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Supporting Sustainability in the Indonesian Geothermal Sector Through New Training Methods for Technicians and Operators.

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ABSTRACT

Indonesia's economic growth depends on ramping up power generation and improving reliability of, and access to sustainable electricity supply across the country. New Zealand Support for Training in the Indonesian Geothermal Sector (NZSTIGS) provides the Government of Indonesia (GOI) with development assistance targeting the human resource development challenges that currently constrain efficiency and productivity in the growing development of geothermal energy supply. The activity is focused on improving the number and quality of the geothermal trades, technicians and plant operators (TTPOs) in the sector. Research confirms there is a skills shortage to meet the demand for an expected 3,500 TTPOs required for 2,200 MW geothermal generating capacity to be built over the coming five years in Indonesia. This is a significant and specific gap reflecting structural, cultural and educational pedagogy issues. This paper will describe the challenges and causality, and the interventions being implemented to overcome this constraint.

1. INTRODUCTION

Need for Geothermal Trades, Technicians and Plant Operators (TTPOs)

There is still no change to the overall power shortage situation in Indonesia, with 60 million people without a regular supply of electricity. Oil production is diminishing and the drive to utilise significant geothermal reserves is strong. The state of the geothermal sector, the government's aspirations and the associated challenges around human resource development to service the sector have been well documented and clearly presented in the Geothermal Energy Human Resource Development Strategy (GEHRDS).

Indonesia has very ambitious expansion plans for its geothermal sector. Expansion is planned for Java, where most of the existing plants are and also on the other Islands; esp Sumatra where the majority of undeveloped resources are situated and where major developments are concentrated. In order to meet its growth objectives, significant investment must be made into ensuring enough people have the right skill sets to support all aspects of sector growth.

From our experience in Indonesia and other South East Asian countries, we made the following observations:

Indonesia is exhibiting many general characteristics, and some specific to vocational education and training (VET) that are common across developing countries. These include:

Fast developing economies with increasing middle classes and the need to secure energy, water, and food production

Often massive growth in key sectors with high numbers of multinational companies setting up

Simple didactic vocational training – if any – with poorly formed VET frameworks and pathways

Non-existent or rudimentary industry certification and moderation mechanisms

Minimal industrial compliance requirements or structures

Predicted TTPO requirements – current position

At present the Indonesian geothermal installations seem to be following the RUPTL-growth scenarios. Therefore, GEHRDS estimates (April 2015) that personnel and TTPO needs will grow accordingly.

One of the significant constraints to expanding the geothermal power sector in Indonesia is the lack of suitably skilled TTPOs to work at the plants. Evidence supports expected future requirement of an additional 3,500 TTPOS (all types/ levels) for 2,200 MW build over next 5 years[1]. Further, it is apparent there are specific misalignments and gaps within this shortfall, including having the right skills in the right locations (mainly Sumatra and Eastern regions) to support anticipated geothermal development across Indonesia. Half of these TTPO needs are likely to be needed in Sumatra due to the level of geothermal expansion planned for this area.

There is already a documented scarcity of TTPO skills, especially in more remote areas outside the main Java centres. Long-term, sustainable support for fast growing geothermal TTPO-demand (in quality AND quantity) is likely to need cooperation with regional

[1] Discussion and published reports, including NZ MFAT Geothermal HRD Programme estimates. These numbers are similar to the ones from BAPPENAS National Geothermal Capacity Building Plan (2011). These are broad estimate numbers covering all staff types – not exclusively technician and trades.

education providers of basic-TTPO-trainees. This means that there will be a need to augment those already in traditional training and also to improve basic training provision through local service providers.

Employment of local residents for geothermal developments in relatively isolated locations is a social and logistical preference for companies (Supreme Energy and Sarulla Operations both indicted this position) and a necessity where no viable alternatives exist, a situation reinforced by government and other social policy decisions/ interventions and sector requirements. There are other development challenges in these regions (primarily Sumatra and Eastern Islands) which have not shared in all of the benefits of Indonesia's economic growth, and this Activity provides an opportunity to enhance development outcomes through skilled employment for otherwise marginalised populations.

The TTPO human resource and training situation in Sumatra is currently not well defined – discussions with local institutions in Padang confirm the need for training of trainers and the expectation is the Eastern Islands would require similar targeted support. In addition, to reach students in more remote locations and with varying job schedules, the feasibility of innovative approaches such as distance and computer-based learning, peer group support and practice based learning needs to be assessed for its potential to further expand reach and enhance training delivery.

The challenges of the skill need, in terms of relevance, quality and quantity have been well documented in various studies and projects, including the recent GEHRDS. There have been significant investments in skill development for the geothermal sector already. However, to date these interventions have been primarily focused on the scientific skills needed to support exploration and resource investigation. There has been little focus on the core trades and technical skills required for plant construction and operations.

There is limited scope to bring in workers from other energy sectors (such as Oil and Gas or thermal/coal-fired power generation) with expansion in these sectors also contributing to support Indonesia's power demands, a situation contingent upon political and other external influences (such as the oil price). Further, there are inherent disincentives in the geothermal sector that further narrows the potential pool of workers to recruit from, despite the tendency for qualified workers to be somewhat mobile in seeking suitable work. Factors limiting the number of workers companies are able to recruit include the lower pay, unattractive work conditions, remote locations and perceived lower status of geothermal jobs in relation to other jobs in the energy sector and lack of attractive career pathways. Once workers are employed in the sector, retention does not appear to be a significant issue for locally resourced company plants due to a scarcity of alternative job prospects in isolated regions.

Development Challenge

Indonesia's economic growth depends on ramping up power generation and improving reliability of, and access to electricity supply across the country. New Zealand, along with other donors, has committed significant development assistance towards increasing the proportion of power generated from renewable sources, with a particular focus on Indonesia's significant geothermal potential.

Geothermal plants include a mix of Government and private sector firms, with Pertamina Geothermal Energy (PGE) and Perusahaan Listrik Negara (PLN), large state-owned companies, dominating planned geothermal development activity. There is growing expectation from energy sector firms that the Technical Vocational Education Training (TVET) system will deliver appropriately qualified and skilled graduates, at the D3/D4 diploma and S1 undergraduate levels they typically hire from. The company's minimum standards expected for graduates is increasing, in line with geothermal expansion and increased sophistication. Firms want graduates who have dexterity and tool skills, problem solving abilities, relevant health and safety knowledge and skills, and technical English competency.

Most geothermal assistance to date has been targeted at exploration/ investigation geothermal activity, rather than skills needed for follow on operations. The education system tends to produce graduates with knowledge of the theory but lacking in the practical work-ready skills needed by private and government geothermal firms. Further, there is limited feasibility to retrain/ upskill and transfer existing workers from Oil and Gas (O&G) sectors or other regions due to the remote locations of many geothermal sites, labour market disincentives and ongoing demand for workers for new O&G initiatives.

New Zealand Support for Training in the Indonesian Geothermal Sector provides the Government of Indonesia with development assistance targeting the human resource development challenges that currently constrain growth of energy supply possible from geothermal sources. This Activity is focused on improving the number and quality of the geothermal Trades, Technicians and Plant Operators operating in the sector - this is a significant and specific gap not being addressed in any systemic way, by either GOI or other development partners.

Therefore, the project activity must focus on supporting the development of sufficient quantity and quality of TTPOs in the regions where these skills will be required. Effective Train the Trainer (TTT) initiatives will be important to helping local institutions develop and deliver sound applied pedagogical approaches to addressing the specific geothermal TTPO training needs.

Other donor-funded and Government-lead initiates, including ongoing Asian Development Bank Polytechnics Education Development Project (PEDP), aim to address these systemic issues across priority sectors that encompass the energy sector. NZSTIGS must work in tandem with these complimentary initiatives, in order to target activities appropriately within the energy and TVET sectors, address underlying systemic issues and maximise impact from MFAT investment.

