TECHNICAL EDUCATION AND SKILLS DEVELOPMENT AUTHORITY

SKILLS NEEDS ANTICIPATION

WORKPLACE SKILLS AND SATISFACTION SURVEY (RENEWABLE ENERGY SECTOR)

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List of Abbreviations

4IR	Fourth Industrial Revolution
DOE	Department of Energy
REMB	Renewable Energy Management Bureau
IDB	Inter-American Development Bank
ESS	Energy Storage System
STEM	Science, Technology, Engineering, and Mathematics
ILO	International Labour Organization
SNA	Skills Needs Anticipation
TVET	Technical and Vocational Education and Training
COP	Conference of the Parties
UN	United Nations
NDC	Nationally Determined Contributions
GHG	Greenhouse Gasses
GW	Gigawatts
MW	Megawatts
DEA	Danish Energy Agency
MSU	Mindanao State University
TPES	Total primary energy supply
MTOE	Millions of tonnes of oil equivalent
AAGR	Average Annual Growth Rate
PEP	Philippine Energy Plan
RE	Renewable Energy
EEC	Energy Efficiency And Conservation
IRENA	International Renewable Energy Agency
CES	Clean Energy Scenario
NEECP	National Energy Efficiency and Conservation Plan

NREP	National Renewable Energy Program
PSOC	Philippine Standard Occupational Classification
GEOP	Green Energy Option Program

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EXECUTIVE SUMMARY

The Philippines has prioritized the utilization of renewable energy (RE) sources in order to diminish its reliance on fossil fuels and enhance its energy resilience. The Renewable Energy Act, implemented in 2008, was designed to encourage the advancement, usage, and commercialization of renewable energy sources. In 2021, the Department of Energy reported a 2.1% rise in the country's overall domestic energy production, primarily driven by substantial expansion in the renewable energy industry. In the same year, the power sector achieved significant progress in renewable energy, as worldwide renewable power capacity increased by more than 314 gigawatts (GW) in the global electricity mix. Policy backing for renewable energy sources remained robust, with 135 nations implementing various forms of targets to promote the use of renewable electricity, and 169 countries setting goals to enhance the adoption of renewable energy.

The Department of Energy in the Philippines has been promoting the establishment of additional renewable energy plants through the utilization of emerging technology, including Solar farms, Hydropower plants, and Biomass Production Plants. These power plants possess the benefit of increasing the capacity for generating power in the electrical grid, while also showing a high level of efficiency.

The Philippines has initiated efforts to enhance the utilization of renewable resources for energy generation, aiming to bolster the country's self-sufficiency. Efforts to enhance the facilitation of projects through legislation and programs that prioritize incentives for renewable industries have also stimulated the development of jobs. In 2011, the country initiated the National Renewable Energy Program (NREP) with the aim of expediting the advancement of renewable energy. Subsequently, in 2019, the Green Energy Option Program (GEOP) was established to promote the use of renewable energy among power consumers. In general, the legislation and measures that have been put into effect show the Philippines' dedication to encouraging the growth and utilization of renewable energy sources.

The Technical Education and Skills Development Authority, along with the Department of Energy (DOE) and its attached agency, the Renewable Energy Management Bureau as well as industry partners, organized various industry consultations to identify the current challenges, opportunities, and skills requirements in the renewable energy sector. These consultations were held in response to the implementation of renewable energy-related laws and programs. While it is crucial to determine the current skill needs, predicting future skill needs is vital for policymakers and educators to effectively plan policy and program development interventions. The implementation of a Skills Needs Anticipation through the Workplace Skills and Satisfaction (SNA-WSS) Survey can accomplish this.

The SNA-WSS Survey for the Renewable Energy Sector is particularly relevant due to the sector's objectives and targets, which emphasize the importance of skills development. This aligns with the Philippine Development Plan 2023-2028, which

underscores the necessity for the country to pursue its promotion of renewable energy sources and its affordable, accessible, reliable, and clean energy outcome. This aligns also the plans focus on the outcome on expanded access to employment opportunities through the anticipation of skills requirements in the priority sectors (including energy).

Methodology

- A descriptive cross-sectional design was used to characterize the variables involved in the study. Following this, probability sampling was employed to capture various representatives of the population. Particularly, stratified random sampling was used to identify the sample size per renewable energy technology, and circular systematic sampling to select the actual respondents who will participate in the study.
- The SNA Manual developed by TESDA with the technical assistance of the International Labour Organization (ILO) served as a basis for the development of the survey questionnaire.
- The questionnaire is subdivided into 12 sections: (1) Profile of the company, (2) Basic organizational background, (3) Critical human resources, (4) Skills in your business, (5) Emerging skills associated with industry developments, (6) Green jobs and the renewable energy sector, (7) Learning and development, (8) Work and employment practice, (9) Business strategy, (10) Work processes and technology, (11) Organizational performance, and (12) Workforce matters.
- Initially, six (6) renewable technologies were considered for the survey: Solar, Biomass, Hydropower, Geothermal, Wind, and Ocean. However, only three of these technologies - **Solar, Biomass, and Hydropower** - received enough responses to be included in the final data processing, cleaning, and analysis.
- Respondents were sampled from 112 operational/production plants owned by various associations/organizations involved in solar, biomass, and hydropower energy technology, such as the Philippine Solar Power Alliance. Philippine Solar and Storage Energy Alliance, Confederation of Solar Developers of the Philippines (CSDP), Biomass Renewable Energy Alliance, Inc. (BREA), and Philhydro Association, Inc. (PHILHYDRO).
- The Department of Energy - Renewable Energy Management Bureau (DOE-REMB) provided its support and commitment to the survey throughout the development and operation of the survey. The agency also provided a database of possible respondents.
- The entire value chain of the renewable energy sector, as identified by the International Labour Organization (ILO), was considered as the strata. The value chain includes the following segments: (1) Equipment Manufacture and Distribution; (2) Project Development; (3) Construction and Installation; (4) Operation and Maintenance; and (4) Cross-Cutting/ Enabling Activities.
- Furthermore, when determining the sample size for the three renewable energy technologies, renewable energy developers and plant operators were considered

as the potential respondents. Ongoing projects and existing plants were also evaluated as factors for selecting respondents.

- A substitution replacement was applied to the sampled units, using the developed guidelines in cases where the enumerators had difficulty contacting or obtaining cooperation. However, when all or almost all information of the sampled respondents is missing or cannot be found through various methods or the respondent declined participation, substitution is not applicable and treated as a nonresponse error.
- The survey yielded a final sample size of 89 operational/ production plants for the three identified renewable energy technologies.
- The survey was either self-administered online or administered by a researcher/enumerator over the phone. In both cases, the Jotform version of the questionnaire was utilized. Additionally, to prevent incomplete or invalid responses, participants who opted for the self-administered survey were contacted as necessary.
- For the proper implementation and standardization of the survey, the survey guide and JotForm guide were developed and disseminated to the participating operational/ production plants. The documents contain necessary reminders to help respondents navigate through the survey platform and the questionnaire.
- The survey was conducted from October 2023 to March 2024. The survey was extended until March 2024 due to the low response rate observed during the first data gathering period.
- The survey collected data from 25 participating operational/production plants. The validated responses were used to generate tabulations

Highlights of the Result of Study

1. **Profile of the Renewable Energy Sector**
   - Top occupational classification of employees across all three RE Technologies are Technicians and Associate Professionals (27.64%), Clerical Support (20.88%) and Professionals (19.22%).
   - The majority of jobs in all three renewable energy technologies are predominantly filled by men. Based on the responses, the distribution of women working in different renewable energy technologies is as follows: Solar (19.33%), Biomass (19.34%), and Hydropower (13.81%).
   - Moreover, when aligning the distribution of women and their corresponding occupation classification, most women working in the RE technology are classified in
   - Concerning employment status, all participating operational/production plants have high percentages of full-time/permanent workers. Specifically, solar technology has 85.87%, the biomass plant has 93.38%, and the hydropower plant has 90.61%. The percentage of part-time employees working in solar technology was 11.52%, followed by biomass technology at 6.62% and hydropower technology at 0.55%. Project-based employees had the smallest proportion or number of employees compared to other types of employees. Solar technology accounted for 2.60% , while hydropower accounted for 8.84% and biomass had none.

- In terms of the highest educational attainment, 61.09% or the majority of the employees for most of the operational/productional plants are College graduates followed by High school graduates (old curriculum or 10-year basic education) with 17.08%.
- In terms of the highest educational attainment per worker in each RE Technology, hydropower plants have the highest number of college graduates, which is 71.82%. It is followed by Solar plants with 67.66% and biomass plants with 51.65%.
- Concerning the age bracket, 41.87% of the workforce are aged 18 to 34, while 34.40% are aged 35 to 44, and 23.72% are 45 and above. Biomass operational/production plants have the highest percentage of the youngest workforce among other plants, with 44.02% of the workforce are in the 18-34 age bracket.
- Only 30.0% of solar operational/production plants are part of multinational companies. With all of the plant's main offices located in the Philippines.
- For all operational/production plants, the majority of employees earn a gross monthly salary above minimum wage to less than Php 26k.
- Solar and Biomass operational/production plants have reported that all of their TVET graduate workers are paid above the minimum wage, with salaries ranging up to Php 26K. According to respondents from the hydropower industry, their TVET graduates receive salaries ranging from Php 26k to Php 50k.
- Respondents in the solar and biomass technology sector reported that they pay TVET certified workers with salaries ranging from above the minimum wage to less than Php 26k per month. Only 86.36% of TVET certified workers receive salaries within the same range from the Hydropower industry.

2. Recruitment in the Renewable Energy Sector

- In terms of vacancies in operational/production plants, 58.49% are college graduates, followed by TechVoc course graduates, 23.66%, and High school graduates (old curriculum or 10-year basic education), 7.28%.
- Most or 40.40% of employees left the operational/production plants due to the resignation, and 36.42 left due to end of contract.
- In terms of technical-vocational education, only 9.49% are employed across the participating operational/production plants.
- By policy, more than 62.28% of the respondents require a college degree or higher while 20.43% require tech-voc graduate.
- Additionally, by policy, more than 61.56% of the positions require continuous learning or developmental activities), followed by at least 3 years of industry-relevant experience with 33.88% and continuous learning/developmental activities had the least percentage with 29.08%.

3. Attrition in the Renewable Energy Sector

- Most of the respondents mentioned that the reasons for fast turnover among operational/production plants are due to other local job opportunities and opportunity to Work Abroad
- In terms of turnover per RE Technology, biomass technology had the highest number of fast turnovers with 50.00%, followed by solar technology with 22.22%. Moreover, the Professionals have the highest percentage of occupational types with fast turn over closely, having 40% followed by 30.0%.
- Majority of the operational/production plants have identified jobs that are difficult to replace such as accountants, maintenance supervisors, plant equipment

specialists, technical workers, QA/QC personnel, pollution control officers, lab analyst, linemen, and chemical technicians.

4. Performance of Employees

- When it comes to underperforming employees, the Operational/Production Plants noted that only a few (3.24%) of their employees are unable to perform the job.
- Most respondents cited the reasons for having underperforming employees are the Lack of specialized and/or advanced technical skills for Renewable Energy, lack of soft skills, lack of management and leadership skills, management and lack of digital skills
- RE plants emphasize performance-related financial incentives, with high entitlement to bonuses (87.58% of plants, 93.94% of employees) and overtime pay (93.94% of plants, 89.41% of employees), alongside a balanced mix of non-pay benefits, internal promotions, and opportunities for long-term career development.

5. Current and Future Skills Demand

- About 43.94% of the respondents have retained their employee size from 2022 to 2023 while 34.70% said they decreased and 21.36% said they increased.
- The following skills were identified by a majority (above 50%) of respondents from the solar technology to be applicable which are Electricians specializing in solar, Photovoltaic System Installers, Commissioning engineer (electrical), Photovoltaic maintenance specialists (electricians specializing in solar), Electrical Engineers, Maintenance Electrician, Occupational Safety and Health, Management, and Administration.
- For biomass technology, the skills identified by more than 50% of respondents are Biomass Manufacturing engineers, Biomass Manufacturing technicians, Laboratory technicians and assistants, Chemical, biological mechanical and electrical engineers, Laboratory technicians and assistants, Operation and maintenance specialists, Biofuels Processing Technicians, Administration.
- For hydropower technology, the skills identified by more than 50% of respondents areDesign engineers (civil, mechanical, electrical, hydropower), Project designers (engineers), Hydropower Strategy Director, Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants), Economic/finance/ risk specialists, Physical and environmental scientists (hydrologists, geologists, ecologists), Market analysts, Land use negotiator, Civil Technicians, Electrical Technicians, Heavy machinery Operators, Welders, Construction Laborers, Transportation workers, Construction Manager / Engineer, Electrical Engineer, Mechanical Engineer, Mechanical Technicians, Plant workers, Management, and Administration
- Only one respondent from solar and biomass technology identified skills that are projected to have a surplus, while two respondents identified surplus skills in hydropower technology.

6. **Emerging Skills Associated with Industry Developments in the Renewable Energy Sector**
   - In terms of the Fourth Industrial Revolution, data gathered from the respondents shows that the majority of the identified emerging skills that are applicable are Solar photovoltaic (PV) power plants and Battery Energy Storage System (BESS), while Biomass technology identified only Biomass valorization as applicable. Hydropower technology respondents identified Hydropower flexibility, Hydropower digitalization, Generators with current-controlled, Energy storage and variable speed turbines, Fish-friendly hydropower technologies, and Energy Storage as applicable emerging skills in their industry.
   - In addition, respondents identified other types of skills such as Analytical Skills and innovation, Leadership, Environmental Specialist, Product Innovation, Material Science, and Digitalization Skills needed in their respective operational/production plants.

7. **Green Jobs in the Renewable Energy Sector**
   - The majority (more than 50%) of respondents had taken action through the creation/change of some jobs that contribute to decarbonization, protecting the ecosystem and biodiversity, reducing energy, materials and water consumption, and minimizing waste and pollution.
   - In terms of green jobs, the majority of the operational/production plants have organization provisions from any aspects of green jobs such as Tree Planting Activities, Policies and activities that assist in the preservation of biodiversity and water conservation, Pollution Control Officer, Safety Officers, Provision Of material recovery and among others.
   - A sizable percentage have received support or are seeking support from the government for green jobs (60.00% from Solar Operational/ Production Plants, while 50.00% and 54.00% from Biomass and Hydro Plants, respectively).
   - Only 10.0% from Solar respondents and 9.09% from Hydro plants received Tax incentives and/or import duties exemption programs, less compared to 25.00% Biomass participants.
   - Few of the participating operational/production plants have an awareness of emerging green skills and jobs, with biomass having the highest responses with 25.00%.

8. **Policies/Programs for the Employees in the Renewable Energy Sector**
   - Most operational/production plants (52.4%) said that their employees are able to perform the job, while only 3.24% are unable to perform the jobs assigned.
   - Reasons why employees are unable to perform the job in the Operational/production plants are the lack of basic renewable energy technology related skills, lack of specialized and/or advanced technical skills for renewable energy, lack of soft skills, and lack of digital skills.

- Operational/production plants have actions and interventions for underperforming employees such as review of appraisals / performance, conduct of re-training, conduct mentoring, and intensify supervision of staff.
- 84.55% of RE plants have a Training Plan, emphasizing the importance of employee training. Additionally, 67.58% have policies for developing high-potential staff, and 61.52% have a Training Budget, showing a commitment to workforce development.
- Most RE plants (79.24%) have a Business Plan, and 74.24% have Standard Operating Procedures, underscoring the importance of strategic planning and consistent operational practices. More than half (58.94%) conduct feasibility studies, ensuring project viability.
- A majority of RE plants (79.24%) have a Business Plan, and 74.24% have Standard Operating Procedures, underscoring the importance of strategic planning and consistent operational practices. More than half (58.94%) conduct feasibility studies, ensuring project viability.

9. Performance of TVET Graduates and/or TVET Certified Employees

- Among the TVET graduate employees, all respondents across all RE technologies have hired TVET graduates. However, the percentage of TVET graduates in their respective plants is relatively low: Solar (2.23%), Biomass (5.09%), and Hydropower (0.55%). This low share also holds for TVET certified workers: Solar (1.49%), Biomass (7.38%), and Hydropower (12.15%)
- Operational/production plants that have hired TVET graduates and TVET certified employees are generally pleased with their work and performance. Of the plants with TVET graduates as employees, 58.33% gave a satisfactory rating, while 41.67% gave a "very" satisfactory rating.
- Among employees with TVET certification, approximately 55.56% of respondents expressed satisfaction, while 44.44% expressed a high level of satisfaction.

CHAPTER 1
INTRODUCTION

The Energy sector plays a crucial role in supporting growth by providing the energy needed to power the country's industries, businesses, and households. Historically, the Philippines has relied heavily on imported non-renewable energy sources like fossil fuels, particularly oil and coal, to meet the country's needs. This reliance on imported fossil fuels has made the country vulnerable to fluctuations in global energy prices and limits the country's energy sources. An example of this is the impending depletion of the Malampaya natural gas fields, which has resulted in high electricity costs.

To address these challenges, the Philippines has promoted the development of renewable energy sources. In 2008, Republic Act No. 9513 or the Renewable Energy Act was enacted to promote the development, utilization, and commercialization of renewable energy sources. The act aims to reduce the country's dependence on fossil fuels and encourage the use of renewable energy sources such as solar, wind, geothermal, hydropower, and biomass.

The past few years have seen significant growth in the renewable energy sector in the Philippines. The Department of Energy's report on the Philippine Energy Situation showed an increase in the total indigenous energy production by **2.1%.** This increase included the support of hydro and other renewable energy sources (18%) despite the cuts in geothermal. Renewable energy plants also increased their gross power generation share by **22.4%** in 2021, a 1.16% percent uptick from **21.24%** last 2020.

With ongoing renewable energy policies and the continued push for a more self-sufficient energy sector, there has been a steady flow of local and international investments in the country. Notable investments include (1) the Asian Development Bank's approval of a **$300 million** loan for the Philippine Renewable Energy Project in 2014; (2) AC Energy (Ayala Corporation) announced in 2021 investments of about **$274 million** in renewable energy in the Philippines; (3) Citicore Renewable Energy Corp. is planning to fund a **$4 billion** investment in new solar projects over the next five years beginning in 2023; and (4) in January 2023, the Trade and Industry Secretary Alfredo E. Pascual announced an estimated **P1.031 trillion** worth of foreign investments in the Philippine renewable projects.

With the government's thrust and industry support, the Technical Education and Skills Development Authority (TESDA) has been performing its mandate of providing relevant skills training, certification, and accreditation. TESDA developed TRs related to machinery and other existing TRs in the Renewable Energy sector. Efforts to provide appropriate training programs are continuously conducted. In contrast, this study will be part of the process for the program and policy-making of TESDA and complement and continue the government's framework for the development of the Renewable Energy sector.

1.1. Objectives of the Study

Generally, this study intends to determine the employers' desired skills and competencies of its workers in the next 5 years and beyond, as well as to determine their level of satisfaction with the competencies and performance of TVET graduates in the Renewable Energy Sector.

The analysis of the survey results will provide information to bring TVET programs attuned to the needs of the labor market/industry and anticipation of the needed skills of the RE sector. This will provide information and evidence that can serve as a basis for the discussion and review of policies that can be formulated to improve and enhance the system.

- Provide quantitative measures on skills, e.g. skills gaps, skills shortages, and skills utilization in the workplace;
- Assess factors that are likely to impact on skills use;
- Identify emerging future skills; and
- Determine the satisfaction of employers on the competencies and performance of TVET graduates in the workplace.

1.2. Scope and Limitations of the Study

Initially, this study aims to cover all the renewable energy technologies that exist in the Philippines such as Geothermal, Hydro, Solar, Wind, Ocean, and Biomass Technology. However, due to the lack of response at the time of the survey, the study proceeded to focus only on three (3) out of the eight (8) identified RE Technologies, such as:

1. **Hydro**
    - Hydro or hydropower uses the natural flow of moving water to generate Electricity.

2. **Solar**
    - Conversion of sunlight into electrical energy, either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation.

3. **Biomass**
    - Biomass means it is made of material that comes from living organisms, such as plants and animals. Biomass can be burned by thermal conversion and used for energy. Thermal conversion involves heating the biomass feedstock in order to burn, dehydrate, or stabilize it.

    a. **Biofuel**
        - These are liquid or gaseous fuels made from biomass. They serve as a renewable alternative to fossil fuels in some parts of the world such as the EU in their transport sector. In the Philippines, **biodiesel** and **bioethanol** are the most common biofuels.

As agreed by the stakeholders during the WSS scoping meeting, the survey included all aspects of the renewable energy sector value chain, which are: (1) Equipment

Manufacture and Distribution; (2) Project Development; (3) Construction and Installation; (4) Operation and Maintenance; and (5) Cross-Cutting/ Enabling Activities.

The Operational/ Production Plants and the corresponding RE Technologies were used as the strata. The scope and descriptions of these RE Technologies were validated with the industry during the scoping and questionnaire validation meeting. A copy of the questionnaire was sent to those who attended the validation meeting for further comments and validations.

Additionally, if there are respondents that are involved in multiple RE technologies, the scope of the information must be limited only to the identified operational/ production plants location and Renewable Energy Technology. As such, the discussion of the results shall only cover the respondents of the participating operational/ production plant representing the specified location and Renewable Energy Technology. The list of respondents are provided by the Department of Energy - Renewable Energy Management Bureau (REMB).

This study focused on generating data/information relevant to the renewable energy sector's needed improvements nationwide. Desired outputs of this study include data on the current skill sets of the labor force; needed actions for improvement, i.e., mechanization/modernization; additional training, among others; and identifying new/emerging skills for further development. These were collected, tabulated, analyzed, and reported on some summary statistics.

CHAPTER 2
REVIEW OF RELATED LITERATURE

This chapter reviewed some of the research conducted and manuals published regarding SNA, particularly an Employer Skills Survey (ESS). The first subsection will provide insight into the importance of conducting an ESS or establishment survey, the areas of interest in this type of study, and the critical information to be included in the survey.

What follows is a brief discussion on the results of the conducted SNA-WSS Survey for the Information Technology and Business Process Management (IT-BPM) and Construction Industries conducted by TESDA with the consultancy from ILO, PSRTI, and the Department of Labor and Employment-Institute for Labor Studies (DOLE-ILS). A part of the discussion is some of the key recommendations from the two studies particularly on improving the conduct of the future SNA-WSS.

Lastly, to give the readers a better understanding and appreciation of the results of this study, background regarding the renewable energy industry is provided. It includes information regarding updates on the Economic Opportunities, Philippines Fuel Matrix Share, Renewable Energy related Laws and Policies and Type of Renewable Energy Technologies in the country.

2.1. Background on Designing an Employer or Establishment Skills Survey

A research paper published in 2016 in the Inter-American Development Bank (IDB) reviewed pieces of evidence from the United Kingdom, other countries, and regions "that have long experience in developing Energy Storage System (ESS)" (Hogarth, 2016). ESS is regarded as just one part of a larger, integrated labor market information system.

Although the research was originally intended to help countries in Latin America and the Caribbean, especially regarding the design of an effective and suitable survey, the results and insights from the paper are also useful for consideration in countries with no systematic approach yet to ESS.

According to Hogarth (2016), one of the important roles being played by ESS is its ability to demonstrate the skills demanded and evident shortages in the industry. CEDEFOP (2010 and 2015) as cited in Hogarth (2016) noted the gap in the demand and supply of skills in Europe, thereby increasing the concern for policymakers. This is particularly typical for Science, Technology, Engineering, and Math (STEM) subjects.

In terms of research interest, ESS aims to look at the skills demand, skills supply, employer or establishment's propensity to invest in training, employment status, wage levels, and educational attainment of workers. As implied, employers are the target respondents for this type of survey as they have a crucial role to play in determining job content and requirements, skills needs, and necessary qualifications and training, depending on industry demand.

Based on the conducted studies in Europe, the following are the core indicators recommended to be obtained from the survey (Hogarth, 2016):

- Characteristics of the workplace (e.g. total number of current employees including full time, part-time, permanent, part of a larger organization)
- Skills demand (e.g. number of employees by occupation, qualification level, wage level, vacancies)
- Skills supply (e.g. training to existing employees including training plan or budget, informal training activities; training to entry-level positions, external training market like the use of local training providers, and training costs)
- Skills imbalances (e.g. number of vacancies, hard-to-fill occupations, number of staff who are not fully competent and reasons, impact on future organizational performance)
- Product market position and organizational performance

In another related study, TESDA, through the assistance from the International Labour Organization (ILO) in 2019, considered other countries' best practices in Skills Needs Anticipation (SNA) in conducting the pilot of the workplace skills and satisfaction surveys in the Construction and Information Technology-Business Process Management. After

this pilot, TESDA was able to develop the SNA Framework for Philippine TVET (Technical Education and Skills Development Authority, 2021). The survey is just one of the methodologies applied for the SNA, with the expected outcome of identifying the skills requirements of a sector. The recommended content of the questionnaire based on this manual is consistent with the core indicators found in similar studies in Europe.

Figure 01. *Skills Needs Anticipation Framework*

Methodology	Tool	Result
Survey	Workplace Skills and Satisfaction Survey Tool	Skills Requirement of the Sector
Industry Consultation	Guide Industry Questionnaire	
Secondary Data	Philippine Development Plan	
	Industry Roadmap	
	JobsFit	
	Studies related to the sector	

Note: Based on the TESDA SNA Manual

2.2. Results of the 2019 and 2020 TESDA SNA-WSS Survey

TESDA piloted the SNA-WSS Survey for the IT-BPM and Construction Industries. Based on the experiences of these two studies, the following were some of the recommendations to enhance the conduct of the study:

- Strengthen the partnerships and data sharing agreements with involved industry associations
- Explore other data collection techniques
- Include qualitative methodology and information on the skills requirements
- Improve skills assessment by including the effect of the COVID-19 pandemic

These recommendations were considered in the development of the questionnaire and the data collection strategies for the Renewable Energy Sector (RE).

2.3. Renewable Energy Sector: An Overview

Global Status Report

The global push to shift to renewable energy resulted from a decades-long campaign by scientists and activists. These so-called “drivers” focused on advocacy for mitigating

climate change effects, the phase-out of fossil fuel in the energy sector, and increasing renewable energy generating facilities that would assist in energy security and cost-effectiveness. This worldwide movement culminated in the signing of the Paris Agreement at the UN Climate Change Conference (COP21) on the 12th of December 2015 by 196 Parties, including the Philippines.

The goal is to maintain a *"global average temperature of 2 degrees celsius industrial levels"* and pursue efforts *"to limit the temperature increase to 1.5 degree celsius above pre-industrial levels"* (UN, n.d.). The Philippines reiterated its commitment in the 26th Session of the Conference of the Parties (COP26), with the delegates particularly emphasized the country's Nationally Determined Contributions (NDC), in which the Philippines committed to a **75%** reduction in Greenhouse gas (GHG) emissions from its 2020 numbers; the country also aimed to increase renewable energy usage to **35%** to enable the "reduction" goals.

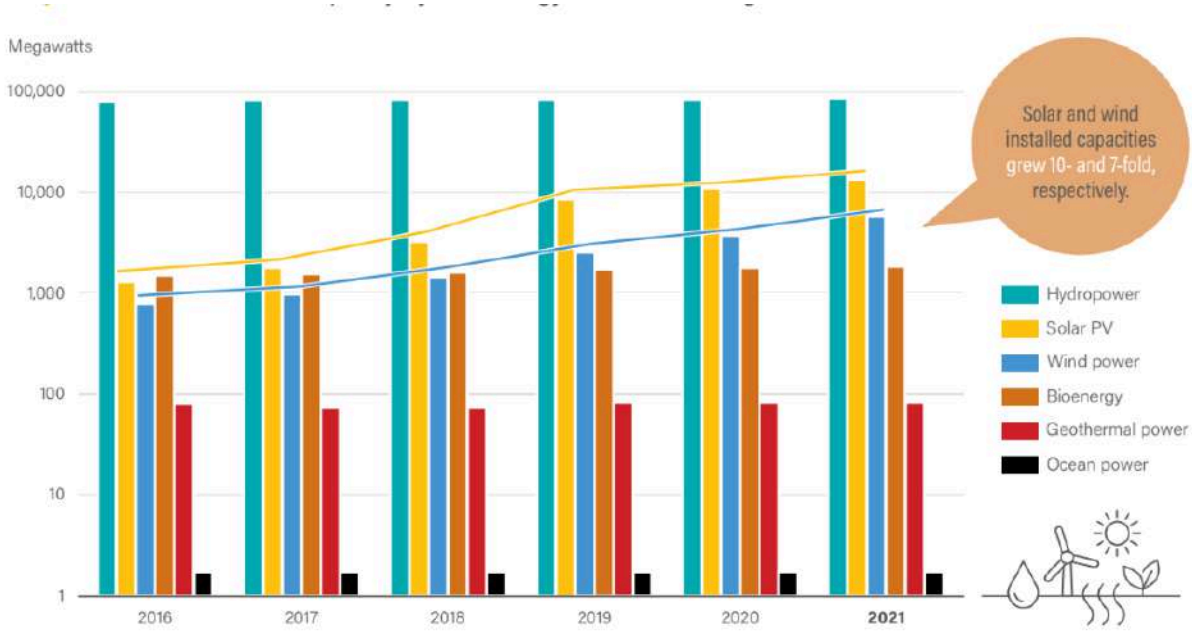
Figure 02. Renewable Indicators 2020 - 2021

INVESTMENT			
New investment (annual) in renewable power and fuels[1]	billion USD	342.7	**365.9**
POWER			
Renewable power capacity (including hydropower)	GW	2,840	**3,146**
Renewable power capacity (not including hydropower)	GW	1,672	**1,945**
Hydropower capacity[2]	GW	1,168	**1,195**
Solar PV capacity[3]	GW	767	**942**
Wind power capacity[4]	GW	745	**845**
Bio-power capacity	GW	133	**143**
Geothermal power capacity	GW	14.2	**14.5**
Concentrating solar thermal power (CSP) capacity	GW	6.2	**6.0**
Ocean power capacity	GW	0.5	**0.5**
HEAT			
Modern bio-heat demand (estimated)[5]	EJ	14.2	**14.0**
Solar hot water demand (estimated)[6]	EJ	1.5	**1.5**
Geothermal direct-use heat demand (estimated)[7]	PJ	462	**508**
TRANSPORT			
Ethanol production (annual)	EJ	2.2	**2.2**
FAME biodiesel production (annual)	EJ	1.4	**1.5**
HVO biodiesel production (annual)	EJ	0.2	**0.3**
POLICIES[8]			
Countries with renewable energy targets	#	165	**166**
Countries with renewable energy policies	#	161	**164**
Countries with 100% renewable heating and cooling targets	#	0	**0**
Countries with 100% renewable transport targets	#	0	**1**
Countries with 100% renewable electricity targets	#	25	**36**
Countries with heat regulatory policies	#	22	**26**
Countries with biofuel mandates[9]	#	65	**65**
Countries with feed-in policies (existing)	#	83	**92**
Countries with feed-in policies (cumulative)[10]	#	136	**144**
Countries with tendering (held in 2021)	#	33	**29**
Countries with tendering (cumulative)[10]	#	111	**131**

Source: United Nations Environment Programme (UNEP)

The report significantly stressed that the “greatest success” in renewables was in the power sector in 2021. It stated that global renewable power withstood the impacts of the Covid pandemic and grew its worldwide capacity, adding more than **314 gigawatts (GW);** thus, renewable energy comprised **28.3%** of the global electricity mix (Figure 02). Policywise, support for renewables remained strong throughout 2021, particularly in the power sector; about **135** countries had some form of renewable electricity target, and **169** countries had in place some type of target to increase the uptake of renewables
.

Figure 03. Global Investment in Renewable Power and Fuels, 20211-2021



Source: UNEP

In 2021, global renewable investment saw a record high hitting around USD 366 Billion (Figure 03) (UNEP, 2022). Solar photovoltaic (PV) and wind power continued to dominate in the amount of investment flow, with solar pv’s accounting for **56%** and window power for **40%**. Additionally compared to fossil fuel, renewable power installations continued to “attract” more investments accounting for **69%** of the total amount committed to new power generation capacity.

Success in renewable energy is achievable, an example is Denmark’s Renewable Energy development; the Danish Energy Agency (DEA) published its comprehensive report on its offshore wind development in 2022. The report touted Demark’s success in terms of being the leading country in offshore wind energy deployment in the North and Baltic Seas. The report also states that offshore wind power is more efficient in terms of output capacity versus onshore wind power, having a **5%** difference, producing power more than **80%** of the time “making it (offshore wind) a more stable source” for the

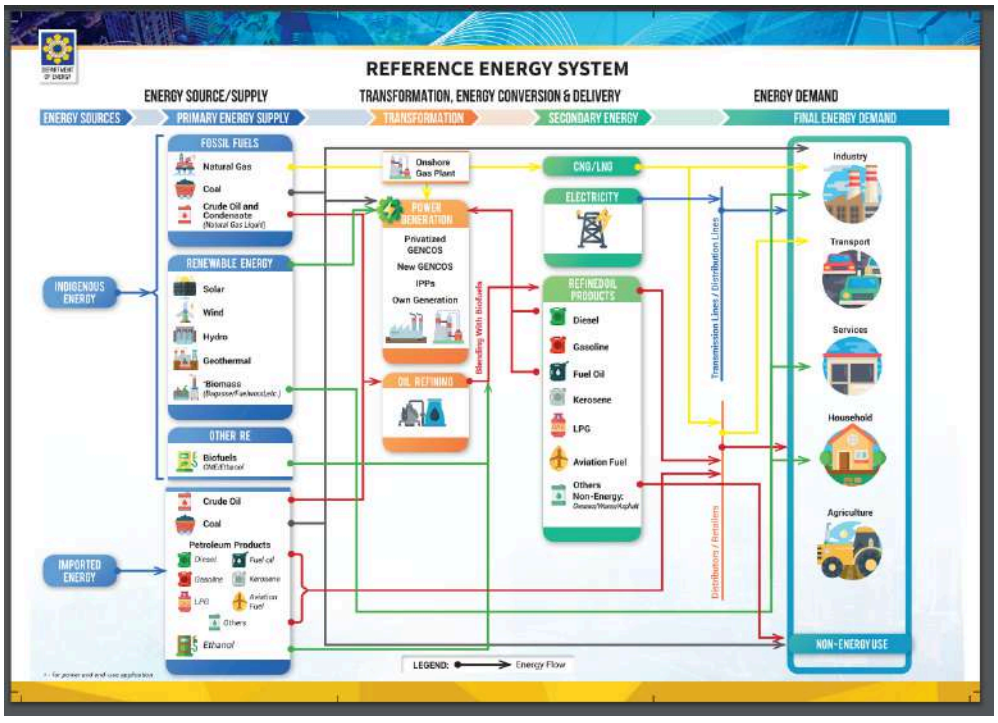
Danish transmission system operator (Offshore Wind Development, 2022). Denmark's offshore wind industry's shows that it had roughly created **75,000** jobs in Europe alone. Furthermore, based on the future plans of the industry, a projected **125,000** more jobs will be created by 2030.

Philippines' Renewable Energy

In the Philippines, the term "renewables" is mostly concentrated in the **Energy Sector** known as *renewable energy.* The past decade has seen the country's increased focus on renewable energy with the support of government initiatives via laws and programs further pushed the national move to a more sustainable and sufficient energy sector.

The Department of Energy (DOE), the main government office in charge of governing and developing policy within the country's power sector, has categorized the energy supplies into two groups: (1) *Net Imports Energy*, these are all energy forms that were sourced and imported from other countries, these are mostly comprised of fossil fuels; (2) *Indigenous Energy*, energy forms produced from within the country's natural resources, these group is comprised of a mix of fossil fuels and renewable energy forms.

Figure 04. Reference Energy System by the DOE

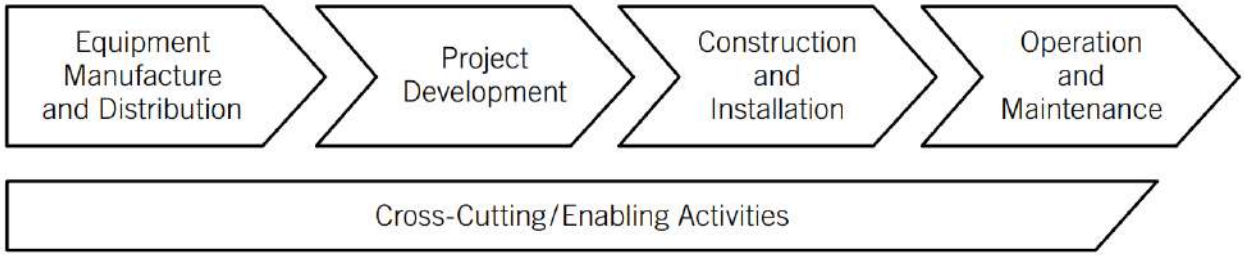


Source: DOE

In addition to the Energy System, the International Labour Organization in its report titled the *"Skills and occupational needs in renewable energy"* presented the whole value

chain system of the renewable energy which are: (1) Equipment Manufacture and Distribution; (2) Project Development; (3) Construction and Installation; (4) Operation and Maintenance; and (5) Cross-Cutting/ Enabling Activities, see figure 05.

Figure 05. Renewable Energy Sector Value Chain



Source: ILO

Going back to Renewable Energy Technologies, these are then further categorized by what resources the electricity is generated from, which are:

Geothermal	These are reservoirs of hot water that exist or are human-made at varying temperatures and depths below the Earth's surface.
Hydro	Hydro or hydropower uses the natural flow of moving water to generate electricity.
Solar	Conversion of sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation.
Wind	Wind turbines, collect and convert the kinetic energy that wind produces into electricity to help power the grid
Biomass	Biomass means it is made of material that comes from living organisms, such as plants and animals. Biomass can be burned by thermal conversion and used for energy. Thermal conversion involves heating the biomass feedstock in order to burn, dehydrate, or stabilize it.
Ocean	Ocean energy refers to all forms of renewable energy derived from the sea. There are three main types of ocean technology: wave, tidal and ocean thermal.

Apart from renewable energy in **power generation**, there are renewables in the form of **fuel** classified under **Biomass**, namely:

Biomass	
Biofuel	These are liquid or gaseous fuels made from biomass. They serve

a.) *Biodiesel*	as a renewable alternative to fossil fuels in some parts of the world such as the EU in their transport sector. In the Philippines, biodiesel and bioethanol are the most common biofuels.
b.) Bioethanol	

The Department of Energy has lobbied for the development of new renewable energy facilities that use innovative technologies, such as the approval of (1) **offshore wind farms**, (2) **ocean power plants**, and (3) **floating solar farms**, in addition to existing renewable energy plants. These types of power plants are now either awaiting approval or in the planning stages of the project.

