MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

COVERSHEET

Minister	Hon Shane Jones	**Portfolio**	Regional Development
Title of Cabinet paper	Progressing the Supercritical Geothermal Energy Project	**Date to be published**	23 December 2024

List of documents that have been proactively released		
Date	**Title**	**Author**
November 2024	Progressing the Supercritical Geothermal Energy Project	Office of the Minister for Regional Development
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Information redacted **YES / ~~NO~~** *(please select)*

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Some information has been withheld for the reasons of Free and frank opinions, Confidential advice to Government, and Commercial information.

In Confidence

Office of the Minister for Regional Development

Cabinet Economic Policy Committee

Progressing the Supercritical Geothermal Energy project

Proposal

1. On behalf of the Regional Development Ministerial Group (RDMG)[1], this paper seeks agreement to ringfence up to $60 million of funding from the Regional Infrastructure Fund (RIF) to drill the first of three exploratory deep wells to prove the commercial viability of supercritical geothermal energy (SCGT), consisting of two stages:

    1.1 the initial drawdown of an up to $5 million grant to MBIE to undertake the detailed design and costings for the first exploratory deep well, in order to allow a full investment proposal to be developed for Cabinet consideration (stage one);

    1.2 contingent on Cabinet approval of a full RIF investment proposal, the drawdown of the remaining funding of up to $55 million to undertake the drilling of the first exploratory well (stage two).

Relation to Government priorities

2. The Government's five pillars to rebuild the economy include a commitment to build infrastructure for growth and resilience; and to promote innovation, science and technology.

3. If supercritical geothermal energy is found to be commercially viable, it would also significantly contribute to the Government's goal of doubling renewable electricity generation to meet the increased demand from greater electrification.

Executive Summary

4. On 20 May 2024, Cabinet agreed to establish the $1.2 billion RIF, a capital fund with the primary purpose of accelerating infrastructure projects that will make a material difference in our regions.

5. Cabinet agreed that the RIF will invest in resilience infrastructure that improves a region's ability to absorb, adapt and/or respond to stresses and

[1] On 20 May 2024, Cabinet agreed to establish the Regional Development Ministerial Group (RDMG) to make specific investment decisions for the Regional Infrastructure Fund, comprising the portfolios of Finance; Infrastructure; Local Government; Māori Development; and Regional Development [CAB-24-MIN-0168.02 refers].

shocks; and enabling infrastructure that ensures regions are well-connected, productive and resilient.

6. GNS Science (GNS) is seeking up to $60 million of government funding through the RIF to drill the first of three exploratory deep wells to prove the commercial viability of SCGT. The Taupō Volcanic Zone (TVZ) is believed to be an excellent site to drill for SCGT as the Earth's crust is thinner compared to many other parts of the world.

7. SCGT is sourced from extremely hot rock heated by magma. Energy harnessed is up to three times higher in volume than current geothermal energy generation from steam at shallower depths and could make a significant contribution to New Zealand's growing electricity needs.

8. While the potential opportunities are significant, the early stage of technology development means there are a number of known (but not completely understood) and unknown risks and challenges. It also means that the timeframe for SCGT to be commercially deployable is long – with an estimated aspirational timeline of 2040. These risks and challenges need to be fully understood and worked through before committing substantial government funding and commencing exploratory drilling.

9. I am therefore seeking your agreement to ringfence up to $60 million of funding from the RIF to drill the first of three exploratory deep wells to prove the commercial viability of SCGT, consisting of two stages:

    9.1 the initial drawdown of an up to $5 million grant to MBIE to undertake the detailed design and costings for the first exploratory deep well, in order to allow a full investment proposal to be developed for Cabinet consideration (stage one);

    9.2 contingent on Cabinet approval of a full RIF investment proposal, the drawdown of the remaining funding of up to $55 million to undertake the drilling of the first exploratory well (stage two).

10. Any government funding to support progressing SCGT will not extend to fully de-risking the commercialisation of SCGT energy for electricity generation, however it will progress the mitigation of technical challenges to SCGT exploitation and may encourage commercial power generators to invest in the next stages of development.

