



Chapter 5

Deploying the Workforce of the Future: The Role of Indonesia's Oil and Gas Workforce and Institutions

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Nearly all of the existing strengths of Indonesia's oil and gas operations can be adapted to suit geothermal development needs. This is a huge asset for Indonesia, as reaching the goals outlined in this report could yield more than 650,000 jobs, many of which could come from the oil and gas workforce.

Indonesia's energy sector is currently undergoing a significant transformation as the country aims to reduce its reliance on fossil fuels. A key component of this transformation is the expansion of renewable energy, particularly geothermal power. The nation's geothermal resources offer abundant opportunities for expanded conventional power generation, next-generation systems, direct-use industrial heat, and geothermal-based cooling.

In fact, Indonesia has some of the best geothermal potential in the world, estimated at approximately 23.7 gigawatts of conventional resources¹ and 2,160 gigawatts of next-generation geothermal potential. (See Chapter 3 supplement, "Expanding the Scope:

Next-Generation Geothermal Opportunities"). This potential places the nation in a uniquely favorable position to develop geothermal energy on a large scale. As of September 2025, the installed capacity of geothermal electricity was 2,744 megawatts, meaning only 11.5% has been utilized from the country's conventional resources. Indeed, Indonesia could reach a goal of 15 gigawatts of geothermal electricity and 15 gigawatts thermal of geothermal heat by 2035—and 25 gigawatts of electricity and 35 gigawatts thermal use by 2045 (see Chapter 7, "Turning Potential into Power: A Policy Blueprint for Indonesia's Geothermal Transformation," Recommendation #2). And reaching these goals could lead to more than 650,000 new jobs in Indonesia.



Resource availability, however, is only part of the story: The significant overlap in skills, technology, and infrastructure with Indonesia’s historic oil, gas, and mining industries—and the existing geothermal skill set from the nation’s conventional geothermal industry—sets the expansion of geothermal apart from other renewable technologies.

INDONESIA’S CURRENT OIL AND GAS WORKFORCE AND POTENTIAL GEOTHERMAL JOBS

Indonesia has been active in the oil and gas sector since the 1800s. This long-standing commitment has helped build a strong foundation of knowledge, experience, and

TRANSFERABLE SKILL SETS FROM THE OIL AND GAS INDUSTRY

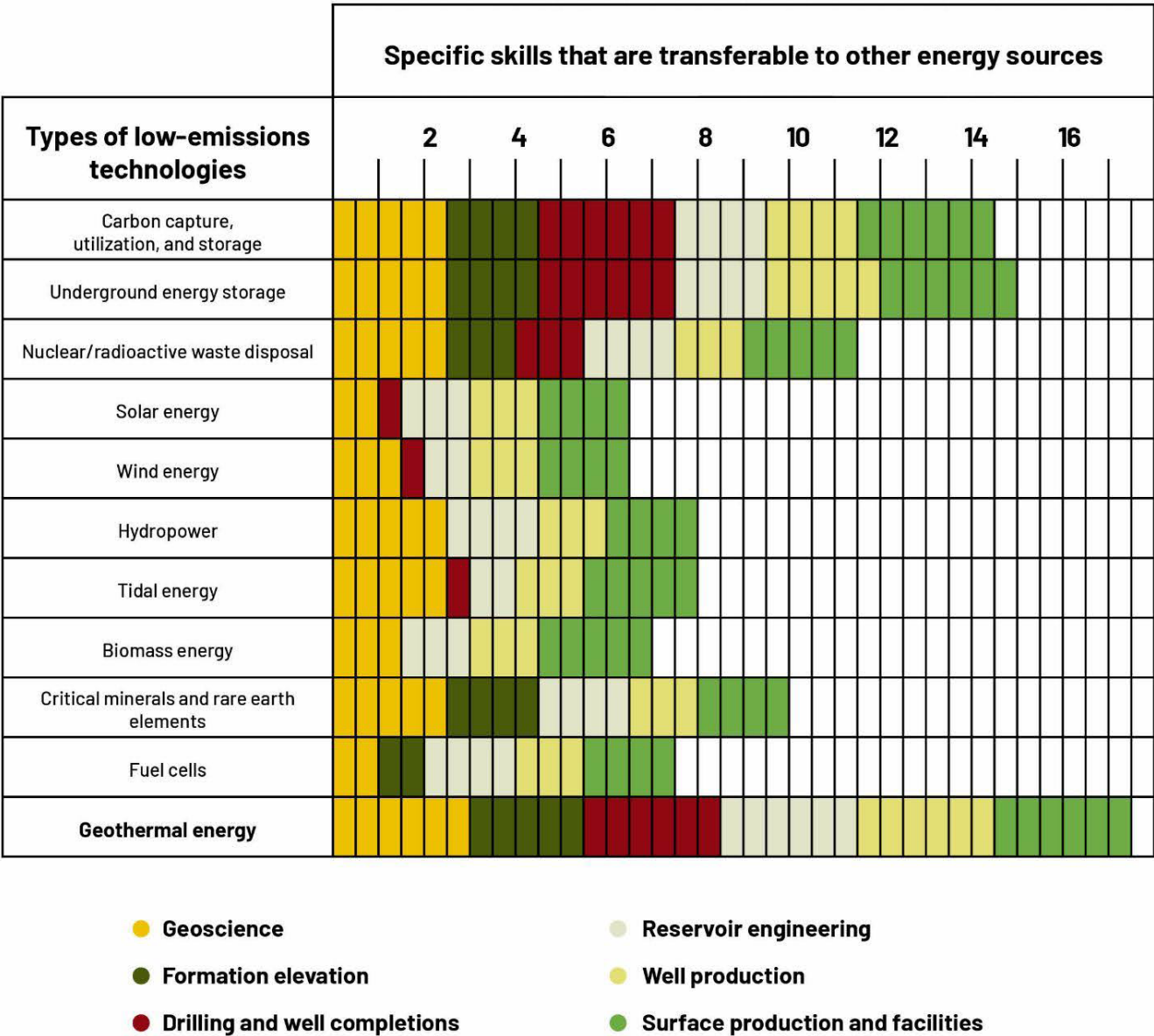


Figure 5.1: Geothermal ranks highest when considering the potential impact of transferring oil and gas skills into other energy transition and low-carbon technologies. Source: Tayyib, D., Ekeoma, P. I., Ofor, C. P., Adetula, O., Okoroafor, J., Egbe, T. I., & Okoroafor, E. R. (2023). *Oil and gas skills for low-carbon energy technologies*. Society of Petroleum Engineers Annual Technical Conference and Exhibition.



infrastructure in subsurface extraction. Nearly all of the existing strengths of Indonesia's oil and gas operations can be adapted to suit geothermal development needs.² This is a huge asset for Indonesia, as it ensures a skilled workforce to help grow the geothermal sector while also maintaining the availability of quality careers for the current oil and gas workforce. This workforce can contribute to not only traditional geothermal power projects but also next-generation geothermal applications, including systems designed for direct industrial heat and thermal storage applications that support cooling and grid stability.

According to data from the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas), as of 2023, the oil and gas sector employed 18,627 Indonesian

workers.³ The oil and gas workforce has many applicable skills for the geothermal sector, in areas ranging from geoscience to drilling and well completion as well as reservoir engineering and well production (see **Figure 5.1**). Proper retraining and reorientation can expand this existing talent pool to allow workers to participate in geothermal projects, which would help address emerging labor demands in the renewable energy sector while cushioning potential job losses in fossil fuel industries.