Industry challenges

The shortage of skilled TTPOs adversely impacts plant operational security and productivity now, and current ad hoc fixes to the problem will not resolve the worsening bottleneck. Current fixes involve sourcing from the scarce skills elsewhere in the system and providing unstructured training on the job, often based on company-specific Standard Operating Procedures (SOP), which in some organisations are used to try to address shortfalls in geothermal specific and work-ready skills. There is no "joined up" system that

facilitates and connects local VET institutions, industry and government agencies to prepare and support sufficient quantity and quality of TTPO workers.

The short-term imperative is private sector multinational and Indonesian companies, both constructors and operators that need staff:

a) with sufficient technical competence to enable normal operations within acceptable risk profiles, and

b) who can meet parent company compliance requirements.

Companies tend to focus on commissioning training and then on embedding their SPOs. Once operational the drive is for increasing productivity and decreasing non-standard occurrences. Increasingly we are seeing a shift in focus at this stage with the company looking to understand what competencies it has in its current workforce, to identify priority gaps and to provide competency based development and training so that it can operate its core business safely and effectively.

The risk factor is compounded for the companies by underdeveloped industry practicing certificates and compliance mechanisms. Hence the initial driver for the company is to understand what competencies it has in its current workforce, to identify priority gaps and to provide competency based development and training so that it can operate its core business safely and effectively.

This also applies to the new geothermal players in Indonesia who are beginning to plan for their plant workforce and are concerned at the lack of training pathways to prepare their future employees. This challenge is compounded by the relative isolation of many new geothermal developments and the need to employ locally

Gaps include TTPO and geothermal specific skills and adequate English language proficiency. English is the main technical language, especially for the international geothermal developers and for geothermal equipment suppliers. All stakeholders and partners have requested that English be the medium of training, and that practice-based learning be the pedagogy adopted. Similar gaps apply to the new geothermal players in Indonesia who are beginning to plan for their plant workforce and are concerned at the lack of training pathways to prepare their future employees.

Competency frameworks and pathways between the energy sub-sectors and from lower to higher-level qualifications are not well defined. This presents a barrier to participation in training and has not encouraged professional and skills development, a situation reinforced by underdeveloped industry practicing certificates and compliance mechanisms.

Comments from Indonesian Stakeholder Energy Firm Personnel

Informal conversations with a wide range of contacts in the sector provided the following feedback;

historically most companies evolved their technician workforce form the local community at the operational site

employed based on their CVs and company interviews.

once employed, staff start their training working alongside the equipment suppliers during the commission period. This is an on-Job training process with limited or no formal recognition.

as more companies have been assigned exploration licences and technology sophistication has increased, so to have companies' minimum standards

companies have indicated their basis for employment is now at least D3 capability from the Indonesia IQF framework and often employ at S1 for technical roles

while this is a change in minimum standard the obligation to employ local staff has not changed so they now expect to work with local ed/training providers

need to ensure program outcomes and teaching abilities are adequate, and that graduates from the local institutions are work ready in terms of their dexterity, tool skills, English language level, health and safety understanding and problem solving abilities.

institutions require strengthening – few are identified as currently capable of delivering the required graduates.

Whilst there has been significant discussion about this problem the following quote from Alex Smillie Star Energy Operations Manager from 2012 remains relevant.

"There is no trade training culture in Indonesia. Star has developed an in house apprenticeship scheme – 3 yrs, through each department, including some computer based learning. The Govt. provides some training around generic areas like health and safety. The "worker" level employees are generally poorly skilled with poor English and come from technical schools. The supervisors may have technical degrees from local universities. The good ones have been educated overseas."

Although energy sector firms currently provide some On Job Training (OJT), the quality and provision of this training is inconsistent, and there is no formal OJT qualification system. Generally training is based on company Standard Operating Procedures. Training provision is also hampered by a predominance of trainers skilled in didactic methods but lacking practical subject skills.

In the medium term, the companies indicate they will work with local technical schools/politekniks to improve the core skills of their worker pipeline. Our observation is that this will require significant input/investment to assist these institutions with curriculum, technology, learning pedagogy and professional development for their staff.

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The “new” and expanding Indonesian companies are voicing a wish to employ D3/D4 graduates and immerse them in a short course over a 7 to 12 week period focused on practical activities that build dexterity and tool skills, problem solving abilities and health and safety knowledge and skills.

This type of short course needs to include but not be limited to the following topics:

Disassembly and reassembly skills using geothermal plant (turbines/pumps/generators)

Use of diagnostics tools used in the geothermal sector

Use of specific company health and safety systems in hazard identification, permit to work, risk management within a geothermal sector

The use of standard operating procedures (SOPs)

Ability to read, interpret and analyse P&I drawings

Able to read, interpret and analyse Human Machine Interface (HMI) data for geothermal plant operations including data analyses, plant layouts, and controlling plant operations.

Maintenance planning and scheduling

In the short term, in addition to developing this type of short course there is the need to train the trainers (TTT) in the additional skills, knowledge and project based learning (PBL) pedagogy.

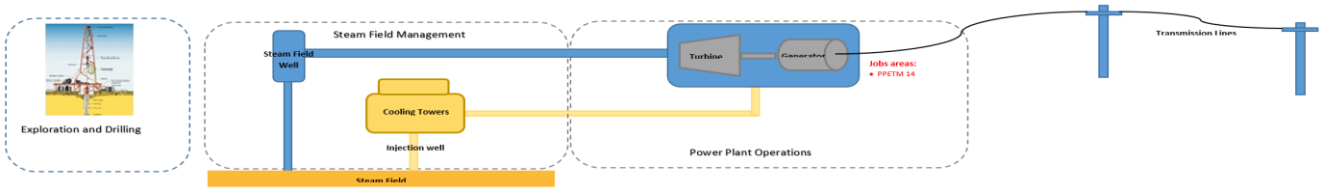
In the longer term, the companies have expectations that the Indonesian VET system will develop appropriate qualifications, curricula and certifications to provide a work-ready labour force. There are signs that the sector is responding, with the development of D4 qualification that include sector specific and practical skills embedded in curriculum which would replace the company need for the above mentioned short courses. This will require work at a structural level with state and country governments as well as industry bodies to assist in the design, implementation and management of whole VET systems. [2]

2. GEOTHERMAL TRADES, TECHNICIANS AND PLANT OPERATORS (TTPOS)

Defining Geothermal TPPOs

It is necessary to define the specific skills encompassed under the TTPO label at the outset in a way that is consistent with geothermal firms’ expectations and needs. These are classified in the below table.

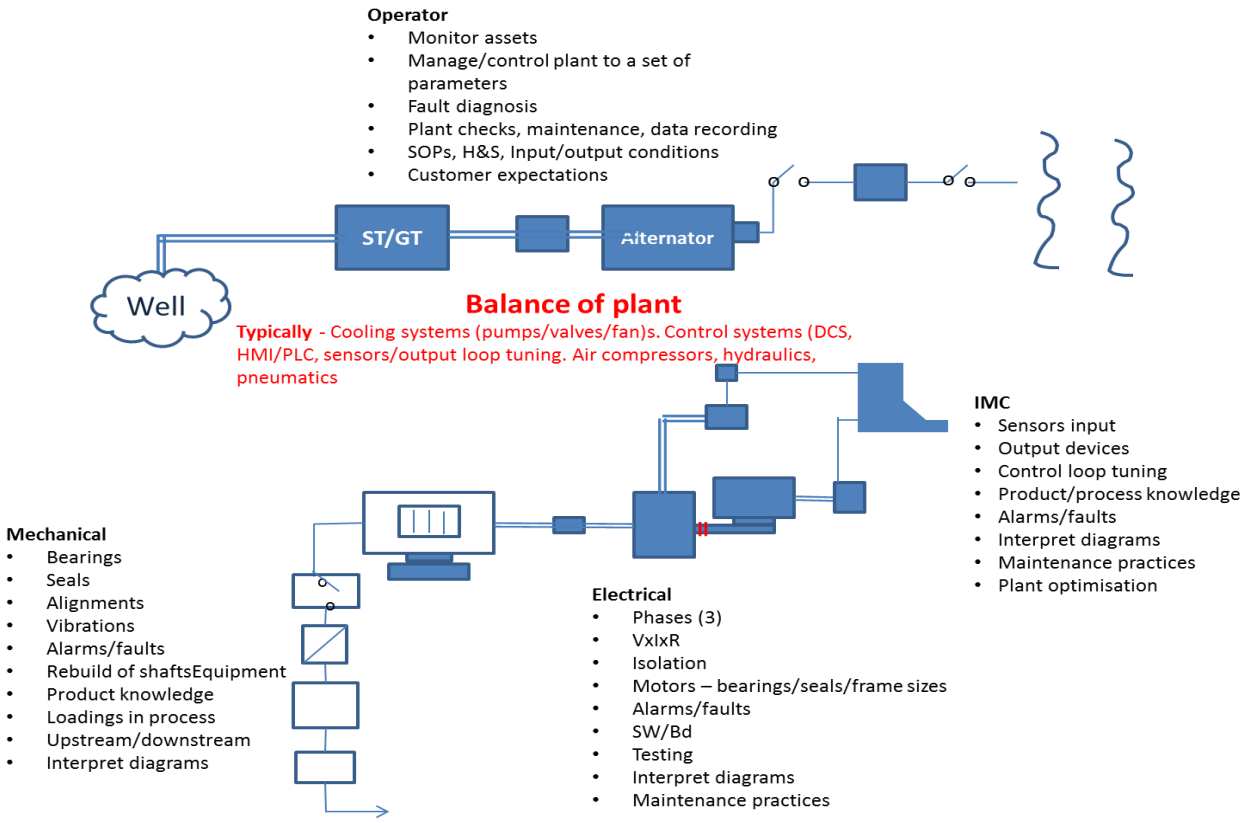
Discussions have reinforced a diverse understanding of the make-up of the geothermal TTPO cohort. We have focused our research around these broad classifications, accepting that the “net” may expand or contract as we progress.