Background

11. On 20 May 2024, Cabinet agreed to establish the RIF, a capital fund with the primary purpose of accelerating infrastructure projects that will make a material difference in our regions. Cabinet agreed high-level settings for the RIF, such as:

    11.1 the RIF invests in projects across the following funding components:

        11.1.1 Resilience infrastructure that improves a region's ability to absorb, adapt and/or respond to stresses and shocks;

11.1.2 Enabling infrastructure that ensures regions are well-connected, productive and resilient.

12. Cabinet agreed that the RDMG would be established to support decision making, and agreed to the following decision-making thresholds:

12.1 RDMG makes decisions on grant investments over $3.00 million and up to and including $35.00 million, as well as all loan and equity investments up to and including $35.00 million

12.2 Cabinet makes decisions on all grant, loan, and equity investments over $35.00 million, or any projects deemed high risk by officials and Crown Regional Holdings Limited [CAB-24-MIN-0168 refers].

13. The RIF opened on 1 July 2024, with the first tranche of projects considered by RDMG on 29 July 2024, and the second tranche considered on 15 October 2024. $895.025m of capital expenditure (CAPEX) and $148.750m of operating expenditure (OPEX) is currently remaining.

Analysis

New Zealand has built experience in geothermal energy since the 1950s

14. One of the areas where New Zealand has achieved international recognition and success is geothermal energy. Since the 1950s, New Zealand has built a reputation and considerable experience in tapping and harnessing geothermal energy for electricity generation.

15. SCGT represents an opportunity to expand New Zealand's capability and experience by accessing much hotter geothermal reservoirs at depths greater than those where conventional geothermal energy has been found (4 to 6 kilometres rather than 1.5 to 2.5 kilometres).

What is supercritical geothermal energy?

16. SCGT energy is sourced from extremely hot rock heated by magma. When pure water exceeds 373 degrees Celsius and 220 bars of pressure, it becomes 'supercritical', making it neither liquid nor gas. In this state, the enthalpy (measurement of energy in a thermodynamic system) is up to approximately three times higher than the production enthalpy of the conventional geothermal steam currently extracted from the high-temperature geothermal fields in the Taupo Volcanic Zone (TVZ).

SCGT has a potential role in New Zealand's future electricity security

17. New Zealand will need significantly more power generation in the future as the economy grows and electrifies. A large proportion of that additional electricity demand will be met by intermittent renewables, such as wind and solar power, for which there is currently a strong pipeline of projects under construction or development. However, as New Zealand's energy mix changes, so do the challenges to the security of our electricity supply.

18. Currently New Zealand relies on hydropower to provide baseload, firming, and peaking power in the electricity system – it delivers around 60 per cent of the country's power. However, if there is insufficient rainfall to replenish the hydro lakes several times during winter (which happens on average every few years), New Zealand faces critical energy shortages. New Zealand is currently experiencing an energy shortage, which has resulted in dramatic price spikes and turning off/down of several industries.

19. Generation plant that runs on intermittent sources (such as wind and solar) cannot be relied on as it is not always windy or sunny. When this happens, intermittent plant needs back up from generation plant that is either baseload (always on) or firming (can turn on quickly and run for hours to days). Baseload and firming alternatives to intermittent renewables are needed from energy sources that are reliable.

20. Several existing sources of baseload and firming generation will become increasingly expensive and commercially challenging to maintain in the future (such as coal- or gas-fired generation). New fuel sources for power generation (imported LNG, hydrogen, biofuels) may begin to contribute to New Zealand's system but will be too expensive to provide baseload power and so are better suited to firming. Other new sources of firming, like grid-scale batteries, will be an important tool but operate only for up to four – eight hours, and are unlikely to be an economic solution to all of New Zealand's future system needs.

21. Existing geothermal power generation in the central North Island and Northland is called "conventional geothermal", which means the heat source is at a depth of less than 3.5km. It is considered technically straightforward to tap into these energy reserves. There is some additional capacity to grow this conventional geothermal by approximately 50 per cent over the next eight years, i.e. from 8,000 GWhr/yr to 12,000 GWhr/yr. However, the anticipated increased national power demand together with a drive towards zero carbon energy generation means that this will not be sufficient over the next two decades to meet expected energy requirements. SCGT could theoretically generate an additional 30,000 GWhr/yr thus providing New Zealand with more options to reach zero carbon.

