1. Existing centres of excellence for sustainable cooling and testing centres for energy efficiency

Armenia

The International Regional Centre of Excellence for Training and Certification was established under Shirakatsy Lyceum in Yerevan, Republic of Armenia, in 2019, with the support of the United Nations Industrial Development Organization. The Centre is adequately equipped to demonstrate existing and emerging technologies and to provide and ensure the development of certified academic programmes for the refrigeration servicing and manufacturing/assembling sectors, with special emphasis on the energy efficiency of proposed solutions. The Centre is certified under the REAL Alternatives for LIFE programme, a European training and certification initiative for technicians working in refrigeration, air conditioning, and heat pumps, with a strong focus on low-global-warming-potential alternative refrigerants.

China

Hefei General Machinery and Electrical Products Inspection Institute (GMPI), located in Hefei, Anhui Province, China, affiliated with the China National Machinery Industry Corporation (SINOMACH).

Colombia

There are four centres with complementary expertise that could form a Regional Centre of Excellence for Latin America, as set out below.

(a) Centre for Research and Development in Air Conditioning and Refrigeration (CIDARE), located in Bogotá, Colombia.

A centre focused on knowledge transfer, affiliated with the Colombian Association of Air Conditioning and Refrigeration (ACAIRE), providing information to meet the needs of organizations through project development, technology management, and innovation management, with the aim of delivering solutions in science, technology, and innovation to stakeholders in the refrigeration and air-conditioning sector and thermal districts. Its services include:

- Training services on refrigeration, air-conditioning, and thermal-district topics;
- Technology transfer as an intermediary service between the supply of and demand for knowledge;
- Poject structuring and consulting supported by methodologies, standards, processes, and a professional team aligned with the objectives of each project;
- Research, development, and innovation management consulting, enhancing the coordination and execution of financial management processes, organizational training and intervention, innovation, and knowledge transfer; and
- A supplier network, a multi-stage consulting process to initiate and develop relationships with suppliers of goods and services that a company needs for its daily operations.

Website: https://www.cidare.org.

(b) Air Conditioning and Refrigeration Research and Development Centre (LPEA), located in Pereira, Colombia.

This centre is part of the Universidad Tecnológica de Pereira, a public institution. It has a laboratory equipped to conduct tests to determine cooling capacity and the energy efficiency ratio in accordance with International Organization for Standardization standard 5151:2017 and its respective national equivalents, power consumption, and the cooling seasonal performance factor in accordance with International Organization for Standardization standard 16358-1:2013, on room-type air-conditioning units with cooling capacities of up to 10.55 kilowatts, equivalent to 36,000 British thermal units per hour. Tests include determination of the energy efficiency ratio for central split-type, packaged, precision, and ducted units with cooling capacities of up to 14.07 kilowatts, equivalent to 48,000 British thermal units per hour, and determination of sound pressure levels. The centre also provides consulting services in energy management, ventilation projects, building thermal systems, air conditioning, and refrigeration, and offers training courses in air-conditioning project management, the cold chain, energy management, and the fundamentals of Article 7 of Colombia's Technical Regulation on Labelling (RETIQ) and its test methods.

Website: https://centrodelaboratorios.utp.edu.co/facultad-de-ingenieria-mecanica/laboratorio-de-ensayos-para-equipos-acondicionadores-de-aire/.

(c) Centre for Research, Development, and Quality in Refrigeration and Air Conditioning (CIRCLI), located in Medellín, Colombia.

This centre is part of the Universidad Pontificia Bolivariana, a private institution, and has the following objectives:

- To serve as a benchmark of excellence in the generation of advanced knowledge, offering creative and innovative solutions, adopting a multidisciplinary approach, and through the training of qualified professionals and activities aimed at strengthening relationships of trust with users and clients;
- To develop products using new equipment and materials; and
- To evaluate refrigeration systems for food, medicines, and perishable goods, and to produce patents that serve as an international benchmark.

The centre has a laboratory where energy efficiency measurements can be performed on various pieces of equipment whose primary function is to generate cold, with the goal of investigating the significant impact that refrigeration and air-conditioning technologies have on quality of life, health conditions, and the environment. It aims to promote the use of refrigeration and air-conditioning systems that are simple in design and manufacture, energy-efficient, and environmentally friendly for the refrigeration, air-conditioning, and cold-chain industries. This centre also carries out training, research, and technology transfer activities, seeking to integrate efforts and resources among the university, businesses, and the government to establish the necessary scientific and infrastructure foundations for developing innovation strategies and technological solutions.

