



حوار أبوظبي بين الدول الآسيوية
المرسلّة والمستقبلة للعمالة

Abu Dhabi Dialogue among the Asian
Labour-Sending and Receiving Countries

Using Skills Mobility Partnerships to Support Skills Development and Climate Adaptation in the GCC



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Abstract

Gulf Cooperation Council (GCC) states are accelerating investments in controlled environment agriculture (CEA) and waste management to strengthen food security, advance circular economy goals, and adapt to climate change. However, both sectors face a widening shortage of skilled technicians able to operate high-tech greenhouses, vertical farms, recycling systems, and waste-to-energy facilities. Meanwhile, Egypt and India possess large youth labor forces but lack training programs fully aligned with GCC technologies and standards. This paper argues that Skills Mobility Partnerships (SMPs), which link skills development in countries of origin with fair, predictable labor mobility to destination countries, offer a practical solution. This paper, funded by the Ministry of Foreign Affairs of Denmark through the Climate Change and Migration Data (CCMD) Programme, produced by Agritecture Consulting, the International Organization for Migration (IOM), and the Center for Global Development (CGD) for the Abu Dhabi Dialogue, estimates that GCC CEA and waste management projects will require over 2,500 certified workers by 2030¹, far exceeding current supply. SMPs can meet this demand by co-developing curricula; building trainer capacity; establishing portable “Green Technician” certifications; and embedding ethical recruitment practices. This approach reduces onboarding costs, lowers turnover, and increases productivity for GCC employers while strengthening skills ecosystems and climate-resilient employment pathways in countries of origin. The paper outlines a how-to guide, financing model, and recommendations for Abu Dhabi Dialogue members. It concludes that pilot SMPs launched by 2026 could contribute to establishing an international reference model for integrating migration, skills development, and climate adaptation.

This paper was funded by the Ministry of Foreign Affairs of Denmark through the Climate Change and Migration Data (CCMD) Programme.



MINISTRY OF FOREIGN AFFAIRS
OF DENMARK

¹ Based on the findings from a 2022 survey of CEA operators in UAE and Egypt plus projections for waste management.

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Introduction

The Gulf Cooperation Council (GCC) states stand at a crossroads, as climate change, food security imperatives, and circular economy ambitions increasingly shape policy priorities, placing renewed emphasis on the availability of skilled human capital to support sustainable growth. Climate change is intensifying food insecurity, water stress, and waste generation, even as demand for sustainable solutions grows. Saudi Arabia, the United Arab Emirates (UAE), Qatar, Bahrain, Kuwait, and Oman are investing billions in controlled environment agriculture (CEA) and circular waste management systems (see more in annexes), yet both sectors share the same constraint: technology and capital are outpacing the supply of skilled technicians and supervisors. Without a trained workforce, these investments—and the region's broader food security, net-zero, and green transition targets, may face implementation challenges. In addition, with GCC states importing 85%² of their food, skilled CEA technicians in particular are not just desirable, they are essential to reduce import dependence and ensure food sovereignty.

Skills Mobility Partnerships (SMPs) offer a solution³. Skills Mobility Partnerships are an innovative tool to more equitably share the benefits of skills development and labour mobility between stakeholders in countries of origin and destination. SMPs do so by addressing labour market needs in both countries of origin and destination and by developing the skills of all workers – those that move for employment abroad and others that join the local labour market. Skills Mobility Partnerships are fully aligned with the Global Compact for Safe, Orderly and Regular Migration (GCM), notably Objective 5 (enhance availability of regular pathways), Objective 6 (fair and ethical recruitment), Objective 18 (skills development and recognition), and Objective 23 (international cooperation). SMPs operationalize these commitments through concrete, sector-specific labour mobility arrangements.

Unlike traditional recruitment, which fills vacancies but leaves employers responsible for costly on-the-job training and slow integration, SMPs deliver workers already trained to GCC standards, with recognized qualifications and portable skills. Indeed, according to a “Needs Assessment for Climate-Smart Agriculture Skills Development in the UAE and Egypt”, research conducted by Agritecture Consulting on behalf of the International Organization for Migration (IOM), employers in both countries reported a significant willingness to pay a premium for certified, skilled labor.⁴ Specifically, in the UAE, 90 percent of employers indicated a willingness to pay more for skilled labor, with 77 percent willing to pay more than 25 percent compared to non-skilled labor. By linking training in countries of origin with predictable, ethical, mobility pathways to countries of destination in the GCC, SMPs minimize downtime, reduce turnover, and give employers confidence in workforce readiness. This paper, produced by Agritecture Consulting, the IOM, and Center for Global Development (CGD), explains how this can be done.

The paper focuses on Egypt and India as illustrative countries of origin, selected on the basis of scale, existing migration linkages, and data availability, rather than as exclusive or preferred sources of future labour. Both countries have large, skilled, youth populations, yet lack modern training systems to meet GCC labor demand. The discussion therefore explores how SMPs can bridge this gap in CEA and waste management. The paper also outlines the financing and business case: the costs of building SMPs; how these costs should be distributed among employers, governments, and development partners; and why such investments deliver significant returns in reduced inefficiencies and improved productivity. Without targeted SMPs, green investments risk underperformance while countries of origin miss the chance to channel their youth talent into quality green jobs, undermining the very goals of a just and climate-resilient transition.

² <https://www.weforum.org/stories/2025/02/gulf-food-security-innovation/>

³ Learn more on SMPs <https://eea.iom.int/sites/g/files/tmzbd1666/files/info-sheet-global-skills-project-and-smpps.pdf>

⁴ This primary research is available upon request.

Methodology⁵

Evidence was gathered through a review of international literature on SMPs and climate adaptation; policy analysis of GCC national strategies; and labor market assessments focused on CEA and waste management. Sector-specific case studies, developed in consultation with available market data, industry reporting, and global precedents, were used to illustrate the potential for SMPs to bridge concrete labor gaps. To acquire primary qualitative data that would complement the existing quantitative research, a sample of three of the three major companies with established operational presence companies in the industry, previously identified in the "Needs Assessment for Climate-Smart Agriculture Skills Development in the UAE and Egypt", were selected for in-depth interviews⁶. The questions were asked to these GCC employers of CEA farms via email in October 2025. For the waste management section, we primarily utilized publicly available data, reports, and other literature.

This paper focuses on Egypt and India as countries of origin for three reasons. First, both have deep agricultural talent pools and large youth cohorts, meaning they can deliver scale if curricula are adapted to GCC technologies and standards. Second, both countries already have emerging case experience in CEA and waste management: Egypt through its mega-greenhouse program and waste-to-energy partnerships with GCC firms, and India through large-scale recycling initiatives and agritech ventures.

The analysis was guided by the following research questions:

1. What are SMPs, and how do they function between countries of origin and countries of destination?
2. What is the demand for skilled labor in CEA and waste management in the GCC and in countries of origin?
3. To what extent are training programs in countries of origin aligned with GCC labor market requirements in these sectors?
4. How can SMPs bridge these gaps, and what barriers and enablers influence their design and implementation?
5. How can SMPs be financed between countries of origin and destination?

Together, these questions frame the case for SMPs as a practical instrument to connect workforce development in Egypt and India with the GCC's food security, net-zero, and green transition targets.

However, the country experiences referenced in this paper are presented as illustrative case studies drawn from background research and are not intended to imply exclusivity or limit the applicability of the proposed approaches across other Abu Dhabi Dialogue Member States or comparable contexts. This paper builds on lessons learned and knowledge generated through previous IOM research and stakeholder engagement, and presents guidance and examples of good practice intended to inform policy dialogue, rather than prescriptive or country-specific recommendations.

⁵ While qualitative & quantitative insights from selected employers provide valuable operational perspectives, findings should be interpreted as indicative rather than representative of the entire GCC CEA and waste management sectors.

⁶ Artificial Intelligence (A.I.) tools were strategically employed during the initial phase of the research to accelerate data aggregation, specifically in identifying and compiling information regarding investments made by individual countries within the CEA and waste management sectors. All data and resources identified or analyzed using A.I. have been rigorously verified and are fully disclosed and accessible through the corresponding footnotes provided throughout this document. Additional data, especially from surveys, have been taken from the "Needs Assessment for Climate-Smart Agriculture Skills Development in the UAE and Egypt" which is available upon request.

Skills Mobility Partnerships

Skills Mobility Partnerships are an innovative tool to more equitably share the benefits of skills development and labour mobility between stakeholders in countries of origin and destination. SMPs do so by addressing labour market needs in both countries of origin and destination and by developing the skills of all workers – those that move for employment abroad and others that join the local labour market.⁷ (Figure 2). Unlike conventional recruitment models, which prioritize rapid vacancy filling and can contribute to “brain drain”, SMPs invest in human capital by strengthening skills systems across the continuum. It is not only the worker whose knowledge is enhanced, but the entire training and skills ecosystem that benefits from upgraded curricula, modern teaching methods, and closer ties to industry demand.

Figure 1. Skills Mobility Partnerships (SMPs)



Source: [IOM \(n.d.\)](#)

⁷ <https://www.iom.int/resources/infosheet-skills-mobility-partnerships>

What distinguishes SMPs from traditional recruitment is that they are not transactional but transformational. They turn migration into a deliberate instrument for workforce development, climate adaptation, and bilateral cooperation. Effective SMPs rest on eight essential elements that make mobility mutually beneficial and sustainable:

1. **Strategic planning.** SMPs are anchored in mid- and long-term workforce projections, ensuring migration flows are guided by future labor demand, not just immediate shortages. This makes them more sustainable than recruitment, which reacts only to short-term gaps and often leaves employers scrambling to retrain workers.
2. **Evidence-based design.** Reliable labor market data from countries of origin and countries of destination is used to forecast demand, identify skills gaps, and shape targeted training. Unlike recruitment, which does not address systemic mismatches, SMPs align training curricula directly with GCC technologies, standards, and projected project pipelines.
3. **Inclusive governance.** Employers, training institutions, and ministries on both sides jointly design SMPs, ensuring alignment with both GCC climate adaptation goals and country of origin development strategies. This multistakeholder approach can help ensure that SMPs are coherent with national and local-level development priorities. For instance, governments will need to work with the private sector to understand changing patterns, structures, and practices of employment, which in turn can help identify relevant changes to migration policy and law, as well as adjustments needed for educational policies and training curricula.
4. **Local development benefits.** By upgrading skills in countries of origin, SMPs stimulate wider job creation, support domestic transitions to greener economies, and make countries of origin more attractive for investment. Unlike recruitment, which extracts workers without investing in skills development, SMPs leave behind stronger training institutions and skilled cohorts valuable at home.
5. **Recognized skills.** Joint curricula and certifications ensure qualifications are portable and credible across borders, reassuring both workers and employers. For businesses, this is the core value proposition: SMP graduates arrive with skills that are pre-aligned to GCC technologies, standard operating procedures, and compliance standards, meaning they can contribute productively from day one. This avoids under-employment, costly and time consuming “top-up training”, reduces downtime, and minimizes the expense and delays of lengthy qualification recognition processes. For workers, recognized credentials provide a career passport; they are valid in both the GCC and countries of origin, enabling upward mobility, aiding with social inclusion, portability across employers, and greater reintegration opportunities upon return.
6. **Fair mobility.** SMPs embed rights-based recruitment and employment practices, following IRIS Standards with zero worker-paid fees.⁸ With standard recruitment, workers often pay significant fees or face opaque hiring processes, lowering efficiency, increasing potential for exploitation, and exposing GCC governments to reputational risks. SMPs instead create transparent, ethical pathways that protect workers and strengthen GCC’s image as a responsible employer. SMPs consider integrating “soft landing” aspects that support and facilitate social inclusion of migrants. And SMPs also support migrants to accumulate human, financial, and social capital during their migration experience, facilitating their portability and opportunities to re-invest in their country of origin.

⁸ The IRIS Standard is a set of global principles that define ethical recruitment. It is based on international labor and human rights instruments and was developed through extensive multi-stakeholder consultation. For more, please see <https://iris.iom.int/iris-standard>.