22. If commercial viability of SCGT can be proven and the technology developed to harness the energy, SCGT could meet a significant amount of our future baseload power needs. Based on GNS's research, Castalia[2] estimates that, excluding resources on protected, limited and conservation land, 30,000 GWh of energy may be available from SCGT annually – more than three quarters of New Zealand's total electricity demand this year.[3]

23. Castalia's initial modelling suggests that even if SCGT generation turned out to be twice as expensive as conventional geothermal *and* it remains viable to continue building thermal generation into the 2040s, it will be economical to

[2] Castalia is a global consultancy firm that specialises in the finance, economics, law, and policy of infrastructure, natural resources and social service provision.
[3] Castalia, 'Supercritical Geothermal in New Zealand: Economic opportunity in renewable electricity generation and for off-grid energy', October 2023.

build 1,265MW of SCGT generating capacity by 2050, roughly equivalent to all of New Zealand's current conventional geothermal capacity.

24. Free and frank opinions

25. Free and frank opinions

26. Any government funding to support progressing SCGT will not extend to fully de-risking the commercialisation of SCGT energy for electricity generation, however it can progress the mitigation of technical challenges to SCGT exploitation and may encourage commercial power generators to invest in the next stages of development.

SCGT has a potential role in supporting regional industry

27. Direct use of geothermal by industry represents opportunities to reduce emissions and reliance on expensive fuels such as gas and coal and grow regional economies. Process heat – mainly gas and coal used in boilers – contributes about eight percent of New Zealand's gross emissions and this can be replaced by geothermal heat alongside electricity generating plant.

28. There are some examples where geothermal heat already provides a spill-over benefit to support regional industry. For example, there is a concentration of wood processing and pulp and paper manufacturing in and around Kawerau that uses geothermal process heat. There is also a dairy processing facility using heat from geothermal steam to make milk powder at Mokai, northwest of Taupō. Mokai also hosts state-of-the-art climate-controlled greenhouses for growth of high quality produce for export. Both of these examples have developed alongside a conventional geothermal electricity generating plant.

29. New or existing industries could choose to locate close to SCGT resources to piggyback on new electricity generation projects, as direct heat typically uses only a proportion of heat compared to electricity generation (generally about five to 15 percent) and can utilise the low-grade heat unsuitable for electricity generation. Geothermal heat extraction solely for the purpose of direct heat of industrial processes is unlikely to be economic alone without demand for power generation.

30. There is also a signficant opportunity for SCGT to attract new industry that relies on 24/7 reliable baseload energy, such as data centres. I understand that both Microsoft and Google have directly invested in geothermal powered data centres recently.[4]

[4] https://www.datacenterdynamics.com/en/news/microsoft-and-g42-to-build-geothermal-powered-data-center-in-kenya/

31. While regions tend to develop economic specialisations based on their natural resource endowment, such as the Kawerau industrial cluster, an industry's choice of location will also factor in other and potentially more determining factors, such as access to markets, transport infrastructure, and workforce. However, once such clusters are established, they may benefit from a more organised approach to their ongoing growth and development in particular, for developing shared infrastructure and in attracting new industries to locate there. Given the long lead-time if SCGT is found to be commercially viable, there is time to upskill the regional workforce to maximise any resulting employment opportunities.

Potential opportunities for the Māori economy

32. A number of the landowners in the TVZ are iwi and hapū entities and trusts, as illustrated in the map attached as Annex One. Confidential advice to Government Support from iwi and hapū landowners for SCGT and opportunities for potential involvement in the drilling programme in the form of, for example, joint venture arrangements, or agreements with access fees, land rent, and commercial remuneration, will be explored as part of developing the detailed drilling design and costings.

