT-enabled energy systems.
- Policy Support: National and EU-level funding supports initiatives for energy-efficient buildings and EV infrastructure.

Challenges:

- Limited AI Integration: Existing VET programs lack modules on machine learning and AI for predictive energy optimization.
- Cybersecurity Gaps: Insufficient focus on securing IoT networks and managing energy data.
- Hybrid Energy Systems: Programs need to expand beyond standalone PV systems to include hybrid renewable energy and storage solutions.

Opportunities:

- Develop advanced training for AI applications and predictive maintenance.
- Introduce cybersecurity modules for smart grid systems and IoT infrastructure.

- Expand VET offerings to include ESS and V2G technology integration.

4. Recommendations for VET Providers in Porto

Modernize Curricula:

- Introduce courses on AI-driven energy systems, machine learning, and predictive maintenance.
- Expand training for cybersecurity in smart energy and IoT applications.

Enhance Renewable Energy Programs:

- Include hybrid energy systems combining solar PV, wind, and ESS.
- Focus on EV Infrastructure:
- Develop specialized training for V2G technologies and energy management in smart grids.

Strengthen Industry Collaboration:

- Partner with local energy companies, construction firms, and government bodies for hands-on training and apprenticeships.
- Adopt European Frameworks:
- Utilize ESCO, EQF, ECVET, and EQAVET frameworks to standardize competencies and ensure high-quality training.

5. Conclusion

The SEB sector in Porto, Portugal, demonstrates strong progress in renewable energy, energy efficiency, and building automation. However, VET programs need to address emerging trends in AI, cybersecurity, and hybrid energy systems to align with the region's growing technological demands. By modernizing training curricula and fostering industry collaborations, Porto can position itself as a leader in sustainable and smart energy solutions.

STEP 3: Identification of Emerging Job Roles and Competencies in the SEB Sector

Based on the analysis of the report *"PED_D7.2: Skills Trends and Identifying Future Skills Gaps"* and earlier *region-specific analyses* of the SEB sector, the following key job roles and associated competencies have been identified as essential to meet evolving technological demands.

1. High-Level Professionals (EQF 6 and above)

Job Role	Key Competencies
Smart Building Systems Engineer	- Design and integration of IoT devices and BAS. - Knowledge of energy-efficient solutions and real-time energy management.
Renewable Energy Systems Engineer	- Expertise in PV system and wind energy design, implementation, and hybrid integration. - Familiarity with energy storage technologies like batteries and hydrogen systems (D7.2: Future Skills Trends).
Cybersecurity Specialist	- Protecting IoT networks and BAS from cyber threats. - Knowledge of energy data privacy and regulatory compliance.
Energy Data Analyst	- Data analytics for energy consumption optimization. - Proficiency in AI and machine learning for predictive energy management (D7.2: Future Skills Trends)..
Facility Manager	- Overseeing operations of smart buildings and energy optimization tools. - Integration of BACS for smart control.
Sustainability Consultant	- Advising on energy-efficient and sustainable building solutions. - Familiarity with ZEB standards.

2. Medium-Level Professionals (EQF 4-5)

Job Role	Key Competencies

BAS Technician	- Installation, configuration, and maintenance of BAS/BACS. - IoT systems troubleshooting.
Energy Technician	- Monitoring energy consumption and optimizing energy usage. - Maintenance of energy-efficient technologies.
HVAC Installer and Technician	- Installation of advanced HVAC systems integrated with BAS. - Ensuring energy efficiency and compliance with sustainability standards.
Renewable Energy Technician	- Installation and maintenance of solar PV systems, wind turbines, and energy storage systems. (D7.2: Future Skills Trends).
EV Infrastructure Technician	- Installation and maintenance of EV charging systems. - Integration with V2G technologies.

3. Low-Level Professionals (EQF 3-4)

Job Role	Key Competencies
Electrical Installer	- Basic wiring, circuit installations, and maintenance for BAS and IoT systems.
Smart Systems Installer	- Configuration of smart lighting, sensors, and energy monitoring devices.
Energy Management Assistant	- Collecting and analysing energy data for optimization.
IT Support Technician	- Supporting IT infrastructure for BAS and IoT devices in buildings.

Emerging Roles Driven by Technological Trends

- The SEB sector's transformation is introducing specialized roles to meet AI, renewable energy, and cybersecurity needs:
- AI Energy Optimization Specialist: Application of AI for predictive maintenance and real-time energy management.

- V2G Integration Specialist: Integration of EV infrastructure with smart grids and energy storage systems.
- Hybrid Energy Systems Technician: Expertise in combining RES (e.g., solar PV + wind + battery storage).
- Cybersecurity Specialist for IoT Systems: Protecting IoT-enabled BAS and energy management networks from cyber threats.

Conclusion

The SEB sector demands a multidisciplinary workforce equipped with technical expertise, digital skills, and a commitment to sustainability. Training programs should align with emerging roles and competency needs such as AI integration, renewable energy hybrid systems, BAS management, and cybersecurity. Continuous upskilling and reskilling through modernized VET curricula are essential to prepare the workforce for the sector's rapid evolution. (*D7.2: Future Skills Trends).*

Identified Gaps in Competencies

The integration of emerging technologies in SEB has exposed certain skill gaps within these programs. The key areas where competencies are either insufficient or missing are as follows:

1. **Digitalization and Automation Technologies**:

- Observation: Programs such as those in Basque country have some courses in automation, but a more extensive focus on smart technologies and Buildings (BAS) and Home Automation Systems (HAS) is limited.
- Competency Gap: Professionals require knowledge of contemporary automation systems and IoT, including competences and skills in digital remote monitoring and control, along with cybersecurity measures.

2. **Renewables and Energy Storage Integration**:

- Observation: Even though, renewable energy technologies are part of the most curriculum, Greece, Portugal, North Macedonia and Spain, however the

specific skills needed for holistic integration of renewable systems with energy storage for higher self-sufficiency remain underdeveloped.

- Competency Gap: Training needs to incorporate competencies in holistic system integration with residential scale RES and energy storage (batteries), along with building BEMS.

3. **Smart Grids & Electricity Markets.**

- Observation: There is almost zero mention of competencies related to modern electricity markets and smart grids integration in all the examined curriculum.
- Competency Gap: Developing knowledge and competences in electricity markets and electricity billing rules. Additionally, knowledge and competences regarding smart grids structure and operation must be developed.

4. **EV Chargers Integration**

- Observation: There is almost zero mention of competencies and skills related to EVs charging infrastructure and the total electrification of buildings and homes in all the examined curriculum.
- Competency Gap: Developing skills in complete buildings electrification, EVs technologies and chargers will strengthen VET graduates to follow the current market trends in SEB sector.

5. **Energy Data Analytics and Efficiency Modelling**:

- Observation: There is limited mention of competencies related to data analytics, which are essential for predictive maintenance and efficiency modelling in SEB.
- Competency Gap: Developing skills in data analytics, energy performance modelling, and simulation would allow VET graduates to optimize building energy use effectively.

6. **Sustainability and Green Buildings**:

- Observation: Programs like in RNM focus on renewable energy but lack specific content on sustainability in construction practices.

- Competency Gap: SEB professionals need knowledge in sustainable construction materials, life-cycle analysis, and energy certification processes to meet modern building standards.

7. **Cross-disciplinary Skills**:

- Observation: VET programs tend to emphasize technical skills, with limited integration of interdisciplinary competencies.
- Competency Gap: Professionals benefit from cross-disciplinary knowledge in areas like project management, communication with digital tools, and regulatory compliance within SEB contexts.

STEP 4: Categorization of Competencies into Thematic Areas for the SEB Sector

Introduction

Essential competencies required for the SEB sector have been categorized into six key thematic areas, aligning workforce skills with emerging technological and market demands. These thematic areas address advancements in smart building technologies, renewable energy systems, data analytics, and the digital transformation of energy management.

The competencies outlined across these six thematic areas address the SEB sector's critical needs for a skilled workforce capable of supporting smart energy solutions, renewable energy adoption, and digital transformation. Training programs must align with these competencies to prepare professionals for emerging job roles, ensuring innovation, sustainability, and energy efficiency in buildings.