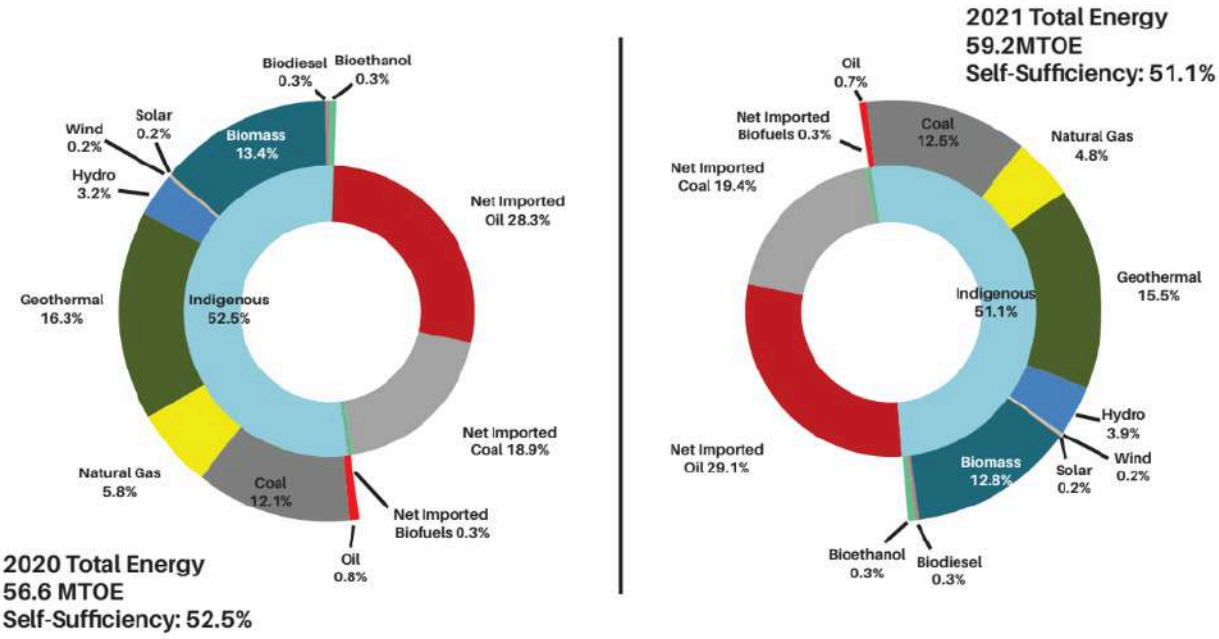
The only distinction between offshore wind and floating solar farms and other renewable energy plants is their location. Both, like traditional renewable power plants, use the same basic mechanism for converting natural resources into electricity. The utilization of these renewable technologies offers the advantage of increasing grid power generation capacity and being highly efficient.

For **Ocean power**, based on a study conducted by the Mindanao State University (MSU), the potential theoretical capacity for this resource is estimated to be about 170,000 MW. This is seen by the Philippine government as one of potential sources of renewable energy. The Department of Energy (DOE) has initially identified ocean energy potential sites including the Hinatuan Passage, Camarines, Northeastern Samar, Surigao, Batan Island, Catanduanes, Tacloban, San Bernardino Strait, Babuyan Island, Ilocos Norte, Siargao Island and Davao Oriental. The DOE has also awarded several contracts for ocean energy related projects starting in 2015.

Based on the DOE publication titled the 2021 Philippine Energy Situationer, the total primary energy supply (TPES) for 2021 reached **59.2 MTOE**, a **4.7 percent** slower rate compared to the previous year's output (DOE, 2021)

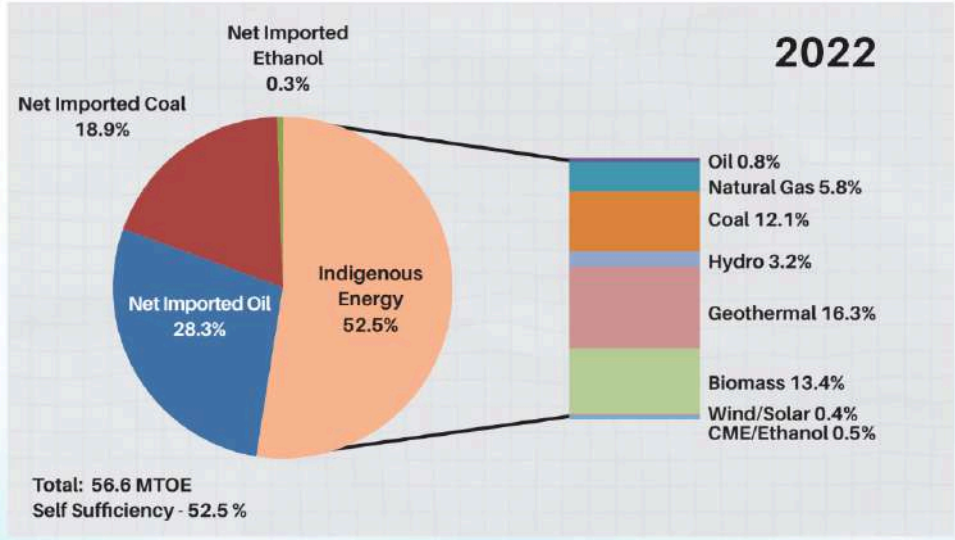
When analyzed (Figure 06), the total ner imported energy grew by **7.6 percent** versus the slower growth of the indigenous energy with only **2.1 percent** making up **51.1 percent** of the country's total energy. Furthermore, supply was boosted in renewable energy with an **18.0 percent** increase despite a **0.7 percent** decrease in geothermal energy.

Figure 06. Total Primary Energy Mix, By Fuel (% Share), 2020-2021



Source: 2021 Philippine Energy Situationer, DOE

Figure 07. Energy Mix, By Fuel (% Share), 2022



Source: 2022 Key Energy Statistics, DOE

In 2022, the Philippines reached about **52.5 percent** self-sufficiency meaning, most of the country's energy supply was generated by local (indigenous) resources (Figure 07). Geothermal energy made up a majority of the renewables, having a share of **16.3 percent**, followed by biomass energy at **13.4 percent** and Hydro with having **3.2 percent** share. Other renewable energy has smaller shares such as wind and solar have

a combined share of **0.4 percent** while the remaining shares were made up of biofuels (Figure 06).

In terms of oil consumption, biodiesel, and bioethanol (forms of biofuel) scored a positive average annual growth rate (AAGR) of **4.0 percent** and **13.0 percent** respectively from 2011 to 2021; both outperformed most fossil fuels except for gasoline (5.2 percent) and diesel (4.1 percent), see Figure 07. These numbers show that the country has moved, albeit slowly, towards having a "greener" and sustainable fuel supply.

Figure 07. Oil Product Consumption, by Type, 2011-2021

	2011	2012	2013	2014	2015	2016
Gasoline	23,185	23,938	24,957	25,833	29,667	32,630
Diesel	43,660	45,632	48,518	51,595	57,545	63,622
Fuel Oil	12,568	12,521	12,475	13,364	14,568	12,862
Aviation Fuel	10,845	11,432	12,049	12,463	13,086	14,879
LPG	12,624	12,434	12,714	13,073	14,842	16,926
Kerosene	1,041	971	947	860	811	777
Biodiesel	887	929	987	1,049	1,171	1,289
Bioethanol	1,216	1,935	2,496	2,765	3,168	3,477
Others**	830	1,198	2,345	3,501	8,368	8,954
Total	**106,857**	**110,991**	**117,489**	**124,503**	**143,226**	**155,414**

	2017	2018	2019	2020	2021	AAGR*
Gasoline	35,509	36,574	39,578	33,688	38,349	5.2%
Diesel	66,939	69,082	71,101	60,345	65,294	4.1%
Fuel Oil	11,719	9,335	8,530	7,303	7,047	-5.6%
Aviation Fuel	16,474	17,390	17,674	6,188	5,741	-6.2%
LPG	18,552	20,486	20,782	19,881	20,582	5.0%
Kerosene	767	638	587	537	565	-5.9%
Biodiesel	1,364	1,400	1,437	1,204	1,310	4.0%
Bioethanol	3,818	3,936	4,276	3,643	4,147	13.0%
Others**	11,397	9,964	7,851	9,228	11,387	29.9%
Total	**166,539**	**168,805**	**171,817**	**142,017**	**154,422**	**3.8%**

Source: DOE

Renewable energy in terms of installed capacity, had a positive average annual growth rate (AAGR) of **4.0 percent** from 2011-2021 (Figure 08). Solar had grown from 23 MW (megawatts) of installed capacity in 2011 to 1, **317 MW** in 2021, showing the most increase out of any other renewables with **78.0 percent** AAGR. Wind placed second with **29.0 percent** AAGR then followed by Biomass with **19.0 percent** while hydro and geothermal each had **1.0 percent** growth. With a positive average annual growth rate (AAGR) from the last decade, it is clear that the Philippines has started to focus on

expanding the number of renewable resources to generate electricity and increase the country's sufficiency.

	2011	2012	2013	2014	2015	2016
Total Installed Capacity	**16,162**	**17,025**	**17,325**	**17,944**	**18,765**	**21,423**
Coal	4,917	5,568	5,568	5,708	5,963	7,419
Oil	2,994	3,074	3,353	3,476	3,610	3,616
Natural Gas	2,861	2,862	2,862	2,862	2,862	3,431
Renewable Energy	5,391	5,521	5,541	5,898	6,330	6,958
Geothermal	1,783	1,848	1,868	1,918	1,917	1,916
Hydro	3,491	3,521	3,521	3,543	3,600	3,618
Wind	33	33	33	283	427	427
Solar[a]	1	1	1	23	165	765
Biomass	83	119	119	131	221	233

	2017	2018	2019	2020	2021	AAGR*
Total Installed Capacity	**22,728**	**23,815**	**25,531**	**26,250**	**26,882**	**5%**
Coal	8,049	8,844	10,417	10,944	11,669	**9%**
Oil	4,153	4,292	4,262	4,237	3,847	**3%**
Natural Gas	3,447	3,453	3,453	3,453	3,453	**2%**
Renewable Energy	7,079	7,227	7,399	7,617	7,914	**4%**
Geothermal	1,916	1,944	1,928	1,928	1,928	**1%**
Hydro	3,627	3,701	3,760	3,779	3,752	**1%**
Wind	427	427	427	443	427	**29%**
Solar[a]	885	896	921	1,019	1,317	**78%**
Biomass	224	258	363	447	489	**19%**

Figure 08. Installed Generating Capacity, by source, 2011-2021

Source: DOE

Based on the report from the International Renewable Energy Agency (IRENA) there are about **70,000** job opportunities created by renewable energy projects in the Philippines with Solar creating **15,000** jobs while biofuels and biomass came in second and third, generating about **14,900** and **14,000** jobs respectively. Geothermal energy placed fourth with about **11,000** jobs while hydropower followed with generating **8,000** jobs; Wind only generated about **5,000** jobs. Additionally, the overall growth of the economy can be attributed to the increased investment in renewable energy.

The most recent edition of the Philippine Energy Plan (PEP) 2020–2040 outlines an all-encompassing strategy for the Department of Energy (DOE) to achieve "inclusive and equitable economic growth" (DOE, 2020). The energy plan also includes the goal of mapping out a transformative path towards achieving a future powered by clean energy. Implementing policies that support aggressive institutional programs for renewable

energy (RE) and energy efficiency and conservation (EEC), along with additional measures, were listed as necessary to achieving this objective. Another important aspect of the energy plan is the presentation of the Clean Energy Scenario (CES), which allows the PEP to implement ambitious plans, regulations, and targets for renewable energy, natural gas, alternative fuels, and energy efficient technology in the Philippines:

Renewable Energy related targets presented in the Clean Energy Scenario

- **35.0 percent and 50.0 percent RE share** in the power generation mix by 2030 and 2040;
- **5.0 percent blending for biodiesel starting 2022**;
- **10.0 percent penetration rate of electric vehicles** for road transport (motorcycles, cars, jeepneys) by 2040;
- **At least 12.0 percent reduction in the GHG emission** for the Nationally Determined Contribution (NDC).

Source: Philippine Energy Plan 2020-2040

Another notable published plan by the Department of Energy (DOE), the National Energy Efficiency and Conservation Plan and Roadmap 2023-2050 (NEECP), is rooted in the enacted Energy Efficiency and Conservation Act, which lays out how the government intends to implement the law and “institutionalize energy efficiency and conservation as a national way of life” (DOE, n.d.), which reiterates part of the goals for the Philippine Energy Plan to continue current efforts to promote Energy Efficiency and Conservation (EEC) as a way of life.

The NEECP identifies the Technical Education and Skills Development Authority (TESDA) as a key stakeholder among government agencies, aligning with TESDA's responsibilities specified in the Energy Efficiency and Conservation Act.

As stated in the NEECP, TESDA shall:

- Collaborate along with the Department of Energy (DOE) and other training and service institutions to create training requirements for certifying energy efficiency and conservation officers.
- Ensure that the Technical Vocational Education and Training Programs will guarantee the promotion of energy efficiency methods and renewable technology.
- Carry out skills training, evaluation, and certification initiatives for mechanics, technicians, installers, and operators of energy-efficient and renewable energy systems.

Source: National Energy Efficiency and Conservation Plan and Roadmap 2023-2050

Renewable Energy Related Laws and Policies

The creation of jobs was spurred by the Philippine government's indication to better facilitate initiatives through laws and programs focused on incentives for renewable sectors. As mentioned previously, the Renewable Energy Act of 2008 and the Energy Efficiency and Conservation Act are two significant pieces of legislation to have been enacted by the government that concerns renewable and clean energy. Other energy related laws and policies have also added to the development of the country's energy sector

Biofuels Act of 2006

This law mandates the reduction of imported fuels and use of biofuels in the Philippines (Republic Act No. 9367, 2007). It aims to reduce the country's dependence on imported oil and to promote the use of locally-produced biofuels;

Renewable Energy Act of 2008

This law establishes the "framework" for the advancement and acceleration of renewable energy development as well as creates programs to increase renewable utilization (Republic Act No. 9513, 2008). It provides incentives for renewable energy projects, including tax exemptions, duty-free importation of equipment, and a feed-in tariff system;

Green Jobs Act of 2016

This law promotes the green skills identification and program development to train and certify workers in various industries for the transition of the country into a green economy (Republic Act No. 10771, 2016). It also encourages the creation of green jobs in the renewable energy sector.

Energy Efficiency and Conservation Act

The Department of Energy (**DOE)** implemented programs and initiatives in line with the enacted laws, such as: (a) Institutionalized energy efficiency and conservation to secure sufficient and stable energy supply, (b) Promotes the development and use of efficient renewable energy technologies; (c) Reinforces related laws for a comprehensive approach across energy-consuming sectors; and (d) Ensures a market-driven approach to energy efficiency and conservation.

(NREP)

This program was launched in 2011 to accelerate the development of renewable energy in the Philippines. It aims to increase the RE-based capacity of the country to an estimated 15,304 MW by the year 2030, almost triple its 2010 level.

Green Energy Option Program (GEOP)

This program was established in 2019 to promote the use of renewable energy among electricity consumers. It allows consumers to choose renewable energy sources, such as solar or wind power, as their energy suppliers.

Figure 05. A consumer guide on the Green Option Program (GEOP)

Source: DOE

Overall, the enacted laws and initiatives demonstrate the Philippines' commitment to promoting the development and use of renewable energy sources. This commitment is complemented by the continued investment by government and private entities to increase renewable energy power plants in the country. By providing incentives,

promoting green jobs, and mandating the use of renewable energy, these initiatives help to create a more sustainable energy future for the Philippines.

CHAPTER 3
METHODOLOGY

3.1. Research Methodology

The SNA-WSS Survey on Renewable Energy aims to provide information to Technical-Vocational Education and Training (TVET) stakeholders on the existing and in-demand skills in the Renewable Energy industry, which can help in the projection of potential future skills needs. This study can also be used as a supplement for policy revisions and strategy changes. The specific objectives of the study are:

- Identify qualification standards and skills certification needed to be designed for new and emerging skills/No Training Regulations;
- Provide quantitative measures on skills (e.g., skills gaps, skills shortages, skills utilization in the workplace); and,
- Assess factors that are likely to impact skills utilization.

3.2. Questionnaire

The research instrument, developed through the assistance of the ILO and used for the first two conducted SNA-WSS Survey, served as the basis for this survey questionnaire.

However, modifications were made based on the nature and characteristics of the Renewable Energy Sector and the conducted industry scoping to better cover the context of the industry. The developed questionnaire also underwent validation with the DOE and the industry related associations involved in the study to ensure accuracy and acceptability to the target respondents.

The questionnaire was divided into 12 sections, as listed below, to achieve the survey objectives. The descriptions from the technical report on the SNA-WSS Survey for the IT-BPM (Philippine Statistical Research and Training Institute, 2020) were adapted, with minimal modifications.

1. **Profile of the Company**
   This gathers information such as the position of the respondent, the name of the operational/ production plant, the location, and the subsector to which the operational/ production plant belongs.

2. **Basic Organizational Background**
   This section asks for information on the distribution of employees by occupational type and employment status, highest educational attainment, age group, and gross monthly salary (PhP). This also asks for the percentage of female employees and

gathers information on which operational/ production plants are part of multinational organizations and the location of their main offices.

3. **Critical Human Resources**

   This particular section asks about the status of employee size from 2021 to 2022, the expected change in employee size for the succeeding years, the presence of unfilled positions in the last six (6) months, whether or not the operational/ production plant has fast turnover and the occupational types that are difficult to retain, in addition to the reasons for fast turnover. Likewise, it inquires about the approximate percentage of employees who would be difficult to replace within three months if they resigned, as well as the top three jobs that would be difficult to replace in the event of resignation, the percentage of employees who left due to resignation, contract termination, or retirement, and the top three reasons for resignation.

   Moreover, this section gathers information on the percentage of vacancies in the operational/ production plant relative to education requirements, the number of employees promoted to managerial and supervisory positions, the presence of structured programs for high-potential employees, the percentage of employees with outstanding performance, and, the percentage of employees supported by career or structured planning policies or practices.

4. **Skills in the Business**

   For this section, respondents are asked on the percentage of employees according to their performance (able to perform the job, unable to perform the job, and have the potential to perform with more demanding duties), reasons behind poor performance and corresponding actions applied, whether actions were done for those with more potential and whenever applicable, the reason why no action was done.

   Correspondingly, the respondents were also asked about the percentage of all positions in the operational/ production plant that by policy require a college degree, two (2) to three (3) weeks of induction training, continuous learning or developmental activities, at least three (3) years industry-relevant experience, and technical vocational certificate or National Certificate. The number of additional employees needed for the succeeding years was also asked as well as the jobs or skills that either may have a shortage, no change, surplus, or will be hard to fill in the next five (5) years and whether those occupations/skills needs/requirements may be addressed by a TVET Program.

5. **Emerging Skills Associated with Industry Developments**

   This section contains questions on the emerging skills about the fourth industrial revolution and the new normal, and how likely those skills will impact skills demand in the next 1-5 years. This section also inquires about the readiness for the emerging

skills, actions undertaken by operational/ production plants who are ready, and preparations done for the human resource relative to the emerging skills.

6. **Green Jobs and the Renewable Energy Sector**
   Questions under this section include the extent of implementation of each operational/ production plant on various aspects of green jobs and provisions for any aspects of green jobs. The section also inquires whether the operational/ production plant has made use of the tax incentives or import duties exemption programs and has received support or is seeking support from any government agency, the name of the agency, the list of emerging skills identified relative to green job, and the relevance of the green industry developments to the current and near-future business needs in terms of knowledge, skills, and attitude.

7. **Learning and Development**
   This section seeks information such as the percentage of payroll expenditure allotted for training. It also seeks the operational/ production plant's rating of various training-related statements using a 5-point scale where 5 means "strongly agree" and 1 means "strongly disagree".

8. **Work and Employment Practice**
   For this section, questions are about the operational/ production plant's policies covering various documents (i.e. business, training, and staff development plans, training budget, and development for high potential staff), the percentage of full-time permanent and contractual employees entitled to various rewards or opportunities, and the extent of information sharing in the operational/ production plant's concerning financial information, business plans, operational challenges, and market analysis.

9. **Business Strategy**
   Under this section, the operational/ production plants were asked to rate various statements regarding the approach to business and the extent of implementation of actions for different areas of business development. Questions on plans of expansion in other areas of business development were likewise included.

10. **Work Processes and Technology**
    This section primarily focuses on gathering information on how up-to-date the operational/ production plant's core equipment that is being used in the production of goods and services compared to the best commonly available technology in the country and overseas.

11. **Organizational Performance**

This particular section asks about the status of outcomes such as profitability, total sales or revenue, and market share for the period 2020 to 2021. Moreover, it seeks information on the percentage of employees exhibiting various behaviors at work.

12. Workforce Matters

The last section of the questionnaire gathers information on the percentage of employees in the facility who are TVET graduates. Likewise, the operational/ production plants are asked to give satisfaction ratings on the work and performance of TVET graduates and TVET-certified employees.

The questionnaire was converted into an online survey, utilizing JotForm, an online and code-free application used to create custom online forms. Additionally, the online survey was used regardless of the survey method (researcher-administered or self-administered).

3.3. Sampling and Sampling Techniques

A total of 112 respondents were provided by DOE-REMB. Each respondent was either a renewable energy developer or power plant operator (company); these respondents were classified into only one type of Renewable Energy Technology. Renewable energy developers or power plant operators (company) were grouped into each of the three (3) RE Technologies (Solar, Biomass, and Hydro).

Stratified random sampling was used to identify the sample size per Renewable Energy Technology, and systematic circular sampling was used to select the actual respondents who would participate in the study. The unit of analysis used in this study is “operational/ production plant”.

Table 1.
Distribution of the Operational/ Production Plants by Renewable Energy Technology

Renewable Energy Technology	Number of Operational/ Production Plant
Solar Technology	48
Biomass Technology	17
Hydropower Technology	47
Total	***112***

Stratified random sampling was used to identify the sample size per Renewable Energy Technology, and circular systematic sampling to select the actual respondents who will participate in the study. Although RE Developers and plant operators (company) were

selected as the sample for the survey, the unit of analysis is the “operational/ production plants”. Thus, the respondent shall only talk about the operations for that particular RE Technologies operational/ production plant.

Although the endorsement and assistance of the associations were sought, contacting or obtaining cooperation from the respondents proved to be challenging. Thus, a substitution replacement was applied to the sampled units, using the developed guidelines.

When the enumerators had difficulty locating and/or identifying the sampled RE developers and plant operators (company) such that no responses were received via emails or phone calls, a substitution replacement was applied.

For follow-up calls, a 2-3 attempts rule was followed, made with at least 15-minute intervals or at different times of the day, before considering it as a one (1) day follow-up call. However, emails and calls made per day may not necessarily be done on consecutive days.

In the cases where all or almost all information of the sampled respondent is missing or cannot be found through various methods (i.e asking the association, desktop research), substitution is not applicable and it is treated as a nonresponse error. Respondents who also refused to participate in the survey due to various reasons such as hectic schedules and other operation-related reasons are considered nonresponse errors. Substitution cannot be applied so as not to result in a survey bias.

Thus, accounting for time and available resources, this study considered the nonresponse error as well as a 10% margin of error and 95% confidence level in calculating the sample size. As a result, the computation yielded a final sample size of 89 where 38 of which are in Solar Technology, 14 are in Biomass Technology and 37 are in Hydropower Technology as seen in Table 2.

Table 2.
Distribution of the Final Sample Size by Renewable Energy Technology

Renewable Energy Technology	Sample Size	Sample Size Percent Share
Solar Technology	38	42.70%
Biomass Technology	14	15.73%
Hydropower Technology	37	41.57%
Total	***89***	***100.00%***

3.4. Preparation for the Survey

The interviewer/enumerator manual previously used in the SNA-WSS Survey for the IT-BPM was adopted with some modifications following the changes in the 2021 questionnaire and data collection method.

Additionally, since most of the respondents will be accessing an online platform to answer the survey, a respondent guide was also developed to provide general instructions and reminders before and during the survey proper. Likewise, instructions are also provided for some specific questions that might require additional clarifications or reminders. Another reference material developed for the respondents is the JotForm guide. This guide contains directions on how to navigate the platform as well as some reminders and recommendations, particularly regarding common errors.

Further, before the conduct of the survey, a mail merge session was organized by the project team to capacitate the enumerators in efficiently creating and sending out letters and emails to the respondents. A database, which also served as the response monitoring sheet for the survey, was prepared to link mail merge functions to email.

3.5. Data Collection Strategies and Processes

The assistance of the Department of Energy - Renewable Energy (DOE-REMB) Team and all the industry associations participating in the study was critical in the data collection. Specifically, the database provided by the DOE-REMB provided complete details for all possible identified respondents from each of the three (3) RE Technologies.

Furthermore, the questionnaire was either researcher-administered via a recorded Zoom interview, call interview, or self-administered via an online application. In all cases, Jotform was utilized. For the RE developers and plant o farperators (company) that served as Zoom interview participants, the online survey link was also provided to give them ample time to prepare the documents/information needed, particularly for the basic organizational background section.

Although an interview is preferred for all respondents to ensure that any clarifications regarding the questionnaire will be answered, resources such as time and the number of hired enumerators, serve as limitations of the study. However, to prevent the survey response from being incomplete or invalid, respondents for self-administered questionnaires were contacted as necessary.

The survey team conducted the data collection from October 2023 to March 2024 and followed the data-gathering process as outlined below:

1. The survey team informed the involved industry associations that the team will start contacting their member plants.
2. An email invitation was sent to the sampled respondents containing guidelines for those who wish to participate in the survey including the mode of data collection,

subsector, online survey link and form password, and important reminders from the survey guide. The initial email contains the following attachments, for the respondent's reference:

- Invitation letter signed by the TESDA Deputy Director General;
- Endorsement letter from the associations (if applicable);
- Survey guide; and
- Consent form

3. The survey team made a series of follow-up emails and calls depending on the responses to the email invitation.
4. Once the facility agrees to participate, a subsequent email is sent containing the JotForm guide and key reminders before and after answering the link. Whereas, in the case of Zoom interviews, the schedule and meeting details are emailed as well.
5. If the respondents declined the invitation, reasons were noted to form part of the recommendations.

The assistance of the DOE-REMB Team was sought throughout the data collection process as contacting the RE developers and plant operators (company) proved to be challenging.

3.6. Editing, Encoding, and Analysis

The accomplished questionnaires were checked for errors or inconsistencies using the developed clarification guide. Once clarified and verified with the respondent, the database was cleaned as appropriate.

Moreover, some of the related responses were coded and combined to generate and correlate various indices. In this study, all of the indices have correlation values of less than 0.4 which means that each variable has all low degrees of correlation. Thus, tables and analysis of the indices are not included in the report.

Other generated tabulations and highlights are presented in the following chapters.

CHAPTER 4
RESULTS AND DISCUSSION

This chapter contains the survey findings in the form of summary statistics and tabulations, which are organized by section following the format of the questionnaire.

Several issues arose during the data collection, affecting the survey's response rate. Although most of the contact details provided by the Department Of Energy - Renewable Energy Management Bureau (REMB) are complete and accurate, one of the main challenges is the responsiveness of target respondents. Replacements were also

generated as necessary but provided this study's limitations alongside other factors, the survey still yielded low response rates.

A total of **25** out of the **89** computed sample sizes participated in the study, yielding an overall response rate of **28.09%, seen in Table 3.A**. Additionally, the response can be further subdivided based on the RE Technologies specialization.

Table 03. A.
Distribution of the Final Sample Size and Response Rate by Renewable Energy Technology

Renewable Energy Technology	Responses	% Response Rate
Solar Technology	10	26.32%
Biomass Technology	4	28.57%
Hydropower Technology	11	29.73%
Total	***25***	***28.09%***

As seen in Table 3.B, the responses from the solar technologies are subdivided into: (1) Roof Mounted; and (2) Ground Mounted Technology. For biomass, the responses were subdivided based on the type of fuel the operational/ production plant produced, which are: (1) Biodiesel; and (2) Bioethanol. Only Hydropower Technology respondents were not subdivided into any specialization.

Table 03. B.
Distribution of Participating Operational/ Production Plant Responses by Renewable Energy Technology and Sub-Renewable Energy Technology Specialization

Renewable Energy Technology	Sub-RE Specialization	Responses	% Response Rate
Solar Technology	Roof Mounted	9	23.68%
	Ground Mounted	1	2.63%
Biomass Technology	Bioethanol Producer	2	14.29%
	Biodiesel Producer	2	14.29%
Hydropower Technology	-	11	29.73%
Total		***25***	***28.01%***

The geographical distribution of the participating operational/production plants is given in Table 4. The table shows that Regions I, IV-B, and VIII have two types of operational/production plants for each Renewable Energy Technology. It should also be noted that no regions had operational/production plants in all three technologies

Based on specialization, most of the ground-mounted types of solar plants are located in Region III; Region IV-A has most of the participating bioethanol plants; and the Cordillera Administrative Region (CAR) has most of the participating hydropower plants.

Table 4.
Distribution of the Participating Operational/ Production Plant Locations by Region and Renewable Energy Technology

Region	Renewable Energy Technology				
	Solar		Biomass		Hydro
	Ground Mounted	*Roof Mounted*	*Bioethanol Producer*	*Biodiesel Producer*	-
CAR					36.4%
NCR				25.0%	
I	10.0%				9.1%
II	10.0%				
III	40.0%				
IV-A			75.0%		
IV-B	10.0%	10.0%			18.2%
VIII	10.0%				9.1%
IX	10.0%				
X					27.3%
Sub-Total	*90.0%*	*10.0%*	*75.0%*	*25.0%*	*100.00%*
Over All Total	***100.00%***		***100.00%***		***100.00%***

4.1. Basic Organizational Background

The survey follows the employee classification in the Philippine Standard Occupational Classification (PSOC), which categorizes employees into nine distinct occupational categories: The occupational categories are as follows:

1. **Managers** - workers that plan, direct, coordinate, and evaluate the overall activities of enterprises, governments, and other organizations, or organizational

units within them, and formulate and review their policies, laws, rules, and regulations.

2. **Professionals** - workers that increase the existing stock of knowledge, apply scientific or artistic concepts and theories, teach about the foregoing in a systematic manner, or engage in any combination of these activities.

3. **Technical and Associate Professionals** - workers that perform mostly technical and related tasks connected with research and the application of scientific or artistic concepts and operational methods, and government or business regulations.

4. **Clerical Support** - workers record, organize, store, compute, and retrieve information related; to and perform a number of clerical duties in connection with money-handling operations, travel arrangements, requests for information, and appointments.

5. **Service and Sales** - workers provide personal and protective services related to travel, housekeeping, catering, personal care, or protection against fire and unlawful acts, or demonstrate and sell goods in wholesale or retail shops and similar establishments, as well as at stalls and on markets.

6. **Skilled Agricultural** - workers grow and harvest field or tree and shrub crops, gather wild fruits and plants, breed, tend, or hunt animals, produce a variety of animal husbandry products, cultivate, conserve, and exploit forests, breed or catch fish and cultivate or gather other forms of aquatic life to provide food, shelter and income for themselves and their households.

7. **Craft and Related Trade** - workers apply specific knowledge and skills in the fields to construct and maintain buildings, form metal, erect metal structures, set machine tools, or make, fit, maintain and repair machinery, equipment or tools, carry out printing work produce or process foodstuffs, textiles, or wooden, metal and other equipment or tools, carry out printing work produce or process foodstuffs, textiles, or wooden, metal and other articles, including handicraft goods.

8. **Plant and Machine Operators, and Assemblers** - workers operate and monitor industrial and agricultural machinery and equipment on the spot or by remote control, drive and operate trains, motor vehicles, and mobile machinery and equipment, or assemble products from component parts according to strict specifications and procedures.

9. **Elementary Occupations** - involve the performance of simple and routine tasks which may require the use of hand-held tools and considerable physical effort.

According to Table 5, the participants in operational/production plants identified the top classifications as follows: Technicians and Associate Professionals at 27.64%, Clerical Support at 20.88%, and Professionals at 19.22%. In addition, Table 5 provides a comprehensive analysis of female employees. Out of all the employee classifications, Clerical Support had the highest percentage of female employees, making up 29.55% of the total employee distribution of 20.88%.

Craft and Related Trade Workers, Plant and Machine Operators and Assemblers, and Elementary Occupations had no female employees across all the participating operational/ production plants.

TESDA aims to develop policies and programs that improve the country's workforce's technical and vocational skills; this includes the Renewable Energy Sector. As such, the agency may consider employees identified as (1) Technicians and Associate Professionals,(2) Clerical Support, (3) Service and Sales Workers, (4) Skilled Agricultural Workers,(5) Craft and Related Trade Workers, (6) Plant and Machine Operators, and Assemblers, and (7) Elementary Occupations, in the RE sector as the size of the labor market who will benefit from the program.

Table 5.
Distribution of Operational/ Production Plant Employees by Occupational Type

Occupational Type	Distribution (%)	
	Total	Female %
Manager	11.74%	25.25%
Professionals	19.22%	22.22%
Technicians and Associate Professionals	27.64%	11.16%
Clerical Support	20.88%	29.55%
Service and Sales Workers	5.22%	29.55%
Skilled Agricultural Worker	0.36%	33.33%
Craft and Related Trade Workers	4.15%	0.00%
Plant and Machine Operators, and Assemblers	7.83%	0.00%
Elementary Occupation	2.97%	0.00%
Total	***100.00%***	***18.15%***

Table 6 indicates that all three renewable energy technologies have a significant proportion of workers classified as technicians and associate professionals. Specifically, Solar and Hydropower technologies have the highest percentages of technicians and associate professionals, with 31.97% and 34.81% respectively. On the other hand, clerical support workers have the highest percentages in biomass technology plants, accounting for 33.08%, while technicians and associate professionals come in second with 21.37%.

Table 6.
Distribution of Employees by Occupational Type per Operational Plant by Renewable Energy Technology

Renewable Energy Technology	Occupational Type									
	Managers	*Professionals*	*Technicians and Associate Professionals*	*Clerical Support*	*Service and Sales Workers*	*Skilled Agriculture Worker*	*Crafts and Related Trade Worker*	*Plant and Machine Operators, and Assemblers*	*Elementary Occupation*	*Total (%)*
Solar Technology	20.07%	23.42%	31.97%	12.27%	4.46%	0.37%	2.60%	0.00%	4.83%	*100.00%*
Biomass Technology	5.60%	10.43%	21.37%	33.08%	7.89%	0.00%	11.70%	7.89%	2.04%	*100.00%*
Hydropower Technology	12.71%	32.04%	34.81%	7.18%	0.55%	1.10%	7.18%	2.21%	2.21%	*100.00%*

In terms of the employment status of the workers in each of the participating plants, the survey focused on three types, (1) Full-Time or Permanent; (2) Part-Time; and (3) Project which are defined as:

- **Full-Time Regular Employment** applies to a person who works 40 hours or more during the reference week. A worker is paid on the basis of a time unit of work such as an hour, a day or a month.
- **Part-Time Employment** applies to a person who works less than 40 hours during the reference week and paid on the basis of a time unit of work such as an hour, a day or a month.
- **Project-Based Employment** applies to a person who has been hired for a specific project only and his employment is coterminous with the project.

Table 7 displays the distribution of employment status among all the plants included, revealing that the majority of workers are categorized as part-time employees. Permanent employees working full-time ranked second with 31.93%, while project-based employees accounted for 21.47%.

TESDA continues to push for a more women inclusive society in the TVET sector, as echoed in the 5th cycle of the National Technical Education and Skills Development Plan

2023 – 2028 under *"Strategic Pillar 2: Quality and productivity of workforce enhanced."* The strategic pillar emphasizes the importance of the agency expanding the availability of high-quality Technical and Vocational Education and Training (TVET), with a particular focus on various marginalized groups, including women, in order to promote gender equality and social inclusion.

With this, it is imperative to provide data results for women working in the participating operational/ production plants. Thus, the same table shows the percentages under each classification of employment status.

The data shows that women make up a small percentage of the workforce at operating/production plants—18.15% of all workers, to be exact. When compared to their overall percentage representation, the proportion of female employees in all classifications is low.

Table 7.

Distribution of the Employees by Employment Status

Employment Status	***Distribution %***	
	Female %	*Total %*
Full-Time/ Permanent	17.20%	90.39%
Part-Time	0.59%	6.88%
Project-Based	0.36%	2.73%
Total	*18.15%*	*100.00%*

When examining the employee percentages across different renewable energy technologies presented in Table 8, it is evident that the majority of workers in all technologies are classified as full-time or permanent employees. Out of all the technologies, biomass representatives had the highest percentage of full-time/permanent employees, with a notable 93.38%.

Table 8.
Distribution of the Employees by Operational/ Production Plants and Employment Status

Renewable Energy	**Employment Status**			
	Full-Time Permanent (%)	*Part-time (%)*	*Project Based %)*	*Total (%)*
Solar Technology	85.87%	11.52%	2.60%	*100.00%*
Biomass Technology	93.38%	6.62%	0.00%	*100.00%*

Hydropower Technology	90.61%	0.55%	8.84%	*100.00%*

Across the participating operational/production plants, the percentage of women employed is consistently low, as seen in Table 9. Only a small fraction, less than 20%, of all jobs are found in the various renewable energy technologies.

The solar energy representatives noted that the industry is known for its technical demand, which may explain the lower percentage of female workers. Another factor that could contribute to this percentage is that many women do not find the industry particularly appealing. The representatives from the hydropower energy industry agreed with the statements and also added that in the hydropower industry, there is a tendency for women to be less inclined to apply for jobs due to the remote locations of the sites. One additional point they mentioned is that hydropower plants as well as other plants operate around the clock (24/7).

The representatives pointed out that the majority of women employed in the factories hold positions in the support group and administration departments.

Table 9.
Percentage of Female Operational/ Production Plant Employees by Renewable Energy Technology

Renewable Energy Technology	%
Solar Technology	19.33%
Biomass Technology	19.34%
Hydropower Technology	13.81%

Regarding ownership (Table 10), only solar technology plants that are part of multinational organizations have been identified, accounting for 30.00%. All of the identified plant locations, 100.00% of them (Table 11), are located in the Philippines.

Table 10.
Percentage of the Operational/ Production Plants part of Multinational Organizations per Renewable Energy Technology

Renewable Energy Technology	%
Solar Technology	30.00%
Biomass Technology	0.00%
Hydropower Technology	0.00%

Table 11.
Distribution of the Multinational Operational/ Production Plants by Location of Main Office

Location	%
Philippines	100.00%
Overseas	0.00%

The survey also includes data on the workers' gross monthly salary, as shown in Table 12. According to the findings, about 43.22% of the plant's employees earn above the minimum wage but less than Php 26k, while around 27.64% of the employees receive a monthly salary ranging from Php 26k to less than Php 50k. These findings reflect the majority, around 70%, of the workforce employed in all the plants that participated.

Representatives from the solar energy sector highlighted the competitive salaries in the industry, which can be attributed to the continuous development of the sector, growing competition among developers, the demand for skilled and talented workers, and local lead initiatives.