Potential Treaty and Waitangi Tribunal issues

33. Iwi and hapū with direct place-based interests in this project include (amongst others): Tūwharetoa, Tūhoe, Ngāti Tahu/ Ngāti Whaoa, Ngāti Rangitihi, Raukawa and through proximity to the Waikato River, Maniapoto and Waikato Tainui. The pilot site for the first well is expected to be at Confidential advice to Governm, which depending on exact location, will include Māori landowner groups, such as Confidential advice to Government

34. I also note there is a current Treaty of Waitangi claim on geothermal (WAI2538). MBIE is currently providing evidence to Crown Law and the Ministry of the Environment who are leading the Crown response into an inquiry on the Crown's resource management reforms, Free and frank opinions

GNS Science and its role in geothermal research

35. GNS is responsible for researching and developing new applications of Earth and materials science, and is leading the 'Geothermal: The Next Generation' project, funded with $10.6 million of funding from MBIE's Endeavour

Research Fund[5], finishing in March 2025. GNS has advised that 'Geothermal: The Next Generation' has attracted significant international attention and interest from experts.

36. The GNS team consists of geophysicists, geologists, experimental geochemists, modellers and strategic advisers. The GNS team has been investigating New Zealand's supercritical geothermal conditions and drawing insights from international experience.

37. The Endeavour Fund contract has allowed GNS to develop considerable capability. For example, it established a globally unique facility that enabled:

    37.1 the study of fluid-rock interactions under supercritical conditions, and has improved knowledge of the supercritical geothermal resource (through research on interactions between New Zealand rocks and fluids at supercritical conditions, modelling system viability and delineating the potential of these resources);

    37.2 research to reduce exploration and technological risks by locating targeted areas and detailing heat transfer at significant depth.

38. GNS has produced a range of reports utilising the funding, including:

    38.1 an inventory of supercritical geothermal resources

    38.2 a report commissioned from Castalia on the economic potential of supercritical geothermal

    38.3 a report looking at well drilling consenting scenarios

    38.4 a number of science publications that are helping to inform supercritical geothermal development.

39. The proposal to drill an exploratory well is informed by the research funded by the Endeavour Fund contract and years of research on the Taupo Volcanic Zone geothermal structure.

40. GNS is currently proposing the drilling of three exploratory wells at an estimated cost of $[Commercia] million. The purpose of drilling three wells is that it provides a more developed understanding of where and how SCGT can be utilised in New Zealand by sampling different sites with varying geothermal characteristics.

41. This paper seeks to progress the development of the first exploratory well, currently estimated to cost up to $60 million.[6] The advantage of this approach is that it provides a staged approach to undertaking the work, which can help to mitigate some of the risks relating to SCGT drilling. These risks include:

    41.1 the risk of significant cost overruns if it turns out that the first well is more expensive than originally estimated,

[5] The purpose of the Endeavour Research Fund is to fund ambitious, well-defined research ideas with potential to positively transform New Zealand's future.

[6] I note that there have been reports in the media of $40 million for the cost of drilling the first exploratory well, but is likely to be closer to $60 million and may even be higher. These figures are estimates only until the detailed design and costing work is completed.

41.2 ensuring that there is sufficient drilling and expert labour to undertake the work,

41.3 being able to apply any learning from drilling the first well to other wells, and

41.4 to preserve the option not to proceed with drilling further wells.

42. I expect that decisions on whether to proceed with drilling the first well will be presented to Cabinet in the Confidential advice to Government. There will also be an opportunity to determine whether to consider commencing work on additional exploratory wells.

SCGT technology is at an early stage of technology development and the timeframe for SCGT to be commercially deployable is long

43. While GNS's research to-date has significantly advanced the understanding of potential SCGT in the TVZ, it is important to be aware that the technology is at an early stage of development. The Castalia report notes that SCGT is currently at approximately level three – the 'experimental proof-of-concept' stage – on the nine-level European Technology Readiness Scale. I am advised that drilling one exploratory well will move the level of technology development from three to five ('technology validated in relevant environment').

44. The timeframe for SCGT to be commercially deployable is currently viewed as long – the Castalia report commissioned by GNS estimates that an 'aspirational timeline' is for the technology to be deployable by 2035 – 2040, with wider rollout between 2040 – 2050.

45. Undertaking the drilling is only one component of successfully harnessing SCGT. The ability to channel and safely convert the energy into electricity will be an important next step towards successfully commercialising the opportunity.

International experience with SCGT

46. There are risks associated with this new technology, but New Zealand would not be the first to attempt it. Deep wells have been drilled by other countries including Iceland, USA (California and Hawaii), Japan and Italy. These have reached supercritical depth and temperature conditions but have not been able to be controlled or flowed so were abandoned, or converted to utilise the conventional reservoir system.

