



Rialtas na hÉireann
Government of Ireland



Geological Survey
Suirbhéireacht Gheolaíochta
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Session 3: Geothermal Opportunities for a Just Transition

Chair: Dr Niamh O'Sullivan, SEAI





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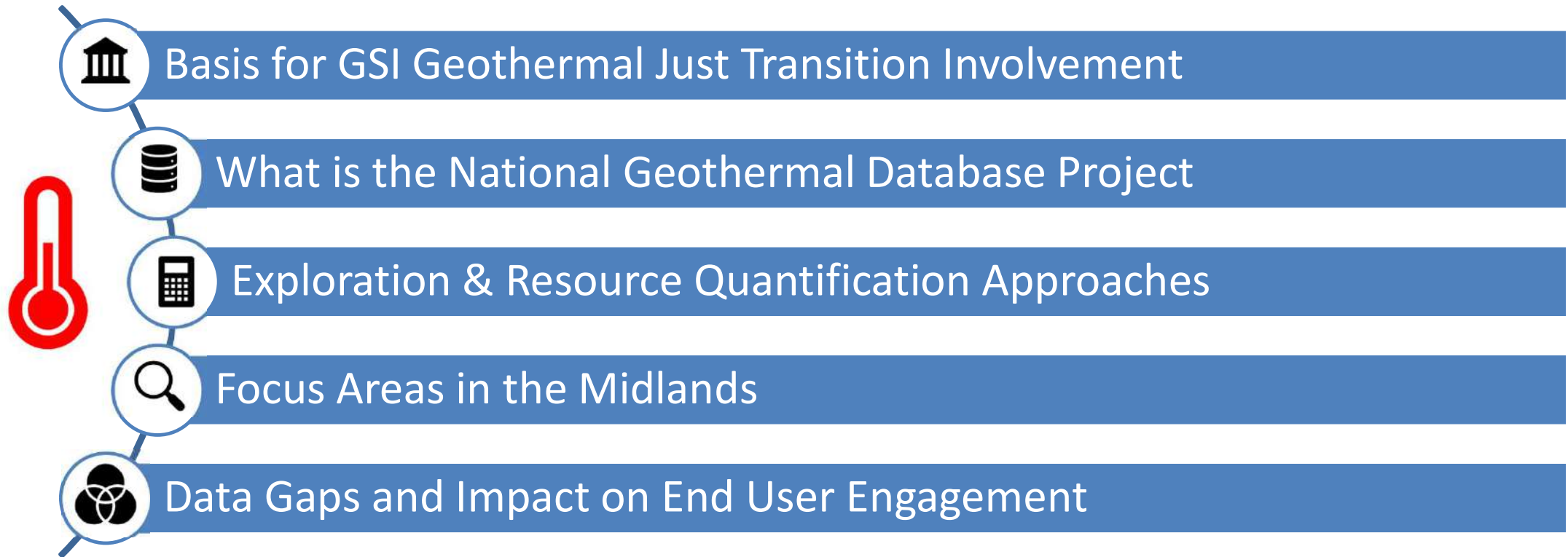
National Geothermal Database: Midlands Resource Assessment

Rory Dunphy

Geoserv Solutions

Geoserv

Outline



Geothermal and the Just Transition in Ireland



Just Transition Region

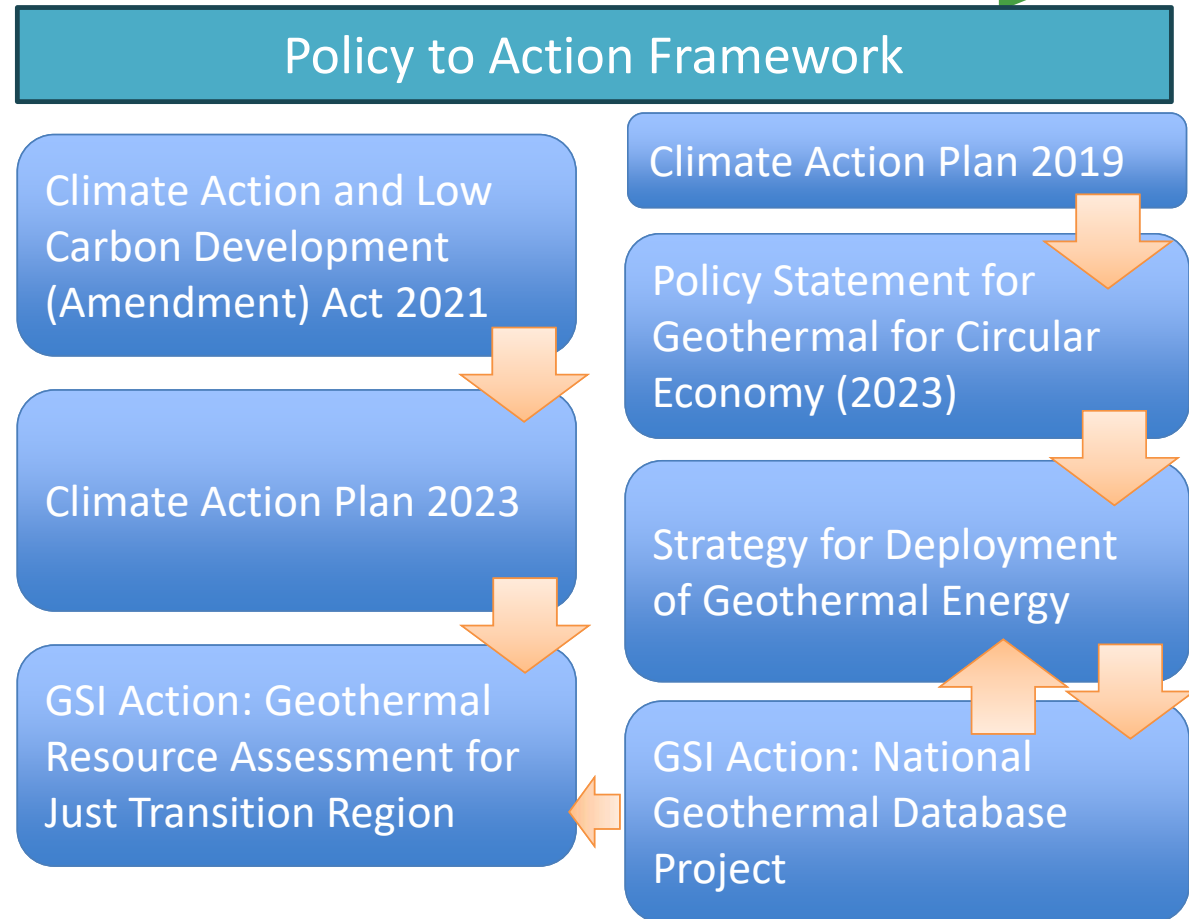
- Offaly, Laois, Longford, Westmeath, Roscommon
- Additional Municipal Districts in Galway, Kildare & Tipperary

Context

- Abrupt end to peat harvesting in the Midlands
- Challenge for small communities
- Drove pivot to new energy solutions

Our Collective Task

- Are there economic opportunities from developing geothermal resources?



