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GAP ANALYSIS REPORT

HRD OS HUMAN RESOURCES DEVELOPMENT OPERATING STRUCTURE

ISKAV

HARÜSEM

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1. Introduction

Regarding the development of technology, public buildings, residences, factories, etc. have developed simultaneously. In particular, the selection of energy efficient components such as automation and control systems in these buildings is important in terms of resource efficiency. According to the International Energy Agency (IEA) Net Zero by 2050 Report[1], the building sector is expected to increase by 75% worldwide by 2050. Buildings in many developed economies have a long lifespan and the existing building stock is expected to still be standing in 2050. Accordingly, demand for heating, cooling and plumbing equipment continues to grow, especially in emerging markets and developing economies. While the sector is growing at this rate, the qualified human resources required by the sector is also increasing.

Currently, the sector, which has a dynamic structure, lacks an educated workforce with high level of skills, knowledge and the right competencies. In order to increase the quality of the workforce, the capacities of vocational education institutions, especially vocational high school teachers, need to be increased. The more the knowledge of teachers is increased, the vision and equipment of the students they teach will increase to the same extent. In this respect, Turkish Society of HVAC and Sanitary Engineers (TTMD), Heating Cooling Air Conditioning Research and Training Foundation (ISKAV) and Harran University Continuing Education Center came together to implement the operation for Improving the Quality of Vocational and Technical Education through the Establishment of Sectoral Centers of Excellence implemented under the Instrument for Pre-Accession Assistance 2014-2020 (IPA II); The Ministry of National Education General Directorate of Vocational and Technical Education as the Operation Beneficiary, the Ministry of Labor and Social Security Department of European Union Financial Assistance as the Program Authority and Contracting Authority, and the Delegation of the European Union to Turkey as the funder applied to the program and became one of the 18 projects supported across Turkey.

The project has three main objectives.

1. Establishing a center of excellence for the installation and air conditioning sector to increase the quality of human resources in the sector and organizing innovative training programs at this center,

1 https://www.iea.org/reports/net-zero-by-2050

2. Increasing the capability and capacity of vocational high school teachers in the sector through innovative approaches,

3. To establish a sustainable communication between NGOs, public institutions, business and education actors in the sector.

In order to realize these objectives, joint action will be taken with project partners and sector stakeholders to eliminate the deficiencies to be identified for the needs of the sector in the activities to be carried out during the project. Through the dialogue activities to be organized, problems will be identified together and solutions will be produced together. By developing international cooperation, the sector will be informed about current technological developments in Europe and the world. In the sectoral excellence center to be established, physical conditions suitable for face-to- face and online training will be created and training programs will be organized according to the needs of the sector.

In this report, the current situation of the heating, cooling and air conditioning (HVAC) sector in Europe and Turkey will be analysed and the content and scope of the training activity to be carried out within the scope of the project will be determined in order to meet the need for qualified labor force in the sector.

2. CURRENT SITUATION IN THE AIR CONDITIONING SECTOR

HVAC sector covers activities such as the design, installation, maintenance and management of indoor air conditioning systems. This sector offers products and services related to heating, ventilation, air conditioning and refrigeration systems (HVAC-R). This systems are used in residential buildings, commercial buildings, industrial facilities, healthcare facilities, shopping malls, hotels and many other areas.

The importance and size of the HVAC sector is based on the following factors:

- **Comfort and Efficiency:** HVAC systems are important for improving people's quality of life and increasing the efficiency of work environments. A proper air conditioning system increases comfort by providing the appropriate temperature, humidity and air quality.

- **Energy Efficiency and Environmental Impacts:** Since air conditioning systems account for a large portion of energy consumption, energy efficiency is an important issue in this sector. More efficient air conditioning systems save energy and reduce environmental impacts.

- **Link with the Structural Development of Buildings:** The increase in newly constructed buildings and the renovation of existing buildings contribute to the growth of the air conditioning sector. Advanced technologies and smart building systems also support innovations in the sector.

- **Health and Safety:** A good air conditioning system can reduce health and safety risks by improving indoor air quality. Especially in hospitals and healthcare facilities, special air conditioning systems are used to meet hygiene and sterilization requirements.

- **Industrial and Commercial Applications:** The air conditioning sector offers specialized systems that are widely used in industrial plants, food production facilities, shopping centers, hotels, airports and other commercial areas.

- **Global Market and Business Opportunities:** The air conditioning sector operates in a global market and offers job opportunities in many countries. This increases job opportunities for various professions such as engineering, design, installation, maintenance and management.

The air conditioning sector is an important industry that improves people's quality of life and supports environmental sustainability. Energy efficiency, technological developments and environmental awareness are important factors that will shape future trends in this sector.

Construction, production, cold chain, transportation and agriculture sectors are the leading sectors that the air conditioning sector is related to. Developments in each sector directly affect the air conditioning sector.

a. Current Situation of HVAC Sector in Europe

With the increase in urbanization, energy consumption and carbon emissions of buildings have also increased significantly. It is known that buildings cause approximately 32% of energy-related carbon emissions and a quarter of global human- induced CO_2 emissions and therefore have a major impact

on climate change. As a result of the analysis made in the International Energy Agency's 2019 energy efficiency report[2], it was determined that every 1 dollar spent on energy efficiency practices in buildings saves 2 dollars in new electricity generation and distribution costs.

Regarding climate and environment, it is predicted that 66% of the population will live in cities in the European Union, which aims for a carbon neutral continent in 2050, and in the whole world[3]. This means that by 2050, urbanization will increase and the people who will live there will have to live in energy efficient buildings. Energy efficiency is prioritized when reducing carbon emissions from existing buildings. However, the integration of renewable energy equipment into buildings is also very important. Improvements to the building envelope, the use of heat recovery ventilation systems to provide quality air, switching to LED lighting systems, the use of on-site solar energy, heat pumps are aimed to reduce carbon emissions. With smart energy management systems, the energy use of the building is monitored and optimized, while energy demand is controlled to minimize energy consumption and energy is used in the most efficient way. Net zero energy buildings, where all these practices come together, play an important role in sustainable building and urban planning and are considered an important step in the fight against climate change.