This categorization will serve as a roadmap for the SEBCoVE curriculum development, upskilling initiatives, and workforce readiness in the evolving SEB sector.

Thematic Areas for the SEB Sector

The following structured categorization aligns the identified competencies with key thematic areas in the SEB sector, ensuring clarity and focus for curriculum development and workforce upskilling.

1. Smart Buildings & Home Automation (BAS & HAS)

- Installation, configuration, and maintenance of BAS and HAS.
- Integration of IoT-enabled devices for smart lighting, HVAC control, and energy monitoring.
- Troubleshooting and optimizing IoT sensors for real-time energy management.
- Knowledge of advanced communication protocols (e.g., LoRaWAN, 5G, and Wi-Fi) for smart buildings.
- Facility management for BAS/BACS operations.

2. Building Energy Management Systems

- Implementation of BEMS for energy optimization and demand response.
- Monitoring and analysing energy consumption data to improve energy efficiency.
- Integration of smart meters and energy management software.
- Hands-on expertise in managing HVAC systems integrated with BEMS for energy-efficient operations.
- Retrofitting older buildings with smart energy solutions to align with ZEB standards.

3. Renewable Energy and Storage Integration

- Design, installation, and maintenance of renewable energy systems, such as solar PV and wind turbines.
- Integration of hybrid renewable systems (e.g., solar PV + wind + energy storage).
- Expertise in ESS, including batteries and hydrogen storage technologies.
- Management of distributed energy systems and their grid integration.
- Application of smart grid technologies for optimizing renewable energy usage.

4. Electrification through EVs and Heat Pumps

- Installation and maintenance of EV charging infrastructure.
- Integration of V2G technologies for energy flow optimization.
- Expertise in heat pump technologies for efficient building heating and cooling.
- Understanding of smart grid compatibility for EV and heat pump systems.
- Monitoring energy usage and optimizing energy flows for electrification solutions.

5. Cybersecurity for SEB Systems

- Securing IoT networks and smart energy systems from cyber threats.
- Implementing data protection strategies for BAS, HAS, and BEMS.
- Ensuring compliance with energy data privacy standards (e.g., GDPR).
- Identifying vulnerabilities and securing communication protocols within smart buildings.
- Providing cybersecurity solutions for V2G technologies and smart grid operations.

6. Data Analytics and AI for Predictive Maintenance

- Application of AI and machine learning for predictive energy optimization and real-time monitoring.
- Analysis of energy consumption data to identify trends and improve efficiency.
- Development of predictive maintenance strategies for BEMS and renewable energy systems.
- Integration of AI-driven fault detection in BAS/BEMS for proactive maintenance.
- Utilizing data analytics for energy flow optimization in EV charging and hybrid energy systems.

Summary Table

Thematic Area	Key Competencies
Smart Buildings & Home Automation	BAS/HAS installation, IoT integration,

	troubleshooting, smart sensor management.
BEMS	BEMS deployment, energy monitoring, HVAC integration, retrofitting for energy efficiency.
Renewable Energy and Storage	PV and wind systems, hybrid solutions, energy storage integration, smart grid usage.
Electrification through EVs & Heat Pumps	EV charging infrastructure, V2G technologies, heat pump installation, smart grid compatibility.
Cybersecurity for SEB Systems	IoT security, data protection, BAS/BEMS cybersecurity, smart grid vulnerability management
Data Analytics and AI	AI for predictive maintenance, energy data analysis, machine learning applications.

Thematic Area	Key Competencies
Smart Buildings & Home Automation	BAS/HAS installation, IoT integration, troubleshooting, smart sensor management.
BEMS	BEMS deployment, energy monitoring, HVAC integration, retrofitting for energy efficiency.
Renewable Energy and Storage	PV and wind systems, hybrid solutions, energy storage integration, smart grid usage.
Electrification through EVs & Heat Pumps	EV charging infrastructure, V2G technologies, heat pump installation, smart grid compatibility.
Cybersecurity for SEB Systems	IoT security, data protection, BAS/BEMS cybersecurity, smart grid vulnerability management.
Data Analytics and AI	AI for predictive maintenance, energy data analysis, machine learning applications.

STEP 5: VET Program Overview in the SEB Sector

Executive summary

The SEB sector requires a skilled workforce capable of addressing the challenges of digitalization, renewable energy integration, and smart energy systems. Updating VET programs with advanced technologies and aligning them with industry demands will equip professionals with the competencies needed to support the sector's sustainable growth.

This section is the fifth step for the Competences GAP identification and evaluates existing **VET programs** in the SEB sector to assess their alignment with emerging competency needs and identify areas requiring improvement.

Key Findings

Existing VET Offerings:

- Current training programs cover key areas such as:
- Smart Systems and IoT Integration: Installation of sensors, energy data management, and BAS/BACS.
- Renewable Energy Systems: Installation of PV systems, wind energy technologies, and ESS.
- Energy Efficiency: Energy audits, optimization of HVAC systems, and smart lighting solutions.
- EV Infrastructure: Installation of EV charging stations and basic grid integration.

Competency Gaps:

- Despite some progress, notable gaps remain:
- Limited focus on AI and machine learning for predictive energy management and optimization.
- Insufficient training on advanced cybersecurity for IoT and energy systems.
- A lack of modules addressing hybrid renewable energy systems and energy storage.
- Inadequate coverage of V2G technologies and EV-smart grid integration.

Curriculum Relevance:

Existing curricula are outdated in addressing the sector's digital transformation needs, particularly in areas such as AI integration, real-time data management, and cybersecurity.

Recommendations

To bridge the identified gaps and ensure alignment with SEB sector demands, the following steps are recommended:

- Modernize Curricula: Incorporate modules on AI, machine learning, predictive maintenance, and energy data analytics.
- Enhance Cybersecurity Training: Focus on securing IoT networks and energy systems.
- Expand Renewable Energy Training: Address hybrid systems and advanced energy storage technologies.
- Develop Specialized EV Modules: Include V2G technologies and smart grid energy flow management.
- Framework Adoption: Align training programs with European frameworks such as ESCO, EQF, ECVET, and EQAVET to ensure standardization and quality.

VET Program Overview: SEB Sector, Crete - Greece

Information gathered for this overview was based on desktop research and a survey used to gather insights from VET providers on course offerings, thematic coverage, and challenges in addressing sectoral needs.

Review of Existing VET Offerings

The survey results highlighted the current state of VET programs in the SEB sector.

Key Training Areas Identified:

Smart Systems and IoT Integration

Topics Covered:

- Installation of smart sensors and IoT devices.
- Management and analysis of energy data.
- BAS/BACS.
- Cybersecurity measures.

Renewable Energy and EMS

Topics Covered:

- Installation and maintenance of PV systems.
- Wind energy technologies.
- Energy storage system integration.
- Smart meters and load response systems.

AI and Machine Learning

- Limited training is provided:
- Application of AI in monitoring systems.
- Development of optimization algorithms.

Energy Efficiency and Management

Topics Covered:

- Building energy audits and performance evaluation.
- Installation of energy-efficient HVAC systems.
- Strategies for energy performance optimization using data.

EV Infrastructure

Topics Covered:

- Installation and maintenance of EV charging stations.
- V2G technologies.
- Integration of EVs into smart grids.

Competency Matching and Gaps Identified

To align VET programs with emerging SEB sector competencies, the following gaps and misalignments were seen:

Competency Area	Current Offerings	Gaps Identified
Smart Building Systems (IoT)	Installation and BAS implementation	Limited focus on real-time data analytics and AI.
Renewable Energy Systems	PV and wind energy installation	Insufficient training on hybrid systems and ESS.
AI and Machine Learning	Basic AI applications	Lack of advanced AI, predictive maintenance, and ML.
Cybersecurity	Cybersecurity measures for BAS systems	Limited integration into IoT and energy systems.
EV Infrastructure	EV charging station installation	Gaps in V2G technology training and smart grid integration.

Curriculum Relevance and Recommendations

The following observations were made regarding curriculum relevance to the SEB sector's transformation needs:

Digital Transformation:

- Existing curricula lack advanced training in AI, machine learning, and real-time energy optimization.