Exploration/Drilling technicians	• Run on-site operations including drill setups, drilling processes using a variety of drill heads. • Carry out drilling operational maintenance • Manage non-routine complex technical situations in drilling
Steam field technicians	• Identify and minimise hazards within a steam field operations • Operate and inspect plant equipment such as pipelines, separators, scrubbers, dump stations and vent stations • Ability to identify steam-field faults, carry out investigations, record and take corrective actions.
Power plant operators	• Control and monitor geothermal power production including injection wells, pumps, separators, condensers, turbines, generators and auxiliary equipment • Regulate the output from production wells and generators • Monitor, regulate and report plant information maintaining desired outcomes using HMI systems
Power plant maintenance technicians	• Disassemble, reassemble and recommission geothermal plant components. • Carry out operational maintenance including replacement of like for like plant components • Ability to identify operational plant faults, carry out investigations, record and take corrective actions • Use of specific monitoring equipment for plant diagnostic including but not limited to vibration tools, infra-red imaging, alignment tools, and sampling tools.

[2] **Note: this is a more substantive exercise than *“defining competencies for compliance certification”*, an additional process that is currently taxing the sector (having started in 2005).**

Operators and technicians typically work the following functions:



Job titles power plant operations and maintenance	**Plant area**
Shift Supervisor	Operations
Senior Operator Power Plant	Operations
Operator	Operations
Junior Operator	Operations
Operations Analyst	Operations
Maintenance Planner	Maintenance
Maintenance Analyst	
Electrical Team Lead	Maintenance
Electrical Technician	
Mechanical Team Lead	Maintenance
Mechanical Technician	
Instrument and Control Team Lead	Maintenance
Instrument and Control Technician	
Steam field Team Lead	Maintenance
Environmental technician	Steam field
Field technician	Steam field
Lab technician	Operations

Levels of Competency

In determining the optimal balance of skills within a company for effective and efficient production there is a need to understand and delineate levels of competency. These are generic descriptors generally applicable across the geothermal industry for operator/technician levels.

Level 1 - "Awareness": Under supervision - Individuals at this level usually follow standard work routines and SOPs; generally work under close supervision; have decision making ability limited to their role; are able to solve routine common problems; are new to the job and building capability over 2 to 3 years and are typically Junior Operators.

Level 2 - "Fundamental": Have some experience under normal circumstances - Individuals at this level usually have procedural or systems experience; work under general supervision; make decisions based on established procedures; able to solve non-routine problems; typically have 3 to 5 years' experience and are Operators.

Level 3 - "Skilled": Have significant experience including under abnormal circumstances - Individuals must have command of the procedures and systems used; work to specific objectives with little direct supervision; are able to solve complex routine problems; are involved in the development of related staff; may have some budget responsibility depending on their role; can lead staff; are able to work cross-functionally; typically have 5 to 10 years' experience and are Senior Operators.

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Level 4 - "Mastery": Are subject matter experts who shape processes, tools and regulations - Individuals have a thorough understanding of the theoretical and practical application of their role; can make decision for their area; build capability of staff and have developed coaching and mentoring skills; able to solve complex non-routine problems; and typically have 10+ years' experience and are Shift Supervisors.

Electrical Technician (Electrical technicians are responsible for maintaining, testing, developing, repairing, and designing electrical wiring and equipment within a geothermal energy system)	Jobs (A)
Will include but not limited to the following skills/competencies. • Understands the geothermal power generation process end to end. • Applies direct current concepts (DC) • Applies alternating current concepts (AC) • Knowledgeable in terms of the location of equipment in the plant, how it operates and what are the normal operating conditions • Able to use a wide ranges of tools such as hand tools, power tools and test equipment including geothermal specific testing equipment. • Able to describe the theory, construction and application of rotating equipment including geothermal turbines, generators, motors, and motor generators • Able to describe the theory, construction, and application of electrical supply components (e.g. batteries and chargers, circuit breakers, switch gear,) • Maintain and repair electrical equipment • Diagnoses problems and perform maintenance on a range of electrical equipment. (e.g. motors, electrical control equipment, control circuits, resistive electrical equipment, valve actuators,) • Able to perform specialist tasks such as motor overhauls, high potential test, relay settings adjustments, motor valve diagnostic testing • Understand and can diagnose control system equipment such as DCS, PLC, HMI following and interpreting electrical wiring diagrams • Ability to work within a team • Able to direct/manage sub-contractors on specific tasks • Able to carry out routine maintenance checks as per maintenance schedules	Skills/Competencies (B)
• Understands the geothermal power generation process end to end. • Knowledgeable in terms of the location of equipment in the plant, how it operates and what are the normal operating conditions • Able to use a wide ranges of tools such as hand tools, power tools and test equipment including geothermal specific testing equipment. • Able to describe the theory, construction and application of rotating equipment including geothermal turbines, generators, motors, and motor generators	Unique to Geo Thermal (C)
In general companies appear to sub contract out a wide range of maintenance work to known maintenance contracting companies who supply a work force from the local region. Most geothermal companies we have had contact with run a small maintenance team who predominately manage the sub-contractor work force through planning. Geothermal Energy Companies source their workforce also locally targeting specific skills and competencies that each specific company requires. There is a push of late by companies however to source graduates from the education sector of Indonesia who have completed D5 level (Technician Level) refer to IQF Improvement through different pathways model. ***Who are they:*** Graduates from a local education provider and local community for new companies constructing a geothermal power plant. In the case of existing geothermal plants, due to the lack of staff turnover the existing workforce due to the location, there is currently no understanding of their background other than the individual companies providing the opportunity to formal study, attend a wide range of short courses, and importantly leaning on the job (experience) as they complete the relevant task. This form of on-job learning has not been formally recognised. ***Where From:*** Predominately companies will employ locally as per their requirements ***What qualifications:*** Moving forward there is a common drive to employ locally from a pool of people who have completed their D3 qualification.	Companies Employment (D) Who are they Where from What Qualifications
Who trains: Most vocational schools with Indonesia provide education from the IQF framework up to and including D3 Level Engineering (mechanical, electrical, Instrument and Control). As companies are looking at employing from within their local region, local vocational schools will need to become familiar with the requirements of the companies and ensure that their graduates are work ready in terms of skills, knowledge, diagnostics abilities and mechanical aptitudes. (e.g. Supreme Energy is working with Andalas State Polytechnic in Padang West Sumatra) ***What qualifications/certifications:*** D1, D2, D3, D4 Technician level of education. In some instances due to the nature of the role and the possible impact on health, safety and wellbeing of the general public there are certain certifications that may need to be meet through government legislations. Education providers in some cases have set their programs up to reflect this requirement.	Education Providers (E) Who Trains What qualifications/certifications
With the focus of companies wanting to employ staff from the local regions, (Chevron, Supreme Energy, Sarulla Energy and Geo Dipa Energy). This does suggest they need to be working with local education providers such as Andalas State Polytechnic in Padang West Sumatra. However companies are also indicating that graduates from these program are often not work ready, work capability and have a range of shills that enable them to use hand tools, power tools and test equipment effective. D3 level indicates that graduates within the specialisation are: 1. Capable of completing a wide coverage of job tasks, choosing appropriate methods from a variety of undefined and defined selections by analyzing data and demonstrating performance with measureable quality. 2. Mastering general theoretical concepts of a specific knowledge and capable of formulating related problem solving procedures. 3. Process capacity to manage team work and construct comprehensive written reports. 4. Responsible for her/his own job and can be assigned responsibility of the attainment of team work performances.	Gaps B-E (F)