The European Union's carbon emission reduction targets have increased demand for green and innovative technologies in the sector. At the same time, there is a strong push towards electrification to reduce dependence on fossil fuels. Switching to heat pumps is an important trend as they are more energy efficient and environmentally friendly compared to conventional systems. Regulatory measures and financial incentives are driving this shift across Europe. In this context, Europe has started to promote heat pumps and efficient products in particular. In response to the challenges posed by Russia's invasion of Ukraine and the disruption of the global energy market, the European Commission is implementing the REPowerEU[4] Plan to phase out fossil fuel imports from Russia. Within the framework of the plan, which was launched in May 2022, measures to reduce dependence on natural gas through energy saving, diversification of energy sources and clean energy generation strategies, and the widespread use of heat pumps have been put on the agenda and are being implemented.

2 https://www.iea.org/reports/energy-efficiency-2019
3 https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Jan/un_2018_worldcities_databooklet.pdf
4 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

In this context, there have been significant developments in the air conditioning sector in Europe in line with green transformation and energy efficiency targets. After the Kyoto protocol, Europe has now switched to the use of CO_2 as refrigerant in cooling systems. It is known that R404 will be restricted for use in new facilities. The use of refrigerants in non-industrial, unregistered cooling systems, in systems that do not comply with the required quality standards poses a danger. For this reason, the use of CO_2, which is a natural refrigerant and thermodynamically increases system efficiency, is becoming widespread. It has high volumetric cooling capacity compared to other refrigerants. In the systems where it is used, smaller pipe diameters are used and smaller capacity compressors are used. Non-flammable and non-toxic CO_2 is a refrigerant that should be preferred first. Global warming potential (GWP) is 1. CO_2 is a very suitable gas for heat recovery. The used CO_2 can be reused in the system instead of releasing it into the atmosphere. It is used as a refrigerant for district heating and cooling. The industry is moving away from refrigerants with high Global Warming Potential (GWP) such as R-410A towards more sustainable options such as hydrofluoroolefins (HFOs) and A2L refrigerants. These new refrigerants are designed to reduce environmental impact while maintaining efficiency.

The adoption of smart thermostats and AI-powered HVAC systems is on the rise. These technologies help optimize energy use, improve comfort, and enable remote control and monitoring. Smart HVAC systems are permeating everyday life as a standard as consumers and businesses seek greater energy efficiency and convenience. Especially in the wake of the COVID-19 pandemic, there is an increased focus on Indoor Air Quality. Technologies such as air purifiers and advanced ventilation systems are being integrated into HVAC installations to provide healthier indoor environments.

EU regulations such as Ecodesign and the Energy Labeling Directive shape the market by setting standards for energy performance and sustainability. These regulations encourage the development and adoption of more energy efficient HVAC products.

In a nutshell, the European HVAC market is estimated to grow significantly due to rising temperatures due to global warming and increasing demand for energy-efficient cooling solutions. The market value is estimated at USD 61.26 billion in 2022 and is expected to reach USD 86.49 billion by 2028, at a compound annual growth rate (CAGR) of 5.9% (Europe HVAC Market-Industry Outlook and Forecast 2023-2028 Report). However, challenges remain, such as high electricity costs, noise

concerns and the need for regulatory compliance. The European HVAC industry is rapidly evolving with a strong focus on sustainability, energy efficiency and technological innovation. Companies that can adapt to these trends by offering advanced, environmentally friendly and energy-efficient solutions are well positioned to succeed in this market.

The European HVAC market is characterized by increasing construction activities and emphasis on energy efficiency. However, in many places VRF systems are replacing chillers. VRF sales are expected to increase in line with global trends as they help save on operating costs. Major players in the HVAC sector include companies such as Aldes, Daikin, Johnson Controls, Mitsubishi Electric, Robert Bosch, Samsung and Siemens AG. These companies gain a competitive advantage in the market by offering energy efficient systems and sustainable solutions. The UK industry is strongly tied to European business trends and is driven by construction activity in London. Therefore, the VRF system will play a vital role in the European HVAC market.

While the sector tends to grow so much with technological developments, the workforce needs of the sector are increasing at the same rate and need to be updated. The European HVAC Services Market size is expected to be USD 14.68 billion in 2024 and is expected to reach USD 20.68 billion by 2029 with an annual growth rate of 7.10%. This growth is directly related to the HVAC equipment market. Any increase in equipment demand will positively impact the market. This is because higher demand for new equipment will lead to higher demand for installation or retrofit services.

During the pandemic, the need for ventilation systems in European countries has significantly increased the demand for HVAC services. Some studies have suggested that the COVID-19 pandemic is particularly impactful in crowded and enclosed indoor spaces such as workplaces, offices, factories and other indoor environments such as churches, restaurants, shopping malls and vehicles. Ventilation with outside air has been shown to dilute indoor pollutants and increase the time required to be exposed to infectious doses. Air filtration, in addition to its ventilation function, reduces the risk of virus transmission compared to increasing the rate of air exchange in an enclosed space. Therefore, the demand for installation services related to air filters has increased significantly since the COVID-19 pandemic.

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b. Current Situation of Air Conditioning Sector in Turkey

In recent years, many national and international studies have been carried out to reduce the global climate crisis and the environmental impacts it brings. The air conditioning sector in Turkey is a highly developed sector depending on the country's various climatic conditions and geographical characteristics. Air conditioning generally covers areas such as heating, cooling, ventilation and air quality control.

Turkey is an important market in the air conditioning sector. Demand is constantly increasing with the increase in population and industrial facilities, especially in big cities. Both heating and cooling systems are important due to the wide climate diversity of our country. While heating systems (boiler, central heating, etc.) are generally used in winter, air conditioning and ventilation systems are of great importance in summer. Ventilation systems are of great importance in ventilation and air quality control, especially for improving indoor air quality and creating healthy living environments. This field has attracted more and more attention in recent years. Large- scale air conditioning systems are used in Turkey's industrial and commercial centers, factories, warehouses and shopping malls. The efficiency and energy consumption of these systems is also an important agenda item. The air conditioning sector in Turkey is an important sector in terms of both growth potential in the domestic market and technological developments. Ever-increasing energy needs and environmental awareness will make the sector even more important in the future.

The air conditioning sector has experienced similar growth with the growth experienced by the construction sector, with which the air conditioning sector is directly related. The growth in the construction sector and urban transformation projects in Turkey have increased the demand for HVAC systems. This has increased the demand for HVAC equipment and led to new investments in the sector. While the global air conditioning sector had a size of 319 billion dollars in 2021, it is projected to reach approximately 477 billion dollars by 2026 with an average annual growth rate of 8.4%.

