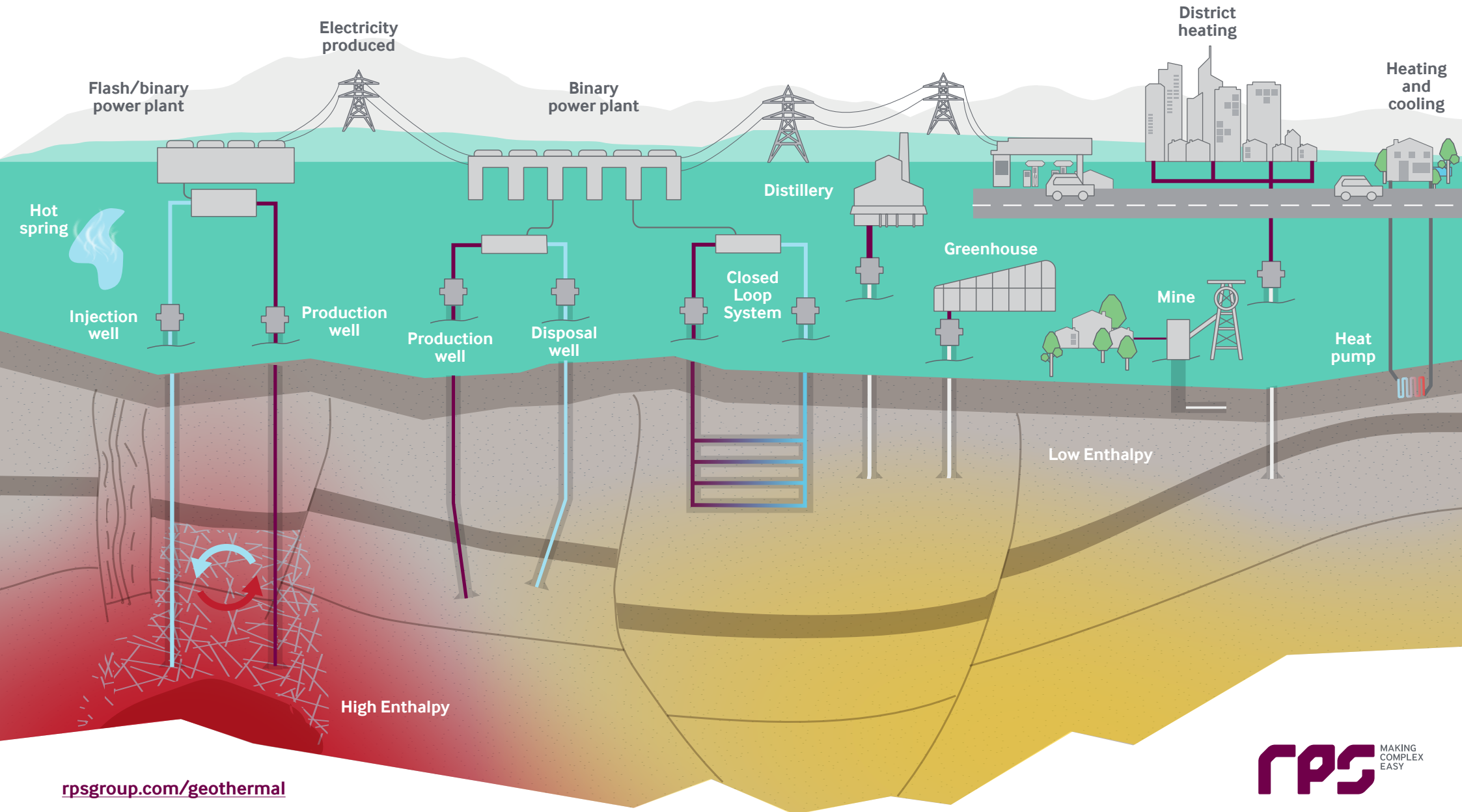


# GEO THERMAL ENERGY

Supporting our clients to thrive in a low carbon economy



# USING THE HEAT BENEATH OUR FEET

Geothermal energy is poised to play a vital role in a global energy transition to more sustainable, renewable energy sources. However, these projects must be developed quickly, safely, and environmentally responsibly and meet financial sustainability for geothermal energy projects to maximise their role in reducing carbon emissions. We use our deep expertise across multiple disciplines to provide commercial and technical advice to our clients to advance these projects and develop them globally.