The global oil and gas (O&G) industry faces significant long-term structural challenges, including fluctuating prices, automation, and regulatory shifts driven by decarbonization goals. Indonesia's oil and gas workforce, specifically in upstream operations, began its decline more

POTENTIAL JOB TRANSITIONS FROM OIL AND GAS TO GEOTHERMAL

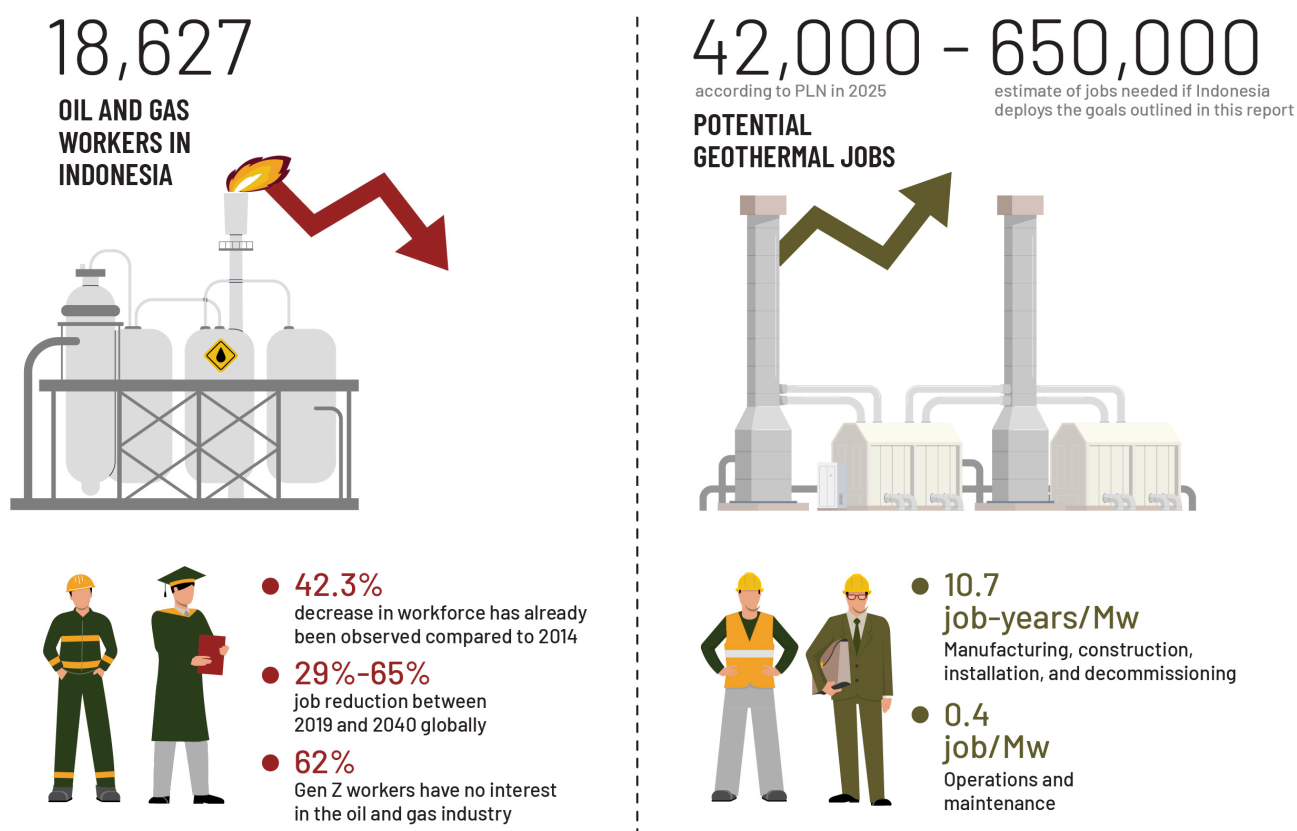


Figure 5.2: Estimated number of potential job transitions from oil and gas to geothermal. Source: Indonesian Petroleum Association. (2017). [Indonesia overview](#); Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas). (2023). [Annual report 2023](#); Ernst & Young. (2020). [Preparing for the future now: Rethinking the oil and gas workforce in 2040](#). EY Global; Halimatussadiyah, A., Irahmani, M., Riefky, T., Nur Ghiffari, M., & Razak Afifi, F. A. (2024). [Employment impacts of energy transition in Indonesia](#). Institute for Economic and Social Research, University of Indonesia; PLN. (2025). [PLN electricity supply business plan \(2025-2034\): Enhancing national energy resilience and sustainability](#). Government of Indonesia.



than a decade ago, with a total decrease of approximately 42.3% between 2014 and 2023.⁴ This number is expected to drop even further if projections are accurate in Indonesia, which could mean a potential loss of between 6,500 and 14,700 additional jobs. This loss of jobs does not account for the accelerating impact of climate change and global decarbonization efforts, both of which will likely drive deeper reductions in the fossil energy global workforce. In contrast, the global O&G workforce experienced short-term recovery, adding approximately 590,000 jobs in 2023 to reach 12.4 million employees, fueled by the development of new projects.⁵ However, despite this temporary rebound, long-term projections remain negative: The International Energy Agency's (IEA's) Net Zero Emissions by 2050 Scenario anticipates a decline of 1.7 million O&G jobs by 2030, and broader fossil fuel employment is expected to fall from 12.6 million to 3.1 million by 2050, underscoring the sector's ongoing structural contraction.⁶

PwC's 2015 oil and gas industry survey found that most respondents expected a decline in employment opportunities and workforce quality.⁷ At the same time, Indonesia's government support for the O&G sector remains strong, and interest among fresh graduates is still relatively high—largely due to the industry's competitive salaries.

With abundant resources, the geothermal industry in Indonesia has significant potential for growth. As the country scales to meet energy transition targets, the Ministry of Energy and Mineral Resources (MEMR) estimates that geothermal development will create more than 4,000 new jobs; PLN estimates the number could be as high as 42,000. While these figures are not explicitly tied to specific gigawatt deployment targets (see Chapter 2, "Powering the Transition: Indonesia's Geothermal Market"), they reflect the government's evolving geothermal development plans. Career fields within MEMR's report include site exploration, drilling, plant construction, system installation, and long-term operation and maintenance. And if the bulk of the nation's geothermal resources were put to work, Project InnerSpace projects a figure far higher, upwards of 650,000 new jobs. (**Figure 5.2**).^{8,9}

The geothermal industry has two major phases in which jobs are created: (a) construction and installation and (b) operations and maintenance. The construction and installation phase is labor-intensive, as it involves civil

works, mechanical and electrical assembly, logistics, and other related services. This phase generates approximately 10.7 job-years per megawatt, but these jobs are temporary roles.¹⁰ The operations and maintenance phase creates fewer jobs, generating approximately 0.4 sustained positions per megawatt, but these roles tend to be longer-term, permanent positions.¹¹ Positions created in this phase focus on the management, repair, and optimization of geothermal plants and infrastructure.

If Indonesia achieves its full potential of 23 gigawatts of conventional geothermal electricity generation by 2060 (as identified by MEMR and outlined in the National Electricity General Plan; see Chapter 2, "Powering the Transition: Indonesia's Geothermal Market," for more on national energy targets), the result could be as many as 255,300 jobs generated. This number would be far beyond the number predicted by MEMR and PLN—a trajectory that would depend on sustained year-over-year expansion of geothermal capacity. This number includes approximately 246,100 temporary jobs during the construction and installation phase, as well as at least 9,200 permanent jobs in operations and maintenance once full capacity is reached. This number would soar to more than 650,000 jobs if the nation meets the combined 60 gigawatts electric and thermal generation goal for 2045 (see Chapter 7, "Turning Potential into Power: A Policy Blueprint for Indonesia's Geothermal Transformation"), based on the methodology followed by the Institute for Economic and Social Research at the University of Indonesia and detailed later in this chapter.¹²

Realizing this level of growth, however, will hinge on the availability of skilled labor; research in the Indonesian geothermal sector indicates that personnel shortages and limited applied skill sets already constrain development,¹³ underscoring the need to strengthen national workforce readiness.