Website: https://www.upb.edu.co/es/investigacion/nuestro-sistema/centros/centro-circli.

(d) System for Research, Innovation, and Technological Development (SENNOVA), located in Bogotá, Colombia.

This system is part of the *Servicio Nacional de Aprendizaje* (SENA), the Colombian government's vocational training agency. Through this system, SENA implements its policy of contributing to the country's science and technology sector, strengthening local capacities in productivity, competitiveness, knowledge generation, and the relevance of the comprehensive vocational

training it provides. Its structure is organized at the national level under the Vocational Training Department and is implemented locally across 118 training centres nationwide, operating through lines of action and mission-driven strategies.

At the executive and national level, the system reports to SENA's vocational training department, whose function is to formulate policies, allocate budgets, and align research projects with the needs of the national and regional productive sector.

At the training-centre level, the structure comprises the Centre Deputy Director, SENNOVA Facilitator, and research groups and incubators (in this particular case, SENA's Centre for Electricity, Electronics, and Telecommunications in Bogotá).

The program lines comprise the Research and Technological Development Line, which promotes applied research in training centres and the development of technologies that solve problems in the productive sector; the Research Training Line, which integrates research-based learning into the curriculum, developing scientific competencies through comprehensive vocational training programmes; and the Innovation and Technological Development for Businesses Line, which focuses on technology transfer, modernizing processes, and supporting innovation in the Colombian business sector.

Its strategies and infrastructure include specialized laboratories (regeneration centre website: https://electricidadelectronicaytelecomu.blogspot.com/p/serviciostecnologicos.html).

Website: https://www.sena.edu.co/es-co/formacion/paginas/tecnologia-innovacion.aspx. SENNOVA portal: http://sennova.senaedu.edu.co/.

Ecuador

(1) Centro de Perfeccionamiento en el Uso de Refrigerantes (CEPUR), located at the Escuela Politécnica Nacional, Quito (EPN), Ecuador; and

(2) the Refrigerant Regeneration Pilot Centre – Escuela Superior Politécnica del Litoral (ESPOL), located at the Escuela Superior Politécnica del Litoral, Guayaquil, Ecuador.

Haiti

Haiti currently has a number of technical and vocational training institutions that provide training related to refrigeration and air-conditioning servicing. These institutions could potentially collaborate with the proposed Thematic Centre to strengthen technical capacity and outreach. In addition, initiatives implemented under the Hydrochlorofluorocarbon Phase-out Management Plan (HPMP) have supported the training of technicians and the strengthening of servicing practices. These experiences could serve as a basis for the development of the Centre's activities. Moreover, there is a regional technical center for Energy Efficiency located in Jamaica. Haiti would benefit from doing technical visits and learning from the technicians there, fostering south-south cooperation.

Jordan

A training centre for sustainable cooling has been established at the Royal Scientific Society to provide hands-on training for technicians working in the refrigeration and air-conditioning sector, using household air conditioners and refrigerators that utilize natural refrigerants as the cooling medium. The Energy Labelling Testing Laboratories, also established at the Royal Scientific Society, provide accredited testing services for household appliances, air conditioners, refrigerators, washing machines, solar thermal heating systems, and photovoltaic systems, in accordance with international and regional standards, for energy efficiency testing.

Kenya

National Industrial Training Centre, Mombasa County, Kenya.

Liberia

At present, Liberia does not have fully established national centres of excellence specifically dedicated to sustainable cooling and testing, or to energy efficiency testing. However, there are a few organizations and emerging institutions in Liberia working on renewable energy, climate action, and sustainable energy technologies, including: (1) the Center for Sustainable Energy Technology (CSET), located in Congo Town, Monrovia, which works on renewable energy technologies, clean cooking, energy awareness, and sustainable energy research; and (2) the Center for Renewable Energy and Climate Actions (CRECA), based in Montserrado County, which focuses on renewable energy, climate change adaptation, sustainability, and environmental advocacy; while it is not yet a formal testing laboratory or cooling centre of excellence, it contributes to energy efficiency and climate-related capacity building in Liberia.

Mali

The centres of excellence for sustainable cooling in Mali are: the National Engineering School – Abderhamane Baba Touré (ENI-ABT), in Bamako; the Central School of Industry, Commerce and Administration, in Bamako; and the University of Sciences, Techniques and Technologies of Bamako (USTTB). The energy efficiency testing centres include a network of Experts for the Promotion of Energy Efficiency (REE-GEM), which is also the Association of Energy Service Companies of Mali. This network is also a member of the Global Energy Service Company Network.

