

Rock Energy



*Ingeniously sharing the everlasting
warmth of Mother Earth*

BI 15. jan 2018
Case: Rock Energy
Thor Erik Musæus, CEO

The Company

- Leading geothermal company with competencies in the full geothermal value chain
- Secured intellectual property rights
- Significant global potential
- Secured widely experienced team within energy, energy systems, drilling, geology, finance and project management
- Projects in negotiation for Norwegian companies. More leads are in pipeline.



Clean



Natural

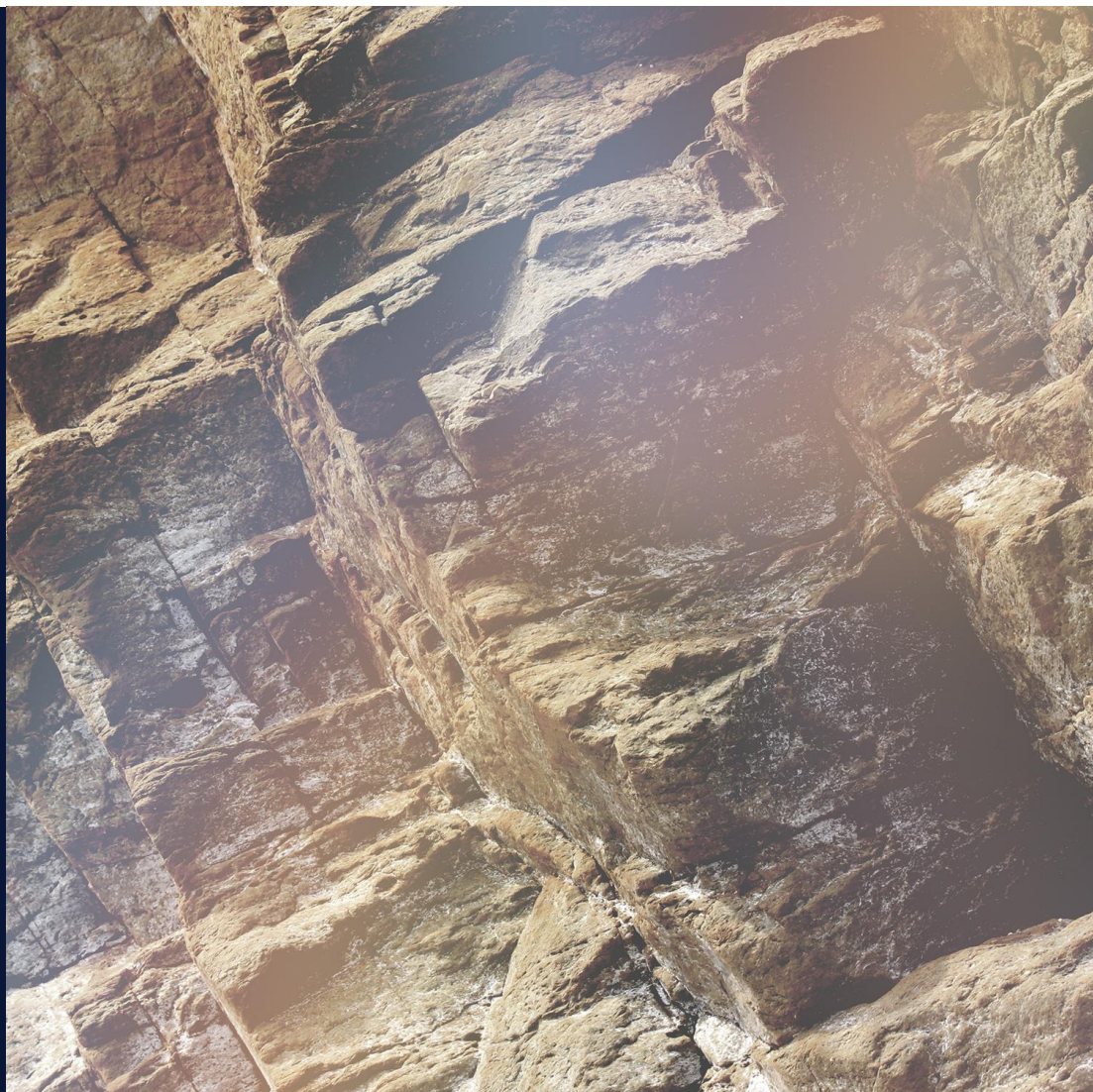


Everlasting

Energy policy and renewables