For this chapter, the Purnomo Yusgiantoro Center (PYC) conducted research to better understand the outlook for geothermal in Indonesia's existing energy sector. Researchers collected primary data via in-depth interviews with industry officials and experts from a cross-section of government agencies, academic institutions, and energy companies, as well as through a survey of recent graduates looking to transition into industry careers (**Figure 5.3**).



The goal of this data collection was to highlight existing engagement in geothermal expansion and training, as well as to examine workforce readiness and general attitudes toward geothermal, whether as institutional opportunity or as potential employment path. Findings from this section provide the empirical basis for the following discussion on institutional engagement and workforce transition.

WORKFORCE TRANSITION: FROM OIL AND GAS, MINING, AND UTILITIES TO GEOTHERMAL

Effective policies developed in collaboration with players from across the industry are foundational for a successful workforce transition. Industry-wide alignment creates strong pathways for training, employee placement, and overall labor mobility. While institutional relationships are currently fragmented and can be difficult to navigate, the country has opportunities to build on existing alignment efforts within the industry and move toward a more cohesive sector-wide strategy.

STUDENT SURVEY RESPONDENTS

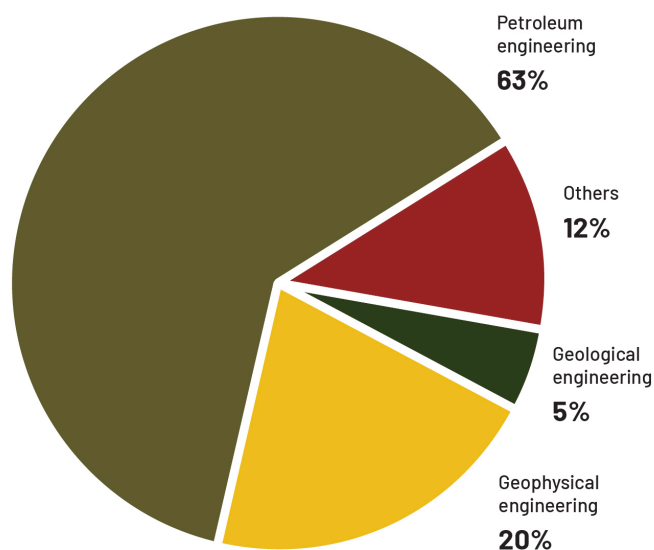


Figure 5.3: Breakdown of student survey respondents by degree. Source: authors.

INSTITUTIONAL WORKFLOW OF MINISTRIES INVOLVED IN WORKFORCE DEVELOPMENT FOR THE ENERGY SECTOR

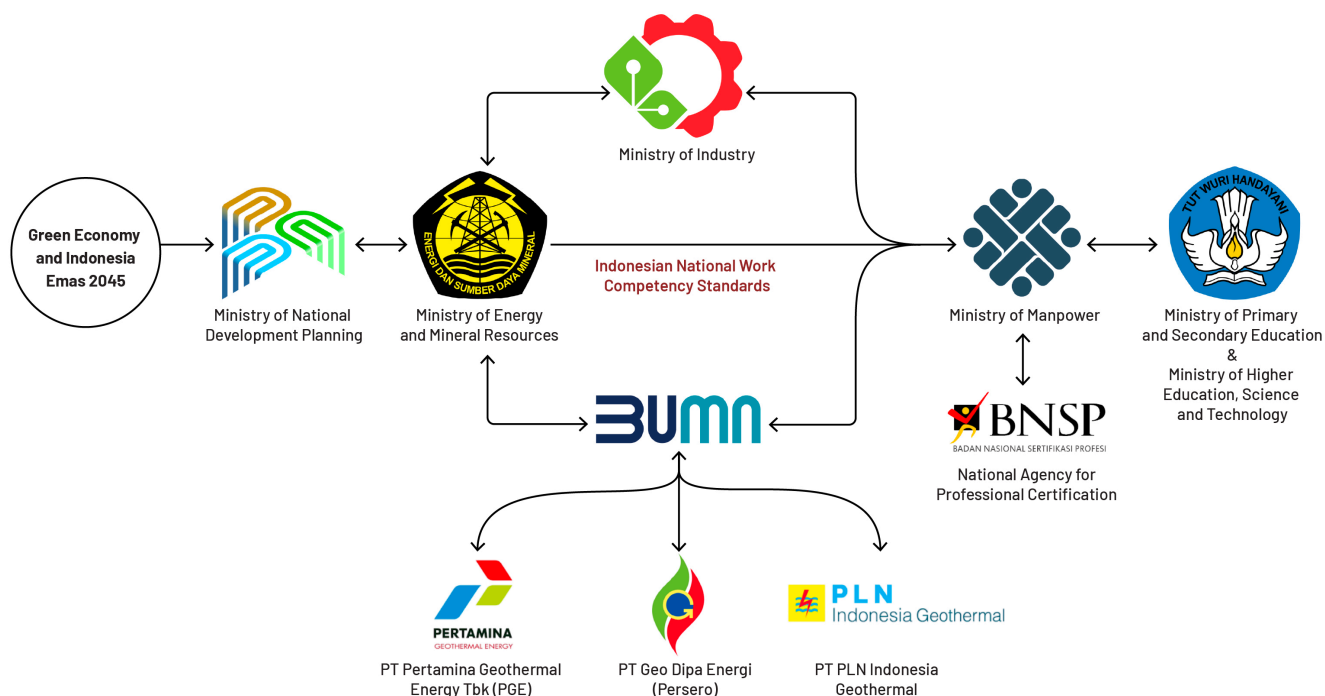


Figure 5.4: Workflow of key institutions involved in energy sector workforce planning and implementation. Source: authors.



A key element of Indonesia’s energy transition plan is the development of a green economy, which includes a strong emphasis on renewable, low-carbon energy sources.¹⁴ One tangible step in this direction was the launch of a Green Workforce Development Roadmap by the Ministry of National Development Planning (colloquially known as *Bappenas*) in 2025; this roadmap explicitly aligns with the National Medium-Term Development Plan for 2025–2029.¹⁵ The plan helps guide sectoral strategies such as the National Energy Policy, informs derivative plans such as the National Energy General Plan, and provides the overarching framework for implementation documents such as the National Electricity General Plan and PLN’s Electricity Supply Business Plan (see Chapter 2, “Powering the Transition: Indonesia’s Geothermal Market”). This alignment reinforces the roadmap’s policy legitimacy and firmly connects it to Indonesia’s national planning hierarchy. While multiple governmental agencies are responsible for different elements of this long-term economic transformation, two ministries share the foundational work that is key to a successful workforce transition.

Bappenas sets the national strategic direction of environmentally stable employment opportunities—including geothermal—through the formulation of the Green Jobs Roadmap.¹⁶ MEMR, as the primary authority in the energy sector, then translates these strategic targets into practical workforce policies.¹⁷

Today, the Ministry of Manpower (MoM) collaborates with sector-specific ministries such as MEMR and the Ministry of Industry to manage the development of standards that provide the framework for formal benchmarking across each industry. These standards are then administered through Professional Certification Bodies, under the National Agency for Professional Certification.

Government, industry, and academic experts in each sector develop these standards—Indonesian National Work Competency Standards (INWCS)—in a collaborative process. The sector-specific representatives propose different standards, and a technical committee then drafts the standards to send on for review by the MoM under the Directorate General of Vocational Training and Productivity Development. Once a set of standards is finalized, the standards become law via ministerial decrees. The INWCS provides the formal basis for national

recruitment, training, and certification programs. For example, a technician aiming to become a certified steam field operator must complete training based on the relevant INWCS and pass a competency test conducted by an authorized Professional Certification Body.

WORK HAS BEGUN: AN OCCUPATIONAL MAP AND NATIONAL WORK COMPETENCY STANDARDS

An economic transition of this magnitude requires significant planning and coordination. Unfortunately, existing geothermal certification and training programs in Indonesia were not designed to take advantage of the nation’s considerable technical capabilities and skills. However, because the sector is already deeply intertwined with Indonesia’s oil and gas industry, the country has ample opportunity to course correct and accelerate the transition.