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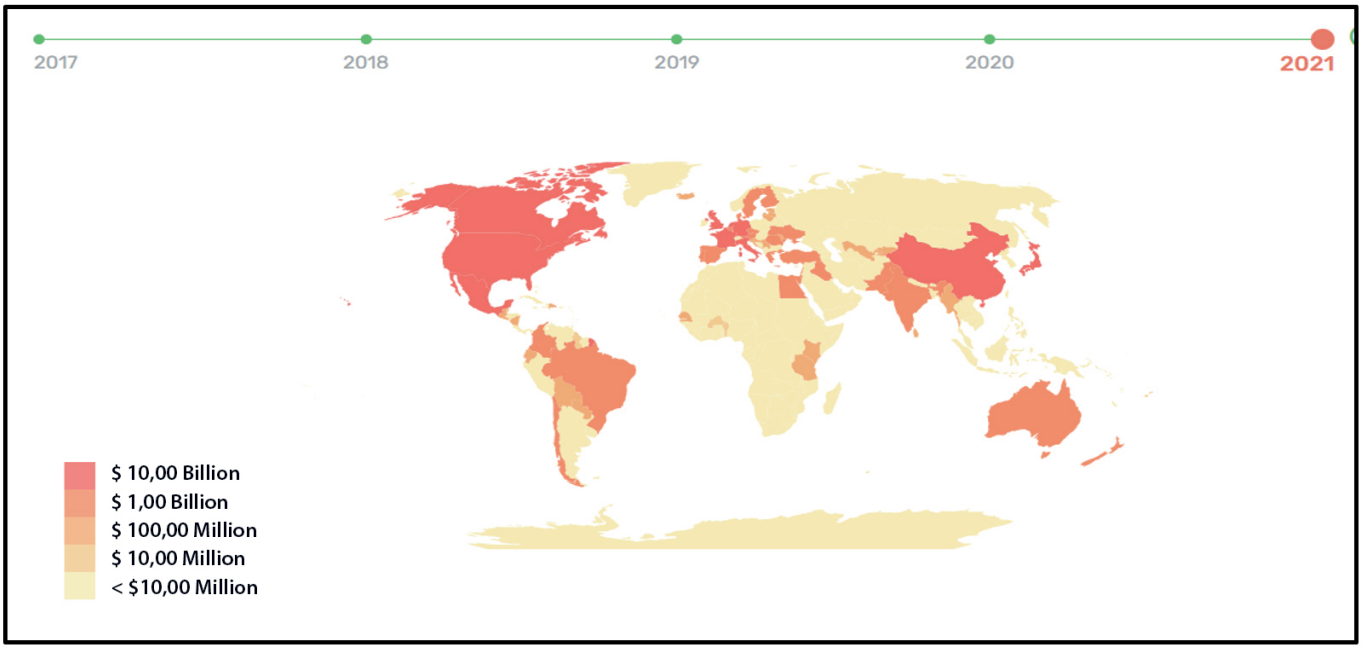

Figure 1: Global import status of the sector

Source: www.comtrade.un.org

The air conditioning sector is divided into sub-product groups: ventilation, heating, cooling, insulation, air conditioning and installation. The global market is dominated by China, Germany, Italy, the USA and Japan. It has become an important actor for the Turkish economy in meeting rapidly growing domestic demand and increasing exports to competitive international markets. When the comparison of 2022-2023 between January-May of our country is made, the export figures, which were 2.7 billion dollars in 2022, increased to 3 billion dollars in 2023 and became the 11th most exported sector. While these exports are mostly made to European Union member countries such as Germany, Russia, United Kingdom, Italy, France, exports are also made to our neighboring countries such as Iraq, Bulgaria and Georgia.

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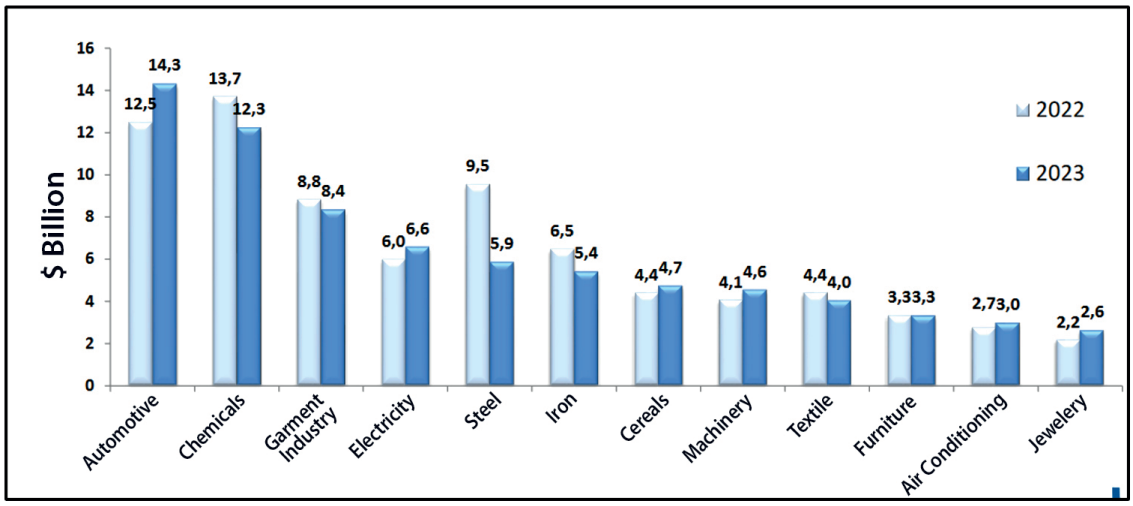

Chart 1: Turkey's sectoral comparison of export data for 2022- 2023

Source: ISIB

When we look at the sub-division of air conditioning systems, installation systems and components have the highest export figures, while the unit price per kg is observed in air conditioning systems and components.