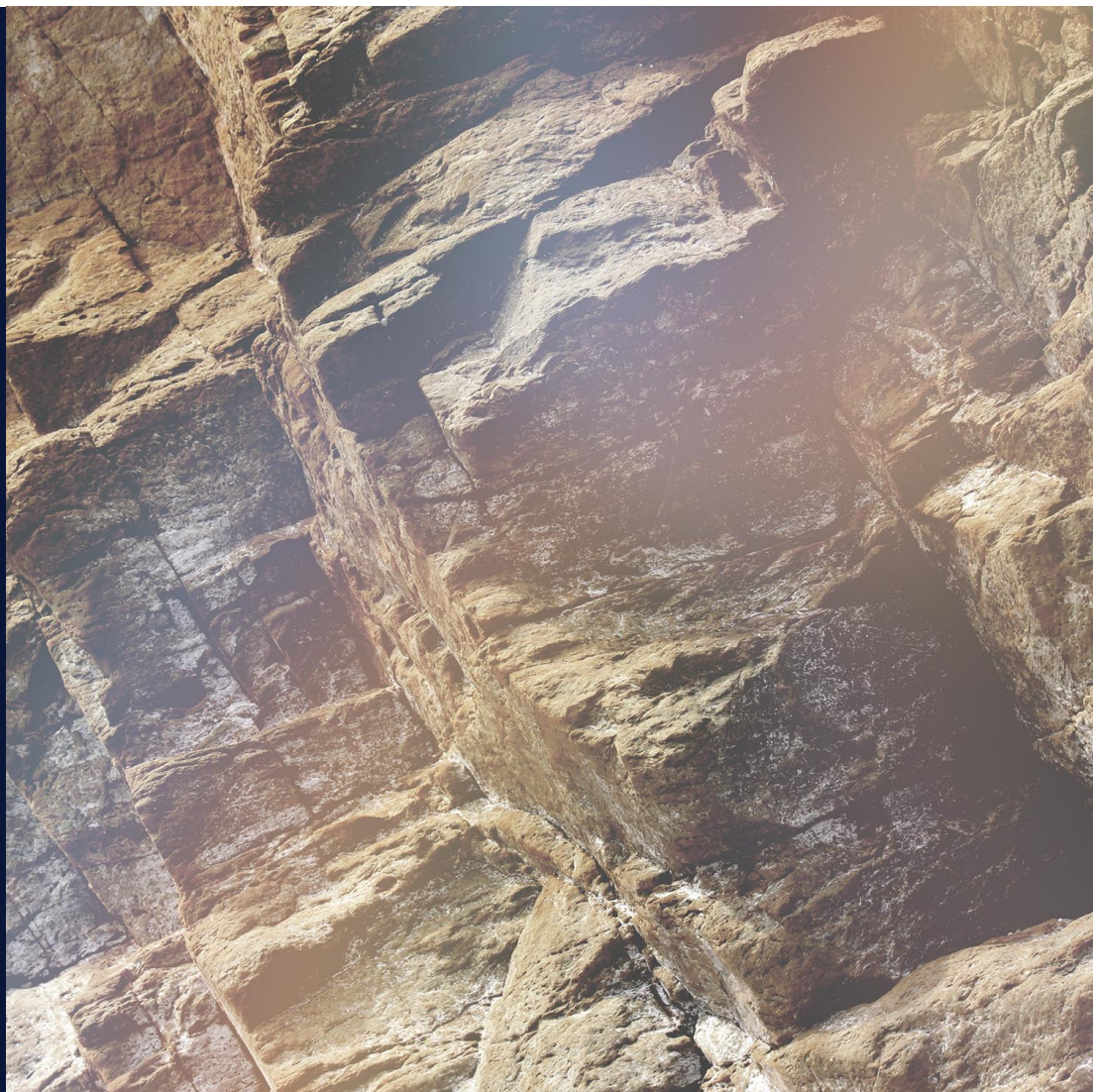
- Climate change – UNs IPCC (est.1988) and reports
 - Human activity
 - Natural development
- Protection of the environment and higher awareness of global and local pollution from energy production and use = positive
- Political attention and actions:
 - Some good based on facts
 - Some not so good based on the next election.
- Political actions and market incentives => push technologies, products and markets to greener solutions.

This is the
BASEMENT FOR GREEN DEVELOPMENT
but
the solutions must be competitive and reliable
and
finally it is all about money !