7. **Migration governance.** SMPs are typically embedded in existing legal and migration pathways, or create new ones where needed, ensuring predictability and order. The role of national migration agencies must be given due consideration and incorporated into SMPs from the planning stage. This is particularly important given that migration governance frameworks (and visa and work authorization processes) vary significantly across countries, including within the GCC. Migration agencies are responsible for processing and issuing the permits and visas that enable cross-border mobility and, in many cases, exercise discretion in granting work authorization, sometimes in consultation with their labor counterparts. Access to information channels and adequate support along the entire migration cycle (pre- departure, post arrival, pre -return) ensures ownership and boosts the start of the SMP experience for the migrant worker. This structured approach contrasts with recruitment, which often operates through ad hoc or fragmented channels, creating uncertainty for both workers and employers.
8. **Cost reduction and shared financing.** Costs in an SMP are ideally distributed among employers, governments, development partners, impact investors, and climate finance ensuring SMPs are both fair and sustainable. Recruitment typically pushes costs onto workers or employers alone; SMPs, by contrast, use blended financing from countries of destination and in-kind contributions from countries of origin (e.g., facilities, trainers, and outreach), reducing risks and delivering a higher return on investment for all stakeholders. Since the training is taking place in the countries of origin, the costs for training are typically lower than in the country of destination.

Why they are needed now

Three dynamics make SMPs between Egypt, India, and the GCC desirable and necessary:

1. **Countries of origin possess strong human capital potential, but training and mobility pathways require further alignment.** Many labour-sending countries across the ADD region and beyond possess large, young, and increasingly educated populations, with substantial numbers of new entrants to the labour market each year. Despite this demographic advantage, common challenges persist in aligning education and training systems with the specific competency requirements of emerging green sectors such as controlled-environment agriculture (CEA) and waste management. Existing agricultural and technical education frameworks are often not calibrated to these evolving industry needs. Skills Mobility Partnerships (SMPs) can help bridge this gap by aligning training curricula with destination-country technologies and standards, certifying competencies, and fostering skills circulation. In doing so, SMPs can support the development of sustainable talent pipelines and long-term strategic relationships between labour-sending and labour-receiving countries. Within the scope of this study, Egypt and India are used as illustrative case examples due to their scale, existing migration linkages with GCC countries, and data availability, rather than as exclusive or preferred sources of future talent. More broadly, strengthening pathways with African countries will be increasingly important, as by 2035 more young Africans are expected to enter the workforce each year than in the rest of the world combined.⁹
2. **Countries of destination are scaling up green sectors at unprecedented speed.** The UAE aims to create 50,000 green jobs by 2030¹⁰; Saudi Arabia's "Vision 2030" places food security and waste-to-energy at the center of diversification; while Qatar, Oman, and Kuwait are pursuing similar strategies. Yet in each case, success depends less on technology procurement than on the availability of a trained workforce able to operate, maintain, and innovate within these systems across both advanced agriculture and waste management.¹¹
3. **There is already evidence of a widening skills gap.** There is growing evidence of a skills mismatch in parts of the region. In the UAE, for example, the pace of adoption of hydroponics and vertical farming technologies in controlled-environment agriculture (CEA) has, in some cases, advanced more rapidly than the availability of workers with specialized operational and technical competencies. This has highlighted the need for targeted training and skills development aligned with emerging CEA systems.¹² Based on our interviews, observation, and online data in the GCC, many large-scale farms remain dependent on short-term expatriate consultants rather than a sustainable labor pipeline.¹³ A parallel skills gap is also evident in the nascent waste management sector, where specialized expertise for recycling, waste-to-energy, and resource recovery is scarce.

These three dynamics converge to create both a risk and an opportunity. Without intervention, the skills gap will widen, investments in green infrastructure will underperform, and GCC states will remain vulnerable to external shocks. With SMPs, however, these challenges can not only be mitigated, but they can be transformed into a regional advantage. SMPs can support the development of structured, legal, and ethical labour mobility pathways that link skills development in countries of origin with GCC climate priorities, delivering trained technicians and specialists for emerging green sectors while also generating development benefits through workforce upskilling and the transfer of know-how via returning and circular migrant workers.

⁹ See <https://www.weforum.org/stories/2023/08/africa-youth-global-growth-digital-economy/>.

¹⁰ See <https://gulfnews.com/business/energy/uaes-updated-energy-strategies-to-create-50000-new-green-jobs-by-2030-says-energy-minister-1.96777384>.

¹¹ See <https://www.consultancy-me.com/news/5237/shortage-of-skilled-workers-means-gcc-companies-must-step-up>.

¹² See <https://agfundernews.com/uae-egypt-will-face-a-significant-shortage-of-skilled-labor-for-climate-smart-farms-heres-why-thats-important>.

¹³ See <https://www.habtoorresearch.com/gccs-labor-market-test/>.

How-to guide: implementing SMPs for CEA and waste management

Why SMPs are needed in CEA and waste management

Annexes 1 and 2 provide an overview of CEA and waste management: why they are pressing issues for GCC states, Egypt, and India; what investments have already been made; how workforce shortages are already constraining investment; and an overview of the major organizations involved in the education and training of CEA and waste management skilled workers. A brief summary is provided below.

Controlled Environment Agriculture (CEA) refers to farming systems that use technology to control and optimize the climate in which crops grow, including hydroponics, vertical farming, and climate-controlled greenhouses.¹⁴ CEA is necessary in the GCC due to the fact that arable land is extremely limited, only 1.4 percent of the region's total land area, and the heavy reliance on food imports. Countries across the GCC, as well as Egypt and India, are therefore already heavily investing in CEA. For example, Saudi Arabia has invested \$220 million¹⁵ in high-tech greenhouses; the UAE has invested \$100 million in agritech companies; and private capital is catalyzing a number of start-ups in India.

Using conservative estimates, over 2,000 new roles will be created by these investments. And yet employers are already indicating a lack of skilled labor, as well as a willingness to hire foreign workers and pay 25 percent more to obtain them. While countries across the GCC have training institutions offering programs to support CEA, enrollment and graduation rates are insufficient to meet the growing need and the industry's standards. At the same time, there are institutions in Egypt (e.g., the American University in Cairo) and India (e.g., the Institute of Horticulture Technology or the Indian Agricultural Research Institute) that could be invested in to provide skilled CEA labor to the GCC.

Waste management refers to the collection, treatment, and disposal of solid and liquid waste. Waste production in the GCC is rapidly increasing, reaching 262.7 million tons in 2023, as is that in Egypt and India. Various strategies aim to divert waste away from landfills through segregation, recycling, composting, waste-to-energy conversion, and circular economy approaches. New facilities are being built, such as two waste-to-energy facilities in Abu Dhabi, and land set aside for private-sector recycling plants. Similarly, Egypt has set an ambitious goal to raise its municipal solid waste recycling rate to 60 percent by 2027 with concurrent investments, and India has signed a memorandum of understanding with the UAE to boost investment in sustainability, renewable energy, and waste management, supporting a circular economy.

Again, however, a lack of skilled workers is constraining the implementation of these investments. The vast majority of these workers are already migrants, especially at the operations and maintenance levels. An internal and conservative estimate suggests that even a 5 percent productivity loss in the GCC waste sector could translate into tens of millions of dollars in opportunity costs each year, underscoring the urgency of SMPs to deliver certified, job-ready technicians.

¹⁴https://www.undp.org/sites/g/files/zskgke326/files/2025-01/controlled_environment_agriculture_for_sustainable_development.pdf

¹⁵ In this paper, all references to dollars are US dollars unless otherwise specified.

The benefits of an SMP

As described above, obtaining skilled workers through an SMP conveys a variety of benefits to GCC employers, offsetting the challenges experienced in pure recruitment (Table 1). Based on a combination of qualitative research from interviews, surveys, and Agritecture's projections of CEA growth in the GCC.¹⁶ This demonstrates that the high turnover, consultant reliance, and productivity loss in the two sectors cost approximately \$38.8 million per year, without factoring in the costs of conducting "on-the-job" training. It is therefore in the best interests of employers to explore financially contributing to a new SMP, alongside investments by GCC states, to create a pipeline of skilled labor from Egypt and India to support their investments.

Table 1. Comparing the costs of pure recruitment, to the value of operating through an SMP¹⁷

Costs under pure recruitment	Value of SMPs
Direct training costs: Employers spend an average of \$2,000+ per technician on in-house training before workers are fully productive.	Day-one readiness: Workers arrive certified to GCC standards, reducing the need for costly in-house training.
High turnover: Annual churn of 20–25 percent requires repeated recruitment cycles, costing ~\$0.8 million/year across the sector.	Retention gains: Structured SMP pathways improve retention by creating predictable pipelines, reducing repeated hiring costs.
Consultant reliance: Heavy dependence on expatriate consultants to cover gaps costs an additional ~\$3 million/year.	Local expertise: SMPs build sustained pools of mid-level technicians, reducing reliance on expensive short-term consultants.
Productivity loss: A conservative 5 percent inefficiency from under-skilled labor translates to ~\$35 million/year in lost output (based on a \$700 million sector).	Productivity boost: Certified workers trained in GCC systems manage fertigation, climate control, and pest systems more effectively, directly improving yields and reliability.
Fragmented training systems: Workers arrive with inconsistent skills, requiring months of retraining to match GCC standards.	Portable certification: A joint "Green Technician" framework ensures skills are portable and recognized, saving employers time and resources.
Narrow private benefit: Costs are borne by many smaller operators, limiting appetite for sustained investment.	Public good and foreign direct investment attraction: SMPs protect GCC governments' sovereign investments in food security and waste management, while building investor confidence in green industries.

¹⁶ Based on a combination of qualitative research from interviews, surveys, and Agritecture's projections of CEA growth in the GCC.

¹⁷ Monetary estimates presented in this table are indicative and based on available market data and stakeholder inputs at the time of analysis. Figures should be interpreted as approximate and may vary depending on context, assumptions, and implementation conditions.

What skills are needed

Table 2 scales workforce requirements using the most credible benchmarks available. Combining the projections suggests that announced CEA projects will require 1,700–2,000 certified workers by 2030, while vertical farms and waste-to-energy plants will create at least 800 additional skilled roles. The total cross-industry demand therefore exceeds 2,500–2,800 skilled technicians, not counting construction labor or ancillary recycling jobs. This demand is concentrated in niche specialisations, such as hydroponic operations, sensor and automation maintenance, waste incineration operations, air-quality control, environmental compliance and safety management, where GCC vocational programmes have limited capacity. For example, manual vertical farms require roughly 7–8 full-time workers per 1,000 m², yet existing training centers in the region are estimated to produce only a few dozen hydroponic technicians per year.

Table 2. Estimated workforce demand across sectors

Sector focus	Capacity and investment	Estimated workforce needed
CEA: Greenhouses ¹⁸	Pure Harvest's high-tech greenhouses produce over 17 million pieces of produce per year and employ about 300 staff. Regional pipelines include more than 350 ha of CEA announced or under construction by 2030.	At 4 technicians/ha, ~1,400 technicians are needed by 2030. Additional projects could raise this above 1,700, and a handful of extra complexes would exceed 2,000 certified roles in operations, mechatronics, quality assurance and food safety.
CEA: Vertical farms ¹⁹	The UAE's Bustanica vertical farm spans 330,000 sq ft (≈30,660 m ²) and uses advanced automation; iFarm's manual example shows 1,220 work-hours/month for 1,000 m ² , equating to ≈7–8 full-time equivalent (FTE) roles. Several projects (Bustanica, iFarm/Spacefarm, AeroFarms, etc.) are operational or planned across the GCC.	Assuming 6 FTE per 1,000 m ² for moderately automated facilities, a regional pipeline of 50,000 m ² vertical farms will require ≈300 skilled staff. Further expansions could raise demand to 400–500.
Waste management: Waste-to-energy ²⁰	<i>Abu Dhabi waste-to-energy</i> : 900,000 t/year (≈2,466 t/day) and 80 MW; <i>Dubai Warsan</i> : 1.9 Mt/year (≈5,206 t/day) and 200 MW; <i>Sharjah</i> : 300,000 t/year (≈822 t/day) and 30 MW; <i>Barka (Oman)</i> : 3,000 t/day and 95–100 MW; <i>Qatar DSWMC</i> : 2,300 t/day and 50 MW; <i>Bahrain Askar</i> : 390,000 t/year (≈1,068 t/day) and 25 MW.	Using the Maryland waste-to-energy staffing ratio (50 operators for 1,500 t/day) yields an estimated 82 operators for Abu Dhabi, 174 for Dubai, 27 for Sharjah, 100 for Barka, 77 for Qatar and 36 for Bahrain – roughly 500 waste-to-energy technicians in total. This excludes construction labor (thousands of workers during build phases).
Waste management and recycling ²¹	Saudi Arabia generates more than 110 million t of waste annually and plans to divert 90 percent of it from landfill by 2040. Kuwait, Oman, Qatar and the UAE have also adopted national waste strategies with ambitious recycling and waste-to-energy targets.	Expanding recycling plants, composting sites and hazardous-waste facilities will likely demand hundreds of additional skilled workers in operations, logistics, environmental compliance and quality control. Exact numbers depend on project pipelines but are not currently met by domestic training programmes.