EXISTING WORK COMPETENCY STANDARDS RELATED TO GEOTHERMAL

No.	INWCS Title
1	Geothermal Well Fluid Flow Test Operator and Supervisor
2	Geothermal Steam Field Facilities Operator
3	Geothermal Operations Supervisor
4	Geothermal Geochemistry Expert
5	Geothermal Geology Expert
6	Geothermal Geophysics Expert
7	Steam Field Equipment Maintenance
8	Geothermal Well Fluid Sampling

Figure 5.5: Existing Indonesian National Work Competency Standards (INWCS) relevant to geothermal energy development and operations. The link for each INWCS title provides the corresponding INWCS information.



A clear, updated occupational map for geothermal can significantly ease these efforts by providing an overview of job types, skill requirements, and qualifications required at each stage of geothermal development. This occupational map would then serve as the foundational reference for the INWCS, ensuring that each standard accurately reflects industry roles and emerging workforce needs. Clarity at this level empowers each institution to carry out its mandate.

Some foundational efforts have begun. MEMR, through its Human Resources Development Agency, is developing a policy on human capital development that proposes the formulation of such a national occupational map tailored to clean energy sectors and specifically to geothermal.¹⁸ As of the writing of this chapter, an update to the framework has not yet been published. Once completed, this map will serve as the foundation for the following:

- Occupational equivalency mapping to guide the integration of new workers, including vocational and university graduates, into industry-relevant roles. This mapping should be led by the MoM, with the Ministry of Higher Education, Science and Technology and relevant technical ministries (such as MEMR) as co-leads.
- Workforce demand projections that estimate how many workers will be needed, in what roles, and across which regions. Development of these projects will be coordinated by Bappenas as the lead institution, with MoM and MEMR as co-leads.
- Policy and regulatory recommendations tailored to each institutional partner, such as the Ministry of Manpower for labor protection and training and the Ministry of Higher Education, Science, and Technology for curriculum development.

Additionally, an ad hoc group has made efforts toward labor planning and produced a list of eight geothermal-specific INWCS (see **Figure 5.5**). In parallel, MEMR is working with the Ministry of Industry and the Ministry of State-Owned Enterprises to update and expand existing geothermal INWCS. However, the current certification plans still largely focus on narrow operational roles and do not yet comprehensively address cross-cutting or transitional roles critical to a modern geothermal workforce, such as geothermal project management, environmental permitting, digital instrumentation, or sustainability auditing.

TRANSITIONAL PLATFORMS: GEOTHERMAL WORKING AREAS IN INDONESIA

Out of 63 Geothermal Working Areas (WKPs) in Indonesia, 17 currently have one or more geothermal plants on site in operation. (The others are in various stages of development, exploration, construction, or tender preparation.) These sites can serve as “transitional platforms” where oil and gas skills, technologies, and experience can be deployed. Having these plants in operation means the industry has a lot of valuable knowledge and skills already that can help with expansion (see **Figure 5.1**). Most of these geothermal power plants are operated by companies with direct or historical affiliations to the oil and gas sector.

A 2023 study looking at the role of oil and gas in the geothermal industry highlighted the importance of knowledge transfer and learning in reducing the overall cost of geothermal development in order to leverage economies of scale and drive innovation.¹⁹ The most immediate and practical benefits for an expanded next-generation geothermal industry can come from oil and gas spillovers, given the extensive technological base and accumulated operational experience of the O&G sector. Indonesia can expect to see similar benefits due to the comparable industrial overlap between O&G and geothermal.

Oil and gas companies are uniquely positioned to redeploy skilled O&G professionals into geothermal roles and contribute to the development of industry-specific training, certification, and competency standards. As shown in **Figure 5.6**, most active geothermal fields are operated by companies that originated in or remain connected to Indonesia’s oil and gas ecosystem.

In addition to domestic players, global oil field service providers already established in Indonesia are also moving into geothermal work. This international engagement not only offers opportunities for technology and knowledge transfer but also increases competition for skilled local talent, underscoring the urgency of national workforce readiness. Halliburton and Schlumberger (now SLB) are both expanding into geothermal work. SLB acquired GeothermEx in 2010 specifically to focus on geothermal consulting and reservoir engineering.



GEOTHERMAL COMPANIES IN INDONESIA AND THEIR O&G AFFILIATIONS

No.	Geothermal Working Area (WKP)	Geothermal Power Plant (PLTP)	Company	O&G Affiliation
1	Sibayak – Sinabung, Sumatera Utara	Sibayak	PT Pertamina Geothermal Energy Tbk (PGE)	Subsidiary of PT Pertamina (Persero), Indonesia's national oil company
2	Lahendong – Tompaso, Sulawesi Utara	Lahendong		
3	Waypanas – Lampung	Ulubelu		
4	Karaha Bodas – Jawa Barat	Karaha		
5	Lumut Balai – Sumatera Selatan	Lumut Balai		
6	Kamojang – Darajat, Jawa Barat	Kamojang	PT Star Energy Geothermal Darajat II	Initially operated by Chevron Geothermal, a subsidiary of Chevron Corporation (US)
		Darajat		
7	Cibeureum – Parabakti, Jawa Barat	Salak		
8	Pangalengan, Jawa Barat	Wayang Windu		
		Patuha	PT Geo Dipa Energi (Persero)	Originally a joint venture between Pertamina and PLN
9	Dataran Tinggi Dieng, Jawa Tengah	Dieng		
10	Sibual-Buali – Sumatera Utara	Sarulla	PT Sarulla Operations Ltd (SOL)	A consortium consisting of: 1. Medco Power, owned by Medco Energi, an energy company with O&G roots 2. Inpex Corporation, a Japanese exploration and production company 3. Kyushu Electric Power Company 4. Itochu Corporation 5. Ormat Technologies, Inc.
11	Ulumbu – NTT	Ulumbu	PT PLN (Persero)	None
12	Muara Laboh – Sumatera Barat	Liki Pinangawan, Muara Laboh	PT Supreme Energy	Founders have backgrounds in Pertamina and Total E&P
13	Rantau Dedap – Sumatera Selatan	Rantau Dedap		
14	Sorik Marapi, Sumatera Utara	Sorik Marapi–Roburan–Sampuraga	PT Sorik Marapi Geothermal Power	Major shareholder is PT Supraco Inondeisa, member of Radiant Group, an O&G service company
15	Sokoria, NTT	Sokoria	PT Sokoria Geothermal Indonesia	Minor shareholder is Bakrie Power, member of Bakrie Group
16	Mataloko, NTT	Mataloko	PT PLN (Persero)	None
17	Blawan Ijen, East Java	Ijen	PT Medco Cahaya Geothermal	Subsidiary of PT Medco Power, 25 owned by Medco Energi, an energy company with O&G roots

Figure 5.6: Major geothermal developers in Indonesia and their links to oil and gas parent companies or subsidiaries. Source: Ministry of Energy and Mineral Resources. (2024). *Performance report of the Directorate General of New, Renewable, and Energy Conservation, Ministry of Energy and Mineral Resources, year 2024*. Government of Indonesia.