However companies are indicating there are gaps in the following areas: • industry practices, (understanding what the industry is and how it operate e.g. geothermal operations from well to transmission) • dexterity skills, (ability to use a range of hand tools correctly, able to use power tools, able to use the correct test equipment, able to read and interpret drawings and manufacturers manual) • problem solving skills, (ability to solve the root causes rather than the symptoms or faults, able to follow simple data analyse within a work environment) • disassemble and reassemble skills of specific plant items, (using appropriate techniques, replacement of component parts like for like, able to recommission and test in place, isolation processes) • Ability to follow standard procedures, maintenance charts, SOPs, fault diagnostic charts • Ability to monitor plant components while in operations following maintenance procedures. (vibration monitoring, oil sampling, infrared analysis) • Understand and apply safe work practices.	
The types of activities may include but not limited at this stage: Short courses such as: • Geothermal operations from well to transmission operation • Safe work practices • Project base short course enabling the use of dexterity skills, problem solving, disassemble and reassemble skills, using operational procedures. (using specific geothermal plant equipment such as motors, motor-control valves, electrical switch gear, isolation processes) • Maintenance practises for geothermal power plants • Root Cause Analysis programs • Operational identification of plant layout using P&I drawings, Human Machine Interface (HMI) and SOPs Medium term activities such as: • Build structured On-job assessment process for identify competencies, • Develop on-job trainers, • Work with identified government agencies to review and establish a possible geothermal strand in D3 curriculum.	Type of Activities (G) Short/Long
Short course framework built for geothermal plant electrical technicians and relevant competencies such as: • Geothermal operations from well to transmission operation (2 days) • Safe work practices (3 days) • Project base short course enabling the use of dexterity skills, problem solving, disassemble and reassemble skills, using operational procedures. (using specific geothermal plant equipment such as motors, motor-control valves, electrical switch gear, isolation processes) (up to 7-10 weeks) • Maintenance practises for geothermal power plants (5 days) • Root Cause Analysis programs (3 days) • Operational identification of plant layout using P&I drawings, Human Machine Interface (HMI) and SOPs (3 days)	Outputs
Medium term activities • Build structured On-job assessment process for identify competencies, (up to 6 months) • Develop on-job trainers and assessors, (once On-job process is designed this short course would take 3 weeks split into two stage giving the graduates the opportunity to practice in the workplace) • Work with identified government agencies to review and establish a possible geothermal strand in D3 curriculum. (time TBC) Long term activity: • Establish a nationally recognised training framework and competencies standards.	Short/medium/long term Outcomes

Following is an example of a detailed assessment of role needs and gaps:

4. CURRENT STATE OF TRAINING - INCLUDING TRAINING COORDINATION, OFF-JOB AND ON-JOB TRAINING PROVISION, CURRENT CAPACITY OF PROVIDERS.

Vocational training systems and institutions

Vocational education delivered by institutional providers in Indonesia comes under the Indonesian Qualification Framework (IQF). The IQF is comparable to similar quality systems in Europe and NZ and is designed to align with these international frameworks and occupational requirements (source IQF, 2012).

In Indonesia, operations and maintenance technicians generally have D3/D4 level qualifications. These base diplomas (electrical, mechanical, civil, instrumentation and control) currently have little specific industrial, operator, or geothermal focus. On entering the workforce, most recent graduates require significant amounts of base technical competency training and introduction to geothermal energy operations to be useful.

The current, traditional didactic teaching system produces theoretical knowledge, research and laboratory skills and there is nothing similar to an apprenticeship system to address the deficit in work-ready skills. Asian culture, particularly of respect for elders, means that inquiry-based learning is challenging unless the tutor has received specific training in student-centered learning. To quote a senior tutor and researcher at University of Indonesia *"we have to change the way our students think and learn, if we want them to be critical thinkers."*

Local VET training systems do not deliver work-ready graduates – even where sector based VET is available. Often local graduates have no practical experience or manual dexterity in handling tools and technical equipment and many exit the largely didactic education system with only theoretical knowledge. Modern applied teaching and learning approaches (such as Project Based Learning) that seek to develop practical work skills and a sense of inquiry in students are not well understood or used by institutions or other training providers in the sector. Train the trainer (TTT) programs need to be embedded across the system to develop trainer skills and pedagogical knowledge to support ongoing effective training delivery by VET institutions and other training providers (e.g. on job and short courses) in the regions.

Education Providers:

Indonesian education providers (both general Poltekniks and specialist pusdiklats) deliver a range of programs focused on the D1, D2, D3 levels for Technician training. The majority of this training is through lectures, laboratories and written projects minimal practical hands on examples. This style of delivery enables the student to gain theoretical knowledge of a topic, research skills and laboratory skills. However, companies are looking for graduates who have dexterity and tool skills, problem solving abilities, and health and safety knowledge and skills.

Company training programs:

Discussions with sector companies indicate that each company has a training program (on-job) which focuses on training their staff on plant individual equipment and SOPs. These are mainly delivered using in house subject matter experts and power point presentations. Some companies do have assessment processes which are informal and not matched to any formal qualification.

In some instances, companies who have multiple sites have developed site specific programs which bear no resemblance to, and are inconsistent with each other e.g. one site program takes up to 6 months while another site takes up to 18 months to complete similar content. This suggests an in-company improvement process is needed, linking best practice delivery methodology, assessment process, and quality systems that are designed and tested within the Indonesia geothermal environment.

Meetings with education providers, geothermal companies and equipment suppliers has provided an understanding of the current environment will enable the shaping of this improvement cycle.

There are three key areas of training that need enhancement:

Formal Off-Job training

Formal On-Job training

Informal On-Job training

Formal off-job training is training that is carried out off site or away from the individual's work area. This type of training can be through Education Providers or Suppliers of relevant equipment. In some instances, there could be specific outcomes which can be assessed, both formal and informal.

Formal on-job training is a training process that is used in companies to assess their employees to either a formal qualification (based on skills) or to relevant company SOPs, and is often tagged to recognition and reward (promotion) processes.

Our research to date indicates there are few formal on-job programs, co-ordinated by either education providers, companies or other providers in the Indonesian geothermal sector. The lack of formal on-job programs, also indicates a need to train a range of people both within companies and education providers on on-job systems and processes, including assessment and moderation, to enable a formal on-job system to operate.

In-Formal on-job training is a range of training activities including programs, courses and presentations that are delivered by either equipment suppliers, buddy systems, and/or company personal who are deemed to be subject matter experts.

Currently our research indicates that most Indonesian geothermal companies do have internal in-formal training systems. However, the co-ordination, capacity to deliver and assessment processes need ratification so that programs can be measured/mapped to specific outcomes and recorded as part of the individual's record of achievement.

Successful on-job training models presuppose a high level of technical skill is available onsite (in companies) both for training and assessment. We suggest that whilst this is an admirable medium term aim, these resources may not currently exist and this model of skill development may need a phased approach.

