HARNESSING A HOT DRY ROCK GEOTHERMAL RESERVOIR WITH BINARY TECHNOLOGY: United Downs, First Integrated Deep Geothermal Project in the UK

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EXERGY

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WHO WE ARE

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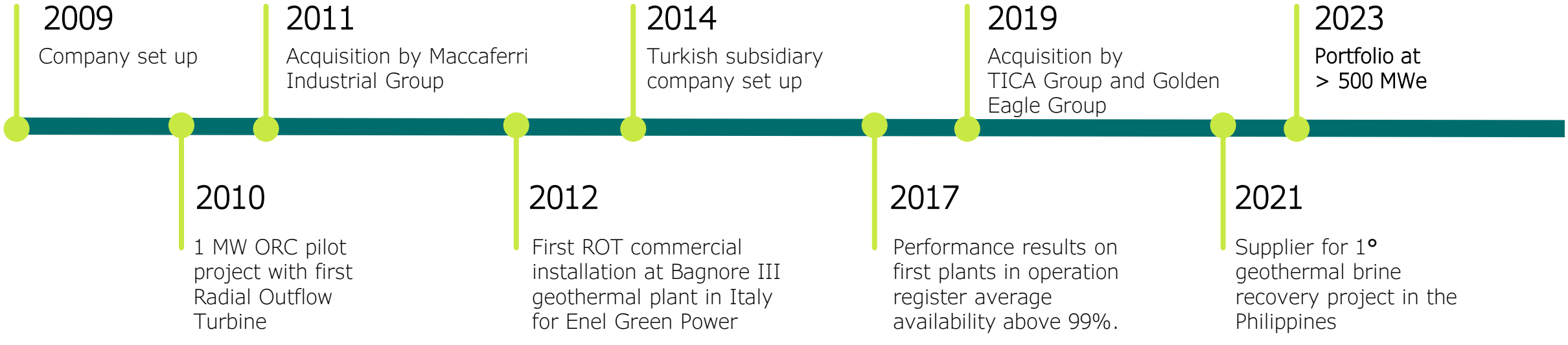
WHO WE ARE

- Organic Rankine Cycles are clean energy systems to exploit **low-medium temperature** heat sources
- The first developer of the Radial Outflow Turbine technology for ORC's market
- The second ORC supplier in the world for geothermal application with more than 500 MWe in portfolio in about 12 years



geothermal

KIND OF GEOTHERMAL RESOURCES

- steam only
- mixed steam and brine
- brine only

RANGE OF PLANT CONFIGURATION

- ORC only
- ORC bottoming of steam turbine
- well-head generators

SITE	CUSTOMER	OPERATION YEAR	TEMPERATURE	OUTPUT GROSS	AVAILABILITY
Saraykoy 5	Greeneco Enerji	2019	170°C	28 MW	99.6 %
Saraykoy 4	Greeneco Enerji	2018	150°C	12 MW	99.0 %
Kuyucak	Turcas	2017	155°C	18 MW	99.0 %
Kubilay	Bestepeler Enerji	2016	139°C	27 MW	99.3 %
Karkey-Umurlu 2	Karadeniz Holding	2016	145°C	12 MW	99.8 %
Mehmet Han	Kipas Holding	2016	160°C	25 MW	99.9 %
Ken Kipas	Kipas Holding	2016	172°C	25 MW	99.6 %
Karkey-Umurlu I	Karadeniz Holding	2015	145°C	12 MW	99.3 %
Saraykoy 1	Greeneco Enerji	2015	135°C	12 MW	99.3 %
Denizli - Tosunlar	Akca Enerji	2014	105°C	3.5 MW	99.8 %
Bagnore	Enel Green Power	2012	150°C	1 MW	99.3 %