Geoserv

What is National Geothermal Database (NGD) Project?



Purpose: Collect high quality publicly available data and disseminate to encourage sustainable geothermal development & inform policy

Priorities:

Short Term - Use what we have to quantify shallow and deep GT resources

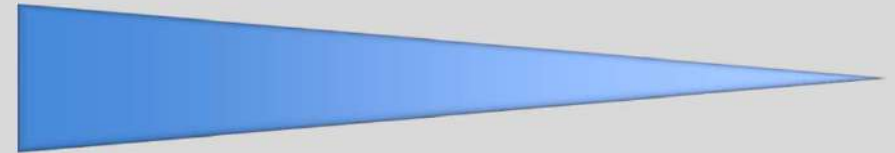
Long Term - Develop programmes for deep drilling, seismic & petrophysical acquisition to fill knowledge gaps

Partnership: Align efforts to areas with high heat demand, district heating potential or other strategic drivers (JT)

National Geothermal Database

Project Scope

Regional Geoscience ↔ Local Pilots



Outreach

What we need to understand in JT Area

Nature of the Demand (End-use)

Geology (Geothermal Reservoir)

Extraction Technology (Engineering)

People & Place (Stakeholders)

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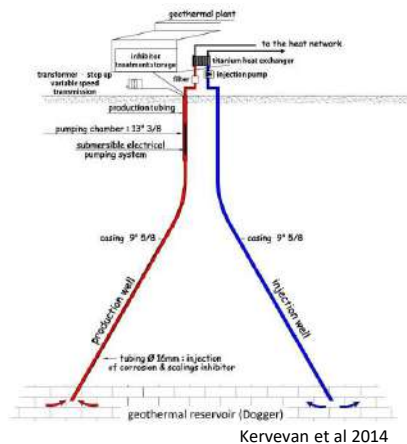
Geothermal = Geology + Technology

Shallow Systems

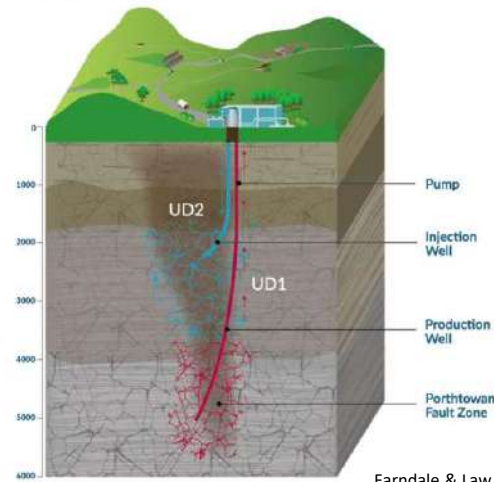
Hybrid / Large Heat Pump



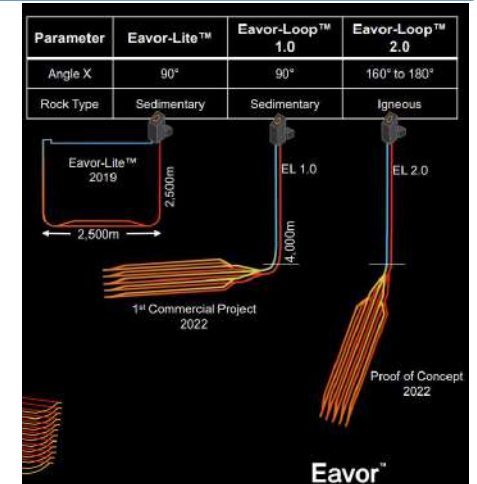
Hydrothermal (HSA) Doublets



Engineered Geothermal Systems



Advanced Geothermal Systems / DBHE



LOW ENTHALPY GEOTHERMAL EXPLORATION IS FINDING THE MOST ECONOMIC TECHNOLOGY TO DELIVER THE REQUIRED TEMPERATURE PROFILE AND HEAT LOAD

The Heat is There!

EXAMPLE SCENARIOS TO QUANTIFY

- 15°C GSHP Residential & Commercial Heat
- 30°C Direct use Horticulture | HT-GSHP Dairy Process
- 60°C Direct use District heating
- 90°C Direct use high temp food processes