Renewable Energy Integration:

- Limited training on hybrid systems combining renewable energy with energy storage.

Cybersecurity:

- Insufficient focus on data security in smart building systems and IoT devices.

EV Infrastructure:

- Current programs do not fully address V2G technologies and energy flow management in smart grids.

Recommendations:

- Update VET curricula to include modules on AI, machine learning, and predictive maintenance.
- Incorporate advanced cybersecurity training tailored for IoT and smart energy systems.
- Expand training for hybrid renewable energy systems and ESS.
- Develop specialized modules for V2G technology and EV-smart grid integration.

Framework Alignment: To standardize and benchmark training programs, the following frameworks should be utilized:

- **ESCO**: To define occupational profiles and competencies.
- **EQF**: To ensure qualifications match sectoral needs.
- **ECVET**: To validate learning outcomes and credits.
- **EQAVET**: To ensure quality assurance in VET programs.

Conclusion

The SEB sector's dynamic evolution requires VET programs to adapt swiftly to bridge existing competency gaps. A focus on advanced technologies such as AI, cybersecurity, and hybrid energy solutions is essential. Aligning curricula with industry demands through collaborative initiatives will ensure a well-prepared workforce capable of supporting the SEB sector's growth.

VET Program Overview – SEB Sector in Brandenburg-Berlin, Germany

The Brandenburg-Berlin region is a critical centre for smart energy transitions, renewable energy adoption, and advanced BAS in Germany. The analysis presented

here evaluates VET programs to determine their relevance and alignment with the emerging competency needs in the SEB sector.

This evaluation is based on a desktop review of VET curricula in the region and interviews with representatives of VET training institutes. The discussions during project-related meetings, particularly with IBBF (Institut für Betriebliche Bildungsforschung) and the Learning and Development Institute (LDI) in Berlin, provided additional insights into current challenges and opportunities within the training landscape.

Review of Existing VET Offerings

The analysis of VET programs highlights areas of strength and key gaps in the competencies required for the SEB sector:

Competency Area	VET Program Coverage	Observations
Smart Building Systems & IoT	Well-developed	Programs emphasize BAS installation and IoT system integration. However, AI-based system optimization is limited.
Renewable Energy Integration	Comprehensive	Training covers solar PV, wind energy, and basic grid integration, but hybrid energy systems (e.g., renewables + storage) are underrepresented.
Energy Efficiency	Strong	VET programs focus on HVAC systems, energy audits, and retrofitting for energy efficiency and ZEB.
AI	Emerging but insufficient	Limited courses exist for AI-driven predictive maintenance and energy data analytics.
Cybersecurity	Limited	Minimal training available for securing IoT networks and protecting BAS against cyber threats.
EV Infrastructure	Growing	Coverage includes EV charging station installation but lacks V2G integration and smart grid management.

Competency Mapping and Identified Gaps

Competency Strengths

- BAS and IoT Systems: Programs provide hands-on training on installation and basic programming for smart building systems.
- Renewable Energy Technologies: Strong focus on solar PV and wind systems, with solid fundamentals in maintenance and grid integration.
- Energy Efficiency: Emphasis on practical techniques for achieving energy savings through HVAC optimization and building retrofitting.

Identified Gaps

AI:

- Lack of modules on AI-driven predictive maintenance and real-time energy optimization.
- Limited exposure to machine learning applications for building energy management.

Cybersecurity:

- Insufficient training on securing IoT ecosystems and BAS networks against cyber threats.
- No dedicated focus on cybersecurity protocols for energy systems.

Hybrid Renewable Energy Systems:

- Missing integration of hybrid solutions combining solar PV + energy storage for decentralized systems.

EV Infrastructure and V2G:

- Programs address basic EV charging station setup but omit advanced competencies in V2G integration and smart grid balancing.

Curriculum Relevance

The VET curricula align with traditional energy and smart building skills but require enhancements to address the SEB sector's digital and technological transformation. Alignment with European frameworks such as ESCO, EQF, and ECVET is evident, but gaps exist in:

- Integrating AI and advanced analytics into EMS.
- Providing comprehensive training on cybersecurity.
- Expanding programs to include hybrid renewable ESS and smart grid integration.

Recommendations for Improving VET Programs

Modernize Curricula:

- Introduce advanced courses on AI and machine learning for predictive maintenance.
- Develop cybersecurity modules tailored for IoT, BAS, and energy systems.

Enhance Renewable Energy Training:

- Expand programs to include hybrid systems integrating ESS (e.g., batteries) with solar PV and wind energy.

Focus on EV Infrastructure Development:

- Add training on V2G technology and its role in grid balancing and energy management.

Strengthen Industry Collaboration:

- Foster partnerships between VET providers and energy technology companies to deliver practical training aligned with emerging trends.
- Use virtual labs, simulations, and augmented reality to supplement classroom learning.

Support the Knowledge Triangle:

- Encourage collaboration among training providers, research institutions, and industry players to align training with evolving market demands.

Conclusion

The Brandenburg-Berlin region has a robust foundation in renewable energy systems, BAS integration, and energy efficiency training. However, gaps remain in AI-driven energy optimization, cybersecurity, and advanced EV infrastructure integration. Modernizing VET programs and fostering stronger industry partnerships will ensure that the region's workforce is equipped with the skills needed to lead the digital and energy transition in the SEB sector.

By addressing these competency gaps and leveraging innovative learning methods, the region can position itself as a centre of excellence for smart energy systems and sustainable building technologies.

VET Program Overview – SEB Sector in Lombardy - Italy

The Lombardy region, one of Italy's most industrialized and innovative areas, is a key driver in the **SEB** sector. With advancements in **renewable energy systems**, **smart building automation**, and **energy efficiency technologies**, there is an increasing demand for a workforce equipped with modern skills.

This report assesses **VET** programs in Lombardy to determine their alignment with the evolving needs of the SEB sector. The findings are based on **desktop research** of existing VET curricula in the region, including training content, learning outcomes, and alignment with emerging technologies.

The analysis highlights:

- Coverage of core competency areas such as smart building systems, renewable energy integration, and energy efficiency.
- Identification of gaps in advanced skills, including **AI-driven energy optimization**, **cybersecurity**, and **hybrid energy systems**.

– Recommendations for enhancing VET programs to prepare the workforce for the sector's technological and digital transformation.

Review of Existing VET Offerings

The analysis highlights both strengths and gaps in VET programs in Lombardy for the SEB sector:

Competency Area	VET Program Coverage	Observations
Smart Building Systems & IoT	Well-developed	Strong focus on BAS and IoT sensor integration. Limited advanced training in data-driven optimization.
Renewable Energy Integration	Comprehensive	Programs cover solar PV installation and wind energy. Hybrid systems combining energy storage are emerging but still limited.
Energy Efficiency	Strong	Courses emphasize HVAC optimization, energy audits, and retrofitting for ZEB.
AI and Data Analytics	Limited	Few programs include AI applications or machine learning for predictive energy optimization.
Cybersecurity	Underdeveloped	Insufficient training on protecting IoT-enabled systems and securing smart grid infrastructures.
EV Infrastructure	Emerging	Basic training on EV charging stations exists, but advanced topics such as V2G integration remain underexplored.

Competency Mapping and Identified Gaps

Strengths

- Smart Building Systems: Programs include IoT device installation, BAS programming, and practical energy management techniques.
- Renewable Energy: Strong emphasis on solar PV systems, wind energy technologies, and energy audits.
- Energy Efficiency: Courses align with Italy's sustainability goals, focusing on retrofitting buildings for energy savings.

Identified Gaps

1. **AI and Predictive Maintenance**:
   - Lack of AI-driven solutions for **energy optimization**, fault detection, and predictive maintenance.
2. **Cybersecurity**:
   - Insufficient focus on securing IoT devices and BAS against cyber threats.
3. **Hybrid Renewable Energy Systems**:
   - Training on integrating energy storage (e.g., batteries) with renewable sources is emerging but not widespread.
4. **EV Infrastructure and V2G**:
   - Programs lack training for advanced V2G technologies and their integration into smart grids.