Solution

- Independent, distributed, local and stand alone energy production benefitting local companies
- No infrastructure or distribution network costs apply
- Emission free, renewable and sustainable with small environmental footprint
- Potential abundance of resources
- Unchanging and reliable energy, allowing continuous generation of reliable base load of heat and/or power 24/7
- Independence from fuel- and energy costs, which is a great advantage over pellets and oil
- Low operational costs
- Increased predictability on future energy costs



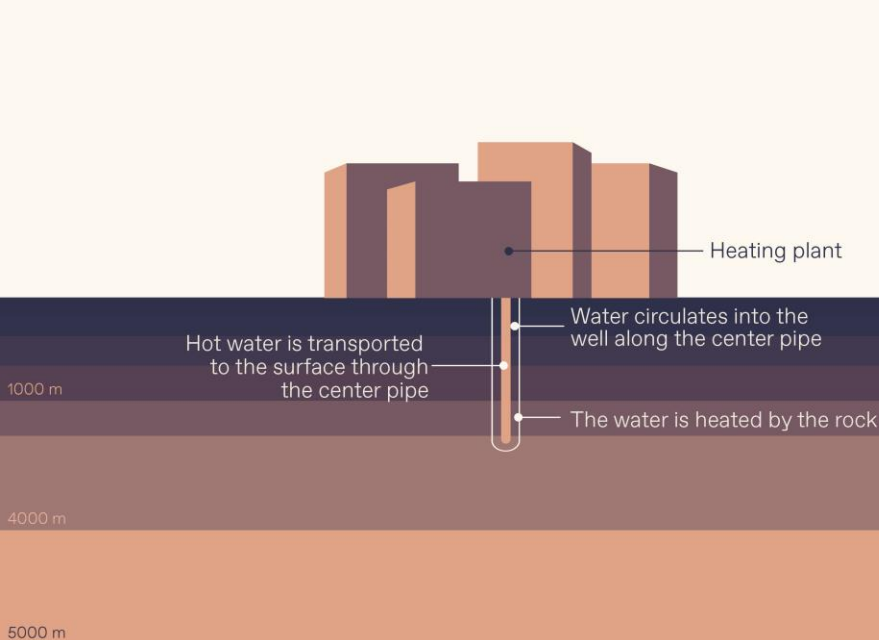
TECHNOLOGY and PROJECTS

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Technology

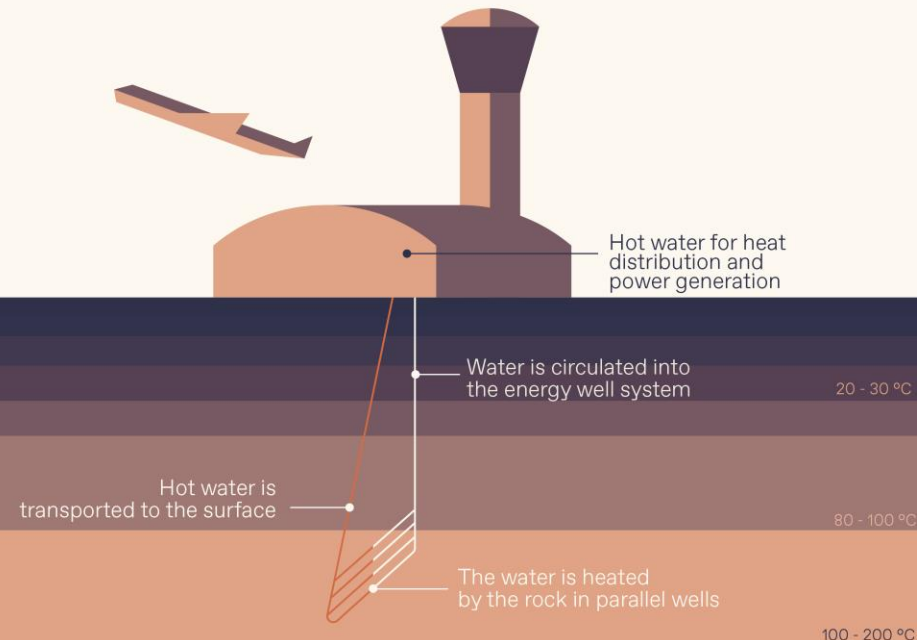
Deep Vertical Energy Wells (800 – 3 000 meters)

- Heat production from Deep Vertical Energy Wells through heat pumps for space heating and hot water
- Possibility to use the heat directly for preheating or deicing of pavements, grounds, roads, bridges etc.



Geothermal Energy Well System (4 000 – 5 000 meters)

- Patented technology for deep geothermal energy production from hot, dry rock
- Ideal applications are district heating systems and combined heat and power production
- Concept under development