4. NEW ZEALAND SUPPORT FOR TECHNICAL TRAINING IN THE INDONESIAN GEOTHERMAL SECTOR - CHANGE INTERVENTIONS AND RATIONALE

Tasks and inputs

NZSTIGS involves two main types of tasks:

1) those that are directly related to training provision in various forms to solve both short and longer term gaps, and

2) those involving structural reforms that are needed to support sustainable ongoing development and quality management of skills in the sector.

Train the Trainer programs for Politeknik and Pusdiklat tutors

From desk research and the design mission phase it was confirmed that the predominant teaching pedagogy in Indonesia is of a didactic style with an emphasis on theory based learning (80/20%) augmented with some practical laboratory style learning (led demonstrations of theory with no practical input by observing students). This style of teaching is supported by the curriculum outlines we reviewed and confirmed in discussion with key teaching personal.

Observation reinforced a general lack of understanding of "practical skills" and how they should be taught within an education environment. For example, many of the tutors from the observed institutions had limited or no experience working in industry other than short professional development industry placements.

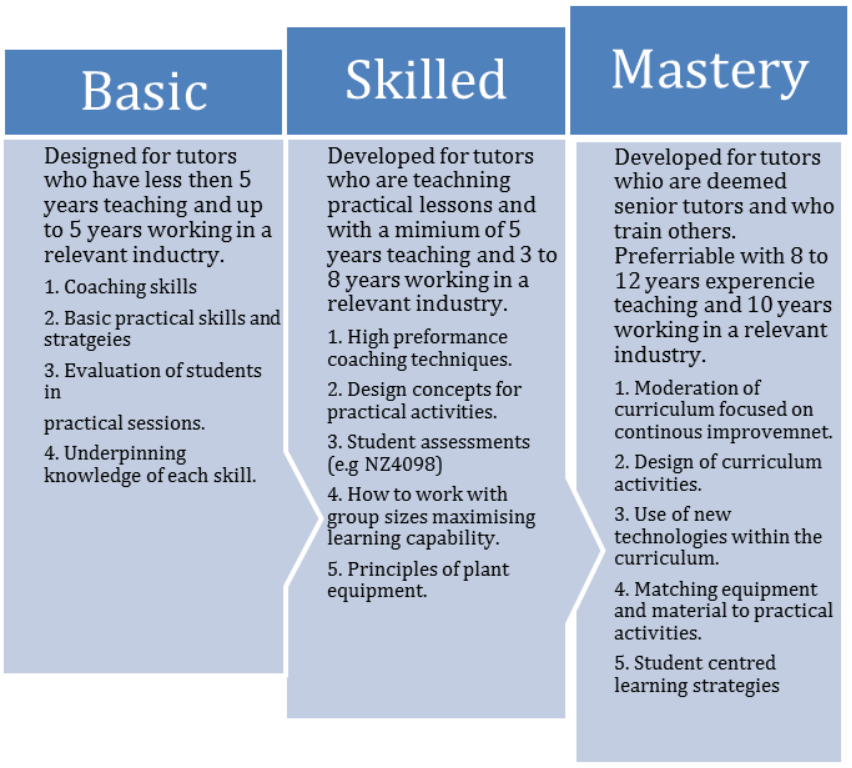
Discussions with geothermal developers reiterated a key concern, that new employees – regardless of the education level they come from (Technical school, D1, D3/D4 or S1) lack practical skills and knowledge; lack knowledge of geothermal operations end to end; and lack understanding of applied health and safety practices within a geothermal energy operation.

These concerns supported the above referenced analysis of teaching practices and the lack of practical based learning opportunities for students.

Based on our early analysis we believe the following intervention will address this gap.

"A three tier Train the Trainer program with specific outcomes at each tier building to a mastery level of competency."

This program will build tutor's capability in best practice teaching methodologies and importantly will assist tutors to gain practical skills to an advanced level, enabling them to effectively teach new students.



Indonesian participants: this task involves the target Politekniks/Vocational Colleges/Universities, and the PPs designated by BPSDM.

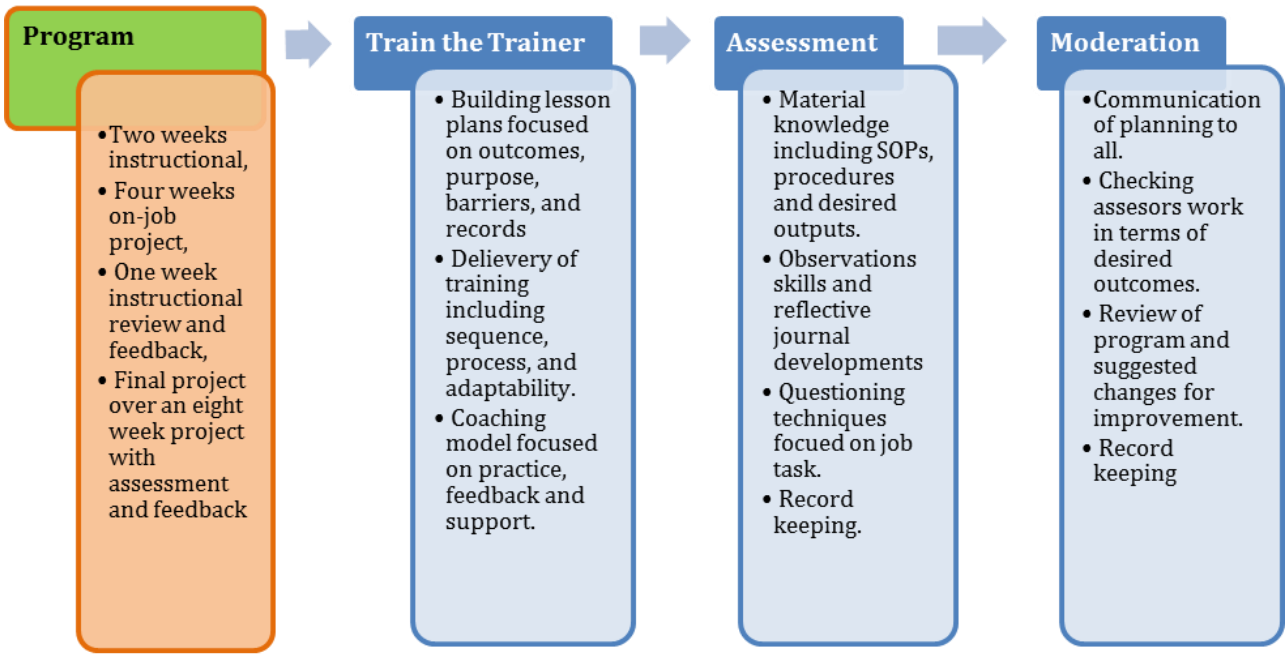
Train the Trainer program for Industry and/or company subject matter experts

Industry training is an important part of building staff capability within any organisation. The most common model used is known as "buddy system training". Buddy system training is a procedure in which two people, the buddies, operate together as a single unit so that they can help each other. Often one person of the pair is more experience and skilled, enabling them to share their knowledge and skills with the other person.

Whilst this practice has evolved, so have the challenges involved in this type of training. For success this system relies on equal intent and full disclosure, however, often this does not happen resulting in variability and poor outcomes. To counter this behaviour, companies who operate manufacturing best practices have taken a more structured approach to on-job training building on a coaching philosophy and assessment process, and using their standard operating procedures (SOP) and their business processes as the training platform.

The following programme will enable Indonesia geothermal companies to build staff capacity.

Three weeks of instructional content with two on-job projects to be completed in the attendees own organisation. The timetable would be two weeks of instructional content, followed by four weeks of on-job project, followed by one week of instructional content, followed by an eight-week on-job project with an assessment.



Indonesian participants: this task will involve current staff from companies, sector-wide (both private and SOEs), and SMEs in the expert pool.

Summary of rationale: Utilising existing infrastructure and embedding capability at target institutions through robust curriculum and TTT will ensure sustainability. In addition developing a more formal on-job training mechanism requires enhancing the teaching and assessment competencies within the companies.

Additional curriculum designed to augment D3/D4 "engineering" disciplines.