ENHANCED GEOTHERMAL SYSTEM

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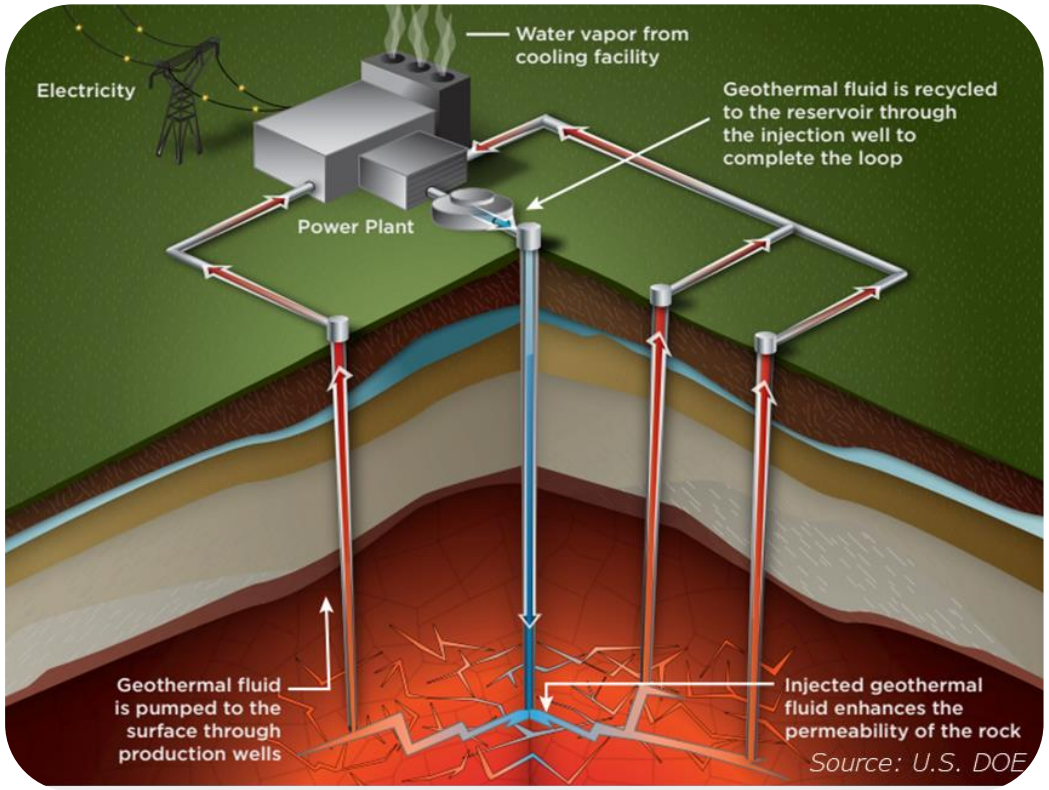
EGS GEOTHERMAL

› Enhanced Geothermal System allows the extraction of thermal energy in regions characterized by thermal anomaly but with low water flow available. This improve the development of geothermal energy in regions previously considered unsuitable

› Closed-loop binary cycle technology is the way to use this potential. This means **negligible greenhouse gas emission**

› This results in a **Baseload Energy Supply** ensuring a consistent and stable power without significant intermittency



UNITED DOWNS DEEP GEOTHERMAL PROJECT

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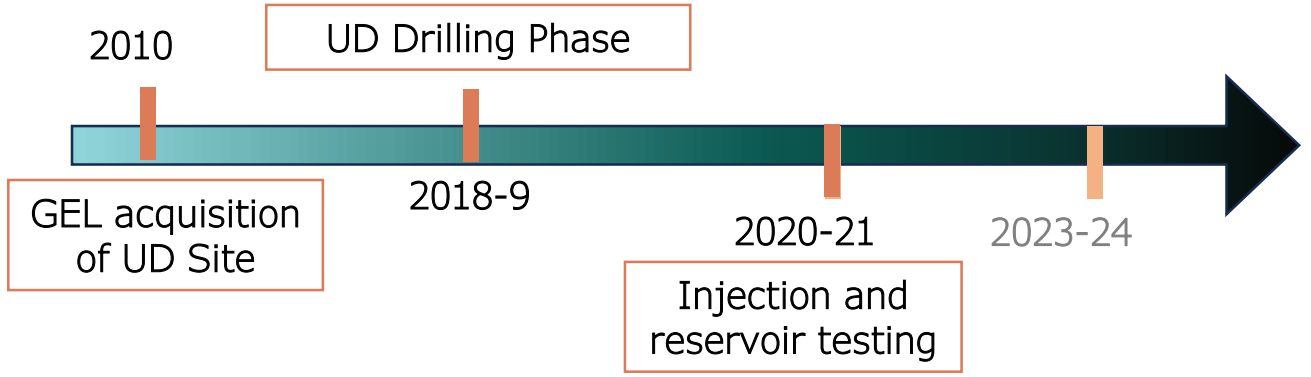
UNITED DOWNS DEEP GEOTHERMAL POWER PROJECT