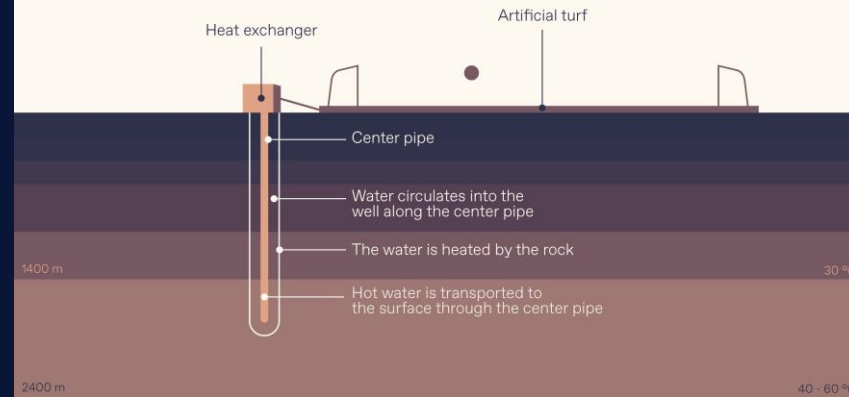
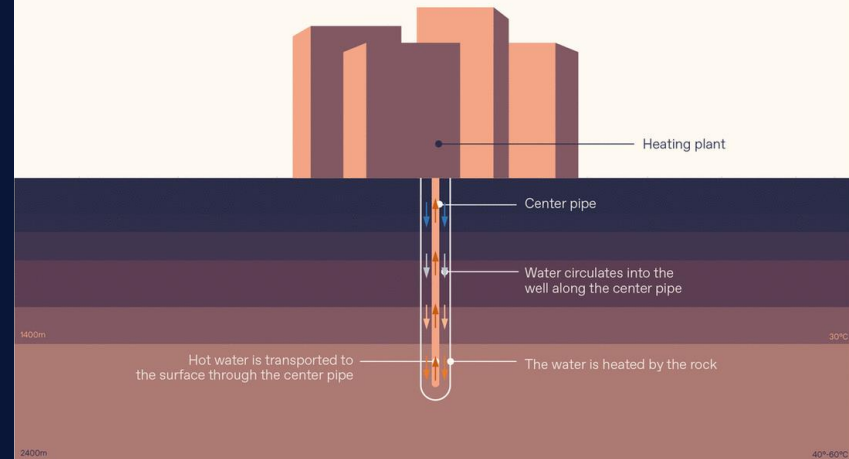
Deep Vertical Energy Wells

- The energy extraction from one well at 1500 meters replaces 25 conventional energy wells at 200 meters.
- A system with deep wells requires less surface area than a large group of shallow wells
- Life Expectancy is 50+ years
- Operational costs without heat pump is 0.05 NOK/kWh



Installed capacity per well*	90 kW	100 kW	110 kW	70 kW
Equivalent usage time	4 000 hours	2 300 hours	1 500 hours	8 760 hours
Energy delivery per well	360 MWh/year	230 MWh/year	165 MWh/year	614 MWh/year
Heat pump	Yes	Yes	No	Yes

*Numbers based on 1500 meter deep wells assuming a temperature gradient of 20 °C/kilometer



PROJECTS

Oslo Airport Gardermoen – Ground heating for the engine test area:

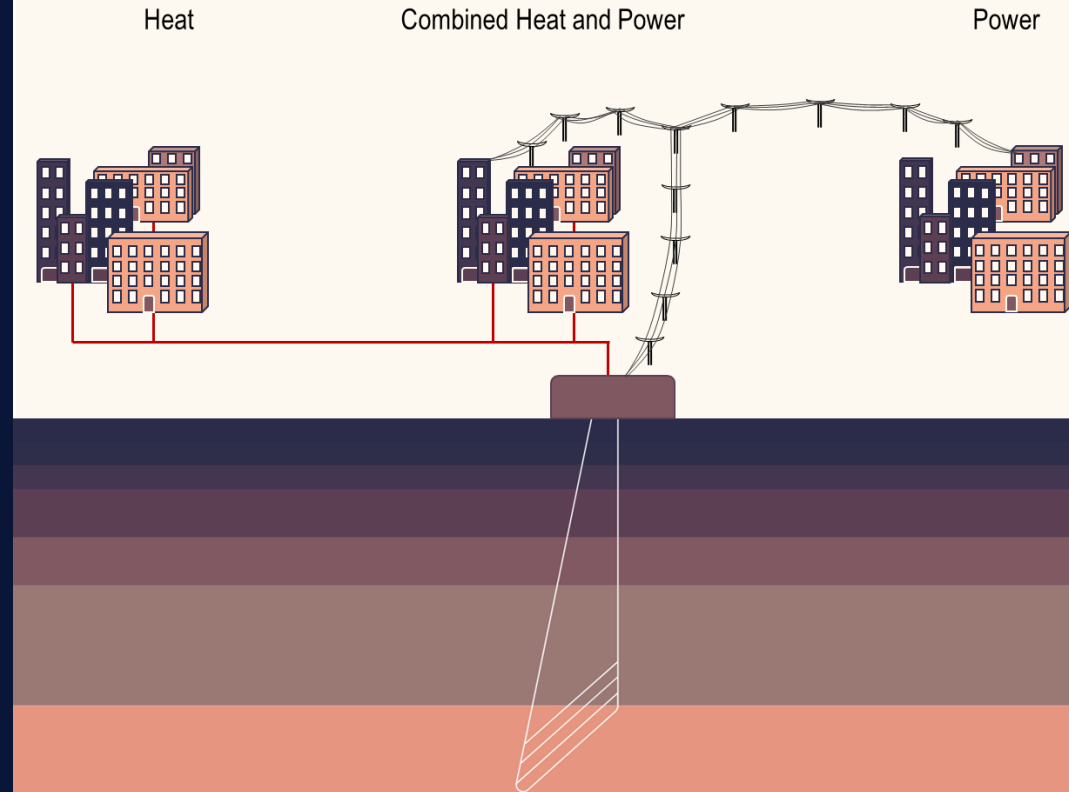
- Ongoing drilling of 2 energy wells to 1500m
- Direct use of heat for keeping the ground at the engine test area free of ice.
- Energy from wells early Q2 2018.