Table 1: Turkey-wide export data Source: ISIB

	2022 (JANUARY-MAY)			2023 (JANUARY-MAY)			% RATE CHANGE		
	Quantity (KG)	Value ($)	Unit Price ($/KG)	Quantity (KG)	Value ($)	Unit Price ($/KG)	Quantity (KG)	Value ($)	Unit Price ($/KG)
HEATING SYSTEM AND COMPONENTS	156.861.534	561.785.695	3,6	133.045.452	581.990.687	4,4	-15,2	3,6	22,1%
COOLING SYSTEM AND COMPONENTS	65.371.233	406.282.443	6,2	62.905.284	445.196.980	7,1	-3,8	9,6	13,9%
AIR CONDITIOINING SYSTEM AND COMPONENTS	37.002.405	376.486.785	10,2	38.472.666	408.323.233	10,6	4,0	8,5	4,3%
INSTALLATION SYSTEM AND COMPONENTS	160.656.403	1.018.056.540	6,3	158.613.725	1.112.257.575	7,0	-1,3	9,3	10,7%
VENTILATION SYSTEM AND COMPONENTS	41.033.945	309.001.012	7,5	40.238.690	357.627.141	8,9	-1,9	15,7	18,0%
INSULATION MATERIALS	74.797.526	69.119.935	0,9	34.051.278	43.622.145	1,3	-54,5	-36,9	38,6%
GENERAL TOTAL	535.723.047	2.740.732.411	5,1	467.327.095	2.949.017.761	6,3	-12,8	7,6	23,3%

Turkey is also a production point for major manufacturers. International companies such as LG, Carrier, Ferroli, Viessman, etc. are engaged in production in Turkey either directly or by establishing local partnerships. SMEs operating in the air conditioning and installation sector, which is of such importance for our country, need to focus more on qualified human resources, research and development and innovation in order to increase their technical infrastructure and know-how. Turkey plays an important role in this sector due to its geographical proximity to Europe, Middle East, Caucasus and Mediterranean countries, ease of transportation and logistics facilities, and lower labor costs compared to Europe.

Since air conditioning is defined as the science of controlling environmental conditions by using thermal processes and systems to meet comfort, hygiene and special process needs, the scope of the air conditioning sector includes heating, cooling, ventilation, air conditioning systems and equipment. In this context, while maintaining the internationally accepted HVAC-R framework, the sector works very closely with the pump, valve, joining element and similar sectors, especially installation insulation, and should be evaluated in the same categories.

The sector attaches great importance to R&D and innovation activities, follows technological developments and makes investments in this field. However, the sector faces challenges such as public procurement problems and high R&D costs, especially for patented products.

Many associations and foundations play an active role in different fields for the development of the sector. These structures generally assume important roles such as developing cooperation between members, ensuring the cooperation of members between institutions, ensuring the flow of sectoral information, and conducting sectoral training programs. The most important non-governmental organizations in the sector are as follows;

- Turkish Society of HVAC and Sanitary Engineers –TTMD
- Heating Cooling Air Conditioning Research and Education Foundation – ISKAV
- Mechanical Installation Contractors Association (MTMD)
- TOBB Air Conditioning Assembly

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- Turkish Pump and Valve Industrialists Association (POMSAD)
- Aegean Cooling Industrialists and Businessmen Association (ESSİAD)
- Heat Water Sound and Fire Insulators Association (IZODER)
- Natural Gas Equipment Industrialists and Businessmen Association (DOSIDER)
- Boiler and Pressure Vessel Industrialists' Association (KBKSB)
- Construction Material Industrialists' Association (IMSAD)
- White Goods Suppliers Association (BEYSAD)
- Cooling Industry Businessmen Association (SOSIAD)
- Air Conditioning and Refrigeration Technicians Association (IKSODER)
- Air Conditioning - Cooling Education, Consultancy and Research Association (ISEDA)
- TMMOB Chamber of Mechanical Engineers

Installation Technology and Air Conditioning; It is a field that is rapidly spreading in our country and in the world, constantly developing technologically and open to innovations. For this reason, this field attracts the attention of countries as both a commercial and strategic industry. In addition, it is an area where serious sensitivities are shown and special planning is made by countries to protect the environment and nature and to use existing resources.

3. LABOR FORCE SITUATION IN THE SECTOR

a. Air Conditioning Sector Workforce Review in Europe

The HVAC sector is experiencing growth and change but needs more skilled labor. In Europe and elsewhere, an aging workforce is a major cause of this shortage. The U.S. Bureau of Labor Statistics (BLS) projects a 6% nationwide growth rate (faster than the average for all occupations) for heating, air conditioning and refrigeration technicians and installers over the next nine years[5]. With 415,800 HVAC technician jobs in 2022, the BLS projects that there will be openings for an average of 37,700 HVAC professionals each year through 2032. Beyond mechanical craftsmanship, HVAC technicians also need to establish good communication skills when working with homeowners or business customers as they troubleshoot the problem or repair, offer tips for follow-up maintenance, or provide options for replacing or upgrading to a more energy efficient HVAC system.

In Europe, HVAC technicians are usually trained at technical universities, vocational schools and technical colleges. The main objective is to gain technical knowledge and skills for those who want to work in the air conditioning sector. These institutions offer both theoretical and practical courses, providing students with comprehensive knowledge in the design, installation, maintenance and repair of HVAC systems. Topics such as the working principles of air conditioning systems, basic components and system design, as well as modern air conditioning equipment energy efficiency technologies are at the center of the training. In addition to the technical aspects of the subject, topics such as legal regulations, environmental standards and building regulations applicable in the sector are among the information given to the students.

In various European countries, HVAC technicians are required to hold certain certifications. These certifications prove that technicians are knowledgeable about current technologies and regulations and have the necessary skills. For example, in Germany there are mandatory certification programs for HVAC technicians. It usually follows a process of vocational training (Ausbildung) followed by obtaining a master certificate (Meisterbrief). The Meisterbrief shows that a technician has a high level of knowledge and skills in a specific field and is often required to start their own business or work in managerial positions. HVAC technicians have to participate in training programs approved by KfW (Kreditanstalt für Wiederaufbau) and BAFA (Bundesamt für Wirtschaft und Ausfuhrkontrolle). These trainings ensure that technicians are up to date on energy efficiency. They must work

5 https://www.bls.gov/ooh/installation-maintenance-and-repair/heating-air-conditioning-and-refrigeration-mechanics-and-installers.htm

in accordance with the German and European standards DIN and EN. Compliance with these standards ensures that technicians provide services at a certain level of quality and safety.

In addition, in accordance with the European Union's F-Gas (Fluorinated Greenhouse Gases Regulation) regulations[6], HVAC technicians must have this certification in order to work with fluorinated gases (F-gases). In Germany, this certification is obtained through exams given by authorized training institutions. F-gas regulations are legal regulations aimed at reducing the use and emission of fluorinated greenhouse gases[7]. These regulations aim to control emissions of F-gases that damage the ozone layer and contribute to global warming. According to the regulation, the goal is to reduce F-gas emissions to one-third of the 2015 level by 2030. F-gases with high global warming potential (GWP) are banned in certain applications. Equipment containing F-gases needs to be labeled and monitored, with regular maintenance and leak checks. Participation in training and certification programs is mandatory for technicians working with F-gases.

b. Air Conditioning Sector Workforce Review in Turkey

The HVAC sector is a broad field that includes heating, cooling, ventilation and air conditioning systems of buildings. In Turkey, education in this sector is possible through vocational high schools and technical schools, vocational colleges, university undergraduate programs and various certificate programs.