National Geothermal Summit 2023

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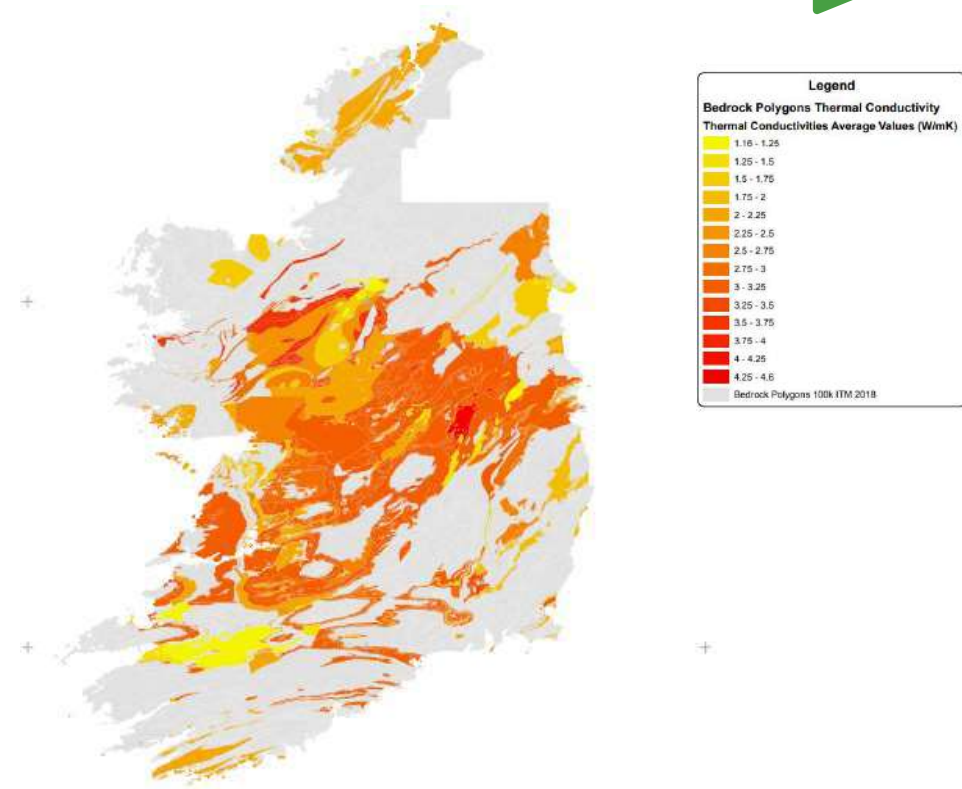
Shallow Resource Quantification

SHORT TERM

- Developing an Ireland specific approach and set of inputs
- Leverage existing thermal conductivity RANGES
- Utilise energy demand scenarios to quantify MWh potential for residential and commercial heating AND cooling

LONG TERM

- Clearly huge data gaps in Thermal Conductivity (&Temperature)
- Need for national scale petrophysical data collection program aligned with GSI operations