Several other projects in pipeline



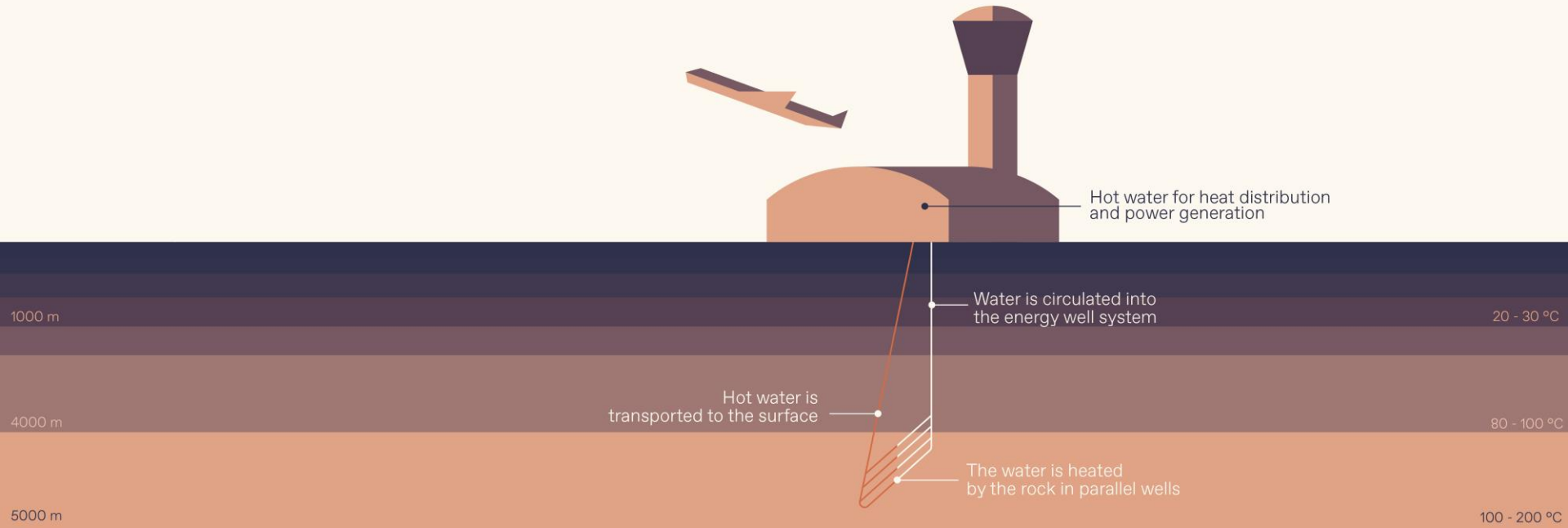
Geothermal Energy Well System

- Technology and project under development
- A closed loop heat exchanger drilled at 5 000 – 6 000 meters below the surface
- Water flows freely through the parallel wells at the bottom, achieving high temperatures by direct contact with the hot rock
- A safe, cost effective and continuous cycle
- Can be used for heating, cooling and/or power generation
- Power output between 2 and 50 MWth
- Timeline 3-5 years



Typical projects – Geothermal Energy Well System

- Oslo Airport Gardermoen: 3-5 MWth for OSL's district heating system
- District heating systems
- Combined heat and power production



Examples drilling rig

Rig requirements

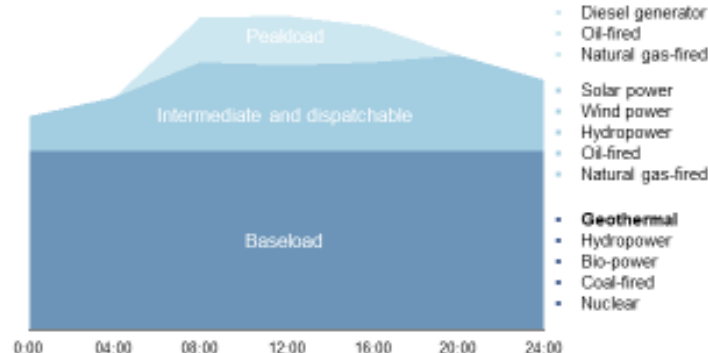
- Small surface foot print
- ~30 – 350 ton hook load depending on project
- Noise level – within public regulations
- Electric operation
- Bigger rig → go deeper → reduced number of wells for equivalent energy extraction



Why geothermal?