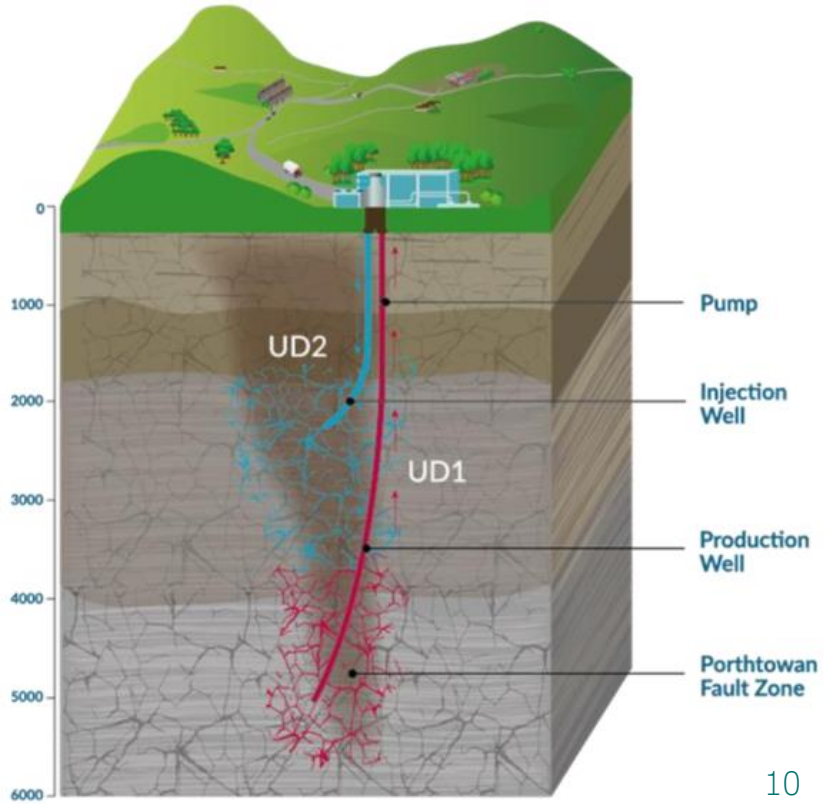
drilling phase

- GEL acquired the site of United Downs in 2010



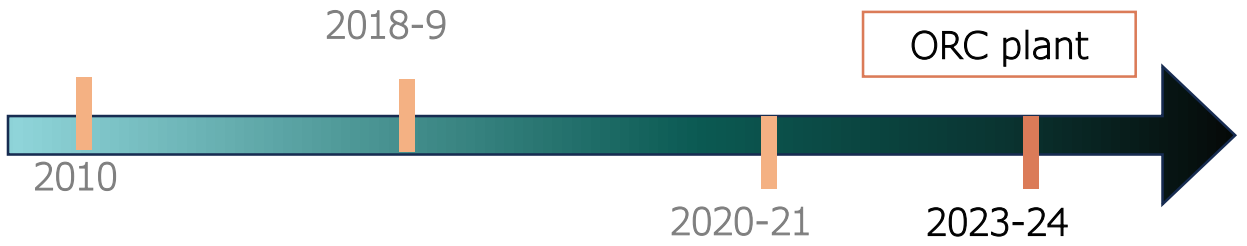
- Two directional wells has been drilled in 2018-2019:
  - Production well (UD-1): 5,275 m MD
  - Injection well (UD-2): 2,393 m MD
  - Production well and injection well in have been put in different position in order to increase water recovery and avoid long-term problems in temperature performance
  - There is a downhole pump in production well to create a pressure sink and increase water recovery

- Drilling and reservoir tests performed in 2020-2021:
  - Injection testing was performed to characterized the granite and improve of injectivity and productivity of the reservoir using hydraulic stimulation.
  - Map the growth of the reservoir during stimulation
  - 7-day reservoir testing to simulate power plant operation