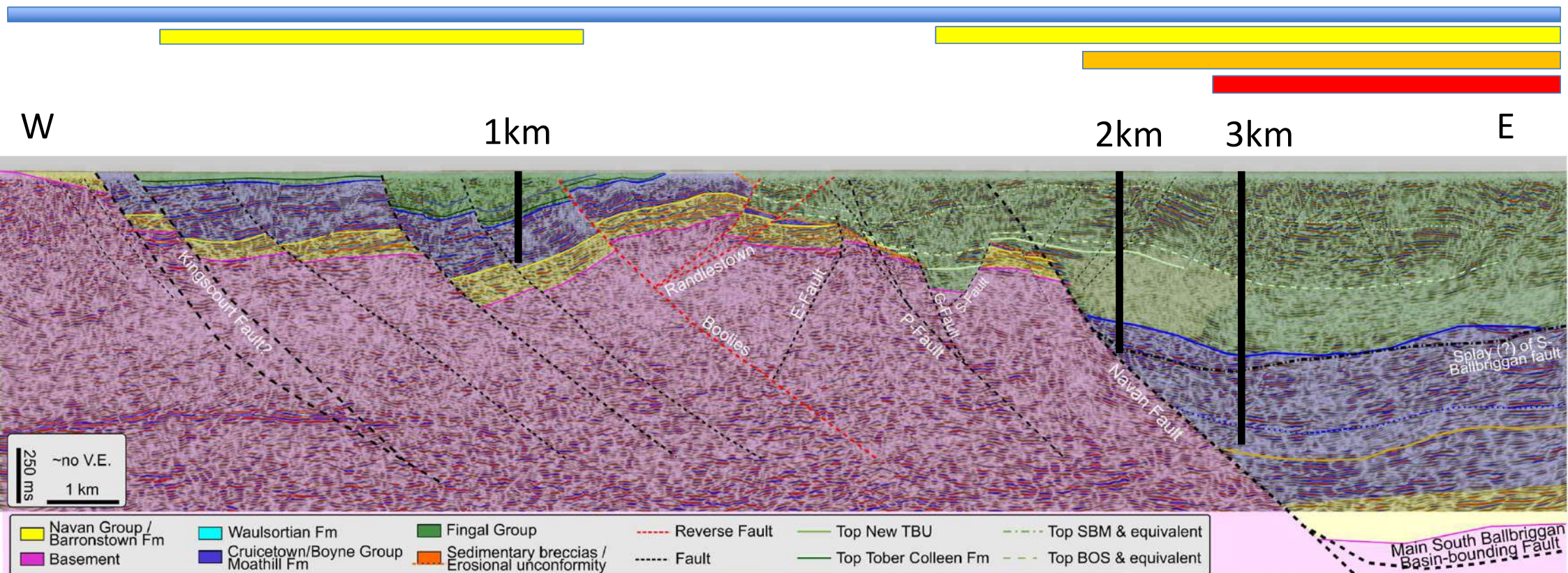


THE MORE INPUT FROM LOCAL USERS THE BETTER THE SCENARIOS & THE DATA PRIORITISATION

Seismic Screening For Deep GT Resource

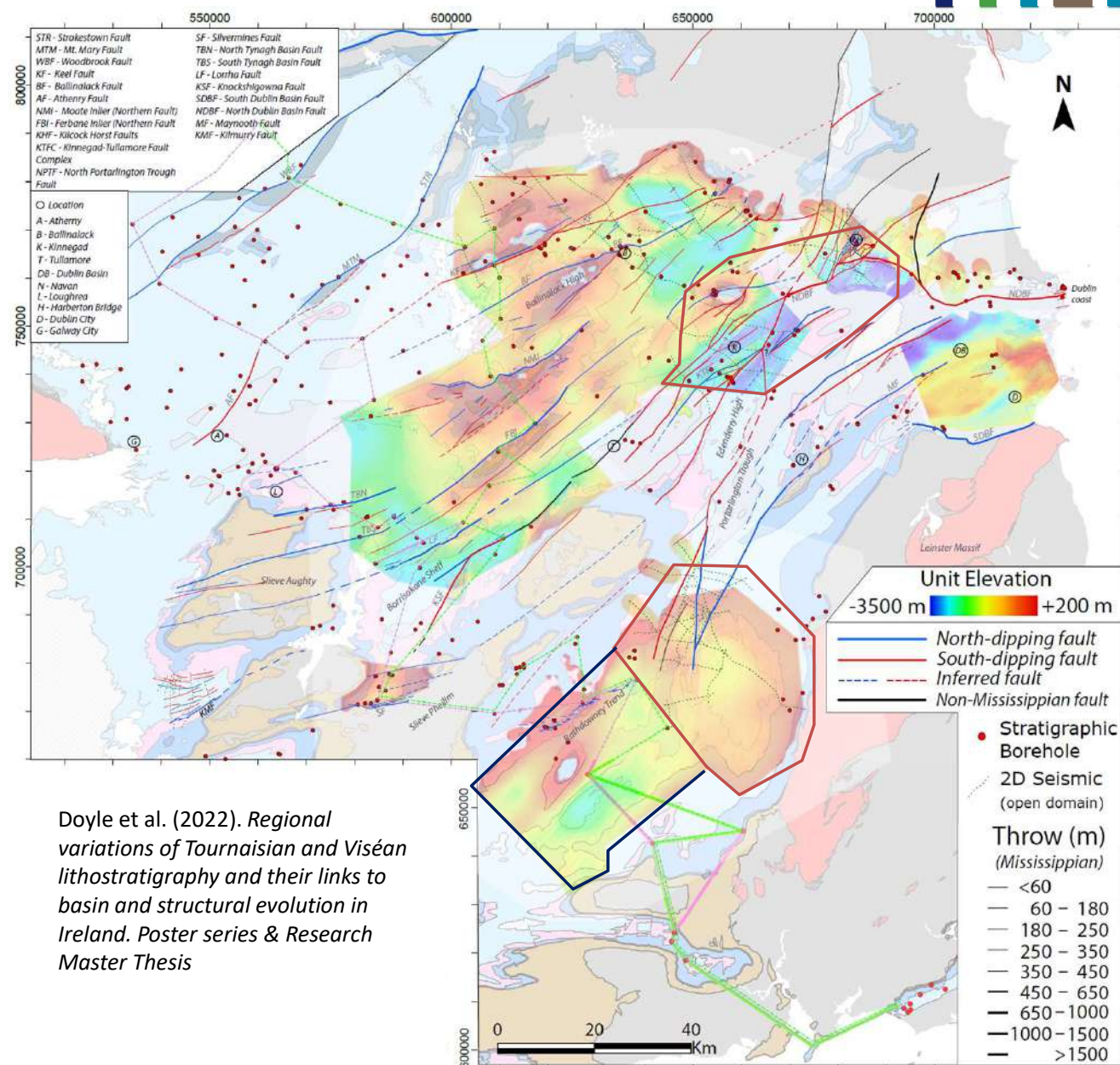


Central Midlands Into the Dublin Basin



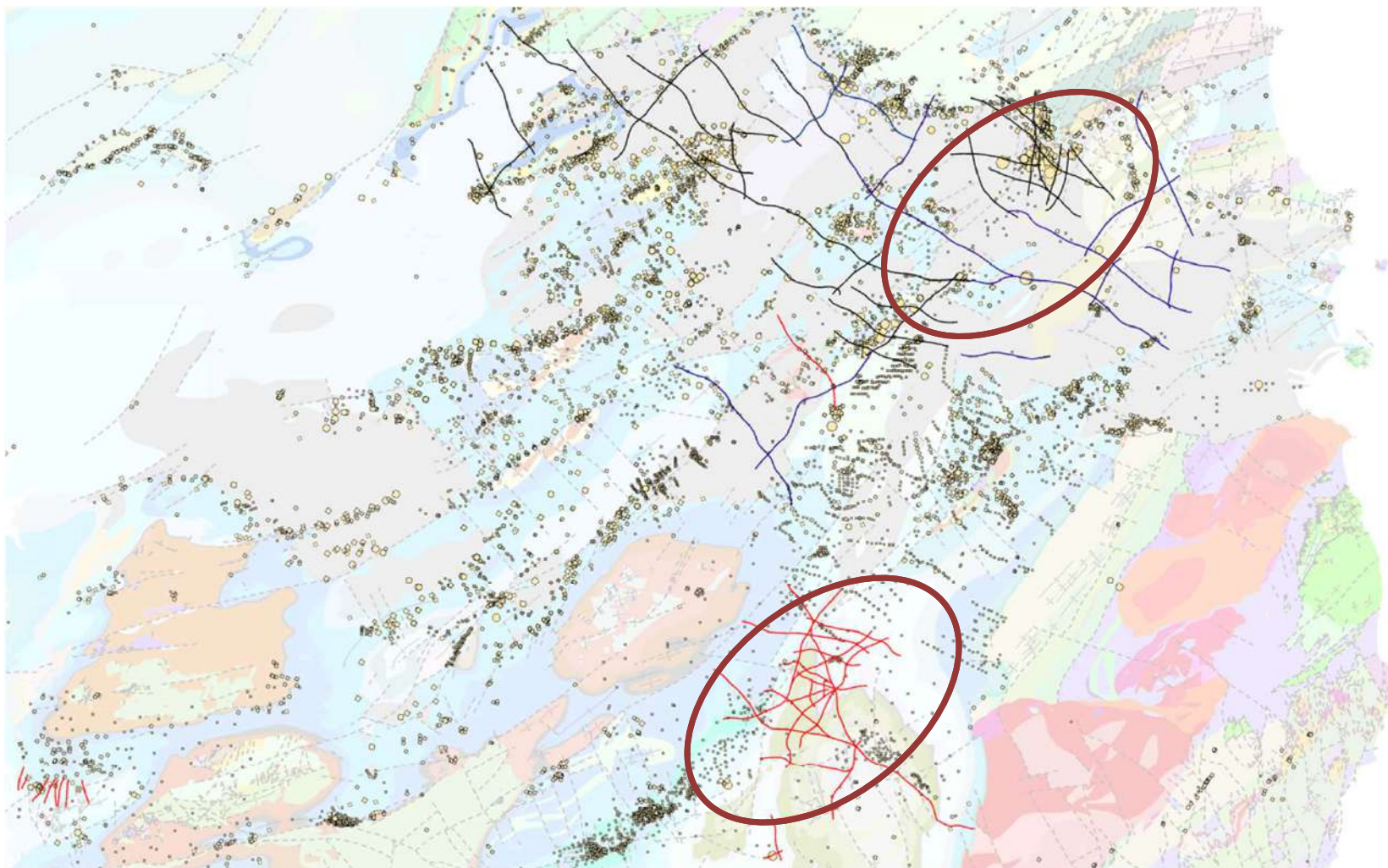
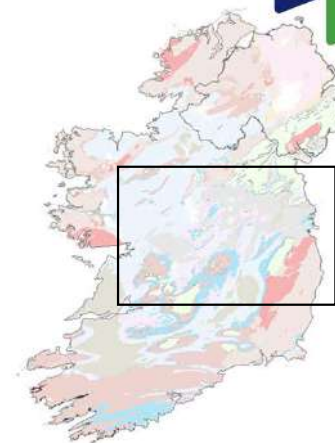
Focus Areas