Table 12.
Distribution of Operational/ Production Plant Employees by Gross Monthly Salary

Gross Monthly Salary (PhP)	%
Minimum wage or below	11.13%
Above minimum wage to less than 26,000	43.22%
26,000 to less than 50,000	27.64%
50,000 to less than 70,000	8.60%
70,000 or more	9.41%
Total	***100.00%***

Based on the information gathered from each renewable energy technology (Table 13), the findings are consistent with those from Table 12. There is a notable contrast in the percentages of employees receiving different salary ranges across various technologies. For solar technologies, the total percentage of employees falling within the salary range above the minimum wage but less than Php 26k and salaries of Php 26k to less than Php 50k is 57.25%. On the other hand, biomass technology plants have a higher percentage of employees in these salary ranges, totaling 82.96%. Participating hydro plants fall in between, with a total of 72.38% of employees falling within these salary ranges.

Table 13.
Distribution of the Operational/ Production Plant Employees by Renewable Energy Technology and Gross Monthly Salary

Renewable Energy Technology	Gross Monthly Salary (PhP)					
	Min. Wage or below (%)	*Above Min. Wage to 26K (%)*	*26K to 50K (%)*	*50K to 70K (%)*	*70K or more (%)*	*Total (%)*
Solar Technology	14.87%	**30.48%**	**26.77%**	11.15%	16.73%	*100%*
Biomass Technology	9.67%	**64.38%**	**18.58%**	3.05%	4.33%	*100%*
Hydropower Technology	8.84%	**34.81%**	**37.57%**	11.60%	7.18%	*100%*

The survey also looked into the operational/production plants' employing technical and vocational education and training (TVET) graduates and/or TVET-certified personnel, as well as the gross monthly salaries they earn. It also important to note that

The results gathered are presented in Table 14. A. The data shows the distribution of RE technologies that have employed both TVET Graduates and TVET-certified employees. In general, around 24.00% of all the plants that took part in the survey have employed TVET graduates, while approximately 32.00% have hired workers who are TVET Certified.

The majority of biomass operational/production plants, 75.00%, employ TVET graduates and TVET-certified workers. In comparison, 40.00% of solar plants hire TVET graduates, and 20% hire TVET-certified workers. The participation rate for hiring TVET graduates in hydropower plants is the lowest at 9.09%, while the percentage of TVET-certified workers is slightly higher at 36.36%.

Table 14.A.
Distribution of Participating Operational/ Production Plants that are employing TVET Graduates and TVET Certified per Renewable Energy Technology

Renewable Energy Technology	Percentage (%)	
	TVET Graduates %	TVET Certified %
Solar Technology	40.00%	20.00%
Biomass Technology	75.00%	75.00%
Hydropower Technology	9.09%	36.36%
Total	**24.00%**	**32.00%**

Note: Some of the Participating Operational/ Production Plants have employees that are both TVET Graduates and TVET Certified

Table 14. B shows the distribution of gross monthly salary for TVET graduates and TVET Certified by RE Technology. According to the data, TVET graduates employed by Solar and Biomass plants receive a monthly salary range of above the minimum wage to Php 26K. On the other hand, TVET graduates working in hydropower plants earn a monthly salary ranging from Php 26k to less than Php 50k.

TVET Certified workers in both Solar and Biomass plants receive a monthly salary range of above minimum wage to Php 26K. Most TVET certified workers hired by hydropower plants, approximately 86.36%, are receiving a salary range of above the minimum wage to Php 26K also.

Table 14. B.
Distribution of the TVET Graduates and TVET Certified Employees by Renewable Energy Technology, by Gross Monthly Salary

Renewable Energy Technology	Gross Monthly Salary (PhP)					
	Min. Wage or below (%)	*Above Min. Wage to 26K (%)*	*26K to 50K (%)*	*50K to 70K (%)*	*70K or more (%)*	*Total (%)*
TVET Graduates						
Solar Technology	0.00%	***100.00%***	0.00%	0.00%	0.00%	*100.00%*
Biomass Technology	0.00%	***100.00%***	0.00%	0.00%	0.00%	*100.00%*
Hydropower Technology	0.00%	0.00%	***100.00%***	0.00%	0.00%	*100.00%*
TVET Certified						

Renewable Energy Technology	Gross Monthly Salary (PhP)					
	Min. Wage or below (%)	*Above Min. Wage to 26K (%)*	*26K to 50K (%)*	*50K to 70K (%)*	*70K or more (%)*	*Total (%)*
Solar Technology	0.00%	***100.00%***	0.00%	0.00%	0.00%	*100.00%*
Biomass Technology	0.00%	***100.00%***	0.00%	0.00%	0.00%	*100.00%*
Hydropower Technology	**4.55%**	***86.36%***	**9.09%**	0.00%	0.00%	*100.00%*

Note: Some of the Participating Operational/ Production Plants have employees that are both TVET Graduates and TVET Certified

Questions were asked about the age distribution among workers at the participating plants, aiming to gather data on current employee demographics. The findings are presented in Table 15.A, showing a notable proportion of employees, approximately 41.87%, falling within the age range of 18-34. Similarly, 34.40% of employees belong to the age group of 35-44. Employees aged 45 and above make up the remaining distribution, accounting for 23.72%.

Table 15. A.
Distribution of the TVET Graduates and TVET Certified Employees by Renewable Energy Technology, by Gross Monthly Salary

Age Group	%
18 to 34	41.87%
35 to 44	34.40%
45 and above	23.72%
Total	***100.00%***

Following the analysis of results in Table 15. B, it is apparent that a significant portion of the workforce falls within the 18 to 34 age range with Biomass Technology having the largest share of 44.02%. It is also worth mentioning that the plants involved in the hydropower technology showed a relatively even distribution across all age groups.

Table 15. B.
Distribution of the Operational/ Production Plant Employees by Renewable Energy Technology and Age Group

Renewable Energy Technology	Age Group (years)			
	18 to 34 (%)	*35 to 44 (%)*	*45 and above (%)*	*Total (%)*

Solar Technology	42.75%	43.12%	14.13%	*100.00%*
Biomass Technology	44.02%	29.01%	26.97%	*100.00%*
Hydropower Technology	35.91%	33.15%	30.94%	*100.00%*

Table 16 shows the relationship between the current workforce age group and their respective employment status across the RE Technologies. The results show that most of the employees from all age groups are full-time/permanent employees across all the participating plants. It is also important to note that workers whose ages are 45 and above are all full-time/permanent employees.

Table 16.
Distribution of the Female Operational/ Production Plant Employees by Employment Status and Age Group

Age Group	Employment Status			Total
	Full time/ Permanent	*Part-time*	*Project Based*	
Age 18 to 34	94.57%	4.35%	1.09%	100.00%
Age 35 to 44	92.11%	2.63%	5.26%	100.00%
Age 45 and above	100.00%	0.00%	0.00%	100.00%

4.2. Critical Human Resources

Tables 17 to 19 show the distribution of the highest educational attainment of the operational/production plants that participated. In response to feedback from previous Workplace Skills and Satisfaction (WSS) Surveys, the questions regarding educational attainment were moved from the "*Basic Organizational Background*" section to the "*Critical Human Resources*" section. This adjustment allows for more effective and necessary input from survey participants.

Table 17 shows that overall, 61.09% of current employees from across the operational/production plants are college level graduates while High school graduates (old curriculum or 10-year basic education) are second largest with 17.08%. There are also employees that are either TechVoc course undergraduates (1.90%) or TechVoc course graduates (9.49%).

Table 17.
Distribution of the Operational/ Production Plant Employees by Highest Educational Attainment

Highest Educational Attainment	%
High school graduate (old curriculum or 10-year basic education)	17.08%
Junior high school graduate	0.12%
Senior high school undergraduate	0.00%
Senior high school graduate	0.83%
TechVoc course undergraduate	1.90%
TechVoc course graduate	9.49%
College level undergraduate	8.42%
College level graduate	61.09%
Master's degree	1.07%
Doctoral degree	0.00%
Total	***100.00%***

When the data for each renewable energy technology is broken down, the same results as shown in the previous table can be seen. According to Table 18, a majority of employees in all three RE Technologies have completed college-level education. Out of the three renewable energy technologies, the majority of employees in hydropower plants are college-level graduates, accounting for 71.82%. Solar plants have 67.66% of their workforce consisting of college-level graduates, while biomass plant workers have 51.65% who are college-level graduates.

Table 18.
Distribution of the Operational/ Production Plant Employees by Highest Educational Attainment and Renewable Energy Technology

Highest Educational Attainment	Renewable Energy Technology		
	Solar	*Biomass*	*Hydropower*
High school graduate (old curriculum or 10-year basic education)	23.05%	17.05%	8.29%
Junior high school graduate	0.37%	0.00%	0.00%
Senior high school undergraduate	0.00%	0.00%	0.00%

Senior high school graduate	0.00%	1.53%	0.55%
TechVoc course undergraduate	0.00%	3.56%	1.10%
TechVoc course graduate	2.60%	12.72%	12.71%
College level undergraduate	4.09%	13.49%	3.87%
College level graduate	67.66%	51.65%	71.82%
Master's degree	2.23%	0.00%	1.66%
Doctoral degree	0.00%	0.00%	0.00%
Total	***100.00%***	***100.00%***	***100.00%***

When analyzing the available vacant positions in operational/production plants, it is important to note that a majority, approximately 58.49%, require candidates to have a college-level education. There are also significant job openings, approximately 23.66%, that necessitate applicants to have completed a TechVoc course.

According to the Solar and Biomass representatives, college workers go through in-house training to further develop their entry-level skills. It was mentioned that the industry has its own programs for their employees. This was comparable to other renewable energy technologies. Solar industry is projected to further expand thus the need for skilled workers and professionals.

Table 19.
Distribution of the Vacancies in the Operational/ Production Plants by Required Educational Qualification, 2022 to 2023

Educational Qualification	%
High school graduate (old curriculum or 10-year basic education)	7.28%
Junior high school graduate	1.04%
Senior high school undergraduate	1.45%
Senior high school graduate	1.85%
TechVoc course undergraduate	0.61%
TechVoc course graduate	23.66%
College level undergraduate	4.74%
College level graduate	58.49%
Master's degree	0.67%
Doctoral degree	0.20%

Total	***100.00%***

Table 20 presents the distribution of job vacancies by RE Technologies. This table confirms Table 19's findings, which state that most positions require a college degree. While the percentage of college-level graduate requirement openings in hydro and solar plants is high—65.50% and 67.48%, respectively—the percentage in biomass plants is lower—42.50 percent. In biomass plants, the proportion of openings requiring a college degree is lower, yet it still makes up the majority. Moreover, biomass facilities have a higher percentage of open positions with TechVoc course requirements (35.50%) than participating solar and hydro plants (24.75% and 10.73%, respectively).

Table 20.
Distribution of the Vacancies by Renewable Energy Technology and Required Educational Qualification, 2022 to 2023

Required Educational Qualification	Renewable Energy Technology		
	Solar	*Biomass*	*Hydro*
High school graduate (old curriculum or 10-year basic education)	6.63%	11.50%	3.73%
Junior high school graduate	0.00%	0.00%	3.11%
Senior high school undergraduate	0.00%	0.00%	4.36%
Senior high school graduate	0.00%	5.00%	0.55%
TechVoc course undergraduate	0.00%	0.00%	1.84%
TechVoc course graduate	24.75%	35.50%	10.73%
College level undergraduate	3.13%	5.50%	5.59%
College level graduate	65.50%	42.50%	67.48%
Master's degree	0.00%	0.00%	2.00%
Doctoral degree	0.00%	0.00%	0.61%
Total	***100.00%***	***100.00%***	***100.00%***

According to the survey, a significant portion of operational/production plants reported that their employee size remained unchanged from 2022 to 2023. A smaller percentage (34.70%) indicated a decrease in employee size, while a minority (24.36%) experienced an increase.

Table 21.
Distribution of the Operational/ Production Plants by Status of Employee Size, 2022 to 2023

Status of Employee Size	%
Decreased	34.70%
Stayed the same	43.94%
Increased	21.36%
Total	***100.00%***

Looking at the employment sizes of various RE Technologies, Table 22 provides that each technology has distinct responses that differ from one another. When it comes to solar plants, approximately half of the respondents reported an increase in their employee sizes. In contrast, 75% of biomass respondents stated that their current pool of workers has increased. According to the data, the majority of hydropower respondents reported no change in their workforce from 2022 to 2023.

Table 22.
Distribution of the Operational/ Production Plants by Renewable Energy Technology and Status of Employee Size, 2022 to 2023

Renewable Energy Technology	Status of Employee Size			
	Decreased (%)	*Stayed the Same (%)*	*Increased (%)*	*Total (%)*
Solar Technology	20.00%	30.00%	50.00%	*100.00%*
Biomass Technology	75.00%	0.00%	25.00%	*100.00%*
Hydropower Technology	9.09%	81.82%	9.09%	*100.00%*

According to the operational/production plants that reported a decrease in employee sizes, the survey goes into the reasons behind the departure of these workers. Table 23 provides an overview of the main factors that lead workers to leave their employer, which comprises resignation, end of contract, termination of contract, and retirement.

Around 40.00% of the respondents mentioned resignation as their primary reason for leaving, closely followed by the end of contract at 36.42%. Only a small percentage of respondents cited termination of contact or retirement as the reason, resulting in a 10.60% and 12.58% share, respectively.

Table 23.
Distribution of Separated Employees from the Operational/ Production Plants by Reason for Leaving

Reason for Leaving	%
Resignation	40.40%
End of Contract	36.42%

Termination of Contract	10.60%
Retirement	12.58%
Total	***100.00%***

When disaggregated by RE Technology (Table 24), a significant percentage of respondents from the solar and biomass technology (78.95% and 51.72% respectively) mentioned resignations as the main cause for employee turnover at their plants. Although a significant portion (30%) of respondents in the hydropower technology industry mentioned resignation as their reason for leaving, the majority (48.54%) cited the end of their contract as the primary factor behind leaving the plant.

Table 24.
Distribution of Separated Employees by Operational/ Production Plants and Reason for Leaving

Renewable Energy Technology	**Reason for Leaving**				
	Resignation (%)	*End of Contract (%)*	*Termination of Contract (%)*	*Retirement (%)*	*Total (%)*
Solar Technology	78.95%	0.00%	0.00%	21.05%	*100.00%*
Biomass Technology	51.72%	17.24%	10.34%	20.69%	*100.00%*
Hydropower Technology	30.10%	48.54%	12.62%	8.74%	*100.00%*

In addition to inquiring about employee size and reasons for leaving, the survey also asked about the operational/production plant's turnover rate, specifically whether they have difficulty retaining workers for longer than six (6) months.

The representatives from the solar industry noted that one factor contributing to employee turnover is the reduced need for personnel in maintaining power plants. Additionally, many workers may choose to relocate for other job prospects. The majority of the representatives also expressed agreement with these statements.

According to the results presented in Table 25, it appears that there are differences among the different RE Technologies when it comes to fast turnovers. A small percentage of operational/production plants from both solar and hydropower (22.22% and 9.09% respectively) reported having fast turnover. Additionally, exactly half (50.00%) of the respondents using biomass technology indicated fast turnover.

Table 25.
Percentage of Operational/ Production Plants with Fast Turnover per Renewable Energy Technology

Renewable Energy Technology	%
Solar Technology	22.22%
Biomass Technology	50.00%
Hydropower Technology	9.09%

Furthermore, the participants who stated having fast turnover were asked to identify the type of occupation that has fast turnover according to the Philippine Standard Occupational Classification. The results are given in Table 26, where professionals accounted for the largest percentage of fast turnover at 40.00%, followed by service and sales workers at 30.00%.

The remaining occupations, which only received a 10.00% share each, were also claimed to have a fast turnover rate: technicians and associate professionals, plant and machine operators and assemblers, and craft and related trade workers.

Table 26.
Distribution of the Occupational Types with Fast Turnover

Occupational Type	%
Manager	0.00%
Professionals	40.00%
Technicians and Associate Professionals	10.00%
Clerical Support	0.00%
Service and Sales Workers	30.00%
Skilled Agricultural Worker	0.00%
Plant and Machine Operators, and Assemblers	10.00%
Craft and Related Trade Worker	10.00%
Elementary Occupation	0.00%
Total	***100.00%***

Note: This table was responded by operational/production plants who reported a fast turnover

The outcomes differ depending on which RE Technology. According to Table 7, respondents from the solar technology, professionals had the highest turnover rate. Meanwhile, 50% of participants from the biomass technology industry identified service and sales workers with fast turnover, and the choices for hydropower technology plants

were split evenly between professionals, craft and related trade workers, and plant and machine operators and assemblers.

Table 27.
Distribution of the Operational/ Production Plants by Occupational Types with Fast Turnover

Renewable Energy Technology	Occupational Type									
	Manager (%)	*Professionals (%)*	*Technicians and Associate Professionals (%)*	*Clerical Support (%)*	*Service and Sales Workers (%)*	*Skilled Agricultural Worker (%)*	*Craft and Related Trade Worker (%)*	*Plant and Machine Operators, and Assemblers (%)*	*Elementary Occupation (%)*	*Total (%)*
Solar Technology	0.00%	66.67%	0.00%	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	*100.00%*
Biomass Technology	0.00%	25.00%	25.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	*100.00%*
Hydropower Technology	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	33.33%	33.33%	0.00%	*100.00%*

Apart from asking about the fast turnover in each RE Technology, the questionnaire also asks about the reasons for this, which can be seen in Table 28. Additionally, the answers were not comparable, which might indicate that the workers left for different reasons and not just one.

Half of the people who said their operational or production business has high turnover (50%) said it was because workers were leaving because of the lack of career prospects. Low wage offered compared to other companies was given as the reason by 28.57% of those participants from the biomass plants. Hydropower respondents gave the same number of reasons as reasons for leaving: Unattractive working conditions, the location of the company or plant, and low pay compared to other companies.

Table 28.
Percentage of Operational/ Production Plants with Fast Turnover per Reason for the Difficulty in Retaining Employees

Reason	Renewable Energy Technology		
	Solar	*Biomass*	*Hydropower*
Low wage offered compared to other companies	25.00%	28.57%	33.33%

Reason	Renewable Energy Technology		
	Solar	*Biomass*	*Hydropower*
Geographical location of the firm/ plant	0.00%	14.29%	33.33%
Unattractive conditions of employment (e.g. risky job, etc.)	0.00%	14.29%	33.33%
Lack of career prospect	50.00%	14.29%	0.00%
Long working hours	0.00%	0.00%	0.00%
Unsocial hours (night shift)	0.00%	0.00%	0.00%
Not enough people who are interested in this type of work	0.00%	14.29%	0.00%
Staff are not interested in long term commitment	25.00%	0.00%	0.00%
Poaching	0.00%	0.00%	0.00%
Lack of access to training	0.00%	0.00%	0.00%
Shift to other employment opportunities locally or abroad (e.g. truck drivers turned taxi/PUV drivers, shift to other industry, etc.)	0.00%	14.29%	0.00%
Other reasons	0.00%	0.00%	0.00%

Note: Multiple responses were allowed.

Table 29 displays the distribution of current employees who pose a challenge to replace within a three-month timeframe after resigning. According to the findings, the majority of respondents in the hydropower sector expressed difficulty in replacing more than 50% of the three renewable energy technologies. In contrast, participants from the solar and biomass technology sectors reported an alternate point of view. The majority of respondents (40.00% and 75.00% respectively) stated that less than 10% of their current employees would be difficult to replace.

Some other reasons for resignations at the three RE Technologies include a lack of interest in long-term commitment from staff, concerns about the geographical location of the firm or plant, not enough people who are interested in this type of work, and the

conditions of employment being less than desirable, such as the inherent risks associated with the job.

Representatives from the hydropower industry emphasized the unique characteristics of each hydro power plant, which may result in different occupations being challenging to replace. However, overall, the representatives agreed with the findings. They emphasized the significance of having a succession plan in place for their employees, primarily because of the plant's long operational lifespan.

Table 29.
Percentage Distribution of Current Employees who would be Difficult to Replace Within Three Months from Resignation

Renewable Energy Technology	Percentage Distribution				
	None	*Less than 10%*	*10-50%*	*More than 50%*	**Total %**
Solar Technology	20.0%	40.0%	20.0%	20.0%	*100.0%*
Biomass Technology	0.0%	75.0%	25.0%	0.0%	*100.0%*
Hydropower Technology	18.2%	9.1%	9.1%	63.6%	*100.0%*

Table 30 displays an extensive list of job titles/positions that have been identified as challenging to replace in the event of resignation. The list of difficult jobs positions to replace is observed throughout the entire value chain of the renewable energy sector, encompassing construction, installation, operations, and maintenance. Some notable technical specific positions that have been identified include:

- Account And Administrative Officer
- Accounting Officer
- Chemical Technician
- Electrician
- Ground Workers
- Instrumentation Technician
- Lab Analyst
- Lineman
- Maintenance Helper
- Maintenance Supervisor
- O&M Supervisor
- Plant Accountant
- Plant Equipment Specialist
- Plant Superintendent
- Pollution Control Officers
- QA/QC Inspector
- Sales Personnel
- Supervisor
- Technical Workers
- WESM Compliance Officer

Table 30.
Identified Jobs that will be Difficult to Replace in Case of Resignation

Renewable Energy Technology	Jobs that are difficult to replace	
Solar Technology	● Account And Administrative Officer ● Accounting Officer ● Certified Engineer ● Chief Project Development And Execution ● Deputy Plant Manager ● Head Of Development ● Head Of Execution ● Human Resource Head	● O&M Supervisor ● Operation & Maintenance Head ● Plant Engineer ● Plant Manager ● Plant Superintendent ● Technical Head ● WESM Compliance Officer
Biomass Technology	● Chemical Engineering ● Chemical Technician ● Chemist ● Company Nurse ● Electrician	● Instrumentation Technician ● Lab Analyst ● Plant Accountant ● Sales Personnel ● Technical Operator

Renewable Energy Technology	Jobs that are difficult to replace	
Hydropower Technology	● Field QS Engineer ● Ground Workers ● Head Equipment Operator ● Lineman ● Maintenance Engineers ● Maintenance Helper ● Maintenance Supervisor ● Manager ● Mini-Hydro Power Plant Manager ● Operations Engineers ● Plant Engineer ● Plant Equipment Specialist	● Plant Manager ● Plant Superintendent ● PMS And Materials Control Engineer ● Pollution Control Officers ● Power Plant Operator ● Project Design Engineer ● Project Manager ● Project Manager/Supervisor ● QA/QC Inspector ● Shift Engineer ● Supervisor ● Technical Workers

In Table 31, it presents the reasons why workers resigned per RE technology. The most common reason for resignation is the choice for other local job opportunities as well as the opportunity to work abroad.

Table 31.
Identified Reasons for Resignation by Operational/ Production Plant

Renewable Energy Technology	Reasons for Resignation
Solar Technology	● Other Local Job Opportunities ● Opportunity to Work Abroad ● Health Reasons
Biomass Technology	● Other Local Job Opportunities ● Opportunity to Work Abroad ● Retirement
Hydropower Technology	● Opportunity to Work Abroad ● Seeking better Compensation ● Not available in relocation

Note: If there are NA then it means there are no responses

Questions were also asked about the percentage distribution of employees who were promoted to managers or supervisors. According to Table 32, the majority of operational/production plants in solar and biomass technology have adoption rates of 60.0% and 63.6% respectively. Additionally, 75.00% of biomass technology plants

reported promoting less than 10% of their employees to managerial or supervisory positions.

Table 32.
Distribution of the Employees Promoted to Managerial and Supervisory Positions per Renewable Energy Technology

Renewable Energy Technology	Percentage Distribution				
	None	*Less than 10%*	*10-50%*	*More than 50%*	*Total %*
Solar Technology	60.0%	10.0%	20.0%	10.0%	*100.0%*
Biomass Technology	0.0%	75.0%	25.0%	0.0%	*100.0%*
Hydropower Technology	63.6%	27.3%	9.1%	0.0%	*100.0%*

Note: The table only considered 2022 as the basis

Regarding corporate planning and policy that focuses on worker development, the survey asked operational and production plants about the percentage of workers benefiting from a structured succession planning policy. This policy aims to create a talent management plan that prepares a pool of trained workers to fill key roles when leaders and other key workers leave their positions.

The results are shown in Table 33, which indicates that while the percentage of employees supported varies, the majority of operational/production plants—88%—have some sort of career-structured succession planning in place for their workers. Approximately 24% of respondents stated that their employees receive less than 10% of their support, 20% said that their employees receive more than 50% , and 44.00% stated that their career-structured succession planning only covers 10% to 50% of their workforce. Only 12% of the participants stated that there is no career-structured succession planning in place at their operating/production plants.

Table 33.
Percentage Distribution of Employees Supported by Career/Structured Succession Planning Policy/Practices for Current and Future Development

Percentage Distribution	%
None	12.00%
Less Than 10%	24.00%
10-50%	44.00%
More than 50 %	20.00%

Total	***100.00%***

Table 34 shows the findings of the operational/production plants categorized by RE Technology. It provides that a significant portion, approximately 40.00%, of respondents in solar technology reported that 10% - 50% of their workers are covered by career-structured planning policies. This result was also observed among the majority (54.55%) of respondents in the hydropower technology sector. Approximately half, around 50.00%, of the participants from the biomass technology indicated that less than 10% of their workers were covered.

Further, respondents from biomass technology said that they have career-structured programs in place for their employees. However, a small percentage of respondents from solar and hydropower technologies, approximately 10.00% and 18.18% respectively, mentioned that they have not yet implemented a career structure succession program within their operational/production plants.

Table 34.
Percentage Distribution of Employees Supported by Career/Structured Succession Planning Policy/Practices for Current and Future Development per Renewable Energy Technology

Renewable Energy Technology	Percentage Distribution				
	None	*Less than 10%*	*10-50%*	*More than 50%*	*Total %*
Solar Technology	10.00%	20.00%	40.00%	30.00%	*100.00%*
Biomass Technology	0.00%	50.00%	25.00%	25.00%	*100.00%*
Hydropower Technology	18.18%	18.18%	54.55%	9.09%	*100.00%*

The survey highlighted the outstanding performances of certain employees, as shown in

Table 35. These individuals are recognized as high-potential, as they possess the ability to take on more challenging responsibilities. The findings reveal that almost 96% of operational/production plants reported that a significant portion, at least 10% above, demonstrated exceptional performance in their respective plants.

Out of this group, 12.00% of plants reported that less than 10% of their employees demonstrated outstanding performance. On the other hand, 36.00% of plants indicated that more than 50% of their workforce were outstanding performers. The remaining 48.00% of plants stated that the percentage of employees with outstanding performance fell between 10% and 50%. Only 4.00% of the respondents reported having no employees who stood out with outstanding performance.

Table 35.
Percentage Distribution of Employees Contributing Outstanding Performance to the Operational/ Production Plant

Percentage	%
None	4.00%
Less than 10%	12.00%
10-50%	48.00%
More than 50%	36.00%
Total	**100.00%**

After a review of these operational plants using their RE Technology, it is important to note that 50% of participants in the solar technology stated that between 10% and 50% of employees perform highly, while the remaining 50% reported that over 50% of employees perform outstandingly. While 10% to 50% of their employees exhibit outstanding performance, according to 54.55% of hydropower respondents. An additional interesting result was that, of the three RE Technologies, only hydropower technology reported to have no employees who consistently performed above and beyond expectations.

Table 36.
Percentage Distribution of Employees Contributing Outstanding Performance to the Operational/ Production Plants per Renewable Energy Technology

Renewable Energy Technology	Percentage Distribution				
	None	*Less than 10%*	*10-50%*	*More than 50%*	*Total %*
Solar Technology	0.00%	0.00%	50.00%	50.00%	*100.00%*

Renewable Energy Technology	Percentage Distribution				
	None	*Less than 10%*	*10-50%*	*More than 50%*	*Total %*
Biomass Technology	0.00%	0.00%	25.00%	75.00%	*100.00%*
Hydropower Technology	9.09%	27.27%	54.55%	9.09%	*100.00%*

Table 37 illustrates the percentage distribution of operational/production plants that have implemented structured programs for managing high potential employees. In many cases, plants have programs in place to effectively manage employees with high potential. A significant majority of respondents, 75.00% to be precise, from the biomass technology sector reported having programs set up to support high potential employees. This was closely followed by 54.5% of respondents from the hydropower sector, and approximately 50% of participants from the solar industry, all of whom also reported having some plans for high-potential employees.

Table 37.
Percentage of Operational/ Production Plants with Structured Program for Managing High Potential Employees by Renewable Energy Technology

Renewable Energy Technology	Percentage (%)
Solar Technology	50.0%
Biomass Technology	75.0%
Hydropower Technology	54.5%

Based on the data provided in Table 38, the survey includes a follow-up question where participants with structured programs are requested to provide the name of at least one program. It is worth mentioning that all three (3) RE Technologies have implemented programs aimed at training and upgrading the skills of their professional and technical workers, which is a notable aspect observed from the table below.

Table 38.
List of Structured Program for Managing High Potential Employees by Renewable Energy Technology

Renewable Energy Technology	Structured Program

Solar Technology	• Career path for Engineers • Individual Development Plan • Training & Development for high potential employees
Biomass Technology	• *S*afety Officers Career Structure Succession Planning • Training and upgrading
Hydropower Technology	• Employee Performance Management System • Management Training • Career Development through trainings and seminars • Training and Seminars

4.3 Skills in Your Business

Table 39 shows the percentages of employee evaluations for the participating plants. Based on the findings, it appears that approximately 96.76% of employees at the participating plants possess the necessary skills to carry out their current job responsibilities, and some may even have the capacity to take on more challenging tasks. A mere 3.24% of employees were found to be incapable of carrying out their job responsibilities.

Among the employees, 52.35% are considered capable of performing their current job tasks but not exceeding expectations, while 44.41% have the potential to take on more demanding duties than their current role.

Table 39.
Distribution of the Employees by Performance Evaluation

Performance Evaluation	%
Able to perform the job but not beyond	52.35%
Unable to perform the job	3.24%
Have the potential to perform with more demanding duties than they currently have	44.41%
Total	***100.00%***

Considering the different types of RE Technology that the plants belong to, the findings consistently show that a majority of employees from all three RE Technologies are categorized as workers who can fulfill their job responsibilities but not much more, see Table 40. Similarly, the second highest percentage of employees were identified as having the potential to handle more challenging tasks.

A small fraction of employees were found to be incapable of fulfilling the job requirements related to solar and biomass technologies.

Table 40.
Distribution of the employees by Renewable Energy Technology and performance evaluation

Renewable Energy Technology	Performance Evaluation			
	Able to perform the job but not beyond (%)	*Unable to perform the job (%)*	*Have the potential to perform with more demanding duties than they currently have (%)*	***Total (%)***
Solar Technology	47.10%	7.00%	45.90%	*100.00%*
Biomass Technology	57.50%	0.00%	42.50%	*100.00%*
Hydropower Technology	52.45%	2.73%	44.82%	*100.00%*

Despite a finding that only a small percentage of employees were identified as underperforming, the survey looked to figure out the reasons behind their lack of performance. According to Table 41, all respondents who have underperforming employees selected the lack of specialized and/or advanced technical skills for Renewable Energy as one of the main reasons. Another important factor mentioned by respondents in both solar and hydro technologies involves the lack of basic skills in renewable energy technology and soft skills such as communication, collaboration, teamwork, and socio-emotional abilities.

Table 41.
Percentage of Operational/ Production Plants with Underperforming Employees by Reason and Renewable Energy Technology

Reason	Percentage (%)		
	Solar	*Biomass*	*Hydropower*
Lack of basic Renewable Energy technology related skills.	66.67%		100.00%
Lack of specialized and/or advanced technical skills for Renewable Energy	100.00%		100.00%
Lack of soft skills (e.g. communication, collaboration and teamwork, socio-emotional, etc.)	66.67%		100.00%
Lack of management and leadership skills	0.00%		100.00%
Lack of office and admin skills	0.00%		0.00%
Lack of digital skills	66.67%		0.00%
Lack of industry specific STEM-related skills/competencies	33.33%		0.00%
Others	0.00		0.00%

Note: Multiple answers were allowed

Regarding the underperforming employees, the survey also inquired about any programs or interventions that the operational/production plant has implemented to enhance the abilities of these employees. Table 42 displays the percentage distribution of intervention implementation frequency across various operational/production plants. The data reveals that most plants, 75.00%, take certain measures when dealing with underperforming employees. These measures include conducting re-training, providing mentoring, and intensifying supervision of staff. Additionally, it was found that regular review of appraisals and performance is also applied by all respondents to underperforming employees.

Table 42.
Distribution of Operational/ Production Plants by Frequency of Implementation of Various Actions or Interventions for Underperforming Employees

Actions/Interventions	Percentage of Implementation			
	Never (%)	Sometimes of when necessary (%)	Always or regularly (%)	Total %
Increase training activity / spend or increase/expand trainee programs	75.00%	25.00%	0.00%	*100.00%*
Conduct of re-training	25.00%	0.00%	75.00%	*100.00%*
Reallocating work	100.00%	0.00%	0.00%	*100.00%*
Review of appraisals / performance	0.00%	0.00%	100.00%	*100.00%*
Conduct mentoring	25.00%	0.00%	75.00%	*100.00%*
Intensify supervision of staff	25.00%	0.00%	75.00%	*100.00%*
Other	0.00%	0.00%	0.00%	*0.00%*

Unlike underperforming employees, as shown in Tables 39 and 40, there is also a significant portion of workers who can take on more challenging tasks. The survey included additional questions regarding this growth potential. Table 43 displays the results of the actions and interventions implemented by operational/production plants to develop their high-potential employees by RE technology. It is shown that a significant proportion of plants from solar and biomass technologies, approximately 60.00% and 75.00% respectively, have taken measures to attract and retain top-tier employees.

Table 43.
Percentage of Operational/ Production Plants that have Undertaken Actions or Interventions to Employees with the Potential to Perform More Demanding Duties per Renewable Energy Technology

Renewable Energy Technology	%
Solar Technology	60.00%
Biomass Technology	75.00%
Hydropower Technology	36.36%

Learning and development, including training and mentoring, was the main focus for all operational/production plants (100.00%) when it came to supporting high potential employees, as indicated in Table 44. Additionally, a majority of the respondents implemented various other actions and interventions. However, only 8.33% of plants implemented job reassignment measures like rotation or deployment.

Table 44.
Percentage of Actions Undertaken or Interventions to Employees with the Potential to Perform More Demanding Duties by Operational/Production Plants

Actions and Interventions	%
Learning and Development (e.g., training, mentoring, etc.)	100.00%
Job reassignments (e.g., job rotation, deployment, etc.)	8.33%
Promotion	58.33%
Salary Increase	91.67%
Other incentives (e.g., travel, etc.)	58.33%

Table 45 supports Table 44 results, where all three RE Technologies plants have implemented learning and development programs for high-potential personnel.

Most solar technology respondents also said they gave their high-potential employees promotions, salary increases, and other incentives like reimbursements and travel expenses, similar to biomass and hydropower plants.

Table 45.

Distribution of Operational/ Production Plants by Frequency of Actions or Interventions to Employees with the Potential to Perform More Demanding Duties per Renewable Energy Technology

Actions/Interventions	Percentage Distribution (%)		
	Solar	*Biomass*	*Hydro*
Learning and Development (e.g., training, mentoring, etc.)	100.00%	100.00%	100.00%
Job reassignments (e.g., job rotation, deployment, etc.)	16.67%	0.00%	0.00%
Promotion	66.67%	50.00%	50.00%
Salary Increase	100.00%	100.00%	75.00%
Other incentives (e.g., travel, etc.)	66.67%	50.00%	50.00%
Others	33.33%	0.00%	25.00%

The survey also asked about the specific job policy requirements of the participating operational/production plant, as presented in Table 48. Most respondents indicated that their current job positions necessitate a college degree or baccalaureate education. Technical Vocational Education and Training (TVET) requirements ranked second with 20.43% among the participating operational/production plants. The combination of these two requirements accounts for approximately 82.71% of the responses provided by the participants.

Table 46.
Distribution of the Positions in each Operational/ Production Plants per Specific Policy Requirements

Requirements by Policy	%
No requirement	5.42%
Primary Education	0.83%
Secondary Education	9.22%
Technical Vocational Education and Training (TVET)	20.43%
Baccalaureate	62.28%

Post-baccalaureate (i.e., Master's degree, doctoral degree)	1.82%
Total	***100.00%***

When examining the answers based on the type of renewable energy technology, it is evident from Table 47 that the results for each operational/production plant remain consistent with the previous table. Most jobs require a Baccalaureate degree, followed by technical vocational education and training (TVET) requirements.

The hydropower plants had the highest percentage of jobs that require a baccalaureate degree, with 77.18%. On the other hand, 25.00% of positions in the biomass technology field require technical vocational education and training (TVET), which is the highest among the three technologies.

Table 47.
Distribution of the Positions in each Operational/ Production Plants per Specific Policy Requirements

Requirements by Policy	**Renewable Energy Technology**		
	Solar	*Biomass*	*Hydropower*
No requirement	15.00%	1.25%	0.00%
Primary Education	0.00%	2.50%	0.00%
Secondary Education	9.30%	15.00%	3.36%
Technical Vocational Education and Training (TVET)	18.30%	25.00%	18.00%
Baccalaureate	57.40%	52.25%	77.18%
Post-baccalaureate (i.e., Master's degree, doctoral degree)	0.00%	4.00%	1.45%
Total	***100.00%***	***100.00%***	***100.00%***

Table 48 displays the requirement policies related to the training of potential employees. A large portion of operational/production plants, 61.56%, reported implementing continuous learning/development activities, while only 29.08% of the plants mentioned having policies for induction training lasting more than two weeks before employees can start their assigned work.

Table 48.
Percentage of the Positions in each Operational/ Production Plants per Specific Policy

Requirements

Requirements by Policy	%
Induction training of more than two week before the post-holder can perform assigned work	29.08%
Continuous learning/developmental activities	61.56%
At least 3 years of industry-relevant experience to do the job	33.88%

Similarly to previous tables, the requirements for employee development are presented based on the responses of participants, categorized by their RE Technology. The results presented in Table 49 confirm the findings from the previous tables. Where most of the plants involved in each of the RE technologies have policies on continuous learning/developmental activities.

Table 49.
Percentage of the Positions in each Operational/ Production Plants per Specific Policy Requirements per Renewable Energy Technology

Requirements by Policy	Percentage (%)		
	Solar	*Biomass*	*Hydropower*
Induction training of more than two week before the post-holder can perform assigned work	33.60%	45.00%	19.18%
Continuous learning/developmental activities	63.60%	52.50%	63.00%
At least 3 years of industry-relevant experience to do the job	38.30%	25.00%	33.09%

Several plants provided additional actions and interventions for high-potential employees, which were not mentioned in the questionnaire. Additionally, only hydropower plants did not provide any other interventions.

Table 50.
Other Actions or Interventions for Employees with the Potential to Perform More Demanding Duties

Renewable Energy Technology	Others
Solar Technology	Performance Bonuses
Biomass Technology	Recognition Awards

Hydropower Technology	*N/A*

The following tables present the list of skills which are applicable to the specific renewable energy technologies and are categorized based on the sector's value chain.