## How is geothermal energy used?

There are many uses of geothermal energy, from heating your home to helping decarbonize industry. The diagram below shows just a few uses of this versatile energy source. Unlike other renewable energy, it is continuous and will not require storage for supply during periods of high demand.

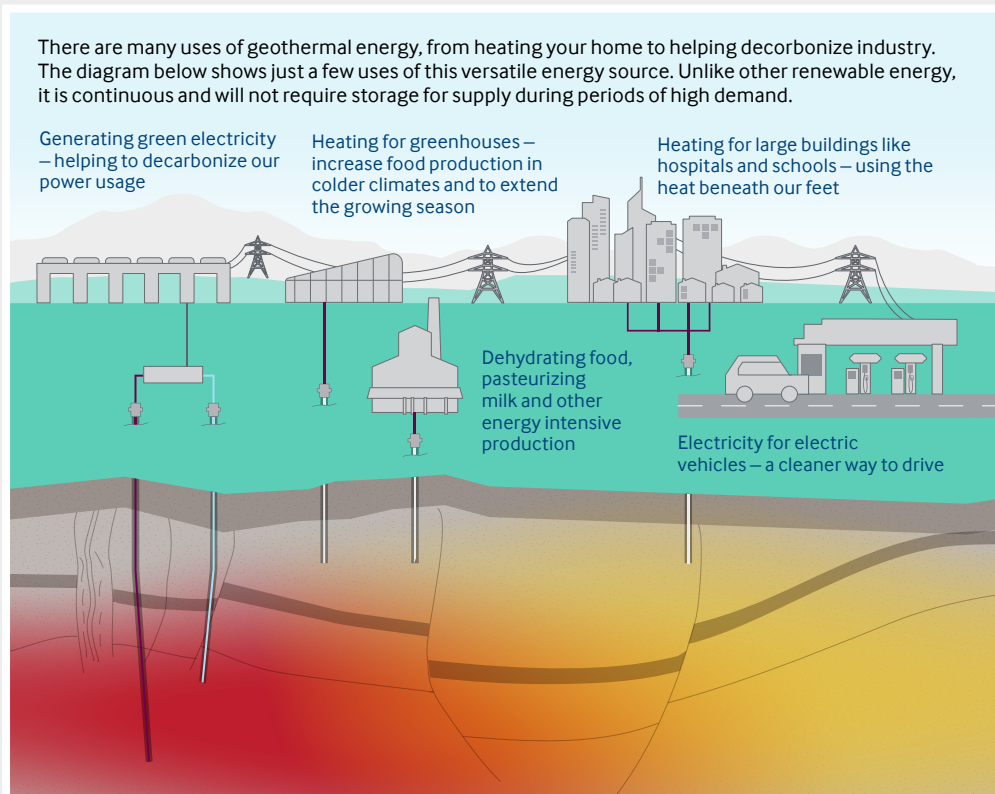
Generating green electricity – helping to decarbonize our power usage

Heating for greenhouses – increase food production in colder climates and to extend the growing season

Heating for large buildings like hospitals and schools – using the heat beneath our feet

Dehydrating food, pasteurizing milk and other energy intensive production

Electricity for electric vehicles – a cleaner way to drive



## A continuously flowing source of clean energy

Unlike other renewable energy sources, geothermal energy is continuous and does not require storage for supply during periods of high demand. It can be used to heat as well as generate electricity. The heat accessible in the upper 10 km of the earth's crust is enough to supply humankind with energy, for millions of years, without producing any CO<sub>2</sub>.

## Why is geothermal energy important?



**Renewable carbon free technology** – The accessible heat in the upper 10 km of the earth's crust can supply us with energy for millions of years without producing any CO<sub>2</sub>.



**Continually flowing** – Its clean energy, delivered on-demand 24 /7, which can be used to heat or generate electricity.



**Flexible** – Besides the uses we've already highlighted here, we're discovering more every year!

## Operating within reduced or smaller space

Geothermal energy has the smallest land footprint of any comparable energy source in the world based on land use per gigawatt hours. This makes it perfect for urban areas, where instant, constant dispatchable heat or power is required. As with everything else, size is relative to their heat and electricity supply requirements. A typical geothermal power plant uses the equivalent of 1,046 sq. km (404 sq.m) of land. Wind energy would need 3,458 sq. km (3237 sq. m) to produce the same GWh. Coal plants in comparison, use approximately 9,433 sq. km (3,642 sq. m).

