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Geo-energy as an integral part of the Energy Transition

Presentation to: Energy Transition Zone

Shift Geothermal June 2021

Who we are:

A consortium of academic institutions and industry leaders with a proven track record of developing innovative technology and building companies in the energy market.

The group has vast real world experience of working in the energy sector fortified with extensive research into alternative energy sources with a focus on geothermal electricity generation. Our own research and that of our extended networks has put us at the epicentre of geothermal R&D.

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Our Vison:

To transform the decarbonisation of energy through sustainable geo-energy solutions

Our Mission:

To position technology and expertise to develop existing subsurface assets and infrastructure, utilising geo-energy solutions that maximise energy recovery and eliminate carbon emissions, as part of a **just** energy transition.

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Our journey, partnerships and collaboration

- 23 years of research into geothermal conversion or adaption of oil and gas wells
- Pioneers of geothermal electricity from coproduced fluids - established the potential of UKCS fields in 2014
- Exploring cutting edge technology such as the use of CO_2 as a working fluid for geothermal power generation in conjunction with ETH Zurich
- Extensive network of expert and academic resources
- Key participants in global geothermal R&D through our partnership and collaboration with:

Durham University

ETH zürich

BritGeothermal

GEOENERGY DURHAM

MANCHESTER 1824 The University of Manchester

HERIOT WATT UNIVERSITY

CYNTHIAN

ONE OPPORTUNITY NORTH EAST

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Why repurpose oil and gas wells & reservoirs for geothermal ?

- Geothermal heat is usually a totally wasted by-product of oil and gas production
- The largest cost of a deep geothermal development is drilling, where these wells already exist, there is an opportunity to deploy geothermal at minimal cost
- Wells are located within a geological context that are already understood, so subsurface risk is mitigated
- Re-purposing wells offers scope for reducing carbon footprint of oil and gas operations
- Removing cost of drilling will accelerate geothermal deployment & technology development
- Geothermal engineering skills and technology are an ideal energy transition opportunity for upstream Operators, Supply Chain, and People

Actively seeking geothermal potential creates a sh*i*ft in thinking from seeing existing fallow well stock as a liability transform to an opportunity for clean energy production and maybe even alternative business models

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Sounds like a good idea, is it economic though ?

- Low efficiency energy capture from low enthalpy co-produced fluids (< 120 deg C)
- High indigenous power requirement of North Sea installations (5 – 50 Mw each) - materiality
- Potential high weight/footprint of ORC/Binary Plant in a constrained offshore platform environment
- High parasitic power consumption associated with increased cooling water demand required for ORC/binary plant
- Lack of remaining economic field life in late-life North Sea assets to achieve payback on major projects
- Lack of examples, norms, or estimating tools to screen likely project cost, weight and performance

Many problems exist and solutions are not immediately evident. This is still an emerging technology and is not just a thermodynamic problem. If it was easy and profitable, it would have probably been done before !

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Why is the efficiency low ?

- Carnot equation applied to low enthalpy co-produced fluids (< 120 deg C) gives a theoretical maximum efficiency of about 25% in a North Sea context

$$\eta_{th} \leq 1 - \frac{T_C}{T_H}$$

Temperature of sink (cold) is practically limited to that of seawater

Temperature of source (hot) is practically limited to that of surface arrival temperatures

Further efficiency losses in practical application can reduce the anticipated power output to fractions of the Carnot maximum, BUT, there are many areas of optimisation