¹⁸ See <https://www.agbi.com/tech/2023/03/agtech-special-report-vertical-farms-uae/>.

¹⁹ See <https://ifarm.fi/blog/how-many-working-hours-does-it-take-to-run-a-vertical-farm>.

²⁰ See <https://www.renewableenergyworld.com/energy-business/new-project-development/waste-management-to-build-55-mw-waste-to-energy-plant-in-maryland-54664/>.

²¹ See <https://www.trade.gov/country-commercial-guides/saudi-arabia-waste-management>.

Who needs to be involved

Developing a successful pilot SMP in the CEA or waste management sectors requires a coordinated ecosystem of stakeholders across both origin and destination countries. This network spans government ministries (Agriculture, Labor, Environment) to align policy, private sector leaders and technology vendors to define skills demand, and academic and training institutions to deliver accredited curricula. International partners and development agencies also play a critical role in facilitating ethical recruitment and shared financing.

A comprehensive mapping of these stakeholders, detailing their specific activities and the strategic rationale for their involvement, is provided in Table 5 (CEA) and Table 7 (Waste Management) in the Annexes.

How a SMP can be facilitated

SMPs are set up within broader migration policies and legal frameworks. For each SMP, there needs to be a vision of how it contributes to realizing the migration, skills, and labor market objectives of all involved countries and how it fits into existing systems and frameworks of all involved countries.

A few key steps to facilitate the design and implementation of a SMP are:

1. **Carry out an assessment and mapping of the existing regular pathways under which workers trained under SMPs can legally enter destination countries and access the labor market.** Such a mapping will look at migration policies, including bilateral migration agreements (BLMAs).²² The ILO-IOM Global Guidance on Bilateral labor Migration Agreements provides a checklist against which BLMAs can be assessed:
 - a. Who are the authorities in charge of developing the BLMA?
 - b. What type of labor migration is covered by the policy / BLMA? (e.g., circular, permanent, seasonal, etc.)
 - c. Is a standard model employment contract included in the agreement?
 - d. Which specific groups of migrant workers are covered? (by gender, profession, and skills)
 - e. Were social partners involved in skill needs identification for the labor market?
 - f. Are clauses included for protection of migrant workers' rights, including the principle of equality of treatment?
 - g. Are health care and other social benefits included in the agreement for migrant workers?
 - h. Have the social partners, NGOs, public, and private stakeholders been involved in the preparation of the agreement?
2. **Map the institutional and administrative processes and their application journey in practice, and identify potential obstacles and barriers to the functioning of the SMP.** Collect information on how the recruitment and immigration processes impact the motivation and decisions of migrant workers. As part of a mapping, identify legislative gaps and assess how they could be addressed in the context of the SMP in the shorter term, with a view to addressing gaps through legislation and regulation in the longer term.
3. **Connect mobility and migration as part of SMPs to clear legal migration pathways and procedures as well as to international matching mechanisms like job-matching platforms (e.g., EU Talent Pool).** This can assure employers that migrant workers are indeed eligible for immigration.

²² Guidance on Bilateral labour migration agreements, February 2022. <https://www.ilo.org/publications/guidance-bilateral-labour-migration-agreements>

4. **Involve key actors operating and taking decisions in institutional and administrative migration processes within the SMP design and implementation.** Find champions within agencies and ministries who can support resolving blockages and finding creative solutions to emerging challenges within relevant institutions (e.g., migration agencies, embassies). This is important, because for businesses and migrants as well as the overall success of SMPs, speed and transparency in processes is key.
5. **Examine possible institutional, policy, or legal reforms of migration and skills recognition systems and optimization of migration procedures (making them faster and more efficient) in line with SMP objectives.** This can include, where appropriate and subject to national frameworks, measures such as the establishment of new visa service centres to facilitate visa and work permit applications in countries of origin; the adoption of technological solutions, including e-visa systems; the introduction of new labour mobility pathways or reforms to access requirements for existing ones; and the development of expedited or priority procedures for work permit processing, including fast-tracking provisions within the context of an SMP. Implementation modalities would necessarily vary across GCC states in line with national migration and labour governance systems. The perspective of employers and their needs for recruitment and migration procedures should be taken into account when assessing how systems could be improved.
6. **Consider avenues for how migrants and business can navigate bureaucratic and administrative migration systems and procedures.** For example, intermediary organizations can decrease the burden on migrant workers and employers in collecting and processing official documents at home and in the destination country and guiding them through administrative processes.
7. **Consider flexibilities in permitting longer-term stay (through visa options and renewals of permits or allowing internal circular mobility within the GCC) while observing the interests of different stakeholders (Box 1).** Some SMPs may opt for circular migration schemes and should then include reintegration support and incentives for circularity or return. In other cases, there may be a stronger interest in providing access to longer-term migration, often favoured by employers that invest in skills development and aim to retain talent.
8. **Moreover, migrant decisions concerning length of stay should be respected.** In the design of SMPs, it will need to be considered whether the existing migration policies and systems place the right incentives and include attractive options.

Box 1. Questions concerning practical aspects of organizing visas and work permits

- What regular pathways and opportunities exist for the specific envisaged SMP model? If there are legal limitations, are there opportunities to create new mobility schemes in the context of the SMP?
- Do admission systems account for skill levels and applicants' skills at large? How are skills integrated into immigration and labor migration policies?
- Where are visa centres located to which participants can apply?
- Are there possible ways to fast-track or facilitate visa application processes, skills recognition processes and accessing work permits for migrant workers under the SMP?

How a SMP can be financed

The financing of SMPs is designed as a cost-sharing, multi-stakeholder model to ensure sustainability and shared benefits for all parties involved. This framework addresses two main categories of costs: those related to program implementation and capacity building and those traditionally borne by the migrants themselves.

Funding and implementation costs

The primary funding for the program implementation, including developing and upgrading skills training curricula, conducting skills recognition and matching, and administering the partnership, is primarily mobilized from three sources. Governments in the country of origin invest in strengthening their educational and Technical and Vocational Education and Training (TVET) infrastructure, while governments in the destination country contribute through legal migration pathways, policy alignment, and bilateral or multilateral development aid and grants. Crucially, the private sector and future employers often provide direct investment or subsidies for training, ensuring the skills taught are directly demand-driven and fit-for-purpose and minimizing the financial exposure of a single governmental entity.

Costs traditionally borne by migrants

A key objective of SMPs is the reduction and ethical sharing of costs traditionally borne by the migrant worker. These costs, if left unaddressed, can create significant debt and vulnerability, and include: recruitment fees and related administrative costs (visa fees, government clearances); training and certification costs; travel and relocation costs (airfare, local transport, and lodging during administrative processes); and insurance and medical costs. By integrating these expenses into the partnership agreement, the model aims for the employer and / or governments to bear these costs, thus lowering the financial barrier for workers, promoting ethical recruitment, and increasing the overall benefits of migration for the workers and their families.

Role of impact investors and climate finance

The project's alignment with green jobs, the circular economy (waste-to-energy), and food security makes it highly attractive to impact investors and climate finance providers. These financing sources are fundamentally geared toward generating measurable, positive social and environmental outcomes alongside a financial return.

- **Impact investors** can fund elements with clear social returns, such as skills development, ethical migration pathways, and worker reintegration, viewing the upskilled, ethically-placed workforce as a high-impact social asset.
- **Climate finance** can specifically target components related to green technology training, curriculum adaptation towards circular economy systems, and supporting the greening of the GCC's agri-tech and waste-management sectors.

The return on investment (ROI) for these investors is both financial and impact-based, with impact outcomes assessed through monitoring indicators aligned with IOM results-based management (RBM) and monitoring, evaluation, and learning (MEL) frameworks, including relevant indicators under Global Compact for Migration (GCM) Objective 18:

1. **Financial ROI.** This can be secured through mechanisms like repayable grants or concessional loans provided to the consortium of employers or country-of-origin governments for upfront costs. Employers see a direct financial return from a job-ready, highly-skilled, and retained workforce (reducing recruitment/onboarding costs, increasing productivity, and improving retention). This productivity gain and cost saving can be used to service the initial investment.
2. **Impact ROI (metrics).** The social and environmental return is measured via key performance indicators (KPIs), which include:
 - **Climate mitigation.** The number of technicians trained to operate waste-to-energy and sustainable CEA systems, leading to quantifiable reductions in GHG emissions or improved resource efficiency.
 - **Social equity.** Documented compliance with ethical labor standards, successful placement rates, improved wages, and the economic benefit realized by returned workers via the reintegration component.
 - **Systemic change.** The strengthening of domestic training institutions and the creation of portable, internationally-recognized “Green Technician” credentials.
 - **Resilience.** Improved capacity of food, energy, and labor systems to withstand and adapt to climate, market, or supply shocks, measured through continuity of operations, workforce retention, and reduced disruption during stress events.

Table 3. Costs involved in developing an SMP, and how they could be shared in phases one and two

Cost item	Description	Phase one (pilot)	Phase two (scale-up)	Rationale / expected benefit
1. Training delivery	CEA and waste-to-energy training delivered in country of origin institutions using GCC technologies and standards.	Employers + Development partners (i.e. impact investors, development banks)	Employers (consortia)	Employers benefit directly from job-ready workers and reduced onboarding costs.
2. Training-of-trainers	Building local trainer capacity for continued delivery at scale.	Country of origin governments + donors	Country of origin governments + GCC governments	Strengthens domestic systems, ensuring sustainability and long-term cost reduction.
3. Curriculum adaptation	Alignment of existing country of origin curricula with GCC agri-tech and waste-management systems.	GCC governments + employers	GCC governments	Linked to national food security and circular economy strategies.
4. Certification and credential recognition	Development of portable "Green Technician" credentials jointly recognized in both country of origin and GCC, and beyond.	Development partners	GCC + country of origin governments	Ensures portability, standardization, and quicker job placement.
5. Recruitment and placement	Ethical hiring, matching candidates with GCC employers, visa processing, and onboarding.	Employers	Employers	IRIS standards require employer-paid recruitment; improves reputation and compliance.
6. Pre-departure orientation and mobility support	Soft skills, language, and rights-based training before travel.	Country of origin governments + development partners	Employers + GCC governments	Promotes ethical, safe, and prepared migration.
7. Travel and deployment	Flights, visa, relocation logistics, family support, and insurance.	Employers	Employers	Required for ethical, zero-fee mobility.
8. On-arrival induction	Orientation on labor rights, safety, and GCC workplace SOPs.	Employers	Employers + GCC governments	Improves retention, safety, and productivity from day one.
9. Monitoring and evaluation	Impact tracking, placement rates, productivity gains, grievance systems, and feedback loops.	Development partners	Mixed (GCC + country of origin governments)	Ensures accountability, scaling, and program improvement.
10. Reintegration and circular skills use	Linking returnees to agritech incubators and waste innovation hubs.	Country of origin governments + donors	Country of origin governments + private partners	Supports domestic job creation, entrepreneurship, and circular economy growth.