Curriculum Relevance

The current VET curricula in Lombardy address foundational competencies but lacks advanced training in key areas relevant to the SEB sector's digital transformation. The following gaps require attention:

- AI and Data Analytics: Limited focus on energy data management and machine learning.
- Cybersecurity: Minimal emphasis on IoT protection and smart grid cybersecurity.

- Hybrid Systems: Few programs cover the integration of renewable energy with energy storage.

The alignment of programs with European frameworks like **ESCO**, **EQF**, and **ECVET** is generally good but requires updates to incorporate **emerging technologies** and **skills trends**.

Recommendations for Improving VET Programs

Modernize Curricula:

- Develop modules on AI-driven energy management, predictive maintenance, and machine learning.
- Introduce specialized training on cybersecurity for IoT, BAS, and EMS.

Expand Renewable Energy Training:

- Include courses on hybrid renewable energy systems that integrate solar PV, wind, and energy storage technologies.

Focus on EV and Grid Integration:

- Add training for V2G technologies, grid balancing, and EV-smart grid interoperability.

Enhance Practical Training:

- Develop hands-on projects and apprenticeships in collaboration with industry leaders.
- Use virtual labs and energy simulation platforms to supplement in-person learning.

Strengthen Industry-VET Partnerships:

- Foster collaborations with renewable energy firms, smart grid developers, and technology providers to align VET programs with market demands.

Adopt European Standards:

- Align training with EQAVET, ESCO, and EQF frameworks to ensure standardized competencies.

Conclusion

The VET programs in Lombardy offer strong foundations in **smart building automation**, **renewable energy systems**, and **energy efficiency**. However, significant gaps exist in emerging areas such as **AI-driven predictive maintenance**, **cybersecurity**, and **hybrid energy solutions**.

To meet the technological advancements of the SEB sector, VET programs in Lombardy must modernize their curricula, strengthen hands-on training, and foster deeper collaborations with industry stakeholders. Addressing these gaps will ensure the region remains a leader in sustainable energy solutions and workforce readiness for the digital transition.

VET Program Overview – SEB Sector in – Porto, Portugal

The **Porto region** in Portugal, driven by technological advancements and energy transition goals, holds significant potential in the **SEB** sector. However, aligning VET programs with emerging industry demands remains a challenge.

This report evaluates the **VET offerings** in the region, focusing on their relevance to SEB sector needs. The analysis is based on:

- Desktop research of existing VET curricula in Porto.
- Survey results from the Polytechnic Institute of Porto (IPP) and associated stakeholders, which highlight the strengths, gaps, and opportunities for VET programs.

The findings are organized into key thematic areas:

- Smart Building Systems and IoT Integration
- Renewable Energy and Energy Storage
- Energy Efficiency and Optimization

- EV Infrastructure

Review of Existing VET Offerings

The analysis of VET programs in Porto reveals foundational coverage but significant gaps in emerging competencies critical to the SEB sector:

Competency Area	VET Program Coverage	Observations
Smart Building Systems & IoT	Limited	Only 33.3% of institutions offer courses covering BAS or IoT integration. Topics include IoT devices and data analysis but lack advanced cybersecurity training.
Renewable Energy Systems	Moderate	Programs address wind energy and basic storage integration. Coverage of PV system installation and advanced hybrid systems is missing.
Energy Efficiency	Partial	Programs focus on smart lighting, energy audits, and hybrid systems. Training on HVAC optimization and advanced energy-efficient solutions is insufficient.
AI and Automation in Energy	Limited	Only 33.3% of institutions address automation, AI, or machine learning. Training includes basic AI applications like predictive maintenance but lacks real-time control system programming.
EV Infrastructure	Emerging	Programs focus on EV charging station installation and V2G technology. However, energy flow management within smart grids remains a gap.

Competency Mapping and Identified Gaps

Strengths

- Smart Systems and IoT: Basic coverage of IoT device installation, energy data analysis, and automation is present.

- Renewable Energy Systems: Strong focus on wind technologies and early efforts in energy storage integration.
- Energy Efficiency: Coverage of energy audits, hybrid technologies, and smart lighting strategies.

Gaps

Advanced IoT and Cybersecurity:

- Lack of training on cybersecurity protocols for BAS and IoT systems.
- Limited focus on advanced programming and optimization for smart buildings.

AI and Predictive Analytics:

- Minimal integration of AI-driven control systems for energy management and predictive analytics.

PV Systems and Hybrid Energy Solutions:

- Training on PV installation and integration with storage systems is underrepresented.

EV Infrastructure and Smart Grid Integration:

- Limited coverage of energy flow management and integration of EVs with smart grids using V2G technologies.

Curriculum Relevance

The VET curricula in Porto partially address competencies needed for the SEB sector but require updates to include:

- Advanced AI and data analytics for predictive maintenance and real-time optimization.
- Cybersecurity for IoT-enabled smart buildings and BAS infrastructure.
- PV systems combined with energy storage integration.
- Smart grid energy flows and V2G technologies for EV infrastructure.

- Alignment with European frameworks such as ESCO, EQF, and ECVET is inconsistent, highlighting the need for modernization to meet market and technological demand.

VET Program Overview – SEB Sector in North Macedonia

This report evaluates the **VET** offerings in North Macedonia in the **SEB** sector. The findings are based on **desktop research** of training curricula and **survey responses** provided by VET institutions. The data was collected as part of the **SEBCoVE** initiative, co-financed by the European Union.

The analysis focuses on how existing VET programs address key competency areas:

- Smart Buildings and IoT Integration
- Renewable Energy and EMS
- AI and Data Analytics
- Energy Efficiency
- EV Infrastructure and Grid Integration

Review of Existing VET Offerings

The VET programs in North Macedonia provide foundational skills but exhibit gaps in emerging technologies required for the SEB sector. Below is an assessment of key competency areas:

Competency Area	VET Program Coverage	Observations
Smart Building Systems & IoT	Basic coverage	Programs focus on IoT device installation and BAS integration. Limited coverage of data analytics and cybersecurity.
Renewable Energy Systems	Moderate	Courses include PV systems and wind energy technologies. Integration of ESS is emerging but limited.

AI and Data Analytics	Minimal	Few programs address AI, machine learning, or predictive maintenance for energy optimization.
Energy Efficiency	Growing	Programs cover HVAC systems, smart lighting, and energy audits. Limited focus on hybrid solutions combining multiple technologies.
EV Infrastructure & Grid Integration	Emerging	Training on EV charging station installation exists, but V2G integration and grid management are largely absent.

Competency Mapping and Identified Gaps

Strengths

- Smart Building Systems: Programs offer basic modules on IoT installation and BAS implementation.
- Renewable Energy Systems: Good foundation in PV system installation and wind energy technologies.
- Energy Efficiency: Programs focus on energy audits, HVAC systems, and lighting optimization.

Gaps

Advanced IoT and AI:

- Limited skills in data analytics, AI integration, and predictive energy optimization.

Energy Storage and Hybrid Solutions:

- Minimal focus on integrating renewable energy systems with battery storage.

Cybersecurity:

- Absence of dedicated training to protect IoT-enabled smart building systems from cyber threats.

EV Infrastructure and V2G:

- Insufficient coverage of V2G technologies and grid balancing systems.

Curriculum Relevance

The current VET curricula align with fundamental skills but require updates to address the digital and technological transformation in the SEB sector. Specific gaps include:

- AI-driven solutions for predictive maintenance and energy optimization.
- Cybersecurity training for smart systems and IoT networks.
- Hybrid renewable energy systems integrating solar PV, wind, and battery storage.
- Advanced competencies for EV grid integration and smart energy management.

Recommendations for Improving VET Programs

Modernize Curricula:

- Integrate modules on AI, machine learning, and data analytics for energy management.
- Introduce cybersecurity training for IoT systems and smart building infrastructure.

Expand Renewable Energy Training:

- Include advanced modules on hybrid systems combining PV, wind, and storage technologies.

Focus on EV and Grid Integration:

- Add training on V2G technologies, grid balancing, and smart grid infrastructure.

Strengthen Practical Training:

- Collaborate with industry partners to provide apprenticeships and real-world simulations.

- Incorporate digital tools such as virtual labs and smart energy monitoring platforms.