- NE Area: Navan, Mullingar, Edenderry, Kinnegad, Trim
- SE Area: Kilkenny, Carlow, Portlaoise, Abbeyleix, Thurles, Athy, Castlecomer
- Higher Resolution mapping and quantification of heat
- More detailed modelling of the recovery potential
- Identify specific locations to drill and test
- Economics for End users



Doyle et al. (2022). *Regional variations of Tournaisian and Viséan lithostratigraphy and their links to basin and structural evolution in Ireland. Poster series & Research Master Thesis*

Long-Term: Large Gaps in Seismic Coverage



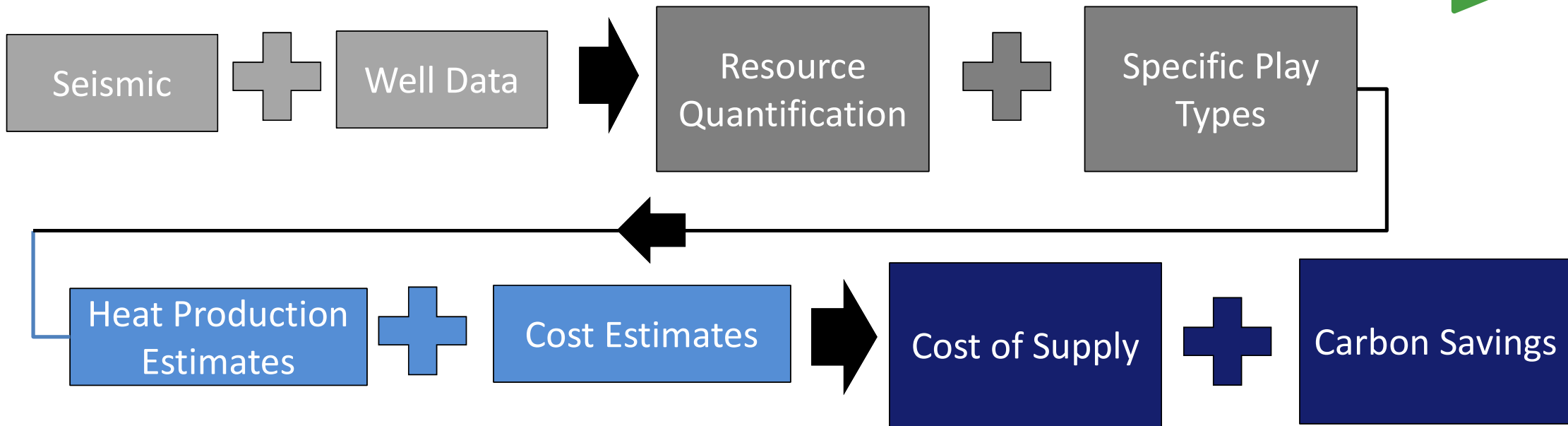
2D Reflection Seismic

- Currently Proprietary
- Available 2D Seismic
- Available 2D Seismic

Max Depth (m)	
UCD iCRAG	• 0.1
borehole database	• 630.4
Public domain	• 1,260.7
	• 1,891

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End Goal – Impactful Engagement Tool



- ❑ Preliminary resource in early 2024, final products end 2024-mid 2025
- ❑ Increased impact if local collaborations can be used to define heat economics
- ❑ Pooling of expertise across government agencies/depts will be critical



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<https://www.gsi.ie/en-ie/programmes-and-projects/geothermal>

PANEL DISCUSSION

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Elements

BY BBA // FJELDCO

ENABLING REGULATORY FRAMEWORKS FOR THE DEVELOPMENT OF GEOTHERMAL RESOURCES

OPPORTUNITIES AND INTERNATIONAL GOOD PRACTICES

National Geothermal Energy Summit
Dublin

11 October 2023

Antoine Lochet, Head of Energy law practice



- / Advice on legal issues relating to the harnessing of Natural Resources, especially geothermal.
- / Advice to governments, inter-governmental agencies and multilateral institutions such as the World Bank and UNDP, on regulatory aspects of geothermal development.
- / The firm has been involved in projects in various countries such as Iceland, France, Turkey, Djibouti, Kenya, Ethiopia, Bulgaria, Kazakhstan, the Comoros Islands, El Salvador, Indonesia.
- / In cooperation with several first-tier law firms, BBA//Fjeldco edits the Geothermal Transparency Guide, providing an overview of the geothermal regulatory framework in 17 countries. The Guide is currently being extended to new jurisdictions.

-  Resource protection and management
-  Takes into account technical specificities of geothermal resource
-  Provides for mechanisms to facilitate social acceptance
-  Attract investment

/ Key Issues to be Dealt with in the Regulatory Framework

**Scope
Definitions**

Ownership

**Sustainable
Use**

**Access to
Resource**

**Licencing
Authority**

**Permits
and Licences**

**Access to
Networks**

**Monitoring
and Surveillance**

**Cascaded
Use**

Access to Data

**Incentives and
Risk Sharing**

De-Commissioning

- / Most countries which are successfully developing their geothermal resources, have established and followed a clear and realistic policy
- / Policies need to consider both the **short-term and long-term goals** of the government in respect of exploration and exploitation of resources
- / It is critical to **understand the country's potential resources**, as well as the success or failure of existing projects
- / Collection of data and the **creation of a „geothermal atlas“** is an important aspect of establishing and maintaining a viable state policy on the use of geothermal reservoirs
- / Policies need to **take into account environmental issues and the potential impact on communities and municipalities**