The main topics focused on in HVAC training are:

- Basic HVAC Systems: Operating principles of heating, cooling, ventilation and air conditioning systems
- Refrigeration: Refrigeration cycles, refrigerants and refrigeration systems
- Electricity and Electronics: Electrical circuits and electronic components used in HVAC systems
- Control Systems: Automation and control mechanisms used for the control of HVAC systems
- Energy Efficiency: Energy saving methods and sustainable HVAC practices

6 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0517
7 https://climate.ec.europa.eu/eu-action/fluorinated-greenhouse-gases/f-gas-portal_en

- System Design and Installation: Design, installation and commissioning of HVAC systems.
- Air conditioning: Indoor air quality, humidity control and comfort conditions
- Maintenance and Repair: Techniques and tools necessary for the maintenance and repair of HVAC systems.

Training in the HVAC sector requires technical knowledge and skills as well as specialization in energy efficiency and sustainability. Training and certifications are an important step towards a career in the sector.

Especially in developing countries, unemployment rates are increasing at the level of young population due to the mismatch between the human resources needed by rapidly growing industries and the expectations of individuals who have completed their education. Vocational and technical education aims to raise a qualified workforce with national and international professional competence, professional ethics and professional values, innovative, entrepreneurial, productive, adding value to the economy in cooperation with social and economic sectors. In vocational high schools and technical schools, which are the first step in the field of installation technology and air conditioning, students are given the basic trainings mentioned above with this awareness. Sanitary system, heating and natural gas indoor installation, home and commercial type coolers, chilling rooms and warehouses, refrigerated vehicles and vehicle air conditioners, refrigerated vehicles and vehicle air conditioners, domestic air conditioners and air conditioning systems installation, commissioning, breakdown and maintenance work is the field of education and training to gain qualifications. Students gain practical knowledge and skills in this regard.

Students who graduate from various branches of the Installation technology and air conditioning field can, if they wish, pass to two-year vocational colleges of universities related to their fields without an exam as long as the practices of YÖK (Council of Higher Education) continue, or they can enter four-year technical education faculties by winning the university exam. Those who cannot pass to higher education can open and operate their own workplaces in their fields with the workplace opening certificates given to them in vocational high school.

According to the data of the YÖK, 26 universities in Turkey have an associate degree program in air conditioning and refrigeration technology. At the undergraduate level, mechanical engineering departments offer detailed information about HVAC systems. In addition, some universities may have special HVAC programs. In addition to these, there are special courses and certificate programs.

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Vocational Training Centers are educational institutions opened in order to train qualified intermediate manpower needed by the industry by providing training to candidate apprentices, apprentices, journeymen and masters in the provinces and professions included in the scope of apprenticeship education and by opening various vocational courses. Vocational Education Centers provide education in the field of installation technology and air conditioning. Since there is parallelism between modular programs and vocational high schools, external and lateral transfer can be made.

Individuals trained in the field of installation technology and air conditioning carry out their work both indoors and outdoors and in all climatic conditions. All employees in this field should interact with employees and customers in other sectors while performing their duties and should carry out their duties in accordance with professional ethics.

There are some international certificates that are also valid in our country and are sought after by employers.

- NATE (North American Technician Excellence): A US-based certification program for HVAC technicians.

- EPA (Environmental Protection Agency): Provides certification on the use and management of refrigerants.

- ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers): Offers professional development and training in the field of HVAC&R.

There are the following branches under the Plumbing Technology and Air Conditioning Area given in our country;

- *Refrigeration Systems Branch:* The purpose of this branch; installation technology and air conditioning in the field of refrigeration systems, refrigeration systems staff to train professional staff with the qualifications of the profession.

- *Air Conditioning Systems Branch:* The aim of this branch is to train professional staff who have the qualifications of the profession of air conditioning systems staff in the field of installation technology and air conditioning.

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- *Building Installation Systems Branch:* The aim of this branch is to train vocational staff who have the qualifications of heating, gas burning devices (maintenance-repair), plumbing profession in the field of installation technology and air conditioning.

When we look at the working areas of graduated students;

- Natural gas contracting companies
- Services of combustion appliances
- Boiler rooms of factories/enterprises
- Installation contracting companies
- Heating installation contractors
- Authorized air conditioning services
- Refrigeration services
- Refrigeration installation contracting companies
- Air conditioning companies
- Installation project preparation units of engineering companies
- In addition, students who graduate from the field of installation technology and air conditioning can start their own business by obtaining a certificate of opening a workplace with their diplomas during their graduation in accordance with Article 18 of the Law No. 4702, and they can also be placed in a department related to their fields by taking additional points in the entrance exam to Vocational Higher Schools.

It is applied in all types and degrees of formal and non-formal vocational and technical education and training institutions where secondary education institutions leading to diplomas in the field of

vocational and technical education and certificate and certificate programs are applied. In order to implement the programs, the standard equipment of the installation technology and air conditioning field and the equipment required by the professions should be provided. The total education period of the field program is planned as 3 academic years after the 9th grade. Students are guided by cooperating with universities, non-governmental organizations, natural gas companies and professional staff in the surrounding area in terms of teaching activities, employment opportunities and planning required by the program.

Education in the field of installation technology and air conditioning in Turkey is divided into two as public and private sectors. Institutions providing education in the public sector are high schools, universities, the Ministry of National Education and vocational training institutions. Trainings given in the public sector are given face-to-face except for force majeure. In Turkey, there are a total of 316 schools in 78 provinces of 81 provinces in the installation technology and air conditioning department. A total of 967 installation technology and air conditioning teachers are employed in this field.

Institutions that provide online training are mostly companies in the private sector. Private sector companies such as Alarko and Bosch provide online and/or face-to-face trainings in their academies. Sectoral associations such as TTMD, ISKAV, ISIB also have activities such as seminars, symposiums, webinars as well as various periodical trainings. In addition to such private sector trainings, there are also courses that provide training to departments such as installation technology and air conditioning departments in our country.