Table 51.A shows the responses from operational/production plants specializing in solar technology. The results highlight the skills identified across the value chain. Based on the results, the following skills/jobs/qualifications that are applicable to most of the participating solar operational/production plants:

- Project designers (engineers)
- Photovoltaic System designer (electrical engineers or technologists)
- Electricians specializing in solar
- System designers (electrical/ mechanical/ structural engineers)
- Photovoltaic System Installers
- Software engineers
- Commissioning engineer (electrical)
- **Photovoltaic maintenance specialists (electricians specializing in solar)**
- Solar Energy Systems Engineers
- Electrical Engineers
- Maintenance Electrician
- Occupational Safety and Health
- Laborer
- Management
- Administration
- Health and safety consultants

It is important to note that the skills mentioned above were found to be applicable to over half of the respondents from solar technology. In addition, at least 50.00% of respondents also identified the following skills as skills projected to be in shortage as highlighted with **bold** format.

The representatives from various technology sectors shared their insights. Solar representatives highlighted the projected shortage of management in their industry, while hydropower plants emphasized their focus on hiring locally in the areas where their power plants are located. Biomass representatives generally agree with the identified skills, but they emphasize that certain skills, such as biomass manufacturing engineers, biomass manufacturing technicians, laboratory technicians and assistants, operation and maintenance specialists, and biofuels processing technicians, should be recognized as having shortage rather than skills with no change.

The industry has recognized that the recent increase in foreign investors and competitors has created a demand for skilled workers. The representatives from Solar explained that a majority of the foreign competitors operate within the Planning Development and

Plant Design value chain segment. Linemen were also recognized as highly sought-after due to the skills they possess, which are in high demand by international competitors.

Table 51. A.
Projected Distribution of the Skills Supply for the next 5 years - SolarTechnology

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
Equipment Manufacture and Distribution	Chemical laboratory technicians and assistants	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Software engineers	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Modellers	0.00%				*100.00%*		*100.00%*
	Manufacturing engineers	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Manufacturing technicians	20.00%		*10.00%*	*10.00%*	*70.00%*	*10.00%*	*100.00%*
	Manufacturing operators	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Building systems specialists	0.00%				*100.00%*		*100.00%*
	Manufacturing quality assurance experts	0.00%				*100.00%*		*100.00%*
	Logistics professionals	20.00%		*20.00%*		*80.00%*	*0.00%*	*100.00%*
	Logistics operators	10.00%		*10.00%*		*90.00%*		*100.00%*
	Equipment transporters	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Procurement professionals	20.00%		*20.00%*		*80.00%*		*100.00%*
	Marketing specialists	10.00%		*10.00%*		*90.00%*		*100.00%*
Project Development	Project designers (engineers)	50.00%		*50.00%*		*20.00%*	*30.00%*	*100.00%*
	Developers/ facilitators	30.00%	*10.00%*	*20.00%*		*40.00%*	*30.00%*	*100.00%*

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
	Environmental and social NGO representatives	40.00%	*10.00%*	*30.00%*		*30.00%*	*30.00%*	*100.00%*
	Procurement professionals	30.00%		*30.00%*		*40.00%*	*30.00%*	*100.00%*
	Seaman (Floating Solar)	0.00%						
`Construction and Installation	Solar Thermal System designer	20.00%	*10.00%*	*10.00%*		*70.00%*	*10.00%*	*100.00%*
	Plumbers specializing in solar	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Photovoltaic System designer (electrical engineers or technologists)	50.00%	*10.00%*	*40.00%*		*50.00%*		*100.00%*
	Electricians specializing in solar	70.00%		*70.00%*		*30.00%*		*100.00%*
	Roofers specializing in solar	20.00%		*20.00%*		*80.00%*		*100.00%*
	System designers (electrical/ mechanical/ structural engineers)	50.00%	*10.00%*	*40.00%*		*50.00%*		*100.00%*
	Photovoltaic System Installers	60.00%		*60.00%*		*40.00%*		*100.00%*
	Welders	30.00%		*30.00%*		*70.00%*		*100.00%*
	Pipe fitters	20.00%		*20.00%*		*80.00%*		*100.00%*
	Project Evaluators	20.00%	*10.00%*	*10.00%*		*70.00%*	*10.00%*	*100.00%*
	Software engineers	50.00%	*10.00%*	*40.00%*		*40.00%*	*10.00%*	*100.00%*
	Quality assurance specialists	30.00%		*30.00%*		*60.00%*	*10.00%*	*100.00%*
	Commissioning engineer (electrical)	60.00%	*10.00%*	*50.00%*		*40.00%*		*100.00%*
	Transportation workers	30.00%		*30.00%*		*60.00%*	*10.00%*	*100.00%*
	Seafarer/ Seaman (Floating Solar)	0.00%						*0.00%*

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
Operation and Maintenance	Photovoltaic maintenance specialists (electricians specializing in solar)	70.00%	*70.00%*			*30.00%*		*100.00%*
	Solar Thermal maintenance specialists (Plumbers specializing in solar)	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Concentrated Solar Power maintenance specialists	30.00%		*30.00%*		*60.00%*	*10.00%*	*100.00%*
	Inspectors	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Recycling specialists	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Building inspector	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Sales occupations	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Sales representatives or estimators	20.00%		*20.00%*		*80.00%*		*100.00%*
	Solar Thermal Installers and Technicians	30.00%		*30.00%*		*60.00%*	*10.00%*	*100.00%*
	Solar Energy Systems Engineers	50.00%		*50.00%*		*40.00%*	*10.00%*	*100.00%*
	Electrical Engineers	90.00%		*90.00%*		*10.00%*		*100.00%*
	Energy Auditors	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Building-Wiring Electrician	0.00%				*60.00%*		*60.00%*
	Residential/Commercial-Wiring Electrician	10.00%		*10.00%*		*80.00%*	*10.00%*	*100.00%*
	Maintenance Electrician	70.00%		*70.00%*		*30.00%*		*100.00%*
	Occupational Safety and Health	80.00%		*80.00%*		*20.00%*		*100.00%*
	Laborer	50.00%		*50.00%*		*50.00%*		*100.00%*

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
	Pile-driving and drilling	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
	Environmental Science Professionals	20.00%		*20.00%*		*70.00%*	*10.00%*	*100.00%*
Cross-Cutting/ Enabling Activities	Trade association and professional society staff	0.00%				*100.00%*	*100.00%*	*200.00%*
	Management	100.00%	*20.00%*	*70.00%*	*10.00%*			*100.00%*
	Administration	90.00%	*10.00%*	*70.00%*	*10.00%*	*10.00%*		*100.00%*
	Publishers and science writers	0.00%				*90.00%*	*10.00%*	*100.00%*
	IT professionals	40.00%		*40.00%*		*50.00%*	*10.00%*	*100.00%*
	Health and safety consultants	50.00%		*50.00%*		*40.00%*	*10.00%*	*100.00%*
Other jobs	Solar Operation & Maintenance Worker	10.00%	*10.00%*					

Table 51. B provides an overview of the responses gathered from the operational/production plants involved in Biomass Technology. Based on the results presented, it is evident that there is a wide array of skills that are relevant and specific to each renewable energy value chain segment. Specifically, the biomass participants indicated that the following skills are applicable to their respective operational/production plants, with at least 50.00% of respondents agreeing.

- Biomass Manufacturing engineers
- Manufacturing quality assurance specialists
- Biomass Manufacturing technicians
- Quality assurance specialists
- Logistics professionals
- Marketing specialist
- Sales workers
- Procurement professionals
- Environmental engineers
- Laboratory technicians and assistants
- Chemical, biological mechanical and electrical engineers
- Transportation workers
- Operation and maintenance specialists
- Biofuels Processing Technicians
- Management
- Administration
- Health and safety consultants

Furthermore, the examination of the responses showed that none of the skills were identified by more than 50% of the respondents as being in short supply in the upcoming five years. Representatives from Biomass noted that engineers play a crucial role in the plant, performing a wide range of activities. They also mentioned that there is a shortage of engineers and licensed professionals in the industry.

Table 51. B.
Projected Distribution of the Skills Supply for the next 5 years - Biomass Technology

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
Equipment Manufacture and Distribution	Biomass Manufacturing engineers	75.00%		75.00%			25.00%	*100.00%*
	Manufacturing quality assurance specialists	50.00%	25.00%	25.00%		25.00%	25.00%	*100.00%*
	Biomass Manufacturing technicians	75.00%		75.00%			25.00%	*100.00%*
	Quality assurance specialists	50.00%	50.00%				50.00%	*100.00%*
	Logistics professionals	50.00%		50.00%		25.00%	25.00%	*100.00%*
	Marketing specialist	50.00%		50.00%		25.00%	25.00%	*100.00%*
	Sales workers	50.00%		50.00%		25.00%	25.00%	*100.00%*
Project Development	Resource assessment specialists	0.00%				75.00%	25.00%	*100.00%*
	Project designers (engineers and scientists)	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Sustainability specialists	0.00%						*0.00%*
	Land use negotiators	0.00%						*0.00%*
	Communications specialists	0.00%						*0.00%*

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
	Environmental and social NGO representatives	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Public relations officer	0.00%						*0.00%*
	Procurement professionals	50.00%		50.00%		25.00%	25.00%	*100.00%*
Construction and Installation	Biochemists and microbiologists	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Environmental engineers	50.00%	25.00%	25.00%		25.00%	25.00%	*100.00%*
	Laboratory technicians and assistants	75.00%	25.00%	50.00%			25.00%	*100.00%*
	Chemical, biological mechanical and electrical engineers	75.00%	25.00%	50.00%			25.00%	*100.00%*
	Project designers and managers	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Software engineers	0.00%						*0.00%*
	Construction professionals	0.00%						*0.00%*
	General electricians, plumbers, roofers	25.00%			25.00%	50.00%	25.00%	*100.00%*
	General construction workers	25.00%			25.00%	50.00%	25.00%	*100.00%*
	Business developers	0.00%						*0.00%*
	Commissioning engineer (electrical)	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Transportation workers	50.00%	50.00%			25.00%	25.00%	*100.00%*
Operation and Maintenance	Plant breeders and foresters	0.00%				75.00%	25.00%	*100.00%*
	Biomass production managers	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Agricultural Machinery Collection Operators	0.00%				75.00%	25.00%	*100.00%*
	Agricultural Machinery Collection Servicing	0.00%				75.00%	25.00%	*100.00%*

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
	Forestry workers	0.00%				75.00%	25.00%	*100.00%*
	Transportation workers	50.00%	50.00%			25.00%	25.00%	*100.00%*
	Laboratory technicians and assistants	75.00%		75.00%			25.00%	*100.00%*
	Operation and maintenance specialists	75.00%		75.00%			25.00%	*100.00%*
	Biomass Plant Technicians	0.00%						*0.00%*
	Biomass Power Plant Managers	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Biofuels Processing Technicians	75.00%		75.00%			25.00%	*100.00%*
	Biofuels/Biodiesel Technology and Product Development Managers	25.00%		25.00%		50.00%	25.00%	*100.00%*
	Design Engineer	0.00%						*0.00%*
	Contract Analyst	0.00%						*0.00%*
Cross-Cutting/ Enabling Activities	Biomass Technology Training/ Trainers	0.00%						*0.00%*
	Biopower Transmission and Distribution	0.00%						*0.00%*
	Trade association and professional society staff	0.00%						*0.00%*
	Management	50.00%		50.00%		25.00%	25.00%	*100.00%*
	Administration	75.00%		50.00%	25.00%		25.00%	*100.00%*
	Publishers and science writers	0.00%						*0.00%*
	IT professionals	25.00%		25.00%				*25.00%*
	Health and safety consultants	50.00%	25.00%	25.00%		25.00%	25.00%	*100.00%*
Other jobs	Instrumentation Technician			25.00%				
	HVAC Technician			25.00%				

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
	Plant Mechanic			25.00%				
	Electrician			25.00%				
	Chemical Technician			25.00%				
	Mechanical Engineer			25.00%				
	Electrical Engineer			25.00%				

Table 51. C displays the data on the projected skills supply for the next 5 years pertaining to operational/production plants in the field of Hydropower Technology. The findings indicate that a significant portion, at least 50.00%, of the respondents from hydropower plants possess skills that can be applied in their respective operational/production plants:

- Design engineers (civil, mechanical, electrical, hydropower)
- Quality assurance specialists
- Marketing specialists
- Sales workers
- Project designers (engineers)
- Hydropower Strategy Director
- Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)
- Economic/finance/ risk specialists
- Physical and environmental scientists (hydrologists, geologists, ecologists)
- Market analysts
- Land use negotiator
- Archaeologists
- Civil Technicians
- Mechanical Technicians
- Electrical Technicians
- Heavy machinery Operators
- Welders
- Pipefitters
- Construction Laborers
- Transportation workers
- Construction Manager / Engineer
- Chemical laboratory technicians and assistants
- Electrical Engineer
- Electrical Technicians
- hydropower Plant Operator
- Hydrographer

- Hydropower Strategy Director
- Mechanical Engineer
- Mechanical Technicians
- Pipe fitters
- Plant workers
- Senior Energy Trader
- Management
- Administration

Upon further review, it was found that there are no skills expected to be in short supply in the next five years identified by more than half of the respondents.Industry representatives emphasized the importance of occupations that require specialized skills, particularly in the construction and installation segment. These skills include expertise in water tunneling, operating tunnel boring machines, and competence in drill and blast skills. The representatives added that only a small number of local companies provide programs and training related to the mentioned skill.

The representative also mentioned that many workers who develop these skills are often recruited by mining companies.

Table 51. C.
Projected Distribution of the Skills Supply for the next 5 years - Hydropower Technology

Value Chain	Areas of Skills/Jobs	Applicability	Changes %					
			Shortage	*No Change*	*Surplus*	*N/A*	*No response*	*Total*
Equipment Manufacture and Distribution	Design engineers (civil, mechanical, electrical, hydropower)	63.64%	*9.09%*	*45.45%*	*9.09%*	*27.27%*	*9.09%*	*100.00%*
	Modeller	36.36%	*9.09%*	*27.27%*		*45.45%*	*18.18%*	*100.00%*
	Software developers	27.27%	*9.09%*	*18.18%*		*54.55%*	*18.18%*	*100.00%*
	Manufacturing engineers	27.27%	*9.09%*	*18.18%*		*54.55%*	*18.18%*	*100.00%*
	Manufacturing technicians	36.36%	*9.09%*	*27.27%*		*45.45%*	*18.18%*	*100.00%*
	Manufacturing operators	45.45%	*9.09%*	*36.36%*		*36.36%*	*18.18%*	*100.00%*
	Quality assurance specialists	9.09%		*9.09%*		*72.73%*	*18.18%*	*100.00%*
	Marketing specialists	18.18%	*9.09%*	*9.09%*		*63.64%*	*18.18%*	*100.00%*
	Sales workers	9.09%		*9.09%*		*72.73%*	*18.18%*	*100.00%*
Project Development	Project designers (engineers)	63.64%	*18.18%*	*36.36%*	*9.09%*	*36.36%*		*100.00%*
	Hydropower Strategy Director	63.64%	*27.27%*	*27.27%*	*9.09%*	*36.36%*		*100.00%*
	Environmental engineer	45.45%	*36.36%*		*9.09%*	*54.55%*		*100.00%*

	Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)	54.55%	36.36%	9.09%	9.09%	45.45%		100.00%
	Economic/finance/ risk specialists	63.64%	36.36%	9.09%	18.18%	36.36%		100.00%
	Physical and environmental scientists (hydrologists, geologists, ecologists)	54.55%	36.36%		18.18%	45.45%		100.00%
	Market analysts	54.55%	27.27%	18.18%	9.09%	45.45%		100.00%
	Land development advisor	36.36%	18.18%	18.18%		63.64%		100.00%
	Land use negotiator	54.55%	27.27%	18.18%	9.09%	45.45%		100.00%
	Communications specialists	45.45%	9.09%	18.18%	18.18%	54.55%		100.00%
	Procurement specialists	45.45%	18.18%	18.18%	9.09%	45.45%	9.09%	100.00%
	Archaeologists	18.18%	18.18%			63.64%	18.18%	100.00%
	Environmental and social NGO representatives	36.36%	18.18%	18.18%		45.45%	18.18%	100.00%
	Public relations officer	45.45%		36.36%	9.09%	54.55%		100.00%
	Procurement professionals	45.45%	9.09%	27.27%	9.09%	54.55%		100.00%
Construction and Installation	Civil Technicians	54.55%	18.18%	36.36%		36.36%	9.09%	100.00%
	Mechanical Technicians	63.64%	36.36%	27.27%		27.27%	9.09%	100.00%
	Electrical Technicians	63.64%	18.18%	45.45%		27.27%	9.09%	100.00%
	Heavy machinery Operators	63.64%	36.36%	27.27%		27.27%	9.09%	100.00%
	Welders	54.55%	18.18%	36.36%		36.36%	9.09%	100.00%
	Pipefitters	54.55%	18.18%	36.36%		36.36%	9.09%	100.00%
	Construction Laborers	54.55%	9.09%	45.45%		36.36%	9.09%	100.00%
	Transportation workers	54.55%	18.18%	36.36%		36.36%	9.09%	100.00%
	Construction Manager / Engineer	54.55%	18.18%	36.36%		36.36%	9.09%	100.00%
Operation and	Chemical laboratory technicians	18.18%	9.09%	9.09%		72.73%	9.09%	100.00%

Maintenance	and assistants							
	Civil Engineer	45.45%	18.18%	27.27%		45.45%	9.09%	100.00%
	Civil Technicians	27.27%	9.09%	18.18%		63.64%	9.09%	100.00%
	Control Room Operator	45.45%	36.36%	9.09%		45.45%	9.09%	100.00%
	Control Specialist	27.27%	18.18%		9.09%	63.64%	9.09%	100.00%
	Damn safety Inspector	45.27%	27.27%	18.00%		45.45%	9.09%	99.82%
	Electrical Engineer	72.27%	27.27%	45.00%		18.18%	9.09%	99.55%
	Electrical Technicians	63.64%	36.36%	27.27%		27.27%	9.09%	100.00%
	Engineering Analyst	27.27%	27.27%			63.64%	9.09%	100.00%
	hydropower Plant Operator	72.73%	36.36%	36.36%		18.18%	9.09%	100.00%
	Hydrographer	18.18%	18.18%			72.73%	9.09%	100.00%
	Hydropower Specialist	27.27%	27.27%			63.64%	9.09%	100.00%
	Hydropower Strategy Director	18.18%	18.18%			72.73%	9.09%	100.00%
	Residential/Commercial-Wiring Electrician	45.45%	9.09%	36.36%		45.45%	9.09%	100.00%
	Mechanical Engineer	81.82%	27.27%	54.55%		9.09%	9.09%	100.00%
	Mechanical Technicians	63.64%	36.36%	27.27%		27.27%	9.09%	100.00%
	Pipe fitters	54.55%	27.27%	27.27%		36.36%	9.09%	100.00%
	Plant Quality Inspector	36.36%	27.27%		9.09%	54.55%	9.09%	100.00%
	Plant workers	54.55%	27.27%	27.27%		36.36%	9.09%	100.00%
	Senior Energy Trader	18.18%	18.18%			72.73%	9.09%	100.00%
Cross-Cutting/ Enabling Activities	Educators and trainers	27.27%	9.09%	18.18%		63.64%	9.09%	100.00%
	Management	81.82%	18.18%	63.64%		9.09%	9.09%	100.00%
	Administration	63.64%	18.18%	45.45%		27.27%	9.09%	100.00%
	Publishers and science writers	27.27%	9.09%	18.18%		63.64%	9.09%	100.00%
Others	Plant Engineer	9.09%		9.09%				
	Plant Equipment Specialist	9.09%		9.09%				

The table below (Table 52) provides a list of hard-to-fill job positions. These positions have been identified by the respondents as

vacancies that are difficult to fill. The operational/production plants are facing this challenge because the job applicants either lack the necessary qualifications or there is a shortage of qualified applicants. Some qualified applicants may choose to work abroad, seek higher pay, or face issues with work schedule or location.

When aligning it with skills presented in the previous tables, the following list of skills have been identified short supply and hard-to-fill categorized by RE technology:

Solar:

- Photovoltaic System designer (electrical engineers or technologists)
- Software engineers
- Commissioning engineer (electrical)
- Photovoltaic maintenance specialists (electricians specializing in solar)
- Management
- Administration

Biomass:

- Manufacturing quality assurance specialists
- Quality assurance specialists
- Environmental engineers
- Laboratory technicians and assistants
- Chemical, biological, mechanical and electrical engineers
- Transportation workers
- Health and safety consultant

Hydropower:

- Project designers (engineers)
- Hydropower Strategy Director
- Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)
- Economic/finance/ risk specialists
- Physical and environmental scientists (hydrologists, geologists, ecologists)
- Market analysts
- Civil Technicians
- Mechanical Technicians
- Heavy machinery Operators
- Welders
- Pipefitters
- Construction Laborers
- Transportation workers
- Construction Manager / Engineer
- Electrical Engineer
- Electrical Technicians
- hydropower Plant Operator
- Mechanical Engineer

- Pipe fitter

Table 52.
Hard-to-Fill Skills per Renewable Energy Technology

Hard-to-Fill Skills		
Solar	*Biomass*	*Hydro*
Software engineers	Manufacturing quality assurance specialists	Design engineers (civil, mechanical, electrical, hydropower)
Manufacturing engineers	Quality assurance specialists	Modeller
Logistics professionals	Marketing specialists	Software developers
Marketing specialists	Procurement professionals	Manufacturing engineers
Project designers (engineers)	Environmental engineers	Manufacturing technicians
Developers/ facilitators	Laboratory technicians and assistants	Manufacturing operators
Environmental and social NGO representatives	Chemical, biological, mechanical and electrical engineers	Marketing specialists
Solar Thermal System designer	Transportation workers	Project designers (engineers)
Plumbers specializing in solar	Operation and maintenance specialists	Hydropower Strategy Director
Photovoltaic System designer (electrical engineers or technologists)	Management	Environmental engineer
Project Evaluators	Administration	Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)

Hard-to-Fill Skills		
Quality assurance specialists	Health and safety consultants	Economic/finance/ risk specialists
Commissioning engineer (electrical)		Physical and environmental scientists (hydrologists, geologists, ecologists)
Photovoltaic maintenance specialists (electricians specializing in solar)		Market analysts
Solar Energy Systems Engineers		Land development advisor
Electrical Engineers		Land use negotiator
Management		Communications specialists
Administration		Archaeologists
IT professionals		Environmental and social NGO representatives
Health and safety consultants		Civil Technicians
		Mechanical Technicians
		Electrical Technicians
		Heavy machinery Operators
		Welders
		Pipefitters

		Hard-to-Fill Skills
		Construction Laborers Transportation workers Construction Manager / Engineer Chemical laboratory technicians and assistants Civil Engineer Control Room Operator Control Specialist Damn safety Inspector Electrical Engineer Engineering Analyst hydropower Plant Operator Hydrographer Hydropower Specialist Residential/Commercial-Wiring

		Hard-to-Fill Skills
		Electrician
		Mechanical Engineer
		Pipe fitters
		Plant Quality Inspector
		Plant workers
		Senior Energy Trader
		Educators and trainers
		Management
		Administration
		Publishers and science writers

Note:

- Are job/qualifications common to at least two renewable energy technology

Table 53 shows the common hard-to-fill jobs titles across the three renewable energy technologies. Among the skills, Administration, Management and Marketing specialists were the skills that are common in all three technologies, other skills were only common to two renewable energy technologies.

Table 53.

Common Hard-to-Fill Skills by Value Chain

Value Chain	***Common Hard-to-Fill Skills***
Cross-Cutting/ Enabling Activities	Health and safety consultants
Cross-Cutting/ Enabling Activities	Administration
Project Development	Environmental and social NGO representatives
Construction and Installation	Environmental engineer
Cross-Cutting/ Enabling Activities	Management
Equipment Manufacture and Distribution	Manufacturing engineers
Equipment Manufacture and Distribution	Marketing specialists
Project Development	Project designers (engineers)
Equipment Manufacture and Distribution	Quality assurance specialists

Note: These are all applicable skills common to two or more RE Technologies

The following three consecutive tables show the percentage distribution of the highest educational requirements needed for the job title by renewable energy technology.

Table 54. A displays the responses provided by participants regarding solar technology. According to the findings, the majority of participants indicated that their main educational qualification was a higher education graduate or college level and above. However, there were a few instances where some individuals mentioned that certain jobs or skills only required a basic education graduate or technical vocational education (TVET) graduate. When considering this alongside the data from the previous table (Table 51. A), the following skills are applicable to at least 50.00% of the respondents in the field of solar technology. These skills have been identified as necessary for individuals with either a basic educational graduate or technical vocational education (TVET graduate) background.

- Photovoltaic System designer (electrical engineers or technologists)
- Electricians specializing in solar
- Photovoltaic System Installers

- Software engineers
- Commissioning engineer (electrical)
- Photovoltaic maintenance specialists (electricians specializing in solar)
- Maintenance Electrician
- Occupational Safety and Health
- Management
- Administration
- Health and safety consultant

It is important to mention that the participants also identified the following job qualifications as applicable: However, all relevant respondents stated that these qualifications require a Higher Education Graduate requirement.

- Project designers (engineers)
- System designers (electrical/ mechanical/ structural engineers)
- Solar Energy Systems Engineers
- Electrical Engineers

Table 54. A.
Projected Distribution of Highest Educational Qualification Needed to Perform Job for the Solar Technology

Value Chain	Areas of Skills/Jobs	Highest Educational Qualification Needed (%)				
		Basic Educational Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	*Technical Vocational Education (TVET Graduate)*	*Higher Education Graduate (College Degree and Above)*	*Not Specified*	**Total**
Equipment Manufacture and Distribution	Chemical laboratory technicians and assistants	0.00%	0.00%	100.00%		*100.00%*
	Software engineers			100.00%		*100.00%*
	Modellers					*0.00%*

	Manufacturing engineers			100.00%	*100.00%*
	Manufacturing technicians		50.00%	50.00%	*100.00%*
	Manufacturing operators	100.00%			*100.00%*
	Building systems specialists				*0.00%*
	Manufacturing quality assurance experts				*0.00%*
	Logistics professionals	50.00%		50.00%	*100.00%*
	Logistics operators	100.00%			*100.00%*
	Equipment transporters	50.00%		50.00%	*100.00%*
	Procurement professionals	50.00%	50.00%		*100.00%*
	Marketing specialists			100.00%	*100.00%*
Project Development	Project designers (engineers)			100.00%	*100.00%*
	Developers/ facilitators			100.00%	*100.00%*
	Environmental and social NGO representatives			100.00%	*100.00%*
	Procurement professionals			100.00%	*100.00%*
	Seaman (Floating Solar)			100.00%	*100.00%*
Construction and Installation	Solar Thermal System designer				*0.00%*

	Plumbers specializing in solar		100.00%			*100.00%*
	Photovoltaic System designer (electrical engineers or technologists)	20.00%		80.00%		*100.00%*
	Electricians specializing in solar	14.29%	42.86%	42.86%		*100.00%*
	Roofers specializing in solar	50.00%	50.00%			*100.00%*
	System designers (electrical/ mechanical/ structural engineers)			100.00%		*100.00%*
	Photovoltaic System Installers	16.67%	33.33%	50.00%		*100.00%*
	Welders	33.33%	66.67%			*100.00%*
	Pipe fitters		100.00%			*100.00%*
	Project Evaluators			100.00%		*100.00%*
	Software engineers	20.00%		80.00%		*100.00%*
	Quality assurance specialists			100.00%		*100.00%*
	Commissioning engineer (electrical)	16.67%		83.33%		*100.00%*
	Transportation workers	33.33%	33.33%	33.33%		*100.00%*
	Seafarer/ Seaman (Floating Solar)					*0.00%*
Operation and Maintenance	Photovoltaic maintenance specialists (electricians specializing in solar)		42.86%	42.86%	*14.29%*	*100.00%*

Solar Thermal maintenance specialists (Plumbers specializing in solar)			100.00%		*100.00%*
Concentrated Solar Power maintenance specialists			100.00%		*100.00%*
Inspectors			100.00%		*100.00%*
Recycling specialists			100.00%		*100.00%*
Building inspector			100.00%		*100.00%*
Sales occupations			100.00%		*100.00%*
Sales representatives or estimators			100.00%		*100.00%*
Solar Thermal Installers and Technicians			100.00%		*100.00%*
Solar Energy Systems Engineers			100.00%		*100.00%*
Electrical Engineers			100.00%		*100.00%*
Energy Auditors			100.00%		*100.00%*
Building-Wiring Electrician		25.00%	50.00%	*25.00%*	*100.00%*
Residential/Commercial-Wiring Electrician		100.00%			*100.00%*
Maintenance Electrician		42.86%	42.86%	*14.29%*	*100.00%*
Occupational Safety and Health			87.50%	*12.50%*	*100.00%*
Laborer	80.00%			*20.00%*	*100.00%*

	Pile-driving and drilling	100.00%				*100.00%*
	Environmental Science Professionals			100.00%		*100.00%*
	Trade association and professional society staff					*0.00%*
	Management	10.00%		80.00%	*10.00%*	*100.00%*
Cross-Cutting/ Enabling Activities	Administration	11.11%	11.11%	77.78%		*100.00%*
	Publishers and science writers					*0.00%*
	IT professionals	25.00%		75.00%		*100.00%*
	Health and safety consultants	20.00%		80.00%		*100.00%*

Table 54. B shows a similar distribution but for participants under biomass technology. Analyzing further the results along with Table 51. B, the list of skills below displays the skills that are relevant to at least 50.00% of the respondents and were identified by those respondents as requiring either basic educational graduate or technical vocational education (TVET graduate) educational attainment.

- Manufacturing quality assurance specialists
- Manufacturing technicians
- Logistics professionals
- Laboratory technicians and assistants
- Transportation workers
- Transportation workers
- Laboratory technicians and assistants
- Operation and maintenance specialists
- Biofuels Processing Technicians

In addition, the survey found that the following job titles were relevant to at least 50.00% of respondents. Although, all of these occupations required a college degree.

- Manufacturing engineers
- Quality assurance specialists
- Marketing specialist
- Sales workers

- Procurement professionals
- Environmental engineers
- Chemical, biological mechanical and electrical engineers
- Management
- Administration
- Health and safety consultants

Table 54. B.
Projected Distribution of Highest Educational Qualification Needed to Perform Job for the Biomass Technology

Value Chain	Areas of Skills/Jobs	Highest Educational Qualification Needed (%)				
		Basic Educational Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	*Technical Vocational Education (TVET Graduate)*	*Higher Education Graduate (College Degree and Above)*	*Not Specified*	**Total**
Equipment Manufacture and Distribution	Biomass Manufacturing engineers			100.00%		*100.00%*
	Manufacturing quality assurance specialists		50.00%	50.00%		*100.00%*
	Biomass Manufacturing technicians		66.67%	33.33%		*100.00%*
	Quality assurance specialists			100.00%		*100.00%*
	Logistics professionals		50.00%	50.00%		*100.00%*
	Marketing specialist			100.00%		*100.00%*
	Sales workers			100.00%		*100.00%*
Project Development	Resource assessment specialists					*0.00%*

	Project designers (engineers and scientists)			100.00%	*100.00%*
	Sustainability specialists				*0.00%*
	Land use negotiators				*0.00%*
	Communications specialists				*0.00%*
	Environmental and social NGO representatives			100.00%	*100.00%*
	Public relations officer				*0.00%*
	Procurement professionals			100.00%	*100.00%*
Construction and Installation	Biochemists and microbiologists			100.00%	*100.00%*
	Environmental engineers			100.00%	*100.00%*
	Laboratory technicians and assistants		33.33%	66.67%	*100.00%*
	Chemical, biological mechanical and electrical engineers			100.00%	*100.00%*
	Project designers and managers			100.00%	*100.00%*
	Software engineers				*0.00%*
	Construction professionals				*0.00%*
	General electricians, plumbers, roofers		100.00%		*100.00%*
	General construction workers	100.00%			*100.00%*
	Business developers				*0.00%*
	Commissioning engineer (electrical)			100.00%	*100.00%*
	Transportation workers		100.00%		*100.00%*

	Plant breeders and foresters			*0.00%*
	Biomass production managers		100.00%	*100.00%*
	Agricultural Machinery Collection Operators			*0.00%*
	Agricultural Machinery Collection Servicing			*0.00%*
	Forestry workers			*0.00%*
	Transportation workers	100.00%		*100.00%*
Operation and Maintenance	Laboratory technicians and assistants	33.33%	66.67%	*100.00%*
	Operation and maintenance specialists	66.67%	33.33%	*100.00%*
	Biomass Plant Technicians			*0.00%*
	Biomass Power Plant Managers		100.00%	*100.00%*
	Biofuels Processing Technicians	66.67%	33.33%	*100.00%*
	Biofuels/Biodiesel Technology and Product Development Managers		100.00%	*100.00%*
	Design Engineer			*0.00%*
	Contract Analyst			*0.00%*
Cross-Cutting/ Enabling Activities	Biomass Technology Training/ Trainers			*0.00%*
	Biopower Transmission and Distribution			*0.00%*
	Trade association and professional society staff			*0.00%*
	Management		100.00%	*100.00%*

Administration	100.00%	*100.00%*
Publishers and science writers		*0.00%*
IT professionals	100.00%	*100.00%*
Health and safety consultants	100.00%	*100.00%*

The same projected distribution for hydropower participants is given in Table 54. C. Similar to the process of analysis from the previous tables for solar and biomass technologies, Table 54. C's list of identified relevant job titles was examined together with the data of Table 51. C. As a result, those surveyed determined that the following skills were at least 50.00% applicable to operational/production plants and that they required either a basic education graduate or a technical vocational education (TVET) graduate educational attainment:

- Civil Technicians
- Mechanical Technicians
- Electrical Technicians
- Heavy machinery Operators
- Welders
- Construction Laborers
- Transportation workers
- Construction Manager / Engineer
- Electrical Technicians
- hydropower Plant Operator
- Mechanical Engineer
- Mechanical Technicians
- Pipe fitters
- Plant workers

Some skills were found to be applicable and identified by all of the hydropower participants as requiring a higher education graduate (college degree and above) attainment; these skills are listed below.

- Design engineers (civil, mechanical, electrical, hydropower)
- Project designers (engineers)
- Hydropower Strategy Director
- Management
- Administration

Table 54. C.
Projected Distribution of Highest Educational Qualification Needed to Perform Job for the Hydro Technology

Value Chain	Areas of Skills/Jobs	Highest Educational Qualification Needed (%)				
		Basic Educational Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	*Technical Vocational Education (TVET Graduate)*	*Higher Education Graduate (College Degree and Above)*	*Not Specified*	**Total**
Equipment Manufacture and Distribution	Design engineers (civil, mechanical, electrical, hydropower)			100.00%		*100.00%*
	Modeller		50.00%	50.00%		*100.00%*
	Software developers			100.00%		*100.00%*
	Manufacturing engineers			100.00%		*100.00%*
	Manufacturing technicians		100.00%			*100.00%*
	Manufacturing operators		80.00%	20.00%		*100.00%*
	Quality assurance specialists			100.00%		*100.00%*
	Marketing specialists			100.00%		*100.00%*
	Sales workers		100.00%			*100.00%*
Project Development	Project designers (engineers)			100.00%		*100.00%*
	Hydropower Strategy Director			100.00%		*100.00%*

	Environmental engineer		85.71%	*14.29%*	*100.00%*
	Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)		83.33%	*16.67%*	*100.00%*
	Economic/finance/ risk specialists		85.71%	*14.29%*	*100.00%*
	Physical and environmental scientists (hydrologists, geologists, ecologists)		83.33%	*16.67%*	*100.00%*
	Market analysts		83.33%	*16.67%*	*100.00%*
	Land development advisor		66.67%	*33.33%*	*100.00%*
	Land use negotiator		80.00%	*20.00%*	*100.00%*
	Communications specialists	25.00%	50.00%	*25.00%*	*100.00%*
	Procurement specialists	20.00%	60.00%	*20.00%*	*100.00%*
	Archaeologists		50.00%	*50.00%*	*100.00%*
	Environmental and social NGO representatives	25.00%	50.00%	*25.00%*	*100.00%*
	Public relations officer	20.00%	60.00%	*20.00%*	*100.00%*
	Procurement professionals	50.00%	25.00%	*25.00%*	*100.00%*
Construction and Installation	Civil Technicians	50.00%	50.00%		*100.00%*
	Mechanical Technicians	57.14%	42.86%		*100.00%*
	Electrical Technicians	57.14%	42.86%		*100.00%*
	Heavy machinery Operators	100.00%			*100.00%*
	Welders	100.00%			*100.00%*

	Pipefitters		100.00%			*100.00%*
	Construction Laborers	66.67%	33.33%			*100.00%*
	Transportation workers	33.33%	66.67%			*100.00%*
	Construction Manager / Engineer	16.67%		83.33%		*100.00%*
Operation and Maintenance	Chemical laboratory technicians and assistants			50.00%	50.00%	*100.00%*
	Civil Engineer			80.00%	*20.00%*	*100.00%*
	Civil Technicians	33.33%	33.33%	33.33%		*100.00%*
	Control Room Operator		20.00%	60.00%	*20.00%*	*100.00%*
	Control Specialist			100.00%		*100.00%*
	Damn safety Inspector	20.00%		60.00%	*20.00%*	*100.00%*
	Electrical Engineer			87.50%	*12.50%*	*100.00%*
	Electrical Technicians	16.67%	66.67%	16.67%		*100.00%*
	Engineering Analyst	33.33%		66.67%		*100.00%*
	hydropower Plant Operator		12.50%	75.00%	*12.50%*	*100.00%*
	Hydrographer			100.00%		*100.00%*
	Hydropower Specialist		33.33%	66.67%		*100.00%*
	Hydropower Strategy Director	50.00%		50.00%		*100.00%*
	Residential/Commercial-Wiring Electrician		80.00%		*20.00%*	*100.00%*
	Mechanical Engineer		11.11%	77.78%	*11.11%*	*100.00%*
	Mechanical Technicians		71.43%	14.29%	*14.29%*	*100.00%*

	Pipe fitters	16.67%	66.67%		*16.67%*	*100.00%*
	Plant Quality Inspector		25.00%	50.00%	*25.00%*	*100.00%*
	Plant workers	16.67%	66.67%	16.67%		*100.00%*
	Senior Energy Trader			100.00%		*100.00%*
Cross-Cutting/ Enabling Activities	Educators and trainers			100.00%		*100.00%*
	Management			100.00%		*100.00%*
	Administration			100.00%		*100.00%*
	Publishers and science writers			100.00%		*100.00%*

TESDA asked the participants if the applicable job titles, listed by renewable energy technology and value chain in the questionnaire, required a technical vocational certificate or national certificate, as shown in Table 55. After comparing the results of Table 55 to other data gathered in Tables 51.A, 51.B, and 51.C, the following job titles show that at least 50.00% of the participating plants said that these jobs are applicable to their respective plants and was also also identified by some participants as (at least 20.00%) require a Technical Vocational Certificate or National Certificate:

Solar:

- Project designers (engineers)
- Photovoltaic System designer (electrical engineers or technologists)
- **Electricians specializing in solar**
- System designers (electrical/ mechanical/ structural engineers)
- **Photovoltaic System Installers**
- **Software engineers**
- Commissioning engineer (electrical)
- Photovoltaic maintenance specialists (electricians specializing in solar)
- Solar Energy Systems Engineers
- Electrical Engineers
- **Maintenance Electrician**
- Occupational Safety and Health
- Management
- Administration
- Health and safety consultants

Biomass:

- Biomass Manufacturing engineers
- **Manufacturing quality assurance specialists**

- **Biomass Manufacturing technicians**
- Quality assurance specialists
- **Procurement professionals**
- **Environmental engineers**
- Chemical, biological mechanical and electrical engineers
- **Transportation workers**
- **Laboratory technicians and assistants**
- **Operation and maintenance specialists**
- **Biofuels Processing Technicians**
- Administration
- **Health and safety consultants**

Hydropower:

- Design engineers (civil, mechanical, electrical, hydropower)
- Project designers (engineers)
- Hydropower Strategy Director
- **Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)**
- Economic/finance/ risk specialists
- Physical and environmental scientists (hydrologists, geologists, ecologists)
- **Market analysts**
- Land use negotiator
- Civil Technicians
- **Mechanical Technicians**
- **Heavy machinery Operators**
- **Welders**
- **Pipefitters**
- Transportation workers
- Construction Manager / Engineer
- Electrical Engineer
- **Electrical Technicians**
- Hydropower Plant Operator
- Mechanical Engineer
- Pipe fitters
- **Plant workers**
- Management
- Administration

Additionally, jobs that were identified by at least 50.00% of the relevant participants are highlighted in **BOLD** format.