Geothermal Industrial Parks: Big Scale Application of Cascaded Use

Case study



-  Two geothermal power plants in Reykjanes operated by HS Orka
 -  Svartsengi Power Plant
 -  Reykjanes Power Plant
-  The businesses in the Resource Park are held by different private entities, municipalities and individuals
-  The businesses located in the Resource Park use certain by-products from the production of electricity or direct use from geothermal reservoirs

/ The Resource Park (Svartsengi)



Blue
Lagoon
Spa

Blue Lagoon
Health Spa

Blue Lagoon
R&D

Northern Light
Inn Hotel

Blue Lagoon
5 Star Hotel

HS Orka
Power Plant
Svartsengi

Carbon
Recycling
International

Orf Genetics



/ The Resource Park (Reykjanes)



Sea Wells

HS Orka
Powerplant
Reykjavik

Stolt Sea Farm

**Precipitated Silica*

**Vertical Farming*

**Algae Farm*

Haustak

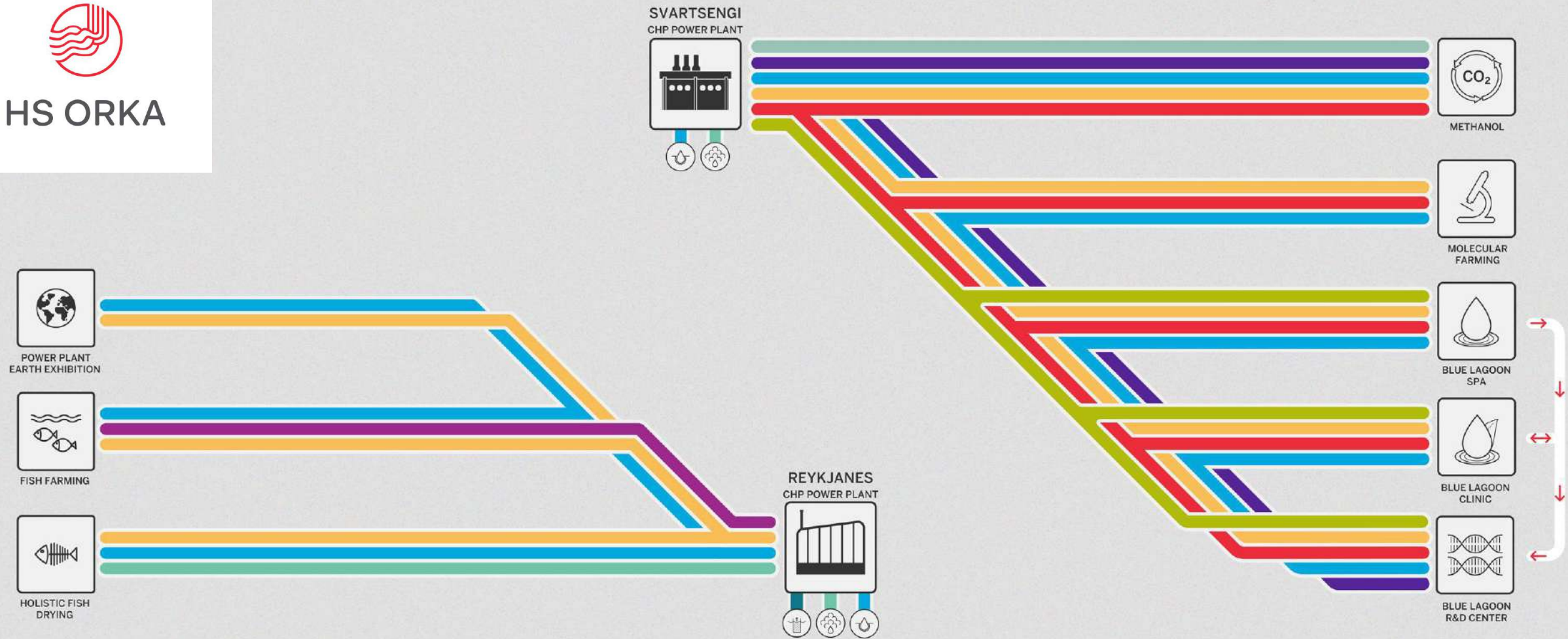
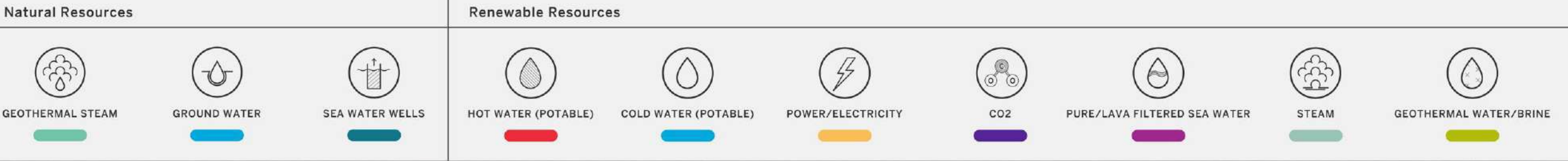
Laugafiskur

Hot Water
Production

The companies in the Resource Park
were built next to the power plants to
be able to utilize the effluent resource
streams from the plants

** potential new ventures*

-  The objective of the Resource Park is to foster a “society without waste”
-  All resource streams flowing to and from the companies in the Resource Park are:
 -  utilised to the fullest extent possible
 -  utilised in as responsible a manner as possible
 -  utilised for the benefit and progress of the community
-  Each of the companies of the Resource Park directly utilises two or more resource streams from the geothermal plants





HS ORKA

HS Orka sells
electricity to homes
and businesses
throughout Iceland

Founded 1974

Leading privately held power generator in Iceland

Owens and operates over 174 MW of geothermal power
production capacity

Owens a 10 MW hydro plant

Engages in hot water production and fresh-water
harnessing sold to a local distribution network

Engages in producing by-products in the Resource Park



HS VEITUR

Founded 2008

Receives from HS Orka:

- hot water
- cold water
- electricity

Held by municipalities and various investors

Engages in

- sale and distribution of hot water
- sale and distribution of cold water
- distribution of electricity

BLUE LAGOON

ICELAND

Founded 1992

Receives from HS Orka:

- hot water
- cold water
- geothermal seawater
- electricity
- steam;
- co2

One of the wonders of the world
(National Geographic)

The Blue Lagoon is made of excess
brine from Svartsengi Power plant

Almost 60% of all tourists that come
to Iceland visit the Blue Lagoon

Why the Resource Park?