## Locations do not have to have volcanic activity

Geothermal energy can be found in many parts of the world, not associated with volcanic activity. It refers to any heat derived from the ground, whether that's a few metres (shallow geothermal) or a few hundred kilometres (deep geothermal) below the surface. As our understanding of the geology and new technologies to extract heat evolves, the prospects for geothermal energy projects are also increasing.

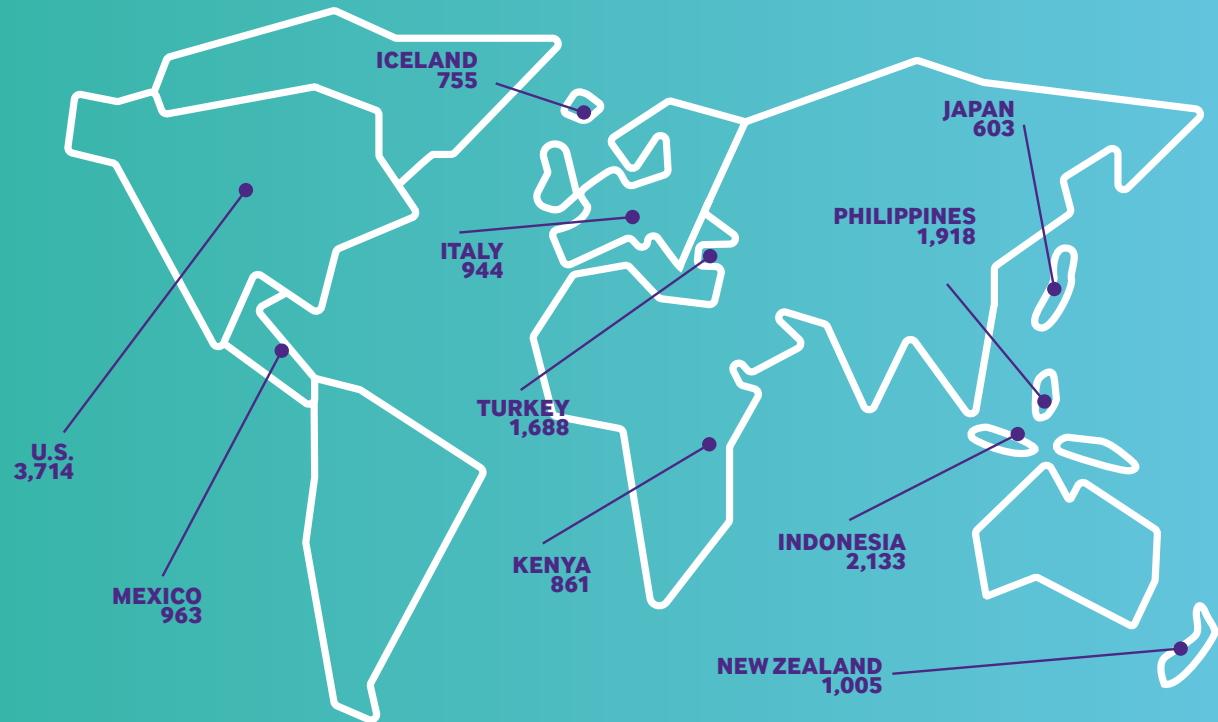
## More investable than ever before

In 2020, global geothermal investments increased six-fold from the year before, exceeding \$675 million. There has been greater market awareness and a reignited interest in geothermal investment. Using technological advances developed for oil and gas, such as Horizontal drilling or HPHT (High Pressure and High-Temperature technology), we can drill deeper and access hotter geothermal fluids, making previously ignored locations geothermally accessible.

Closed loop systems allow fluids to circulate with a higher heat absorption capacity than water, enabling the use of geothermal energy in previously unfavourable areas. The repurposing of disused mine discharge waters also makes a more buoyant investor potential.

Most of the world's geothermal energy is produced by 10 countries, but more are seeing the benefits.