Recommendations for the Abu Dhabi Dialogue

To translate potential into practice, Abu Dhabi Dialogue member states need a roadmap for developing and governing SMPs for climate adaptation. The following steps provide structured guidance for policymakers:

1. Strengthen skills development and recognition

- **Encourage joint curricula between GCC employers and institutions in countries of origin**, focused on hydroponics, greenhouse management, recycling, waste-to-energy, and circular economy skills. Doing so will more easily enable migration and qualification recognition. Where possible, draw on existing international frameworks such as the Hydroponics Technician Qualification Pack under India's National Skills Development Corporation (NSDC/ASCI); and ISO and HACCP certifications for food safety and environmental management provide recognized benchmarks. In waste management, global programs supported by the International Labor Organization (ILO) and ASEAN on green jobs and circular economy skills could also inform curricula, ensuring that SMPs align with international best practice rather than starting from scratch.
- **Establish a mutual recognition framework** for "Green Technician" credentials co-owned by GCC ministries of agriculture, relevant country of origin ministries, and regional accreditation bodies.
- **Fund training-of-trainers programs** so targeted training institutions in the labor sending countries can deliver modules, financed through cost-sharing among employers, GCC governments, country of origin institutions, and international partners. Employers are motivated to invest because it lowers onboarding costs and ensures a pipeline of job-ready workers. ADD Member States, including GCC countries, co-finance initiatives to advance food security and circular economy objectives.. Country of origin governments and private actors contribute facilities and trainers, recognizing that upgraded training systems strengthen their domestic labor markets. Development partners (e.g., World Bank, IOM, Islamic Development Bank, and African Development Bank) invest as part of their mandates to promote the just transition, green jobs, and reduced irregular migration. Impact Investors and Climate Finance providers can fund the systemic costs of training, particularly curriculum adaptation and capacity building, by seeking a blended return on investment tied to measurable climate outcomes (e.g., green skills adoption) and improved social equity (e.g., ethical migration pathways).

2. Design predictable labor mobility pathways

- **Pilot mobility schemes** between interested ADD Member States, linking labour-sending contexts with GCC greenhouse and waste management facilities, while embedding IRIS standards for ethical recruitment.
- **Integrate SMPs into bilateral agreements** between GCC and sending countries, covering visas, contracts, and protections.
- **Ensure reintegration pathways bolster opportunities for returnees** to agritech incubators, waste innovation hubs, and microfinance schemes in their countries of origin.

3. Promote public–private partnerships (PPPs)

- **Establish sector consortia** (greenhouse employers, waste-to-energy operators) to co-finance training hubs and share recruitment costs.
- **Partner with development banks, impact investors, climate finance, and UN agencies** (IOM, IFAD, FAO, UNIDO, World Bank, AfDB, Islamic Development Bank, SIRC, etc.) to de-risk employer investments and co-finance training hubs through blended models where governments, employers, and international partners share costs, ensuring zero worker-paid fees. For example, the EU's THAMM Plus Talent Partnership channels EU and Italy funds into co-financed training in Morocco and Tunisia, while the Islamic Development Bank's Green Skills Accelerator supports waste management and sustainable agriculture training through blended public–private financing.
- **Encourage multinational agritech and waste firms to partner with local training institutes**, accelerating knowledge transfer and ensure updated training programs in line with private sector demands.

4. Establish robust governance and standards

- **Create a GCC–country of origin Task Force**, ideally hosted under the GCC Executive Office, to coordinate curricula, credential recognition, and worker rights.
- **Institutionalize gender and youth participation** targets (20–30 percent women, priority for under-30 workers).
- **Require evidence-based monitoring and evaluation**, tracking placement, retention, and productivity data to guide scale-up, alongside sector-specific impact indicators such as food security gains in CEA and landfill diversion rates in waste management.
- **Embed worker protection mechanisms**, including regular worker surveys, grievance redress channels, and structured feedback loops, ensuring that workers' voices inform program governance and continuous improvement.

Conclusion

The green transition of GCC economies will hinge not only on capital investment and technology deployment, but on the availability of skilled workers able to operate, maintain, and adapt these systems over time. Without adequately trained people, investments in food security, climate-smart agriculture, and circular economy infrastructure risk underperforming or remaining underutilized—undermining both climate objectives and economic returns.

Skills Mobility Partnerships (SMPs) offer a viable pathway to address this challenge. By embedding training, certification, ethical recruitment, and reintegration into structured labour mobility schemes, SMPs align workforce development with climate adaptation needs while supporting equitable and inclusive growth. In doing so, they respond directly to the ADD commitment to ensuring that the transition to a low-carbon economy is not only environmentally sustainable, but also socially just.

The experiences from climate-smart agriculture and waste management underscore both urgency and opportunity. Across the ADD region, countries of origin continue to face youth labour market pressures, while destination countries experience growing shortages of specialised green skills. If left unaddressed, these dynamics risk slowing sectoral growth and amplifying social vulnerability. When addressed through well-designed SMPs, however, they can generate shared benefits:

- **For ADD destination countries:** reliable pipelines of green-skilled workers to support food security, circular economy, and climate adaptation strategies aligned with net-zero ambitions.
- **For labour-sending countries:** strengthened skills ecosystems, improved workforce productivity and competitiveness, and reintegration pathways that contribute to climate-resilient livelihoods.
- **For migrant workers:** access to decent, formal employment opportunities, safe and dignified mobility pathways, and clearer prospects for skills recognition and career progression.
- **For employers and the private sector:** predictable access to an ethically recruited, future-ready workforce, alongside reduced skills mismatches and reputational gains.

Forward-Looking Priorities for ADD Membership

Building on these findings, and in line with the ADD Declaration's focus on labour mobility, skills, and social protection for a Just Transition, three forward-looking priorities emerge for ADD Member States.

First, institutionalise climate-responsive SMPs as a core ADD cooperation modality.

ADD members could formally recognise SMPs as a regional instrument for aligning labour mobility with climate adaptation and green growth objectives. This would support policy coherence across labour, climate, food security, and skills agendas, while enabling pilots in priority sectors such as climate-smart agriculture, waste management, and other green transition sectors.

Second, strengthen mutual recognition of green skills and certifications across the ADD region.

The ADD platform provides a ready forum to advance regional dialogue on skills standards, recognition frameworks, and competency-based certification and skills retention —particularly for emerging green occupations. Progress in this area would reduce skills mismatches, lower recruitment costs, and improve mobility outcomes while supporting national workforce localisation strategies.

Third, deepen public–private partnerships to co-design and co-finance SMPs.

Consistent with the ADD Declaration's emphasis on engaging employers, Member States could expand structured roles for agribusinesses, utilities, waste operators, and training providers in SMP design and delivery. This would help ensure that training content matches real labour market demand and that migration pathways remain responsive to evolving technological and climate needs.

Regarding the funding of such SMPs, the ADD secretariat could look into the possibility of integrating Green Bonds and Sustainability-Linked Bonds (SLBs) into the SMP framework. A feasibility study would have to look into the question to what extent SMPs for green skills would be aligned with pension funds and insurance companies' allocation models who need long-duration, stable-return assets with measurable environmental or social outcomes to match their pension liabilities. More in-depth research could look into Workforce Key Performance Indicators of SMPs, such as certification, job placement, gender inclusion, and Operations & Maintenance reliability, and if they are suitable as SLB targets, particularly for natural-capital and climate-transition investors who prioritize verifiable real-economy outcomes.

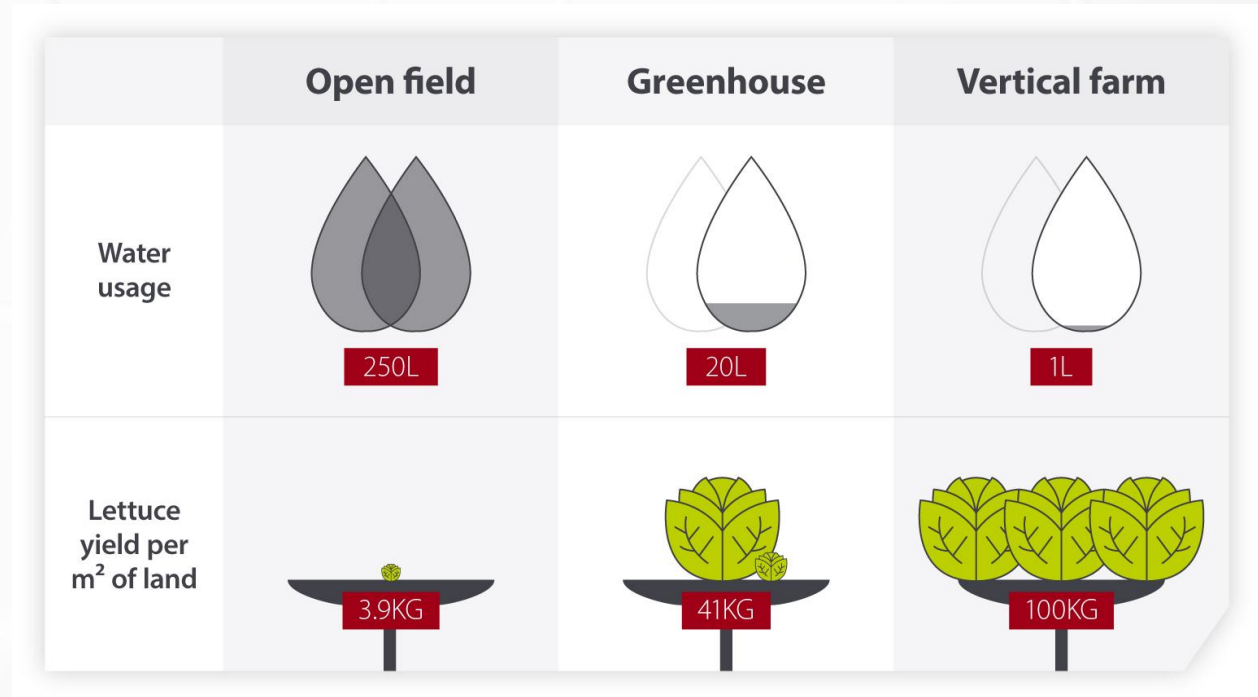
The Abu Dhabi Dialogue is uniquely positioned to translate these commitments into action. By launching the first climate adaptation–focused SMPs in climate-smart agriculture and waste management by 2026, ADD Member States can demonstrate how labour mobility, skills development, and social protection can jointly advance a Just Transition.

In doing so, the ADD can move beyond pilot initiatives toward a regional model that supports climate resilience, decent work, and shared prosperity, setting a global precedent for how migration governance can contribute to a fair and sustainable green economy.

Annex 1. Case Study: Controlled Environment Agriculture

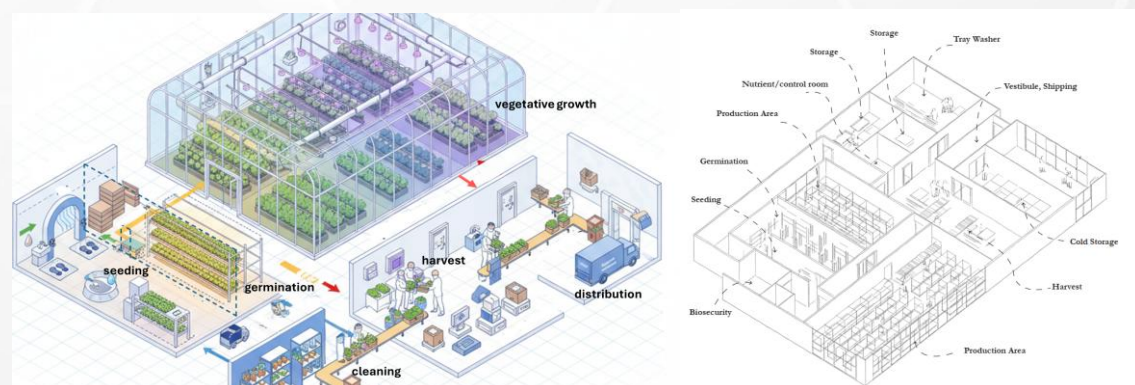
Controlled Environment Agriculture (CEA) refers to farming systems that use technology to control and optimize the climate in which crops grow. This includes hydroponics, vertical farming, and climate-controlled greenhouses, all of which optimize water, nutrients, and environmental conditions to achieve higher yields with lower resource use (Figures 3 and 4).