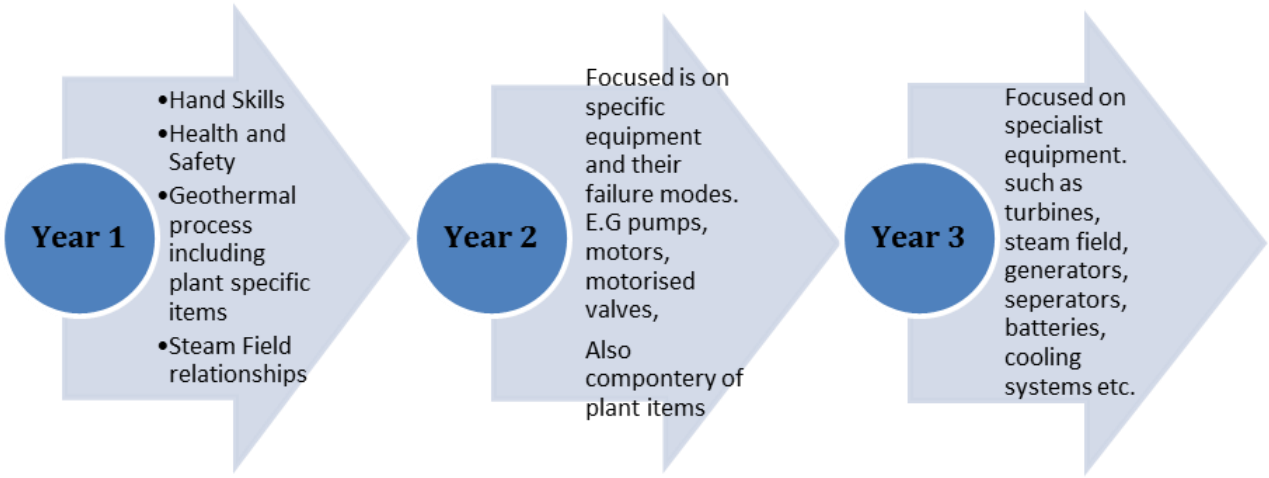
Discussions (with the Politekniks and Universities in Indonesia) on the application of the D3 Indonesian Qualifications Framework level outcomes for engineering, confirm that whilst D3 is the desired level of employment for geothermal developers, the existing D3 curriculum has no reference to geothermal energy. Both thermal energy and renewable energy is referenced in some cases, however this is limited and depended on the level of capability of the institutions tutors.

Geothermal developers confirmed that they targeted D3 graduates because they perceive that this level of graduate should be able to: complete a wide range of tasks using appropriate methods; have a mastery level of theoretical concepts in a specific engineering discipline enabling them to formulate problem solving strategies; and, should be able to manage and be responsible for their own job/task and attainment of team performance.

However, the companies report that the base practical skill level that they believe graduates should have is not common and that there is a general lack of mechanical aptitude and ability to apply theoretical concepts to plant equipment and machinery.

The solution to this is to to augment the D3 and D4 "engineering" curriculum with practical components of study, that meet industry's desire for work ready graduates. Whilst KEMERINSTEKDIKTI has previous experience implementing a new model of training in the film sector with Singaporean assistance and is open to a new model for geothermal, changing curricula rather than teaching methods is a longer term process. This activity involves shaping additional (or substitute) practical based learning interventions focused on developing mechanical aptitudes, hand skills, health and safety in the workplace, use of SOPs, and disassemble and reassemble of plant equipment, and inserting over the duration of the D3/D4.

In addition, a cirricula will be designed to augment S1 graduates with practice-based "real world skills" courses.



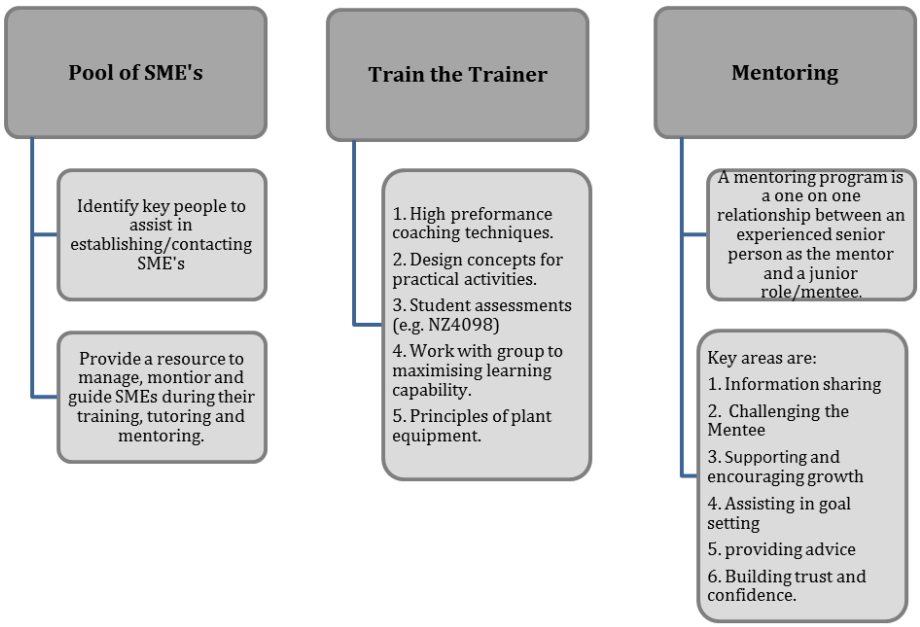
Indonesian participants: this task will involve the target Politekniks/Vocational Colleges/Universities.

Summary of rationale: Without exception, the key stakeholders spoken with, state that local employment, improved curriculum at D3/D4/S1 levels at accessible politekniks, and focused short courses for advanced skills are important to them.

Set up a system, including training to establish a pool of subject matter experts (SME) from the geothermal sector who can be used as short course facilitators and support-persons for industry training.

There is a lack of knowledge and experience across all disciplines in operations and maintenance for power plant operations, and steam field management in both the geothermal operation companies, and across the training sector. The lack of skilled workers is also apparent in well drilling operations and contracting companies.

That said, geothermal power plants have been operating in Indonesia since the 1980's (PGE's Kamojang and Chevron plants at Salak and Darajat). The "compulsory retirement" age in Indonesia is 58, and discussions suggest there is a potential pool of Indonesian (and expat) technical experience that could be harnessed as trainers to help fill a short-term gap. Identifying such individuals, especially those newly retired, is possible: they will be trained to teach and mentor. It is considered more appropriate to train competent technicians to teach, than to try to give technical competency to current non-technical trainers.



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Indonesian participants: BPSDM will be the partner and recipient agency.