Installed capacity in megawatt electrical (MWe)



Year-end 2020

Source: ThinkGeoEnergy research 2021

# SUPPORT ACROSS THE ASSET LIFECYCLE

## BUSINESS CASE AND DUE DILIGENCE

RPS can help you develop your business case and project scope to align with regulatory frameworks, stakeholder needs, market and financial feasibility conditions and preferred models of funding and delivery. We offer the advice and guidance you need to define what success looks like for your geothermal project and develop a clear plan for achieving your goals.

### What we do

### Making complex easy

#### Commercial advisory

Our team provides energy producers with strategy and commercial advice, guiding energy exploration and asset infrastructure development worldwide. Our economists and energy specialists draw on the latest economic, consumer and other relevant data to deliver informed opinions and independent evaluations to guide geothermal developments, by understanding alternative funding streams and supply chains.

#### Sub-surface geology and reservoir engineering

Understanding sub-surface geology is key to determining a geothermal project's feasibility. Our team of geologists, geophysicists, and engineers have over 40 years of experience interpreting, evaluating, and modelling the subsurface and its behaviour. We have developed our independent expertise across the vast majority of the world's energy-producing basins, often working in challenging geographic locations and complex geological environments. We take a data-driven approach to facilitate transparent communication, accurate decision-making, and the right conversations with investors, regulators and key stakeholders.

#### Independent reporting

Independent reporting on complex energy projects requires highly experienced technical and commercial professionals with international operating experience to provide an impartial, informed and considered view for the client.

RPS has a wealth of experience in providing independent technical and economic assessments of energy assets internationally. Our specialists work closely with clients to find the most practical and cost-effective solutions – to deliver long term viability and ongoing value to stakeholders and shareholders.



## CASE STUDY

### Seismic interpretation for Tu Deh-Kah Geothermal

RPS is excited to have provided seismic interpretation services for the historic Tu Deh-Kah Geothermal (TDKG) project. This 7-15 MW geothermal project will serve the Fort Nelson First Nation, one of the most northern communities in British Columbia, Canada. Currently, the region relies on fossil fuel-generated electricity as it is not integrated with the provincial electric grid. This renewable energy project involves converting a depleted gas reservoir into a geothermal energy facility. The project is 100% Indigenous owned and led, and will provide reliable and clean electricity, as well as abundant direct heat for buildings and greenhouses, creating new opportunities for economic growth for this remote community.

The TDKG project is based on converting a depleted gas reservoir in the Presqu'île Barrier Reef Complex into a new geothermal project and to do so requires a thorough understanding of the sub-surface geology to determine the project's feasibility.

To estimate potential energy output, calculate profit and demonstrate long-term project sustainability, the TDKG team needed to determine the likely flow rates of the water within the reservoir. The higher the flow rates, the faster water would move through the system, producing more energy. The better the porosity and permeability of the water-bearing reservoirs, the more likely to achieve high flow rates and hence heat to energy conversion.

A first step in understanding any reservoir's deliverability (whether it be of hydrocarbons or hot water) is to delineate the structure and map the distribution of porous zones within that structure in order to maximise the probability of drilling a new well into a zone that would prove the project's potential. Unfortunately, the data available to the TDKG team over the carbonate reef was limited despite the earlier production and previous mapping etc. and was restricted to well-log data only. Historically acquired 3D seismic had been shot but was prohibitively expensive to purchase.

The challenge was to pinpoint the best possible location to drill confidently, cost-effectively and quickly based on limited data. Based on our deep sub-surface expertise, RPS was selected to maximise such data as were available and evaluate if the proposed drilling target was fit for purpose.

Read the full case study [here](#).



*Photos Copyright Ryan Dickie.  
Ryan Dickie is an Indigenous Photographer, Filmmaker and Conservationist based in Fort Nelson, British Columbia.*

# APPROVALS AND ENGAGEMENT

We support your team to plan for success in the approvals phase while mitigating key project risks. From development applications and approvals strategy to environmental assessment and the negotiation of offsets and conditions, our team is here to help you navigate the complexities of project planning and lay the groundwork for a smooth design and delivery phase.

## What we do

## Making complex easy

Consents, permits and licences.

Our environmental permitting and compliance team profoundly understand what it takes to get large-scale energy infrastructure projects approved. We have extensive experience in approval processes and regulatory regimes and apply a data-driven approach to environmental consulting, utilising state-of-the-art technologies, including visualisation, spatial intelligence and dynamic scenario modelling. Shaping informed decisions, we support our clients as they develop geothermal projects across the globe.