In 1974, the Volcanological Survey of Indonesia completed a five-year geothermal inventory of Sumatra, Sulawesi, and the Halmahera Islands.²⁰ At that point, a decree was issued to instruct the national state-owned oil company, Pertamina, to take up the leading role in the development of geothermal energy in Indonesia. With NZ\$25 million in aid from the Government of New Zealand, deep exploration drilling was carried out at Darajat and Kamojang beginning that same year. This would lay the foundation for future five-year development plans, which formalized the reduction of dependence on oil in overall consumption and an increase in exploration for renewable energy resources.²¹

In the 1980s, the government ramped up its efforts to explore geothermal use, particularly in the electricity sector. In 1981, another presidential decree allowed Pertamina to enter joint ventures with local and international partners to further develop geothermal fields. Several partners started carrying out detailed exploration and exploitation drilling activities, providing several recommendations for power plant construction,²² which eventually led to power plants in Darajat and Kamojang coming online in 1983 and 1991, respectively.^{23,24}

Today, oil and gas companies operate, in terms of generating capacity, 15% of global geothermal power plants;²⁵ the other operators are either geothermal developers or energy utility companies. Utility companies hold the higher share at 62%. In Indonesia, 46.4% of geothermal power plants are owned by geothermal developers and independent power producers Star Geothermal Energy, KS Orka, Supreme Energy, and Geo Dipa Energi. The oil and gas companies Pertamina (through its subsidiary Pertamina Geothermal Energy) and Medco Energi (through its subsidiary Medco Power Indonesia) own just more than 30% of the nation's geothermal assets. (Medco's subsidiary formed a joint venture with Ormat Technology Inc., known as Medco Cahaya Geothermal.) Medco recently reached a commercial operation date for its 35 megawatt geothermal power plant in Blawan Ijen, East Java.²⁶ The utility (PLN) and one of its subsidiaries operate 23.5% (see **Figure 5.7**).²⁷

The small portion of oil and gas industry ownership of geothermal power plants presents an opportunity.²⁸ After all, as much as 80% of the requirements for a geothermal project involve capacity and skills that are similar to those in the oil and gas industry. (See **Figure 5.1** to see overlapping skill sets between the oil and gas industry and geothermal development.)

INDONESIA GEOTHERMAL POWER PLANT OWNERSHIP

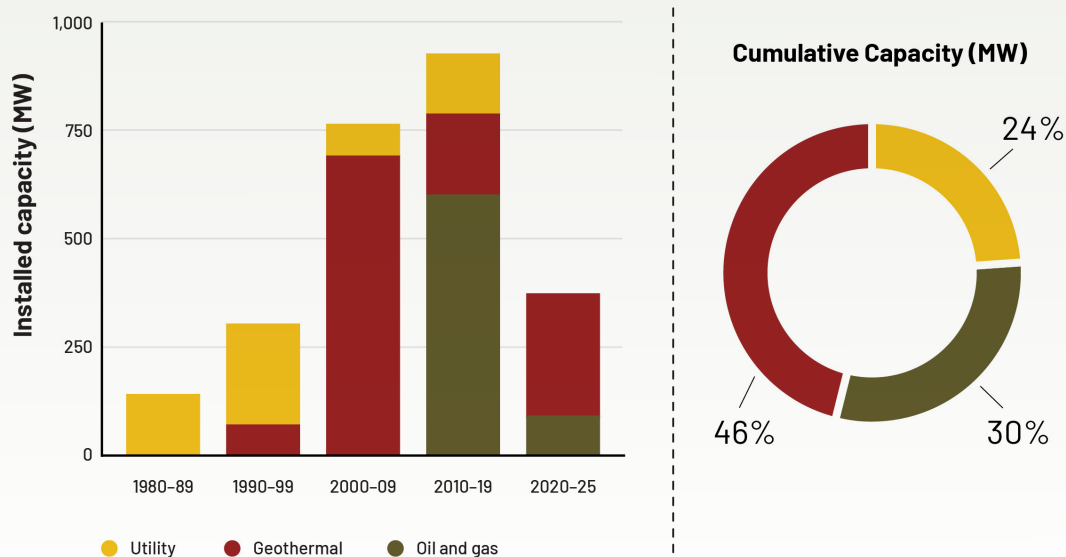


Figure 5.7: Distribution of ownership among public, geothermal, and O&G entities operating geothermal power plants. MW = megawatts. Source: Prepared by IESR using data from Global Energy Monitor. (2025). [Global Geothermal Power Tracker](#); company profiles for Geo Dipa Energi, Pertamina Geothermal Energy, PLN and its subsidiaries, Sarulla Operation, Star Geothermal Energy, and Supreme Energy; Directorate General of New, Renewable Energy and Energy Conservation. (n.d.). [GENESIS: Geothermal Energy Information System/](#).



Other multinational firms that typically support the O&G sector are in earlier stages of geothermal engagement in Indonesia. Viridien (formerly CGG) supports PGE from its European office and is awaiting further regulatory clarity to expand its local presence. Cegal (Norway), National Energy Services Reunited (Middle East), and Repsol (Spain) are also monitoring developments and preparing geothermal market entry strategies in Indonesia. These emerging international linkages position Indonesia to become a regional hub for geothermal technology and workforce development.

KNOWLEDGE AND SKILL GAPS

Exploration and Resource Characterization

Understanding overlapping technical competencies is essential for designing targeted reskilling programs. Both the oil and gas and geothermal industries need multi-source subsurface data to model and predict geologic conditions. For decades, the oil and gas industry has compiled such data (e.g., seismic, well logs, and core samples).²⁹ By adopting the same data-centric framework that leverages shared tools, data, and expertise, the geothermal sector can take the risk out of resource assessment and well location targeting.³⁰ The geothermal industry is also developing high-resolution subsurface data sets and models to guide economical resource development and plant operations.³¹ However, to enable next-generation geothermal expansion, Indonesia needs a much broader and accessible subsurface database to guide investment and technology shifts; MEMR's Data and Information Center³² could play this role.

Today, Indonesia's geothermal data are difficult to access because they are controlled by the state, fragmented across agencies, legally restricted, and poorly digitized. Improving the data's accessibility will be critical to growing the sector.

Data-sharing is further constrained by confidentiality provisions and fragmented ownership among MEMR, SKK Migas, and research institutions, underscoring the need for institutional cooperation to standardize access and reporting. The systematic public release of

drilling and performance data from government and pilot programs would accelerate replication, reduce exploration risk, and build the technical foundation for advanced geothermal systems (see Chapter 7, "Turning Potential into Power: A Policy Blueprint for Indonesia's Geothermal Transformation").

Drilling and Well Completion

Both the oil and gas and geothermal industries use drilling and well completion technologies. For conventional geothermal, however, engineers need to learn about volcanology systems, which can require additional training in moving higher volumes of fluid than with oil and gas.³³ Geothermal engineers also must, at times, work in higher temperatures (up to 350°C) and harsher environments due to igneous rock.³⁴

Stimulation Technologies

In next-generation geothermal, specifically engineered geothermal systems, stimulation technology is used to create additional permeability for accessing heat. Geothermal reservoir stimulation shares techniques with hydraulic fracturing but often targets reactivation of natural fractures rather than the creation of new ones.³⁵ Operating pressures and induced-seismicity hazards are site- and mechanism-dependent, and although the pressure and associated risks are lower than for oil field operations,³⁶ the best practice is to design for permeability while managing seismic risk with the use of established monitoring and threshold-based response systems.³⁷ This type of technology requires additional skill development, which should be introduced across MEMR through its Human Resources Development Agency, in coordination with the Ministry of Higher Education, Science, and Technology to align academic and professional training standards.

Operations and Risk Management

The oil and gas workforce has experience in financing and risk management for subsurface resource development, as well as existing relationships with investors familiar with the requirements of subsurface development. Leveraging these relationships could facilitate additional private sector investment in geothermal projects.³⁸



DEVELOPING A NEW WORKFORCE: INTERVIEWS WITH EXPERTS

The interviews PYC conducted with education experts highlighted the broader scope of competency gaps for petroleum engineering graduates looking to transition to geothermal roles. While there are many transferrable skills (e.g., drilling, geomechanics), the scope of oil and gas studies is narrower than what geothermal requires (e.g., heat flow modeling, geothermal chemistry). Knowledge required in the geothermal energy sector includes exploration, exploitation, and downstream use such as electricity generation. As geothermal expands beyond power into industrial heat and cooling, necessary knowledge will include low- and medium-temperature applications, system integration for manufacturing, and building-scale geothermal technologies. **Figure 5.1** illustrates how a new graduate or experienced reservoir engineer's areas of expertise relate to the requirements for a geothermal reservoir engineer.³⁹

Today, academic curricula in Indonesia lack coursework and training in key skills such as risk mitigation, project economics, and cross-functional project management—all vital skills in geothermal operations. These gaps highlight the need for curriculum modernization under the Ministry of Higher Education, Science, and Technology's vocational transformation agenda⁴⁰ and the Bappenas Green Workforce Development Roadmap.⁴¹ Experienced industry players will have an essential role in guiding curriculum reform, offering practical training platforms, and bolstering the job-readiness of new graduates.