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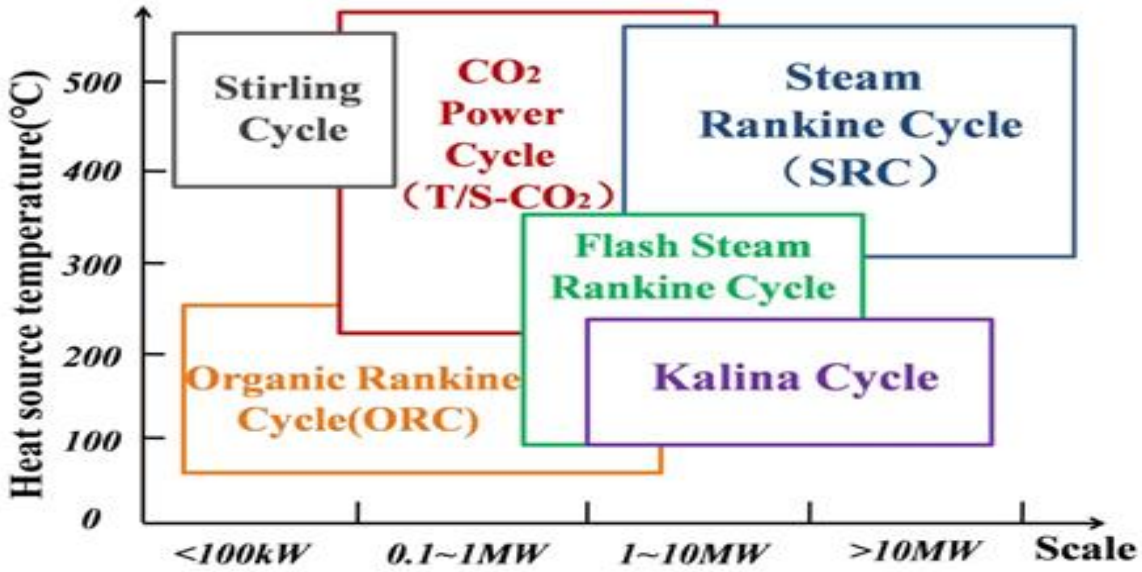
Why investigate ORC plant in particular ?



ORC is conventionally regarded as the most applicable cycle at the low temperatures of brine geothermal, but new research shows potential to improve efficiency by a factor of 3 to 5 times by adopting different energy cycles and working fluids, it is these that SHIFT are primarily interested in researching

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RESEARCH	SINGLE WELL	FIELD SCALE	UTILITY / BASIN SCALE
HEADLINE TECHNOLOGY	CLOSED-LOOP GEOTHERMAL	PRODUCER-INJECTOR GEOTHERMAL & OPEN-LOOP BRINE GEOTHERMAL	CPG THERMOSYPHON WITH CCS AND GEOTHERMAL ENHANCED ALLAM CYCLE
THERMODYNAMIC CYCLES	ORC, TFC, SCRC, KALINA	ORC, TFC, SCRC, CPG ALLAM CYCLE	SCRC ALLAM CYCLE
WORKING FLUID	S-CO_2 , ORGANIC REFRIDGERANTS, NH_3	BRINE, ORC, TFC, SCRC SCO_2	SCO_2
TARGET ELECTRICAL POWER OUTPUT/UNIT	100KWe – 500KWe	500KWe-25MWe	25MWe-100MWe-?
KEY ENABLERS	HX design, turbomachinery mass flowrate, cost/unit	S-CO_2 ”spike sequestration”	Allam cycle and CPG proof of concept, gas to wire
TIME SCALE	2 YEARS	5 YEARS	10 YEARS

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With all the problems, is this a practical technology then ?

- Yes, it already exists and can be deployed today, but wide-scale uptake requires improved economics by reducing deployment cost and improving efficiency :-

  - ✓ New thermodynamic energy cycles and supercritical working fluids offer opportunity to treble efficiency
  - ✓ Closed-loop systems can increase T-Source to that of the reservoir
  - ✓ Downhole heat exchangers will reduce size/weight, and installation cost, of surface facilities
  - ✓ Turbo machinery and working fluid matching offers possibility to make this technology compact and energy-dense

Worldwide research is ongoing to address the challenges of waste heat recovery in universities, businesses, and government/EU agencies.

SHIFT is seeking-out this research, commissioning more, and attempting to combine them into a solution to help transition the oil and gas industries transition to a low-carbon future

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How can we move forward together

- Shift has already built significant momentum, adding academic institutes, interested asset owners and technology providers to a growing list of partners and stakeholders.
- The research to date shows that geo-energy represents:

  - ✓ A real opportunity for the local supply chain to remain relevant, utilising existing skills and technology with particular focus on Oilfield Service Companies and EPC specialists.
  - ✓ Provides achievable short- and medium-term reductions in emissions for existing assets in the UKCS and beyond in delivery of Net Zero emissions obligations.
  - ✓ Has the potential to become a utility scale solution and a constituent part of the ongoing energy transition.

We belief that Geo-energy should be a key component of the UK energy mix, accelerating the delivery of Net Zero Solutions whilst securing a strong economic future for the North East and the indigenous energy supply chain.

Lets make it happen!

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