Nigeria

Standards Organization of Nigeria Testing Laboratory for Energy Efficiency, Ogba, Lagos, Nigeria.

Qatar

- Qatar Cool, Doha;
- GORD Academy, Qatar Science and Technology Park;
- The West Energy Centre, Hamad Medical City;
- The EMCO District Cooling Plant, Umm Ghuwailina; and
- Qatar University (College of Engineering) Stadium Cooling Research, Qatar University.

Slovak Republic

At present, the Slovak Republic does not have a formally designated centre of excellence for sustainable cooling or a dedicated national testing centre for energy efficiency specifically established under the implementation framework of the Kigali Amendment. However, relevant professional and technical capacities exist in Slovakia, in particular through the Slovak Association for Cooling, Air Conditioning and Heat Pumps /Slovenský zväz pre chladenie, klimatizáciu a tepelné čerpadlá (SZ CHKT) and the associated Certification Body for Cooling, Air Conditioning and Heat Pumps / Certifikačný orgán pre chladenie, klimatizáciu a tepelné čerpadlá (CO CHKT), located in Šamorín, Slovak Republic. The Association provides training, examinations, and certification activities in the field of fluorinated greenhouse gases and refrigeration, air-conditioning, and heat pump technologies. These bodies are not formally designated as centres of excellence for sustainable cooling, but they represent an important part of the existing national

professional infrastructure supporting safe, qualified, and legally compliant handling of refrigerants, including activities relevant to the transition towards climate-friendly alternatives.

Somalia

While Somalia is a member of the East African Centre of Excellence for Renewable Energy and Efficiency (EACREEE), current in-country efforts under the National Ozone Office are primarily focused on the following priority areas:

(1) the refrigeration and air-conditioning sector, developing and implementing standardized technician certification schemes, and modernizing and harmonizing training curricula in national technical and vocational education and training (TVET) institutions, following international best practices; and

(2) the Kigali Implementation Plan, establishing regulatory quota systems and strengthening monitoring, reporting, and verification frameworks for controlled substances. These efforts are expected to progressively create demand for enhanced national capacity in testing and verification.

South Africa

The following existing centres relevant to sustainable cooling and energy efficiency testing were identified:

- Regional centre of excellence (Africa): the Africa Centre of Excellence for Sustainable Cooling and Cold Chain, located in Kigali, Rwanda, whose function is cooling research and development, testing, and training.
- Research centre: the Council for Scientific and Industrial Research (CSIR), located in Pretoria, South Africa, whose function is energy systems, testing, and modelling.
- National institute: the South African National Energy Development Institute (SANEDI), located in Johannesburg, South Africa, whose function is energy efficiency programmes.
- University centre: the University of Johannesburg, located in Johannesburg, South Africa, whose function is industrial energy-efficient technology.
- National testing laboratory: the South African Bureau of Standards Appliance Laboratory, located in Pretoria, South Africa, whose function is appliance energy efficiency testing.

Turkiye

Türkiye currently does not have a single formally designated national centre of excellence dedicated exclusively to sustainable cooling, low-global-warming-potential refrigerants, and refrigeration, air-conditioning, and heat pump energy efficiency under the Montreal Protocol framework. However, the following private-sector testing centres and laboratories have been identified as relevant to energy efficiency testing and verification in the cooling, refrigeration, and heating, ventilation, and air-conditioning sectors:

(1) Turkish Standards Institution (TSE) — Energy-related Testing and Calibration Laboratory infrastructure.

- Location: the Institution operates laboratory infrastructure in several provinces and campuses across Türkiye, including the Anadolu Yakası Energy, Materials and Calibration Laboratories structure in Istanbul. The Institution provides testing, calibration, conformity assessment, certification, and standards implementation services. Its infrastructure is

relevant to energy-related product testing, conformity assessment, certification, and the implementation of national and international standards, and it also has an important role in strengthening heating, ventilation, air-conditioning, and refrigeration testing capacity, including fan-coil testing through cooperation with Eurovent Certification.

(2) Martek Soğutma Sistemleri — Research and Development Laboratory.

- Location: Selimpaşa Mahallesi, 5008 Sokak No:20/A, Silivri, Istanbul, Türkiye. The laboratory conducts performance, temperature, and energy consumption tests for commercial refrigeration equipment.

