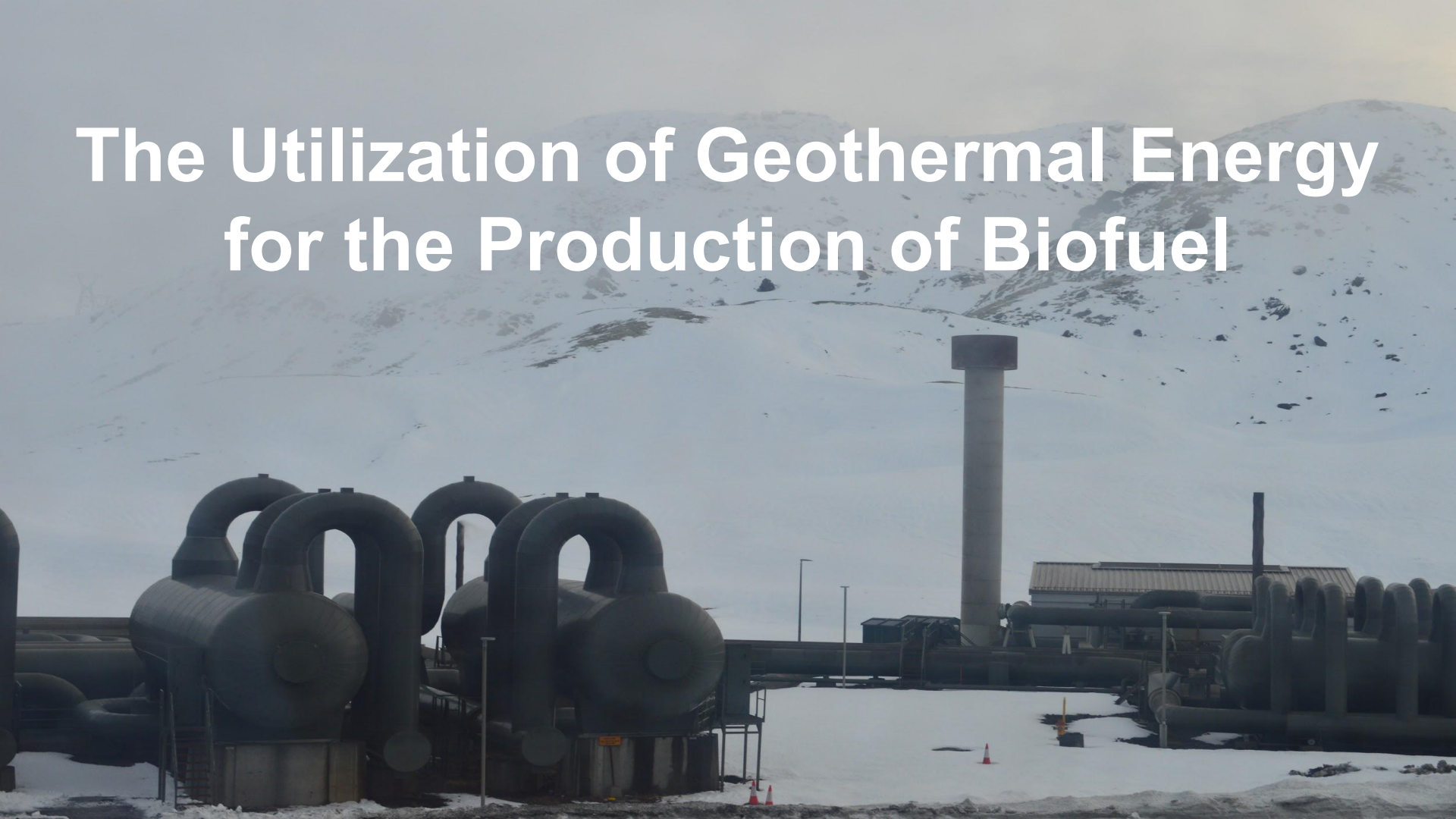


The Utilization of Geothermal Energy for the Production of Biofuel



Meet the Team



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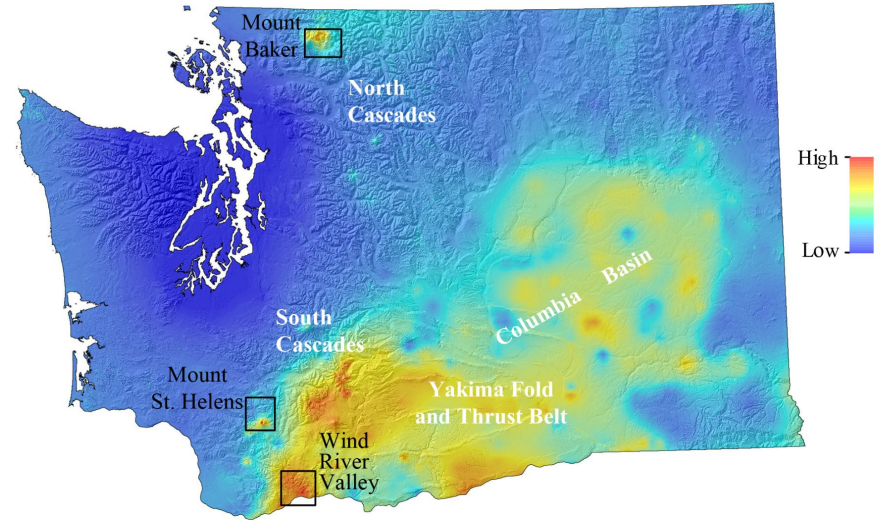
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CSO
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Introduction

- The Pacific Northwest has a large convergent boundary, but geothermal production is limited
- Less than 50% of Washington's and Oregon's electricity is comprised of renewables
- Currently small operations in an area that has historically been open to environmentally progressive changes
- The region's resources are being underutilized



Geothermal favorability in Washington state (2)

The Golden Circle

Why?

The Pacific Northwest needs to increase its renewable energy capabilities and phase out the use of fossil fuels.

How?

The utilization of regional geothermal resources and emerging alternative fuel technologies.

What?

Consult and/or partner with geothermal power plants to use their CO₂ byproduct for the production of e-methanol.