Set up a series of technical short courses

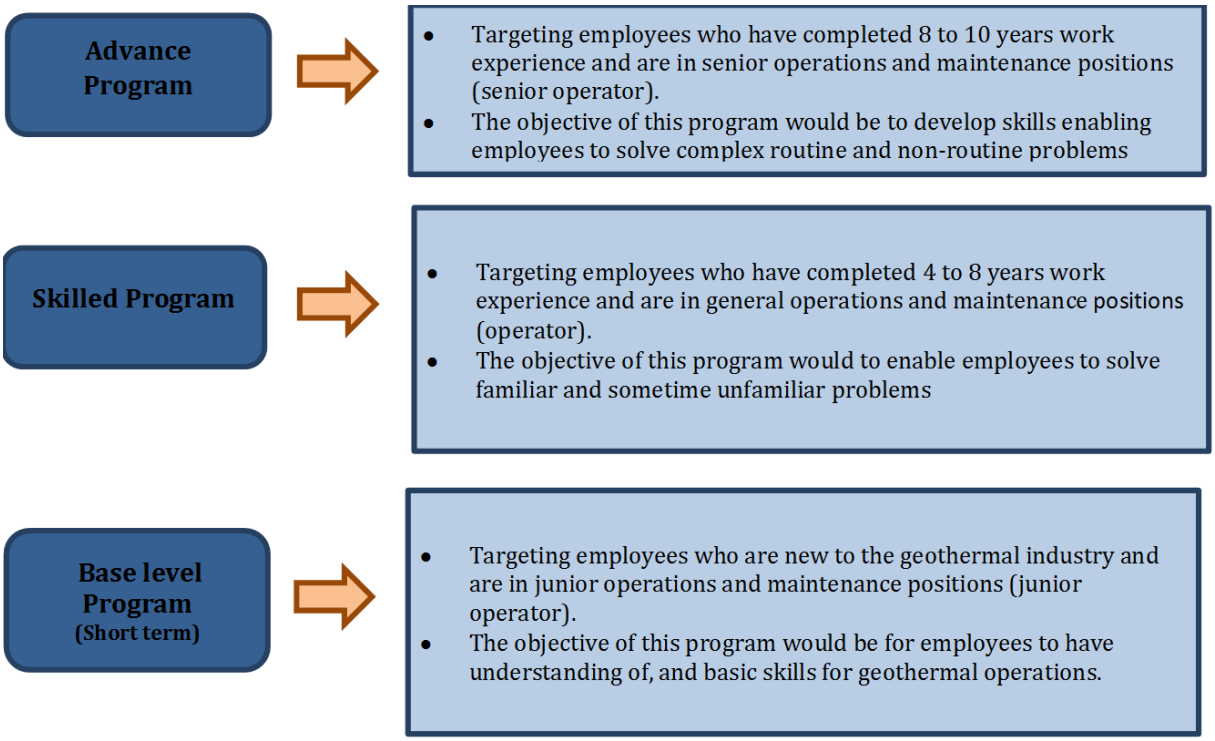
All phases of this project have reinforced the lack of technical short courses available for companies to send their staff to. All education and company parties commented on the urgent need for short courses to fill the gap (to facilitate improvements in productivity) whilst core training was developed, and also for the longer term to support on-job upskilling.

Building on the activity "Curriculum Improvement design for D3 curriculum", a short course structure is being implemented to build and enhance technical capability in geothermal operations and maintenance at the operator and technician levels.

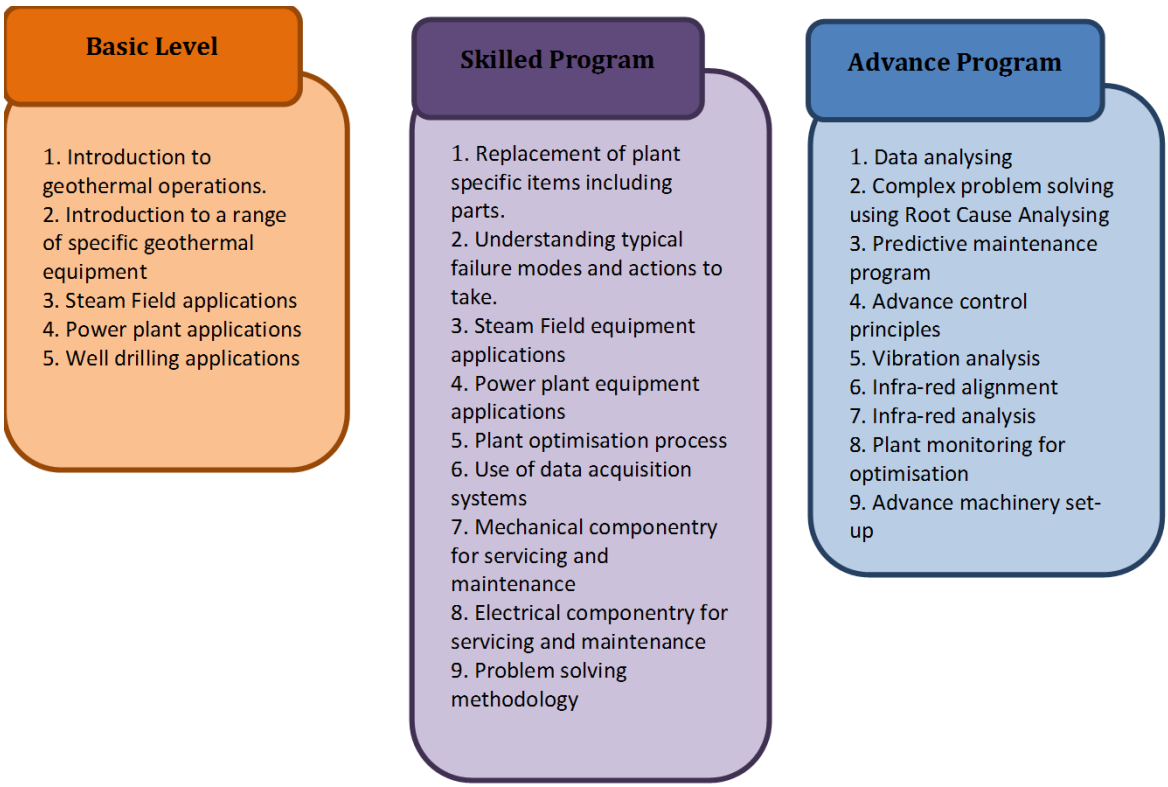
In the short term, a three-tiered approach to short course upskilling has been designed with the base level eventually being replaced by the suggested changes to the D3 curriculum.

This upskilling mode will also be applied to the "drilling technician" cohort.

Typically, each program would comprise a series of short courses as shown:



(Note: these are typical examples and not an exhausted list.)



A number of tasks are being completed in tandem with the short course program development, including:

Training the Trainer for Industry (includes assessment processes)

A learning management system to ensure student/employee achievements are recorded.

An implementation plan enabling short course delivery while ensuring industry trainers are suitable trained to both deliver and assess their student/employee.

Implementation of the short courses is proceeding with a medium/long term outcome of embedding capability in Indonesia geothermal industry trainers to ensure sustainability following the end of the New Zealand support. Activites include:

1. Identification of short courses that immediately add value/impact to organisations at both the skilled and advanced levels.

2. Using New Zealand expertise in both vocational and industry-based training to deliver the range of identified short courses over the first 24 months.

3. Using New Zealand expertise for training the trainers, in parallel to the short course program for industry trainers to build Indonesia geothermal industry capability (targeting PLN, PPs, Geothermal private/SOE companies, Politekniks, and retired industry SMEs).

4. As each train the trainer program is completed and graduated trainers have achieved the required standards (both as trainers and in technical subject matter), the New Zealand expertise will shift its emphasis from delivering short courses to mentoring and assisting the graduated trainers in the delivery of short courses.

5. In conjunction with building this capability, a learning management system is needed to ensure graduates from the short courses "records of achievement" are recorded. Visibility and transferability of learning is a critical step to attracting and empowering the employees.

6. Work with key identified BPSDM (and PP) personnel to develop their skills and knowledge in training the trainer programs, enabling them to develop assessment and moderation capabilities, and competency as short course trainers/assessors and managers of the "system".

7. Develop company staff capability to deliver, assess and moderate short course/on-job delivery within their own organisation.

Indonesian participants: designated PPs, Politekniks, as future short course tutors. Geothermal private/SOE companies as industry trainers.

Summary of rationale: Without exception, the key stakeholders spoken with, state that local employment, improved curriculum at D3/D4/S1 levels at accessible politekniks, and focused short courses for advanced skills are important to them. Embedding this capability and curriculum in as many places as possible enhances the sustainability potential.