Indonesia currently has two formal education programs that specifically focus on geothermal engineering. Bandung Institute of Technology (ITB) has offered a master's program in geothermal since 2008, producing a total of 288 graduates, or 12 per year. Most alumni have successfully entered the workforce, with 36% working in geothermal development companies and 24% in related industries. Others have pursued careers in academia and government agencies or have furthered their

PROGRAMS RELATED TO GEOTHERMAL AT INDONESIAN UNIVERSITIES

No.	Universities	Program Offered	Details of the Program
1	Universitas Gadjah Mada	Geothermal Research Center	- Under the Department of Geological Engineering - Provide multidisciplinary collaboration, particularly researchers from the Geophysics Study Program, Faculty of Mathematics and Natural Sciences
		Master of Geological Engineering Study Program	Under the Geological Engineering Department
2	Universitas Indonesia	Geothermal geology course	Offered as mandatory course for third-year undergraduate students in Geological major under the Department of Geoscience, Faculty of Mathematics and Natural Sciences
3	UPN Veteran Yogyakarta	Geothermal Exploration Expertise Group	Under the Department of Geophysical Engineering
4	Universitas Padjajaran	- Geothermal Geochemical Exploration course - Geothermal Geology of Indonesia course - Geothermal Hydrogeochemistry course	Offered as elective courses for master's students in the Geological Engineering Department
5	Universitas Pertamina	Geophysics of New and Renewable Energy Concentration for Geophysical Engineering Major	Under Geophysical Engineering Program

Figure 5.8: Overview of geothermal-related degree and training programs across Indonesian higher-education institutions.



studies at the doctorate level.⁴² The ITB program also offers a fast-track pathway for undergraduate students from petroleum engineering who want to study in the geothermal master's program by providing a bridging course related to geothermal topics in the third year. ITB also provides training courses in collaboration with Indonesian geothermal companies such as Geo Dipa Energi and PLN to improve employees' skills. The second program has been offered since 2012 by the University of Indonesia, where students can pursue a master's program in geothermal exploration. Indonesia's other universities offer only elective courses in geothermal or provide resources through research centers (**Figure 5.8**).

In contrast, at least 13 universities across Indonesia offer petroleum engineering programs.⁴³ Each university produces an estimated 30 to 60 graduates, which means approximately 390 to 780 fresh graduates seek employment every year in the oil and gas industry—23 to 46 times more than for geothermal. Many of these graduates

have competencies that are also necessary for geothermal jobs, particularly in subsurface engineering, drilling, and reservoir management. Leveraging the petroleum education pipeline for geothermal workforce needs would help diversify graduates' career prospects and accelerate the expansion of the geothermal talent pool.

According to MEMR, geothermal power plants currently operating nationwide employ more than 5,200 direct workers and an estimated 870,000 indirect workers.⁴⁴ Existing geothermal development plans have a projected workforce demand ranging from 4,000⁴⁵ to 42,000⁴⁶ direct workers by 2060 to meet national policy targets. (See Chapter 2, "Powering the Transition: Indonesia's Geothermal Market," for more on national targets.) To meet the lower target, Indonesia's academic institutions will need to produce 6 to 7 times the current number of qualified graduates—between about 115 and 120 graduates per year, up from the current 17. Producing 42,000 geothermal-certified workers will require 15 to 30 times

GAP BETWEEN GEOTHERMAL GRADUATE SUPPLY AND INDUSTRY DEMAND

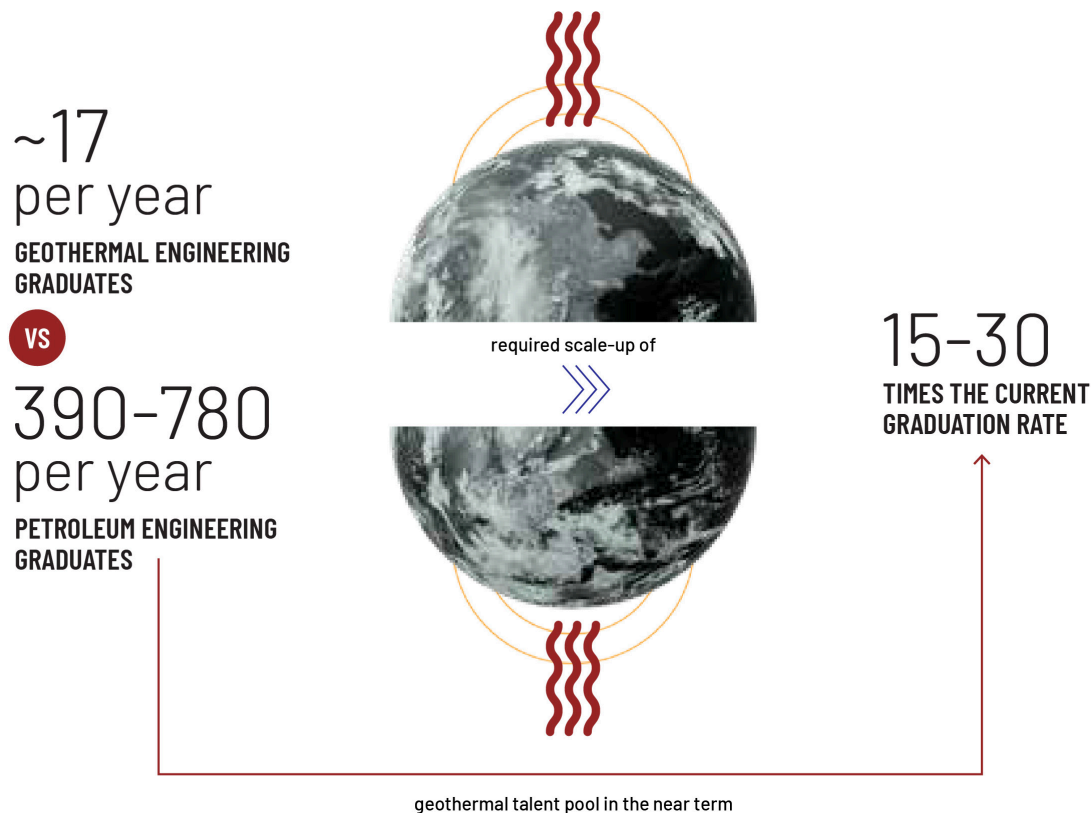


Figure 5.9: Comparison of projected geothermal workforce needs and current graduate output, highlighting the shortfall in skilled labor supply. Source: author calculations.