The representative from the solar energy industry emphasized the importance of having competent and qualified personnel. They also pointed out the lack of recognized standards in the industry and expressed a strong interest in collaborating with TESDA to address any wrong practices.

At the validation meeting, the representatives from the biomass industry identified additional skills **Power Market Analysts, Energy Traders, Plant Operators, Distributed control system (DCS) Engineers and Plant Auxiliary Operators**. These skills were identified as occupations with high demand in other bigger capacity plants and provide workers with better

compensation.

Table 55.
Percentage of Operational/ Production Plants based on the Technical Vocational Certificate/National Certificate Requirement per Renewable Energy Technology

Renewable Energy Technology	Value Chain	Areas of Skills/Jobs	%
Solar	Equipment Manufacture and Distribution	Chemical laboratory technicians and assistants	100.00%
		Software engineers	50.00%
		Manufacturing engineers	100.00%
		Manufacturing technicians	50.00%
		Manufacturing operators	100.00%
		Logistics professionals	50.00%
		Logistics operators	100.00%
		Equipment transporters	50.00%
		Procurement professionals	100.00%
	Project Development	Project designers (engineers)	20.00%
		Developers/ facilitators	33.33%
		Procurement professionals	33.33%
	Construction and Installation	Solar Thermal System designer	50.00%
		Plumbers specializing in solar	100.00%
		Photovoltaic System designer (electrical engineers or technologists)	40.00%
		Electricians specializing in solar	57.14%
		Roofers specializing in solar	50.00%
		System designers (electrical/ mechanical/ structural	20.00%

	engineers)	
	Photovoltaic System Installers	66.67%
	Welders	100.00%
	Pipe fitters	100.00%
	Project Evaluators	50.00%
	Software engineers	60.00%
	Quality assurance specialists	33.33%
	Commissioning engineer (electrical)	33.33%
	Transportation workers	66.67%
Operation and Maintenance	Photovoltaic maintenance specialists (electricians specializing in solar)	42.86%
	Concentrated Solar Power maintenance specialists	33.33%
	Inspectors	50.00%
	Recycling specialists	50.00%
	Solar Thermal Installers and Technicians	33.33%
	Solar Energy Systems Engineers	20.00%
	Electrical Engineers	33.33%
	Energy Auditors	50.00%
	Building-Wiring Electrician	100.00%
	Residential/Commercial-Wiring Electrician	100.00%
	Maintenance Electrician	80.00%
	Occupational Safety and Health	60.00%
Cross-Cutting/ Enabling Activities	Management	28.57%
	Administration	28.57%
	Health and safety consultants	50.00%
Other jobs	Solar Operation & Maintenance Worker	10.00%
Equipment Manufacture and Distribution	Manufacturing quality assurance specialists	25.00%
	Biomass Manufacturing technicians	75.00%
Project Development	Project designers (engineers and scientists)	25.00%

		Environmental and social NGO representatives	25.00%
		Environmental engineers	25.00%
Biomass	Construction and Installation	Laboratory technicians and assistants	75.00%
		Chemical, biological mechanical and electrical engineers	25.00%
		General electricians, plumbers, roofers	25.00%
		Transportation workers	50.00%
	Operation and Maintenance	Operation and maintenance specialists	50.00%
		Biofuels Processing Technicians	50.00%
	Cross-Cutting/ Enabling Activities	Administration	25.00%
		IT Professionals	25.00%
		Health and safety consultants	25.00%
	Others	Instrumentation Technician	25.00%
		HVAC Technician	25.00%
		Plant Mechanic	25.00%
		Electrician	25.00%
		Chemical Technician	25.00%
		Mechanical Engineer	25.00%
		Electrical Engineer	25.00%
	Equipment Manufacture and Distribution	Design engineers (civil, mechanical, electrical, hydropower)	16.67%
		Modeller	100.00%
		Software developers	100.00%
		Manufacturing engineers	50.00%
		Manufacturing technicians	100.00%
		Manufacturing operators	60.00%
		Quality assurance specialists	100.00%
		Marketing specialists	50.00%
		Sales workers	100.00%
	Project Development	Project designers (engineers)	42.86%

Hydropower		Hydropower Strategy Director	50.00%
		Environmental engineer	75.00%
		Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)	60.00%
		Economic/finance/ risk specialists	28.57%
		Physical and environmental scientists (hydrologists, geologists, ecologists)	66.67%
		Market analysts	60.00%
		Land development advisor	100.00%
		Land use negotiator	60.00%
		Communications specialists	33.33%
		Procurement specialists	50.00%
		Archaeologists	100.00%
		Environmental and social NGO representatives	100.00%
		Public relations officer	75.00%
		Procurement professionals	66.67%
	Construction and Installation	Civil Technicians	66.67%
		Mechanical Technicians	57.14%
		Electrical Technicians	57.14%
		Heavy machinery Operators	100.00%
		Welders	80.00%
		Pipefitters	83.33%
		Construction Laborers	20.00%
		Transportation workers	66.67%
		Construction Manager / Engineer	40.00%
	Operation and Maintenance	Chemical laboratory technicians and assistants	100.00%
		Civil Engineer	100.00%
		Civil Technicians	100.00%
		Control Room Operator	75.00%

	Control Specialist	100.00%
	Damn safety Inspector	100.00%
	Electrical Engineer	50.00%
	Electrical Technicians	100.00%
	Engineering Analyst	33.33%
	hydropower Plant Operator	33.33%
	Hydrographer	100.00%
	Hydropower Specialist	66.67%
	Hydropower Strategy Director	100.00%
	Residential/Commercial-Wiring Electrician	66.67%
	Mechanical Engineer	57.14%
	Mechanical Technicians	80.00%
	Pipe fitters	50.00%
	Plant Quality Inspector	66.67%
	Senior Energy Trader	100.00%
Cross-Cutting/ Enabling Activities	Educators and trainers	66.67%
	Management	33.33%
	Administration	28.57%
	Publishers and science writers	66.67%
	Plant Equipment Specialist	100.00%

Table 56 presents the distribution of the area where the jobs are needed. Notable Locations where participants mentioned the potential applicability of professions include:

- Digos City, Davao Del Sur
- Palawan
- Quezon Province
- Eastern Samar
- Region I

Table 56.
Area where job/skill is needed per Renewable Energy Technology

Renewable Energy Technology	Value Chain	Job/Skill	Area				
			Nationwide	Specific Area	Not Specified	Total	Areas
Solar	Equipment Manufacture and Distribution	Chemical laboratory technicians and assistants	100.00%	0.00%		*100.00%*	
		Software engineers	100.00%	0.00%		*100.00%*	
		Manufacturing engineers	50.00%	50.00%		*100.00%*	Digos City
		Manufacturing technicians	100.00%	0.00%		*100.00%*	
		Manufacturing operators	100.00%			*100.00%*	
		Logistics professionals	50.00%	50.00%		*100.00%*	N/A
		Logistics operators		100.00%		*100.00%*	N/A
		Equipment transporters		100.00%		*100.00%*	N/A
		Procurement professionals	50.00%	50.00%		*100.00%*	N/A
		Marketing specialists	100.00%			*100.00%*	
	Project Development	Project designers (engineers)	80.00%	20.00%		*100.00%*	Palawan
		Developers/ facilitators	100.00%	0.00%		*100.00%*	
		Environmental and social NGO representatives	50.00%	25.00%	*25.00%*	*100.00%*	N/A
		Procurement professionals	33.33%	33.33%	*33.33%*	*100.00%*	N/A

Technology		Solar Thermal System designer		50.00%	*50.00%*	*100.00%*	N/A
		Plumbers specializing in solar	100.00%			*100.00%*	
		Photovoltaic System designer (electrical engineers or technologists)	100.00%			*100.00%*	N/A
		Electricians specializing in solar	57.14%	42.86%		*100.00%*	Palawan
		Roofers specializing in solar	50.00%	50.00%		*100.00%*	N/A
		System designers (electrical/ mechanical/ structural engineers)	60.00%	40.00%		*100.00%*	N/A
	Construction and Installation	Photovoltaic System Installers	66.67%	33.33%		*100.00%*	N/A
		Welders	66.67%	33.33%		*100.00%*	N/A
		Pipe fitters	100.00%			*100.00%*	
		Project Evaluators	50.00%	50.00%		*100.00%*	
		Software engineers	40.00%	40.00%	*20.00%*	*100.00%*	N/A
		Quality assurance specialists	33.33%	33.33%	*33.33%*	*100.00%*	N/A
		Commissioning engineer (electrical)	50.00%	33.33%	*16.67%*	*100.00%*	N/A
		Transportation workers	66.67%	33.33%		*100.00%*	N/A
		Photovoltaic maintenance specialists (electricians specializing in solar)	71.43%	14.29%	*14.29%*	*100.00%*	N/A
		Solar Thermal maintenance specialists (Plumbers specializing in solar)		100.00%		*100.00%*	N/A
	Operation and Maintenance	Concentrated Solar Power maintenance specialists	33.33%	66.67%		*100.00%*	
		Inspectors	50.00%	50.00%		*100.00%*	N/A

		Recycling specialists		50.00%	*50.00%*	*100.00%*	N/A
		Building inspector	100.00%			*100.00%*	
		Sales occupations	100.00%			*100.00%*	
		Sales representatives or estimators	100.00%			*100.00%*	
		Solar Thermal Installers and Technicians		100.00%		*100.00%*	Region I
		Solar Energy Systems Engineers	80.00%	20.00%		*100.00%*	Region I
		Electrical Engineers	55.56%	22.22%	*22.22%*	*100.00%*	palawan
		Energy Auditors		50.00%	*50.00%*	*100.00%*	N/A
		Residential/Commercial-Wiring Electrician		100.00%		*100.00%*	Palawan
		Maintenance Electrician	57.14%	14.29%	*28.57%*	*100.00%*	Palawan
		Occupational Safety and Health	50.00%	25.00%	*25.00%*	*100.00%*	Palawan
		Laborer	60.00%	20.00%	*20.00%*	*100.00%*	N/a
		Pile-driving and drilling	50.00%	50.00%		*100.00%*	N/a
		Environmental Science Professionals	50.00%	50.00%		*100.00%*	N/a
	Cross-Cutting/ Enabling Activities	Management	40.00%	40.00%	*20.00%*	*100.00%*	Palawan Digos City
		Administration	44.44%	44.44%	*11.11%*	*100.00%*	Palawan
		IT professionals	25.00%	50.00%	*25.00%*	*100.00%*	N/A
		Health and safety consultants	40.00%	40.00%	*20.00%*	*100.00%*	N/A
Biomass Technology	Equipment Manufacture and Distribution	Biomass Manufacturing engineers	100.00%			*100.00%*	
		Manufacturing quality assurance specialists	100.00%			*100.00%*	
		Biomass Manufacturing technicians	66.67%	33.33%		*100.00%*	Quezon

	Quality assurance specialists	66.67%		*33.33%*	*100.00%*	Province N/A
	Logistics professionals	100.00%			*100.00%*	
	Marketing specialist	100.00%			*100.00%*	
	Sales workers	100.00%			*100.00%*	
Project Development	Project designers (engineers and scientists)	100.00%			*100.00%*	
	Environmental and social NGO representatives	100.00%			*100.00%*	
	Procurement professionals	100.00%			*100.00%*	
Construction and Installation	Biochemists and microbiologists	100.00%			*100.00%*	
	Environmental engineers	100.00%			*100.00%*	
	Laboratory technicians and assistants	100.00%			*100.00%*	
	Chemical, biological mechanical and electrical engineers	100.00%			*100.00%*	
	Project designers and managers	100.00%			*100.00%*	
	General electricians, plumbers, roofers	100.00%			*100.00%*	
	General construction workers		100.00%		*100.00%*	Quezon Province
	Commissioning engineer (electrical)	100.00%			*100.00%*	
	Transportation workers	100.00%			*100.00%*	
Operation and Maintenance	Biomass production managers	100.00%			*100.00%*	
	Transportation workers	100.00%			*100.00%*	
	Laboratory technicians and assistants	100.00%			*100.00%*	
	Operation and maintenance specialists	100.00%			*100.00%*	
	Biomass Power Plant Managers	100.00%			*100.00%*	

		Biofuels Processing Technicians	100.00%			*100.00%*	
		Biofuels/Biodiesel Technology and Product Development Managers	100.00%			*100.00%*	
	Cross-Cutting/ Enabling Activities	Management	50.00%		*50.00%*	*100.00%*	
		Administration	66.67%		*33.33%*	*100.00%*	
		IT professionals	100.00%			*100.00%*	
		Health and safety consultants	100.00%			*100.00%*	
Hydropower Technology	Equipment Manufacture and Distribution	Design engineers (civil, mechanical, electrical, hydropower)	42.86%	42.86%	*14.29%*	*100.00%*	Luzon
		Modeller	100.00%			*100.00%*	
		Software developers	100.00%			*100.00%*	
		Manufacturing engineers	100.00%			*100.00%*	
		Manufacturing technicians	75.00%	25.00%		*100.00%*	Region 1
		Manufacturing operators	75.00%	25.00%		*100.00%*	
		Marketing specialists	100.00%			*100.00%*	
	Project Development	Project designers (engineers)	57.14%	28.57%	*14.29%*	*100.00%*	Eastern Samar
		Hydropower Strategy Director	71.43%	14.29%	*14.29%*	*100.00%*	Luzon
		Environmental engineer	60.00%	20.00%	*20.00%*	*100.00%*	Luzon
		Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)	66.67%	16.67%	*16.67%*	*100.00%*	Luzon
		Economic/finance/ risk specialists	71.43%	14.29%	*14.29%*	*100.00%*	Luzon
		Physical and environmental scientists (hydrologists, geologists, ecologists)	66.67%	16.67%	*16.67%*	*100.00%*	Luzon
		Market analysts	66.67%	16.67%	*16.67%*	*100.00%*	Luzon
		Land development advisor	66.67%		*33.33%*	*100.00%*	
		Land use negotiator	60.00%	20.00%	*20.00%*	*100.00%*	Luzon
		Communications specialists	75.00%		*25.00%*	*100.00%*	

	Procurement specialists	80.00%		*20.00%*	*100.00%*	
	Archaeologists	50.00%		*50.00%*	*100.00%*	
	Environmental and social NGO representatives	75.00%		*25.00%*	*100.00%*	
	Public relations officer	80.00%		*20.00%*	*100.00%*	
	Procurement professionals	75.00%		*25.00%*	*100.00%*	
Construction and Installation	Civil Technicians	66.67%	16.67%	*16.67%*	*100.00%*	N/A
	Mechanical Technicians	57.14%	28.57%	*14.29%*	*100.00%*	Region I
	Electrical Technicians	57.14%	28.57%	*14.29%*	*100.00%*	Region I
	Heavy machinery Operators	57.14%	28.57%	*14.29%*	*100.00%*	Region I
	Welders	66.67%	16.67%	*16.67%*	*100.00%*	N/A
	Pipefitters	83.33%		*16.67%*	*100.00%*	
	Construction Laborers	83.33%		*16.67%*	*100.00%*	
	Transportation workers	83.33%		*16.67%*	*100.00%*	
	Construction Manager / Engineer	83.33%		*16.67%*	*100.00%*	
Operation and Maintenance	Chemical laboratory technicians and assistants	50.00%		50.00%	*100.00%*	
	Civil Engineer	40.00%	20.00%	*40.00%*	*100.00%*	N/A
	Civil Technicians	33.33%	33.33%	*33.33%*	*100.00%*	N/A
	Control Room Operator	80.00%		*20.00%*	*100.00%*	
	Control Specialist	100.00%			*100.00%*	
	Damn safety Inspector	60.00%		*40.00%*	*100.00%*	
	Electrical Engineer	62.50%	12.50%	*25.00%*	*100.00%*	Region I
	Electrical Technicians	100.00%			*100.00%*	
	Engineering Analyst	66.67%	33.33%		*100.00%*	N/A
	hydropower Plant Operator	62.50%	12.50%	*25.00%*	*100.00%*	Region I
	Hydrographer	100.00%			*100.00%*	
	Hydropower Specialist	66.67%	33.33%		*100.00%*	N/A
	Hydropower Strategy Director	50.00%	50.00%		*100.00%*	

	Residential/Commercial-Wiring Electrician	40.00%	20.00%	*40.00%*	*100.00%*	N/A
	Mechanical Engineer	66.67%	11.11%	*22.22%*	*100.00%*	Region I
	Mechanical Technicians	71.43%		*28.57%*	*100.00%*	
	Pipe fitters	50.00%	16.67%	*33.33%*	*100.00%*	N/A
	Plant Quality Inspector	50.00%	25.00%	*25.00%*	*100.00%*	N/A
	Plant workers	50.00%	16.67%	*33.33%*	*100.00%*	N/A
	Senior Energy Trader	100.00%			*100.00%*	
Cross-Cutting/ Enabling Activities	Educators and trainers	100.00%			*100.00%*	
	Management	77.78%	22.22%		*100.00%*	Region I
	Administration	85.71%	14.29%		*100.00%*	
	Publishers and science writers	66.67%	33.33%		*100.00%*	

Table 57 shows the percentage of women in STEM areas at initiative operating and production plants. The data show that STEM jobs are underrepresented by women in most plants across all three RE technologies. It is also notable that Biomass technology plants all report less than 25% of women employed hold STEM-related jobs.

Table 57.
Percentage of Women in STEM-related Occupations by Renewable Energy Technology

RE Technology	Actions Undertaken		
	Less than 25%	25% or more	Total
Solar Technology	70.00%	30.00%	*100.00%*
Biomass Technology	100.00%	0.00%	*100.00%*
Hydropower Technology	72.73%	27.27%	*100.00%*

In Table 58, each operational/production plant who said that they have less than 25.00% women working in STEM jobs listed down the reasons why there were low percentages. Across the renewable energy technologies common reasons are:

- Male dominated type of jobs;
- Low women applying for STEM related jobs in the plants;
- Some STEM-related positions in the field are not attractive to female applicants;
- Some positions are physically demanding; and
- Typical work in the plants for women are office and document related

Based on the findings in Table 57 and 58, it is evident that there is a significant underrepresentation of women in STEM-related occupations within the country's workforce. According to a report by Rappler in 2023 which was taken from LinkedIn data, it was found that women comprise only 36.3% or 3 out of 10 workers in the area of Science, Technology, Engineering, and Mathematics (STEM). In comparison to neighboring countries in the Asia Pacific Region, the gender gap in STEM fields in the Philippines is one of the widest. This is especially noticeable when considering that women make up 58.8% of the Philippine workforce in non-STEM related fields.

On a global scale, the data reveals that 29.2% of women are employed in STEM fields, whereas 49.3% of women work in non-STEM occupations. Despite a significant gender disparity in STEM fields, the Philippines made significant progress in promoting gender equality, according to the World Economic Forum's Global Gender Gap Report (GGGR) for 2023. The country's ranking improved from 19th to 16th out of 146 countries, reflecting its ongoing efforts in gender equality.

Table 58.
Reasons for Low Representation of Women in STEM-related Occupations by Renewable Energy Technology

Renewable Energy Technology	Reasons
Solar Technology	● Applicants Were All Men. ● Hand On Works ● More On Technical Works ● Nature Of Work (Exposed To Weather) ● No Applications Made From A Group Of Women. ● No Interested Applicants Were Noticed ● Physical Strength Differences Of Women And Men ● Power Plant Field Works Are Not Popular With Women ● Power Plant Operations Work Are Not Popular With Women ● There Are More Available Male Applicants To The Job ● We Have Not Received Any Women For Work Applications ● We Hire Women For Office Works And Not For Technical Positions ● We Maintain Solar Farm, We Normally Need Male Technician ● We Need Women In Clerical Job
Biomass Technology	● Company's Preference ● Less Job Opportunities For Women ● Low Turnout ● Male Roles Are Required ● Physical Work ● Work Atmosphere
Hydropower Technology	● Company's Preference ● Less Job Opportunities For Women ● Level Of Competency Against Other Applicants ● Low Number Of Applicant ● Low Percentage Of Graduates On The Female Sector ● Low Turnout ● Male Are More Flexible Considering The Nature Of The Job ● Male Dominated Roles Are Required ● Non Hazardous Positions Suitable For Females Are Limited ● Operations/Shifting Schedule ● Physical Work ● Risk Specifically On Construction Is Not Conducive For Female Applicant ● Women Not Applying ● Women Not Interested In This Field Of Work ● Work Atmosphere

Table 59 shows the list of STEM related jobs where there are low women representations, it can be seen that most occupations deal in the operation and maintenance aspect of the plant. Specific common STEM-related jobs include:

- Engineers - Power Plant Operation and Maintenance
    - Chemical
    - Mechanical
    - Geodetic
    - Electrical
- Technicians - Power Plant Operations and Equipment Maintenance
    - Electrical
    - Mechanical
    - Operators
    - Plant Specialized Technician

Table 59.
STEM Related Occupations with Low representations of Women in the Operation/ Production Plants by Renewable Energy Technology

Renewable Energy Technology	Reasons
Solar Technology	● Cost And Commercial Personnel ● Electrical Engineer ● Electrician ● Electronic Communication Engineer ● Line Electricians ● Line Technicians ● Linemen ● Grounds Maintenance Worker ● O&M Engineer ● O&M Supervisor ● O&M Technician ● Power Plant Field Technician ● Power Plant Maintenance Engineer ● Power Plant Operations Engineer ● Safety And Environment Officer ● System Monitoring For The Solar Generation ● Technician (Troubleshooting On Solar Generation Defects And Problems) ● Welder
Biomass Technology	● Chemical Engineering ● Electrical Engineers ● Engineering Maintenance Personnel ● Mechanical Engineering ● Power Plant Technicians ● Production Supervisor

Renewable Energy Technology	Reasons
Hydropower Technology	• Accountant • Control Specialist • Dam Or Substation Tenders • Electrical Technicians • Equipment Operators • Field Design Engineer • Geodetic Engineer • Heavy Equipment Operator • Maintenance Engineer • Mechanical Technicians • Operations And Maintenance Technician • Operations Engineer • Plant Maintenance Personnel • Plant Operators • Power Plant Designers • Power Plant Engineer • Power Plant Operator • Power Plant Technical Personnel • Power Plant Technician • Welder

4.4 Industry Development and Emerging Skills

Table 60 shows the percentage distribution of impact of skills demand in emerging skills related with industry development over the next 5 years; the following shows the followings list of emerging skills that were identified by at least 50.00% of the participating operational/production plants either as more skills demanded, stayed the same or both:

Solar:

- Solar photovoltaic (PV) power plants
- Battery Energy Storage System (BESS)

Biomass

- Biomass valorization

Hydropower

- Hydropower flexibility
- Hydropower digitalization
- Generators with current-controlled
- Energy storage and variable speed turbines
- Fish-friendly hydropower technologies
- Energy Storage

The Solar representative emphasized the Battery Energy Storage System (BESS) as an

emerging technology in the industry. If TESDA were to consider developing a program for BESS, it would be advisable to embed it under existing programs that are relevant to solar energy technology.

Table 61 shows other related emerging skills listed by the operational/production plants. The answers focus more on the digitalization and big data pathway that most sectors have already been applying to their respective industry.

Solar:

- Analytical Skills and innovation
- Leadership

Biomass:

- Environmental Specialist
- Product Innovation
- Material Science

Hydropower:

- Digitalization Skills

Table 60.

Percentage Distribution on the Impact of Skills Demand in Emerging Skills Associated with the Industry Developments over the Next 1-5 Years by Renewable Energy Technology

Renewable Energy Technology	Emerging Skills	Impact on Skills Demand				
		More skills demanded (%)	*Staying the same (%)*	*Fewer skills demanded (%)*	*Not Applicable (%)*	*Total %*
Solar Technology	**Fourth Industrial Revolution**					
	Passive solar	10.00%	0.00%	10.00%	80.00%	*100.00%*
	Solar photovoltaic (PV) power plants	70.00%	30.00%	0.00%	0.00%	*100.00%*
	Solar thermal installations	20.00%	20.00%	10.00%	50.00%	*100.00%*
	Concentrated solar power	20.00%	10.00%	10.00%	60.00%	*100.00%*
	Solar cooling	20.00%	10.00%	10.00%	60.00%	*100.00%*
	Battery Energy Storage System (BESS)	50.00%	10.00%	0.00%	40.00%	*100.00%*
	Other Industry Developments (e.g Philippine laws, code, roadmap)					
	Energy Efficiency and Conservation Officer	0.00	0.00	0.00	100.00%	100.00%
Biomass Technology	**Fourth Industrial Revolution**					
	Biomass valorization	25.00%	25.00%	0.00%	50.00%	*100.00%*

Renewable Energy Technology	Emerging Skills	Impact on Skills Demand				
		More skills demanded (%)	*Staying the same (%)*	*Fewer skills demanded (%)*	*Not Applicable (%)*	*Total %*
	Pretreatment methods	25.00%	0.00%	25.00%	50.00%	*100.00%*
	Thermochemical conversion	25.00%	0.00%	25.00%	50.00%	*100.00%*
	Biochemical conversion	0.00%	0.00%	25.00%	75.00%	*100.00%*
	Energy Storage	25.00%	0.00%	0.00%	75.00%	*100.00%*
	Other Industry Developments (e.g Philippine laws, code, roadmap)					
	Energy Efficiency and Conservation Officer	50.00%			50.00%	*100.00%*
Hydropower Technology	**Fourth Industrial Revolution**					
	Hydropower flexibility	72.73%	9.09%	9.09%	9.09%	*100.00%*
	Hydropower digitalisation	81.82%	9.09%	9.09%	0.00%	*100.00%*
	Energy storage and variable speed turbines	45.45%	27.27%	9.09%	18.18%	*100.00%*
	Generators with current-controlled rotors	54.55%	18.18%	9.09%	18.18%	*100.00%*
	Novel small-scale hydropower technologies	63.64%	9.09%	18.18%	9.09%	*100.00%*
	Fish-friendly hydropower technologies	63.64%	9.09%	27.27%	0.00%	*100.00%*
	Energy Storage	45.45%	27.27%	9.09%	18.18%	*100.00%*
	Other Industry Developments (e.g Philippine laws, code, roadmap)					
	Energy Efficiency and Conservation Officer	0.00	0.00	0.00	100.00%	*100.00%*

Table 61.
Percentage Distribution on the Impact of Skills Demand in Emerging Skills (Others) Associated with the Industry Developments over the Next 1-5 Years by Renewable Energy Technology

Renewable Energy Technology	Emerging Skills	Impact on Skills Demand				
		More skills demanded (%)	*Staying the same (%)*	*Fewer skills demanded (%)*	*Not Applicable (%)*	*Total %*
Solar Technology	**Fourth Industrial Revolution**					

Renewable Energy Technology	Emerging Skills	Impact on Skills Demand				
		More skills demanded (%)	*Staying the same (%)*	*Fewer skills demanded (%)*	*Not Applicable (%)*	*Total %*
	Analytical Skills and innovation	10.00%	0.00%	0.00%	90.00%	*100.00%*
	STEM (Science, Technology, Engineering and Mathematics)					
	Leadership	10.00%	0.00%	0.00%	90.00%	*100.00%*
Biomass Technology	**Fourth Industrial Revolution**					
	Environmental Specialist	25.00%	0.00%	0.00%	75.00%	*100.00%*
	Product Innovation	25.00%	0.00%	0.00%	75.00%	*100.00%*
	Material Science	25.00%	0.00%	0.00%	75.00%	*100.00%*
Hydropower Technology	**Fourth Industrial Revolution**					
	Digitalization Skills	25.00%	0.00%	0.00%	75.00%	*100.00%*

The number and corresponding distribution of participants who said that they are aware of and ready for the developing skills associated with the growth of the renewable energy industry are displayed in the table. At least 50.00% of participants across all three renewable energy sources are aware of and prepared for the Emerging Skills Associated with the Industry Developments, with solar plants accounting for the largest percentage of responders (80.00%).

Table 62.
Percentage of Operational/ Production Plants that are Aware of and Ready for the Emerging Skills Associated with the Industry Developments by Renewable Energy Technology

Renewable Energy Technology	Yes	%	No	%	Total
Solar Technology	8	80.00%	2	20.00%	100.00%
Biomass Technology	2	50.00%	2	50.00%	100.00%

Renewable Energy Technology	Yes	%	No	%	Total
Hydropower Technology	6	54.55%	5	45.45%	100.00%

Table 63 displays the different actions of the aware plants. A few of the plants provided more than one response. The majority of plants reported having actions in place to meet the requirements; at least 50.00% of participants came from solar and biomass technologies, while hydropower participants were divided between the three options, accounting for 33.33% spread among the choices.

Table 63.
Percentage of Operational/ Production Plants that are Aware of the Emerging Skills Associated with the Industry Developments by Relative Actions Undertaken and by Renewable Energy Technology

	Actions Undertaken		
Renewable Energy Technology	*Established plans to address the requirements.*	*Started some initiatives/programs in terms of training and development of the human resource.*	*Started some initiatives/programs for the acquisition of equipment and materials relevant for the requirements.*
Solar Technology	50.00%	40.00%	10.00%
Biomass Technology	50.00%	25.00%	25.00%
Hydropower Technology	33.33%	33.33%	33.33%

Note: *The divisor is the number of operational/production plants who are aware and ready and not the total number of participating facilities per type of Renewable Energy Technology*

Table 64 displays the percentage distribution of operational/production plants that are aware and responded to the emerging skills. Only 50.00% of operational/production plants from the two renewable energy technologies are included in the table, while a majority of 66.67% from the hydropower plants were highlighted in the presentation.

Table 64.
Percentage of Operational/ Production Plants that have taken action given the identified emerging skill, by Renewable Energy Technology

Renewable Energy Technology	%

Solar Technology	50.00%
Biomass Technology	50.00%
Hydropower Technology	66.67%

Table 65 displays the percentage distribution of operational/production plants that are aware of and prepared for the rising skills connected to the fourth industrial revolution based on their human resource preparations. The majority of operational/production plants (88.89%) stated that they reskill current employees to acquire the necessary competencies, 61.11% stated they will hire new employees with the necessary skills, and 58.33% stated they will reskill current employees to acquire the necessary competencies. Regarding the new skills linked to the fourth industrial revolution, none of the participants had made any additional preparations.

Upskilling programs are typically offered after completing initial education or training. These programs aim to enhance, refine, or update knowledge, skills, and competencies. They help individuals in developing new skills to advance in their present position or progress in their career.

The participants were allowed to choose multiple responses in the questionnaire.

Table 65.
Percentage of Operational/ Production Plants that are Aware of and Ready for the Emerging Skills Associated with the Fourth Industrial Revolution by Preparations on Human Resource

Preparations	%
Hire new employee/s who have the required skills	61.11%
Reskill existing employee/s to acquire the required competencies	58.33%
Upskill existing employee/s to acquire the required competencies	88.89%
Others	0.00%

Note: Multiple responses were allowed

The participants were allowed to choose multiple answers in the questionnaire. After categorizing the participants according to the renewable energy technology (Table 66), the vast majority of plants from all three renewable energy technologies—all biomass

and solar technology respondents—said they would upskill current workers to obtain the necessary competencies, and majority from solar and hydropower also said they will reskill existing workers/s to acquire the required competencies.

Table 66.
Percentage of Operational/ Production Plants that are Aware of and Ready for the Emerging Skills Associated with the Fourth Industrial Revolution by Preparations on Human Resource and Renewable Energy Technology

Response	Renewable Energy Technology		
	Solar Technology %	*Biomass Technology %*	*Hydropower Technology %*
Hire new workers/s who have the required skills	50.00%	100.00%	33.33%
Reskill existing workers/s to acquire the required competencies	75.00%	0.00%	100.00%
Upskill existing workers/s to acquire the required competencies	100.00%	100.00%	66.67%
Others	0.00%	0.00%	0.00%

Note: Multiple responses were allowed

Subsequently, the participants were asked to provide a reason for their inability to take action. Table 67 shows that a majority (56.00%) of those respondents said that they have no infrastructure to use for conducting training/learning and development initiatives, followed by the 32.00% of respondents saying that they have no budget to conduct the training/learning and development initiatives and 20.00% saying they have reasons other than responses listed in the questionnaire.

The results are displayed in Table 68 based on the participants' classification of renewable energy technologies. Both biomass and hydropower technologies have a majority of respondents (75.00% and 63.64%, respectively) who stated that they lack the infrastructure necessary to carry out initiatives for training and development. Only a handful of respondents chose other explanations.

Those “other” reasons given by the participants are given in Table 69 based also on the renewable energy technology classification.

Table 67.

Percentage of Operational/ Production Plants that have not taken action for the emerging skill by Reasons

Reasons	Responses	
	Number	*%*
No budget to conduct the training/learning and development initiatives	8	32.00%
No infrastructure to conduct training/learning and development initiatives	14	56.00%
Others	5	20.00%

Note: Multiple responses were allowed.

Table 68.
Percentage of Operational/ Production Plants that are Aware of and Ready for the Emerging Skills Associated with the Fourth Industrial Revolution but not ready/have taken actions by Responses

Responses	Renewable Energy Technology		
	Solar	*Biomass*	*Hydro*
	%	*%*	*%*
No budget to conduct the training/learning and development initiatives	40.00%	25.00%	27.27%
No infrastructure to conduct training/learning and development initiatives	40.00%	75.00%	63.64%
Others	20.00%	25.00%	18.18%

Table 69.
Other Reasons No Action is Taken by Renewable Energy Technology

Renewable Energy Technology	Other Reasons
Solar Technology	• Ongoing implementation of Policies • No development of company policies for the emerging skills
Biomass Technology	• Still establishing the needed infra and budget allocation

Hydropower Technology	• The company has introduced digitalization and restructuring of HR

4.5 Green Jobs and the Renewable Energy Sector

In 2016, the Philippine government passed Republic Act No. 10771, also known as the “Philippine Green Jobs Act of 2016”. This law aims to identify necessary skills, create training programs, and certify workers for various industries that contribute to environmental preservation, conserve natural resources, and promote the country's sustainable development and transition to a green economy.

In addition, the law offers incentives to businesses that adopt production and manufacturing practices aimed at decarbonizing the economy, minimizing energy, materials, and water usage, and preserving natural resources. These practices also have the potential to generate employment opportunities that are both fulfilling and financially stable, while ensuring workplace security.

Under the law, TESDA is tasked to develop the training regulations needed to carry out skills training, program registration, and assessment and certification. This is done to meet the demand for skilled workers in the green economy.

TESDA is currently implementing efforts to "green" the TVET System. This includes integrating "green" competencies into existing and future programs through the Green TVET Framework, which is overseen by the National Institute of Technical Education and Skills Development - Green Technology Center. These initiatives have revised 89 Training Regulations (TR) to include Green Competencies, which include energy-related qualifications.

TESDA includes the identification and potential priority of "green jobs" through its industry prioritization, which includes the use of methodologies to accurately identify green jobs. The Workplace Skills and Satisfaction Survey is a method being utilized by TESDA to provide input to the skills mapping process. Section 4.5 will present the findings and analysis of the questions regarding green jobs.

In Table 70, shows distribution of operation/production plants by the extent of implementation on the aspect of green jobs. It shows that a majority of plants have either created or changed some jobs that contribute to (1) decarbonization, 72.27%; (2) protecting the ecosystem and biodiversity, 65.91%; (3) reducing energy, materials and water consumption, 81.21%; and (4) minimizing waste and pollution, 80.61%. These results indicate that the plants under the Renewable Energy Sector have made significant changes in applying these aspects in their corporate structures.
Developing the county's renewable energy supply has both economic and environmental benefits. It reduces the country's reliance on fossil fuels and has the potential to

generate in-demand green jobs that are specifically designed for the growing renewable energy sector.

Table 70.
Distribution of Operational / Production Plants by Extent of Implementation on the Different Aspects of Green Jobs

Aspects of Green Jobs	Extent of Implementation			
	No action so far and no plan in the near future (%)	*No action so far but planning to act (%)*	*Have created/changed some jobs as described (%)*	*Total %*
Contribute to 'decarbonization'	8.33%	19.39%	72.27%	*100.00%*
Contribute to 'protecting the ecosystem and biodiversity'	3.03%	31.06%	65.91%	*100.00%*
Contribute to 'reducing energy, materials and water consumption'	0.00%	18.79%	81.21%	*100.00%*
Contribute to 'minimizing waste and pollution'	3.33%	16.06%	80.61%	*100.00%*

The related provisions that resulted in these changes are listed by renewable energy groupings in Table 71. Common provisions added by either two or three renewable energy technology classifications are as follows:

- Tree Planting Activities
- Policies and activities that assist in the preservation of biodiversity and water conservation
- Pollution Control Officer
- Safety Officers
- Provision Of material recovery facility

Based on the results, hiring of pollution control officers and procurement of materials recovery facilities were common provisions identified by respondents from all three (3) renewable energy sectors.

Under the Department of Environment and Natural Resources (DENRs) revised version of the guidelines for Pollution Control Officer, DAO-2014-02, **Pollution Control Officer** is defined as a technical person competent in pollution control and management and is officially accredited by the Environment Management Bureau (EMB) Regional Offices.