Foster Industry Collaboration:

- Develop partnerships with local and international companies to align training with market demands.

Conclusion

The VET programs in North Macedonia provide a solid foundation in **renewable energy** and **smart building systems** but lack focus on emerging technologies such as **AI**, **cybersecurity**, and **V2G infrastructure**. Updating curricula, expanding interdisciplinary skills, and fostering stronger **industry-VET partnerships** are critical to bridging the competency gaps and preparing the workforce for the evolving SEB sector.

VET Program Overview – SEB Sector in the Basque Country - Spain

The Basque Country, one of Spain's leading industrial and technological hubs, has made significant strides in the **SEB** sector. With strong regional policies promoting energy efficiency, renewable energy adoption, and digitalization, there is a growing need for a highly skilled workforce to meet emerging technological challenges.

This overview evaluates the **VET** programs in the Basque Country to determine their alignment with SEB sector needs. The findings are based on **desktop research** of existing VET curricula in the region, including course structures, content focus, and learning outcomes. The analysis focuses on six key thematic areas:

- Smart Buildings and IoT Integration
- Renewable Energy and Energy Storage Systems

- Energy Efficiency
- Electrification through EV Infrastructure
- Cybersecurity for SEB Systems
- AI and Data Analytics for Predictive Maintenance

Review of Existing VET Offerings

The VET offerings in the Basque Country demonstrate strengths in core areas but also reveal gaps in emerging technologies:

Competency Area	VET Program Coverage	Observations
Smart Building Systems & IoT	Well-developed	Training focuses on **BAS installation**, **IoT integration**, and energy monitoring. Limited modules on advanced **data-driven optimization**.
Renewable Energy Integration	Comprehensive	Strong emphasis on **solar PV systems** and wind energy. Limited training on integrating **ESS** with renewable systems.
Energy Efficiency	Strong	Programs align with Spain's energy policies, focusing on **HVAC optimization**, retrofitting, and energy audits.
AI and Data Analytics	Limited	Few programs cover **machine learning** or **AI-driven predictive maintenance** for energy systems.
Cybersecurity	Emerging	Limited coverage of **cybersecurity measures** for IoT, BAS, and smart grid systems.
EV Infrastructure	Growing	Programs focus on **EV charging station installation** but lack emphasis on **V2G** technologies and smart grid integration.

Competency Mapping and Identified Gaps

Strengths

- Smart Building Systems and IoT: Solid foundation in BAS and IoT technologies for energy control and building automation.
- Renewable Energy Systems: Comprehensive training on solar PV and wind systems aligns well with Spain's renewable energy targets.
- Energy Efficiency: Programs address retrofitting older buildings, HVAC optimization, and energy audits to meet ZEB standards.

Identified Gaps

- AI and Data Analytics:
- Minimal focus on AI-driven predictive maintenance and machine learning for energy management.
- Limited training on using data analytics for real-time monitoring and optimization.
- Cybersecurity:
- Insufficient emphasis on protecting IoT ecosystems and smart grid systems from cyber threats.
- Energy Storage Integration:
- Training programs do not adequately address the integration of ESS (e.g., batteries) with renewable energy.
- EV Infrastructure and V2G Technologies:
- While EV charging station training is available, there is limited focus on V2G systems and their role in smart grid integration.

Curriculum Relevance

The current VET curricula address foundational competencies for the SEB sector, including smart building systems, renewable energy, and energy efficiency. However, the sector's digital transformation requires additional training in the following areas:

- AI applications for predictive energy management.
- Cybersecurity for IoT-enabled systems and smart grids.
- Hybrid energy systems integrate renewable energy with ESS.

- V2G infrastructure and smart grid management.

Alignment with European standards such as ESCO, EQF, and ECVET is evident, but curricula require updates to incorporate advanced skills and emerging technologies.

Recommendations for Improving VET Programs

Modernize Curricula:

- Integrate modules on AI-driven energy systems, machine learning, and data analytics for predictive maintenance.
- Develop cybersecurity-focused courses to secure IoT-enabled BAS and smart grids.

Enhance Renewable Energy Programs:

- Expand training to include hybrid energy systems that combine solar PV, wind energy, and energy storage technologies.

Focus on EV Infrastructure and V2G:

- Add specialized training on V2G systems and smart grid integration to support electrification goals.

Promote Practical Learning:

- Use virtual labs and simulations to complement hands-on training.
- Establish partnerships with renewable energy companies, EV developers, and smart building firms to deliver apprenticeships and real-world projects.

Strengthen Industry Partnerships:

- Collaborate with industry stakeholders to ensure VET programs remain relevant to technological advancements and market demands.

Adopt European Standards:

- Align training outcomes with EQAVET, ESCO, and EQF frameworks to ensure standardized competencies across Europe.

Conclusion

The Basque Country's VET programs provide strong foundations in smart building systems, renewable energy technologies, and energy efficiency. However, to meet the evolving demands of the SEB sector, curricula must incorporate advanced competencies in AI-driven optimization, cybersecurity, and energy storage systems.

By modernizing training programs, expanding practical learning opportunities, and fostering stronger industry collaborations, the Basque Country can prepare a skilled workforce capable of driving innovation

Consolidated VET Program Overview in SEBCoVE regions

The VET programs across the analysed regions provide a solid foundation in **basic competencies** such as BAS, renewable energy, and EV installation. However, there are critical gaps in **advanced competencies** needed to prepare the workforce for the SEB sector's technological evolution.

Addressing gaps in **AI, cybersecurity, hybrid systems**, and **V2G technologies** should be prioritized to align training with market demands and emerging innovations. By modernizing VET curricula and incorporating forward-looking skills, professionals will be equipped to lead the transition toward sustainable and intelligent energy systems in the SEB sector.

Training modules recommended

To bridge the competency gaps identified, here's a breakdown of specific training modules that VET programs that could incorporate, aligning them with the required competencies for the SEB sector. Each module is designed to target a particular gap and equip trainees with practical and theoretical skills relevant to modern SEB needs.

1. Digitalization and Automation Technologies Module

Competencies Addressed: Home automation, IoT integration, cybersecurity, BAS.

Suggested Modules:

- Home Automation: Managing devices such as smart lights, thermostats, security cameras, and entertainment systems, enabling remote and/or schedule control via apps or voice.
- IoT for Smart Buildings: Covering IoT device installation, configuration, and management within a building environment.
- Cybersecurity Essentials for SEB: Focused on protecting data and systems in smart building technologies from unauthorized access.
- BAS Integration: Hands-on training with sensors, actuators, and programmable logic controllers (PLCs) for automating HVAC, lighting, and security systems.

2. Renewables and Energy Storage Integration Module

Competencies Addressed: Renewable energy technologies, energy storage utilization and self-sufficient system integration.

Suggested Modules:

- Solar and Wind Energy Systems: Practical and theoretical knowledge on installing and managing solar panels and small-scale wind turbines.
- Smart ESS: Training on modern energy storage technologies, including battery systems, integration with the grid, and off-grid applications.
- System Integration for Renewable Energy in Buildings: Focus on connecting renewable systems with BAS to refine energy use and performance within smart buildings.

3. Smart Grids & Electricity Markets Module

Competencies Addressed: Knowledge of modern electricity markets and utilization of smart grids structure and operation.

Suggested Modules:

- Smart Grids architectures: Covers all the structural layouts and relevant operation of smart grids, focusing on smart buildings utilization and roles.
- Electricity Markets introduction: Introduces policies, tools and methods of modern electricity markets, focusing on how building can incorporate these market tools.

4. EV Chargers Integration Module

Competencies Addressed: related to EVs charging infrastructure and the total electrification of buildings.

Suggested Modules:

- EVs Types: Introduces the types of EVs and its technical characteristics, along with their electricity needs.
- EVs Charger Types and Installation Rules: Covers chargers' types and installation methods both for secure electricity supply and for data collection and analysis, enabling trainees to monitor, control and optimize energy usage.
- Predictive Maintenance and Diagnostics: Training in using data analytics for anticipating chargers' failures and conducting timely maintenance, enhancing energy efficiency and system reliability.

5. Energy Data Analytics and Efficiency Modelling Module

Competencies Addressed: Data-driven optimization, predictive maintenance, energy efficiency modelling.