47. For example, in 2019 an exploratory supercritical well in Iceland was successfully drilled into 420-degree Celsius fluid at a depth of 4.5km. The drilling approach used for that well provides useful lessons that can be applied in New Zealand, even though long-term fluid extraction was not successful.

48. The ability to utilise and apply the knowledge learned to date from international partners will be critical to the success of further developing SCGT technology in New Zealand. This includes avoiding mistakes previously

made by other international exploratory wells and utilising cutting edge technology and practices.

49. Confidential advice to Government

50. Confidential advice to Government

Implementation

51. SCGT is currently at a conceptual phase and has never been attempted in New Zealand before. A range of operational precursors have been identified that need to be completed to enable drilling to commence. This includes fulfilling regulatory requirements such as resource consent, obtaining a more robust understanding of the costs and operational requirements to construct the well, establishing an entity to undertake the works, and leveraging international partners' expertise and possibly co-funding to support the project.

52. Given that there is some level of uncertainty involved in undertaking the works, MBIE officials recommend that commencing foundational work will support the development of New Zealand's first exploratory SCGT well. The foundational work will provide Ministers with more detailed information on the costs, requirements, and risks involved in proceeding with the construction of the well.

53. To proceed with the first stage progressing SCGT in New Zealand I recommend that MBIE is provided with $5 million through RIF to undertake the following in collaboration with partners such as GNS:

    53.1 Confirm the pilot site for the first well, which is expected to be at Confidential advice to Governm, define all preliminary well siting in the reservoir, and ascertain land acquisition requirements if needed;

    53.2 Commence early and active engagement with interested environmental and place-base stakeholders, including the potential for any impacts on cultural assets and taonga such as geothermal surface features; sites of cultural significance; and the practices and mātauranga associated with them;

    53.3 Commence regulatory approvals such as resource consent, which will require iwi and hapū engagement;

    53.4 Confidential advice to Government

    53.5 Undertake the drilling design of the well to provide detailed cost estimates for the project;

53.6 Determine the labour and machinery requirements to implement to drilling design;

53.7 Explore international co-funding and/or collaboration opportunities, specifically starting with Japan, Iceland and the United States; and

53.8 Provide options and seek approval from the Minister of Finance and myself on an appropriate commercial structure to undertake the project.

54. It is expected that many of the tasks outlined above can be undertaken concurrently. Confidential advice to Government

55. Detailed drilling site, well design, confirming the pilot site and associated land acquisition, determining labour and machinery requirements, exploring international collaboration/co-funding opportunities are expected to be completed in Confidential advice to Gover.

56. As outlined in CAB-24-MIN-0168.02, this project will be considered against RIF assessment criteria, and that officials from across MBIE and other relevant agencies as necessary, will provide decision-makers with robust business cases, including advice on the expected return from investments and public benefit, and CRHL's expert financial, commercial, and management assessment.

57. There are numerous potential risks that may delay or halt the project prior to commencing drilling, which includes but are not limited to:

Confidential advice to Government

58. These potential risks will be closely monitored and addressed during the drilling programme design process.

59. Once stage one above is completed, Cabinet will have the option to proceed with the second stage of the project. This is expected to consist of commencing the construction of the well itself through a commercial entity agreed to by Ministers, once resource consent is granted. The estimated cost to undertake the work will be informed by the detailed drilling design, which

Confidential advice to Government

Cost-of-living Implications

60. This proposal will not directly address cost-of-living issues in the short term. However if the commercial viability of SCGT is proven, in the longer term this proposal may lead to a positive impact on energy prices for business and household. The full potential of SCGT will be able to be better understood when/if the first deep well is successfully drilled.

Financial Implications

61. This proposal seeks agreement to a grant of $5 million from the RIF to undertake the detailed drilling design and costings, and to agree in principle to ringfence $55 million from the RIF to drill an exploratory deep well, with drawdown contingent on Cabinet approval of a full investment proposal. The funding associated with the RIF was determined as part of the Government's Budget 2024 process. There are no new financial implications associated with this proposal.