Figure 2. Understanding CEA



Source: <https://www.danthermgroup.com/uk/insights/why-controlled-environment-agriculture-cea-is-the-future-of-farming>.

Figure 3. Greenhouse and vertical farm layout diagrams



Why CEA is important

CEA is necessary in the GCC due to the fact that arable land is extremely limited, accounting for only 1.4 percent of the region's total land area ([Alpen Capital, 2023](#)). Most of the terrain consists of deserts and arid zones, with harsh climatic conditions, low soil fertility, and chronic water scarcity that make conventional agriculture nearly impossible. Even in Saudi Arabia, which holds over 80 percent of the GCC's total agricultural land, just 1.6 percent is arable. In smaller Gulf states such as the UAE (0.7 percent), Qatar (1.2 percent), Bahrain (2.0 percent), Kuwait (0.5 percent), and Oman (0.3 percent), agricultural potential is even more constrained ([Alpen Capital, 2023](#)).

By enabling food production independent of soil quality or external climate, CEA allows crops to grow in non-arable and urban spaces such as warehouses, rooftops, or desert zones. Through hydroponics, vertical farming, and advanced greenhouse systems, water use can be reduced by up to 90 percent, while yields per square meter can exceed those of open-field farming by 5–10 times²³.

Investments in CEA

GCC

Saudi Arabia

Since 2021, Saudi Arabia has invested approximately \$220 million in high-tech greenhouses, including vertical and horizontal farming technologies, and has committed to scaling greenhouse cultivation by thousands of hectares by 2030.²⁴ The Agricultural Development Fund supports vertical farming through subsidies and financing programs covering up to 50 percent of indoor-farming equipment costs. International partnerships are accelerating this momentum: Saudi Arabia has signed \$3.7 billion in agri-tech and CEA deals with China,²⁵ and an additional \$114 million with the Netherlands for greenhouses, vertical farms, and agri-software in 2025, driving rapid technology transfer and innovation.²⁶ Further showcasing this leadership, the Ministry of Environment, Water and Agriculture (MEWA) and the National Research & Development Center for Sustainable Agriculture (Estidamah) on the 26th of November of 2025, hosted the Third International Virtual Workshop on Smart, Sustainable and Innovative Agri-Tech Solutions, which drew over 6,000 online viewers and featured 16 international experts from 8 countries. The event confirmed the Kingdom's strategic focus on integrating advanced technologies, skilled human capital, and modern policy to build long-term resilience in its agri-food systems.²⁷

UAE

The UAE aims to locally produce 30 percent of its fresh food consumption by 2030²⁸. The Abu Dhabi Investment Office (ADIO) invested \$100 million in 2020 across agritech companies, including vertical-farming startups, while the Dubai Food Tech Valley is developing GigaFarm, a 900,000 sq ft AI-driven vertical farm expected to produce 3 million kg of food annually²⁹. Additionally, Silal's Innovation Oasis and AgriTech Academy, a 300,000 m² R&D and training facility, develops technologies for high-temperature cultivation, water scarcity, and energy efficiency, while training the next generation of agritech professionals. Major investments have already been made: the UAE is home to one of the world's largest vertical farms: Bustanica, a \$40 million investment; while Pure Harvest Smart Farms, which has raised \$180.5 million, has expanded across the GCC with controlled-climate greenhouses.³⁰

²³ See <https://www.mdpi.com/2311-7524/10/2/117>

²⁴ https://www.najdagritech.com/post/saudi-arabia-invests-220-million-high-tech-greenhouses_agritech

²⁵ <https://www.china-briefing.com/china-outbound-news/saudi-arabia-and-china-sign-agricultural-and-trade-deals>

²⁶ <https://igrownnews.com/saudi-arabia-agriculture-latest-news/>

²⁷ <https://estidamah.gov.sa/en/media-center/news/Pages/Estidamah-Organizes-the-Third-International-Virtual-Workshop-to-Enhance-Smart-and-Innovative-Agricultural-Solutions.aspx>

²⁸ See <https://news.uppersetup.com/insights/vertical-farming-in-the-uae/>

²⁹ See <https://news.uppersetup.com/insights/vertical-farming-in-the-uae/>

³⁰ See <https://east-fruit.com> and <https://www.wamda.com/>.

Bahrain

Bahrain is also moving toward food-system innovation. The Bahrain Real Estate Investment Company (Edamah), part of the sovereign wealth fund Mumtalakat, partnered with Badia Farms to develop a 50,000 m² sustainable vertical farm in Hamala³¹. Bahrain's participation in regional events such as the Bahrain International Garden Show 2025 demonstrates its commitment to sustainable agriculture and collaboration with neighbors like the UAE on climate-smart farming³².

Oman

In Oman, the government promotes vertical farming as a promising avenue for entrepreneurship and youth employment under Vision 2040, offering incentives and budget allocations to encourage startups³³. The Ministry of Agriculture and Fisheries announced 30 new investment projects for food security, several focusing on greenhouses and hydroponic systems³⁴.

Qatar

Qatar's National Food Security Strategy targets 70 percent self-sufficiency in vegetable production, with the agriculture sector projected to grow at a 6 percent compound annual growth rate (CAGR) through 2031³⁵. The country is rapidly adopting hydroponics, vertical farming, and smart irrigation. Innovative local firms such as VFarms are deploying solar-powered, off-grid vertical farms using atmospheric water generators to harvest water from air, ensuring independence from external water sources³⁶.

Kuwait

Kuwait is positioning itself as a regional leader in aeroponics and vertical farming. GreenLife Company and CleanGreens Solutions are building the world's largest aeroponic greenhouse in Abdali, expanding from 7,500 m² to 24,000 m²³⁷. In 2024, Kuwait inaugurated its first commercial indoor vertical farm, a joint venture between NOX Management and German company &Ever, advancing the goals of New Kuwait 2035 to diversify the economy, strengthen food security, and foster innovation and job creation in agritech³⁸.

Egypt

CEA has been driven largely by the state's mega-greenhouse push, launched in 2017 via the National Company for Protective Cultivations—with plans commonly referenced as "100,000 feddans" (≈42,000 ha) of protected cultivation and thousands of units already inaugurated across multiple sites.³⁹

India

Private capital is catalyzing CEA scale-up: UrbanKisaan received investment from BASF Venture Capital to expand hydroponic greenhouses and vertical farms⁴⁰, Eeki Foods raised ~\$7 million in 2025 to grow climate-controlled farms nationwide⁴¹, and Kheyti's award-winning "greenhouse-in-a-box" model is spreading low-cost protected cultivation among smallholders altogether signaling momentum from high-tech peri-urban farms to frugal, small-farm solutions.⁴²

³¹ See <https://www.gulfagriculture.com/news/edamah-and-badia-farms-partner-on-innovative-new-agricultural-project-in-bahrain/>.

³² See <https://www.verticalfarmdaily.com/article/9707461/uae-promotes-sustainability-initiatives-at-bahrain-international-garden-show-2025/>.

³³ See <https://www.mcbs.edu.om/the-future-of-vertical-farming-in-oman-prospects-for-boosting-agriculture-and-entrepreneurship-towards-vision-2040/>.

³⁴ See <https://globalflowcontrol.com/newsroom/oman-to-launch-30-investment-projects-for-food-security/>.

³⁵ See <https://www.ifpinfo.com/qatar-agriculture-market-current-landscape-and-future-opportunities-through-2031/>.

³⁶ See <https://www.verticalfarmdaily.com/article/9731995/vfarms-grows-record-breaking-lettuce-in-qatar-using-solar-power-and-atmospheric-water/>.

³⁷ See <https://www.verticalfarmdaily.com/article/9724016/kuwait-to-get-largest-aeroponic-greenhouse-thanks-to-partnership/>.

³⁸ See <https://thetartupscene.me/MenaEcosystems/Kuwait-Inaugurates-Its-First-Large-Scale-Indoor-Vertical-Farm>.

³⁹ See <https://www.hortidaily.com/>.

⁴⁰ See <https://www.basf.com>.

⁴¹ See <https://economictimes.indiatimes.com/tech/funding/agri-startup-eekei-raises-7-million-from-sixth-sense-ventures-to-expand-operations/articleshow/122181028.cms?from=mdr>

⁴² See <https://earthshotprize.org/winners-finalists/kheyti/>.

Workforce shortages as a constraint to CEA

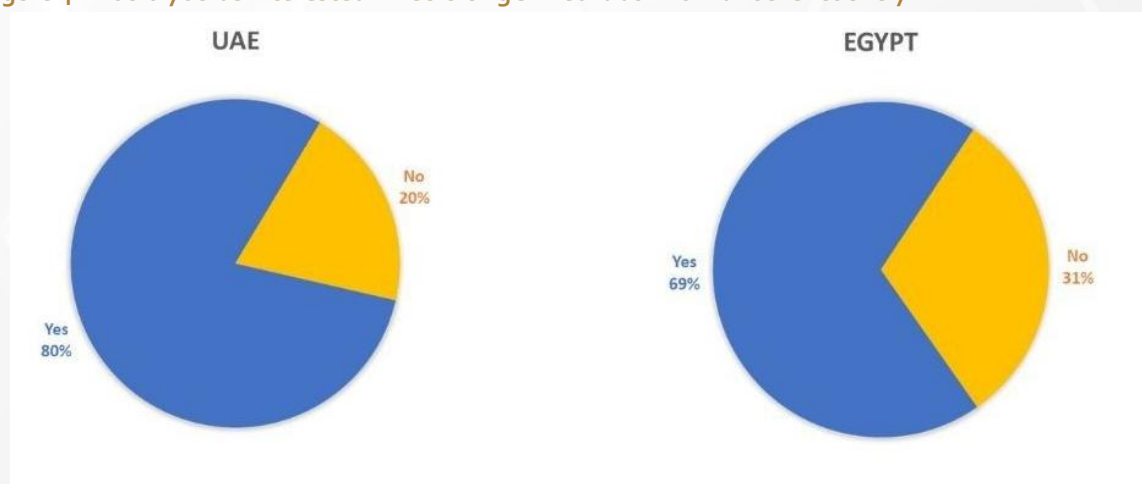
CEA requires a technically skilled workforce capable of managing complex systems and processes across production, energy, and quality control. Core operational roles typically include:

- Operating and maintaining irrigation and fertigation systems.
- Managing climate control technologies, including sensors, automation, and AI-based monitoring.
- Implementing integrated pest management (IPM) in closed systems.
- Overseeing food safety, quality assurance, and traceability standards.

Using conservative benchmarks (~4 skilled technicians per greenhouse hectare; 1 per 1,000 m² for vertical farms, adjusted for automation), announced and expected projects imply demand for roughly 1,400–1,700 certified roles by 2030. A handful of additional greenhouse complexes would push this above 2,000 roles across operations, mechatronics, quality assurance, and food safety.

At present, the GCC states face a critical shortage of trained technicians to perform these functions (Box 2). Data from the Needs Assessment for Climate-Smart Agriculture Skills Development in the UAE and Egypt by Agritecture Consulting and IOM, reinforce the scale of the skilled labor gap. Among 26 commercial operators surveyed in the UAE and Egypt, 92 percent reported interest in hiring additional skilled labor, and nearly three-quarters said they would recruit foreign workers if given reliable pathways. Critically, over 75 percent confirmed that certifications of operational skills matter, and virtually all respondents stated they would pay a premium for certified workers: most in the range of 11–25 percent more, and some indicating willingness to pay over 25 percent more. Employers also highlighted high turnover, poor technical knowledge, and lack of standardized training as persistent barriers. This primary evidence underscores that GCC employers are not only experiencing shortages but are ready to reward certification and structured pathways—precisely the gaps that a SMP can fill.