Economic Model

Social Business Model Canvas

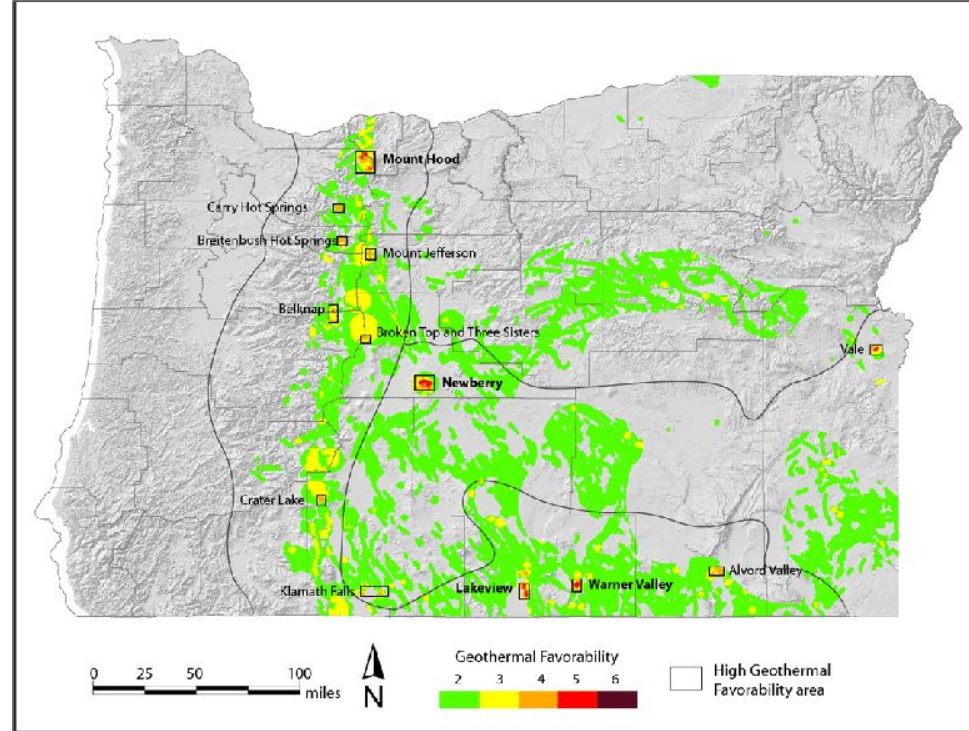


<p>Key Resources</p> <ul style="list-style-type: none"> • Access to the Pacific Northwest's geothermal fluid • Microorganisms and feed • Financial and intellectual capital • Employees • Companies/local governments interested in the concept <p><i>What resources will you need to run your activities? People, finance, access?</i></p>	<p>Key Activities</p> <ul style="list-style-type: none"> • Presenting our concept to local governments and utility companies in areas with geothermal extraction potential for economic and utility opportunity • Helping geothermal companies mitigate waste via the use of CO2 in the creation of biofuels 	<p>Type of Intervention 2</p> <ul style="list-style-type: none"> • Integration of renewable energy in the Pacific Northwest • Creation of biofuel to be sold across the United States <p><i>What is the format of your intervention? Is it a workshop? A service? A product?</i></p>	<p>Segments 1</p> <ul style="list-style-type: none"> • The environment • Communities in the Pacific Northwest • Other communities vulnerable to the effects of climate change <p><i>Who benefits from your intervention?</i></p> <p>Beneficiary</p>	<p>Value Proposition 3</p> <ul style="list-style-type: none"> • Preexisting and proposed geothermal extraction operations <u>with</u> the simultaneous production of biofuel <p>Beneficiary Value Proposition</p> <p>Impact Measures</p> <ul style="list-style-type: none"> • Biofuel produced by clients (kg) <p><i>How will you show that you are creating social impact?</i></p>
<p>Partners + Key Stakeholders</p> <ul style="list-style-type: none"> • The United States federal government • Washington's state government • Community members • Vehicle owners • Local business owners/energy providers • Tourists • The environment <p><i>Who are the essential groups you will need to involve to deliver your programme? Do you need special access or permissions?