The guidelines also provide the list of duties and responsibilities of an accredited PCO, important tasks with regards to sustainability and preservation, as listed below:

- Together with the Managing Head, ensure compliance with the requirements of **PD 1586, RA 6969, RA 8749, RA 9003, RA 9275**, their respective implementing rules and regulations (IRRs), and other pertinent rules and regulations;
- Identify significant environmental aspects and impacts of the establishment's operational activities and recommend possible mitigating measures in the formulation, preparation and/or review of the Environmental Management Plan and Contingency Plan;
- Ensure the proper performance, operation, and maintenance of environmental management facilities or systems of the establishment such as the following:
    - Wastewater treatment facilities;
    - Air pollution control devices referred to in DAO 2000-03,
    - Hazardous waste management storage areas (permanent or
    - temporary);
    - Solid waste segregation/management facilities (i.e. MRFs, sanitary
    - landfills, composting facilities, etc .); and
    - Environmental monitoring devices such as the Continuous Emission, Monitoring Systems, Air Monitoring Stations, effluent flow, metering/measuring devices, groundwater monitoring wells, and other environmental monitoring devices.
- Monitor compliance to the requirements specified in the Environmental Compliance Certificate and the commitments stipulated in the Environmental Management and Monitoring Plans or Environmental Performance Report and Management Plans. and report the same in the Compliance Monitoring Report (CMR);
- Monitor activities pertaining to the installation or construction of pollution source and control facilities to ensure compliance with the National Emission Standards for Source Specific Air Pollutants and National Ambient Air Quality Standards and report monitoring results to DENR as part of the Self-Monitoring Report (SMR);
- Monitor activities pertaining to the operation and maintenance of pollution control facilities to ensure compliance with the Effluent Standards and report monitoring results to DENR as part of the SMR;
- Monitor the use of chemicals, especially those listed under the Priority Chemicals List (PCL) and those with Chemical Control Orders (CCO) and the generation of solid and hazardous wastes. Monitoring data shall be submitted as part of the SMR and the PCL Compliance Certificate;
- Monitor the importation or distribution of chemicals especially those listed under the PCL and those with CCO and the generation of solid and hazardous wastes. Monitoring data shall be submitted as part of the SMR and the PCL Compliance Certificate (applicable only for importers or distributors of chemicals);
- As a liaison officer to EMB, keep himself/herself abreast with the requirements of

the Department;
- Coordinate regulatory programs ,and activities with the city/provincial/municipal governments (if applicable);
- Initiate and intensify environmental management activities including awareness campaign within their organization;

The government also has policies on the establishment of Material Recovery Facilities (MRFs) as stated in Republic Act No. 9003 or the "*Ecological Solid Waste Management Act of 2000*". The DENR defines MRFs as facilities where segregated wastes are brought for final sorting. Additionally, it serves as a location for storing segregated recyclable materials, such as paper, plastics, and metal, until they are sold to junk dealers or recyclers. Additionally, the MRF serves as an infrastructure for the conversion of biodegradable waste into compost.

The Ecological Solid Waste Management Act of 2000 requires the establishment of Material Recovery Facilities (MRFs) in barangays or groups of barangays. The Material Recovery Facilities (MRFs) should be engineered to efficiently receive, sort, process, and store biodegradable and recyclable materials in an environmentally responsible manner. The facility should take into account the following factors:

- The design of the structure, site layout, and equipment should be optimized to provide efficient
- Secure processing, movement, and storage of materials.

Additionally, the facility should be constructed to enable convenient and safe external access and to accommodate smooth internal flow. The EMB Regional Office or the NSWMC Secretariat can offer technical support in setting up a Material Recovery Facility (MRF).

Table 71.
Examples of Organizational Provisions from any Aspects of Green Jobs, by Renewable Energy Technology

Renewable Energy Technology	Provisions
Solar Technology	● **Tree Planting and Seedlings donation to DENR** ● Sustainable future Policies ● **Safety officer** ● **Pollution Control Officer** ● **Procedures in protecting the ecosystem and biodiversity** ● Hybrid work setup which reduces emissions due to commute/travel ● Solar Power Plant Operations Engineer ● Selling of International Renewable Energy Certificates

	(IREC) ● Energy Auditors
Biomass Technology	● Segregation Of Garbage And Minimal Usage Of Energy And Water ● **Pollution Control Officer** ● Program On Waste Minimization ● **Wastewater Facility & Material Recycling Facility**
Hydropower Technology	● **Establishment of Tree Farm That Contributes To The Preservation Of Biodiversity And Water Conservation.** ● **Compliance, Safety And Pollution Officer** ● Environmentalists ● Establishment of Foresters ● **Tree Planting Activities And Watershed Projects** ● **Pollution Control Compliance** ● **Provision Of Material Recovery Facility** ● Less Carbon Footprint Compared To Other Resource-Based Res ● Reducing Waste Materials ● **Training For Pollution Control Officers**

With respect to the Green Jobs Act of 2016, specifically under section 6, the law provides incentives to encourage business enterprises to generate and sustain green jobs. Business will enjoy the following incentives:

- A special deduction can be taken for fifty percent (50%) of the total expenses incurred for skills training and research development. This deduction is in addition to the ordinary and necessary business deductions allowed for these expenses under the National Internal Revenue Code of 1997, as amended; and

- The tax and duty exemption for importing capital equipment is subject to the condition that the equipment be genuinely, directly, and solely utilized to support the creation of environmentally friendly jobs inside the commercial operation.

Additionally, incentives that will be granted under this Act shall be in addition to fiscal and non-fiscal incentives already granted or provided under existing laws, orders, issuances and regulations.

With this, Table 72 displays the number and proportion of operating/production plants classified by renewable energy technology, that have plans on the aspects of green jobs and have been or are being supported by a government agency. The findings indicate that a minimum of 50.00% of the participants from all three technologies have either received incentives or are actively seeking support. Among the participants in the Solar Technology sector, 60.00% have either received incentives or are actively seeking help. In comparison, only 50.00% and 54.55% of respondents in the Biomass and

Hydropower Technology sectors, respectively, fall into this category.

Table 72.
Percentage of Operational/ Production Plants with Plans and Acts on Aspects of Green Jobs that Have Received Support or are Seeking Support from any Government Agency by Renewable Energy Technology

Renewable Energy Technology	Has received Tax Incentives/seeking support from any Government Agency	
	No.	*%*
Solar Technology	**6**	60.00%
Biomass Technology	2	50.00%
Hydropower Technology	6	54.55%

The table below, Table 73, shows the list of government agencies identified by the respondents that have either received incentives or are seeking support in relation to Green Jobs classified per renewable energy technology.

The DOE and DENR were the most common agencies identified by the respondents from all three renewable energy technologies. Other agencies where the respondents have either received incentives or are seeking support are the Department of Labor and Employment (DOLE), Department of Science and Technology (DOST), Energy Regulatory Commission (ERC) and TESDA.

Table 73.
Government Agencies where the Operational/ Production Plants Receive/Seek Assistance in relation to Green Jobs, by Renewable Energy Technology

Renewable Energy Technology	Government Agencies
Solar Technology	● Department of Environment and Natural Resources (DENR) ● Department of Energy (DOE) ● Department of Labor and Employment (DOLE) ● Energy Regulatory Commission (ERC)
Biomass Technology	● Department of Energy (DOE) ● Department of Labor and Employment (DOLE) ● Department of Environment and Natural Resources (DENR) ● Department of Science and Technology (DOST)
Hydropower Technology	● Department of Environment and Natural Resources (DENR) ● Department of Energy (DOE) ● Technical Education and Skills Development Authority (TESDA)

Note: Multiple responses are allowed.

Table 74 displays the form of assistance provided to participants who stated that they received incentives or other forms of support from various government entities. The results indicate that among all types of assistance provided, 50.00% of the participants across the three RE technologies identified the specific type of support offered by various national governments.

Table 74.
Percentage of the support from the Government received by the Operational/ Production Plant

Support from the Government	Renewable Energy Technology					
	Solar		Biomass		Hydro	
	No.	%	No.	%	No.	%
Tax incentives and/or import duties exemption programs	2	33.33%	1	50.00%	1	16.67%
Technical assistance to ensure labor law compliance to green jobs	3	50.00%	0	0.00%	1	16.67%
Data/Information request as reference in the formulation of strategies and potential green jobs development	2	33.33%	0	0.00%	1	16.67%
Operational Plant/ Production Plants, curriculum, and instructional materials development	0	0.00%	0	0.00%	0	0.00%
Program registration, assessment, and certification including green goods and services	2	33.33%	0	0.00%	3	50.00%
Skills development relating to Green Jobs/Skills	0	0.00%	1	50.00%	0	0.00%
Special business facilitation program for business enterprises creating green jobs	0	0.00%	0	0.00%	1	16.67%
Business development support (e.g. prototyping/modeling of technologies, clean technology development)	0	0.00%	1	50.00%	1	16.67%
Environmentally friendly modes of transport	1	16.67%	0	0.00%	0	0.00%

Support from the Government	Renewable Energy Technology					
	Solar		Biomass		Hydro	
	No.	%	No.	%	No.	%
Sustainable tourism planning	0	0.00%	0	0.00%	0	0.00%
Green building practices	0	0.00%	1	50.00%	0	0.00%
Others:						
Seasonal Agricultural Worker Program (SAWP)	0	0.00%	1	50.00%	0	.00%

Note: Multiple responses are allowed.

The survey also examined the participants' knowledge of emerging abilities specific to the classification of renewable energy technologies. The findings are presented in Table 75. The data reveals that a majority of the respondents lack awareness about new skills in the aspect of green jobs. Specifically, just 10.00% of respondents from the solar technology sector, 25.00% from the biomass sector, and 9.09% from the hydropower sector reported having knowledge of any emerging skills.

Table 75.
Percentage of Operational/ Production Plants that are Aware of Emerging Skills Resulting from Green Jobs, by Renewable Energy Technology

Renewable Energy Technology	%
Solar Technology	10.00%
Biomass Technology	25.00%
Hydropower Technology	9.09%

For those respondents that said that they are aware of emerging skills resulting from green jobs, Table 76 shows the list of emerging technologies that they know.

Table 76.
Identified Emerging Skills as a Result of Green Jobs by Renewable Energy Technology

Renewable Energy Technology	Identified Emerging Skills
Solar Technology	● Renewable energy resource development ● Sustainable practice mapping

Renewable Energy Technology	Identified Emerging Skills
Biomass Technology	● Waste Reduction Practices ● Efficient Consumption Of Energy ● Efficient Consumption Of Raw Materials
Hydropower Technology	● Energy traders

Table 77 then shows the percentage of operational/production plants categorized under 'green' industry innovations that are pertinent to present and upcoming company requirements, as well as Renewable Energy Technology. Participants were provided with a list of activities or skills related to the growth of the "green" industry. They were then asked to identify places where these activities or abilities were needed in the business. These areas could be knowledge, skills, competencies, or not applicable to the operational or production plant.

Analyzing the percentages of responses by area with business needs and renewable energy, the following list of “green” industry development activities and skills are applicable to at least 50.00% of the participants in all areas of business needs (Knowledge, Skills and Competencies):

Solar:

- **Pollution Control Officer**
- **Environmental Safety and Regulation Practice**
- Compliance Officer

Biomass:

- **Pollution Control Officer**
- **Environmental Safety and Regulation Practice**
- Environmental impact assessment
- Environmental monitoring
- Waste Management and Recycling Experts
- Environmental Compliance Manager

Hydropower:

- **Pollution Control Officer**
- **Environmental Safety and Regulation Practice**
- Compliance Officer
- Environmental impact assessment
- Environmental monitoring
- Waste Management and Recycling Expert

The results showed that Pollution Control Officer (PCO) and Environmental Safety and Regulation Practice were the common type of “green” industry development identified by the participants across all three (3) renewable energy technologies.

Table 77.
Percentage of Operational/ Production Plants by ‘green’ industry developments relevant to (current and near future) business needs and Renewable Energy Technology

Renewable Energy Technology	"Green" Industry Development	Areas with Business Needs							
		Knowledge (Critical understanding, theories and principles) (%)		*Skills (Skills mastery and innovation for solving complex problems) (%)*		*Competencies (Managing activities and tasks) (%)*		*Not Applicable (%)*	
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Solar Technology	Pollution Control Officer	7	70.00%	5	50.00%	8	80.00%	0	0.0%
	Environmental Safety and Regulation Practice	6	60.00%	5	50.00%	9	90.00%	1	10.0%
	Compliance Officer	6	60.00%	5	50.00%	8	80.00%	1	10.0%
	Environmental Chemist	0	0.00%	0	0.00%	0	0.00%	10	100.0%
	Environmental impact assessment	4	40.00%	4	40.00%	4	40.00%	4	40.0%
	Environmental monitoring	3	30.00%	5	50.00%	6	60.00%	2	20.0%
	Maritime Sustainability Consultants	1	10.00%	1	10.00%	1	10.00%	9	90.0%
	Marine Renewable Energy Specialists	2	20.00%	2	20.00%	2	20.00%	8	80.0%

Renewable Energy Technology	"Green" Industry Development	Areas with Business Needs							
		Knowledge (Critical understanding, theories and principles) (%)		*Skills (Skills mastery and innovation for solving complex problems) (%)*		*Competencies (Managing activities and tasks) (%)*		*Not Applicable (%)*	
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
	Waste Management and Recycling Experts	6	60.00%	4	40.00%	5	50.00%	3	30.0%
	Environmental Compliance Manager	4	40.00%	5	50.00%	6	60.00%	3	30.0%
	Green Operations Advisor	2	20.00%	2	20.00%	3	30.00%	7	70.0%
	Circular Economy Analyst	0	0.00%	0	0.00%	1	10.00%	9	90.0%
	Recycling Program Coordinator	0	0.00%	0	0.00%	1	10.00%	9	90.0%
Biomass Technology	Pollution Control Officer	3	75.00%	4	100.00%	3	75.00%	0	0.00%
	Environmental Safety and Regulation Practice	4	100.00%	3	75.00%	3	75.00%	0	0.00%
	Compliance Officer	2	50.00%	1	25.00%	2	50.00%	1	25.00%
	Environmental Chemist	1	25.00%	0	0.00%	0	0.00%	3	75.00%
	Environmental impact assessment	2	50.00%	3	75.00%	2	50.00%	1	25.00%
	Environmental monitoring	2	50.00%	3	75.00%	2	50.00%	1	25.00%
	Maritime Sustainability Consultants	1	25.00%	0	0.00%	0	0.00%	3	75.00%

Renewable Energy Technology	"Green" Industry Development	Areas with Business Needs							
		Knowledge (Critical understanding, theories and principles) (%)		*Skills (Skills mastery and innovation for solving complex problems) (%)*		*Competencies (Managing activities and tasks) (%)*		*Not Applicable (%)*	
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
	Marine Renewable Energy Specialists	0	0.00%	1	25.00%	0	0.00%	3	75.00%
	Waste Management and Recycling Experts	2	50.00%	3	75.00%	2	50.00%	1	25.00%
	Environmental Compliance Manager	3	75.00%	2	50.00%	3	75.00%	0	0.00%
	Green Operations Advisor	1	25.00%	2	50.00%	1	25.00%	2	50.00%
	Circular Economy Analyst	1	25.00%	0	0.00%	0	0.00%	3	75.00%
	Recycling Program Coordinator	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Hydropower Technology	Pollution Control Officer	10	90.91%	10	90.91%	10	90.91%	0	0.00%
	Environmental Safety and Regulation Practice	10	90.91%	9	81.82%	9	81.82%	0	0.00%
	Compliance Officer	9	81.82%	10	90.91%	10	90.91%	1	9.09%
	Environmental Chemist	4	36.36%	4	36.36%	3	27.27%	3	27.27%
	Environmental impact assessment	8	72.73%	7	63.64%	7	63.64%	1	9.09%
	Environmental monitoring	7	63.64%	7	63.64%	6	54.55%	1	9.09%

Renewable Energy Technology	"Green" Industry Development	Areas with Business Needs							
		Knowledge (Critical understanding, theories and principles) (%)		*Skills (Skills mastery and innovation for solving complex problems) (%)*		*Competencies (Managing activities and tasks) (%)*		*Not Applicable (%)*	
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
	Maritime Sustainability Consultants	2	18.18%	3	27.27%	1	9.09%	3	27.27%
	Marine Renewable Energy Specialists	1	9.09%	1	9.09%	2	18.18%	3	27.27%
	Waste Management and Recycling Experts	6	54.55%	6	54.55%	6	54.55%	1	9.09%
	Environmental Compliance Manager	5	45.45%	6	54.55%	3	27.27%	0	0.00%
	Green Operations Advisor	2	18.18%	2	18.18%	3	27.27%	2	18.18%
	Circular Economy Analyst	1	9.09%	2	18.18%	2	18.18%	3	27.27%
	Recycling Program Coordinator	2	18.18%	3	27.27%	2	18.18%	0	0.00%

4.6 Learning and Development

Table 78 presents the distribution of payroll expenditure dedicated to learning and development (L&D) programs conducted by operational or production plants and external providers, broken down by renewable energy technology. The expenditure is categorized into four ranges: None, Less than 10%, 10-50%, and More than 50%. Based on the provided data, Solar Technology companies show a balanced distribution in their spending on both internal and external training programs. For internal programs, 50% of the respondents allocate less than 10% of their expenditure, while 30% use 10-50%, and the remaining 20% allocate more than 50%. For external programs, only 10% allocate more than 50%, 40% allocate between

10-50%, another 40% allocate less than 10%, and 10% spend nothing. This indicates a moderate to high investment in workforce development for Solar Technology companies.

Biomass Technology companies exhibit minimal internal training investment, with all respondents allocating less than 10%. However, 25% of these companies commit more than 50% of their payroll to external training, showing a reliance on external expertise for training, while the remaining 75% allot less than 10%.

Hydropower Technology companies have a varied approach. For internal training, 18.18% of the companies spend nothing, 27.27% allocate between 10-50%, and 54.55% allocate less than 10%. For external training, 18.18% allocate 10-50% of the payroll expenditure, 72.73% apportion less than 10%, and 9.09% do not dedicate any funds. This suggests a lower overall investment in formal training programs compared to Solar and Biomass technologies.

In terms of training needs assessment, Solar Technology companies again show a balanced result, with 50% allocating between 10-50%, 40% allocating less than 10%, and 10% dedicating more than 50% of their payroll expenditure. Biomass Technology companies are more conservative, with 25% setting aside between 10-50%, 50% allocating less than 10%, and 25% spending nothing. For Hydropower Technology, 18.18% designate between 10-50%, 45.45% allocate less than 10%, and the remaining 36.36% spend nothing.

This data highlights that Solar Technology companies are generally more proactive and balanced in investing in training and development. Biomass Technology relies heavily on external providers for significant training needs, while Hydropower Technology companies appear to invest the least in structured training programs and assessments. This data also supports the previous data presented on the structured program for managing high potential employees, where it was reported that all three (3) RE technologies have implemented programs aimed at training and upgrading the skills of their professional and technical workers, as well as the data on the programs or interventions that the operational/production plants have implemented to enhance the abilities of underperforming employees and and retain high-potential employees.

Table 78.
Distribution of Payroll Expenditure Allocated for Learning and Development Programs Conducted by the Operational/ Production Plants and External Providers by Renewable Energy Technology

Renewable Energy Technology	Payroll Expenditure				
	None	*Less than 10%*	*10-50%*	*More than 50%*	*Total %*

Learning and training programs developed and conducted by the company					
Solar Technology	0.00%	50.00%	**30.00%**	20.00%	*100.00%*
Biomass Technology	0.00%	100.00%	**0.00%**	0.00%	*100.00%*
Hydropower Technology	18.18%	54.55%	27.27%	0.00%	*100.00%*
Learning and training programs developed and conducted by external providers (public and private training providers)					
Solar Technology	10.00%	40.00%	**40.00%**	10.00%	*100.00%*
Biomass Technology	0.00%	75.00%	**0.00%**	25.00%	*100.00%*
Hydropower Technology	9.09%	72.73%	18.18%	0.00%	*100.00%*
Training Needs Assessment conducted by the establishment for their workers					
Solar Technology	0.00%	40.00%	**50.00%**	10.00%	*100.00%*
Biomass Technology	25.00%	50.00%	**25.00%**	0.00%	*100.00%*
Hydropower Technology	36.36%	45.45%	18.18%	0.00%	*100.00%*

In relation to the information presented above, Table 79 below shows the distribution of responses to various statements related to Learning and Development (L&D) programs, categorized by rating scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) and by renewable energy technology (Solar, Biomass, Hydropower).

As seen from the data, in terms of the provision of in-house learning and training programs, all RE technologies have respondents that agree and strongly agree that they do provide in-house learning and training programs. However, 10% of the Solar Technology respondents and 9.09% for Hydropower Technology strongly disagree with this statement. In terms of their support for learning and training programs conducted by private and public training providers, all RE technologies also have respondents in agreement with their support. However, 10% of the respondents from Solar Technology strongly disagree with this statement. As for the provision or

support of learning and training programs that are required by the job (includes both in-house and external programs), Solar Technology has the highest percentage of respondents who are in strong agreement (40%), but it is also the only RE technology that has respondents who strongly disagree with the statement (10%).

When asked about employees having a say in their own learning and training needs, 10% of the Solar Technology respondents strongly disagreed with this, while the remaining 60% and 30% agree and strongly agree respectively. 50% of the Biomass Technology respondents were neutral about this, while the other half agreed. 27.27% of the Hydropower Technology respondents were also neutral, while 63.64% and 9.09% of the respondents agreed and strongly agreed respectively.

In terms of their learning and training programs covering future skills needs, it was also Solar Technology that had respondents strongly disagreeing with the statement (10%). Other Solar Technology respondents agreed (60%) and strongly agreed (30%). Biomass Technology respondents have neutral to positive responses, with 25% answering neutral, another 25% agreeing, and 50% strongly agreeing. Hydropower Technology also had neutral to positive responses, with 27.27% answering neutral, 54.55% agreeing, and the remaining 18.18% in strong agreement.

Lastly, the respondents were asked if their learning and training programs cover STEM skills and competencies. Again, only Solar Technology had respondents in strong disagreement (10%). The rest of the respondents agree (40%) and strongly agree (50%) with the statement. For Biomass Technology, 25% of the respondents were neutral about the statement, while 75% agreed. Meanwhile, for Hydropower Technology, 27.27% of the respondents were neutral, 54.55% agreed, and 18.18% strongly agreed. As presented earlier in Section 4.3, despite the focus on STEM skills, there is underrepresentation of women in STEM jobs across all three RE technologies, particularly in Biomass, where less than 25% of women hold STEM-related positions. Common reasons include male-dominated job types, low female applicants, unattractive STEM roles, and physically demanding positions. Nationally, women occupy only 36.3% of STEM roles, compared to 58.8% in non-STEM fields. This disparity is wider in the Philippines than in neighboring Asia Pacific countries, despite the country's efforts to improve gender equality, as evidenced by its improved ranking in the World Economic Forum's Global Gender Gap Report for 2023. Most STEM jobs with low female representation are in operation and maintenance, such as engineers and technicians in various specializations. This highlights the need for targeted initiatives to encourage more women to pursue and remain in STEM careers within the renewable energy sector.

Table 79.
Distribution of Operational/ Production Plants by Rating Scale Various Statements related to Learning and Development, by Renewable Energy Technology

Statement	Rating Scale					
	Strongly Disagree %	*Disagree %*	*Neutral %*	*Agree %*	*Strongly Agree %*	*Total %*
We provide in-house learning and training programs.						
Solar Technology	10.00%	0.00%	20.00%	20.00%	50.00%	*100.00%*
Biomass Technology	0.00%	0.00%	0.00%	50.00%	50.00%	*100.00%*
Hydropower Technology	9.09%	0.00%	9.09%	54.55%	27.27%	*100.00%*
We support learning and training programs conducted by private and public training providers						
Solar Technology	10.00%	0.00%	0.00%	40.00%	50.00%	*100.00%*
Biomass Technology	0.00%	0.00%	0.00%	75.00%	25.00%	*100.00%*
Hydropower Technology	0.00%	0.00%	27.27%	36.36%	36.36%	*100.00%*
We only provide or support learning and training programs that are required by the job (includes both in-house and external programs)						
Solar Technology	10.00%	0.00%	0.00%	50.00%	40.00%	*100.00%*
Biomass Technology	0.00%	0.00%	50.00%	25.00%	25.00%	*100.00%*
Hydropower Technology	0.00%	18.18%	18.18%	45.45%	18.18%	*100.00%*
Employees have a say in their own learning and training needs.						
Solar Technology	10.00%	0.00%	0.00%	60.00%	30.00%	*100.00%*
Biomass Technology	0.00%	0.00%	50.00%	50.00%	0.00%	*100.00%*
Hydropower Technology	0.00%	0.00%	27.27%	63.64%	9.09%	*100.00%*

Our learning and training programs cover future skills needs.						
Solar Technology	10.00%	0.00%	0.00%	60.00%	30.00%	*100.00%*
Biomass Technology	0.00%	0.00%	25.00%	25.00%	50.00%	*100.00%*
Hydropower Technology	0.00%	0.00%	27.27%	54.55%	18.18%	*100.00%*
Our learning and training programs cover STEM skills and competencies						
Solar Technology	10.00%	0.00%	0.00%	40.00%	50.00%	*100.00%*
Biomass Technology	0.00%	0.00%	25.00%	75.00%	0.00%	*100.00%*
Hydropower Technology	0.00%	0.00%	27.27%	54.55%	18.18%	*100.00%*

Analyzing the two complementary tables on the respondents' L&D programs paints a nuanced picture. Solar Technology stands out with the most extensive offerings, compared to Biomass and Hydropower, mirroring the higher expenditure on its L&D programs found in the previous analysis. This translates to a wider range of in-house and external training opportunities for Solar employees, with a focus on crucial future skills and STEM fields.

4.7 Work and Employment Practice

The succeeding tables tackle the work and employment practices of the RE companies. Table 80 presents the data on the percentage of operational/production plants that have various policies covering specific documents. The data collected represents the whole of the RE sector and was not segregated into the RE technologies. Based on the data, the Training Plan is the most common document among the plants (84.55%), which suggests a strong emphasis on employee training that is critical for maintaining skill levels, ensuring safety, and boosting productivity. The next most common policy is the Business Plan at 79.24%, indicating that these organizations recognize the importance of having a strategic roadmap to guide their operations and growth. Standard Operating Procedure Policies are also widely implemented (74.24%), reflecting the importance of having standardized procedures to ensure consistency, quality, and safety in operations. Policies on the Development for High Potential Staff are also common at 67.58%, highlighting the value placed on nurturing talent and preparing future leaders within the organization. For policies on the Training Budget, 61.52% of the respondents from all RE technologies are reported to have them, which shows that they do allocate financial resources to support their training initiatives. In addition, more than half of the plants (58.94%) conduct feasibility studies, indicating a prudent approach to evaluating the viability of projects before committing resources. Staff Development Policy/Plan was the least common among the respondents, although the responses were still more than half (56.21%). This still signifies that many plants are focused on the continuous development of their workforce.

Table 80.
Percentage of Operational/ Production Plants with Policies Covering Various Documents

Documents	%
Business Plan	79.24%
Training Plan	84.55%
Training Budget	61.52%
Staff Development Policy/Plan	56.21%
Development for High Potential Staff	67.58%
Feasibility Study Preparation	58.94%
Standard Operating Procedure Policies	74.24%

Note: Multiple responses are allowed.

On the other hand, the table below now details the percentage distribution of operational/production plants with policies covering various documents, categorized by renewable energy technology: Solar, Biomass, and Hydropower. For Solar Technology, all plants have SOP policies, ensuring standardization and consistency in operations. Business Plans and Training Plans both have a very high prevalence at 90% each, indicating that nearly all solar technology plants have a structured business plan and a strong commitment to employee training. Training Budget, Staff Development Policy/Plan, and Development for High Potential Staff all had a high percentage of responses at 80% each. Majority of the Solar Energy respondents also conduct feasibility studies (70%).

For Biomass Technology, all respondents have a training plan, highlighting the critical importance of training in biomass technology. The Business Plan is the next most prevalent policy at 75%. Half of the plants have policies that cover Training Budget, Development for High Potential Staff, and Standard Operating Procedure Policies, although these figures are lower compared to other RE technologies. Biomass Technology also had a low percentage on the Staff Development Policy/Plan and Feasibility Study Preparation (25% each), which suggests that there is less emphasis on formal staff development plans and fewer plants conduct feasibility studies for this RE technology.

In terms of the policies covering various documents for the Hydropower Technology, the most prevalent policy is Feasibility Study Preparation. In fact, this is the highest figure among the three RE subsectors. This indicates that Hydropower plants put a strong emphasis on project evaluation. At 72.73% each are the policies on Business Plan, Development for High Potential Staff, and Standard Operating Procedure Policies. The least common policy is the Training Plan with 54.55%.

Based on the data provided, it can be assumed that Solar Technology plants tend to have the most comprehensive coverage across all document types, highlighting a strong overall emphasis on planning, training, and standardization. Biomass technology plants show strong training plans but weaker in other areas such as staff development and feasibility studies. Hydropower technology plants have a balanced approach but show particular strength in feasibility studies and development for high-potential staff.

Table 81.
Percentage Distribution of Operational/ Production Plants with Policies Covering Various Documents by Renewable Energy Technology

Renewable Energy Technology	Policies Covering Various Documents						
	Business Plan	***Training Plan***	***Training Budget***	***Staff Development Policy/Plan***	***Development for High Potential Staff***	***Feasibility Study Preparation***	***Standard Operating Procedure Policies***
Solar Technology	90.00%	90.00%	80.00%	80.00%	80.00%	70.00%	100.00%

Biomass Technology	75.00%	100.00%	50.00%	25.0 0%	50.00%	25.00%	50.00%
Hydropower Technology	72.73%	63.64%	54.55%	63.64%	72.73%	81.82%	72.73%

Note: Multiple responses were allowed.

Table 82 presents data on the percentage of operational/production plants and their full-time employees entitled to various rewards or opportunities. The data was not segregated into the different RE technologies, and thus represents all the sector's respondents. As seen from the data, there is a high entitlement to bonuses and overtime pay, with 87.58% of plants offering performance-based bonuses to 93.94% entitled full-time employees, and 93.94% providing overtime pay to 89.41% employees. These common rewards indicate a strong emphasis on financial incentives tied to performance and extra hours worked.

Non-pay benefits and internal promotions are moderately prevalent, with 85.61% of plants offering non-pay benefits to 83.17% entitled full-time employees and 82.58% providing opportunities for internal promotion to 84.78% employees. These benefits are crucial for employee retention and satisfaction.

Job rotation and share options are less common, with 43.33% of plants offering job rotation opportunities to 54.13% eligible full-time employees and 30.45% providing share options to 49.56% of the employees. Based on these figures, these less common options are also offered to less employees as they have the lowest numbers in the rewards or opportunities. It is also important to note that these benefits are still significant for a notable portion of employees, aiding in career development and long-term incentives.

Meanwhile, individual performance-related pay is available in 62.12% of plants, with 89.42% of employees entitled to this compensation, highlighting a focus on rewarding individual contributions.

Based on this given information, it can be said that renewable energy plants emphasize performance-related financial incentives and provide a balanced mix of rewards and opportunities that support both immediate financial needs and long-term career development.

Table 82.
Percentage of Full-Time Employees in the Operational/ Production Plants Entitled to Various Rewards or Opportunities

Rewards or Opportunities	Percentages	
	Operational/ Production Plants (%)	*Entitled Full-Time Employees (%)*
Individual performance related pay	62.12%	89.42%
Bonuses based on overall organizational performance	87.58%	93.94%
Share options for employees	30.45%	49.56%
Eligible for internal promotion	82.58%	84.78%
Non-pay benefits (such as child-care, health insurance, travel allowance, study leave, food subsidies etc.)	85.61%	83.17%
Opportunities for job rotation at other locations (including overseas)	43.33%	54.13%
Overtime pay	93.94%	89.41%

Note: Multiple responses were allowed.

The next table, Table 83, now provides detailed insights into the percentage of full-time employees in renewable energy operational/production plants who are entitled to various rewards or opportunities, this time according to the RE technologies: solar, biomass, and hydropower technologies. Based on the data, there is a strong emphasis on performance-related financial incentives, with bonuses and overtime pay being highly prevalent. Solar plants offer bonuses in 90% of cases, with 85.56% of employees entitled, while biomass plants universally provide these bonuses, covering 96.25% of employees. Hydro plants, though offering bonuses in 72.73% of cases, ensure 100% employee entitlement. Overtime pay is widely available, with solar and biomass plants offering it universally, and hydro plants covering 81.82% of cases, benefiting 94.44% of employees. Non-pay benefits and internal promotions are also significant, with solar plants providing comprehensive coverage for both,

while biomass and hydro plants offer substantial but slightly less uniform benefits. Job rotation opportunities vary, with solar and hydro plants providing more options compared to biomass plants, which offer none. Share options are the least common benefit, especially in biomass plants, but are highly valued in hydro plants where 100% of employees are entitled. Individual performance-related pay is universally offered in biomass plants, covering 96.25% of employees, while solar and hydro plants have lower provision rates but still ensure high employee entitlement. Overall, the mix of rewards and opportunities in renewable energy plants supports a balanced approach to employee motivation, combining immediate financial incentives with long-term career development benefits.

Table 83.
Percentage of Full-Time Employees in the Operational/ Production Plants Entitled to Various Rewards or Opportunities by RE Technologies

Rewards or Opportunities	RE Technologies					
	Solar		*Biomass*		*Hydro*	
	Operational/ Production Plants (%)	*Entitled Full-Time Employees (%)*	*Operational/ Production Plants (%)*	*Entitled Full-Time Employees (%)*	*Operational/ Production Plants (%)*	*Entitled Full-Time Employees (%)*
Individual performance related pay	50.00%	72.00%	100.00%	96.25%	36.36%	100.00%
Bonuses based on overall organizational performance	90.00%	85.56%	100.00%	96.25%	72.73%	100.00%
Share options for employees	30.00%	38.67%	25.00%	10.00%	36.36%	100.00%
Eligible for internal promotion	100.00%	87.00%	75.00%	83.33%	72.73%	84.00%
Non-pay benefits (such as child-care, health insurance, travel allowance, study leave, food subsidies etc.)	100.00%	87.00%	75.00%	62.50%	81.82%	100.00%

Opportunities for job rotation at other locations (including overseas)	80.00%	72.38%	0.00%	0.00%	50.00%	90.00%
Overtime pay	100.00%	73.80%	100.00%	100.00%	81.82%	94.44%

Note: Multiple responses were allowed.

Meanwhile, the following tables show the distribution of the operational/production plants by extent of sharing various information. Table 84 shows the collective data across all the RE technologies, while Tables 84A, 84B, and 84C present the data for each subsector, namely Solar, Biomass, and Hydro Technology, respectively. The analysis of information sharing practices across various renewable energy technologies reveals distinct patterns. Collectively, operational/production plants demonstrate varied approaches to information dissemination. Financial information is predominantly shared selectively, with only 12.73% of plants sharing it with all employees. Business plans are slightly more widely shared, yet only 15.76% of plants share these with all employees. Operational challenges and market analysis are the most frequently shared types of information, with 53.18% and 36.06% of plants, respectively, sharing these with all employees.

For solar technology plants, the sharing of financial information is relatively limited, with only 20% of plants sharing this information with all employees. Business plans are similarly restricted, with 20% of plants sharing these widely. Conversely, operational challenges are more openly shared, with 80% of plants disseminating this information to all employees. Market analysis information is evenly split, with 40% of plants sharing this with all employees.

Biomass technology plants exhibit a more conservative approach to information sharing. Financial information is shared selectively, with no plants sharing it with all employees. Business plans follow a similar trend, with only selective sharing. Operational challenges are less frequently shared, with no plants distributing this information widely. However, market analysis information sees a 50/50 split between selective sharing and sharing with all employees.

Hydropower technology plants show a different trend, with financial information shared with all employees in 18.18% of plants. Business plans are shared with all employees in 27.27% of plants. Operational challenges and market analysis information are more openly shared, with 54.55% and 18.18% of plants, respectively, sharing these with all employees.

Overall, the analysis highlights that while operational challenges and market analysis information are more frequently shared across all types of renewable energy plants, financial information and business plans are generally kept more restricted, often shared only

with select employees or management. This trend suggests a cautious approach to disseminating sensitive financial and strategic information within the renewable energy sector.

Table 84.
Distribution of the Operational/ Production Plants by Extent of Sharing Various Information

Information	Extent of Sharing			Total (%)
	Not generally shared (%)	*Only with some employees e.g. management only (%)*	*Shared with ALL employees (%)*	
Financial Information	37.12%	50.15%	12.73%	*100.00%*
Business Plans	12.42%	71.82%	15.76%	*100.00%*
Operational Challenges	3.33%	43.48%	53.18%	*100.00%*
Market Analysis	9.70%	54.24%	36.06%	*100.00%*

Note: Multiple responses were allowed.

Table 85A.
Distribution of the Operational/ Production Plants by Extent of Sharing Various Information for Solar Technology

Information	Extent of Sharing			Total (%)
	Not generally shared (%)	*Only with some employees e.g. management only (%)*	*Shared with ALL employees (%)*	
Financial Information	50.00%	30.00%	20.00%	*100.00%*

Business Plans	10.00%	70.00%	20.00%	*100.00%*
Operational Challenges	10.00%	10.00%	80.00%	*100.00%*
Market Analysis	20.00%	40.00%	40.00%	*100.00%*

Note: Multiple responses were allowed.

Table 85B.
Distribution of the Operational/ Production Plants by Extent of Sharing Various Information for Biomass Technology

Information	Extent of Sharing			Total (%)
	Not generally shared (%)	*Only with some employees e.g. management only (%)*	*Shared with ALL employees (%)*	
Financial Information	25.00%	75.00%	0.00%	*100.00%*
Business Plans	0.00%	100.00%	0.00%	*100.00%*
Operational Challenges	0.00%	75.00%	25.00%	*100.00%*
Market Analysis	0.00%	50.00%	50.00%	*100.00%*

Note: Multiple responses were allowed.

Table 85C.
Distribution of the Operational/ Production Plants by Extent of Sharing Various Information for Hydro Technology

Information	Extent of Sharing	Total (%)

	Not generally shared (%)	*Only with some employees e.g. management only (%)*	*Shared with ALL employees (%)*	
Financial Information	36.36%	45.45%	18.18%	*100.00%*
Business Plans	27.27%	45.45%	27.27%	*100.00%*
Operational Challenges	0.00%	45.45%	54.55%	*100.00%*
Market Analysis	9.09%	72.73%	18.18%	*100.00%*

Note: Multiple responses were allowed.