Figure 4. Would you be interested in recruiting skilled labor from another country?



Source: "Needs Assessment for Climate-Smart Agriculture Skills Development in the UAE and Egypt"

Box 2. The cost of skill shortages in GCC CEA operations

As part of our research, we conducted direct outreach with emails to a sample of directors and senior managers of CEA companies across the GCC to better understand the on-the-ground workforce challenges. Feedback from these stakeholders consistently highlighted a severe shortage of technically skilled growers and agronomy professionals, forcing companies to recruit expertise from abroad, a process that increases costs, delays operations, and reduces local workforce participation.

Participants reported that most local growers lack familiarity with high-tech systems and continue to rely on traditional methods that undermine efficiency. One operator cited a costly incident in which mismanagement of a Priva dosing and lighting system led to plants receiving 18 hours of light instead of 10, resulting in substantial energy losses.

All respondents emphasized that they would gladly pay a salary premium for certified, job-ready technicians, particularly those trained in labor management, production scheduling, integrated pest management (IPM), power management, and inventory control. This feedback reinforces that Skills Mobility Partnerships (SMPs) can directly address existing inefficiencies, reducing operational losses, increasing productivity, and accelerating the GCC's green transition by ensuring a reliable pipeline of certified local and migrant technicians trained to GCC standards.

Education and training requirements

The Regulated Qualifications Framework (RQF) provides a useful benchmark to classify the complexity and training duration required for CEA roles (Table 6). These are indicative estimates, but they illustrate that CEA workforce development must be tiered, aligning entry-level technical training with more advanced supervisory and quality-assurance qualifications. Designing SMP curricula around these RQF-aligned tiers will ensure the GCC develops a workforce capable of operating, maintaining, and scaling modern food production systems efficiently and safely.

Table 4. The skills required for CEA roles

RQF Level	Tasks	Training requirements
2-3 Entry technician	Operating and maintaining irrigation or fertigation systems	Typically a few weeks to a few months of training
3-4 Intermediate technician	Implementing IPM and basic greenhouse operations	Around three to six months of training
4-5 Advanced technician	Managing climate control technologies, sensors, and automation systems	Approximately six months to one year of training
5-6 Supervisory / managerial	Overseeing food safety, quality assurance, and traceability systems	Usually one to two years of formal education or diploma-level study

The rest of this section outlines how the various countries of destination and countries of origin train for CEA roles.

GCC

In the GCC, CEA training leverages advanced technologies like AI-driven hydroponics and water-efficient greenhouses to ensure food security in arid climates, addressing regional skills gaps.

King Abdullah University of Science and Technology (KAUST) in **Saudi Arabia** anchors efforts through its Center for Desert Agriculture, offering Ph.D. programs, undergraduate internships, and translational projects on desert CEA⁴³, alongside the Edible Education Program integrating sustainable agriculture into K-12 curricula.⁴⁴ Moreover, in Saudi Arabia, the Estidamah National R&D Center for Sustainable Agriculture has launched consecutive greenhouse management training programs, covering smart irrigation, crop monitoring, climate control systems, and energy-saving techniques.

Qatar's Hamad Bin Khalifa University (HBKU) runs the Hydroponics & Aquaponics with AIoT (HAIAT) project⁴⁵, exposing talent to data-driven greenhouse control. These programs align with Vision 2030 and regional agri-tech ambitions.

Egypt

Egypt's CEA education addresses water scarcity and desert farming through programs emphasizing hydroponics, aquaponics, and greenhouses, aligning with Egypt's 2030 sustainability goals. The American University in Cairo (AUC) is a cornerstone, offering the Water, Energy, Food Technologies (WEFT) Diploma⁴⁶, a two-semester program (18 credit hours) covering modern agriculture, aquaculture, irrigation, and sustainable energy. AUC's Desert Development Center (DDC)⁴⁷ delivers hands-on training. AUC's Center for Applied Research on the Environment and Sustainability (CARES)⁴⁸ supports these with facilities like solar-powered greenhouses and aquaponics labs for practical learning.

Community initiatives, such as IOM-backed hydroponics training with firms like Schaduf and Gebal Egypt's Training of Trainers in Upper Egypt⁴⁹, provide entry-level feeder programs for local farmers. The International Center for Agricultural Research in Dry Areas (ICARDA)⁵⁰ collaborates with Egypt's Agricultural Research Center for workshops. These efforts help address skills gaps noted in IOM studies and recent AgFunder research demonstrating a looming shortage of skilled labor for climate-smart farms in UAE and Egypt. However, they remain limited in scale and coverage. Egypt continues to face a shortage of technicians trained specifically in GCC-relevant CEA technologies, highlighting the need for SMPs.⁵¹

India

India's CEA training ecosystem supports urban farming and soilless cultivation to tackle land scarcity, with programs from short workshops to structured courses fostering hydroponics and vertical farming expertise. The Institute of Horticulture Technology (IHT) in Greater Noida offers a two-week Commercial Hydroponics Training with hands-on system design and business models⁵², while the Indian Institute of Skill Development Training (IISDT) provides a two-month online Certificate in Hydroponics.⁵³ The Indian Agricultural Research Institute (ICAR-IARI) in New Delhi, through its Centre for Protected Cultivation Technology (CPCT), runs regular courses on climate-controlled greenhouses and nurseries, and a three-month Skill Development Course on Hydroponics and Aeroponics.⁵⁴ The National Skill Development Corporation (NSDC) and Agriculture Skill Council of India (ASCI) offer standardized Hydroponics Technician Qualification Packs for employer-aligned training.⁵⁵

While these programs remain limited in scale, many already embed competencies that overlap with GCC requirements, such as fertigation, climate control, and food safety protocols. This alignment suggests that

⁴³ See <https://saudipedia.com/en/article/4070/government-and-politics/centers/center-for-desert-agriculture>.

⁴⁴ See <https://www.kaust.edu.sa/en/research/sustainable-food-security/edible-education-program>.

⁴⁵ See <https://elmi.hbku.edu.qa/en/projects/hydroponics-and-aquaponics-with-aiot-in-qatar-haiat>.

⁴⁶ See <https://sse.aucegypt.edu/programs/graduate/water-energy-food-diploma>.

⁴⁷ See <https://www1.aucegypt.edu/catalog04/Research/cenddc/cenddc.html>.

⁴⁸ See <https://sse.aucegypt.edu/centers-labs/cares>.

⁴⁹ See <https://gebalegypt.com/training-of-trainers-in-dandara-upper-egypt/>.

⁵⁰ See <https://icarda.org/>.

⁵¹ See <https://agfundernews.com/>.

⁵² See <https://iht.edu.in/commercial-hydroponic-training/>.

⁵³ See <https://iisd.com/course/hydroponics-1564>.

⁵⁴ See <https://krishisuvidha.in/hydroponic-aeroponic-farming-course-at-icar-iari/>.

⁵⁵ See <https://nsdcindia.org/nos-listing/2>.

SMPs could focus on modest curriculum augmentation (e.g., GCC-specific automation systems, standards compliance) rather than wholesale retraining, making the model more efficient and cost-effective.

Table 5. Stakeholders involved in developing a pilot SMP in CEA

SMP Element	Key Stakeholders	Core Activities & Implementation	Value Proposition & Rationale
1. Strategic Planning	GCC Agriculture & Labor Ministries, Egypt & India Agriculture Ministries, Private Farm Operators	Anchoring SMPs in mid- and long-term workforce projections (e.g., Vision 2030, Food Security 2051) rather than reacting to immediate shortages.	Ensures migration flows are guided by future labor demand, making the model sustainable.
2. Evidence-Based Design	Research Institutions (King Abdullah University of Science and Technology - KAUST, The American University in Cairo - AUC, Indian Council of Agricultural Research - ICAR); National Data Agencies	Using reliable labor market data to forecast demand and identify skills gaps. Aligning training curricula directly with specific GCC technologies and standards.	Addresses systemic mismatches that standard recruitment misses; ensures training is relevant to actual project pipelines.
3. Inclusive Governance	GCC food security task forces; AUC; ICAR; IOM; employer consortia, Ministries of Labor, Agriculture, Foreign Affairs and Interior	Joint design of the SMP to align GCC climate goals with country-of-origin development strategies. Governments and private sector collaborate to identify needed changes in migration policy and law.	Ensures coherence with national and local development priorities; builds a responsive system that adapts to changing employment patterns.
4. Local Development Benefits	Training farms in Upper Egypt; ICAR demo farms; local trainers certified	Upgrading skills in countries of origin and training local trainers. Investing in institutions rather than just "extracting" workers.	Stimulates wider job creation and domestic green transitions; leaves behind stronger training institutions and skilled cohorts valuable at home.
5. Recognized Skills	Accreditation Bodies; Tech Vendors (Netafim, Priva); Certifiers	Developing joint curricula and portable certifications. Ensuring skills are pre-aligned to GCC SOPs and compliance standards.	For Employers: Productivity from "Day 1" (no top-up training/downtime). For Workers: A "career passport" valid in both regions, enabling upward mobility and reintegration.
6. Fair Mobility	IOM; Recruitment Agencies; Employers	Zero worker-paid fees; pre-departure orientation (contracts, safety); post-arrival orientation and onboarding	Protects workers' human and financial capital; strengthens the GCC's image as a responsible employer; reduces reputational risks associated with opaque hiring.
7. Migration Governance	Migration Agencies; Ministries of Interior/Labor	Embedding SMPs in existing legal pathways or creating new ones. Managing visa/permit processing and providing support along the entire migration cycle (pre-departure to pre-return).	Provides predictability and order (unlike ad hoc/fragmented recruitment channels); ensures ownership and clarity for both workers and employers.
8. Cost Reduction & Shared Financing	Donors; Impact Investors; Climate Finance; Governments; Employers	Blended financing: Destination countries/partners fund training; Origin countries provide in-kind (facilities/trainers).	Reduces risk and delivers higher ROI. Training costs are lower in countries of origin, and shared financing prevents costs from being pushed onto workers.

Annex 2. Case Study: Waste Management

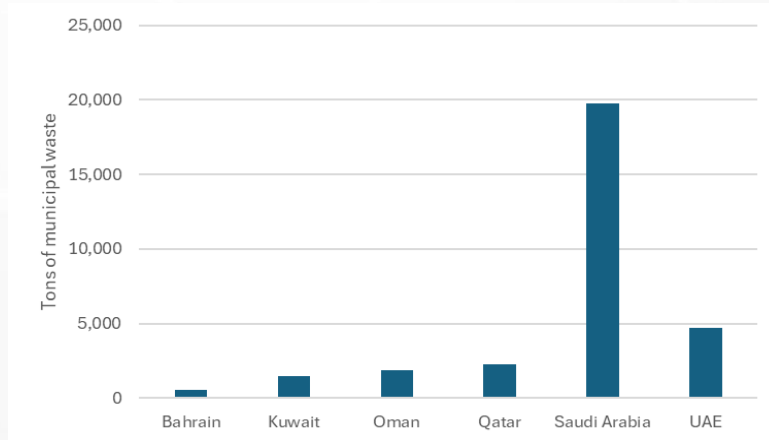
Waste management refers to the collection, treatment, and disposal of solid and liquid waste in ways that protect human health and the environment while enabling resource recovery. Modern waste management goes beyond landfilling to encompass segregation, recycling, composting, waste-to-energy conversion, and circular economy approaches that transform waste streams into valuable inputs. Effective systems require coordination across the entire lifecycle of materials, production, consumption, and disposal, supported by skilled technicians, engineers, and operators.

Why waste management is important

Historically, the main contributor to waste in the GCC is construction and demolition waste (CDW), which constitutes more than half the overall waste production, alongside rising demand for waste-to-energy (waste-to-energy) solutions, plastics and packaging recovery, and e-waste recycling as regulations tighten, followed by municipal solid waste (MSW) with about one quarter. The other waste fractions are industrial waste and hazardous waste.