Geothermal provides reliable baseload energy...

Illustrative energy production by technology and hour of the day



...and enjoys multiple benefits over other renewables

Energy source	Suitable to replace boilers	Independent from fuel prices	Independent from weather conditions	Ease of logistics	Heating (H), Cooling (C), Power (P)
Geothermal	●	●	●	●	H, C, P
Solar	◐	●	◐	●	H, P
Hydropower	◐	●	◐	●	P
Wind power	◐	●	◐	●	P
Seawater heat pump	●	●	●	◐	H, C
Air/water heat pump	●	●	◐	●	H, C
Pellets boiler	●	◐	●	◐	H, C

Key drivers for utilizing Rock Energy's solutions

- Baseload renewable energy solution with a long operating life that is independent from weather conditions and fuel prices
- Low and predictable operating costs
- Environmentally friendly solution that is completely free from air and noise pollution with a significantly smaller footprint and visual impact than wind and solar
- Clear advantages as a heating source in cold climate regions where the load factor is higher and the loss of energy transformation can be reduced
- Hard dry rocks are available more or less everywhere and offer almost unlimited energy resources

MARKETS

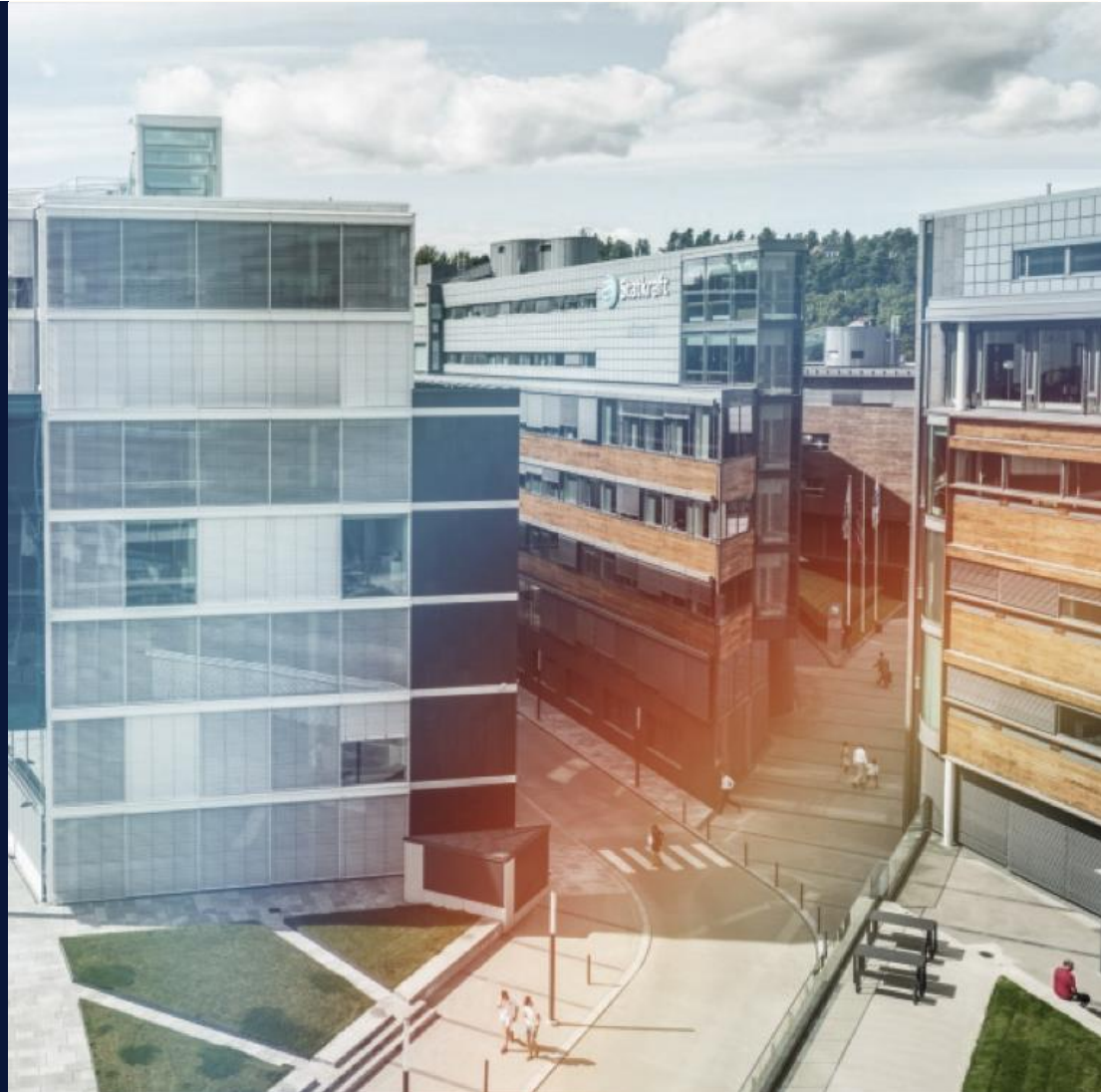
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The Nordic Market