(3) Systemair Türkiye — 365 Performance Center.

- Location: Demirciler Mahallesi, Makine Organize Sanayi Bölgesi, 5. Cadde No:5, 41455. Dilovası, Kocaeli, Türkiye. The centre conducts thermal, leakage, and fan tests for data-centre cooling units and air-handling units, including factory acceptance testing and annual performance data analysis.

(4) Daikin Isıtma ve Soğutma Sistemleri Sanayi Ticaret Anonim Şirketi — Research and Development Cooling Reliability Laboratories.

- Location: Kargalıhanbaba OSB Mahallesi, Organize Sanayi 1 Sokak No:28, 54300, Hendek, Sakarya, Türkiye. The laboratories support seasonal efficiency, performance, acoustic, safety, and transportation durability verification activities for heating, ventilation, air-conditioning, and refrigeration products.

(5) Friterm Termik Cihazlar Sanayi ve Ticaret Anonim Şirketi — Research and Development Centre, Research and Development Laboratory, and Performance Testing Laboratories.

- Location: İstanbul Deri Organize Sanayi Bölgesi, Dilek Sokak No:10, X-12 Özel Parsel, 34957, Tuzla, Istanbul, Türkiye. The laboratories conduct experimental studies to determine the energy efficiency, thermal performance, and pressure drop characteristics of heat exchangers and heating, ventilation, air-conditioning, and refrigeration equipment.

Tuvalu

Tuvalu currently does not have any accredited energy efficiency testing laboratories or dedicated centres of excellence for sustainable cooling. The country relies on the Pacific Appliance Database (PAD) for testing results from Australia, Fiji, and New Zealand, particularly when equipment is not registered in that database or in the Tuvalu Department of Energy database.

United Kingdom

The United Kingdom, through its Department for Environment, Food and Rural Affairs (Defra), provides Official Development Assistance (ODA) funding to the Sustainable Cooling and Cold Chain Solutions programme (SCCCS), delivered by the United Nations Environment Programme and partners. The programme supports implementation of the Kigali Amendment by strengthening capacity, policy frameworks, and market systems for the uptake of energy-efficient and low-global-warming-potential cooling technologies. Activities focus on reducing cooling and cold-chain-related emissions and improving system efficiency, including through reducing food and vaccine loss and strengthening cold-chain systems in developing markets for poverty reduction, improved livelihoods, and strengthened climate resilience. The programme supports a hub-and-spoke model designed to deliver training, technical assistance, and demonstration of sustainable cooling solutions, while generating lessons from local implementation that can inform replication in other contexts.

The programme currently operates through the following in-country facilities:

- The Africa Centre of Excellence for Sustainable Cooling and Cold Chain (ACES), in Kigali, Rwanda;
- The Specialist Outreach and Knowledge Establishment (SPOKE), in Kenya;
- Technical assistance to the design and development of the Haryana-United Kingdom Centre of Excellence on Sustainable Crop Post-Harvest Management and Cold-Chain (CoE-SPMCC), in India.

Hub and SPOKE delivery model

The programme has supported the development of a hub-and-spoke model centred on ACES as a reference hub, with associated SPOKE activities operating in local contexts. This model is designed to provide training, technical assistance and demonstration of cooling solutions, while enabling learning from local implementation to inform wider application in other contexts. The hub (ACES) provides facilities for training, testing and demonstration of cooling and cold chain solutions. The SPOKE model focuses on deploying and testing solutions in local settings, generating practical insights on implementation. More information on the Hub-SPOKE model can be found at this link: Clean Cooling's Centre of Excellence & SPOKE model.

System-level approach

The programme is underpinned by a systems-based approach to cold chain development. This approach is designed to support end-to-end cold chain systems, from production through to distribution, across both food and health sectors. Delivery partners, including the Centre for Sustainable Cooling (University of Birmingham led consortium), have developed modelling tools, training programmes and financial and business models intended to support sectoral stakeholders (farmers, industry, funders, policy makers, governments) in designing more efficient, resilient and sustainable cold chain systems. These materials are currently being applied in programme countries to support ongoing operations. Information provided on the SCCCS programme reflects the UK's perspective as a donor, based on delivery partner reporting and programme monitoring.

Zimbabwe

Currently the country does not have centres of excellence for sustainable cooling, nor testing centres for energy efficiency.