4.8 Business Strategy

In terms of the Business Strategy of the Renewable Energy sector, Table 86 presents the distribution of responses from operational/production plants in the renewable energy (RE) sector regarding their approaches to business, rated on a five-point Likert scale. For the statement about customization in products and services, 44.70% agree and 9.39% strongly agree, indicating a focus on tailored solutions. Regarding competitive success based on price, 46.06% agree and 12.42% strongly agree, suggesting a price-sensitive market. For competing in a market for premium quality products or services, 36.36% agree and 35.45% strongly agree, emphasizing a high standard of quality. In terms of developing unique or innovative products or services, 36.36% agree and 28.36% strongly agree, highlighting an emphasis on innovation. Overall, the responses suggest that the RE sector is characterized by a balance of customization, quality, competitive pricing, and innovation, which are critical factors for success in this industry.

The following tables categorize these responses according to the three RE technologies: Solar, Biomass, and Hydropower.

Table 86.
Distribution of the Operational/ Production Plants by Rating Various Approaches to Business

Approach to Business	**Rating Scale**					
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Total**

Compared to Operational/ Production Plants in the RE Sector, there is a 'more-than-average' amount of customization in our products and services	3.03%	9.39%	33.48%	44.70%	9.39%	*100.00%*
Compared to other Operational/ Production Plants in the RE Sector the competitive success of our products and services is dependent on price in the vast majority of cases	0.00%	9.09%	32.42%	46.06%	12.42%	*100.00%*
Our business mostly competes in a market of premium quality products or services	3.03%	6.36%	18.79%	36.36%	35.45%	*100.00%*
Our products and services rely on developing unique or innovative products or services	0.00%	9.39%	25.15%	39.09%	26.36%	*100.00%*

Tables 87A, 87B, and 87C provide a detailed distribution of responses from operational/production plants in the RE sector, specifically focusing on solar, biomass, and hydro technologies, regarding their business approaches. In the previous analysis, it was noted that the RE sector is characterized by a balance of customization, quality, competitive pricing, and innovation. This detailed breakdown further supports these findings but also highlights some distinctions among different technologies. For biomass technology, 50.00% agree and 10.00% strongly agree on the amount of customization, 70.00% agree and 10.00% strongly agree that success is dependent on price, 60.00% agree and 20.00% strongly agree that they compete in a premium quality market, and 40.00% agree and 20.00% strongly agree on the reliance on innovation. For solar technology, 75.00% agree on customization, 50.00% agree and 50.00% strongly agree that success is price-dependent, and 50.00% agree and 50.00% strongly agree both on competing in a premium market and relying on innovation. For hydro technology, 45.45% agree and 9.09% strongly agree on customization, 18.18% agree and 27.27% strongly agree that success depends on price, 38.36% agree and 38.36% strongly agree on competing in a premium market, and 27.27% agree and 9.09% strongly agree on relying on innovation. These insights highlight the varying emphasis on customization, price sensitivity, quality, and innovation across different RE technologies, reflecting a nuanced landscape within the sector, with solar technology plants showing a higher consensus on all factors compared to biomass and hydro technology plants.

Table 87A.
Distribution of the Operational/ Production Plants by Rating Various Approaches to Business for Solar Technology

Approach to Business	Rating Scale					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Compared to Operational/ Production Plants in the RE Sector, there is a 'more-than-average' amount of customization in our products and services	0.00%	10.00%	30.00%	50.00%	10.00%	*100.00%*
Compared to other Operational/ Production Plants in the RE Sector the competitive success of our products and services is dependent on price in the vast majority of cases	0.00%	0.00%	20.00%	70.00%	10.00%	*100.00%*
Our business mostly competes in a market of premium quality products or services	0.00%	10.00%	20.00%	50.00%	20.00%	*100.00%*
Our products and services rely on developing unique or innovative products or services	0.00%	10.00%	30.00%	40.00%	20.00%	*100.00%*

Table 87B.
Distribution of the Operational/ Production Plants by Rating Various Approaches to Business for BiomassTechnology

Approach to Business	Rating Scale					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total

Compared to Operational/ Production Plants in the RE Sector, there is a 'more-than-average' amount of customization in our products and services	0.00%	0.00%	25.00%	75.00%	0.00%	*100.00%*
Compared to other Operational/ Production Plants in the RE Sector the competitive success of our products and services is dependent on price in the vast majority of cases	0.00%	0.00%	50.00%	50.00%	0.00%	*100.00%*
Our business mostly competes in a market of premium quality products or services	0.00%	0.00%	0.00%	50.00%	50.00%	*100.00%*
Our products and services rely on developing unique or innovative products or services	0.00%	0.00%	0.00%	50.00%	50.00%	*100.00%*

Table 87C.

Distribution of the Operational/ Production Plants by Rating Various Approaches to Business for Hydro Technology

Approach to Business	Rating Scale					
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Total**
Compared to Operational/ Production Plants in the RE Sector, there is a 'more-than-average' amount of customization in our products and services	9.09%	18.18%	45.45%	9.09%	18.18%	*100.00%*

Compared to other Operational/ Production Plants in the RE Sector the competitive success of our products and services is dependent on price in the vast majority of cases	0.00%	27.27%	27.27%	18.18%	27.27%	*100.00%*
Our business mostly competes in a market of premium quality products or services	9.09%	9.09%	36.36%	9.09%	36.36%	*100.00%*
Our products and services rely on developing unique or innovative products or services	0.00%	18.18%	45.45%	27.27%	9.09%	*100.00%*

Meanwhile, Table 88 provides insights into the extent of implementation of collaborations between operational/production plants and academic or government education agencies for future skills supply across different renewable energy technologies. For solar technology, 10.00% of plants have taken no action and have no plans to act in the near future, 50.00% have not taken action yet but plan to do so, and 40.00% have already created or changed some jobs as described. In biomass technology, 25.00% of plants have taken no action and have no plans to act in the near future, another 25.00% have not taken action but plan to act, and 50.00% have created or changed some jobs as described. For hydropower technology, 27.27% of plants have taken no action and have no plans to act in the near future, 54.55% have not taken action but plan to do so, and 18.18% have created or changed some jobs as described. This data highlights varying levels of engagement in collaborative efforts for future skills development, with biomass technology showing the highest level of job creation or change (50.00%), while hydropower technology has the highest percentage of plants planning to take action (54.55%) and solar technology exhibiting an almost balance between those planning to act (50.00%) and those who have already made changes (40.00%).

Table 88.
Distribution of the Operational/ Production Plants by Extent of Implementation on Collaborating with the Academe and the Government Education Agencies for Future Skills Supply by Renewable Energy Technology

Renewable Energy Technology	Extent of Implementation			Total
	No action so far and no plan in the near future	*No action so far but planning to act*	*Have created/changed some jobs as described*	
Solar Technology	10.00%	50.00%	40.00%	*100.00%*
Biomass Technology	25.00%	25.00%	50.00%	*100.00%*
Hydropower Technology	27.27%	54.55%	18.18%	*100.00%*

Table 89 shows the distribution of operational production plants with plans to expand into other areas of renewable energy technology. The data suggests that a significant portion of these plants are looking to diversify their renewable energy production. For instance, the largest portion (60.00%) of plants with expansion plans are focused on solar technology. Following closely behind is biomass technology, with 75.00% of plants planning to expand in this area, while a lower percentage (54.55%) of hydropower plants plan to expand.

Table 89.
Percent Distribution of Operational/ Production Plants with Plans to Expand on Other Areas of Development by Renewable Energy Technology

Renewable Energy Technology	No.
Solar Technology	60.00%
Biomass Technology	75.00%
Hydropower Technology	54.55%

Meanwhile, the last table for this section, Table 90, outlines various areas where renewable energy companies in the Philippines are focusing their efforts for expansion. Solar energy plants have several areas for development, such as building new solar facilities in other provinces, like Bataan, Tarlac, Nueva Eciha, and Palawan. This indicates a geographic diversification strategy to increase solar energy production capacity. Additionally, there is a focus on research and development (R&D), innovation, and forming partnerships with international vendors, highlighting the sector's commitment to technological advancements and global collaboration. There is also a focus on branching out into other renewable energy technologies, demonstrating a commitment to diversification. Moreover, their plans to increase the capacity of existing plants

indicate a drive to enhance production efficiency and output.

For Biomass Technology, their identified areas for development include increasing their plant machines, and feedstock supply/sourcing, and developing new products, all of which exhibit their efforts in boosting production capacity and efficiency, and diversifying the product offerings and exploring new market opportunities within the biomass sector. During the validation meeting, representatives discussed the current shift in focus within the solar technology industry towards roof-mounted systems. As a result, there is expected to be an increased demand for skills related to this specific type of solar technology in the future.

The identified areas of development for hydropower technology include the integration of solar energy projects with hydropower operations, which suggests a move towards hybrid renewable energy solutions, enhancing overall energy production capabilities. Another is the expansion of the number of power plants, which underscores a commitment to increasing the scale of hydropower production. Last is the diversification into other renewable energy technologies like solar and wind, which indicates a strategic approach to broaden the energy mix and reduce dependency on a single energy source.

Table 90.
Areas of Development for Expansion by Renewable Energy Technology

Renewable Energy Technology	Identified Areas of Development
Solar Technology	● New Solar Facilities in Other provinces (Bataan, Tarlac, and Nueva Ecija, North and South Palawan) ● Expansion to Other RE Technologies ● Research and development, innovation, partnerships with international vendors/suppliers ● Increase Plant Capacity
Biomass Technology	● Additional Plant Machines ● Additional Feedstock Supply/ Sourcing ● Development of New products
Hydropower Technology	● Additional Solar Energy Farm Facility Project ● Additional Power Plant Projects ● Expansion to Other RE Technologies such as Solar and Wind

4.9 Work Processes and Technology

Table 91 offers a comprehensive analysis of the operational status of production plants in the renewable energy sector, specifically focusing on the condition of core equipment relative to the best commonly available technology. The table benchmarks equipment conditions against both domestic and international standards across three renewable energy technologies: solar,

biomass, and hydropower.

In the solar technology sector, 80% of plants are equipped with up-to-date technology domestically, while 10% are 1-5 years behind, and another 10% lag by more than 5 years. However, when compared internationally, only 60% of solar plants are up-to-date, with 30% trailing by 1-5 years and 10% by more than 5 years. This indicates that while the majority of solar plants are technologically current within the country, there is a noticeable gap when compared to global standards.

Biomass technology presents a more concerning picture. Domestically, only 50% of biomass plants are up-to-date, with the remaining 50% falling 1-5 years behind. The situation is worse on the international front, where no biomass plants meet the current best technology standards. Instead, 75% are 1-5 years behind, and 25% are more than 5 years behind, highlighting a technological lag in this sector both domestically and internationally.

Hydropower technology shows a mixed scenario. Domestically, 63.64% of hydropower plants are up-to-date, 27.27% are 1-5 years behind, and 9.09% lag by more than 5 years. Internationally, the figures drop, with only 36.36% of plants up-to-date, 45.45% trailing by 1-5 years, and 18.18% by more than 5 years. This indicates a moderate level of technological advancement, with a notable discrepancy between domestic and international standards.

Overall, solar technology plants are the most advanced, with a higher percentage of up-to-date equipment both domestically and internationally. Biomass plants are the least advanced, particularly when benchmarked against international standards. Hydropower plants show a moderate level of technological currency, with a slight portion lagging behind global advancements. This analysis underscores the varying levels of technological adoption across different renewable energy sectors and highlights the need for targeted improvements, especially in the biomass sector, to meet international benchmarks.

Comparing the data from this section to the previous one on business strategy, it can be seen that the renewable energy sector's strategic focus on customization, quality, competitive pricing, and innovation varies across different technologies, reflecting distinct business approaches. Solar plants show strong alignment across all strategic factors, emphasizing comprehensive business strategies and advanced technological status. Biomass plants prioritize cost-effectiveness and premium quality but lag in technology, indicating a need for upgrades. Hydropower plants exhibit moderate engagement in customization and innovation, with balanced but less aggressive strategies. Collaboration for future skills development also varies, with biomass leading in job creation and hydropower showing the highest intent to act. Expansion plans indicate a strong focus on solar and biomass, with hydropower diversifying. This correlation between business strategies, collaboration efforts, expansion plans, and technological advancements underscores the need for targeted improvements, particularly in biomass technology, to meet international standards and enhance sector competitiveness.

Table 91.
Distribution of the Operational/ Production Plants by Core Equipment Condition as Compared with the Best Commonly Available Technology by Renewable Energy Technology

Renewable Energy Technology	How up-to-date is the equipment			
	Up to date	*1 to 5 years behind*	*More than 5 years behind*	**Total**
Compared with those in the country				
Solar Technology	80.00%	10.00%	10.00%	*100.00%*
Biomass Technology	50.00%	50.00%	0.00%	*100.00%*
Hydropower Technology	63.64%	27.27%	9.09%	*100.00%*
Compared with those overseas				
Solar Technology	60.00%	30.00%	10.00%	*100.00%*
Biomass Technology	0.00%	75.00%	25.00%	*100.00%*
Hydropower Technology	36.36%	45.45%	18.18%	*100.00%*

4.10 Organizational Performance

The following tables tackle the organizational performance of operational/production plants in the renewable energy sector. Table 92 in particular presents a breakdown of operational production plants across different renewable energy technologies and their corresponding outcomes from 2022 to 2023, focusing on profitability, total sales/revenue, and market share. In terms of profitability, solar technology witnessed a mix of changes, with 10% of plants decreasing, 50% remaining constant, and 30% increasing. Biomass technology saw 25% of plants decrease in profitability, 25% maintain, and 50% increase. Similarly, hydropower technology experienced variations, with 18.18% decreasing, 18.18% remaining stable, and 18.18% increasing, while 45.45% saw no change. Concerning total sales/revenue, solar and biomass technologies displayed similar trends, with a portion of plants decreasing (10% and 25% respectively), a significant portion staying the same (40% each), and a considerable portion increasing (40% and 50% respectively). Hydropower technology had 9.09% of plants decreasing, 27.27% staying the same, and 18.18% increasing, with 45.45% unchanged. Regarding market share, solar and hydropower technologies demonstrated varying shifts, while biomass technology remained relatively stable. Across all three technologies, there were plants that experienced decreases, stability, and increases in market share, highlighting the complexity of the market dynamics.

The information provided reveals that profitability, sales/revenue, and market share experienced

fluctuations within each technology sector, indicating the dynamic nature of the renewable energy market. While some plants saw decreases in profitability and sales, others remained stable or even increased in these metrics. Market share also exhibited variability, with some plants gaining, losing, or maintaining their share of the market. These findings underscore the importance of adaptability and strategic management for renewable energy plants to navigate changing market conditions and sustain growth in a competitive landscape.

Table 92.
Distribution of the Operational/ Production Plants by Renewable Energy Technology and Rating of Different Outcomes from 2022 to 2023

Renewable Energy Technology	Rating				
	Decrease	Stay the same	Increase	Not Applicable	Total
Profitability					
Solar Technology	10.00%	50.00%	30.00%	10.00%	*100.00%*
Biomass Technology	25.00%	25.00%	50.00%	0.00%	*100.00%*
Hydropower Technology	18.18%	18.18%	18.18%	45.45%	*100.00%*
Total Sales/ Revenue					
Solar Technology	10.00%	40.00%	40.00%	10.00%	*100.00%*
Biomass Technology	25.00%	25.00%	50.00%	0.00%	*100.00%*
Hydropower Technology	9.09%	27.27%	18.18%	45.45%	*100.00%*
Market Share					
Solar Technology	10.00%	50.00%	10.00%	30.00%	*100.00%*
Biomass Technology	0.00%	25.00%	50.00%	25.00%	*100.00%*
Hydropower Technology	9.09%	27.27%	9.09%	54.55%	*100.00%*

The following table (Table 93) now breaks down the data for four categories of employee behavior: going above and beyond the call of duty without being asked, taking up the duties of a colleague without being asked, regularly putting in more hours than contractually expected into their jobs, and making helpful suggestions for improving the operation within the organization. The data is further categorized by the percentage of employees exhibiting each behavior (None, <10, 10-50, >50) and the total number of employees.. The succeeding tables, Tables 93A, 93B, and 93C, breaks down the data for three different renewable energy technologies: solar, biomass, and hydropower respectively.

For Table 93, the data shows that most employees across the renewable energy plants tend to go above and beyond the call of duty without being asked, with 47.12% falling into the 10-50%

range, while only 3.03% do so rarely and 37.42% frequently. Similarly, when it comes to taking up the duties of a colleague without being asked, 45.15% of employees fall into the 10-50% range. However, 42.12% of employees rarely or never put in more hours than contractually expected, indicating a possible adherence to work-life balance. In contrast, a majority (60.45%) of employees frequently make helpful suggestions for improving operations. Overall, the data suggests that while employees are moderately proactive in going above and beyond and taking up additional duties, they are particularly engaged in suggesting improvements, yet less inclined to regularly work beyond their expected hours. This indicates a workforce that is committed to contributing ideas for operational enhancements while maintaining a balanced approach to their workload.

Table 93.
Distribution of the Operational/ Production Plants by Percentage of Employees Exhibiting Various Behavior at Work

Behavior	Number of Employees				
	None	<10	10-50	>50	*Total*
Go above and beyond the 'call of duty' without being asked	3.03%	12.42%	47.12%	37.42%	*100.00%*
Take up the duties of a colleague without being asked	6.36%	14.39%	45.15%	34.09%	*100.00%*
Regularly put in more hours than contractually expected into their jobs	0.00%	23.79%	34.09%	42.12%	*100.00%*
Make helpful suggestions for improving the operation within the organization	0.00%	9.09%	30.45%	60.45%	*100.00%*

Tables 94A, 94B, and 94C provide a comprehensive breakdown of employee behavior within solar, biomass, and hydro renewable energy plants, highlighting distinct patterns in work ethic and engagement. Biomass stands out with the highest percentage of employees (60%) frequently going above and beyond without being asked, indicating strong motivation and a sense of ownership. Solar employees follow with 37.42%, while hydro has 36.36% in this category. Hydro employees lead in taking up colleague duties without being asked (45.45%), suggesting a collaborative culture, compared to solar (45.15%) and biomass (40%). Hydro employees are also least likely to work more than expected, with 36.36% rarely or never doing so, indicating balanced workloads or efficient time management, while solar and biomass report higher percentages (42.12% and 50% respectively). In making suggestions for improvement, hydro employees are the most proactive (72.73%), surpassing solar (60.45%) and biomass (70%), underscoring a culture of continuous improvement. These findings highlight the importance of understanding and fostering unique organizational cultures within renewable

energy plants to optimize employee engagement and productivity.

Table 94. A.
Distribution of the Operational/ Production Plants by Percentage of Employees Exhibiting Various Behavior at Work for Solar Technology

Behavior	Number of Employees				
	None	<10	10-50	>50	*Total*
Go above and beyond the 'call of duty' without being asked	0.00%	10.00%	30.00%	60.00%	*100.00%*
Take up the duties of a colleague without being asked	10.00%	0.00%	40.00%	50.00%	*100.00%*
Regularly put in more hours than contractually expected into their jobs	0.00%	10.00%	50.00%	40.00%	*100.00%*
Make helpful suggestions for improving the operation within the organization	0.00%	0.00%	30.00%	70.00%	*100.00%*

Table 94. B.
Distribution of the Operational/ Production Plants by Percentage of Employees Exhibiting Various Behavior at Work for Biomass Technology

Behavior	Number of Employees				
	None	<10	10-50	>50	***Total***
Go above and beyond the 'call of duty' without being asked	0.00%	0.00%	75.00%	25.00%	*100.00%*
Take up the duties of a colleague without being asked	0.00%	25.00%	50.00%	25.00%	*100.00%*
Regularly put in more hours than contractually expected into their jobs	0.00%	25.00%	25.00%	50.00%	*100.00%*
Make helpful suggestions for improving the operation within the organization	0.00%	0.00%	25.00%	75.00%	*100.00%*

Table 94. C.
Distribution of the Operational/ Production Plants by Percentage of Employees Exhibiting Various Behavior at Work for Hydro Technology

Behavior	Number of Employees				Total
	None	<10	10-50	>50	
Go above and beyond the 'call of duty' without being asked	9.09%	27.27%	36.36%	27.27%	*100.00%*
Take up the duties of a colleague without being asked	9.09%	18.18%	45.45%	27.27%	*100.00%*
Regularly put in more hours than contractually expected into their jobs	0.00%	36.36%	27.27%	36.36%	*100.00%*
Make helpful suggestions for improving the operation within the organization	0.00%	27.27%	36.36%	36.36%	*100.00%*

4.11 Workforce Matters

In the earlier section, Table 14.A showed the distribution of participating operational/ production plants that are employing TVET Graduates and TVET Certified per Renewable Energy Technology, where it can be recalled that around 24% of surveyed plants employ TVET graduates, while about 32% have hired TVET-certified workers. Now, Table 95 shows the percentage of TVET graduate employees and TVET-certified employees in operational/production plants by renewable energy technology. The provided data reveals a gap between the number of TVET graduates and TVET-certified employees. While Biomass boasts the highest percentages (5.09% graduates, 7.38% certified), Solar has the least (2.23% graduates, 1.49% certified). Interestingly, Hydropower has the second-lowest graduates (0.55%) but the second-highest certified employees (6.52%). Overall, there are more certified workers (12.15%) than graduates (3.20%), suggesting on-the-job training or outdated TVET programs may be the cause. Investing in TVET programs that partner with renewable energy companies can ensure graduates possess the necessary skills for this growing industry.

Table 95.
Percentage of TVET Graduate Employees and TVET-Certified Employees in Operational/ Production Plant by Renewable Energy Technology

Renewable Energy Technology	Percentage Employed (%)
TVET Graduate Employees	
Solar Technology	*2.23%*
Biomass Technology	*5.09%*
Hydropower Technology	*0.55%*
Total	***3.20%***

TVET Certified Employees	
Solar Technology	*1.49%*
Biomass Technology	*7.38%*
Hydropower Technology	*12.15%*
Total	***6.52%***

Meanwhile, Table 96 shows the satisfaction rating of vocational and technical education (TVET) program graduates and certified employees on their work and performance. Based on the data, there is a consistent high rating of satisfaction among both TVET graduates and certified professionals. Both groups showed the highest level of agreement (47% each) in feeling highly satisfied with their work and performance, with no instances of strong disagreement or irrelevant responses. While a slightly larger proportion of TVET graduates (58.33%) expressed neutrality compared to certified employees (55.56%), the difference was minimal. Certified employees displayed a slightly stronger inclination towards agreement (44.44%) than TVET graduates (41.67%). These results suggest that TVET programs may effectively equip graduates with necessary skills, or individuals perceive their skills as well-utilized in their roles. Positive organizational culture may also contribute to this satisfaction. It's important to note that this data comes from a single source and may not fully represent the entire TVET workforce. However, the high satisfaction levels are promising.

Table 96.
Distribution of Operational/ Production Plants with TVET-Graduate Employees by Satisfaction Rating on Employees Work and Performance

TVET Workforce	Satisfaction Rating						
	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Not Applicable*	**Total**
TVET Graduate	0.00%	0.00%	0.00%	58.33%	41.67%	0.00%	*100.00%*
TVET Certified	0.00%	0.00%	0.00%	55.56%	44.44%	0.00%	*100.00%*

The following tables, Tables 97A, 97B and 97C, now specify distribution of operational/production plants with TVET-graduate employees by satisfaction rating on employees work and performance for each subsector, namely Solar Technology, Biomass Technology, and Hydro Technology respectively. In Solar Technology, a notable 100% of employees expressed satisfaction with their work and performance, evenly split between "Strongly Agree" and "Agree" responses. Similarly, Biomass Technology exhibited high satisfaction rates, with all TVET graduates and two-thirds of certified employees reporting satisfaction. Conversely, Hydro Technology demonstrated a higher satisfaction rate among certified employees (75%) compared to TVET graduates (25%). These findings hint at several potential factors contributing to employee satisfaction, including the effective preparation of graduates by TVET programs, a strong alignment between job roles and individual skills, and

positive company cultures. However, it's essential to acknowledge the limitations of the data, such as the small sample size and potential variations in company dynamics. The unanimous satisfaction within Solar Technology particularly calls for further investigation into its underlying drivers. Despite these nuances, the overall trend suggests a prevalent satisfaction among both TVET graduates and certified employees in the renewable energy sector, though additional data would be necessary for more conclusive insights.

Table 97A.
Distribution of Operational/ Production Plants with TVET-Graduate Employees by Satisfaction Rating on Employees Work and Performance for Solar Technology

TVET Workforce	Satisfaction Rating						
	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Not Applicable*	**Total**
TVET Graduate	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	*100.00%*
TVET Certified	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	*100.00%*

Table 97B.
Distribution of Operational/ Production Plants with TVET-Graduate Employees by Satisfaction Rating on Employees Work and Performance for Biomass Technology

TVET Workforce	Satisfaction Rating						
	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Not Applicable*	**Total**
TVET Graduate	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	*100.00%*
TVET Certified	0.00%	0.00%	0.00%	66.67%	33.33%	0.00%	*100.00%*

Table 97C.
Distribution of Operational/ Production Plants with TVET-Graduate Employees by Satisfaction Rating on Employees Work and Performance for Hydro Technology

TVET Workforce	Satisfaction Rating						
	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*Not Applicable*	**Total**
TVET Graduate	0.00%	0.00%	0.00%	25.00%	75.00%	0.00%	*100.00%*

TVET Certified	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%	*100.00%*

CONCLUSIONS AND RECOMMENDATIONS

The workplace skills and satisfaction survey conducted within the renewable energy sector offers valuable insights into the current state of the workforce, revealing both strengths and areas for improvement. Across solar, biomass, and hydropower technologies, employees demonstrate varying levels of engagement, skill utilization, and satisfaction, reflecting the diverse dynamics within each subsector.

The findings emphasize the critical importance of aligning workforce development initiatives with national priorities, particularly those outlined in the National Technical Education and Skills Development Plan (NTESDP) 2023-2028. Integrating green skills training, expanding TVET offerings, fostering industry collaboration, promoting lifelong learning, driving innovation, and ensuring quality assurance are essential steps to address skills gaps, enhance workforce productivity, and support sustainable economic growth within the renewable energy sector.

The report highlights the gender disparity in the renewable energy sector, with women making up only 18.15% of the workforce in operating/production plants and less than 20% of all jobs across various renewable energy technologies. This underrepresentation is particularly notable in STEM-related positions, where common barriers include male-dominated job types, low female applicants, unattractive STEM roles, and physically demanding positions. Despite the national efforts to promote gender equality, as reflected in the improved ranking in the World Economic Forum's Global Gender Gap Report for 2023, women remain significantly underrepresented in STEM fields, particularly in renewable energy. The report also underscores the sector's strategic focus on customization, quality, competitive pricing, and innovation, with solar plants showing strong alignment across all strategic factors, biomass plants prioritizing cost-effectiveness and premium quality, and hydropower plants exhibiting moderate engagement in customization and innovation.

Additionally, the report highlights the employment and educational landscape within the renewable energy sector. The majority of employees are college-level graduates, with significant job openings requiring a college degree or technical vocational education and training (TVET). While biomass plants employ the highest percentage of TVET graduates and certified workers, there are more certified workers overall than graduates. Salary data reveals that most employees earn above the minimum wage but less than Php 26k, with TVET graduates and certified workers in hydropower plants earning slightly more. The high turnover rates, particularly among professionals and service workers, are driven by a lack of career prospects and low wages compared to other companies. Despite these challenges, the high satisfaction ratings among TVET graduates and certified employees suggest that TVET programs effectively equip individuals with the necessary skills and contribute to a positive organizational culture. This comprehensive analysis underscores the need for targeted initiatives to address gender

disparities, improve job conditions, and enhance skills development in the renewable energy sector.

Overall, the findings highlight the importance of tailored strategies for each renewable energy technology, recognizing distinct patterns in workforce engagement, skill utilization, and satisfaction. For example, biomass technology plants report the highest percentage of employees going above and beyond without being asked, indicating strong motivation and ownership. Conversely, hydropower technology plants demonstrate the highest satisfaction rates among certified employees, suggesting effective training programs or job role alignment.

Recommendations on the Identified Issues and Policy Implication

1. Explore TVET as a means to impart skills needed by workers under the top occupational types in the sector.
    a. Given that a significant proportion of college-educated individuals are employed in the sector, and that the top three occupations are professionals, technicians and associate professionals, as well as clerical support, it is evident that the industry is inclined towards professionalization. Certain occupations were found to both require a college degree and TVET Certification.

    b. Thus, TESDA can work with industry stakeholders to identify qualifications that can be complemented with TESDA programs.

    c. TESDA and CHED can use programs in Baccalaureate courses as part of the implementation of the Philippine Credit Transfer System.

2. Review of Existing TVET programs for the RE sector terms of the following:
    a. Based on the skills in-demand and urgently needed, TESDA identified various skills for prioritization. It was also noted that some of the identified skills have corresponding programs already being implemented by TESDA.
    b. For those who were identified as having corresponding TVET Programs, TESDA must review existing Training Regulations and competency standards to fit the technical skills/job requirements of the RE sector is recommended, to ensure that they are closely aligned with the sector's needs. The review of the existing programs will require the updating of training arrangements, assessment arrangements, including the upgrading of trainers and assessors. Based on the study, the TVET programs for review are as follows:

RE Technology	Value Chain	Priority 1	Priority 2	Equivalent TVET Program
For Training Regulations Development				
Hydro	Operation and	Electrical		Electrical Installation and

	Maintenance	Technicians		Maintenance NC II
Hydro	Operation and Maintenance	Pipe fitters		Pipefitting (Metallic) NC II
Hydro	Construction and Installation	Heavy machinery Operators		Heavy Equipment Operation (Bulldozer) NC II HEO (Articulated Off-Highway Dump Truck) NC II HEO (Backhoe Loader) NC II HEO (Concrete Pump) NC II HEO (Container Stacker) NC II HEO (Crawler Crane) NC III HEO (Forklift) NC II HEO (Hydraulic Excavator) NC II HEO (Wheel Loader) NC II HEO (Motor Grader) NC II HEO (Overhead and Gantry Crane) NC III HEO (Paver) NC II HEO (Rigid Off-Highway Dump Truck) NC II HEO (Rigid On-Highway Dump Truck) NC II HEO (Road Roller) NC II HEO (Rough Terrain Crane) NC III HEO (Screed) NC I HEO (Tower Crane) NC III HEO (Transit Mixer) NC II HEO (Truck Mounted Crane) NC III
For Competency Standards Development				
Solar	Construction and Installation	Photovoltaic System Installers		PV Systems Installation NC II
Solar	Operation and Maintenance	Maintenance Electrician		Electrical Installation and Maintenance NC II
Hydro	Construction and Installation	Electrical Technicians		Electrical Installation and Maintenance NC II
Hydro	Construction and Installation	Pipe fitters		Pipefitting (Metallic) NC II

c. The identified skills/jobs in this survey, as mentioned above, shall comprise the priorities of TESDA for program development and scholarship allocation.

Meanwhile, the jobs/skills from the list which require higher education or baccalaureate degree may be consulted/ endorsed to government agencies (e.g., Commission on Higher Education) with jurisdiction to it.

d. It is important to prioritize the review of courses related to Photovoltaic (PV) Systems. This is based on the validation meeting where representatives from the Solar Technology Industry emphasized the need for different skills in order to pursue Roof Mounted Solar Systems.

3. Development of New TVET Programs including Emerging Green Skills Required by the RE Sector
    a. In the advent of industry developments, the development of new programs that are required by the sector is also recommended. These can be undertaken through the development of new competency standards, microcredentials, and/or specialized training modules reflecting current industry demands and emerging technologies. As gleaned from the results of the study, the following programs are recommended for development of TVET programs:

RE Technology	Value Chain	Priority 1	Priority 2	Remarks
For Training Regulations Development				
Solar	Operation and Maintenance		Photovoltaic maintenance specialists	
Hydro	Operation and Maintenance	Mechanical Technicians		
Hydro	Project Development	Physical and environmental scientists (hydrologists, geologists, ecologists)		
Hydro	Project Development	Land use negotiator		
Hydro	Operation and Maintenance		Plant workers	
For Competency Standards Development				
Solar	Construction and Installation		Electricians (specializing in solar)	

Biomass	Operation and Maintenance		Operation and maintenance specialists	
Biomass	Operation and Maintenance		Biofuels Processing Technicians	
Biomass	Construction and Installation		Laboratory technicians and assistants (specific to Biomass)	
Biomass	Equipment Manufacture and Distribution	Biomass Manufacturing technicians		

b. The Biomass Renewable Energy Alliance, Inc (BREA) also provided a list of in-demand skills not mentioned in the skills mapping, they also added that the skills are needed in plants with higher capacity. Based on this, the following skills are advised to be developed into ***Competency Standards*****:**
    - Power Market Analysts
    - Energy Traders
    - Plant Operators
    - Distributed control system (DCS) Engineers
    - Plant Auxiliary Operators

    This is because the participants from the validation also noted that there are few workers needed in operating and maintaining power plants.

c. TESDA must also look into developing identified emerging technologies and skills as part of its mandate to promulgate relevant standards.

Emerging Technology	
RE Technology	Emerging Technology
Solar	● Solar photovoltaic (PV) power plants ● Battery Energy Storage System (BESS)
Biomass	● Biomass valorization
Hydropower	● Hydropower flexibility ● Hydropower digitalization ● Generators with current-controlled ● Variable speed turbines

	● Fish-friendly hydropower technologies ● Energy Storage

4. It is recommended to prioritize the enhancement of the integration of TVET graduates and certified workers into the RE sector.
    a. Promote the recognition of TVET certification in the industry to boost the employment prospects of TVET-certified workers.
    b. TESDA is recommended to foster collaboration with the RE sector to establish clear pathways from secondary education through TVET into RE sector employment, and develop joint programs enabling TVET graduates to pursue higher degrees, thereby enhancing their employability.
    c. TVET must be promoted as a viable career path. This can be achieved through the strengthening of the partnership between TESDA and the RE companies, wherein they collaborate in conducting awareness campaigns and providing career guidance to highlight RE sector opportunities for TVET graduates and certified workers, while establishing job placement services tailored to their needs and engaging with employers to facilitate hiring.
    d. It is also recommended to support lifelong learning and skills upgrading for TVET graduates by offering opportunities for continuous education and adapting to industry changes, alongside implementing Recognition of Prior Learning (RPL) systems to acknowledge their skills and ease their transition into more advanced roles.

5. In relation to the previous recommendation, the delivery of Enterprise-Based Training is recommended to be strengthened.
    a. To enhance employability in the RE sector, TESDA should bolster enterprise-based training through dual training, apprenticeships, and in-company programs, crucial for equipping graduates with industry-relevant theoretical knowledge and practical skills essential for successful careers.

    b. It is necessary to review the delivery mode based on the validation meeting. Some representatives pointed out that many plants are located in remote areas, which could hinder the agency and partner industry's ability to provide face-to-face training services.

    c. TESDA should encourage more companies/employers in the sector to participate as training providers to increase the capacity to provide training for the sector's critical skills needs.

6. Green Jobs and Sustainable Practices are recommended to be promoted and enhanced further in TVET.
    a. The integration of green competencies in TVET programs must be adhered to, most especially for programs related to RE. Thus, the curriculum of the existing programs must be reviewed to incorporate sustainability concepts and green technologies. Moreover, specialized modules focused on renewable energy, waste management, water conservation, and sustainable agriculture can be developed to further promote green competencies in TVET.

    b. A Training of Trainers for green competencies must be conducted. Further, trainers must be encouraged to attend industry conferences and seminars on sustainability.

    c. It is also recommended for TVIs to partner with companies in the RE sector to ensure that training programs meet industry needs, arrange internships and apprenticeships with businesses that practice sustainability, and establish advisory boards with industry experts to guide curriculum updates.

    d. Competency assessment tools must also be reviewed to measure students' proficiency in green competencies. Moreover, it must be ensured that certifications are recognized by industries and align with national and international standards.
    e. Through TESDA's National Institute for Technical Education and Skills Development - Green Technology Center (NITESD-GTC) possible skills/competencies for green skills and jobs may be embedded to existing related programs or be studied for program development.

Emerging Green Skills and Jobs	
Jobs	**Skills**
● **Pollution Control Officer** ● Compliance Officer ● Waste Management and Recycling Experts ● Energy traders	● **Environmental Safety and Regulation Practice** ● Environmental impact assessment ● Environmental monitoring ● Renewable energy resource development ● Sustainable practice mapping

7. Encourage Participation of Women in STEM and RE related programs
    a. There is a low percentage of women working in the three RE technologies, with fewer being employed in STEM positions.

    b. TESDA may be able to support this aspect as the agency has been continuously advocating for women in non-traditional trades. With this, it is recommended to continue gender mainstreaming through the integration of gender perspectives into all programs and projects, ensuring that gender considerations are central to planning, implementation, monitoring, and evaluation.

    c. Gender-Sensitive Policies and Practices must be strengthened. Relative to the implementation of Enterprise-Based Training, a thorough review of existing policies of these companies must be conducted to ensure they promote gender equality and implement new policies where gaps are identified. This includes policies related to recruitment, training, workplace environment, and career progression. Moreover, the enterprises must be encouraged to develop recruitment campaigns specifically aimed at attracting women to STEM roles in the sector.

    d. To expand access to STEM education and training, TESDA should offer scholarships, grants, and financial incentives for women to pursue STEM education and training programs and partner with schools, colleges, and universities to enhance STEM curriculum and create pathways that lead directly to careers in the RE sector.

8. To empower TVET graduates and certified workers in the RE sector to secure competitive salaries, advance their careers, and contribute effectively to sustainable economic development, it is recommended that TESDA focus on skills development, particularly on 21st century skills, financial literacy, industry alignment, and advocacy for fair compensation.
    a. Through the collaboration of TESDA with the RE sector, it is recommended that the sector enhances its skills-based salary progression by developing frameworks that link skills acquisition through TVET programs to salary progression in the sector, encouraging continuous skills development and upgrading.

    b. TESDA is also recommended to strengthen their financial literacy programs to empower graduates in effectively managing their salaries and planning for long-term financial stability. Moreover, TESDA is also recommended to strengthen the integration and delivery of 21st century skills to ensure that graduates are well-equipped to meet the demands of a modern workforce. This includes enhancing their capabilities in critical thinking, problem-solving, digital literacy, and adaptability, which are essential for success in an ever-evolving job

market. By focusing on these areas, TESDA can help create a more competent and resilient workforce that is capable of thriving in various industries, including the rapidly growing renewable energy sector.

c. Industry-responsive training is also recommended to be strengthened by collaborating closely with industry partners to ensure TVET programs are aligned with the evolving skills demands of the renewable energy sector, thereby enhancing graduates' marketability and potential for higher salaries.

d. Through the career guidance counseling services of TVIs, TVET graduates and certified workers can be encouraged to pursue specialized training and certifications that qualify them for higher-salary positions within RE technologies, such as advanced installation and maintenance roles.

9. Strengthen Partnerships with RE associations/companies on the recognition of future graduates in TVET.
    a. It is notable that there is a low percentage of hired workers that are either TVET graduates or TVET certified across the sector.

    b. Thus, it is recommended that TESDA collaborate with the industry through strong partnerships. Possible candidate for partnerships are the associations who showed interest in collaborating with TESDA at the validation meeting which are:
        - Philippine Solar and Storage Energy Alliance (PSSEA)
        - Biomass Renewable Energy Alliance, Inc (BREA)
        - Philhydro Association, Inc. (PHILHYDRO)

    c. Through this, TESDA may encourage the industry to consider TVET graduates in their hiring policy;

    d. Possible partners may also be encouraged to become training providers or provide experts in the development of TVET programs.