Legislative Implications and Regulatory Impact Statement

62. This proposal contains no legislative implications, and a Regulatory Impact Statement is not required.

Climate Implications of Policy Assessment

63. A Climate Implications of Policy Assessment (CIPA) is not required for this proposal. However, if the commercial viability of SCGT is proven and the energy is able to be harnessed, direct use of geothermal by industry represents opportunities to reduce emissions and reliance on expensive fuels such as gas and coal. Process heat – mainly gas and coal used in boilers – contributes about 8 per cent of New Zealand's gross emissions.

Population and Human Rights Implications

64. This proposal will not have any direct population implications. However, population implications will be explored as part of the full investment proposal that is presented to Cabinet for approval to drawdown funds for drilling.

65. This proposal contains no human rights implications.

Use of external resources

66. No external resources were involved in the preparation of the policy advice in the paper.

67. I note that some external resource will be required for this proposal due to the nature of the work being highly-specialised and needing a level of expertise not held in government departments.

Consultation

68. The following departments were consulted: The Treasury, the Ministry of Foreign Affairs and Trade, the Department of the Prime Minister and Cabinet, New Zealand Transport Agency, the Ministry of Transport, the Department of Internal Affairs, Public Service Commission, the Ministry of Primary Industries, Te Puni Kōkiri, the Ministry for Culture and Heritage, and the Ministry of Housing and Urban Development.

Communications and Proactive Release

69. I intend to make a public announcement about the proposal contained in this paper following Cabinet's decision. I intend to release this Cabinet paper and associated minute within 30 days of final Cabinet decisions being made.

Recommendations

On behalf of the Regional Development Ministerial Group, the Minister for Regional Development recommends that the Committee:

1 **note** that on 20 May 2024, Cabinet agreed to establish the $1.2 billion Regional Infrastructure Fund (RIF) [CAB-24-MIN-0168 refers]

2 **note** that Cabinet agreed that the RIF will invest in resilience infrastructure that improves a region's ability to absorb, adapt and/or respond to stresses and shocks; enabling infrastructure that ensures regions are well-connected, productive and resilient;

3 **note** that Cabinet also agreed that the Regional Development Ministerial Group (RDMG) comprising of the portfolios of Finance; Infrastructure; Local Government; Regional Development; and Māori Development, would be established to support decision making, and agreed that Cabinet make decisions on all grant, loan, and equity investments over $35.00 million, or any projects deemed high risk by officials and Crown Regional Holdings Limited (CRHL);

4 **note** that GNS Science (GNS) is seeking up to $60 million of government funding from the RIF to drill the first of three exploratory wells to prove the commercial viability of supercritical geothermal energy (SCGT);

5 **note** that, if the commercial viability of SCGT can be proven and the technology developed to harness the energy, SCGT could meet a significant amount of New Zealand's future electricity demand, and would contribute to the Government's goal of doubling renewable electricity generation;

6 **note** that any government funding to support progressing SCGT will not extend to fully de-risking the commercialisation of SCGT energy for electricity

generation, although it should resolve some technological risks associated with progressing towards commercialisation;

7 **note** that, while the potential opportunities of SCGT are significant, the early stage of technology development means there are a number of known (but not completely understood) and unknown risks and challenge that need to be fully understood and working through before committing government funding and commencing exploratory drilling;

8 **agree** to ringfence up to $60 million of funding from the RIF to fund an exploratory deep well to prove the commercial viability of SCGT, consisting of two stages:

8.1 the initial drawdown of an up to $5 million grant to MBIE to undertake the detailed design and costings for the first exploratory deep well, in order to allow a full investment proposal to be developed for Cabinet consideration (stage one);

8.2 contingent on Cabinet approval of a full RIF investment proposal, the drawdown of the remaining funding of up to $55 million to undertake the drilling of the exploratory well (stage two).

9 Confidential advice to Government

10 **note** that officials will provide options and seek approval from the Minister of Finance and myself on an appropriate commercial structure to undertake the drilling project;

11 Confidential advice to Government

Authorised for lodgement.

Hon Shane Jones

Minister for Regional Development

Annex One: Map of mana whenua land within Taupo Volcanic Zone

Confidential advice to Government, Commercial Information