CONSTRAINTS IN DEVELOPING A GEOTHERMAL WORKFORCE FROM THE OIL AND GAS SECTOR

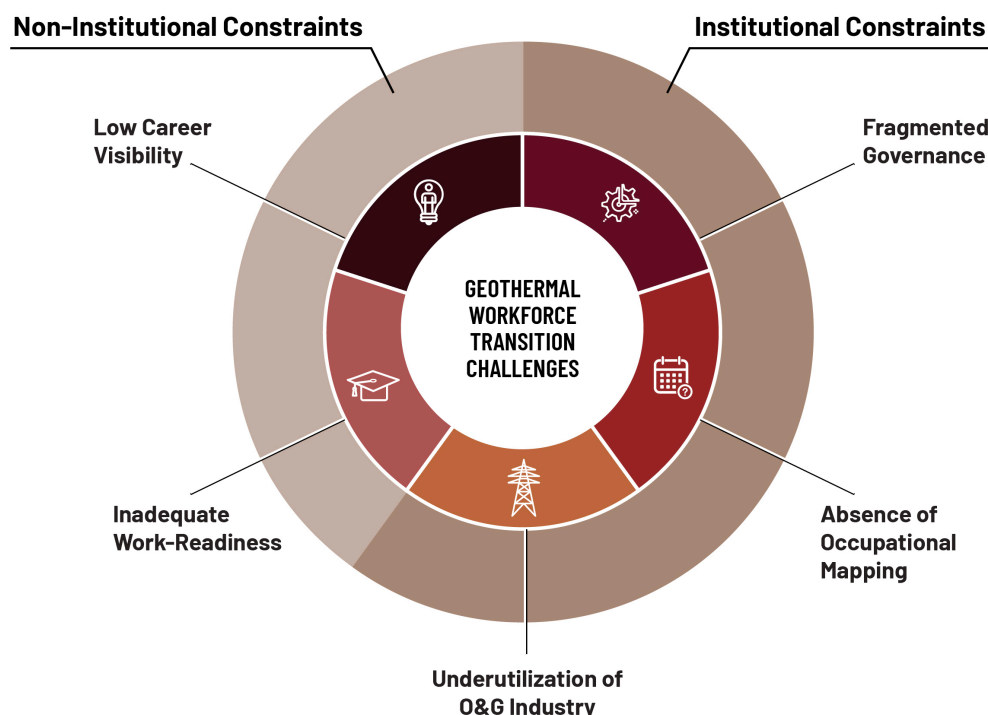


Figure 5.10: Key institutional and non-institutional barriers affecting workforce skills transfer from the oil and gas sector to geothermal development. Source: authors.

the current number of graduates (**Figure 5.9**). Scaling to this level will demand not only expanded academic programs but also robust accreditation systems, certification pathways, and closer industry alignment to ensure that training outcomes match workforce needs. With changes to certification programs, many of these jobs could potentially be filled by oil and gas workers.

BARRIERS TO GEOTHERMAL WORKFORCE DEVELOPMENT

Indonesia does face barriers to developing a strong and responsive geothermal workforce, particularly in the context of transitioning labor and expertise from the oil and gas sector. These barriers are categorized into institutional and non-institutional constraints (**Figure 5.10**).

An Unknown and Underskilled Career Path

In the PYC interviews and survey, employers in Indonesia's geothermal sector consistently reported that new graduates lack the interdisciplinary and site-readiness

skills required for complex project environments. Training tends to be narrow and theoretical, offering minimal exposure to economics, permitting processes, and stakeholder engagement. As a result, graduates often struggle upon entry.

Despite Indonesia's vast geothermal potential, the sector remains relatively unknown and undervalued among students and early-career professionals. Geothermal is often perceived as technically limited and less lucrative than oil and gas. These issues hamper the sector's ability to compete for top graduates. Inclusion of geothermal modules in university outreach, government- or industry-supported scholarships, and job placements can all help overcome this perception.

The PYC survey found that despite their transferable skills, 84% of respondents preferred oil and gas as their first career choice; only 7% selected geothermal as their top option. Geothermal was selected as a second-choice pathway by 66% of respondents (see **Figure 5.11**). Close to 63% of graduates ranked attractive salaries



INDUSTRY SECTOR RANKING ACCORDING TO RECENT GRADUATES

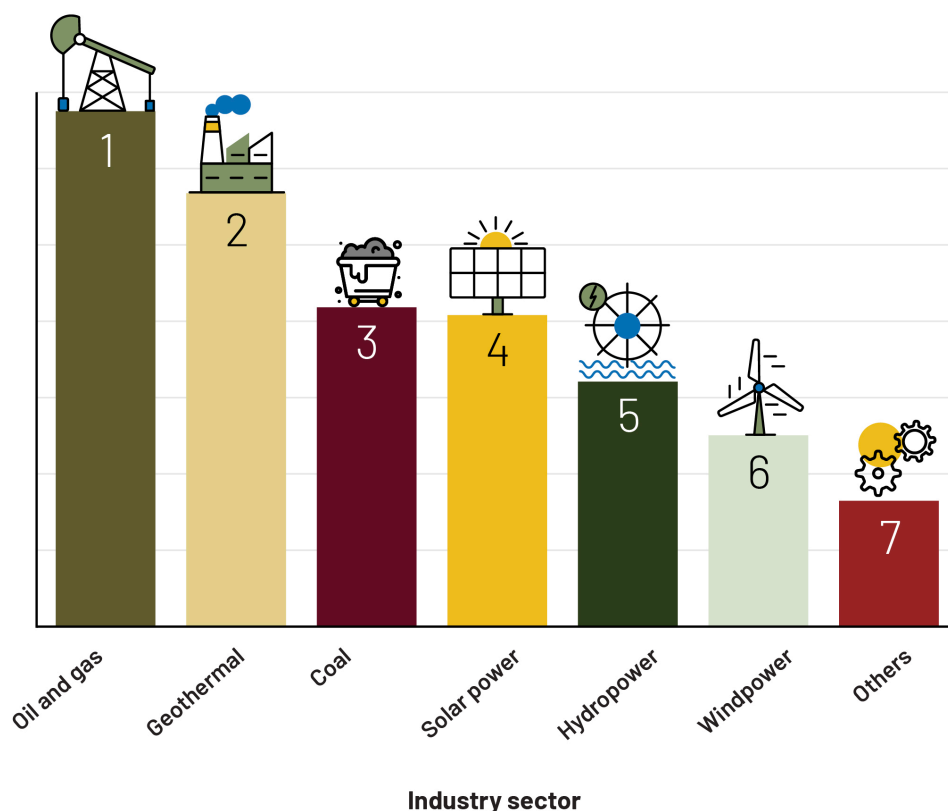


Figure 5.11: Survey-based ranking of industry sector preferences among Indonesia's recent graduates. Source: authors.

and benefits as their top priorities in career decision-making, reinforcing the perception that the oil and gas industry offers superior financial rewards. By contrast, social and environmental considerations ranked lowest among the factors influencing respondents' career choices, highlighting a persistent value gap that may hinder interest in clean energy careers.

To align geothermal workforce development with national capacity targets, Indonesia should scale up and diversify its geothermal education pathways, including establishing new degree programs, integrating geothermal content into related disciplines, and expanding vocational and diploma programs across the geothermal value chain.

During the interviews PYC conducted, one geothermal consultant mentioned they offer training to fulfill the "competency gap" for professionals looking for a career shift into geothermal. The courses range from beginner to advanced and cover technical skills such as well management and non-technical skills such as project management and economic aspects.

Fragmented Governance and Weak Institutional Coordination

As explained earlier in this chapter, Indonesia's workforce planning for the geothermal sector remains institutionally fragmented. The mandates of Bappenas (planning); MEMR (sectoral policy); MoM (manpower development); and the Ministry of Higher Education, Science, and Technology (education and training) are not aligned under a common operational framework, which makes policy formulation, funding, curriculum design, and training hard to execute. Indonesia would benefit from looking at how countries such as New Zealand and India work across ministries and align skills development with national energy transition goals.⁴⁷

Absence of Comprehensive Occupational Mapping for Geothermal Transition

Without a clear taxonomy of emerging occupations, required competencies, and learning outcomes, institutions such as MoM and the Ministry of Higher



Education, Science, and Technology cannot design coherent programs to advance the level of skills needed for a workforce or develop curriculum strategies. The lack of occupational mapping also limits private sector alignment with national human resource development plans. International experiences such as the European Union's European Skills, Competences, Qualifications and Occupations (ESCO) platform⁴⁸ and India's Skill Council for Green Jobs⁴⁹ illustrate how structured occupational frameworks can facilitate labor mobility, standardization, and curriculum design. For Indonesia, these lessons emphasize the need to develop a National Geothermal Occupational Map under the INWCS to unify workforce planning and skill certification across the geothermal sector.