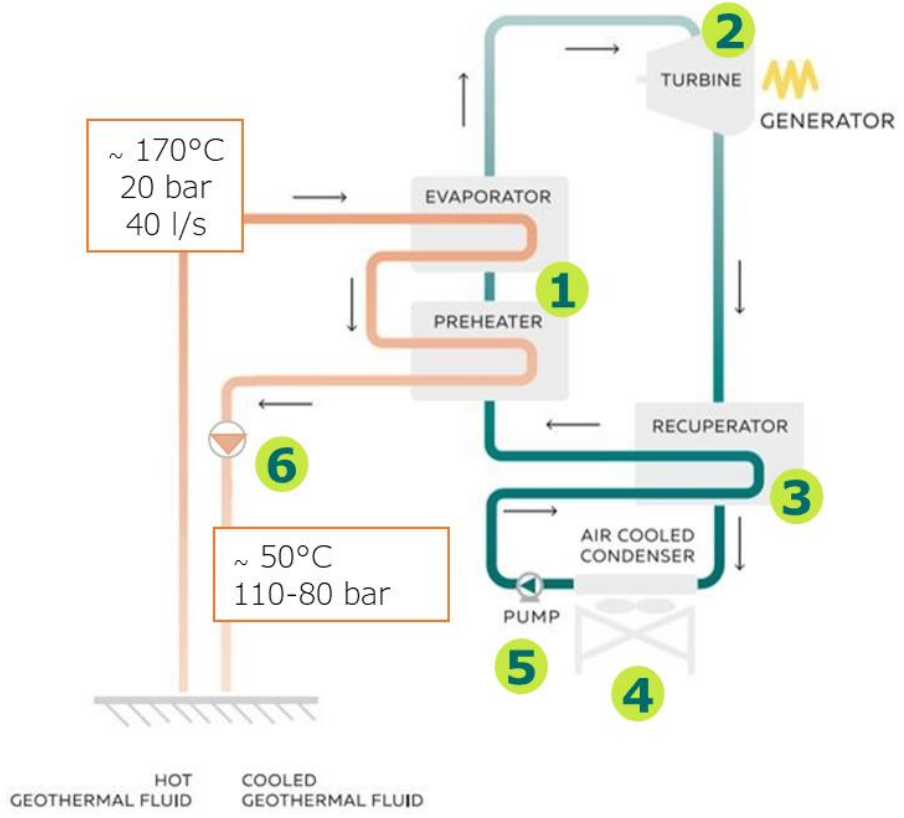
ORC plant

› Exergy was contracted to design and build the binary ORC power plant 2023-2024



Conceptual process flow diagram of ORC plant

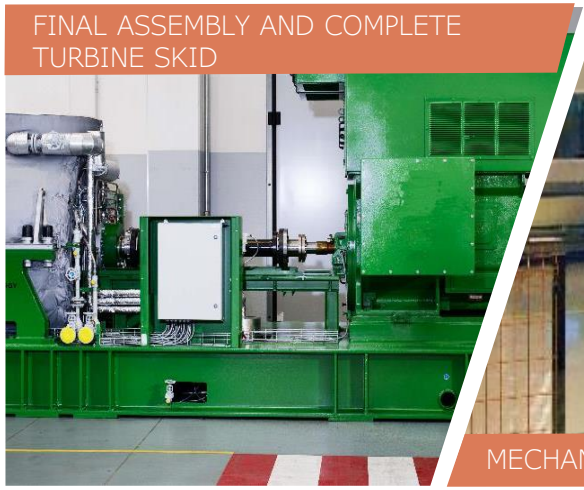
1. Organic fluid warms up in the preheater, vaporizes in the evaporator and superheated
2. Vapour expands in the turbine producing power at the generator
3. Recuperator exchanges heat between the vapour to preheat the fluid
4. A condenser releases the waste heat and turns the organic fluid back into a liquid
5. The pump gives the pressure needed for the cycle
6. After heat exchange in the hot exchangers the brine is completely reinjected minimizing plant emissions



Exergy's technology

- **Conceptualized by Exergy**, the Radial Outflow Turbine (ROT) is unique in the ORC marketplace