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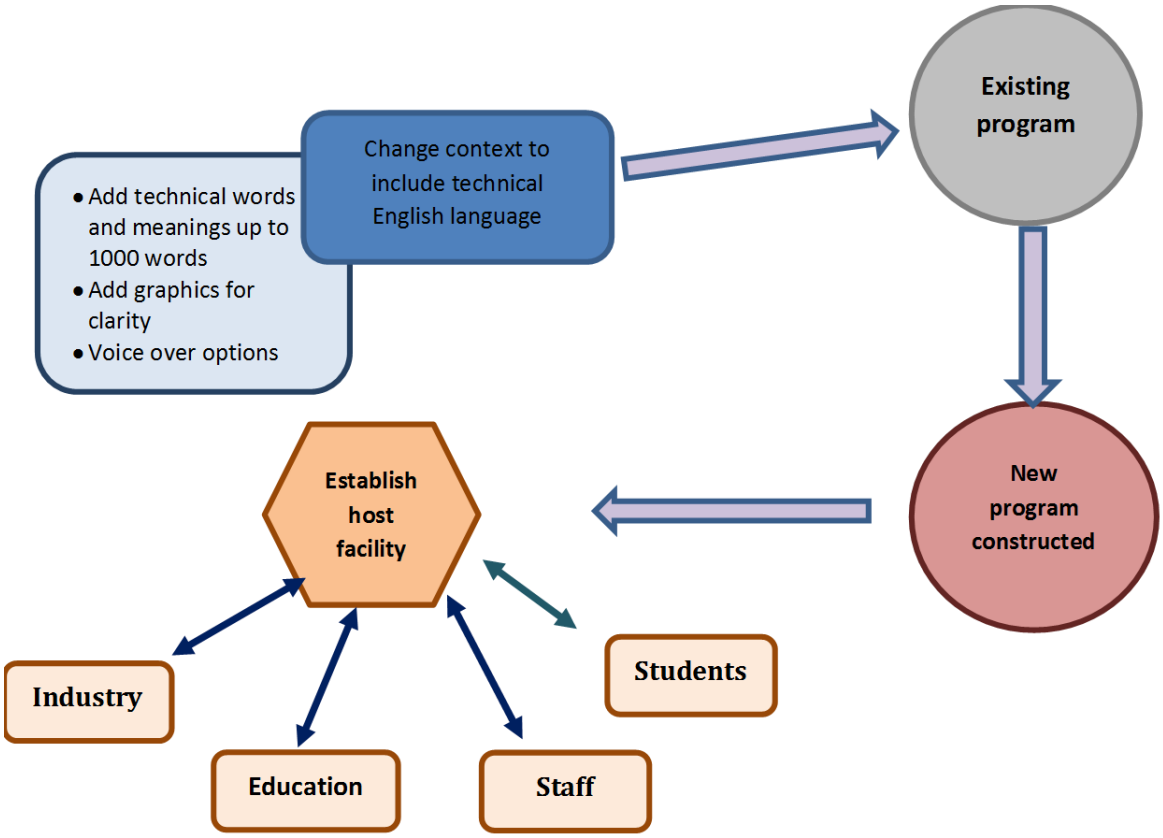
English language provision and support

Discussions with both education providers and geothermal developers in Indonesia indicate a strong interest in building staff and student's abilities in English language vocabulary and comprehension. This is driven by the equipment suppliers who document their operational and maintenance manuals in English - the accepted global language for engineering.

English language is also used in the supplier's plant monitoring equipment such as distributive control systems (DCS), programmable logic controllers (PLC) and SCADA equipment. While it is accepted that generally, most staff and students will speak in their native tongue there is a need for them to read and comprehend English sufficiently to make appropriate decisions when operating and servicing geothermal plant operations. In addition, enhancing technical English is seen as a key part of the capacity building in the partner institutions.

With the need to assist both staff and students in this area, implementing a designed on-line English program has enabled all staff and students access to continue their English language ability away from either their work or full time studies program.

This activity uses a modified supplementary English programme focused on knowledge of key groups of words – 1000 key words plus 1000 technical words. This is a supported, self-paced, on-line learning process aimed at functionality in vocabulary and comprehension, rather than a formal language education.



Indonesian participants: the programme is accessible for students, tutors and company staff as well as staff of Pusdiklats and central agencies. Trainers in politekniks and PPs will be trained to support learners.

Summary of rationale: The companies define English as their operational language and want all technical staff to be functional in English. This is a "quick fix" solution aimed at increasing appropriate technical vocabulary and core grammar rather than a formal English course leading to IELTS or equivalent testing.

5. PROGRESS

NZSTIGs implementation began in August 2018 following the establishment of government to government partnership agreements between the Government of New Zealand and the Government of Indonesia. The delays is securing the project have required a review and re-establishment of connections, collaborations and partnerships for Wintec as the implementing entity. That said, good progress has been made in the first year of activity with the focus on development and provision of curriculum and training, and capacity building in areas deemed key to get longer term sustainability. We report progress here under each of the activities listed in section 4 above, to July 2019.

Train the Trainer programs for Politeknik and Pusdiklat tutors

Curriculum - Three levels of curriculum for training the trainer (TTT) have been developed. Curriculum includes all aspects required for ongoing delivery of this training. We are training trainers – but also establishing a system so that those trained become future trainers of trainers. Each packet of curriculum includes a graduate profile – clearly defining the learning outcomes from the training;

courseware, including comprehensive student and tutor guide books, reflective journals, lesson plans, practical exercises; assessments and review processes.

Provision - Approximately 40 tutors have attended the first two iterations of course provision with another 28 due to attend in August 2019. This includes attendees from partner politekniks, partner Pusdiklats and state owned geothermal developers. There is an ongoing programme of delivery planned out to end 2020.

Embedding – Planning is underway with two partner institutions to progress from course participation to teacher observers to co-teaching to mentored teaching during 2020.

Train the Trainer program for Industry and/or company subject matter experts

Progress has been slower in this activity as we have worked to engage the system in a way that will ensure effective ongoing management of the eventual resource. Private companies especially are seeing benefit in engaging subject matter experts as trainers, particularly given that the NZSTIGS programme affords them the opportunity to train these SMEs in effective teaching practices. A number of provisions of this training are planned for late 2019 and early 2020.

Additional curriculum designed to augment D3/D4/S1 "engineering" disciplines.

Curriculum – Core curriculum modules have all been developed. As above, each includes graduate profile – clearly defining the learning outcomes from the training; courseware, including comprehensive student and tutor guide books, reflective journals, lesson plans, practical exercises; assessments and review processes.

Provision - A change in intention on the part of the partner vocational institutions to move from augmenting D3 provision to developing specialist energy or geothermal provision at D4 has meant that this material will be used and embedded in new curriculum development rather than used to supplement old curriculum. The partner institutions are working on this whilst they put their tutors through the TTT courses outlined above.

Set up a system, including training to establish a pool of subject matter experts (SME) from the geothermal sector who can be used as short course facilitators and support-persons for industry training.

Identification of potential SMEs is underway. Two groups have been identified; retired (or contactable) experienced, expatriate geothermal operations and engineering people, and Indonesian industry personnel at or nearing retirement. This activity is ongoing.

Set up a series of technical short courses

Curriculum – As at mid-2019, approximately 24 discrete modules of technical short course curriculum have been developed. These range (as described in section 4) from basic general introductory topics (e.g. Introduction to geothermal systems, or Basic hand tool use) to advanced technical subjects (e.g. Alignment, or Vibration control). As with other curriculum, each includes graduate profile – clearly defining the learning outcomes from the training; courseware, including comprehensive student and tutor guide books, reflective journals, lesson plans, practical exercises; assessments and review processes.

This development is ongoing with approximately 50 subjects identified for development. The objective is not "provision of training", but "embedding of training".

Provision – At mid-2019 6 courses with 98 participants have been delivered. By end 2019 approximately 350 participants will have attended 18 course occurrences. The attendees are a mix of company technicians and vocational school/politeknik/PP tutors upskilling to support their future teaching.

English language provision and support

The English language tool has been developed and is in use. All participants on the range of NZSTIGS courses are allocated passes to access the learning package.

6. CONCLUSION

The impact of the NZSTIGS programme will not be measurable for some years, beyond direct measurement and characterization of actual training provision and course participation. All data relating to course participation, including evaluative data is being recorded and assessed on a regular basis. Engaging the companies further in actual skills and learning management processes and capturing on-job improvement through qualitative reviews will be needed to assess benefit. Evidence of embedded student centered and project based teaching practice, and project based curriculum will potentially be available by 2021.

We remain confident that the basic step of exposing Indonesian tutors (already well trained academics) to new teaching pedagogy will significantly impact student learning outcomes and employee behaviours. Changing the way Indonesian students learn and overcoming cultural norms around questioning and challenging to produce critical thinking, enquiry focused employees will also require changes in company expectations and recognition processes.

All these are imperatives if Indonesia is going to achieve productivity and reliability levels that justify investment in costly renewable energies, such as geothermal.

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