While the GCC population reached 62.1 million by the end of 2024, the latest data released by the Statistical Centre for the Cooperation Council for the Arab Countries of the Gulf (GCC-Stat) indicates that the total waste collected in the GCC states by the end of 2023 is estimated at approximately 262.7 million tons, marking an increase of 153.7 percent compared to the figures recorded in 2019, primarily comprising MSW, CDW, and agricultural waste. Meanwhile, the total waste treated reached 192.0 million tons, which reflects a 128.5 percent increase. The region's waste management challenges are particularly pronounced in Saudi Arabia and the UAE, which collectively account for approximately 75 percent of the total waste generated (Figure 6).⁵⁶

Figure 5. Processed Municipal Waste Generated by Households in GCC Countries (2023)



Source: <https://dp.marsa.gccstat.org/ar/%D8%A7%D9%84%D9%86%D9%81%D8%A7%D9%8A%D8%A7%D8%AA>.

Yet waste is also an important problem in countries of origin. Egypt produces around 100 million tonnes of waste annually, with agricultural, drainage, canal, and municipal waste making up the majority, as reported by the National Solid Waste Management Program (NSWMP) in 2023. E-waste is rising rapidly, now more than 690,000 tonnes annually. Egypt is one of the largest producers and consumers of plastic waste in Africa and the Arab world. The country generated about 2.5 to 5 million tons of plastic waste annually by 2022/2023, making up 10-14 percent of Egypt's total waste.

Finally, India generates around 62 million tonnes of municipal solid waste (MSW) annually—a figure expected to rise to 165 million tonnes by 2030. While 75–80 percent of this waste is collected, only about 22–28 percent is processed. Municipal solid waste accounts for roughly 70 percent of total waste, alongside 3.5 million tonnes of plastic waste (of which just nine percent is recycled) and over 1.6 million tonnes of e-waste in 2022, making India the world's third-largest generator.

⁵⁶ www.gccstat.org, تقرير إحصاءات النفايات في دول مجلس التعاون لدول الخليج العربية لعام 2023م العدد 3 | مايو 2025 م

Investments in waste management

GCC

Saudi Arabia

Saudi Arabia's 2021 Waste Management Law mandates licensing, classification, and oversight of all waste activities⁵⁷, while its Vision 2040 plan aims to divert 90 percent of waste away from landfills through recycling (40 percent), composting (31 percent), and waste-to-energy (16 percent) mechanisms.⁵⁸ Saudi Arabia's Public Investment Fund (PIF) subsidiary Saudi Investment Recycling Company (SIRC) has been forming alliances to develop national waste-treatment capacity. In December 2024 it signed a memorandum of understanding (MoU) with Veolia to create a regional champion for organic, industrial and hazardous waste, aiming to expand treatment capacity and align with Vision 2030.⁵⁹ SIRC also partnered with SUEZ to access its expertise in waste-to-energy and hazardous-waste management⁶⁰ and with ABB (through SIRC's subsidiary EADA) to develop circularity and energy-efficiency solutions for electronic and solid waste.⁶¹ Additionally, Aramco Digital partnered with Indian start-up Recykal to deploy AI-based digital platforms for tracing recyclable plastics and reducing landfill waste⁶², while SIRC's subsidiary Yadoum signed a 20-year deal with NADEC to recycle 150 000 t/yr of agricultural waste into organic fertiliser.⁶³

UAE

The UAE, under its National Agenda for Integrated Waste Management (2031), targets treatment of 80 percent of municipal solid waste, near-total treatment of hazardous waste, widespread landfill sanitation, and stronger separation/collection systems.⁶⁴ They have invested heavily in waste-to-energy facilities. Abu Dhabi's Emirates Water & Electricity Company and Tadweer Group awarded a 30-year concession to a consortium led by Marubeni and Hitachi Zosen Inova to build a 900 000 t/yr waste-to-energy plant that will generate about 80 MW of electricity and cut ~1.1 Mt CO₂-e annually.⁶⁵ Dubai's Warsan waste-to-energy facility, a US\$1 billion public-private project, is designed to process 1.9 Mt of waste annually (45 percent of Dubai's municipal waste) and supply 200 MW of power under a 35-year concession.⁶⁶ In Sharjah, a joint venture between BEEAH and Masdar opened the Middle East's first waste-to-energy plant in 2022; it treats over 300 000 t of waste a year and produces 30 MW of electricity [beeahgroup.com](https://www.beeahgroup.com). The partners plan to double capacity to 600 000 t and nearly 60 MW, which would displace up to 1 Mt of CO₂ and power 60 000 homes.⁶⁷ Tadweer later acquired Masdar's stake, making Tadweer and BEEAH co-owners, with expansion plans continuing.⁶⁸

⁵⁷ See <https://saudipedia.com>.

⁵⁸ See <https://www.trade.gov/country-commercial-guides/saudi-arabia-waste-management>.

⁵⁹ See <https://www.veolia.com/en/our-media/press-releases/veolia-and-saudi-investment-recycling-company-sign-memorandum>.

⁶⁰ See <https://www.suez.com/en/news/press-releases/suez-sirc-join-forces-foster-circular-economy-turning-waste-into-resources-saudi-arabia>.

⁶¹ See <https://new.abb.com/news/detail/118898/abb-to-collaborate-with-eada-a-subsi-dary-of-the-saudi-investment-recycling-company-on-circularity-and-energy-efficiency>.

⁶² See <https://www.sustainableplastics.com/news/aramco-digital-recykal-partner-advance-waste-management-saudi-arabia>.

⁶³ See <https://www.argaam.com/en/article/articleDetail/id/1658888>.

⁶⁴ See <https://www.wasterecyclingmea.com/the-national-agenda-for-integrated-waste-management-launched-in-the-uae>.

⁶⁵ See <https://www.marubeni.com/en/news/2024/release/00017.html>.

⁶⁶ See <https://www.ramboll.com/en-us/projects/energy/largest-of-its-kind-waste-to-energy-facility-in-dubai>.

⁶⁷ See <https://www.beeahgroup.com/services/waste-to-energy/>.

⁶⁸ See <https://masdar.ae/en/news/newsroom/tadweer-group-acquires-waste-to-energy-stake-from-masdar>.

Bahrain

Bahrain's national waste-management strategy targets recycling 90 percent of household waste and converting the remainder to energy, but implementation has lagged. In 2022 the Ministry of Municipalities Affairs issued a tender for a waste-to-energy facility; fifteen international companies bid to build a plant that would sort recyclable material and incinerate residual waste to generate up to 98 MW of power, with completion targeted for 2027.⁶⁹ An earlier plan to develop a 25 MW waste-to-energy plant at the Askar landfill (treating ~390 000 t/yr) under a public-private BOT arrangement lists French firm CNIM as developer⁷⁰, but progress appears limited. In July 2024 the ministry signed an MoU with the UAE's Tadweer Group to explore investment opportunities, including waste-to-energy, sustainable aviation fuel, plastic recycling, e-waste recycling and joint research; the parties emphasised collaboration and knowledge-exchange to develop future projects.⁷¹

Oman

Oman's waste-management company be'ah (Oman Environmental Services Holding Co.) is leading a shift from landfill to energy recovery. In August 2025, the country's power-procurement body invited bidders for a 95–100 MW waste-to-energy plant at Barka; the project will treat up to 3 000 t/day of municipal solid waste, generate around 760 GWh of electricity and reduce ~302 000 t of CO₂ annually, with be'ah supplying feedstock and taking an equity stake.⁷² Commercial operations are expected in 2031.⁷³ Be'ah also signed an agreement with Oman Cement Company to provide tyre-derived fuel and explore refuse-derived fuel solutions, aiming to achieve 60 percent waste utilisation by 2025 and 80 percent by 2030.⁷⁴

Qatar

Qatar invested about \$1.09 billion in the Domestic Solid Waste Management Centre (DSWMC) at Mesaieed, which processes ~2,300 t of waste daily and produces 50 MW of energy, sending 42 MW to the grid and diverting about 95 percent of waste from landfill.⁷⁵ The DSWMC produced over 245 000 MWh of electricity in 2024 and serves as the core of national waste-management efforts.⁷⁶ Qatar's government reported that approximately 54 percent of household, commercial and industrial waste was recycled by 2023 and aims to increase this to 95 percent by 2030; over 153 land plots have been allocated to private-sector recycling projects, and more than 50 plots at Al-Afjah have been set aside for recycling factories.⁷⁷ Despite these recycling ambitions, more than half of other waste streams still go to landfill.⁷⁸

Kuwait

Kuwait relies heavily on landfilling but is beginning to diversify. Kuwait Municipality issued a tender in December 2024 for a feasibility study under its National Waste Management Strategy 2040; the aim is to reduce landfill by developing recycling and recovery facilities, with bids due in March 2025.⁷⁹ In January 2025 the cabinet approved plans to invite local and foreign firms to build large recycling plants, acknowledging that daily waste exceeds 14 000 t while existing plants handle only 2,000–2,500 t.⁸⁰ A joint project between the government and Kuwait Cement Company is developing a complex to convert municipal waste into dry fuel; design work started in 2024 and the trial operation is slated for 2028.⁸¹ Private firm Metal Recycling Company (MRC) is investing in a steel-recycling facility capable of processing 60 000 t/yr of scrap steel by 2025; MRC already operates Kuwait's medical-waste incinerators and is building a spent-catalyst reclamation plant.⁸²

⁶⁹ See <https://www.mun.gov.bh/newportal/en/municipal-affairs/events/humaidan-15-global-companies-compete-establish-waste-energy-facility>.

⁷⁰ See <https://araburban.org/en/infocenter/projects/>.

⁷¹ See <https://www.wasterecyclingmea.com/news/waste-management/tadweer-group-and-bahrain-join-forces-to-explore-investment-opportunities-in-waste>.

⁷² See <https://www.wasterecyclingmea.com/top-stories/waste-to-energy/launch-of-ipp-marks-a-key-milestone-in-oman-s-first-waste-to-energy-project>.

⁷³ See <https://www.utilitybusinessmena.com/electricity/oman-opens-bidding-for-first-ever-waste-to-energy-project>.

⁷⁴ See <https://www.globalcement.com/news/item/17603-be-ah-provides-alternative-fuel-for-oman-cement-company>.

⁷⁵ See <https://araburban.org/en/infocenter/projects/>.

⁷⁶ See <https://www.wasterecyclingmea.com/news/waste-management/qatar-s-waste-and-recycling-landscape-an-overview>.

⁷⁷ See <https://www.trade.gov/market-intelligence/qatar-waste-energy-initiatives>.

⁷⁸ See <https://www.wasterecyclingmea.com/news/waste-management/qatar-s-waste-and-recycling-landscape-an-overview>.

⁷⁹ See <https://www.zawya.com/en/projects/industry/kuwait-issues-tender-for-waste-treatment-projects-feasibility-study-h13c9smi>.

⁸⁰ See <https://www.zawya.com/en/projects/industry/kuwait-to-build-several-waste-recycling-plants-lzrvtbpg>.

⁸¹ See <https://timeskuwait.com/municipality-unveils-key-updates-on-kuwait-modernization-plan/>.

⁸² See <https://www.sustainabilitymea.com/kuwaits-mrc-to-launch-advanced-steel-recycling-facility-in-2025/>.

Egypt

Egypt Vision 2030, together with the National Solid Waste Management Program (NSWMP), establishes a comprehensive framework to modernize waste collection systems, expand infrastructure, strengthen the role of NGOs, and formalize the informal sector, targeting a 50 percent reduction in waste pollution by 2030 (MPED, 2023). Egypt has set an ambitious goal to raise its municipal solid waste recycling rate to 60 percent by 2027, supported by the Waste Management Law (No. 202/2020), which has successfully attracted private-sector investment. Since 2018, the number of private recycling contracts has expanded from just 2 to 36⁸³, spanning collection, transport, treatment, and recycling across multiple governorates.