Suggested Modules:

- Energy Data Analytics for Building Management: Introduces tools and methods for data collection and analysis, enabling trainees to monitor and optimize energy usage.
- Energy Efficiency Modelling: Covers modelling techniques for predicting energy consumption and identifying areas for improvement.

- Predictive Maintenance and Diagnostics: Training in using data analytics for anticipating system failures and conducting timely maintenance, enhancing energy efficiency and system reliability.

6. Sustainability and Green Building Module

Competencies Addressed: Sustainable construction, environmental impact assessment, energy certification processes.

Suggested Modules:

- Green Building Standards and Certifications: Training on various certifications like LEED and BREEAM, and the methods to achieve and maintain compliance.
- Sustainable Materials and Construction: Covers materials and techniques that reduce environmental impact, such as low-emission materials and recyclable resources.
- Life-Cycle Assessment in SEB: Practical knowledge on assessing the full environmental impact of building systems from installation through end-of-life.

7. Cross-disciplinary and Soft Skills Module

Competencies Addressed: Project management, regulatory compliance, communication in digital environments.

Suggested Modules:

- Project Management in SEB Contexts: Equips trainees with planning, budgeting, and coordination skills specific to SEB projects.
- Regulatory Compliance and Standards: Training in understanding and applying regulations related to building energy management, environmental impact, and occupational health and safety.
- Digital Communication and Collaboration Tools: Familiarizes trainees with tools like BIM (Building Information Modelling), collaborative platforms, and software for remote work and digital project management.

By aligning these specific modules with competency gaps, VET programs can create a more holistic curriculum that addresses the technological and interdisciplinary needs for professionals in the SEB field. Each module equips trainees with both foundational and specialized skills to navigate the challenges of a rapidly evolving SEB landscape effectively.

STEP 6: Stakeholders feedback

Consolidated Workshop Report: SEB Sector Workforce Development

This report consolidates findings from regional workshops with industry representatives conducted in Greece (Crete), Italy (Lombardy), North Macedonia, Germany (Berlin-Brandenburg), Spain (Basque Country), and Portugal (Porto). The workshops brought together industry experts, VET providers, and professional associations to identify technological drivers, workforce needs, and competency gaps in the SEB sector.

Key themes identified include the growing importance of IoT and smart building systems, renewable energy technologies and energy storage, AI-driven energy management, cybersecurity, and EV infrastructure integration. The workshops highlighted existing training gaps and emphasized the need for modernized curricula, practical training, and industry partnerships to equip the workforce with the skills required for the SEB sector's digital and sustainable transformation.

The workshops aimed to:

- Identify technological drivers impacting the SEB sector.
- Highlight workforce competency needs for emerging job roles.
- Assess training gaps in existing VET programs and propose recommendations.

Key Findings by Region

Greece: Crete

Key Insights**:**

- Training needs include BAS, IoT systems, and EV charging infrastructure.
- Limited practical training in energy storage systems.

Challenges: Lack of specialized electricians trained in smart technologies.

Conclusion: Practical and interdisciplinary training is critical to addressing skill shortages.

Italy: Lombardy

Key Insights:

- Need for **IoT programming skills**, cybersecurity, and energy storage integration.
- AI-driven **predictive maintenance** is an emerging requirement.

Challenges: Workforce unfamiliarity with advanced IoT and AI systems.

Conclusion: Upskilling in AI, cybersecurity, and energy storage is essential.

North Macedonia

Key Insights:

- Workforce shortages due to brain drain and outdated training programs.
- Demand for BAS, renewable energy installation, and cybersecurity skills.

Challenges: Low-quality adult education and lack of practical training.

Conclusion: Stronger industry partnerships and modernized VET curricula are needed.

Germany: Berlin-Brandenburg

Key Insights:

- Competency needs include BAS programming, renewable energy integration, and sustainability practices.
- AI-driven optimization and cybersecurity for IoT systems are critical gaps.

Challenges: Insufficient interdisciplinary training combining IT and energy management.

- Conclusion: Focus on modernizing curricula to address AI, cybersecurity, and circular economy needs.

Spain: Basque Country

Key Insights:

- Training needs include BAS integration, AI-driven predictive tools, and renewable energy storage.
- Emphasis on smart grid management and energy data analytics.

Challenges: Lack of cybersecurity training and limited focus on hybrid energy systems.

Conclusion: Enhanced VET training in AI, cybersecurity, and renewable energy storage is needed.

Portugal: Porto

Key Insights:

- Key areas of focus include IoT-enabled smart building systems, AI applications, and EV infrastructure.
- Practical experience in energy storage and smart grid integration is limited.

Challenges: Gaps in cybersecurity training and predictive energy analytics.

Conclusion: Updating VET curricula to include cybersecurity, AI, and EV-smart grid integration is crucial.

Consolidated Competency Needs

The workshops identified the following **core competencies** required across all regions:

1. Smart Buildings & IoT Integration

- Installation, programming, and maintenance of **BAS.**
- Skills in **IoT system integration**, communication protocols (e.g., Zigbee, LoRa), and real-time monitoring.
- Cybersecurity measures to protect IoT-enabled systems.

2. Renewable Energy Systems and Storage

- Design, installation, and optimization of **solar PV** and wind energy systems.
- Integration of **battery storage solutions** with renewable energy technologies.

3. AI and Data Analytics

- Competence in **AI-driven predictive maintenance** and **energy data analytics**.
- Use of machine learning tools to optimize energy performance and identify faults.

4. EV Infrastructure and Grid Integration

- Installation and maintenance of **EV charging stations**.
- Integration of **V2G** technologies for energy flow management.

5. Sustainability and Circular Economy

- Skills for **energy-efficient design** and resource reuse in building systems.
- Knowledge of environmental standards, **building energy audits**, and circular energy solutions.

Common Challenges

- **Skills Gaps**: Limited workforce skills in AI, IoT, energy storage, and cybersecurity.

- **Training Quality**: Insufficient hands-on and interdisciplinary training programs.
- **Brain Drain**: Skilled workers, particularly in North Macedonia, emigrate for better opportunities.
- **Cybersecurity**: Minimal focus on protecting interconnected smart building systems.
- **Integration Issues**: Lack of training for integrating EVs, renewable energy, and smart grids.

Recommendations

Modernize Training Programs

- Integrate modules on **AI, cybersecurity**, and IoT systems into VET curricula.
- Introduce interdisciplinary training that combines IT, energy systems, and BAS skills.

Enhance Practical Learning

- Promote hands-on training through **simulations, apprenticeships**, and real-world projects.
- Use virtual labs and digital tools for energy system simulations.

Strengthen Industry Partnerships

- Collaborate with **industry stakeholders** to align VET programs with market needs.
- Establish knowledge-sharing platforms for emerging technologies.

Address Regional Challenges

- In North Macedonia, reduce **brain drain** through incentives and sustainable training programs.
- In Germany, Italy, and Spain, prioritize **cybersecurity** and AI integration in training.

Focus on Emerging Technologies

- Develop specialized courses on **V2G technologies**, energy storage, and AI-driven analytics.

Conclusion

The SEB sector across Europe presents significant opportunities for workforce development, but critical gaps remain in **AI, cybersecurity, energy storage**, and **V2G technologies**. Addressing these challenges through **modernized VET programs**, enhanced **practical training**, and stronger **industry collaborations** will ensure a skilled, future-ready workforce capable of driving the energy transition and technological innovation in the SEB sector.

STEP 7: Gap Analysis: SEB Sector Competencies Across Regions

The **Gap Analysis** identifies the differences between the competencies required to meet future workforce demands in the **SEB** sector and those currently offered by **VET** systems.

The analysis compares findings from previous steps conducted for the following regions:

- Crete (Greece)
- Lombardy (Italy)
- Basque Country (Spain)
- Berlin-Brandenburg (Germany)
- North Macedonia
- Porto (Portugal)
- The report focuses on four thematic areas where competency gaps were evaluated and prioritizes the most critical gaps based on market demands and technological advancements.