- **In-House** developing, engineering, manufacturing and testing of the turbine



FINAL ASSEMBLY AND COMPLETE TURBINE SKID

MECHANICAL GROUP TEST AND RUN-IN BED

QUALITY CONTROL, TOLERANCE CHECK

BALANCING AND SPIN TEST MACHINE

Exergy's technology

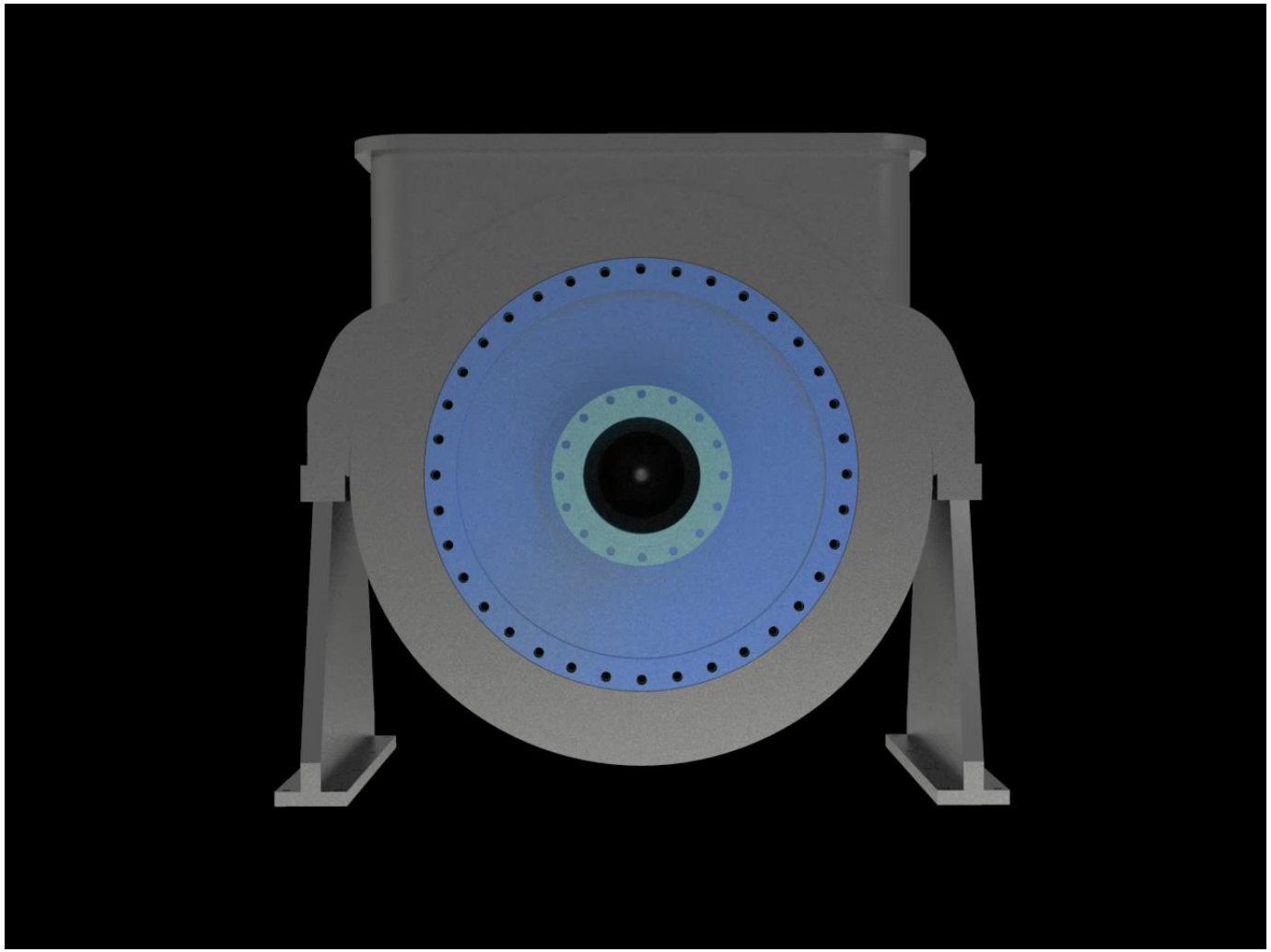
- **Radial development of the stages**
  means perfect match between volumetric flow and cross section

- **Higher number of stages (9+)**
  means higher isentropic efficiency and better off-design performance