- the brine makes the Blue Lagoon possible

Held by various local and
international shareholders

Operates:

- a retreat spa
- restaurants
- hotels
- travel services
- a psoriasis clinic
- a research and development centre

Produces:

- skin care products



Holistic Fish Processing

Complete utilization of fish products

Drying of parts of fish that were previously thrown away. With this method the product can be stored for an extended period in hot and dry regions while still containing all necessary nutrients, i.e. protein

The products are primarily shipped to Africa where, due to the ease of storage, they can be stored outside for up to 2 years without the need for cooling

Why the Resource Park?

- fresh ground water is heated up (90°C) with excess heat from Reykjanes power plant
- the heat is used for the drying process

Receive from HS Orka:

- hot water
- cold water
- electricity



Pioneer in the manufacturing of growth factors and other recombinant proteins in plants

ORF Genetics started in stem cell research but has been producing skin care products from their plants, selling all over the world

Why the Resource Park?

- by using effluent heat from the nearby Geothermal plant, less electricity is needed.

Founded 2001

Receives from HS Orka:

- hot water
- cold water
- electricity



**CARBON
RECYCLING
INTERNATIONAL**

Founded 2006

Receives from HS Orka:

- hot water
- cold water
- electricity
- CO_2
- steam

Held by various local and international entities

Produces renewable methanol from carbon dioxide, hydrogen, and electricity for energy storage, fuel applications, and efficiency enhancement

Why the Resource Park?

- electricity from the power plant is used to produce hydrogen which is an intermediate in the process
- natural CO_2 from the power plant is used as a raw material





Stolt Sea Farm

Founded 2012

Receives from HS Orka:

- cold water
- electricity
- lukewarm clean seawater

The condensers of the turbines of the geothermal plant in Reykjanes are cooled with seawater from boreholes, that has been filtered through the lava layers, resulting in pure lukewarm seawater. Creating ideal conditions for growing tropical fish

Why the Resource Park?

- by using effluent heat from the nearby geothermal plant, less electricity is needed



Matorka is a pioneer in producing environmentally friendly and sustainable seafood utilizing effluent heat from the Svartsengi power plant to regulate water temperature

Why the Resource Park?

- by using effluent heat from the nearby geothermal plant, less electricity is needed

Founded 2011

Receives from HES Orka:

- effluent heat
- electricity



- / Multiple permits for one resource
- / Clearly define the activities allowed under the permits (direct use, power generation etc.)
- / Clearly provide for the possibility to extract by-products such as minerals or CO2
- / Shared liability of the users
- / Ownership of the resource or right of use