Competence Gaps Identification

1 Buildings/Home Automation, IoT, and Cybersecurity

Competency	Regions Providing Training	Identified Gaps
BAS	Crete, Lombardy, Basque Country	Limited focus on **advanced optimization** (e.g., real-time AI).
IoT System Integration	All regions (basic levels)	Lack of **advanced programming** skills and **data-driven control** systems.
Cybersecurity for BAS/IoT	None adequately addressed	Minimal training on securing IoT systems and **smart grids**.
Communication Protocols (LoRa, Zigbee)	Basque Country, Berlin-Brandenburg	Gaps in hands-on knowledge of evolving **communication protocols** for BAS.

2 Renewable Energy Technologies and Storage

Competency	Regions Providing Training	Identified Gaps
Solar PV Installation & Maintenance	All regions	Adequate coverage; however, gaps in integrating **hybrid systems**.
Wind Energy Systems	Lombardy, Basque Country	Partial coverage; insufficient focus on **combined solutions** with storage.
ESS (Batteries)	Emerging in Lombardy, Berlin-Brandenburg	Limited emphasis on integrating **batteries** with renewable systems.
Hybrid Energy Systems	None fully addressed	Programs lack focus on **renewable + storage** integration.

3 Smart Grid Integration and Electricity Markets

Competency	Regions Providing Training	Identified Gaps

Smart Grid Basics	Lombardy, Berlin-Brandenburg	Limited understanding of **smart grid energy flows**.
Grid Balancing and Integration	Partially in Germany and Italy	Missing hands-on modules on **renewable energy grid balancing**.
Electricity Market Mechanisms	None fully addressed	Gaps in understanding **energy markets** and dynamic grid pricing.

4 EV Charging Integration

Competency	Regions Providing Training	Identified Gaps
EV Charging Station Installation	All regions	Strong basic coverage but lacking integration with **smart grids**.
V2G Technologies	None fully addressed	Absence of training for **V2G systems** and grid energy optimization.
Energy Management for EV Charging	Partially addressed in Basque Country	Minimal focus on managing EV charging within **building energy systems**.

Future-Oriented Competencies

The following forward-looking competencies were identified as essential for future SEB sector professionals but are currently missing from most VET offerings:

- AI-Driven Monitoring and Control Systems
- Integration of AI and machine learning for predictive energy optimization and fault detection.
- Hybrid Renewable Energy Systems
- Competence in combining solar PV, wind energy, and ESS for decentralized systems.
- Advanced Cybersecurity for Smart Systems
- Training to secure IoT systems, smart grids, and BAS.

- V2G Technologies
- Competencies in integrating EV infrastructure with smart grids for bidirectional energy flows.
- Data Analytics and Predictive Maintenance
- Use of data-driven insights to optimize energy systems, reduce downtime, and improve energy performance.
- Smart Grid and Energy Market Knowledge
- Understanding electricity market mechanisms, dynamic grid pricing, and energy flows.

Prioritization of Competence Gaps

The most critical gaps have been prioritized based on current market needs, technological advancements, and industry demand:

Cybersecurity for IoT and Smart Energy Systems:

- Protecting IoT-enabled BAS, energy storage systems, and grids is crucial as cyber threats rise.

AI and Predictive Analytics:

- AI-driven optimization and predictive maintenance will be key for efficiency in smart buildings and energy systems.

V2G Technology:

- Training professionals to integrate EVs into smart grids and EMS is essential for electrification.

Hybrid Renewable Energy Systems:

- Integrating multiple renewable sources with energy storage will ensure grid reliability and sustainability.

Smart Grid Integration and Energy Markets:

- Professionals need to understand grid balancing and electricity market mechanisms to manage energy flows effectively.

STEP 8: Competence Framework for the SEB Sector

This **Competence Framework** was developed to bridge the gap between **current VET** offerings and the competencies needed to meet future sector demands. Using data gathered through **desktop research, stakeholder workshops, and VET program evaluations** across multiple European regions—**Greece (Crete), Germany (Berlin-Brandenburg), Italy (Lombardy), Spain (Basque Country), North Macedonia**, and **Portugal (Porto)**—this framework addresses the specific needs of the SEB sector.

The framework identifies and categorizes competencies into four thematic areas:

1. **Smart Building Systems** – Focused on IoT integration, automation systems, and cybersecurity.
2. **Renewables, Storage, EVs, and EMS**– Addressing the installation, integration, and monitoring of renewable energy, energy storage, and EV infrastructure.
3. **Smart Grids, Electricity Markets, and Energy Data Analytics** – Highlighting smart grid integration, load demand response, V2G technologies, and energy data optimization.
4. **Energy Systems, Circular Economy, and Sustainability** – Emphasizing energy efficiency, resource optimization, and sustainable building management.

The identified competencies include **practical skills ("Being Able to Do")** and **theoretical knowledge**, ensuring that VET systems align with **market needs**,

technological advancements, and **European regulatory frameworks**. This academic exploration underscores the importance of modernizing educational curricula to incorporate forward-looking competencies such as **AI-driven energy management**, **predictive analytics**, and **cybersecurity**.

The findings aim to inform policymakers, VET providers, and industry stakeholders, fostering the development of a **future-ready workforce** capable of driving innovation and achieving sustainability in the SEB sector.

Thematic Area 1: Smart Building Systems

Competencies – "Being Able to Do"

- C1.1: Install and maintain smart sensors, actuators, and IoT devices.
- C1.2: Analyse data for smart building systems, including energy management and automation.
- C1.3: Configure and program BAS/BACS.
- C1.4: Protect smart building infrastructure using cybersecurity measures.

Knowledge

- N1.1: Home automation & IoT protocols, data transmission, and system integration in smart environments.
- N1.2: BAS protocols and technologies.
- N1.3: Cybersecurity threats and data privacy in interconnected systems.

Thematic Area 2: Renewables, Storage, EVs, and EMS

Competencies – "Being Able to Do"

- C2.1: Install and maintain PV and other small-scale renewable energy technologies.
- C2.2: Integrate energy (electricity) storage systems in buildings.
- C2.3: Conduct real-time energy monitoring and predictive analytics to optimize energy use.

- C2.4: Install/maintain EV charging infrastructure and relevant monitoring devices.
- C2.5: Install and program BEMS.

Knowledge

- N2.1: Renewable energy system installation and optimization techniques, including electricity storage systems (batteries).
- N2.2: EV charger types and installation techniques.
- N2.3: Regulatory frameworks for EVs, RES, and energy efficiency.
- N2.4: Integrate energy optimization strategies in the design and operation of buildings.

Thematic Area 3: Smart Grids, Electricity Markets, and Energy Data Analytics

Competencies – "Being Able to Do"

- C3.1: Understand smart grid structures and their interaction with smart buildings.
- C3.2: Understand load demand response and V2G technology.
- C3.3: Understand electricity market operations and billing strategies.
- C3.4: Use data-driven insights to enhance energy efficiency and program predictive analytics for optimal energy flows.

Knowledge

- N3.1: Smart grid architectures, purposes, and operations.
- N3.2: Smart electrical installations, monitoring, and control systems.
- N3.3: Electricity market rules, load demand participation, and billing strategies.
- N3.4: Energy data analytics and optimization algorithms.

Thematic Area 4: Energy Systems, Circular Economy, and Sustainability

Competencies – "Being Able to Do"

- C4.1: Understand optimal use of energy resources in generation, consumption, and storage.
- C4.2: Implement recycling and waste reduction initiatives for electrical installations.
- C4.3: Understand environmental impact assessments for energy projects.
- C4.4: Manage resource reuse and recycling within building systems.
- C4.5: Conduct building energy audits to identify opportunities for energy efficiency improvements.

Knowledge

- N4.1: Circular economy principles applied to energy production and consumption.
- N4.2: Environmental laws and standards for sustainable energy systems.
- N4.3: Energy-efficient technologies, smart meters, and their application in residential and commercial buildings.
- N4.4: EU energy efficiency standards and building regulations.

Conclusion

This Competence Framework establishes a comprehensive structure that aligns the competencies required in the SEB sector with the needs of future-oriented professionals. The framework emphasizes key thematic areas such as smart building systems, renewable energy and storage, smart grid integration, and circular economy practices to ensure a holistic approach to energy transition and sustainability.