- **Low speed (1500/3000 rpm) means** low noise and vibrations

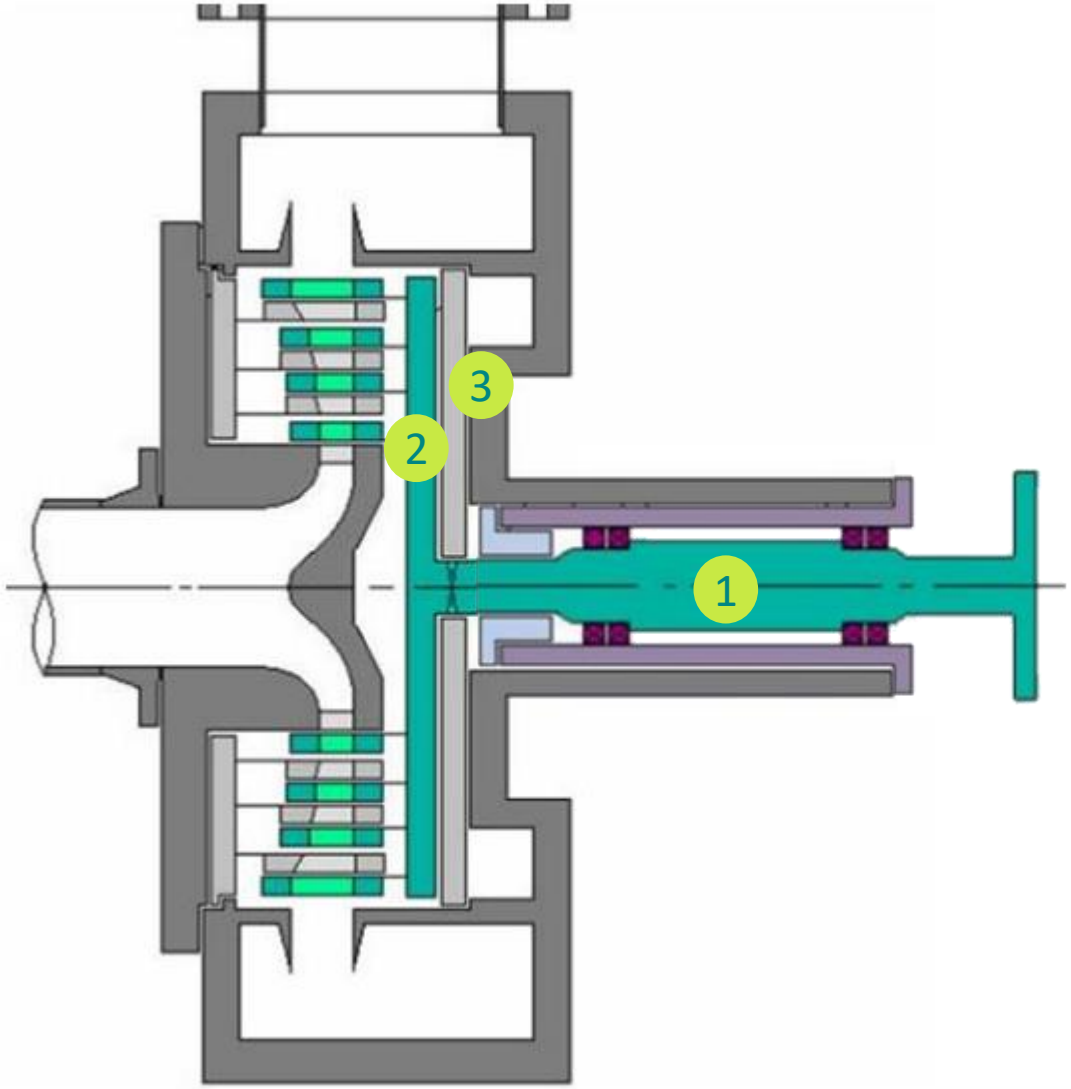
- **Single-disk, overhung configuration**
  enhanced components accessibility
  possibility for multiple admissions/extractions on one disk