Underutilization of the Oil and Gas Industry as a Workforce Transition Partner

Despite the strong overlap of competencies between oil and gas and geothermal, the expertise of O&G professionals remains underutilized in Indonesia's workforce transition. Mechanisms for recognizing and transferring these skills into geothermal projects are still limited, resulting in missed opportunities to accelerate labor reallocation and address immediate capacity gaps.

STRATEGIES TO SURPASS BARRIERS

The following strategies and recommendations focus on practical mechanisms to surmount barriers. Each strategy is mapped to the specific constraints it addresses. As

MAPPING OF RECOMMENDATIONS TO CORRESPONDING CONSTRAINTS

Recommendations			Constraints				
			Fragmented Governance	Absence of Occupational Mapping	Underutilization of O&G Industry	Inadequate Work-Readiness	Low Career Visibility
Laying the Institutional and Strategic Foundation	Recommendation #1	Establish the Energy Workforce Transition Task Force (EWTT)	✓	✓	✓	✓	✓
	Recommendation #2	Develop Bridging Program Framework and Fast-Track Certification for Oil and Gas Professionals	✓	✓	✓	✓	✓
Program Implementation and System Building	Recommendation #3	Institutionalize a Geothermal Occupational Map and the INWCS	✓	✓	✓	✓	✓
	Recommendation #4	Pilot a Geothermal Immersion Program for Final-Year Students and Vocational Institutions	✓	✓	✓	✓	✓

Figure 5.12: Links between identified constraints in geothermal workforce development and corresponding strategic recommendations. Source: authors.



Indonesia refines its training and certification frameworks, it should design programs that reflect the full spectrum of geothermal technologies—conventional, next generation, and direct use—which will help prepare the workforce for not only power generation but also industrial heat and geothermal cooling systems (see **Figure 5.12**).

Laying the Institutional and Strategic Foundation

Indonesia has the pieces necessary to build a vibrant geothermal workforce with strong institutional mechanisms and policy coherence. The following four recommendations (some of which are explored in more detail in Chapter 7) could help the nation bridge sectors, mobilize stakeholders, and deliver programs that can scale.

#1: Establish the Energy Workforce Transition Task Force.

The Energy Workforce Transition Task Force (EWTTF) should be formalized through a presidential instruction to ensure strong cross-ministerial mandate, resource alignment, and policy continuity. The task force will be coordinated by the Human Resources Development Agency at MEMR, serving as the secretariat, with members from the MoM; the Ministry of Higher Education, Science and Technology; Bappenas; the National Agency for Professional Certification; and industry associations.

The task force's mandate will cover labor forecasting, occupational mapping, training, and designing certifications. Through a unified coordination platform, the EWTTF would bridge fragmented governance in workforce planning, align education and industry needs, and guide the development of geothermal and broader energy-transition job standards to enhance graduate work-readiness and sectoral labor resilience. See Chapter 7, "Turning Potential into Power: A Policy Blueprint for Indonesia's Geothermal Transformation," for more.

#2: Develop Bridging Program Framework and Fast-Track Certification for Oil and Gas Professionals.

A structured framework to connect the industries should formally recognize the oil and gas competencies that are relevant to geothermal.

Developing this framework would begin with an equivalency matrix that maps oil and gas job roles to geothermal functions, followed by training to close the gaps. Embedding the program in the INWCS and using Recognition of Prior Learning under the National Agency for Professional Certification as the mechanism for validating existing competencies would enable current O&G professionals to make the transition efficiently.

Additionally, developing a fast-track certification program would validate oil and gas professionals' existing skills against geothermal INWCS. Laying out pathways to bridge the skills could close minor gaps, with certification tied to direct hiring pipelines. This process creates a formal mechanism to absorb skilled workers into geothermal and helps ensure the country will have the necessary labor pool to meet a large growth in geothermal power, heat, and cooling.

These actions would ensure that decades of experience in subsurface exploration, drilling, and project management are used for geothermal. They would also improve the visibility of geothermal careers by showing clear, formalized pathways for oil and gas professionals to enter the sector, making geothermal a more attractive career option.

Program Implementation and System Building

Once institutional foundations are in place, the next step is to scale programs and systems that ensure long-term workforce readiness.

#3: Institutionalize a Geothermal Occupational Map and the INWCS.

A national geothermal occupational map should define job families across the project life cycle and translate them into formal INWCS documents. This step would provide clarity on required skills while also establishing shared standards across ministries and training institutions. Moreover, it will strengthen graduate work-readiness, as curricula and certification would be directly tied to defined occupational outcomes recognized by both the government and industry.



#4: Pilot a Geothermal Immersion Program for Final-Year Students and Vocational Institutions.

Geothermal project sites and the relevant ministries and institutions should develop a three- to six-month immersion program at geothermal project sites for students in their final years of study, which will provide practical exposure and mentorship in exploration, drilling, reservoir testing, and operations. This program would ensure that theoretical knowledge is complemented by real-world skills. This recommendation also responds to the low visibility and attractiveness of geothermal careers, as direct engagement with active projects would demonstrate geothermal's relevance, career potential, and contribution to Indonesia's energy transition.

CONCLUSION

Indonesia's geothermal potential offers not only a pathway to low-carbon energy generation but also a valuable opportunity to absorb and redeploy talent from its declining fossil fuel sectors. This alignment ensures that Indonesia's energy growth is decarbonized as well as socially just and employment secure. With the nation facing structural shifts in the global energy landscape, building a skilled and responsive geothermal labor force is essential to ensuring an inclusive and just energy transition.

Indonesia is uniquely positioned to pursue such a geothermal-centered workforce transition: It has the resources and the workforce. From exploration and drilling to reservoir management and plant operations, many of the technical functions in the nation's O&G and geothermal sectors are not only analogous but often interchangeable, with some targeted training. Moreover, institutional legacies in education, training, and industrial expertise—particularly within state-owned and O&G-affiliated companies—can serve as valuable assets for accelerating geothermal workforce readiness.

This transition should embrace all geothermal solutions. Direct-use heat, industrial applications, and geothermal cooling can multiply the benefits of power generation and create a resilient, integrated energy system that supports Indonesia's broader decarbonization and efficiency goals. Incorporating these next-generation and thermal

applications into training, policy, and investment planning will ensure Indonesia captures the full economic and employment potential of geothermal energy.

With proper training and certification, geothermal could achieve enough growth to anchor more than 650,000 durable, skilled jobs across Indonesia.

However, progress has been slow due to several persistent barriers. Institutionally, Indonesia's workforce development ecosystem is fragmented. Ministries responsible for planning (Bappenas), sectoral policy (MEMR), training and certification (MoM and National Agency for Professional Certification), and education (Ministry of Higher Education, Science, and Technology) operate under separate mandates, with limited coordination, leaving gaps in labor forecasting, occupational standardization, and program implementation. Establishing a coordinated platform such as the Energy Workforce Transition Task Force would help align mandates, budgets, and monitoring systems across ministries. At the same time, most geothermal-specific competencies remain poorly defined in national occupational maps and the INWCS, which impedes curriculum development and limits alignment across academic and vocational institutions.

The recommendations offered in this chapter could form the building blocks of a national workforce transition program that can be integrated into Indonesia's National Medium-Term Development Plan, the National Energy General Plan, and a just transition agenda.

Now, Indonesia needs the political will, institutional alignment, and investment to connect these assets with the country's clean energy future. If implemented decisively, this approach could position Indonesia as a regional leader in green workforce transformation by 2035. By taking these steps, Indonesia can ensure that its energy transition is not only technologically feasible and economically viable but also socially inclusive and workforce driven.



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