By addressing both practical "being able to do" skills and the theoretical knowledge required, the framework enables the development of a workforce equipped to meet technological advancements, energy efficiency goals, and sustainability standards in the SEB sector.

CHAPTER 3

Skills and knowledge required to perform each competence

Each of the competencies includes actionable skills and foundational knowledge essential for professionals to effectively meet the demands in the Smart Electricity for Buildings sector. These details will support curriculum development, ensuring alignment with industry requirements and technological advancements.

1. Digitalization and Automation Technologies

Being Able to Do: (competence):

- C1.1 Install and maintain smart sensors, actuators, and IoT devices
  - **Skills Needed:** Proficiency in electrical installation, smart devices setup, and hardware troubleshooting.
  - **Knowledge Needed:** Understanding of smart devices specs, power requirements, and wiring standards.
- C1.2 Analyse data for smart building systems, including energy management and automation
  - **Skills Needed:** Data interpretation, familiarity with building analytics software, and reporting.
  - **Knowledge Needed**: Basics of EMS, key performance indicators (KPIs) for buildings, and data analysis principles.
- C1.3 Configure and program BAS/BACS
  - **Skills Needed:** Programming in relevant BAS languages (e.g., BACnet, Modbus), troubleshooting BAS, and system configuration.
  - **Knowledge Needed:** BAS architecture, control protocols, and programming syntax.
- C1.4 Protect smart building infrastructure using cybersecurity measures
  - **Skills Needed:** Cybersecurity protocols, risk assessment, and network monitoring.

- **Knowledge Needed:** Common cyber threats, encryption standards, and IoT data security practices.

2. Renewables and Energy Storage Integration

Being Able to Do: (competence):

- C2.1 Install and maintain PV, and other small scale renewable energy technologies
  - **Skills Needed:** PV and other RES installation, electrical wiring, diagnostics, and routine maintenance.
  - **Knowledge Needed:** RES and grid coupling specs, wiring standards for RES, and safety protocols.
- C2.2 Integrate energy (electricity) storage systems in buildings
  - **Skills Needed:** Battery setup, energy flow configuration, and storage system diagnostics.
  - **Knowledge Needed:** Energy storage fundamentals, battery chemistry, and grid requirements for energy storage integration.
- C2.3 Conduct real-time energy monitoring and predictive analytics to optimize energy use
  - **Skills Needed:** Data collection, real-time analytics, and software navigation.
  - **Knowledge Needed:** Predictive analytics in energy systems, energy use patterns, and EMS metrics.

3. Smart Grids and Electricity Markets

Being Able to Do: (competence):

- C3.1 Understand smart grids structures and their interaction with the smart buildings.
  - **Skills Needed:** smart meters and smart devices installation for buildings grid coupling.
  - **Knowledge Needed:** Smart grids architectures, purposes and operations.
- C3.2 Understand load demand response and V2G technology
  - **Skills Needed:** Calculate costs and benefits considering current market regulations.
  - **Knowledge Needed:** Smart electrical installations, monitoring and control.
- C3.3 Understand electricity markets operation and billing strategies
  - **Skills Needed:** Calculate costs and benefits considering current market billing strategies.
  - **Knowledge Needed:** Electricity markets rules, load demand participation and billing.

4. EV Chargers Integration

Being Able to Do: (competence):

- C4.1 Install and maintain EVs charging infrastructure and relevant monitoring devices
  - **Skills Needed:** Install and maintain EVs charging infrastructure and relevant monitoring devices.
  - **Knowledge Needed:** EVs Charger types, installations techniques, and protocols.
- C4.2 Implement V2G technologies for grid stabilization and energy exchange
  - **Skills Needed:** V2G configuration, energy transfer management, and load balancing.

- **Knowledge Needed:** V2G protocols, grid balancing, and peak load response.

- C4.3 Predictive Maintenance and Diagnostics
  - **Skills Needed:** Conduct timely maintenance, and reliable system repairing.
  - **Knowledge Needed:** Trained in using data analytics for anticipating chargers' failures.

5. Energy Data Analytics and Efficiency Modelling

Being Able to Do: (competence):

- C5.1 Implement secure communication protocols for energy and building management systems
  - **Skills Needed:** Secure protocol setup (e.g., VPN, SSL), encryption, and access management.
  - **Knowledge Needed:** Communication standards, encryption, and regulatory compliance for data sharing.
- C5.2 Integrate energy optimization strategies in the design and operation of buildings
  - **Skills Needed:** Programming BEMS, energy use patterns, and metrics.
  - **Knowledge Needed:** Integrate energy optimization strategies in the design and operation of buildings.
- C5.3 Use data-driven insights to enhance energy efficiency and programming predictive analytics for optimal energy flows
  - **Skills Needed**: Study and develop energy efficient strategies and scenarios.
  - **Knowledge Needed:** Energy data analytics and optimization algorithms.

6. Sustainability and Green Building

Being Able to Do: (competence):

- C6.1 Follow Green Building Standards and Certifications
  - **Skills Needed:** Resource assessment, sustainability planning, and process efficiency.
  - **Knowledge Needed:** Sustainable resource principles, energy efficiency practices, and lifecycle analysis.
- C6.2 Optimize the use of sustainable resources in energy generation and storage
  - **Skills Needed:** Resource assessment, sustainability planning, and process efficiency.
  - **Knowledge Needed:** Sustainable resource principles, energy efficiency practices, and lifecycle analysis.
- C6.3 Implement recycling and waste reduction initiatives for electrical systems.
  - **Skills Needed:** Waste management, recycling processes, and resource recovery.
  - Knowledge Needed: Waste management regulations, environmental impact assessments, and recycling standards.
- C6.4 Understand environmental impact assessments for electrical installations
  - **Skills Needed:** Understanding impact assessment, environmental risk analysis, and reporting.
  - **Knowledge Needed:** Environmental laws, sustainability metrics, and ecosystem impact assessments.

7. Cross-disciplinary and Soft Skills

Being Able to Do: (competence):

- C7.1 Apply Project Management

  - **Skills Needed**: Ability to prioritize tasks, keep track of milestones, deliverables, and dependencies.
  - **Knowledge Needed:** Project management principles, detailed project plan that covers scope, schedule, budget, resources, and include risk management, quality assurance, and communication plans.
- C7.2 Follow Regulatory Compliance and Standards
  - **Skills Needed:** review and interpret regulations and standards to ensure compliance and assess how regulations apply to SEB projects.
  - **Knowledge Needed:** Laws, directives and regulations in the electrical installations and relevant fields.
- C7.3 Use Digital Communication and Collaboration Tools
  - **Skills Needed:** Establish open and transparent communication channels.
  - **Knowledge Needed:** Effective usage of communication channels, social media, and specific tools.
- C7.4 Risk Management
  - **Skills Needed:** Identify, assess, and prioritize risks early in the project.
  - **Knowledge Needed:** Risk management strategies and contingency plans to address potential issues.

General Conclusions

The Competences and Skills Gap Analysis for the SEB sector has unveiled critical insights into the current and emerging workforce demands across six European regions. This study underscores the transformational role of technological advancements such as AI, RES, IoT-enabled building automation, and cybersecurity in shaping the future of the sector.

Key findings highlight significant gaps in VET programs, particularly in areas like AI-driven predictive energy management, hybrid renewable energy systems integration, and IoT cybersecurity. Despite regional strengths in renewable energy and energy efficiency initiatives, the report identifies widespread challenges in aligning training programs with market needs for advanced skills, including smart grid technologies, EV charging infrastructure, and energy data analytics.

To bridge these gaps, the study recommends targeted modernization of VET curricula to include emerging technologies, hands-on training for hybrid systems, and advanced cybersecurity measures. Strengthening industry collaboration and adopting European frameworks like ESCO and EQF are also crucial for standardizing competencies and ensuring alignment with market demands.

By addressing these gaps through innovative training solutions and robust industry partnerships, the SEB sector can build a highly skilled, multidisciplinary workforce capable of driving the transition to sustainable, smart energy systems across Europe. This effort will not only meet the sector's immediate needs but also pave the way for long-term resilience and innovation in the face of evolving technological and sustainability challenges.

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