Major projects are reshaping the sector. Zero Carbon Ventures⁸⁴, an Emirati low-carbon solutions provider, and Egyptian waste management company Green Planet have joined forces to launch a joint waste-to-energy plant, Zero Carbon Green Planet (ZCGP). This facility in Cairo will process 400 tons of organic waste daily into graphene, hydrogen, and fertilizer, creating at least 250 jobs. Partnerships like ZCGP could serve as natural anchors for a SMP, where Egyptian technicians are trained on-site in advanced waste-to-energy processes with a view to deploying certified cohorts into both Egyptian and GCC facilities, ensuring knowledge transfer, workforce readiness, and scalability across the region.

In Assiut, a new EGP 250 million (c. \$5.2 million) recycling plant with German-Dutch technology is underway, adding significant processing capacity. The government has also earmarked \$200 million⁸⁵ for future waste-to-energy projects, reinforcing its commitment to sustainable growth and private-sector collaboration.

India

To address these challenges, India is scaling up investment in waste management, with \$1.64 billion⁸⁶ worth of projects listed on the India Investment Grid. Asian Development Bank (ADB) has committed \$200 million⁸⁷ under the Swachh Bharat Mission-Urban 2.0 to improve waste management in 100 cities. Meanwhile, private players are expanding capacity, Kundan Green Energy⁸⁸ is building an 11.5 MW waste-to-energy facility in Jabalpur, and Haryana is adding three new plants in Gurgaon, Manesar, and Faridabad as part of its 2025 clean-up drive.⁸⁹ Sector leaders include Antony Waste Handling Cell Ltd., A2Z Green Waste Management Ltd., and Attero Recycling Pvt Ltd.

As an illustration, the UAE and India have signed an MoU in 2024 to boost investment in sustainability, renewable energy, and waste management, supporting a circular economy.⁹⁰ In June 2025, Kothari Industrial Corporation Ltd. (KICL) partnered with BEEAH Tandeef International Investment Limited, Sharjah, to apply BEEAH's digital waste systems, smart bins, and waste-to-energy expertise in Tamil Nadu and other states. The collaboration, aligned with the Swachh Bharat initiative, emphasizes public-private partnerships and aims to modernize India's waste sector with technologies like route optimization, solar-powered bins, and digital platforms.

⁸³ See <https://egyptianstreets.com/>.

⁸⁴ Ibid.

⁸⁵ See <https://www.kenresearch.com/egypt-organic-waste-management-market>.

⁸⁶ See <https://www.mordorintelligence.com>.

⁸⁷ See <https://bfsi.economictimes.indiatimes.com/>.

⁸⁸ See <http://Mercomindia.com>.

⁸⁹ See <https://timesofindia.indiatimes.com/city/gurgaon/3-waste-to-energy-plants-to-come-up-in-gurgaon-faridabad-in-2-years-says-cm-saini/articleshow/123838089.cms&sa=D&source=docs&ust=1765276902175557&usq=AOvVaw1uGrEfSQfUp1AXQ-gRtQw5>.

⁹⁰ See <https://mnre.gov.in/en/document/mou-between-the-ministry-of-investment-of-the-united-arab-emirates-and-the-ministry-of-new-and-renewable-energy-of-the-republic-of-india-on-investment-cooperation-in-renewable-energy-sector/>.

Workforce shortages as a constraint to waste management

The waste management sector in the GCC is expanding rapidly under national sustainability strategies, yet workforce shortages, particularly of skilled workers and specialized technicians, present a major barrier to operational efficiency and innovation. Modern waste systems require diverse and specialized skill sets across collection, recycling, and waste-to-energy processes. Key competencies include:

- Operating and maintaining heavy vehicles, collection systems, and transfer stations.
- Running recycling, composting, and waste-to-energy plants, including treatment and valorization processes.
- Applying environmental monitoring, quality, health, safety, and compliance standards.
- Using data engineering, internet-of-things tools, and artificial intelligence applications for logistics optimization and smart city integration.
- Applying specialized engineering in thermal waste-to-energy processes, e-waste management, construction and demolition material recovery, and polymer chemistry for advanced recycling.

In 2018, the ILO noted that skills in waste management and recycling were not yet in demand in the UAE, as reflected in the large volumes of waste being dumped in open fields (ILO, 2018). This did not mean employers rejected skilled professionals, but rather that the sector was underdeveloped and lacked demand for such roles. The ILO emphasized that increasing the availability of skilled professionals could itself stimulate the development of recycling and waste management projects. The report emphasized that expanding the pool of qualified professionals could facilitate the development of waste management and recycling initiatives. Nonetheless, the substantial investments, ambitious policy frameworks, and strategic targets introduced in recent years are likely to reshape the sector and significantly increase the demand for a skilled workforce across multiple levels.

For instance, in Saudi Arabia, the national waste management strategy aims to create around 100,000 jobs in the sector by 2040, according to the targets set by the National Center for Waste Management and the Saudi Investment Recycling Company. This includes direct management, recycling, and related activities⁹¹. In Qatar, the waste management sector could generate between 9,000 and 19,000 jobs by 2030⁹², accounting for direct jobs in collection, transport, sorting, and recycling, as well as positions created by the development of the circular economy and waste-to-energy projects.

Without a structured approach to training and mobility, however, these job creation targets risk being undermined by the same inefficiencies seen in CEA, high turnover, poor technical preparation, and reliance on expensive consultants. An internal and conservative estimate suggests that even a 5 percent productivity loss in the GCC waste sector could translate into tens of millions of dollars in opportunity costs each year, underscoring the urgency of SMPs to deliver certified, job-ready technicians.

While migrant workers currently play a significant role in operational and technical functions, SMPs are positioned as a transitional and complementary mechanism that supports productivity, knowledge transfer, and skills upgrading alongside national workforce development and localization strategies.

⁹¹ See <https://oxfordbusinessgroup.com/reports/saudi-arabia/2024-report/energy-utilities/efficient-solutions-recycling-initiatives-and-waste-to-energy-projects-are-poised-to-bolster-the-kingdoms-sustainability-efforts-analysis/>.

⁹² See <https://www.invest.qa/en/media-centre/news-and-articles/increased-momentum-towards-a-circular-economy-drastic-changes-and-opportunities-to-transform-the-gcc-region>.

Education and training requirements

Again, the RQF provides a useful reference to assess the range and depth of skills required in this sector (Table 7).

Table 6. The skills required for waste management roles

RQF Level	Tasks	Training requirements
2-3	Entry technician / operator	Operating and maintaining heavy vehicles, collection systems, and transfer stations
3-4	Intermediate technician	Running recycling, composting, and waste-to-energy plants
4-5	Advanced technician / supervisor	Applying environmental monitoring, quality, health, and safety standards
5-6	Data and systems specialized	Using data engineering, IoT, and AI tools for smart waste logistics
6-7	Specialized engineer / manager	Designing and overseeing thermal waste-to-energy processes, hazardous and e-waste treatment, materials recovery, and polymer-based recycling systems

GCC

Training and education are emerging as pivotal factors in the professionalization of the GCC's waste management sector. Institutions such as BEEAH⁹³ have established dedicated education arms, training thousands of operatives in operational safety, recycling practices, and sustainability awareness. Tadweer⁹⁴ similarly runs technical programs tailored to municipal solid waste, recycling, and landfill operations. At the academic level, universities including Khalifa University and UAE University (UAU) offer environmental engineering and sustainability programs, yet a persistent gap remains between academic curricula and the specialized skills demanded in industry, particularly in advanced recycling, waste-to-energy, and materials recovery.

Egypt

Education and training are advancing in parallel: institutions like the American University in Cairo⁹⁵ and the German University in Cairo offers specialized programs in waste management and environmental engineering, while private centers provide short-term certifications on waste minimization and environmental compliance.

⁹³ See <https://www.beeahgroup.com/services/education/>.

⁹⁴ See <https://www.tadweer.ae/>.

⁹⁵ See <https://catalog.aucegypt.edu>.

India

On the skills side, India has developed a broad range of training initiatives to meet growing demand in the waste management sector. The Skill India Digital Hub (SIDH)⁹⁶, through the Skill Council for Green Jobs, offers certifications such as “Manager–Waste Management”. Academic institutions are also active: the Institute of Government and Management Studies (IGMPI)⁹⁷ provides postgraduate and executive diplomas in advanced waste practices and technologies, while NITTTT Chennai runs a diploma course tailored to India’s waste classification, collection, processing, and recycling challenges. Complementing these, the Centre for Science and Environment (CSE)⁹⁸ delivers online training in e-waste, plastics, and landfill operations. Further programs are offered through TERI SAS – ICWMR⁹⁹, including weekend and certificate courses that emphasize waste entrepreneurship and sustainability.

⁹⁶ See <https://www.skillindiadigital.gov.in>.

⁹⁷ See <https://igmpi.ac.in/waste-managemen>.

⁹⁸ See <https://www.cseindia.org/page/waste-online-training>.

⁹⁹ See <https://icwmr.terisas.ac.in/>.

Table 7. Stakeholders involved in developing a pilot SMP in waste management

SMP Element	Key Stakeholders	Core Activities & Implementation	Value Proposition & Rationale
1. Strategic Planning	GCC waste authorities (Tadweer, Saudi Investment Recycling Company (SIRC), GCC Accreditation Center (GAC)); country of origin environment ministries; private operators	Anchoring SMPs in National Waste Strategies and Vision 2030. Setting targets for waste-to-energy technicians, recycling engineers, and O&M staff based on long-term goals.	Aligns workforce creation directly with waste diversion and circular economy targets, ensuring sustainability rather than short-term fixes.
2. Evidence-Based Design	The ILO, Central Pollution Control Board (CPCB), National Solid Waste Management Programme (NSWMP) (Egypt), GCC-Stat	Mapping waste-to-energy, recycling, and MSW project pipelines. Using data to estimate specific labor needs (e.g., 100,000+ jobs in Saudi by 2040) and skill gaps.	Ensures the workforce supply matches actual sector growth and technology standards, avoiding systemic skills mismatches.
3. Inclusive Governance	GCC waste authorities; AUC Environmental Engineering; Skill India Digital Hub (SIDH); IOM	Co-designing curricula and certification with employers and ministries. Establishing worker protection mechanisms (surveys, grievance channels, voice platforms).	Builds trust and ensures alignment with rights-based frameworks. Harmonizes GCC climate goals with country-of-origin development priorities.
4. Local Development Benefits	Training Colleges; Recycling Labs; Waste-to-Energy Pilot Plants	Upgrading training colleges and establishing pilot plants in origin countries. Supporting returnees to launch recycling startups and green businesses.	Reduces landfill dependency in home countries. Stimulates domestic job creation and makes the origin country more attractive for green investment.
5. Recognized Skills	IOM, GCC accreditation, vendors	Developing a portable "Waste Technician" certificate covering waste-to-energy plant ops, recycling, e-waste, and logistics.	For Employers: Job-readiness on "Day 1" (handling complex recycling/WtE machinery). For Workers: A career passport that allows for mobility and higher wages.
6. Fair Mobility	Employers, recruitment agencies, IOM	Enforcing IRIS standards (zero worker-paid fees). Providing pre-departure (safety/contracts) and post-arrival orientation. Ensuring safe housing.	Protects worker rights and strengthens the GCC's reputation as a responsible employer. Reduces risks of unethical recruitment practices.
7. Migration Governance	Migration Agencies; Ministries of Interior/Labor;	Integrating SMPs into bilateral MoUs (e.g., Egypt/India → UAE/Saudi). Managing permits/visas for predictable cross-border mobility.	Creates legal, orderly pathways for migration. Ensures mutual recognition of credentials and ownership of the migration cycle.
8. Cost Reduction & Shared Financing	Employers; GCC Governments; Impact Investors; Climate Finance; Donors	Blended financing: Destination countries/investors fund technical training; Origin countries provide in-kind (labs, trainers).	Lowers training costs (conducted in origin). Distributes risk among stakeholders and delivers a higher ROI by producing a specialized, retained workforce.

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