Environmental Impact Assessments

Environmental Impact Assessments (EIAs) are integral to the planning and development process of a geothermal project. Our environmental specialists prepare environmental assessment documentation containing site-specific data, and we identify any environmental and socio-economic impacts that might arise from development. To reduce risk and cost, we follow a staged approach that identifies potentially significant adverse effects early in the process, so they are avoided, managed, mitigated, or offset. We have delivered EIAs for many large-scale renewable energy projects around the globe.

Stakeholder and community engagement

Understanding community values is one of the most crucial yet complex aspects of doing business today.

We create engagement programs that are evidence-based, meaningful and measurable, assisting clients to connect with their stakeholders, communities and customers. Working throughout the project lifecycle we design and deliver engagement that facilitates shared understanding of intent, impact and benefit.



## Seaham Garden Village

Seaham Garden Village features a pioneering mine water sourced district heating scheme to create a better future for residents and the environment in a historic mining area. This renewable energy source has a practically zero carbon footprint, and with one-quarter of UK properties sitting on the coalfields, abandoned mines have great potential to help us meet net zero carbon by 2050.

We acted as Technical Utility Infrastructure Advisor for the developer Tolent Living to develop this low carbon, sustainable heat source for potentially the UK's first large-scale minewater district heating scheme.

This renewable energy source has the potential to have a practically zero-carbon footprint. As an energy source unaffected by external factors, it will maintain a stable price and is viable enough to compete against gas suppliers. The site will provide 1,500 homes, a primary school, shops, a health and wellbeing hub and an innovation centre.

Built immediately adjacent to the Coal Authority's Dawdon Mine Water Treatment Plant (MWTS), this scheme protects a vital drinking water aquifer by abstracting 100 to 150 litres per second of saline mine water up to the surface for treatment. At present, this resource is simply discharged into the sea.

Seaham Garden Village will be supplied with heat from the mine water treatment scheme, which has been warmed via geothermal processes to provide a year-round continuous water supply at 18 – 20°C.

Since June 2019, our role has involved liaising with multiple stakeholders, including the Coal Authority, Durham County Council, Environmental Agency, Tolent's technical team, contractors and potential equipment suppliers. Given the innovative and relatively complex nature of the proposed District Heating Network, a large proportion of our work has been related to the minewater heat pump proposal, its low-temperature nature and its integration with the 1,500 planned houses.

The individual development cells are being let to separate house builders, which has involved significant stakeholder engagement. We have aided this process by explaining in layman's terms the technicalities and opportunities that the scheme will bring.

Read the full case study [here](#).



# DESIGN AND TECHNICAL SERVICES

We support your team to plan for success in the approvals phase while mitigating key project risks. From development applications and approvals strategy to environmental assessment and the negotiation of offsets and conditions, our team is here to help you navigate the complexities of project planning and lay the groundwork for a smooth design and delivery phase.

## What we do

Sub-surface geology and reservoir engineering  
Sub-surface geology and reservoir engineering

Field development planning and operations

Seismic operations management and support

Drilling support and wellsite geology

Water resourcing and water/environmental management

## Making complex easy

Using knowledge built up over decades of hydrogeology and petroleum geology studies, RPS can identify, delineate and geologically describe both low and high enthalpy geothermal projects. Understanding the geology and the geothermal conditions helps capture and limit the subsurface uncertainty inherent in any geothermal development.

The best opportunity to influence project life cycle economics starts with development concept selection and continues through to Front-End Engineering Design (FEED). It's during these phases that our project team comprising all the sub-surface disciplines, and integrated with key personnel for conceptual engineering, will identify, assess and rank feasible options, with the objective of selecting the preferred development scheme to maximise ultimate recovery and optimise economic performance over the life of the field.

Seismic data can reveal what lies beneath the earth's surface and is essential for geothermal exploration and appraisal. However, it must be collected safely and efficiently and meet technical specifications. At RPS, we manage survey design, commercial oversight, in-country and onshore support, health and safety, seismic processing, and data hosting, with this constantly in mind. We support our clients throughout each phase of their seismic acquisition project - from defining and planning, seismic acquisition through to data preparation and delivery.