4. RECOMMENDATIONS FOR IDENTIFYING AND ADDRESSING GAPS

As in all other sectors, the most important need in the sector, which is growing every year, is qualified employees. Increasing the quality of the information received during the education of people employed in the sector as engineers or technicians is the most important step to overcome this deficiency.

One of the biggest reasons for the limitations in access to qualified workers in vocational education is the lack of technical infrastructure in schools. Due to budget constraints and the lack of equipment and laboratories in schools, students are only able to apply their theoretical knowledge when they come together with the private sector in internship programs. For this reason, teachers have the opportunity to learn this new information with the up-to-date information brought by the students who are on internship in the field.

This situation reveals the importance of establishing close relations and cooperation with the business world. Differences in industrialization and climatic conditions between cities also shape students' orientations in the field and the skills they are able to develop. For example, Şanlıurfa and Ankara, which are the implementation regions of the project, have two different climatic conditions. Ankara's well-developed air conditioning industry provides students with high opportunities to find internships and employment upon graduation. Similarly, the equipment and laboratory facilities of schools are higher than in other regions. Technicians and technicians trained in air conditioning in Şanlıurfa and the nearby geography have focused on cooling due to climatic conditions. In interviews with local actors in the region, it was stated that there is a shortage of labor force, especially for maintenance/repair works, due to the intense need for cooling from spring months to the summer season. In this regard, awareness should be raised so that young people are directed to vocational training starting from high school.

Due to the differences in the level of consciousness in Turkey and the problems arising from the education system in our country, it is seen that students do not consciously choose their schools to receive education in vocational high schools, and they do not come knowing what the jobs they will do after graduation are. The image of vocational high schools is being damaged day by day. In recent years, vocational high schools have become the choice of students who are relatively less successful in exams. Vocational high schools, which are the most suitable environment to gain expertise at an early age, need to work to regain the value they have lost in the eyes of parents and students. In this regard, the private sector should cooperate with schools to meet the need for qualified personnel, support the physical equipment in schools, and explain the importance of vocational education to students and their families through employment-guaranteed training and scholarship programs.

While the lack of equipment and hardware in schools is an important issue, another important issue is the lack of knowledge of teachers. In the interviews with teachers who lacked equipment in their schools, they stated that they received up-to-date information on the working principles and applications of new equipment introduced to the market in line with technological innovations from their students doing internships in the field. It was determined that vocational high school teachers, who need to constantly renew themselves in order to keep up with the updates in equipment, should increase their awareness and knowledge level by participating in in-service trainings organized by the Ministry of National Education and trainings organized by the private sector. Especially in the current conjuncture, closely following the technological developments in the private sector, following the issues that will be affected by the sector due to the current regulations concerning our country, which has close trade re-

lations with the European Union, should be among the priorities of educators at all levels who prepare their students for working life. In the rapidly changing world conditions, the public and private sectors should cooperate in order to contribute to the development of our teachers.

In the dialogue activity carried out within the scope of the project, meetings were held with the participation of sector representatives. In the surveys conducted with the participants on the disadvantages of technical high schools and the possibilities of cooperation with vocational high schools in the field, the most prominent factors were the lack of practice, inadequacy of laboratories, inappropriate curriculum, knowledge level of trainers, prejudice of the society, society's view of vocational high schools and prejudices.

As for the expected cooperation between private sectors and vocational high schools, the following suggestions were made:

- The private sector is expected to be in close contact with vocational high schools in order to meet their employment needs. In this process, internships and activities to introduce vocational fields should be organized for schools.

- Similarly, teachers should be encouraged to develop close relationships with the privatesector.

- Private sector representatives should be able to share their experiences with teachers to create a sustainable education model. Teachers should organize training programs together with experts and cooperate in updating the curriculum.

- Vocational colleges, the next step after vocational high schools, are envisioned to play an active role in bringing the private sector and schools together.

- The private sector is expected to provide theoretical and practical specialization trainings for employment and mentoring in terms of transferring practical experience of the profession.

- Activities should be carried out to give students experience in different fields according to their abilities. For this purpose, the skills of each student should be determined through observations and examinations in schools. While some students are talented in sales, others may be talented in production and/or assembly. Student-oriented strategies should be developed to increase the attractiveness of vocational education and make it preferable.

- The first issue regarding the opportunities that vocational high school students will face in the field after graduation is the possibility of not meeting their salary expectations. In the face of this low wage policy of the private sector, newly graduated young people, who are generally employed with minimum wage, seek jobs in different fields instead of the departments they have studied.

- It has been observed that schools with renewed infrastructure and modern designs are preferred intensively, but schools with inadequate infrastructure are not preferred at all. This shows that when the practice areas of the schools in our country are well modernized and introduced in co-operation with the sector, the preference may be higher.

- After creating the infrastructure to raise awareness, there are problems in transferring this infrastructure to students. The sponsoring company that provides the school's equipment should plan trainings at the school in a sustainable manner, taking into account gender equality in interaction with students and trainings. Teachers who are so intertwined with the private sector should participate in sectoral trainings, fairs and projects to increase their qualifications and renew themselves, and environments should be created where they can transfer their innovations to students one-on-one.

- Students who have received vocational education in well-equipped schools in a quality manner, instead of working at home, are turning to working life abroad according to their fields of specialization. In the long run, this may lead to a loss of labor force and a loss of young population in our country.

- It has been observed that there has recently been a concern among families that everyone's children should go to university and that vocational high schools are put on the back burner due to the concerns that vocational high school students can be even more successful than an undergraduate student with their skills. At this point, private sector representatives should organize events such as career days in schools where they can come together with families and share experiences.

- Within the scope of on-the-job training, a curriculum change was made 2 years ago in high schools, where students work 5 days in the workplace and receive training on the 6th day. For these students, who are ultimately children, this practice should be organized in cooperation with the private sector and schools by examining its technical and social efficiency.

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5. ACTIONS FOR THE PROJECT OBJECTIVES

Based on the current situation of the air conditioning sector, it is seen that the need for qualified workforce will continue to increase in the coming years with the developing technology. One of the objectives of this project prepared in cooperation with TTMD, ISKAV and HARÜSEM is "to establish a center of excellence for the installation and air conditioning sector in order to increase the quality of human resources in the sector and to organize innovative training programs in this center."

For this purpose, in order to meet the need for qualified human resources of the private sector with current technological developments, training content and materials including the following titles will be prepared to be given to teachers within the scope of the project.