10. It is recommended that TESDA help address the employee turnover and reasons for resignations in the RE sector.
    a. TESDA and RE companies are recommended to enhance career development opportunities by developing and promoting career advancement pathways within TVET programs emphasizing continuous skill development and professional growth, strengthen job matching and placement services to better align TVET graduates' skills with industry demands, and improve wage and benefits awareness through incorporation of modules on wage negotiation and understanding benefits packages within TVET curricula to empower graduates in making informed decisions about job offers, thus mitigating turnover driven by wage disparities compared to industry standards.

b. Possible collaboration with industry stakeholders may include the practices to improve working conditions, job satisfaction, and employer engagement in renewable energy plants, addressing concerns about location, workplace safety, and overall job attractiveness to reduce turnover and foster a supportive work environment through partnerships with TESDA.

c. TESDA is also recommended to establish mechanisms to monitor sectoral challenges affecting employee retention in RE technologies, enabling TESDA to proactively adapt training programs and policies.

11. Endorse the results of the survey to the TESDA Regional and Provincial Offices to Enhance the implementation of the Area-Based Demand Driven TVET program related to Renewable Energy Sector.
    a. In order to enhance the effectiveness of the Area-Based and Demand Driven TVET as the agency's central strategy, it is recommended that provincial and regional offices enhance their respective Provincial and Regional TESDP Action Programming by aligning it with the specific areas of development identified by the renewable energy industry. Notable provinces in the solar industry with potential areas of development include Bataan, Tarlac, Nueva Ecija, and Palawan.
        i. Thru, TESDA may be able to further enhance its current list of priority skills in the energy sector *(see Annex E)*
    b. Additionally, there are ongoing RE operational/production plant projects that the DOE has approved. Thus, TESDA ROPO's are advised to meet and consult with DOE counterparts to know where TESDA can provide support in terms of skills training and enhancement.

Recommendations on the Conduct of the Survey

1. Commitment and endorsement of relevant government agencies, such as the Department of Energy - Renewable Energy Management Bureau (DOE-REMB) was crucial to the success of the survey. The DOE-REMB provided TESDA with a list of RE developers and operational/production plants that were included in the universe. Additionally, the DOE-REMB assisted TESDA in following up on possible respondents when the response rate was still low. It can be concluded that associations are more likely to respond to a survey when it is mentioned that their organizations have government endorsement. For future WSS Surveys, it is recommended that TESDA obtain the commitment and support of the primary government agency or agencies for each respective sector.

2. According to the feedback from the survey respondents, they mentioned that the length of the survey was an issue that led to their delay to participate. Therefore, it is advisable to properly assess and compress the survey to make it more appropriate for future surveys. Specifically in Section C, TESDA needs to further narrow its scope of analysis

to which value chain is used.

One participant in the validation process commented that the survey included the construction and installation phase of the value chain, which requires an entirely different set of skills and people compared to the actual operation and maintenance of a plant where most of the renewable energy specific skills are needed.

3. Another challenge that emerged during the implementation was that although some plants expressed interest in participating, there were additional obstacles that hindered their ability to complete the survey, such as schedule conflicts. It is advisable to have a pool of potential replacements ready before commencing the survey.

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Annex A
Projected Distribution of Skills Supply, Hard-to-fill Skills, and Highest Educational Qualifications For Solar Technology

Note: All Not Applicable (NA) entries/responses in C6.1 were not included in this table.

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Equipment Manufacture and Distribution	Chemical laboratory technicians and assistants		10.00%		0.00%	100.00%	0.00%	0.00%	100.00%
Equipment Manufacture and Distribution	Software engineers		20.00%		50.00%	50.00%			100.00%
Equipment Manufacture and Distribution	Modellers								
Equipment Manufacture and Distribution	Manufacturing engineers		20.00%		100.00%				100.00%
Equipment Manufacture and Distribution	Manufacturing technicians		10.00%	10.00%		100.00%		50.00%	50.00%
Equipment Manufacture and Distribution	Manufacturing operators		10.00%			100.00%	100.00%		

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Equipment Manufacture and Distribution	Building systems specialists								
Equipment Manufacture and Distribution	Manufacturing quality assurance experts								
Equipment Manufacture and Distribution	Logistics professionals		20.00%		50.00%	50.00%	50.00%		50.00%
Equipment Manufacture and Distribution	Logistics operators		10.00%			100.00%	100.00%		
Equipment Manufacture and Distribution	Equipment transporters		20.00%			100.00%	50.00%		50.00%
Equipment Manufacture and Distribution	Procurement professionals		20.00%			100.00%	50.00%	50.00%	
Equipment Manufacture and Distribution	Marketing specialists		10.00%		100.00%				100.00%
Project Development	Project designers (engineers)		50.00%		20.00%	80.00%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Developers/ facilitators	10.00%	20.00%		33.33%	66.67%			100.00%
Project Development	Environmental and social NGO representatives	10.00%	30.00%		50.00%	50.00%			100.00%
Project Development	Procurement professionals		30.00%			100.00%			100.00%
Project Development	Seaman (Floating Solar)								100.00%
Construction and Installation	Solar Thermal System designer	10.00%	10.00%		50.00%	50.00%			
Construction and Installation	Plumbers specializing in solar		10.00%		20.00%	80.00%		100.00%	
Construction and Installation	Photovoltaic System designer (electrical engineers or technologists)	10.00%	40.00%		20.00%	80.00%	20.00%		80.00%
Construction and Installation	Electricians specializing in solar		70.00%		16.67%	66.67%	14.29%	42.86%	42.86%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Construction and Installation	Roofers specializing in solar		20.00%			100.00%	50.00%	50.00%	
Construction and Installation	System designers (electrical/ mechanical/ structural engineers)	10.00%	40.00%			100.00%			100.00%
Construction and Installation	Photovoltaic System Installers		60.00%			100.00%	16.67%	33.33%	50.00%
Construction and Installation	Welders		30.00%			100.00%	33.33%	66.67%	
Construction and Installation	Pipe fitters		20.00%			100.00%		100.00%	
Construction and Installation	Project Evaluators	10.00%	10.00%		50.00%	50.00%			100.00%
Construction and Installation	Software engineers	10.00%	40.00%		40.00%	60.00%	20.00%		80.00%
Construction and Installation	Quality assurance specialists		30.00%		33.33%	66.67%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Construction and Installation	Commissioning engineer (electrical)	10.00%	50.00%		16.67%	66.67%	16.67%		83.33%
Construction and Installation	Transportation workers		30.00%			100.00%	33.33%	33.33%	33.33%
Construction and Installation	Seafarer/ Seaman (Floating Solar)								
Operation and Maintenance	Photovoltaic maintenance specialists (electricians specializing in solar)	70.00%			14.29%	57.14%		42.86%	42.86%
Operation and Maintenance	Solar Thermal maintenance specialists (Plumbers specializing in solar)		10.00%			100.00%			100.00%
Operation and Maintenance	Concentrated Solar Power maintenance specialists		30.00%			100.00%			100.00%
Operation and Maintenance	Inspectors		20.00%			100.00%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Recycling specialists		20.00%			100.00%			100.00%
Operation and Maintenance	Building inspector		10.00%			100.00%			100.00%
Operation and Maintenance	Sales occupations		10.00%			100.00%			100.00%
Operation and Maintenance	Sales representatives or estimators		20.00%			100.00%			100.00%
Operation and Maintenance	Solar Thermal Installers and Technicians		30.00%			100.00%			100.00%
Operation and Maintenance	Solar Energy Systems Engineers		50.00%		60.00%	40.00%			100.00%
Operation and Maintenance	Electrical Engineers		90.00%		11.11%	88.89%			100.00%
Operation and Maintenance	Energy Auditors		20.00%			100.00%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Building-Wiring Electrician					100.00%		25.00%	50.00%
Operation and Maintenance	Residential/Commercial -Wiring Electrician		10.00%			100.00%		100.00%	
Operation and Maintenance	Maintenance Electrician		70.00%			71.43%		42.86%	42.86%
Operation and Maintenance	Occupational Safety and Health		80.00%			75.00%			87.50%
Operation and Maintenance	Laborer		50.00%			60.00%	80.00%		
Operation and Maintenance	Pile-driving and drilling		20.00%		50.00%	50.00%	100.00%		
Operation and Maintenance	Environmental Science Professionals		20.00%						100.00%
Cross-Cutting/ Enabling Activities	Trade association and professional society staff								

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Cross-Cutting/ Enabling Activities	Management	20.00%	70.00%	10.00%	50.00%	50.00%	10.00%		80.00%
Cross-Cutting/ Enabling Activities	Administration	10.00%	70.00%	10.00%	11.11%	88.89%	11.11%	11.11%	77.78%
Cross-Cutting/ Enabling Activities	Publishers and science writers								
Cross-Cutting/ Enabling Activities	IT professionals		40.00%		25.00%	75.00%	25.00%		75.00%
Cross-Cutting/ Enabling Activities	Health and safety consultants		50.00%		40.00%	60.00%	20.00%		80.00%
Other jobs	Solar Operation & Maintenance Worker	10.00%			100.00%				

Annex B
Projected Distribution of Skills Supply, Hard-to-fill Skills, and Highest Educational Qualifications For Biomass Technology

Note: All Not Applicable (NA) entries/responses in C6.1 were not included in this table.

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Equipment Manufacture and Distribution	Manufacturing engineers		75.00%		66.67%	33.33%			100.00%
Equipment Manufacture and Distribution	Manufacturing quality assurance specialists	25.00%	25.00%		50.00%	50.00%		50.00%	50.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Equipment Manufacture and Distribution	Manufacturing technicians		75.00%		100.00%			66.67%	33.33%
Equipment Manufacture and Distribution	Quality assurance specialists	50.00%			100.00%				100.00%
Equipment Manufacture and Distribution	Logistics professionals		50.00%			100.00%		50.00%	50.00%
Equipment Manufacture and Distribution	Marketing specialist		50.00%		50.00%	50.00%			100.00%
Equipment Manufacture and Distribution	Sales workers		50.00%		100.00%				100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Resource assessment specialists								
Project Development	Project designers (engineers and scientists)		25.00%			100.00%			100.00%
Project Development	Sustainability specialists								
Project Development	Land use negotiators								
Project Development	Communications specialists								

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Environmental and social NGO representatives		25.00%			100.00%			100.00%
Project Development	Public relations officer								
Project Development	Procurement professionals		50.00%		100.00%				100.00%
Construction and Installation	Biochemists and microbiologists		25.00%			100.00%			100.00%
Construction and Installation	Environmental engineers	25.00%	25.00%		50.00%	50.00%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Construction and Installation	Laboratory technicians and assistants	25.00%	50.00%		33.33%	66.67%		33.33%	66.67%
Construction and Installation	Chemical, biological mechanical and electrical engineers	25.00%	50.00%		33.33%	66.67%			100.00%
Construction and Installation	Project designers and managers		25.00%			100.00%			100.00%
Construction and Installation	Software engineers								
Construction and Installation	Construction professionals								

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Construction and Installation	General electricians, plumbers, roofers			25.00%		100.00%		100.00%	
Construction and Installation	General construction workers			25.00%		100.00%	100.00%		
Construction and Installation	Business developers								
Construction and Installation	Commissioning engineer (electrical)		25.00%			100.00%			100.00%
Construction and Installation	Transportation workers	50.00%			50.00%	50.00%		100.00%	

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Plant breeders and foresters								
Operation and Maintenance	Biomass production managers		25.00%			100.00%			100.00%
Operation and Maintenance	Agricultural Machinery Collection Operators								
Operation and Maintenance	Agricultural Machinery Collection Servicing								
Operation and Maintenance	Forestry workers								

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Transportation workers	50.00%			50.00%	50.00%		100.00%	
Operation and Maintenance	Laboratory technicians and assistants		75.00%		33.33%	66.67%		33.33%	66.67%
Operation and Maintenance	Operation and maintenance specialists		75.00%		33.33%	66.67%		66.67%	33.33%
Operation and Maintenance	Biomass Plant Technicians								
Operation and Maintenance	Biomass Power Plant Managers		25.00%			100.00%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Biofuels Processing Technicians		75.00%			66.67%		66.67%	33.33%
Operation and Maintenance	Biofuels/Biodiesel Technology and Product Development Managers		25.00%			100.00%			100.00%
Operation and Maintenance	Design Engineer								
Operation and Maintenance	Contract Analyst								
Cross-Cutting/ Enabling Activities	Biomass Technology Training/ Trainers								

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Cross-Cutting/ Enabling Activities	Biopower Transmission and Distribution								
Cross-Cutting/ Enabling Activities	Trade association and professional society staff								
Cross-Cutting/ Enabling Activities	Management		50.00%		50.00%	50.00%			100.00%
Cross-Cutting/ Enabling Activities	Administration		50.00%	25.00%	33.33%	66.67%			100.00%
Cross-Cutting/ Enabling Activities	Publishers and science writers								

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Cross-Cutting/ Enabling Activities	IT professionals		25.00%			100.00%			100.00%
Cross-Cutting/ Enabling Activities	Health and safety consultants	25.00%	25.00%		100.00%				100.00%
Other jobs	Instrumentation Technician		25.00%						
Other jobs	HVAC Technician		25.00%						
Other jobs	Plant Mechanic		25.00%						

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Other jobs	Electrician		25.00%						
Other jobs	Chemical Technician		25.00%						
Other jobs	Mechanical Engineer		25.00%						
Other jobs	Electrical Engineer		25.00%						

Annex C
Projected Distribution of Skills Supply, Hard-to-fill Skills, and Highest Educational Qualifications For Hydropower Technology

Note: All Not Applicable (NA) entries/responses in C6.1 were not included in this table.

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Equipment Manufacture and Distribution	Design engineers (civil, mechanical, electrical, hydropower)	9.09%	45.45%	9.09%	28.57%	57.14%			100.00%
Equipment Manufacture and Distribution	Modeller	9.09%	27.27%		100.00%			50.00%	50.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Equipment Manufacture and Distribution	Software developers	9.09%	18.18%		100.00%				100.00%
Equipment Manufacture and Distribution	Manufacturing engineers	9.09%	18.18%		50.00%	50.00%			100.00%
Equipment Manufacture and Distribution	Manufacturing technicians	9.09%	27.27%		50.00%	50.00%		100.00%	
Equipment Manufacture and Distribution	Manufacturing operators	9.09%	36.36%		40.00%	60.00%		80.00%	20.00%
Equipment Manufacture and Distribution	Marketing specialists	9.09%	9.09%		100.00%				100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Project designers (engineers)	18.18%	36.36%	9.09%	71.43%	28.57%			100.00%
Project Development	Hydropower Strategy Director	27.27%	27.27%	9.09%	71.43%	14.29%			100.00%
Project Development	Environmental engineer	36.36%		9.09%	60.00%	20.00%			85.71%
Project Development	Sustainability specialists (natural resource/ environmental planners, social scientists, cultural consultants)	36.36%	9.09%	9.09%	66.67%	16.67%			83.33%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Economic/finance/ risk specialists	36.36%	9.09%	18.18%	71.43%	14.29%			85.71%
Project Development	Physical and environmental scientists (hydrologists, geologists, ecologists)	36.36%		18.18%	66.67%	16.67%			83.33%
Project Development	Market analysts	27.27%	18.18%	9.09%	50.00%	33.33%			83.33%
Project Development	Land development advisor	18.18%	18.18%		33.33%	33.33%			66.67%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Land use negotiator	27.27%	18.18%	9.09%	40.00%	40.00%			80.00%
Project Development	Communications specialists	9.09%	18.18%	18.18%	25.00%	50.00%		25.00%	50.00%
Project Development	Procurement specialists	18.18%	18.18%	9.09%		60.00%		20.00%	60.00%
Project Development	Archaeologists	18.18%			50.00%				50.00%
Project Development	Environmental and social NGO representatives	18.18%	18.18%		25.00%	50.00%		25.00%	50.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Project Development	Public relations officer		36.36%	9.09%		80.00%		20.00%	60.00%
Project Development	Procurement professionals	9.09%	27.27%	9.09%		75.00%		50.00%	25.00%
Construction and Installation	Civil Technicians	18.18%	36.36%		50.00%	33.33%		50.00%	50.00%
Construction and Installation	Mechanical Technicians	36.36%	27.27%		57.14%	28.57%		57.14%	42.86%
Construction and Installation	Electrical Technicians	18.18%	45.45%		42.86%	42.86%		57.14%	42.86%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Construction and Installation	Heavy machinery Operators	36.36%	27.27%		71.43%	14.29%		100.00%	
Construction and Installation	Welders	18.18%	36.36%		50.00%	33.33%		100.00%	
Construction and Installation	Pipefitters	18.18%	36.36%		66.67%	16.67%		100.00%	
Construction and Installation	Construction Laborers	9.09%	45.45%		50.00%	33.33%	66.67%	33.33%	
Construction and Installation	Transportation workers	18.18%	36.36%		66.67%	16.67%	33.33%	66.67%	

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Construction and Installation	Construction Manager / Engineer	18.18%	36.36%		66.67%	16.67%	16.67%		83.33%
Operation and Maintenance	Chemical laboratory technicians and assistants	9.09%	9.09%		50.00%				50.00%
Operation and Maintenance	Civil Engineer	18.18%	27.27%		60.00%	20.00%			80.00%
Operation and Maintenance	Civil Technicians	9.09%	18.18%		100.00%		33.33%	33.33%	33.33%
Operation and Maintenance	Control Room Operator	36.36%	9.09%		60.00%	20.00%		20.00%	60.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Control Specialist	18.18%		9.09%	80.00%				100.00%
Operation and Maintenance	Damn safety Inspector	27.27%	18.00%		100.00%		20.00%		60.00%
Operation and Maintenance	Electrical Engineer	27.27%	45.00%		50.00%	25.00%			87.50%
Operation and Maintenance	Electrical Technicians	36.36%	27.27%		80.00%	20.00%	16.67%	66.67%	16.67%
Operation and Maintenance	Engineering Analyst	27.27%			66.67%	33.33%	33.33%		66.67%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Hydroelectric Plant Operator	36.36%	36.36%		75.00%	12.50%		12.50%	75.00%
Operation and Maintenance	Hydrographer	18.18%			100.00%				100.00%
Operation and Maintenance	Hydropower Specialist	27.27%			100.00%			33.33%	66.67%
Operation and Maintenance	Hydropower Strategy Director	18.18%			100.00%		50.00%		50.00%
Operation and Maintenance	Residential/Commercial-Wiring Electrician	9.09%	36.36%		80.00%			80.00%	

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Mechanical Engineer	27.27%	54.55%		55.56%	33.33%		11.11%	77.78%
Operation and Maintenance	Mechanical Technicians	36.36%	27.27%		57.14%	28.57%		71.43%	14.29%
Operation and Maintenance	Pipe fitters	27.27%	27.27%		83.33%		16.67%	66.67%	
Operation and Maintenance	Plant Quality Inspector	27.27%		9.09%	50.00%	25.00%		25.00%	50.00%
Operation and Maintenance	Plant workers	27.27%	27.27%		33.33%	50.00%	16.67%	66.67%	16.67%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Operation and Maintenance	Senior Energy Trader	18.18%			100.00%				100.00%
Cross-Cutting/ Enabling Activities	Educators and trainers	9.09%	18.18%		66.67%	33.33%			100.00%
Cross-Cutting/ Enabling Activities	Management	18.18%	63.64%		44.44%	55.56%			100.00%
Cross-Cutting/ Enabling Activities	Administration	18.18%	45.45%		28.57%	71.43%			100.00%
Cross-Cutting/ Enabling Activities	Publishers and science writers	9.09%	18.18%		33.33%	66.67%			100.00%

Renewable Energy Value Chain	Skills/Jobs	Skills Supply			Hard-to-fill		Highest Educational Qualification		
		Shortage	No change	Surplus	Hard to fill	Not hard to fill	Basic Education Graduate (HS Grad Old Curriculum or SHS Graduate K-12 Curriculum)	Technical Vocational Education (TVET) Graduate	Higher Education Graduate (College Degree and above)
Others	Plant Engineer		9.09%			9.09%			
Others	Plant Equipment Specialist		9.09%			9.09%			

Annex D
Summary of Identified Priorities by the RE Technology

RENEWABLE ENERGY VALUE CHAIN	JOBS/SKILLS/ QUALIFICATIONS	JOBS/SKILLS IMMEDIATELY NEEDED (% Share)		ASSESS THE SHORTAGE OF WORKERS IN FILLING-UP THE SKILLS REQUIREMENTS *(% Share)*		
		In the next 1-3 years	In the next 3-5 years	Low (below 100)	Medium (100-500)	High (above 500)
Solar Technology						
Construction and Installation	Electricians specializing in solar		66.67%		70.00%	
Construction and Installation	Photovoltaic System Installers		100.00%		60.00%	
Operation and Maintenance	Photovoltaic maintenance specialists (electricians specializing in solar)		57.14%			70.00%

RENEWABLE ENERGY VALUE CHAIN	JOBS/SKILLS/ QUALIFICATIONS	JOBS/SKILLS IMMEDIATELY NEEDED (% Share)		ASSESS THE SHORTAGE OF WORKERS IN FILLING-UP THE SKILLS REQUIREMENTS *(% Share)*		
		In the next 1-3 years	In the next 3-5 years	Low (below 100)	Medium (100-500)	High (above 500)
Operation and Maintenance	Maintenance Electrician		71.43%		70.00%	
Biomass Technology						
Equipment Manufacture and Distribution	Biomass Manufacturing technicians	100.00%			75.00%	
Operation and Maintenance	Operation and maintenance specialists	33.33%	66.67%		75.00%	
Operation and Maintenance	Biofuels Processing Technicians		66.67%		75.00%	

RENEWABLE ENERGY VALUE CHAIN	JOBS/SKILLS/ QUALIFICATIONS	JOBS/SKILLS IMMEDIATELY NEEDED (% Share)		ASSESS THE SHORTAGE OF WORKERS IN FILLING-UP THE SKILLS REQUIREMENTS *(% Share)*		
		In the next 1-3 years	In the next 3-5 years	Low (below 100)	Medium (100-500)	High (above 500)
Construction and Installation	Laboratory technicians and assistants	33.33%	66.67%		75.00%	
Hydropower Technology						
Construction and Installation	Civil Technicians	50.00%	33.33%	0.00%	36.36%	18.18%
Construction and Installation/	Mechanical Technicians	57.14%	28.57%	0.00%	27.27%	36.36%
Construction and Installation	Electrical Technicians	42.86%	42.86%	0.00%	45.45%	18.18%

RENEWABLE ENERGY VALUE CHAIN	JOBS/SKILLS/ QUALIFICATIONS	JOBS/SKILLS IMMEDIATELY NEEDED (% Share)		ASSESS THE SHORTAGE OF WORKERS IN FILLING-UP THE SKILLS REQUIREMENTS *(% Share)*		
		In the next 1-3 years	In the next 3-5 years	Low (below 100)	Medium (100-500)	High (above 500)
Construction and Installation	Heavy machinery Operators	71.43%	14.29%	0.00%	27.27%	36.36%
Construction and Installation	Welders	50.00%	33.33%	0.00%	36.36%	18.18%
Construction and Installation	Pipefitters	66.67%	16.67%	0.00%	36.36%	18.18%
Construction and Installation	Construction Laborers	50.00%	33.33%	0.00%	45.45%	9.09%

RENEWABLE ENERGY VALUE CHAIN	JOBS/SKILLS/ QUALIFICATIONS	JOBS/SKILLS IMMEDIATELY NEEDED (% Share)		ASSESS THE SHORTAGE OF WORKERS IN FILLING-UP THE SKILLS REQUIREMENTS *(% Share)*		
		In the next 1-3 years	In the next 3-5 years	Low (below 100)	Medium (100-500)	High (above 500)
Construction and Installation	Transportation workers	66.67%	16.67%	0.00%	36.36%	18.18%
Operation and Maintenance	Electrical Technicians	80.00%	20.00%	0.00%	27.27%	36.36%
Operation and Maintenance	Mechanical Technicians	57.14%	28.57%	0.00%	27.27%	36.36%
Operation and Maintenance	Pipe fitters	83.33%		0.00%	27.27%	27.27%

RENEWABLE ENERGY VALUE CHAIN	JOBS/SKILLS/ QUALIFICATIONS	JOBS/SKILLS IMMEDIATELY NEEDED (% Share)		ASSESS THE SHORTAGE OF WORKERS IN FILLING-UP THE SKILLS REQUIREMENTS *(% Share)*		
		In the next 1-3 years	In the next 3-5 years	Low (below 100)	Medium (100-500)	High (above 500)
Operation and Maintenance	Plant workers	33.33%	50.00%	0.00%	27.27%	27.27%
Project Development	Physical and environmental scientists (hydrologists, geologists, ecologists)	66.67%	16.67%	18.18%		36.36%
Project Development	Land use negotiator	40.00%	40.00%	9.09%	18.18%	27.27%

Annex E

Summary of Identified Energy Related Priority Programs by Regions, and Provinces

Region	Province	Sector	Qualification
REGION VI	AKLAN	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC II
REGION VI	AKLAN	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC III

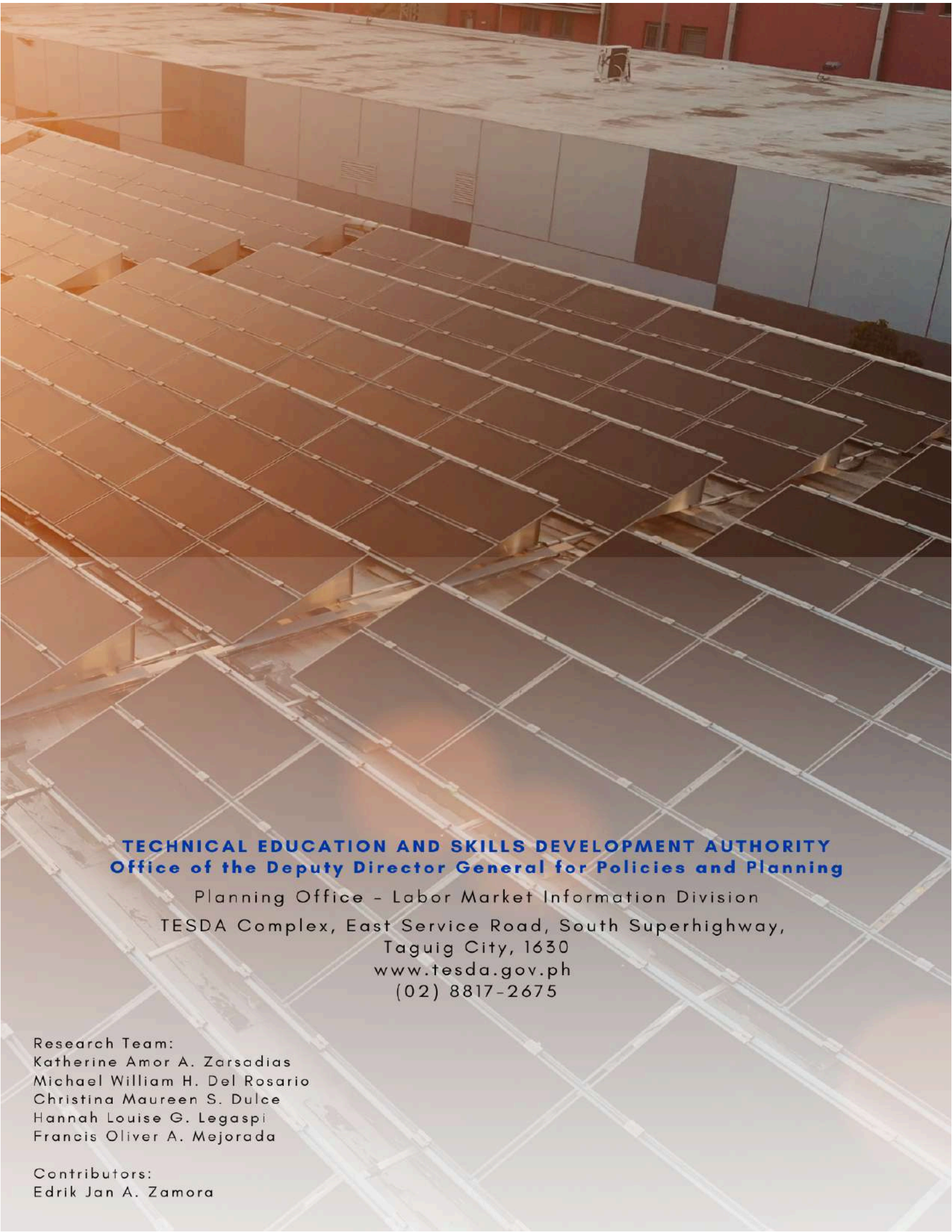
Region	Province	Sector	Qualification
REGION VI	AKLAN	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC IV
REGION VI	AKLAN	ENERGY	FLUX-CORE ARC WELDING (FCAW) NC I
REGION VI	AKLAN	ENERGY	FLUX-CORE ARC WELDING (FCAW) NC II
REGION VI	AKLAN	ENERGY	FLUX-CORE ARC WELDING (FCAW) NC III
REGION VI	AKLAN	ENERGY	GAS METAL ARC WELDING (GMAW) NC I
REGION VI	AKLAN	ENERGY	GAS METAL ARC WELDING (GMAW) NC II
REGION VI	AKLAN	ENERGY	GAS TUNGSTEN ARC WELDING NC II
REGION VI	AKLAN	ENERGY	GAS TUNGSTEN ARC WELDING NC IV
REGION VI	AKLAN	ENERGY	GAS WELDING NC I
REGION VI	AKLAN	ENERGY	GAS WELDING NC II
REGION VI	AKLAN	ENERGY	RAC SERVICING (PACU-CRE) NC III (SUPERSEDED)
REGION VI	AKLAN	ENERGY	SHIELDED METAL ARC WELDING (SMAW) NC I
REGION VI	AKLAN	ENERGY	SHIELDED METAL ARC WELDING (SMAW) NC II
REGION VI	AKLAN	ENERGY	SHIELDED METAL ARC WELDING (SMAW) NC III
REGION VI	AKLAN	ENERGY	SHIELDED METAL ARC WELDING (SMAW) NC IV
REGION VI	AKLAN	ENERGY	SUBMERGED ARC WELDING NC I
REGION VI	AKLAN	ENERGY	SUBMERGED ARC WELDING NC II
REGION VI	ANTIQUE	ENERGY	ELECTRIC POWER DISTRIBUTION LINE CONSTRUCTION NC II
REGION VI	ANTIQUE	ENERGY	NO EQUIVALENT QUALIFICATION
REGION VI	ANTIQUE	ENERGY	PV SYSTEMS INSTALLATION NC II
REGION VI	ANTIQUE	ENERGY	TRANSMISSION LINE INSTALLATION AND MAINTENANCE NC II
REGION V	CAMARINES SUR	ENERGY	ASSEMBLY OF SOLAR NIGHTLIGHT AND POST LAMP
REGION XI	DAVAO CITY	ENERGY	ABLE SEAFARER ENGINE NC II
REGION XI	DAVAO CITY	ENERGY	AGRICULTURAL DRONE OPERATION LEVEI II

Region	Province	Sector	Qualification
REGION XI	DAVAO CITY	ENERGY	AGRICULTURAL CROPS PRODUCTION NC I
REGION XI	DAVAO CITY	ENERGY	AGRICULTURAL CROPS PRODUCTION NC II
REGION XI	DAVAO CITY	ENERGY	AGRICULTURAL CROPS PRODUCTION NC III
REGION XI	DAVAO CITY	ENERGY	AUTOMOTIVE MECHANICAL ASSEMBLY NC II
REGION XI	DAVAO CITY	ENERGY	AUTOMOTIVE MECHANICAL ASSEMBLY NC III
REGION XI	DAVAO CITY	ENERGY	AUTOMOTIVE SERVICING NC I
REGION XI	DAVAO CITY	ENERGY	AUTOMOTIVE SERVICING NC II
REGION XI	DAVAO CITY	ENERGY	BOAT BUILDING (COMPOSITE MATERIALS) LEVEL II
REGION XI	DAVAO CITY	ENERGY	DIESEL POWER PLANT OPERATION & MAINTENANCE NC II
REGION XI	DAVAO CITY	ENERGY	DRIVING (ARTICULATED VEHICLE) NC III
REGION XI	DAVAO CITY	ENERGY	ELECTRIC POWER DISTRIBUTION LINE CONSTRUCTION NC II
REGION XI	DAVAO CITY	ENERGY	ELECTRIC POWER DISTRIBUTION OPERATION AND MAINTENANCE NC III
REGION XI	DAVAO CITY	ENERGY	ELECTRIC POWER DISTRIBUTION OPERATION AND MAINTENANCE NC IV
REGION XI	DAVAO CITY	ENERGY	MACHINING NC II
REGION XI	DAVAO CITY	ENERGY	PLANT MAINTENANCE NC I
REGION XI	DAVAO CITY	ENERGY	PURE BATTERY PROPELLED ELECTRIC VEHICLE SERVICING LEVEL II
REGION XI	DAVAO CITY	ENERGY	PV SYSTEMS INSTALLATION NC II
REGION XI	DAVAO CITY	ENERGY	RAC SERVICING (DOMRAC) NC II
REGION XI	DAVAO CITY	ENERGY	TRANSMISSION LINE INSTALLATION AND MAINTENANCE NC II
REGION XI	DAVAO DEL SUR	ENERGY	ELECTRIC POWER DISTRIBUTION LINE CONSTRUCTION NC II
REGION XI	DAVAO DEL SUR	ENERGY	PV SYSTEMS INSTALLATION NC II

Region	Province	Sector	Qualification
REGION XI	DAVAO DEL SUR	ENERGY	RAC SERVICING (DOMRAC) NC II
REGION XI	DAVAO DEL SUR	ENERGY	RAC SERVICING NC II (PACKAGE TYPE AIR CONDITIONING UNIT/COMMERCIAL REFRIGERATION EQUIPMENT)
REGION VI	ILOILO	ENERGY	ELECTRONIC POWER DISTRIBUTION LINE CONSTRUCTION NC II
REGION VI	ILOILO	ENERGY	PHOTOVOLTAIC SYSTEMS INSTALLATION NC II
REGION VI	ILOILO	ENERGY	PURE BATTERY PROPELLED ELECTRIC VEHICLE SERVICING LEVEL II/BATTERY ELECTRIC VEHICLE SERVICING (PUV) LEVEL II
REGION VI	NEGROS OCCIDENTAL	ENERGY	CUSTOMER SERVICES NC II
REGION VI	NEGROS OCCIDENTAL	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC II
REGION VI	NEGROS OCCIDENTAL	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC III
REGION VI	NEGROS OCCIDENTAL	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC IV
REGION VI	NEGROS OCCIDENTAL	ENERGY	ELECTRONIC PRODUCTS ASSEMBLY AND SERVICING NC II
REGION VI	NEGROS OCCIDENTAL	ENERGY	RAC SERVICING (DOMRAC) NC II
REGION VII	NEGROS ORIENTAL	ENERGY	DRIVING NC II
REGION VII	NEGROS	ENERGY	ELECTRICAL INSTALLATION MAINTENANCE NC II

Region	Province	Sector	Qualification
	ORIENTAL		
REGION VII	NEGROS ORIENTAL	ENERGY	HEAVY EQUIPMENT OPERATION (TOWER CRANE) NC II
REGION VII	NEGROS ORIENTAL	ENERGY	HEAVY EQUIPMENT OPERATION (TRUCK MOUNTED CRANE) NC II
REGION IV-B	OCCIDENTAL MINDORO	ENERGY	ASSEMBLY OF SOLAR NIGHT LIGHT AND POST LAMP
REGION IV-B	OCCIDENTAL MINDORO	ENERGY	PV INSTALLATION NC I/II/III
REGION IV-B	OCCIDENTAL MINDORO	ENERGY	SOLAR POWER IRRIGATION SYSTEM (SPIS) OPERATION AND MAINTENANCE LEVEL II
REGION IV-B	PALAWAN	ENERGY	ASSEMBLY OF SOLAR NIGHTLIGHT AND POST LAMP
REGION V	SORSOGON	ENERGY	PV SYSTEM INSTALLATION NC II
REGION XII	SOUTH COTABATO	ENERGY	CHEMICAL PROCESS OPERATIONS NC III
REGION XII	SOUTH COTABATO	ENERGY	PV SYSTEM DESIGN NC III
REGION III	ZAMBALES	ENERGY	CARPENTRY NC II
REGION III	ZAMBALES	ENERGY	COMPUTER SYSTEMS SERVICING NC II
REGION III	ZAMBALES	ENERGY	CONSTRUCTION PAINTING NC II
REGION III	ZAMBALES	ENERGY	DOMESTIC WORK NC II
REGION III	ZAMBALES	ENERGY	DRIVING (ARTICULATED VEHICLE) NC III
REGION III	ZAMBALES	ENERGY	DRIVING (PASSENGER BUS/STRAIGHT TRUCK) NC III
REGION III	ZAMBALES	ENERGY	DRIVING NC II
REGION III	ZAMBALES	ENERGY	ELECTRICAL HELPER
REGION III	ZAMBALES	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC II
REGION III	ZAMBALES	ENERGY	ELECTRICAL INSTALLATION AND MAINTENANCE NC III

Region	Province	Sector	Qualification
REGION III	ZAMBALES	ENERGY	FLUX CORE ARC WELDING NC II
REGION III	ZAMBALES	ENERGY	FLUX CORE ARC WELDING NC III
REGION III	ZAMBALES	ENERGY	GAS METAL ARC WELDING NC I
REGION III	ZAMBALES	ENERGY	GAS METAL ARC WELDING NC III
REGION III	ZAMBALES	ENERGY	GAS METAL ARC WELDING NC NC II
REGION III	ZAMBALES	ENERGY	GAS TUNGSTEN ARC WELDING NC II
REGION III	ZAMBALES	ENERGY	GAS TUNGSTEN ARC WELDING NC IV
REGION III	ZAMBALES	ENERGY	HOUSEKEEPING NC II
REGION III	ZAMBALES	ENERGY	PIPEFITTING (METALLIC) NC II
REGION III	ZAMBALES	ENERGY	PIPEFITTING (METALLIC) NC II
REGION III	ZAMBALES	ENERGY	PROGRAMMING (.NET) NC III
REGION III	ZAMBALES	ENERGY	PROGRAMMING (JAVA) NC III
REGION III	ZAMBALES	ENERGY	PROGRAMMING (ORACLE) NC III
REGION III	ZAMBALES	ENERGY	SECURITY SERVICES NC II
REGION III	ZAMBALES	ENERGY	SHIELDED METAL ARC WELDING NC II
REGION IX	ZAMBOANGA DEL SUR	ENERGY	PV SYSTEM INSTALLATION NC II



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