When drilling a geothermal well, project delivery outcomes need to be balanced technically, socially, environmentally and economically.

RPS has provided wellsite supervision for over 40 years and has built a global network of over 200 trained geological well operations personnel.

Depending on the geothermal development, to produce geothermal energy, water is needed. Our expertise covers all aspects of water resource investigation and development, including abstraction, reinjection and discharge, and management. From strategic planning and site investigation to detailed design, construction supervision and environmental monitoring, we provide solutions that reflect and respond to local environments, objectives and constraints.



## CASE STUDY

### Californian Feasibility Study

RPS was approached by an American company wishing to evaluate the geothermal potential of the southern part of California. Our client is looking to supply power directly to organisations like hospitals, hotel complexes, universities and other facilities at a lower than network cost. The client aims to do this by accessing the geothermal heat from below the ground near the site.

To determine the project's feasibility, we verified published geothermal maps before focussing on areas that showed promise and mapped the potential heat expected at depth in greater detail. After having determined a range of likely depth vs temperature scenarios, the next consideration was the likely lithologies that any well would have to penetrate and pass through on its way down to total depth.

Well design considerations needed to include such issues as the likely rate of penetration, casing point settings, required well-bore width at depth vs idealised flow-to-surface rates, and subsurface thermodynamic calculation of heat loss/exchange in the well bore, amongst many others. Our well-design team worked with the geoscientists to test the feasibility and range of uncertainty of specific 'drilling and production' scenarios and the impact of that uncertainty on the power deliverability and economic viability of the proposed sites.

*Travertine Hot Springs, California*

# PROJECT MANAGEMENT AND DELIVERY SUPPORT

RPS supports your team in delivering projects on time and on budget while managing risk. From tendering and contractor engagement, to program management and contract administration, we can assist you in selecting the consultants and contractors that best suit your project, location and needs.

## What we do

## Making complex easy

### Program management

Program management is recognised for its key role in enabling organisations to manage and navigate change to deliver lasting value.

We have the experience and skill to advise you on how best to implement and manage successful programs of change and adaption. Our collaborative approach can help you to realise the benefits of strategic change to uncover innovative solutions through strategic advice, management and business-wide support.

Our expertise spans all phases of a program and underlying projects, as well as the management and staffing of program offices. We can also assist with the establishment of and advise on project prioritisation within a program.

### Project management

We have the expertise to guide you through the life cycle of your project, from inception to completion. With our specialisms in project planning, procurement, design and delivery, we are experts in advising clients on how to achieve the right balance of time, cost and quality.

### PMO systems and structures

We work with your team to develop a customised project control framework, while introducing efficiencies, monitoring and controls that expand your team's capability to deliver positive outcomes.

From an independent review of your Project Management Office (PMO), programs and projects to the evaluation of service requirements for delivery, we are committed to delivering innovative and economical solutions that enhance the value of your project investments.



# CAPABILITY DEVELOPMENT

At RPS, we design flexible and scalable training solutions that cover a wide range of subjects.

We set our clients up for success by sharing technical knowledge and transferring skills. We increase understanding and improve individuals' and teams' decision-making through various development solutions so that energy can be brought to market, cost effectively and safely.

Our courses cover topics on energy transition, renewable energy, oil and gas, ESG, professional skills development and health and safety.

Geothermal courses are currently in the development include fluid dynamic and thermal modelling, hydrogeology and groundwater modelling, mining hydrology and hydrogeology, geomechanics, subsurface geophysics and modelling, geochemistry, repurposing oil and gas fields for geothermal, well design and full-cycle economics.

Instructor-led training is delivered in the classroom, virtually or in the field and can be blended with self-paced learning. Courses are also available for in-house training.



More information and a complete schedule can be found [here](https://rpsgroup.com/geothermal).



# OUR STORY

RPS is a leading global professional services firm providing technical consultancy and operational support to the delivery of low carbon solutions throughout the asset lifecycle. We have deep expertise in the delivery of both offshore and onshore projects.

With 5,000 employees across 125 countries, we are a global organisation with a connected outlook and approach. We have a strong focus on Environmental, Social and Corporate Governance (ESG), with sustainability at the heart of our strategies.

The stand out for our clients is that we use our deep expertise to solve problems that matter, making them easy to understand and we're easy to work with – Making complex easy.