- **Built-in mechanical group extraction**
  reduced downtimes



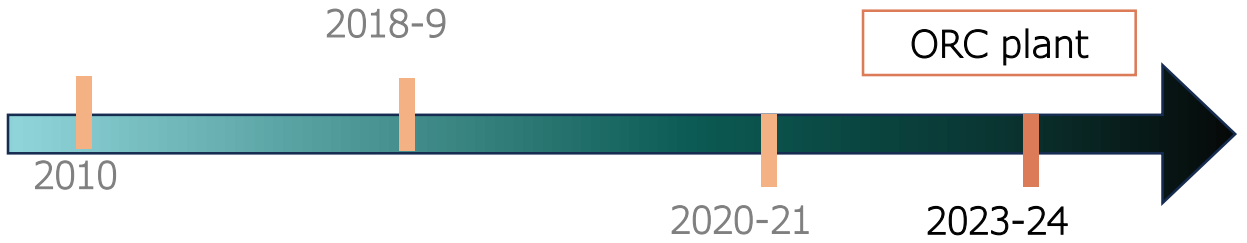
Exergy's technology

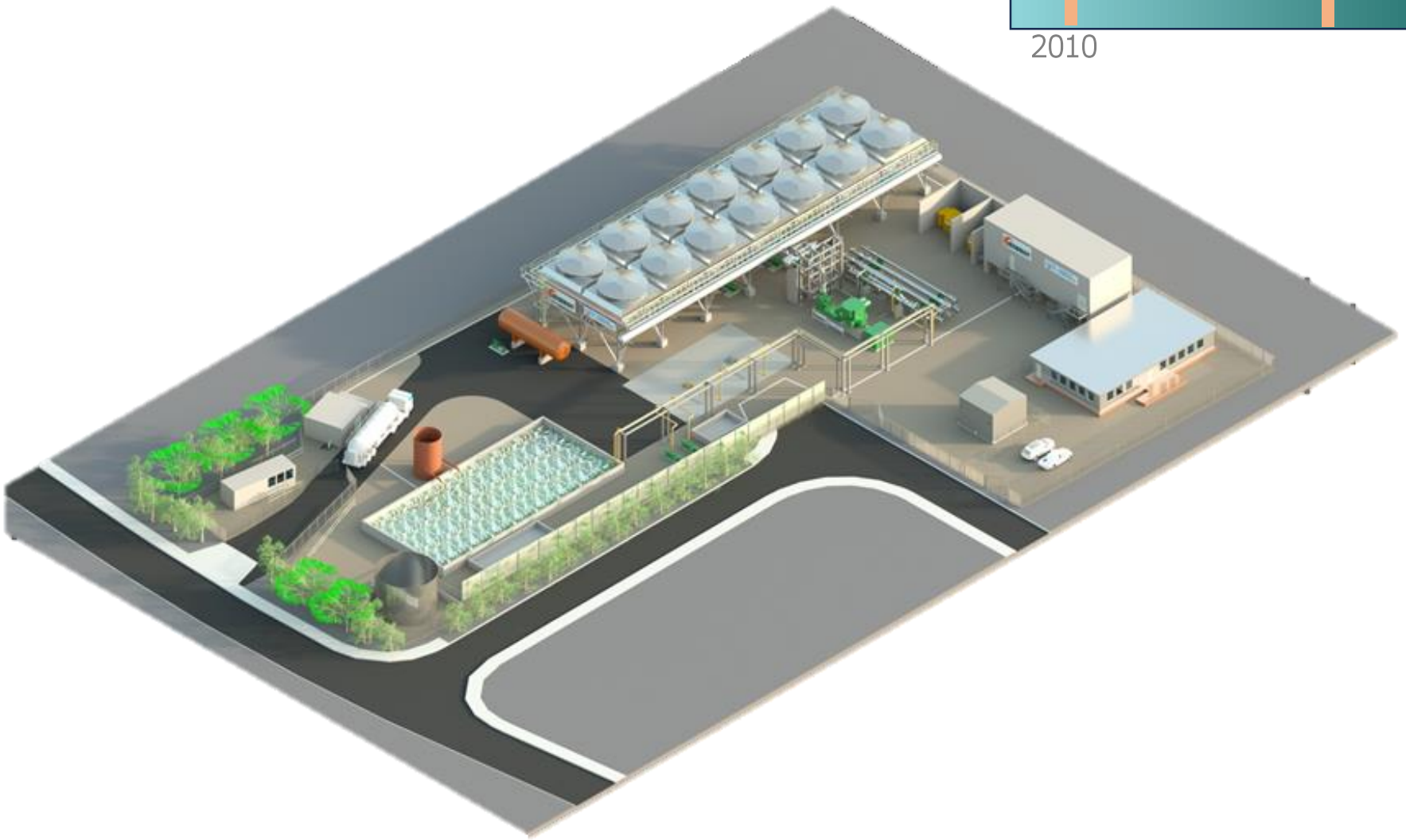
- Patented technology allows to remove the mechanical group without any fluid drainage or loss.
- The built-in mechanical group 1 can be extracted to facilitate and maintain a longer life of the bearings.
- The rotor disk 2, by adhering to the casing 3 allows the extraction of the mechanical group avoiding the working fluid to leak.
- The entire maintenance operation can be completed in about 1 day.



UNITED DOWNS DEEP GEOTHERMAL POWER PROJECT

ORC plant





› The system will be delivered in 18 months, with start-up expected in 2024

› Once in operation, this installation will save around 6,500 tons of CO2 emissions per year compared to an equal production of conventional fossil fuel power generation