Total energy consumption: 1,177 TWh/yr
(2010)

Heat demand in the Nordics:

- Football pitches: 1.58 TWh / 164 MEUR p.a.
- Parking lots and sidewalks
- Office buildings
- Malls: 768 malls with in excess of 5,000m² (2013)
- Airports: More than 100 airports with more than 25,000 passengers p.a.
- Industry: 400 TWh p.a. (1/3 of the market)
- District Heating: 114.6 TWh / 7,607 MEUR p.a.



The European Market

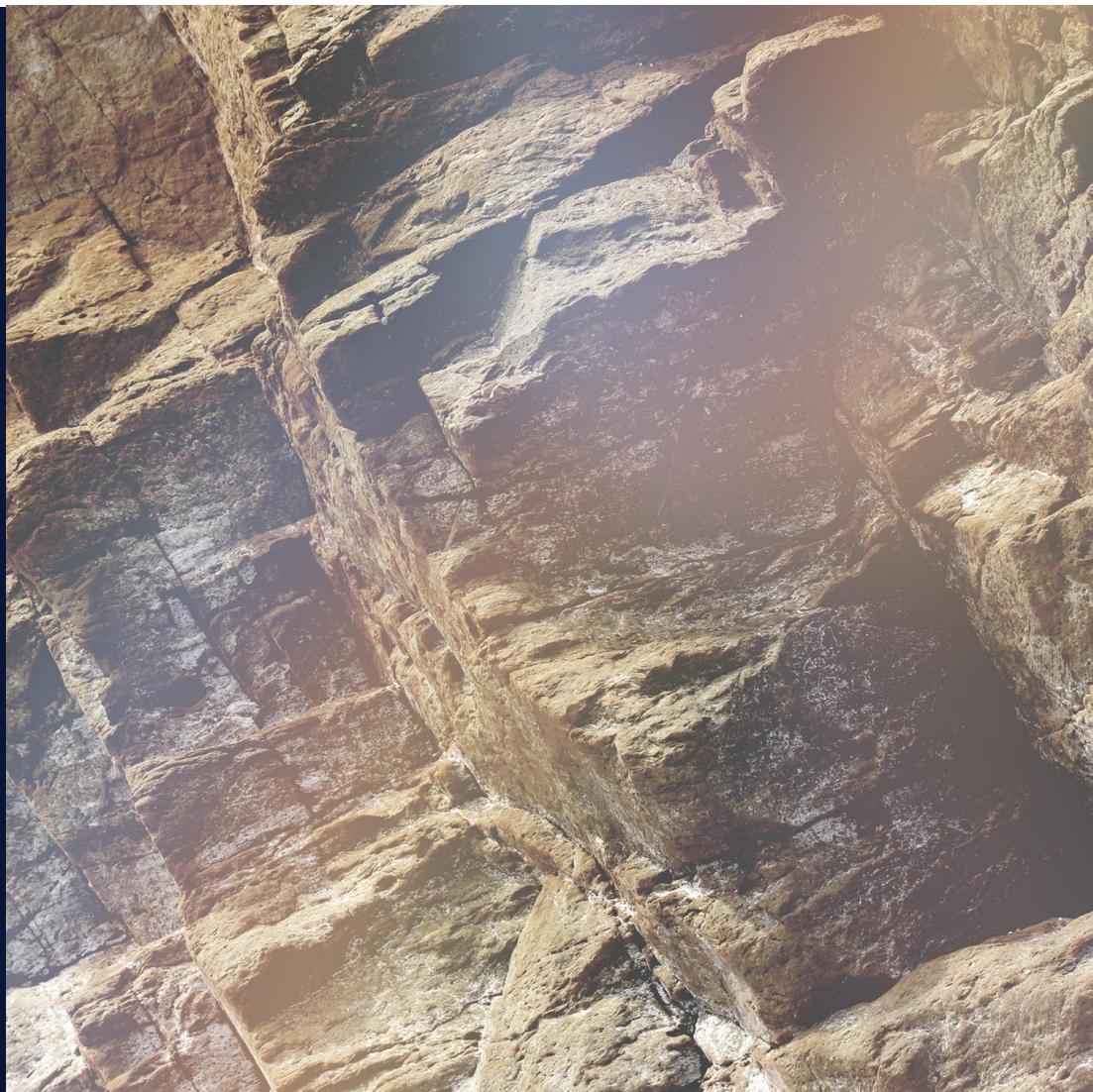
Total energy consumption: 21,000 TWh
(2016)