TOPICS	DURATION
Learning Tools Usage Training	
A. Brazing • What is Soldering? o Soldering Types and Properties, o Differences between Soldering and Welding o Differences between Capillary Soldering and Solder Welding • Brazing and Filler Materials Used in Brazing o Brazing Wires for Joining Copper and Copper o Brazing Wires for Joining Copper and Brass	8
• Brazing and the Decapsulants Used o Copper and Copper, Copper and Copper Alloys Used in Copper and Copper Alloys and Their Properties,	8
• Capillary Brazing o Capillary Brazing for Joining Copper and Copper, o Capillary Brazing for Joining Copper and Brass	8

• Brazing Joint Types • Cleaning and Preparation in Brazing • Accurate Flame Adjustment for Brazing with Oxy-Gas Flame o Types of Flame Used in Oxy-Gas Soldering o Safe Flame Generation with Oxy Gas o How to Separate the Flame Used in Soldering with Oxy-Gas o Rule for Safe Opening and Closing of Oxy-Gas Cylinders and Gas Regulator o Pulleys and Nozzles Used as Oxy-Gas Equipment • Considerations in Brazing Applications • Cleaning After Brazing • Non-Destructive and Destructive Testing in Brazing • Occupational Health and Safety in Brazing Flame Recoil Safety Valves • Occupational Health and Safety in Brazing o PPE for oxy-gas soldering o Flame Recoil Safety Valves used in Oxy-Gas Welding types and Features	8
• Applications of Capillary Brazing of Pipes • Braze Welding Applications	8
B. Overview Of Synthetic And Alternative Coolants 1. Synthetic and natural refrigerants • HCFC and HFC refrigerants • ASHRAE flammability and toxicity classification • Saturation pressure-saturation temperature relationship 2. National and international regulations and standards • F-Gas regulation and its implications • Overview of EN 378 and other relevant standards 3. Mixed refrigerants • Temperature shift, bubble point and dew point concepts in mixed refrigerants • Analysis with P-h diagram	4

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C. Vapor-Compression Mechanical Refrigeration Cycle **1. Explanation of the refrigeration cycle with animations** • Duties of the compressor, condenser, expansion valve and evaporator in the cycle • Superheat and subcooling concepts and measurement • Condensation pressure control and energy efficiency **2. Analysis of the cooling cycle using Cool Pack software** • Drawing the cycle in accordance with the given operating conditions by means of software and analyzing the results **3. Auxiliary and safety elements used in the refrigeration cycle** • Solenoid valves, • Sight glass, • Filter-dryer, • Liquid tank, • Low and high pressure automatics, • Automatic oil pressure differential, • Evaporator pressure regulator, • Suction accumulator, • Condenser pressure regulator	4
D. Air Conditioning **1. Overview of air conditioning and its applications** • Air conditioning and its components • Indoor air quality and related standards **2. Air handling unit** • Explanation of air handling unit and its components with animations, • Air handling units within the framework of Eurovent standards **3. Chiller** • Explanation of the structure, working principle and types of water chillers with animations, • Full and partial load efficiency concepts **4. Cooling tower** • Cooling tower structure, working principle, types, • Factors affecting business conditions. **5. Relationship between air handling unit, chiller and cooling tower** • Evaluation of the factors affecting the interoperability of these components in terms of energy efficiency.	4

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E. Psychochrometric Diagram **1. Representation of the properties of moist air in a psychrometric diagram** • Dry bulb temperature • Wet bulb temperature • Relative humidity • Enthalpy • Specific humidity • Dew point temperature • Specific volume **2. Analysis of basic air conditioning processes in psychrometric diagram** • Dry heating/cooling • Cooling/dehumidification • Heating/humidification • Adiabatic cooling • Demonstration of the summer air conditioning process in a psychrometric diagram	4
F- Occupational Health And Safety And Environmental Protection Measures o Defines the legal and workplace rules on occupational health and safety. o Explains how to reduce risk factors related to occupational health and safety. o Explains the emergency procedures to be applied in case of danger. o Explains national and international regulations on climate change. o Explains the basic concepts of fluorinated greenhouse gases that cause climate change. o Principles of Montreal, Kyoto Protocol and Ozone Depleting Substances and F-Gas regulations. o Explains the basic concepts related to the environmental effects of fluorinated greenhouse gases that cause climate change. o Appropriate equipment, materials and equipment to be used against spills and leaks - Contraband search detector - Digital Manifold - IR thermometer - Manual manifold - Gas recollection device - Digital scales - Hand tools and their use - Countersinking tools and their use - Use of copper tube blow molding tools	2

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• **Basic thermodynamic and indirect leakage control principles**
  • SI units related to heat, pressure, mass, density, energy
  • Basic principles of cooling systems
• **Functions of the main elements in the cooling system**
o Basic functions of compressors.
  - Effects of fluorinated refrigerant leakage on compressor operation
  - Considerations for the installation of the compressor, including control and safety equipment
  - Operating principles of suction/discharge valves
  - The process of checking the oil level in the compressor crankcase
  - Data to be entered about the compressor in the logbook
	6

o Explains the basic functions of condensers.
  - Leakage risks related to condensers
  - Adjusting the high pressure automatics
  - Considerations for the installation of the condenser, including control and safety equipment
  - How to adjust the safety and control elements of the condenser
  - Control process of high/low pressure lines
  - How to evacuate non-condensable gases from the system
  - Effect of non-condensable gases on the system
  - Data to be entered about the condenser in the logbook
o Main tasks of evaporators including defrosting system
  - Leakage risks related to evaporators
  - Adjust the evaporator pressure regulator
  - Considerations for the installation of evaporators, including control and safety equipment
  - Safety and control elements related to the evaporator
  - Control process of discharge and suction lines
  - Data to be entered about the evaporator in the logbook
o Main tasks of expansion valves
  - Leakage risks associated with expansion valves
  - Points to be considered in the installation of expansion valves
  - Adjustment of expansion valves
o Control process of the filter dryer
  - Data to be entered in the logbook about expansion valves
o Preparation for brazing of copper tubes
o Study low-GWP refrigerants as an alternative to fluorinated greenhouse gases
	6

o Safe operation measures for alternative refrigerants o The behavior of alternative refrigerants under different outdoor conditions in terms of energy efficiency o Maintenance and repair of refrigeration equipment o Leakage control methods o Tightness testing process o Failure and leakage intervention approaches o Gas recovery methods and techniques. o Nitrogen testing and leak detection o Use of the vacuum pump o Refrigerant system filling methods and techniques o The content of the records to be kept about the tests and controls performed o Detection of potential leakage points of refrigeration, air conditioning and heat pump devices o Records to review before performing a leak check o Data to be entered in the log about the leak o To read the concepts of subcooling, superheat for fluorinated refrigerant charge	8
G . Heat pump General Definitions 1.Refrigerant Gas Cycle General Information • Heat pump cycle - What is the Carnot Cycle? • History of the heat pump • Heat Pump Working Principle • COP & EER definitions (Heat pump efficiency)	2
2. Heat Pump Types • Types in terms of heat pump drive (Mechanical T. - Thermal T.) • Types in terms of Resources • Ground Source Heat Pumps • Water Source Heat Pumps • Air Source Heat Pumps	2
3. Components Composing the Heat Pump • Compressors and compressor turbines. • Expansion Valve - Expansion Valve • Evaporator - Evaporator • Condenser - Condenser • Four-way valve • Electronic components, boards and sensors.	2