</i></p>	<p>Channels 5</p> <ul style="list-style-type: none"> • B2B marketing with utility companies • Networking with regional NGOs <p><i>How are you reaching your users and customers?</i></p>	<p>Customer 4</p> <ul style="list-style-type: none"> • Business owners • Regional manufacturers <p><i>Who are the people or organisations who will pay to address this issue?</i></p>	<p>Customer Value Proposition 5</p> <ul style="list-style-type: none"> • Increased access to renewable energy at an affordable rate in the long term <p><i>What do your customers want to get out of this initiative?</i></p>	
<p>Cost Structure</p> <ul style="list-style-type: none"> • Primary Costs: Staff, company website, other administrative costs • The goal is to become a nationwide consulting firm that helps geothermal power plants incorporate biomass production into their processes. <p><i>How do they change as you scale up?</i></p>		<p>Surplus</p> <ul style="list-style-type: none"> • All profits will go towards expanding the geothermal network across the United States <p><i>Where do you plan to invest your surplus?</i></p>		<p>Revenue</p> <ul style="list-style-type: none"> • Consulting fees (100%) <p><i>Break down your revenue sources by %</i></p>

Case Study

Klamath Falls, Oregon

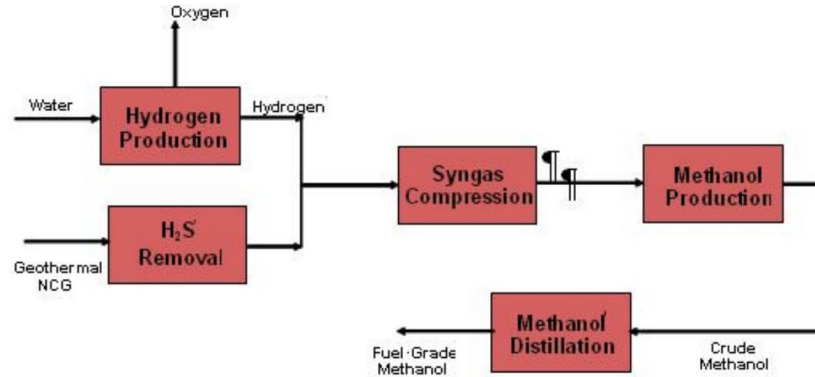
- Located in the Cascadia Subduction Zone, a volcanically active part of the U.S.
- Initially using between 1.2-1.6 MW of geothermal power to heat 27 buildings in town, as well as sidewalk and bridge melting systems⁽⁴⁾
- Recent expansion with new power plant, adding 10 MW of geothermal power capacity⁽⁵⁾
- New power is being supplied to some homeowners and local businesses for heating⁽⁵⁾
- Biofuel could bring in more profits for utility companies to continue expanding operations, and broaden their reach



Klamath Falls, located in the bottom left, is just one example of many areas in Oregon and Washington with geothermal favorability ⁽⁸⁾

e-Methanol Process

Overall Process:



Source 10

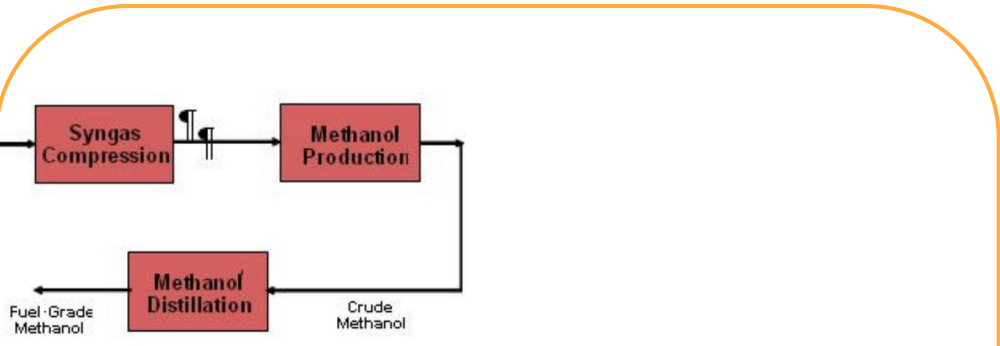
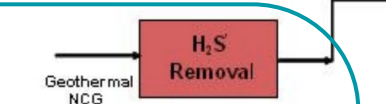
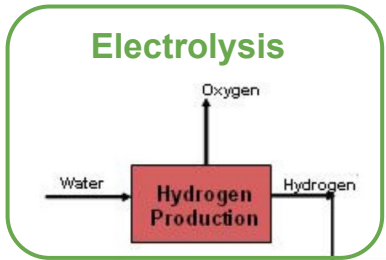
Inputs:

- Electricity from geothermal plant
- Non-compressible gases (NCGs) from geothermal plant waste
- Water (in excess)

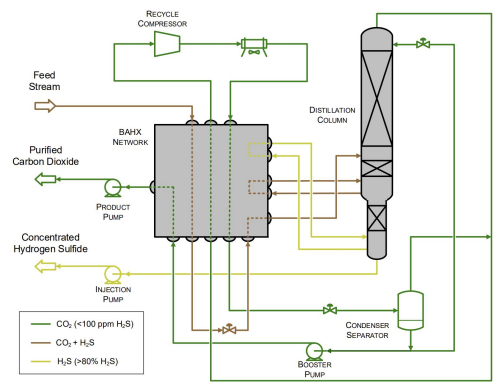
Final Products:

- Liquid methanol fuel
- Excess energy from the geothermal plant

Methanol Biofuel Process



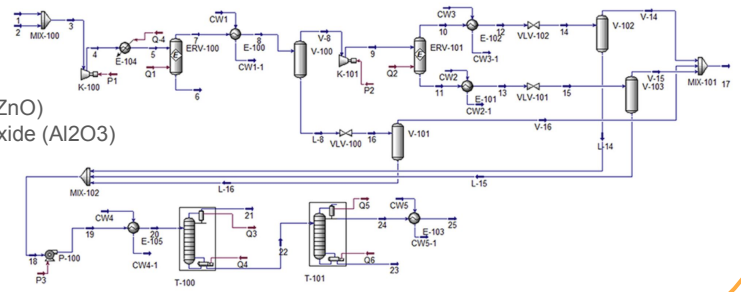
Separation of H₂S and CO₂ via Distillation⁽¹⁰⁾



e-Methanol Production via CO₂ Hydrogenation⁽¹²⁾

Catalyst Options:

- Cu
- Zinc Oxide (ZnO)
- Aluminum Oxide (Al₂O₃)



Biofuel statistics

Methanol produced per year	.175 million kg CH₃OH/year
Gross profit if sold as methanol	3.5 million \$/year
CO ₂ saved (from burning e-methanol as opposed to coal)	439,455 lb CO₂ per year per plant
CO ₂ saved (from burning e-methanol as opposed to gen fuel)	334,440 lb CO₂ per year per plant
CO ₂ saved (from burning e-methanol as opposed to natural gas)	216,417 lb CO₂ per year per plant

Assumptions

- Water is not a limiting factor for chemical processing
- 96% efficiency for conversion of CO₂ to CH₃OH (methanol)
- 35% efficient conversion rate from methanol to power grid
- Calculated values per 1.5MW capacity geothermal plant
- Calculated cost using a PPA price of 15 cents/kWh
- Tax credits **not** factored into calculations⁽³⁾
- Assuming 90% capacity factor of geothermal plant

Feasibility & Future Flexibility

Feasibility Now

- Biofuels will likely be a key player for the phasing out of fossil fuels.
- Utilizing geothermal energy to create biofuel can present economic opportunities in a growing renewable industry.
- Using the CO₂ waste to produce more energy generates enough revenue to justify capital expenses.
- Guarantee of long term return on investment.

Flexibility for the Future

- If EVs are highly favored over alternative fuels, e-methanol is still marketable to the shipping industry
- If the market for e-methanol degrades, it is simple to switch production from e-methanol to solely geothermal power for utility use.
- Geothermal operations in this part of the country are unlikely to deplete in the long term.

Sustainability

- Our project aligns with Sustainable Development Goals (SDGs) 7, 9, 11, and 12.
- We have the potential to divert thousands of pounds of carbon dioxide per year.
- We fall into the **regional** category of the Sustainability Complex. We intend to become a nationwide consulting firm in the future.




Conclusion

- The Pacific Northwest's great potential⁽¹⁾
- Low startup and operational costs
- Our ideas are feasible and practical, and will encourage geothermal power plants to maximize their potential



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15. [Calculations](#)



Thank You!
Any Questions?