Heat demand

- Office buildings
- Malls
- Airports
- Industry
- District Heating: 30 BEUR p.a.

Combined Heat and Power (CHP) demand
Manufacturing Industries (1/3 of the current CHP
market):

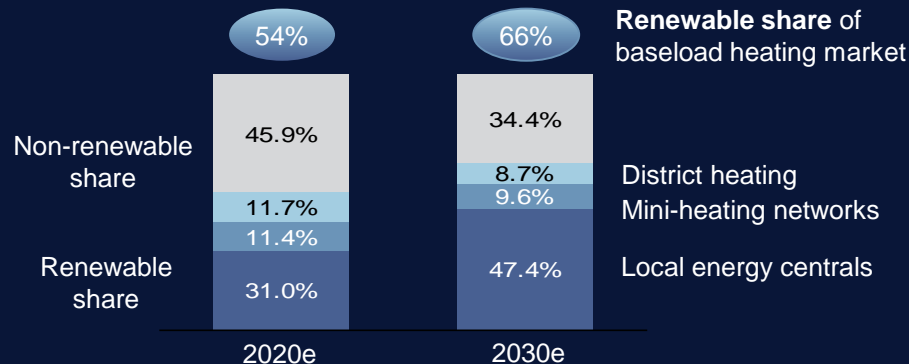
- Paper and Allied Products
- Chemicals and Allied Products
- Petroleum Refining



The renewable baseload heating market is estimated to grow through 2030

Market potential for renewable baseload heating in Norway

Estimated baseload heating market in Norway¹



- **The renewable baseload heating market holds the largest market potential for geothermal energy in the Nordics**
- Although the Norwegian baseload heating market is expected to decline through 2030 due to inter alia energy efficiency measures in buildings and increased utilization of small scale heat pumps...
- ...the renewable share of the Norwegian baseload heating market is estimated to grow from 20.4 TWh (54%) in 2020 to 21.2 TWh (66%) in 2030, posing as an imminent opportunity for geothermal to feed local energy centrals, mini- and district heating networks
- Capturing a 1% share of the renewable baseload heating market in 2030 equates to NOK ~150m in revenues²

Local energy centrals

- Local energy centrals refer to independent and local heating systems used to heat single residential, industrial and commercial buildings
- Local energy centrals differ from most other heating solutions as they are not connected to a distribution network
- Hence, there is no cost of distribution associated, only the cost of producing energy
- Energy delivery of between ~1 – 20 GWh/year

Mini-heating networks

- Mini-heating networks refer to local energy solutions with a limited geographic distribution network (e.g. a small cluster of commercial buildings)
- Mini-heating networks mainly differ from district heating systems in terms of the scale and length of its distribution network
- Energy delivery of between ~1 – 20 GWh/year

District heating

- District heating refers to the distribution of heat generated in a centralized location for residential and commercial heating requirements such as space heating and water heating
- District heating is prevalent in all Nordic countries, with the exception of Norway, and fulfils a varying degree of the heating demand
- Energy delivery of between ~20 – 150 GWh/year

Geothermal can be a key technology to increase the renewable share of the Nordic baseload heating market

BUSINESS MODELS

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Three business models and alternatives in between

1

Independent Power Producer (IPP)

Rock Energy **develops plants for clients** and receives construction margins and/or royalty fees in return

Margins to be determined on deep vertical energy wells with or without HP

Ideal model for the **Nordic market**

Capital light efforts for the Company

2

Build, Own & Operate (BOO)

Rock Energy **builds and owns its own plants**, then sells energy on long-term contracts to end-users

Revenues to be determined through offtake agreements

Ideal model for the **Nordic market**

Capital heavy efforts for the Company as it has to take on construction costs

3

Licensing

Rock Energy **licenses its technology to partners abroad** in return for licensing fees from partner constructed plants

Licensing fees targeted to be a percentage of each plant's revenues

Ideal model for the **global market**

Capital light efforts for the Company

Geothermal heat increases quality of life

Indoor football halls and Fifa rankings Iceland



Thank you
for
your attention

www.rockenergy.no

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