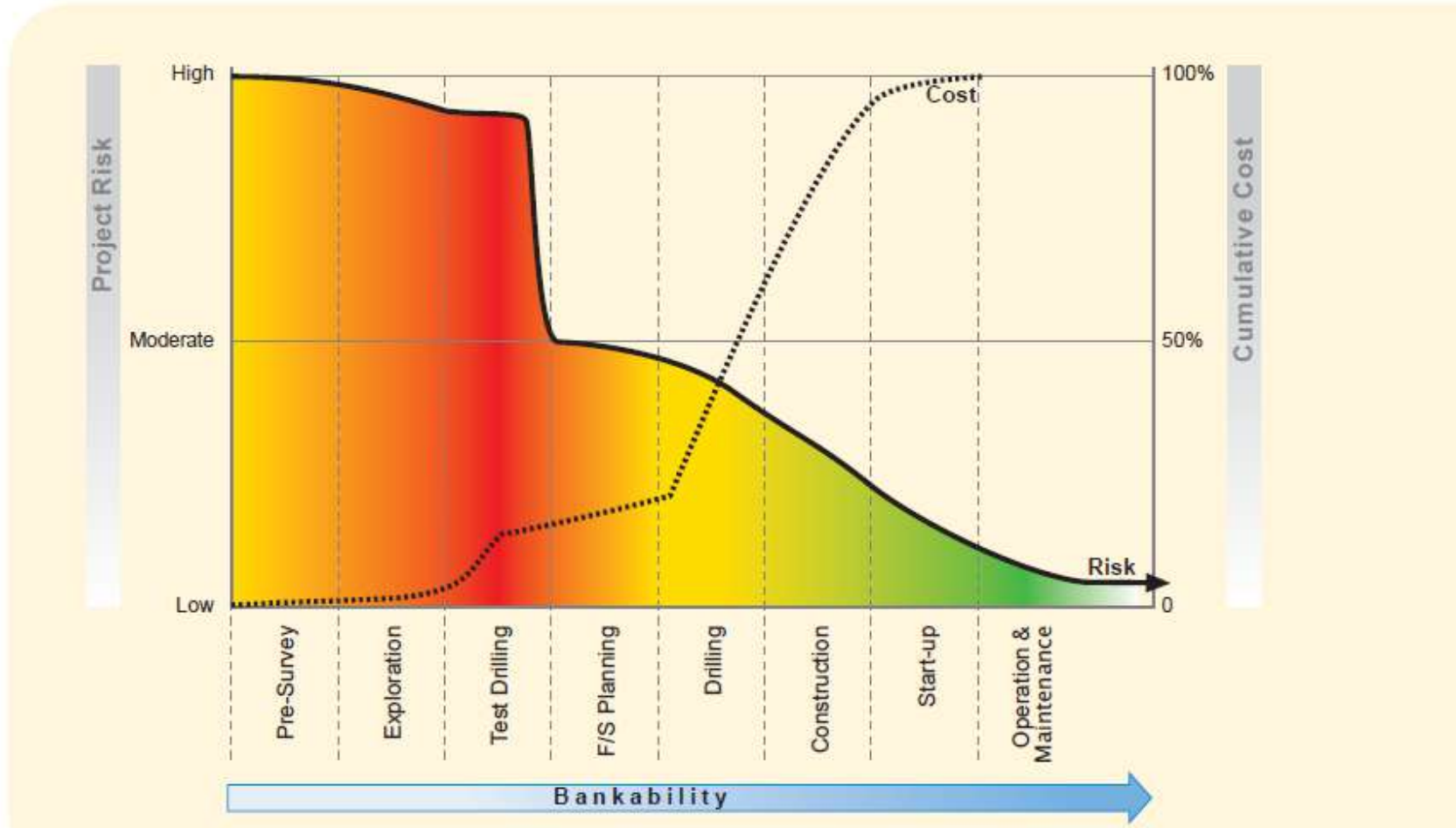
Risk mitigation schemes



Elements

BY BBA // FJELDCO

/ Risk profile and costs depending on project development phase



- / Mitigate or share risk of geothermal exploration – resource risk**

- / Examples of risk mitigation schemes**

 - / Netherlands

 - / France

 - / Turkey

- / Structure of risk mitigation schemes**

 - / public, private or hybrid financing

 - / Type of scheme: guarantee, insurance, grant, loans

 - / Risk to be covered

/ Background

- Created with the aim to increase private sector investment in exploration drilling in Turkey.
- Partial coverage of exploration drilling costs in case of unsuccessful wells.
- Capitalized with a US\$39.8 million grant from the Clean Technology Fund.
- Implementing agency : Development and Investment Bank of Turkey (TKYB).

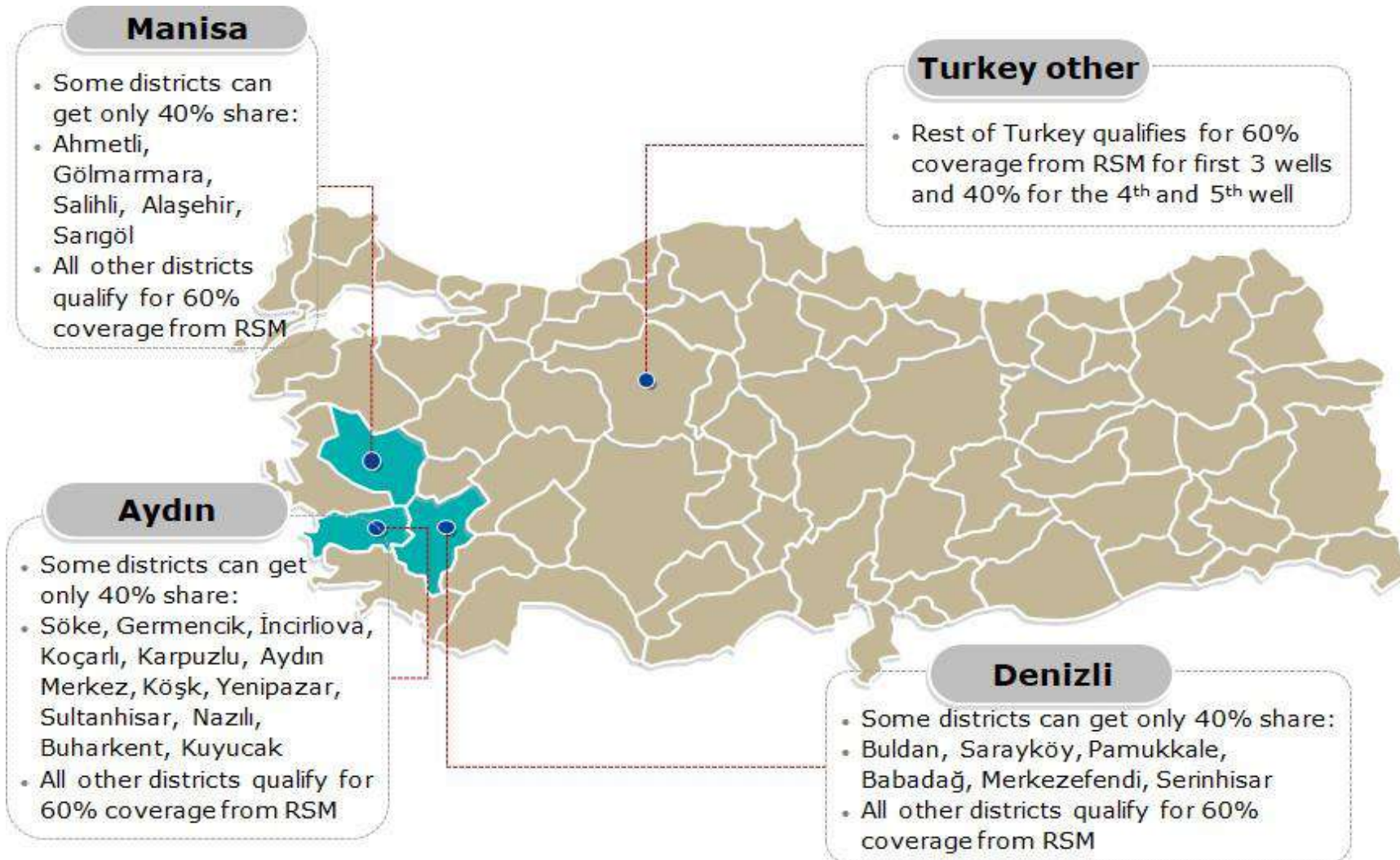
/ Supported projects

- Drilling of up to five wells in a given geothermal license area to validate the viability of power production, and/or direct use applications.
- The exploration wells to be supported by the RSM can be of production size, medium size or slim holes.

/ Mechanism

- Eligible license holders can apply.
- 60% of the cost of failed wells are covered in most of the country.
- Only 40% covered within well explored areas.
- Pay-out capped at \$4,000,000.
- Success fee guarantee of 5% of the estimated well cost is provided by the beneficiary (LoC or escrow account).
- Success fee retained if the completed well meets or exceeds the success criteria.

Case study - Turkey Geothermal Risk Sharing Mechanism





✓ **Success criteria:** Defined in gross output in MW, based on

- Enthalpy (kJ/kg);
- Flow (kg/s);
- WHP - Well head pressure;
- Drawdown;
- Temperature in slim holes.

CONTACT US

REYKJAVÍK

Katrínartún 2
19 Floor
105 Reykjavík
Iceland
Tel: +354 550 0500
Fax: +354 550 0505
Acc: accounting@bbafjeldco.is
Legal services: bbafjeldco@bbafjeldco.is
Applications: umsokn@bbafjeldco.is

LONDON

Berkeley Square House
London
W1J 6BD
UK
Tel + 44 (0) 7595 057 460
E-mail: bbafjeldco@bbafjeldco.is
Applications: gunnar@bbafjeldco.is