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H. Air Source Heat Pump Installation Details **1. Air Source Heat Pump** • Air Source Heat Pump Types • Heating - Cooling - Hot water appliances • Pool heat pumps • Heating only (hot water devices) • Self-cooled heat pumps • Determination of power - capacity values of Air Source Heat Pumps	2
2. Heat Pumps Installation • Recognition of installation components and working principles • Heat pump installation design criteria • Auxiliary basic products Buffer tanks & special boilers • 3 way valve working principle and installation • Air purifier working principle and installation • Safety valve working principle and installation • Closed expansion tank working principle and installation • Installation pressure loss / Circulation pump calculation • Circulation pump installation • Circulation pump control	2
3. Basic Air Conditioning • Types of Air Conditioning • Radiator System • Fancoil System • Underfloor heating/cooling • Ceiling Heating / Cooling • Controlled ventilation system	2
4. Examination of Assembly Systems Applications • Heating system diversification created by cascade connection of multiple heat pumps • Hybrid application of heat pump and solar energy • Combined application of a Heat Pump and another heating system • Designing the heating of more than one heated area / system with Heat Pump system	2

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I. Commissioning - Maintenance - Fault Detection - Repair in Heat Pump Systems **1. What to do when commissioning the system** • Assembly Diagram Check • Electrical installation control • Device position control • Filling out the commissioning form **2. Gas Cycle Side Fault Detection** • Gas pressure control • Operation performance and volume control • System check based on fault code **3. Detection of Installation Side Faults** • Water pressure control • Checking valves, check valves and strainers • Installation pressure and air control • Temperature and flow control **Detection of Electrical Side Faults** • Voltage Control • Unit Ampere control • Signal cables Inspection • Sensor and sensor cables inspection • Electronic card control	2
I. OVERVIEW OF THE USE OF CARBON DIOXIDE IN REFRIGERATION SYSTEMS • Introduction Alternative Refrigerants • Safety and Risk Management • Design Differences • Containment and Leak Detection • Maintenance and Repair • Renovation of Existing Systems • Legislation and Standards Alternative Refrigerants • Financial, environmental, safety and reliability costs of leakages • Field Research and Guidance	2

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J. LABORATORY/WORKSHOP PRACTICE IN THE USE OF CARBON DIOXIDE IN COOLING SYSTEMS • Realization of effective control of site conditions • Checking that the application site is well ventilated and establishing an escape plan against various adverse system responses • Assess leakage risks and leakage potential • Assessing and implementing the correct and effective use of safety equipment • Checking the position of the equipment used for testing purposes • Charging carbon dioxide as a refrigerant in test equipment • Observation of 3 states of matter in carbon dioxide charged into test equipment • Implementation of what to do in case of possible leakage or leakage in systems using carbon dioxide in cooling All equipment used for the test is left as it should be	8
K- VRV INPUT • Basic Refrigeration Cycle • What are VRV Systems, places of use • VRV models and types. • VRV Piping diagrams	2
VRV Installation • Indoor unit types, layout, installation and • Piping • Drainage Line design • Leakage Tests	2
VRV Installation • Outdoor unit installation rules • Communication and power lines • Vacuum • Additional gas charge calculation • Circuit purchase	2
VRV Malfunction • Fault Diagnostics, • Failure Codes • Fault Resolution Flowcharts • Component and system measurements	2

Controls & Automation • Indoor Unit Controls • Central Controls • Energy Distribution Billing Systems • Automation Systems (Modbus, Bacnet)	2
Workshop - VRV • Failure simulations • Cooling system analysis	2
Workshop • Failure simulations • System analysis	4

With the training content to be prepared for the second objective of the project, "to increase the capability and capacity of vocational high school teachers in the sector with innovative approaches", it is planned to organize a training program for 180 vocational high school teachers for 6 days online and 6 days face-to-face. In addition to the main topics, teachers' existing knowledge will be updated with the training content that will be elaborated with current developments prepared by trainers who are in close contact with the private sector.

6. CONCLUSION

The aim of the center to be established within Harran University within the scope of the project is to become a sectoral continuing education center for learning innovative technologies in the field of installation technology and air conditioning. This center will carry out both online and on-the-job trainings and will provide certification at national and international level. This center, which was established to meet the needs of the sector and the region, is to carry the professional knowledge and skill levels of teachers in the field of installation technologies and air conditioning to an advanced level by using today's technologies in order to train more qualified personnel in vocational and technical high schools.

In terms of sustainability, it is to improve the knowledge and skill levels of teachers in the fields of installation technologies and air conditioning within the vocational and technical high schools, which are the main source of labor force and the first step in training qualified personnel, by using

today's technologies. It will enable the personnel working in the sector to increase their professional competencies.

180 teachers from different provinces of Turkey will be trained in groups of 30. Teachers will be able to learn and teach the current and developing technologies used in the sector and the tools they need to teach them.

In this context;

- Building, strengthening and improving the relations of project partners with target groups
- Ensure sustainability of project activities
- Raising public awareness on the importance of vocational and technical education
- Ensuring information flow between project partners
- Involving sector stakeholders in the process and receiving their contributions in activities
- Building bridges between project partners and other stakeholders in the sector
- Ensuring that project activities reach a wider audience
- Providing regular information in order to avoid disruptions in the announcement of activities during the project
- To ensure that the project target group and final beneficiaries follow current developments through international events and to create networking environments for institutional cooperation.

The project partners will carry out joint work to ensure that the cooperation networks to be established during and after the project are sustainable, to maintain the bridge between the private sector and the world of education, and to continue training activities for the private sector to access qualified labor force.

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ISKAV

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