REFERENCES

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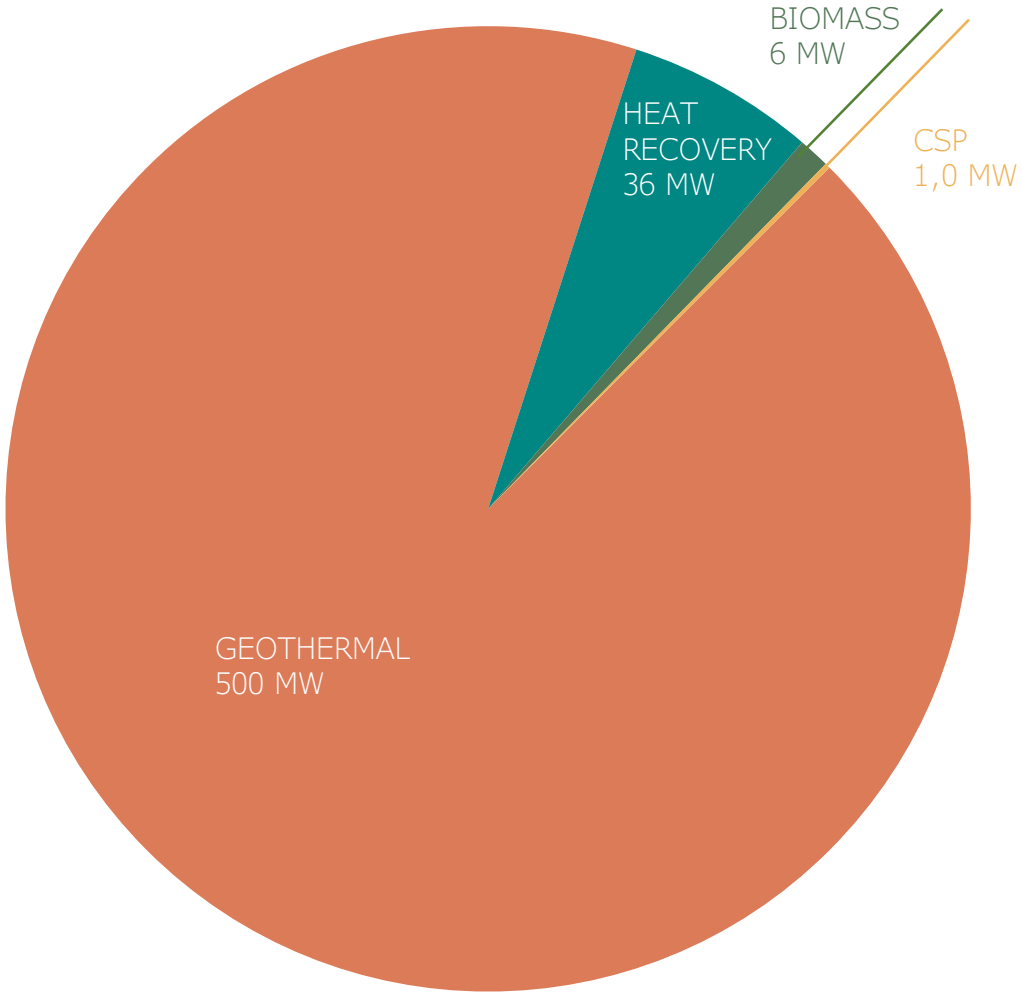
REFERENCES

APPLICATION	MW
GEOTHERMAL	500
HEAT RECOVERY	36
BIOMASS	6
CSP	1
TOTAL	571



EDC/MINDANAO 3,THE PHILIPPINES/3,6 MWe

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GREENECO ENERJI/SARAYKÖY 6, TURKEY/28 MWe

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BEŞTEPELER ENERJI/KUBILAY 1,TURKEY/24 MWe

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EDA RENOVAVEIS/PICO ALTO,AZORES/4 MWe

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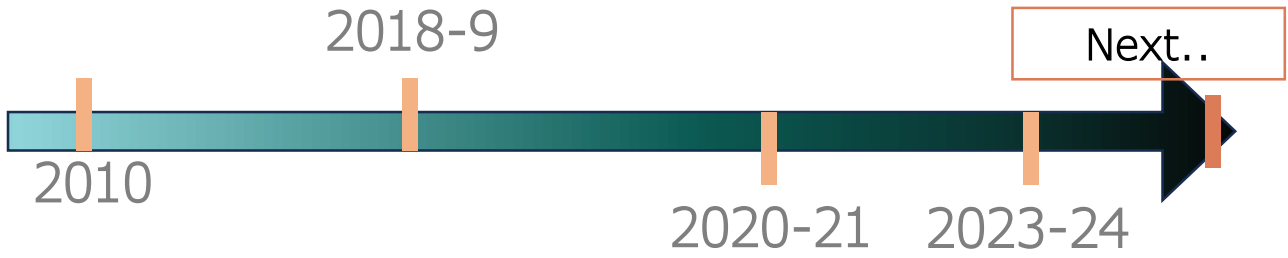
Further step



› The demand for lithium is projected to increase significantly further by 2050

The traditional method of extracting lithium from continental brine deposits involves open air evaporation, which concentrates the brine but results in the loss of large volumes of water. This evaporation-based process raises concerns about its overall sustainability.

› The new approach, called direct lithium extraction (DLE), encompasses various technologies, including thermal and electrochemical processes. DLE technologies have overcome many limitations of conventional lithium extraction, particularly in terms of water usage.

› In addition to this, a part of the available heat is allocated to heat generation (e.g. district heating)

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